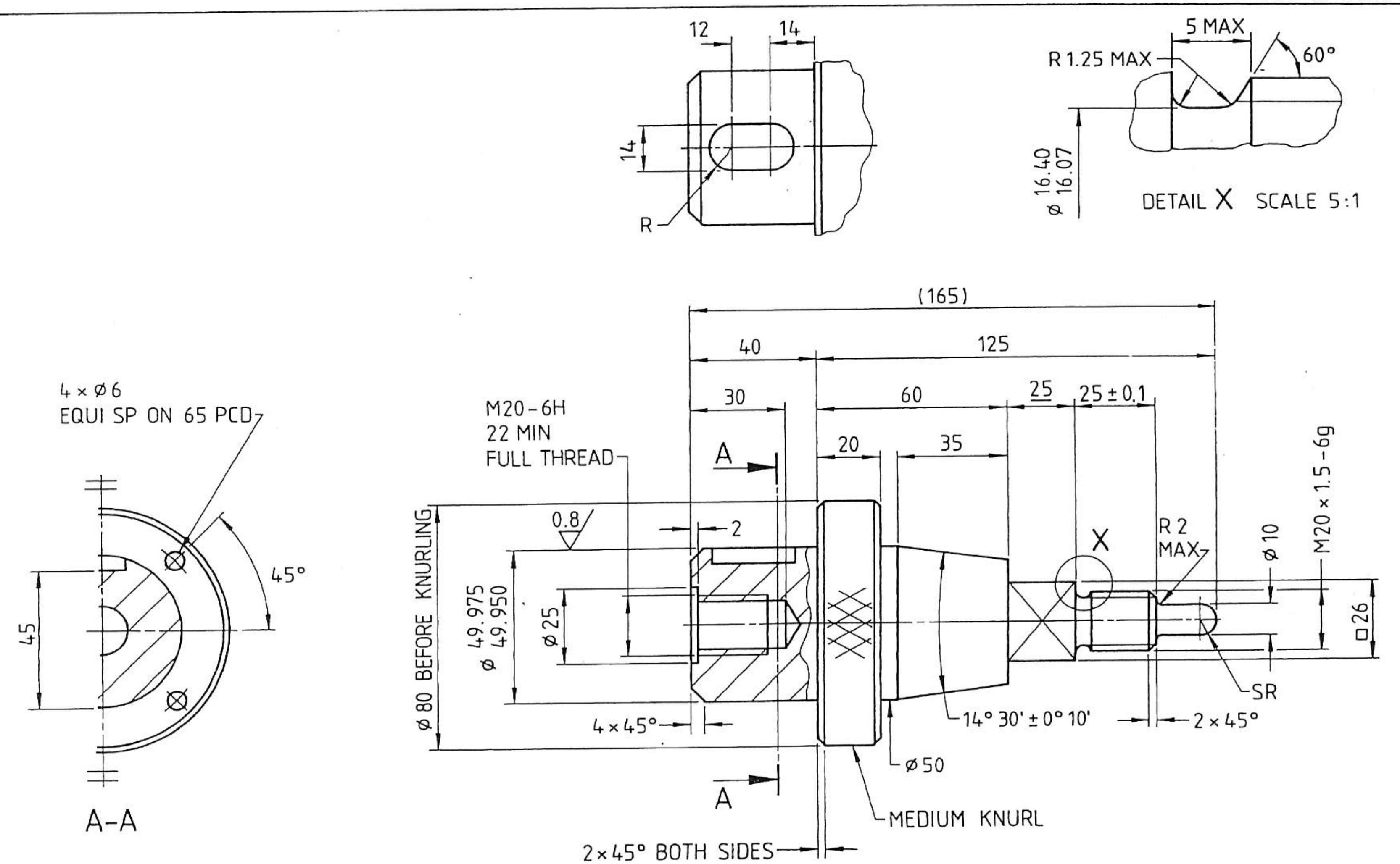


DO NOT SCALE

FINISH TO BS 1134	TOLERANCE	MATERIAL	PROJECTION	DRAWN MAP	ORIGINAL	ALL DIMENSIONS IN mm	
1.6 ∇ ALL OVER EXCEPT	DIMENSIONAL ± 0.2	STEEL TO BS 970		DATE 86 06 17	SCALE	CONNECTOR	DRG NO.
WHERE STATED	ANGULAR ± 2° UNLESS	070M26		CHECKED LD	1:1		2
THREADS TO BS 3643	OTHERWISE STATED			DATE 86 06 30			

15 Machining and surface texture indication (see also PD 7306)

Symbols indicating surface texture

The basic symbol is a tick the two legs of which are inclined at approximately 60° to the line representing the surface, as shown in figure 88(a).

If machining of the surface is required, a bar is added to the basic symbol as shown in figure 88(b).

If removal of material is not permitted, a circle is added to the basic symbol as shown in figure 88(c).

The line thickness used for the symbols should be the same as that used for the dimensions on the drawing.

Application of symbols

Symbols should normally be shown once on each surface, preferably on the same view as the size or location dimensions of the surface.

Symbols may be applied to the outline representing the surface, to a projection line, to a leader line, or to an extension of a dimension line. In all cases the symbol should be applied normal to the line.

Indications added to the symbols

Surface texture values (R_a roughness values, see BS 1134) in micrometres (μ m) are added to the symbols as in figure 89. When only one value is specified it represents the maximum permissible value of surface roughness.

When it is necessary to specify maximum and minimum values of surface roughness, the maximum limit is placed above the minimum limit (see figure 89).

Where all the surfaces are to be machined a general note may be used, as shown in figure 90, and a value added if necessary.

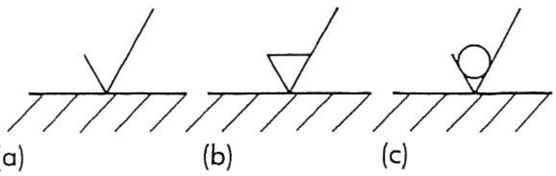


Figure 88. Surface texture symbols

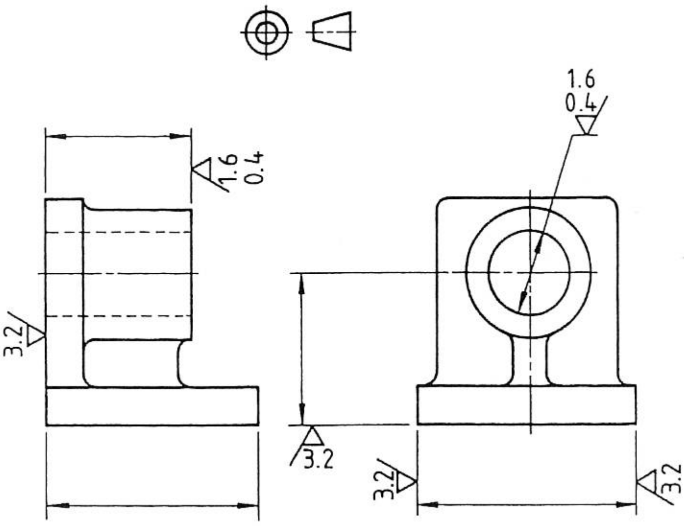
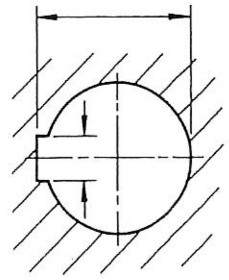


Figure 89. Application of surface texture symbols and values

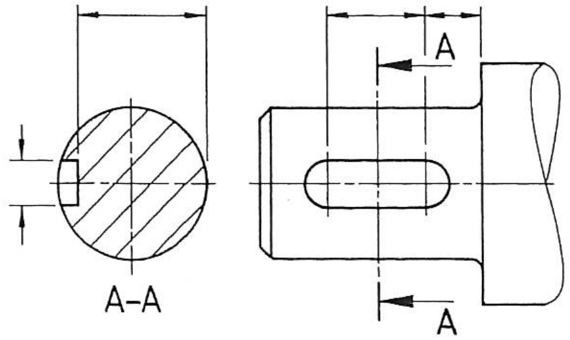
Figure 90. Machining indicated by a general note

Keyways

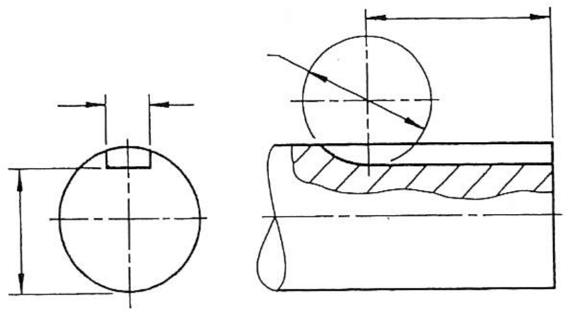
Methods of dimensioning keyways in hubs and shafts are shown in figure 83(a), (b) and (c), and Woodruff keyways in figure 83(d).



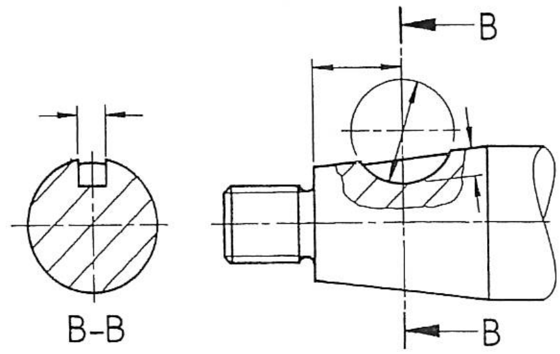
(a) Keyway in a parallel hub



(b) Keyway in a shaft for a BS rectangular key



(c) Keyway at end of shaft for a BS rectangular key



(d) Woodruff keyway (in a tapered shaft)

Figure 83. Dimensioning keyways

13 Tapered features

Dimensioning

Tapered features may be dimensioned by different methods as in figures 84 and 85.

