Gear Types

- Helical gears are ones in which the teeth are at a helix angle with respect to the axis of the gear.

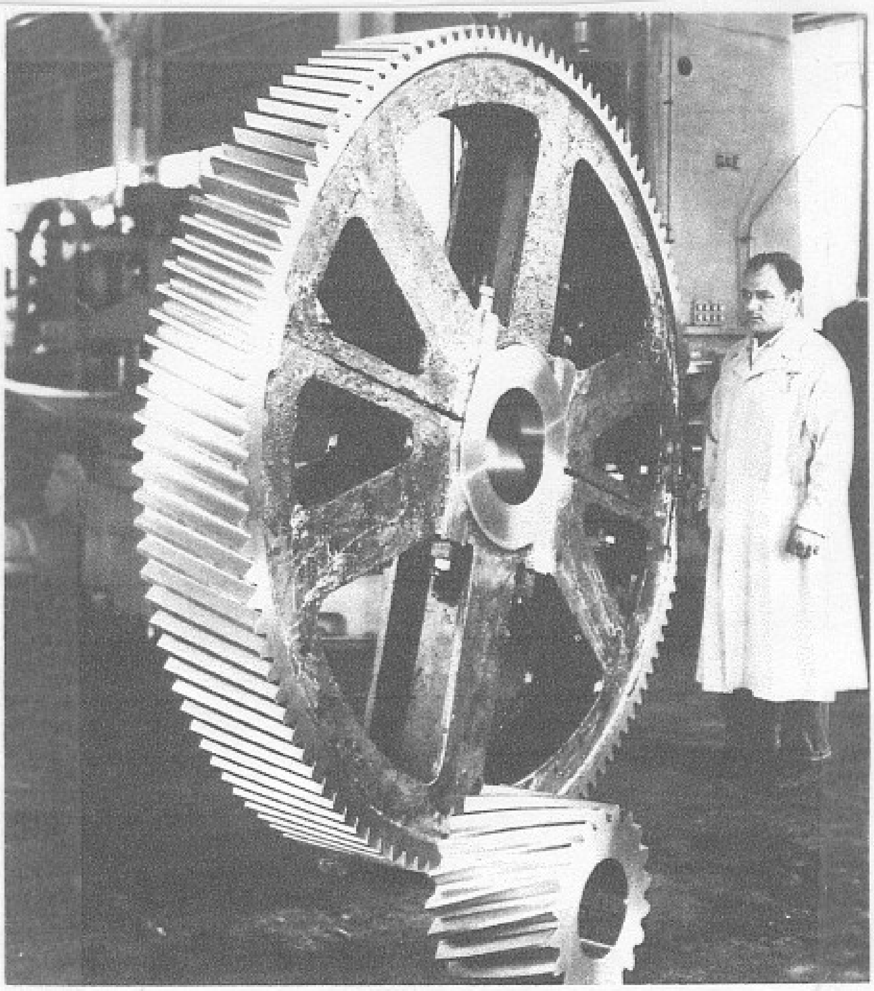


Figure 11-3 The gear shown is right handed, the pinion left handed. Because of the large size of the gear, it was manufactured in two halves and then assembled as shown. When gears are made in this manner, they are known as split gears. [Courtesy Illinois Gear Division, Wallace Murray Corporation.]

- Helical gears are quieter and smoother than spur gears because of the gradual contact between the angled surfaces as the teeth mesh together. They are better suited for applications of high speed large power transmission, or where noise abatement is important.
- A spur gearset can be 98 to 99% efficient (Power Out / Power In) A helical gearset will be 96 to 98% efficient due to the sliding friction along the helix angle.
- Helical gears also have a reaction force along the axis of the gear and so they require thrust and radial bearings

