

ENGINEERING DRAWING

(NSQF)

(As per Revised Syllabus July 2022)

Group 6

Pump Operator cum Mechanic



Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA



**NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI**

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Engineering Drawing (NSQF) 1 Year
Group 6 Engineering Trades
As per Revised syllabus July 2022 under CTS

Developed & Published by



National Instructional Media Institute

Post Box No.3142
Guindy, Chennai - 600032
INDIA
Email: chennai-nimi@nic.in
Website: www.nimi.gov.in

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Engineering Drawing NSQF Group 6 Engineering Trades (Revised 2022)** under CTS will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

New Delhi - 110 001

SHRI. ATUL KUMAR TIWARI., I.A.S.,
Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

PREFACE

The National Instructional Media Institute(NIMI) was set up at Chennai, by the Directorate General of Training, Ministry of skill Development and Entrepreneurship, Government of India, with the technical assistance from the Govt of the Federal Republic of Germany with the prime objective of developing and disseminating instructional Material for various trades as per prescribed syllabus and Craftsman Training Programme(CTS) under NSQF levels.

The Instructional materials are developed and produced in the form of Instructional Media Packages (IMPs), consisting of Trade Theory, Trade Practical, Test and Assignment Book, Instructor Guide, Wall charts, Transparencies and other supportive materials. The above material will enable to achieve overall improvement in the standard of training in ITIs.

A national multi-skill programme called SKILL INDIA, was launched by the Government of India, through a Gazette Notification from the Ministry of Finance (Dept of Economic Affairs), Govt of India, dated 27th December 2013, with a view to create opportunities, space and scope for the development of talents of Indian Youth, and to develop those sectors under Skill Development.

The emphasis is to skill the Youth in such a manner to enable them to get employment and also improve Entrepreneurship by providing training, support and guidance for all occupation that were of traditional types. The training programme would be in the lines of International level, so that youths of our Country can get employed within the Country or Overseas employment. The **National Skill Qualification Framework (NSQF)**, anchored at the National Skill Development Agency(NSDA), is a Nationally Integrated Education and competency-based framework, to organize all qualifications according to a series of **levels of Knowledge, Skill and Aptitude**. Under NSQF the learner can acquire the Certification for Competency needed at any level through formal, non-formal or informal learning.

The **Engineering Drawing** NSQF Group 6 - Engineering Trades (Revised 2022) under CTS is one of the book developed by the core group members as per the NSQF syllabus.

The **Engineering Drawing** NSQF Group 6 - Engineering Trades (Revised 2022) under CTS as per NSQF is the outcome of the collective efforts of experts from Field Institutes of DGT, Champion ITI's for each of the Sectors, and also Media Development Committee (**MDC**) members and Staff of **NIMI**. NIMI wishes that the above material will fulfill to satisfy the long needs of the trainees and instructors and shall help the trainees for their Employability in Vocational Training.

NIMI would like to take this opportunity to convey sincere thanks to all the Members and Media Development Committee (MDC) members.

Chennai - 600 032

EXECUTIVE DIRECTOR

ACKNOWLEDGEMENT

The National Instructional Media Institute (NIMI) sincerely acknowledge with thanks the co-operation and contribution of the following Media Developers to bring this IMP for the course **Engineering Drawing Group 6 - Engineering Trades** as per NSQF Revised 2022.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. M. Sangara pandian	-	Training Officer (Retd.) CTI, Govt. of India, Guindy, Chennai - 32.
Shri. G. Sathiamoorthy	-	Jr. Training Officer - SG (Retd.) Govt I.T.I, Trichy, DET - Tamilnadu.
Shri. V. Kalaimani	-	Jr. Training Officer, Govt I.T.I, Puthukottai, DET - Tamilnadu.
Shri. C.C. Subramanian	-	Training Officer (Retd.) Balamandir PHMITI, Chennai - 17.

NIMI CO-ORDINATORS

Shri. Nirmalya Nath	-	Deputy General Manager, NIMI, Chennai - 32.
Shri. G. Michael Johny	-	Manager, NIMI, Chennai - 32.

NIMI records its appreciation of the **Data Entry, CAD, DTP Operators** for their excellent and devoted services in the process of development of this IMP.

NIMI also acknowledges with thanks, the efforts rendered by all other staff who have contributed for the development of this book.

INTRODUCTION

Theory and procedure along with the related exercises for further practice

This book on theory and procedure along with related exercises contains theoretical information on **1 Year Engineering drawing** NSQF (Revised syllabus July 2022 Group 6 - Engineering Trade) and procedure of drawing/sketching different exercise for further practice are also available. Wherever required, BIS specification has been used.

Exercise for further practice

The practice exercise is given with Theory and procedure for 1st Year book made obsolete as it was felt that, it is very difficult to work in workbook using drawing instruments. It is well known fact that, any drawing is prepared on suitable standard size of drawing sheets only.

The instructor is herewith advised to go through the instructions given below and to follow them in view of imparting much drawing skill in the trainees.

Acquiring the above said ability and doing small drawings is not a simple task. These books will provide a good platform for achieving the said skills.

Time allotment:

Duration of 1 Year : 40 Hrs

Sl. No.	Topic	Exercise No.	Time Allotment
1	Introduction to Engineering Drawing and Drawing Instruments	1.1.01 - 1.1.05	2
2	Free hand drawing	1.2.06 - 1.2.08	6
3	Drawing of Geometrical Figures	1.3.09 - 1.3.12	4
4	Reading of dimension and Dimensioning Practice	1.4.13 & 1.4.14	4
5	Symbolic representation	1.5.15	10
6	Reading of Job drawing and piping Layout	1.6.16 & 1.6.17	14
			<hr/> 40 Hrs

Instructions to the Instructors

It is suggested to get the drawing prepared on A4/A3 sheets preferably on only one side. If separate table and chair facility is available for every trainee then it is preferred to use A3 sheets and if the drawing hall is provided with desks then A4 sheets may be used. However while preparing bigger drawings on A4 sheets suitable reduction scale to be used or multiple sheets may be used for detailed and assembly drawings.

First the border and the title block to be drawn only for the first sheet of the chapter. Eg. for conical sections only first sheet will have the title block whereas the rest of the sheets of that chapter will have only borders.

Serial number of sheet and total no. of sheets to be mentioned on each sheet.

The completed sheet to be punched and filled in a box file/ suitable files and preserved by the trainees carefully after the approval of instructor, VP and Principal of the Institute.

The file may be referred by the authority before granting the internal marks at the end of the Year.

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LEARNING /ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Read and apply engineering drawing for different application in the field of work.**

SYLLABUS

1 Year

Group 6 - Revised syllabus July 2022
Engineering trades under CTS

Duration: 1 Year

CTS Trades Covered: Pump Operator cum Mechanic

S.no.	Syllabus	Time in Hrs
1	Introduction to Engineering Drawing and Drawing Instruments – <ul style="list-style-type: none">• Conventions• Sizes and layout of drawing sheets• Title Block, its position and content• Drawing Instruments	2
2	Free hand drawing of - <ul style="list-style-type: none">• Geometrical figures and blocks with dimension• Transferring measurement from the given object to the free hand sketches.• Free hand drawing of hand tools and measuring tools	6
3	Drawing of Geometrical figures: <ul style="list-style-type: none">• Angle, Triangle, Circle, Rectangle, Square, Rhombus, Parallelogram.• Lettering & Numbering - Single Stroke.	4
4	Reading of dimension and Dimensioning Practice	4
5	Symbolic representation - <ul style="list-style-type: none">• Different symbols used in the Pump operator cum Mechanic trade.	10
6	Reading of Job drawing and piping Layout	14
	Total	40

Introduction to engineering drawing and drawing instruments

Communication

There are many different ways of communicating ideas, information, instructions, requests, etc. They can be transmitted by signs or gestures, by word of mouth, in writing, or graphically. In an industrial context the graphical method is commonly used with communication is achieved by means of engineering drawings.

If oral and written communication only were used when dealing with technical matters, misunderstandings could arise, particularly in relation to shape and size. The lack of a universal spoken language makes communication and understanding even more difficult because of the necessity to translate both words and meaning from one language to another.

However, the universally accepted methods used in graphical communication through engineering drawings eliminate many of these difficulties and make it possible for drawing prepared by a British designer to be correctly interpreted or "read" by, for example, his German, French or Dutch counterparts.

Equally important, the components shown on the drawings could be made by suitably skilled craftsmen of any nationality provided they can "read" an engineering drawing.

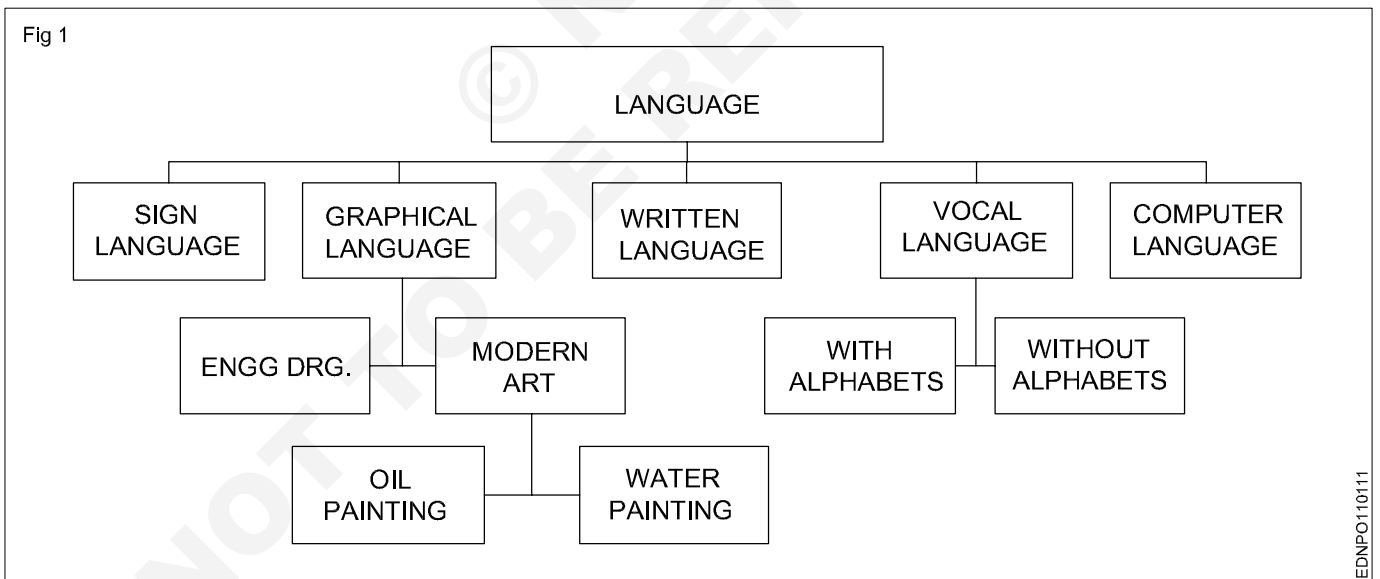
Conventionally prepared engineering drawings provide the main means of communication between the "ideas" men (the designers and draughtsman) and the craftsmen (machinists, fitters, assemblers, etc.). For the communication to be effective, everyone concerned must interpret the drawing in the same way. Only then will the finished product be exactly as the designer envisages it.

To ensure uniformity of interpretation, the British Standards Institution has prepared a booklet entitled BS 308:1972, Engineering Drawing Practice. Now in three parts, this publication recommends the methods which should be adopted for the preparation of drawing used in the engineering industry.

The standards and conventions in most common use and hence those required for a basic understanding of engineering drawing are illustrated and explained in this book.

Language

1 It is the media of communication (Fig 1)



Conclusion

Effective communication is possible when graphical language is supported by written language/vocal language and vice versa.

Engineering drawing is a language that uses both graphical language and written language for effective communication.

Engineering drawing is a graphical language that also uses written language for effective communication.

The importance of Engineering Drawing

The economic success of any country is mainly dependent on its industrial development. Due to globalization, any industry in our country is expected to be of a global market standard. For the above-mentioned reasons, our Indian products require very high quality for their size, dimension, fit, tolerance, and finish etc.

To produce the best standard product, all the technical personnel (Engineers to Craftsman) in an industry must have a sound knowledge of engineering drawing because engineering drawing is the language of engineers. Engineering drawing is a universal language. Different types of lines make up their alphabets. Technical personnel in any industry, including craftsman, are expected to communicate anything concerning a part or a component by means of drawings involving lines, symbols, conventions, abbreviations etc.

With our spoken languages, it is impossible to express the details of a job or a product. Engineering drawing knowledge and practise are a must for designing or producing a component or part. Even a small mistake in the drawing may reflect very badly on the product. Therefore, reading and doing engineering drawings are very essential for craftsmen and engineers.

A drawing is a graphical representation of an object, or part of it, and is the result of creative thought by an engineer or technician. When one person sketches a rough map in giving direction to another, this is graphic communication. Graphic communication involves using visual materials to relate ideas. Drawings, photographs, slides, transparencies, and sketches are all forms of graphic communication. Any medium that uses a graphic image to aid in conveying a message, instructions, or an idea is involved in graphic communication.

One of the most widely used forms of graphic communication is the drawing. Technically, it can be defined as **"a graphic representation of an idea, a concept or an entity which actually or potentially exists in life"**

Drawing is one of the oldest forms of communicating, dating back even farther than verbal communication. The drawing itself is a method of communicating necessary information about an abstract, such as an idea or concept or a graphic representation of some real entity, such as a machine part, house or tools. There are two basic types of drawings: Artistic and Technical drawings.

Technical drawings

Technical drawings allows efficient communication among engineers and can be kept as a record of the planning process. Since a picture is worth a thousand words, a technical drawing is a much more effective tool for engineers than a written plan.

The technical drawing, on the other hand is not subtle, or abstract. It does not require an understanding of its creator, only on understanding of technical drawings. A technical drawing is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept in to reality. Therefore, a technical drawing often contains more than just a graphic representation of its subject. It also contains dimensions, notes and specifications.

Fields of use

Technical drawing is the preferred method of drafting in all engineering fields, including, but not limited to, civil engineering, electrical engineering, mechanical engineering and architecture.

Purpose of studying engineering drawing

- 1 To develop the ability to produce simple engineering drawing and sketches based on current practice
- 2 To develop the skills to read manufacturing and construction drawings used in industry.
- 3 To develop a working knowledge of the layout of plant and equipment.
- 4 To develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators.

Main types of Engineering drawing

Regardless of branch of engineering the engineering drawing is used. However based on the major engineering branches, engineering drawing can be classified as follows: (Fig 2)

Mechanical engineering drawings

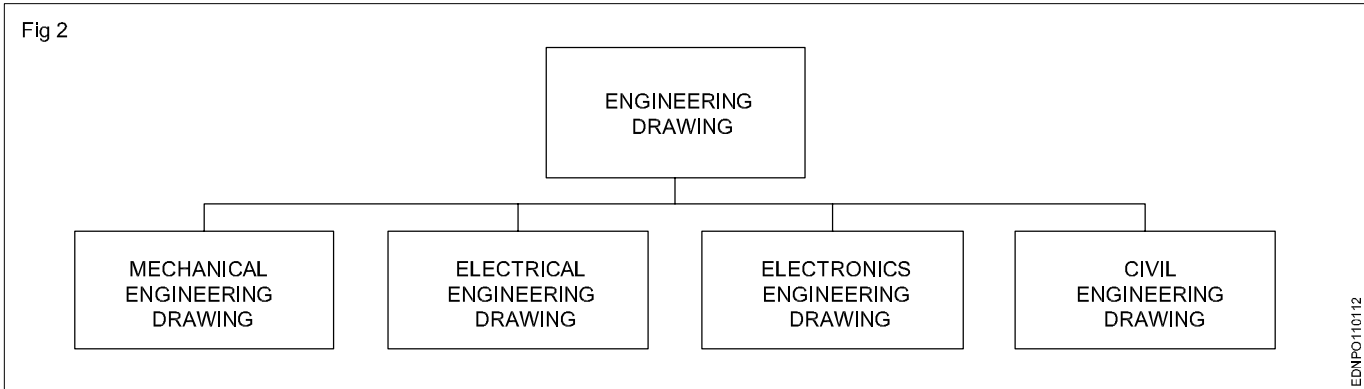
Some examples of mechanical engineering drawings are part and assembly drawings, riveted joints, welded joints, fabrication drawings, pneumatics and hydraulics drawings, pipeline diagrams, keys coupling drawings etc. (Fig 3&4)

Electrical Engineering drawing

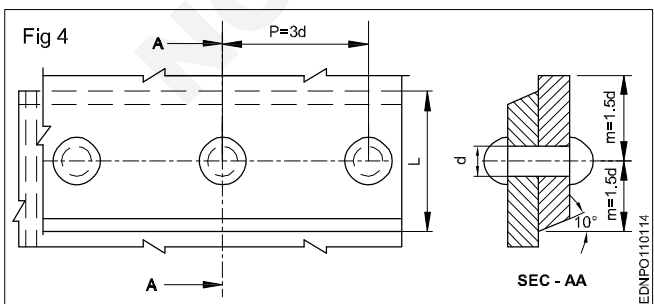
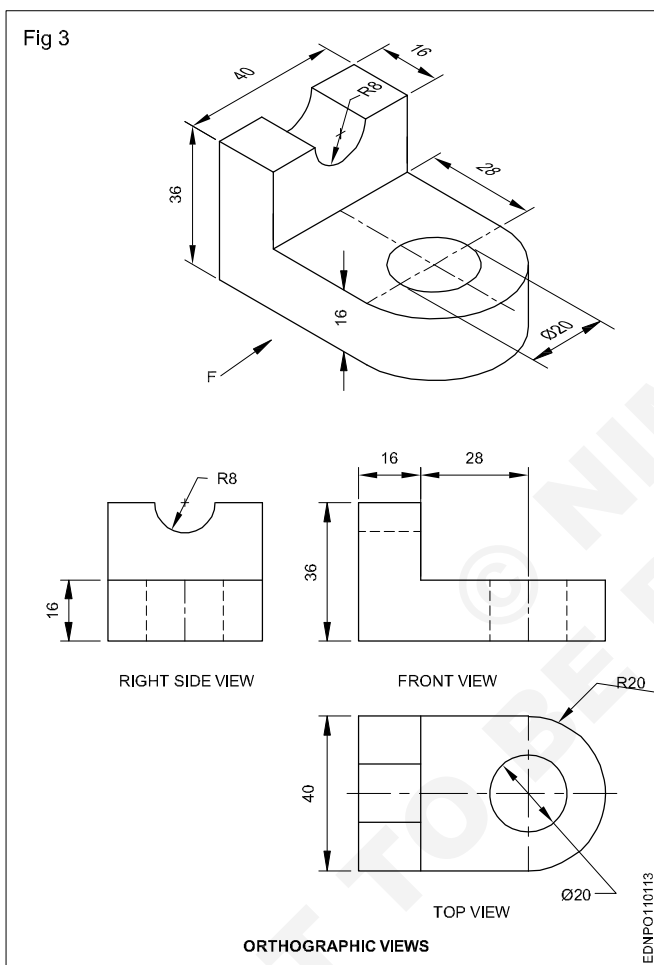
Wiring diagrams of home and industries, circuit diagrams, electrical installation drawings etc.

Example

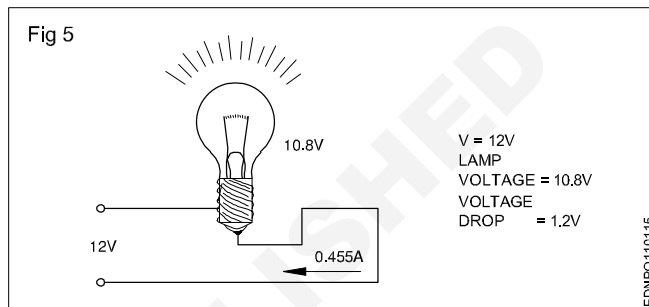
The voltage supply to a filament lamp is 10.8V. The voltage should be 12V. (Fig 5)



Mechanical Engineering drawing (Fig 3 & 4)

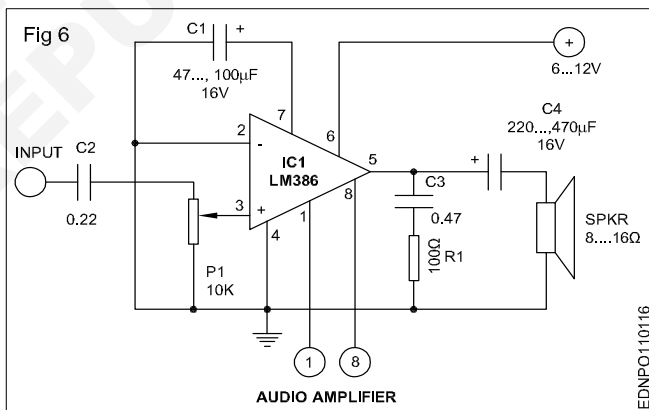


Electrical Engineering drawing (Fig 5)

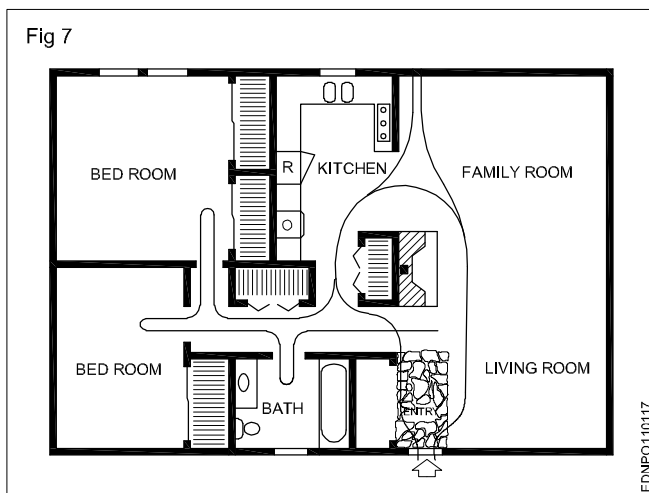


Electronics Engineering drawing

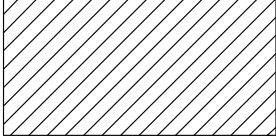
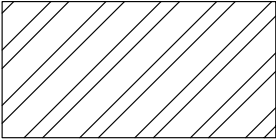
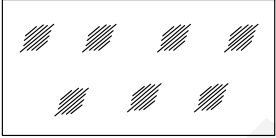
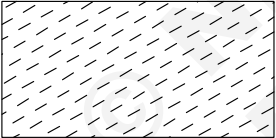
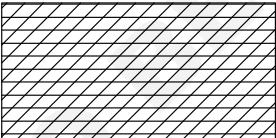
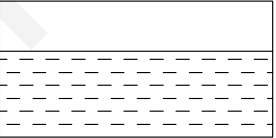
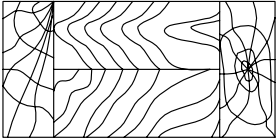
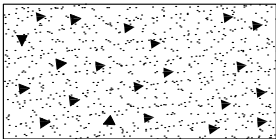
Audio amplifier (Fig 6)



Civil Engineering drawing (Fig 7)



Conventions

TYPE	CONVENTION	MATERIALS
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its alloy, etc
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating materials		Porcelain, Stoneware, Marble, Slate etc
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, insulating & Filling Materials etc
Liquid		Water, Oil, Petrol, Kerosene etc
Wood		Wood, Plywood etc
Concrete		Concrete

Sizes and layout of drawing sheets

Size of drawing sheets (in mm): While being worked on or handled, the drawing sheets are prone to tear along the edges. So slightly larger(untrimmed) sheets are preferred. They are trimmed afterwards. IS:10811:1983 lays down such as designation of preferred trimmed and untrimmed sizes.

Designation of sheets: The drawing sheets are designated by symbols such as A0, A1, A2, A3, A4 and A5. A0 being the largest and A5 is smallest. Table 1 below gives the length and breadth of the above sizes of sheets. (Trimmed and untrimmed)

The relationship between two sides is same as that between a side of a square and its diagonal.

TABLE 1

Designation	Trimmed size	Untrimmed size
A0	841 x 1189	880 x 1230
A1	594 x 841	625 x 880
A2	420 x 594	450 x 625
A3	297 x 420	330 x 450
A4	210 x 297	240 x 330
A5	148 x 210	165 x 240

Special elongated series increasing its widths, double, treble etc. are denoted as follows A3 x 3, A3 x 4, A4 x 3, A4 x 4, A4 x 5. Please refer Table 2.

TABLE 2

Special elongated series

Designation	Size
A3 x 3	420 x 891
A3 x 4	420 x 1189
A4 x 3	297 x 630
A4 x 4	297 x 841
A4 x 5	297 x 1051

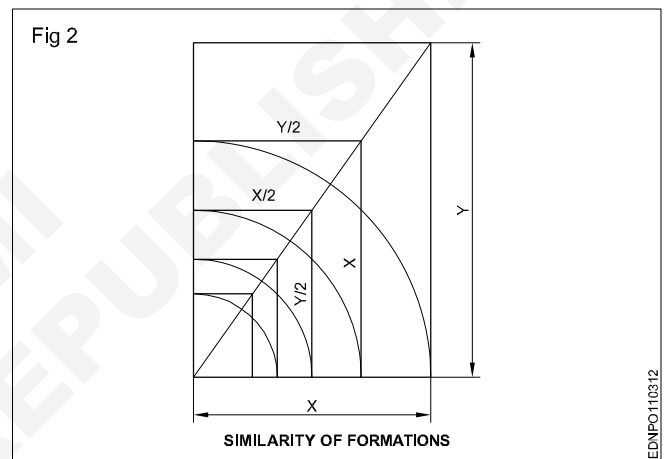
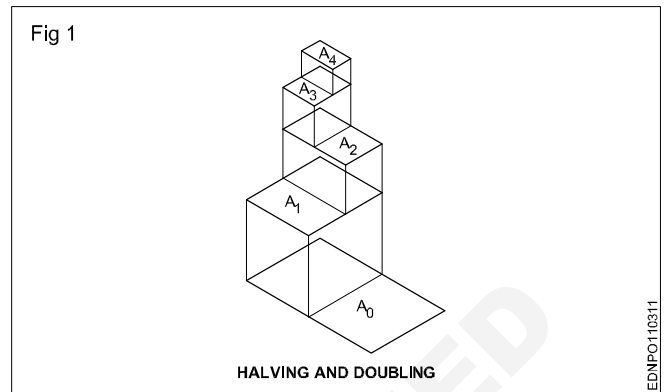
Fig 1 & 2 shows how the sheet sizes are formed by halving/doubling and similarity of format.

White drawing papers that do not turn yellow on exposure to air are used for finished drawings, maps, charts and drawings for photographic reproductions.

For pencil layouts and working drawings, cream-coloured papers are best suited.

Quality drawing paper: The drawing papers should have sufficient teeth or grain to take the pencil lines and withstand repeated erasing.

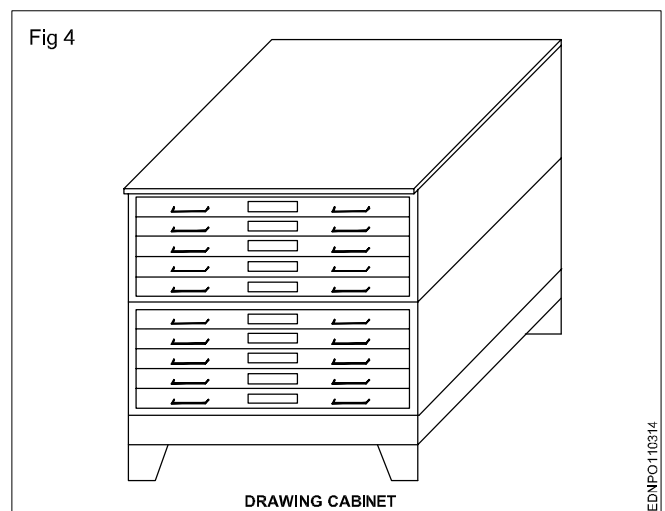
To get uniform lines, backing paper is to be placed on the drawing board before fixing drawing/tracing paper,. Before starting the drawing, the layout should be drawn. (Ref: IS:10711)



The following is the method of folding printed drawing sheets as recommended by BIS. (Fig 3)

Method of folding of printed drawing sheets as per BIS SP: 46-2003

When drawings sheets are in more numbers, they have to be folded and kept in order to save the trace required for preserving them (Fig 4).

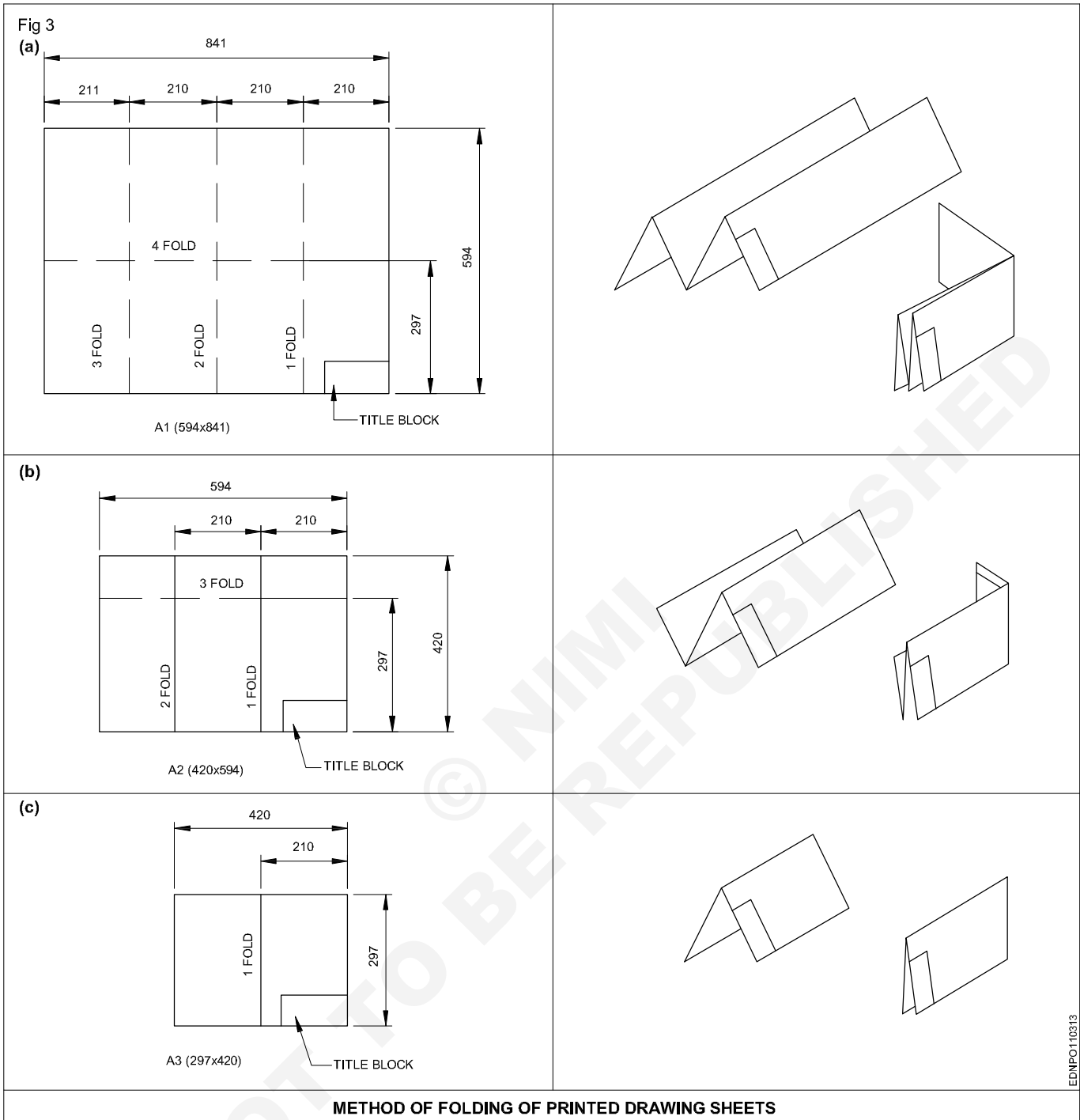


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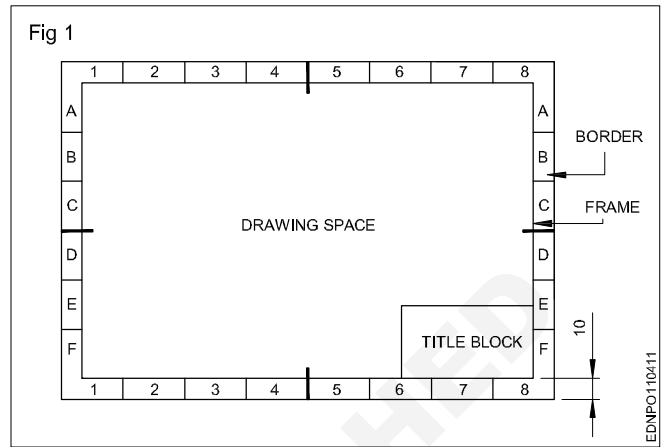
Method of folding printed drawing sheets (Fig 3)



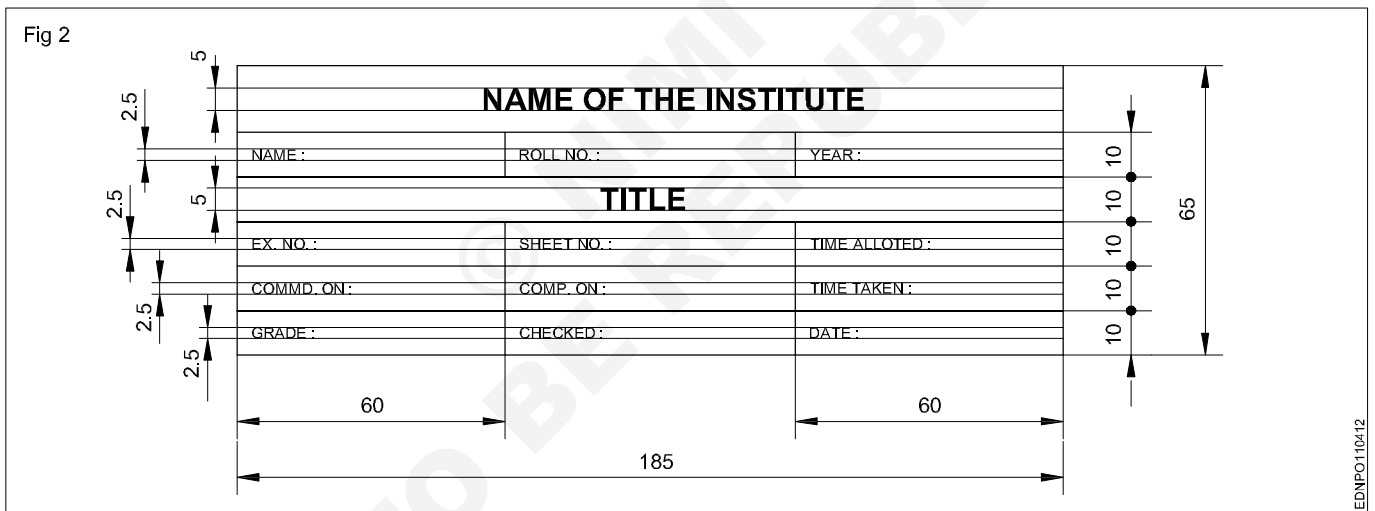
Title block, its position and content

Layout of drawing sheet

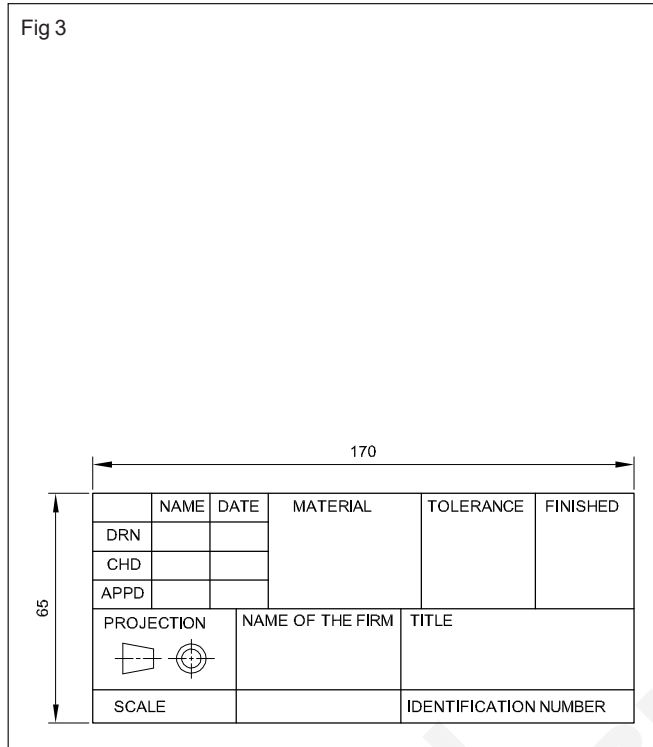
As a standard practice, sufficient margins are to be provided on all sides of the drawing sheet. The drawing sheet should have drawing space and title space. A typical layout of a drawing sheet is shown in the (Fig 1 & 2).



