POORNIMA
COLLEGE OF ENGINEERING

Transmission of motion and power

1 Introduction

The mechanisms which are used to transmit the required motion and power from one shaft to another shaft are called mechanical drives. These drives are extensively used in automobiles, workshops, processing and transport industry.

2 Types of mechanical drives

1. Belt and rope drives
2. Chain drives
3. Gear drives

Belt drives

Types of belts

(a) Flat belt

It is mostly used in factories and workshops, where a moderate amount of power is to be transmitted. The distance between two pulleys is not more than 8 meters apart.

(b) V –belt

It is mostly used in factories and workshops, where a moderate amount of power is to be transmitted. The distances between two pulleys are very near to each other.

(c) Circular belt or rope belt

It is mostly used in the factories and workshops, where a greater amount of power is to be transmitted. The distance between two pulleys is more than 8 meters.

12.4.2 Difference between Flat belt and V- belt

. Flat belt drive drive

Flat belt	V-belt
1 It is suitable for moderate power transmission when the distance between the shafts is large.	It is suitable for high power transmission when the distance between the shafts is small.

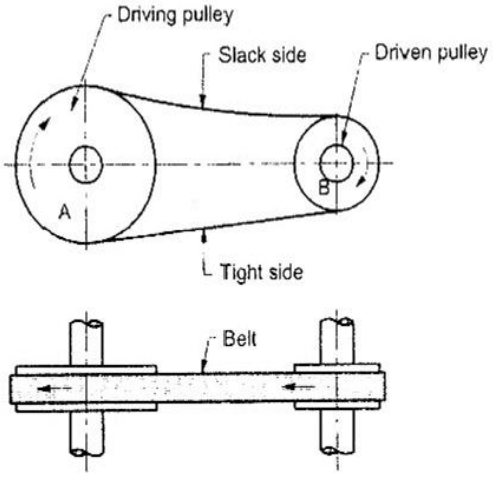
2 There is chance of slip due to less frictional grip between pulley and belt. Hence it is not a Positive drive.	There is less chance of slip due to more frictional grip between belt and pulley.
3 Require large space	Due to compactness, required less space.
4 High velocity ratio may not obtain.	High velocity ratio may be obtained.
5 For same value of co-efficient of friction, angle of lap and allowable tension the power transmission by flat belt is less than that of V -belt drive.	For same value of co-efficient of friction, angle of lap and allowable tension the power transmission by V-belt is higher than that of flat belt.

12.4.3 Types of belt drives

(a) Open belt drive

Use

It is used when the driven pulley is to be rotated in the same direction as the driving pulley.



Construction

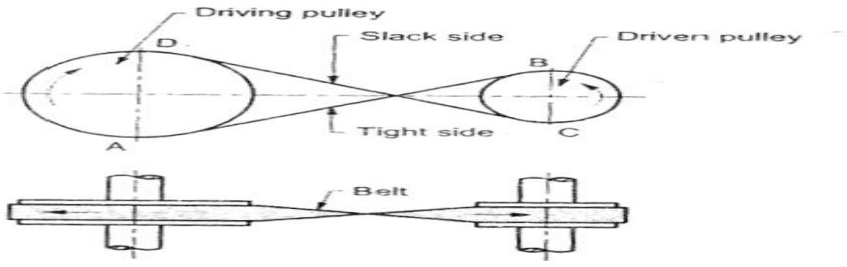
In this driving pulley pulls the belt on one side and drives it to the other side. So the

tension on pulled side will be more than other side. The tension on pulled side is known as tight side and other side is known as slack side.

(b) Crossed belt drive

Use

It is used when the driven pulley is to be rotated in the opposite direction to that of driving pulley.



