SRI LANKA STANDARD 409 : PART 1 : 2004

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SRI LANKA STANDARD

ENGINEERING DRAWING PRACTICE

PART 1 : RECOMMENDATIONS FOR GENERAL PRINCIPLES (FIRST REVISION)

SRI LANKA STANDARDS INSTITUTION

ENGINEERING DRAWING PRACTICE
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(FIRST REVISION)

SLS 409 Part 1 : 2004

Gr. 22

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SRI LANKA

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

CONTENT

Sri Lanka Standard
ENGINEERING DRAWING PRACTICE
PART 1 RECOMMENDATIONS FOR GENERAL PRINCIPLES
(First Revision)

FOREWORD

This standard was approved by the Sectoral Committee on Materials, Mechanical Systems and Manufacturing Engineering and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2004-12-09

Engineering drawing is the graphical language of communication in engineering both nationally and internationally. Drawings made to the accepted standards in one country, when based on standards published by the International Organization for Standardization (ISO), are understood and can be used around the world in virtually all countries. With this in mind it was recognized and accepted to be important as a policy for this revision that particular attention and care should be paid to the quality of content of both text and figures to ensure their clarity and ease of understanding.

The recommendations of this standard have been established having regard to the requirements of different methods of reproduction.

This standard provides recommendations for engineering drawings in the manufacturing industries associated with mechanical engineering but does not cover the requirements of the building, architectural, civil and structural engineering and construction services industries.

This standard is presented and published in three separate parts:

Part 1 Recommendations for general principles
This Part deals with general principles; it leads through from the choice of paper sizes and scales to a complete drawing of views and sections awaiting the application of dimensions, tolerances and related information.

Part 2 Dimensioning and tolerancing of size
This Part deals with dimensioning, tolerancing and interpretations and the application of surface roughness symbols.

Part 3 Geometrical tolerancing
This Part deals specifically with geometrical tolerancing.

The Sri Lanka Standards Institution gratefully acknowledges the uses of the following publications, in the preparation of this standard :

a) ISO Standards Handbook 12 on Technical Drawings.

b) **BS 308 : 1993** Engineering Drawing Practice
Part 1 Recommendations for general principles

NOTES ON THE PRESENTATION OF THIS STANDARD

1 *The figures in this standard are independent and each is selected solely for its simplicity and clarity to illustrate only the text to which it relates. They are not the only possible examples and they are not intended as design examples or to be fully dimensioned working drawings, but otherwise are drawn according to the basic recommendations of this standard.*

2 *Linear dimensions shown in the figures are in millimetres.*

3 *This standard recognizes both the first and third angle projection methods as having equal status but the firs t angle projection method is more frequently used.*

4 *Due to the limitations of sizes of the figures in this standard, the sizes of arrowheads may not conform to* ***6.4****.*

1 SCOPE

This Part of the Sri Lanka Standard is concerned with the general principles of engineering drawing practice. It recommends drawing layout, types of lines, lettering, methods of orthographic projection, sections, scales and the conventional representation of common features.

2 REFERENCES

ISO 14	Straight-sided splines for cylindrical shafts with internal centering - Dimensions, tolerances and verification
ISO 128	Technical drawings - General principle of presentation
ISO 866	Centre drills for centre holes without protecting chambers
ISO 2162	Technical product documentation - Springs
ISO 2540	Centre drills for centre holes with protecting chamber
ISO 2541	Centre drills for centre holes with radius form – Type R
ISO 4156	Straight cylindrical involute splines - Metric module, side fit - Generalities, dimensions and inspection
ISO 8826	Technical drawings - Rolling bearings
ISO 9222	Technical drawings - Seals for dynamic applications Part 2 Detailed simplified presentation
SLS 433	Sizes of drawing sheets

3 TYPES OF DRAWINGS IN COMMON USE

3.1 General

A drawing is either of the following :

a) In general, any form of graphical representations ; or
b) In particular, a graphical representation of an object which depicts the form and/or position of the object. A drawing may consist of more than one sheet.

3.2 Design layout drawing

A design layout drawing represents in broad principles the feasible solutions meeting the design requirements. A design scheme may fulfill a similar function.

3.3 Detail drawing

A detail drawing depicts a single object and includes all the necessary information required (for example : the form, dimensions, tolerances, material, finishes, treatment, etc.) to define completely that object. A single part drawing fulfills a similar function.

An object will normally be referred to as a component, a part or an item (as contained in an item list, see **3.9**)

3.4 Tabular drawing

A tabular drawing depicts an object (see **3.3**) typical of a series of similar such objects having their variable characteristics presented in tabular form. (This could equally relate to a series of similar assemblies).

3.5 Assembly drawing

An assembly drawing shows two or more parts, or sub-assemblies, in their assembled form, including any dimensions and instructions necessary to effect assembly. An item list should be included or referred to in the assembly drawing.

3.6 Combined drawing

A combined drawing shows an assembly, item list and constituent details drawn separately but all on the same drawing.

3.7 Arrangement drawing

An arrangement drawing of the complete finished product or equipment shows the arrangement of assemblies. It includes important functional and/or performance features. An installation

drawing is a particular variation which provides the necessary information to effect proper installation on site or in further equipment.

3.8 Diagram

A diagram is a drawing depicting, by the use of simplified representation, the function of a system or the relationship between component parts.

3.9 Item list

An item list is a list of parts required for an assembly, shown either on the drawing or on a separate list.

3.9.1 The item list may be included on the drawing itself or be a separate document.

3.9.2 When the item list is included on the drawing, it should be so positioned to be read in the viewing direction of the drawing. The lists may be positioned/provided in conjunction with the title block. Its outlines may be drawn with continuous thick lines (type **A**) (see Table **3**)

3.9.3 Where the item list is shown on a separate document, this shall be identified by the same number as that of the parent drawing.

However, to distinguish this identification from that of the parent drawing, it is recommended that the item list number be preceded by the prefix "item list" (or a similar term in the language used on the documents).

The sheet sizes for separate item lists shall be chosen in accordance with **4.1**

3.9.4 It is recommended that the item list be arranged in columns by means of continuous thick or thin lines (type **A** or **B**) (see Table **3**) to allow information to be entered under the following headings (the sequence of these is optional) :

a) item ;
b) description ;
c) quantity ;
d) reference ; and
e) material.

NOTE : *If necessary more columns can be added to cover specific requirements (see **3.9.10**)*

3.9.5 The "item" column shows the relevant item reference number as shown on the relevant drawing (see **11**).

3.9.6 The "description" column shows the designation of the item. Abbreviations may be used if they do not impair clarity. If the item concerns a standard part (for example, bolt, nut, stud etc.), its standard designation shall be used, in accordance with the relevant standard.

3.9.7 The "quantity" column shows the total number of a particular item necessary for one complete assembly.

3.9.8 The "reference" column is used to identify items which are not completely represented on the parent drawing, such as parts represented on other ready-made parts. According to the case, the number of the other drawing, the relevant standard, the code or any similar information may be entered here.

3.9.9 The "material" column shows the type and quality of the material to be used. If this is a standard material, its standard designation shall be given.

3.9.10 The item list can additionally include other information necessary for the finished product for example

a) stock number;
b) unit mass;
c) state of delivery; and
d) remark.

3.9.11 Entries should be made in the relevant columns in horizontal rows. For clarity, it is recommended that each item entry be separated by means of continuous thick or thin lines (type **A** or **B**) (see Table **3**).

3.9.12 The sequence of the entries shall follow that of the item references. When the item list is included on the drawing, the sequence shall be from bottom to top, with headings of the columns immediately underneath. With separate item list, the sequence shall be from top to bottom, with headings at the top.

3.9.13 The entries may be executed by means of free-hand lettering, stenciling, or any other appropriate means, preferably using capital letters as specified in **7.**

3.10 Drawing list

A drawing list is a list of drawings associated with an assembly.

4 DRAWING SHEETS

4.1 Sizes

It is recommended that **ISO A** series drawing sheet sizes be used as specified in **SLS 433.** Sizes of these sheets are given in Table **1.** Sizes larger than A0 should be exceptional.

TABLE 1 - Recommended drawing sheet sizes (trimmed)

Designation (1)	Size mm (2)	Minimum border width from drawing frame to edge of sheet mm (3)
A0	841 x 1189	20
A1	594 x 841	20
A2	420 x 594	10
A3	297 x 420	10
A4	210 x 297	10

4.2 Formats

4.2.1 *General*

Drawing sheets have two formats.

a) Landscape : intended to be viewed with the longer side of the drawing sheet horizontal, (see Figure **1a**).
b) Portrait : intended to be viewed with the longer side of the drawing sheet vertical (see Figure **1b**).

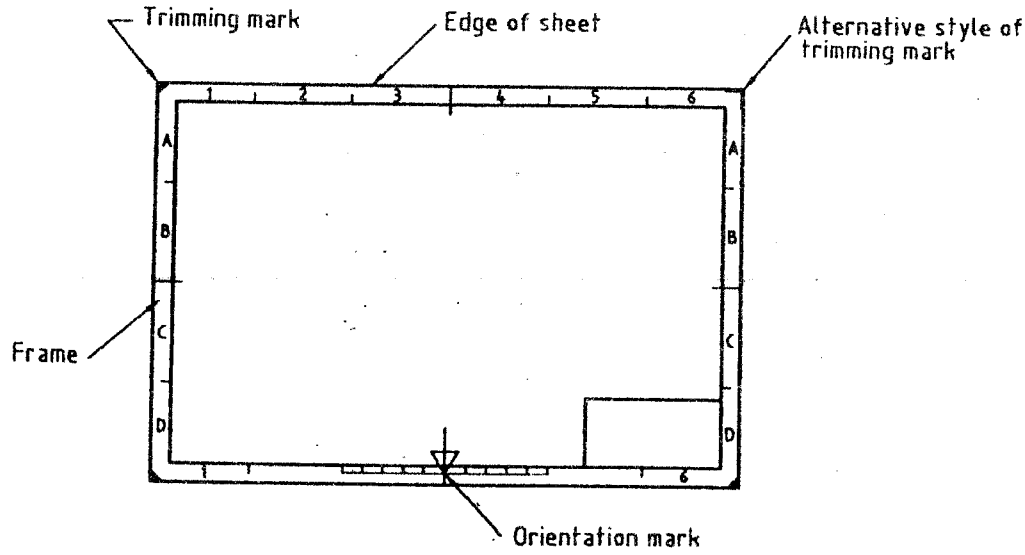
4.2.2 *Borders and frames*

4.2.2.1 General

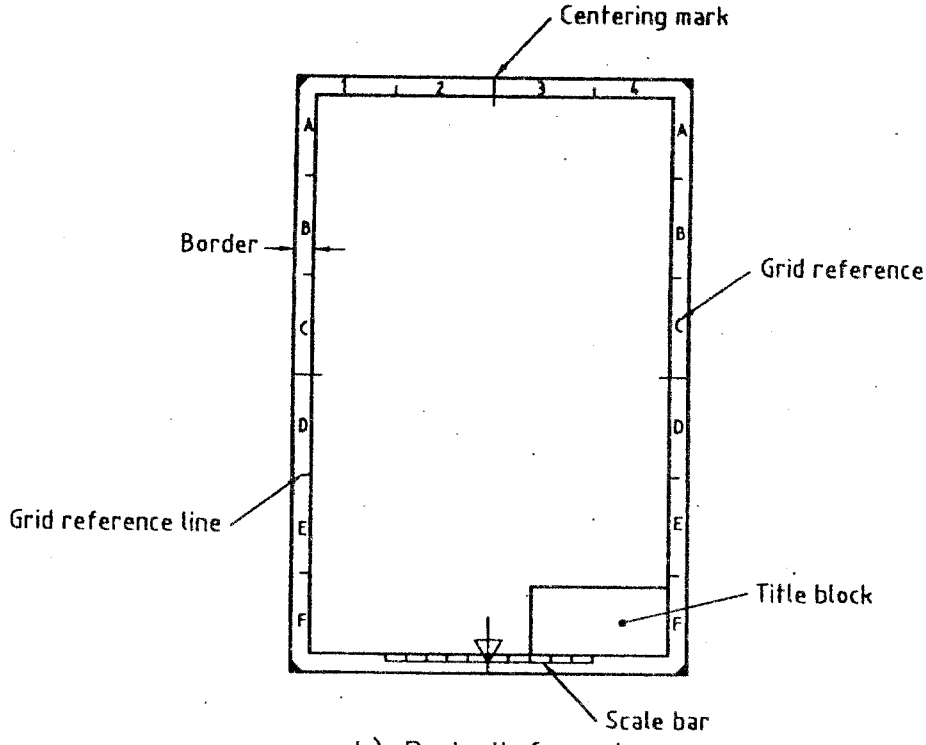
It is recommended that all sheets should include a frame to enclose the drawing area together with the title block and other standard information. The frame should be symmetrical with the edges of the sheet. The minimum widths of the borders are shown in Table **1**. In the majority of cases the values shown are sufficiently large to allow for gripping during printing. The frame could accommodate such marks as are necessary for reduced-size reproduction techniques.

4.2.2.2 Frame lining

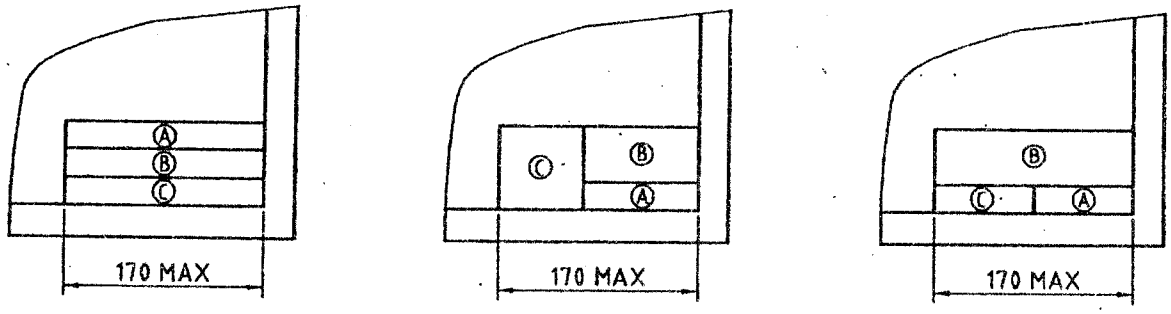
Lines forming the frame should be continuous thick (type A) (see Table **3**) and of a minimum thickness of 0.5 mm.



a) Landscape format



b) Portrait format



c) d) e)

FIGURE 1 - Drawing sheets showing frame, title and other markings

4.2.2.3 Grid system or zoning

The provision of a grid reference system is recommended, where necessary, in order to permit easy location on the drawing of details, changes, etc.

The number of divisions should be divisible by two and be chosen in relation to the complexity of the drawing. It is recommended that the length of any side of the rectangles comprising the grid should not be less than 25 mm and not more than 75 mm.

The grid reference system lines should be drawn as short lines of 0.5 mm minimum thickness (see Figure 1).

The rectangles of the grid should be referenced by means of capital letters down the vertical edges beginning at he top and numerals along the horizontal edges beginning at the left-hand side of the sheet. The references may be repeated on the opposite sides.

The letters and numerals should be placed in the borders, close to the frame at a minimum distance of 5 mm from the edges of the trimmed sheet, and should be written in upright characters (see Figure 1).

4.2.2.4 Centering marks

Centering marks should be provided to facilitate positioning of the drawing for reproduction processes. They should extend from the edges of the sheet to the frame and beyond by approximately 5 mm (see Figure 1).

4.2.2.5 Orientation marks

An orientation marks may be provided in the form of a triangular arrowhead located on that centering mark adjacent to and pointing towards the intended position of the drawing user (see Figure 1).

4.2.2.6 Print folding marks

Folding marks, where required, may be indicated according to the method of folding employed.

4.2.2.7 Scale bar

The scale bar should be figure-less, have a minimum length of 100 mm and be divided into 10 mm intervals. It should preferably be located symmetrically about a centering mark, near the frame and in the border. It should have a maximum width of 5 mm and the continuous strokes should be of 0.5 mm maximum thickness. The scale bar is recommended for drawings which are intended to be reproduced at a different scale.

4.2.3 *Title block*

The title block is the area of the drawing sheet which contains the information required for the identification, administration and interpretation of the drawing. Any technical drawing and associated documents shall be provided with a title block.

It applies to all fields of engineering (mechanical, electrical, civil etc.). It facilitates exchanges of documents and ensure compatibility between them. This does not preclude additional or more detailed instructions being prescribed in particular standards in certain specific fields.

Title block should preferably be placed in the lower right hand corner of the drawing frame (see Figure 1).

The title block should preferably consist of one or more adjoining rectangles. These may be sub-divided into boxes for the insertion of specific information (see Figures 1c, d, and e).

4.2.4 *Basic information*

To achieve uniformity of arrangement, the information required for inclusion within the title block shall be grouped into adjoining rectangular zones as follows :

a) The identification zone ; and
b) One or more zones for additional information.

4.2.4.1 Supplementary information

The identification zone shall give the following basic information :

a) Registration or identification number ;
b) Title of the drawing ; and
c) Name of the legal owner of the drawing.

The identification zone shall be positioned in the right-hand bottom corner of the title block, seen in its correct viewing direction. It shall be made conspicuous by framing with continuous lines of the same thickness as those used for the frame of the drawing space.

Examples of the arrangements of the basic items **a, b** and **c** are shown in Figures **1 c, d** and **e** as **A, B** and **C** respectively.

Items **A, B** and **C** are mandatory.

4.2.4.2 The registration or identification number of the drawing as determined by the owner, shall be placed in the right-hand bottom corner of the identification zone.

4.2.4.3 The title of the drawing shall describe the contents of the drawing functionally (for example, designation of the article or assembly depicted).

4.2.4.4 The name of the legal owner of the drawing (firm, company, enterprise, etc.) may be the official owner's name, an abridged trade name or an emblem.

4.2.5 It is recommended that provision be made for basic information such as the following :

a) Date of drawing ;
b) Signature(s),e.g. drawn by, authorized by ;
c) Original scale ;
d) Copyright clause ;
e) Projection symbol ;
f) Reference to standards and/or related specifications ; and
g) Issue information.

4.2.6 The following list gives additional or supplementary information which should be considered for inclusion in the drawing format. The list is not necessarily comprehensive.

a) Material and specification ;
b) Treatment/hardness ;
c) Finish ;
d) Surface texture ;
e) General tolerances ;
f) Key to geometrical tolerancing ;
g) Screw thread forms ;
h) Sheet size ;
j) First used on ;
k) Similar to ;
l) Equivalent part ;
m) Supersedes ;
n) Superseded by ;
o) Tool references;
p) Gauge references ; and
q) Warning notes, e.g. 'Do not scale'.

5 SCALE

5.1 Scale

The scale is the ratio of the linear dimension of an element of an object, as represented in the original drawing, to the real linear dimension of the same element of the object itself.

5.2 Full size

A scale with ratio of 1 : 1

5.3 Enlargement scale

An enlargement scale is a scale where the ratio is larger than 1 : 1. It is said to be larger as its ratio increases.

5.4 Reduction scale

A reduction sale is a scale where the ratio is smaller than 1 : 1. It is said to be smaller as its ratio decreases.

5.5 Designation

The complete designation of a scale shall consist of the word "SCALE" (or its equivalent in the language used on the drawing) followed by the indication of its ratio, as follows;

a) SCALE 1 : 1 for full size ;
b) SCALE x : 1 for enlargement scales ; and
c) SCALE 1 : x for reduction scales.

5.6 Designation of multiple scale

Where it is necessary to use more than one scale on a drawing, each scale has to be clearly identified.

Where a drawing is drawn substantially to one main scale and only subsidiary views are drawn to other scales then that main scale only is entered against "MAIN SCALE".

5.7 Recommended scales

Recommended scales should be as specified in Table 2.

TABLE 2 - Recommended scales

Category	Recommended scales
Enlargement scales	50:1 20:1 10:1 5:1 2:1
Full size	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

If for special applications, a larger or a smaller scale is needed than those recommended, the range must be extended either direction, provided that the new scale is derived from a recommended scale by multiplying the numerator or denominator by an integral power of 10. In exceptional cases where for functional reasons the recommended scales cannot be applied, intermediate scales may be chosen.

6 LINES

6.1 Presentation

6.1.1 All lines should be black and dense. It is important that all the lines on a drawing, including those added in any revisions, should be of consistent density and reflectance.

The lines on any one drawing sheet should preferably be entirely in pencil or in ink. If a mixture of pencil and ink is used, every effort should be made to ensure that uniform density and reflectance are maintained.

6.1.2 The clear space between lines should be not less than 0.7 mm.

6.2 Thickness

The thickness of lines should be chosen according to the size and the type of the drawing from the following range :

0.18, 0.25, 0.35, 0.5, 0.7, 1, 1.4 and 2 mm*

For all views of one object to the same scale, the thickness of the lines should be the same.

* Owing to difficulties in certain methods of reproduction, the line thickness of 0.18 should be avoided.

6.3 Types of line and their application

6.3.1 *General*

Only those types of line shown in Table 3 should be used. Examples of their application are shown in Figure 2.

6.3.2 *Dashed lines*

Dashed line should comprise dashes of consistent length and spacing, approximately to the proportion shown in Table 3. They should start and end with dashes in contact with the hidden or visible lines from which they originate, except when the hidden line continues as a visible line. Dashed lines should also meet with dashes at tangent point and corners.

6.3.3 *Chain lines*

Chain lines should comprise alternate long and short dashes, of consistent length and spacing. They should start and end with a long dash. Where angles are formed in chain lines, long dashes should meet at corners. Where chain lines meet arcs they should join at the tangent point with a long dash.

Centre lines should extend only a short distance beyond the feature unless required for dimensioning or other purposes. In general they should not extend through the spaces between views, except when clarity would be enhanced. They should not terminate at another line of the drawing.

Where center lines define points or angles they should cross one another at long dash portions of the line.

TABLE 3 Types of line

Line (1)	Description (2)	General application (3)
A ———	Continuous thick	A1 Visible outlines A2 Visible edges
B ———	Continuous thin	B1 Imaginary lines of intersection B2 Dimension lines B3 Projection lines B4 Leader lines B5 Hatching B6 Outlines of revolved sections in place B7 Short centre lines
C ~~~	Continuous thin irregular	* C1 Limits of partial or interrupted views and sections,if the limit is not an axis
D —/\/\/\—	Continuous thin straight with zigzags	** D1 Limits of partial or interrupted views and sections,if the limit is not an axis.
E – – – –	Dashed thick	E1 Hidden outlines E2 hidden edges
F – – – –	Dashed thin ***	F1 Hidden outlines F2 Hidden edges
G ——— - ———	Chain thin	G1 Centre lines G2 Lines of symmetry G3 Trajectories and loci G4 Pitch lines (including circles)
H	Chain thin,thick at ends and changes of direction	H1 Cutting planes
J ——— - ———	Chain thick	J1 Indication of lines or surfaces to which a special requirement applies (drawn adjecent to surface)
K ——— - - ———	Chain thin double dashed	K1 Outlines and edges to adjacent parts K2 Outlines and edges of alternative and extreme positions of movable parts K3 Centroidal lines K4 Initial outlines prior to forming # K5 Parts situated in front of a cutting plane K6 Bend lines on develop blanks or patterns

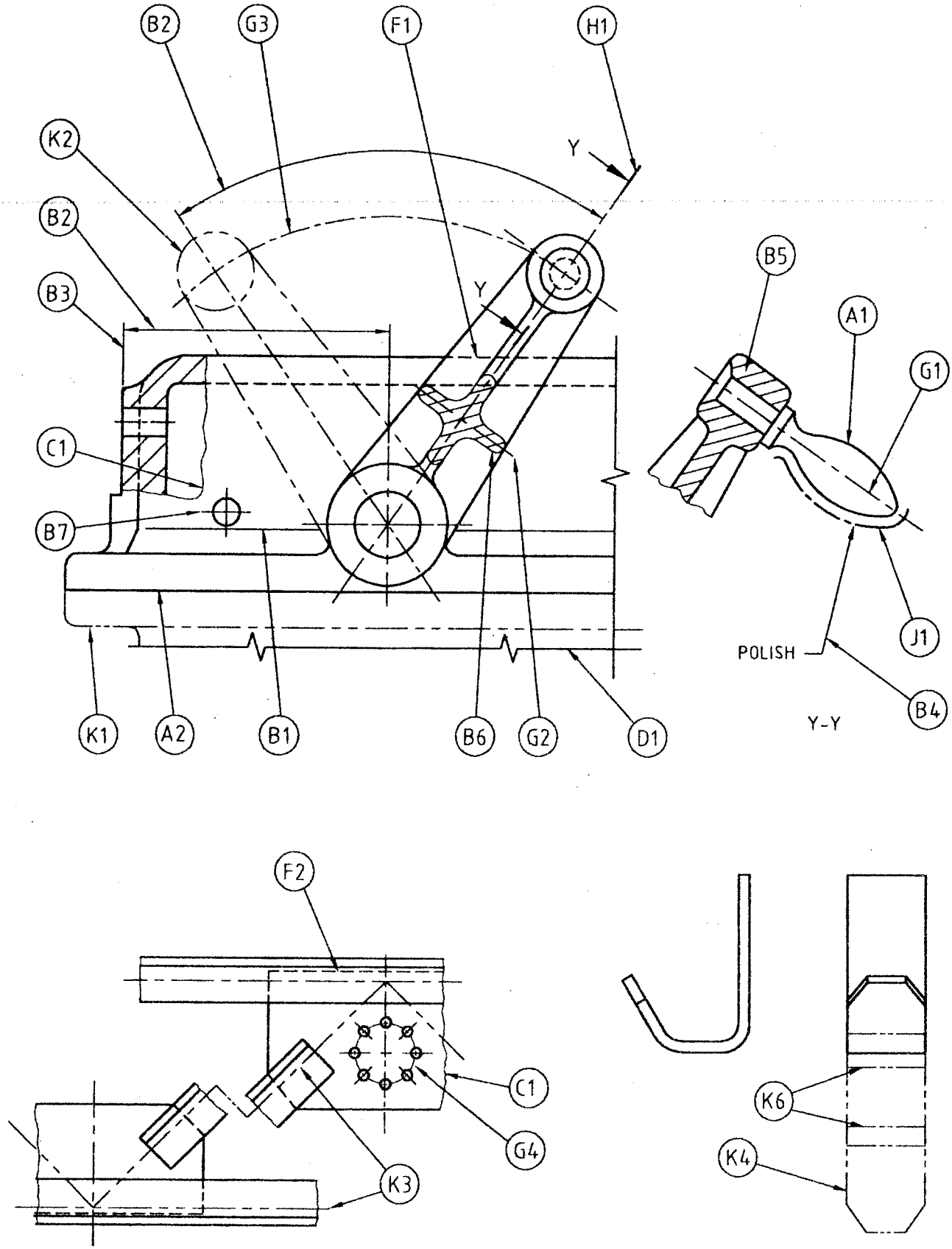
NOTE : *The lengths of the long dashes shown for lines G H J and K are not necessary typical due to the confines of the space available.*

* See also 9.7 and 10.7

** Note that in use it extends a short distance beyond the outline this type of line is suited for production of drawing for machines.

