

Transmission of Motion and Power

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Shaft	Axle
It is a rotating member.	It is a non-rotating member.
Its primary function is to transmit power.	Its primary function is to provide support to parts like a wheel, pulley, drum, etc. It does not transmit power.
It is subject to primary bending and torque.	It is subject to bending moment primarily due to transverse load.
Its design is more complex than that of the axle.	Its design is simpler than that of the shaft.
The cross-section of the shaft is usually circular because it gives minimum vibration and stress.	The cross-section of the axle may be different such as rectangular, square, circular, etc.
They are used for electric motors, I.C. Engine shaft, gear, etc.	They are used in cars, trucks, railway buggies, etc.
They may or may not be under normal load.	It is fitted into the housing by means of bearings.
The shaft is basically divided into two types, the first is the transmission shaft and the second is the machine shaft.	The axle is basically divided into three types, the first is the front axle, the second is the rear axle, and the third is the stub axle.

AXLE

- A central shaft for a rotating wheel or gear.
- Axle may be fixed to the wheels rotating with them, or fixed to its surroundings.
- Bearing or bushing provided at mounting points.
- Bearing or bushing sits inside the hole in the wheel.

SHAFT

- Shaft is a mechanical component transmits torque and rotation.
- Shaft used to connect other components of a drive train can not be connected directly.
- Shaft are carries of torque.
- Shaft subject to torsion and shear stress.

Belt Drive

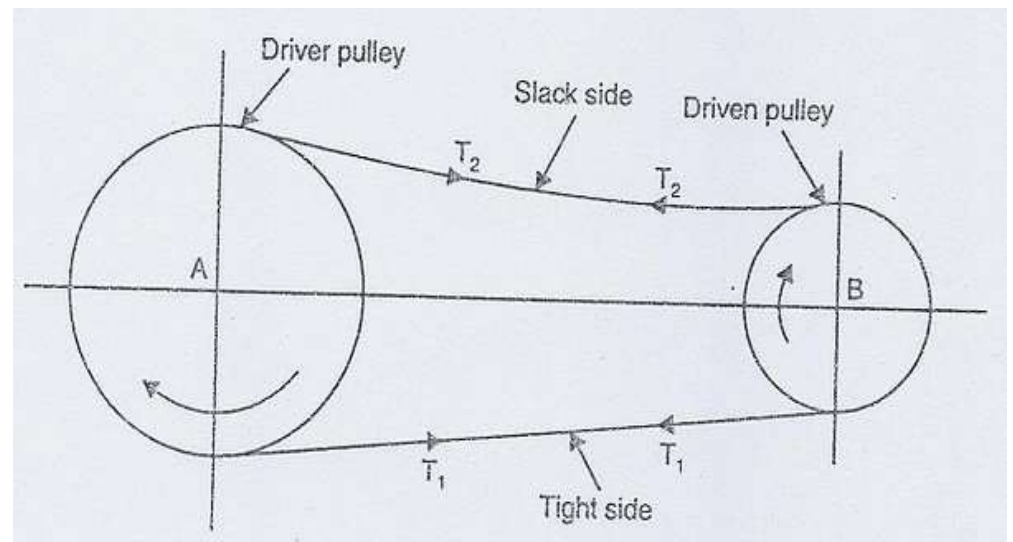
- A belt drive is one of the most popular types of power transmission methods besides gears, chain drives, shaft couplings and lead screws.
- A belt drive is a frictional drive that transmits power between two or more shafts using pulleys and an elastic belt.
- In most cases, it is powered by friction but it may also be a positive drive. It can operate at wide ranges of speed and power requirements. It is also highly efficient.



Tight side and slack side

When belt is running over pulley, the friction creates grip on pulley which creates tension on one side of belt which makes the driven pulley to run, this side is called tight side. The other side does not experience same tension, that side is called slack side.

what causes slack side and tight side is the difference in tension induced due to friction between the pulley and belt. If pulleys are rotating in clockwise direction, relative motion is anticlockwise for belt. hence friction will be in clockwise direction where ever is considered on belt



2. Selection of a Belt Drive

Following are the important factors in selection of a belt drive:

- Speed of the driving and driven shafts
- Speed reduction ratio
- Power to be transmitted
- Centre distance between the shafts
- Positive drive requirements
- Shafts layout
- Space available
- Service conditions

3. Types of Belt Drives

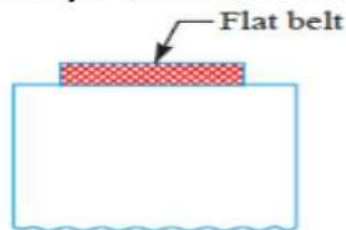
The belt drives are usually classified into the following three groups:

- *Light drives. These are used to transmit small powers at belt speeds up to about 10 m/s as in agricultural machines and small machine tools.*
- *Medium drives. These are used to transmit medium powers at belt speeds over 10 m/s but up to 22 m/s, as in machine tools.*
- *Heavy drives. These are used to transmit large powers at belt speeds above 22 m/s as in compressors and generators*

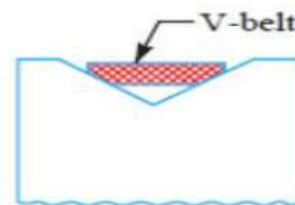
4. Types of Belts

The following are the common types of belts :

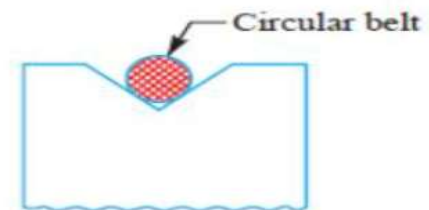
- *Flat belt.* The flat belt as shown in Fig. 1 (a), is mostly used in the factories and workshops, where a moderate amount of power is to be transmitted, from one pulley to another when the two pulleys are not more than 8 metres apart.
- *V- belt.* The V-belt as shown in Fig.1 (b), is mostly used in the factories and workshops, where a great amount of power is to be transmitted, from one pulley to another, when the two pulleys are very near to each other.
- *Circular belt or rope.* The circular belt or rope as shown in Fig. 1 (c) is mostly used in the factories and workshops, where a great amount of power is to be transmitted, from one pulley to another, when the two pulleys are more than 8 metres apart.



(a) Flat belt.



(b) V-belt.

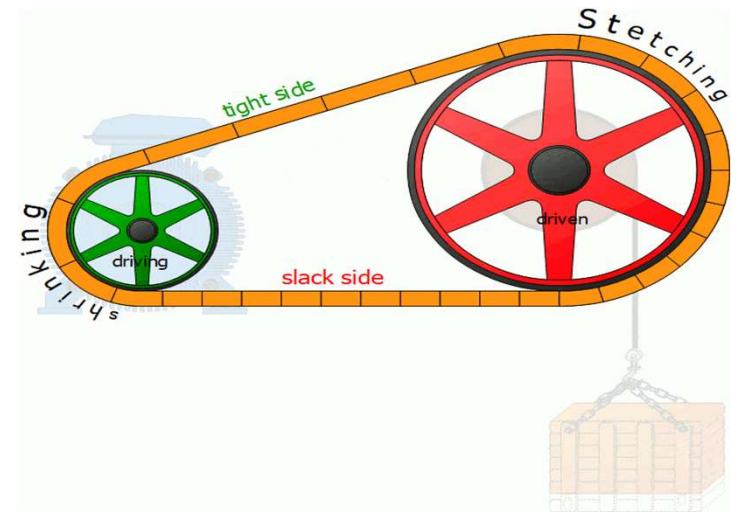
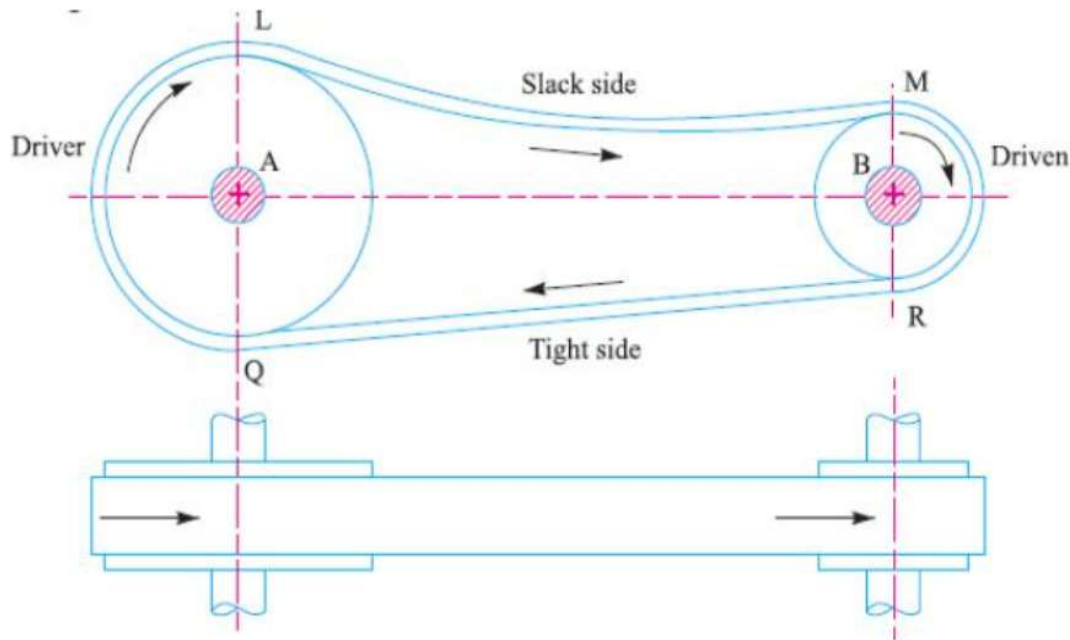


(c) Circular belt.

