Transmission of Motion and Power

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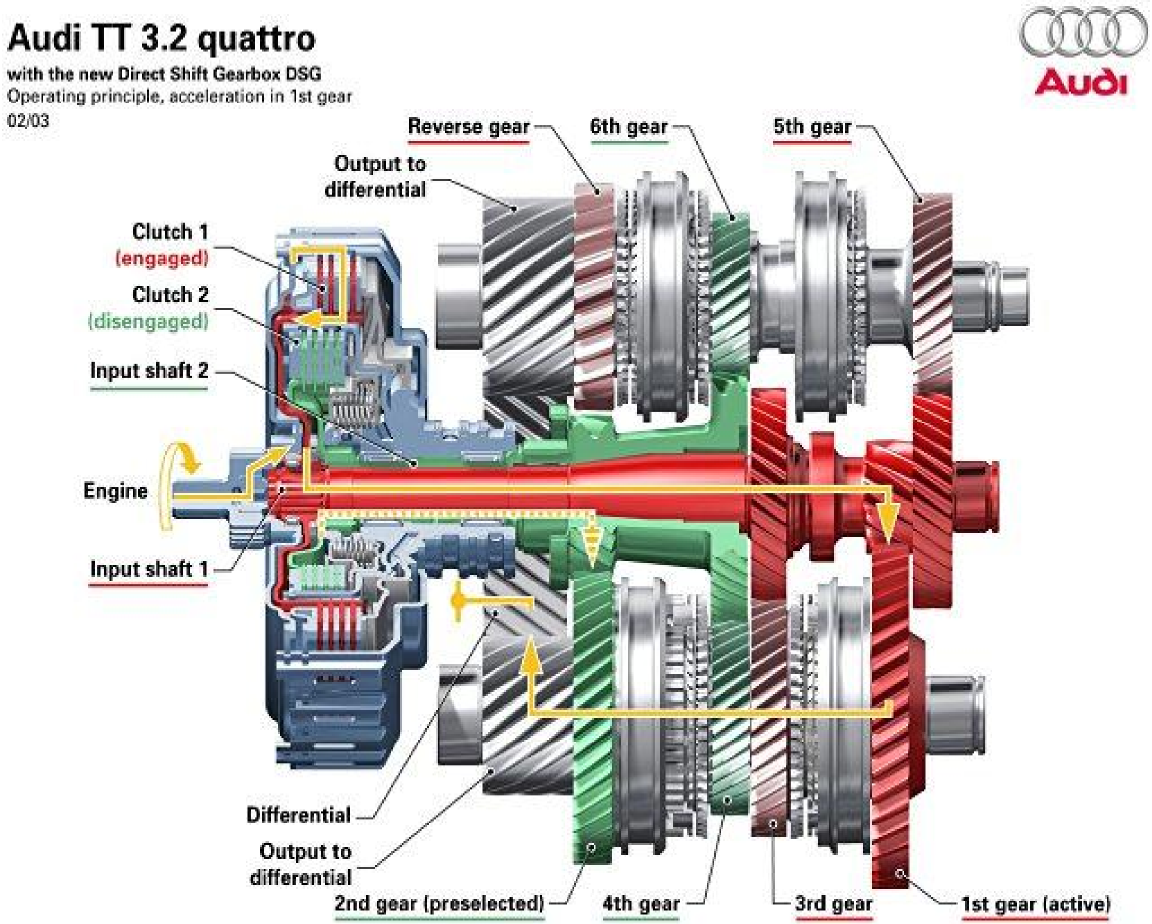
DRIVE

- Drive is the mechanism which is used to transmit mechanical power from the prime mover to a machine, from one machine to another or from one member of machine to another.



Need of Drives

- The prime movers (generally electric motors) have high speeds while the machines require a smaller speed with larger torque.

- The speed of driven member may have to be frequently changed where as the speed of prime mover should be kept constant for its use to the full advantage.

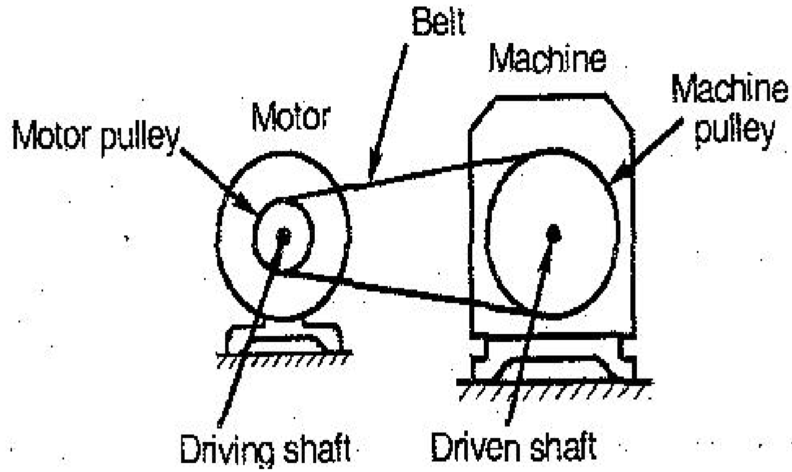
- To operate several machines from only one prime mover e.g. group drive.