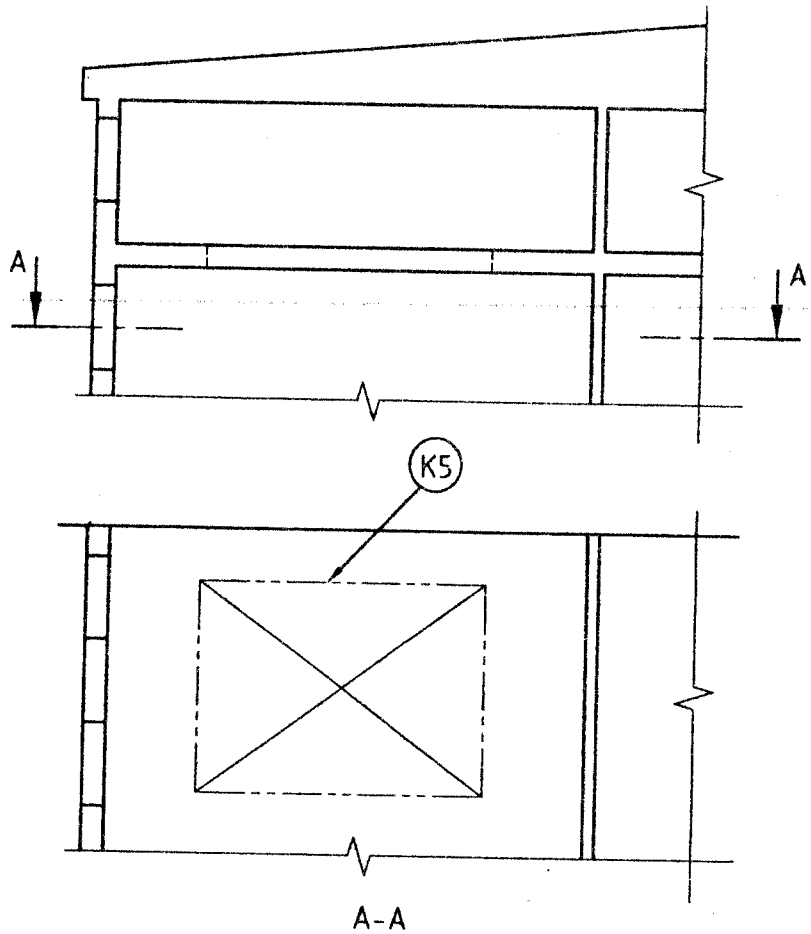
*** This F type line is more common in the UK but on any one drawing or set of drawing only one type of dashed line should be used.

\# Included in ISO 128:1982 and used mainly in the building industry.



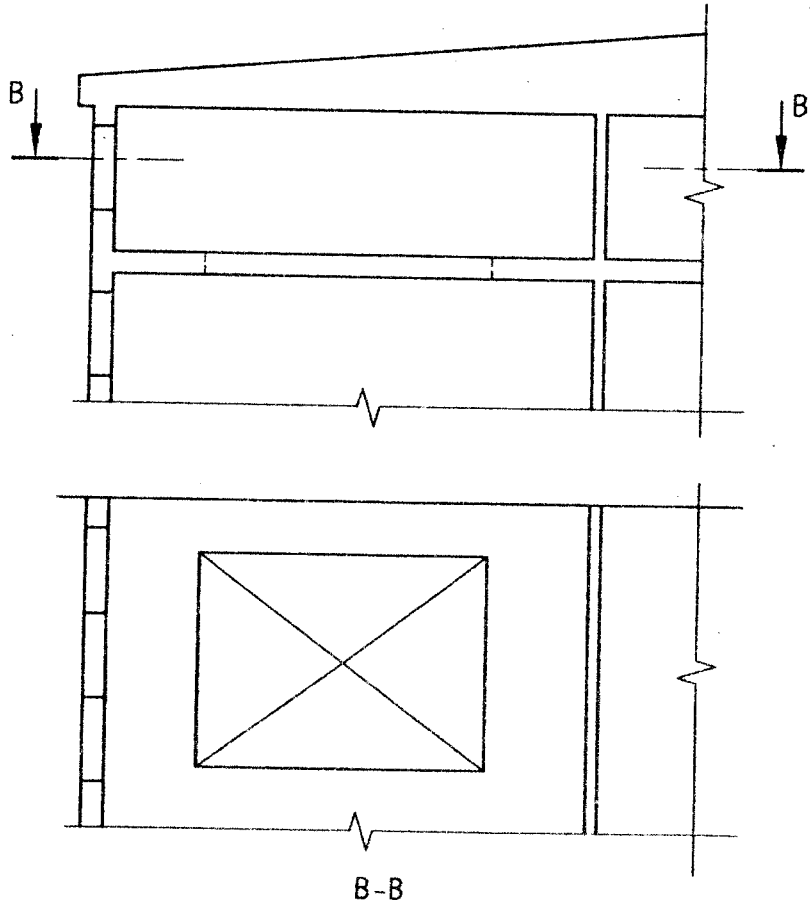
(a)

FIGURE 2 - Applications of the various types of line



A-A

FIGURE 2 - Concluded



B-B

FIGURE 2 - Concluded

6.3.4 *Coinciding lines*

When two or more lines of different type coincide, the following order of priority should be observed (see Figure 3 and Table 3):

a) Visible outlines and edges (continuous thick line, type **A**);

b) Hidden outlines and edges (dashed line type **E** or **F**);

c) Cutting planes (chain thin line, thick at ends and changes of cutting planes, type **H**) ;

d) Centre lines and lines of symmetry (chain thin line, type **G**) ;

e) Centroidal lines (chain thin double-dashed line, type **K**) ; and

f) Projection lines (continuous thin line type **B**).

Outlines of adjacent parts in an assembly should coincide, with the exception of thin material in section (see Figure 32).

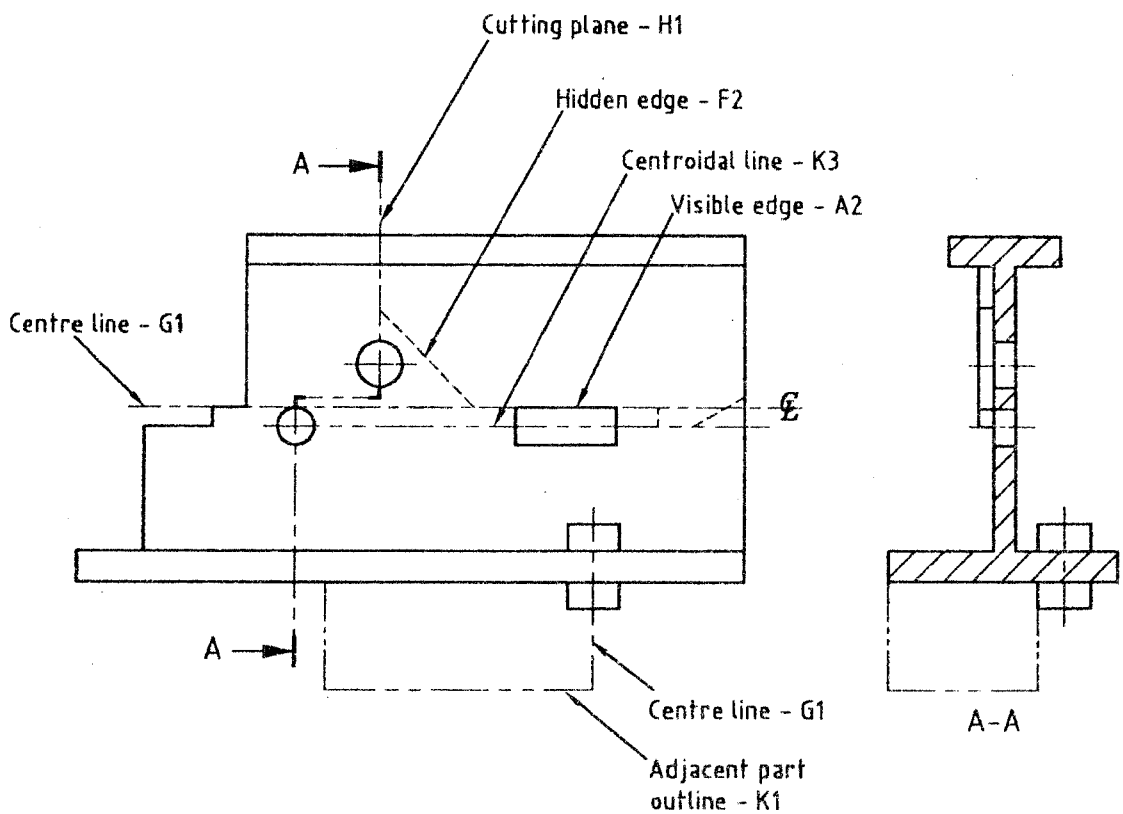


FIGURE 3 - Priorities of coinciding lines

6.3.5 *Leader lines*

A leader line of type **B** shows where dimensions, notes, etc. are intended to apply.

A leader line should terminate

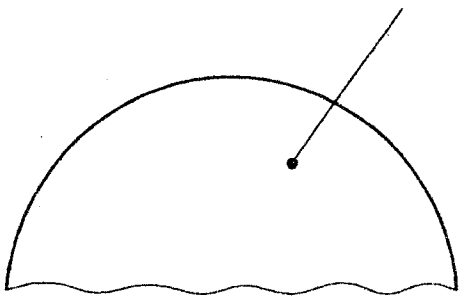
a) with a bold dot, if it ends within the outline of an object (see Figure **4a**) ;

b) with an arrowhead, if it ends on the outline of an object (see Figure **4b** and **6.4**) ;

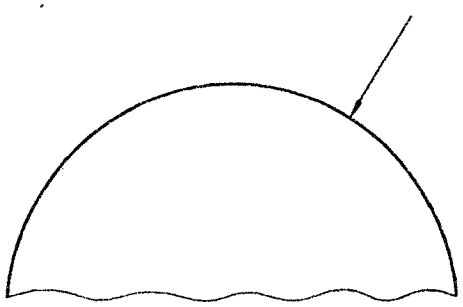
c) without dot or arrowhead if it ends on a dimension line (see Figure **4c).**

The slope of leader lines for notes, item references, etc. should contrast with that of adjacent lines.

The use of long or intersecting leaders should be avoided. Leader lines should not pass through the intersection of other lines.

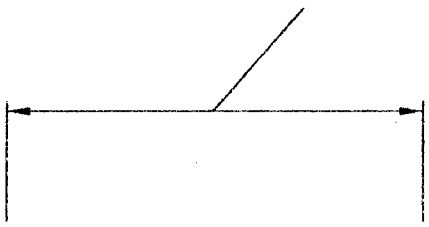


(a)



NOTE :*When an arrowed leader line points to an arc it should align with its centre*

(b)



(c)

FIGURE 4 - Leader lines

6.4 Arrowheads

6.4.1 *General*

Arrowheads should be approximately triangular, formed with straight lines and symmetrically placed about the dimension line, leader line or stem. Arrowheads drawn manually should be filled in.

NOTE : *Arrowheads drawn by machine need not be filled in, in which case they should be drawn with type B lines. Care should be taken that unfilled arrowheads are not confused with the symbol for taper.*

The point of the arrowhead should touch the projection line, outline, cutting plane line or other limiting line (see Figure **4b** and **c**).

6.4.2 *Proportions*

The length of an arrowhead should be approximately three times its width.

6.4.3 *Sizes*

6.4.3.1 Dimension and leader lines.

Arrowheads on dimension and leader lines hold be 3 mm to 5 mm long. (see Figure **4b** and **c**).

6.4.3.2 Arrows showing direction of viewing

The arrowhead should be 7 mm to 10 mm long. The stem of the arrow should be approximately the same but not less than the length of the arrowhead (see the arrows drawn in Figure **3** to show the cutting plane A-A).

7 LETTERING

7.1 General

It is important that characters should be uniform and equally capable of being produced by hand, stencil, machine or other means. The characters on the drawing should remain legible not only in a full size copy but also in the form of a reduced copy or as an image on a microfilm viewing screen.

Clarity, style, size and spacing are important, particularly for figures, as unlike letters they rarely fall into identifiable patterns and have to be read individually. Characters should be open form

and devoid of serifs and other embellishments. All strokes should be black and of consistent density compatible with line work. Care should be taken that sufficient spaces exist between characters and parts of characters to ensure that 'filling in' will not take place during reproduction.

7.2 Style

No particular style or lettering is recommended, the aim should be to produce legible and unambiguous characters. Vertical and sloping characters are both suitable for general use but the presentation should be consistent on any one drawing sheet, i.e. vertical and sloping letters should not be mixed.

Capital letters (upper case) are preferred to lower case as they are less congested and are less likely to be misread when reduced in size. It is recommend that lower case letters be restricted to instances where they form part of a standard symbol, code or abbreviation.

NOTE : *Example in Figure 5, are provided as guide only.*

7.3 Character height and proportions

7.3.1 *Character height*

Table **4** lists the minimum recommended heights for upper case characters.

TABLE 4 - Character height

Application (1)	**Drawing sheet size** (2)	**Minimum character height mm** (3)
Drawing number,etc.	A0, A1, A2 and A3	7
	A4	5
Dimensions and notes	A0	3.5
	A1,A2,A3 and A4	2.5

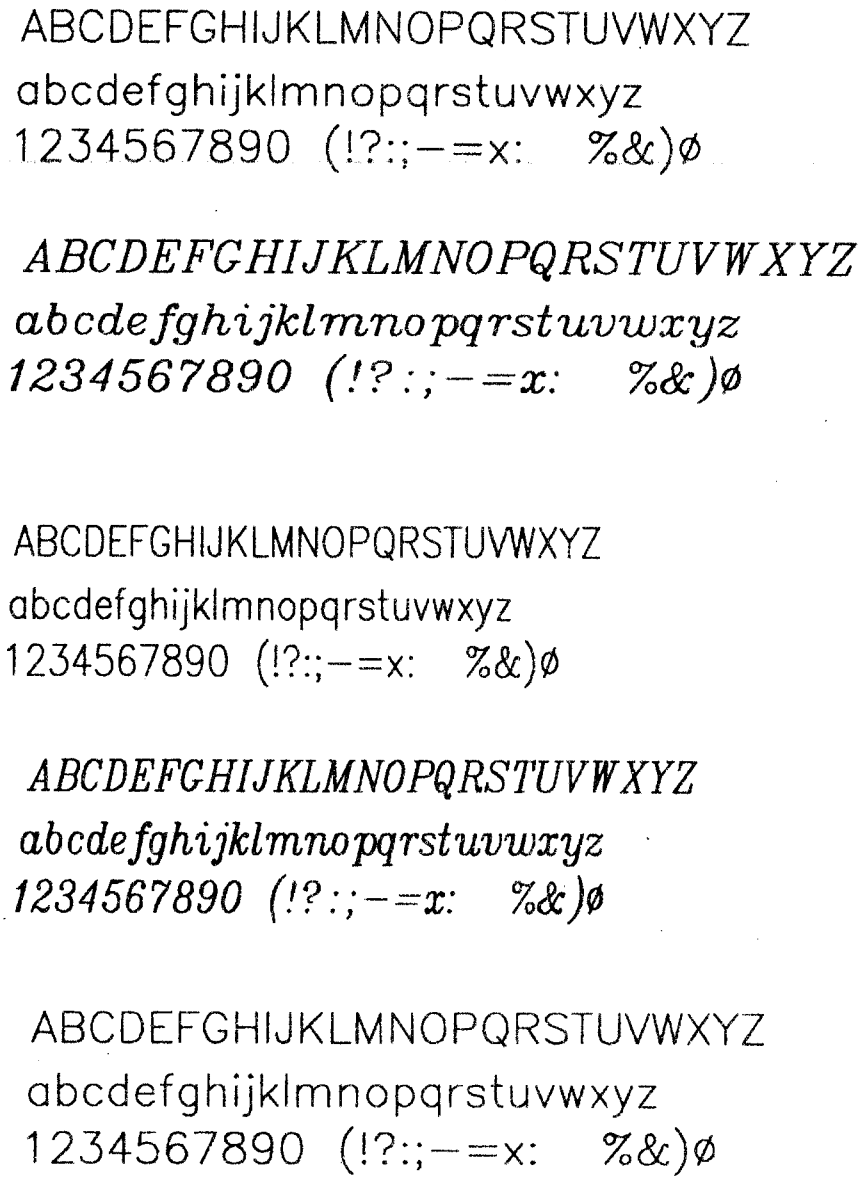


FIGURE 5 - Examples of characters (see note under 7.2)

7.3.2 *Character proportions*

It is stressed that the dimensions given in Table 4 are the minimum heights for upper case characters. When lower case characters are used they should be proportioned so that the body height is approximately 0.6 times the upper case height.

The stroke thickness of the character should be approximately 0.1 times the character height and the clear space between characters and parts of characters should be approximately 0.7 mm for 2.5 mm upper case characters, other sizes being in proportion.

The space between lines of lettering should be not less than half the character height but, in the case of titles, closer spacing may sometimes be unavoidable.

7.4 Orientation of lettering

When a landscape format drawing sheet is used with the title block at the bottom right-hand corner (see Figure **1a**), notes should be lettered parallel to the long side of the sheet. When a landscape format drawing sheet is used in portrait position, the title block should appear at the left-hand side and notes should be lettered perpendicular to the long side of the sheet.

7.5 Location of notes

7.5.1 Notes of a general nature should be grouped together and not spread over the drawing.

7.5.2 Notes of a specific nature should appear near the relevant (specified) feature, but not so near as to crowd the view.

7.6 Underlining

Underlining of notes is not recommended. Where emphasis is required, larger character should be used.

8 PROJECTION

8.1 Systems of projection

Multi-view orthographic is predominantly used in engineering drawings. In this connection the views are designated as follows :

View in direction a = View from the front ;
View in direction b = View from above ;
View in direction c = View from the left ;
View in direction d = View from the right ;
View in direction e = View from below ; and
View in direction f = View from the rear.

The front view (principal view) having been chosen (see **9.3**) the other views should make angles of 90^0 or multiples thereof (see Figure **6**).

There are two systems of projections known as FIRST ANGLE and THIRD ANGLE, both based on a framework of planes at right angles. Both are approved internationally and have equal status.

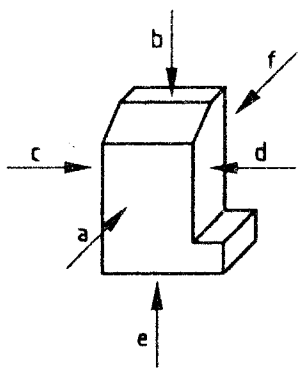


FIGURE 6 - Designation of views

8.1.1 *First angle projection method*

With reference to the front view (a), the other views are arranged as follows (see Figure 7):

The view from above (b), is placed underneath ;
The view from below (e), is placed above ;
The view from the left (c), is placed on the right ;
The view from the right (d), is placed on the left ; and
The view from the rear (f) may be placed on the left, or on the right, as convenient.

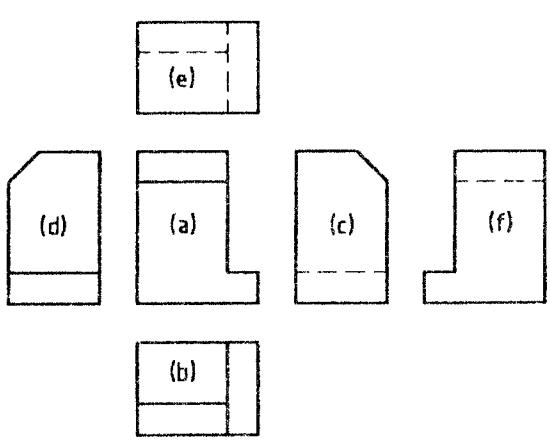


FIGURE 7 - Example of first angle projection

In first angle projection each view shows what would be seen by looking on the far side of an adjacent view (see Figure **8**).

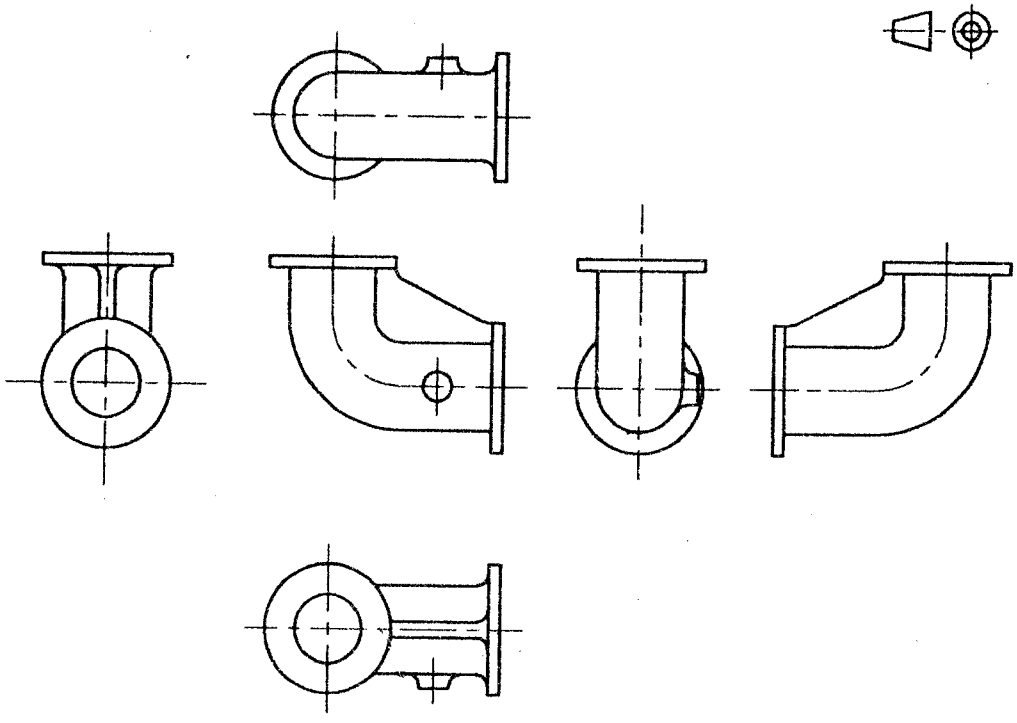


FIGURE 8 - Example of first angle projection

8.1.2 *Third angle projection method*

With reference to the front view (a), the other views are arranged as follows (see Figure **9**):

The view from above (b), is placed above ;
The view from below (e), is placed underneath ;
The view from the left (c), is placed on the left ;
The view from the right (d), is placed on the right ; and
The view from the rear (f) may be placed on the left, or on the right, as convenient.

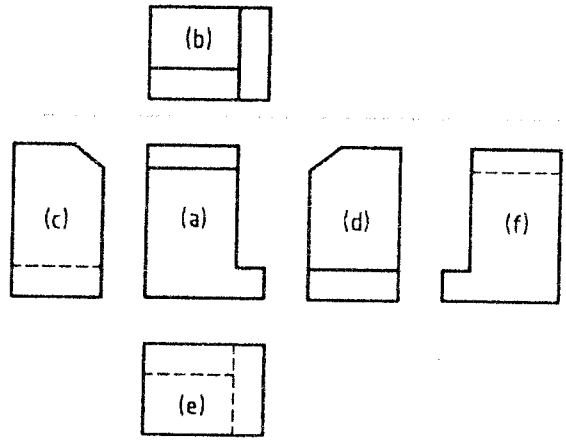


FIGURE - 9 Example of third angle prijection

In the third angle projection each view shows what would be seen by looking on the rear side of an adjacent view (see Figure **10**)

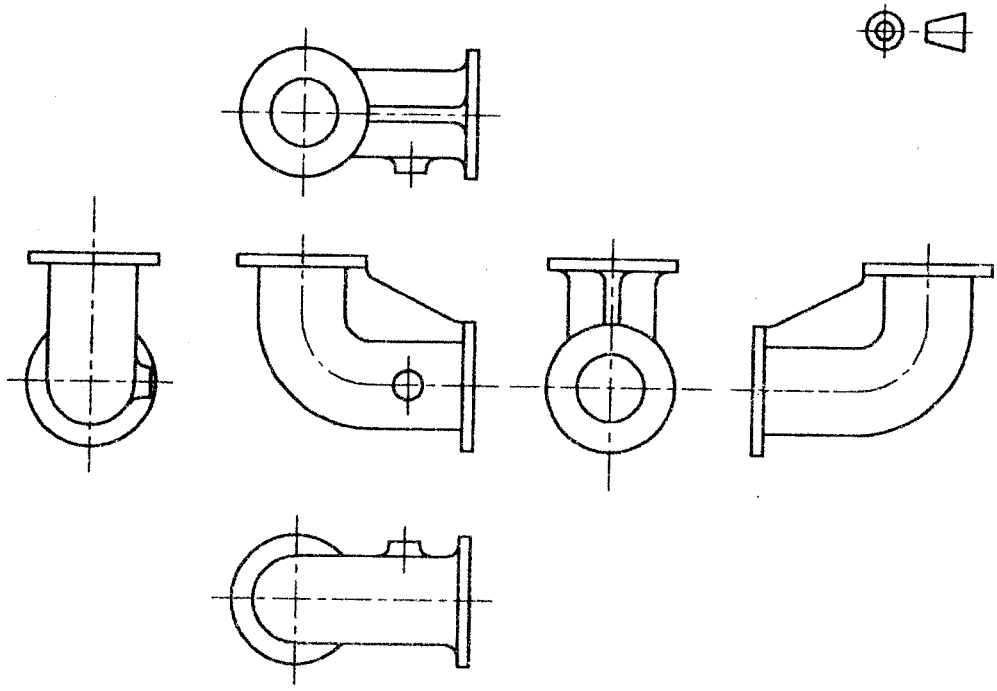


FIGURE 10 - Example of third angle projection

8.1.3 Under exceptional circumstances if the position of a view cannot conveniently conform to the method indicated by the symbol, the direction of viewing should be clearly indicated by an arrow and be referenced (see Fig **11**)

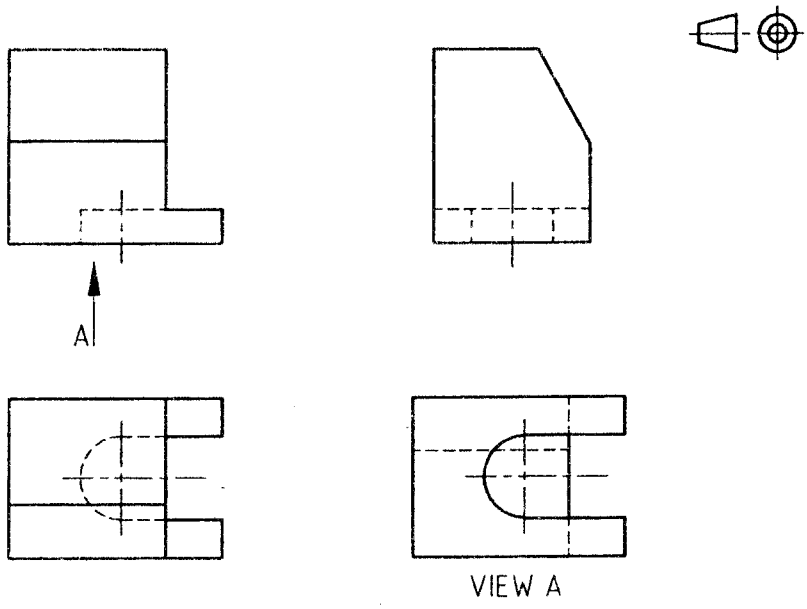


FIGURE 11 - Special arrangement of views

8.1.4 *Indication of method*

The system of projection used on a drawing should be indicated by the appropriate symbol (see Figure **12**).

