SIMPLE CLutches WITH MULTIPLE fUNCTIONS

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Abstract: The clutches are largely used in machine building, and on the correct selection of them, depends – to a great extent – their safe and long operation as well as the reliability of the kinematic chain equipped with them. The guarantee of these demands for the mechanical power transmission between shafts represents a ticklish problem for all areas and engineering applications that require compact, simple and reliable systems. One of the objectives of this paper is to present the design of new types of simple clutches able to accomplish more functions, as well as those characteristics of safety and elastic clutches. In this respect, they provide motion transmission and torque transmission respectively; vibration and shock protection; compensation of the assembling deviations and / or the deviations during the operation; load limitation – with or without kinematic flow interruption.

Key words: elastic and safety clutch, load limitation, vibration and shock protection

1. INTRODUCTION

The modern design of the mechanical transmissions requires the finding of optimum solutions from a constructive and functional point of view, and the constructive design must be correlated with the technological one. In this respect, it is possible to obtain mechanical components with reduced gauge and small weight, with high reliability and low cost. In this respect, the paper aims at conceiving some new clutches variants.

For a correct, safe and economical operation of a machine, it is necessary that its components should be designed and accomplished properly. The mechanical transmission protection against overloads, using some safety clutches, represents one of the directions that must be taken into consideration from the conceiving stage. This has influence both on the machines and equipments gauge and on their reliability and so implicitly on the materials and energy consumptions [1], [2].

Thus, the designers can decrease the value of the safety coefficient for the dimensioning of the mechanical transmissions of the equipments.

Besides the main function of the torque transmission and rotational motion transmission between two consecutive elements of a kinematic chain, the safety clutches fulfil the function of transmitted torque limitation, in case of overload occurrence during the performance. In this respect, the over stressing and deterioration of the kinematic chain elements are avoided.

The overloads – that may occur in transmission due to various factors such as the machine starting or stopping, the passing through a resonance zone, or too high overloads of the driven mechanism – can be dynamic (with shocks), with a very short duration, or quasi-static, with a long duration. Irrespective of the overload type, these can lead to the machine deterioration and, eventually, failure [1].

Taking into consideration all overloads, for the transmission calculus, this can lead to an excessive overmeasuring, situation that cannot be accepted. If a safety clutch is assembled in the kinematic chain of the mechanical transmission, then the mechanical properties of the materials for the transmission components can be fully used [2].

The following features must characterize safety clutches:
- Reliability and safe operation;
- Limitation accuracy, to a certain required value of the transmitted torque;
- Possibility to adjust the transmitted torque;
- Capacity to automatically restore the kinematic flow, after the overload stops.

The elastic clutches are mobile permanent mechanical clutches with elastic intermediate elements, metallic or non-metallic involved in the transmission torque; the elastic elements ensure clutch properties, namely: the damping of torsion shock and vibration, the limitation of resonance vibration by changing the natural frequency of the mechanical system, the elastic compensation of shaft position deviations due to the execution and assembly inaccuracies [1].

The elastic clutches are characterized by stiffness and damping capacity.

Because the combination of the two types of clutches (safety clutches and elastic clutches) leads to a system with a high level of complexity, it is essential, both from a technical and economic point of view, to conceive new clutch variants. These clutches have to combine the two function groups, under the conditions of a reduced complexity construction, similar to a simple clutch [2].

The basic criteria of constructive generation of the elastic and safety clutches are the following [3]:
- The clutch must take over the axial, radial and angular deviations.

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The relative motion between the two semi-clutches, as well as the load uncoupling must take place without shocks.

The clutch must have a reduced rigidity. It is recommended a $M(\phi)$ characteristic with an increased tendency and a high damping capacity.

The clutch elasticity can be modified by changing or adding some elastic constructive elements.

The heat emission owing to the shock damping and the relative rotation between semi-clutches will be taken into considerations.

The damage of one elastic element must not lead to the clutch destruction.

The constructive elastic elements that can be readily easy to be destroyed, must be replaced, if possible without the clutch disassembling and without the axial displacement of the shafts.

The change of the rotating sense must be allowed without any clearance.

For the safety increase in operation, the component elements of the clutch must not have protuberances.

One of the aspects followed in mechanical transmission design is the avoidance of the use of the components with relative motion during the operation. In the case of clutches – for their reliability increase – the avoidance of some components with relative motion is followed in comparison with both the driving semi-clutch and the driven semi-clutch.

Safety clutches achieve the coupling and uncoupling by means of some intermediary elements that – during these processes – are in relative motion as compared to the two semi-clutches.

Taking into consideration this aspect, the conceiving of some safety clutches is followed for which the uncoupling and coupling processes can be achieved without the use of some intermediary elements, in relative motion as compared to the driving semi-clutch and the driven one.

Therefore, the paper proposes three variants of elastic and safety clutches.

2. ELASTIC AND SAFETY CLUTCHES WITH FRONTAL ACTIVE RABBETS AND ELASTIC ELEMENTS

This section proposes to modify variants the safety clutches with balls frontally disposed in order to damp shocks and vibrations.

