Keys and Coupling

- A key is a piece of mild steel inserted between the shaft and hub or boss of the pulley to connect these together in order to prevent relative motion between them.
- It is always inserted parallel to the axis of the shaft. Keys are used as temporary fastenings and are subjected to considerable crushing and shearing stresses.
- A keyway is a slot or recess in a shaft and hub of the pulley to accommodate a key.

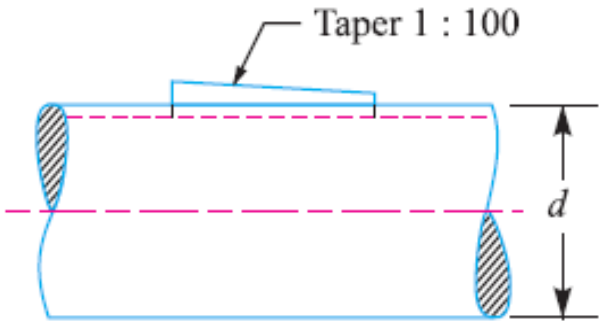
Types of Keys

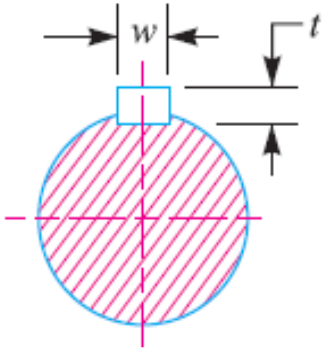
1. Sunk keys
2. Saddle keys
3. Tangent keys
4. Round keys
5. Splines

Sunk Keys

The sunk keys are provided half in the keyway of the shaft and half in the keyway of the hub or boss of the pulley

1. *Rectangular sunk key*. The usual proportions of this key are :
Width of key, $w = d / 4$; and thickness of key, $t = 2w / 3 = d / 6$
where d = Diameter of the shaft or diameter of the hole in the hub.
The key has taper 1 in 100 on the top side only.



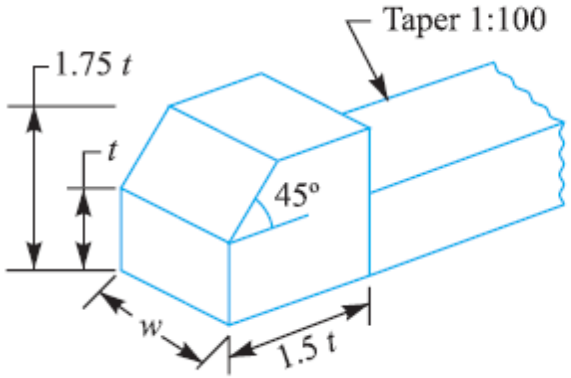


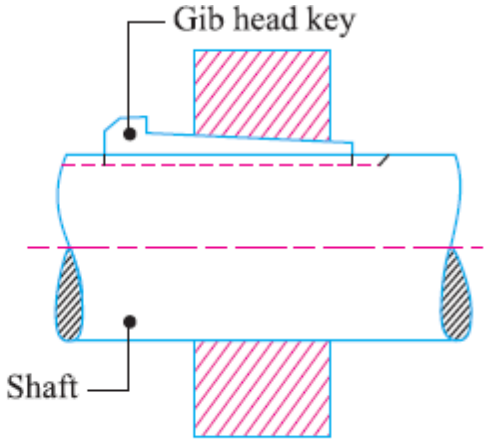
2. *Square sunk key.* The only difference between a rectangular sunk key and a square sunk key is that its width and thickness are equal, *i.e.*

$w = t = d / 4$

3. *Parallel sunk key.* The parallel sunk keys may be of rectangular or square section uniform in width and thickness throughout. It may be noted that a parallel key is a taperless and is used where the pulley, gear or other mating piece is required to slide along the shaft.

