MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

DEPARTMENT MECHANICAL ENGINEERING

MACHINE DRAWING PRACTICE
LAB MANUAL

SUBJECT NAME	Machine Drawing Practice
SUBJECT CODE	1930374
COURSE-BRANCH	B. Tech - Mechanical Engineering
YEAR-SEMESTER	II - I
ACADEMIC YEAR	2020-2021
REGULATION	MLRS-R19

MARRI LAXAMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT

MISSION AND VISION OF THE INSTITUTE:

Our Vision:

To establish as an ideal academic institutions in the service of the nation the world and the humanity by graduating talented engineers to be ethically strong globally competent by conducting high quality research, developing breakthrough technologies and disseminating and preserving technical knowledge.

Our Mission:

To fulfill the promised vision through the following strategic characteristics and aspirations:

- Contemporary and rigorous educational experiences that develop the engineers and managers;
- An atmosphere that facilitates personal commitment to the educational success of students in an environment that values diversity and community;
- Prudent and accountable resource management;
- Undergraduate programs that integrate global awareness, communication skills and team building across the curriculum;
- Leadership and service to meet society's needs;
- Education and research partnerships with colleges, universities, and industries to graduate education and training that prepares students for interdisciplinary engineering research and advanced problem solving;
- Highly successful alumni who contribute to the profession in the global society.

Vision and Mission statements of the Department of Mechanical Engineering:

Vision Statement:

"The Mechanical Engineering Department strives immense success in the field of education, research and development by nurturing the budding minds of young engineers inventing sets of new designs and new products which may be envisaged as the modalities to bring about a green future for humanity"

Mission Statement:

1. Equipping the students with manifold technical knowledge to make them efficient and independent thinkers and designers in national and international arena.

2. Encouraging students and faculties to be creative and to develop analytical abilities and efficiency in applying theories into practice, to develop and disseminate new knowledge.
3. Pursuing collaborative work in research and development organizations, industrial enterprises, Research and academic institutions of national and international, to introduce new knowledge and methods in engineering teaching and research in order to orient young minds towards industrial development.

PROGRAM EDUCATIONAL OBJECTIVE

PEO 1: Graduates shall have knowledge and skills to succeed as Mechanical engineer's for their career development.

PEO 2: Graduates will explore in research.

PEO 3: Mechanical Graduates shall have the ability to design products with various interdisciplinary skills

PEO 4: Graduates will serve the society with their professional skills

PROGRAM OUTCOMES

- **A.** Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization for the solution of complex engineering problems.
- **B.** Problem Analysis: Identify, formulate, research, review the available literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science and engineering sciences.
- **C.** Design and development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specific needs with appropriate considerations for public health safety and cultural, societal and environmental considerations.
- **D.** Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
- **E.** Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations.
- **F.** The Engineer and society: Apply reasoning, informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
- **G.** Environment and sustainability: Understand the impact of the professional engineering solutions in society and environmental context and demonstrate the knowledge of and need for sustainable development.
- **H.** Ethics: Apply ethical principles and commitment to professional ethics, responsibilities and norms of the engineering practice.
- **I.** Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multi disciplinary settings.
- **J.** Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend, write effective reports, design documentation, make effective presentations, give and receive clear instructions.
- **K.** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **L.** Life – long learning: Recognize the need and have the preparation, ability to engage in independent and life – long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES:

PS01: Students acquire necessary technical skills in mechanical engineering that make them employable graduate.

PSO2: An ability to impart technological inputs towards development of society by becoming an entrepreneur.

COURSE OBJECTIVES:

1. To understand the basic principles of fluid mechanics.

2. To identify various types of flows.

3. To understand boundary layer concepts and flow through pipes.

4. To evaluate the performance of hydraulic turbines.

5. To understand the functioning and characteristic curves of pumps.

COURSE OUTCOMES:

ME 374.1	Conventional representation of materials, common machine elements and parts.
ME 374.2	Selection of section planes and drawing of sections and auxiliary sectional views.
ME 374.3	Methods of dimensioning, general rules for sizes and placement of dimensions.
ME 374.4	Title boxes, their size, location and details.
ME 374.5	Types of Drawings – working drawings for machine parts.
ME 374.6	Developing assembly drawings using part drawings of machine components.

LIST OF EXPERIMENTS

PART-A

Drawing of Machine Elements and simple parts:

1. Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.
2. Types of sections-selection of section planes and drawing of sections and auxiliary sectional views.
3. Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and taper features.
4. Title boxes, their size, location and details. Common abbreviations and their usage.
5. Working drawings of machine parts. Popular forms of screw threads, bolts, nuts, stud bolts etc. Keys, cotter and knuckle joints, Riveted joints, shaft couplings, spigot and socket pipe joint, Bearings.

PART-B

Assembly Drawings:

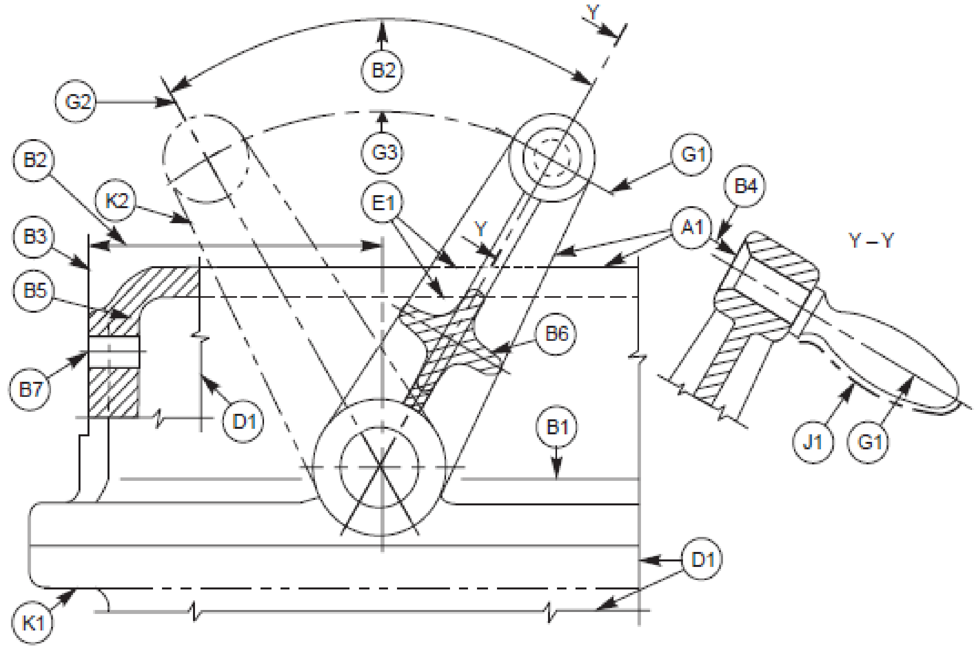
1. Steam engine parts – Stuffing boxes, Cross heads, Eccentrics.
2. Machine tool parts – Tailstock, Tool Post, Machine Vices.
3. Other machine parts – Screwjacks, Petrolengine C.R, Plummerblock, FuelInjector.
4. Valves – Steam stop valve, spring loaded safety valve, feed check valve and aircock.

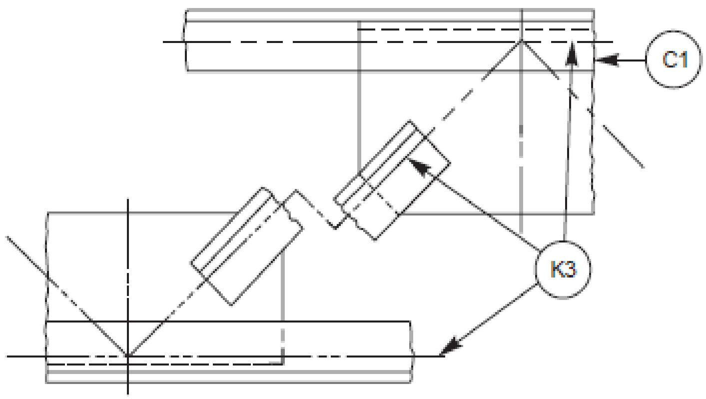
INDEX

1.1 Lines conventions

Lines of different type and thickness are used for graphical representation of objects. the type of lines and their application are shown in fig.

Line	*Description*	*General Applications*
A	Continuous thick	A1 Visible outlines
B	Continuous thin (straight or curved)	B1 Imaginary lines of intersection B2 Dimension lines B3 Projection lines B4 Leader lines B5 Hatching lines B6 Outlines of revolved sections in place B7 Short centre lines
C	Continuous thin, free-hand	C1 Limits of partial or interrupted views and sections, if the limit is not a chain thin
D	Continuous thin (straight) with zigzags	D1 Line (see Fig. 2.5)
E	Dashed thick	E1 Hidden outlines
G	Chain thin	G1 Centre lines G2 Lines of symmetry G3 Trajectories
H	Chain thin, thick at ends and changes of direction	H1 Cutting planes
J	Chain thick	J1 Indication of lines or surfaces to which a special requirement applies
K	Chain thin, double-dashed	K1 Outlines of adjacent parts K2 Alternative and extreme positions of movable parts K3 Centroidal lines





1.2 order of priority of of coincidinglines

When two or more lines of different types coincide, the following order of priority should be observed:

(*i*) Visible outlines and edges (Continuous thick lines, type A),

(*ii*) Hidden outlines and edges (Dashed line, type E or F),

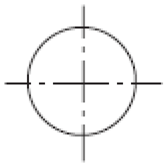
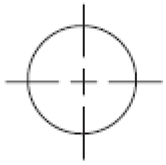
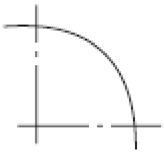
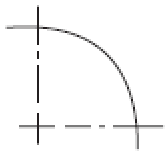
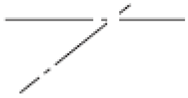
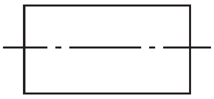
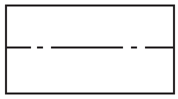
(*iii*) Cutting planes (Chain thin, thick at ends and changes of cutting planes, type H),

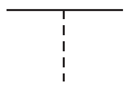
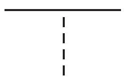
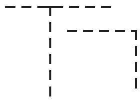
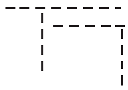
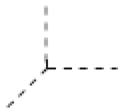
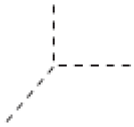
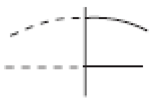
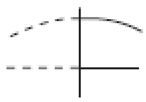
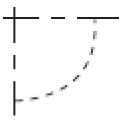
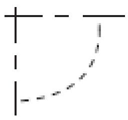
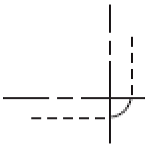
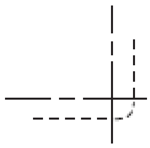
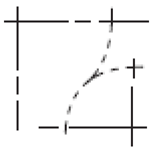
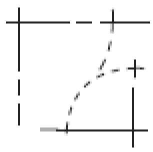
(*iv*) Centre lines and lines of symmetry (Chain thin line, type G),

(*v*) Centroidal lines (Chain thin double dashed line, type K),

(*vi*) Projection lines (Continuous thin line, type B).

The invisible line technique and aixs representation should be followed as per the recommendations given in Table below.

Instructions	*Correct*	*Incorrect*
Axis line starts and ends with a longer dash		
Two axes intersect with longer dashes		
		
		
Axis extends the boundary with a longer dash		

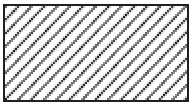
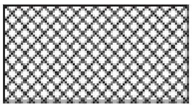
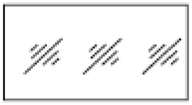
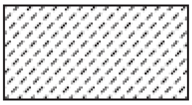
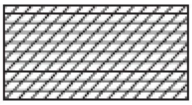
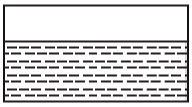
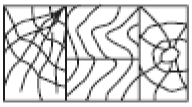
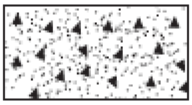
Instructions	*Correct*	*Incorrect*
Begin with a dash, not with a space		
Dashes intersect without a gap between them		
Three dashes meet at the intersection point		
As a continuation of a visible line/arc, begin with space		
Invisible arcs begin with a dash		
Small arcs may be made solid		
Two arcs meet at the point of tangency		

1.3 Conventionalrepresentation.

Certain draughting conventions are used to represent materials in section and machine elements in engineering drawings.

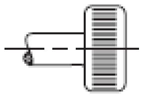
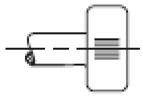
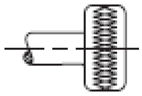
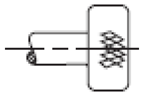
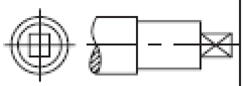
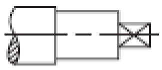
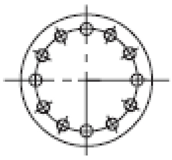
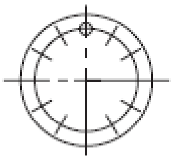
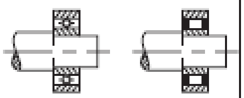
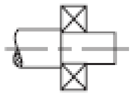
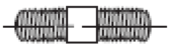
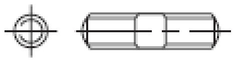
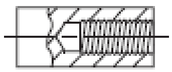
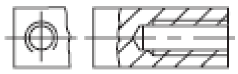
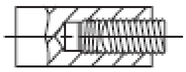
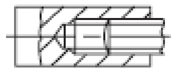
1.3.1 Materials

As a variety of materials are used for machine components in engineering applications, it is preferable to have different conventions of section lining to differentiate between various materials.

Type	Convention	Material
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its Alloys, etc.
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating material		Porcelain, Stoneware, Marble, Slate, etc.
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, Insulating and Filling materials, etc.
Liquids		Water, Oil, Petrol, Kerosene, etc.
Wood		Wood, Plywood, etc.
Concrete		A mixture of Cement, Sand and Gravel

1.3.2 MachineComponents

When the drawing of a component in its true projection involves a lot of time, its convention may be used to represent the actual component.

Title	Subject	Convention
Straight knurling		
Diamond knurling		
Square on shaft		
Holes on circular pitch		
Bearings		
External screw threads (Detail)		
Internal screw threads (Detail)		
Screw threads (Assembly)		

Title	Subject	Convention	
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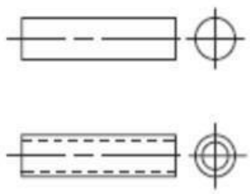
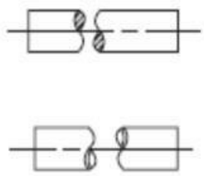
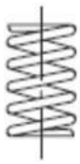
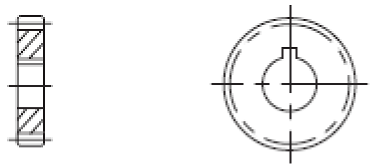
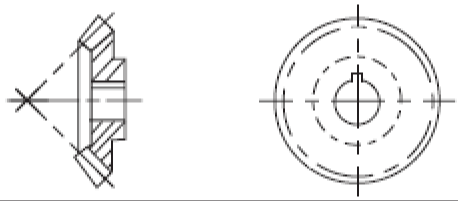
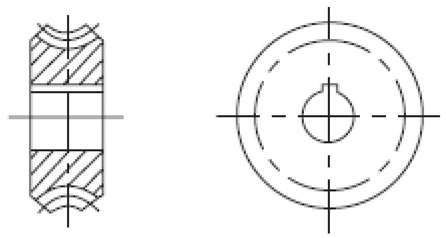
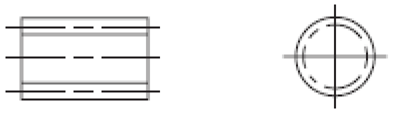
Interrupted views			
ski-elliptic leafspring			
Semi-elliptic leafspnng			
	Subject	Convention	DiagranInwtic Representa0on
Cylindncalc ompression sing			
Cylindncalte nsion spnng			

Title	Convention
Spur gear	
Bevel gear	
Worm wheel	
Worm	

Methods of Dimension:

1.4 DIMENSIONING

A drawing of a component, in addition to providing complete shape description, must also furnish information regarding the size description. These are provided through the distances between the surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these features on a drawing, using lines, symbols, figures and notes is called dimensioning.

1.4.1 General principal

Dimension is a numerical value expressed in appropriate units of measurement and indicated on drawings, using lines, symbols, notes, etc., so that all features are completely defined.

1. As far as possible, dimensions should be placed outside theview.
2. Dimensions should be taken from visible outlines rather than from hiddenlines.
3. dimensioning to a centre line should be avoided except when the centre line passes through the centre of ahole.
4. Each feature should be dimensioned once only on adrawing.
5. Dimensions should be placed on the view or section that relates most clearly to the Correspondingfeatures.
6. Each drawing should use the same unit for all dimensions, but without showing the unit Symbol.
7. No more dimensions than are necessary to define a part should be shown on adrawing.
8. No features of a part should be defined by more than one dimension in any onedirection.

1.4.2 Method ofExecution

The elements of dimensioning include the projection line, dimension line, leader line, dimension line termination, the origin indication and the dimension itself

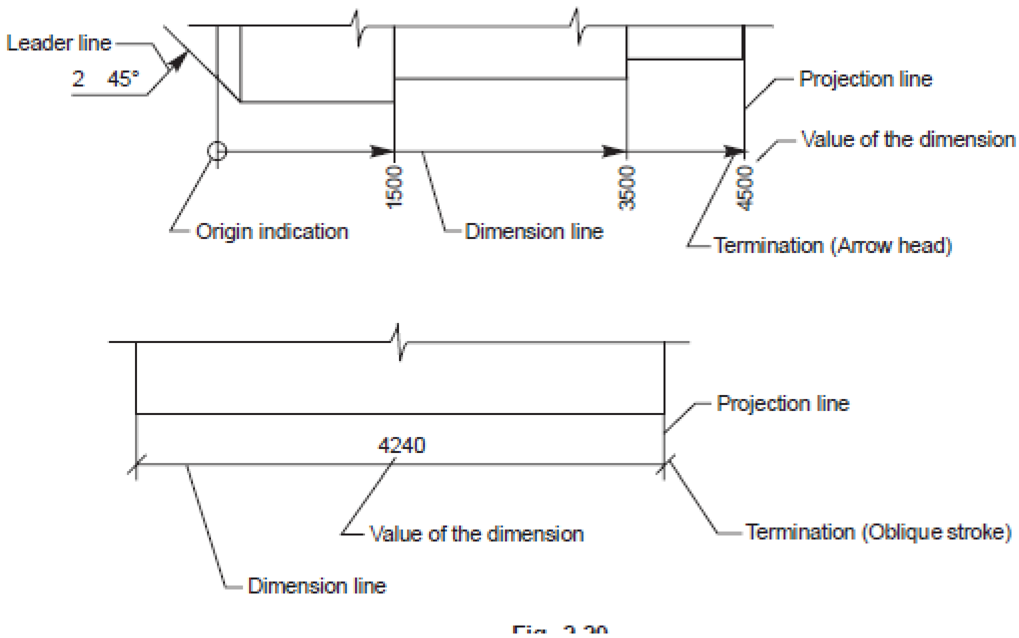
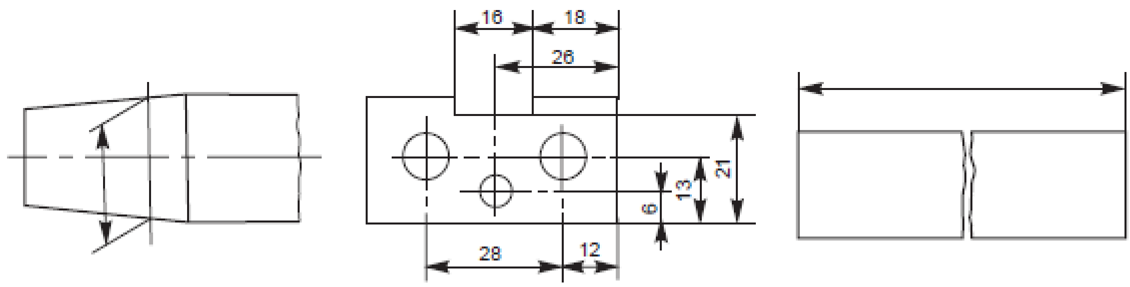


Fig 1.2 elements of dimensioning

The following are some of the principle to be adopted during execution of dimensioning.

1. Projection and dimension lines should be drawn as thin continuouslines.
2. Projection lines should extend slightly beyond the respective dimensionlines.
3. Projection lines should be drawn perpendicular to the feature beingdimensioned.
4. Projection lines and dimension lines should not cross each other, unless it is unavoidable (Fig.1.4).
5. A dimension line should be shown unbroken, even where the feature to which it refers, is shown broken (Fig.1.4).
6. A centre line or the outline of a part should not be used as a dimension line, but may be used in place of projection line(Fig1.3).

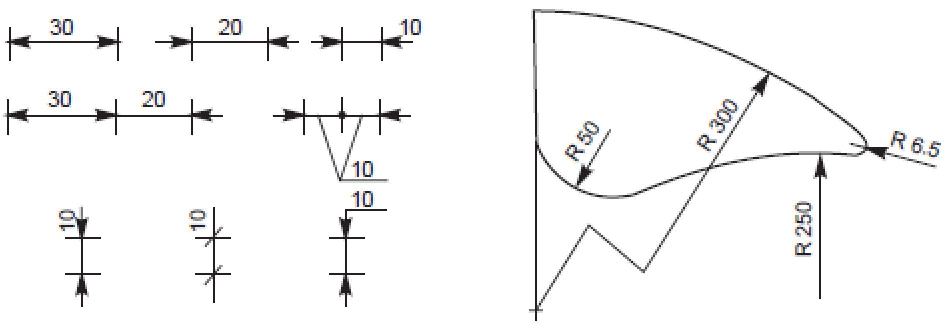


1.4.3 Termination and OriginIndication

Dimension lines should show distinct termination, in the form of Arrow head arrow heads or oblique strokes or where applicable, an origin indication. As shown fig.1.4

1. The arrow head is drawn as short lines, having an included angle of 15°, which is closed andfilled-in.
2. The oblique stroke is drawn as a short line, inclined at45°.
3. The origin indication is drawn as a small open circle of approximately 3 mm indiameter.

The size of the terminations should be proportionate to the size of the drawing on which they are used. Where space is limited, arrow head termination may be shown outside the intended limits of the dimension line that is extended for that purpose. In certain other cases, an oblique stroke or a dot may be substituted (Fig1.25).



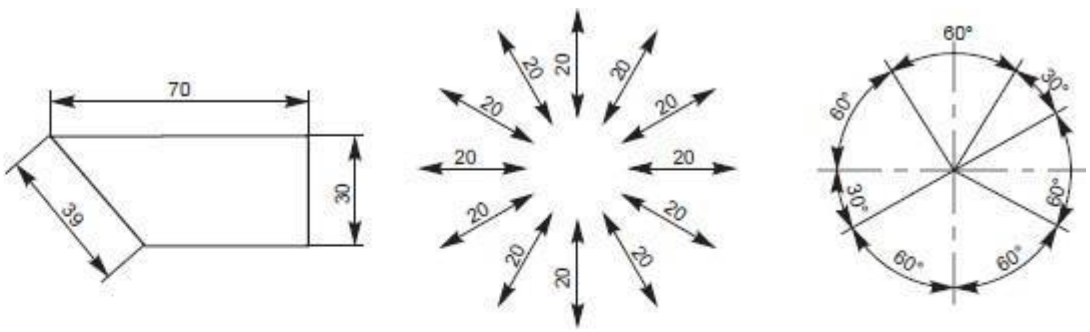
1.4.4 Methods of IndicatingDimensions

Dimensions should be shown on drawings in characters of sufficient size, to ensure complete legibility. They should be placed in such a way that they are not crossed or separated by any other line on the drawing. Dimensions should be indicated on a drawing, according to one of the following two methods.

Method- 1(Alligned system)

Dimensions should be placed parallel to their dimension lines and preferably near the middle, above and clear-off the dimension line (Fig. 1.6). An exception may be made where super-imposed running dimensions are used (Fig.1.7)

Angular dimensions may be oriented as shown in Fig. 1.8



Method 2:

(Uni-directional System)

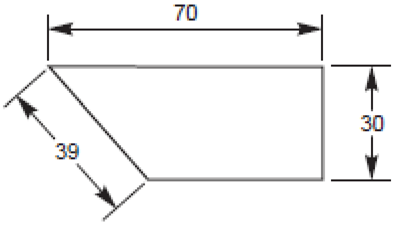
Dimensons should be indicated so that they can be read from the bottom of the drawing only.

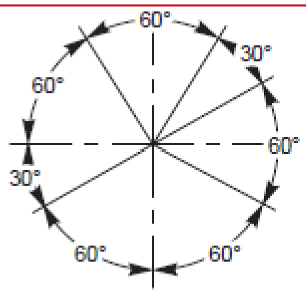
Non-horizontal dimension lines are interrupted, preferably near the middle, for insertion of the dimension (Fig. 1.9).

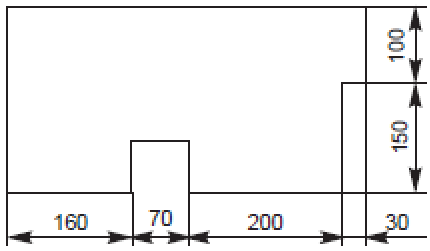
Angular dimensions may be oriented as in Fig. 1.10

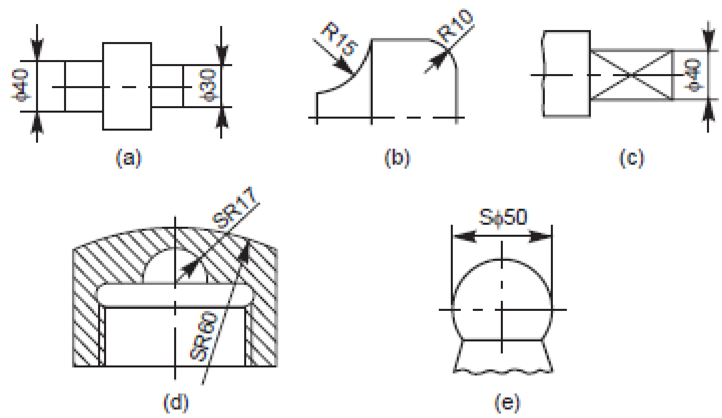
The following indications (symbols) are used with dimensions to reveal the shape identification and to improve drawing interpretation. The symbol should precede the dimensions (Fig. 1.11).

φ : Diameter Sφ : Spherical diameter R : Radius SR : Spherical radius : Square dharm d:Design-1.pm5









1.4.5 Arrangement ofDimensions

The arrangement of dimensions on a drawing must indicate clearly the design purpose.

Chain Dimensions:

Chains of single dimensions should be used only where the possible accumulation of tolerances does not endanger the functional requirement of the part (Fig. 1.12).

Parallel Dimensions

In parallel dimensioning, a number of dimension lines, parallel to one another and spaced-out are used. This method is used where a number of dimensions have a common datum feature (Fig. 1.13).

Super-imposed Running Dimensions

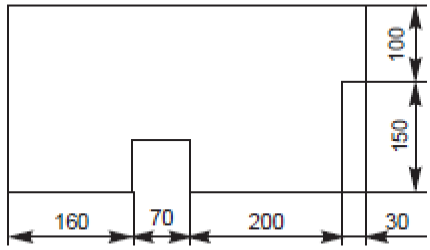
These are simplified parallel dimensions and may be used where there are space limitations (Fig. 1.14).

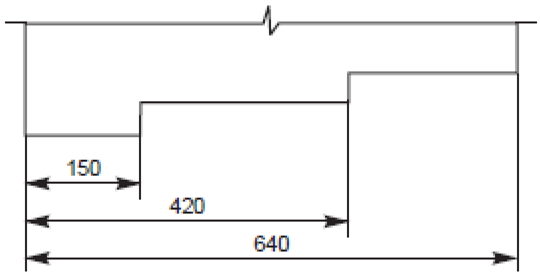
Combined Dimensions

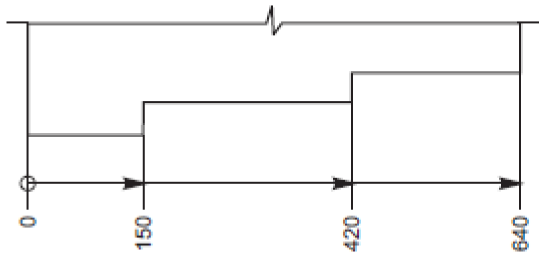
These are the result of simultaneous use of chain and parallel dimensions (Fig. 1.15).

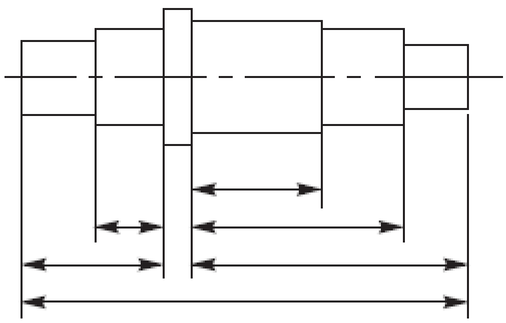
Co-ordinate Dimensions

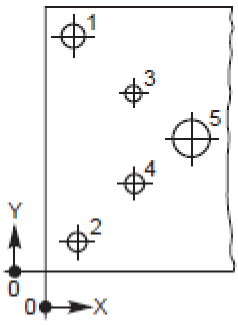
The sizes of the holes and their co-ordinates may be indicated directly on the drawing; or they may be conveniently presented in a tabular form, as shown in Fig. 1.16











	X	Y	ϕ
1	20	160	15.5
2	20	20	13.5
3	60	120	11
4	60	60	13.5
5	100	90	26
6			
7			
8			
9			
10			

1.4.6 Special Indications

Diameters

Diameters should be dimensioned on the most appropriate view to ensure clarity. The dimension value should be preceded by φ. Figure 1.16 &1.17 shows the method of dimensioning diameters.

