

# POWER TRANSMISSION METHODS AND DEVICES

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## 6.1 INTRODUCTION

Power is transmitted from one shaft to another by means of belts, ropes, chains and gears. For large distance between the shafts, belts, ropes and chains are used whereas for small distances, gears are used.

Belts, ropes and chains are flexible types of connectors. Belts and ropes transmit power due to friction between them and the pulley. If the power transmitted exceeds the force of friction, the belt or rope slips over the pulley. During motion these are strained due to tensions in them. So due to slipping and straining action, belts and ropes are not positive types of drives as their velocity ratio is not constant. Whereas chains and gears have constant velocity ratio. Hence, whenever velocity ratio is required to be very exact between two shaft, as in a watch mechanism, and also when the distance between the shafts is very small, toothed wheels called gears find their use. The toothed wheels are thus needed to transmit in variable velocity ratio, and to be able to transmit huge torques from the driver to the follower.

In some cases, where belts and ropes are used, gear wheels could also be used. The following considerations are a guide line to decide the type of drive:

1. Disposition of the shafts i.e. their angular position of the connecting shafts.
2. Direction of motions.
3. Distance between the shafts.
4. Requirements of speed involved (i.e. for driving and driven shafts speed).
5. Types of maintenance required, and
6. Power to be transmitted.
7. Positive drive requirements

## 6.2 BELT AND ROPE DRIVES

The flexible wrapping connectors (belt and ropes) are used for transmitting power from one shaft to another. When the wrapping connectors takes the form of a band, whose thickness is small in comparison with width, it is called a belt. If its cross-section is circular or approximately circular, it is called a rope. Belts and ropes are endless, their ends are joined by a fastener. To transmit power from one shaft to another, an endless belt or rope is passed over pulleys mounted on the two shafts. The belt or rope must be kept in tension so that the motion is transmitted from one shaft to another without slip.

In case of rope drives, grooved pulleys are used. The rope is gripped on its sides as it bends down in the groove reducing the chances of slipping.

For an unstretched belt mounted on the pulleys, the outer face is under tension and its inner face is under compression as shown in Fig. 1.

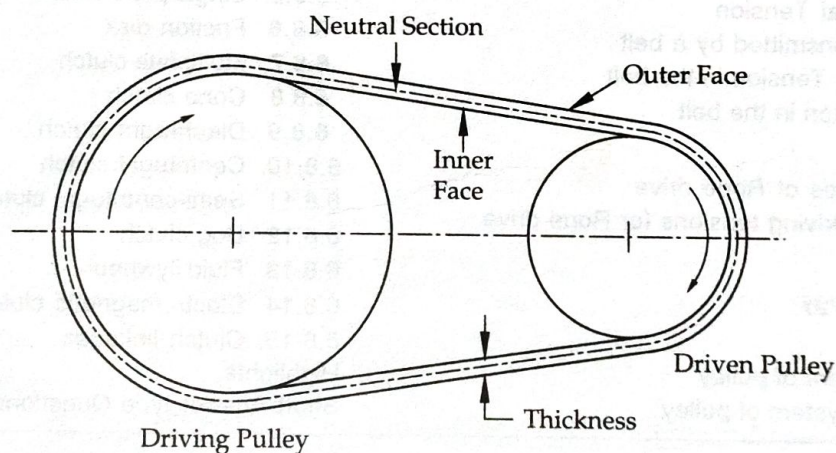


Fig. 1 Belt Drive

In between there is a section, which is neither under tension nor under compression, is known as the neutral section. This is usually considered at half the thickness of the belt.

The effective radius of a pulleys is the sum of half of the belt thickness and the radius of the pulley.

### 6.2.1 Types of Belts

These days, many types of belts are used. Some important types of belts are given below:

1. **Flat Belt:** A belt having rectangular cross-section is known as a flat belt as shown in Fig 2. It is mostly used in factories for moderate power transmission from one pulley to another at a distance not more than 8 meters. In this case, rim of the pulley is slightly crowned as it helps to keep the belt running centrally on the rim of the pulley.
2. **V-Belt:** The belt having trapezoidal cross-section is known as V-Belt as shown in Fig. 3. It is mostly used in factories and workshops for transmitting great amount of power, when the two

pulleys are very near to each other. To take the advantage of wedge section, the groove on the rim of the pulley is made deeper.

