## Keys, Cotter-Joints, Pin-Joints

Keys, cotters and pin joints are some examples of removable (temporary) fasteners. Assembly and removal of these joints are easy as they are simple in shape. The standard proportions of these joints are given in the figures.

## Keys

Keys are machine elements used to prevent relative rotational movement between a shaft and the parts mounted on it, such as pulleys, gears, and wheels.

For making the joint, grooves or keyways are cut on the surface of the shaft and in the hub of the part to be mounted.

Key may be divided into two main types:
(i) Taper keys (ii) Parallel or feather keys.

*Taper keys*

Taper key is uniform in width but tapered in thickness. The standard taper of this key is 1 in 100. The nominal thickness is the large end of the key. There are several types of taper key as following:

*1- Sunk taper key*

The standard form of this key either of rectangular or square cross-sections. It is sunk in shaft to the depth of one-half its nominal thickness, the remaining portion fits in the keyway inside the hub.

Approximately proportions of a sunk taper key of rectangular cross-section; if the diameter of shaft is D then:

*Width of key, W = 0.25 D + 2 mm*
*Thickness of key, T = 0.67 W (at the thicker end).*

In case of a sunk key of square cross-section, the nominal thickness is kept equal to the width of the key as illustrate in figure (1-18).

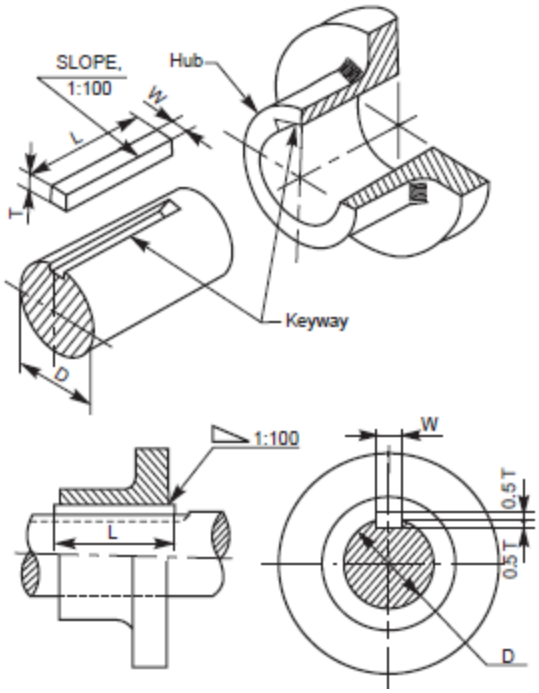



Figure (1-18) sunk taper Key

*2- Pin taper key*

Round keys are of circular cross-section, usually tapered (1:50) along the length. A round key fits in the hole drilled partly in the shaft and partly in the hub (Fig. 1-19). The mean diameter of the pin may be taken as 0.25 D, where D is shaft diameter.

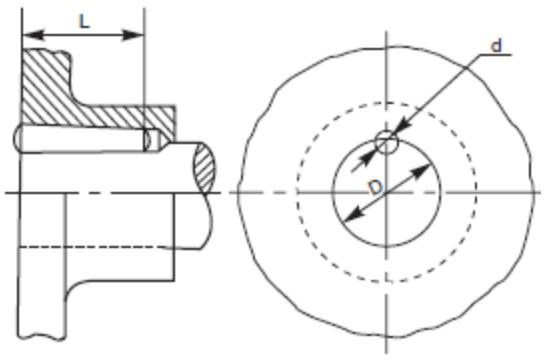



Figure (1-19) Pin taper Key

*3- Saddle key*

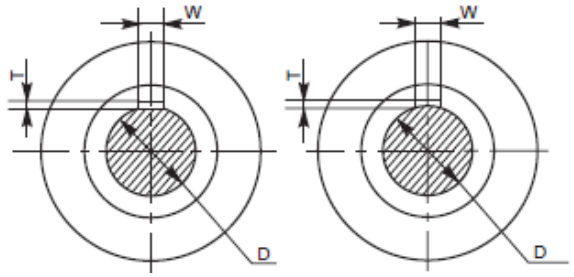
These are taper keys, with uniform width but tapering in thickness on the upper side. These are made in two forms*: hollow* and *flat*.

- *Hollow saddle key*

A hollow saddle key has a concave shaped bottom to suit the curved surface of the shaft. A keyway is made in the hub of the mating piece (fig 1-20a).

- *Flat Saddle key*

It is similar to the hollow saddle key, except that the bottom surface of it is flat. Apart from the tapered keyway in the hub of the mounting, a flat surface provided on the shaft is used to fit this key in position (Fig. 1-20b).