Chords, Arcs, Angles and Radii

The dimensioning of chords, arcs and angles should be as shown in Fig. 1.18. Where the centre of an arc falls outside the limits of the space available, the dimension line of the radius should be broken or interrupted according to whether or not it is necessary to locate the centre

Where the size of the radius can be derived from other dimensions, it may be indicated by a radius arrow and the symbol R, without an indication of the value (Fig1.19).

Equi-distant Features

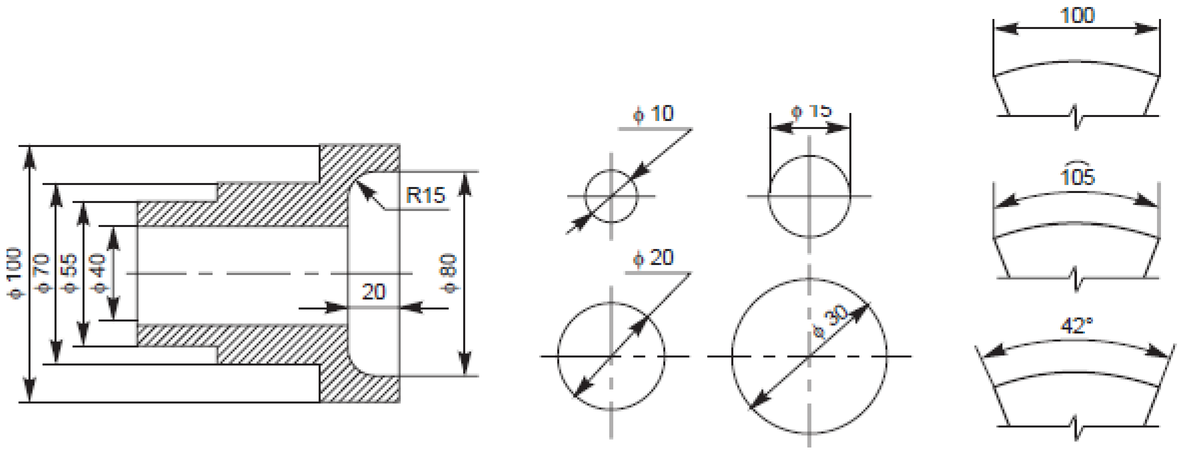
Linear spacings with equi-distant features may be dimensioned as shown in Fig. 1.20

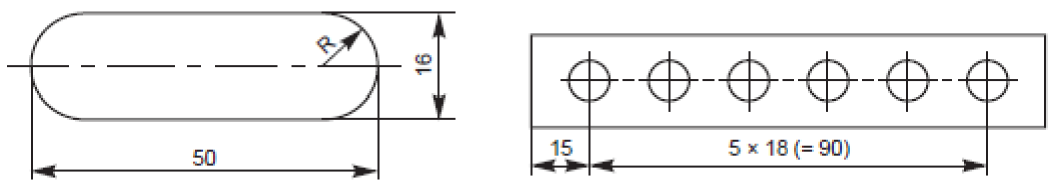
Chamfers and Countersunks

Chamfers may be dimensioned as shown in Fig. 2.51 and countersunks, as shown in Fig. 1.22.

Screw Threads

Screw threads are always specified with proper designation. The nominal diameter is preceded by the M10 letter M. The useful length of the threaded portion only should be dimenioned as shown in Fig. 1.23. While dimensioning the internal threads, the length of th drilled hole should also be dimensioned .

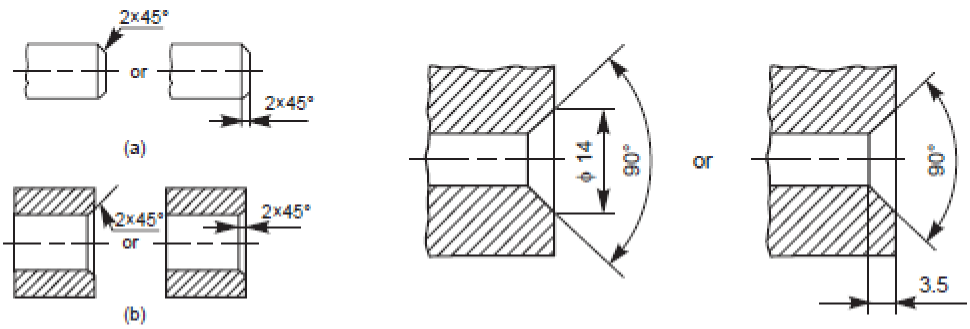


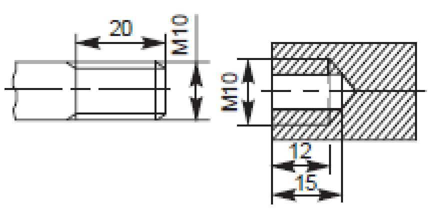


Tapered Features

Tapered features are dimensioned, either by specifying the diameters at either end and the length, or the length, one of the diameters and the taper or the taper angle (Fig. 1.24*a*).

A slope or flat taper is defined as the rise per unit length and is dimensioned by the ratio of the difference between the heights to its length (Fig1.24 *b*).





1.5 STANDARDABBREVIATIONS

Standard abbreviations in draughting are recommended as notes to provide a brief and clear instructions. Table 2.9 provides the draughting abbreviations for general terms and Table 1.4.1

Draughting abbreviations

Term	*Abbreviation*	*Term*	*Abbreviation*
Across corners	A/C	Maunfacture	MFG
Across flats	A/F	Material	MATL
Approved	APPD	Maximum	max.
Approximate	APPROX	Metre	m
Assembly	ASSY	Mechanical	MECH
Auxiliary	AUX	Millimetre	mm
Bearing	BRG	Minimum	min.
Centimetre	Cm	Nominal	NOM
Centres	CRS	Not to scale	NTS
Centre line	CL	Number	No.
Centre to centre	C/L	Opposite	OPP
Chamfered	CHMED	Outside diameter	OD
Checked	CHD	Pitch circle	PC
Cheese head	CH HD	Pitch circle diameter	PCD
Circular pitch	CP	Quantity	QTY
Circumference	OCE	Radius	R
Continued	CONTD	Radius in a note	RAD
Counterbore	C BORE	Reference	REF
Countersunk	CSK	Required	REQD
Cylinder	CYL	Right hand	RH
Diameter	DIA	Round	RD
Diametral pitch	DP	Screw	SCR
Dimension	DIM	Serial number	Sl. No.
Drawing	DRG	Specification	SPEC
Equi-spaced	EQUI-SP	Sphere/Spherical	SPHERE
External	EXT	Spot face	SF
Figure	FIG.	Square	SQ
General	GNL	Standard	STD
Ground level	GL	Symmetrical	SYM
Ground	GND	Thick	THK
Hexagonal	HEX	Thread	THD
Inspection	INSP	Through	THRU
Inside diameter	ID	Tolerance	TOL
Internal	INT	Typical	TYP
Left hand	LH	Undercut	U/C
Machine	M/C	Weight	WT

Abbreviations for materials

Material	*Abbreviation*
Aluminium	AL
Brass	BRASS
Bronze	BRONZE
Cast iron	CI
Cast steel	CS
Chromium steel	CrS
Copper	Cu
Forged steel	FS
Galvanised iron	GI
Gray iron	FG
Gunmetal	GM
High carbon steel	HCS
High speed steel	HSS
High tensile steel	HTS
Low carbon steel	LCS
Mild steel	MS
Nickel steel	Ni S
Pearlitic malleable iron	PM
Phosphor bronze	PHOS.B
Sheet steel	Sh S
Spring steel	Spring S
Structure steel	St
Tungston carbide steel	TCS
Wrought iron	WI
White metal	WM

1.6 GRAPHICLANGUAGE

1.6.1 General

A technical person can use the graphic language as powerful means of communication with others for conveying ideas on technical matters. However, for effective exchange of ideas with others, the engineer must have proficiency in (*i*) language, both written and oral, (*ii*) symbols associated with basic sciences and (*iii*) the graphic language. Engineering drawing is a suitable graphic language from which any trained person can visualise the required object. As an engineering drawing displays the exact picture of an object, it obviously conveys the same ideas to every trained eye.

Irrespective of language barriers, the drawings can be effectively used in other countries, in addition to the country where they are prepared. Thus, the engineering drawing is the universal language of all engineers.

1.6.2 Importance of GraphicLanguage

The graphic language had its existence when it became necessary to build new structures and create new machines or the like, in addition to representing the existing ones. In the absence of graphic language, the ideas on technical matters have to be conveyed by speech or writing, both are unreliable and difficult to understand by the shop floor people for manufacturing.

1.6.3 Need for CorrectDrawings

The drawings prepared by any technical person must be clear, unmistakable in meaning and there should not be any scope for more than one interpretation, or else litigation may arise. In a number of dealings with contracts, the drawing is an official document and the success or failure of a structure depends on the clarity of details provided on the drawing. Thus, the drawings should not give any scope for mis-interpretation even by accident.

It would not have been possible to produce the machines/automobiles on a mass scale where a number of assemblies and sub-assemblies are involved, without clear, correct and accurate drawings. To achieve this, the technical person must gain a thorough knowledge of both the principles and conventional practice of draughting. If these are not achieved and or practiced, the drawings prepared by one may convey different meaning to others, causing unnecessary delays and expenses in production shops.

1.70 classification of Drawings

It is pertaining to machine parts or components. It is presented through a number of orthographic views, so that the size and shape of the component is fully understood. Part drawings and assembly drawings belong to this classification.

Production Drawing

A production drawing, also referred to as working drawing, should furnish all the dimensions, limits and special finishing processes such as heat treatment, honing, lapping, surface finish, etc., to guide the craftsman on the shop floor in producing the component. The title should also mention the material used for the product, number of parts required for the assembled unit, etc.

3 Part Drawing

Component or part drawing is a detailed drawing of a component to facilitate its manufacture.

All the principles of orthographic projection and the technique of graphic representation must be followed to communicate the details in a part drawing. A part drawing with production details is rightly called as a production drawing or working drawing.

Assembly Drawing

A drawing that shows the various parts of a machine in their correct working locations is an assembly drawing There are several types of such drawings.

Design Assembly Drawing

When a machine is designed, an assembly drawing or a design layout is first drawn to clearly visualise the performance, shape and clearances of various parts comprising the machine.

Detailed Assembly Drawing

It is usually made for simple machines, comprising of a relatively smaller number of simple parts. All the dimensions and information necessary for the construction of such parts and for the assembly of the parts are given directly on the assembly drawing. Separate views of specific parts in enlargements, showing the fitting of parts together, may also be drawn in addition to the regular assembly drawing.

Sub-assembly Drawing

Many assemblies such as an automobile, lathe, etc., are assembled with many pre-assembled components as well as individual parts. These pre-assembled units are known as sub-assemblies.

Installation Assembly Drawing

On this drawing, the location and dimensions of few important parts and overall dimensions of the assembled unit are indicated. This drawing provides useful information for assembling the machine, as this drawing reveals all parts of a machine in their correct working position.

1.2.4.5 Assembly Drawings forCatalogues

Special assembly drawings are prepared for company catalogues. These drawings show only the pertinent details and dimensions that would interest the potential buyer. Figure 1.4 shows a typical catalogue drawing, showing the overall and principal dimensions.

1.2.4.6 Assembly Drawings for InstructionManuals

These drawings in the form of assembly drawings, are to be used when a machine, shipped away in assembled condition, is knocked down in order to check all the parts before reassembly a installation elsewhere .these drawings have component numbered a the job.

Exploded Assembly Drawing

In some cases, exploded pictorial views are supplied to meet instruction manual requirements.

These drawings generally find a place in the parts list section of a company instruction manual.

shows drawings of this type which may be easily understood even by those with less experience in the reading of drawings; because in these exploded views, the parts are positioned in the sequence of assembly, but separated from each other.

1.2.4.8 Schematic Assembly Drawing

It is very difficult to understand the operating principles of complicated machinery, merely from the assembly drawings. Schematic representation of the unit facilitates easy understanding of its operating principle. It is a simplified illustration of the machine or of a system, replacing all the elements, by their respective conventional representations.

Machine Shop Drawing

Rough castings and forgings are sent to the machine shop for finishing operation (Fig. 1.8).

Since the machinist is not interested in the dimensions and information of the previous stages, a machine shop drawing frequently gives only the information necessary for machining. Based on the same principle, one may have forge shop drawing, pattern shop drawing, sheet metal drawing, etc.

Experiment 1

2.1 Screwed fasteners

Introduction

A machine element used for holding or joining two or more parts of a machine or structure is known as a fastener. The process of joining the parts is called fastening. The fasteners are of two types : permanent and removable (temporary). Riveting and welding processes are used for fastening permanently. Screwed fasteners such as bolts, studs and nuts in combination, machine screws, set screws, etc., and keys, cotters, couplings, etc., are used for fastening components that require frequent assembly and dissembly.

SCREW THREAD NOMENCLATURE

A screw thread is obtained by cutting a continuous helical groove on a cylindrical surface (external thread). The threaded portion engages with a corresponding threaded hole (internal thread); forming a screwed fastener. Following are the terms that are associated with screw threads (Fig. 2.11).

Major (nominal) diameter

This is the largest diameter of a screw thread, touching the crests on an external thread or the roots of an internal thread.

Minor (core) diameter

This is the smallest diameter of a screw thread, touching the roots or core of an external thread (root or core diameter) or the crests of an internal thread.

Pitch diameter

This is the diameter of an imaginary cylinder, passing through the threads at the points where the thread width is equal to the space between the threads.

Pitch

It is the distance measured parallel to the axis, between corresponding points on adjacent screw threads.

Lead

It is the distance a screw advances axially in one turn.

Flank

Flank is the straight portion of the surface, on either side of the screw thread.

Crest

It is the peak edge of a screw thread, that connects the adjacent flanks at the top.

Root

It is the bottom edge of the thread that connects the adjacent flanks at the bottom.

Thread angle

This is the angle included between the flanks of the thread, measured in an axial plane.

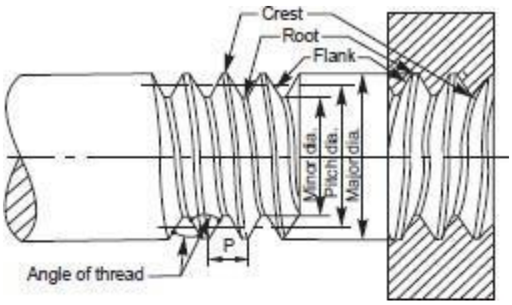


Fig 1.1.1 Screw thread Nomenclature

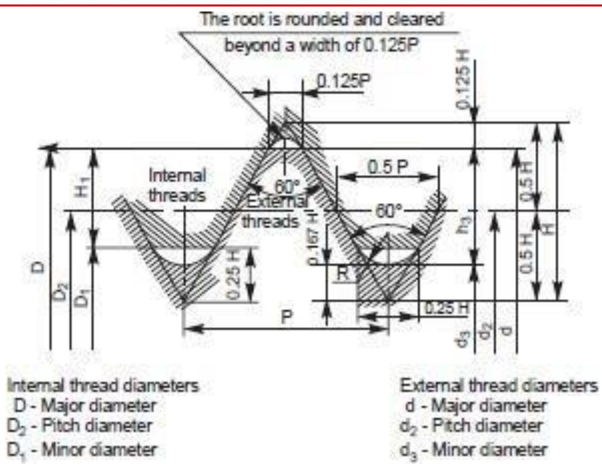
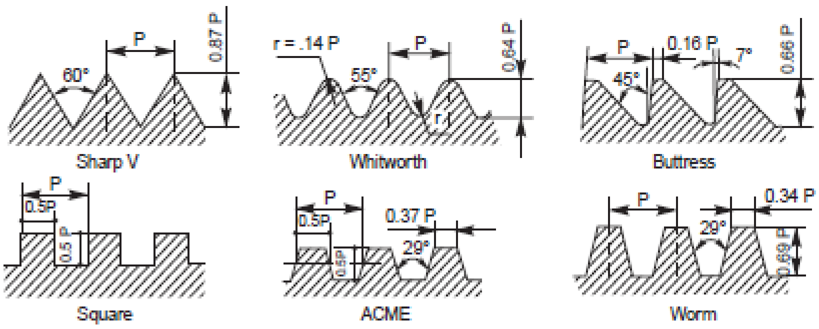


Fig 2.2.2 Metric thread Screw thread



2.1.2 FORMS OFTHREADS

Bureau of Indian Standards (BIS) adapts ISO (International Organisation for Standards) metric threads which are adapted by a number of countries apart from India.

The design profiles of external and internal threads are shown in Fig. 2.1.2

other thread profiles

Apart from ISO metric screw thread profile, there are other profiles in use to meet various applications.

V-Thread (sharp)

This thread profile has a larger contact area, providing more frictional resistance to motion.

Hence, it is used where effective positioning is required. It is also used in brass pipe work.

British Standard Whitworth (B.S.W) Thread

This thread form is adopted in Britain in inch units. The profile has rounded ends, making it less liable to damage than sharp V-thread.

Buttress Thread

This thread is a combination of V-and square threads. It exhibits the advantages of square thread, like the ability to transmit power and low frictional resistance, with the strength of the V-thread.

It is used where power transmission takes place in one direction only such as screw press, quick acting carpenter's vice, etc.

Square Thread

Square thread is an ideal thread form for power transmission. In this, as the thread flank is at right angle to the axis, the normal force between the threads, acts parallel to the axis, with zero radial component. This enables the nut to transmit very high pressures, as in the case of a screw jack and other similar applications.

ACME Thread

It is a modified form of square thread. It is much stronger than square thread because of the wider base and it is easy to cut. The inclined sides of the thread facilitate quick and easy engagement and disengagement as for example, the split nut with the lead screw of a lathe.

Worm Thread

Worm thread is similar to the ACME thread, but is deeper. It is used on shafts to carry power to worm wheels.

THREAD DESIGNATION

The diameter-pitch combination of an ISO metric screw thread is designated by the letter 'M'

followed by the value of the nominal diameter and pitch, the two values being separated by the sign '×'. For example, a diameter pitch combination of nominal diameter 10 mm and pitch 1.25

mm is designated as M10 × 1.25.

If there is no indication of pitch in the designation, it shall mean the coarse pitch. For example, M 10 means that the nominal diameter of the thread is 10 mm and pitch is 1.5 mm.

Following are the other designations, depending on the shape of the thread profile : SQ 40 × 10 – SQUARE thread of nominal diameter 40 mm and pitch 10 mm ACME 40 × 8 – ACME thread of nominal diameter 40 mm and pitch 8 mm

WORM 40 × 10 – WORM thread of nominal diameter 40 mm and pitch 10 mm 5.6

MULTI-START THREADS

A single-start thread consists of a single, continuous helical groove for which the lead is equal to the pitch. As the depth of the thread depends on the pitch, greater the lead desired, greater will be the pitch and hence smaller will be the core diameter, reducing the strength of the fastener. To overcome this drawback, multi-start threads are recommended. Fig 2.1.4

In multi-start threads, lead may be increased by increasing the number of starts, without increasing the pitch. For a double start thread, lead is equal to twice the pitch and for a triple start thread, lead is equal to thrice the pitch.

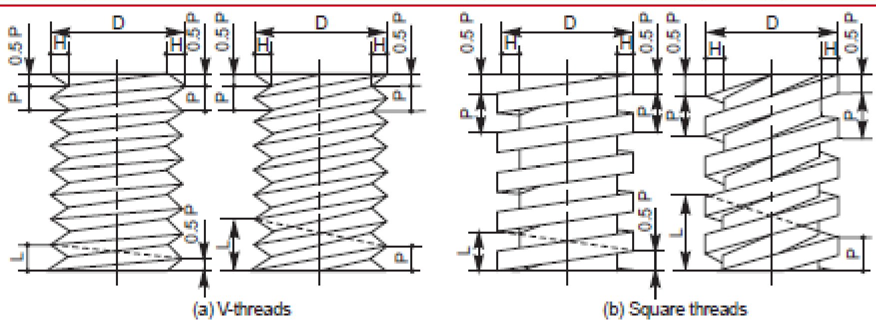


Fig 2.1.4 single &multi start threads

2.1.3 BOLTEDJOINT

A bolt and nut in combination is a fastening device used to hold two parts together. The body of the bolt, called shank is cylindrical in form, the head; square or hexagonal in shape, is formed by forging. Screw threads are cut on the other end of the shank. Nuts in general are square or hexagonal in shape. The nuts with internal threads engage with the corresponding size of the external threads of the bolt. However, there are other forms of nutsusedto suit specific requirements. For nuts, hexagonal shape is preferred to the Bolted joint square one, as it is easy to tighten even in a limited space. This is because, with only one-sixth of a turn, the spanner can be re-introduced in the same position. However, square nuts are used when frequent loosening and tightening is required, for example on job holding devices like vices, tool posts in machines, etc. The sharp corners on the head of bolts and nuts are removed bychamfering.

2.1.4. Methods of Drawing Hexagonal (Bolt Head) Nut Drawing hexagonal bolt head or nut, to the exact dimensions is labourious and time consuming. Moreover, as standard bolts and nuts are used, it is not necessary to draw them accurately. The following approximate methods are used to save the draughting time

Empirical relations : Major or nominal diameter of bolt = D

Thickness of nut, T= D Width of nut across flat surfaces, W = 1.5D + 3 mm

Radius of chamfer, R = 1.5D

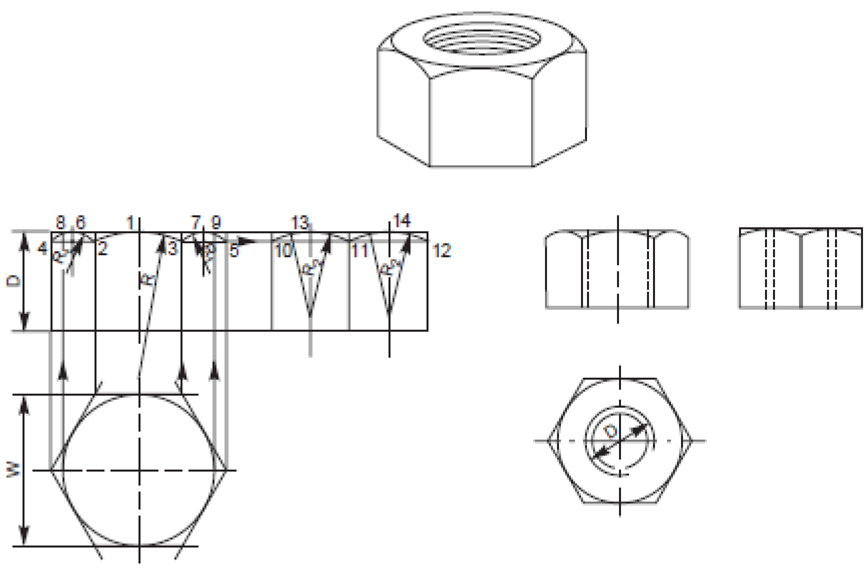


Fig 2.1.5 Method of drawing views of hexagonal NUT

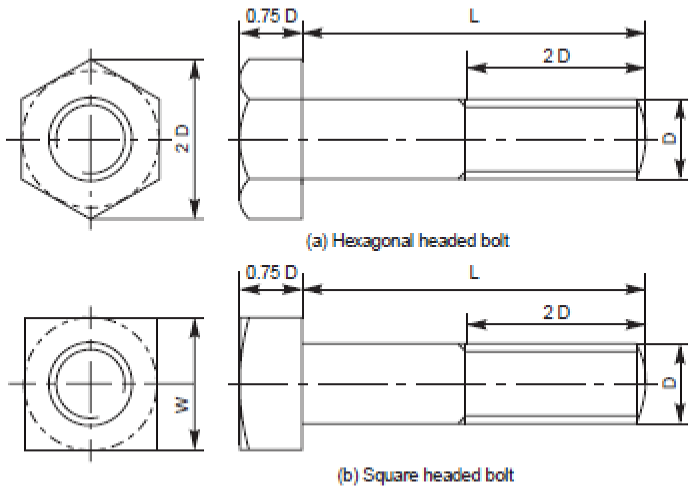
Method of drawing views of a hexagonal nut (Method I)

PROCEDURE

1. Draw the view from above by drawing a circle of diameter, W and describe a regular hexagon on it, by keeping any two parallel sides of the hexagon,horizontal.
2. Projecttheviewfromthefront,andtheviewfrom side,and marktheheight equaltoD.
3. With radius R, draw the chamfer arc 2-1-3 passing through the point 1 in the frontface.
4. Mark points 4 and 5, lying in-line with 2 and3.
5. Locate points 8,9 on the top surface, by projecting from the view fromabove.
6. Draw the chamfers 4–8 and5–9.
7. Locate points 6 and 7, lying at the middle of the outer twofaces.
8. Draw circular arcs passing through the points 4, 6, 2 and 3, 7, 5, after determining the radius R geometrically.
9. Project the view from the side and locate points 10, 11 and12.
10. Mark points 13 and 14, lying at the middle of the two faces (view from theside).
11. Draw circular arcs passing through the points 10, 13, 11 and 11, 14, 12, after determining the radius R geometrically.

2.1.5 Hexagonal and Square Headed Bolts

Figure 2.17 shows the two views of a hexagonal headed bolt and square headed bolt, with the proportions marked.



Washers

A washer is a cylindrical piece of metal with a hole to 0.15 D receive the bolt. It is used to give a perfect seating for the nut and to distribute the tightening force uniformly to the parts under the joint. It also prevents the nut from damaging the metal surface under the joint. Figure 2.18 shows a washer, with the proportions

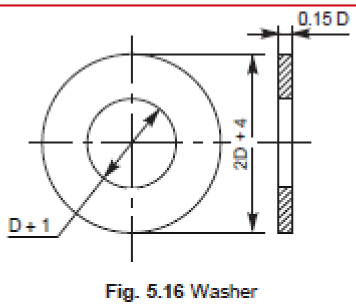


Fig. 5.16 Washer

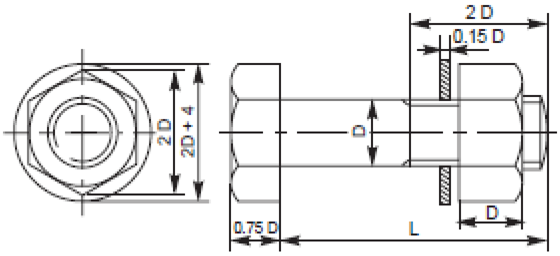


Fig2.1.8 washer fig 2.1.9 A hexagonal headed bolt with a nut & a washer in position

Other Forms ofBolts

2.1.6. Square Headed Bolt with SquareNeck

It is provided with a square neck, which fits into a corresponding square hole in the adjacent part, preventing the rotation of the bolt(Fig2.1.10)

T-Headed Bolt With Square Neck

In this, a square neck provided below the head, prevents the rotation of the bolt. This type of bolt is used for fixing vices, work pieces, etc., to the machine table having T-slots

Hook Bolt

This bolt passes through a hole in one part only, while the other part is gripped by the hook shaped bolt head. It is used where there is no space for making a bolt hole in one of the parts. The square neck prevents the rotation of the bolt.

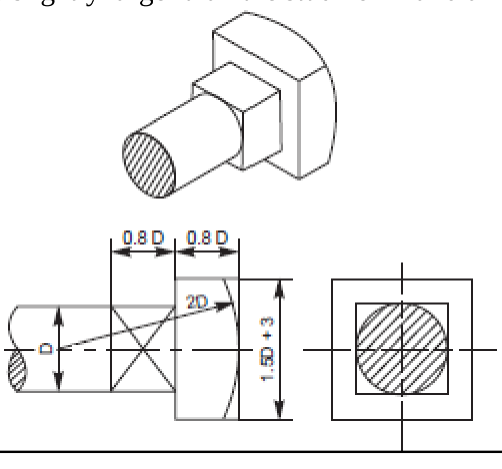
Eye Bolt

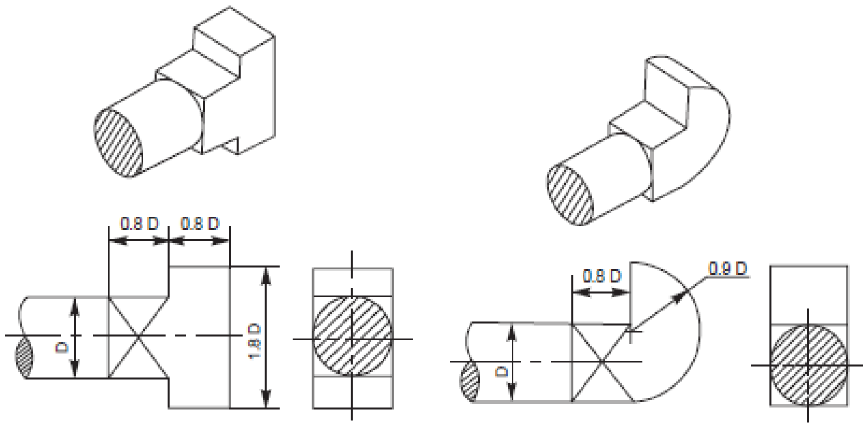
In order to facilitate lifting of heavy machinery, like electric generators, motors, turbines, etc., eye bolts are screwed on to their top surfaces. For fitting an eye bolt, a tapped hole is provided, above the centre of gravity of the machine.

