ENGINEERING DRAWING

(NSQF)

2^{nd} Year

Group - I

(For Mechanical Trade Group)

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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Engineering Drawing (NSQF) - 2^{nd} Year

Group - I (For Mechanical Trade Group)

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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 2nd Year Group - I** NSQF **(Mechanical Trade Group of 22 Trades)** 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

RAJESH AGGARWAL
Director General/ Addl. Secretary
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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** 2nd Year Group - I (Mechanical Trade Group of 22 Trades under CTS) is one of the book developed by the core group members as per the NSQF syllabus.

The **Engineering Drawing** 2nd Year Group - I (Mechanical Trade Group of 22 Trades 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.

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032

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 (2nd Year Group - I (Mechanical Trade Group of 22 Trades)** as per NSQF.

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Shri. G. Michael Johny	-	Assistant 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 **2nd year Group - I Engineering drawing NSQF** (Mechanical Trade Group of 22 Trades) 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 2nd 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 2nd Year : 80 Hrs

Time allotment for each module has been given below. Group - I (Mechanical Trade Group of 22 Trades) Engineering Trades.

S.No	Title	Exercise No.	Time in Hrs
1	Construction of scales and diagonal scales	2.1.01	4
2	Conic sections (Ellipse and Parabola)	2.2.02	3
3	Sketches of nuts, bolt, screw thread, different types of locking devices e.g. Double nut, Castle nut, Pin, etc.	2.3.03 & 2.3.04	6
4	Sketches of foundation	2.4.05	8
5	Rivets and rivetted joints, welded joints	2.5.06 - 2.5.09	10
6	Sketches of pipes and pipe joints	2.6.10	10
7	**Assembly view of** Vee blocks, Bush & Bearing, Different types of Coupling viz., Muff coupling, Half Lap Coupling, Flange coupling, etc. Simple work holding device e.g. vice, Drawing details of two mating blocks and assembled view	2.7.11 - 2.7.16	25
8	Sketch of shaft and pulley, belt, gear, gear drives	2.8.17& 2.8.18	14
			80 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 instructors, VPS and Principals of the Institute.

The file may be referred by the authority before granting the internal marks at the end of 2nd Year.

CONTENTS

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

2^{nd} Year **Group - I (Mechanical Trade Group of 22 Trades)** **Duration: One Year**

S.no.	Syllabus	Time in hrs
I	**Construction of scales and diagonal scale**	4
II	**Conic sections (Ellipse and Parabola)**	3
III	**Sketches of nuts, bolt, screw thread, different types of locking devices e.g. Double nut, Castle nut, Pin, etc.**	6
IV	**Sketches of foundation**	8
V	**Rivets and rivetted joints, welded joints**	10
VI	**Sketches of pipes and pipe joints**	10
VII	**Assembly view of** 1 Vee blocks 2 Bush & Bearing 3 Different types of Coupling viz., Muff coupling, Half Lap Coupling, Flange coupling, etc. 4 Simple work holding device e.g. vice 5 Drawing details of two mating blocks and assembled view	25
VIII	**Sketch of shaft and pulley, belt, gear, gear drives**	14
	Total	80

Group - I (Mechanical Trade group).

Following 22 trades have been covered in mechanical trade group

(Fitter, Turner, Machinist, Machinist Grinder, Mechanic Machine Tool Maintenance, Operator Advance Machine Tool, Mechanic Motor Vehicle, Mechanic Agriculture Machinery, Ref. & A/C Mechanic. Central Air conditioning plant, Mechanic Mining Machinery, TDM (D&M), TDM (J&F), Marine Fitter, Aeronautical Structure, Spinning Technician, Textile Wet processing Technician, Weaving Technician, Textile Mechatronics, painter General, Mechanic Maintenance (Chemical plant),Refractory Technician.)

Construction of scales and diagonal scale

Plain Scale, Representative fraction (R.F)and Diagonal Scale

Scales : It is difficult to draw the components to their actual sizes, because they may be too large to be accommodated on the drawing sheet or too small to draw and cannot be effectively used in the shop floor. For example, think of making the drawing of a motor car. It is too long and wide to be drawn on the drawing sheet to its original size. Similarly small component like wheel of a wrist watch or its needle (hands) if drawn to its original size will not be legible enough for use in the shop floor.

So depending on the situation drawings are drawn smaller or larger than the actual sizes. When we say that the drawings are smaller or larger, we mean that a given length in the drawing will be smaller or larger than the corresponding length in the object.

The ratio of the length in the drawing to its corresponding length of an object, when both the lengths are in the same unit, it is called the **Representative Fraction** (RF).

$$RF = \frac{\text{Size of the component in the Drawing}}{\text{Actual size of the component}}$$

Depending on the situation the term scale implies either RF or a measuring device itself made for a particular RF.

RF has two elements of which one of the element is always'1'.

Example of RF: 1:5, 1:20, 10:1, 50:1 etc.

First element in the RF always represents the size in the drawing while the second element represents the corresponding size of the object.

Reduction and enlarged scale

Thus RF such as 1:3; 1:100 etc are the reduction scales and the drawings made is smaller than the object.

Similarly RF such as 10:1; 50:1 etc are the enlarged scales and the drawings made are larger than the object.

RF may be written in one of the two ways shown below:

$\frac{1}{20}$ or 1:20 (Reduction scale)

$\frac{15}{1}$ or 15:1 (enlargement scale)

Different reduction scales are recommended by BIS vide IS:10713 are as follows:

Full scale 1:1

Reduction scales:

1:2	1:5	1:10
1:20	1:50	1:100
1:200	1:500	1:1000
1:2000	1:5000	1:10000

The recommended enlarged scales are

50:1	20:1	10:1
5:1	2:1	

Designation of scale: 1:1 for full scale

1:20 for reduction scale

20:1 for enlargement scale

To construct a scale the following information is essential

- RF of the scale
- Units which it must represent example mm; cm; m; ft; inches etc.
- the maximum length it must show

Minimum length of the scale = RF x the maximum length required to be measured.

Here RF is expressed as a fraction.

Recommended length of the scale is 15 or 30 cm but prefer 15 cm.

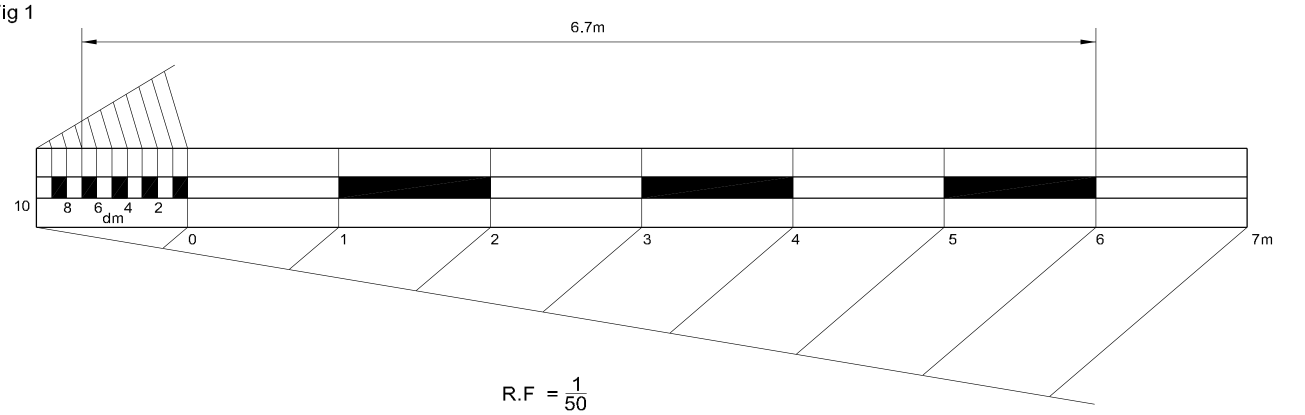
Plain scales (Fig 1)**:** Scales are drawn in the form of rectangle, of length 15 cm (can be upto 30 cm) and width 15 mm. It is divided into suitable number of parts. The first part of the line is sub-divided into smaller units as required.

Every scale should have the following salient features:

- The zero of the scale is placed at the end of the first division from left side.
- From zero, mark further divisions are numbered towards right.
- Sub-divisions are marked in the first division from zero to left side.
- Names of units of main divisions and sub divisions should be stated/printed below or at the end of the divisions.
- Indicate the `RF' of the scale.

Example of construction of a plain scale to measure metres and decimetres. RF = $\frac{1}{50}$ and to measure upto 8 metres. Minimum standard length of scale = 15 cm.

Fig 1



The length of the scale = RF x maximum length to be measured = $\frac{1}{50}$ x 8 x 100 cm = 16 cm.

Length of 16 cm is divided into 8 equal parts or major divisions each representing one metre. If each major division is divided into 10 sub-divisions each sub-division will represents one decimetre.

A distance of 6.7 m will be shown as in the figure 1.

Diagonal scale: Plain scales cannot be used for taking smaller measurement. The distance between the consecutive divisions on a plain scale, at best can only be 0.5 mm. In other words, the smallest measurement that can be taken. Using a plane scale of RF 1:1 is 0.5 mm. If the RF of a plain scale is 1:5, the smallest measurement such a scale can take is 2.5 mm (0.5 mm x 5).

To overcome this limitation two different types of scales are employed. They are

- Diagonal scale
- Vernier scale

Principle of diagonal scale: Diagonal scale relies on a "diagonal" to divide a small distance into further equal parts.

Principle of diagonal scale is based on the principle of similar triangles.

Example: A small distance AB is to be divided into 10 equal parts using diagonal scale.

AB is the line to be divided into 10 equal parts.

Diagonal scale is shown in the figure 2.

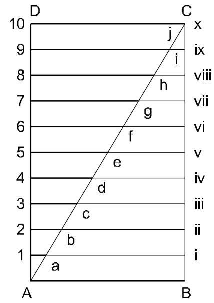
Side AD is the line to be divided into 10 equal parts 1 to 10. Parallel lines are drawn to AB from points 1,2.....10.

Join one of the diagonal AC.

Join parallel line cuts the diagonal at a,b.....j.

Distance 1 - a is $\left(\frac{1}{10}\right)^{th}$ of AB = 0.1 AB

Fig 2



Distance 2 - b is $\left(\frac{2}{10}\right)^{th}$ of AB = 0.2 AB

Distance a - i is $\left(\frac{9}{10}\right)^{th}$ of AB = 0.9 AB

Distance b - ii is $\left(\frac{8}{10}\right)^{th}$ of AB = 0.8 AB

If AB is 1 mm then 1 - a will be 0.1 mm and 2 - b will be 0.2 mm.

Similarly a - i will be 0.9 mm and c - iii will be 0.7 mm.

Parallel lines on both sides of the diagonal can be considered for measurement.

Practice

1.1 Construct a plain scale of R.F 1/20 to read 1.2 m and minimum distance of 10 cm.

1.2 Construct a rectangle whose perimeter is 1800 m and its sides are in the ratio of 3:4, using scale of R.F 1:16000.

1.3 Construct a plain scale to show metres and decimetres long enough to measure upto 5 m. RF = 1/40. Mark a length of 3.7 m on it.

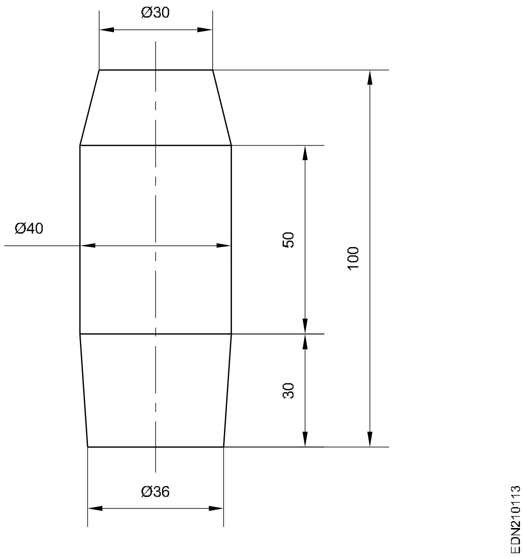
1.4 Construct a diagonal scale for 4 m length and show the length 2.69 m, 1.09 m and 0.08 m. (RF = 1/5)

1.5 A rectangular plot of land area 9 Sq.m is represented on a map by a similar rectangle of 1 square centimetre. Calculate the R.F of the scale of the map. Construct a plain scale to read metres from the map. The scale should be long enough to measure upto 45 metres on the scale to indicate a distance of 25m.

1.6 Construct a diagonal scale of R.F = 1:32,00,000 to show km and long enough to measure upto 350 km. Show distances 237 km and 222 km on the scale.

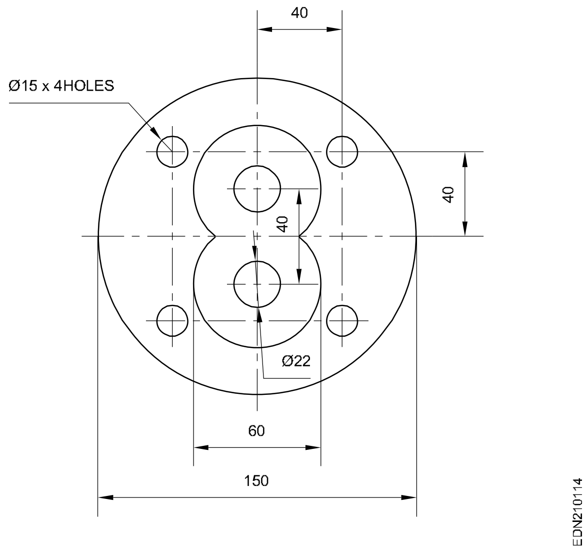
1.7 Reproduce the given template in full size. (1:1) scale according to the dimensions. Fig 3

Fig 3



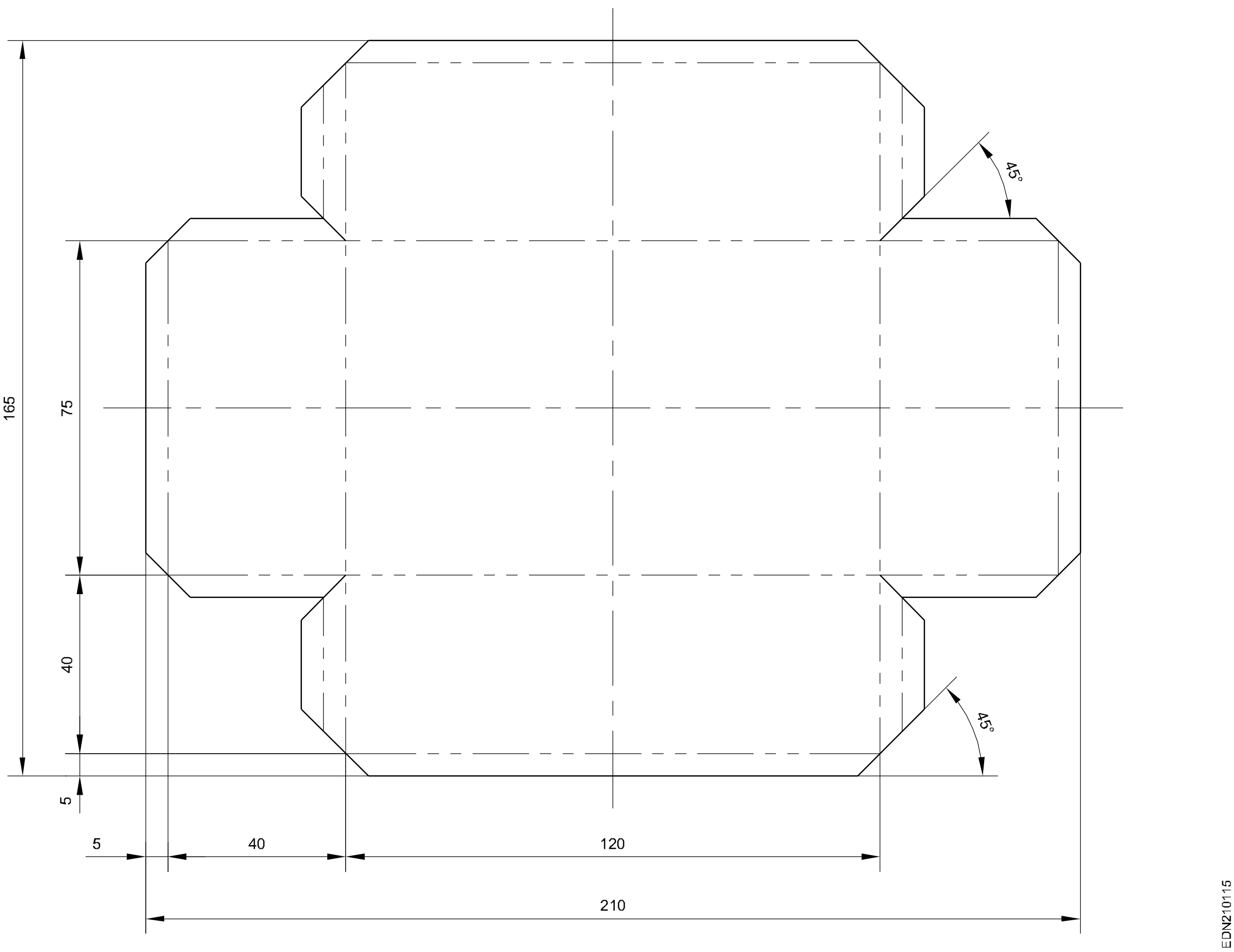
1.8 Draw the given fig 4 in reduced scale i.e 1:2 scale according to the dimensions.

Fig 4



1.9 Draw the Fig 5 in 1:2 scale according to the dimensions.

Fig 5



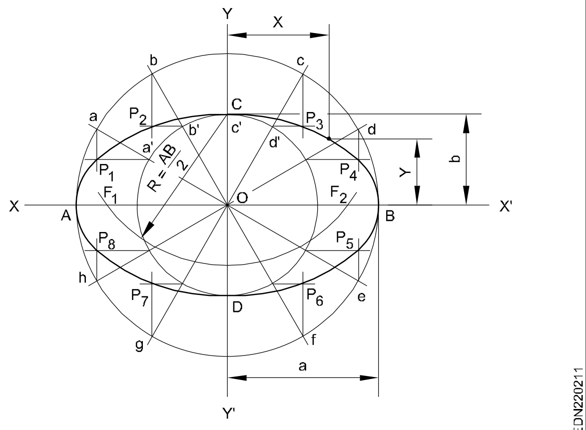
Conic Sections (Ellipse & Parabola)

Ellipse

1 Construct an ellipse by concentric circle method. Major axis 80 mm. Minor axis 40 mm. (Fig 1)

- Draw the major axis AB (80 mm) and minor axis CD (40 mm), bisecting at right angle at 0.
- '0' as centre OA and OC as radius, draw two concentric circles.
- Draw a number of radial lines through '0' (say 12) cutting the two circles.
- Mark the points on the outer circle as a,b,c.
- Similarly mark the corresponding intersecting points on inner circle as a',b',c'.
- From points such as a,b,c... draw lines parallel to minor axis.
- From points such as a', b',c'.... draw lines parallel to the major axis to intersect with the corresponding vertical lines at points P_1, P_2, P_3.... etc.
- Join all these points with a smooth curve by free hand or using "french curve" and form the ellipse.
- To find the 'Foci' - with half the major axis (a) as radius and with 'C' on the minor axis as centre, draw an arc cutting the major axis, at two points, mark them as F_1F_2 the focus points of the ellipse.

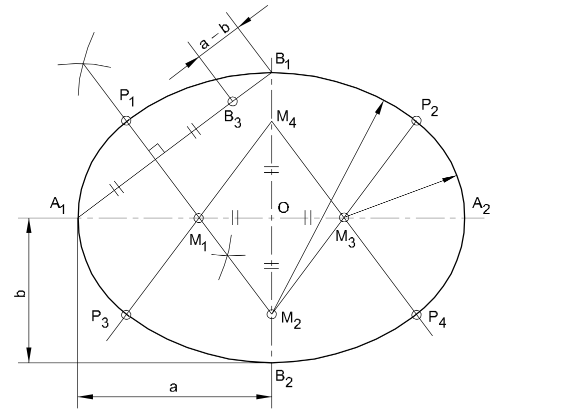
Fig 1



2 Construct an ellipse by four centre method - Major axis = 80 mm and Minor axis = 40 mm - Type A. (Fig 2)

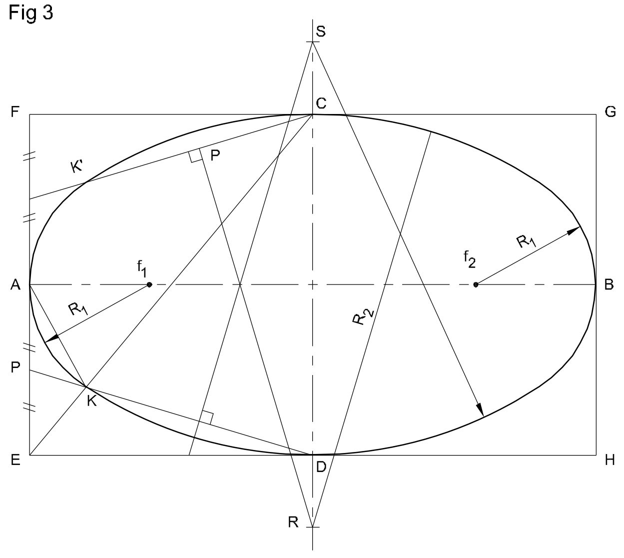
- Draw the major axis A_1A_2 and minor axis B_1B_2.
- Set off B_1M_2 and B_2M_4 equals to A_1B_1.
- Join A_1B_1 and set off B_1B_3 equal to a-b (a = OA_1, b = OB_1)
- Draw a bisector on A_1B_3 which intersects A_1A_2 at M_1.
- Similarly obtain M_3. M_2 & M_4 as centres and B_1M_2 as radius, draw arcs P_1P_2 & P_3P_4.
- M_1M_3 as centres and M_1P_1 as radius, draw arcs P_1P_3 & P_2P_4 and complete the ellipse.

Fig 2



3 Construct an ellipse by four centre method - Major axis = 80 mm and Minor axis = 40 mm - Type B. (Fig 3)

Fig 3



- Draw the rectangle EFGH (80 x 40) and draw AB & CD represent major and minor axis.
- Join EC
- Bisect AE and mark P the mid-point.
- Join DP meeting EC at K.
- Draw perpendicular bisectors of KD and extend DC and locate point `S'.
- 'S' as centre SD as radius draw the arc KD.
- Similarly get the point 'R'.
- Join AK and draw perpendicular bisector on it, and meet AB at f_1.

- 'f_1' as centre, Af_1 as radius, draw an arc KK'.
- Mark centre 'f_2' so that $Bf_2 = Af_1$.
- Now R, S, F_1 & F_2 are the four centres of the ellipse.

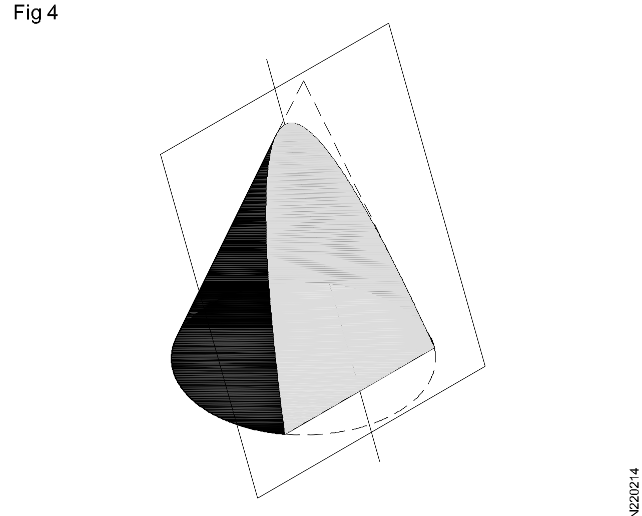
Similar to the procedure followed for drawing curves KD and KK_1 and complete the ellipse.

Follow the procedures given below and construct parabolic curves in the work book.

4 Parabola: It is one of the conic sections.

When the cutting plane is parallel to the generators (slant line) of the cone, (and inclined to the axis) the section obtained is called "Parabola". (Fig 4)

Fig 4



PARABOLA

Properties: Parabola is defined as the locus of a point which moves so that the ratio of its distance from a fixed point F (called the focus) and a directrix bears a constant and equal to 1 (Unity).

In other words if the perpendicular distance of any point on the curve from a fixed line called directrix is equal to its distance from focus, the curve is called "Parabola". (Fig 5)

Elements of Parabola

Axis: It is a line (XX') perpendicular to the directrix and passing through the focus.

Vertex (V)**:** It is the mid point of the perpendicular line drawn from focus to directrix.

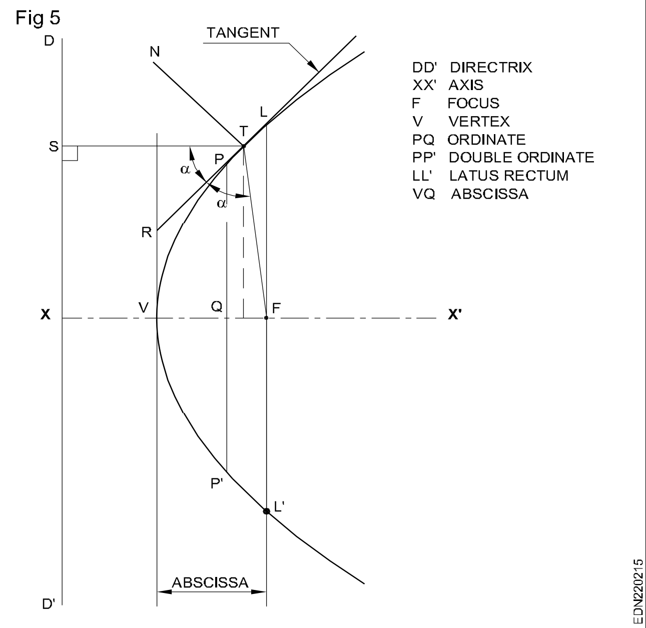
Ordinate: Perpendicular distance of any point P on the curve to the axis line PQ.

Double ordinate: When the ordinate is extended to meet the curve on the other side. Crossing the axis, it is twice the ordinate line P-Q-P^1 is the double ordinate.

Latus rectum: The double ordinate which passes through the 'Focus' is called latus rectum. (LFL')

5 Abscissa: The distance along the axis XX' from vertex (V) and a point through which the double ordinate passes is called the "Abscissa" VQ is the abscissa corresponding to the ordinate PQ (Fig 5).

Fig 5



Tangent and normal for the point T

- Draw TS perpendicular to directrix
- Draw TF
- Bisect angle STF, it will be tangential to parabola at P.
- Draw TN perpendicular to tangent will be normal at P.

A parabola can be constructed by any one of the following methods:

- ordinate method
- rectangle method
- tangent method
- parallelogram method
- offset method

Practical application: Search lights, reflecting surfaces for light and sound, bridge arches, wall brackets and largely used in graphic methods for determining the stress upon beams and girders etc.

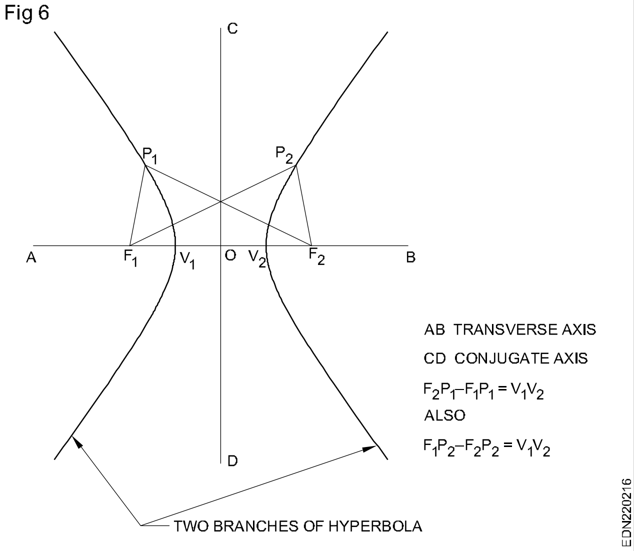
Hyperbola (Fig 6)**:** It is a conic section, formed by cutting plane inclined to the axis (not parallel to the generator) and passes through the base. It is the locus of the point which moves so that its distance from a fixed point, the 'Focus' (F) bears a constant ratio (this ratio is called eccentricity and it is always greater than 1) to its perpendicular distance from a straight line called the Directrix.

It is the path of a point moving in such a way that the difference of its distances from the fixed points is a constant and is equal to the distance between the vertices of the two branches of the hyperbola. This distance is also known as major axis of the hyperbola. (Fig 6)

6 Transverse axis (Fig 6)**:** It is the (horizontal axis) line passing through the two vertices (V_1,V_2)of the pair of hyperbola.

FOCI (F_1,F_2)**:** The two fixed points used for defining a hyperbola are called the foci and they lie on the traverse axis.

Fig 6

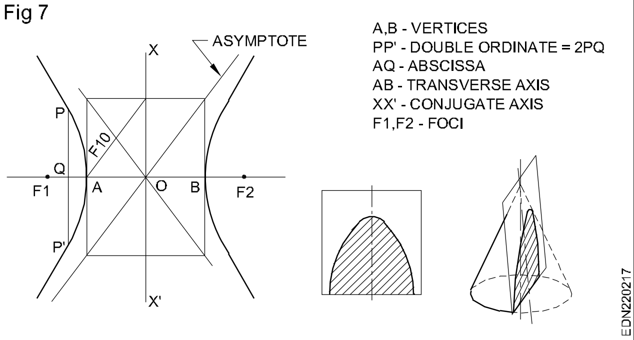


Ordinate: It is the perpendicular distance from any point on the curve to the transverse axis.

7 **Double ordinate:** The distance between the two (similar) points PP' (Fig 7) perpendicular to the axis.

Abscissa: The distance from vertex to the point on the axis where the double ordinate cuts the axis. (AQ in Fig 7)

Fig 7

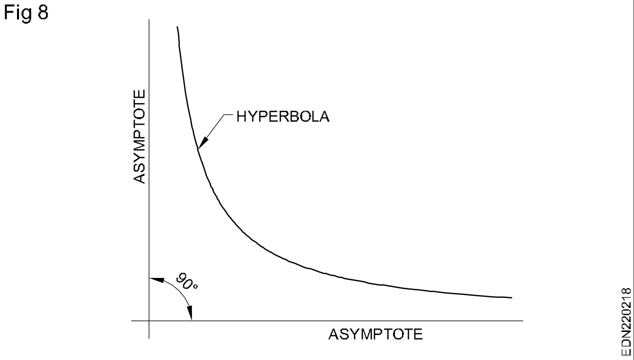


Conjugate axis: It is the perpendicular XX' to the transverse axis passing through the mid point of the transverse axis AB.

Asymptotes: These are lines passing through the center and tangential to the curve at infinity.

8 **Rectangular hyperbola:** When the angle between the asymptotes is 90° the curve is called a rectangular or equilateral hyperbola. (Fig 8)

Fig 8

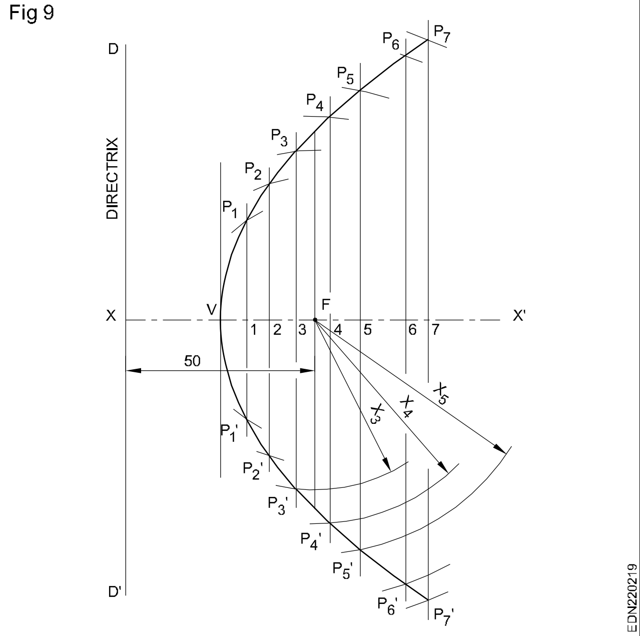


Practical application: Rectangular hyperbola and its application in design of water channels. Further it also represents Boyle's law graphically and in design of Electronic transmitter receiver and Radar antenna.

9 Parabola

Construct a Parabola from a given focus is at 50 mm from the directrix. (Fig 9) - Ordinate method.

Fig 9



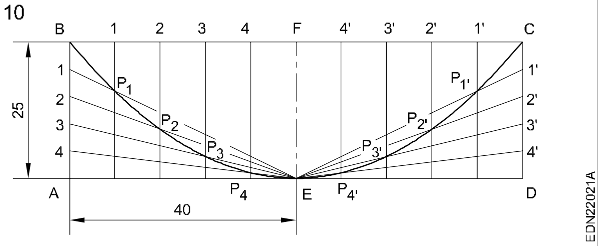
- Draw a vertical line D-D[1] the directrix.
- Draw horizontal line XX[1], the axis through any point X on the directrix.
- Mark the focus 'F' on XX[1] = 50 mm from X (on the directrix).
- Mark the mid point of XF, as V.
- Mark a number of points from V towards right side on the axis as 1,2,3,4.....
- Draw vertical lines through these points as shown, forming double ordinates.
- Point 'F' as centre, X-1 as radius, draw arcs on the co-ordinates (vertical lines) passing through 1, mark points P_1 & P_1'.
- X-2 as radius, F as centre, draw arcs on the 2nd ordinate, mark P_2 & P_2'.
- Similarly get point P_3, P_4.... P_3', P_4' etc. on the axis as above.
- Join all the points with a smooth curve, by free hand and form the parabola curve.

10 Construct a Parabola given the base and axis of a rectangle; base 80 mm, axis 25 mm - Rectangle method. (Fig 10)

- Draw a rectangle ABCD of sides 80 mm & 25 mm.
- Mark centre points of AD and BC, as E and F, join EF.

- Divide AB & CD and into any number of equal parts say 5. Also divide AE and ED into the same number of equal parts and number them as shown.
- From point E on AD, draw lines to the divisions on AB & CD.
- From the points on AED, draw parallel lines to EF.
- Mark the intersecting points P_1, P_2, P_3, P_4 on either side of axis.
- Form the parabola by joining the points BEC and intersecting with a smooth curve, passing through P_1, P_2 .....

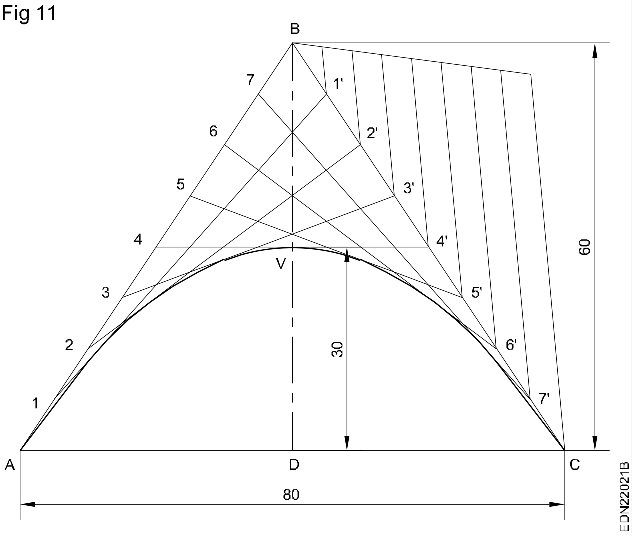
Fig 10



11 Construct a Parabolic curve with base as 80 mm and axis 30 mm - Tangent method. (Fig 11)

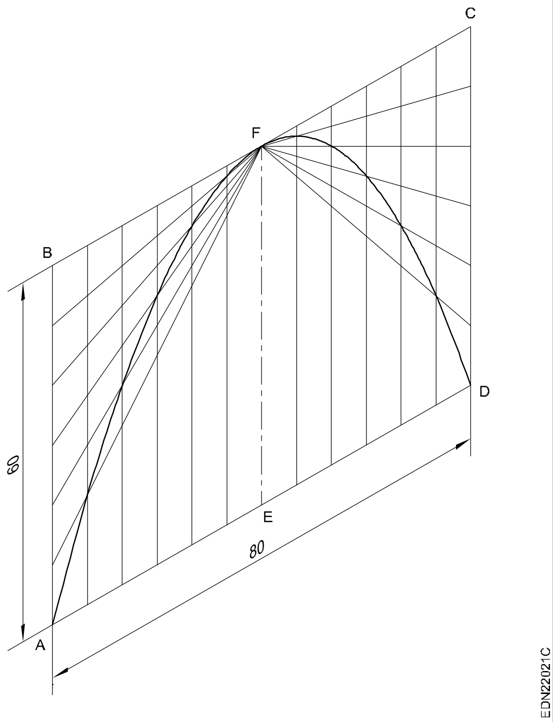
- Draw an isosceles triangle of base 80 mm and altitude 60 mm (double the abscissa).
- Join BD and mark mid point V, the vertex.
- Divide AB and BC into same number of equal parts using divider/other methods.
- Mark the points on AB as 1,2,3 etc in ascending order..
- Similarly mark 1', 2', 3' etc on CB but in descending order.
- Draw lines 1-1', 2-2'..... 7-7'.
- Join the points with A, V and C with a smooth curve. AVC is tangential to line 1 1', 2 2' etc and form the required parabola.

Fig 11



12 Parabolic curve of sides 80 and 60 making 60°/120° Parallelogram method. (Fig 12)

Fig 12



- Procedure is similar to the exercise (11) rectangle method of drawing a Parabolic curve.

13 Hyperbola

Procedure

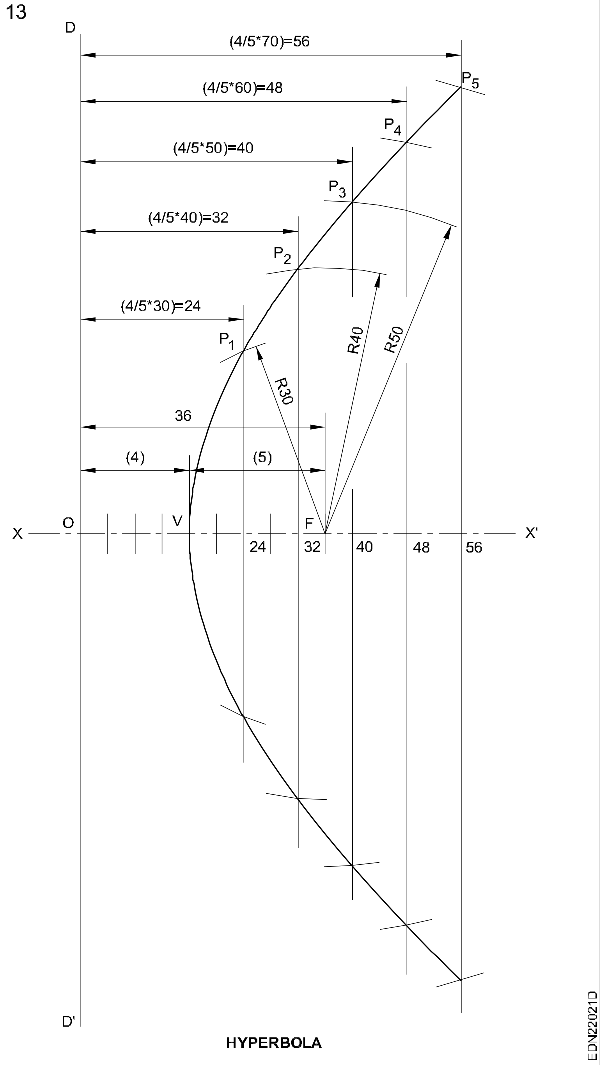
Construct a hyperbola for that eccentricity and the distance of focus from the directrix are given. (Fig 13)

- Draw the locus of a point which moves so that its distance from a fixed point (Focus) and a line (directrix) bears a constant ratio of 5/4 (i.e eccentricity). Assume the focus at a distance of 36 mm from the directrix.
- Draw a directrix DD^1 and perpendicular XX^1 to it at 0.
- Mark F on XX^1 at a distance of 36 mm from 0.
- Divide 'OF' into nine equal parts and mark 4th division as 'V'.
- Prepare a table as shown below such that the ratio of the value in each column is 4:5

From directrix	24	32	40	48	56
From focus	30	40	50	60	70

- Draw parallels to directrix at distances 24,32 etc.
- F as centre and radius equal to 30, 40 etc. draw arcs to intersect the corresponding lines drawn in the previous step.
- Mark the intersecting points as P_1, P_2...etc.
- Complete the hyperbola by a smooth curve passing through these points.

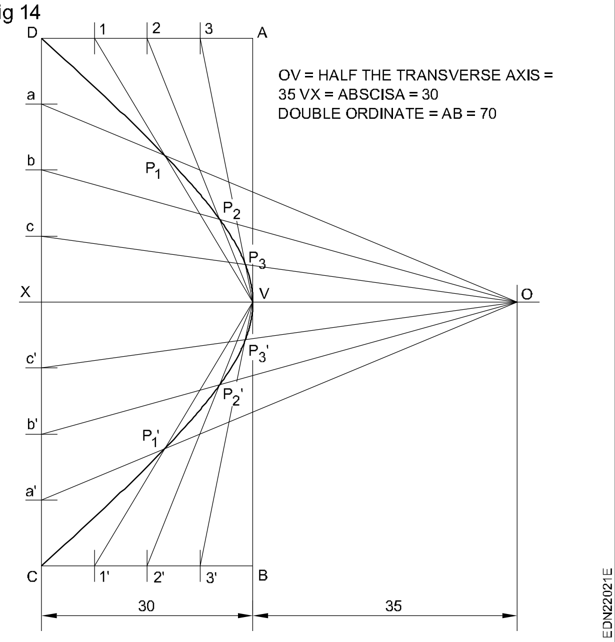
Fig 13



14 Given the double ordinate, abscissa and distance between vertices (Fig 14)

- Draw a hyperbola with double ordinate 70 mm and abscissa 30 mm (rectangle method) and the transverse axis 70 mm.

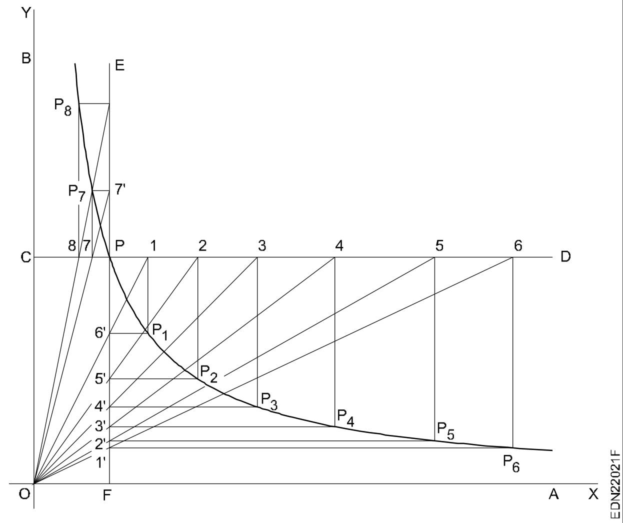
Fig 14



- Draw the rectangle ABCD 70 x 30 mm.
- Mark the mid points V, X on AB and CD.
- Join VX and extend it outside to '0' 35 mm (70/2) from V.
- Divide AD and BC into 4 equal parts. Mark them as $1,2,3,1^1,2^1,3^1$.
- Join these points to V by straight lines.
- Divide DX;XC into 4 equal parts, each mark them as a,b,c,c^1,b^1,a^1.
- Join '0' to these points by straight lines.
- Mark the intersecting points as P_1,P_2 etc as shown.
- Join V-D-C with a smooth curve through P_1,P_2,P_3 etc.

15 Draw a rectangular hyperbola, given the position of a point on the curve. (Fig 15)

Fig 15



- Draw a rectangular hyperbola given asymptotes as OX and OY are at right angles and a point P on the curve is 30 mm and 10 mm from OX and OY respectively.
- Draw the asymptotes OA and OB at right angles to each other and locate the given point P. (10 mm from OX and 30 mm from OY)
- Draw the lines CD and EF passing through P and parallel to OA and OB respectively.
- Locate number of points 1,2,3 etc. (not necessarily equidistant) along the line CD.
- Join 1,2,3 etc to O and extend if necessary till these lines meet the line EF at points 1', 2', 3' etc.
- Draw vertical lines through 1,2,3 etc. parallel to EF and through 1', 2', 3' etc. parallel to CD to intersect at P_1, P_2, P_3 etc.

  A smooth curve passing through P_1, P_2, P_3 etc. is the required rectangular hyperbola.

Note: Rectangular hyperbola is a graphical representation of Boyle's law, PV = constant. This curve also finds application in the design of water channels.

Construct a hyperbola passing through a given point between the asymptotes making any angle other than 90°.

Parabolic curves

Construct various types of curves as per the procedure given in the theory book.

