Section Views

Learning Objectives

After studying this chapter, you will be able to:

- Visualize a section view along a cutting plane.
- Construct section views.
- Draw various types of sections.
- Apply conventional drafting practices in sectioning.
- Describe how section views are created in CAD drafting.

Technical Terms

Aligned section
Auxiliary section
Broken-out section
Crosshatching
Cutting-plane line
Full section
Half section
Hatch boundary
Hatching
Offset section
Outline sectioning
Partial section
Phantom section
Removed section
Revolved section
Section lines
Section view
Thin section

A ***section view*** is a view "seen" beyond an imaginary cutting plane. The plane passes through an object at a right angle to the direction of sight, **Figure 10-1A**. Section views are used to show interior construction, or details of hidden features, that cannot be shown clearly by exterior views and hidden lines, **Figure 10-1B**. Section views are also used to show the shape of exterior features. Examples of these types of section views include automobile body components, airplane wings, and fuselage sections.

Cutting-Plane Lines

The cutting plane of a section is indicated by a ***cutting-plane line***. (Note that the term *cutting-plane line* should not be confused with the term *cutting plane*. You can easily tell the difference by the use of the hyphen in *cutting-plane line*.) Cutting-plane lines are usually made up of a series of heavy dashes, each about 1/4" long, **Figure 10-2A**. However, a heavy line of alternating long dashes 3/4" to 1 1/2" long with a pair of short dashes 1/8" long spaced 1/16" apart can also be used. Some drafters favor a simplified representation of the cutting-plane line that includes only the ends, **Figure 10-2B**.

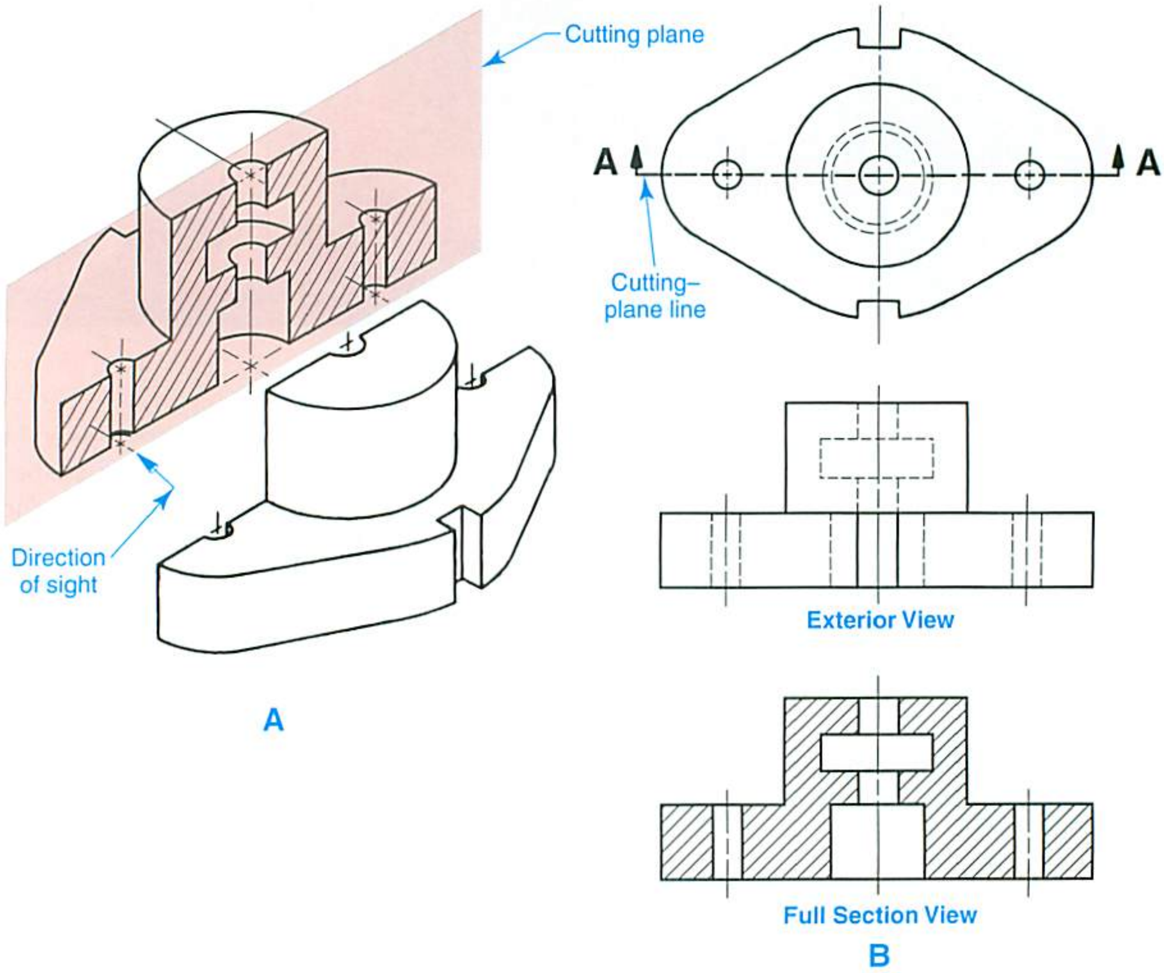


Figure 10-1. Section views show the construction details and shapes of parts.

Arrowheads at the ends of the cutting-plane line are used to indicate the direction in which the section is viewed. If necessary, the cutting-plane line is labeled with letters to identify the section. For objects having one major centerline, the cutting-plane line can be omitted if the section is clearly along the centerline. The cutting plane may also be bent or offset to show details of hidden features to better advantage, **Figure 10-2C**.

Projection and Placement of Section Views

Whenever possible, a section view should be projected from, and perpendicular to, the cutting plane. The section view should be placed "behind" the arrows indicating the viewing direction, **Figure 10-3**. This arrangement should be maintained whether the section is adjacent to, or removed some distance from, the cutting plane.

Section Lines

The exposed (cut) surface of the section view is indicated by ***section lines***. Section lining is sometimes called ***crosshatching***. Section lines emphasize the shape of a detail, or differentiate one part from another.

Section lines are thin, parallel lines drawn with a sharp pencil or No. 0 (0.3 mm) pen in manual drafting. In CAD drafting, section lines are generated as crosshatching patterns using the **Hatch** command. Section lines should not be drawn around dimensions that are required inside of the section view. This will provide clarity to the drawing.

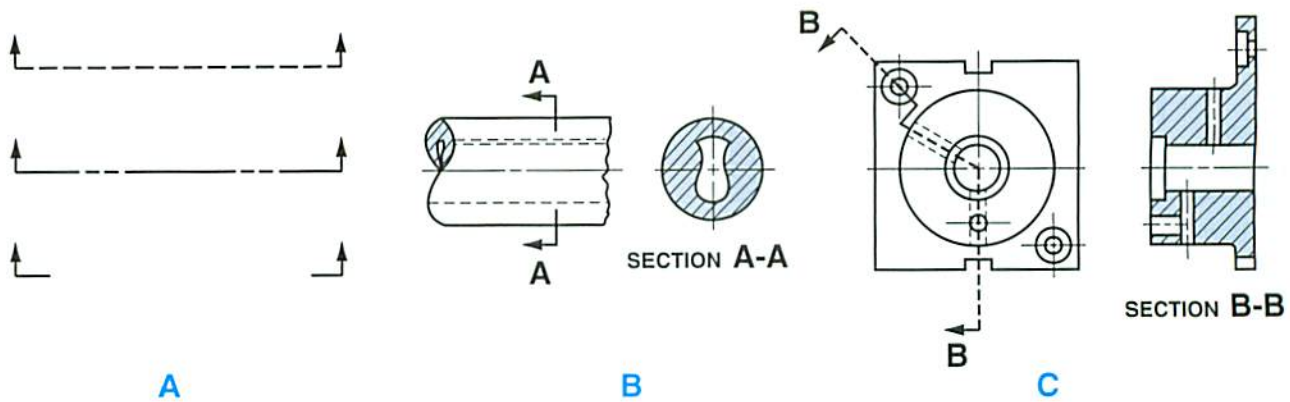


Figure 10-2. Conventions for drawing cutting-plane lines. A—Lines may be drawn using a series of equal length dashes, alternating long and short dashes, or the ends only. The arrowheads indicate the direction of viewing. B—Some drafters prefer cutting-plane lines that consist of only the ends and the arrowheads. C—Sometimes cutting-plane lines are "offset" through several different planes to show many different features.

Angle and Direction of Section Lines

Section lines should be drawn at an angle of 45° to the main outline of the view, **Figure 10-4A.** On adjacent parts, section lines should be drawn at an angle of 45° in the opposite direction, **Figure 10-4B.** For a third adjacent part, section lines should be drawn at an angle of 30° or 60°, **Figure 10-4C.** Where the normal 45° angle of section lining is parallel, or nearly parallel, to the outline of the part, a different angle should be chosen, **Figure 10-4D.** Section lines should not be intentionally drawn to meet at common boundaries.

Spacing of Section Lines

Section lines should be uniformly spaced throughout the section, **Figure 10-5.** However, spacing may be varied according to the size of the drawing. Section lines should be spaced approximately 1/8″ to 3/16″ apart.

In general, in manual drafting, spacing should be as wide as possible to save time. This will also improve the appearance of the drawing.

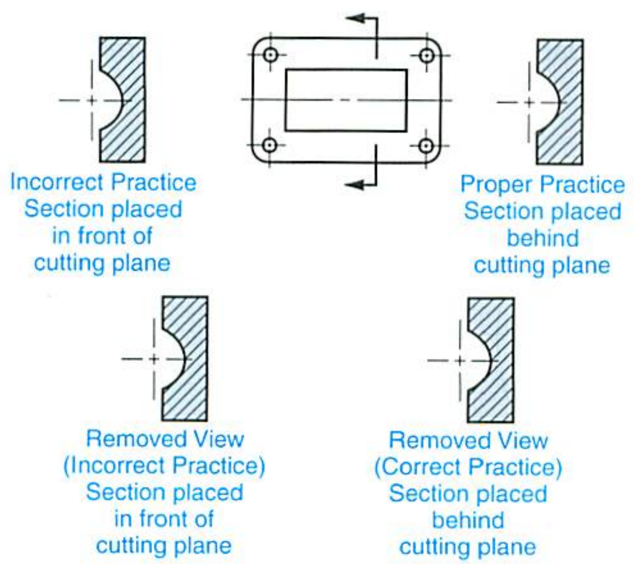


Figure 10-3. The section view should be placed "behind" the cutting-plane line arrows. This is the case whether the view is drawn in the normal projected position or as a removed section.

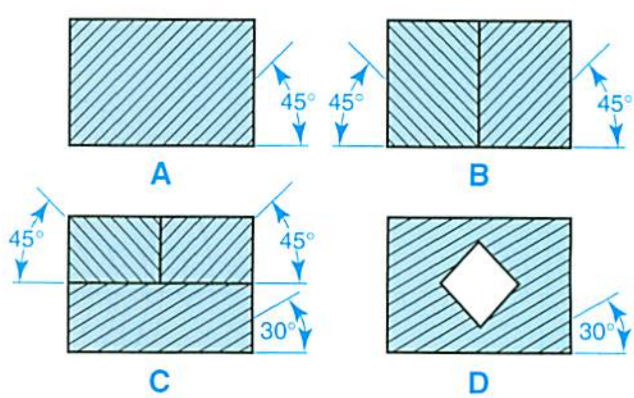


Figure 10-4. Conventions for drawing section lines. A—Section lines should be drawn at a 45° angle to the object lines outlining the view. B—When two parts are adjacent to each other, the section lines should be drawn at opposite 45° angles. C—If three parts are adjacent to each other, the third part should have section lines at 30°. D—If the object lines are parallel, or nearly parallel, to 45°, a different angle should be used.

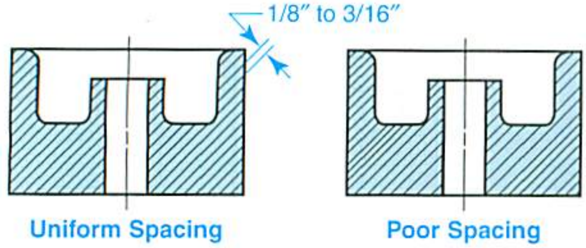


Figure 10-5. Section lines should always be uniformly spaced.

Section lines should end at the visible outline of the part without gaps or overlaps.

Hidden Lines behind the Cutting Plane

Hidden lines that normally would appear behind the cutting plane should be omitted in the section view unless needed for clarity, **Figure 10-6A**. In half sections, hidden lines are shown on the unsectioned half only if needed for dimensioning or clarity on the drawing, **Figure 10-6B**.