12. Types of Flat Belt Drives

The power from one pulley to another may be transmitted by any of the following types of belt drives.

- a) *Open belt drive. The open belt drive, as shown in Fig. 4, is used with shafts arranged parallel and rotating in the same direction.*



- b) *Crossed or twist belt drive. The crossed or twist belt drive, as shown in Fig. 5, is used with shafts arranged parallel and rotating in the opposite directions. The shafts should be placed at a maximum distance of $20b$, where b is the width of belt and the speed of the belt should be less than 15 m/s.*

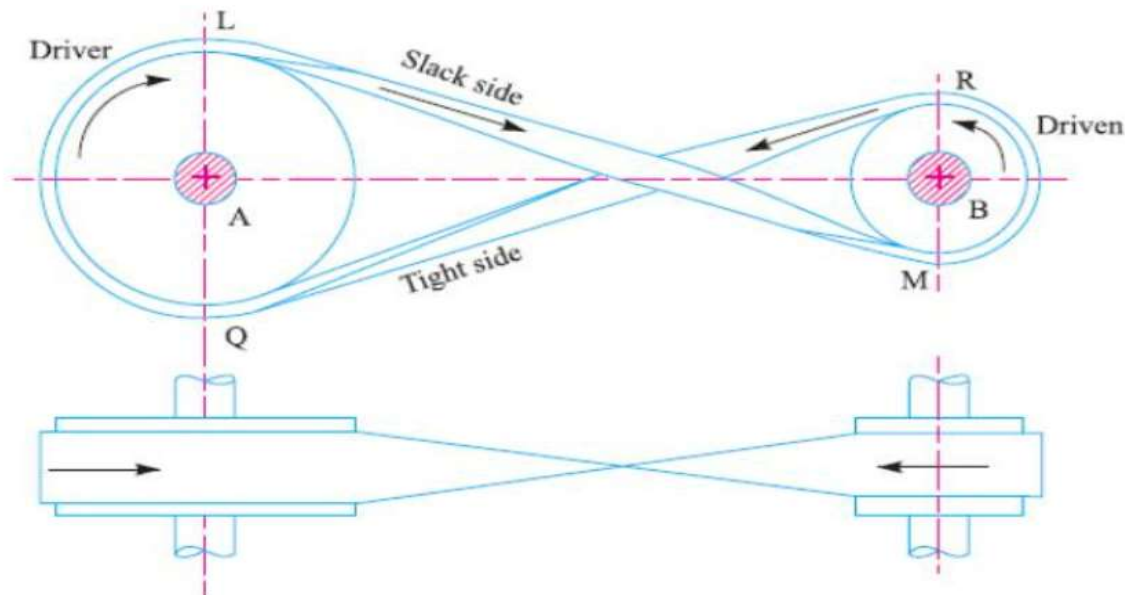
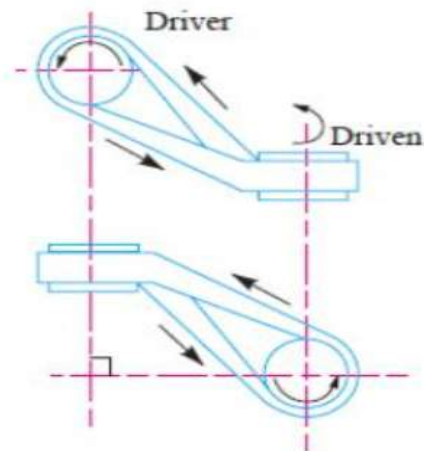
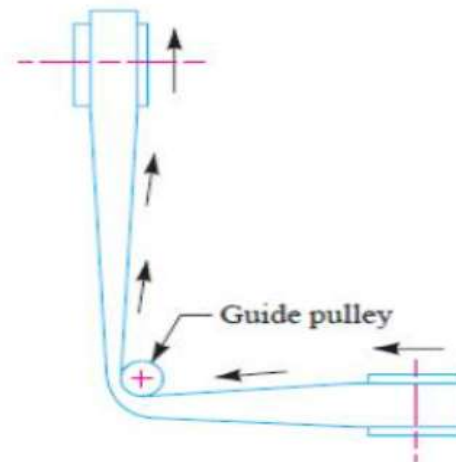


Fig. 5. Crossed or twist belt drive.