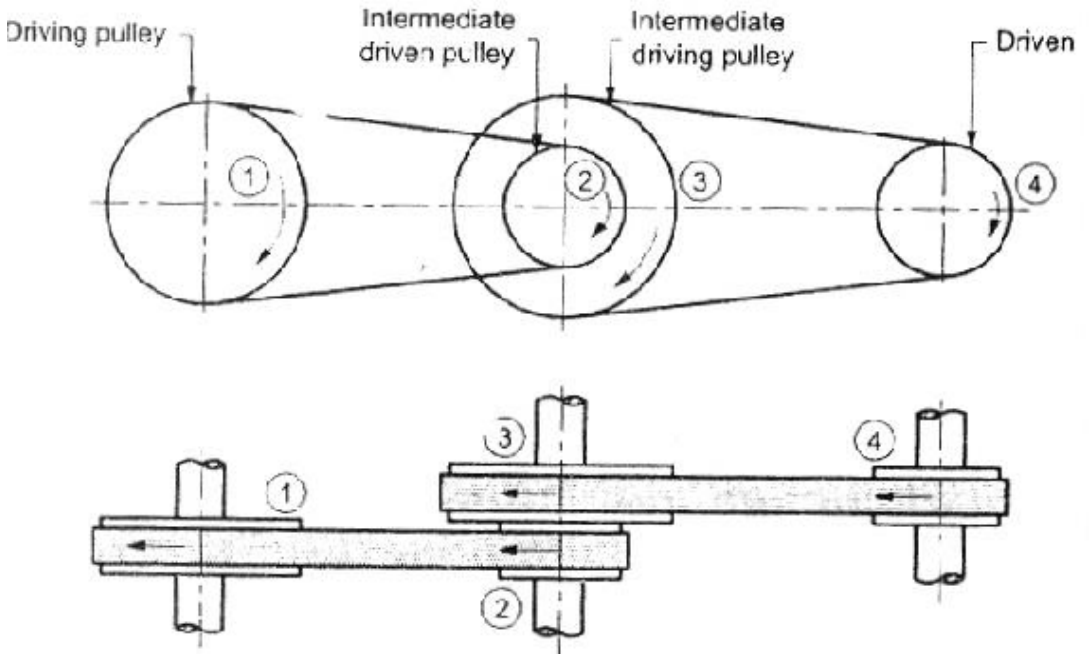
Construction

In cross belt drive the belt bents in two different planes, it therefore wears more rapidly. In this case driving pulley pulls the belt from one side (i.e. BA.) and delivers it to the other side (i.e. DC). So the tension on side AB is more called tight side as compare to tension on the side of belt CD which is known as slack side.

(c) Compound belt drive

Use

It is used when the distance between input and output shaft is very large. In this drive intermediate or compound shaft pulley is used.



Rope Drive

Rope drives are widely used where a large amount of power is to be transmitted from one shaft to another shaft over a considerable distance. The frictional grip in case of rope drive is more than flat belt drive or V-belt drive.

Types of Rope Drives

Depending upon the type of material used for the rope, the rope drives are classified as follows,

(a) Fiber ropes

The fiber ropes are made from fibrous material such as hemp, manila and cotton. Fiber ropes are used when shafts are about 60 meters apart.

(b) Wire ropes

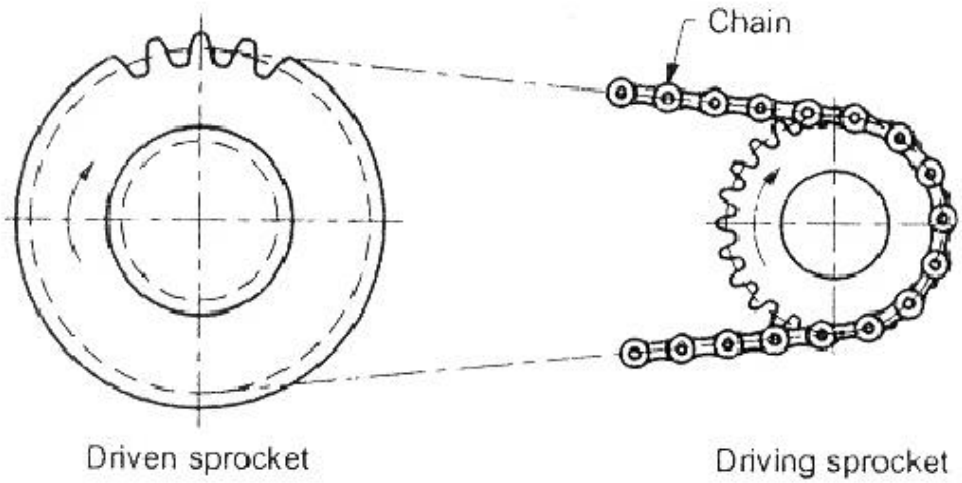
The wire ropes are made from metallic wires. Wire ropes are used when shaft are about 150 meters apart. The wire ropes are used in elevators, mine hoists, cranes, conveyors etc.

Chain drive

Slipping occurs in belt and rope drives. In order to avoid this slipping phenomenon chain drives are used.

Construction

A chain drive consists of three elements driving sprocket, driven sprocket and an endless chain which is wrapped around two sprockets. A chain consists of a number of links connected by pin joints, while the sprockets are toothed wheels and fit into the corresponding recesses in the links of the chain.



Advantages

1. It provides a positive transmission and slip is not present.
2. It gives a constant velocity ratio.

Applications

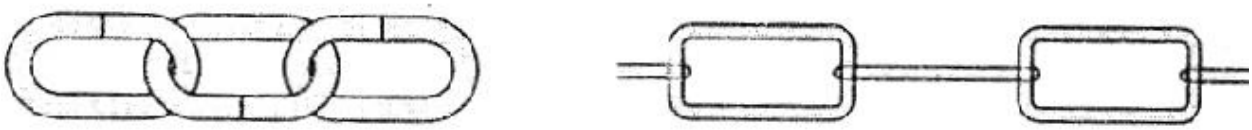
Bicycles, motor cycles, agricultural machinery, textile machinery and material handling equipments.

Types of Chains

The chains are classified into following three groups

1. Hoisting and Hauling chains
2. Conveyor chains
3. Power transmission chains

(1) Hoisting and hauling chains



(a) Chain with oval links (b) Chain with square links

Use

It used for hoisting and hauling purposes.