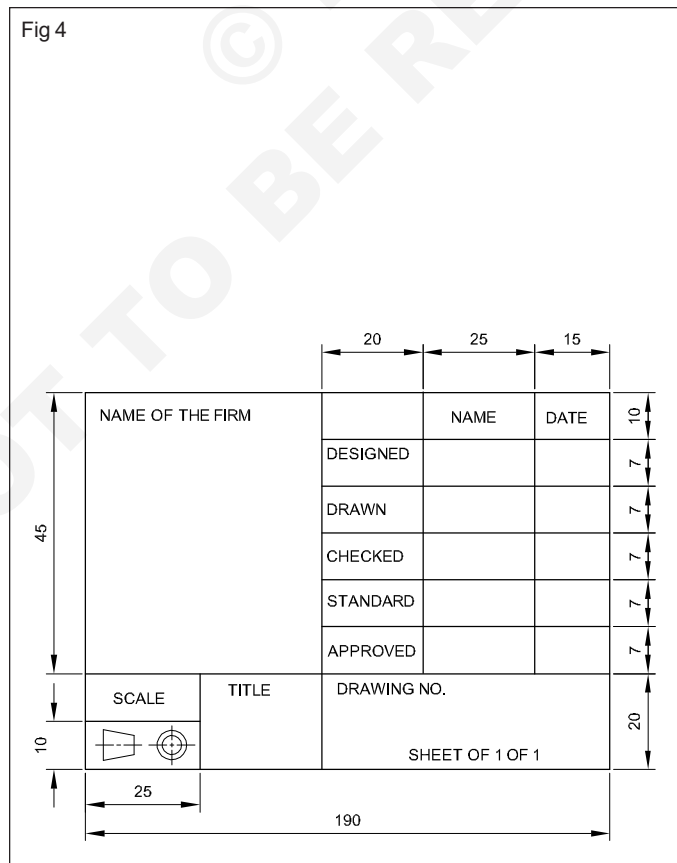
Title Block - 1



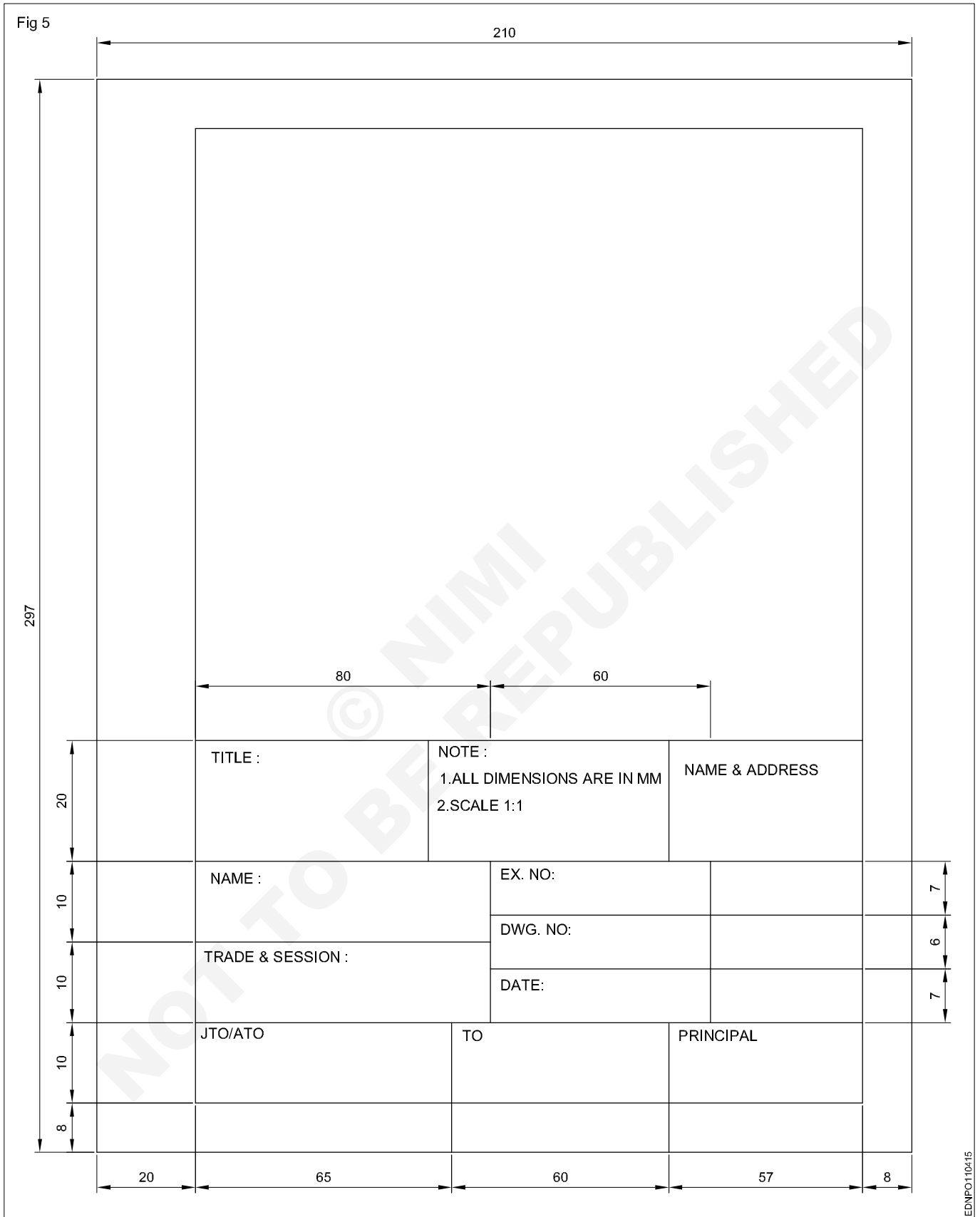
Title Block - 2



Title Block - 3



Title Block - Position and content - 1



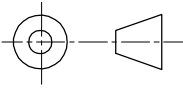
Title Block - Position and content - 2

Fig 6

DO NOT SCALE

REVISION			
SL.N	DESCRIPTION	DATE	APPX
A	M12 WAS ½ WHIT.	14.12.18	A.W.D

4			
3			
2			
1	A7325	VALVE BODY	1
DRG OR PART NO.	DESCRIPTION	QTY.	

UNLES OTHERWISE STATED ALL DIMENSIONS IN MILLIMETRES. TOLERANCES LINEAR: ANGULAR:		DRN	1:1:78	JKL	(NAME OD THE FIRM)
		CKD	2:1:78	MLN	
(TITLE OF DRW.)					
MATERIAL : CAST STEEL					
DRAFTING STANDARD AS 1100	FINISH AS MACHINED	ISSUED	4:2:78	PFP	SIZE A3
					DRG NO A24641
					SHEET 1 OF 1

EDNPO110416

Item Reference on Drawing Sheet

05	TIGHTENING PIN	01	MILD STEEL	
04	WORKPIECE	01	ANY MATL.	
03	SCREW ROD	01	STD.	
02	"U" CLAMP	01	CAST IRON	
01	"V" BLOCK	01	CAST IRON	
PART NO	DESCRIPTION OF ITEM	QTY/ASSY	MATERIAL	REMARKS
BILL OF MATERIALS				

The drawing sheet on which the drawings to be prepared should be prepared first by following the procedure given below:

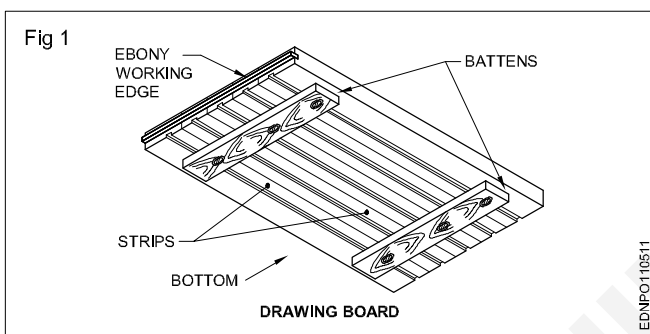
- 1 Take A4/A3 drawing sheet.
- 2 Mark the borders and draw the title block as mentioned.

- 3 Follow the same procedure for A3 drawing sheet where the title block is to be drawn right side bottom corner and the border dimensions remain same.
- 4 Title block to be drawn whenever the title of the drawing changes. Eg. for the geometrical construction chapter the title block may be drawn in the first sheet only where as on the remaining sheets borders to be drawn before they are used for preparing drawings.

Drawing instruments

The following are the commonly used equipment in a drawing office.

Drawing board (Fig 1): Drawing board is one of the main pieces of equipment for Draughtsman. It is used for supporting the drawing paper/tracing paper for making drawings. It is made of well-seasoned wood strips of about 25 mm thick or masonite, free from knots and warping. It should be softer enough to allow insertion and removal of drawing pins. Two battens are fastened to the board by screws, in slotted joints. They prevent warping and at the same time permit expansion and contraction of the strips due to the change of moisture in the atmosphere.



One of the shorter edges of the drawing board is provided with an "ebony edge" (hardwood) fitted perfectly straight.

Standard drawing boards are designated as follows as per IS:1444-1989.

Sl. No.	Designation	Size (mm)
1	D0	1500 x 1000 x 25
2	D1	1000 x 700 x 25
3	D2	700 x 500 x 15
4	D3	500 x 350 x 15

The working edge (ebony) must be straight.

Now-a-days drawing boards are available with laminated surfaces. The flatness can be checked by placing a straight edge on its surface. If no light passes between them, the surface is perfectly flat.

'T' Square: It is of 'T' shape, made of well-seasoned wood. It has two parts., head/stock and blade. One of the edges of the blade is the working edge. The blade is screwed to this head such that the working edge is at a right angle to the head. (Fig 2a)

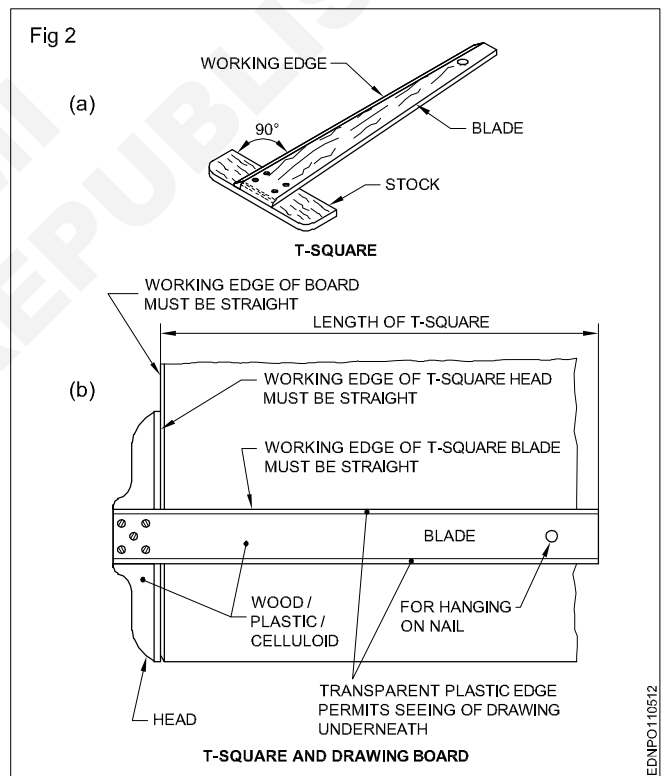
The standard 'T' square is designated as follows with dimensions shown in mm; as per IS:1360-1989.

Sl. No.	Designation	Blade length
1	T0	1500
2	T1	1000
3	T2	700
4	T3	500

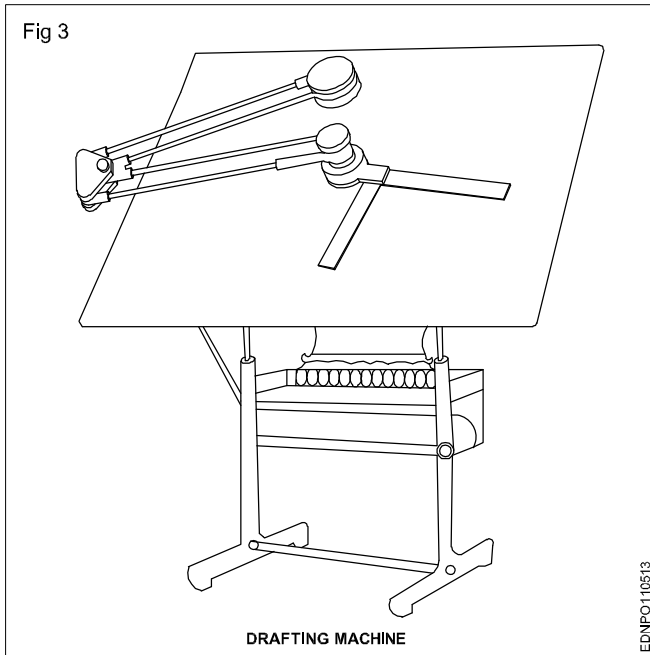
The 'T' square is used with its head against the ebony edge of the drawing board to draw horizontal lines, and parallel lines and to guide/hold the set squares, stencils etc.

Fig 2b shows how the 'T' square is used.

'T' square should never be used as a hammer or as a guide for trimming papers.



Drafting in the machine (Fig 3): It serves the functions of a Tee square, set square, protractor and scale. They come in different sizes and have a pattern called the 'Pantograph' type. It is fitted on the top left side, edge of the drafting board, mounted on an adjustable frame or table. It requires a large area of working place. The angle of the drafting board can be adjusted by the pedal operating system. There are two counterweights to balance the angular position of the board and the drafting head. It is more suitable for the production drawing office.



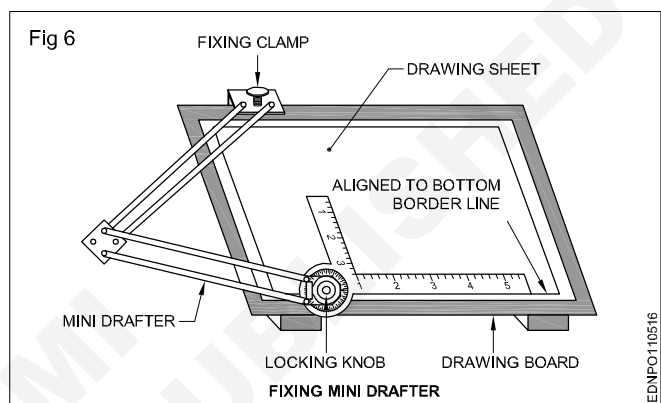
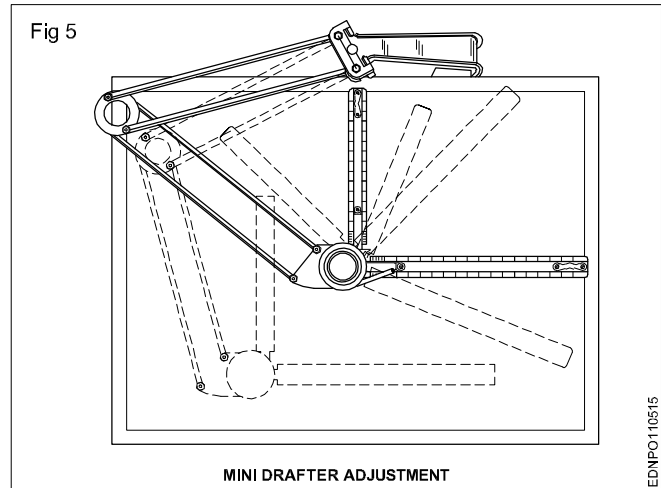
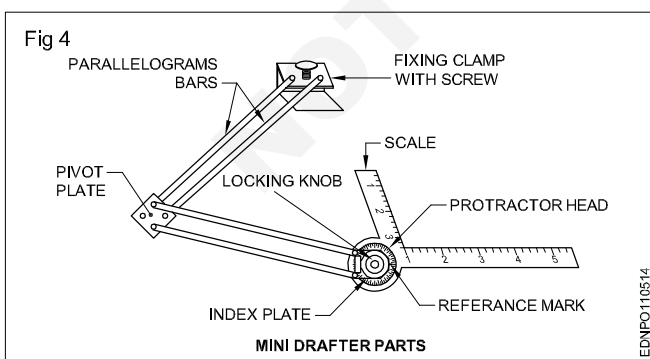
On the other end, a protractor head H with swivelling and locking arrangement is fitted with two scales at right angles.

The protractor head has a spring-loaded clutch relieving handle, which rotates and locks at 15° intervals automatically. For setting any angle other than multiples of 15°, the clutch spring is released and by rotating the centre knob, the zero line is set to the required angle and the friction clutch knob is tightened. It is capable of rotating 180°, thereby any angle can be set.

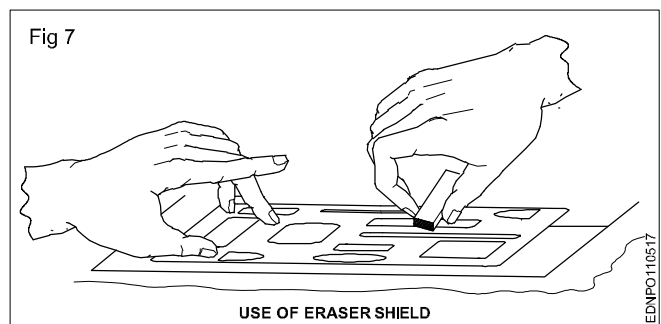
The scales are bevelled on both sides, graduates to 1:1 & 1:2. They can be reversed with the help of dovetail slide fitting.

There is a fine adjusting mechanism on the drafting head to set the scale parallel to the edge of the board. The scales also can be adjusted if there is an error in measuring 90° between them.

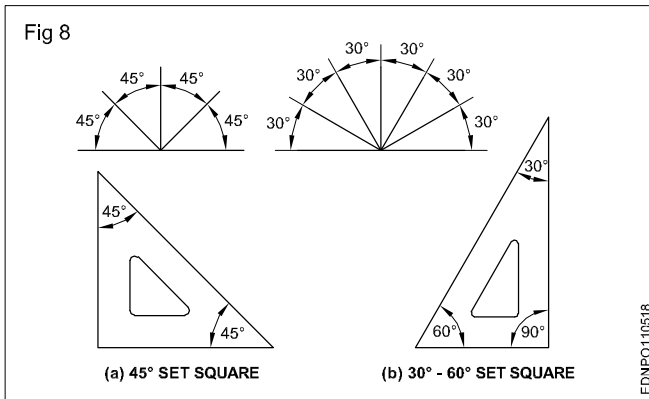
The mini drafter is an important device used for making drawing quickly & accurately. This instrument has the combination of T-square, set square, protractor and scales, it helps to draw the drawings at a faster rate. (Fig 4,5 & 6)



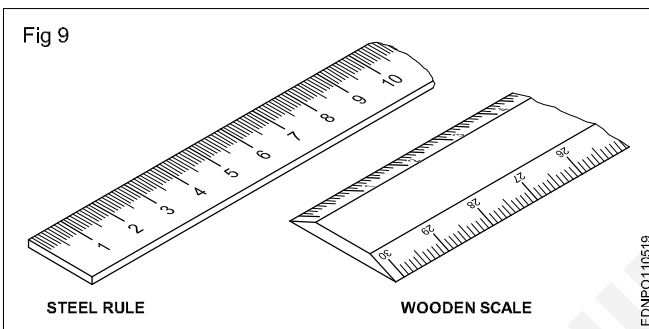
Erasing shield: When, on a drawing, if a part of a line or some lines among many other lines needs to be erased or modified, in a normal way erasing will damage the other nearby lines. In such a situation an erasing shield is effectively useful. It is a thin metallic sheet having small openings of different sizes and shapes. A suitable opening is aligned to the line to be erased and the line is removed by the eraser. (Fig 7)



Set square (IS:1361-1988): Transparent celluloid /Plastic set squares are preferred and are commonly used rather than ebonite ones. They are two in number, each having one corner with 90°. The set square with 60° & 30° of 250 mm long and 45° of 200mm long is convenient for use. (Fig 8)



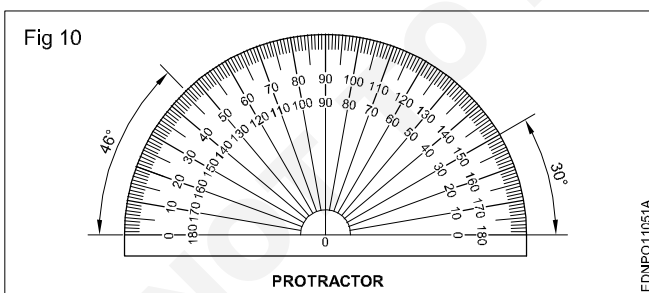
Scales: Scales are used to transfer and or measure the dimensions. They are made of wood, steel, ivory, celluloid or plastic, stainless steel scales are more durable. different types of scales used are shown in Fig 9. They are either flat, bevel-edged or triangular cross-sections. Scales of 15cm long, 2cm wide or 30cm long 3.5cm wide are in general use.



Protractor: A protractor is an instrument for measuring angles. It is semi-circular or circular and is made of a flat celluloid sheet.

The angles can be set or measured from both sides, aligning the reference line and point '0' with the corner point of the angle.

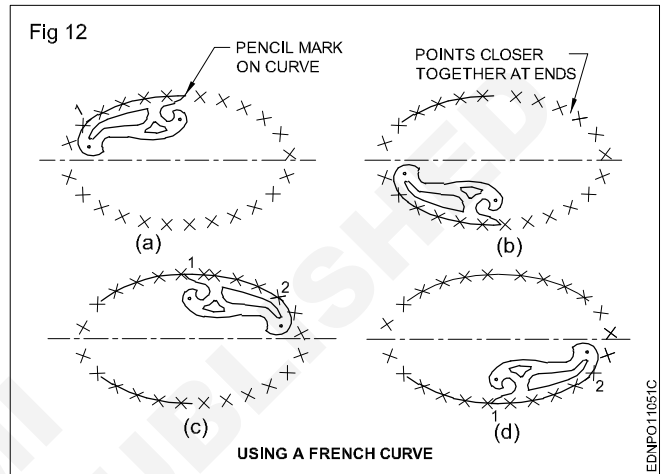
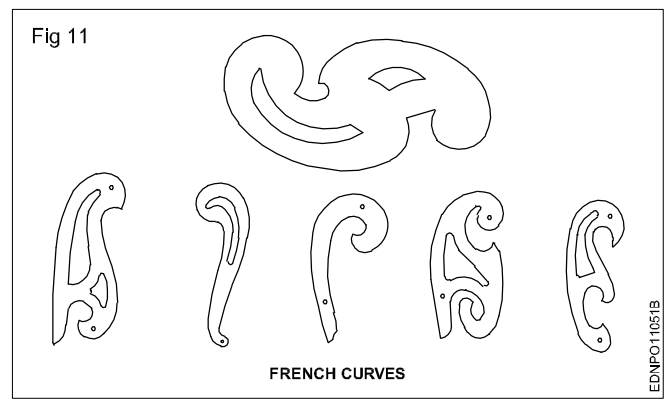
Figure 10 shows how to read or set the angle. A protractor can also be used to divide a circle or draw sectors.



French curves (Fig 11)

These are made in many different shapes, normally come in sets of 6, 12, 16 etc. French curves are best suited to draw smooth curves/arcs (which cannot be drawn by a compass) with ease. To draw a smooth curve using a french curve first set it by trial against a part of the line to be drawn, then shift it to the next portions.

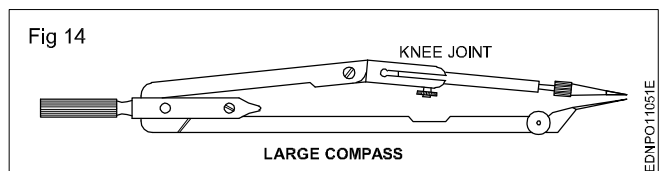
Fig 12 shows how to use the french curve and draw smooth curves. They are made of transparent celluloid (no bevel edge).



An instrument box contains the following: (Fig 13a to h)

- Large compass (with attachment facility) (a)
- Large divider (b)
- Bow compasses(pencil/ink), bow divider (c)
- Lengthening bar (d)
- Pen point for attachment (e)
- Screwdriver (f)
- Lead case (g)
- Liner (h)

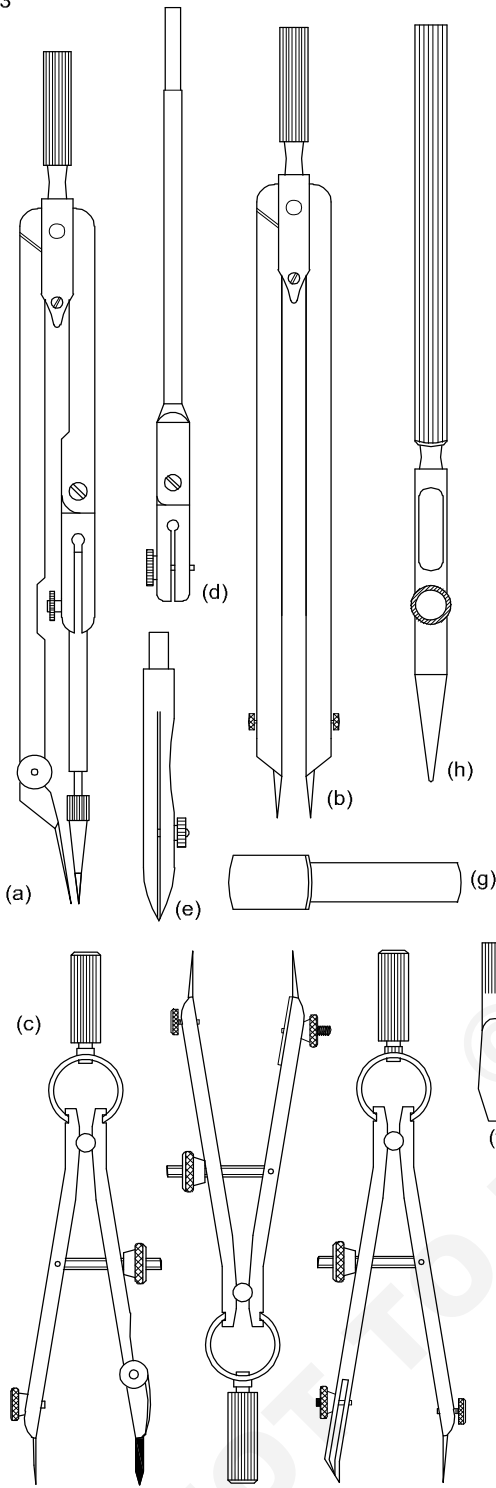
Large compass (Fig 14): It has a knee joint in one leg that permits the insertion of a pen or pencil point or attaching a lengthening bar with a pen or pencil point attached to it. It is used for drawing large circles/arcs and also for taking large measurements.



As a rule, while drawing concentric circles, small circles should be drawn first before the centre hole gets worn.

Large divider: It is used to transfer dimensions and divide lines into several equal parts. Divider with adjustable joints is preferable rather than plain legs. (Fig 15)

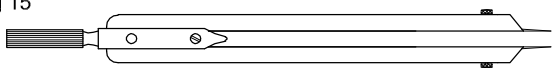
Fig 13



DRAWING INSTRUMENTS

EDNPO11051D

Fig 15



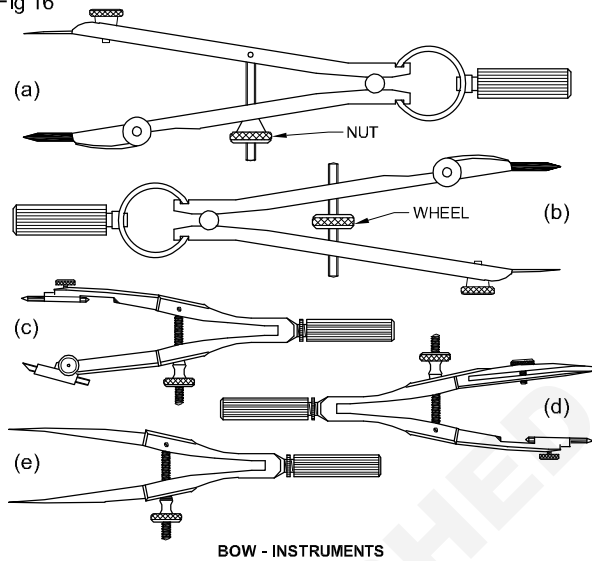
DIVIDER

EDNPO11051F

Bow instruments: Bow pencil and bow pen compass are used for drawing circles of approximately 25 mm radius. A bow divider is used for marking or dividing smaller spaces. There are two types (i) Integral legs with spring action (16e) (ii) two legs are held with a curved spring on top with a handle on it.

Fig 16 shows different types of bow instruments. Adjustments should be made with the thumb and middle finger.

Fig 16

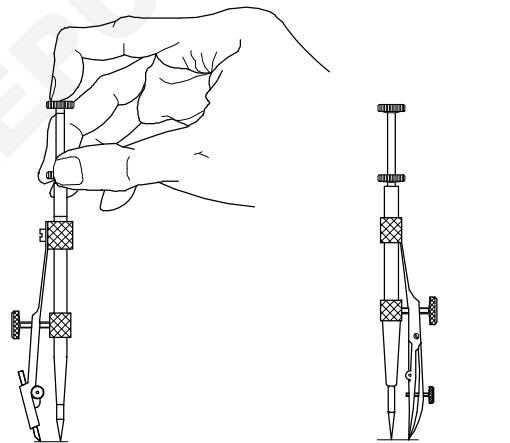


BOW - INSTRUMENTS

EDNPO11051G

Drop spring bow pencil and pen (Fig 17): Drop spring bow pencil and pen are designed for drawing multiple identical small circles. Example: rivet holes, drilled/reamed holes. The central pin is made to move freely up and down through the tube attached to the pen or pencil unit.

Fig 17



DROP SPRING BOW PENCIL

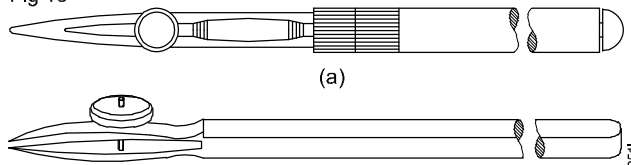
DROP SPRING BOW PEN

DROP SPRING BOW INSTRUMENT

EDNPO11051H

Inking pen or liner or ruling pen (Fig 18): It is used to ink the straight lines drawn with the instruments but never for freehand lines or lettering.

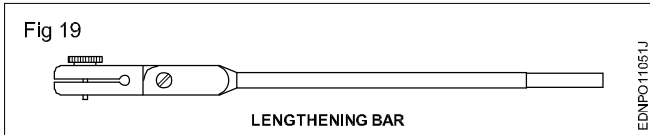
Fig 18



RULING PENS

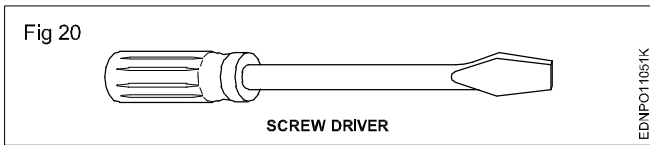
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Lengthening bar (Fig 19): To draw larger circles, it is fitted to the compass. The pencil point or pen point is inserted into its end.

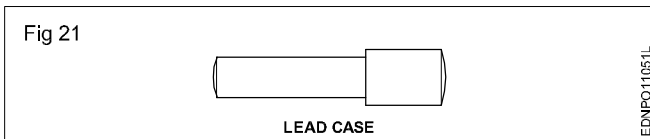


Replaceable spare pencils, pens and needle points for the compass are available in the instrument box.

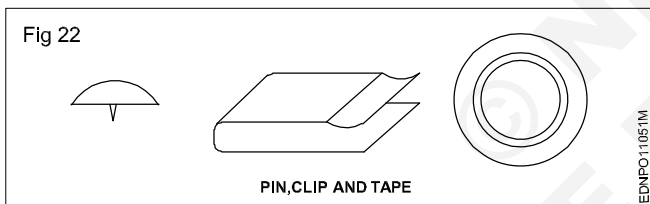
Screwdriver (Fig 20): Used for adjusting the screws of the instruments.



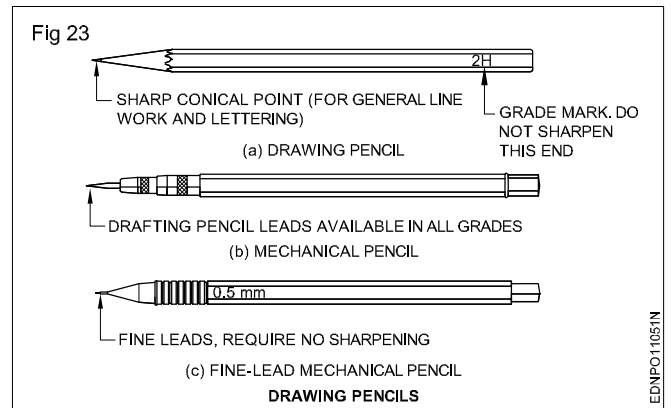
Lead case (Fig 21): Lead case is the box for holding the pencil leads.



Pin, Clip, Cello tape: Drawing sheet should be fastened onto the drawing board firmly temporarily so that it does not shake during preparing the drawing. For this purpose, the pins, clips and cello tapes are used (Fig 22)



Pencils, Grade and Selection (Fig 23)



Grades of pencils: Pencils are graded according to the hardness or softness of the lead.

The hardest pencil is 9H grade and the softest pencil is 7B grade. The selection of the grade of pencils depends on the type of line work required and the paper on which it is used.

Softer lead pencils are used to produce thicker and darker line work, but they wear out quickly. Medium grades of H and 2H are used for general line work as well as for lettering.

Selection of pencils: Pencil grades vary from one brand to another brand. Select the grades of the pencil depending upon the type of line work. For construction lines, you can choose 2H or 3H, for lettering and object lines grade H pencils. In general H, HB and 2H are used.

H - medium-hard

HB - medium-soft

2H - hard

Now-a-days automatic (Mechanical) pencils or clutch pencils are available in different sizes (lead dia. 0.3, 0.5, 0.7 or 0.9). Leads can be replaced as per the required grade of hardness. They produce lines of uniform width without sharpening.

Free hand drawing of - Geometrical figures and blocks with dimension





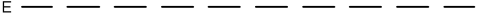





Lines - Types and applications in drawing

Drawings are made up of different types of lines. Just a language with alphabet and grammar.

Lines of different thicknesses and features are used for specific use.

Technical drawings are drawn with different types of lines. By proper choice and application of lines, product features can be correctly defined in a drawing. Different types of lines recommended for specific applications are given in Table 1.

Table 1
Types of lines and their application

Lines	Description	General applications See figure and other relevant figure
A  0.5	Continuous thick	A1 Visible outlines A2 Visible edges
B  0.2	Continuous thin (straight)	B1 Imaginary lines of intersection B2 Dimension lines B3 projection lines or extension line B4 Leader lines B5 Hatching B6 Outlines of revolved sections in place B7 Short centre lines B8 Thread line B9 Diagonal line
C  0.2	Continuous thin free hand	C1 Limits of partial or interrupted views & sections, if the limit is not a chain thin
D  0.2	Continuous thin (Straight) with zig-zags	D1 Line (See figures)
E  0.3	Dashed thick	E1 Hidden outlines E2 Hidden edges
F  0.2	Dashed thin	F1 Hidden outlines F2 Hidden edges
G  0.2	Chain thin	G1 Centre lines G2 Lines of symmetry G3 Trajectories
H  0.3	Chain thin, thick at ends & changes of direction	H1 Cutting planes
J  0.5	Chain thick	J1 Indication of lines or surfaces to which a special requirement applies
K  0.2	Chain thin double-dashed	K1 Outlines of adjacent parts K2 Alternative and extreme positions of movable parts K3 Centroidal lines K4 Initial outlines prior to forming K5 Parts situated in front of the cutting plane

1 This type of line is suited for production of drawings by machines.
2 Although two alternatives are available, it is recommended that on any one drawing, only one type of line be used.

