TOPICS TO BE COVERED

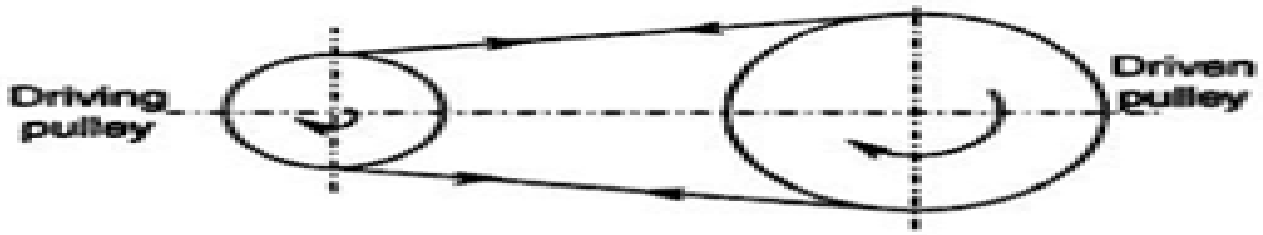
- POWER TRANSMISSION SYSTEM
- RATIO OF BELT
- TENSION OF FLAT BELT DRIVE
- CHAIN DRIVE
- MAXIMUM POWER TRANSMISSION
- SLIP
- CREEP
- CLUTCH
- TYPES
- GEAR DRIVE
- GEAR TRAIN

POWER TRANSMISSION SYSTEM

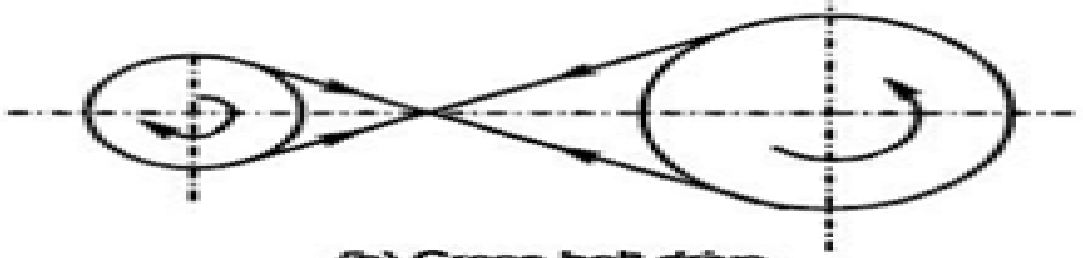
- **Power transmission** is the movement of energy from its place of generation to a location where it is applied to perform useful work. **Power** is **defined** formally as units of energy per unit time.
- To transmit power from the prime mover to the driven machine either flexible or non-flexible drive elements are used. Gears are an example of rigid or non-flexible drives whereas belts, chains and ropes are flexible drive elements. Flexible elements are used when there is larger centre distance between the shafts to be connected. Flexible drives are simple in construction, are less noisy, have low initial and maintenance cost and help in absorbing shock loads and damping vibrations. Low and variable velocity ratio is the main disadvantages of these drives.

BELT DRIVE

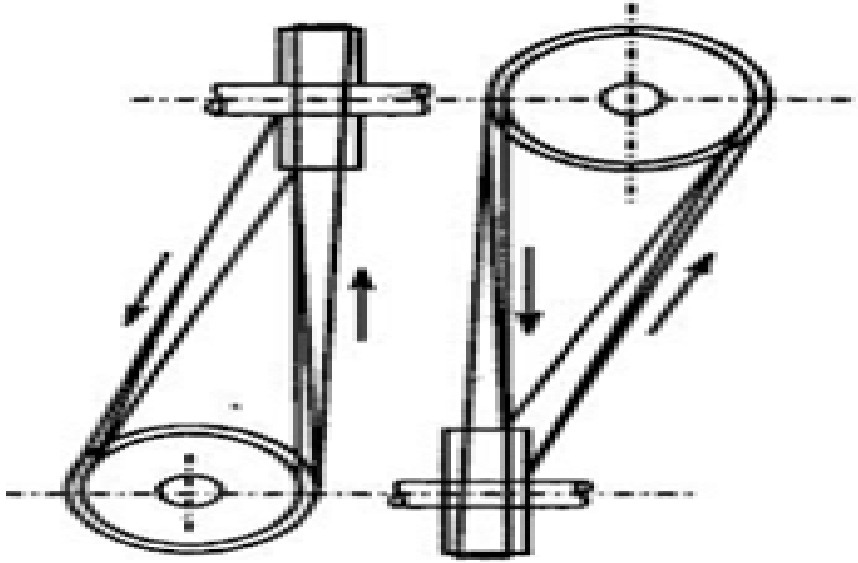
- a mechanism in which power is transmitted by the movement of a continuous flexible belt.
- A belt drive consists of two pulleys attached to each shaft and an endless belt wrapped around them with some initial tension. Power is transmitted from the driver pulley to the belt and from the belt to the driven pulley with the help of friction. Friction between belt and pulley surface limits the maximum power that can be transmitted. If this limiting value is exceeded, belt starts slipping. Belts have limited life and should be periodically inspected for wear, aging, and loss of elasticity and should be replaced at the first sign of deterioration.



