Chapter 10
GEARS AND GEAR TRAINS

Previous year Question paper

1. **Explain epicyclic gear train with diagram-6,7 marks**
2. **six advantages of gear drive- 2,6 marks**
3. **Nomenclature of spur gear with diagram-6,7 marks**
4. **Reverted gear train with diagram,velocity ratio-7,8marks**

10.13 PLANETARY OR EPICYCLIC GEAR TRAIN

In an epicyclic gear train the axis of at least one of the gear is in motion relative to the other gear rotates in the fixed axis. A simple epicyclic gear train is shown in *Fig* 10.21. Consider two gear wheels S and P, the axes of which are connected by an arm F. The gear S and arm F rotate about same axis O_1. The gears S and P constitute a simple gear train and the gear P rotates on axis O_2. If the gear S is fixed so that the arm can rotate about the axis of S, the gear P would also move around S in addition to the motion about its own axis. The advantages of epicyclic gear train are

1. High speed reduction can easily be achieved.
2. Compact and occupies less space.

Epicyclic gear trains are used in differential gear of automobile, wrist watches, hoists and pulley blocks.

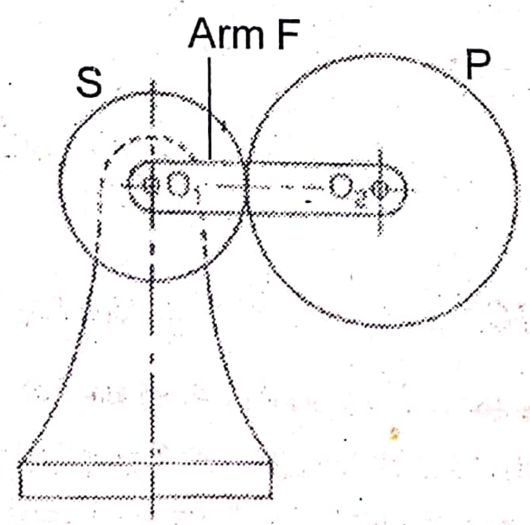


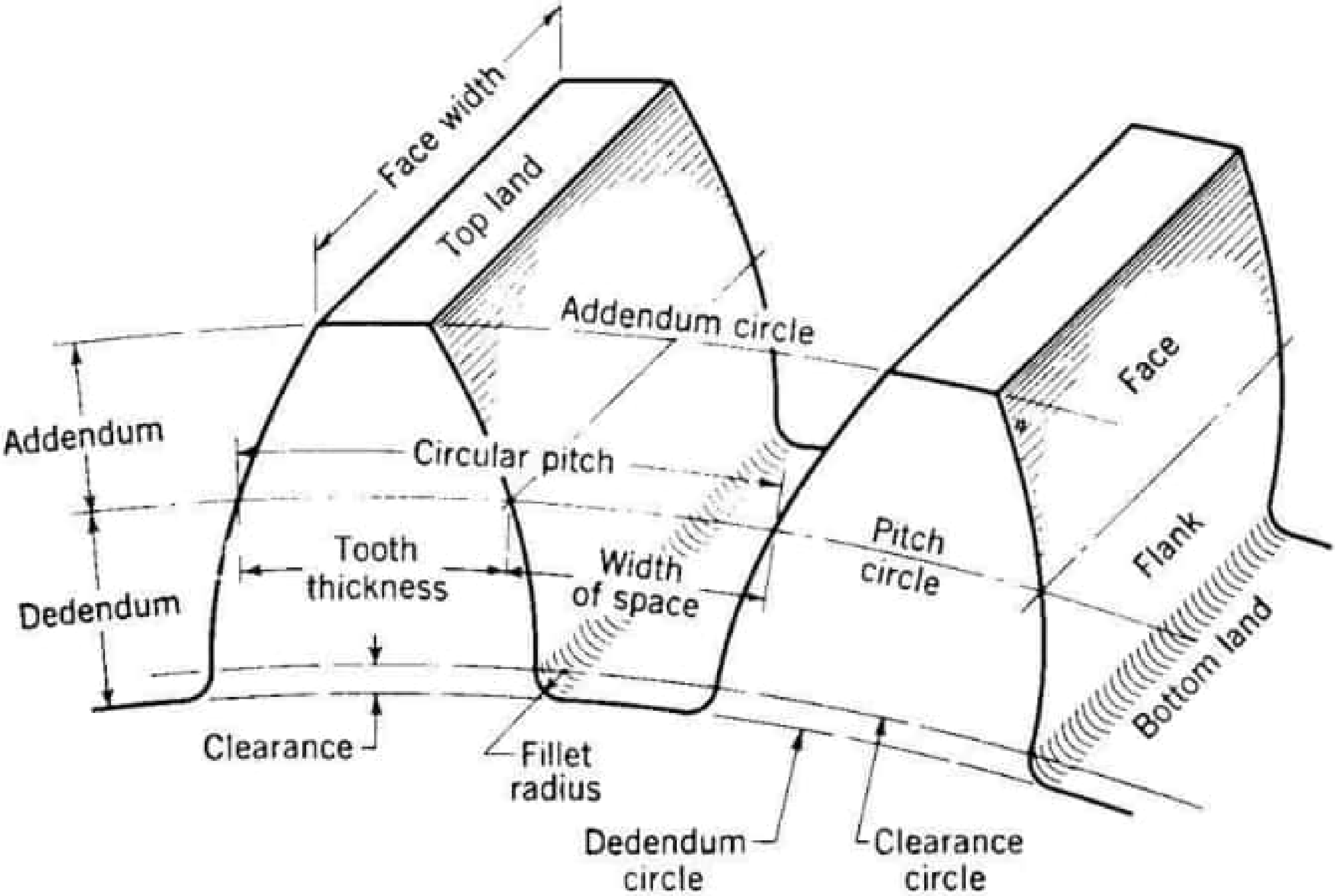
Fig. 10.21 Epicyclic gear train

10.14 PRACTICAL APPLICATIO...

Advantages of gear drive

1. Give positive drive and constant speed without slip.
2. More compact
3. Can be operated at higher speeds
4. High efficiency
5. Lighter loads on shafts and bearings
6. Used where precise timing is desired
7. Wide range of power transmitted.
8. Less maintenance.
9. Can be used for non intersecting and non parallel shafts

Gear Nomenclature



1. ***Pitch cylinders*** **:**Pitch cylinders of a pair of gears in mesh are the imaginary friction cylinders which by pure rolling together to transmit the same motion as the pair of gears.

2. ***Pitch circle*** : It is an imaginary circle with radius equal to the radius of pitch cylinder.

3. ***Pitch circle diameter*** **:** It is the diameter of the imaginary pitch circle.

4. ***Pitch surface*** **:** It is the surface of the pitch cylinder.

5. ***Pitch point*** **:** It is the point of contact of the two pitch circles of the meshing gears.

