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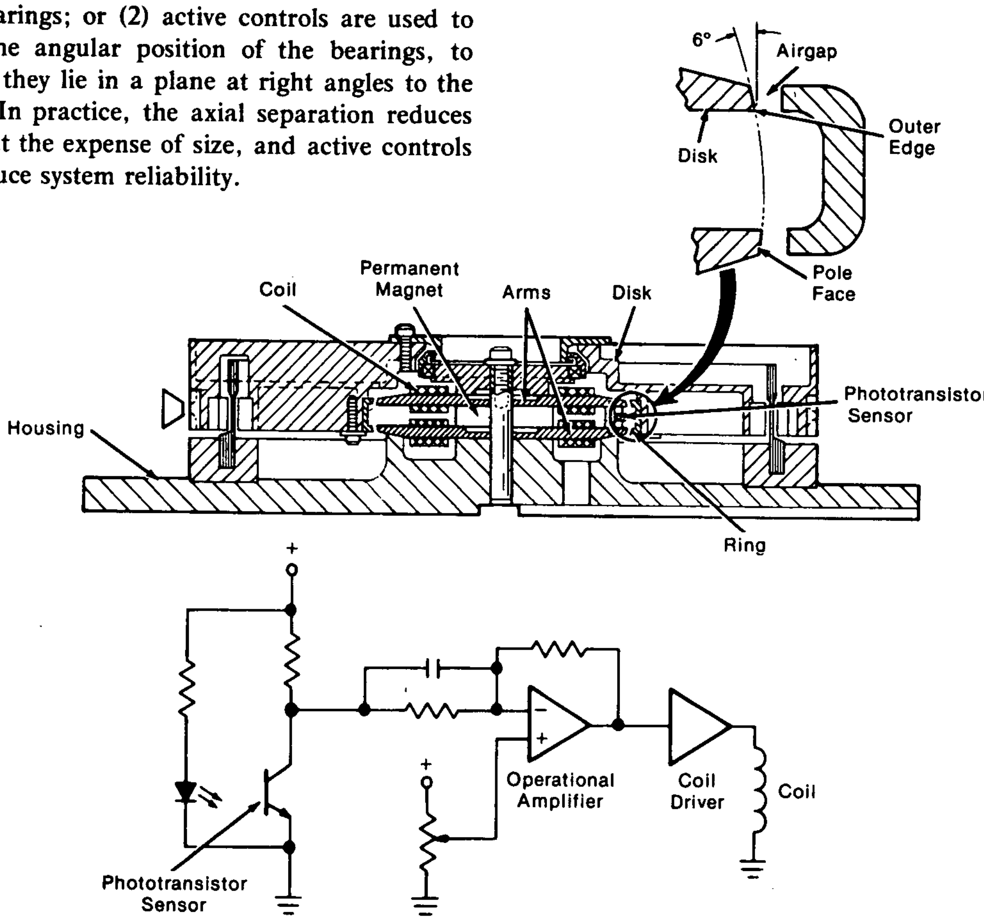
Single Radial Magnetic Bearing: A Concept

To support a shaft with stability and to resist torsional loads, mechanical and magnetic bearings have generally been matched in pairs at opposite ends of the supported shaft. Typically, the arrangement of magnetic bearings in pairs is complicated by the inherent instability of the bearings about axes other than that of the shaft being supported. Two techniques now are employed to overcome this instability: (1) axial separation is increased between pairs of bearings; or (2) active controls are used to maintain the angular position of the bearings, to assure that they lie in a plane at right angles to the shaft axis. In practice, the axial separation reduces instability at the expense of size, and active controls tend to reduce system reliability.

The illustration shows a magnetic bearing capable of supporting a shaft without these drawbacks. It has a magnetic structure that keeps the inner and outer bearing halves alined. An active electronic feedback circuit is used to maintain the bearing centered radially. The structure approximates the surface of a sphere and causes the magnetic flux to flow circumferentially in the outer member of the pole faces.



Single Radial Magnetic Bearing: A Concept

(continued overleaf)

A two-piece permanent ring magnet creates a radially-directed magnetic field in the airgap. This field maintains both halves of a disk and a ring annulus in a common plane. The magnetic flux flows radially outward through the arms, via the ring, across the airgap, and back to the magnet. Radial control of the position of the disks and ring is established by vernier magnetic fluxes (derived from current-carrying coils), which aid or oppose the permanent-magnet flux in the airgap. The pole faces of the arms are shaped to approximate the contour of a sphere having its center at the center of the disk, thus making the bearing inherently stable in torsion.

Control current is supplied to the coils to change the net flux in the airgaps if a disturbance alters gap length between the disk and ring. The restoring control current, and therefore the applied flux, is precisely the amount needed to force the ring and disk into the proper radial position.

Control signals for the coils are derived by a phototransistor optoelectronic sensor (as seen in the figure) and depend on position and rate-of-change in position of the disk and ring. The phototransistor emitter/collector path is connected to a positive dc source through a resistor. The sensor output voltage is dc coupled to the inverting input terminal of an operational amplifier. The noninverting input is connected to a potentiometer slider. The potentiometer is dc energized and is adjusted for the desired radial separation between pole faces of the disk and ring. The amplifier output signal is fed to a coil driver which energizes the windings.

Note:

Requests for further information may be directed to:

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Patent status:

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Categories: 06 (Mechanics)
01 (Electronics - Components and Circuitry)