SAFETY FIRST WITH FRICTION-ELEMENT ACTION TRIGGERED BY SPRING ENGAGEMENT

The electrification of off-road vehicles propelled by motor-based direct drives (spurred by the advancement of longer-life battery technologies) has prompted innovation in brake and clutch technology as well. RANGER Pursuit EV vehicle image courtesy Polaris

FRICTION-BASED

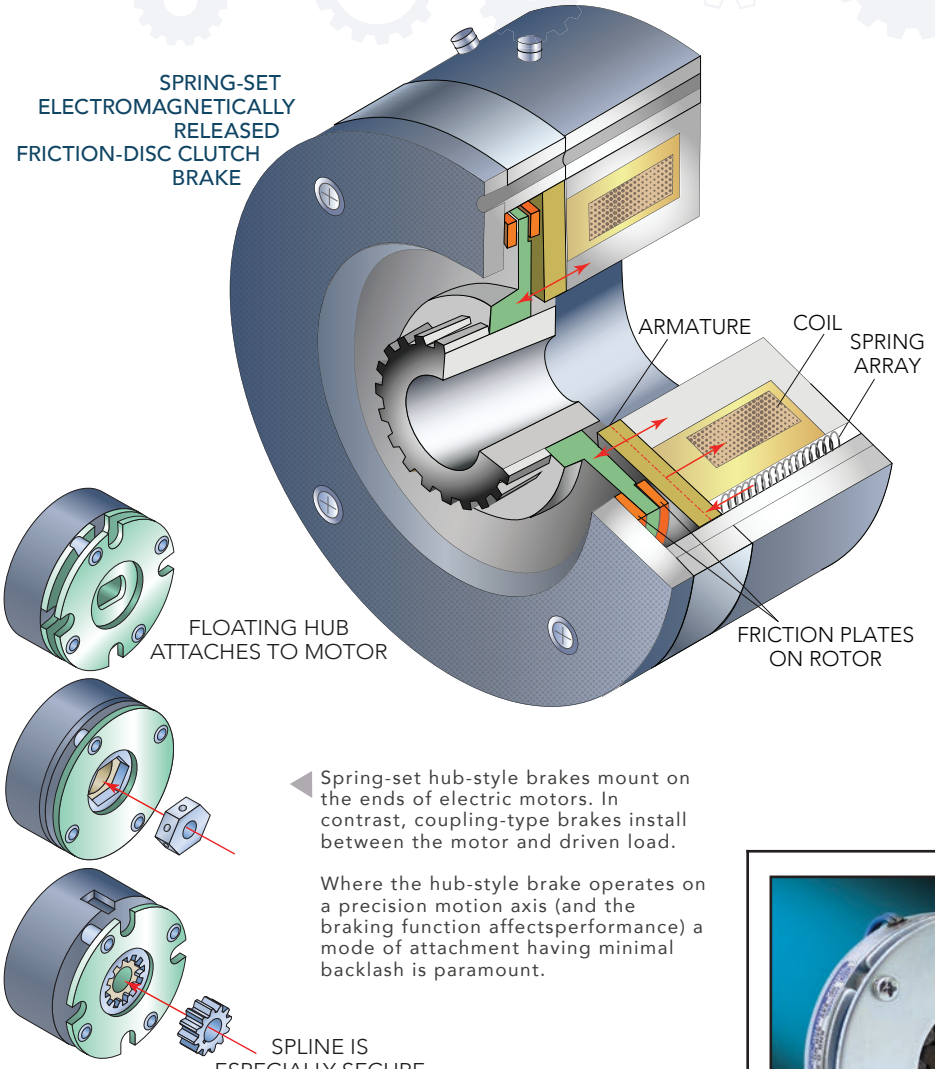
brakes and clutches that use springs (typically axial-compression coil springs) for engagement are an exceptionally important class of components. No wonder their variations often justify unique designations that underscore their very specific and essential functions in machine designs. These include certain:

- Spring-set brakes
- Failsafe brakes
- Slip clutches
- Safety and e-stop brakes
- Holding brakes
- Servomotor brakes

The *power-off* designation emphasizes how these particular components default to a spring-loaded condition that brings attached loads to a nonmoving state upon removal of release power. That means the mode of disengagement for these units is quite important as well. In most cases, these brakes and clutches are released in one of two ways:

- They are electromagnetically released
- They are pneumatically released

During electromagnetic disengagement, application of a field on an assembly armature counteracts the spring force clamping together the friction elements and separates friction elements. During pneumatic disengagement, application of power occurs via air pressure in a piston chamber — which in turn counteracts the spring force clamping together the friction elements and releases the friction-based hold … for independent rotation of the axis output.



In power-off friction brakes, spring pressure forces the friction discs (or elements) into engagement to stop and hold the load. Then an electromagnetic or pneumatic release system spreads the elements apart to disengaging the unit. Such spring engagement offer a key advantage — the ability to serve as failsafe brakes even during power loss. That contrasts with the electromagnetically engaged brakes.