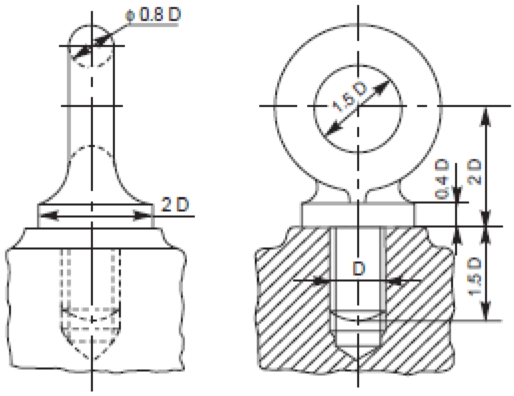
Stud Bolt or Stud

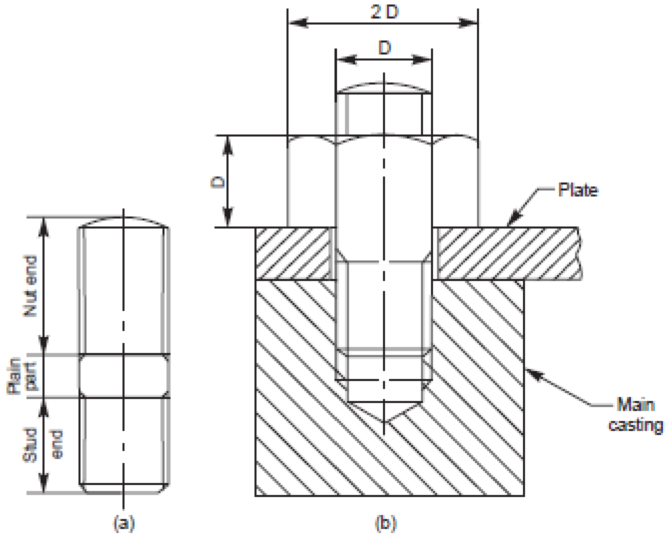
It consists of cylindrical shank with threads cut on both the ends (Fig. 5.22 *a*). It is used where there is no place for accommodating the bolt head or when one of the parts to be joined is too thick to use an ordinary bolt.

The stud is first screwed into one of the two parts to be joined, usually the thicker one. A stud driver, in the form of a thick hexagonal nut with a blind threaded hole is used for the purpose. After placing the second part over the stud, a nut is screwed-on over the nut end. It is usual to provide in the second part, a hole which is slightly larger than the stud nominal diameter.









2.1.7.

Other Forms of Nuts

Flanged Nut

This is a hexagonal nut with a collar or flange, provided integral with it. This permits the use of a bolt in a comparitively large size hole (Fig. 5.23 *a*).

Cap Nut

It is a hexagonal nut with a cylindrical cap at the top. This design protects the end of the bolt from corrosion and also prevents leakage through the threads. Cap nuts are used in smoke boxes or locomotive and steam pipe connections (Fig. 5.23 *b*).

Dome Nut

It is another form of a cap nut, having a spherical dome at the top (Fig. 5.23 *c*).

Capstan Nut

This nut is cylindrical in shape, with holes drilled laterally in the curved surface. A tommy bar may be used in the holes for turning the nut (Fig. 5.23 *d*). Holes may also be drilled in the upper flat face of the nut.

5 Slotted or Ring Nut

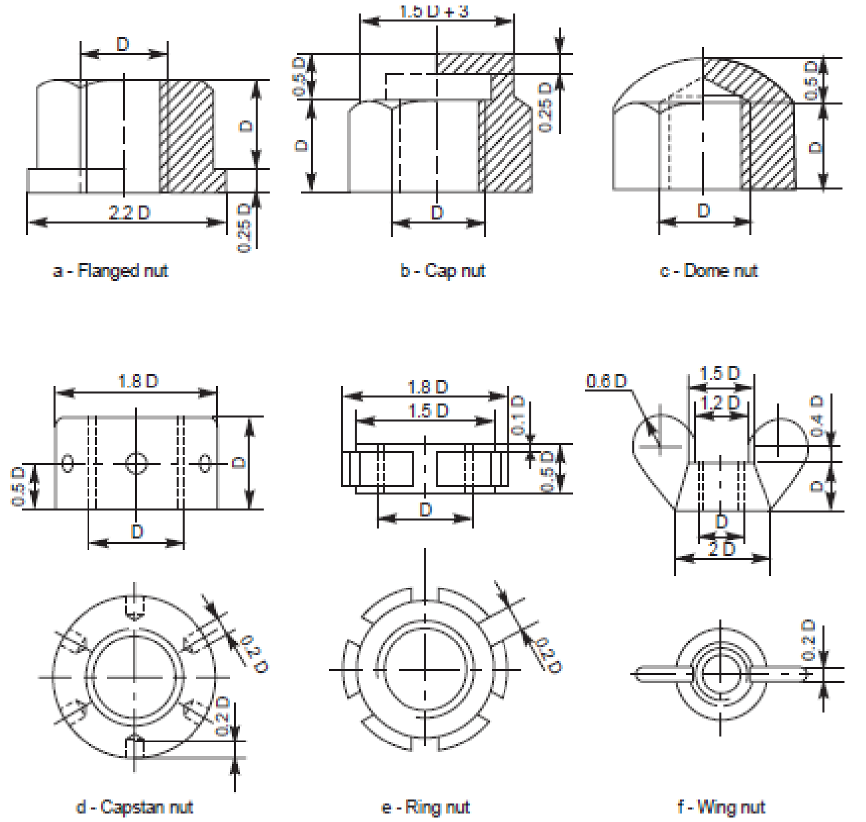
This nut is in the form of a ring, with slots in the curved surface, running parallel to the axis. A special C-spanner is used to operate the nut. These nuts are used on large screws, where the use of ordinary spanner is inconvenient.

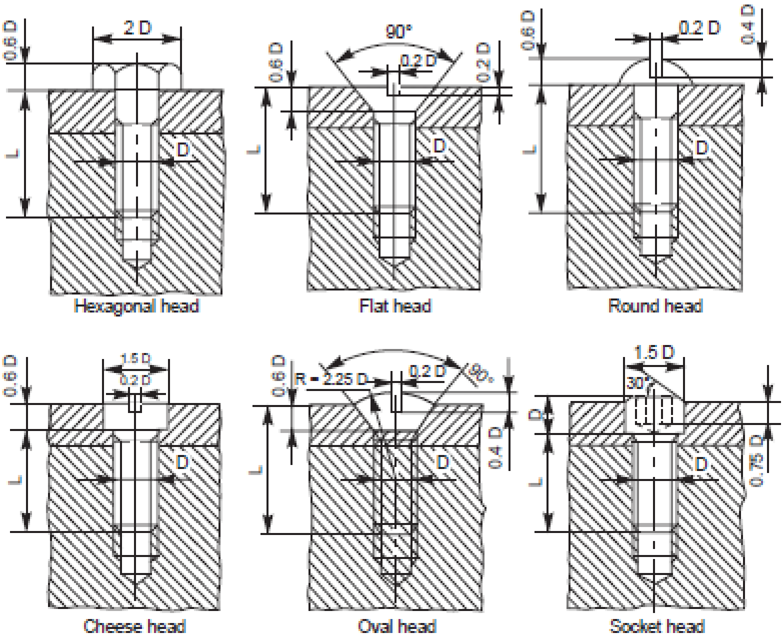
Wing Nut

This nut is used when frequent removal is required, such as inspection covers, lids, etc. It is operated by the thumb.

2.1.8 Cap Screws and MachineScrews

Cap screws and machine screws are similar in shape, differing only in their relative sizes. Machine screws are usually smaller in size, compared to cap screws. These are used for fastening two parts, one with clearance hole and the other with tapped hole. The clearance of the unthreaded hole need not be shown on the drawing as its presence is obvious. Figure 5.24 shows different types of cap and machine screws, with proportions marked.





2.1.9 LOCKING ARRANGEMENTS FORNUTS

The bolted joints, though removable in nature, are required to stay firm without becoming loose, of their own accord. However, the joints used in the moving parts of a machinery, may be subjected to vibrations. This may slacken the joint, leading to serious breakdown.

To eliminate the slackening tendency, different arrangements, as discussed further, are used to lock the nuts :

1. LockNut

This is the most commonly used locking device. In this arrangement, a second nut, known as lock nut is used in combination with a standard nut (Fig. 5.27 *a*). The thickness of a lock nut is usually two-thirds D, where D is the major diameter of the bolt. The lock nut is usually placed below the standard nut. To make the joint, the lock nut is first screwed tightly and then the standard nut is tightened till it touches the lock nut. Afterwards, the locknut is then screwed back on the standard nut, which is held by a spanner. The threads of the two nuts become wedged between the threads of the bolt.

2 Locking by Split Pin

A split pin, made of steel wire of semi-circular cross-section is used for locking the nut. In this arrangement, the split pin is inserted through a hole in the bolt body and touching just the top surface of the nut. Then, the ends of the pin are split open to prevent it from coming out while in use.

Locking by Castle Nut

A castle nut is a hexagonal nut with a cylindrical collar turned on one end. Threads are cut in the nut portion only and six rectangular slots are cut through the collar. A split pin is inserted through a hole in the bolt body after adjusting the nut such that the hole in the bolt body comes in-line with slots. This arrangement is used in automobile works.

Wile's Lock nut

It is a hexagonal nut with a slot, cut half-way across it. After tightening the nut in the usual manner, a set screw is used from the top of the nut, compressing the two parts. For this purpose, the upper portion of the nut should have a clearance hole and the lower portion tapped (Fig. 2.1.2.2)

Locking by Set Screw

In this arrangement, after the nut is tightened, a set screw in fitted in the part, adjoining the nut, so that it touches one of the flat faces of the nut. The arrangement prevents the loosening tendency of the nut (Fig. 2.1.2.3)

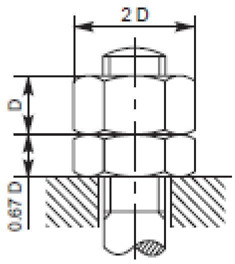
Grooved Nut

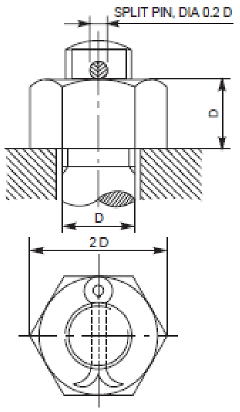
It has a cylindrical grooved collar, integrally provided at the lower end of the nut. This collar fits into a corresponding recess in the adjoining part. In this arrangement, after tightening the nut, a set screw is inserted from one end of the upper part, so that the end of the set screw enters the groove, preventing the loosening tendency of the nut (Fig. 2.1.2.4).

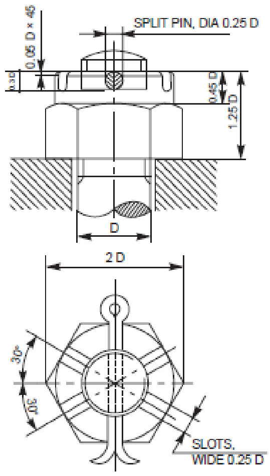
Locking by Screw

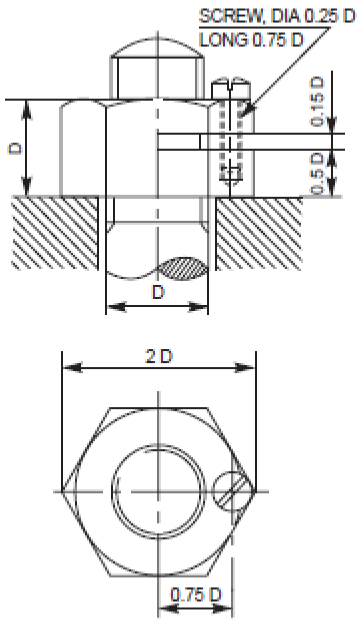
In this, a cap nut with an integral washer and with a threaded hole in the cylindrical cap, is used. A corresponding tapped hole at the top end of the bolt is also required for the purpose.

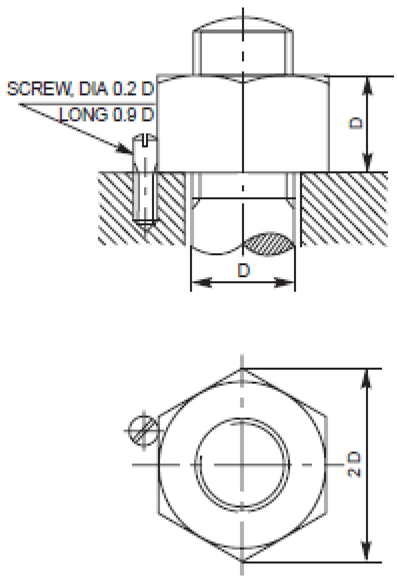
In this arrangement, a set screw fitted through the cap and through the bolt end, prevents the loosening tendency of the nut, when the pitches of the main nut and the set screw are different (Fig2.1.2.5). This type of arrangement is used for fitting the propeller blades on turbine shafts.

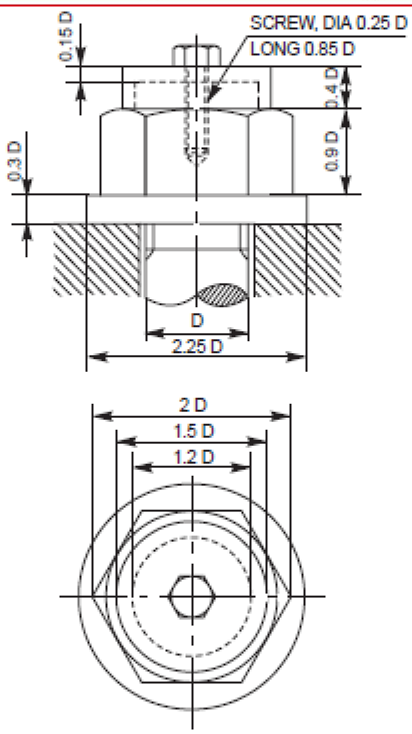


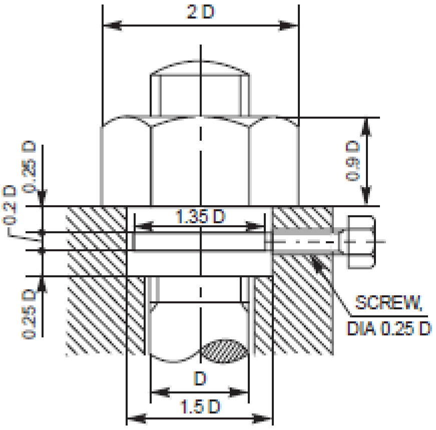


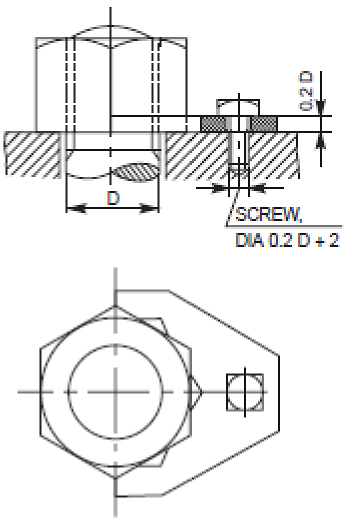


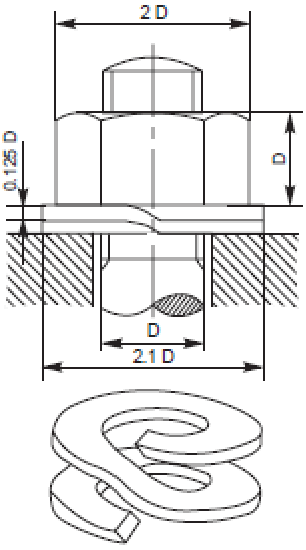












2.1.10 FOUNDATIONBOLTS

Foundation bolts are used for fixing machines to their foundations. Foundation bolts are made by forging from mild steel or wrought iron rods. The bolt size depends upon the size of the machine and the magnitude of the forces that act on them when the machine is in operation.

2.1.11. Eye Foundation Bolt

This is the simplest form of all foundation bolts. In this, one end of the bolt is forged into an eye and a cross piece is fixed in it. Figure 5.36 shows an eye foundation bolt that is set in concrete.

2.1.12 Bent Foundation Bolt

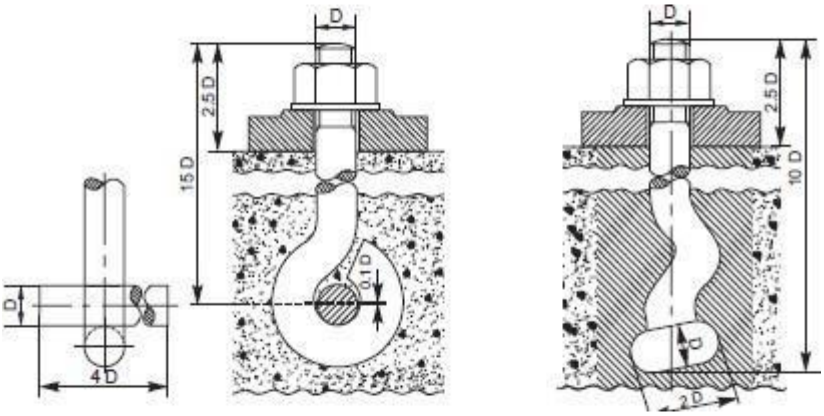
As the name implies, this bolt is forged in bent form and set in cement concrete. When machines are to be placed on stone beds, the bolts are set in lead. Figure 5.37 shows a bent foundation bolt that is set first in lead and then in cement concrete, resulting in a firm and stable bolt.

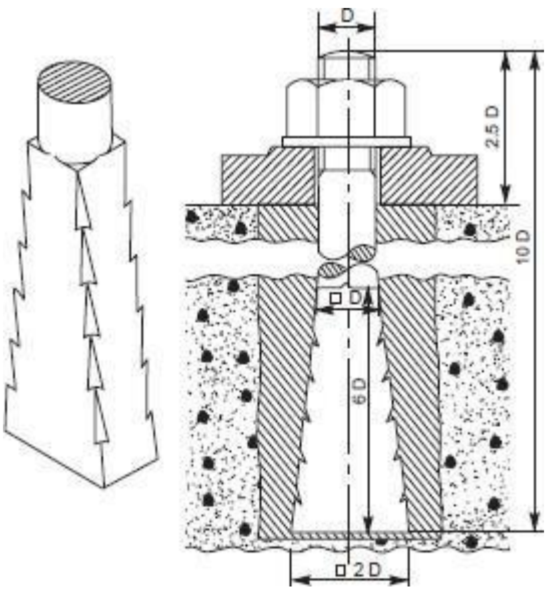
2.1.13 Rag FoundationBolt

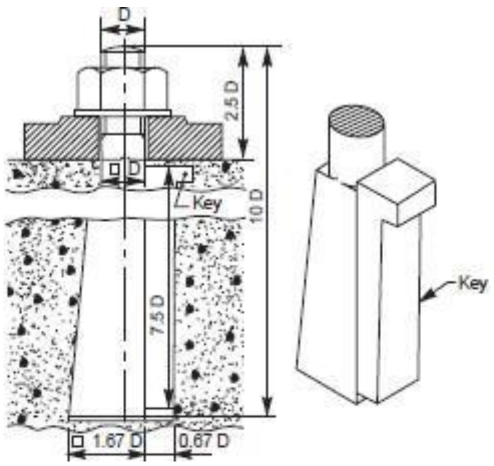
This bolt consists of a tapered body, square or rectangular in cross-section, the tapered edges being grooved. Figure 5.38 shows a rag foundation bolt that is set first in lead and then in cement concrete.

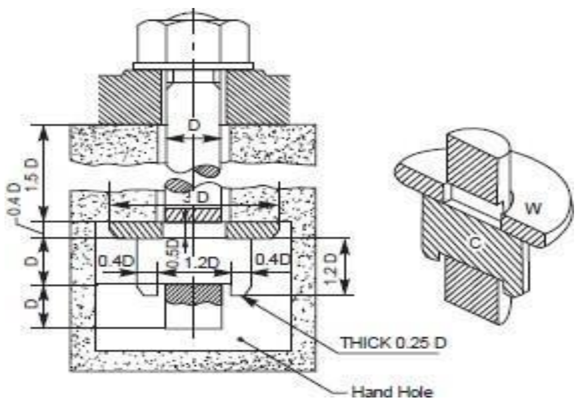
2.1.14 Lewis FoundationBolt

This is a removable foundation bolt. The body of the bolt is tapered in width on one side. To use this bolt, a pit is produced in cement concrete, by using a (foundation) block. Once the concrete sets-in, the bolt is placed in it so that the tapered bolt surface, bears against the tapered face of the pit. A key is then inserted, bearing against the straight surfaces of the pit and the bolt. This arrangement makes the bolt firm in the bed. However, the bolt may be removed by withdrawing the key.









Experiment 2

KEYS,COTTERS AND PINJOINTS

2.2:KEYS

Keys are machine elements used to prevent relative rotational movement between a shaft and the parts mounted such as pulleys, gears, wheels, couplings, etc. Figure 2.2.1

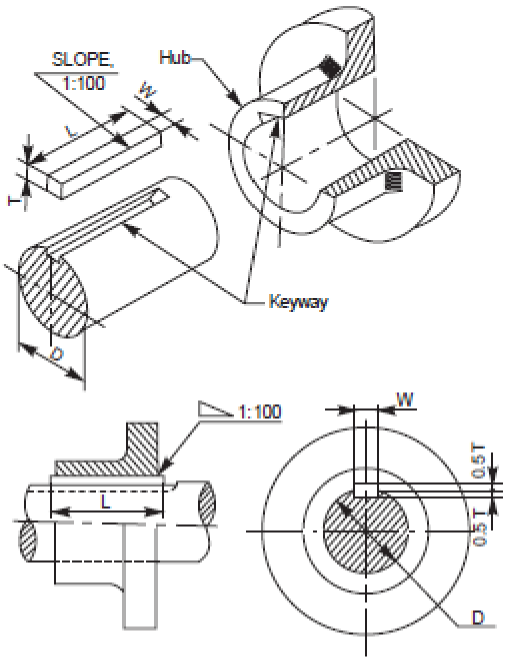
For making the joint, grooves or keyways are cut on the surface of the shaft and in the hub of the part to be mounted. After positioning the part on the shaft such that, both the keyways are properly aligned, the key is driven from Keyway the end, resulting in a firm joint. For mounting a part at any intermediate location on the shaft, first the key is firmly placed in the keyway of 1:100 the shaft and then the part to be mounted is slid from one end of the shaft, till it is 0.5 fully engaged with the key.

Keys are classified into three

saddle keys, sunk keys and round keys.

1 Saddle Keys

These are taper keys, with uniform width but tapering in thickness on the upper side. The magnitude of the taper provided is 1:100. These are made in two forms:hollow and flat.



a) 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. When a hollow saddle key is fitted in position, the relative rotation between the shaft and the mounting is prevented due to the friction between the shaft and key (Fig. 2.2.2).

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. 2.2.3).

Sunk keys :

These are the standard forms of keys used in practice, and may be eithersquare or rectangular in cross- section. The end may be squared or rounded. Generally, half the thickness of the key fits into the shaft keyway and the remaining half in the hub keyway. These keys are used for heavy duty, as the fit between the key and the shaft is positive.

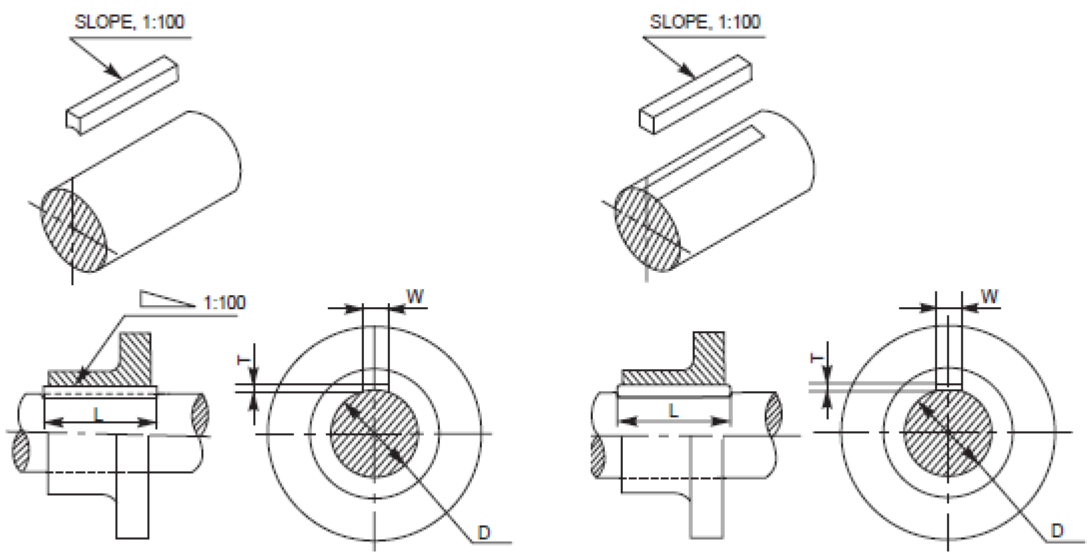


Fig 2.2.3 flat saddle key

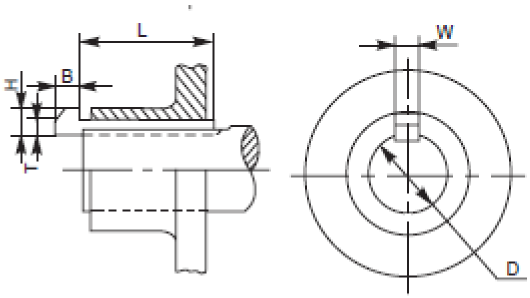
Sunk keys may be classified as:

(*i*) taper keys, (*ii*) parallel or feather keys and (*iii*) woodruff keys.

Taper Sunk Key

These keys are square or rectangular in cross-section, uniform in width but tapered in thickness. The bottom surface of the key is straight and the top surface is tapered, the magnitude of the taper being 1:100. Hence, the keyway in the shaft is parallel to the axis and the hub keyway is tapered.

A tapered sunk key may be removed by driving it out from the exposed small end. If this end is not accessible, the bigger end of the key is provided with a head called gib.

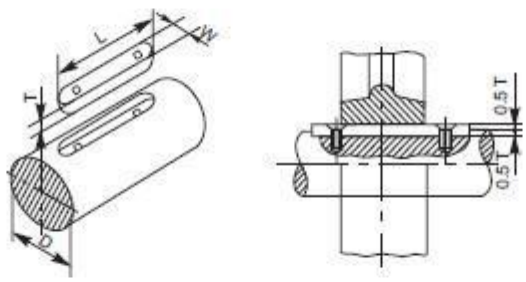


Parallel or Feather Keys

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.)mountedare required to slide along the shaft; permitting relative axial movement. To between the key and the keyway in which itslides.

The feather key may be fitted into the keyway provided on the shaft by two or more screws (Fig. 2.2.5) or into the hub of the mounting (Fig. 2.2.6).

In this key, a projection known as peg is provided at the middle of the key. The peg fits into a hole in the hub of the sliding member (Fig. 6.6 *a*). Once placed in a position, the key and the mounting move axially as one unit.

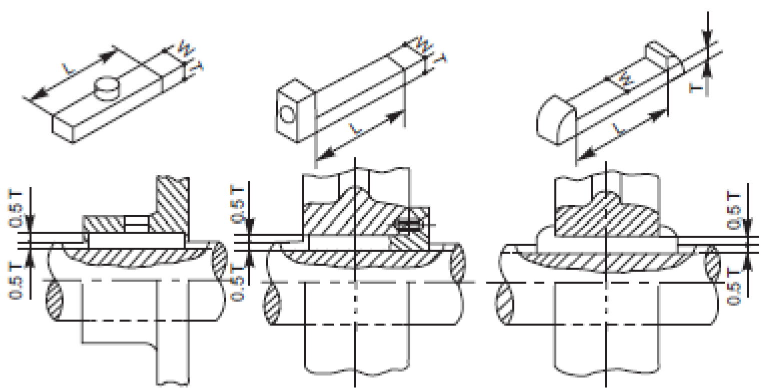


Single Headed Feather Key

In this, the key is provided with a head at one end. The head is screwed to the hub of the part mounted on the shaft (Fig. 2.2.6 *b*).

Double Headed Feather Key

In this, the key is provided with heads on both ends. These heads prevent the axial movement of the key in the hub. Here too, once placed in position, the key and the mounting move as one unit (Fig2. 2.6 *c*).



(a) (b) (c)

Woodruff Key: It is a sunk key, in the form of a segment of a circular disc of uniform thickness (Fig. 2.2.7

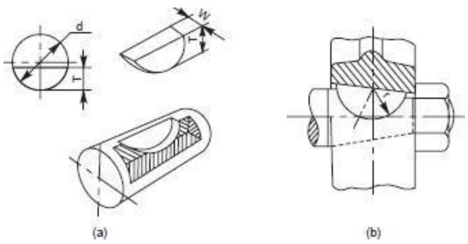
a)As the bottom surface of the key is circular, the keyway in the shaft is in the form of a circular.

recess to the same curvature as the key. A keyway is made in the hub of the mounting, in the usual manner. Woodruff key is mainly used on tapered shafts of machine tools and automobiles.

