

Power transmission elements, Shafts

Expected Learning Outcome

- Types of Kinematic pairs
- Different types of power transmission elements used in the machines
- Types of belts
- Belt drive systems
- Chain drive system
- Types of gears used in the machines

7.1.Introduction

The machines are the prime movers to do canning, sausage, packaging, refrigeration etc. A machine is a device which receives energy in so available form and utilizes it to do some particular type of work. In a broad sense, a simple machine is a device which enables us to do some useful work at some point or to overcome some resistance, when an effort or force is applied to it at some other convenient point. A compound machine is a device consisting of a number of simple machines which enables us to do some useful work at a faster speed or with a much less effort as compared a simple machine. The theory of machines may be defined as that branch of Engineering Science which deals with the study of relative motion between the various parts of a machine, and forces which act upon them.

7.2.Sub-divisions of theory of machines

Kinematic:

It is that branch of theory of machines which deals with the relative motion between the various machine parts.

Dynamics:

It is that branch of theory of machines, which deals with the forces and their effects, while acting on the machine parts in motion.

Kinetics:

It is that branch of theory of machines, which deals with the inertia forces which arise from the combined effect of the mass and motion of the m/c parts.

Statics:

It is that branch of theory of machines which deals with the forces and their effects while the machine parts are at rest. The mass of the parts is assumed to be negligible.

7.3.Kinematic link or Element

Each part of a machine which moves relative to some other part is known as kinematic link.

Kinematic pairs

The two links or elements of a machine when in contact with each other are said to form a pair if the relative motion between them is completely fixed.

Types of kinematic pairs:

- **Sliding pair:** when the nature at contact between the elements of a pair is such that it can only slide relative to other, the pair is known as sliding pair. The piston and cylinder, cross head and guides of a reciprocating steam engine ram and it guides, tail stocks on the Lathe bed etc. are the examples. A sliding pair has a completely constrained motion.

- **Turning pair:** When the nature of contact between elements of a pair is such that it can only turn or revolve about a fixed axis. A shaft with collars at both ends fitted in to a circular hole, the crankshaft in a journal bearing in an engine, lathe spindle supported in head stock, cycle wheels turning over their axles etc. A turning pair also has a completely constrained motion.
- **Screw pair:** When the nature of contact between the elements of a pair is such that one element can turn about the other by screw threads, it is thus known as screw pair. The lead screw of a lathe with nut and bolt with a nut are the examples of a screw pair.
- **Spherical pair:** When the nature of contact between the elements of a pair is such that one element with spherical shape turns or swivels about the fixed element, the pair formed is called a spherical pair. The ball and socket joint, pen supporters joint in a pen stand etc. are the examples of a spherical pair.
- **Lower pair:** When the two elements of a pair have a surface contact when relative motion takes place and the surface of one element slides over the surface of other, the pair formed is known as lower pair: turning pair, screw pair form lower pairs.
- **Higher pair:** when the relative motion between the elements of a pair is partly turning and partly sliding, then the pair is known as higher pair. The elements of higher pairs, generally have line or point contact. A pair of friction discs, toothed gearing, belt and rope drives ball and roller bearings and cam and follower are the examples of higher pairs.
- **Forced closed pair:** When the elements of a pair are kept in contact by the action of external forces, the pair is said to be a forced closed pair. The cam and the follower is an example of forced closed pair, as it is kept in contact by the forces exerted by spring and gravity.

7.4. Power transmission Elements

The elements which are common to all methods of drive in machines are Shafting, Bearing and fixings, Belt driving, Chain driving, Rope driving, Friction driving and Toothed gearing.

7.4.1. Shaft

A shaft is a rotating machine element which is used to transmit power from one place to another. The power is delivered to the shaft by some tangential force and the resultant torque or torsional moment set up within the shaft permits the power to be transferred to various machines linked up to the shaft. In order to transmit the power from one shaft to another, the various members such as pulleys, gears etc. are mounted on it. These members along with the forces exerted upon them causes the shaft to bend. In other words, we may say that a shaft is used for the transmission of torque and bending moment.

Types of shafts

- **Transmission shafts:** Transmission shafts transmit power between the source and the machines absorbing power. The counter shaft, line shafts, overhead shafts and all factory shafts are transmission shafts. Since these shafts carry machine parts such as pulleys, gears etc. therefore they are subjected to bending in addition to twisting.
- **Machine shafts:** These shafts form an integral part of machine itself. The crankshaft is an example of machine shaft.

