LORD Corporation

Magnelok™ – Rotary Brake Technology

NDIA Joint Armaments
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A Technology-Oriented Global Corporation

Core Competencies:
• Surface science
• Polymer science and engineering
• Material science
• Mechanical design
• Dynamic system design and analysis
• Electromechanical systems

♦ $610 million annual sales
♦ 2,400+ employees
♦ 17 manufacturing facilities and 8 R&D centers in 9 countries
♦ Over 90 sales and service centers worldwide
♦ Corporate headquarters in Cary, NC
♦ Privately held
Aerospace Customers
Magneto-Rheological (MR) Fluid-Based Controllable Dampers

- LORD Corporation’s MR technology has been proven through the licensing and broad intellectual property portfolio used in developing BWI Group’s MagneRide™ suspension system. The system now appears with more than 500,000 MR devices in more than a dozen models from multiple automotive OEMs of LORD MR technology.
♦ Complimentary to MR fluid technology

♦ Magnelok™ devices contain no MR fluid and provide better locking capability and complete decoupling

♦ In linear versions, normal force is proportional to the magnitude of the magnetic field

♦ Application of magnetic field causes the housing to constrict radially and squeeze the piston

♦ Force is a function of the magnetically-controlled normal force and the coefficient of friction
Rotary Magnelok™ Brakes Became Particularly Intriguing as They Evolved into Band Brakes

- The rotary Magnelok™ brake utilizes a flexible band
- The band is pulled azimuthally around the core by the rotor cup
- The rotary Magnelok™ brake leverages the property that the friction coefficient affects the torque output exponentially—leading to the potential of very high torques in small packages

\[
Torque = P_{mag} r^2 w(e^{\mu \phi} - 1)
\]
Failsafe (Power-to-Unlock) Magnelok™ Brakes are a complementary development

**Traditional Magnelok™ Band-Brake** (power-to-engage)
Magnetic field controls the normal force and hence the frictional force

**Failsafe Magnelok™ Band-Brake** (power-to-unlock)
Band stiffness controls normal force and hence frictional force

A version of the technology that changes state in response to an electrical pulse has been demonstrated, and is near T.R.L. 2.
... is lower weight

Torque/Weight

\[ T/W \ (Nm/kg) \]

\[
T = \frac{2}{3} P \pi \mu (r_o^3 - r_i^3)
\]

... takes less space

Torque/Volume

\[ T/V \ (Nm/cc) \]

\[
T = Pwr^2 \left( e^{\mu \phi} - 1 \right)
\]
Magnelok™ band-brake performance example

100 N-m Magnelok™ Band Brake

75 mm (3 in) diameter
25.4 mm (1 in) axial length
~ 0.5 kg (1 lb) weight

Torque (N-m) vs. Current (A) graph
Magnelok™ – Applications

♦ Aerospace Applications

– Control surface motor drive locking devices
– Backdrive prevention devices
– Stopping brakes and electrical brake actuators
– Control stick, knob or other human interface locks
– Cockpit door locks
– Seat recline or other articulation mechanism locks
– Retractable door step hinge locks
– Exit door hinge locks
– Kitchen galley cart wheel locks
– Cargo container wheel locks
– Thrust reverser mechanism locks
– Bin door hinge locks
– Engine door locks
– Helicopter particle separator mechanism locks
– Helicopter winch mechanism locks
– Landing gear door locks

♦ Industrial Applications

– General Industrial electric brake motors
  – Many applications from fractions of an oz-in to thousands of ft-lb have been demonstrated
– Belt tensioners
– Door hold-open locks
– Seat articulation locks
Questions?

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