The belt does not touch the bottom of the groove. It needs little adjustment. Due to wedging action. It can transmit more power as compared to flat belts. For transmitting more power between two pulleys, multiple V-belts can be used.

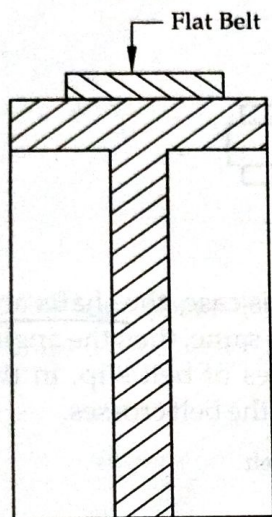


Fig. 2

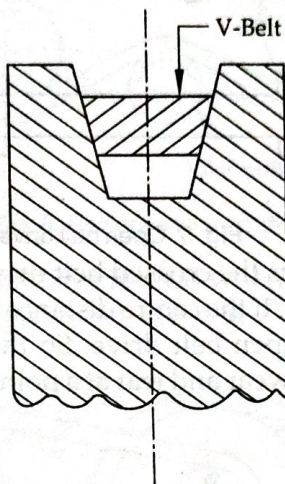


Fig. 3

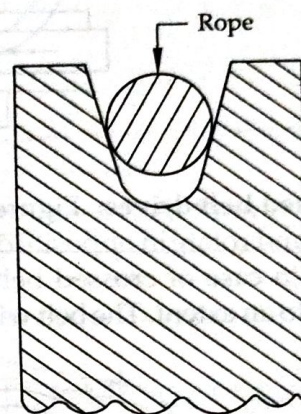


Fig. 4

3. **Circular belt or rope:** The belt having circular cross-section is known as circular belt or rope shown in Fig. 4. In factories, it is used for power transmission, when the distance between the two pulleys is more than 8 meters.

### ★ 6.2.2 Material for Belt

The material used for belts and ropes must be strong, flexible and durable. It must have a high coefficient of friction. Generally, belts are classified according to the belt material used.

1. Leather belts
2. Cotton belts
3. Rubber belts

The selection for material is also influenced by climate as well as the service conditions. Usually leather, cotton and rubber are the materials used for flat belts. V-belts are made of rubber impregnated fabric. Angle of 'V' varies between 30 to 40 degree.

### 6.2.3 Types of Flat Belts Drives

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

1. Open belt drives ✓
2. Crossed belt drive ✓
3. Quarter turn belt drive
4. Belt drive with idler pulleys
5. Compound belt drive ✓
6. Stepped pulley drive.
7. Fast and loose pulley drive.

★ 1. **Open belt drive:** Figure 5 shows the open belt drive. In this drive, both the shafts are arranged parallel and rotate in the same direction. This drive is generally used, where the centre distance between the two parallel shafts are 14 to 16 m. If this distance is too large, then belt begins to vibrate in a direction perpendicular to the direction of motion which shortens the belt life and also there will be power loss. In case of very small centre distance, the belt slip increases.

In case of horizontal drives, as shown in Fig. 5, to increase angle of contact the tension in the lower side is more (known as tight side) whereas the tension in the upper side is less (known as slack side). If the angle of contact is less then the belt slip increases.

