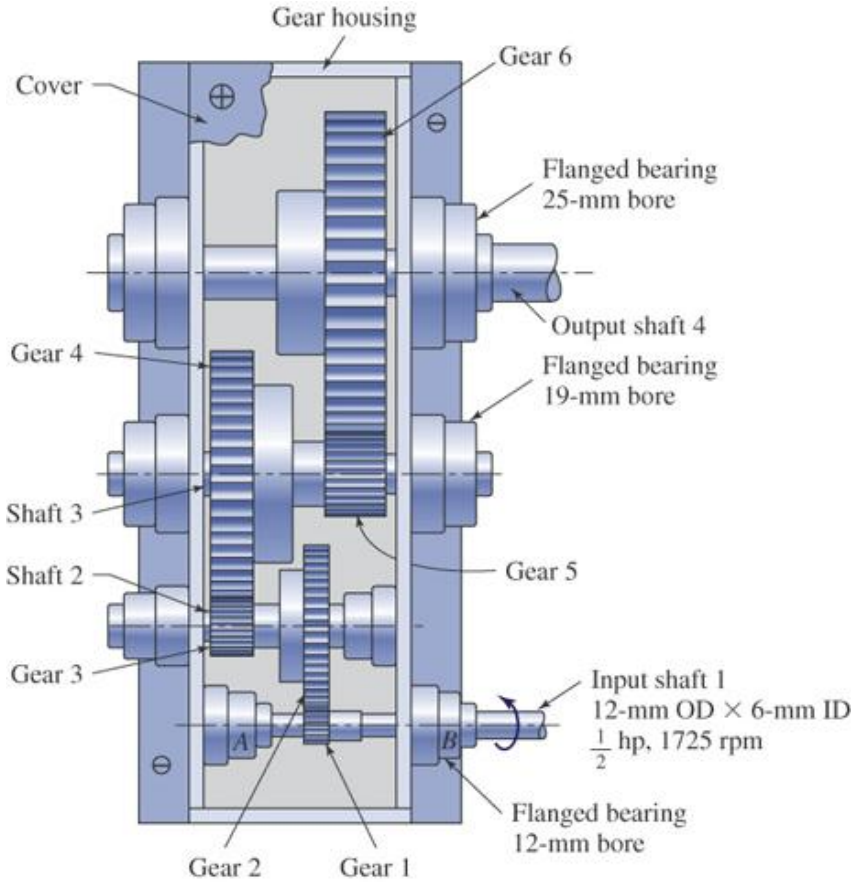
Gears

What we need to Know about them.

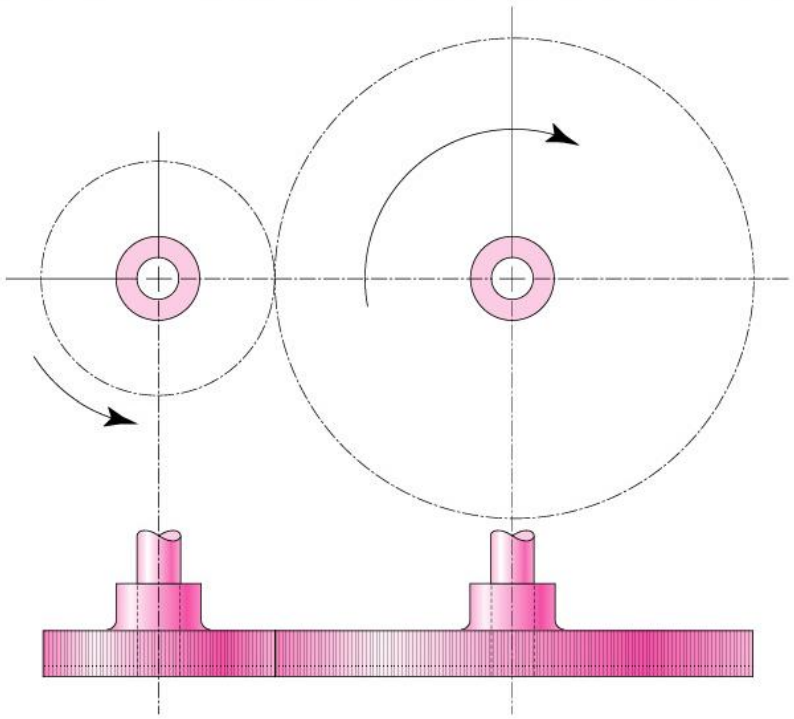
1. Type of gears
2. Terminologies or nomenclatures
3. Forces transmitted
4. Design of a gear box



Type of Gears

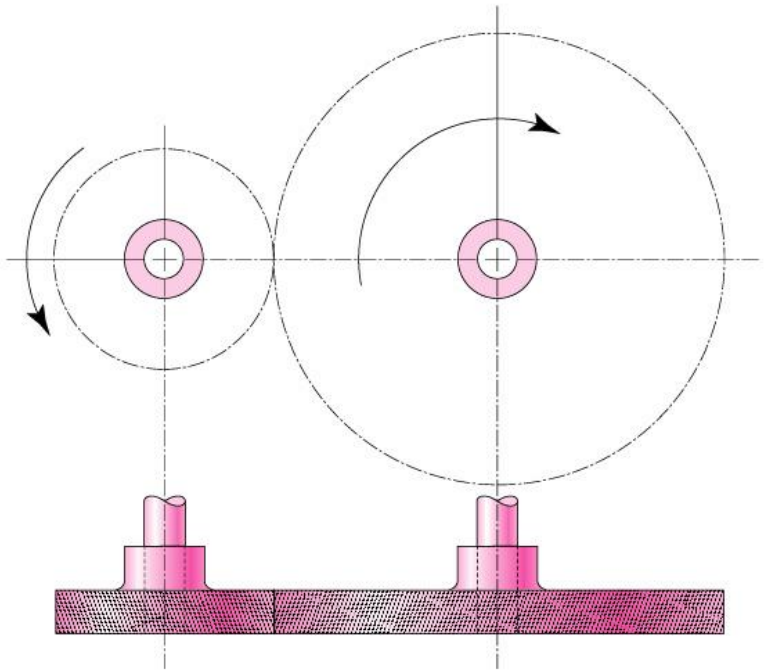
- Spurs
- Helical
- Bevel
- And Worm Gears

Spur Gears



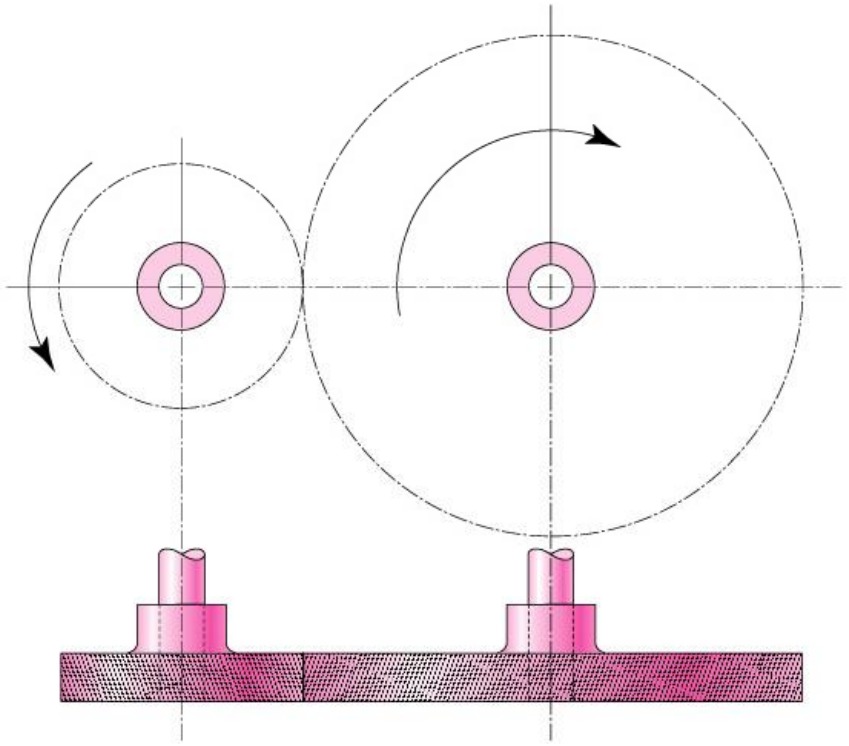
Are used in transmitting torque between parallel shafts

Helical Gears



Are used in transmitting torques between parallel or non parallel shafts, they are not as noisy as spur gears