( b ) (a)

Figure (1-20) Saddle Key

The proportion of saddle key:

*Width of key, w=0.25D+2 mm*

*Nominal thickness=0.33W*

*4- Gib-head Taper Key*

A tapered sunk key is provided with a head called gib. Fig (1-21) shows the application of a key with a gib head. Following are the proportions for a gib head:

If D is the diameter of the shaft, then,

*Width of key, W = 0.25 D + 2 mm*

*Thickness of key, T = 0.67 W (at the thicker end)*

*Standard taper = 1:100*

*Height of head, H = 1.75 T*

*Width of head, B = 1.5*

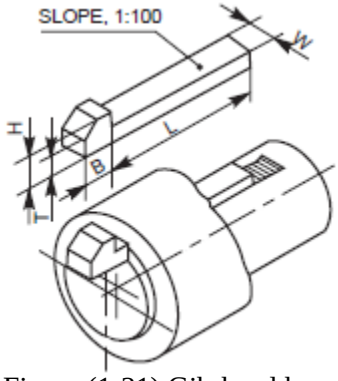



Figure (1-21) Gib-head key

*Parallel or feather key*

A parallel or feather key is a sunk key, uniform in width and thickness as well. These keys are used when the parts (gears, clutches, etc.) mounted are required to slide along the shaft; permitting relative axial movement. To achieve this, a clearance fit must exist between the key and the keyway in which it slides. Figure (1-22) shows types of feather keys.

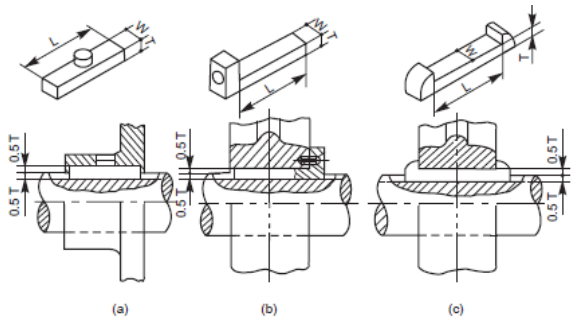



Figure (1-22) feather key

*Splines key*

Splines are keys made integral with the shaft, by cutting equi-spaced grooves of uniform cross section. The shaft with splines is called a splined shaft. The splines on the shaft fit into the corresponding recesses in the hub of the mounting, with a sliding fit, providing a positive drive and at the same time permitting the latter to move axially along the shaft (Fig. 1-23).

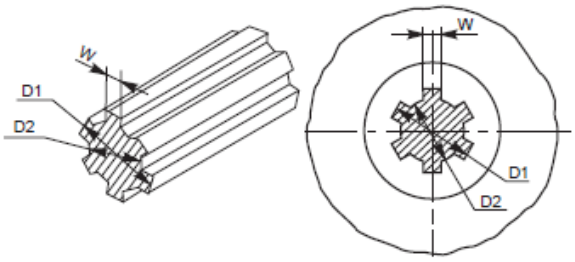



Figure (1-22) Spline key

*Woodruff key*

It is a sunk key, in the form of a segment of a circular disc of uniform thickness (Fig. 1-24). As the bottom surface of the key is circular the keyway in the shaft is in the

form of a circular recess to the same curvature as the key. The following are the proportions of woodruff keys:

If D is the diameter of the shaft,

*Thickness of key, W = 0.25 D*
*Diameter of key, d = 3 W*
*Height of key, T = 1.35 W*
*Depth of the keyway in the hub, T1 = 0.5 W + 0.1 mm*
*Depth of keyway in shaft, T2 = 0.85 W*

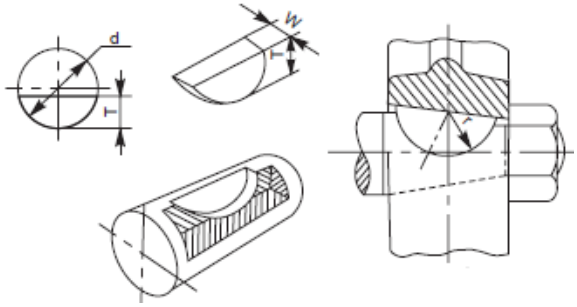



Figure (1-24) Woodruff key

**Cotter Joints**

A cotter is a flat wedge shaped piece, made of steel. It is uniform in thickness but tapering in width, generally on one side; the usual taper being 1:30. The lateral (bearing) edges of the cotter and the bearing slots are generally made semi-circular instead of straight. Cotter joints are used to connect two rods, subjected to tensile or compressive forces along their axes. These joints are not suitable where the members are under rotation. The following are some of the commonly used cotter joints:

*1- Cotter Joint with sleeve*

This is the simplest of all cotter joints, used for fastening two circular rods. To make the joint, the rods are enlarged at their ends and slots are cut. After keeping the rods butt against each other, a sleeve with slots is placed over them. After aligning the slots properly, two cotters are driven-in through the slots, resulting in the joint (Fig. 1-25). The rod ends are enlarged to take care of the weakening effect caused by the slots.

