NASA TECH BRIEF
Marshall Space Flight Center

Turbopump Radial and Axial Rotor Support System

A turbopump rotor bearing which allows the rotor to operate above the first two lateral critical speeds and a self-compensating thrust balancer with a capacity of 0 to 200,000 lbs. (0 to 27,600 N) of thrust have been developed for operation at cryogenic temperatures and high pressures. The turbopump rotor support system has two sets of preloaded angular contact bearings, one set near each end of the turbopump, mounted in radially flexible springs with predetermined stiffness, for lateral critical speed control. One set of bearings is free to move axially, while the other set is restricted in one direction by a hard stop and in the other direction by a spring force towards pump suction. The rolling element bearings absorb transient axial loads.

The thrust balancer consists of a thrust runner, a variable flow-area inner seal, several fixed area orifices, and a self-aligning fixed area face seal which forms the outer seal. High pressure liquid is fed to the shallow cavity between the sills through both the face seal and the orifices. Flow continuity through these fixed areas and that of the inner sill results in a pressure profile over the cavity and a corresponding axial force. If this force is not in equilibrium with the other axial loads, the rotor will be displaced in a direction opposite to the force unbalance. If the force generated by the thrust balancer is insufficient to equalize the axial rotor forces, the rotor will move in a direction to reduce the inner sill clearance. The reduced clearance results in a reduction of the inner sill flow area, which then causes the cavity pressure to increase so as to maintain flow continuity.

The action of the thrust balancer is, therefore, self-compensating in that the rotor system will be displaced axially until the cavity pressure results in thrust equilibrium.

The self-aligning face-seal feature of the design is unique due to the "floating" characteristic being tolerant of impeller housing distortion and therefore permitting close clearance with reduced flow. This is extremely important because all leakage or parasitic flows reduce pump efficiency and eventually result in increased engine weight. The unique design of the thrust balancer minimizes leakage bypass and obviates the need for the conventional thrust balancer and allows operation at low flow rates and high thrust capacity.

Notes:

1. Information concerning this innovation may be of interest to turbomachinery designers and manufacturers in general and to pump designers and manufacturers in particular.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B72-10264

Patent status:

No patent action is contemplated by NASA.

Source: P. S. Buckmann of
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