1 Construct a parabolic curve from a given focus is at 50 mm from the directrix (Fig 1).

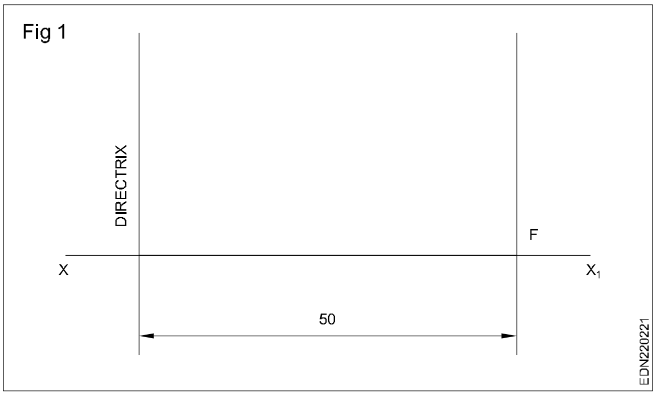


Fig 1

2 Construct a parabolic curve given that the base 80 mm and axis 25 mm by rectangle method (Fig 2).

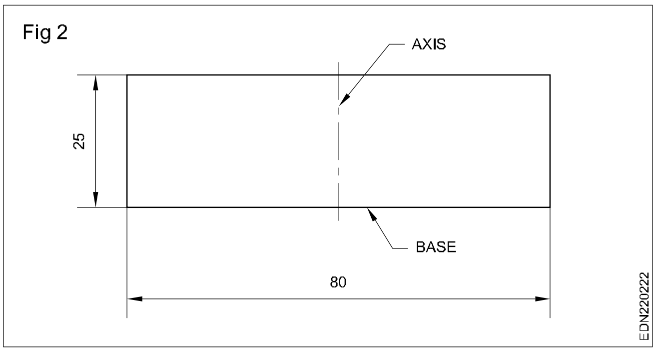


Fig 2

3 Construct a parabolic curve with base 80 mm and axis 30 mm by tangent method (Fig 3).

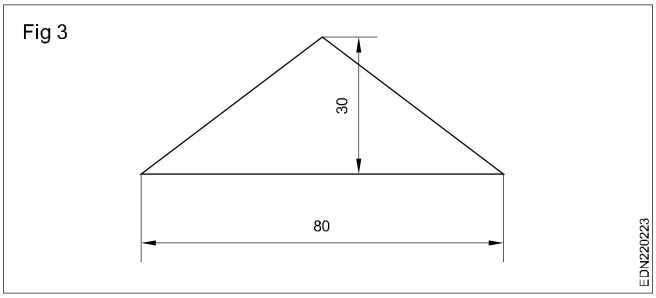


Fig 3

4 Construct a parabolic curve of sides 60 mm and 40 mm making 60°/120° by parallelogram method (Fig 4).

5 Draw a hyperbola given that the distance between the directrix and focus is 36 mm. The ratio between the fixed point and the line directrix is 4:5 (Fig 5).

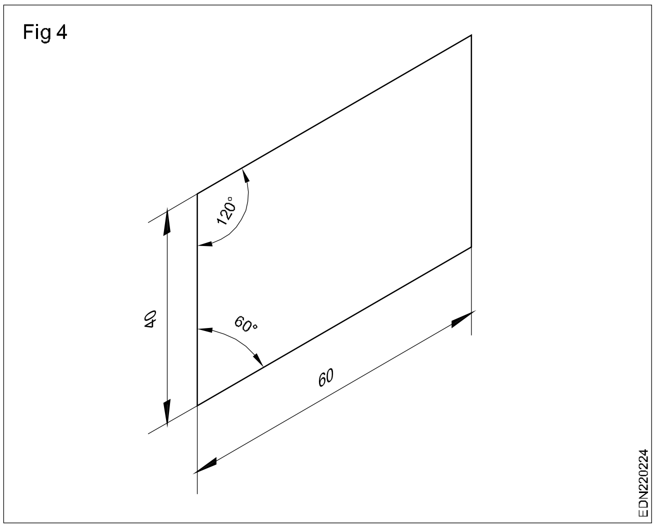


Fig 4

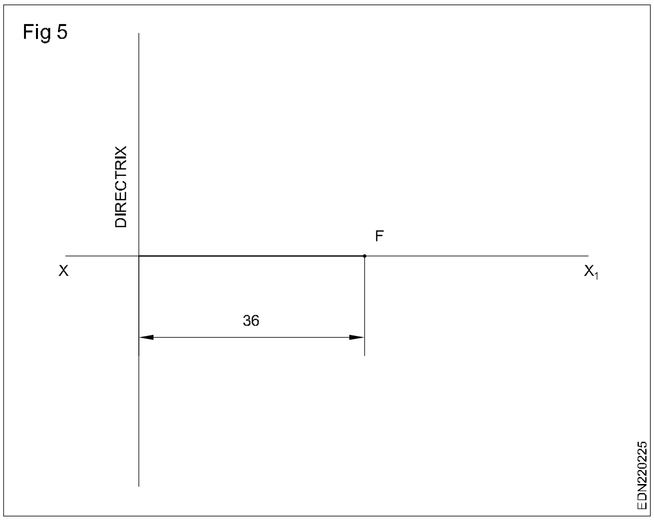


Fig 5

6 Construct a hyperbola to the given double ordinate 70 mm, abscissa 30 mm and transverse axis 35 mm (Fig6).

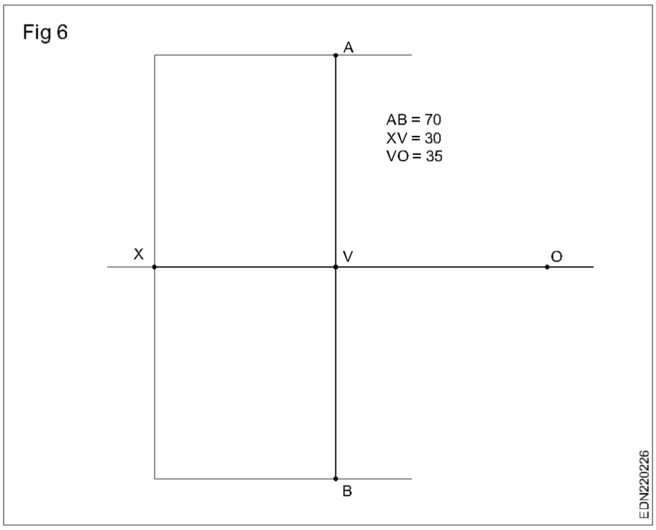
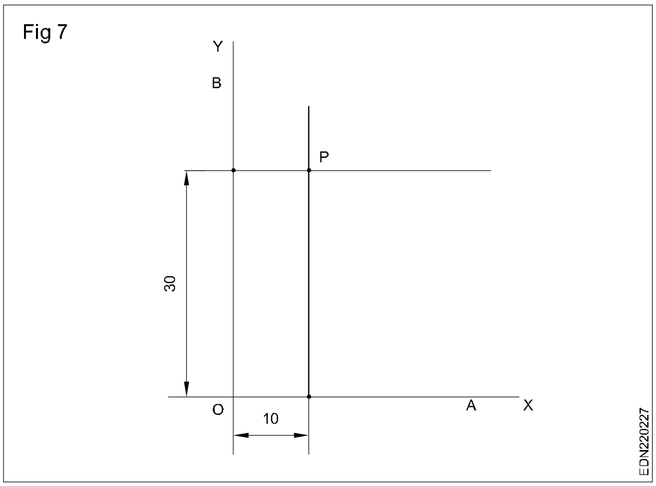


Fig 6

7 Construct a rectangular hyperbola given that the position of the point 30 mm on OY 10 mm on OX (Fig 7).

8 Two straight lines OA and OB make an angle of 75° between them. `P' is a point 15 mm from OA and 35 mm from OB. Draw a hyperbola through `P', with OA and OB as asymptotes.



Note: Follow the same procedure of previous exercise.

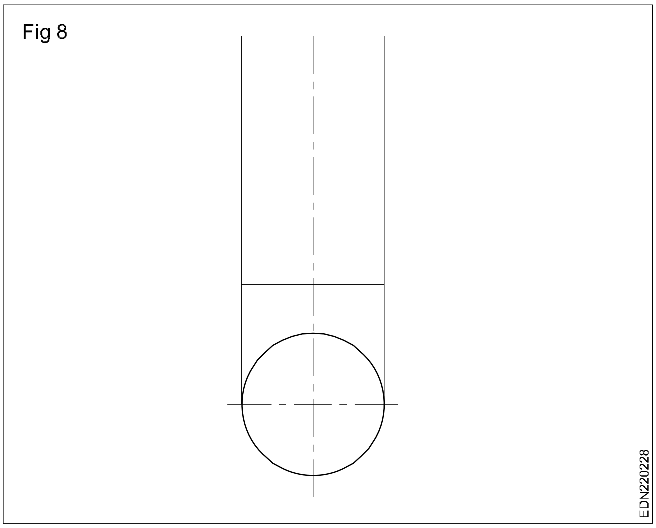
9 Construct an involute of a circle of diameter 40 mm by radial line method.

10 Construct an involute of a circle diameter 40 mm by concentric method.

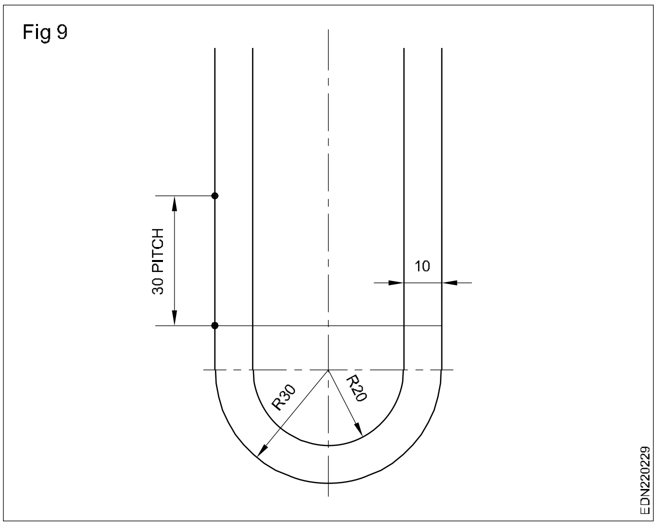
11 Construct an involute of square of side 30 mm.

12 Construct an involute of a heptagon (Polygon) in a circle of diameter 40 mm.

13 Construct a helix for two revolutions of a point on a cylinder of dia 40 mm and pitch of helix 30 mm. (Fig 8.)



14 Construct a helical spring of 10 mm square has an outside dia of 60 mm and pitch 30 mm. Draw two pitches of the spring (Fig 9).

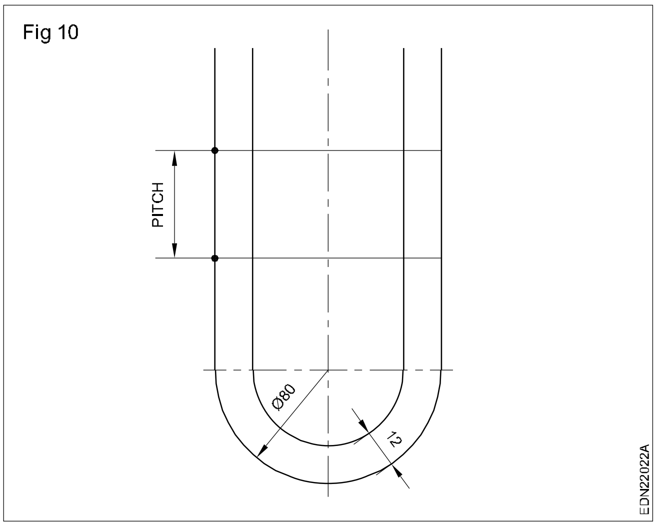


15 On a cylindrical rod of dia 80 mm, a square helical groove of depth 12 mm is cut forming square thread. Assuming the pitch equal to 24 mm, draw 2 complete turns of the thread. Find the helix angle. Width, thickness and depth of the thread are same (Fig 10).

Outside dia = 80 mm

Depth of thread = 12 mm

Pitch of thread = 24 mm



Sketches of screw threads and bolts

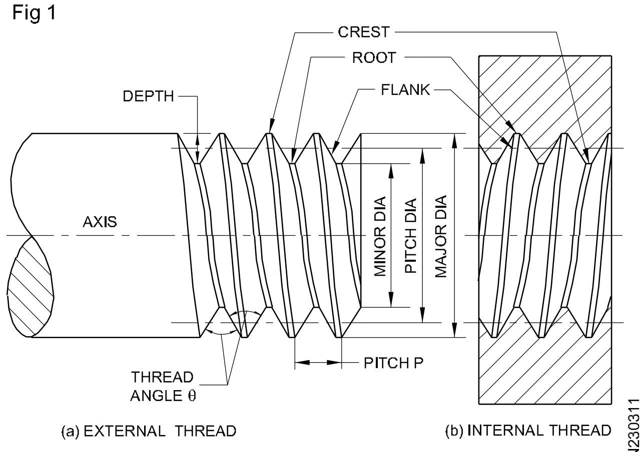
Screw thread is a helical groove formed on cylindrical surfaces either external or internal. In other words **Screw thread** is a ridge of uniform section in the form of helix either on a cylinder or inside a cylindrical surface. It is most important single feature in engineering. The application of screw threads to bolts, nuts, screws, studs etc, enable us to join two or more components together easily and also can be dismantled without damaging any components. The first screw thread which was standardised is "Whitworth" Screw Thread (BSW) was designed by Sir Joseph Whit Worth in 1841 in England. In 1864, William Sellers designed Sellers Thread.

External thread: It is the thread formed on the outside of any cylindrical surface e.g., bolt, screw and stud, pipes etc.

Internal thread: It is the thread formed inside a component say a hole or Nut.

Elements of screw thread: Fig 1 shows elements of a 'V' thread.

Fig 1



SCREW - THREAD NOMENCLATURE

Right hand thread: is a thread that advances into the work when turned clockwise. It is the commonly used thread unless and otherwise stated. (Fig 2a)

Left-hand thread: It is the thread that advances into engagement when turned anti clockwise. (Fig 2b)

Single start thread: it is a thread form, cut on the cylinder. Unless otherwise stated, threads are single start thread, also called single start. (Fig 3a)

Multiple or multistart threads: a thread combination of same profile formed by two or more helices on the cylinder. For single revolution, the axial movement of nut or screw is double, triple or quadruple depending on the start of the thread. (Figs 3b, c,d & e)

Fig 2

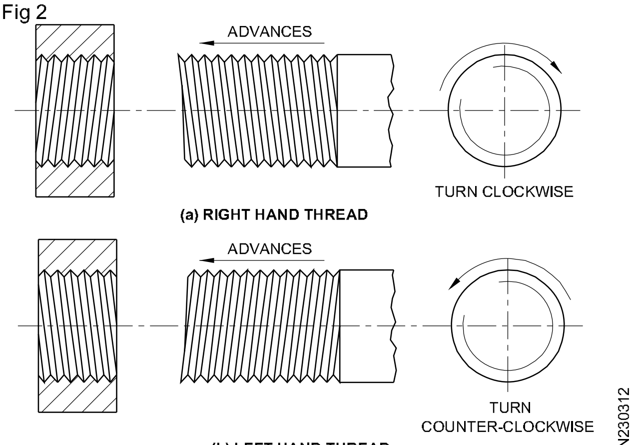
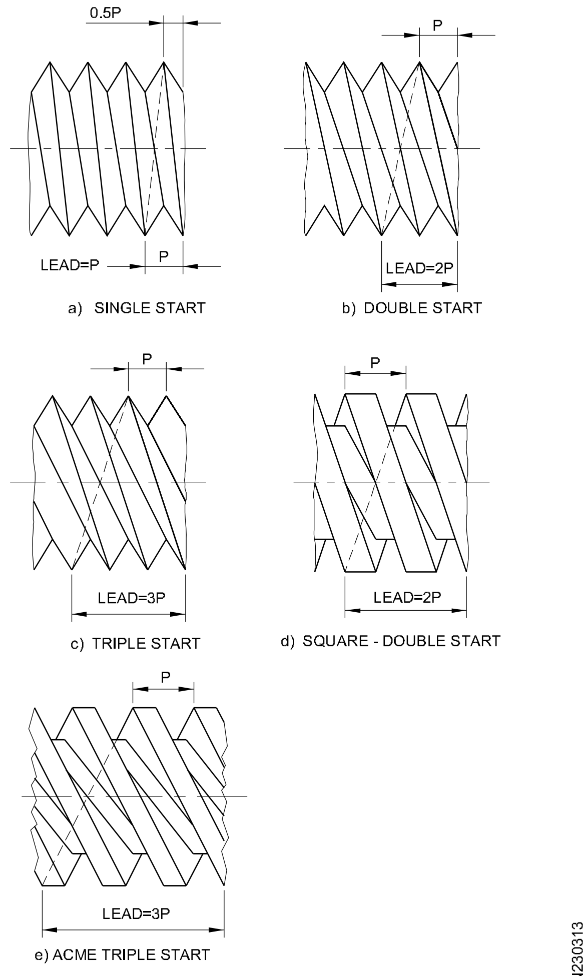


Fig 3

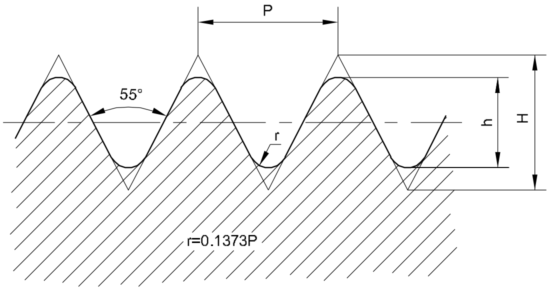


MULTIPLE THREADS

Vee threads

Types of `V' threads: The most commonly used thread before introducing metric thread is **British Standard Whit Worth thread (BSW),** it is adopted by U.K. Fig 1 shows the proportions of the thread profile of BSW. Its thread angle is 55°.

Fig 1



BRITISH STANDARD WHIT WORTH THREAD (BSW)

EDN230321

Pitch of a thread in inch system. P in inches = 1 divided by no.of threads in one inch.

Example: Designation 1/2" BSW i.e 1/2" nominal diameter, BSW thread, 12 TPI.

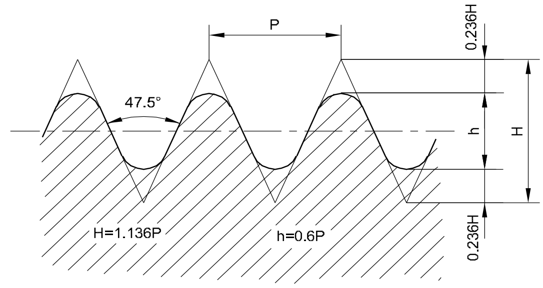
British Standard Fine (BSF) threads: Profile of the BSF thread is same as of BSW (55°) but the pitches are finer comparing to pitches of same dia BSW threads. BSF threads are used in Automobile, Air crafts and for fine mechanisms. Since the pitch is small, core diameter or the effective diameter is larger.

British Association thread (BA thread): Its angle is $47\frac{1^\circ}{2}$.

Designation example 1"BA - nominal dia 1" BA threads.

This thread is used, generally for small instruments. All the British Standard threads are of Inch system. (Fig 2)

Fig 2

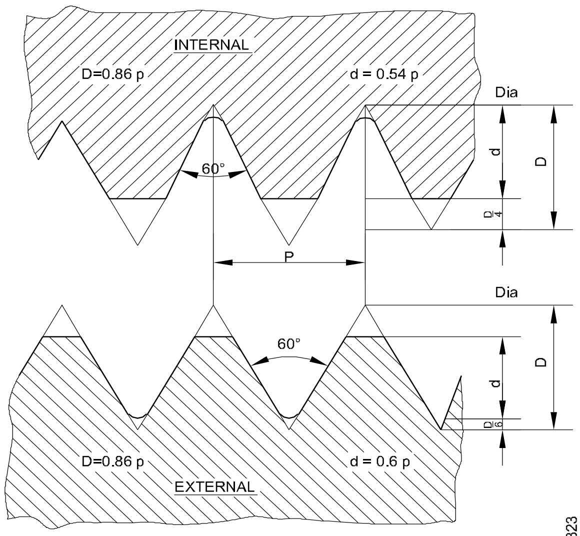


BRITISH ASSOCIATION THREAD (BA)

EDN230322

Metric threads: IS:4218 Bureau of Indian Standards (BIS) has recommended the use of ISO metric threads. Its thread angle is 60°. Fig 3 shows the metric thread form with proportions.

Fig 3



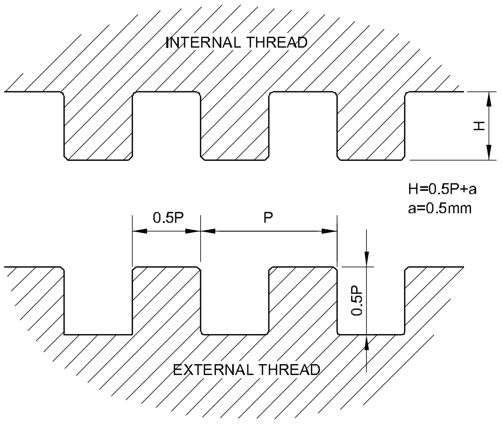
UNIFIED THREAD

EDN230323

Different types of threads

Square threads (Fig 1)**:** In this thread the flanks are perpendicular to the axis of the thread.

Fig 1



SQUARE THREAD

EDN230331

Square threads are used for transmitting motion or power. Eg. Screw jack, vice handles, cross-slide and compound slide, activating screwed shafts.

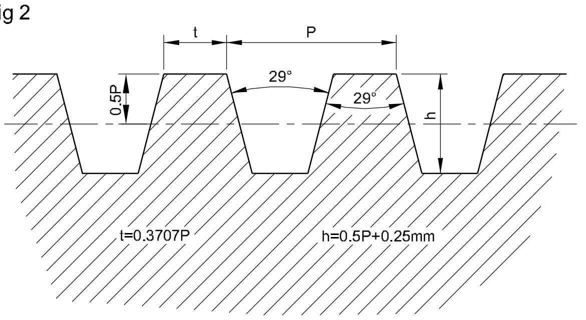
DESIGNATION: A square thread of nominal dia. 60mm and pitch 9 mm shall be designated as Sq.60 x 9 IS: 4694 - 1968.

Trapezoidal threads: These threads have a profile which is neither square nor 'V' thread form and have a form of trapezoid. They are used to transmit motion or power. The different forms of trapezoidal threads are:

- acme thread
- metric acme thread
- buttress thread etc.

Acme thread (Fig 2)**:** This thread is a modification of the square thread. It has an included angle of 29°. It is preferred for many jobs because it is fairly easy to machine. Acme threads are used in lathe lead screws. This form of thread enables the easy engagement of the half nut. The metric acme thread has an included angle of 30°.

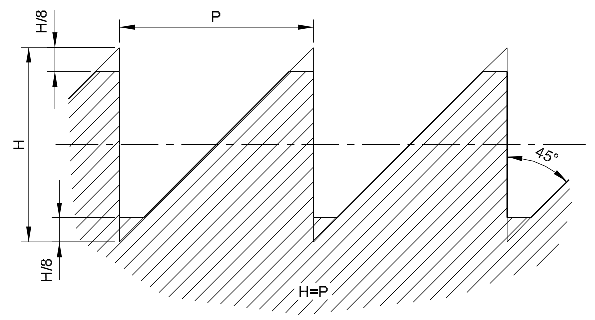
Fig 2



ACME THREAD

Buttress thread: In Buttress thread one flank is perpendicular to the axis of the thread and the other flank is at 45°. These threads are used on the parts where pressure acts at one flank of the thread during transmission. Fig 3 shows the various elements of a buttress thread. These threads are used in power press, carpentry vices, ratchets, etc.

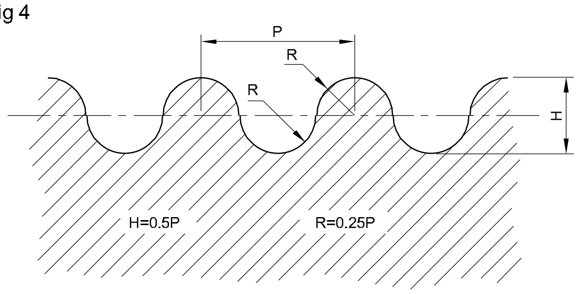
Fig 3



ONLY 45°
BUTTRESS THREAD

Knuckle (round) thread (Fig 4)**:** it has a semi circular form, different from Vee and trapezoidal thread. It is not sensitive against damage as it is rounded. It is used for valve spindles, railway carriage couplings, hose connections,etc.

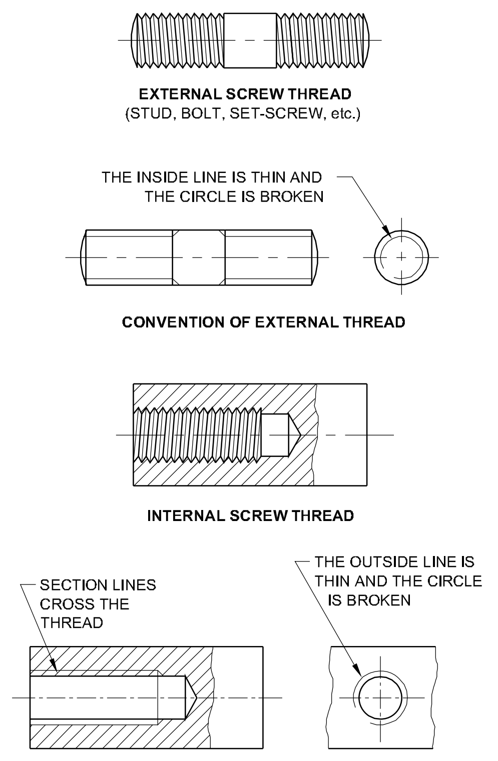
Fig 4



KNUCKLE THREAD

Convention of threads: Since drawing the profile of threads is cumbersome and does not serve any special purpose, the thread forms are conventionally represented by thin line. Fig 5 shows the convention of threads on the screw and end view.

Fig 5



CONVENTION OF INTERNAL THREAD

Designation of screw threads: Metric threads M20- meaning nominal diameter 20 mm coarse pitch (equal to 2.5 mm Ref: IS: 4218-part II) or M20 x 1.5 means nominal diameter 20 mm pitch 1.5 mm.

M 20 x 1.5 "Triple start" where pitch is 1.5 mm and lead is 4.5 mm.

Threads are designated by their nominal major diameter and type of thread. Apart from the nominal dia and type of thread, pitch; L.H (left hand) if it is not right hand thread and class of thread are indicated.

Eg. M24 - Metric thread nominal dia 24 mm (Coarse pitch 2.5 mm)

M24 x 1.25 fine pitch 1.25 mm.

M24 x 2.5H Tolerance grade of internal thread.

M24 x 2.5g Tolerance grade of external thread.

M 24 x 2.5 H8g7 fit of the nut and bolt.

For multi-start threads, Double Start, Triple start etc are mentioned.

Eg. M45 x Triple Start

BSW Thread: $1\frac{1}{2}$ BSW - nominal diameter $1\frac{1}{2}$ TPI 6 (Threads per inch)

BSF Threads: $1\frac{1}{2}$ BSF

Example

- SQ 30 x 6 IS:4964 A square thread of nominal dia 30 mm and pitch 6 mm.
- Tr40 x 7 A single start ISO metric trapezoidal screw thread of nominal dia 40 mm and pitch 7 mm.
- Tr 40 x 14 (P7) LH

  A multiple start left hand (double start) ISO metric trapezoidal screw thread of nominal dia 40 mm, lead 14 mm and pitch 7 mm.

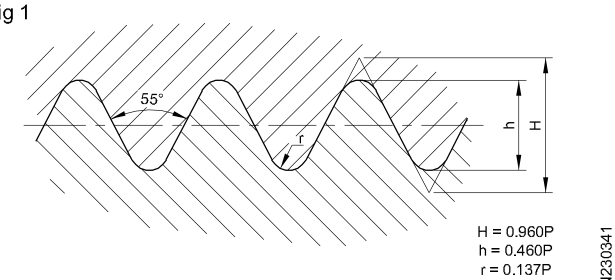
Pipe threads

Pipe threads are used for fastening purposes intended for mechanical assembly of components of pipe fittings, cocks, valves etc, where pressure type joints are not required on the threads. IS:2643 (Part 1 to 3) lays down the standard pipe sizes, pitch thread profile and tolerance etc.

The (nominal) sizes are expressed as 1/8, 1/4 .....1 ... $1\frac{1}{2}$ ...6 available in 24 sizes.

Fig 1 shows the basic profile of thread and proportions.

Fig 1



PIPE THREAD FOR FABRICATION PURPOSES

Thread angle = 55°

Theoretical depth H = 0.96049p

Actual depth h = 0.640327p = $\frac{2}{3}$ x H

Radius of crest and root r = 0.137329p

Crest and root are rounded to H/6

The pitch value varies from 0.907 to 2.309 mm.

According to the tolerances provided, **external threads** are classified as **Class A** and **Class B.**

Class A applies to screw threads requiring snug fit, where accuracy of thread form is essential.

Class B threads applies to threads of ordinary commercial quality. The choice of Class A or B depends upon the conditions of application. The tolerance values of Class B threads are double that of class A threads. Only one class of tolerance is specified for internal threads.

Designation of threads

Examples - External thread of size 3 with Class A tolerance shall be designated as

External pipe threads G3A- IS:2643.

Internal threads of size 3 shall be designated as Internal Pipe threads G3 - IS:2643.

Different types of bolts

In joining number of parts together and dismantling without damaging any parts, devices called Bolts, nuts, screws etc are made use of. These are called **"Screwed fasteners".** Bolt is a metallic cylindrical rod having a specific shape on one end called **"Head"** and the other end called the **shank** with screw threads cut on it. All the fasteners are generally made of steel of good tensile strength.

Bolts are known by the shape of head viz., Hexagonal, Square, Cylindrical or cheese headed, cup or round, 'T' hook, eye bolt etc. and shank dia. The shape of head is selected depending upon the purpose for which it is used. While engaging or dismantling a nut on to bolt, to prevent the rotation of bolt, bolt head is held by another spanner.

All the fasteners size/specifications follow letter M, stands for Metric (size) e.g. Hex.bolt M 20 x 100 i.e hexagonal bolt shank dia 20 mm, 100 mm long.

Hexagonal head bolts: For drawing purpose, irrespective of shape of head, bolt head thickness is taken as **0.8d** where **d** is the diameter of the shank. The length of bolt varies according to dia and the requirements. Figs 1 & 2 show the bolt head and bolt. The top corners of the hexagon are chamfered to avoid sharp corners which get damaged while using spanner and also injurious while handling.

Fig 1

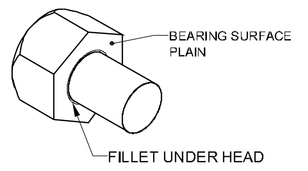
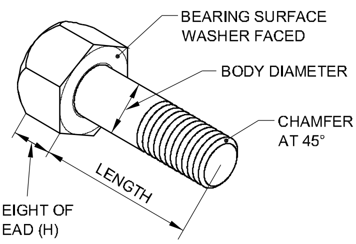


Fig 2



There are three grades of hex.head bolts viz (i) Precision, (ii) Semi precision and (iii) Black denoted by letters A, B & C respectively according to their dimensional accuracies.

Hexagonal bolts Grades A and B IS:1364 part-1 M3 to M36. (12 Sizes)

Grade C IS:1363-part-1 M5 to M36 (10 sizes)

Grade C Black IS:3138 M42 to M156 (23 Size) are available.

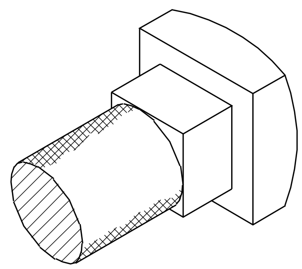
Hexagonal bolts Grades A and B IS:1364 part-1 M3 to M36. (12 Sizes)

Grade C IS:1363-part-1 M5 to M36 (10 sizes)

Grade C Black IS:3138 M42 to M156 (23 Size) are available.

Square head bolt: Square head bolt is the second commonly used bolt, when the bolt head is not accessible. The square head generally sits with in a square cavity, which prevents its rotation while the nut is handled. Fig 3 shows a square head bolt of plain shank and with square neck. They are of grade C (black) IS: 2585 Diameters available from 6 to 39 mm (15 sizes).

Fig 3

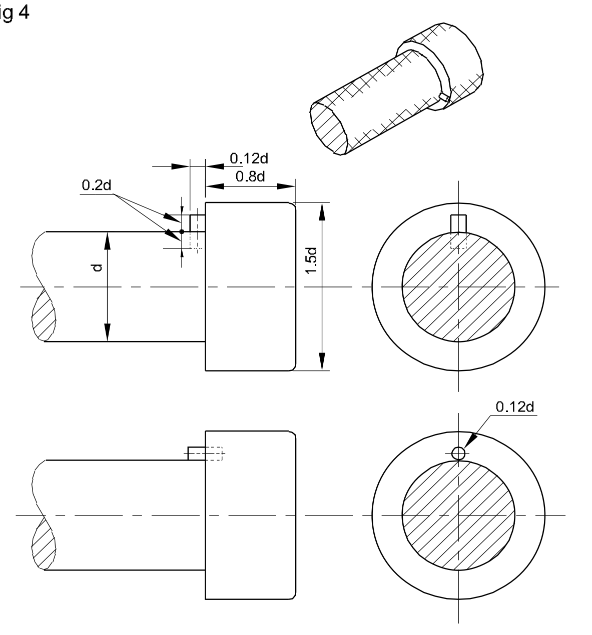


SQUARE HEADED BOLT (WITH SQUARE NECK)

EDN230353

Cylindrical or Cheese head bolts: It is also called as round head bolts. As the name implies, its head is cylindrical. To prevent rotation while handling nut, the head is fitted with a small pin of 0.12 d projecting out by 0.2 d. The pin is fitted close to the head perpendicular to the axis or on to the head close to the shank parallel to the axis. The pin fits into corresponding recess in the adjacent part. There is no need to use spanner to hold the head. It is most commonly used on big ends of connecting rods, eccentrics etc. (Fig 4).

Fig 4

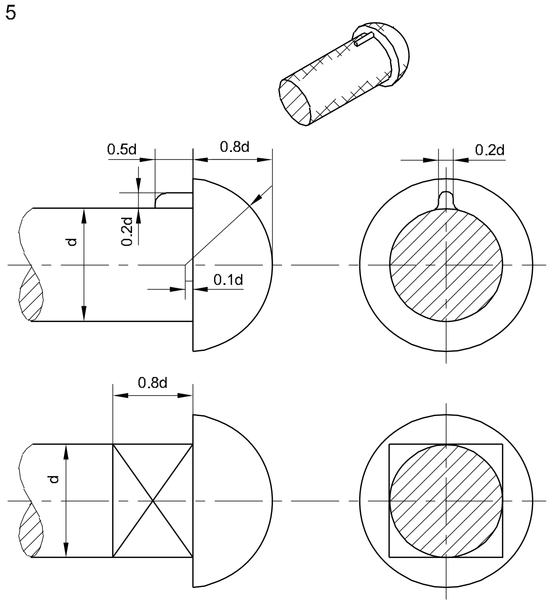


CYLINDRICAL OR CHEESE HEADED BOLT

EDN230354

Cup head or round head bolt: It has hemispherical head with a snug or square neck. The snug is formed while forging. Its function is same as round head bolt. (Fig 5)

Fig 5



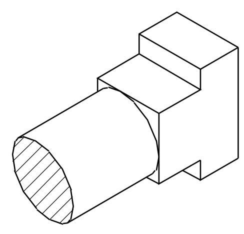
CUP HEADED OR ROUND HEADED BOLT

EDN230355

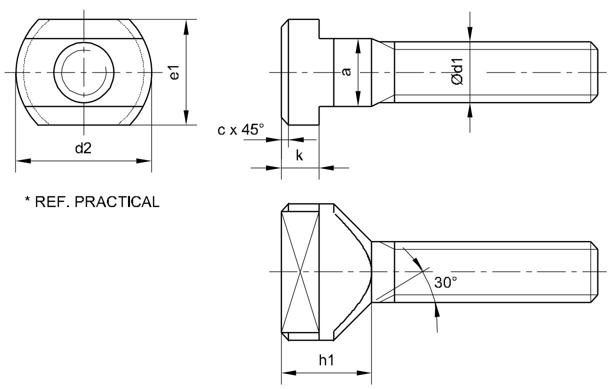
'T' head bolt: Its head is in the shape of `T' which is accommodated in 'T' slots of machine tool tables. The neck is usually of square cross section. Apart from their use in machine tools, they are used in stuffing box and gland in boiler mountings etc. (Fig 6a)

Standard 'T' bolts: There are T bolts as per IS;2014 to suit T slots according to IS:2013. (Fig 6b)

Fig 6



a) T - HEADED BOLT



(b) T - BOLT AS PER IS : 2014

EDN230356

Hook bolt: It is slightly different from 'T' head bolt. It is used when it is not possible to drill a hole in the component in position. (Fig 7)

Eye bolt: It has a short hollow cylinder head attached to the shank perpendicular to its axis. Because of its flat circular faces, rotation of bolt is prevented while handling nut. (Fig 8)

Fig 7

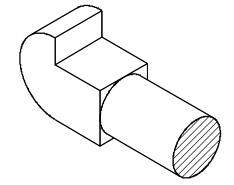
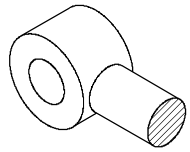
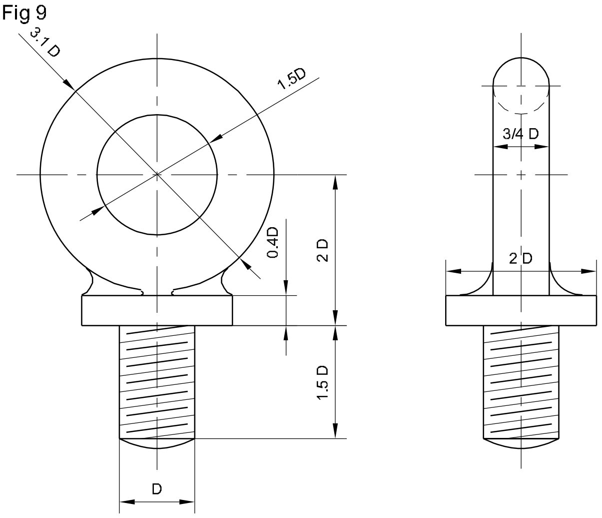


Fig 8



Lifting eye bolt: Its head is in the form of Tarso, ring made of cylindrical rod. It is forged with a washer shaped base and shank. The shank is threaded and fits into the machine/motor body. It is used to lift the machines or motors for shifting and aligning during erection. (Fig 9)

Fig 9



Counter sunk head bolt: It has a counter sunk head which does not project outside the hole. Its rotation in hole is arrested by means of a **snug** on the taper surface or square neck, by the suitable cavity on the component. (Fig10)

Cap screw or tap bolt: Where there is no possibility of using a nut, tapped hole is provided in the major part of the assembly and a clearance hole is drilled on the part to be fitted. (Fig 11)

Designation: Threaded fasteners are designated in the sequence as an example shown Hex.bolt M20 x 75 - IS:1364-B.

1 Nomenclature: Hex.bolt (shape of head)

2 Size - M 20 x 75 x 1.5 dia 20; length 75, pitch 1.5

3 Type - A,B or C. A - Precision

B - Semi-Precision

C - Black

Fig 10

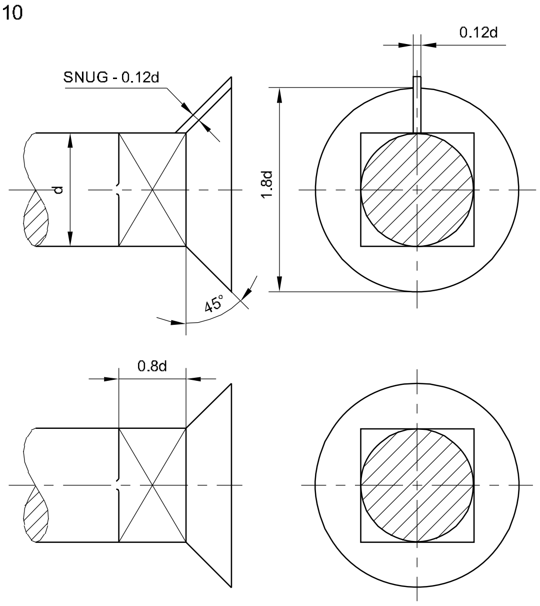
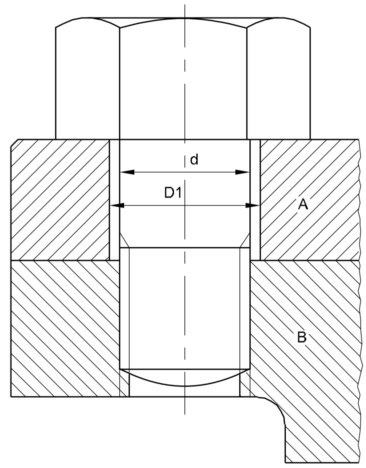


Fig 11



Type designation be avoided as far as possible in Product standard.

Holes for taking the bolts are of slightly larger diameter, ie; clearance holes of fine, medium and coarse series of tolerance grades H12,H13 & H14 vide IS:1821. (Dimensions for clearance holes for bolts and screws)

NB: Recommended dia and Nominal lengths of bolts, screws, studs and thread lengths are available in IS:4206

Dimensions for width across flats for hexagon, hexagonal flanged bolts, screws and nuts ref IS:9519.

IS:1363 Part-1, 2 & 3 for Grade C

IS:1364 (Part 1 to 5) for Grade A and B of hexagonal bolts, screws and nuts.

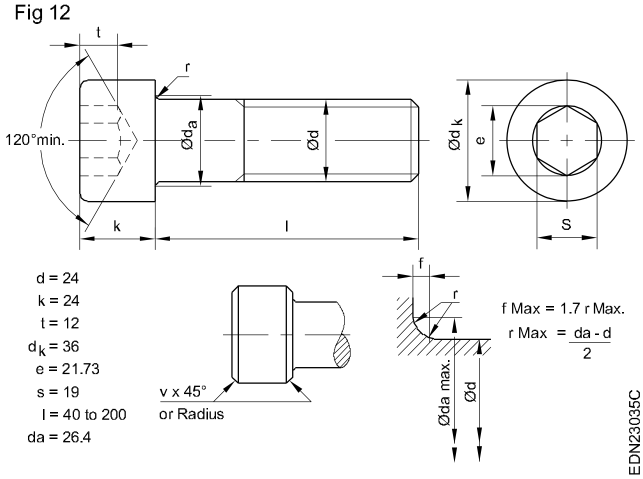
Hexagonal socket head cap screw (IS:2269): These are available from M1.6 to M36 (16 sizes), length 2.3 mm to 200mm depending upon the dia. It has the advantage over the other set screws, its hexagonal socket head flushes in the metal, so the head does not project outside.

They are used on machine tables and on assemblies. (Fig12) It is operated with an allen key.

Designation: A hexagonal socket cap screw of size M12 length 60 mm property class 12.9 shall be designated as

Hexagonal socket head cap screw M12 x 60-12.9-IS:2269.

Fig 12

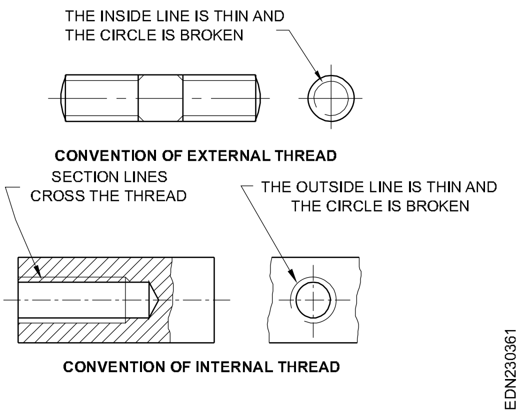


Practice

1 Draw the conventions of external and internal thread with edge views. (Fig 1)

Draw the conventions of threads as shown above also indicate the type and size of thread as mentioned in the dimensioning technique exercise.

Fig 1

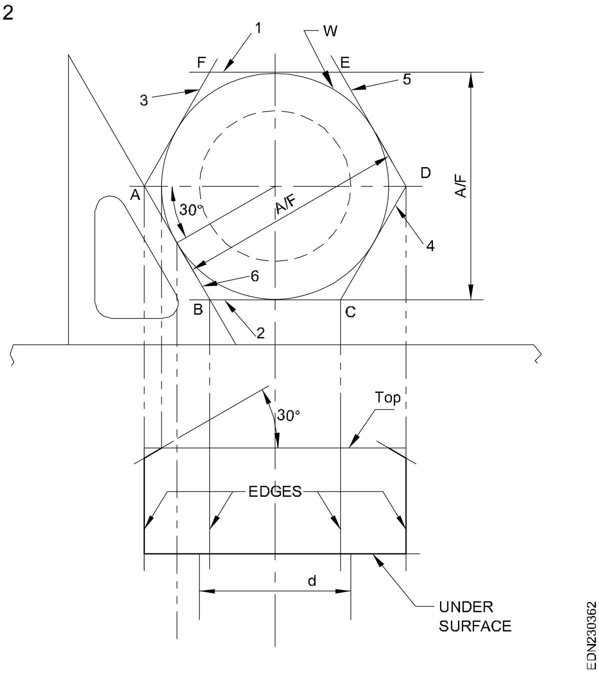


2 Sketch the views of a hexagonal bolt M10 x 50.

Proportion of bolt head and other features.

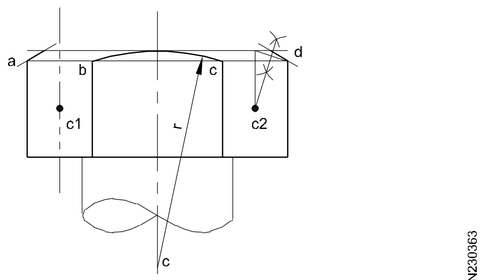
- Given bolt diameter = 10 mm (M10).
- Bolt head across flat = 1.5d + 3 mm
  = 1.5 x 10 + 3 = 18 mm
- Bolt head thickness = 0.8d to 0.9d
  = 0.8 x 10 = 8 mm
- Radius of chamfer = 1.5d or 1.4d
- Length of bolt in this case = 3d to 4d approx = 50 mm.
- Sketch a regular hexagon of side 10 mm.
- Sketch a hidden circle touching the sides of the hexagon.
- Sketch a concentric circle of ϕ 10 mm. this is the plan of the bolt. (Fig 2)
- Sketch projectors from the corners of hexagon parallel to axis.
- Form a rectangle of the projectors equal to the thickness of the bolt head. (8 mm in this case)
- Sketch 30° lines as shown in Fig 2.

Fig 2



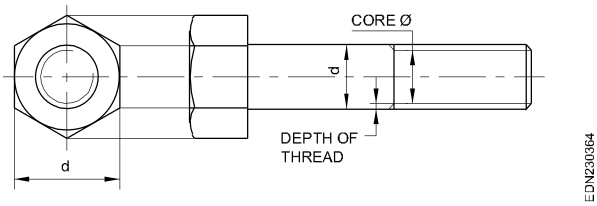
- Sketch arcs as shown in Figure 3.

