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Prototype of pneumatic flexible shaft coupling tangential

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Abstract: In our workplace, we deal with research of pneumatic flexible shaft couplings in the long term. Our main goal is to minimize dangerous torsional vibration in mechanical systems, using pneumatic flexible couplings as torsional vibration active tuners. Therefore, many pneumatic couplings prototypes have to be manufactured and tested. In this article, a pneumatic flexible shaft coupling with enlarged compression volume is presented. The coupling was manufactured according to granted patent and utility model. Its main goal is to modify the shape of load characteristics, which are common for tangential-type pneumatic couplings.

Keywords: Pneumatic flexible shaft coupling tangential; Prototype; Enlarged compression volume.

Prototyp pneumatycznego elastycznego sprzęgła stycznego wałów

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Streszczenie: Od wielu lat nasz zespół zajmuje się badaniami prototypów pneumatycznych elastycznych sprzęgieł stycznych wałów. Głównym celem tych prac jest zbadanie możliwości wykorzystania tego rodzaju sprzęgieł w roli tunerów, pozwalających na dynamiczne strojenie, w tym przede minimalizację niebezpiecznych drgań skrętnych występujących w urządzeniach mechanicznych. Jest to niezwykle pracochłonne zadanie, bowiem wymaga testowania znacznej liczby sprzęgieł należących do omawianej grupy. W przedstawionym artykule zaprezentowano opatentowane pneumatyczne elastyczne sprzęgło styczne wałów o zwiększonej objętości sprężania. Podjęte prace koncentrują się generalnie na modyfikacji kształtu charakterystyk obciążeniowych tego rodzaju sprzęgieł, opracowywanych standardowo w przypadku grupy pneumatycznych sprzęgieł stycznych.

Słowa kluczowe: Pneumatyczne elastyczne sprzęgło wałowe styczne; Prototyp; Zwiększona objętość kompresji.

1. Introduction

Nowadays, flexible shaft couplings are the most utilized machine parts for the flexible transmission of load torque in machines with rotary power transmission, mainly in order to avoid dangerous torsional shocks and vibration in the systems. Therefore, a flexible coupling with suitable dynamic properties, particularly dynamic torsional stiffness, has to be carefully chosen for each specific application, e.g. [1—8], otherwise serious failures can occur, e.g. [9—11].
Flexible elements of flexible shaft couplings are made of various materials, mainly of rubber, plastic and metal. During the operation of mechanical systems, it comes particularly to the fatigue and ageing of rubber and plastic flexible

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elements and to the ageing and wearing down of the metal flexible elements of applied flexible coupling, e.g. [11], [12]. Consequently, the applied flexible coupling loses its original dynamic properties and thus the ability to carry out its important functions in a torsionally oscillating mechanical system (TOMS), mainly the tuning of a mechanical system in terms of torsional dynamics. The disadvantages of the mentioned flexible elements can be eliminated using pneumatic flexible elements, for example air springs, e.g. [13], [14]. The flexible transmission of torque is ensured by compressed gaseous medium, which do not suffer from fatigue or ageing. The main advantage of pneumatic flexible shaft couplings is the possibility to change their torsional stiffness which depends on the gaseous medium pressure value in its pneumatic flexible elements. This makes it possible to suitably adapt the dynamic torsional stiffness of a pneumatic coupling to the actual operating mode of a mechanical system.

At our department, we deal with development, research and application of pneumatic flexible shaft couplings into mechanical systems. We focus mainly on continuous tuning of mechanical systems during their operation in terms of torsional dynamics using pneumatic flexible shaft couplings as active torsional vibration tuners. For the continuous tuning, we use electronic control systems, developed by us. Our extensive research in the field of pneumatic torsional vibration tuners and torsional dynamics also leads to improvements of our pneumatic tuners and control systems, e.g. [1—5], [7], [8]. In order to achieving specific operational properties, a new pneumatic tuner was designed and manufactured. The manufacturing was funded by the grant project VEGA 1/0528/20: „Solution of new elements for mechanical system tuning“. The aim of this article is to introduce this new pneumatic tuner, protected by means of the granted patent SK 278152 B6 [15], namely "Pneumatic coupling with enlarged compression volume" and the granted utility model SK 7442 Y1 [16], namely the "Pneumatic coupling with enlarged compression volume and damping ability".
Due to the reason that mechanical properties of mentioned pneumatic coupling were not experimentally determined yet, this article deals mainly with principles and expected properties of the coupling.