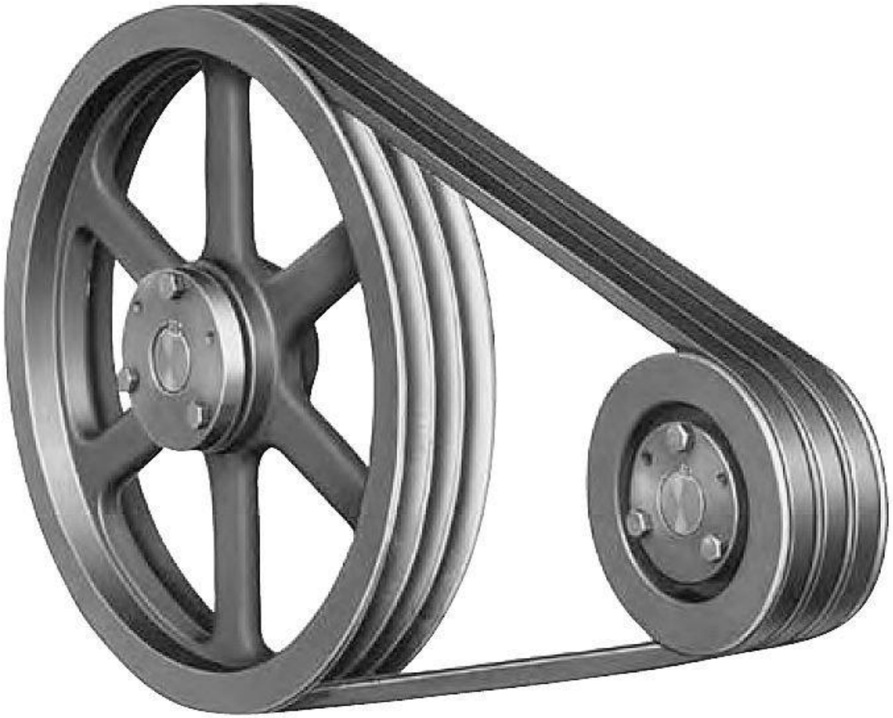
- Sometimes the machines are not coupled directly to the prime mover shaft due to considerations of safety, convenience and maintenance.

INDIVIDUAL DRIVE

- In an individual drive or self contained drive, each machine has its own electric motor and starter.
- The motor may drive the machine shaft through direct coupling or belt, chain, gear or through some multi or variable speed transmission.

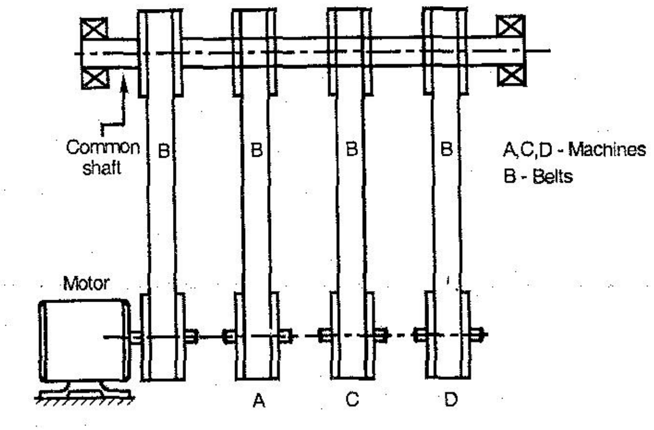
This type. of drive is suitable where a few machines are scattered over a large area.





GROUP DRIVE

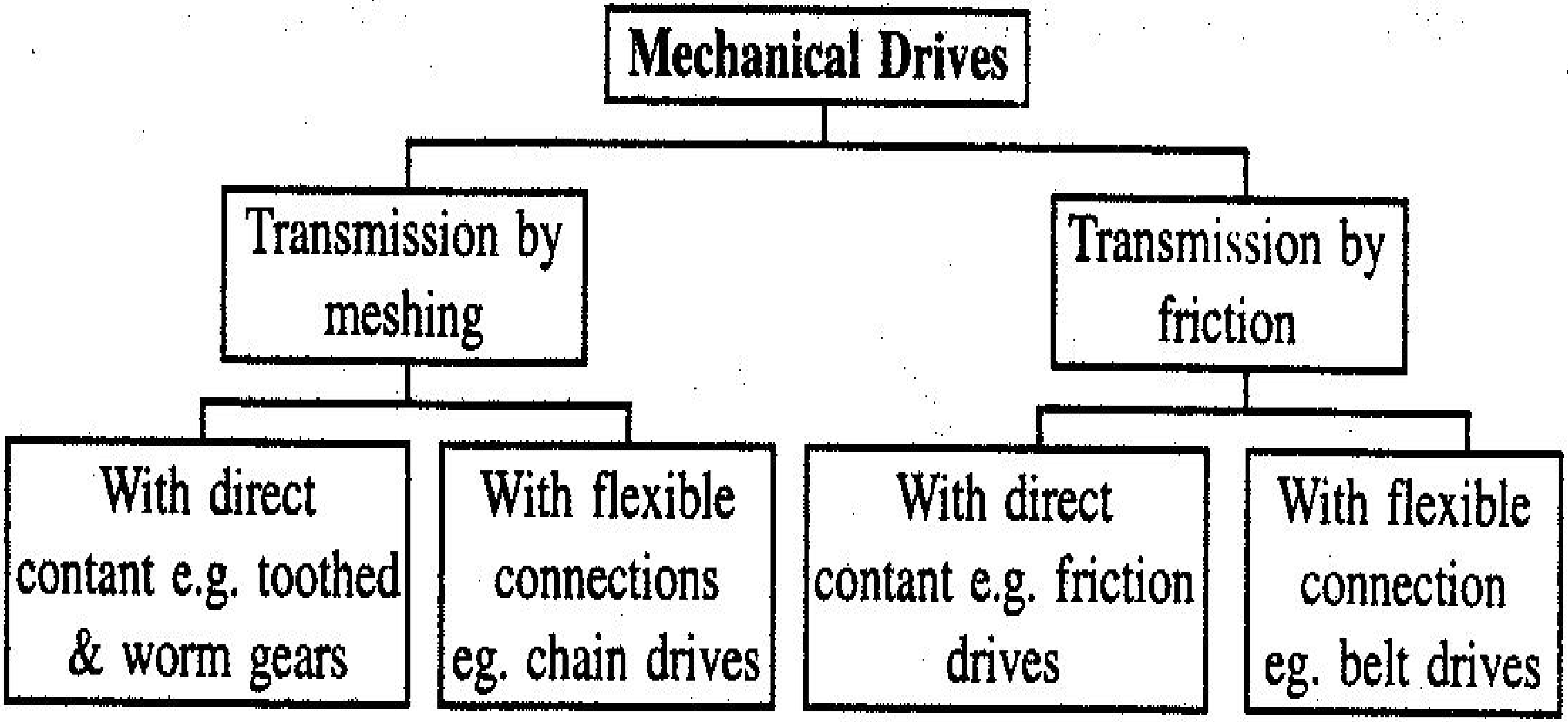
- In group drive, a very powerful motor drives an overhead shaft ('main shaft') which runs from one end to the other end of the shop.
- The main shaft drives another shaft called `countershaft' which in turn drives the machine drive shaft.
- `Fast and loose pulleys' are provided on the countershaft for starting and stopping the machine spindle.