- c) *Quarter turn belt drive. The quarter turn belt drive (also known as right angle belt drive) as shown in Fig. 6 (a), is used with shafts arranged at right angles and rotating in one definite direction. A quarter turn belt drive with a guide pulley, as shown in Fig. 6 (b). In order to prevent the belt from leaving the pulley, the width of the face of the pulley should be greater or equal to $1.4 b$, where b is width of belt.*



(a) Quarter turn belt drive.



(b) Quarter turn belt drive with guide pulley.

Fig. 6

- d) *Belt drive with idler pulleys. A belt drive with an idler pulley (also known as jockey pulley drive) as shown in Fig. 7 and 8, is used with shafts arranged parallel and when an open belt drive can not be used due to small angle of contact on the smaller pulley.*

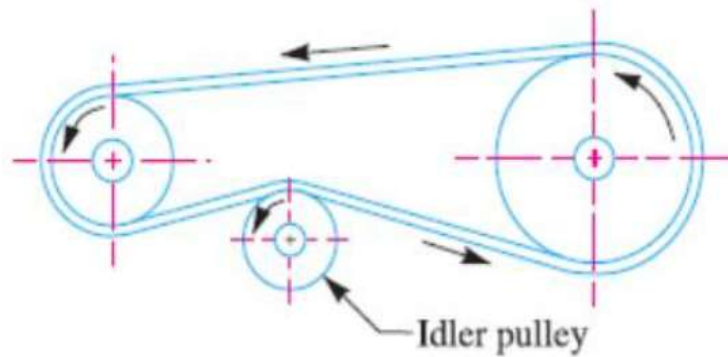


Fig. 7. Belt drive with single idler pulley.

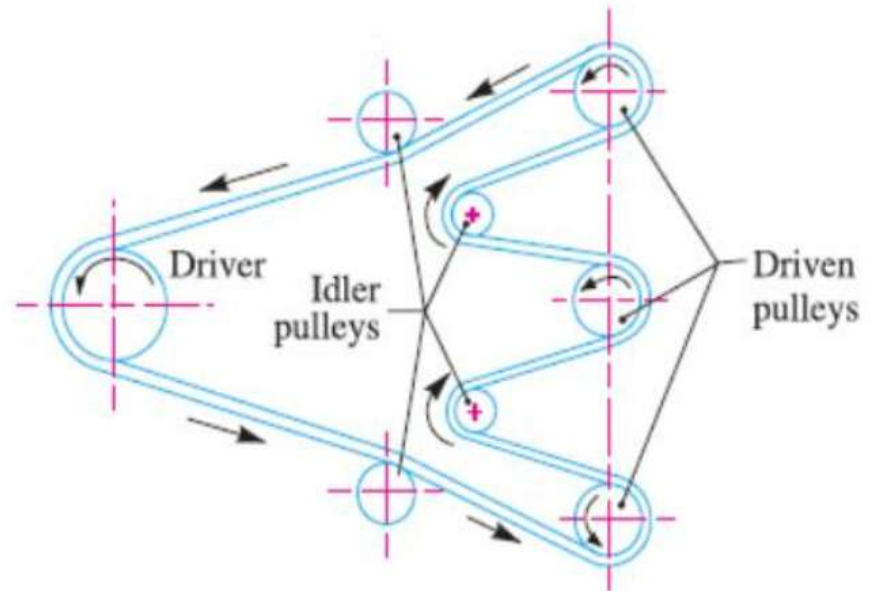


Fig. 8. Belt drive with many idler pulleys.

e) *Compound belt drive. A compound belt drive as shown in Fig. 9, is used when power is transmitted from one shaft to another through a number of pulleys.*