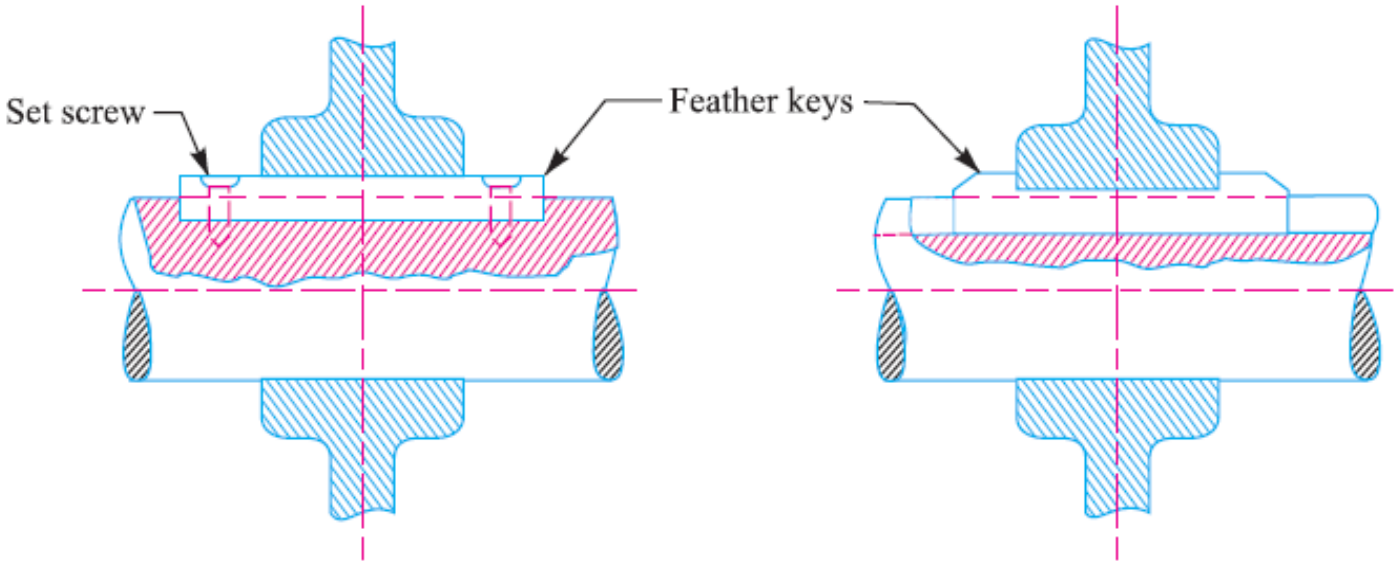
4. *Gib-head key.* It is a rectangular sunk key with a head at one end known as ***gib head.*** It is usually provided to facilitate the removal of key





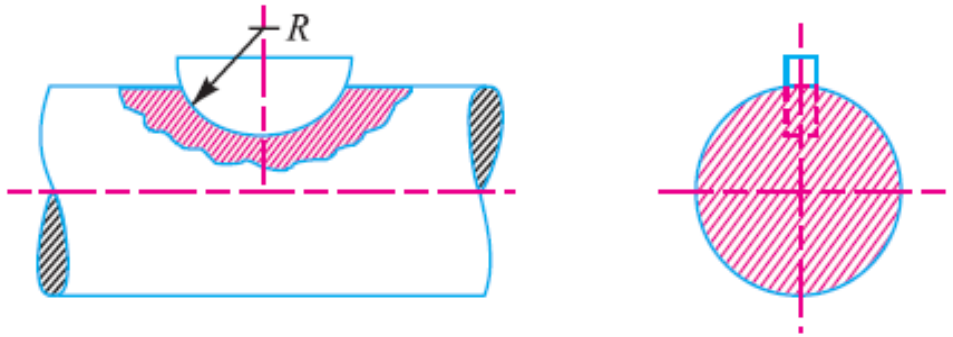
5. *Feather key*.

- A key attached to one member of a pair and which permits relative axial movement is known as ***feather key*.** It is a special type of parallel key which transmits a turning moment and also permits axial movement. It is fastened either to the shaft or hub, the key being a sliding fit in the key way of the moving piece.



6. *Woodruff key.*

- The woodruff key is an easily adjustable key. It is a piece from a cylindrical disc having segmental cross-section in front view. A woodruff key is capable of tilting in a recess milled out in the shaft by a cutter having the same curvature as the disc from which the key is made. This key is largely used in machine tool and automobile construction.

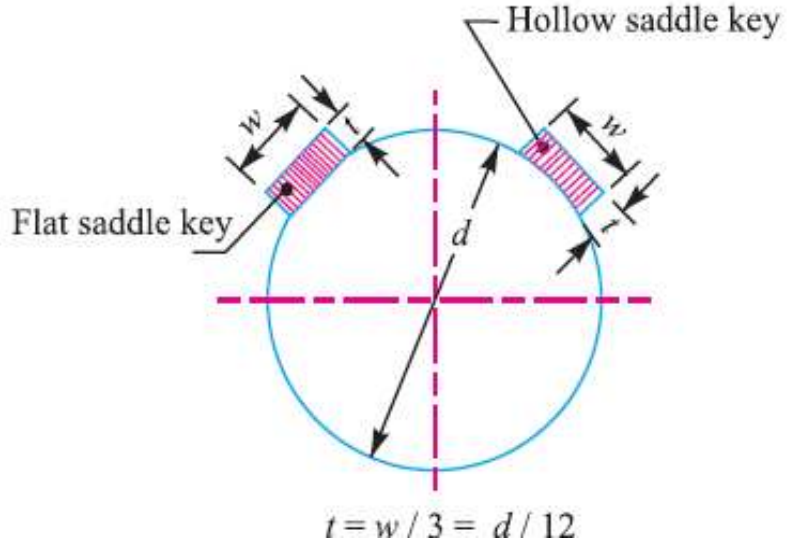


Saddle keys

The saddle keys are of the following two types :