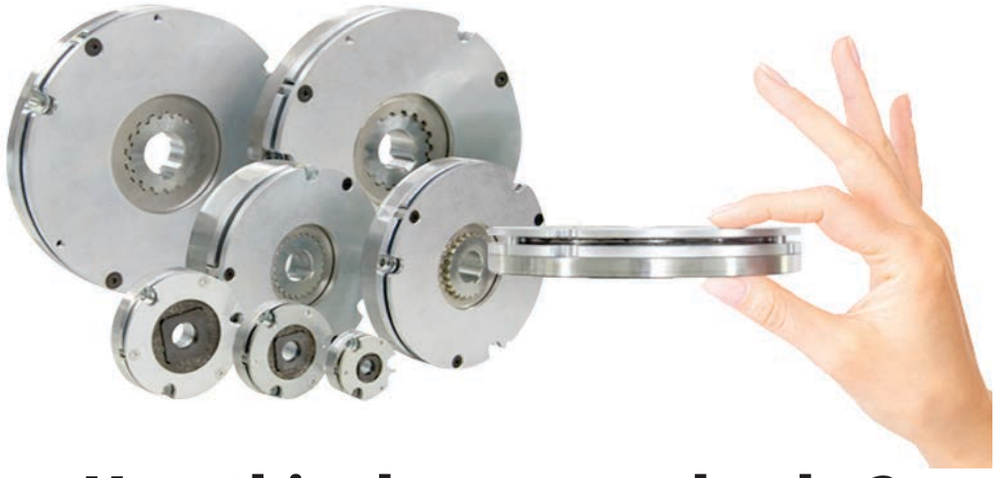
◀ Spring-set hub-style brakes mount on the ends of electric motors. In contrast, coupling-type brakes install between the motor and driven load.

Where the hub-style brake operates on a precision motion axis (and the braking function affectsperformance) a mode of attachment having minimal backlash is paramount.

Clutches based on spring force and friction-plate action are often used to transmit mechanical power from a constantly rotating motor-output shaft to some end-of-axis process requiring only intermittent rotation.

One of two common variations (in which a clutch hub assembly directly attaches to the motor drive shaft and not the output) includes:

- A fixed cylinder or housing with pressure-applying springs and (to apply lateral force for disengagement) either a pneumatic inlet and internal circuit (as well as an exhaust port for quick response) or wiring and a coil for electromagnetic action
- A moving (rotating) axis-output sleeve assembly containing friction discs and upon which an output pulley, pinion gear, or sheave bolts
- A drive hub enclosed by the housing and sleeve — and having one or more fins (for engagement with the sleeve's friction elements) as well as an armature if a typical electromagnetically released unit



How thin do you need to be? (RNB-T and MCNB-T)

Ogura electromagnetic thin style holding brakes: Ultra-thin style of holding brakes are designed to reduce the overall footprint of a motor brake package. Through internal flux improvements, brakes are thinner and lighter but can produce similar torques of previous designs.

Standard brakes are rated up to 50 Nm / 37 lb-ft. Custom designs with thermistors and built-in sensors are possible. Brakes are primarily designed for holding but can accommodate emergency stops. Some coils are designed for low power operation (12V) but 24V is required for brake disengagement. Brakes are primarily used for robotics, warehouse automation, medical equipment, electric vehicle parking brakes and on various stepper and servomotors.

Benefits you will see using Ogura holding brakes:

- Torque is electrically controlled over a very wide speed range
- Units are sealed and do not produce wear particles
- Larger units are available with fans for forced air cooling, providing additional heat dissipation
- Extremely fast torque response
- Units can be sized for continuous slip

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Without any external power, the housing assembly's springs push together the sleeve's friction discs and the hub's fins. Then for disengagement, either electromagnetic or pneumatic-cylinder force compresses the springs to allow the fins and friction discs to disengage.

Brakes based on spring force for friction-plate action are by default locked, because in the absence of any external power, mechanical springs hold stationary-side plates, fins, or friction discs in engaged contact with drive-side friction discs. No wonder the failsafe function of many of these brakes is indispensable in medical diagnostic equipment as well as general automation relayed to discrete motion control and servomotor designs such as robotics and mobile equipment complemented by holding brakes.

> Innovations in new and advancing applications are spurring a widening array of brake uses — as well as increased safety for end users. That's especially true of spring-set electrically released brakes.
>
> These have undergone significant innovation over the past several years as developments in friction materials and spring designs have enabled use in myria ew applications — especially in medical and personal-mobility indus tries.

Strengths: Spring-set brakes are a top choice for emergency-braking applications on the motor-driven axes of robotic arms, vertical axes, and machines that have the capacity to injure personnel should a power failure occur. That includes escalators, airport-baggage handlers, and elevators. They also benefit motion designs that slow loads with the

motor before the brake engages … and they're suitable as holding mechanisms as well.

There are also countless variants of spring-set brakes and clutches specifically for use on precision motion and servo applications. Many of these have low-backlash hub coupling morphology. That means they have a female spline subcomponent on their friction-element assembly that precisely mates with a matching square, D-shaped, polygon, or hexagon-shaped spline on the electric motor output shaft (or in some cases the driven shaft).

Precision-machined splines help minimize (and avoid amplification of unavoidable) radial backlash associated with the internal clearances needed to let the friction elements run free (unengaged) upon application of pneumatic or electromagnetic power. Some units even incorporate diaphragm springs for zero-backlash operation. Otherwise, typical no-load backlash (depending on the component diameter) might be 0.2° to 0.8° or so.

Constraints: The force applied by the springs in spring-set units is a factor that limits the maximum torque rating. In addition, the maximum force of the disengaging system in a spring-set unit must be well matched to the spring force to be overcome during power-on release situations. More basic spring-set brakes and clutches can also introduce excessive impulse and shock loading on precision operations.

Case in point: Consider an inclined conveyor with regularly spaced on-off cycles. Here, a power-off brake that is spring-set may suffice to prevent load crashes during power failures. But advanced conveyor installations working to position discrete product of varied size (without jerking) may need multiple deceleration rates via more sophisticated spring-set or other brakes complemented by an advanced motor-and-drive pairing.