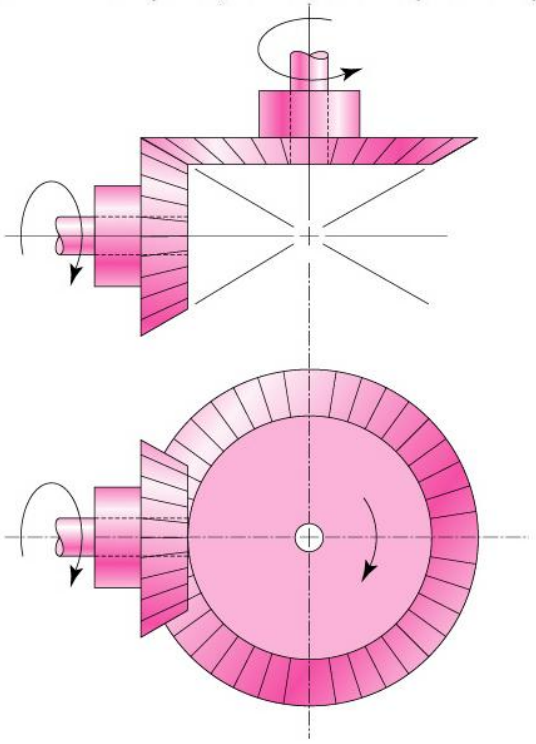
Fig. 13.2



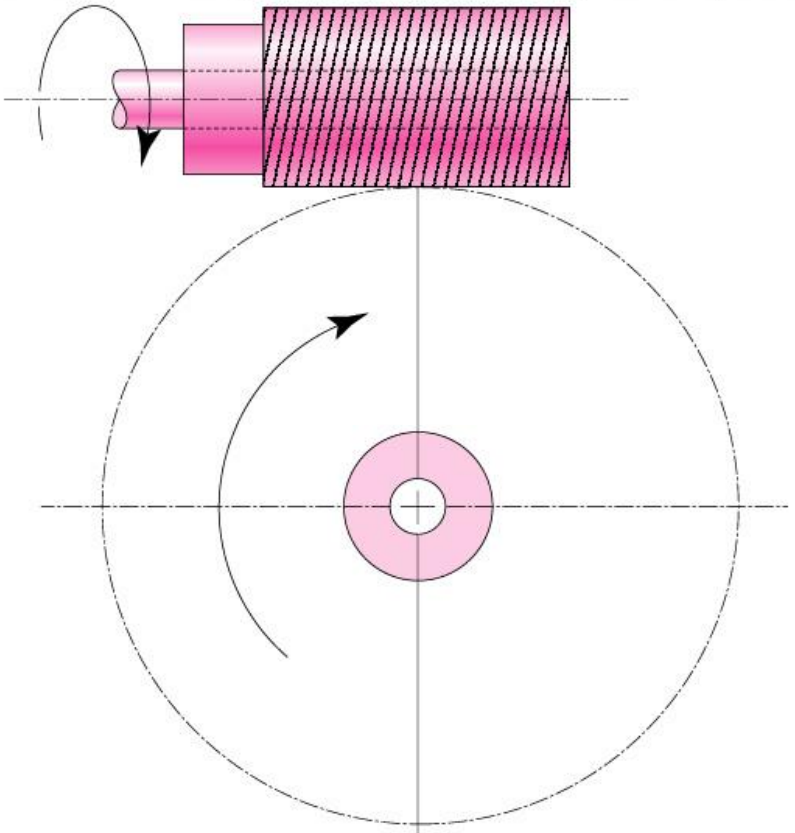
Bevel Gears

- Are used to transmit rotary motion between intersecting shafts

Teeth are formed on conical surfaces, the teeth could be straight or spiral.

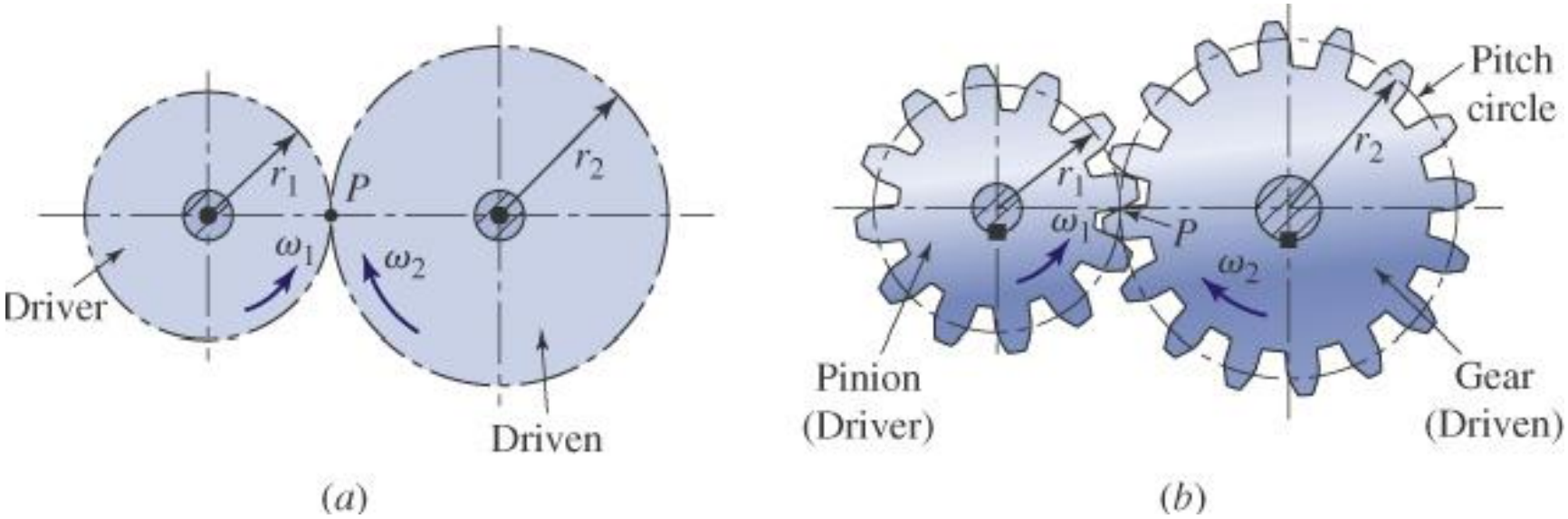


Worm Gears



Are used for transmitting motion between non parallel and non transmitting shafts, Depending on the number of teeth engaged called single or double. Worm gear mostly used when speed ratio is quiet high, 3 or more