1. Flat saddle key, and **2.** Hollow saddle key.

- A ***flat saddle key*** is a taper key which fits in a keyway in the hub and is flat on the shaft. It is likely to slip round the shaft under load. Therefore it is used for comparatively light loads.
- A ***hollow saddle key*** is a taper key which fits in a keyway in the hub and the bottom of the key is shaped to fit the curved surface of the shaft. Since hollow saddle keys hold on by friction, therefore these are suitable for light loads. It is usually used as a temporary fastening in fixing and setting eccentrics, cams etc.

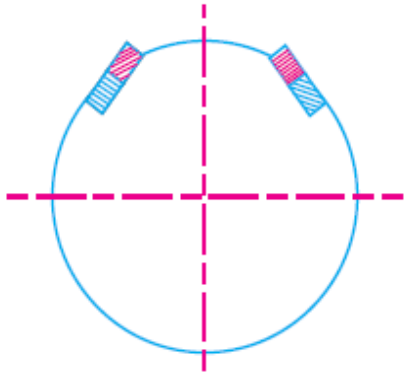


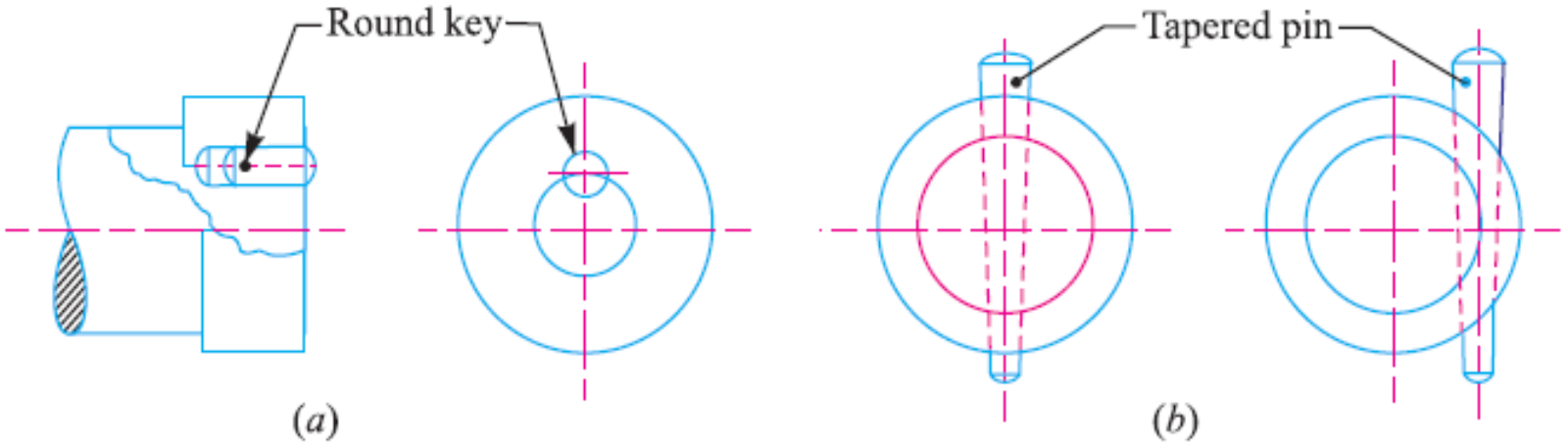
Tangent Keys

- The tangent keys are fitted in pair at right angles. Each key is to withstand torsion in one direction only. These are used in large heavy duty shafts

Round Keys

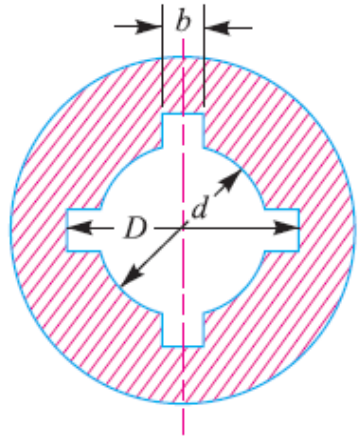
- The round keys, are circular in section and fit into holes drilled partly in the shaft and partly in the hub. They have the advantage that their keyways may be drilled and reamed after the mating parts have been assembled. Round keys are usually considered to be most appropriate for low power drives.