These are further classified as,

Chain with oval links

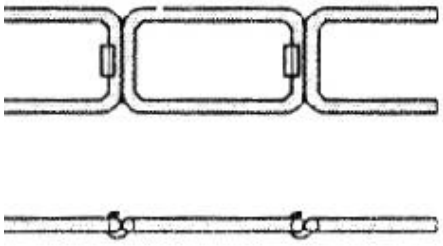
Chain with square links

(2) Conveyor chains

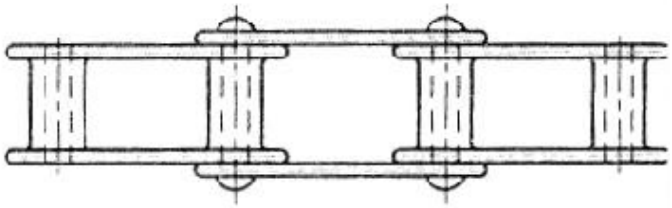
Use

Elevating and conveying the material continuously and they run at low speeds.
The conveyor chains are of the following two types.

Detachable or hook joint type chain
Closed joint type chain



(a) Hooke joint



(b) Closed joint chain

The conveyor chains are usually made of malleable cast iron. These chains do not have smooth running operation.

(3) Power transmission chain

Use

Transmitting motion from one shaft to another shaft. These chains operate at maximum speed of 15 m/sec.

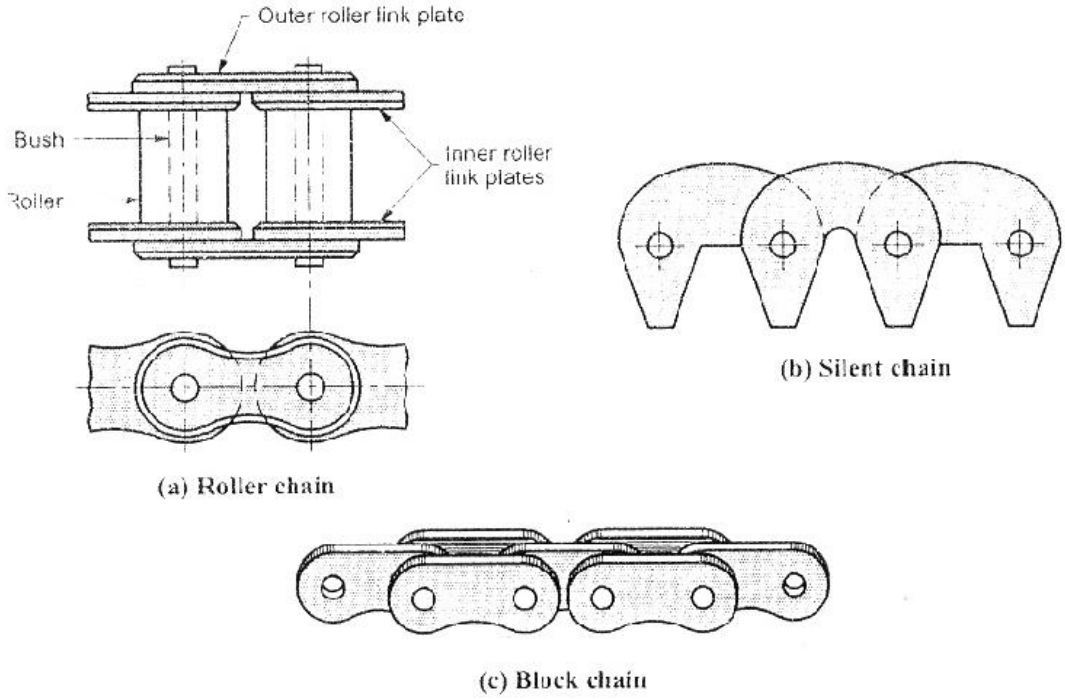
Types of power transmission chains are as follows,

(a) Roller chains

It has rollers around the bushes and held between roller link plates. The roller chain consists of two rows of outer and inner plates. The pins are fitted to the outer plate and passed through the bushings which are pressed into the inner plate.

(b) Bush chain

The bushed chains are similar in design of roller chain except that they have no rollers in it.



(c) Silent chain (Inverted tooth chain)

Use

To achieve an almost silent performance in power transmission. It consists of special links which directly get engaged with the sprocket teeth.

