ME 101

ENGINEERING GRAPHICS

CHAPTER 7

SECTIONING AND CONVENTIONS

7.1. SECTIONAL VIEW DEFINED AND SHOWN

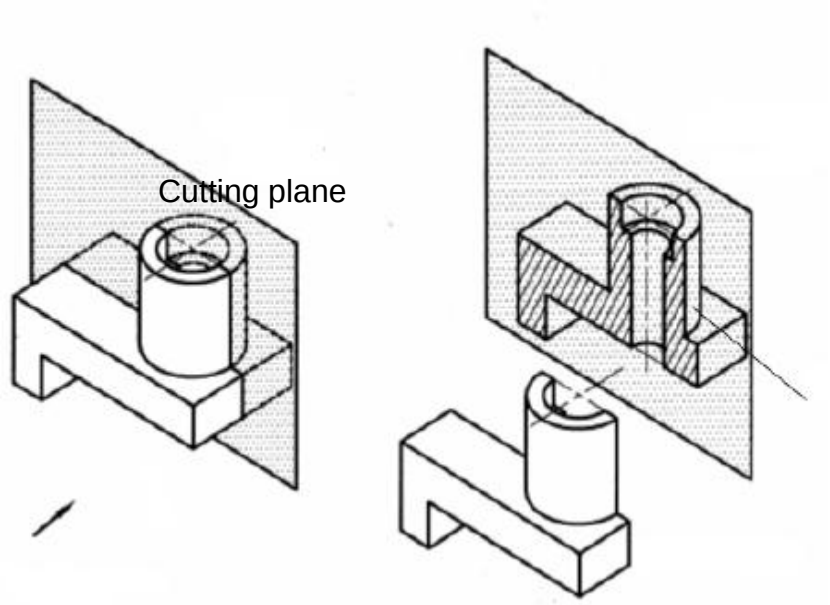
Hidden lines made with short dashes show the parts of an object that cannot be seen. This method is satisfactory if the object is solid or its interior simple. In drawings, which show many inside details, or several pieces together, the hidden lines become confusing or hard to read. In such cases views, called SECTIONS, are drawn to show the object as if it were cut apart.

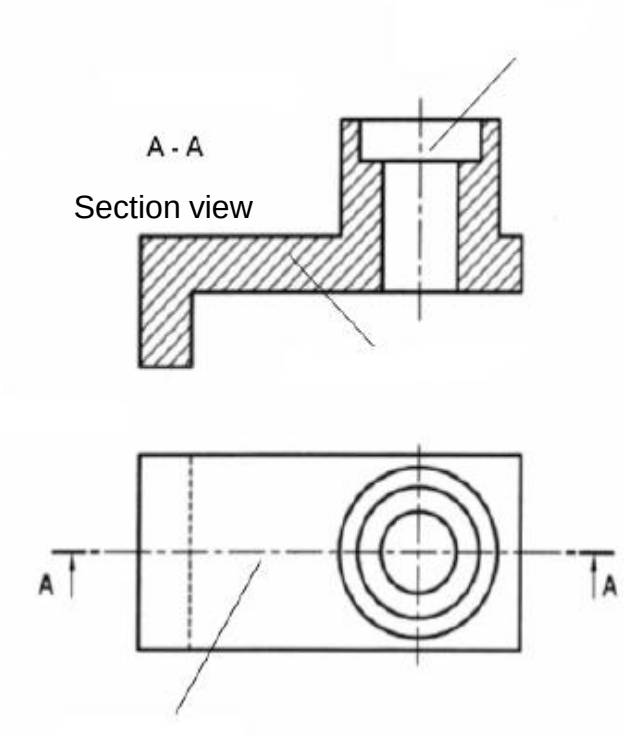
Sectional views are often preferable because they show clearly and emphasize the solid portions, the voids, and the shape of objects.

Introduction: Sectional view

❑ If the drawing cannot fully show the interior detail of the object, a sectional view (slicing through the object) is drawn to reveal the interior detail.

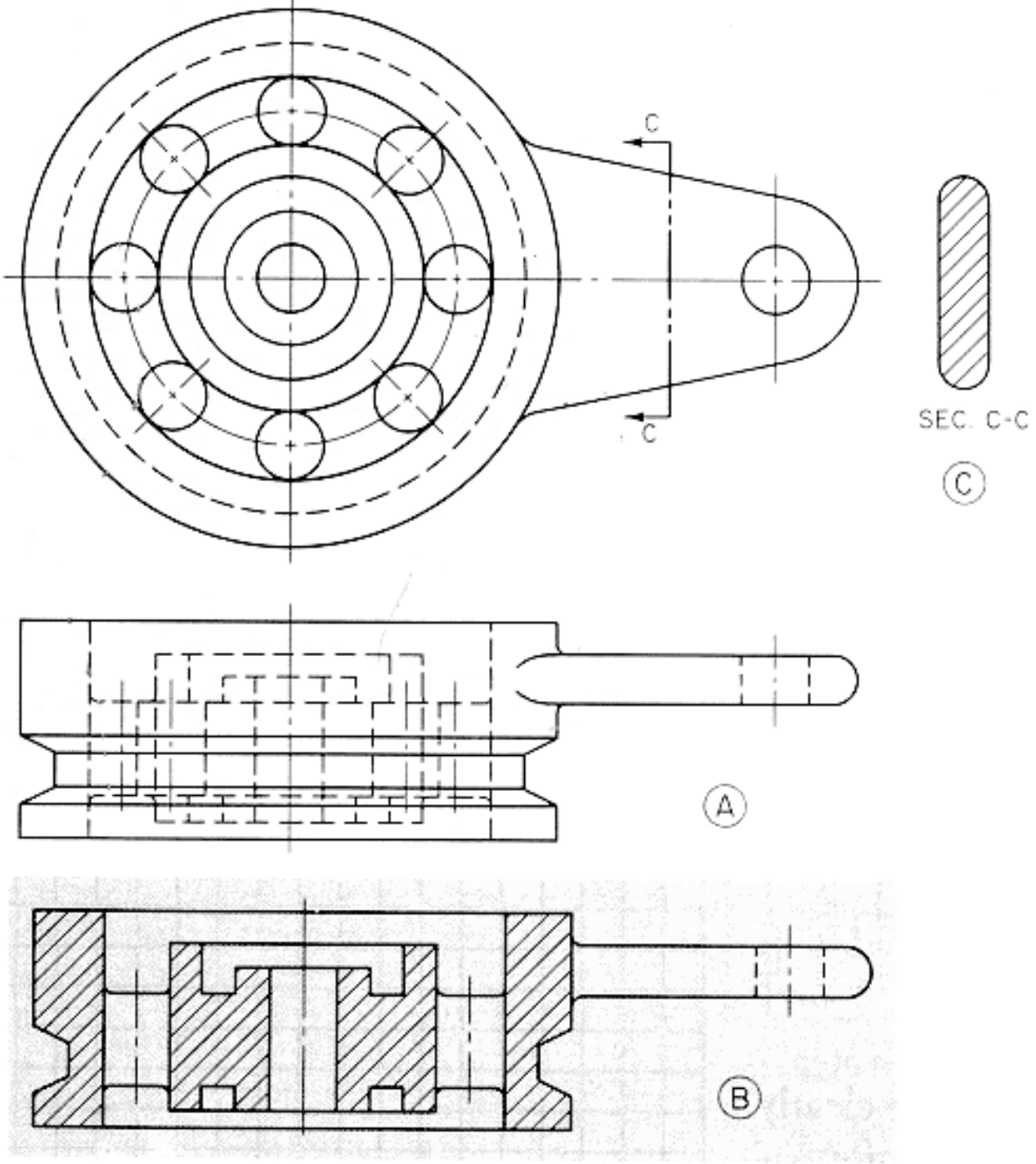
❑ A sectional view is obtained by assuming the piece to be cut apart by an imaginary cutting plane and the part in front of the plane removed, thus exposing the interior.





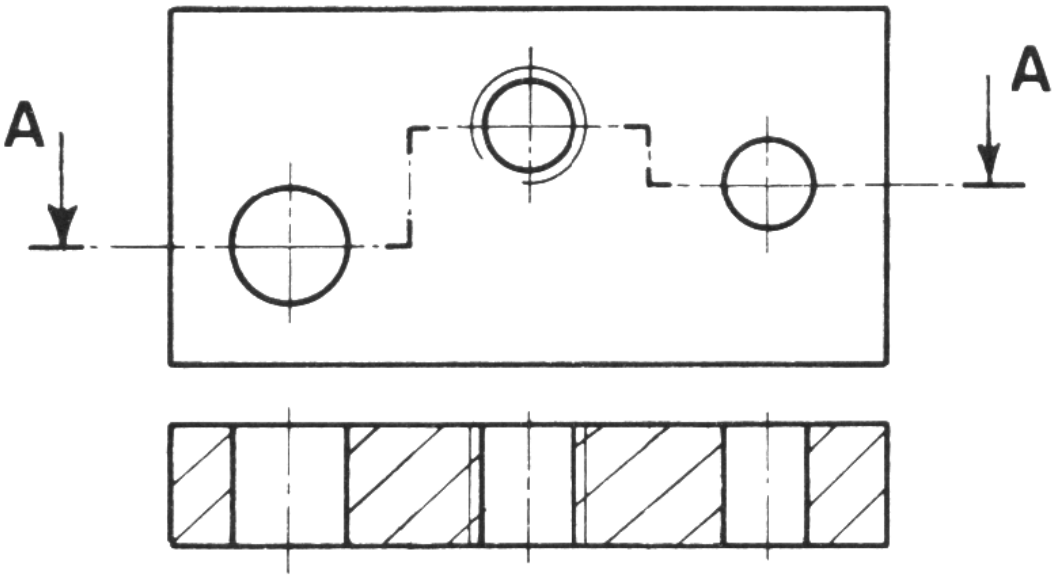
View direction

Cutting-plane line

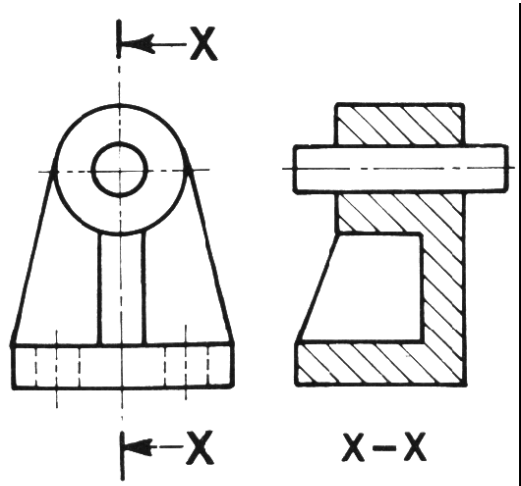

C
C
SEC. C-C
C
A
B

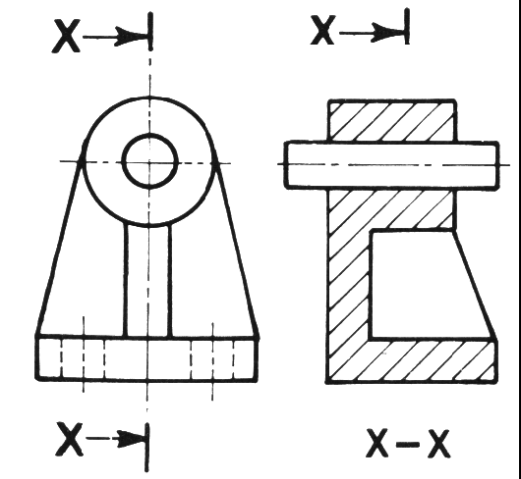
Therefore a sectional view must show which portions of the object are solid materials and which are spaces. This is done by section lining with uniformly spaced thin lines generally at 45^{o}, sometimes called “cross hatching”, the solid parts with lines, as shown at (c). The part supposed to be cut away is not left out in the top view. In sectioning:

1. a cutting plane,
2. directional arrows,
3. identification letters, and
4. Sectioning (or “cross hatching”,) lines are used.



SECTION A-A





A SECTIONAL VIEW is obtained by assuming the piece to be cut apart by an imaginary cutting plane and the part in front of the plane removed, thus exposing the interior. This is shown in pictorial form in Fig.7.1 (a), (b). The imaginary cutting plane is shown as at (a). The appearance of the cut surface, after the front portion has been removed, is shown as at (b). The sectional view with the orthographic representation is shown in Fig.7.1 (c).

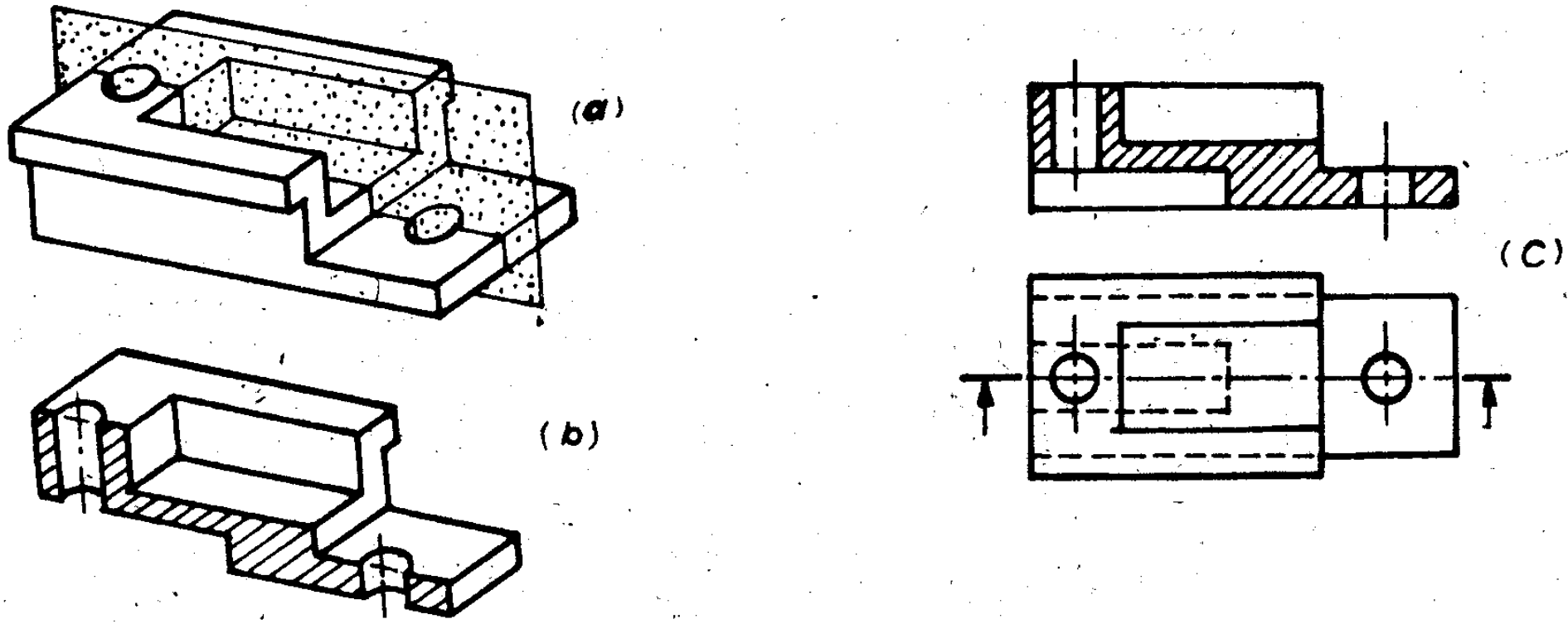


Fig. 7.1 A sectional view is obtained by cutting an object with an imaginary cutting plane at (a) Exposed interior at (b) orthographic representation of sectional view at (c).

7.2 TYPES OF SECTIONS

Depending on the number of cutting planes, sectional views are classified as simple with one cutting plane and complex with two or more cutting planes. If the cutting-plane line cuts entirely across the object, it is called a FULL SECTION. If the cutting plane cuts halfway through the object, it is a HALF SECTION. In addition to these there are broken-out sections, rotated sections, removed sections, auxiliary sections, and assembly sections.

1. FULL SECTION
2. HALF SECTION
3. BROKEN-OUT SECTIONS
4. ROTATED SECTIONS
5. REMOVED SECTIONS
6. AUXILIARY SECTIONS
7. ASSEMBLY SECTIONS

7.2.1 FULL SECTION

When the cutting plane passes fully through an object, the section is called a full section as in Fig. 7.2. The cutting plane may pass straight through, as at (a) or be offset, changing direction forward or backward, to pass through features it would otherwise have missed, as at (b) and (c).

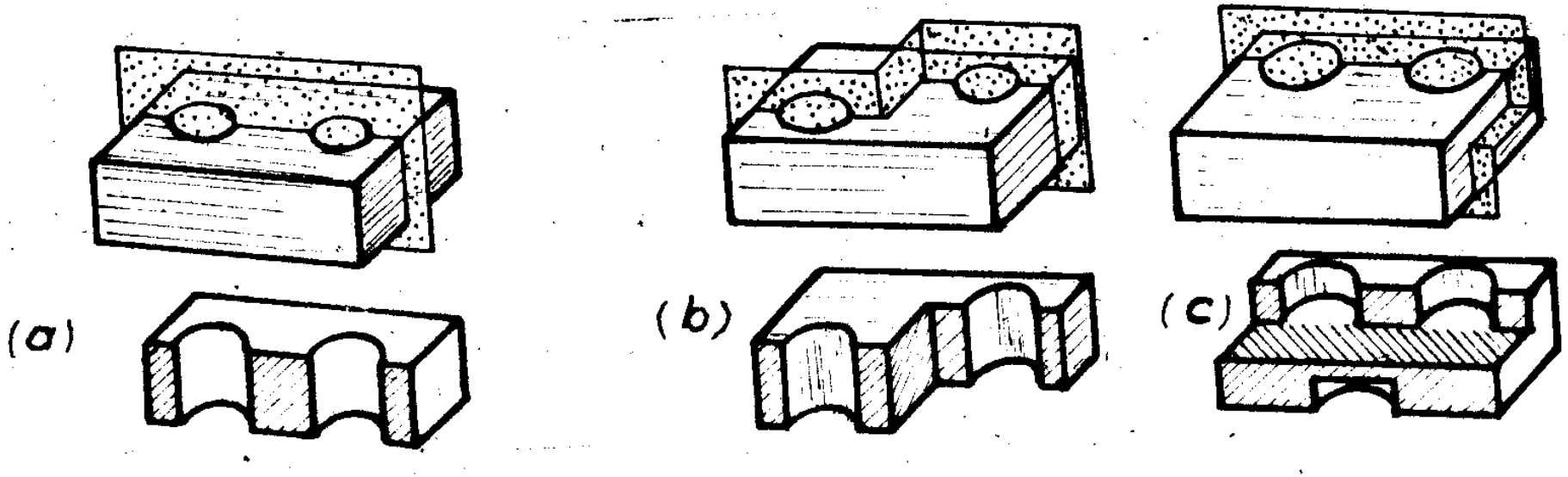


Fig. 7.2 Cutting planes for a full section. The plane may be used to cut straight across (a) or change direction (b and c) to pass through features to be shown.

The cutting plane may also be taken parallel to the frontal plane as at (a) and (b) in Fig. 7.3 parallel to the profile plane as at (c) Fig. 7.3, parallel to the horizontal plane, or at an angle.

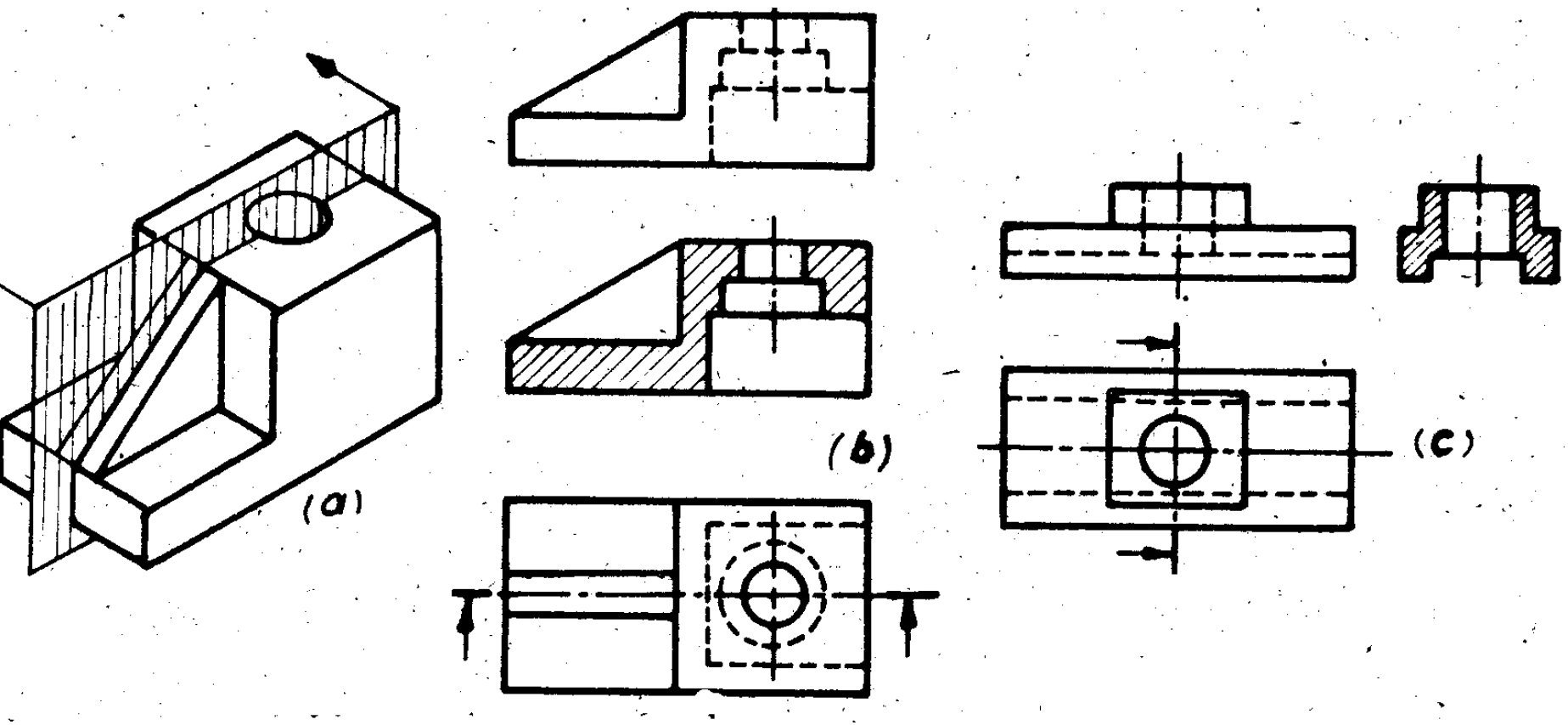


Fig. 7.3 A full section parallel to the frontal plane at (b) and A full Section parallel to the profile plane at (c).

The cutting plane may be offset in any part in order to show some detail or to miss some part as at (a) and (b) in Fig. 7.4. Note that the change in plane direction is not shown on the sectional view, for the cut is purely imaginary and no edge is present on the object at this position.