In the above range, for craftsmen, 0.5 is preferred. This Table shows the 0.5 line range and other lines under this range.

The numbers on the right side of the lines refer to the line thickness in mm.

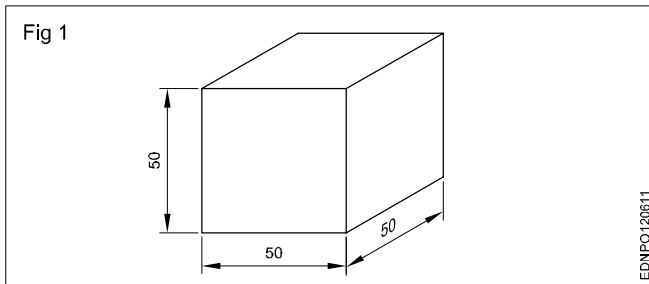
Geometrical figures and blocks with dimension

Freehand sketching: Apart from making drawing using instruments, often craftsmen will be required to make drawings with their free hand.

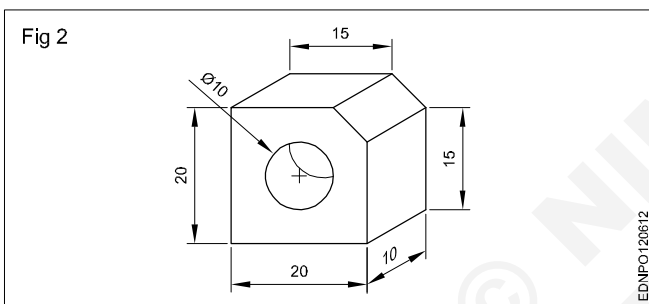
Freehand sketching is the easiest method to express the shape of a piece part or a component by an engineer or craftsman.

Freehand sketches are not usually made to scale. However, they should be as nearly to the proportions as possible.

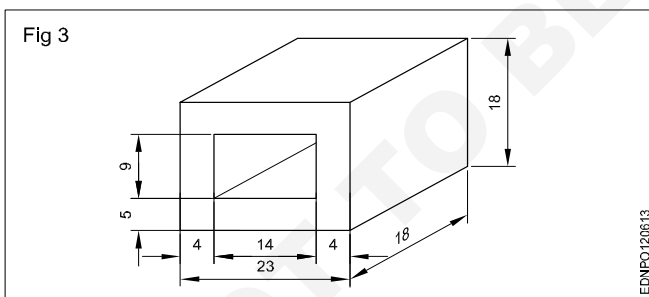
Cube (Fig 1)



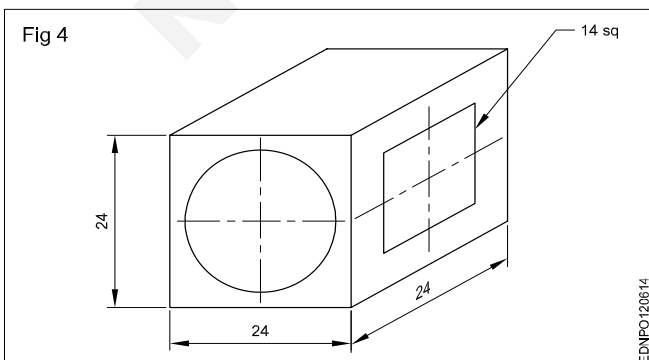
Square block (Fig 2)



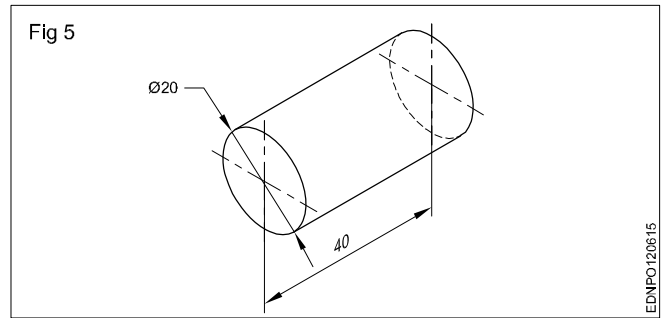
Rectangular block (Fig 3)



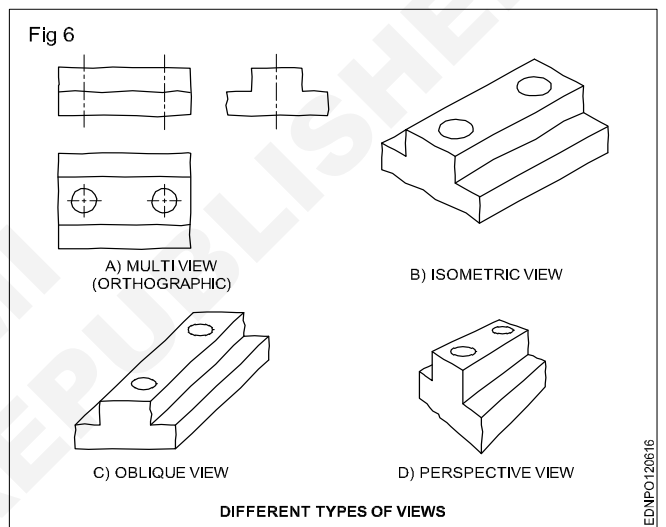
Cube block (Fig 4)



Cylinder (Fig 5)



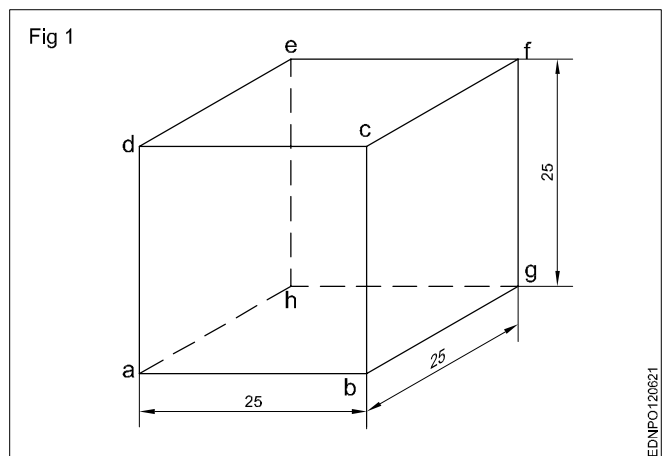
Materials for free hand sketching: (Fig 6) A4 size sheet (preferably a pad instead of loose papers) pencils of soft grade. Example H, HB, and a good quality eraser are the only materials required. For drawing different darkness, the pencil points should be sharpened to a conical shape.



Procedure

Freehand drawing of solid figures, cubes, cuboids, cone, prism, pyramid, frustum of a cone with dimensions

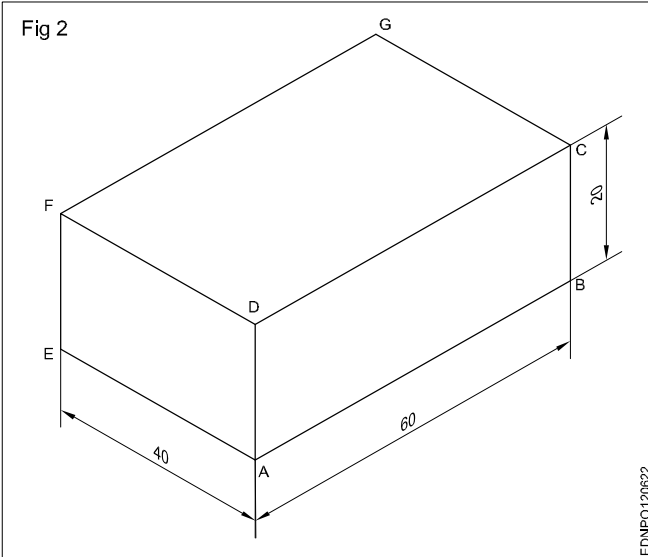
Cube (Fig 1)



- Draw squares of a, b, c and d.
- Draw 30° from points b, c and d for the length of 25mm.
- Mark point g from b, f from c and e from d as shown in the figure.
- Joint all points.

Cuboid (Fig 2)

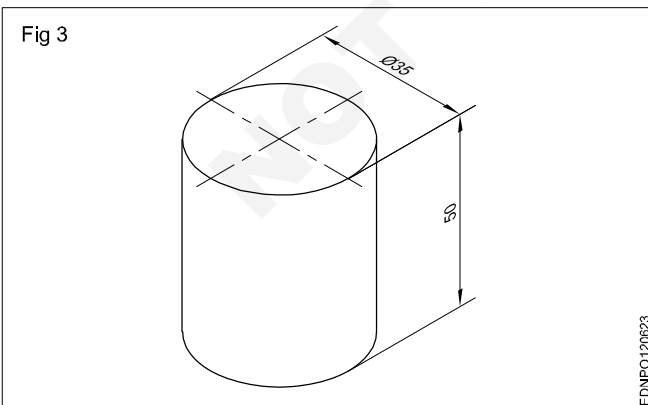
Draw the isometric drawing of a cuboid of base 60 mm x 40 mm and the height of 20 mm. (Fig 2)



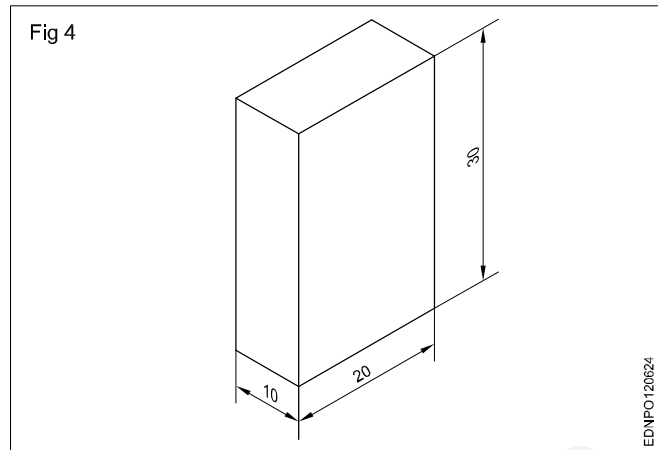
Draw the three isometric axes through the point 'A'.

- Mark $AB = 60\text{mm}$, $AE = 40\text{mm}$ and $AD = 20\text{mm}$ representing the three sides of cuboid.
- Draw two vertical lines EF and BC parallel to AD from points E and B respectively.
- Similarly, draw two more lines parallel to AB and AE to mark G 's interesting point from F and C .
- Draw lines parallel to DC and FG Draw lines parallel to DF and GC .
- Join all the points.

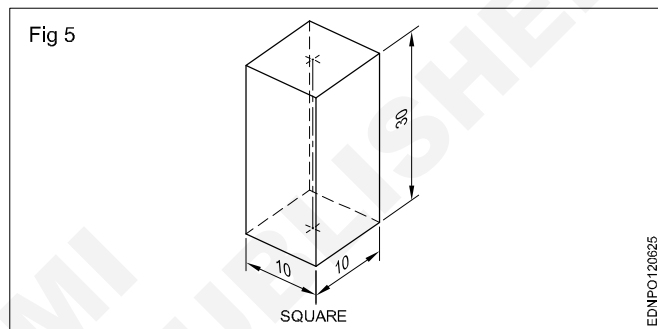
Cylinder (Fig 3)



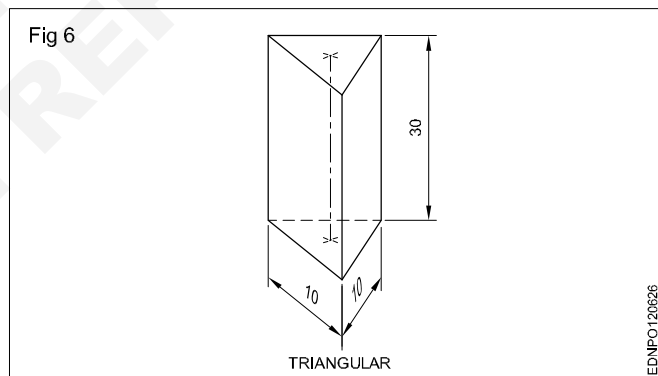
Rectangular prism (Fig 4)



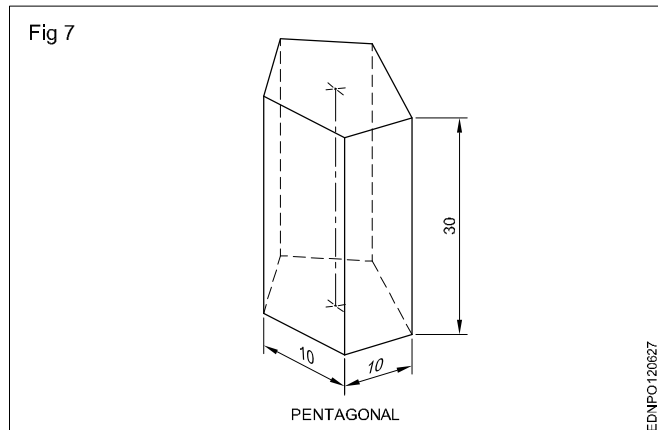
Square Prism (Fig 5)



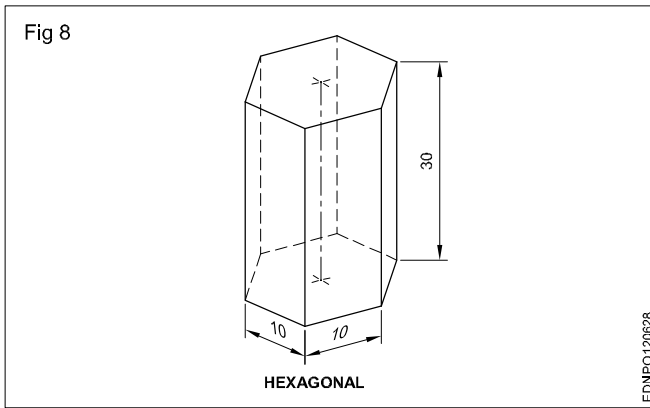
Triangular Prism (Fig 6)



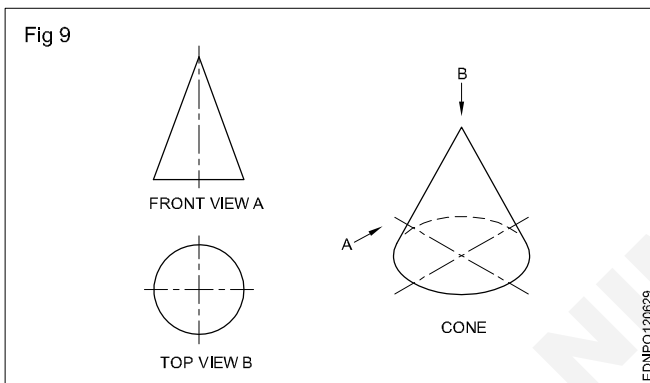
Pentagonal prism (Fig 7)



Hexagonal prism (Fig 8)



Cone: When a right-angled triangle revolves about one of its sides forming the right angle, a cone is generated. Cone forming has a circular face and a slant curved surface. (Fig 9)



Pyramids: Pyramids are polyhedron solids having a base surface whose shape may be triangular, square or polygon and as many slant triangular faces as there are sides in the base. All the slant triangular faces join at a common point called APEX.

Similar to prisms, pyramids also are known by the shape of their base viz triangular, square, rectangular, pentagonal, hexagonal etc. The imaginary line joining the centre of the base to the apex is called the AXIS.

Fig 10 shows some pyramids and their views.

When a semi-circle revolves about its diameter a sphere is generated. A sphere has no flat surface. (Fig 11D)

Frustums: Pyramid/cone is cut parallel to the base and the top portion is removed. The remaining bottom portion is called the frustum of a pyramid/cone.

If the cutting plane is at an angle to the axis/base, the pyramids or cones are called "Truncated pyramids or cones".

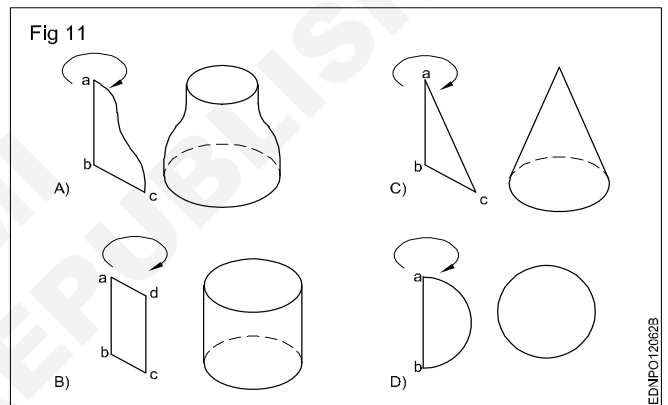
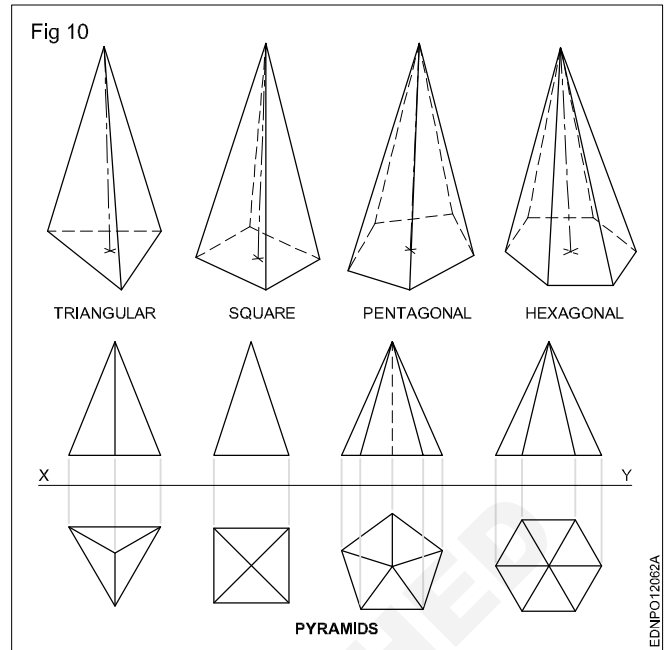
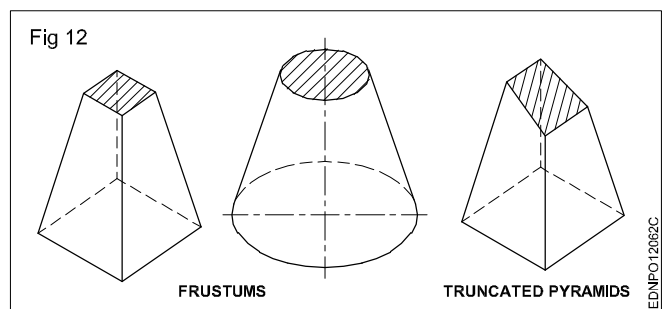
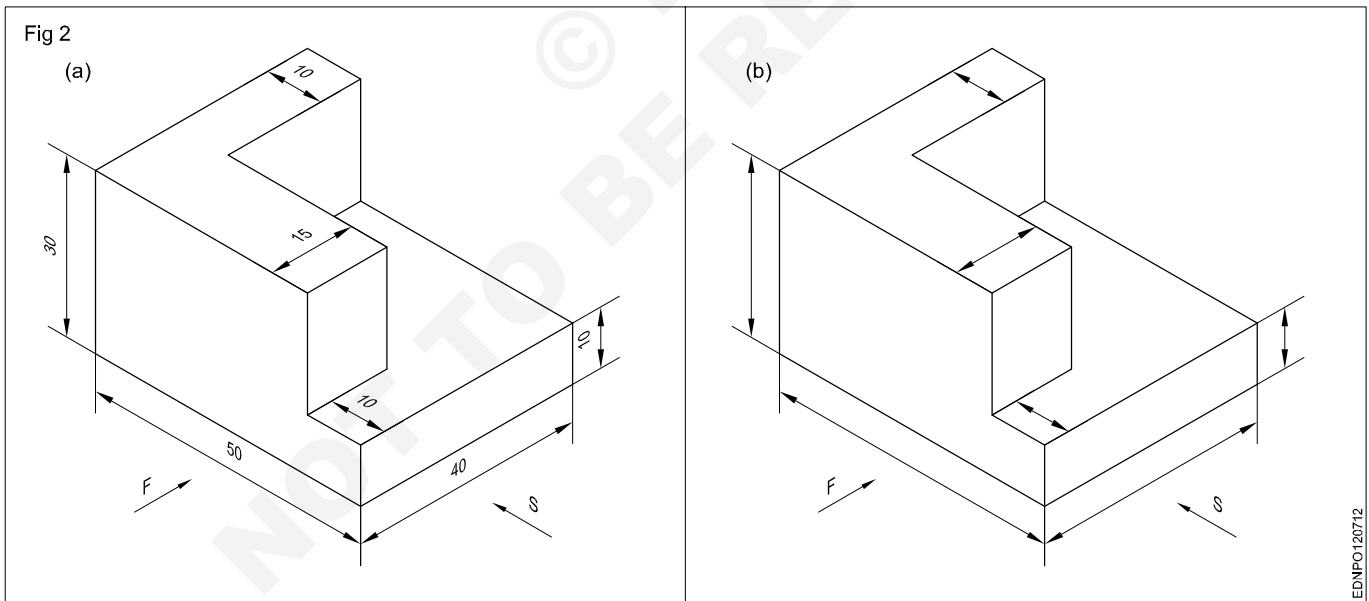
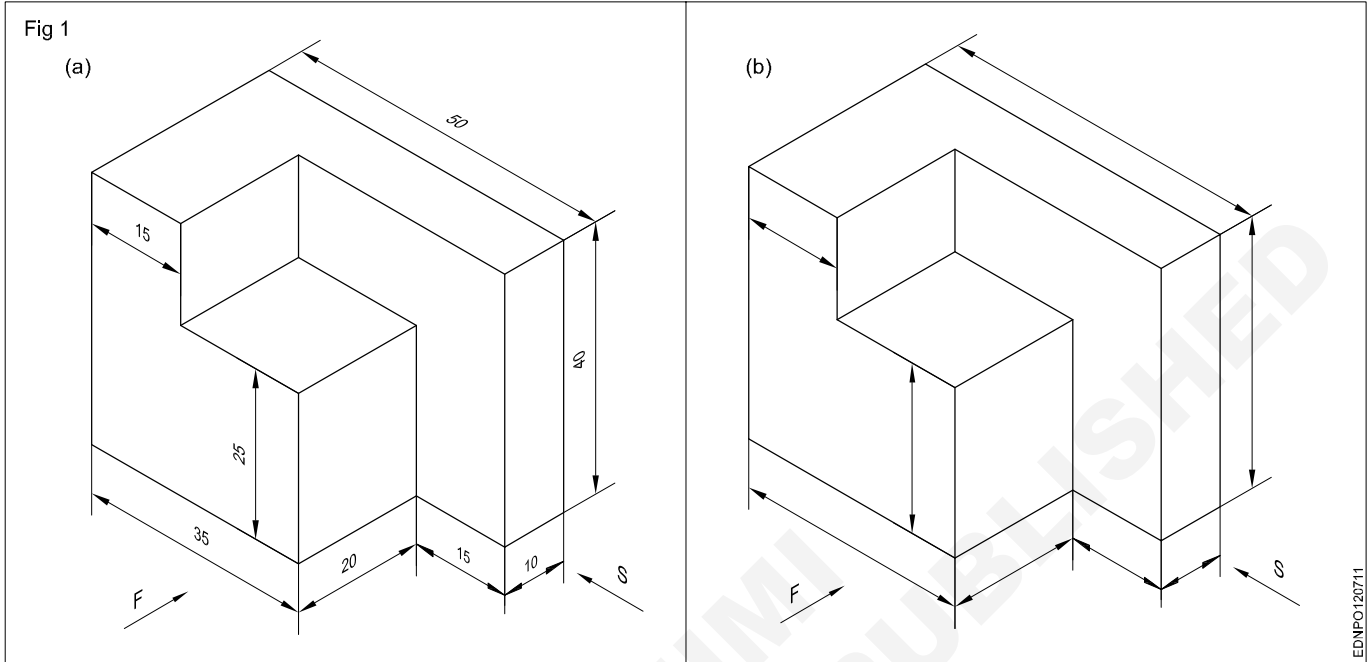
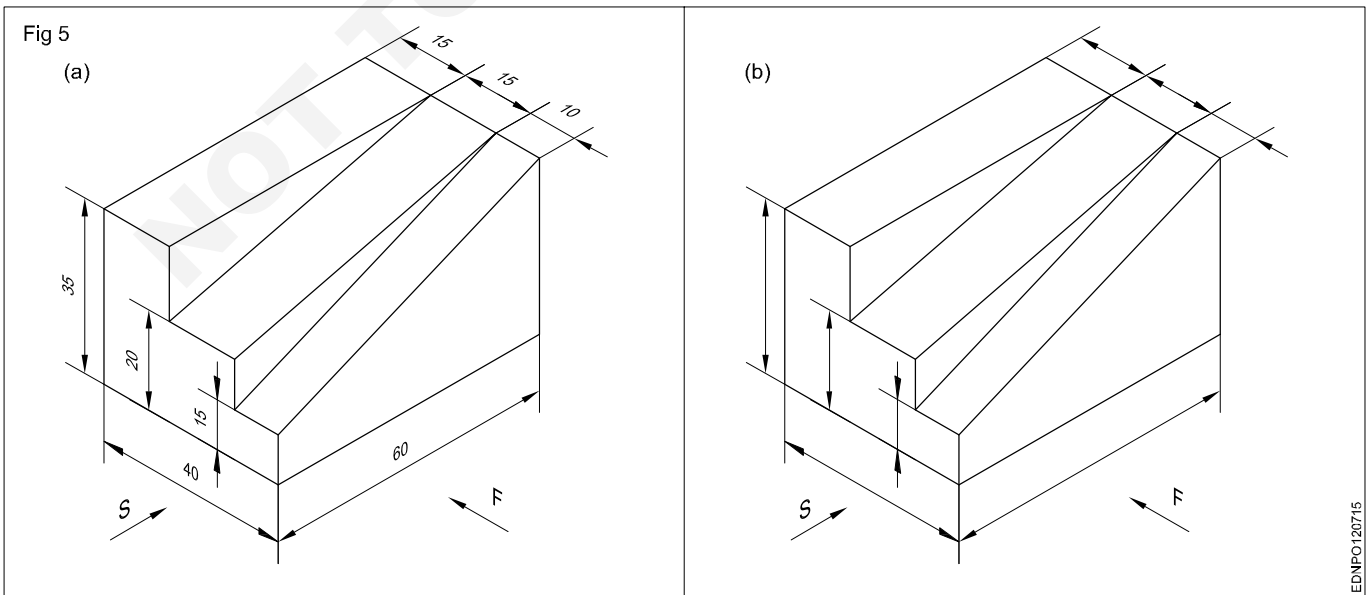
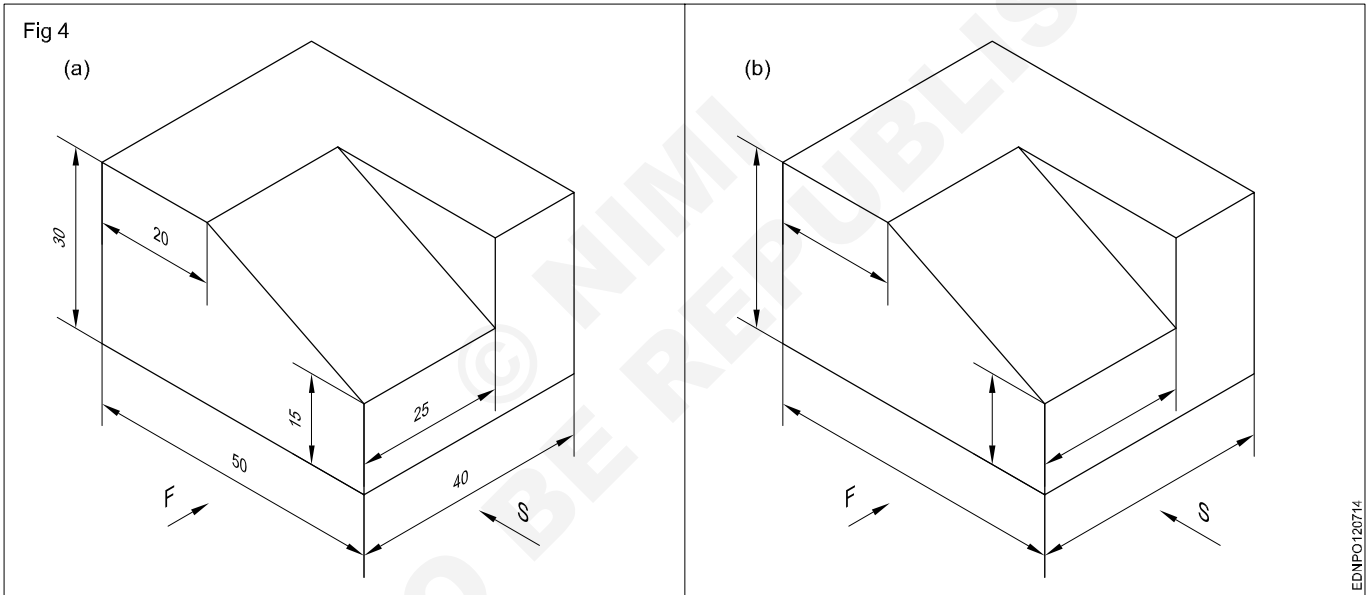
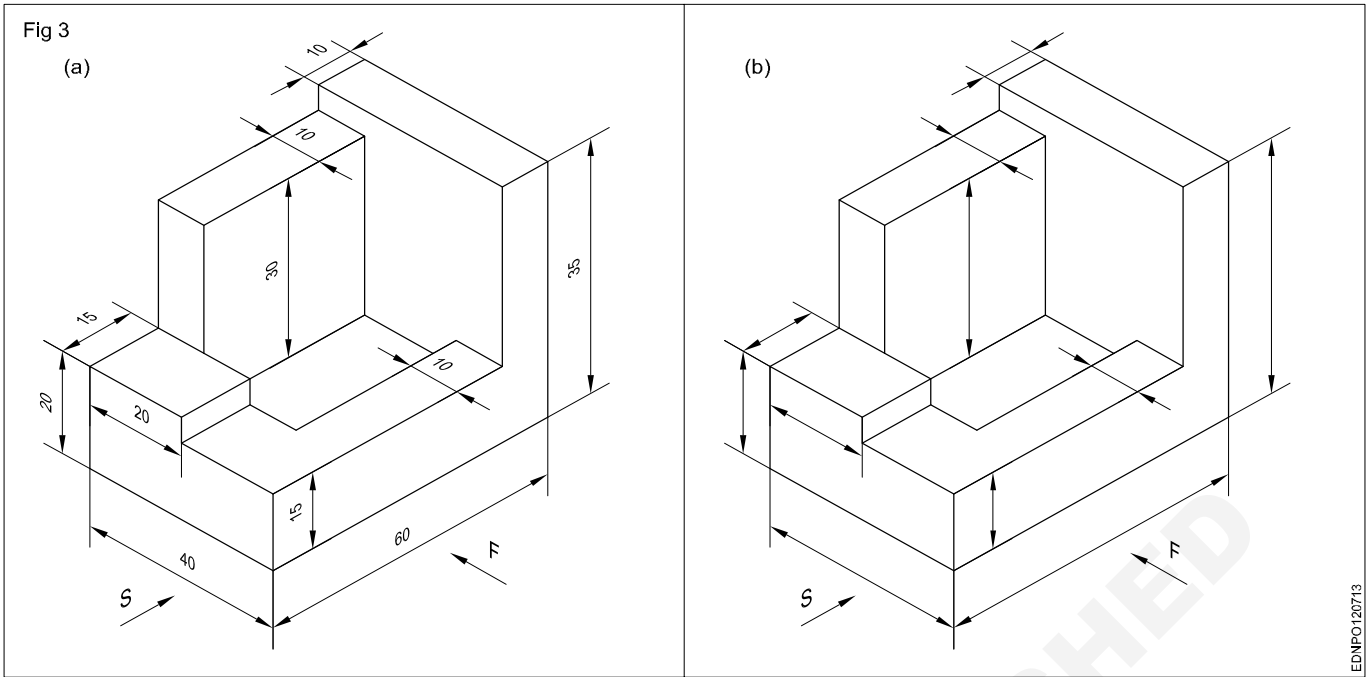


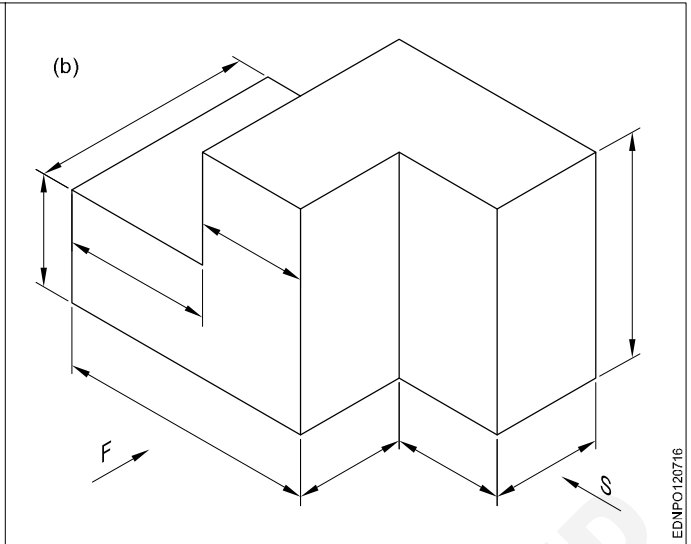
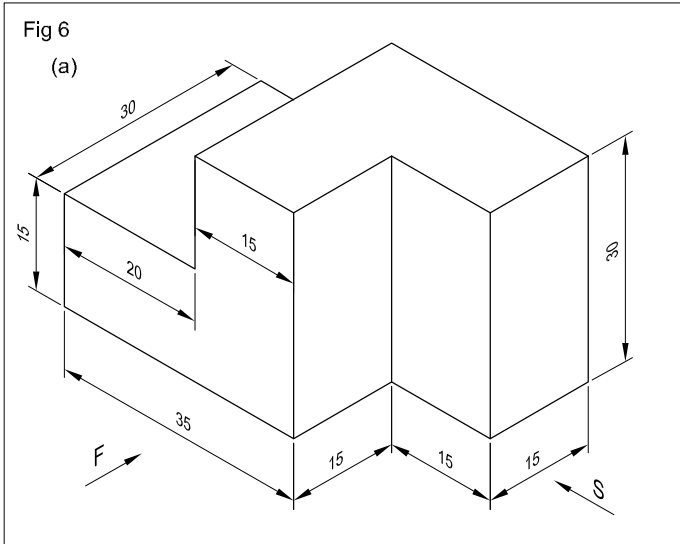
Fig 12 shows frustums and truncated pyramids. All items we use are solids. Their shapes may confirm individual geometrical solids like prisms, cones or other combinations.