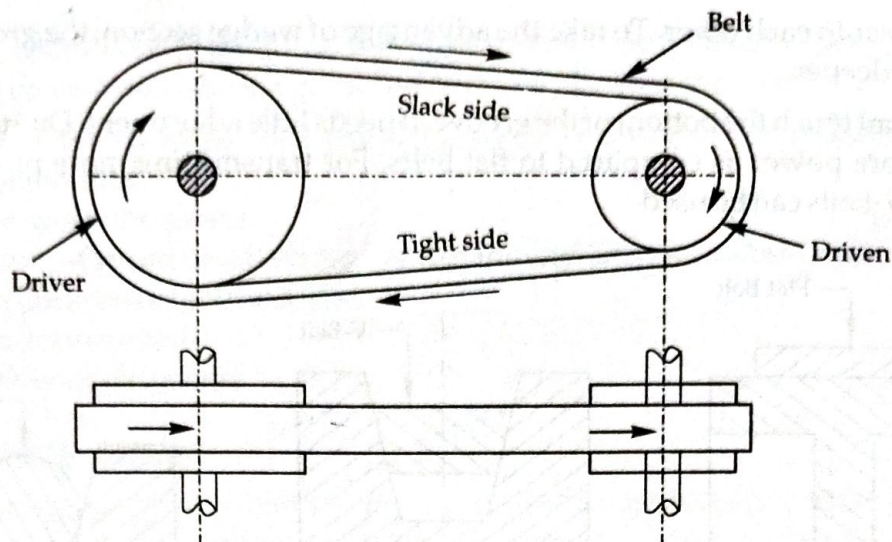


Fig. 5 Open belt driver

2. **Crossed belt drives:** Figure 6 shows the crossed belt drive. In this case, the shafts are arranged parallel and rotate in opposite direction. If the centre distance remains same, then the angle of contact is more in case of crossed belt than open belt drive. So the chances of belt slip, in this drive is reduced to an extent. The belt will more wear and tear at a point where the belt crosses.

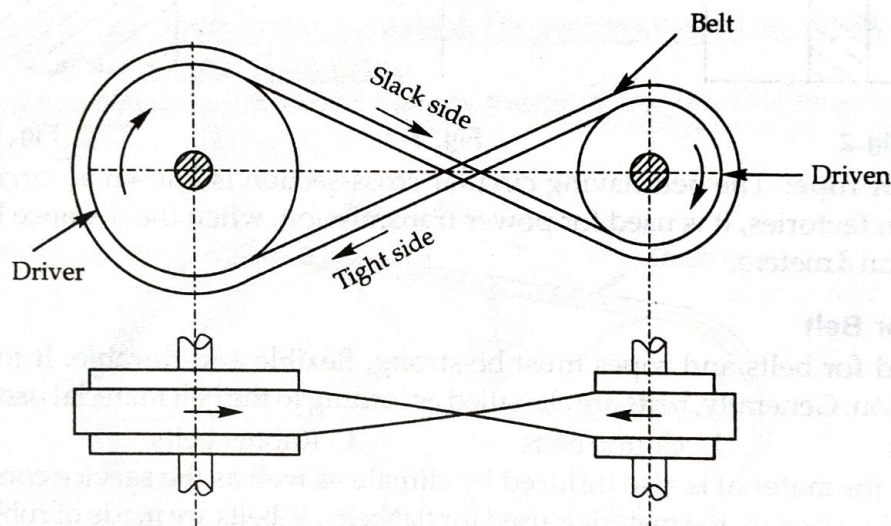


Fig. 6 Cross belt drive

3. **Quarter turn belt drive:** In this drive, the axis of rotation of the pulleys connected by the belt may be at right angles or at any other angle whether intersecting or non-intersecting. When the two connecting pulleys are at right angles, it is known as quarter turn drive shown in Fig. 7.