Splines

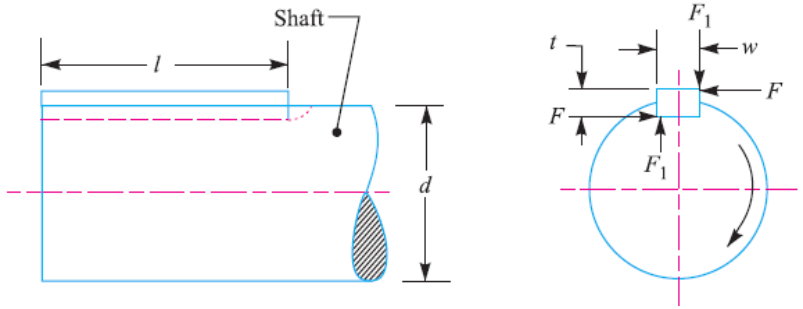
- Sometimes, keys are made integral with the shaft which fits in the keyways broached in the hub. Such shafts are known as ***splined shafts***.
- These shafts usually have four, six, ten or sixteen splines. The splined shafts are relatively stronger than shafts having a single keyway.
- The splined shafts are used when the force to be transmitted is large in proportion to the size of the shaft as in automobile transmission and sliding gear transmissions. By using splined shafts, we obtain axial movement as well as positive drive is obtained.



$D = 1.25\ d$ and $b = 0.25\ D$

Strength of a Sunk Key

Let T = Torque transmitted by the shaft,
F = Tangential force acting at the circumference of the shaft,
d = Diameter of shaft,
l = Length of key,
w = Width of key.
t = Thickness of key, and



Considering shearing of the key, the tangential shearing force acting at the circumference of the shaft,

$$F = \text{Area resisting shearing} \times \text{Shear stress} = l \times w \times \tau$$

$\therefore$ Torque transmitted by the shaft,

$$T = F \times \frac{d}{2} = l \times w \times \tau \times \frac{d}{2} \quad \ldots(i)$$

Considering crushing of the key, the tangential crushing force acting at the circumference of the shaft,

$$F = \text{Area resisting crushing} \times \text{Crushing stress} = l \times \frac{t}{2} \times \sigma_c$$

$\therefore$ Torque transmitted by the shaft,

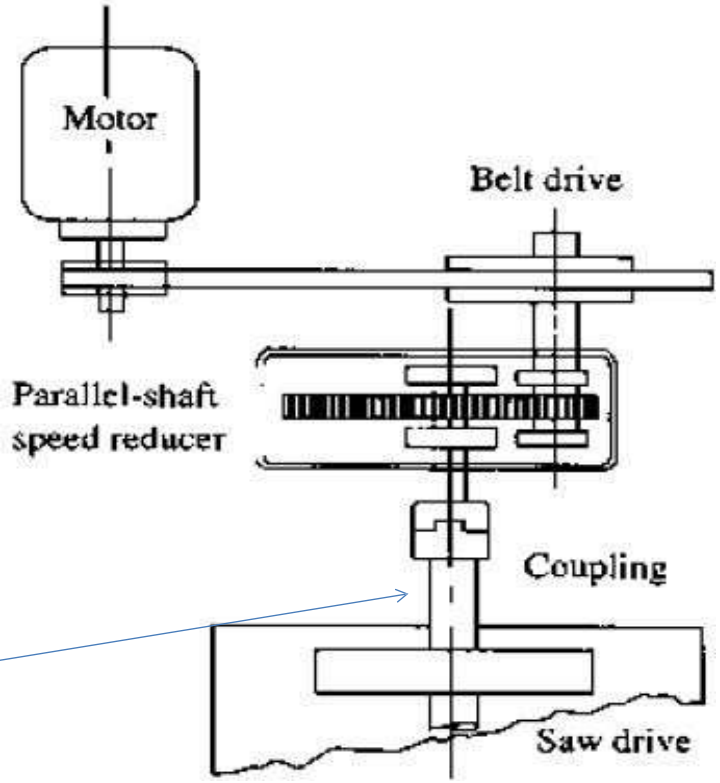
$$T = F \times \frac{d}{2} = l \times \frac{t}{2} \times \sigma_c \times \frac{d}{2} \quad \ldots(ii)$$

Shafts and Couplings

To provide,

- Easy to connect or disconnect.
- Misalignment (Mechanical flexibility)
- Reduce shocks in transmission
- Protection against overloads

Coupling



Saw Mill

Types of Shafts Couplings

Shaft couplings are divided into two main groups as follows :

1. *Rigid coupling.* It is used to connect two shafts which are perfectly aligned. Following types of rigid coupling are important from the subject point of view :

(*a*) Sleeve or muff coupling.

