NASA TECH BRIEF
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Design Curves for Optimizing Stability of Herringbone-Grooved Journal Bearings

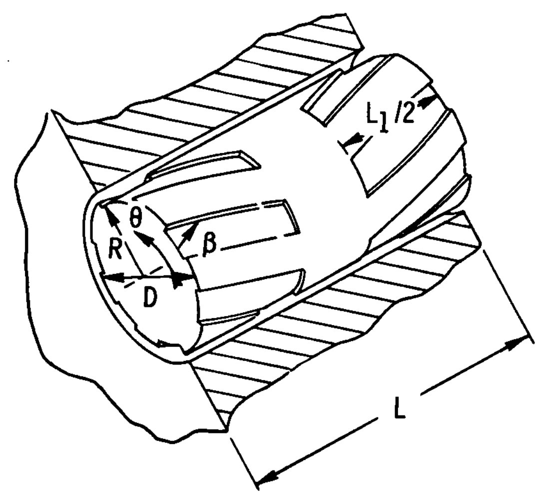
Design curves have been developed for optimizing herringbone-grooved bearing design parameters to maximize bearing stability and load bearing capacity. The curves span a wide range of operating conditions, including: lubricant compressibility numbers from 0 (incompressible) to 80, bearing length-to-diameter ratios from ¼ to 2, and either rotating or stationary grooved members.

The herringbone-grooved journal bearing was investigated in quest of a bearing which would overcome the two problems of self-excited whirl instability and load capacity. The objective of this study was to determine groove parameters which would maximize the stability of the bearing, or the resistance to self-excited whirl.

More than any other factors, self-excited whirl instability and low load capacity limit the usefulness of gas-lubricated self-acting journal bearings. The whirl problem is the tendency of the journal center to orbit the bearing center at an angular speed less than or equal to half that of the journal about its own center. In many cases, the whirl amplitude is large enough to cause destructive contact of the bearing surfaces.

The low load capacity of self-acting gas-lubricated journal bearings is also a serious concern in many applications, largely because of the low viscosity of gases. Also, unlike a liquid lubricant, a gaseous lubricant changes its density as it passes through the bearing. This so-called compressibility effect results in a "terminal" load condition. That is, the load capacity does not increase indefinitely with speed, but quickly approaches a fixed value.

The figure shows the bearing studied. The bearing has angled, shallow grooves in the journal surface. The grooves can be partial as shown or extend the complete length of the bearing. Also, the grooves can be placed in the rotating or non-rotating surface. The purpose of these grooves is to pump fluid toward the center of the bearing and thereby increase the lubricant pressure in the bearing. This self-pressurization can increase the load capacity over that of a smooth bearing; it is also responsible for the good stability of the herringbone bearing. The herringbone bearing is unidirectional; that is, it pumps inwardly for only one direction of rotation.



From the design curves, optimum groove configurations were determined to maximize the stability of herringbone-grooved journal bearings.

Compared with bearings optimized to maximize load capacity, bearings optimized for stability (1) allow a thousandfold increase in bearing-supported mass in some cases before onset of instability (the most pronounced increases are for bearings with small length-to-diameter ratios operating at high compressibility numbers), and (2) lose no more than 77 percent of their load capacity in any case studied. Stability is much greater when the grooved member rotates.

Notes:

1. These design curves should be of interest to manufacturers and users of bearings and general rotary equipment.
2. Further information is available in the following report:
   NASA TN-D-7803 (N74-34888), Optimization of Self-Acting Herringbone-Grooved Journal Bearings for Maximum Stability

(continued overleaf)

Copies may be obtained at cost from:
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