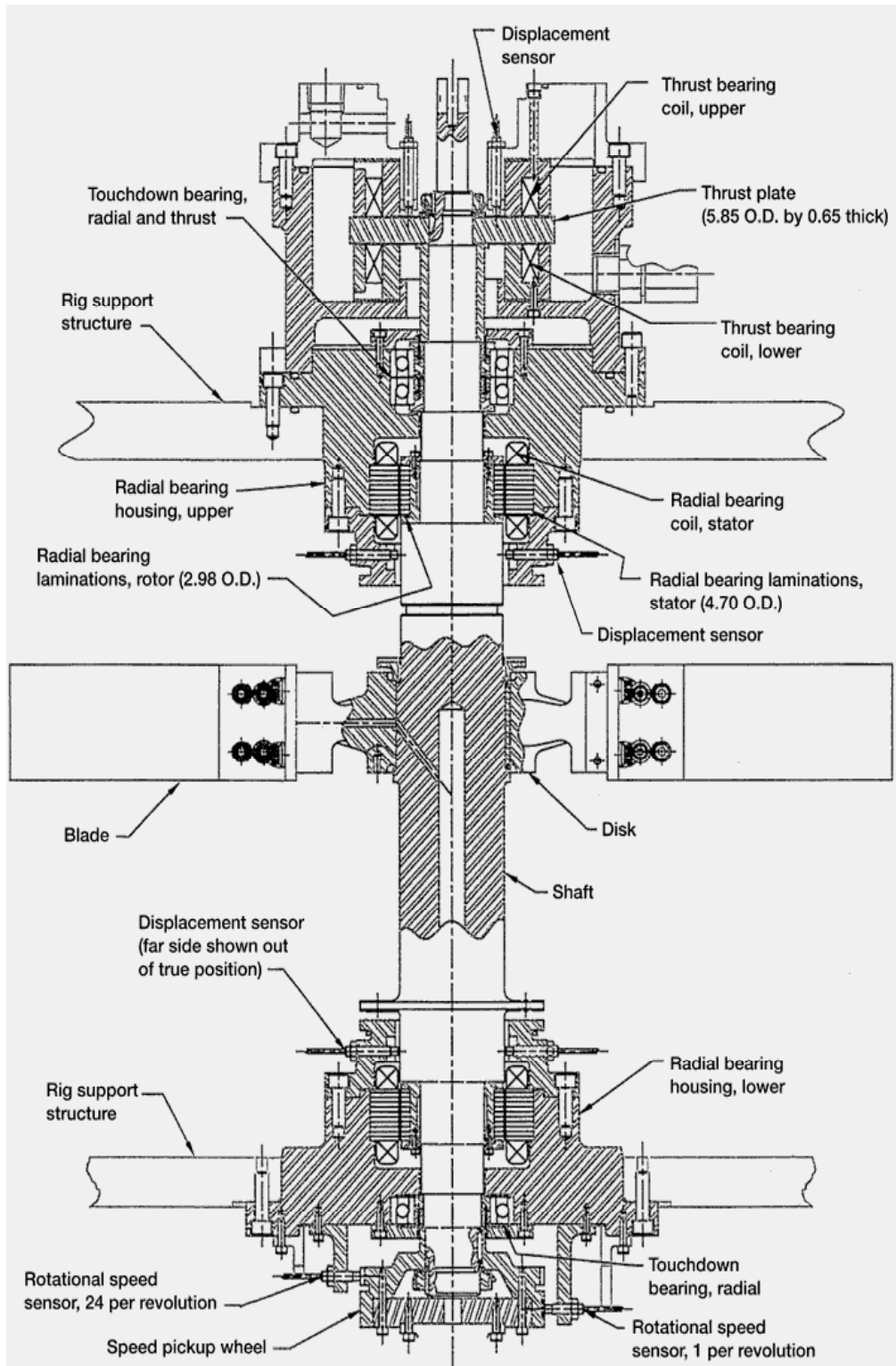


# **Dynamic Spin Rig Upgraded With a Five-Axis-Controlled Three-Magnetic-Bearing Support System With Forward Excitation**

The NASA Glenn Research Center Dynamic Spin Rig is used for experimental evaluation of vibration analysis methods and dynamic characteristics for rotating systems (ref. 1). Measurements are made while rotors are spun and vibrated in a vacuum chamber. The rig has been upgraded with a new active magnetic bearing rotor support and excitation system. This design is expected to provide operational improvements over the existing rig. The rig will be able to be operated in either the old or new configuration.

In the old configuration, two ball bearings support the vertical shaft of the rig, with the test article located between the bearings. Because the bearings operate in a vacuum, lubrication is limited to grease. This limits bearing life and speed. In addition, the old configuration employs two voice-coil electromagnetic shakers to apply oscillatory axial forces or transverse moments to the rotor shaft through a thrust bearing. The excitation amplitudes that can be imparted to the test article with this system are not adequate for components that are highly damped. It is expected that the new design will overcome these limitations.



*Glenn's upgraded Five-Axis Three Magnetic Bearing Dynamic Spin Rig. All dimensions given in inches. O.D., outer diameter.*

Long description of figure Illustration-- of rig showing (top to bottom) displacement sensor, upper thrust bearing coil, thrust plate (5.85 O.D. by 0.65 thick), lower thrust bearing coil, radial and thrust touchdown bearing, rig support structure, stator radial bearing coil, upper radial bearing housing, rotor radial bearing laminations (2.98 O.D.), stator radial bearing laminations (4.70 O.D.), displacement sensor, blade, disk, shaft, displacement sensor (far side shown out of true position), lower radial bearing housing, rig support structure, radial touchdown bearing, rotational speed sensor (24 per revolution), rotational speed sensor (1 per revolution), and speed pickup wheel.

A preliminary upgrade of the Dynamic Spin Rig (ref. 2) incorporated a single heteropolar radial active magnetic bearing, which allows for both magnetic excitation and suspension of the rotor. The magnetic bearing replaced the lower mechanical ball bearing and gave improved operations. Results from that upgrade have been used in building a total magnetically suspended rotor (see the engineering drawing of the rig). The new design, called the Five-Axis Three Magnetic Bearing Dynamic Spin Rig, has five independent axes of controlled motion. There is an  $x$ -axis and a  $y$ -axis translation at each upper and lower magnetic radial bearing, as well as a  $z$ -axis translation at the magnetic thrust bearing. Both radial bearings are heteropolar. Simultaneously energizing the bearings (refs. 3 and 4) fully levitates the rotor. This rig design allows for higher excitation amplitudes (by virtue of full rotor suspension, which permits larger rotor translation and tilt displacements) than are achievable with the older rig configuration. At the time of this writing, the rig was operated up to 10 000 rpm with an unbladed rotor. For a detailed description of the rig, see reference 5.

## References

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