Object Lines behind the Cutting Plane

In general, object lines behind the cutting plane are shown in the section view. However, they may be omitted where the section view is clear without them, **Figure 10-7**. If omitting the lines will not save a large amount of drafting time, they should be left in.

Sometimes, it is necessary to rotate visible features in the section view so that clarity is improved. Note in **Figure 10-7** that one of the spokes is rotated "into" the cutting plane. This is preferred practice.

Types of Section Views

Many types of section views have been adopted as standard sectioning procedure. Each type has a unique function in drafting. The different types of section views and their uses are discussed in the following sections.

Full Sections

In a ***full section***, the cutting plane passes entirely through an object. The cross section behind the cutting plane is exposed, **Figure 10-8**. The cutting-plane line and section title may be omitted if the section view is in the same position used for the orthographic projection view. A full section view usually replaces an exterior view in order to show interior features.

Half Sections

A ***half section*** shows the internal and external features of an object in the same view,

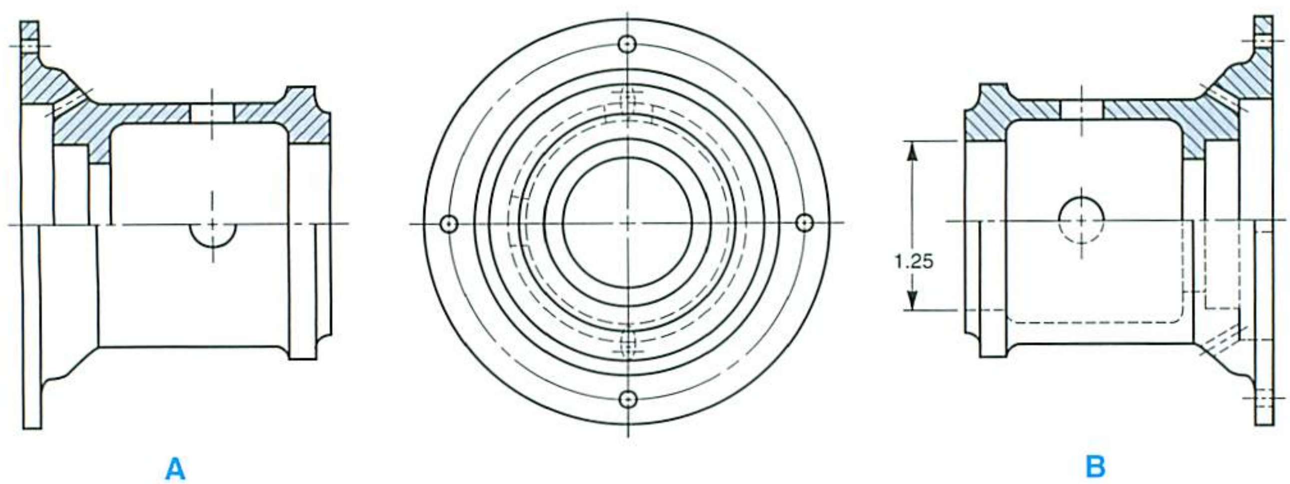


Figure 10-6. Hidden lines in section views. A—Hidden lines behind the cutting plane are typically left out unless needed for clarity. B—In half section views, hidden lines should be included on the unsectioned half only if needed for clarity.

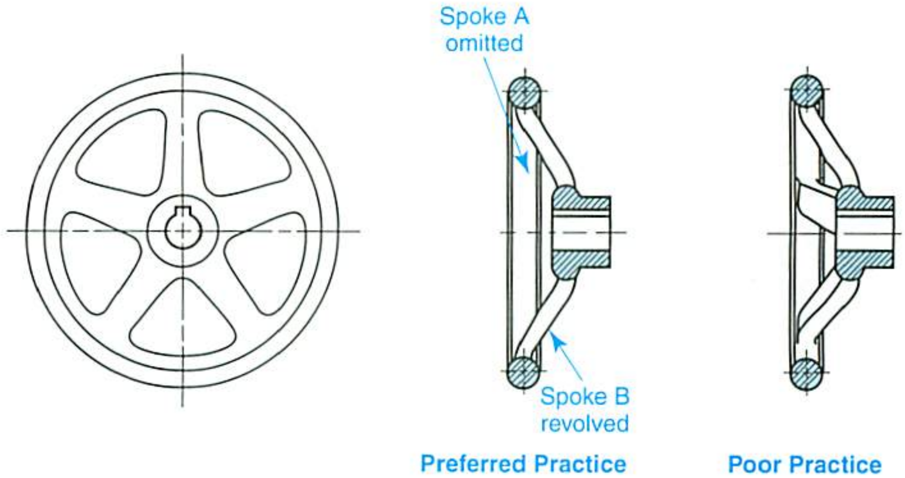


Figure 10-7. If the view will still be clear, object lines behind the cutting plane can be omitted in the section view. In addition, sometimes it is necessary to rotate parts of the object in the section view so that the clarity of the drawing is improved. (American National Standards Institute)

Figure 10-9. Half section views are useful for showing details of symmetrical objects. Two cutting planes are passed at right angles to each other along the centerlines or symmetrical axes, **Figure 10-9A**. One-quarter of the object is "removed" and a half section view is exposed. The cutting-plane lines and section titles are omitted. The view shows half of the interior details and half of the exterior details, **Figure 10-9B**.

Revolved Sections

A *revolved section* is obtained by passing a cutting plane through the centerline or axis of the part to be sectioned. The resulting section is "revolved" 90° in place to obtain the view, **Figure 10-10**. The cutting-plane line is omitted for symmetrical sections. Object lines may be removed on each side of the section and break lines used for clarity. A revolved section is used to show the true shape of the cross section of an object. It is typically used to show the cross section of an elongated object, such as a bar. Revolved sections are also used to show a feature of a part, such as a rib, arm, or linkage.

Removed Sections

A *removed section* is one that has been moved out of its normal projected position in the standard arrangement of views, **Figure 10-11**. A removed section is similar to a revolved section, except that the cross section is removed from the actual view of the part. The removed section should be labeled

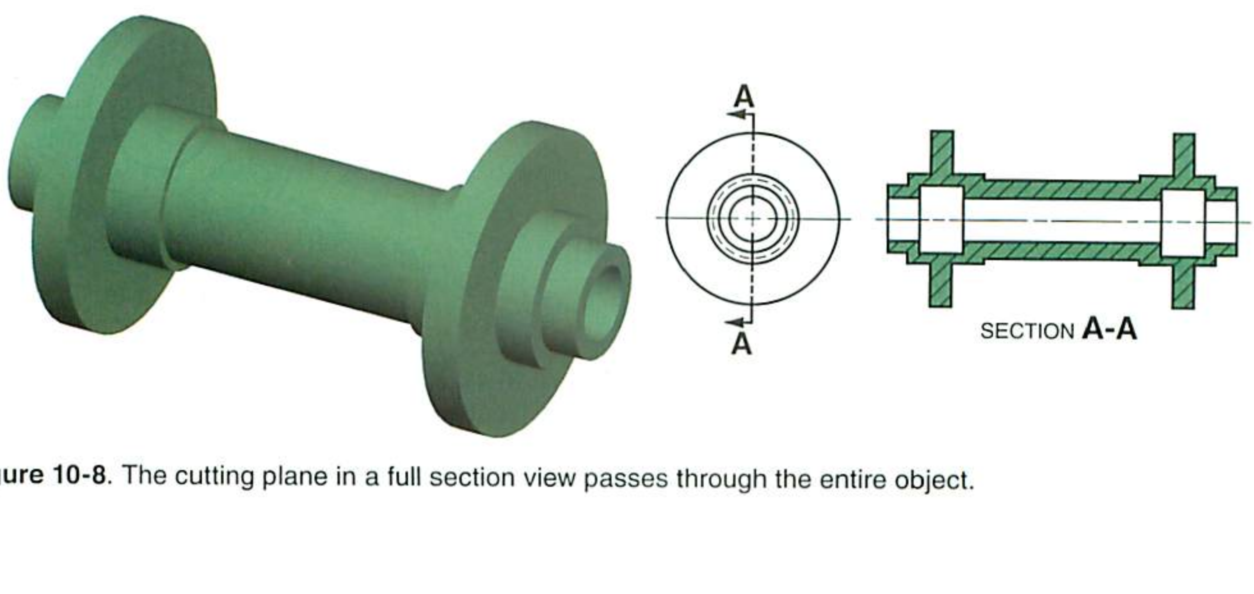


Figure 10-8. The cutting plane in a full section view passes through the entire object.

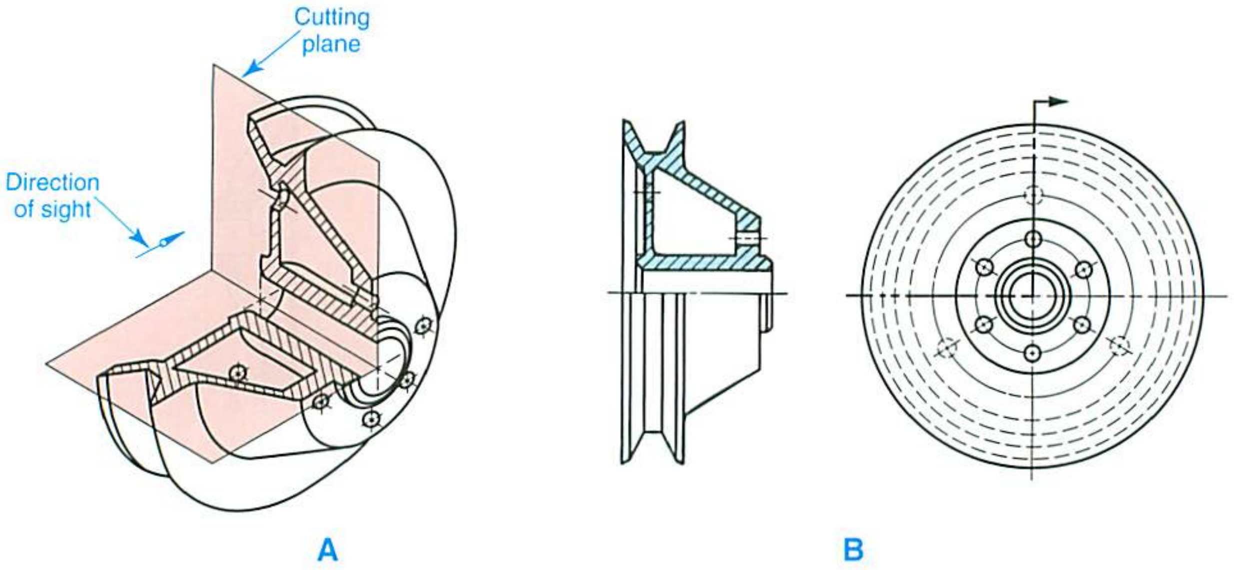


Figure 10-9. A half section view shows both interior and exterior features of an object in the same view.

with a section title and placed in a convenient location on the same sheet. If the removed section must be located on another sheet in a set of drawings, appropriate identification and zoning references should be made. The view can be drawn at a different scale if necessary to show details. If this is the case, the scale must be indicated on the view.

Offset Sections

The cutting plane for an *offset section* is not a single plane. It is stepped, or offset, to pass through features that lie in more than one plane, Figure 10-12. The path of the cutting plane is shown on the view to be sectioned. The features are drawn in the section view as if they were in one plane. In other words, the offsets in the cutting plane are not shown in the section view. An offset section view is useful when details of features that lie in more than one plane need to be shown.

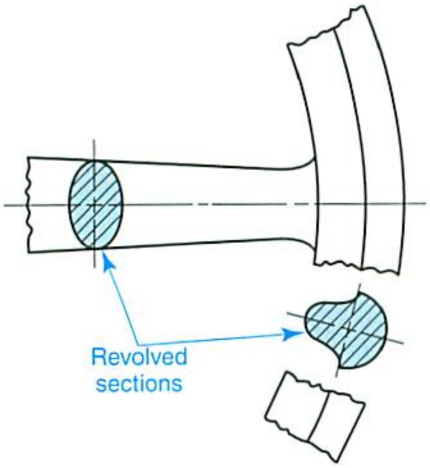


Figure 10-10. A revolved section view shows the cross section of a feature. It is rotated 90° in place to show the profile. A revolved section can be shown in a break or "inside" the object lines.

