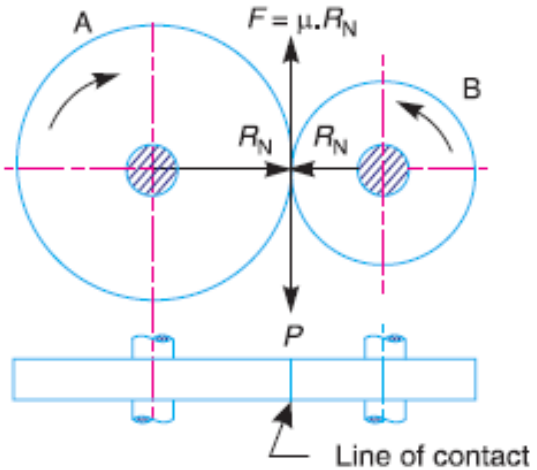
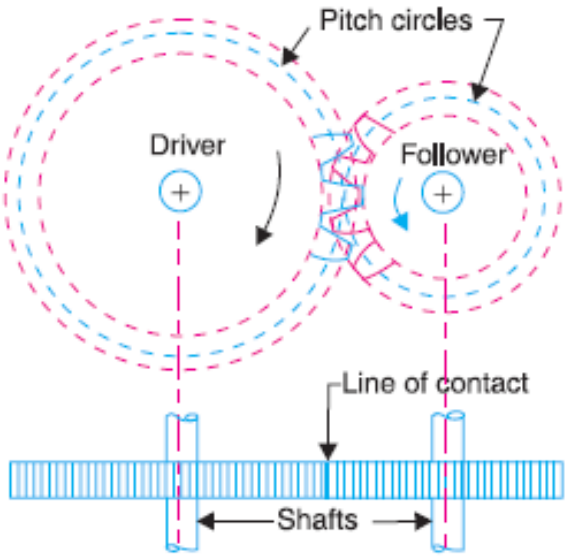
Power Transmission by Gears



(*a*) Friction wheels.



(*b*) Toothed wheels.

A body of circular or frustrum of a cone and of uniform small width having teeth of identical shape on its internal or external circumferential surface, is called a GEAR or TOOTHED WHEELS.

Advantages

1. It transmits exact velocity ratio.
2. It may be used to transmit large power.
3. It has high efficiency.
4. It has reliable service.
5. It has compact layout.

Disadvantages

1. The manufacture of gears require special tools and equipment.
2. The error in cutting teeth may cause vibrations and noise during operation.