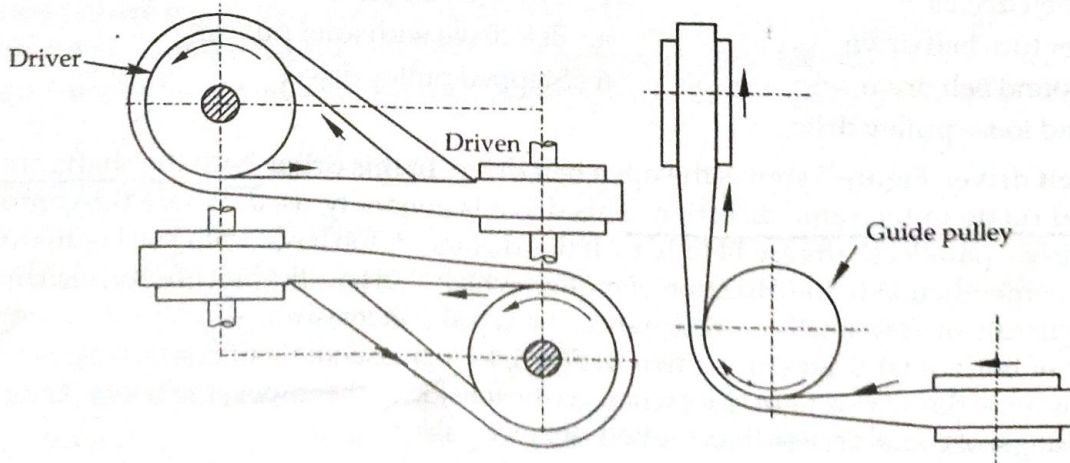


Fig. 7 (a) Quarter turn belt drive

Fig. 7(b) Quarter turn belt drive with guide pulley

4. **Belt drive with idler pulley:** Figure 8 shows the belt drive with idler pulleys. This drive is used with shafts arranged parallel and when an open belt drive cannot be used due to small angle of contact on the smaller pulley. This type of drive is provided to obtain high velocity ratio and when the required belt tension cannot be obtained by other means.

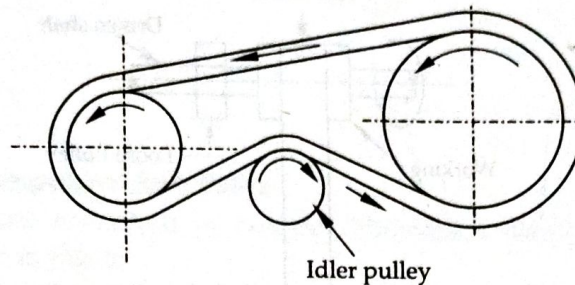


Fig. 8 Belt drive with an idler pulley

5. **Compound belt drive:** This type of drive is used when power is transmitted from one shaft to another through a number of pulleys. It is shown in Fig. 9.

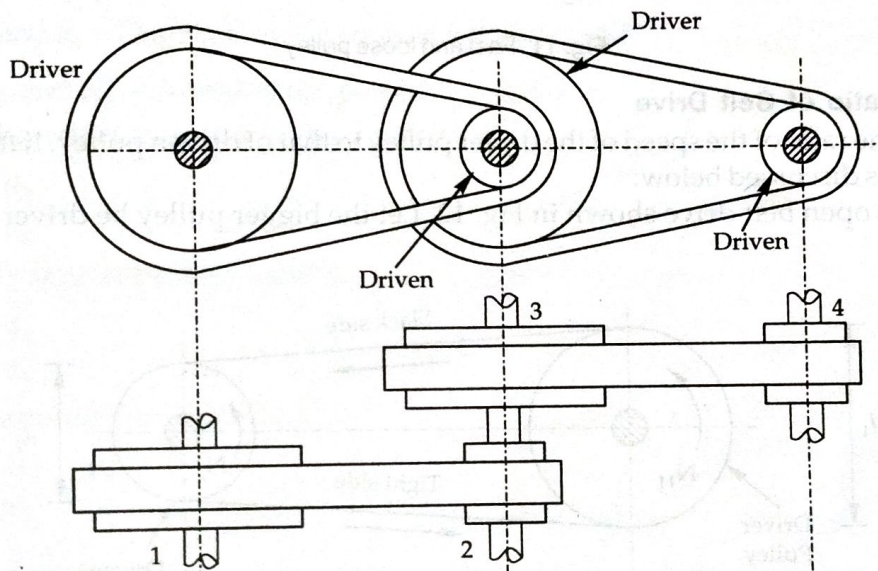


Fig. 9 Compound belt drive

6. **Stepped pulley drive:** This type of drive is used for changing the speed of the driven shaft while the main or driving shaft runs at constant speed. This is accomplished by shifting the belt from one part of the steps to the other. A stepped pulley drive is shown in Fig. 10.

