Computer Aided Machine Drawing
Assembly Drawing

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Assembly Drawing

- A machine is an assembly of various links or parts.
- It is necessary to understand the relation between the various parts of the unit for the purpose of design and production.
- An assembly drawing is one which represents various parts of a machine in their working position.
- These drawings are classified as design assembly drawings, working assembly drawings, sub-assembly drawings, installation assembly drawings.

Assembly Drawing

- *Design assembly drawing* is an assembly drawing made at *the design stage* while developing a machine.

It is made to a larger scale so that the required changes or modifications may be thought of by the designer, keeping in view both the functional requirement and aesthetic (جمالي) appearance.

- *Working assembly drawing* are normally made for *simple machines*, comprising small number of parts. Each part is completely dimensioned to *facilitate easy fabrication*.

- *A sub-assembly drawing* is an assembly drawing of a group of related parts which form *a part of a complicated machine*. Thus, a number of such sub-assembly drawings are needed to make a *complete unit*.

- *An installation assembly drawing* reveals the relation between different units of a machine, giving location and dimensions of few important parts.

Assembly Drawing – Examples

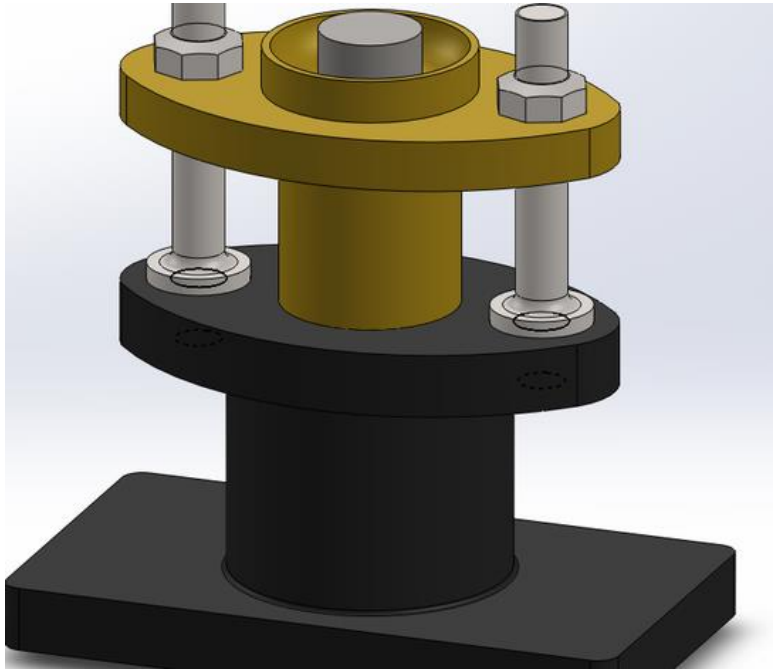
Engine Parts – 1 Stuffing حشو Box

Function:

- It is used to prevent loss of fluid such as steam, between sliding or turning parts of machine elements.
- In a steam engine, when the piston rod reciprocates through the cylinder cover; stuffing box provided in the cylinder cover, prevents leakage of steam from the cylinder.

Components:

1 - Stuffing box body
2 – Glad (سداده)
3 – Bush
4 – Studs and nuts M12



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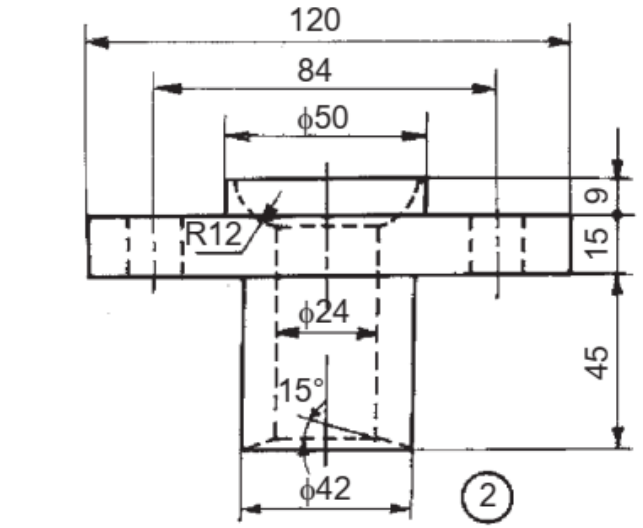
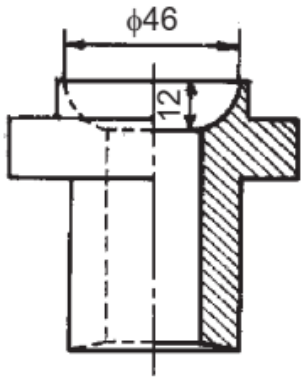
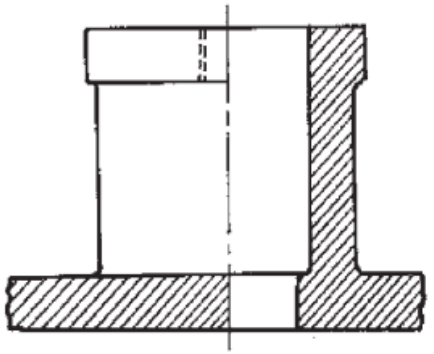
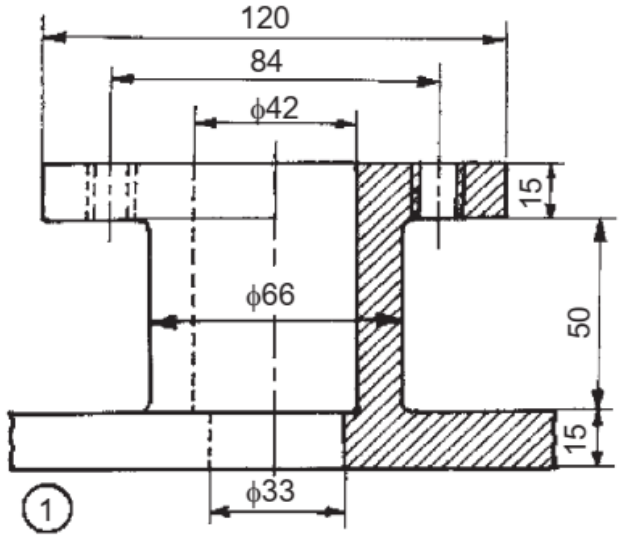
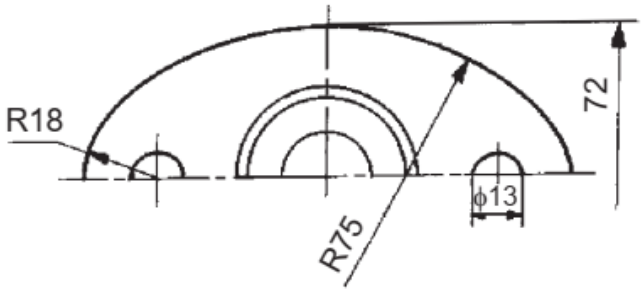
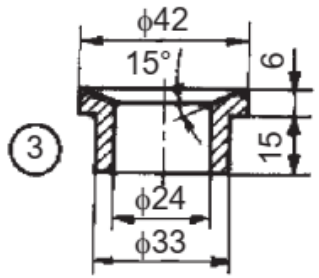


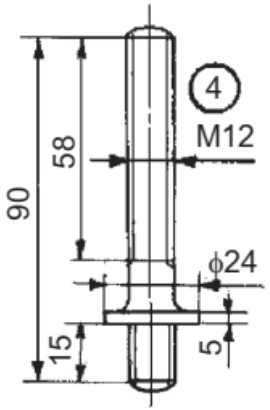


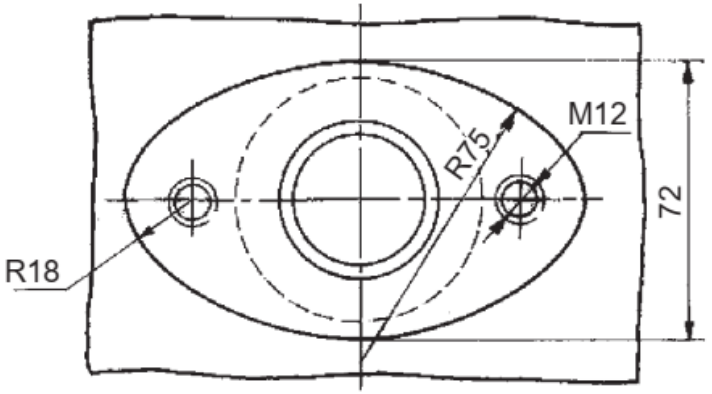












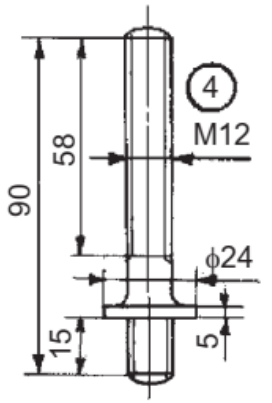
Engine Parts – 1 Stuffing Box

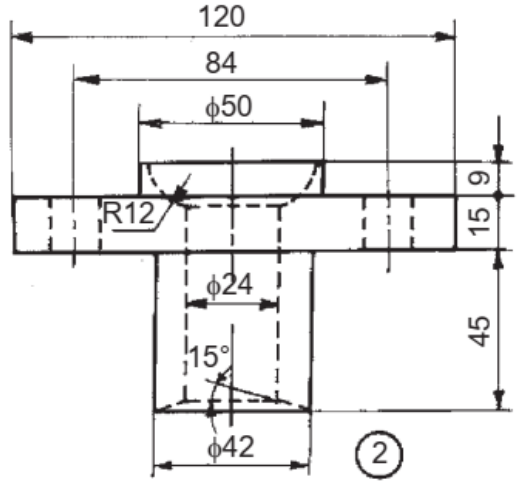
Assembly:

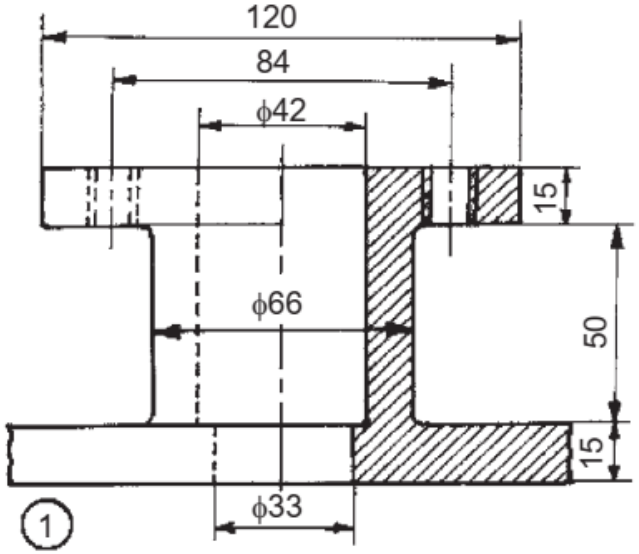
- At the base of stuffing box body 1, a bush 3 is placed such that the beveled (مشطوف) edge of the bush is at the inner side of the body.
- Gland 2 is placed at the other end of the body and is connected to the main body by means of studs 4 and nuts.
- The space between the reciprocating rod and the bush and the gland is packed with a packing material such as mineral fibres (ألياف), leather, rubber.

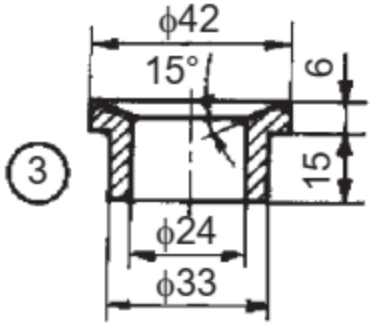
Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Gland	Brass	1
3	Bush	Brass	1
4	Stud	MS	2
5	Nut, M12	MS	2









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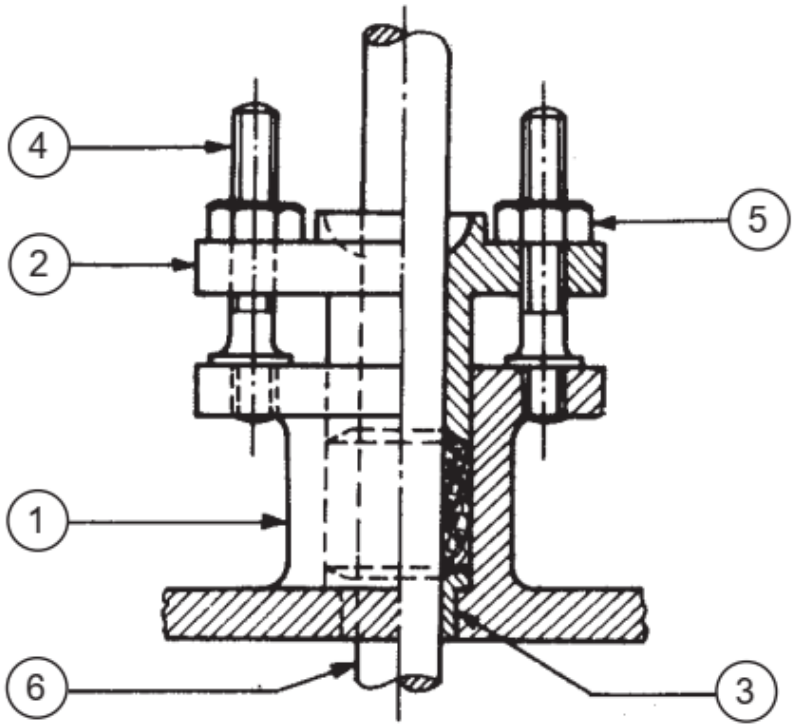
- Gland 2 is placed at the other end of the body and
- is connected to the main body by means of studs 4 and nuts.
- The space between the reciprocating rod and the bush and the gland is packed with a packing material such as mineral fibres (ألياف), leather, rubber.



Parts list

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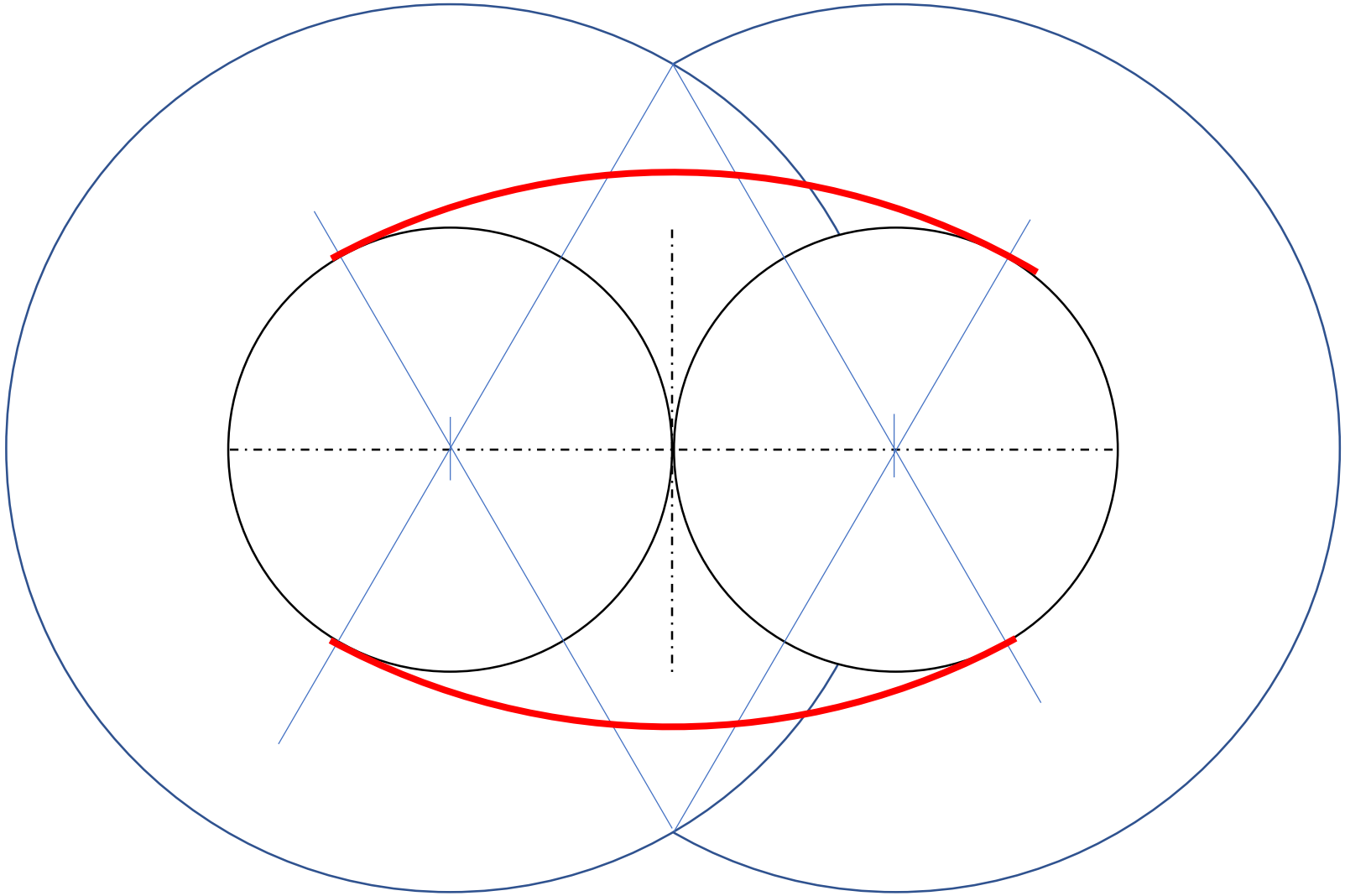
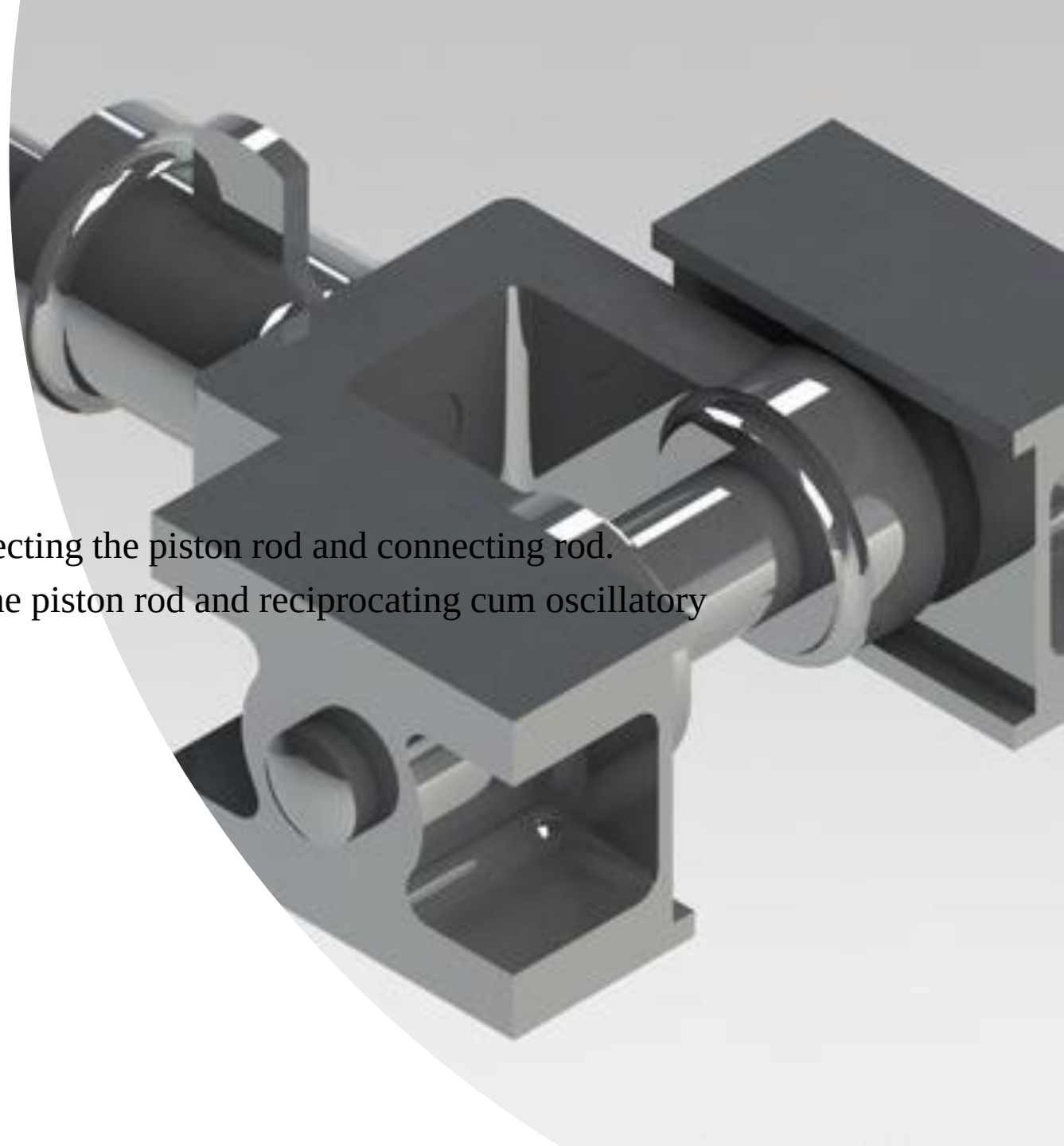
1	Body	CI	1
2	Gland	Brass	1
3	Bush	Brass	1
4	Stud	MS	2
5	Nut, M12	MS	2

Ellipse Drawing



Engine Parts – 2 Steam Engine Crosshead



- *Function:*

  - Crosshead is used in horizontal steam engines for connecting the piston rod and connecting rod.
  - Ensures reciprocating motion along a straight line for the piston rod and reciprocating cum oscillatory motion for the connecting rod.

