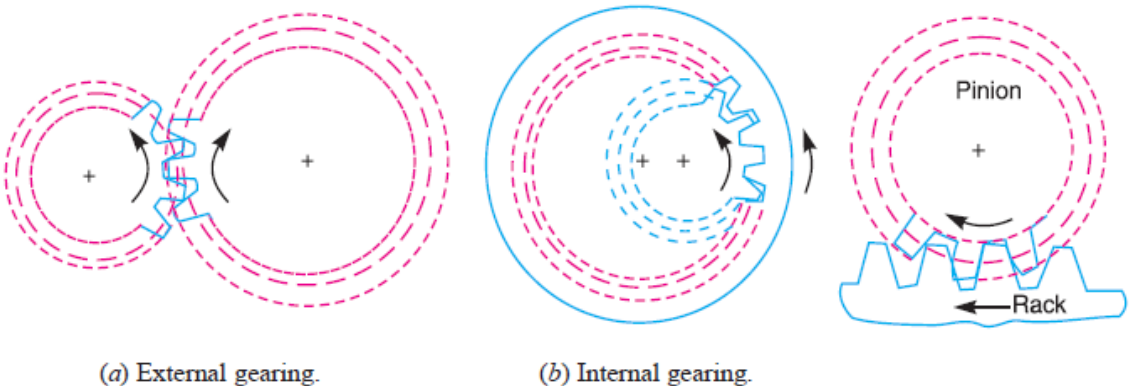

Fig. 2

Fig. 3. Rack and pinion.

Sometimes, the gear of a shaft meshes externally and internally with the gears in a straight line, as shown in Fig. 3. Such type of gear is called ***rack and pinion***. The straight line gear is called rack and the circular wheel is called pinion. A little consideration will show that with the help of a rack and pinion, we can convert linear motion into rotary motion and ***vice-versa*** as shown in Fig.3.

4. *According to position of teeth on the gear surface*. The teeth on the gear surface may be **(*a*)** straight, **(*b*)** inclined, and **(*c*)** curved.
The spur gears have straight teeth whereas helical gears have their teeth inclined to the wheel rim. In case of spiral gears, the teeth are curved over the rim surface.

Terms Used in Gears

1. *Pitch circle*. It is an imaginary circle which by pure rolling action, would give the same motion as the actual gear.

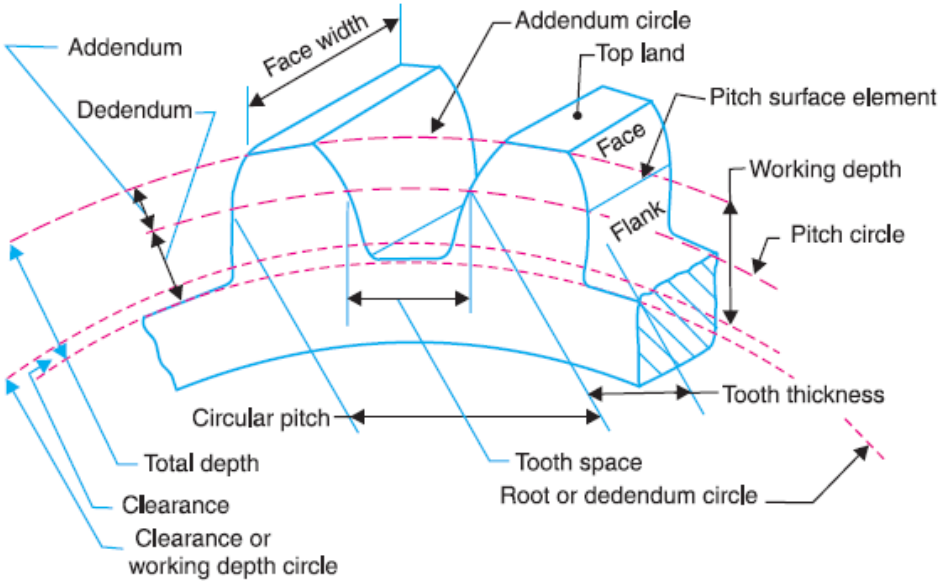

Fig. 4. Terms used in gears.