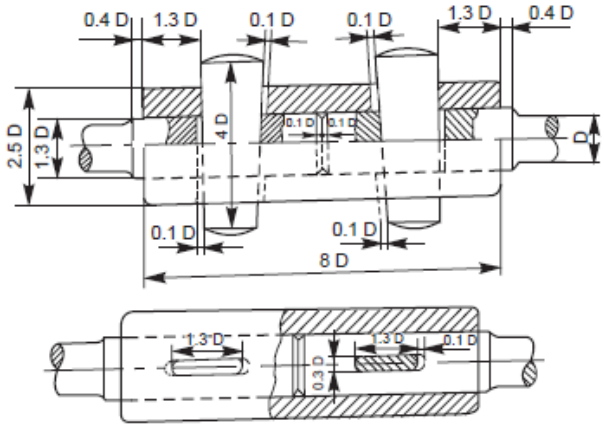



Figure (1-25) Cotter joint with sleeve

*2- Cotter Joint with Socket and Spigot Ends*

This joint is also used to fasten two circular rods. In this, the rod ends are modified instead of using a sleeve. One end of the rod is formed into a socket and the other into a spigot (Fig. 1-26) and slots are cut. After aligning the socket and spigot ends, a cotter is driven-in through the slots, forming the joint.

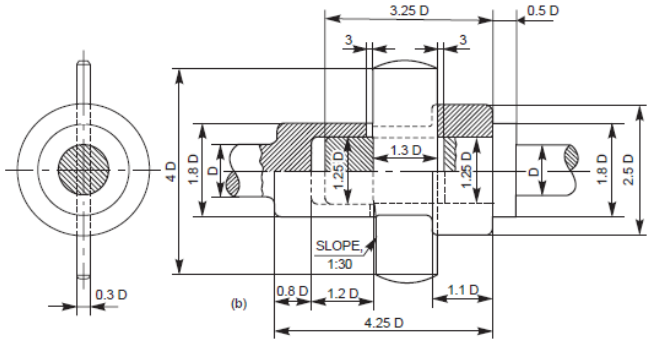



Figure (1-25) Cotter joint with socket and spigot end

*3- Cotter Joint with a Gip*

This joint is generally used to connect two rods of square or rectangular cross-section. To make the joint, one end of the rod is formed into a U-fork, into which, the end of

the other rod fits in. When a cotter is driven-in, the friction between the cotter and straps of the U-fork causes the straps to open. This is prevented by the use of a gib. Fig (1-26) shows this joint.

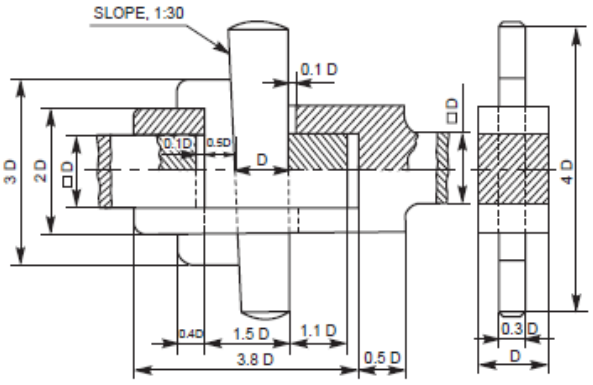



Figure (1-26) Cotter joint with a Gip

## Pin Joint or Knuckle Joint

Knuckle joint is a pin joint used to fasten two circular rods. In this joint, one end of the rod is formed into an eye and the other into a fork (double eye). For making the joint, the eye end of the rod is aligned into the fork end of the other and then the pin is inserted through the holes and held in position by means of a collar and a taper pin (Fig. 1-27).

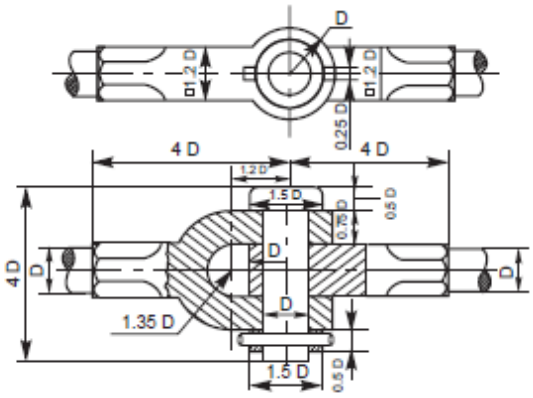



Figure (1-27) Knuckle joint

## Question

1- Draw three view of spline shaft and a hub mating on it if the shaft diameter is 50 mm
2- Two square rods of side 50 mm each are connected by a cotter joint with a gib. Sketch the following views of the assembly: (a) half sectional view from the front and (b) view from the side.

3- Answer the following:

- A key is a temporary joint (True/False)
- A cotter is a permanent joint (True/False).
- Pin joints may be temporary or permanent joints (True/False).
- The standard taper on the face of a key is _____.
- Taper sunk key is tapered on both sides (True/False).
- Woodruff key is a type of sunk key (True/False).
- Feather keys are used with _____.
  (a) Gears (b) Flywheel (c) Pulleys.
- A knuckle joint is used to fasten two square rods (True/False).