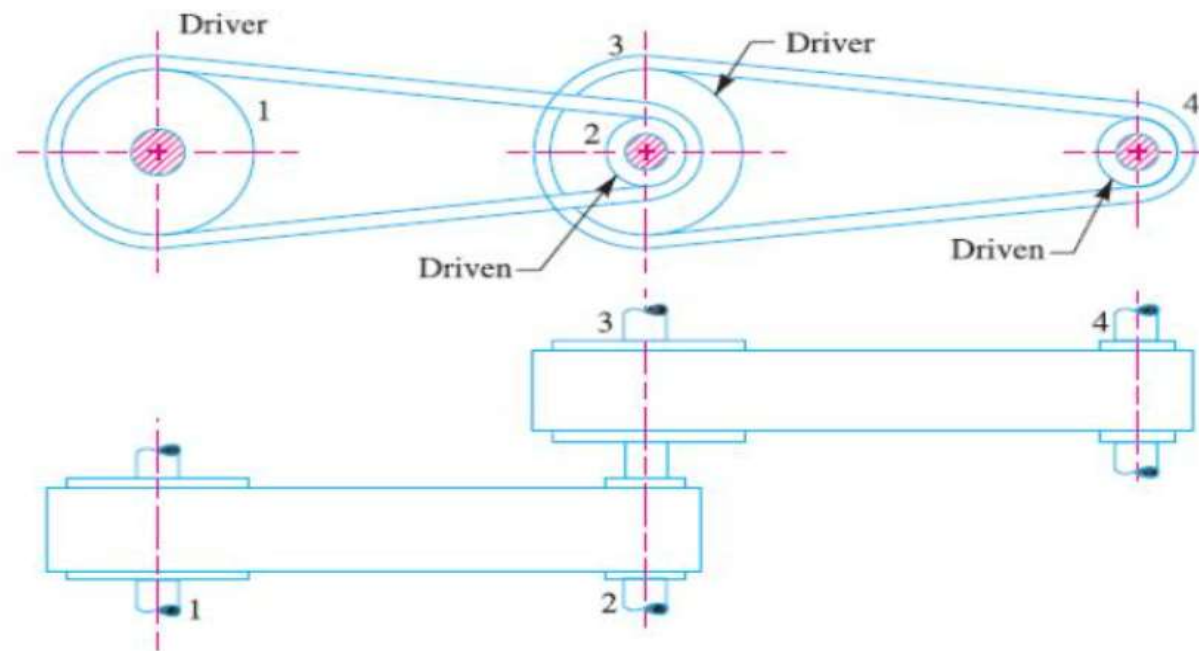


Fig. 9. Compound belt drive.

- f. *Stepped or cone pulley drive.* A stepped or cone pulley drive, as shown in Fig. 10, is used for changing the speed of the driven shaft while the main or driving shaft runs at constant speed.
- g. *Fast and loose pulley drive.* A fast and loose pulley drive, as shown in Fig. 11, is used when the driven or machine shaft is to be started or stopped whenever desired without interfering with the driving shaft.

