toothTIPS

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This installment is the conclusion of a two-part series on epicyclic gearing—when it works, where it doesn't, and why that is.

The application range of epicyclic gearing has now become unlimited. As an example, shuttle astronauts were required to break loose some large bolts on an instrument panel during a space mission. A torch was not practical, and the bolts were sheared using a glove with a built-in drive socket turned by a planetary drive—proof that the numerous advantages inherent in epicyclics are daily widening their range of applications. However, servomotors and controllers require features not experienced in a high-torque rolling mill, and a gas turbine places quite different demands on the drives. Among other features, the former require a ripple free velocity. When power travels through a gear unit, the end result can sometimes be other than uniform motion.

This disappointing result can appear even with constant torque and uniform direction. A typical example given in a technical journal involved window manufacturing, with a servomotor planetary reducer driving a positive displacement pump in order to caulk the panes. Instead of a smooth regular caulk the variations resulted in periodic globs. Planetary units have features that make them attractive for most positional applications. These include high torsional rigidity, negligible deflection, and minimal misalignment due to reactions along the central shafting and supports. When the ripple feature is unacceptable to the unit design, assembly and quality must be meticulous. When there is fluctuating torsional stiffness, the ripple effect is more than likely to be present. The gear type also can have a positive or detrimental effect. Spur gears roll against each other, with variances in the contact ratio and tooth deflections. Helical gears have gradually advancing contact, resulting in more uniform motion. High-speed and high power planetary gear units feature helical or double-helical gears with sleeve bearings and pressurized lubrication.

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Some manufacturers have a preference for double-helical gears over spur gears; however it does make load sharing even more difficult. The general consensus is that high precision spur teeth are preferable to helical teeth. Most high efficiency units for medium speeds and powers are equipped with roller bearings and spur gears. Some small and medium sized planetaries are designed with a floating planetary carrier. Well built units are ultra-reliable. We know of several constantly running high-power units that are only inspected on a five-year cycle. Pitch line velocities are considerably reduced; one compressor drive would have with a parallel shaft unit gears running at 7,500 fpm, and an alternative planetary unit would run at 5,000 fpm. A further advantage lies in the bearing selection which is based on external loading only. The resultant radial forces on input and output shafts are zero.

Planetary gear units only transmit torque. Comparably rated parallel shaft units have approximately three times the moment of inertia of comparable planetary units, which reduces the unit's total energy consumption. Internal couplings are used in some epicyclic designs to transmit torque between the elements, allowing some relative motion or misalignment. Usually the gear tooth type of coupling is selected. Internal couplings are also used for high-capacity rigid connections. Couplings with one set of teeth are of single articulation. These couplings are used where the geometry of the assembly prevents any significant misalignment, and a typical use is in vehicle planetaries where the sun or planet is crowned to compensate for misalignment. The more commonly used double articulation couplings permit parallel and angular misalignment of the coupling members. They are required when the output of one stage is connected to the input of the next stage. When significant misalignment is anticipated, the external coupling teeth are crowned to prevent the teeth ends contacting. Crowning also compensates for low-speed summation errors.

In conclusion the obvious advantages of planetary gear units can be seen from its application on a triple roller plate bending machine. The shaft mounted unit had a 49 inch diameter, a length of 98 inches and a torque rating of 24,780,000 ins./lbs. The total reduction of 1,000:1 was achieved with five stages. A weight saving of 75 percent over a standard parallel shaft unit was also the result of the planetary selection.

ABOUT THE AUTHOR:

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