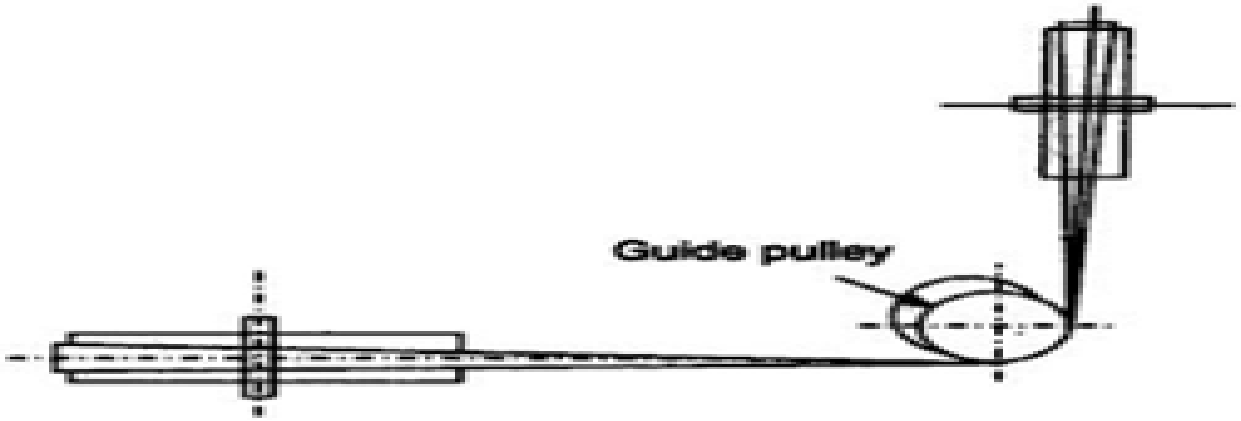
(a) Open-belt drive



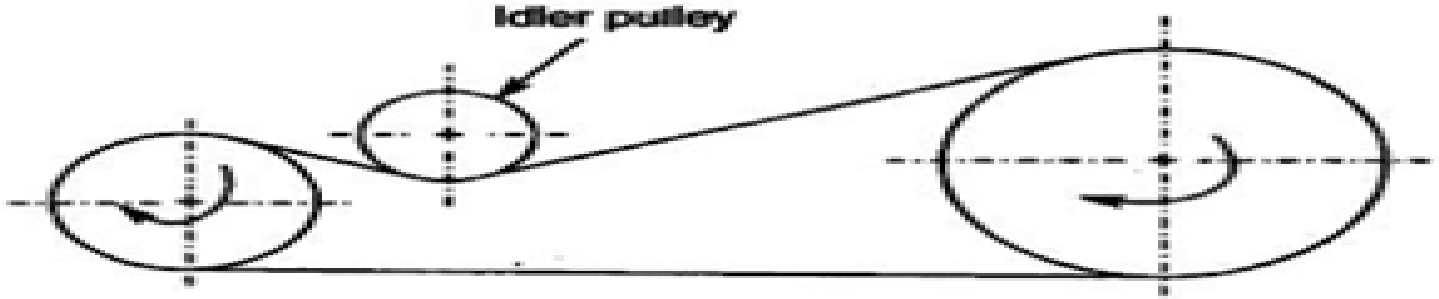
(b) Cross-belt drive



(c) Quarter-turn drive



(d) Right-angled drive



Use of idler pulley.