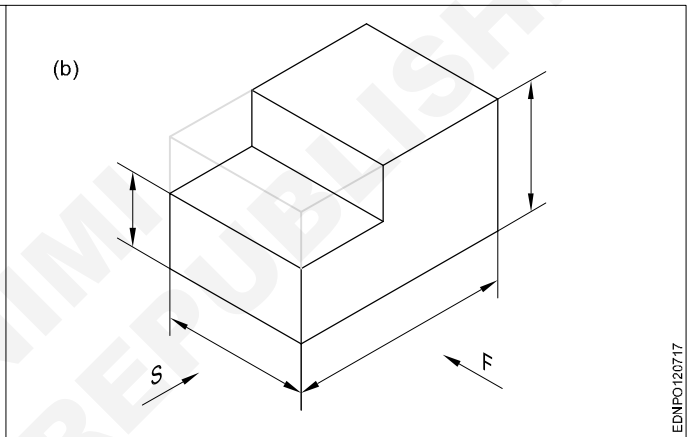
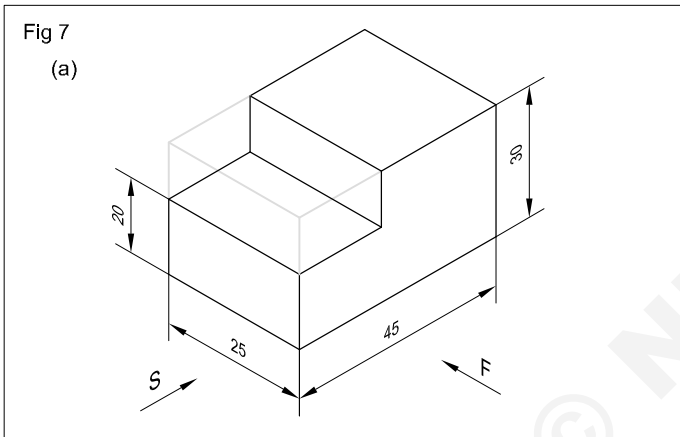
Free hand drawing of - Transferring measurement from the given object to the free hand sketches



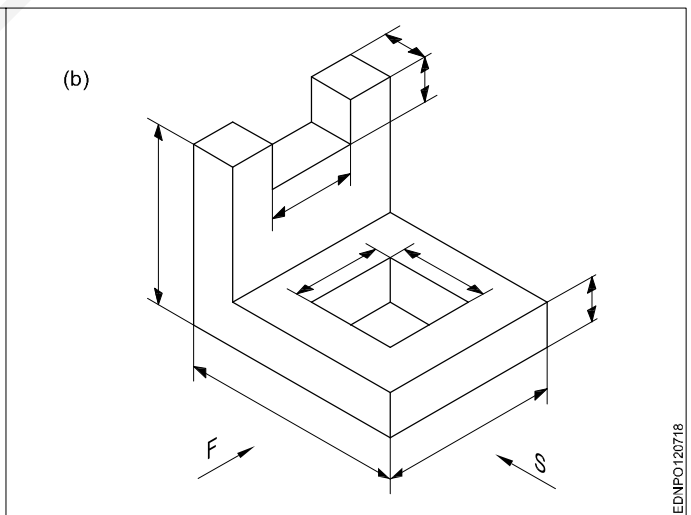
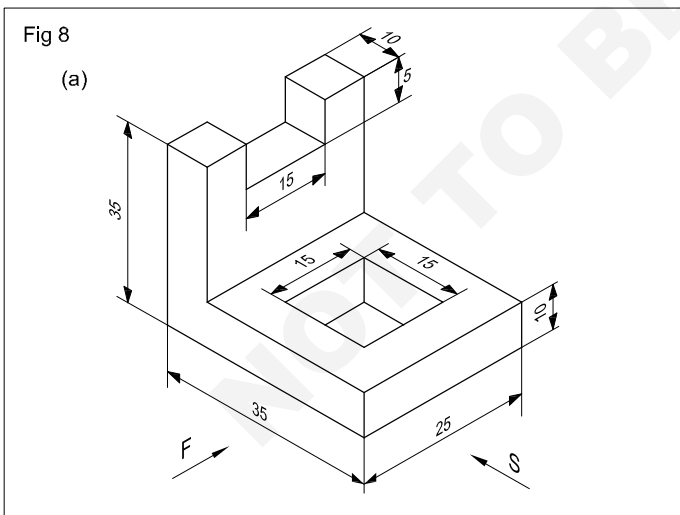




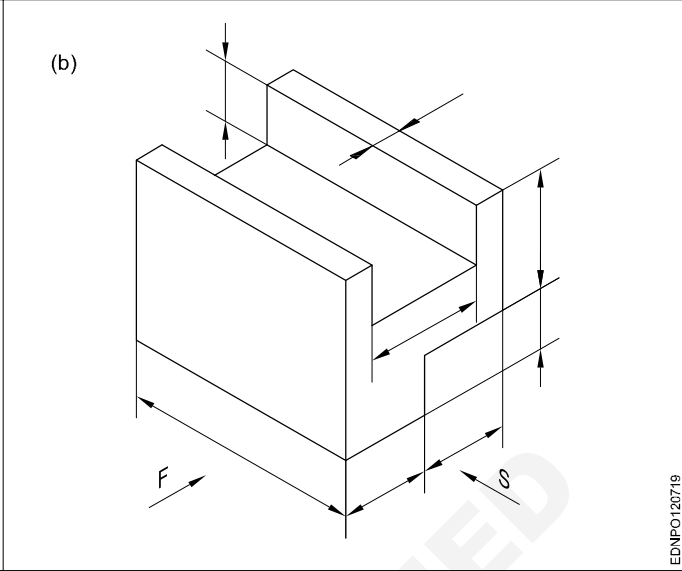
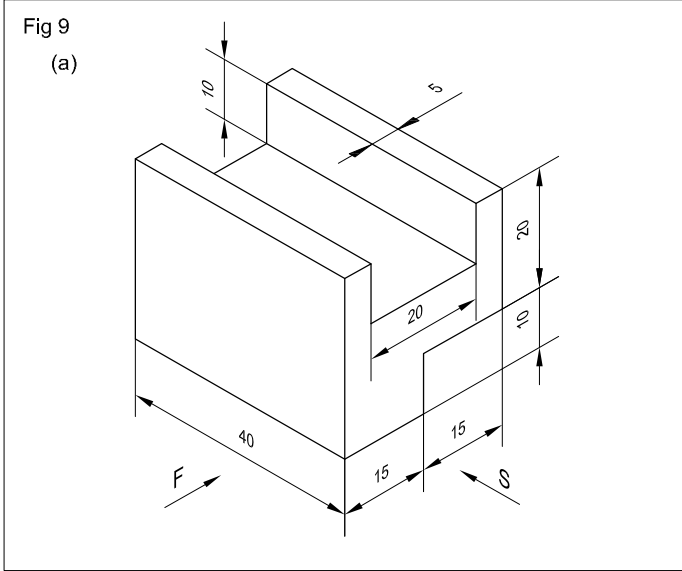
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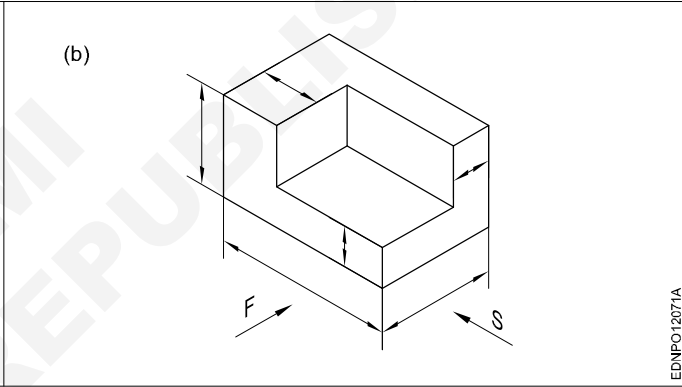
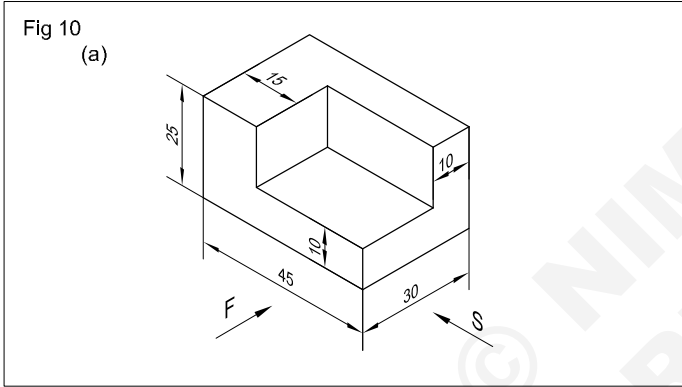
EDNPO120717



EDNPO120718



EDNPO120719



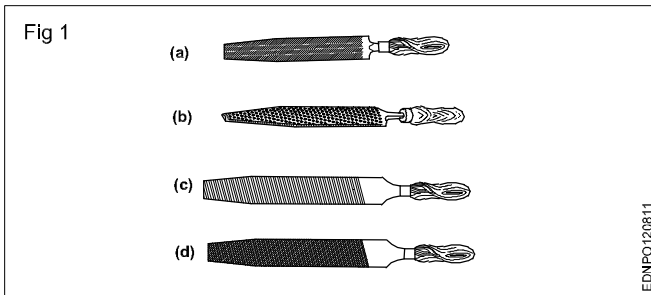
EDNPO12071A

Free hand drawing of hand tools and measuring tools

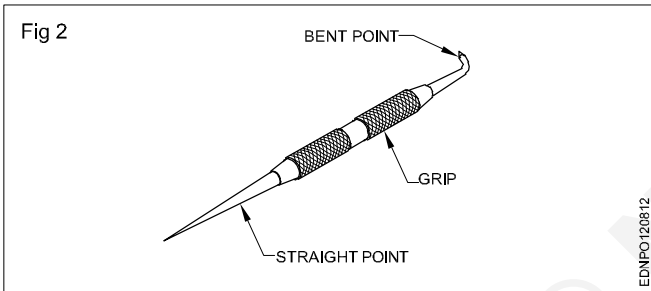
Hand Tools

Files (Fig 1)

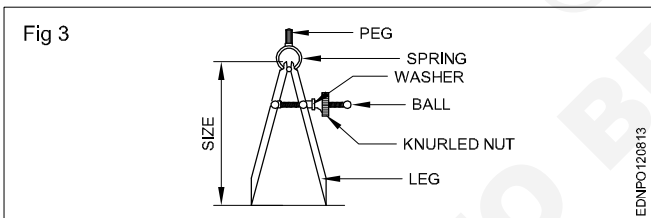
- a Curved cut file
- b Rasp cut file
- c Single cut file
- d Double cut file



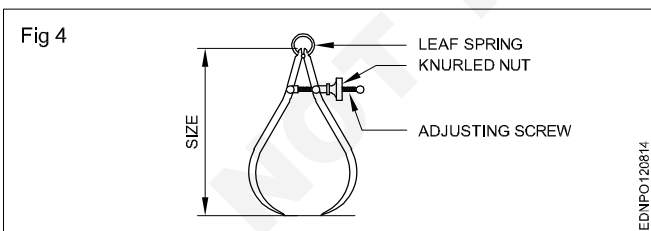
Scriber (Fig 2)



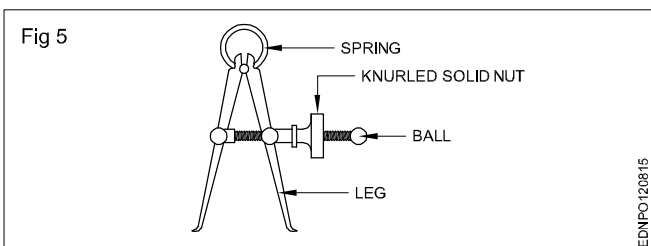
Divider (Fig 3)



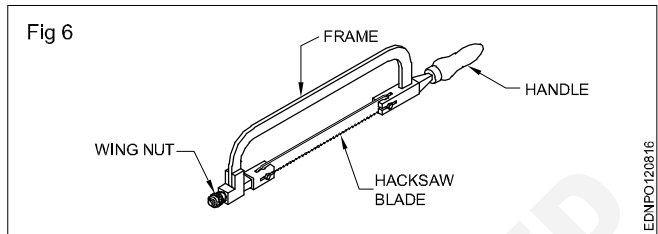
Outside caliper (Fig 4)



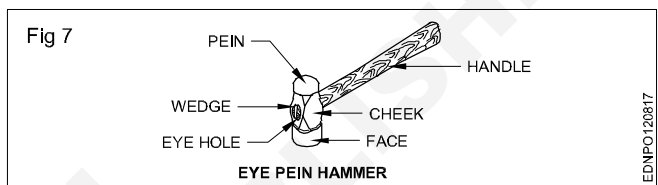
Inside caliper (Fig 5)



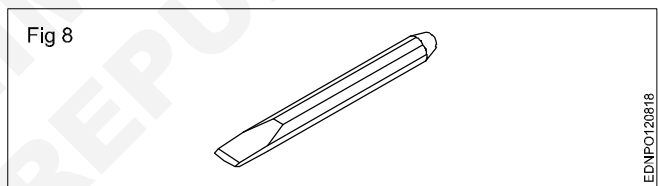
Hacksaw (Fig 6)



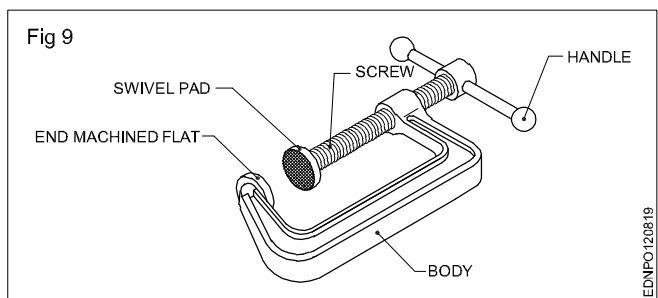
Ball pein hammer (Fig 7)



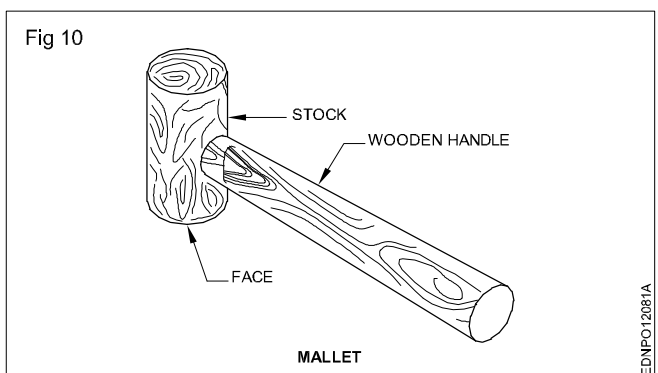
Chisel (Fig 8)



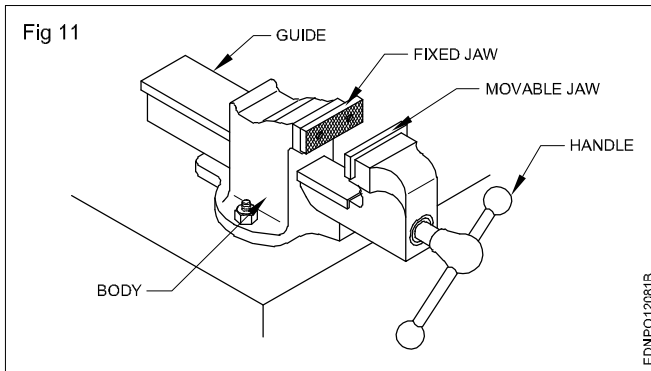
'C' clamp (Fig 9)



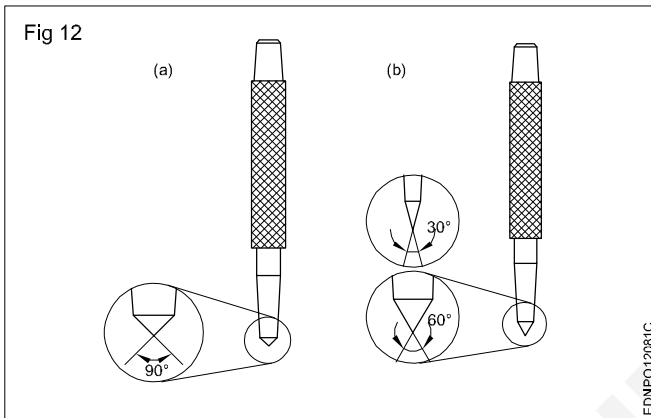
Mallet (Fig 10)



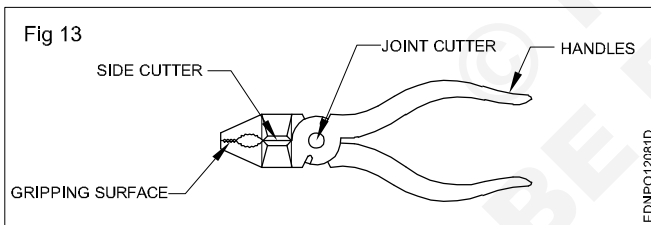
Bench vice (Fig 11)



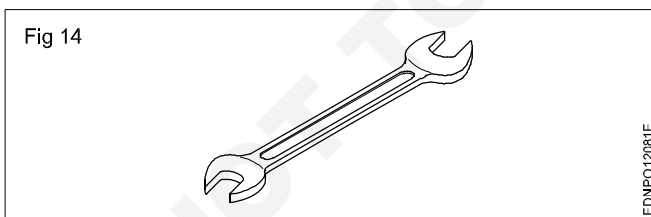
Centre punch (Fig 12)



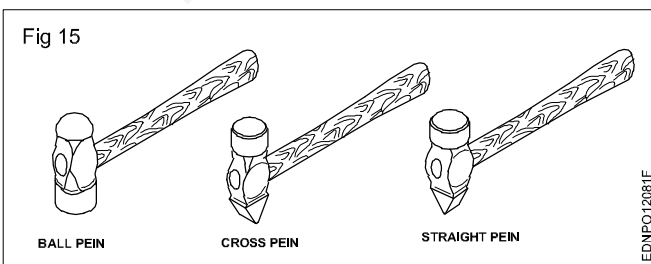
Cutting plier (Fig 13)



Open-end spanner (Fig 14)

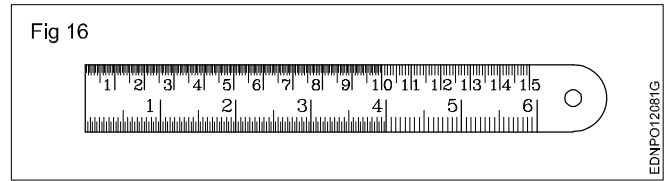


Hammers (Fig 15)

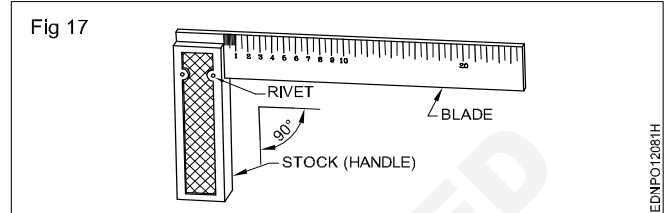


Measuring Tools

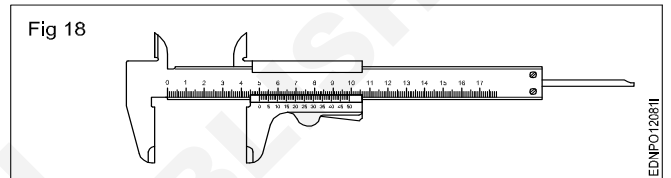
Steel rule (Fig 16)



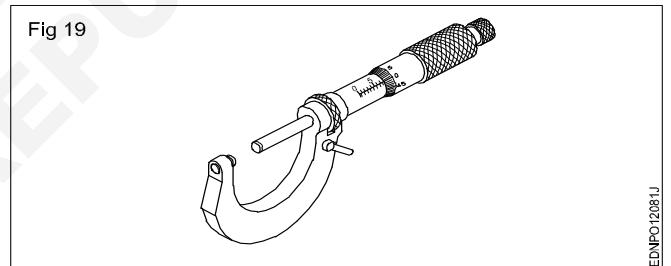
Try square (Fig 17)



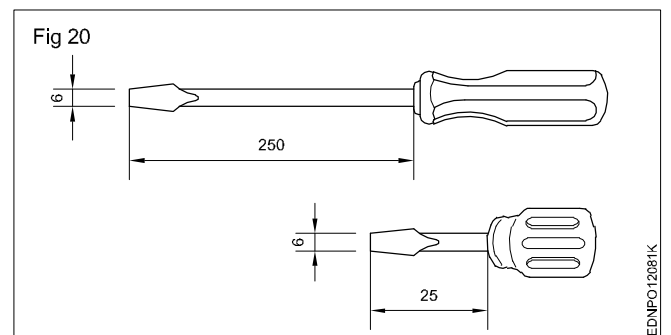
Vernier caliper (Fig 18)



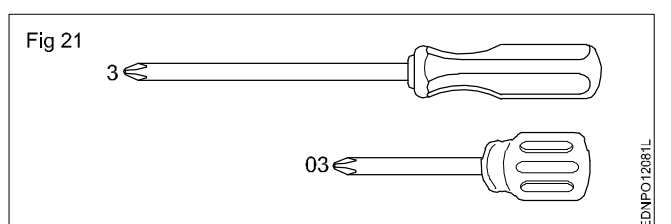
Micrometer (Fig 19)



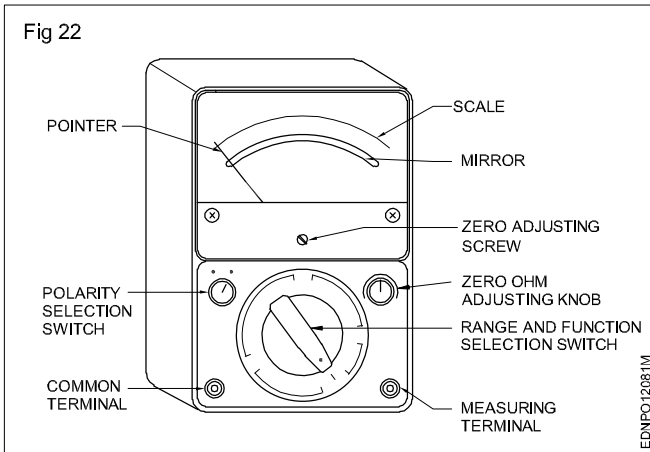
Screwdriver (Fig 20)



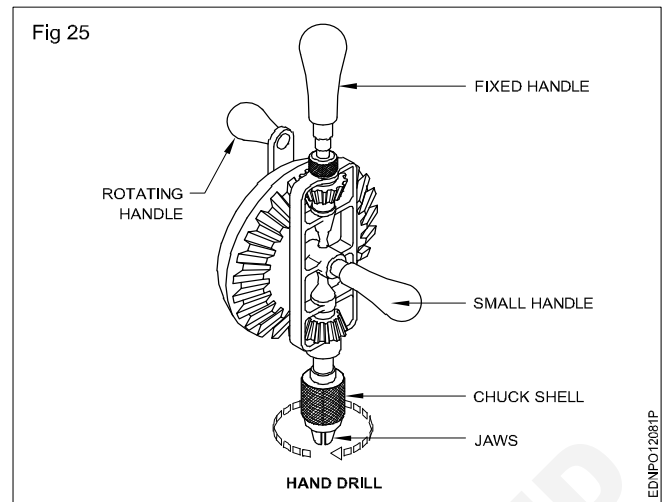
Screwdriver with cross-type tips (Fig 21)



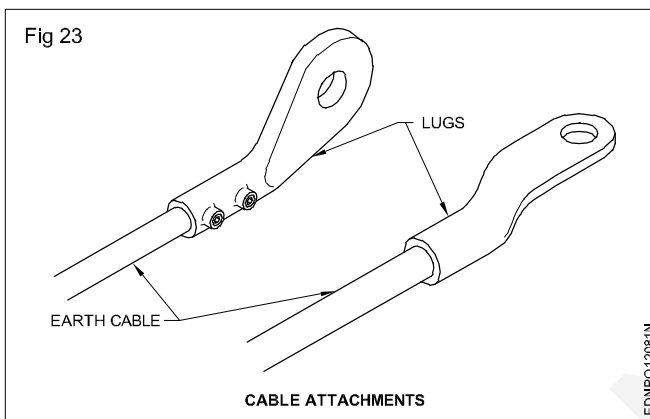
Analog multimeter (Fig 22)



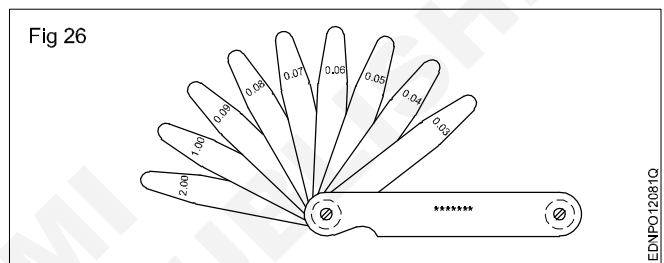
Hand drill (Fig 25)



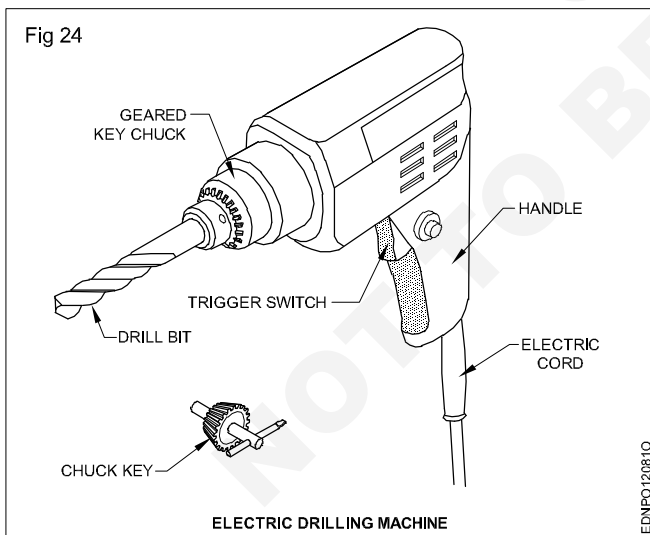
Cable attachments (Fig 23)



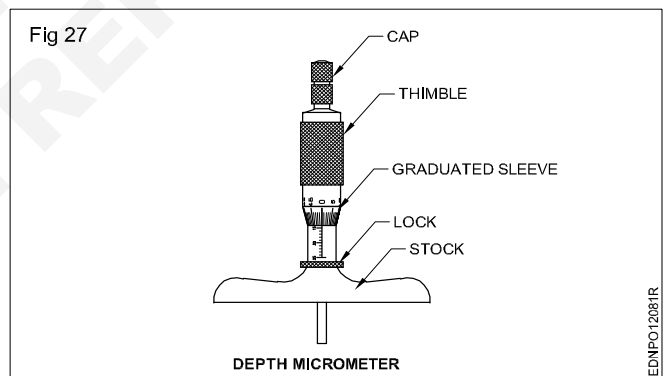
Feeler gauge (Fig 26)



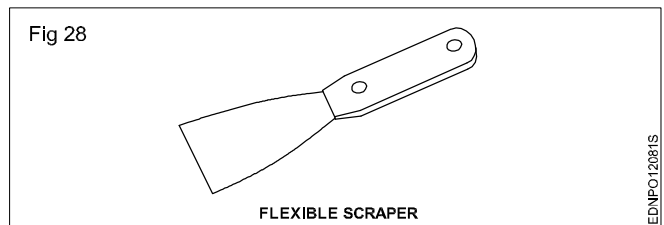
Electric drilling machine (Fig 24)



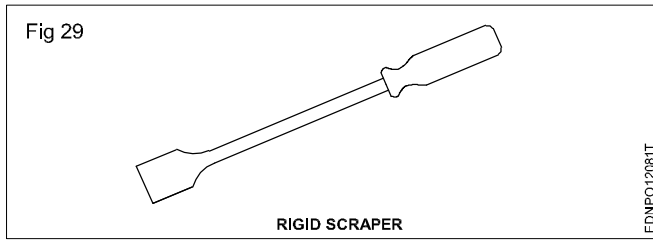
Depth micrometer (Fig 27)



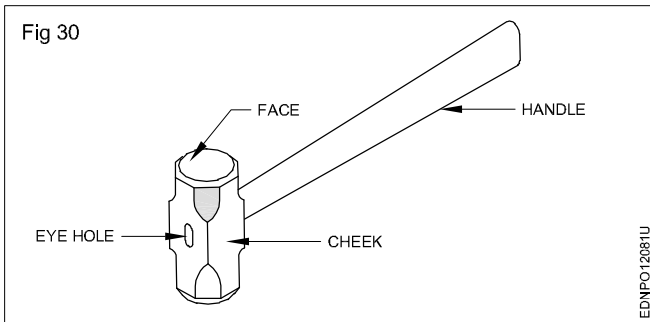
Flexible scraper (Fig 28)



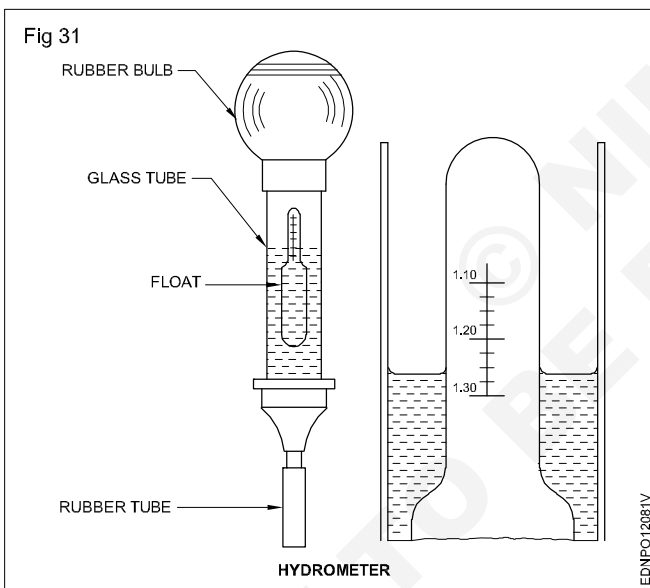
Rigid scraper (Fig 29)



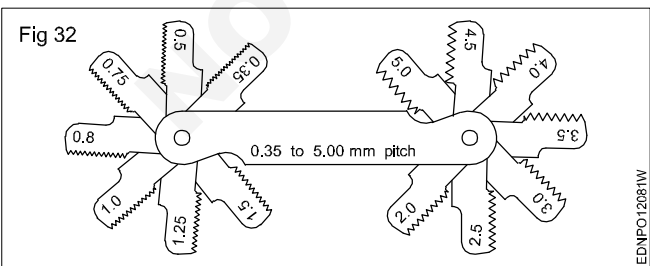
Sledge hammer (Fig 30)



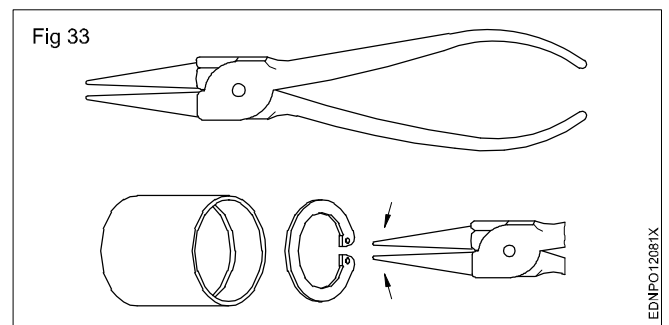
Hydrometer (Fig 31)



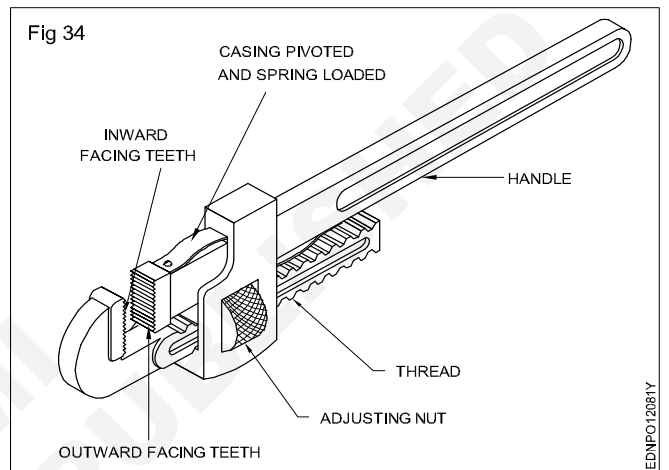
Pitch gauge (Fig 32)



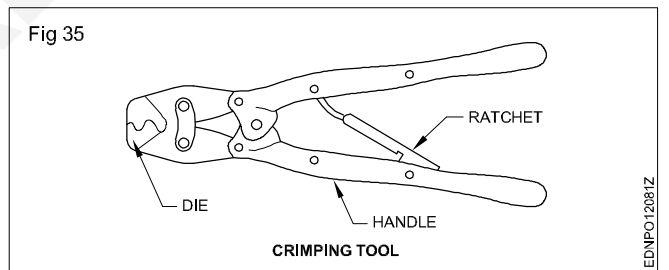
Internal circlip plier (Fig 33)



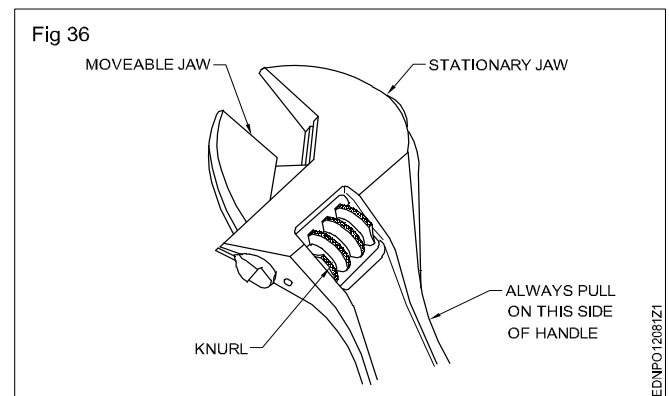
Stillson pipe wrench (Fig 34)



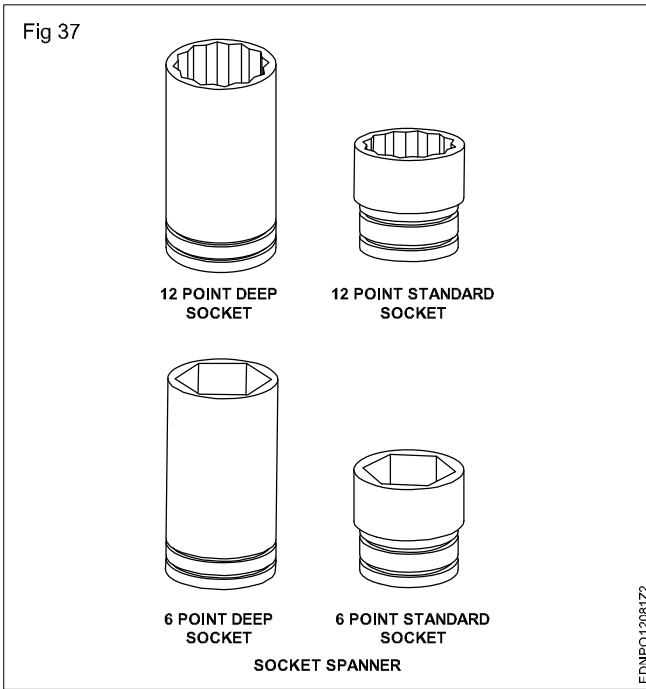
Crimping tool (Fig 35)



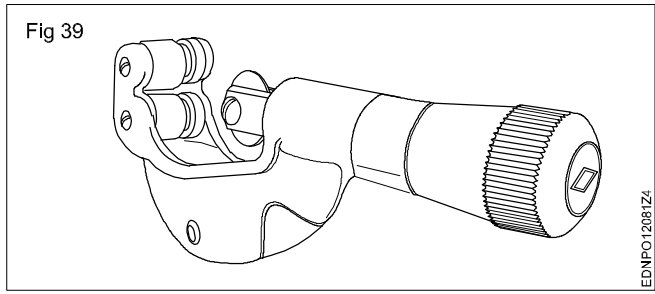
Adjustable spanner (Fig 36)



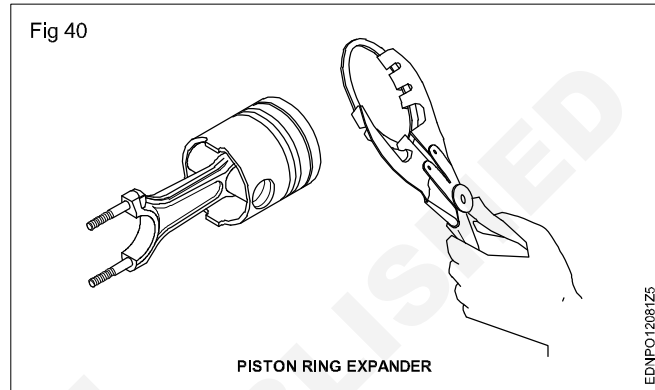
Socket spanner (Fig 37)