Gear Terminology

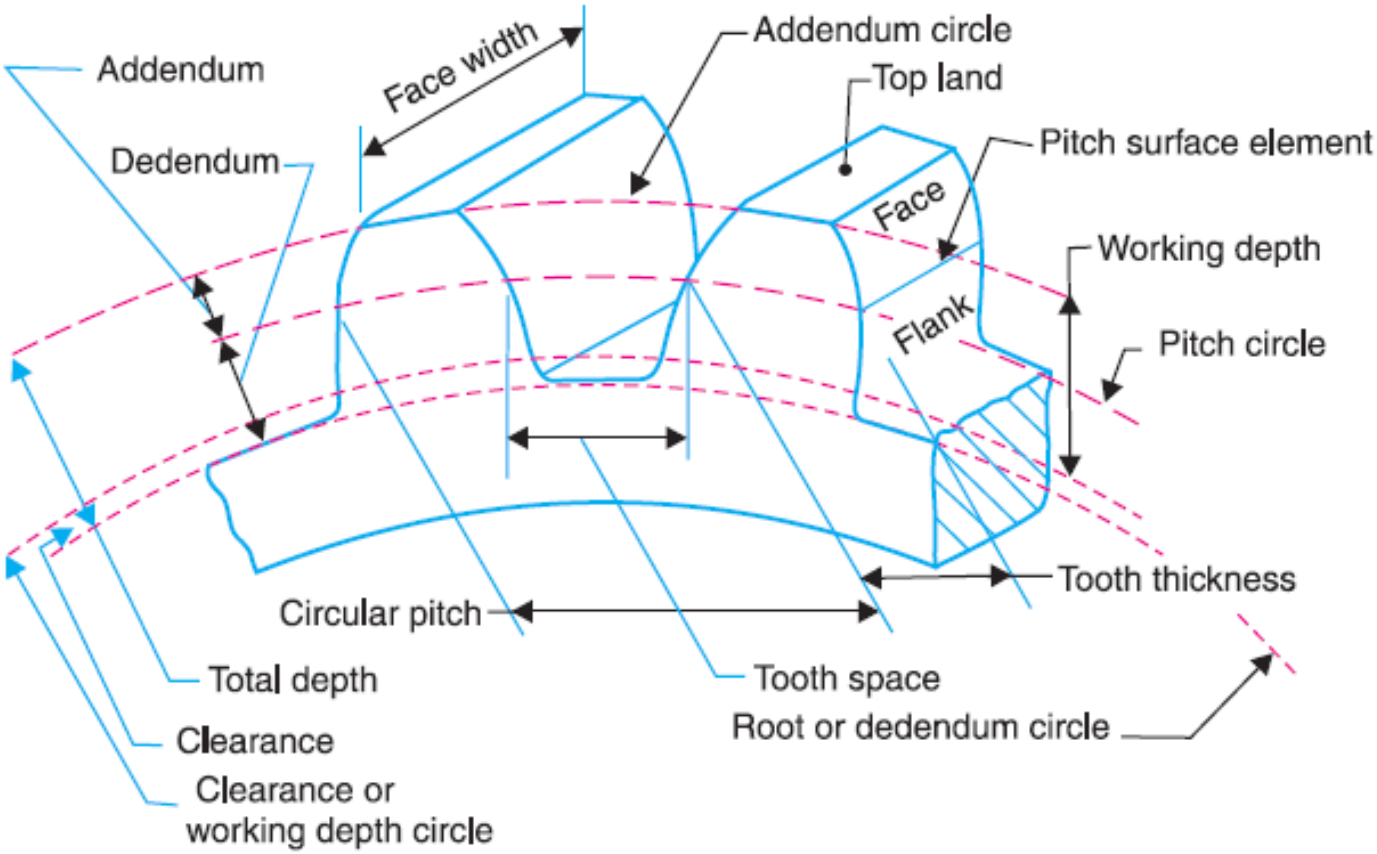
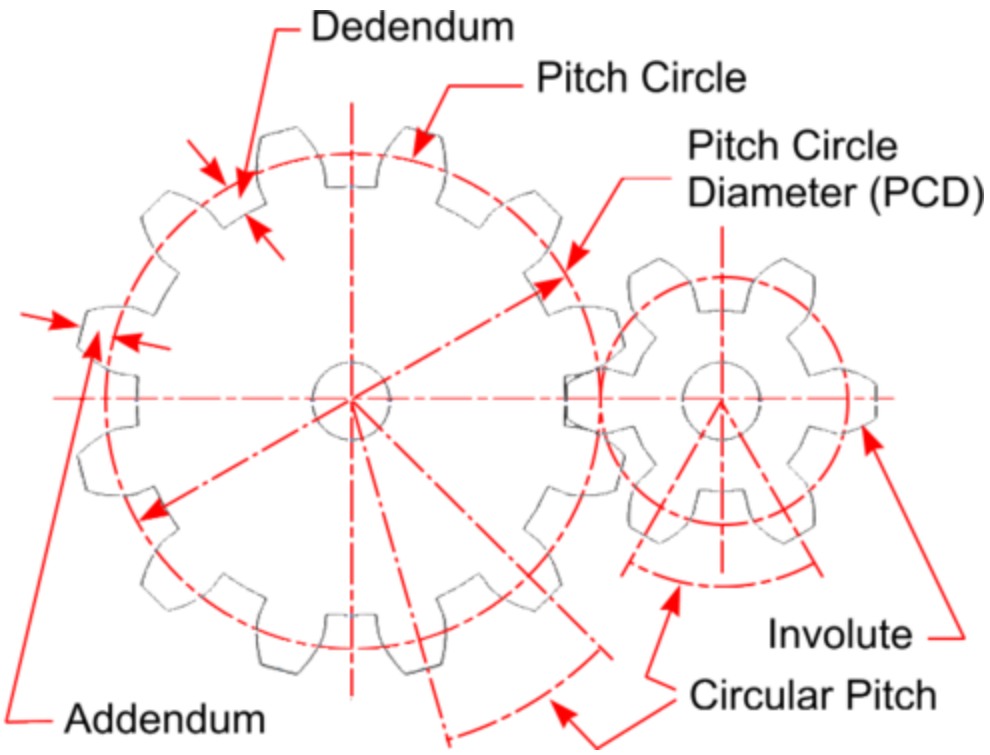