Velocity Ratio

Velocity Ratio is the ratio of speeds of driver and driven pulley. Let

N_1, d_1 = speed (rpm) and diameter of driving pulley

N_2, d_2 = speed (rpm) and diameter of driven pulley

t = thickness of belt

$$\text{Velocity Ratio}, \frac{N_2}{N_1} = \frac{d_1}{d_2}$$

$$\text{Velocity Ratio}, \frac{N_2}{N_1} = \frac{d_1 + t}{d_2 + t}$$

If thickness of the belt is considered

CHAIN DRIVE

- **Chain drive** is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.
- Roller chain and sprockets is a very efficient method of power transmission compared to (friction-drive) belts, with far less frictional loss.
- Although chains can be made stronger than belts, their greater mass increases drive train inertia.
- Drive chains are most often made of metal, while belts are often rubber, plastic, urethane, or other substances.
- Drive belts can slip unless they have teeth, which means that the output side may not rotate at a precise speed, and some work gets lost to the friction of the belt as it bends around the pulleys. Wear on rubber or plastic belts and their teeth is often easier to observe, and chains wear out faster than belts if not properly lubricated.

Condition for maximum power transmission

- Power transmitted by the belt is given by,

$$P = (T_1 - T_2)v$$

- for maximum power transmission:

CENTRIFUGAL TENSION= T/3

SLIP & CREEP

- **Slip is there when belt does not grip pulley fully and perfectly i.e. there is not full friction between the pulley and the belt.**
- **Slip Is due to incorrect tensions in the belt such that driver pulley moves and the driven pulley does not move. It is more prominent in a V-belt drive than a flat belt drive.**
- when a belt rotate through two pulleys, upper side of this drive will tight side and lower side will be slack side, now a certain portion of belt will pass through the area where it will change from tight side to slack side, then the length of that specific portion of the belt will expand and contract subsequently and a relative motion will happen between belt and pulley surface. This phenomenon is called creep of belt. This effects a slight reduction in velocity of follower pulley than driven one. proper selection of belt material and belt length can reduce this loss.
- **Both slip and creep cause relative motion between the pulley and belt. These also reduce power transmission.These should be reduced to the minimum.**

EFFECT OF SLIP ON VELOCITY RATIO

Slip of belt over the pulleys reduces the velocity ratio. Let

s1 = percentage slip between driver and belt

s2 = percentage slip between belt & driven pulley

s = total percentage slip

$$\text{Velocity Ratio}, \frac{N_2}{N_1} = \frac{d_1 + t}{d_2 + t}\left[1 - \frac{s}{100}\right]$$

CLUTCH

- A **clutch** is a mechanical device that engages and disengages the power transmission, especially from driving shaft to driven shaft.

Types of Clutches:

- **According to the method of transmitting torque:**

1. Positive clutch (Dog clutch)
2. Friction clutch:

- Cone clutch
- Single plate clutch
- Multi-plate clutch
- Diaphragm clutch

3. Hydraulic clutch

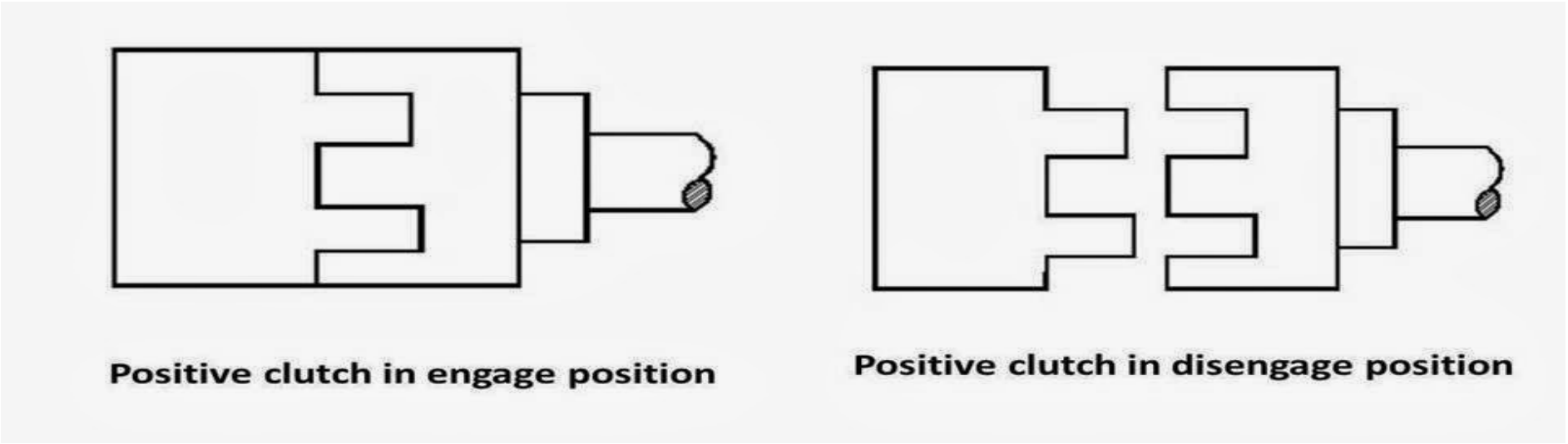
- **According to the method of engaging force:**

