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STUDY ON A MECHANISM WITH A THREE-SLIDING TRIAD, USED TO SCISSORS

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Abstract: It is being studied the kinematics of a mechanism which has triad with links, one outdoor and three indoor. We adopt a range of sizes for the mechanism, we write the relations for positions and we determine the successive positions. It appears that the mechanism satisfies the conditions imposed by technology, meaning the press cuts out, on the fly, with this mechanism, a metallic or non-metallic strip of material. They are written the relations for speed and acceleration. They are determined the charts of positions, velocities and acceleration. The calculations and the charts confirm the proper functioning of the mechanism.

1. Introduction

They are known many mechanisms used in different types of mechanical scissors. In [1] is also indicated the mechanism of fig. 1, which has two conductive elements 1 and 1' and 2 and 3 links are solidarity with H and H' knives. We decided to study further the possibilities of this mechanism. In [2] is being studied the kinematics of a mechanism with triad, and in [3] are established the triad aspects, by kinematics.

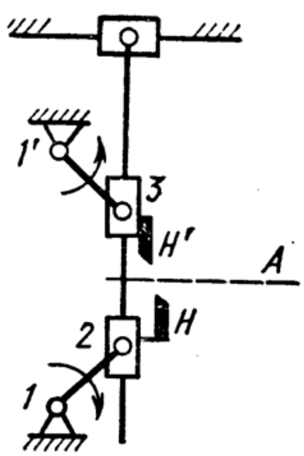

Fig. 1. Mechanism for scissors

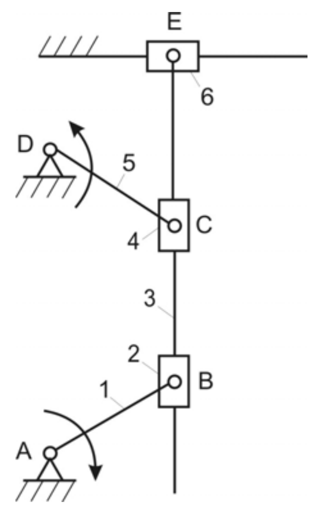

Fig. 2. Kinematic Scheme

2. The mechanism structure

The kinematic scheme of the mechanism, which is required for structural analysis, is given in fig. 2. The mechanism has 6 movable elements and 8 joints of fifth grade, so the degree of mobility is M = 2, the conductive elements are 1 and 5. In fig. 3 is shown the structural scheme and in fig. 4 is given the decomposition in kinematics groups. It appears that the mechanism is composed of two cranks, 1 and 5, and a triad of 3rd order, which has an outer and two inner flies, which is a rare triad.

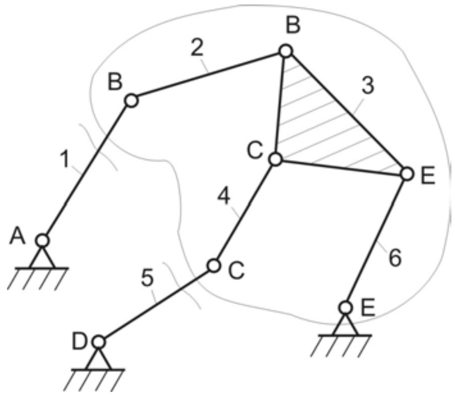

Fig. 3. The structural scheme

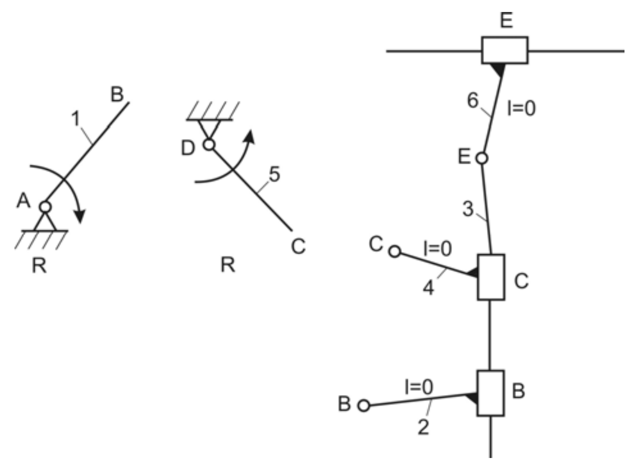

Fig. 4. R + R + Triad

3. The positions analysis

Based on the notations of fig. 5, are written the relations:

$$x_B = a\cos\varphi \; ; \; y_B = a\sin\varphi \tag{1}$$

$$x_C = b\cos\psi \; ; \; y_C = y_D + b\sin\psi \tag{2}$$

$$S_6 = x_B = x_C \; ; \; S_2 = y_E - y_B \; ; \; S_4 = y_E - y_C \; ; \; S = S_2 - S_4 \tag{3}$$

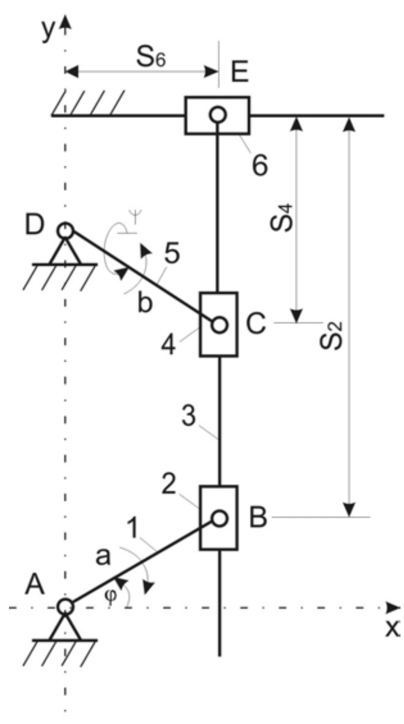

Fig. 5. The scheme for computing

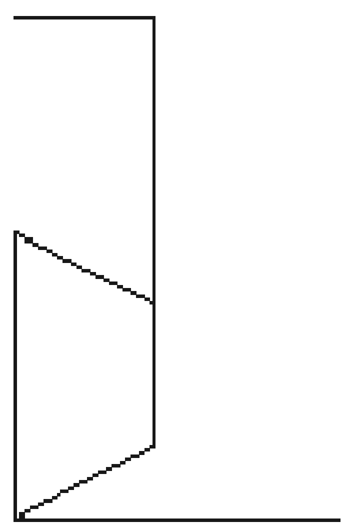

Fig. 6. The modeled position of the mechanism

Figure 6 shows the mechanism position, shaped with these relations, similar to that of figure 5.

Were adopted as mechanism dimensions the following: a = b = 0.1 m, 0.2 m y_D=, y_E=0.35 m, n = 120 rpm, considering the fine mechanics domain. The movements of the two cranks are connected as follows: $\varphi = -\psi$.

Successive positions of the mechanism are given in figure 7. Observe the symmetry positions of the cutter contact area, detailed in Fig. 8 and 9 (ψ = 180 ... 330).