(d) Block chain

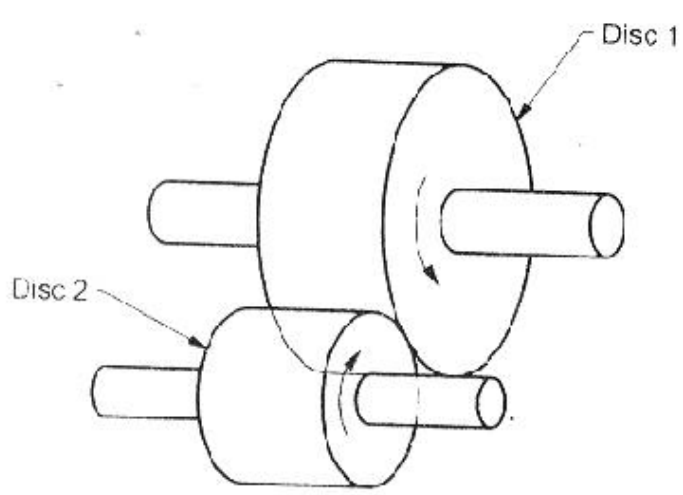
Use

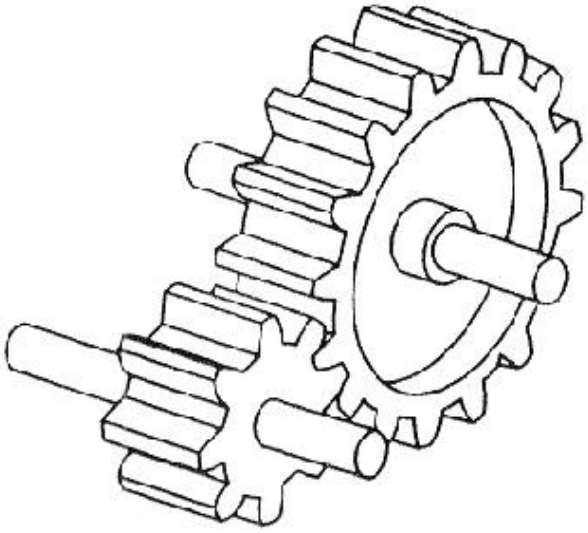
Transmitting the power at low speed. In this chains rubbing takes place between teeth and the links.

Gear drive

In case of rope and belt drives we have seen that the velocity ratio transmitted cannot be exact due to the slip of rope or belt on the pulley. Also due to frictional losses the efficiency of power transmission in such drives is less. The power may be transmitted from one shaft to another by means of mating gears with high transmission efficiency. In early days, friction discs as shown in figure were used for transmitting the power from one shaft to another shaft. In such a case, the power transmission capacity depends on friction between surfaces of two discs. Therefore, this method is not suitable for transmitting higher power as slip occurs between the discs.

(a) Frictional disc *(b) Gear drive*





In order to transmit a definite power from one shaft to another shaft to the projection on one disc and recesses on another disc can be made which can mesh with each other. This leads to the formation of teeth on both discs and the discs with teeth on their periphery are known as "Gears".

Advantages

1. It is a positive drive (no slip) i.e. it transmits exact velocity ratio from one shaft to another shaft.
2. It can transmit very large power.
3. High transmission efficiency.
4. Requires less space.
5. Reliable.

Disadvantages

1. Manufacturing cost of gear is high, since special tools and machinery is required for gear manufacturing.
2. Maintenance cost of gear drive is also high due to lubrication requirements.
3. The error in cutting teeth may cause vibrations and noise during operation.
4. It requires precise alignment of shafts.

Terms related to gears

(1) Pitch circle

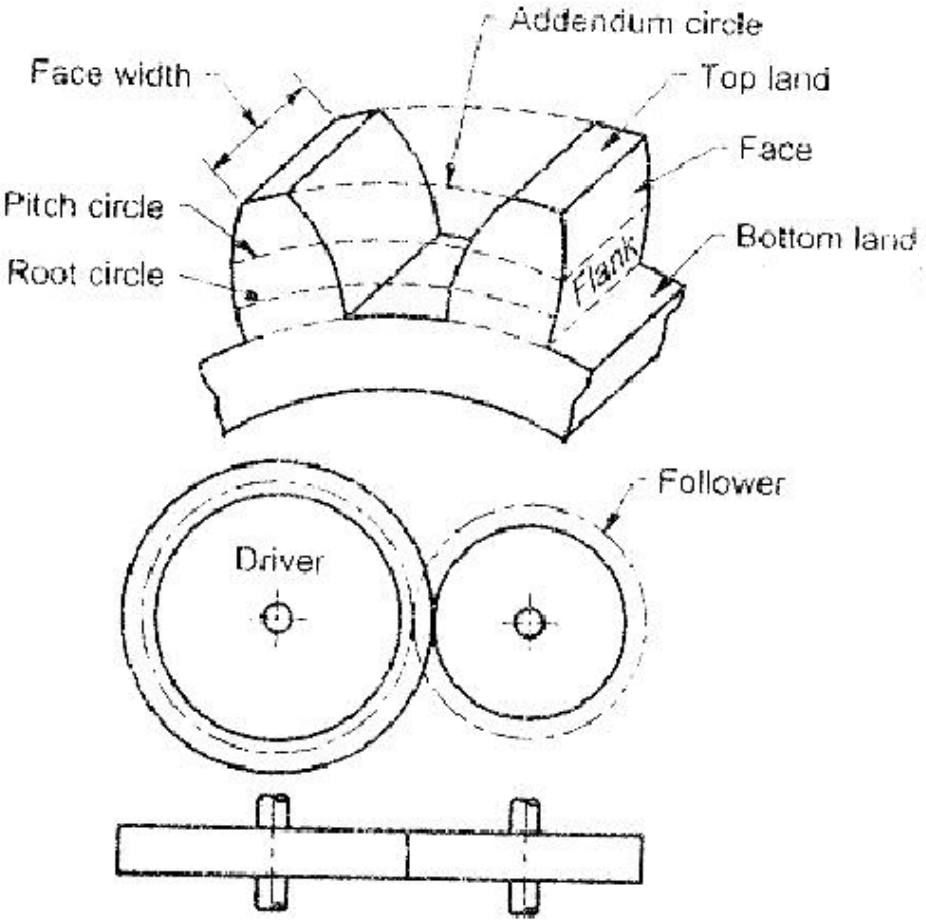
It is an imaginary circle by which pure rolling action would give the same motion as the actual gear.

