ME 101
ENGINEERING GRAPHICS

CHAPTER 4

ORTHOGRAPHIC DRAWING

Introduction and Objectives

This lecture introduces the following topics of orthographic projection:

- Selection of views
- Partial views
- Revolution conventions
- Removed views
- Fillet and Round
- Run-outs
- Representation of holes
- Boss
- Intersection of Cylinders

Objective:

❑ Engineering students are required to understand and practice a complete representation and drawing of orthographic views of an object.

4.15. SELECTION OF VIEWS

In practical work, it is important to choose the combination of views that will describe the shape of an object in the best and economical way. Often only two views are necessary, for example a cylindrical shape if on vertical axes, would require only a front and top view, if on a horizontal axes only a front and profile view. Cones and pyramidal shapes can also be described in two views. Fig.4.24 illustrates two view drawings. Two views are generally considered minimum for the description of even a simple Object. However, many cylindrical and square cross-sectioned parts may be represented adequately by only one view provided diameter dimensions of cylinder are given marked with letter "D" or with the symbol "ϕ" and provided edge dimensions of square cross-section are given marked with letters "SQ" or with the symbol "□" (Fig.4.25).

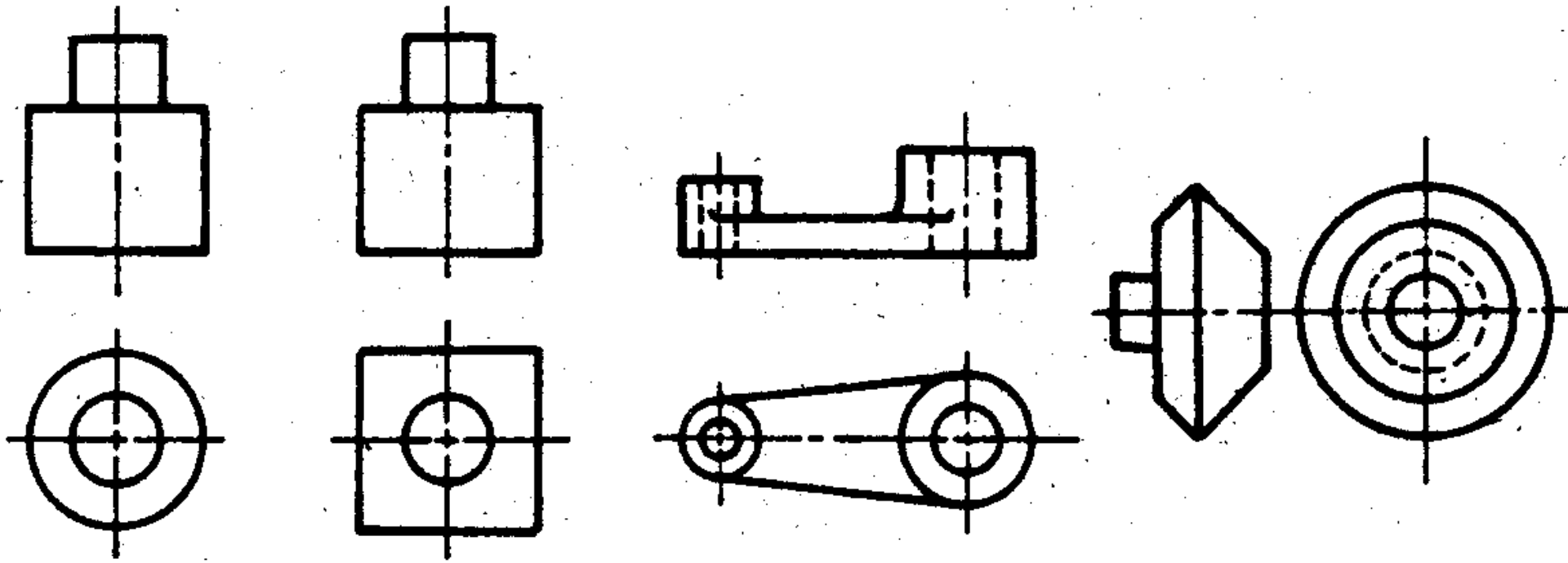


Fig.4.24.Two view drawings. These are sufficient for any object havinq a third view identical with or similar to one of the two views given.

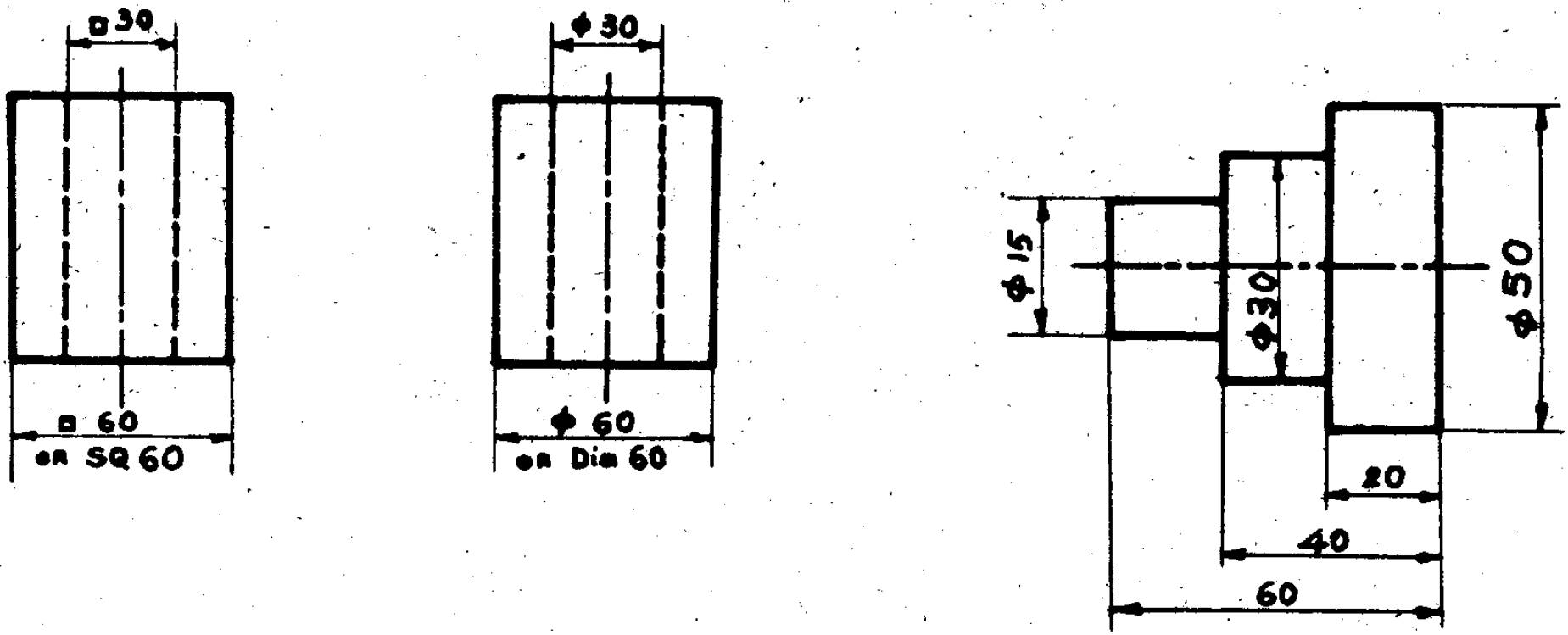


Fig.4.25 One view drawings.

- Some shapes will need more than the three regular views or some special views such as partial, auxiliary, etc. for adequate description.
- Objects can be thought of as being made up of combination of simple geometrical solids (principally cylinders, prisms, cones and pyramids) and the views necessary to describe any object would be determined by the directions from which it would have to be viewed to see the characteristic contour shape of these parts.(Fig.4.26) for example is made up of several prisms and cylinders. If each of these simple shapes is described and its relation to the others is shown the object will be fully represented. In the majority of cases the three regular views (front, top and left side) are sufficient to do this.

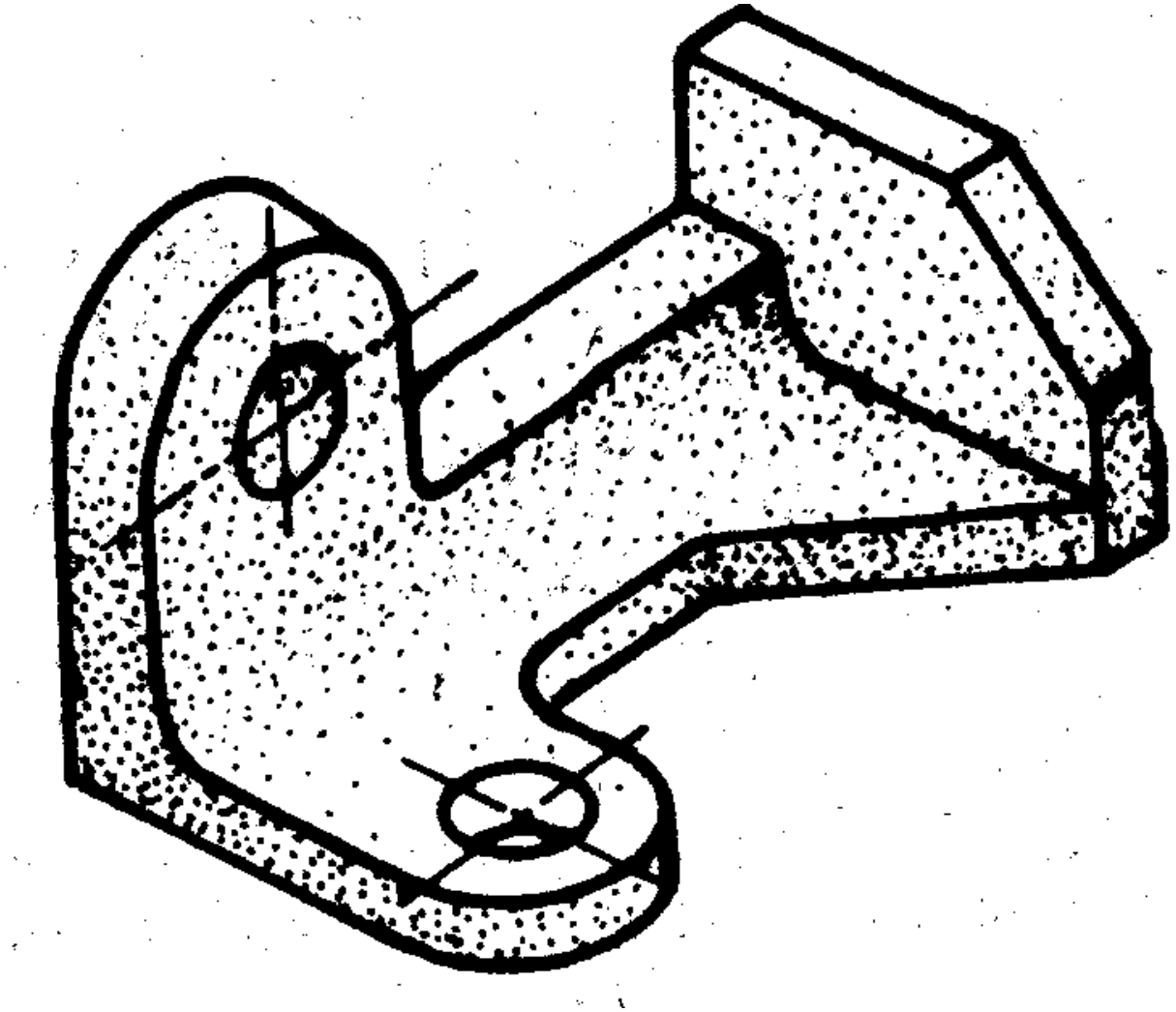


Fig.4.26.Geometric shapes combined. Even the most complicated objects can be analysed as combined geometric shapes.

- Sometimes two views are proposed as sufficient for an object on the assumption that the contour in the third direction is of the shape that would naturally be expected (Fig.4.27)
- With the object preferably in its functioning position and with its principal surfaces parallel to the planes of projection visualise the object, mentally picturing the orthographic views one at a time to decide the best combination. In (Fig.4.28) the arrows show the direction of observation for the six principal views of an object, and indicate the mental process of the person making the selection. After studying the object we have correctly chosen the front, top and left side views as the best combination for describing this piece. As a rule the view containing the fewer dashed lines are preferred. If the views do not differ in this respect, the main three views of the object are preferred in standard practice.

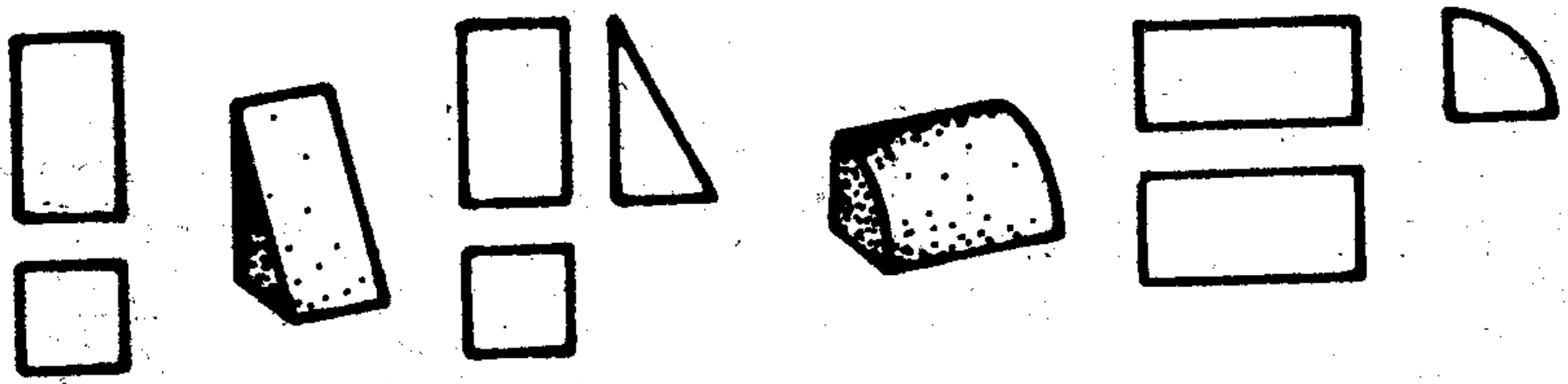


Fig.4.27. A study of views. Two views do not describe a rectangular object (A), but a wedge shape (B) or a quarter round (C) is described by two views.

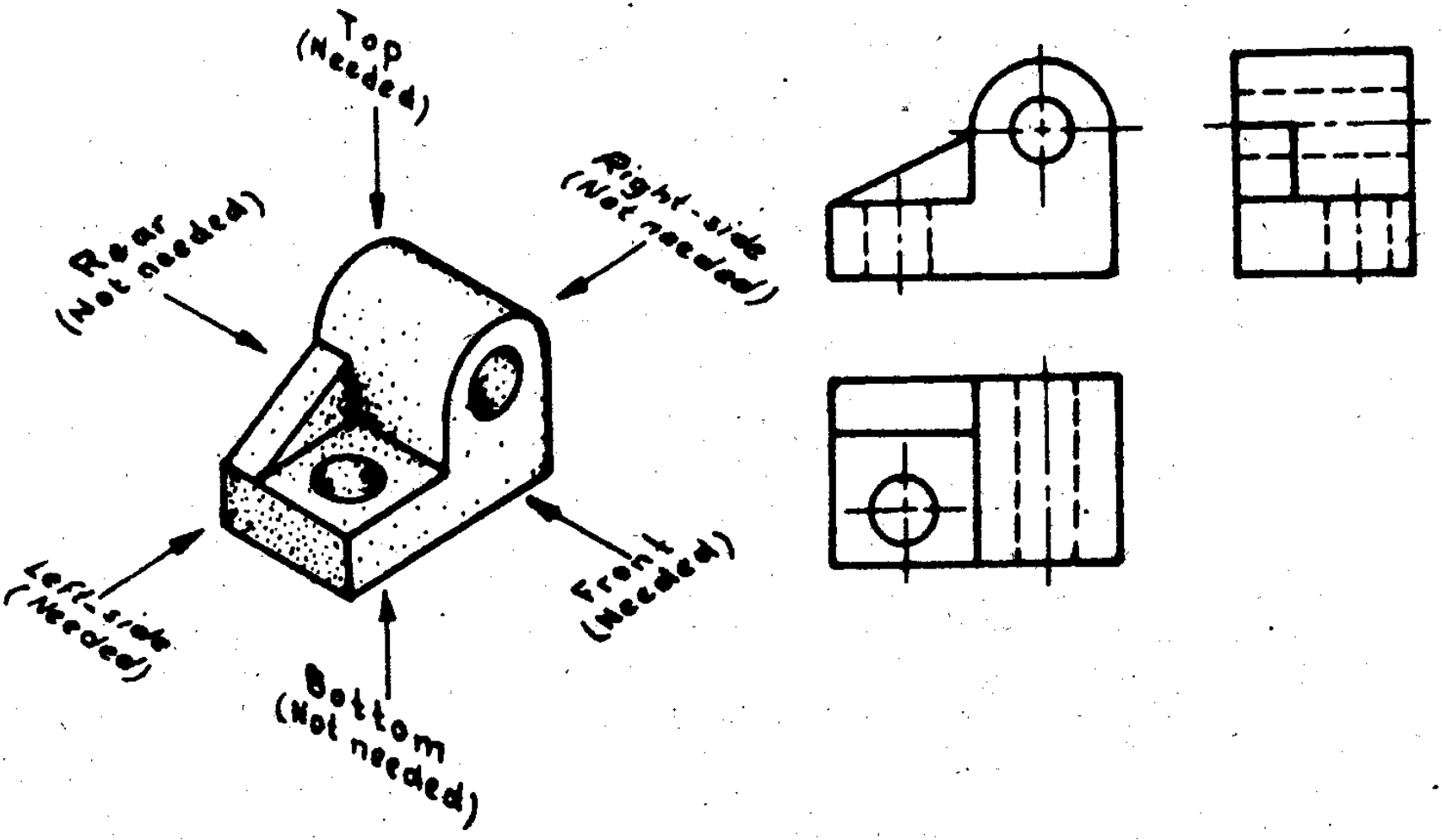


Fig. 4. 28. Selection of views. A view must be drawn in each direction (Front, top and profile) needed to conclusively designate every feature of the object, but unnecessary views must not be drawn.