1. Spring types clutch
2. Centrifugal clutch
3. Semi-centrifugal clutch
4. Electro-magnetic clutch

- **According to the method of control:**

1. Manual clutch
2. Automatic clutch

Positive clutch (Dog clutch)



- In the positive clutch, grooves are cut either into the driving member or into the driven member and some extracted parts are situated into both driving and driven member. When the driver releases clutch pedal then these extracted parts insert into grooves and both driving and driven shaft revolve together. When he push the clutch pedal these extracted parts come out from grooves and the engine shaft revolve itself without revolving transmission shaft.

Friction clutch

- In this types of clutches, friction force is used to engage and disengage the clutch. A friction plate is inserted between the driving member and the driven member of clutch. When the driver releases the clutch pedal, the driven member and driving member of clutch, comes in contact with each other. A friction force works between these two parts. So when the driving member revolves, it makes revolve the driven member of clutch and the clutch is in engage position.

Cone clutch

- It is a friction type of clutch. As the name, this type of clutch consist a cone mounted on the driven member and the shape of the sides of the flywheel is also shaped as the conical. The surfaces of contact are lined with the friction lining. The cone can be engage and disengage form flywheel by the clutch pedal.

Single plate clutch

- In the single plate clutch a flywheel is fixed to the engine shaft and a pressure plate is attached to the gear box shaft. This pressure plate is free to move on the spindle of the shaft. A friction plate is situated between the flywheel and pressure plate. Some springs are inserted into compressed position between these plates. When the clutch pedal releases then the pressure plate exerts a force on the friction plate due to spring action. So clutch is in engage position. When the driver pushes the clutch pedal it due to mechanism it serves as the disengagement of clutch.

Centrifugal clutch

- As the name in the centrifugal clutch, centrifugal force is used to engage the clutch. This type of clutch does not require any clutch pedal for operating the clutch. The clutch is operated automatically depending upon engine speed. It consist a weight pivoted on the fix member of clutch. When the engine speed increase the weight fly of due to the centrifugal force, operating the bell crank lever, which press the pressure plate.

GEAR…..

