ORIGINAL RESEARCH PAPER

Engineering

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DESIGN OF ELASTIC AND SAFETY CLUTCHE WITH RUBBER ROLLERS AND SHEAR STIFFENERS

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ABSTRACT

The modular design imposes finding the optimal solutions from constructive and functional point of view. The constructive design must be correlated with the technological one. Thus, it is possible to obtain mechanical components with reduce building limit and weight, with high durability and small price. In this context, the present paper presents the conceiving and the design of a new clutch with multiple functions, the elastic and safety clutch. This type of clutch combines the functions of elastic and safety clutches, and it will be denoted as elastic and safety clutch with rubber shushing and shear studs.

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.

The elastic clutch could take over, overloads up to a certain torque value. Over this value, when the transmission is not provided with a load disengagement system, the elastic elements of the clutch are destroyed, this corresponding with the placing of transmission out of the operation.

The safety clutch fulfils (besides the main function of the torque transmission) the function of torque limitation or automatic interruption of the connection between the coupled shafts, in the case of some overloads' occurrence, during the performance. The safety clutches assure the transmission performance up to the limit torque value, for what the safety elements are designed. Over this value, it

appears the relative slipping between the semi-clutches, which involves the mechanical transmission protection. Taking the data above into consideration, it results the necessity of some clutches, that by the associated functions to allow the load disengagement before that the elastic elements to be destroyed.

ELSRIC AND SAFETY CLUTCH

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.

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.

THE STRUCTURAL SCHEME OF THE ELASTC AND SAFETY CLUTCH

The elastic and safety clutches are characterized thought the next functions (functional technique criterions):

- they make the bundle between two shafts (with relative fix variable position) and ensure the moment transmission and the rotation motion between the shafts (according to the general definition);
- the power transmission is braked off when the resistive moment outruns an imposed limit value;
- the energy flux braking off it is realized basis on an elastic element deformation.

From the analysis of the proprieties corresponding to the elastic and safety clutches, a distinct importance goes to the elastic element modelling, a thus as to ensure the every flux automated braking off, at the torque limit value.

From the use in technique mechanisms critic analysis [2], it resulted that the cam mechanism (figure1) lends oneself (the best) to the demands previously formulated, thus:

Figure 1 presents the structural schemes of the elastic and safety clutch with flat translation followers [3, 4, 5, 6].

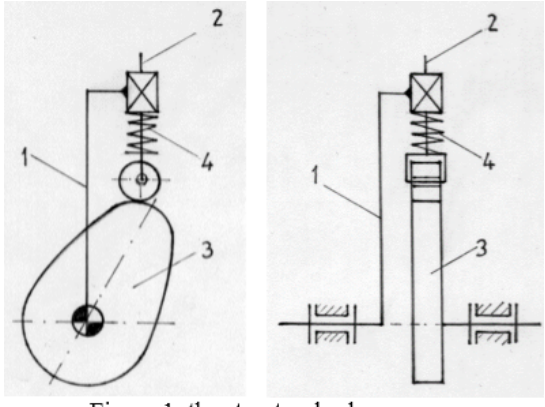


Figure 1: the structural schemes

CONSTRUCTION OF THE CLUTCH

The elastic clutch with bolts

For elastic couplings with bolts Fig. 2, the semicuples are connected by bolts and the elastic sleeves mounted thereon. The elastic bushings are retained on the bolt by means of washers and elastic rings. These couplings allow for reduced compensation of coaxial shaft displacements: 0.3 ... 0.6 mm for radial displacements below 1 ° for angular displacements. The axial displacements are small, under load they are compensated by axial compensation of the rubber bush. A check is made at the crushing request between the bolt and the elastic bush as well as the bolt bending.

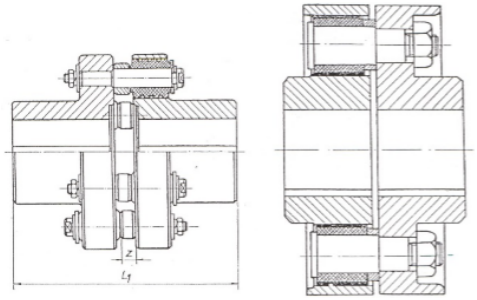


Figure 2: the elastic clutch with bolts

The tangential force that loads a bolt is:

$$F_{tc} = \frac{2M_{tc}}{zD_1}, \quad (1)$$

$$M_{tcap} = \frac{1}{2} D_1 z d_3 l_6 \sigma_{as} \geq M_{tc} \quad (2)$$

where z is the number of bolts.
The contact pressure is

$$p = \frac{F_{tc}}{d_b l_b} = \frac{2M_{tc}}{z d_b l_b D_1} \leq p_a. \quad (3)$$