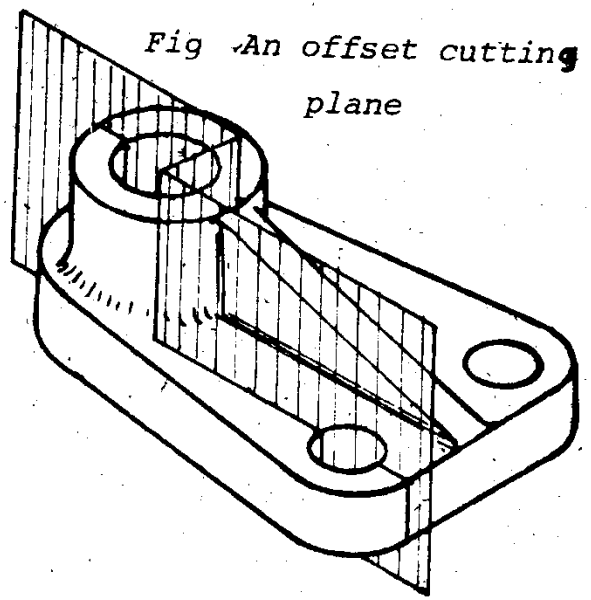
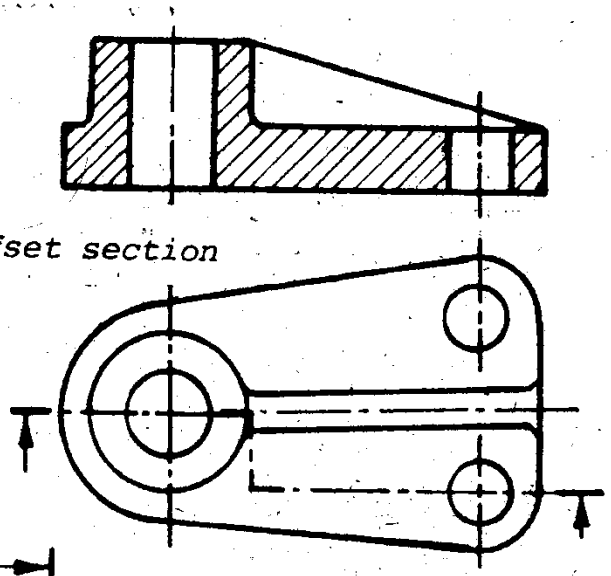


Fig An offset cutting plane



An offset section

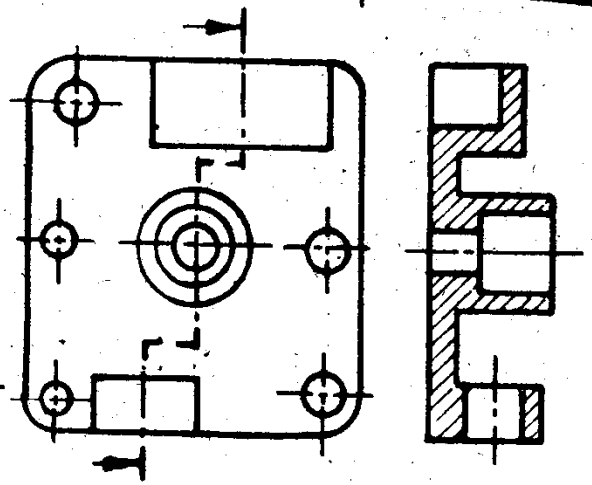
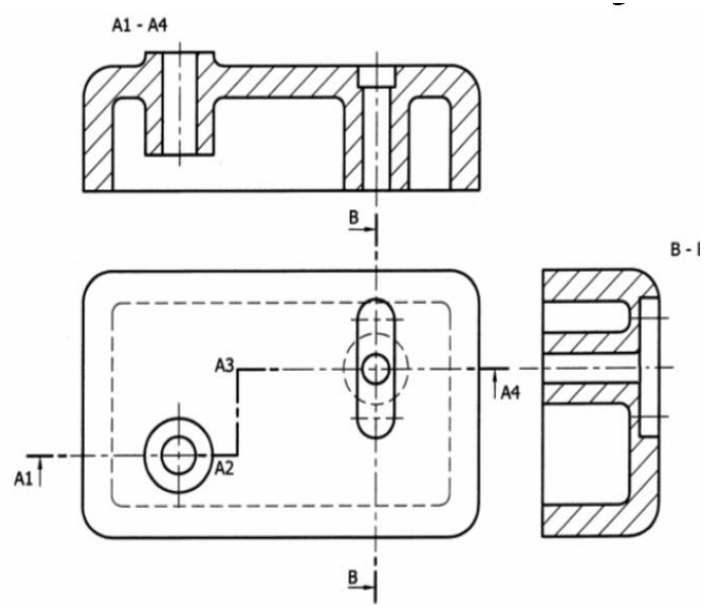
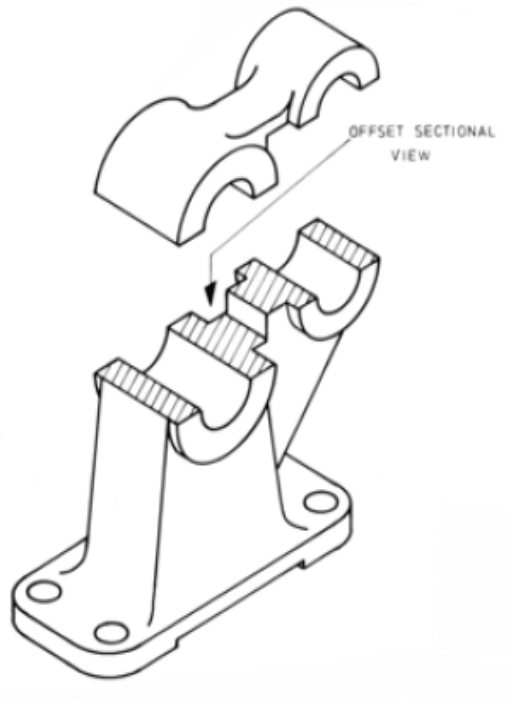


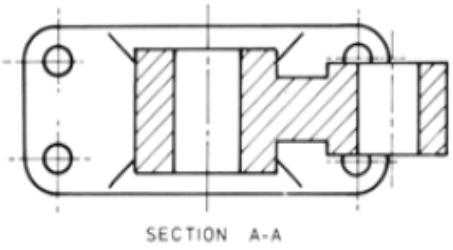
Fig.7.5 An offset section

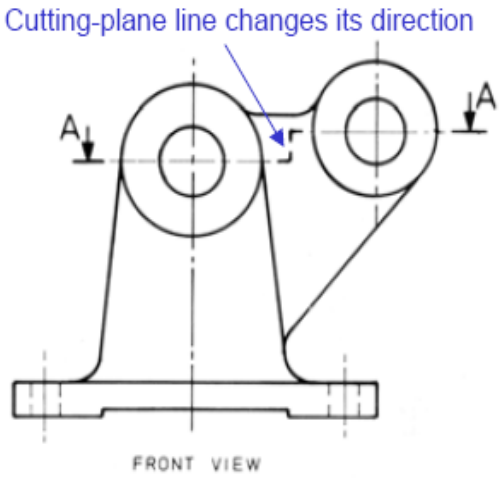
Full Section

❑ The cutting plane may be offset in any part in order to show some details or to miss some parts.







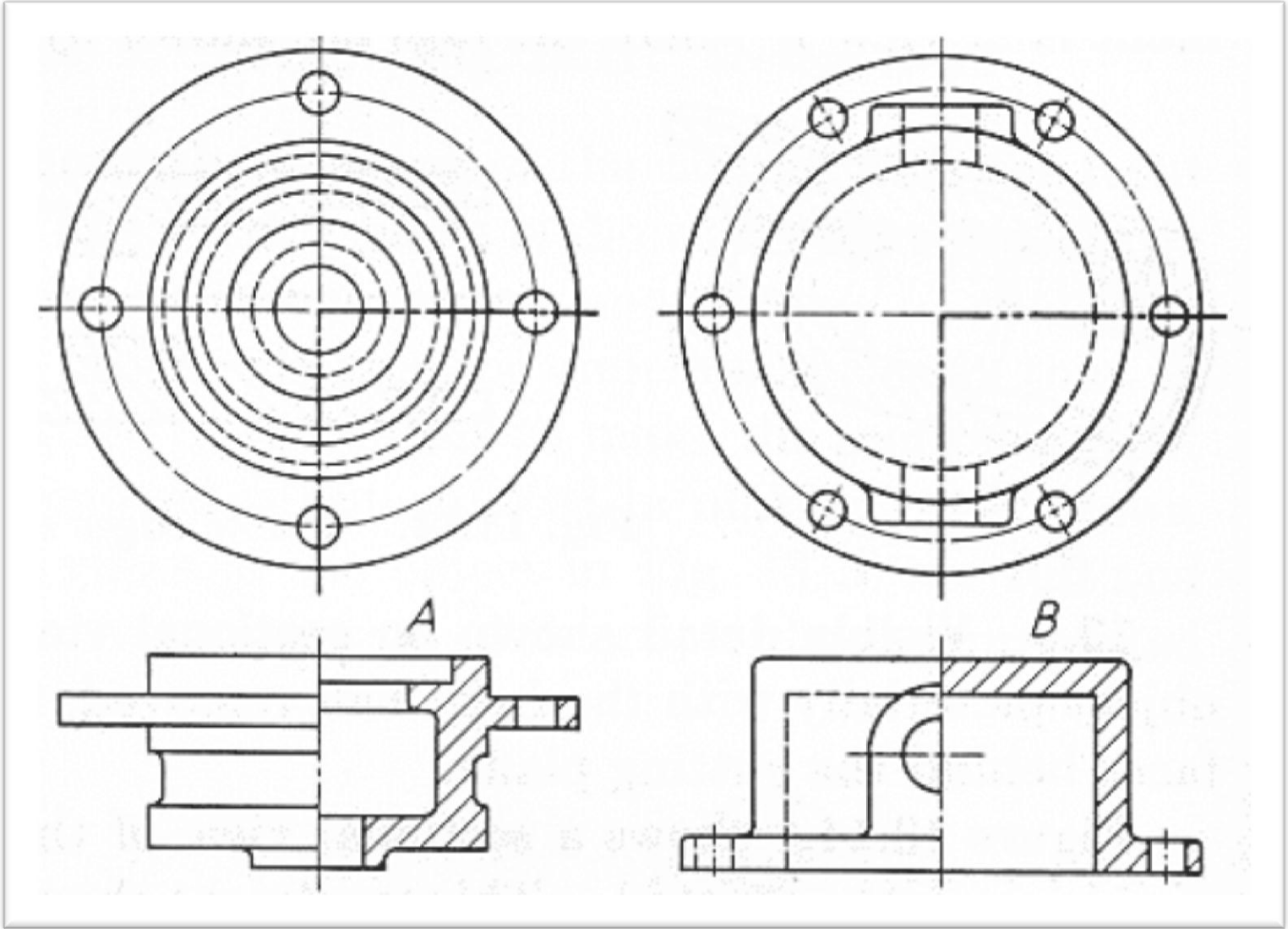


An offset cutting plane is used to reveal the detail of two bosses.

7.2.2 HALF SECTION

A half section is made by cutting halfway through an object. See Fig. 7.6. Thus one half is drawn in section and the other half is an outside view. Hidden lines are not used on this half because inside details are visible on the section.

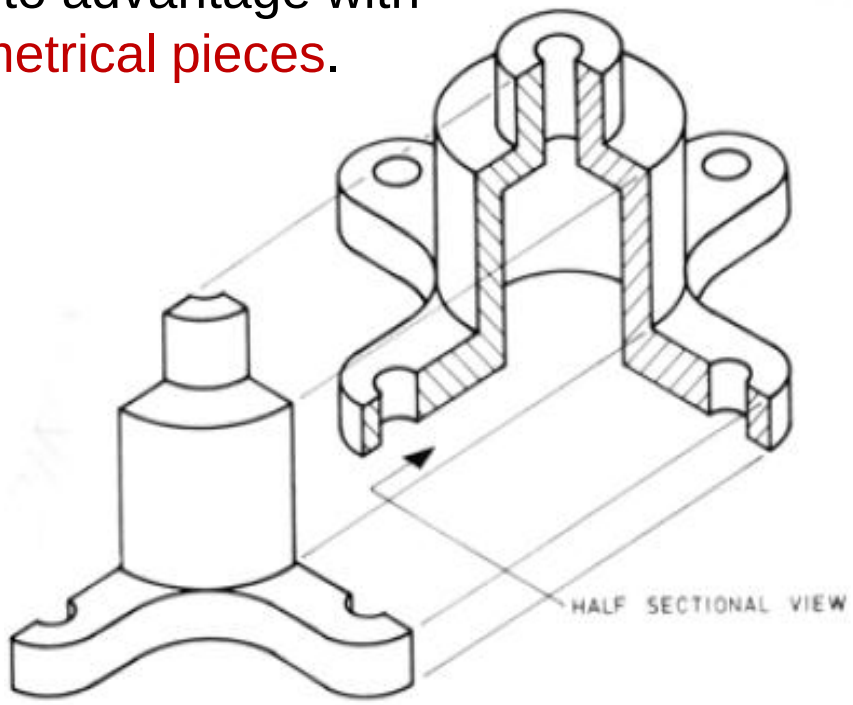
However hidden detail on the unsectioned part may be shown for clarity or for dimensioning purposes as in Fig.7.6 (b).

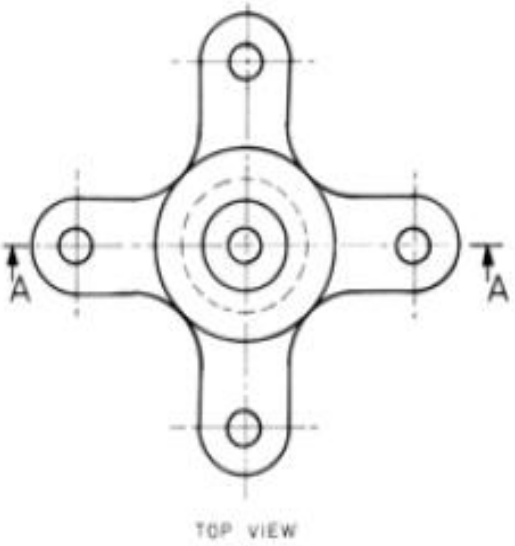


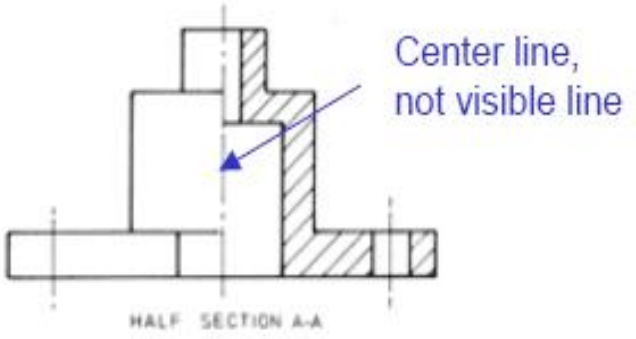
Half Section

- A half section is made by cutting halfway through an object.
- One half is drawn in section and the other half is an outside view.
- Hidden lines are not used on this half because inside details are visible on the section.

- Half sections can be used to advantage with symmetrical pieces.







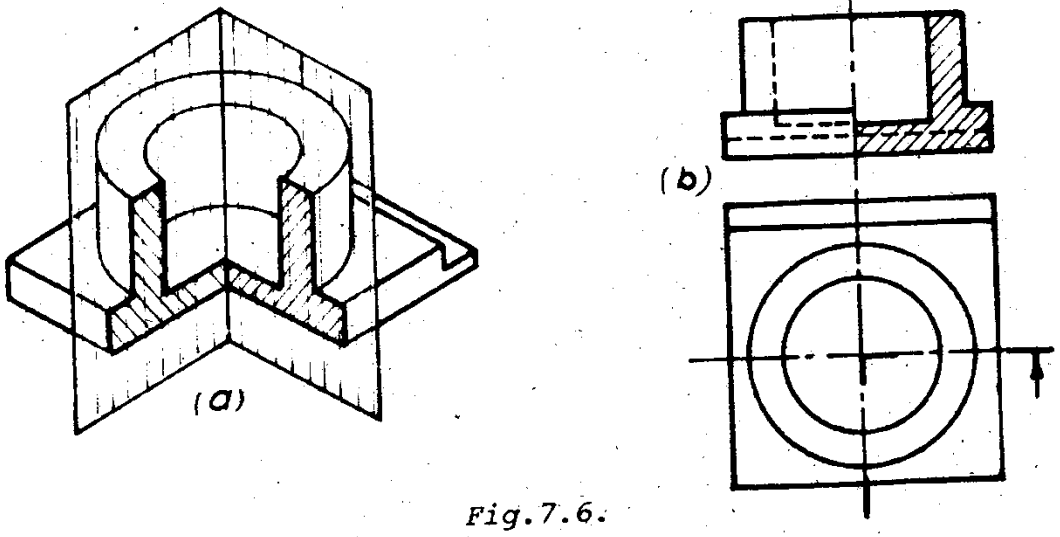


Fig.7.6.

Half sections can be used to advantage with symmetrical pieces as in Fig.7.8 as well as with assemblies as in Fig.7.9.

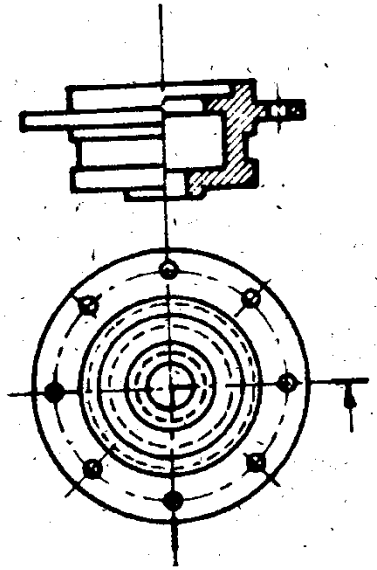


Fig. 7.8

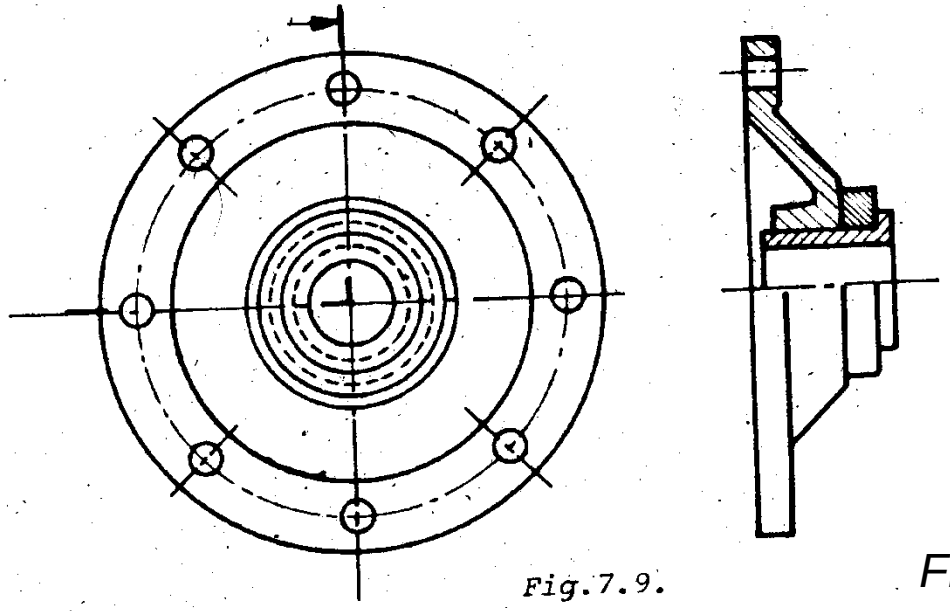


Fig.7.9.

Fig. 7.8,9 Half section dashed lines are not necessary.

7.2.3 BROKEN-OUT SECTION

This type of section shows only an interior portion of the object in section. The cutting plane passes part-way through the object, and the area immediately in front of the plane is broken and removed, thus revealing the interior details in this area. At the point where the object is considered broken, an irregular break line is used to indicate the break. Fig.7.10 (a) and (b) illustrate the advantage of the broken out section, which eliminates the need for excessive section lining.

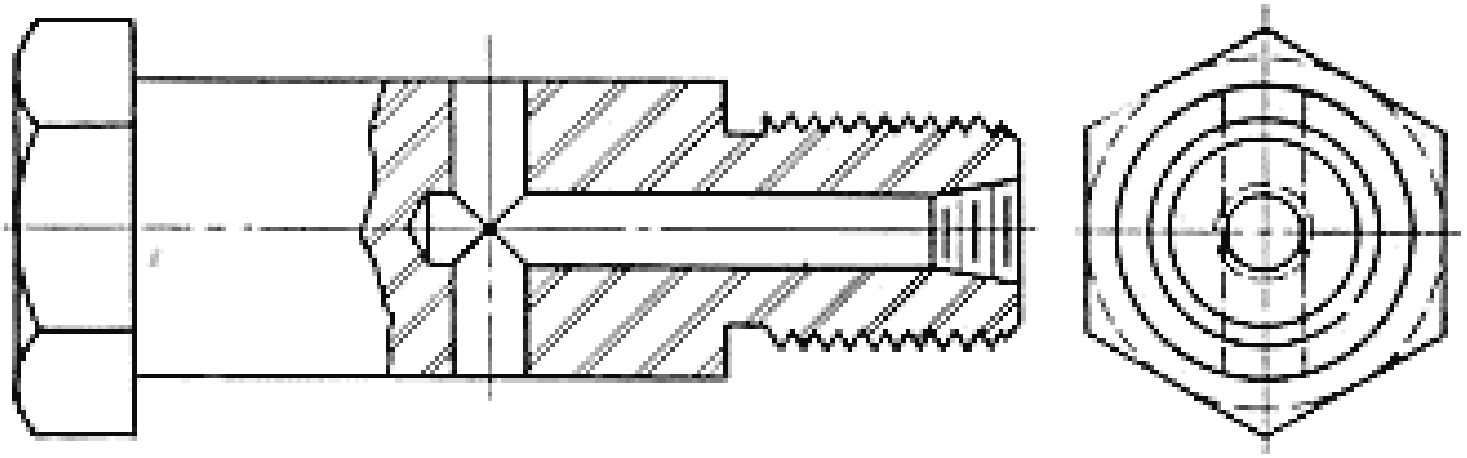
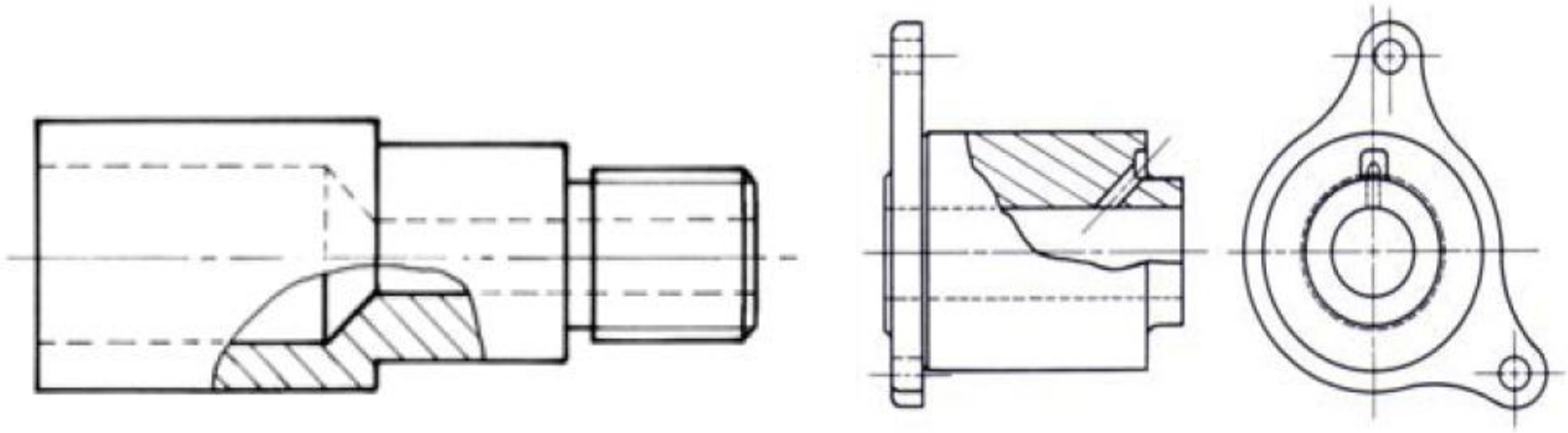
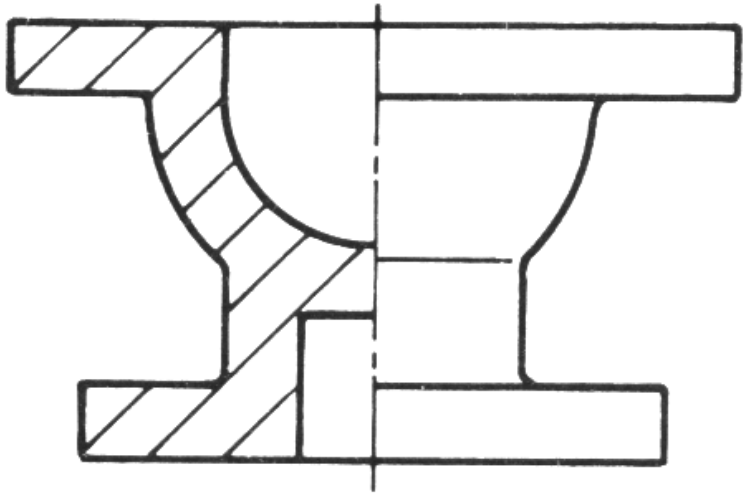