- 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

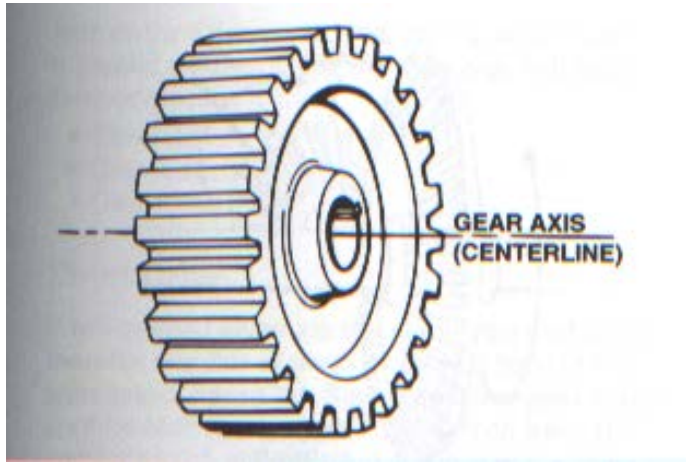
Bevel Gear

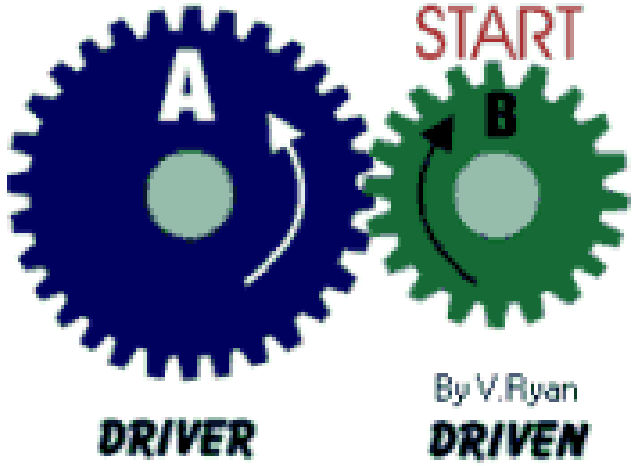
c. Non-intersecting and Non-parallel

worm and worm gears

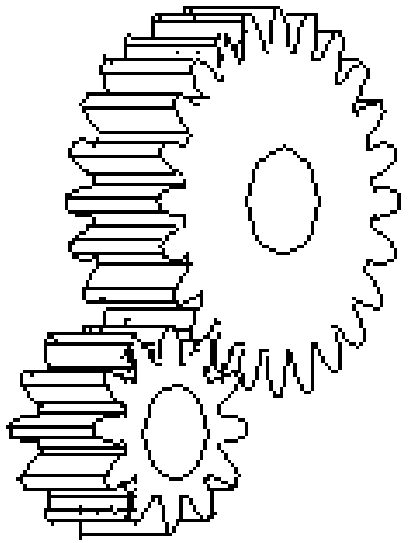
SPUR GEAR

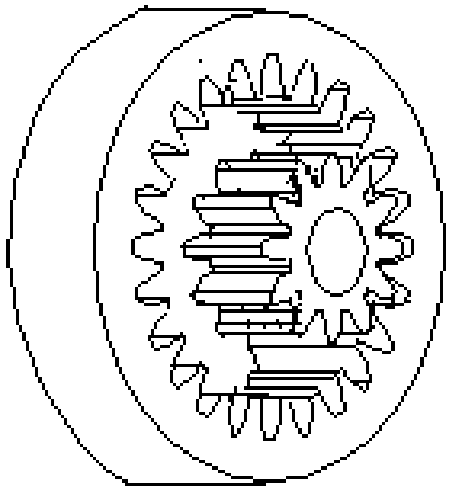
- Teeth is parallel to axis of rotation
- Transmit power from one shaft to another parallel shaft
- Used in Electric screwdriver, oscillating sprinkler, windup alarm clock, washing machine and clothes dryer





External and Internal spur Gear…





Helical Gear

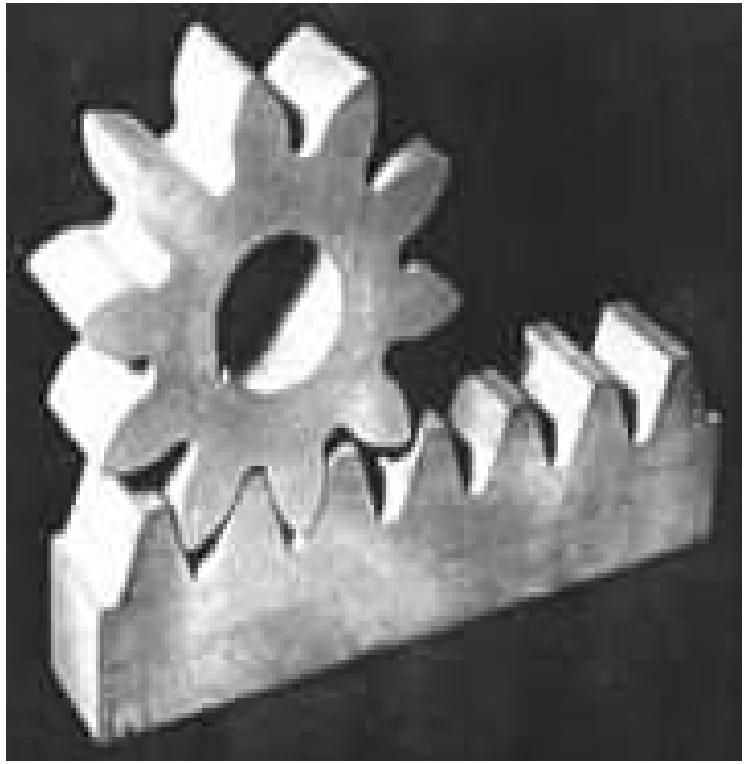
- The teeth on helical gears are cut at an angle to the face of the gear
- This gradual engagement makes helical gears operate much more smoothly and quietly than spur gears
- One interesting thing about helical gears is that if the angles of the gear teeth are correct, they can be mounted on perpendicular shafts, adjusting the rotation angle by 90 degrees

Helical Gear…

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



Bevel gears

- **Bevel gears** are useful when the direction of a shaft's rotation needs to be changed
- They are usually mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well
- The teeth on bevel gears can be **straight**, **spiral** or **hypoid**
- locomotives, marine applications, automobiles, printing presses, cooling towers, power plants, steel plants, railway track inspection machines, etc.