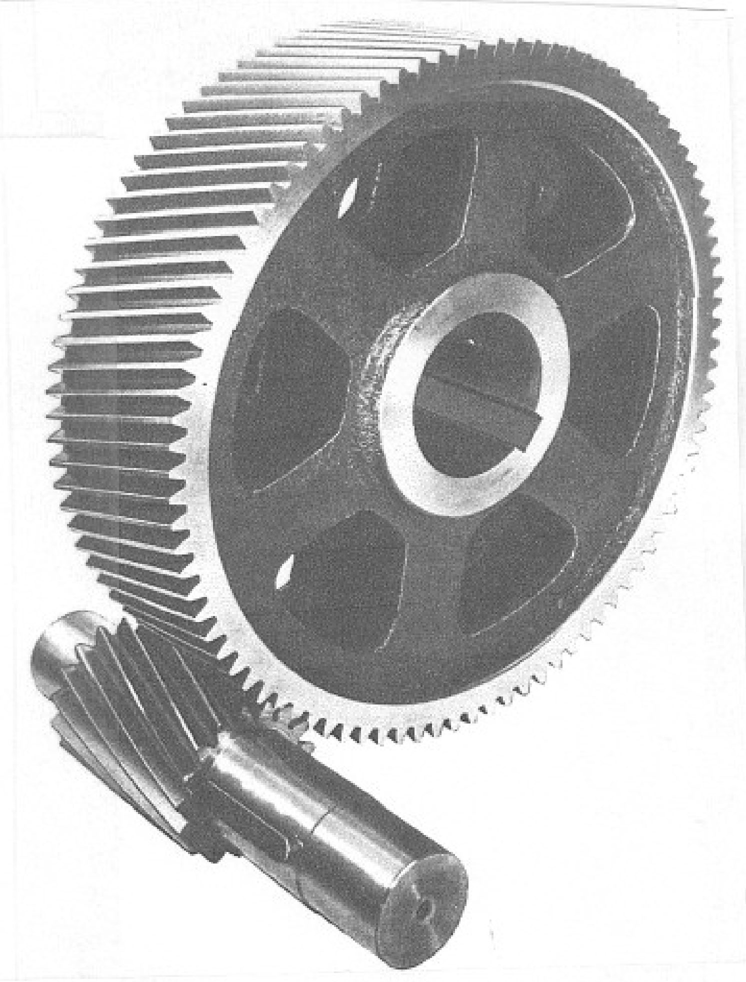


Figure 11-1 When a pair of meshing helical gears are mounted on parallel shafts, as shown, they must be of opposite hand. [Courtesy Horseburgh and Scott.]

Figure 11-2 When meshing helical gears are mounted on nonparallel shafts, they are known as crossed helical gears. Crossed helical gears may be of the same or opposite hand. [Courtesy Eaton Corporation, Industrial Drive Division.]

Crossed helical gears are only 50 to 90% efficient

- Herringbone gears are two helical gears of identical pitch and diameter but of opposite hand on the same shaft. There is a concellation of the thrust load and so no thrust bearing is needed. This type of gear is expensive

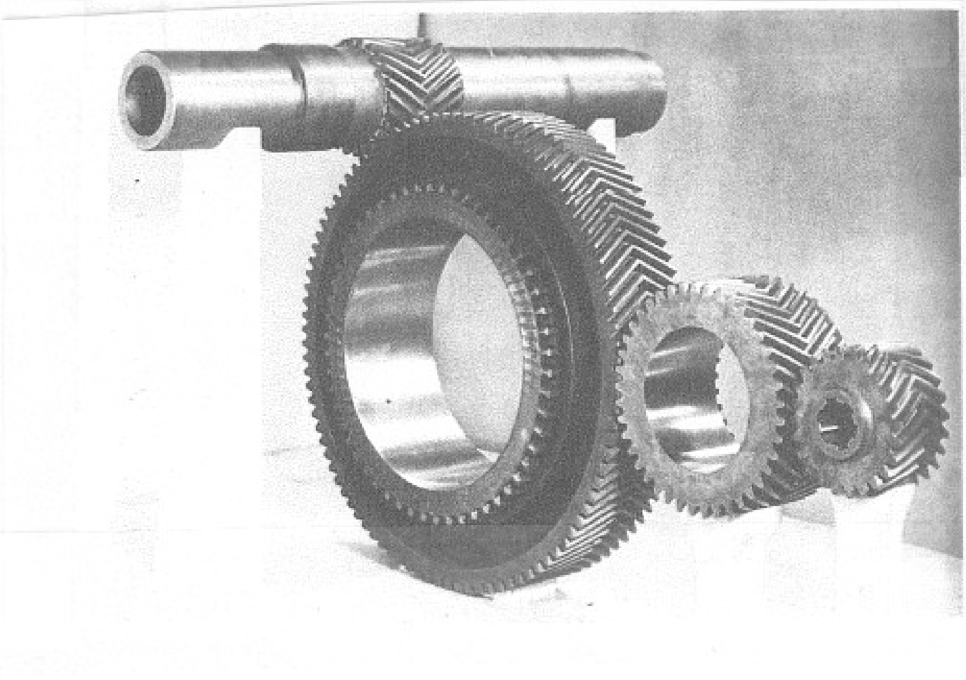


Figure 11-5 (a) Train of continuous tooth herringbone gears. In the continuous variety of herringbone gears, the teeth are cut up to the center of the gears.