The symbol should be placed in a space provided for the purpose in the title block of the drawing.

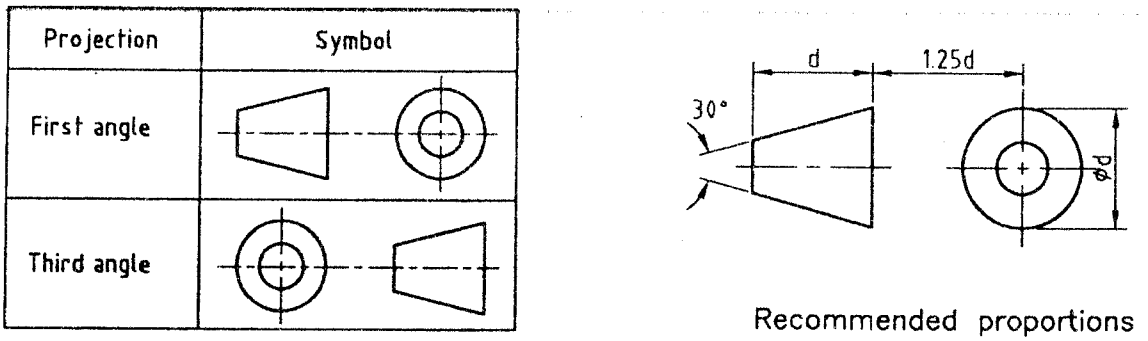


FIGURE 12 - Symbols indicating methods of projection

9 VIEWS

9.1 General

The manner of presentation of engineering drawings may vary considerably depending on the circumstances in which they are used. However, the principle should be to present the information in the most economic manner without impairing clarity or completeness.

When planning the layout of a drawing, due regard should be paid to the spacing of views, including sectional views and sections, to ensure clear reading.

In those cases where it is an advantage to position the views not according to the strict pattern of the first or the third angle projection methods, the use of reference arrows permits the various views to be freely positioned.

With the exception of the principal view, each view shall be identified by a capital letter which is repeated near the arrow needed to indicate the direction of viewing for the relevant view.

The designated views may be located irrespective of the principal view. The capital letters identifying the referenced views shall be placed either immediately below or above the relevant views. In any one drawing the references shall be placed in the same way. No other indication is necessary (see Figure 13)

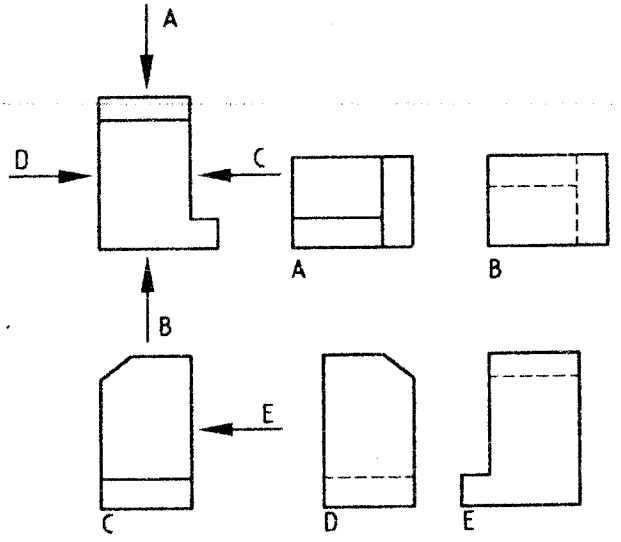


FIGURE 13 - Layout of views

9.2 Number of views

It is necessary before commencing a drawing to have a clear mental picture of the views to be shown. The number of views should be the minimum necessary to ensure that the drawing cannot be misunderstood.

A view which shows no more than a diameter or thickness is unnecessary if this information can be shown by an additional dimension or a note on another view. A view which carries neither dimensions nor note is probably unnecessary.

NOTE : *Figures 7, 8, 9 and 10 show a full complement of the basic projected views. Obviously in practice only a selected minimum are used, depending on the complexity of the subject.*

9.3 Choice of views

The choice of a view should be made to impart the maximum information clearly. Hidden detail lines should be used only where essential but they should not be used for dimensioning.

The most informative view of an object shall be used as the front or principal view. Generally, this view shows the part in the functioning position. Parts which can be used in any position should preferably be drawn in the main position during manufacturing or mounting.

When other views (including sections) are needed, these shall be selected according to the following principles:

a) to limit the number of views and sections to the minimum necessary and sufficient to fully delineate the object without ambiguity ;

b) to avoid the need for hidden outlines and edges ; and

c) to avoid unnecessary repetition of details.

NOTE : *An isometric or similar view of a complex part or assembly may be of considerable value in the understanding of the drawing.*

9.4 Partial views

It is not always necessary to draw a full view. Where partial views give sufficient information they may be used.

The partial views shall be cut off by a continuous thin irregular line (type **C**) or continuous thin straight with zig-zags (type **D**) depending on the size of the cut feature (see Figure **14**). Direction of views should be shown by a capital letter and shall always be positioned normal to the direction of reading.

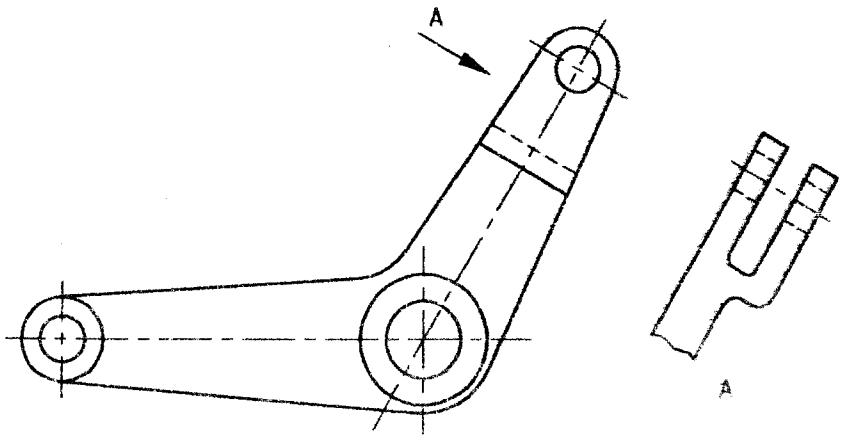


FIGURE 14 - Example of a partial view projected from a full view

9.5 Revolved views

Where the actual shape does not appear clearly due to the projection angle, the actual shape may be indicated by drawing with the part revolved (see Figure **15a**).

Further, where there is a fear of misreading, the line used for revolving shall be retained (see Figure **15b**).

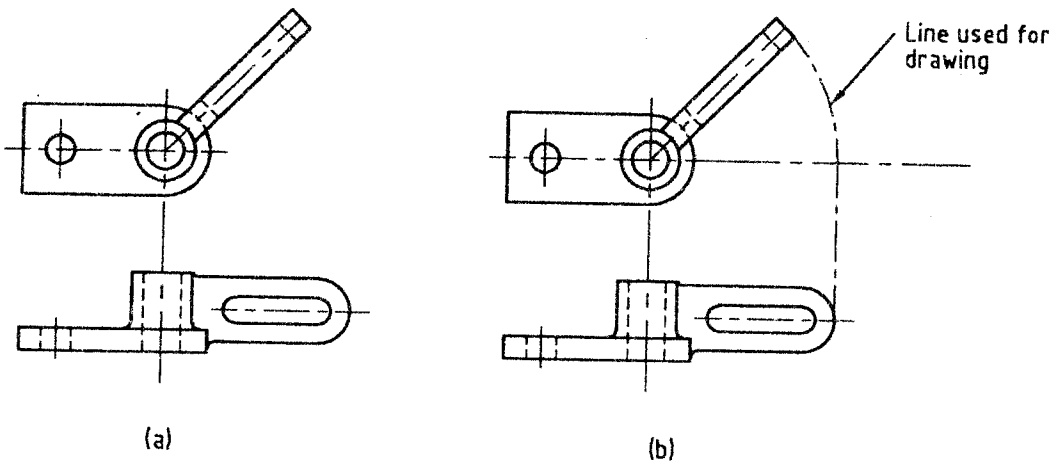
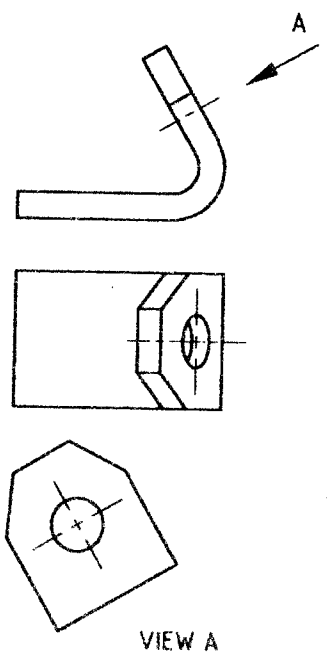


FIGURE 15 - Revolved view

9.6 Auxiliary views

Objects having inclined faces may have such faces projected to show the true shape of the inclined surface (see Figure **16**).

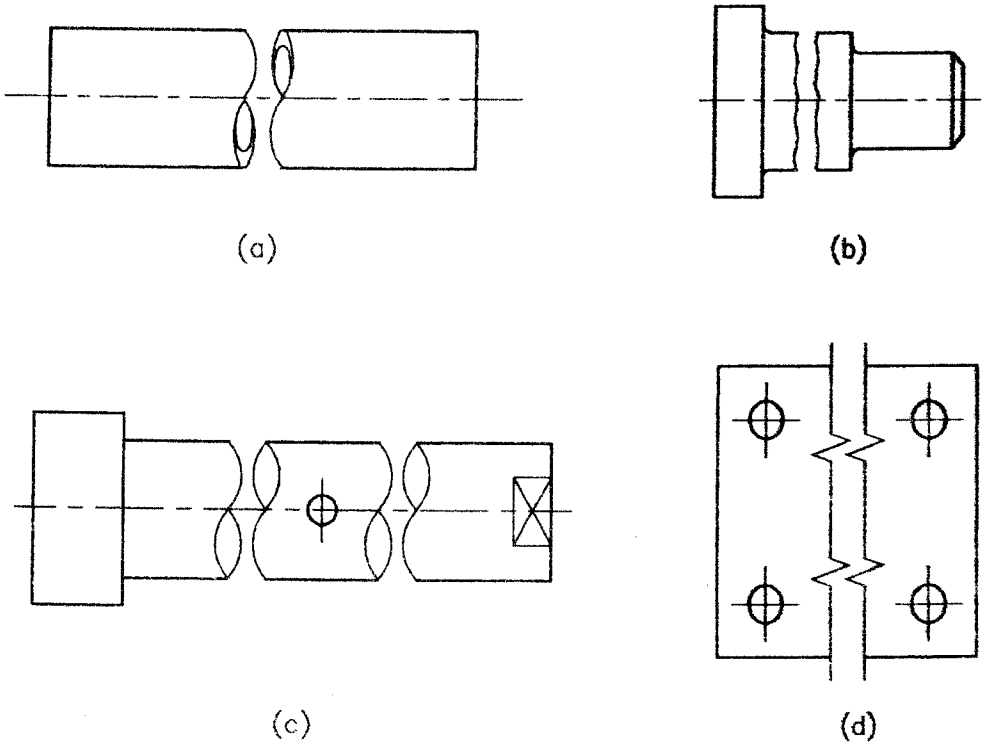


NOTE : *View title and the arrow may be omitted if the meaning is clearwithout them*

FIGURE 16 - Auxiliary view showing true shape of inclined surfaces

9.7 Interrupted views

To save space, only portions of a large or long object which are sufficient for its definition need be shown. The limits of the portions retained are shown conventionally or as for partial views and the retained parts are drawn close to each other (see Figure 17). These methods apply equally to sections.



NOTE:
1 The break line revealine a cylindrical shape is drawn using a type B line.
2 The type D continuous thin (straight) with zigzags continuous a short distance beyond the outline

FIGURE 17 - Methods of indicating an interrupted view

9.8 Enlarged features

In cases where the general scale used for a drawing is so small that details of a particular feature cannot be shown clearly or dimensioned adequately, that feature may be [illegible] or encircled by a continuous thin line (type B) and identified by a capital letter. The feature is then drawn again to stated larger scale accompanied by its identification letter (see Figure 18).

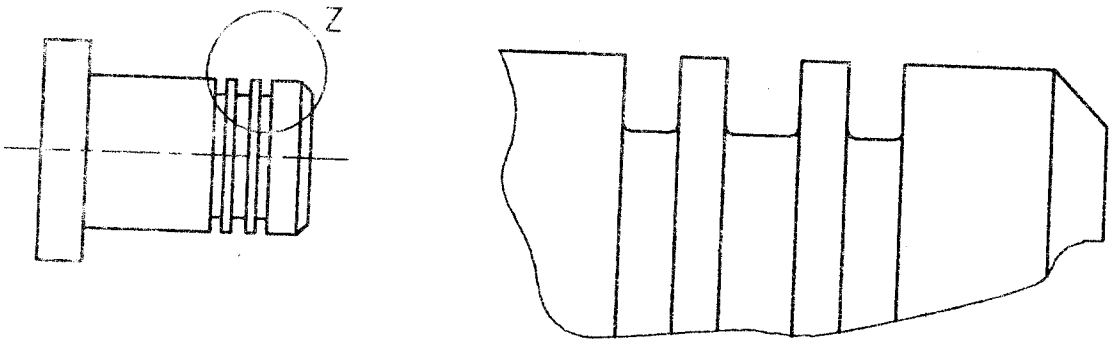


FIGURE 18 - Enlarged features

9.9 Representation of repetitive features

Repeated illustrations of identical features and parts may be avoided by drawing one and indicating the positions of the others by their centre lines (see Figure **19**).

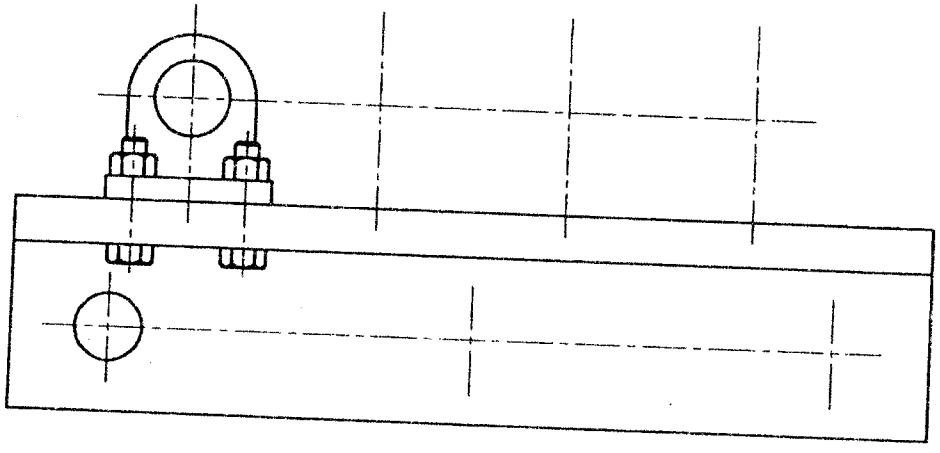


FIGURE 19 - Repeated parts and features

When several holes, bolts, rivets, slots etc. are present in a regular pattern as for example in Figure **20** only the locating centre lines required to establish the pattern need be indicated. The remainder of the information should be given in a note.

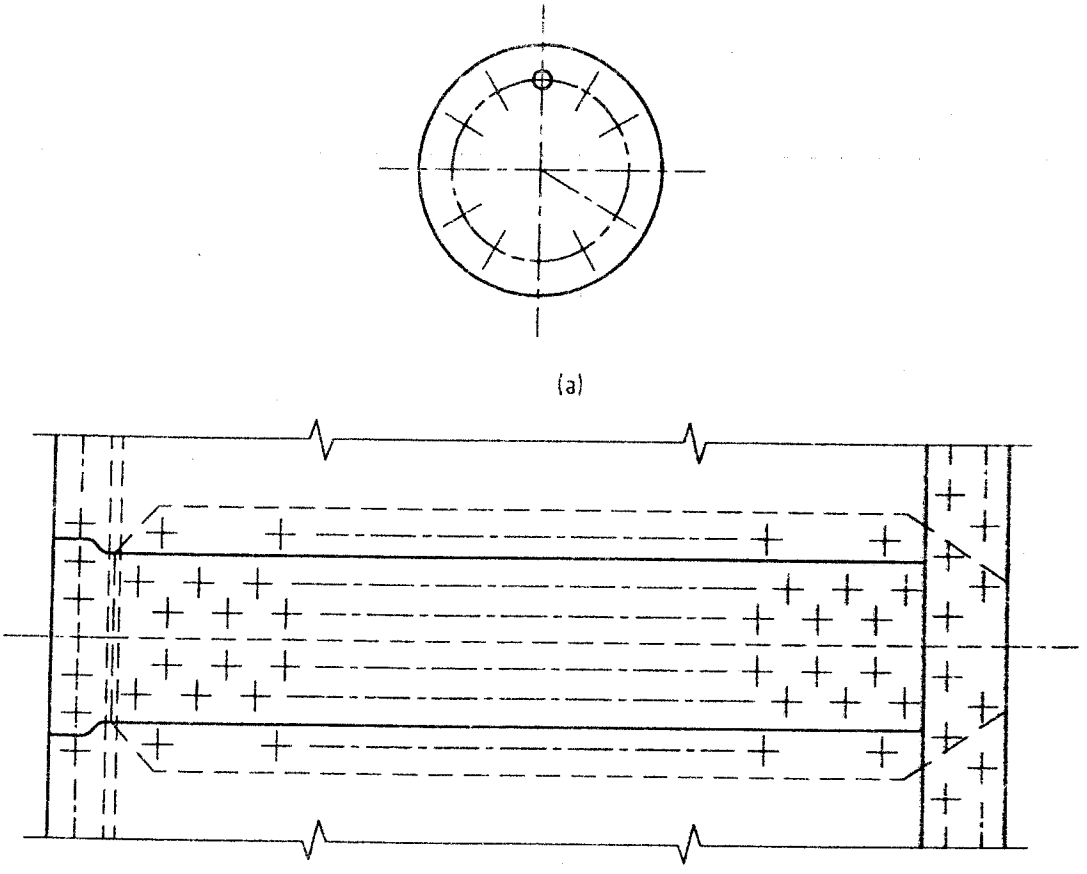


FIGURE 20 - Patterns of repetitive features

When a single feature such as a notch or a keyway is located adjacent to and in relationship with one or more repetitive features, those repetitive features should be shown in full at the location to establish the relationship (see Figure 21).

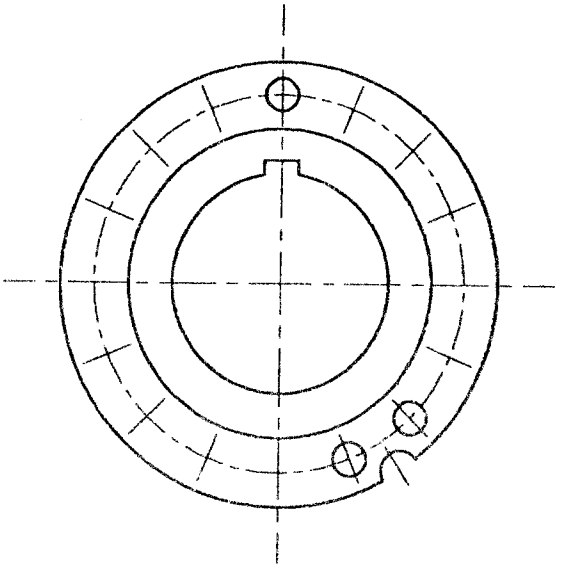


FIGURE 21 - Locating repeated features

The detailing of a small area should suffice for a larger area of a continuous pattern, e.g. knurling, perforated sheet, chequer plate, etc. (see Figure 22).

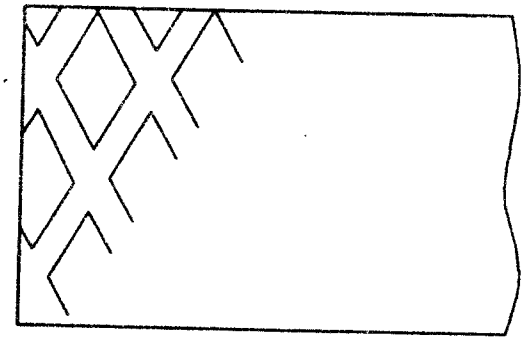


FIGURE 22 - Economy in showing patterns

9.10 Representation of symmetrical parts

To save time and space, symmetrical objects may be drawn as a fraction of the whole (see Figures **23** and **24**)

The lines of symmetry is identified at its ends by two thin short parallel lines drawn at right angles to it (see Figure **23a, 23b** and **23d**).

Another method is to show the lines representing the object extending a little beyond the line of symmetry (see Figure **23c**). In this case, the short parallel lines may be omitted.

If a part is not truly symmetrical the foregoing may still apply with the addition of an adequately extensive partial view or a note identifying the asymmetrical feature(s) (see Figure **24**).