6. ***Circular pitch*** : This is the distance between the corresponding point of successive teeth measured along the circumference of the pitch circle. The circular pitch is equal to the sum of the tooth thickness and width of space. It is denoted by p_c and is given by

$$\boxed{p_c = \frac{\pi d}{T}} \qquad ..(10.3)$$

where

d = Pitch circle diameter in mm.

T = Number of teeth.

7. ***Diametral pitch*** : It is the number of teeth per unit length of the pitch circle diameter in mm. It is denoted by p_d and is given by .

$$\boxed{p_d = \frac{T}{d}} \qquad ...(10.4)$$

8. ***Module*** : It is the ratio of pitch circle diameter in mm to the number of teeth . It is denoted by m and is given by

$$\boxed{m = \frac{d}{T} = \frac{1}{p_d}} \qquad ...(10.5)$$

($\therefore$ Module is reciprocal of diametral pitch.)

Module and the circular pitch must be the same for the gears in mesh.

Also it can be seen that

$$\boxed{p_c p_d = \frac{\pi d}{T} \times \frac{T}{d} = \pi} \qquad ...(10.6)$$

And

$$\boxed{p_c = \pi \frac{d}{T} = \pi m} \qquad ...(10.7)$$

9. ***Addendum circle*** **:** The circle passing through the tips of teeth.
10. ***Dedendum circle*** **:** It is the circle passing through the roots of teeth.

11. ***Addendum*** **:** The radial distance between the pitch circle to the addendum circle is called *addendum*. Its standard value equal to the module.
12. ***Dedendum*** **:** The radial distance between the pitch circle to the dedendum circle is called *dedendum*. Its standard value equal to 1.157 times the module.

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13. ***Full depth of teeth*** : The radial distance between the addendum circle to the dedendum circle is called the full depth of the teeth.

$$\text{Full depth} = \text{Addendum} + \text{Dedendum}$$

$$= m + 1.157m \qquad = 2.157m$$

14. ***Working depth of teeth*** : It is defined as the sum of the addendum of two mating gears, and is equal to $2m$.

15. ***Pressure angle*** : It is the angle between the common normal at the point of tooth contact and the common tangent to the pitch circle.

16. ***Clearance*** : It is the difference between the dedendum of one gear and the addendum of the mating gear. It is denoted by c and is given by

$$c = 1.157m - m = 0.157m$$

17. ***Top land*** : It is the surface at the top of tooth .

18. ***Bottom land*** : It is the surface at the root of tooth in between two adjacent teeth.