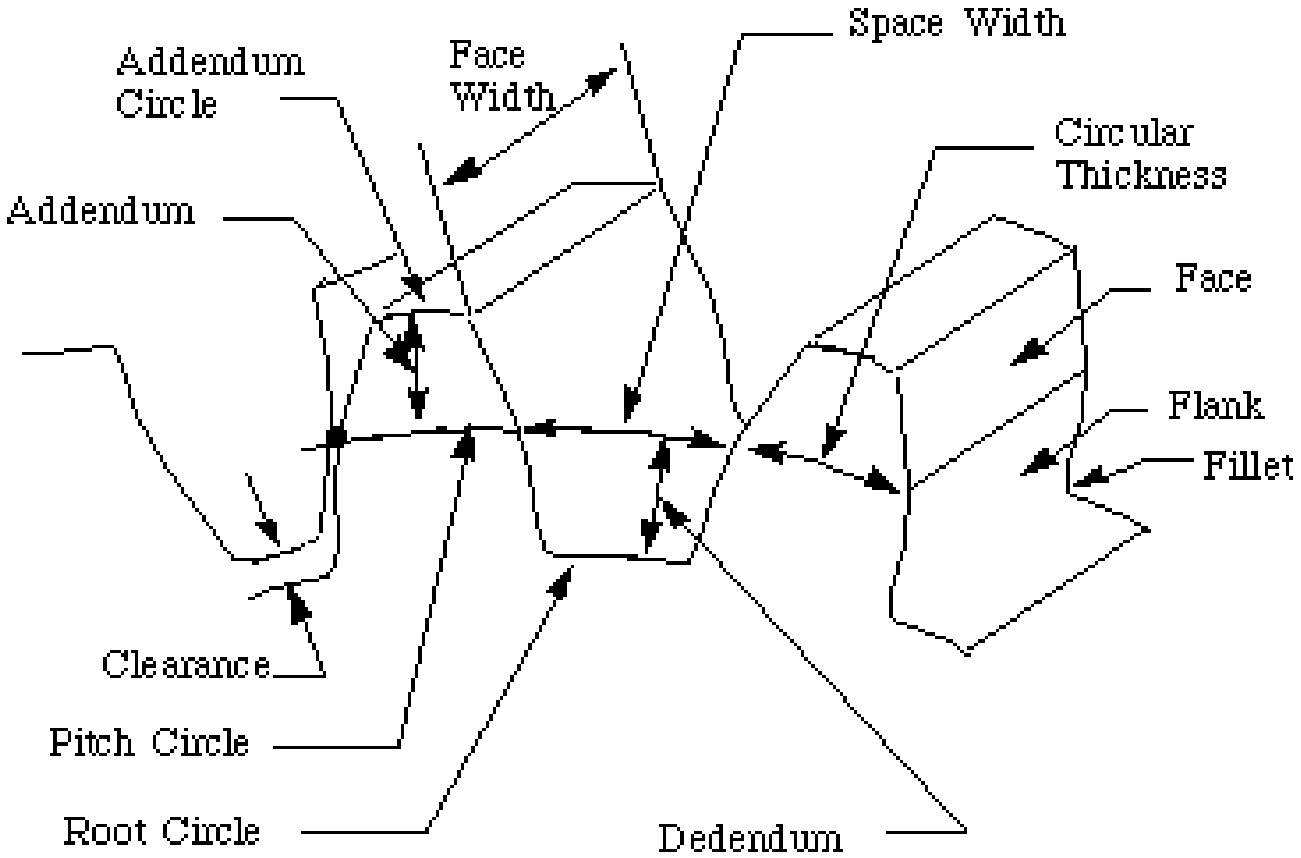
Straight and Spiral Bevel Gears

WORM AND WORM GEAR

- **Worm gears** are used when large gear reductions are needed. It is common for worm gears to have reductions of 20:1, and even up to 300:1 or greater
- Many worm gears have an interesting property that no other gear set has: the worm can easily turn the gear, but the gear cannot turn the worm
- Worm gears are used widely in material handling and transportation machinery, machine tools, automobiles etc

WORM AND WORM GEAR

NOMENCLATURE OF SPUR GEARS



NOMENCLATURE….