NOTE : *Complete views should be drawn if these forms of representation might lead to misunderstanding.*

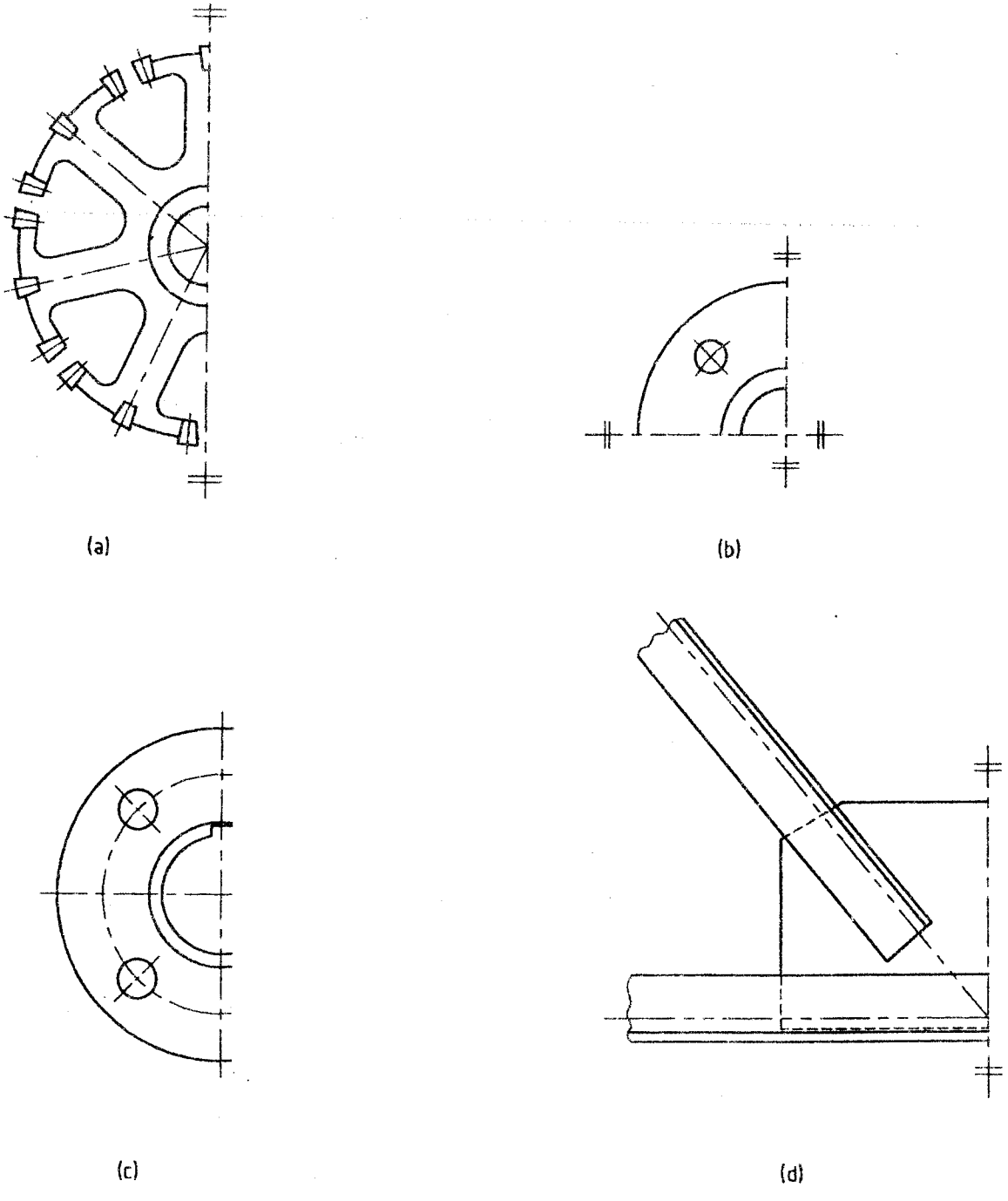


FIGURE 23 - Representation of symmetrical parts

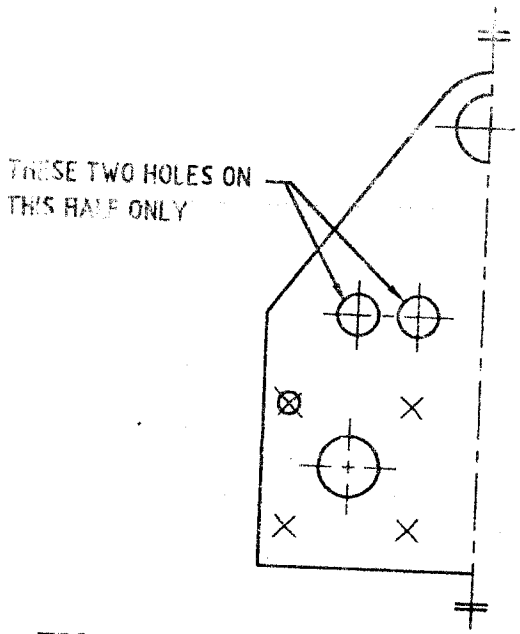


FIGURE 24 - Representation of symmetrical parts with asymmetrical features added

10 SECTIONS AND SECTIONAL VIEWS

10.1 Section or cross section

Generally, a section or cross section is a view or an outline taken at a cutting plane through an object which will be in particular either :

a) Section : an elemental slice, having no substance, taken through an object or part of an object revealing the outline shape solely at the selected cutting plane; or

b) Sectional view : the resultant view at a cutting plane revealing detail not otherwise readily visible, of an object or part of an object including other visible outlines situated beyond that selected cutting plane when seen in the direction of viewing.

10.2 General rules

The rules for the arrangement of views (see **8** and **9**) apply when drawing sections.

Where the location of a single cutting plane is obvious, no indication of its position or identification is required (see Figures **25** and **33**). Where the location is not obvious (see Figure **6**), or where it is necessary to distinguish between several cutting planes (see Figure **43**), the position of the cutting plane(s) are indicated by means of a chain thin, thick at ends and changes of direction line (type **H**). The cutting plane(s) and resulting section(s) are identified by, for example, capital letters, the direction of viewing being indicated by arrows. The identifying character should be close to the stem of the arrow.

The section identification should be placed below the relevant section. The word 'SECTION' should not appear unless it is considered necessary.

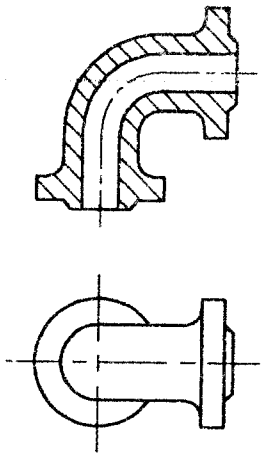


FIGURE 25 - Cutting plane not indicated

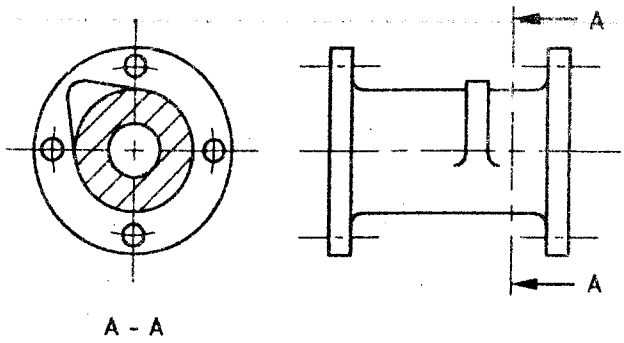


FIGURE 26 - Cutting plane indicated

10.3 Hatching

10.3.1 Hatching is generally used to show sectional areas. The simplest form of hatching is usually adequate for the purpose, and may be based upon continuous thin lines (type **B**) at a convenient angle, preferably 45^0, to the principal outlines or lines of symmetry of the sections (see Figures **2a, 27b** and **c**).

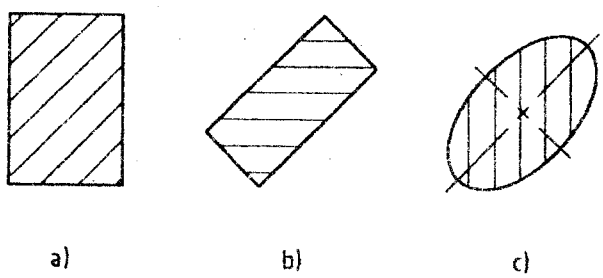


FIGURE 27 - Examples of orientation of hatching

10.3.2 Spacing between the hatching lines should be chosen in proportion to the size of the hatched areas, provided that the requirements for minimum spacing are maintained

The minimum space between parallel lines, including hatching, should never be less than twice the thickness of the heaviest line. It is recommended that these spaces should never be less than 0.7 mm.

NOTE : *Allowance may be made for the methods of reproduction that are to be used*

10.3.3 The separated areas of a section of the same part should be hatched in an identical manner (see Figure **28**). The hatching of adjacent parts should be carried out with different directions or spacing, or a combination of both (see Figure **28b**).

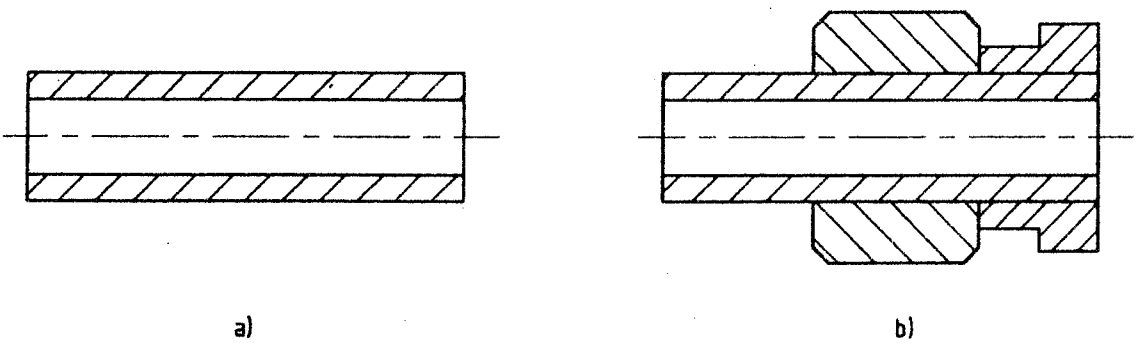


FIGURE 28 - Hatching of separated areas and adjacent parts

10.3.4 The hatching of a large area may be limited to a zone within the outline or to that portion which touches adjacent parts (see Figure **29**).

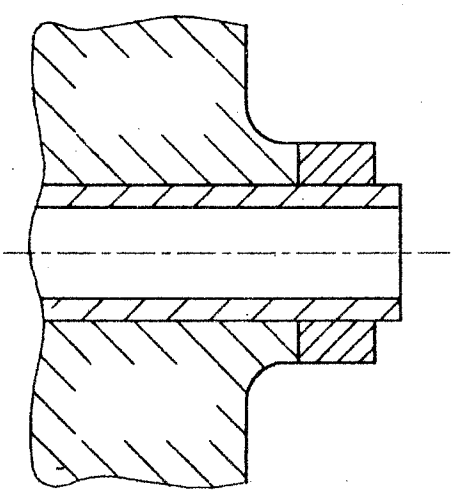


FIGURE 29 - Hatching of large areas

10.3.5 Where sections of the same part in parallel planes are shown side by side, the hatching shall be identical, but may be off-set along the dividing line between the sections if greater clarity is considered necessary (see Figure **30**).

10.3.6 Hatching shall be interrupted when it is not possible to place inscriptions outside the hatched area (see Figure **31**).

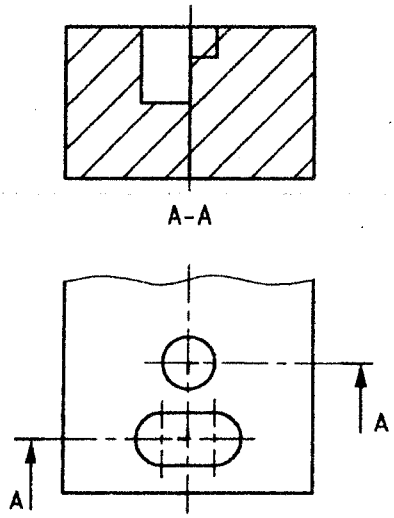


FIGURE 30 - Hatching of parallel planes

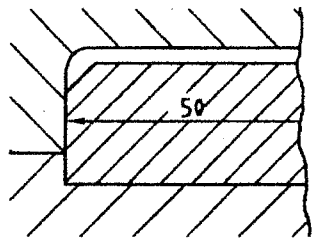


FIGURE 31 - Subordianation of hatching

10.3.7 Hatching may be used to indicate type of materials in sections. If different types of hatching are used to indicate different materials, the meaning of these hatching shall be clearly defined on the drawing or by reference to appropriate standards.

10.4 Thin material in section

Thin material in section may be shown filled in, in preference to showing the material thickness out of scale and hatched. When adjacent parts are thus shown a clear space of not less than 1 mm should be left between them (see Figure **32**).

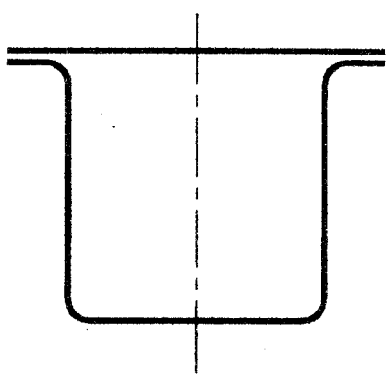


FIGURE 32 - Section through thin material

10.5 Features and parts in longitudinal section

In principle, ribs, webs, spokes of wheel , and the like should not be hatched in longitudinal section (see Figures **33** and **34**).

Fasteners, shafts, and the like should be treated in the same way (see Figure **35**).

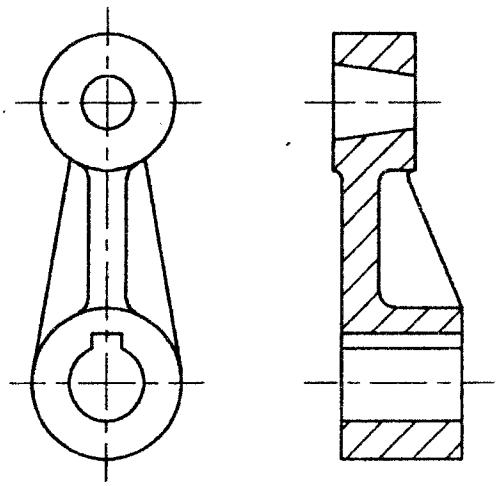


FIGURE 33 - Web in longitudinal section

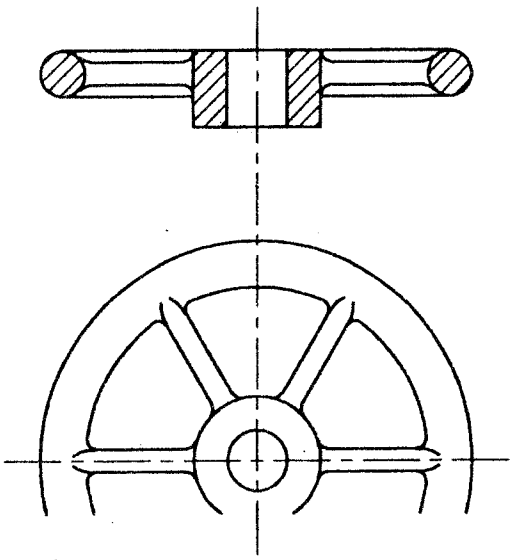


FIGURE 34 - Spokes in longitudinal section

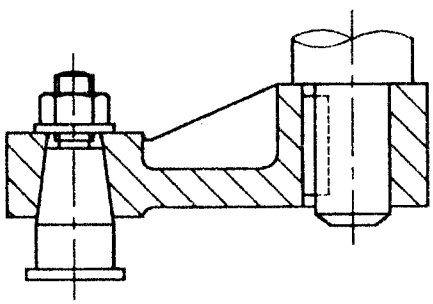
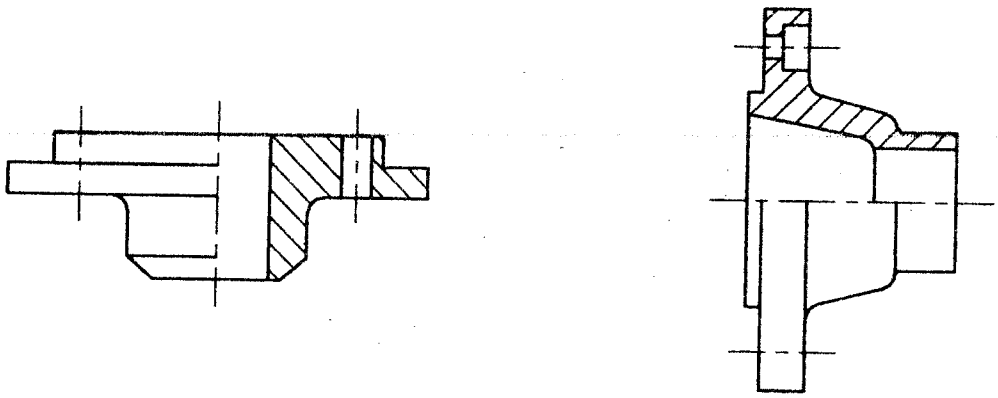


FIGURE 35 - Assembly of pin, lever, and shaft

10.6 Half sections

Symmetrical parts may be drawn half in section and half in full (see Figure **36a**)or bottom half in outside view and top half in section (see Figure **36b**).



(a) (b)

FIGURE 36 - Half section

10.7 Local sections

A local section may be drawn if a complete or a half section is not convenient. The local break can be shown by either a continuous thin irregular line (type **C**) (see Figure **37**) or by continuous thin straight line with zigzags (type **D**) (see Figure **2**).

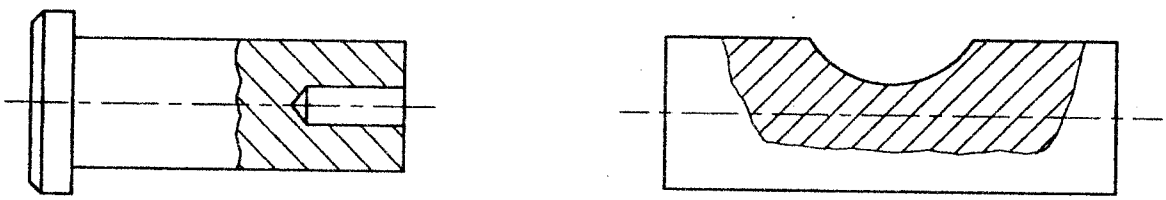


FIGURE 37 - Local section

10.8 Revolved and removed sections

Cross sections may be revolved in the relevant view or removed.

10.8.1 *Revolved sections*

Revolved sections show the shape of a symmetrical cross section on the relevant view of the part, the cutting plane being revolved in position (see Figure **38**). The outline of the section is drawn with a continuous thin straight or curved line (type **B**). If a revolved section cannot be shown or dimensioned clearly it is drawn as a removed section (see **10.8.2**).

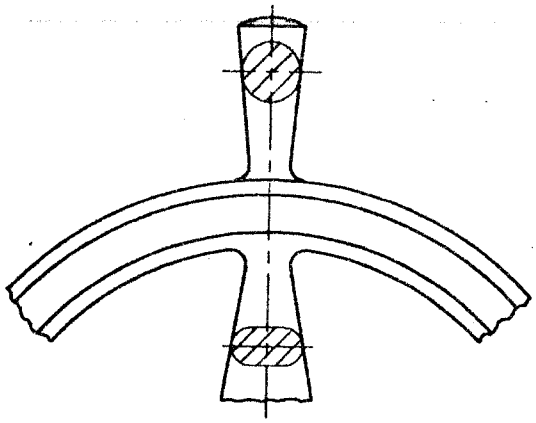


FIGURE 38 - Revolved sections

10.8.2 *Removed sections*

A removed section may be shown in a conventional manner, either in projection or in any convenient place on the drawing (see Figure **39a**), using the identified section plane A-A.

When a removed section is symmetrical it may be placed near the view and connected with it by its line of symmetry using a chain thin line (type G), through the cutting plane as shown in Figure **39a**.

In all cases the outline of the section is drawn with a continuous thick line (type **A**).

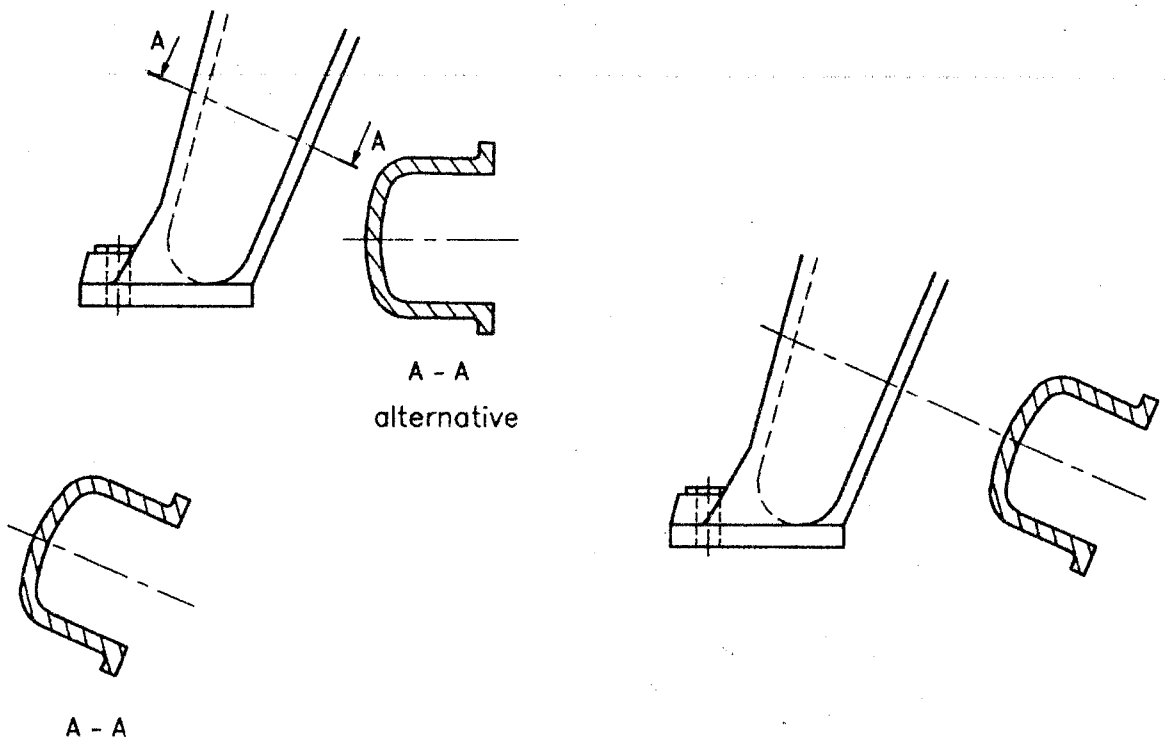


FIGURE 39 - Removed sections

10.9 Successive sections

Successive removed sections should be arranged in sequence as may be convenient for the layout and understanding of the drawing (see Figure **40**). The direction of viewing should be consistent whenever possible.

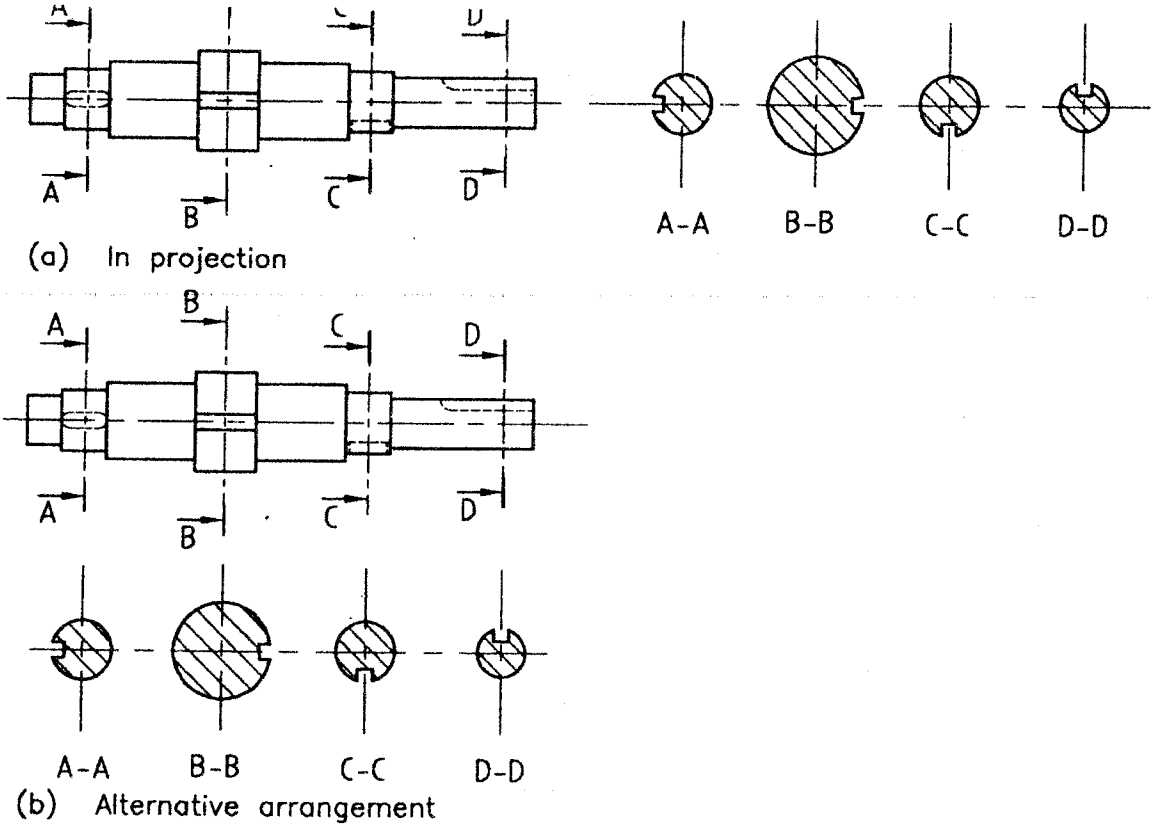


FIGURE 40 - Successive sections

10.9.1 An object having a complex shape may be drawn with several sectional views (see Figure **41**).

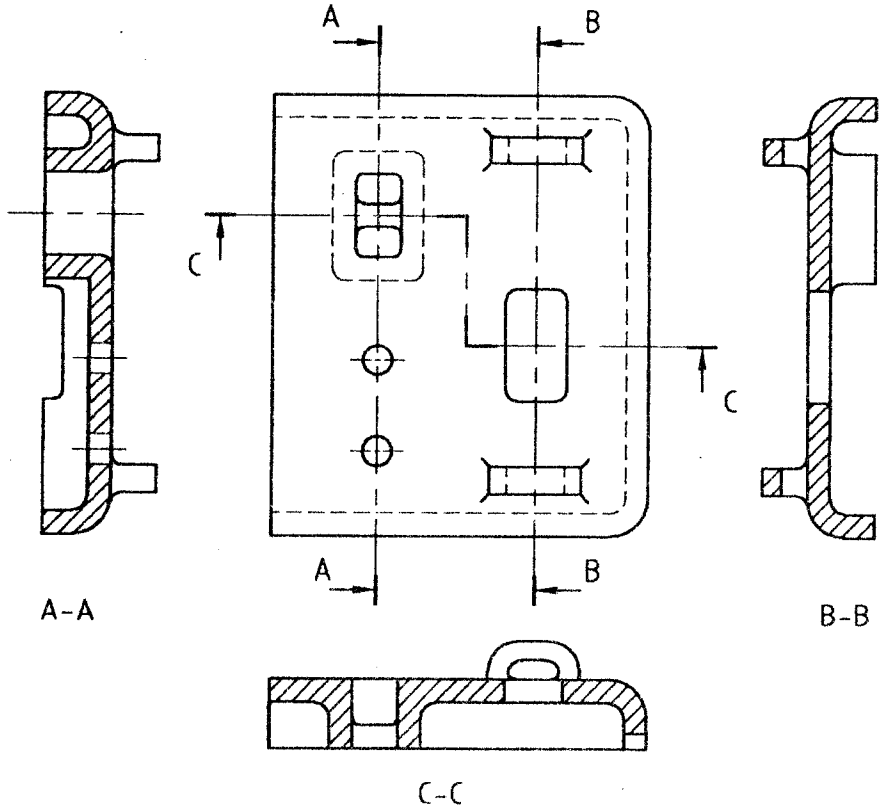
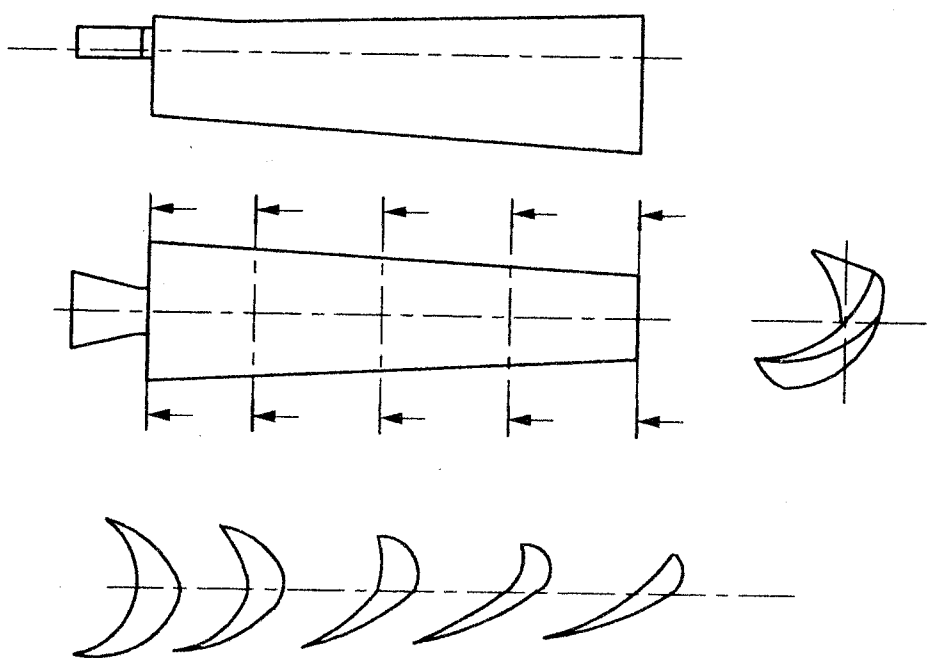


FIGURE 41 - Sections of an object of complex shape

10.9.2 An object whose shape is changing gradually may be represented by several sections (see Figure **42**).



NOTE : *Hatching may be omitted for clarity*

FIGURE 42 - Sections of an object with changing shape

10.10 Section taken in more than one plane

10.10.1 *Sectioning in parallel planes*

An example of a section in two or more parallel planes where the change in section occurs on a centre line is shown in Figure **43a**.

