Above, the unit's torque is set pneumatically. Typical slip clutches consist of two assemblies — cartridge and housing. The former is setscrewed or keyed to an input shaft; the housing is connected to either the output shaft, or attached to an output gear or pulley with a bronze bearing, to allow relative motion between the input and output gear or pulley.

Simplifying with slip clutches

Slip clutches are commonly used to protect against overloads, but they serve other functions as well — increasing machine speeds, applying constant tension to webs or wires, indexing mechanisms, holding, and controlling torque, to name a few.

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Continuous and intermittent slip clutches find myriad uses, and engineers improve new motion control applications with them every day. How do they work? Torque is transmitted from flats on a clutch hub to mating flats on inner plates (through friction pads) and then to outer plates through torque pins, to the housing and an output gear or pulley. Torque level is controlled by compressing springs with an adjusting nut.

For a fixed-torque clutch, a collar is attached to the hub in a fixed position instead of to the adjusting nut. In operation, either the input shaft or the housing can act as input member, with the other member being driven.

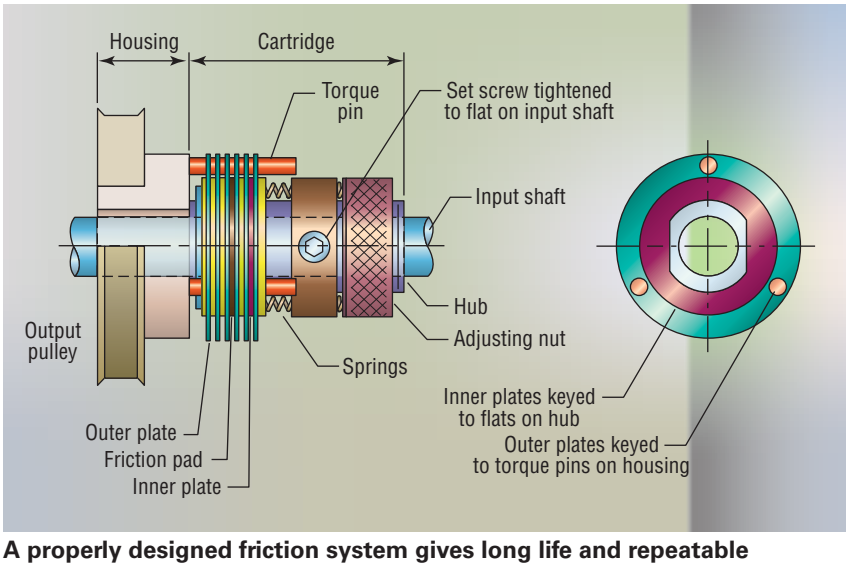
Continuous slip clutches can provide long life in a broad range of applications, and at a cost advantage compared to alternative solutions. Torque ranges from oz/in. to more than 1,000 lb/in. Clutch capacity is dependent on torque, rpm and duty cycle, all of which are interdependent, so a reduction in any of these factors allows increase in any other. The limiting factor is heat buildup, which is measured in Watts:

Watts = Torque (in. lb) × rpm × 0.011

Excess heat above design wattage shortens clutch life. The friction plate design, when running within design limits, generally operates for more than 30 million cycles: In most applications, the clutch outlasts the mechanism in which it is installed.

Where to apply

One of the most common applications of slip clutches is overload protection. Shear pins and ball detents are other mechanisms used here as well. However, while shear pins effectively save mechanisms, they op-



A properly designed friction system gives long life and repeatable torque. With electric or pneumatic actuation, torque settings can be changed easily and repeatedly. Uses include turning screws automatically to a torque limit, closing valves, setting controls, and similar torque-control applications.

Slip clutches are also used to hold robotic elements in a stationary position, on automatic toilet seats, and in sewer-pipe cleaning equipment. Above: Miniature units find use in moveable airplane video display screens, braiding machines, plotters, fiber optic cable systems, automatic doors, bar code printers, and truck mirrors.

erate only once, and must then be replaced. Ball detents slip at a set torque, with pulsating torque from zero to the breakaway setting. Once the impediment is removed, it again provides overload protection.