Taper symbol

The international symbol for taper is ▷ and its direction shows that of the taper (see figure 85 and section 9).

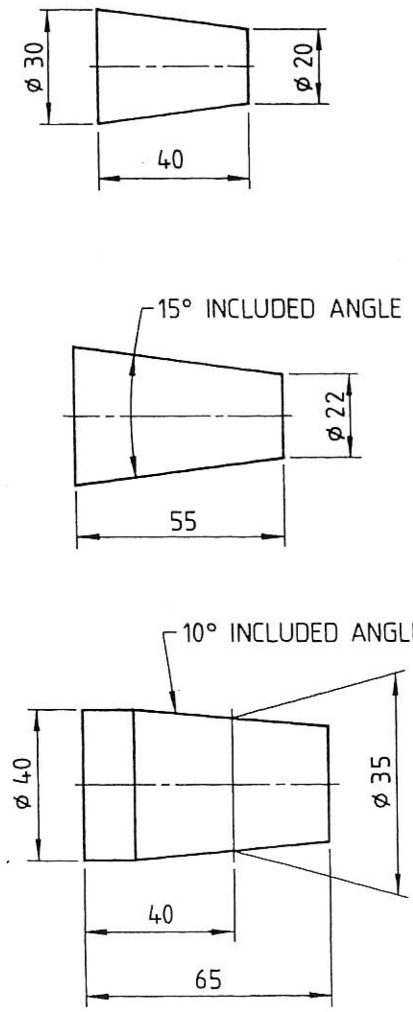


Figure 84. Dimensions defining tapered objects

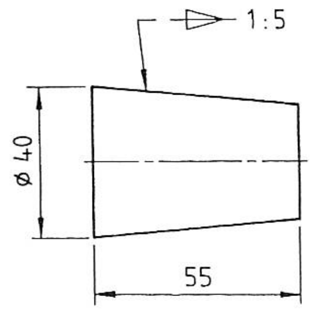


Figure 85. Taper symbol

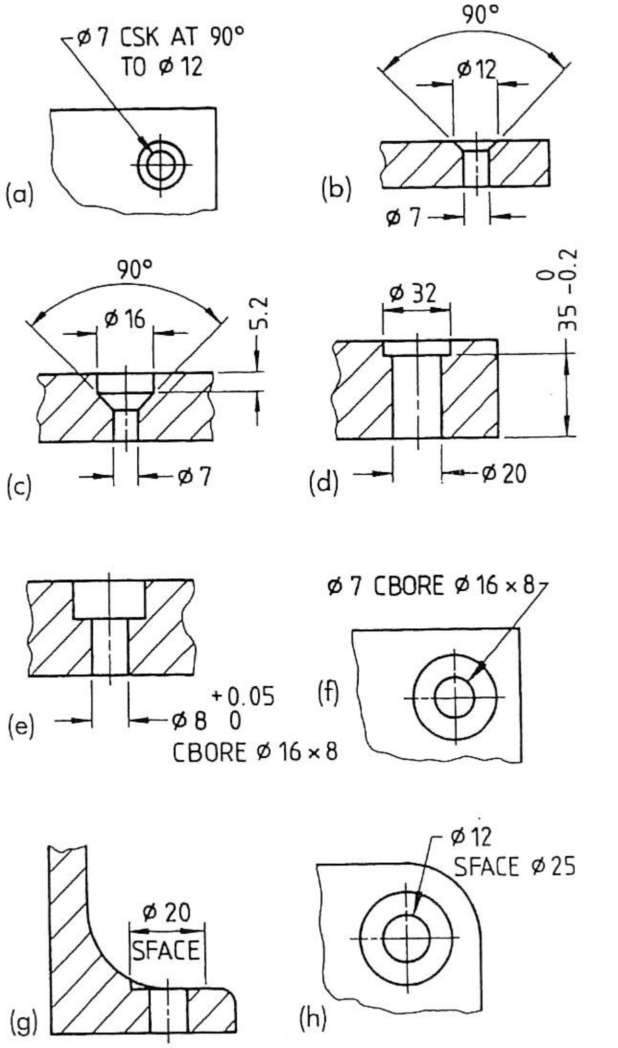


Figure 78. Dimensioning countersinks, figures (a), (b) and (c); counterbores, figures (d), (e) and (f); and spotfaces, figures (g) and (h)

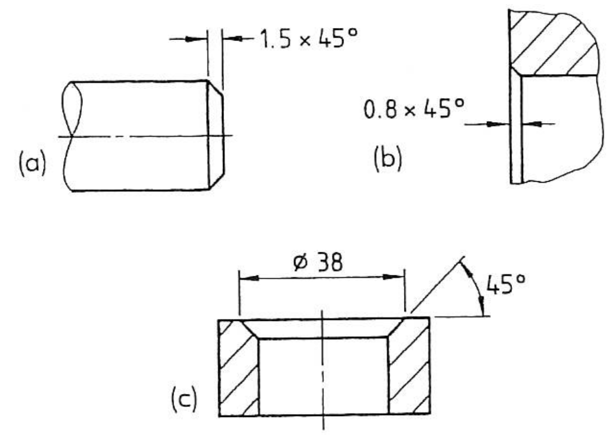


Figure 79. Dimensioning 45° chamfers

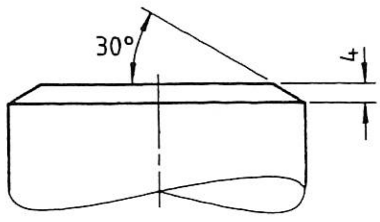


Figure 80. Dimensioning chamfers at angles other than 45°

Countersinks, counterbores and spotfaces

When dimensioning a countersink, counterbore or spotface, the dimensions should be given as in figure 78. Notes such as CBORE TO SUIT M6 CH HD SCREW should not be used.

The term 'spotface' implies that the depth is the minimum necessary to provide a completely machined surface of the specified diameter.

Chamfers

Chamfers at 45° should be dimensioned as shown in figure 79 and not described by a note.

Chamfers at angles other than 45° are dimensioned as shown in figure 80.

Bolts, screws, nuts and washers

These may be drawn to the dimensions specified in BS 3692 or BS 4190 for ISO metric bolts, screws and nuts, and to BS 4320 for washers. For recommended drawing ratios see PD 7300.

Radii

Radii should be dimensioned by a dimension line that passes through, or is in line with, the centre of the arc. The dimension line should have one arrowhead only, that which touches the arc. The symbol R is placed in front of the dimension.

Radii of arcs which need their centres located should be dimensioned as in figure 71 (a). Radii of arcs which need not have their centres located should be dimensioned as shown in figure 71 (b).

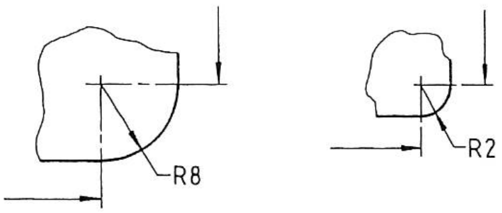
The radius of a spherical surface should be dimensioned as in figure 72.

Where the size of a radius is defined by other dimensions, it is indicated with a radius dimension line and the symbol R without a value (see figure 73).

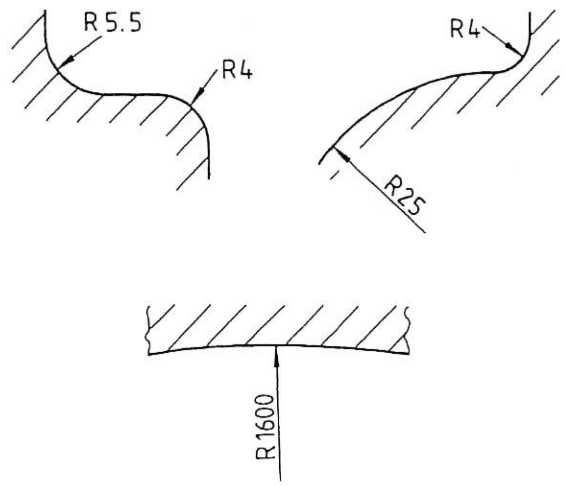
Size of holes

Typical methods of dimensioning holes are shown in figure 74. Methods of production (e.g. drill, punch, core, ream, etc.) are not specified except where they are necessary to the function. The depth of drilled holes, when given in note form, refers to the depth of the cylindrical portion of the hole and not to the point of the drill.

For international understanding the word 'hole' is omitted from notes unless its use is considered necessary.