Once placed in position, the key tilts and aligns itself on the tapered shaft (Fig. 6.8 *b*). The following are the proportions of woodruff keys:

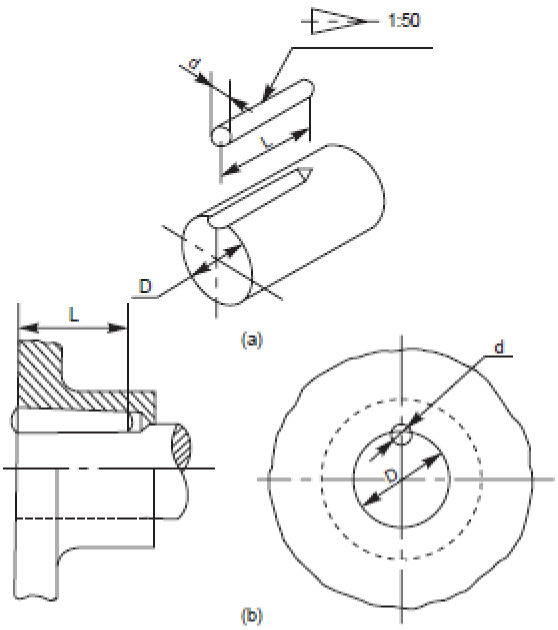
If D is the diameter of the shaft,
Thickness of key, W = 0.25 D
Diameter of key, *d*= 3 W
Height ofkey,T = 1.35W

Depth of the keyway in the hub, T = 0.5 W + 0.1 mm Depth of keyway in shaft, T= 0.85 W



Round Keys

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. 6.9). The mean diameter of the pin may be taken as 0.25 D, where D is shaft diameter. Round keys are generally used for light duty, where the loads are not considerable.



2.3 COTTERJOINTS

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 (Fig. 1.30).

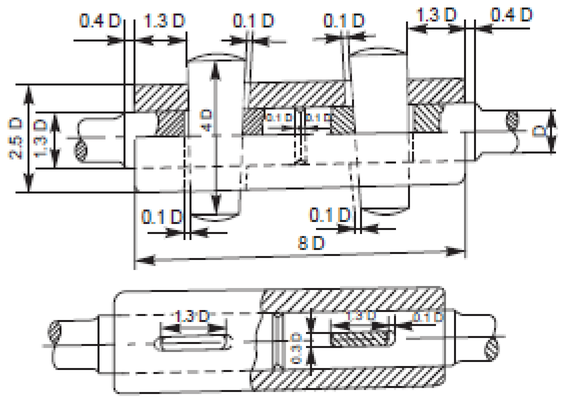
This increases the bearing area and permits drilling while making the slots. The cotter is locked in position by means of a screw .

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. 6.12). The rod ends are enlarged to take care of the weakening effect caused by the slots.

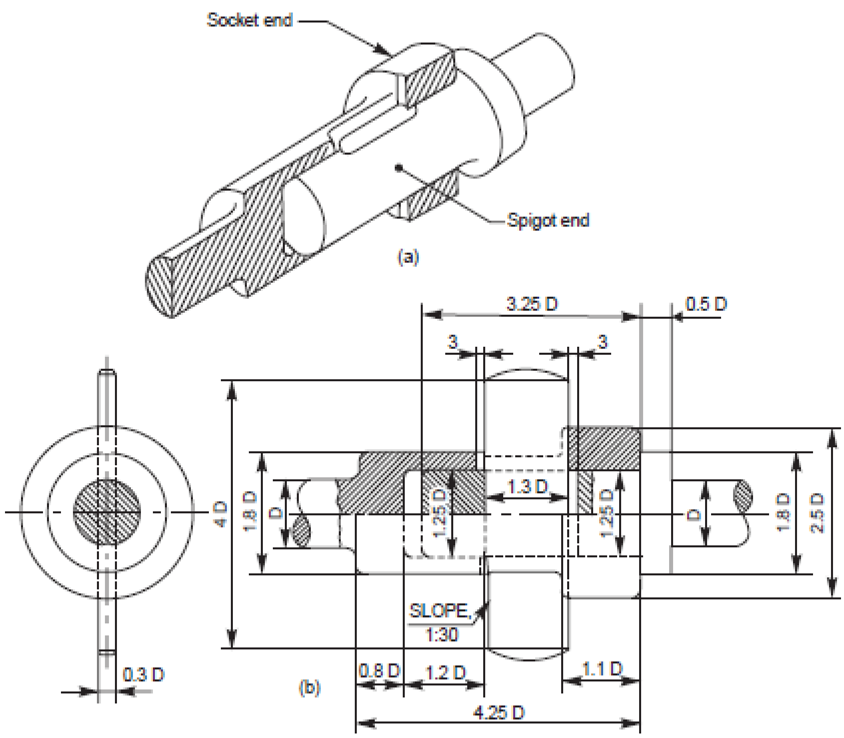
The slots in the rods and sleeve are made slightly wider than the width of cotter. The relative positions of the slots are such, that when a cotter is driven into its position, it permits wedging action and pulls the rod into the sleeve.



(c)

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. 6.13) and slots are cut. After aligning the socket and spigot ends, a cotter is driven-in through the slots, forming the joint.

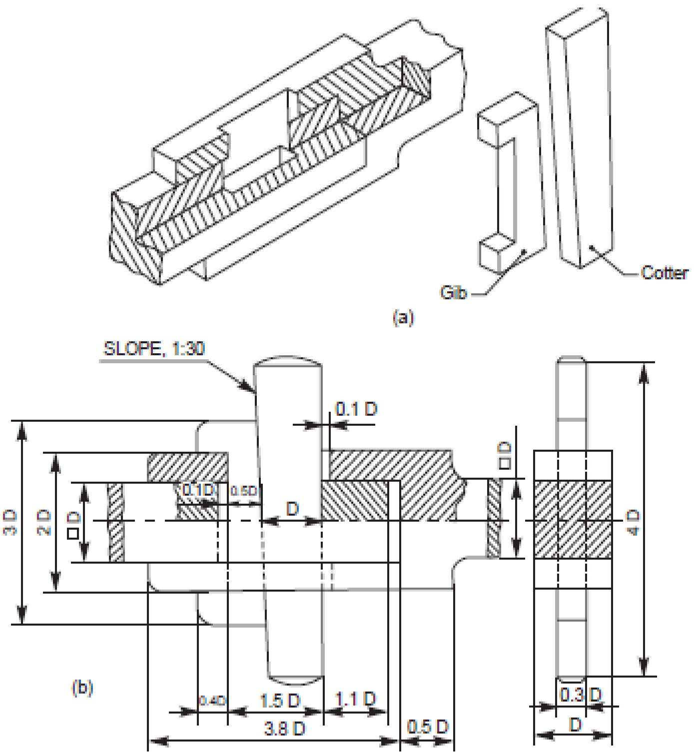


Cotter Joint with a Gib

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.

A gib is also a wedge shaped piece of retangular cross-section with two rectangular projections called lugs. One side of the gib is tapered and the other straight. The tapered side of the gib bears against the tapered side of the cotter such that, the outer edges of the cotter and gib as a unit are parallel. This facilitates making of slots with parallel edges, unlike the tapered edges in case of ordinary cotter joint. Further, the lugs bearing against the outer surfaces of the fork, prevents the opening tendency of the straps.



Knuckle Joint

A 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.2.2.1.2). Once the joint is made, the rods are free to swivel about the cylindrical pin.

Knuckle joints are used in suspension links, air brake arrangement of locomotives, etc.

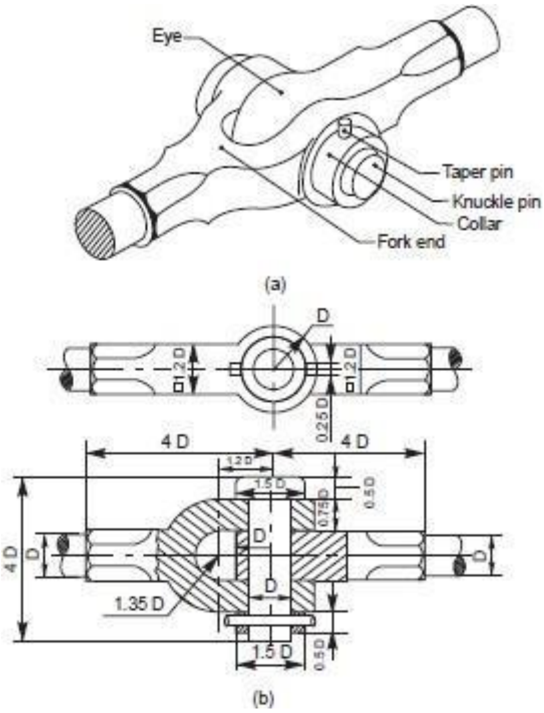


Fig 2.2.12 Knuckle joint

2.4 Riveted joints forplate:

INTRODUCTION

Riveted joints are permanent fastenings and riveting is one of the commonly used method of producing rigid and permanent joints. Manufacture of boilers, storage tanks, etc., involve joining of steel sheets, by means of riveted joints. These joints are also used to fasten rolled steel sections in structural works, such as bridge and roof trusses.

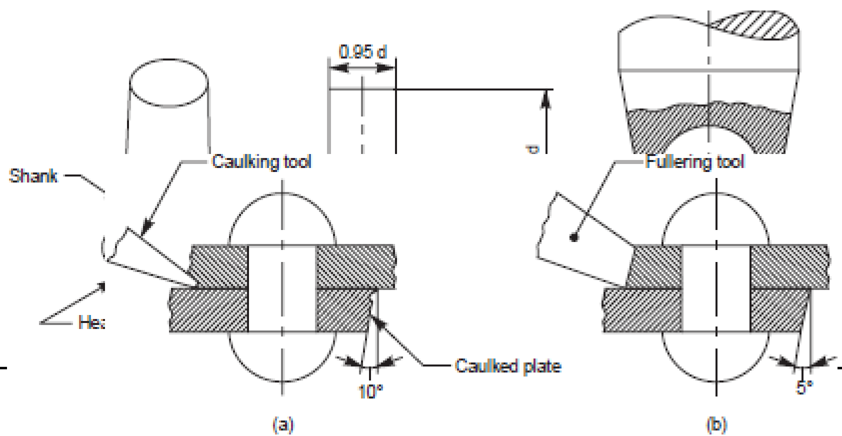
RIVETS AND RIVETING

Rivet

A rivet is a round rod of circular cross-section. It consists of two parts, viz., head and shank (Fig. 2.3.1 (*a*)). Mild steel, wrought iron, copper and aluminium alloys are some of the metals commonly used for rivets. The choice of a particular metal will depend upon the place of application.

Riveting

Riveting is the process of forming a riveted joint. For this, a rivet is first placed in the hole drilled through the two parts to be joined. Then the shank end is made into a rivet head by applying pressure, when it is either in cold or hot condition.



Caulking and Fullering

Riveted joints must be made air tight in applications such as boilers and other pressure vessels.Caulking or fullering is done to make the riveted joints air tight.

Caulking

The outer edges of the plates used in boiler and other pressure vessels are bevelled. To produce air tight riveted joints, these bevelled edges of the plates are caulked. Caulking is an operation in which the outer bevelled edges of the plates are hammered and driven-in by a caulking tool.

The caulking tool is in the form of a blunt edged chisel (Fig. 2.3.2a *a*).

Fullering

Similar to caulking, fullering is also used to produce air tight joints. Unlike the caulking tool, the width of the fullering tool is equal to the width of the bevelled edges of the plates (Fig. 2.3.2 (*b*)).
Experiment 3

2.4.1 RIVETHEADS

Various forms of rivet heads, used in general engineering works and boiler construction and as recommended by Bureau of Indian Standards, are shown in Fig. 10.3. The standard proportions are also indicated in the figure4

DEFINITIONS

The definitions of the terms, associated with riveted joints are given below:

Pitch

It is the distance between the centres of the adjacent rivets in the same row. It is denoted by ‘ *p*’ and usually taken as 3 *d*, where *d* is the rivet diameter.

Margin

It is the distance from the edge of the plate to the centre of the nearest rivet. It is usually taken as 1.5 *d*, where *d* is the rivet diameter. It is denoted by ‘ *m*’.

Chain Riveting

If the rivets are used along a number of rows such that the rivets in the adjacent rows are placed directly opposite to each other, it is known as chain riveting (Fig. 2.3.3).

Zig-Zag Riveting

In a multi-row riveting, if the rivets in the adjacent rows are staggered and are placed in-between those of the previous row, it is known as zig-zag riveting (Fig. 2.3.4).

Row Pitch

It is the distance between two adjacent rows of rivets. It is denoted by ‘p ’ and is given by, *r*

p = 0.8p, for chain riveting

p = 0.6p, for zig-zag riveting.

Diagonal Pitch

This term is usually associated with zig-zag riveting and is denoted by 'p '. It is the distance *d* between the centre of a rivet in a row to the next rivet in the adjacent row.

2.5 CLASSIFICATION OF RIVETEDJOINTS

Riveted joints may be broadly classified into : structural joints and pressure vessel joints.

2. 5.1 StructuralJoints

Structural steel frames are made by using rolled steel plates and sections of standard shapes, as shown in Fig.

Figure 2.3.5 shows an angle joint used to connect two plates at right angle. Here, an (equal) angle is used to connect the plates, by a single row of rivets.

Built-up girder

However, it should be noted that the length of the joint is decided by the load to be resisted by the joint.

Lozenze or Diamond Butt Joint

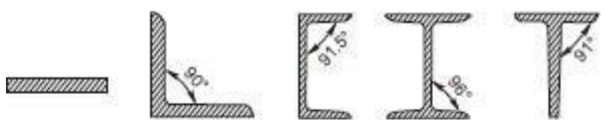
This is one kind of butt joint made either with a single or double strap. As the name implies, the rivets in this joint are arranged in a diamond shape. Figure 10.8 shows a double strap diamond butt joint. The joint is generally used to connect tie bars in bridge structures and roof trusses.

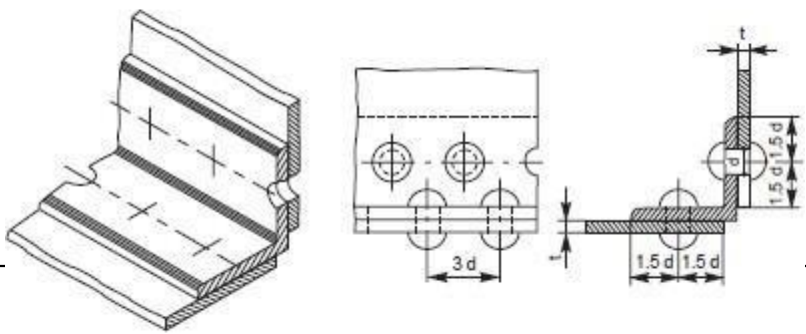
Boiler Joints

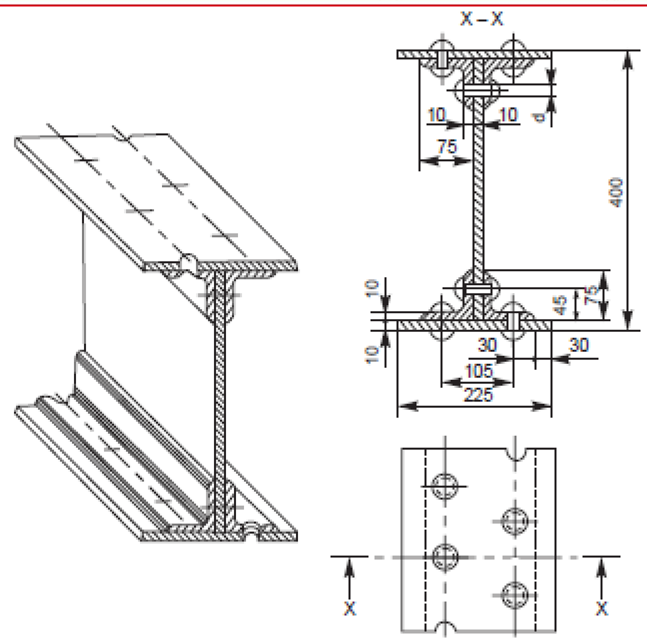
These joints are used mainly for joining metal sheets used in the construction of boilers, water tanks and pressure vessels. Obviously, these joints must be made air-tight, as the above vessels are required to retain fluids and withstand internal fluid pressure as well.

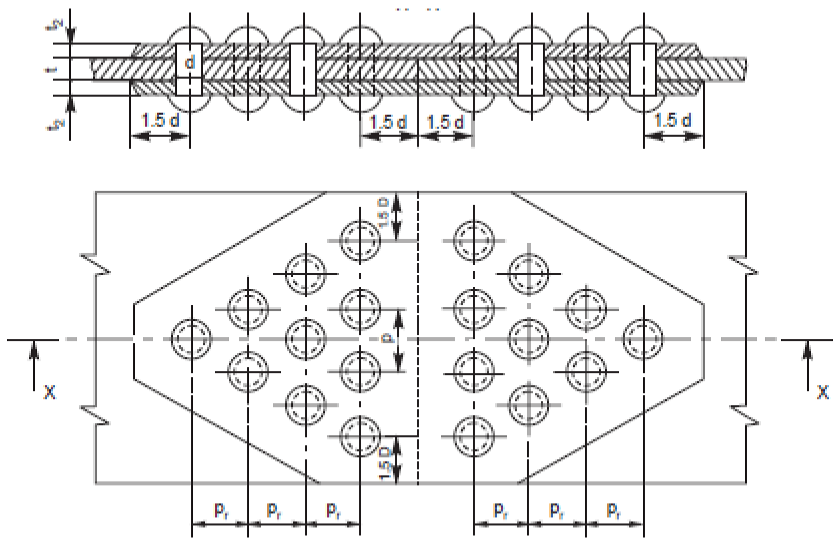
For manufacturing boilers, water tanks and pressure vessels, the edges of the plates to be joined (in case of lap joints only) are first bevelled. The plates are then rolled to the required curvature of the shell. Holding the plates together, holes are then drilled and riveting is followed.

Boiler joints are classified as: lap joints, butt joints and combination of lap and butt joints.









1 Lap Joints

In a lap joint, the plates to be riveted, overlap each other. The plates to be joined are first bevelled at the edges, to an angle of about 80° (Fig. 10.9). Depending upon the number of rows of rivets used in the joint, lap joints are further classified as single riveted lap joint, double riveted lap joint and so on.

Butt Joints

In a butt joint, the plates to be joined, butt against each other, with a cover plate or strap, either on one or both sides of the plates; the latter one being preferred. In this joint, the butting edges of the plates to be joined are square and the outer edges of the cover plate(s) is(are) bevelled.

These joints are generally used for joining thick plates, and are much stronger than lap joints. Figures 10.12 and 10.13 show single riveted single strap and a single riveted double strap, butt joints respectively.

In a single strap butt joint, the thickness of the strap (cover plate) is given by, $t = 1.125\ t\ 1$

If two straps are used, the thickness of each cover plate is given by, $t = 0.75\ t\ 2$

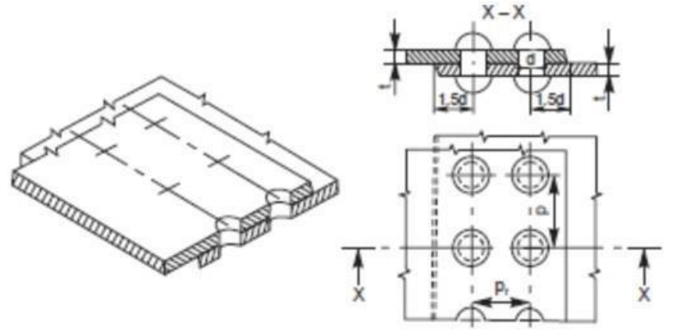
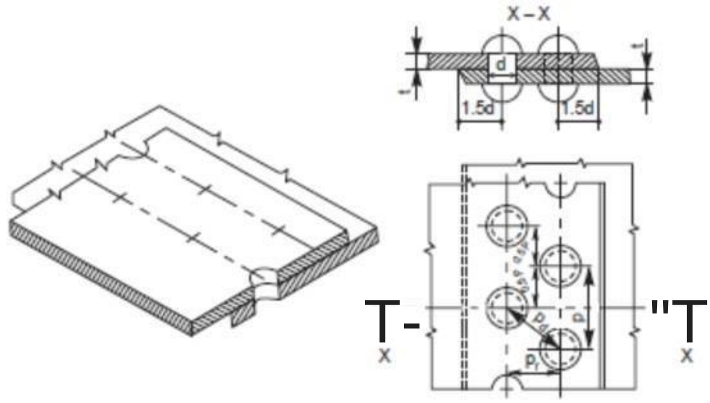
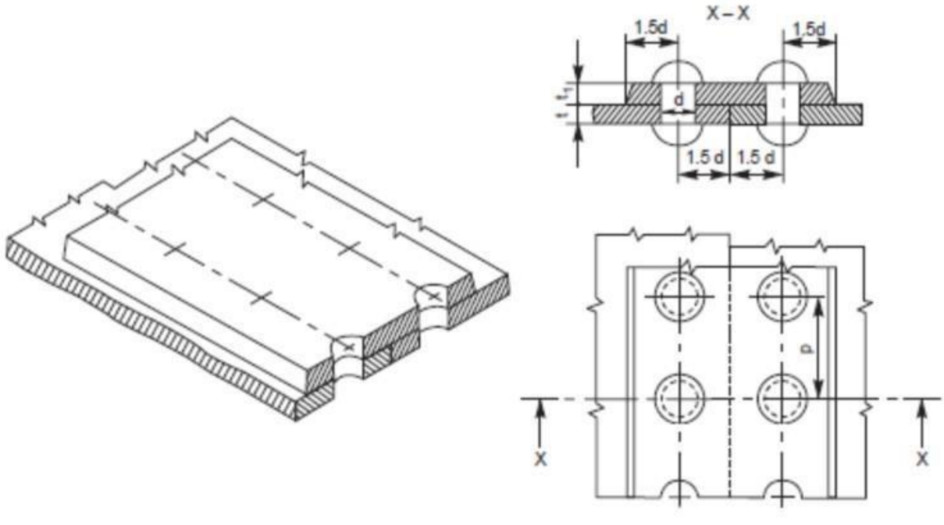
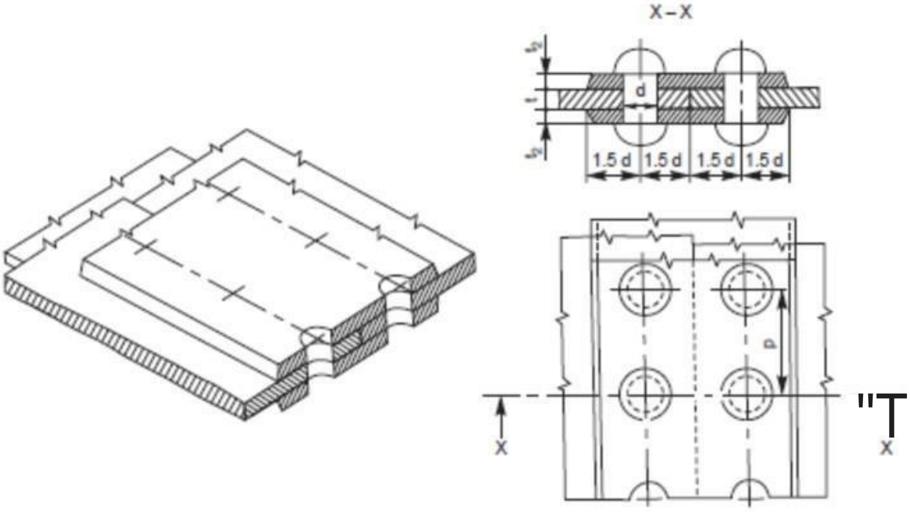
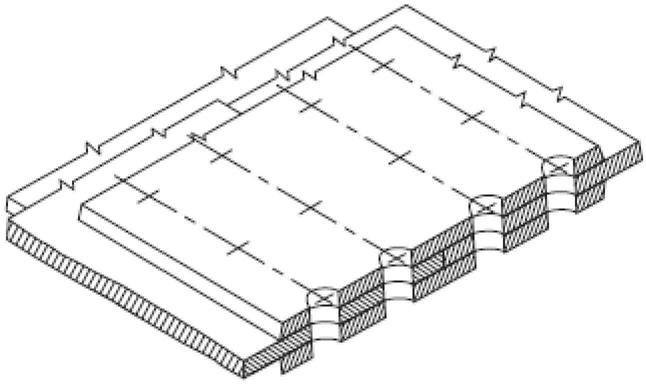


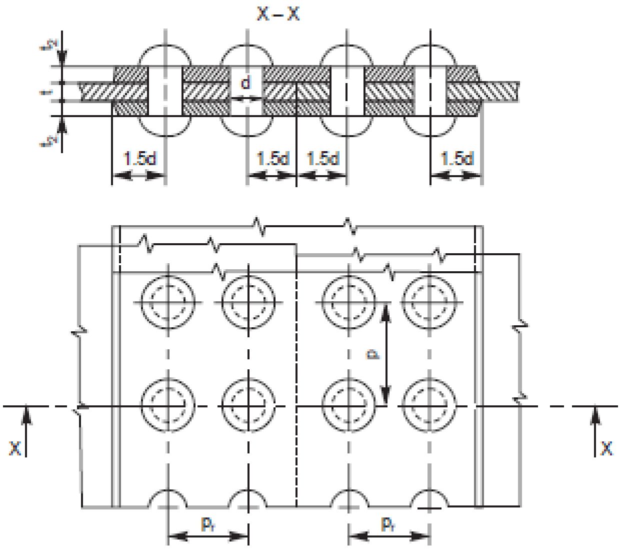
Fig. 10.10 Double riveted chain lap joint

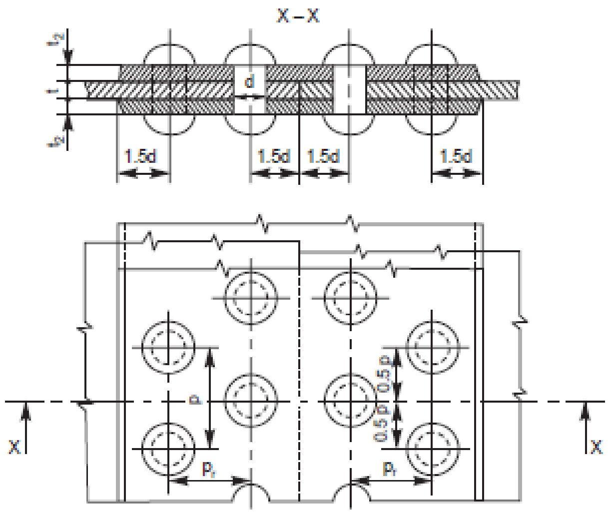









X – X
d
1.5d
1.5d
1.5d
1.5d
p
X
X


X – X
d
1.5d
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0.5 p
0.5 p
X
X

Experiment 4

2.6 SHAFT

COUPLINGSINTRODU

CTION

Shaft couplings are used to join or connect two shafts in such a way that when both the shafts rotate, they act as one unit and transmit power from one shaft to the other. Shafts to be connected or coupled may have collinear axes, intersecting axes or parallel axes at a small distance.

Based on the requirements, the shaft couplings are classified as: (*i*) rigid couplings, (*ii*) flexible couplings, (*iii*) loose or dis-engaging couplings and (*iv*) non-aligned couplings.

2.6.1 RIGIDCOUPLINGS

Rigid shaft couplings are used for connecting shafts having collinear axes. These are further sub-classified into muff or sleeve couplings and flanged couplings.

1 Sleeve or Muff Couplings

This is the simplest of all couplings. It consists of a sleeve called muff, generally made of cast iron, which is fitted over the ends of the shafts to be connected. After properly aligning the keyways in the shafts and sleeve, a sunk key is driven-in; thus making the coupling. Instead of a single key running the entire length of the sleeve, it is desirable to use two keys, which may be inserted from the outer ends of the sleeve; thus overcoming the possible mis-alignment between the keyways.

The following are the types of muff couplings: 7.2.1.1 Butt-muff Coupling

In this, the ends of the two shafts to be coupled butt against each other, with the sleeve keyed to them, as discussed above (Fig.3.4.1).

Half-lap Muff Coupling

In this, the ends of the shafts overlap each other for a short length. The taper provided in the overlap prevents the axial movement of the shafts. Here too, after placing the muff over the overlapping ends of the shafts, a saddle key(s) is(are) used to make the coupling (Fig. 2.4.2).

Split-muff Coupling

In this, the muff is split into two halves and are recessed. A number of bolts and nuts are used to connect the muff halves and the recesses provided accommodate the bolt heads and nuts.

For making the coupling, a sunk key is first placed in position and then the muff halves are joined by bolts and nuts . This type of coupling is used for heavy duty work.

