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Langley Research Center



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Two-Directional Active Damper

The active damper system shown in Figure 1 is to be used in studies of payload isolation technology and for the investigation of related dynamic control problems. Because of weight and power consumption considerations, the active damper is probably not suitable for full-scale applications. As a laboratory apparatus, however, it appears to be versatile and useful in a number of ways. It provides easily adjustable damping and, simultaneously, acts as a multichannel shaker system.

The active damper consists of a permanent magnet assembly, an armature with four flat planar coils, a relative velocity sensor, and a suspension system. The key element is the armature windings. The magnetic field between the parallel flat pole faces of the primary field magnet is almost uniformly distributed and has a distinct outline which is nearly the same as that of the pole faces. The flux lines are normal to the pole faces and are approximately straight. The armature coils are located partially between the pole pieces.

The region of appreciable magnetic field for the armature coil assembly is as shown inside the dashed boundary of Figure 2. The pair of coils a and c must be used in unison. When electrical currents of equal magnitude, I_{ac} , pass through these two coils, equal and opposite forces are generated on the armature and on the magnet. The direction of the resultant force, \bar{F}_{ac} , acting on the armature due to the currents in coils a and c is illustrated. The magnitude of this force is proportional to the instantaneous magnitude of I_{ac} .

Coils b and d are used in the same way except that the direction of the resultant force, \bar{F}_{bd} , generated by them is always perpendicular to \bar{F}_{ac} . Consequently, both the magnitude and the direction of the resultant

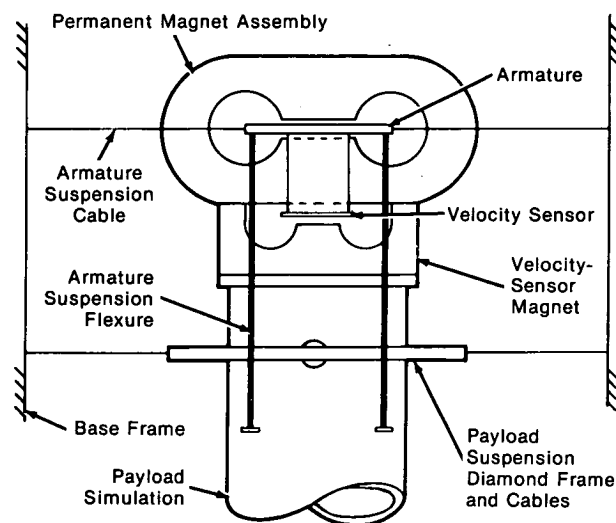


Figure 1. Active Damper Installation System

force ($\bar{F} = \bar{F}_{ac} + \bar{F}_{bd}$) can be controlled by the magnitude, phase, and direction of currents I_{ac} and I_{bd} .

In order to use the electromagnetic actuator as an active damper, the resultant force must be controlled and made proportional to the relative velocity between the armature and the field magnet. This is accomplished with the two-directional relative velocity sensor shown schematically in Figure 3. The secondary field magnet is rigidly attached to the primary magnet. The search coils are mounted on and move with the armature plate and act as a dc generator. The open-circuit output voltage, e , is proportional to the relative velocity between the secondary field magnet and the search coil.

The design arrangement is such that the output e_a of the search coil, a , is proportional to the instantaneous relative velocity component V_a in the direction a

(continued overleaf)

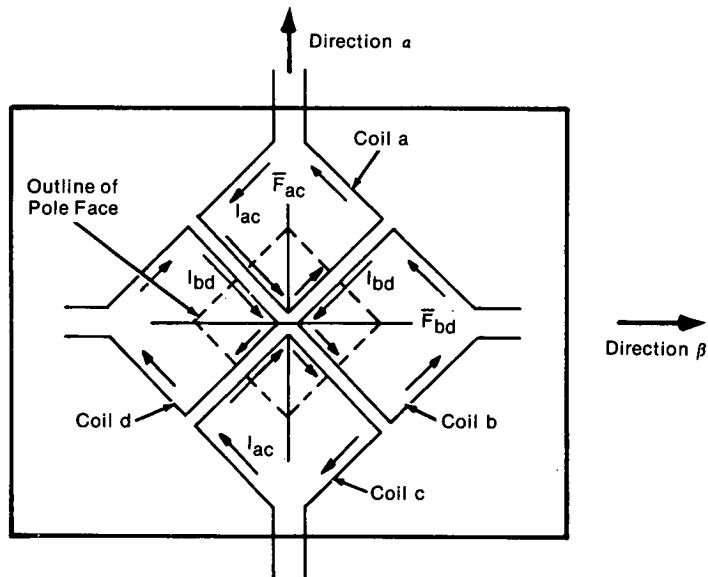


Figure 2. Current and Force Components in Armature Coil Assembly

shown in Figure 2. The operation of search coil β and the armature coils b and d is similar. The combination of the actuator and the velocity sensor makes it possible to generate damping forces in any direction

Notes:

1. Further information is available in the following report:
NASA CR-132550 (N75-14808), Study of Providing Omnidirectional Vibration Isolation to Entire Space Shuttle Payload Packages

Copies may be obtained at cost from:

North Carolina Science & Technology
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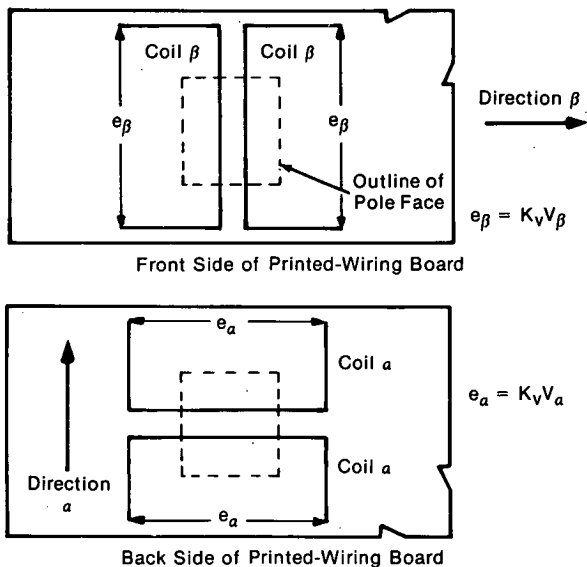


Figure 3. Two-Dimensional Relative-Velocity-Sensor Schematic in the plane of the armature plate. This system can provide damping for two translational modes and for two rocking modes (e.g., pitch and yaw modes when they coincide with the principal coordinates of the system). During tests, it has provided up to 30 percent damping.