Research Paper

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The Influence of the Geometric and Control Parametres on the Characteristic of the Elastic and Safety Clutch

Geometric

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ABSTRACT

The paper presents the roll and the importance of geometry components for determination the theoretical characteristics for the elastic and safety clutches. There are also presented the structural schemes of the elastic and safety clutch and the transversal section through the clutch with flat translation followers. There are presented the geometrical models for the determination of torsion moment that can be transmitted by the clutch on the radius curves. For the expressions simplifying it was considered the case when the cam semi-clutch is profiled by circle arcs, the algorithm being also valid for the case of the profiles with others curves. The are presented some characteristics of the elastic and safety proposed clutch.

INTRODUCTION

In general expression, by mechanical clutch it's understand a technical system which makes the bundle between two shafts, with relative fix and relative variable position and it ensures the unmodified transmission of the torque and of the rotation moment between the shafts; the bundle between the shafts realized by the clutch, must also ensures the power transmission in the condition of the existence of meaningful linear and/or angular deviations [6].

In the case of diverse applications, when the mechanical transmission imposes it, there can be combined the simple functions of one clutch type with the simple functions of another clutch type, obtaining a combined coupling. In this case, the combined coupling is obtained by the connection, of two or more simple clutches, in a certain manner, on purpose to accomplish accordingly the imposed complex functional role of mechanical transmission. A condition imposed to the elastic clutches is that at the breakage of an element, the clutch does not failure immediately. If there is only an elastic element, the total breakage of the clutch has to be inferred, in case of partial fractures or the fissures. Another condition imposed to elastic clutches is that the elastic elements that can rapidly be destroyed, to be easily replaced – if it is possible without the clutch disassembling or the axial displacement of the axle stubs [7], [8].

The paper presents the roll and the importance of geometry components for determination the theoretical characteristics for the elastic and safety clutches.

CONSTRUCTION OF THE CLUTHE

Figure 1 presents the structural schemes of the elastic and safety clutch and figure 2 presents the transversal section through the clutch with flat translation followers [5].

The elastic and safety clutch presented in figure 2 belongs to the category of clutches generated from mechanisms with rotation cam and flat translation follower; the cam as well the follower is non-degenerated [1], [3], [4].

The constructive solution allows the pretension adjustment without to take to pieces the clutch. The clutch contains the equiangular cam 3, with three prominences, which represents one of the semi-clutches and the second semi-clutch is represented by the flange 2. On this flange there are mounted the three flat translation followers 13 – that are equiangular disposed – as well as the fastening and adjusting elements 12, that are necessary for the pretension of the compression spiral springs 11.

The driving semi-clutch 1, transmits the torsion moment by means of the equiangular cam 3, that are in contact with the three flat translation follower 13, due to the pressing force of the compression spiral springs 11. Knowing the elastic characteristic of the compression springs, the pressing force necessary for the torque transmission can be adjusted by means of the special screws 12.

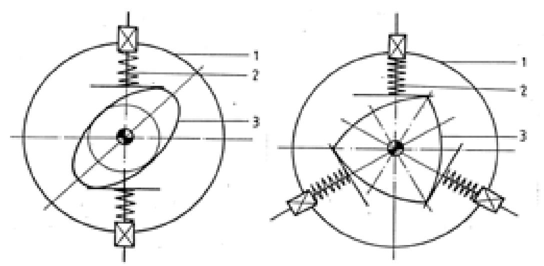

Figure 1: Structural scheme of the elastic and safety clutch with flat translation followers

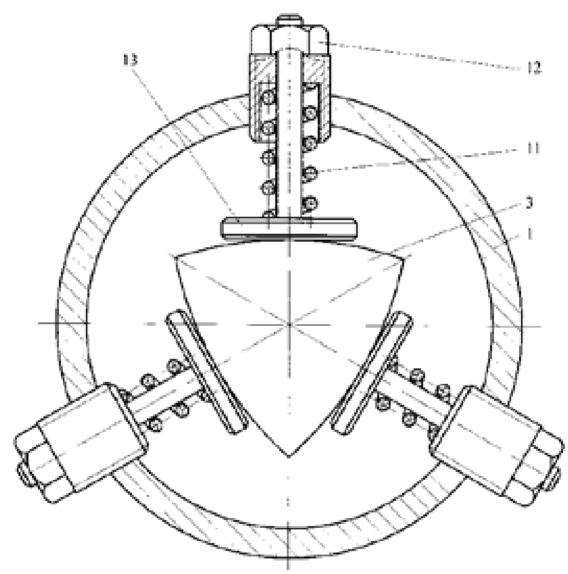

Figure 2: Constructive scheme of the safety clutch

The clutch accomplishes the functions of the elastic and safety clutches and it assures a good damping of torsion shock and vibrations; it also provides the compensation of axial, radial and angular deviations in relative large limits.