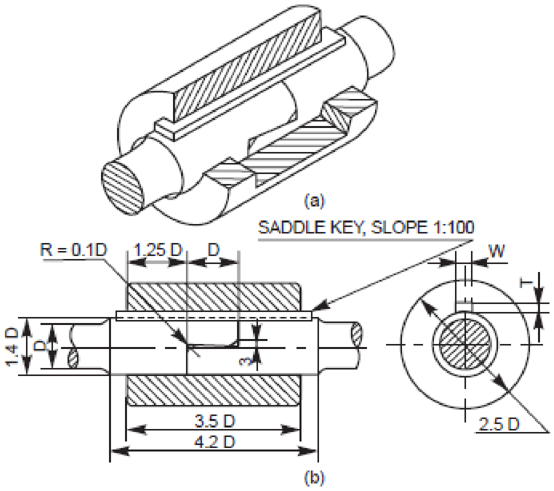


Fig 2.4.1 Buff muffcoupling

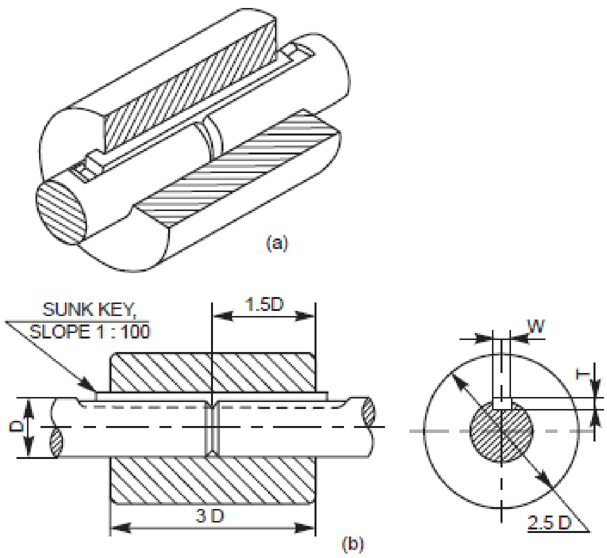


Fig 2.4.2 Half muffcoupling

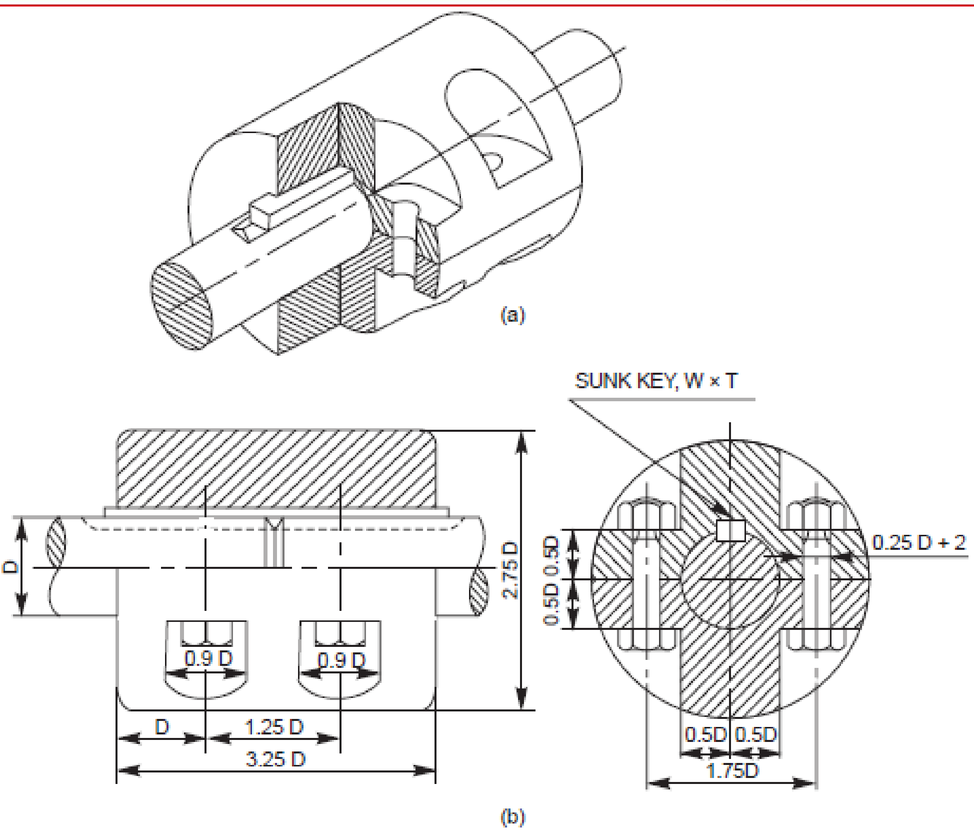


Fig 2.4.3 Split muff coupling

Flanged Couplings

These are the standard forms of couplings, most extensively used. In a flanged coupling, flanges are either fitted or provided at the ends of shafts. The flanges are fastened together by means of a number of bolts and nuts. The number and size of the bolts depend upon the power to be transmitted and hence, the shaft diameter.

Flanged Coupling with Detachable Flanges

In this, two flanges are keyed, one at the end of each shaft, by means of sunk keys (Fig. 2.4.4).

For ensuring correct alignment, a cylindrical projection may be provided on one flange which fits into the corresponding recess in the other.

In the design shown in figure, the bolt heads and nuts are exposed and liable to cause injury to the workman. Hence, as a protection, the bolt heads and nuts may be covered by providing an annular projection on each flange. A flanged coupling, using these flanges is called a protected flanged coupling (Fig. 2.4.5).

Solid Flanged Coupling

Couplings for marine or automotive propeller shafts demand greater strength and reliability.

For these applications, flanges are forged integral with the shafts. The flanges are joined together by means of a number of headless taper bolts (Fig. 2.4.6).

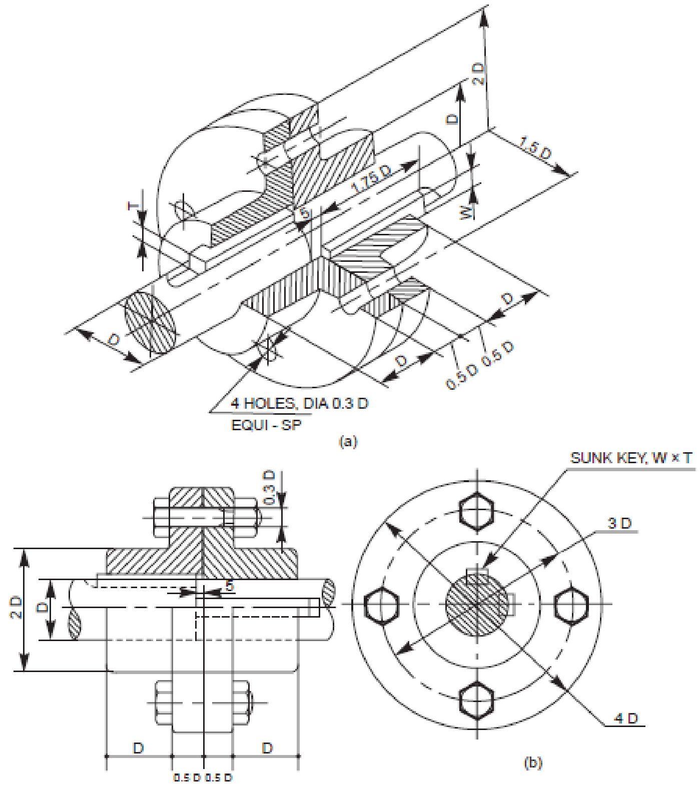


Fig 2.4.4 flanged coupling

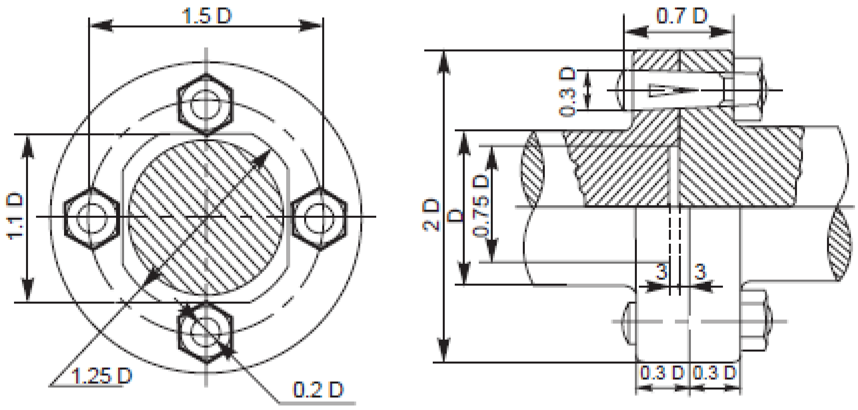


Fig 2.4.6 solid flanged coupling

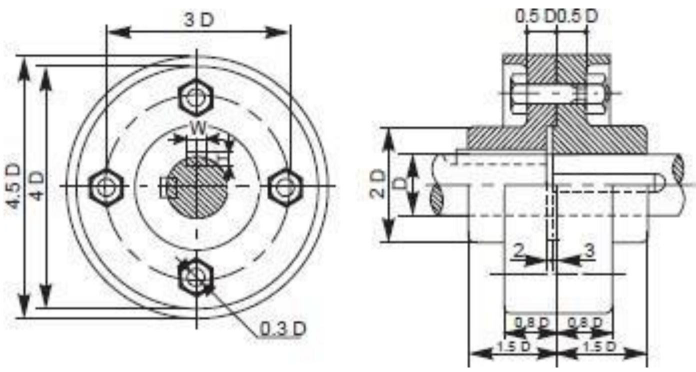


Fig 2.4.5 protected flanged coupling

2.6.2 FLEXIBLECOUPLINGS

Perfect alignment of two shafts is impossible to achieve and difficult to maintain, because of inevitable bearing wear and other reasons. To overcome the trouble, flexible couplings are employed. These permit relative rotation or variation in the alignment of shaft axes within certain limits. The following are the types of flexible couplings:

Bushed Pin Type Flanged Coupling

It is the modified version of a protected flanged coupling. In this, bolts are replaced by bushed pins. The smaller ends of the pins are rigidly fastened by nuts to one of the flanges, while the enlarged ends are covered with flexible material like leather or rubber bushes, in the other flange (Fig. 2.4.7). The flexible medium takes care of mis-alignment, if any, and acts as a shock absorber. These couplings are used to connect prime mover or an electric motor and a centrifugal pump.

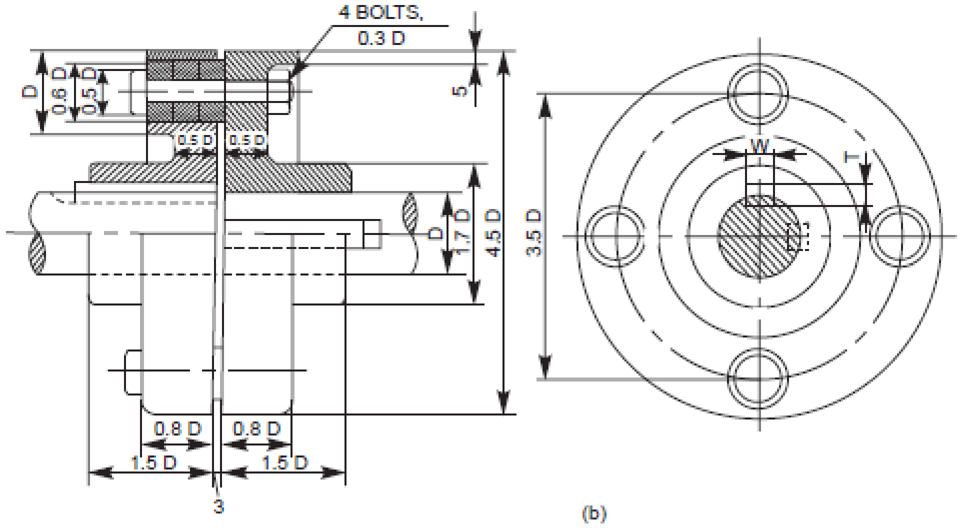


Fig 2.4.7 Bushed Pin Type Flanged Coupling

Compression Coupling

This consists of a compressible steel sleeve which fits on to the ends of the shafts to be coupled. The sleeve corresponds to the shaft diameter and its outer surface is of double conical form. The sleeve has one through cut longitudinally and five other cuts, equi-spaced, but running alternately from opposite ends to about 85% of its length; making it radially flexible.

The two flanges used have conical bores and are drawn towards each other by means of a number ofbolts and nuts, making the sleeve firmly compressed onto the shafts. Here, the friction between theshafts and sleeve assists power transmission and the bolts do not take any load. Because of the presence of flexible sleeve, the coupling takes care of both axial and angular mis-alignment of shafts (Fig. 2.4.8).

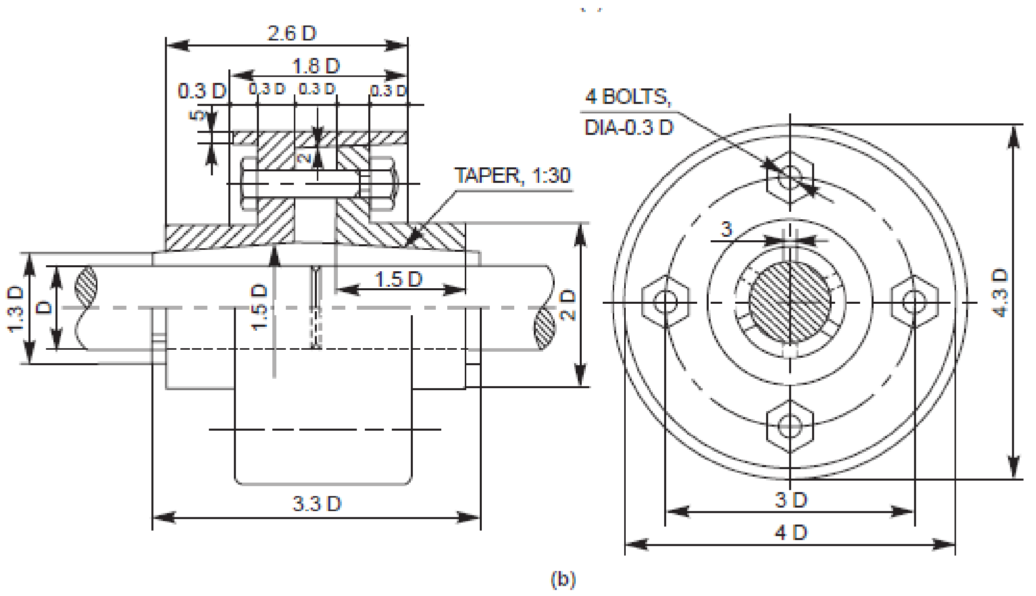


Fig 2.4.8 Compression Coupling

2.6.3 DIS-ENGAGINGCOUPLINGS

Disengaging couplings are used when power transmission from one shaft to another is intermittent. With this, the shafts can be engaged or disengaged as and when required, even during rotation. A dis-engaging coupling in general consists of one part firmly fixed to the driving shaft and another one mounted with provision for sliding over the driven shaft.

The part that is mounted on the driven shaft, can be made to slide at will to engage or disengage from the rotating driving shaft. The following are the examples of dis-engaging couplings.

Claw Coupling

In this, each flange has a number of identical claws which engage into the corresponding recesses in the flange. One flange is firmly fitted to the driving shaft by means of a taper sunk key. The other one is placed over the driven shaft by two feather keys, so that it can slide freely on it. The sliding flange has a groove on the boss, into which the forked end of a lever fits. By operating the lever, the sliding flange may be moved so as to engage with or disengage from the fixed flange (Fig. 2.4.9). This type of coupling is generally used on slow speed shafts.

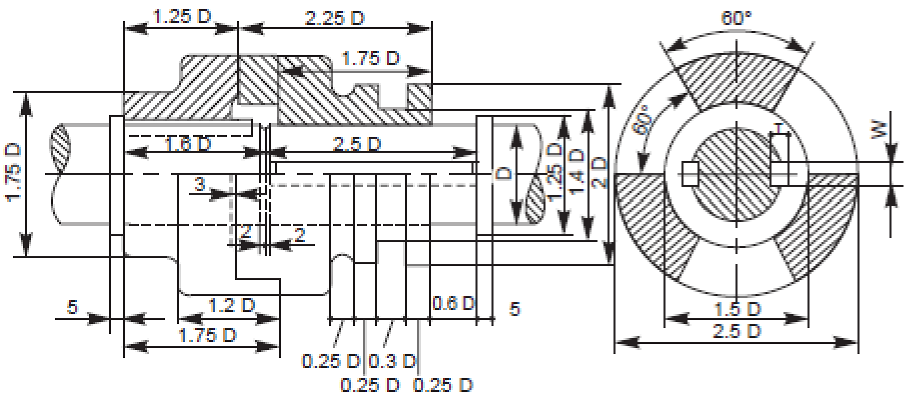


Fig 2.4.9 Claw Coupling

Cone Coupling

In this, two shafts may be coupled together by means of two flanges with conical surfaces (on the inside of one and on the outside of the other) by virtue of friction. Here too, one flange is firmly fitted to the driving shaft by means of a taper sunk key, whereas the other slides freely over a feather key fitted to the driven shaft. The sliding flange may be moved by means of a forked lever fitted into the groove provided on it. (Fig. 2.2.10).

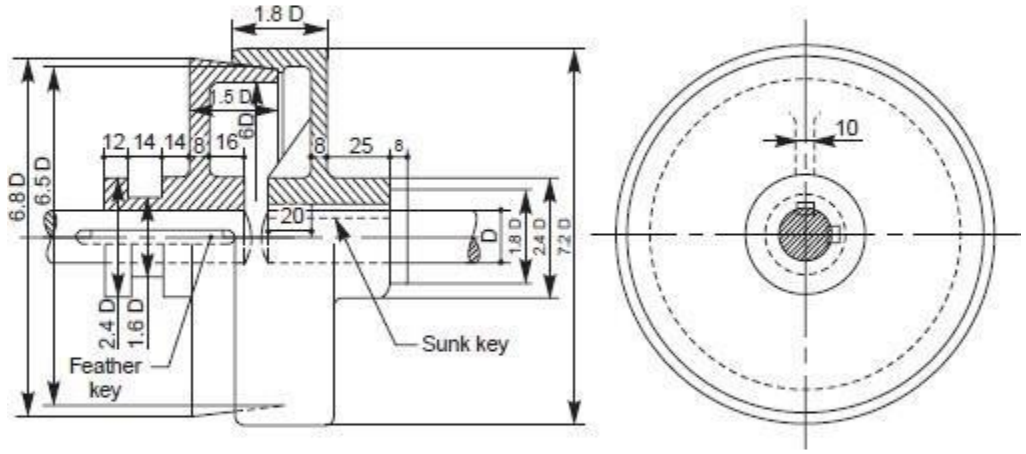


Fig 2.4.10 cone coupling

2.6.4 NON-ALIGNEDCOUPLINGS

Non-aligned couplings are used to transmit power between two shafts which are not coaxial.

The following are the examples of non-aligned couplings:

Universal Coupling (Hooke's Joint)

It is a rigid coupling that connects two shafts, whose axes intersect if extended. It consists of two forks which are keyed to the shafts. The two forks are pin joined to a central block, which has two arms at right angle to each other in the form of a cross (Fig. 2.4.11). The angle between the shafts may be varied even while the shafts are rotating.

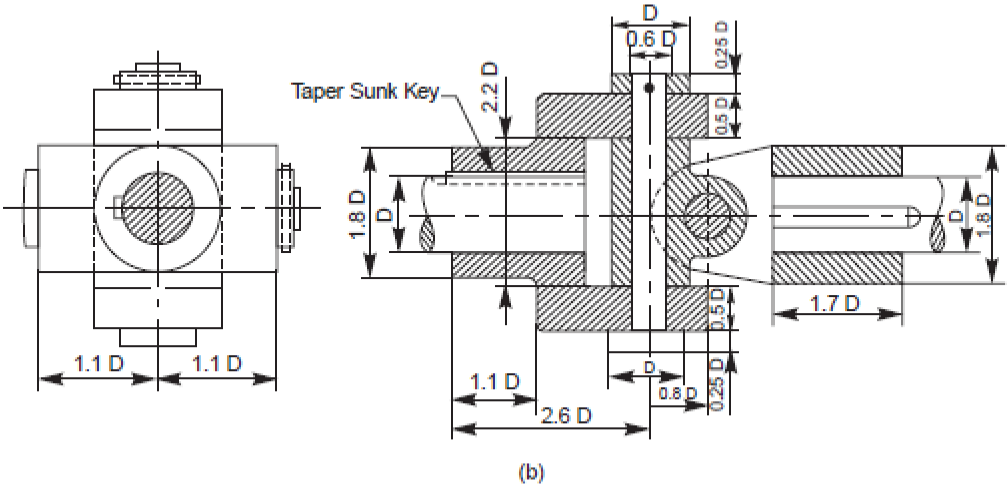


Fig 2.4.11 Universal Coupling

Oldham Coupling

It is used to connect two parallel shafts whose axes are at a small distance apart. Two flanges, each having a rectangular slot, are keyed, one on each shaft. The two flanges are positioned such that, the slot in one is at right angle to the slot in the other.

To make the coupling, a circular disc with two rectangular projections on either side and at right angle to each other, is placed between the two flanges. During motion, the central disc, while turning, slides in the slots of the flanges. Power transmission takes place between the shafts, because of the positive connection between the flanges and the central disc (Fig. 2.4.12).

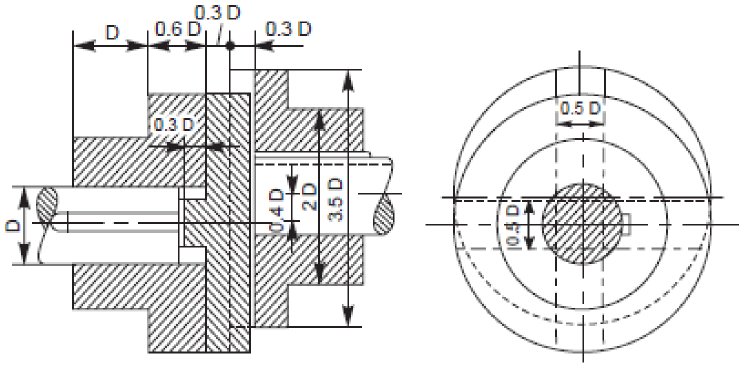


Fig 2.4.12 Oldham Coupling

Cushion Coupling

One of the most commonly used flexible couplings now-a-days is the cushion coupling. The H.P

rating of these couplings for various speeds, range from 0.2 to 450.

The tyre of the coupling is made of natural and synthetic rubber, impregnated with canvas or rayon. The hubs are made of C I or steel (Fig. 2.4.13).

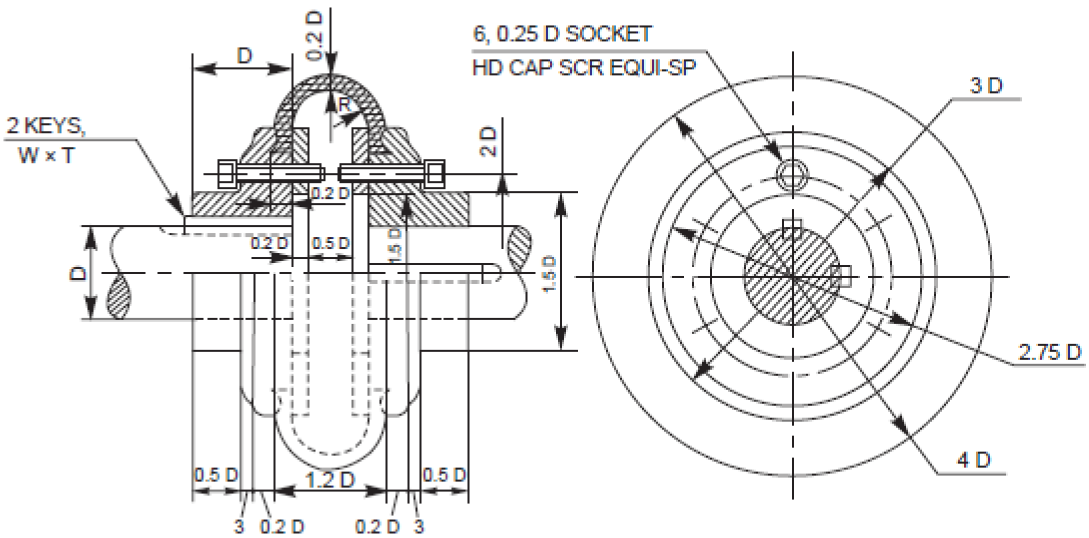


Fig 2.4.13 Cushion Coupling

2.7 PIPEJOINTS

Socket and spigot joint

This type of hydraulic joint is used extensively, where fluids under high pressures are to be conveyed. In this, oval shaped flanges are cast integral with the pipe ends. The flanges are joined with bolts and nuts.

For proper alignment of the pipes, a spigot or projection is formed in the centre of one flange and is made to fit in a corresponding socket or recess provided in the other flange. A gasket, made of rubber or canvas is compressed between the spigot and socket ends (Fig2.4.14).

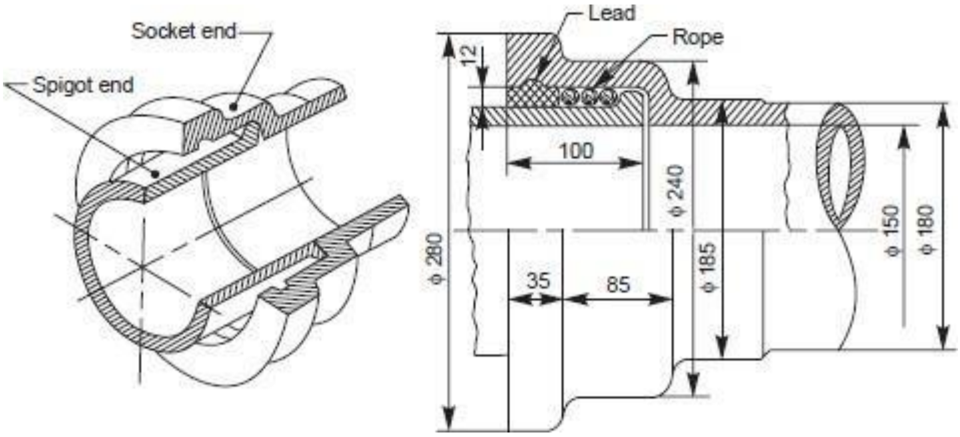


Fig 2.4.14 socket & spigot joint

Experiment 5

2.8 Bearings

INTRODUCTION

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, engine crankshafts, transmission or line shafts in workshops, etc. Bearings are broadly classified into two categories: sliding contact bearings and rolling contact bearings or antifriction bearings.

2.8.1 SLIDING CONTACTBEARINGS

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.

Journal Bearings

When the load on a bearing is perpendicular (normal) to the shaft axis, the bearing is known as a journal bearing. In fact, the term 'journal', refers to that part of the shaft which is in contact with the bearing.
The following are some of the types of journal bearings:
Solid Journal Bearing

Solid Journal Bearing

This is the simplest among the journal bearings, and usually made of cast iron. This consists of a cylindrical block with a rectangular base. The hole in the cylindrical block supports the shaft and the holes in the base are used for bolting down the bearing. A hole provided at the top of the body is used for introducing lubricant into the bearing (Fig. 2.5.1). The drawback of this bearing is the absence of provision for adjustment in case of wear and hence it has to be discorded.

Bushed Journal Bearing

This bearing consists of mainly two parts, the body and the bush. The body is usually made of cast iron and the bush of soft materials such as brass, bronze or gunmetal. The bush is press fitted in the body; preventing relative axial and rotary motion. With this arrangement, to renew the bearing, it is only necessary to renew the bush. The oil hole provided at the top of the body and running through the bush is used to introduce the lubricant (Fig.2.5.2).

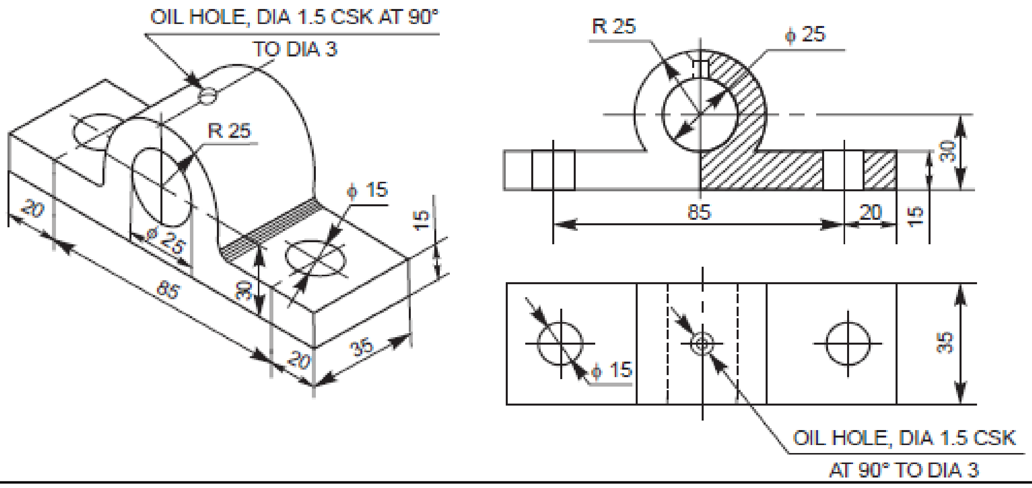


Fig 2.5.1 Solid Journal Bearing

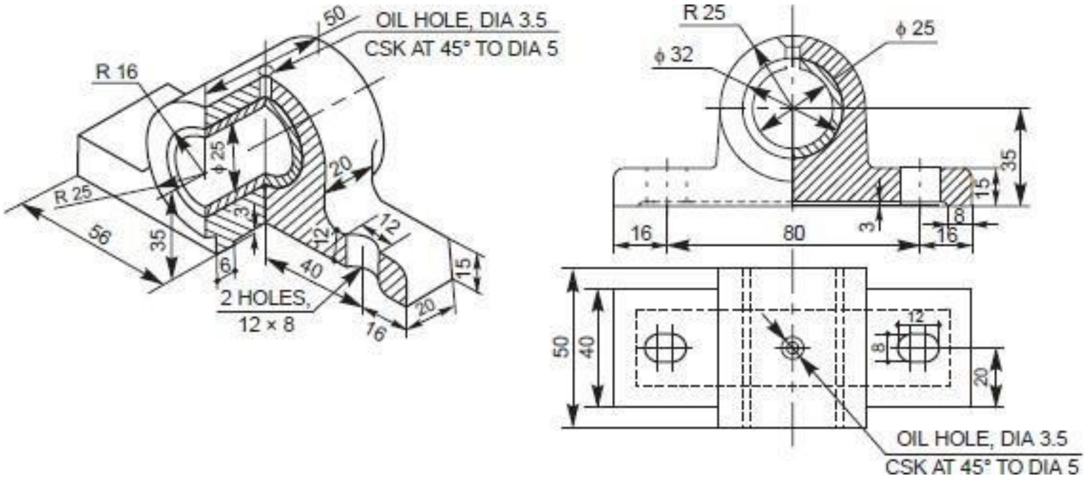
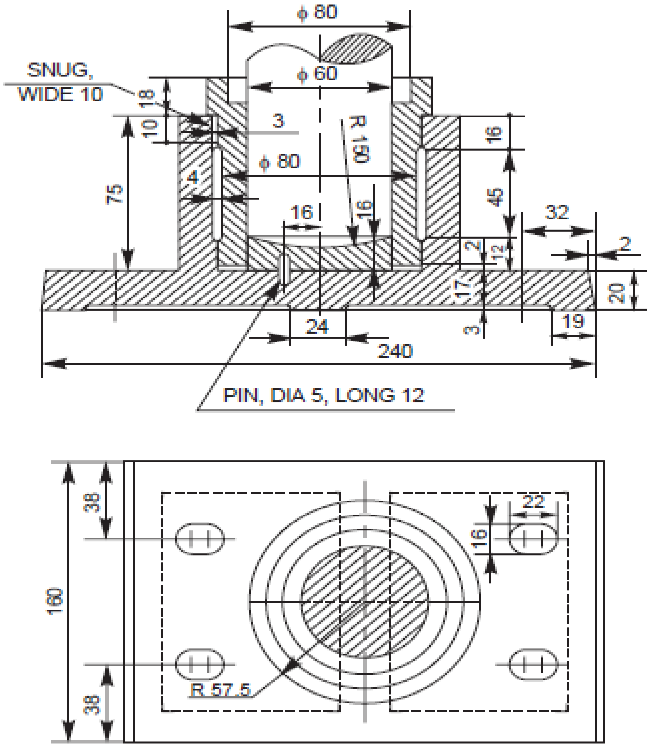


Fig 2.5.2 Bushed Journal Bearing



Thrust Bearings

Thrust bearings are used to support shafts subjected to axial loads. These bearings are classified into: pivot or foot-step bearings and collar bearings.

