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About the Calculations of the Biconic Agent Element Assembly

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Abstract

This paper aims to illustrate some aspects of how the biconic agent element assembly is being determined. The analysed solution derives from the improvement of the cone clutch assembly and of the tapered rings. The technological elements and the assembly elements are being marked out, and then is being determinate the value of the operating algorithm of the forces and of the capacity of transmitting the biconic agent element assembly.

Key words: *assembly, biconic agent element , capacity carrying, coefficient of friction*

General Considerations

Elastic clutch assemblies are the result of a forced contact between the interlinked areas of the parts which are going to be put together.

If the deformations of the areas which come into contact are elastic, the assembly can be removed, but if a plastic deformation interferes, then the assembly cannot be removed.

The elastic clutch assembly has its advantages:

- great capacity of transmitting the static or the varying loadings;
- ensures an adequate alignment of the cylindrical fit parts;
- easy to be put together;
- allows the construction of some machine elements which contain at least two pieces, having the purpose of saving the expensive and defective materials.

Among the disadvantages, one can mention:

- possibility of loosening the fit during the running process;
- impairment of the contact areas during the removal process;
- parts must be carefully chosen so that their dimension should match almost perfectly.

Biconic agent element assembly derives from the improvement of the cone clutch assembly and of the tapered rings.

A whole by noising with intermediate biconic elements the disadvantage of a big number of elements of assembly, so a price of cost much higher, being necessary a careful processing of assembly, joint surfaces in condition of smaller roughness.

However, presents the advantage which results from the functional condition of torque and nomely is necessary a moment of friction forces smaller comparative with other systems of assembly as exemple the overall gathering that.

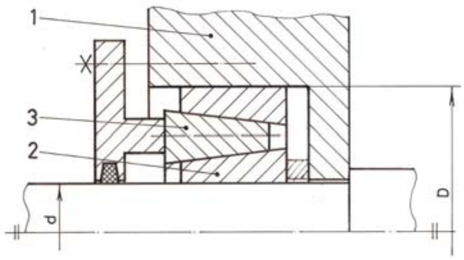

Fig. 1. Example of a biconic agent element assembly

They are used during the assembling process of the shaft hub parts. A pair of collars contains an external collar 1, an internal collar 2 and an agent collar 3. The surfaces which get in contact with each other are conical, and the surfaces which get in contact with the parts which are to be assembled (shaft and hub) are cylindrical.

When clumping the collars with some threaded items which act upon the intermediate collar, the collars come into contact with the conical areas, so that the external collars are bending and they bond to the hub. Furthermore, the internal collars are being compressed and they assemble on the shaft.

The internal and external collars are coped in one way (they are elastic collars) in order to avoid important pre-stretching on the shaft and on the hub.

The internal and external areas of the collars have $R_a \leq 0.6\mu m$ ruggedness, and the bore hole from the hub and the shaft should have $R_a \geq 3.2\mu m$ ruggedness in the fixed joining area. The collars are made of improved alloy steel (30MoCrNi20), and after the thermal treatment the breaking limit should be $R_m \geq 750$ MPa.

From a technological point of view, considering the fact that the collars which form a pair have a supple ending, the cut up operation is made after the adjustment. The width of the xxxx should be chosen so that the collar can compensate the positive allowance: (2.5...3) mm.

According to the advice of the manufacturing companies, the gap of the shaft should be (h8), and those of the hub (H8).

Concerning the mounting technology, some assignations should be made:

- the shaft and the bore from the hub should be carefully operated ($R_a \geq 3.2$ µm);
- the conical surfaces of the elements should be assembled with mineral oil (it is forbidden the usage of molybdenum disulphide doped oil).

The advantages of biconic element assembly are:

- repeated mounting and demounting without deteriorating the surfaces;
- the hub should be well positioned in relation to the shaft, and the axial and angular position.

Among the disadvantages one can mention:

- important radial dimensions of the hub
- higher costs.

The Forces System and the Transmission of Capacity of the Assembly in Pressing with Biconic Agent Element Assembly

For these assemblies the collars are clamped with a nut (or with another tightening device) because if there would be an axial gliding or an elastic deformation we would talk about a tightening pressure upon the agent areas. These assemblies transmit the moment of torsion because of the tightening areas between the collars and the assembling parts.

The stationary fit is the result of the radial elastic deformation of the conical collars which are under the action of an axial pressing force.

In order to establish the conduction capacity of the assembly, one should calculate the radial clumping forces Q_1 according to the pressing force F_{a1} (the relation between Q_1 and F_{a1} is being established when writing consecutively the condition of equilibrium after the direction of the axial force after each collar: external, internal or intermediary fig. 1, based on the forces from fig 2). The coefficients of friction for the four contact zones are taken into account.