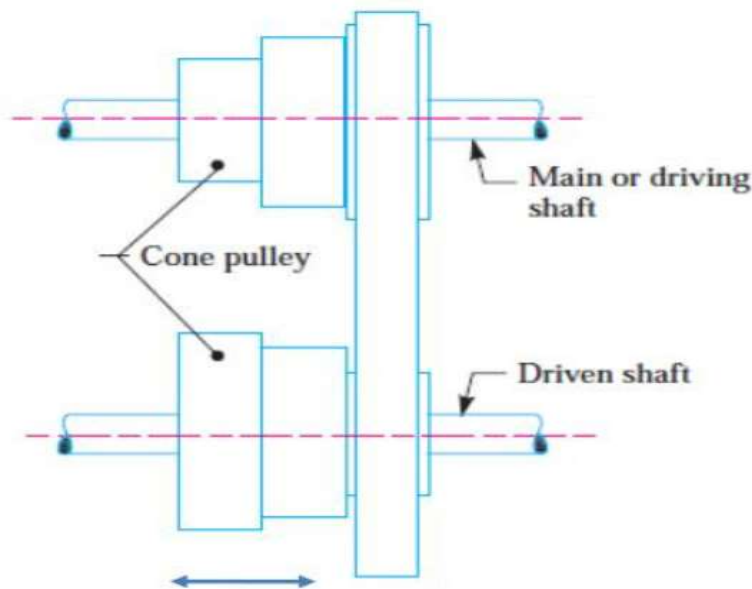


Fig. 10. Stepped or cone pulley drive

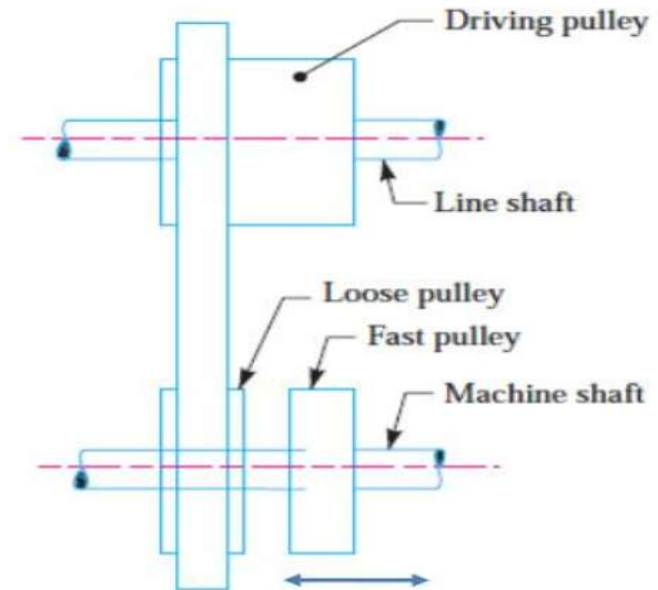


Fig. 11. Fast and loose pulley drive

Application of Belt Drive

- to transfer power from the motor shaft to the drum shaft in washing machines.
- automobile alternators.
- Flour mills.
- lathes, milling machines, drilling machines.
- paper mills.
- Conveyors.

Advantages of Belt drive

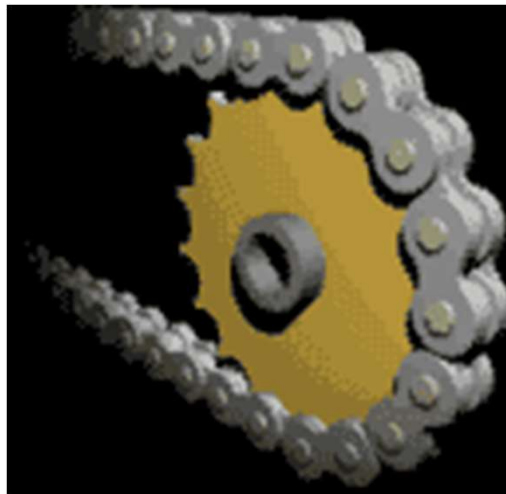
- Flexible, simple in construction, smooth operations.
- Efficient at high speeds and protects against overload.
- Running and maintenance cost is low.
- Relatively long life and easy to work with.

Disadvantages of Belt drive

- Loss of power due to slip and creep in turn results in low efficiency.
- Not preferred for shortcentre distances.
- because of the endlessness of the belt, joints reduce the life of the belt.
- Not a positive 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.

Application Chain Drive



1. Bicycles, motor cycles
2. Agriculture machinery
3. Conveyors
4. Rolling mills
5. Road rollers
6. Metal and wood working machinery
7. Textile industry
8. Building construction
9. Material handling equipment