(a) Dimensioning radii of arcs which need their centres located



(b) Dimensioning radii of arcs which need not have their centres located

Figure 71. Dimensioning radii of arcs

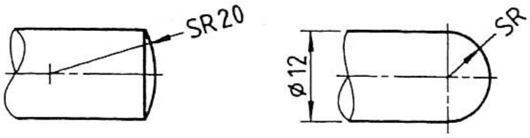


Figure 72. Dimensioning spherical radii

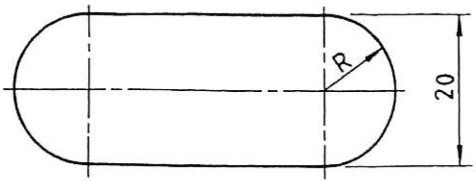


Figure 73. Indicating radii by other dimensions

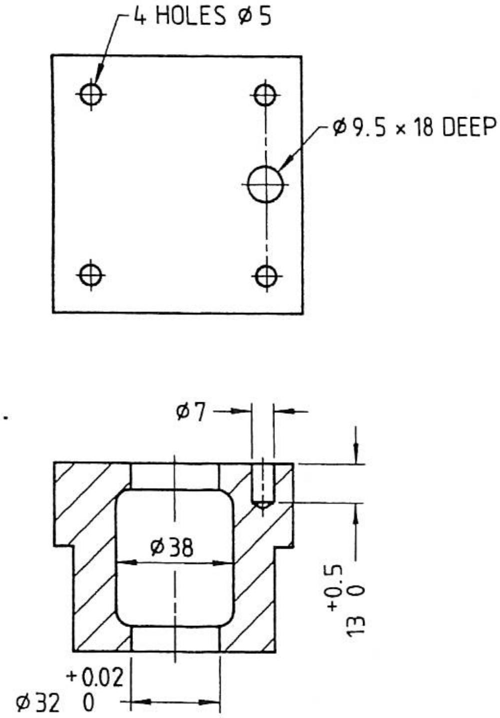


Figure 74. Dimensioning holes

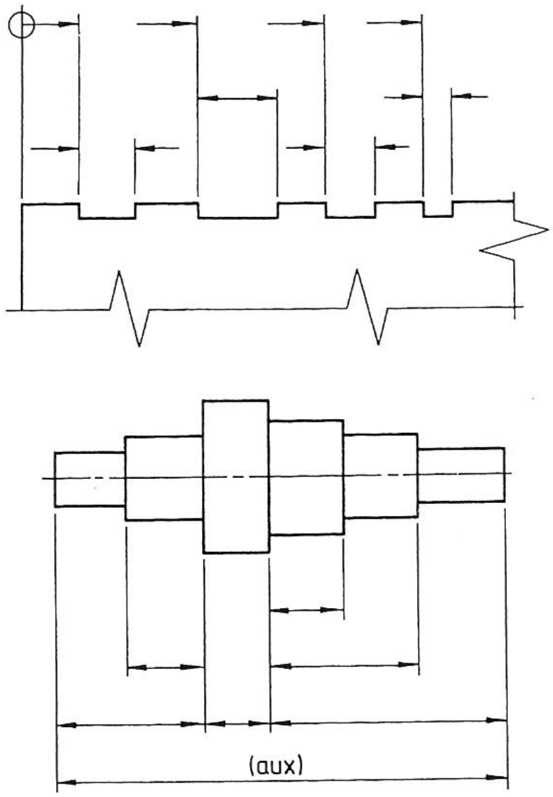


Figure 64. Combined dimensioning

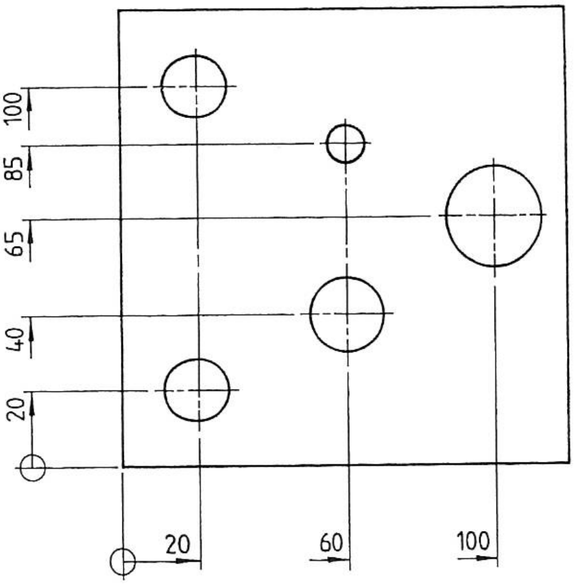
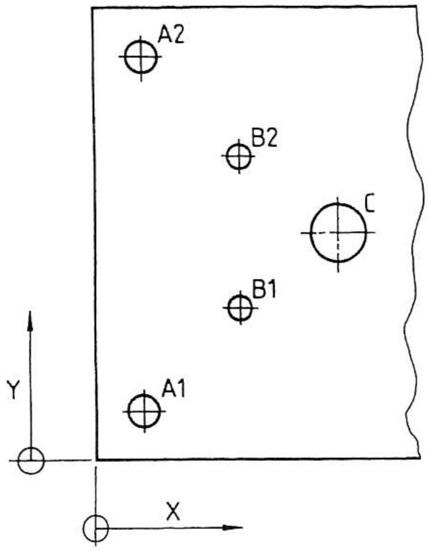


Figure 65. Dimensioning by coordinates



HOLE	X	Y	ø
A1	20	20	15
A2	20	160	15
B1	60	60	10
B2	60	120	10
C	100	90	25

Figure 66. Dimensioning by coordinates and a table

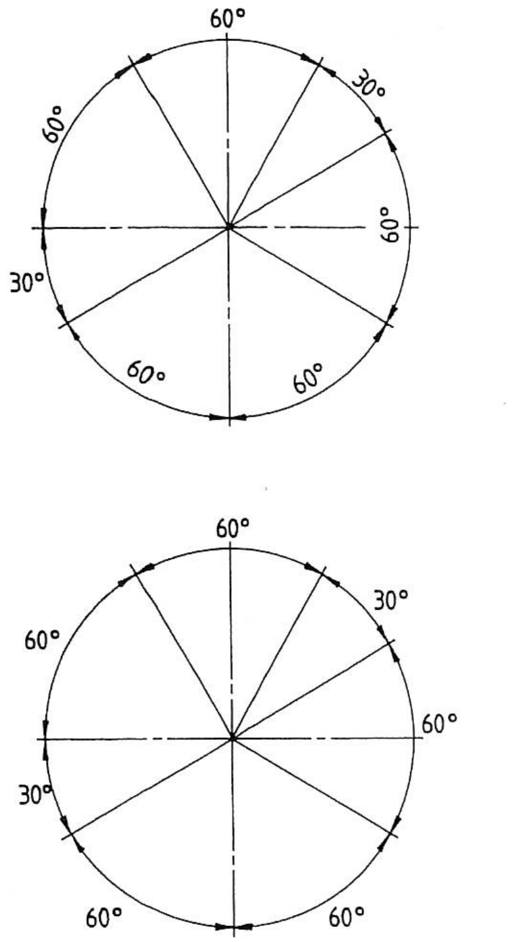


Figure 56. Orientation of angular dimensions

Figure 57. Dimensioning small features

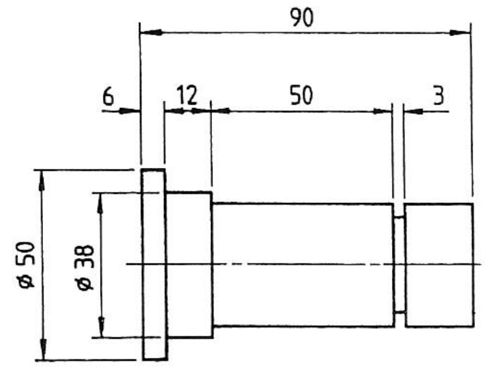


Figure 58. Larger dimensions placed outside smaller dimensions

Auxiliary dimensions

Where an overall dimension is shown, one of the intermediate dimensions would be redundant and therefore would not be shown, as in figure 58. Exceptions may be made where redundant dimensions would provide useful information; in these cases they should be given as auxiliary dimensions. Where all the intermediate dimensions are necessary, the overall length can be given as an auxiliary dimension (see figure 59).

Further applications are shown in figures 60 and 76.

Auxiliary dimensions should not be toleranced (see section 14) and should be shown thus: (90), (50), (100), etc., as in figures 59 and 60. Auxiliary dimensions, though useful in manufacture, do not govern acceptance of the product.

