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UNIVERSAL DRIVE WITH DAMPING ELEMENTS IN THE FORM OF TORSION SPRINGS

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Abstract. An improved universal drive has been developed, with the technical result of enhanced reliability and increased efficiency in damping torsional vibrations under non-stationary torque conditions during acceleration and deceleration. This is achieved through the simultaneous action of the damping properties of the installed springs under torsional vibrations and axial impact loads.

КАРДАННАЯ ПЕРЕДАЧА С ДЕМПФИРУЮЩИМИ ЭЛЕМЕНТАМИ В ВИДЕ ПРУЖИН КРУЧЕНИЯ

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Ключевые слова: приводной вал, демпфер крутильных колебаний, пружина кручения, карданная передача, карданный вал, карданный шарнир.
Аннотация. Был разработан приводной карданный вал, технический результат которого заключается в повышении надёжности и эффективности демпфирования крутильных колебаний в условиях нестационарного крутящего момента при разгоне и торможении. Это достигается за счёт одновременного демпфирующего эффекта установленных пружин, которые снижают крутильные колебания и осевые ударные нагрузки.

The proposed universal joint belongs to the field of mechanical engineering and is designed for use in the drives of mechanisms and machines to transmit torque between shafts positioned at an angle to each other.

A known universal joint [1] consists of a flexible shaft and a protective casing. The flexible shaft is made as a rope with crossed lay, with splined shafts featuring an external spherical surface located at its ends. The joint also includes flanges with bushings that have an external spherical surface, onto which bushings with an internal spherical surface are mounted. These are rigidly connected to a protective casing, which is constructed as two tubes sliding axially relative to each other. The disadvantages of this universal joint include its complex design, limited torque transmission capacity due to the strength constraints of the ropes used, and the labor-intensive maintenance process, which requires disassembling the universal shaft and detaching its coupling halves from the transmission.

Another known universal shaft [2] includes a connecting shaft, a first universal joint, a second universal joint, a coupling clutch, and a longitudinal axis. The shaft is loaded by spring mechanisms located in the displacement block of the connecting shaft, which also ensure centering of the fitting in a conical bore. The centering fitting features a base element secured to either the coupling clutch or the first universal joint. The disadvantages of this universal shaft include its complex design, limited torque transmission capacity due to the coupling clutch, and the labor-intensive maintenance process, which requires disassembling the universal shaft and detaching its coupling halves from the transmission.

A known universal joint [3] consists of two coupling halves and an elastic intermediate element positioned between them. This intermediate element is made up of several curved strips uniformly distributed around the perimeter of the coupling halves' ends. The universal joint is also equipped with spacers that ensure a guaranteed clearance between the strips. The disadvantages of this universal joint include increased wear of the elastic intermediate element, a complex design, limited vibration damping range due to its dependence on the clearances between the strips, and a labor-intensive maintenance process that requires disassembling the universal shaft and detaching its coupling halves from the transmission.

A known universal joint [4] includes two universal joints rigidly connected by a detachable universal shaft. The shaft features a movable axial connection at its center, designed as a splined tailpiece on one shaft half inserted into a corresponding splined sleeve on the other shaft half. This arrangement allows for axial reciprocating movement of the shaft halves and torque transmission, while simultaneously damping axial loads through a tension-compression spring installed on the splined sleeve within a protective casing. The disadvantage of this universal joint is the lack of torsional vibration damping during non-stationary moments, such as acceleration and deceleration. This can lead to failures, such as twisting of the universal shafts, reducing their service life and, consequently, the overall reliability of the system.

The objective is to improve reliability and efficiency in damping torsional vibrations during non-stationary moments, such as acceleration and deceleration, by eliminating friction and wear of the elastic intermediate element while simplifying the universal joint's design.

This objective is achieved by modifying the known universal joint, which includes two universal joints rigidly connected by a detachable universal shaft with a movable axial connection. The connection is formed by a splined tailpiece on one shaft half inserted into a corresponding splined sleeve on the other half, allowing axial reciprocating movement of the shaft halves and torque transmission while damping axial loads.