Fig. 12.5. Terms used in gears.



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

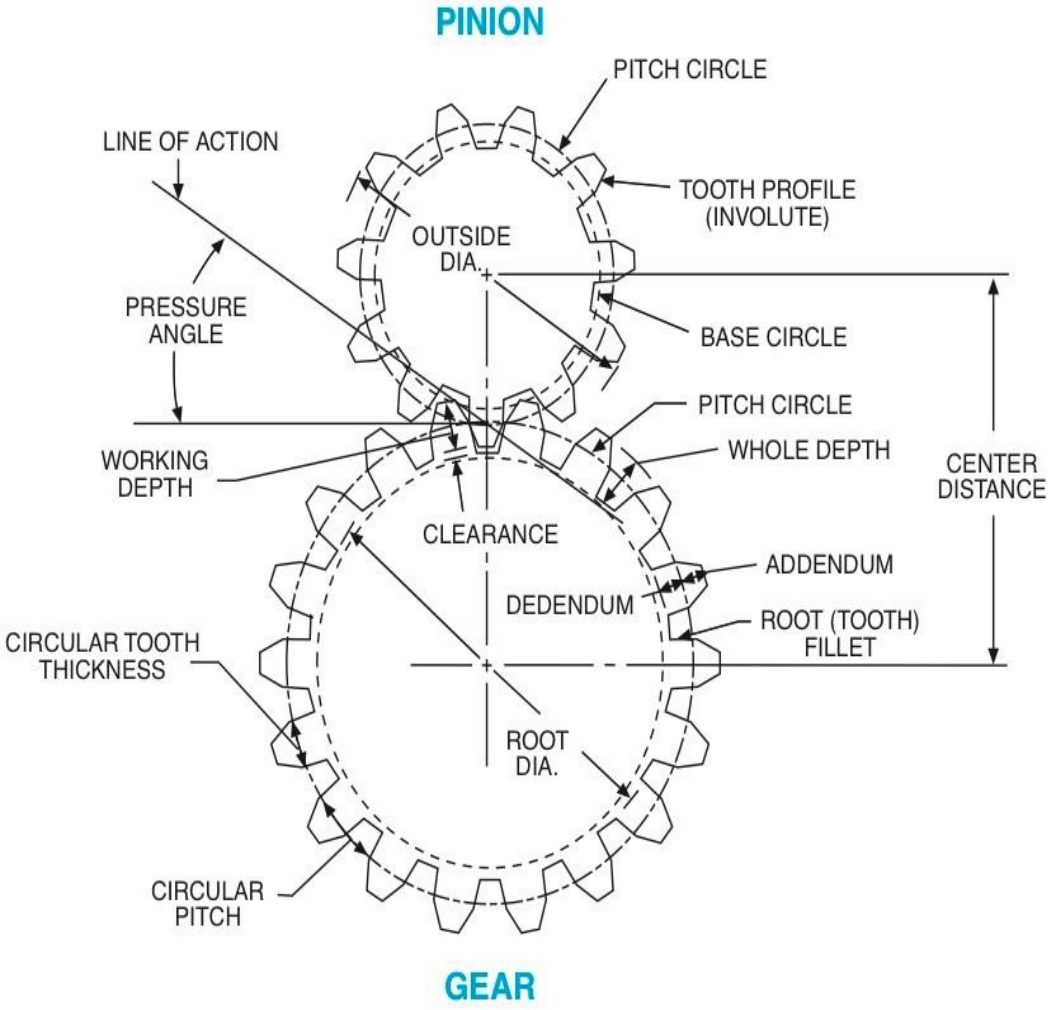
2. Pitch circle diameter. It is the diameter of the pitch circle. The size of the gear is usually specified by the pitch circle diameter. It is also known as pitch diameter.