An example where the changes in secretion occur at positions other than on centre lines is shown in Figure **43b.**

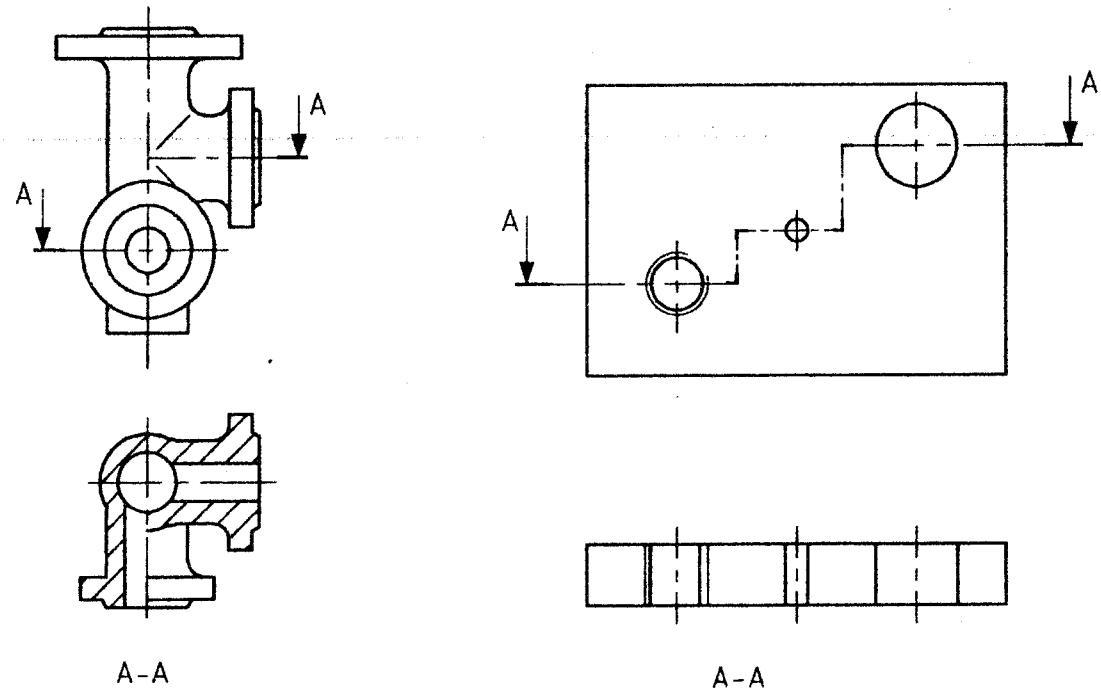


FIGURE 43 - Section in parallel planes

10.10.2 *Sectioning in intersecting planes*

Where a section is taken in two intersecting planes, the section in that plane which is not positioned normal to the intended sectional view is shown by convention moved or revolved around into that primary plane (see Figure **44 a** and **b**).

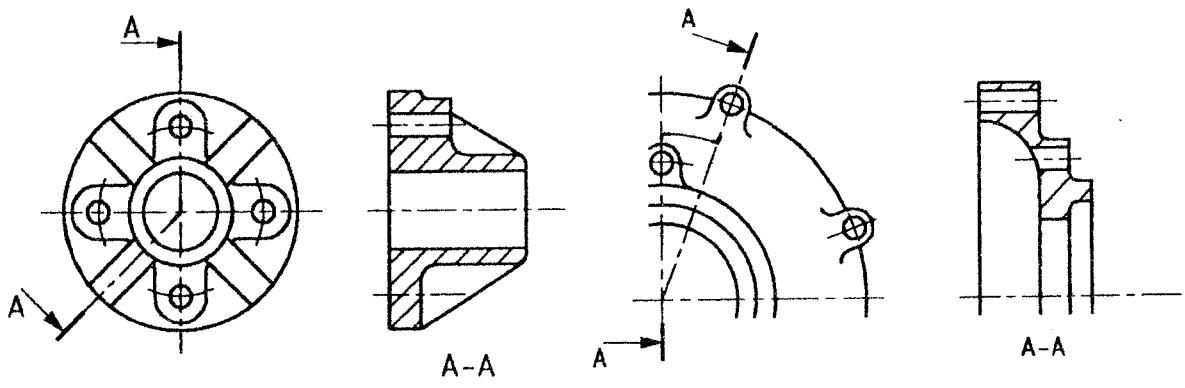
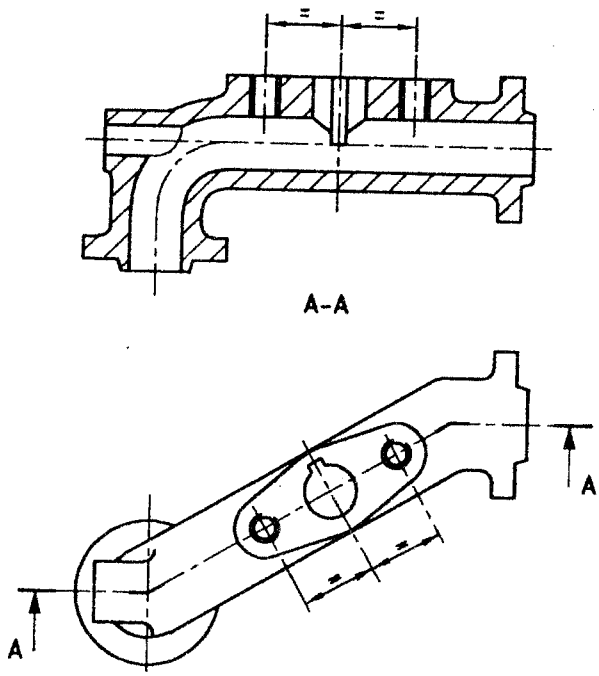


FIGURE 44 - Examples of section in intersecting planes

10.10.3 *Sectioning in contiguous planes*

When a section is to be taken through more than two contiguous planes where the two end planes and the selected plane of projection are parallel, it may be of advantage for the details on the connecting plane(s) to be shown as if viewed normal to the cutting plane (see Figure **45**).



NOTE : *The small boss and hole are shown normal to the cutting plane*

FIGURE 45 - Section in contiguous planes

11 ITEM REFERENCES

11.1 Item references are used on assembly drawings to identify the items (components, parts). All item references are shown in an item list giving the appropriate information on the items concerned.

11.2 Item references should generally be composed of Arabic notation numerals (see Figure **46**). They may be augmented by letters when necessary.

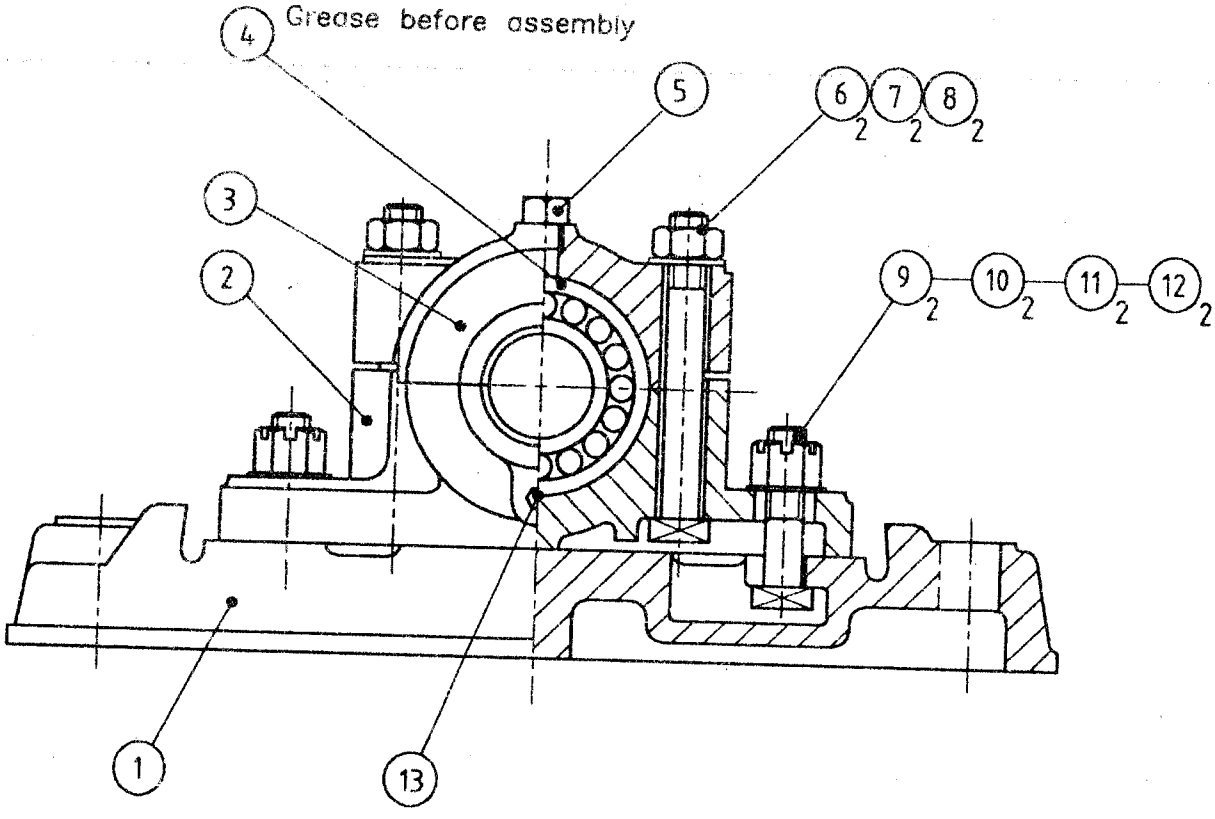


FIGURE 46 - Item references

11.3 All item references on the same drawing shall be of the same type and height of lettering. They must be clearly distinguishable from all other indications. This can be achieved for example by

a) using characters of a larger height, for example twice the height, as used for dimensioning and similar indications;

b) encircling the characters of each item reference (see Figure **47c**); in that case the circles shall have the same diameter and be drawn with continuous thin lines (type B); and

c) combing methods (a) and (b).

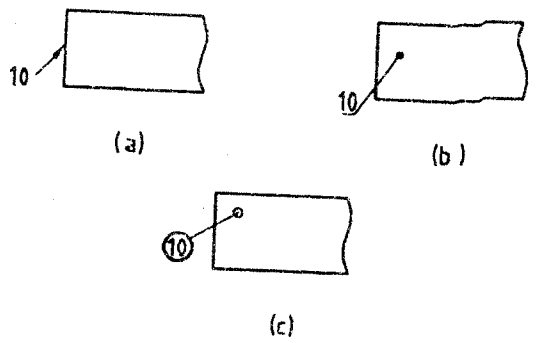


FIGURE 47 - Lettring of item references

11.4 The layout of item references on drawings should be arranged, preferably, in vertical column and/or horizontal rows. They should be connected to the respective itmes by leader lines terminating with dots within the outline of the components.

When this is not possible, arrowheads may be used terminating at the outline.

The references should not be placed so near to the views as to cause a crowding effect. However, leader lines should be no longer than necessary to maintain clarity of presentation. They should not be drawn at right angles to the outlines of the items to which they refer (see Figure 46).

11.5 The leader line may be omitted if the relation between the item reference and its associated item is evident. (see Figure 46 - Item 6 to 8 and 9 to 12)..

Leader lines shall not intersect. They should be kept as short as practicable and generally they should be drawn at an angle to the item reference. In the case of encircled item references, the leader line shall be directed towards the centre of the circle..

11.6 The item references for associated components should be shown against the same leader as the main item reference, (see Figure 46 - Items 6 to 8 and 9 to 12) with the circles either contiguous or connected by a short continuous thin line (type B).

11.7 Item references of identical items need only be shown once, provided that there is no risk of ambiguity.

Subject to clarity, when identical items are used in two or more positions, they need only be referenced once on the drawing, and the number of positions given by the small numerals placed to the right side and slightly below the item reference (see Figure 46 - Item 6 to 8 and 9 to 12). In case of ambiguity an explanatory note may be added to the item reference.

11.8 A distinct sequence for numbering should be adopted

a) according to the possible order of assembly ;

b) according to the importance of the parts (sub-assemblies, major items, minor parts etc.) ; and

c) according to any other logical sequence.

11.9 The item reference for a component may be complemented by any required instruction (see Figure 46- Item 4).

12 SYMBOLS & ABBREVIATIONS

12.1 General

12.1.1 Symbols and abbreviations are used on drawings to conserve space and time and yet to give precise and closer description. Only commonly used and understood symbols and abbreviations should be used (see Table 5) ; others should be avoided and the intended meaning expressed in words. Symbols used by a particular engineering discipline or in a particular industry should only be used with care and reference should be made to the appropriate standards defining such symbols.

12.1.2 Abbreviations are the same in the singular and plural. Full stops are not used except where the abbreviation makes a word (e.g. No.). In Table 5, capital letters are shown and are preferred as being more likely to remain legible when reproduced.

12.1.3 Symbols and abbreviations for physical quantities and units of measurement, some of which are lower case are defined in the appropriate standards.

12.1.4 Where symbols are used by convention to specify and represent a system, method or process in a symbolic form without depiction in conventional drawing form, reference to the appropriate standards should be made.

TABLE 5 - Commonly accepted symbols and abbreviations

Term	Abbreviation or symbol
Across flats	AF
Assembly	ASSY
Centres	CRS
Centre line on a view and across the centre line	C
Centre line in a note	CL
Centre of gravity	CG
Chamfered, or chamfer (in a note)	CHAM
Cheese head	CH HD
Countersunk/countersink	CSK
Countersunk head	CSK HD
Counterbore	CBORE
Cylinder or cylindrical	CYL
Diameter (in a note)	DIA
Diameter (preceding a dimension)	Ø
Dimension	DIM
Drawing	DRG
Equally spaced	EQUI SP
External	EXT
Figure	FIG
Full indicated movement	FIM
Hexagon	HEX
Hexagon head	HEX HD
Insulated or insulation	INSUL
Internal	INT
International Organization for Standardization	ISO
Least material condition	LMC
Left hand	LH
Long	LG
Machine	MC
Material	MATL
Maximum	MAX
Maximum material condition	MMC
Minimum	MIN
Not to scale*(in a note)	NTS
Number	NO
Pattern number	PATT NO.
Pitch circle diameter	PCD
Radius (in a note)	RAD
Radius (preceding a dimension)	R
Reference	REF
Required	REQD

TABLE 5 (Concluded)

Term	Abbreviation or symbol
Right hand	RH
Round head	RD HD
Screw (or screwed)	SCR
Sheet (referring to a drawing sheet)	SH
Sketch (prefix to a drawing number)	SK
Specification	SPEC
Spherical	SPHERE
Spherical diameter (only preceding a dimension)	SØ
Spherical radius (only preceding dimension)	SR
Spotface	SFACE
Square (in a note)	SQ
Square (preceding a dimension)	ß or ☒
Sri Lanka Standards Institution	SLSI
Standard	STD
Taper (on diameter or width)	⟶
Thread	THD
Thick	THK
Tolerance	TOL
Typical or typically	TYP
Undercut	UCUT
Volume	VOL
Weight	WT

* A dimension not to scale is underlined (see **SLS 409 : Part 2**)

NOTE

1) ***For surface texture symbols see*** *SLS 409 : Part 2.*
2) *For geometrical tolerance symbols see* ***SLS 409 : Part 3.***

13 CONVENTIONAL AND SIMPLIFIED REPRESENTATION

13.1 Adjacent parts

Where their representation is necessary, parts adjacent to an object are drawn with chain thin double dashed lines (type **K**). It is important that the adjacent part never hides the principal part, but may itself be hidden by the latter (see Figure **48**).

Adjacent parts are usually shown in outline and if shown in section are not hatched.

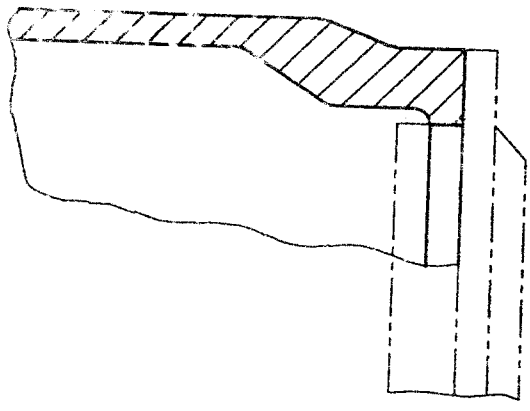


FIGURE 48 - Adjacent parts

13.2 True intersections

True geometric intersection lines shall be drawn with continuous thick lines (type **A**), when visible, or with dashed lines (type **E** or **F**) when hidden (see Figure **49**).

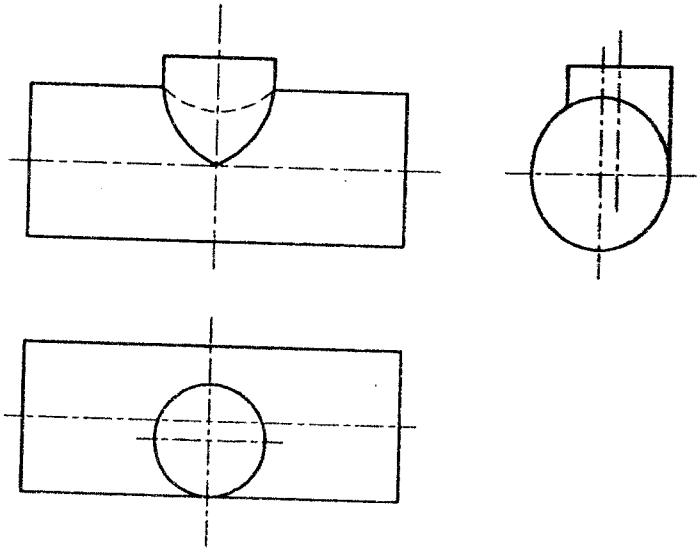


FIGURE 49 - True intersection

13.3 Imaginary intersections

Imaginary intersection lines (such as fillets or rounded corners) may be indicated in a view by means of continuous thin lines (type **B**) not touching the outlines (see Figure 50).

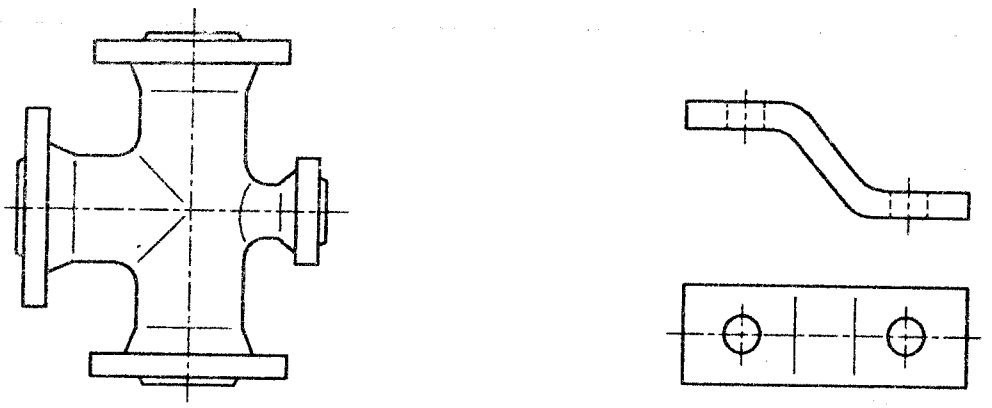


FIGURE 50 - Imaginary intersections

13.4 Simplified representation of intersections

Simplified representations (the simplified representation should be avoided if it affect the comprehensibility of the drawing) of true geometric or imaginary intersection lines may be applied at intersections

a) between two cylinders : the curved lines of intersection are replaced by straight lines (see Figure 51a, b, and c) ; and

b) between a cylinder and a rectangular prism : the displacement of the straight line of intersection is omitted (see Figure 51c, and e).

As the difference in size between the intersecting parts increases, the simplified representation (see Figure **51a** to **e)** only gives a better approach to a real intersection, provided that the axes of the intersecting parts are both mutually perpendicular and intersect, or nearly so.

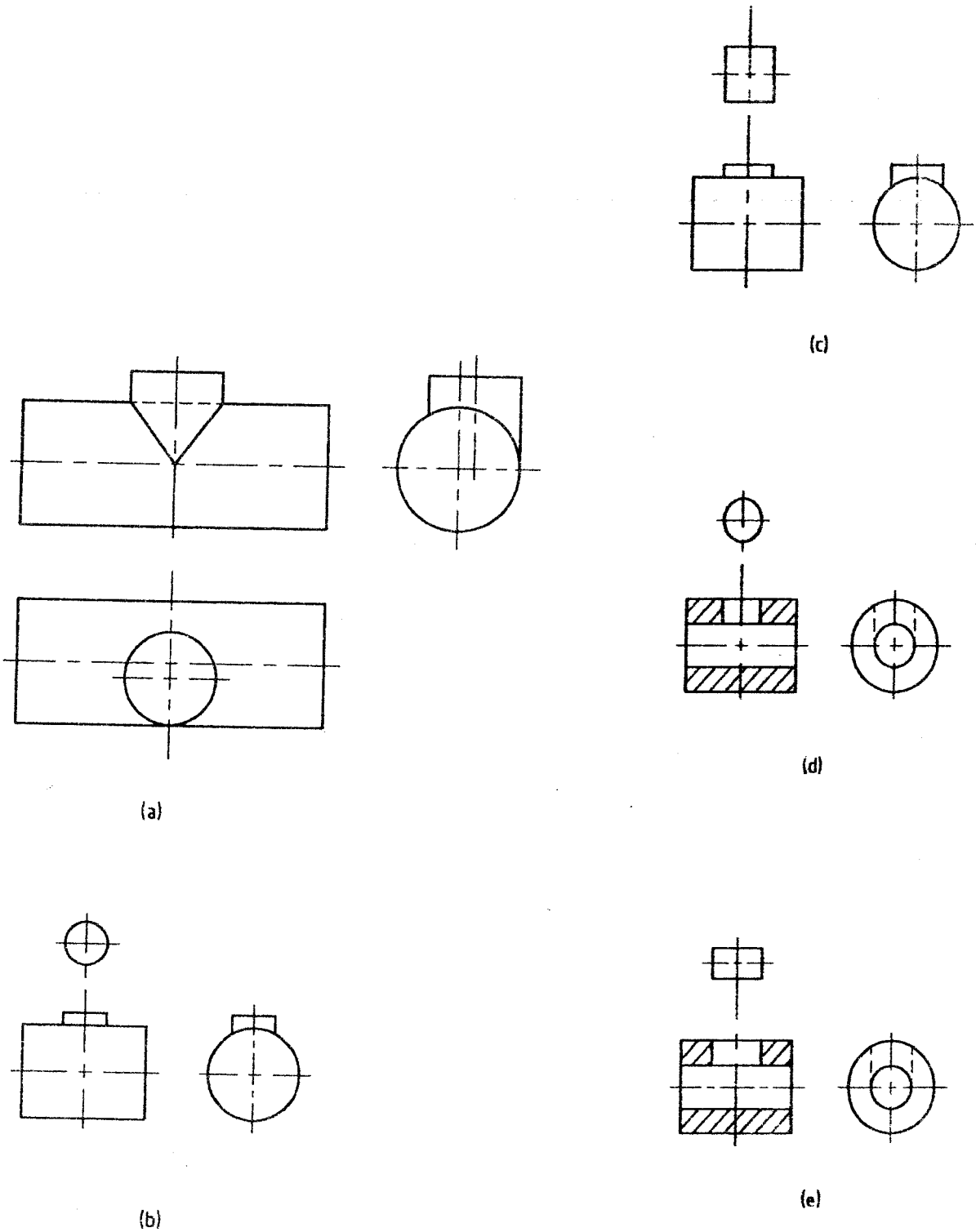


FIGURE 51 - Simplified representation of intersections

13.5 Developed views (initial outlines)

When it is necessary to depict the initial outlines of a part prior to forming, the initial outline should be indicated by a chain thin double dashed line (type K4) (see Figure 52).

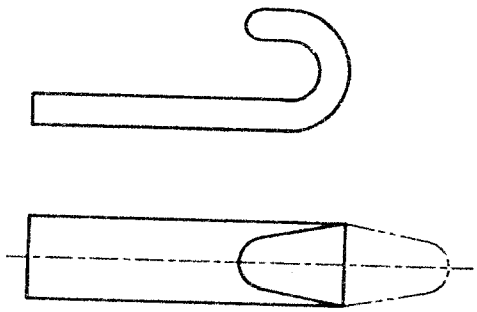


FIGURE 52 - Developed views

13.6 Transparent material

Transparent material should be drawn as non-transparent.

13.7 Plane faces on cylindrical parts

In order to avoid drawing a supplementary view or section, flat surfaces such as squares, tapered squares and local flats may be indicated by crossed diagonal lines (type B) (see Figure 53).

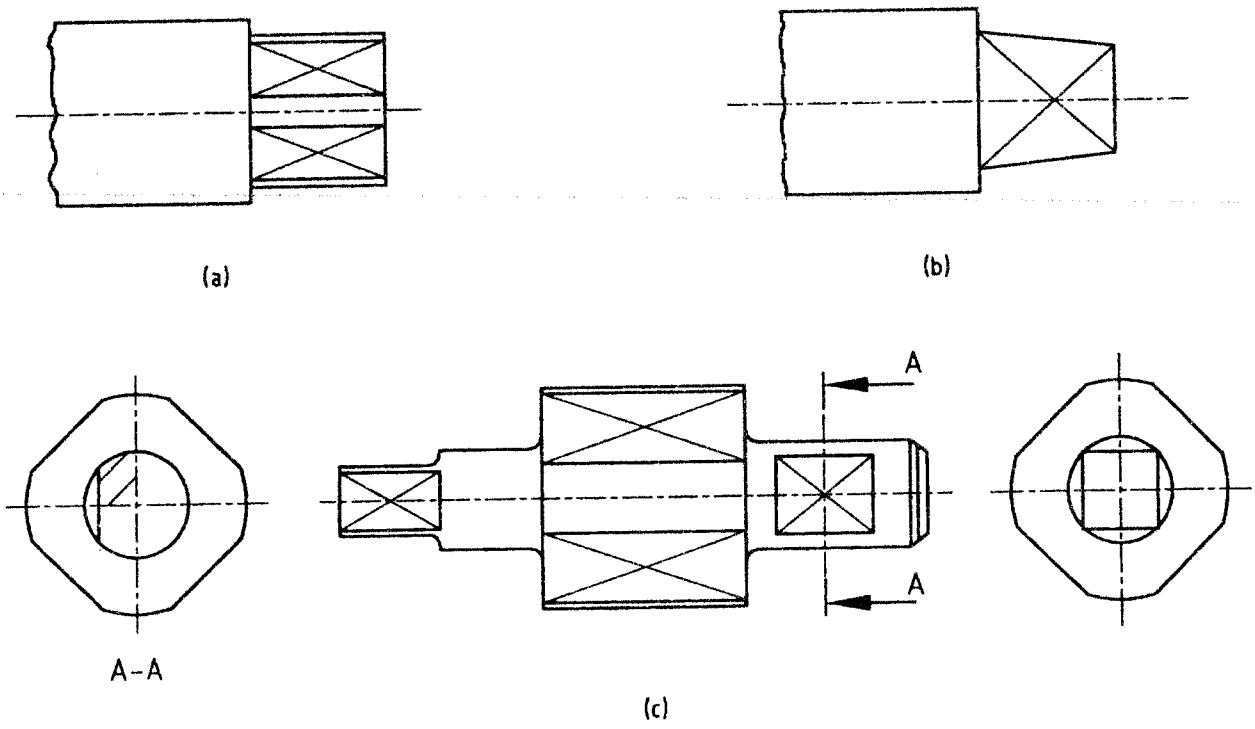


FIGURE 53 - Indication of flat features on cylindrical parts

13.8 Knurling

Type of knurling is indicated by showing only part of the surface so treated using continuous thin line (type **B**) (see Figure **54**).

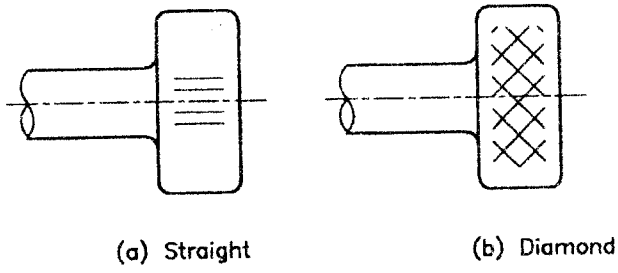


FIGURE 54 - Examples of knurling

13.9 SPLINES AND SERRATIONS

13.9.1 *Spline joint*

Spline joint shall be defined as the connecting, co-axial, elements that transmit torque through the simultaneous engagement of equally spaced teeth situated around the periphery of a cylindrical internal member with similar spaced mating spaces situated around the inner surface of the related cylindrical external member.

13.9.1.1 Straight-sided spline

One member of a spline joint having teeth or spaces that have straight-sided flank profiles.

13.9.1.2 Involute spline

One member of a spline joint having teeth or spaces that have involute flank profiles.

13.9.1.3 Serration

One member of a spline joint having teeth or spaces that generally have flank profiles of 60^0 pressure angle.

13.9.2 *Graphical symbols*

The graphical symbol for the straight-sided splines shown Figure **55a.**

The graphical symbol for the involute splines and serrations is shown in Figure **55b.**

FIGURE 55 - Graphical symbols

13.9.3 As a fundamental principle, the part of a spline joint shall be represented as a solid part without teeth, but with the addition of the root surface in a continuous thin line (type **B**) or the pitch surface in thin chain line (type **G**).

13.9.4 Simplified representations of straight sided splines are given in Table **6.**

13.9.5 Simplified representation of involute opline and serration are given in table 7.

NOTE : *For more details of splines and serration see ISO 14 and ISO 4156.*

TABLE 6 - Simplified representation of straight sided splines

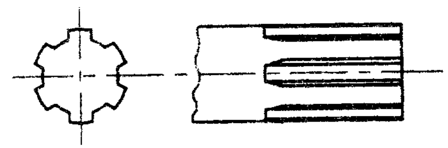
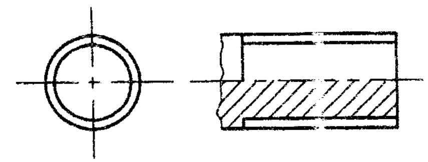
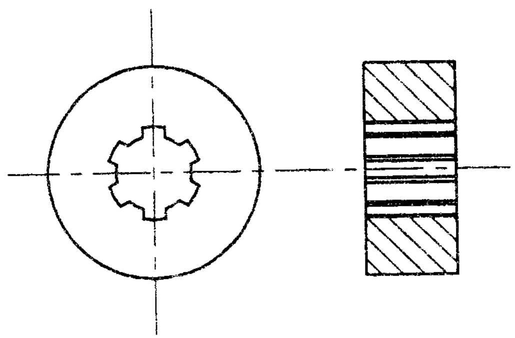
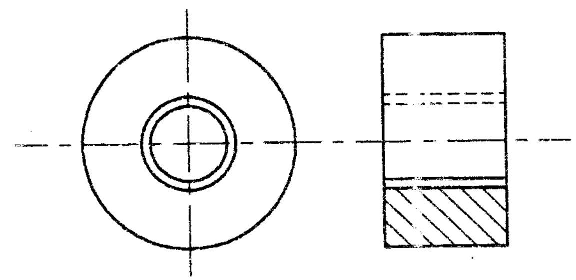
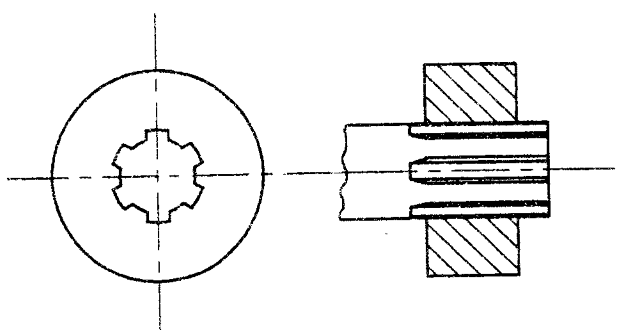
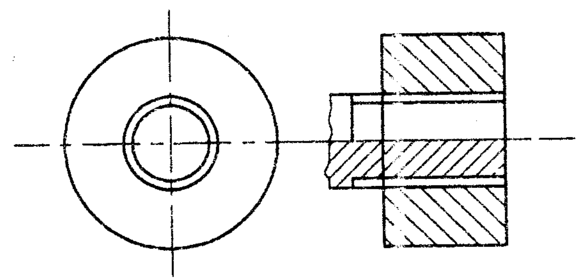
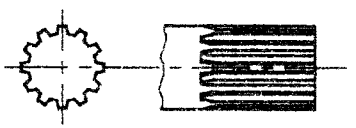
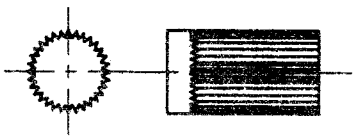
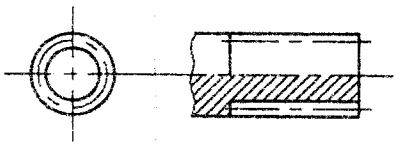
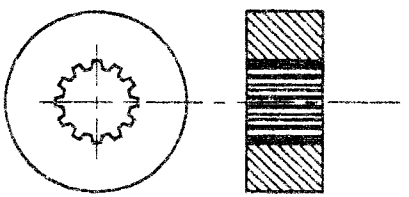
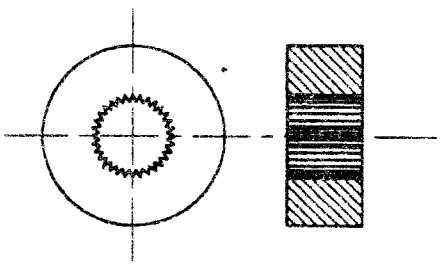
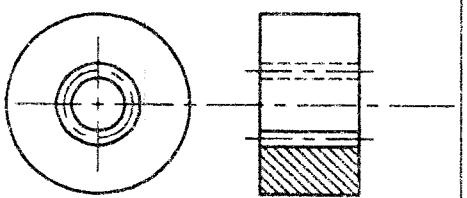
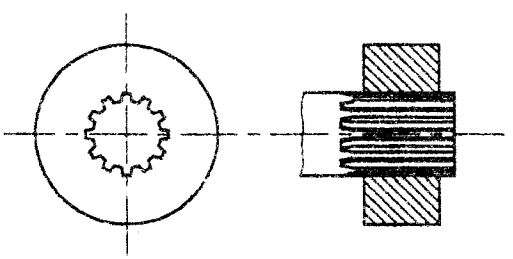
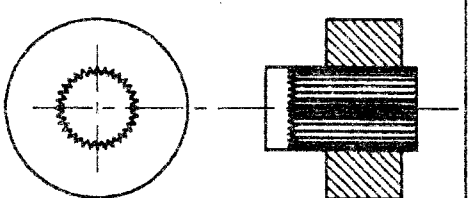
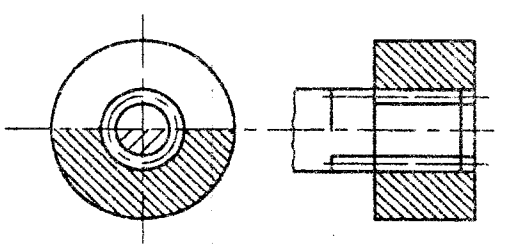
Description (1)	Subject (2)	Convention (3)
Splined shaft		
Splined hub		
Splined joint		

TABLE 7 Simplified representation of involute spline and serration

Description (1)	Subject: Involute spline (2)	Subject: Serration (3)	Convention (4)
Splined shaft			
Splined hub			
Splined joint			

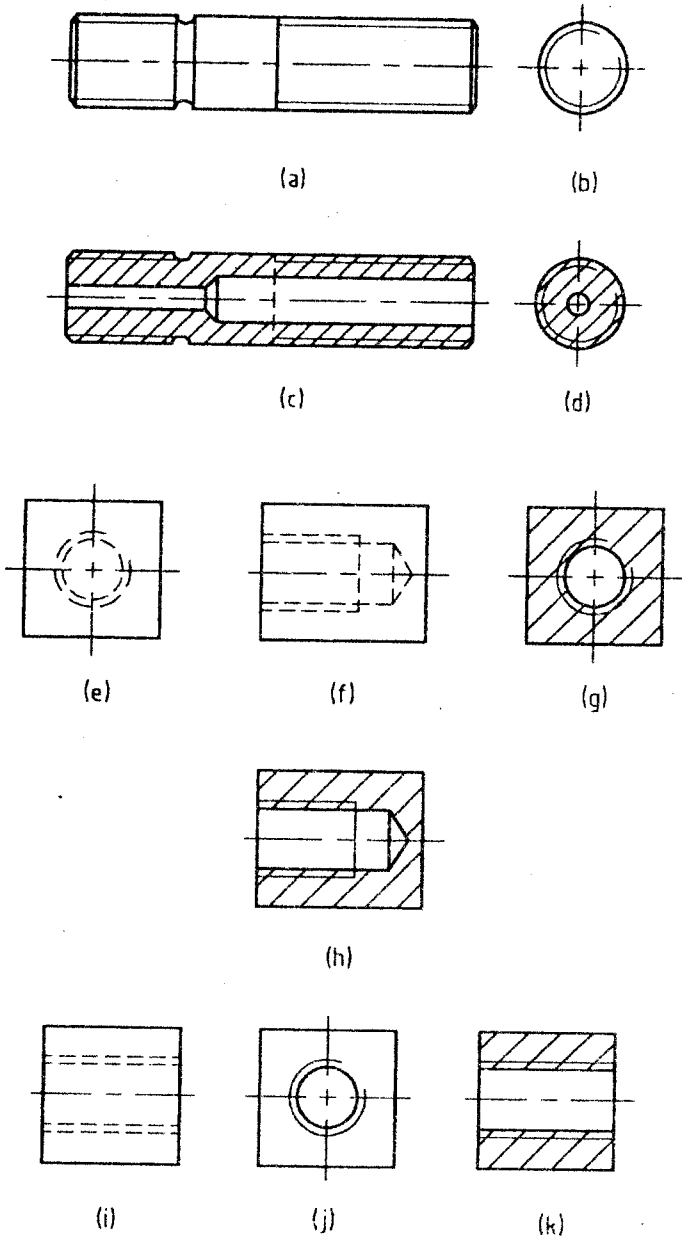


FIGURE 56 - Convention for screw threads

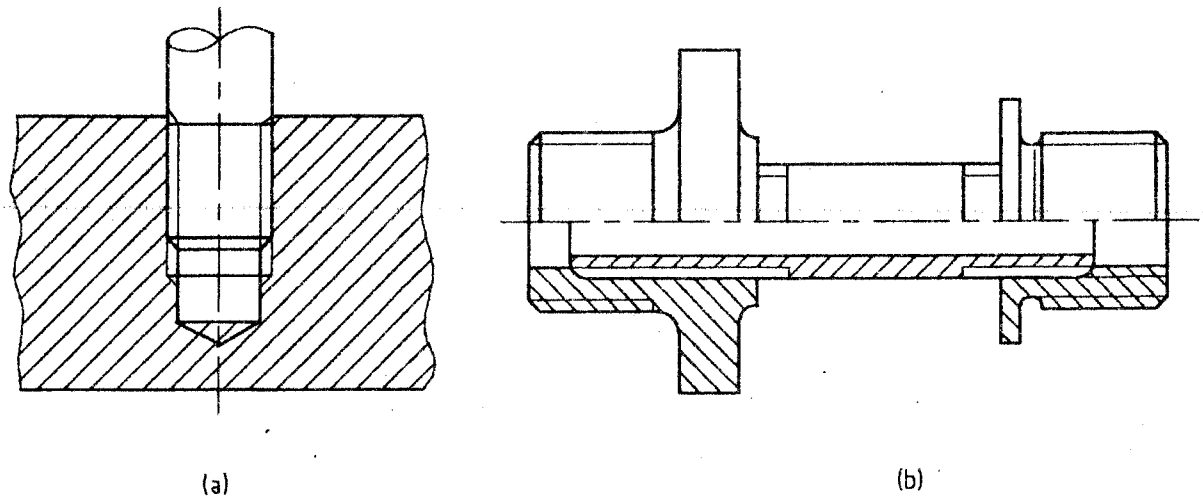


FIGURE 57 - Conventions for assembled screw threads

13.10. Threaded parts

13.10.1 *General*

True representation of screw threads is only rarely required, for example on very large scale drawings and for special profiles, where a conventional method would not clearly identify the screw thread. For all normal purposes the conventional representation of screw threads, as shown in Figures **56** and Figure **57**, is preferred and is independent of the type of screw thread. The type and dimensions of standard screw threads are normally designated in notes form in accordance with the relevant standard. Special screw threads may require to be directly dimensioned on the view.

13.10.2 *Visible screw threads*

For visible screw threads, the crests of threads should be defined by a continuous thick line (type A) and the roots of threads by a continuous thin line (type B)

On an end view of a visible screw thread, the thread roots should be represented by a portion of a circle, drawn with a continuous thin line (type B) (see Table **3**), its length extending over not less than three quadrants (see Figures **57 b** and **j**).

It is recommended that the space between the lines representing the major and minor diameters of the thread be as close as possible to the correct depth of the thread, but in all cases this spacing shall be not less than

a) twice the thickness of the thick line; or
b) 0.7 mm,

whichever is the larger.

13.10.3 *Hidden screw threads*

For hidden screw threads, the crests and the roots should be defined by dashed lines (type **E** or **F**) but one type only on the same drawing (see Figure **56 e, f** and **i**).

For the recommended spacing between the two dashed lines. see **13.10.2**

On an end view of a hidden screw thread, the root is represented using a dashed line (type E or F, but the same as that used for the crests and the one type only on the same drawing) following a portion of a circle, its length extending over not less than three quadrants (see Figure **56**).

13.10.4 *Section of threaded parts*

For threaded parts shown in section, hatching should be extended to the line defining the crests of the thread (see Figure **56c, d, g, h,** and **k**).

13.10.5 *Limits of useful length of screw threads*

The limit of useful length of a screw thread should be shown by a continuous thick line (type **A**) or a dashed line (type **E** or **F**) (but one type only on the same drawing) depending on whether this limit visible or hidden. This line should terminate at the line defining major diameter of the thread (see Figure **56a, c, f, h, i** and **k** and Figure **57a** and **b**).

Incomplete threads or the limits of useful length are not shown except in the case where there is a functional necessity (see Figure **57a**). The method of indication is to extend the root line at an angle so as to meet the crest line (see Figure **57**).

13.10.6 *Assembled threaded parts*

The foregoing conventions apply to assemblies of threaded parts. However, externally threaded parts should always be shown covering internally threaded parts and should not be hidden by them (see Figure **57a** and **b**).

In complex assembles where the conventional method would not yield a clear picture of the screw threads, the method depicted in Figure **58** may be used. It is recommended to show the correct depth of thread, but it is not necessary to draw the correct pitch of thread, nor its exact profile. This method may also be used for illustrations in publications, etc.

NOTE : *For more details of representation of screw threads and threaded parts refer* ***ISO 6410-1***

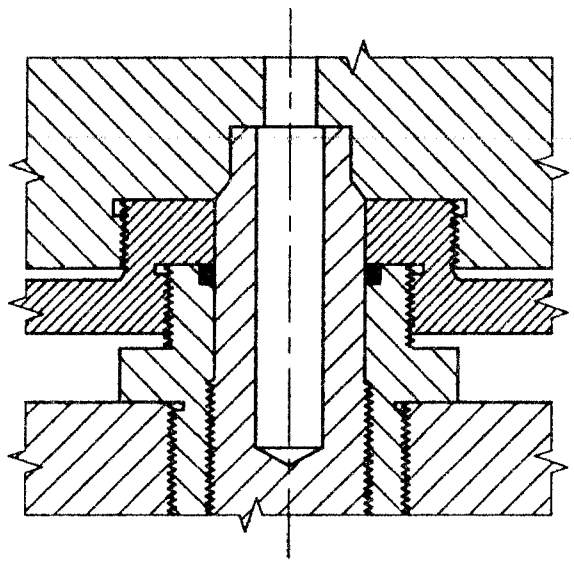
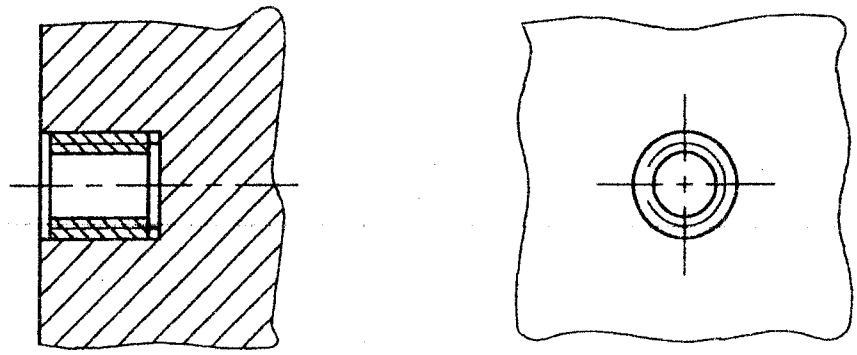


FIGURE 58 - Assembled threaded parts

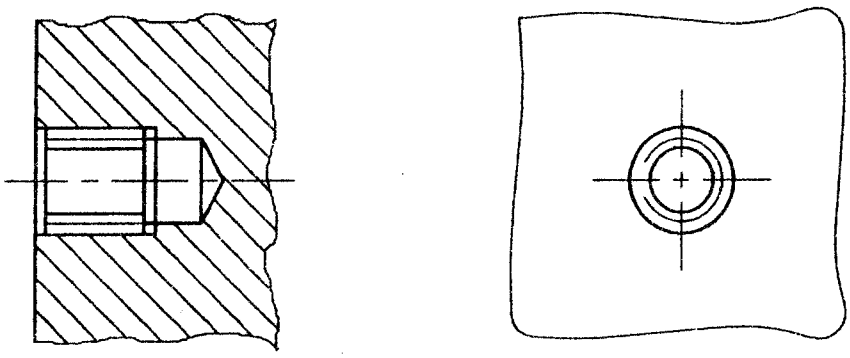
13.10.7 *Screw threaded inserts*

The conventional representation of threaded inserts (see Figure **59a**), including wire thread inserts (see Figure **59b**) follows the conventions for screw threads. The insert is depicted using a continuous thick line (type **A**). The run-out of the female thread (where used) receiving the insert may be omitted. The male thread priority rule (see **13.10.6**) applies both for depicting a male threaded part assembled in the insert (see Figure **59b**).

NOTE : *For details of representation of screw threaded inserts See ISO 6410 Part 1 and 2.*



(a) Conventions for threaded inserts



(b) Conventions for wire thread inserts

FIGURE 59 - Conventions for screw thread inserts

13.11 Bearings

A general convention for rolling element bearing in section without taking account of type or detail is shown in Figure 60.

NOTE : *For more details of representation of rolling bearing see* ***ISO 8826***

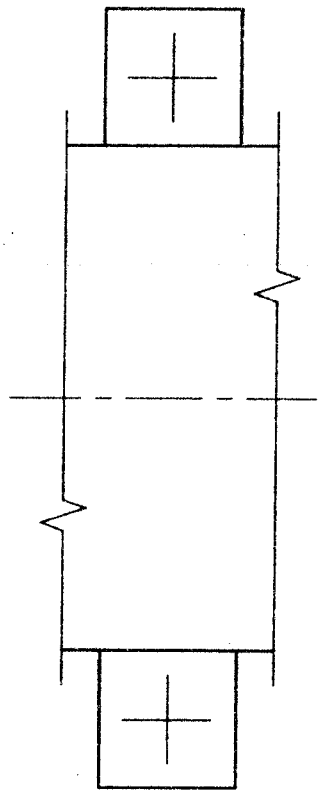


FIGURE 60 - Convention for rolling element bearing

13.12 Shaft seals

A general convention for shaft seals in section without talking account of type or detail is shown in Figure **60**.

NOTE : *For more details of representation of shaft seals see* ***ISO 9222-1*** *and ISO* ***9222-2.***

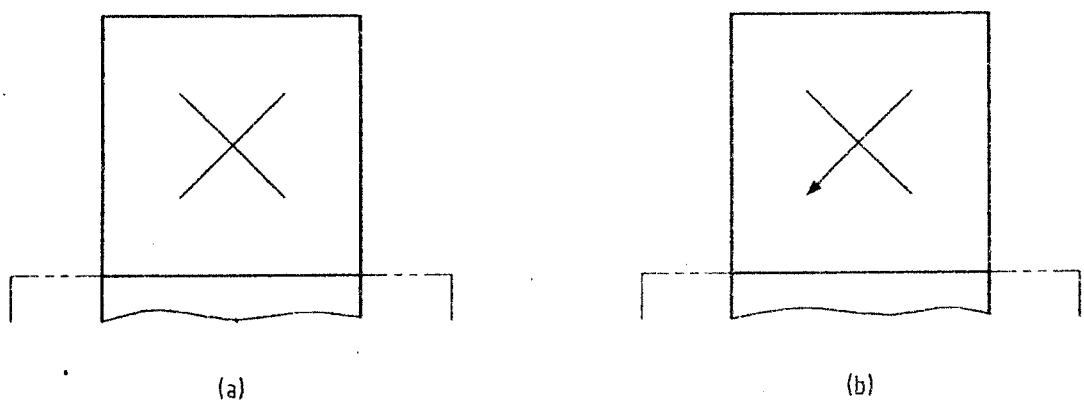


FIGURE 61 - Convention for shaft seal

13.13 Gears

13.13.1 *General*

The conventional representation of the toothed portion of gears including worm gearing and chain wheels is represented (except in axial section) as a solid part without teeth, but the addition of the pitch surface by a chain thin line (type **G**).

The conventions apply to both and detail assembly drawings and examples are given in Figures **62** to Figure **70.** Similar conventions apply to chain wheels as shown in Figure **71.**

13.13.2 *Detail drawings (individual gears)*

13.13.2.1 Contours and edges

In an unsectioned view contours and the edges of each gear are represented as a solid gear bounded by the tip surface (see Figure **62**). In an axial section, two gear teeth are represented unsectioned at the diametrically opposed position in the plane of section. The convention applies whether there is an even or an odd number of teeth and irrespective of the type of gear tooth (see Figure **62**).

13.13.2.2 Pitch line

All pitch line indications are represented by chain thin line (type **G**) whether applied to full views, sectional views or concealed portions of views.

In projections normal to gear axes (see Figure **62**) :

a) for gears of spur type the pitch line is represented by the pitch circle;
b) for bevel gears the pitch line is represented by the external pitch circle, i.e. at the reference circle on the back cone; and
c) for worm wheels the pitch line is represented by the median pitch circle.

In the projection parallel to the axis, the pitch line is represented by its apparent contour extending the line beyond the gear contour on each side (see Figure **62**).

In the projection parallel to the axis, it is represented the pitch circle by chain thin line (type G) external pitch circle in case of a level and the median pitch circle in the case of worm wheel (see Figure **62**).
In a projection normal to the axis, pitch circle is represented by its apparent contour, extending the line beyond the gear contour on each side (see Figure **63**).

13.13.2.3 Root surface

The root surface is not normally shown except in sectional views.

However, where it is helpful to show the root surface in full views, it is represented by a thin continuous line (type **B**) (see Figure **63**).

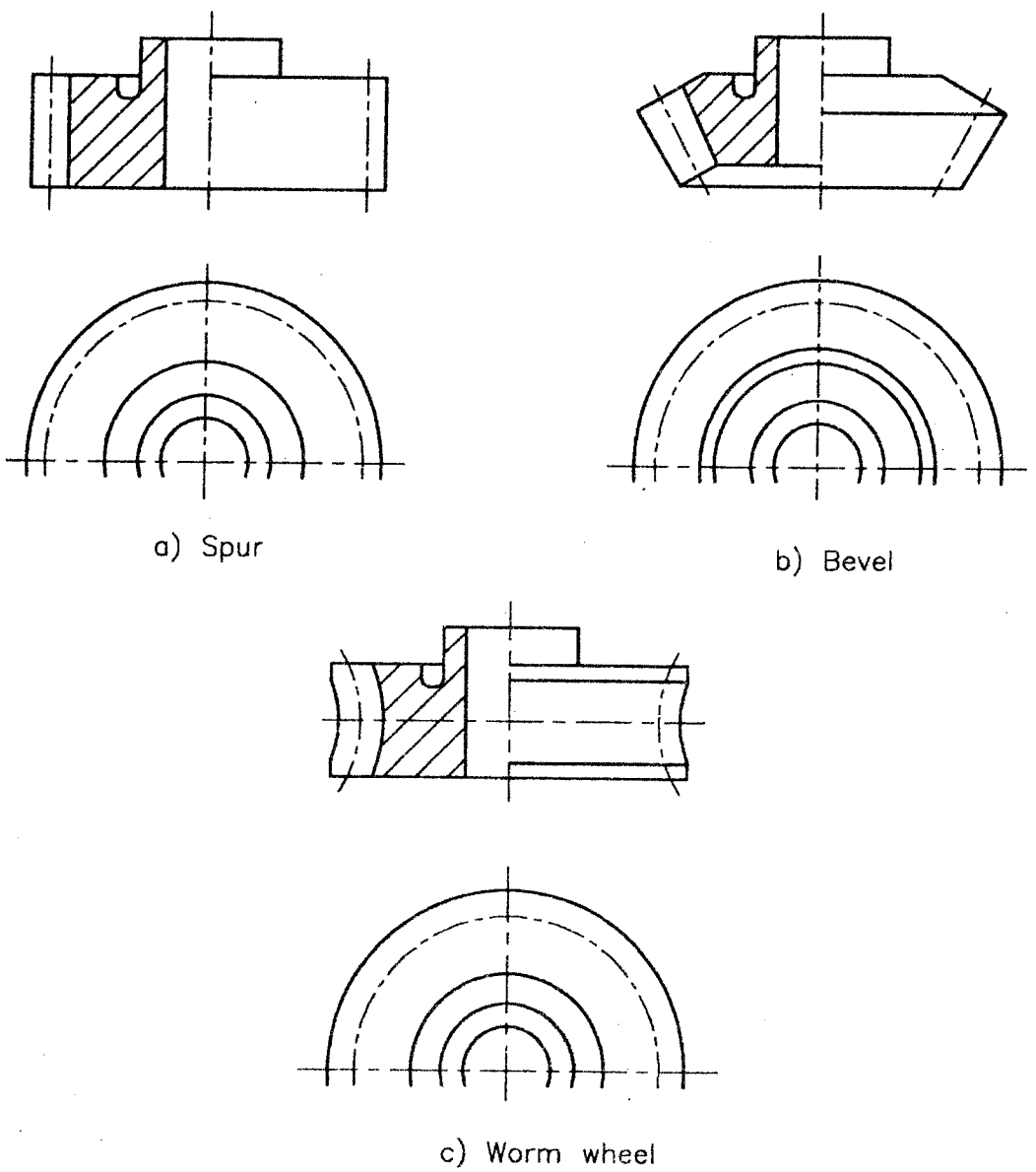


FIGURE 62 - Gears showing convention for contours edges,pitch lines and circles

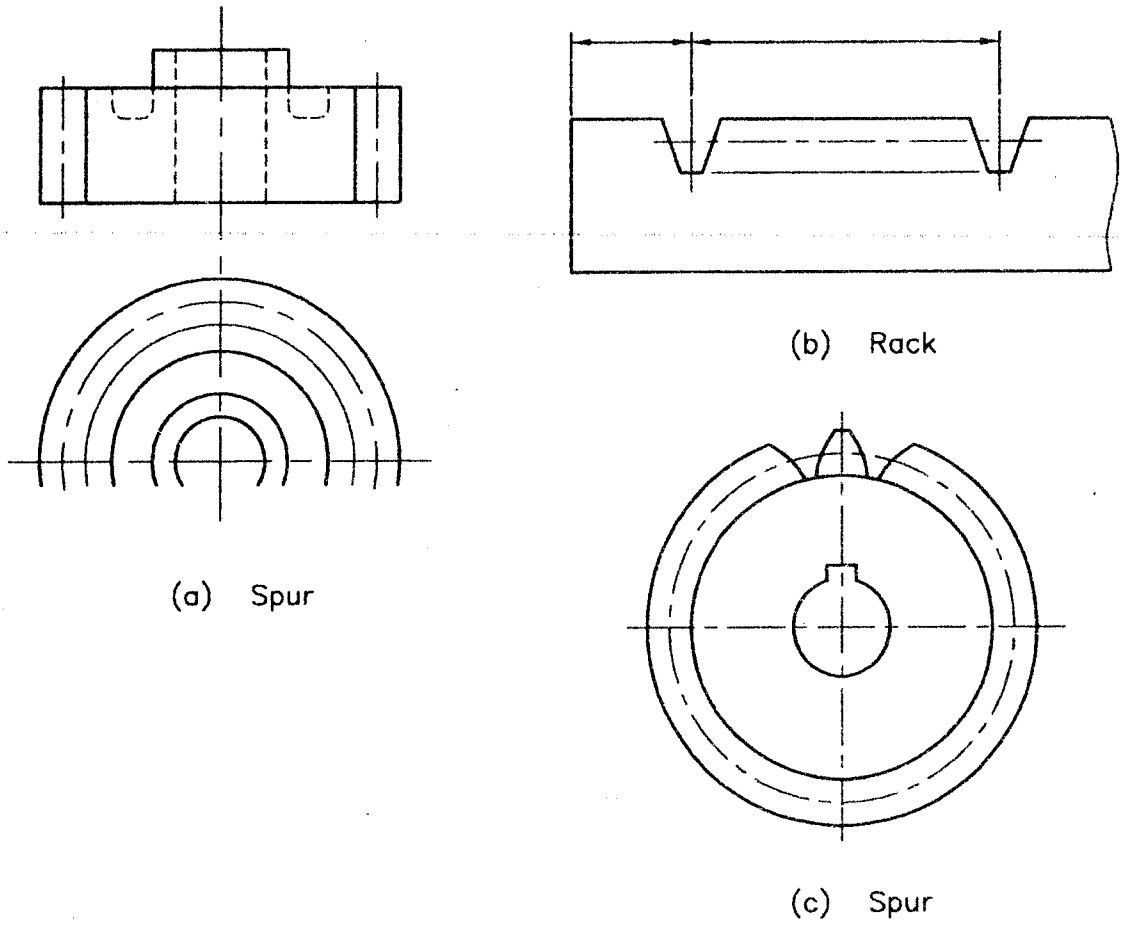


FIGURE 63 - Gears and rack: showing conventions for root surface

13.13.2.4 Teeth

Teeth profile should be specified either by reference to a standard or by a drawing to a suitable scale.

If it is essential to show one or two teeth on the gear drawing itself (either to define the ends of a toothed portion or rack, or in order to specify the position of the teeth in relation to a given axial plane) a continuous thick line (type **A**) is used (see Figure **63b** and **c**).

To indicate the direction of the teeth of a gear or rack on the view of the tooth surface in a projection parallel to the gear axes, three continuous thin line (type **B**) of the corresponding form and direction should be shown (see Table **8** and Figure **64**).

NOTE : *If the mating gears are represented, the direction of the teeth should be shown on one gear only (see Figure **66**).*

TABLE 8 - Indication of gear teeth systems

Tooth system (1)	Indication (2)
Helical to the right	
Helical to the left	
Double helical	
Spiral	

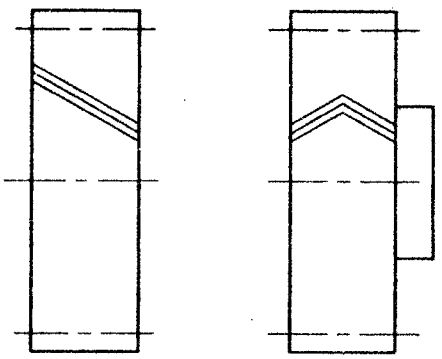


FIGURE 64 - Examples of use of symbols for gear teeth systems

3.13.3 *Assembly drawings (gear pairs)*

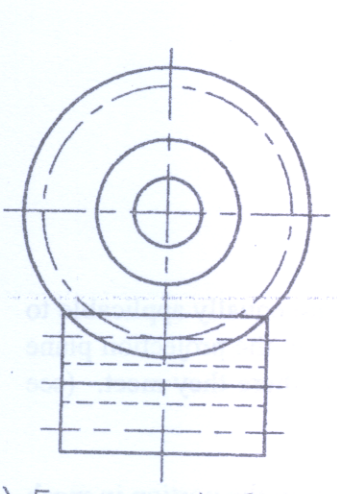
The recommendation for the representation of gears on detail drawings are equally applicable to assembly drawings. In the case of a pair of bevel gears for a gear shown in the projection plane parallel to its axis the pitch lines of that gear are extended to the point where they meet. (see Figure **65b** and **c**).

Neither of the two gears of a gear pair is assumed to be hidden by the other in the portion in mesh (see Figure **65a,** except in the following two cases:

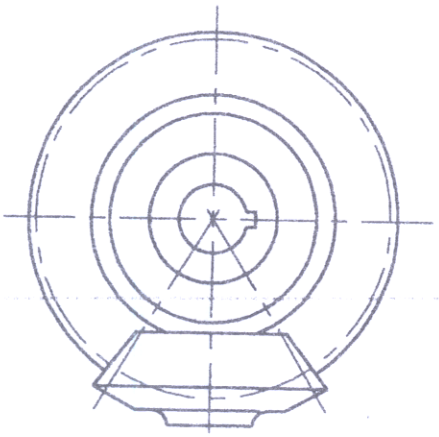
a) If one of the gears, the whole of which is located in front of the other, effectively conceals part of it (see Figures **65b** and **c**) ; and

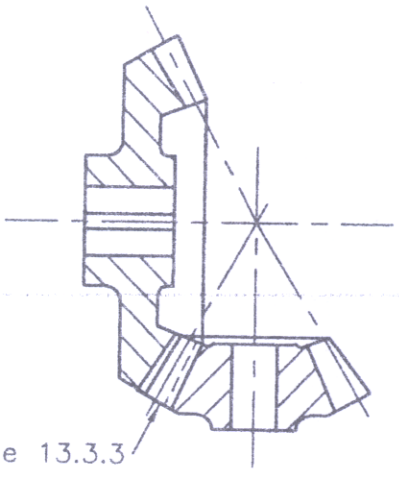
b) If both gears are represented in axial sections, in which case one of the two gears, chosen arbitrarily, is assumed to be partly concealed by the other (see Figure **65b**).

In these two cases, concealed contour edges need not be represented if they are not essential to the clarify of the drawing (see Figures **65b** and **c**).

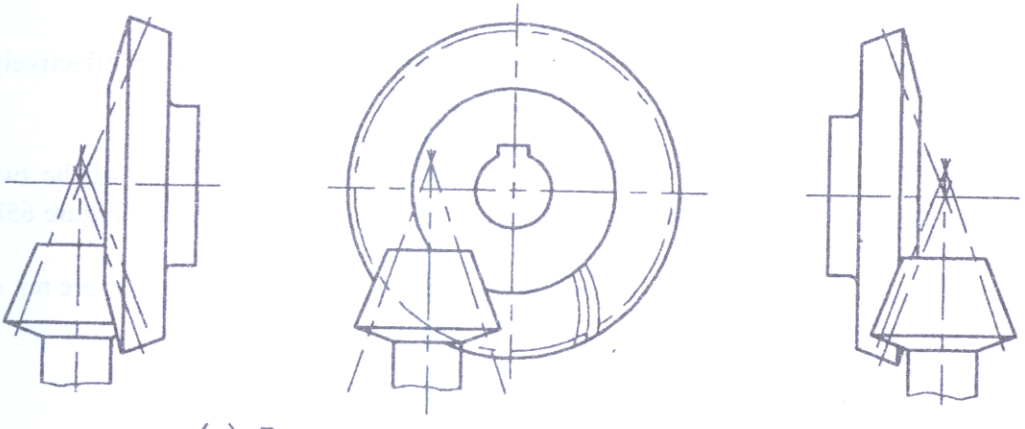


(a) Engagement of worm and wheel

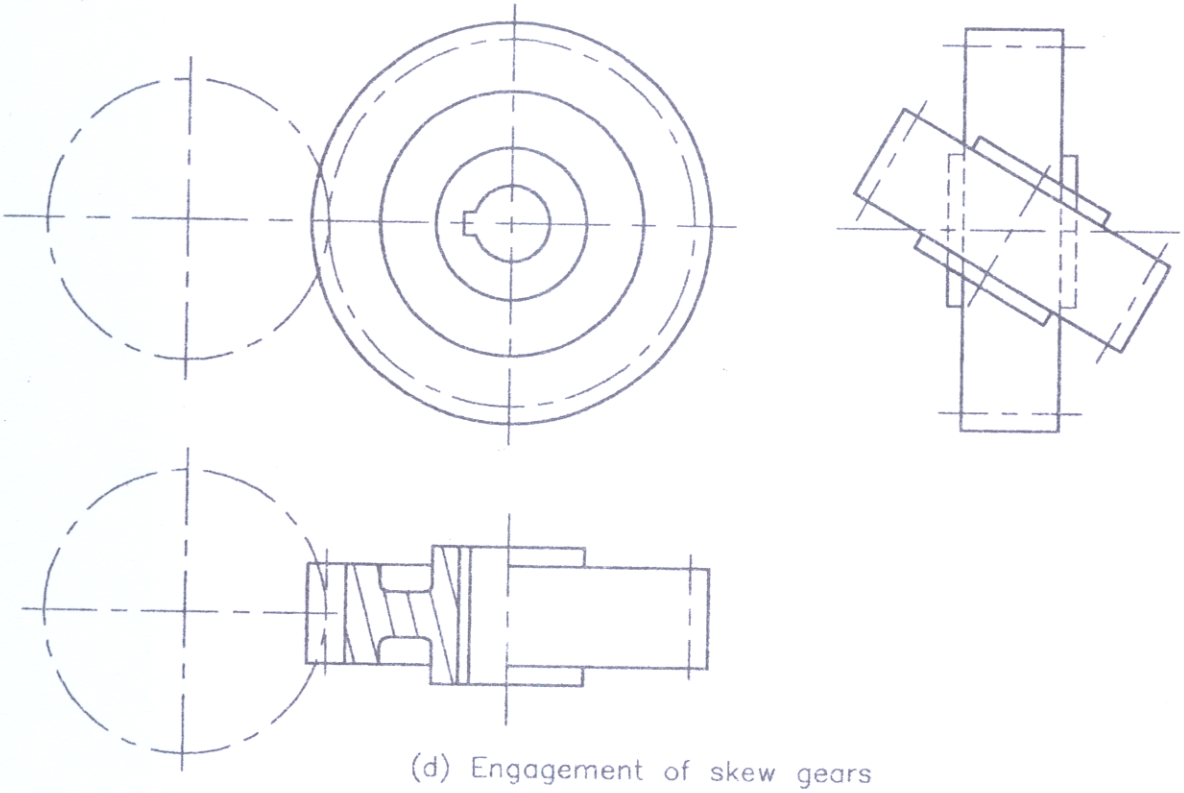




(b) Engagement of bevel gears



(c) Engagement of hypoid bevel gears



(d) Engagement of skew gears

FIGURE 65 - Assembled mating gears

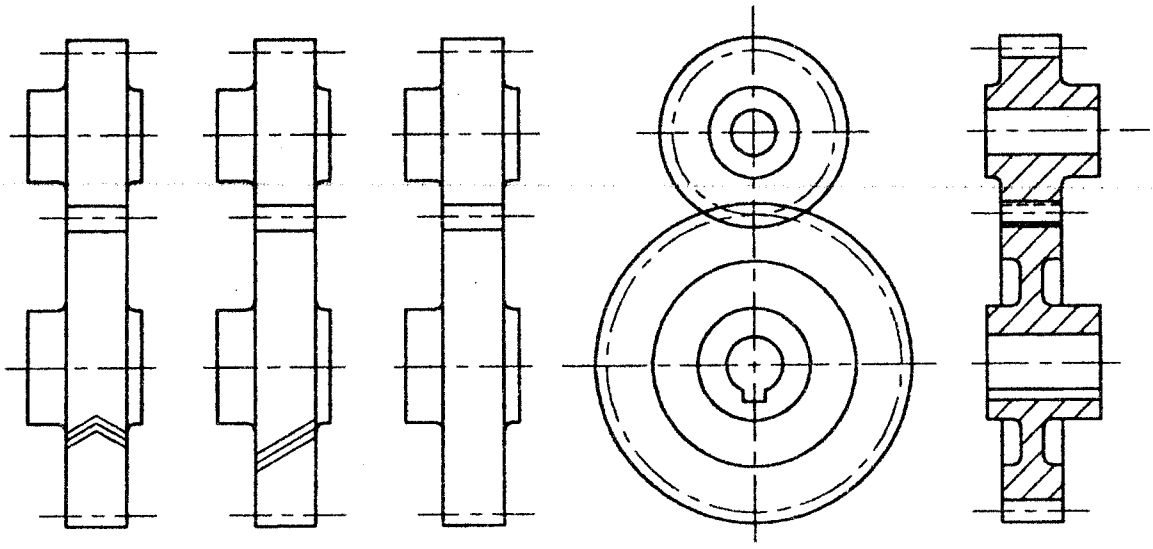


FIGURE 66 - External engagement of cylindrical gears

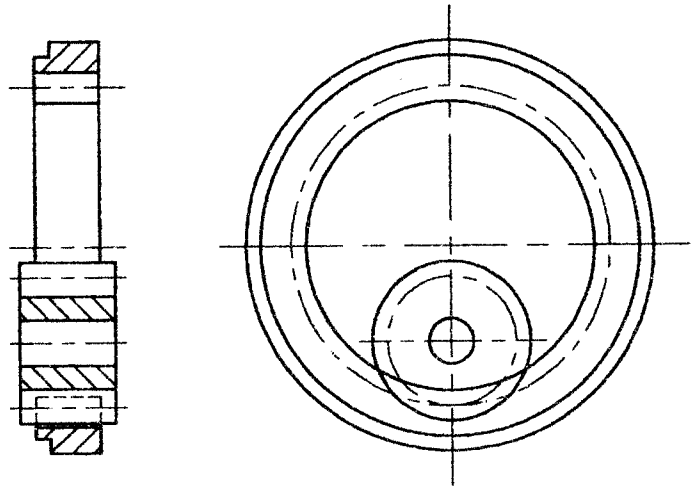


FIGURE 67 - Internal engagement of cylindrical gears

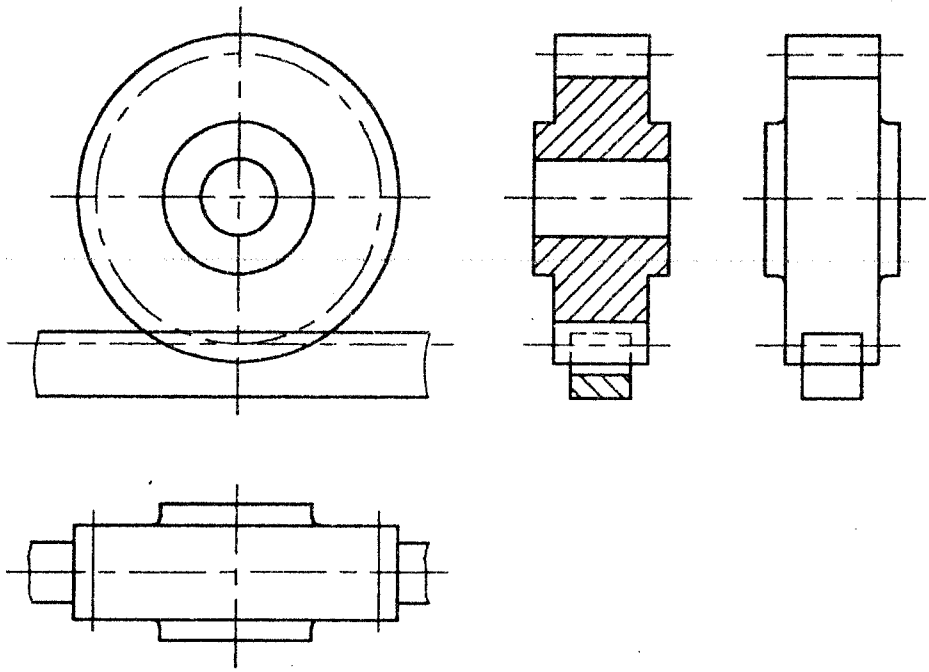
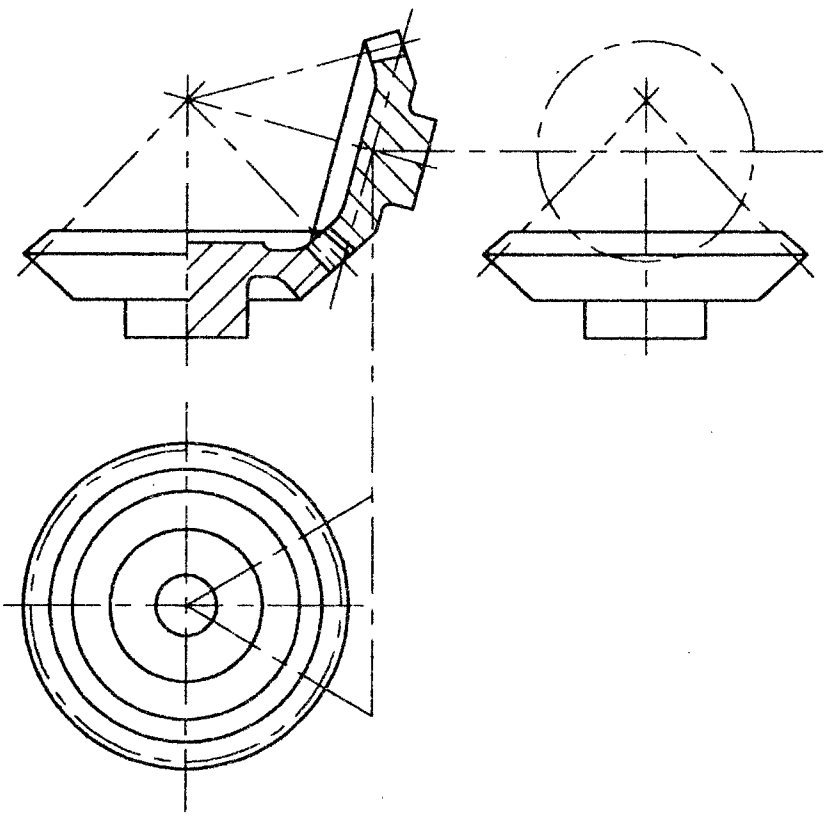


FIGURE 68 - Engagement of pinion with rack



NOTE : *The type B lines (see table 3) are construction lines and should be omitted on the drawing.*