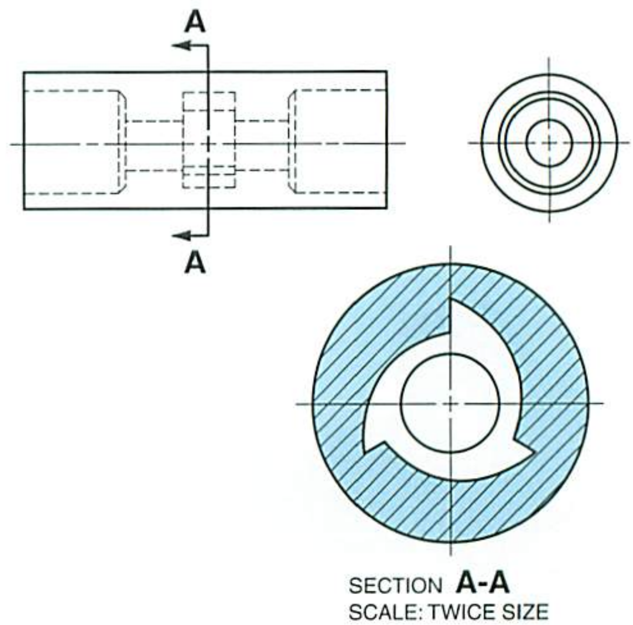


Figure 10-11. A removed section is not drawn in the normal location. It is identified with a section label and placed in an appropriate location. A different scale can be used for the view if needed to show details.

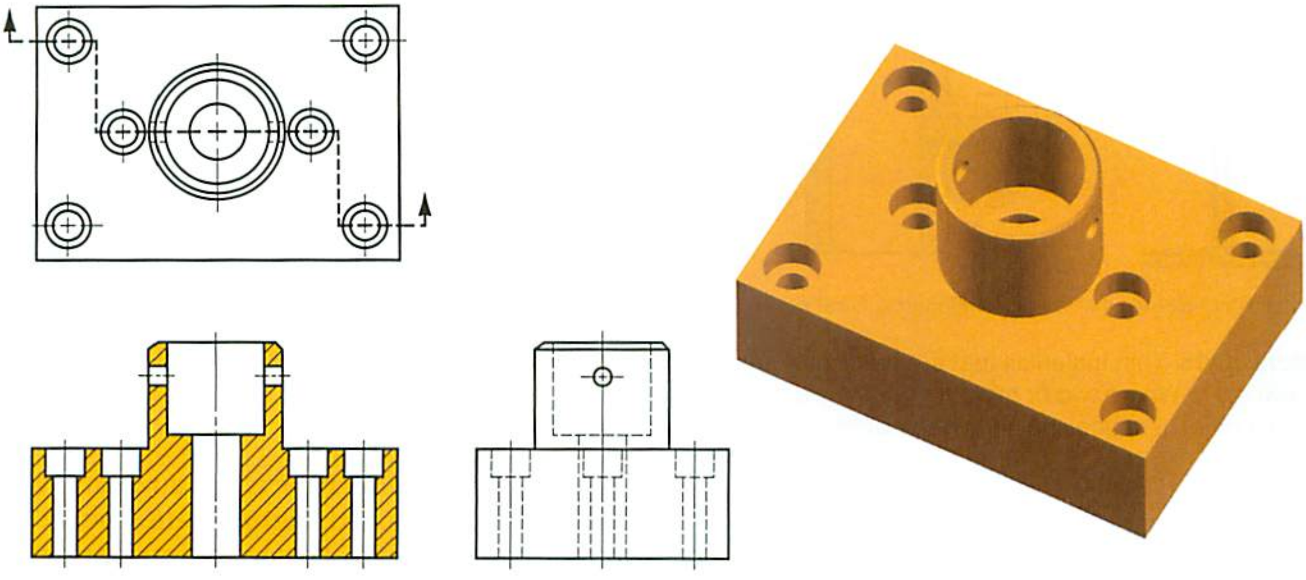


Figure 10-12. The cutting plane in an offset section view is bent, or "offset," to pass through several different features that do not lie in the same plane.

Broken-Out Sections

A ***broken-out section*** shows interior details where less than a half section (a partial section) is required to convey the necessary information, **Figure 10-13**. The partial section appears in place on the regular view. Break lines are used to limit the sectioned area.

Aligned Sections

Certain objects may be misleading when a true projection is made. In an ***aligned section***, features such as spokes, holes, and ribs are drawn as if rotated into, or out of, the cutting plane, **Figure 10-14**. Aligned section views are used when actual or true projection would be confusing. Note in **Figure 10-14** that the offset

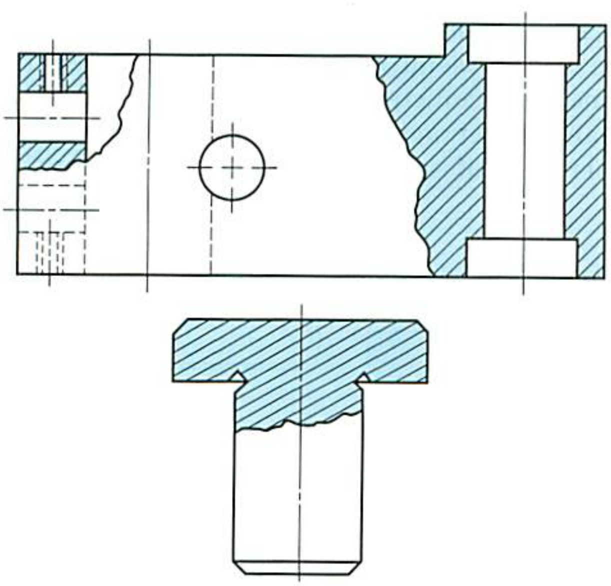


Figure 10-13. A broken-out section view is shown on the regular view. The view is limited by break lines.

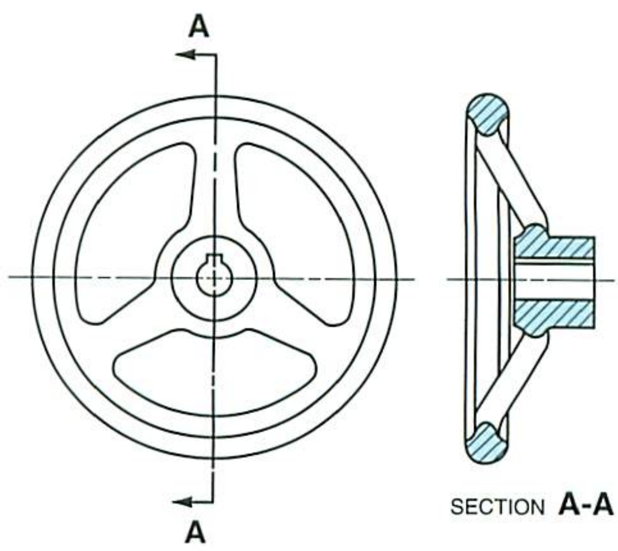


Figure 10-14. An aligned section view has features that are not shown in their true position. Features such as spokes are shown rotated to provide clarity.

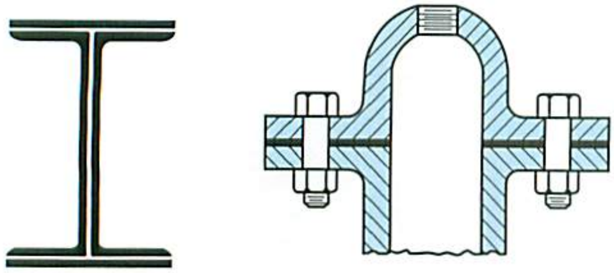


Figure 10-15. Thin materials that are sectioned are shown solid. Where two or more thin materials are next to each other, a space should be left between them.

features have been rotated to align with the centerline and projected to the section view for clarity. If these features were projected directly, their lengths and locations would be distorted.

Thin Sections

Structural shapes, sheet metal parts, and packing gaskets are often too thin for section lining. A ***thin section*** can be shown solid, **Figure 10-15**. Where two or more thicknesses are shown, a space should be left between the thicknesses. The space should be large enough to be visible on drawing reproductions.

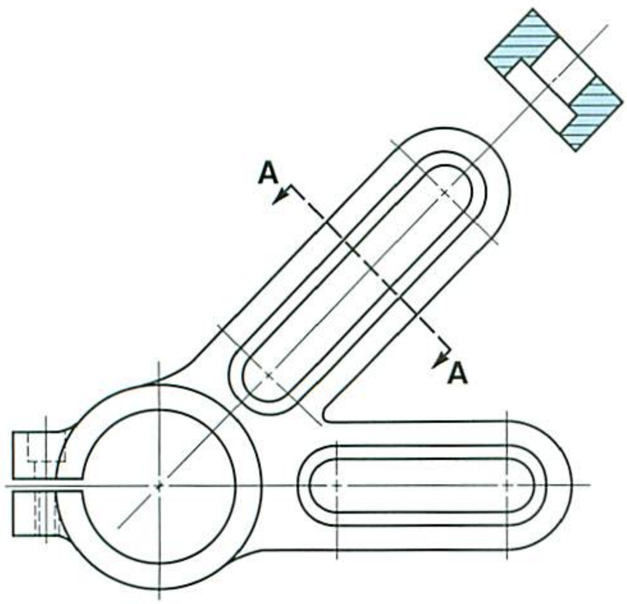


Figure 10-16. An auxiliary section view is an auxiliary view that is sectioned. The view appears in the normal position for an auxiliary view.

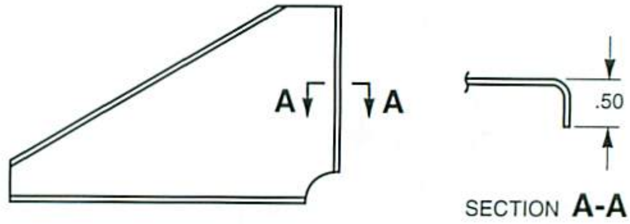


Figure 10-17. Partial section views are used when information can be accurately communicated without drawing a complete view. (General Dynamics, Engineering Dept.)

Auxiliary Sections

An ***auxiliary section*** is an auxiliary view that has been sectioned, **Figure 10-16**. The section should be shown in its normal auxiliary position. If necessary, the auxiliary section should be identified with letters and a cutting-plane line. For information on the construction of auxiliary views, see Chapter 12. The auxiliary section is used to add clarity to critical areas of a drawing.

Partial Sections

A ***partial section*** is used to show details of objects without drawing complete conventional views. Using partial views saves drafting time, **Figure 10-17**.

Phantom Sections

A ***phantom section*** or *hidden section* is used to show interior construction while retaining the exterior detail of a part. This type of section is not used much in industry. Two examples of phantom section views are shown in **Figure 10-18**. This type of section is also used to show the

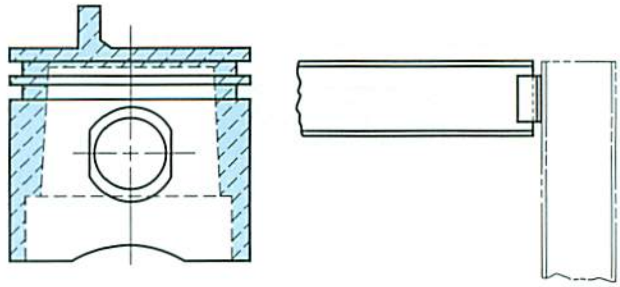


Figure 10-18. Phantom section views are used to show both the visible and internal features on the same view. This type of section view is not frequently used in industry.

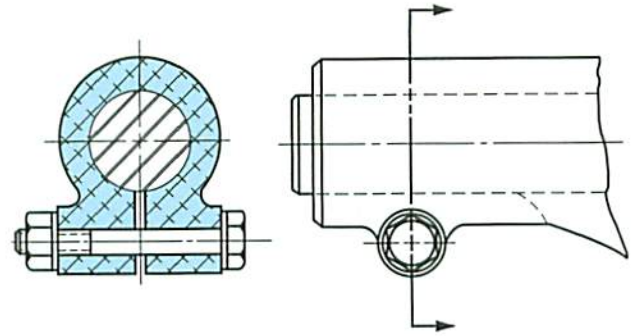


Figure 10-19. When standard parts are at a right angle to the cutting plane, they are sectioned. When they are parallel to the cutting plane, they are not sectioned. The shaft is sectioned in this example because it is perpendicular to the cutting plane. The bolt is parallel to the cutting plane and is not sectioned.

positional relationship of an adjacent part. The section lines in a phantom section view are typically a series of short dashes.

Unlined Sections

Standard parts such as bolts, nuts, rods, shafts, bearings, rivets, keys, pins, and similar objects should not be sectioned if the axis of the object lies in the cutting plane. This is done for clarity on the drawing. (When the axis of the part is perpendicular to the cutting plane, the part should be sectioned.) See **Figure 10-19** and **Figure 10-20**.

Conventional Sectioning Practices

Certain practices have become standard procedure for section views. The following practices should be followed, in combination with the practices discussed in this chapter for specific types of sections.