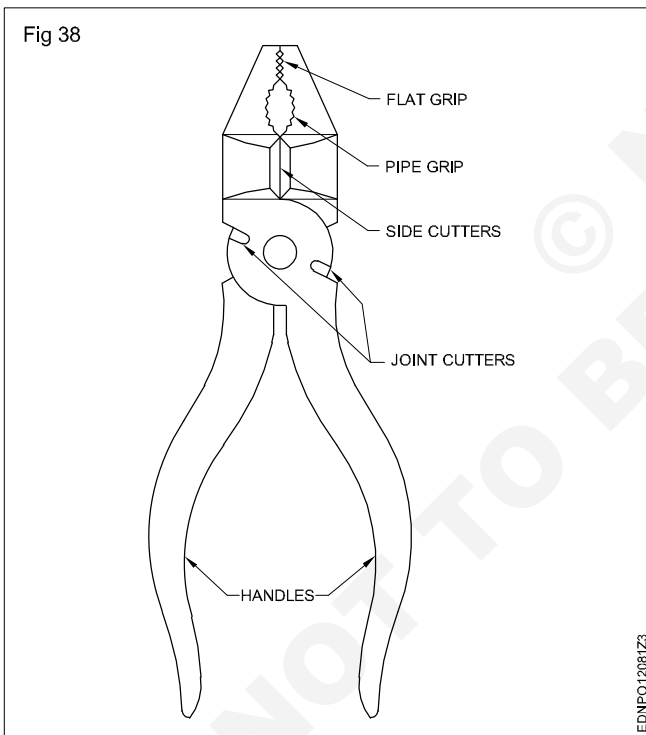
Pipe cutter (Fig 39)



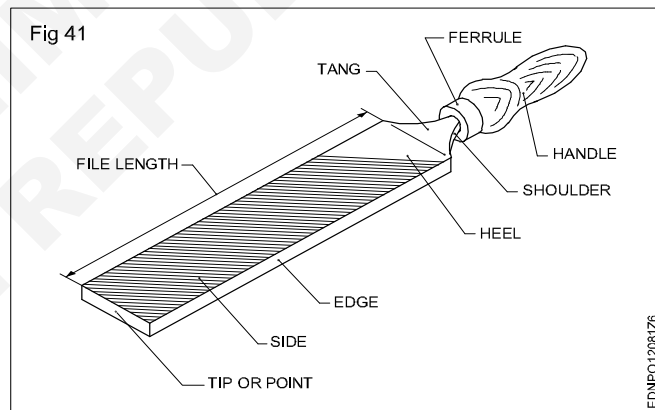
Piston ring expander (Fig 40)



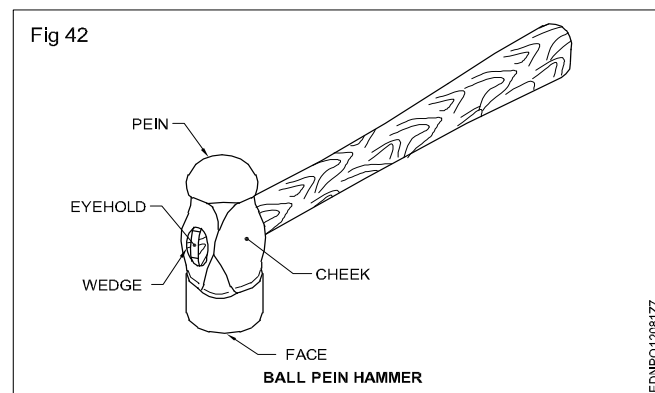
Cutting plier (Fig 38)



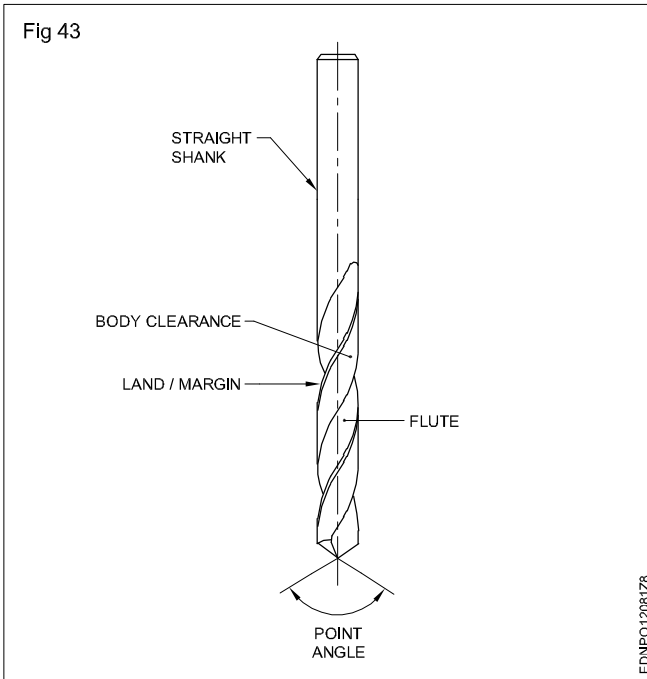
Hand file (Fig 41)



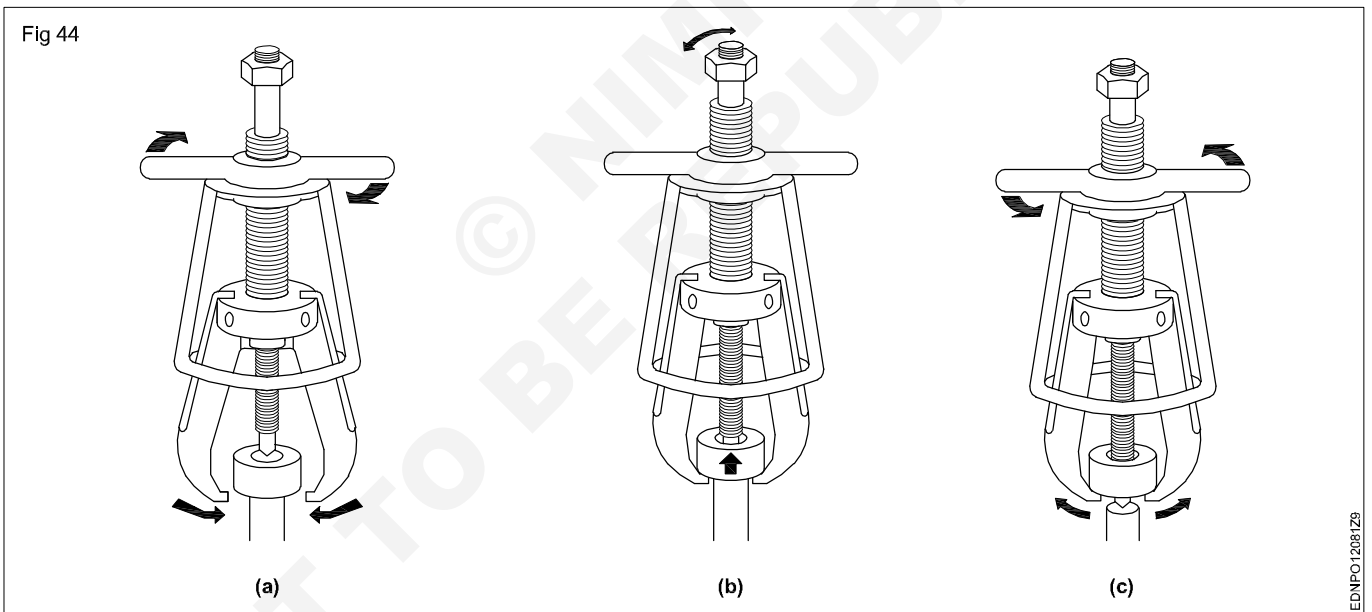
Ball pein hammer (Fig 42)



Drill (Fig 43)



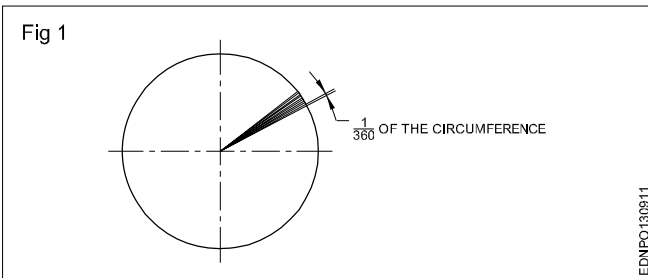
Operations of Puller (Fig 44)



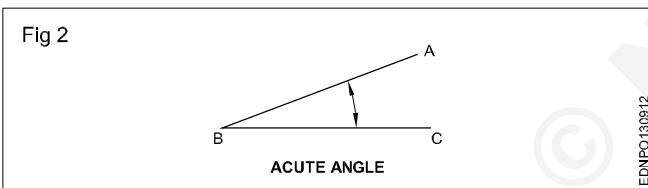
Drawing of geometrical figures - Angle & triangle

Angles: Angle is the inclination between two straight lines meeting at a point or meeting when extended. AB and BC are two straight lines meeting at B. The inclination between them is called an angle. The angle is expressed in degrees or radians.

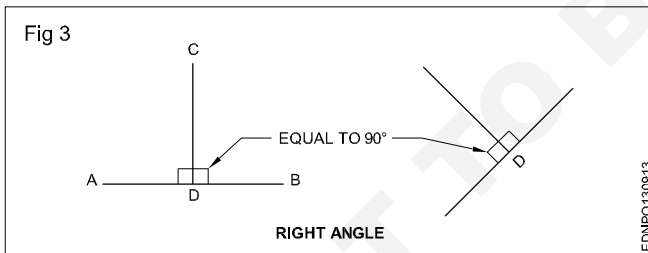
Concept of a degree: When the circumference of a circle is divided into 360 equal parts and radial lines are drawn through these points, the inclination between the two adjacent radial lines is defined as one degree. Thus a circle is said to contain 360°. (Fig 1)



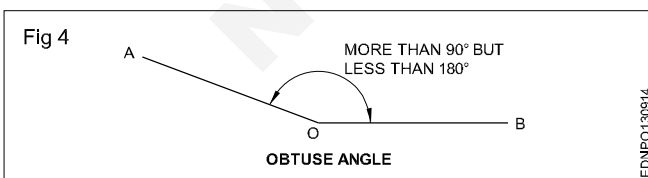
Acute angle: An angle that is less than 90° is called an acute angle. (Fig 2)



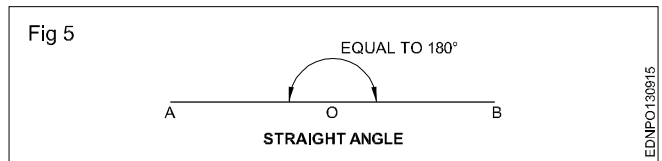
Right angle: The angle between a reference line and a perpendicular line is called a right angle. (Fig 3)



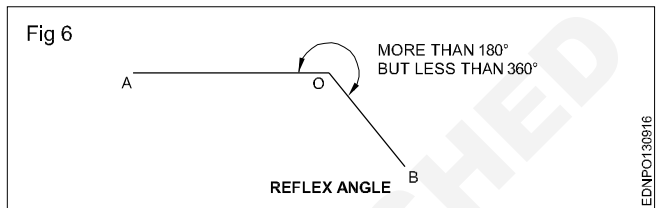
Obtuse angle: This refers to an angle between 90° and 180°. (Fig 4)



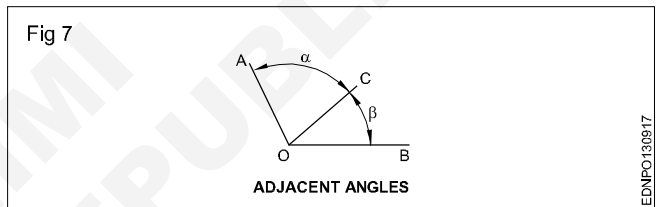
Straight angle: This refers to an angle of 180°. This is also called the angle of a straight line. (Fig 5)



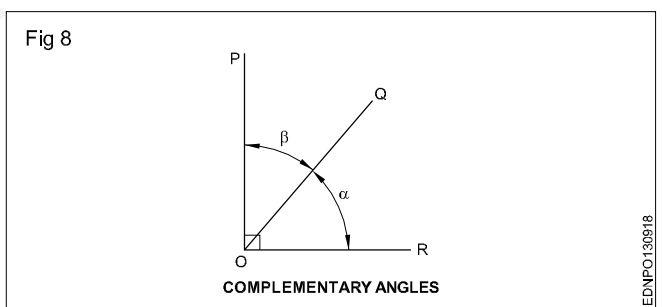
Reflex angle: It is the angle that is more than 180°, but less than 360°. (Fig 6)



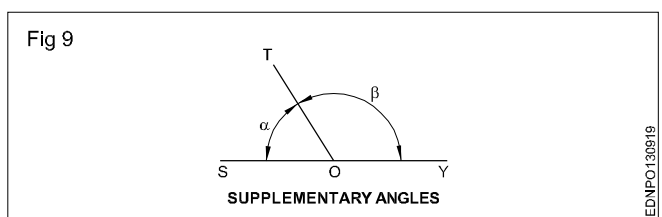
Adjacent angles: These are the angles lying on either side of a line. (Fig 7)



Complementary angles: When the sum of the two angles is equal to 90°, angle POQ + angle QOR = 90° angle POQ and angle QOR are complementary angles to each other. (Fig 8)



Supplementary angle: When the sum of the two adjacent angles is equal to 180°, for example, angle SOT + angle TOY = 180°, angle SOT and angle TOY are supplementary angles to each other. (Fig 9)



Triangle - different types

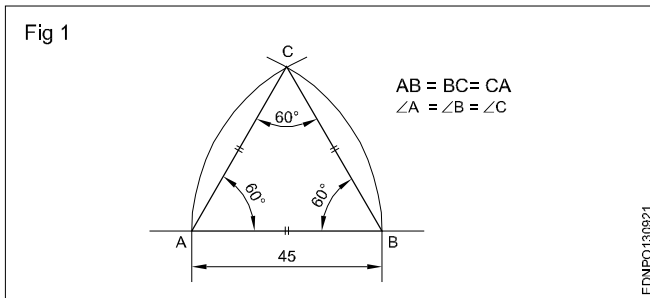
Triangle is a closed plane figure having three sides and three angles. The sum of the three angles always equals to 180° .

To define a triangle, we need to have a minimum of three measurements as follows:

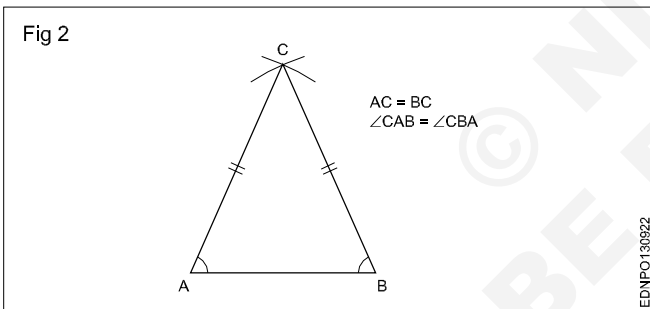
- 3 sides or
- 2 sides and one angle or
- 2 angles and one side

Types of triangles

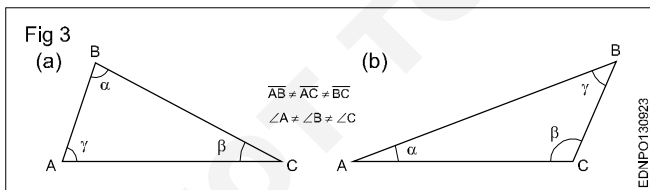
1 Equilateral triangle is a triangle having all the three sides equal. Also all the three angles are equal (60°). (Fig 1)



2 Isosceles triangle has two of its sides equal. The angles opposite the two equal sides are also equal. (Fig 2)



3 Scalene triangle has all three sides unequal in length. All three angles are also unequal. (Fig 3)



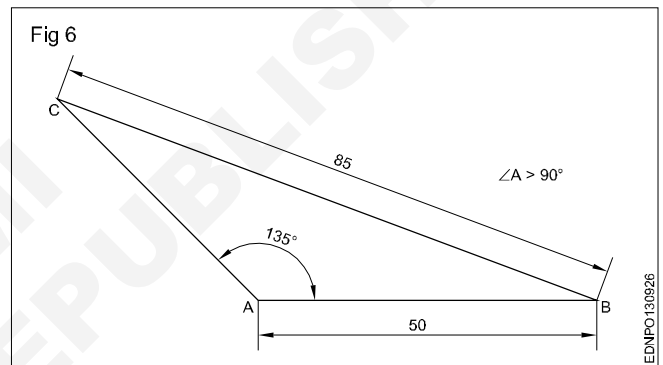
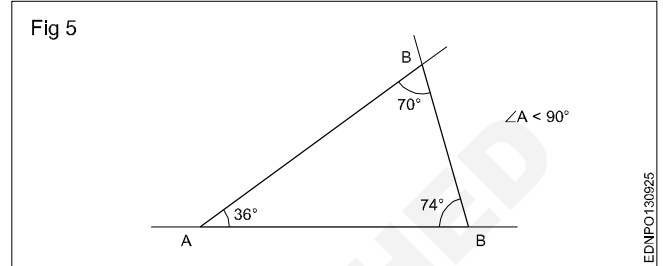
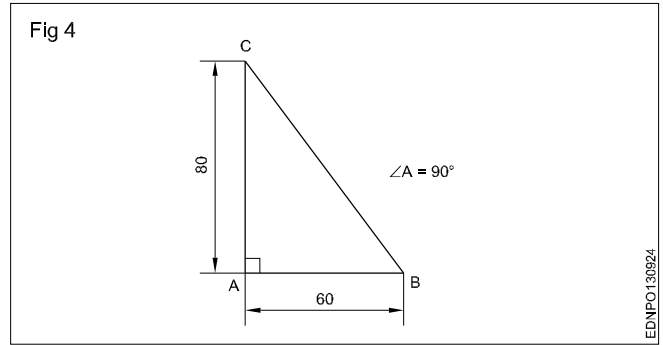
4 A right-angled triangle is one in which one of the angles is equal to 90° (Right angle). The side opposite the right angle is called the hypotenuse. (Fig 4)

5 An Acute angled triangle is one in which all the three angles are less than 90° . (Fig 5)

6 Obtuse angled triangle has one of the angles more than 90° . (Fig 6)

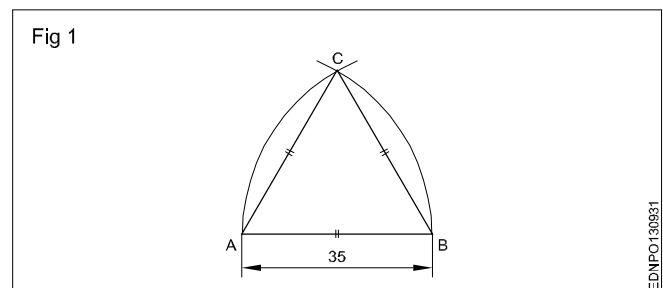
The sum of the three angles in any triangle is equal to 180° .

The sum of any two sides is more than the third side.



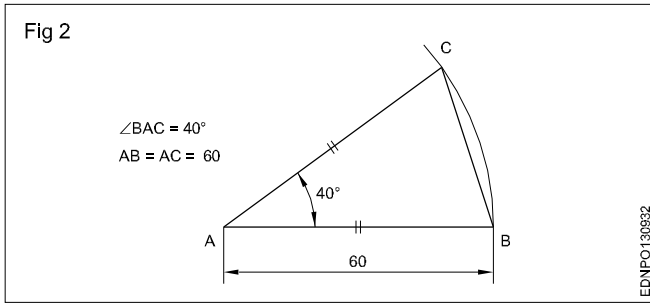
Procedure to draw the triangle

- 1 Equilateral triangle (Fig 1) $AB = BC = CA = 35$ mm.**
 - Draw a line and mark AB 35 mm side of the triangle.
 - Draw radius from centre A and B, arcs cutting mark at C (Fig 1).
 - Join CA and CB.
 - ABC is a required triangle.



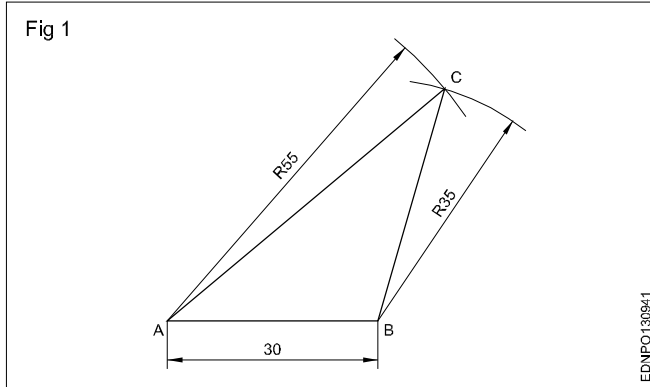
- 2 Isosceles triangle : $AB = AC = 60$ mm & $\angle BAC = 40^\circ$.**

- Draw the side AB equal to 60 mm. 'A' as the centre, draw an arc of radius AB.
- Draw a line AC at 40° to AB.
- Join BC to form the triangle ABC. (Fig 2)



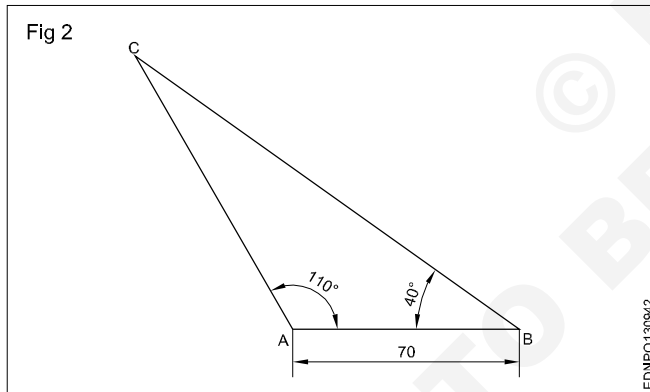
Exercise

- 1 Scalene triangle: $AB = 30$ mm, $AC = 55$ mm & $BC = 35$ mm. (Fig 1)

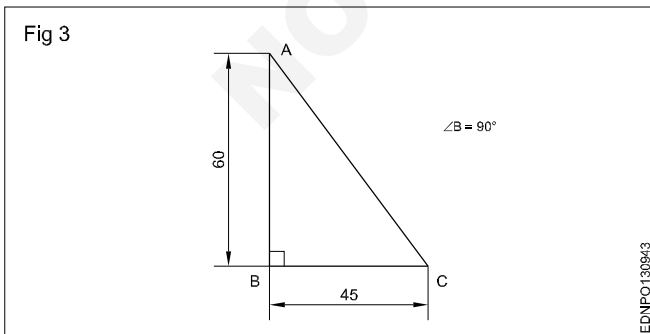


- 2 Scalene triangle: $AB = 70$ mm. (Fig 2)

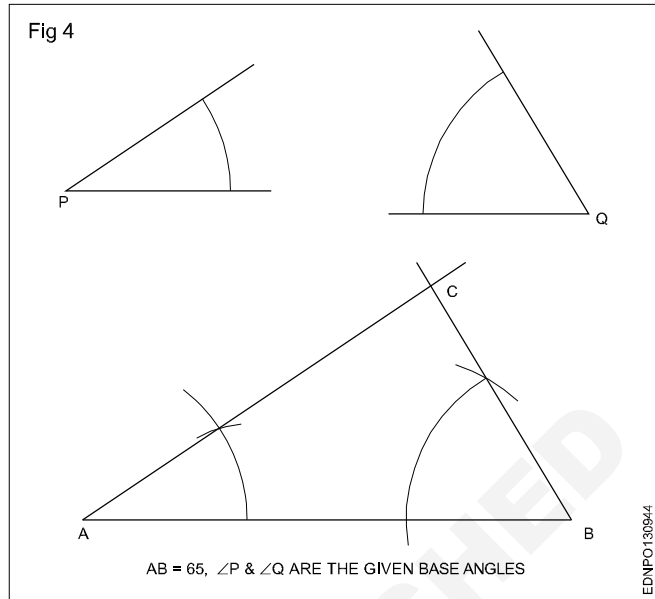
$\angle ABC = 40^\circ$ & $\angle BAC = 110^\circ$



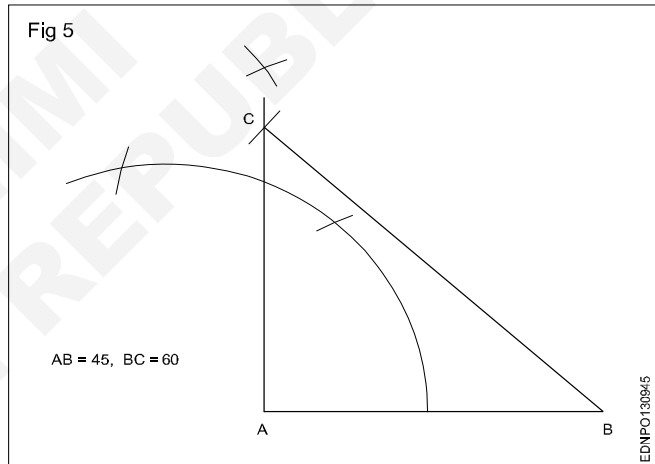
- 3 Right angled triangle: $AB = 60$ mm, $BC = 45$ mm. (Fig 3)



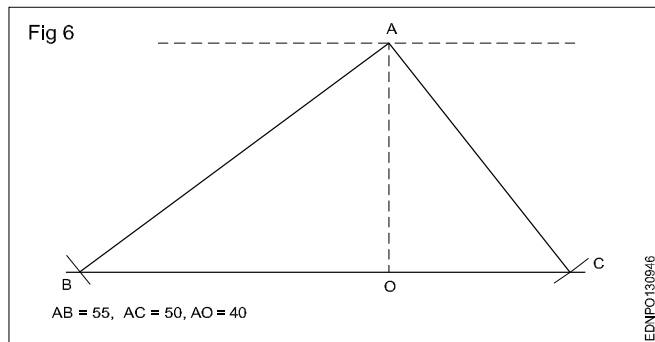
- 4 Draw a triangle when one side and 2 angles being given in Fig 4.



- 5 Draw a right angled triangle when the base and hypotenuse being given in Fig 5.



- 6 Draw a triangle with the altitude and two sides being given in Fig 6.



Drawing of geometrical figures - Circle

Circle: Circle is a plane figure bounded by a curve, formed by the locus of a point which moves so that it is always at a fixed distance from a stationary point the "Centre".

Radius: The distance from the centre to any point on the circle is called the "Radius".

Diameter: The length of a straight line between two points on the curve, passing through the centre is called the "Diameter". (D: Dia or d) It is twice the radius.

Circumference: It is the linear length of the entire curve, equal to πD .

Arc: A part of the circle between any two points on the circumference or periphery is called an 'Arc'.

Chord: A straight line joining the ends of an arc is called the chord. (Longest chord of the circle is the diameter)

Segment: A part of the circle or area bound by the arc and chord is the segment of the circle.

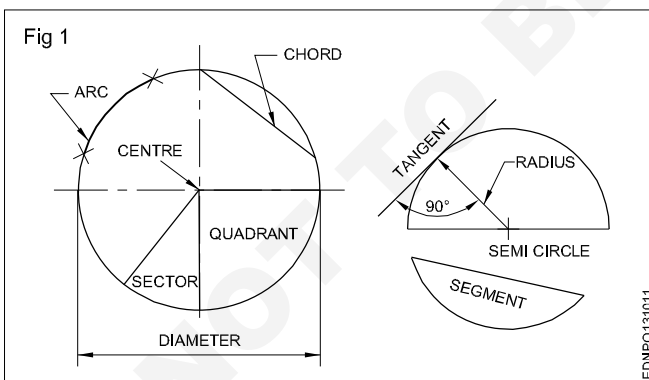
Sector: It is the part of a circle bounded by two radii (plural of radius) meeting at an angle and an arc.

Quadrant: Part of a circle with radii making 90° with each other is a quadrant (one-fourth of the circle).

Half of the circle is called a semi-circle.

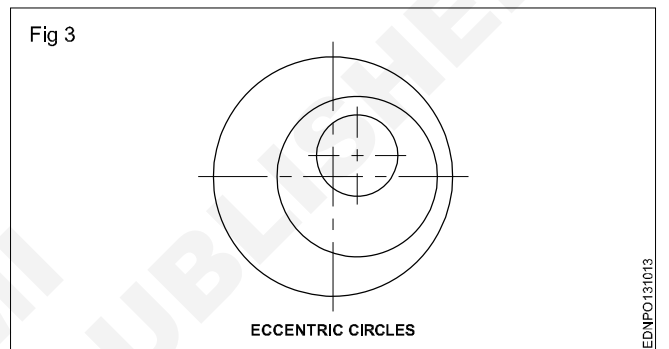
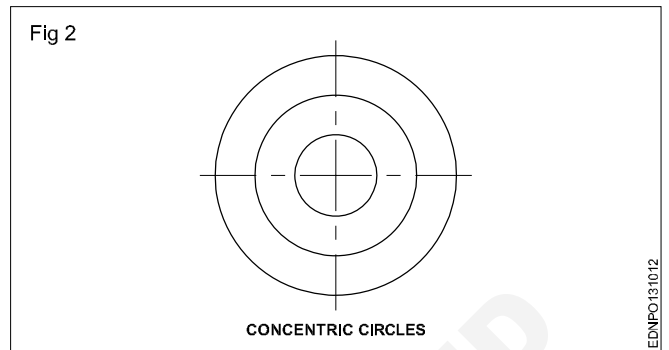
Tangent: The tangent of a circle is a straight line just touching the circle at a point. It does not cut or pass through the circle when extended.

Fig 1 shows all the above elements.



Concentric circles: When two or more circles (drawn) have a common centre, they are called concentric circles. Ball-bearing is the best example of concentric circles. (Fig 2)

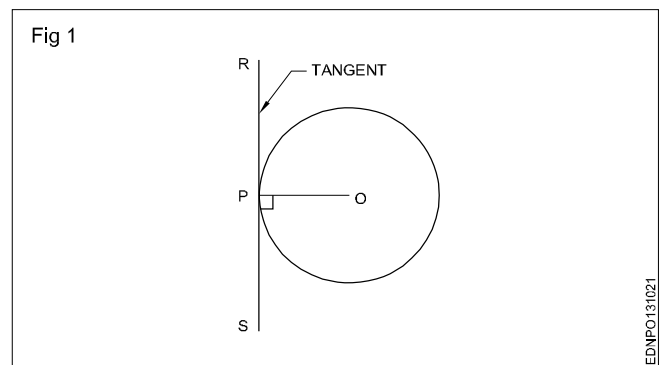
Eccentric circles: Circles within a circle but with different centres are called eccentric circles. (Fig 3)



Circle and Arcs

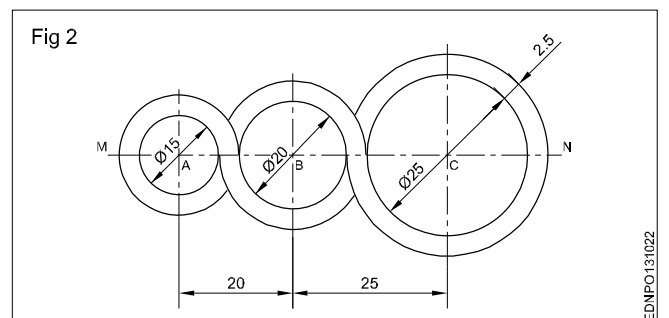
Exercise

- 1 Draw a tangent to a given circle of ϕ 50 mm at any point 'P' on it. (Fig 1)

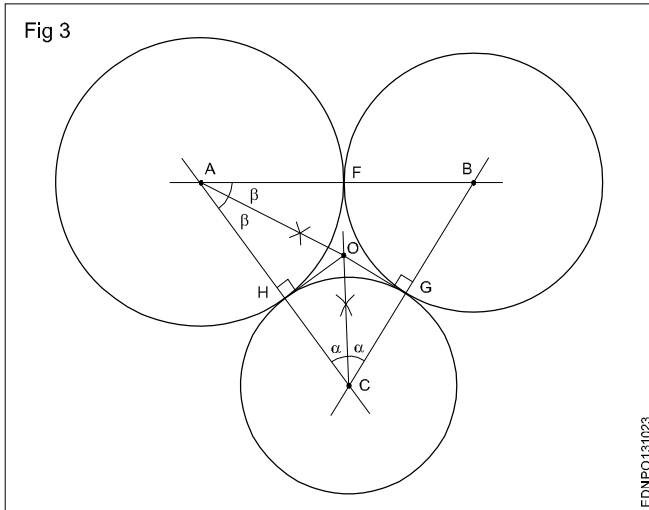


- 2 Draw a loop of 3 circles pattern. (Fig 2)

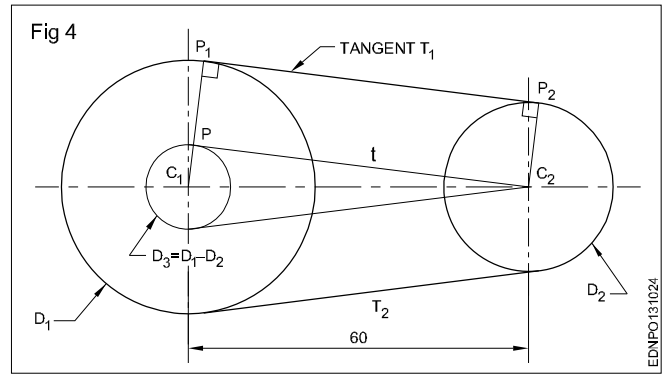
Draw any line MN and mark points A, B and C. So that AB = 20 mm and BC = 25 mm.



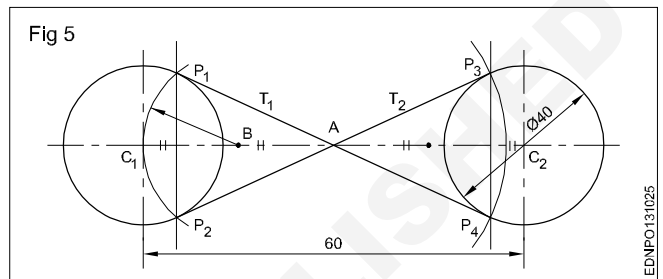
3 3 Draw three circles tangential to each other if centres A, B & C are given. (Fig 3)



4 Draw external tangents to circles of dia 40 and 30 and centre distance 60 mm. (Fig 4)

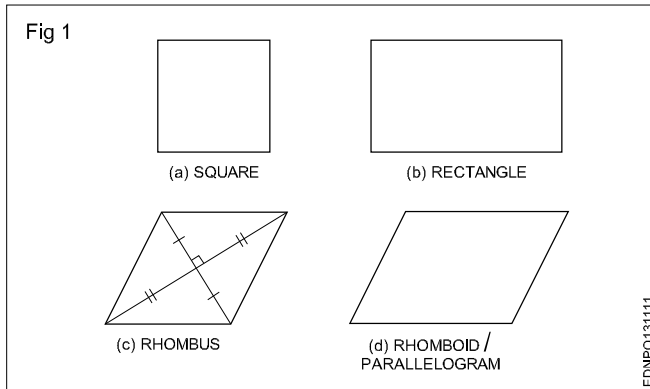


5 Draw internal tangents to circles of the same diameter 40 each and a centre distance of 60 mm. (Fig 5)



Drawing of geometrical figures - Square, rectangle, rhombus and parallelogram

Quadrilateral is a plane figure bounded by four sides and four angles. Sum of the four angles in a quadrilateral is (interior angles) equal to 360° . The side joining opposite corners is called diagonal. To construct a quadrilateral out of four sides, four angles and two diagonals a minimum of five dimensions are required of which two must be sides. Quadrilaterals are also referred as Trapezium. (Fig 1)



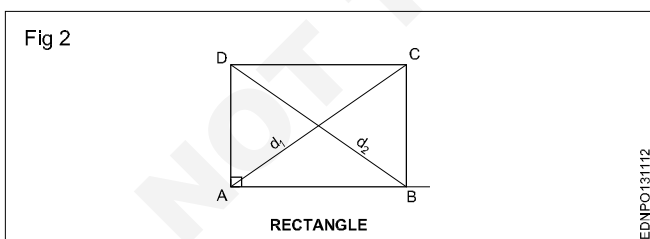
Types of quadrilaterals (Fig 1)

- Square
- Rectangle
- Rhombus
- Rhomboid / Parallelogram

Square: In a square all the four sides are equal and its four angles are at right angles. The two diagonals are equal and perpendicular to each other.