(*b*) Clamp or split-muff or compression coupling, and

(*c*) Flange coupling.

2. *Flexible coupling.* It is used to connect two shafts having both lateral and angular misalignment. Following types of flexible coupling are important from the subject point of view :

(*a*) Bushed pin type coupling,

(*b*) Universal coupling, and

(*c*) Oldham coupling.

Sleeve Coupling

Split-Muff Coupling

Flanged Coupling

Flexible Coupling

Oldham Coupling

Universal Coupling

Gear Coupling

Fluid Coupling

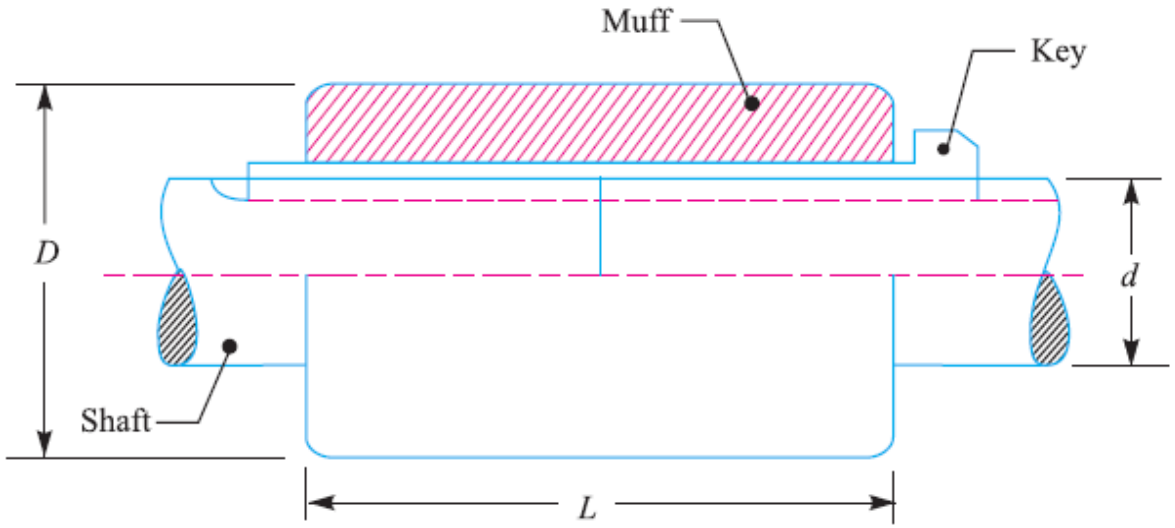
Sleeve or Muff-coupling

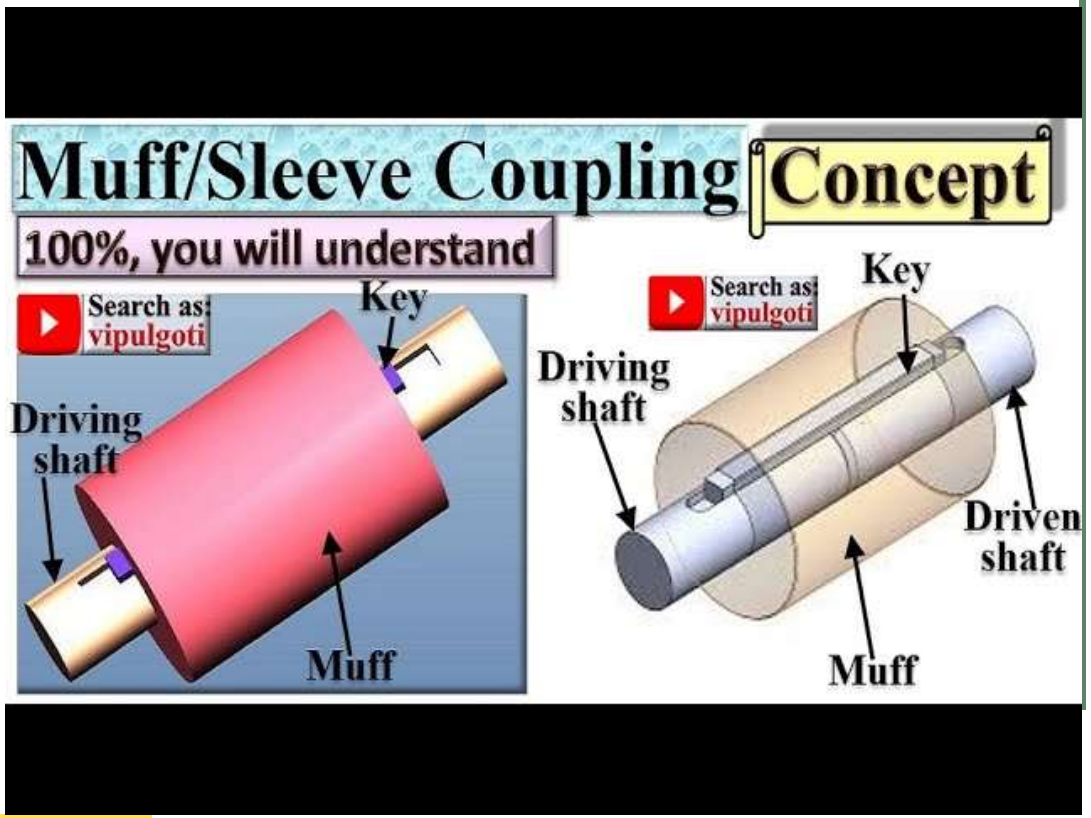
It is the simplest type of rigid coupling, made of cast iron. It consists of a hollow cylinder whose inner diameter is the same as that of the shaft. It is fitted over the ends of the two shafts by means of a gib head key. The power is transmitted from one shaft to the other shaft by means of a key and a sleeve. It is, therefore, necessary that all the elements must be strong enough to transmit the torque. The usual proportions of a cast iron sleeve coupling are as follows :

