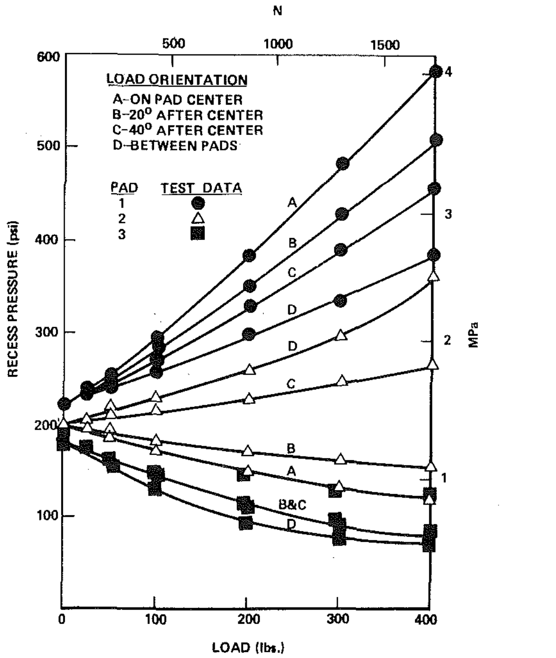

Fig. 10 Measured recess pressures for a three-pad, 2-in. (50.8 mm) dia Fluid Pivot journal bearing with new cams and ramps at a speed of 200 ft/s (61.0 m/s) and at various loads and load orientations. The test bearing had an (*L/D*) = 0.4, diametral clearance = 0.003 in. (0.08 mm), preload factor = 0.5, recess position = 6 deg downstream from center, and used 150 SUS @ 100°F (37.8°C) oil

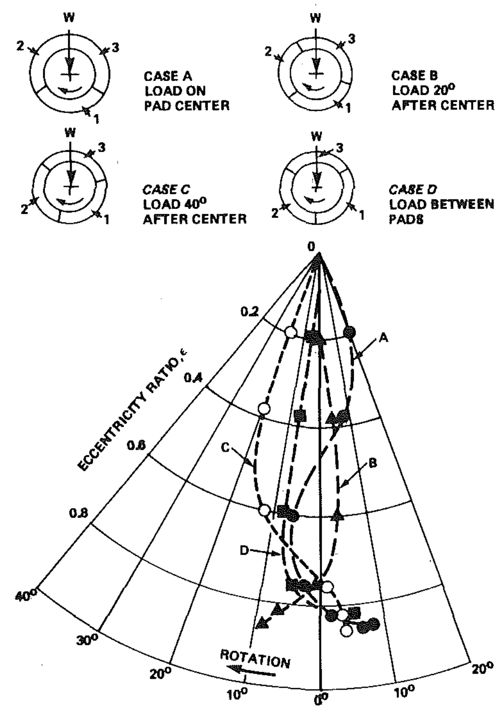

Fig. 11 Measured loci at various load orientations for the three-pad Fluid Pivot journal bearing with new cams and ramps. Experimental data are from the same tests considered in Fig. 10.

puter program. As of this writing, modifications to the computer program to account for the nearly vertical locus and the downstream position of the pad recess are being investigated. The behavior of the recess pressures reported in Fig. 10 shows that all pads generate hydrodynamic/hydrostatic action over the entire range of load orientations tested. This is significant since certain kinds of loading (e.g., gear loading) may vary considerably in both magnitude and direction.

The attainment of a vertical locus is expected to help the Fluid Pivot journal bearing realize its full $\bar{D}_{XX}$ damping potential (in accordance with the results of [3]) and also help to minimize any instability problems which might result from its previously high attitude angle and correspondingly high cross-coupled stiffness.

Conclusions

A new type of tilting pad journal bearing has been developed through a combination of research and testing, service experience, and computer analysis. The basic principle of operation of the Fluid Pivot journal bearing has been verified both experimentally and analytically. This bearing offers several advantages compared to conventional mechanically pivoted journal bearings:

(1) a simpler, more compact design,

(2) only 40–60 percent of the power loss and corresponding oil flow requirements,

(3) substantially higher damping, particularly at lighter loads,

(4) the elimination of a mechanical pivot, seals, and associated problems, and

(5) the ability to monitor pad recess pressures, which gives a good indication of the proper performance of each pad.

References

1 "Hydrostatically Supported Tilting Pad Journal Bearing," U. S. Patent No. 3,549,215 (1970); invented by L. W. Hollingsworth and assigned to Pioneer Motor Bearing Company, South San Francisco, Calif.

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DISCUSSION

A. J. Smalley[2] and D. F. Wilcock[2]

The authors should be congratulated on an excellent and informative paper. It makes clear the painstaking effort which has gone into the development of this bearing and presents, most effectively, the constructional and operational features of the bearing.

Our interest in the Fluid Pivot Journal Bearing originated when we were asked to develop the computerized analysis of the bearing whose results are reported in the paper. This project itself presented both a significant challenge and the reward of simulating, as observed, the remarkable mechanical characteristics of this bearing.

Our analysis was for the original design with vertical stops at the down stream end of each pad. As outlined in the paper, it was our prediction that the freedom of the pads to lift, while restrained by a vertical stop, reduced, but did not fully eliminate cross coupling stiffness effects nor the potential for hydrodynamic instability. The recent developments of profiled cams and ramps at the down stream end of each pad, and shifting of the recess to a down stream position, have experimentally achieved the near vertical journal locus which is characteristic of stable bearings. It is to be hoped that, in the future, there will be prediction and experimental verification of the dynamic stability promised by these results for the new configuration.

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Authors' Closure

We appreciate very much the discussion by Drs. Smalley and Wilcock. Due to space limitations, we could not describe in detail all of the interesting aspects of their computer analysis, which would be deserving of a paper in itself. The analysis proved extremely valuable in subsequent development of the bearing.

Recent tests of the bearing in its new configuration by rotating machinery manufacturers have indicated considerable improvement in dynamic performance. We share with Drs. Smalley and Wilcock the hope that further analysis and experimental data will continue to confirm the benefits to be expected with the attainment of a vertical locus.