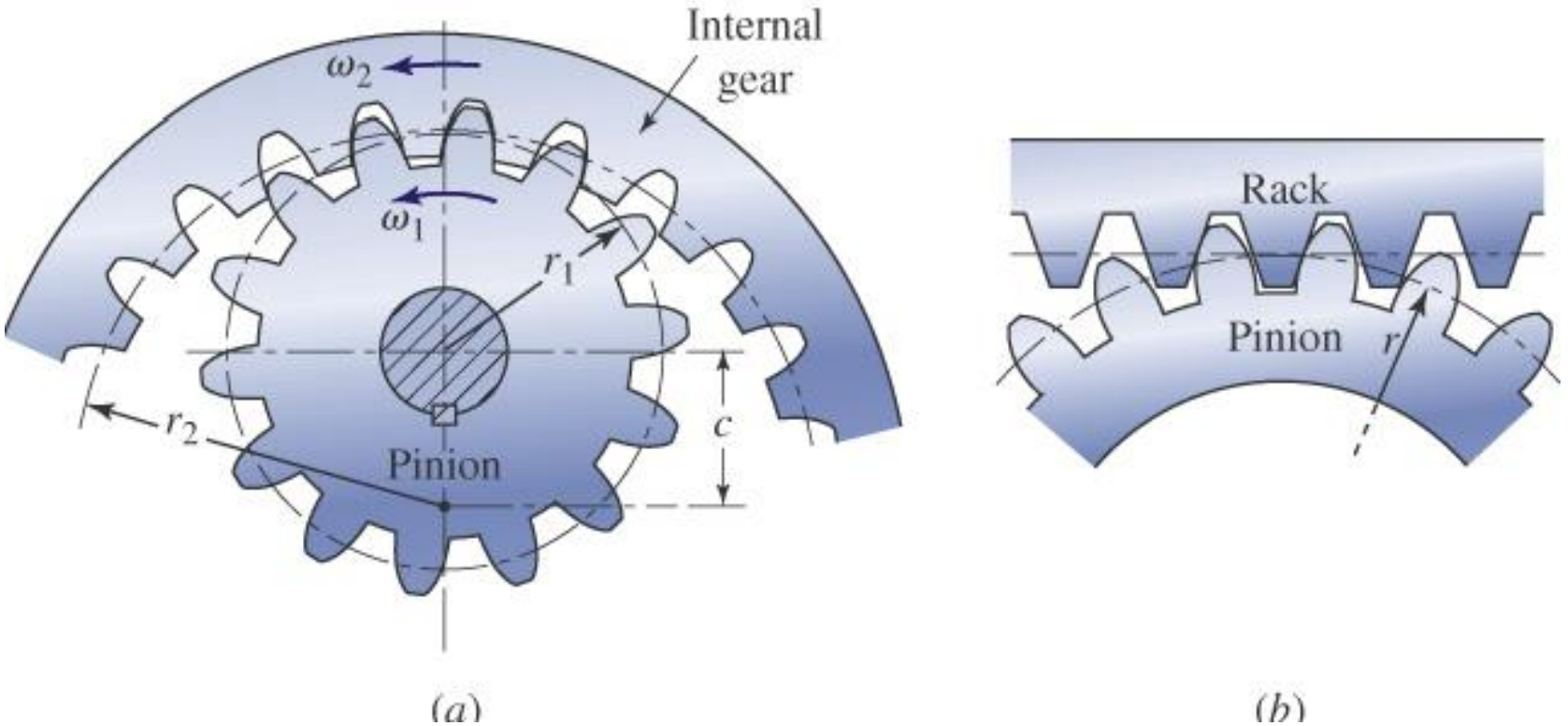
Nomenclature

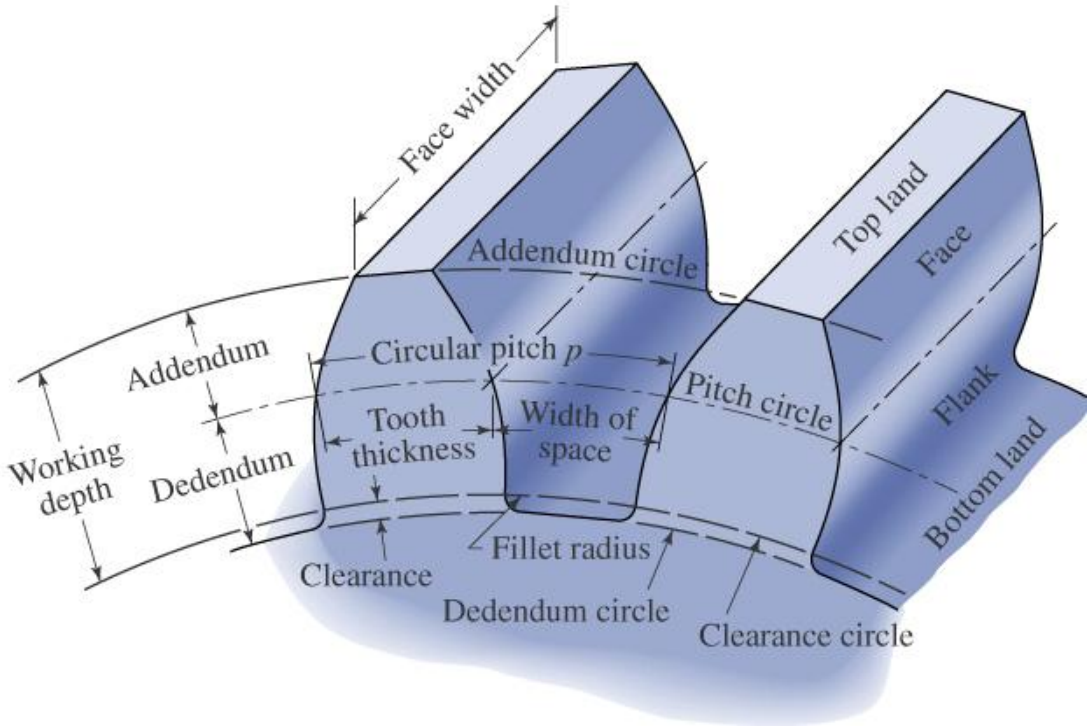


Smaller Gear is Pinion and Larger one is the gear

In most application the pinion is the driver, This reduces speed but it increases torque.

Internal Spur Gear System





pitch circle, theoretical circle upon which all calculation is based

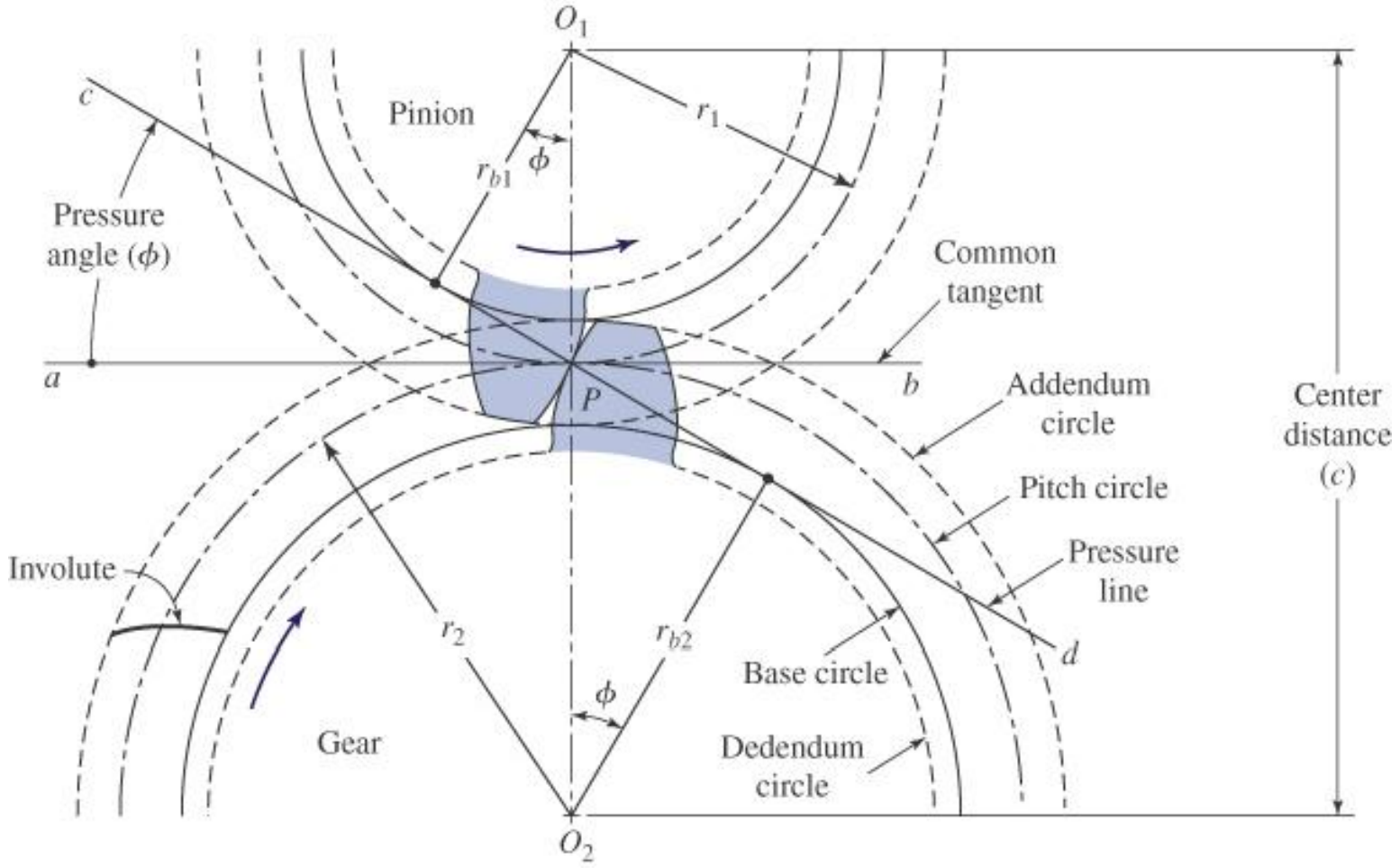
p, Circular pitch, p the distance from one teeth to the next, along the pitch circle. $p=\pi d/N$

m, module=d/N pitch circle/number of teeth

$p= \pi m$

P, Diametral Pitch $P=N/d$

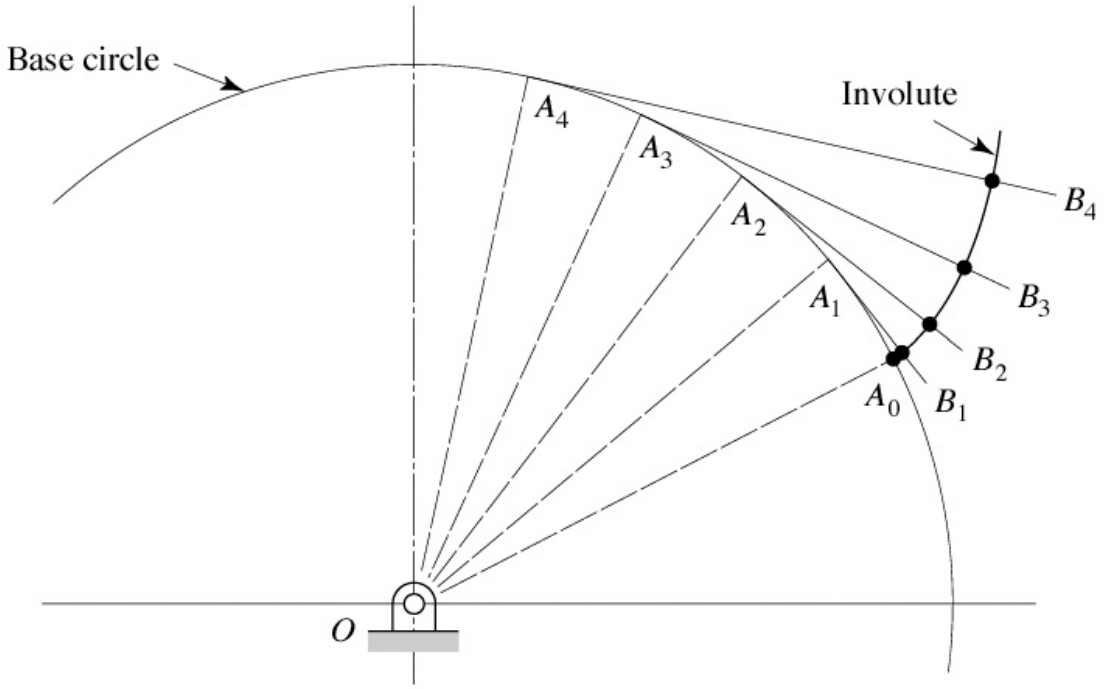
$pP= \pi$



Angle Φ has the values of 20 or 25 degrees. Angle 14.5 have been also used.