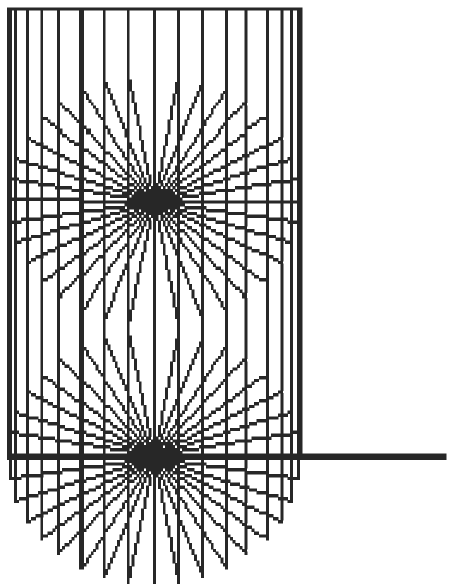

Fig. 7. Successive positions of the mechanism

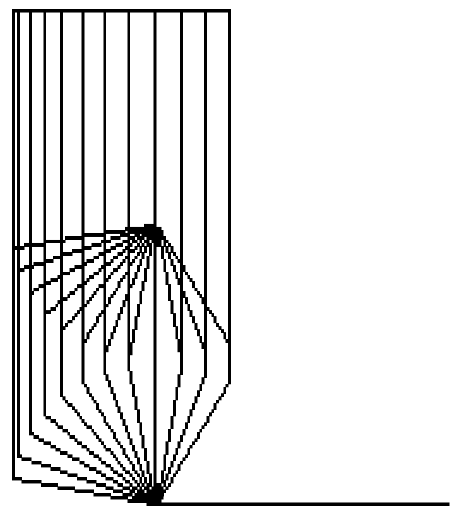

Fig. 8. Positions for the contact area

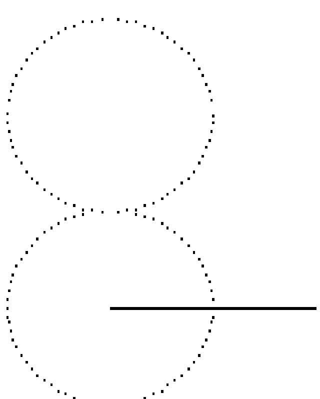

Fig. 9. The circles described by C and B

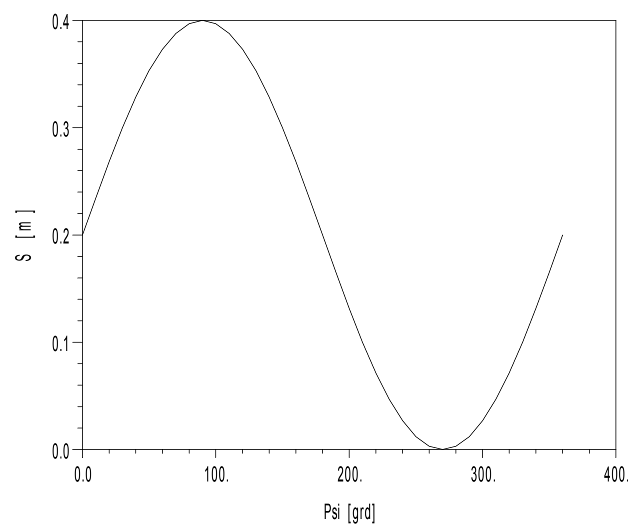

Fig. 10. S(ψ) law

Changes in race S, meaning in the distance between the two cutters, is given in fig. 10. From fig.1 and 10 we observe that are two links that do not touch, but peaks of H and H ' cutters reach the same order, when ψ = 270 degrees. Starting from ψ = 0, H' cutter climbs, reaching a maximum at ψ=90, then down to ψ= 270 and climbs back up to ψ= 0. Shearing occurs when rotating cutters, just heading ψ= 270 degrees, moment at which useful forces are maximum.

In figure 11 we see the ordinates variation of C and B points in relation to time. Is observed as one increases and the other decreases, symmetrical, being tangent to ψ= 270 degrees, meaning at t = 0.1 seconds (Table 1). Table 1 gives these values for the interest area, ascertaining the symmetrical variation of the two ordered. It thus appears that the mechanism satisfies the imposed conditions.