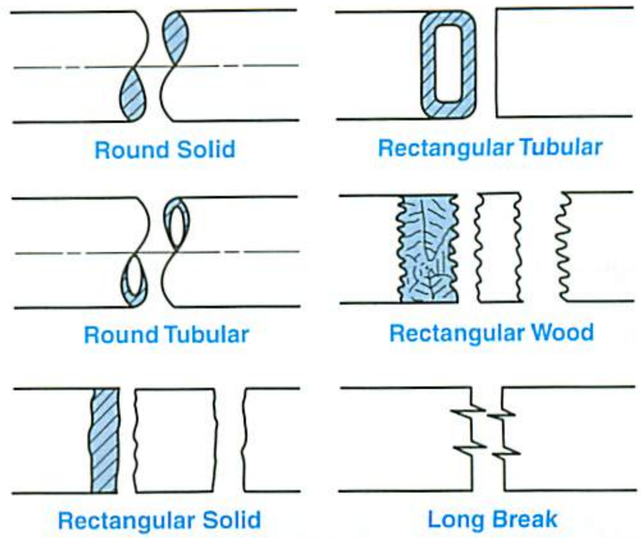


Figure 10-21. When sectioning breaks in bar and tubing stock, there are accepted drawing conventions according to the stock.

Drawing Rectangular Bar, Cylindrical Bar, and Tubing Breaks

For long parts with a uniform cross section, such as bar or tubing stock, it is usually not necessary to draw the full length. Often, the piece is drawn to a larger scale and a break made to show the cross section. The break is sectioned as shown in **Figure 10-21**. The true length of the piece is indicated by a dimension, **Figure 10-22**.

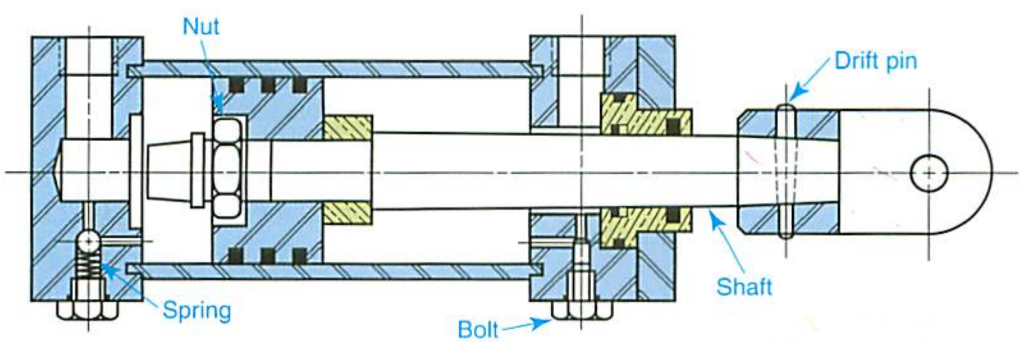


Figure 10-20. Standard parts such as shafts, bolts, nuts, and pins should only be sectioned if they are perpendicular to the cutting plane. The parts shown are parallel to the cutting plane.

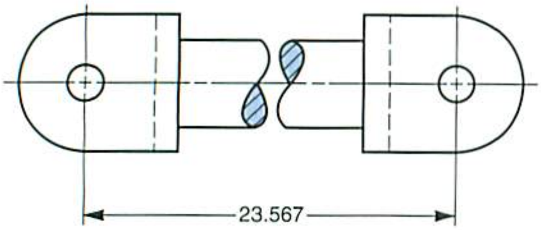


Figure 10-22. Conventional breaks permit long, uniformly shaped objects to be drawn to a scale large enough to present the details clearly.

CAD

Drawing "S" Breaks

Using Instruments (Manual Procedure)

The conventional breaks for cylindrical bars and tubing are known as "S" breaks. In manual drafting, these breaks can be drawn with a template, or constructed as follows.

1. Draw the rectangular view for the bar or tube, **Figure 10-23A**.
2. Lay off fractional radius widths on the end to be sectioned.
3. Scribe 30° construction lines to locate the radii centers (Points A, B, C, and D), **Figure 10-23B**. (For a wider sectioned face, use a 45° projection on four angles adjacent to the centerline.)
4. Set the compass on a radius center and adjust it so the arc passes through the center axis and stops short of the outside edge, **Figure 10-23C**. Only three radii centers are used, depending on placement of the sectioned face.
5. Complete the ends of the S curve by freehand, **Figure 10-23D**.
6. Draw the inside curve by freehand when tubing is being represented.
7. Add section lining to the visible sectioned part, **Figure 10-23E** and **Figure 10-23F**.

Note

When an S break is shown with stock continuing on both sides of the break, the sectioned faces are diagonally opposite. Refer to **Figure 10-21**. The S break can also be drawn freehand by estimating the width of the S and crossing at the centerline.

Using the Arc, Mirror, and Hatch Commands (CAD Procedure)

As previously discussed, sectioned areas in CAD drafting are created using the **Hatch** command. Conventional breaks for cylindrical bars and tubing can be drawn by first creating the S curves with the **Arc** and **Mirror** commands and then using the **Hatch** command to add the crosshatch pattern.

1. Enter the **Line** command and draw the rectangular view for the bar or tube. Draw the centerline using a centerline linetype. Refer to **Figure 10-23A**.
2. Enter the **Xline** command and use object snaps to draw a construction line between the endpoints of the rectangular view. Enter the **Offset** command and offset this line to the right side using a fractional offset distance based on the radius of the part. Refer to **Figure 10-23A**. Then, enter the **Trim** command and trim the offset line to the centerline.
3. Enter the **Arc** command. Enter the **3 Points** option and draw an arc forming the upper S curve. Using object snaps, select the intersection of the centerline and the vertical axis line as the first point. Select the midpoint of the offset line as the second point, and the intersection of the vertical axis line and the upper horizontal line of the part as the third point. Refer to **Figure 10-23C**.
4. To create the rounded arc at the top of the curve, draw an elliptical arc. Enter the **Ellipse** command and enter the **Arc** option. Using object snaps, specify the axis endpoints as the intersections of the

previously drawn arc and the vertical axis line. Specify the distance to the other axis as the midpoint of the offset line. Then, specify the start angle as 270° and the end angle as 0°. This draws an elliptical arc from the midpoint of the offset line to the upper intersection of the arc and the vertical axis line. To complete the curve, enter the **Trim** command and trim the upper portion of the previously drawn arc to its intersection with the elliptical arc. The two arc segments should resemble the upper curve in **Figure 10-23D**.

5. Enter the **Mirror** command and mirror the upper portion of the S curve to create the right curve below the centerline. Using object snaps, pick two points along the centerline to specify the mirror axis.
6. Enter the **Mirror** command and mirror the new curve to create the left curve below the centerline. Using object snaps, pick two points along the vertical axis to specify the mirror axis.
7. Erase the vertical axis line and the offset line or place the lines on a construction layer and freeze the layer. Then, enter the **Hatch** command. Specify an appropriate material pattern for the part. Select the interior area formed by the curves on the lower half of the part to create the crosshatch pattern. Specify an appropriate scale for the pattern. Preview the results if needed before ending the command. Refer to **Figure 10-23E**.
8. If you are drawing a conventional break for tubing, create the inside curve by using the **Arc** and **Ellipse** commands or the **Spline** command. Plot points for the curve as needed and use them to construct the curve. Once the inside and outside curves are complete, enter the **Hatch** command and select the section area to create the crosshatch pattern.

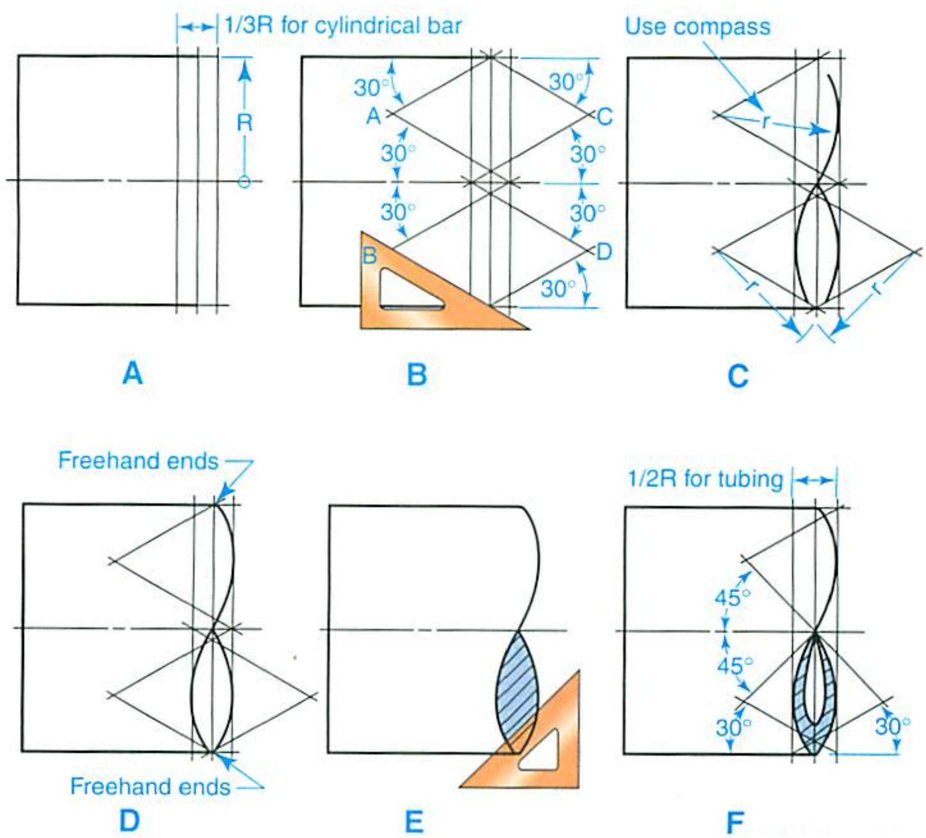


Figure 10-23. Conventions for drawing "S" breaks in round bar stock and tubing.

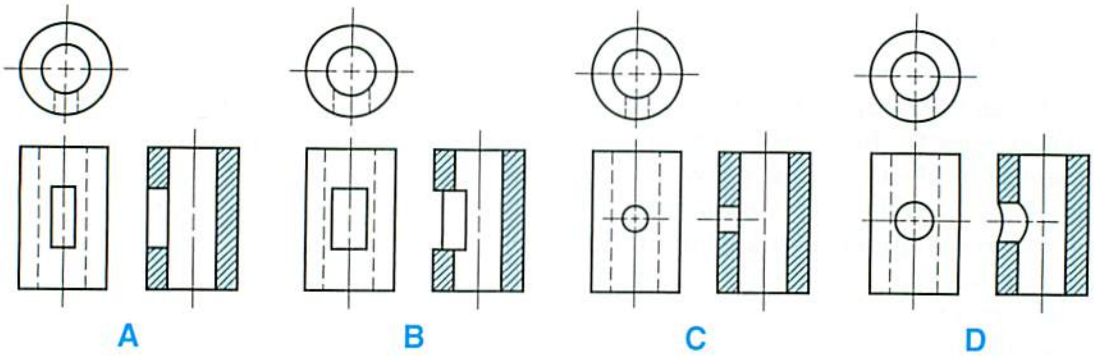


Figure 10-24. Projecting intersections in section views. A and C—When the offset of the true projection is small, the intersection can be drawn without the offset. B and D—When the offset of the true projection is large, the offset can be projected or approximated with circular arcs. (American National Standards Institute)

Intersections in Section Views

When a section is drawn through an intersection, and the offset or curve of the true projection is small, the intersection can be drawn conventionally without an offset or curve, **Figure 10-24A** and **Figure 10-24C**. Intersections of a larger configuration can be projected or approximated by circular arcs, **Figure 10-24B** and **Figure 10-24D**.

Ribs, Webs, Lugs, and Gear Teeth in Section Views

Ribs and webs are used to strengthen machine parts. When the cutting plane extends along the length of a rib, web, lug, gear tooth, or similar flat element, the element is not sectioned, **Figure 10-25A**. This will avoid creating a false impression of thickness or mass.

An alternate method of section lining is shown in **Figure 10-25B**. The spacing is twice that of the regular section. This spacing is used where the actual presence of the flat element is not sufficiently clear without section lining.

When the cutting plane cuts an element crossways, the element is sectioned in the usual manner, **Figure 10-25C**. Gear teeth are not sectioned when the cutting plane extends through the length of the tooth, **Figure 10-25D**. Gear teeth are sectioned when the cutting plane cuts across the teeth. For example, the profile view of a worm gear should be sectioned.