Gear profile is constructed from the base circle. Then additional clearance are given.

How Gear Profile is constructed

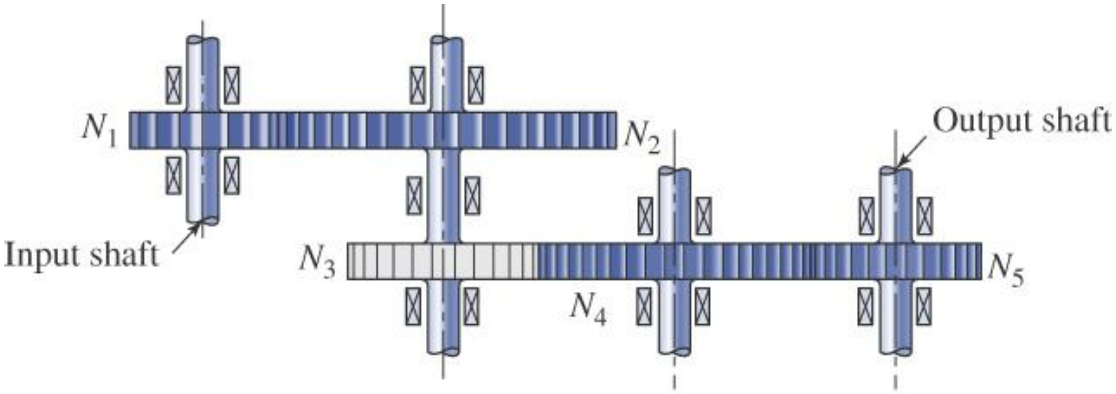


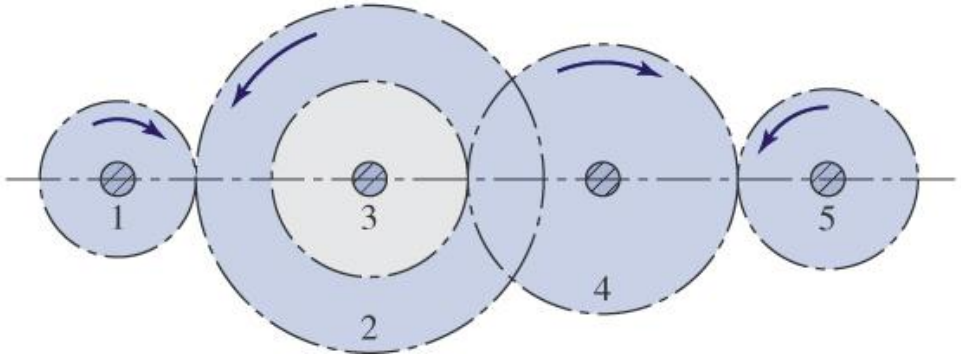
$A_1B_1=A_1A_0$, $A_2B_2=2\ A_1A_0$, etc

Standard Gear Teeth

Item	20^o full depth	20^o Stub	25^o full depth
Addendum a	1/P	0.8/P	1/P
Dedendum	1.25/P	1/P	1.25/P
Clearance f	0.25/P	0.2/P	0.25/P
Working depth	2/P	1.6/P	2/P
Whole depth	2.25/P	1.8/P	2.25/P
Tooth thickness	1.571/P	1.571/P	1.571/P
Face width	9/P<b<13/P	9/P<b<13/P	9/P<b<13/P

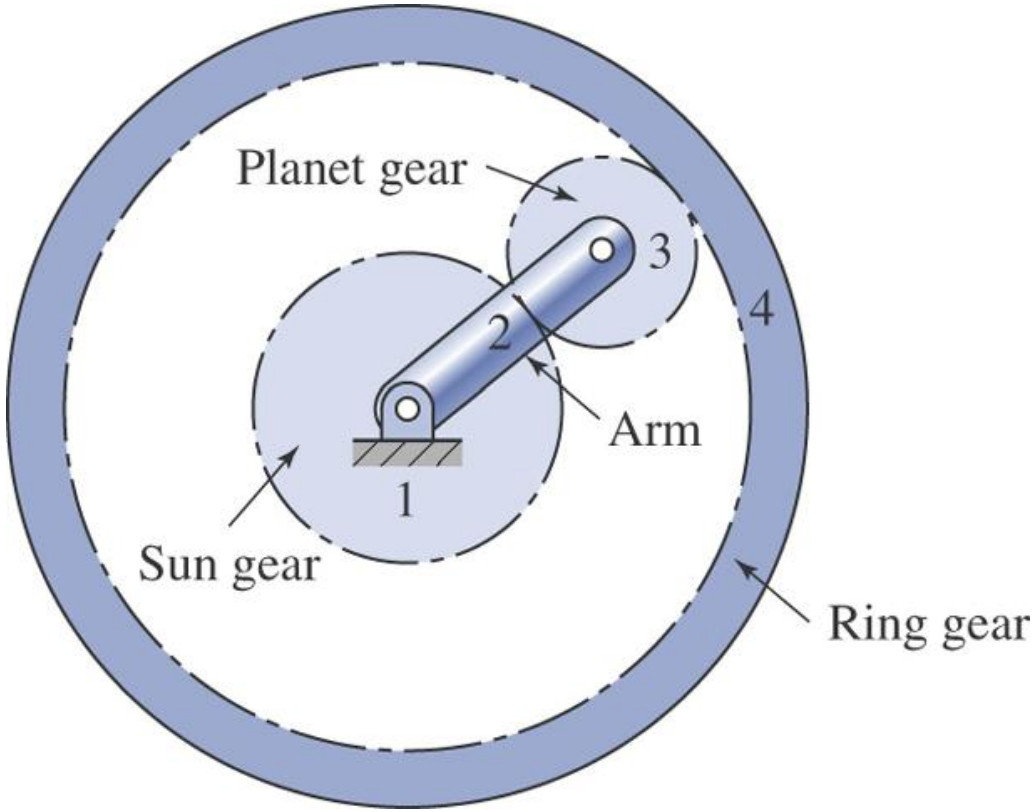
Gear Trains





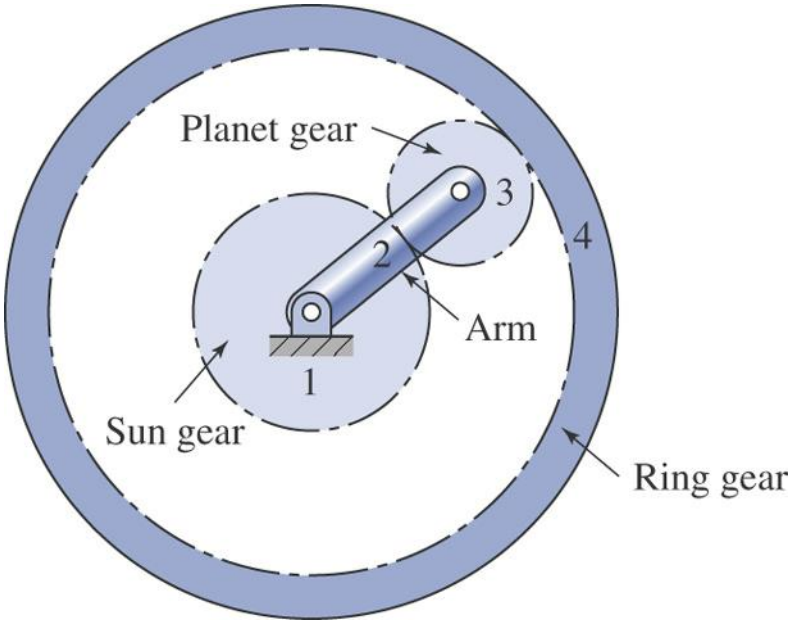
$$\frac{n_5}{n_1} = (-\frac{N_1}{N_2})(-\frac{N_3}{N_4})(-\frac{N_4}{N_5})$$

Planetary Gear train
You can get high torque ratio in a smaller space



There are two inputs to the planetary gears, RPM of sun and Ring,
The out put is the speed of the arm.

