Applying Zero Backlash Brakes in Magnetic Therapy

by: DN Staff in Automation & Motion Control on April 12, 2011

Major depression is a serious medical disorder affecting more than 14 million American adults every year. Often a debilitating condition, depression results in a persistent state of sadness which interferes with an individual's thoughts, behavior, mood and physical health.

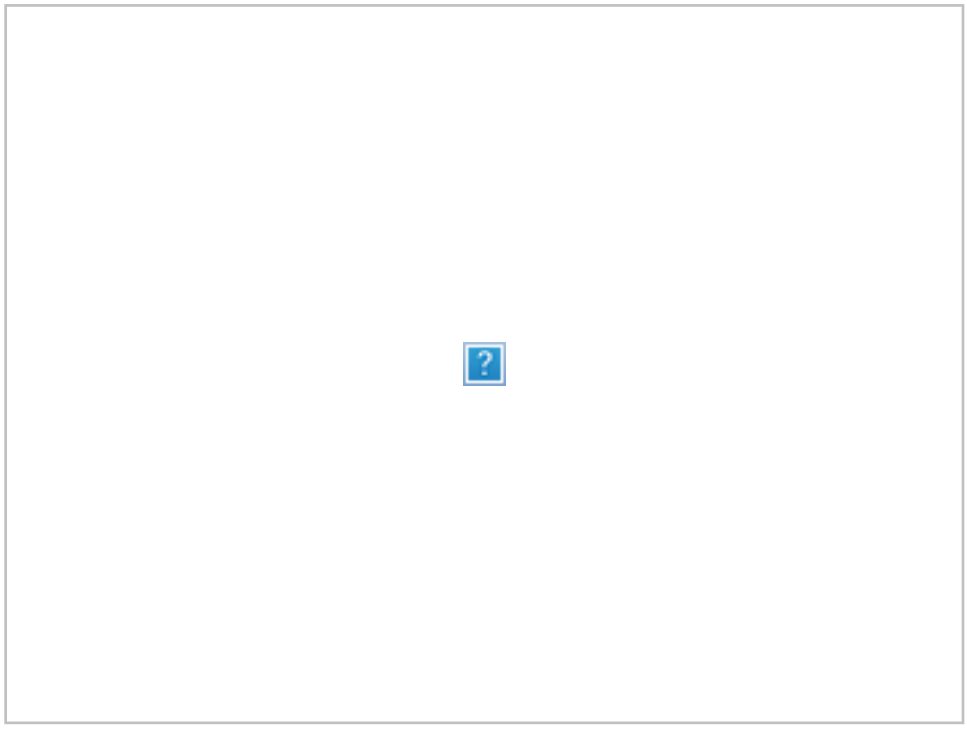
Common treatment for sufferers
involves pharmaceutical products prescribed by physicians that are sometimes required for extended periods of time. Medications and professional counseling will usually help patients manage the negative effects of depression but for some, anti-depressants fail to provide improvement. Extreme cases can result

in
complete incapacitation of the patient and hospitalization.

As an alternative to the
pharmaceutical approach to depression
treatment, Neuronetics Corp. of Malvern, PA, has designed the NeuroStar TMS (transcranial magnetic stimulation) Therapy System. TMS is a non-invasive, non-systemic treatment for depression that applies a highly focused, pulsed magnetic field to stimulate function in targeted brain regions. NeuroStar TMS Therapy is performed in a physician's office. Each treatment lasts about 40 minutes and takes place daily for four to six weeks. To date, NeuroStar reports that there are have been none of the physical effects reported that are commonplace
with drug treatment. Patients can immediately return to normal daily activities.

Highly-Integrated and High-Efficiency Step-Down DC/DC Converter

Microchip Technology MCP16331 Non-Synchronous Buck Regulator features a high-side switch, fixed frequency peak current-mode control, internal compensation, peak current limit, and overtemperature protection.



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A recent article in The Wall Street Journal titled, "Using Electricity, Magnets for Mental Illness," detailed increasing research into techniques to stimulate or calm the brain with electricity, magnets, ultrasound and infrared waves. The article notes that "of the new brain-stimulation therapies, the most developed is transcranial magnetic stimulation, (which was) cleared by the FDA in 2008."

Designing the TMS Device

NeuroStar engineers developing the TMS treatment needed a reliable means of holding the treatment coil in place during therapy sessions and turned to Ogura Industrial Corp. for suggestions. This was a major design consideration as it is necessary for the magnetic treatment coil to be able to be positioned in different axes of motion to accommodate the different physical characteristics of individual patients.