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. Addendum. It is the radial distance of a tooth from the pitch circle to the top of the tooth.

6. Dedendum. It is the radial distance of a tooth from the pitch circle to the bottom of the tooth.



7. Addendum circle. It is the circle drawn through the top of the teeth and is concentric with the pitch circle.

8. Dedendum circle. It is the circle drawn through the bottom of the teeth. It is also called root circle.

9. 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.

10. 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.***

11. Working Depth:- It is the radial distance from the addendum circle to the clearance circle. It is equal to the sum of the addendum of the two meshing gears.

12. 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.

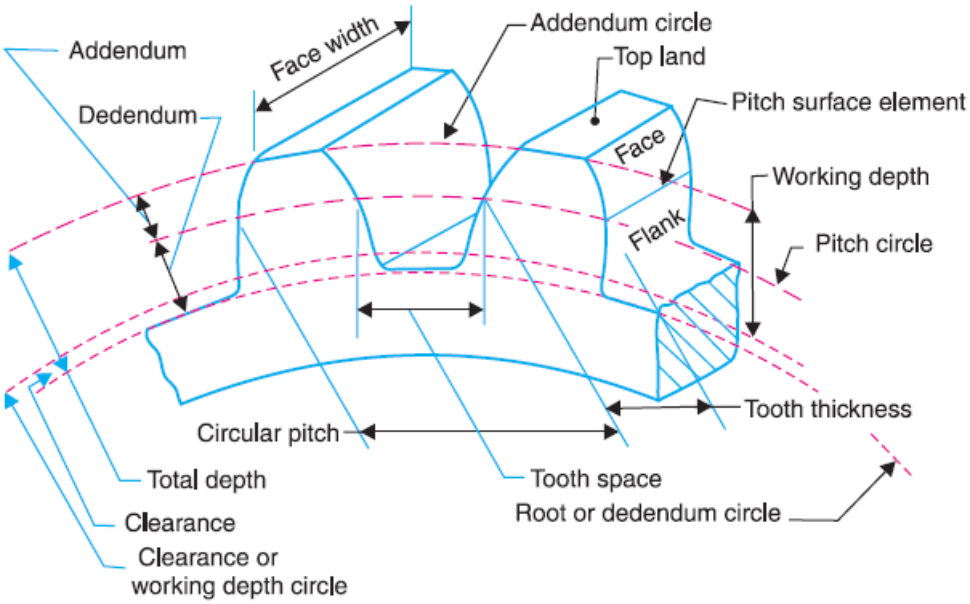


Fig. 12.5. Terms used in gears.

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.

A little consideration will show that the two gears will mesh together correctly, if the two wheels have the same circular pitch.

Note : If D_1 and D_2 are the diameters of the two meshing gears having the teeth T_1 and T_2 respectively, then for them to mesh correctly,

