A TECHNICAL PAPER FROM BODINE ELECTRIC COMPANY

Introduction to Planetary Gearmotors

These gearheads are sometimes called “epicycloidal” gearheads because the points on the rotating planets trace epicycloidal curves as they turn. The term “planetary” is also applicable because the rotating action of the entire assembly around the central sun gear mimics the movement of a solar system. Planetary gear trains are being used increasingly as actuators in applications where more torque is required from a smaller drive train package. Planetary gear trains are also used for differential systems and applications where very low reduction ratios are required. The input, output and auxiliary shafts can be connected to any of the three stages to achieve the speed/torque requirements of the application.

Construction of a Typical Planetary Gearhead

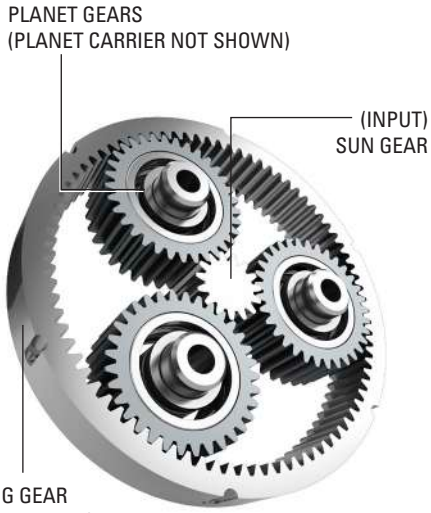
A planetary gearhead is comprised of a sun gear, a ring gear, and a planet carrier assembly that uses three to five planet gears. The **sun gear** is generally the motor pinion, and the **ring gear** is generally in the housing. The **planet carrier** is usually a stamped or cast plate with a number of studs attached on which the planets revolve. The **planet gears** share the load, revolving around the sun gear. The output shaft is generally attached to the planet carrier of the output stage. Lubrication is usually a thick, sticky grease.

Calculating Planetary Gear Ratio

In most planetary gearmotors the sun gear is the input, the planet carrier is the output, and the ring gear is kept stationary. However the sun, carrier and ring can be the input, the output or can be held stationary. Which piece rotates determines the gear ratio and whether the gear set is a speed reducer or an increaser and in which direction the output turns.

For example, the chart below shows the resulting ratio for a gear set which has a ring gear with 84 teeth and a sun gear with 12 teeth (the planets are irrelevant for the gear ratio calculation).

Input	Output	Stationary	Calculation	Gear Ratio
Sun (S)=12	Planet Carrier (C)	Ring (R)=84	1+R/S	8:1



Main components of a typical planetary geartrain

Advantages of Planetary Gearheads

- **Compact size and lower weight:** as much as 50% reduction in diameter with same torque output as an equivalent parallel shaft gearhead.
- **High torque** density
- **Several planets share the load** rather than one gear, the more planets the more load sharing.
- **Longer gear life** at similar loads.
- **Lower backlash** than equivalent parallel shaft gearheads.
- **High efficiency.** 97% per stage is common.
- Typical ratio per stage is 9:1, 4 stages up to 9000:1.
- **Coaxial center shaft arrangement,** no offset output shaft, easy to install.
- **Modular;** planetary stages can be stacked to increase the gear reduction.