To construct a square we need to know (a) length of the side or (b) length of the diagonal.

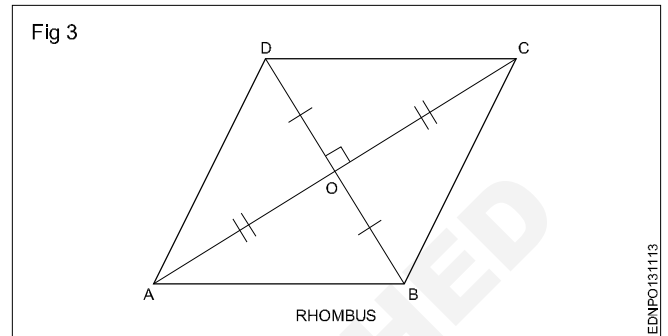
Rectangle (Fig 2): In a rectangle, opposite sides are equal and parallel and all four angles are right angles.



To construct a rectangle we need to know the length (AB), two adjacent sides or (AD and BC) are diagonal and one side.

Fig 2 shows a rectangle ABCD, Sides $AB = DC$ and $BC = AD$. Diagonals AC and BD are equal. Diagonals are not bisect at right angles.

Rhombus (Fig 3): In rhombus all the four sides are equal but only the opposite angles are equal. ABCD is the rhombus where $AB = BC = CD = AD$.

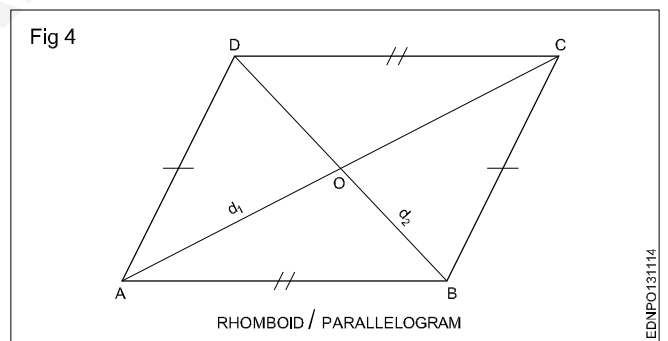


Angle $ABC = \text{Angle } ADC$ and Angle $BAD = \text{Angle } BCD$.
Diagonals AC and BD are not equal but bisecting at right angles.

$AO = OC$ and $BO = OD$.

To construct a rhombus we need to know (a) two diagonals (b) one diagonal and an opposite angle or (c) one side and its adjacent angle.

Rhomboid/Parallelogram (Fig 4): In a parallelogram opposite sides are equal and parallel. Opposite angles are also equal. Diagonals are not equal but bisect each other.



Parallelogram is also known as rhomboid. To construct a parallelogram we need (a) two adjacent sides and an angle between them or (b) one side, diagonal, and an angle between them or (c) two adjacent sides and perpendicular distance between the opposite sides.

In the parallelogram ABCD, $AB = DC$; $AD = BC$

Angle $DAB = \text{angle } DCB$, angle $ABC = \text{angle } ADC$

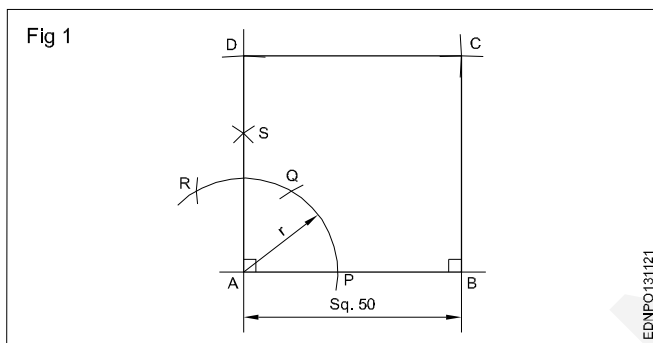
Sides AB, CD and AD, BC are parallel.

Diagonals AC and BD are not equal but bisect at O.

Procedure to draw the square, rectangle, rhombus and parallelogram

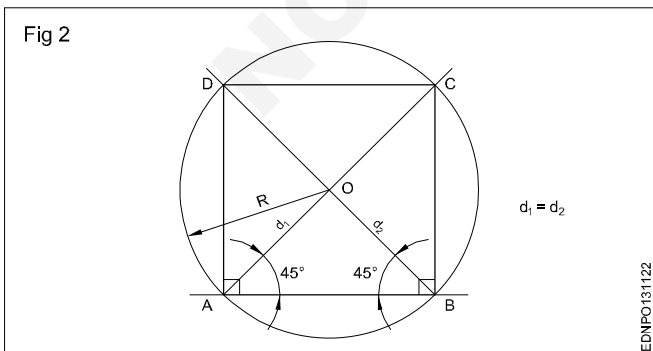
Square

- 1 1st method (Fig 1):** A square of side 50 mm by erecting perpendicular.
- Draw a line AB 50 mm long.
 - 'A' as centre, draw an arc of convenient radius 'r' touching the line AB at 'P' as shown in Fig 1.
 - 'P' as centre and radius 'r' draw another arc cutting the earlier drawn arc at 'Q'.
 - 'Q' as centre and radius 'r', draw another arc cutting at 'R'.
 - Bisect QR at S and extend.
 - Mark 50 mm on AS extended line. AD = 50 mm.
 - From points B and D, draw parallels to AD and AB and complete the square ABCD.



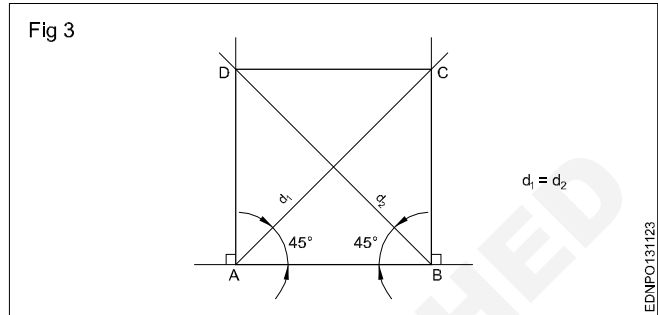
- 2 2nd method (Fig 2):** A square of side 60 mm using 45° setsquare and compass.

- Draw a horizontal line AB = 60 mm long.
- From points A and B, using 45° setsquare, draw 45° lines both intersecting at 'O'.
- Draw a circle of radius OA or OB with centre 'O'.
- 'A' as centre and AB as radius, draw an arc. The arc cuts the circle at D.
- Similarly draw an arc with centre D with radius AB and get point C.
- Join AD, DC & CB and complete the square.



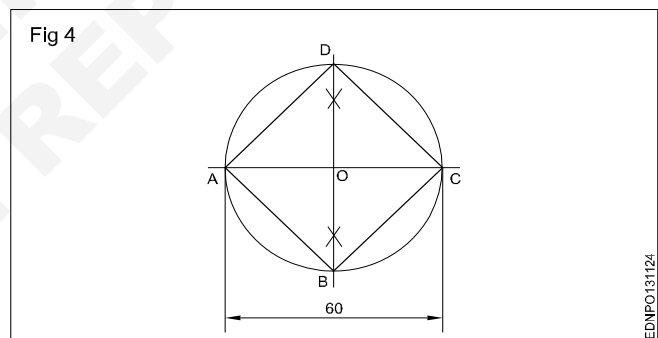
- 3 3rd method (Fig 3):** A square of side 60 mm long by erecting perpendicular and also using 45° setsquare.

- Draw line AB equal to 60 mm.
- Erect perpendicular from A and B using 60° or 45° setsquare.
- Draw 45° from A and B, cutting perpendicular lines at C and D.
- Join A,D,C and B. ABCD is required square.



- 4 Square having diagonal 60 mm (Fig 4)**

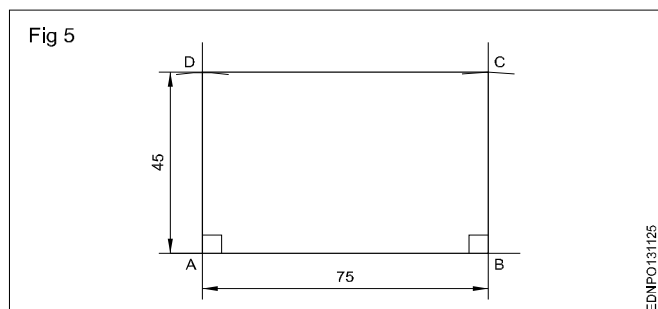
- Draw horizontal and vertical centre lines intersecting at 'O'.
- 'O' as centre, draw a circle of radius 30 mm passing through centre lines at A,B,C and D.
- Join points A-B, B-C, C-D and D-A. ABCD is the required square, whose diagonal is 60 mm.



- 5 Rectangle (Fig 5)**

Draw a rectangle of side AB = 75 mm, side AD = 45 mm using setsquare and compass.

- Draw the side AB equal to 75 mm.
- Erect perpendiculars at A and B.
- Mark off a height 45 from A and B, at D and C.
- Join C and D to complete the rectangle.



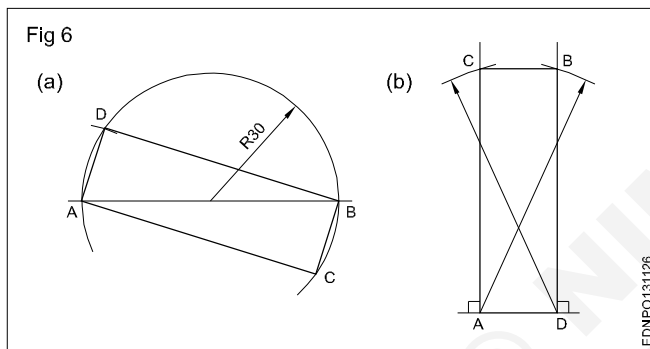
6 Rectangle - Diagonal - 60 mm and one side 20 mm 1st method (Fig 6a)

- Draw a line AB 60 mm.
- Draw a circle with AB as its diameter.
- 'A' as centre, draw an arc of R20, cutting the circle at D.
- Join AD and BD.
- Draw AC parallel to DB.
- Join BC and complete the rectangle.

2nd method (Fig 6b)

- Draw a line AD = 20 mm long.
- Draw perpendiculars from A and D upwards.
- A and D as centres, draw arcs of 60 mm radius cutting perpendiculars at B and C.
- Join BC.

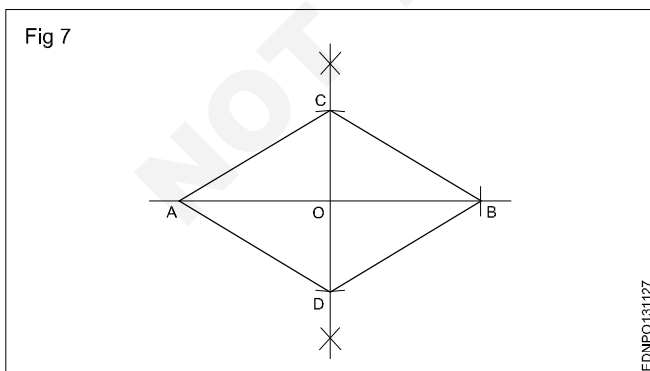
ADBC is the required rectangle of side 20 mm and diagonal 60 mm.



7 Rhombus (Fig 7)

Diagonals AB = 80 mm, CD = 50 mm

- Draw a line AB equal to 80 mm
- Draw perpendicular bisector of AB, passing through O.
- mark OC = OD = 25 mm.
- Join the points AC, CB, BD and DA to complete the rhombus.



8 Rhombus (Fig 8)

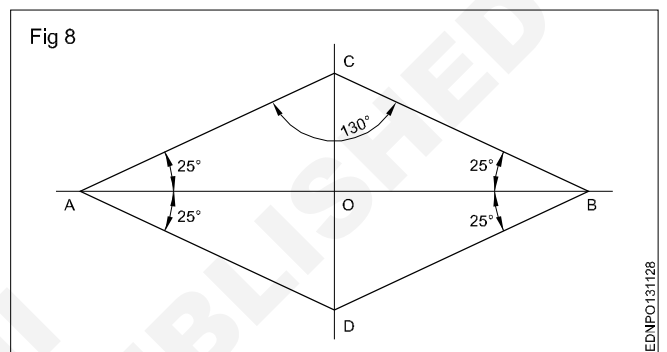
Diagonal AB = 80 mm

$\angle ACB = 130^\circ$

Let the diagonal is equal to 80 mm and the angle is 130° .

- Draw the diagonal AB equal to 80 mm.
- Set an angle of 25° at A and B and draw the lines, meeting at C.
- Join AC and BC.
- Draw AD parallel to CB.
- Draw BD parallel to CA.

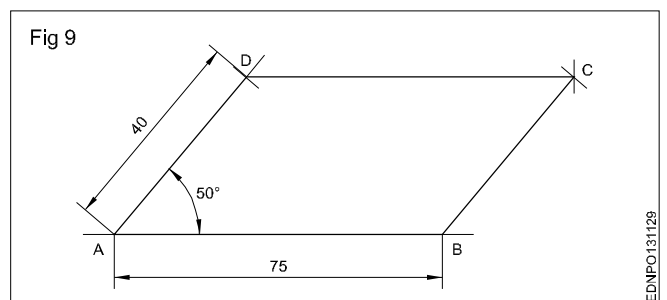
ADBC is the required rhombus.



9 Parallelogram (Fig 9)

Sides = 75 mm and 40 mm, angle 50°

- Draw a line AB = 75mm.
- Draw a line AD equal to 40 mm and 50° angle to AB.
- D as centre, draw an arc of radius equal to AB.
- 'B' as centre, draw an arc of radius equal at AD, upwards such that they meet at a point 'C'. Join ABCD to get the required parallelogram.



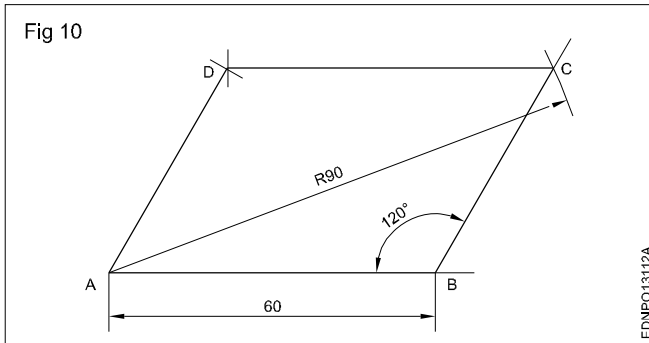
10 Parallelogram (Fig 10)

Parallelogram - Side AB = 60 mm

Diagonal AC = 90 mm $\angle ABC = 120^\circ$

- Draw a line AB = 60 mm. Draw a line of angle 120° at B to AB.
- 'A' as centre with radius 90 mm, draw an arc cutting 120° line from B at C.
- 'C' as centre, radius = AB, draw an arc.
- 'A' as centre and BC as radius, draw another arc, both arcs meet at 'D'. Join AD and DC.

ABCD is the required parallelogram.

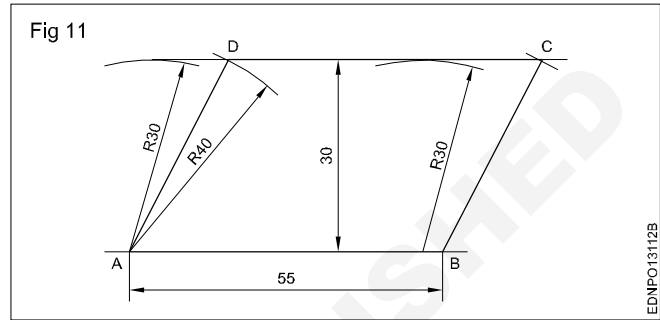


11 Parallelogram (Fig 11)

Sides AB = 55 mm, BC = 40 mm and vertical height = 30 mm.

- Draw the line AB = 55 mm long.
- A and B as centers and radius (R) 30mm, draw arcs above the line.
- Draw a parallel tangential line to AB touching the arcs.
- A and B as centers, draw an arc of 40mm radius cutting the line at D and C.

ABCD is the required Parallelogram.



Lettering and numbering - Single stroke

Styles of lettering: Many styles of lettering are in use today. However, a few styles which are commonly used are shown in Fig 1.

Fig 1

ABCDEFGH abcdefgh	GOTHIC ALL LETTERS HAVING THE ELEMENTARY STROKES OF EVEN WIDTH ARE CLASSIFIED AS GOTHIC
ABCDEFGH abcdefgh	ROMAN ALL LETTERS HAVING THE ELEMENTARY STROKES "ACCENTED" OR CONSISTING OF HEAVY AND LIGHT LINES ARE CLASSIFIED AS ROMAN
<i>ABCDEFGH</i> <i>abcdefgh</i>	ITALIC ALL SLANTING LETTERS ARE CLASSIFIED AS ITALIC. THESE MAY BE FURTHER DESIGNATED AS ROMAN-ITALICS, GOTHIC-ITALICS, TEXT-ITALICS
ABCDEF abcde	TEXT THIS TERM INCLUDES ALL STYLES OF OLD ENGLISH, GERMAN TEXT. BRADLEY TEXT OF OTHERS OF VARIOUS TRADE NAMES. TEXT STYLES ARE TOO ILLEGIBLE FOR COMMERCIAL PURPOSES

EDNIP0131211

Standard heights/Width: The standard heights recommended by BIS SP: 46-2003 are in the progressive ratio of "square root 2". They are namely 2.5 - 3.5 - 5 - 7 - 10 - 14 and 20 mm. The height of lower case letter (without tail or stem) are 2.5, 3.5, 5, 7, 10 and 14 mm.

There are two standard ratios for the line thickness "d". They are A & B. In A = line thickness (d) is h/14 and in B=line thickness (d) is h/10.

Lowercase means small letters, as opposed to capital letters. The word yes, is for example, is in **lowercase**, while the word YES is in **upper case**. For many programmes, this distinction is very important. Programmes that distinguish between **uppercase** and **lowercase** are said to be case sensitive

The width of different letters in terms of "d" is as follows:

Lettering A

Width (W)	Capital letters	Width
1	I	1d
5	J,L	5d
6	C,E,F	6d
7	B,D,G,H,K,N,O,P,R,S,T,U & Z	7d
8	A,Q,V,X,Y	8d
9	M	9d
12	W	12d

Lower case letters and numerals

Width (W)	Letters/Numerals	Width
1	i	1d
3	j,l	3d
4	f,t,l	4d
5	c,r	5d
6	a,b,d,e,g,h,k,n,o,p,q,s,u,v;3;5	6d
7	a,0 (zero), 2,4,6,7,0,8,9	7d
9	m	9d
10	w	10d

The width of different letters in terms of stroke (line) is as follows:

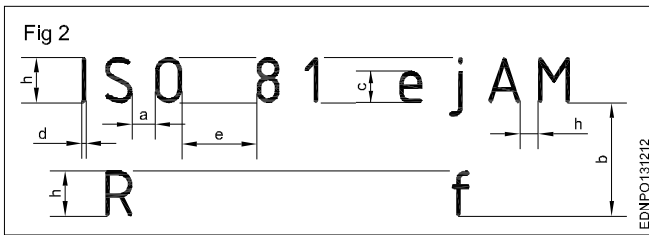
Uppercase Lettering BIS SP: 46-2003

Width (W)	Capital letters
1	I
4	J
5	C,E,F,L
6	B,D,G,H,K,N,O,P,R,S,T,U & Z
7	A,M,Q,V,X,Y
9	W

Lower case letters and numerals

Width (W)	Letters/Numerals
1	i
2	l
3	j,l
4	c,f,r,t
5	a,b,d,e,g,h,k,n,o,,q,s,u,v,x,y,x 0,2,3,5 to 9
6	0,2,3,5 to 9 a,4

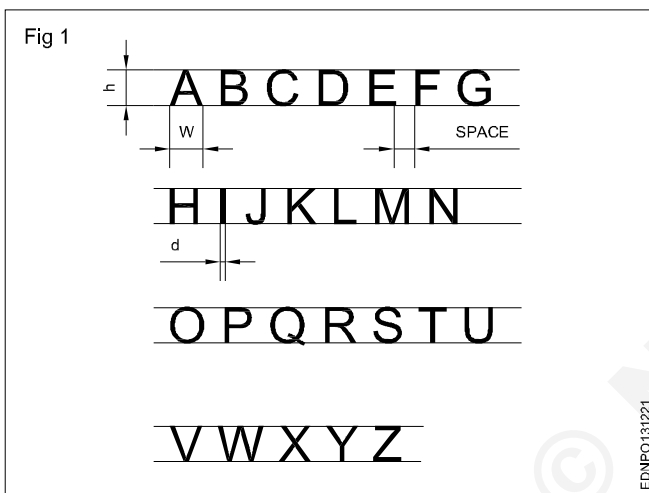
Spacing of letters: Recommended spacing between characters, a minimum spacing of baselines and minimum spacing between words as per BIS SP: 46-2003 are given below in Fig 2.



Lettering

Procedure

- 1 Print 10 mm single stroke capital letters and numerals in vertical style using either scale or set-square and by freehand. (Fig 1)



- Draw horizontal parallel lines (thin lines) of 10 mm distance.

10 mm distances denote the height of the letter.

- Mark the width of the letters recommended by BIS (IS:9609-1983)

The width of different letters in terms of 'd' is as follows: 'd' indicates stroke thickness i.e d: h/ 10.

Width (W)	Capital letters
1	I
4	J
5	C, E, F, L
6	B, D, G, H, K, N, O, P, R, S, T, U & Z
7	A, M, Q, V, X, Y
9	W

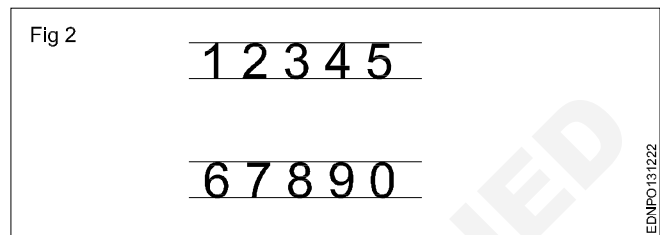
For curved letters use a smooth freehand curve.

Print straight line letters using either scale or set-squares.

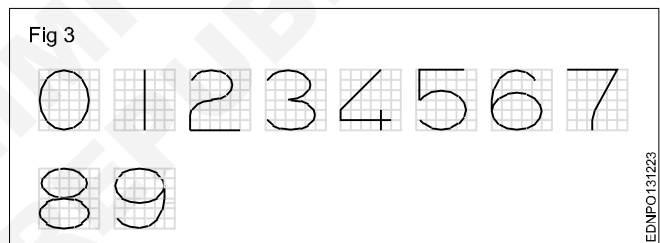
To maintain the uniform thickness of the line, use a conical point soft grade pencil and avoid too much sharpness.

Guidelines of both top and bottom should always be drawn with a sharp pencil.

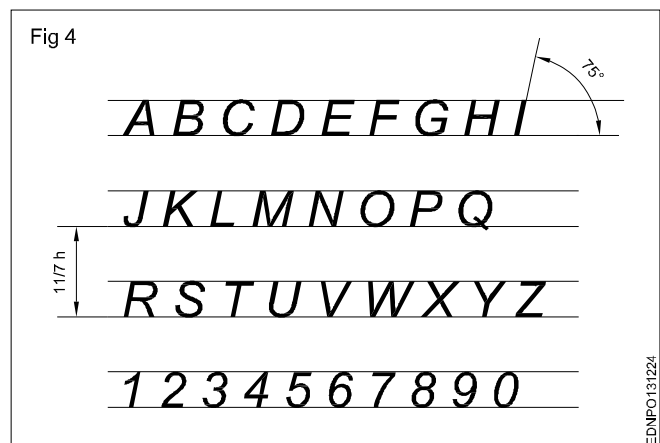
Numerals 2.1 (Fig 2)



- Follow the same procedure of letters.
- 'h' is height of numerals and 'd' is the stroke thickness.
- Width of numerals in terms of 'd' is as follows shown in square grid (Fig 3).



- 2 Print 10 mm single stroke capital letters and numerals in inclined style (Fig 4).



Practice the following lettering exercises in A3/A4 paper as per the given ratio

1 Single stroke inclined letters of ratio 7:6, 7:5, 7:4, 7:3, 7:1 (Fig 5)

Fig 5

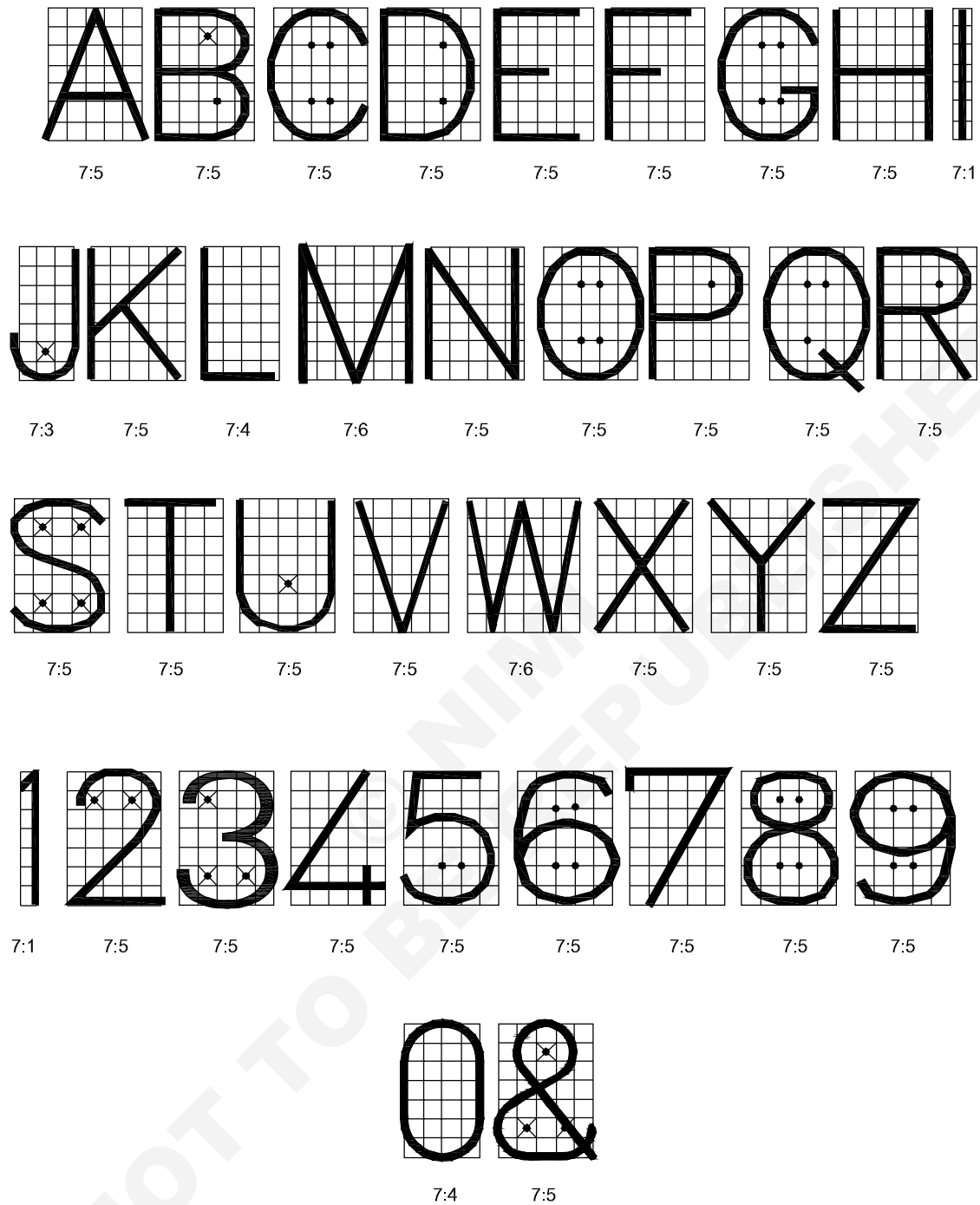


SINGLE STROKE INCLINED LETTERS

EDNPO131225

2 Single stroke vertical letters of ratio 7:6, 7:5, 7.4, 7:3, 7:1 (Fig 6)

Fig 6

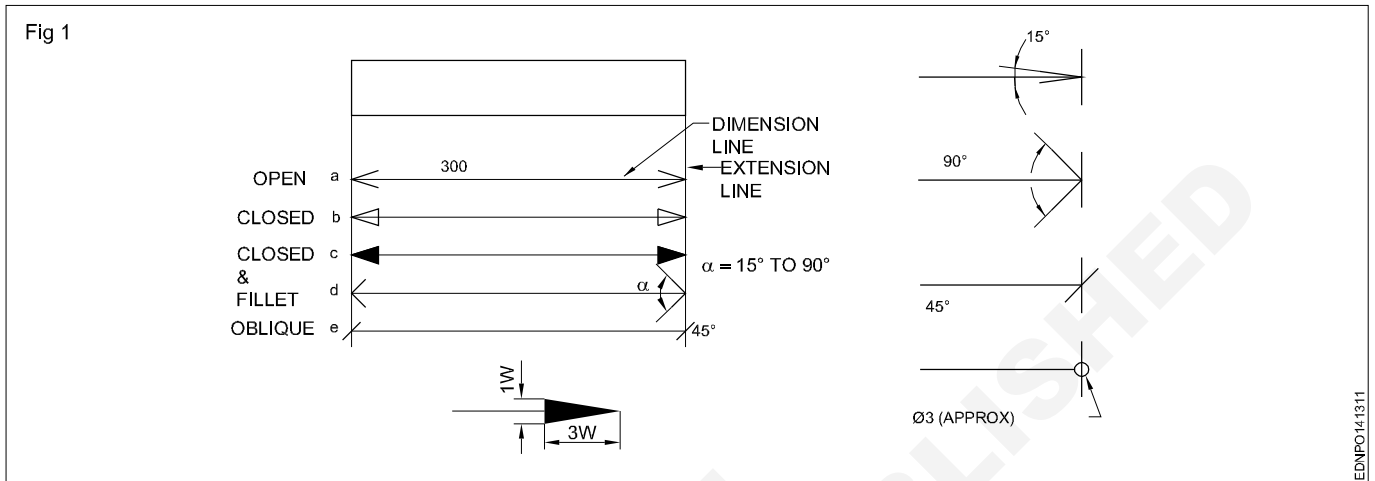


SINGLE STROKE VERTICAL LETTERS

EDNFO131226

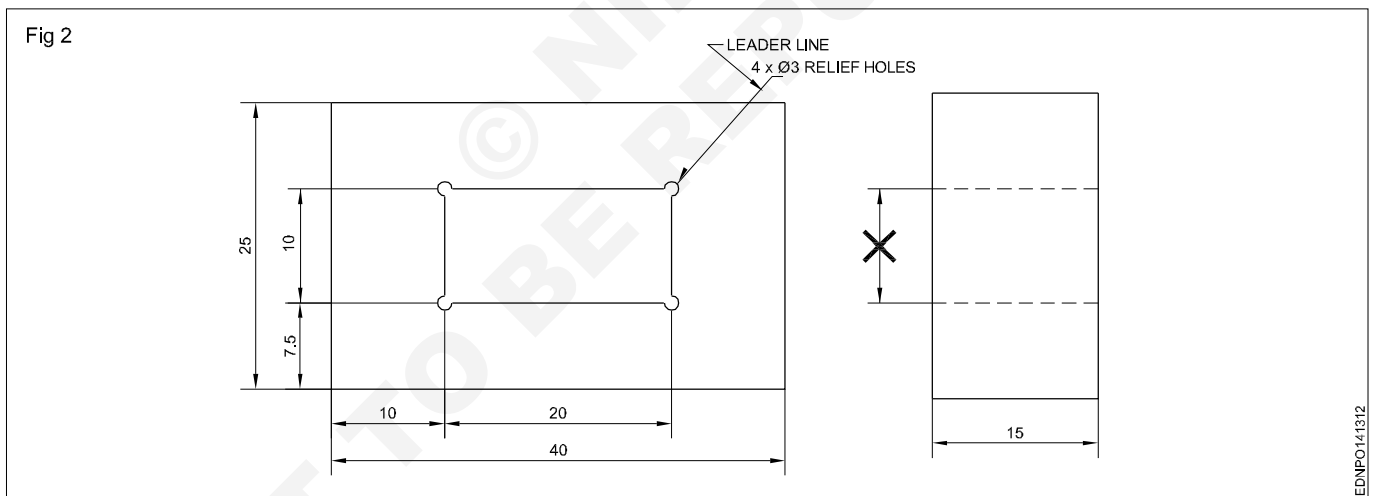
Reading of dimension

Dimension line: These are thin continuous lines, terminated at ends by arrowheads, dots or oblique lines touching the extension line. (Fig 1)



A dimension line may cut or cross another dimension line where there is no other way.

Dimension to the hidden lines be avoided. (Fig 2)



Arrowheads may be placed outside where space is insufficient.

Leader line: It is a thin continuous line. It connects a note or dimension with the features to which it applies. (Fig 2)

Termination and Origin indication: The size of the terminations (arrowheads/oblique strokes) shall be proportional to the size of the drawing. Only one style of arrowhead shall be used on a single drawing. However, where the space is too small for the arrowheads, it may be substituted by a dot or by an oblique line. Arrowheads are drawn as short lines forming barbs at any convenient

included angle between 15° and 90°. They may be open, closed or closed and filled in. Oblique strokes are drawn as short lines inclined at 45°. (Fig 1)

Indicating dimensional values on drawings: All dimensional values shall be shown on drawings in characters of sufficient size to ensure complete legibility on the original drawings as well as on reproductions made from micro-filming.

They shall be placed in such a way that they are not crossed or separated by any other line on the drawing.

Dimensioning - Position of dimensioning (aligned, unidirectional)

Definitions related to dimensioning

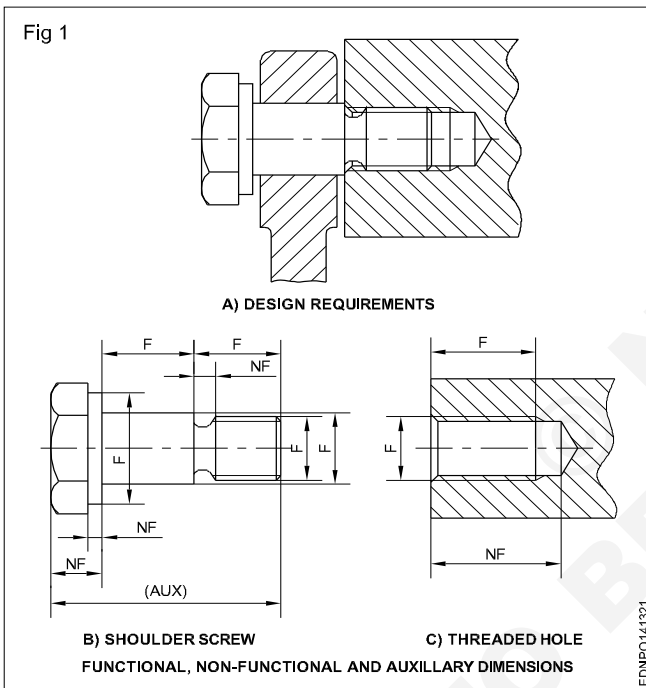
Dimension: It is a numerical value expressed as an appropriate unit of measurement and indicated graphically on technical drawings with lines, symbols and notes.

Dimensions are classified according to the following types:

Functional dimension (F): It is a dimension that is essential to the function of the component or space. They are generally shown with limits. (Fig 1)

Non-functional dimension (NF): It is a dimension that is not essential for the function of the component or space.

Auxiliary or Reference dimension (AUX/REF): It is the dimension given for information only. It is derived from the values given on the drawing or related documents and it will not be given for production or inspection. (Fig 1)

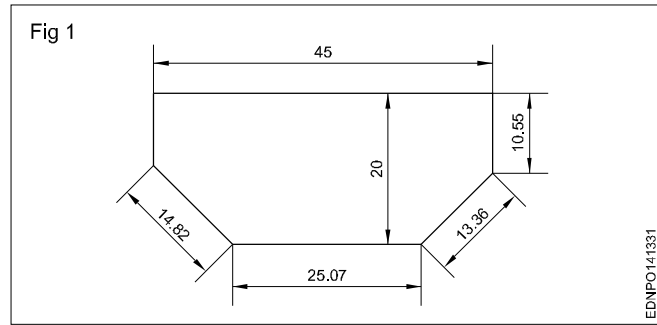


Methods of indicating values

Methods of indicating values: There are two methods used for indicating the values. Only one method should be used on any drawing.