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

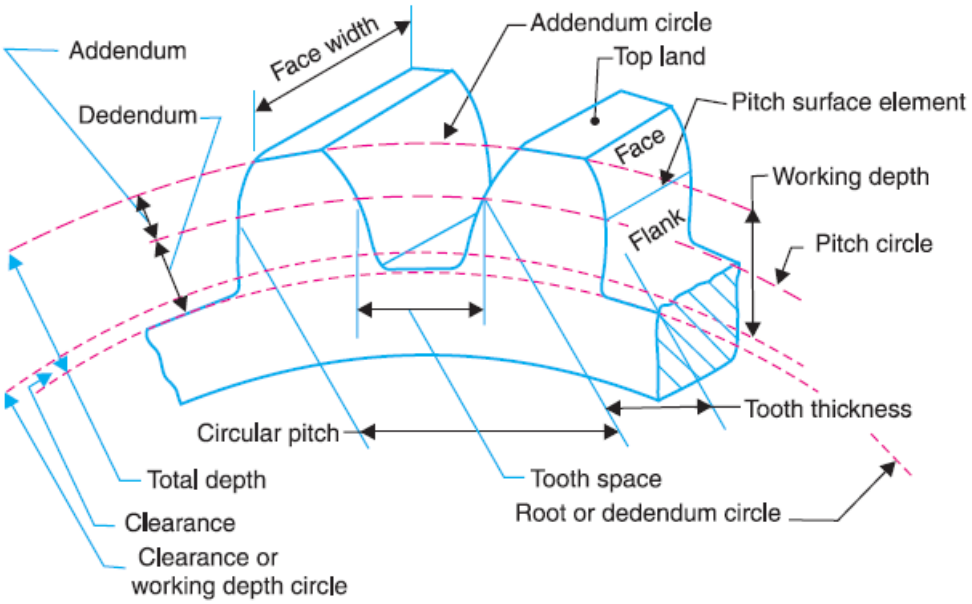


Fig. 12.5. Terms used in gears.

Diametral pitch. It is the ratio of number of teeth to the pitch circle diameter in millimetres. It is denoted by p_d . Mathematically,

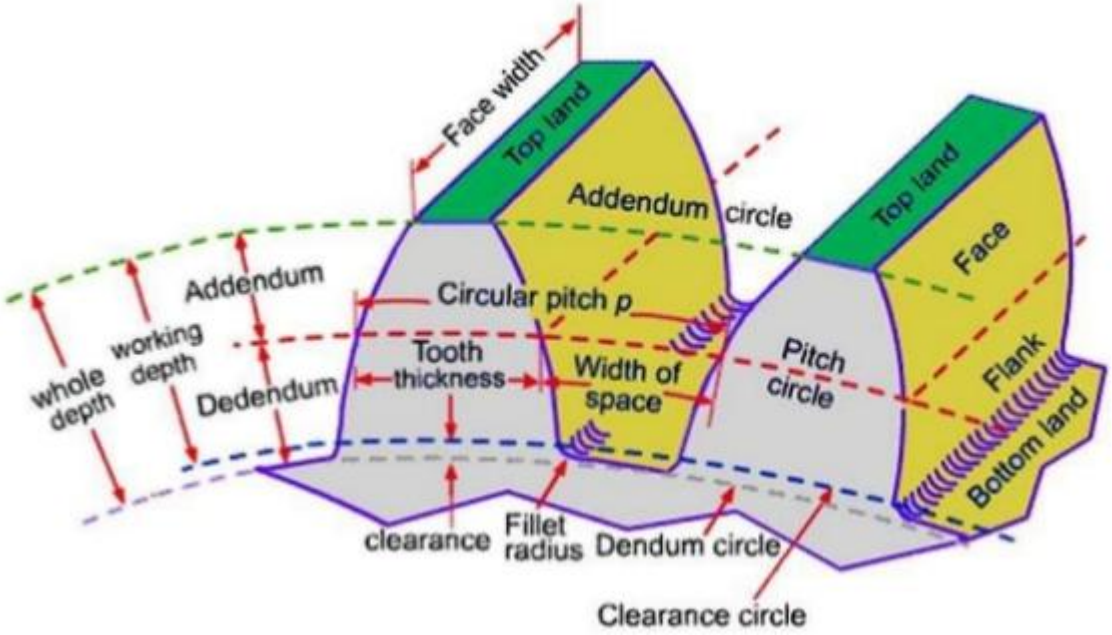
$$\text{Diametral pitch,} \qquad p_d = \frac{T}{D} = \frac{\pi}{p_c} \qquad \ldots\left(\because\ p_c = \frac{\pi D}{T}\right)$$

where T = Number of teeth, and

D = Pitch circle diameter.

Module. It is the ratio of the pitch circle diameter in millimeters to the number of teeth. It is usually denoted by m. Mathematically,

$$\text{Module,} \quad m = D/T$$



16. Tooth thickness. It is the width of the tooth measured along the pitch circle.

17. Tooth space. It is the width of space between the two adjacent teeth measured along the pitch circle.

18. Backlash. It is the difference between the tooth space and the tooth thickness, as measured along the pitch circle. Theoretically, the backlash should be zero, but in actual practice some backlash must be allowed to prevent jamming of the teeth due to tooth errors and thermal expansion.