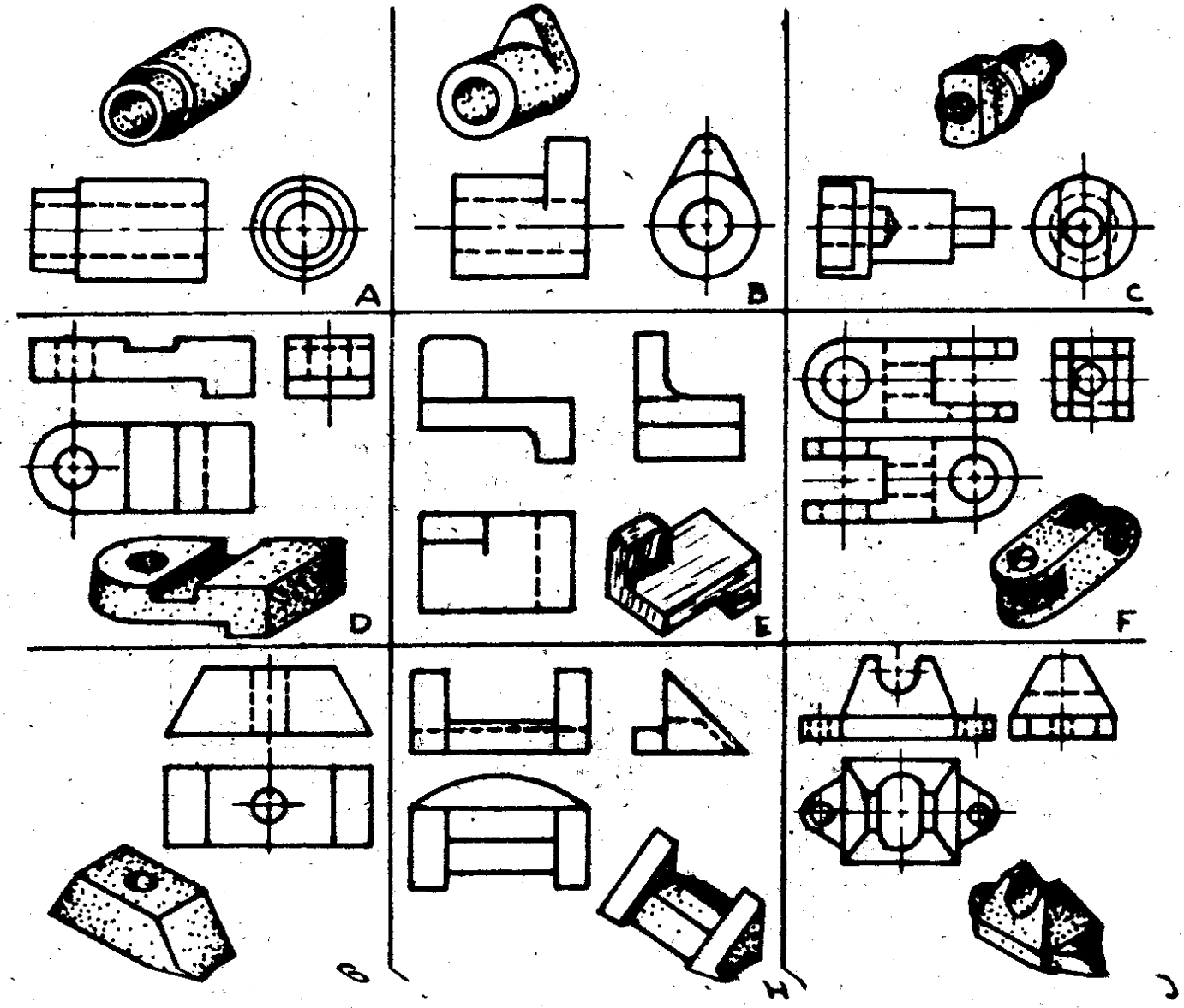


Fig.4.29. Selection of view study. Determine each case why the views shown are best in choice.

4.16.PARTIAL VIEWS

- A view may not need to be complete, but may show only what is necessary in the clear description of the object (Fig.4.30)

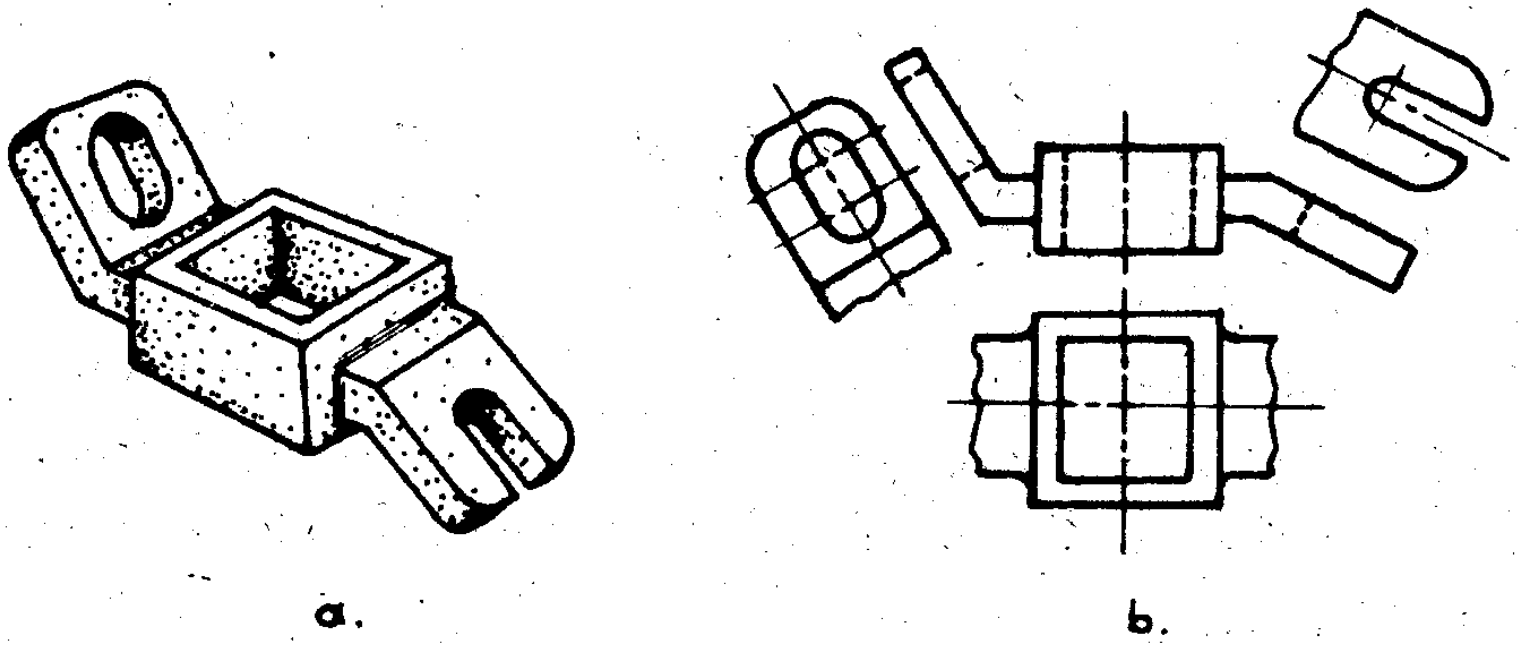
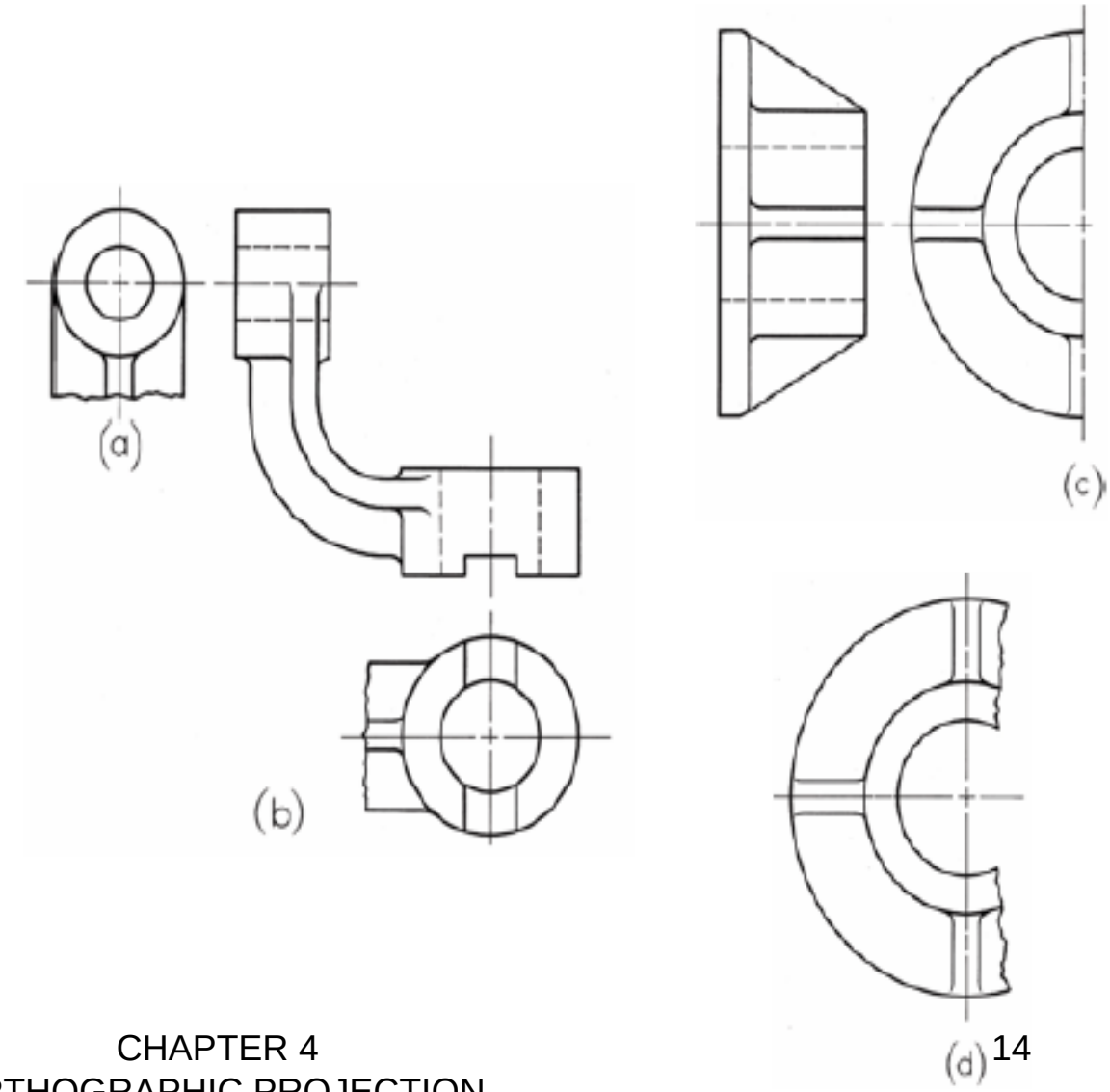


Fig.4.30. Partial views

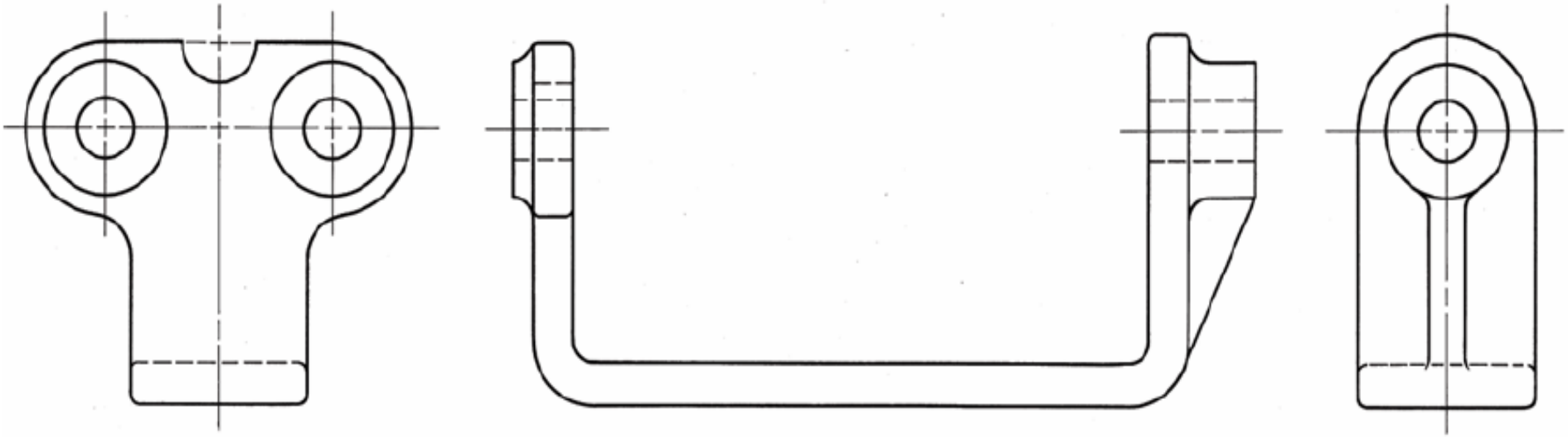
Partial views

- A view may not need to be complete but may show only what is necessary for the clear description of the object. Such a view is a partial view
- A break line may be used to limit the view, as shown in (a) and (b).
- If symmetrical, a half-view may be drawn on one side of the center line (c), or a partial view, "broken out" may be drawn (d).
- Do not place a break line where it will coincide with a visible or hidden line



Partial views

- Occasionally the distinctive features of an object are on opposite sides.
- In either complete side view there will be a considerable overlapping of shapes.
- In such cases two side views are often the best solution. The views are partial views and in both, certain visible and invisible lines have been omitted for clarity.



4.17.REVOLUTION CONVENTIONS

In some cases true projections of the objects are either awkward, confusing or actually misleading (Fig.4.31a) shows an object that has three triangular ribs, three holes equally spaced in the base and a keyway. The front view (b), true projection, but it is not recommended. One of the ribs foreshortened, the holes do not appear in their true relations to the rim of the base, and the keyway is projected as confusing hidden lines. The conventional method at (c) is preferred not only because it is simpler but also requires less drafting time. Each of the features mentioned has been revolved in the top view to along the horizontal centre line from where it is projected to the correct front view at (c), another example is shown in (Fig.4.32).

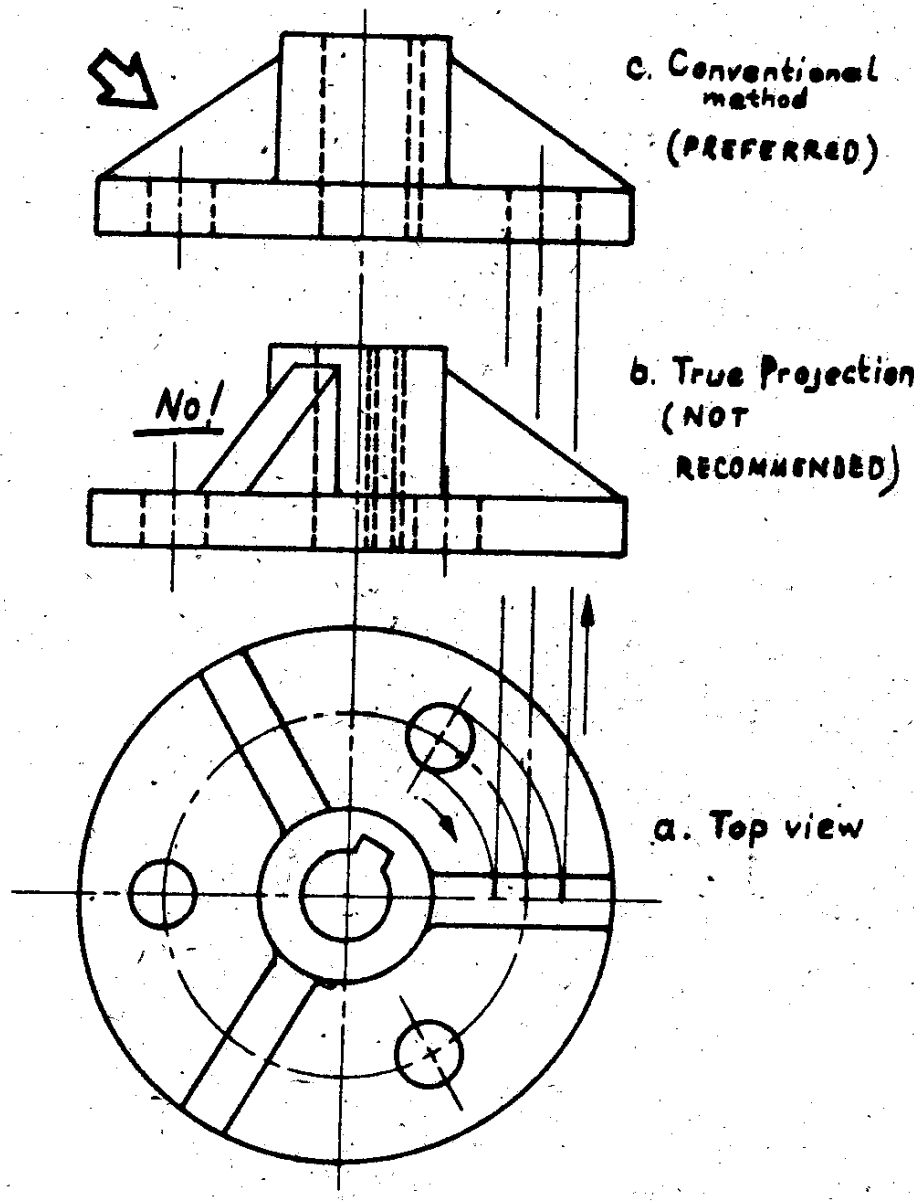


Fig.4.31. Revolution conventions.

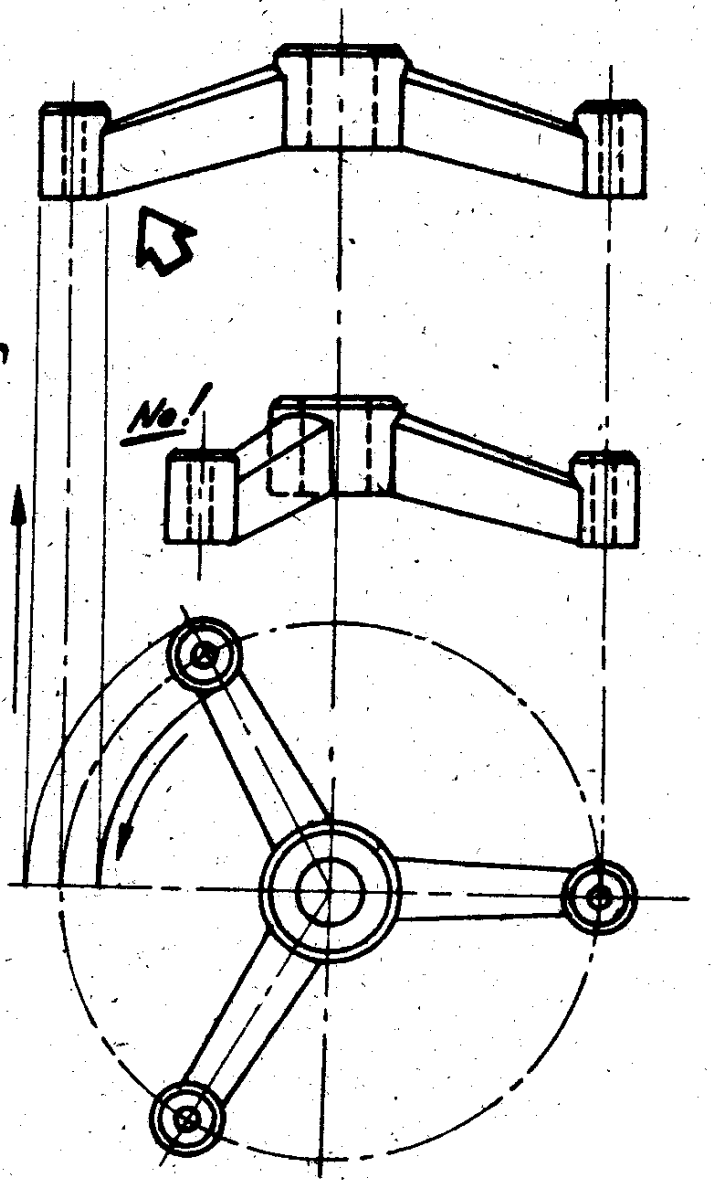
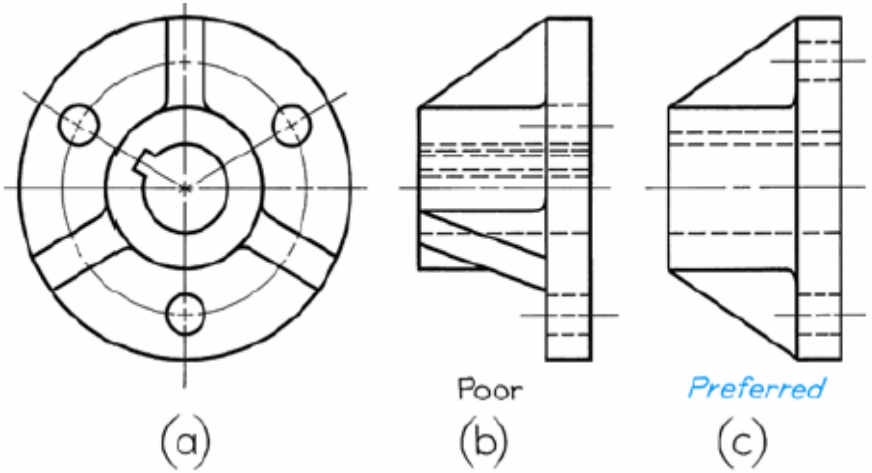
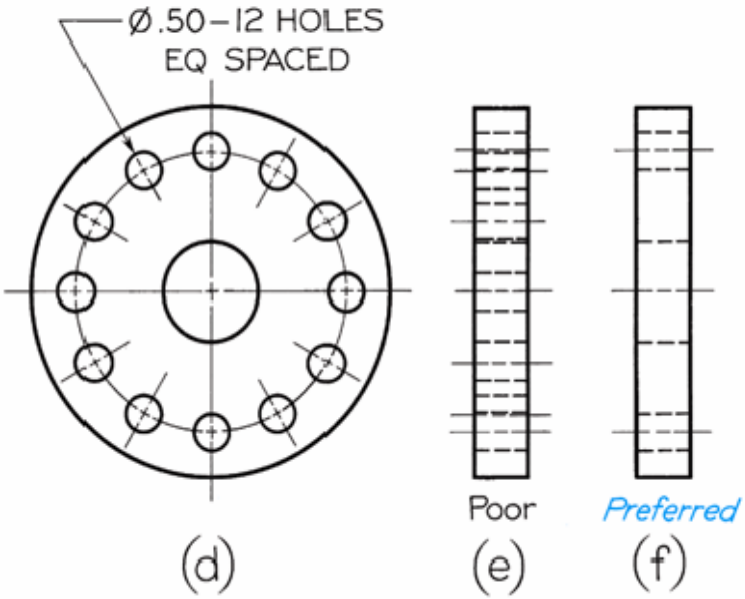


Fig.4.32. Revolution conventions.