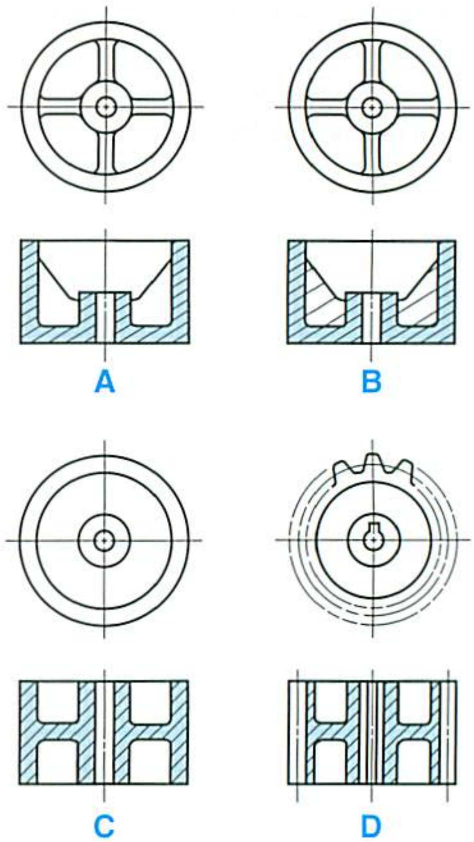


Figure 10-25. Sectioning practices for regular features in machine parts. A—Ribs and webs should not be sectioned when they fall on the cutting plane. B—An alternate method of sectioning ribs and webs is sometimes used. C—When the cutting plane cuts the element crossways (so that the plane is perpendicular to the element), the element should be sectioned normally. D—When the cutting plane passes through the end of a gear tooth, the tooth should not be sectioned.

Outline Sectioning

If the drawing remains clear, section lines on a sectioned drawing should be shown only along the borders of the part. This is known as ***outline sectioning,*** **Figure 10-26**. This convention is particularly useful on large parts where considerable time would be required to draw section lines.

Section Titles

As previously discussed, letters used to identify the cutting plane are included in the title of the section (for example, SECTION A-A, SECTION B-B, etc.). When the single alphabet is exhausted, multiples of letters may be used. For example, titles such as SECTION AA-AA and SECTION BB-BB can be used. The section title always appears directly under the section view.

When a section view is located on a sheet other than the one containing the cutting plane indication, the sheet number and zone of the cutting plane indication should be referenced for easy location. A similar cross reference should be located on the view containing the cutting-plane line.

Scale of the Section View

Preferably, sections should be drawn to the same scale as the outside view they are taken from. When drawn to a different scale, the scale should be specified directly below the section title, **Figure 10-27**.

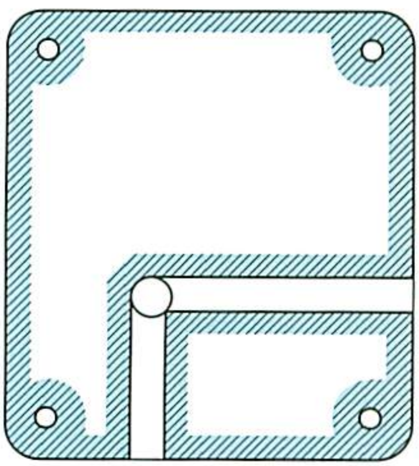


Figure 10-26. Outline sectioning should be used for large parts where all of the necessary information will still be communicated.

Material Symbols in Section Views

Standard symbols used for sectioning materials are shown in **Figure 10-28**. General purpose section lining (used for cast iron) should be used for all materials, except parts made of wood, whenever possible. However, on detail and assembly drawings of multi-material parts, the appropriate material symbols should be used. This calls attention to the different materials that the parts are made of.

On many drawings, however, symbolic sectioning serves no practical purpose. Therefore, general purpose section lining should be used whenever possible. The general purpose symbol requires less time to draw. Also, the materials, processes, and protective treatment necessary to meet the design requirements of a part are normally indicated on the drawing or parts list.

Hatching Section Views on CAD Drawings

One of the most time-consuming tasks in manual drafting is adding section lines to a section view. In CAD drafting, this process is called ***hatching***. The **Hatch** command automates the creation of section lines. After entering this command, a material pattern is selected and the areas to hatch are specified. In most cases, you can pick a closed area and automatically fill the area with the desired pattern. The following sections discuss the common methods used in hatching section views.

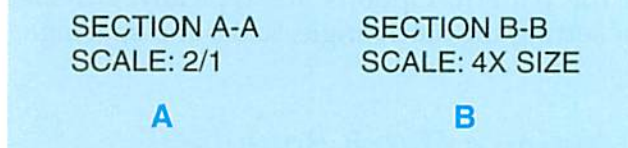


Figure 10-27. When the scale of a section view is different from the scale of the rest of the drawing, the scale should be indicated directly below the section title.

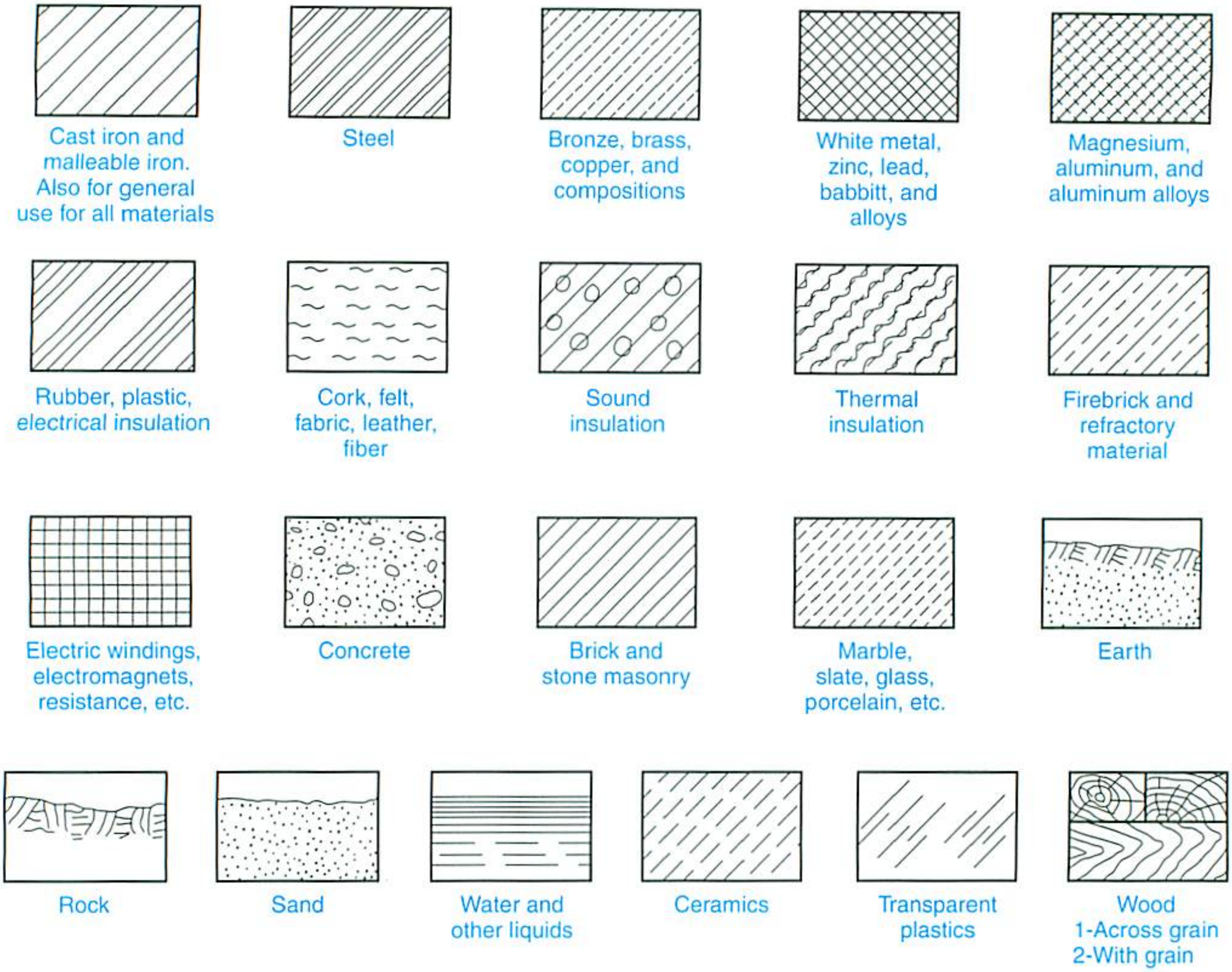


Figure 10-28. Different symbols are used to indicate materials in section views. (John Deere & Co.)

Selecting a Hatch Pattern

Most CAD programs provide a number of standard hatch patterns representing various materials, **Figure 10-29**. The ANSI31 pattern is used for cast iron and general purpose section lining. You can also typically create custom hatch patterns. Depending on the scale of the drawing, you may need to adjust the appearance of the pattern. Options are typically provided for setting the hatch angle, scale, and spacing.

Defining a Hatch Boundary

A ***hatch boundary*** consists of the lines, circles, and other objects that border the area to be hatched. Picking a point inside a boundary area allows you to fill the area with the hatch pattern, **Figure 10-30**. In many cases, you can also select a closed object, such as a circle, rectangle, or polyline boundary, to hatch the interior area. In most cases, the boundary surrounding the area must be closed in order to apply the hatch pattern.

When using the **Hatch** command, you are typically given the option to preview the results before the area is hatched. If the pattern needs to be modified, you can make changes before ending the command. You can also typically edit hatch patterns after they have been drawn by using the appropriate editing command.

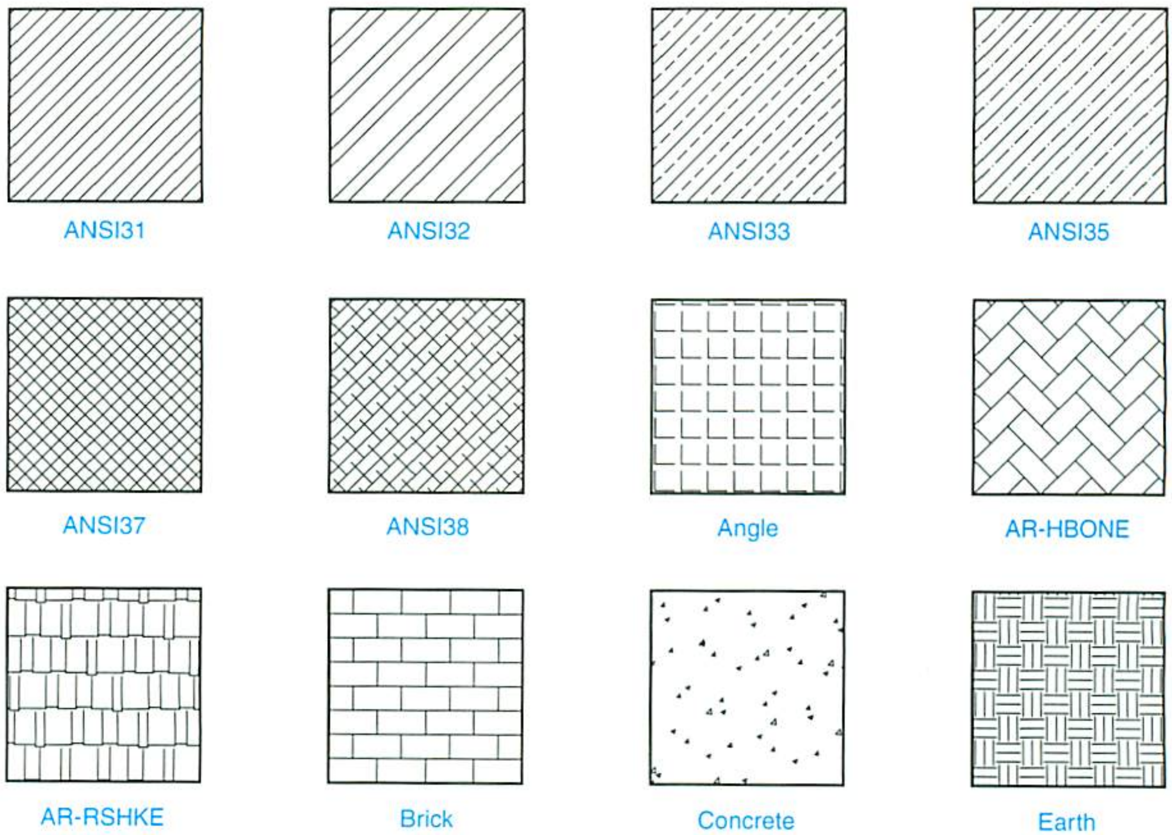


Figure 10-29. A variety of hatch patterns are available in most CAD programs. (Autodesk, Inc.)