Fig 3



- Sketch the shank to the specified length. Also sketch the threaded portion as per convention. (Fig 4)

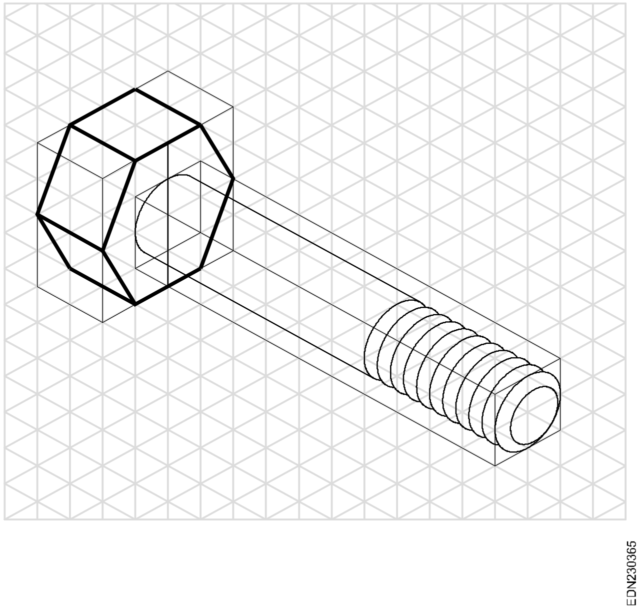
Fig 4



3 Sketch the pictorial view of a hexagonal bolt.

Sketch the view as shown in Figure 5.

Fig 5

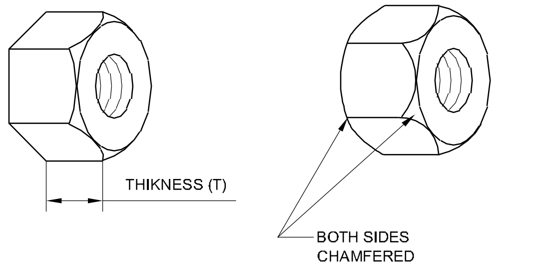


Different types of nuts, locking devices e.g. double nut, castle nut, screws and pin, etc,.

Nut is a metallic piece of definite shape with threaded (screwed) hole on the centre of the face. It is used on the end of the bolt/screw to hold the parts in position.

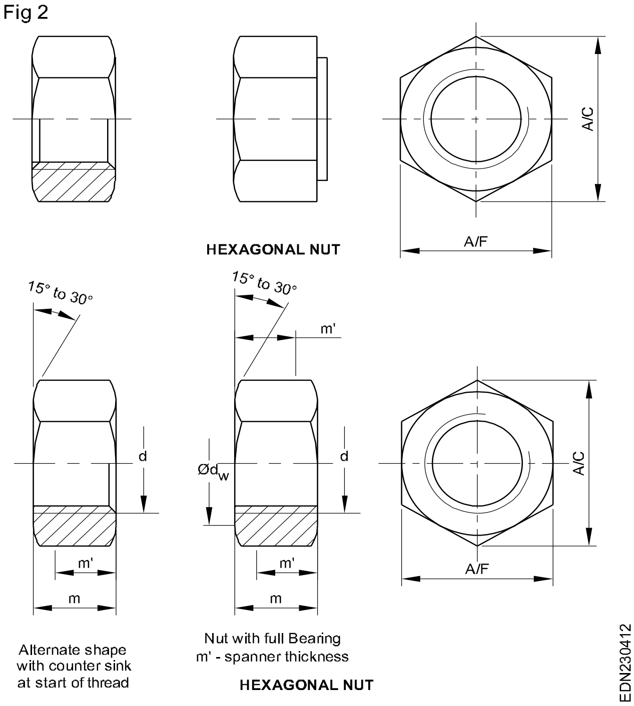
Nuts are known by their shape or their cross-section. The most commonly used forms are hexagonal and square. Nuts are specified by the shape of the nut and the nominal dia of bolt/screw on which they are used. (Fig 1)

Fig 1



Hexagonal nut (Fig 2)**:** it is made of hexagonal bar with a screwed/threaded hole in the centre. To avoid the damaging of the corners on the face, they are chamfered at 30°, with reference to the base. Theoretically the thickness of the nut is equal to the diameter of the bolt and corner to corner is 2d i.e., twice the diameter of the bolt.

Fig 2

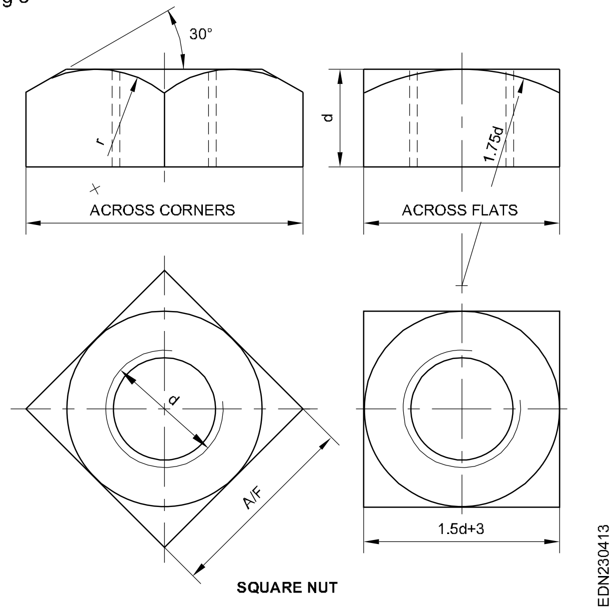


The actual sizes are specified in IS:1363, 1364, 3138.

Thin hex.nuts are available IS:1364 (Part-4).

Square nut (Fig 3)**:** It is made out of square bar. Side of the square is equal to 1.5d + 3 mm and radius of the chamfer is 2d. Sizes are from M6 to M39.

Fig 3



IS:2585 lays down the standard sizes available.

For drawing purposes, the following sizes of the nut are considered.

Bolt nom. dia = d

Thickness of nut T = d

Width across Flats W = 1.5d + 3mm

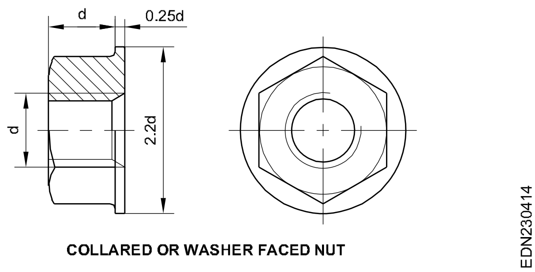
Angle of chamfer = 30°

Radius of chamfer arc = 2d (approx.)

Special Nuts

Collared nut: It is a regular hexagon nut with a washer face. It avoids cutting groove on the metal while tightening and also can be used on comparatively larger holes. It is available from M8 to M36 IS:7795-1975. (Fig 4)

Fig 4

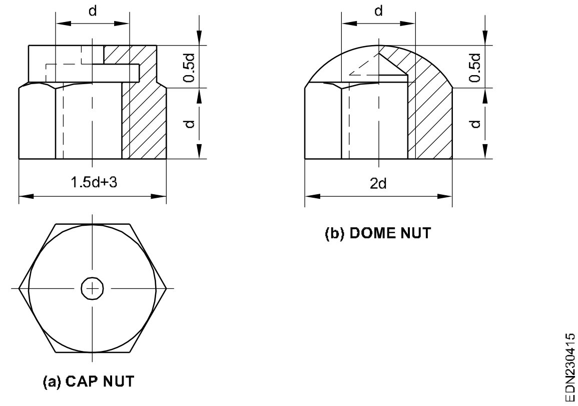


Cap nut: it is also a hexagonal nut, the hole covered by a cylindrical flat cap. It protects the end of the bolt from corrosion and leakages of oils through the threads. Figure shows the nut. It has a cavity of 0.25 d and end metal thickness 0.25d. (Fig 5a)

Dome nut (as per BIS) Dome nut: it is a hexagonal nut with blind hole having hemispherical top end. Its use is same as above. Dome nut is available from M6 to M34 IS;2687

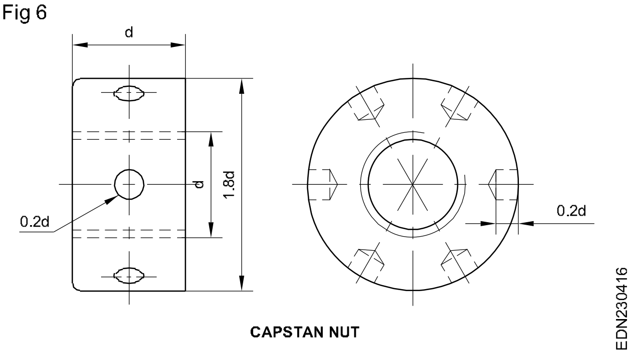
It is made of steel, brass or aluminum. Steel nuts may be from rolled, forged or extruded. Nuts of sizes M24 and above. (Fig 5b)

Fig 5



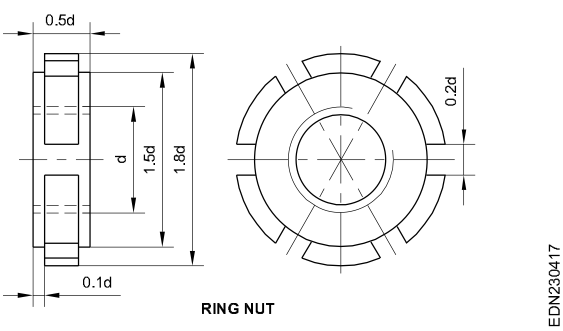
Capstan nut or cylindrical nut: It has six blind hole equispaced on the circumference. The diameter and depth of the hole is equal to 0.2d. Diameter of the nut is 1.8d. A hook spanner is used to operate. (Fig 6)

Fig 6



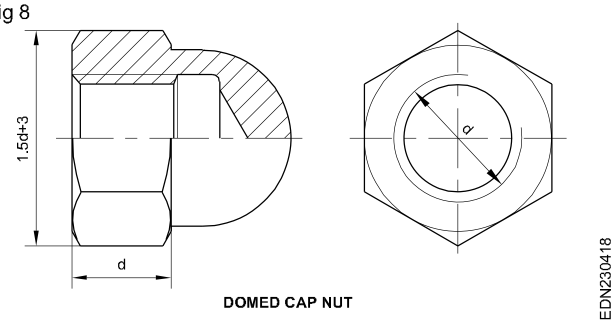
Ring nut: Its diameter is 1.8 d and thickness is 0.5 d. The thickness is reduced to 0.3d, by 0.1 d from both the faces forming 1.5d cylindrical faces. Six slots of 0.2d width are milled on the circumference to the depth of 0.15d. Special spanner is used to operate the nut. (Fig 7) These are used in pairs, one nut acting as a lock nut.

Fig 7



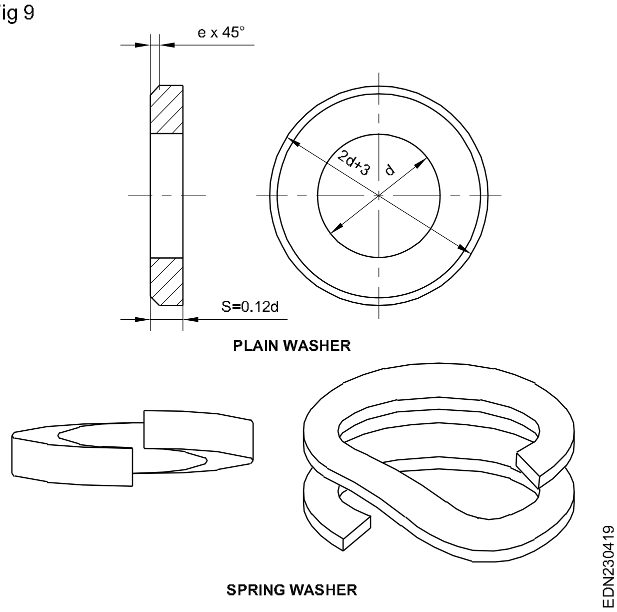
Domed Cap nut (IS:7790): Hexagon nut with a hemispherical top. Its function is similar to cap nut. It is available in 11 sizes from M6 to M24 diameter bolts/screw. They are made of steel, brass or aluminum alloy. It prevents corrosion and leakage of fluids from the threads. (Fig 8)

Fig 8



Washer: It is a cylindrical thin disc with a hole in the centre. Washer helps to provide smooth bearing surface between the nut and the part on which it is used. There by it prevents the nut corners from cutting into the metal. (Fig 9)

Fig 9



There are plain washers (IS:2016:5370) and spring washers (IS:6755,3063,6735).

Plain washers are available from basic hole size 4 to 155 mm dia to suit bolt/screw size from M 1.6 to M 150 mm. One face is chamfered at 45°. While spring washer exerts pressure on the nut tightening and keeps the thread gripped on the thread.

Screws

Grub screws are comparatively smaller in dia and short in length. They are made of hardened steel,used for holding two parts in position eg., a collar pulley, or gear on a shaft.

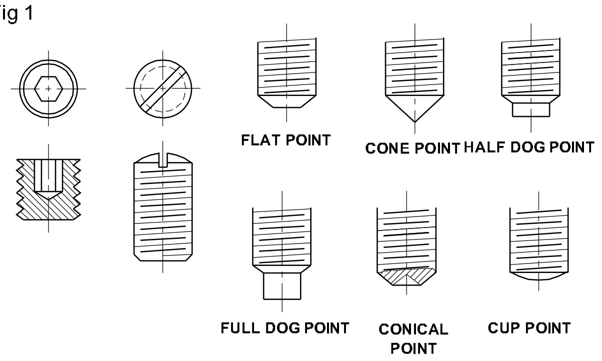
On driving it into position, it produces a clamping force, resists relative motion between the assembled parts. The grub screws are fully cylindrical , on one end they are provided with hexagonal socket or screw driver slot. On the other end they are formed into different points. (Fig 1)

Hexagonal socket grub screws or screw driver slot are of following types.IS: 6094 (Fig 1)

They are namely as follows:

- Flat point (FP)
- Cone point (TP)
- Full dog point (FDP)
- Half dog point (HDP)
- Cup point (CP)
- Conical point

Fig 1

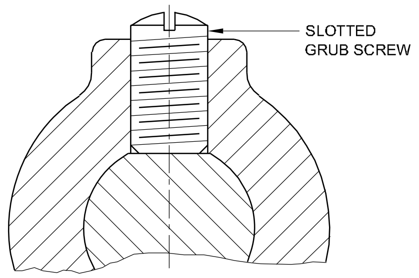


These are designated by the shape of their ends. These are available in sizes M3, M4, M5, M6, M8, M10, M12, M16, M20, M 24, Max. length 60 mm. These are operated by using hex. bent key (Allen key).

Slotted grub screws as per IS:2388 are designated by letters. (Fig 2)

- Type A - Flat end
- Type C - Conical end
- Type E - Cylindrical dog point
- Type G - Tapered dog point
- Type J - Cup point
- Type K - Oval point

Fig 2



Set screws (Not as per BIS)**:** These screws are operated by screw drivers or a spanner. They are available in different sizes M1 to M24. The lengths vary according to dia.

Function of a set screw is same as that of grub screw.

The set screw has different form of head

i cup or round head

ii square head

iii cylindrical or cheese head

iv fillister head

v counter sunk head

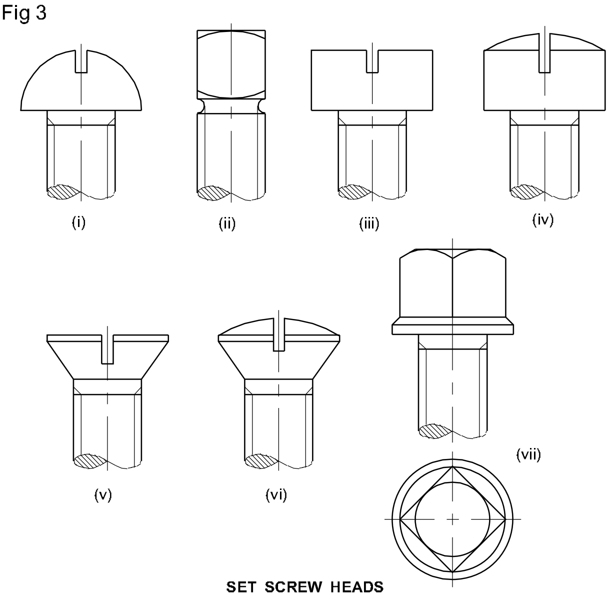
vi rounded counter sunk head

vii square head with collar.

Fig 3 shows the above screws.

Screws are specified by designating the head, diameter; length and IS:No and property class.

Fig 3

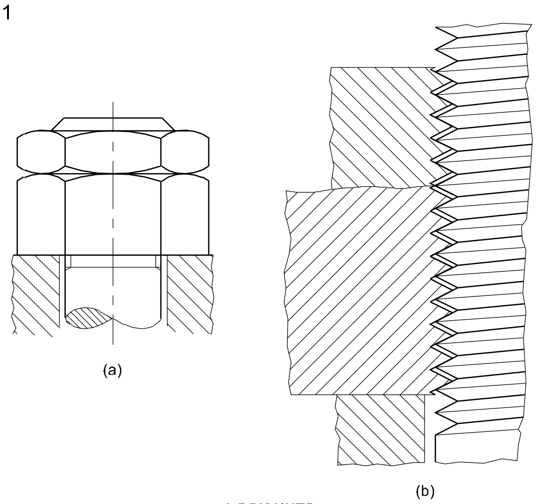


Locking devices

Locking devices: There are different types which are used to prevent nuts from getting loose on machines subjected to vibrations or impacts.

The most commonly used device is a lock nut. It is an additional nut called Lock nut engaged on the other. The thickness of lock nut may be 0.6 d to 0.8 d; d being the diameter of the bolt. The top nut when tightly engaged on the nut, it prevents the nut becoming loose. (Fig 1)

Fig 1

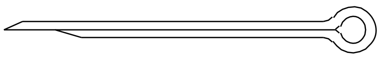


LOCK NUTS

EDN230431

Split Pin: It is made of semi circular steel wires (IS:549) bent through 180°, forming a spherical head. It is passed through the split pin holes in the bolt/screw ends and the ends are opened back wards. There by it locks the nuts in their position. They are available in 16 sizes, 0.6 mm to 20 mm depending upon the bolt dia 2.5 to 170 mm dia. (Fig2)

Fig 2

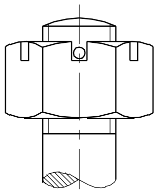


SPLIT PIN

EDN230432

Slotted nut IS:2232: It is a hexagonal nut with slots of width 0.25 d cut on the top end of the nut through the opposite faces. A split pin is inserted through the slot in the hole drilled on the bolt end in line with the slot. The split end of the pin is opened securing the nut. The width of the slot is 0.25 d and 0.3 d deep, split pin dia is 0.2 d. (Fig 3)

Fig 3

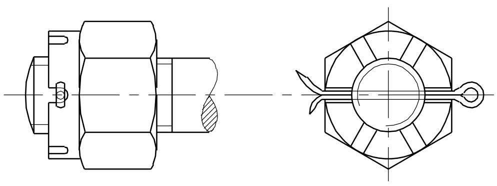


SLOTTED NUT

EDN230433

Castle nut IS: 2232: It is similar to slotted nut with semi circular end slots cut on the cylindrical part called "castle", on the nut. A split pin is passed through and lock the nut. (Fig 4)

Fig 4



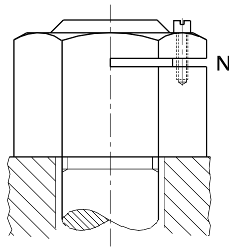
CASTLE NUT

EDN230434

The above are available in grades A,B & C sizes M4 to M100.

Sawn nut or Wiles nut: It is a normal hexagonal nut cut half way through one of its corners. The width of the slot is 0.15d located at 0.2 d from top of the nut. A tapped hole is cut on the nut as shown. A set screw when tightened at the top thin part of nut slightly bends, there by pressing on the threads. This prevents the slackening of nut. (Fig 5)

Fig 5



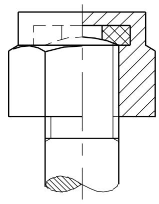
SAWN NUT

EDN230435

Simmond's lock nut: The hexagonal nut has a closed cavity on one end and a fiber ring is fitted inside it. The internal dia meter of a fiber ring is slightly less than the core diameter. When the nut is screwed down, bolt end cuts thread on the fiber ring.

The fiber ring gives greater grip over the bolt threads and prevents slackening the nut. (Fig 6)

Fig 6

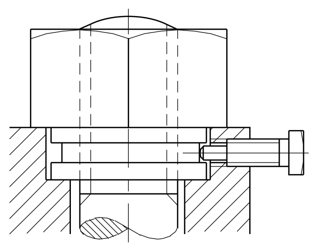


SIMMOND'S LOCK - NUT

EDN230436

Penn, ring or grooved nut: A part of the nut is turned round with a round groove. When the bolt hole is very close to the edge, a counter bored hole is provided. The dog point of set screw, through the tapped hole, sits on to the groove. When screwed in, the nut is prevented from getting loosened. (Fig 7)

Fig 7



PENN, RING OR GROOVED NUT

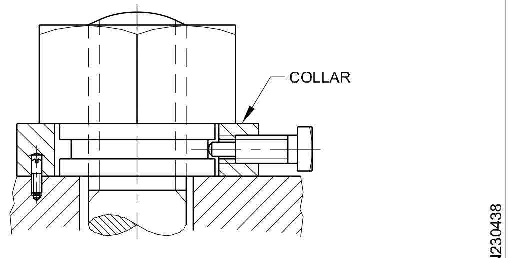
EDN230437

The same nut can be locked as shown in Fig 8 with a collar when it is away from edge.

Locking by Locking plate or stop plate: a plate with grooves to suit the nut is placed on the nut and screwed down to the body with a screw. (Fig 9)

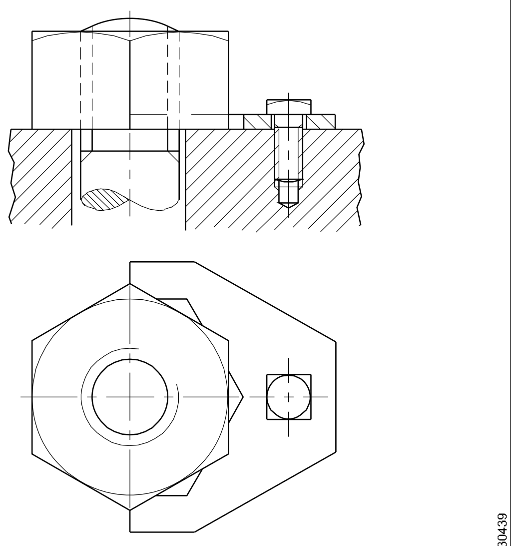
Locking by screw: A screw fixed by the side of the face prevents movement of the nut. (Fig 10)

Fig 8



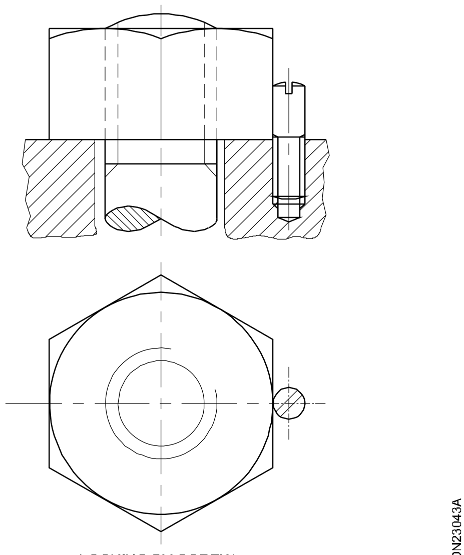
PENN, RING OR GROOVED NUT

Fig 9



LOCKING PLATE

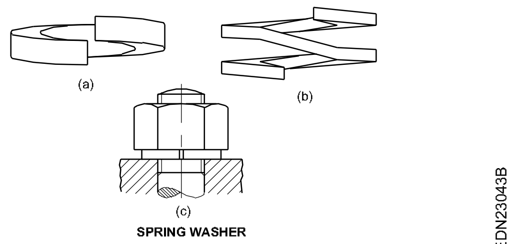
Fig 10



LOCKING BY SCREW

Apart from the methods mentioned above, spring washers, single coiled or double coiled washer are used to lock the nuts. By tightening the nut, the nut presses the spring and deform. This exerts pressure on the nut, prevents rotation of nut, when tightened in position. (Fig 11)

Fig 11

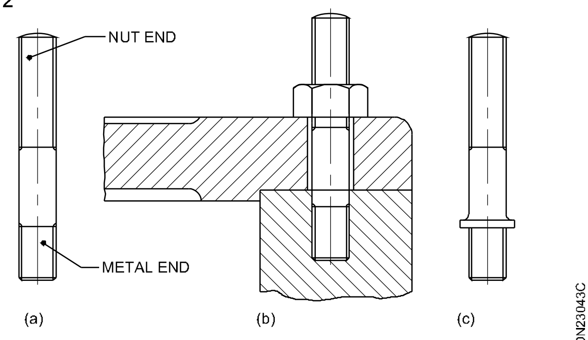


SPRING WASHER

Locking by wire: screw ends have holes through which wire is passed after the nuts are screwed down. Wire prevents nuts coming off.

Stud or stud bolt (Fig 12)**:** It is only a cylindrical shank having threads on both ends, with the plain portion in between. One end is shorter, that is screwed into the machine body called "Metal end". The other end longer one which takes nut is called Nut end. (Fig 12a) Some studs have a collar called "collar studs". (Fig 12c) Studs are screwed into the metal end, using double (lock nut) nut method. After removing the nuts, the other part with plain hole is placed in position and nuts are screwed on to the nut end. (Fig 12b)

Fig 12



There are three types of studs:

Type A - recommended for use in steel; metal end length = 1 d.

Type B - recommended for use in cast iron; metal end length = 1.5d.

Type C - recommended for use in aluminum, metal end length = 2 d

M4, M8, M12, M16 & M20 are available. Lengths 25 mm to 200 according to dia.

Designation stud B M24 x 200 IS:1862.

Sketches of foundation bolts

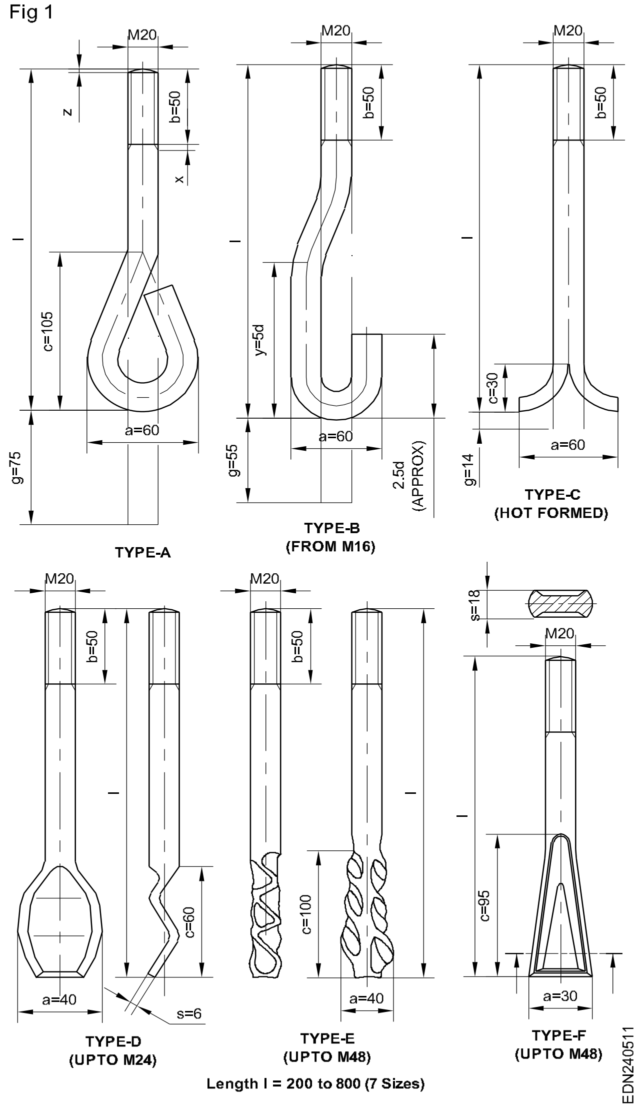
Machines are generally subjected to vibration. Due to this the machines are likely to shift or move from their positions. To overcome this the machines are fixed to the ground with the help of devices called foundation bolts.

These bolts do not have a specific shape of head like Hexagonal or square bolts. The length of the shank is according to the thickness of nut and the thickness of machine base. This odd shaped part holds the machine firmly to the ground.

Types (Fig 1 & 2)

As per IS:5624-1970, there are six types designated as Type A, B, C, D, E & F. Fig.1 shows the same. They are available in 13 dia sizes from M8 to M72, lengths 80mm to 3200 mm. These are designated by the shank dia and length, without nut. The ends are formed by forging.

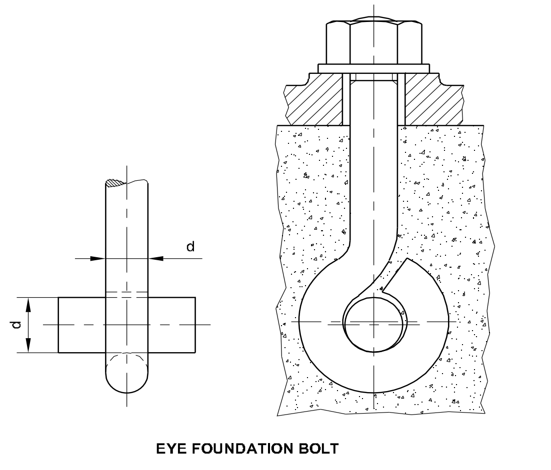
Fig 1



There are other non standard forms which are generally used are:

- Eye foundation bolt
- Rag foundation bolt
- Lewis foundation bolt and
- Cotter foundation bolt

Fig 2

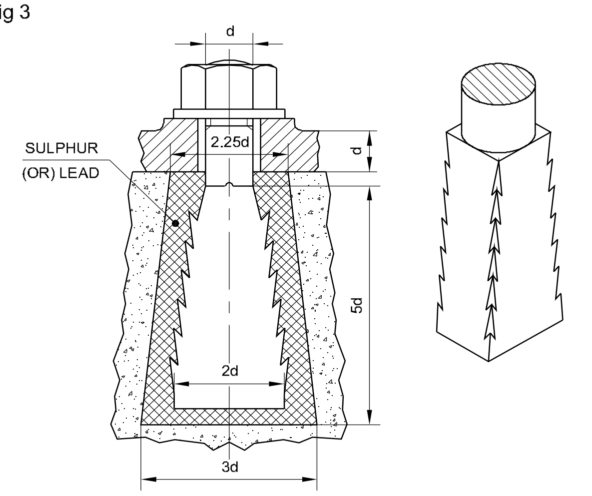


EYE FOUNDATION BOLT

Eye foundation bolt: Simple forms of these bolts can be quickly forged from a mild-steel or wrought-iron. These bolt are suspended in the hole and cement grout is then poured to fill up the space around them. It has a piece of mild-steel bar passing through the eye and at right angles to it. The stationary engines and lathe machines are fixed on the foundation by these bolts.

Rag bolt (Fig 3)**:** It is in the shape of a rectangular pyramid with round shank on the tapered end. The corners are formed into rags or grooved, forming small projections. These are placed in the foundation cavity in position as above and molten lead or sulphur is poured around it. When the molten lead sulphur/lead solidified, the bolts are held firmly. The machines are placed in position and nuts are fixed. By melting the lead or burning sulphur the bolt can be removed.

Fig 3

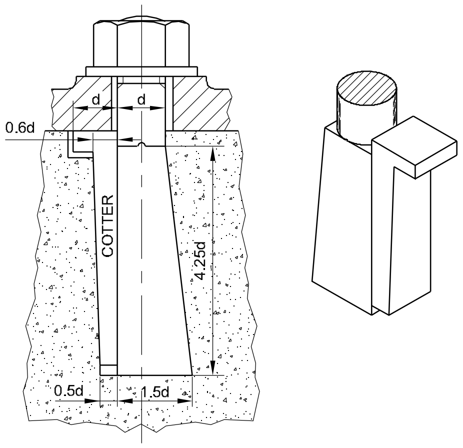


RAG FOUNDATION BOLT

Lewis Foundation bolt (Fig 4)**:** It is a rectangular shank bolt with one side taper. A gib head key is placed on the other side of taper as in earlier type and concrete is put around. It is aligned. The foundation bolt can be easily withdrawn by removing the gib head key first and then the bolt.

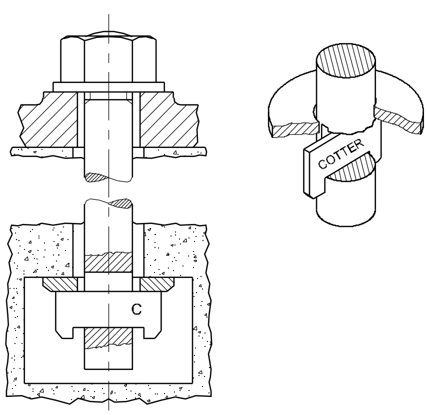
Cotter bolt (Fig 5)**:** It has a rectangular slot through which a double headed cotter is placed. A cast iron washer rests above the cotter. Through a hand hole, connecting the cavity in the concrete the bolt is pulled down and lifting the cotter, the cotter is placed in position.

Fig 4



LEWIS FOUNDATION BOLT

Fig 5



COTTER FOUNDATION BOLT

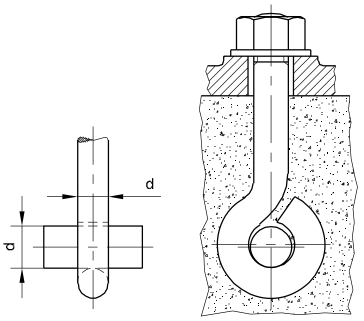
Practice of sketches of foundation bolts

Draw the figures of foundation bolts shown below.

1 Sketch the Eye foundation bolt shown in (Fig 1)

d = 20 mm

Fig 1



EYE FOUNDATION BOLT

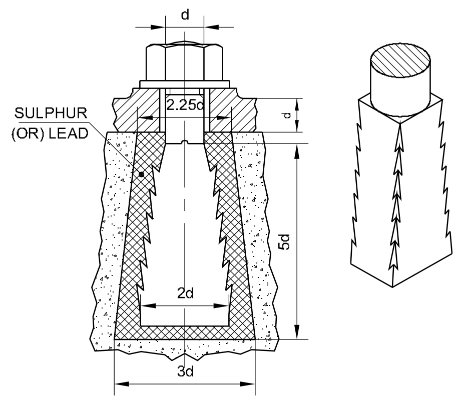
2 Sketch the Rag foundation bolt shown in (Fig 2)

d = 20 mm

3 Sketch the Lewis foundation bolt shown in (Fig 3)

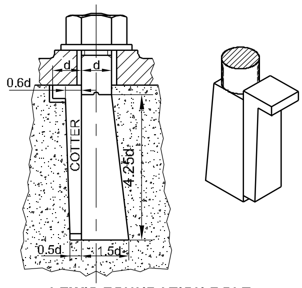
d = 20 mm

Fig 2



RAG FOUNDATION BOLT

Fig 3

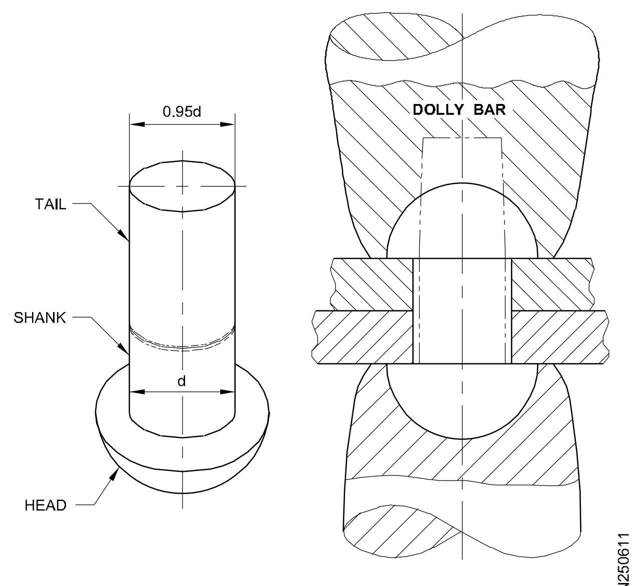


LEWIS FOUNDATION BOLT

Rivets

Rivet is a cylindrical rod of either carbon steel or wrought iron or non-ferrous metal. It consists of a head and shank tapering at the end facilitating easy placement in the rivet holes. Rivets are used to hold the plates or steel sections firmly, just as in steam boilers, girders, steel structures, ship building. The rivet holes are made either by punching or by drilling. When the plates are aligned, the heated rivets are placed through the holes. By using rivet sets, the tail part of the shank is formed into the head closing the hole. The plates are held firmly between the heads on cooling. To prevent leakages of boiler shells, during which the plate ends and rivet head end are pressed by hammering using a tool similar to blunt cold chisel. Fig 1 shows how riveting is done.

Fig 1



RIVET AND RIVETING

Types of rivets:

- Boiler rivets
- Hot forged rivets for hot closing
- Cold forged solid steel rivets for hot closing
- Non-ferrous rivets
- Cold forged rivets for cold closing
- Bi-furcated rivets for general purposes
- Solid drilled tubular and semi-tubular rivets.

Rivets are also broadly classified as:

- Structural rivets
- Boiler rivets
- Small rivets for general work
- Rivets for ship building
- Aircraft rivets.

Rivets are manufactured either by cold heading or hot forging. Cold headed rivets are adequately heat-treated so that the stresses set up in the cold heading process are eliminated. If they are hot forged, the finished rivets are cooled gradually. The rivets should be concentric with the shank. They shall be free from imperfection and heavy scales. The ends of the rivets shall be clearly sheared and free from rags or burrs.

They are available in different lengths and selected according to the requirements (IS:1928 for boiler rivets, dia 12 to 48mm).

Boiler rivets of different types of heads as per IS:1928-1961 are shown in Fig 2. They are

- Snap head
- Ellipsoidal head
- Pan head type I & II
- Pan head with taper neck
- Conical head
- Countersunk head
- Rounded countersunk head
- Flat head
- Steeple head

Boiler rivets are used in boiler shells, mountings gussets stays etc. They have generally tapered necks at 60° chamfer for preventing the leakages of steam. Table 1 shows the preferred length and diameter combination for boiler rivets.

Structural/General purpose rivets IS:1929, IS:2155: Structural rivets are used in structures like girders of bridges, trusses of roof etc.

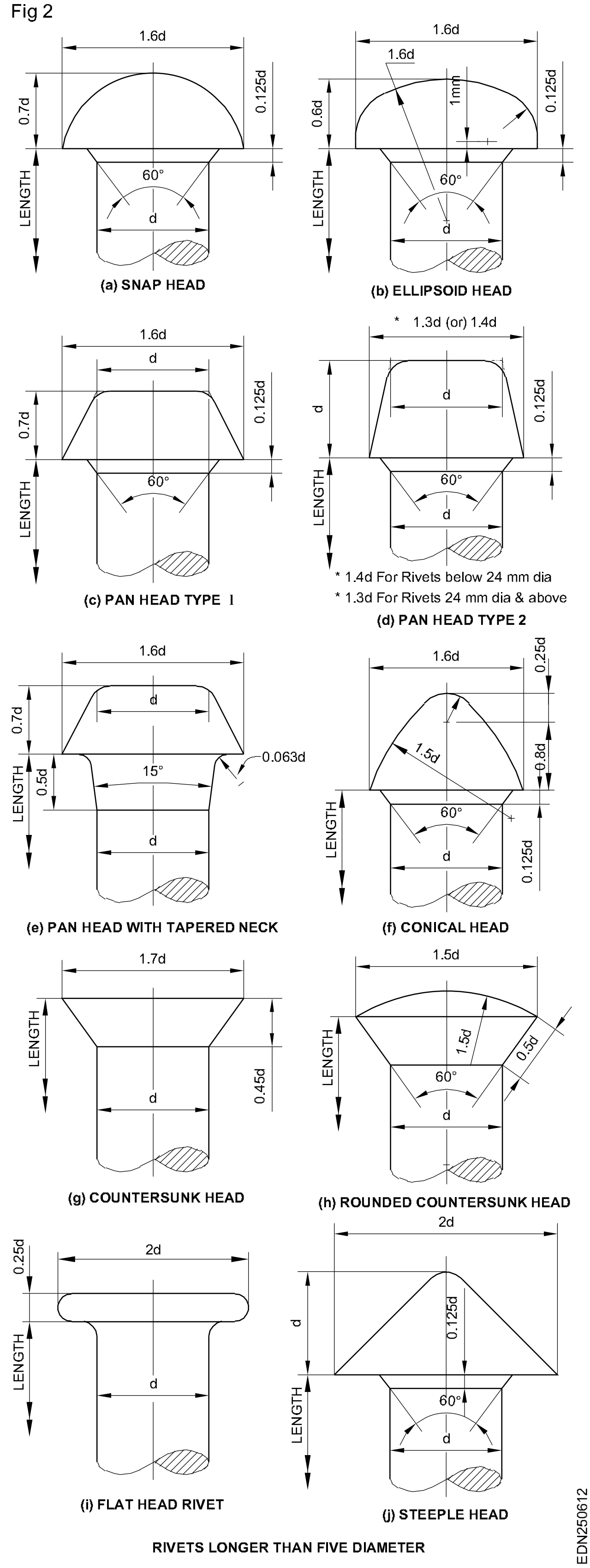
Their shank dia (IS:1929) varies from 12 mm to 36 mm. The proportions shown are for rivets of dia from 12 mm to 36 mm. The above rivets are used even for general work.

The dimensions are from 12 mm to 50 mm. Structural rivet and boiler rivets are made of low carbon steel and wrought iron. (Fig 3)

Small rivets are used for general work, may be made of "non-ferrous metals" viz copper, brass or aluminium. Diameters are 1.6, 2, 2.5, 3, 4, 5, 6, 8 and 10 mm of varying lengths in steps of 2 mm upto 24 mm and then in steps of 3 mm. IS:2907.

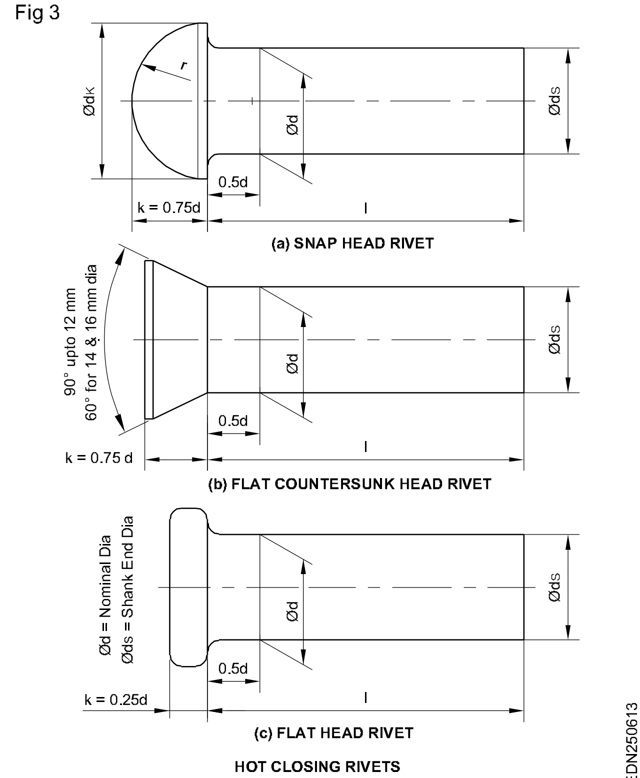
Rivets are designated by its shape, dia, length, IS. No and materials.

Fig 2



RIVETS LONGER THAN FIVE DIAMETER

Fig 3



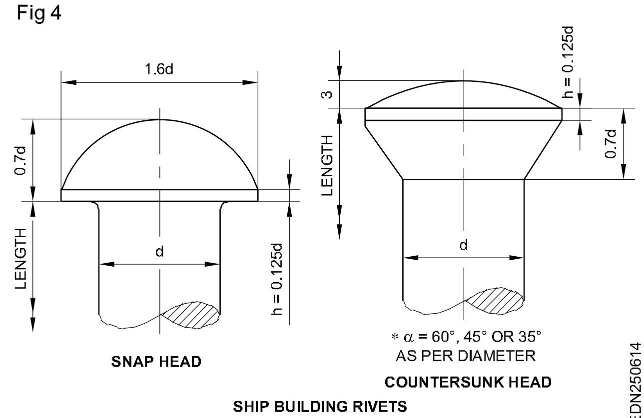
HOT CLOSING RIVETS

Ship building rivets (Fig 4)**:** (IS:4732)

- Snap head
- Countersunk head.

The dia ranges from 16 to 33 mm in steps of 2 mm upto 24 mm and rest in steps of 3 mm. The length of rivets vary from 27 mm to 180 mm in steps of 3 mm. They are made of mild steel bars.

Fig 4



SHIP BUILDING RIVETS

The snap head or cup head rivet is the most commonly used rivet. Countersunk head rivets are used where the top surface of the plate is required to be free from projecting rivet heads. Rivet proportions given in the figure are with reference to shank diameter of the rivets.

Selection of rivet dia: The diameter of the rivet is based on the thickness of the plates to be joined. A general formula to find the dia `d' for plate thickness `t' is

$d = 6\sqrt{t}$, where `t' is in millimeters.

$d = 1.2\ \sqrt{t}$ to $1.4\ \sqrt{t}$, where the `t' is in inches.

Recommended value

Thickness of plate t in mm

8, 9, 10, 11, 12, 14, 16, 18, 20, 22, 25

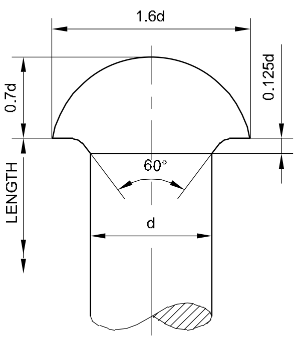
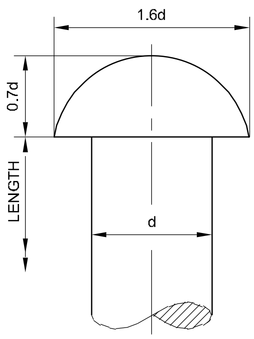
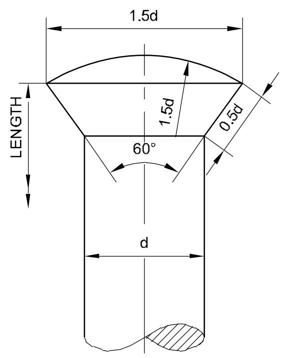
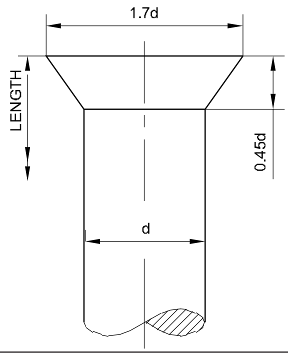
Dia of rivet d in mm

17, 18, 19, 20, 21, 22, 24, 25, 27, 28, 30

Length of rivet is selected according to the thickness of plates and just long enough to fill the hole completely and make the head. Rivet joints are formed by drilling holes in plates together (grade of hole H 12). The rivet is placed through the holes and the shank is either hot forged or cold forged.