Components:

- 1 – Crosshead Block
- 2 – Piston rod
- 3 – Gudgeon pin
- 4 – Slide block
- 5 – Cotter

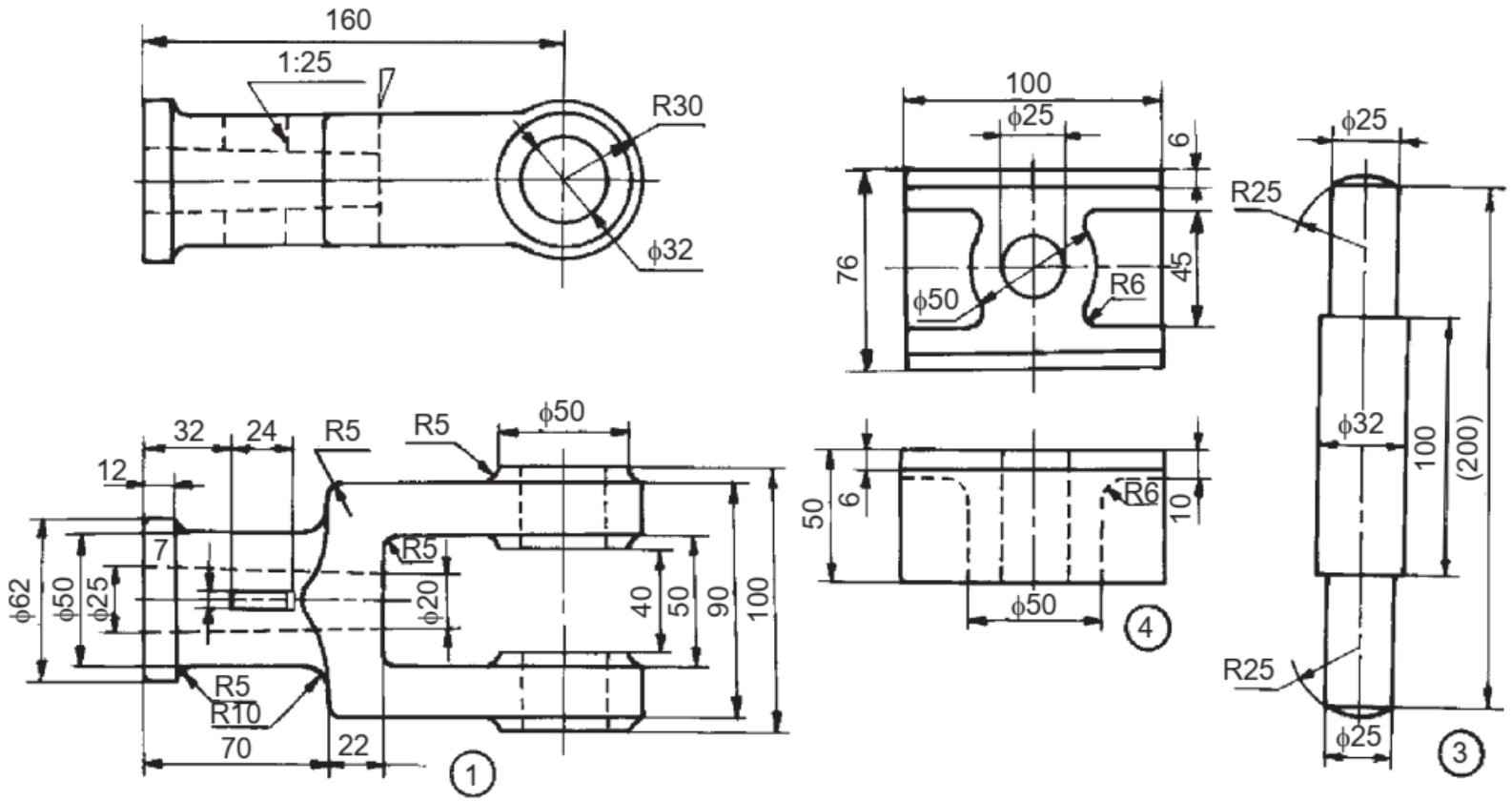
Engine Parts – 2 Steam Engine Crosshead

Components:

1 – Crosshead Block
2 – Piston rod
3 – Gudgeon pin
4 – Slide block
5 – Cotter

Parts list

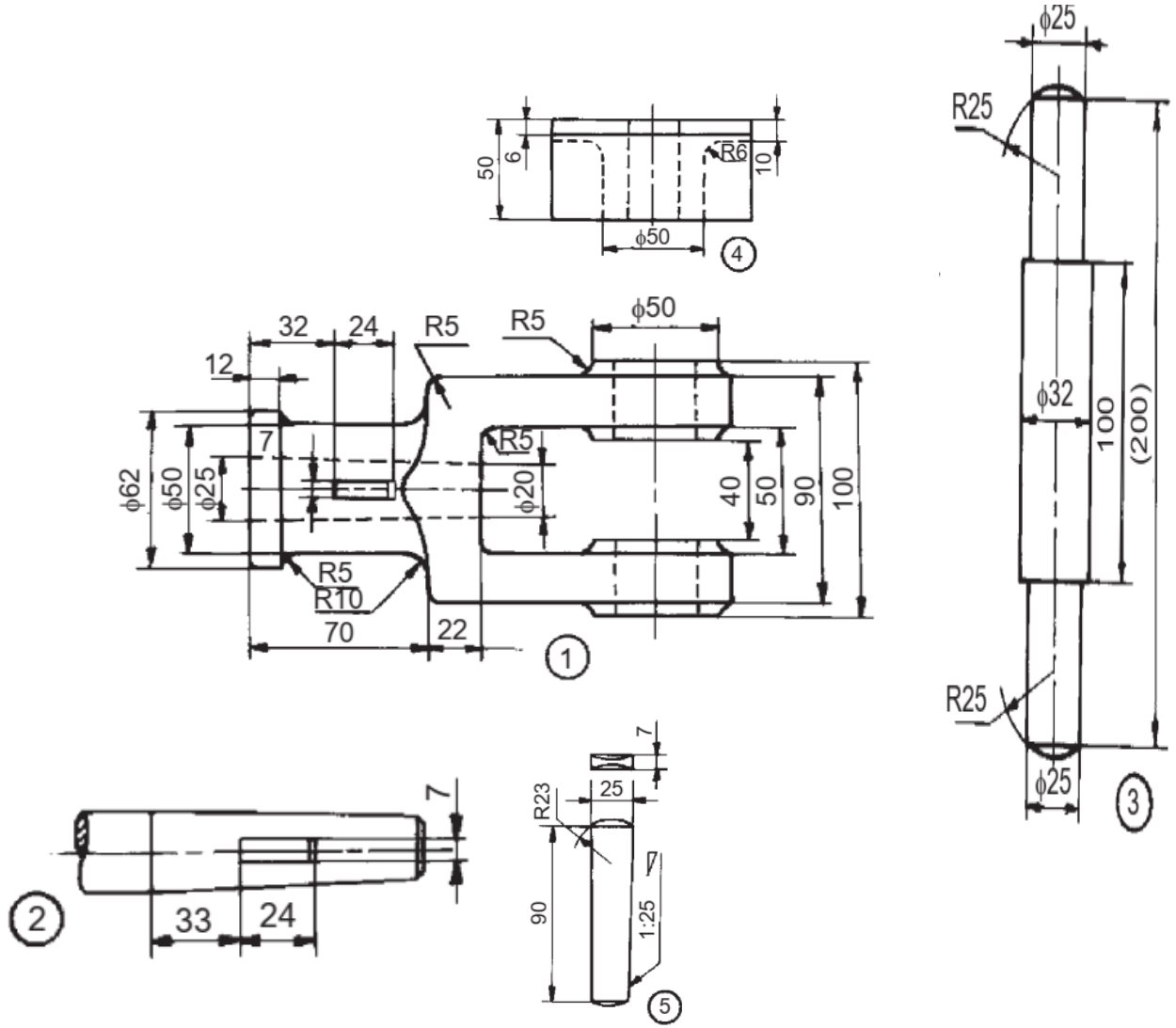
Part No.	Name	Matl	Qty
1	Block	CS	1
2	Piston rod	MS	1
3	Gudgeon pin	MS	1
4	Slide block	CI	2
5	Cotter	MS	1



Engine Parts – 2 Steam Engine Crosshead

Assembly:

- The crosshead, with the help of slide block 4, reciprocates between two guides provided in the engine frame.
- The gudgeon pin 3, connects the slide blocks with the crosshead block 1. This acts as a pin joint for the connecting rod
- The piston rod 2 is secured to the crosshead block by means of the cotter 5.



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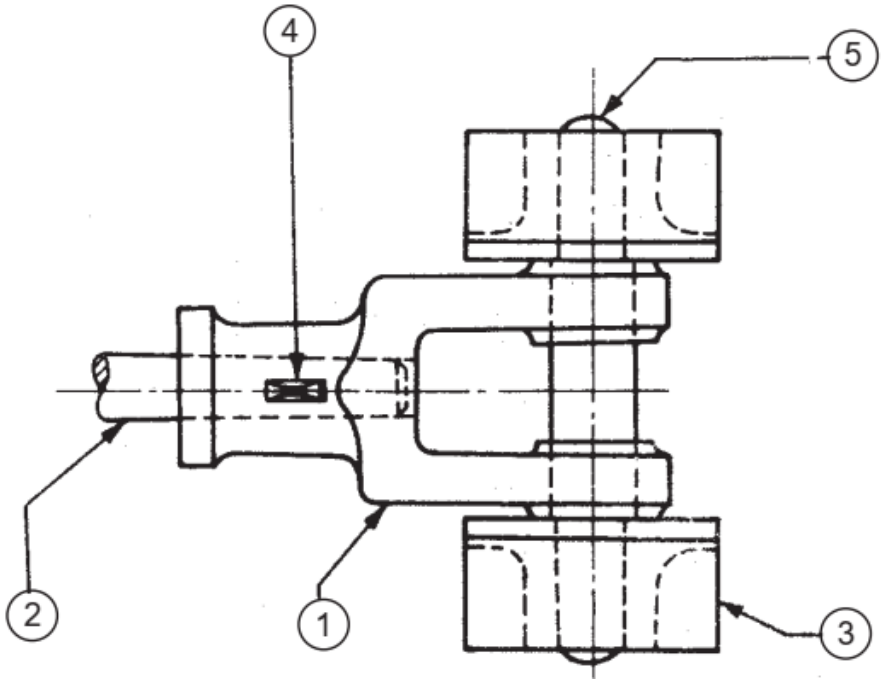
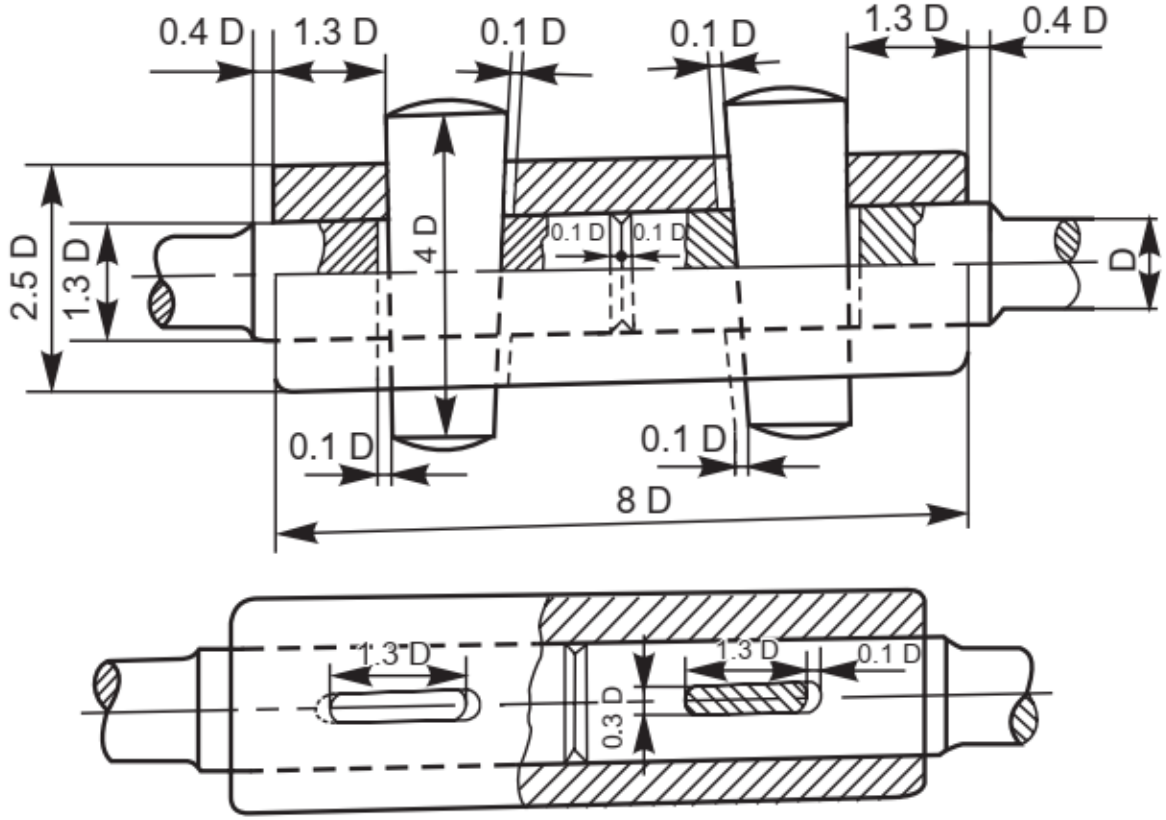
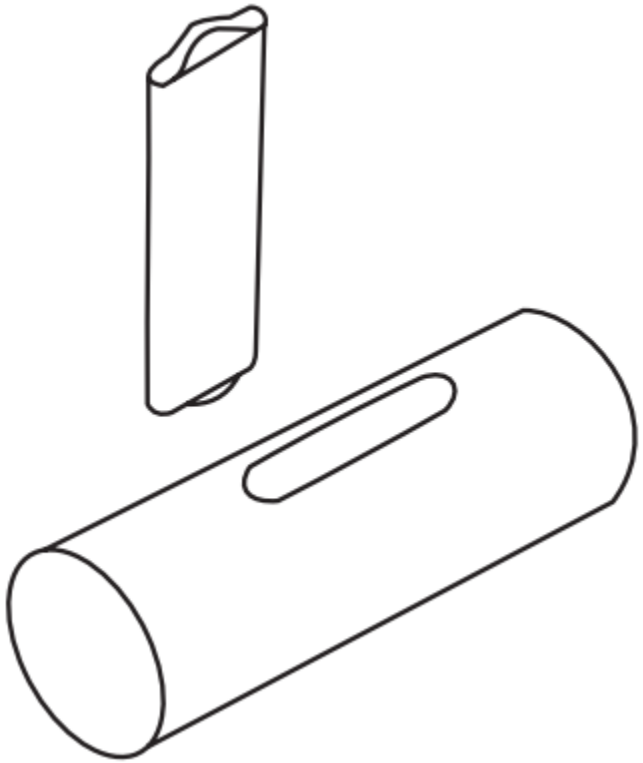


Cotter joints

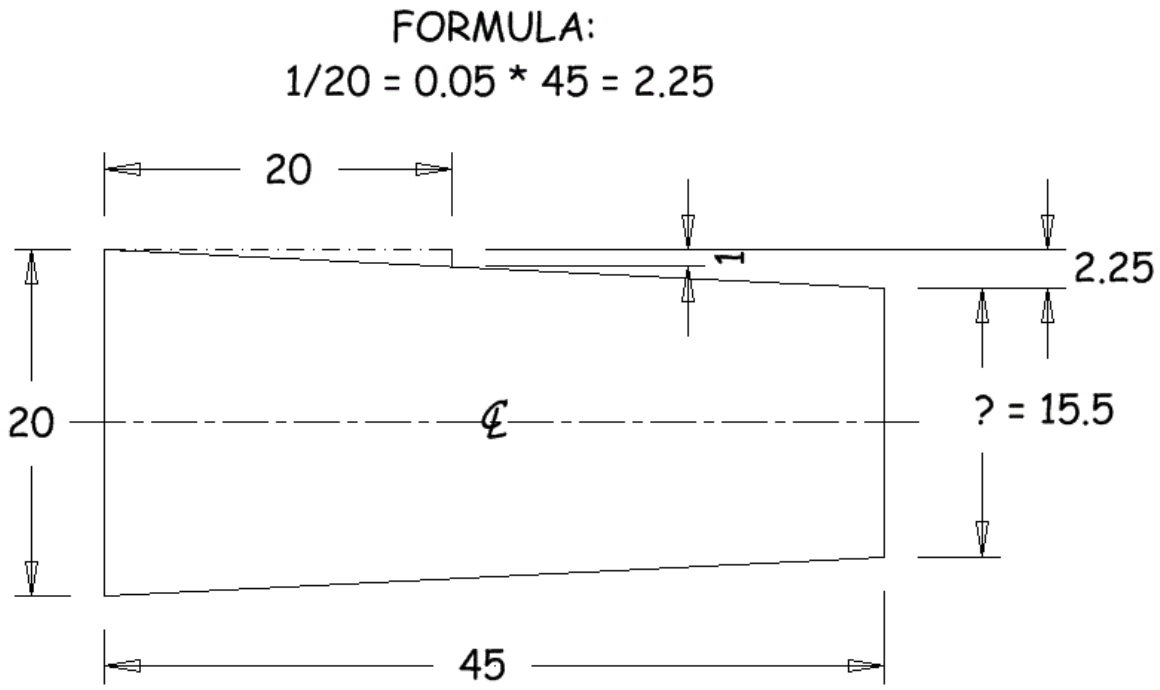
- A cotter is a flat wedge(وتد / مثبت)-shaped piece, made of steel.





Cotter joints

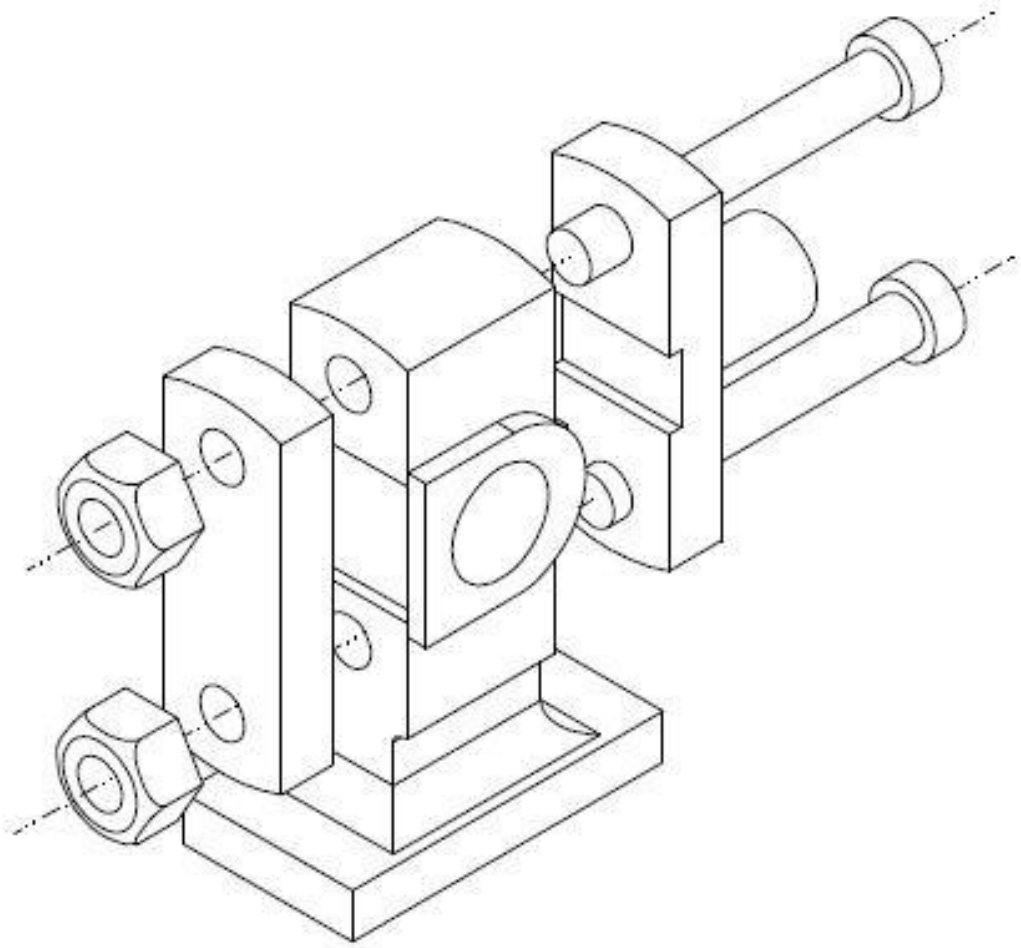
It is uniform in thickness but tapering in width, generally on one side; the usual taper being 1:30.



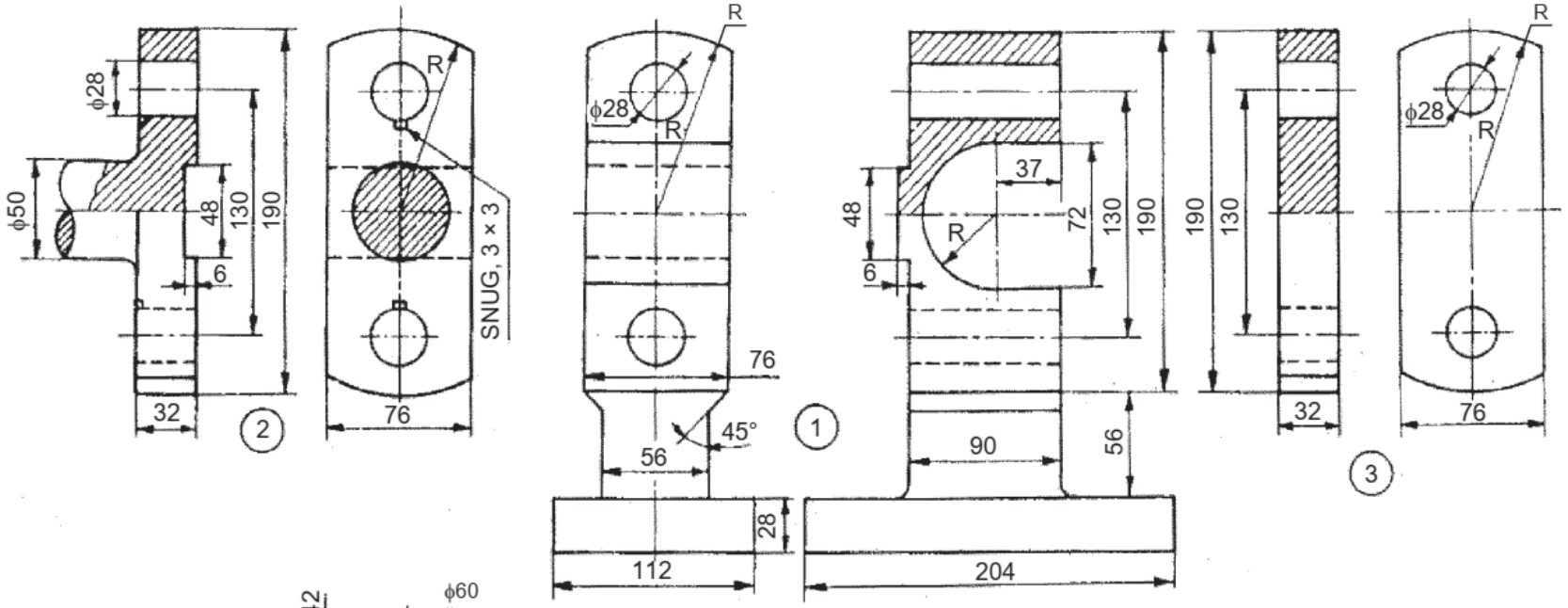
Engine Parts – 3 Steam Engine Crosshead

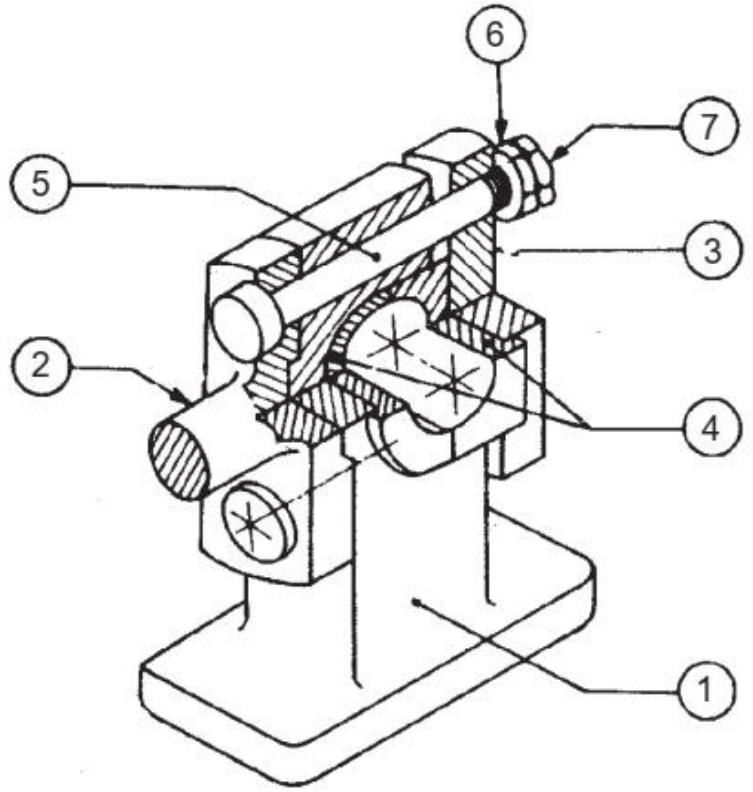
Components:

1 – Body
2 – Rod end
3 – Cover plate
4 – Brasses
5 – Bolt
6 – Nut
7 – Lock nut



Engine Parts – 3 Steam Engine Crosshead





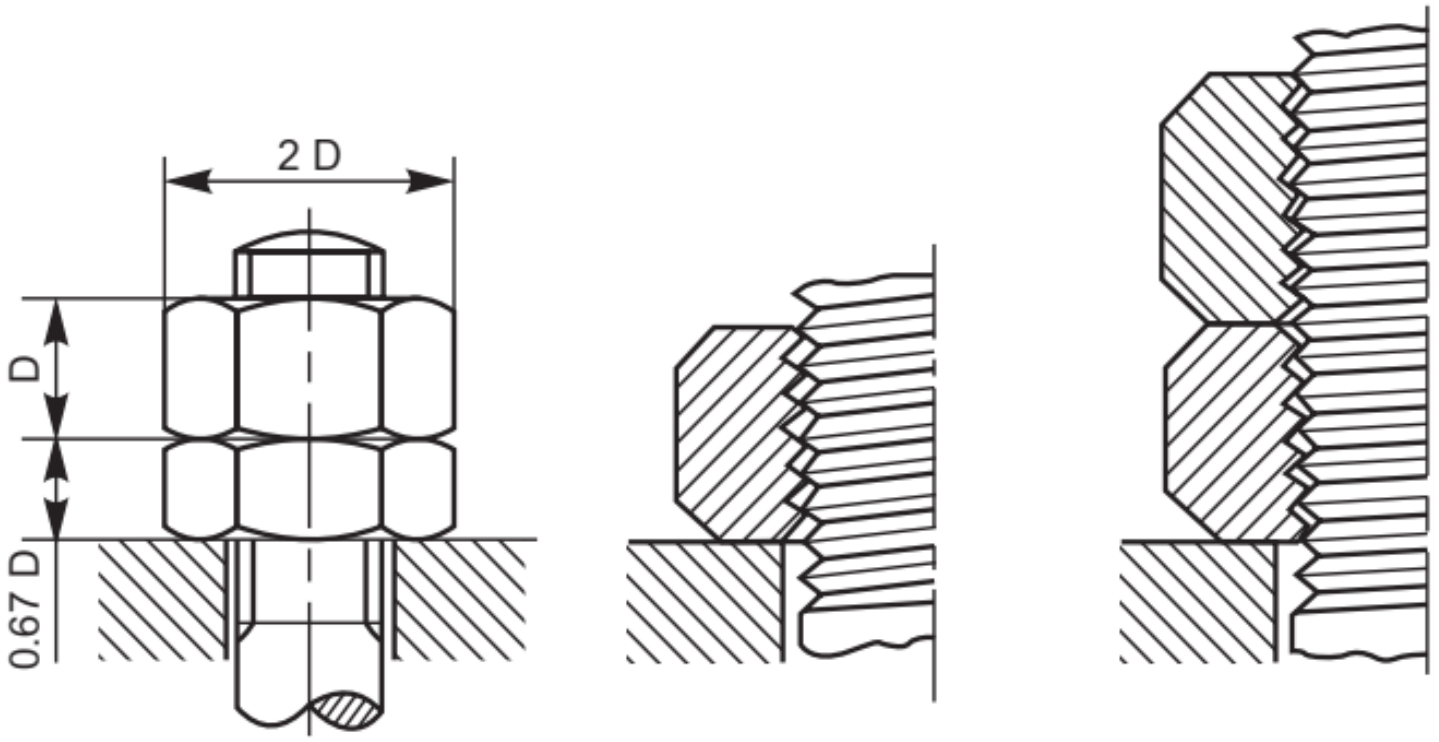
Parts list

Sl. No.	Name	Matl	Qty
1	Body	CI	1
2	Rod end	MS	1
3	Cover plate	MS	1
4	Brasses	Brass	1
5	Bolt	—	2
6	Nut	—	2
7	Lock nut	—	2

It consists of a body or slide block 1, which slides in-between parallel guides in the frame of the engine. The piston rod end 2 is fitted to the crosshead with the help of bolts 5 and nuts 6 and 7 after placing the brasses 4, and cover plate 3 in position.

