

## **Advanced Roller Pinion Technology Provides Increased Accuracy for Motion Control Applications**

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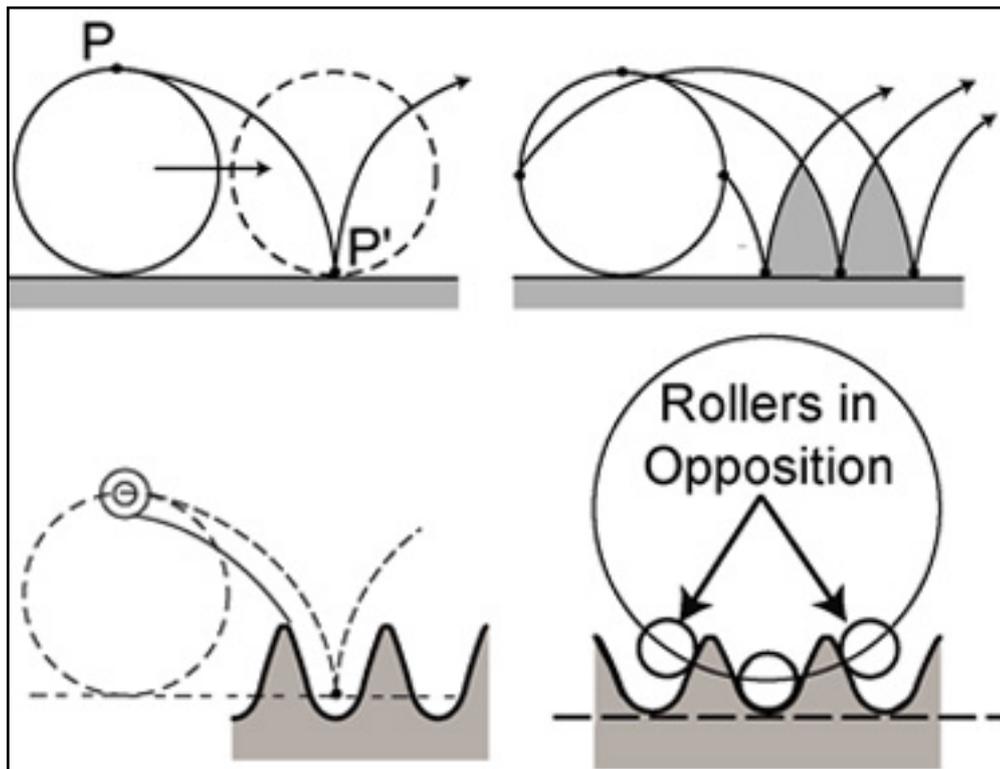


Rack and pinion technology is commonly used in linear motion systems to convert rotary motion into linear motion. Providing versatile operation, rack and pinion systems can be employed in a variety of motion control applications, ranging from cutting systems to medical and robotics applications. A traditional rack and pinion system is comprised of a toothed circular pinion that engages teeth on a flat rail, otherwise known as a rack. The rack has a machined-tooth profile cut in it, which engages with the teeth of the pinion. This engagement causes the pinion to rotate, moving along the rack in a straight line.

While sufficient for many application requirements, traditional rack and pinion systems can experience many limitations, including high cost, limited accuracy and low efficiency. Further, these systems can suffer from costly maintenance requirements, high noise levels, increased vibration, particle emissions, velocity inconsistency and tooth fatigue. Backlash can also be a problem unless expensive dual or split pinion systems are implemented. However, these systems cause additional concerns, such as complex operation and limited accuracy. For example, a dual pinion system results in extra initial costs due to the need to purchase two drive systems as well as maintenance costs from increased wear. On the other hand, the springs in a split pinion system may give slightly if the drive dynamic overcomes the force of the spring, causing the spring to affect the accuracy of the motion.

In place of traditional rack and pinion systems, machine designers can implement a system featuring roller pinion technology. Roller pinion systems combine the form factor of a rack and pinion with the rolling technology of a cam, creating a design that eliminates many performance limitations. This design is 99 percent efficient in rotary to linear motion conversion, resulting in superior accuracy and longer life, while providing significant advantages and solving many demanding application requirements.