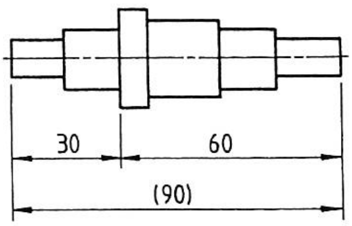


Figure 59. Overall length added as an auxiliary dimension

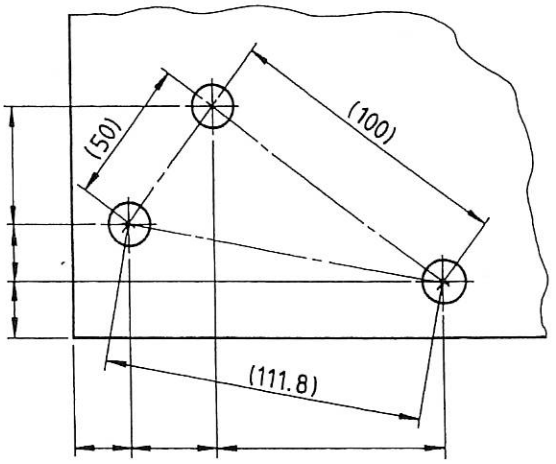


Figure 60. Application of auxiliary dimensions

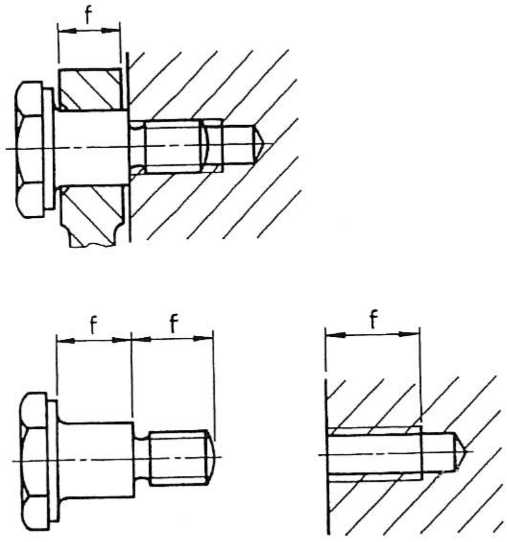


Figure 48. Functional dimensioning

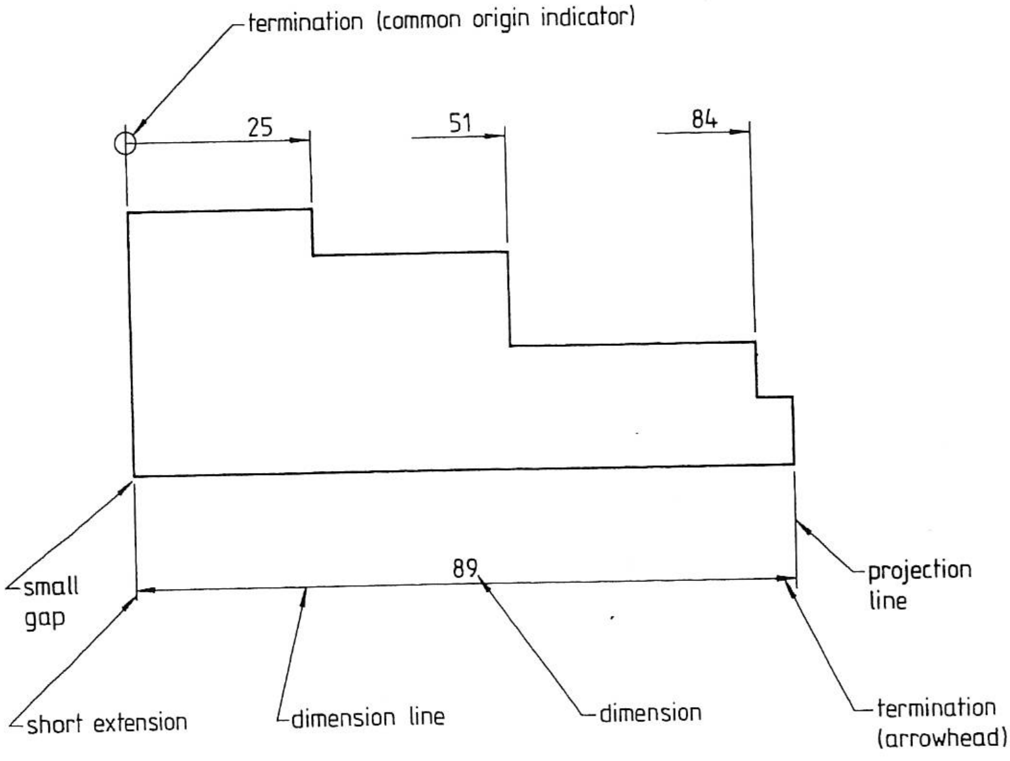


Figure 49. Elements of dimensioning

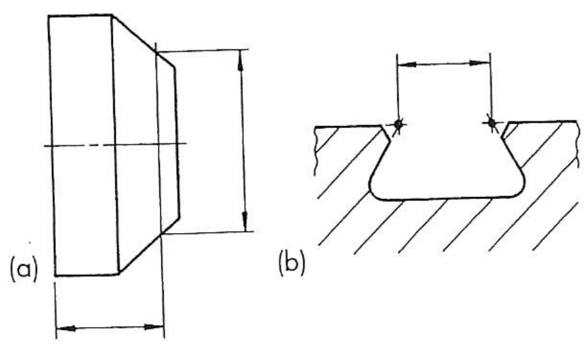


Figure 50. Projection lines from points of intersection

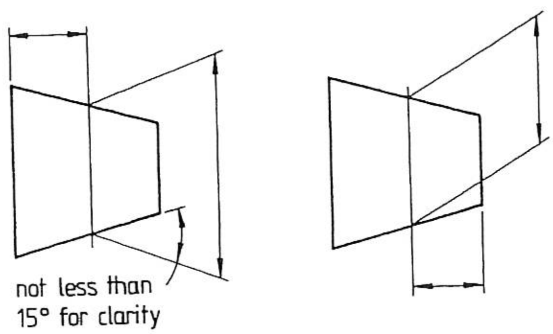


Figure 51. Projection lines oblique to feature

When a pair of gears is drawn in mesh neither is assumed to be hidden by the other in the portion in mesh except:

(a) if one gear is located in front of the other and thereby effectively conceals part of it (see the left-hand view of figure 45(b));

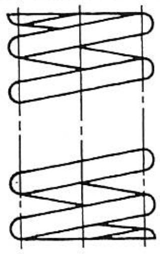
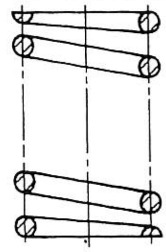
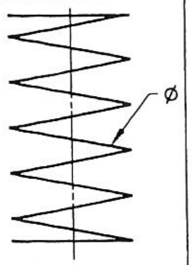
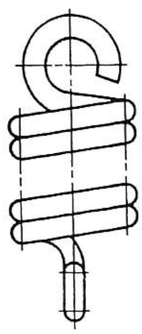
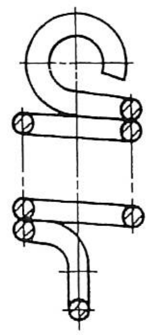
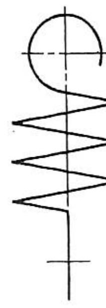
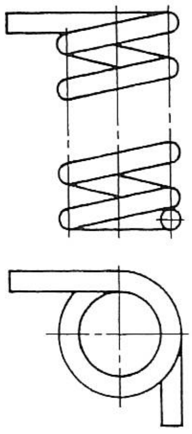
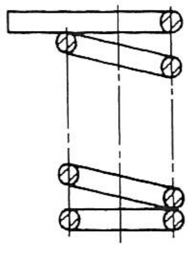
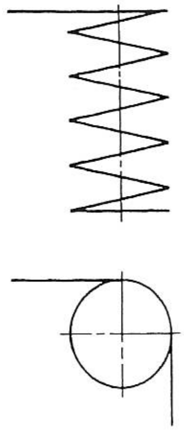
(b) if both gears are drawn in axial section, in which case one gear, chosen arbitrarily, is assumed to be partly concealed by the other (see the right-hand view of figure 45(b)).

In these two cases, hidden edges in the portion in mesh are not normally shown (see figure 45(b)).

For a pair of bevel gears drawn in mesh, extend the lines representing the pitch lines of the teeth to form the pitch cones (see figure 45(b)).

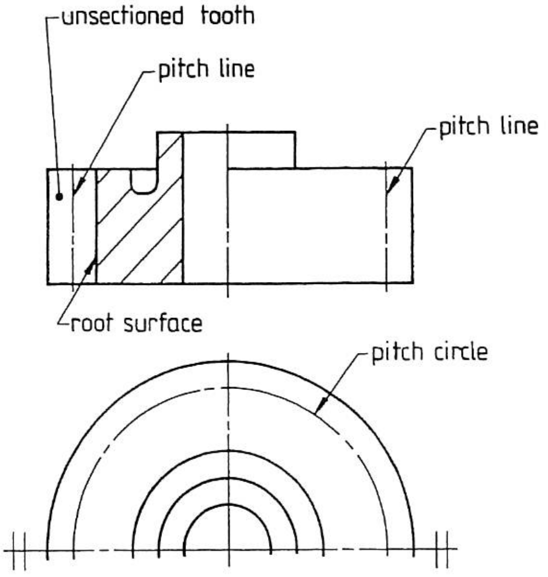
Springs

Figure 47 illustrates by means of examples the conventional representations for cylindrical helical springs. In views and sections take care to show the correct direction of the helix.

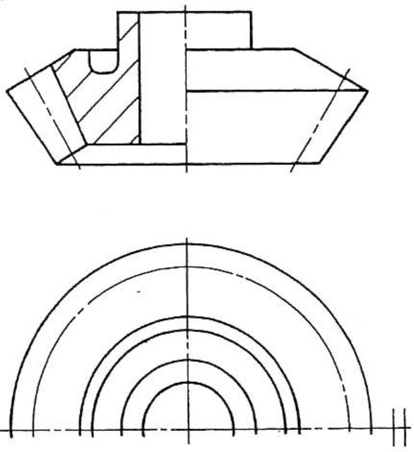
Description	Representation		
	View	Section	Simplified*
(a) Cylindrical helical compression spring of wire of circular cross section			
(b) Cylindrical helical tension spring of wire of circular cross section			
(c) Cylindrical helical torsion spring of wire of circular cross section			

*If necessary, indicate 'wound left- (or right-) hand.'
The springs shown are all wound right-hand.
If necessary, the cross section of the spring material may be indicated in words or by a symbol, see (a).