FIGURE 69 - Engagement of bevel gears, axis intersection at any angle

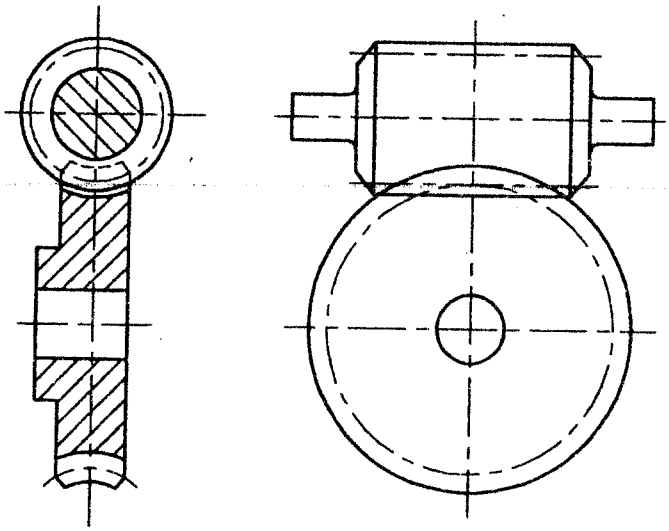


FIGURE 70 - Engagement of wheel with cylindrical worm

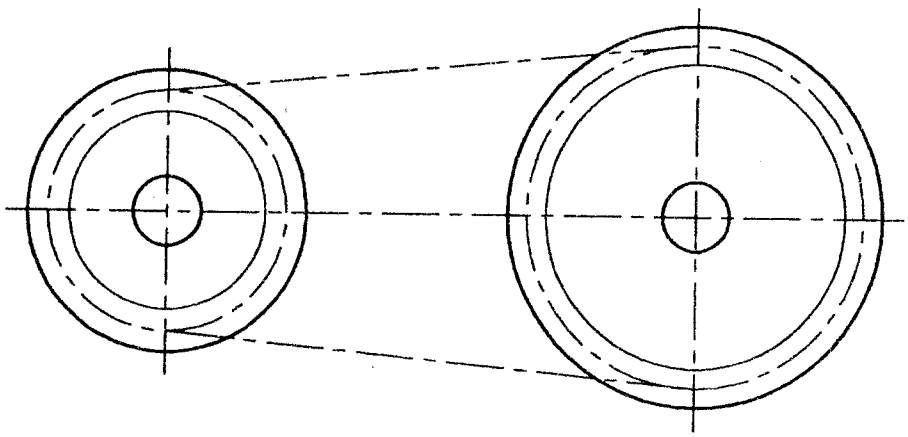


FIGURE 71 - Chain wheels

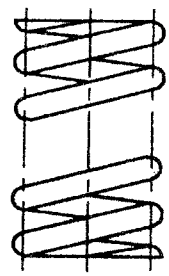
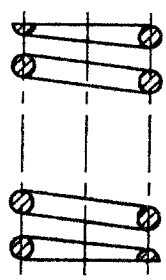
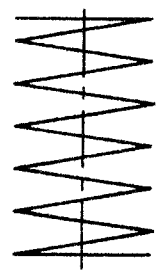
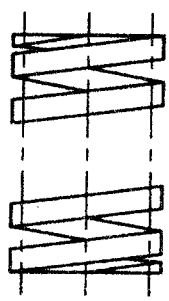
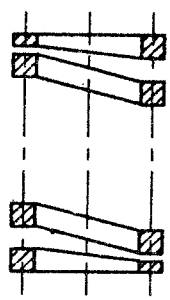
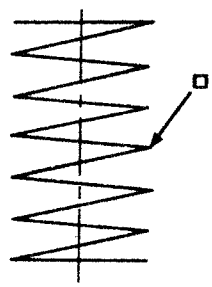
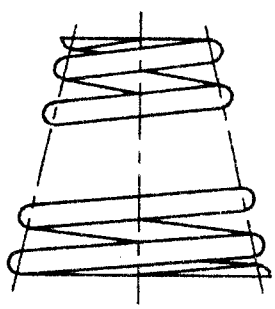
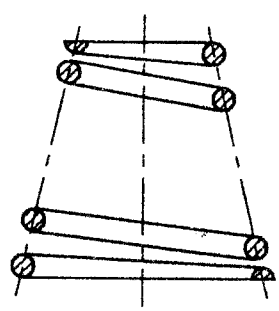
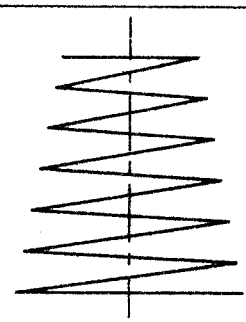
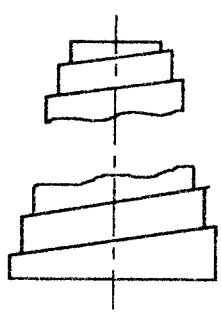
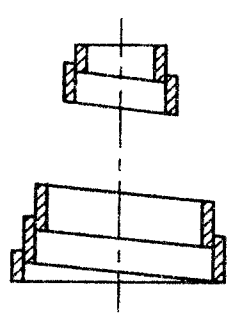
13.14 Springs

The conventional and simplified representation of springs are illustrated in Table **9** to Table **15.**

In a detail drawing the specification of the spring is normally presented in listed form. Where a detail drawing records more than one variation a tabulation form may be appropriate. In views and sections care should be taken to show the correct direction of the helix of helical springs. In the simplified representations it may be necessary to indicate the wire section and the direction of helix by symbol and note. Finish of wire ends for compression springs other than closed and ground will need to be indicated.

NOTE : *For more details of representation of springs see ISO 2162*

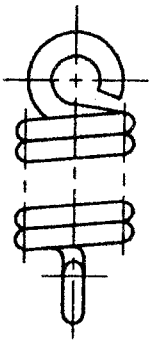
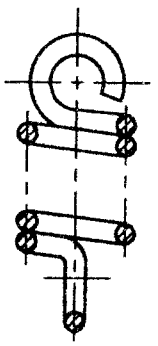
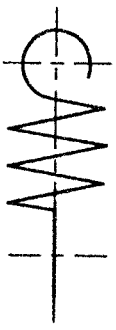
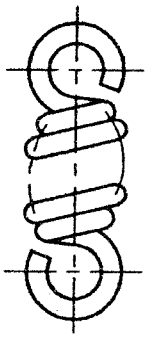
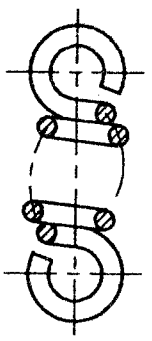
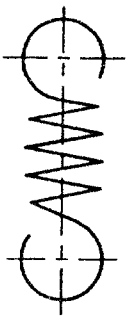
TABLE 9 - Simplified representation of compression springs

Description	Conventional representation		Simplified representation*
	View	Section	
(1)	(2)	(3)	(4)
(a) Cylindrical helical compression spring of wire of circular cross –section			
(b) Cylindrical helical compression spring of wire of rectangular cross–section			
(c) Conical helical compression spring of wire of circular cross–section			
(d) Conical helical compression spring of wire of rectangular cross–section (volute spring)			

NOTE: *ISO 2162 also includs double–conical helical compression barrel spring, double–conical helical compression waisted spring and spring nest of two cylindrical helical compression springs*

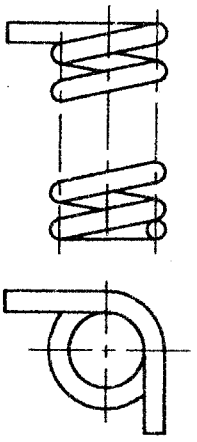
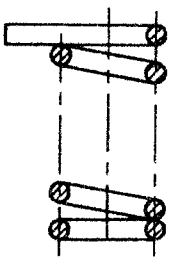
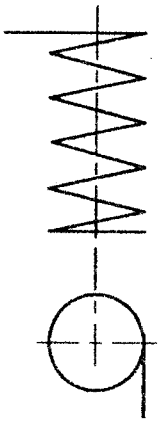
* If necessary, indicate wound left–(or right–) hand. If necessary the cross–section of the spring material may be indicated in words or by a symbol, see (b).

TABLE 10 - Simplified representation of tension springs

Description (1)	Conventional representation		Simplified representation* (4)
	View (2)	Section (3)	
(a) Cylindrical helical tension springs of wire of circular cross–section			
(b) Double–conical helical tension spring of circular cross–section			

* If necessary, indicate"wound left–(or right–)hand". If necessary the cross–section of the spring material may be indicated in words or by a symbol,see(b) of figure 64.

TABLE 11 - Simplified representation of torsion springs

Description (1)	Conventional representation		Simplified representation** (4)
	View (2)	Section (3)	
Cylindrical helical torsion springs of wire of circular cross–section			

**If necessary, indicate"wound left–(or right–)hand". If necessary the cross–section of the spring material may be indicated in words or by a symbol,see(b) of figure 64.

TABLE 12 - Simplified representation of torsion bar springs

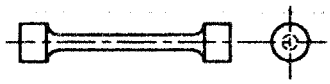
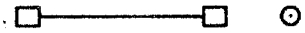
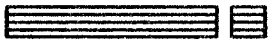
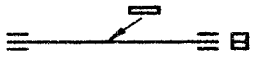
Description (1)	Conventional representation (2)	Simplified representation (3)
Torsion bar spring of circular cross-section		
Stacked laminated torsion bar spring of strips of rectangular cross-section		

TABLE 13 - Simplified representation of cup springs(disc springs)

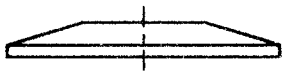
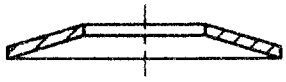
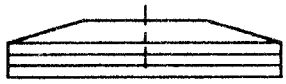
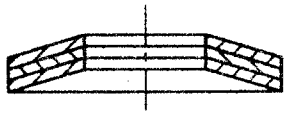
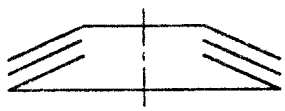
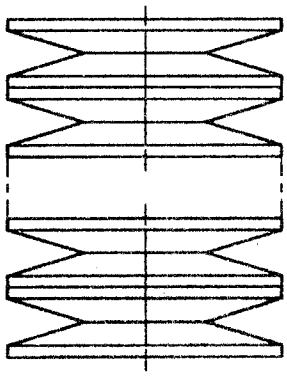
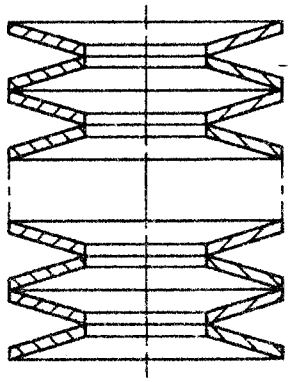
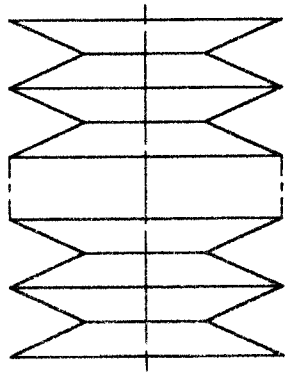
Description (1)	Conventional representation		Simplified representation
	View (2)	Section (3)	(4)
(a) Disc spring			
(b) Multi-disc(discs placed in the same direction)			
(c) Multi-disc spring (successive discs alternating in diretion)			

TABLE 14 - Simplified representation of leaf springs

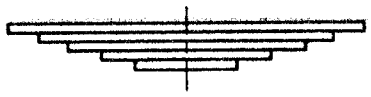
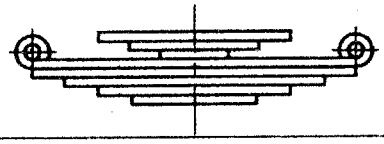
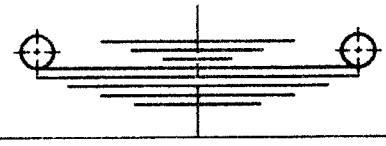
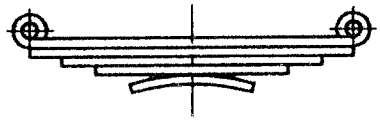
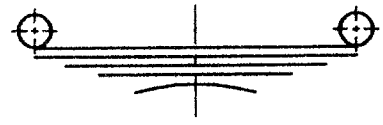
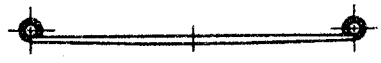
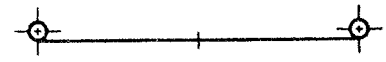
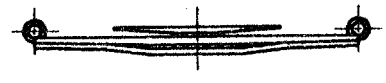
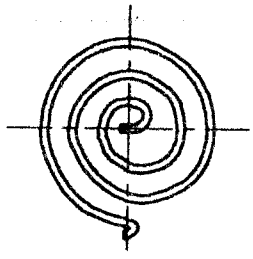
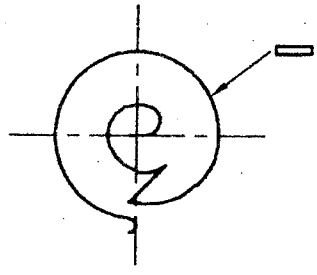
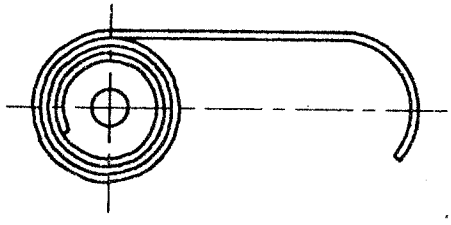
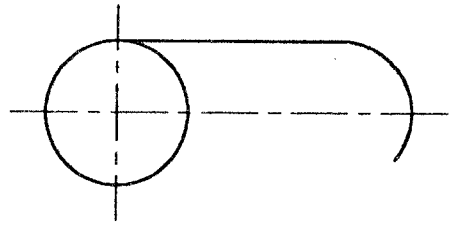
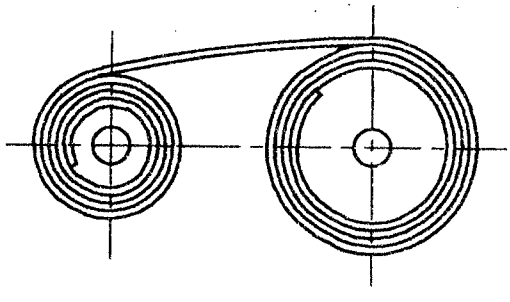
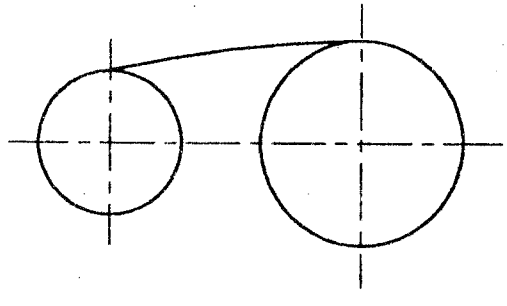
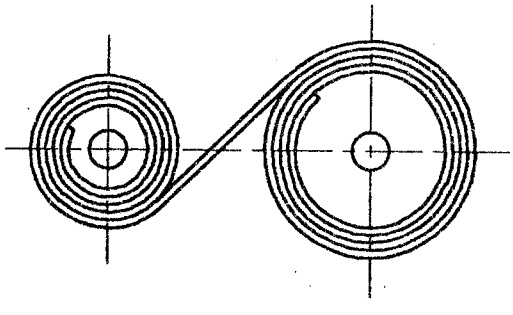
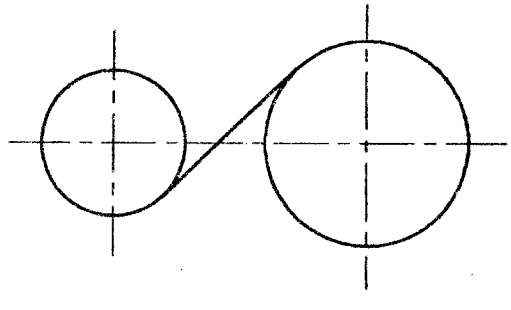
Description (1)	Conventional representation (2)	Simplified representation (3)
(a) Laminated leaf spring without eyes		
(b) Laminated leaf spring with eyes		
(c) Laminated leaf spring with eyes and helper spring		
(d) Laminated leaf spring with eyes and auxiliary spring		
(e) Parabolic single–leaf spring with eyes		
(f) Parabolic multi–leaf spring without eyes		
(g) Parabolic multi–leaf spring with eyes		
(h) Parabolic multi–leaf spring with eyes and helper spring		
(i) Parabolic multi–leaf spring with eyes and auxiliary spring		

TABLE 15 - Simplified representation of wound strip springs

Description (1)	Conventional representation (2)	Simplified representation (3)
Spiral spring of strip of rectangular cross–section		
Constant force		
		
		

13.15 Threaded fasteners

When a simplified representation of screw and nuts will suffice for an assembly drawing, only the essential features need be indicated, as shown in Table **16**. The degree of simplification will depend on the kind of screw or nut represented and the scale and purpose of the drawing, therefore the following features should not be included:

a) Edges of chamfers of nuts and screw heads;
b) Thread run-out;
c) The shape of ends of bolts; and
d) Undercuts.

13.16 See annex A for the simplified representation of centre holes.

14 Marking

Drawing produced to the recommendations of this standard should bear a statement to the effect, e.g. **'drawn to SLS 409'**

TABLE 16 - Simlified representation of threaded fasteners

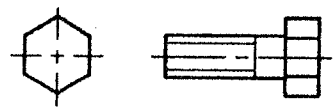
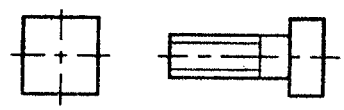
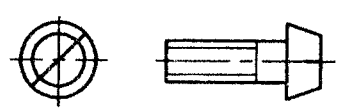
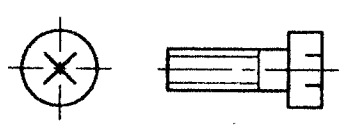
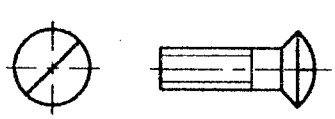
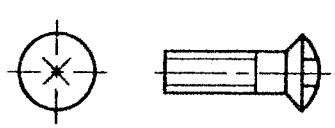
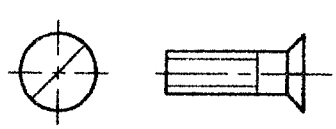
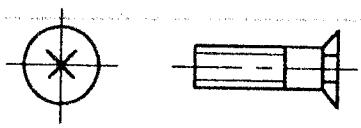
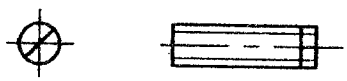
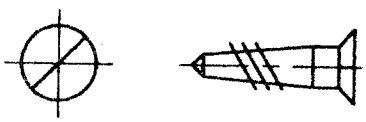
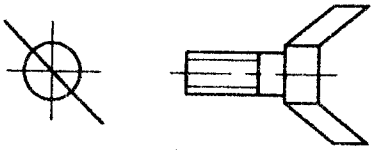
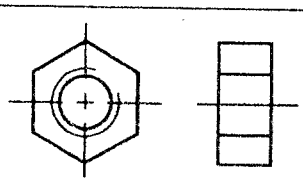
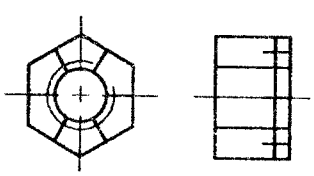
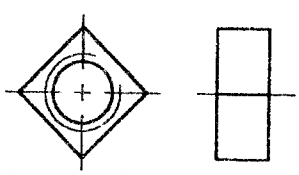
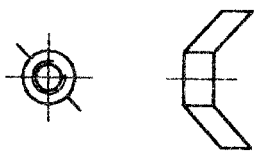
Item (1)	Description (2)	Simplified representation (3)
1	Hexagon head screw	
2	Square head screw	
3	Hexagon socket screw	
4	Pan head screw,slotted	
5	Cheese head screw,cross slotted	
6	Raised countersunk screw slotted	
7	Raised countersunk screw,cross slotted	
8	Countersunk screw,slotted	

TABLE 16 - (Concluded)

Item (1)	Description (2)	Simplified representation (3)
9	Countersunk screw,cross slotted	
10	Setscrew,slotted	
11	Wood and self–tapping screw,slotted	
12	Wing screw	
13	Hexagon nut	
14	Slotted nut	
15	Square nut	
16	Wing nut	

APPENDIX A
SIMPLIFIED REPRESENTATION OF CENTRE HOLES AND THEIR DESIGNATION
(informative)

A.1 General

ISO 6411 gives recommendations on the simplified representation of centre holes and their designation. The simplified representation of centre holes may be used particularly when it is not necessary to show the exact form and size and where the designation of standardized centre holes is sufficient for information.

Generally, three different requirements may be defined for the form and size of centre holes.

a) A centre hole is required on the finished part;
b) A centre hole may be accepted on the finished part, but is not a fundamental requirement; and
c) No centre hole should exist on the finished part

A.2 Simplified representation

The symbols representing centre holes and their application to the end face of a shaft are shown in column 2 of Table **1.**

A.3 Designation of centre holes

The designation of centre holes is dependent on the centre drill used and may be indicated with reference either to **ISO 6411** or to any other relevant standard.

The designation of the centre hole itself consists of:

a) a reference to **ISO 6411;**
b) the letter for the type (R,A or B);
c) the pilot diameter d; and
d) the outside countersink centre hole diameter D.

The two values are separated by a solidus.

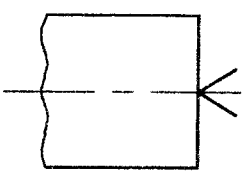
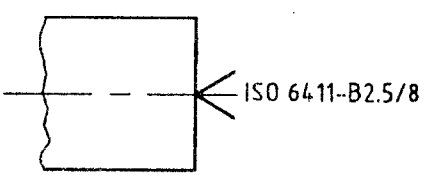
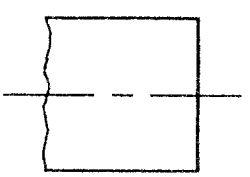
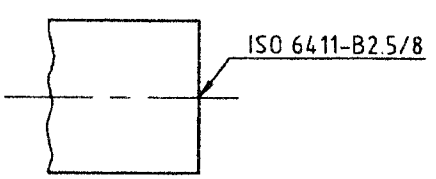
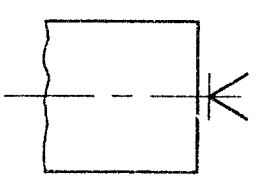
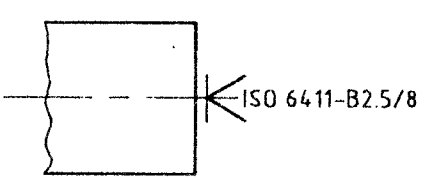
By way of example and referring to Table **18**, a centre hole* type B with d= 2.5 mm and D_3 = 8 mm may be indicated on the drawing as:

ISO 6411 - B 2.5/8

A.4 Interpretation of indication

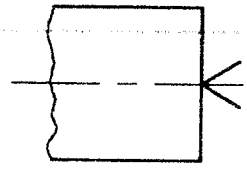
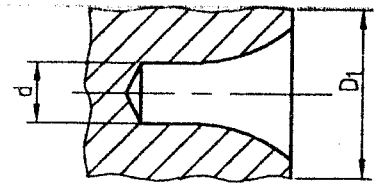
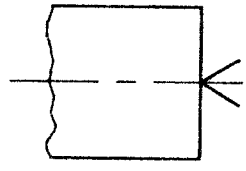
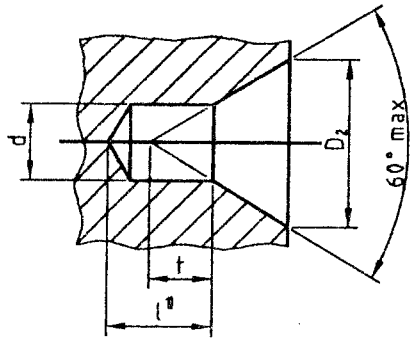
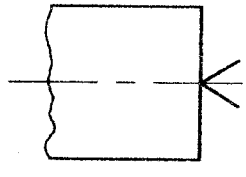
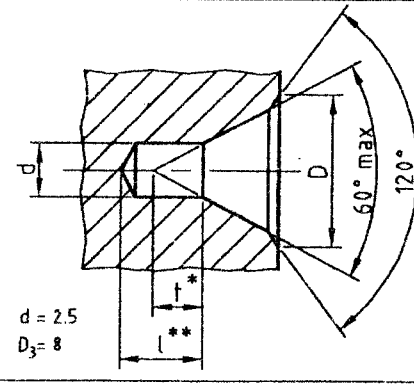
The relationship between the various designations used to indicate the centre holes, the dimensions represented by the given designations, and dimensions depending on the centre drill used are shown in Table **18.**

TABLE - 17 Representation and designation of centre holes on drawings

Requirement (1)	Representation (2)	Designation (3)
Centre hole is required on the finished part.		
Centre hole may remain on the finished part.		
No Centre hole should exit on the finished part.		

*For the machining of such a centre hole, a drill with d=2.5 mm and d = 10 mm according to **ISO 2540** is used

TABLE 18 - Interpretation of the designation

Type of centre hole (1)	Examples ofdesignation (2)	Interpretation (3)
R with radius from (centre drll according to ISO 2541)		 d = 3.15 D_1 = 6.7
A without protecting chamfer (centre drill according to ISO 866)		 d = 4 D_2 = 8.5
B without protecting chamfer (centre drill according to ISO 2541)		 d = 2.5 D_3 = 8

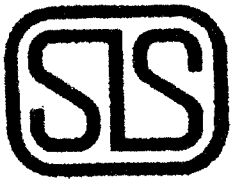
* For dimension t, see SLS 409 part2

** Dimension l depend on the length of the centre drill. It should not be less than t.

SLS CERTIFICATION MARK

The Sri Lanka Standards Institution is the owner of the registered certification mark shown below. Beneath the mark, the number of the Sri Lanka Standard relevant to the product is indicated. This mark may be used only by those who have obtained permits under the SLS certification marks scheme. The presence of this mark on or in relation to a product conveys the assurance that they have been produced to comply with the requirements of the relevant Sri Lanka Standard under a well designed system of quality control inspection and testing operated by the manufacturer and supervised by the SLSI *which includes surveillance inspection of the factory, testing of both factory and market samples.*

Further particulars of the terms and conditions of the permit may be obtained from the Sri *Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.*



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SRI LANKA STANDARDS INSTITUTION

The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Science & Technology.

The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

The Institution is financed by Government grants, and by the income from the sale of its publications and other services offered for Industry and Business Sector. Financial and administrative control is vested in a Council appointed in accordance with the provisions of the Act.

The development & formulation of National Standards is carried out by Technical Experts and representatives of other interest groups, assisted by the permanent officers of the Institution. These Technical Committees are appointed under the purview of the Sectoral Committees which in turn are appointed by the Council. The Sectoral Committees give the final Technical approval for the Draft National Standards prior to the approval by the Council of the SLSI.

All members of the Technical & Sectoral Committees render their services in an honorary capacity. In this process the Institution endeavours to ensure adequate representation of all view points.

In the International field the Institution represents Sri Lanka in the International Organization for Standardization (ISO), and participates in such field of standardization as are of special interest to Sri Lanka.

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