- **Pitch surface**: The surface of the imaginary rolling cylinder (cone, etc.) that the toothed gear may be considered to replace.
- **Pitch circle**: A right section of the pitch surface.
- **Addendum circle**: A circle bounding the ends of the teeth, in a right section of the gear.
- **Root (or dedendum) circle**: The circle bounding the spaces between the teeth, in a right section of the gear.
- **Addendum**: The radial distance between the pitch circle and the addendum circle.
- **Dedendum**: The radial distance between the pitch circle and the root circle.
- **Clearance**: The difference between the dedendum of one gear and the addendum of the mating gear.

NOMENCLATURE….

- **Face of a tooth**: That part of the tooth surface lying outside the pitch surface.
- **Flank of a tooth**: The part of the tooth surface lying inside the pitch surface.
- **Circular thickness** (also called the **tooth thickness**): The thickness of the tooth measured on the pitch circle. It is the length of an arc and not the length of a straight line.
- **Tooth space**: pitch diameter The distance between adjacent teeth measured on the pitch circle.
- **Backlash**: The difference between the circle thickness of one gear and the tooth space of the mating gear.
- **Circular pitch** (Pc) : The width of a tooth and a space, measured on the pitch circle. $P_c = \frac{\pi D}{N}$

NOMENCLATURE….

- **Diametral pitch (**Pd): The number of teeth of a gear unit pitch diameter. The diametral pitch is, by definition, the number of teeth divided by the pitch diameter. That is,

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

Where

Pd = diametral pitch

N = number of teeth

D = pitch diameter

- **Module** (m): Pitch diameter divided by number of teeth. The pitch diameter is usually specified in inches or millimeters; in the former case the module is the inverse of diametral pitch.

$$m = D/N$$

VELOCITY RATIO OF GEAR DRIVE

d = Diameter of the wheel

N =Speed of the wheel

ω = Angular speed

velocity ratio (n) = $$\frac{\omega_2}{\omega_1} = \frac{N_2}{N_1} = \frac{d_1}{d_2}$$

