



technology opportunity

Axial Halbach Magnetic Bearings

Using magnetism and passive control to reduce friction for axial loads



Innovators at NASA's Glenn Research Center have developed a bearing that uses magnetism to significantly reduce friction for an axial load. The Axial Halbach Magnetic Bearing includes a novel stator and rotor architecture that employs a non-contact support system using magnetic fields. This unique configuration produces an axial repulsion force that is sufficient to levitate the rotor. The bearing is inherently stable as it requires no active control system to maintain levitation and represents a significant technological advance over conventional axial bearings which are associated with wear, leaks, and friction loss. NASA and private industry are striving to develop all-electric aircraft to reduce emissions, cut use of fossil fuels, and eliminate excessive maintenance costs linked with lubrication system failures. Reliable, low-friction bearings will be an essential part of this effort.

Benefits

- **Strong:** Maximizes the magnetic field strength and reduces unwanted magnetic flux
- **Stable:** Eliminates the need for an expensive and complex active control system
- **Simple:** Reduces system complexity and weight by reducing the number of independent technologies required for functionality
- **Efficient:** Reduces costly maintenance associated with traditional engine systems (active lubrication, wear, and limited rotational speed)
- **Effective:** Improves with speed, as opposed to conventional bearings, which degrade as speed increases

Applications

- Electric motors
- Computer disk drives
- Clean room applications using pumps and compressors
- Medical instrumentation systems

Technology Details

The Axial Halbach Magnetic Bearing is a self-contained electromagnetic axial bearing that produces levitation force between the rotor and the stator. The unique implementation of the non-contact electromagnetic support system is a critical enabling feature of the design.

How It Works

A Halbach array consists of a series of permanent magnetic elements oriented geometrically such that each bar is at a right angle to the orientation of the adjacent bars (see Figure 1). This configuration strongly enhances the magnetic field on one side of the array and cancels it on the other. Halbach arrays are commonly used in magnetic levitation (maglev) for high speed trains and also for steering charged particles in subatomic accelerators.

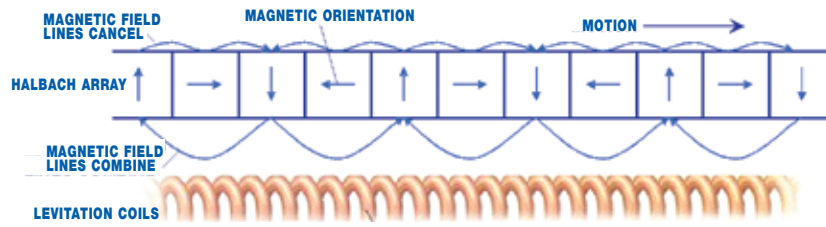


Figure 1. A Basic Halbach Array

An axial Halbach bearing includes multiple permanent magnets arranged in a Halbach array in a rotor and multiple conductors in the form of wire coils in a stator. When set in motion, time-varying magnetic fields interact with the passive coils in the stator to produce repulsive forces between the rotor and stator, suspending the rotor. The system must be set into motion before levitation occurs; however, once the system reaches critical speed, it is inherently stable and requires no active control (computer circuitry, algorithms, or sensors) as is called for by traditional magnetic bearings. The system maintains levitation until the speed decreases below critical speed. At this point, the system comes to rest on an auxiliary mechanical bearing system that is required for start-up, shutdown, and rest conditions.

Why It Is Better

In conventional engine systems, failures within the lubrication system and mechanical bearings account for a large percentage of maintenance costs. The use of magnetic suspension minimizes these concerns. While magnetic bearings have been available for years, they have often required active control and have not been widely used for axial loads. The Halbach arrangement of magnets and unique non-contact electromagnetic support system allow this innovation to improve reliability and efficiency while offering both passive control and axial loading.

Licensing and Partnering Opportunities

Glenn's Technology Transfer and Partnership Office seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Axial Halbach Magnetic Bearing (LEW-18066-1) for commercial applications.

For More Information

For more information about this and other technology licensing opportunities, please visit:

Technology Transfer and Partnership Office

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