Table 1

Rivets for general purposes and boiler rivets (12 to 48 mm diameter) IS:1929-1961
IS:1928-1961

Snap head rivet for boilers	Snap head rivet for general purpose	Rounded countersunk head for general purpose and boilers	Flat countersunk head for general purpose and boilers
			

Basic size of rivets, D, mm: 12 14 16 18 20 22 24 27
30 33 36 39 42 48

Preferred length and diameter combination for rivets for general purposes and boiler rivets

Length mm	**Diameter, mm**													
	12	**14**	**16**	**18**	**20**	**22**	**24**	**27**	**30**	**33**	**36**	**39**	**42**	**48**
28	x	–	–	–	–	–	–	–	–	–	–	–	–	–
35.5	x	x	x	–	–	–	–	–	–	–	–	–	–	–
40	x	x	x	x	–	–	–	–	–	–	–	–	–	–
50	x	x	x	x	x	x	–	–	–	–	–	–	–	–
63	x	x	x	x	x	x	x	x	–	–	–	–	–	–
80	x	x	x	x	x	x	x	x	x	–	–	–	–	–
100	–	–	x	x	x	x	x	x	x	x	x	x	x	x
150	–	–	–	–	–	x	x	x	x	x	x	x	x	x
200	–	–	–	–	–	–	–	–	x	x	x	x	x	x
250	–	–	–	–	–	–	–	–	–	–	–	–	x	x

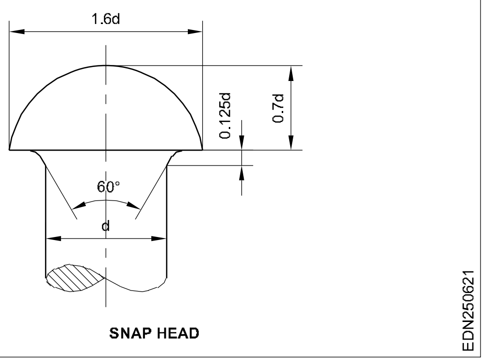
Note: Preferred combinations are indicated by "x"

Practice of standard rivet forms as per BIS

1 Snap head rivet (Fig 1)

Draw a snap head rivet suitable for joining plates of 25 mm thick.

Fig 1



Diameter of rivet = $6 \times \sqrt{25} = 6 \times 5 = 30$ mm

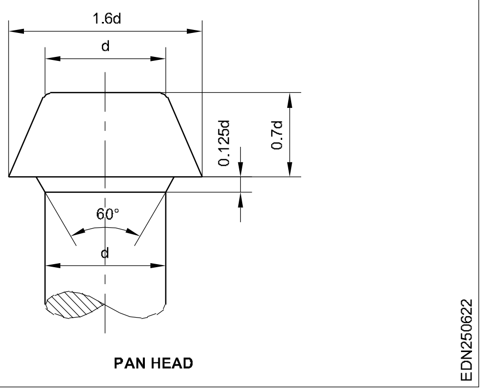
- Draw a thin horizontal line.
- Draw vertical centre lines.
- Mark diameter of rivet shank and head.
- Form the rivet head as per proportions.
- Draw the shank with short break.
- Draw firm lines of the edges of the rivet.
- Show the dimensions in terms of dia of shank. (Fig 1)

2 Pan head rivet

Draw a pan head rivet of shank diameter 30 mm. (Fig 2)

- Follow the procedure of snap head rivet.

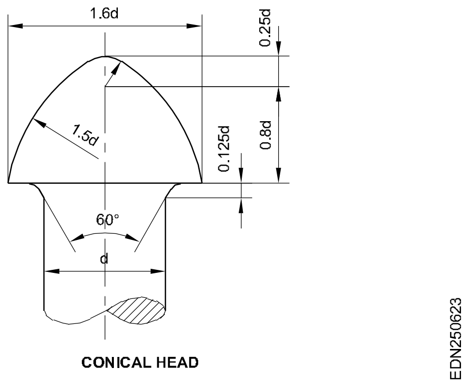
Fig 2



3 Conical head rivet

Draw a conical head rivet of shows diameter 25 mm. (Fig3)

Fig 3



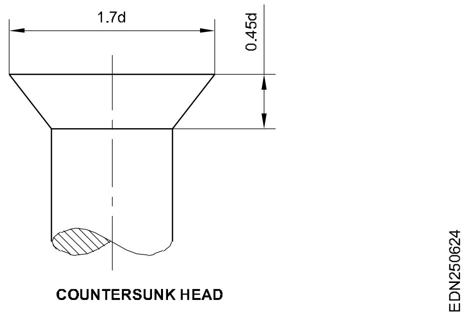
- Draw a horizontal thin line.
- Draw a vertical centre line.
- Mark the diameter of rivet head and shank as per proportion.
- Set off 0.8d on the centre line as shown in Fig 3 from the horizontal line.
- 0.25d as radius, draw an arc as shown in Fig 3.
- 1.5d as radius, draw another arc, tangential to the previous arc of radius 0.25d.
- Draw the firm lines of the edges of the rivet.
- Show the dimensions in terms of diameter of shank.

4 Countersunk head rivet

Draw a countersunk head rivet of shank diameter 25 mm.

- Draw a horizontal line.
- Draw a centre line.
- Follow the procedure of earlier exercises and complete the rivet head. (Fig 4)

Fig 4



Riveted joints

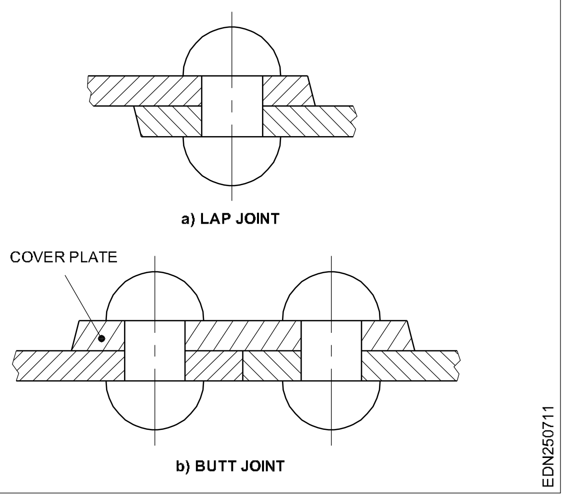
Types of riveted joints

- Lap joint
- Butt joint

When the plates are placed one above the other, the joint is called Lap joint. The distance between the centres of adjoining rivets in the same row is called the pitch. (Fig 1)

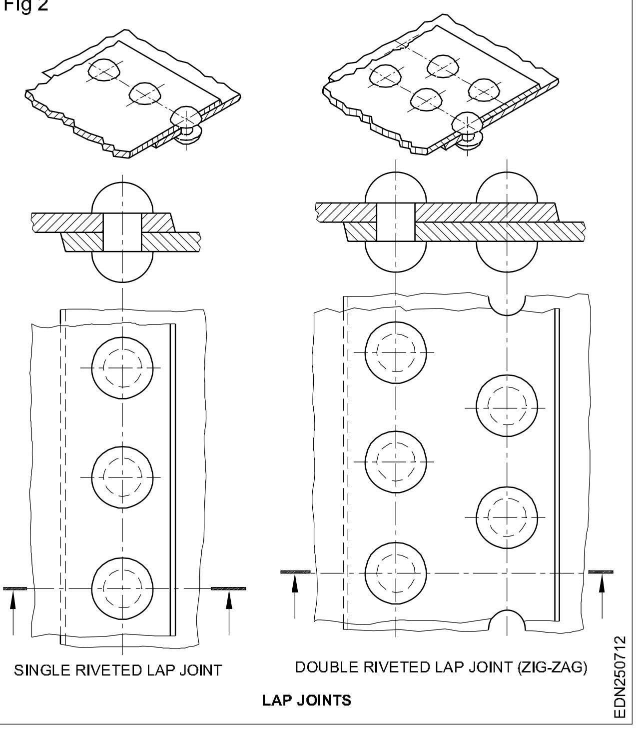
In the lap joints only two plates are used placing one over the other and riveted. In butt joints, the plate ends are placed face to face, single or double cover plates are used to rivet them together.

Fig 1



When the number of rows are two or more, rivets are arranged in chain or zig-zag formation. (Fig 2)

Fig 2



Types of lap joints

Single riveted lap joint: There is only one row of rivets. The plates to be joined are placed one above the other to a lap length of 3d, d being dia of the rivet. In any riveted joint, the distance between the end of the plate to the centre of rivet and centre of the hole is called `Margin' (m).

Riveted joints are named according to the number of rows of rivets, a single riveted lap joint has one row of rivets, double riveted lap joint has two rows of rivets - triple riveted joint has three rows of rivets. The rows may be chain or zig-zag. (Fig 3a & b)

Proportions of riveted joints: The diameter of rivet, pitch and margins are calculated to prevent failure of joint, forming a safe and efficient joint. For all sizes, thickness of the plates is considered first.

- Diameter of rivet d = $6\sqrt{t}$ called Unwim's rule
- Pitch (Max.) P = 3d
- Margin M = 1.5d
- Min. Pitch = d + 30 mm
- Row pitch for chain riveting (Pr) = 0.8P
- Row pitch of zig-zag (Pr) = 0.6P
- Diagonal pitch (Pd) = (2P + d) /3
- Length of rivet = thickness of plates (plate grip) + 1.25d or 1.7d

Butt joints: When the plates butt against each other the joint is called butt joint. The joint may have either single cover plate or double cover plate and single riveted, double riveted and triple riveted etc. on each plate. These are generally used on longitudinal seams of cylindrical boiler shells etc. (Fig 4)

In butt joint, the thickness of cover plates or strap with respect to plates being joined is

- single strap = 1.125t
- double strap = 0.6t to t

Fig 4

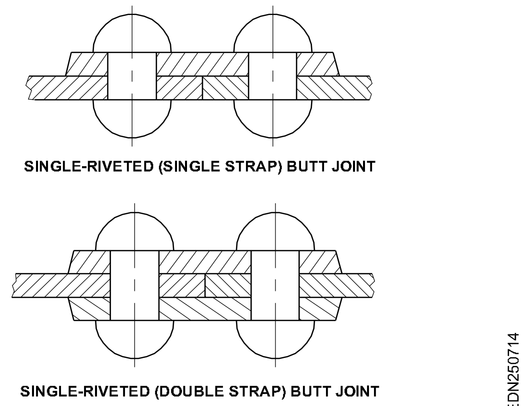
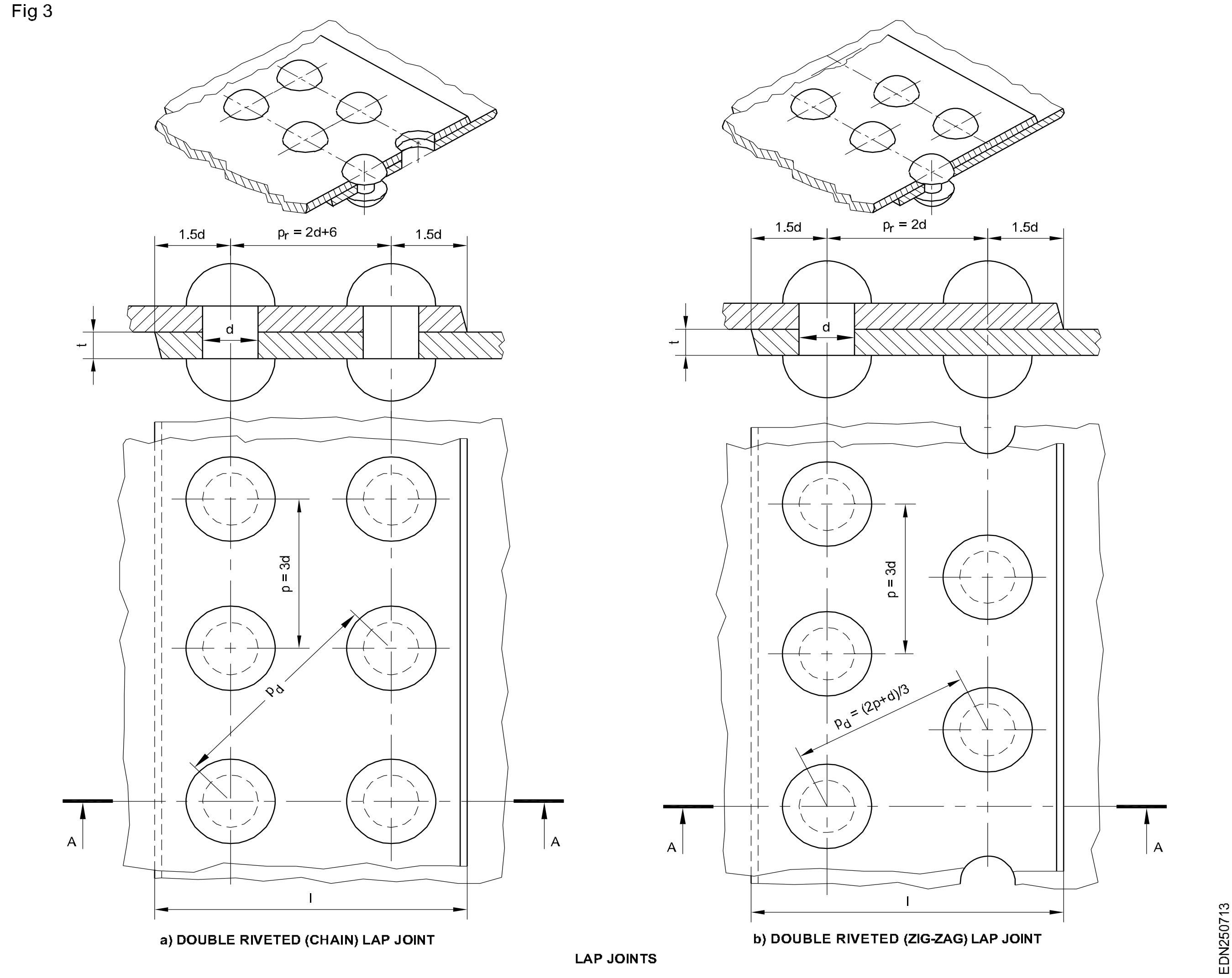


Fig 3



LAP JOINTS

"Chain riveting" and zig-zag riveting: When the rivets in the rows are placed directly opposite to each other it is called chain riveted. (Fig 5a) If rivets are staggered it is called zig-zag riveted. (Fig 5b)

The distance between the rows of rivets is called "Row pitch" Pr. The value of row pitch (Pr) in the case of chain riveting is 0.8 P and 0.6 P for zig-zag riveting.

The distance between the centre of one rivet in one row to the centre of the nearest rivet in the adjoining row is called diagonal pitch - Pd (Fig 5b)

The figures show the double riveted butt joint (zig-zag) double strap.

Caulking and Fullering: (Fig 6) Due to high internal pressure of steam or water in the boiler, there is the possibility of the leakage of steam or water through rivet holes or joint i.e., between plates. To prevent such leakages the rivet heads and plate ends are firmly forced together. It is called caulking and fullering. For caulking a blunt type chisel is used by hammering the rivet head/plates. (Fig 6a)

In fullering a tool with thickness equal to that of plate is used to hammer the edges of the plate. It is used to press the plate ends. (Fig 6b)

Figures 7 show how the plates at right angles can be joined using rivets.

Fig 6

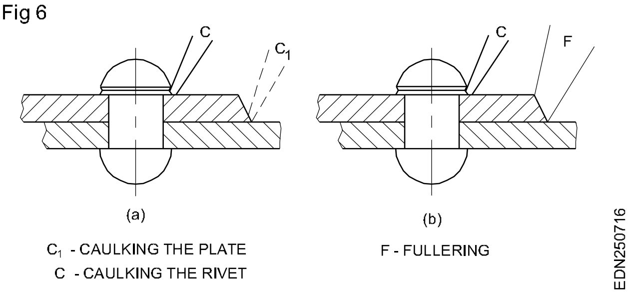
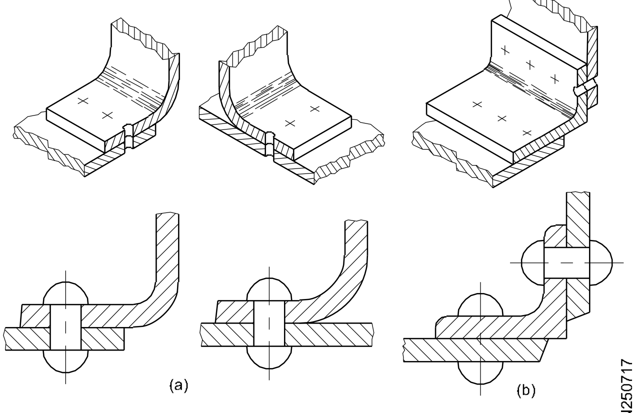
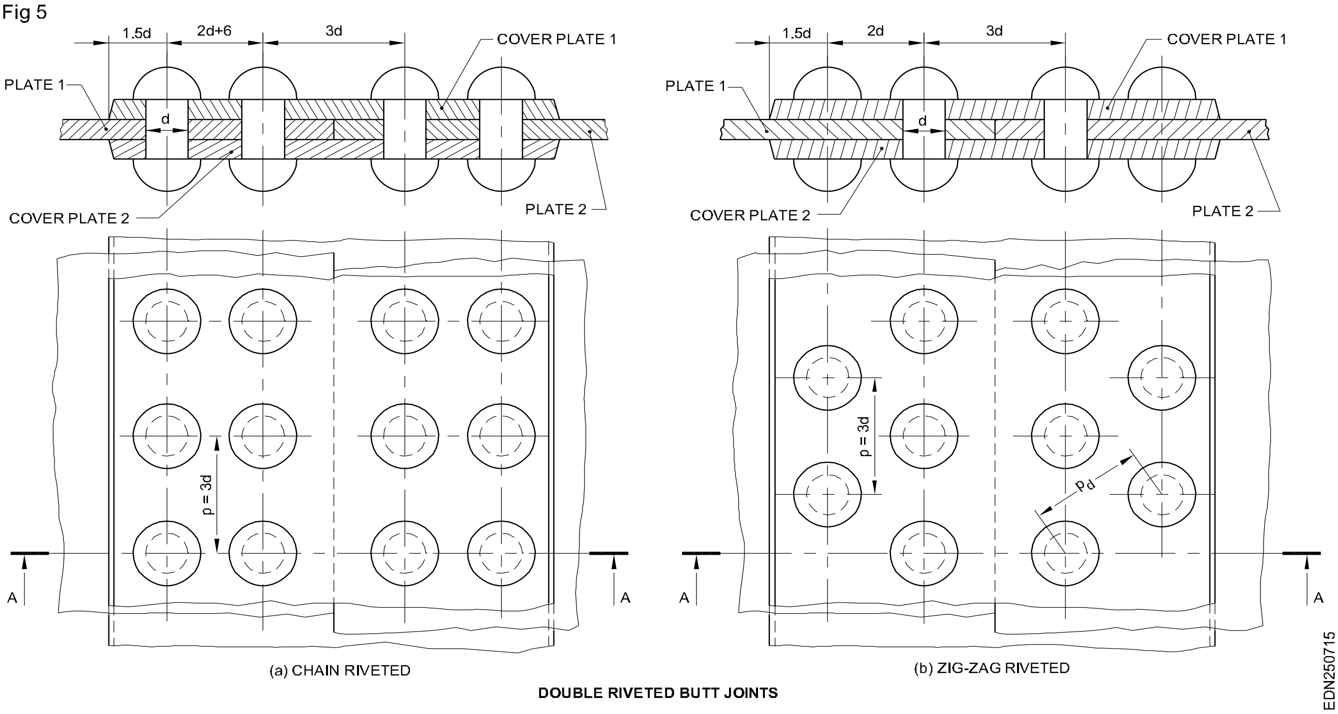


Fig 7



CONNECTION OF PLATES AT RIGHT ANGLES

Fig 5



DOUBLE RIVETED BUTT JOINTS

Method of indicating and dimensioning of rivets

Generally rivets are indicated by their centre lines thickened in the direction and at right angles to the seam. (Fig 1)

The Table No.1 shows the symbols for rivets.

Table 1

TABLE OF SYMBOLS FOR RIVETS AND BOLTS
(Clauses 6.3.1.1, and 6.5.3.1)

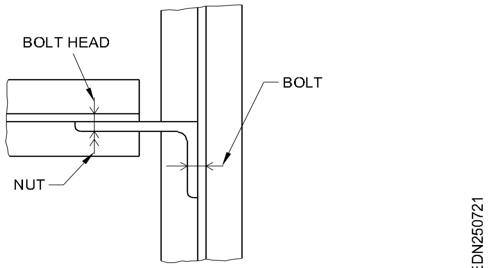
DESCRIPTION	METHOD OF DRAWING IN		
	VIEW	SECTION	
RIVET, GENERAL			
RIVET, COUNTERSUNK ON BACK SIDE			
RIVET, COUNTERSUNK ON FRONT SIDE			
RIVET, COUNTERSUNK ON BACK AND FRONT SIDE			

EDN2507T1

To distinguish between bolts and rivets in a side view or section, it may be useful to add an arrow (angle about 90°) at each end of the centre line of the bolts/rivets.

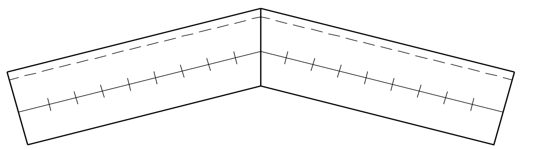
In case to nuts for bolts if any, this is marked by double arrow as in Fig 2.

Fig 1



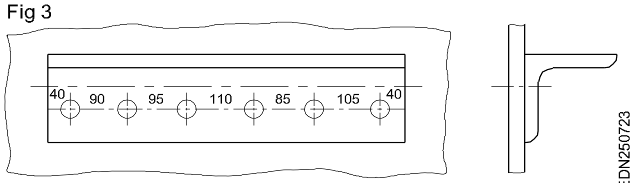
The centre lines for rivets/bolts shall be represented by continuous thin lines. (Fig 3)

Fig 2



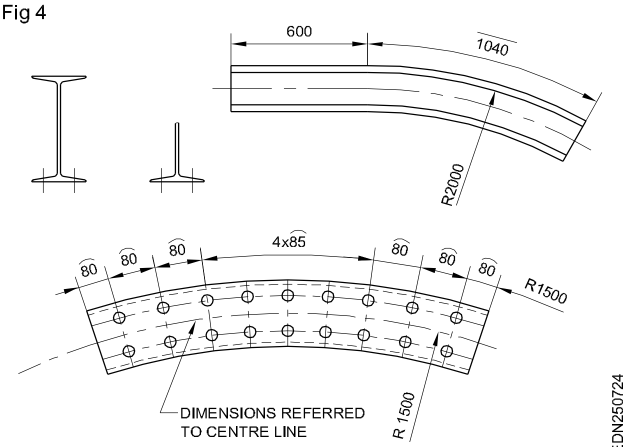
The centre line or the neutral fibre is indicated when necessary by a long chain thin line is shown in Fig 4.

Fig 3



In case of special methods of dimensioning a note should be added to explain to which feature the dimension, refers For example dimension referred to centre line or dimensions referred to graduation. (Fig 5)

Fig 4



Practice of riveted joints

1 Single riveted lap joint (Fig 1)

Draw a single riveted lap joint, joining 25 mm thick plates. Show minimum 3 rivets.

Calculations:

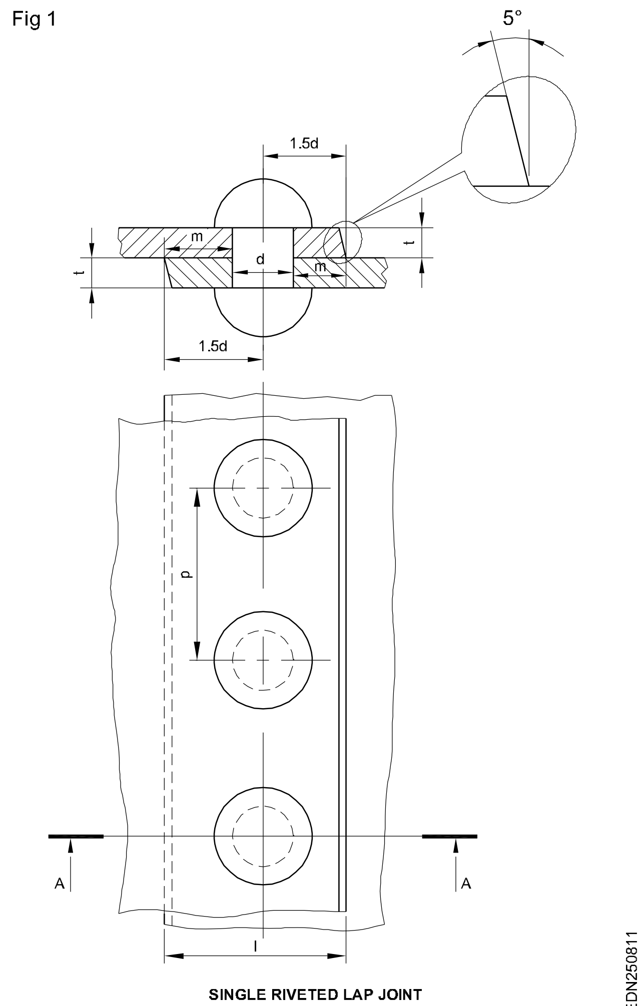
Dia of rivet = $6\sqrt{t} = 6\sqrt{25}$ = 6 x 5 = 30 mm

Pitch of rivet = 3d = 3 x 30 = 90 mm

Margin from rivet hole to end of plate = 1.5d = 1.5 x 30 = 45mm.

- Mark vertical centre line.
- Draw three horizontal lines 25 mm apart in front elevation.
- Form the rivet heads (on 30 mm shank) on the centre line.
- Draw the plates and section them as shown
- Draw the rivet head circle and hidden circles for shank dia.
- Draw the edge of the plates in front view at 80° - 85°.
- Project the edges on to top view.

Fig 1



SINGLE RIVETED LAP JOINT

- Mark two pitch distances of 90 mm each.
- Draw visible edges of plates and rivets in firm lines. (Fig1).

2 Double riveted (chain) lap joint (Fig 2)

Draw a double riveted lap joint/chain riveting with 35 mm thick plates. Show a minimum of 3 rivets.

Data:

Dia of rivet = $6\sqrt{t} = 6\sqrt{35}$ round to = $6\sqrt{36}$ = 6x6 = 36mm (approx.)

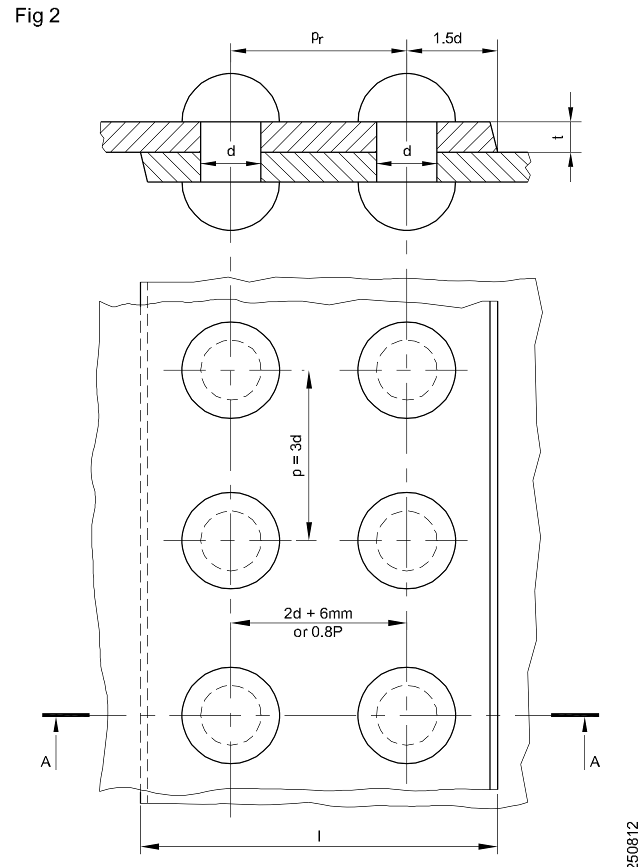
Pitch p = 3d = 3 x 36 mm = 108 mm

Row pitch (P_r) = 0.8 P or 2d + 6 mm = 86.4 mm or 78 mm

Margin = 1.5d = 1.5 x 36 mm = 54 mm

- Draw the plates one over the other, mark pitch (P_r) and lap (l) 54 mm on either side.
- Draw the rivet heads, ends of the plates at lap and beyond short break.
- Hatch the plates in opposite directions.
- Project and draw the top view as in Practice 1.
- Show the cutting plane. Show the proportions instead of dimensions in terms of dia of rivet. (Fig 2)

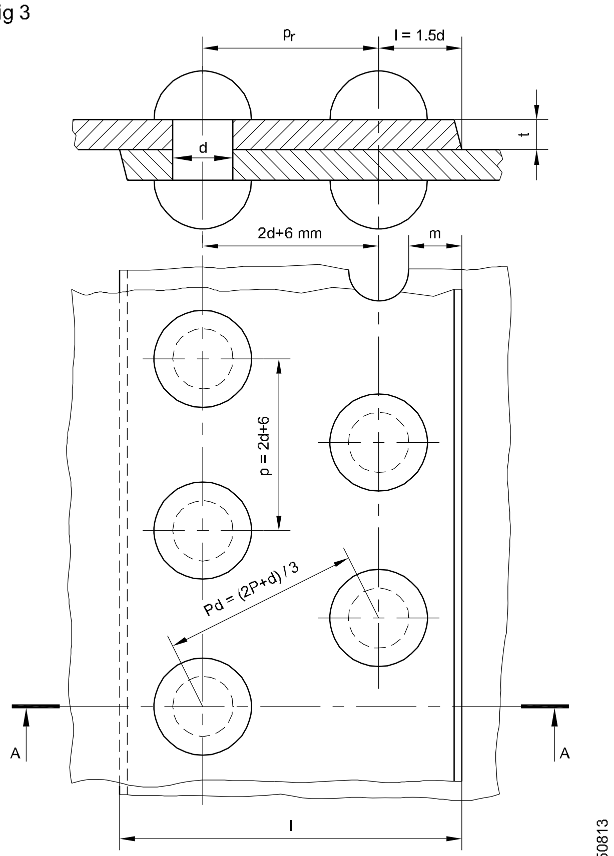
Fig 2



DOUBLE RIVETED (CHAIN) LAP JOINT

3 Double riveted (zig-zag) lap joint (Fig 3)

Fig 3



DOUBLE RIVETED (ZIG-ZAG) LAP JOINT

Draw a double riveted zig-zag lap joint, joining 35 mm thick plates.

Data:

Dia of rivet = $6\sqrt{t}$ = $6\sqrt{35}$ round to = $6\sqrt{36}$ = 6x6 = 36mm (approx.)

Pitch P = 3d = 108 mm

Row pitch (P_r) = 0.8 P or 2d + 6 mm = 86.4 d or 78 mm

Diagonal pitch (P_d) = $\frac{(2P+d)}{3} = \frac{2\times108+36}{3} = \frac{252}{3}$ = 84mm

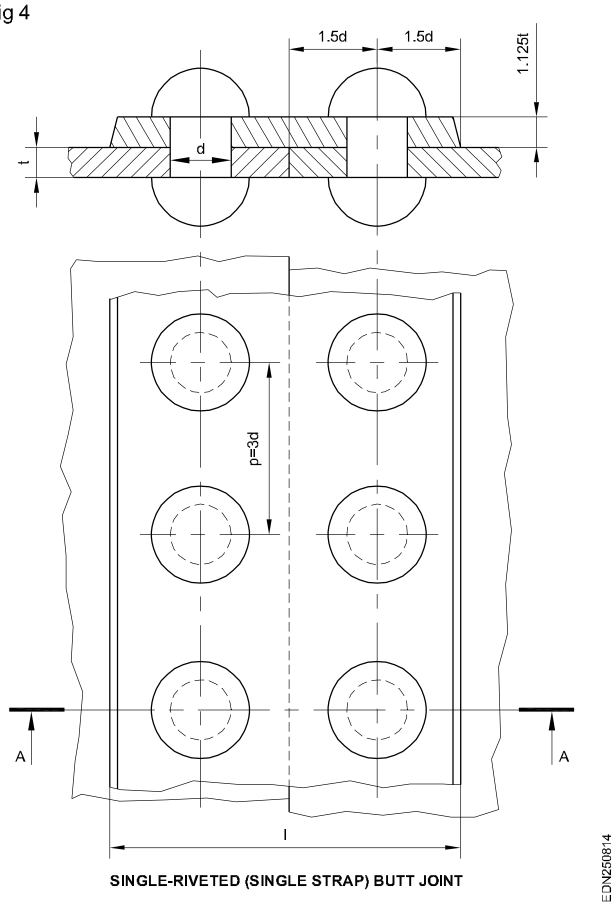
Margin = d = 36 mm or lap (l) = 1.5d = 54 mm

- Draw the plates as in previous practice and mark centre lines at P_r = 78 or 86 mm, draw rivet heads.
- Mark the ends of the plates.
- Project on to top view, mark three rivet centres at distance. (108 mm)
- Draw intersecting arcs with P_d as radius from centre.
- Draw rivet head circles and shank as hidden circles.
- Draw the edges of the plates as shown
- Show proportions of plate thickness. (Fig 3)

4 Single riveted (Single strap) butt joint (Fig 4)

Draw a single riveted butt joint with single cover plate. Two plates of 36 mm thick butting each other are to be joined by riveting.

Fig 4



SINGLE-RIVETED (SINGLE STRAP) BUTT JOINT

Calculations:

Given plate thickness t = 36 mm

Dia of rivet = $6\sqrt{t}$ = 36 mm

Pitch of rivets P = 3d = 108 mm

Lap l = 1.5d = 54 mm

for butt joints

Single cover plate thickness

1.125 t = say 40 mm

Pitch of rivets = 3d = 108 mm

Row pitch for chain riveting = 2d + 6 = 78

- Draw the plates in position with single cover plate.
- Mark the centre of rivets and draw rivets.
- Hatch the plates.
- Project and draw the top view showing minimum 3 rivets in a row.
- Show the broken end of the plates.
- Dimension the views. (Fig 4)

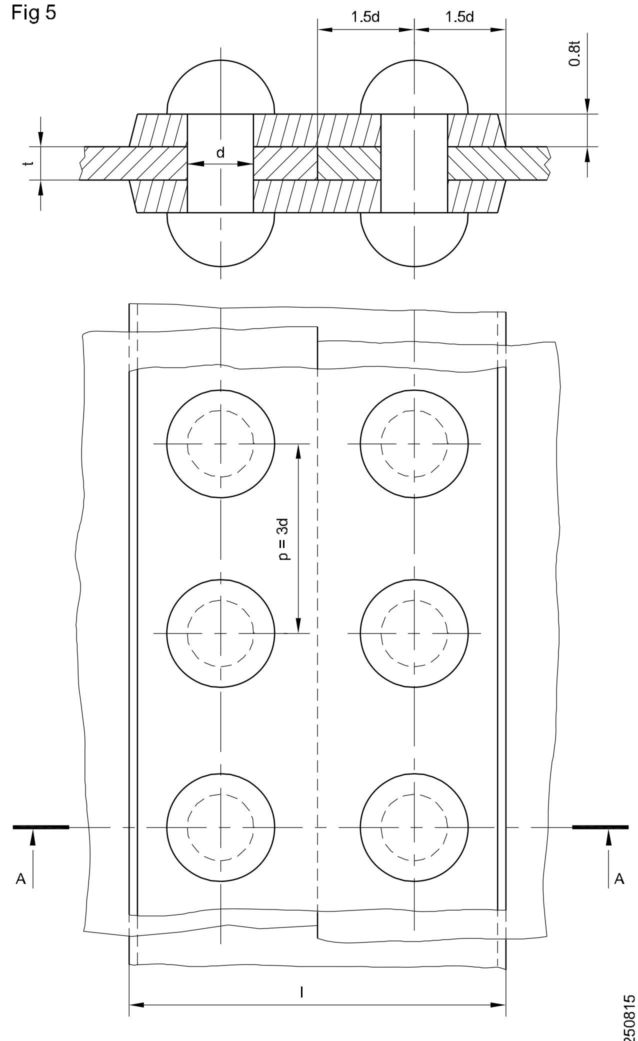
5 Single riveted (Double strap) butt joint (Fig 5)

Draw single riveted double strap butt joint (chain). Plate thickness 25 mm.

Calculate the rivet dia, pitch, distance etc.

Double cover plate thickness (0.6 t to t)

Fig 5



SINGLE-RIVETED (DOUBLE STRAP) BUTT JOINT

Average = 0.8t

0.8 t = 20 mm

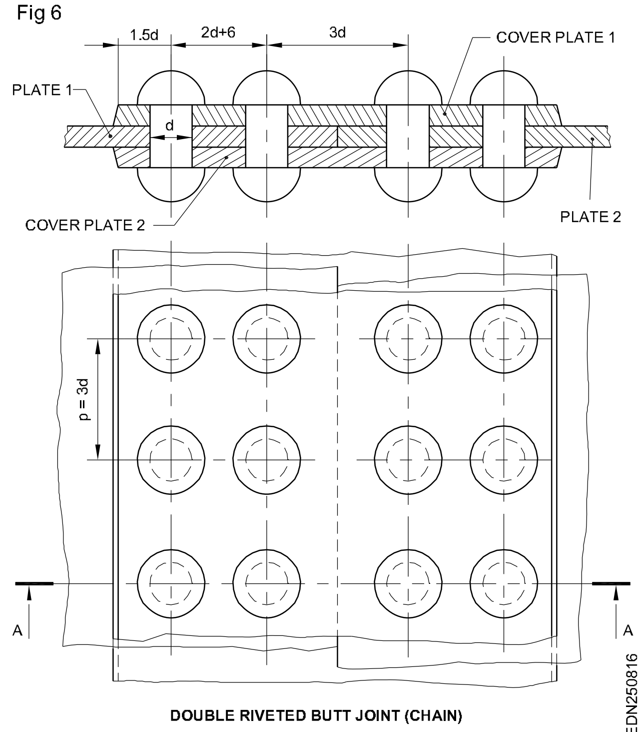
- Draw the main plates and cover plates in position.
- Mark two rows of rivets with distance as shown in Fig5.
- Draw the rivets and hatch the plates.
- Project and draw the top view with minimum 2 pitches.
- Show the end cover plates and main plates.
- Show dimensions in terms of dia (d). (Fig 5)

6 Double riveted butt joint (chain) (Fig 6)

Draw a double riveted butt joint to join 25 mm thick plates, double cover plates chain riveting.

- Calculate the rivet diameter, row pitch, pitch, margin etc as in previous exercise.
- Draw the plates with double cover plates (10d + 12 mm) long.
- Mark the centres of rivets as shown in the Fig 6.
- Draw the rivet head and the plate ends.
- Project and draw the plates showing thickness and rivets.

Fig 6



DOUBLE RIVETED BUTT JOINT (CHAIN)

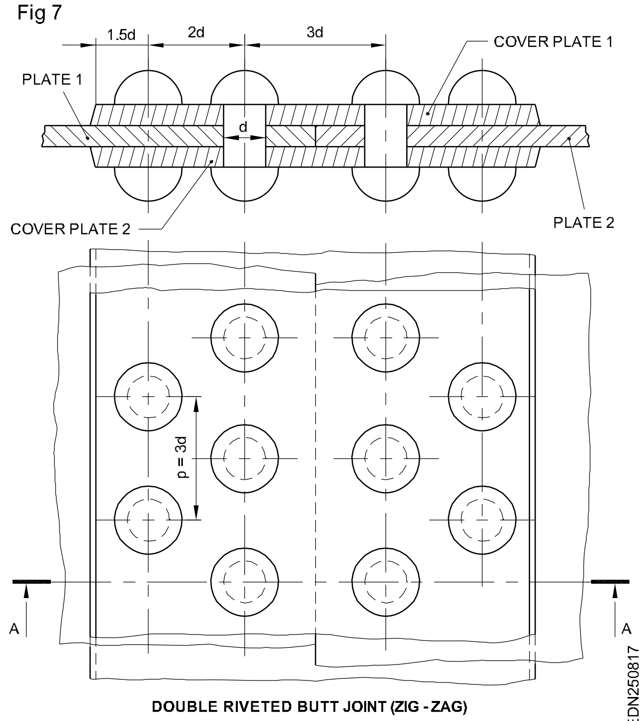
- Hatch the plates
- Show dimensions/proportions. (Fig 6)

7 Double riveted butt joint (zig-zag) (Fig 7)

Draw a double riveted butt joint to join 25 mm thick plates, double cover plates by zig-zag riveting. (Fig 7)

- Calculate the rivet diameter, row pitch, pitch, diagonal pitch margin etc as done in previous exercises.

Fig 7



DOUBLE RIVETED BUTT JOINT (ZIG - ZAG)

- Follow the same procedure of earlier joints and complete the drawing.

8 Riveted joint with connection plates at right angles (Fig 8)

Draw the riveted joints connecting plates at right angles with a & b bent plate c angle iron, plate thickness 25.

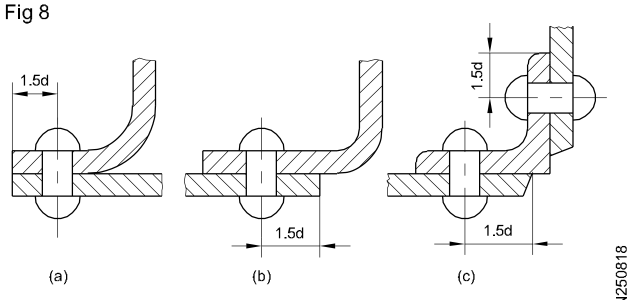
Using bent plate

- Draw the plate bent at radius not less than 2t.
- Mark the centre of the rivet 1.5d from centre of arc.
- Draw the other plate to be riveted and rivet (two methods are shown)
- Show proportions of Fig 8a and 8b.

Using angle plate

- Mark the centre of rivet holes at 1.5d + t from the corner of the angle plate.
- Draw the plates, draw the rivets and hatch.
- Show proportions. (Fig 8c)

Fig 8



CONNECTION OF PLATES AT RIGHT ANGLES

Welded joints

Different types of welded joints

The 5 basic welded joints are:

1 Butt joint

2 Corner joint

3 Lap joint

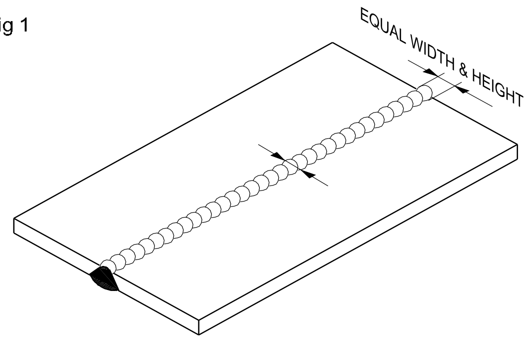
4 Tee joint and

5 Edge joint

Butt Joint: (Fig 1)

The joint which is formed by placing the ends of two parts together is called butt joint. In butt joint the two parts are lie on the same plane or side by side. It is the most simplest type of joint used to join metal or plastic parts together.

Fig 1



The different weld types in butt welding are:

i Square Butt weld

ii Bevel groove weld

iii V-groove weld

iv J-groove weld

v U-groove weld

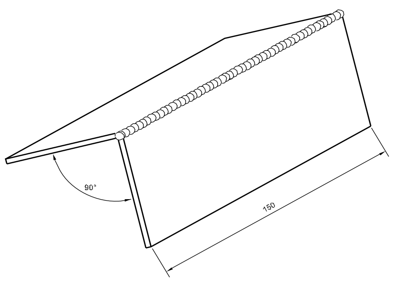
vi Flare-V-groove weld

vii Flare-bevel-groove butt weld

Corner Joint (Fig 2) :

The joint formed by placing the corner of two parts at right angle is called corner joint (see fig above). Two parts which is going to be weld with corner joint forms the shape of L.

Fig 2



The different weld types in corner joint are as follows:

i Fillet weld

ii Spot weld

iii Square-groove weld or butt weld

iv V-groove weld

v Bevel-groove weld

vi U-groove weld

vii J-groove weld

viii Flare-V-groove weld

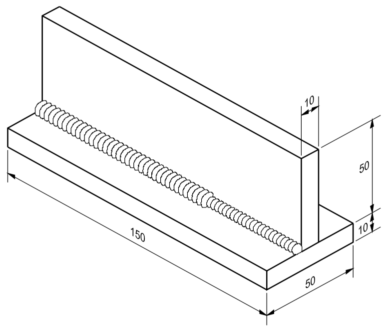
ix Edge weld

x Corner-flange weld

T-Joint (Fig 3):

The joint which is made by intersecting two parts at right angle (i.e at 90 degree) and one part lies at the centre of the other. It is called as T joint as the two part welded look like english letter 'T'.

Fig 3



The types of welds in T joint are as follows:

i Fillet weld

ii Plug weld

iii Slot weld

iv Bevel-groove weld

v J-groove weld

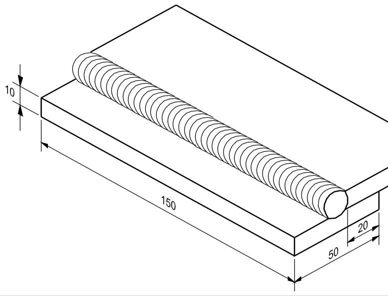
vi Flare-bevel groove

vii Melt-through weld

Lap Joint (Fig 4):

The lap joint is formed when the two parts are placed one over another and than welded (see fig above). It may one sided or double sided. This types of welding joints are mostly used to join two pieces with different thickness.

