PERMANENT MAGNETIC GRADIENT SPIRAL MOTOR: RADIAL MAGNETS

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The Spiral Magnetic Motor, which can accelerate a magnetized rotor through 90% of its cycle with only permanent magnets, was an energy milestone for the 20th century patents by Kure Tekkosho in the 1970's. However, the Japanese company used old ferrite magnets which are relatively weak and an electrically-powered coil to jump start every cycle, which defeated the primary benefit of the permanent magnet motor design. The principle of applying an inhomogeneous, anisotropic magnetic field gradient force $Fz = \mu \cos \varphi \, dB/dz$, with permanent magnets is well-known in physics, e.g., Stern-Gerlach experiment, which exploits the interaction of a magnetic moment with the aligned electron spins of magnetic domains. In this case, it is applied to $dB/d\theta$ in polar coordinates, where the force $F\theta$ depends equally on the magnetic moment, the cosine of the angle between the magnetic moment and the field gradient. The radial magnetic field increases in strength (in the attractive mode) or decreases in strength (in the repulsive mode) as the rotor turns through one complete cycle. An electromagnetic pulsed switching has been historically used to help the rotor traverse the gap (detent) between the end of the magnetic stator arc and the beginning (Kure Tekko, 1980). However, alternative magnetic pulse and switching designs have been developed, as well as strategic eddy current creation. This work focuses on the switching mechanism and applies novel magnetic pulse methods and advantageous angular momentum improvements. For example, a collaborative effort has begun with Toshiyuki Ueno (University of Tokyo) who has invented an extremely low power, combination magnetostrictive-piezoelectric (MS-PZT) device for generating low frequency magnetic fields and consumes "zero power" for static magnetic field production (Ueno, 2004, 2007a). Utilizing a pickup coil such as an ultra-miniature millihenry inductor with a piezoelectric actuator or simply a Wiegand wire geometry, it is shown that the necessary power for magnetic field switching can be achieved in order to deflect the rotor magnet in transit. The Wiegand effect itself (bistable FeCoV wire called "Vicalloy") invented by John Wiegand, utilizing Barkhausen jumps of magnetic domains, is also applied for a similar achievement (Wiegand, 1981), (Dilatush, 1977). Conventional approaches for spiral magnetic gradient force production have not been adequate for magnetostatic motors to perform useful work. It is proposed that integrating a magnetic force control device with a spiral stator inhomogeneous magnetic field motor is a viable approach to add a sufficient nonlinear boundary shift to retain and apply the angular momentum gained in 315 degrees of the motor cycle.

Keywords: magnetic gradient, spiral magnet, inhomogeneous magnetic field, piezoelectric-magnetostrictive, magnetic pulse control, magnetostatic energy density, axial magnetic field
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