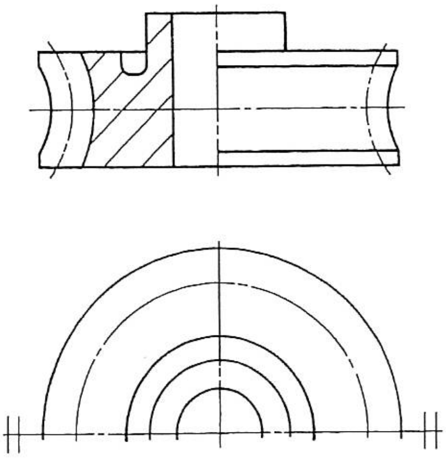
Figure 47. Conventions for representing cylindrical helical springs



(a) Spur



(b) Bevel



(c) Worm wheel

Figure 43. Conventional representation for gears

Gears

On both detail and assembly drawings, all types of gears and chain wheels are conventionally represented (except in axial section) as solid parts without teeth. The pitch circle and pitch lines are added to the conventional representation using type F lines (see table 1).

Examples of this conventional representation are shown in figures 43 to 46.

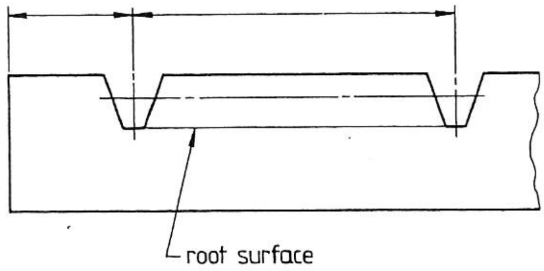
In an axial sectional view an unsectioned tooth is shown in the plane of section at each side of the gear. This convention applies to gears with even or odd numbers of teeth and to any type of gear.

Teeth profile should be specified either by reference to a standard or by a separate view of one tooth to a suitable scale.

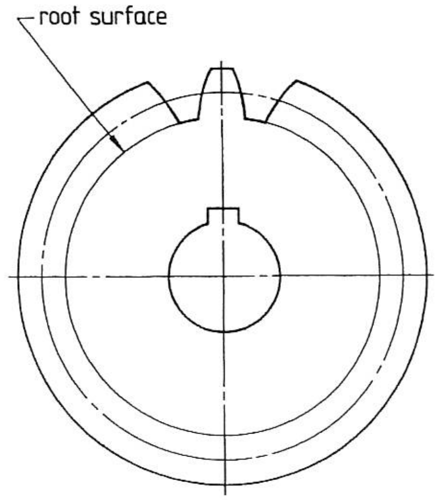
One or two teeth may be shown on the drawing itself:

(a) to define the ends of a toothed portion or rack (see figure 44(a));
(b) to specify the position of the teeth relative to a feature on the gear such as the keyway in the bore (see figure 44(b)).

In these cases the root surface of the teeth may be shown with a type B line (see table 1). Otherwise the root surface is generally shown only in sectional views (see figure 43(a)).



(a) Ends of rack defined



(b) Teeth position specified relative to keyway

Figure 44. Examples of gears where one or two teeth need to be shown

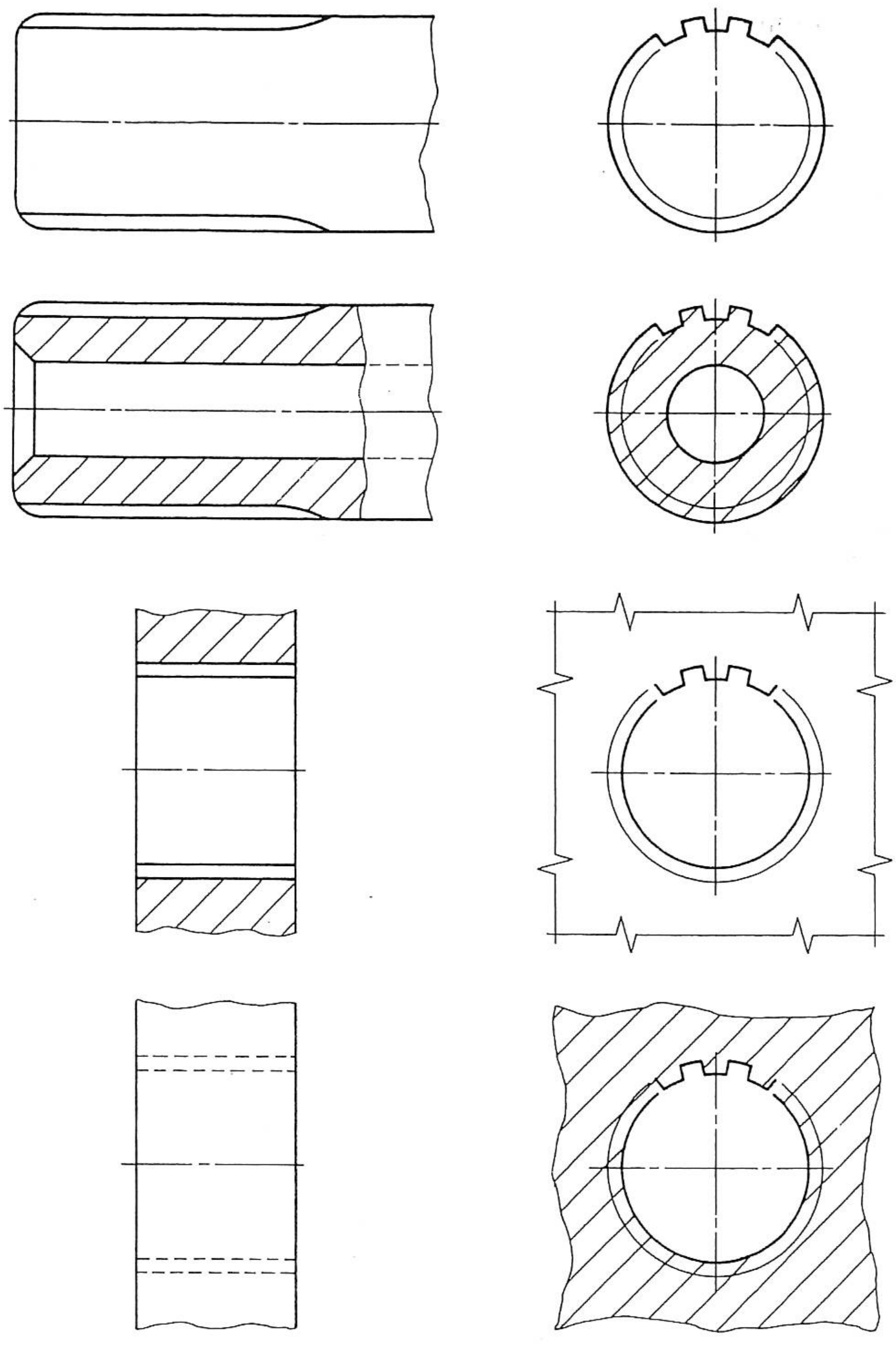


Figure 38. Splines

Splines and serrations

In end view the teeth of all splines and serrations may be shown in simplified form (see figures 38 and 39).

The conventions for splines in full view and section shown in figure 38 apply also for serrations.

The dimensions of splines and serrations with any other necessary information should be shown in a note.

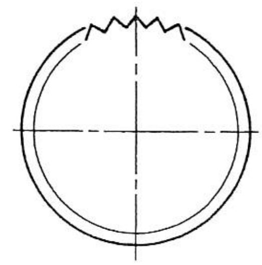


Figure 39. Serrations

9 Symbols and abbreviations

General

Symbols and abbreviations are used on drawings to save space and time whilst giving precise and clear description. Only commonly used and understood symbols and abbreviations should be used; a selection is given below. Others should be avoided and the intended meaning expressed in words.

Abbreviations are the same in the singular and plural. Full stops are only used where the abbreviation itself makes a word (e.g. NO. and FIG.).

Welding symbols

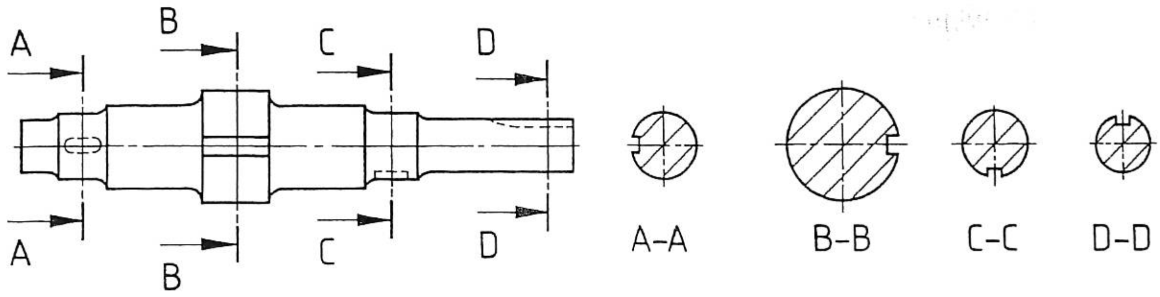
Where welds are to be shown by means of symbols, reference should be made to BS 499: Part 2.