Lock nut

- This is the most commonly used locking device.
- The thickness of a lock nut is usually two-thirds D, where D is the major diameter of the bolt.
- The lock nut may be placed below the standard nut or vice versa.



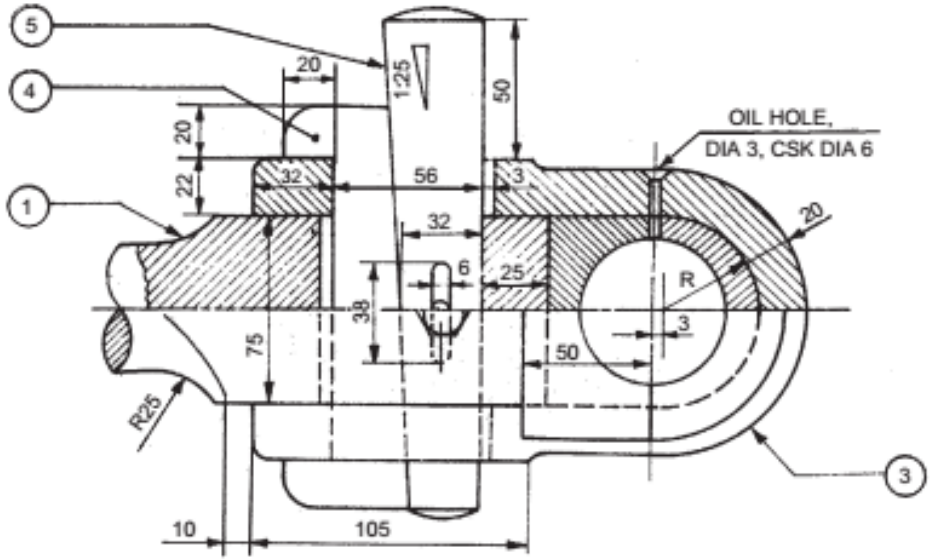
Engine Parts – 4 Steam Engine Connecting Rod End

Function:

- Connecting rod in a steam engine connects the crosshead at one end (small end) and the crank at the other end (big end).
- The cross-section of the connecting rod can be square/circular in shape.

Components:

1 – Connecting rod
2 – Brasses
3 – Strap
4 – Jib
5 – Cotter
6 – Set Screw



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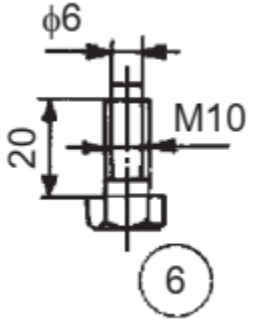
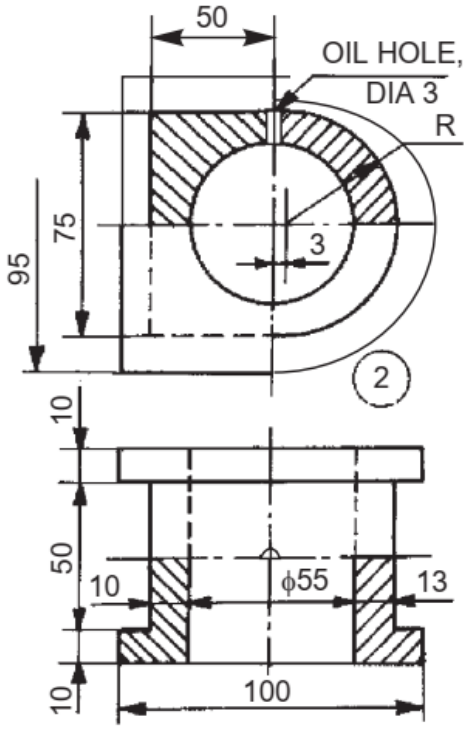
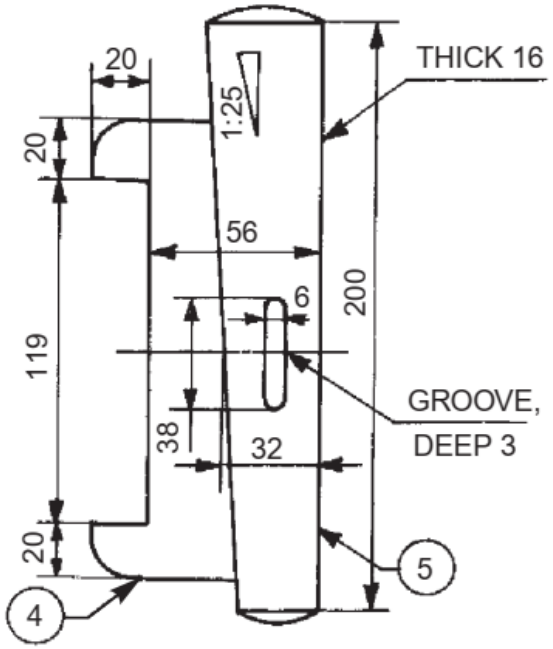
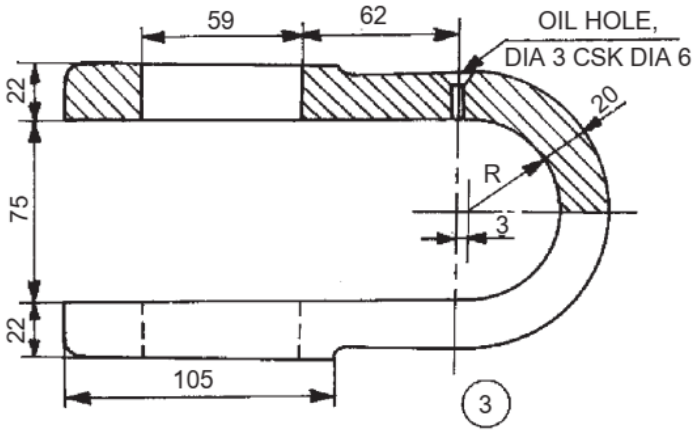


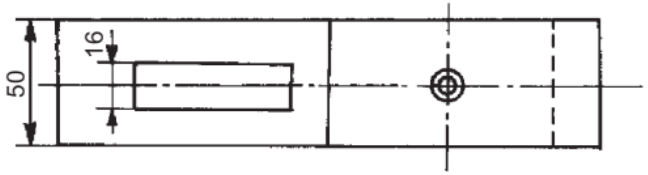
Parts list

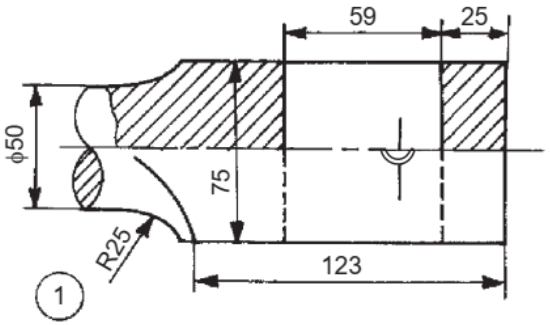
Part No.	Name	Matl.	Qty.
1	Connecting rod	FS	1
2	Brasses	GM	2
3	Strap	MS	1
4	Jib	MS	1
5	Cotter	MCS	1
6	Set-screw	MCS	1

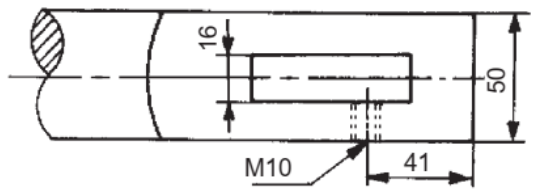




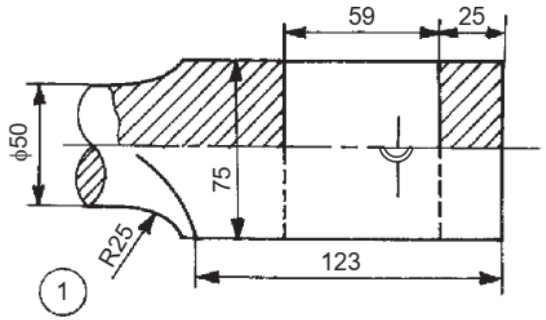






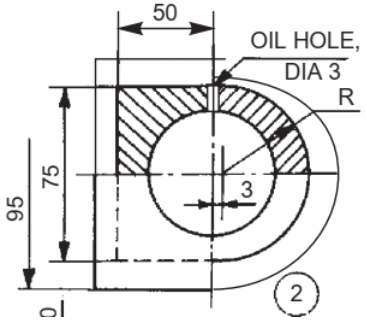


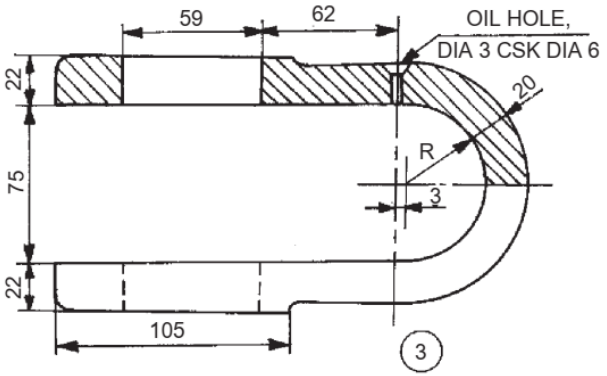
Engine Parts – 4 Steam Engine Connecting Rod End



Assembly:

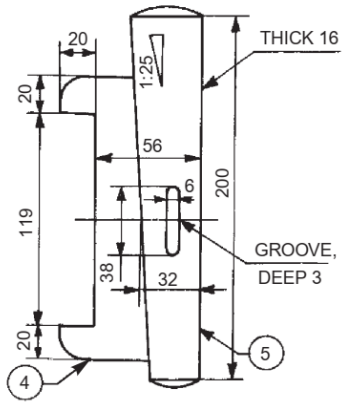
- Strap 3 connects both the square end of the connecting rod 1 and the brasses 2.
- The strap is fastened to the rod by jib 4 and cotter 5.
- Finally, the cotter is locked in position by the set-screw 6.

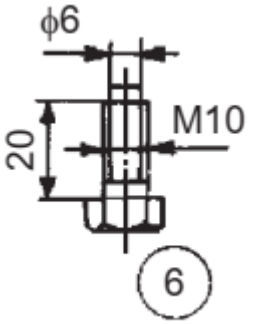




Parts list

Part No.	Name	Matl.	Qty.
1	Connecting rod	FS	1
2	Brasses	GM	2
3	Strap	MS	1
4	Jib	MS	1
5	Cotter	MCS	1
6	Set-screw	MCS	1

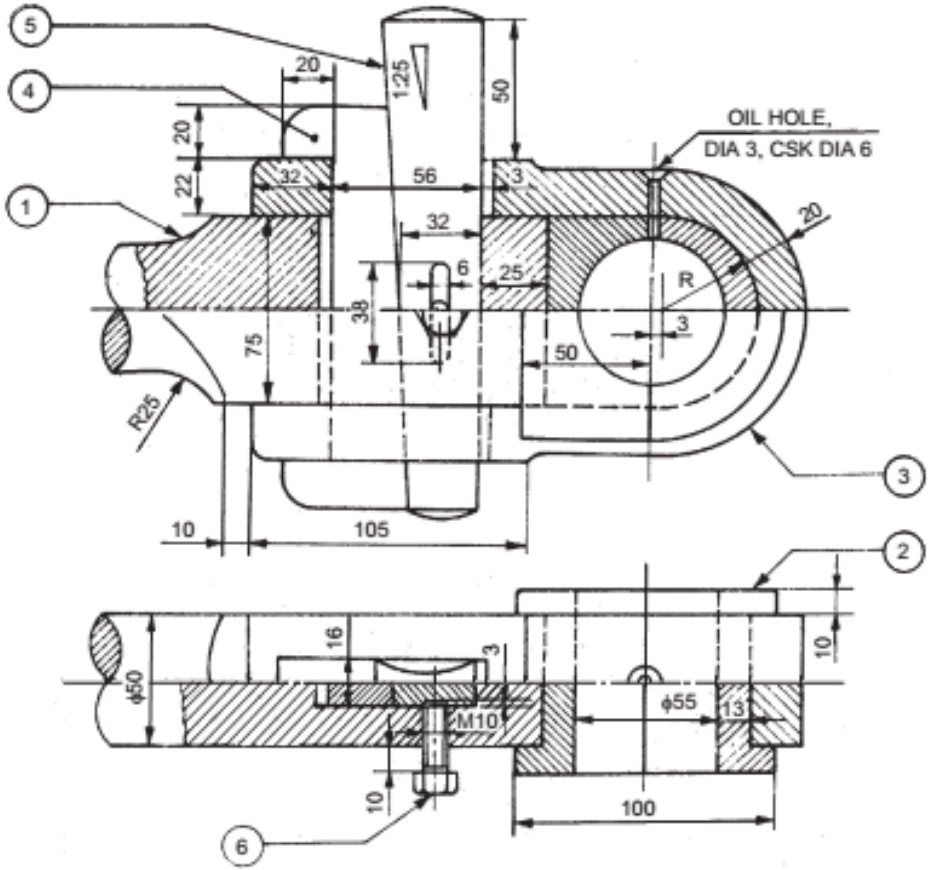




Engine Parts – 4 Steam Engine Connecting Rod End

Assembly:

- Strap 3 connects both the square end of the connecting rod 1 and the brasses 2.
- The strap is fastened to the rod by jib 4 and cotter 5.
- Finally, the cotter is locked in position by the set-screw 6.



Parts list

Part No.	Name	Matl.	Qty.
1	Connecting rod	FS	1
2	Brasses	GM	2
3	Strap	MS	1
4	Jib	MS	1
5	Cotter	MCS	1
6	Set-screw	MCS	1

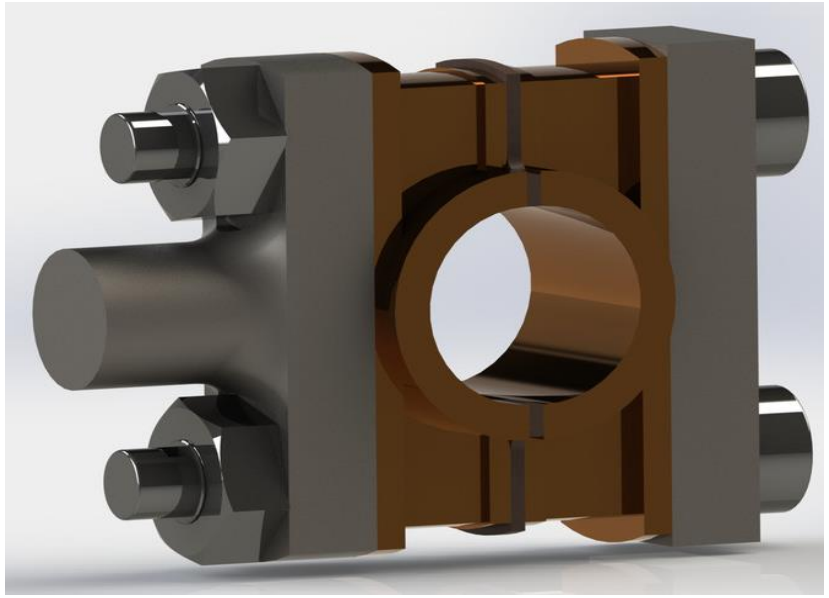
Engine Parts – 5 Marine Engine Connecting Rod End

Function:

- Marine engines are used to produce high power as such all parts of the engine are sturdy (متين) and strong.

Components:

1 – Rod end
2 – Cover end
3 – Bearing brass
4 – Bolt
5 – Split Cotter
6 – Snug
7 – Leather packing



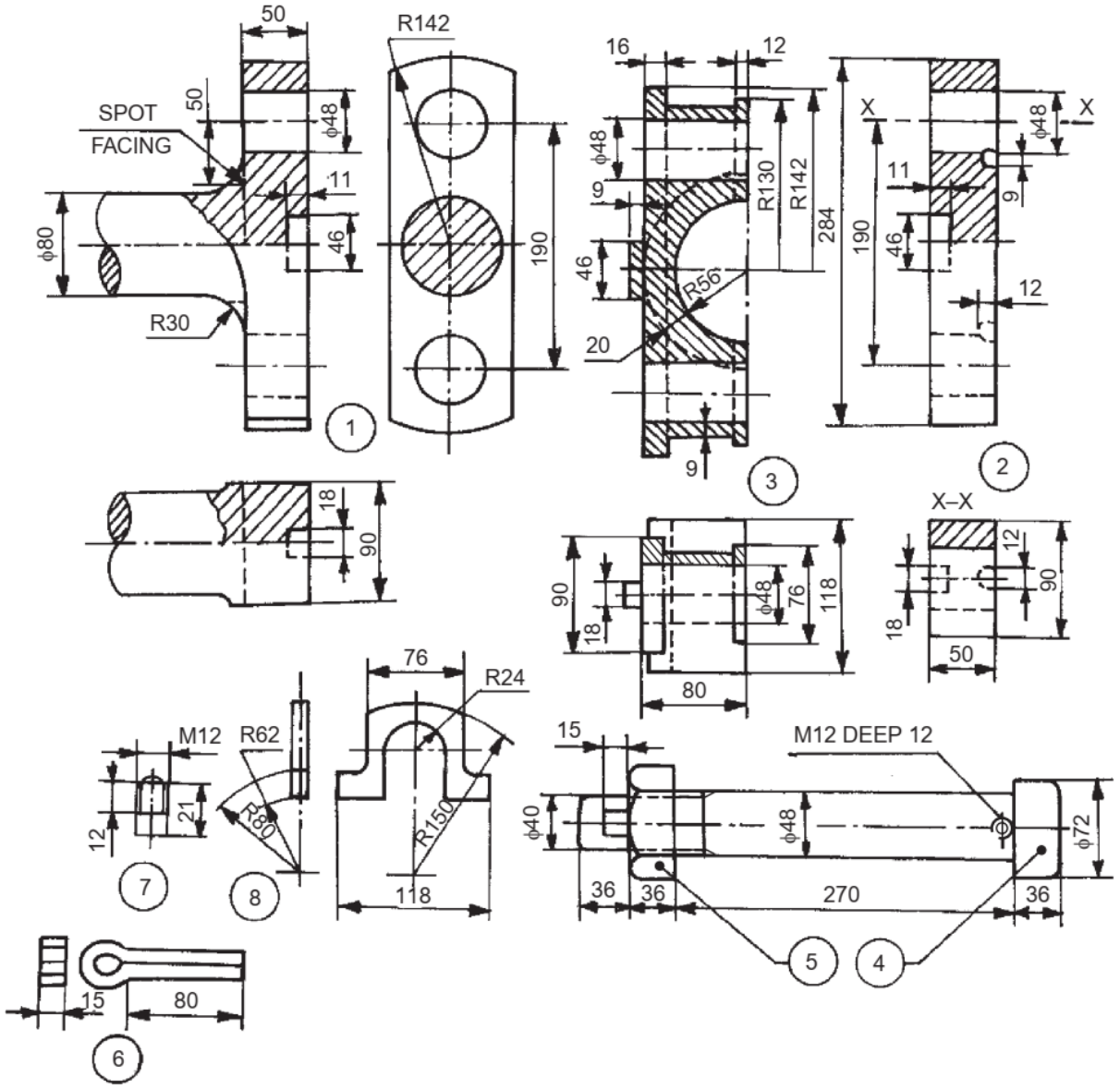
Engine Parts – 5 Marine Engine Connecting Rod End

Components:

1 – Rod end
2 – Cover end
3 – Bearing brass
4 – Bolt
5 – Nut
6 – Split Cotter
7 – Snug
8 – Leather packing

Parts list

Sl. No.	Name	Matl.	Qty.
1	Rod end	FS	1
2	Cover end	FS	1
3	Bearing brass	GM	2
4	Bolt	MS	2
5	Nut	MS	2
6	Split cotter	MS	2
7	Snug	MS	2
8	Leather packing	—	2



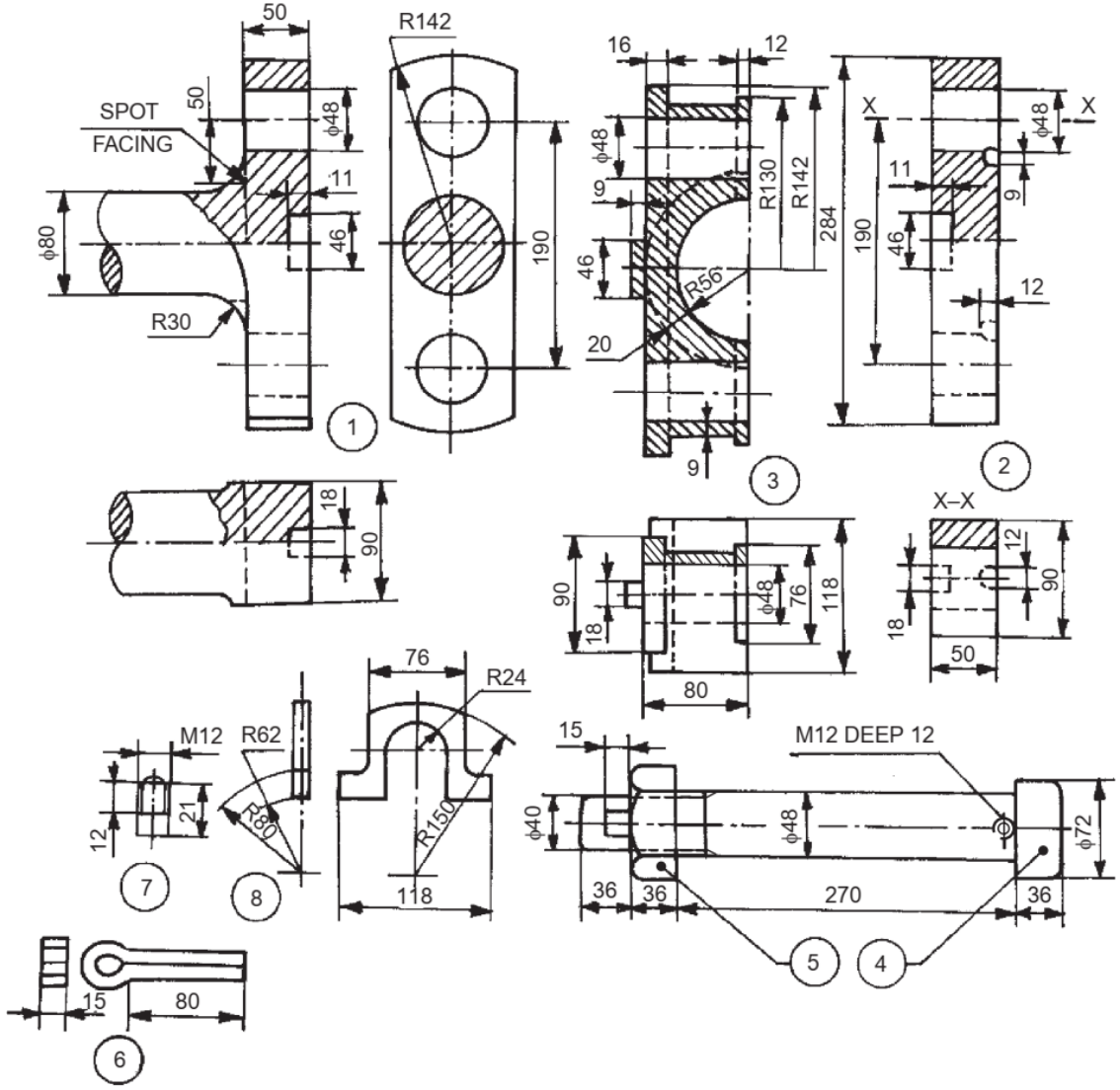
Engine Parts – 5 Marine Engine Connecting Rod End

Assembly:

- It consists of two halves of the bearing brasses 3,
- The cover end 2 and the rod end 1 are placed in position and fastened by means of bolts 4 and nuts 5,
- after placing the leather packing 8 in-between the bearing brasses.
- Snug 7 in the bolts, prevents rotation of the bolts while they are tightened with the nuts.
- Split cotters 6 are used to prevent the loosening tendency of the nuts.