- A worm gear has one tooth wrapped continuously around its circumference (similar to a screw thread).

A large speed ratio (200 to 1) could not be reasonably achieved in one reduction because of the size of the gear required. If a spur gear pinion had 20 teeth, the larger spur gear would have 4000 teeth. A better solution is to use a worm gear. They are designed not to backdrive and can only be driven from the worm.

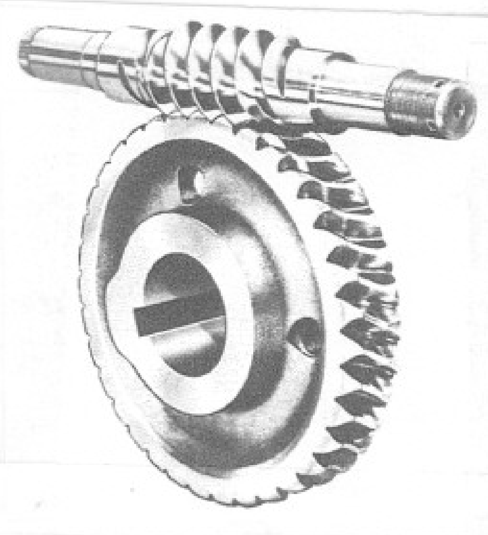


Figure 11-18 A single enveloping worm gear set. [Courtesy Illinois Gear Division, Wallace-Murray Corporation.]

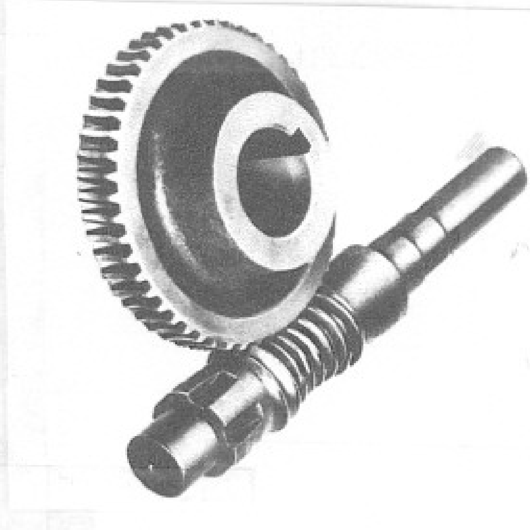


Figure 11-19 A double enveloping worm gear set. [Courtesy Michigan Tool Company.]

- A rack and pinion has teeth that are trapezoids but are still involutes. They are typically used in steering of automobiles.

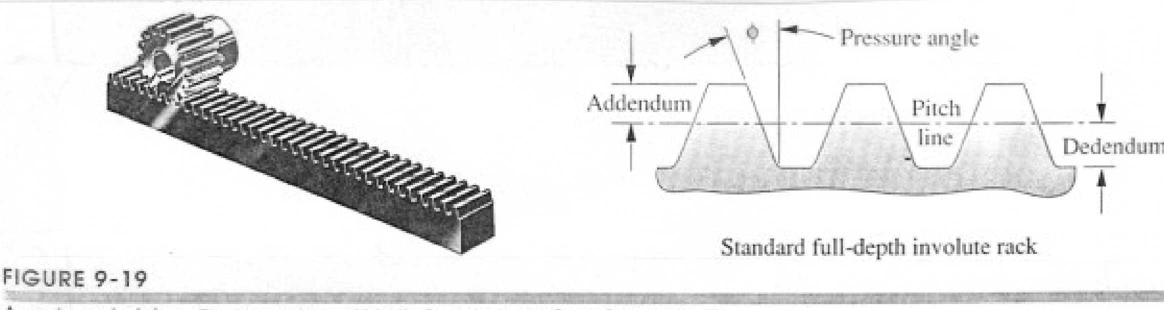


FIGURE 9-19
A rack and pinion *Photo courtesy of Martin Sprocket and Gear Co., Austin, TX*