19. Face of tooth. It is the surface of the gear tooth above the pitch surface.

20. Flank of tooth. It is the surface of the gear tooth below the pitch surface.

21. Top land. It is the surface of the top of the tooth.

22. Face width. It is the width of the gear tooth measured parallel to its axis.

23. Profile. It is the curve formed by the face and flank of the tooth.

24. Fillet radius. It is the radius that connects the root circle to the profile of the tooth.

Classification of Toothed Wheels

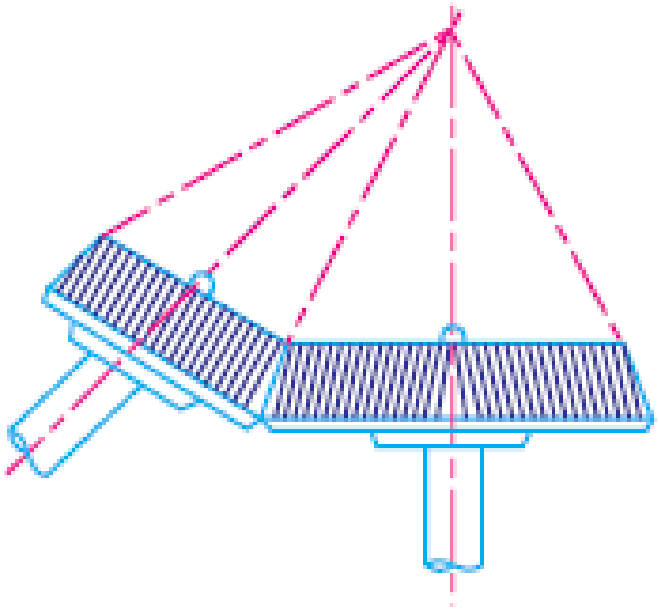
1. ***According to the position of axes of the shafts.***

   (a) Parallel, (b) Intersecting, and (c) Non-intersecting and non-parallel.

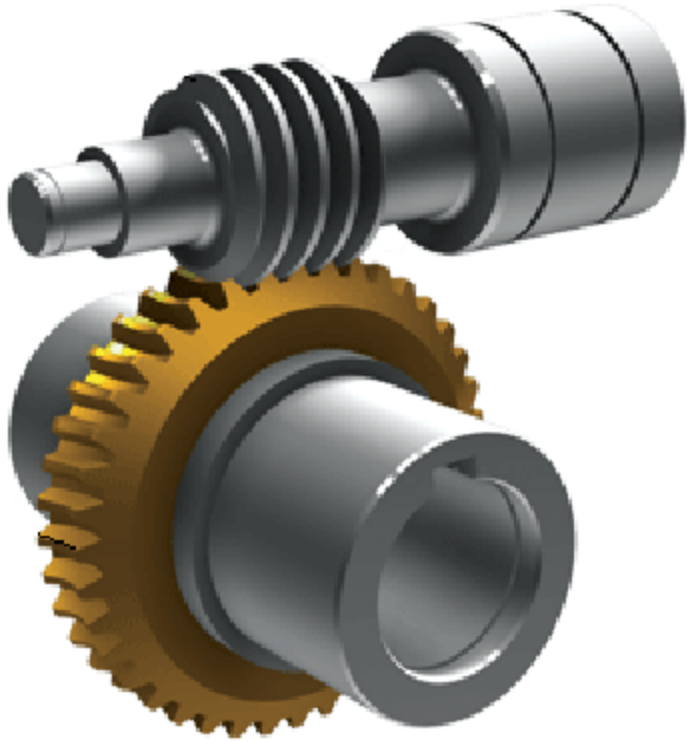
a. Spur Gear:- The gears used to connect the shafts in which their axes of rotation are parallel to each others are called ***"SPUR GEARS"*** and such an arrangement is called spur gearing. Generally, these gears have teeth parallel to the axis of the wheel.