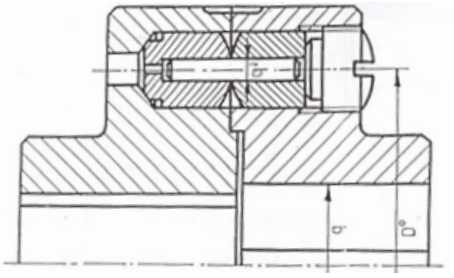
Check crushing between bolt and sleeve

$$\sigma_s = \frac{2M_{tc}}{z d_3 l_6 D_1} \leq \sigma_{as} \quad (4)$$

The safety clutch

These safety couplings are recommended in transmissions where overloads occur rarely, incidentally but with high values. Their disadvantage lies in the fact that it is necessary to replace the broken pin in order to bring the mechanical transmission back into operation. The safety couplings with shear pins transmit a torque that can be given by the relationship:

$$M_{tcap} = \frac{\pi}{8} z D_0 d_1^2 \gamma \sigma_r = M_{t\,lim} \quad (5)$$



The shear pins are dimensioned

Figure 3: the safety clutch

$$z d_1^2 = \frac{8}{\pi} \cdot \frac{M_{t\,lim}}{D_0 \gamma \sigma_r} \quad (6)$$

$$M_{t\,lim} \leq (1{,}15 \ldots 1{,}2) M_{tc} \quad (7)$$

Elastic and safety clutches with rubber bush and shear studs

Starting from the structural schemes and from the representative functions and proprieties – of the elastic and safety clutch, the next anterior of constructive generation can be formulated:

- the clutch must absorb radial and angular tilts;
- the relative movement between the semi clutches, as well as the releasing must be made without shocks;
- the clutch must have a reduce rigidity ; it is suggested a characteristic Mt() with a rising
- inclination and a big damping capacity ;
- the clutch elasticity could be modify – by changing or adding of a constructive elastic elements;
- when the clutch is turning round, big axial forces doesn't appear;
- the clutch mustn't brake down when au elastic element is destroyed ;
- the elastic constructive elements, which can be destroyed fast, must be fatly replace; if it's possible without demount the clutch;
- the changing of the rotation sense must be permitted without duty cycle;
- for the safety enlargement in running the component elements of the clutch mustn't have protuberances.

Bay sis on these criterions, for each structural representative scheme – is generating one constructive variant. One of thesis schemes describe succinct from constructive and running point of view.

The elastic and safety clutches are characterized by a variable rigidity (nonlinear characteristic) – relation (8), and the protecting condition of the mechanic transmission is presented with relation (9), [1]:

$$k(\varphi) = \frac{dMt(\varphi)}{d\varphi} \quad (8)$$

$$M_{t\,\lim}(1+\Delta) \leq M_{t\,\max a} \quad (9)$$

$k(\varphi)$ - represents the tangent to the curve of the torsion moment, that is written depending on the relative rotation; φ - the relative rotation angle, between the semi-clutches; $Mt(\varphi)$ - the torsion moment corresponding to the clutch deformation with the angle $M_{t\lim}$; - the torsion moment when the uncoupling produces or ends; $M_{t\max a}$ - the maximum torsion moment admitted by the strength of the most weak clutch element Δ - the relative error reset inputs in function of the clutch [1, 4].

Figure 4 shows Elastic and safety coupling with rubber buches and shear pin

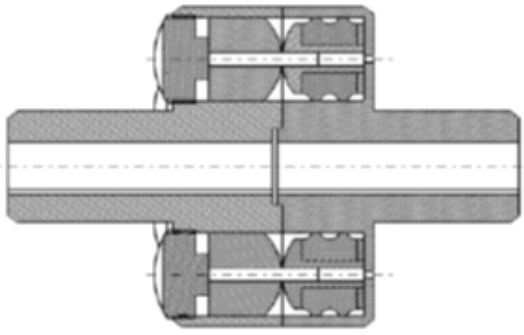


Figure 4: the elastic and safety clutch

The clutch feature is shown in Figure 5

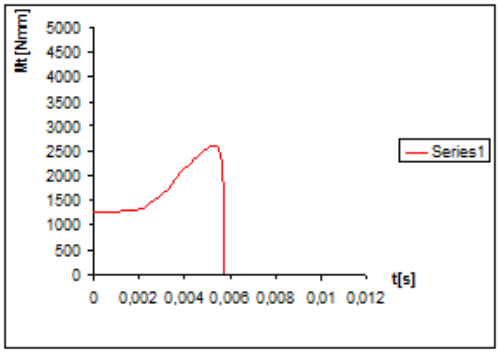


Figure 5: the characteristic clutch

CONCLUSIONS

The elastic and safety clutch with with rubber bush and shear studs:

The clutch can take shocks and torsional vibrations;

The characteristic of the clutch is progressive;

The relative rotation angle between the semi-clutches is a function of the dimensions and the frustum's angle between the generating line and it is based and of numbers of elastic dowels;

When the maximum torque, for which the clutch was designed, is exceeded, the transmission load decoupling takes place, the clutch fulfils the safety function;

The clutch can take over technological and assembling deviations; The clutches ensure the compensation of axial, radial and angular deviation in relatively large limits;

The clutch might be designed for different torques; moreover, it

has a small size and a low cost.

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