Fig 4



The Various weld types in lap joint are:

i Fillet weld

ii Bevel-groove weld

iii J-groove weld

iv Plug weld

v Slot weld

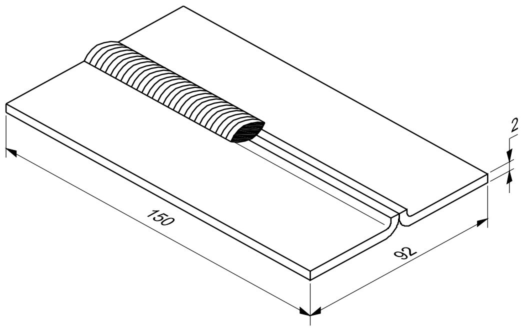
vi Spot weld

vii Flare-bevel-groove weld

Edge Joint (Fig 5):

The joint formed by welding the edges of two parts together are called edge joint. This joint is used where the edges of two sheets are adjacent and are approximately parallel planes at the point of welding. In this joint the weld does not penetrates completely the thickness of joint, so it can not be used in stress and pressure application.

Fig 5



The various weld types in this welding joint are:

i Square-groove weld or butt weld

ii Bevel-groove weld

iii V-groove weld

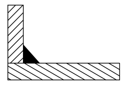
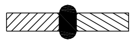
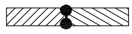
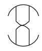
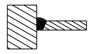
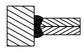
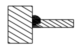
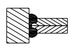
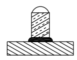
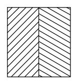
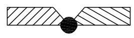
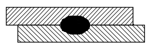
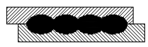
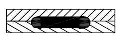
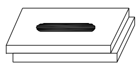
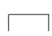
iv J-groove weld

v U-groove weld

vi Edge-flange weld

vii Corner-flange weld

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		

Sketches of pipes and pipe joints

Pipe layouts and joints

Pipes are used for carrying fluids, such as water, steam, oil, gas, etc. from one place to another. Circular pipe made cast iron, steel, copper, aluminium, plastic, cement etc. are used for this purpose. Joining of pipes and their fittings for making required layout can be made by different methods and the process is named plumbing. Commonly used pipe joints, the pipe specials and the drawing method of piping layouts using symbols are discussed in this chapter.

Pipe Joints

A pipe is a tube and generally considered as circular in cross-section in engineering practice, pipes are assumed to be straight and stiff, and are available in standard lengths. At the same time, a tube is assumed as flexible pipe and available in coil form. The size of a pipe is designated by its inner diameter and thickness. Pipes are joined by many methods (Fig 1) and they are named as

a Screwed pipe joint

b Welded pipe joint

c Flanged pipe joint

 i Integral flanges

 ii Screwed flanges

d Glued or cemented pipe joint

e Soldered pipe joint

Pipe fittings or specials

To connect two pipes together and to make branches, reduction or increase of diameter, etc. different parts of a pipeline called pipe fittings or specials are used. Screwed pipe specials commonly used in plumping are shown in Fig 2. The screw threads used on pipe fittings are of fine size in pitch and slightly different from the standards threads for nuts and bolts. The size values are available in engineering tables.

Depending on the shape and purpose, the joints commonly used are classified into the following categories:

1 Socket and spigot joint

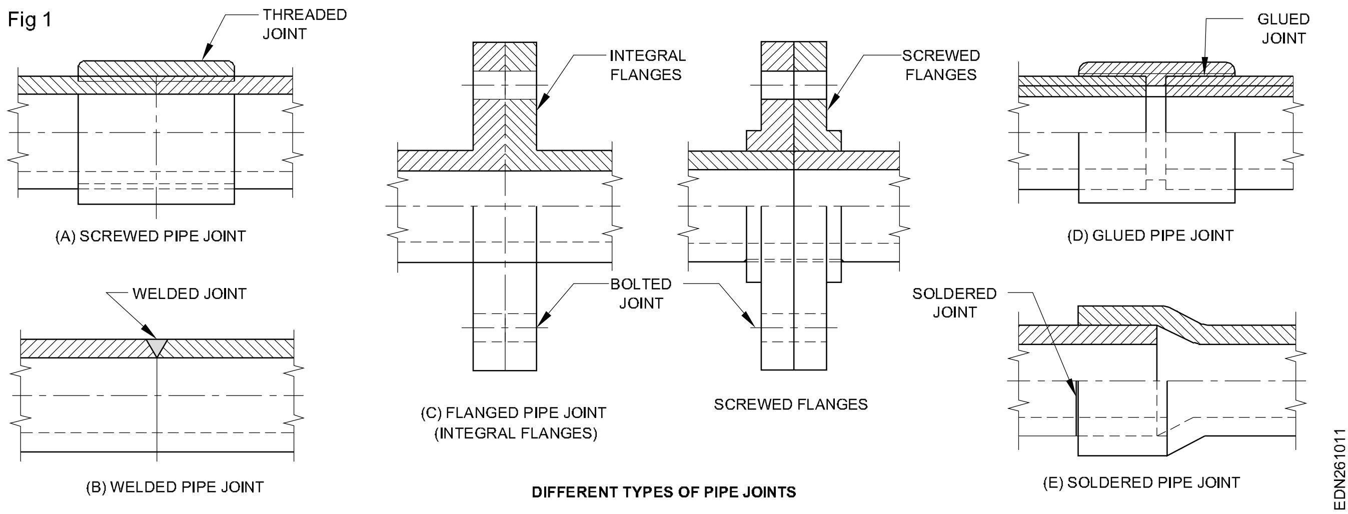
2 Screwed union joint

3 Integral flanged pipe joint (Integral or screwed)

4 Hydraulic (Armstrong) pipe joint

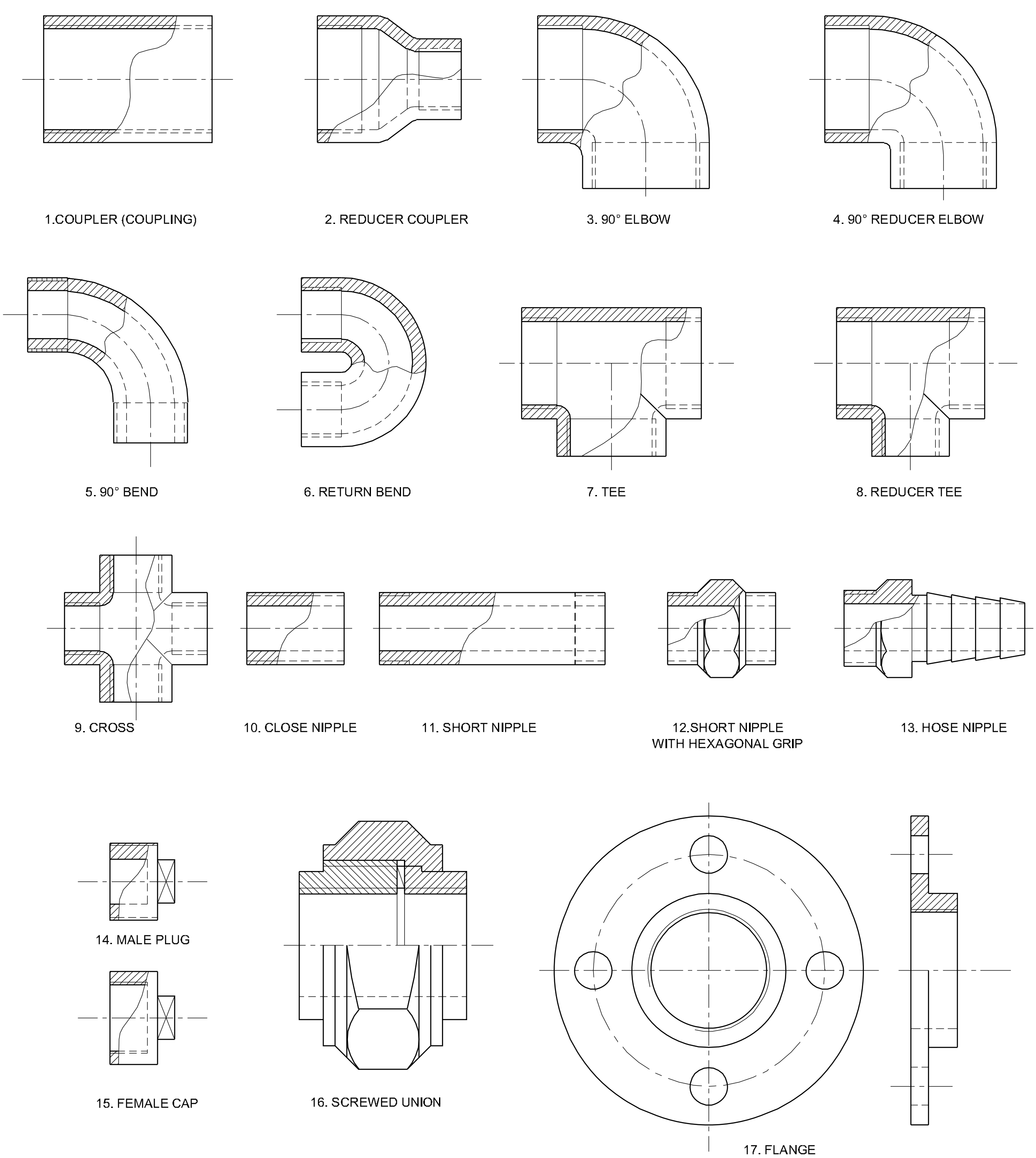
5 Expansion joints

Fig 1



DIFFERENT TYPES OF PIPE JOINTS

Fig 2



PIPE FITTINGS

EDN261012

Piping layout drawings

Piping layout drawings can be classified into the following categories:

1 Double line isometric layout

2 Single line isometric layout

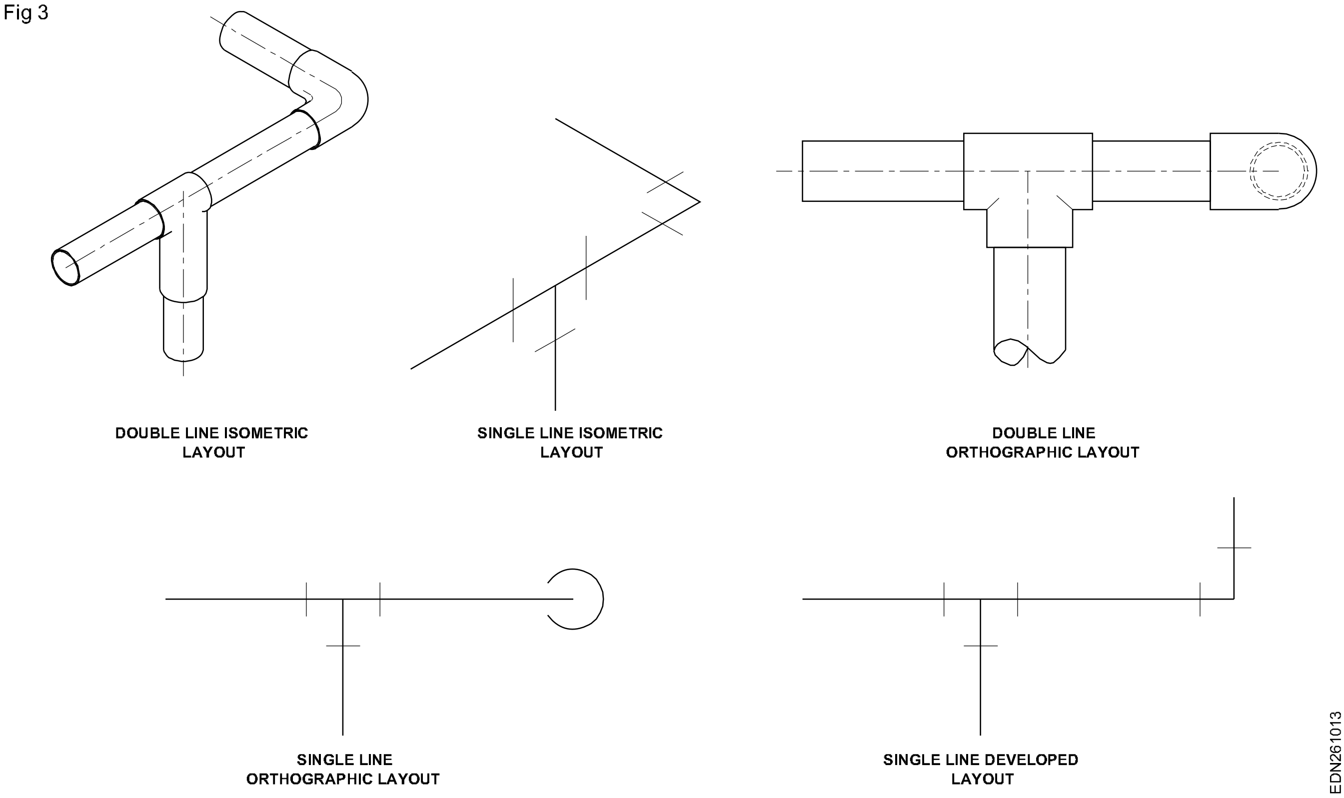
3 Double line orthographic layout

4 Single line orthographic layout

5 Single line developed layout

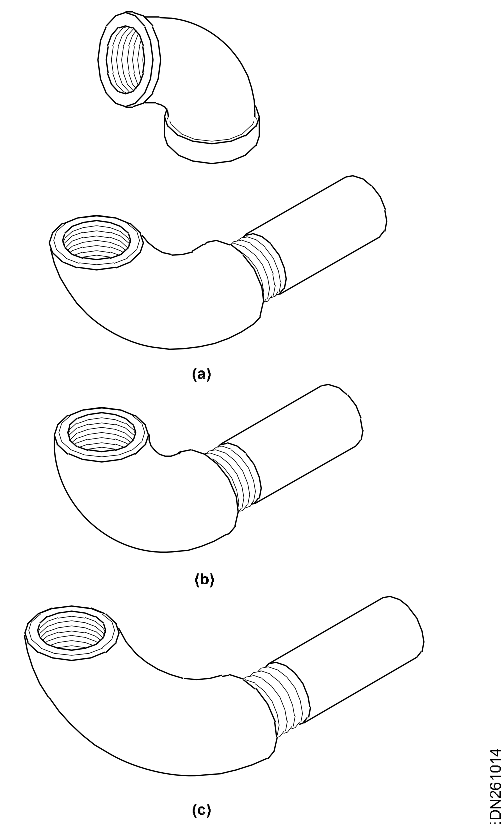
In double line piping layouts, all the pipe are represented by two lines and fittings as shown in Fig 3.

Fig 3



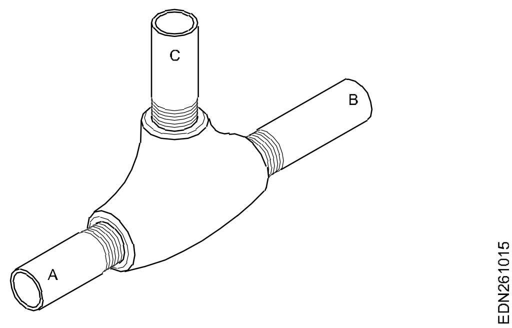
Elbows (Fig 4)

Fig 4



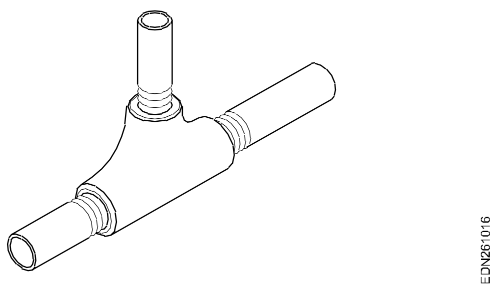
Tee branch (Fig 5)

Fig 5



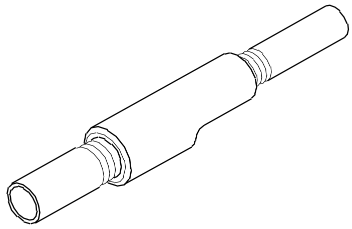
Reducing tee branch (Fig 6)

Fig 6



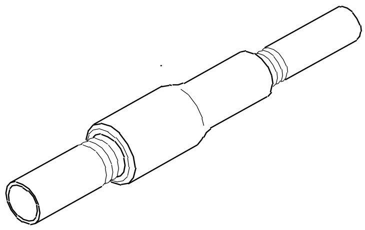
Eccentric reducer (Fig 7)

Fig 7



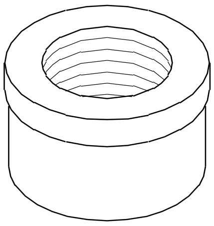
Concentric reducer (Fig 8)

Fig 8



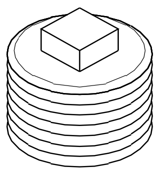
Cap (Fig 9)

Fig 9



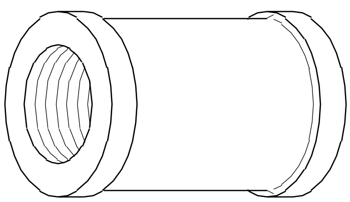
Plug (Fig 10)

Fig 10



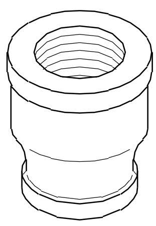
Coupling (Fig 11)

Fig 11



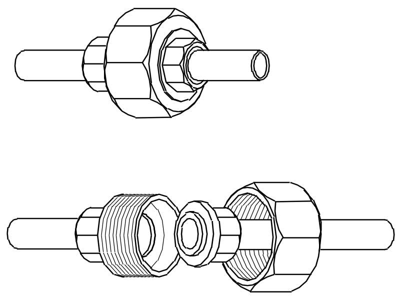
Reducer (Fig 12)

Fig 12



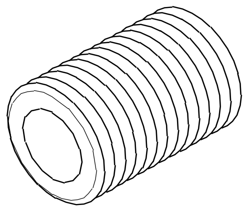
Union (Fig 13)

Fig 13



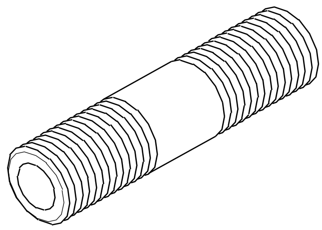
Close nipple (Fig 14)

Fig 14



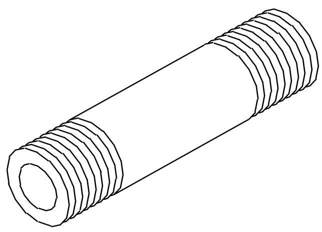
Short nipple (Fig 15)

Fig 15



Long nipple (Fig 16)

Fig 16



Pipe threads (Fig 17)

Fig 17

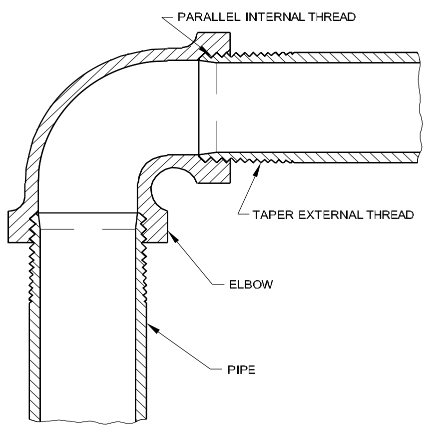


Fig 18 shows the double line orthographic view of a piping layout and Fig 19 shows the converting this piping layout into single line orthographic view.

Fig 18

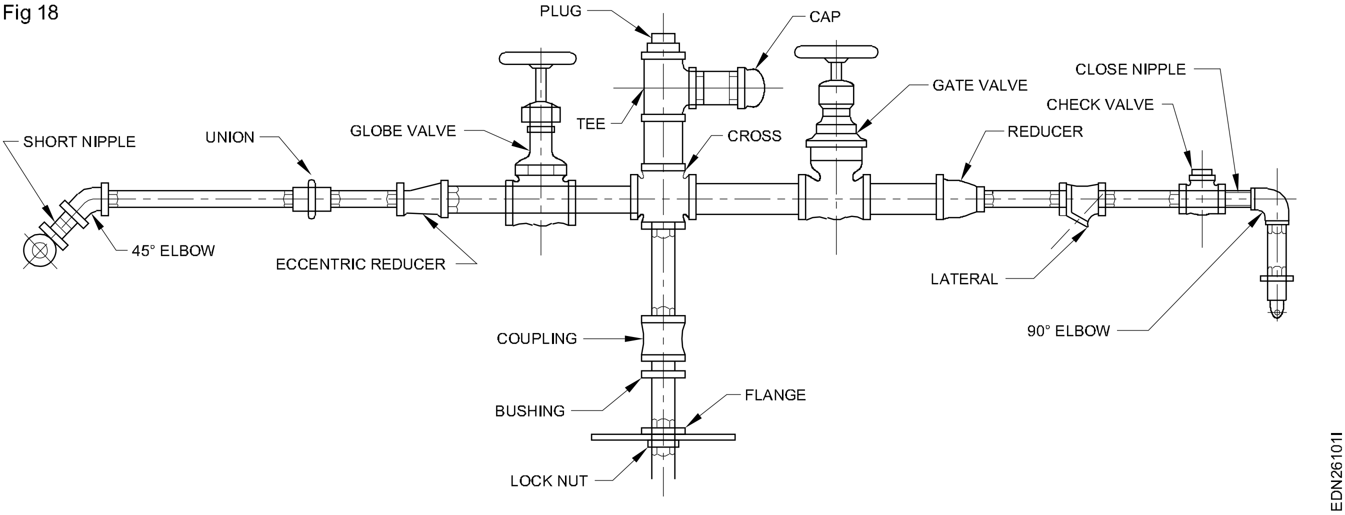
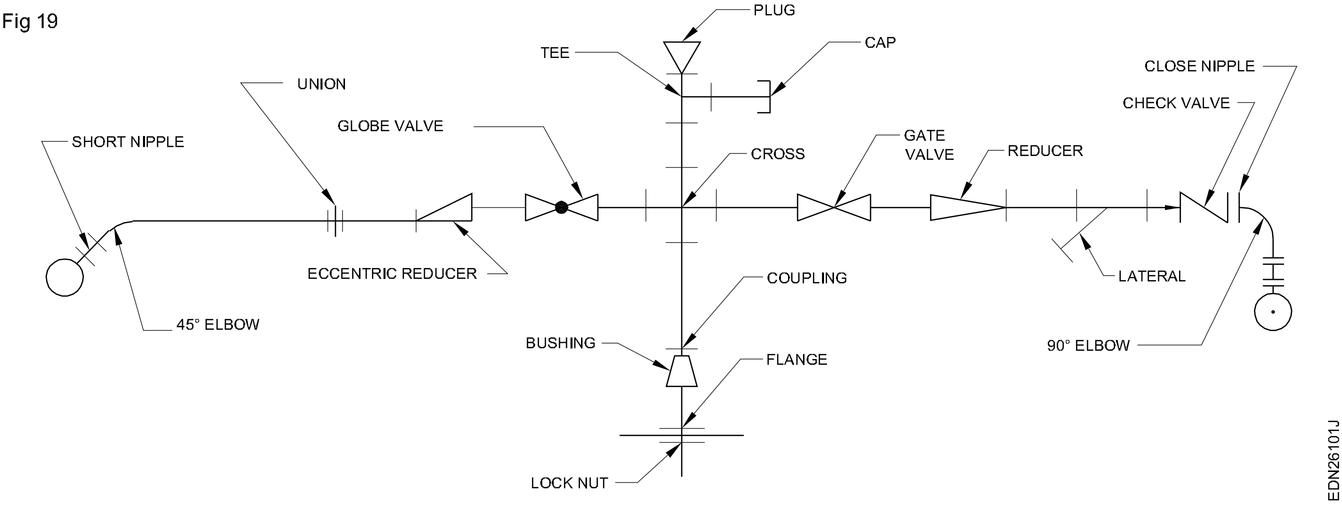


Fig 19



Assembly view of Vee blocks

Constructional features

'V' blocks are devices used for marking and setting up work on machines. The features of a common type of 'V' blocks are as given in Figure 1.

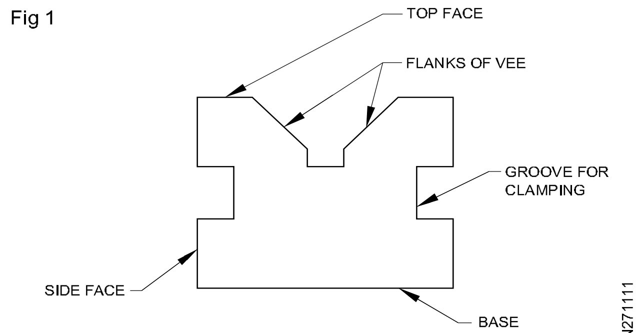
The included angle of the VEE is 90° in all cases. 'V' blocks are finished to a high accuracy in respect of dimension, flatness and squareness.

TYPES

'V' blocks of different types are available. As per B.I.S. they are:

- single level, single groove 'V' block (Fig 1)

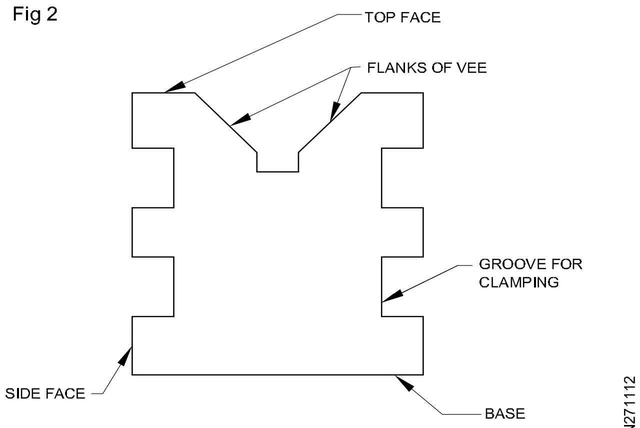
Fig 1



SINGLE LEVEL SINGLE GROOVE 'V' BLOCK

- single level, double groove 'V' block (Fig 2)

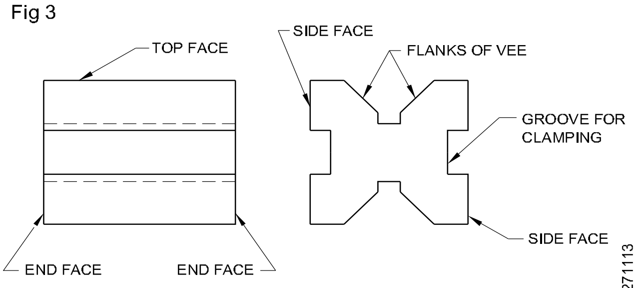
Fig 2



SINGLE LEVEL DOUBLE GROOVE BLOCK

- double level, single groove 'V' Block (Fig 3)

Fig 3



DOUBLE LEVEL SINGLE GROOVE 'V' BLOCK

- matched pair 'V' block. (Fig 4)

Single level, single groove 'V' block (Figure 1)

This type has only one 'V' groove and has single square slots cut on both the sides.

This slot on both the sides, accommodates the work-holding clamps.

Single level, double groove 'V' block (Fig 2)

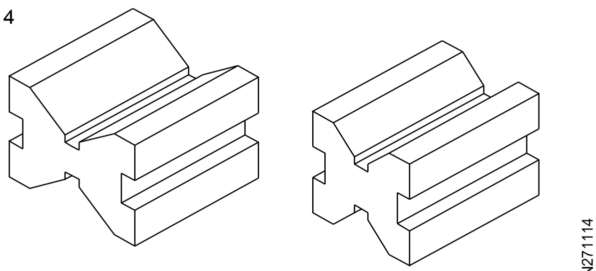
In this case, the 'V' block will have two slots on both sides. This permits for positioning the clamps depending on the diameter of the jobs.

Matched pair 'V' block (Figs 4 and 5)

These blocks are available in pairs which have the same size and same grade of accuracy. They are identified by the number or the letter given by the manufacturer. These sets of blocks are used for supporting long shafts parallel to the marking off or machine tables.

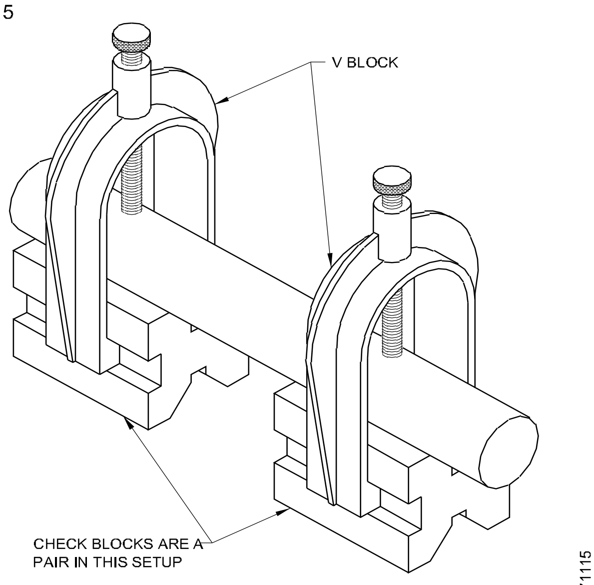
'V' blocks are made in pairs of exactly the same size and shape. They are ground parallel and square on all their sides, and have the 'Vee' groove cut in the centre, symmetrical to the centre line.

Fig 4



MATCHED PAIR 'V' BLOCK

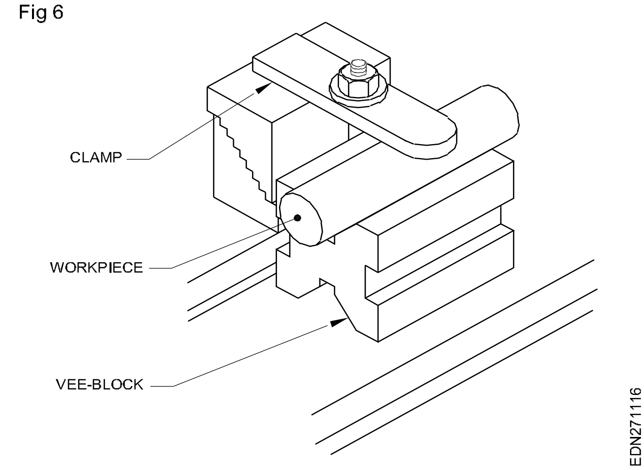
Fig 5



'V' BLOCKS SUPPORTING A SHAFT FOR MARKING OUT AND DRILLING

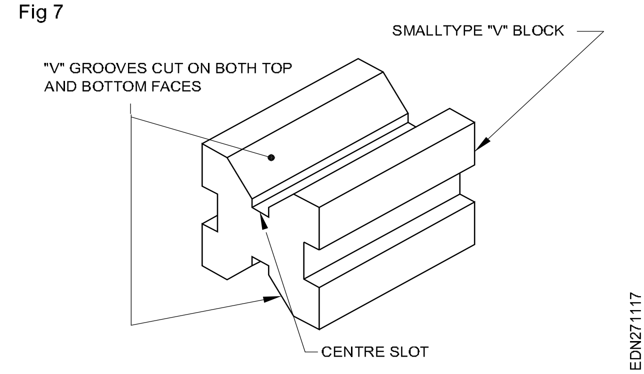
'V' blocks are used to support and clamp round workpieces. (Fig 6)

Fig 6



Smaller type 'V' blocks have the 'V' grooves cut both on the top and bottom faces. (Fig 7)

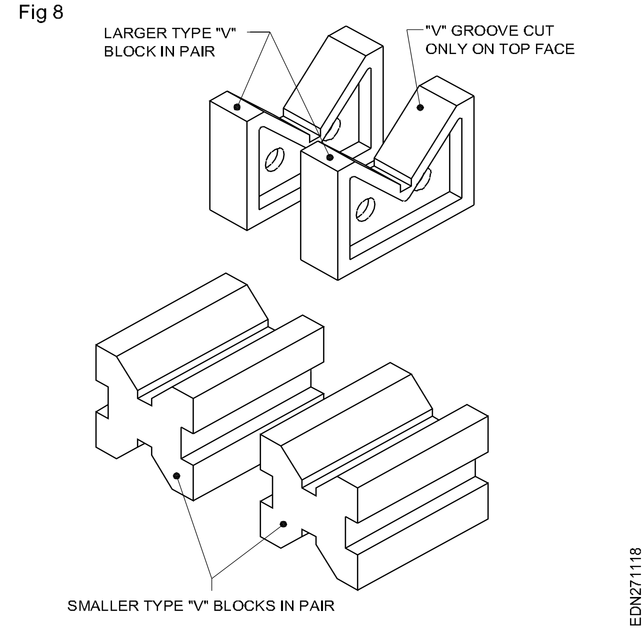
Fig 7



The narrow slots at the apex of the 'V' grooves provide clearance for the drill during drilling operations, and also provide space for chips to flow away during the machining operations.

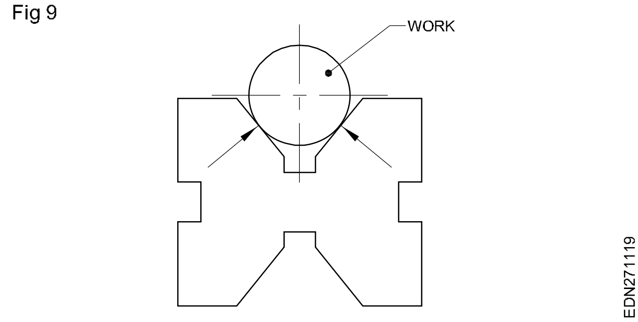
Small sizes of 'V' blocks are made of hardened steel, and larger sizes are made of cast iron. The larger sizes do not have slots on the side faces. (Fig 8)

Fig 8



When selecting a 'V' Block to support a round workpiece, the size of the 'V' block selected should be such that the workpiece touches the flanks of the 'V' groove at about the centre. (Fig 9)

Fig 9



Designation

'V' blocks are designated by the nominal size (length), the minimum and maximum diameters of the workpiece capable of being clamped and the grade and the number of the corresponding B.I.S. standard.

In the case of matched pairs it should be indicated by the letter 'M'.

For 'V' blocks with clamps it should be indicated as 'WITH CLAMPS'.

Example

1 A 50 mm long (nominal size) 'V' block capable of clamping workpieces between 5 to 40 mm in diameter and Grade A will be designated as - 'V' block 50/5/5-40 A - B.I.S. 2949.

2 In the case of a matched pair, it will be designated as 'V' block M50/5-40 A B.I.S. 2949.

3 For'V' blocks supplied with clamps, the designation will be 'V' block with clamp 50/5-40 A B.I.S.2949.

Grades and materials

'V' blocks are available in Grade 'A' and Grade 'B'.

Grade A

A grade 'V' blocks are more accurate and are available only up to 100 mm length. These are made of high quality steel.

Grade B

B grade 'V' blocks are not as accurate as A grade 'V' blocks and these are useful for general machine shop work. These 'V' blocks are available up to 300 mm length. Grade B 'V' blocks are made of closely grained cast iron.

Clamping devices for 'V' blocks

For holding cylindrical jobs firmly on V blocks, U clamps are provided (Fig 10)

Because 'V' blocks are supplied in pairs of the same size and shape, it is possible to support long workpieces so that they are parallel to the surface upon which the blocks rest, such as on a machine, worktable or a surface table. (Fig 11)

Fig 10

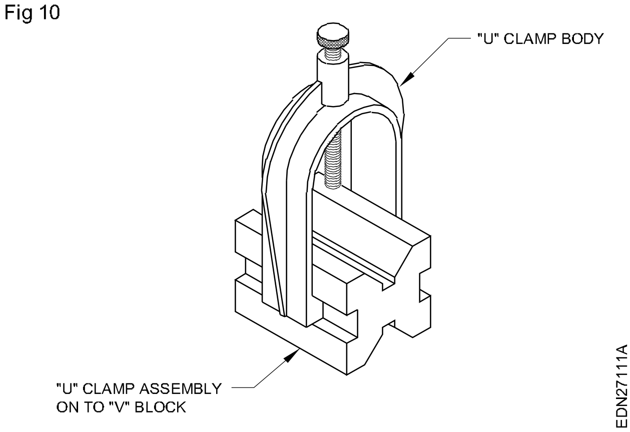
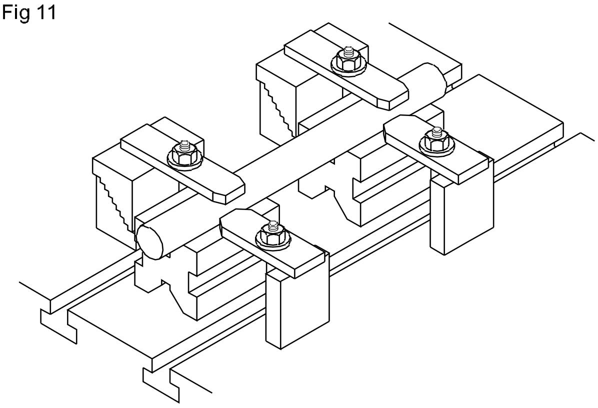
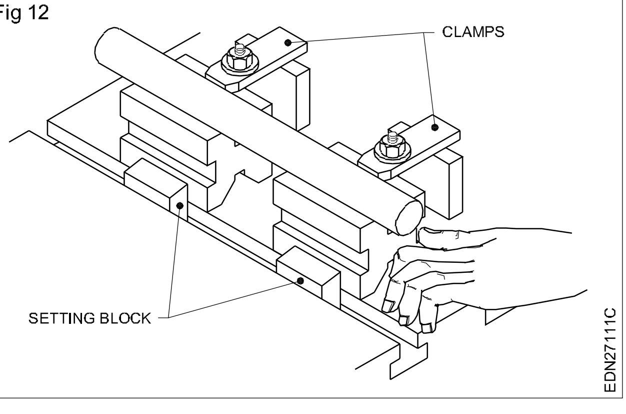


Fig 11



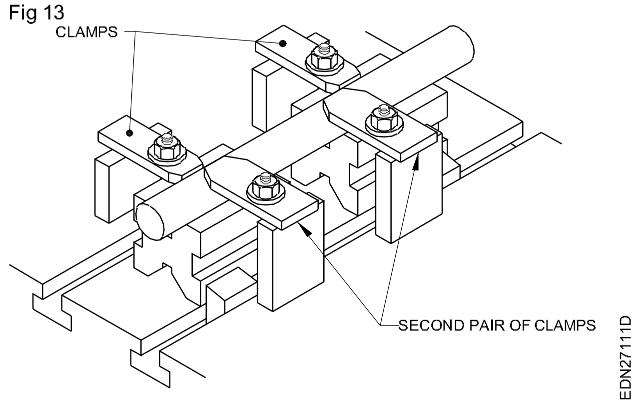
When round workpieces have to be clamped parallel to the edge of a machine worktable, one or two 'V' blocks are first set up parallel on the worktable, using clamps and setting blocks. (Fig 12)

Fig 12



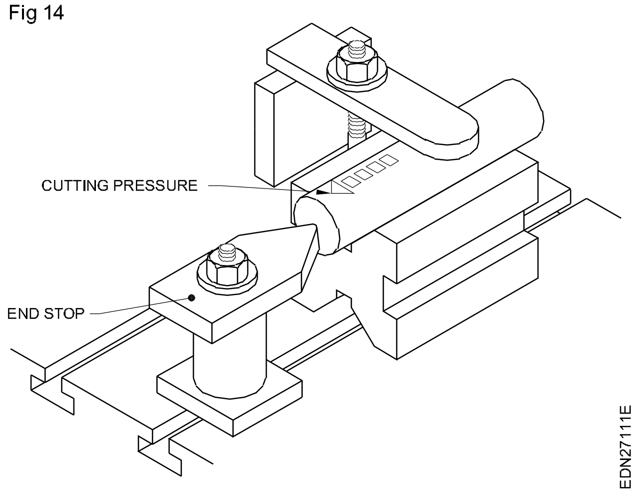
Then a second clamp or pair of clamps is used to clamp the workpiece in the 'V' block(s). (Fig 13)

Fig 13



When machining operations are likely to push the workpiece out of position, an end stop can be used to prevent movement of the workpiece. The end stop is clamped to the machine work table as shown in Fig 14.

Fig 14



'V' blocks Grade 'A' will have a hardness of 650 to 700 HV (60 to 63 HRC)

'V' blocks Grade 'B' will have a hardness of 180 to 220 HB. 'V' blocks of both grades should be suitably stabilized.

Grade 'B' 'V' blocks are made from suitable quality closely grained cast iron.

In B.I.S. standard (IS: 2949-1974) a table is provided to indicate the dimensions of the 'V' blocks, together with the maximum and minimum diameters of the workpiece that can be accommodated on the 'V'block.

Assembly view of bush & bearing

Shaft bearings are machine elements to support rotating shafts against radial and axial forces. The frictional distance acting against rotation is kept to a minimum by providing smooth surfaces for the mating parts and application of a lubricant. Bearings can be of sliding contact type or rolling contact type. The choice of the group depends upon the characteristic of the bearing and the scope of application.

Classification of shaft bearings

Shaft bearings are broadly classified into two groups:

a Sliding contact bearings

b Rolling contact bearings

Sliding contact bearings the relative motion between the shaft and the support is purely sliding, whereas in rolling contact bearings a set of balls or rollers rolls between the shaft and the supporting surface. Since the rolling friction is less than the sliding friction, rolling contact bearings are also known as anti-friction bearings.

Types of sliding contact bearings

Sliding contact bearings used for shafts can be grouped as:

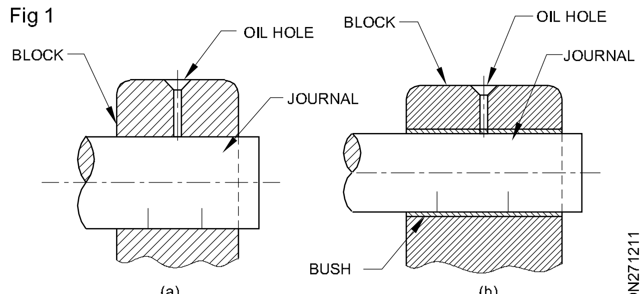
1 Journal bearings (Fig 1)

2 Pivot or footstep bearings (Fig 2)

3 Thrust or collar bearings (Fig 3)

Journal is the cylindrical smooth portion of a shaft which is actually sliding inside the bearing body. Fig 1a shows such an arrangement called simple or solid journal bearing. If a bush made of less friction material, like brass or bronze, is fitted tightly inside the block and the shaft rotates inside the bush, then it is called bushed journal bearing (Fig 1b).

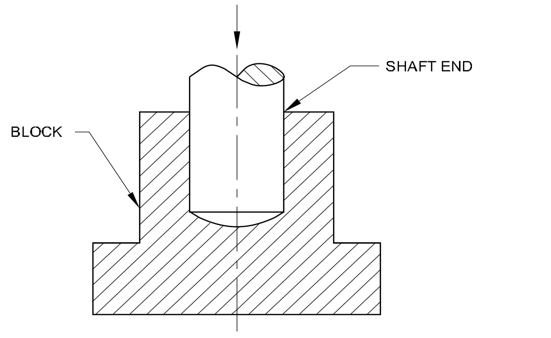
Fig 1



SOLID JOURNAL BEARING

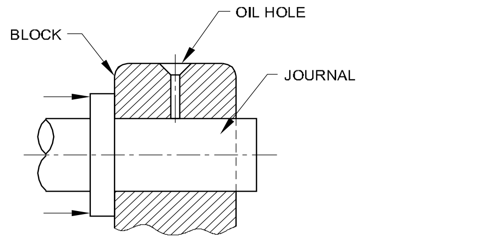
When the rotating shaft is vertical in position and the end of the shaft is to be supported by a block for axial load, the arrangement is called pivot or foot step bearing as shown in Fig 2. If a rotating shaft has axial load along with radial, such a shaft is supported by a bearing after providing a projection or step on the shaft as shown in Fig 3 and is called thrust or collar bearing. The common fits given between the sliding surfaces are:

Fig 2



PIVOT OR FOOTSTEP BEARING

Fig 3



TRUST OR COLLAR BEARING

H7/g6, H7/f7,H8/e8 and H7/d10

Solid and Bushed journal bearings

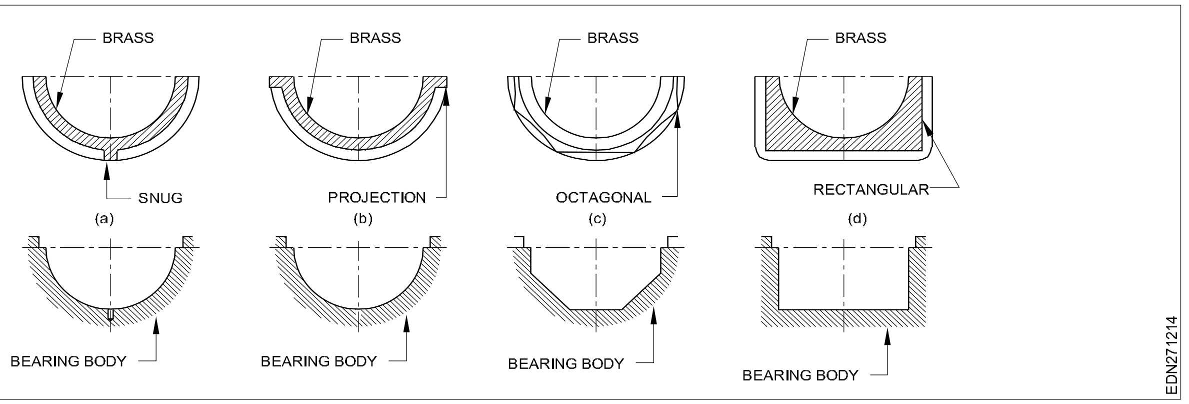
A solid journal bearing is the simplest form of sliding contact bearing. Here the bearing is a cylindrical block with a rectangular base (sole) having holes for bolting it to the machine body. the block has a cylindrical hole to receive the journal portion of the shaft. An oil hole is drilled from the top to admit lubricant to the mating surfaces. Cast iorn is the material used for the block, since it offers less friction than mild steel.

Compared to the solid journal bearing, a bush of brass, bronze or gun metal is introduced between the shaft and the block for reducing the sliding friction. Solid bearings are used in light and low speed working conditions whereas bushed bearings are suitable to handle higher loads at medium speed.