Revolution conventions

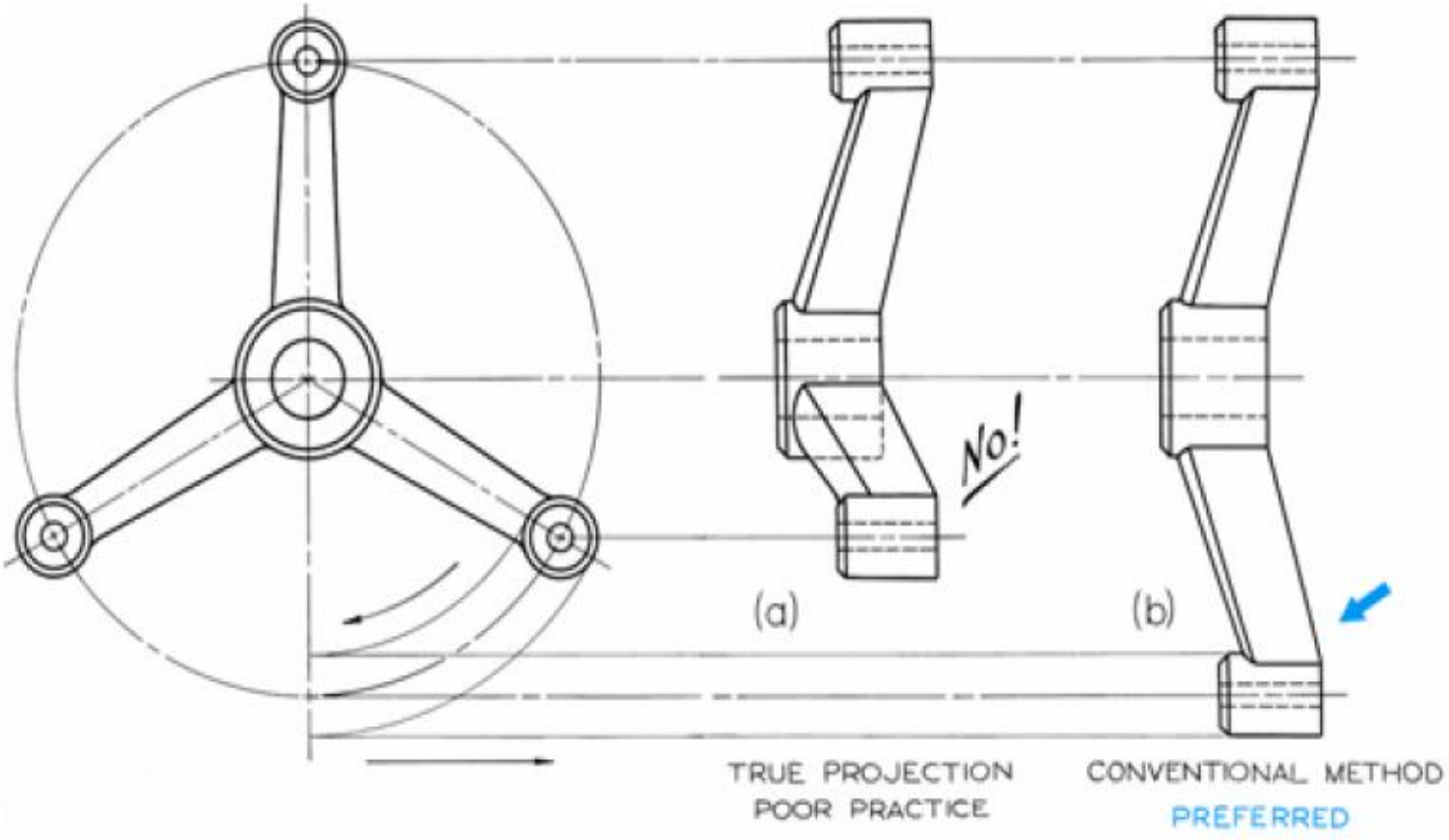
- Regular multiview projection may sometimes become awkward, confusing, or actually misleading
- In part (a) there are three triangular ribs, three holes equally spaced in the base, and a keyway.
- Regular projection causes the lower rib to appear in a foreshortened position and the holes do not appear in true relation to the rim. Additionally, the keyway is projected as a confusion of a hidden line.
- In this case, the revolution convention shown in part (c) is preferable.



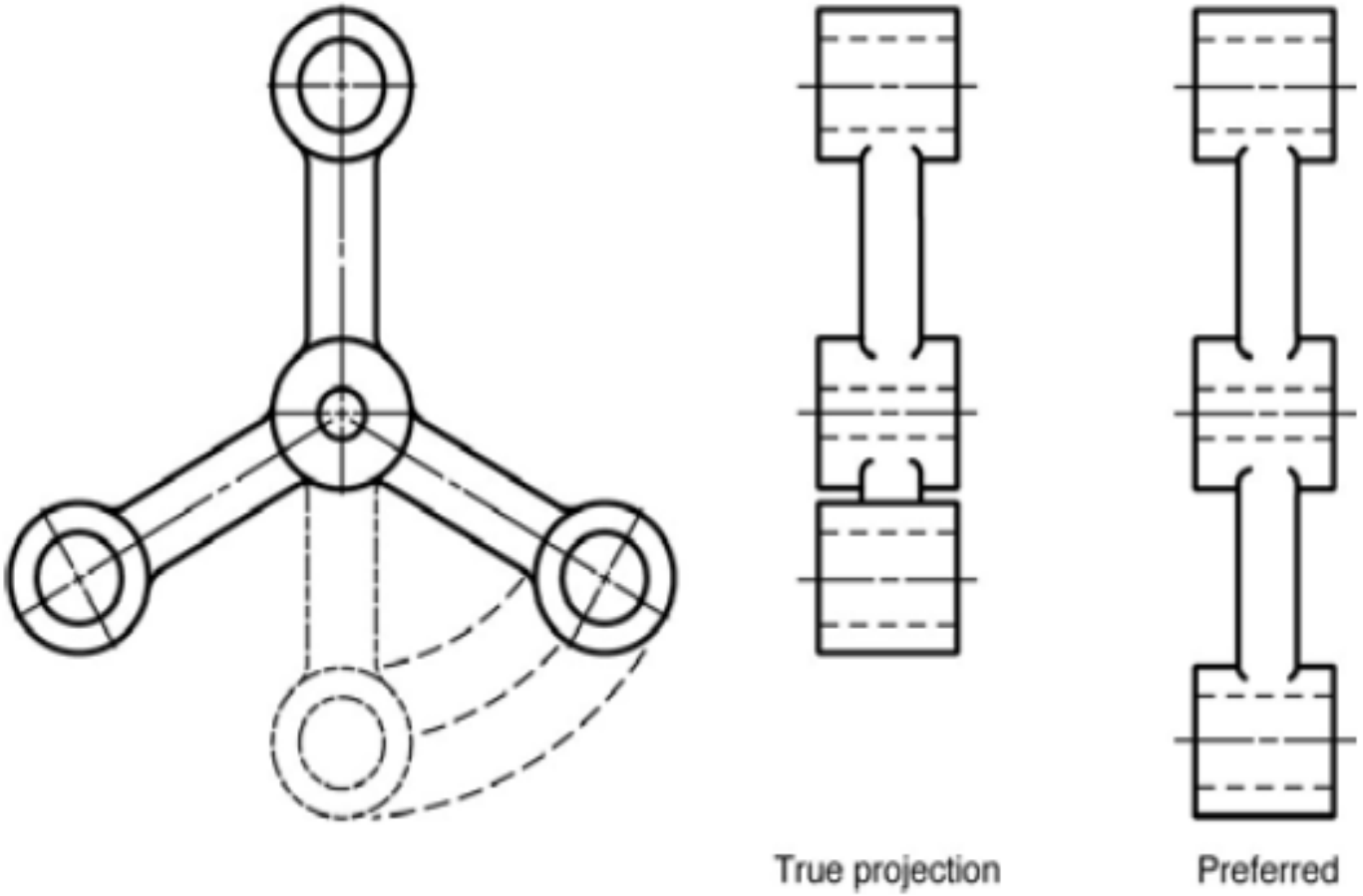


Revolution conventions

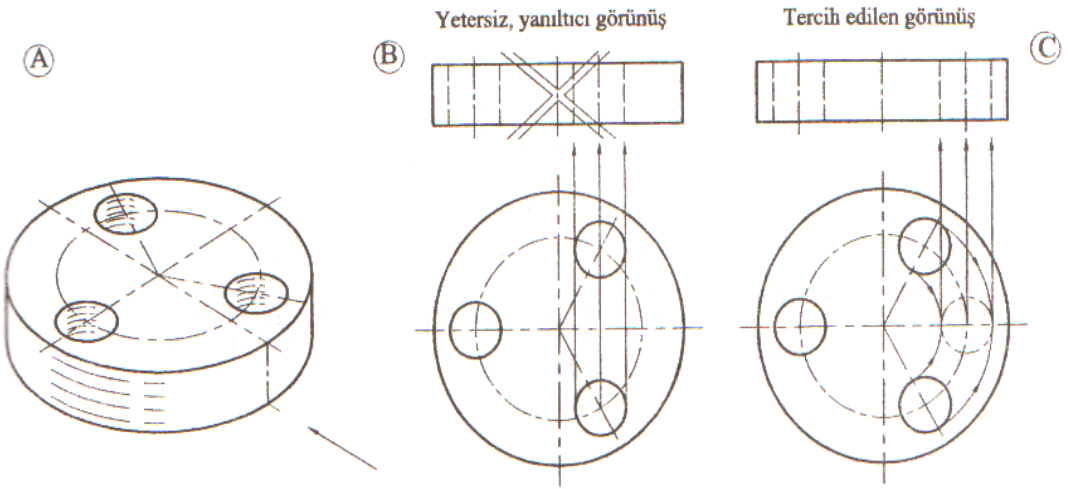
- Features are revolved in the front view to lie along the vertical center line, from where it is projected to the correct side view.



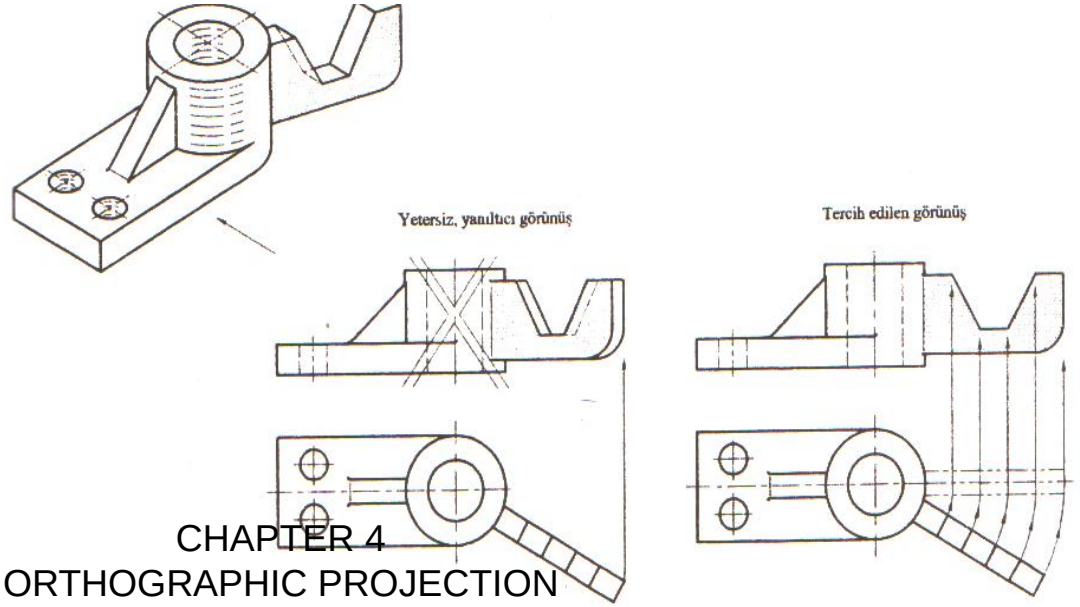
Revolution conventions



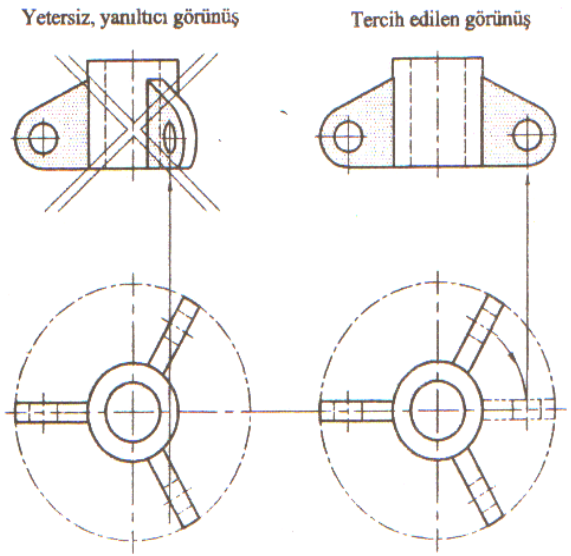
Revolution conventions

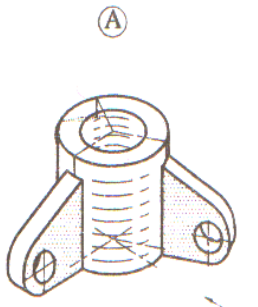


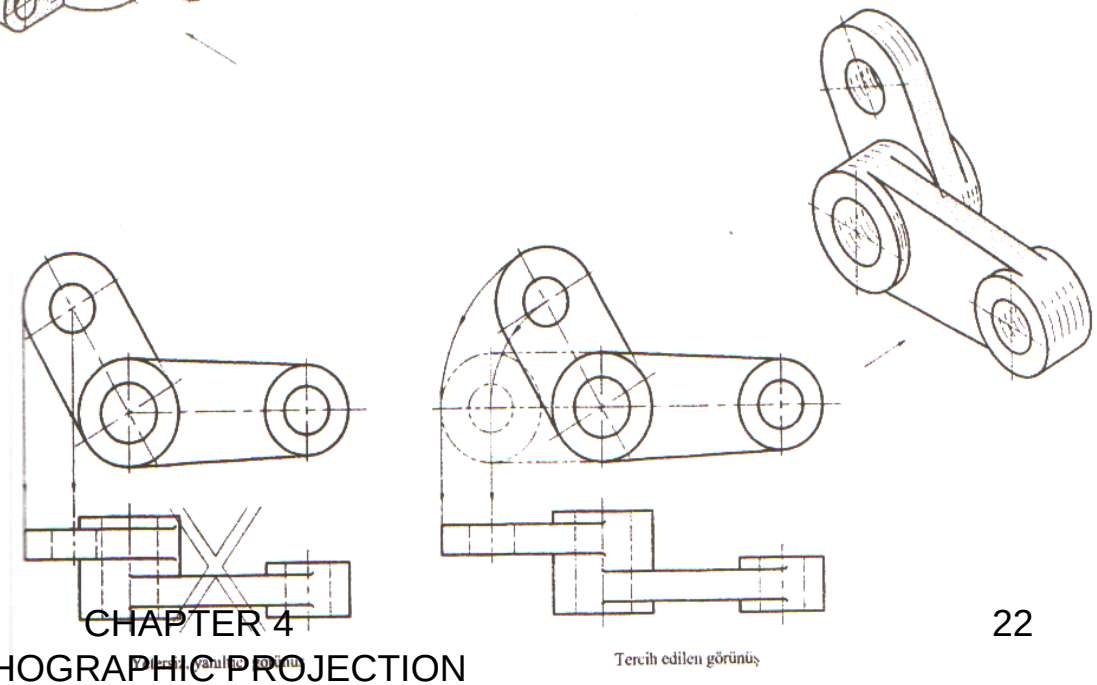
Şekil 3.60 Döndürülmüş görünüşler



Revolution conventions







4.18. REMOVED VIEWS

- A removed view, is a complete or a partial view removed to another place on the sheet, so that it no longer is in direct projection with any other view as shown in (Fig.4.33). Such a view may be used to show some features of the object more clearly, possibly to a large scale or to save drawing a complete regular view. A viewing plane line is used to indicate the part being viewed the arrows at the corners showing the direction of sight.
- The removed view should be labelled as VIEW A-A or VIEW B-B etc. The letters referring to those placed at the corners of the viewing plane.