Slip clutches also continue slipping until impediments are removed. However, friction-plate designs slip at breakaway torque with constant, continuous torque. The basic design uses axially loaded plates and friction pads to transmit the torque. So, the higher the axial load, the higher the torque that can be transmitted.

Axial load is supplied mechanically by various spring arrangements. Load also can be applied pneumatically or electrically; here, torque can be changed during operation by varying air pressure or the voltage. Servomechanisms can also vary torque to suit mechanism requirements. This simplifies setup, as changes are easy to set and repeat as needed.

Cushioning and tension control are other applications for continuous slip clutches. For example, during the acceleration of a machine or mechanism, slip clutches can be designed so that their static friction is lower than their dynamic friction. This results in gradual application of torque, which can cushion loads that are applied suddenly.

When tension on a web of paper or film, a wire, or thread is applied gradually in this manner, it is half of suddenly applied load. This allows machines to run faster without overloading or breaking the material. Cushioning benefits larger mechanisms as well, allowing higher speeds and reducing impact on gears, pulleys, and slides or chains.

Tension-control applications include labeling machines, wire winding, film processing, thread control on knitting or sewing machines, and printing machinery to simple tension control on items such as fishing reels. Tension can be applied by pulling material around a roller, between two rollers, or other ways. As the material is pulled, it must make the roller turn and overcome the torque setting in the slip clutch, which applies a force to the material.

When the machine stops pulling, force drops to zero. In some cases, the clutch can turn slowly in the opposite direction so that there is no slack, and force always remains constant. This further reduces sudden forces.

Slip clutch cushioning significantly prolongs tool life in applications such as bottle capping or screw turning. Even more helpful is how the clutches eliminate slippage of tools against product, and move the slippage to within the clutch. For example, capping machines use pairs of elastomer wheels to screw caps onto bottles as they come down a line. When a cap bottoms out, older machines let the wheels slip against the cap, which often damages the product and shortens the elastomer wheel life. Newer machines incorporating a clutch to assume slip make the wheels stop when caps bottom out. (Clutch life can exceed 30 million cycles.)

In addition to longer tool life and reduced product wear, torque is ap-

plied more accurately to caps, and can be changed for different products. With electric or pneumatic actuation, torque settings can be changed at will, with minimal setup time and associated cost. Similar applications include the installation of screws to a set torque limit, and closing valves.

A clutch's continuous slip characteristic also can be used to index tables, conveyors and other mechanisms. A simple, relatively inexpensive index mechanism for low speed applications consists of a device that holds a pin on an index wheel. The clutch slips continuously until a solenoid removes the hold, allowing the wheel to turn. The solenoid then returns the holding component to position before the wheel indexes to the next pin. Pins can be located to allow a full or partial revolution, and simply moving the pins can change the cycle. Uneven indexes also are easy to program by spacing the pins unevenly. The clutch also provides overload protection in these applications.

For force control, slipping clutches can push on connecting arms. Sometimes this force control is used on ice machines to push a frozen tray into a "harvesting" cycle. When a single revolution is completed, it signals a new freezing cycle to begin. This inexpensive mechanism reduces cycle time considerably, which also saves energy.

Similarly, on conveyor applications, transported product can push against gates without damage to the product or the conveyor if the gates are fitted with slip clutches. Here, slippage occurs only in the clutch, which also provides overload protection.

When used as friction hinges, slip clutches are installed at pivot points to hold lids, covers, doors, and display screens in position. Adding a one-way clutch also eliminates resistance, as here, a raised cover remains in place. Fingertip force is all that is required to move the cover. The slip clutch provides a smooth, cushioned action in applications where jerky motions must be avoided.

In fact, slip clutches can be used in any application where temporary stoppages occur when a mechanism is held at random. When a motor moves a mechanism into a locked position, such as closing a door or reaching a linear motion stop, it may be useful to apply slip at the end of the cycle. Rather than using a time delay to prevent the motor from burning up, a slip clutch can remove the load from the motor for any length of time.

For more information, call (800) 562-9522 or visit polyclutch.com.

Circle XXX