In the proposed design, the universal joints are movably connected to the detachable shaft, enabling reversible axial and angular movements under axial loads and torque. The universal joints are connected to the detachable shaft via torsion springs with mutually opposite windings. These springs are installed concentrically along the axis in radial grooves of the detachable shaft halves and the universal joints. The springs are secured at their end coils to the universal joint and the corresponding detachable shaft half, enclosed within protective casings. The casings are attached to the detachable shaft halves in a removable manner, allowing parts of the shaft to be replaced or repaired without disassembling the entire universal joint, while also securing the torsion springs in the radial grooves to prevent bending and unwinding.

The technical result is enhanced reliability and damping efficiency of torsional vibrations during non-stationary moments, achieved by the combined damping action of the installed springs during torsional vibrations and axial impact loads [5].

Cardan Drive (fig. 1) consists of two cross-shaped universal joints, each featuring a spider with trunnions (1). Cups (2) are mounted on the trunnions, containing needle rolling elements (3) arranged concentrically relative to the trunnion axis. These are installed on two opposing trunnions via cups and retaining rings (4) in fork holes equipped with flanges (5) for external attachment of the Cardan drive. The other two trunnions, along with the cups and needle rolling elements, are secured in yokes integrated with the shaft ends (6 and 7) of the Cardan shaft. These shaft ends are equipped with special diametrical grooves housing spring elements (8) and fasteners (9) for fixing the spring elements' ends to the yokes. The opposite ends of the spring elements, positioned along the Cardan drive axis, are fixed on the shaft ends in a similar manner. One or both shaft ends of the Cardan drive feature a sleeve (10) with internal splines (11), accommodating the Cardan shaft (12) with matching splines (13). This setup allows axial movement within the splines (11) when the Cardan drive angle changes. The spring elements (8) are protected by housings (14) and seals (15). The external flange (5) of the Cardan drive, to which torque is applied, is referred to as the input flange, while the opposite external flange is called the output flange.

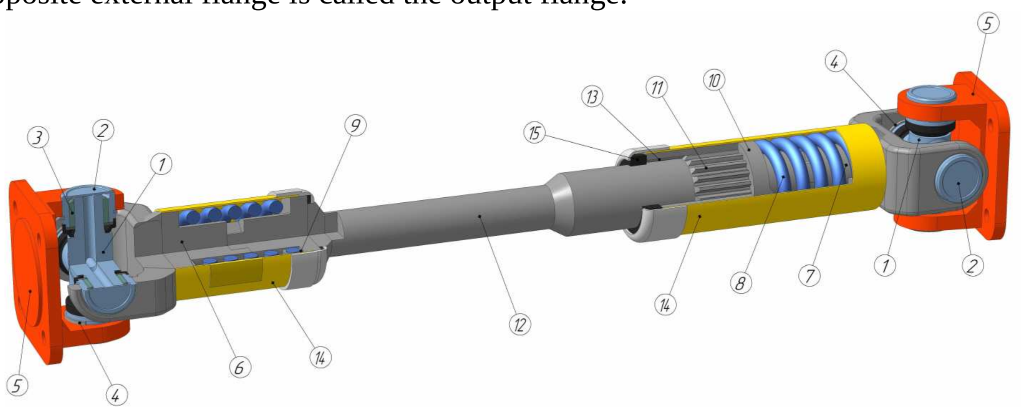

Fig. 1. Universal drive with damping elements in the form of torsion springs

Operation of the Cardan Drive: the rotational torque is transmitted through the input flange (5) to the spider (1), then to the fork integrated with the shaft ends of the Cardan shaft (6). From there, it is transferred through the input spring element (8) to the sleeve (10) with internal splines (11). The torque is further transmitted via the Cardan shaft (12) and the output spring element to the output flange (5). Protective housings (14) and seals (15) shield the springs from contaminants and foreign objects. When the angle of inclination of the Cardan drive changes, the Cardan shaft (12) moves within the splines (11), proportionally adjusting the inter-flange distance of the drive while maintaining its functionality. In the presence of torque fluctuations, the spring elements dampen dynamic loads through the elastic deformations of the spring elements (8).

The technical result is an improvement in reliability and efficiency of torsional vibration damping under non-steady torque conditions during acceleration and deceleration. This is achieved through the simultaneous damping effect of the installed springs, which mitigate torsional vibrations and axial impact loads [6].

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