Difference between Individual and Group

Individual Drive	Group Drive
(1) Initial capital investment is high.	(1) Initial capital investment is low.
(2) The speed of a machine can be regulated independently.	(2) A set of cone pulleys give wide range of spindle speed.
(3) It is suitable for a small size workshop or where machines may be moved frequently.	(3) It is suitable for medium and large size workshops where machines are not scattered over large area.
(4) Failure of a motor, on an individual machine does not affect other machines.	(4) Failure of this system stop all the machines in the group.
(5) Less power is wasted if the machines are underutilized.	(5) It will be more economical when utilization factor is high.

Mechanical Drives



Basis of Selection of Drive

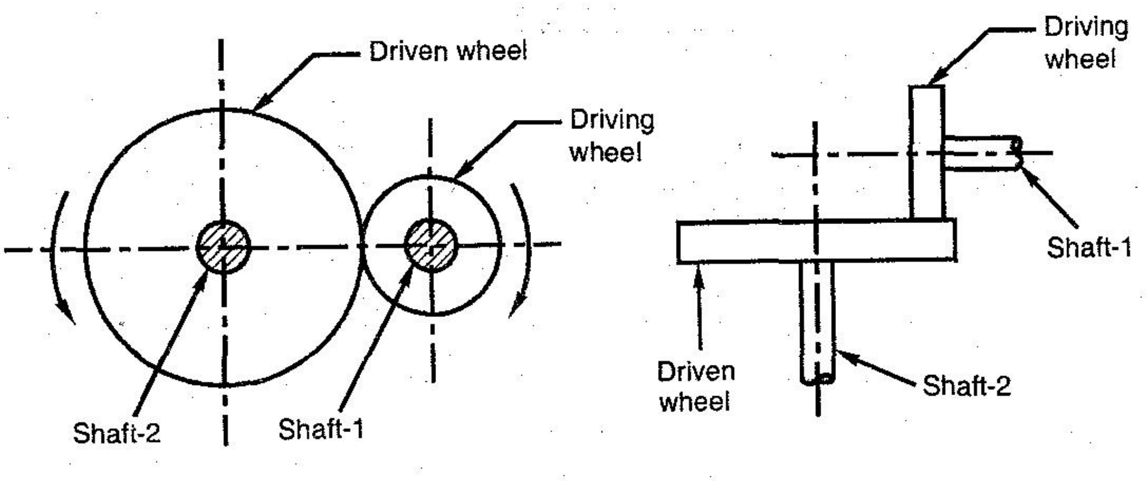
- Magnitude of power to be transmitted
- Speeds of driving and driven shafts
- Distance between the shafts
- Overall dimensions

POWER TRANSMITTED BY THE SHAFT

The power transmitted by the shaft P (in kW) is given by

$$P = \frac{2\pi NT}{1000 \times 60}$$ where, N = speed in RPM, T = torque in N.m.

FRICTION DRIVE



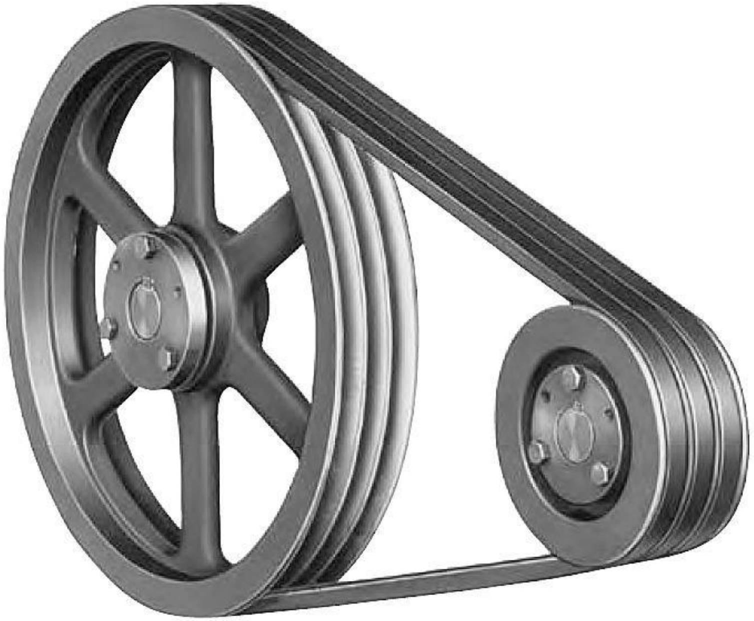
(a) Drive with parallel axes

(b) Drive with intersecting axes

- Friction drive is used for light load transmission between parallel shafts or between shafts with intersecting axes. The driving and driven wheel are in contact with sufficient pressure between them.
- The driving wheel drive the driven wheel by virtue of friction between them. The friction wheels do not give a positive drive and slip may occur for large power transmission.
- If the friction wheels are assumed to operate without slip, the surface speed of both wheels will be equal.

BELT DRIVE

- A belt is a thin inextensible band wrapped tightly over two pulleys which are mounted on shafts.
- Belt-drive is one of the most common and effective means for transmission of motion from one shaft to another.
- It is extensively used in mills and factories when the distance between the shafts is not very big.



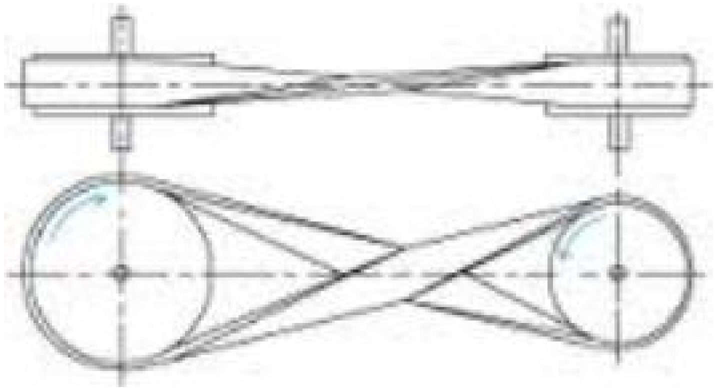
BELT DRIVE

- The belt transmits power from the driving pulley to the driven pulley by frictional resistance between belt and surface of pulley.
- There is always possibility of some slipping between the belt and faces of pulley when the belt moves over pulleys.
- The character of motion transmitted is not positive. Where positive drive is required, gears or chains should be used.