(2) Pitch circle diameter (d)

It is the diameter of the pitch circle. The size of gear is usually specified by the pitch circle
diameter.

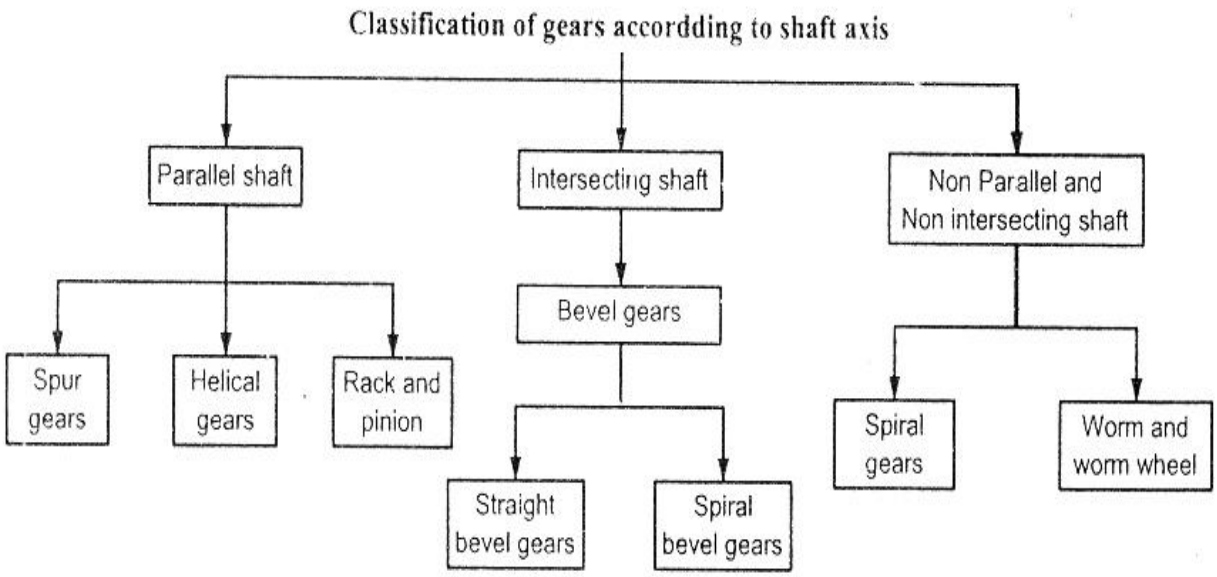
(3) Pressure angle or angle of obliquity
It is an angle between the common normal to two gear teeth at the point of contact and the
common tangent at common point between two pitch circles.
(4) Circular pitch (P_c)
It is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth.
$P_c = \pi D/T$ Where, T = number of teeth

(5) Module (m)
It is ratio of the pitch circle diameter in millimeters to number of teeth.
$m = d/T$



Classification of gears

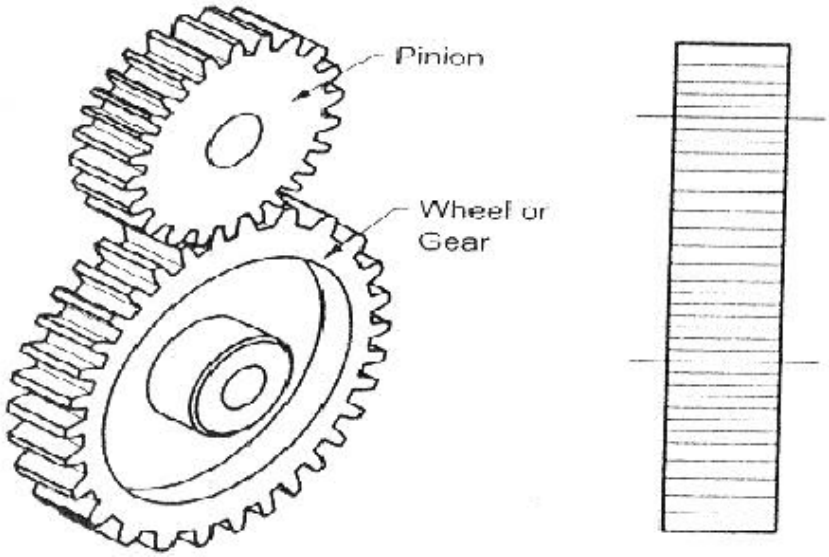
1. According to position of shaft axes
2. According to peripheral velocity of gears
3. According to type of meshing
4. According to type of teeth profile



(a) Spur gear

Use

When the axis of two shafts are parallel to each other. These gears have teeth parallel to the axis of the shaft.