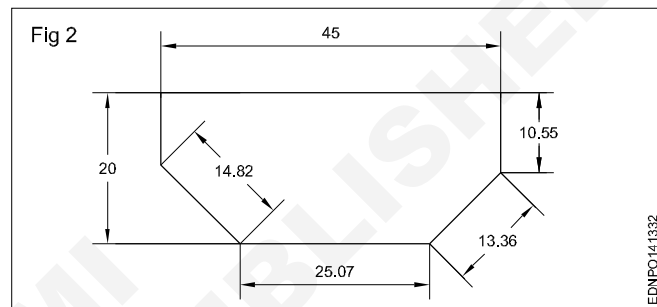
Method 1 Aligned system

Dimensional values shall be placed parallel to their dimension lines and preferably near the middle, above and clear of the dimension line. However, values shall be indicated so that they can be read from the bottom of the drawing. Dimension lines should not be broken. Dimensioning of angles is also given in the same way. (Fig 1) This method is known as an **aligned system** of dimensioning.

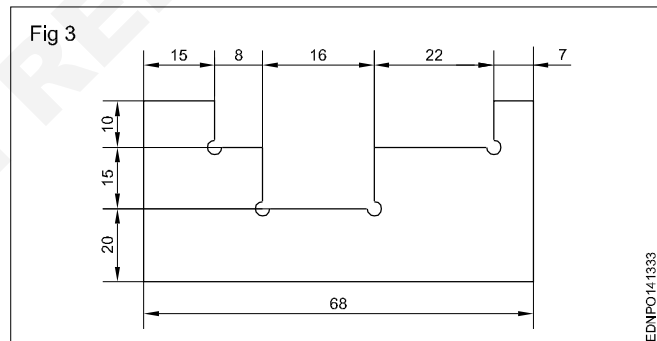


Method 2 Unidirectional system

Dimensional values shall be indicated so that they can be read from the bottom of the drawing sheet. Non-horizontal dimension lines are interrupted, preferably near the middle so that the value can be inserted. (Fig 2). This method is termed a **unidirectional system** of dimensioning.



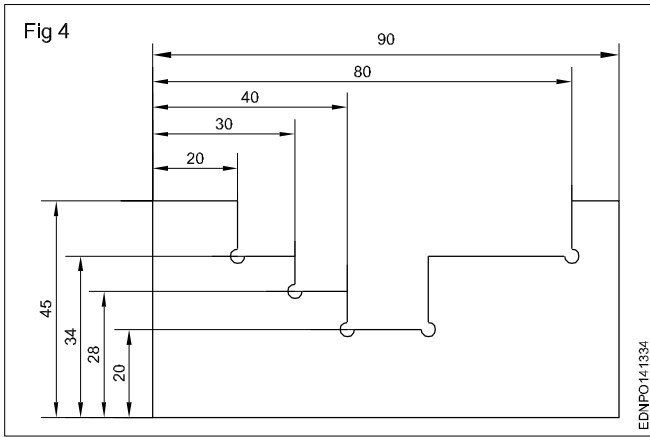
Chain dimensioning: It is used where the possible accumulation of tolerances does not infringe (effect) on the functional requirement of the component. (Fig 3)



Dimensioning from a common feature is used where several dimensions of the same direction relate to a common origin.

Dimensioning from a common feature may be executed as parallel dimensioning or as superimposed running dimensioning.

Parallel dimensioning: Dimensions of features are taken from one datum/common origin and are shown parallel to another and placed so that the dimensional values can easily be added in Fig 4.

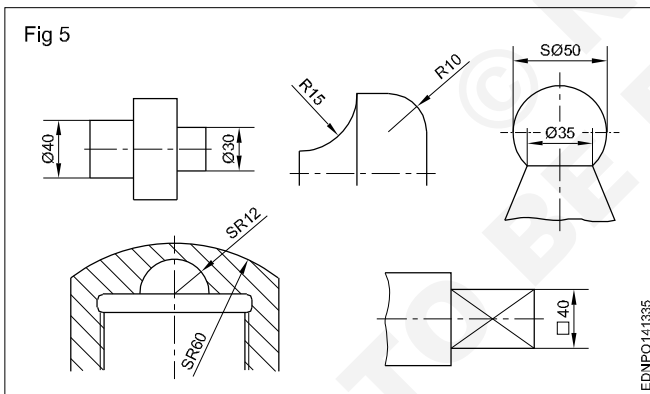


Dimensioning cylindrical and spherical features: Cylindrical features have diameter and length whereas sphere has a diameter only.

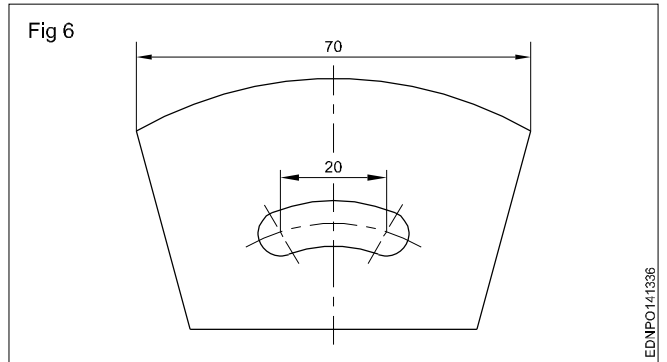
Diameter may be indicated by any one of the abbreviation D, Dia, d, dia or ϕ and radius may be indicated by R, r, Rad or rad by square. Any one abbreviation or symbol on a drawing may be indicated by SQ or \square .

The length if any required to give along with dia, if it is shown as ϕ ...x... long. (Fig 5)

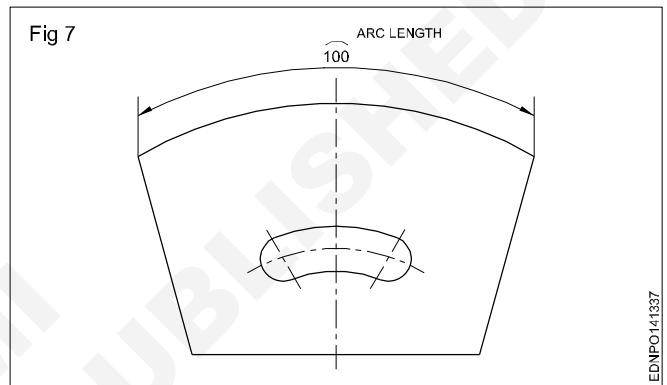
- ϕ - Diameter
- R - Radius
- \square - Square
- SR - Spherical radius
- S ϕ - Spherical diameter



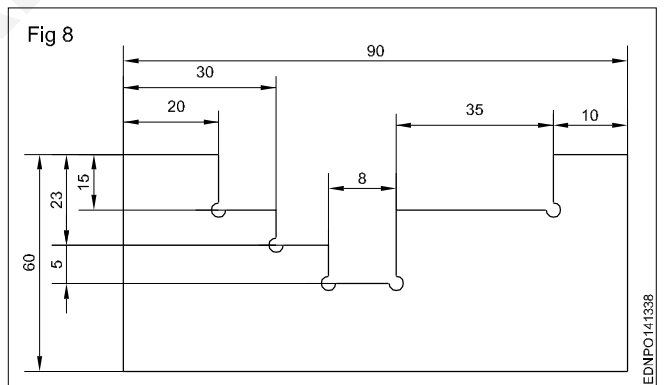
Dimensioning a chord: For dimensioning of the chord, refer Fig 6. It is shown as linear size.



Dimensioning an arc/radius: A small arc is shown over the dimension value, while dimensioning an arc. (Fig 7)



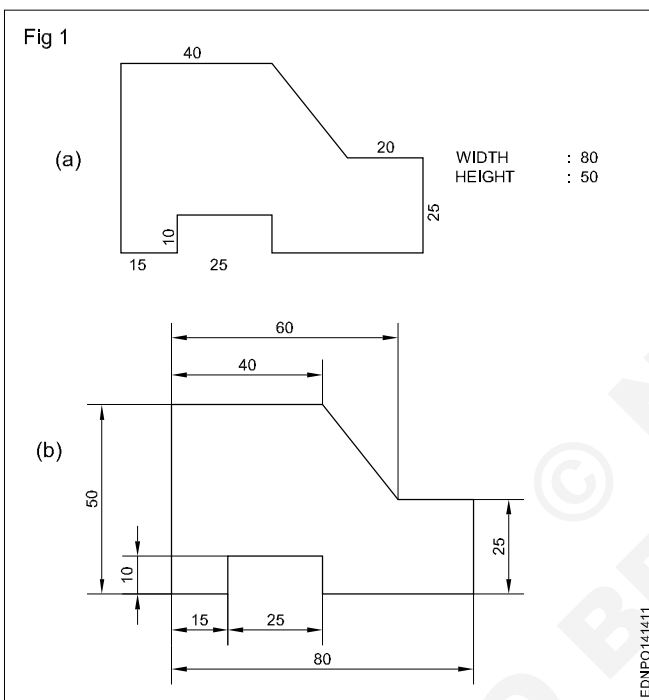
Combined dimensioning: Dimensions are given in chain dimensioning and parallel dimensioning. The common feature is combined. (Fig 8)



Practice of dimensioning

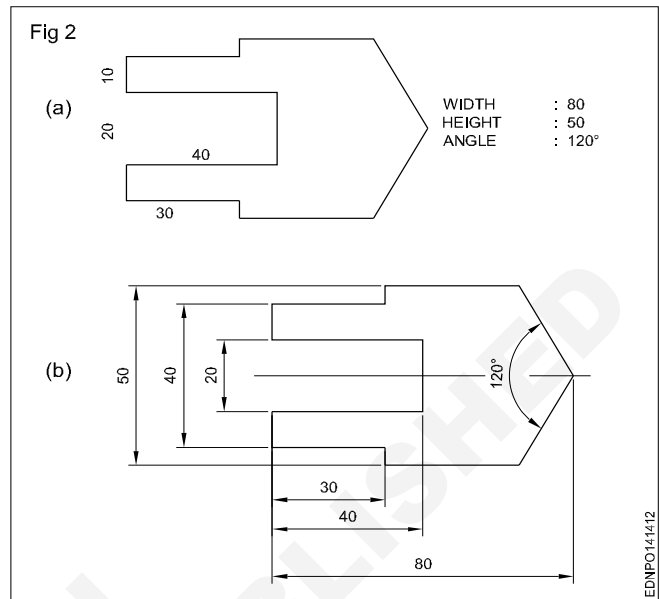
1 To the given drawing of the profile sheet metal as shown in Fig 1, place the dimensions in the aligned system. (Fig 1a)

- Draw the drawing of the sheet metal to 1:1 scale.
- Draw the extension lines in continuation of outlines.
- Draw the dimension lines. (Fig 1b)
- Place the dimension value near the middle and above the dimension line to be read from "bottom and right hand side" of the drawing.



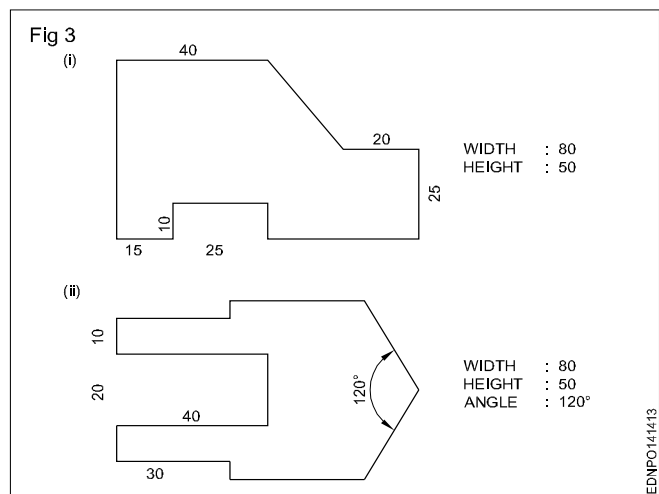
2 To the given drawing of the profile sheet metal as shown in Fig 2a, give the dimensions in the unidirectional system. (Fig 2b)

- Place the horizontal dimensions above and middle of the dimension line without break.
- Break the dimension in the middle of all non-horizontal dimension lines. (Fig 2b)



3 Draw the two sheet metal templates to full scale with appropriate lines use 0.5 range line thickness. (Fig 3)

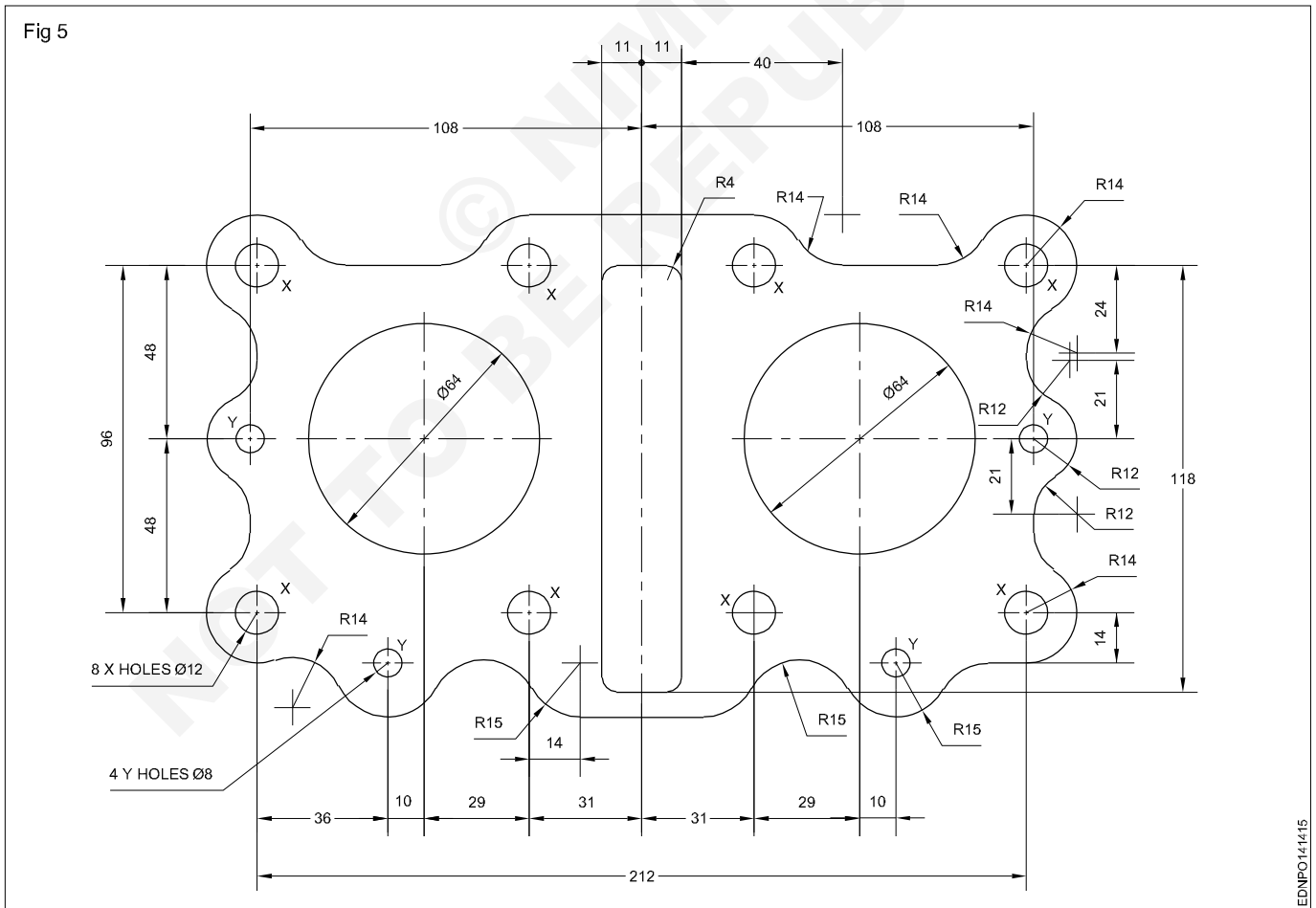
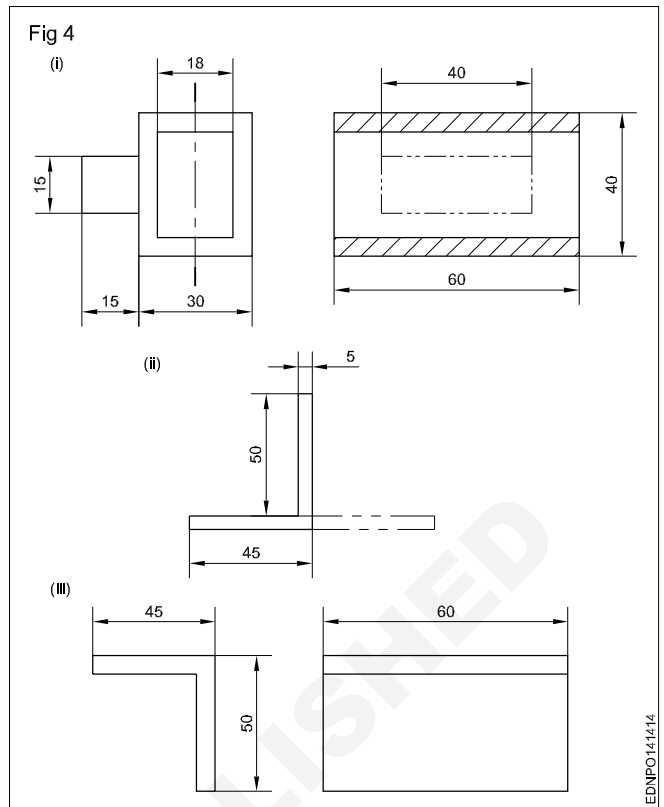
- Draw a rectangular block of length 80 mm and width 50 mm in thin lines.
- Incorporate the features of the template as per the given dimension.
- Draw by thick lines all visible outlines.
- Give dimensions and maintain the line thickness as per the line range (0.5).
- Complete the figure and remove the unwanted lines.



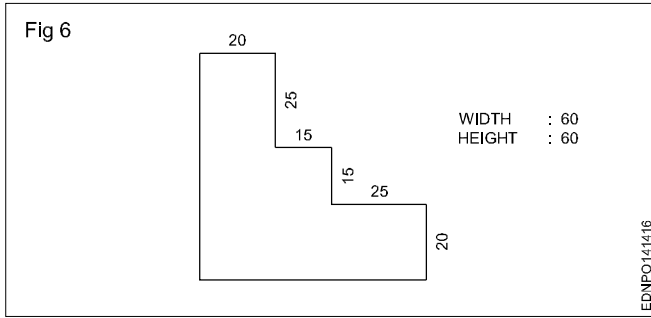
- 4 Draw the figures given. Maintain the types of lines as per the B.I.S and choose correct line thickness. (Fig 4)
- According to the given dimensions, draw the figures given in Fig 4.
 - Select the appropriate lines and maintain uniformity.
 - Remove (erase) unwanted lines, arcs and complete the drawing.

Note: Draw the dimension line terminations as per IS:11669-1986.

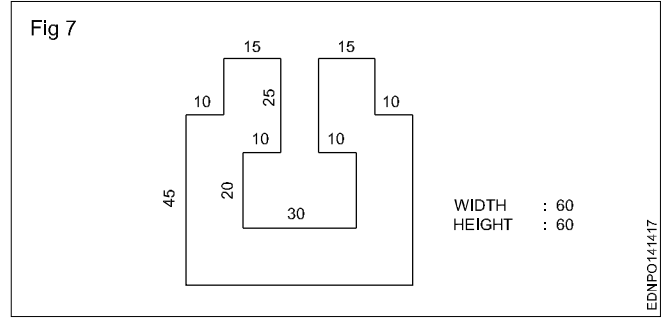
- 5 The motor cycle engine gasket is shown in figure 5. There are some mistakes in dimensioning. Reproduce the same in the A3/A4 sheet provided and correct the mistakes according to the aligned system of dimensioning. (Fig 5)



6 Draw the given cover plate and give the dimensions in the aligned system. (Fig 6)


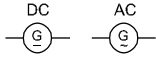
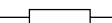

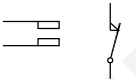
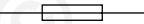

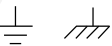

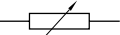



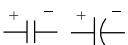


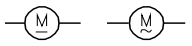






7 Draw the cover plate given in the figure and place the dimensions in the unidirectional system. (Fig 7)



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Symbolic representation - Different symbols used in the pump operator cum mechanic trade

S.No.	Description	Symbol
1	Battery	
2	Generator	
3	Resistance	
4	Coil with core	
5	Contact breaker point	
6	Fuse	
7	Bulb (Lamp)	
8	Earth / Ground	
9	Heavy duty switches	
10	Rheostat	
11	Induction coil	

S.No.	Description	Symbol
12	Condenser	
13	Wire crossed	
14	Ammeter	
15	Motor	
16	Switch	
17	Coil (Without core)	
18	Spark gap	
19	Rectifier (Diode)	
20	Wire joint	
21	Voltmeter	

Symbolic representation of weld, brazed and soldered joints

Convention used for Welded joints

S.no	Designation	Illustration	Symbol
1	Fillet		
2	Square butt		
3	Single V-butt		
4	Double V-butt		
5	Single U-butt		
6	Double U-butt		
7	Single bevel butt		
8	Double bevel butt		
9	Single J-butt		
10	Double J-butt		
11	Stud		
12	Bead edge or seal		
13	Sealing run		
14	Spot		
15	Seam		
16	Stitch		
17	Plug weld		

1 Symbolic representation of supplementary welding symbols

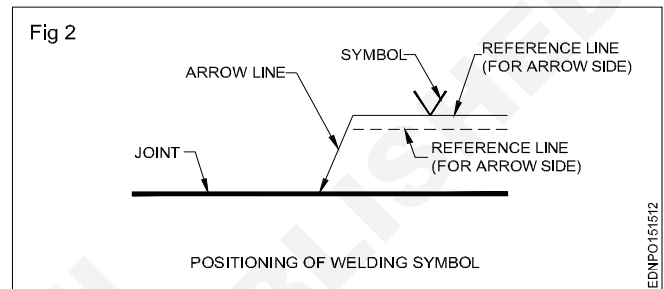
Fig 1

SHAPE OF WELD SURFACE	SYMBOL
1) FLUSH SURFACE	
2) CONVEX SURFACE	
3) CONCAVE SURFACE	

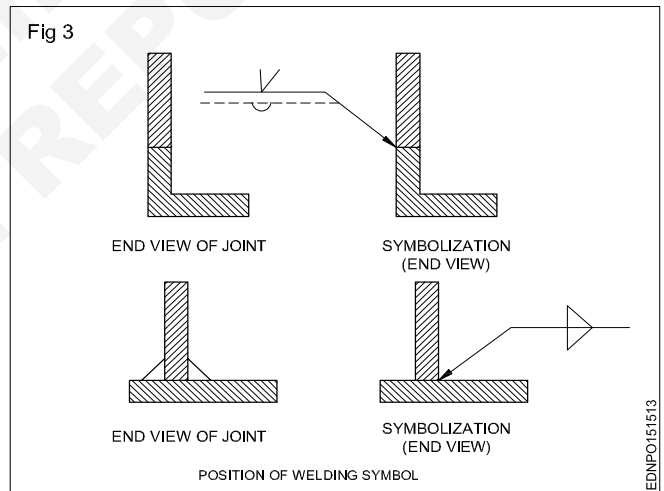
SUPPLEMENTARY WELDING SYMBOLS

EDNIP0151511

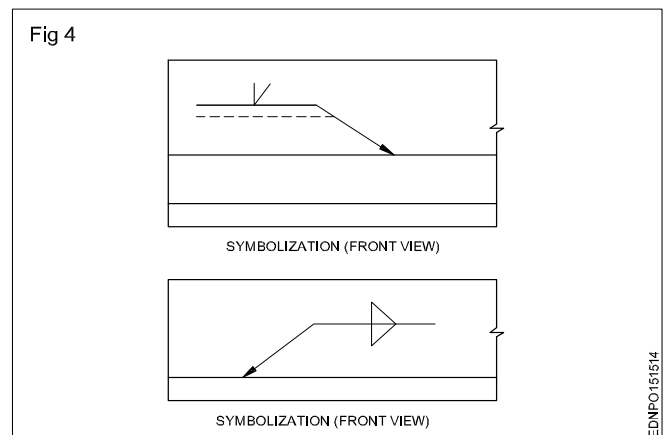
2 Symbolic representation of Positioning of welding symbols



3 Symbolic representation of End view of joint, its symbolization and front view of its symbolization










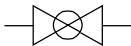


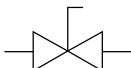







4 Brazed and soldered joints



Symbolic representation of piping joints and fittings

Isometric and orthographic symbols for pipe fittings







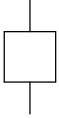





S. No.	Description	Isometric symbol (right face)		Orthographic symbol	
		Screwed	Flanged	Screwed	Flanged
1	Joint/Coupling				
2	Reducer				
3	90° elbow	---	---		
	(i) Turned up				
	(ii) Turned down				
4	Tee	---	---		
	(i) Turned up				
	(ii) Turned down				
5	Cross				
6	Bend			---	---
7	Plug (female)/(dead end)				
8	Plug (male)		---		---
9	Union		---		---
10	Hose nipple		---		---

Image	Valves	Buttweld Symbol	Flanged Symbol
	Gate		
	Globe		
	Ball		
	Plug		
	Butterfly		
	Needle		

Layout symbols in preparation of layout diagram

Some symbols from B.I.S. for two wiring schemes

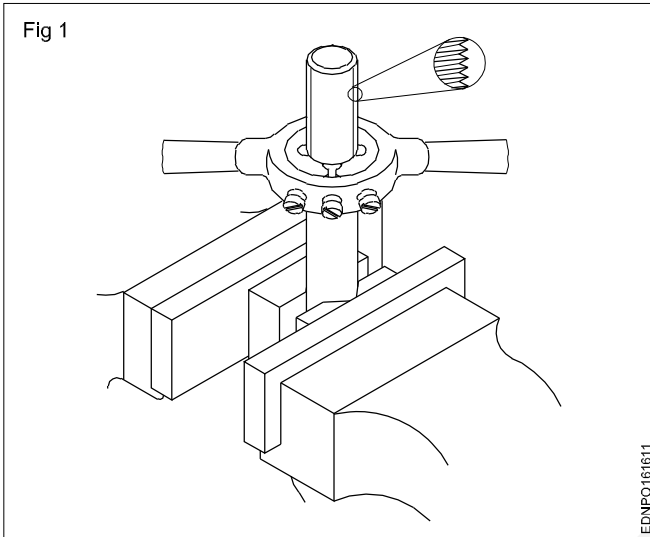
Sl.No.	Description	Symbols used in the circuit diagram	Symbols used in layout diagram
1	One-way switch, single pole		
2	One-way switch, two poles		
3	One-way switch, three poles		
4	Multi-position switch single pole		
5	Two-way switch		
6	Intermediate switch		
7	Push-button or bell-push		
8	Socket outlets, 6A		
9	Socket outlets, 16A		
10	Lamp or outlet for lamp		
11	Fuse		

SI.No.	Description	Symbols used in the circuit diagram	Symbols used in layout diagram
12	Bell		
13	Buzzer		
14	Earth point		
15	Circuit breaker		
16	Terminal strip		N.A
17	Link (closed)		N.A
18	Plug and socket (male and female)		N.A
19	Ceiling rose		N.A
	N.A: Not applicable		

Reading of job drawing

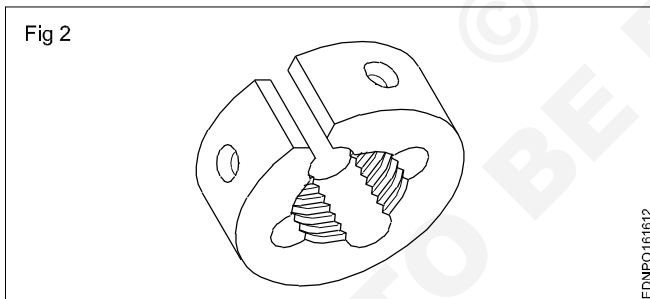
Read and write the following. (Fig 1)

- 1 Why threaded job is held in a split piece in between the vice jaw?



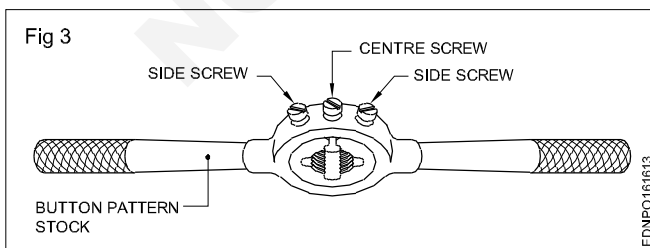
Read and write the following. (Fig 2)

- 1 Why a slot cut is given in a circular die?
- 2 Why two holes are provided in split die?



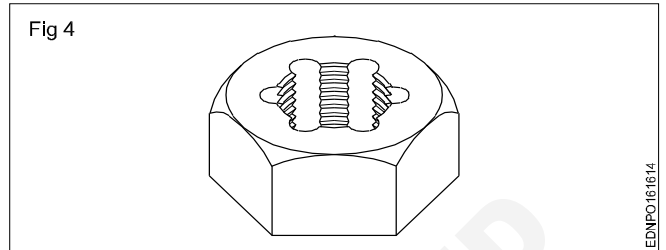
Read and write the following. (Fig 3)

- 1 What is the use of side screw?
- 2 What is the use of centre screw?



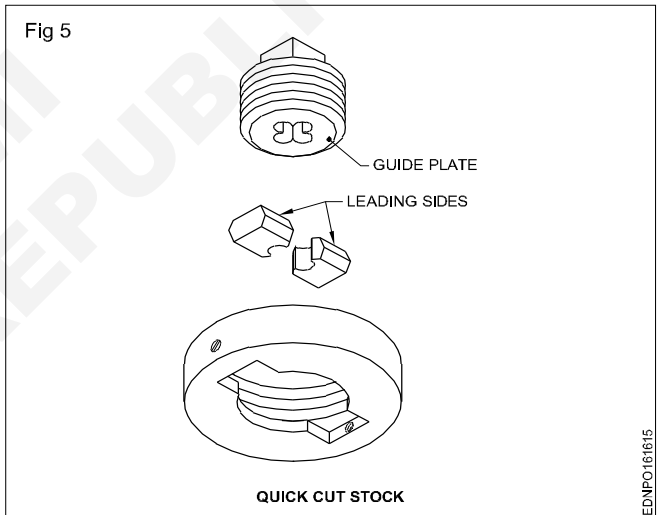
Read and write the following. (Fig 4)

- 1 Where this type of die nut is used?



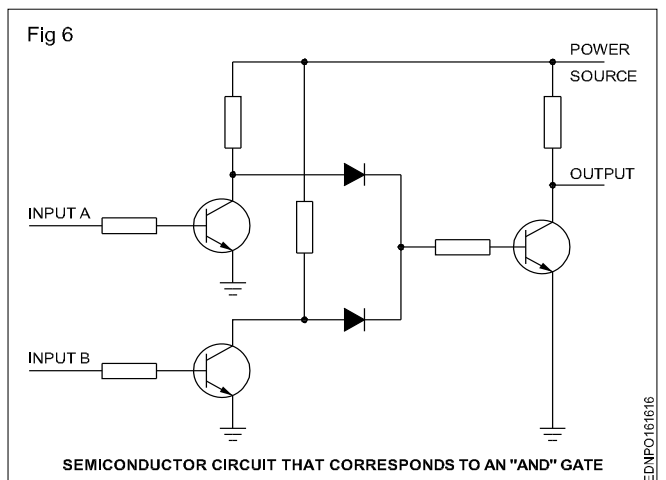
Read and write the following. (Fig 5)

- 1 What is the use of guide plate?
- 2 What is the use of leading sides?
- 3 Why both die halves should have the same serial number?



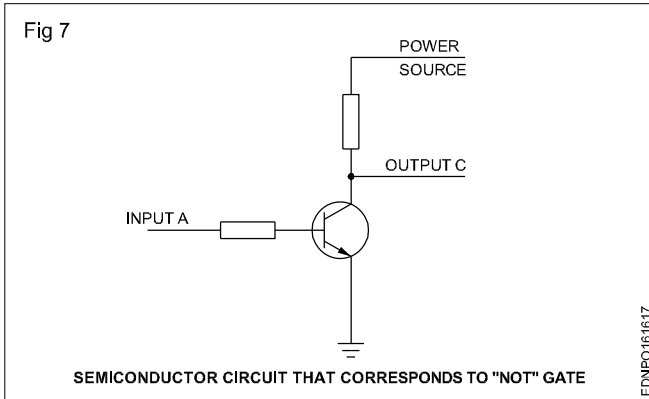
Read and write the following. (Fig 6)

- 1 What is the use of diodes in this circuit?
- 2 What is the effect if any one transistor not functioning?
- 3 Write the truth table of AND gate.



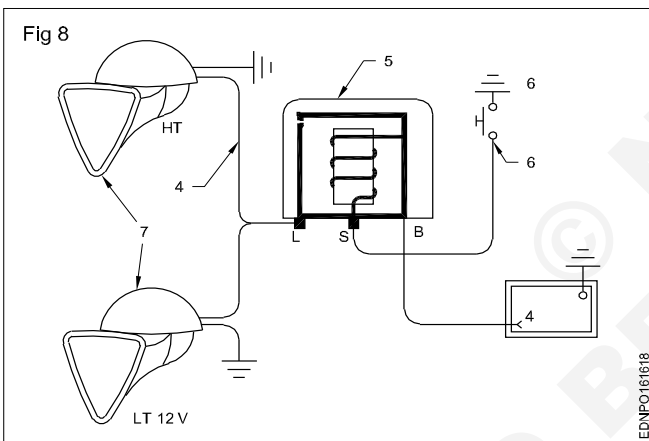
Read and write the following. (Fig 7)

- 1 What type of gate is thin?
- 2 What is the output of thin gate?
- 3 How many output is there in NOT gate?



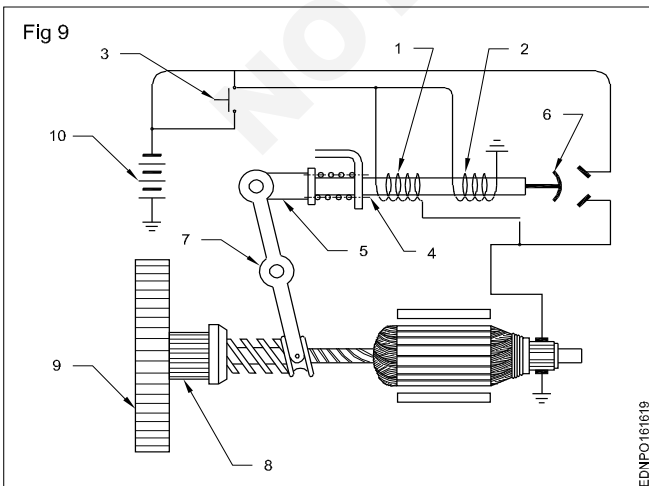
Read and write the following. (Fig 8)

- 1 What is the use of relay?
- 2 What is the working principle of relay?
- 3 What is current sensing relay?
- 4 Which type of relay is given in the diagram?



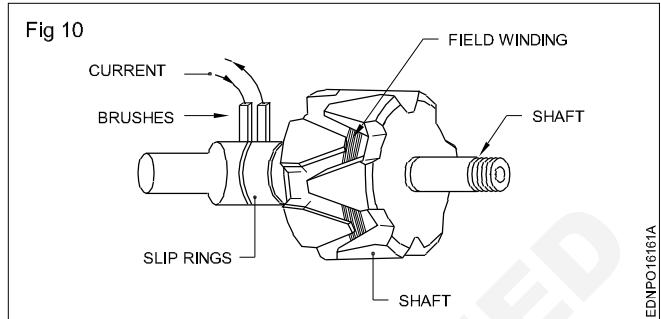
Read and write the following. (Fig 9)

- 1 How many coils are used in the circuit?
- 2 What is the function of solenoid switch?
- 3 What is fly wheel ring gear?