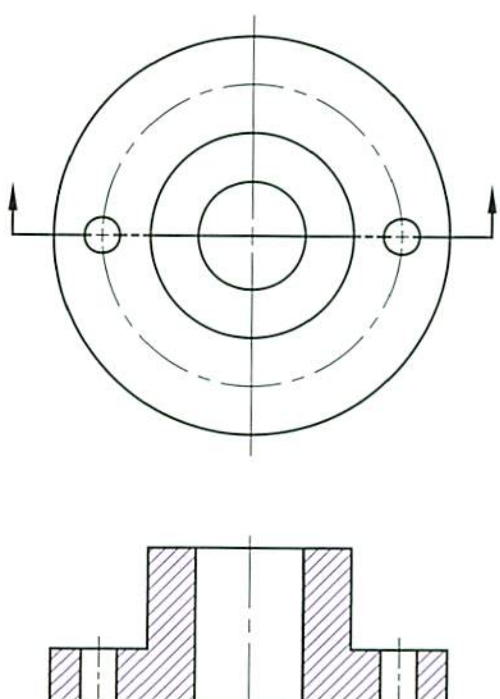


Figure 10-30. The **Hatch** command is used to hatch interior areas on a CAD drawing. Picking a point inside a closed boundary fills the area with the specified pattern. The ANSI31 pattern is used in this example.

Chapter Summary

A section view is a view that is "seen" beyond an imaginary cutting plane. The plane passes through the object at a right angle to the direction of sight. Section views are used to show interior construction or details of hidden features that cannot be shown clearly using hidden lines. Section views are also used to show the shape of exterior features.

The cutting plane of a section is indicated by a cutting-plane line. Cutting-plane lines are usually a series of heavy dashes, each about 1/4" long. But, other line symbols are also used. Whenever possible, a section view should be projected from, and perpendicular to, the cutting plane.

The exposed (cut) surface of the section view is indicated by section lines. Section lining is often called crosshatching. Section lining consists of thin, parallel lines or a specific symbol to represent a particular material. Section lines for general purpose sectioning should be drawn at an angle of 45° to the main outline of the view and are usually spaced 1/8" to 3/16" apart.

Hidden lines behind the cutting plane should be omitted in section views unless needed for clarity. Visible lines behind the cutting plane are usually shown.

There are numerous types of sections used in mechanical drafting. Recognized types include full sections, half sections, revolved sections, removed sections, offset sections, broken-out sections, aligned sections, thin sections, auxiliary sections, partial sections, phantom sections, and unlined sections. Each type is designed for a specific application.

Certain practices have become standard procedure for representing section views. These include conventions for drawing bar and tubing breaks, intersections, and standard parts such as ribs, webs, lugs, and gear teeth. For certain large parts, outline sectioning is used.

On CAD drawings, the sectioning process is referred to as hatching. The **Hatch** command is used to create section views. CAD programs typically provide a number of predrawn hatch patterns representing different types of materials.

Review Questions

1. A section view is a view "seen" beyond an imaginary _____.
2. What purpose is served by the arrowheads at the ends of a cutting-plane line?
3. The exposed (cut) surface of a section view is indicated by _____ lines.
4. In CAD drafting, section views are drawn with crosshatching patterns using what command?
5. Section lines should be drawn at an angle of _____ degrees to the main outline of the view.
6. Section lines should be spaced approximately _____ to _____ apart.
7. In general, are object lines behind the cutting plane shown in the section view?
8. Name five types of section views that are commonly used in drafting.
9. In a(n) _____ section, the cutting plane passes entirely through an object.
10. In a(n) _____ section, cutting planes are passed at right angles to each other along the centerlines or symmetrical axes.
11. A(n) _____ section is obtained by passing a cutting plane through the centerline or axis of the part to be sectioned.
12. A(n) _____ section is one that has been moved out of its normal projected position in the standard arrangement of views.
13. The cutting plane for a(n) _____ section is "stepped" to pass through features that lie in more than one plane.
14. In a(n) _____ section, features such as spokes, holes, and ribs are drawn as if rotated into, or out of, the cutting plane.
15. A(n) _____ section is an auxiliary view that has been sectioned.
16. What is another name for a phantom section?
17. The conventional breaks for cylindrical bars and tubing are known as _____ breaks.

18. Which feature is typically not sectioned when the cutting plane extends along the length of the feature?
    A. Gear tooth
    B. Lug
    C. Rib
    D. None of the above features are typically sectioned.
19. The section title always appears directly _____ the section view.
20. In CAD drafting, adding section lines is called _____.
21. In CAD drafting, which pattern is used for cast iron and general purpose section lining?
22. In CAD drafting, a _____ consists of the lines, circles, and other objects that border the area to be filled with a section pattern.

Drawing Problems

The following problems are designed to give you practice in drawing various types of section views. They are also designed to assist in developing an understanding of their applications. Draw each problem as assigned by your instructor. The problems are classified as introductory, intermediate, and advanced. A drawing icon identifies the classification. These problems can be completed manually or using a CAD system.

The given problems include customary inch and metric drawings. Use the dimensions provided. Use one A-size or B-size sheet for each problem. Select the proper scale for the sheet size being used.

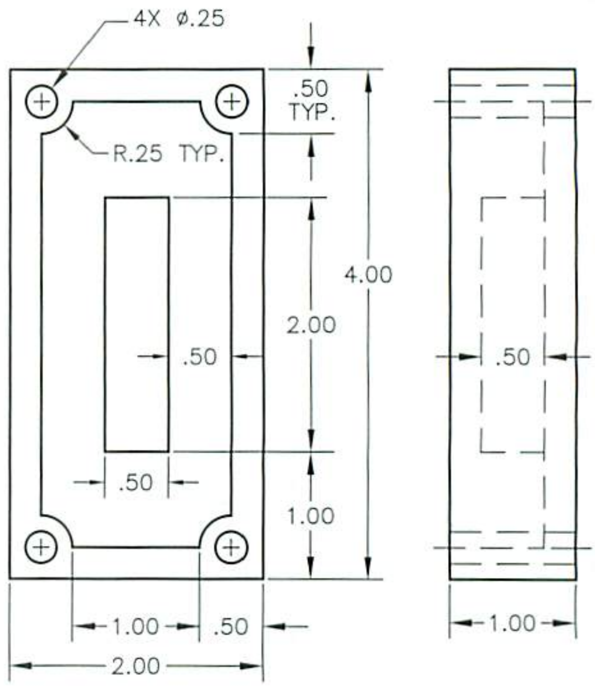
If you are drawing the problems manually, use one of the layout sheet formats given in the Reference Section. If you are using a CAD system, create layers and set up drawing aids as needed. Draw a title block or use a template. Save each problem as a drawing file and save your work frequently.

Full Sections

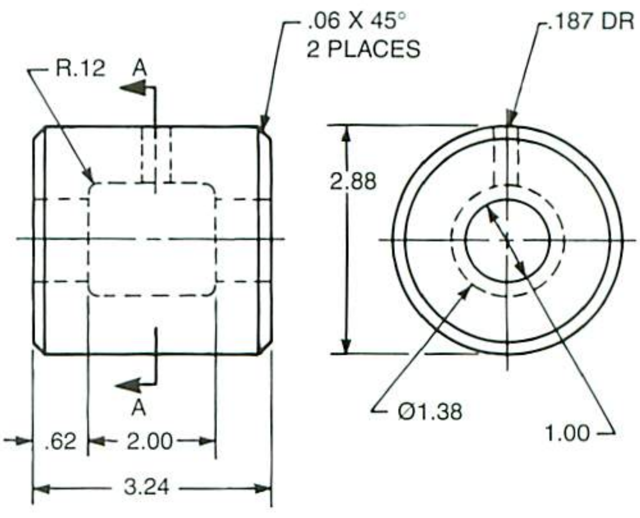
Study the drawings shown in Problems 1–7. Draw and dimension the necessary views for each problem, including a full section view. For the problems where the cutting-plane line has not been given, select the best location for the section plane to show interior details.