Types of Belt Drive :

Flat belt drives:

- Open Belt Drive :
- Crossed Belt or Twist Belt Drive :
- Quarter Twist
- Right angle drive
- Stepped Pulley Drive
- Fast and Loose Pulley Drive
- Compound Drive



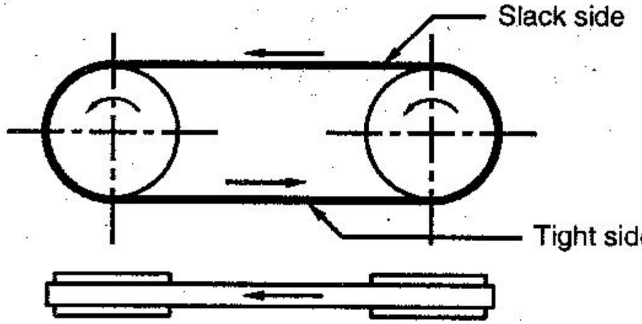
Types of Belt Drive :

Open Belt Drive:

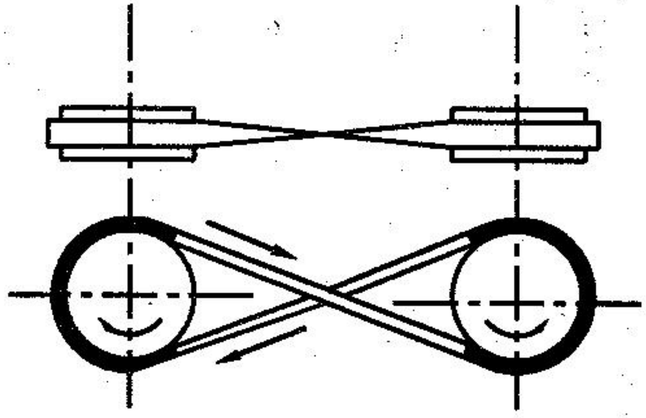
- In this type of drive, the shafts are arranged in parallel and they rotate in the same direction.

Crossed Belt or Twist Belt Drive :

- When the shafts are parallel but need to be rotated in opposibe directions, this drive is used.
- As the belts cross each other, there will be too much wear and tear.
- This type of drive should be used for larger distance between the shafts and lower speeds only.



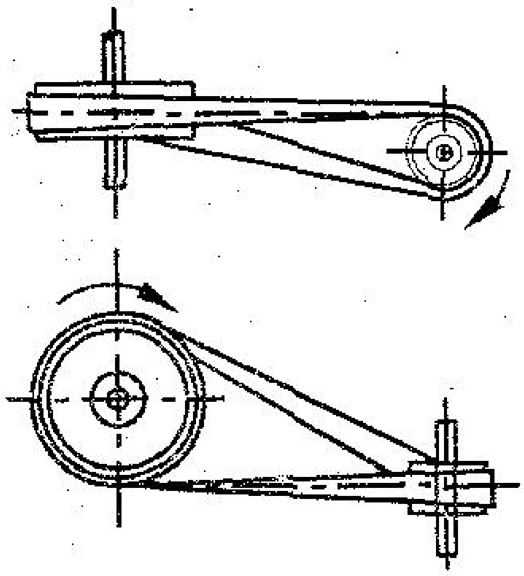
Open belt drive


Crossed belt or twist belt drive

TYPES OF BELT DRIVE:

Quarter Twist Drive:

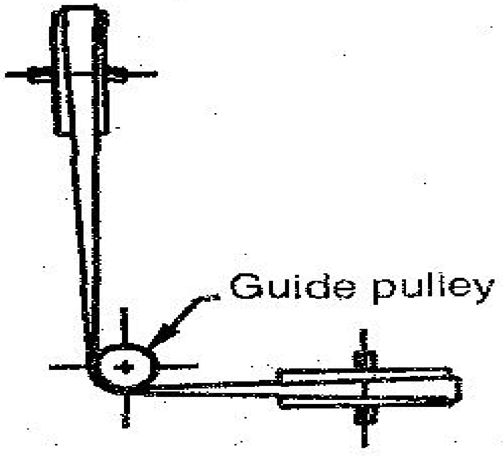
- The shafts are at right angles and rotate in the same definite direction (Clockwise or anticlockwise). The face of the pully should be wide enough,. not allowing the belt to leave the pulleys.



Quarter twist drive

Right Angle Drive :

- It is used with shafts axes making 90° with each other. It may also be used when reversible motion is required.