In this respect, modifying the geometry of active rabbets is propose by introducing elastic elements, resulting three different solutions of active rabbets, as follows:

- active rabbets whose sides are made of laminated springs packets 4, mounted with prisms 5, via screws 7 (Figure 1, a);
- the active sides are made of laminated springs packets 4, maintained in contact with balls 3 through some cylindrical helical compression springs 6, mounted in slots processed on the sides of the driven semi-clutch 2; the mounting of laminated springs packets is through prisms 5 and screws 7 (Figure 1, b);
- the active sides are materialised by the surface of some laminated springs on whose outer surface (surface that comes into contact with slots practiced in driven semi-clutch 3) was vulcanised rubber (Fig.1, c).

Load is transmitted through elastic elements 4 that are in contact with balls 3, mounted in slots processed in the driving semi-clutch 1.

The elastic elements 4 may consist of packets of steel spring blades, which may be different in thickness and number of blades in packets, depending on the torque to be transmitted; the cylindrical helical compression springs 6 (see Figure 1, b) also may have different rigidities, all of these determining the global characteristic of the elastic and safety clutches.
Another determining factor in terms of elastic characteristic of clutches is the constructive form of processed rabbets in driven semi-clutch 2. In the operation of these clutches, two situations occur:

- operation at relatively high loads, when the elastic elements 4 are wrapped on the guiding curve of the rabbets practiced in driven semi-clutch 2;
- operation at very high loads corresponding to the uncoupling torque and the amplification of relative motion between the semi-clutch elements.

3. ELASTIC AND SAFETY CLUTCH WITH AXIAL LAMINATED SPRINGS

The constructive scheme of the elastic and safety clutch with axial laminated springs is presented in Figure 2. The clutch consists of the two semi-clutches 1 and 2, the elastic joint between them being achieved by means of the axial laminated springs' packets 4. Depending on the desired transmitted torque, the laminated springs can be disposed in packets of two or more laminated springs, having an end fixed rigidly, by means of the prisms 5, tightened with the screws 7. The other ends of the laminated springs are introduced freely in the space obtained by the arrangement of rolls 3. The cap 6 closes and seals the clutch.

The elastic and safety clutch with axial laminated springs presents three characteristic operation situations, namely:

- operation at low loads, operation at high loads and operation at very high loads.

In the case of the first operation situation, the laminated springs' packets slip on the rolls and do not wrap around the guiding curve of the fixing elements 5.

For the second operation situation, the laminated springs' packets wrap around the guiding curve of the fixing elements 5.

The operation at very high loads corresponds to the load uncoupling moment and to an increase in the relative rotation angle between the two semi-clutches.

The constructive shape of the elements for the fixing of the laminated spring packets requires the elastic characteristic of the clutch.

The guiding elements 5 can be profiled with various shapes of the guiding curve (Figure 3). The sliding friction between the elastic elements and the rolls can be replaced with the rolling friction between the rolls and the laminated springs, because of the free fit between the rolls and the semi-clutch 2.

4. ELASTIC AND SAFETY CLUTCH WITH METALLIC ROLLS AND ROLL-SHAPED RUBBER ELASTIC ELEMENTS

The constructive scheme of this clutch is presented in Figure 4.

The elastic joint between the semi-clutches 1 and 2 is achieved by means of the rubber bushings 4, fixed on the bolts 5 by means of the antifriction bushings 6. The driven semi-clutch is equipped with the multiple metallic rolls 3, fixed by free fit on the bolts 8.

The load is transmitted from the semi-clutch 1 to the semi-clutch 2 by means of the metallic rolls 3, which are in contact with the rubber elastic rolls 4.
5. CONCLUSIONS

From the dynamic study of the safety clutches, during their operation, it could be observed that the load limitation (the uncoupling) takes place with very high acceleration variation, the uncoupling and coupling being achieved with very high shocks. Even the passing from one uncoupling stage to another – without the complete uncoupling – takes place with shock [1], [3].

The elastic clutches can take over overloads up to a certain torque value. Above this value, if the transmission is not provided with a load disengagement system, the elastic elements are destroyed, leading to failure in the transmission system. The elastic clutches are characterized by a good reduction of torsion shocks and vibrations and by the compensation of axial, radial and angular deviations within relatively large limits during the assembling and operation process.

In this respect, it is obvious that in engineering practice there are frequent situations in which it is necessary to combine the simple functions of the safety clutches with the simple functions of the elastic clutches (such as shock and vibration protection and deviation compensation).

The constructive solutions of the elastic and safety clutches presented have the following advantages:

- They provide the compensation of the axial, radial and angular deviations, a good damping of the torsion shocks and vibrations, through the contact between the balls and the laminated springs packets (Figure 1); the laminated springs’ packets and the metallic rolls (for the clutch presented in Figure 2), and between the rubber and metallic rolls (for the clutch presented in Figure 4, respectively).
- Different elastic characteristics can be obtained, depending on the constructive shape, the elastic elements type as well as their position in the clutch.
- They provide a relative motion between the two semi-clutches, in terms of the type of the semi-clutches component elements; above the prescribed limits of the transmitted torque desired, the elastic clutch becomes a safety one.
- They provide the limitation of the transmitted capable torque.
- The clutches presented have a simple construction, reduced gauge dimensions and a low cost as compared to combined clutches that accomplish the same functions.

REFERENCES