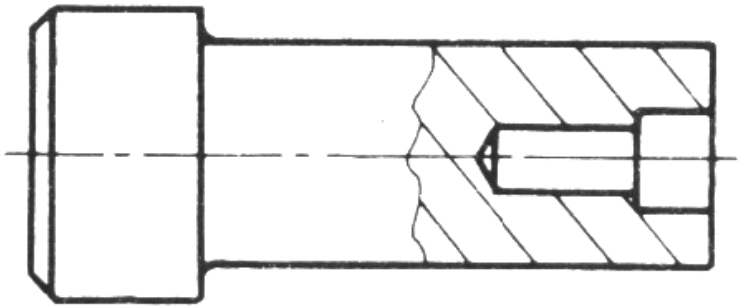
Fig. 7.10 Broken-out sections

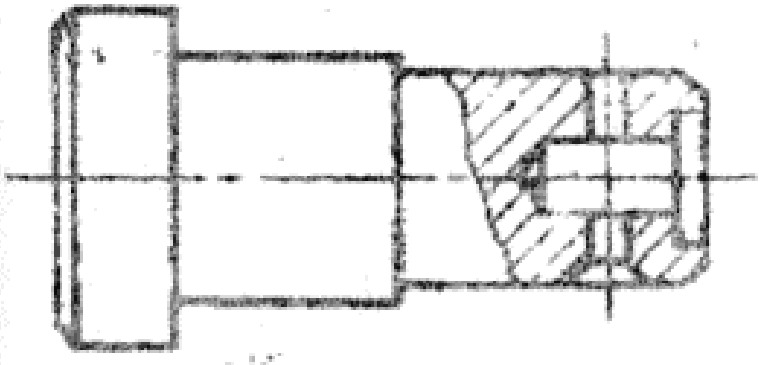
Broken-out Section

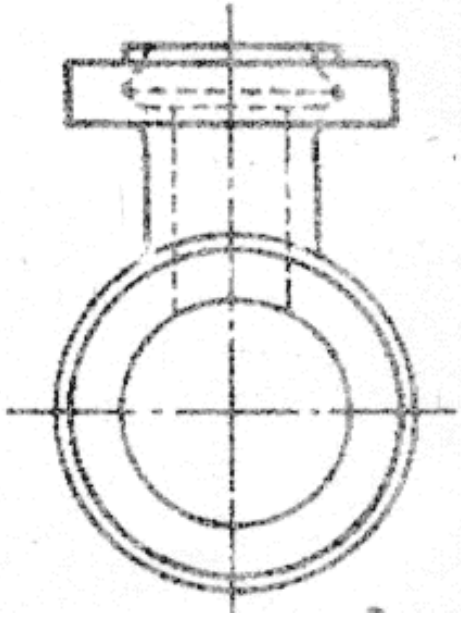
- If the space is limited, partial view may be used. The boundary of the section is drawn freehand.
- This type of section shows only an interior portion of the object in section. The section area is shown immediately in front of the plane.
- At the point where the object is considered broken, an irregular break line is used to indicate the break.

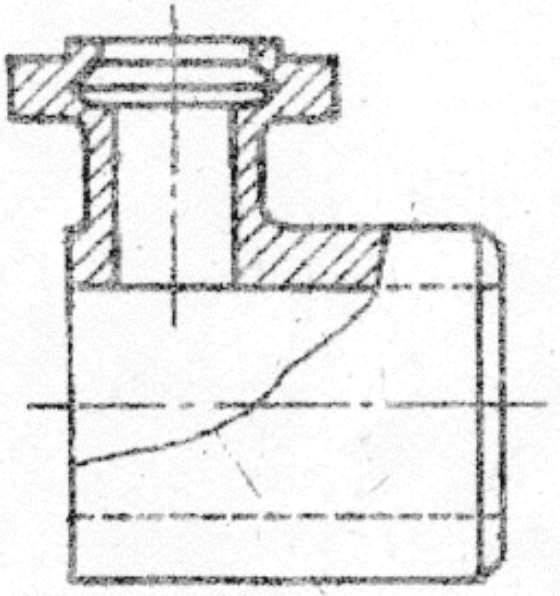






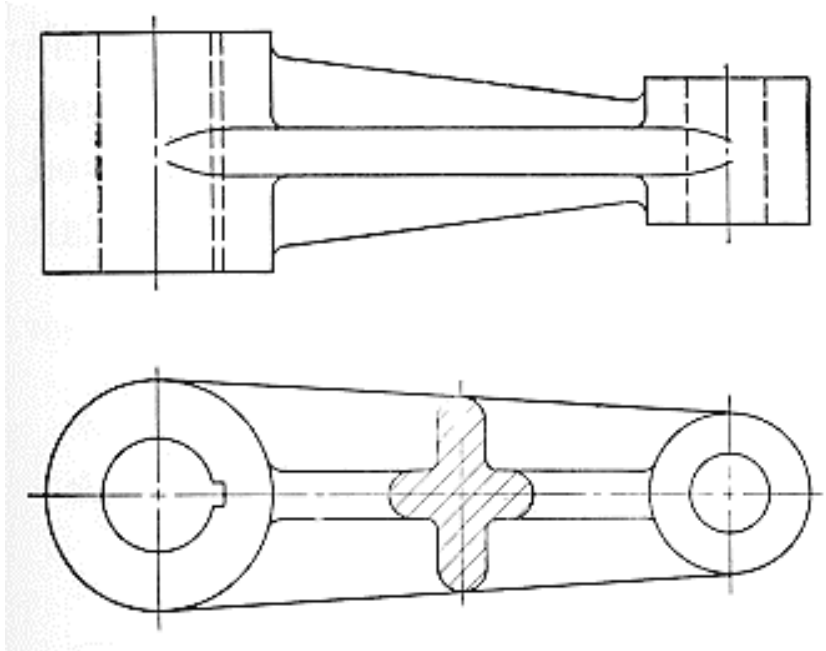






7.2.4 ROTATED SECTION

Some parts of an object have to be rotated to show the section. Rotating means turning the section until it is parallel with the plane of projection. The cutting plane is passed perpendicular to the axis of the part to be cut. See Fig.7.11. The cut portion is revolved 90 degrees and drawn in this position. The resulting view is a Rotated section.



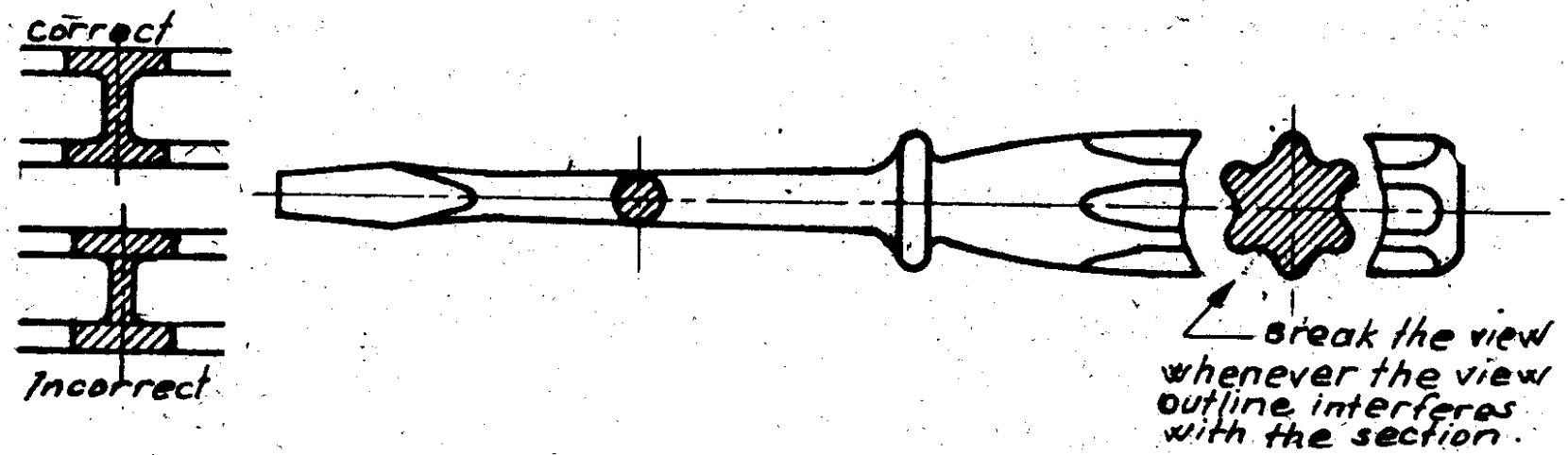
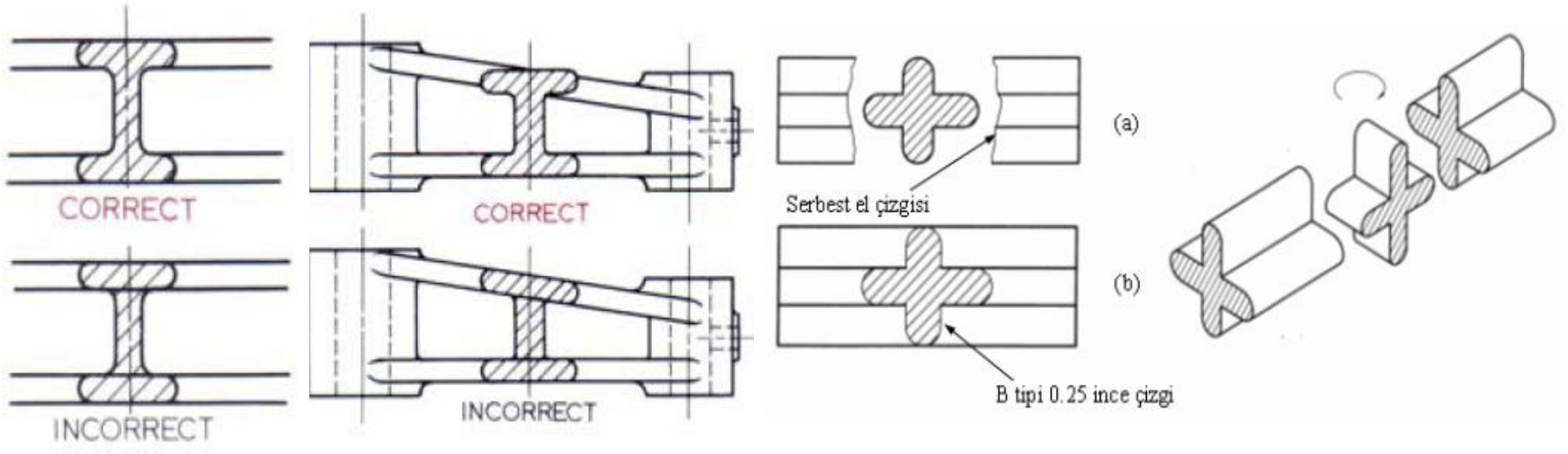


Fig. 7.11 A rotated section

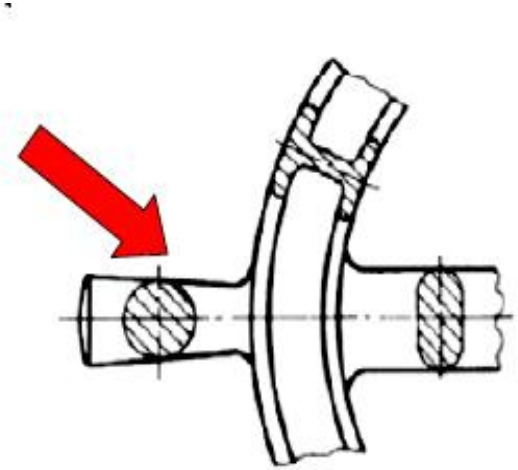
Rotated Section

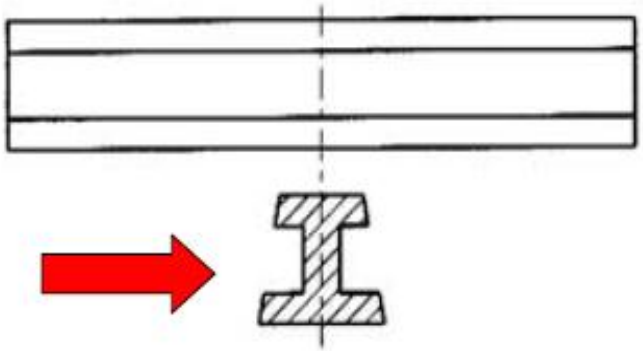
- Some parts of an object have to be rotated to show the section.
- Rotating means turning the section until it is parallel with the plane of projection.
- The cutting plane is passed perpendicular to the axis of the part to be cut. The resulting view is a Rotated section.

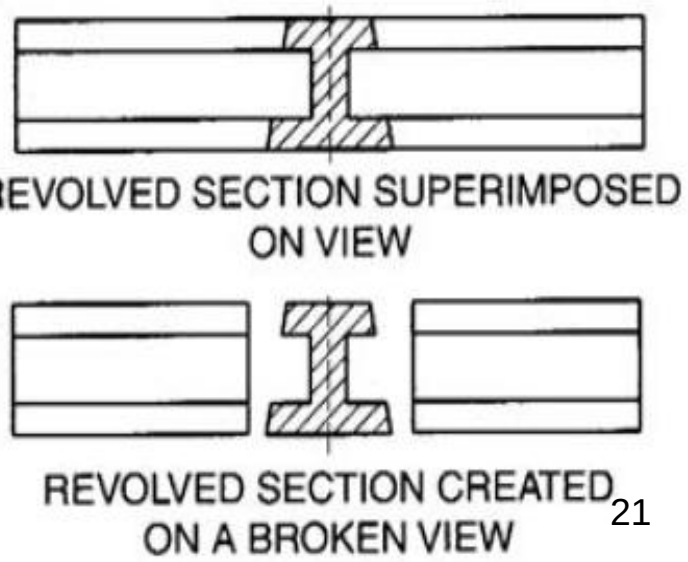


Rotated Section

- The superimposition of the revolved section requires the removal of all original lines covered by it.

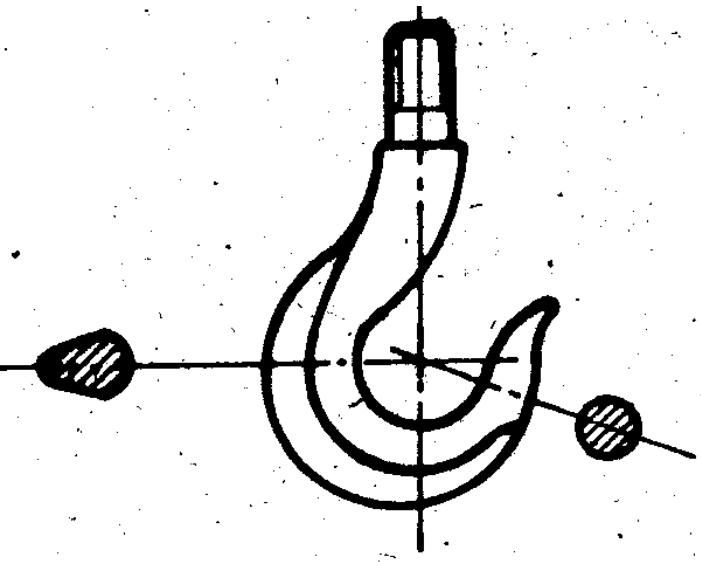






7.2.5 REMOVED SECTIONS

This type section is a revolved section drawn outside the normal view, as in Fig.7.13. Removed sections are used whenever restricted space for the section or the dimension of it, prevents the use of an ordinary rotated section. When the shape of a piece is not uniform several sections may be required, as in Fig.7.14. These sections are represented by a series of cutting planes and identifying letters, as section A-A, B-B; C-C and so on.



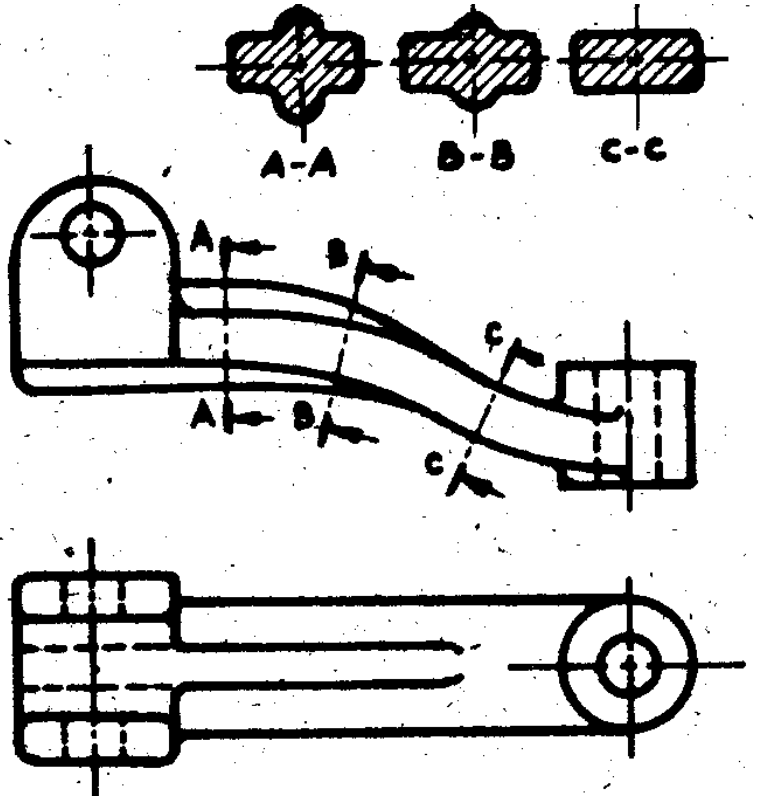
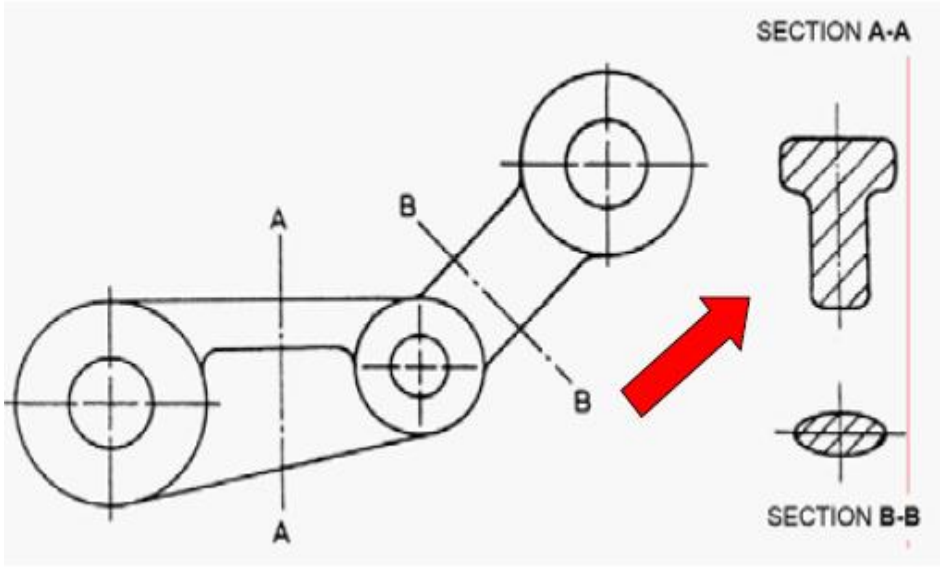
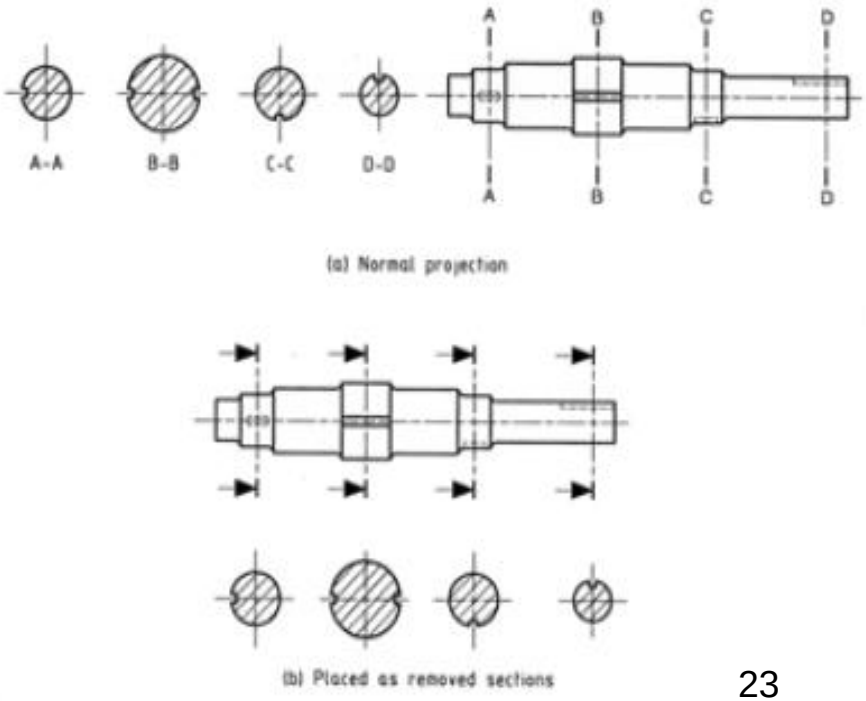


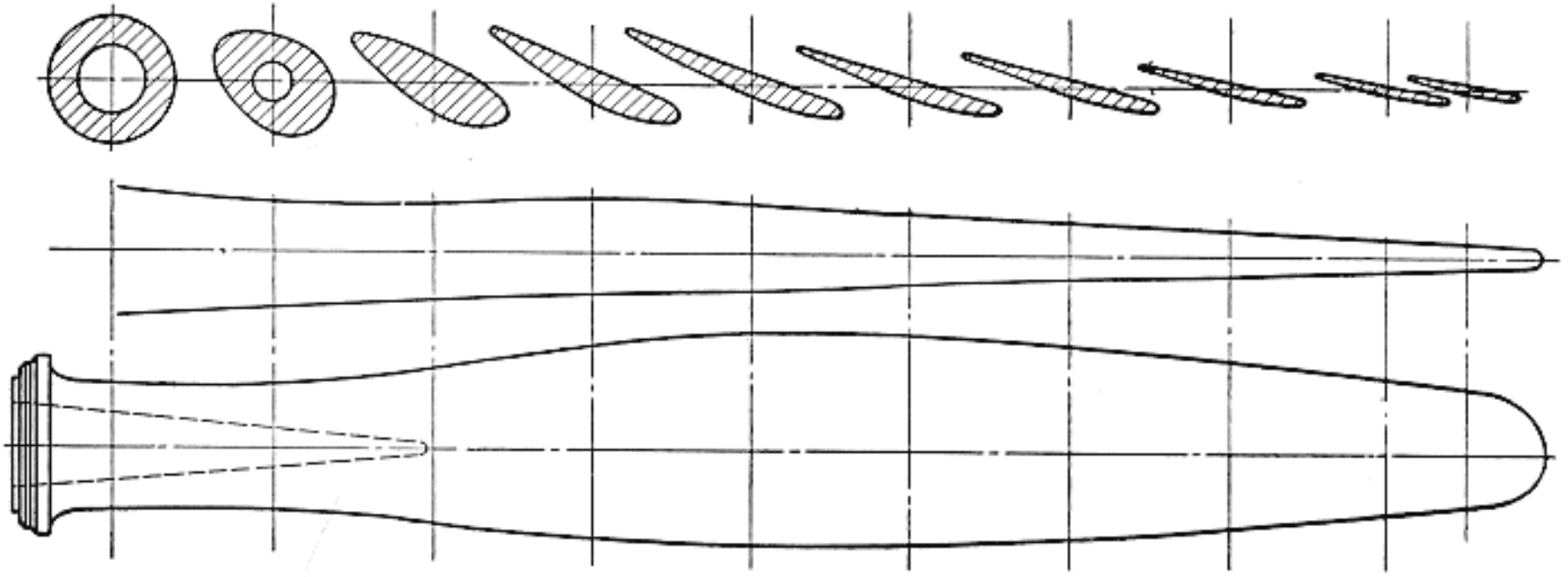
Fig. 7.14 Removed sections. The cutting planes and the mating sections must be identified.