Example of planetary Gear train



Gear 1, sun , RPM 1200, Number of teeth 20,

Planet Gear , Number of teeth 30

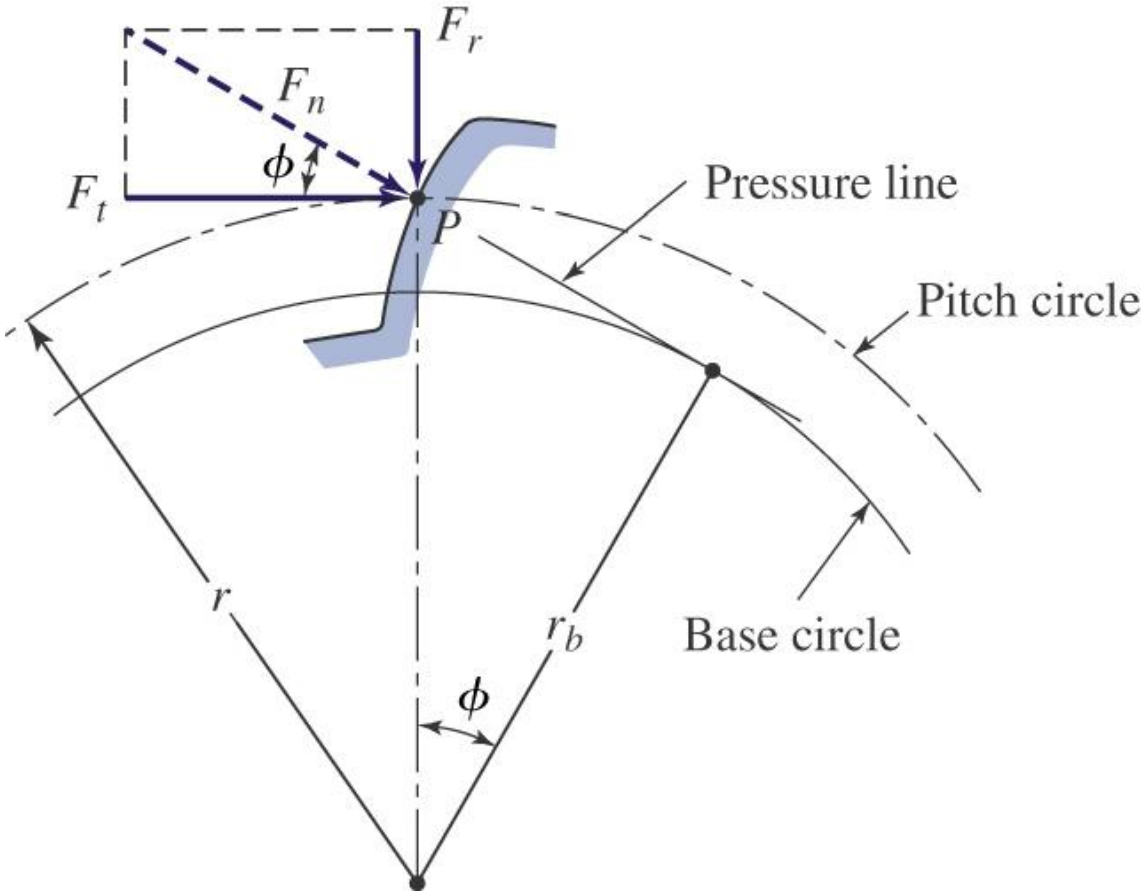
Ring Gear, Rotates RPM 120, and teeth of 80,

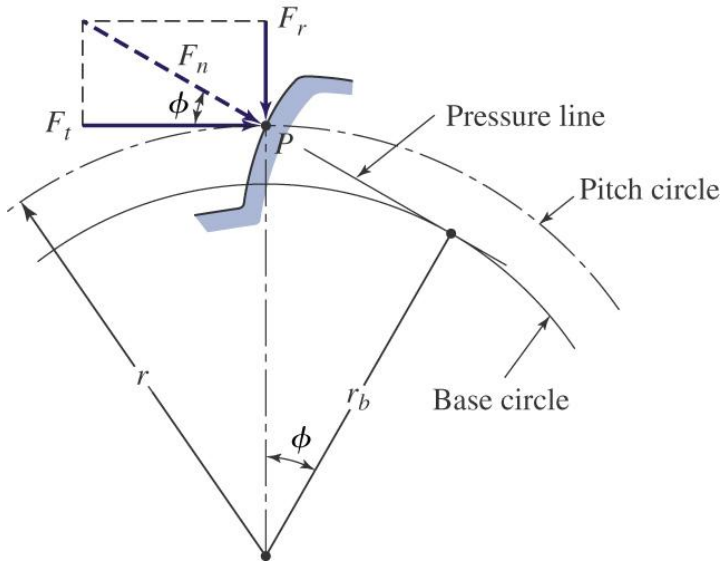
¼ horse power, find the speed of the arm and torque on the ring.

Alternatively you may have Certain Out put Torque requirements

Transmitted Load

- With a pair of gears or gear sets, Power is transmitted by the force developed between contacting Teeth





$$F_t = F_n \cos\phi$$

$$F_r = F_n \sin\phi$$

$$V = d/2\omega = d * \frac{2\pi RPM}{60}$$ d in, RPM rev./min, V in/sec

$$V = \frac{\pi dn}{12}$$ d in, n rpm, V fpm

$$hp = \frac{Tn}{63000}$$ Toque lb-in

$$F_t = \frac{33000hp}{V}$$ V fpm

$$KW = \frac{F_t V}{1000} = \frac{Tn}{9549}$$ T= N.m, V m/s, F Newton

These forces have to be corrected for dynamic effects , we discuss later, considering AGMA factors

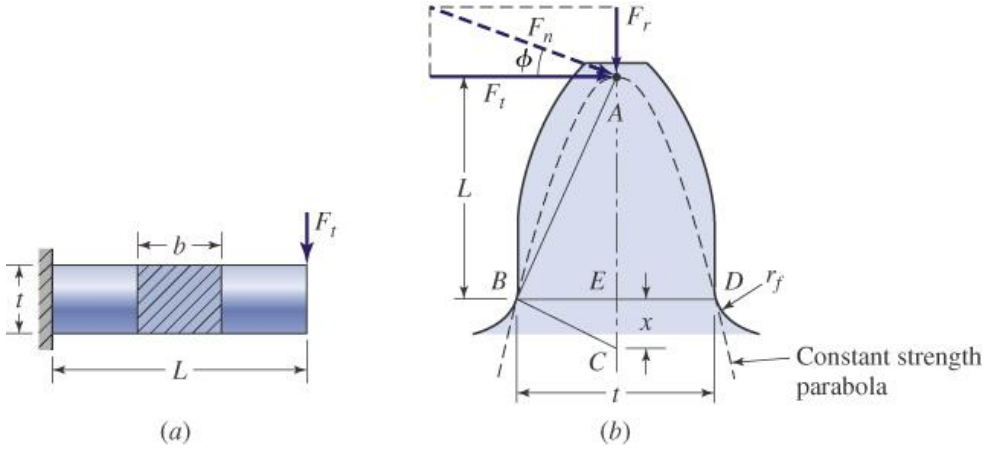
Some Useful Relations

- F=33000hp/V V fpm English system

- Metric System
- KW=(FV)/1000=Tn/9549
- F newton, V m/s, n rpm, T, N.m
- hp= FV/745.7=Tn/7121