Pivot or foot-step bearing

This bearing is used to support a vertical shaft under axial load. Further, in this, the shaft is terminated at the bearing. The bottom surface of the shaft rests on the surface of the bearing which is in the form of a disc. The bush fitted in the main body supports the shaft in position and takes care of possible radial loads coming on the shaft.

The disc is prevented from rotation by a pin inserted through the body and away from the centre. The bush is also prevented from rotation by a snug, provided at its neck, below the collar (Fig. 2.5.3). The space between the shaft and the collar, serves as an oil cup for lubricating the bearing. The bush and the body are recessed to reduce the amount of machining. The base of the body is also recessed to serve the same purpose.

Collar thrust bearing

This is generally used for supporting a horizontal shaft under axial load. Further, in this, the shaft extends through and beyond the bearing. The shaft in a collar thrust bearing may consists of one or more collars which are either fitted to or integral with the shaft (Fig. 12.10). The collars rotate against the stationary split bearing surfaces.

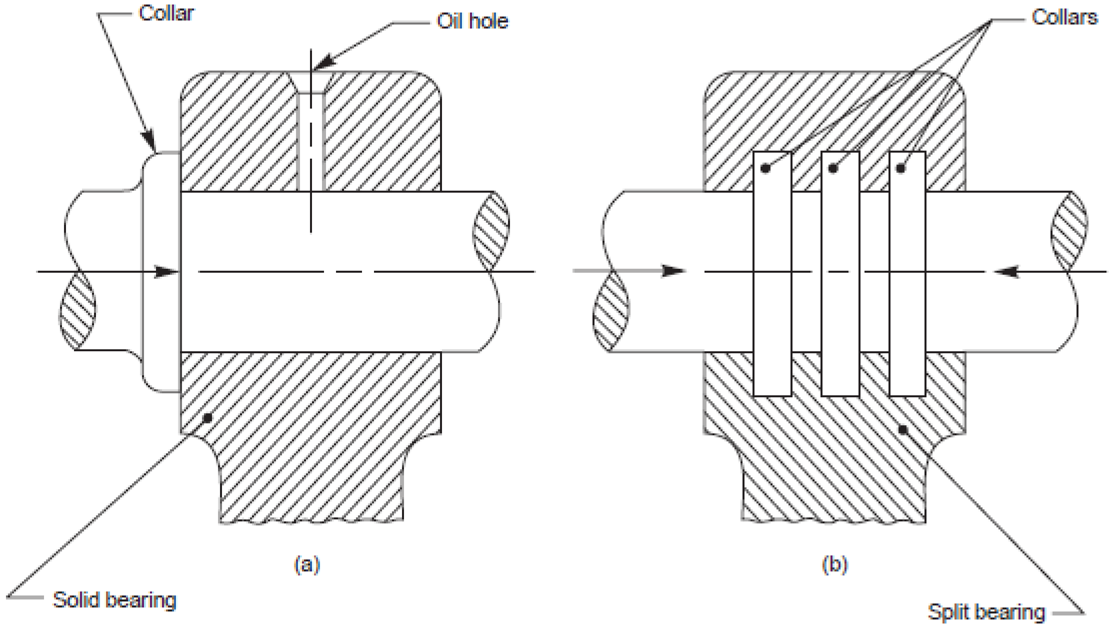


Fig2.5.4 a) singlecollar bearing Fig b)Multi collarbearing

2.8.2 ROLLING CONTACT (ANTI-FRICTON)BEARINGS

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.

Radial Bearings

Radial bearings are used to resist normal (radial) loads acting on the shafts. These bearings are sub-divided on the basis of the shape of the rolling elements used, viz., ball bearings, roller bearings and taper roller bearings.

Thrust Bearings

These bearings are used to support shafts subjected to axial loads. In general,balls as rolling elements are used in these bearings and rollers only in special cases. Figure 2.5.5 shows the mounting of a shaft with a thrust ball bearing.

illustrates a foot-step bearing with a thrust ball bearing to resist axial loads and a radial ball bearing to position the vertical shaft and also to resist the possible radial loads

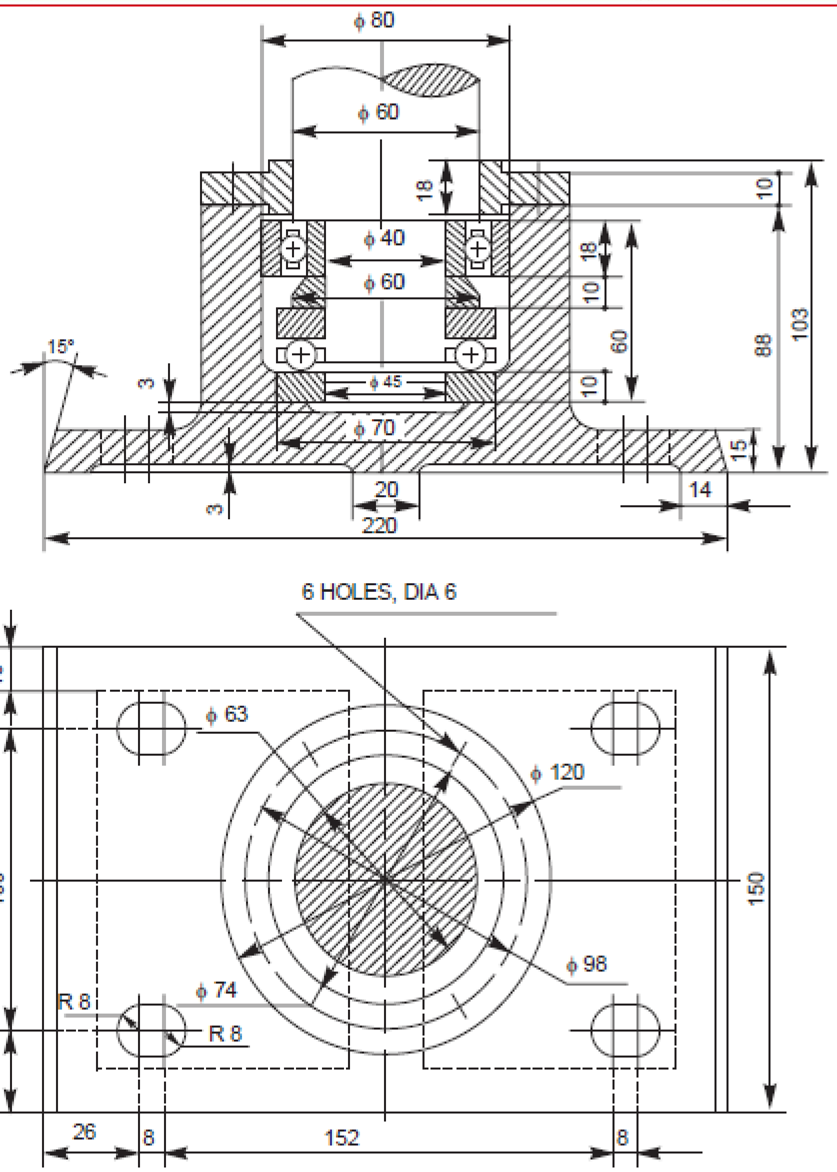


Fig 2.5.5 . foot-step bearing with a thrust ball bearing

Experiment 6

3.0 ASSEMBLY AND DETAILS DRAWING.

A] STEPS TO DRAW ASSEMBLY DRAWING FROM DETAILS DRAWING:-

1. Understand the purpose, principle of operation and field of application of the given ma This will help in understanding the functional requirements of individual parts and theirlocation.

2. Examine thoroughly, the external and internal features of the individualparts.

3. Choose a proper scale for the assemblydrawing.

4. Estimate the overall dimensions of the views of the assembly drawing and make the ou blocks for each of the required view, leaving enough space between them, for indicating dimensions and adding requirednotes.

5. Draw the axes of symmetry for all the views of the assemblydrawing.

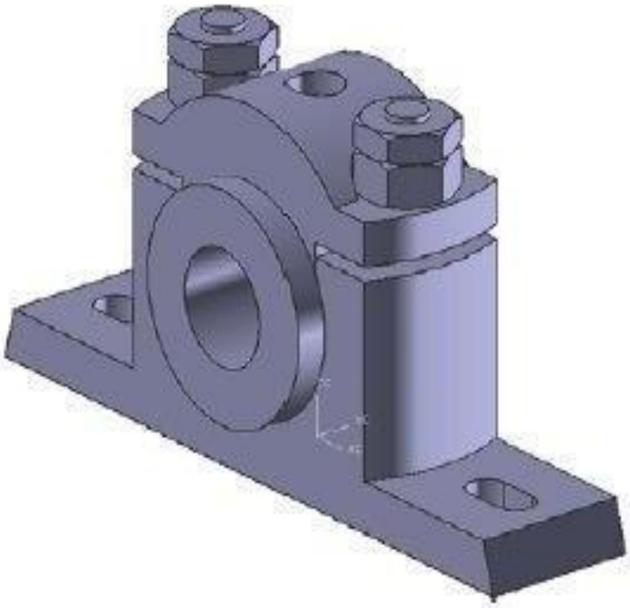
6. Begin with the view from the front, by drawing first, the main parts of the machine and adding the rest of the parts, in the sequence ofassembly.

7. Project the other required views from the view from the front completeviews.

8. Mark the location and overall dimensions and add the part numbers on thedrawing.

9. Prepare the partslist.

3.1] PLUMMER B LOCK (PEDASTALBEARING)



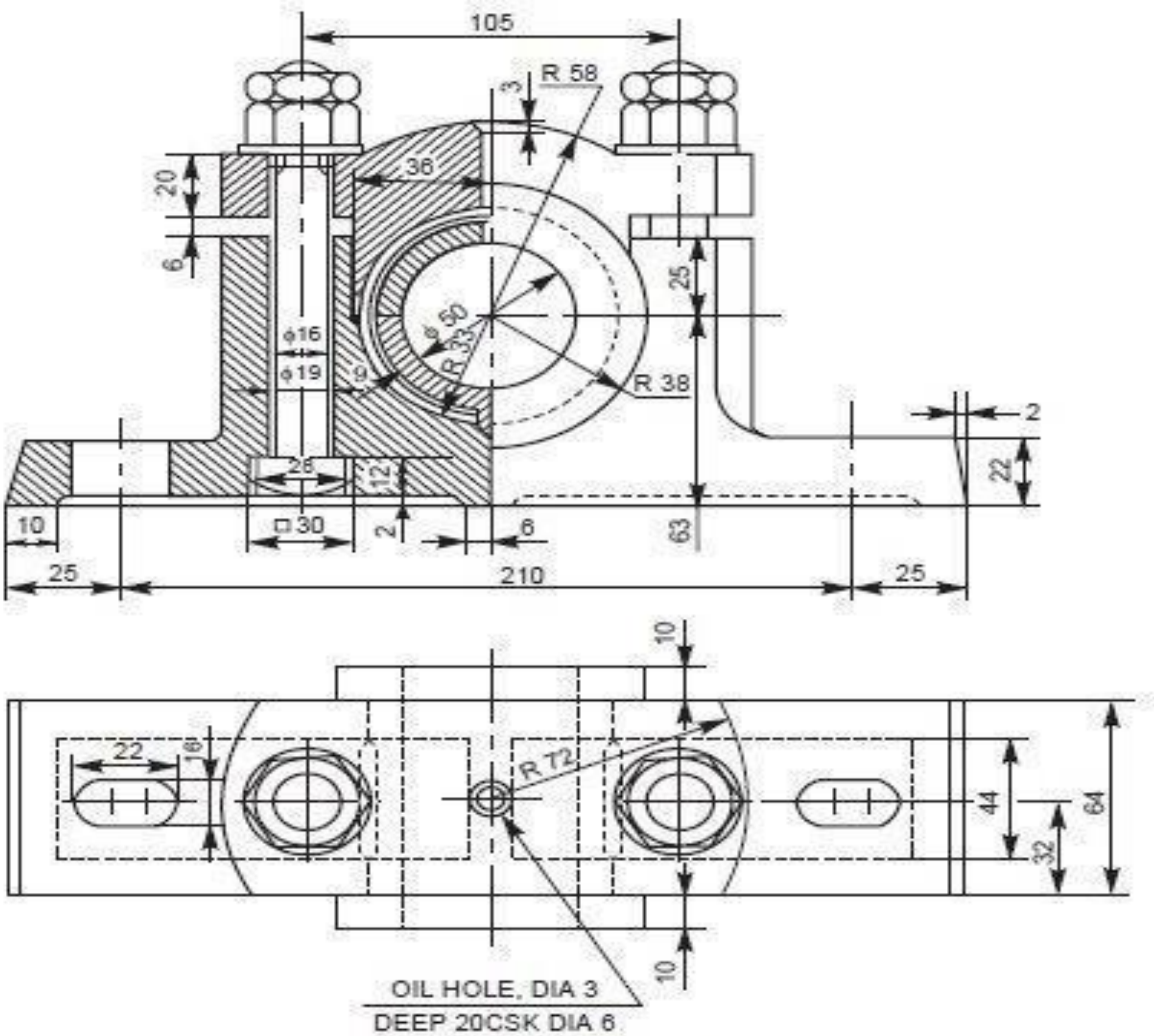
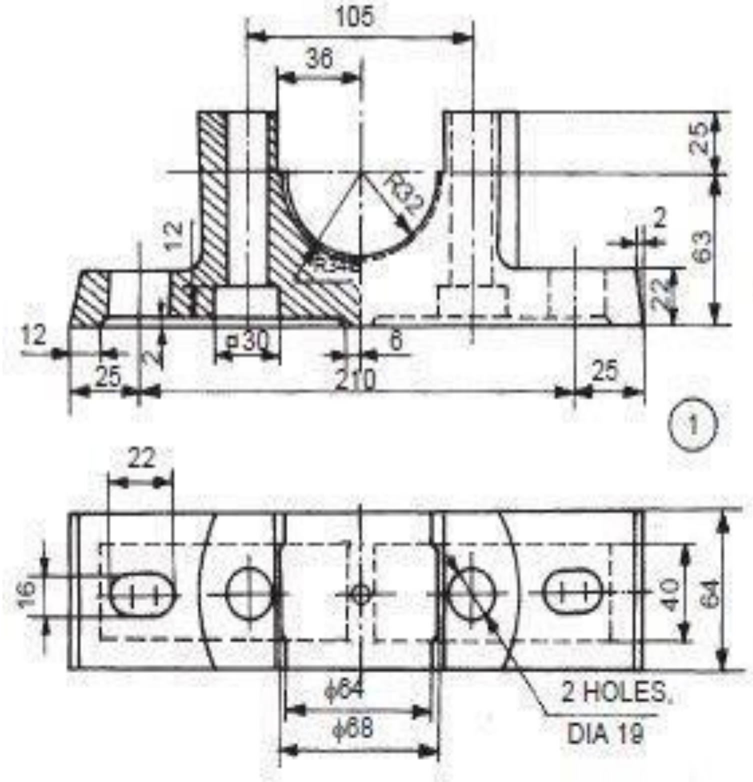
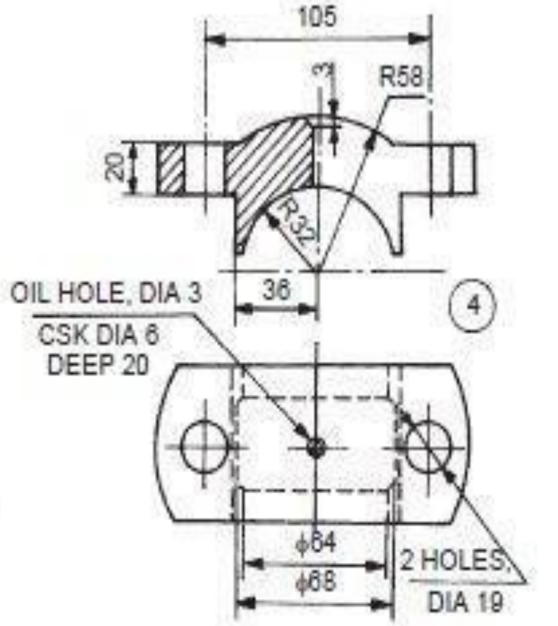
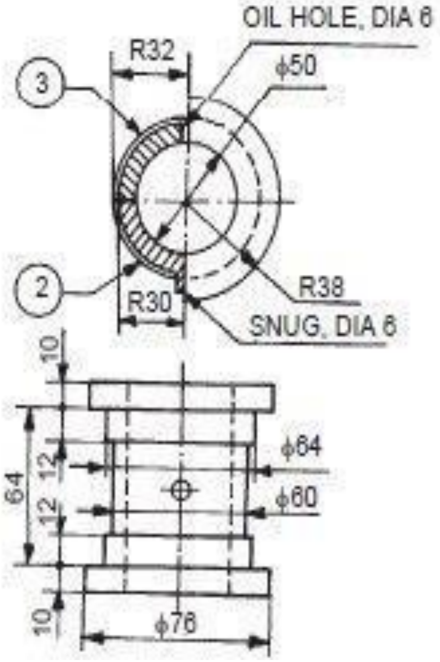


Fig. 12.4 Plummer block

DETAILS OF PLUMMER BLOCK

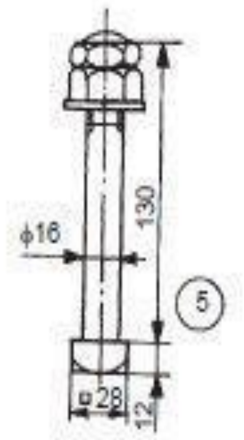




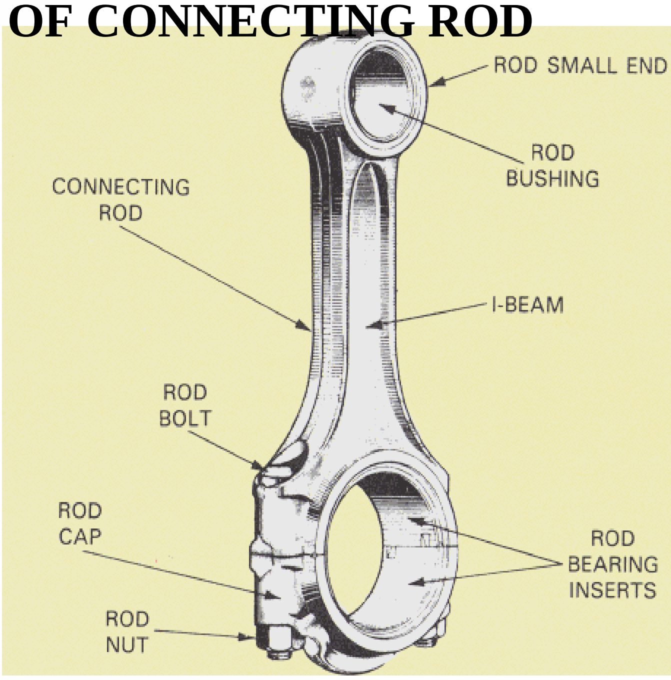


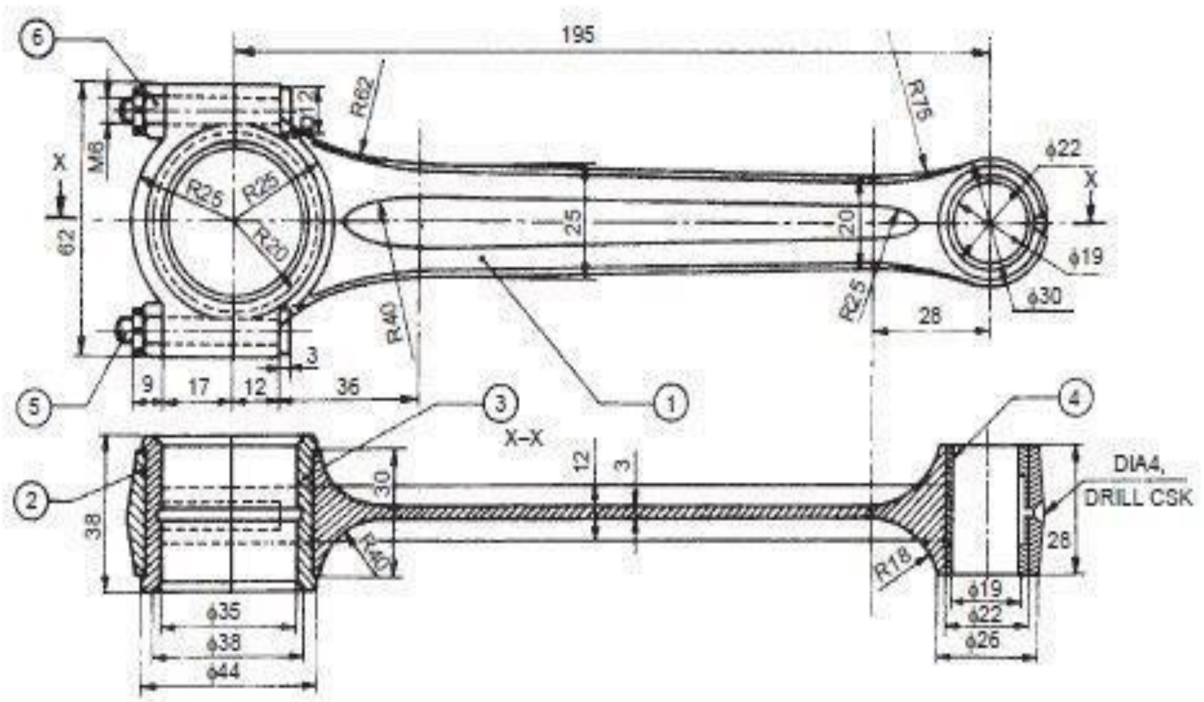
Parts list

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



3.2] ASSEMBLY OF CONNECTING ROD



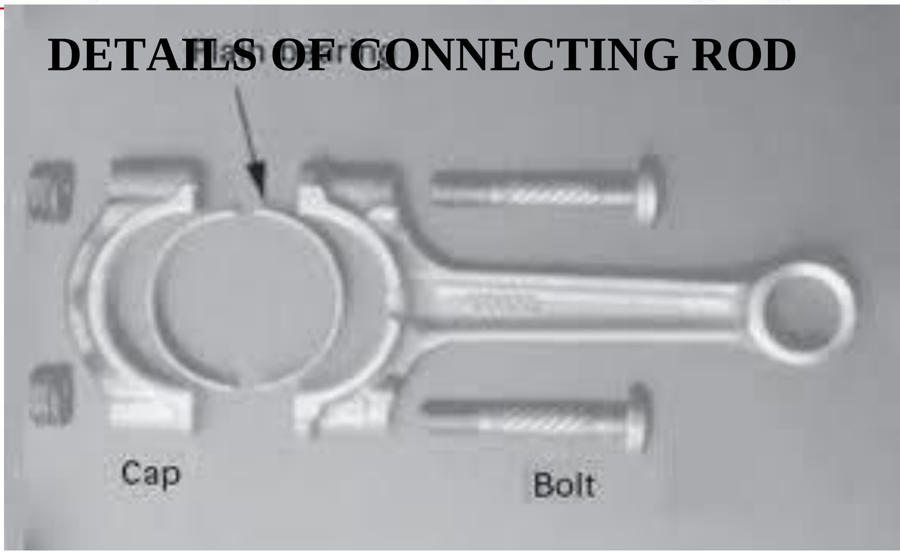


Parts list

Part No.	Name	Matl.	Qty.
1	Rod	FS	1
2	Cap	FS	1
3	Bearing brass	GM	2
4	Bearing bush	P Bronze	1
5	Bolt	MCS	2
6	Nut	MCS	2