Another name given to the spur gearing is ***helical gearing,*** in which the teeth are inclined to the axis and the gears are termed as ***helical gears***. The single and double helical gears connecting parallel shafts are shown in the below Fig. The double helical gears are known as ***herringbone gears.***

Bevel Gears:- The gears used to transmit motion from one shaft to another when their axes intersect are called **"BEVEL GEARS"** and the arrangement is called Bevel Gearing. The bevel gears, like spur gears, may also have their teeth inclined to the face of the bevel, in which case they are known ***as helical bevel gears***.



Spiral Or Skew Bevel Gear:- When the axes of rotation of shafts carrying the gears are neither parallel nor intersecting, the gears are called Spiral Or Skew Bevel Gear.



2. According to the peripheral velocity of the gears.

(a) Low velocity, (b) Medium velocity, and (c) High velocity.

The gears having velocity less than 3 m/s are termed as ***low velocity gears*** and gears having velocity between 3 and 15 m/s are known as ***medium velocity gears***. If the velocity of gears is more than 15 m/s, then these are called ***high speed gears.***

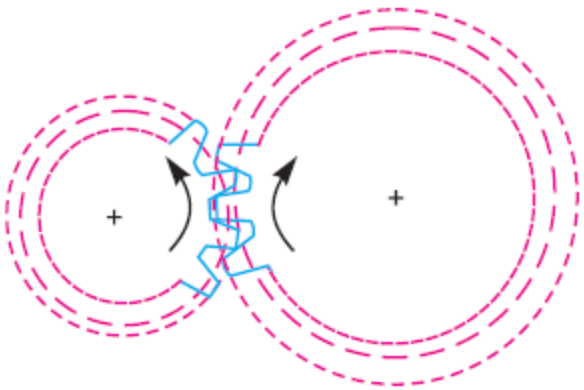
3. According to the type of gearing.

(***a) External gearing, (b) Internal gearing, and (c) Rack and pinion.***

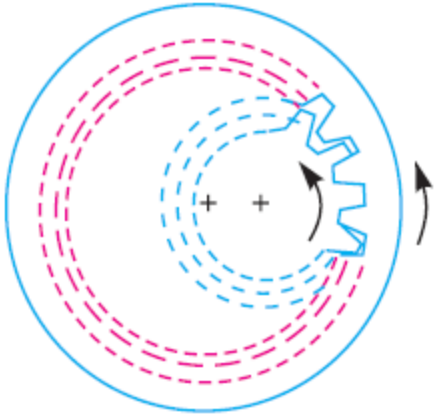
In external gearing, the gears of the two shafts mesh externally with each other as shown in Fig. The larger of these two wheels is called spur wheel and the smaller wheel is called pinion. In an external gearing, the motion of the two wheels is always unlike, as shown in Fig.

In internal gearing, the gears of the two shafts mesh internally with each other as shown in Fig. The larger of these two wheels is called annular wheel and the smaller wheel is called pinion. In an internal gearing, the motion of the two wheels is always like.

Rack and Pinion:- Sometimes, the gear of a shaft meshes externally and internally with the gears in a straight line, as shown in Fig. 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.



(*a*) External gearing.



(*b*) Internal gearing.

