FEATURES OF THE MAGNETORHEOLOGICAL DAMPER IN COMPARISON WITH OTHER TYPES OF MAGNETIC DAMPERS

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A damper is a device that is mostly used to extinguish or prevent mechanical oscillations and vibrations that occur during the operation of machines as part of structural elements or in kinematic hinge mechanisms. They reduce the impact of these mechanisms and absorb most of the axial loads that occur due to the movement of the rod and piston. Magnetic dampers are used in the production and rewinding of: wires, cables, threads, in winding and knitting equipment; in the production of fishing line, winding wire, synthetic and natural threads and cord; in the paper, textile and packaging industry. The magnetic type of the damper has a stable torque regardless of the speed of rotation, does not change during stopping and acceleration, and is also not prone to slipping.

Magnetic dampers. In this type of damper (see Fig. 1.), vibration damping occurs not only due to viscous friction in the throttle elements, but also due to the selective placement of magnets. This allows the reduction or increase in the force of resistance due to the interaction of magnetic poles, when opposite or identical poles meet, respectively. Effective selection of the configuration and location of the magnets can significantly vary the support force of the damper, in particular at the final stages of the "compression" and "expansion" modes.

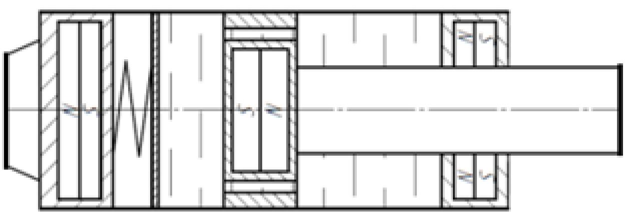

Fig. 1. Simplified diagram of a magnetic damper

Magnetic dampers are distinguished by the ability to significantly change the resistance force and the ability to include a variable resistance diagram in the final stages of the "compression" and "expansion" modes. These dampers are independent. However, they can have significant length, which complicates their application in some mobile robotic systems, and the problem of sensitivity to temperature remains partially unsolved.

Electromagnetic dampers. Compared to other types of dampers, electromagnetic dampers are technologically more complex. They need an external energy source. These dampers, despite the higher complexity and cost, solve more tasks. By powering the stator or coil, it is possible to precisely and quickly adjust the magnetic interaction with the guide elements and permanent magnets. In addition, the design allows generating electricity during the operation of the damper (see Fig. 2). This ensures accurate adjustment of the resistance force in a wide range [1].

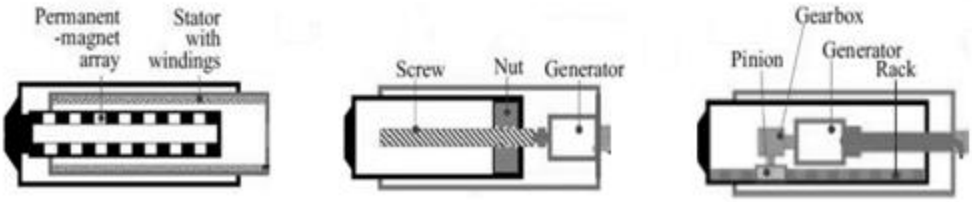

Fig. 2 – Schematic representation of electromagnetic dampers

The use of a mechatronic system, including a controller and sensors, provides a stable operation of the damper in a wide temperature range and influence the resistance diagram.

Magnetorheological dampers. The viscosity of a magnetorheological fluid can change several times faster due to an applied magnetic field, with a response time of up to 40 ms. This liquid retains its activity at low temperatures (up to -25°C), which makes it suitable for use in a wide temperature range. An effective way to control the characteristics of a magnetorheological damper is to use throttle holes and a concentric gap to influence the fluid with an alternating magnetic field. This ensures high accuracy of liquid viscosity regulation, especially under the conditions of narrow gaps [2-3]. Magnetorheological fluid can exist in two states: unactivated and activated. In the unactivated state, it is Newtonian, while in the activated state, sliding stresses occur, which makes it difficult for the fluid to move through the gap.

The proposed design solution (see Fig. 3) provides an opportunity to effectively solve problems associated with the functional characteristics of the damper. Winding management is implemented through a controller connected to an external power source. Therefore, the device provides thermal stabilization and adjustment of the characteristics of the magnetorheological fluid, especially in the throttle channels, which is optimal in terms of energy efficiency [4].

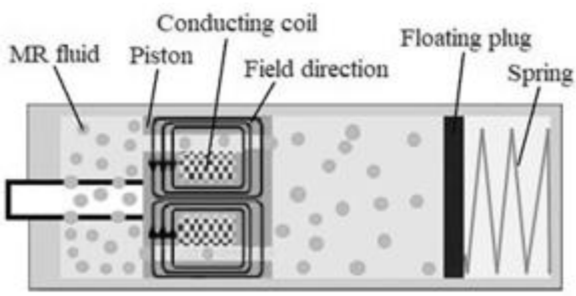

Fig. 3 – Schematic representation of a magnetorheological damper

The main characteristics of a magnetorheological fluid include dependencies such as: the variation of the yield stress with the intensity of the applied magnetic field and the variation of the shear stress according to the shear rate gradient in the non-activated state of the fluid. Application of these dependencies allows you to accurately calculate the necessary geometric parameters of devices and their channels. It follows from the dependence of the yield stress on the strength of the magnetic field that there is a saturation effect in magnetic fluids [5]: after reaching a certain level of the intensity of the magnetic field, the yield stress remains almost unchanged, and a further increase in the strength of the magnetic field does not significantly affect the rheological properties of the liquid (starting with a magnetic field intensity of 200 kA/m - the "saturation point").

The peculiarity of magnetorheological dampers is in the application of ferromagnetic and magnetorheological fluids as a working medium. These fluids allow you to precisely control the characteristics of the damper. The use of sensors and a controller allows you to set the necessary resistance diagrams.

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