Fig. 19.1 Petrol engine connecting rod

DETAILS OF CONNECTING ROD



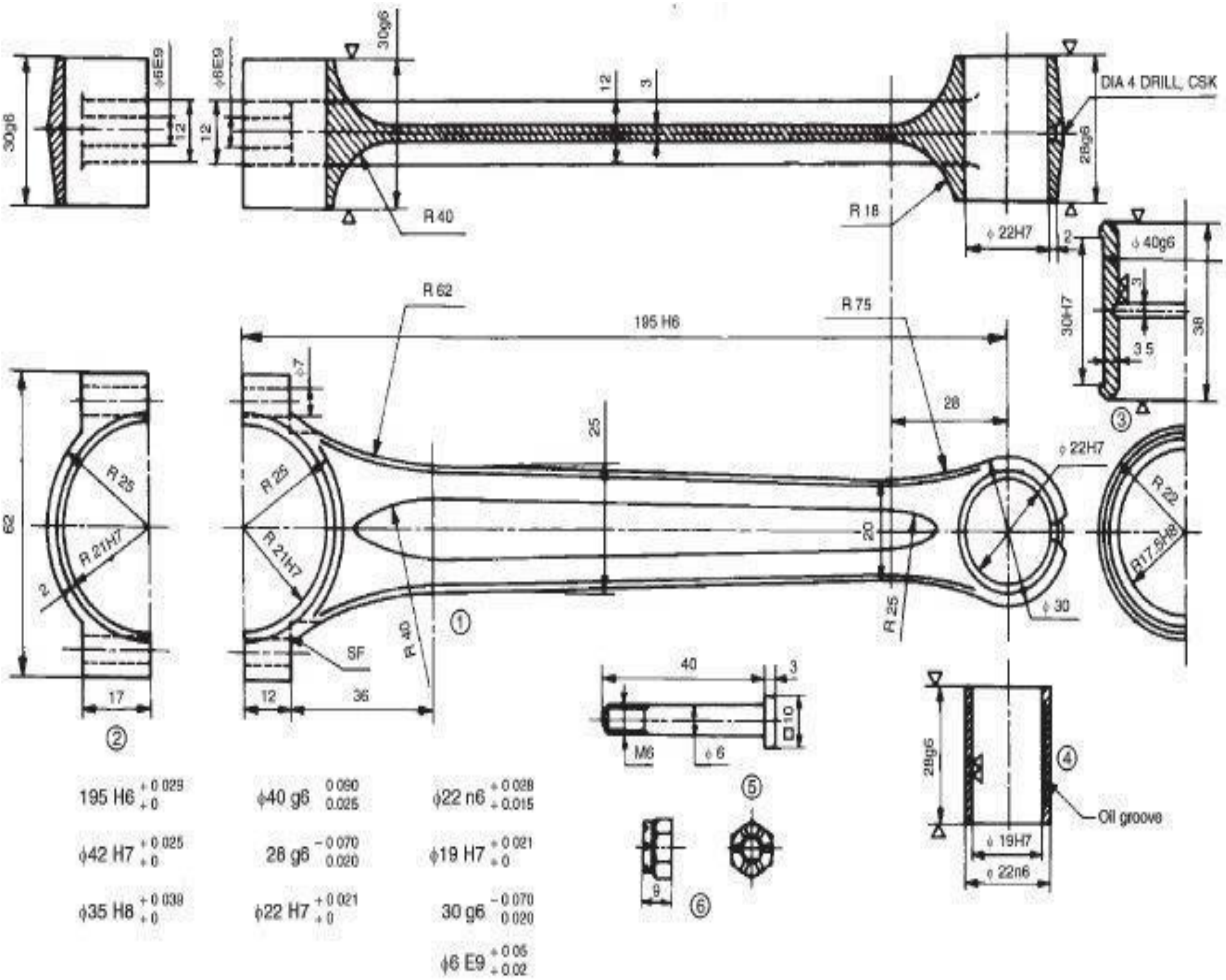


Fig. 20.7 Details of petrol engine connecting rod

3.3 ASSEMBLY OF LATHE TAIL-STOCK

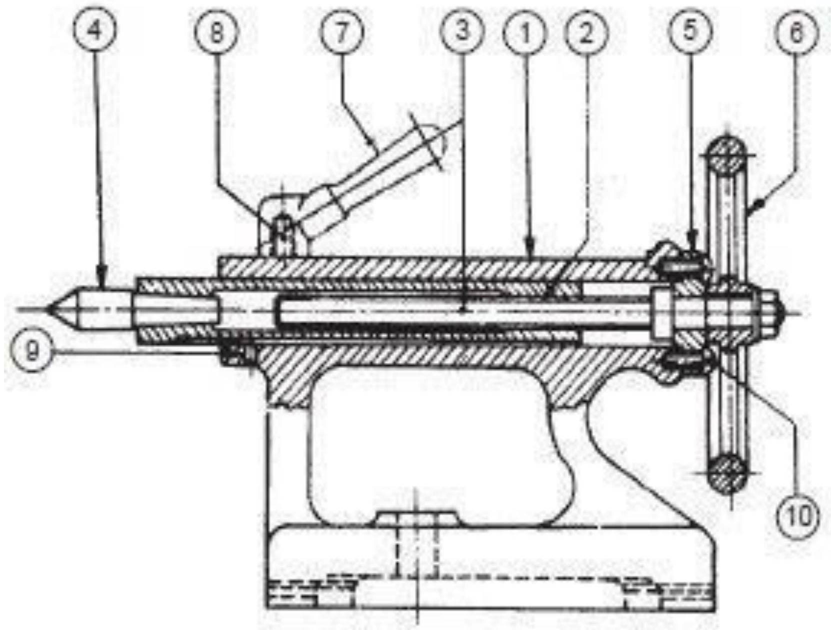
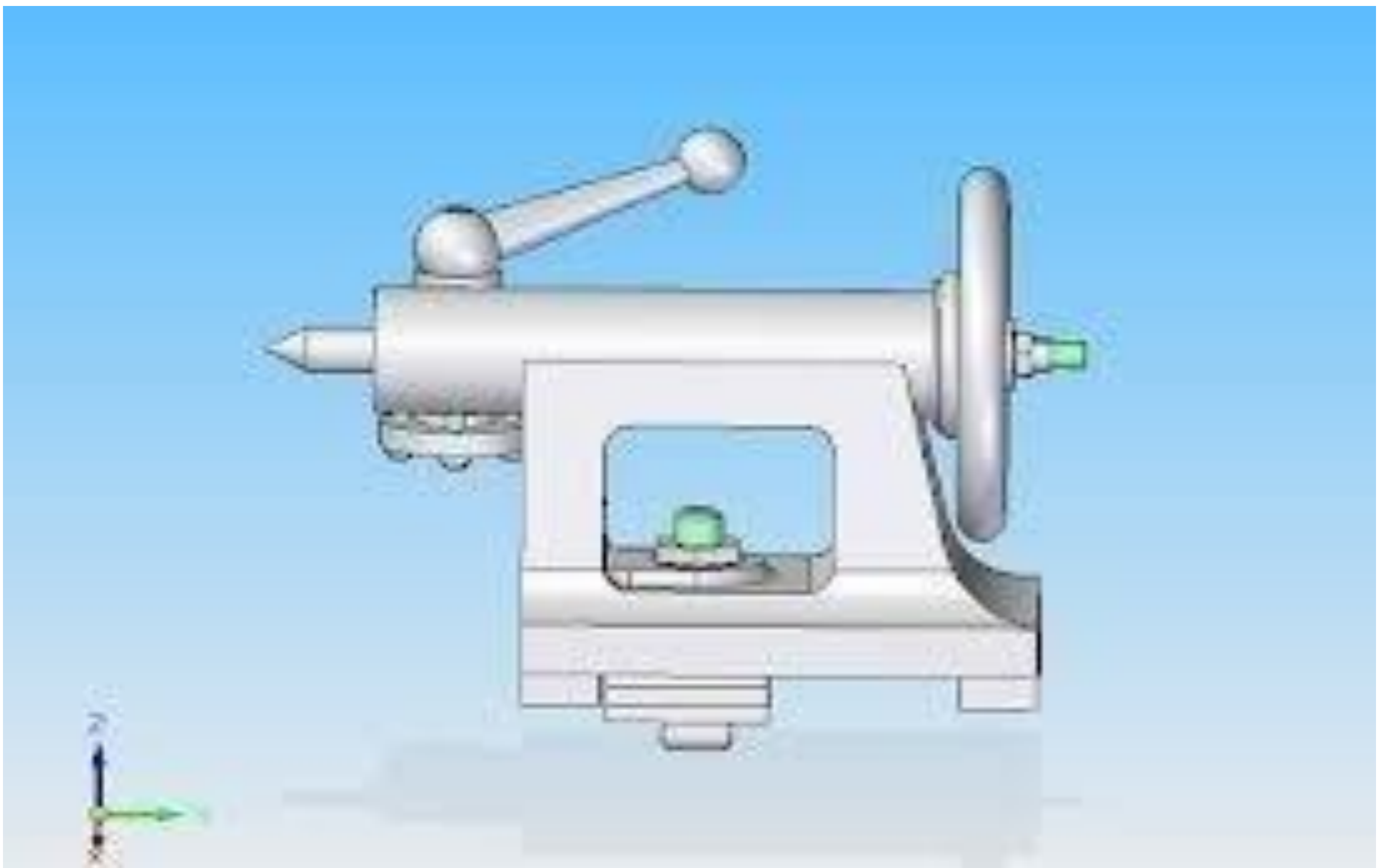


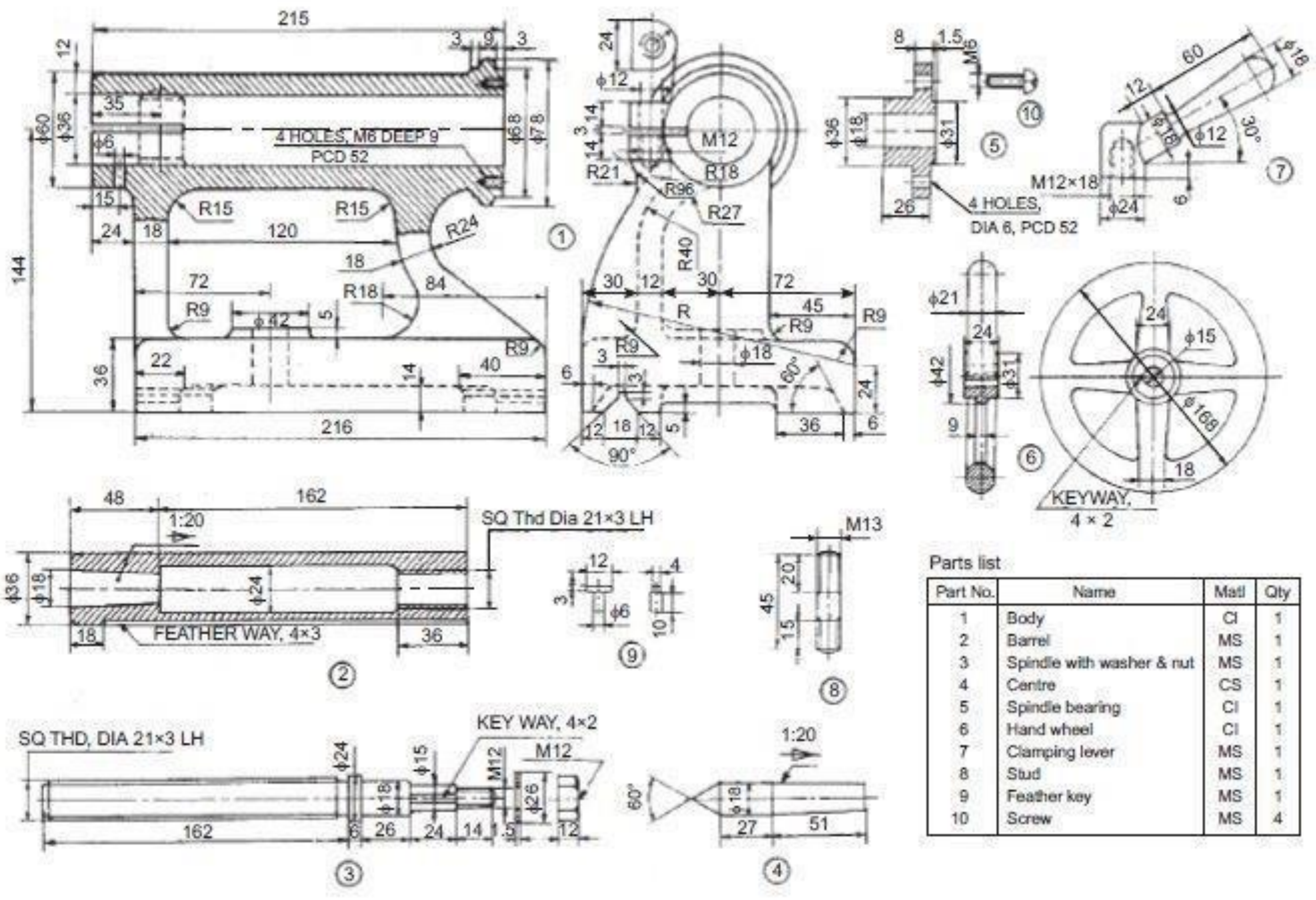
Fig. 18.18A Lathe tail-stock

Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Barrel	MS	1
3	Spindle with washer & nut	MS	1
4	Centre	CS	1
5	Spindle bearing	CI	1
6	Hand wheel	CI	1
7	Clamping lever	MS	1
8	Stud	MS	1
9	Feather key	MS	1
10	Screw	MS	4



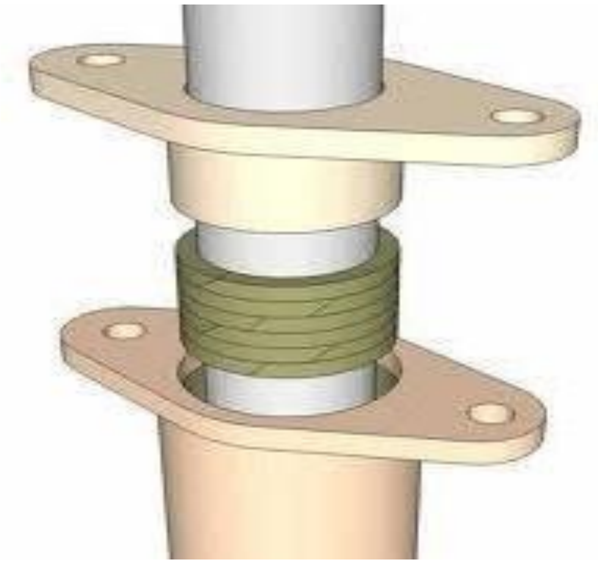
DETAILS OF LATHE TAIL-STOCK

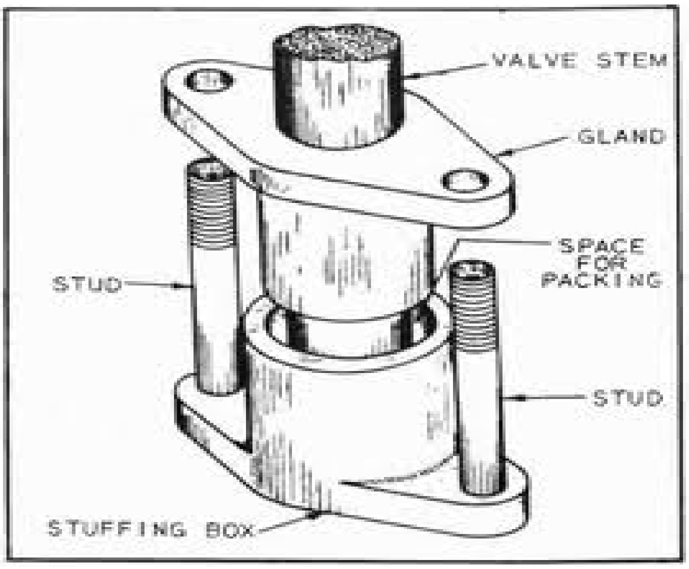


Part No.	Name	Matl	Qty
1	Body	CI	1
2	Barrel	MS	1
3	Spindle with washer & nut	MS	1
4	Centre	CS	1
5	Spindle bearing	CI	1
6	Hand wheel	CI	1
7	Clamping lever	MS	1
8	Stud	MS	1
9	Feather key	MS	1
10	Screw	MS	4

Fig. 18.18 Lathe tail-stock

3.4] ASSEMBLY OF GLAND &STUFFING BOX





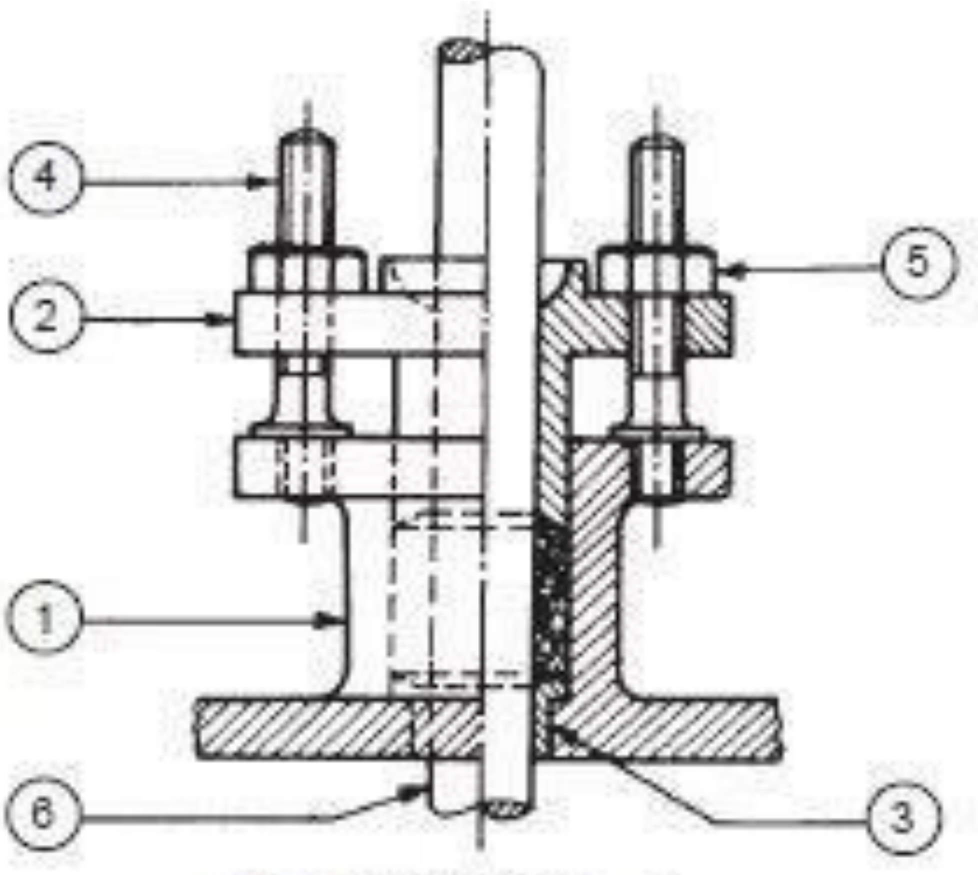
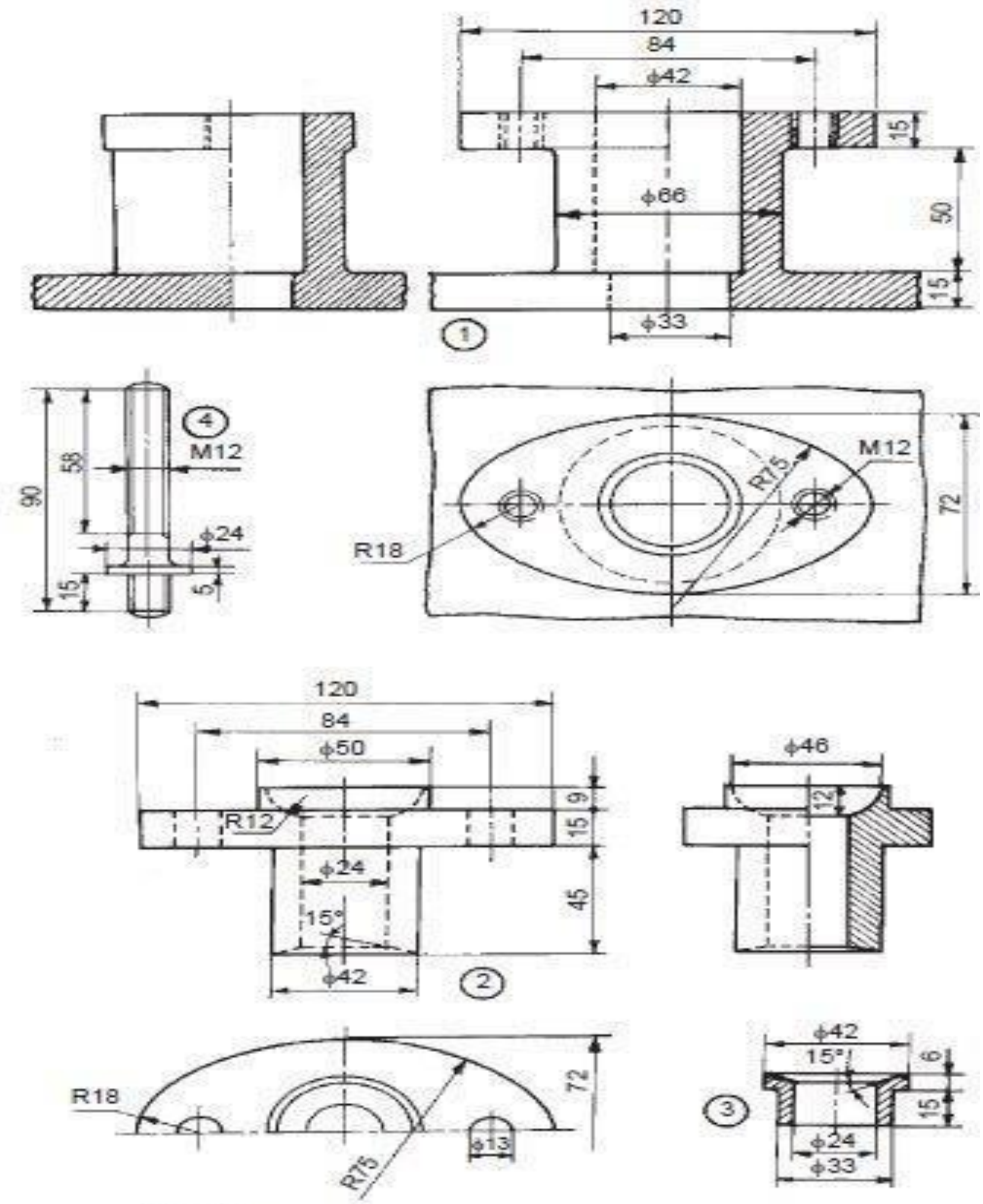


Fig. 18.1A Stuffing box

DETAILS OF GLAND & STUFFING BOX

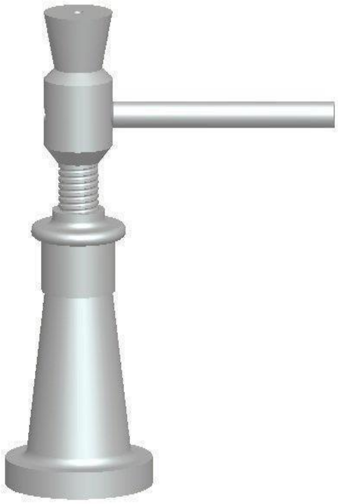


Parts list

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

Fig. 18.1 Stuffing box

3.5] ASSEMBLY OF SCREW JACK



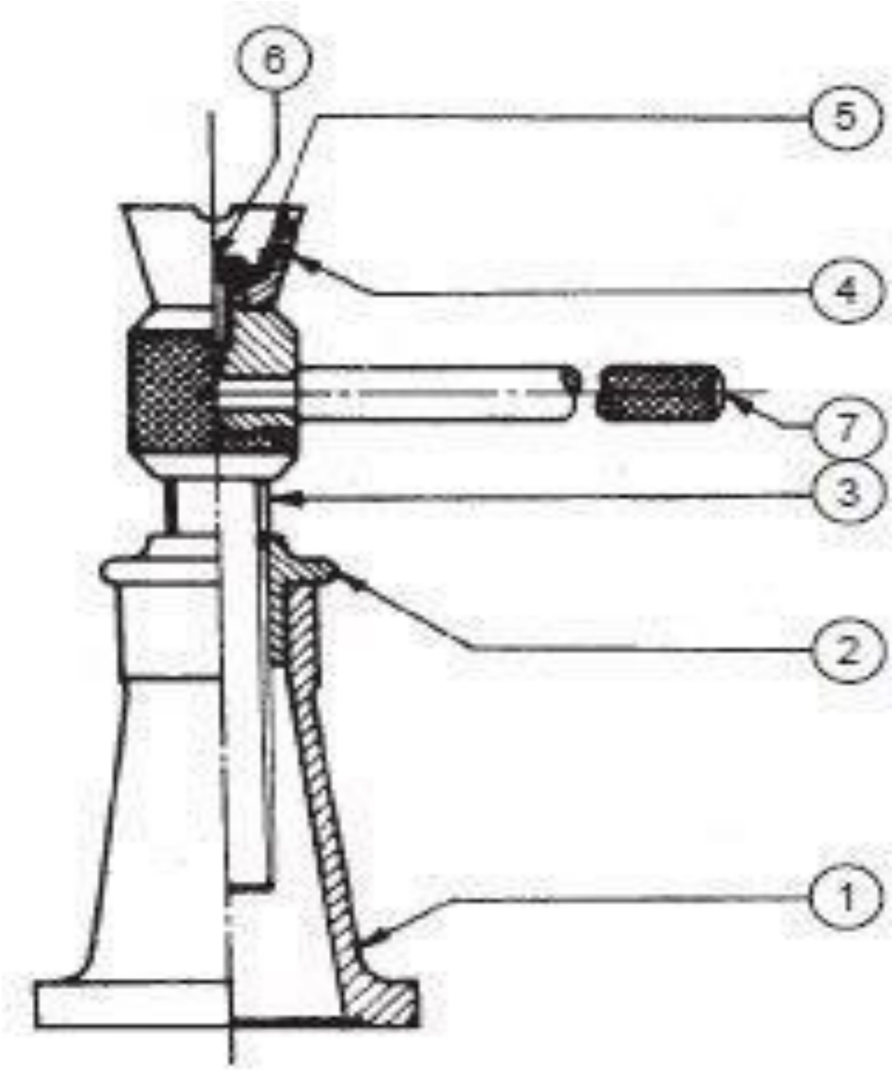
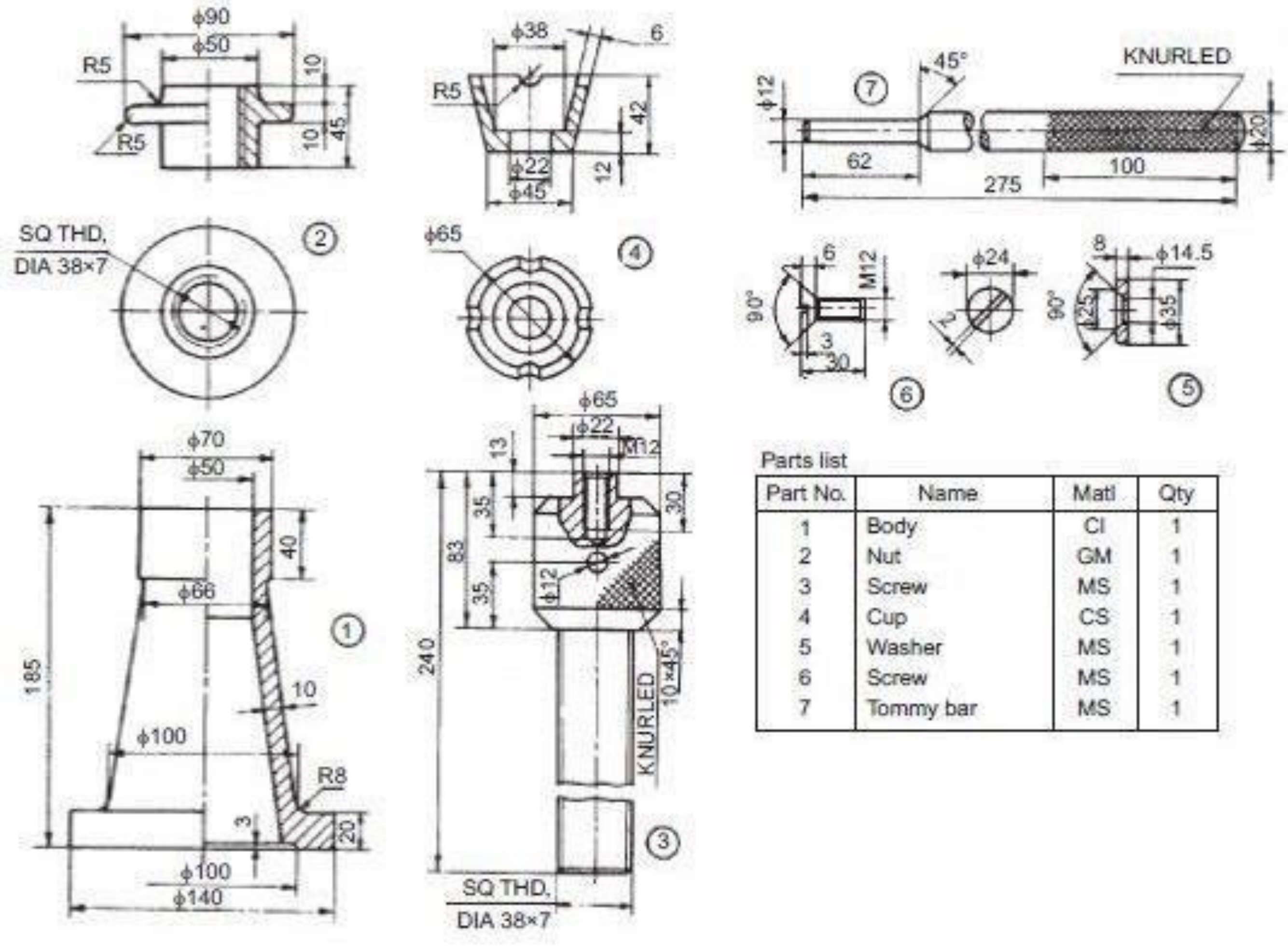


Fig. 18.51A Screw jack

DETAILS OF SCREWJACK



Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Nut	GM	1
3	Screw	MS	1
4	Cup	CS	1
5	Washer	MS	1
6	Screw	MS	1
7	Tommy bar	MS	1