ANALYTICAL DETRMINATION OF THE TORQUE FOR THE CLUTCH AND THE ELASTIC CHARACTERISTIC

In this chapter the torque expression is analytical modelled and in the second part of the chapter there are determined the theoretical and experimental elastic characteristic for the first representative variant considered [3], [4].

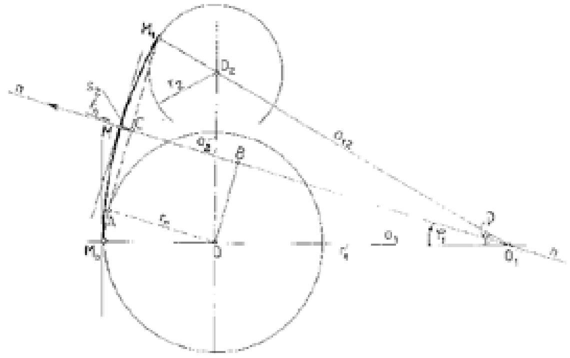

Figure 3: Geometrical model for the torque determination on the curved radius M_0M_2

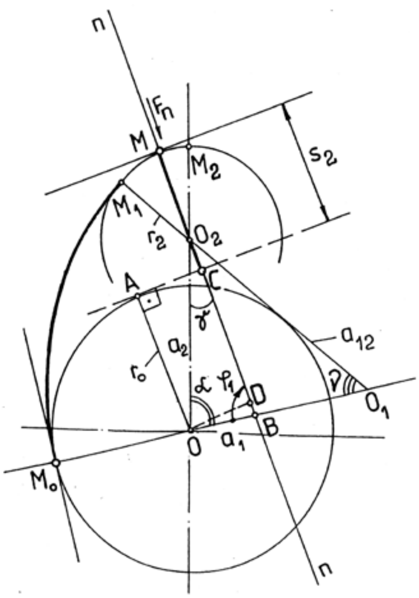

Figure 4: Geometrical model for the torque determination on the curved radius M_1M_2

Starting from the structural scheme from the figure 1 and from the constructive variant from figure 3, in figure 4 is presented the geometrical models for the determination of torsion moment that can be transmitted by the clutch on the curved radius M_0M_1 and M_1M_2:

$$O_1M_0 = O_1M = O_1M_1 = r_1 \tag{1}$$

$$OM_0 = OA = r_0 \tag{2}$$

$$O_2M_1 = r_2 \tag{3}$$

$$OO_1 = a_1 = r_1 - r_0 \tag{4}$$

$$OO_2 = a_2 \tag{5}$$

$$O_1O_2 = a_{12} = r_1 - r_2 \tag{6}$$

The transfer of a variable torque, under the limit torque, is characterized by the relative displacement between the semi-clutches and thus between the cam and the rod. According to Figure 3 the transferred torque is determined by the connecting force between the cam and the rod (which is oriented after the normal n-n) and by its moment arm, OB, relative to the cam's fulcrum. The connecting force cam-rod is determined by the stiffness of the spiral spring k_a, the initial strain δ and by the rod's displacement s_2, which produces the current strain of the spring. Thus, in the case of negligible friction between cam and rod the following can be written (see figure 3):

$$T^* = \left[k_a\left(s_2 + \delta\right)\right] \cdot OB \tag{7}$$

$$T = n\left[k_a\left(s_2 + \delta\right)\right] \cdot OB \tag{8}$$

$$T = \mathrm{n}T^* = \mathrm{n}\, k_a\left[(r_1 - r_0)(1-\cos\varphi_1) + \delta\right]\left\{(r_1 - r_0)\cdot \sin\varphi + \mu\left[(r_1 - r_0)(1-\cos\varphi_1) + r_0\right]\right\} \tag{9}$$

$$K(\varphi) = \frac{dT(\varphi)}{d\varphi} \tag{10}$$

where by T* it had been written down the moment that corresponds to a single proeminence ($T^* = T/n$, n – the number of the prominences of the cam and the number of the flat translation followers).

The determination of the s_2 - change of place will be performing distinctly, for each circle arc of the cam profile. $K(\varphi)$ express the tangent to the curve moment which is traced in function oh the φ relative rotation angle between the semi-clutches. For the elastic characteristics determination of the clutches with flat translation followers utilissing circle arc profiles (see figure. 3), it is necessary the determination of $K(\varphi)$ for the two characteristic sections M_0M_1, M_1M_2, figure 4.

