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Matej URBANSKÝ[1], Peter KAŠŠAY[2], Jozef KRAJŇÁK[3]

Supervisor: Robert GREGA[4]

PNEUMATYCZNE ELASTYCZNE SPRZĘGŁO TŁOKOWE O DUŻYCH MOŻLIWOŚCIACH TŁUMIENIA

Streszczanie: W artykule omówiono nowo opracowane pneumatyczne elastyczne sprzęgło tłokowe o dużych możliwościach tłumienia. Sprzęgło to może być stosowane w przemyśle motoryzacyjnym jako dwu-masowe koło zamachowe. Zostało ono tak skonstruowane, aby spełniać rolę sprzęgła pneumatycznego o wysokim poziomie podatności. Ma ono możliwość przenoszenia obciążeń skrętnych w obu kierunkach oraz tłumi drgania skrętne. Postać konstrukcyjna tego sprzęgła jest chroniona patentem.

Słowa kluczowe: pneumatyczne podatne sprzęgło wału, sprzęgło podatność, koło zamachowe dwu-masowe, zdolność tłumienia

PISTON PNEUMATIC FLEXIBLE SHAFT COUPLING WITH DAMPING ABILITY

Summary: The paper presents a newly developed Piston pneumatic flexible shaft coupling with damping ability, applicable in the automotive industry as a dual-mass flywheel. Its design is focused on creating a pneumatic high-flexible coupling, able to transmit a load torque in both directions and to dampen torsional vibration. The coupling is protected by means of a patent.

Keywords: pneumatic flexible shaft coupling, high-flexible coupling, dual-mass flywheel, damping ability

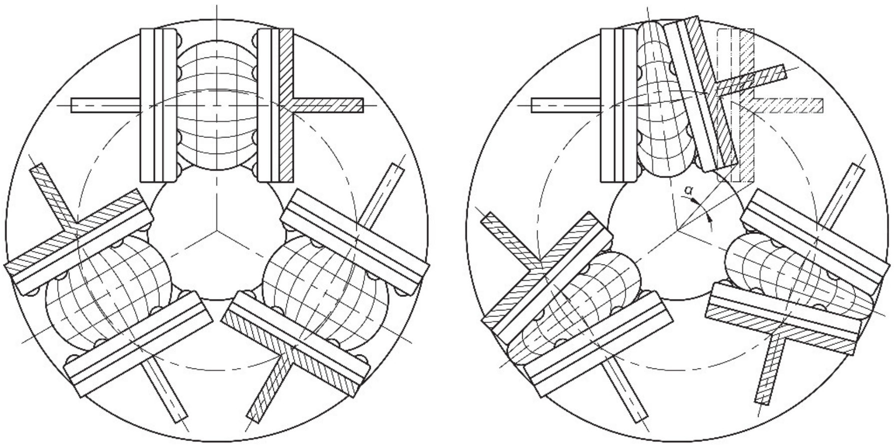
1. Introduction

Nowadays, flexible shaft couplings are the most utilized machine parts for the flexible transmission of load torque in machines with rotary power transmission, mainly

[1] Technical University of Košice; Faculty of Mechanical Engineering, Department of Machine Design and Transport Engineering; Matej.Urbansky@tuke.sk
[2] Technical University of Košice; Faculty of Mechanical Engineering, Department of Machine Design and Transport Engineering; Peter.Kassay@tuke.sk
[3] Technical University of Košice; Faculty of Mechanical Engineering, Department of Machine Design and Transport Engineering; Jozef.Krajnak@tuke.sk
[4] prof. Ing., PhD.; Technical University of Košice; Faculty of Mechanical Engineering; Department of Machine Design and Transport Engineering; Robert.Grega@tuke.sk

in order to avoid dangerous torsional 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. [2-5, 9].

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 elements and to the ageing and wearing down of the metal flexible elements of applied flexible coupling, e.g. [1, 7]. 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. [6, 8]. 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 (for example Fig.1) 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.



a) b)

Figure 1. A tangential pneumatic flexible shaft coupling, a) in basic position, b) in fully loaded state (at maximum twist angle α)

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. [2-5]. In order to improve the tuners in terms of better utilization of their pneumatic flexible elements and achieving specific operational properties, a new pneumatic tuner was designed. The aim of this article is to introduce this new pneumatic tuner, protected by means of the patent[5], namely the "Piston pneumatic flexible shaft coupling with damping ability". Due to the reason that mentioned pneumatic coupling is not manufactured yet, this article deals mainly with principles and expected advantages of the coupling.