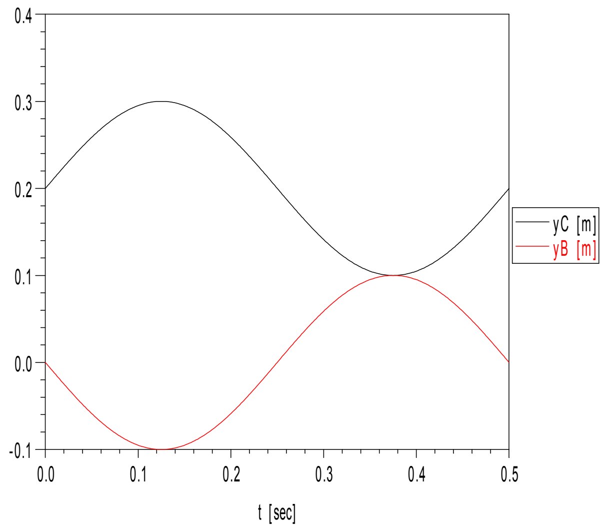

Fig. 11. Ordinates variations of C and B points

Table 1

Psi	t	yC	YB
260	.3611111	.1015193	9.848072E-02
261	.3625	.1012312	9.876879E-02
262	.3638889	.1009732	9.902676E-02
263	.3652778	.1007454	9.925457E-02
264	.3666667	.1005478	9.945216E-02
265	.3680556	.1003806	9.961944E-02
266	.3694444	.1002436	9.975638E-02
267	.3708333	.1001371	9.986293E-02
268	.3722222	.1000609	9.993908E-02
269	.3736111	.1000152	9.998476E-02
270	.375	.1	.1
271	.3763889	.1000152	9.998478E-02
272	.3777778	.1000609	9.993911E-02
273	.3791667	.100137	9.986298E-02
274	.3805556	.1002436	9.975644E-02
275	.3819445	.1003805	.0996195
276	.3833333	.1005478	9.945224E-02
277	.3847222	.1007454	9.925465E-02
278	.3861111	.1009731	9.902686E-02
279	.3875	.1012311	.0987689
280	.3888889	.1015192	9.848084E-02

The t (ψ) correlation and race variations are given in fig. 12. S_6 curve shows that E point (fig. 2) goes to the left, exceeds y axis, reaches a minimum at ψ=180 degrees, then returns to the right, exceeds y-axis and reach its original position.

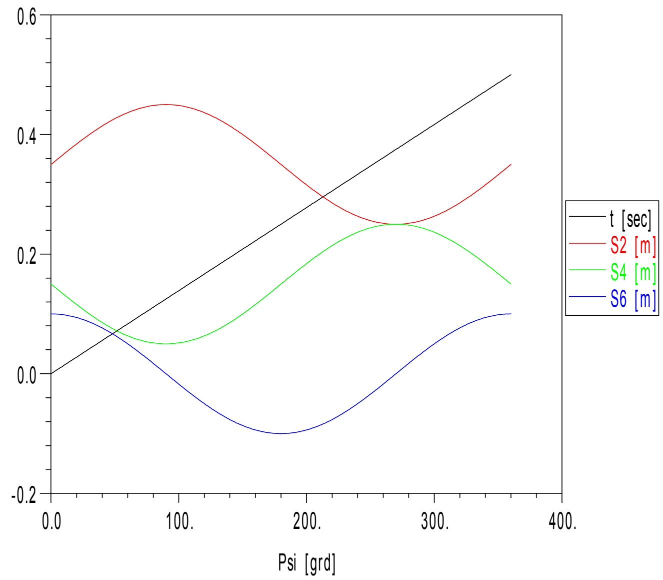

Fig. 12. Races variations

4. Speeds and accelerations

It derivates twice with respect to time, the relations from positions, resulting in:

$$\dot{x}_B = -a\sin\varphi\cdot\dot{\varphi}\ ;\ \dot{y}_B = a\cos\varphi\cdot\dot{\varphi} \tag{4}$$

$$\dot{x}_C = -b\sin\psi\cdot\dot{\psi}\ ;\ \dot{y}_C = b\cos\psi\cdot\dot{\psi} \tag{5}$$

$$\dot{S}_6 = \dot{x}_B = \dot{x}_C\ ;\ \dot{S}_2 = -\dot{y}_B\ ;\ \dot{S}_4 = -\dot{y}_C\ ;\ \dot{S} = \dot{S}_2 - \dot{S}_4 \tag{6}$$

$$\ddot{x}_B = -a\cos\varphi\cdot\dot{\varphi}^2 - a\sin\varphi\cdot\ddot{\varphi}\ ;\ \ddot{y}_B = -a\sin\varphi\cdot\dot{\varphi}^2 + a\cos\varphi\cdot\ddot{\varphi} \tag{7}$$

$$\ddot{x}_C = -b\cos\psi\cdot\dot{\psi}^2 - b\sin\psi\cdot\ddot{\psi}\ ;\ \ddot{y}_C = -b\sin\psi\cdot\dot{\psi}^2 + b\cos\psi\cdot\ddot{\psi} \tag{8}$$

$$\ddot{S}_6 = \ddot{x}_B = \ddot{x}_C\ ;\ \ddot{S}_2 = -\ddot{y}_B;\ \ddot{S}_4 = -\ddot{y}_C\ ;\ \ddot{S} = \ddot{S}_2 - \ddot{S}_4 \tag{9}$$

From figure 13 are observed the symmetrical variations of the points C and B vertical components velocity, with zero values at ψ=90 and 270 degrees, and also the variation of E speed.