Roller Chain



Silent Chain



Leaf Chain



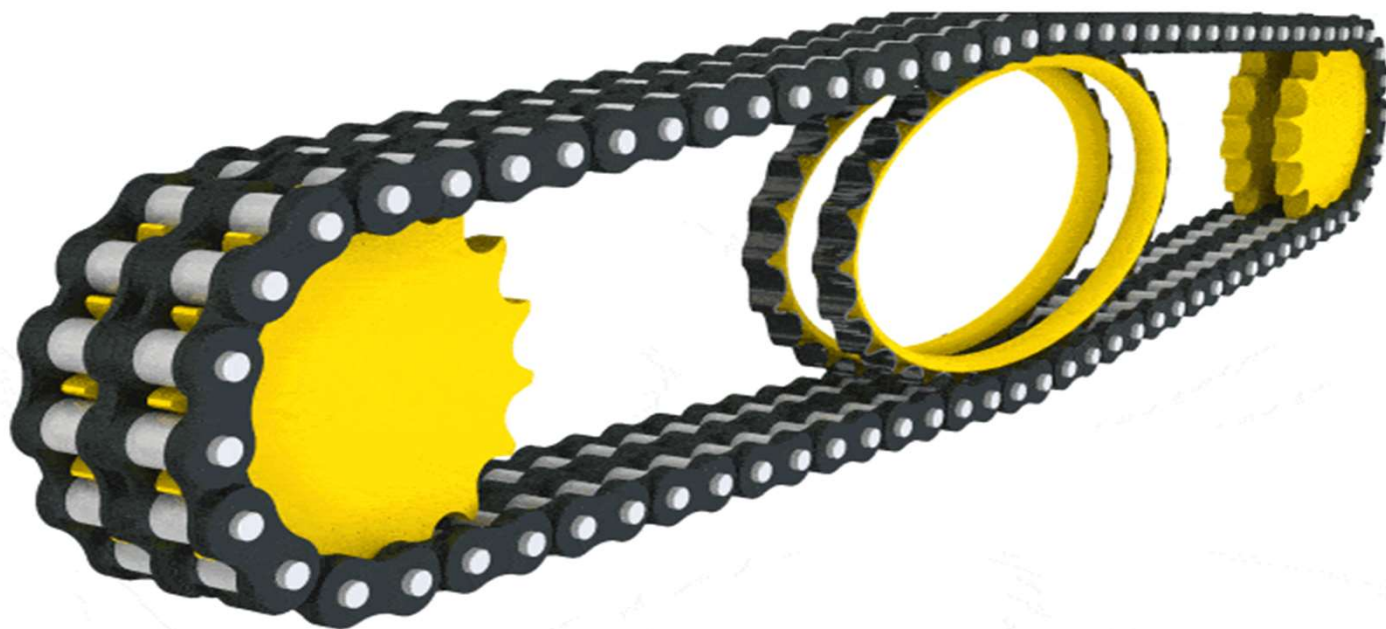
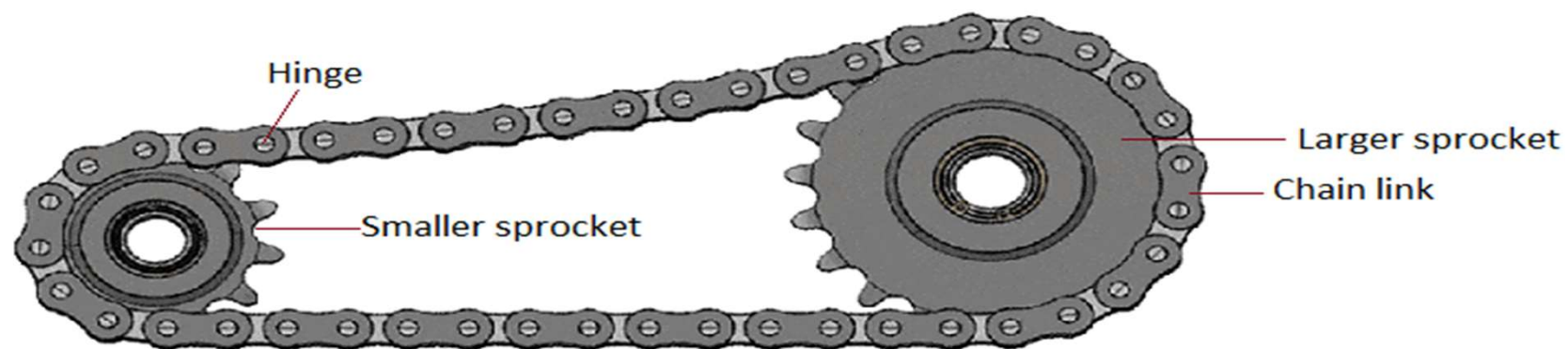
Flat Top Chain

TYPES OF CHAIN DRIVE



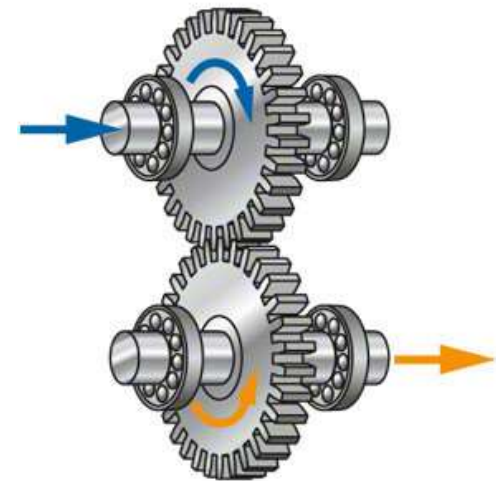
Engineering Chain





Gear drives are packaged units used for a wide range of power-transmission applications. They are used to transmit power to a driven piece of machinery and to change or modify the power that is transmitted.

A gear is wheel provided with teeth which mesh with the teethe on another wheel, or on to a rack, so as to give a positive transmission of motion from one component to another.