2. Proposed pneumatic flexible shaft coupling

Proposed pneumatic flexible shaft coupling (Fig.2, Fig.3, Fig.4) is made up of a driving flange (1) and driven flange (2).

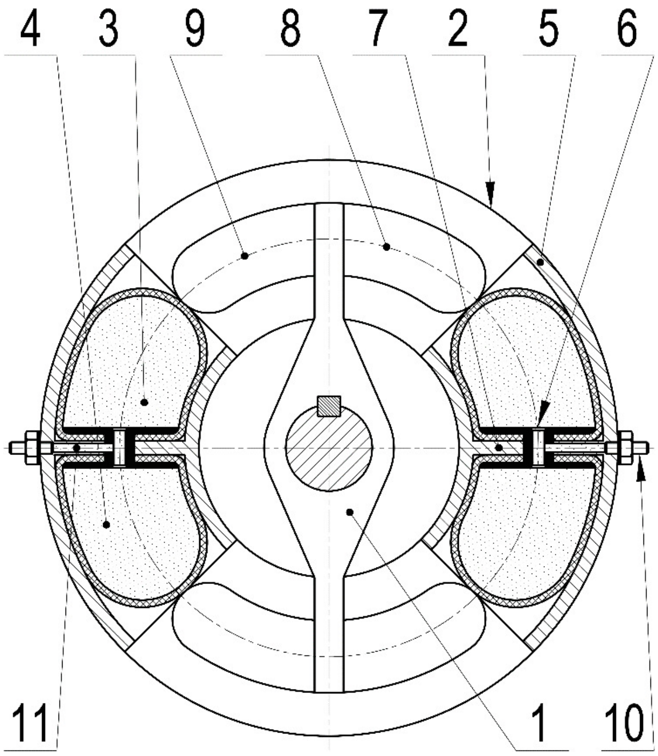


Figure 2. The piston pneumatic flexible shaft coupling with damping ability in unloaded state

Between the flanges are pneumatic flexible units, tangentially arranged. Each pneumatic flexible unit is made out of pushed right chamber (3) and pushed left chamber (4), filled with gaseous medium and placed motionlessly in the hollow cases (5), which are attached to the driven flange (2). Mutual interconnection of the

[5] Urbanský Matej, Homišin Jaroslav. 2016. *Piston pneumatic flexible shaft coupling with damping ability*. Patent No. SK 288443 B6. Banská Bystrica: ÚPV SR. 4 p.

chambers (3) and (4) is ensured using throttle jets (6) placed in support parts (7) of the hollow cases (5). Whole piston body consists of right piston body (8) and left piston body (9). Piston bodies (8) and (9) are attached to the driving flange (1). The pneumatic flexible units are inflated to required overpressure of gaseous media through the valves (10) and ducts (11). The basic position of the piston bodies and the driving flange (1) in relation to the driven flange (2) is herewith defined (Fig.2).
The transmission of a load torque in one direction causes the twist of the driving flange (1) in relation to the driven flange (2) and the left piston bodies (9) are therefore pushed into pushed right chambers (3) so that the pushed flexible right chambers (3) are shaped according to the piston bodies (Fig.3), while pushed flexible left chambers (4) remain undeformed. If the transmission of a load torque in another direction occurs, the process happens vice-versa.