Outer diameter of the sleeve, $D = 2d + 13$ mm

and length of the sleeve, $L = 3.5\ d$

where d is the diameter of the shaft.





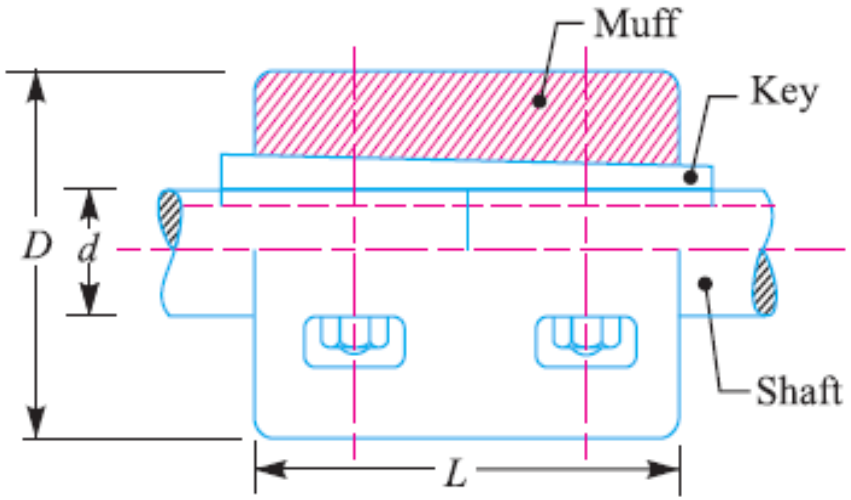
Clamp or Compression Coupling

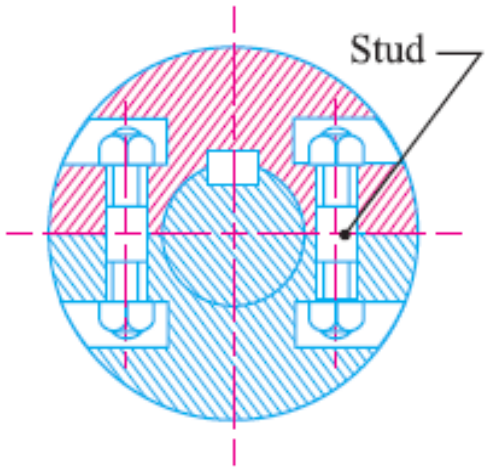
It is also known as ***split muff coupling.*** In this case, the muff or sleeve is made into two halves and are bolted together. The halves of the muff are made of cast iron. Both the halves are held together by means of mild steel studs or bolts and nuts. This coupling may be used for heavy duty and moderate speeds. The advantage of this coupling is that the position of the shafts need not be changed for assembling or disassembling of the coupling.

Diameter of the muff or sleeve, $D = 2d + 13$ mm

Length of the muff or sleeve, $L = 3.5\ d$

where d = Diameter of the shaft.