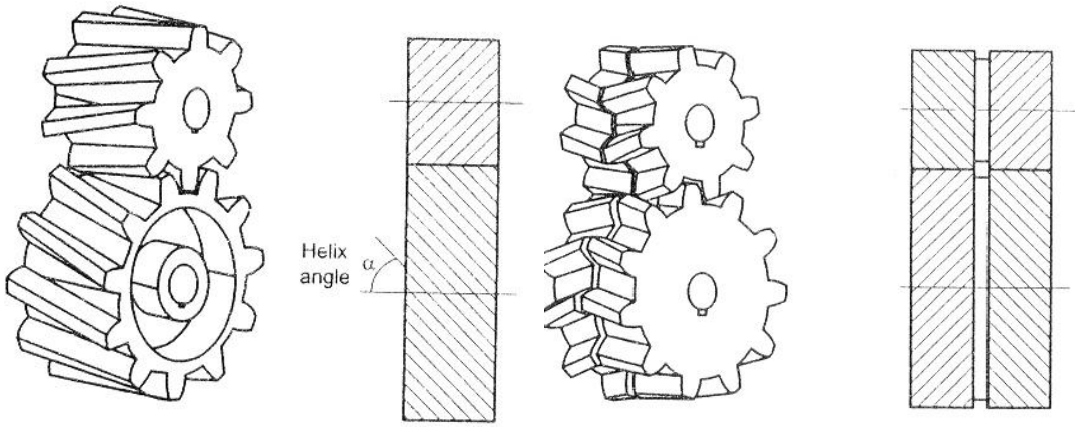
(b) Helical gear

In helical gears the teeth are at some angle called helix angle with respect to axis of the shaft.

Advantages

1. It runs quieter as compared to spur gears since the contact between teeth is gradual.
2. Transmission of load is gradual which results in low impact stresses and reduction in

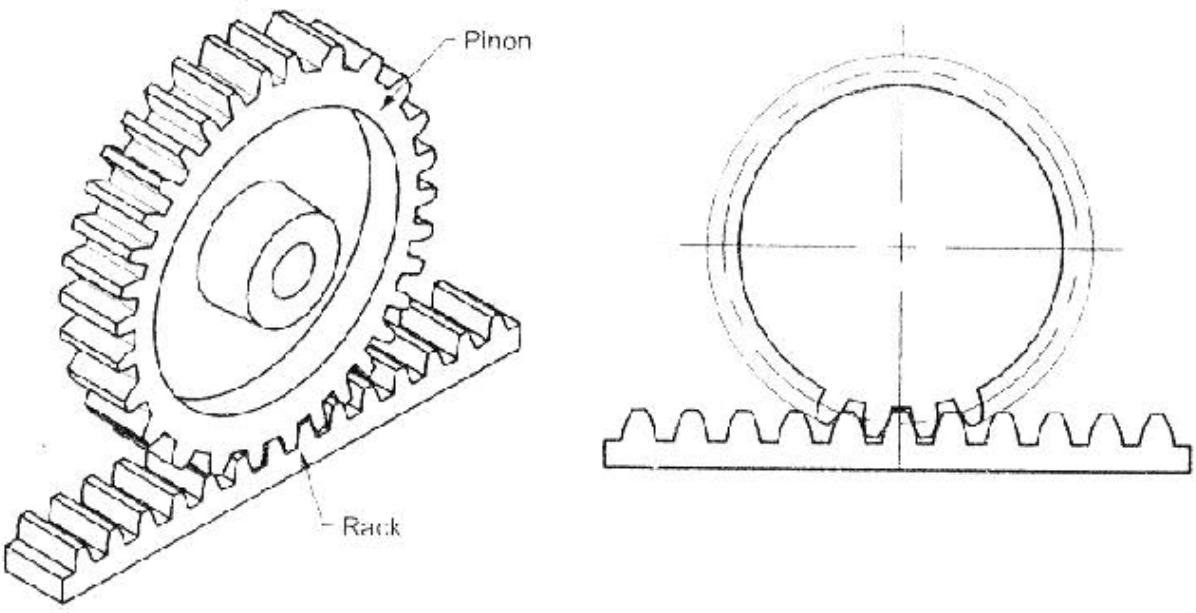
noise. Thus they are used for high speed transmission.



(a) Single Helical Gear *(b) Double Helical Gear*

Disadvantage
They induce axial thrust in one direction on the bearings.

(c) Rack and pinion



It is a special case of spur gear in which one gear is having infinite diameter called "Rack".

Use
To transmit the rotary motion into reciprocating motion or vice-versa.

Application
Lathe machine, drilling machine and measuring instrument.

