NASA TECH BRIEF

Hermetically Sealed Vibration Damper

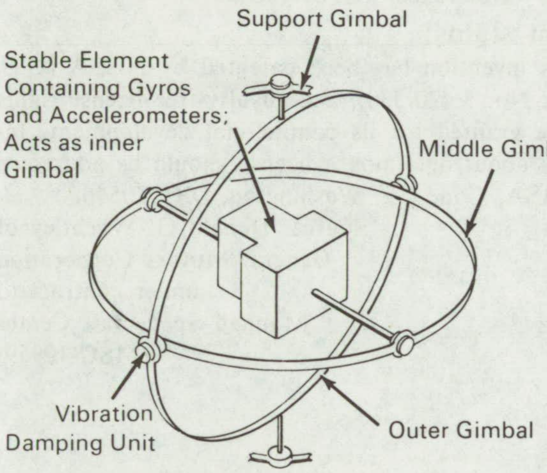

Figure 1. Gimbal-Mounted Inertial Measuring Unit

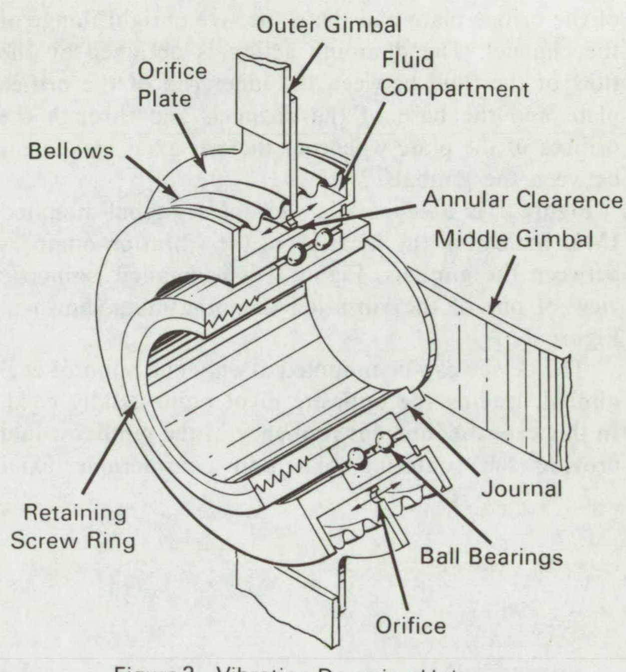

Figure 2. Vibration Damping Unit

The problem:

To devise a means of damping the effects of external vibration and shock on inertial measuring units (IMU) of guidance and navigation systems. The information provided by IMU is highly critical because the reliability and accuracy of the entire guidance system depends upon the capacity of the gyroscopic components to maintain preset references and provide accurate readouts. Imperfections in the operation of gyros can cause drift, which, if known and constant, can be corrected and the error compensated. A major problem, however, may arise if the rate of drift is not constant. This condition can be caused by severe shock and turbulence, such as, for example, that which occurs in the flight of the spacecraft, especially during the phases of launch and re-entry.

The solution:

A relatively simple, hermetically sealed, fluidic vibration damper has been devised for installation at each pivotal mounting between gimbals to isolate the inertial sensors from external vibration and other disruptive forces. Shock mounts cannot be used to isolate the outer housing because of structural requirements; consequently, if isolators are used, they must be located inside the housing. Although resilient elastomeric isolators can somewhat dampen

(continued overleaf)

vibration, they are ineffective for vibrations of high intensity; therefore, fluid damping, which will give the degree of isolation necessary to cope with the forces likely to be encountered in flight, is employed in this device.

How it's done:

A fluid damper has been integrated into the basic structure of the gimbal-mounted IMU at the pivotal mountings between the gimbals. An annular channel defines the bearing for the journal of one gimbal of the assembly. The co-operating gimbal is attached to an annular orifice plate that fits closely around the channel and reciprocally slides between the confines of the upright flanges of the channel. The channel is filled with damping fluid and sealed by a flexible bellows that is connected and hermetically sealed at each face of the orifice plate and the respective upright flange of the channel. The damping action is obtained by the flow of the fluid between the inner rim of the orifice plate and the base of the channel, and through the orifices of the plate whenever there is axial movement between the gimbals.

Figure 1 is a schematic view of a gimbal-mounted IMU indicating the location of the vibration dampers between the gimbals. Figure 2 is a detailed isometric view of one of the vibration damping units shown in Figure 1.

The device can be mounted at only one point of each gimbal, leaving the opposite pivot point axially rigid. In this case the inherent resiliency of the gimbal would provide the centering bias and considerable axial damping would still be obtained. It is envisioned that the entire gimbaled structure can have such a device incorporated at the pivotal junction between each of the gimbals in each of the three axes, either singly or in pairs. This arrangement could effectively dampen vibration and shock in any direction, and, at the same time, permit free relative rotation of the gimbals.

Notes:

1. Although this innovation was designed for guidance systems in spacecraft, it could be useful in any application of inertial guidance and navigation systems, regardless of the type of platform employed.
2. Documentation is available from:
   Technology Utilization Officer
   Manned Spacecraft Center
   Houston, Texas 77058
   Price $3.00
   Reference: TSP69-10634

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,420,338), and royalty-free license rights will be granted for its commercial development. Inquiries about obtaining a license should be addressed to NASA, Code GP, Washington, D.C. 20546.

Source: Donald G. Wheatley of
General Motors Corporation
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