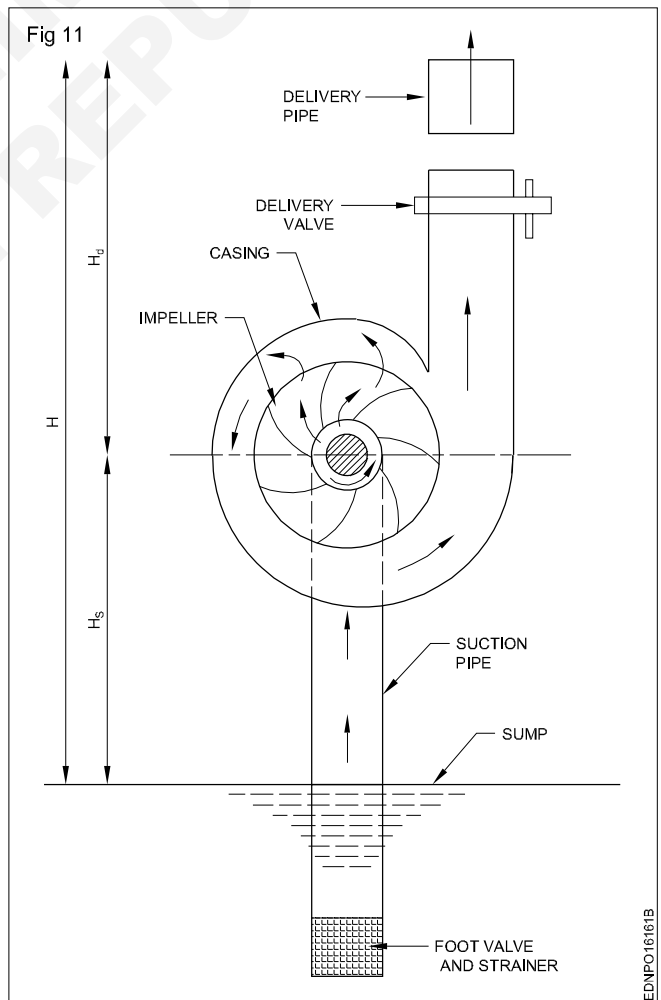
Read and write the following. (Fig 10)

- 1 Which component is used to cool the rotor assembly?
- 2 How to connect the stator assembly?
- 3 Which material is used for lamination?
- 4 How many windings are there in the starter assembly?
- 5 What is the working principle of stator and rotor function?



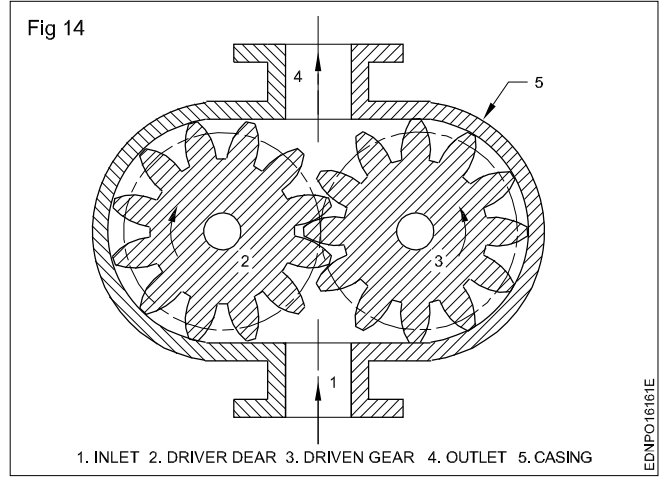
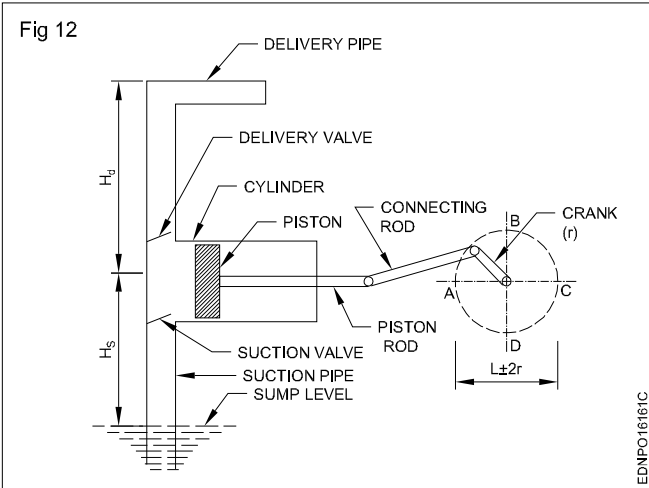
Read and write the following. (Fig 11)

- 1 What is the name of this pump?
- 2 What is the working principle of this pump?
- 3 What is the rotating part of this pump?
- 4 Where the foot valve and strainer are located?
- 5 Where the suction pipes are fitted?



Read and write the following. (Fig 12)

- 1 What is the name of pump?
- 2 What is the working principle of this pump?
- 3 Where the piston is located?
- 4 What is the name of part connects piston and connecting rod?
- 5 Why does the piston move back and forth?

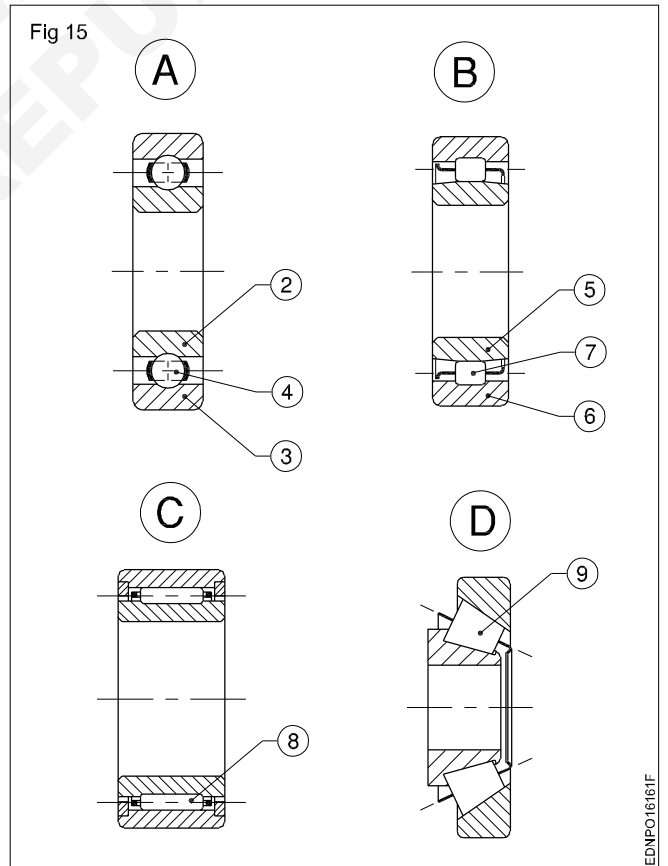
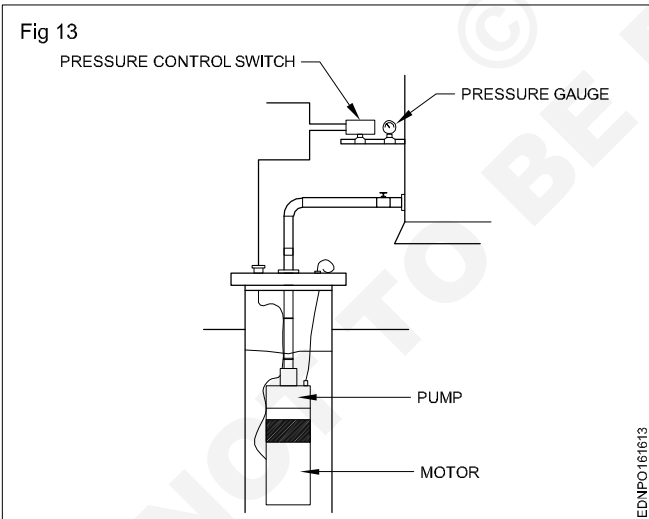


Read and write the following. (Fig 15)

- 1 Write the name of bearing 'A'?
- 2 Write the name of bearing 'B'?
- 3 Write the name of bearing 'C'?
- 4 Write the name of bearing 'D'?
- 5 Write the name of part no.2?
- 6 Write the name of part no.6?
- 7 Write the name of part no.7?

Read and write the following. (Fig 13)

- 1 What is the name of pump?
- 2 What is the other name of submersible pump?
- 3 Where to keep the submersible pump?

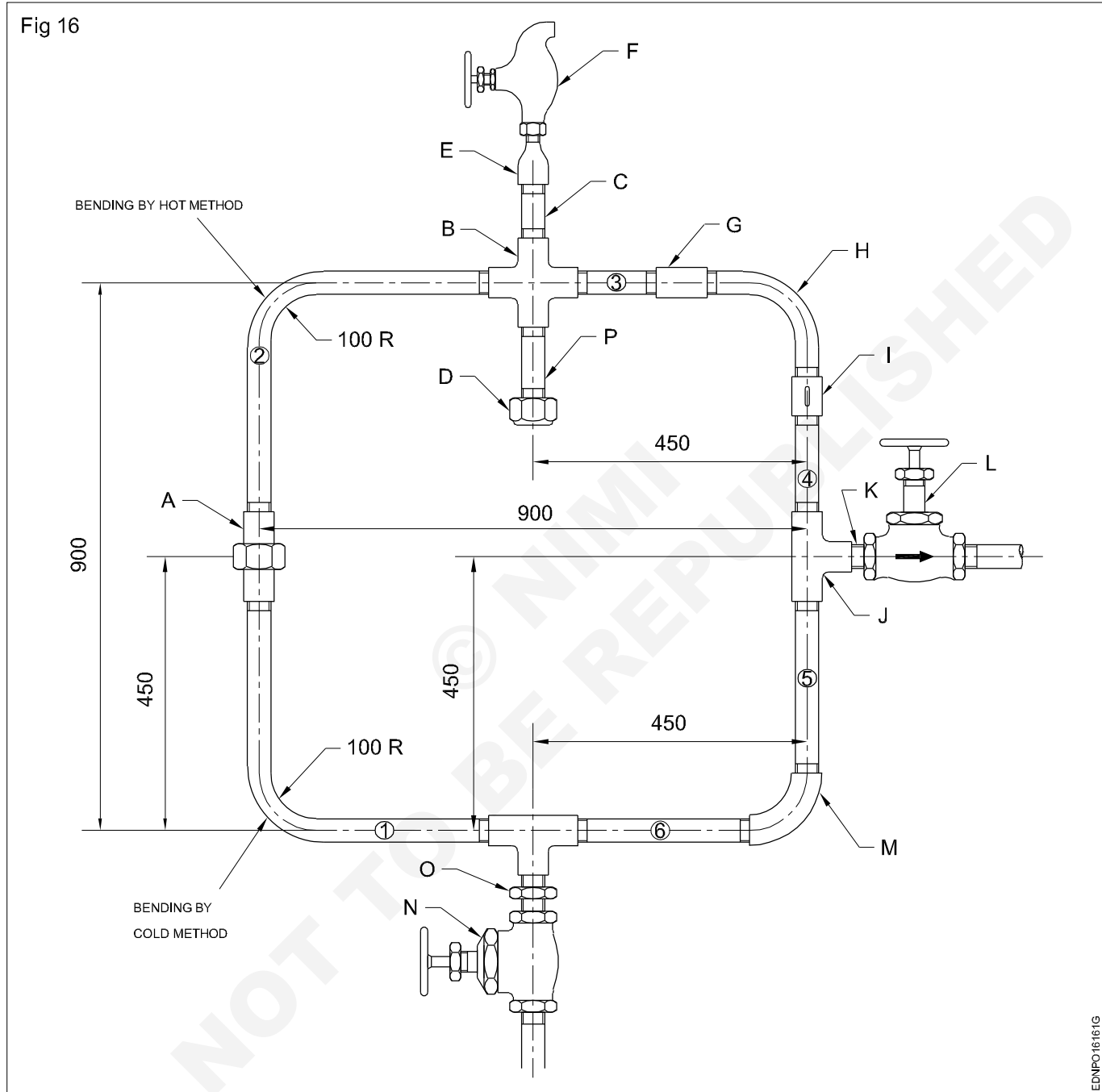


Read and write the following. (Fig 14)

- 1 What is the name of pump?
- 2 Write the type of pump?
- 3 Where gears are located?

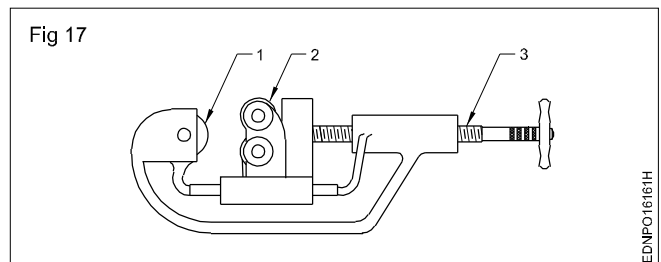
Read and write the following. (Fig 16)

- | | |
|---------------------------------|---------------------------------|
| 1 What is the name of part 'G'? | 5 What is the name of part 'C'? |
| 2 What is the name of part 'H'? | 6 What is the name of part 'E'? |
| 3 What is the name of part 'M'? | 7 What is the name of part 'F'? |
| 4 What is the name of part 'A'? | |



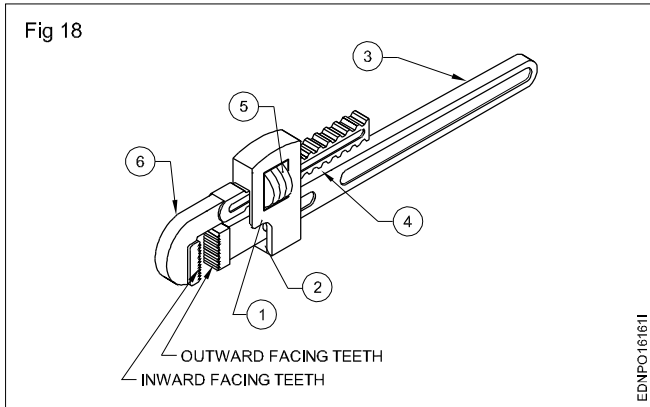
Read and write the following. (Fig 17)

- 1 Write the name of tool?
- 2 What is the name of part no.1?
- 3 What is the name of part no.2?



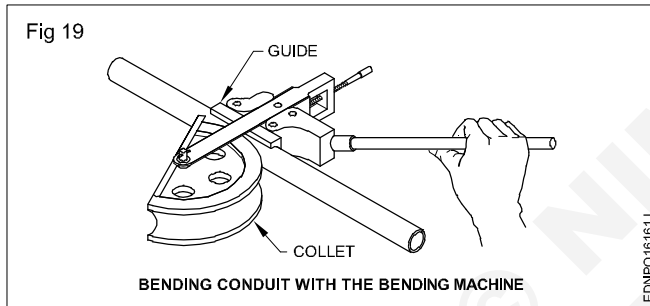
Read and write the following. (Fig 18)

- 1 Write the name of tool?
- 2 Write the uses of tool?
- 3 What is the name of part no.5?
- 4 What is the name of part no.6?



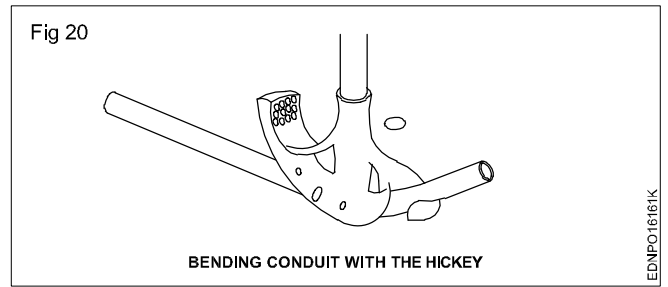
Read and write the following. (Fig 19)

- 1 Write five points about precautions while bending?



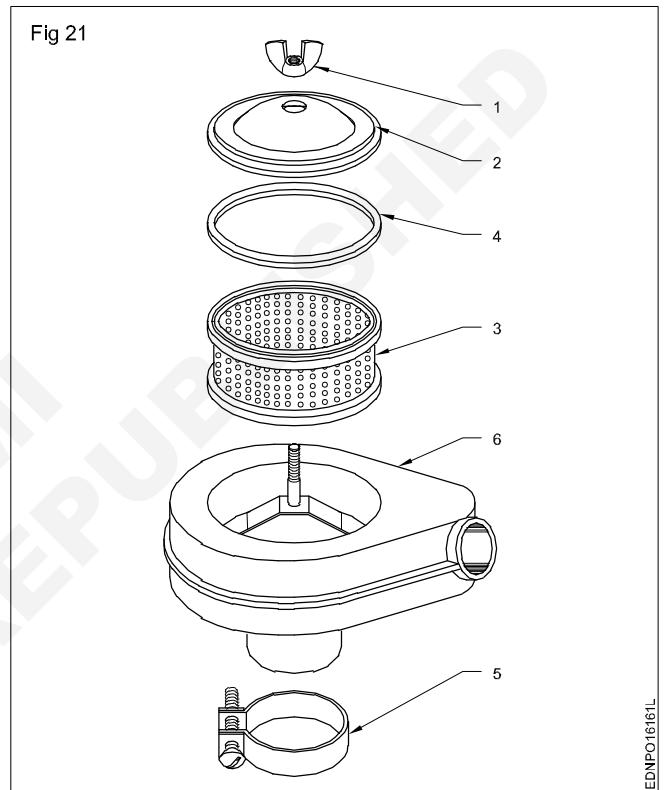
Read and write the following. (Fig 20)

- 1 Write about Hickey?
- 2 Which material made of Hickey?
- 3 Which size of pipe can make bending?



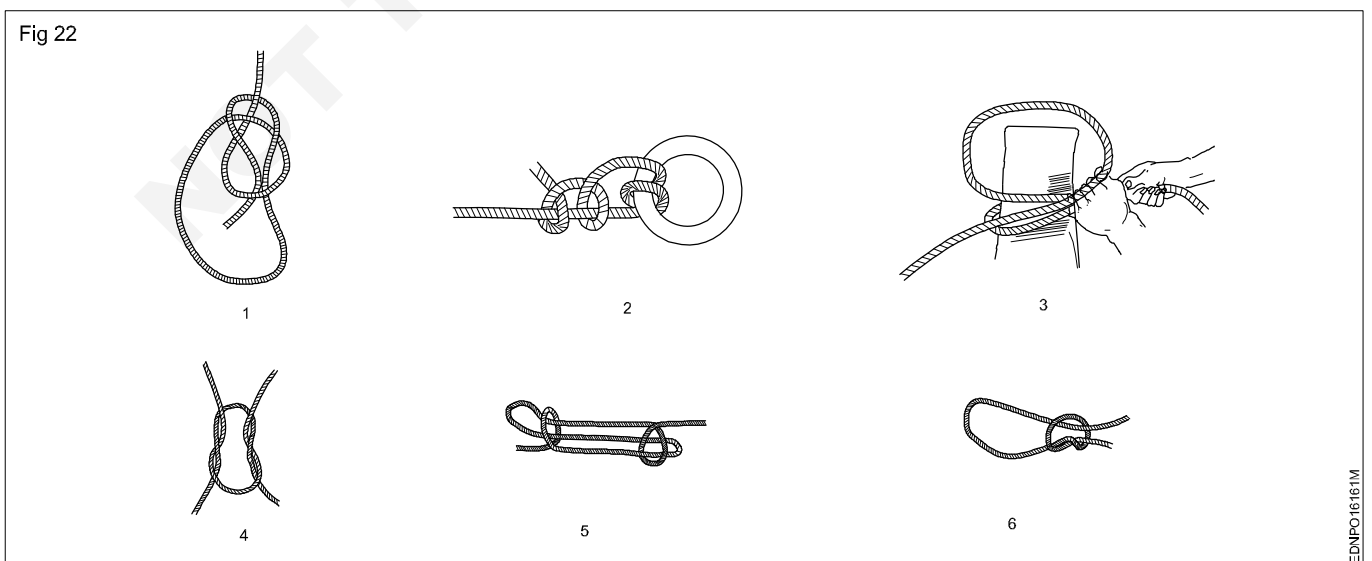
Read and write the following. (Fig 21)

- 1 What is the name of part no.1?
- 2 What is the name of part no.3?



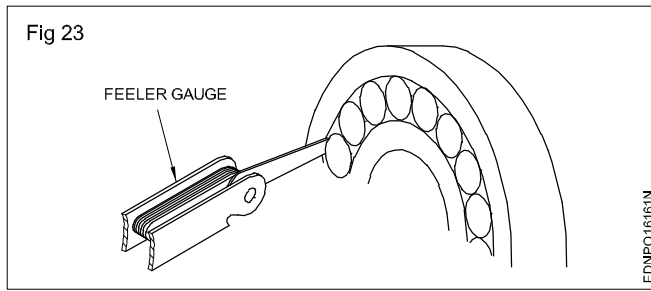
Read and write the following. (Fig 22)

- 1 Write the name of knots 1 to 6 shown in the figure?



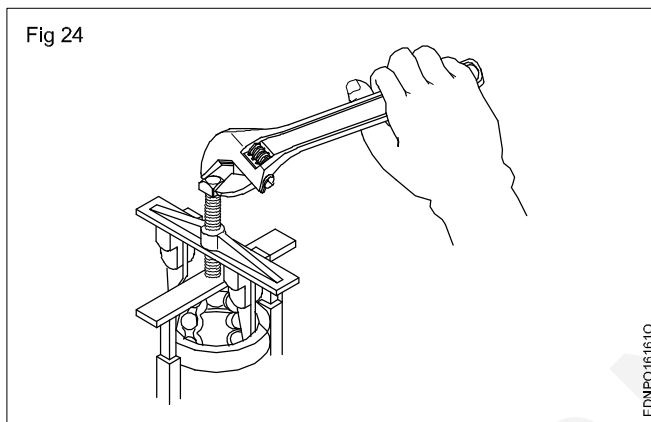
Read and write the following. (Fig 23)

- 1 What activity is going on?
- 2 What is the purpose of this activities?



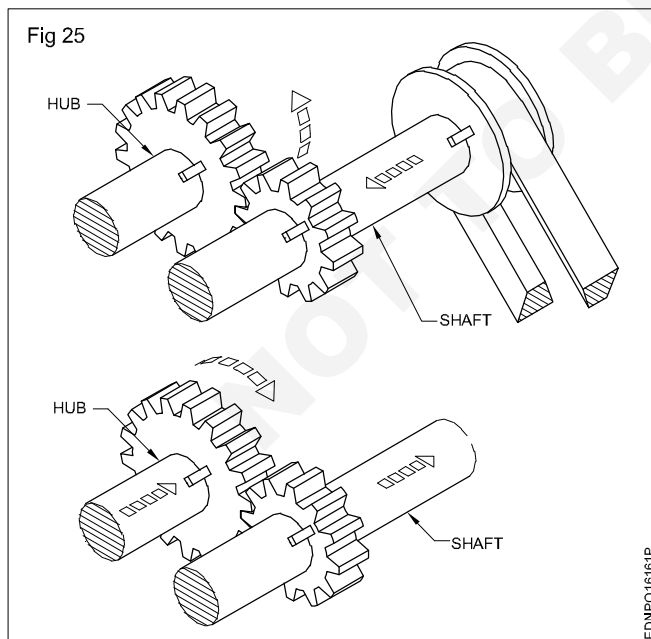
Read and write the following. (Fig 24)

- 1 What activity is going on?
- 2 Write the procedure of this activities?



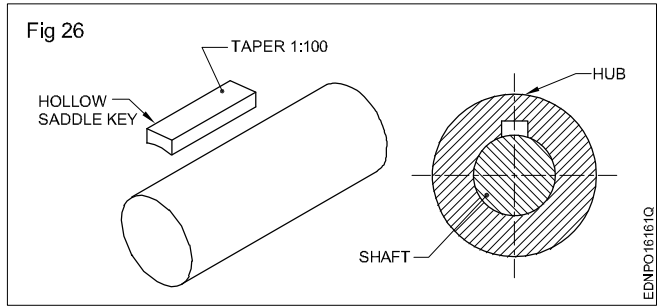
Read and write the following. (Fig 25)

- 1 Write the name of assembly?



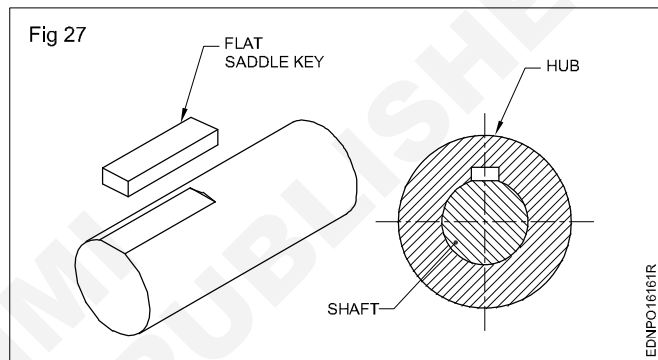
Read and write the following. (Fig 26)

- 1 Write the shape of Hollow saddle key?



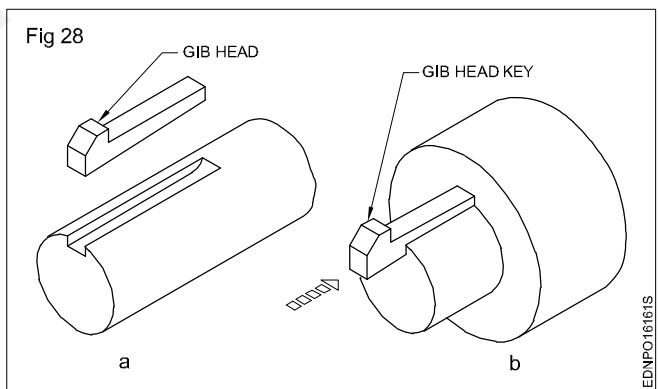
Read and write the following. (Fig 27)

- 1 Write the shape of Flat saddle key?
- 2 Write the assembly of Flat saddle key?



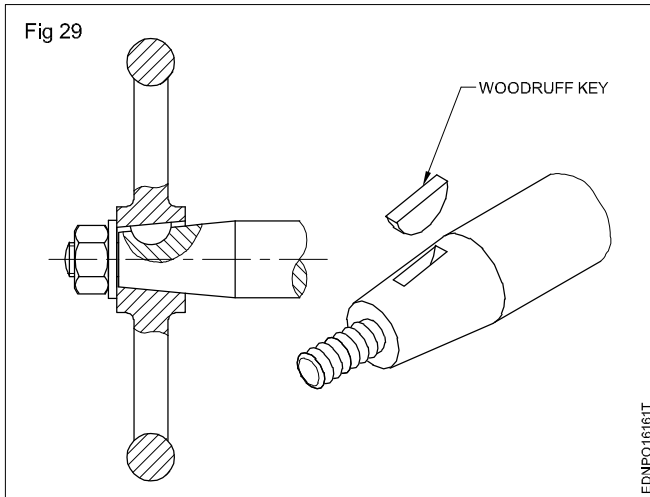
Read and write the following. (Fig 28)

- 1 Write a taper ratio of gib - headed key?
- 2 Why gib - headed key is not good for high speed?



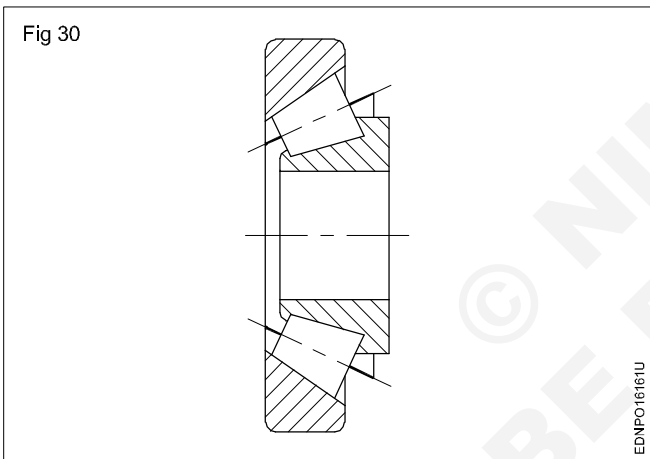
Read and write the following. (Fig 29)

- 1 Where semicircular key is used?



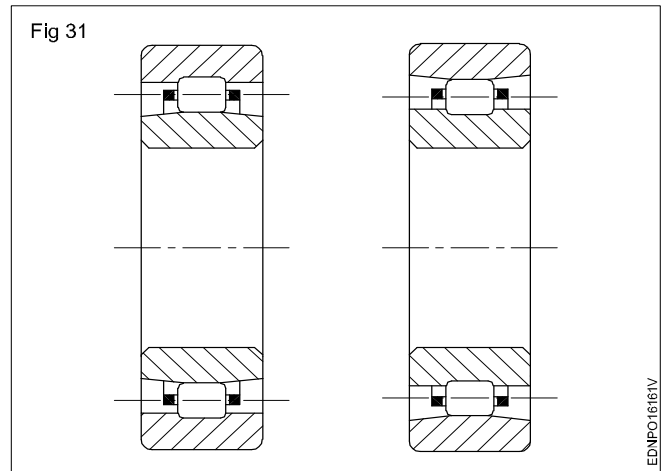
Read and write the following. (Fig 30)

- 1 Where taper roller bearings are used?
- 2 Which type of load is acting in taper roller bearing?



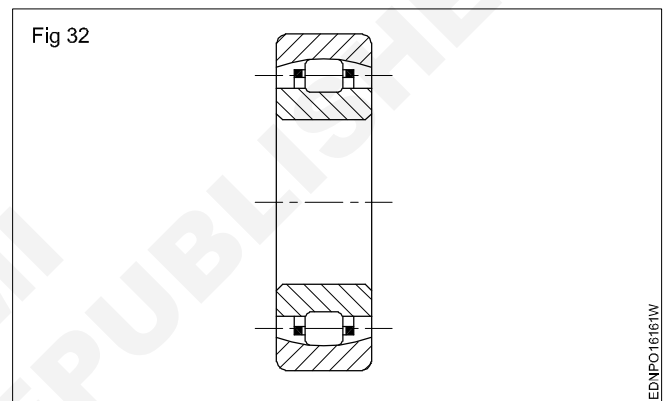
Read and write the following. (Fig 31)

- 1 How many types of roller bearings are there?
- 2 Which type of load is acting in roller bearing?



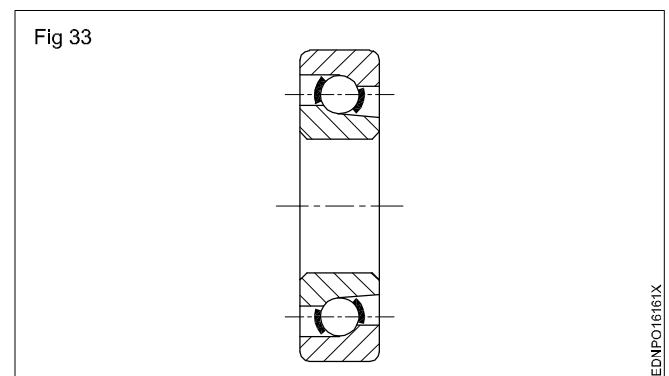
Read and write the following. (Fig 32)

- 1 Write about the shape of Self aligning roller bearing?



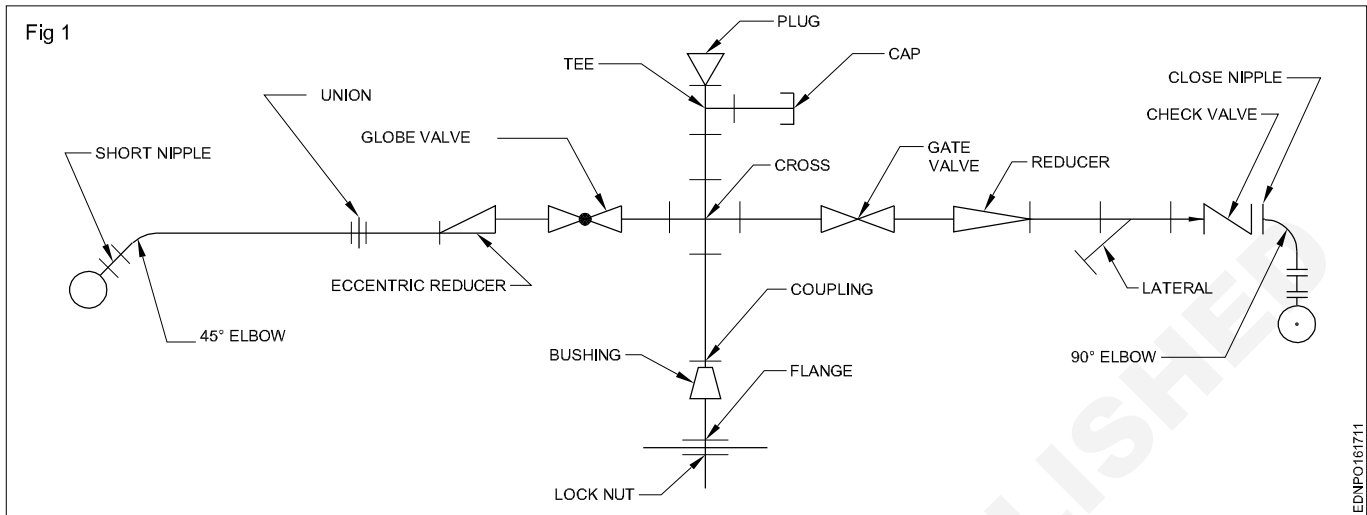
Read and write the following. (Fig 33)

- 1 Which type of load is acting in Angular contact ball bearing?

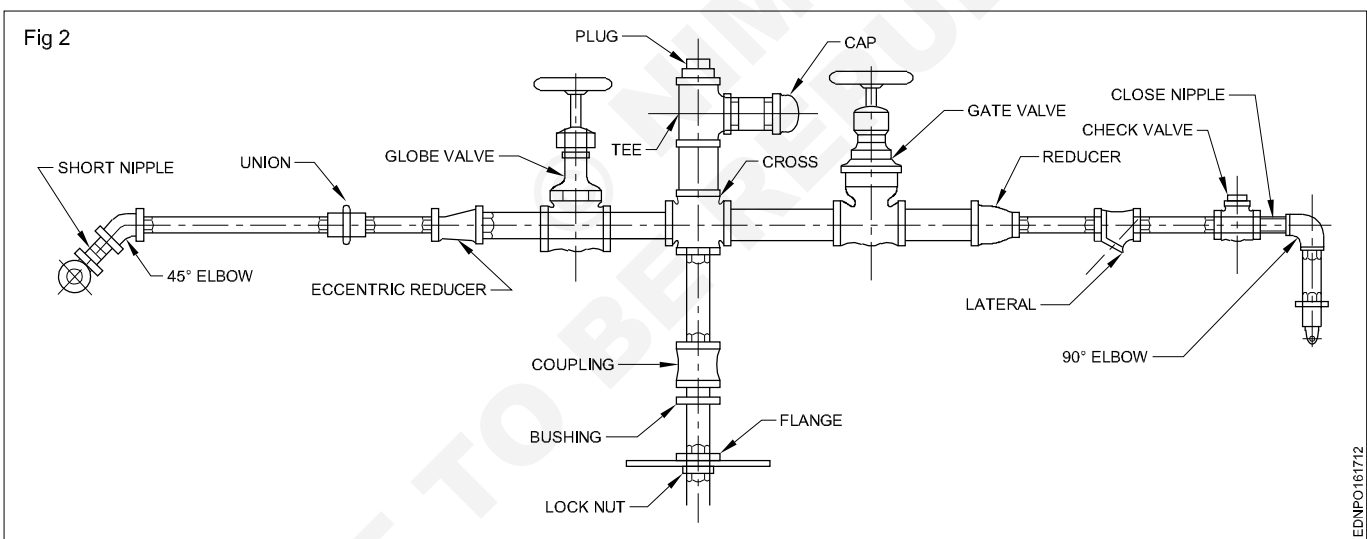


Reading of piping layout

Piping layout of Single line Orthographic view (Fig 1)



Piping layout of Double line Orthographic view (Fig 2)



Read and write the following. (Fig 1&2)

- 1 What is the purpose of union?
- 2 Where flange coupling is to be used?
- 3 What is the difference between union and flange coupling?
- 4 What is the use of Globe valve?
- 5 What is the use of Gate valve?
- 6 What is the difference between Globe valve and gate valve?
- 7 Where Eccentric reducer is used?
- 8 Where check valve is used?
- 9 Why lock nut is required?
- 10 State the purpose and use of plug cap?