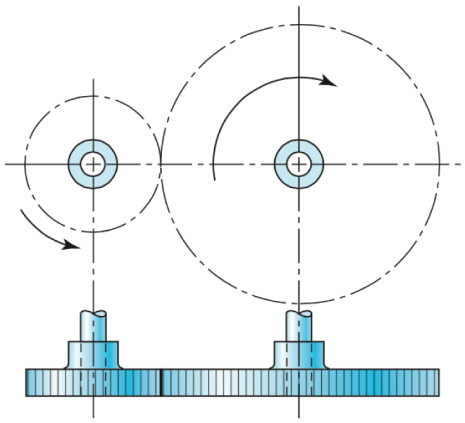
Introduction to gears

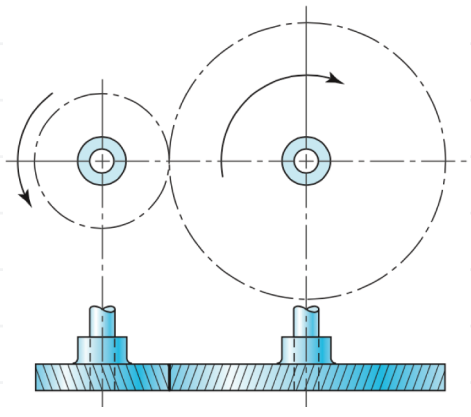
Types of gears

There are four standard types of gears, each used for different applications.

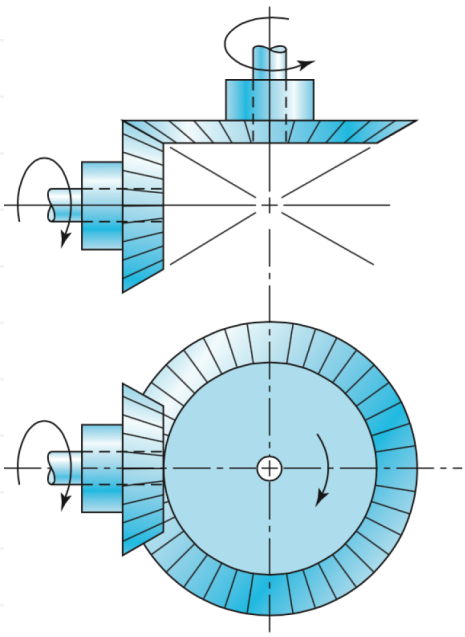
(1) Spur gears have teeth parallel to the axis of rotation and are used to transmit motion from one shaft to another, parallel, shaft. Of all types, the spur gear is the simplest and, for this reason, will be used to develop the primary kinematic relationships of the tooth form. (Budynas)



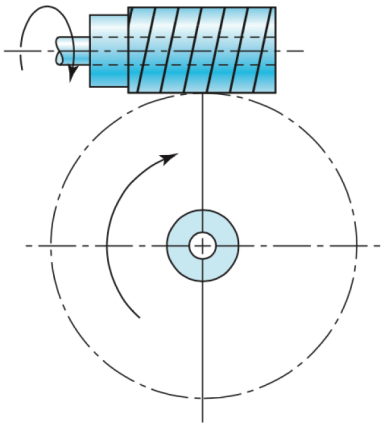
(2) Helical gears have teeth inclined to the axis of rotation. Helical gears can be used for the same applications as spur gears and, when so used, are not as noisy, because of the more gradual engagement of the teeth during meshing. The inclined tooth also develops thrust loads and bending couples, which are not present with spur gearing. Sometimes helical gears are used to transmit motion between nonparallel shafts. (Budynas)



(3) Bevel gears have teeth formed on conical surfaces and are used mostly for transmitting motion between intersecting shafts. (Budynas)



(4) Worms and worm gears represent the fourth basic gear type. As shown, the worm resembles a screw. The direction of rotation of the worm gear, also called the worm wheel, depends upon the direction of rotation of the worm and upon whether the worm teeth are cut right-hand or left-hand. Worm gearsets are also made so that the teeth of one or both wrap partly around the other. Such sets are called single-enveloping and double-enveloping worm gearsets. Worm gearsets are mostly used when the speed ratios of the two shafts are quite high, say, 3 or more. (Budynas, conedrive.com)