Commonly accepted symbols and abbreviations

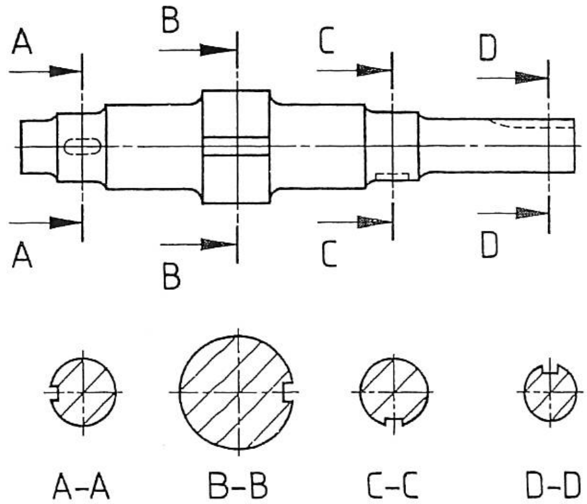
Term	*Abbreviation or symbol*
Across flats	AF
Assembly	ASSY
Centres	CRS
Centre line	
on a view	℄
in a note	CL
Chamfered, chamfer (in a note)	CHAM
Cheese head	CH HD
Countersunk	CSK
Countersunk head	CSK HD
Counterbore	CBORE
Cylinder or cylindrical	CYL
Diameter (in a note)	DIA
Diameter (preceding a dimension)	⌀
Drawing	DRG
Equally spaced	EQUI SP
External	EXT
Figure	FIG.
Hexagon	HEX
Hexagon head	HEX HD
Hydraulic	HYD
Insulated or insulation	INSUL
Internal	INT
Left hand	LH
Long	LG
Material	MATL
Maximum	MAX
Minimum	MIN
Number	NO.
Pattern number	PATT NO.
Pitch circle diameter	PCD
Radius (in a note)	RAD
Radius (preceding a dimension)	R
Required	REQD
Right hand	RH
Round head	RD HD
Screw (or screwed)	SCR
Sheet	SH
Sketch	SK
Specification	SPEC
Spherical diameter (only preceding a dimension)	S⌀
Spherical radius (only preceding a dimension)	SR
Spotface	SFACE
Square (in a note)	SQ
Square (preceding a dimension)	□* or ⊠
Standard	STD
Taper, on diameter or width	▷ (orientated to direction of taper)
Thread	THD
Typical or typically	TYP
Undercut	UCUT
Volume	VOL
Weight	WT

* This symbol is recognized internationally

Further recognized abbreviations for particular subjects are listed in other British Standards.



(a) In projection



(b) Alternative arrangement

Figure 31. Successive sections

Successive sections. Successive removed sections of a part are shown in figure 31. The sections should all be viewed in the same direction whenever possible. If, through lack of space, successive removed sections cannot be shown in true projection, as in figure 31 (a), they may be arranged as in figure 31 (b).

Revolved and removed sections, because they have no thickness, are sections and not sectional views.

Parts and features of parts not normally sectioned

When a sectional view is given where the cutting plane passes longitudinally through fasteners, such as bolts and nuts, and shafts, ribs, webs, spokes of wheels, etc., it is the practice to show them in external view (see figure 32).

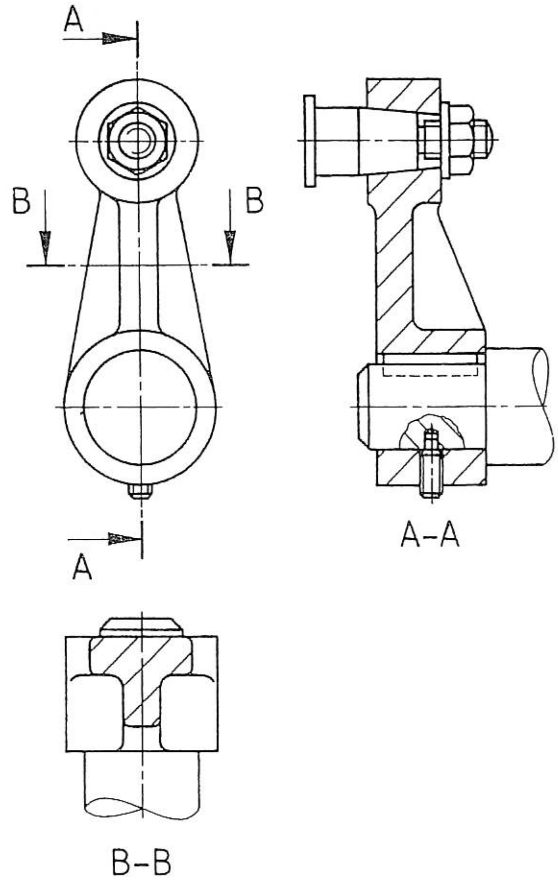


Figure 32. Conventions in longitudinal section

Types of sectional views and sections

Sectional views in one plane. Examples of sectional views in one plane are shown in figures 19 and 23.

Sectional views in more than one plane.
(a) Sectional views in two or more parallel planes. A sectional view in two parallel planes is shown in figure 24 and one in three parallel planes in figure 25.

(b) Sectional views in intersecting planes. Where a sectional view is taken in two intersecting planes the view, by convention, is drawn as if the two cutting planes were one continuous plane. The part of the view on the plane that is not normal to the sectional view required, is shown moved or revolved into the other plane (see figure 26).

The hatching on sectional views in more than one plane follows the same principles as for sectional views in one plane. The thick line portions of the cutting plane show its changes of direction.

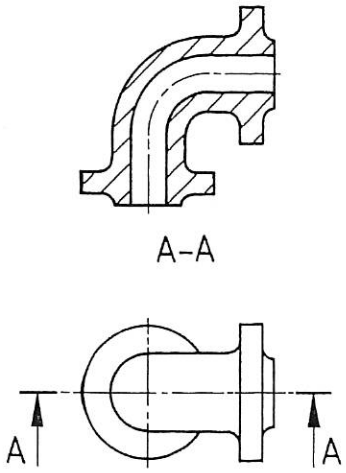


Figure 23. Sectional view in one plane

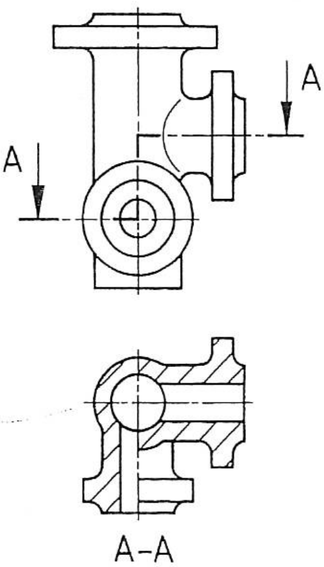


Figure 24. Sectional view in two parallel planes where the change in direction of the cutting plane occurs on a centre line

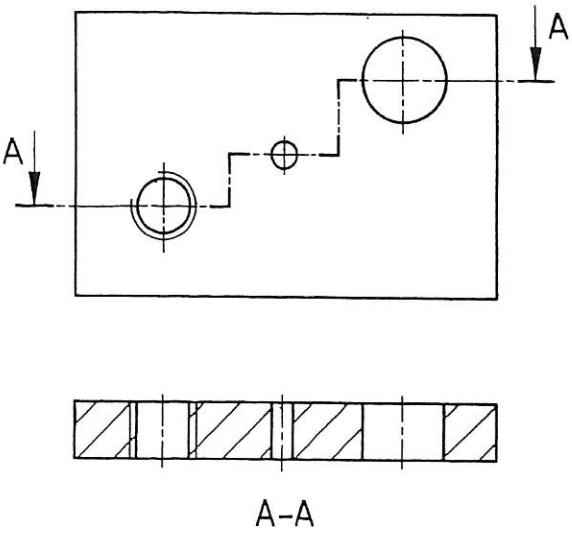


Figure 25. Sectional view in three parallel planes where the changes in direction of the cutting plane do not occur on a centre line

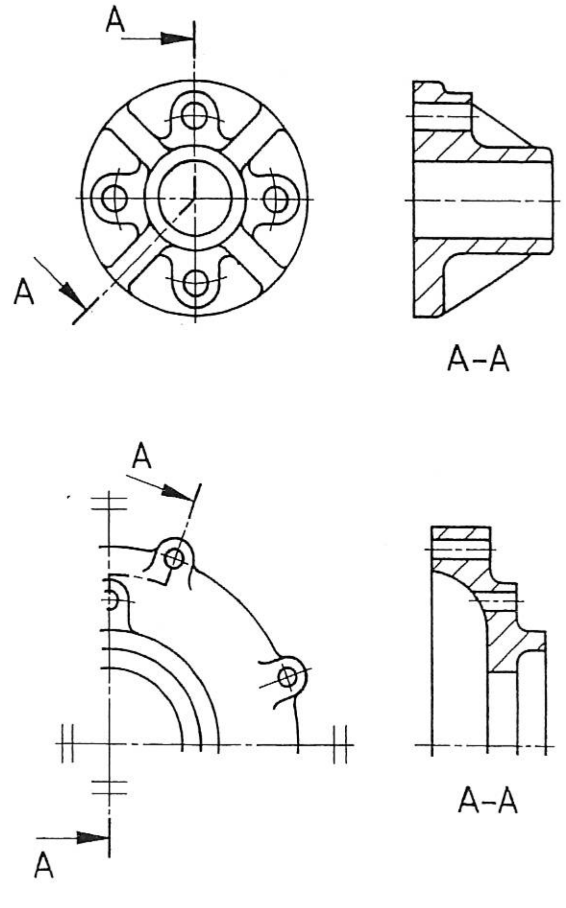


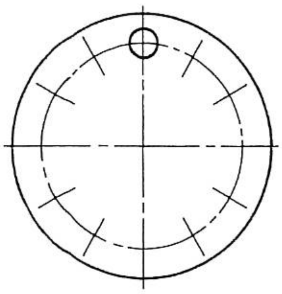
Figure 26. Sectional views in intersecting planes

Representation of repetitive features

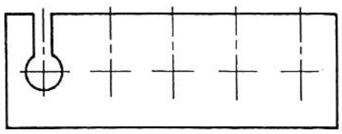
Repeated illustrations of similar features and parts may be avoided by drawing one and showing the positions of the others by their centre lines (see figure 17).

