



Vernier Permanent Magnet Machines with High Torque Density

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a new rotor design for vernier machines useful for low-speed and direct drive applications such as industrial automation.

The new design improves torque density and power factor, and utilizes ferrite magnet material instead of rare earth magnets to reduce cost.

Overview

The vernier permanent magnet (VPM) machine first appeared about 20 years ago. This motor has the potential to create torque well beyond other types of permanent magnet machines and compete with rare earth material-based designs. VPMs are an attractive alternative for direct-drive applications and well suited for low speed motoring/braking.

To further increase torque density and cope with the low power factor feature of VPMs, engineers have previously proposed two major structural designs of double air gap VPMs: a double rotor and a dual stator design. However, these require the addition of a rotor or stator layer, increasing manufacturing complexity and introducing structural and reliability concerns. Less complex solutions offering similar performance are necessary before vernier machines can become commercially successful.

The Invention

UW–Madison researchers have developed a VPM rotor geometry that improves torque density and power factor by routing the stator flux in a way that boosts it. The new, single barrier design comprises an iron section with an air barrier near the rotor core to guide the stator magnet flux in a desirable path. This was created for the spoke-type configuration topology, where the magnets are aligned similar to the spokes of a bicycle wheel in the rotor. This design solution boosts the flux without compromising performance or cost.

Applications

- Low-speed, high-torque industrial motor drive, such as an industrial cooling fan
- MW-level wind turbine
- Marine propulsion
- Electric transportation
- Amenable to high-torque compact footprint application

Key Benefits

- Higher torque density and power factor than competing solutions
- Manufacturing adaptability ready for mass production with no extra cost
- Compatible with standard industrial PM motor drive
- Utilizes cheaper and more abundant ferrite magnet material

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- Not reliant on rare earth magnets

Stage of Development

The researchers have developed models to optimize placement and dimensions of the air gaps and have established these with simulations. Results and benefits have been further verified in experiments.

Additional Information

Related Technologies

- [Find more motor technologies developed by Prof. Thomas Lipo and Wenbo Liu.](#)

Tech Fields

- [Engineering : Electric machines](#)

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