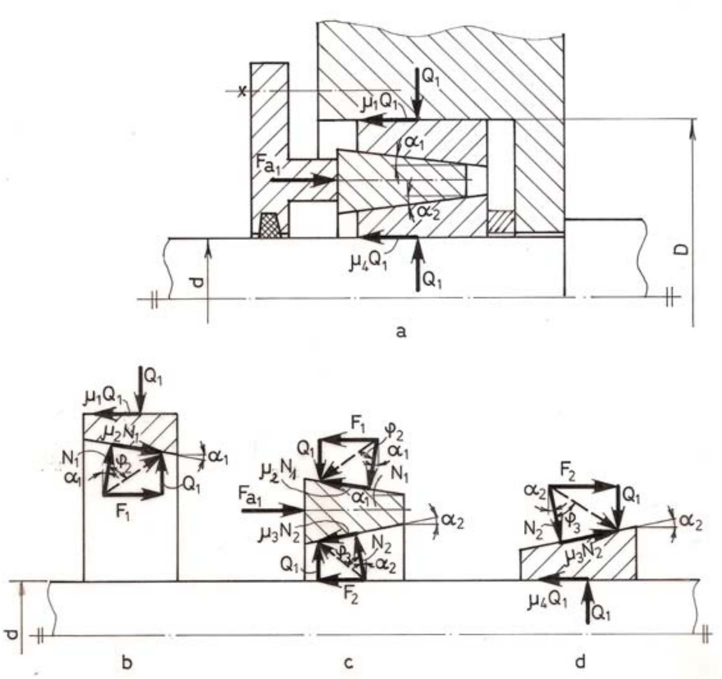

Fig. 2. Some geometrical elements of the biconic element stationary fit – a;
B - forces which act upon the external collar;
c - forces which act upon the intermediary collar;
d - forces which act upon interior collar.

According to fig. 2, for the intermediary collar one obtains the following equation:

$$F_{a1} - F_1 - F_2 = 0\,, \tag{1}$$

where:

$$F_1 = Q_1 \times tg(\alpha_1 + \varphi_2)\,, \tag{2}$$

and

$$F_2 = Q_1 \times tg(\alpha_2 + \varphi_3)\,. \tag{3}$$

It results:

$$F_{a1} = F_1 + F_2 \tag{1'}$$

$$F_{a1} = Q_1 \times [tg(\alpha_1 + \varphi_2) + tg(\alpha_2 + \varphi_3)] \tag{4}$$

It is being determined that the axial force F_{a1} does not depend on the coefficients of friction of the external collar and the bore of hub or on the friction coefficient of the internal collar and the shaft.

From the 4th equation the clamping force is being determined (the radial chocking effect):

$$Q_1 = \frac{F_{a1}}{tg(\alpha_1+\varphi_2)+tg(\alpha_2+\varphi_3)} \quad . \tag{4'}$$

The moment of torsion which can be transmitted by the assembly has a minimal value at the end of the shaft's diameter, where a possible slipping might take place.

$$M_{f1} = \mu Q_1 \times \frac{d}{2} = \mu \times \frac{F_{a1}}{tg(\alpha_1+\varphi_2)+tg(\alpha_2+\varphi_3)} \times \frac{d}{2} \quad . \tag{5}$$

The functional condition of conduction through friction of the moment of torsion is:

$$M_{f1} \geq M_{tc} = \beta \times M_t \, , \tag{6}$$

where β is the coefficient of safety when slipping (β =1.5...3) and therefore the following equation derives:

$$\mu \times \frac{F_{a1}}{tg(\alpha_1+\varphi_2)+tg(\alpha_2+\varphi_3)} \times \frac{d}{2} = \beta \times M_t \, , \tag{6'}$$

from which the axial force is determined function of the moment of nominal torsion M_t and of the geometrical dimensions of the assembly.

Knowing the value of F_{a1} the bending screws can be sized.

Conclusions

This paper discusses the issue of clutch assemblies with biconic agent elements, which is, as far as I know, one of the first works of this kind. Furthermore, this paper presents different composing elements of the biconic agent elements of the clutch assembly, some technological and mounting elements, the forces and the transmission capacity of this type of assembly.

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Asupra calculului asamblărilor prin strângere cu elemente intermediare biconice

Rezumat

Lucrarea prezintă unele cercetări privind determinarea capacităţii portante a asamblărilor prin strângere cu elemente intermediare biconice. După precizarea soluţiei constructive utilizate (derivate din perfecţionarea asamblărilor prin strângere pe con şi a celor cu inele tronconice), în lucrare se evidenţiază unele elemente tehnologice şi de montaj şi se elaborează algoritmul de determinare a forţelor dezvoltate în asamblare.