The number of repetitive features and any other necessary information should be given by dimensioning or by a note.

When a single feature, such as the notch and keyway in figure 18, is to be positioned relative to one or more repetitive features, those repetitive features should be drawn in full to make the relationship clear.



(a) Holes on circular pitch



(b) Slots on linear pitch

Figure 17. Representation of repetitive features

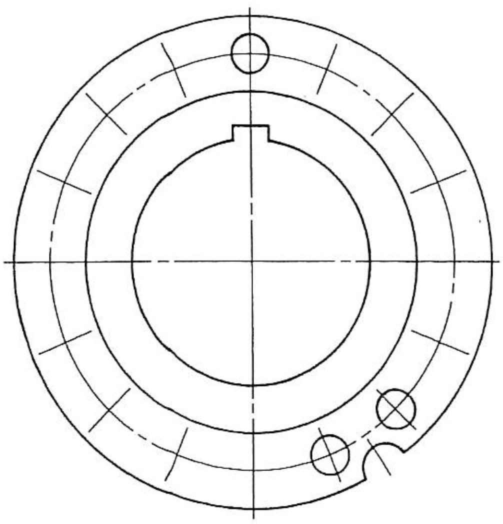


Figure 18. Positioning repetitive features relative to single features

7 Sections and sectional views

General

Sections and sectional views result when cutting planes are passed through an object. Although the terms are often used as if they were interchangeable, they have distinct meanings as follows:

section: the outline of the object at the cutting plane only. Visible outlines beyond the cutting plane in the direction of viewing are not shown. Therefore a section has no thickness.

sectional view: the outline of an object at the cutting plane together with all visible outlines seen beyond the cutting plane in the direction of viewing.

Arrangement

The rules for the arrangement of views (see sections 5 and 6) apply when drawing sections and sectional views.

Cutting planes

Cutting planes are shown by type G lines (see table 1). The direction of viewing is shown by arrows with large heads (see section 3), the points of which touch the cutting plane. A capital letter, placed close to the stems of the arrows, labels the cutting plane. The same letter is used in an identifying title, such as A-A, which should be placed below the resulting section or sectional view. If considered necessary the title may be SECTION A-A, and this form is used for both a section and a sectional view. (See figure 19.)

Where the position of a single cutting plane is obvious it need not be shown and the resulting section or sectional view is not given an identifying title. See figures 45 and 67.

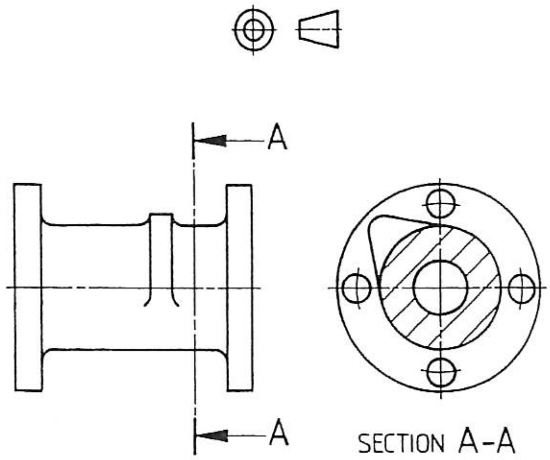


Figure 19. Indication of cutting planes

6 Views on drawings

General

The presentation of the information should be clear and as complete as necessary. When planning the layout of a drawing, take care with the spacing of the views to make sure that the drawing can be read easily.

Number of views

Before beginning a drawing it is necessary to have a clear mental picture of the views to be shown. The number of views should be the minimum necessary to ensure that there will be no misunderstanding. Views should be chosen to need as few hidden lines as possible.

Partial views

It is not always necessary to draw a full view. Sometimes a partial view is adequate. An example is shown projected from an inclined feature (see view A in figure 12).

It may be helpful to draw an enlarged partial view if the general scale of a drawing is so small that a particular feature cannot be shown clearly or dimensioned adequately. The feature is framed with a type B line (see table 1) and identified with a capital letter. The feature is then drawn again to a stated larger scale with its identification letter (see figure 13).

The boundary which limits a partial view is drawn with a type C or type D line (see table 1) depending on the length of the boundary. See figure 3.

Simplified representation of symmetrical parts

It is not always necessary to draw symmetrical parts in full. A fraction of the whole part may be drawn instead (see figure 14). A line of symmetry is shown by a type F line (see table 1). Two short parallel type B lines (see table 1) are drawn at each end of and at right angles to the line of symmetry. The outline of the part is extended slightly beyond the line of symmetry.

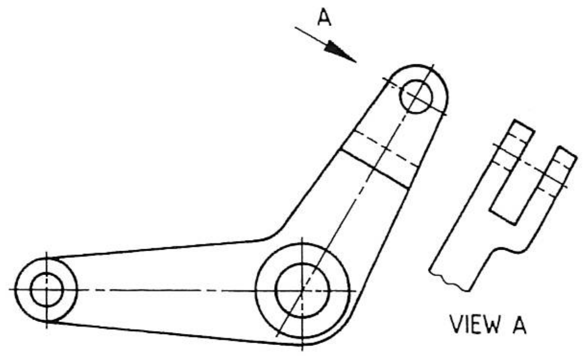


Figure 12. Partial view projected from an inclined feature

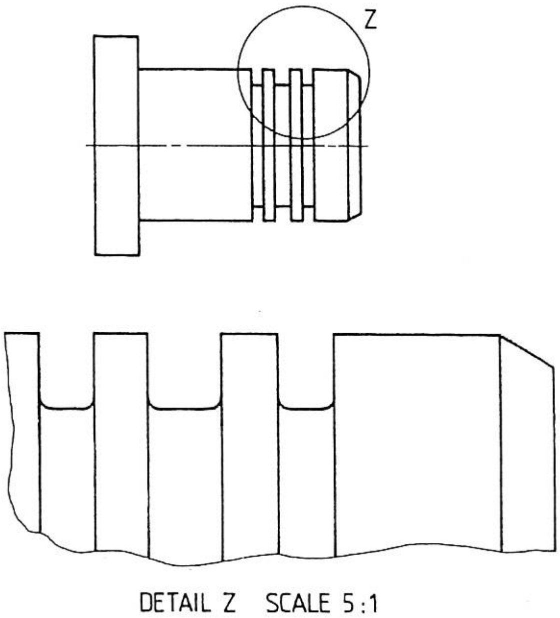


Figure 13. Enlarged partial view

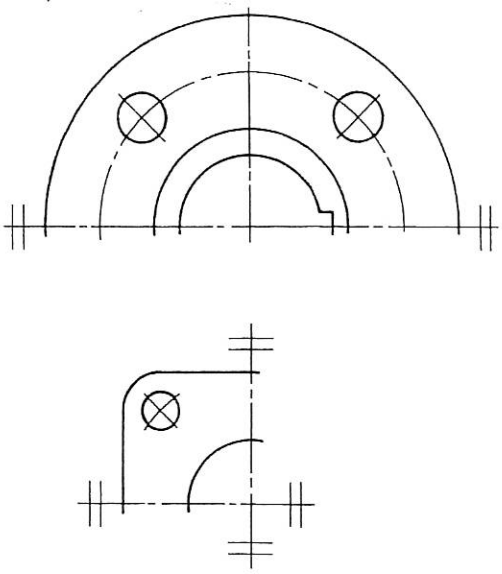


Figure 14. Symmetrical parts

4 Lettering and numerals

General

Clarity, style, spacing and size are important. Numerals especially should be drawn clearly as they often have to be read on their own. All strokes should be black and of uniform density.

Style

In general, capital letters should be used. Some suggested examples of letters and numerals are shown in figure 8.

ABCDEFGHIJKLMNOPQRST
UVWXYZ
1234567890

ABCDEFGHIJKLMNOP
QRSTUVWXYZ
1234567890

Figure 8. Examples of letters and numerals

Character height

The dimensions and notes should be not less than 3 mm tall. Titles and drawing numbers are normally larger.

Direction of lettering

Notes and captions should be placed so that they can be read in the same direction as the information in the title block. For dimensions see section 11.

Location of notes

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

Notes relating to specific details should appear near the relevant feature, but not so near as to crowd the view.

Underlining

Underlining of notes is not recommended. Larger characters should be used to draw attention to a note or caption.

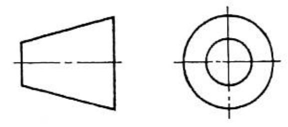
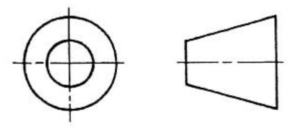
5 Systems of projection

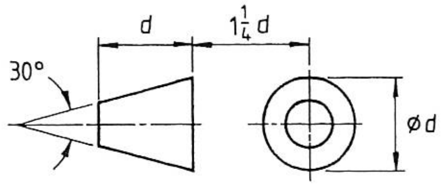
General

Either first or third angle projection may be used. Mixed projections on one drawing are undesirable. If, exceptionally, a view cannot be conveniently shown in its correct projected position, the direction of viewing should be clearly shown. An arrow and view title may be used, similar to those in figure 12.

Projection symbols

The system of projection used on a drawing should be indicated by the appropriate symbol given in figure 9.

