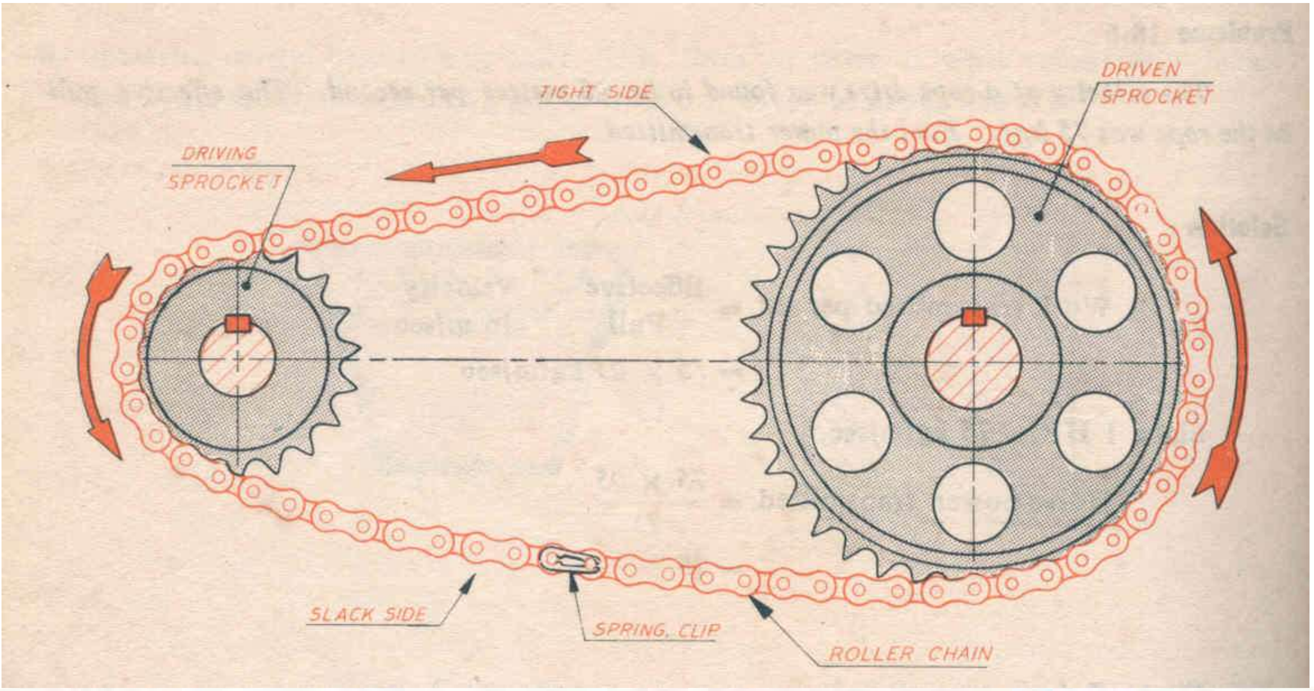
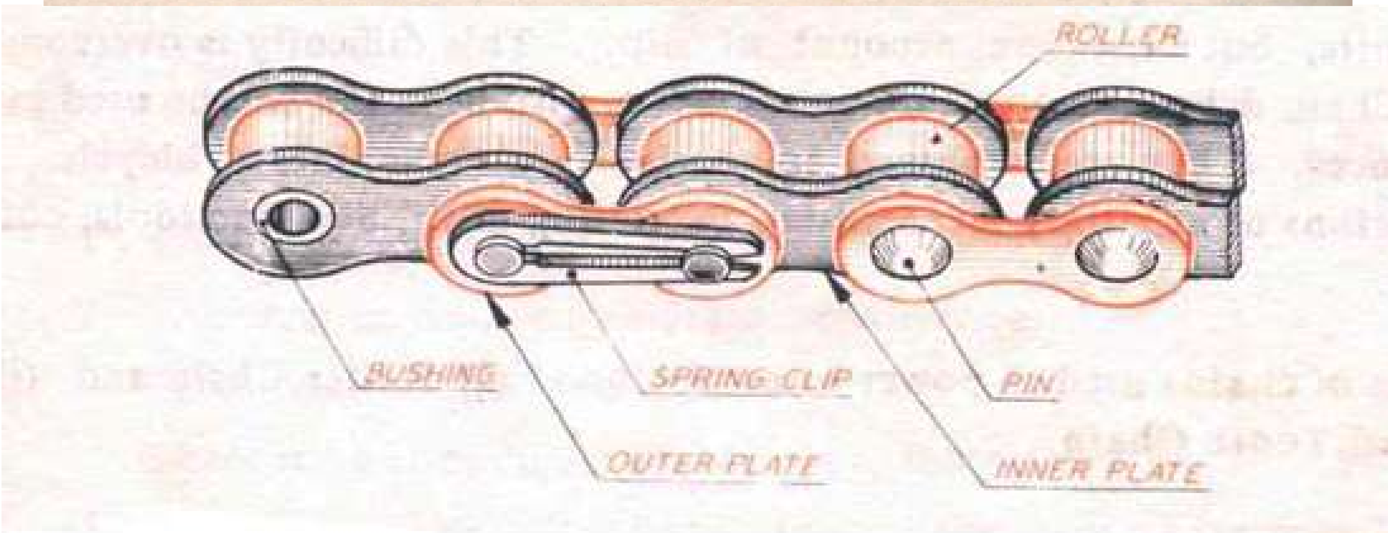
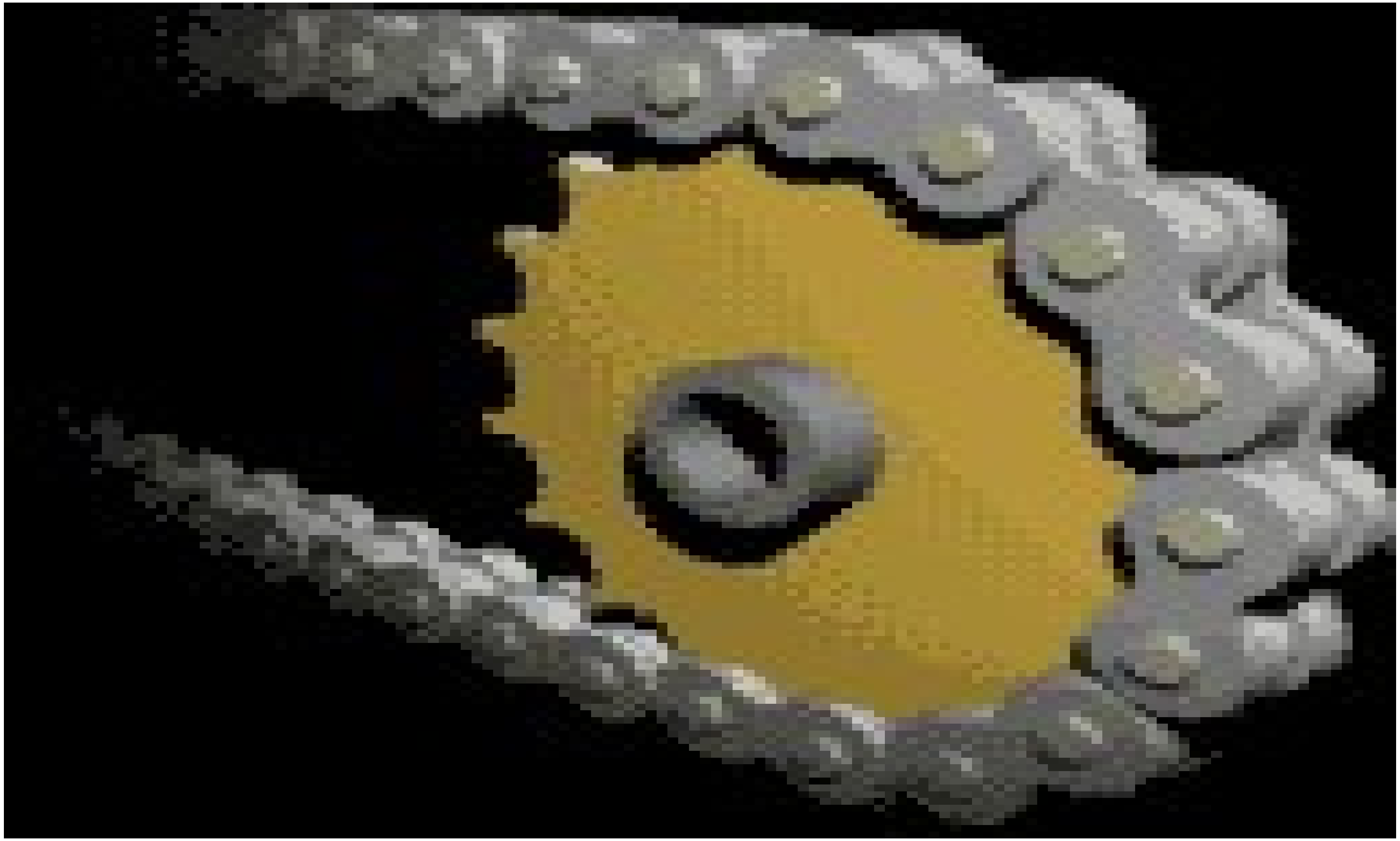
Chain Drives

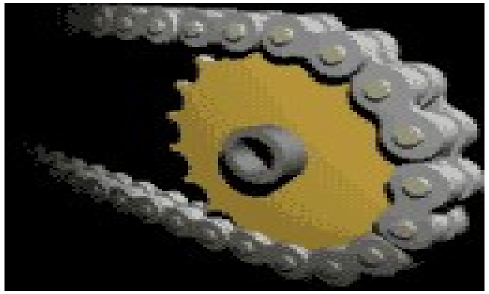




Chain Drive



Chain Drive



- Chain drives are positive drives having no slip and velocity ratio remaining constant.
- A chain drive consists of a chain and two sprockets. The sprockets are teethed wheels over which an endless chain is fitted.
- Chain drives are employed in bicycles, motor cycles, rolling mills, agricultural machineries, machine tools, conveyors etc.

Chain Drive – Advantages

- Positive non-slip drives
- Efficiency is high
- Employed for small as well as large centre distances up to 8m.
- Permit high velocity ratio up to 8:1
- Transmit more power than belt drives
- They produce less load on shafts compared to belt drives
- Occupy less space and are more compact than belt drives
- Maintenance is low

Chain Drive – Disadvantages

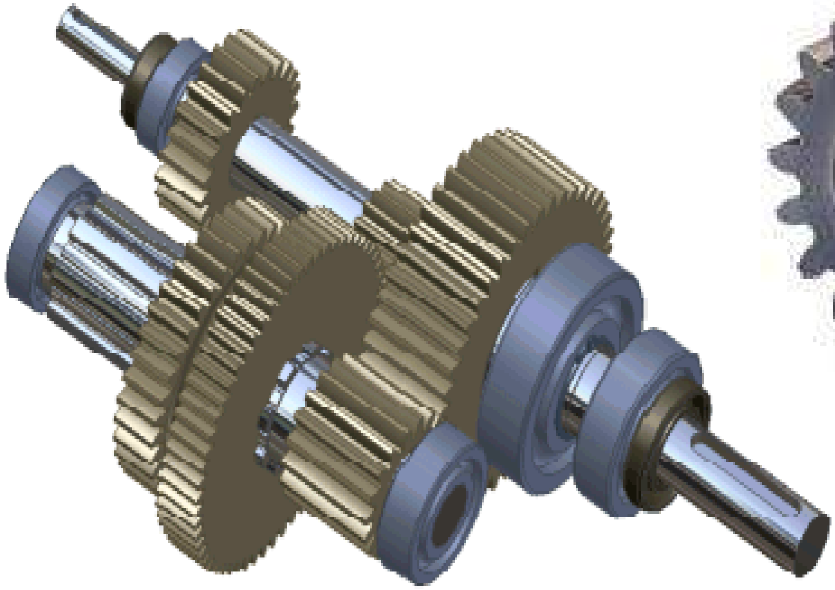
- Driving and driven shafts should be in perfect alignment
- Requires good lubrication
- High initial cost

Rope Drive

- When centre distances are greater than 10 m
- Power to be transmitted is more than 200 HP
- Used in lifts, cranes,hoists etc

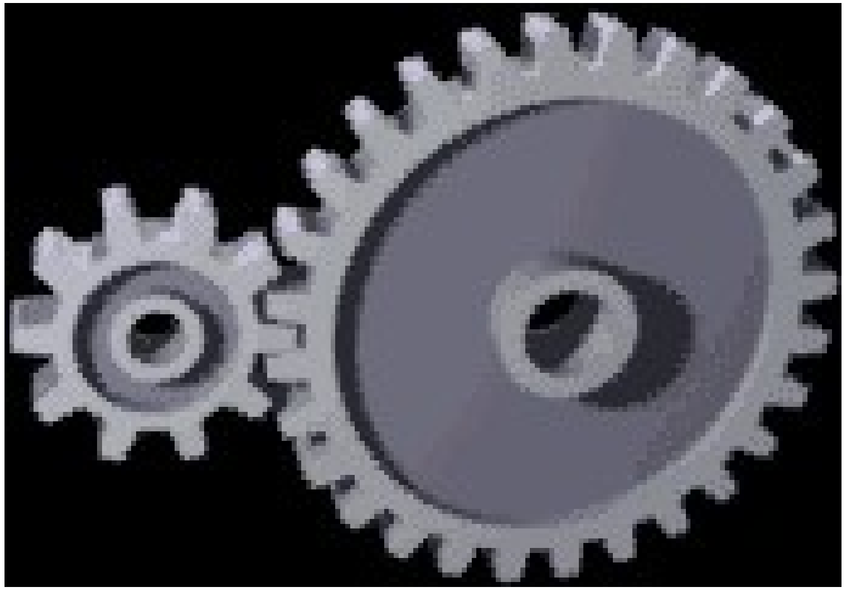
Gear Drives

GEAR DRIVE



Gear Drives

- Gears are defined as toothed wheels which transmit power and motion from one shaft to another by means of successive engagement of teeth.



- Gear drives are used when the power to be transmitted is moderate to large with a constant velocity ratio and the distance between the driver and driven shafts is relatively small.

TYPES OF GEARS

Gears are classified according to the position of axes of the shafts.

a. Parallel

1.Spur Gear

2.Helical Gear

3.Rack and Pinion

b. Intersecting

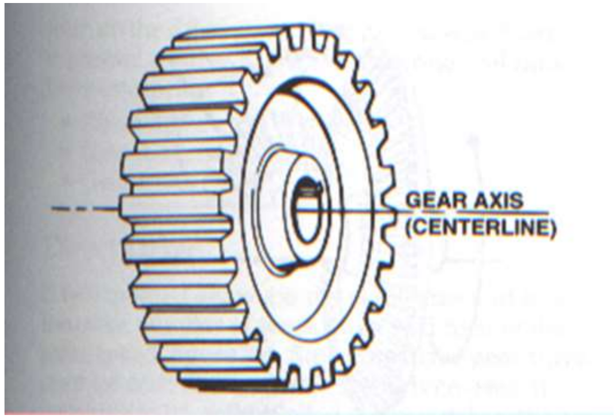
Bevel Gear

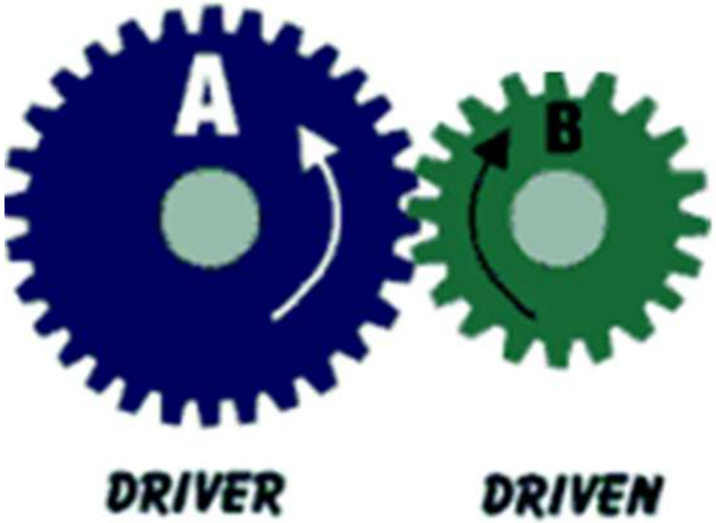
c. Non-intersecting

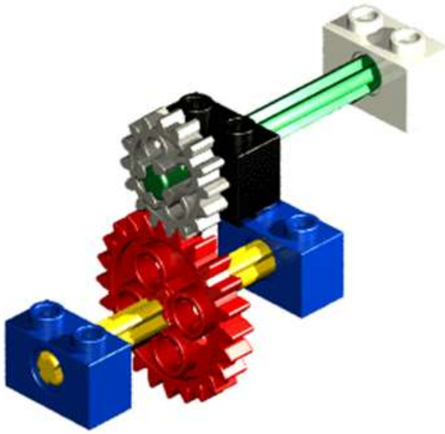
worm and worm gears

SPUR GEAR

- Teeth's are cut parallel to the axis of rotation
- Transmit power from one shaft to another parallel shaft
- Used in machine tools & automobile gearing





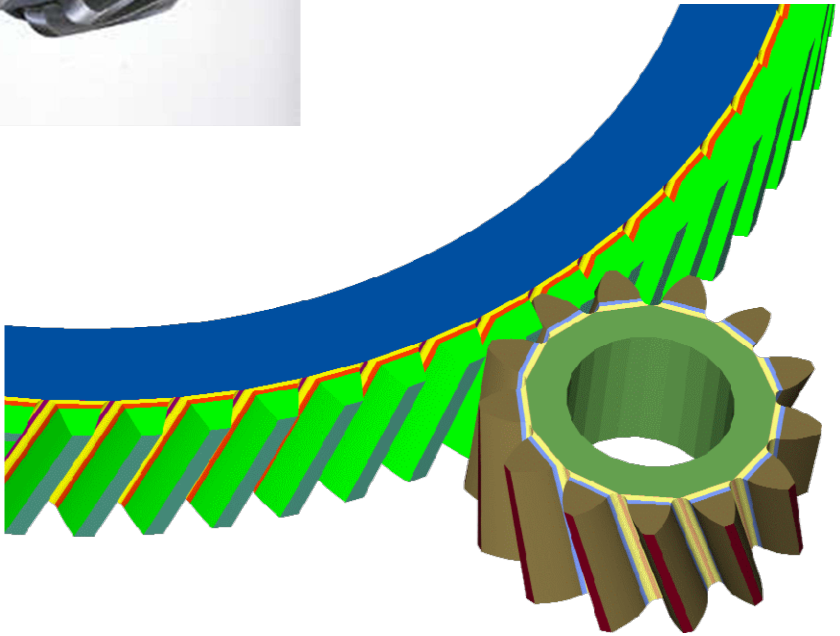


Helical Gear

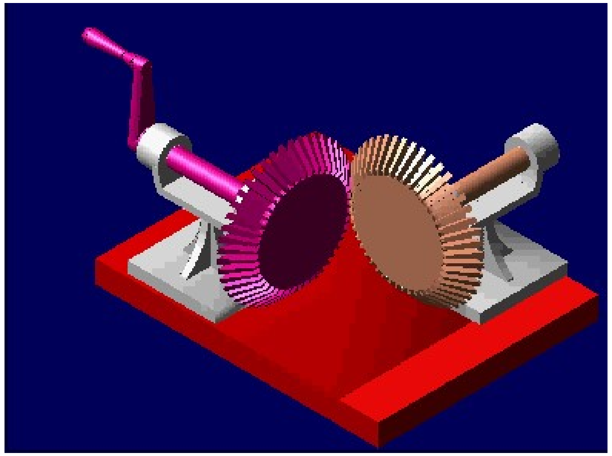
The teeth on helical gears are cut at an angle to the axis of rotation.

In helical gears the next pair of teeth would be engaging before the previous pair is about to separate.

This gradual engagement makes helical gears operate much more smoothly and quietly than spur gears.

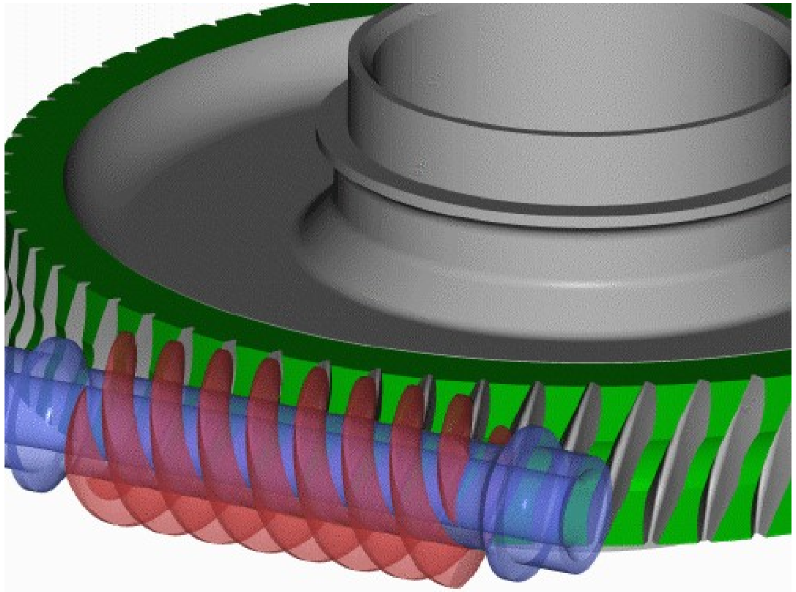


Bevel gears

- **Bevel gears** are used to transmit power between two shafts whose axes intersect with each other.
- Usually the shafts are at right angles to each other but the angle between the shafts may either be greater or less than 90°
- The teeth on bevel gears can be **straight** or **spiral.**
- Gears of equal size called **mitre** gears.

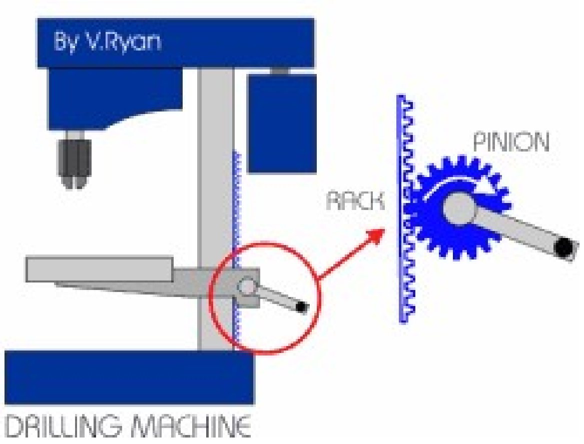
WORM AND WORM GEAR

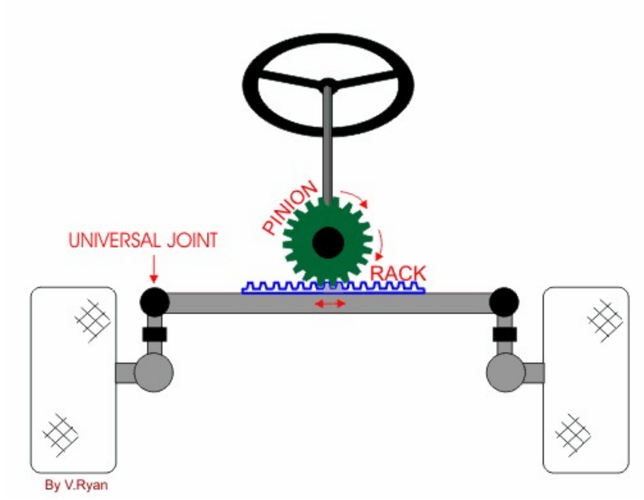


- Worm gears are used to transmit power between two shafts when their axes are at right angles to each other but non intersecting.
- They are used to obtain high velocity ratios as high as 300:1 or greater.
- Used in machine tools, material handling equipments etc.

Rack and pinion

- **Rack and pinion gears** are used to convert rotary motion (From the pinion) into linear motion (of the rack)
- Widely used in steering system of automobiles and in machine tools.





Gear Drive – Advantages

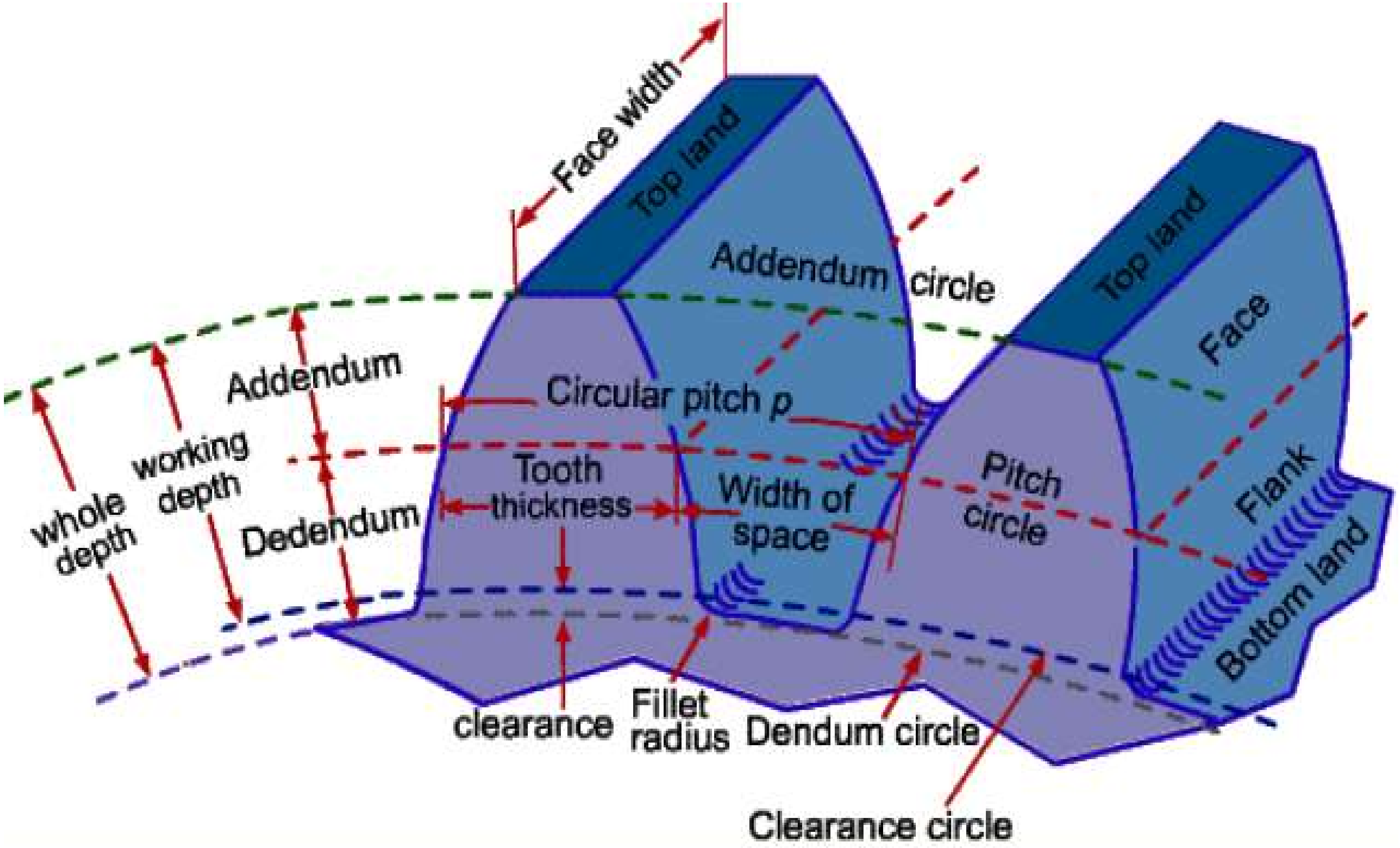
Advantages

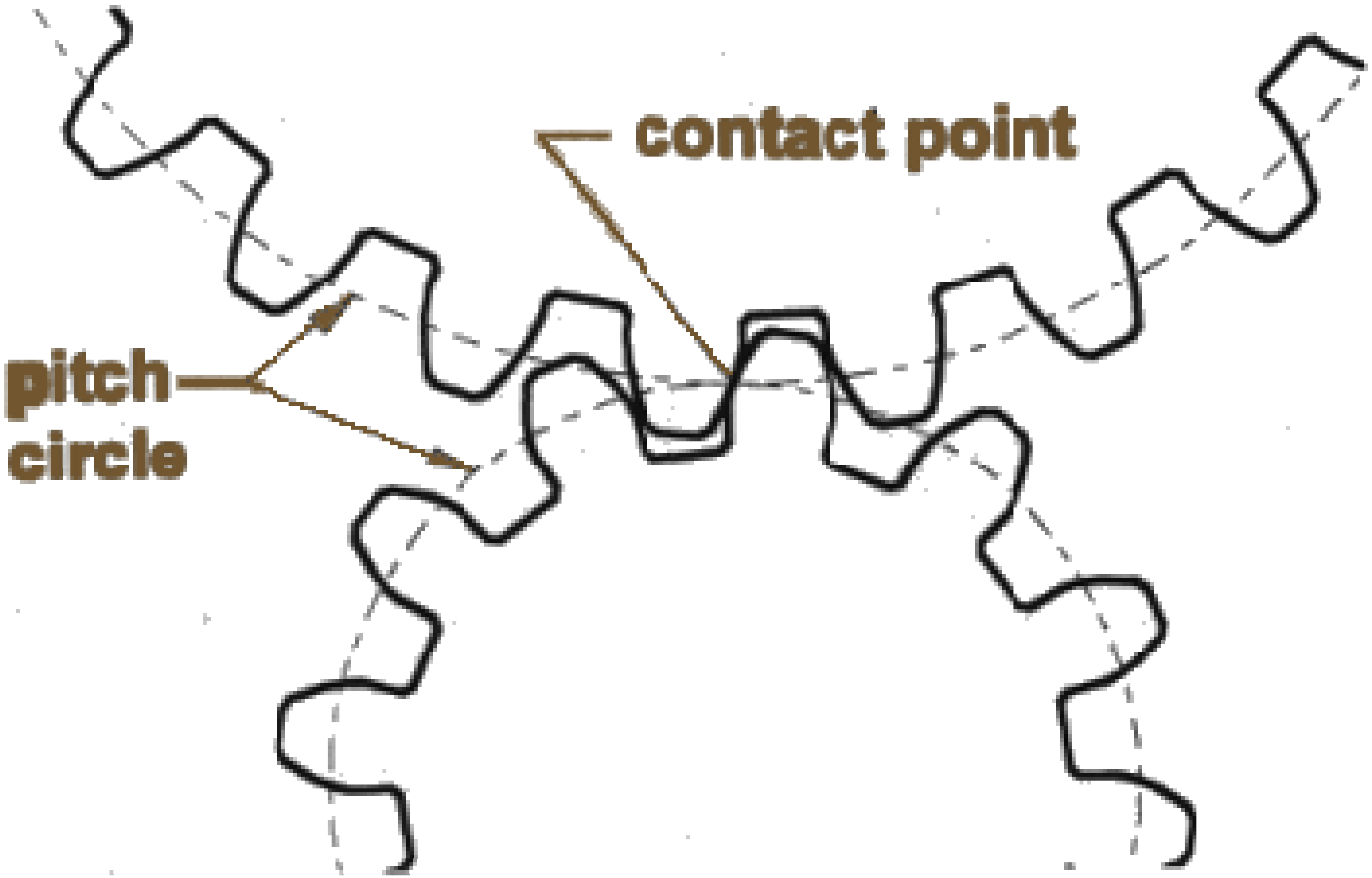
- ✓ Positive, non-slip drives, hence transmission efficiency high.
- ✓ Most convenient for very small center distances.
- ✓ Transmits power when the axes of the shafts are parallel, nonparallel, intersecting, non-intersecting.
- ✓ Velocity ratio will remain constant throughout.
- ✓ Employed for low, medium and high power transmission.
- ✓ Gears are employed for wide range of applications

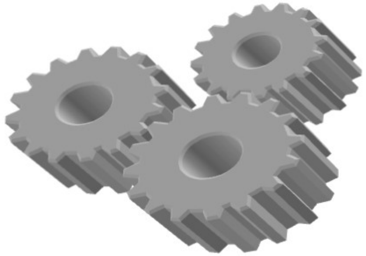
Gear Drive – Limitations

- ✓ Not suitable for shafts of very large center distances.
- ✓ Require some kind of lubrication.
- ✓ At very high speeds noise and vibrations will be more.
- ✓ Not economical because of the increased cost of production
- ✓ Use of large number of gear wheels in gear trains increases the weight of the machine.

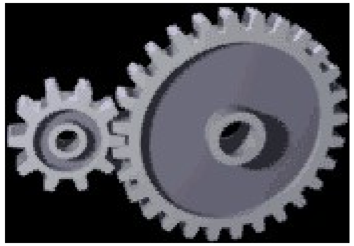
NOMENCLATURE OF SPUR GEARS




contact point
pitch
circle



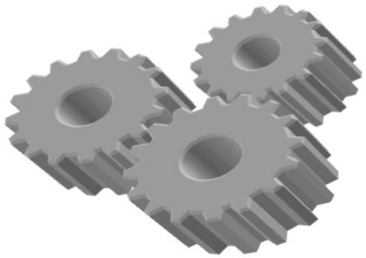
NOMENCLATURE



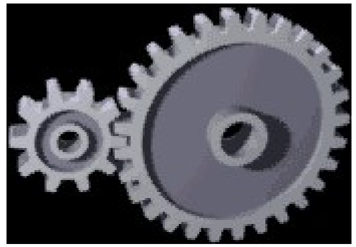
- Circular Pitch (Pc) : It is the distance measured along the circumference of the pitch circle from a point of one tooth to the corresponding point on the adjacent tooth. It is the width of a tooth and a space, measured on the pitch circle

$$P_c = \frac{\pi D}{T}$$

- Where D is the pitch circle diameter and T is the number of teeth.



NOMENCLATURE



- **Diametrical pitch** (Pd): It is defined as the number of teeth per unit length of pitch circle diameter.

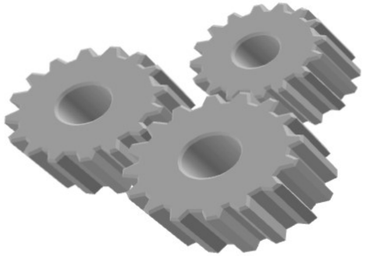
$$P_d = \frac{T}{D}$$

Where

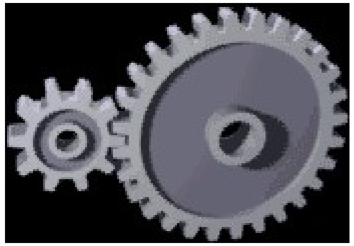
Pd = Diametrical pitch

T = number of teeth

D = pitch diameter



NOMENCLATURE



- **Module** (m): It is the ratio of the pitch circle diameter to the number of teeth. Module is the inverse of diametral pitch

$$m = D/T$$

$$m = 1/Pd$$

Gear drive – Velocity ratio

The velocity ratio of a gear drive is defined as the ratio of the speed of the driven gear to the speed of the driving gear.

Expression for velocity ratio of gear drive

d1 & d2 - pitch circle diameter of the driving & driven gears(mm)

T1 & T2 - number of teeth on the driving & driven gears

N1 & N2 - speed of the driving & driven gears in rpm

Assuming no slip between pitch cylinders of two gear wheels,

the linear speed of the two pitch cylinders must be equal.

Gear drive – Velocity ratio

$$\textit{Linear speed of the pitch cylinder of the Driving gear} = \textit{Linear speed of the pitch cylinder of the Driven gear}$$

$$\pi\, d_1 N_1 = \pi\, d_2 N_2$$

$$\frac{N_2}{N_1} = \frac{d_1}{d_2} \qquad \ldots\ldots\ldots\ldots (1)$$

Circular pitch for both the meshing gears remains same.

i.e. $$p_c = \frac{\pi d_1}{T_1} = \frac{\pi d_2}{T_2}$$

$$\frac{d_1}{d_2} = \frac{T_1}{T_2} \qquad \ldots\ldots\ldots\ldots (2)$$

Gear drive – Velocity ratio

From equation (1) and (2)

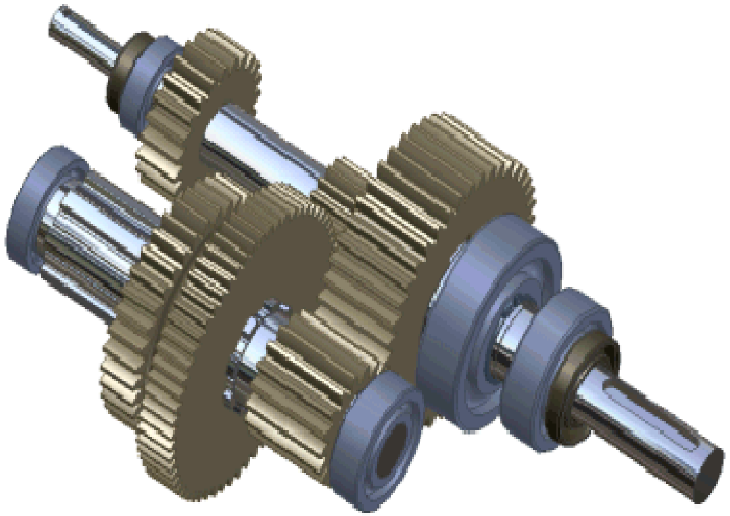
$$\text{Velocity Ratio of a Gear Drive} = \frac{N_2}{N_1} = \frac{d_1}{d_2} = \frac{T_1}{T_2}$$

Velocity ratio of the worm and worm wheel is expressed as

$$\text{Velocity ratio} = \frac{\text{Speed of the Worm Wheel}}{\text{Speed of the Worm}} = \frac{\text{No. of threads on the Worm}}{\text{No. of teeth on Worm Wheel}}$$

GEAR TRAINS

- A gear train is an arrangement of number of successively meshing gear wheels through which the power can be transmitted between the driving and driven shafts.
- The gear wheel used in a gear train may be spur, bevel, helical etc.
- Meshing gears should be of same type.



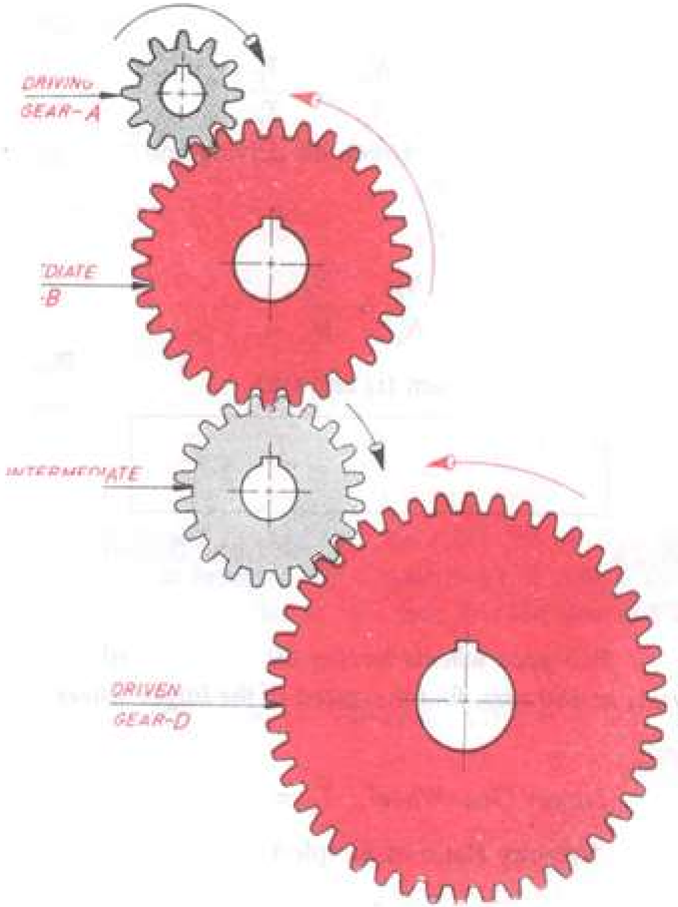
Types of Gear Trains

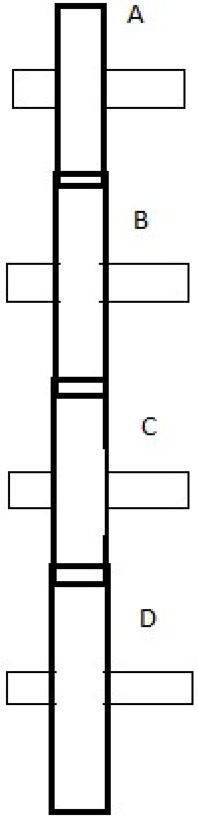
- Simple gear train
- Compound gear train

Simple Gear Train:

- Motion is transmitted between two shafts with intermediate or idler gears and with only one gear on each shaft.
- The idler gears do not influence the velocity ratio of the gear train, but merely change the direction rotation of the driven gear.

Simple Gear Train





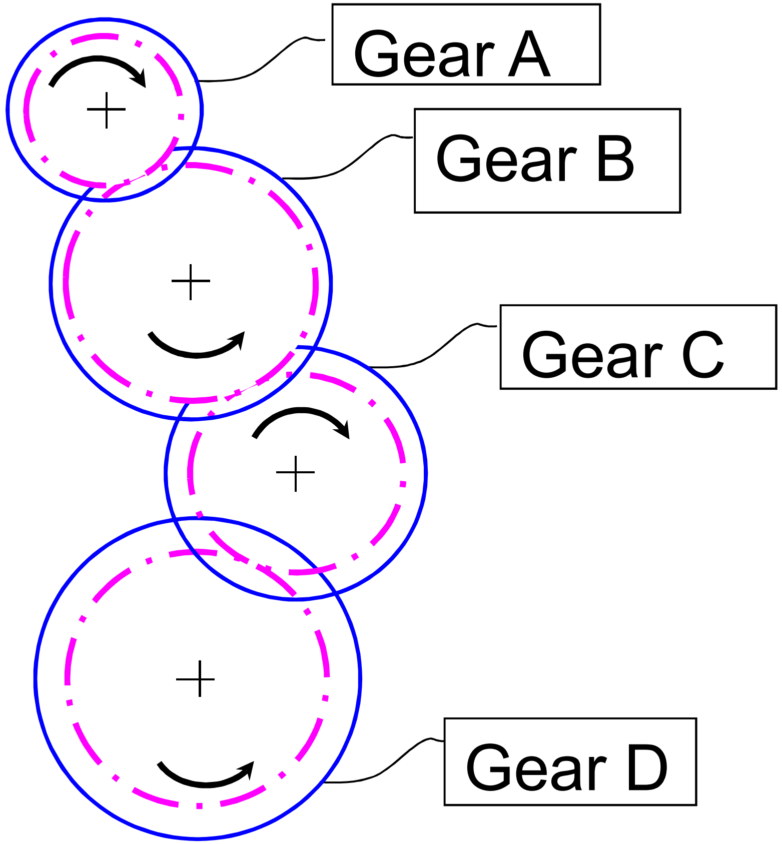
Simple gear train

A → Driving gear

B → Intermediate gear

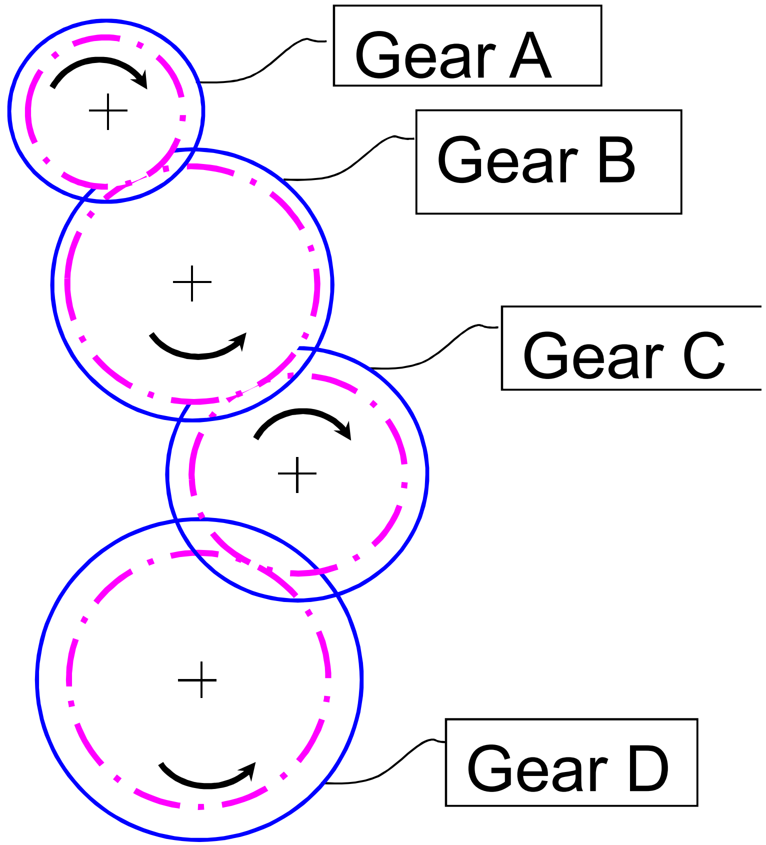
C → Intermediate gear

D → Driven gear



Simple gear train

Velocity ratio of a simple gear train.



N_A & T_A – speed (rpm) and no. of teeth gear A

N_B & T_B – speed (rpm) and no. of teeth gear B

N_C & T_C – speed (rpm) and no. of teeth gear C

N_D & T_D – speed (rpm) and no. of teeth gear D

i. A drives B

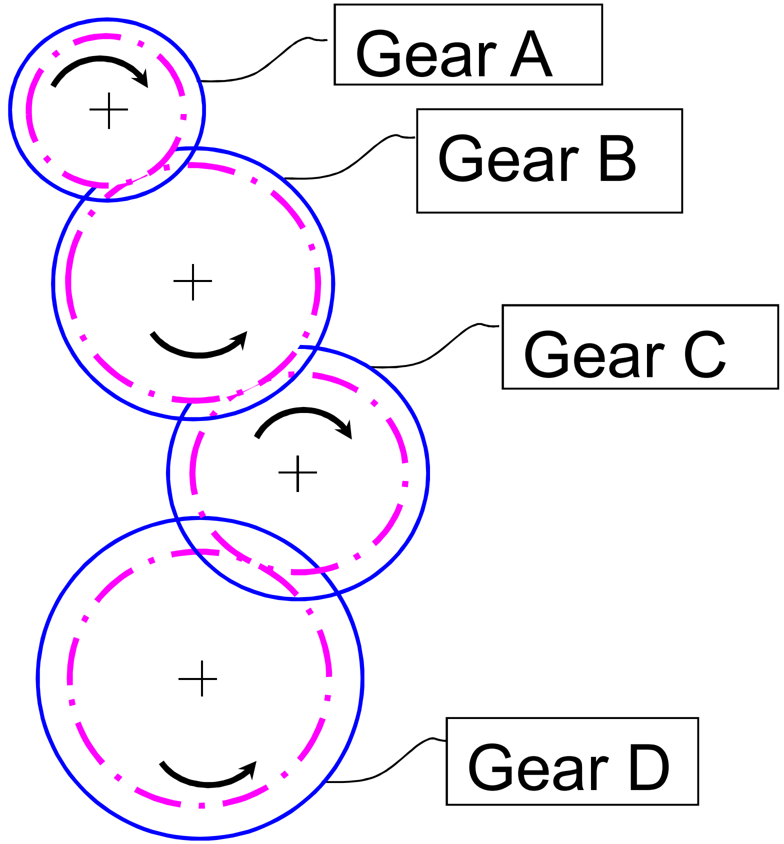
$$\frac{N_B}{N_A} = \frac{T_A}{T_B}$$

ii. B drives C

$$\frac{N_C}{N_B} = \frac{T_B}{T_C}$$

iii. C drives D

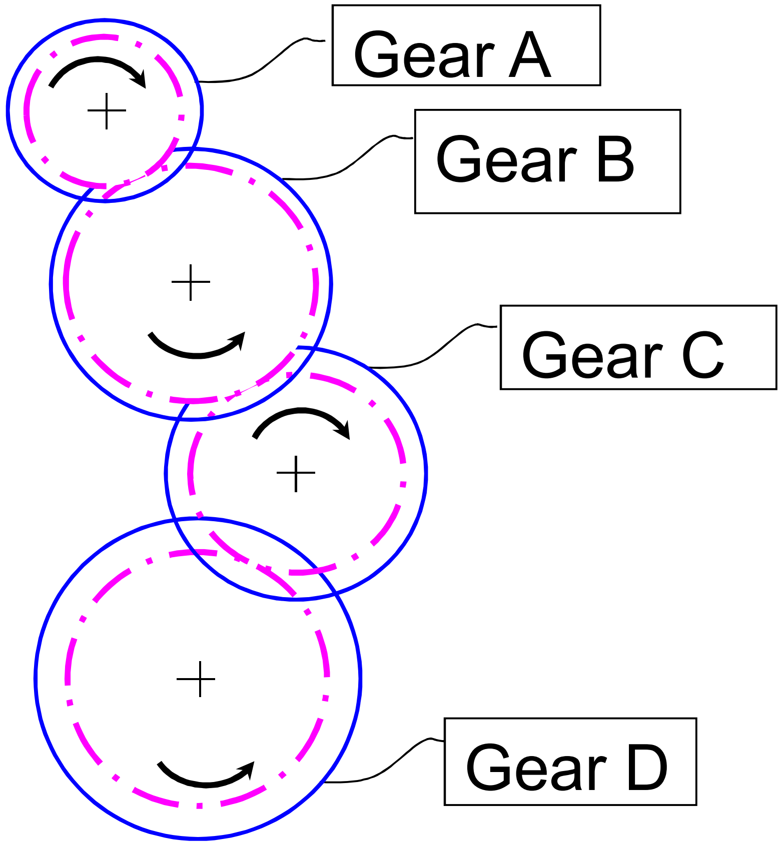
$$\frac{N_D}{N_C} = \frac{T_C}{T_D}$$



Velocity ratio between the driving and driven gears is given by,

$$\text{Velocity Ratio} = \frac{N_D}{N_A}$$

$$= \frac{N_D}{N_C} \cdot \frac{N_C}{N_B} \cdot \frac{N_B}{N_A}$$



Substituting from (i), (ii) and (iii)