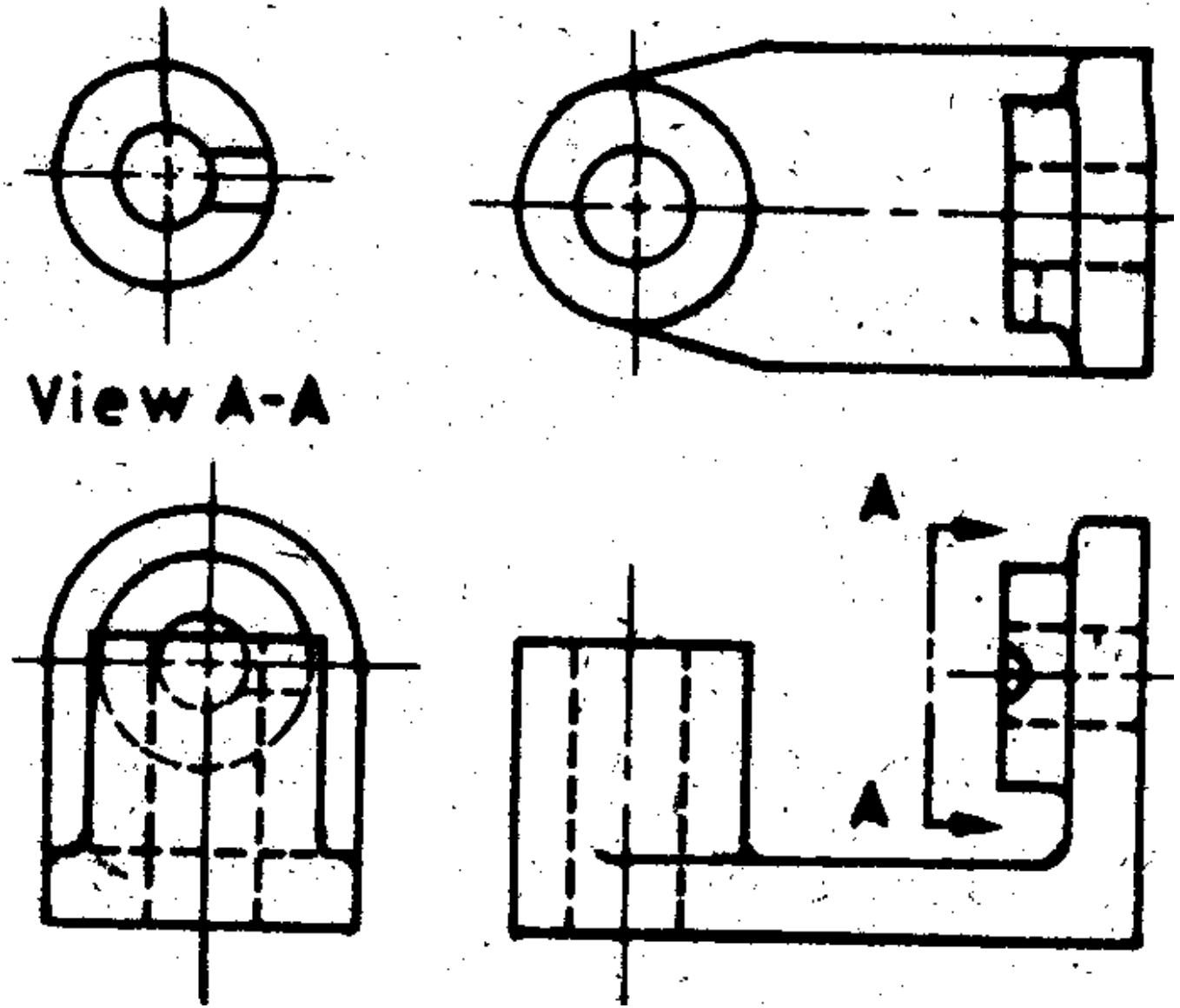
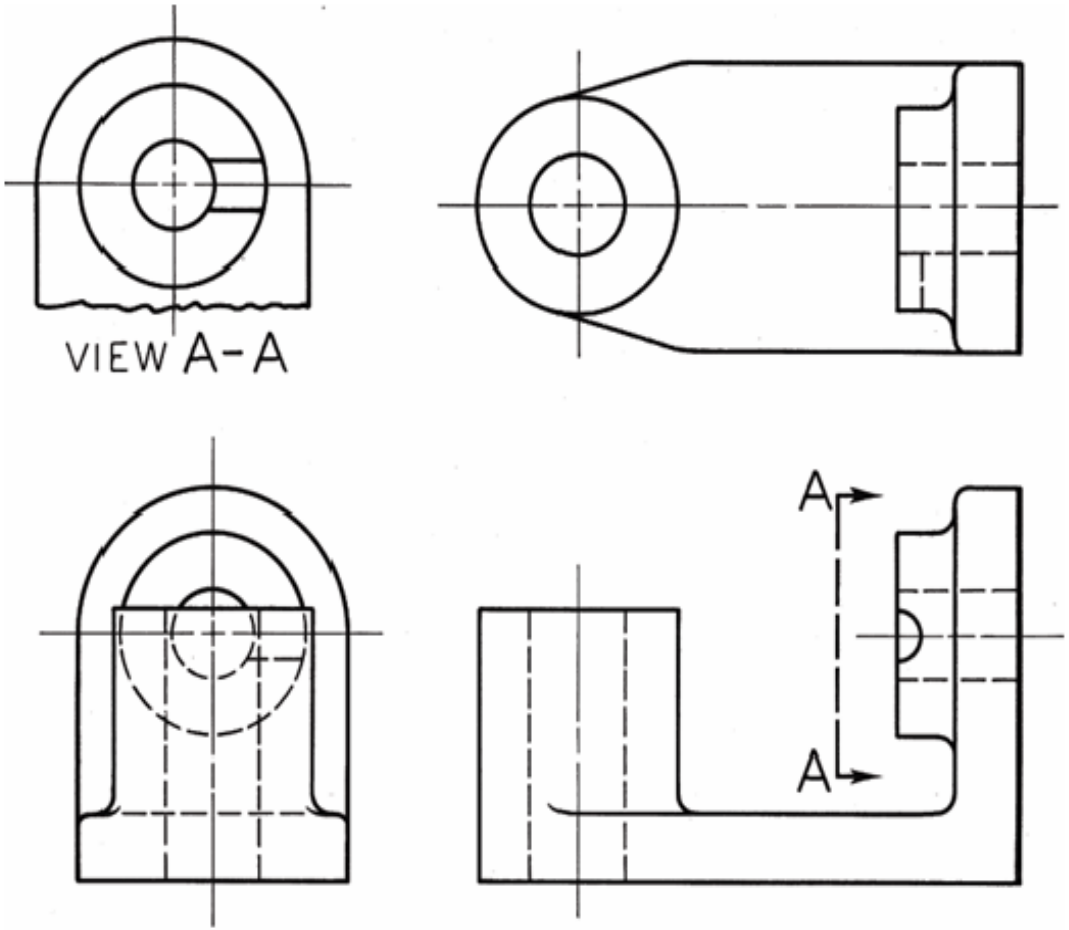


Fig.4.33.Removed views

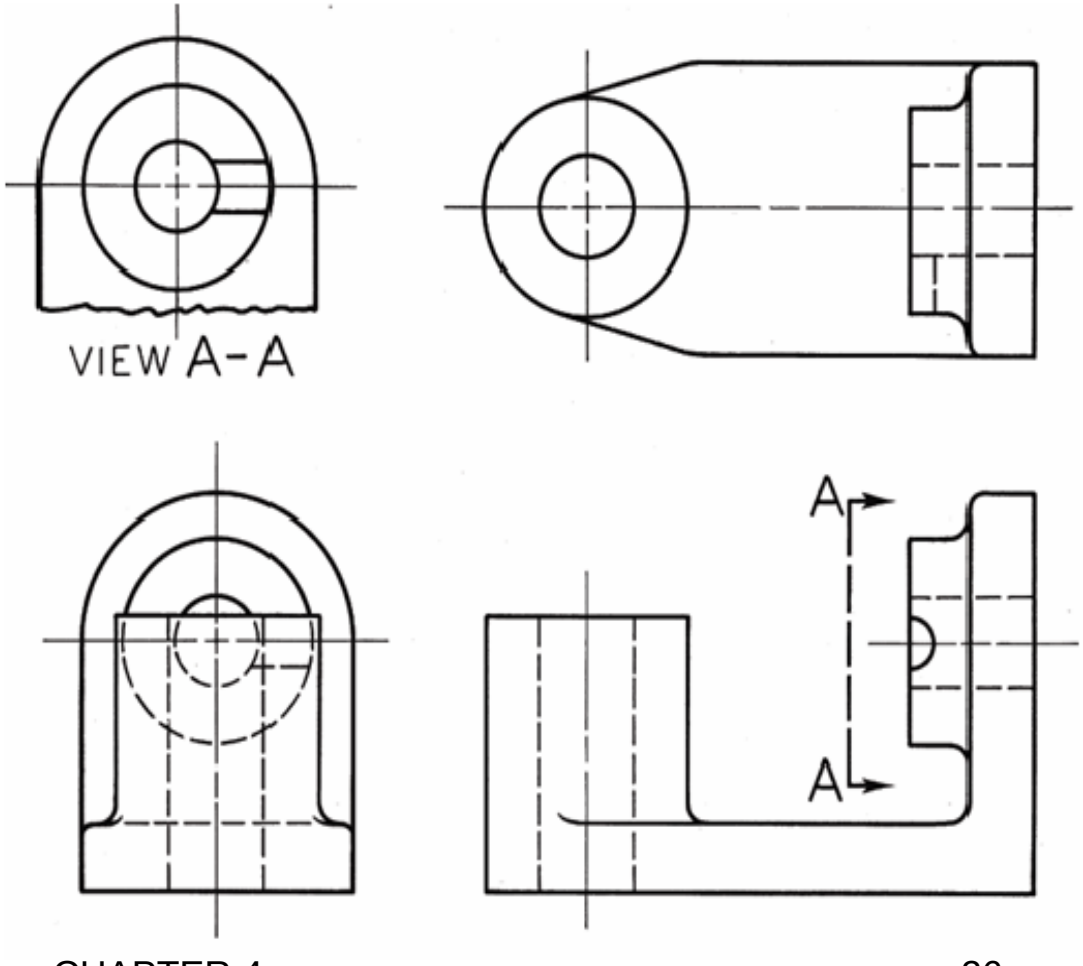
Removed views

- A removed view is a complete or partial view removed to another place on the sheet so that it is no longer in direct projection with any other view
- A removed view may be used to show some feature of the object more clearly, possibly to a large scale, or to save drawing a complete regular view.



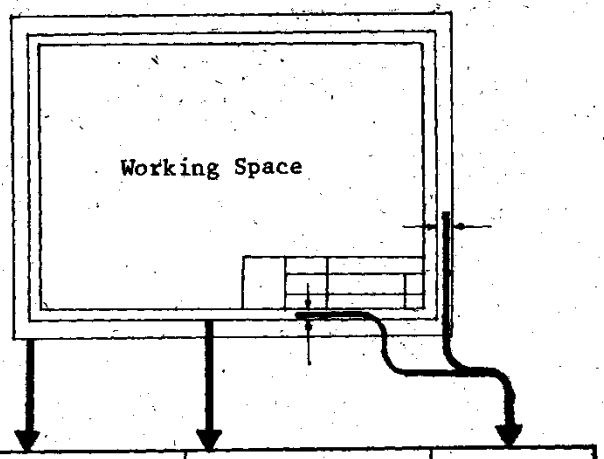
Removed views

- A viewing-plane line is used to indicate the part being viewed; the arrows at the corners show the direction of sight.
- The removed view should be labeled VIEW A-A or VIEW B-B and so on, the letters refer to those placed at the corners of the viewing-plane line.



4.19.DRAWING SIZES

Standard sizes for sheets of drawing papers can be seen in Fig.4.34.



	Basic size	Trimmed size (Filing form)	Margin
4A0	1720 x 2420	1682 x 2378	20
2A0	1230 x 1720	1189 x 1682	15
A0	880 x 1230	841 x 1189	10
A1	625 x 880	594 x 841	10
A2	450 x 625	420 x 594	10
A3	330 x 450	297 x 420	10
A4	240 x 330	210 x 297	5
A5	165 x 240	148 x 210	5
A6	120 x 165	105 x 148	5

Fig.4.34. Standard sizes for drawing sheets

4.20. SPACING THE VIEWS

- View spacing is necessary so that the drawing will be balanced within the space provided. A little preliminary measuring is necessary to locate the views.

- In spacing a three view drawing spaces A (Fig.4.35) should be approximately equal, and spaces B should be equal to, or slightly less than, either of spaces A. Space C should be approximately equal, and space D should be equal to or slightly less than space C. Adjustments should be made for notes, dimensions and also for title box.

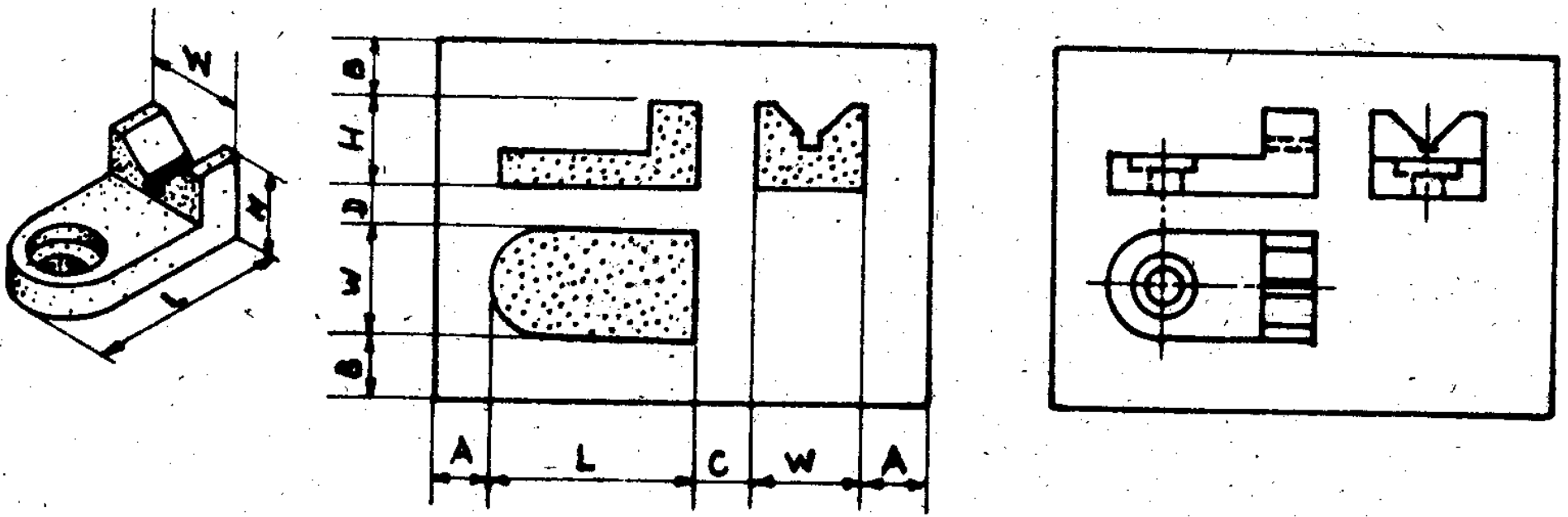


Fig.4.35. Spacing a three view drawing on a paper

4.21. PROJECTING THE VIEWS

- After laying out the views locate and draw the various features of the object. In doing this, carry the views along together, that is, do not attempt to complete one view before proceeding to another. Draw first the most characteristic view of a feature and then project it.

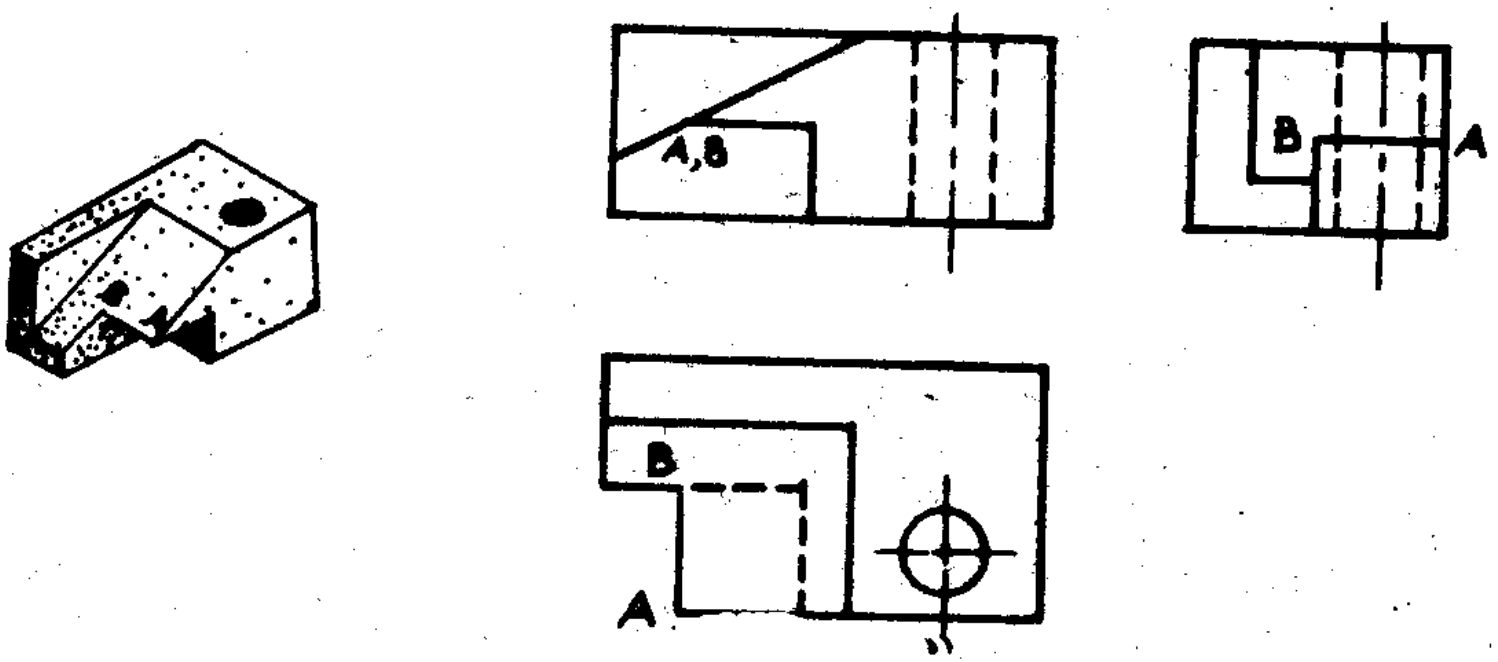


Fig.4.36. Projection of lines. Carry all views along together. The greatest mistake possible is to try to complete one view before starting another.

- Projections between front and profile views are made by employing the T square to draw the horizontal line (or to locate a required point) as shown in (Fig.4.37).

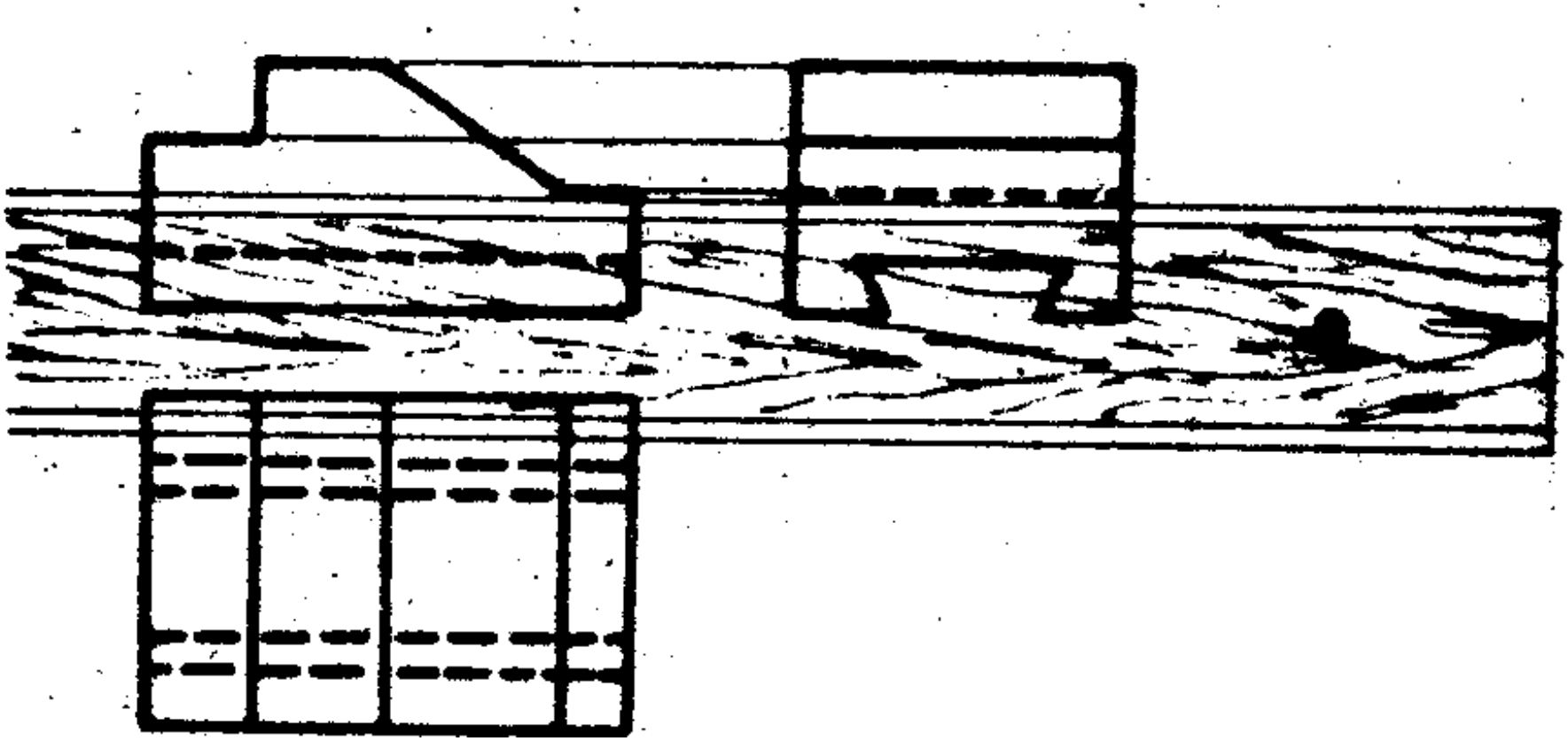


Fig. 4. 37. Making a horizontal projection. This is the simplest operation in drawing. The T square provides all horizontal lines.