(d) Bevel gear

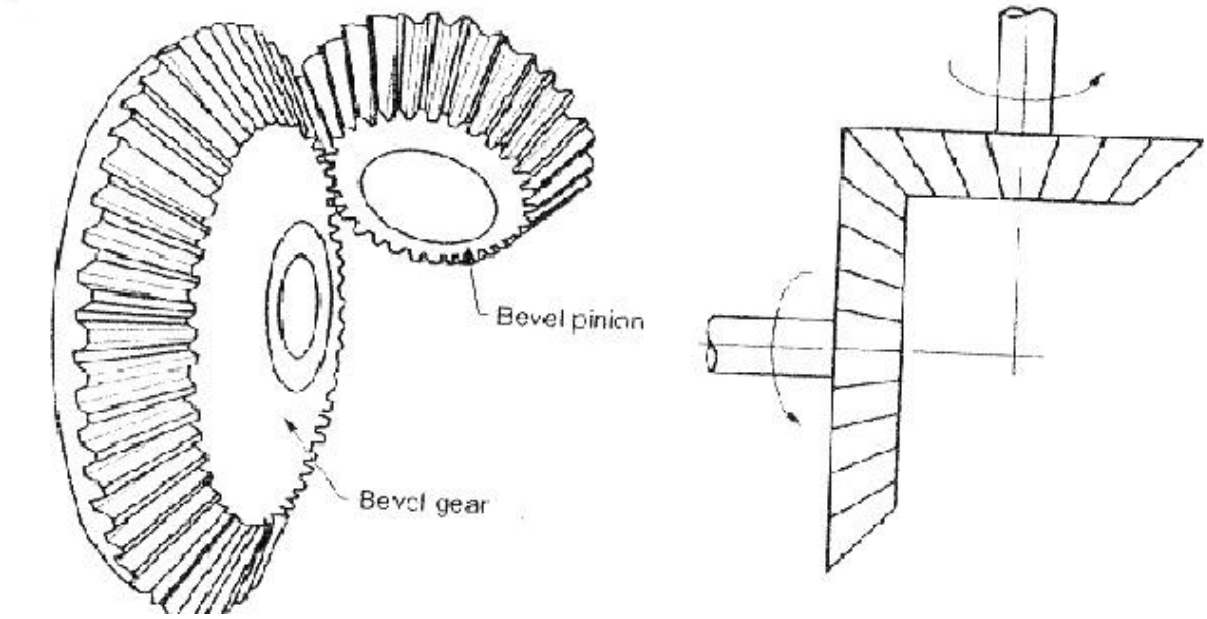
Use

When power is required to be transmitted from one shaft to another shaft which are intersecting to each other then bevel gears are used. Generally, the angle between two shafts is 90º.

The bevel gears are of two types,

1. Straight bevel gear
2. Spiral bevel gear

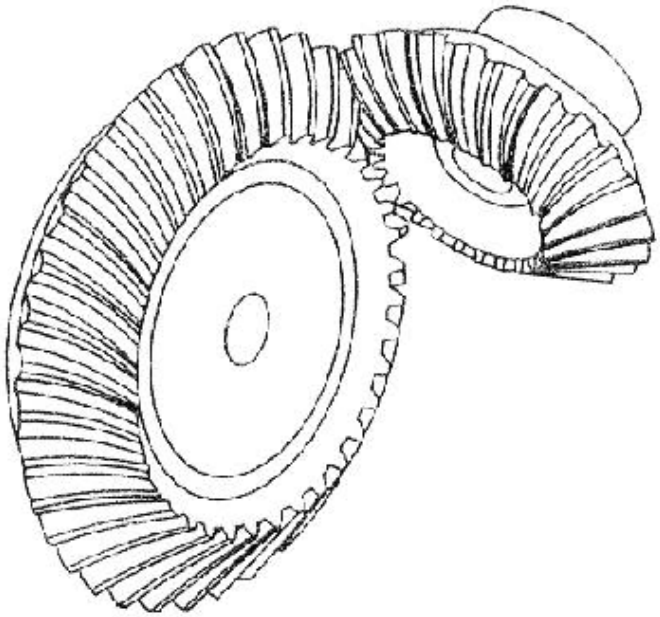
(1) Straight bevel gears

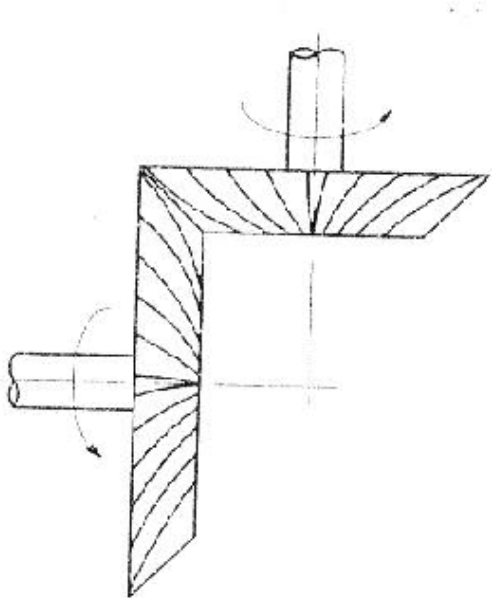


In straight bevel gears the teeth are formed straight on the cones, and they are parallel to the axis of the gear.

(2) Spiral bevel gears

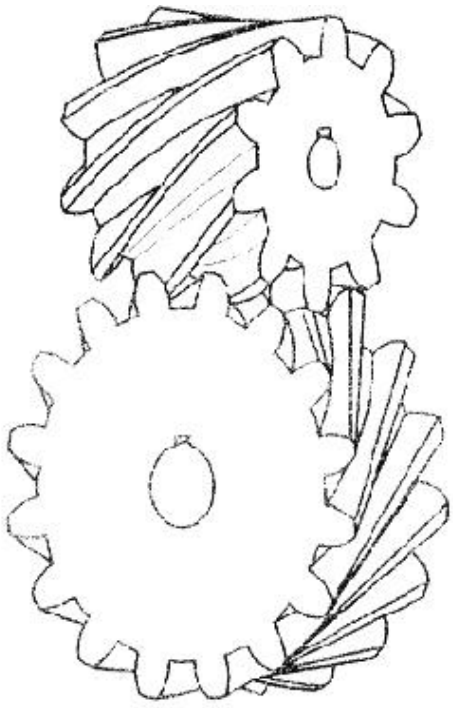
In a spiral bevel gear, the teeth are formed at an angle with respect to its axis. The contact between two meshing teeth is gradual and smooth from start to end, as in case of
helical gears.