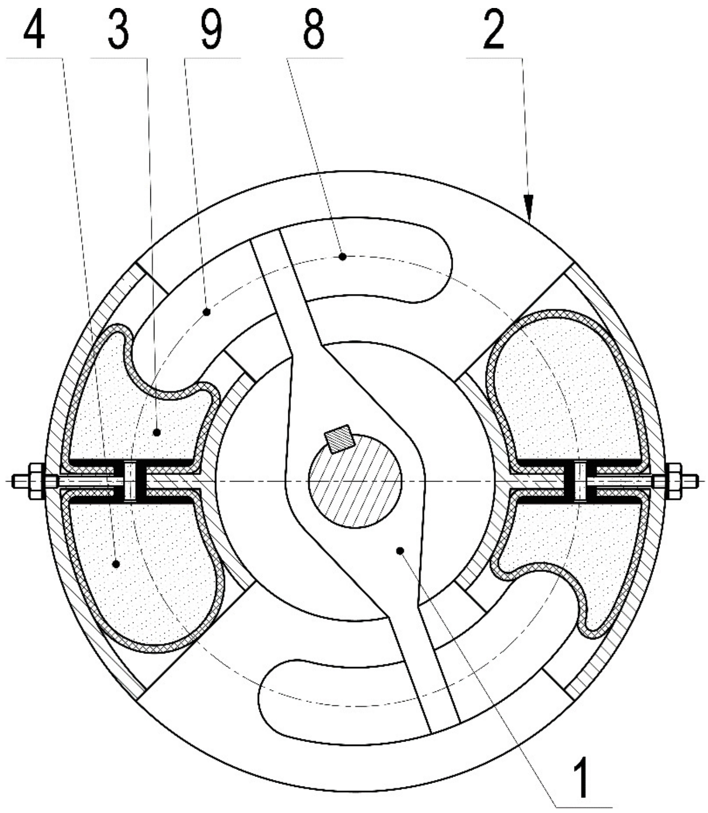


Figure 3. The piston pneumatic flexible shaft coupling with damping ability in a partially loaded state

The compression of gaseous media in pneumatic flexible units is proportional to the load, which causes a flexible torque transmission in mechanical systems. If the character of a load torque transmitted by the coupling is pulsating, the gaseous medium in pneumatic flexible units is forced to stream through throttle jets (6). Hereby, the throttling work (proportional to the damping work) is characterized.

The design of the coupling allows its maximum angle of twist of $\alpha = 40$ degrees (Fig.4)

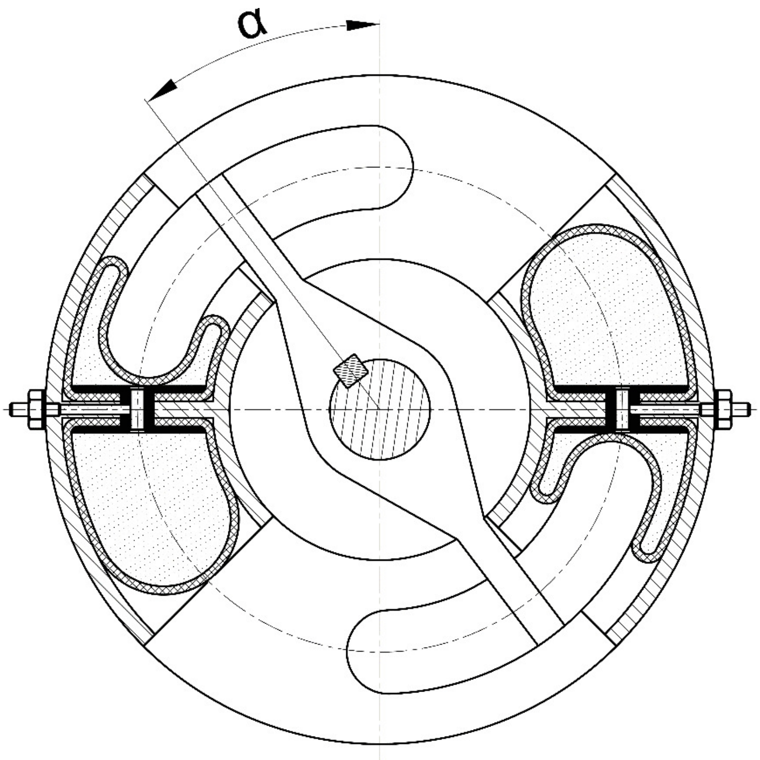


Figure 4. The maximum twist angle of the piston pneumatic flexible shaft coupling with damping ability

Conclusion

The piston pneumatic flexible shaft coupling with damping ability can be applied in systems of mechanical drives. It allows flexible torque transmission in both directions and thanks to the ability to change its torsional stiffness and to dampen torsional vibration, ensure the tuning of these systems at various operating conditions.
The design of the piston pneumatic flexible shaft coupling is focused on creating the high-flexible coupling which is able to transmit a load torque in both directions and to dampen torsional vibration. The current trend in the field of flexible shaft couplings, the most noticeable in automotive industry, is just the development and utilization of high-flexible couplings as dual mass flywheels. Because gaseous media throughout its lifetime is not subject to ageing, resulting that pneumatic couplings do not lose

their initial positive dynamic properties, it seems to be very advantageous to develop flexible couplings with the advantages of both pneumatic and high-flexible couplings.

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