19. ***Tooth thickness*** **:** It is the width of the tooth measured along the pitch circle.
20. ***Tooth space*** : It is width of the space between the two adjacent teeth measured along the pitch circle.
21. ***Back lash*** **:** It is the difference between the tooth thickness and tooth space measured along the pitch circle.
22. ***Face*** **:** This is the tooth surface between the pitch circle and the top land.
23. ***Flank*** **:** This is the tooth surface between the pitch circle and the bottom land.
24. ***Face width*** **:** This is the length of tooth measured parallel to the axis of the gear.
25. ***Fillet*** **:** It is the curved portion of the tooth flank at the root circle or dedendum circle.
26. ***Profile*** **:** It is the curve formed by the face and flank of the tooth.

The gear 1 (i.e. first driver) drives the gear 2 (i.e. first driven or follower) in the opposite direction. Since the gears 2 and 3 are mounted on the same shaft, therefore they form a compound gear and the gear 3 will rotate in the same direction as that of gear 2. The gear 3 (which is now the second driver) drives the gear 4 (i.e. the last driven or follower) in the same direction as that of gear 1. Thus in a reverted gear train, the motion of the first gear and the last gear is like.

Let

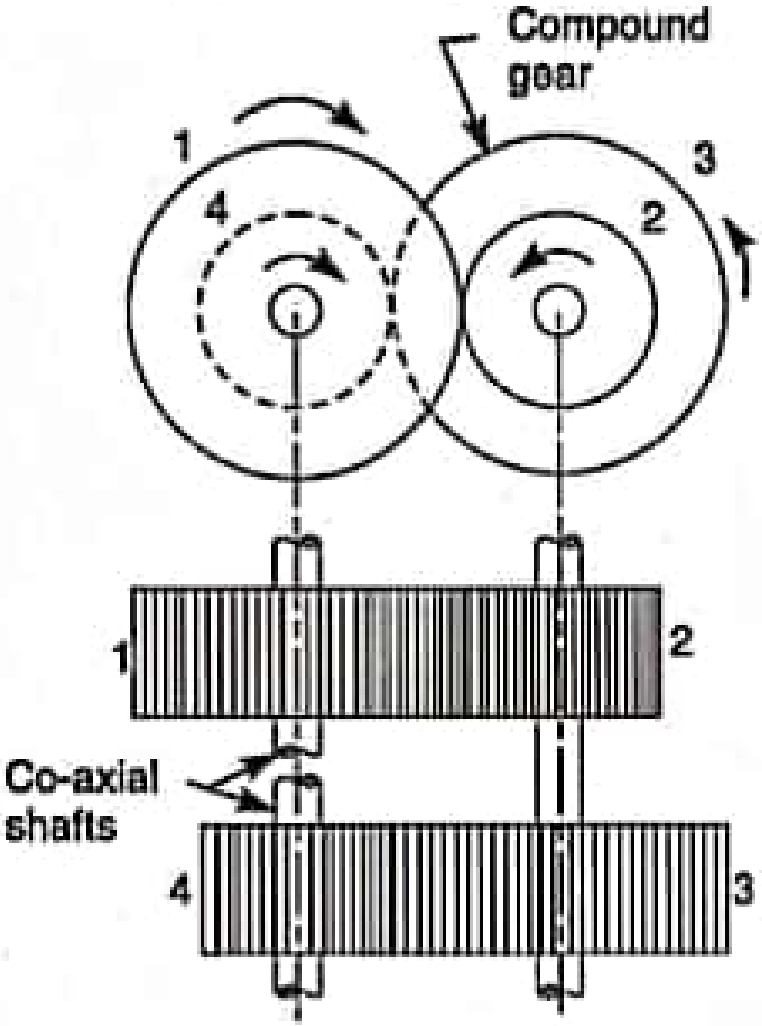
$T1$ = Number of teeth on gear 1,

$N1$ = Speed of gear 1 in r.p.m.

Similarly,

$T2, T3, T4$ = Number of teeth on respective gears, and

N2, N3, N4 = Speed of respective gears in r.p.m.



Reverted gear train.

Reverted gear train.

The circular pitch or module of all the gears is assumed to be same, therefore number of teeth on each gear is directly proportional to its circumference or radius.

$$T1 + T2 = T3 + T4 \text{ .... (ii)}$$

and

$$Speed\ Ratio = \frac{Product\ of\ number\ of\ teeth\ in\ driven\ gears}{Product\ of\ number\ of\ teeth\ in\ driver\ gears}$$

$$\frac{N_1}{N_4} = \frac{T_2 \times T_4}{T_1 \times T_3}$$

The reverted gear trains are used in automotive transmissions, lathe back gears, industrial speed reducers, and in clocks (where the minute and hour hand shafts are co-axial).