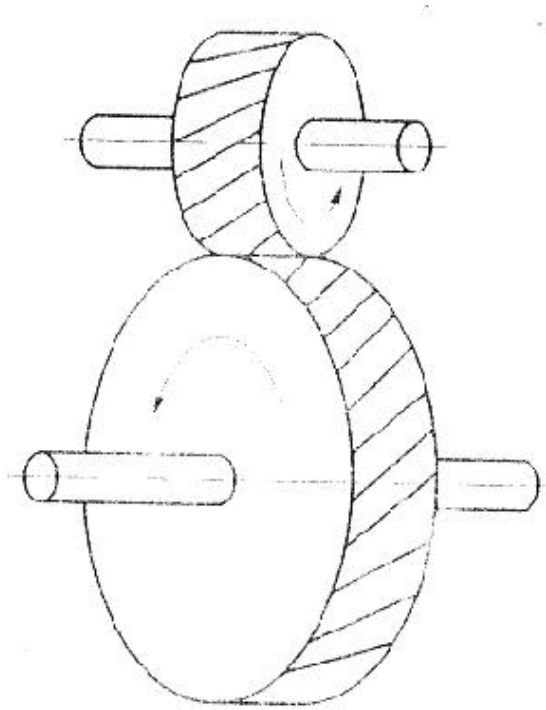




Application
Automobile differential

(e) Spiral Gears (Skew gears or Crossed helical gears)

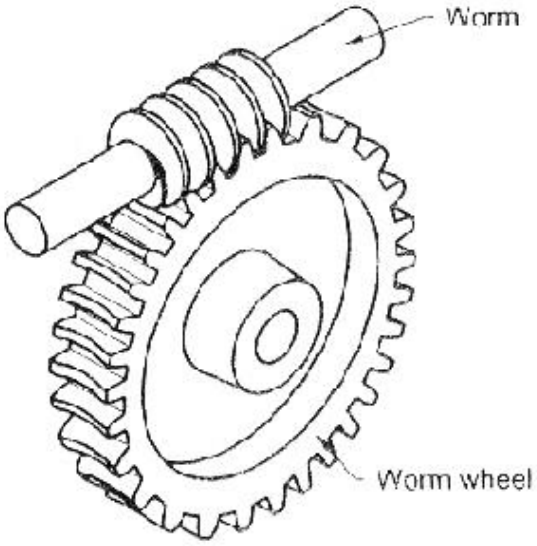


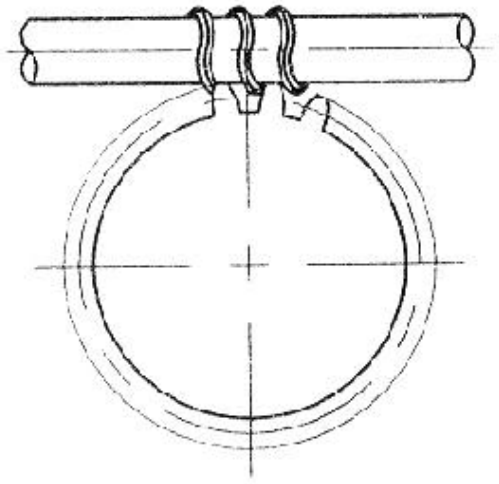


Use
1. To transmit power from one shaft to another shaft which are non parallel and non intersecting.

2. For low load transmission only since they have point contact between mating teeth.

(f) Worm and worm wheel





Use

To transmit power from one shaft to another shaft which are non intersecting and their axes are normally at right angles to each other.

Application

Lathe machine to get large speed reduction.

Comparison between belt drive, chain drive and gear drive

Sr. No.	Particulars	Belt drive	Chain drive	Gear drive
1	Main elements	Pulleys, belt	Sprockets, chain	Gears
2	Slip	Slip may occurs	No slip (Positive drive)	No slip (Positive drive)
3	Suitability	For large centre distance	For moderate centre distance	For short centre distance
4	Space requires	Large	Moderate	less (compact)
5	Design, manufacturing, complexity	Simplest	Simplest	Complicated
6	Failure	Failure of belt does not cause the further damage of machine.	Failure of chain may not seriously damage the machine.	Failure of gear may cause serious break down in the machine.
7	Life	Less	Moderate	Long
8	Lubrication	Not required	Require	Require proper lubrication
9	Installation cost	Less	Moderate	More
10	Use	For low velocity	For moderate velocity ratio	For high velocity ratio
11	Examples	Use as a first drive in transmission	Bicycle, Automobile	Machine tools, Automobile, gear boxes