- Using the T square and a triangle as illustrated in (Fig. 4.38) makes projections between front and top views.

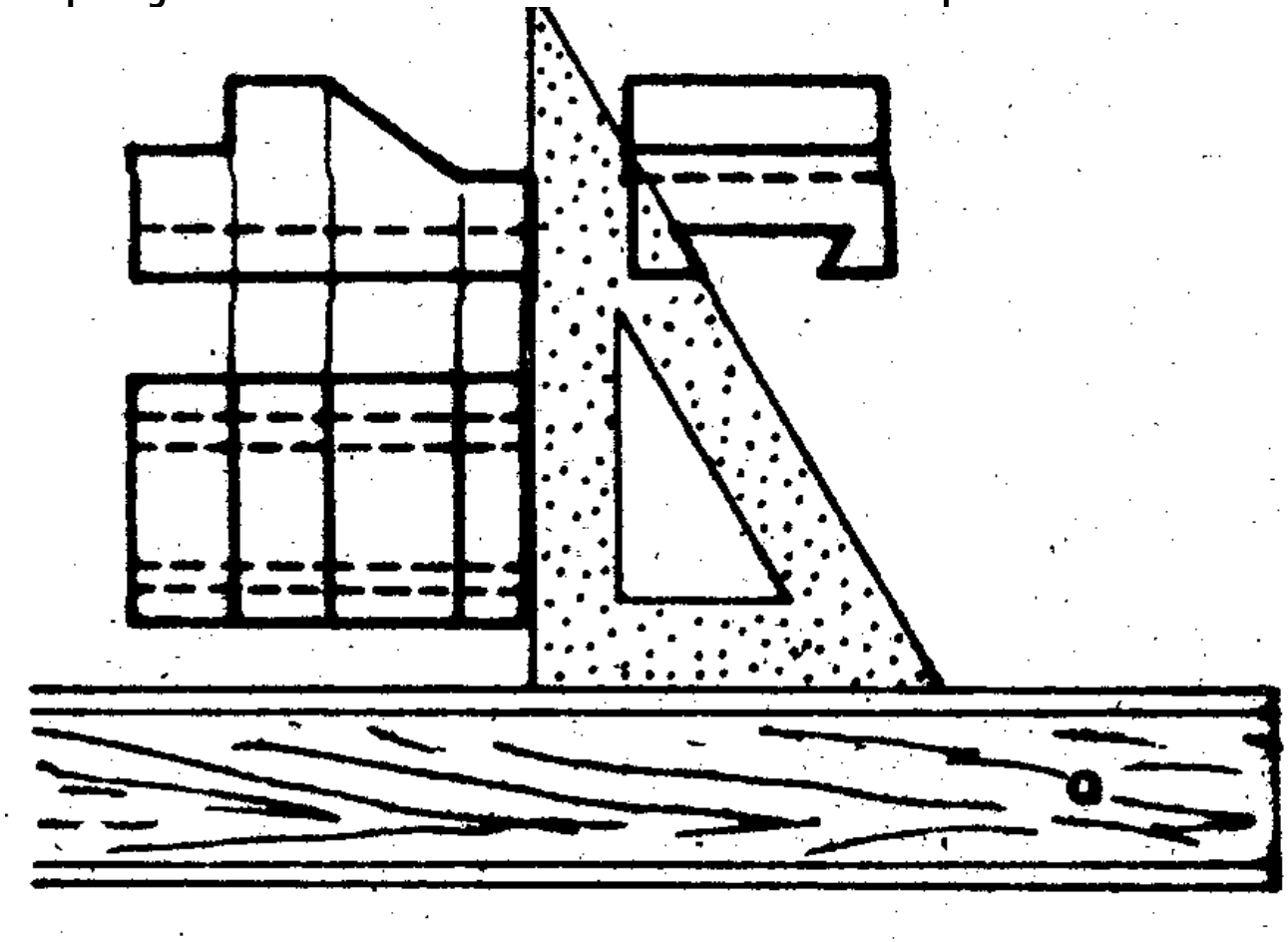


Fig. 4. 38. Making a vertical projection the 90º angle of a triangle with one leg on the horizontal T square produces vertical.

- Projections between the top and side views can not be projected directly but must be measured and transferred or found by special construction. In practice it is generally recommended for the sake of accuracy that the depth dimensions be transferred with the aid of dividers or scale; these methods are best when only a small number of very accurate measurements are to be transferred. The 45º mitre line method, is a convenient method, especially when transferring a large number of points as when plotting a curve (Fig.4.39).

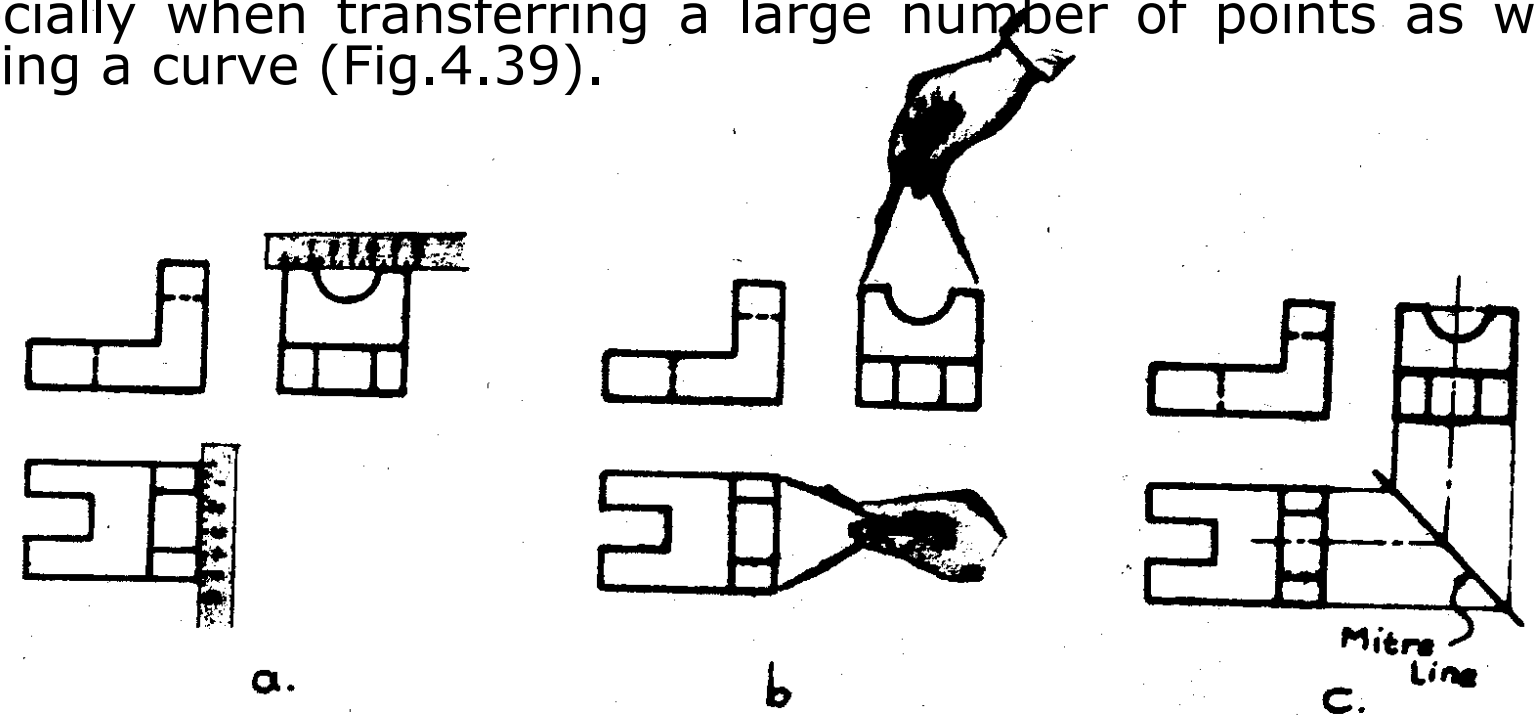


Fig.4.39. Transferring depth dimension

4.22. ORDER OF DRAWING

The order of drawing is important, as speed and accuracy depend largely upon the methods used in laying down lines. Avoid duplications of the same measurements and keep to a minimum changing from on instrument to another; an orderly placement of working tools on the drawing table will save time, when changing instruments. The usual order of working is shown in (Fig.4.40).

1. Decide the combination of views that will best describe the object. A freehand sketch will aid in choosing the views and in planning the general arrangements of the sheet.

2. Decide what scale to use, and by calculation or measurement find a suitable standard sheet size.

3. Space the views on the sheet.

4 Lay the principal dimensions and then block in the views with light, sharp, accurate outline and centerlines. Draw centerlines for the axes of all symmetrical views or parts of views. Every cylindrical part will have a centerline as the projection of the axis of the piece. Every circle will have two perpendicular centerlines intersecting at its center.

5 Draw in the details of the part, beginning with the dominant characteristic shape and progressing to the minor details such as fillets and rounds. Carry the views along together, projecting a characteristic shape, as shown, in one view to the other views, instead of finishing one view before starting another. Use a minimum of construction and draw the lines to finished weight, if possible, as the views are carried along. Do not make the drawing lightly and then "heavy" the lines later.

6 Lay out and letter the title.

7 Check the drawing carefully.

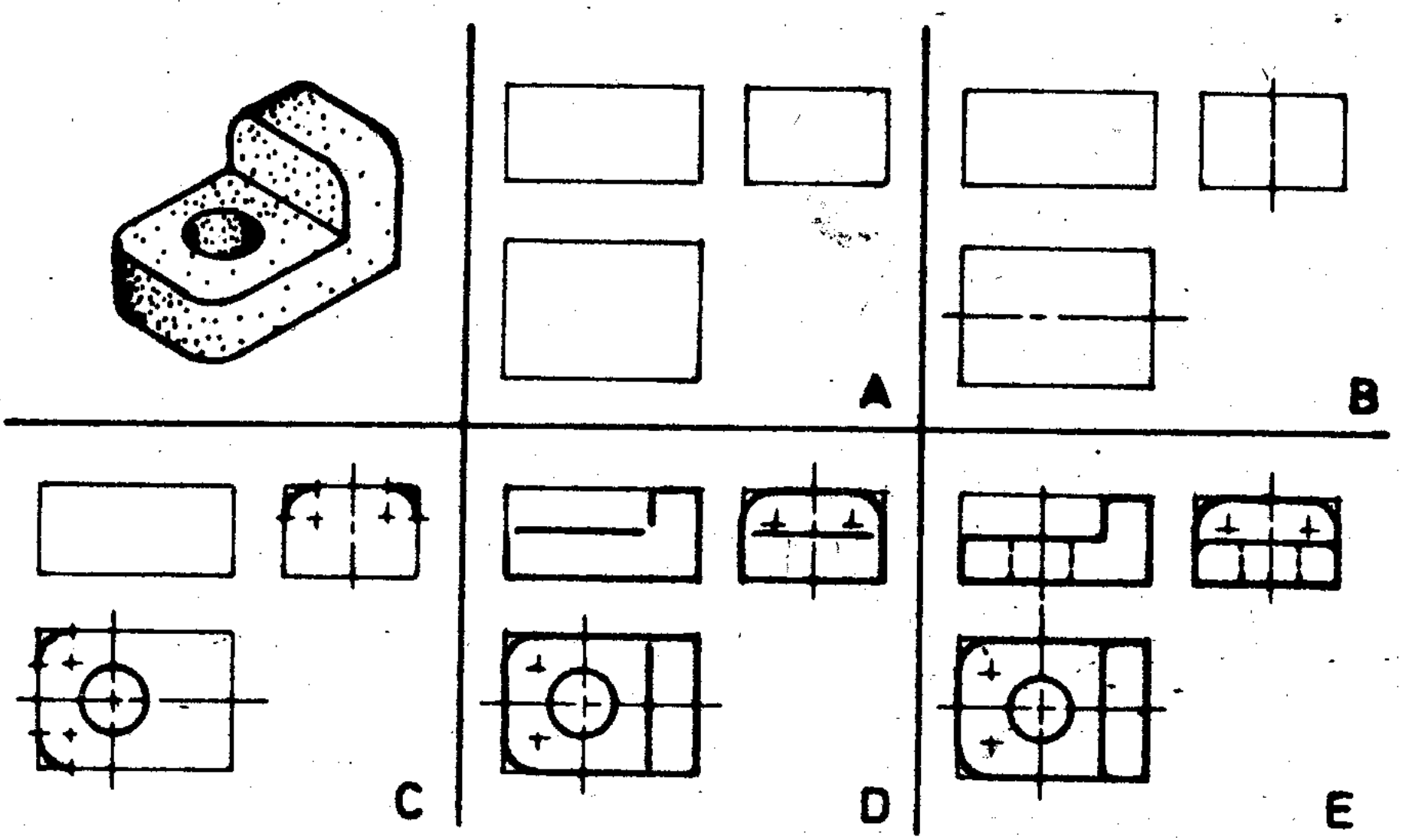


Fig. 4.40 Stages in drawing. (A) Block out the views. (B) Locate the center lines. (C) Start details, drawing arcs first. (D) Draw dominant details. (E) Finish.

4.23. SHOP PROCESSES

- Shop processes are properly a part of shaping, dimensioning and specification for working drawings. For the reading and the drawing the shop processes should be studied, especially for the hole processing (drilling, reaming etc.) and for information on fillets, rounds, chamfers spotfaces, bosses, counterbores, countersinks, finished surfaces, etc. and method of part manufacture.

4.24. FILLET AND ROUND

- A rounded interior corner is called a fillet, and a rounded exterior corner, a round (Fig.4.41a). Sharp corners should be avoided in designing parts to be cast or forged, not only because they are difficult to produce but in the case of interior corners are a source of weakness and failure.
- Two intersecting rough surfaces produce a rounded corner (Fig.4.41b) if one of these surfaces is machined (c) or if both surfaces are machined (d) the corner becomes sharp.

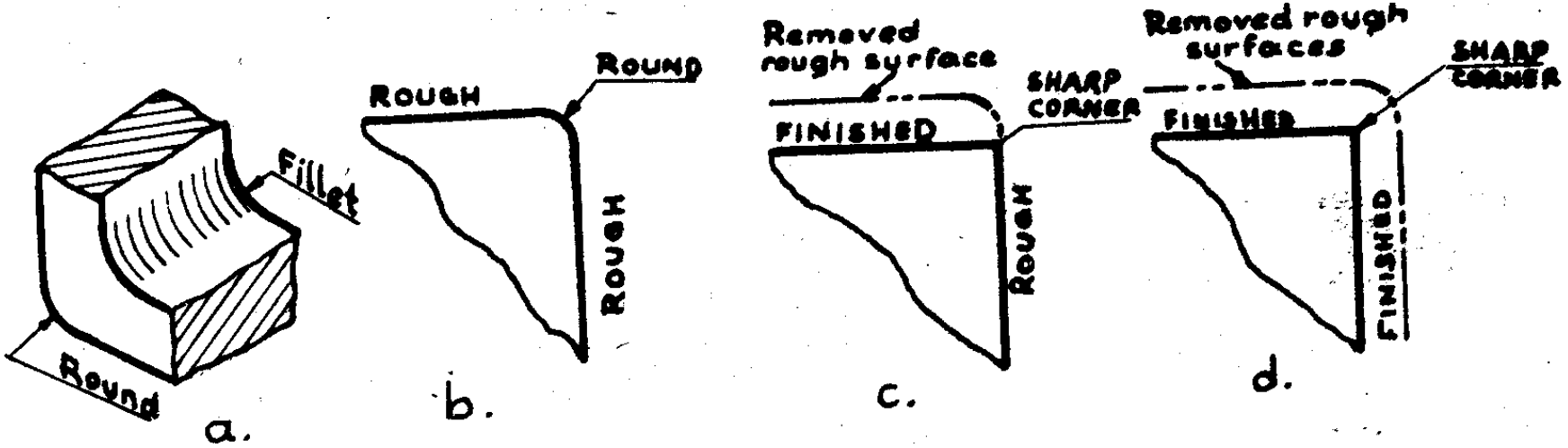


Fig 4.41. Rough and finished surfaces.

Therefore, on a drawing a rounded corner means that both intersecting surfaces are rough (The result of casting or forging) and a sharp corner means that one or both surfaces are machined. Fillets and rounds should be drawn with the bow pencil or bow pen if they are 3 mm radius or larger. Those smaller than 3R should be made carefully freehand.

4.25. RUNOUTS

- The correct method of representing fillets in connection with plane surfaces tangent to cylinders is shown in (Fig.4.42). These small curves and the extension of the edge view of the related plane are

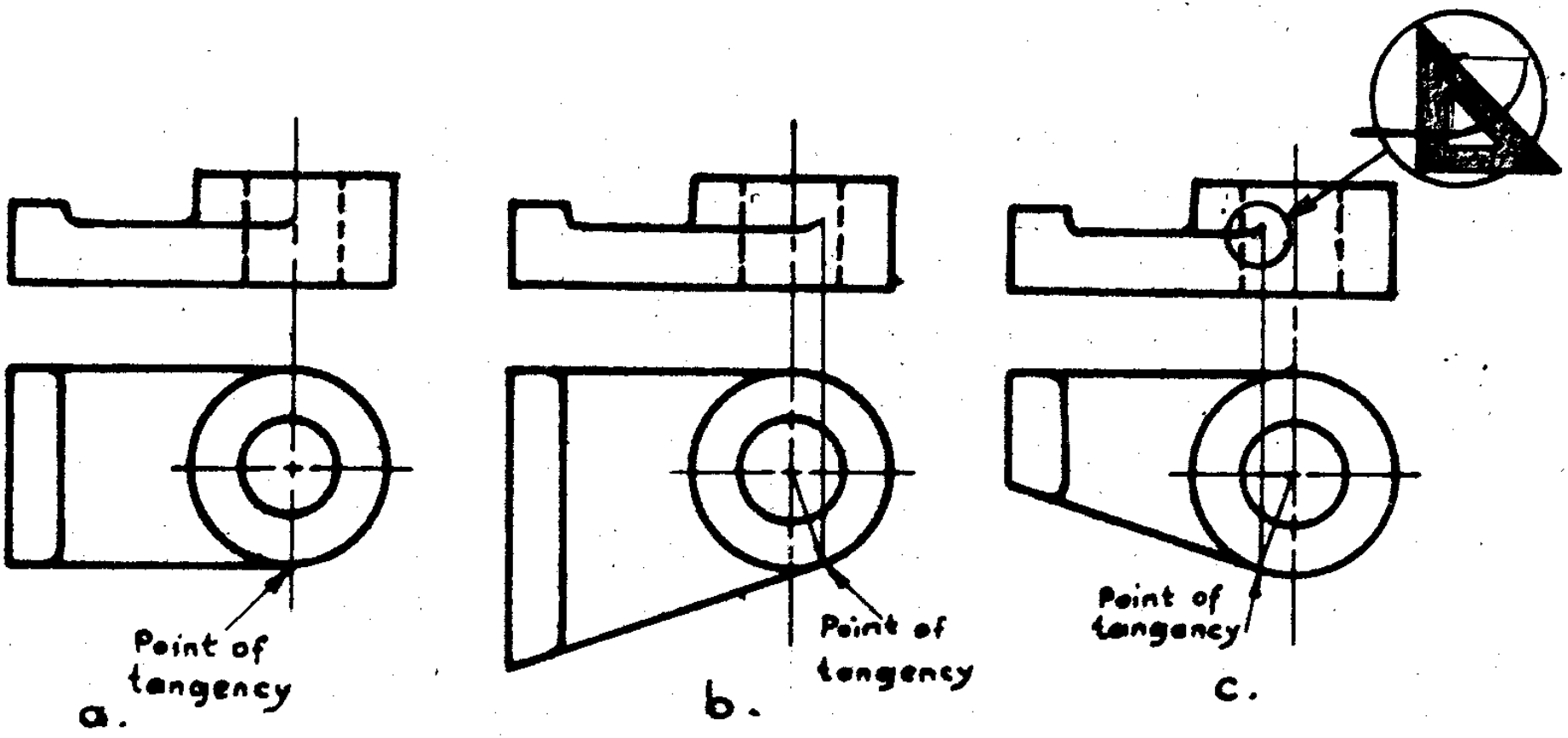


Fig.4.42. Runout.