In the next figures the characteristic of the clutch is shown, for different values of the geometric and control parameters, starting with the initial characteristic described by the following reference values, noted in each diagram (see figure 3):

r_0 = 32mm; r_1 = 100mm; r_2 = 17mm;

K_a = 28 N/mm; δ = 5 mm

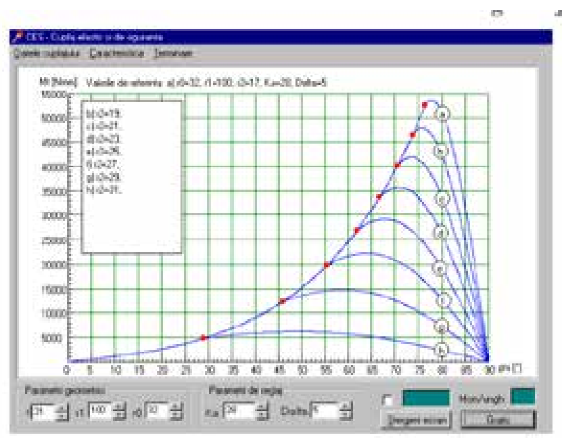

Figure 5: The characteristics clutch for variable r_2

Figure 5 represents a set of curves of the M_t=f(φ) characteristic, for which the fillet radius r_2 of the cam's profile is varied, while the other parameters are kept constant. Analyzing the set of curves the following observations are made: if the fillet radius increases and tends towards the value of the base circle's radius the torque transmitted by the clutch decreases, the disengagement happening without any shocks and as r_2 decreases the torque increases, causing the disengagement to happen with shocks.

Figure 6 shows the graphical representation of a set of curves that describe the $M_t=f(\varphi)$ characteristic, for which the radius of curvature is varied, while the other parameters are kept constant. The radius r_1 decreases from the initial value towards the value at which it can no longer transfer the torque, meaning $r_1 = r_0$. The torque transferred by the clutch decreases with the decrease in curvature radius, causing also a decrease in the tangent to the curve. At the connection point the pass/change from the progressive to the regressive branch is done with shocks, as the value of r_1 increases.

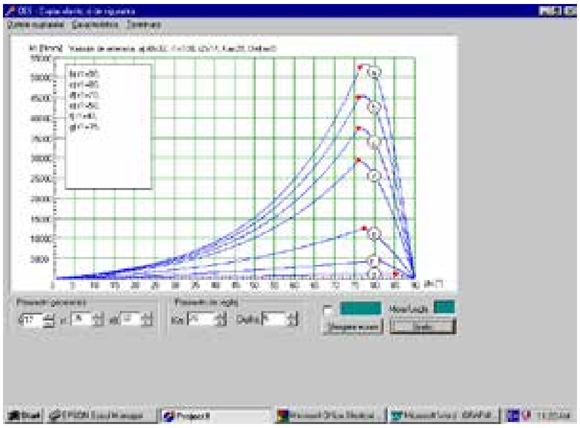

Figure 6: The characteristics clutch for variable r_1

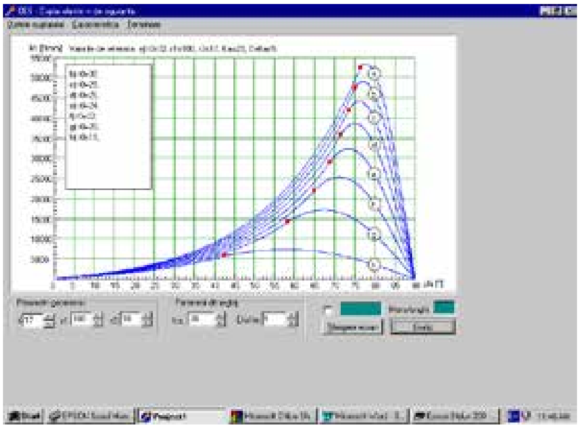

Figure 6: The characteristics clutch for variable r_0

Figure 7 represents a set of curves of the torque as a function of the relative rotation angle between the semi-clutches $M_t=f(\varphi)$, for which the base circle's radius is varied, while the other parameters are constant. The torque transmitted by the clutch decreases as the radius of the base circle decreases until $r_0 = r_1$.

CONCLUSIONS

Analyzing the theoretical characteristics obtained by the variation of both geometric and control parameters for the elastic and safety clutch with flat rods and pressure spiral spring, a series of conclusions can be drawn, the most important of which are given below:

- The characteristic of the clutch is progressive;
- The relative rotational angle between the semi-clutches is a function of the cam's number of profiles, which gives the clutch a high elastic strain;
- The change in geometric parameters causes a change in the clutch's characteristic, maximum torque transferred by the clutch, angle of torque between the semi-clutches, and the characteristic's slope.

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