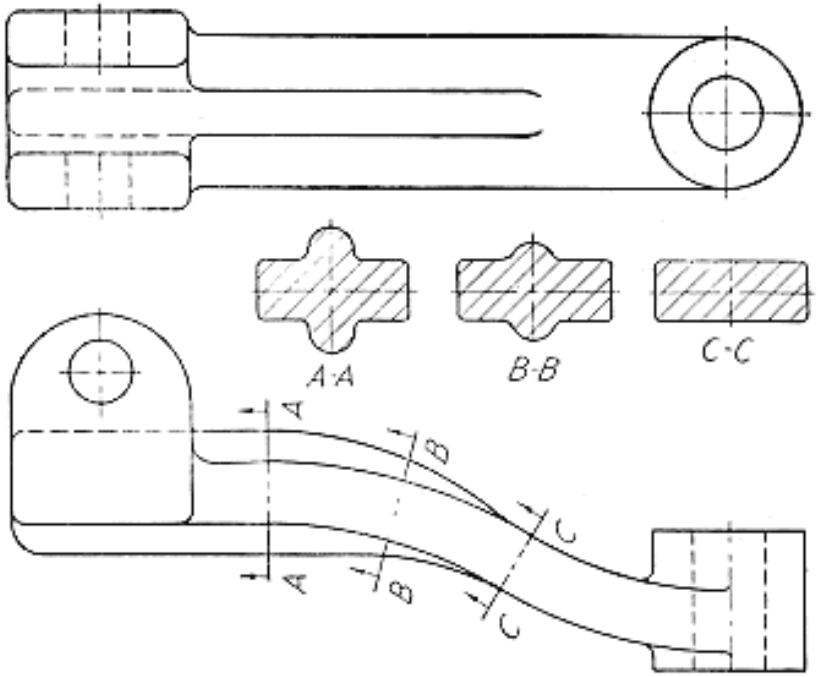
Removed Section

- This type of section is a revolved section drawn outside the normal view.
- Removed section are used whenever restricted space for the section or the dimensioning of it prevents the use of an ordinary rotated section.
- When the shape of a piece is not uniform several sections may be required.








A-A
B-B
C-C
A
B
C
A
B
C

7.2.6 ASSEMBLY SECTIONS

This type section is made up of a combination of parts as in Fig. 7.9. The purpose of an assembly section is to reveal the interior of a machine or structure so that the separate parts can be clearly shown and identified But the separate parts do not need to be completely described.

The small amount of clearances between mating or moving parts on assembly drawing is not shown. Even the clearance between a bolt and its hole, which may be as much as 1 mm or 1/16, is rarely shown.

On assembly drawing only such hidden details as are needed for part identification or dimension is drawn.

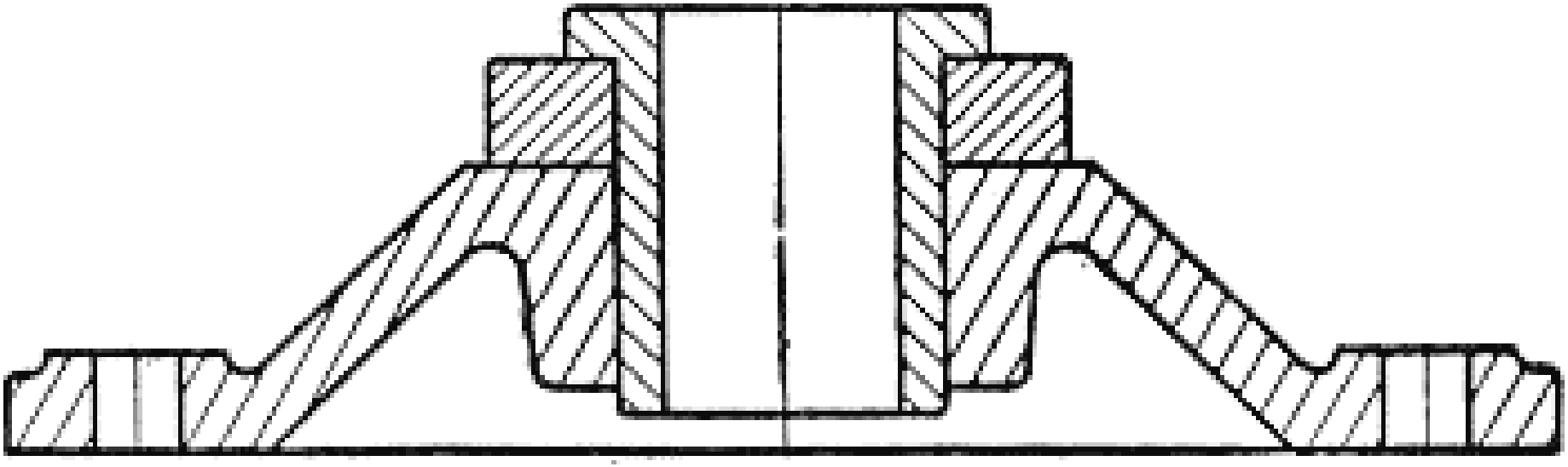
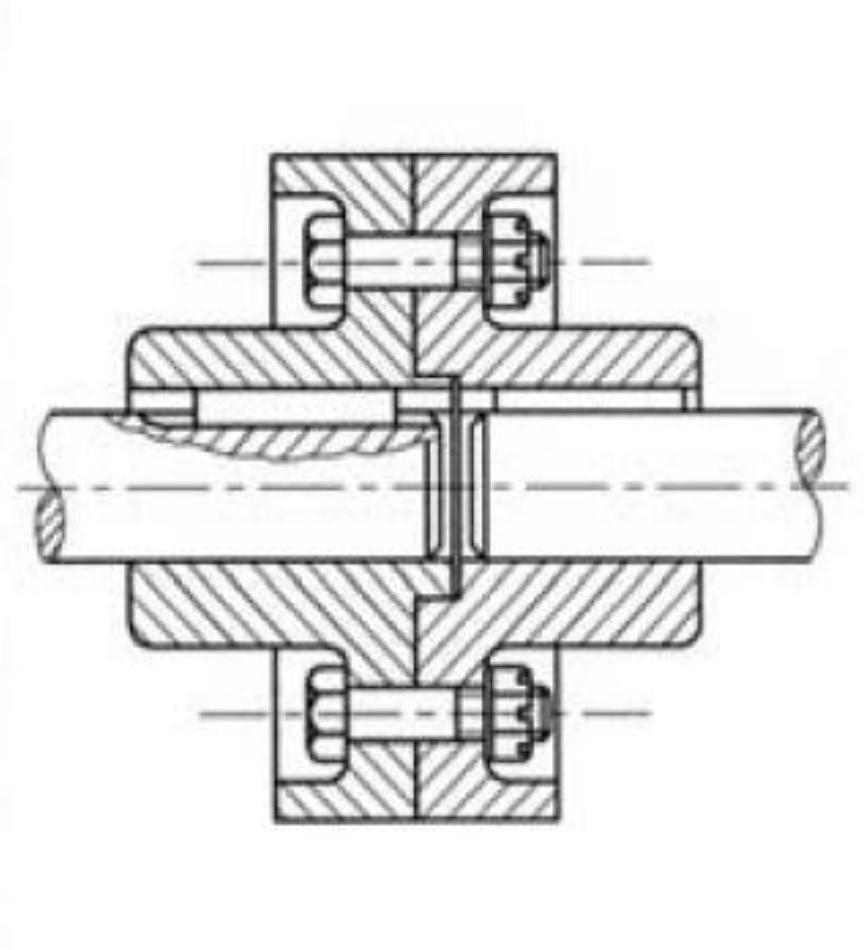


Fig. 7.16 Assembly in Section

Assembly Section

- This type of section is made up of a combination of parts.
- The purpose of an assembly section is to reveal the interior of a machine or structure so that the separate parts can be clearly shown and indentified. But the separate parts do not need to be completely described.



7.3. RULES IN SECTIONING

7.3.1 Hidden and Visible Lines in Section

Sections are used primarily to replace hidden-line with visible-line; thus, as a rule hidden lines should be omitted in sectional views.see-Fig.7.15 (d). A correct front view and a sectional view are shown in Fig.7.15 (a) and (b). As stated before the hidden lines do not clarify the drawing; they tend to confuse.

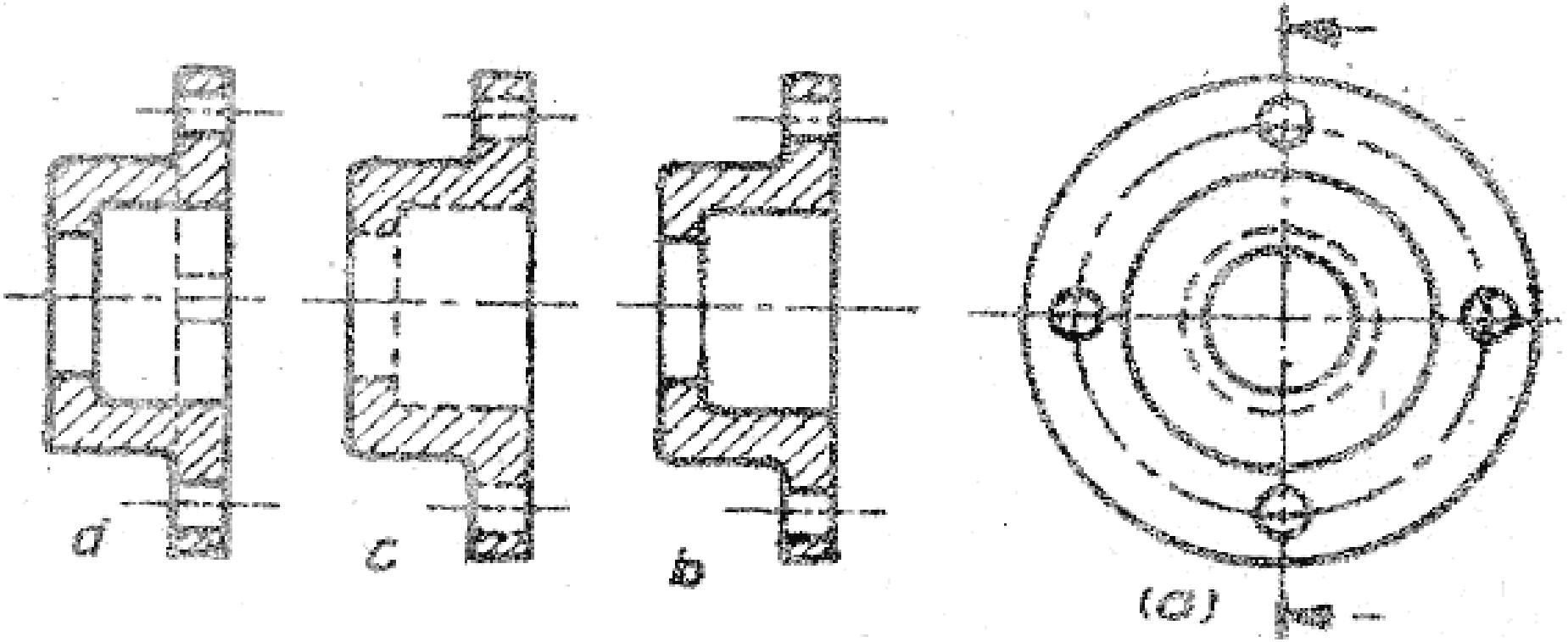


Fig. 7.17 Hidden lines in sections

However, hidden edges and surfaces are shown if necessary for the description of the object. They should also be used in such cases to make it possible to omit a view. Fig.7.16.

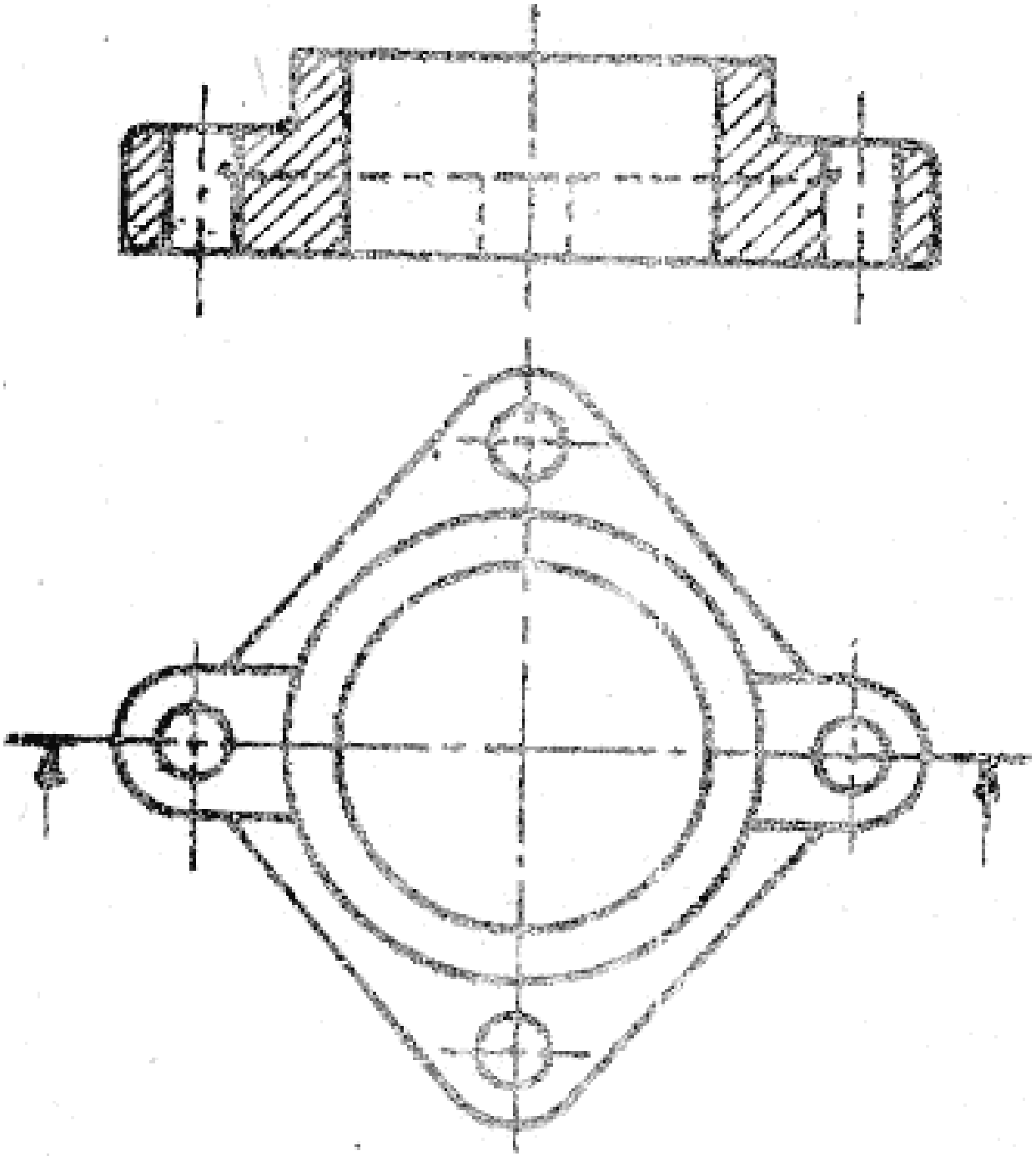
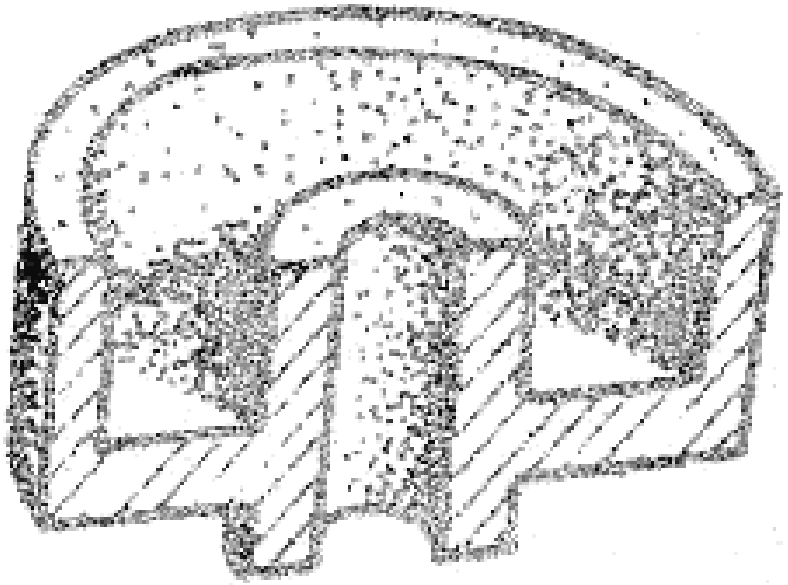
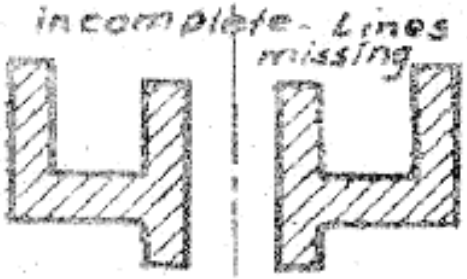


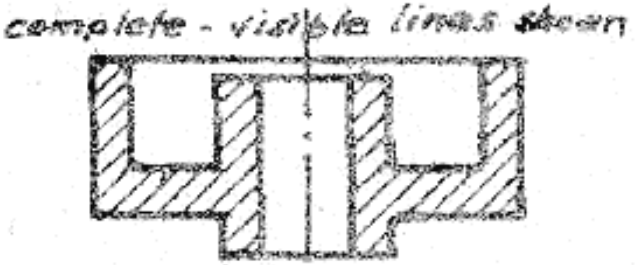
Fig. 7.18 Hidden edges and surfaces are shown.



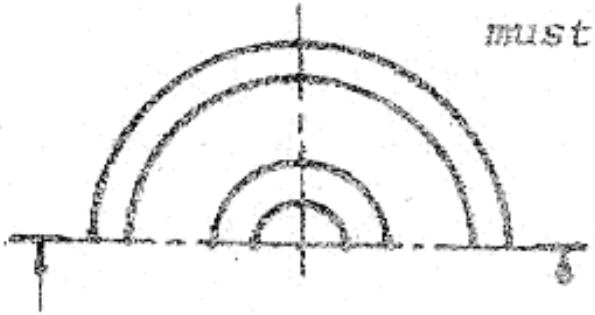
A section-lined area is always completely bounded by a visible outline, never by a hidden line as in Fig.7.15 (c). Therefore all visible edges and contours behind the cutting plane should be shown, as in Fig.15 (a) and (b), Fig.7.17 (c), otherwise a section will appear to be made up of disconnected and unrelated parts as shown in Fig.7.17 at (b).



(b) If only the sectioned area were shown, the view would be incomplet.

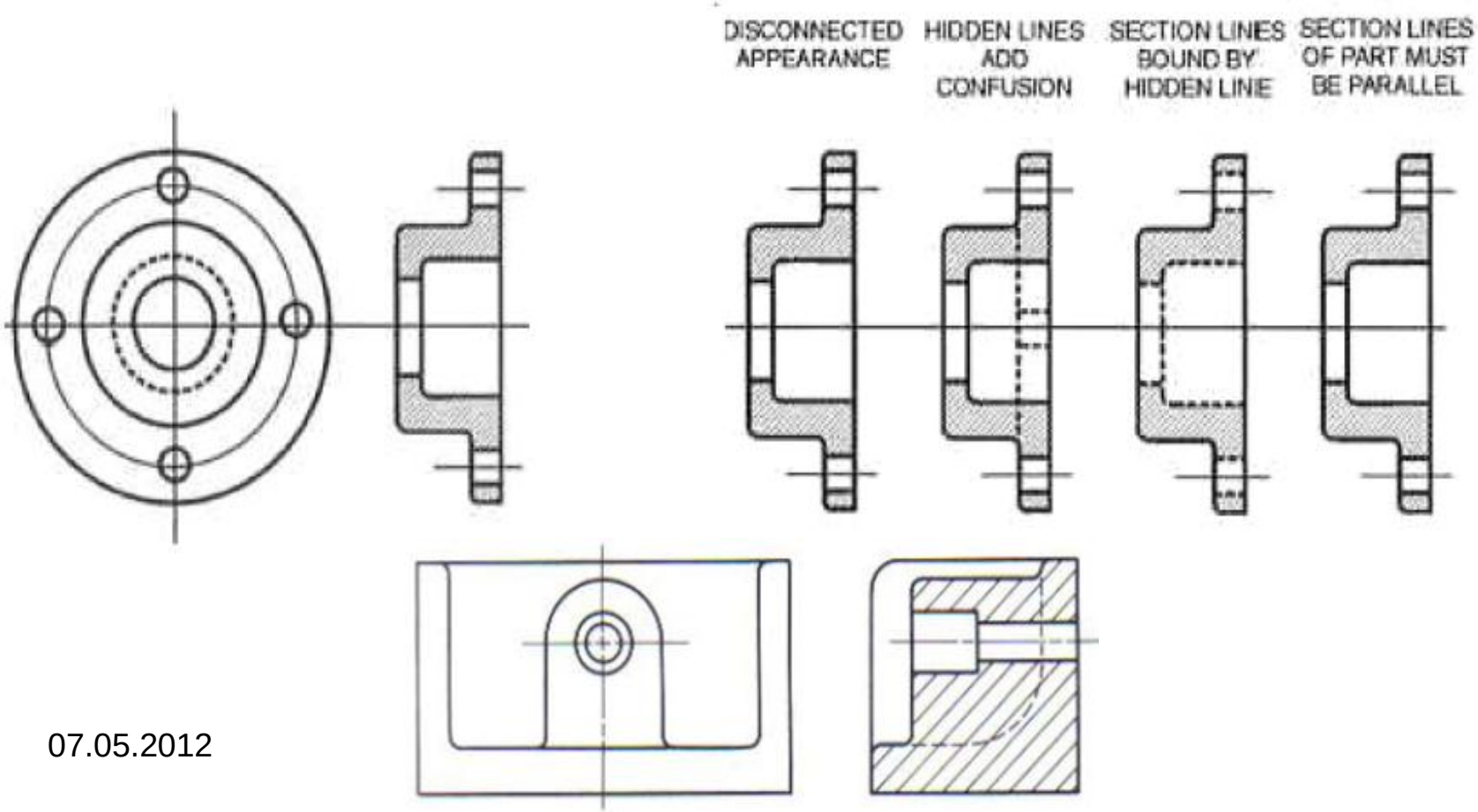


(c) Visible lines behind the section must be shown also.

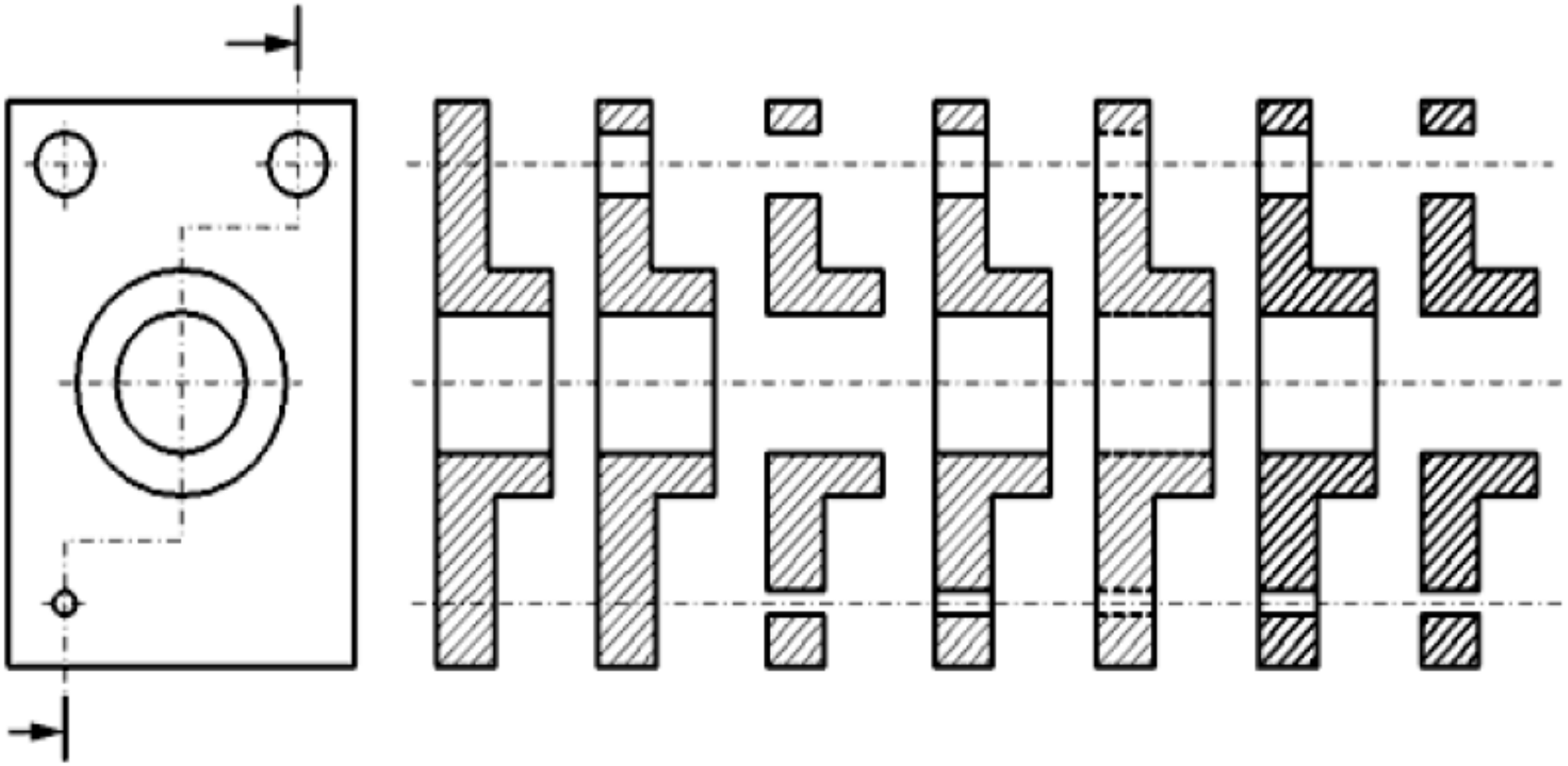


Hidden and visible lines in section

- All visible edges and contours behind the cutting plane should be drawn.
- Hidden lines should be omitted in sectional views. Sometimes hidden lines, which are necessary for clearness, should be drawn.

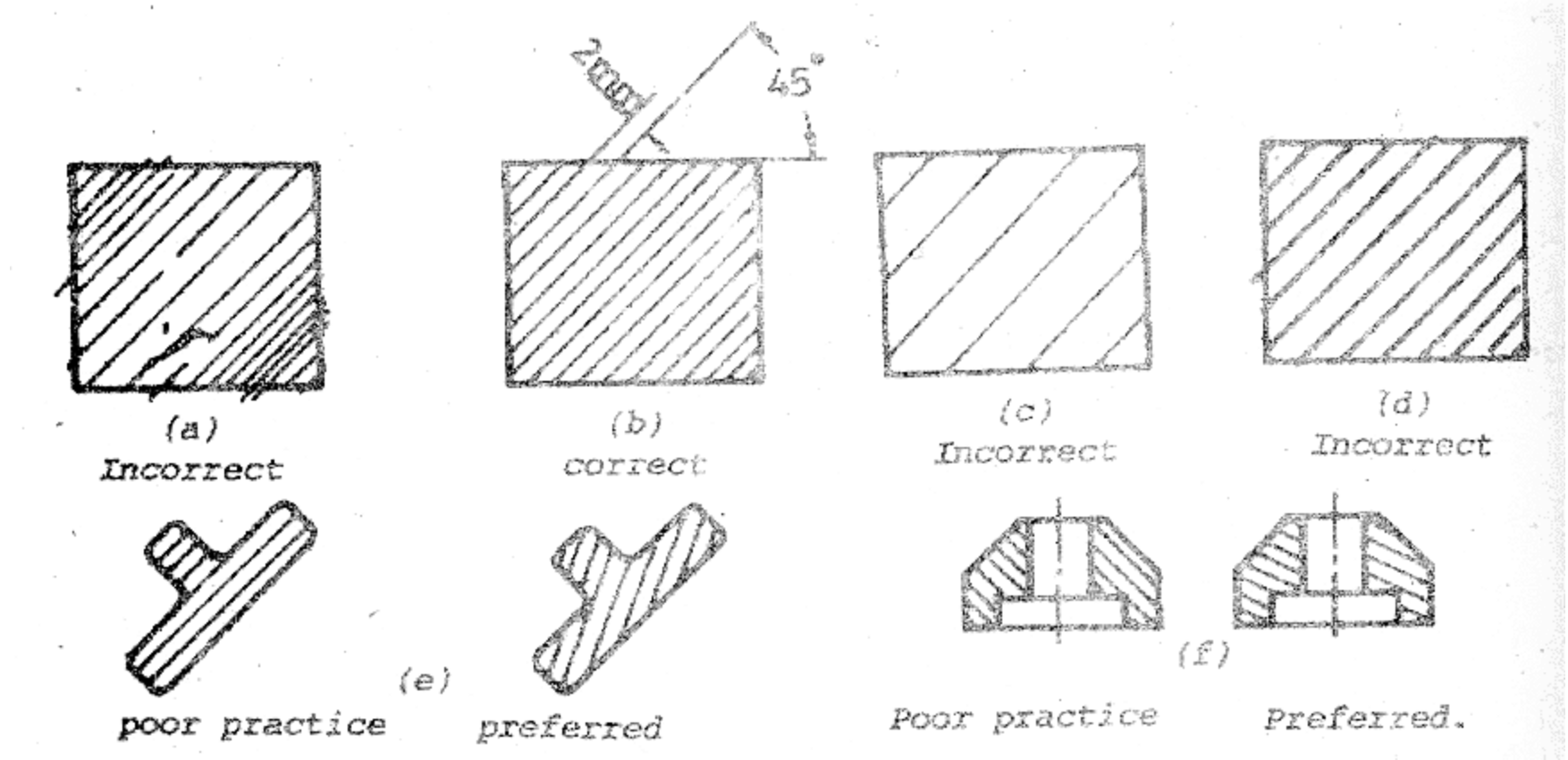


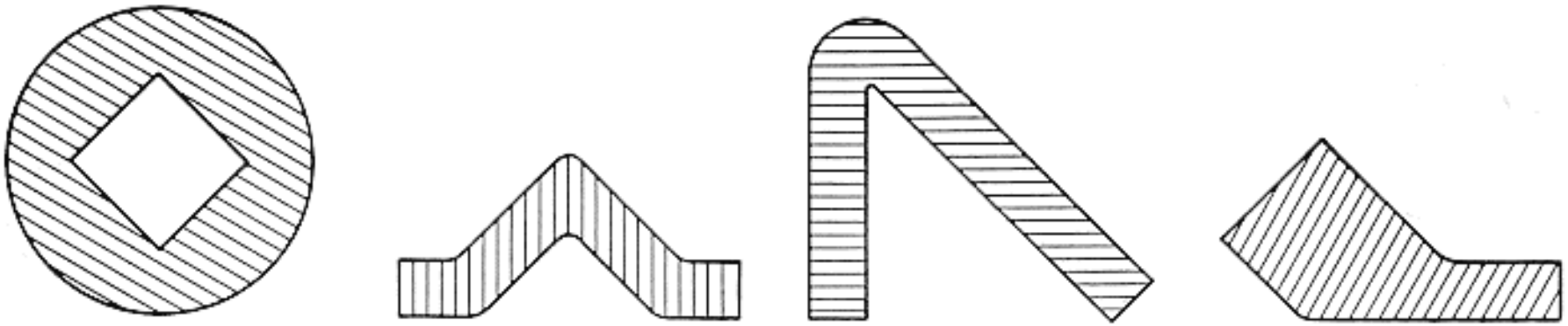
Hidden and visible lines in section



7.3.2. Section Lining (cross-hatching)

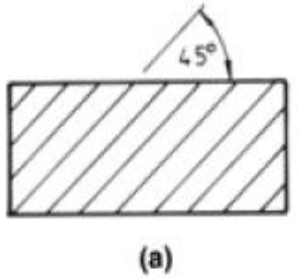
Section lining of a cut surface is indicated by fine lines. These are drawn as continuous lines, usually at an angle of 45º, as shown in Figure 17. This requires uniform spacing of the lines. For most purposes the distance between lines can be about 2 mm spaced by eye. For small areas use closer spacing, 1 mm, while for large area use wider spacing, 3 or 4 mm. Section lining or cross-hatching lines should not be parallel or perpendicular to any main visible line bounding the sectioned area (see Figure 17 for correct and incorrect practices).

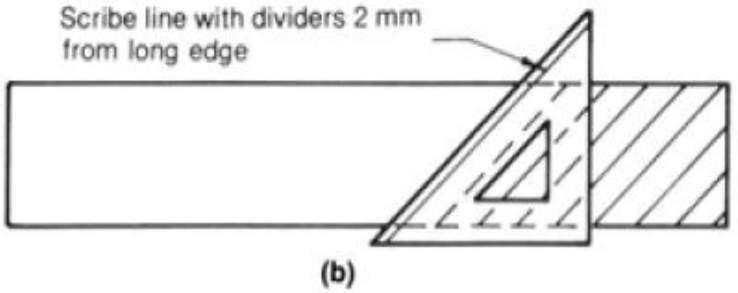


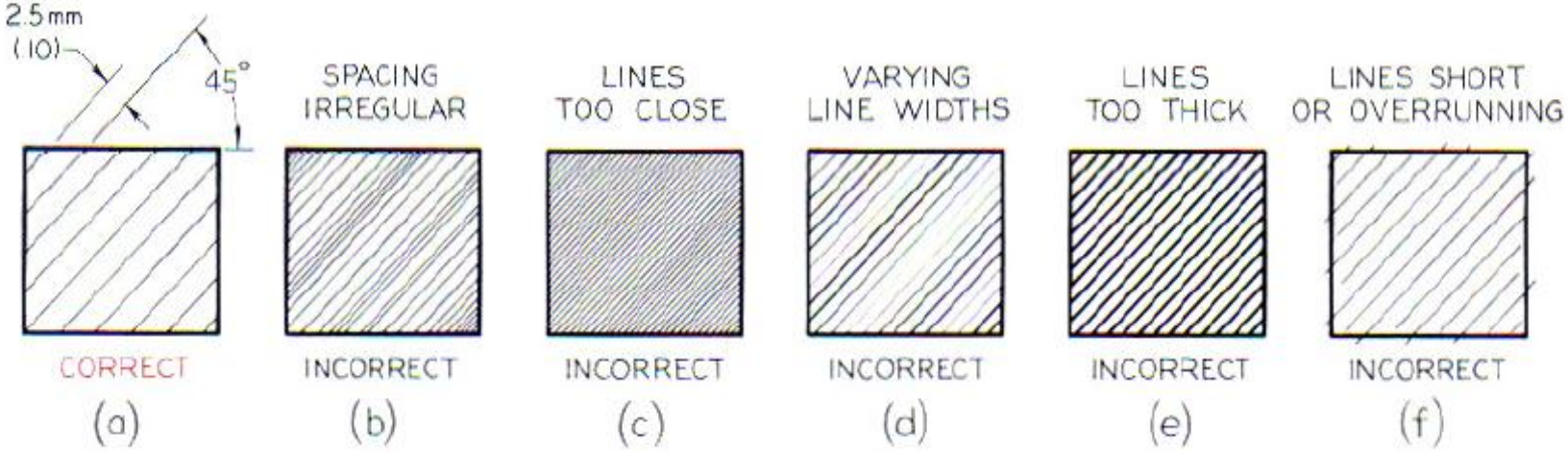


Section lining

- Hatching lines are ‘thin line’, and are normally drawn 45º to the horizontal, right or left.
- Hatching lines are shown only part in contact with the cutting plane.
- If the shape of the section would bring the hatching lines parallel to one or more of the sides, another angle may be used.

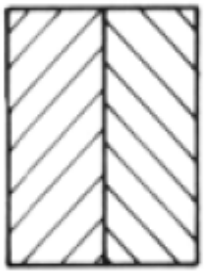




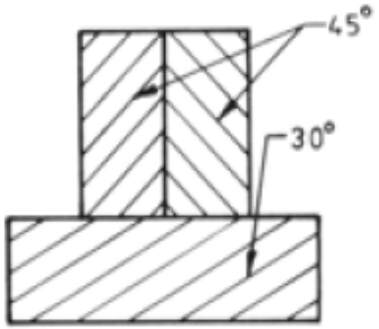


Crosshatching of adjacent parts

For adjacent parts, hatching on one part should be at right angles to the hatching on the other part



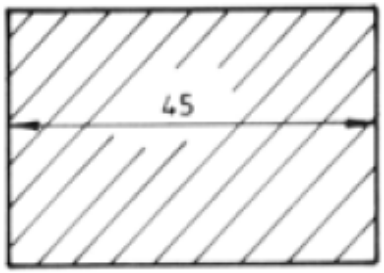
(a)



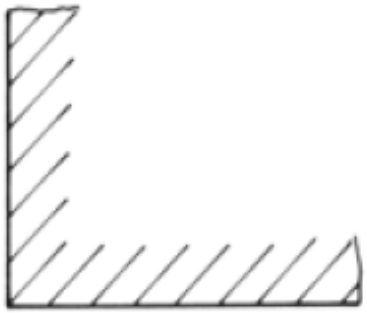
(b)

For more than two adjacent parts, vary the angle and/or the spacing of hatching lines

Dimensions may be inserted in hatching area by interrupting the hatching lines.



(c)



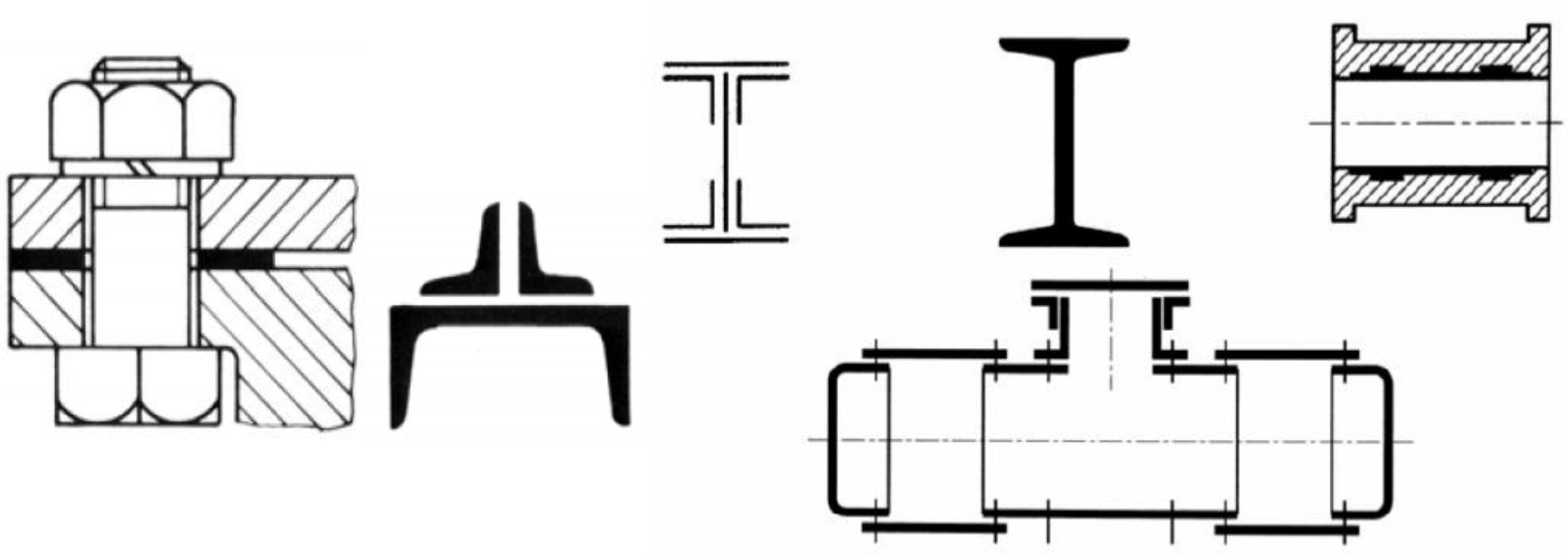
(d)

For large area, place hatching lines around the edges of the area

Thin material in section

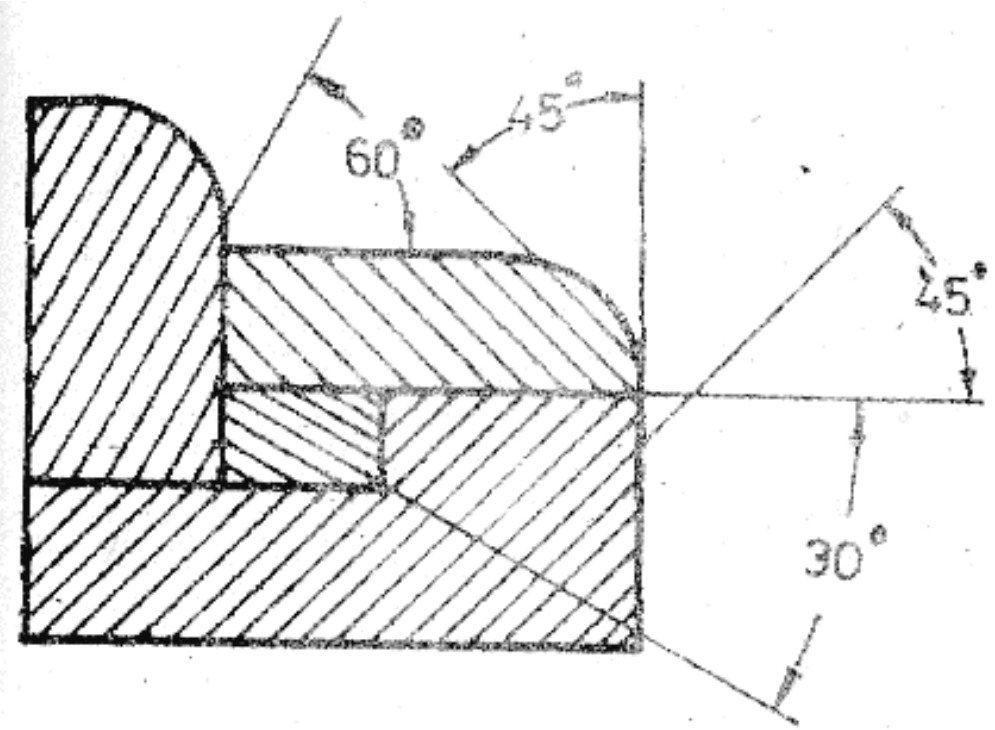
- For very thin area, e.g. Gaskets, plastic sheet, packing, sheet metal, these areas should be filled dark.

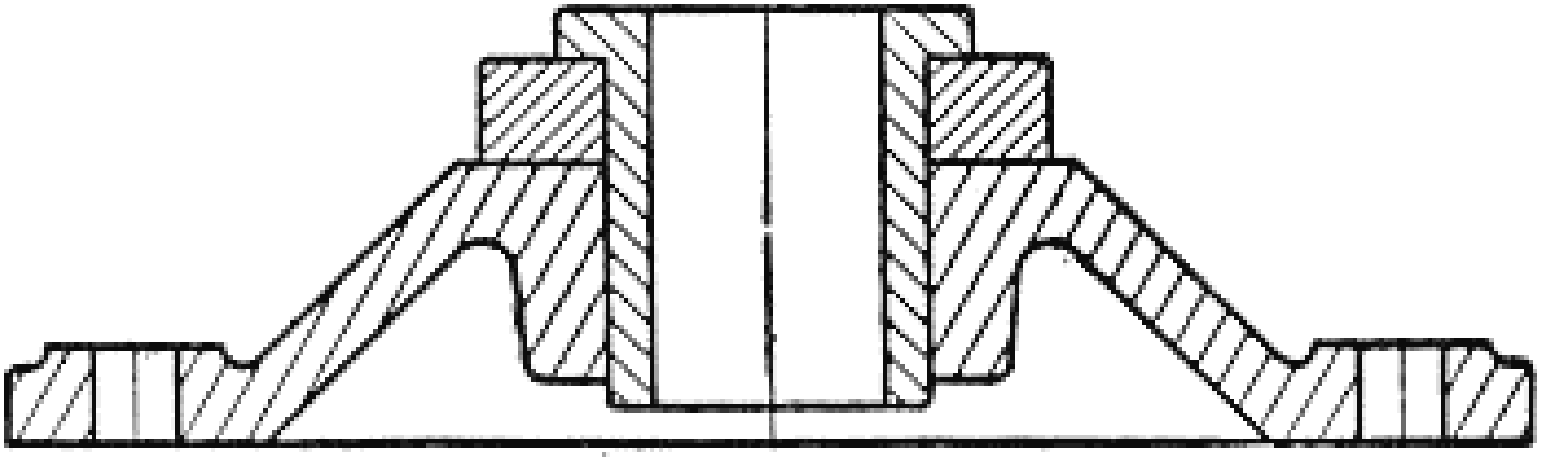
- A small space should be left between thin adjacent parts.



7.3.3. Cross-hatching of Adjacent Parts

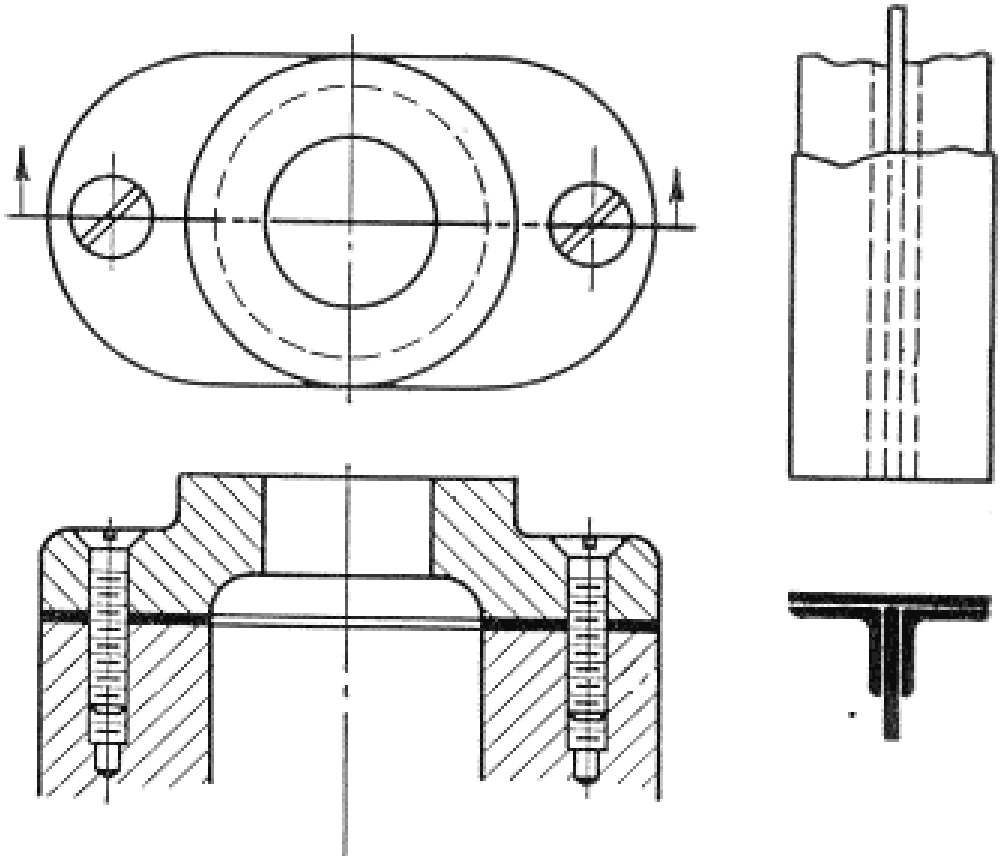
The section lines on two adjacent pieces should slope at 45º, in opposite directions. If a third or fourth piece adjoins the other pieces, as in Figure 18, they ordinarily are cross-hatched at 30º and 60º. An alternate use would be to vary the spacing without changing the angle.

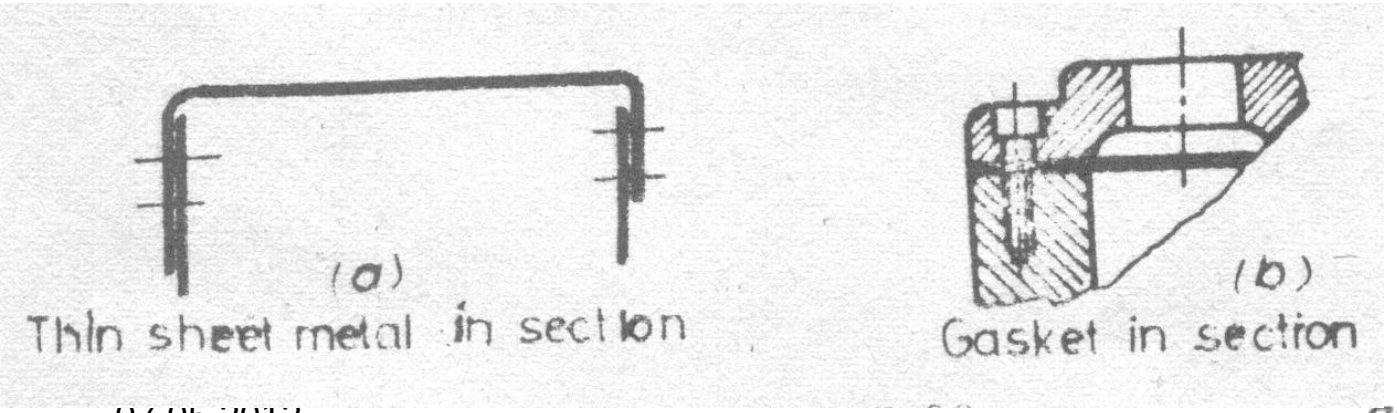




7.3.4. Thin Material in Section

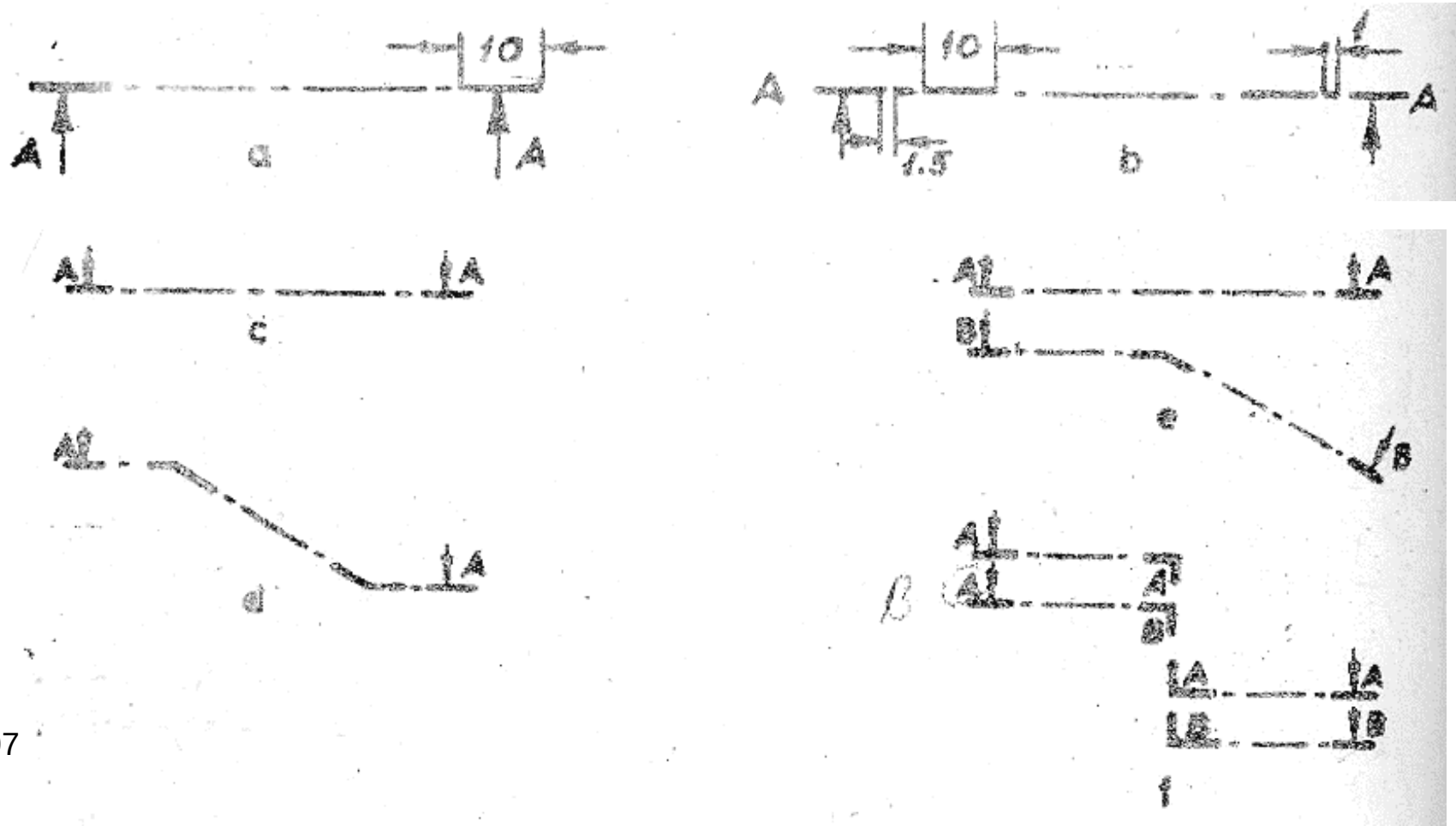
Very thin sections, as of sheet metal, gaskets or structural-steel shapes to small scale, may be shown in solid black, with white spaces between the parts as in Figure 19.



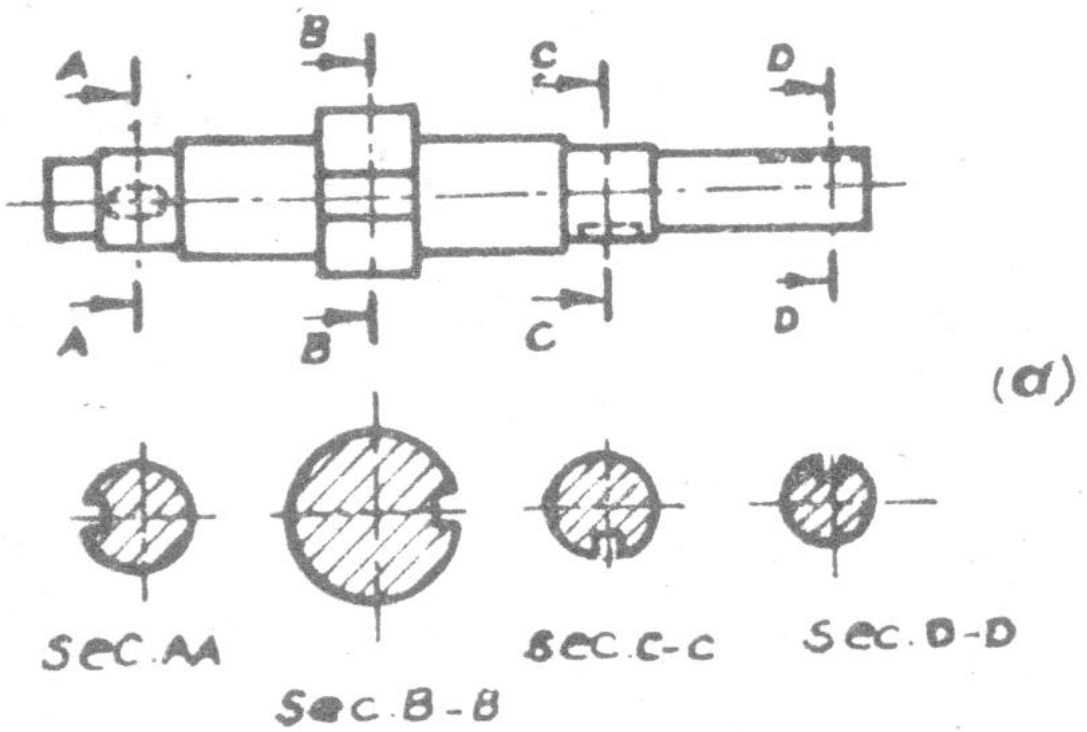


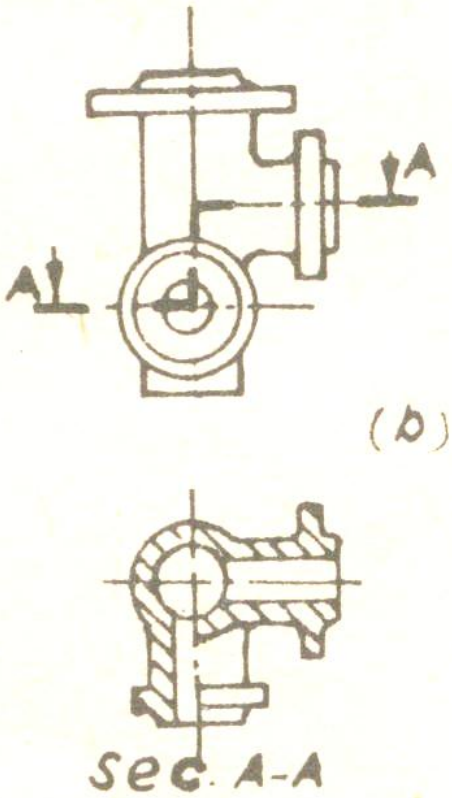
7.3.5 Cutting Plane Lines

The cutting plane line is an imaginary plane passed through the object at the place a section is to be made. It is shown on a drawing by a symbol which is not desirable to show through its entire length. So the beginning and ending of the plane is shown as in Figure 20. This imaginary line may be more completely identified with reference letters along with arrows to show the direction in which the view is taken.



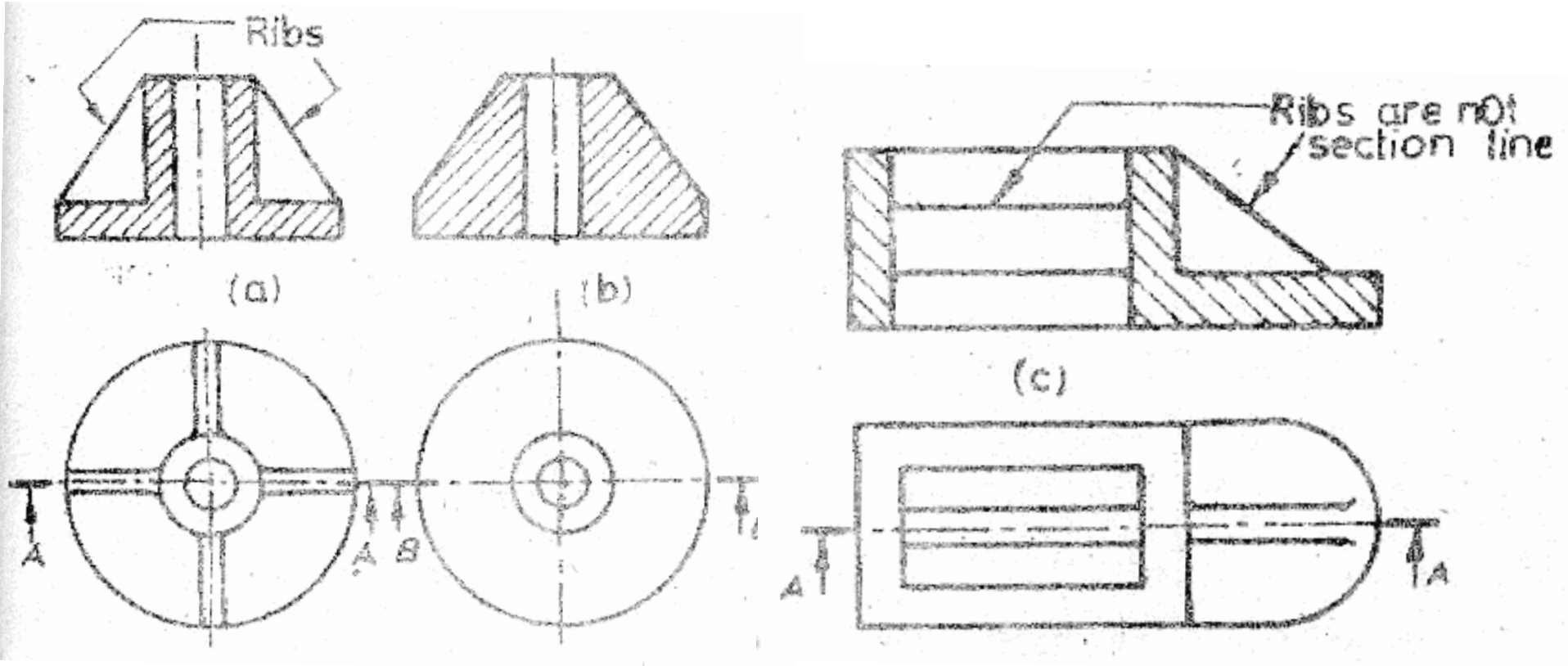
Either symbol may be used to show where the cut has been made. Often when the position of the section is evident, the cutting plane symbol is omitted. Removed sections usually need the cutting plane symbol with arrows to show the direction of sight and with letters to name the resulting sectional view (see Figure 22,a,b). Often, many sections will be made from the same view and perhaps placed elsewhere on the drawing sheet. This procedure may take it necessary to name each section with letters in order to relate it to the view through which the section was taken



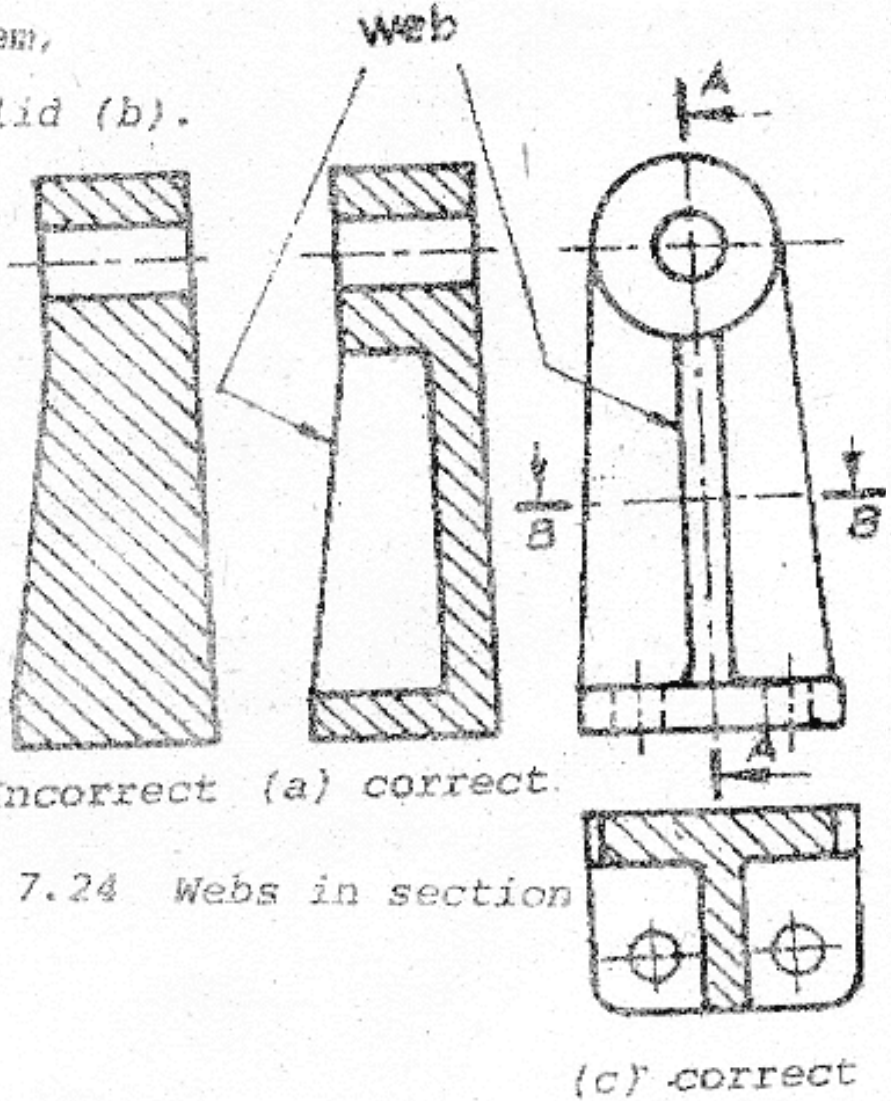


7.4 RIBS AND WEBS IN SECTION

When the cutting plane passes longitudinally through a rib as in Figure 23 or a web as in Figure 24, the cross-hatching is eliminated from the ribs and webs as if the cutting plane were just in front of them. Ribs are used to add strength to the parts, therefore, when the cutting plane passes through the ribs lengthwise the cross-hatching would give the misleading impression that the section was conical. When the cutting plane cuts a rib or web at right angles to its length or axis direction to show its thickness it is always cross-hatched (see Figure 25).



of them,
a solid (b).



(b) Incorrect (a) correct

(c) correct

Fig. 7.24 Webs in section

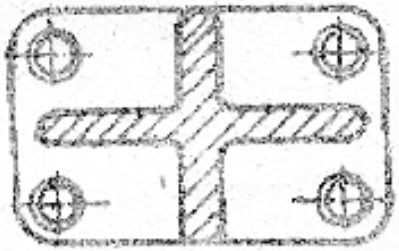
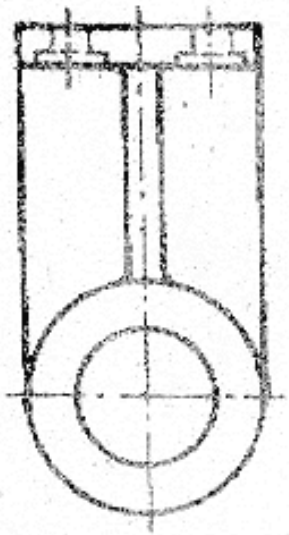
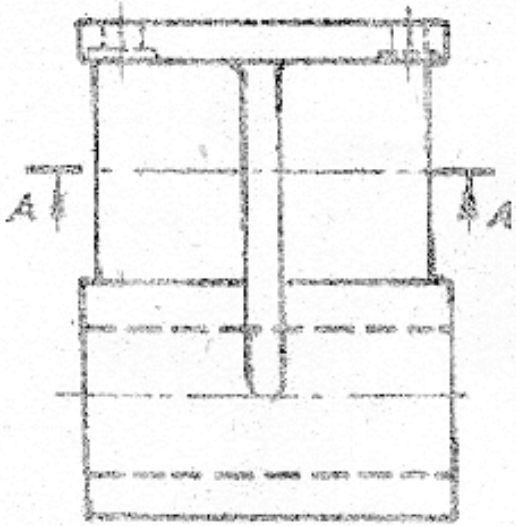


Fig. 7.25 Ribs in section





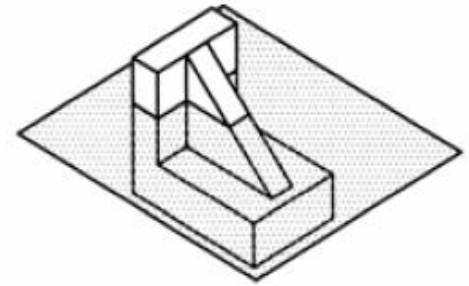
Web: Takviye
Rib : Kaburga

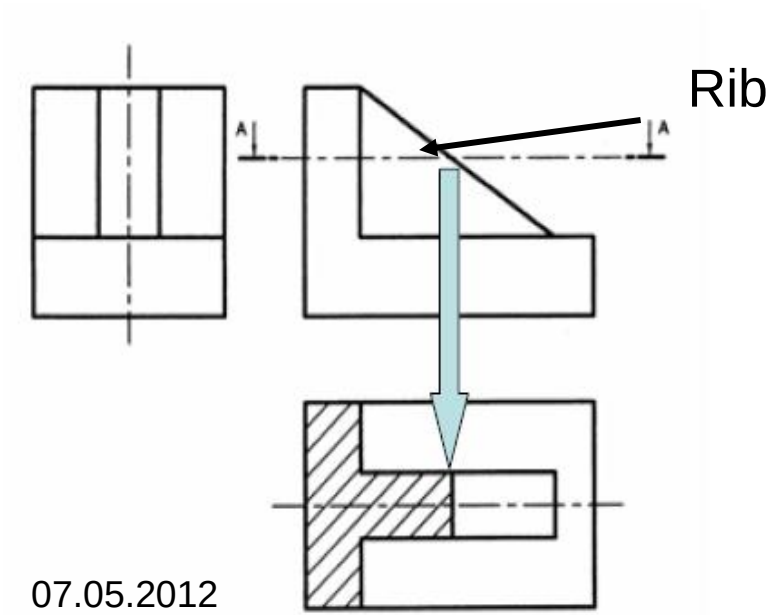
Spoke : Kanat
Arm : Kol

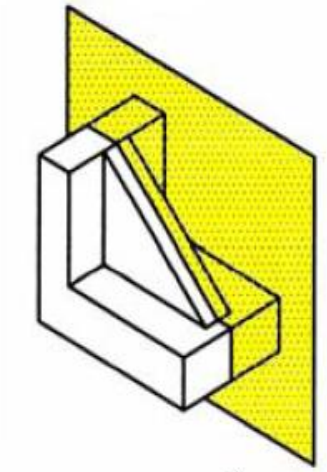
Lug : Kulp, Kulak

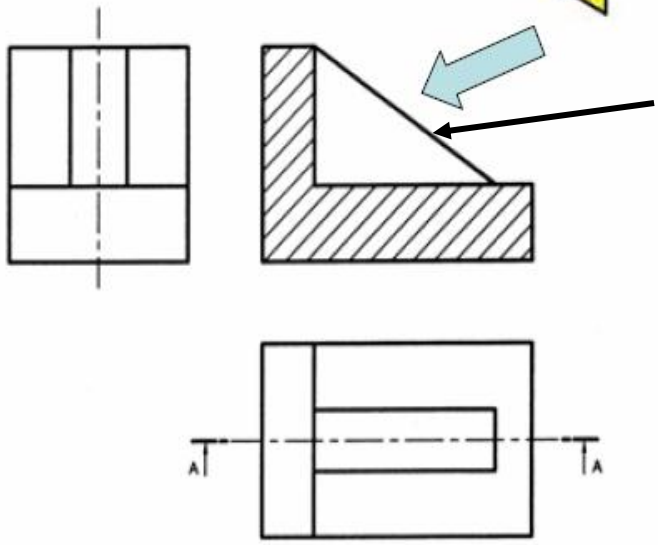
Ribs & Webs in section

❑ When the cutting plane longitudinally through a rib or of a web, the crosshatching is eliminated from the ribs and webs as if the cutting plane were just in front of them.



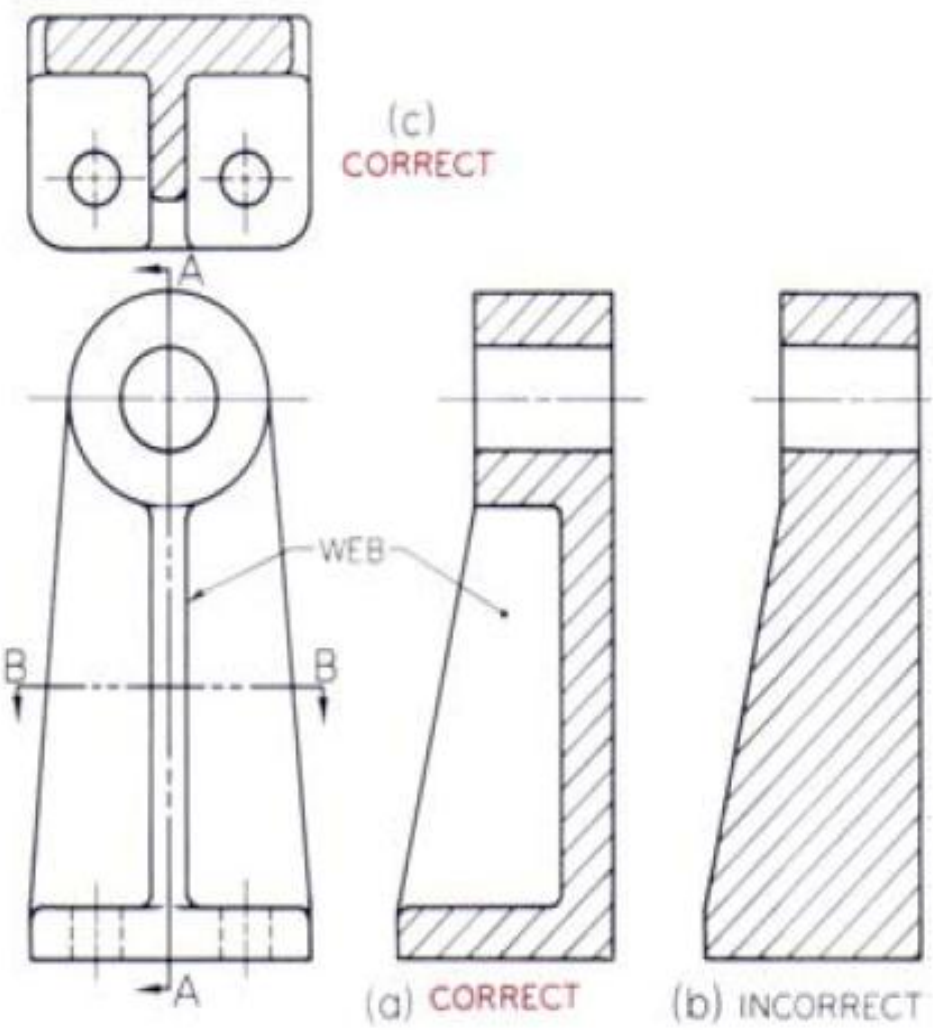






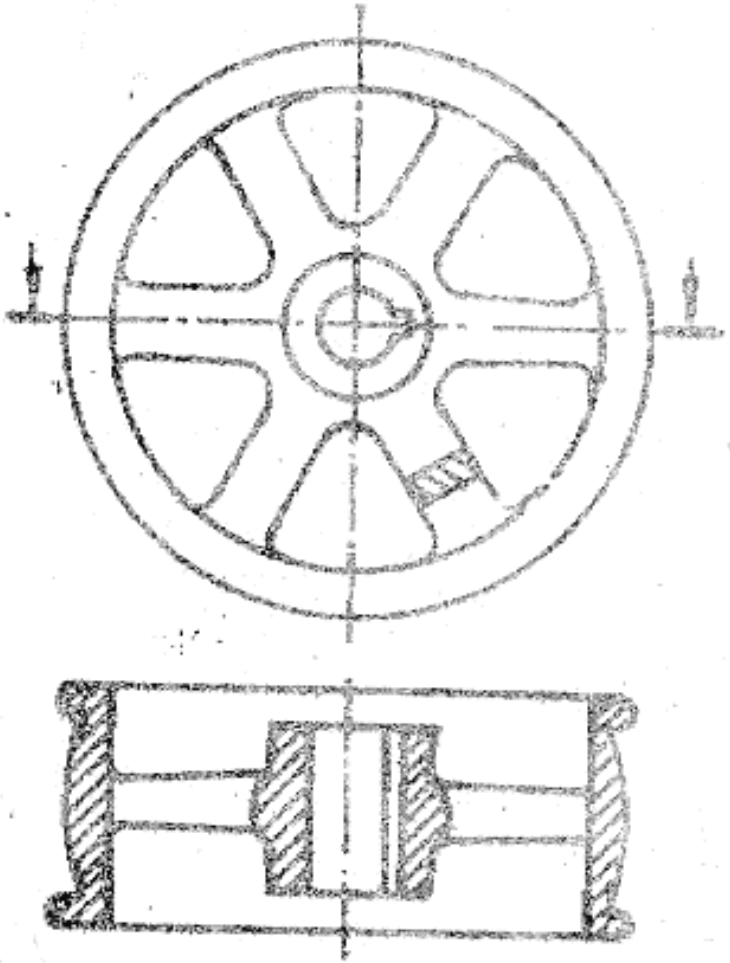
Ribs & Webs in section

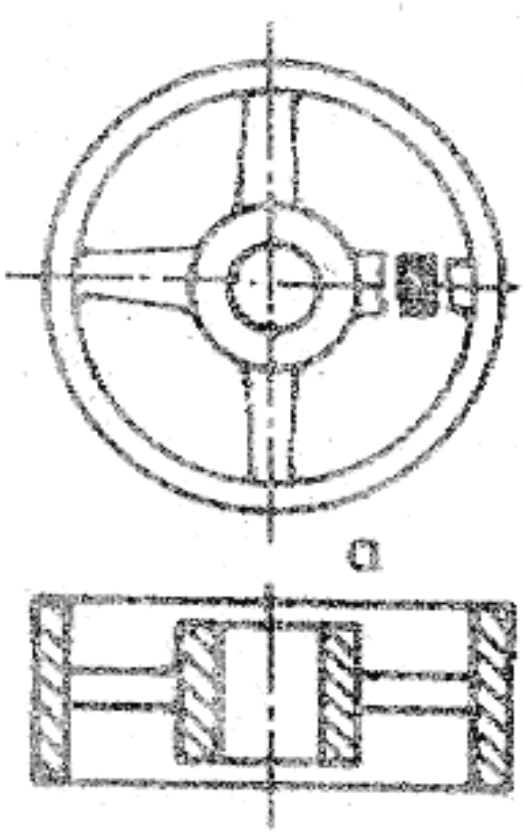
- Ribs are used to add strength to the parts, therefore when the cutting plane passes through the ribs lengthwise the section lining would give the misleading impression that the section was conical.
- When the cutting cuts a rib or web at right angles to its length or axis direction to show its thickness it is always section lined.

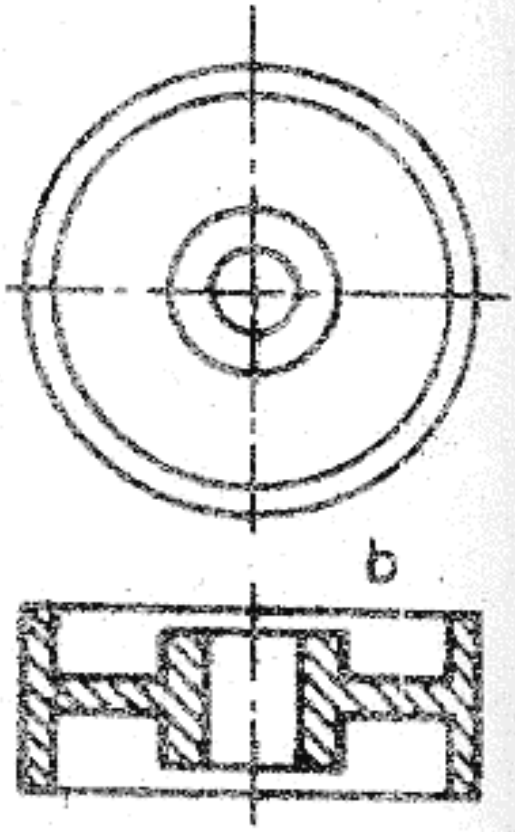


7.5 SPOKES AND ARMS IN SECTION

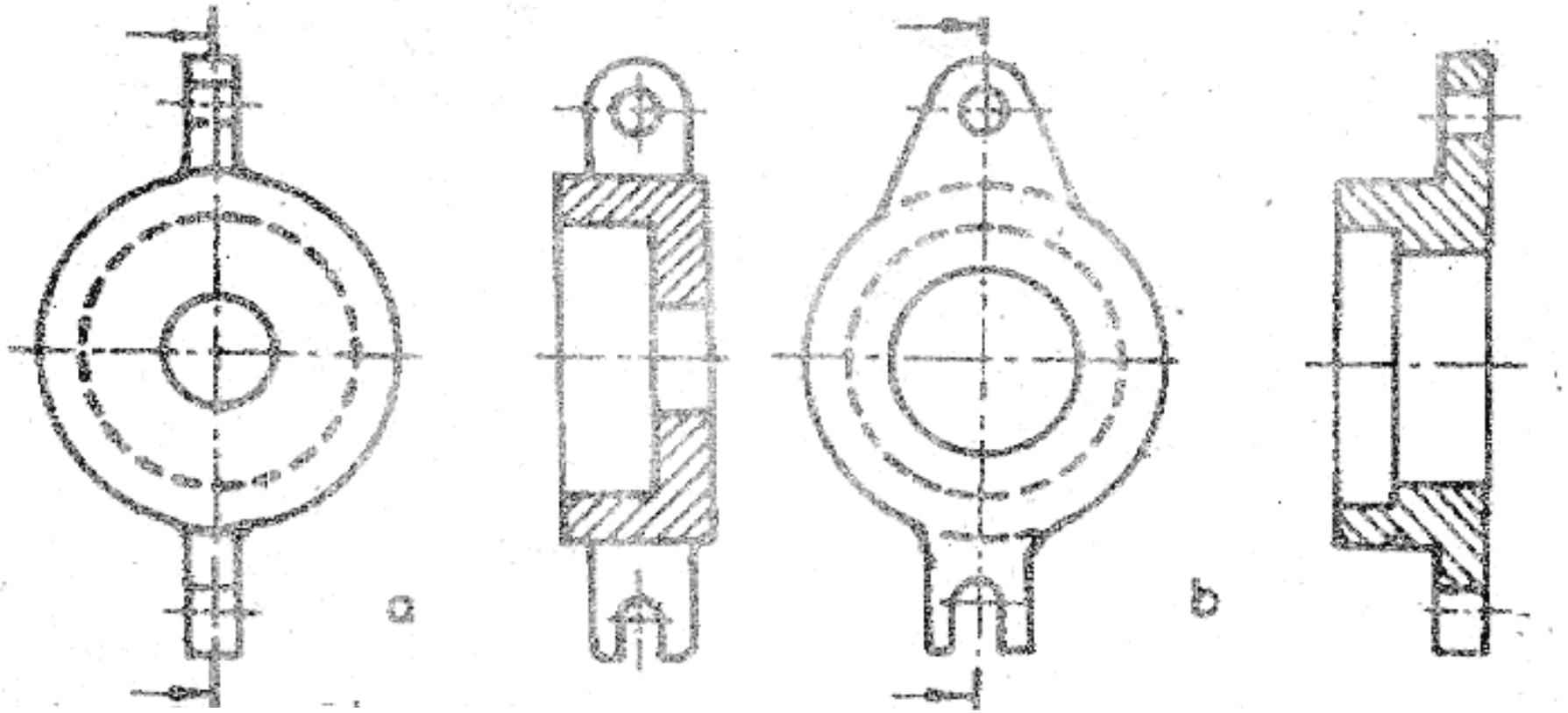
When a cutting plane passes through pulley spokes or arms, the drawing is made as in Figure 26, where the plane is thought of as being just in front of the spokes. Even though the cutting plane passes through two of the spokes, the sectional view in Figure 27 (a) must be made without cross-hatching the spokes in order to avoid the appearance of solid web, as in Figure 27 (b).





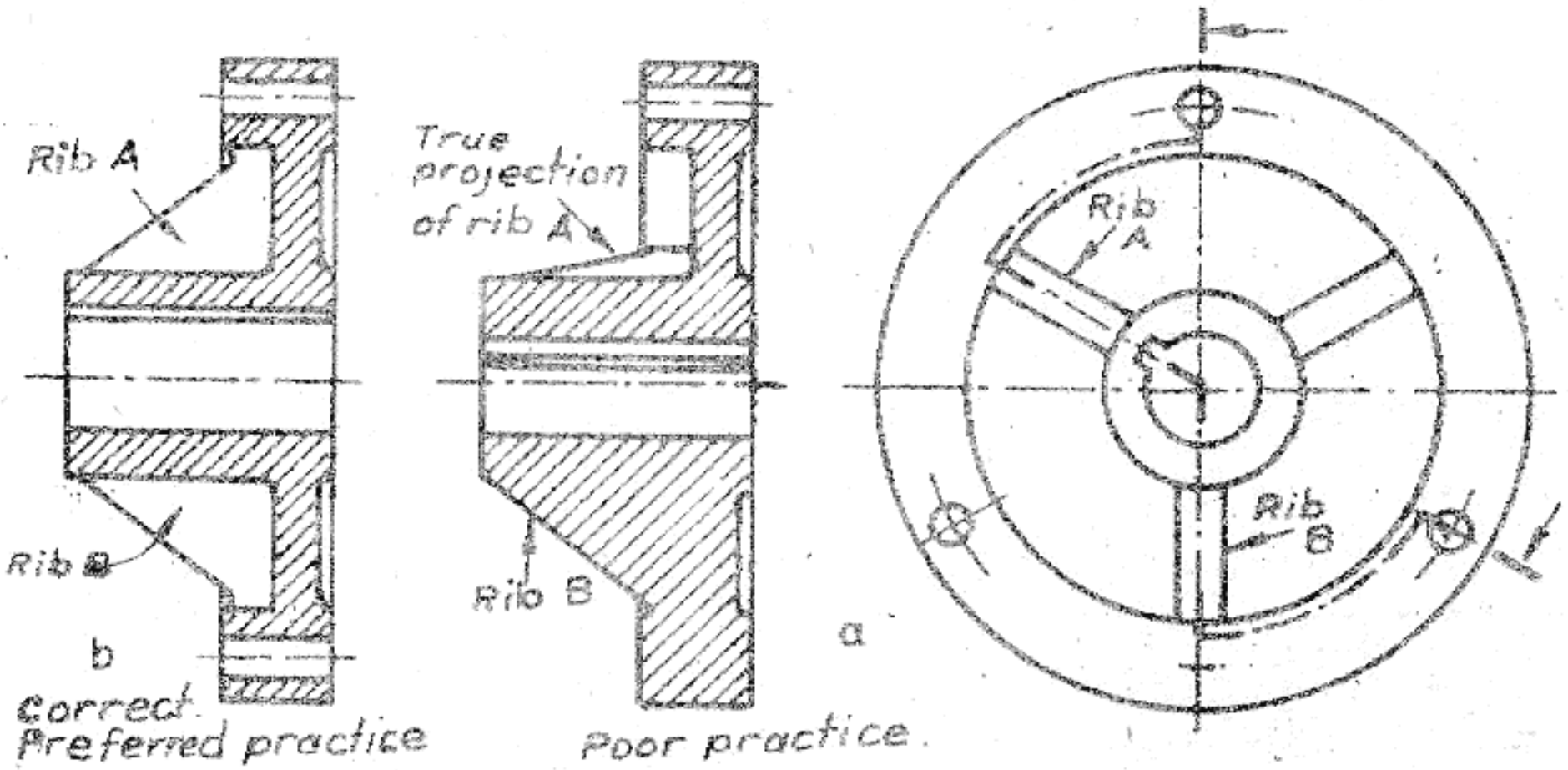


In addition to **ribs and spoke, nuts, bolts and washers**, all circular cross-sectioned items such as **shafts, pins, rods, and rivets should not be sectioned in full**. Small **lugs or ears are treated like spokes.** Figure 28 (a) is an example in which the projecting lugs were not sectioned. At (b) projecting lugs are located so that the cutting plane would pass through them crosswise; hence they are sectioned.

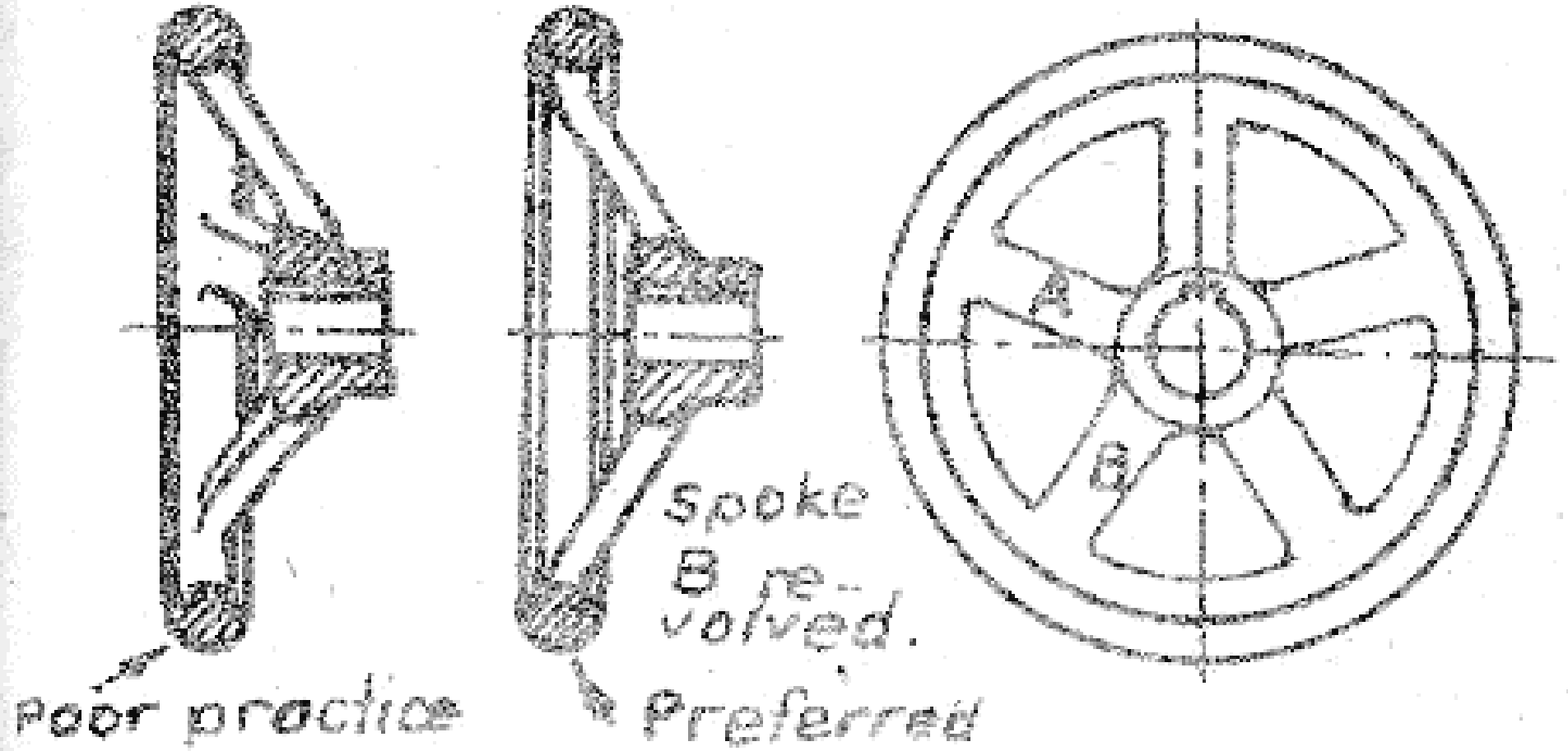


7.6 ALIGNED RIBS, SPOKES, HOLES AND LUGS

Ribs, spokes, holes and lugs are most common parts that may occur in odd numbers. These parts will give an unsymmetrical and misleading section if the principles of true projection are strictly obeyed as seen in Figure 29 (a). The correct projection and section is shown at (b), where Rib A is drawn as if aligned, or in other words, the rib is rotate to the path of vertical cutting plane and then projected to the side view. Note that neither rib should be sectioned.

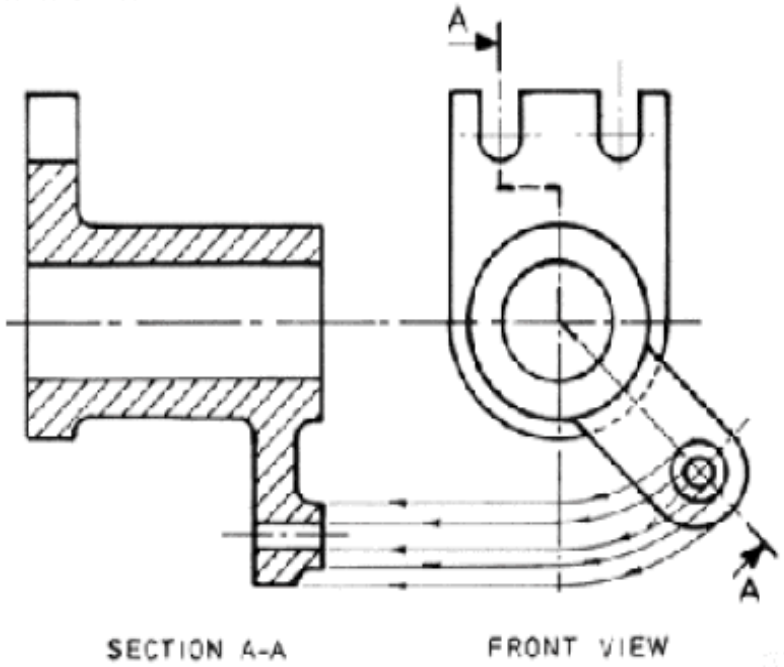


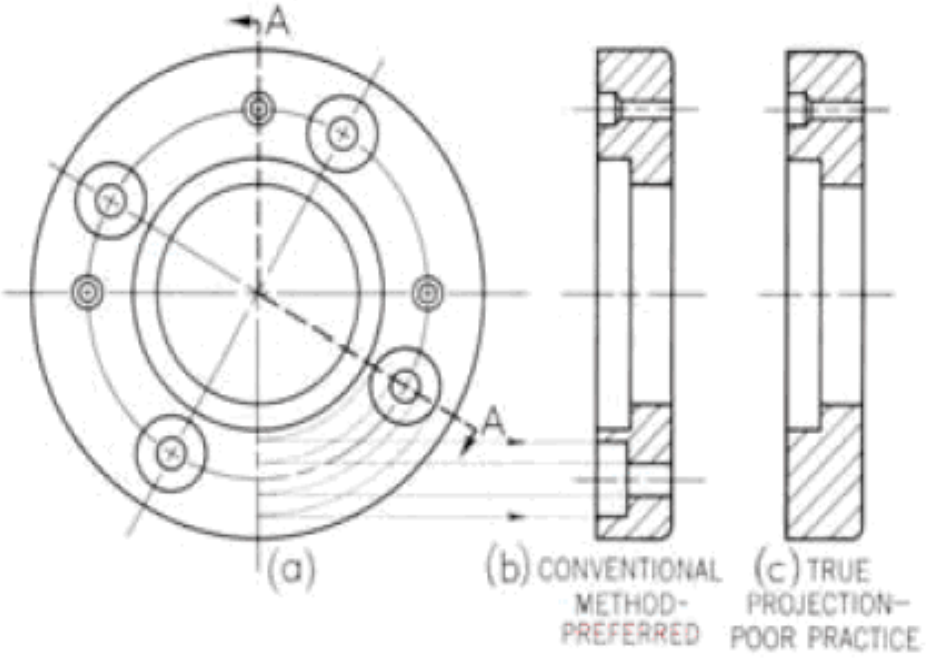
When there are an odd number of spokes in a wheel as is the case with the part in Figure 30 they should be shown aligned in the sectioned view so as to reveal their true location with reference to the rim and the axis of the wheel..



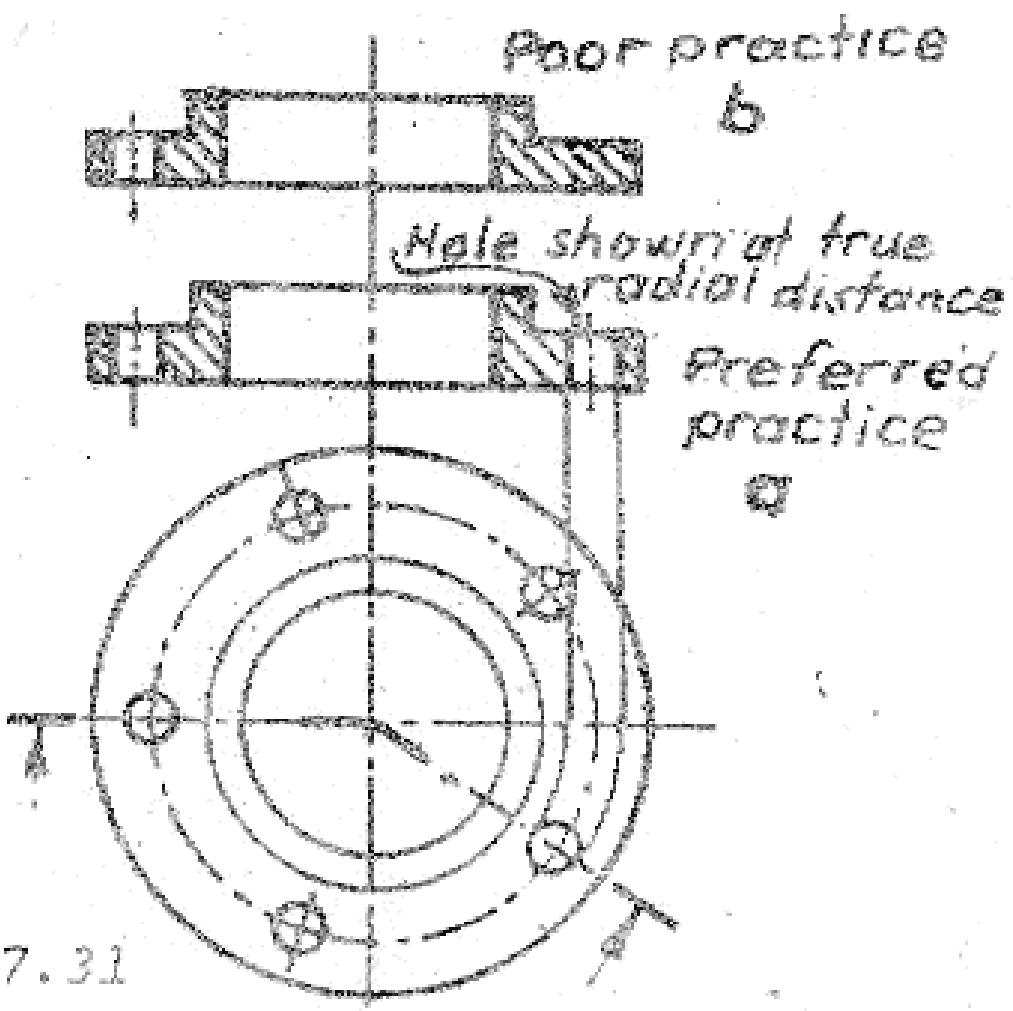
Aligned ribs, spokes, holes and lugs

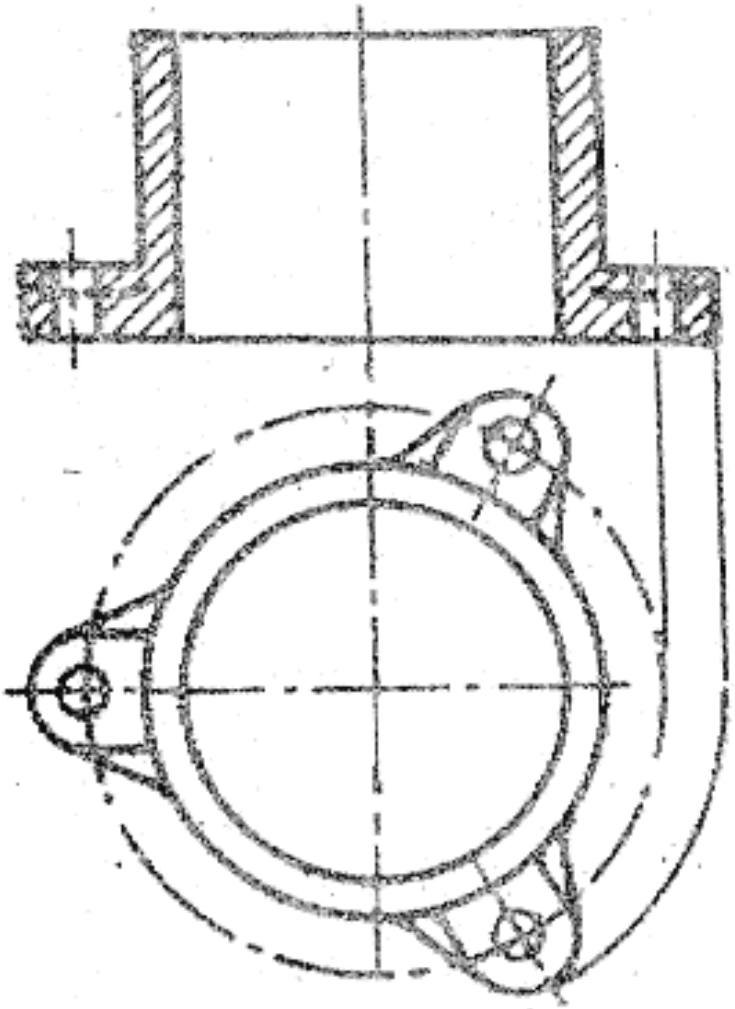
❑ Ribs, spokes, holes and lugs are the most parts that may occur in odd numbers. These parts will give unsymmetrical and misleading section if the principles of true projection are strictly obeyed.





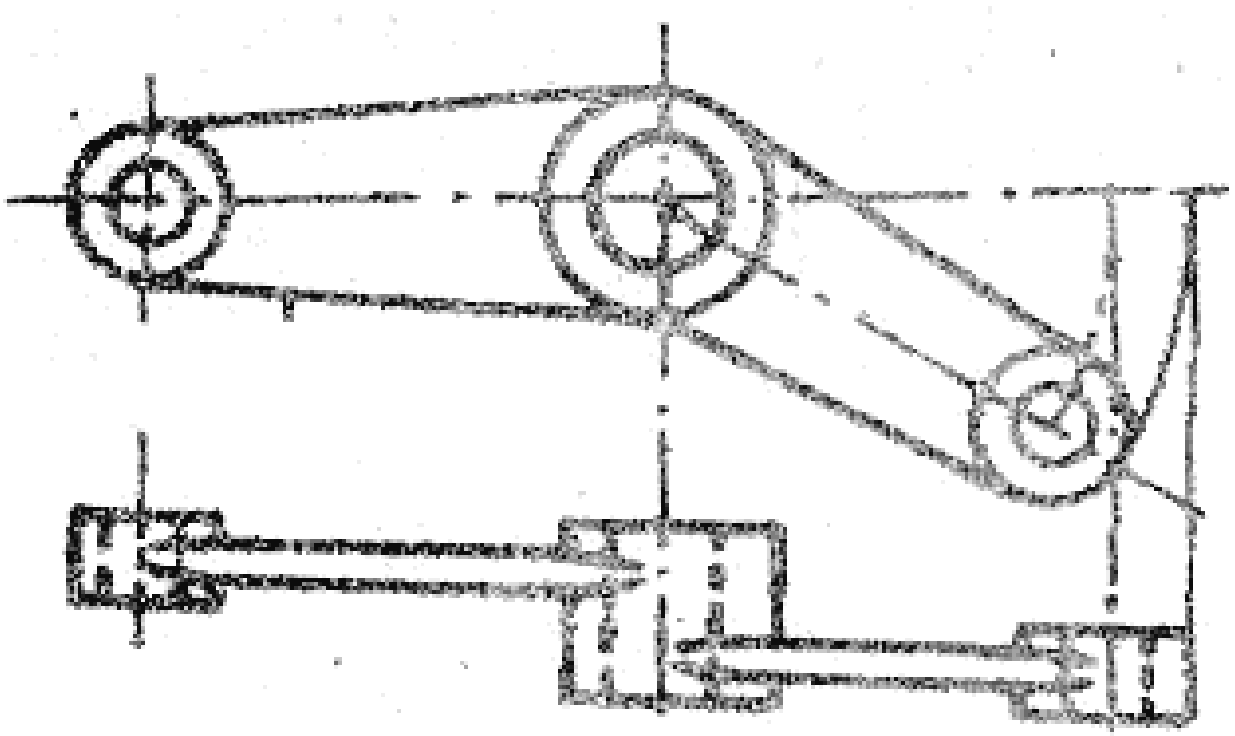
Odd number of holes and lugs must also be treated likewise (see figures 31 and 32). These two figures show other examples of conventional representation. The sectional view are drawn as if lower projection of hole and lug had been swung until the portion of the cutting plane through them formed a continuous plane with the other portions. It should be noted that the hidden lines in the sectioned view in Figure 32, are necessary for a complete description of the lugs

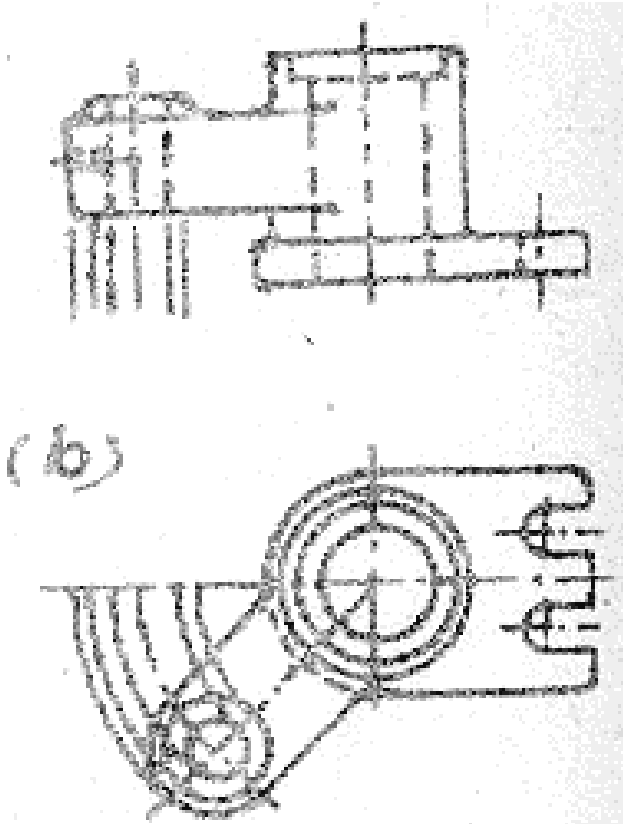




7.7 ALIGNED ELEMENTS IN FULL VIEW

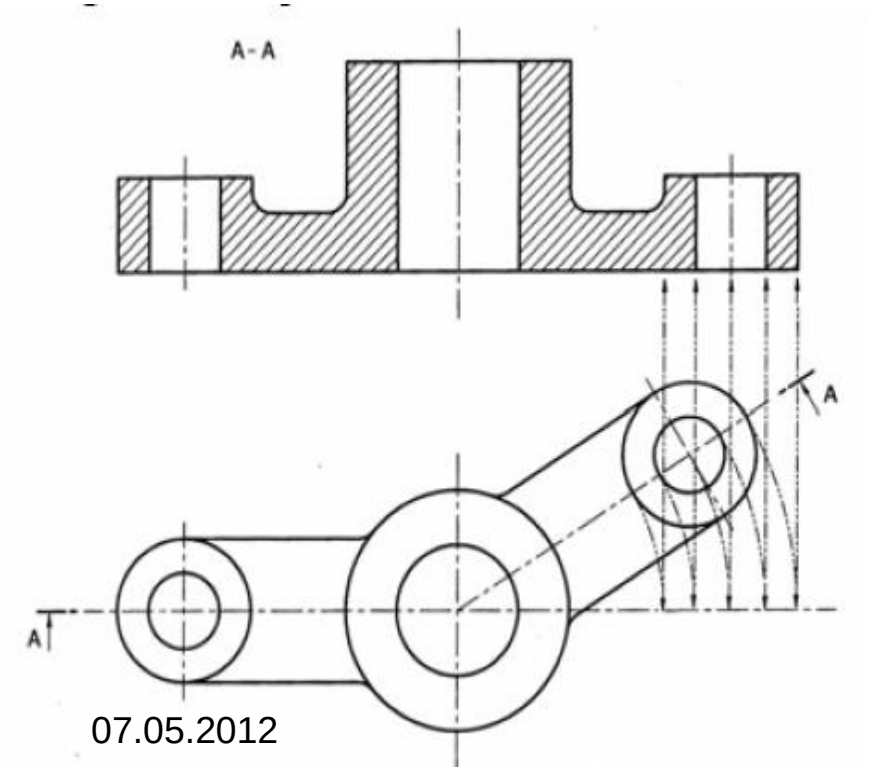
In full views, as well as in sectional views, certain violations of the rules of true projection are accepted as a good practice because they add to the clearness of the drawing. Figure 33, may be shown straightened out or aligned in one view. This is to avoid drawing in a foreshortened position.

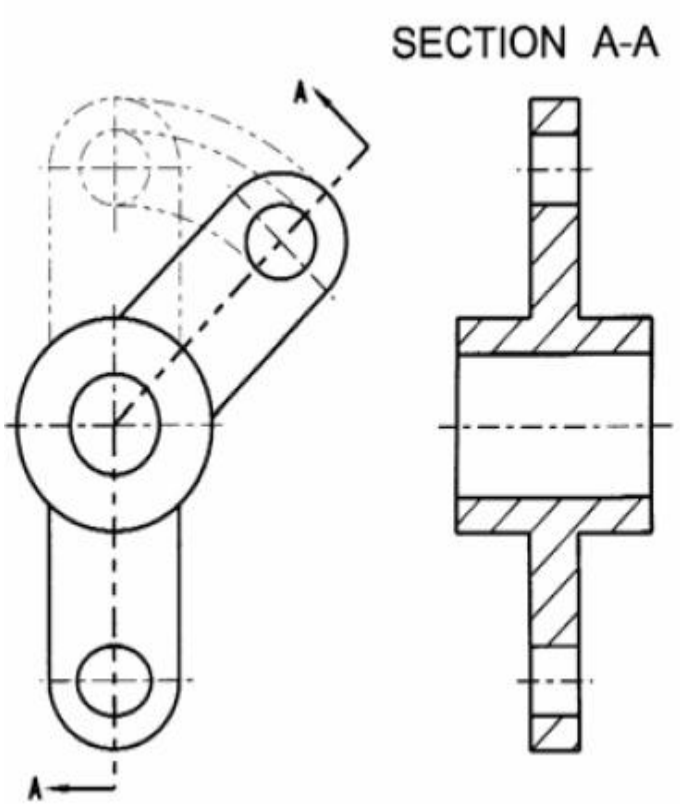




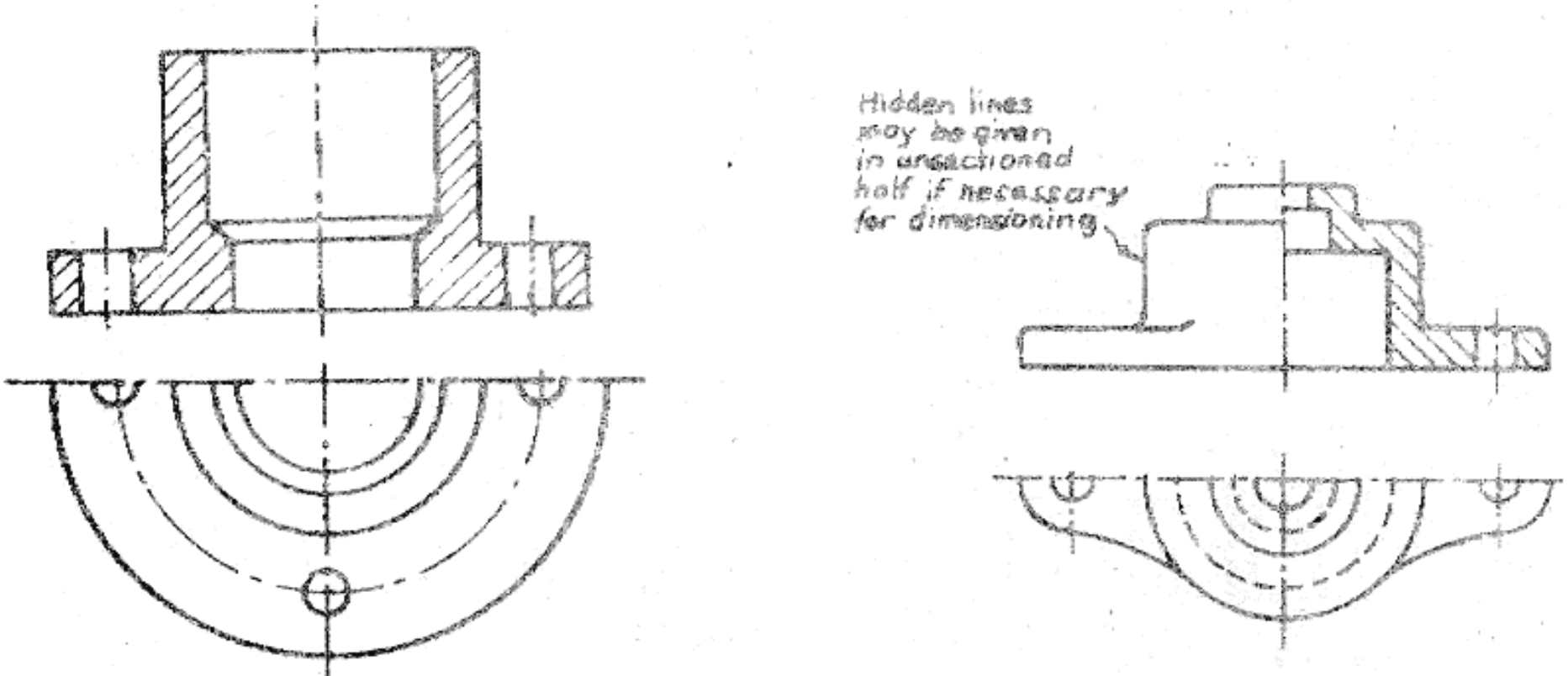
Aligned elements in full view

- In full views, as well as in sectional views, certain violations of the rules of true projection are accepted as good practice because they add to the clearness of the drawing.
- Therefore, the full sectional view is taken after rotating the aligned portion of the object.



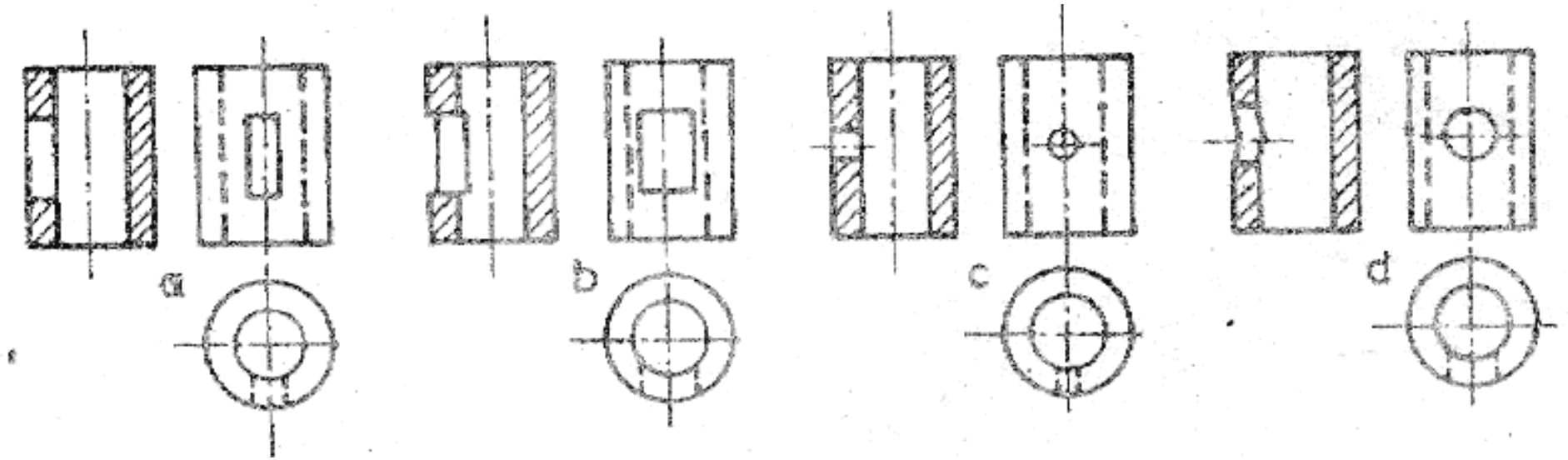


When the space available is limited to allow a satisfactory scale to be used for the representation of a symmetrical piece, it is considered good practice to make one view a half, as shown in Figure 34. The half view, however, must be the top or side view and not the front view.



7.8 INTERSECTIONS IN SECTIONING

Where an intersection is small or unimportant in a section, it is a standard practice to disregard the true projection of the intersection as shown in Figure 35 (a and c). Larger intersection may be projected, as shown at (b), or approximated by circular arcs, as shown for the smaller hole at (d).



7.9 CONVENTIONAL BREAKS

To shorten certain views of long parts, conventional breaks are recommended as in Figure 36. Parts thus broken must have the same section throughout, or if tapered they must have a uniform taper. The breaks used on cylindrical shafts or tubes are often referred to as “S-breaks” and are usually drawn entirely or partly freehand.