### **How It Works**



**Figure 1. (top left) The initial cord is drawn as the circle rolls forward and point P rolls on a flat plane to point P'; (top right) multiple points are placed on the circle at regular intervals and develop tooth-like profiles; (bottom left) a roller is placed at each point to act as pinion teeth, modifying the tooth profile to create the rack teeth; (bottom right) the modified circular design of the tooth profile allows two rollers to remain loaded in opposition at all times.**

Roller pinion

technology operates with a pinion consisting of bearing-supported rollers that engage a unique tooth profile. This tooth design varies from traditional rack and pinion designs. Instead of a typical sliding spur gear, it behaves like a cam and follower, providing a smooth rolling movement to eliminate unwanted sliding friction. Cam followers, also known as bearing or track rollers, are rolling element bearings with either an integral stud or an inseparable inner ring for yoke mounting on a pin or shaft.

The accompanying figures illustrate roller pinion technology development, in addition to its efficient rolling movement. In Figure 1, the initial cord is drawn as the circle rolls forward and point P rolls on a flat plane to point P'. Figure 2 shows multiple points placed on the circle at regular intervals going through the same process and developing tooth-like profiles. In Figure 3, a roller is then placed at each point to act as pinion teeth, modifying the tooth profile to create the rack teeth. In Figure 4, the modified circular design of the tooth profile allows two rollers to remain loaded in opposition at all times, eliminating the backlash as the rollers engage the rack. The rollers meet the rack with a tangent path and smoothly roll down the tooth face. This meshing geometry eliminates tooth slap, sliding friction, fatigue, noise and precision errors associated with a traditional rack and pinion design.

## Advantages of Roller Pinion Technology

The distinctive tooth design of a roller pinion system allows for increased performance advantages over alternative motion control solutions. Each tooth is precisely measured relative to the first, maintaining high positional accuracy and eliminating cumulative error. This results in accurate positioning of up to  $\pm 30 \text{ }\mu\text{m}$  ( $\pm 0.00118 \text{ in.}$ ) — within half the diameter of a human hair — at high speeds of up to 11 m/sec (36.1 ft./sec). The low-friction design ensures minimal heat is created during fast-paced operations and reduces significant wear on components. Further, it limits backlash to less than  $3.2 \text{ }\mu\text{m}$  [ $0.00013 \text{ in.}$ ].

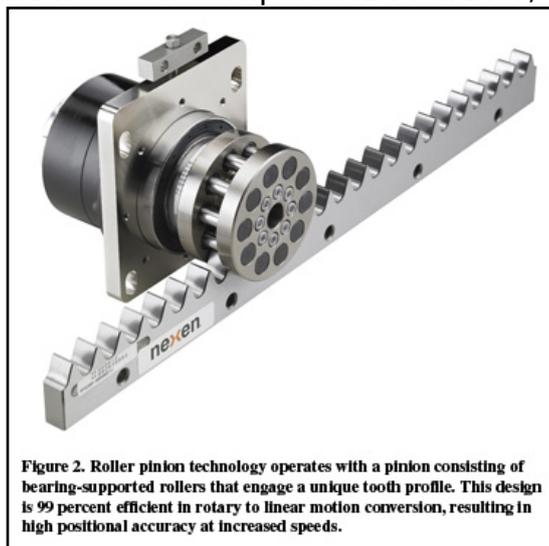


Figure 2. Roller pinion technology operates with a pinion consisting of bearing-supported rollers that engage a unique tooth profile. This design is 99 percent efficient in rotary to linear motion conversion, resulting in high positional accuracy at increased speeds.

Due to the efficient, smooth engaging process between the rollers and teeth, roller pinion technology provides nearly silent operation at low speeds and less than 75 db at full speed. Less noise and vibration reduces inaccuracy in precision sensors and encoders, also creating a more preferable working environment for personnel who may have to work near machinery. The smooth operation of roller pinion systems also minimizes maintenance requirements, generally requiring only a light lubrication bi-annually. In applications where particle emissions are undesirable or environmental contamination would mix with the lubrication, the roller pinion system may be run lubrication-free as long as the speed is less than 30 m/min. This makes roller pinion systems well suited for applications such as clean rooms, food processing and pharmaceutical production.

For optimal machine design flexibility and maximum system performance, roller pinion systems provide multiple accessories and options. For example, diverse pinion mounting options include a shaft mount or a direct mount to ISO 9409 gearboxes. The flange mount pinions are directly mounted to the gearhead, ensuring the highest degree of stiffness and accuracy, with no shaft or brushing required. Since the direct-mount pinions are rigidly secured close to the drive bearings, they ensure high performance. Roller pinion systems can be purchased in standard segmented lengths — 1 meter and 0.5 meter — and custom cut as required, delivering unlimited run lengths and providing machine builders with the ultimate flexibility to accommodate diverse application requirements.

Roller pinion systems deliver the high performance levels needed for motion control

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applications, providing a reliable and efficient solution with high accuracy, virtually no backlash and minimal maintenance.

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