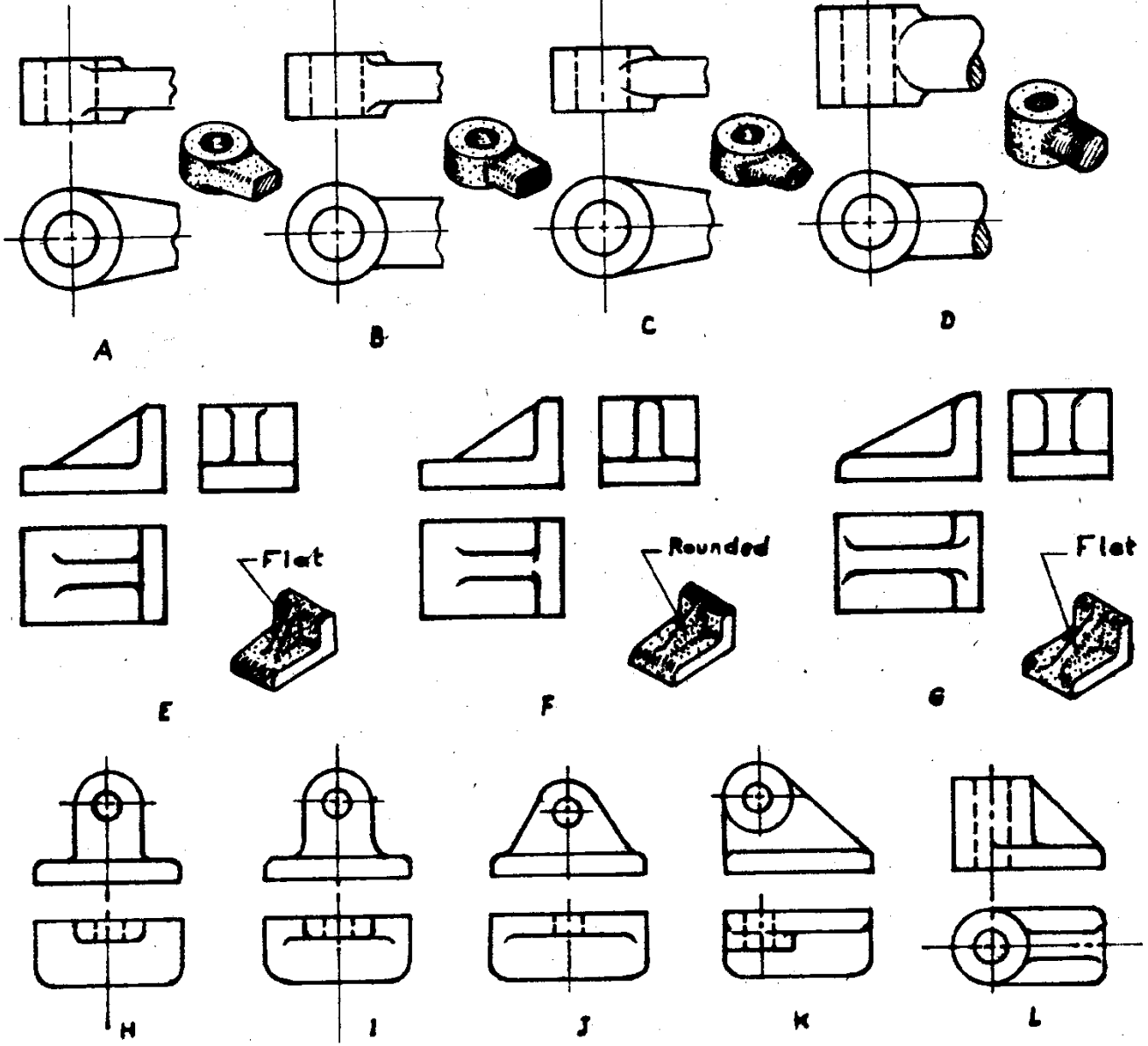
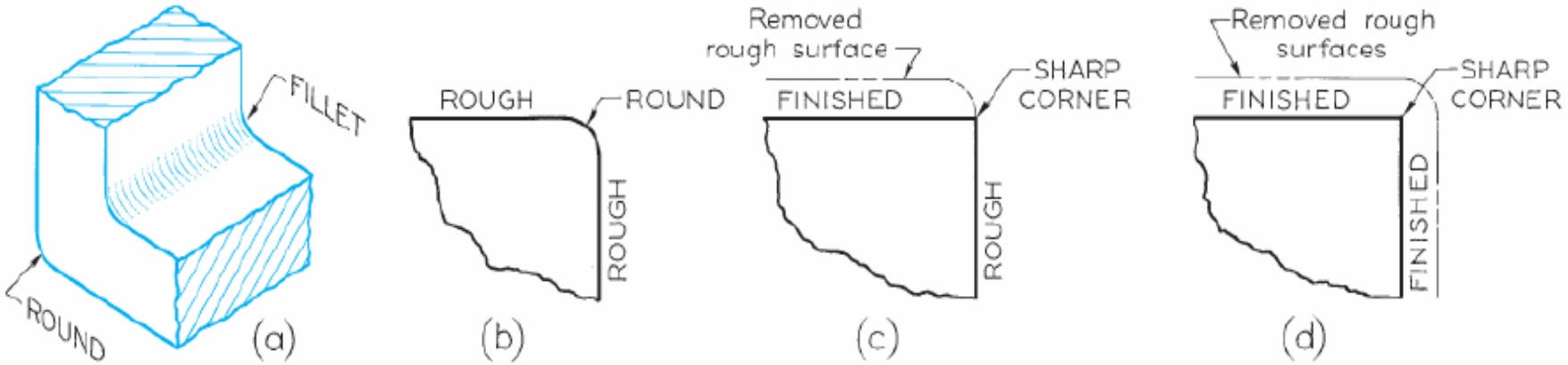


Fig. 4. 43. Conventional fillets, rounds and runouts.

Typical filleted intersections are shown in (Fig.4.43) the runouts from (a) to (d) differ, because of the different shapes of the horizontal intersecting members.

Fillet & Round

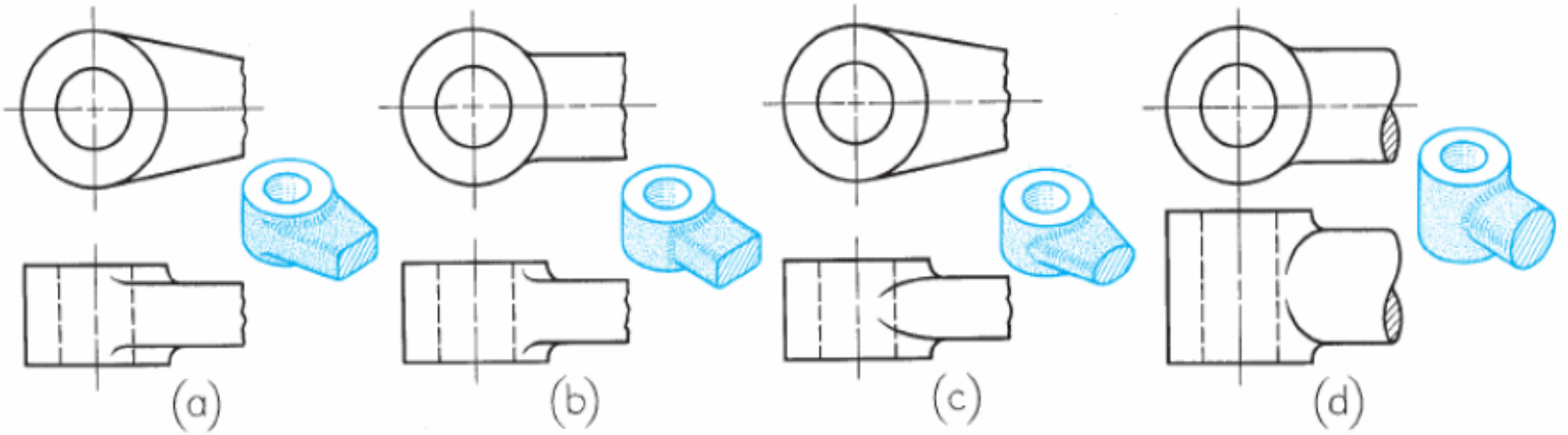
- A rounded interior corner is called a fillet, and a rounded exterior corner is called a round.
- In cast or forged objects, two intersecting rough surfaces produce a rounded corner. If one or both of these surfaces is machined, the corner becomes sharp. On a drawing, a rounded corner means that both intersecting corners are rough, and a sharp corner means that one or both surfaces has been machined.
- On working drawings, fillets and rounds are never shaded.



Runouts

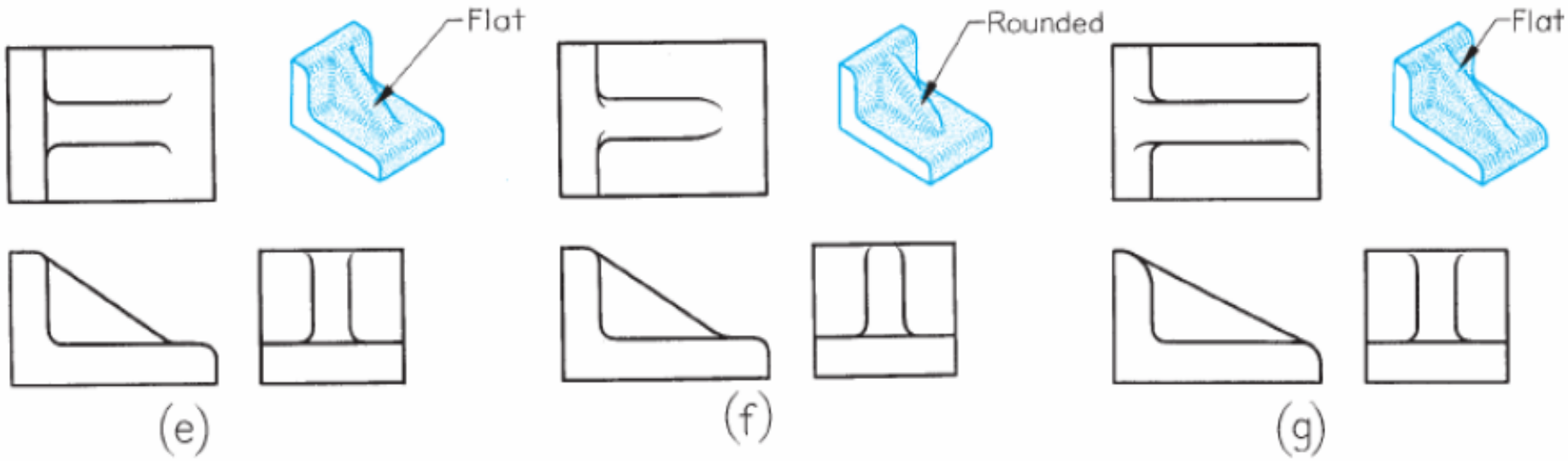
- A runout is produced when a filleted or rounded corner between two plane surfaces intersects a cylindrical surface. The small curve of intersection is called a runout, and is shown in the drawing to represent this intersection.

- In the figures below, the radiuses of the runouts differ because of the different shapes of the horizontal intersecting members.



Runouts

- A runout results when a rounded web intersects a rounded corner.
- At (e), the top surface of the web is flat with only slight rounds along the edge, while at (f), the top surface of the web is considerably rounded.
- When two different sizes of fillets intersect, (g), the direction of the fillet is dictated by the larger fillet.



4.26.CONVENTIONAL EDGES

- Rounded and filleted intersections eliminate sharp edges and sometimes make it difficult to present a clear shape description. In fact true projection in some cases may be actually misleading as shown in (Fig.4.44) (a) in which the front view of rail is blank, a clearer representation results if lines are added for rounded and filleted edges as shown at (b) and (c). The lines are projected from the actual intersections of the surfaces as if the fillets and rounds were not present.

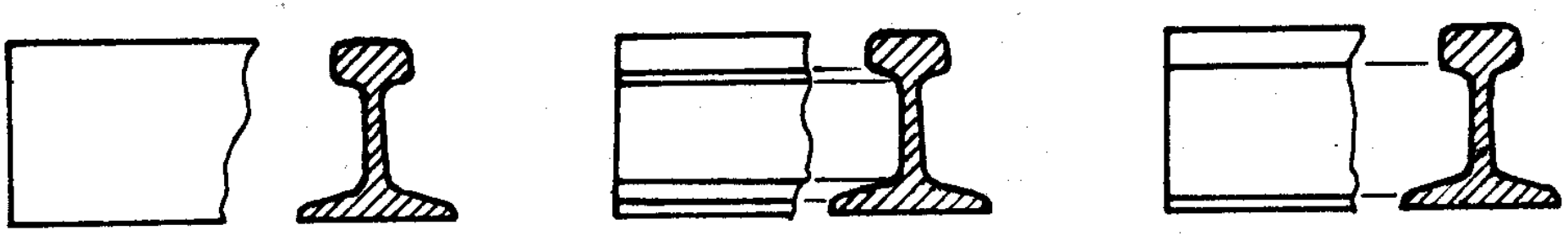


Fig.4.44. Conventional representation of a rail.

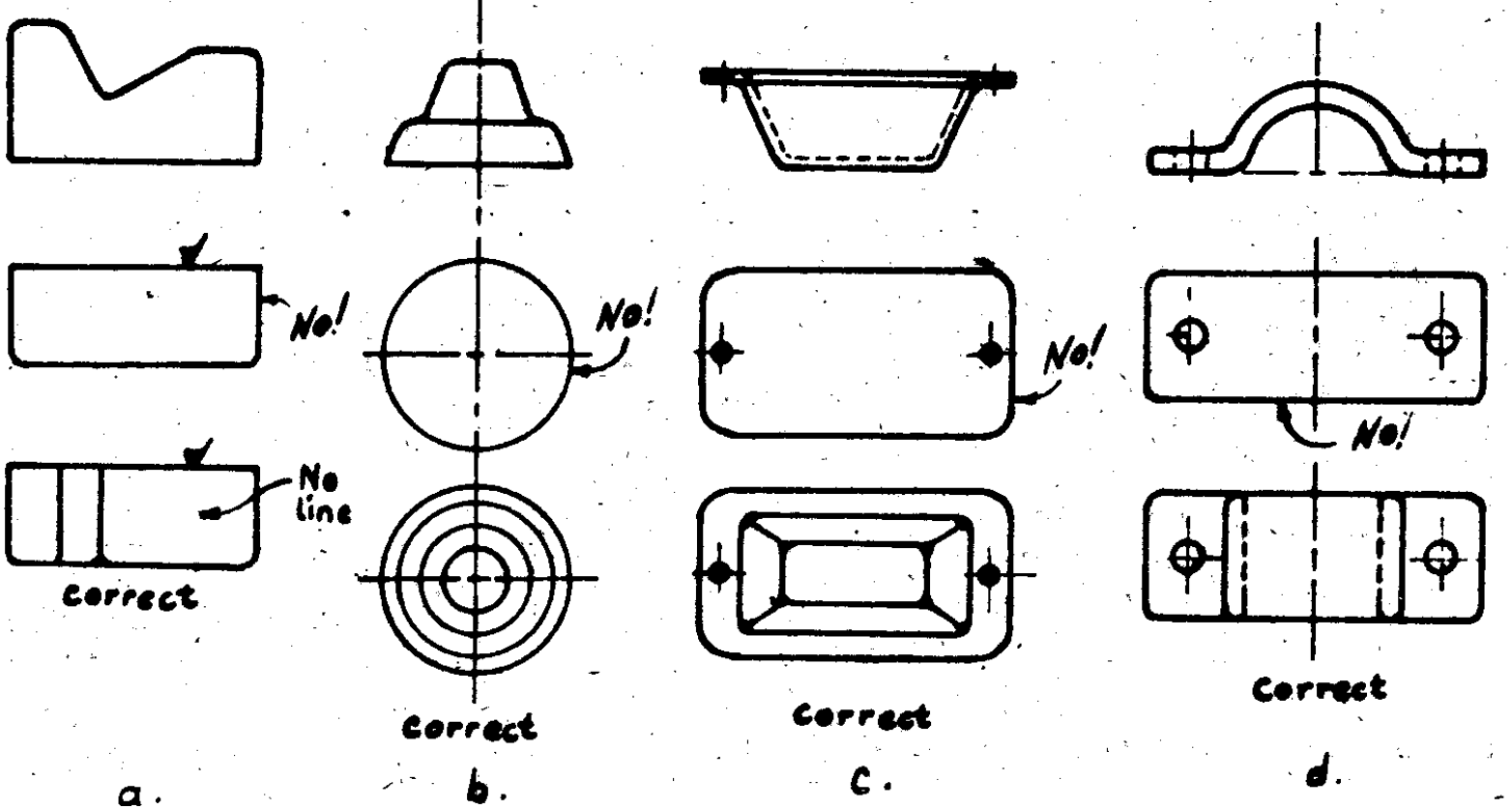


Fig. 4. 45 Conventional edges. See the use of small Y's where rounded or filleted edges meet a rough surface.

In (Fig.4.45) two top views are shown for each given front view. The lower top views are nearly devoid of lines that contribute to the shape description. While the upper top views in which lines are used to represent the rounded and filleted edges, are quite clear.

4.27.REPRESENTATION OF HOLES

- The correct method of representing the most common types of machined holes is shown in (Fig.4.46). Instructions to the machinist are given in the form of notes or in the form of standard dimensioning principles of shape. Hole sizes are always specified by diameter – NEVER BY RADIUS

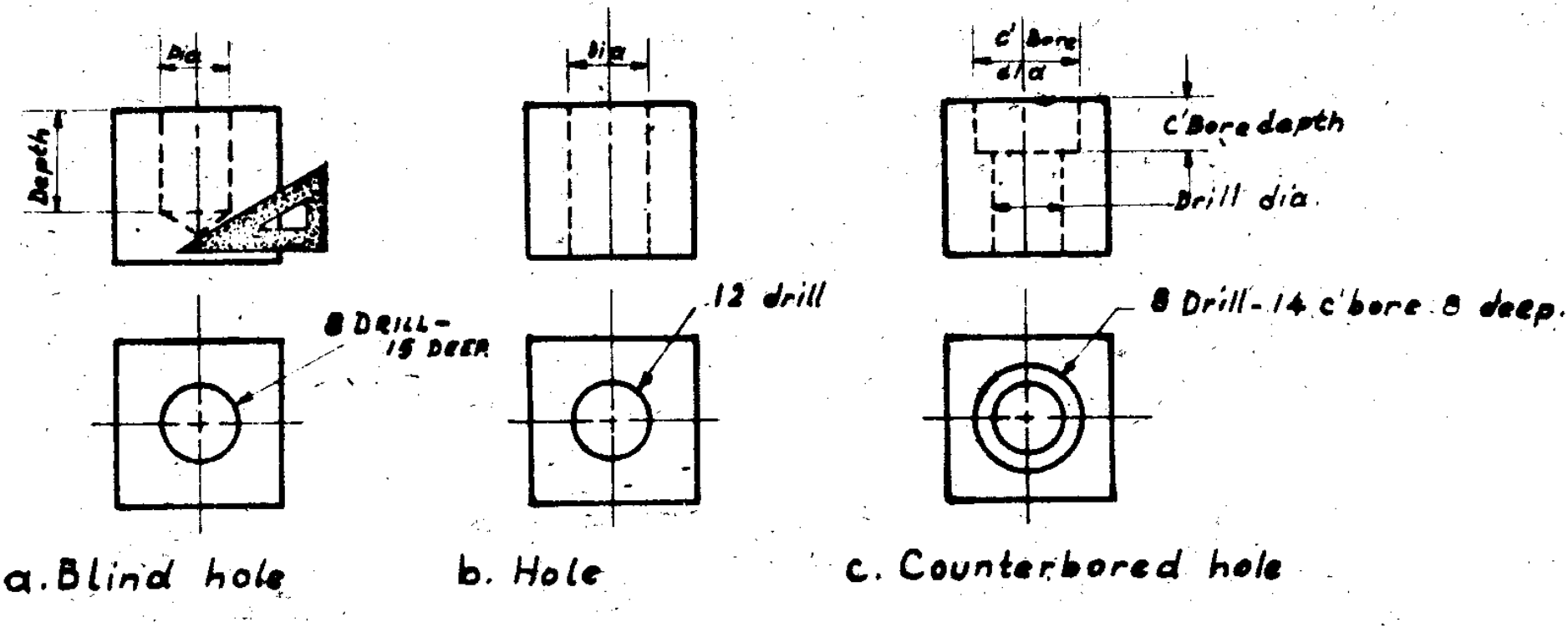


Fig.4.46. How to represent holes.

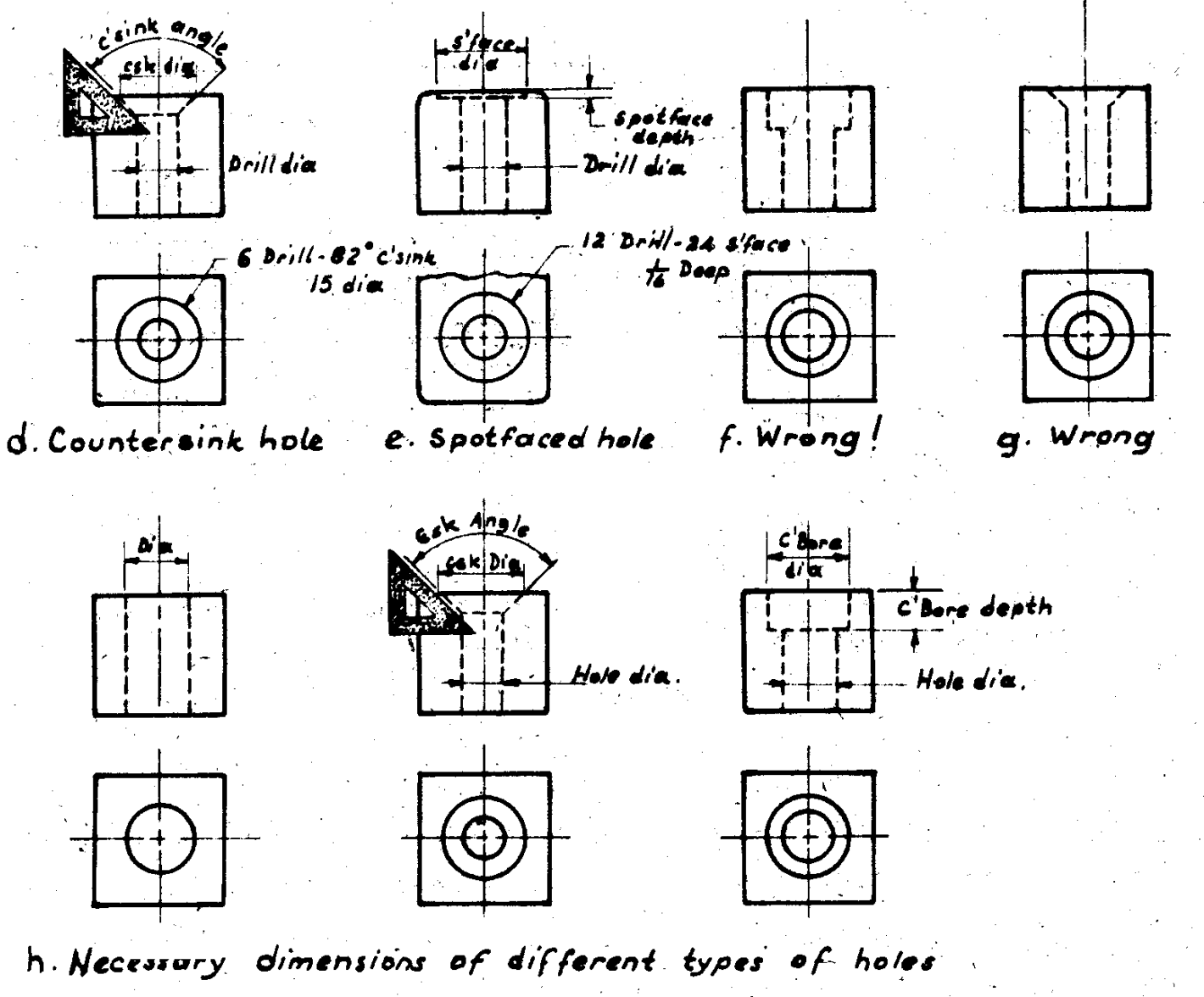
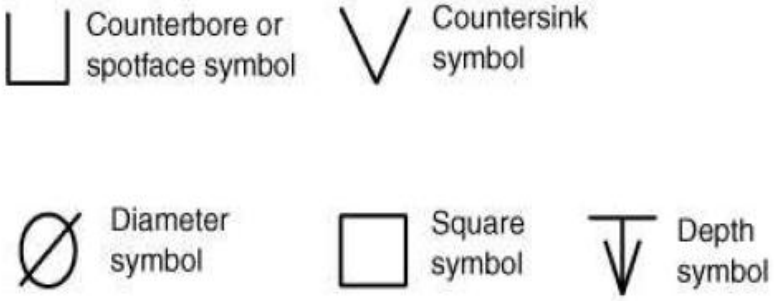
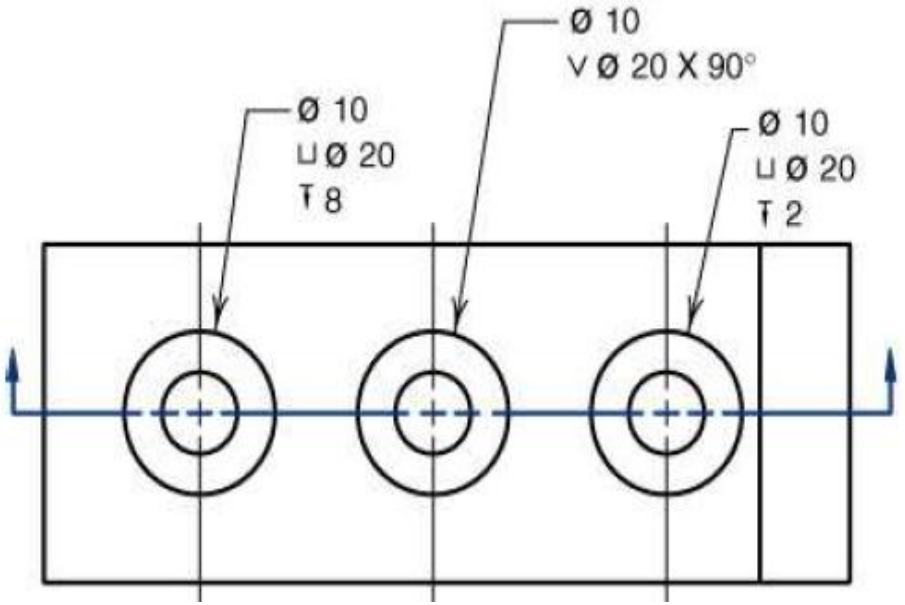


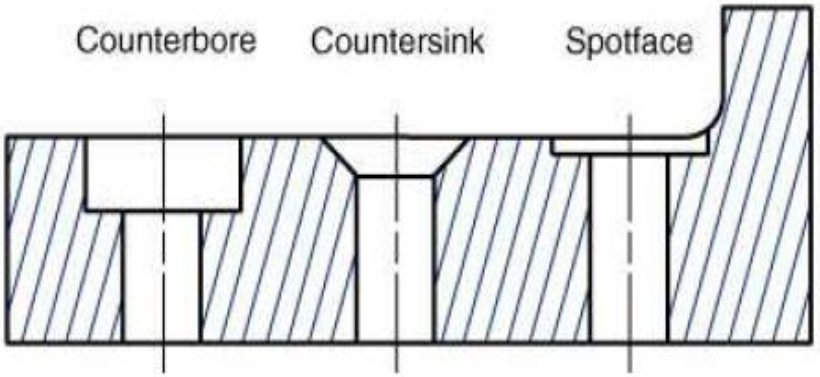
Fig.4.46. How to represent holes.

Representation of Holes

Hole sizes are always specified by diameter – NEVER BY RADIUS

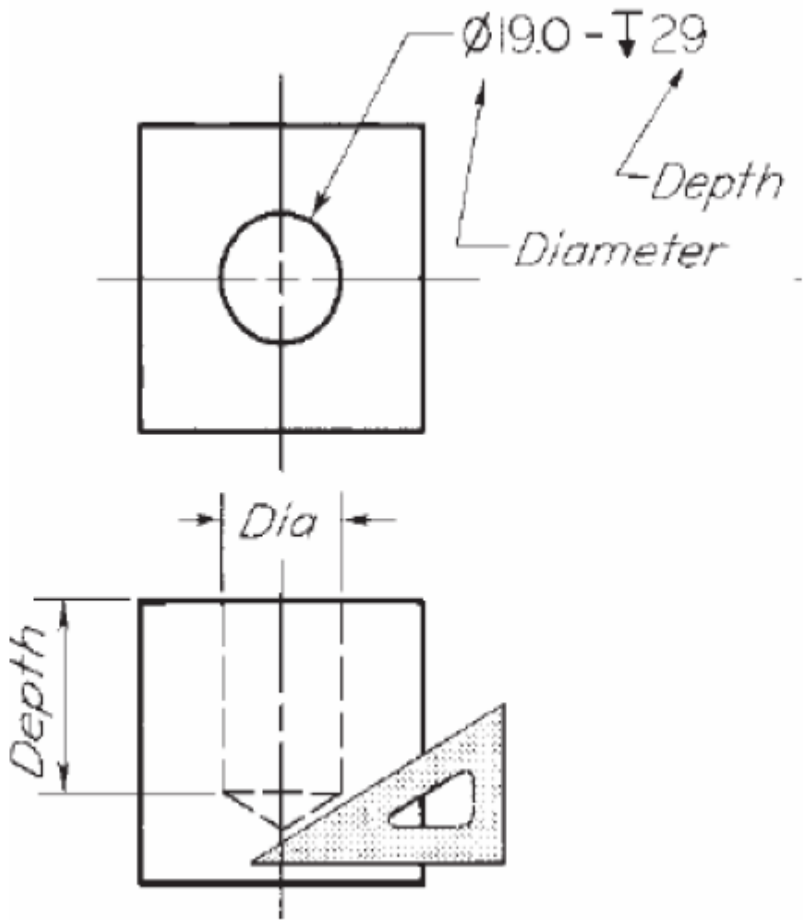






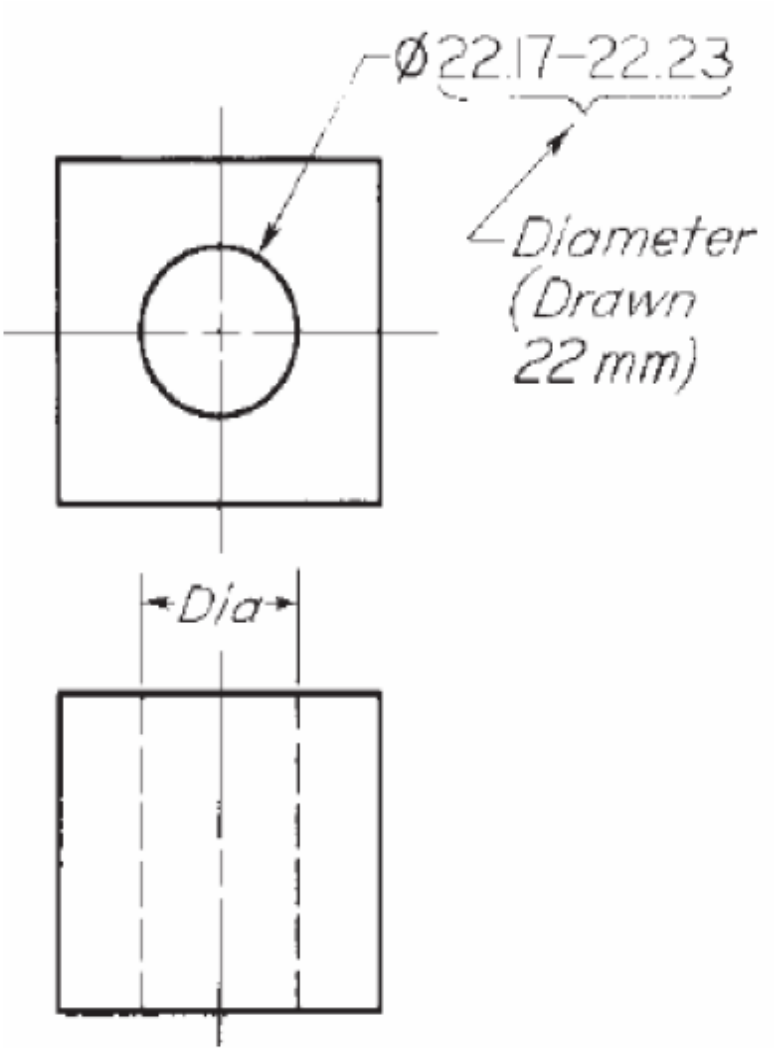
Representation of Holes

- A drilled hole is a **through hole** if it goes through the member.
- If the hole has a specified depth, the hole is called a **blind hole**. The depth includes the cylindrical portion of the hole only.
- The point of the drill leaves a conical bottom in the hole drawn with the 30º-60º triangle.



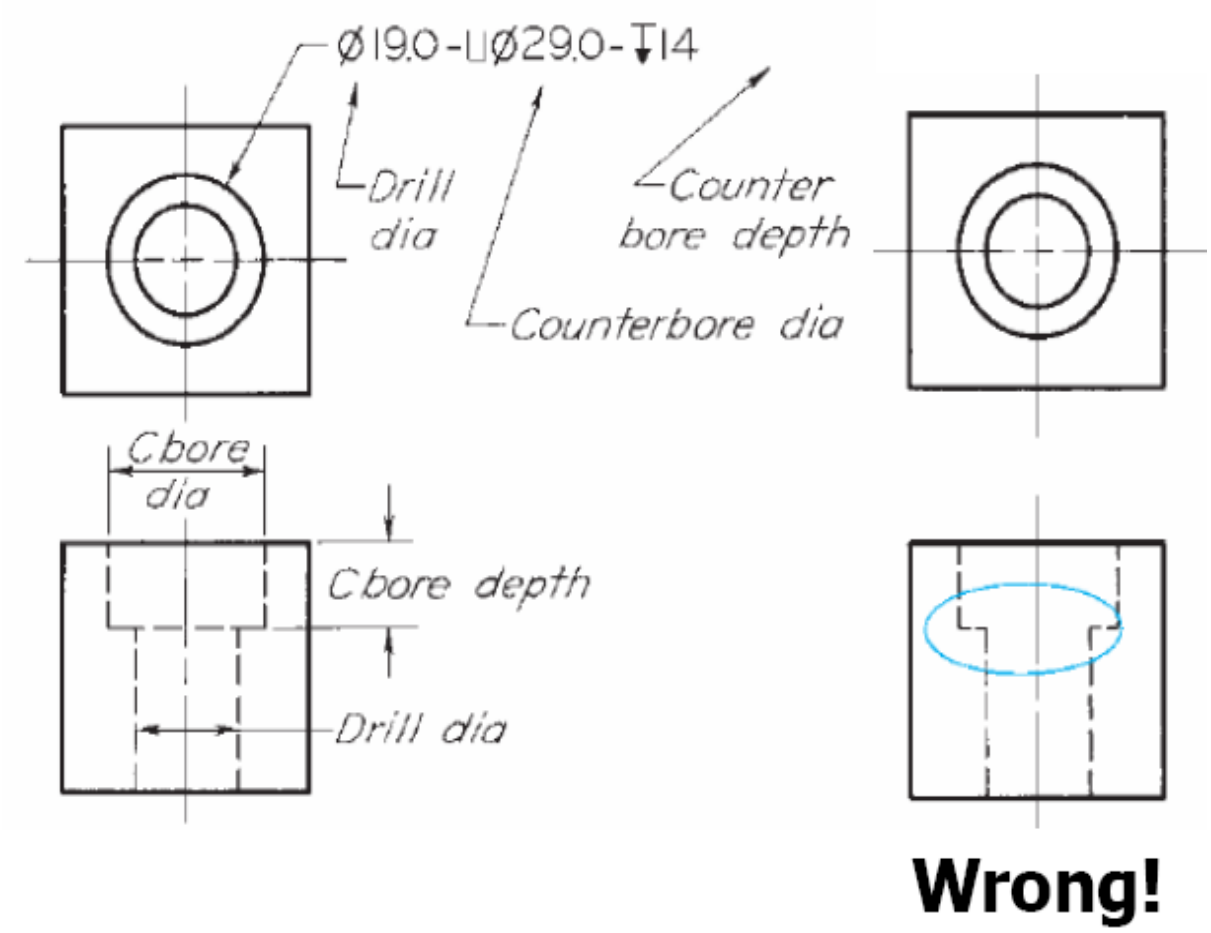
Representation of Holes

- A through drilled or reamed hole is drawn as shown. The note tells how the hole is to be produced.
- The tolerance is ignored when actually laying out the hole.