Introductory

1. Box End Cap

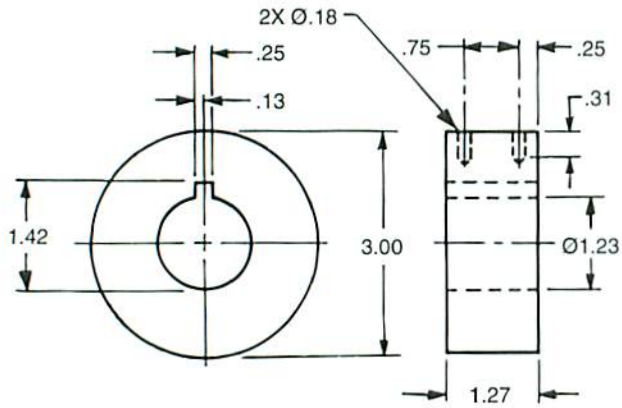


2. Sleeve



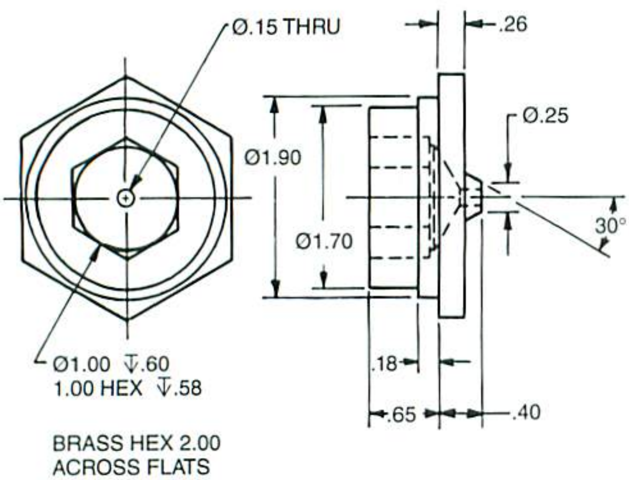
Introductory

3. Roller Blank

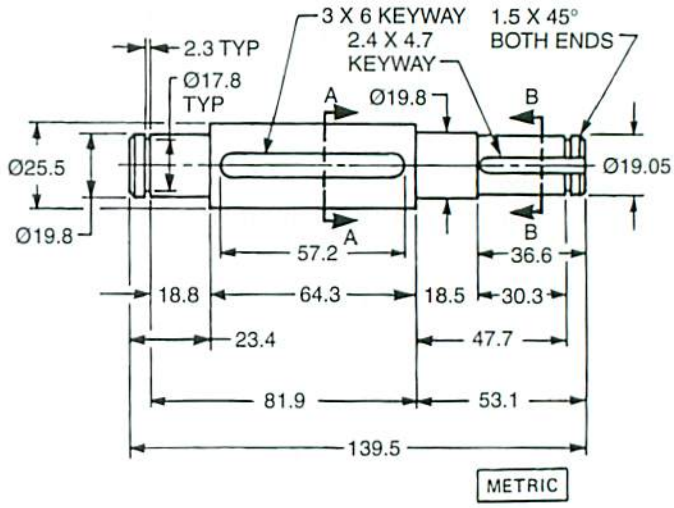


Intermediate

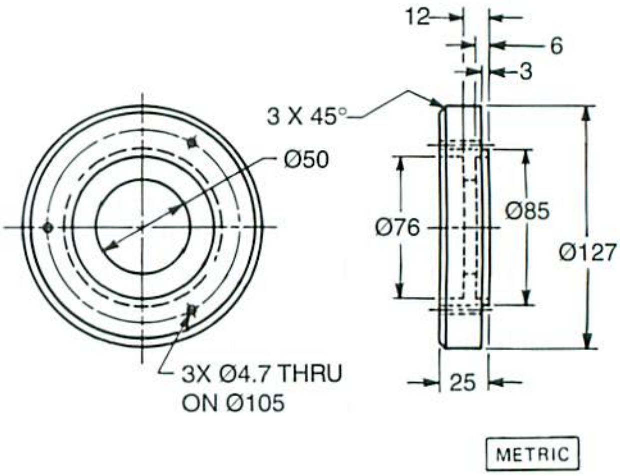
4. Orifice



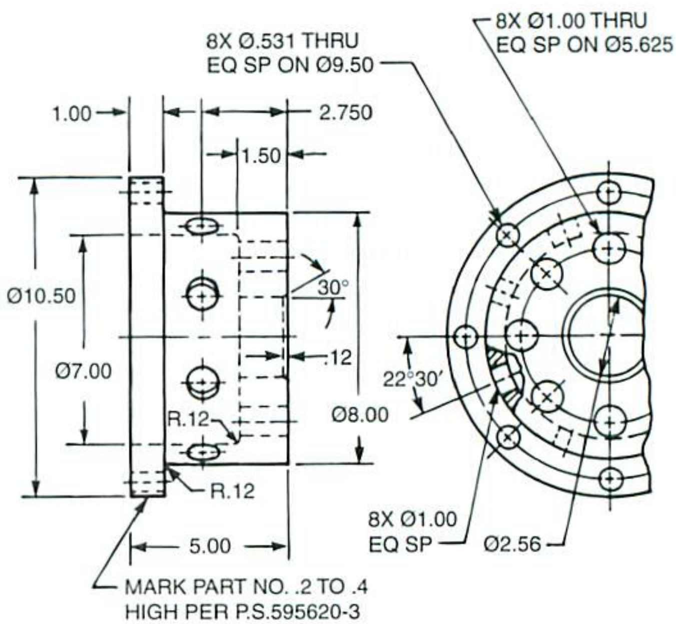
5. Worm Shaft



6. Crankshaft End Cap



7. Shaft Bracket

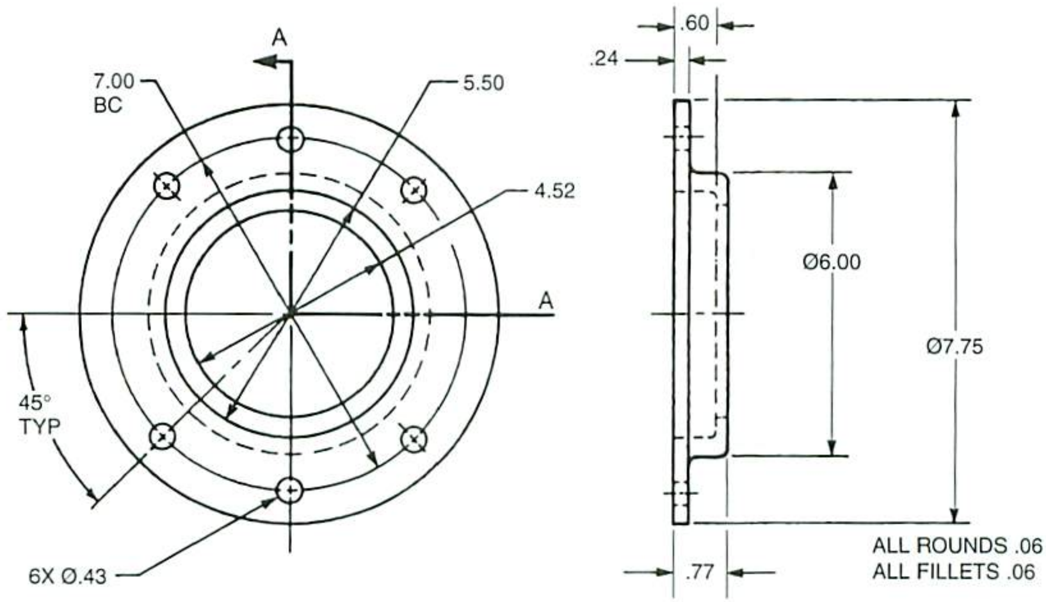


Half Sections

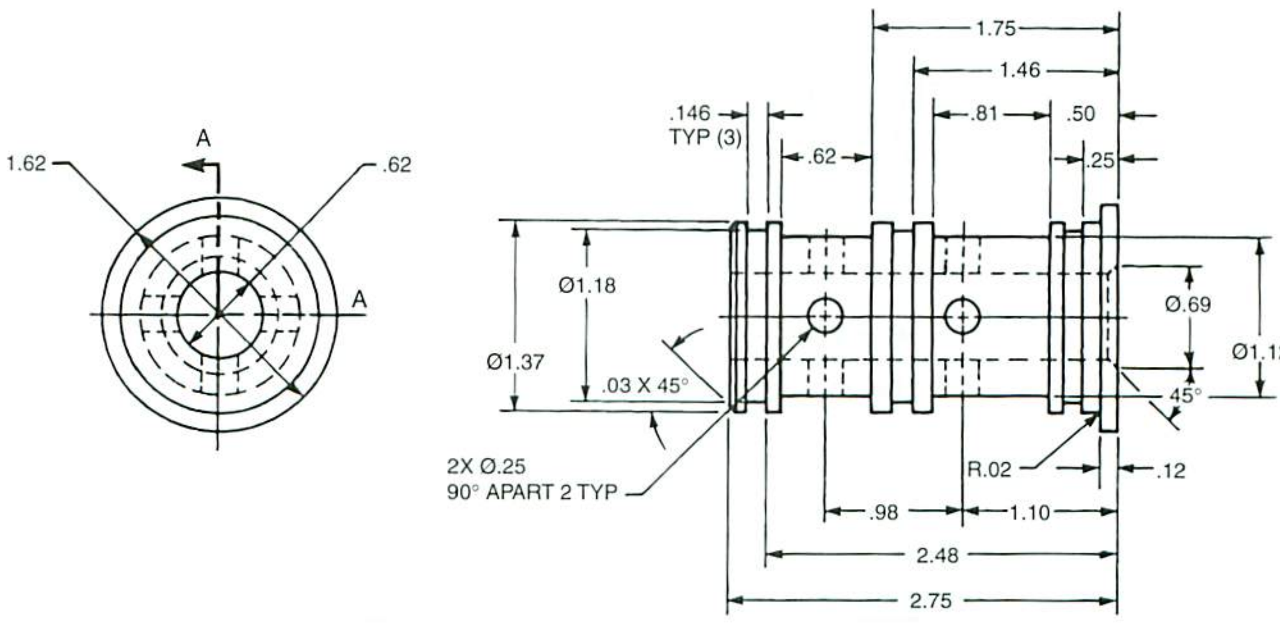
Study the drawings shown in Problems 8–11. Draw and dimension the necessary views for each problem, including a half section view.

Intermediate

8. Carrier Seal

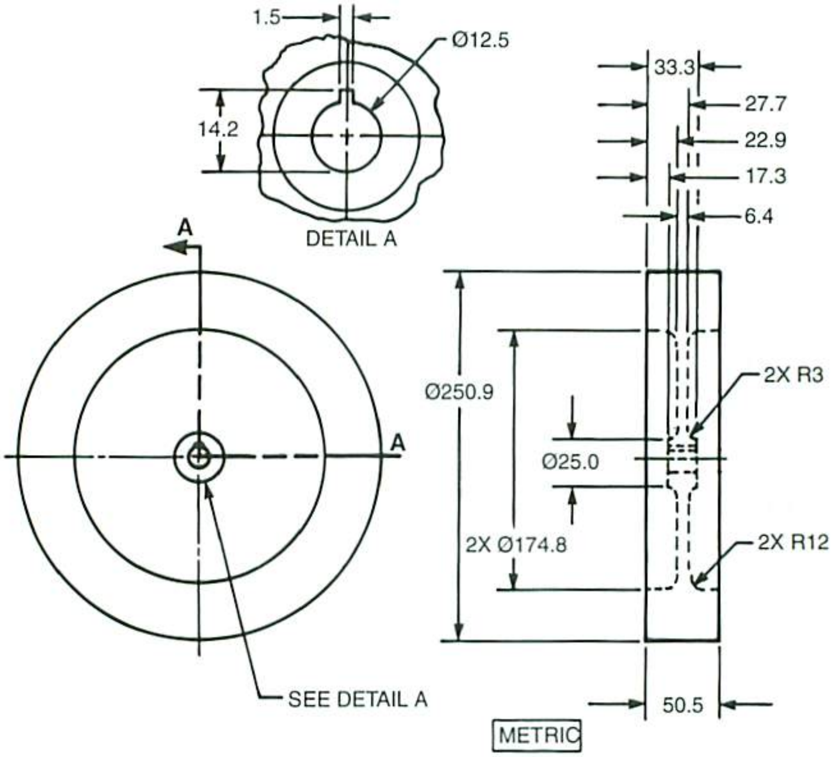


9. Sleeve Pressure Regulator

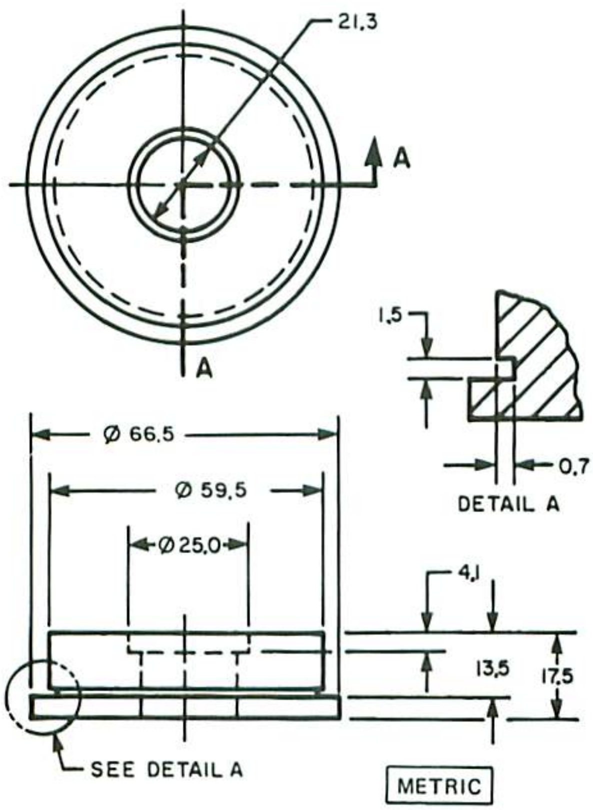


Intermediate

10. Drive Wheel



11. Piston

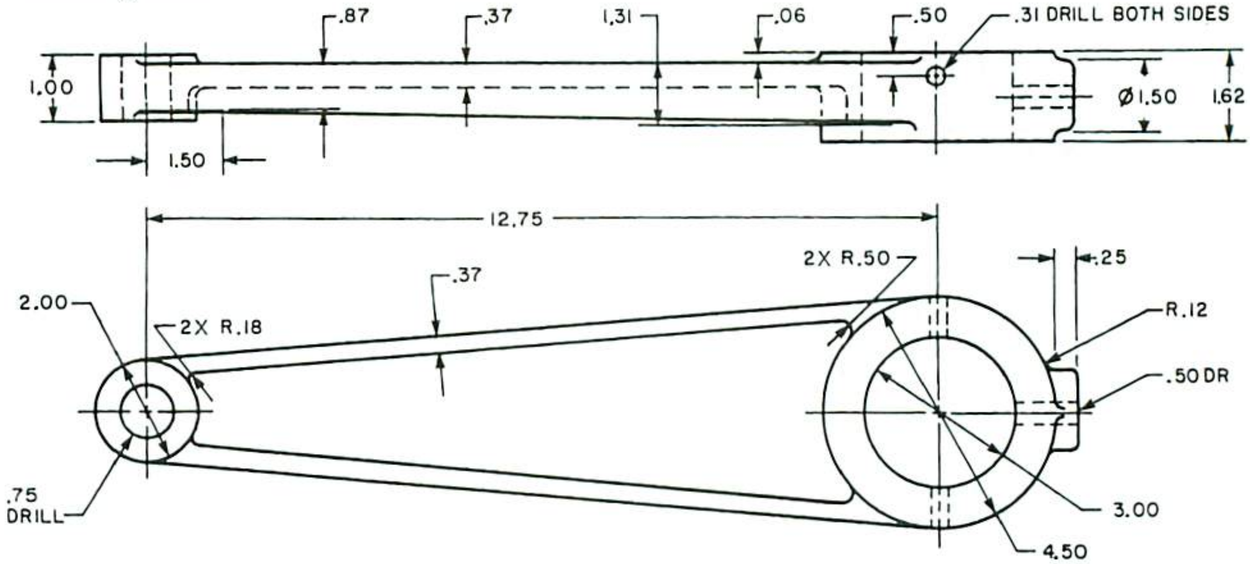


Revolved Sections

Study the drawings shown in Problems 12 and 13. Draw and dimension the necessary views for each problem. Show revolved sections of the appropriate features.