Pedestal Bearing

A pedestal bearing (also called plummer block) is a sliding contact journal bearing with longitudinally split bush fitted inside the block. The cap is bolted in position using two steel bolts. The split construction of the bush enables easy assembly of the shaft and adjustment for the wear of the bush. The two halves of the bush are known as brasses and are made by brass or gun metal. The rotation of the brasses (bush halves) is prevented by providing (a) snug at the bottom, (b) projection on bearing body, (c) octagonal shape of the seat, or (d) rectangular shape of seat as shown in Fig 4. The part details of a pedestal bearing (with snug at bottom) is given in Fig 5. Pedestal bearings can be used to support large size shafts carrying heavy radial loads at medium speeds up to about 1000 revolutions per minute.

Fig 4



Draw the given details of the Pedestal bearing and draw the following views of the assembly.

1 Front view 2 Top view 3 Side view

Fig 5

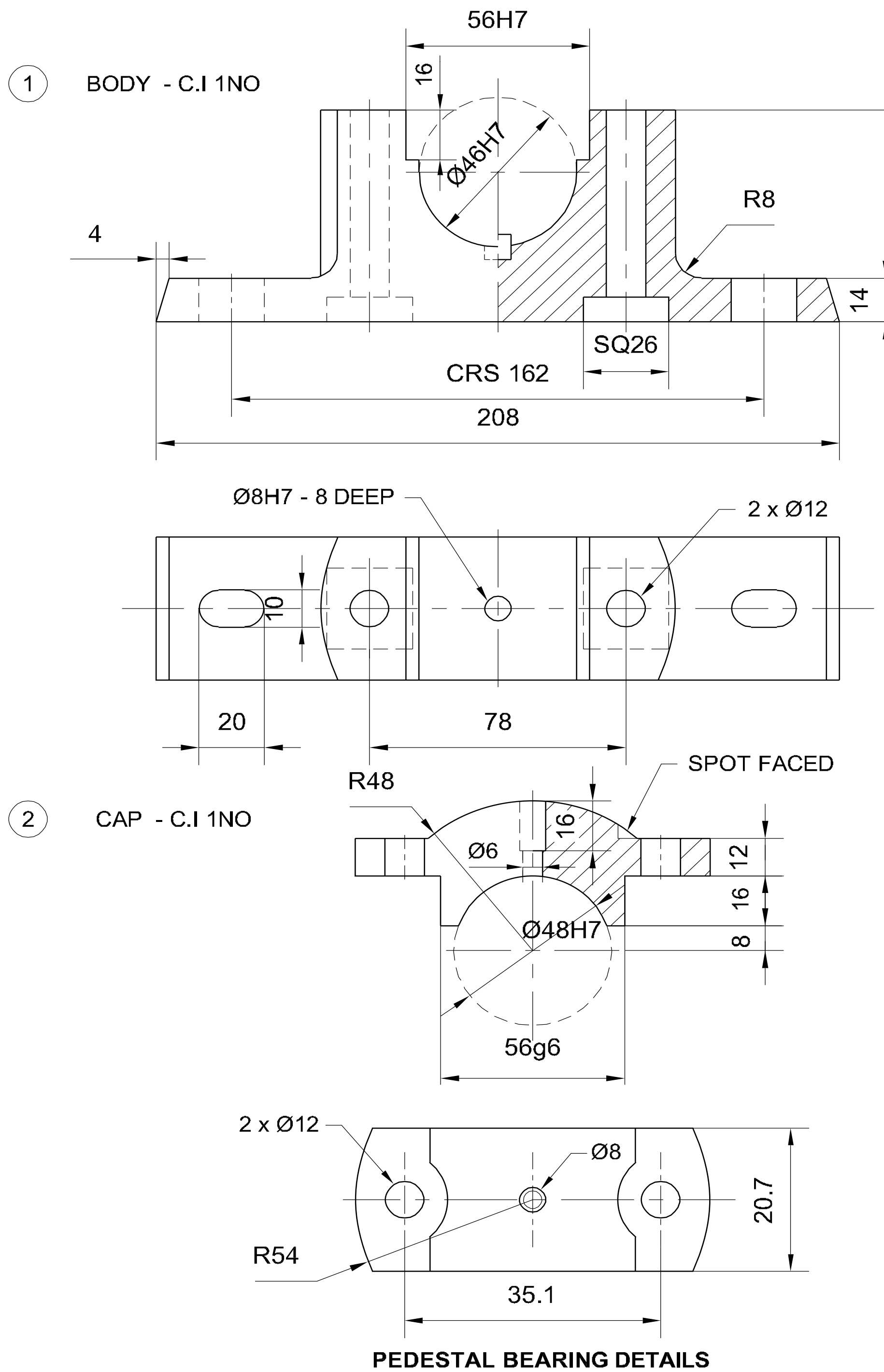
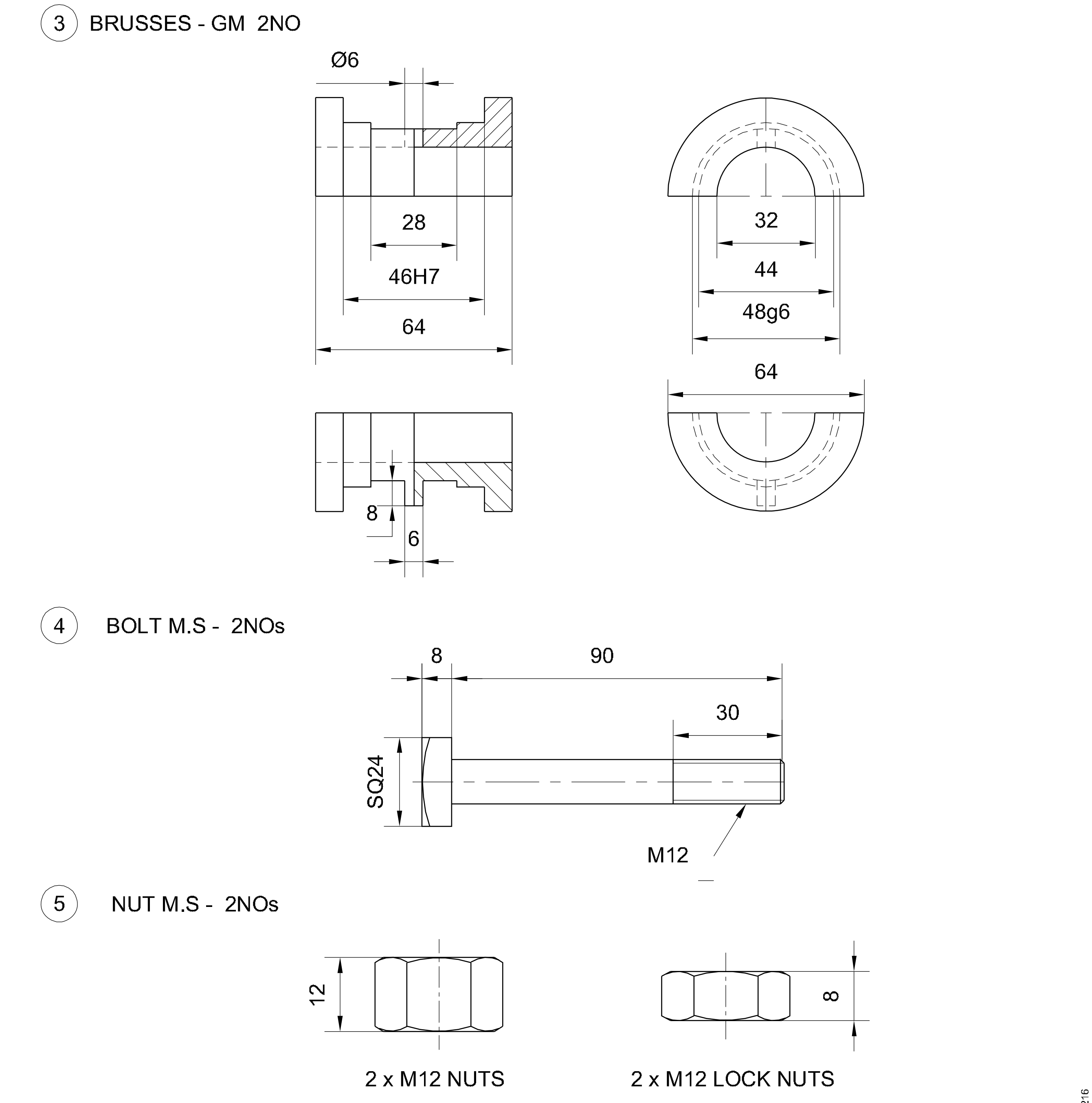


Fig 6



PEDESTAL BEARING DETAILS

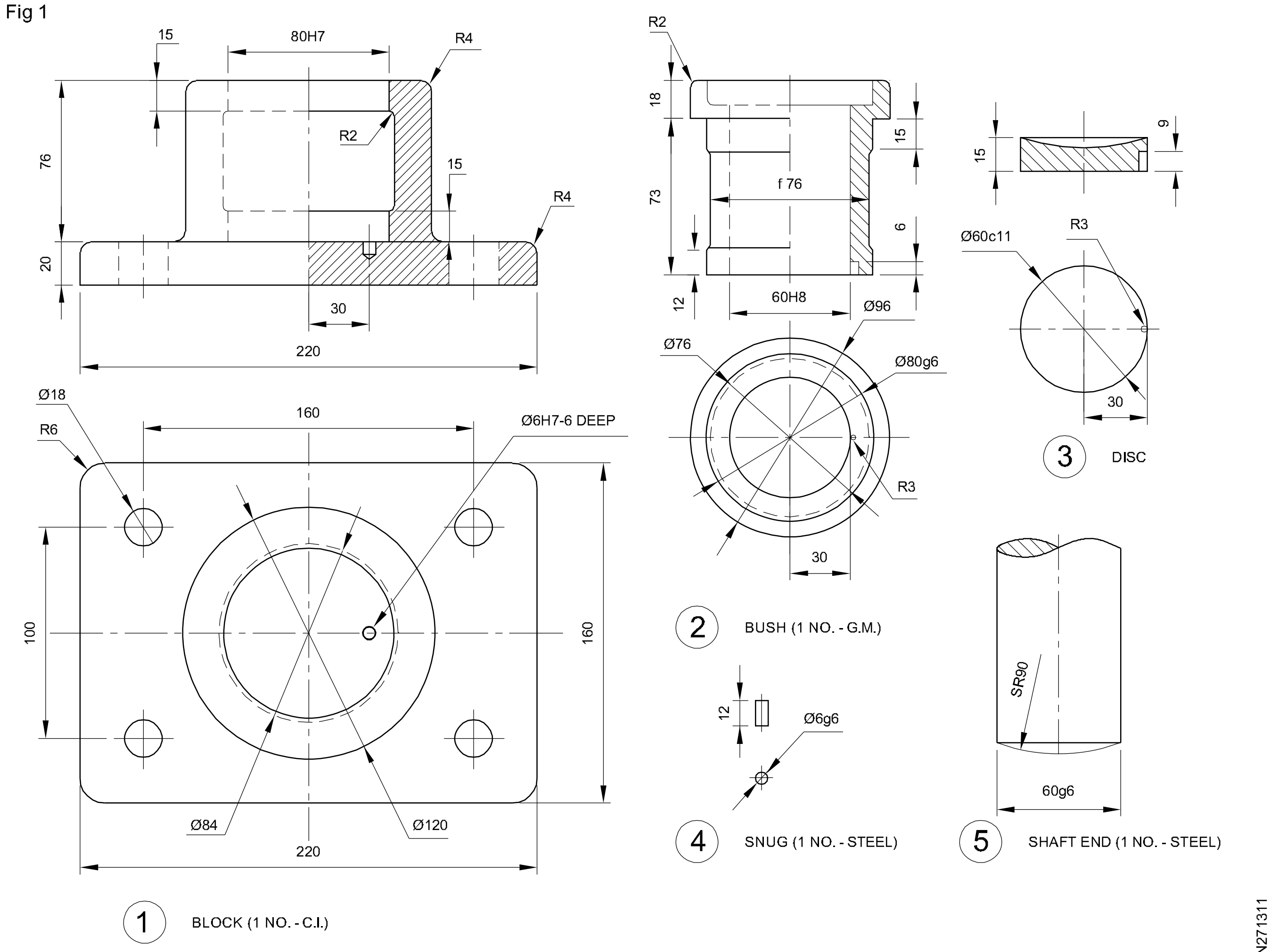
Assembly view of bearings

Foot step Bearing

Footstep or pivot bearing is used to support vertical shaft ends for axial loads. A gunmetal bush having collar on top is placed inside a cast iron body called sole. Inside the bush, a gunmetal disc is placed to support the end of the shaft. Fig 1 shows the part details. A snug is provided on the sole between the bush and the disc in order to prevent the rotation of them. Note that the shaft end has a convex surface and the disc has a matching concave surface to support. The bush and the block are recessed to reduce the machining length of the bush and to result better fitting. The hollow collar portion of the bush provides a slot around the shaft to admit lubricating oil.

The body has to be drawn first and then the bush and disc are placed in position. Locate the snug and place the shaft to complete the thin line drawing. After removing the unnecessary lines, convert the thin lines to visible and hidden lines. Write the dimensions and hatch the sectioned areas to complete the views.

Fig 1



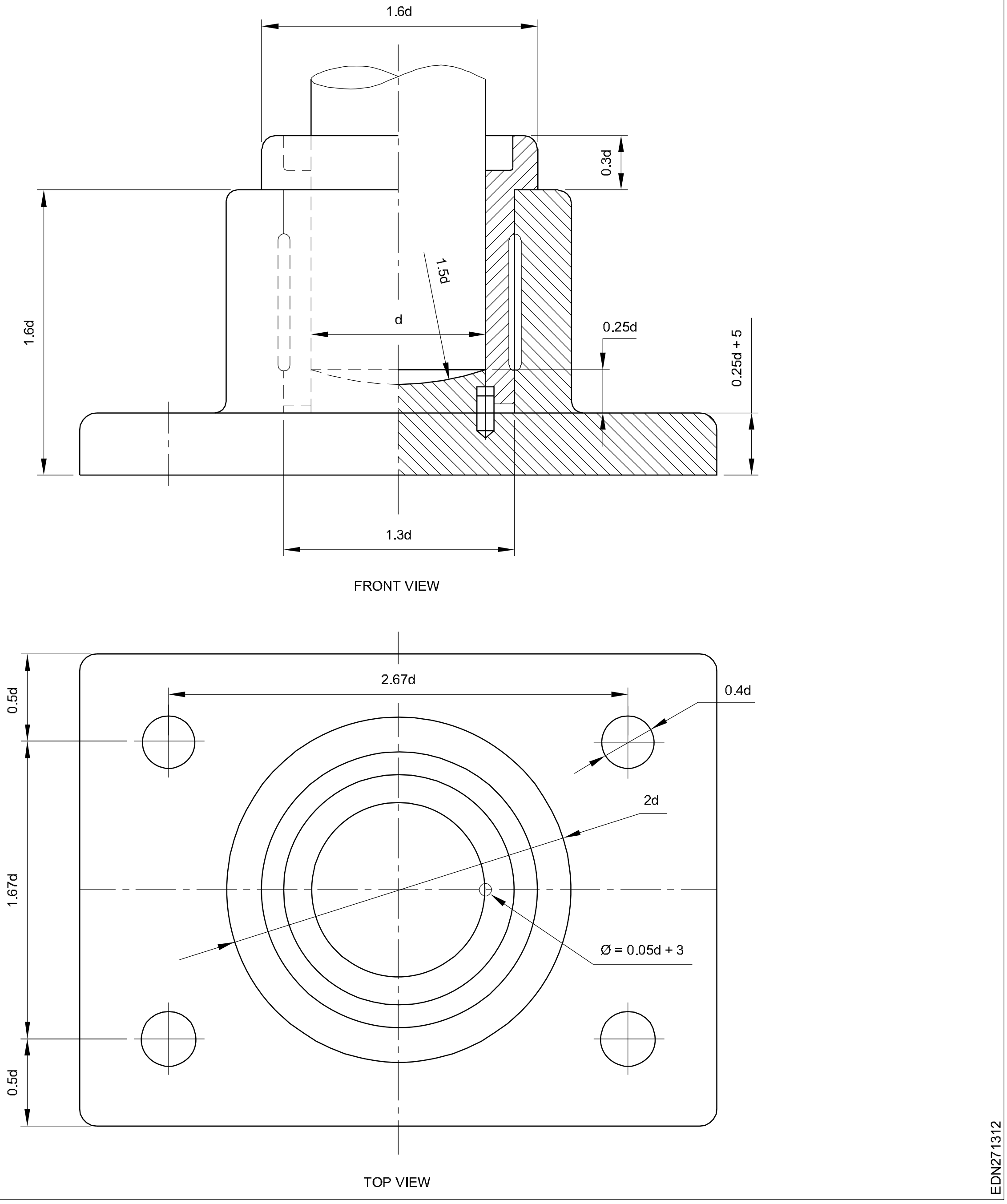
FOOTSTEP BEARING (PARTS)

Practice : Assemble and draw the part drawing of a foot step bearing shown in Fig 2.

1 Front view

2 Top view

Fig 2



Shaft bearings

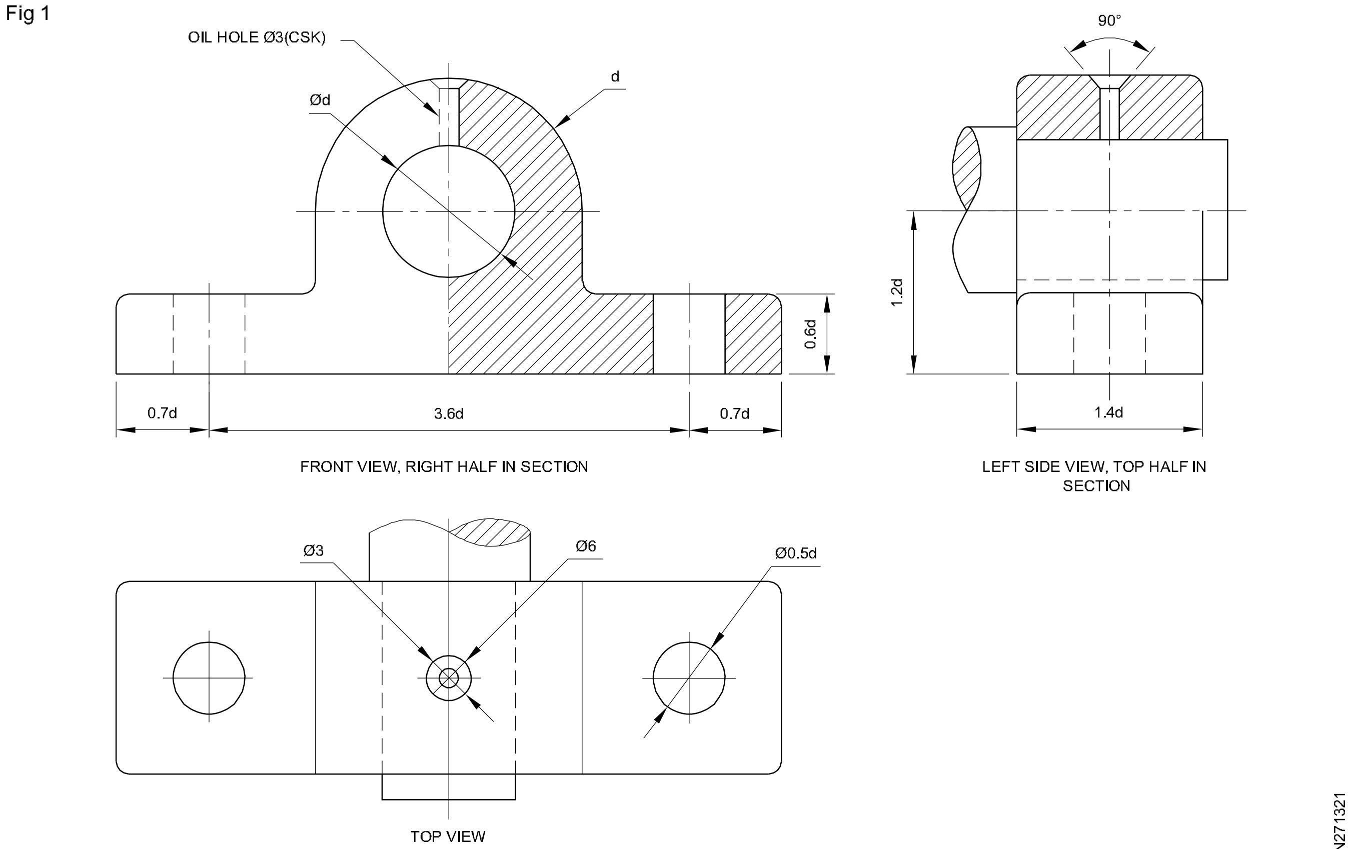
Practice : Sketch the following view of a solid journal bearing assembly and mark the dimensions in terms of diameter (d) (Fig 1).

1 Front view

2 Top view

3 Side view

Fig 1



SOLID JOURNAL BEARING (ASSEMBLY)

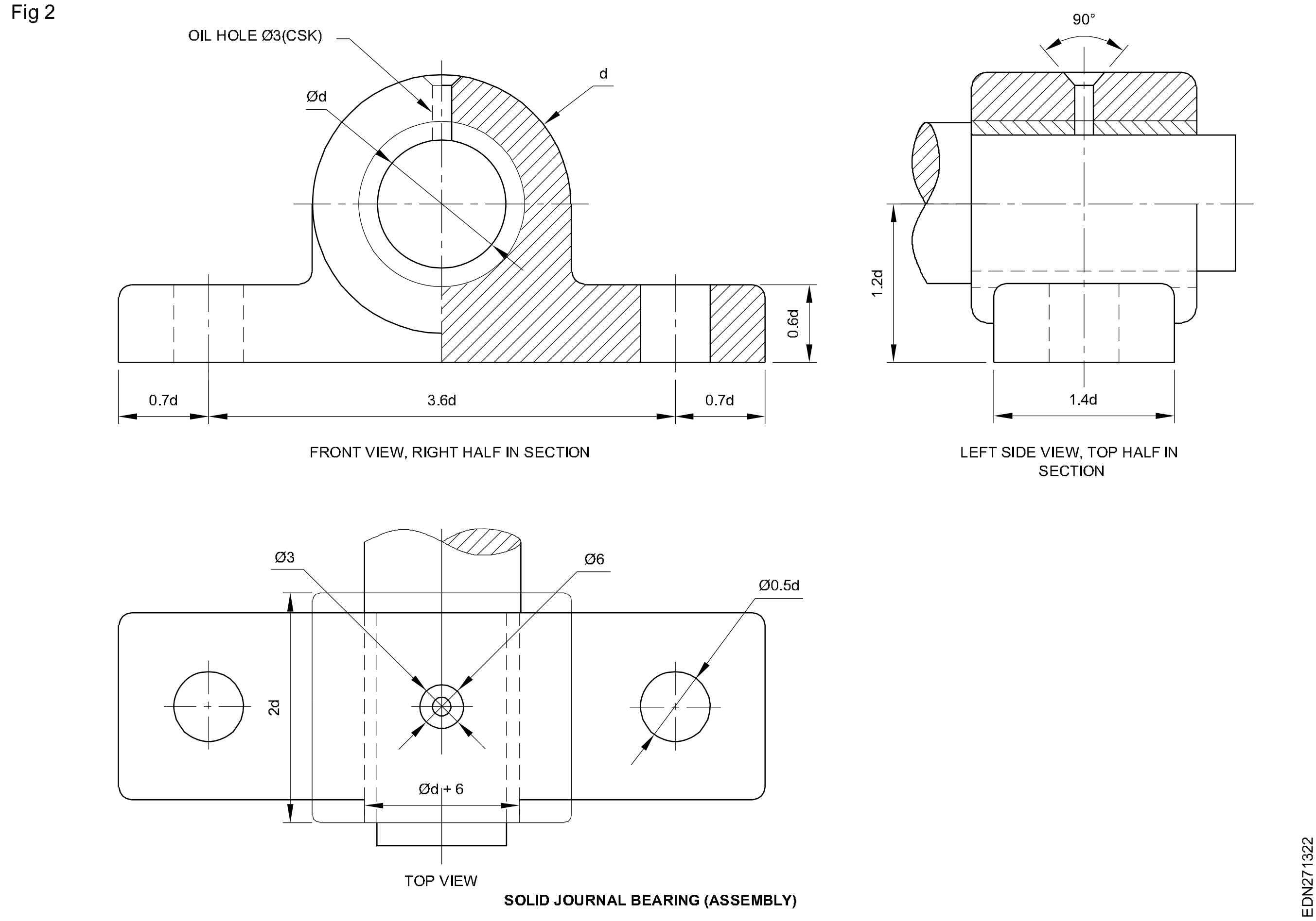
Practice : Draw the following views of a bushed journal bearing assembly and mark the proportions in terms of diameter d (Fig 2).

1 Front view

2 Top view

3 Side view

Fig 2



SOLID JOURNAL BEARING (ASSEMBLY)

Assembly view of different types of coupling viz, muff coupling, half lap coupling, flange coupling, etc.

Study of assembled views of a simple coupling

Shaft Couplings

Mechanical power in the form of torque is transmitted from one shaft to another by using couplings, pulleys, gears, clutches, etc. These power transmitting shafts, which are in rotation, are supported by sliding contact bearings or rolling contact bearings. A shaft coupling is a device to couple or connect two shaft ends. In machines, different types of couplings are used. One common use of coupling is to connect prime movers like engines or motors to drive generators, pumps, blowers, compressors, fans, different types of machines, etc. This chapter on shaft couplings explains different types of commonly used couplings, their parts and the method of preparing assembly drawings

Classification of shaft couplings

Commonly used couplings in machines are classified into the following categories:

1 Muff couplings
   a Solid type muff couplings
   b Split type muff couplings
2 Flanged couplings
   a Rigid type flanged couplings
   b Flexible type flanged couplings
3 Non-aligned couplings
   a Universal couplings
   b Oldham's couplings

In all these couplings power is transmitted from the input shaft to the coupling unit and then to the output shaft through taper or parallel sunk keys.

Assembly drawings

An assembly drawing is an orthographic view or views of various parts of a machine placed together in their proper working position. Assembly drawings may be classified as design assembly drawings, sub-assembly, installation assembly drawings, etc. By drawing an assembled view of components, the method of fitting them and dimensional error if any, will be classified.

Steps for the preparation of assembly drawings

1 Study the general features of the machine and the working principle of the unit to be assembled

2 Read the part drawings to understand the shape and go through the dimensions to know the fitting method and the position of mating parts.

3 Estimate the overall dimensions of the views of the assembly and the space requirements for inserting dimensions and notes. Choose a suitable scale of drawing according to them.

4 Draw the centre lines representing the axes for symmetry for all the view so that the relative positions of views are located.

5 Start drawing of the front view with the main components like body, bed, spindle or shaft, etc. using thin (Type B) lines. Add the remaining parts one by one in the same manner following the sequence of assembly.

6 Project and draw the other required views from the elevation and remove the unnecessary lines and extensions.

7 Draw the nuts, bolts, screws, springs, etc on the centre lines provided and convert the visible edges to thick (Type A) lines as well as important hidden edges if any, into short dashed (Type F) lines.

8 Mark the overall dimensions as well as the size of the standard components like nut, bold, screw, etc. on the views.

9 Draw the section lines (hatching) at the sectioned areas and finish the views.

10 Mark the part numbers on the views, prepare a list of parts (bill of material), print instructions if any, fill up the title block, etc. to complete the assembly drawing.

Guidelines for the preparation of assembly drawings

1 Draw the centre lines of the views first and then start drawing the main object of the assembly using thin lines. After completing the assembled view, and removing unnecessary lines, the visible edges are to be converted to thick lines.

2 Hidden details are not generally shown in sectioned assembly drawings

3 Overall dimensions and very important part dimensions which are specifying the assembled unit are to be marked on the views

4 For clarity of the views as well as for saving time, standard parts like bolts, nuts, screws, locking pins, springs etc. may be represented by a centre line in longitudinal view and a cross mark in axial view. However, the specification should be marked on them as a note.

5 In manual drafting, thick lines coming closer than 0.5 mm have to be represented by a single line.

6 On assembled views, the part numbers are to be marked. The numbers may be encircled and a leader line can be used to connect to the associated item. The leader lines should not intersect and be short.

7 Item references of related items like nut, bolt, washer etc. may be shown against the same leader line. Item references of identical items need not be shown.

8 Item list may be included in the drawing and the position of the list should be such as to be read in the viewing direction of the drawing. The outlines of the list may be thick line and may be placed in conjunction with the title block.

Muff Couplings

A muff coupling basically consists of a hollow cast iron cylinder (muff) fitted over the two ends of shafts to be connected and a sunk key common to them for transferring the power. The muff couplings are also called box or sleeve couplings. Common types of muff couplings are:

1 Solid muff coupling

2 Split muff coupling

Solid muff coupling

A solid muff coupling consists of a sleeve with a key way to connect the shaft ends and a sunk key of length slightly more than the sleeve.

Split muff coupling

In a split muff coupling the sleeve is longitudinally split into two halves. They are joined by bolts after fitting the sunk key in position. In split muff coupling four bolts are used for clamping the halves. For heavy power transmission large split muff couplings having eight or twelve bolts are used. It is to be noted that split muffs are easy to fit and remove without moving the shaft ends.

Flanged Couplings

In flanged couplings, cast iron flanges are fitted at the ends of shafts using sunk keys and they are joined by bolts. The number and size of bolts depend upon the power to be transmitted and hence the shaft diameter. Bolts of numbers 3, 4, 6, 8, 12 and 16 are given for shafts of size from small to large diameters. Flanged couplings are grouped as

1 Rigid type flanged coupling.

2 Flexible type flanged coupling.

Shaft couplings

Draw the part details of a solid muff coupling given in Fig1. Assemble them and draw the sectional elevation and sectional view of the coupling (Fig 2).

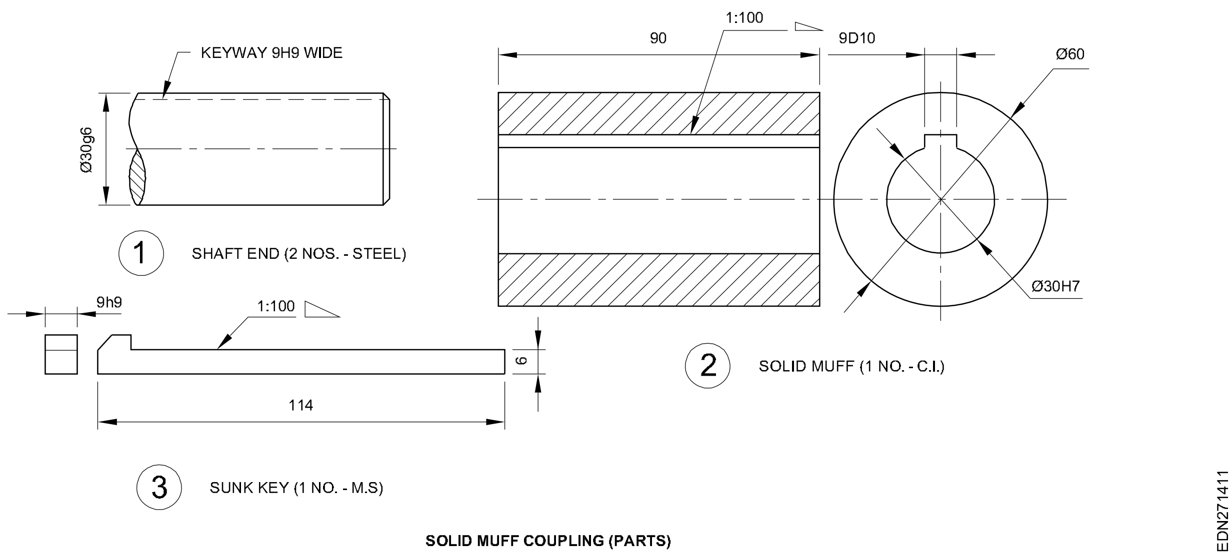
1 Draw the centre lines of front view and side view and then sketch the views as shown in Fig 2A.

2 Remove the unnecessary lengths of lines and convert the thin lines to Type A and Type B lines as shown in Fig 2B.

3 Print the important dimensions, draw the section lines and print the caption, etc. to finish the drawing as Fig2c.

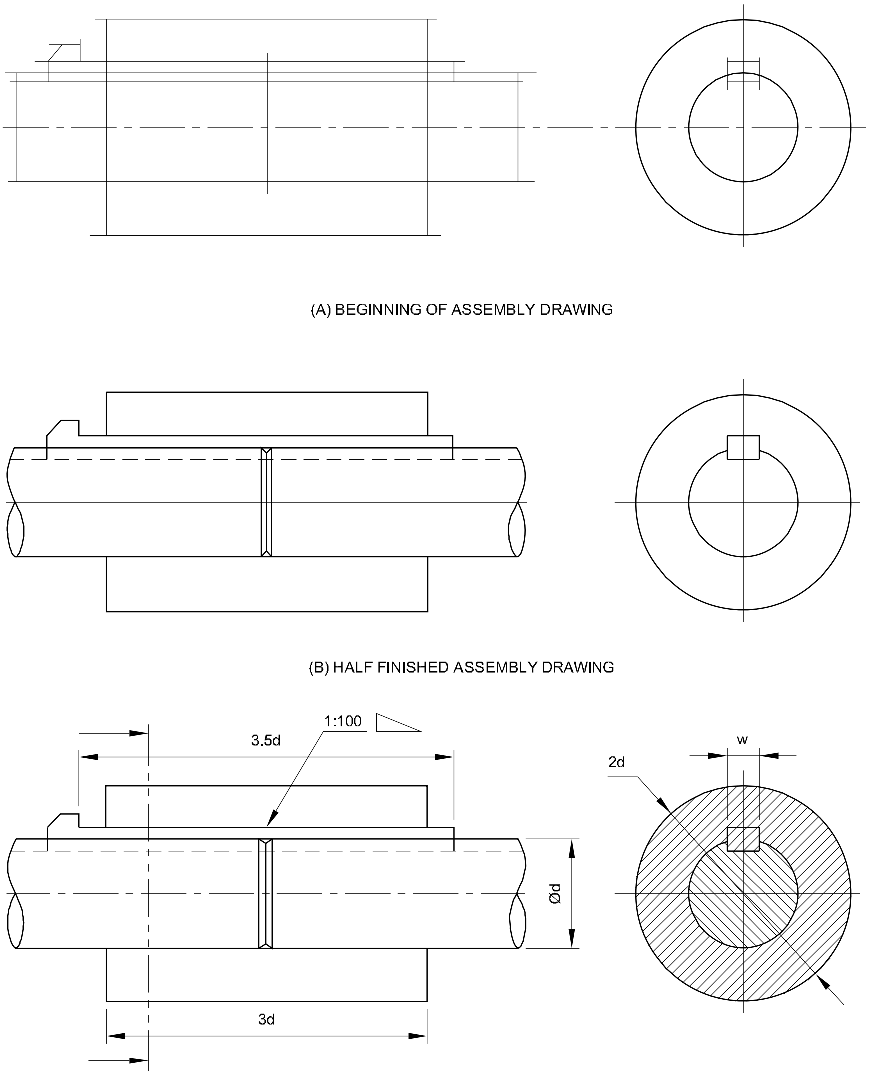
Note: The assembly drawings given in this lesson are dimensioned in terms of the diameter of the shaft. This is to enable students for knowing the approximate proportions in order to sketch the assembly by specifying the shaft diameter.

Fig 1



SOLID MUFF COUPLING (PARTS)

Fig 2



(A) BEGINNING OF ASSEMBLY DRAWING

(B) HALF FINISHED ASSEMBLY DRAWING

(C) FULLY FINISHED ASSEMBLY DRAWING

SOLID MUFF COUPLING (ASSEMBLY)

EDN271412

Assembly view of split muff coupling (Four bolts type)

Draw the part details of a split muff coupling having four bolts are given in Fig 3. Assemble them and draw the front view, top view and assembly (Fig 4).

Fig 3

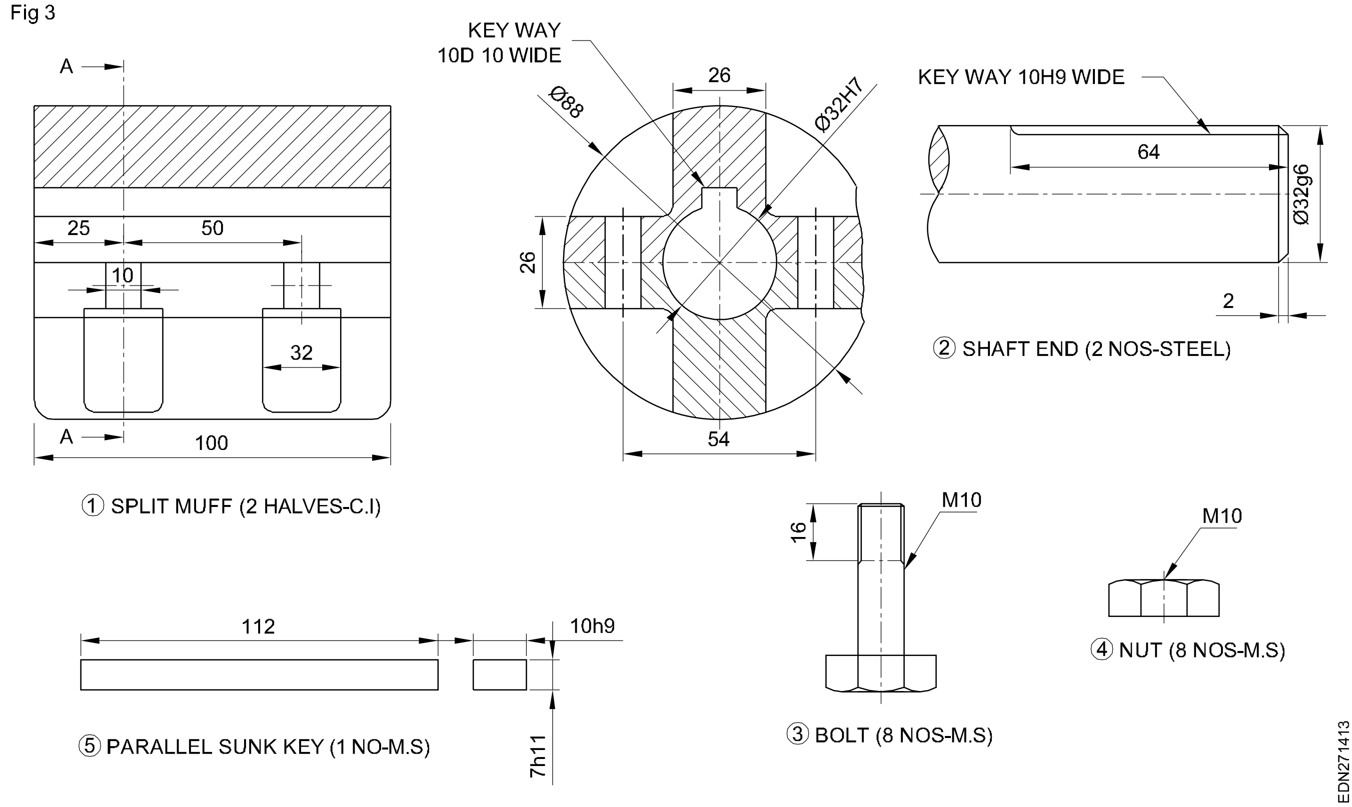
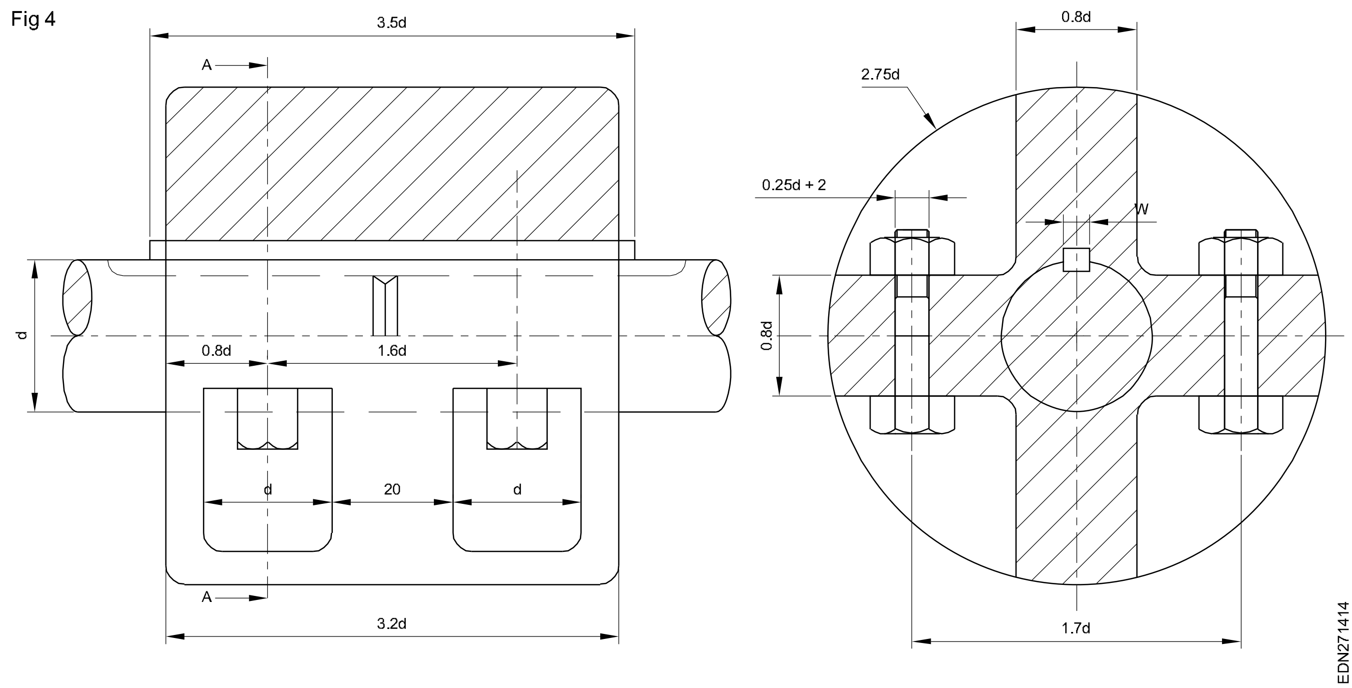


Fig 4



Assembly view of split muff coupling (Eight bolts type)

Draw the part details of a split muff coupling of eight bolt type shown in (Fig 5). Draw the front view, top view and assembly (Fig 6).