2. Materials and Methods

2.1. Pneumatic flexible shaft coupling tangential with enlarged compression volume

In the Figure 1 we can see the manufactured prototype of pneumatic flexible shaft coupling tangential with enlarged compression volume.

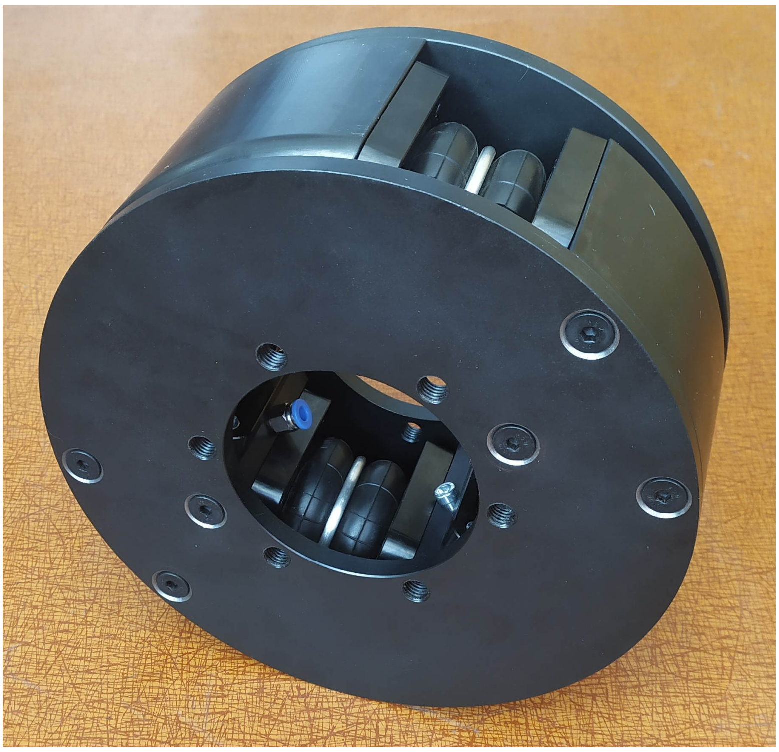


Figure 1. Pneumatic flexible shaft coupling tangential with enlarged compression volume

Figure 2. Inner arrangement of the pneumatic coupling

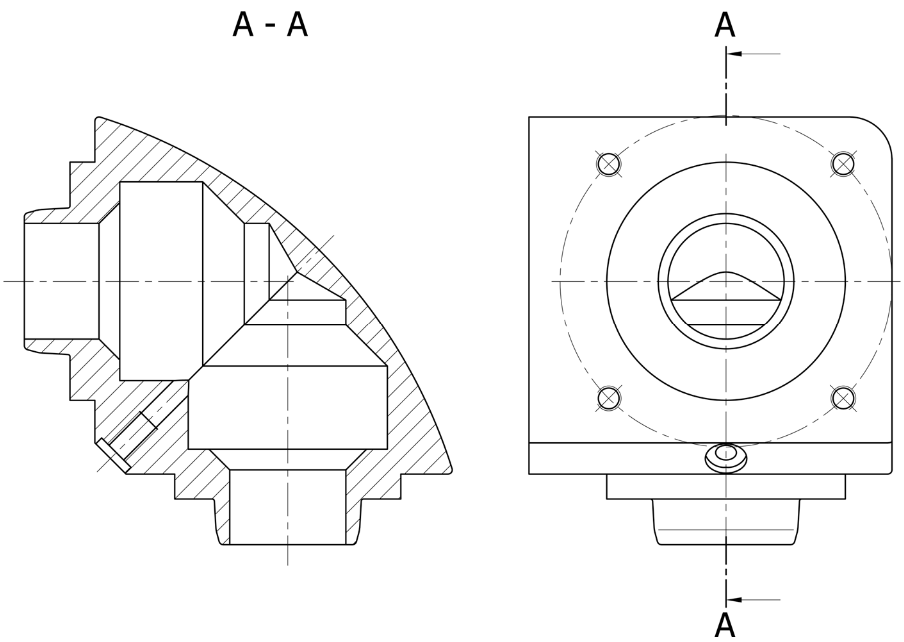
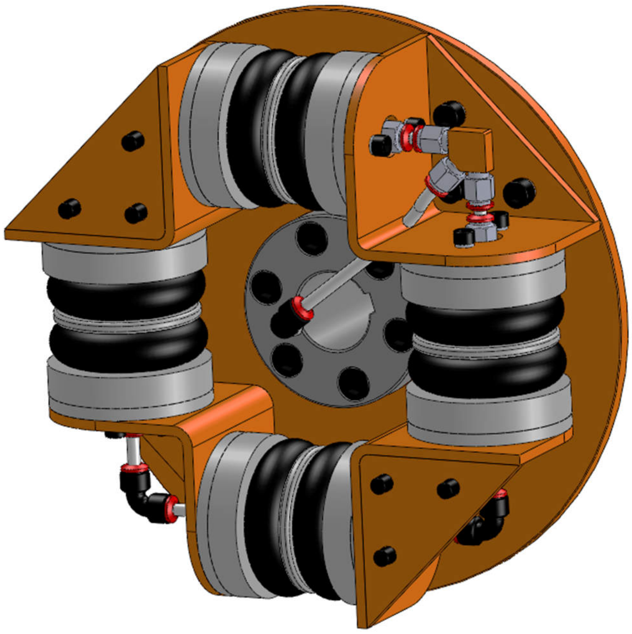