Parts list

Sl. No.	Name	Matl.	Qty.
1	Rod end	FS	1
2	Cover end	FS	1
3	Bearing brass	GM	2
4	Bolt	MS	2
5	Nut	MS	2
6	Split cotter	MS	2
7	Snug	MS	2
8	Leather packing	—	2



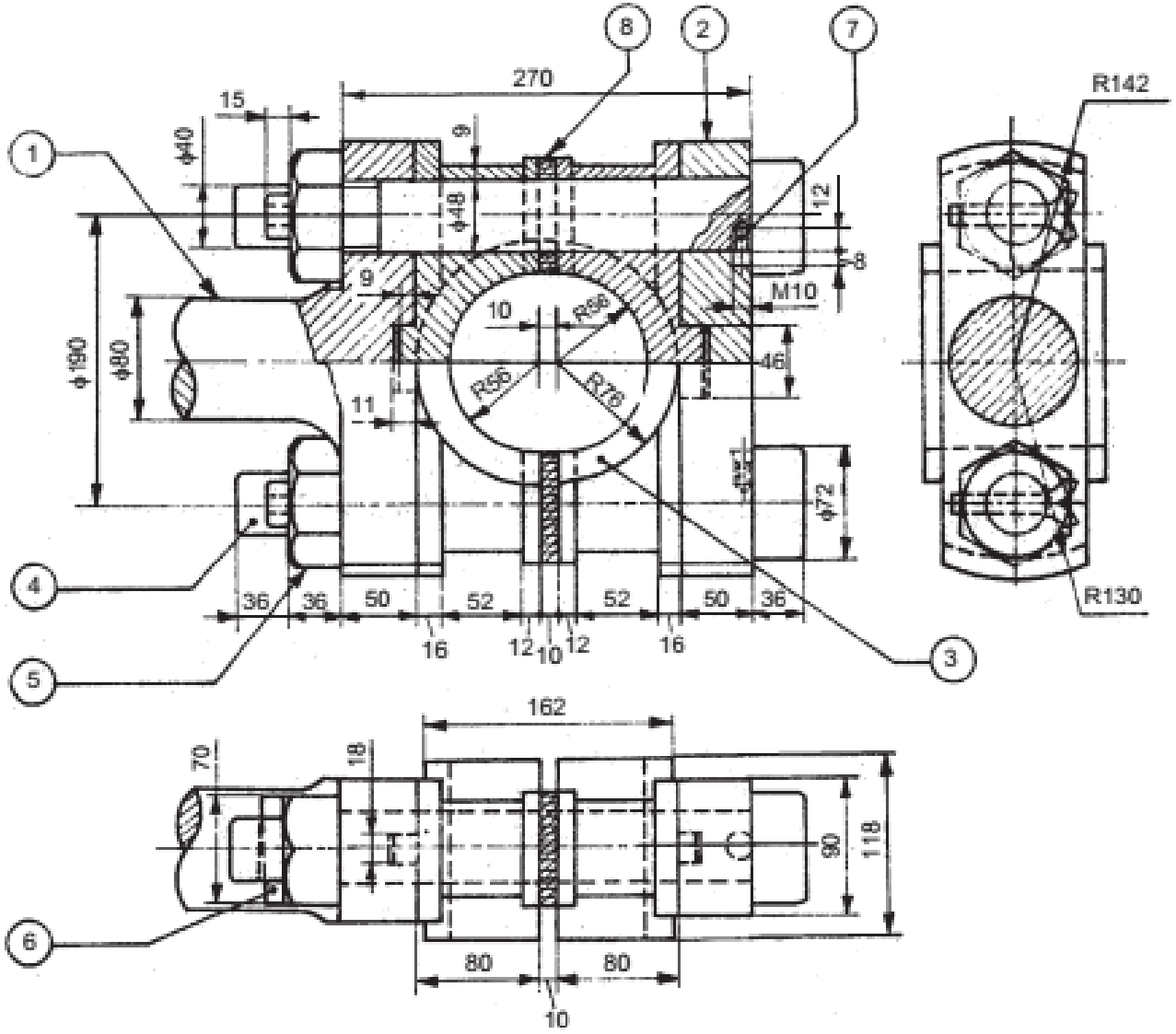
Engine Parts – 5 Marine Engine Connecting Rod End

Components:

1 – Rod end
2 – Cover end
3 – Bearing brass
4 – Bolt
5 – Split Cotter
6 – Snug
7 – Leather packing

Parts list

Sl. No.	Name	Matl.	Qty.
1	Rod end	FS	1
2	Cover end	FS	1
3	Bearing brass	GM	2
4	Bolt	MS	2
5	Nut	MS	2
6	Split cotter	MS	2
7	Snug	MS	2
8	Leather packing	—	2



Machine tools – 6 Single Tool Post

Function:

- Tool posts of several designs are available to support and hold the cutting tools in lathe machines.
- which supports one cutting tool at a time and is used on small sized lathes.
- This unit is fixed on the compound rest of the lathe carriage.

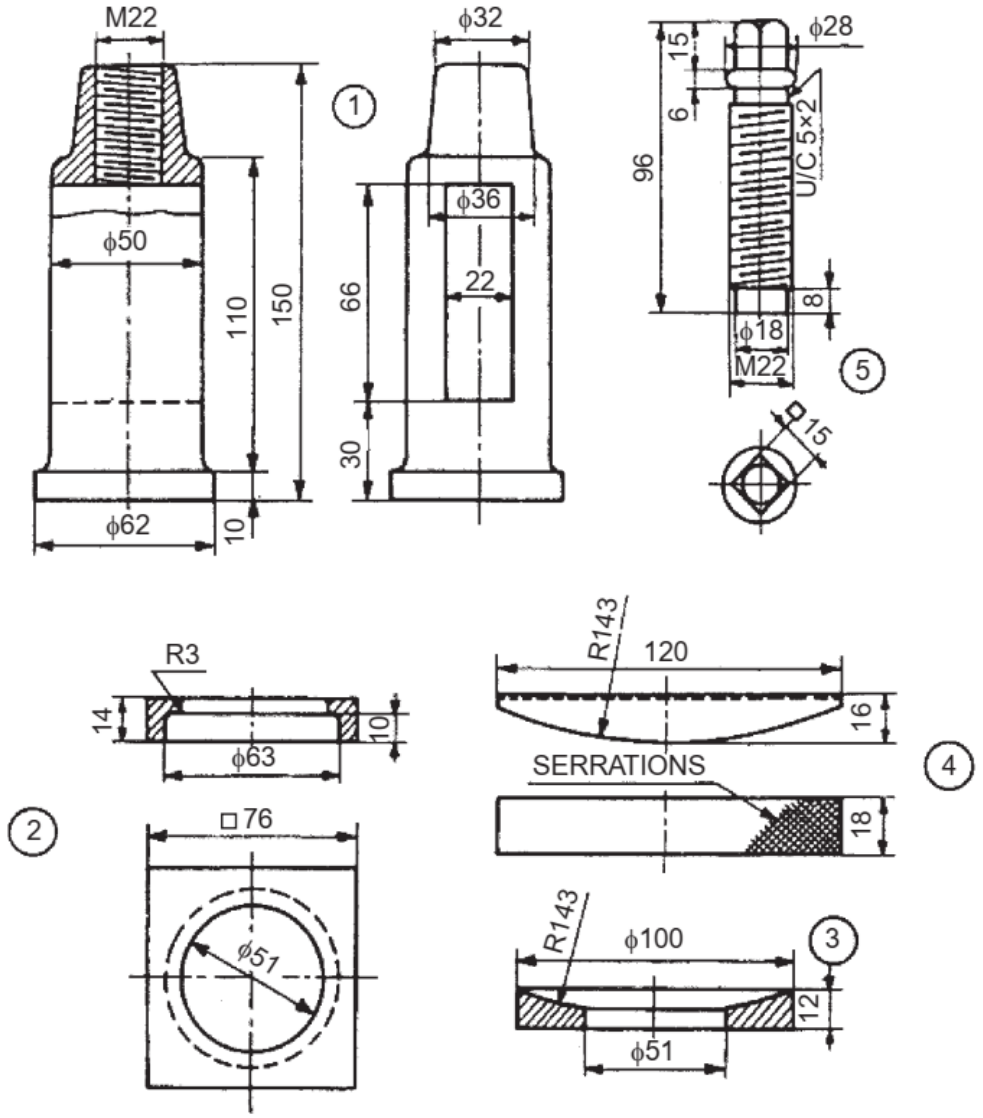
Components:

1 – Piller
2 – Block
3 – Wedge
4 – Ring
5 – Screw

Machine tools – 6 Single Tool Post

Components:

1 – Piller
2 – Block
3 – Wedge وتد/مثبت
4 – Ring
5 – Screw



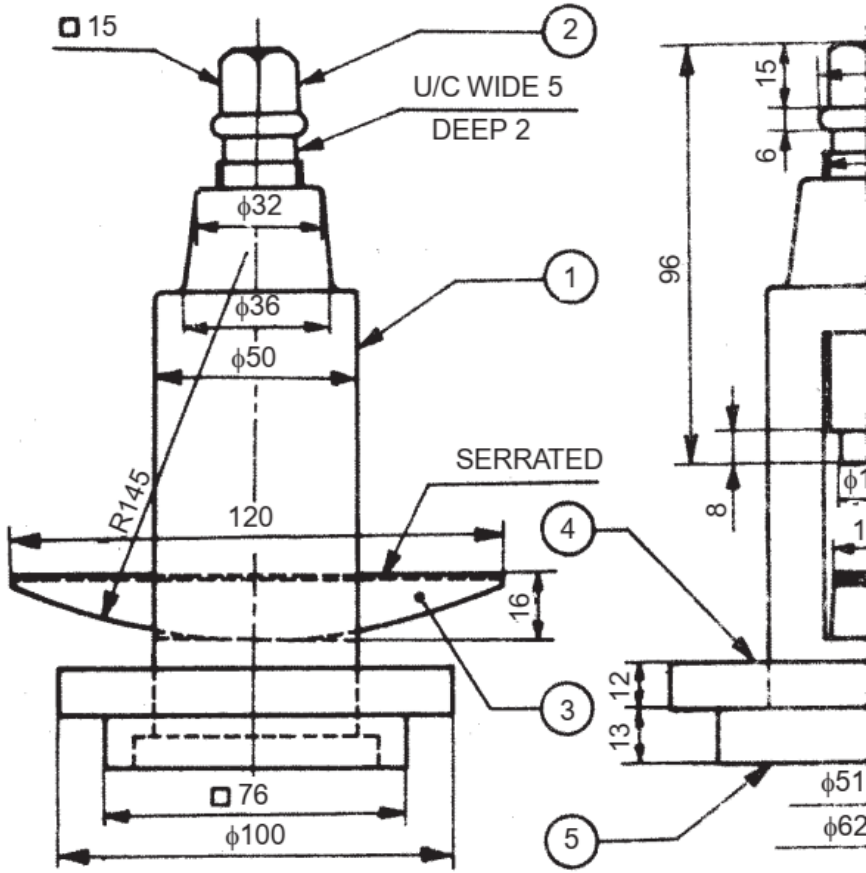
Machine tools – 6 Single Tool Post

Parts list

Part No.	Name	Matl.	Qty.
1	Body	MS	1
2	Clamp screw	MCS	1
3	Wedge	CI	1
4	Ring	MS	1
5	Square block	MS	1

Assembly:

- The single tool post consists of a circular body 1 with a collar (طوق) at one end and a threaded hole at the other.
- A vertical slot is provided in the body to accommodate the tool/tool holder.
- The body is slid through the square block 5, which is finally located in the T-slot, provided in the compound rest.
- The design permits rotation of the body about the vertical axis.
- A circular ring 4 having spherical top surface is slid over the body and the wedge 3 is located in the vertical slot.
- The tool / tool holder is placed over the wedge.
- By sliding the wedge on the ring, the tool tip level can be adjusted.
- The tool is clamped in position by means of the square headed clamping screw 2, passing through the head of the body.



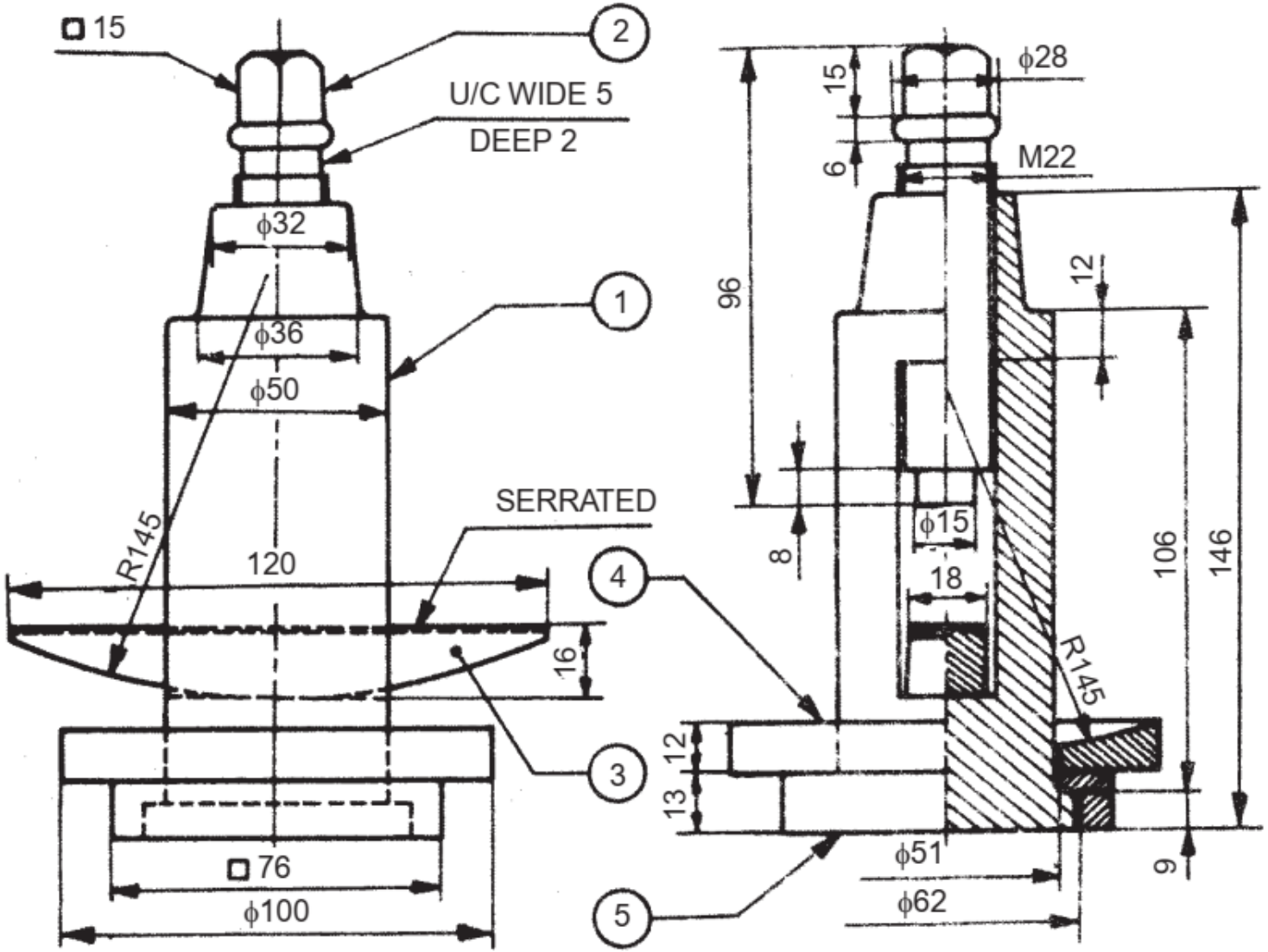
Parts 3 and 4 are reversed in the figure.

Machine tools – 6 Single Tool Post

Parts list

Part No.	Name	Matl.	Qty.
1	Body	MS	1
2	Clamp screw	MCS	1
3	Wedge	CI	1
4	Ring	MS	1
5	Square block	MS	1

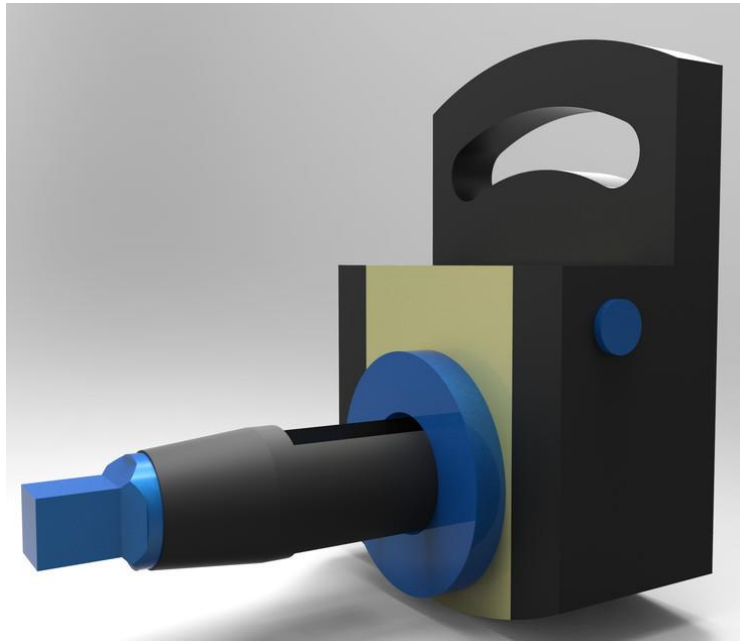
Parts 3 and 4 are reversed in the figure.



Machine tools – 7 Clapper Block

Function:

- It is a sub-assembly of the tool head of a shaping machine.
- It is used for holding the shaper cutting tool.
- The design of the clapper block is such that it relieves يزيح the tool during the return stroke.



Components:

1 – Swivel plate
2 – Drag release plate
3 – Pin
4 – Tool holder
5 – Tool clamping Screw
6 - Washer

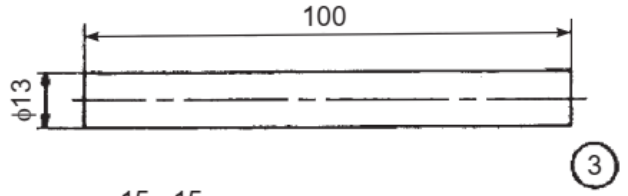
Machine tools – 7 Clapper Block

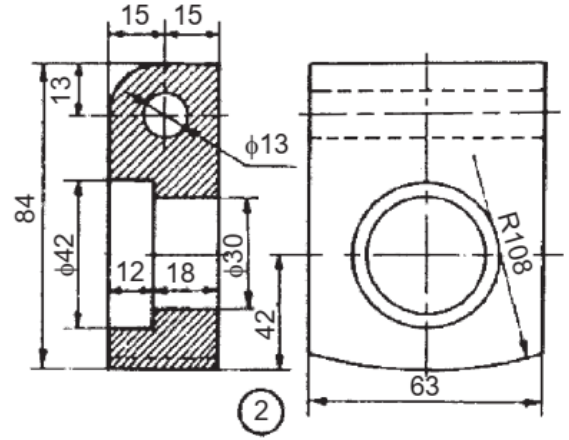
Components:

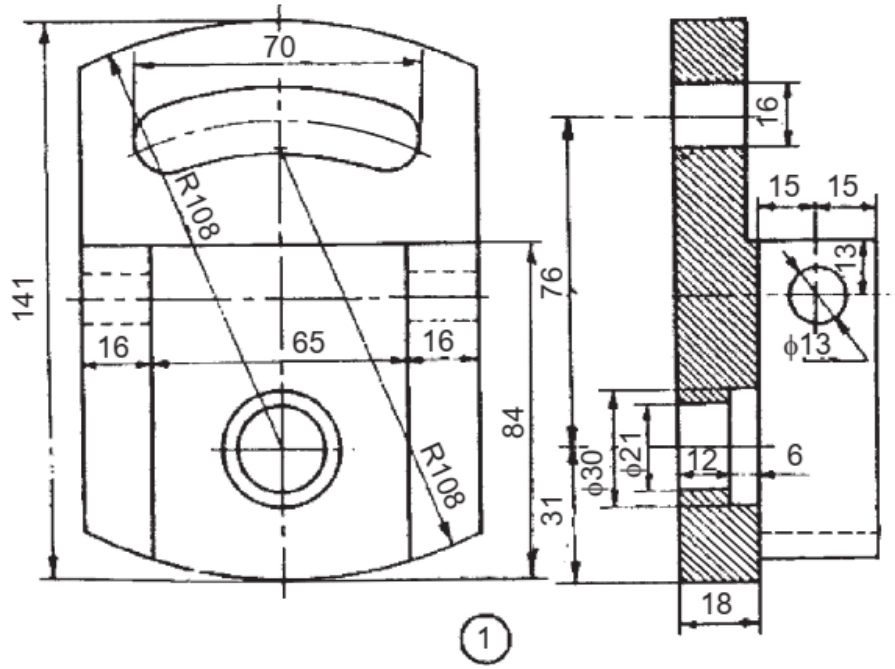
1 – Swivel plate
2 – Drag release plate
3 – Pin
4 – Tool holder
5 – Tool clamping Screw
6 - Washer

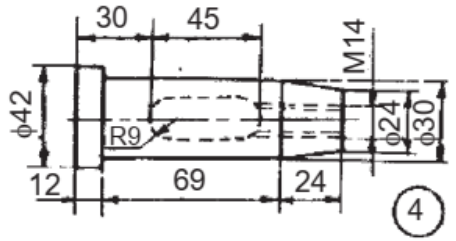
Parts list

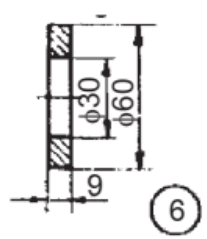
Part No.	Name	Matl	Qty
1	Swivel plate	CI	1
2	Drag release plate	CI	1
3	Pin	MS	1
4	Tool holder	MCS	1
5	Tool clamping screw	MS	1
6	Washer	MS	1

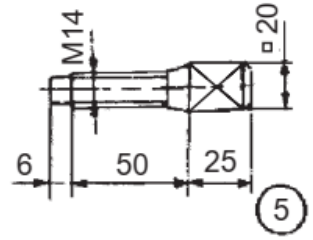




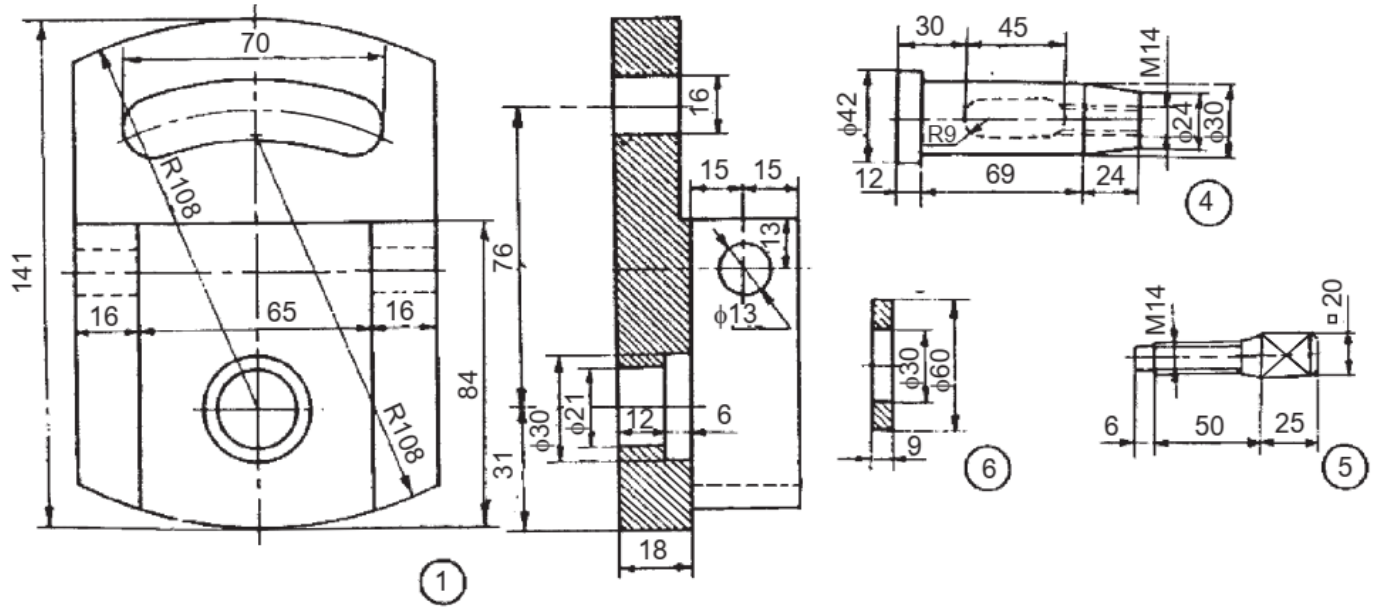


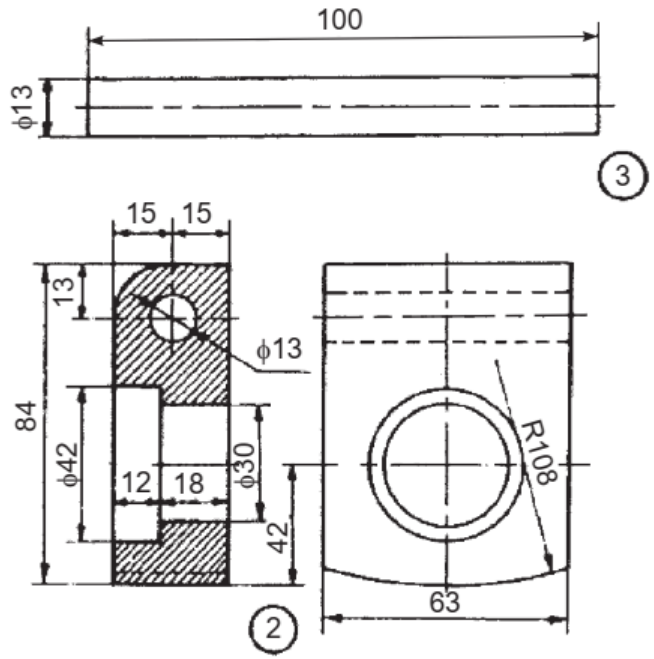






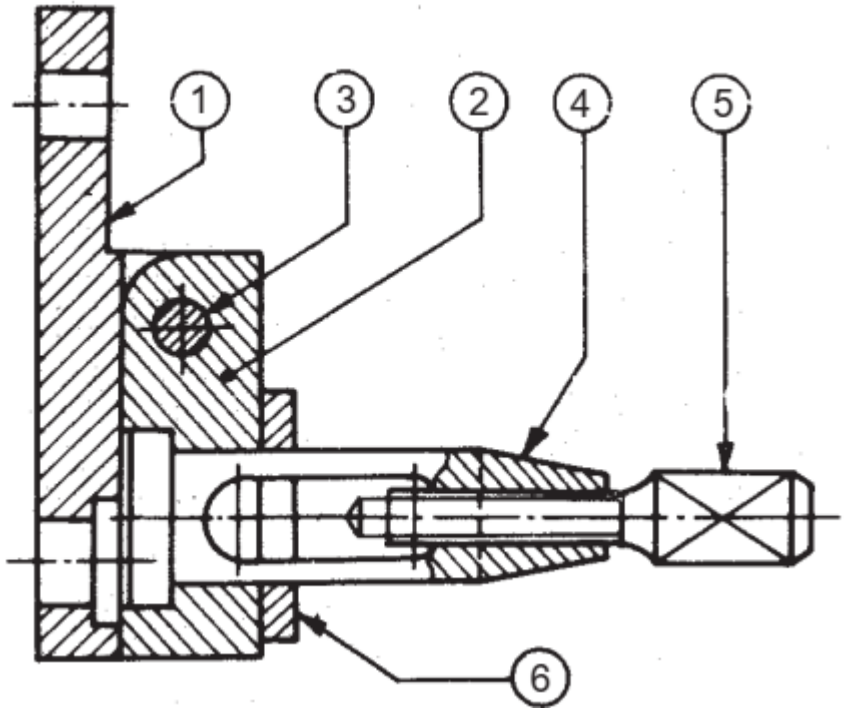
Machine tools – 7 Clapper block





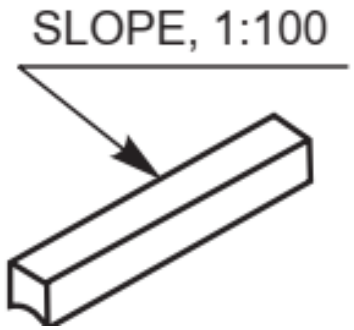
Assembly:

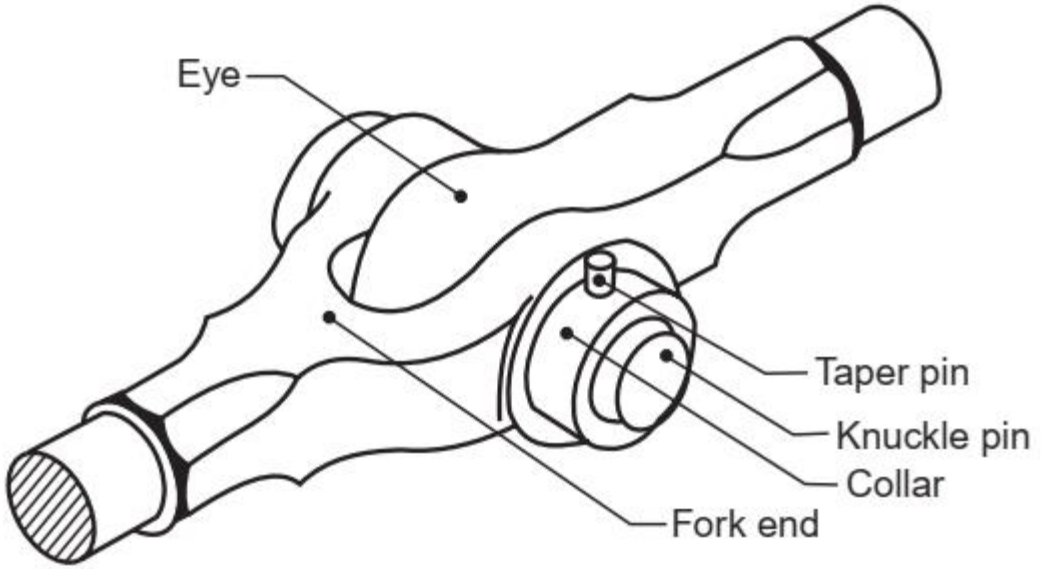
- It consists of a swivel plate 1, attached to the vertical slide of the tool head of the shaping machine.
- The drag release plate 2 relieves the tool during the return stroke.
- The drag release plate carries the tool holder 4 and the tool is fixed by means of the tool clamping screw 5.
- The washer 6 is used over the drag release plate for providing even bearing surface to the tool.



Keys, and Pin joints

Keys and pin joints are some examples of removable (temporary) fasteners.

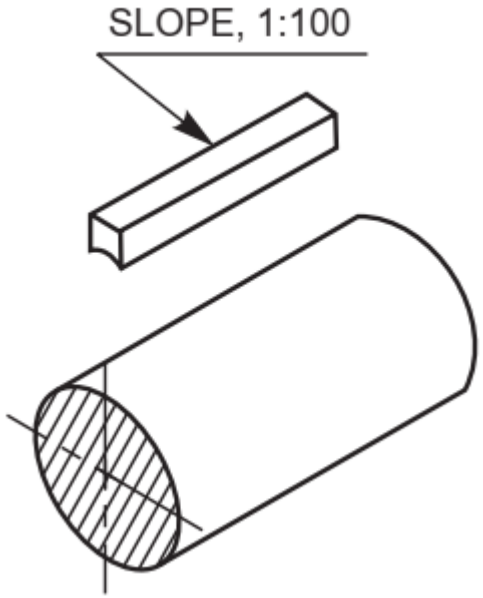


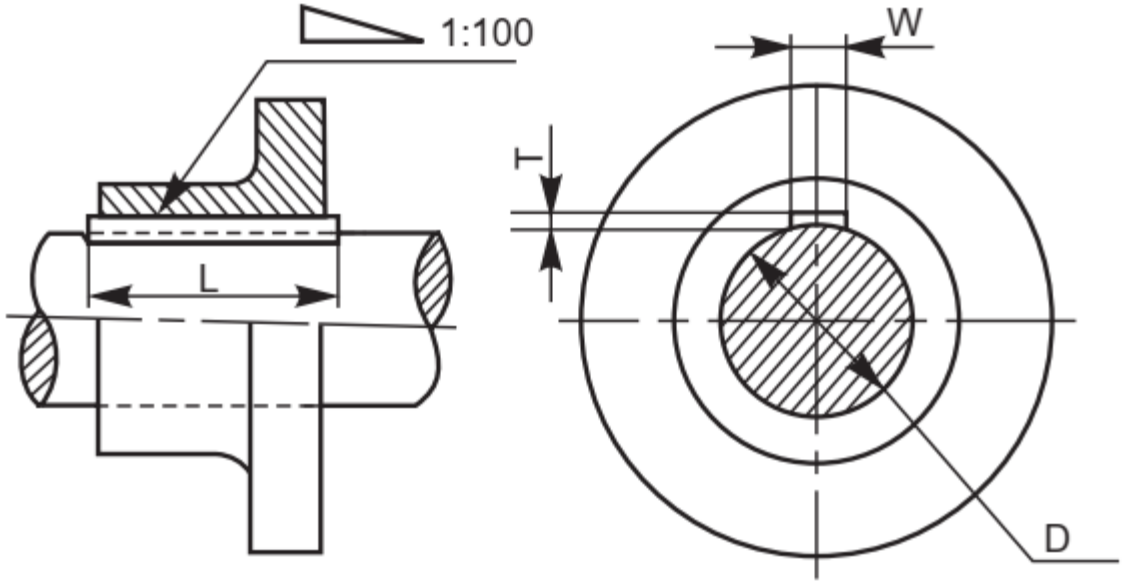


Keys

Keys are machine elements used to prevent relative rotational movement between a shaft and the parts mounted on it

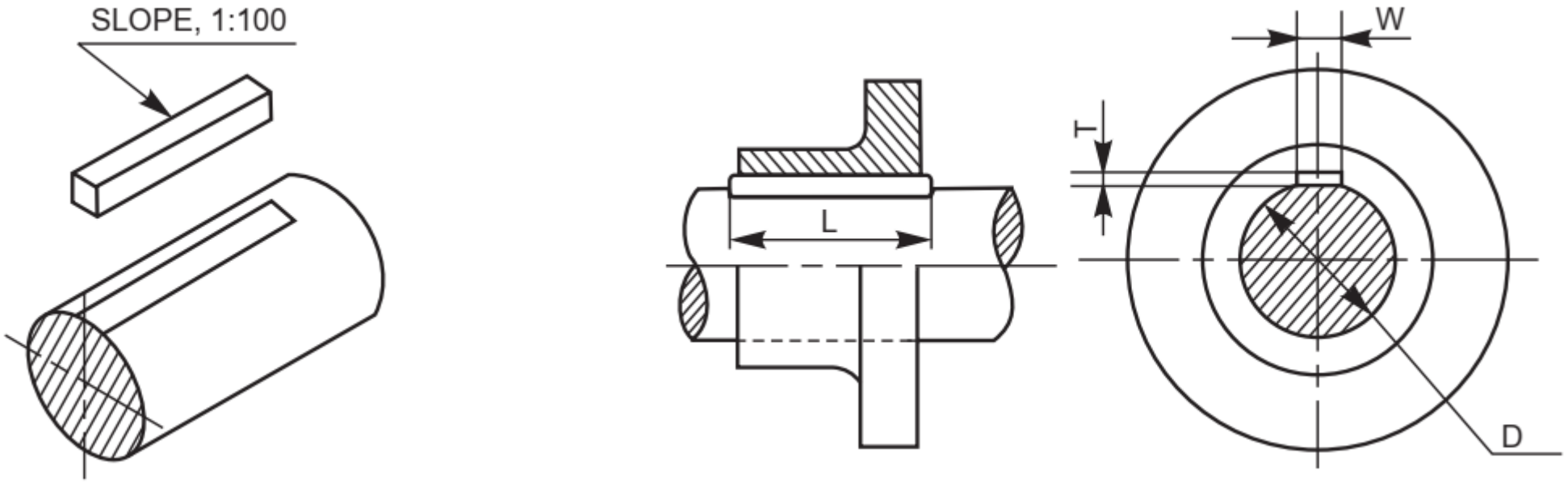
- *Hollow saddle key:* A hollow saddle key has a concave shaped bottom to suit the curved surface of the shaft, on which it is used.
- A keyway is made in the hub of the mounting, with a tapered bottom surface.
- The relative rotation between the shaft and the mounting is prevented due to the friction between the shaft and key.





Keys

- *Flat saddle key:* It is similar to the hollow saddle key, except that the bottom surface of it is flat.
- A flat surface provided on the shaft to fit this key in position.
- The two types of saddle keys discussed above are suitable for light duty only.



Sunk Keys

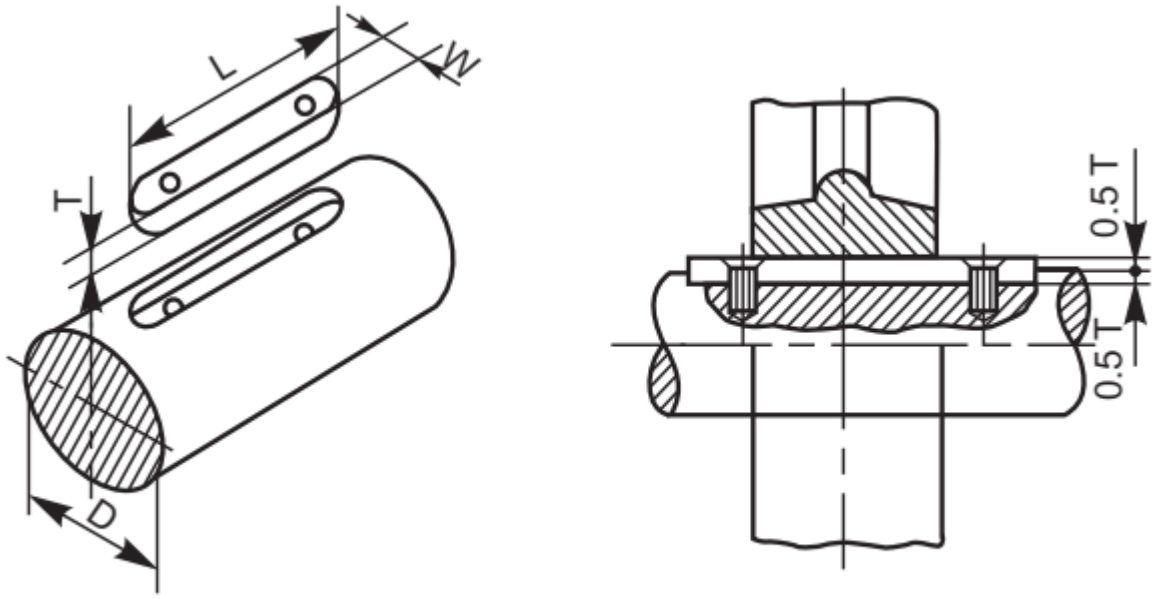


Fig. 6.5 Parallel sunk key

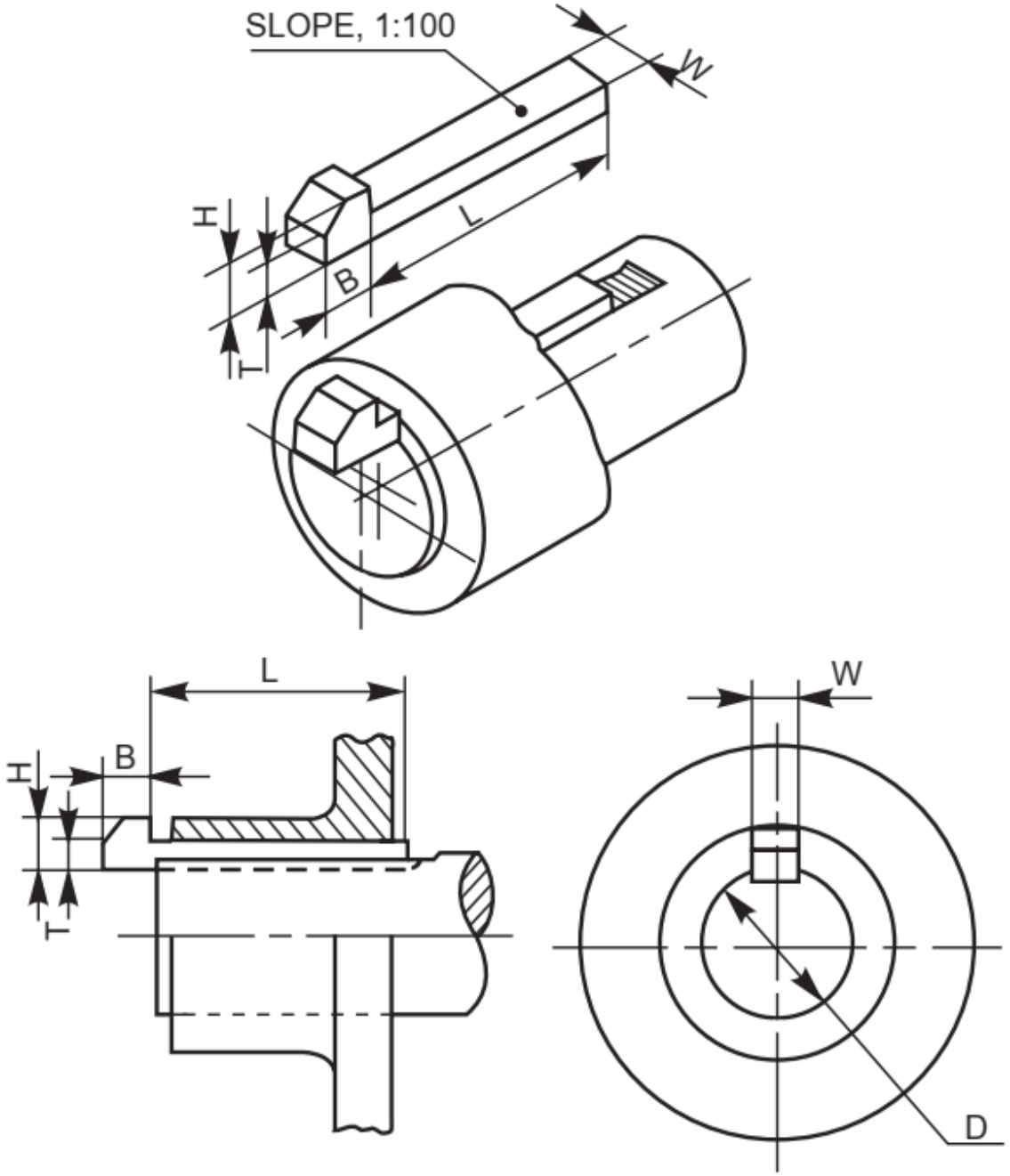


Fig. 6.4 Key with gib head

Pin Joints

- A pin is used to fasten two rods that are under the action of a tensile force; although the rods may support a compressive force if the joint is guided.

- Pins are usually used in flexible coupling because is allows for certain degree of flexibility.

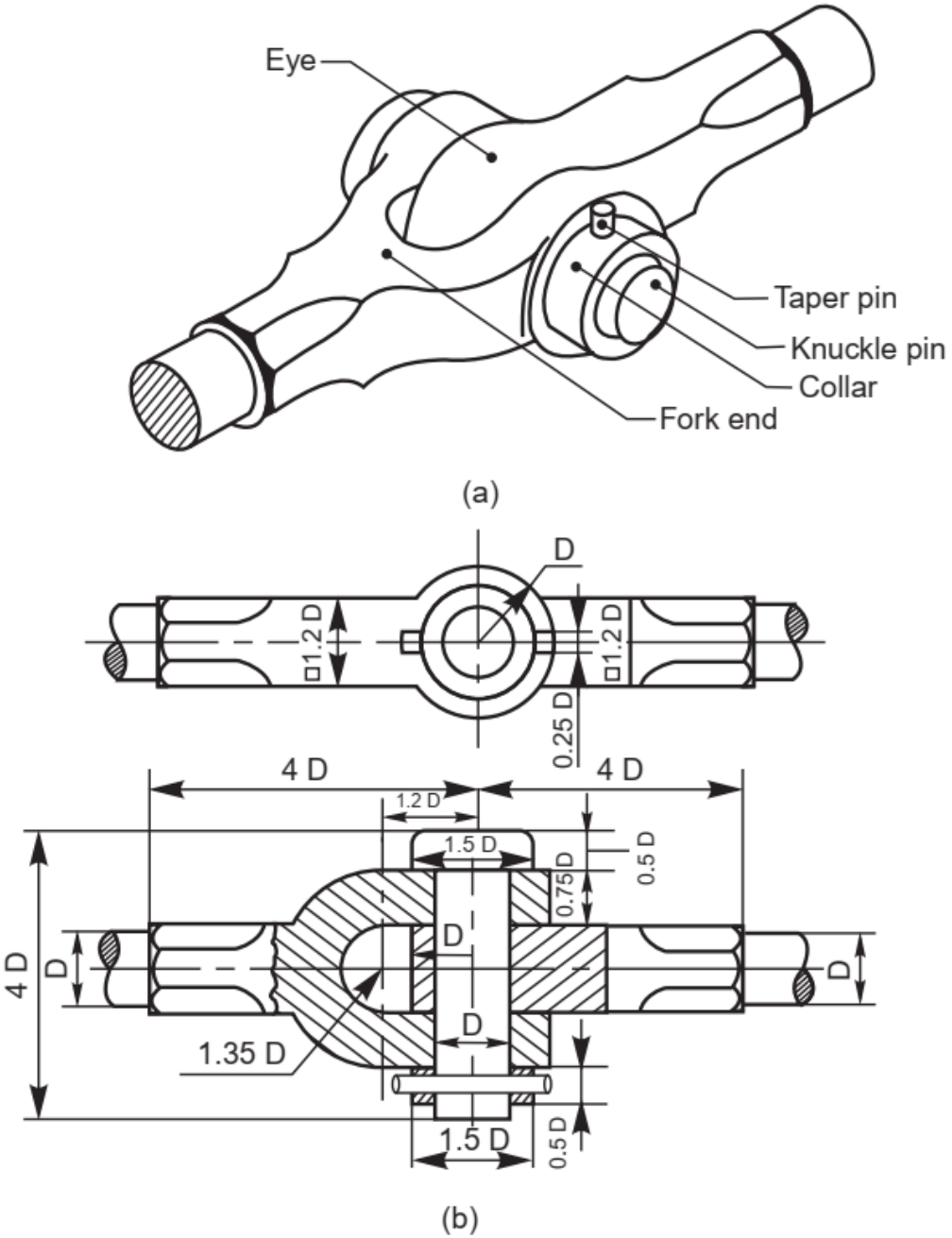
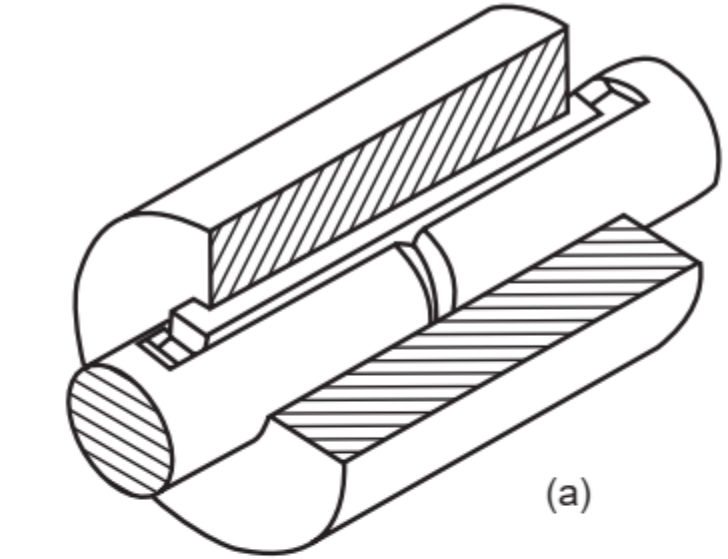
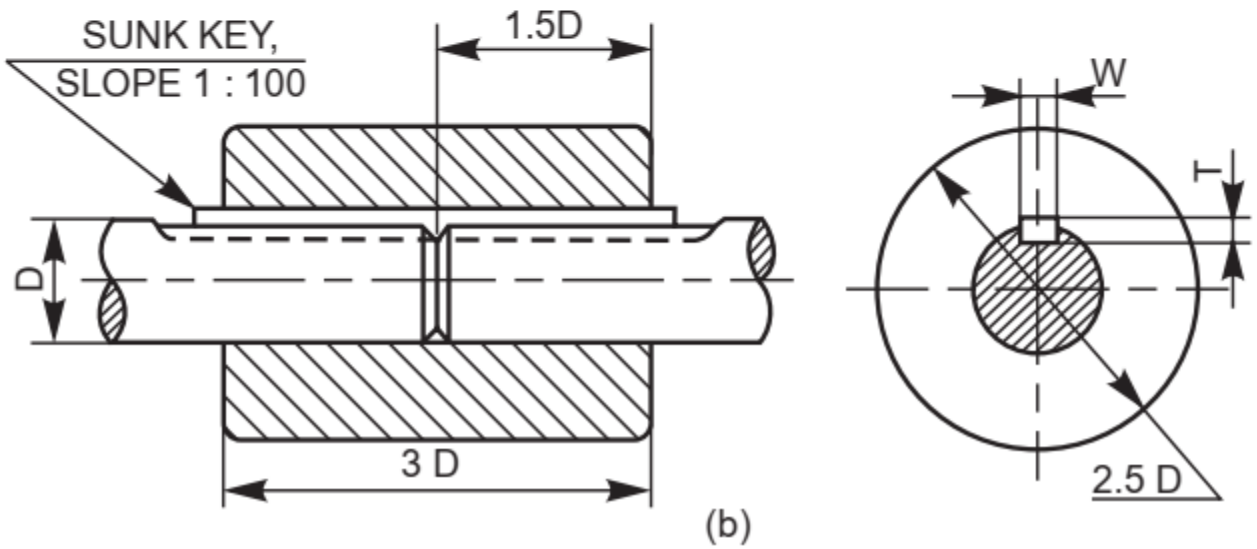


Fig. 6.15 Knuckle joint

Shaft coupling

- Keys and pens joints are usually used in shaft coupling.
- Such as the rigid coupling shown in figure in which a sunk key is used to connect the shaft with the outer flange.





