Elastic and Safety Clutches with Rubber Bushing and Shearing Pins

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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 reduced 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 bushing and shearing pins.

Key-Words: Elastic and safety clutch, Multiple functions, Rubber bushing, Shearing pin

1 Introduction
In general expression, by mechanical clutch one understands a technical system which makes the bundle between two shafts, with relative fixed and 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 ensure 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, [1], [2].

2 Elastic and Safety Clutch
A condition imposed to the elastic clutches is that at the breakage of an element, the clutch does not fail 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.

Taking the data above into consideration, this paper will present a new type of clutch, whose component elements can accomplish the functions of a combined clutch. It will be presented by the name “Elastic and Safety Clutch” [3], [4], [5].

3 The Structural Scheme of the Elastic 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 fixed variable position) and ensure the
moment transmission and the rotation motion between the shafts (according to the general definition);

- The power transmission is broken 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 [1], [3], [4], [5].

Figure 1

4 Construction of the Clutches

This section presents the constructive solutions of the three new elastic and safety clutches with multiple functions.

4.1 Elastic Clutch with Pins

At the elastic clutches with pins, figure 2, the semi-clutches are connected by pins and elastic bushings assembled on these.

The elastic bushings are retained on pins by means of some washers and elastic rings. These clutches allow low compensations of the coaxial movements shafts, respectively for radial movements: 0.3 ... 0.6 mm and under 1° for angular displacements. The axial displacements and low; under load these are compensated by the axial offset of the rubber bushing.

Verification is made at crushing test between the pin and elastic bushing, as well as at the pin bending [1], [2].

4.2 The safety clutch

These safety clutches are recommended in the transmissions where the overloads are rare, casual but high values. Their disadvantage is that the restoration of mechanical transmission service necessary to replace the broken pin [1], [2].

Verification is made at crushing test between the pin and elastic bushing, as well as at the pin bending [1], [2].
The shearing pins are dimensioned using the following relation:

$$M_{\text{lim}} = \frac{\pi}{8} z D_0 d_1^2 \frac{\gamma}{\sigma_t} = M_{\text{lim}}$$

(5)

where $M_{\text{lim}}$ is:

$$M_{\text{lim}} \leq (1,15...1,2) M_{\text{lc}}$$

(7)

### 4.3 Elastic and Safety Clutches with Rubber Bushings and Shearing Pins

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 $M_t(\phi)$ 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.

Based on these criteria, 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], [4]:

$$k(\phi) = \frac{dM_t(\phi)}{d\phi}$$

(8)

$$M_{t_{\text{lim}}} (1 + \Delta) \leq M_{t_{\text{max,a}}}$$

(9)

where:

$k(\phi)$ - represents the tangent to the curve of the torsion moment, that is written depending on the relative rotation;

$\phi$ - the relative rotation angle, between the semi-clutches;

$M_t(\phi)$ - the torsion moment corresponding to the clutch deformation with the angle $\phi$;

$M_{t_{\text{lim}}}$ - the torsion moment when the uncoupling produces or ends;

$M_{t_{\text{max,a}}}$ - the maximum torsion moment admitted by the strength of the most weak clutch element

$\Delta$ - the relative error reset inputs in function of the clutch [1], [4].

Figure 4 presents the constructive solution of the proposed elastic and safety clutch. The clutch is consisted of the following components:

1 - driving semi-clutch;
2 - driven semi-clutch;
3 - screw plug;
4 - pins;
5, 6 - metal shearing bushings;
7 - elastic bushing;
8 - washer.

Figure 5 presents the assembly consisted of the shearing element and fastening elements of the elastic bushing, that takes over the torsion shocks and vibrations, position offsets.
Figures 6 presents the assembly consisted of the shearing element and fastening elements of the elastic bushing, mounted in a semi-clutch.

Figure 7 presents the elastic and safety clutches assembled with all components.

5 Conclusion

The elastic and safety clutches with rubber bushings and shearing pins (figure 4) present the next advantages, [2], [4]:

- the clutch must absorb radial and angular tilts;
- the clutches have a simple construction, cabaret reduced dimension, chip price;
- the clutches ensure the compensation of axial, radial and angular deviation in relative large limits;
- the clutches ensure the a relative movement between the semi – clutches, in function of the nature and of the disposing mode of the component elements; above the accepted limits, the elastic cloth becomes a safety one;
- the clutches ensure the limitation and the adjustment of the transmitted moment.

Because the big number of the structural schemes which can be derived is very large, from the presented solution can be conceived, by analogy, other variants; variants which will constitute the basis of the further researches in the presented domain.

References: