Sectional Views: More Alternatives

For all the examples shown in the previous pages, single-plane sectional views have been used. There are several other useful methods of finding sectional views which we will now examine more closely.

Half Sections

These can be very useful for symmetrical objects. The cutting plane removes one quarter of the object and shows the interior of one half of the object and the exterior of the other half. The half section is at its most useful in assembly drawings where it is possible to show an internal assembly and an external construction on the same view.

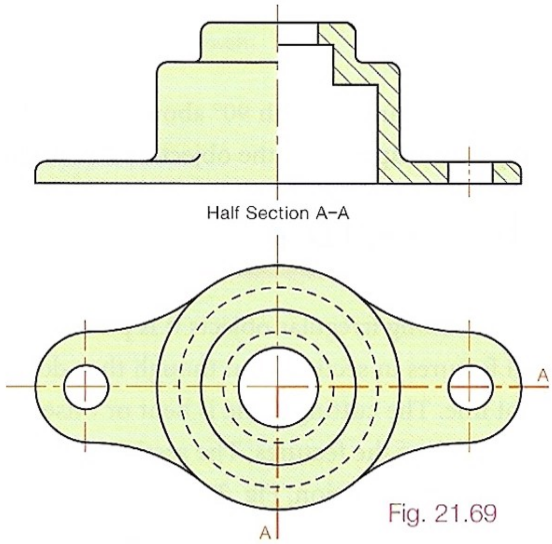


Fig. 21.69

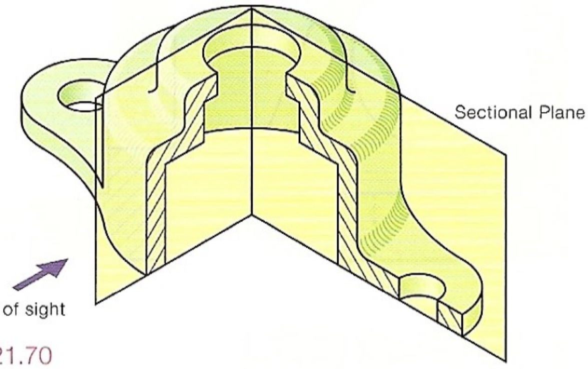


Fig. 21.70

It can be seen from the pictorial, Fig. 21.70, that the section plane removes one quarter of the object. Half sections will often present difficulty when dimensioning and for this reason hidden lines are often included in the unsectioned half.

Broken-out Sections

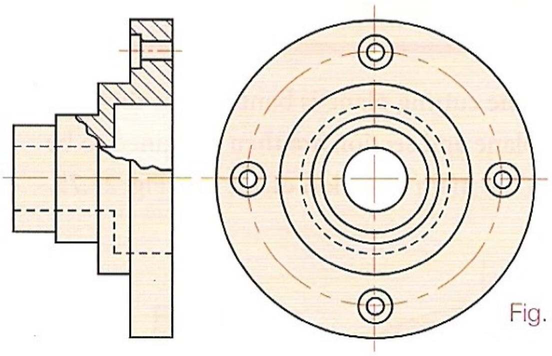


Fig. 21.71

A broken-out section is used when only a small area of the object(s) needs to be sectioned in order to explain the construction. A full section or even a half section are not necessary. The edges of a broken-out section are limited by a break line. Fig. 21.71 shows an example of a broken-out section.

Successive Sections

When an object such as a bar, spoke or arm changes shape along its longitudinal axis, this change can be shown by using successive sections as shown in Fig. 21.72.

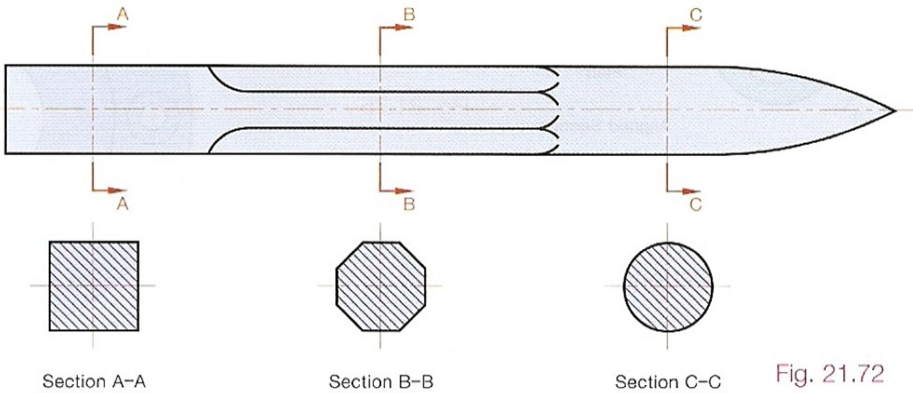


Fig. 21.72

Revolved Sections

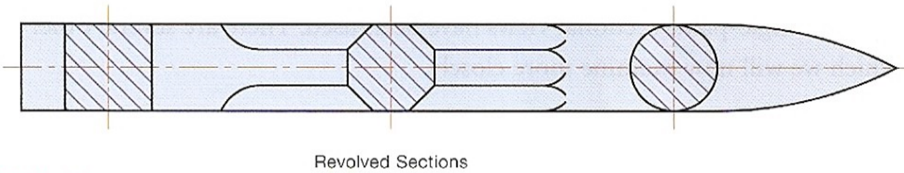


Fig. 21.73

Revolved sections show the shape of the cross-section on the actual view of the part. Such sections are made by assuming a plane perpendicular to the centre line or axis and then revolving the plane through 90° about a centre line so that the true shape of the section can be seen. The section is actually superimposed on the object and all original lines covered by it should be removed.

Offset Sections

When sectioning irregular objects it is possible to show several features in section even though they do not lie in a straight line. The cutting plane is bent or offset to pass through each of the features. The sectional view produced is called an offset section. Fig. 21.74 shows an example of an offset section. It can be seen that the cutting plane in elevation is bent twice at 90° in order to pass through the centres of the two holes, one of which can be seen in elevation and the other in plan. **The bends or offsets in the cutting plane are never shown in the sectional view.**

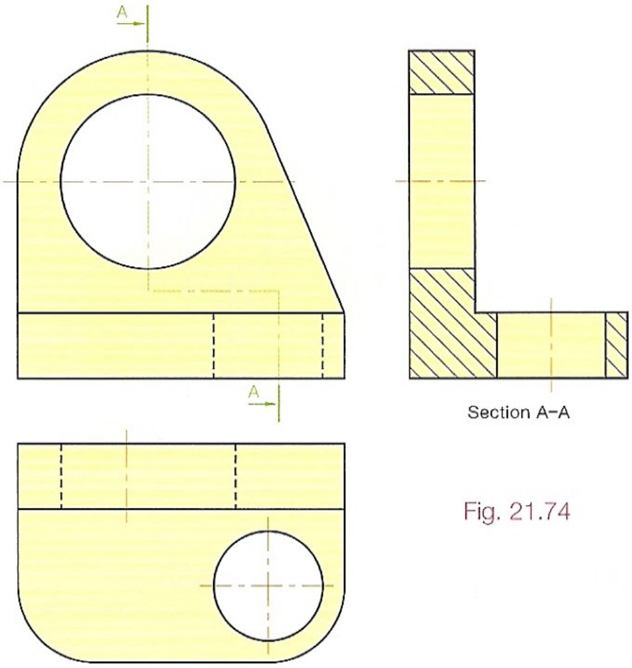


Fig. 21.74

Aligned Sections

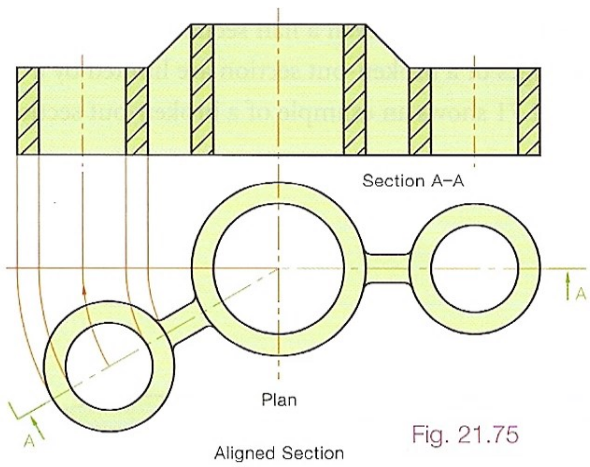


Fig. 21.75

In an aligned section, the cutting plane is bent to pass through an angled element. The plane and section are then imagined to be revolved to align with the main direction of the cut. Fig. 21.75 shows cutting plane A–A bent to pass through the angled arm, and then rotated to a horizontal position where it is projected to the sectional elevation.

Fig. 21.76 shows a second example of an aligned section. The cutting plane is bent to include one of the drilled

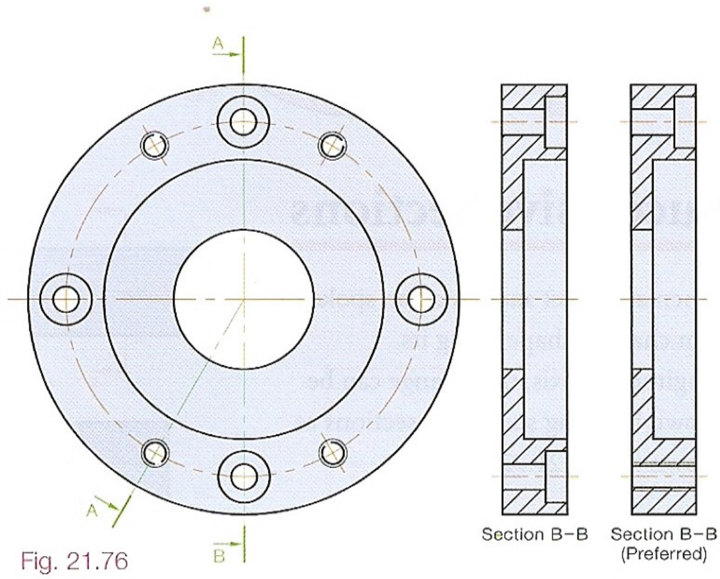


Fig. 21.76

and counter-bored holes and one of the threaded holes. The aligned section A–A produces a much more informative view than does section A–B which is a vertical section taken along the centre line.

For all aligned sections the angle of revolution should always be less than 90°.

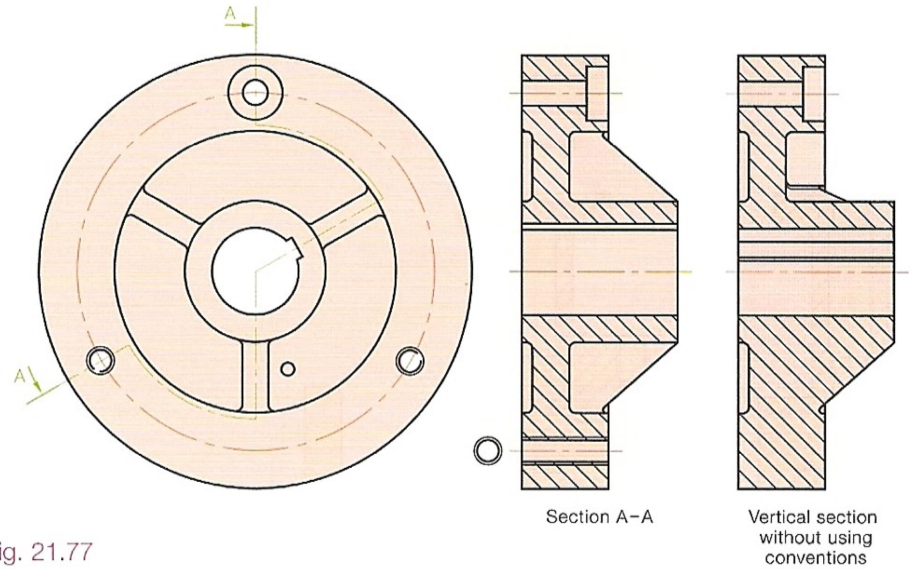


Fig. 21.77

Another example of an aligned section is shown in Fig. 21.77. The cutting plane is offset in circular arc bends to include the upper counter-bored hole, the upper rib, the keyway, the centre hole, the lower rib and one of the lower threaded holes. These features are imagined to be revolved to line up vertically and then projected to give the section. It is now worth looking at the second section drawn in Fig. 21.77. This is a vertical section through the centre without using conventions, e.g. the rib is hatched. This section is less informative, confusing and takes longer to draw.

Worked Examples: Sectional Views

Figures 21.78a and 21.78b shows two views of a gear housing in third-angle projection.

(1) Make the following drawings in third-angle projection:
- **(i) A sectional elevation on the cutting plane X–X.**
- **(ii) A sectional elevation on the cutting plane Y–Y.**
- **(iii) A sectional plan on cutting plane Z–Z.**

Hidden details need not be shown.

(2) Insert the following on the drawing:
- **(i) Title 'GEAR HOUSING'.**
- **(ii) ISO projection symbol.**
- **(iii) Four leading dimensions.**

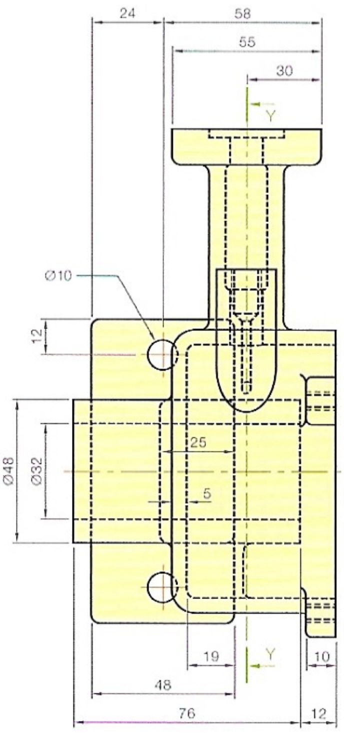


Fig. 21.78a

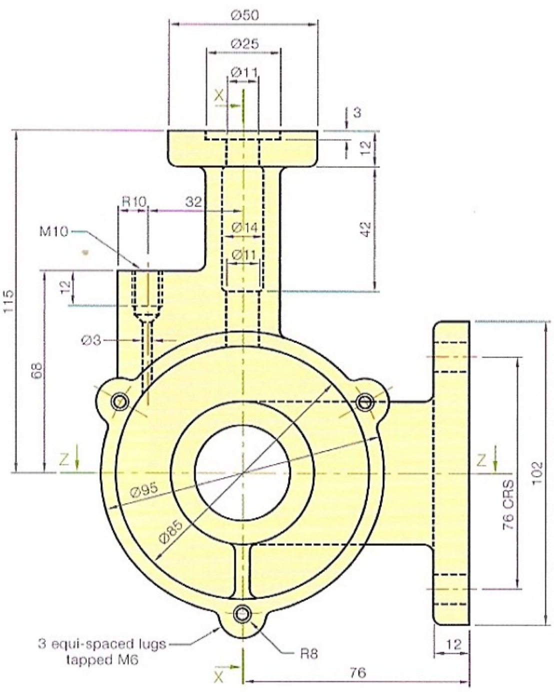


Fig. 21.78b

HIGHER LEVEL

Solution

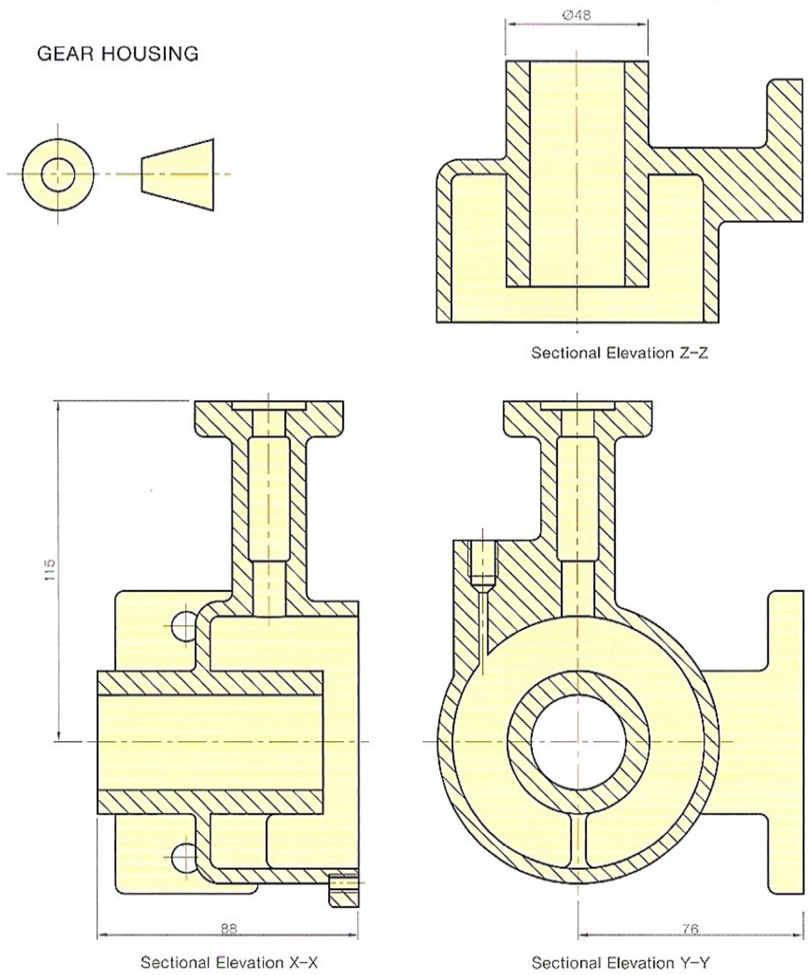


Fig. 21.79

Figures 21.80a and 21.80b show two elevations of a distribution casting. Draw the following views of the distribution casting in first- or third-angle projection:

(1) A front elevation by viewing the given front elevation in the direction of arrow A.

(2) A sectional plan view, through B–B, projected from the front elevation.

(3) Insert the following on the drawing:

(i) Title 'DISTRIBUTION CASTING'.

(ii) ISO projection symbol.

(iii) Four leading dimensions.

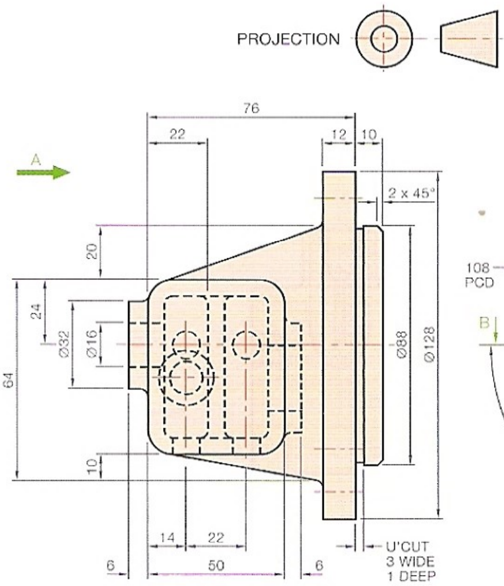
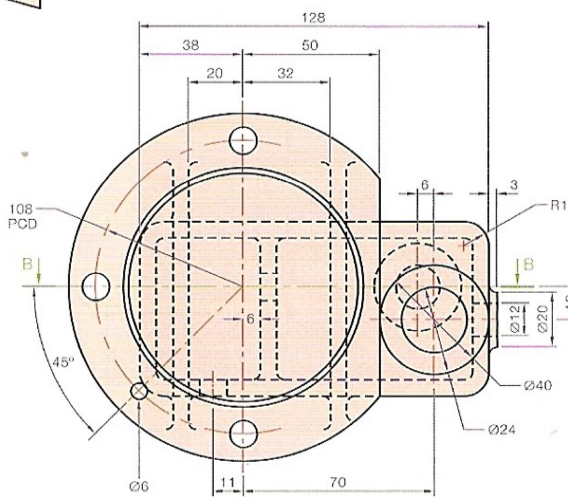


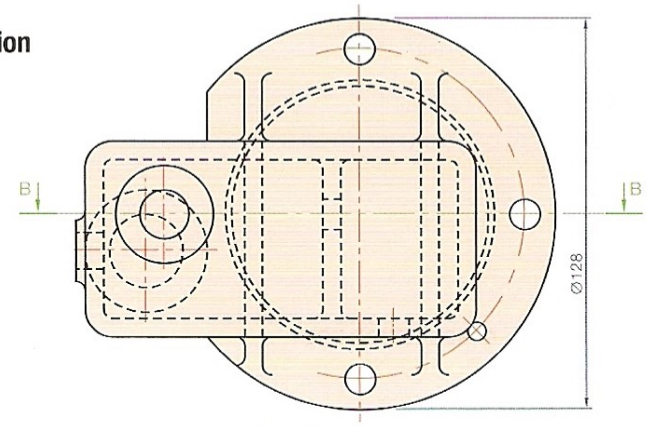
Fig. 21.80a



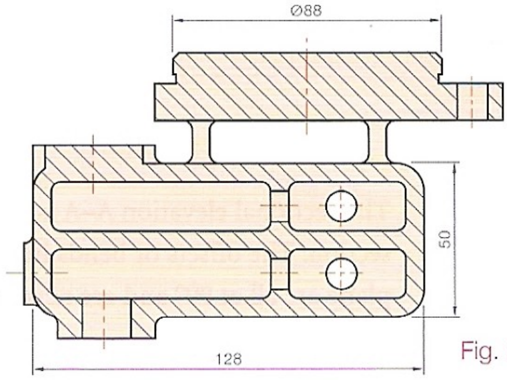
ALL HOLES Ø10 UNLESS STATED OTHERWISE
ALL WALLS AND WEBS 6 THICK
FILLET RADII R3

Fig. 21.80b

Solution

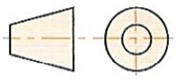


Front Elevation



Sectional Plan B–B

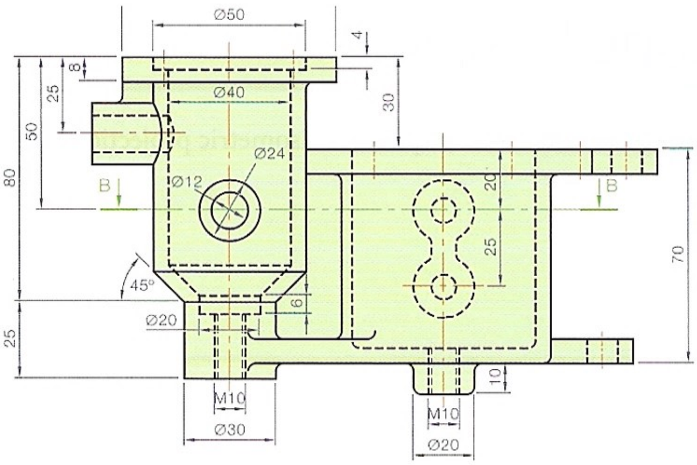
DISTRIBUTION CASTING

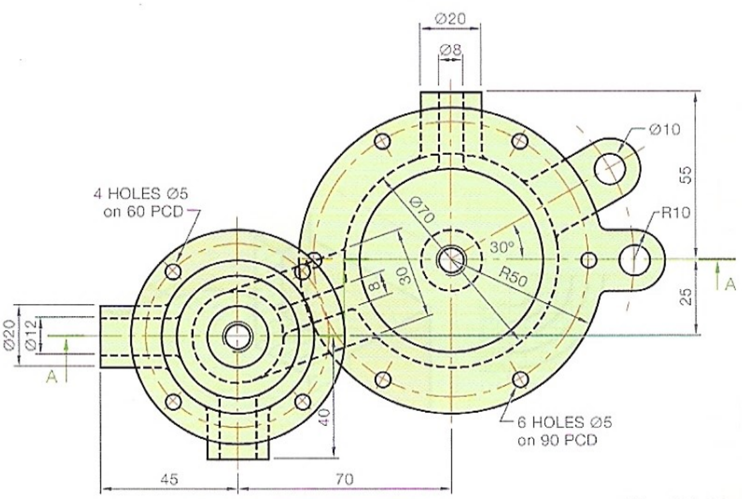


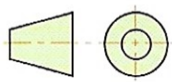
PROJECTION

Fig. 21.81

HIGHER LEVEL







ALL WALL THICKNESSES 5 mm
ALL WEB THICKNESSES 8 mm

Fig. 21.82

Fig. 21.82 shows the plan and elevation of a carburettor body.

(1) Draw the following views of the carburettor in first- or third-angle projection:

(i) A sectional elevation on A–A.

(ii) A sectional plan on B–B.

(2) Insert the following on the drawing:

(i) Title 'CARBURETTOR BODY'.

(ii) ISO projection symbol.

(iii) Cutting and titles on sectional views.

(iv) Four leading dimensions.

Hidden details are not required.

Solution

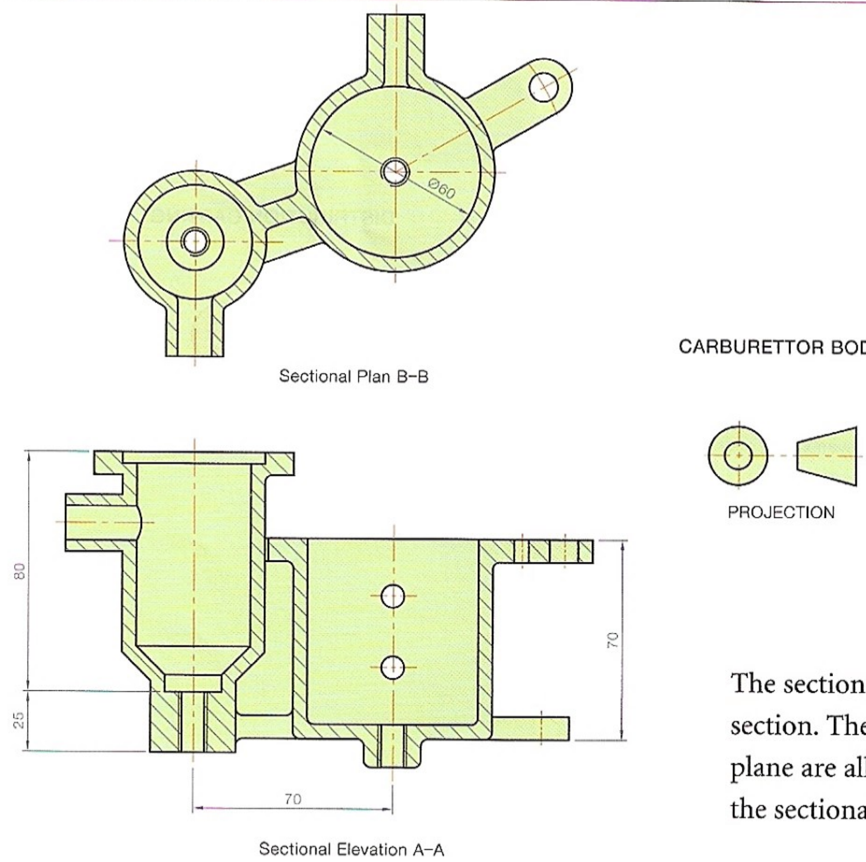


Fig. 21.83

The sectional elevation A–A is an offset section. The offsets or bends in the cutting plane are all at 90° and are never shown in the sectional view.

Pictorial Drawings of Sectioned Objects

It is often helpful in the representation of an object to draw the sectioned object in pictorial. Isometric projection is the most usual projection method used.

Worked Examples

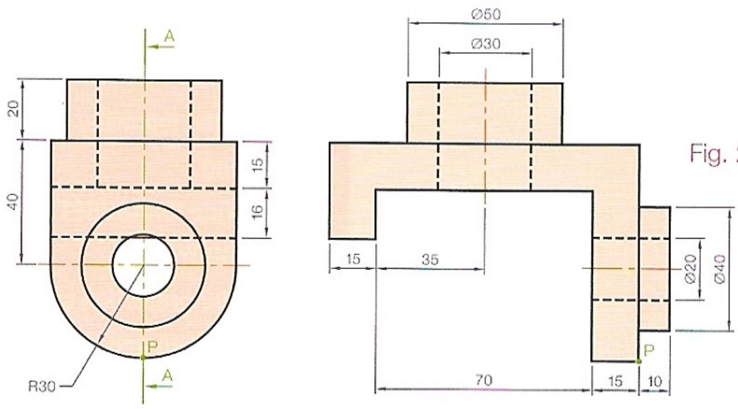


Fig. 21.84

Fig. 21.84 shows two elevations of a machine casting. Draw an isometric view of the casting, viewed on the section plane S–S, with the right-hand side removed. Make point P the lowest point of the drawing.

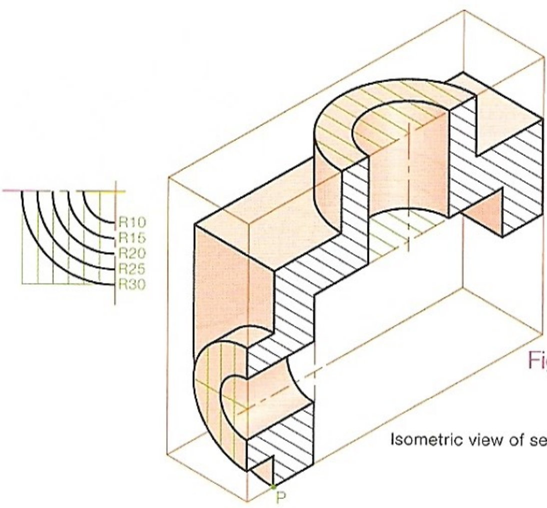


Fig. 21.85

Isometric view of sectioned solid

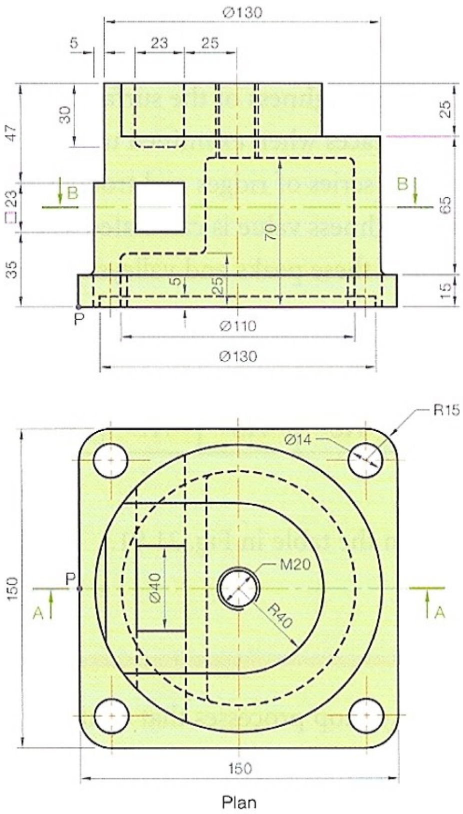


Fig. 21.86

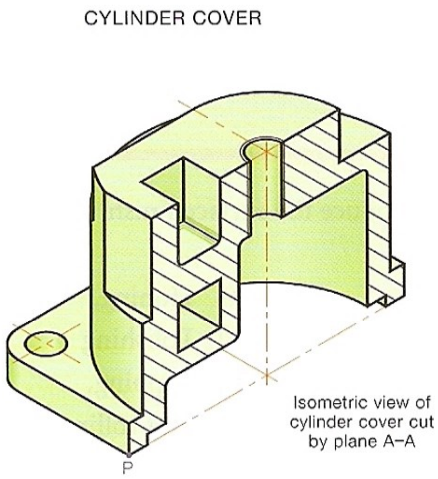
The elevation and plan of a cylinder cover, in first-angle projection, are shown in Fig. 21.86.

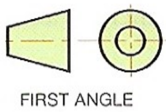
(i) Draw a sectional elevation on A–A.

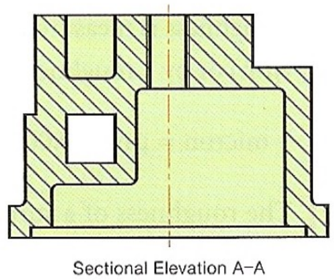
(ii) A sectional plan on B–B.

(iii) An isometric view of the sectioned elevation with point P as the lowest point on the pictorial.

Solution







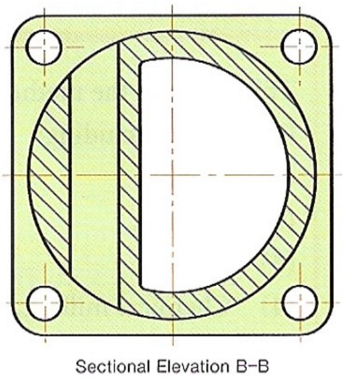


Fig. 21.87

Surface Finish

Accurate control of surface quality and finish is often necessary. Engine parts, for instance, that have been accurately machined will produce less friction and less wear and will therefore last longer. The quality of finish specified must be related to the function of the surface because as the quality of finish becomes finer the cost of producing that finish increases. If the surface finish is unimportant then it should not be specified. The ideal finish is the roughest one that will do the job properly.

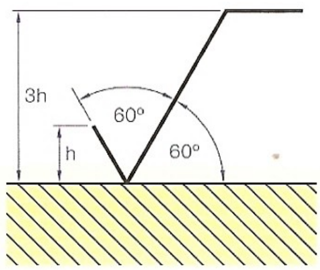
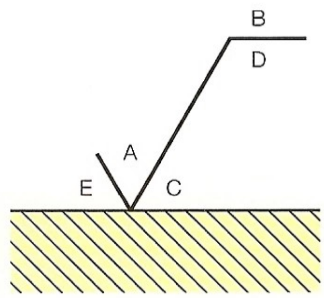


Fig. 21.88



A Roughness value
B Method of treatment
C Direction of lay
D Sampling length
E Machining allowance

Fig. 21.89

Fig. 21.88 shows the proportions of the standard symbol used to show finish type and quality. Fig. 21.89 gives the key to the information layout.

A. Roughness Value

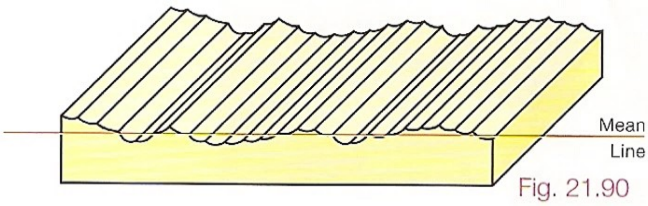


Fig. 21.90

This value indicates the average roughness of the surface. Even the smoothest of machined surfaces when examined under large magnification will show a series of ridges and troughs left behind by tool marks. The roughness value is calculated as the average amount of deviation of these peaks and valleys from a mean line.

Roughness is measured in microns (μm) or by a roughness number (N).

1 micron = μm = 0.0001 mm

Microns	0.025	0.05	0.1	0.2	0.4	0.8	1.6	etc
Roughness No.	N1	N2	N3	N4	N5	N6	N7	etc

Fig. 21.91

The roughness of a surface in microns and the roughness number are related as shown in the table in Fig. 21.91.

B. Method of Treatment

This refers to the method of treatment used to produce the surface finish. There are many shop processes that could be listed here, including:

(1) Sawing,
(2) Planing,
(3) Drilling,
(4) Chemical milling,
(5) Milling,
(6) Reaming,
(7) Roller burnishing,
(8) Grinding,
(9) Honing,
(10) Polishing
(11) Lapping,
(12) Hot rolling,
(13) Forging,
(14) Extruding,
(15) Cold rolling,
(16) Die casting.

HIGHER LEVEL

C. Direction of Lay

This indicates the direction or directions in which the finish is laid down when machining. These are indicated in Fig. 21.92.

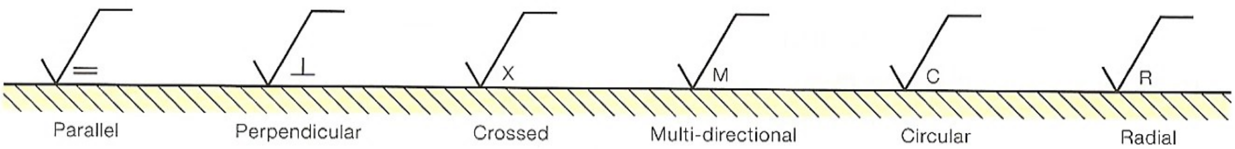


Fig. 21.92

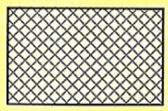
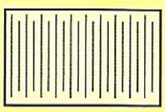
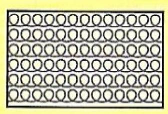
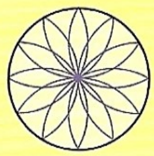
√=	**Lay of finish parallel to visible edge of surface.**	
√X	**Lay of finish angled in both directions to visible edge of surface.**	
√⊥	**Lay of finish perpendicular to visible edge of surface.**	
√M	**Lay multi-directional.**	
√C	**Lay is approximately circular relative to the centre of the surface indicated.**	
√R	**Lay is approximately radial relative to the centre of the surface indicated.**	

Fig. 21.93

D. Sampling Length

This value is not usually necessary. It indicates the maximum allowed spacing between repetitive units of the surface pattern.

E. Machining Allowance

This is another value that is not usually necessary. It gives the amount that is to be removed from a stock or standard size.

Symbol Options

There are three symbol options shown in Fig. 21.94 which further specify the surface finish.

(1) Machined finish.
(2) Machined finish or any other finishing method may be used.
(3) Machining is not to be done. Another method of finishing must be used.

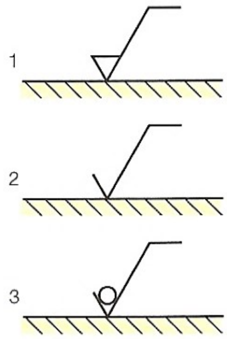


Fig. 21.94

HIGHER LEVEL

Examples

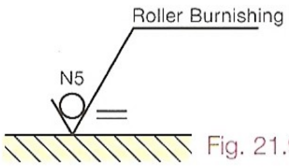


Fig. 21.95

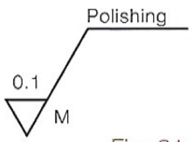


Fig. 21.96

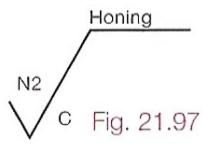


Fig. 21.97

A roller-burnished finish is to be laid parallel to the plane indicated to a roughness number of N5 (0.4 microns).

A polished finish layed down multi-directionally to a roughness value of 0.1µm (microns).

A honed finish layed down in a circular pattern to a roughness value of N2, 0.05 microns.

Note:

(1) When indicating surface characteristics, it is important that only those numbers which are required to specify the surface adequately for the function should be included in the symbol.
(2) The symbol is always made in the standard upright position.
(3) The symbol is never drawn at an angle or upside down. Fig. 21.98 shows examples.

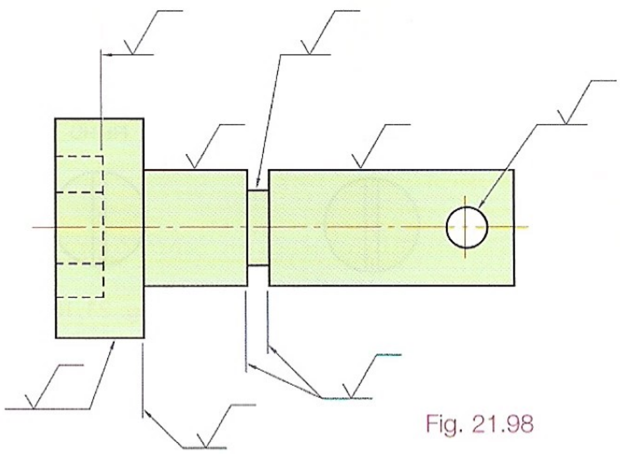


Fig. 21.98

Methods of Assembly

There are many methods used to join elements of an assembly, ranging from bolts, screws and studs, rivets, folded seams and welded joints. We will look at each of these areas in a little more detail.

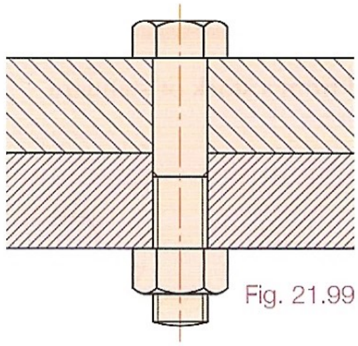


Fig. 21.99

Bolts

The term 'bolt' usually refers to a through bolt which passes through clearance holes in two or more pieces and receives a nut to tighten and hold the parts together. The head and nut are usually hexagonal but may be square.

Cap Screws

Cap screws usually pass through a clearance hole in one member and screw into another which acts as the nut. A cap screw generally has a greater length of thread than a bolt. There are a large range of head types on cap screws as shown in Figures 21.100a to 21.100i.

Fig. 21.100a

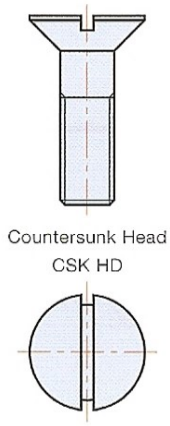


Fig. 21.100b

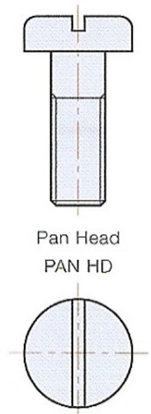


Fig. 21.100c

Fig. 21.100d

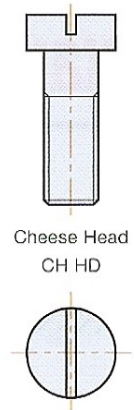


Fig. 21.100e

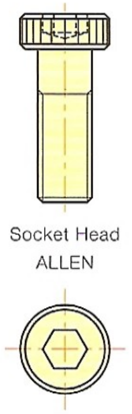


Fig. 21.100f

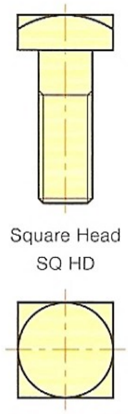


Fig. 21.100g

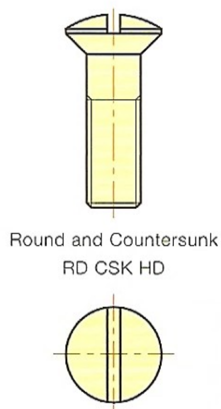


Fig. 21.100h

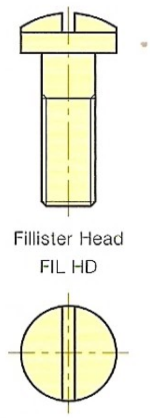


Fig. 21.100i

Most of the heads of the cap screws have been shown with slots to receive a flat head screwdriver. They are also produced to accommodate other types of screwdrivers.

Stud

A stud is a steel rod which has been threaded on both ends. The stud is usually passed through a clearance hole in one member and screwed into the other member. A nut is then tightened onto the free end as shown in Fig. 21.101. The end of the stud may have a slot or an Allen key socket to aid in its insertion into the threaded hole.

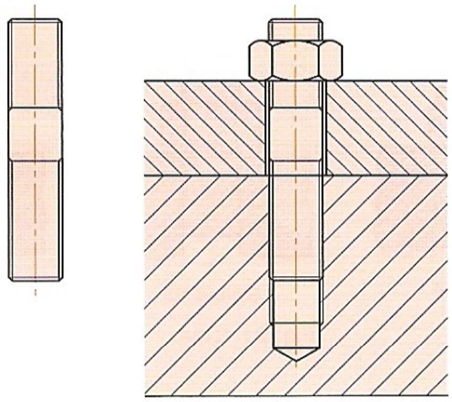


Fig. 21.101

Machine Screws

Machine screws are similar to cap screws but are much smaller. They are threaded nearly to the head and are very useful for screwing into thin material.

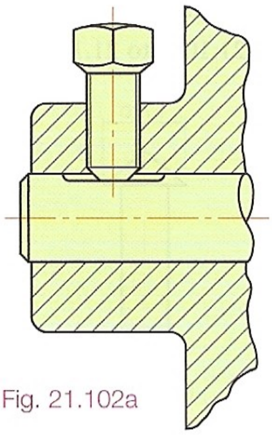


Fig. 21.102a

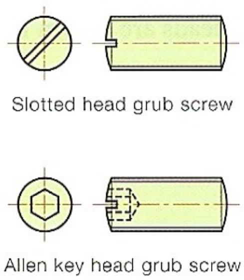


Fig. 21.102b

Set Screws

A set screw is used to prevent relative motion between two parts. Their most common use is to secure pulleys etc. onto their axle shafts. The set screw is screwed into one part and its point puts pressure on the other part. If a little flat area is milled onto the shaft where the set screw is to make contact with it, then a much stronger fixing is achieved. Set screws are not able to cope with heavy loads or loads that are applied suddenly. Figures 21.102a to 21.102c shows a number of set screws and some possible variations in the tip shape.

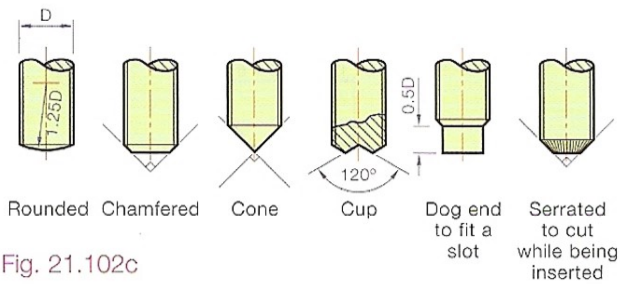


Fig. 21.102c

Lock Nuts and Locking Devices

There are many special nuts and devices to ensure that nuts do not work loose due to vibration during their working life. Some of the more common types are shown below in Figures 21.103a to 21.103h.

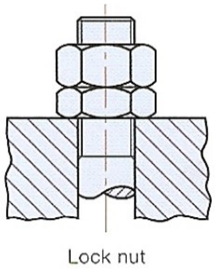


Fig. 21.103a

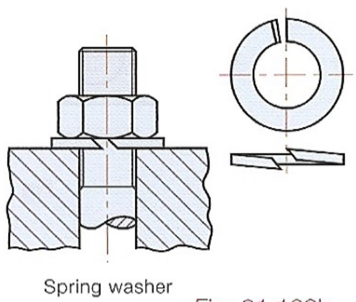


Fig. 21.103b

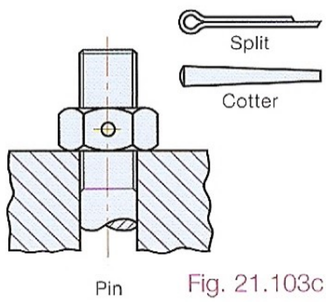
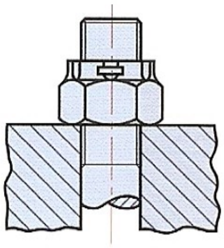
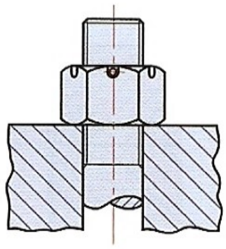


Fig. 21.103c



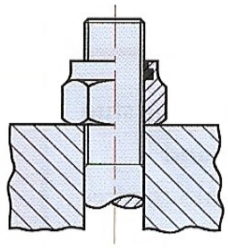
Castle nut

Fig. 21.103d



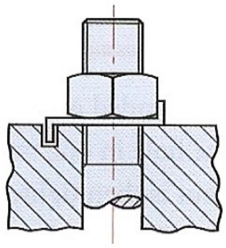
Slotted nut

Fig. 21.103e



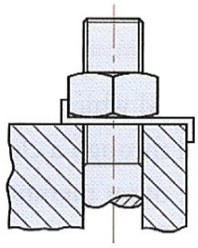
Simmonds lock nut with a plastic locking ring

Fig. 21.103f



Tab

Fig. 21.103g



Tab over edge

Fig. 21.103h

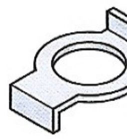
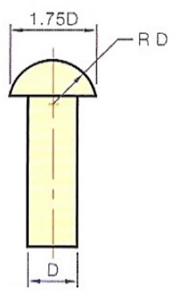


Fig. 21.103[i]

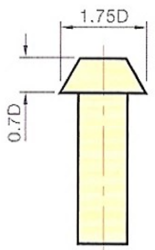
Rivets

Rivets are seen as a permanent method of joining sheet metal and rolled steel together. They are made from wrought iron soft steel, copper, brass and occasionally other metals. Each rivet has one pre-formed head, the second head is formed using a hammer and a 'dolly bar' or by machine. The process of forming the second head compresses the shank of the rivet, pushing it against the sides of the hole. A number of different rivet heads are shown in Figures 21.104a to 21.104f.



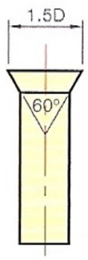
Snaphead

Fig. 21.104a



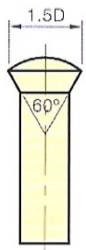
Panhead

Fig. 21.104b



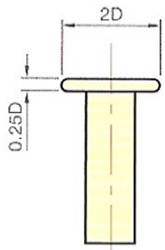
Countersunk head

Fig. 21.104c



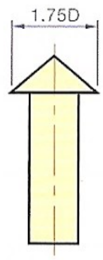
Raised and Countersunk head

Fig. 21.104d



Flat head

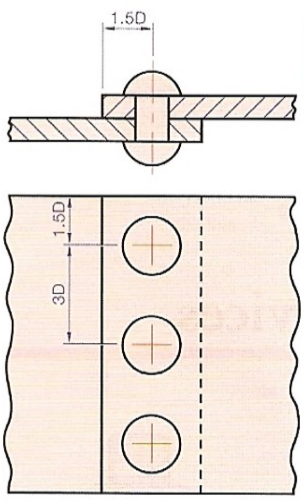
Fig. 21.104e



Cone head

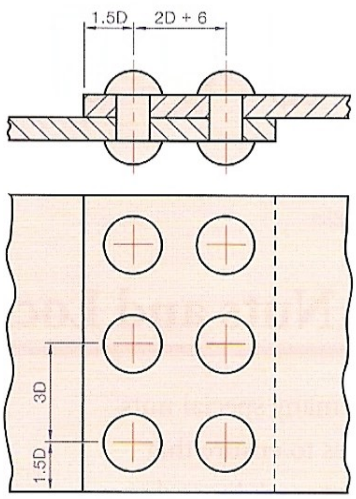
Fig. 21.104f

When riveting, it is important to space the holes for the rivets carefully. If the holes are too far apart there will not be enough rivets to give the joint strength, while if they are too close together the amount of holes being drilled weakens the joint. Figures 21.105a to 21.105e shows some typical rivet layouts.



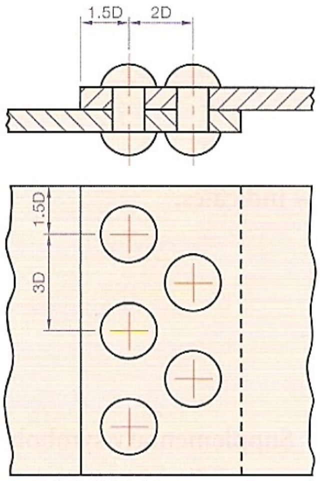
Single Lap

Fig. 21.105a

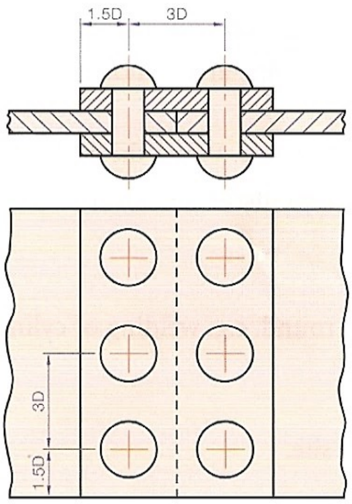


Double Row Lap

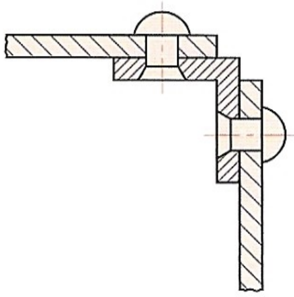
Fig. 21.105b



Zigzag Lap Fig. 21.105c



Double Cover Plate Fig. 21.105d



Corner Fig. 21.105e

Welding

Welding is a method of joining metals by using heat to melt and fuse them together. A filler metal is usually necessary to fill the joint. Because of the range of welded joints, a system of symbols are used to display the complete welding information on a drawing in a simple and clear manner, see Fig. 21.106.