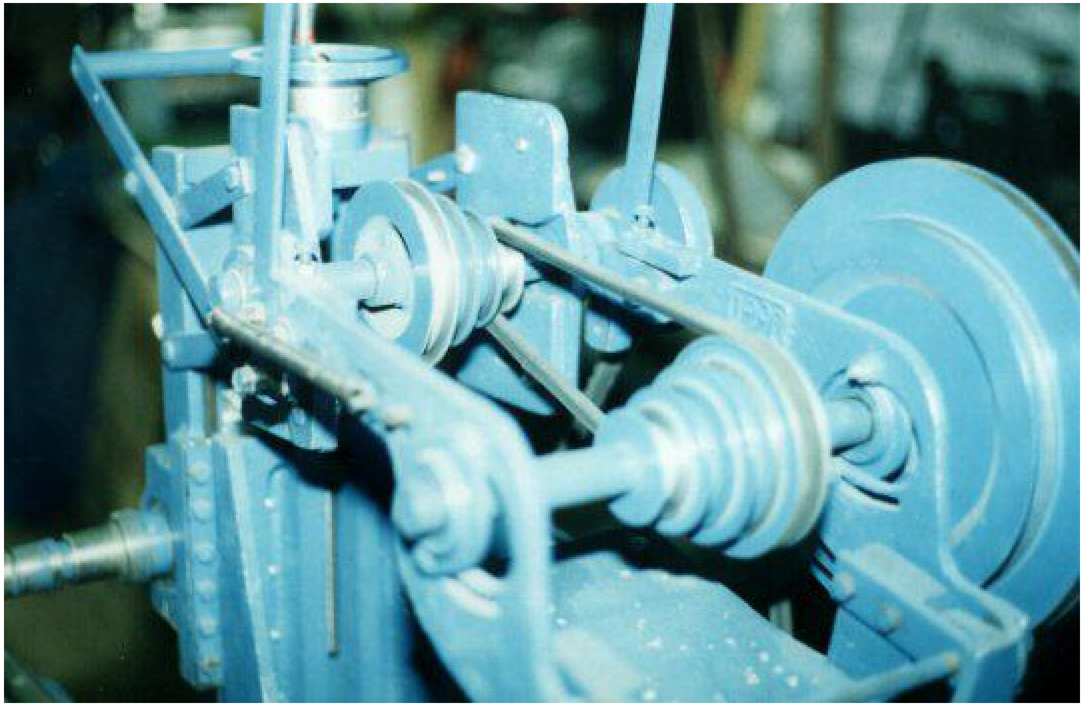


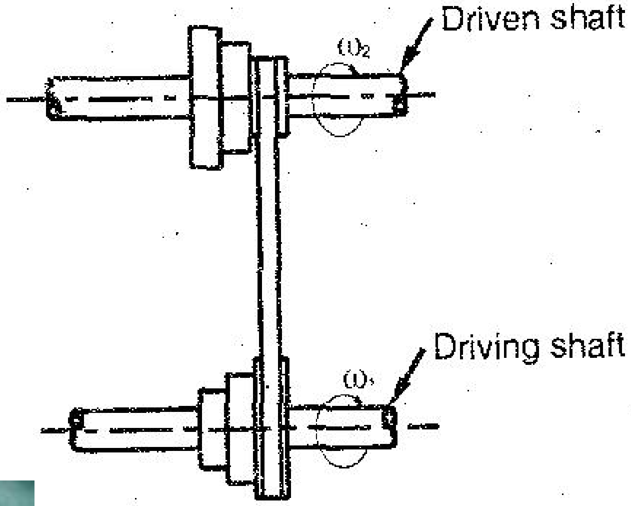
Right angle drive

Types of Belt Drive:

Stepped Pulley Drive

This is used for stepped change in speed of driven shaft for constant speed of driving shaft.



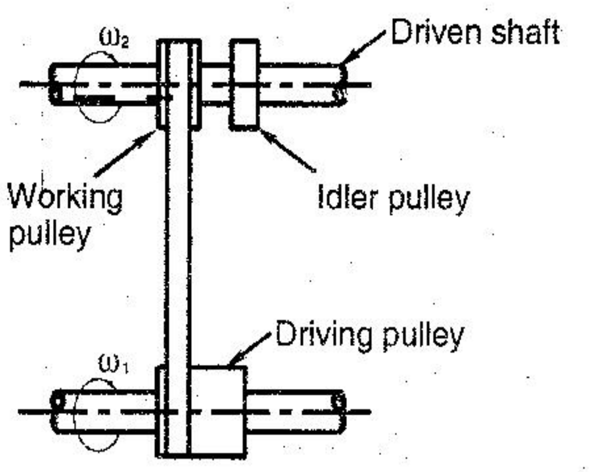


Stepped pulley drive

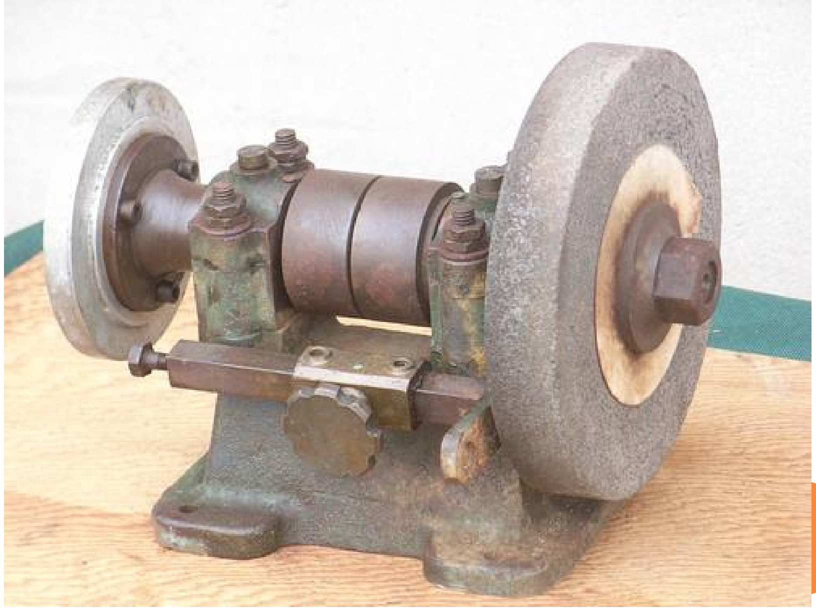
Types of Belt Drive:

Fast and Loose Pulley

- This type of drive is used when the driving shaft rotates continuously but the driven is to be rotated ’and stopped too often.
- There are two pulleys mounted on the driven shaft, a fast and a loose.
- The fast pulley is keyed to the shaft while the loose pulled (idler) can rotate freely on the shaft.
- When the driven shaft is to be stopped, the belt is pushed to the loose pulley with the help of a lever.