Fig 5

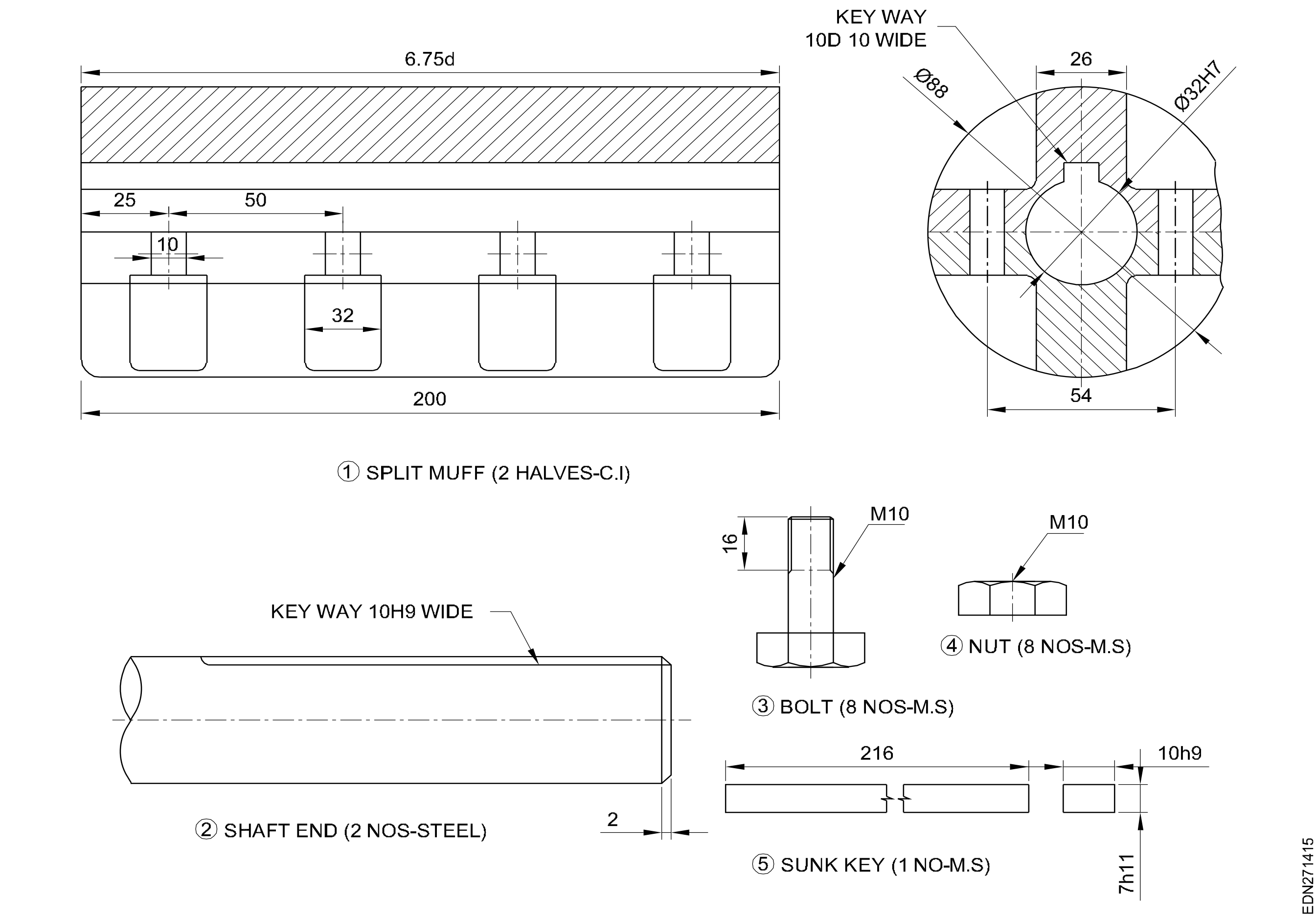
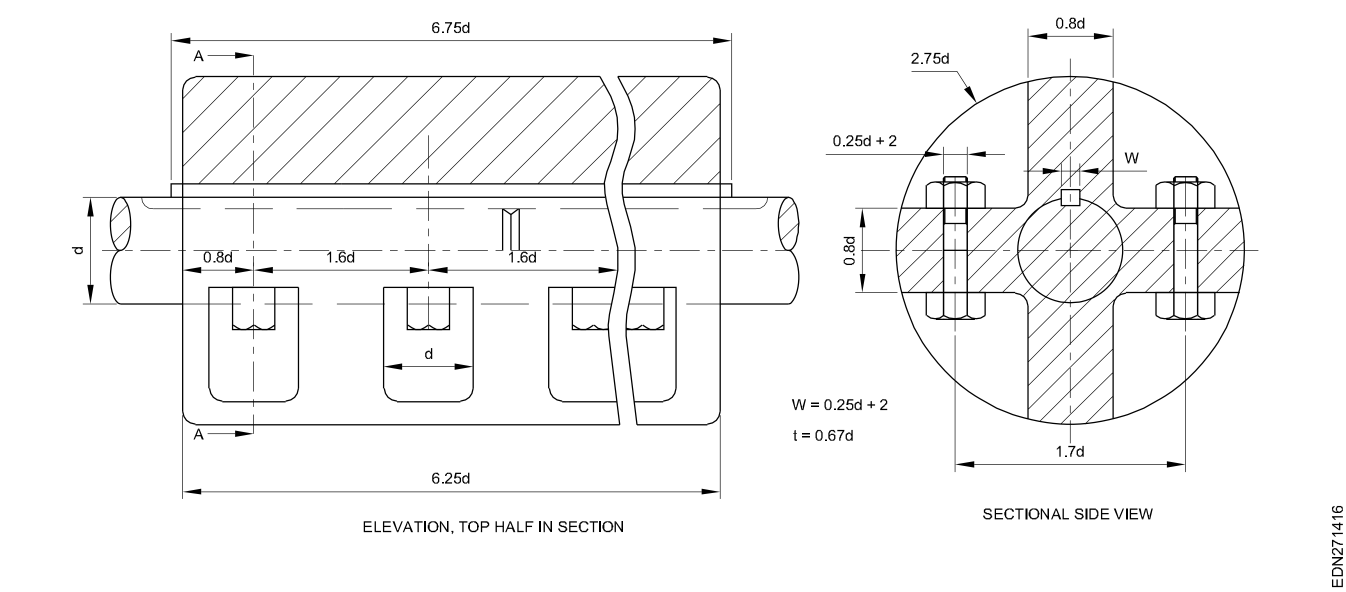


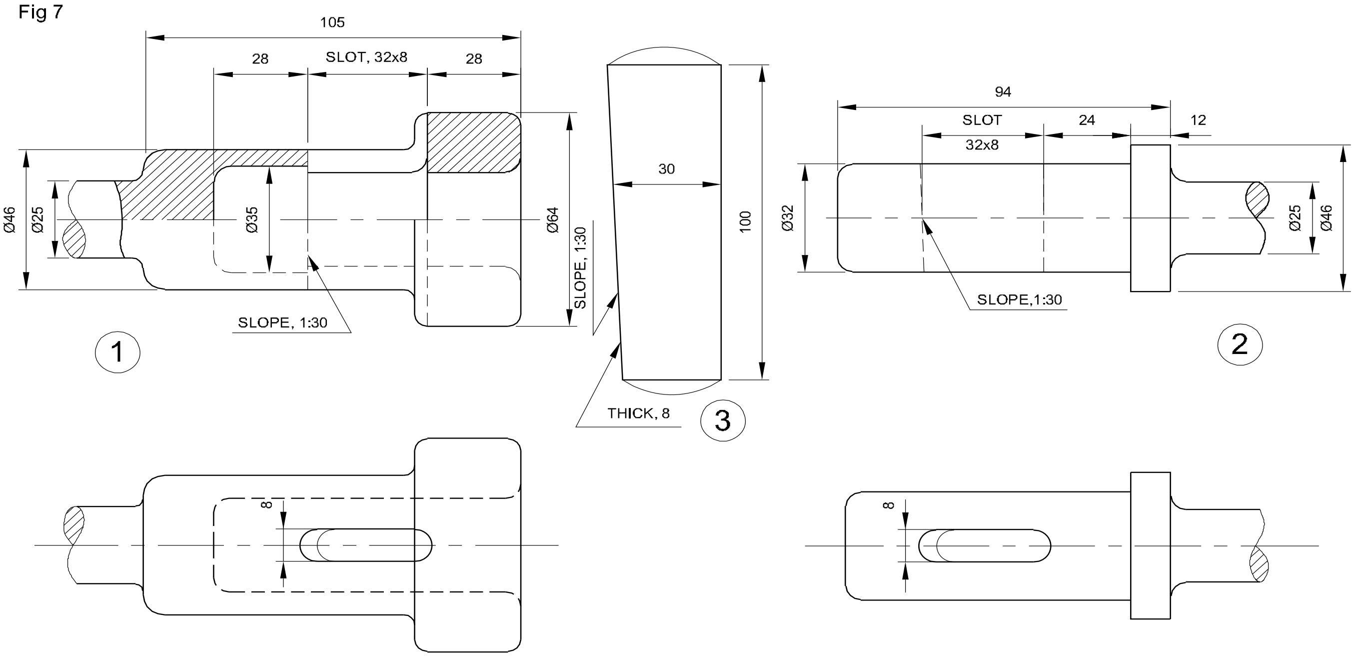
Fig 6



Assembly view of half lap coupling

Draw the part details of a half lap coupling given in (Fig 7). Assemble them and draw the front view, top view and assembly (Fig 8).

Fig 7

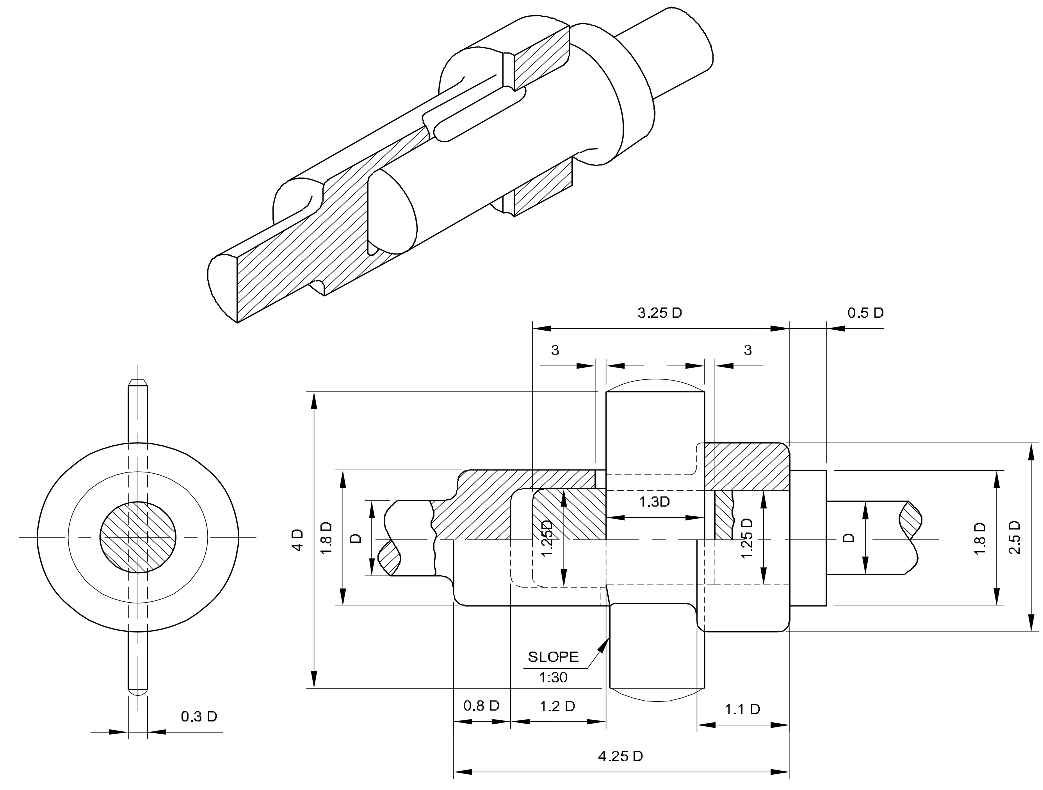


SL. NO.	NAME	MATERIAL	QTY
1	SOCKET END	MS	1
2	SPIGOT END	MS	1
3	COTTER	HCS	1

EDN271417

PARTS AND ASSEMBLY OF SOCEET AND SPIGOT JOINT

Fig 8



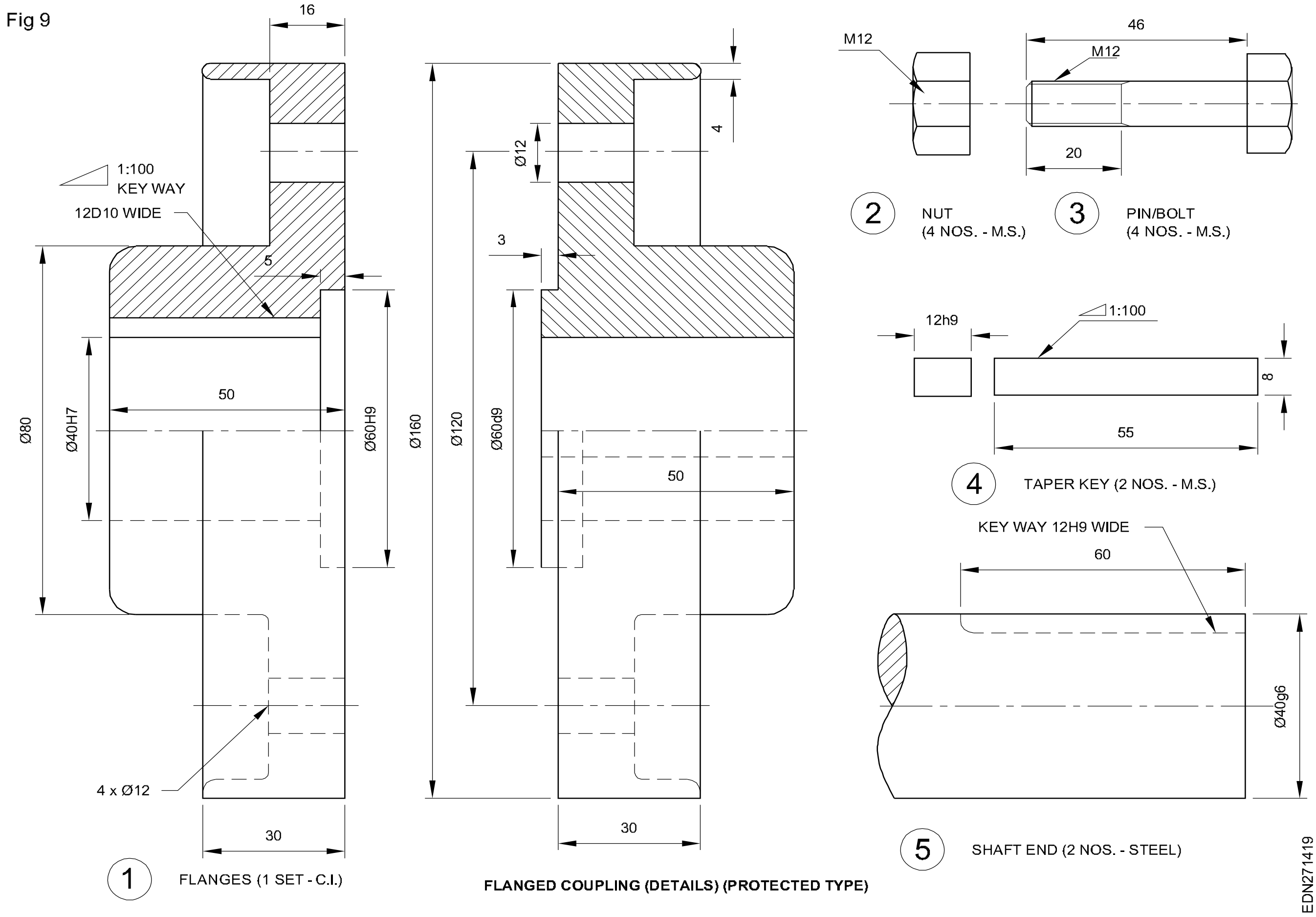
ASSEMBLY OF SOCKET AND SPIGOT

EDN271418

Assembly view of flange coupling

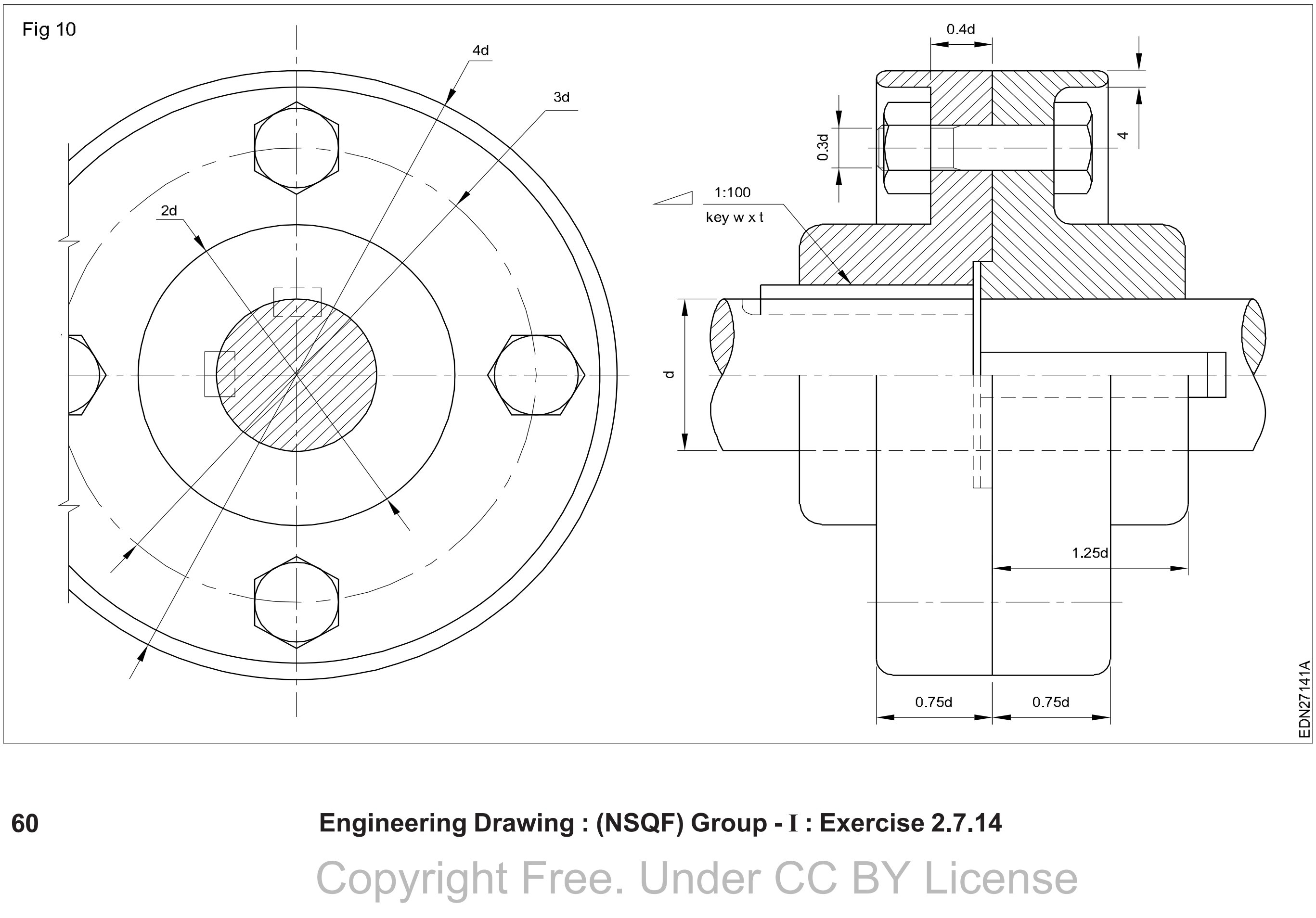
Draw the part details of a flanged coupling having four bolts are given in (Fig 9). Assemble them and draw the front view, top view and assembly (Fig 10).

Fig 9



FLANGED COUPLING (DETAILS) (PROTECTED TYPE)

Fig 10



Assembly view of simple work holding device e.g. vice

Pictorial view of Tool maker's vice (Fig 1)

Fig 1

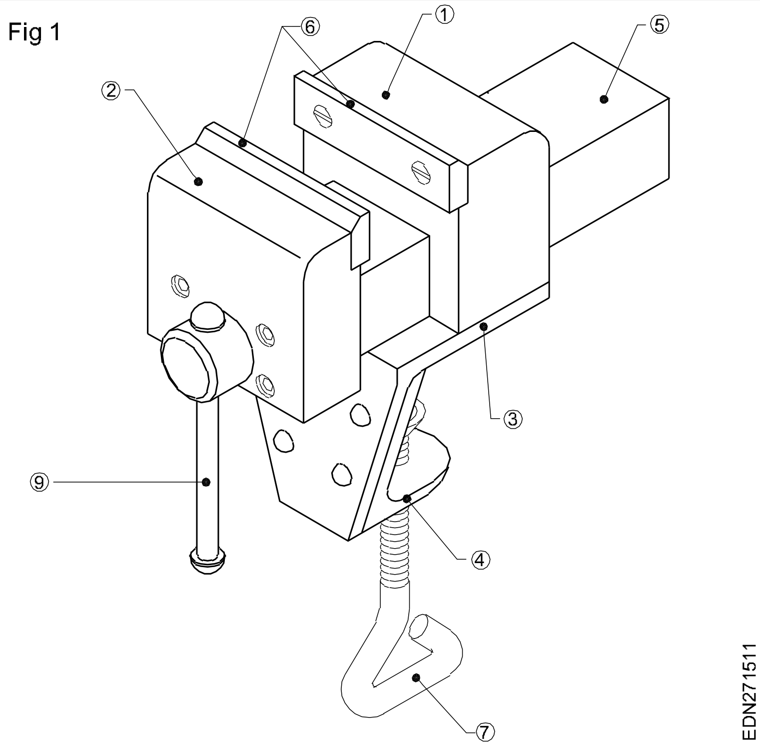
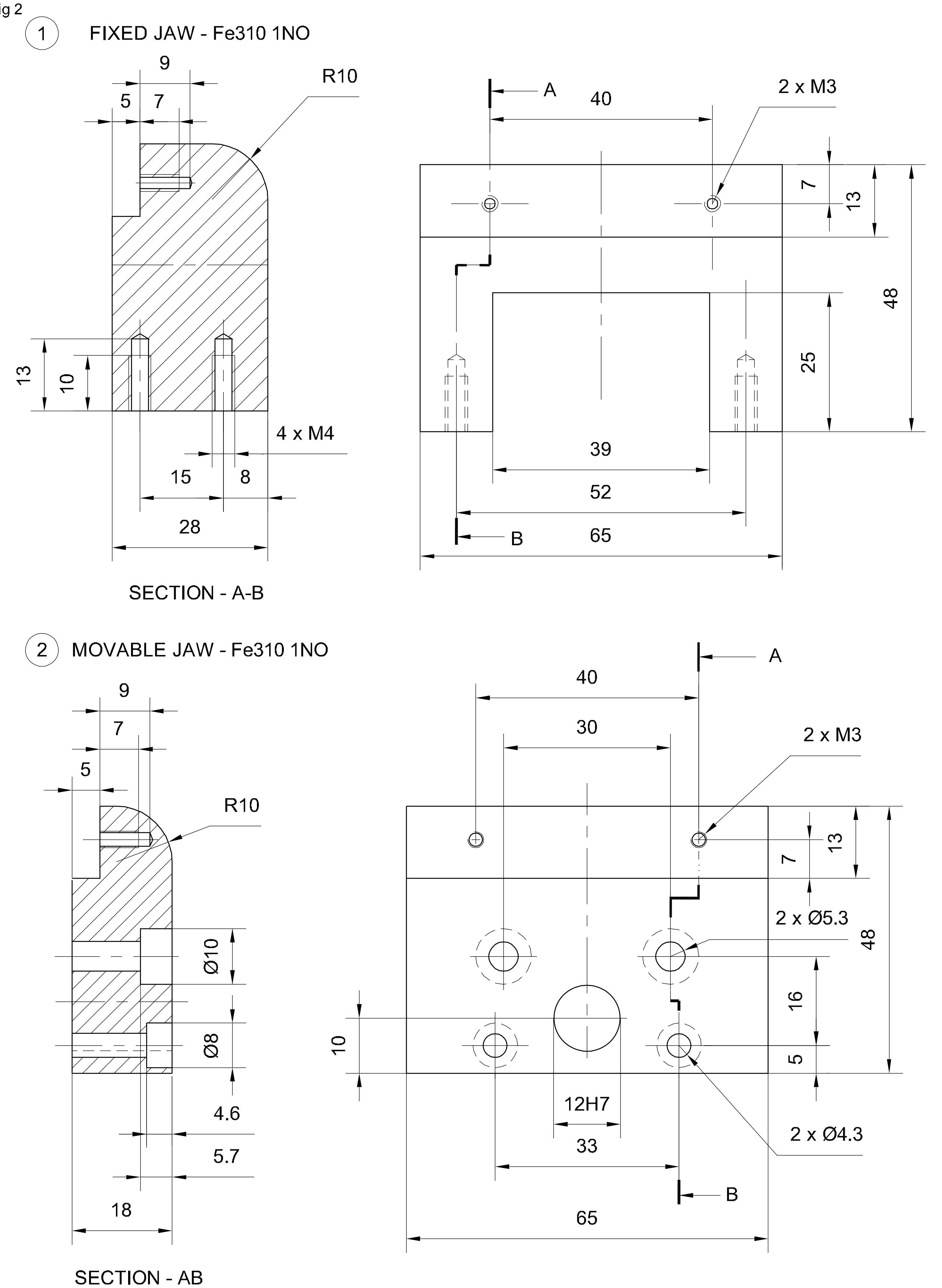
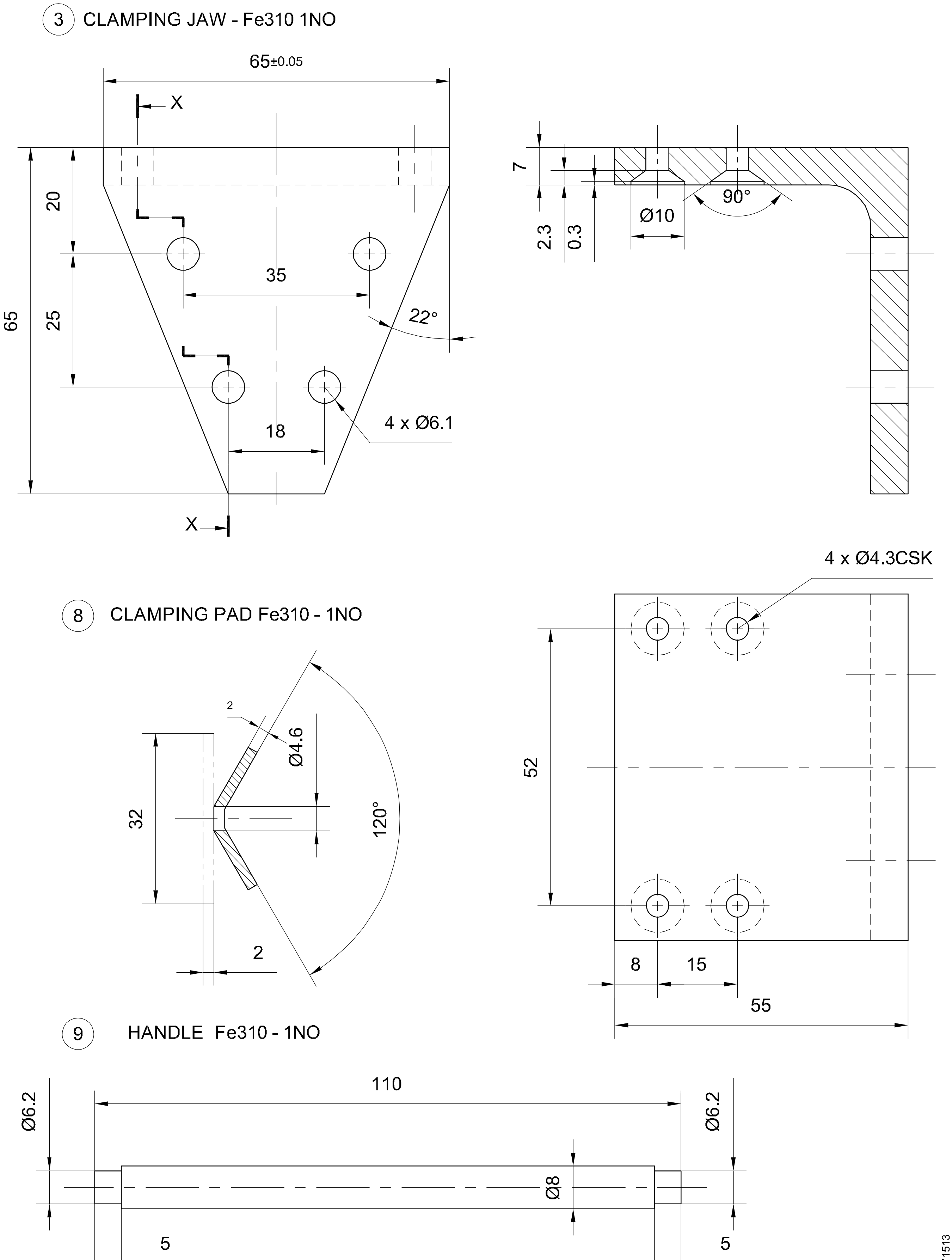


Fig 2

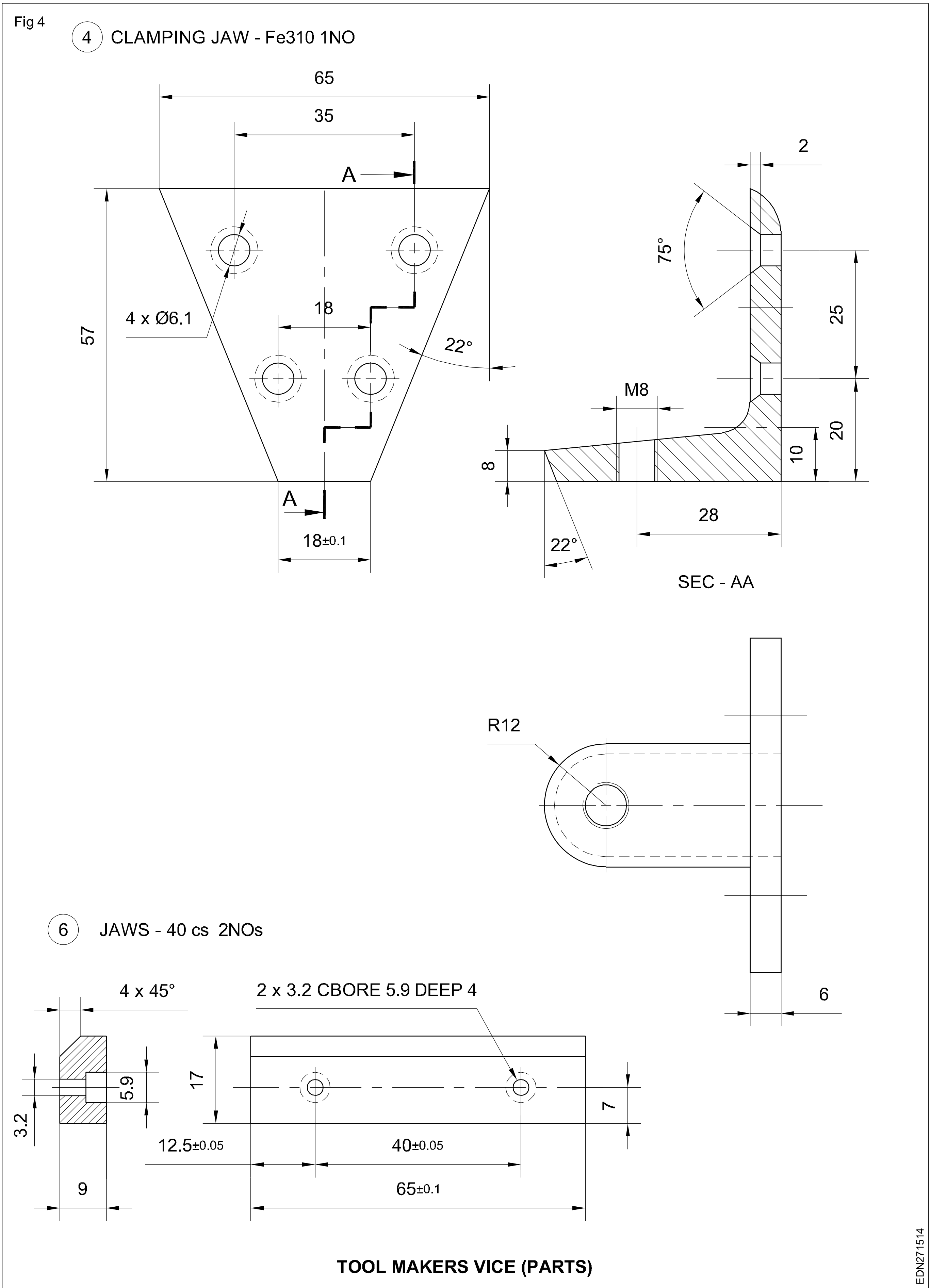


TOOL MAKERS VICE (DETAIL CONTD)

Fig 3

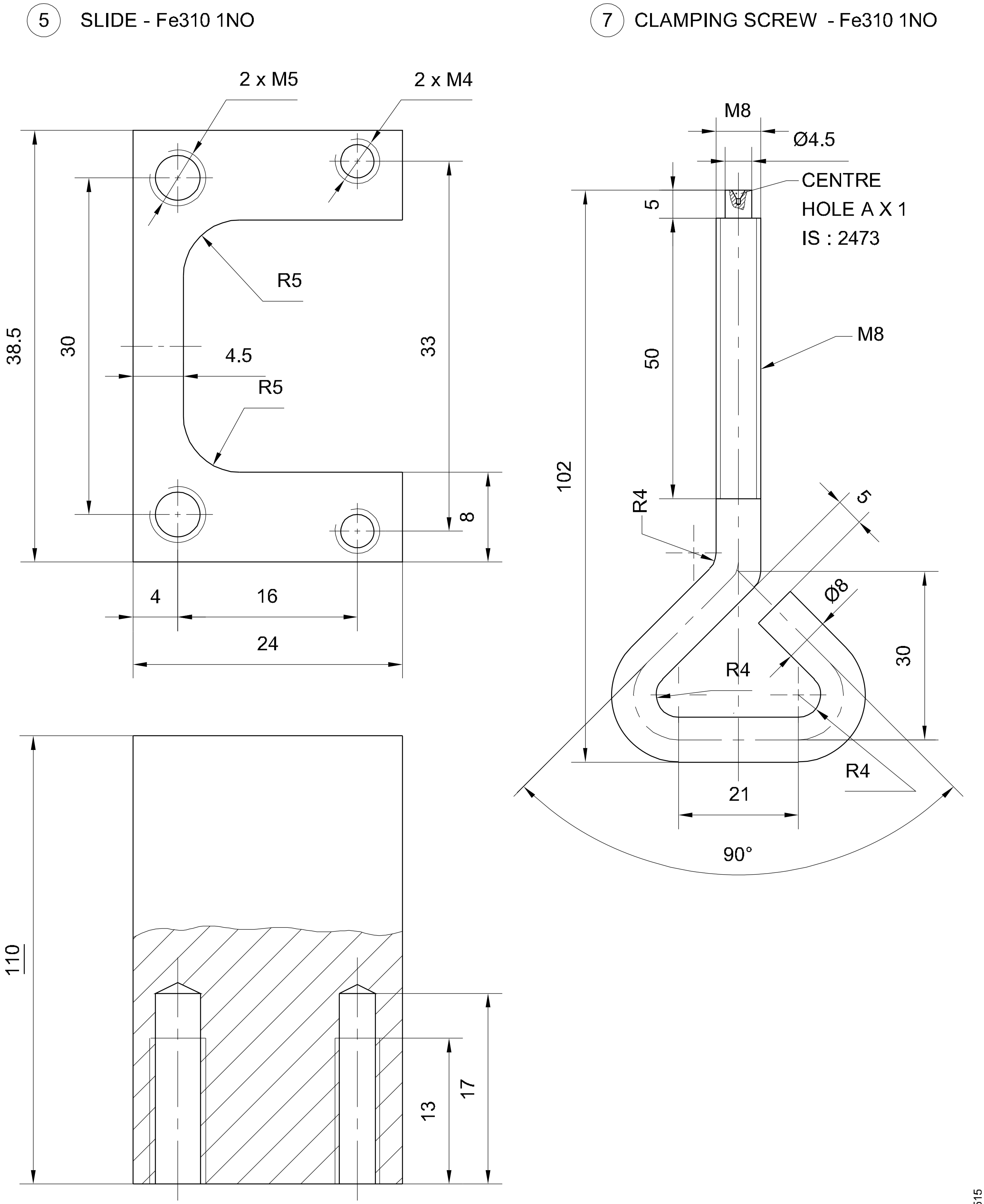


TOOL MAKERS VICE (parts)



TOOL MAKERS VICE (PARTS)

Fig 5



TOOL MAKERS VICE DETAILS

Fig 6

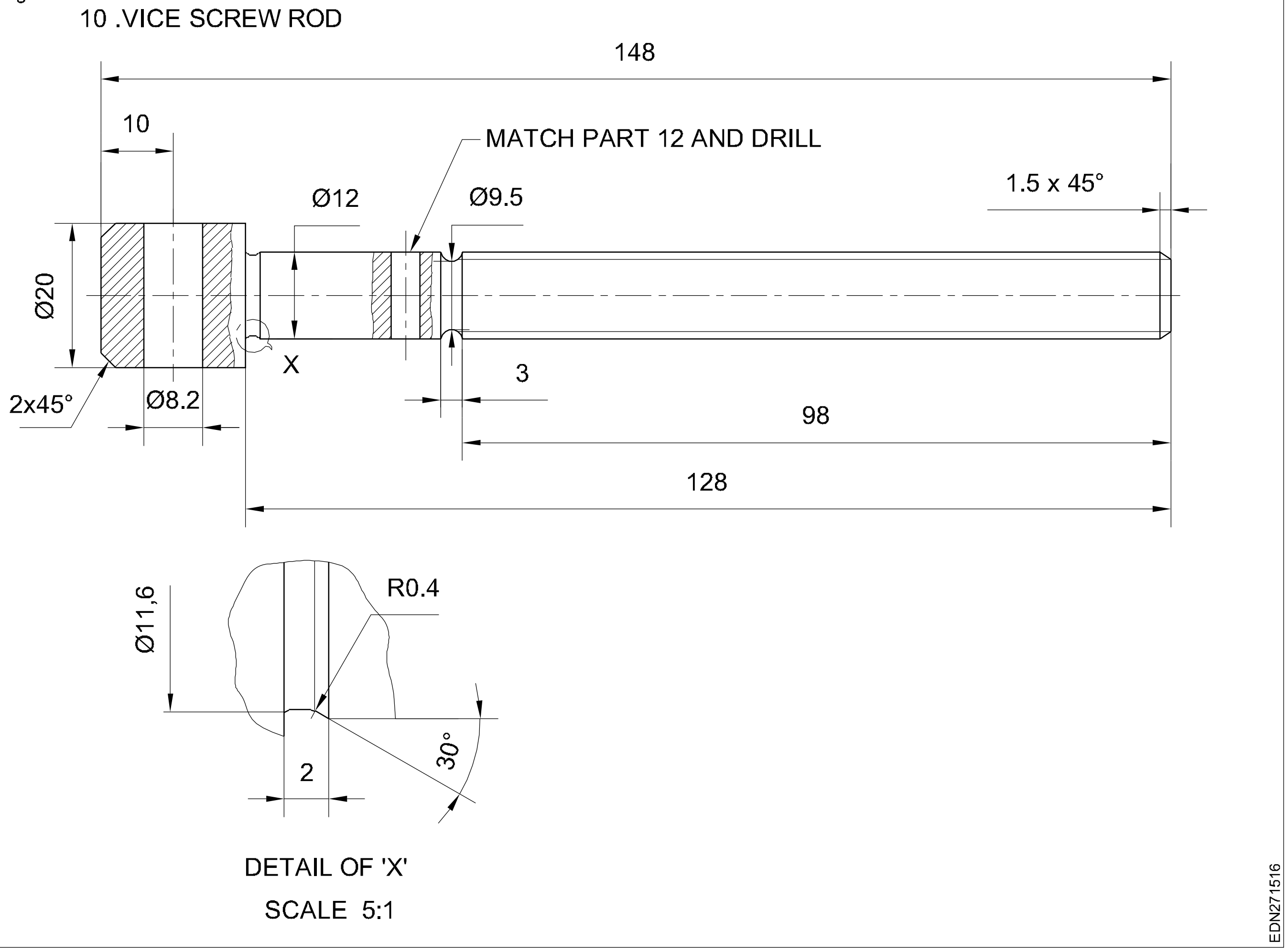
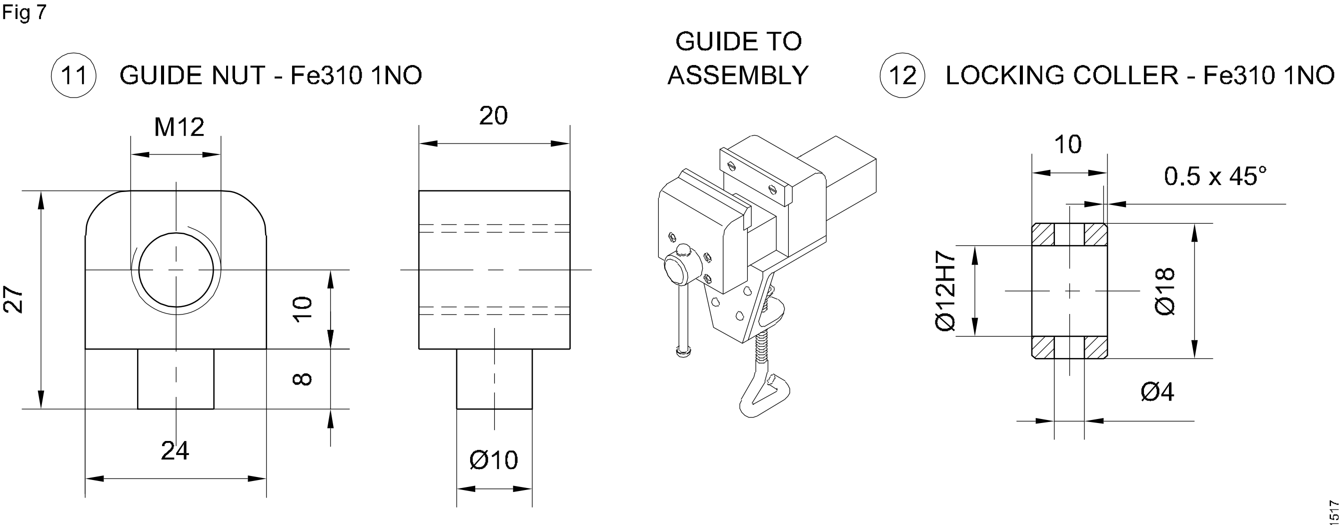


Fig 7



TOOL MAKERS VICE DETAIL

Part No.	No off	Description	Stock size	Material	Remarks
19	2	Washer	OD12x1D6.5x2thk		Std
18	1	Cylindrical pin	4h8 x 16	IS:2393	Std
17	4	Snap head rivet	6 x 15	IS:2155	Std
16	4	Slotted CSK head screw	BM4 x 14	IS:6761	Std
15	4	Slotted cheese head screw	BM3 x 25	IS:1366	Std
14	2	Hex. Socket head screw	M4 x 25	IS:2269	Std
13	2	Hex. Socket head screw	M5 x 25	IS:2269	Std
12	1	Locking collar	ϕ 18 - 12	Fe310	-
11	1	Guide nut	□25 - 30	Fe310	-
10	1	Vice screw rod	ϕ 20 -152	Fe310	-
9	1	Vice handle	ϕ 8 -115	Fe310	-
8	1	Clamping pad	ISST35 x 2 - 35	Fe310	-
7	1	Clamping screw	ϕ 8 - 175	Fe310	-
6	2	Jaws	20ISF10 - 67	40C8	-
5	1	Sliding piece	40ISF 25 - 115	Fe310	-
4	1	Clamping jaw	<6545 x 8 - 70	Fe310	-
3	1	Clamping jaw	<7070 x 8 - 70	Fe310	-
2	1	Movable jaw	50 ISF 20 - 70	Fe310	-
1	1	Fixed jaw	50 ISF 30 - 70	Fe310	-

Material list - Part No.1 to 12 details are given in drawing. Rest 13 to 19 their specifications and sizes are given.

Assembly view of simple work holding device

Draw the following views of the drawing shown in Fig 1 and Fig 2. Select suitable scale if the scale is not mentioned. If any dimension is missing select suitably.

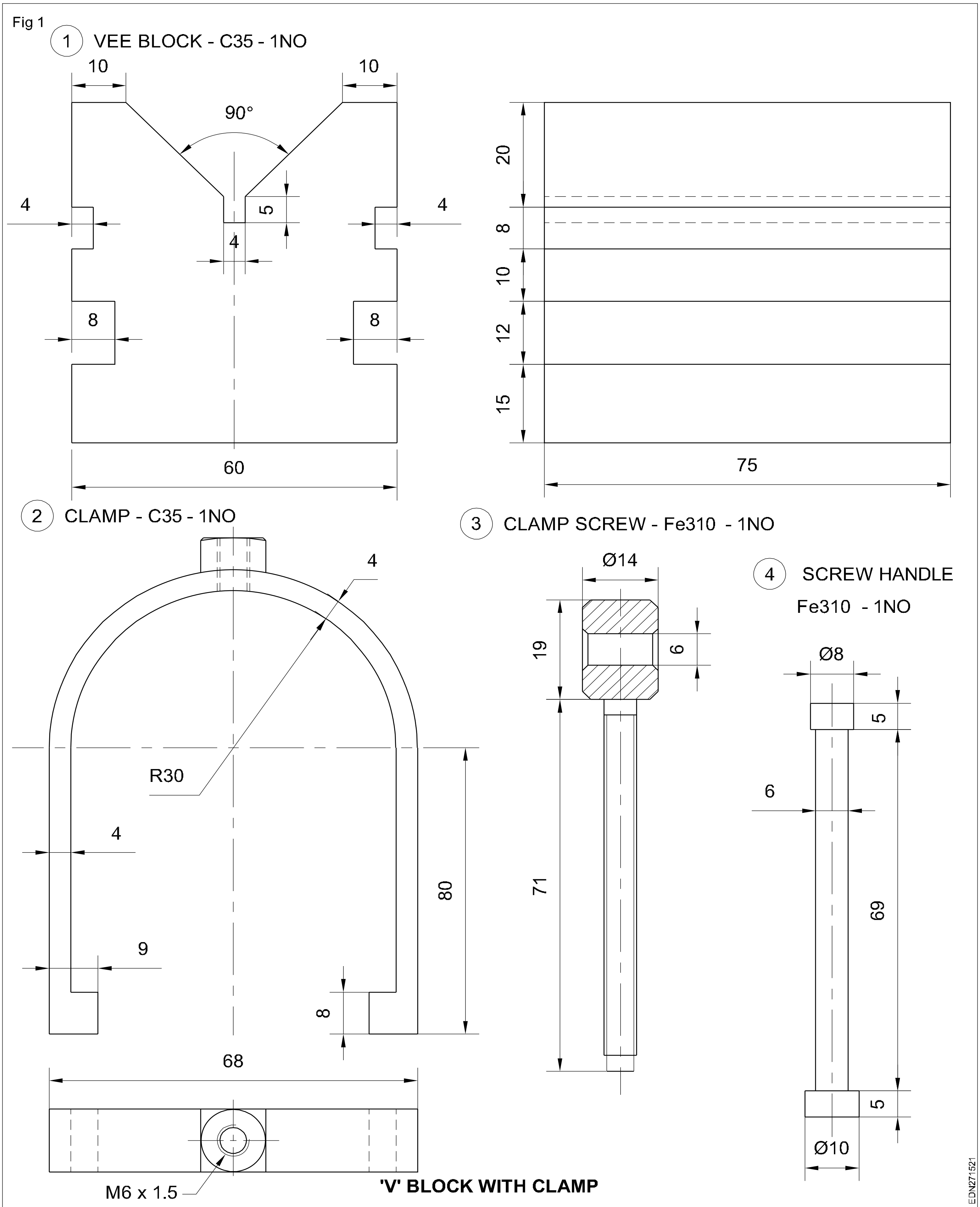
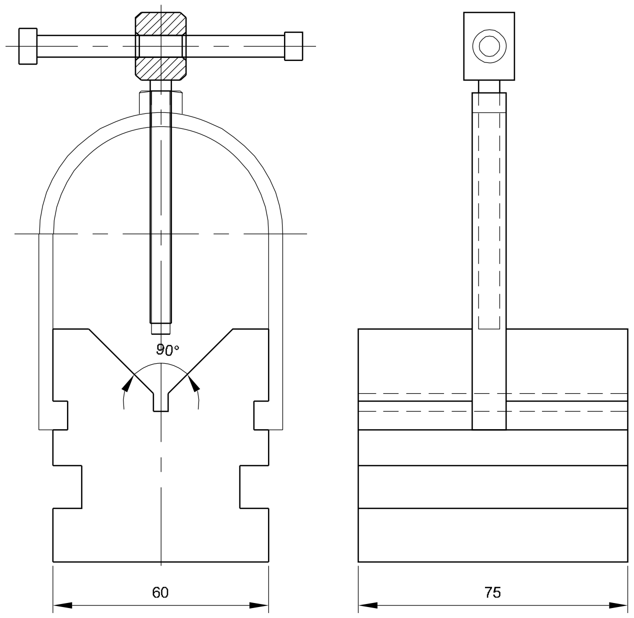


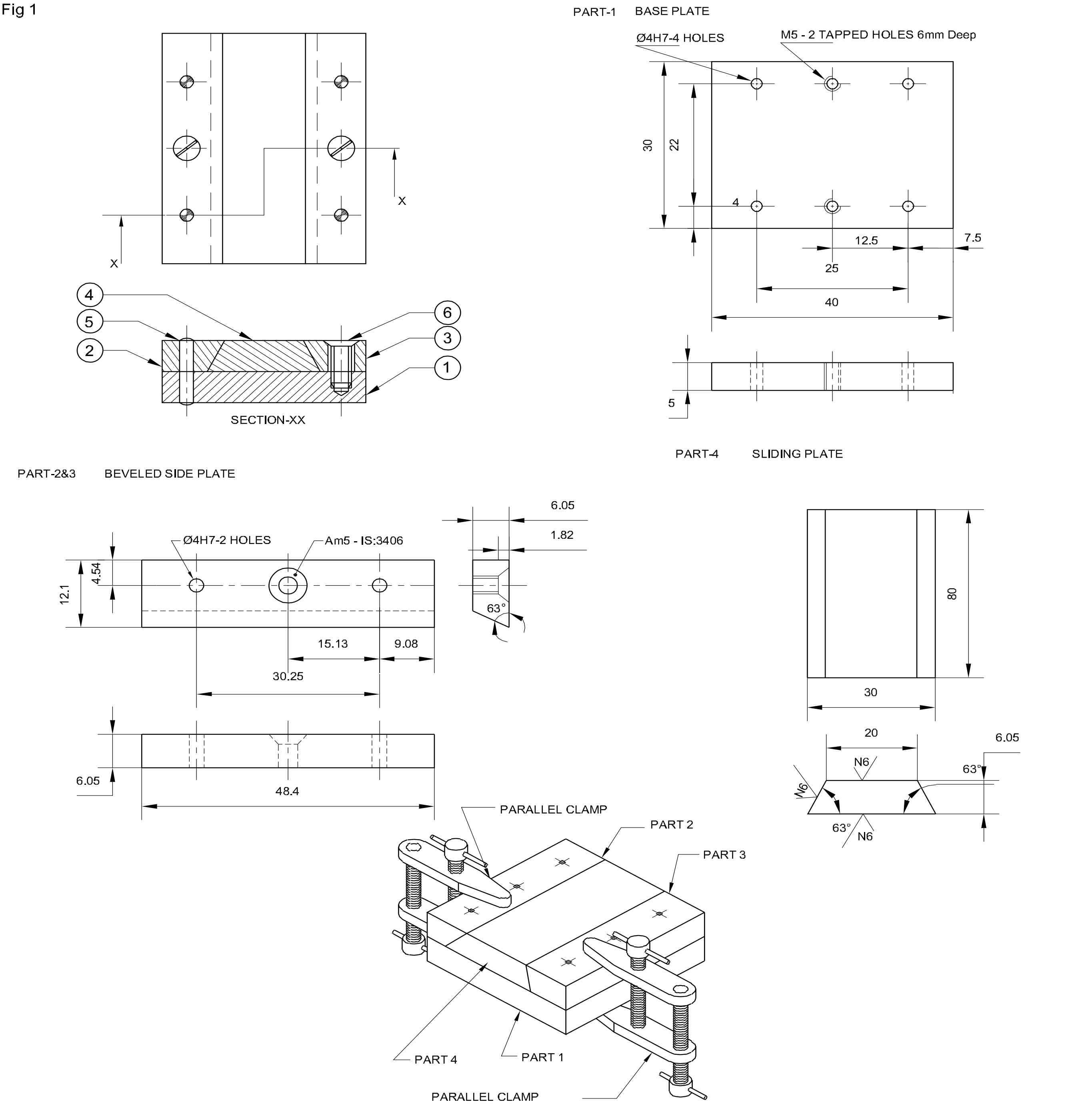
Fig 2



Assembly view of drawing details of two mating blocks and assembled view

Dove tail sliding fit angle parts and assembly

Fig 1



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PART NO
2	AM5-15IS:1365	CSK SCREW	30CB	6
4	4H8x20IS:2393	CYLINDRICAL PIN	40CB	5
1	35ISF12-85	SLIDING PLATE	Fe310	4
2	25ISF12-85	BEVELED SIDE PLATE	Fe310	2&3
1	65ISF12-85	BASE PLATE	Fe310	1

EDN271611

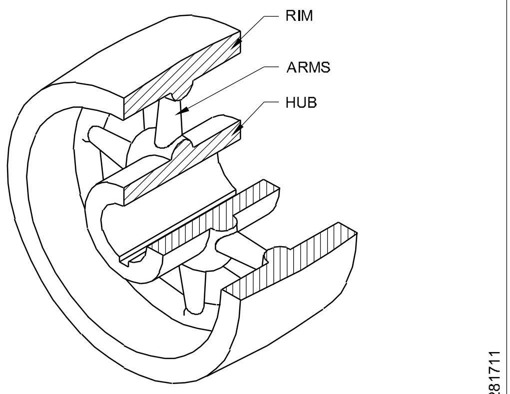
Sketch of shaft & pulley and belt

Pulley for flat belt

Pulleys for flat belts are made from cast iron or mild steel and are available in solid or split form.