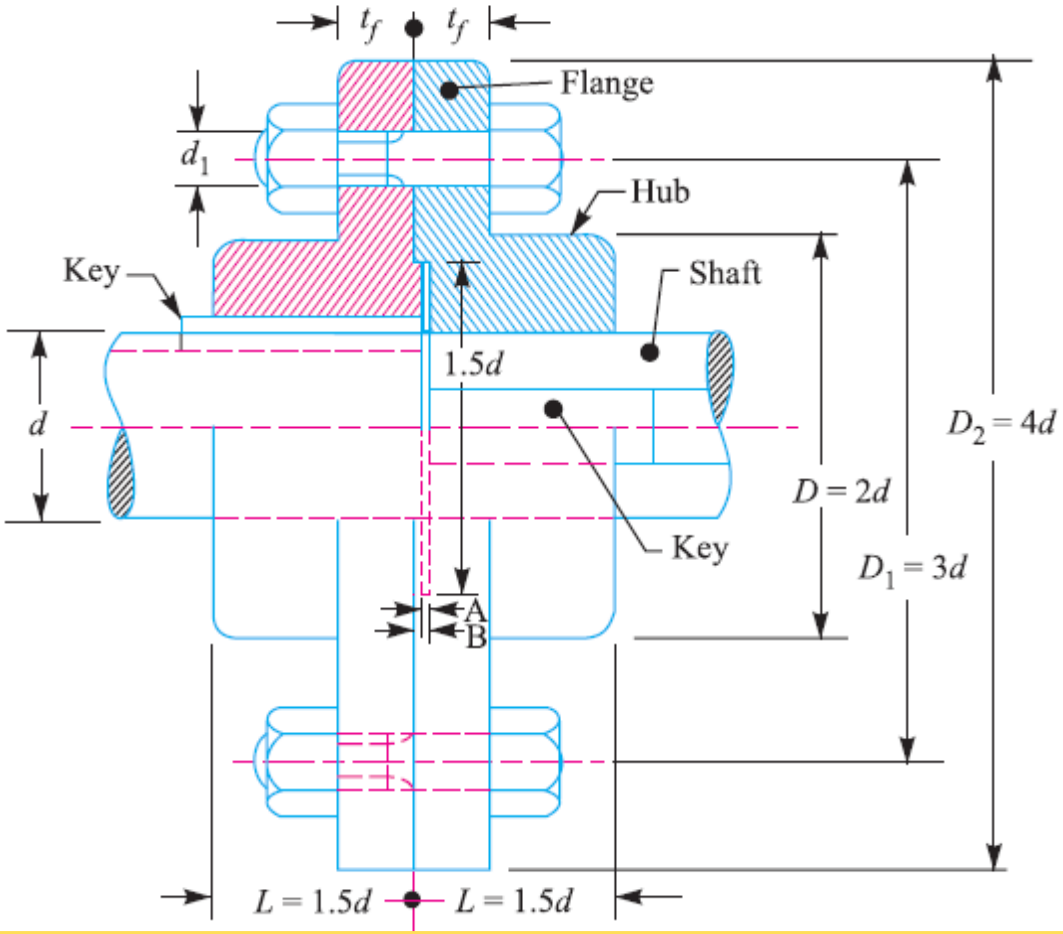
Flange Coupling

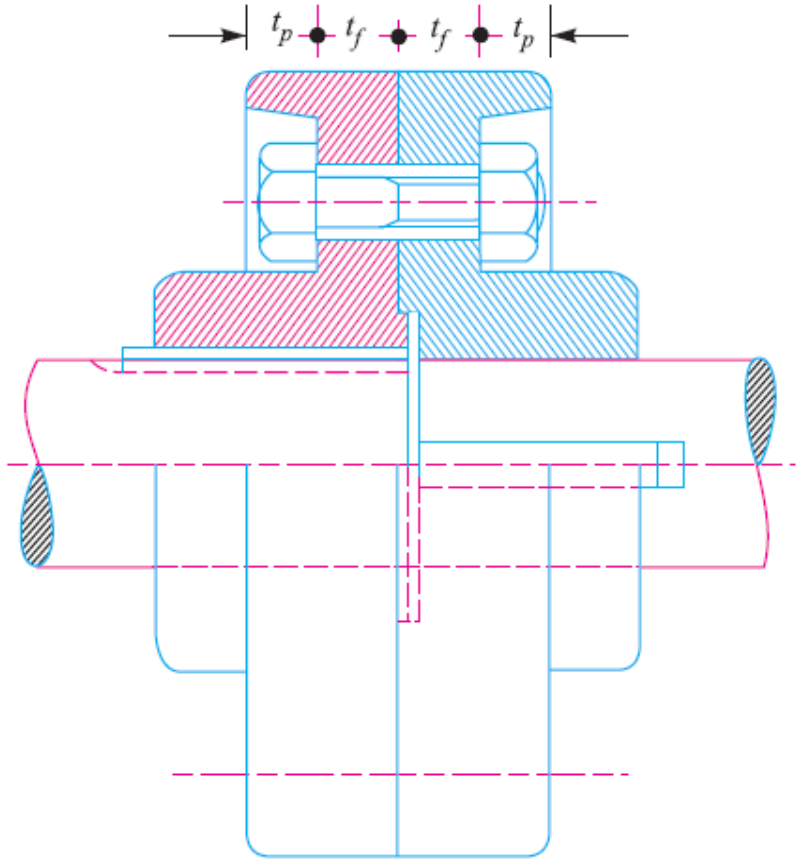
A flange coupling usually applies to a coupling having two separate cast iron flanges. Each flange is mounted on the shaft end and keyed to it. The faces are turned up at right angle to the axis of the shaft. One of the flange has a projected portion and the other flange has a corresponding recess. This helps to bring the shafts into line and to maintain alignment. The two flanges are coupled together by means of bolts and nuts. The flange coupling is adopted to heavy loads and hence it is used on large shafting. The flange couplings are of the following three types :