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

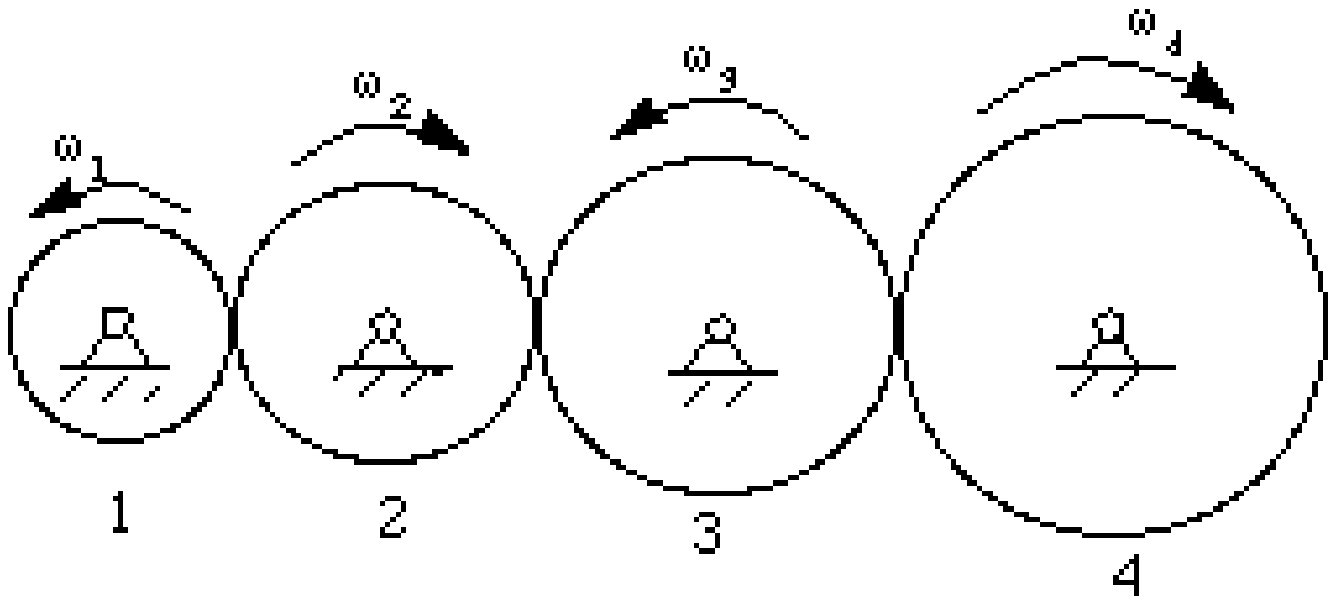
Types of Gear Trains

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

Simple Gear Train

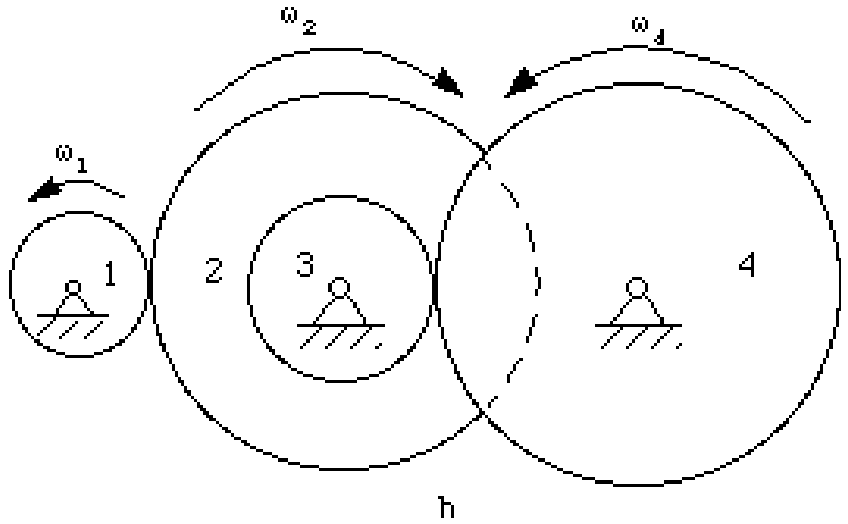
- The most common of the gear train is the gear pair connecting parallel shafts. The teeth of this type can be spur, helical or herringbone.
- Only one gear may rotate about a single axis

Simple Gear Train

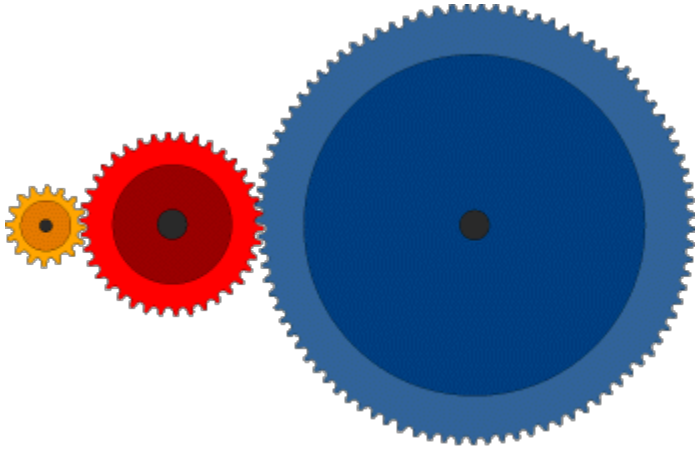


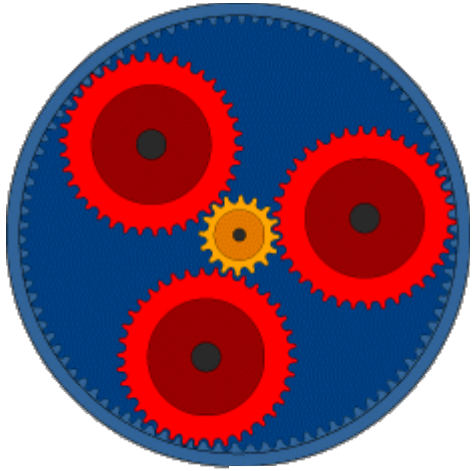
Compound Gear Train

- 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...

- In this train, the blue gear has six times the diameter of the yellow gear
- The size of the red gear is not important because it is just there to reverse the direction of rotation
- In this gear system, the yellow gear (the sun) engages all three red gears (the planets) simultaneously
- All three are attached to a plate (the planet carrier), and they engage the inside of the blue gear (the ring) instead of the outside.

Planetary Gear Train…

- Because there are three red gears instead of one, this gear train is extremely rugged.
- planetary gear sets is that they can produce different gear ratios depending on which gear you use as the input, which gear you use as the output, and which one you hold still.

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