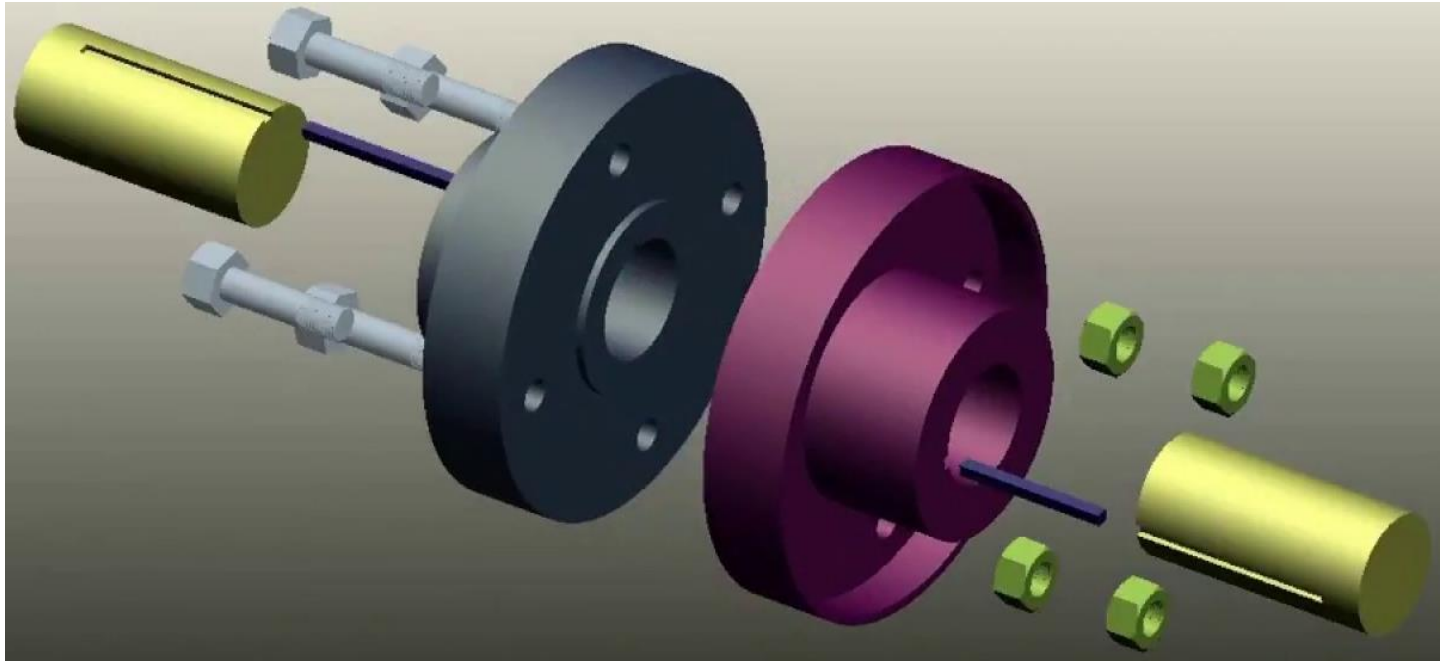
Shaft Coupling – 8 Protected Flanged Coupling

Function:

- This Coupling is used to join two shafts so that they act as a single unit during rotation and power can be transmitted from one shaft to the other.
- The protected flanged coupling is a rigid shaft coupling, the axes of the shafts being collinear.

Components:

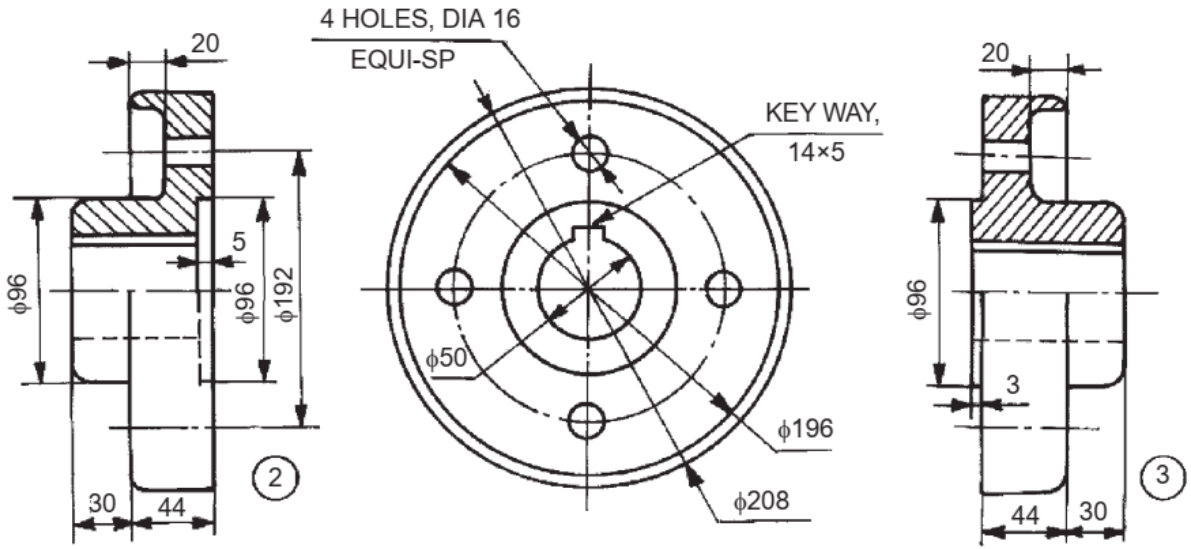
1 – Shaft
2 – Flange
3 – Flange
4 – Bolt with nut
5 – Key

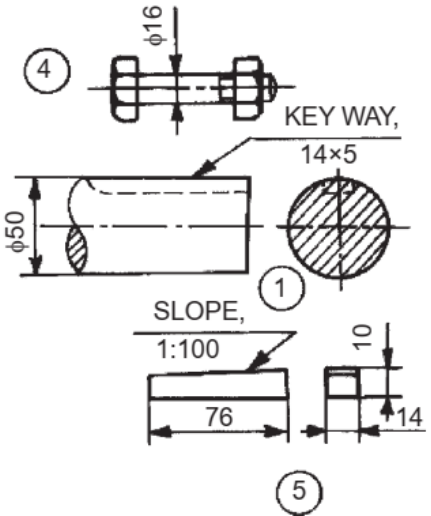


Shaft Coupling – 8 Protected Flanged Coupling

Components:

1 – Shaft
2 – Flange
3 – Flange
4 – Bolt with nut
5 – Key





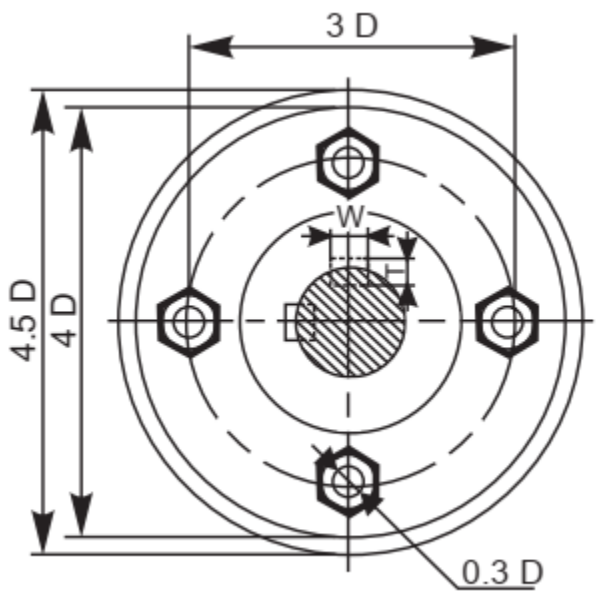
Parts list

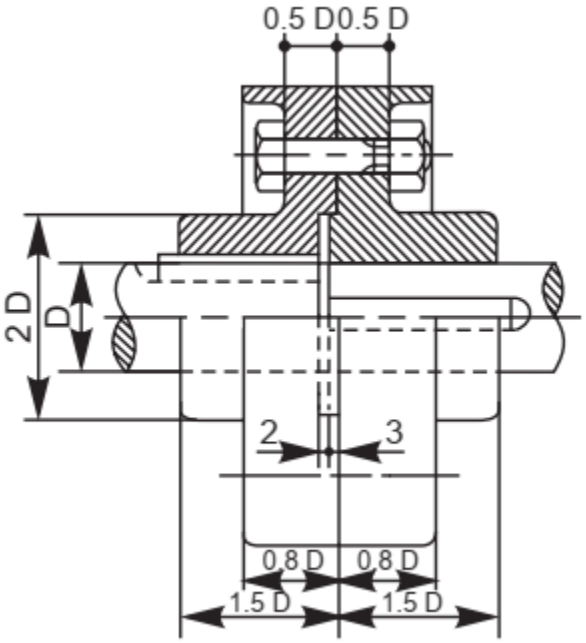
Sl. No.	Name	Matl.	Qty.
1	Shaft	MS	2
2	Flange	CI	1
3	Flange	CI	1
4	Bolt with nut	MS	4
5	Key	MS	2

Shaft Coupling – 8 Protected Flanged Coupling

Assembly:

- The flanges 2 and 3 are mounted at the ends of two shafts 1 by means of keys 5.
- Later, the two flanges are connected to each other by means of bolts with nuts 4.
- Hence, the name protected flanged coupling.





Parts list

Sl. No.	Name	Matl.	Qty.
1	Shaft	MS	2
2	Flange	CI	1
3	Flange	CI	1
4	Bolt with nut	MS	4
5	Key	MS	2

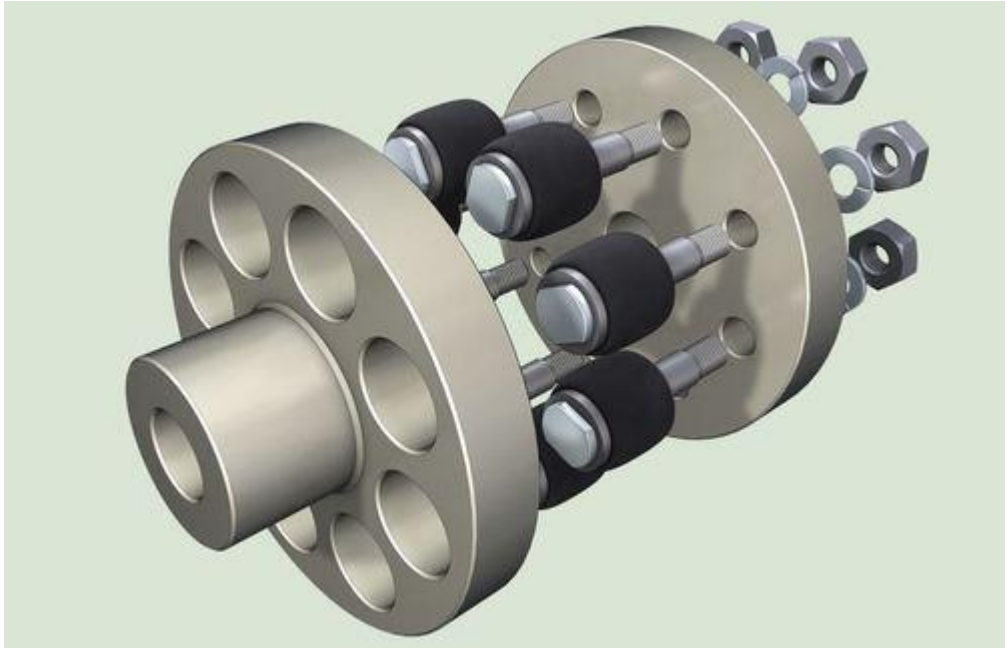
Shaft Coupling – 9 Bushed-pin type Flanged Coupling

Function:

- This coupling is also used to join two circular shafts.
- However, this is not a rigid coupling, but a flexible one.
- Flexible couplings are preferred to rigid ones, as perfect alignment of two shafts is difficult to achieve; which is the requisite condition for rigid couplings.

Components:

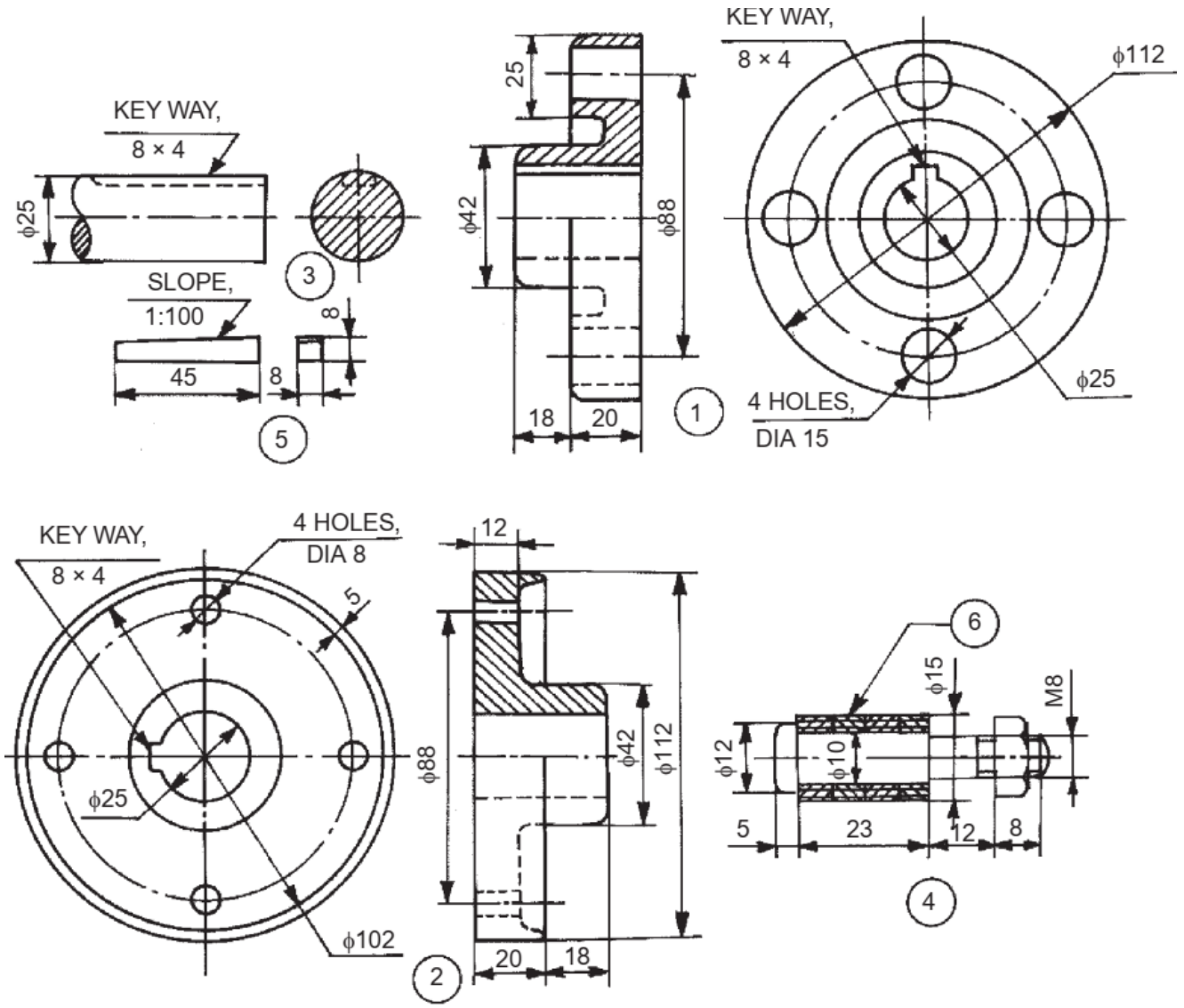
1 – Flange
2 – Flange
3 – Shaft
4 – Pin with nut
5 – Feather Key
6 - Bush



Shaft Coupling – 9 Bushed-pin type Flanged Coupling

Components:

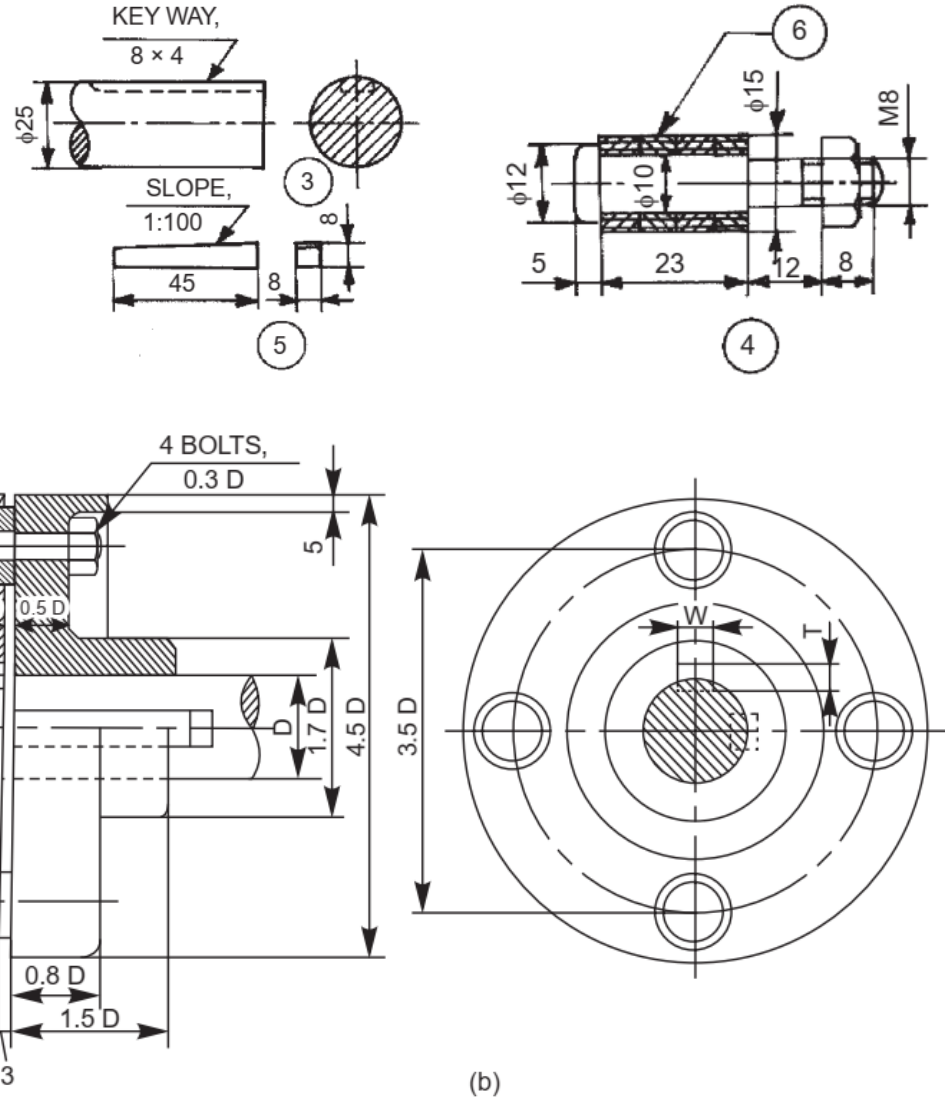
1 – Flange
2 – Flange
3 – Shaft
4 – Pin with nut
5 – Feather Key
6 - Bush



Shaft Coupling – 9 Bushed-pin type Flanged Coupling

Assembly:

- Flanges 1 and 2 are mounted on the ends of shafts 3 by using sunk keys 5.
- The smaller ends of pins 4 are rigidly fixed to the flange 2 by means of nuts, whereas the enlarged ends, covered with flexible bushes 6, are positioned in the flange 1.
- The flexible medium takes care of mis-alignment if any, and also acts as a shock absorber. These couplings are used to connect prime mover or an electric motor and a centrifugal pump, electric motor and a reduction gear, etc.



Shaft Coupling – 10 Universal Coupling

Function:

- This is a rigid coupling and is used to connect two shafts, whose axes intersect if extended.

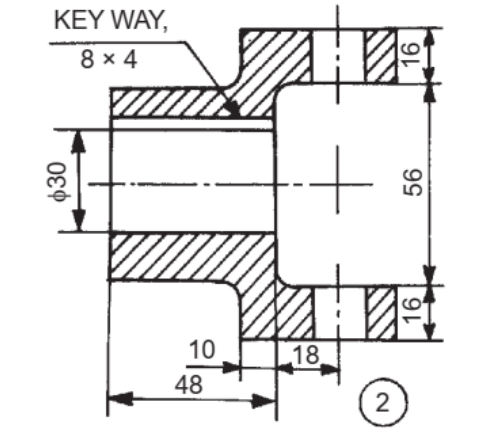
Components:

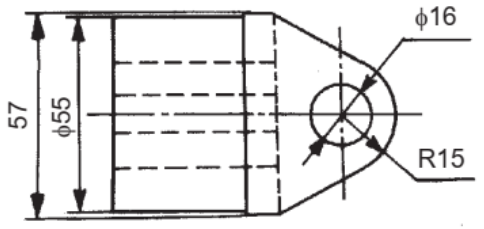
1 – Shaft
2 – Fork
3 – Central Block
4 – Pin
5 – Collar
6 - Key

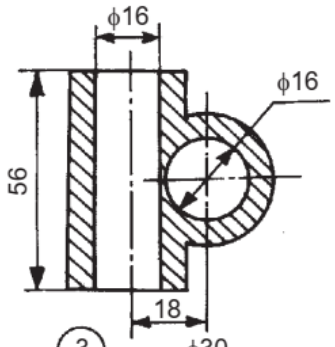
Shaft Coupling – 10 Universal Coupling

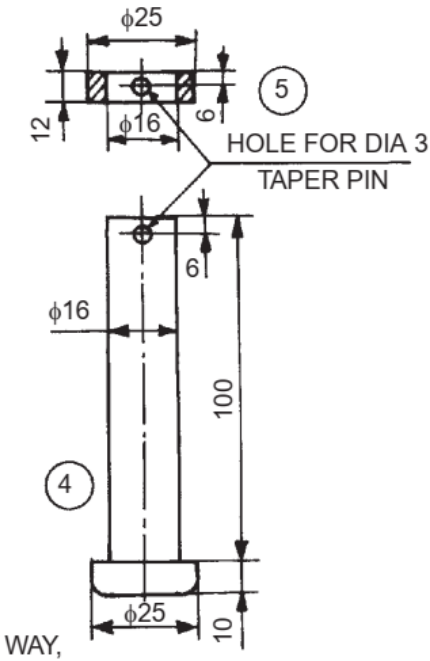
Components:

1 – Shaft
2 – Fork
3 – Central Block
4 – Pin
5 – Collar
6 - Key



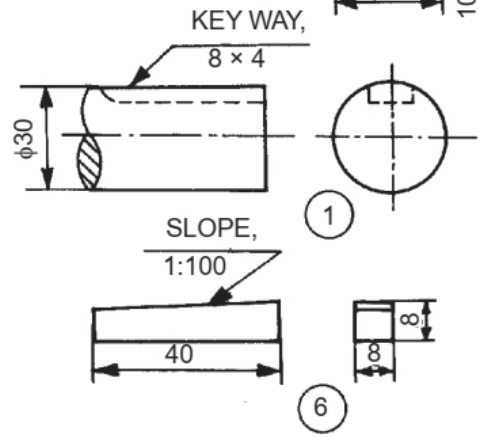






Parts list

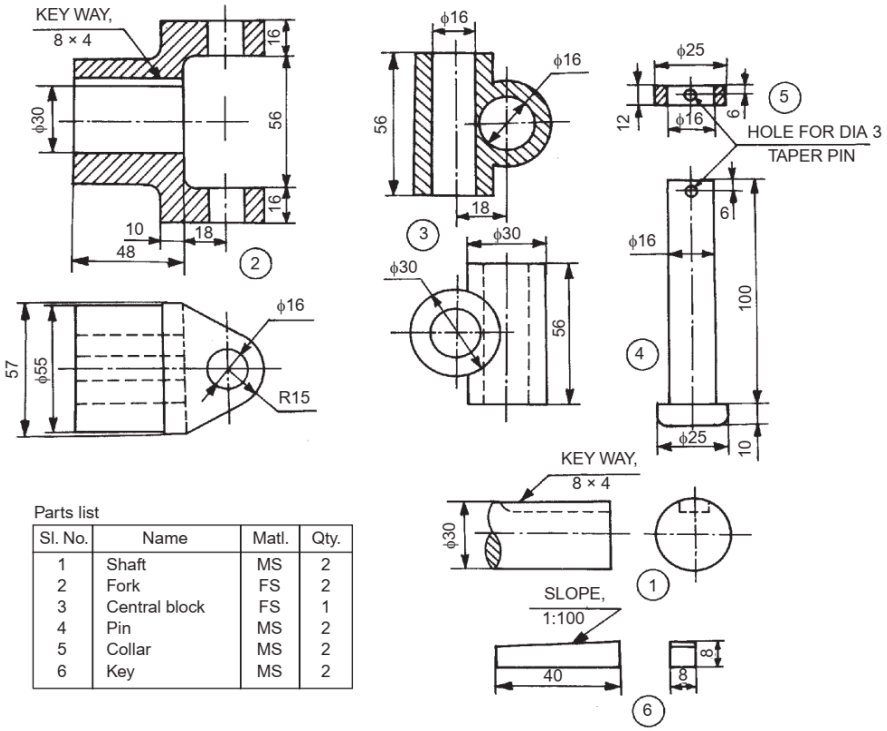
Sl. No.	Name	Matl.	Qty.
1	Shaft	MS	2
2	Fork	FS	2
3	Central block	FS	1
4	Pin	MS	2
5	Collar	MS	2
6	Key	MS	2