2. *Pitch circle diameter*. It is the diameter of the pitch circle. The size of the gear is usually specified by the pitch circle diameter. It is also known as ***pitch diameter***.
3. *Pitch point*. It is a common point of contact between two pitch circles.
4. *Pitch surface*. It is the surface of the rolling discs which the meshing gears have replaced at the pitch circle.
5. *Pressure angle or angle of obliquity*. It is the angle between the common normal to two gear teeth at the point of contact and the common tangent at the pitch point. It is usually denoted by φ. The standard pressure angles are 14.5° & 20°
6. *Addendum*. It is the radial distance of a tooth from the pitch circle to the top of the tooth.
7. *Dedendum*. It is the radial distance of a tooth from the pitch circle to the bottom of the tooth.
8. *Addendum circle*. It is the circle drawn through the top of the teeth and is concentric with the pitch circle.
9. *Dedendum circle*. It is the circle drawn through the bottom of the teeth. It is also called root circle.
10. *Circular pitch*. It is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth. It is usually denoted by p_c. Mathematically,
Circular pitch, $p_c = \pi D/T$
where D = Diameter of the pitch circle, and
T = Number of teeth on the wheel.
11. *Diametral pitch.* It is the ratio of number of teeth to the pitch circle diameter in millimetres. It is denoted by p_d . Mathematically,

$$p_c = \frac{\pi D_1}{T_1} = \frac{\pi D_2}{T_2} \quad \text{or} \quad \frac{D_1}{D_2} = \frac{T_1}{T_2}$$

Diametral pitch, $p_d = \frac{T}{D} = \frac{\pi}{p_c}$ $\quad \ldots\left(\because p_c = \frac{\pi D}{T}\right)$

where T = Number of teeth, and
D = Pitch circle diameter.

12. *Module*. It is the ratio of the pitch circle diameter in millimeters to the number of teeth.It is usually denoted by m. Mathematically, Module, $m = D/T$

Note : The recommended series of modules in Indian Standard are 1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, and 20. The modules 1.125, 1.375, 1.75, 2.25, 2.75, 3.5, 4.5, 5.5, 7, 9, 11, 14 and 18 are of second choice.

13. *Clearance*. It is the radial distance from the top of the tooth to the bottom of the tooth, in a meshing gear. A circle passing through the top of the meshing gear is known as ***clearance circle***.

14. *Total depth*. It is the radial distance between the addendum and the dedendum circles of a gear. It is equal to the sum of the addendum and dedendum.

Path of contact. It is the path traced by the point of contact of two teeth from the beginning to the end of engagement.

Length of the path of contact. It is the length of the common normal cut-off by the addendum circles of the wheel and pinion.

Arc of contact. It is the path traced by a point on the pitch circle from the beginning to the end of engagement of a given pair of teeth. The arc of contact consists of two parts, *i.e*.

(*a*) *Arc of approach*. It is the portion of the path of contact from the beginning of the engagement to the pitch point.

(*b*) *Arc of recess*. It is the portion of the path of contact from the pitch point to the end of the engagement of a pair of teeth.

Gear Materials

The material used for the manufacture of gears depends upon the strength and service conditions like wear, noise etc. The gears may be manufactured from metallic or non-metallic materials. The metallic gears with cut teeth are commercially obtainable in cast iron, steel and bronze. The nonmetallic materials like wood, raw hide, compressed paper and synthetic resins like nylon are used for gears, especially for reducing noise.

The cast iron is widely used for the manufacture of gears due to its good wearing properties, excellent machinability and ease of producing complicated shapes by casting method. The cast iron gears with cut teeth may be employed, where smooth action is not important. The steel is used for high strength gears and steel may be plain carbon steel or alloy steel. The steel gears are usually heat treated in order to combine properly the toughness and tooth hardness. The phosphor bronze is widely used for worm gears in order to reduce wear of the worms which will be excessive with cast iron or steel.

Length of Path of Contact

Consider a pinion driving the wheel as shown in Fig.5. When the pinion rotates in clockwise direction, the contact between a pair of involute teeth begins at *K* (on the flank near the base circle of pinion or the outer end of the tooth face on the wheel) and ends at *L* (outer end of the tooth face on the pinion or on the flank near the