For operator convenience, depressing one button releases all the Ogura brakes, providing

freedom of movement to the system. The counter-balanced gantry can be extended
or retracted as well as rotated around the mast. The therapist manually moves the coil into the most effective location. Once the treatment coil is positioned and directed at the targeted brain region, the button is released and the Ogura Power-Off Brakes lock and hold the coil in position for the duration of the procedure. Should the position need to be readjusted, the one-button operation provides for simple repositioning.

Once the patient is reclined in
the treatment chair, the treatment coil is positioned so that magnetic pulses are focused on specific regions of the brain. It is critical that once the coil is positioned and therapy commences, no slipping or wandering of focus location
occurs. The magnetic pulses generated by the treatment coil must remain on the
targeted area of the brain.

RNB electromagnetic
spring-applied brakes from Ogura were selected to hold the mast and gantry arm
of the TMS securely during the therapy sessions. These brakes, designed for holding and emergency braking, are considered power-off brakes in that no power
is needed to hold the brake, due to the use of a spring to keep it in place. In addition, the zero backlash feature of the RNB design eliminated the possibility of flutter or drift of the gantry arm and mast during operation.

Furthermore, because the RNB is a
power-off brake, there is also no electrical signal to interfere with the TMS system during use. Power is only applied to release the brake when the treatment coil is adjusted to the individual patient.

Although it was not a primary
design consideration, cost of operation of the RNB is negligible. Power

consumption is minimized since the RNB is only energized while adjusting the system to the individual patient. During treatment the RNB is static, stable, non-interfering and power-free.

Spring Set Brake Details

The Ogura RNB-1.6Z Zero backlash brake used in the TMS system is a self-contained electromagnetic system for braking and holding rotary shafts with high angular accuracy.

Power off (or spring set) brakes use coil springs to apply a force to stationary plates to squeeze or clamp a rotating disc. When the rotating disc needs to spin freely again, a dc electromagnetic field is used to act against the spring forces, releasing the brake.

Most spring set brakes contain a bit of radial air gap or looseness between the rotating disc and the customers shaft. This is called backlash, and in most applications is not an issue. However, in exact positioning applications, like Neuronetics TMS, backlash is detrimental to system performance. To eliminate backlash and make the brakes suitable for Neuronetics' positioning requirements, Ogura designed a unique hub/spring assembly.

For Neuronetics' TMS, Ogura used a machined steel drive hub (affixed to the customer's shaft using a key and two sets screws). This drive hub is fixed to Ogura's low inertia flat spring steel friction disc. The resulting strong, yet flexible disc

allows for stiff (zero
backlash) radial torque while smoothly flexing (axially) during braking.

Ogura's high coefficient friction
material is bonded to the brakes pressure plate and backing plate, both of which will make contact with the rotating steel friction disc during braking. On most zero backlash brakes the friction material is bonded to the steel disc, which means the friction material would rotate during disengagement. Since Ogura bonds the friction material to the non-rotating components, only the thin spring steel disc rotates so higher operating speeds can be achieved. More importantly, there is less vibration because the thin steel disc is inherently balanced. To ensure smooth braking and high torque, the pressure plate/friction
disc and the backing plate/friction disc assemblies are precision ground for flatness before assembly.

Constant torque is created by the
use of three coil springs captured in precision trepanned cavities. These springs apply even pressure to the pressure plate to contact and compress the friction disc against the stationary backing plate.

Once the
brake is engaged (and shaft stopped) the Ogura spring steel friction disc assembly holds the load firmly and will not flex radially. This provides a firm position for the equipment to apply the proper magnetic pulses to the patient.

To release the brake, a dc
voltage is applied to the coil, creating a magnetic field in opposition to (and stronger than) the springs clamping forces. This attracts (pulls) the pressure plate back though its air gap, releasing the brake from the friction disc/drive hub assembly and allows the shaft to turn freely with no drag or noise.

This was an important
consideration in the TMS design, since quiet operation is essential in a therapeutic environment. Since the RNB power-off brakes are only energized

when
the treatment coil is being positioned, the treatment coil, once put into place, is held securely with no electrical noise or "hum" to distract the patient.

Another feature of the RNB-Z
series brake is that, because of its unique hub arrangement, it can operate in any orientation (shaft verticle for example) and not produce any residual drag when the brake is disengaged. A traditional splined hub design would have produced both unwanted drag and noise in Neuronetics' sensitive application.

Frank Flemming is president of Ogura Industrial Corp.

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