Bending Strength of the a Gear Tooth

$$\sigma = \frac{Mc}{I} = \frac{(F_t L)t/2}{bt^3/12} = \frac{6F_t}{bt^2}$$



Earlier Stress Analysis of the Gear Tooth was based on

A full load is applied to the tip of a single tooth

The radial load is negligible

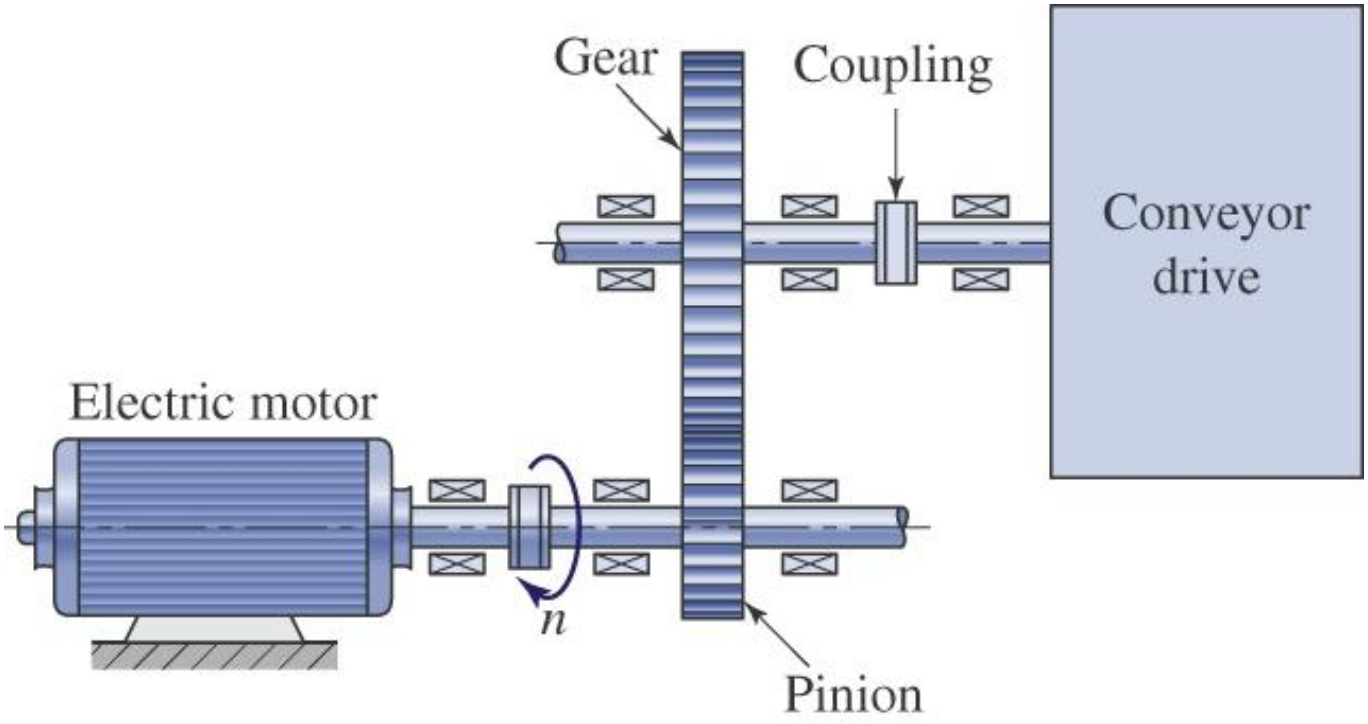
The load is uniform across the width

Neglect frictional forces

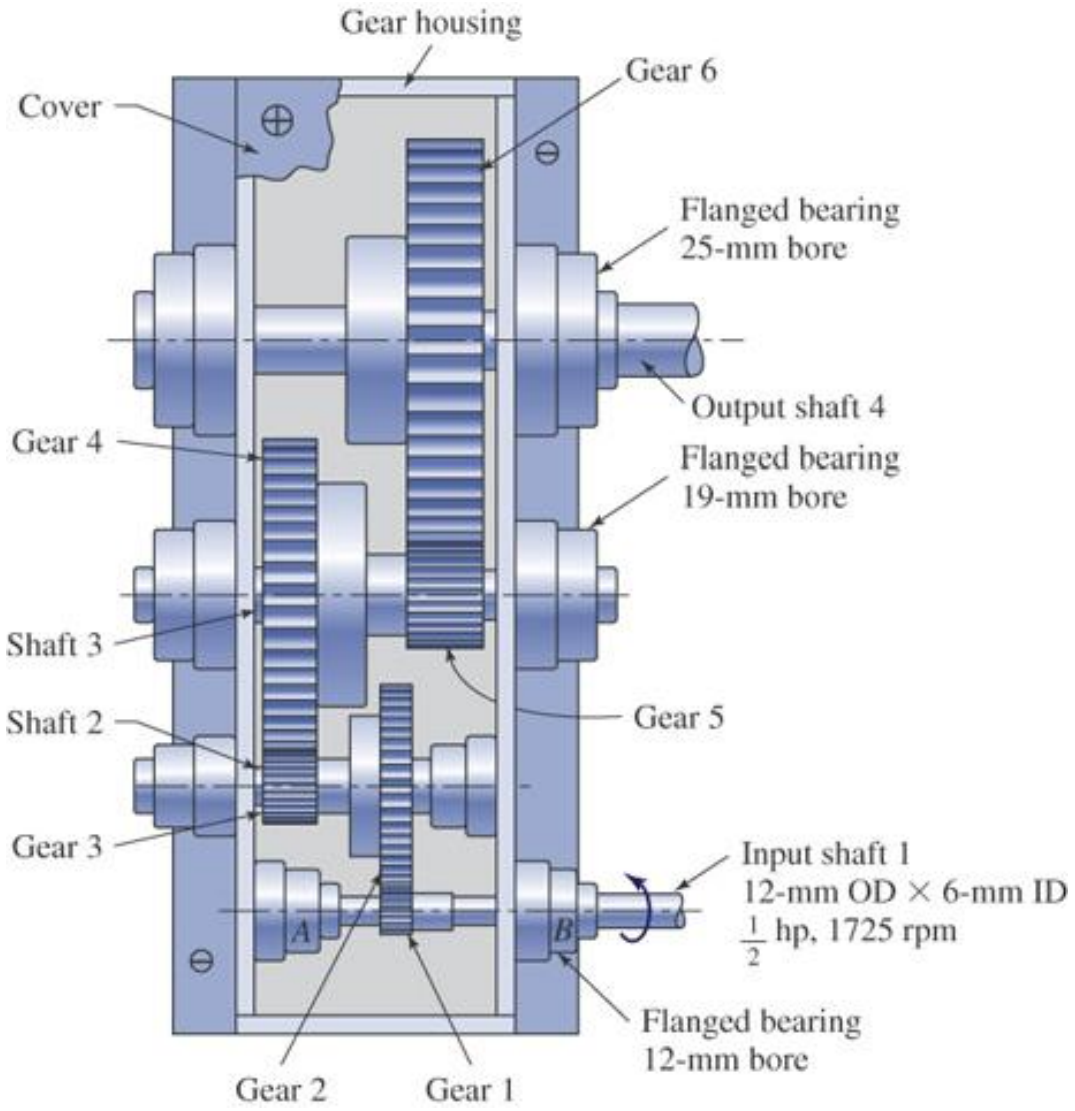
The stress concentration is negligible

This equation does not consider stress concentration, dynamic effects, etc.

Example:
A conveyor drive involving heavy-shock torsional loading is operated by an electric motor, the speed ratio is 1:2 and the pinion has Diameteral pitch P=10 in^{-1}, and number of teeth N=18 and face width of b=1.5 in. The gear has Brinnel hardness of 300 Bhn. Find the maximum horspower that can be transmitted, using AGMA formula.



Gear Box Design



GEARS

Gears, gear trains and gear box

GEAR

- Power transmission is the movement of energy from its place of generation to a location where it is applied to performing useful work

- A gear is a component within a transmission device that transmits rotational force to another gear or device

TYPES OF GEARS

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

a. Parallel

1.Spur Gear

2.Helical Gear

3.Rack and Pinion

b. Intersecting

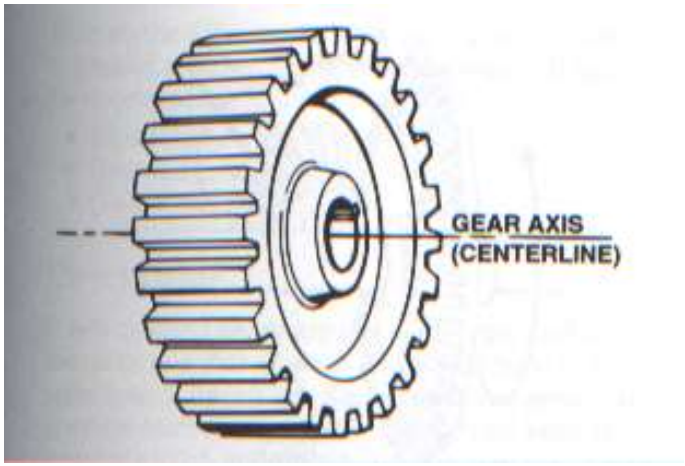
Bevel Gear

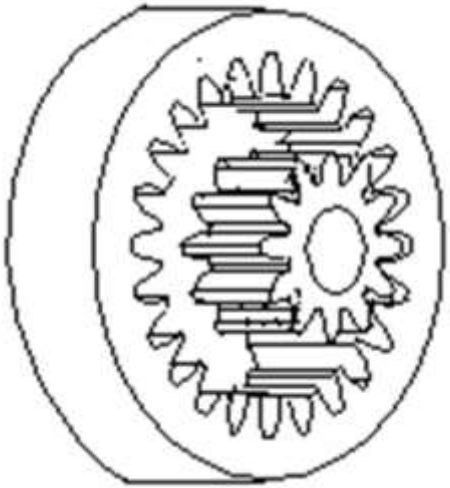
c. Non-intersecting and Non-parallel

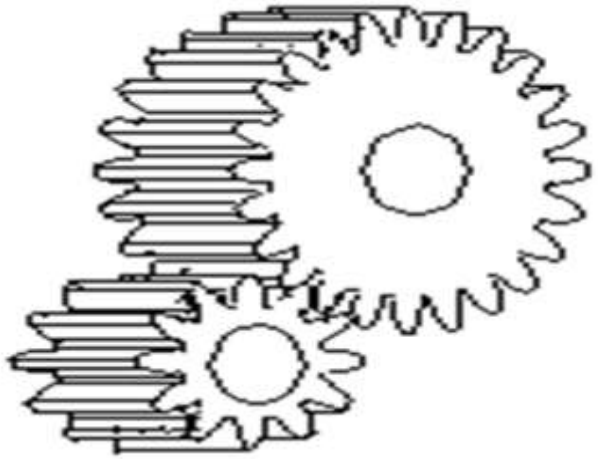
worm and worm gears

SPUR GEAR

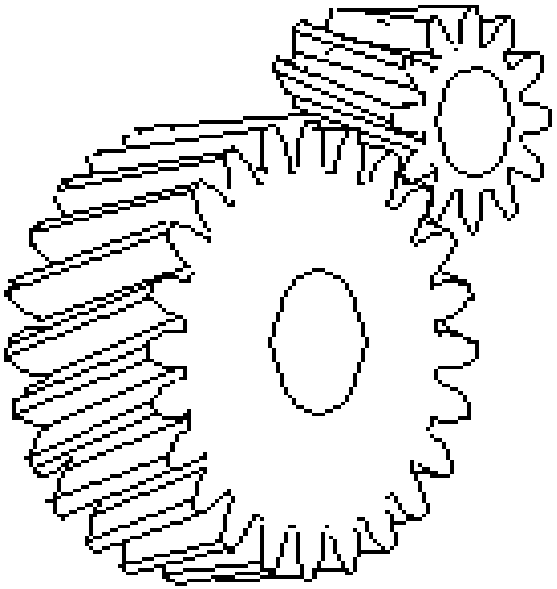
- Teeth is parallel to axis of rotation
- Transmit power from one shaft to another parallel shaft