- Bevel gears are based on rolling cones and are used for non-parallel intersecting shafts

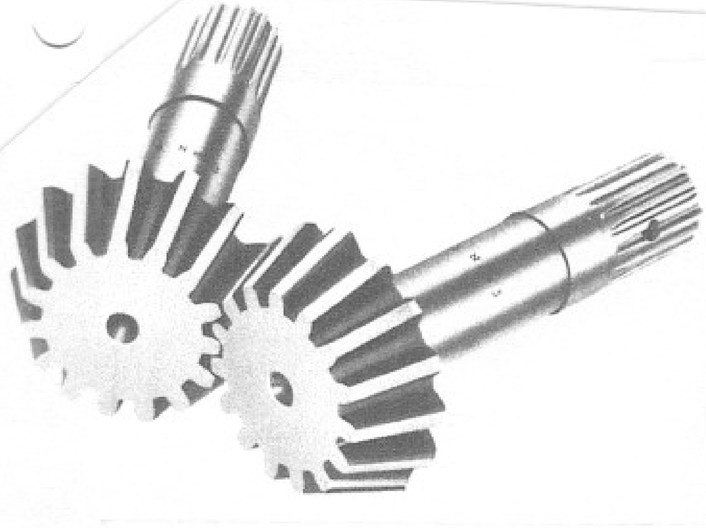


Figure 11-23 Straight bevel gears. [Courtesy Eaton Corporation, Industrial Drives Division.]

Figure 11-25 Spiral bevel gears. [Courtesy Gleason Works, Rochester, N.Y.]

The advantages and disadvantages of straight bevel and spiral bevel gears are similar to those of the spur and helical gears.

- Hypoid gears are used if the axes between the gears are non-parallel and nonintersecting. They are based on rolling hyperboloids of revolution.

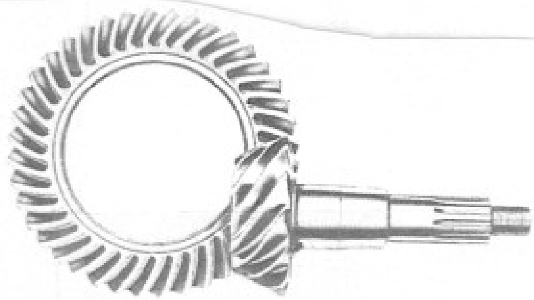
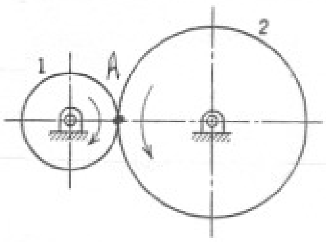


Figure 11-26 Hypoid bevel gears. [Courtesy Gleason Works, Rochester, N.Y.]

Simple Gear Trains

- Two gears can mesh if and only if they have the same circular pitch or diametral pitch $P_d = \frac{\pi}{P_c}$
- Let's consider the motion of pt. A for the following gears →

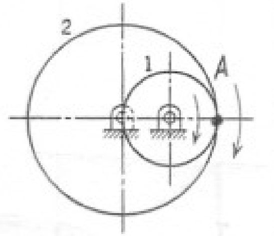
External Gearing



$$V_A = -\omega_1 R_1 = \omega_2 R_2$$

$$\frac{\omega_1}{\omega_2} = -\frac{R_2}{R_1}$$

Internal Gearing



$$V_A = -\omega_1 R_1 = -\omega_2 R_2$$

$$\frac{\omega_1}{\omega_2} = \frac{R_2}{R_1}$$

The circular pitch has to be the same for both gears

$$P_c = \frac{\pi d_1}{N_1} = \frac{\pi d_2}{N_2} \quad \therefore \quad \frac{d_1}{N_1} = \frac{d_2}{N_2} \quad \text{and} \quad \frac{d_1}{d_2} = \frac{R_1}{R_2} = \frac{N_1}{N_2}$$

Therefore

$$\frac{\omega_1}{\omega_2} = -\frac{N_1}{N_2} \text{ (external)} \qquad \frac{\omega_1}{\omega_2} = \frac{N_1}{N_2} \text{ (internal)}$$

- A single gearset of spur, helical, or bevel gears is usually limited to a ratio of about 10 : 1 because of cost, size, manufacturing, and packaging