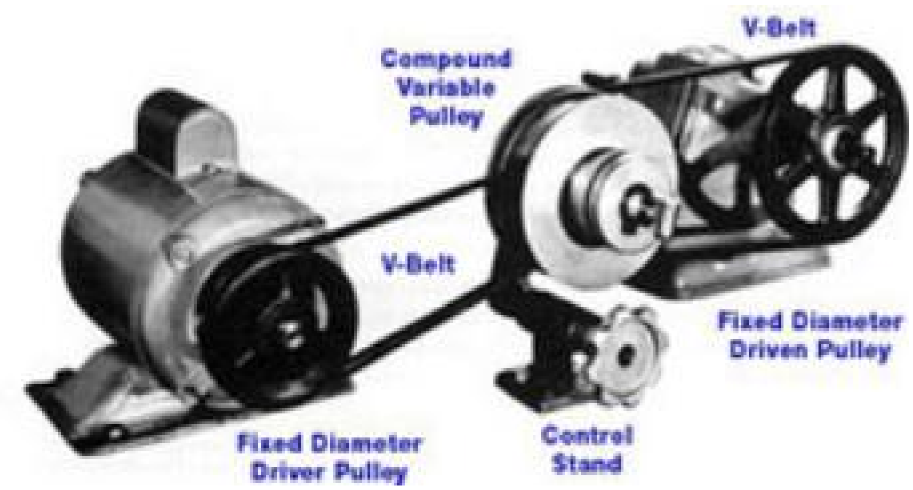
Fast and loose pulley drive

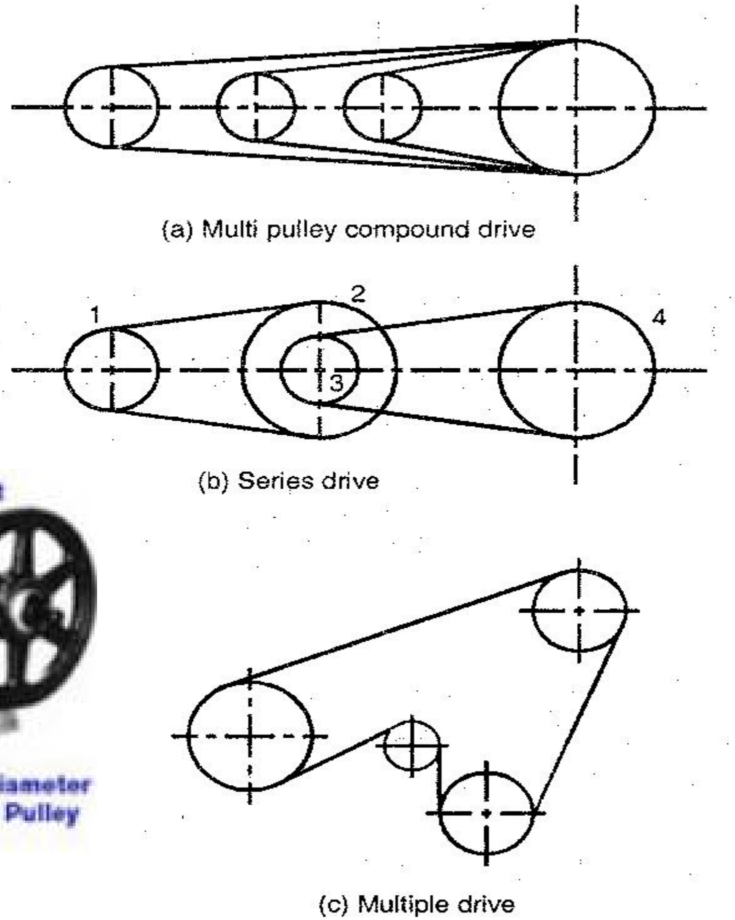


Types of Belt Drive:

Compound Drive:

This type of drive is used when several shafts are driven from one central shaft.



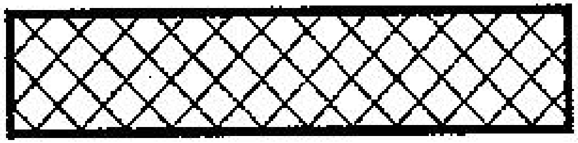


Compound drives

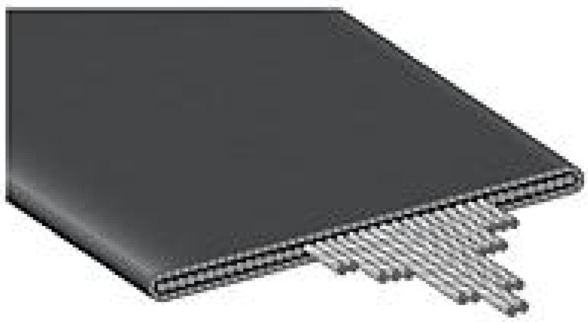
Types of Belt

Flat Belt:

- The main materials used for flat-belts are leather, rubber, cotton and balata. The flat belts can give a greater speed reduction ratio and operate at greater speeds. They can also be crossed to provide opposite rotation of driven and driving pulley. These belts are available in form of long strap which can be joined to make it endless.



Flat belt (Section view)



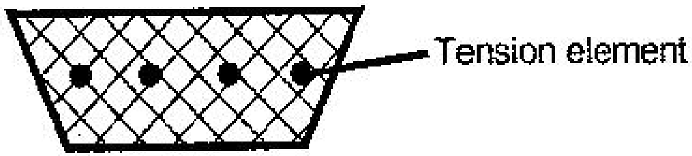
Types of Belt

V – Belt:

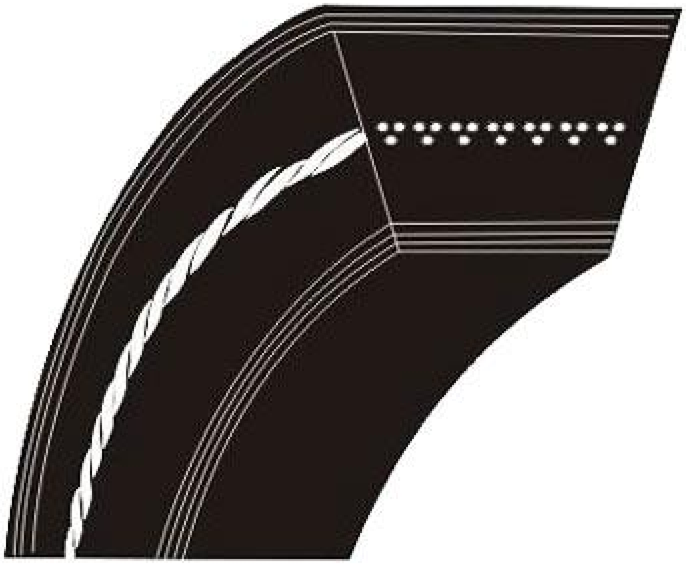
- The V-belts are able to transmit higher torque at less widths and tensions than flat belts.