Types of Gears



Spur Gears



Helical Gears



Gear Rack



Bevel Gears



Miter Gears



Worm Gears



Screw Gears



Internal Gears

Types of Gears & Their Uses



Hypoid Gears



Spur Gear



Worm Gear



Screw Gear



Internal Gear



Rack Gear



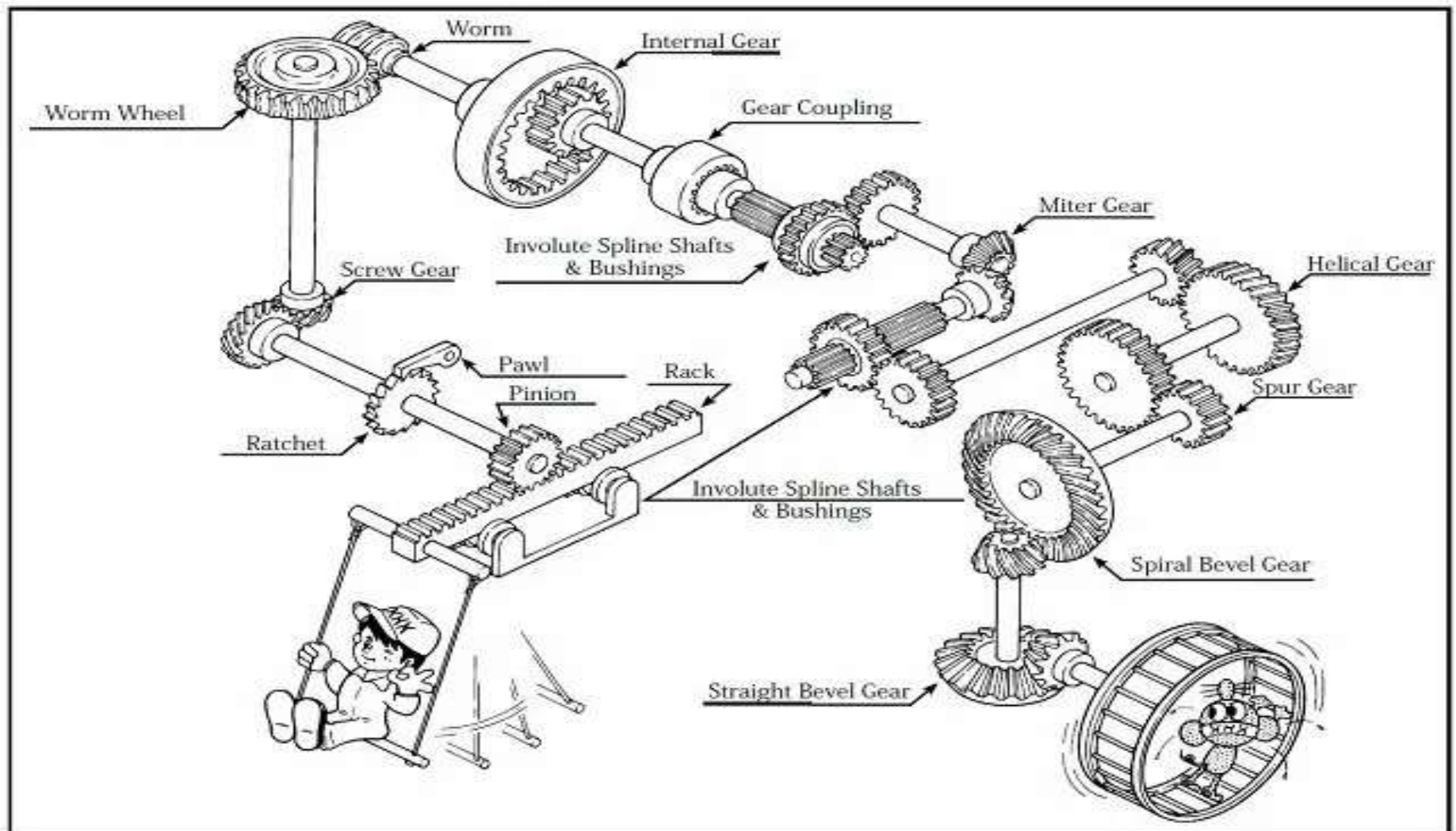
Herringbone Gear



Double Helical

Advantages of gear drives

- Positive drives.
- High transmission efficiency.
- High velocity possible, even up to 60:1
- Velocity ratio will remain constant throughout.
- Used for low, medium and high power transmission.



Classification of types of gears from the point of positional relations of the attached shafts

When the gears' two shafts are parallel (parallel shafts)

Spur gear, rack, internal gear and helical gear, etc.
Generally they have a high transmission efficiency.

When the gears' two shafts intersect each other (intersecting shafts)

Bevel gear is in this category.
Generally they have a high transmission efficiency.

When the gears' two shafts are not parallel or intersect (offset shafts)

Worm gear and screw gear belong in this group.
Because of the sliding contact, the transmission efficiency is relatively low.

Type of Gear	Application
Worm Gear	Instruments Lifts and elevators Material handling systems Automobiles (steering systems)
Spur Gear	Clocks Pumps Watering systems Household appliances Clothes washing and drying machines Power plants Material handling systems Aerospace and aircraft Railways and trains
Bevel Gear	Pumps Power plants Material handling systems Aerospace and aircraft Railways and trains Automobiles

Helical Gear	<p>Similar to spur gears but with greater loads and higher speeds.</p> <p>Automobiles (transmission systems)</p>
Rack and Pinion	<p>Weighing scale</p> <p>Material handling and transfer systems</p> <p>Railways and trains</p> <p>Automobiles (steering systems)</p>