Fig. 12.3

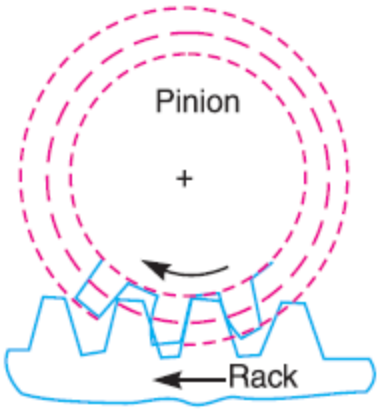
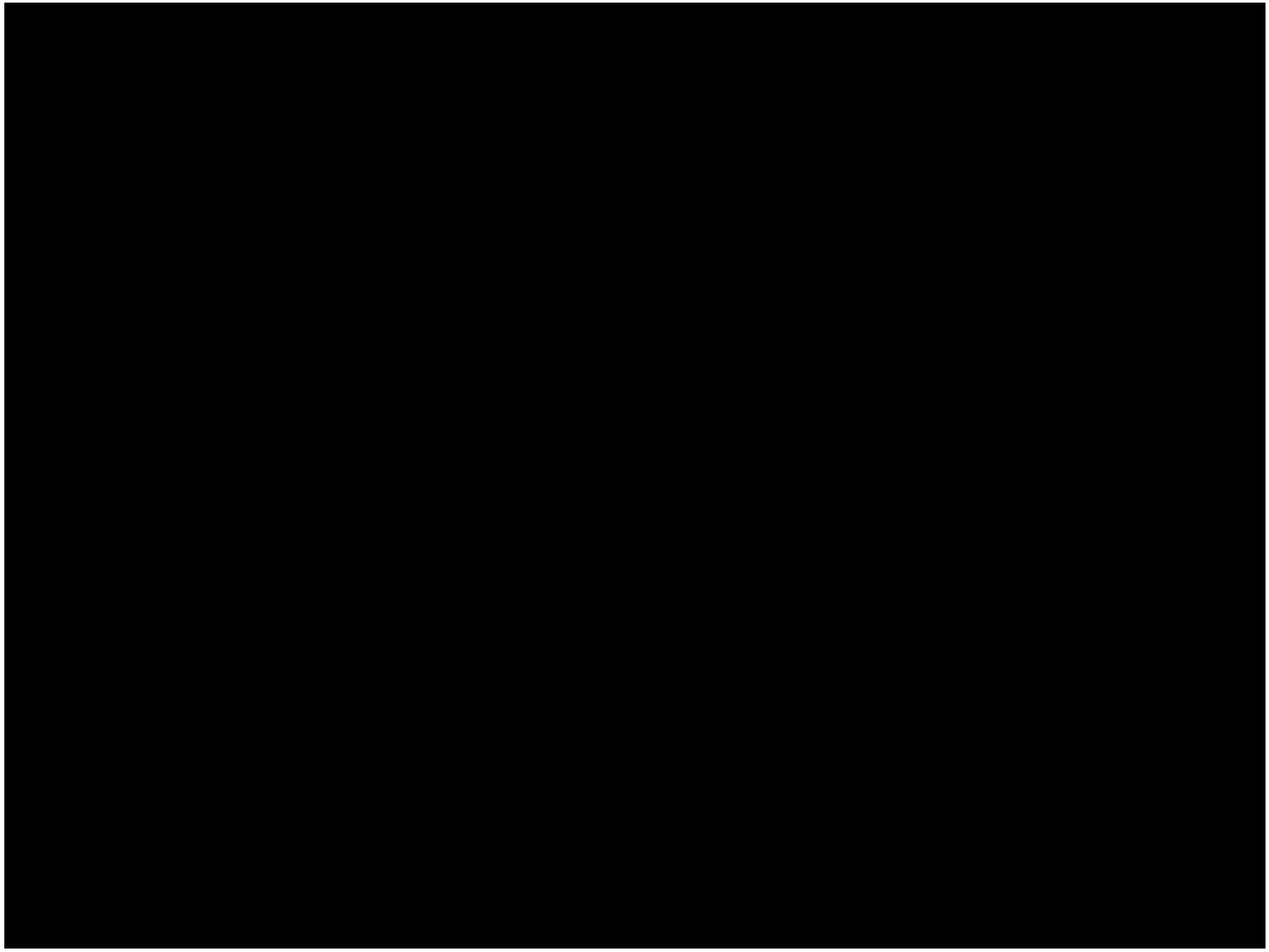


Fig. 12.4. Rack and pinion.



GEAR TRAIN

Sometimes, two or more gears are made to mesh with each other to transmit power from one shaft to another. Such a combination is called gear train or train of toothed wheels. The nature of the train used depends upon the velocity ratio required and the relative position of the axes of shafts. A gear train may consist of spur, bevel or spiral gears.

Types of Gear Trains

1. Simple gear train,
2. Compound gear train,
3. Reverted gear train,
4. Epicyclic gear train.

Simple Gear Train:-

COMPOUND GEAR TRAIN

EPICYCLE GEAR TRAIN