7. **Fast and loose pulley drive:** This type of drive is used when the driven or machine shaft is to be started or stopped whenever desired without interfering with the driving shaft. A pulley which is keyed to the machine shaft is called fast pulley and runs at the same speed as that of machine shaft. A loose pulley runs freely over the machine shaft and

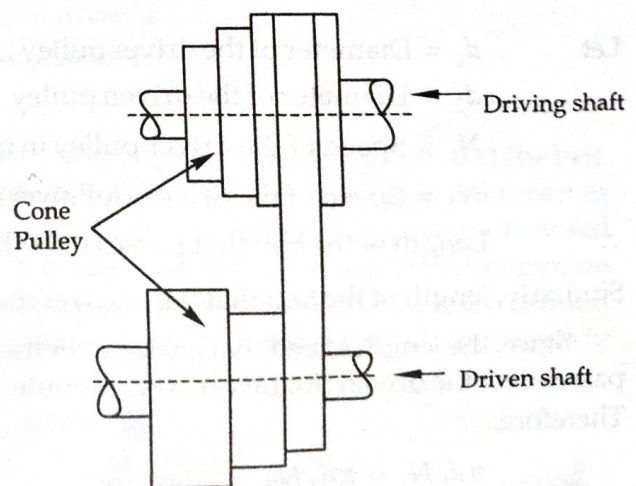


Fig. 10 Stepped or cone pulley drive

is incapable of transmitting any power. When the driven shaft is required to be stopped, the belt is pushed on to the loose pulley by means of sliding bar having belt forks (or lever). A fast and loose pulley drive is shown in Fig. 11.

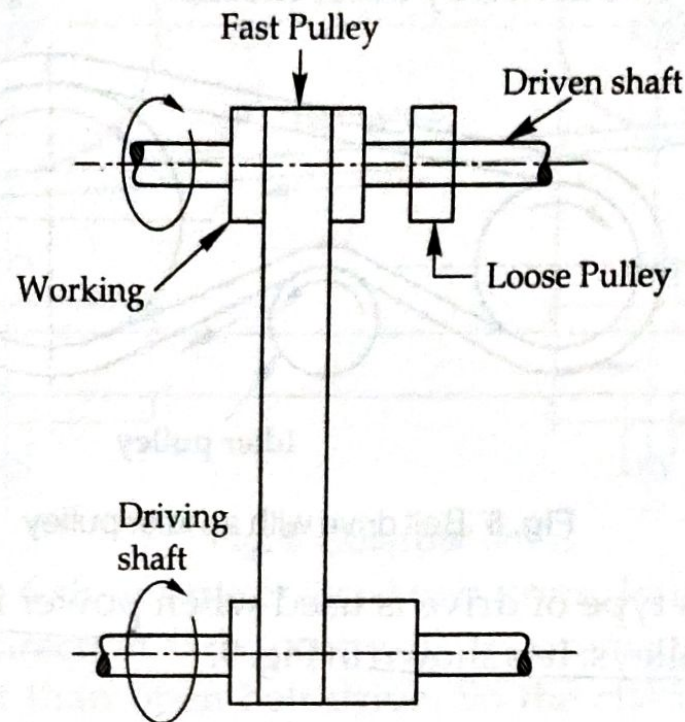


Fig. 11 Fast and loose pulley

### 6.3 ROPE DRIVE

When a large amount of power are to be transmitted over a considerable distance then ropes are used in place of belts. The flat belt drive is limited to a distance of 8 m and for large power transmission, it would result in excessive belt cross-section. The frictional grip of rope drive is more as compare to V drive. Also with the help of rope drives power can be transmitted to several main shafts from one driving pulley. It is used in hoists, spinning mill, transway, cranes, well drilling etc.

The rope drives use two types of ropes:

1. Fibre ropes

2. Wire ropes

#### 6.3.1 Advantages of rope drives

The following are the advantages of rope drives:

1. They have low cost and operation is economical
2. They have high mechanical efficiency
3. The outdoor conditions affects them very little.
4. The shaft may be out of strict alignment
5. They have smooth, steady and quite operation irrespective of amount of power and centre distance.
6. Power may be taken off in any direction and in fractional parts of the whole amount.