In figure 14 were given the variations of S, S ', S'' parameters with time t. For reasons of scale, it was represented 50 * S. The curves are sinusoids and cosine, so they have symmetries and thus are kinematics correlated.

The accelerations variations are given in figure 15, the curves are all trigonometrics, with symmetries. y_B'' and y_C'' have opposite values at ψ=90 and 270 and are zero at ψ= 0, 180, 360 degrees.

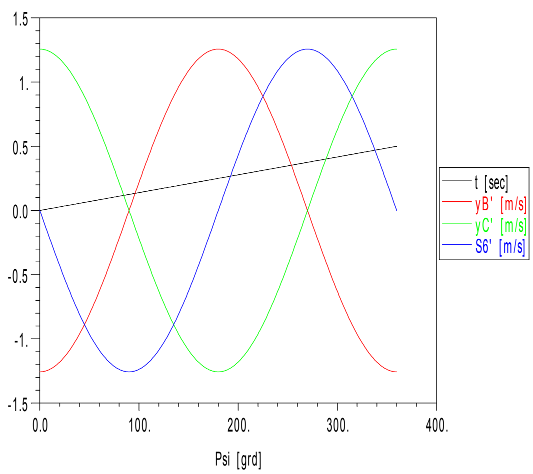

Fig. 13. Velocity variations

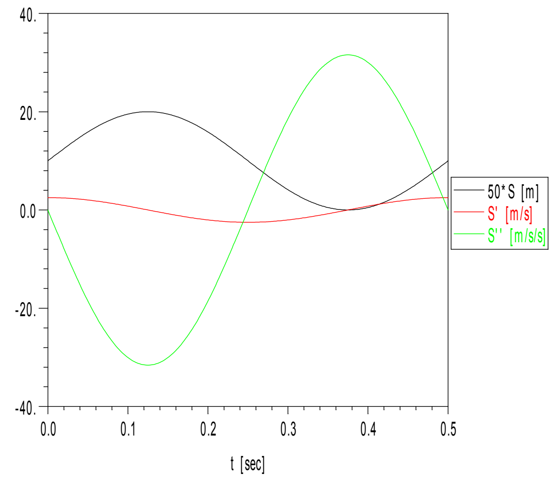

Fig. 14 The variation S=BC, S', S'' with t time

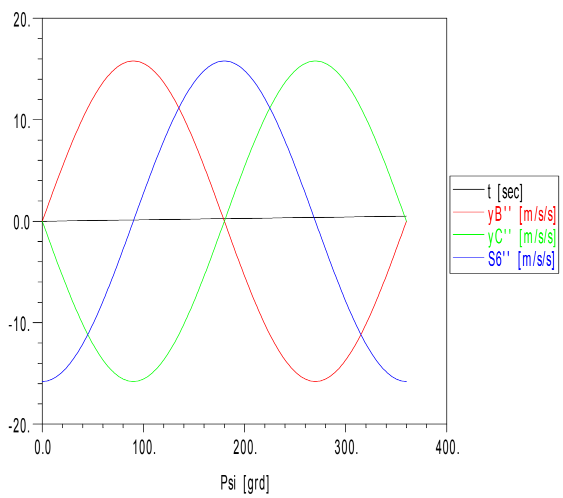

Fig. 15. Acceleration variations

5. Conclusions

The mechanism is intended to press that cuts out, on the fly, a metallic or non-metallic strip of material. The mechanism satisfies the imposed conditions. Charts of the positions, velocities and accelerations confirm proper functioning of the mechanism. Although it contains a triad with sliding, the mechanism calculation is easy, due to symmetries.

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