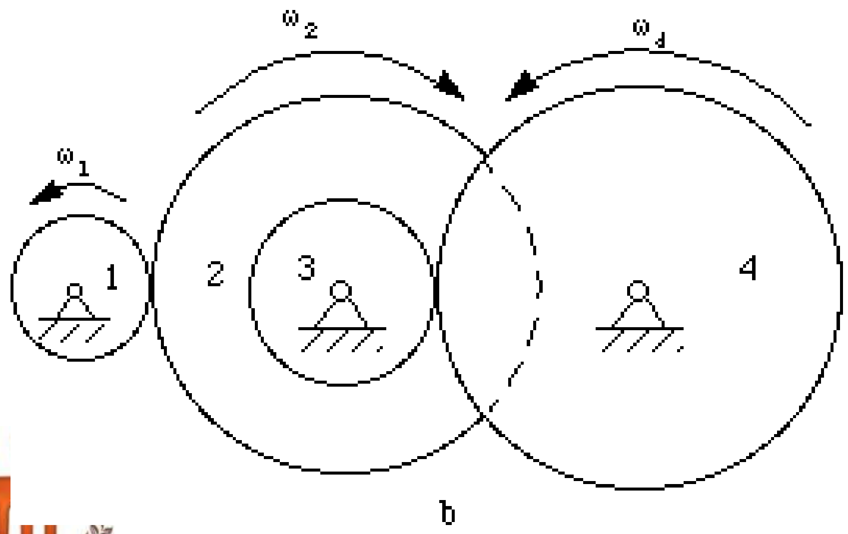
$$\text{Velocity Ratio} = \frac{N_D}{N_A}$$

$$= \frac{T_C}{T_D} \cdot \frac{T_B}{T_C} \cdot \frac{T_A}{T_B}$$

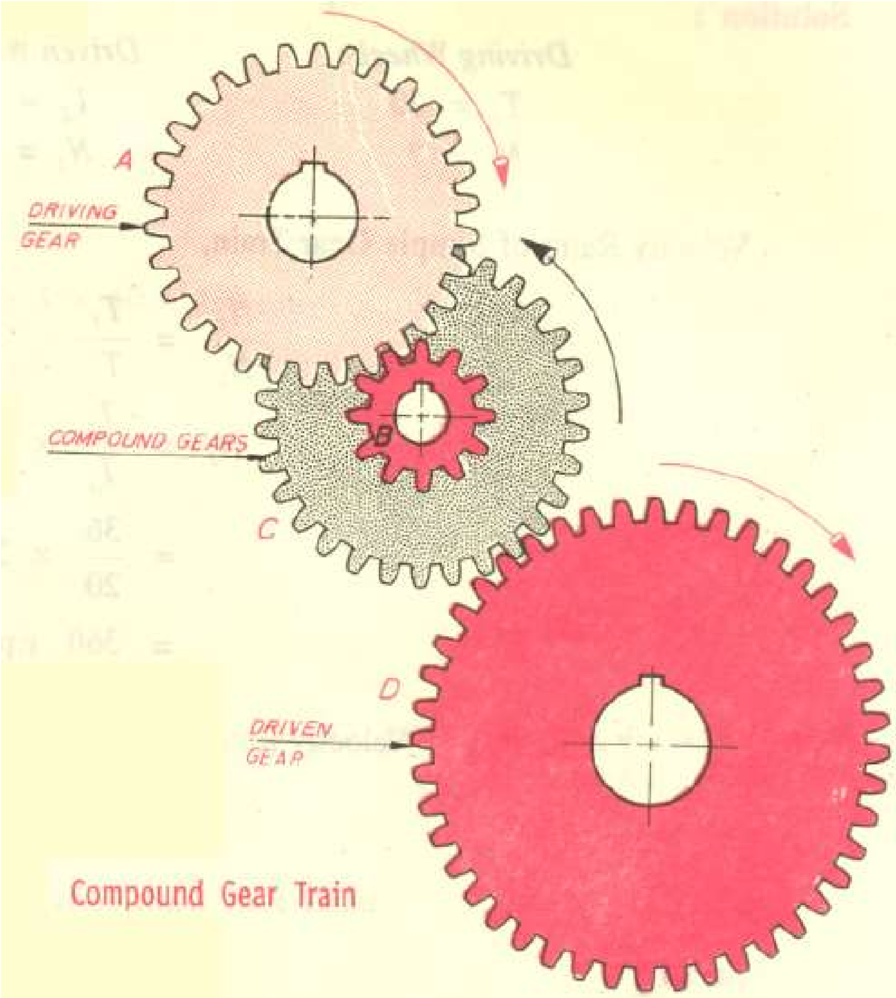
$$\text{Velocity Ratio } \frac{N_D}{N_A} = \frac{T_A}{T_D}$$

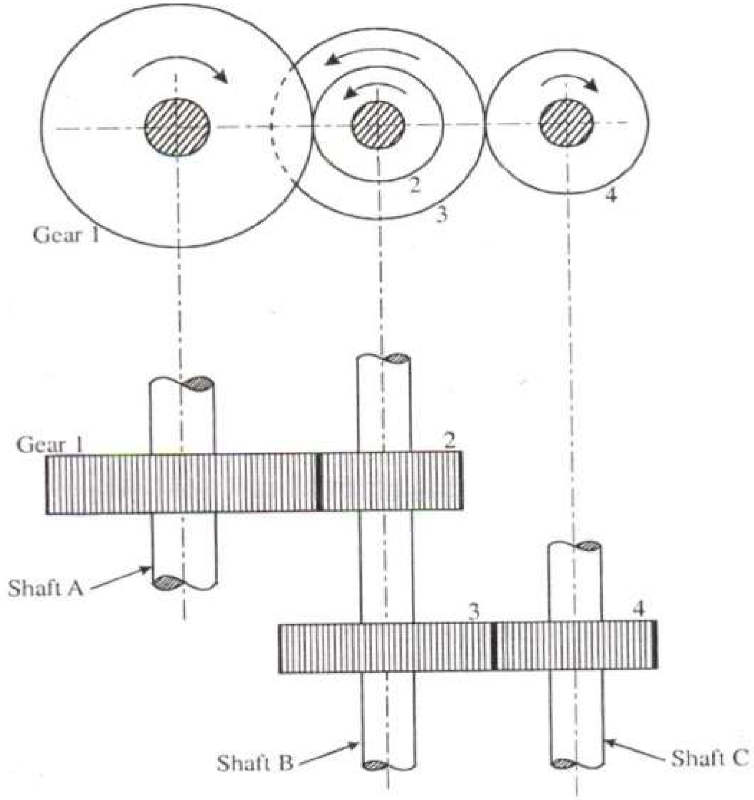
Compound Gear Train

- Compound gear train is used when large velocity ratio is required
- Each shaft except the first and last shafts carries two gear wheels.