Fig. 18.51 Screw jack

3.6] CROSS HEAD ASSEMBLY

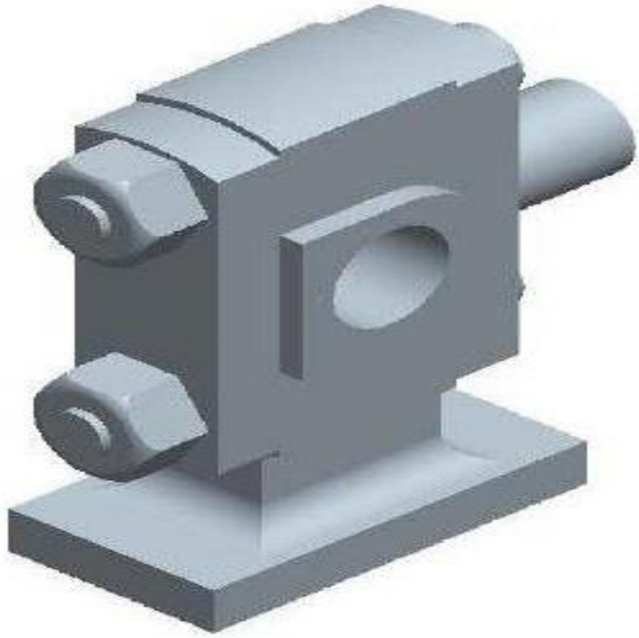


Figure 1 The Crosshead assembly

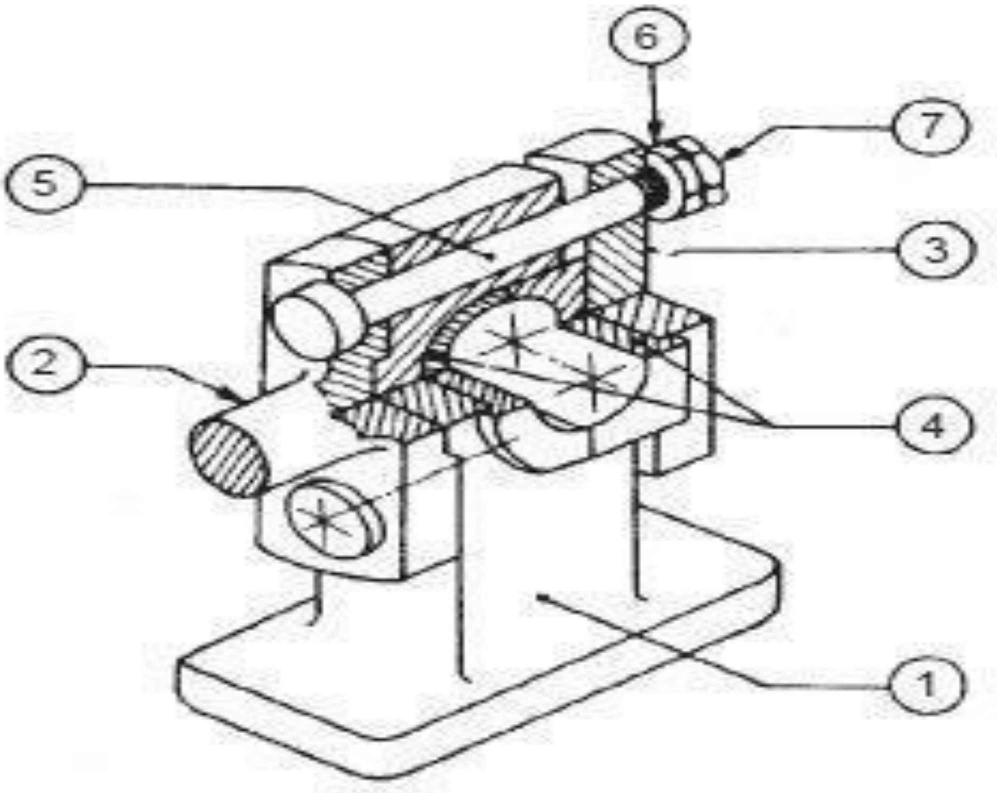


Fig. 18.3A Crosshead

DETAILS OF CROSS HEAD

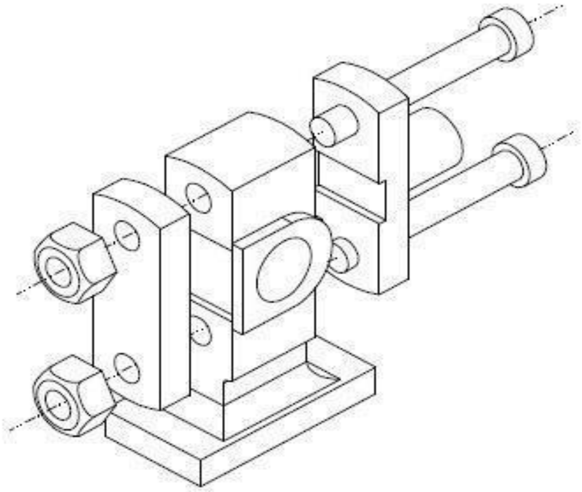
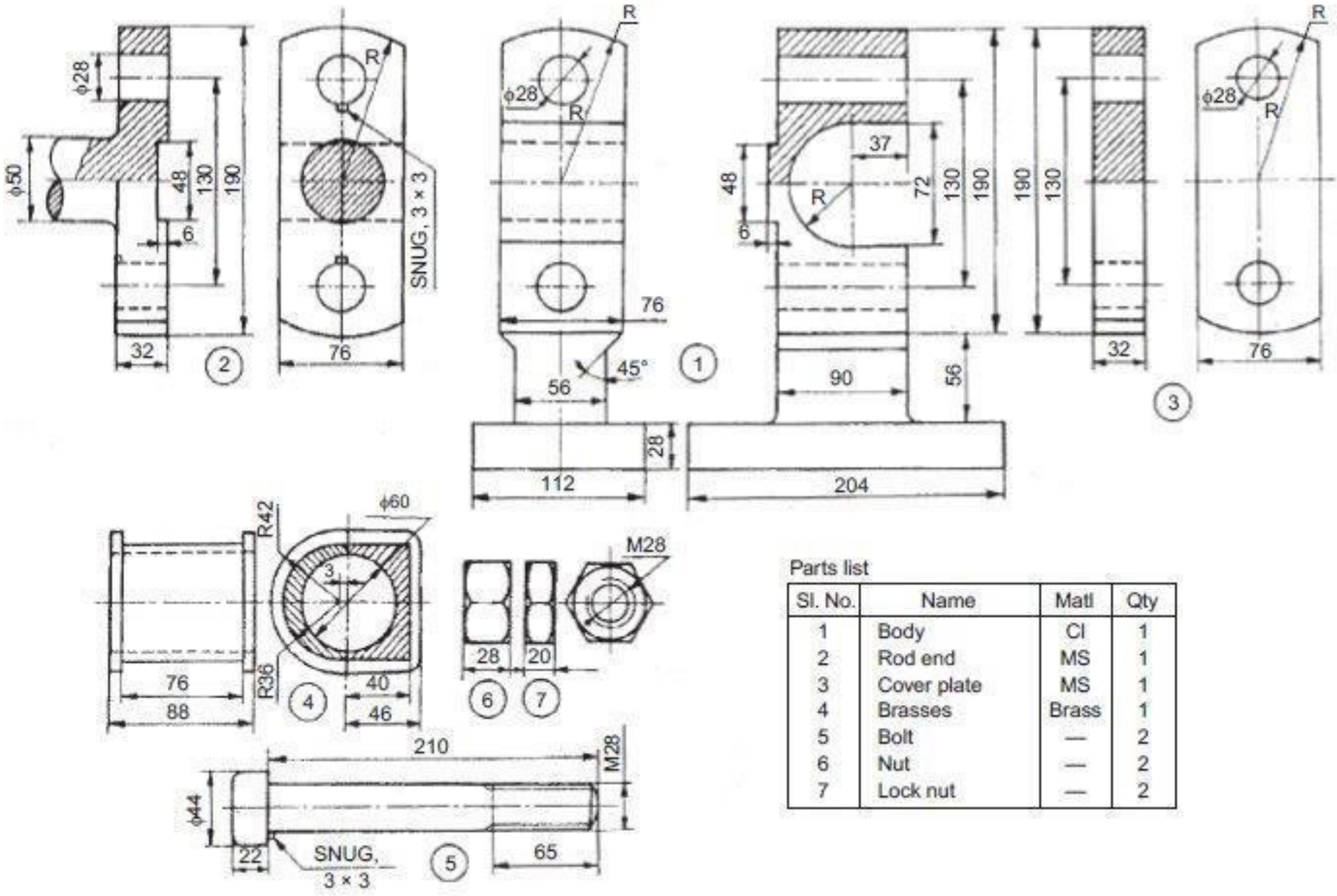


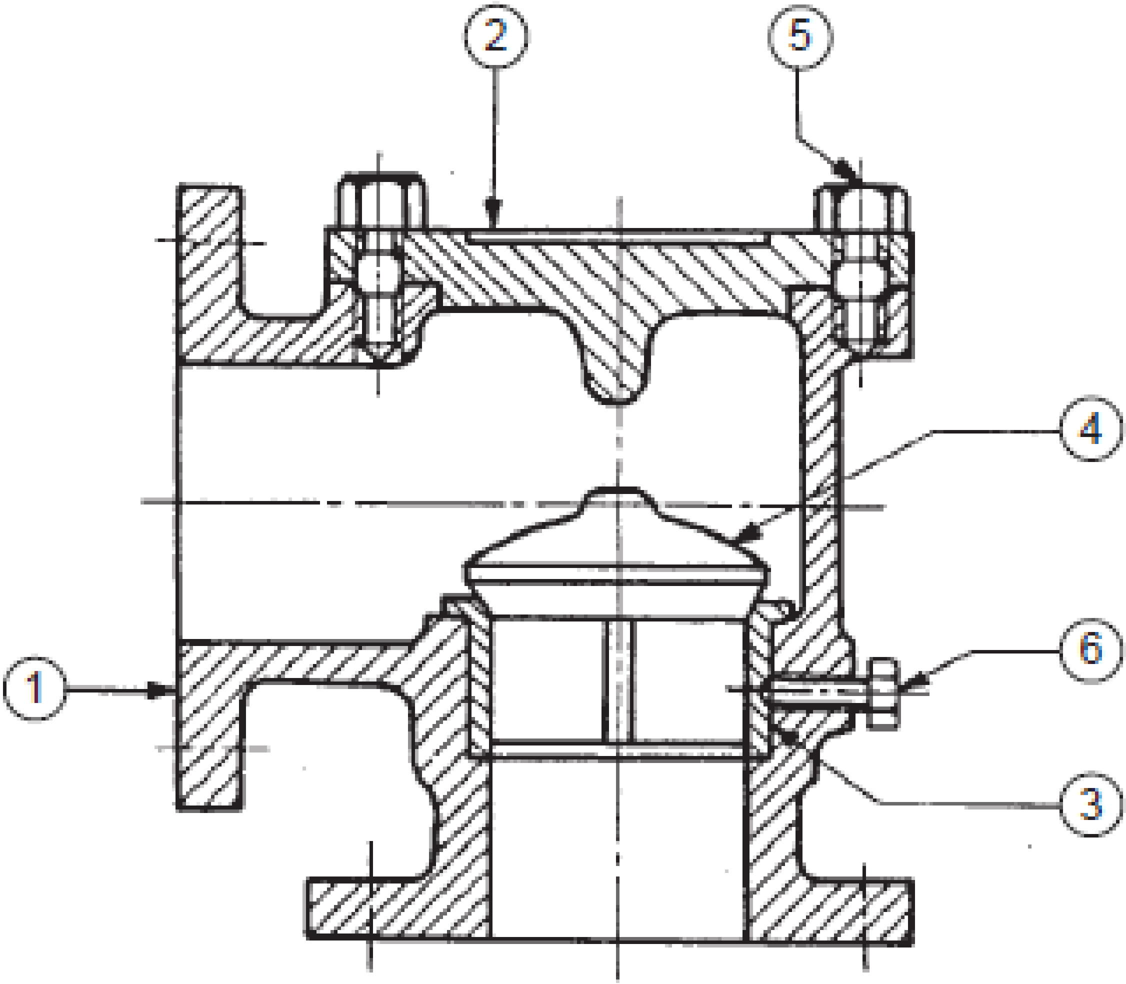
Figure 2 The exploded state of Crosshead assembly

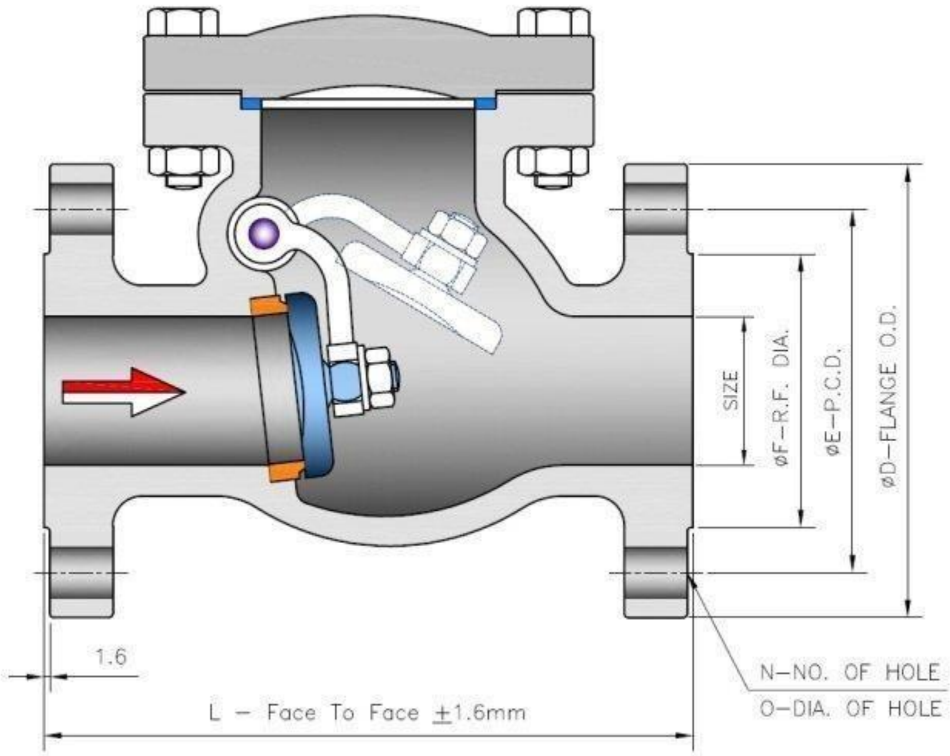


Parts list

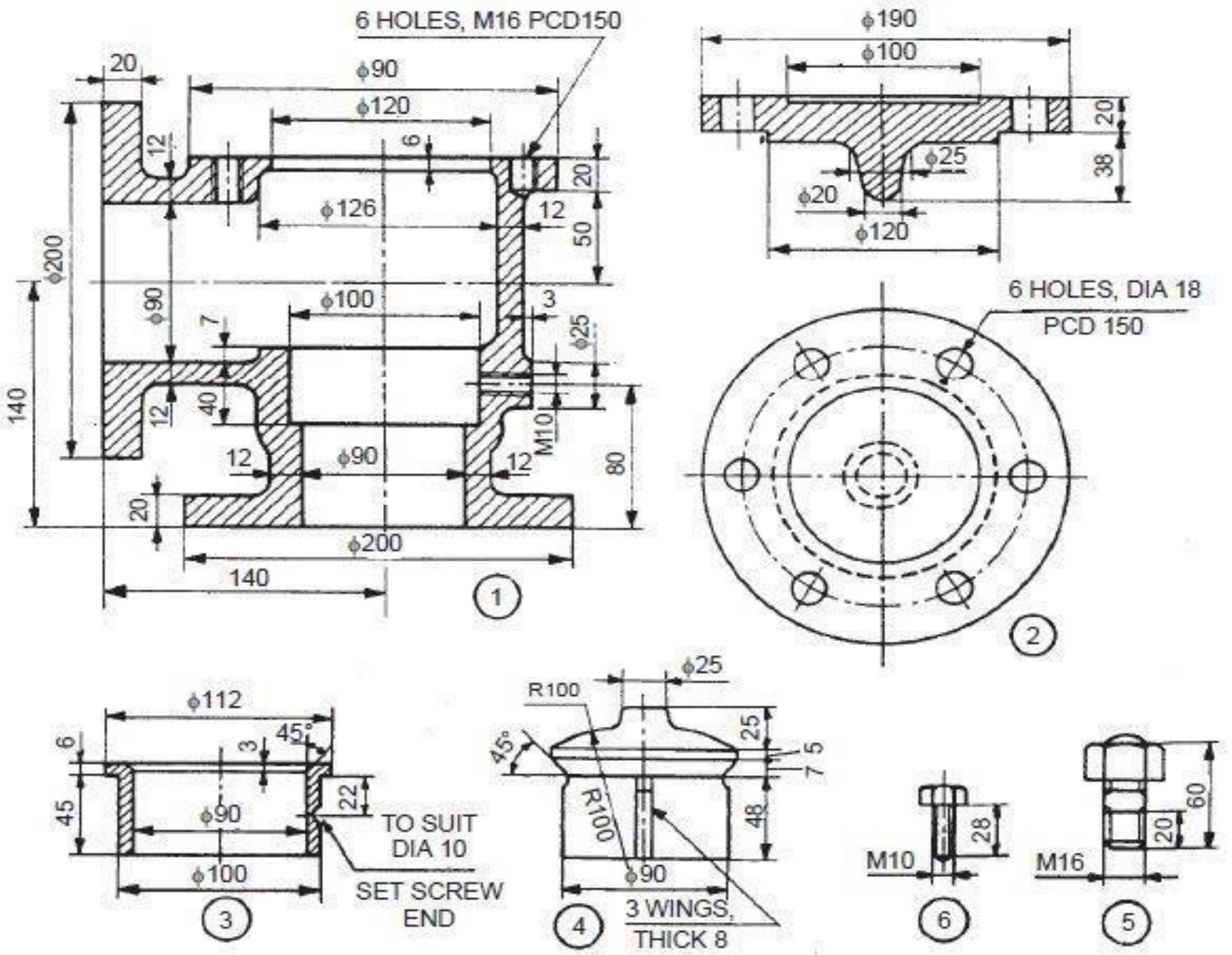
Sl. No.	Name	Matl	Qty
1	Body	CI	1
2	Rod end	MS	1
3	Cover plate	MS	1
4	Brasses	Brass	1
5	Bolt	—	2
6	Nut	—	2
7	Lock nut	—	2

3.7] ASSEMBLY OF NON-RETURN VALVE





DETAILS OF NON-RETURN VALVE



Parts list

No.	Name	Matl	Qty
1	Body	Brass	1
2	Cover	Brass	1
3	Valve seat	Bronze	1
4	Valve	Brass	1
5	Stud with nut	MS	6
6	Set screw	MS	1

Fig. 18.30 Non-return valve (Light duty)

3.8] ASSEMBLY OF FEED CHECK VALVE

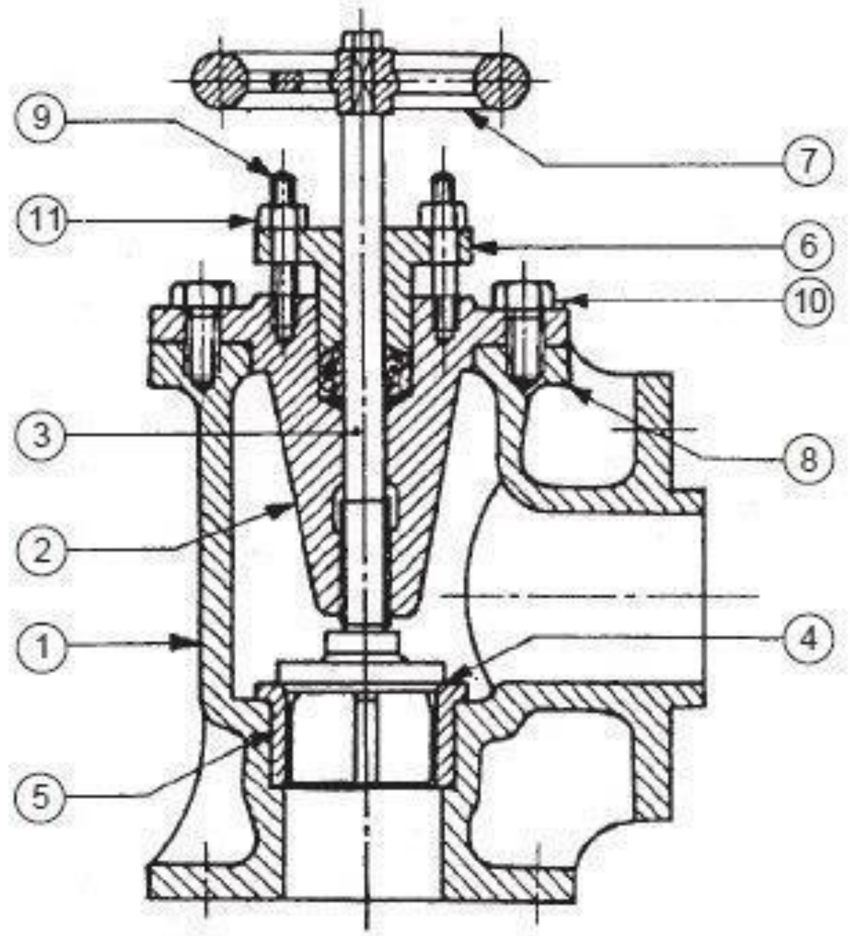
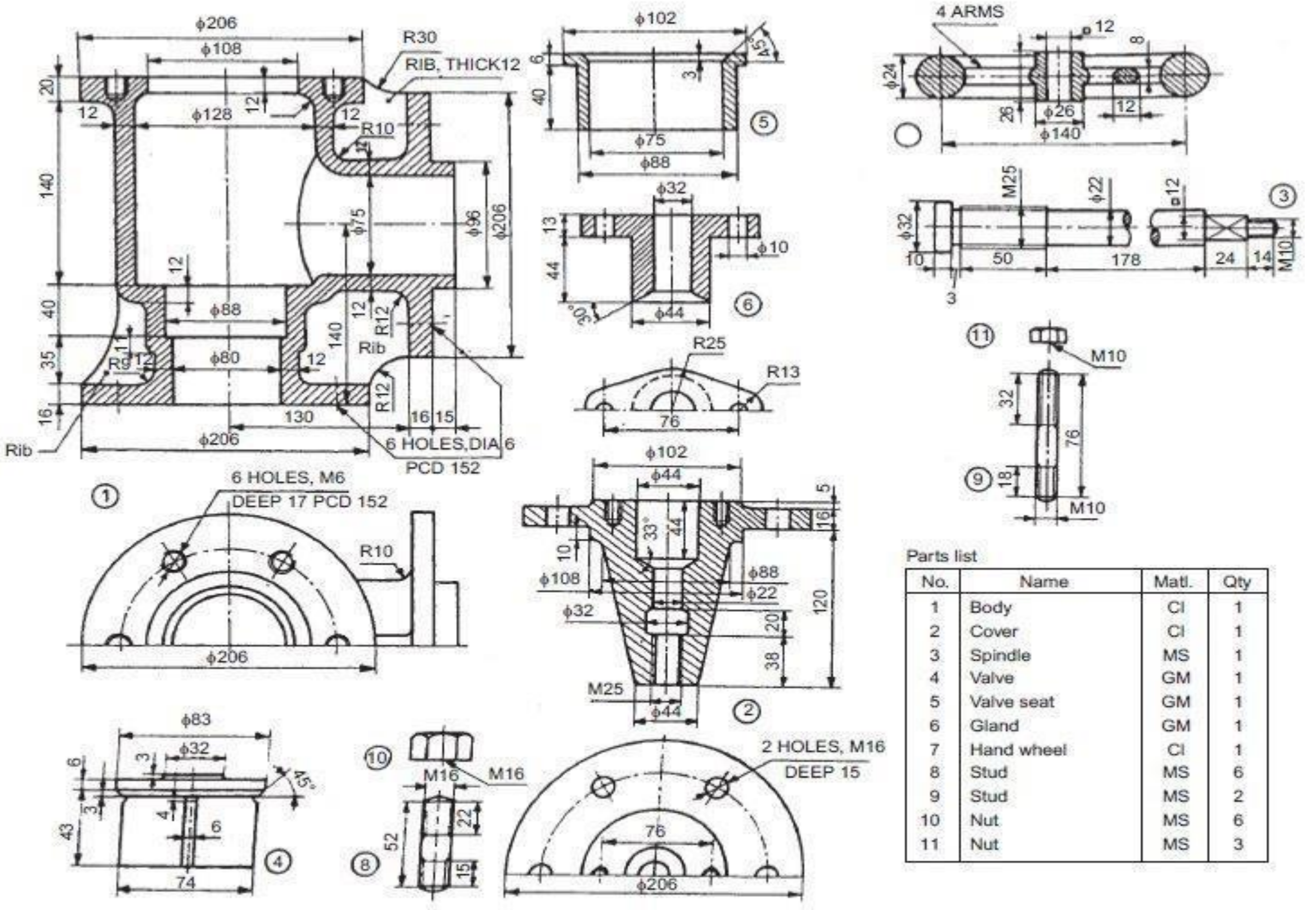


Fig. 18.34A Feed check valve

DETAILS OF FEED CHECK VALVE

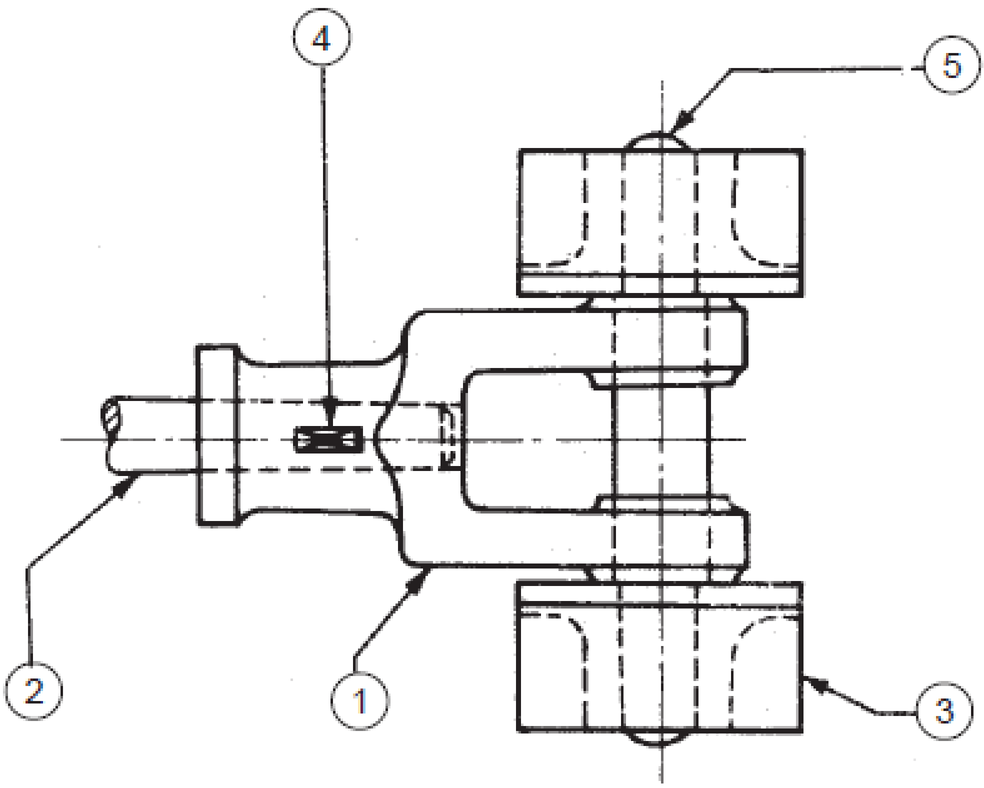


Parts list

No.	Name	Matl.	Qty
1	Body	CI	1
2	Cover	CI	1
3	Spindle	MS	1
4	Valve	GM	1
5	Valve seat	GM	1
6	Gland	GM	1
7	Hand wheel	CI	1
8	Stud	MS	6
9	Stud	MS	2
10	Nut	MS	6
11	Nut	MS	3

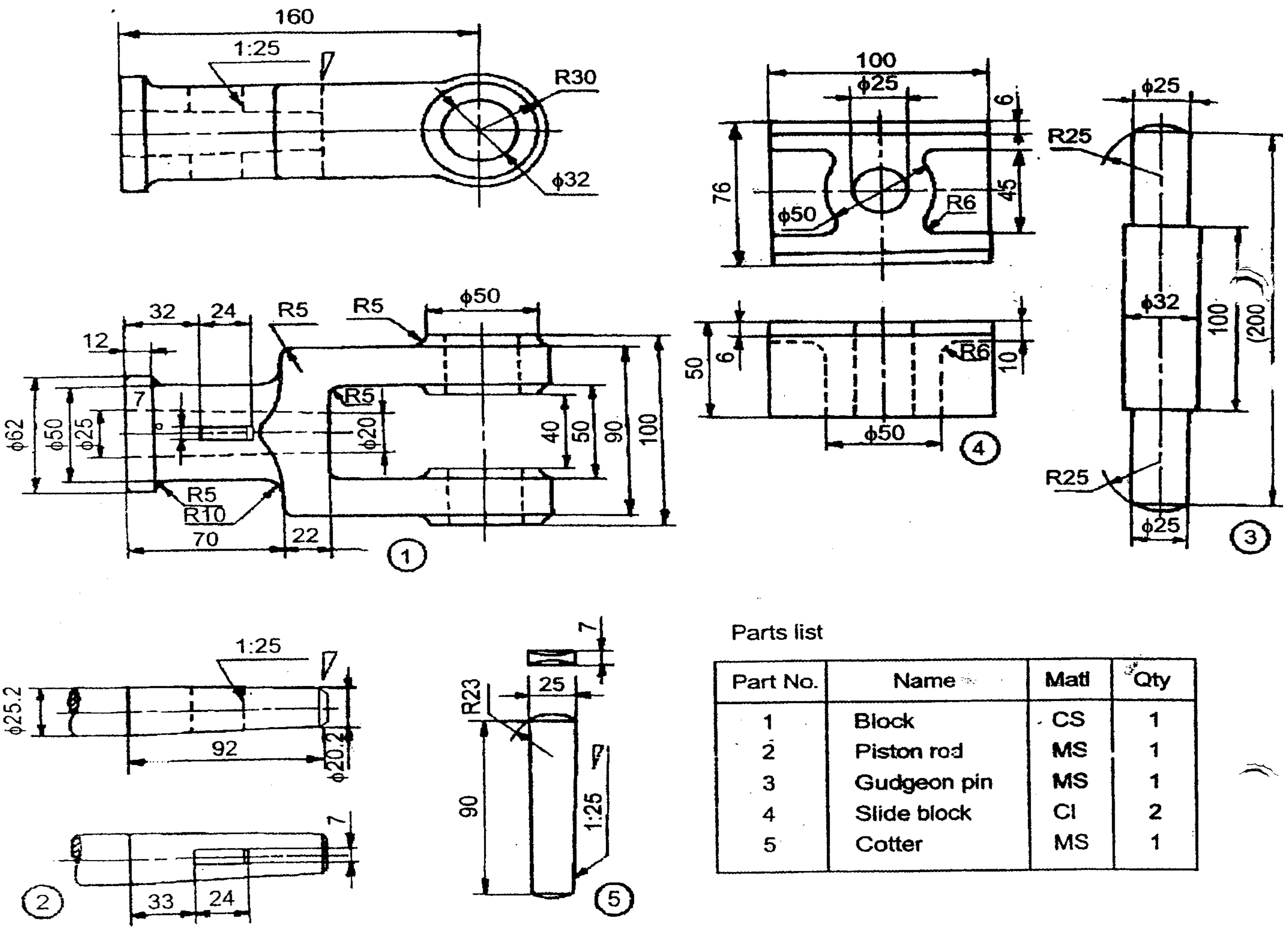
Fig. 18.34 Feed check valve

3.9] ASSEMBLY OF STEAM ENGINE CROSSHEAD



DETAILS OF STEAM ENGINE CROSSHEAD

STEAM ENGINE CROSSHEAD



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

Fig. No. 1