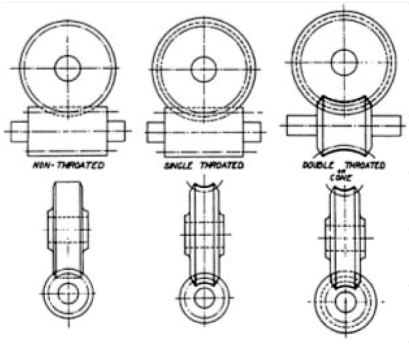
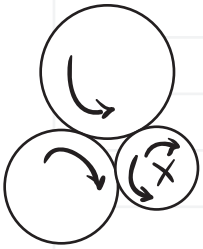
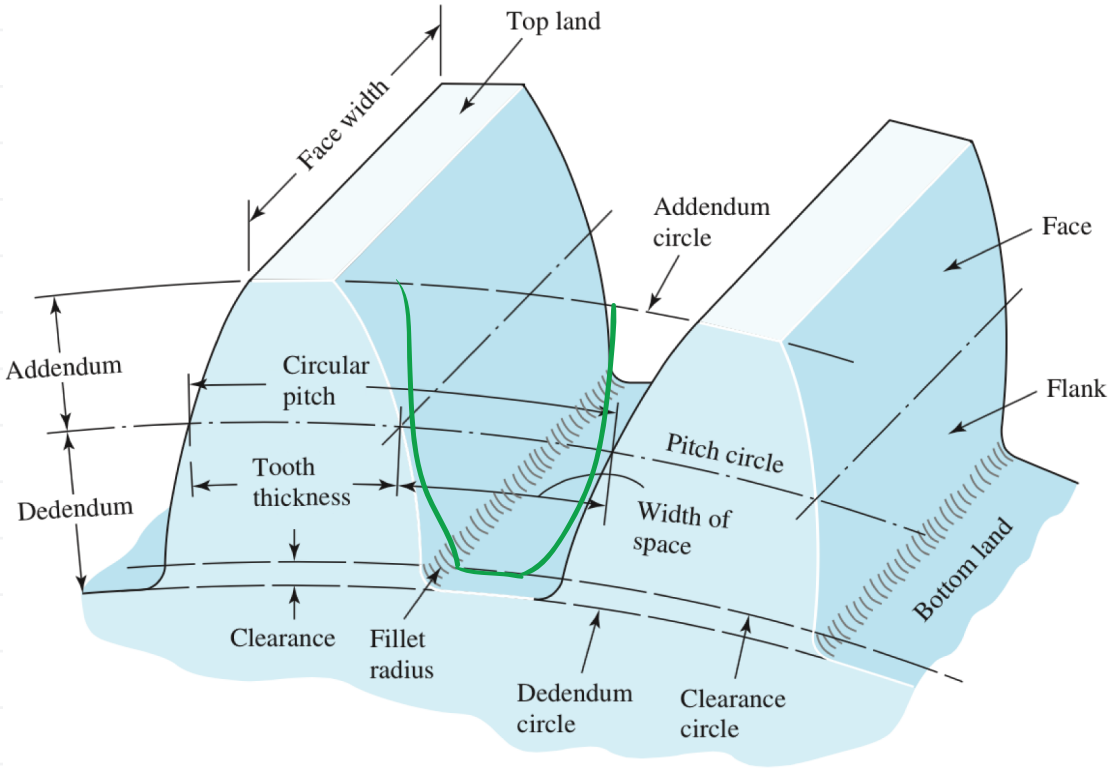


Figure 1: Three Worm Gear Designs

Spur gear nomenclature





The pitch circle is a theoretical circle upon which all calculations are usually based; its diameter is the pitch diameter. The pitch circles of a pair of mating gears are tangent to each other. A pinion is the smaller of two mating gears. The larger is often called the gear. (Budynas)

The circular pitch p is the distance, measured on the pitch circle, from a point on one tooth to a corresponding point on an adjacent tooth. Thus the circular pitch is equal to the sum of the tooth thickness and the width of space. (Budynas)

The module m is the ratio of the pitch diameter to the number of teeth. The customary unit of length used is the millimeter. The module is the index of tooth size in SI. (Budynas)

The diametral pitch P is the ratio of the number of teeth on the gear to the pitch diameter. Thus, it is the reciprocal of the module. Since diametral pitch is used only with U.S. units, it is expressed as teeth per inch. (Budynas)

The addendum a is the radial distance between the top land and the pitch circle. (Budynas)

The dedendum b is the radial distance from the bottom land to the pitch circle. (Budynas)

The whole depth h_t is the sum of the addendum and the dedendum. (Budynas)

The clearance circle is a circle that is tangent to the addendum circle of the mating gear. The clearance c is the amount by which the dedendum in a given gear exceeds the addendum of its mating gear. (Budynas)

The backlash is the amount by which the width of a tooth space exceeds the thickness of the engaging tooth measured on the pitch circles. (Budynas)

Here are some important relationships. Let
P be the diametrical pitch,
N be the number of teeth,
d be the pitch diameter in inches or millimeters,
m be the module in mm, and
p be the circular pitch in inches or millimeters.

$$P = \frac{N}{d} = \frac{1}{m}$$

$$m = \frac{d}{N} = \frac{1}{P}$$

$$p = \frac{\pi d}{N} = \pi m = \frac{\pi}{P}$$

$$p P = \pi$$