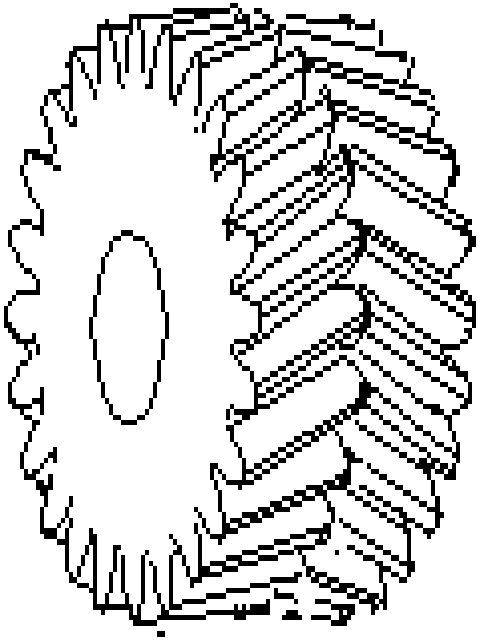




Helical Gear



Herringbone gears



Rack and pinion

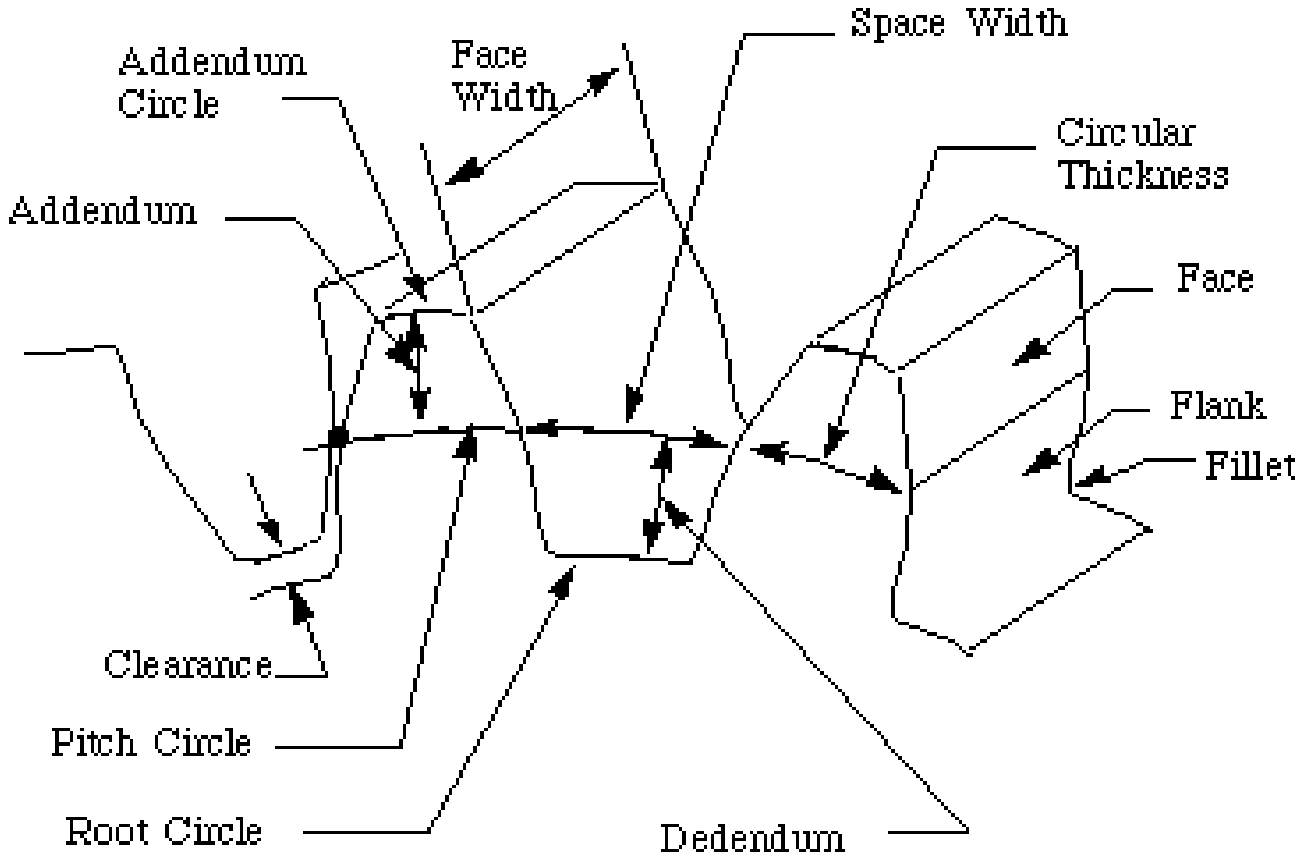
- **Rack and pinion gears** are used to convert rotation (From the pinion) into linear motion (of the rack)

- A perfect example of this is the steering system on many cars

Straight and Spiral Bevel Gears

WORM AND WORM GEAR

NOMENCLATURE OF SPUR GEARS



GEAR TRAINS

- A gear train is two or more gear working together by meshing their teeth and turning each other in a system to generate power and speed
- It reduces speed and increases torque
- Electric motors are used with the gear systems to reduce the speed and increase the torque

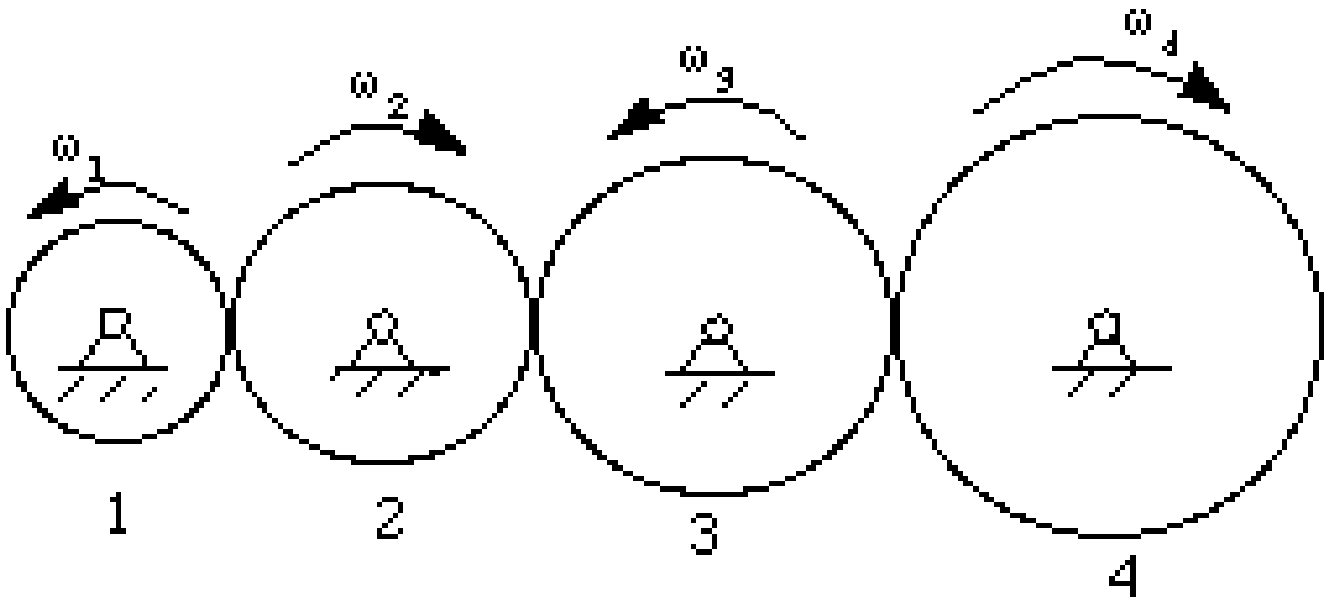
Types of Gear Trains

- Simple gear train
- Compound gear train
- Planetary gear train

Simple Gear Train

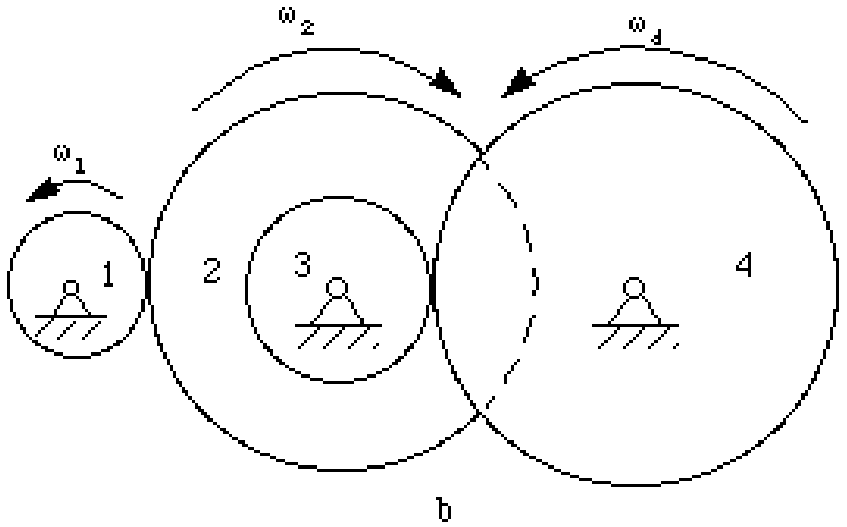
- The most common of the gear train is the gear pair connecting parallel shafts. The teeth of this type can be spur, helical or herringbone.
- Only one gear may rotate about a single axis