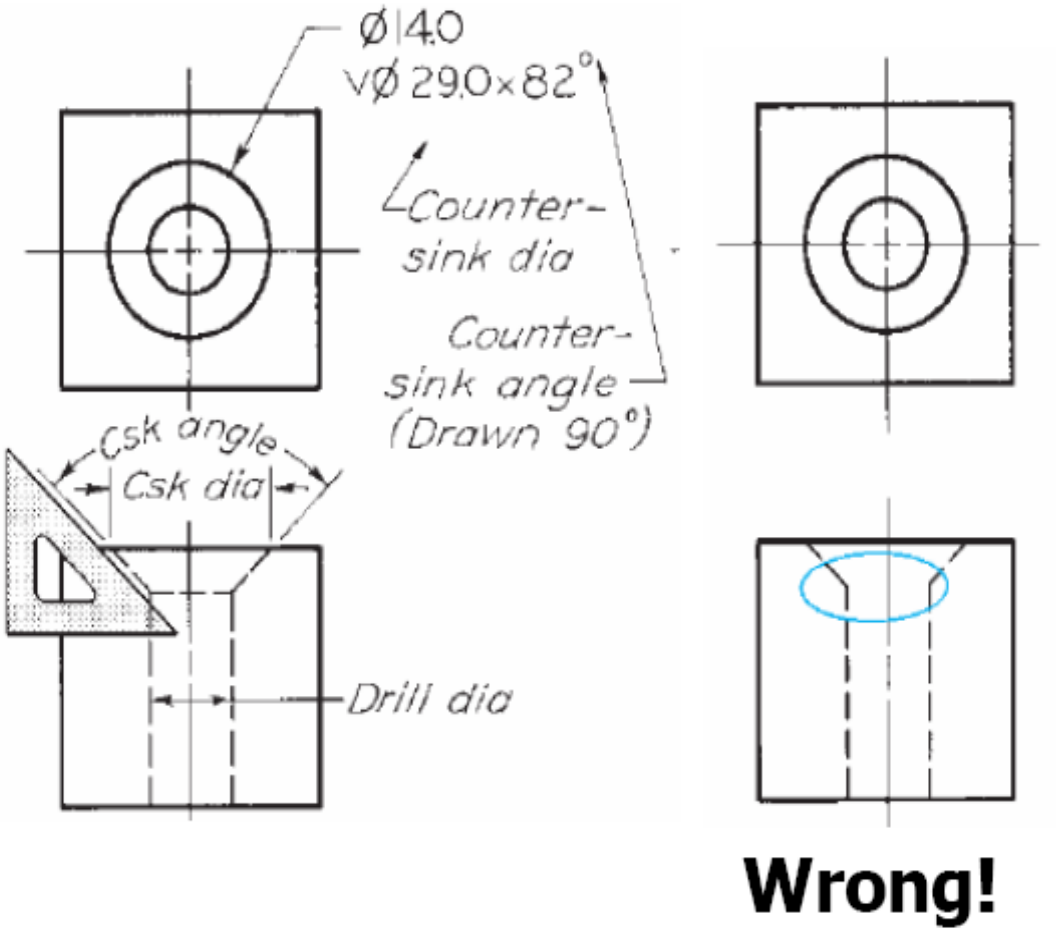
Representation of Holes

- A drilled and counterbored hole is a hole that is drilled then the upper part is enlarged cylindrically to a specified diameter and depth.



Representation of Holes

- A drilled and countersunk hole is a hole that is drilled then the upper part is enlarged conically to a specified angle and diameter.



4.28.BOSS

A boss is a projection of a circular cross section on a casting or forging as shown in (Fig.4.47.)

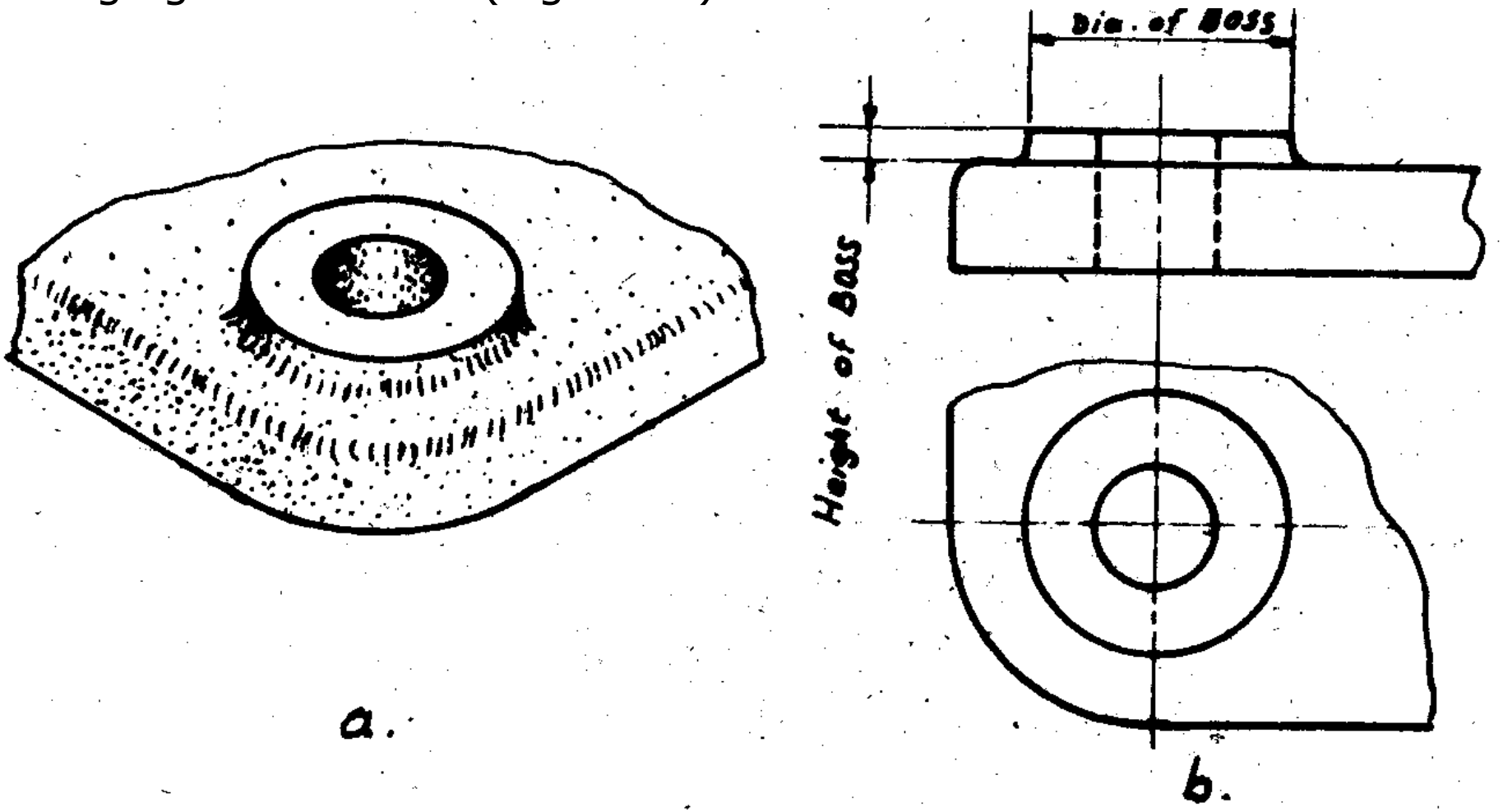
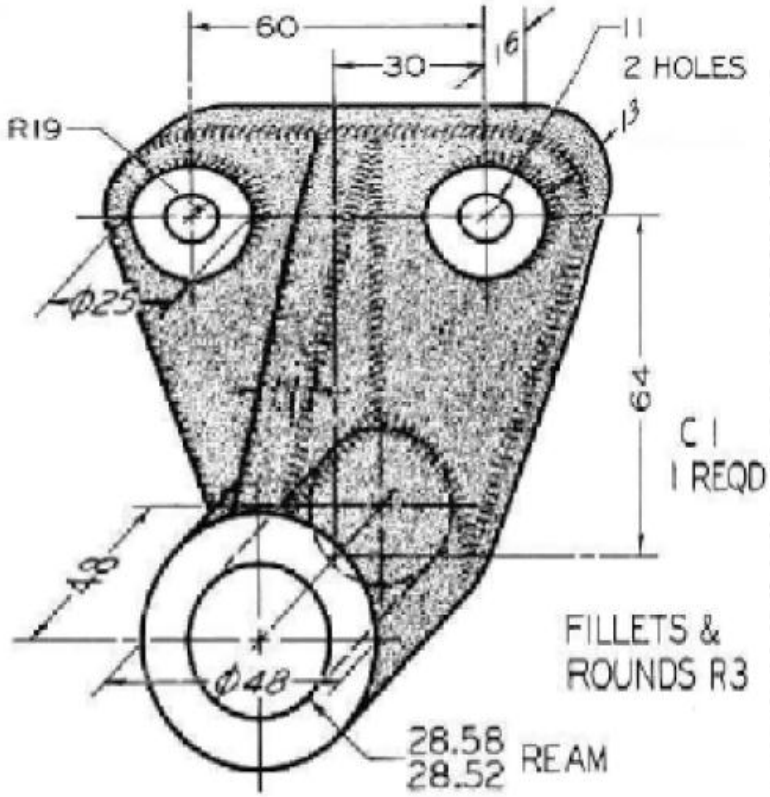
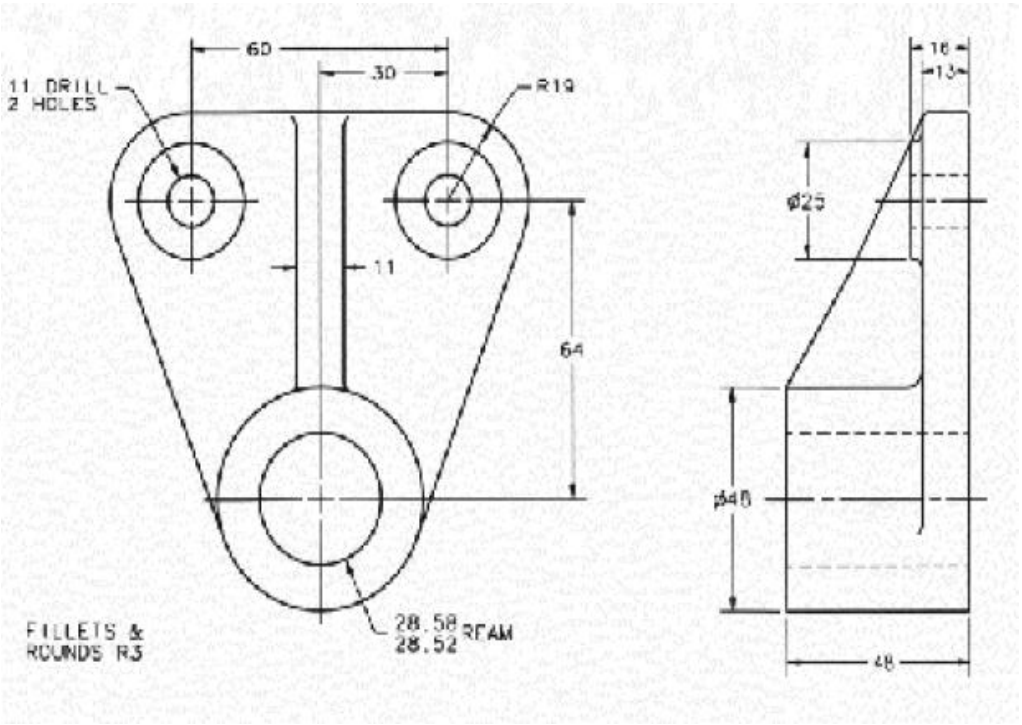


Fig.4.47. The boss.

Boss

A boss is a projection of a circular cross section on a casting or forging.





4.29. INTERSECTIONS OF CYLINDERS

- The intersection of a small cylinder with a large cylinder is shown in (Fig.4.48a). The intersection is so small that is not plotted, a straight line being used instead. At (b) the intersection is larger but still not large enough to justify the plotting the curve, the curve being approximated by drawing an arc whose radius (r) is the same as radius (R) of the large cylinder. At (c), the intersection is significant enough to constructing the true curve. At (d), the cylinders have the same diameter. The figures of intersection consist of two semi-ellipses that appear as straight lines in the front view.

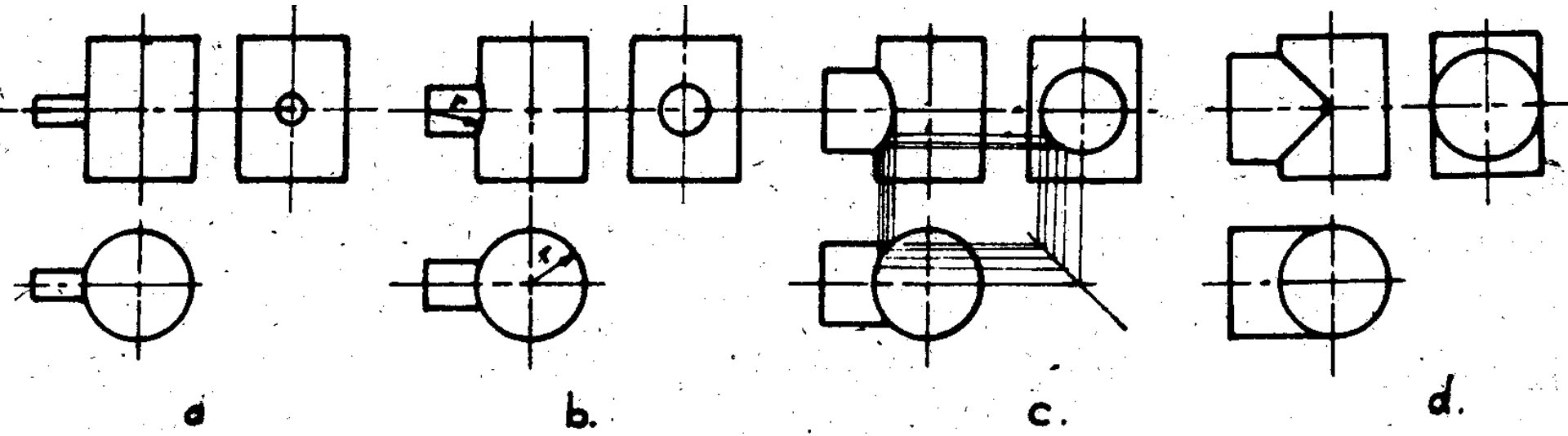


Fig.4.48. Intersection of cylinders.

- If the intersecting cylinders were holes the intersections would be similar to those for the external cylinders.
- If (Fig.4.49a), a narrow prism intersect a cylinder, but the intersection is insignificant and it is ignored. At (b) the prism is larger and the intersection noticeable enough to warrant construction as shown. At (c) and (d) are shown a key seat and a small drilled hole, respectively, in both cases the intersection is not important enough to construct.

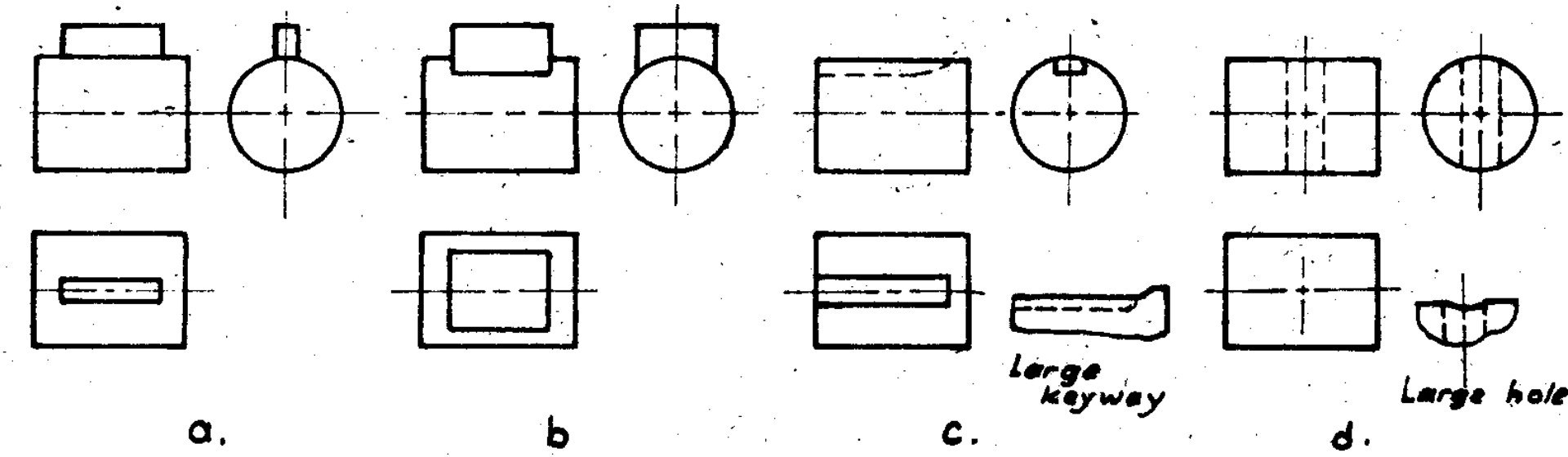


Fig.4.49. Intersections.

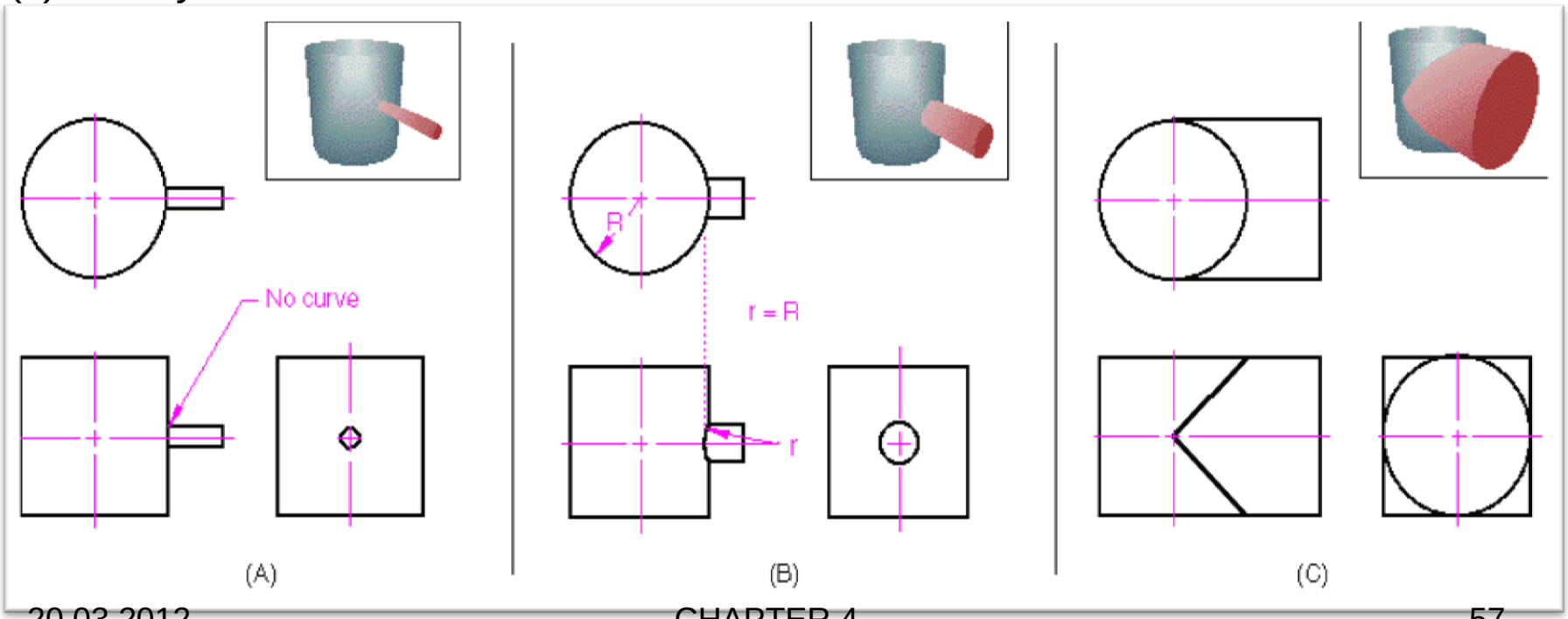
Intersections of Cylinders

"Intersections" are used to show the union of two or more cylinders.

(a) The intersection is so small that it is not plotted, a straight line is being used instead.

(b) The intersection is larger but still not large enough to justify plotting the curve being approximated by drawing an arc whose radius (r) is the same as radius (R) of the large cylinder.

(c) The cylinders have the same



Intersections of Cylinders and prism

(A) A narrow prism intersect a cylinder, but the intersection is insignificant and it is ignored.

(B) the prism is larger and the intersection noticeable enough to warrant construction

(C) the prism is as large as the diameter of the cylinder, so that the intersection occurs at the cylinder axis.