The flat pulleys have a wide rim with a crowned surface for retention of the belt. The hub is strongly designed and provides the means of securing the pulley to the shaft. The arms unite the hub and rim into a rigid assembly. The arms of a pulley may be of circular or elliptical cross-section, but larger at the hub than at the rim. (Fig 1)

Fig 1



FLAT PULLEY

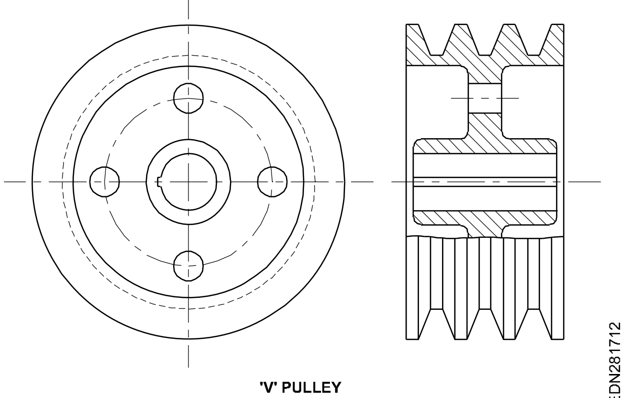
Crowned face of pulley

The rim of a pulley for flat belt is generally made convex and this is called the crowned face of the pulley. The crown faced pulley will keep the belt centralised even if there is any slight tendency to run off. Shifting the belt from the fast pulley to the 'loose' pulley will be quick and easy. Excessive crowning will be injurious to belting.

'V' groove pulley (Fig 2)

These pulleys have one or more 'V' grooves to carry the V belts. (Fig 2) shows a V belt pulley having three V grooves. These pulleys are widely used in transmission of motion in machine tools and are made from cast iron, wrought iron, mild steel or wood.

Fig 2



'V' PULLEY

Fast and loose pulley

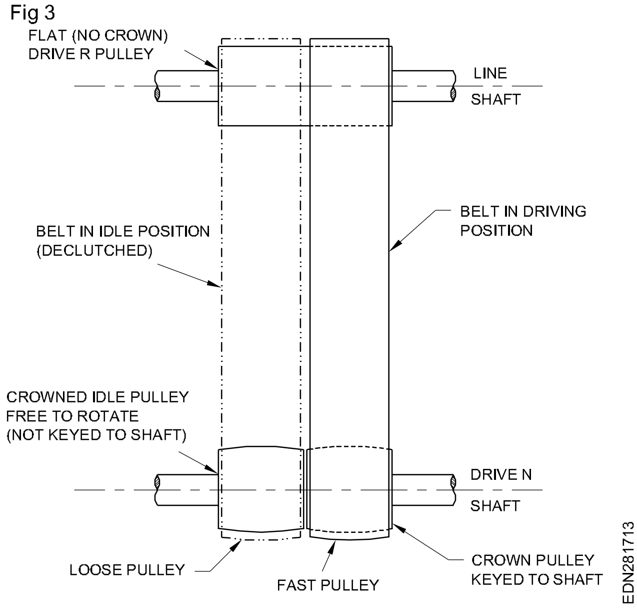
Pulleys are usually secured to their shafts by means of a key or grub screw. The function of the pulley keyed to the shaft is to convey rotation from the driving to the driven pulley by means of a belt. This is called a fast pulley.

The loose pulley is not keyed to the shaft and is free to rotate on the shaft.

Function (Fig 3)

A machine can be easily stopped or started whenever required by the use of a pair of fast and loose pulleys. This pair is mounted on a counter- shaft near the machine to be operated. When the driving belt from the main shaft is on the fast pulley, the countershaft is in motion. If the belt is shifted from the fast pulley on to the loose pulley, the countershaft will stop rotation. Fig 3 shows the position of the fast and loose pulleys in a driving system.

Fig 3



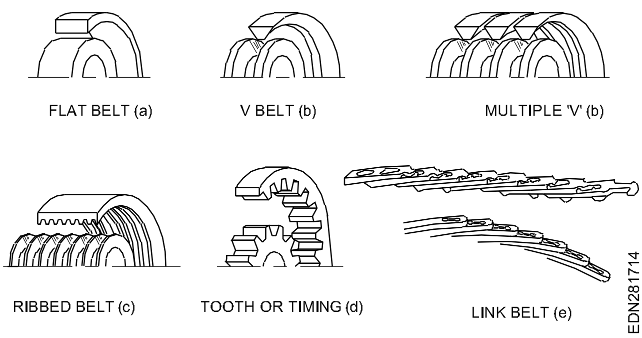
Types of belts (Fig 4)

Basically five types of belts are used for the transmission of power.

- Flat belt (Fig 4a)
- V-belt and multiple V-belt (Fig 4b)
- Ribbed belt (Fig 4c)
- Toothed or timing belt (Fig 4d)
- Link belt (Fig 4e)

The choice of a particular belt depends upon speed ratio, centre distance, flexibility, strength, economy and maintenance consideration of the driving system.

Fig 4



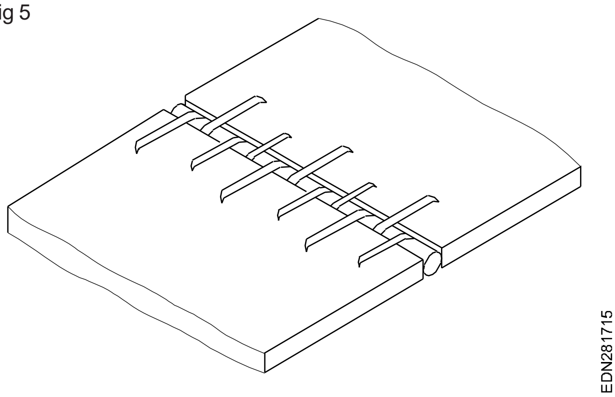
V-belts

'V'belt drives are generally used when the distance between the shafts is too short for flat belt drives. Owing to the wedge action between the belt and the sides of the groove

Wire type belt fastener

Fig 5 shows the wire type fastener generally used on light duty machines.

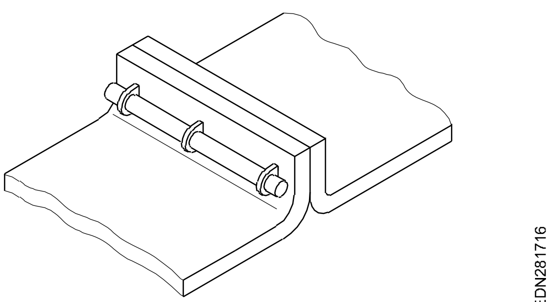
Fig 5



'Lagrelle' type belt fastener

Fig 6 shows a lagrelle type fastener used on heavy duty machines.

Fig 6



Jackson-type belt fastener

The Jackson-type fastener illustrated in Fig 7 is used on medium duty machines.

Crescent plate belt fastener

Fig 8 shows a mechanical type belt fastener which is used on medium duty machines.

Fig 7

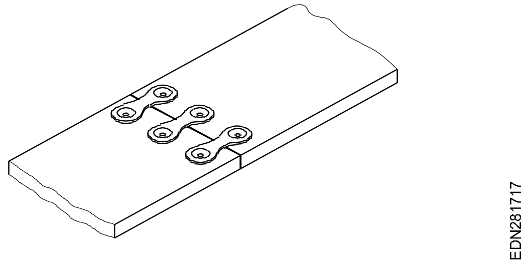
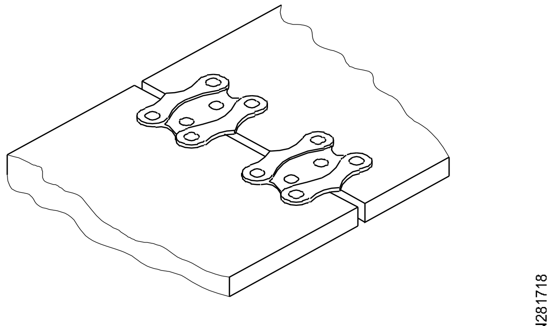


Fig 8

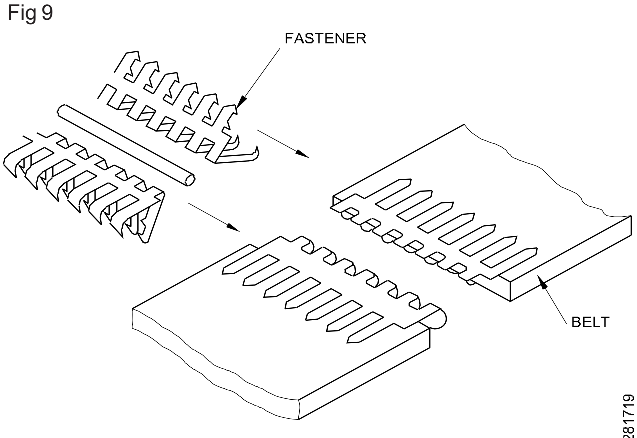


"CRESCENT" - PLATE BELT FASTENER

Belt fasteners (Alligator type)

Alligator type fasteners are used in joining belting for industrial purposes. The belt fastener is made of steel sheets conforming to IS:513-1973. The pins shall be made from mild steel wire conforming to IS: 280-1972. Belt fasteners are shown in Fig 9 and the position of the pin in a joint is illustrated in Fig 10.

Fig 9



ALLIGATOR TYPE BELT FASTENER

Specification

The fastener designation and pin size, thickness of belt and other dimensions are given in the table as per IS: 5593-1980.

Cross-belting (Fig 11)

Stepped drives (Fig 12)

Stepped drives are used to obtain different speed ratios. Pulleys of different sizes are employed.

Three different speeds can be obtained by changing the belt position from one step to another.

Fig 10

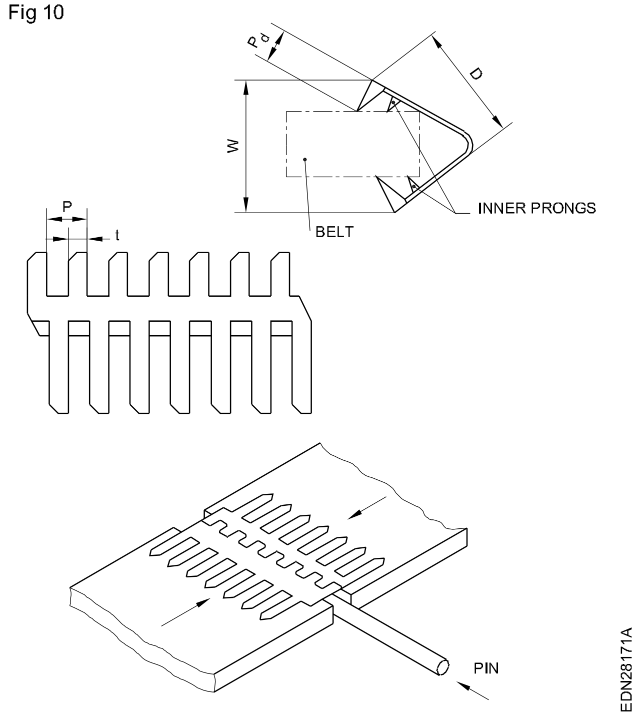


Fig 11

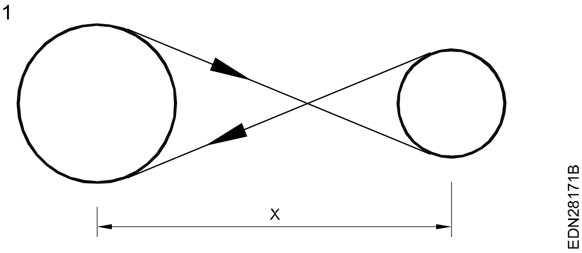
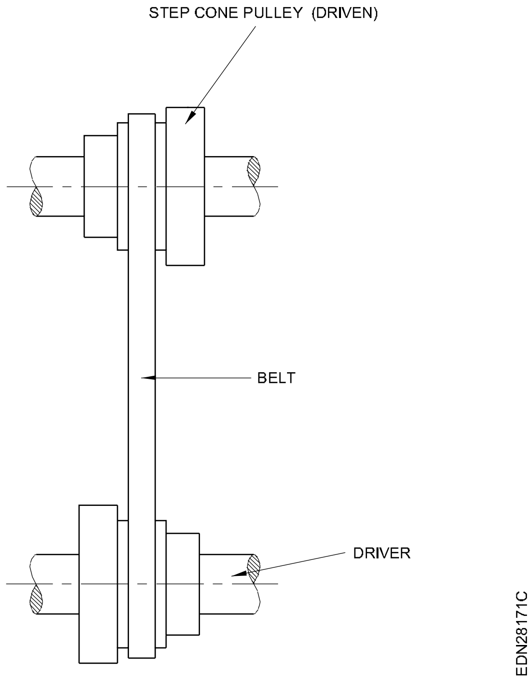


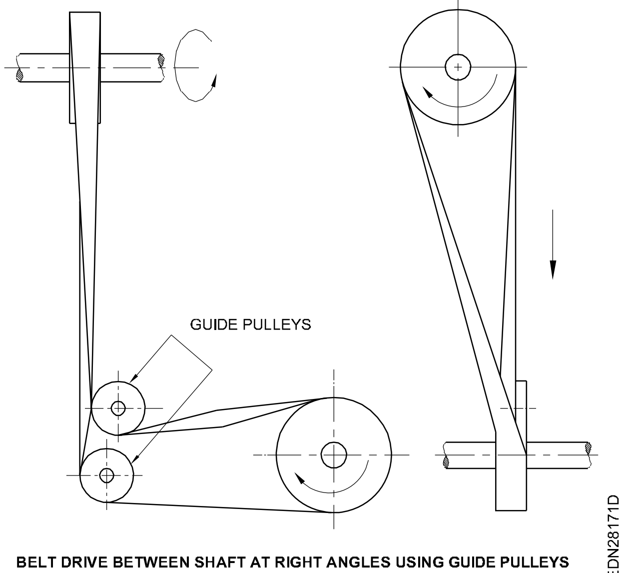
Fig 12



Right angled drive (Fig 13)

This drive is employed between shafts at right angles using tide pulleys. In this the horizontal drive is converted into vertical drive with the help of the guide pulleys.

Fig 13



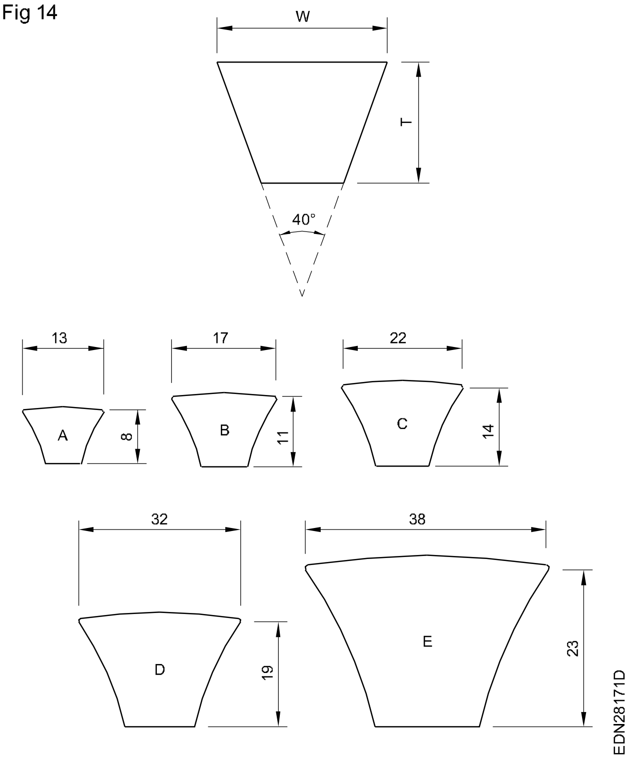
BELT DRIVE BETWEEN SHAFT AT RIGHT ANGLES USING GUIDE PULLEYS

V- belts

'V' belt drives are generally used when the distance between the shafts is too short for flat belt drives. Owing to the wedge action between the belt and the sides of the groove in the pulley, the V belt is less likely to slip, hence more power can be transmitted.

The endless V belt is shaped roughly like a trapezium in cross- section, and is made of cord and fabric, and is treated with rubber and moulded together in a uniform manner and shape. The cross-sectional symbol of a V - belt is shown in Fig 14.

Fig 14



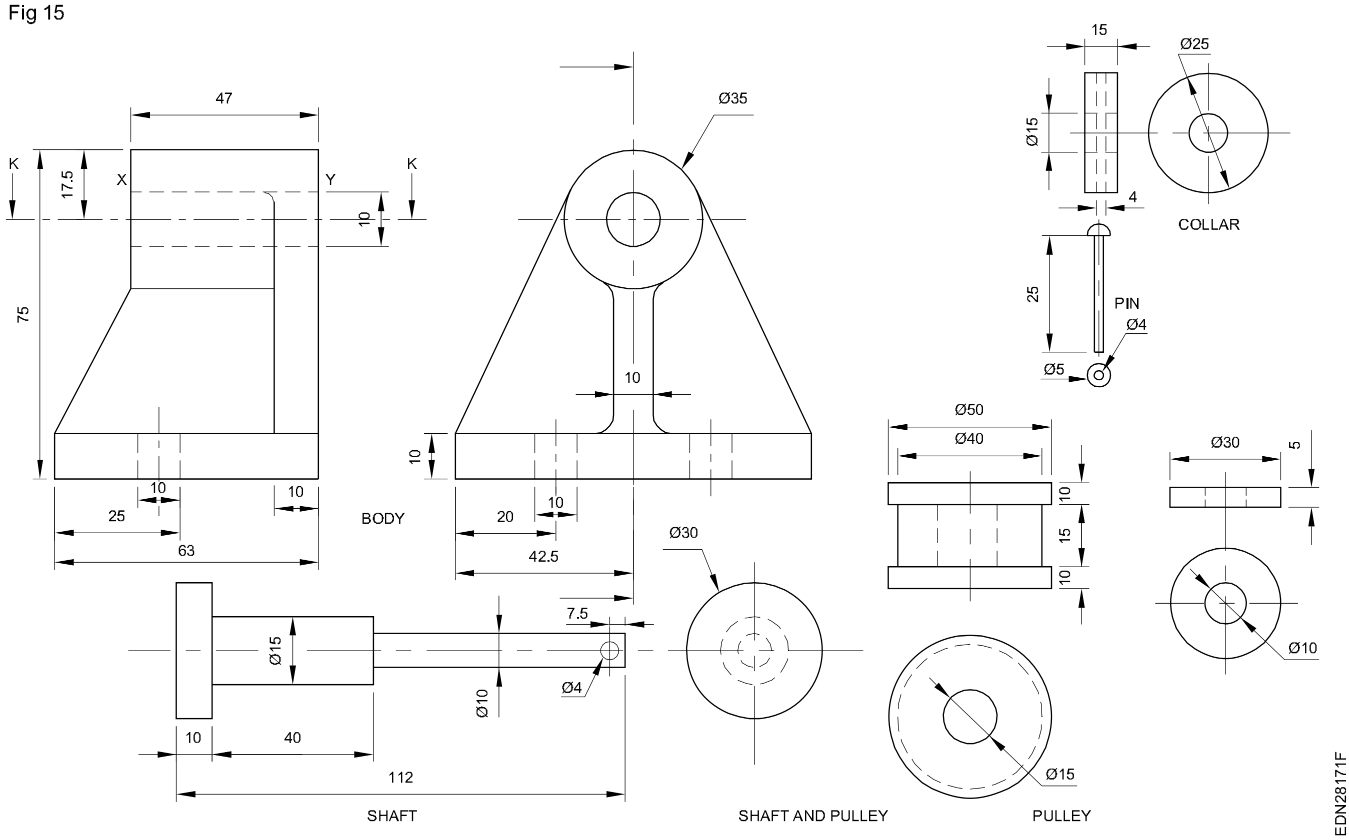
Advantages of V-belt drive

- It is compact, so installation is possible in limited space.
- It is used when the centre distance between the driver and the driven pulleys is short.
- Less vibration and noise.
- Cushions the motor and bearing against load fluctuation.
- Easy replacement and maintenance.

Shaft and pulley

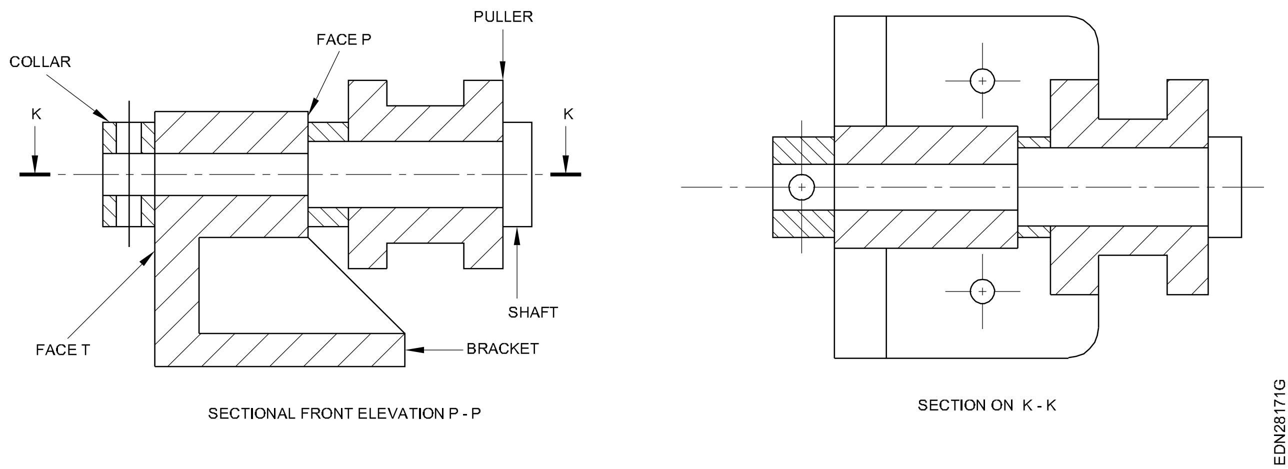
Draw the following views of shaft and pulley parts detail shown in Fig15. Select suitable scale if the scale is not mentioned and any dimension is missing select suitably.

Fig 15



Assembled view of shaft and pulley (Fig 16)

Fig 16



Sketch of gear, gear drives

Introduction

Gear

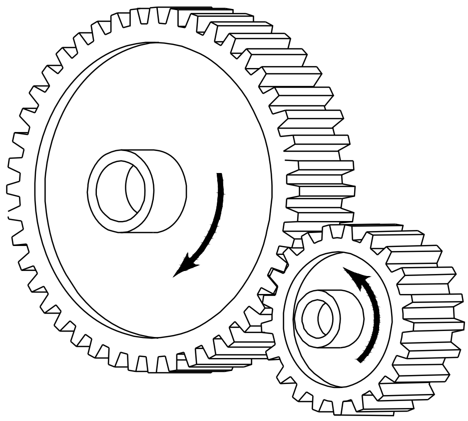
A wheel having teeth of uniform formation provided on its circumferential surface is called gears. (Fig 1)

Gears are used to transmit the power from one shaft to another shaft by means of friction.

Classification of gears

Gears may be classified into three groups according to the position of shaft arrangement.

Fig 1



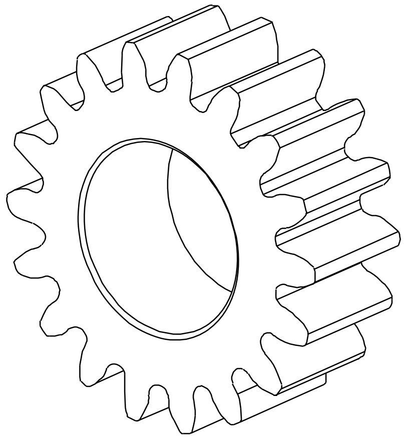
SPUR GEAR

Sl. No.	Position of shaft	Gear types
1	Parallel shaft	Spur, Helical Herringbone and Inclined gear
2	Inclined shaft	Bevel gear
3	Non parallel & Non intersecting shaft	Worm & Worm wheels

Spur gear (Fig 2)

The teeth in these gear are parallel to the axis of the shaft and are straight.

Fig 2

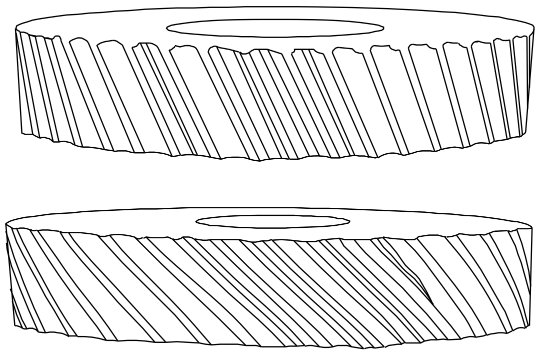


SPUR GEAR

Helical gear

The teeth in this gear are inclined to the axis of the shaft. (Fig 3)

Fig 3



PICTORIAL VIEW OF A HELICAL GEAR

Helical gears can be meshed in either parallel (or) crossed combination as shown in Fig 4.

Herringbone gear

It is a special type of gear because of connecting of two helical gear of opposite hand. (Fig 5)

Fig 4

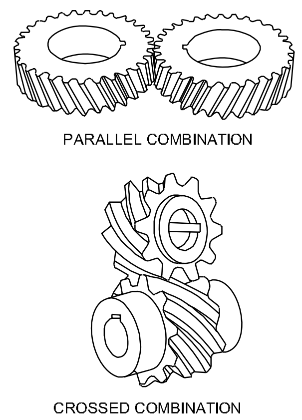
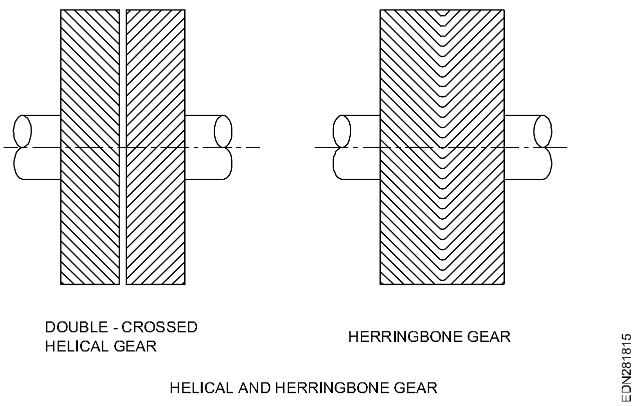


Fig 5



HELICAL AND HERRINGBONE GEAR

Bevel gear

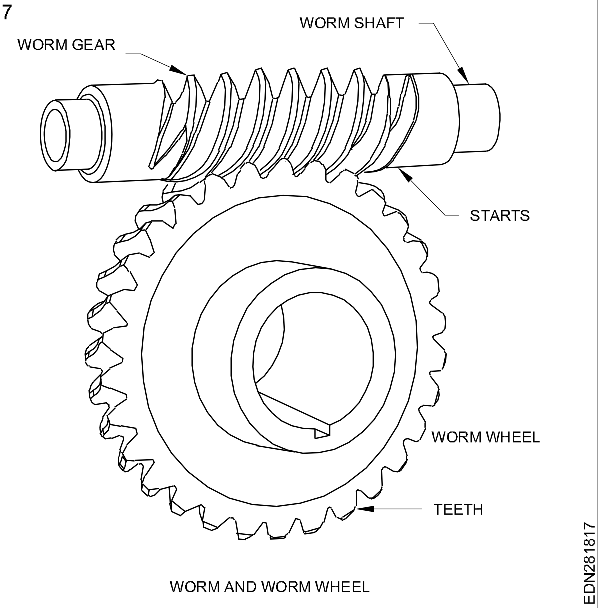
The shape of such gears in a truncated right circular cone with teeth on the curved surfaces. (Fig 6)

Worm and worm wheel

Worm or worm gear is a fairly long cylindrical part having thread on the surface.

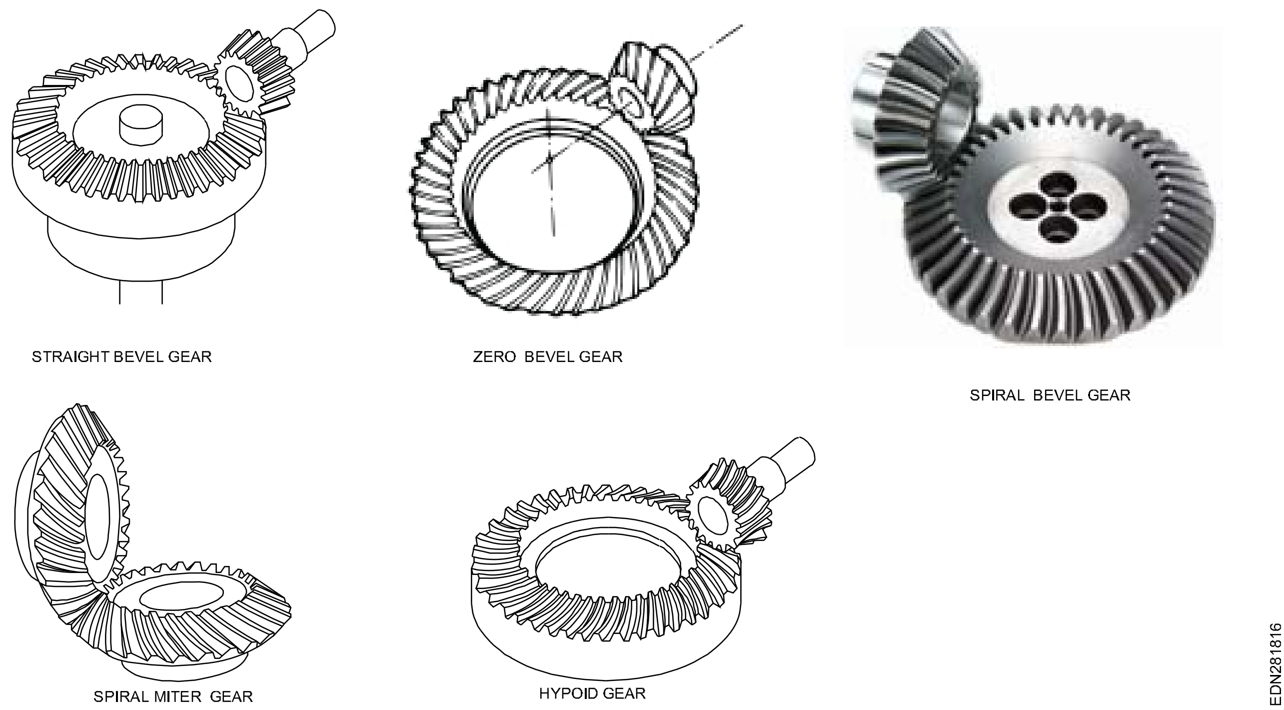
Worm and worm wheel are gear sets that offer high gear reduction and torque. (Fig 7)

Fig 7



WORM AND WORM WHEEL

Fig 6

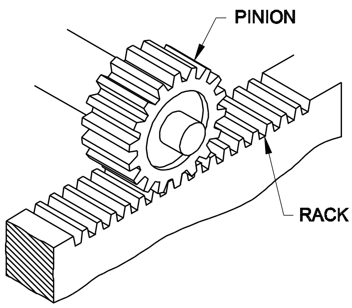


Rack and pinion

A rack is a straight bar with toothed surface and a pinion is a small gear. (Fig 8)

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion

Fig 8



RACK AND PINION ARRANGEMENT

Gear nomenclature (Fig 9)

Various parameter related to gear or pinion are discussed below.

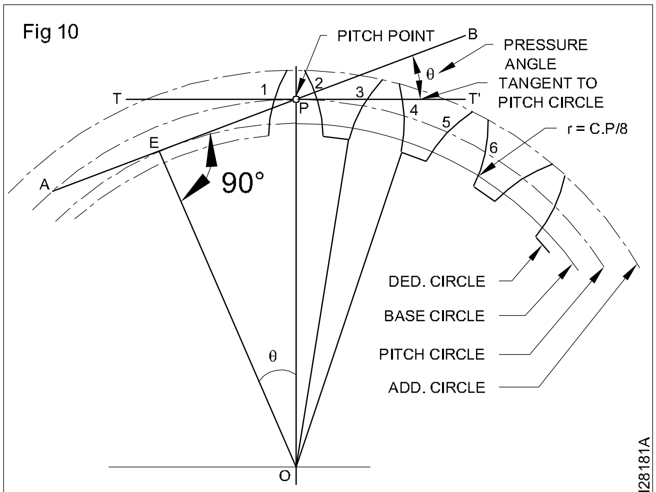
Pitch circle : It is an imaginary circle which by pure rolling action would give the motion as actual gears.

Pitch circle diameter : It is the diameter of the pitch circle. The size of the gear is usually specified by the PCD. It is also called pitch diameter.

Module : It is the ratio of pitch circle diameter to the number of teeth. (Fig 10)

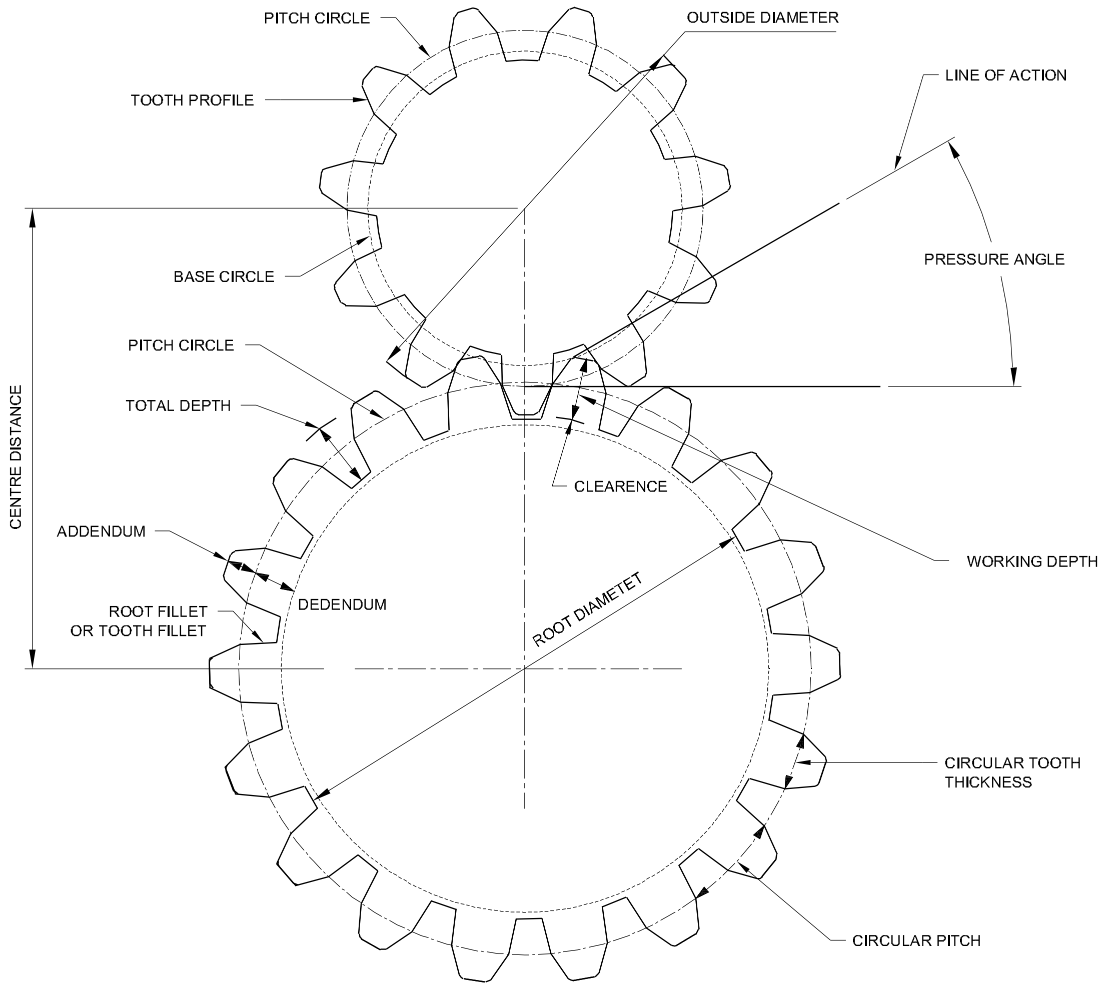
$$m = \frac{D}{N}$$

Fig 10



PROFILE OF INVOLUTE TEETH

Fig 9



GEAR NOMENCLATURE

Pressure angle (ϕ) : This is the included angle within the common tangent and the line of action.

Addendum (a) : It is the radial distance between the pitch circle and top of the tooth.

$$a = m$$

Dedendum (d) : It is the radial distance between the pitch circle and the bottom of the tooth. Generally it taken as

$$d = 1.157\ m$$

Circular pitch (CP) : It is the arc length measured along pitch circle between a point on a tooth to the corresponding point on the next tooth.

$$CP = \frac{\pi D}{N} = \pi m$$

Diametrical pitch (P_d) : This is the ratio of number of teeth to the diameter of the pitch circle.

$$P_d = \frac{N}{D}$$

It is the reciprocal of module $Pd = \frac{1}{m}$

Outside (or) Addendum circle (D_a) : It is the diameter of the addendum.

$$D_a = D + 2a$$

Dedendum circle (Dd) : It is the diameter of the dedendum

$$D_d = D - 2d$$

Whole depth (dh) : It is the sum of addendum and dedendum of a tooth.

$$dh = a + d$$

Clearance (c) : It is the difference between the dedendum and the addendum.

$$\text{Clearance} = d - a = 0.157\ m$$

Tooth thickness : It is the thickness of the tooth measured along the pitch circle.

$$\text{Tooth thickness} = \frac{CP}{2}$$

Working depth : It is the distance by which a tooth extends into the space of a mating gear.

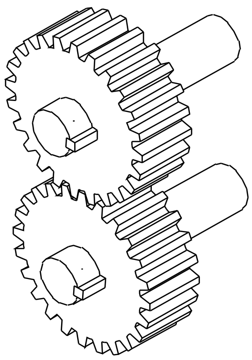
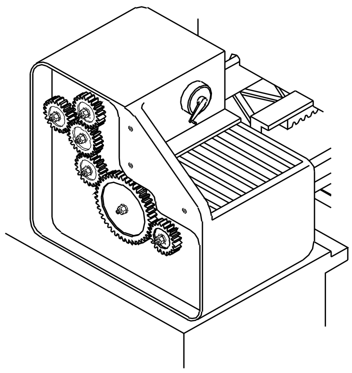
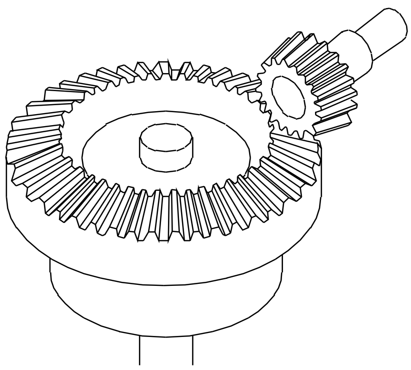
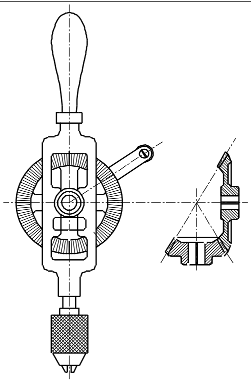
Working depth = Whole depth - Clearance

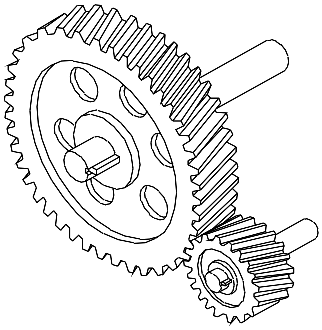
(or) Twice the addendum

Practical application of gear wheel : (Fig 11) shows the types of gears along with practical application.

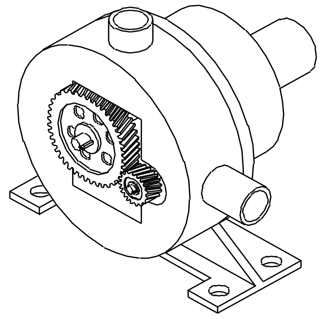
Type of gears along with their practical application

Fig 11

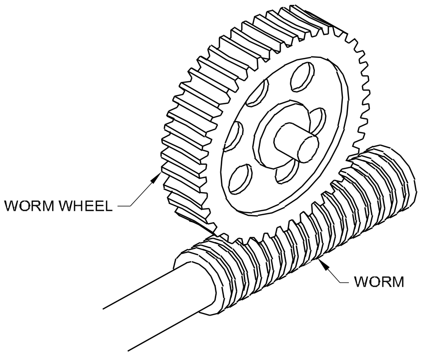
GEAR ARRANGEMENT	PRACTICAL APPLICATION
 SPUR GEAR	 SPUR GEAR (LATHE MACHINE)
 BEVEL GEAR	 BEVEL GEAR (HAND DRILL MACHINE)



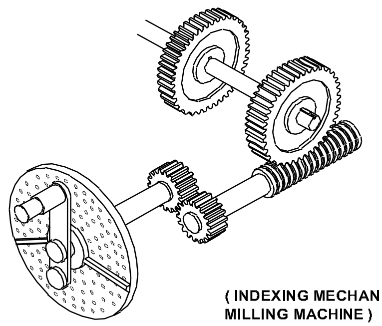
HELICAL GEAR



HELICAL GEAR (GEAR BOX)



WORM AND WORM WHEEL



(INDEXING MECHANISM IN MILLING MACHINE)

WORM AND WORM WHEEL

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