Figure 3. Hollow triangular-shaped interconnecting elements

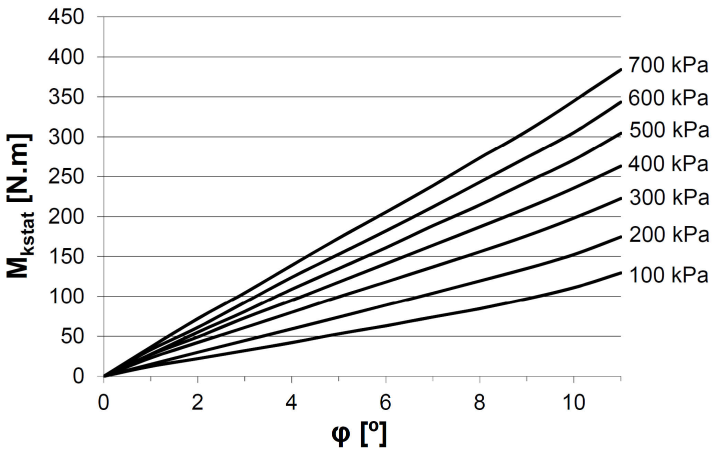
In the Figure 2 we can see the inner arrangement of the pneumatic coupling displayed in Figure 1. We can see that four Rubena-type [14] pneumatic flexible elements (DUNLOP 2 3/4ꝏx 2) are arranged tangentially and they are interconnected using special triangular-shaped elements, which are hollow. We can see the triangular-shaped elements in detail in the the Figure 3. The cavities which are created in the hollow triangular-shaped interconnecting elements enlarge the original compression volume, whereby the original compression volume is determined mainly by the volume of the four pneumatic flexible elements.

2.2. Expected properties of the coupling

Compared to the standard design of pneumatic flexible shaft coupling tangential (Figure 4), we can see that the visible interconnecting tubes were replaced using the hollow triangular-shaped interconnecting elements (Figure 2). This solution provides more reliable and durable design with enhanced aesthetic.



a)



b)

Figure 4. a) Standard pneumatic flexible shaft coupling tangential type 4-2/70-T-C and its static load characteristics b)

From the point of view of mechanical properties of pneumatic coupling, we expect the load characteristics (dependences of load torque M_k on the angle of twist of a coupling ϕ at various initial overpressure values in the compression volume of a pneumatic coupling – see for example Figure 4.b) of the new design to be more linear than the load characteristics of the standard pneumatic flexible shaft coupling tangential type 4-2/70-T-C (Figure 4). This is because larger volume of gaseous media is compressed so the overpressure in the compression volume will increase slower during twisting of the coupling.

3. Conclusion

The next research of the prototype of the pneumatic flexible shaft coupling tangential will be focused on determining the static and dynamic properties of the coupling, which means i.a. load characteristics, static and dynamic torsional stiffness, damping ability, etc. Determining the properties is crucial for determining the dynamic behaviour of a torsional oscillating mechanical system, where the coupling will be applied.

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