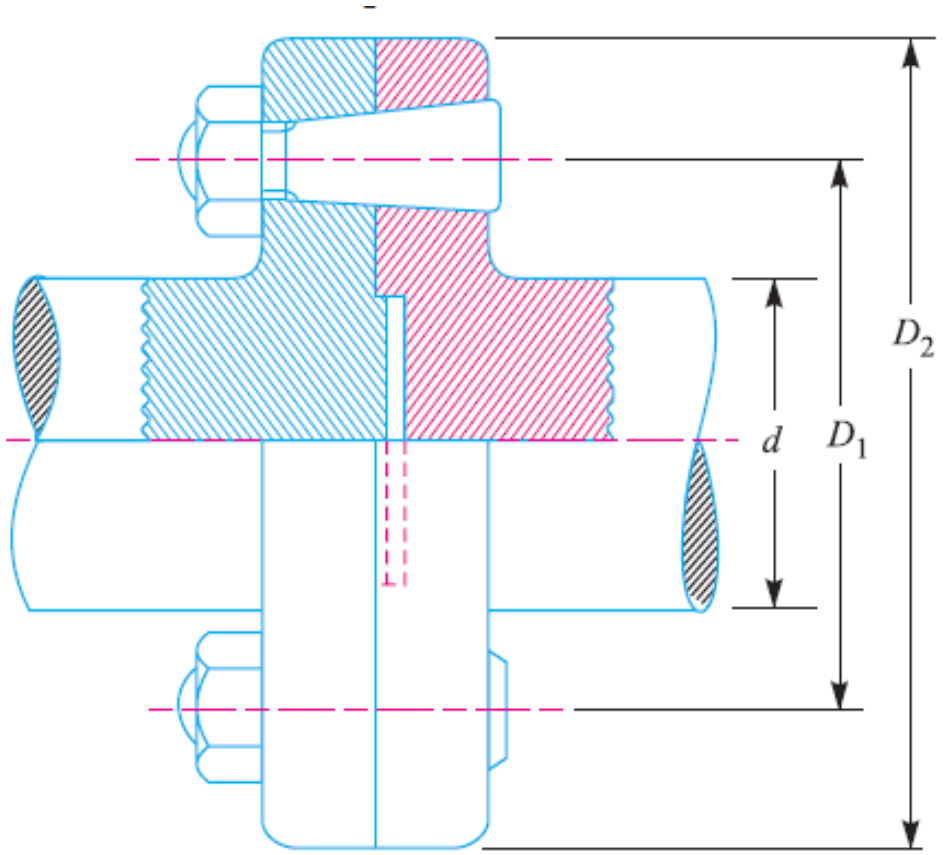
1. ***Unprotected type flange coupling.*** In an unprotected type flange coupling, each shaft is keyed to the boss of a flange with a counter sunk key and the flanges are coupled together by means of bolts. Generally, three, four or six bolts are used. The keys are staggered at right angle along the circumference of the shafts in order to divide the weakening effect caused by keyways.

2. ***Protected type flange coupling.*** In a protected type flange coupling, the protruding bolts and nuts are protected by flanges on the two halves of the coupling, in order to avoid danger to the workman.

3. *Marine type flange coupling.* In a marine type flange coupling, the flanges are forged integral with the shafts. The flanges are held together by means of tapered headless bolts, numbering from four to twelve depending upon the diameter of shaft.



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Bushed-pin Flexible Coupling