- The wedging action of the belt in its groove enables the belts to be used on short centre distance where flat belts would have insufficient contact area.

- V-belts are available in endless form with standard lengths and cross-section. The belts are made from fabric and vulcanised rubber with a cotton or nylon cord tension elements.



V - belt (Section view)



Ribbed Belt

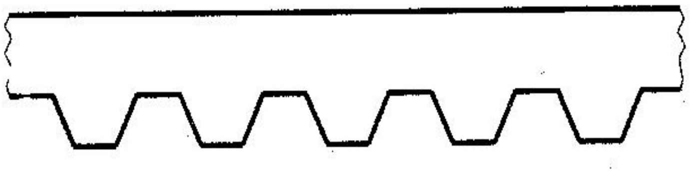
- With characters of V belt and flat belts, Ribbed belt has soft and tough property as flat belt and tight and effective property as V belt.
- 1. Transmission power so high that at the same condition its 30% higher than common V belts

- 2. With tight transmission system, at the same transmission power, its occupied space is 25% smaller than common V belt .

TYPES OF BELT

Timing Belt:

- They are molded endless flat belts with regularly spaced teeth formed on one side.
- Drives using timing belts incorporate the positive action of a chain and sprocket drive with most of the advantages of the other types of belt drives.
- There is positive tooth and groove engagement of the belt without slip, creep and speed variations. So there is precise synchronization between driving and driven elements.
- These belts can also be used for power transmission with high efficiency.
- They are available in endless form with wide variety of standard lengths, widths and pitches to choose from.



Timing belt (Side view)

VELOCITY RATIO OF PULLEYS :

- Motion of belt is achieved by virtue of friction between the surface of the pulley and belt. But there is some amount of slip between them when power is being transmitted. Slip of about 1.5 to 2 percent is present under normal conditions.

Let D_1 and D_2 be the diameters of the driver and follower pulleys respectively.
Let N_1 and N_2 denote their speeds in revolutions per minute (or second).

Surface speed of driver = $\pi D_1 N_1$

Surface speed of follower = $\pi D_2 N_2$

Assuming that there is no slip,

Surface speed of driver = speed of belt = surface speed of follower.

or, $\pi D_1 N_1 = \pi D_2 N_2$

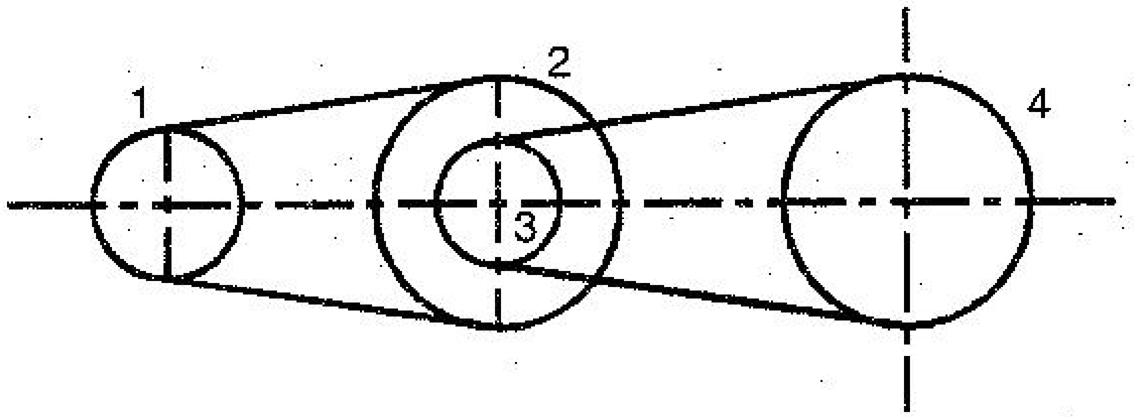
$$\frac{N_2}{N_1} = \frac{D_1}{D_2}$$

Above equation is true for open as well as crossed belts but sense (direction) of rotation is the same for open belt drive pulleys while opposite for crossed belt drive pulleys.

If we take into consideration the thickness of belt 't',

$$\frac{N_2}{N_1} = \frac{D_1 + t}{D_2 + t}$$

VELOCITY RATIO OF COMPOUND PULLEYS :



For the compound drive

$$\therefore \quad \frac{N_2}{N_1} = \frac{D_1}{D_2} \text{ and } \frac{N_4}{N_3} = \frac{D_3}{D_4}$$

$$\therefore \quad \frac{N_4}{N_3} \times \frac{N_2}{N_1} = \frac{D_3}{D_4} \times \frac{D_1}{D_2}$$

But $N_2 = N_3$ as both pulleys are mounted on same shaft

$$\therefore \quad \frac{N_4}{N_1} = \frac{D_1}{D_2} \times \frac{D_3}{D_4}$$

Creep

- Creep is a phenomenon caused by the elasticity of the belt material. The belt is stretched more on the tight side than on the slack side. Due to this, the length being received and being delivered by a pulley is different. This phenomenon is called creep.

Shaft, Axle and Spindle

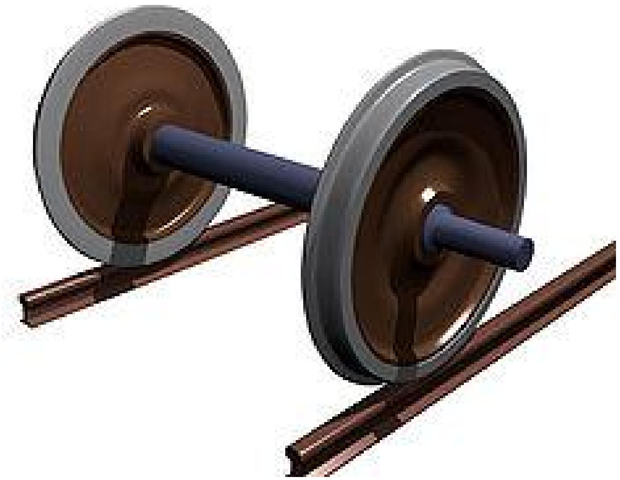
- **Shafts** are machine member mostly with circular cross–section which support revolving parts of machine such as pulleys, gears and flywheels for transmitting power. They are subjected to bending as well as **torsional loads**.