Shaft Coupling – 10 Universal Coupling

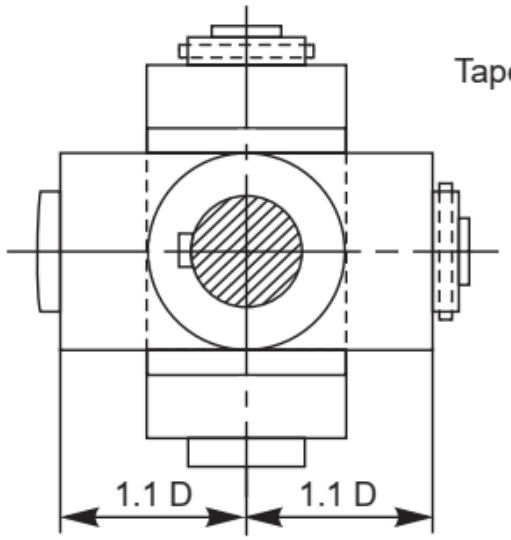
Assembly:

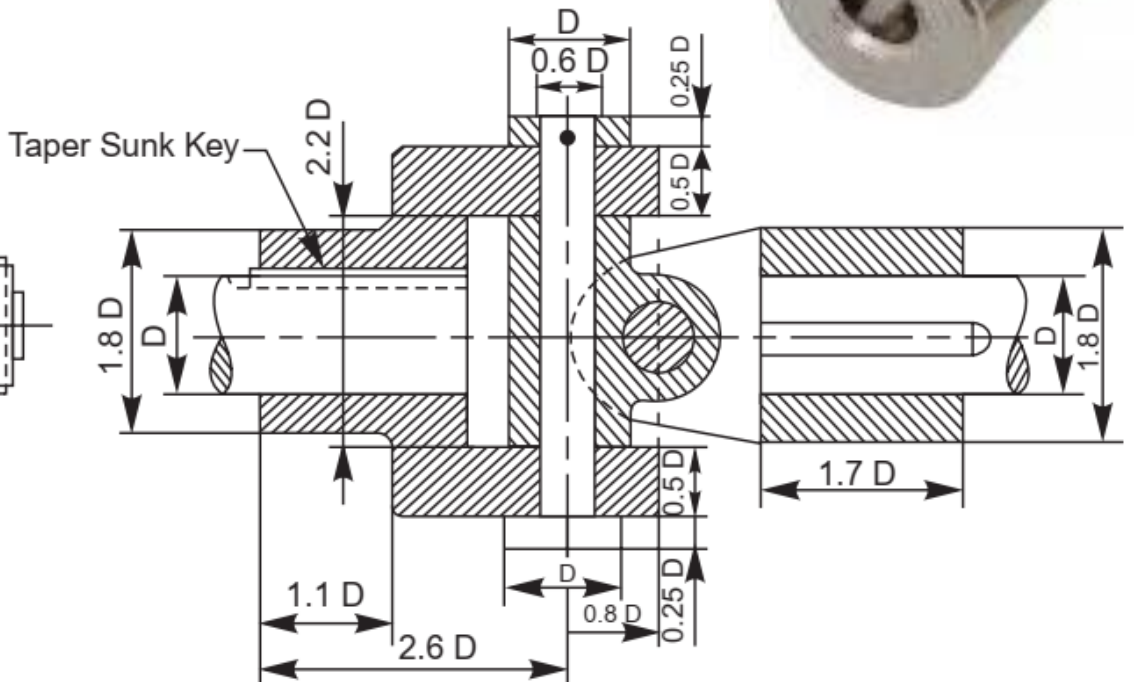
- The forks 2 are mounted at the ends of two shafts 1, making use of sunk keys 6.
- The central block 3, having two arms at right angle to each other, is placed between the forks and connected to both of them by using pins 4 and collars 5.
- A taper pin (not shown) is used to keep the pins 4 in position. During rotation of shafts, the angle between them can be varied.



Parts list

Sl. No.	Name	Matl.	Qty.
1	Shaft	MS	2
2	Fork	FS	2
3	Central block	FS	1
4	Pin	MS	2
5	Collar	MS	2
6	Key	MS	2





Bearings

- Bearings are supports for shafts, providing stability, and free and smooth rotation.

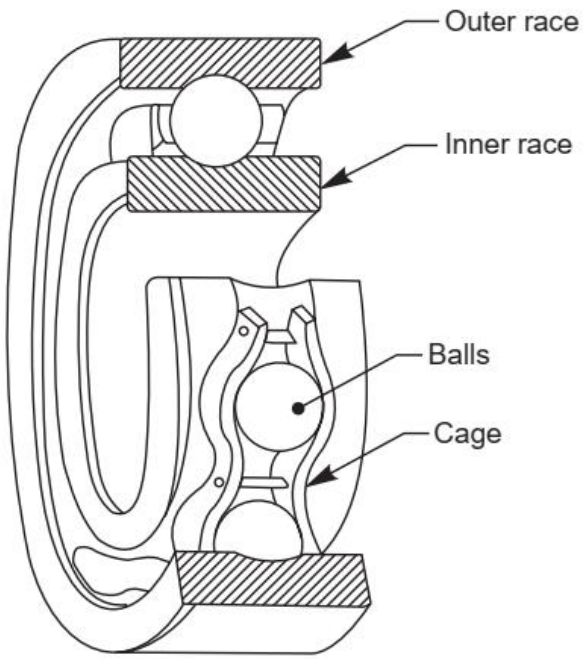
- The importance of bearings may be understood from the supporting requirement of *machine tool spindles* (عمود دوران), *engine crankshafts*, *transmission or line shafts* in workshops,

- Bearings are broadly classified into two categories: *sliding contact bearings* and *rolling contact bearings or antifriction bearings*.

Rolling Contact Bearings (Anti-Friction)

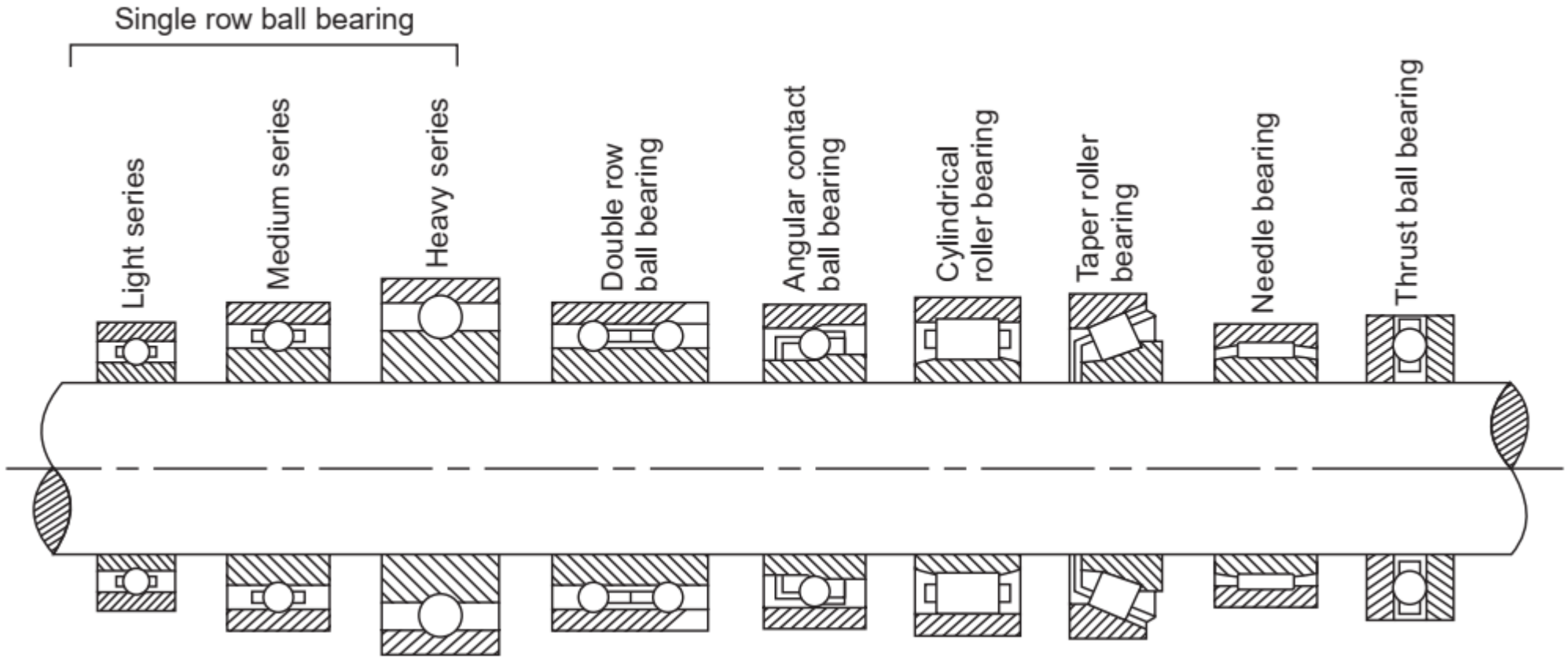
- The bearings, in which a rolling friction is present, are known as rolling contact bearings. As rolling friction is very much less than sliding friction, rolling contact bearings are called antifriction bearings

- The bearing consists of four parts: inner race, outer race, balls or rollers and a cage or retainer



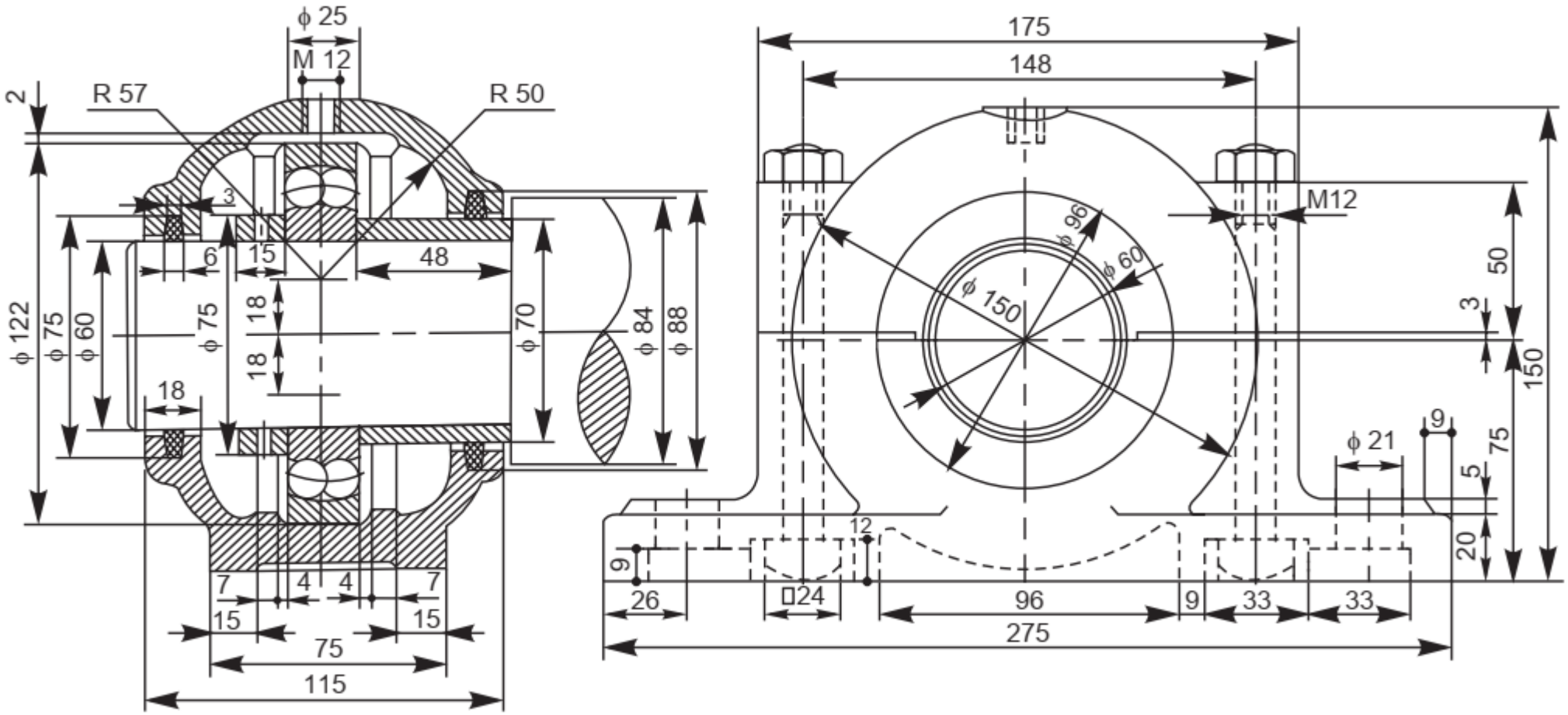
Rolling Contact Bearings (Anti-Friction)

Different types of anti-friction bearings



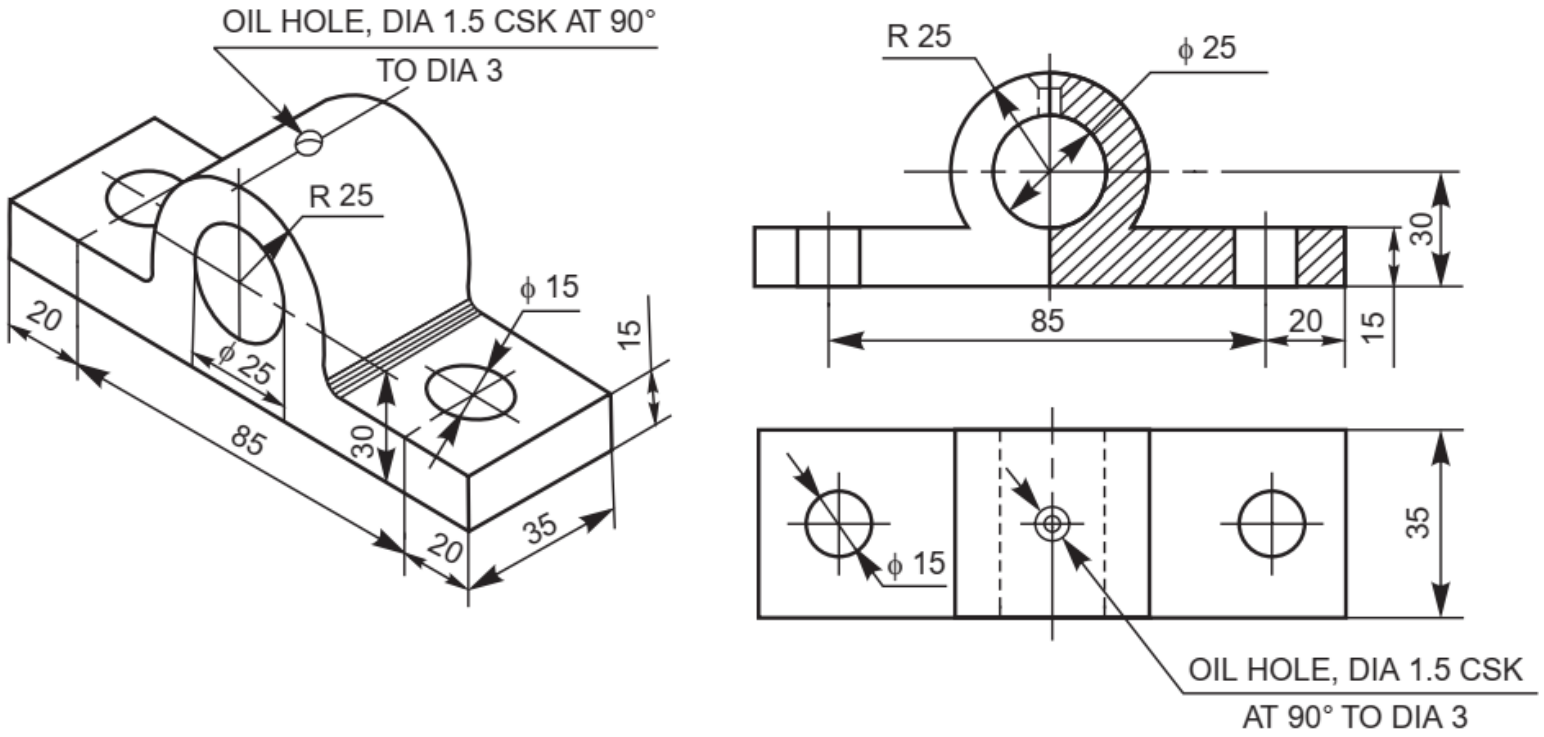
Rolling Contact Bearings (Anti-Friction)

Plummer block with double row self-aligning ball bearing



Sliding Contact Bearings

- Sliding contact bearings are those in which the rotating shaft has a sliding contact with the bearing and the friction is relatively high.
- Hence, these bearings require more *lubrication*.
- According to the direction in which the bearing is loaded, these bearings are further classified as: *journal bearings and thrust bearings.*



Bearings – 11 Plummer Block Bearing

Function:

- This bearing is used for long shafts, requiring intermediate support, especially when the shaft cannot be introduced into the bearing, end-wise.

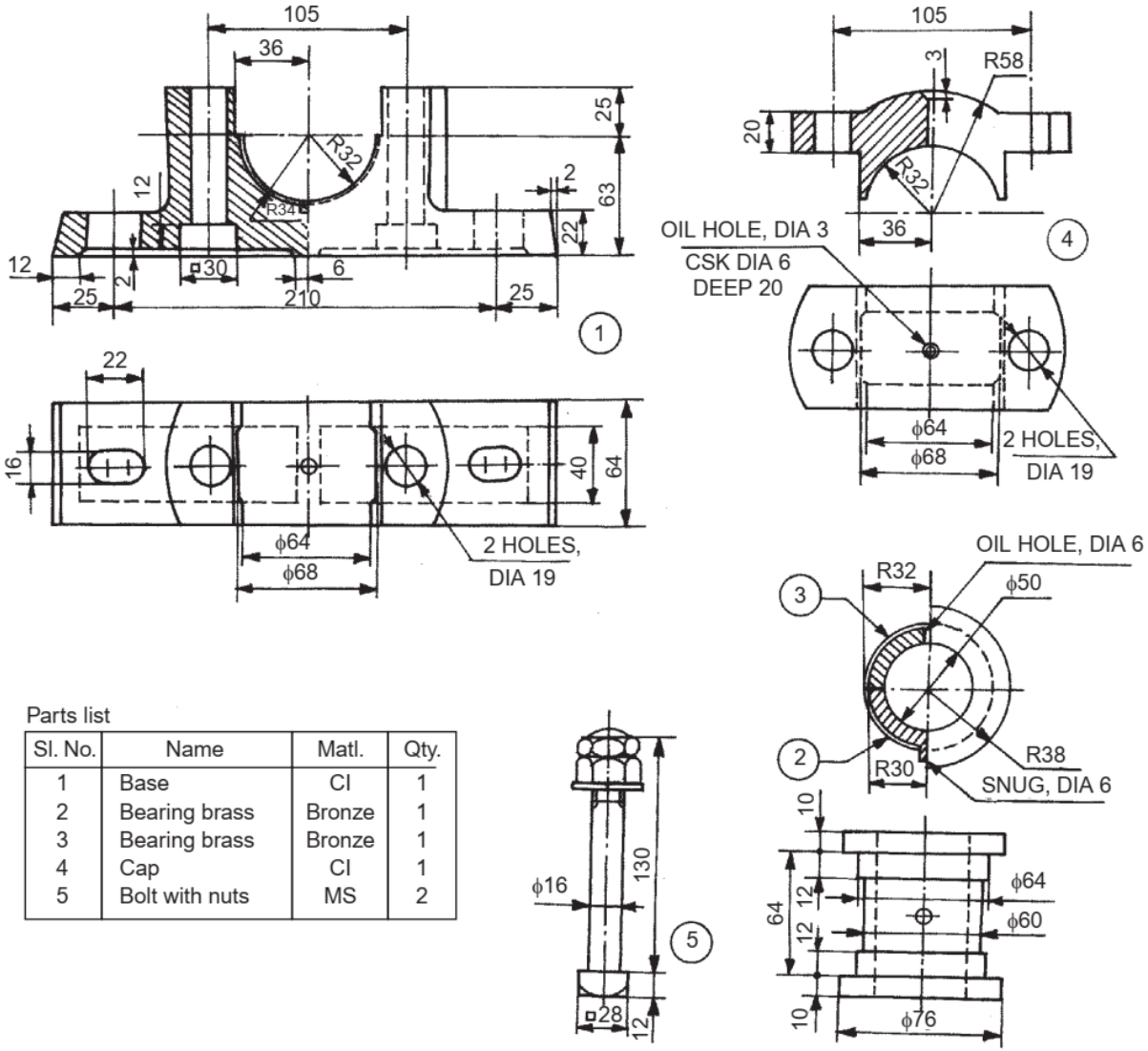
Components:

1 – Base
2 – Bearing brass
3 – Bearing brass
4 – Cap
5 – Bolt and nuts

Bearings – 11 Plummer Block Bearing

Components:

1 – Base
2 – Bearing brass
3 – Bearing brass
4 – Cap
5 – Bolt and nuts



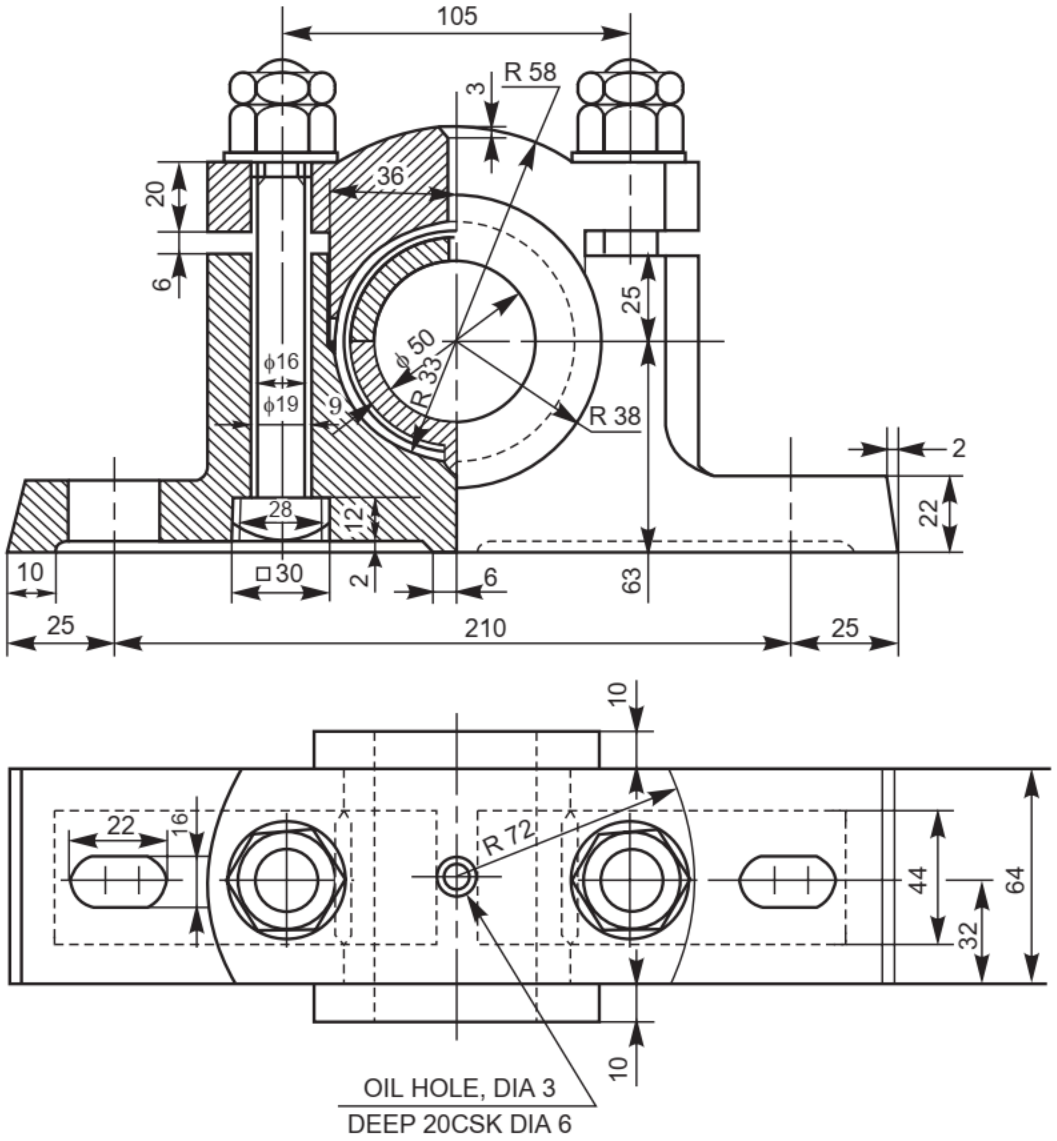
Parts list

Sl. No.	Name	Matl.	Qty.
1	Base	CI	1
2	Bearing brass	Bronze	1
3	Bearing brass	Bronze	1
4	Cap	CI	1
5	Bolt with nuts	MS	2