A: Joint – the joint is shown as a butt joint regardless of the type of weld joint to be used.
B: Arrow – indicates joint line.
C: Reference line.
D: Weld symbol.

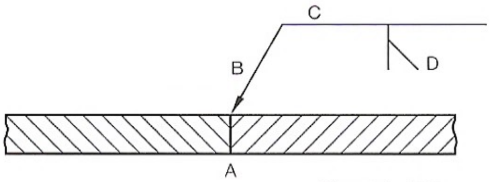


Fig. 21.106

Each of these symbols are shown below in Figures 21.107 and 21.108.

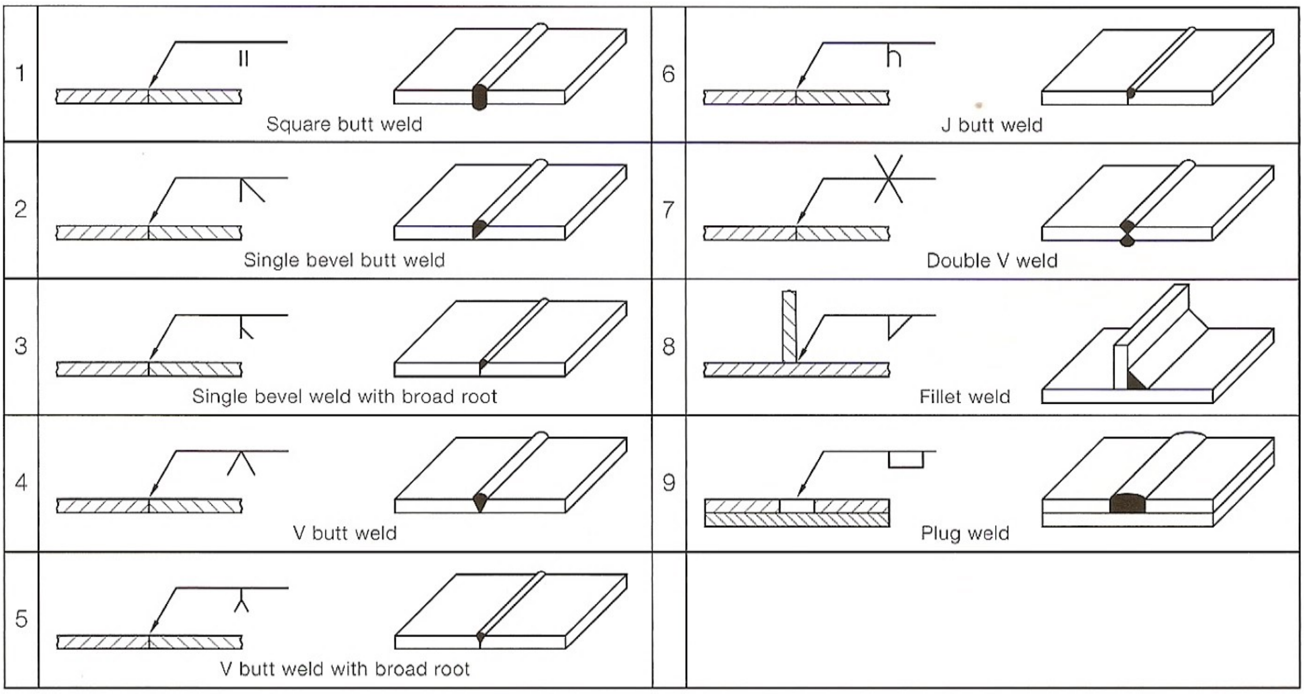
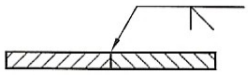
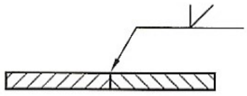


Fig. 21.107

HIGHER LEVEL

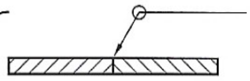


Weld this side. When the symbol is below the reference line the weld is to be placed where the arrow indicates.

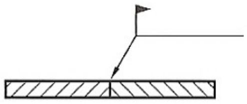


Weld the far side. When the symbol is above the reference line the weld is to be placed on the far side of the joint that the arrow indicates.

Supplementary Symbols

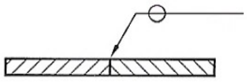


Weld all round, e.g. welding of cylinders, pipes etc.

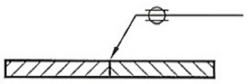


Weld on site.

Supplementary symbols are used with the main welding symbol to give additional information.



Spot weld.



Seam weld.

Fig. 21.108

Activities

OFFSET SECTIONS

Q1.

(i) Draw the given elevations of the machined block as shown in Fig. 21.109.

(ii) Project an offset sectional plan A–A from the elevation.

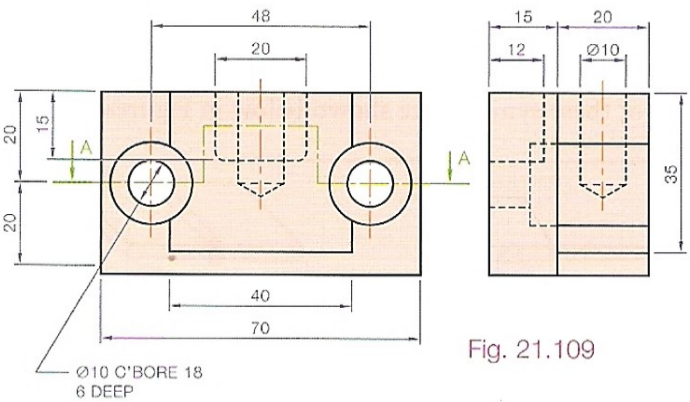


Fig. 21.109

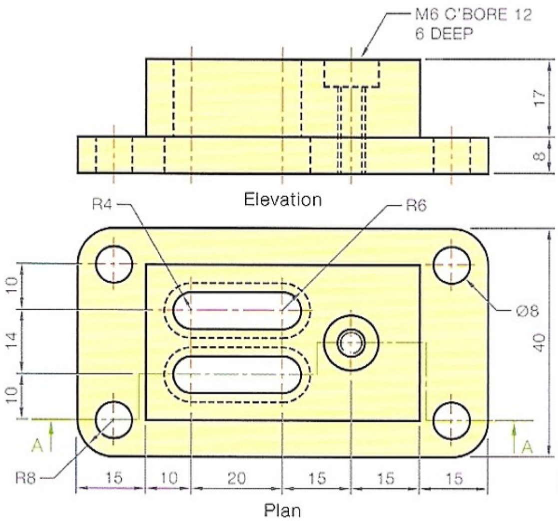


Fig. 21.110

Q2. Given the plan and elevation of a shaped block in Fig. 21.110.

(i) Draw the given plan.

(ii) Project the offset section on section plane A–A.