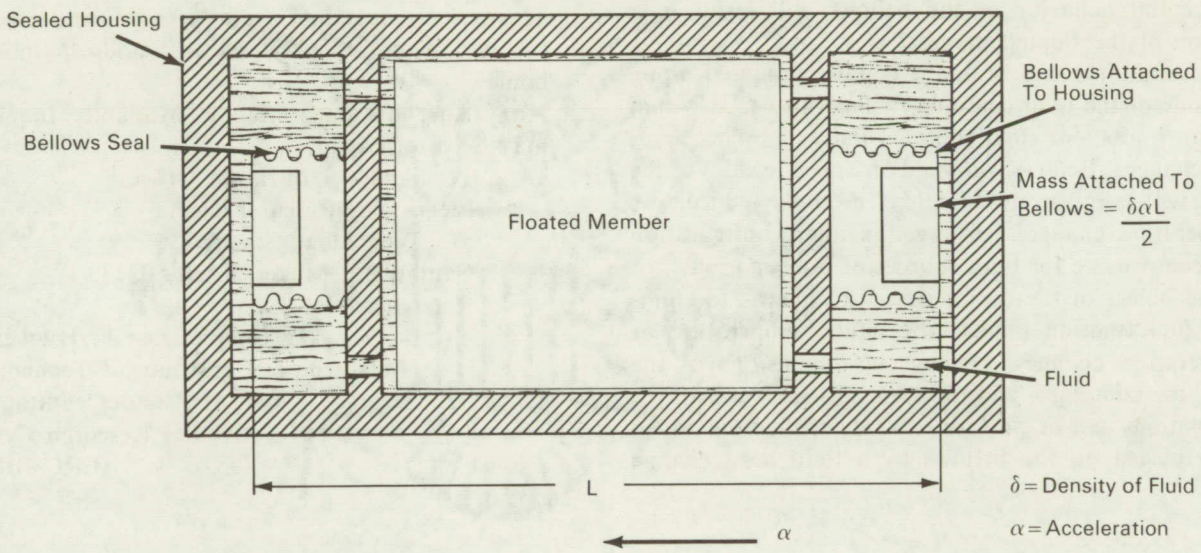
# NASA TECH BRIEF



## Acceleration Insensitive Fluid Expansion Compensator




To achieve high performance levels in floated-angular and acceleration-sensitive instruments, the floated member must be free to rotate about the output axis with minimum friction. The floatation plus magnetic suspension provide a friction-free rotational axis for the floated member. Float motions parallel or perpendicular to the output axis will, due to extreme rotational sensitivity of the float, produce error rotations about the output axis.

A device has been reduced to prototype stage that compensates for temperature and acceleration effects on a fluid-floated mass in a sealed container. It compensates for the action of these forces on the floated member of a high performance angular or acceleration sensing instrument.

An essentially incompressible fluid with a cubical expansion greater than the sealed housing containing it, will at some increased temperature create a pressure sufficient to rupture the container. However, fluid pressure can be maintained below the rupture strength of the container by a volume compensation capsule.

The volume compensation capsules, sealed bellows, used in present-day sensing instruments are required to have a volume compensation-to-pressure relationship that is sufficient to maintain a specified pressure level over a known temperature range. The bellows are mounted in holes about the floated member of the instrument. As the fluid expands with increasing temperature, the bellows contract and the fluid pressure remains essentially constant within predetermined limits.

In a hole without a bellows, expanding fluid must flow to equalize the pressure. The floated member has

(continued overleaf)

a small clearance with the walls of its container (a few thousands of an inch), and is a restriction to the fluid flow. Because of the fluid flow restriction, the pressure in the hole will rise and act on the surface of the float, resulting in motion of the floated member. Temperature changes cannot cause float motion if bellows are mounted in all the holes surrounding the periphery of the floated member since the fluid pressure forces are then held in equilibrium.

However, bellows mounted about the periphery of the floated member, in particular two bellows mounted on opposite sides of the float, cannot compensate for acceleration-induced float motion. With this configuration, a pressure gradient is created by the fluid head that accompanies a change in acceleration and will expand one bellows while contracting the other. The differential behavior of the bellows will result in a motion of the floated member.

In summary, one or more bellows mounted along one side of the fluid container will compensate, within certain limits, for float motions induced by acceleration changes. Bellows mounted on opposite sides of the float will compensate for float motions induced by temperature changes. However, neither configuration will compensate for both sources of float motion.

The object of the device described here is to eliminate float motion induced by either temperature or acceleration changes. Having the dimensions of the float, the container, and the constants for the bellows, calculations can be performed to determine the added force placed on the bellows by a fluid head change caused by a change in acceleration. Knowing the force added by the fluid head, a mass can be determined that will produce the same force on the bellows for any acceleration. This calculated mass can be fastened to one end of the bellows and the other end of the bellows fastened to the container. The bellows end fastened to the container is the one towards the center of the float.

With a change in acceleration, the force acting on the bellows changes due to the fluid head in the usual manner, but the mass fastened to the end of the bellows applies an equal and opposite force; therefore, there is no motion of the bellows.

If every hole distributed about the float has a bellows with an attached mass as above, the float will not move due to acceleration or temperature changes.

**Notes:**

1. This design could find use in precision instruments for the regulation of gases or liquids in moving bodies.
2. No further documentation is available. Inquiries may be directed to:

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   Electronics Research Center
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   Reference: B68-10559

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