2.1 Basic Geometry Of Spur Gears

The fundamentals of gearing are illustrated through the spur gear tooth, both because it is the simplest, and hence most comprehensible, and because it is the form most widely used, particularly for instruments and control systems.

The basic geometry and nomenclature of a spur gear mesh is shown in **Figure 2-1**. The essential features of a gear mesh are:

1. Center distance.
2. The pitch circle diameters (or pitch diameters).
3. Size of teeth (or module).
4. Number of teeth.
5. Pressure angle of the contacting involutes.

Details of these items along with their interdependence and definitions are covered in subsequent paragraphs.

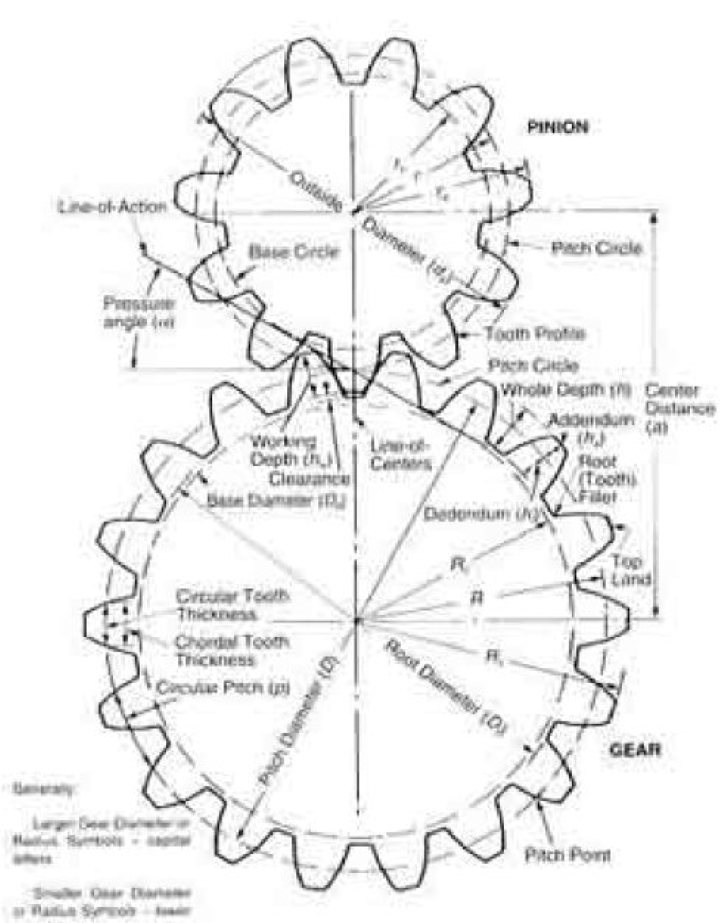


Fig. 2-1 Basic Gear Geometry

2.2 The Law Of Gearing

A primary requirement of gears is the constancy of angular velocities or proportionality of position transmission. Precision instruments require positioning fidelity. High-speed and/or high-power gear trains also require transmission at constant angular velocities in order to avoid severe dynamic problems.

Constant velocity (i.e., constant ratio) motion transmission is defined as "conjugate action" of the gear tooth profiles. A geometric relationship can be derived (2, 12)* for the form of the tooth profiles to provide conjugate action, which is summarized as the Law of Gearing as follows:

"A common normal to the tooth profiles at their point of in all positions of the contacting teeth, pass through a fixed point on the line-of-centers called the pitch point."

Any two curves or profiles engaging each other and satisfying the law of gearing are conjugate curves.

2.3 The Involute Curve

There is almost an infinite number of curves that can be developed to satisfy the law of gearing, and many different curve forms have been tried in the past. Modern gearing (except for clock gears) is based on involute teeth. This is due to three major advantages of the involute curve:

1. Conjugate action is independent of changes in center distance.

2. The form of the basic rack tooth is straight-sided, and therefore is relatively simple and can be accurately made; as a generating tool it imparts high accuracy to the cut gear tooth.

3. One cutter can generate all gear teeth numbers of the same pitch.

The involute curve is most easily understood as the trace of a point at the end of a taut string that unwinds from a cylinder. It is imagined that a point on a sting, which is pulled taut in a fixed direction, projects its trace onto a plane that rotates with the base circle. See Figure 2-2. The base cylinder, or base circle as referred to m gear literature, fully defines the form of the involute and in a gear it is an inherent parameter, though invisible.

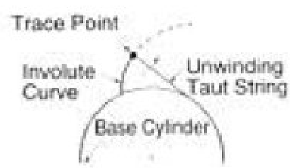
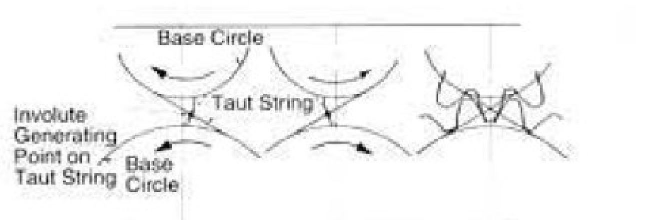


Fig. 2-2 Generation of an Involute by a Taut String

The development and action of mating teeth can be visualized by imagining the taut string as being unwound from one base circle and wound on to the other, as shown in Figure 2-3a. Thus, a single point on the string simultaneously traces an involute on each base circle's rotating plane. This pair of involutes is conjugate, since at all points of contact the common normal is the common tangent which passes through a fixed point on the line-of-centers. If a second winding/unwinding taut string is wound around the base circles in the opposite direction, **Figure2-3b**, oppositely curved involutes are generated which can accommodate. motion reversal. When the involute pairs are properly spaced, the result is the involute gear tooth, **Figure 2-3c.**



(a) Left-Hand Involutes (b) Right-Hand Involutes (c) Complete Teeth Generated by Two Crossed Generating Taut Strings contact must,

Fig. 2-3 Generation and Action of Gear Teeth

* Numbers in parenthesis refer to references at end of text.