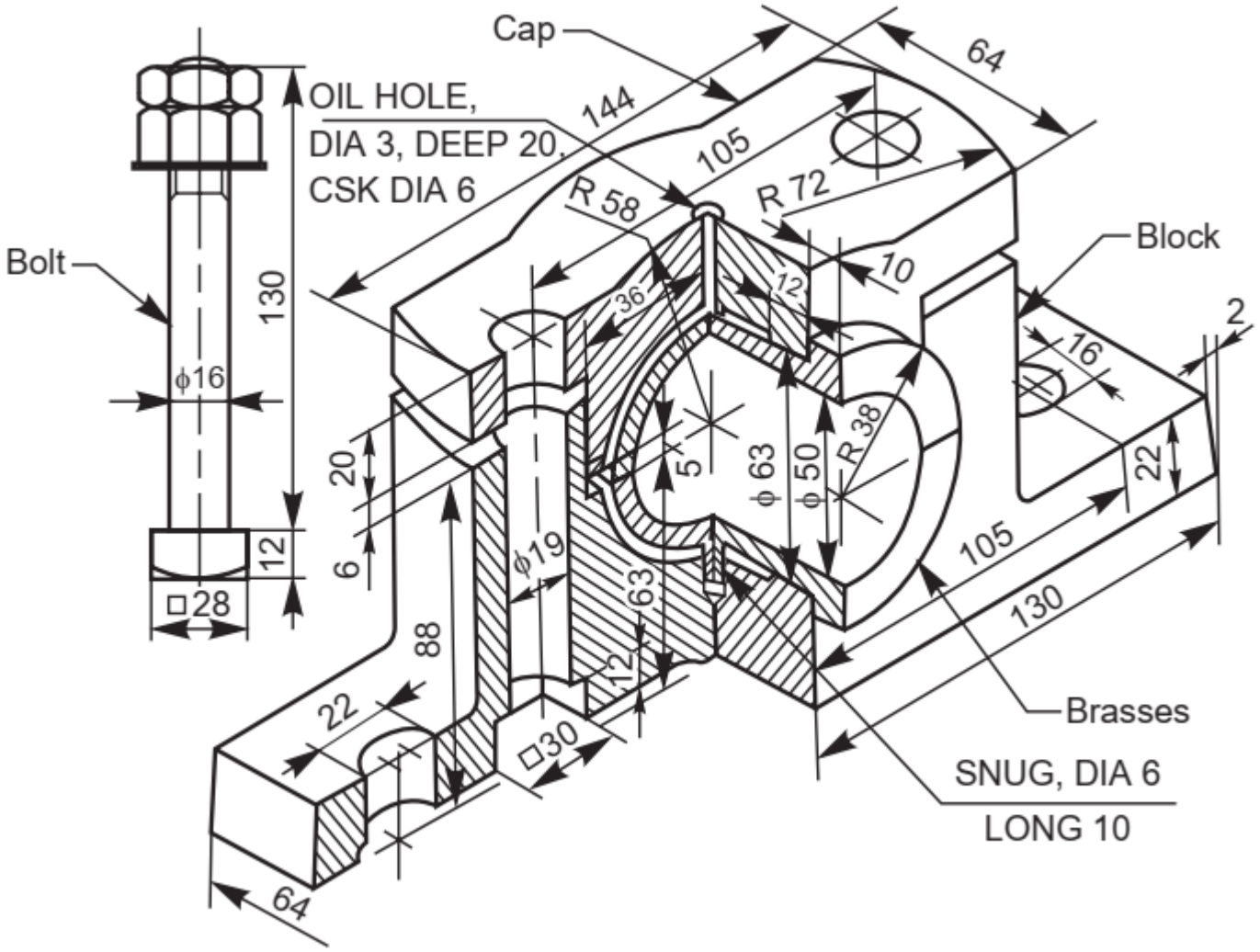
Bearings – 11 Plummer Block Bearing

Assembly:

- The bottom half 2 of the bearing brass is placed in the base 1 such that, the snug of the bearing enters into the corresponding recess in the base; preventing rotation of the brasses.
- After placing the journal (shaft) on the bottom half of the bearing brass, kept in the base; the upper half of the bearing brass 3 is placed and the cap 4 is then fixed to the base, by means of two bolts with nuts 5.
- The bearing is made of two halves so that the support can be introduced at any location of the long shaft.



Bearings – 11 Plummer Block Bearing



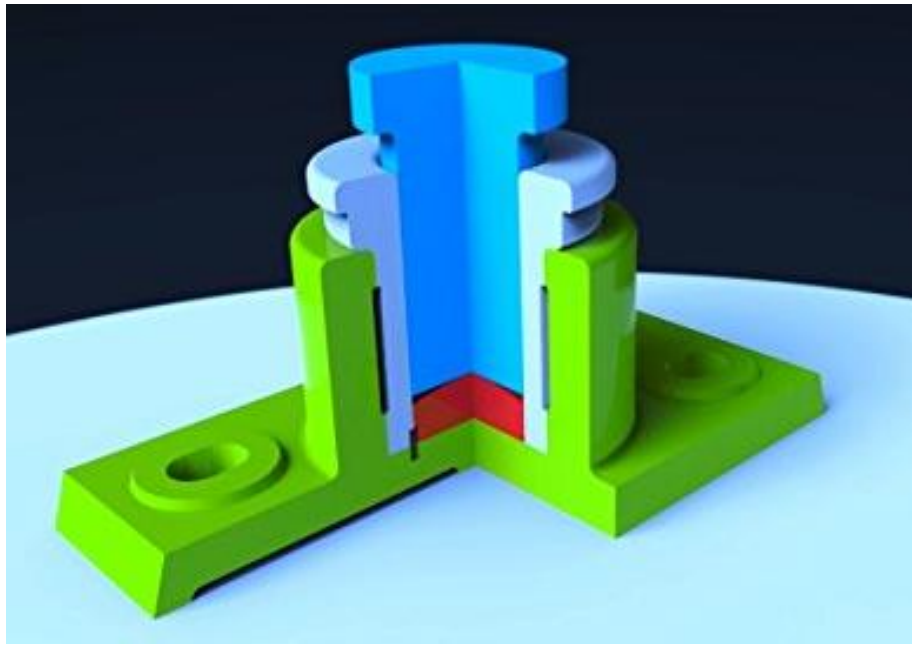
Bearings – 12 Foot-Step Bearing

Function:

- This consists of two bearings, one in the form of a disc and the other in the form of a bush.
- It is intended to support a vertical shaft under axial load.
- The axial load is resisted by the disc shaped bearing provided at the bottom of the shaft, whereas the bush bearing resists radial load on the shaft.

Components:

1 – Body
2 – Bush
3 – Disc
4 – Shaft
5 – Pin



Bearings – 12 Foot-Step Bearing

Components:

1 – Body
2 – Bush
3 – Disc
4 – Shaft
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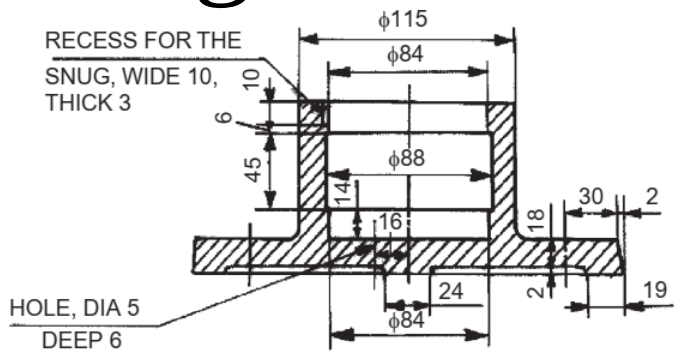

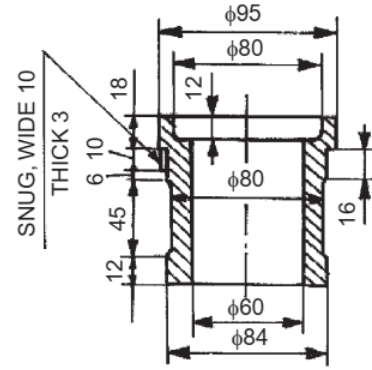

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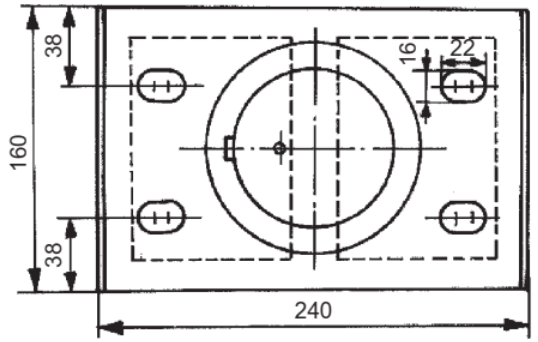

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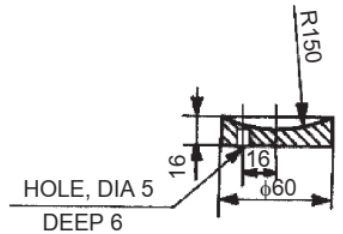
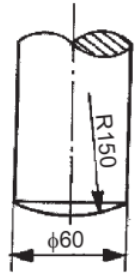


3

Parts list

Sl. No.	Name	Matl.	Qty.
1	Body	Cast iron	1
2	Bush	Brass	1
3	Disc	P Bronze	1
4	Shaft	Mild steel	1
5	Pin	Mild steel	1



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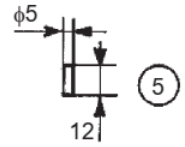
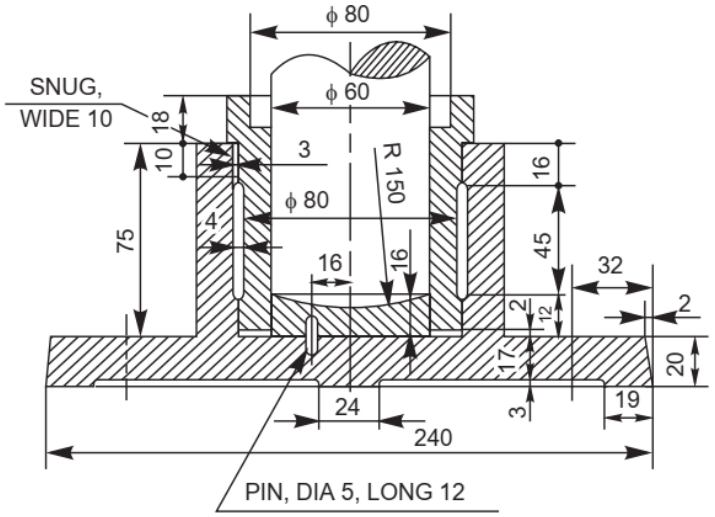


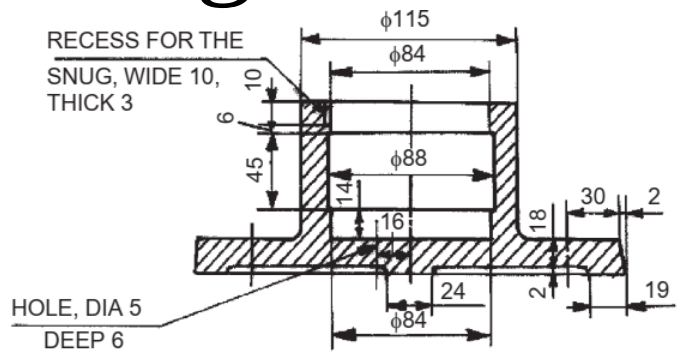
5

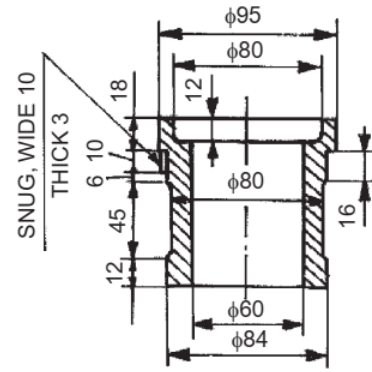
Bearings – 12 Foot-Step Bearing

Assembly:

- The disc 3 is located in the body 1 after placing the pin 5 in the corresponding hole in the body.
- This prevents the rotation of the disc, due to rotation of the vertical shaft.
- Bush 2 is now placed in the body such that, the snug on the bush rests in the recess provided in the body.
- This assembly is now ready to support the vertical shaft 4.







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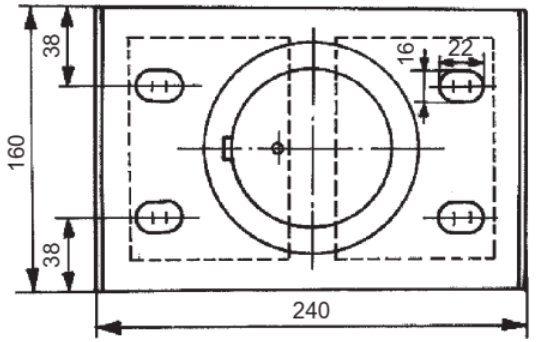

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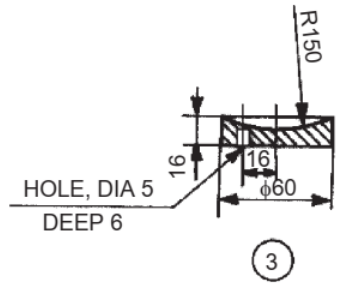

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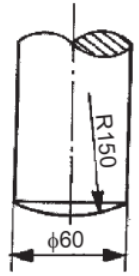

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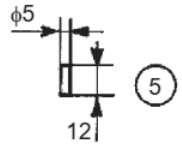

5

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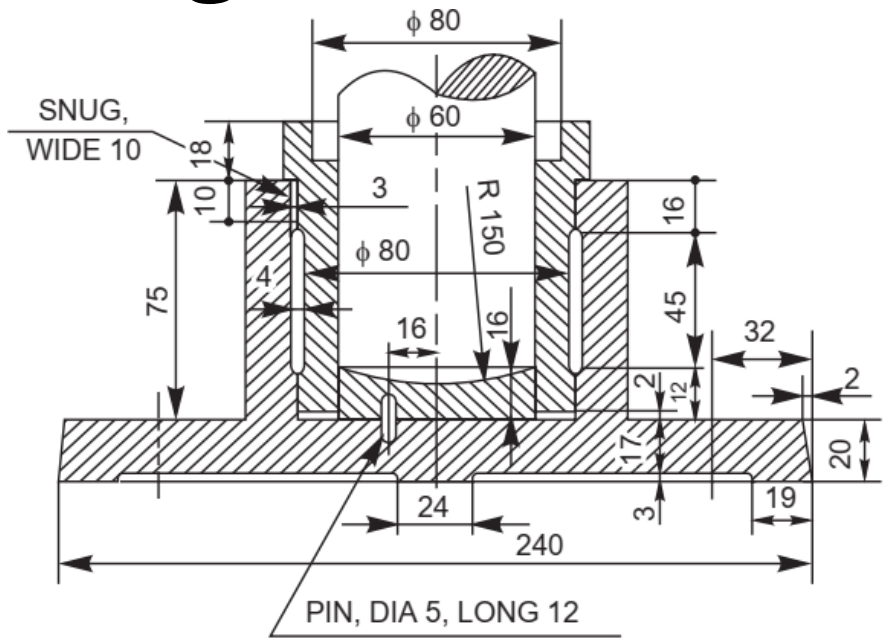
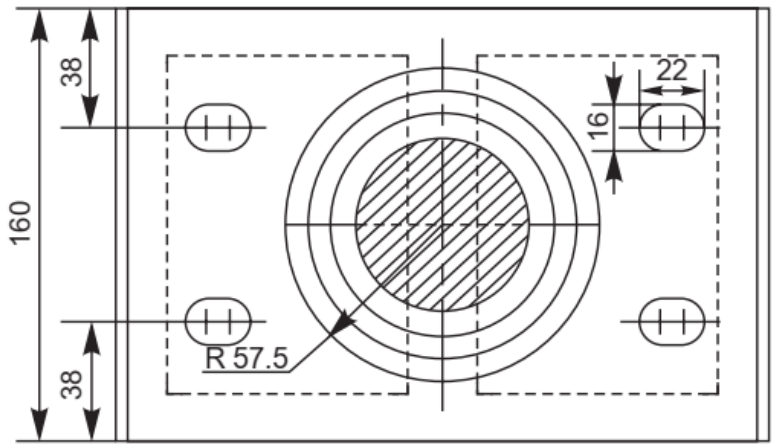
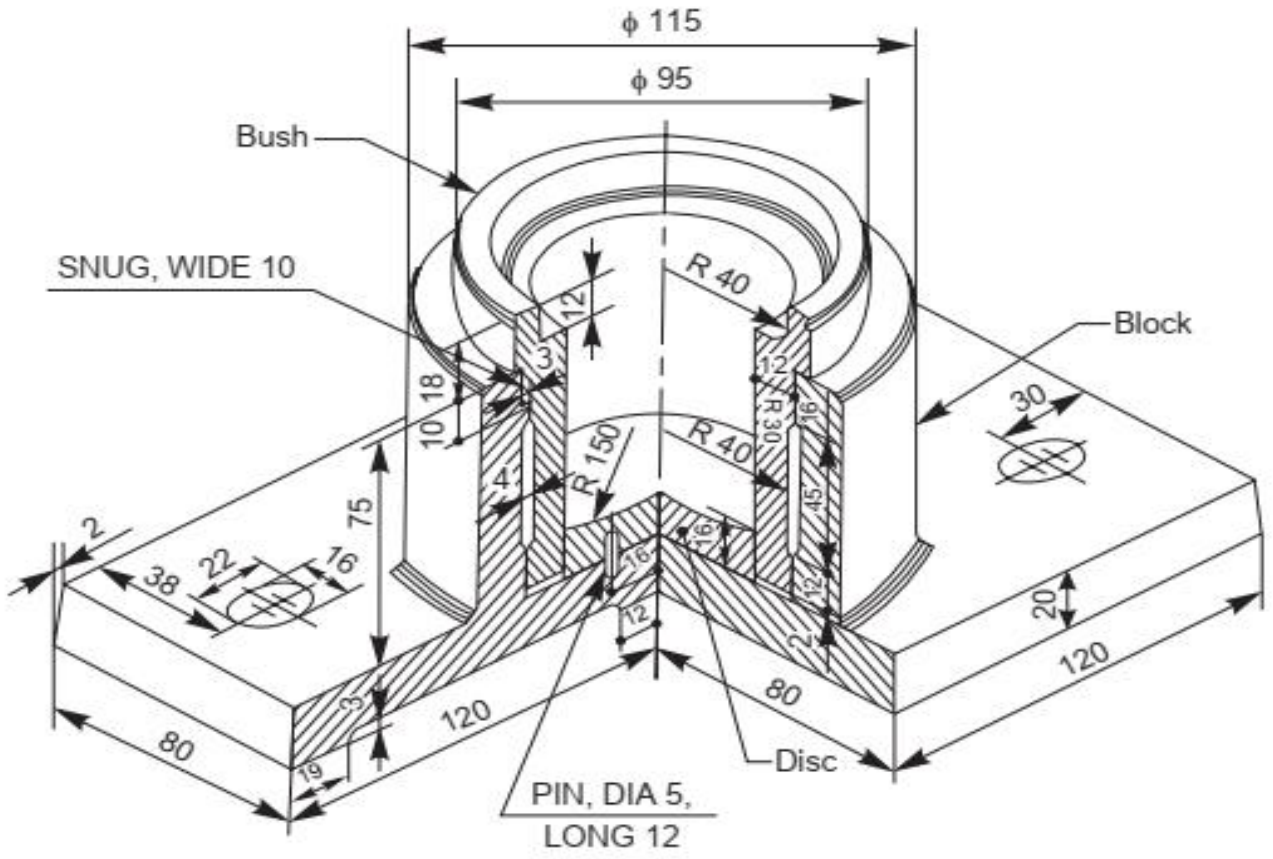




Bearings – 12 Foot-Step Bearing

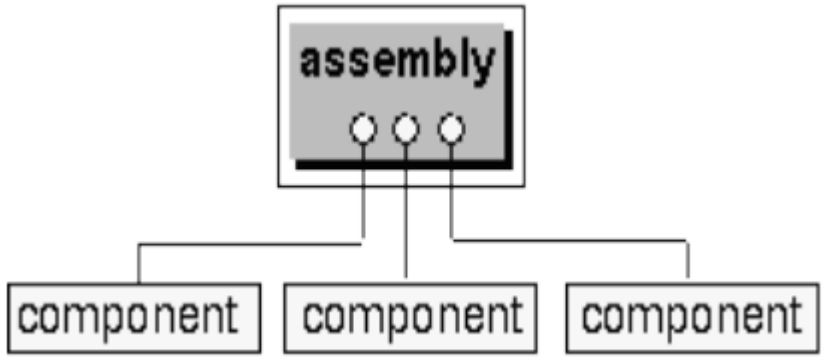


Assembly using NX

- NX 10 *Assembly* is a part file that contains the individual parts.

- They are added to the part file in such a way that the parts are virtually in the assembly and linked to the original part.

- All the parts are selectable and can be used in the design process for information and mating to ensure a perfect fit as intended by the designers.



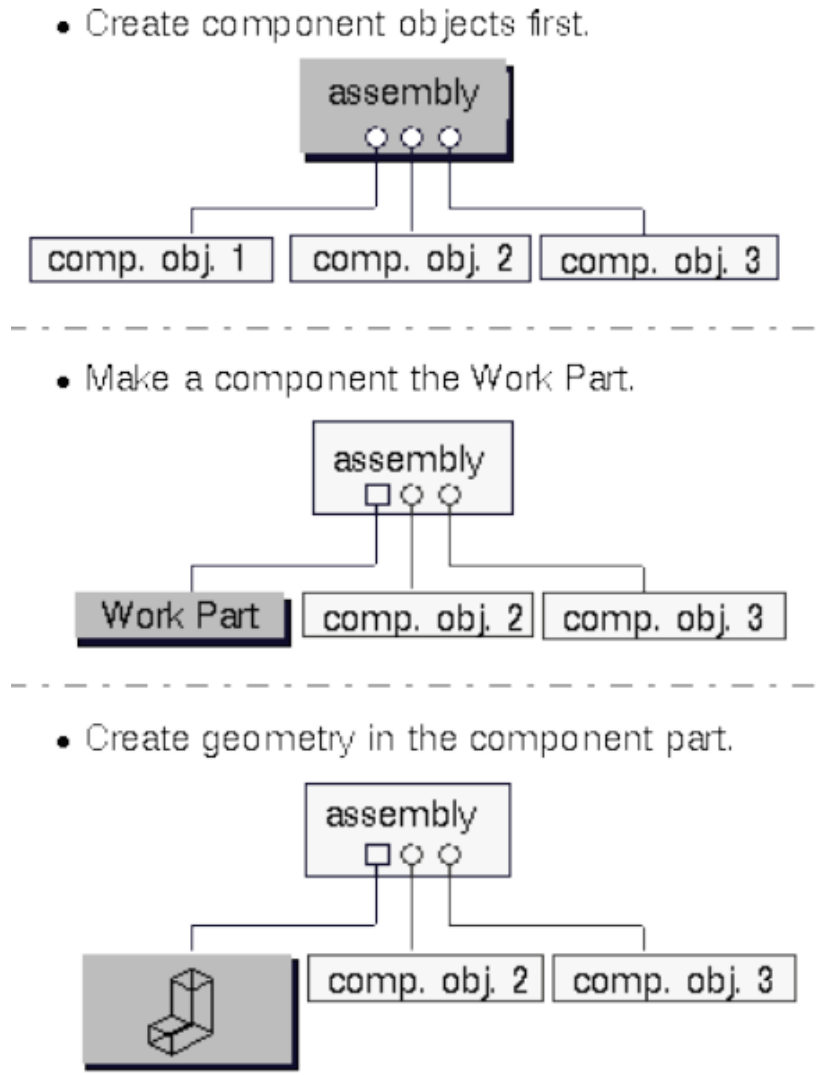
Assembling Approaches used by NX

1. **Top-Down Approach**

- The assembly part file is created first and components are created in that file.
- Then individual parts are modeled.
- This type of modeling is useful in a new design.

2. **Bottom-Up Approach**

- The component parts are created first in the traditional way and then added to the assembly part file.
- This technique is particularly useful, when part files already exist from the previous designs, and can be reused.



Final Project

The components of (xxx) are shown in figure. It is required to

1. Redraw all the components views of (xxx).
2. Draw the three views of each component
3. Draw the isometric view of each component.
4. Assemble the parts and draw half sectional view from the front, with bottom half in section,
5. Assemble the parts and draw view from the above and side.
6. 3-D CAD model for all the components
7. 3-D CAD model for the assembly
8. Printed drawing sheet (Drafting) for all the components and the assembly from the CAD software.

Each group consists of 8 members and should submit the 8 required elements for one selected assembly part. The project presentation is due to Dec 23th in the Lab. All projects must be ready at that time. ***The best project(s) will be awarded.***