Projection	Symbol
First angle	
Third angle	



Recommended proportions

Figure 9. Symbols indicating method of projection

Table 1. Types of line

Line	Description	Application
A	Continuous thick	Visible outlines and edges
B	Continuous thin	Dimension, projection and leader lines, hatching, outlines of revolved sections, short centre lines, imaginary intersections
C	Continuous thin irregular	Limits of partial or interrupted views and sections, if the limit is not an axis
D	Continuous thin straight with zigzags	
E	Dashed thin	Hidden outlines and edges
F	Chain thin	Centre lines, lines of symmetry, trajectories and loci, pitch lines and pitch circles
G	Chain thin, thick at ends and changes of direction	Cutting planes
H	Chain thin double dashed	Outlines and edges of adjacent parts, outlines and edges of alternative and extreme positions of movable parts, initial outlines prior to forming, bend lines on developed blanks or patterns

Coinciding lines

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

(a) visible outlines and edges (type A);

(b) hidden outlines and edges (type E);

(c) cutting planes (type G);

(d) centre lines, etc. (types F and B);

(e) outlines and edges of adjacent parts, etc. (type H);

(f) projection lines (type B).

Figure 4 illustrates the more common priorities of coinciding lines.

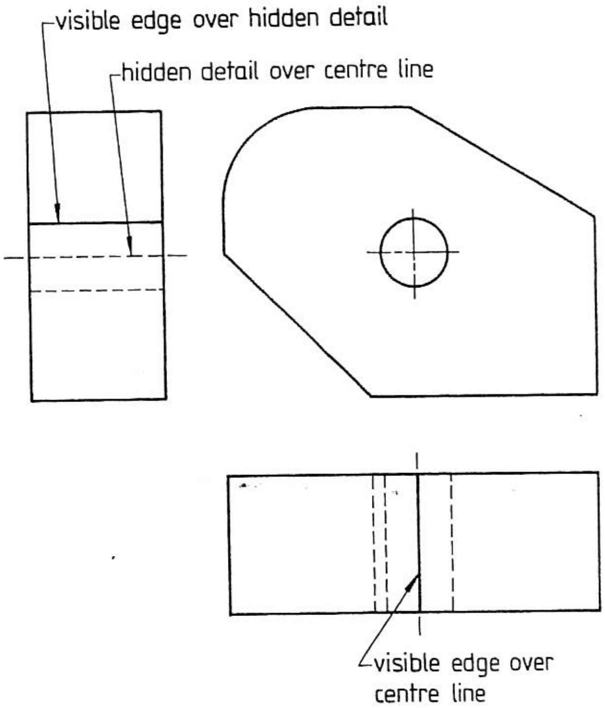
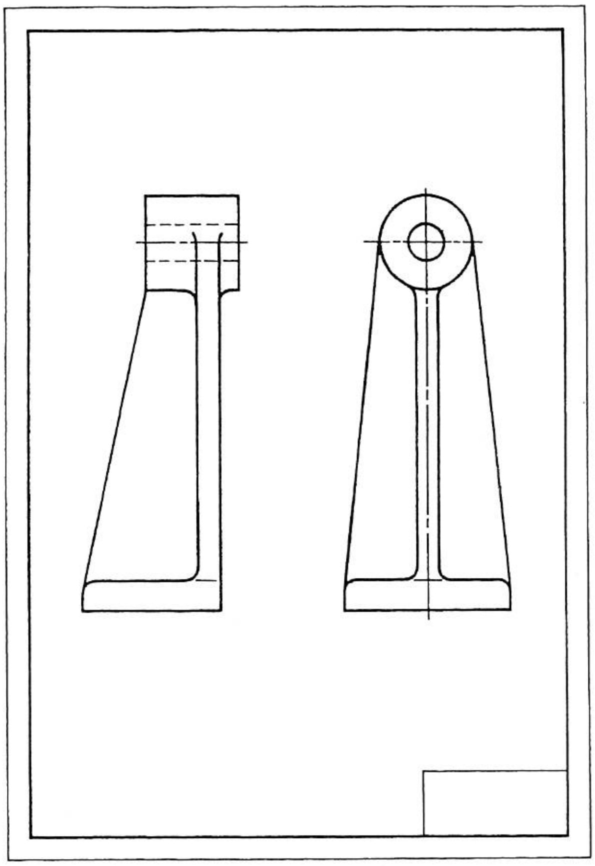
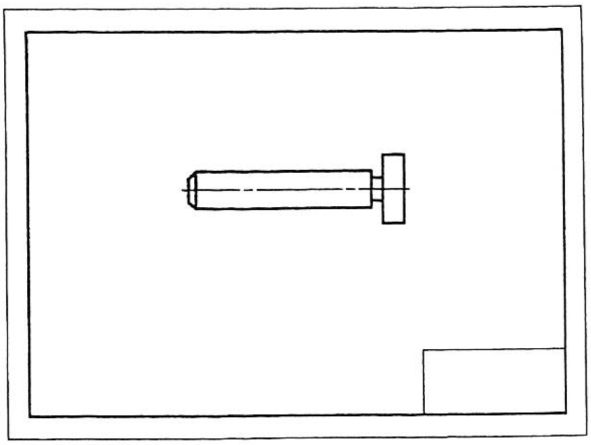


Figure 4. Priority of coinciding lines

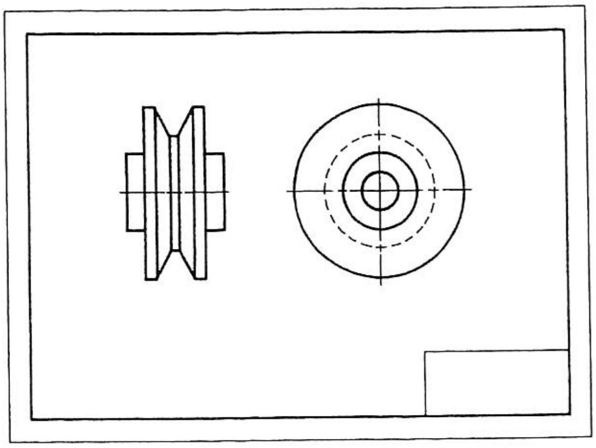


(a)

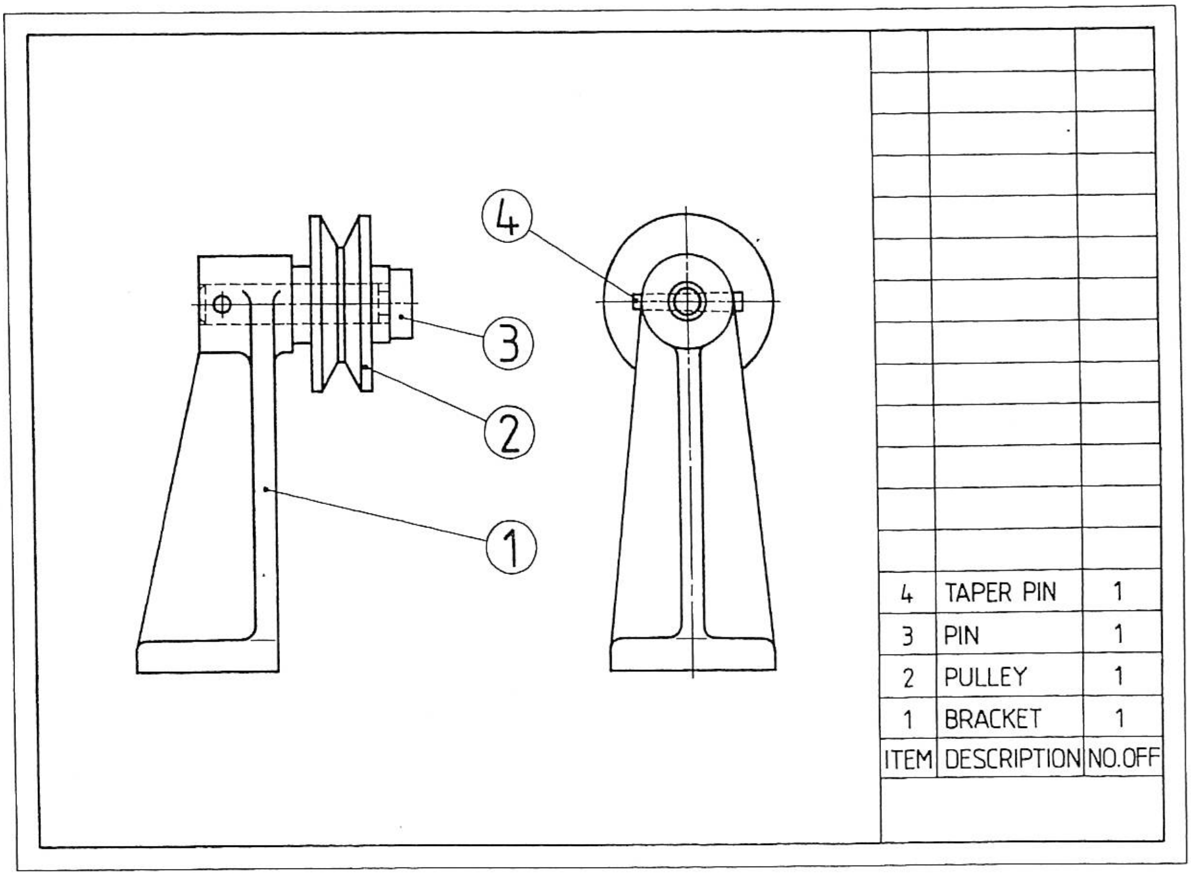
Detail (single-part) drawings



(b)



(c)



(d) Assembly drawing

Figure 2. Types of drawings