Simple Gear Train



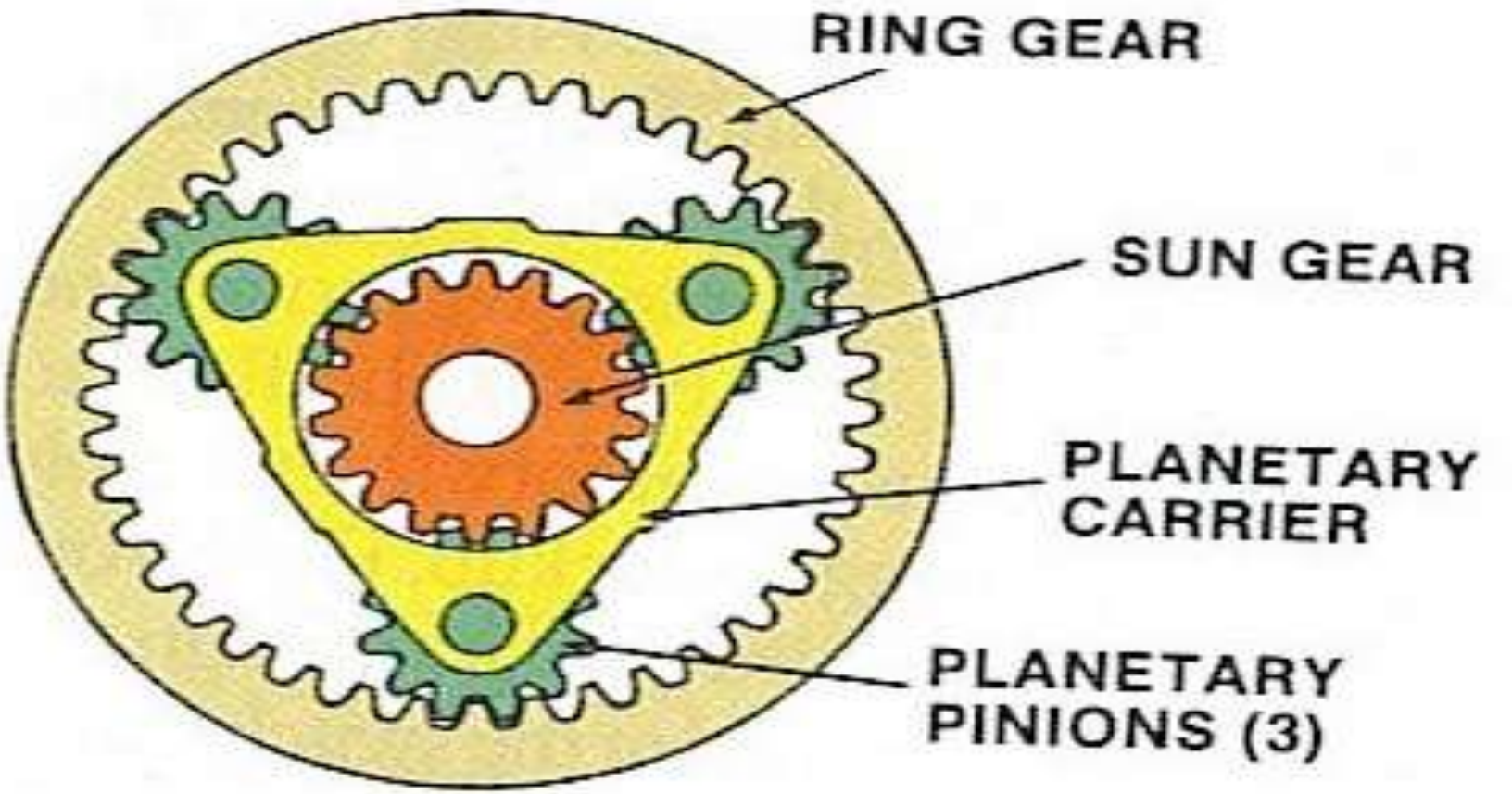
Compound Gear Train

- For large velocities, compound arrangement is preferred
- Two or more gears may rotate about a single axis



Planetary Gear Train (Epicyclic Gear Train)

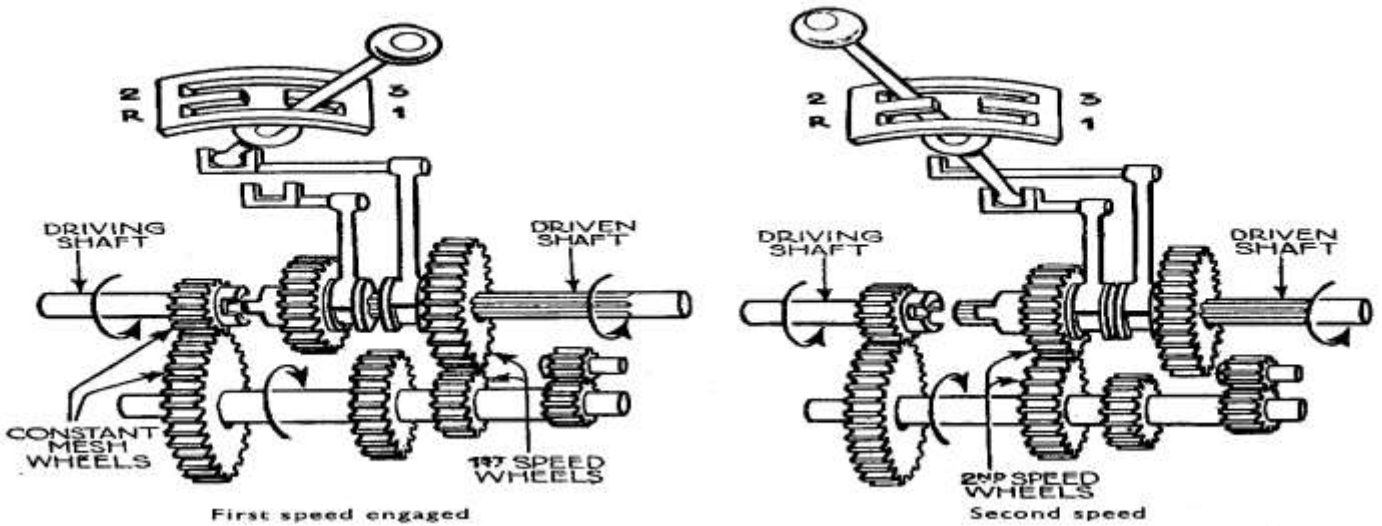
Planetary Gear Train



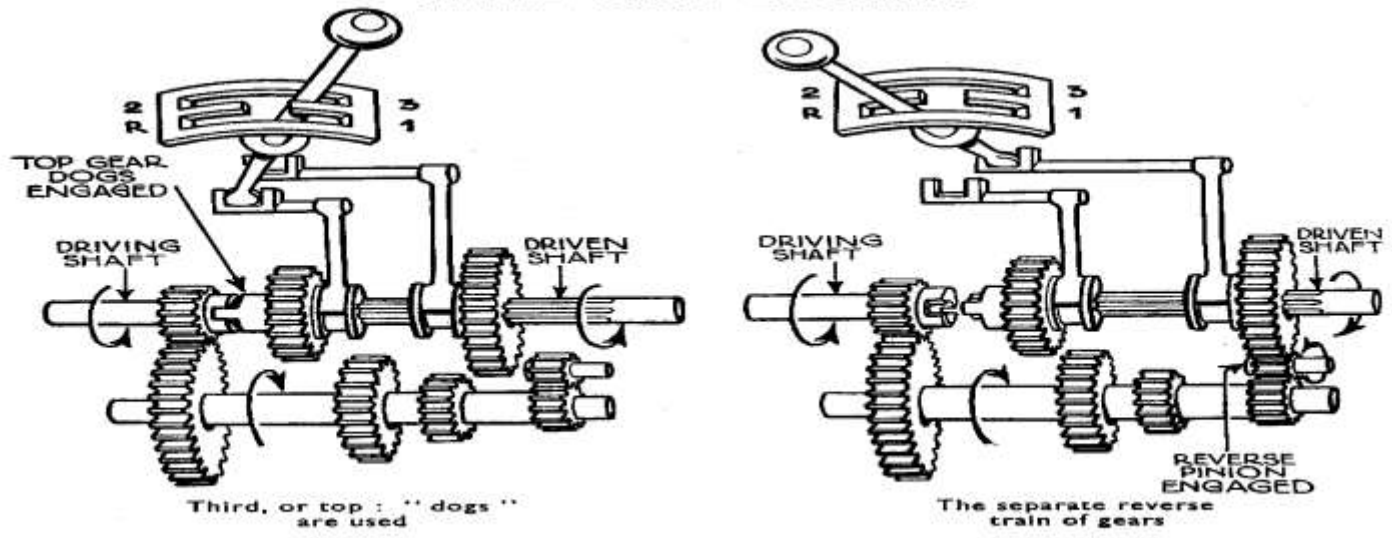
Planetary Gear Train

- They have higher gear ratios.
- They are popular for automatic transmissions in automobiles.
- They are also used in bicycles for controlling power of pedaling automatically or manually.
- They are also used for power train between internal combustion engine and an electric motor

Sliding mash gear box



SIMPLE GEAR DIAGRAMS



Constant mash / synchromesh