Compound Gear Train



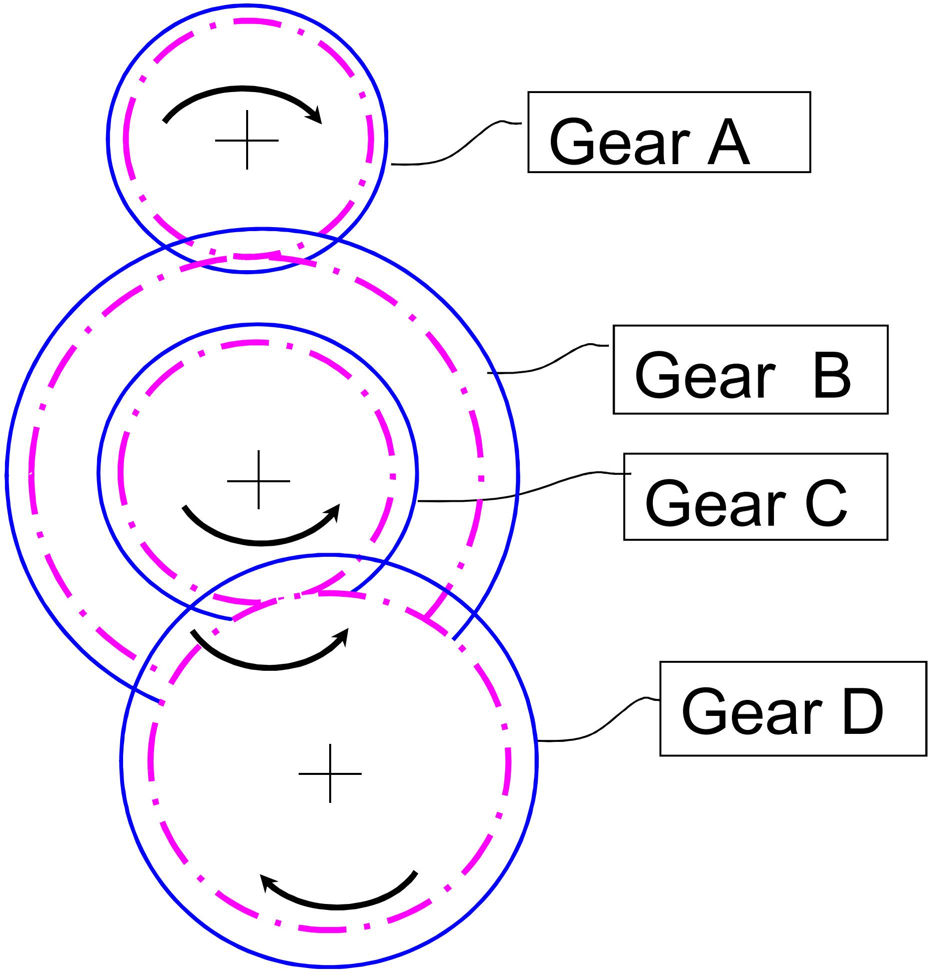


Compound gear train

Compound gear train

N_A = speed in RPM of gear A
N_B = speed in RPM of gear B
N_C = speed in RPM of gear C
N_D = speed in RPM of gear D

T_A = Number of teeth of gear A
T_B = Number of teeth of gear B
T_C = Number of teeth of gear C
T_D = Number of teeth of gear D



Gear A drives B,

$$\frac{N_B}{N_A} = \frac{T_A}{T_B} \qquad \text{..........(1)}$$

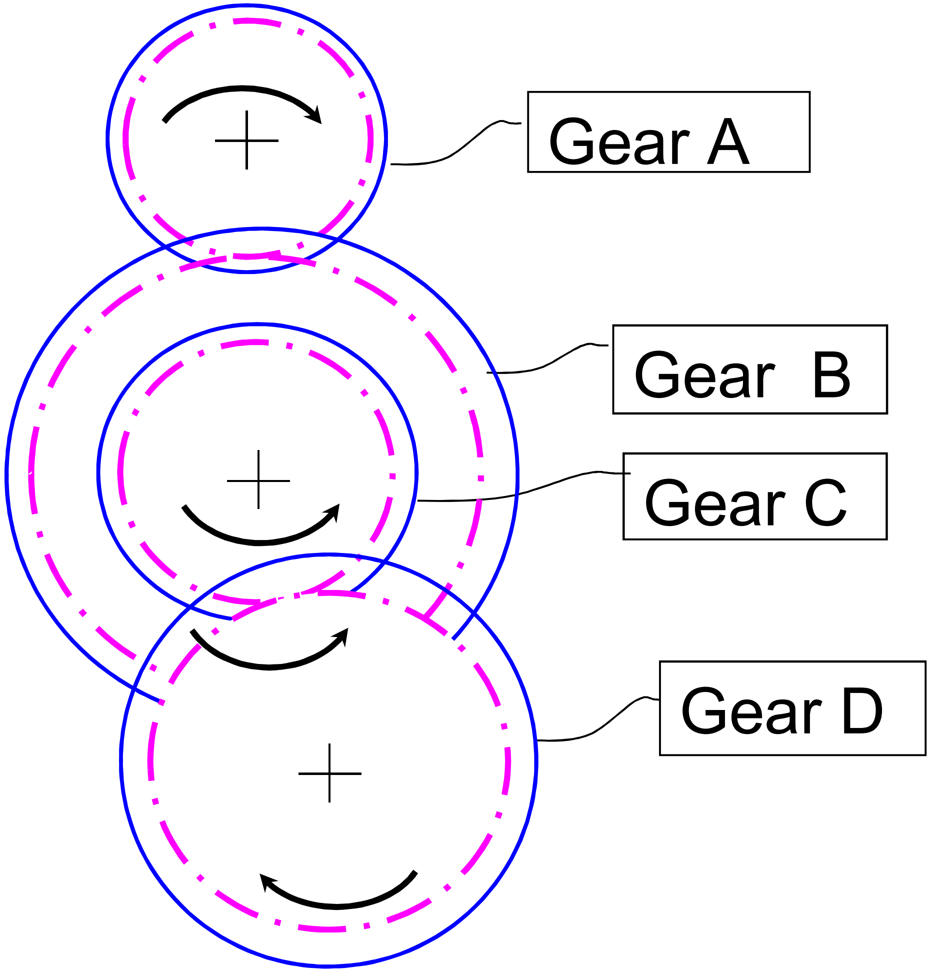
Since gears B and C are keyed to the same shaft,

Both of them rotate at the same speed

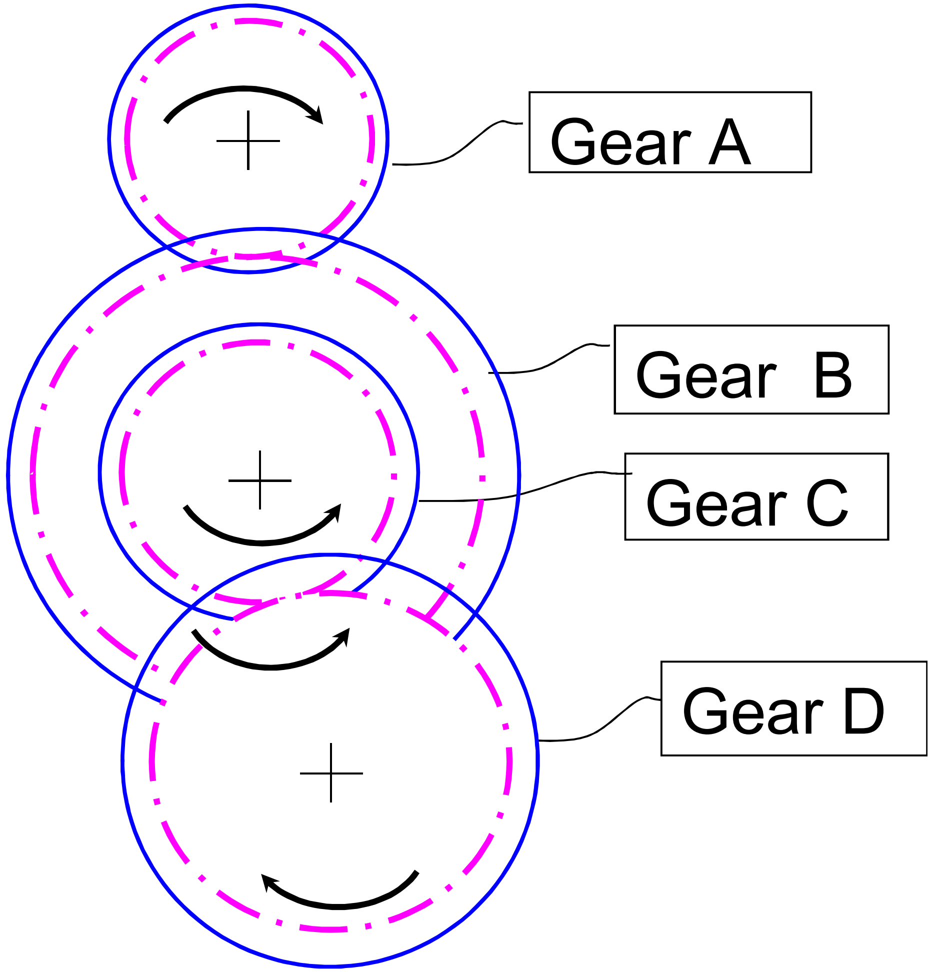
$$N_B = N_c \text{ but } T_B \neq T_c$$

Gear C drives D,

$$\frac{N_D}{N_C} = \frac{T_C}{T_D} \qquad \text{.........(2)}$$



Velocity Ratio $= \dfrac{N_D}{N_A} = \dfrac{N_D}{N_C} \cdot \dfrac{N_B}{N_A}$



Substituting from (1) and (2)

Velocity ratio = $\dfrac{N_D}{N_A} = \dfrac{T_C}{T_D} \cdot \dfrac{T_A}{T_B}$

Velocity Ratio = $\dfrac{\text{Product of the No. of teeth of driving gears}}{\text{Product of the No. of teeth of driven gears}}$