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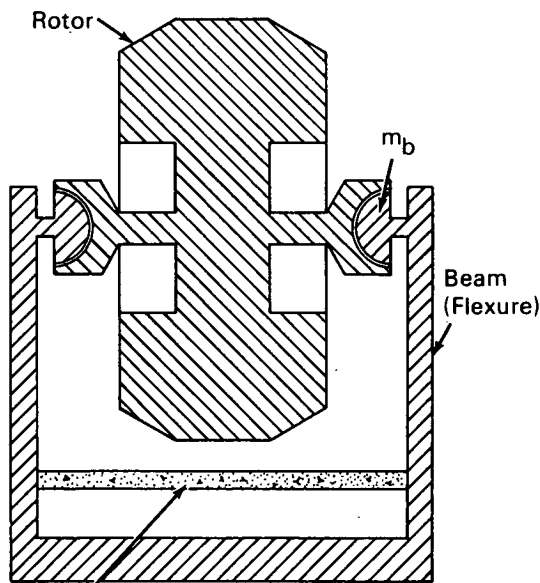
# NASA TECH BRIEF



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## Hydrodynamic Squeeze-Film Bearings for Gyroscopes

For the past six years, intensive studies have been conducted on squeeze-film bearings and grease or oil bearings for gyroscopes and high angular momentum wheels. Squeeze film bearings operate on a vibration principle and can be considered, in some respects, as self pressurizing bearings. Primary advantages are: compactness; simple construction; easy regulation;



Piezoceramic Bar

and minimal friction, requiring only the use of ambient gas as a lubricant.

Grease or oil bearings are cones or spheres resting in receptacles of matching shape. Spiral grooves are carefully etched or machined into the bearing so that the lubricant is carried by the grooves as the bearing turns. This forces the lubricant to the bearing apex,

where enough pressure is generated to hold the bearing free of the receptacle.

Testing was carried out by applying electricity to piezoelectric ceramics, causing vibrations at thousands or millions of Hz that were amplified and transmitted to the bearing. The first cycle or two separated the journal from the bearing and admitted air to the minute space between them. The continued vibration held the contained air to an average pressure that was higher than ambient and prevented the opposed surfaces from touching. These bearings are quite different from hydrostatic bearings ("air bearings") which require constant play of a stream of air between the surfaces. Tech Brief B68-10180 describes the concept in detail (see fig.).

The rotor ran smoothly through 24,000 rpm without apparent whirl instability. The squeeze-film transducer provided a squeeze amplitude up to 400  $\mu$ in. peak to peak at a frequency of 4800 Hz. The squeeze-film bearing proved its ability to support the rotor's weight (0.3 lb) without the hydrodynamic action.

Start-up and coast-down data from the rotor were taken both with and without the squeeze-film action. During both start-up and coast-down the squeeze-film bearing helped to maintain a gas film; the effect is more evident in the coast-down data. The existence of the gas film during starts and stops eliminates sliding damage and reduces criticality of surface-material problems. Since the start-up friction accounted for about 50% of the available motor torque, the squeeze-film action also eases electrical design requirements of the spin motor. Thus the fundamental feasibility and the conceptual validity of squeeze-film assistance for the hydrodynamic, gas-lubricated, spin-axis bearing during starting and stopping have been experimentally demonstrated.

(continued overleaf)

**Note:**

Requests for further information may be directed  
to:

Technology Utilization Officer  
Code A&TS-TU  
Marshall Space Flight Center  
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No patent action is contemplated by NASA.

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