- **Axle** may or may not rotate and supports revolving parts. It is subjected to bending only. The part of shaft within the bearing is known as journal.

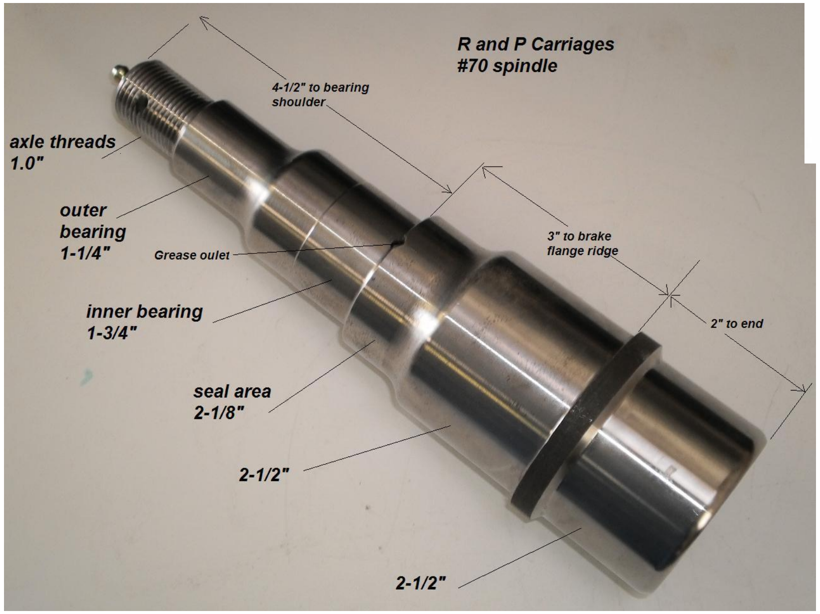
- **Spindle** is a machine shaft that drives or supports either a cutting tool or the workpiece on which machining is performed.

Shafts

Axle



Spindle


R and P Carriages
#70 spindle
4-1/2" to bearing shoulder
axle threads
1.0"
outer
bearing
1-1/4"
Grease oulet
3" to brake flange ridge
2" to end
inner bearing
1-3/4"
seal area
2-1/8"
2-1/2"
2-1/2"

Chain Drive

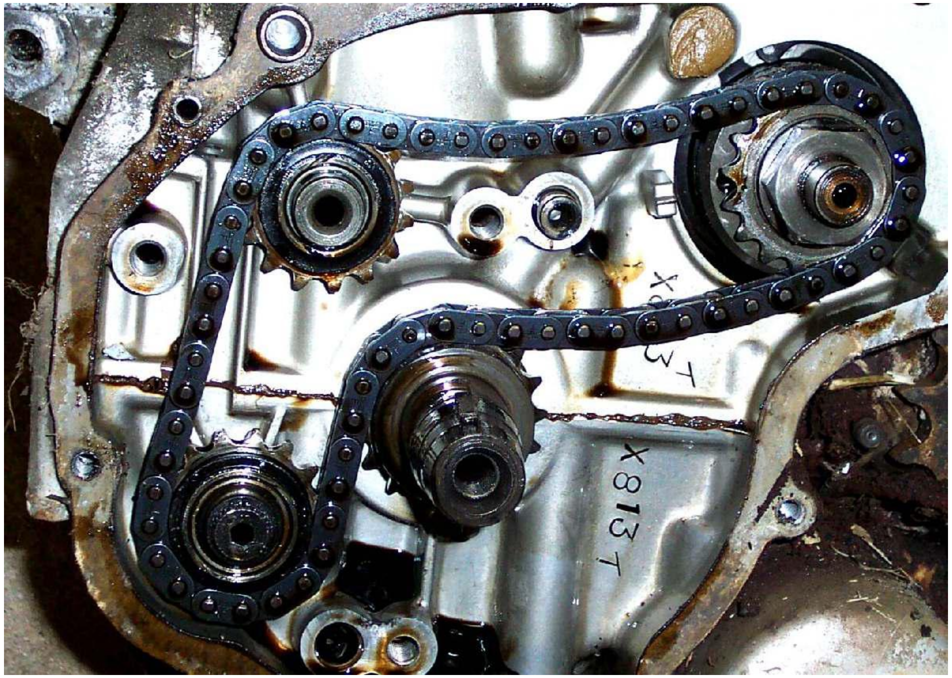
- A chain is made up of a series of links with the links held together with steel pins.

- This arrange makes a chain a strong, long lasting way of transmitting rotary motion from one gear wheel to another.

- Chain drive has one main advantage over a traditional gear train. Only two gear wheels and a chain are needed to transmit rotary motion over a distance.

- With a traditional gear train, many gears must be arranged meshing with each other in order to transmit motion.

Chain Drive



Chain Drive

- When working out gear / velocity ratio and the rpm of chain driven gears it must be remembered that the chain is ignored.
- This means the you simply find out the teeth per gear wheel and the rpm and use the same method of calculating as you would with a normal, meshing gear system (see gear work sheets)

Chain Drives V/S Belt Drive

Advantages of chain drives over belt drives are:

- No slippage between chain and sprocket teeth.
- Negligible stretch, allowing chains to carry heavy loads.
- Long operating life expectancy because flexure and friction contact occur between hardened bearing surfaces separated by an oil film.
- Operates in hostile environments such as high temperatures, high moisture or oily areas, dusty, dirty, and corrosive atmospheres, etc., especially if high alloy metals and other special materials are used.
- Long shelf life because metal chain ordinarily doesn't deteriorate with age and is unaffected by sun, reasonable ranges of heat, moisture, and oil.
- Certain types can be replaced without disturbing other components mounted on the same shafts as sprockets.

Drawbacks of chain drives that might affect drive system design are:

- Noise is usually higher than with belts or gears, but silent chain drives are relatively quiet.
- Chain drives can elongate due to wearing of link and sprocket teeth contact surfaces.
- Chain flexibility is limited to a single plane whereas some belt drives are not.
- Usually limited to somewhat lower-speed applications compared to belts or gears.
- Sprockets usually should be replaced because of wear when worn chain is replaced. V-belt sheaves exhibit very low wear