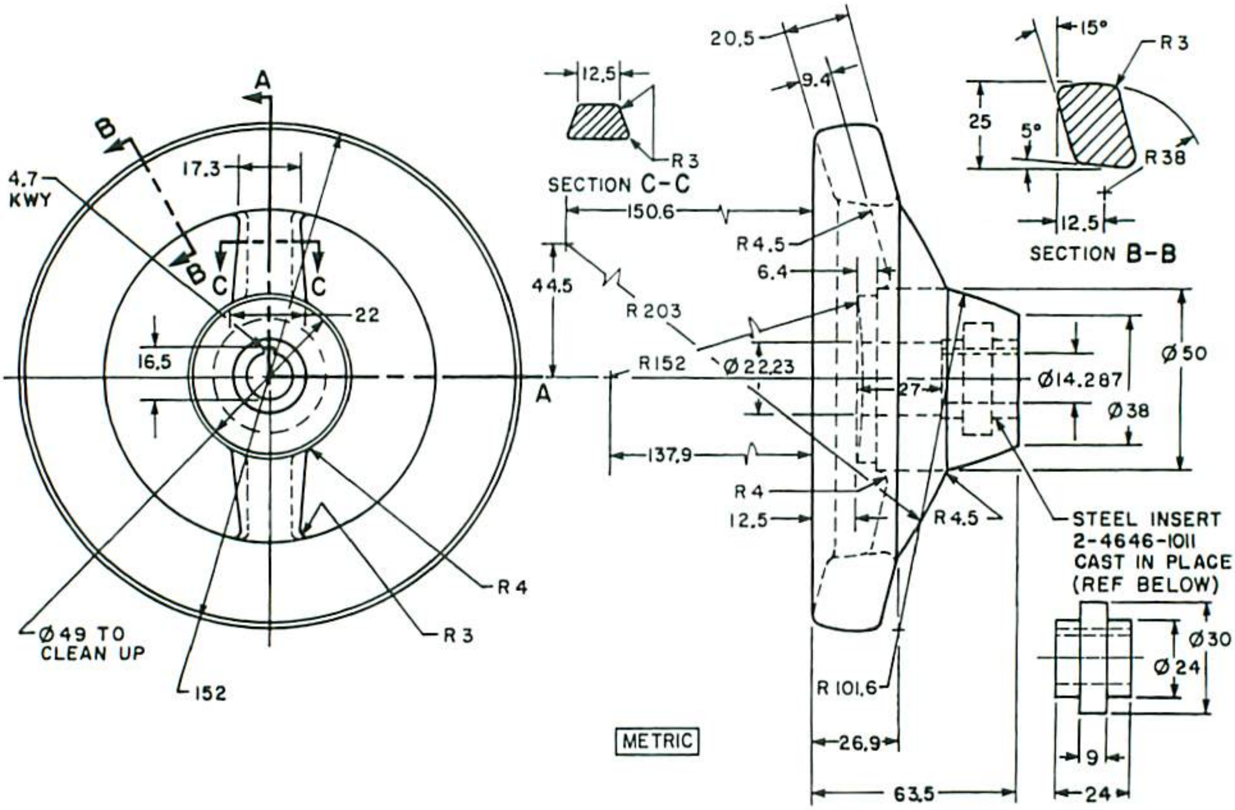
Intermediate

12. Elevating Arm



Advanced

13. Handwheel

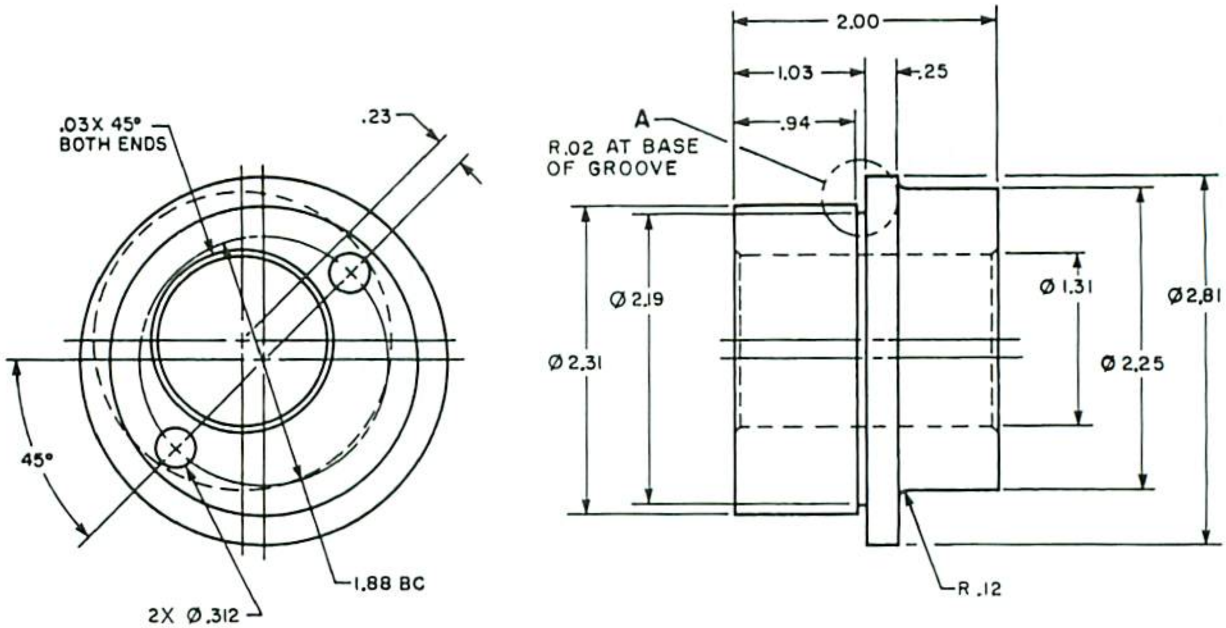


Removed Sections

Study the drawings shown in Problems 14 and 15. Draw and dimension the necessary views for each problem. Include a removed section view of the features indicated.

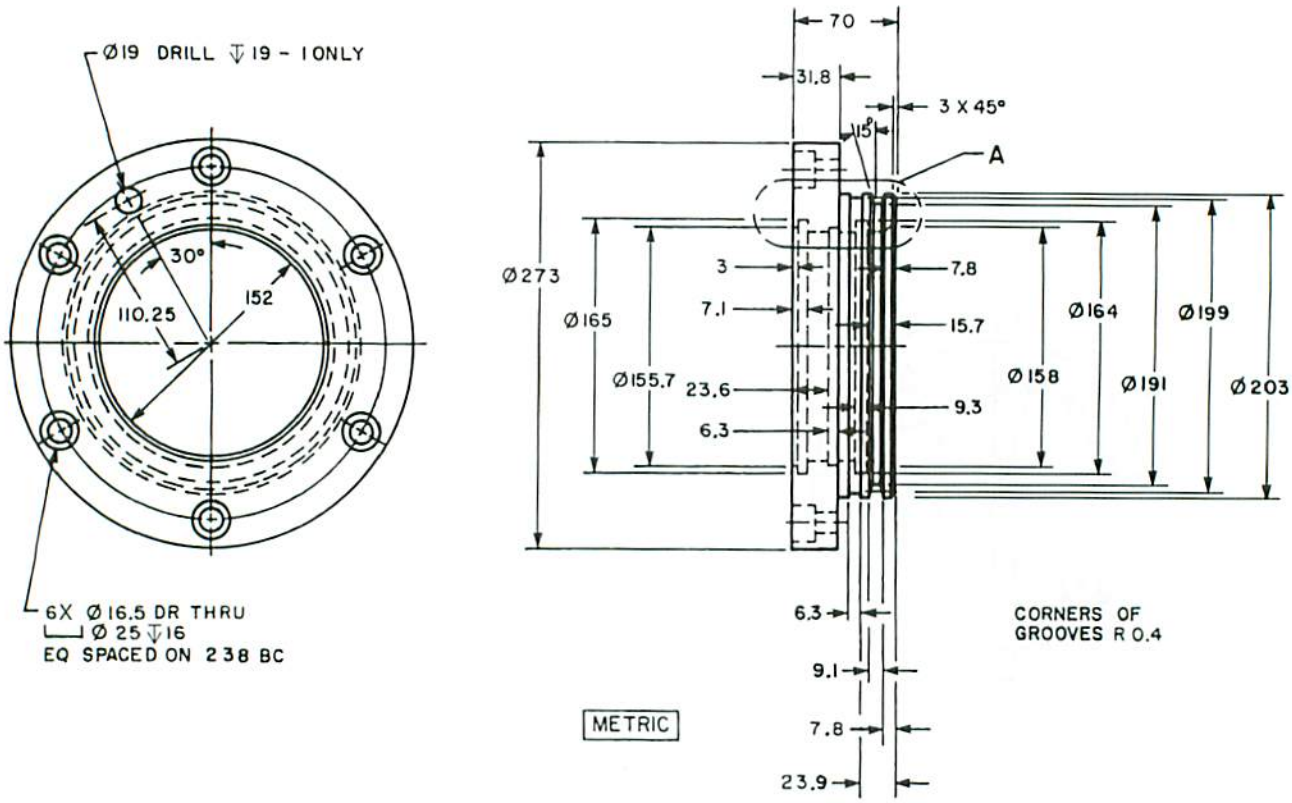
Intermediate

14. Lower Eccentric



Advanced

15. Head Machining—Lower Cylinder

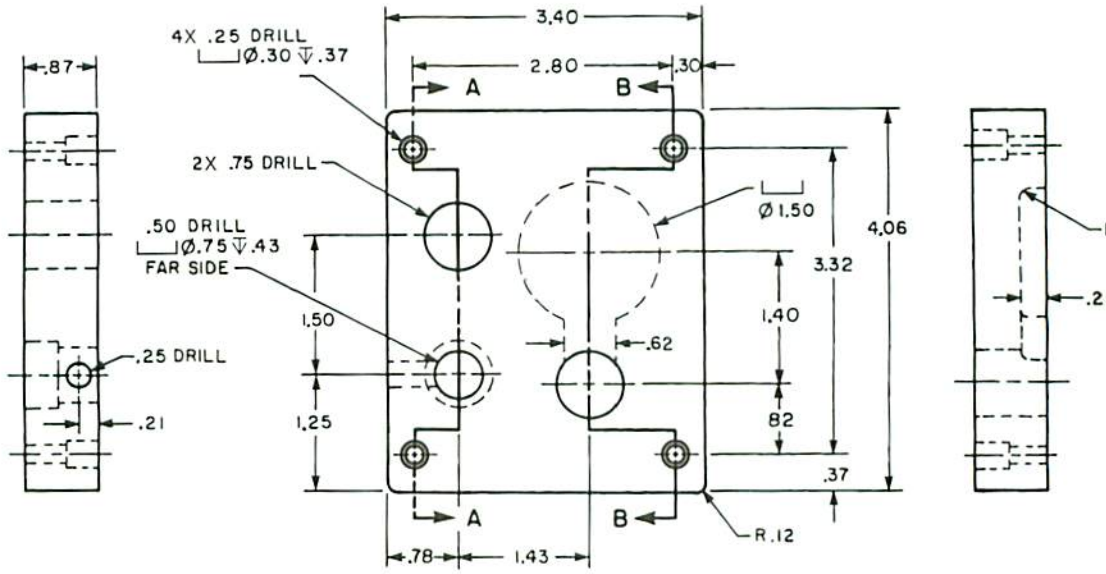


Offset Sections

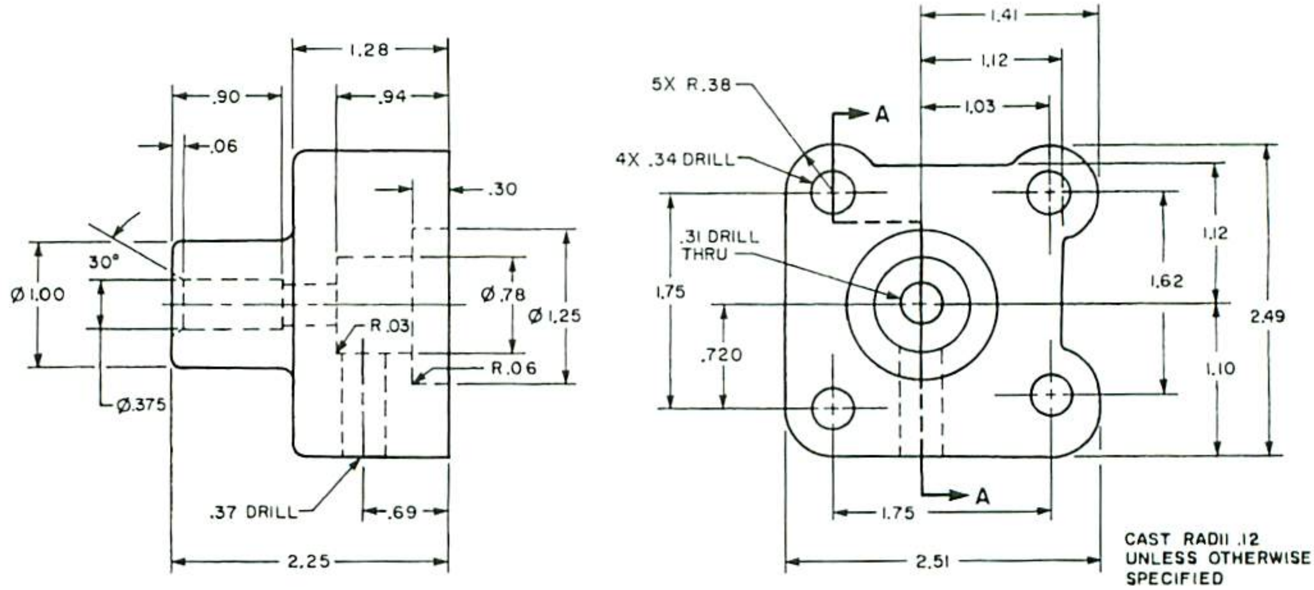
Study the drawings shown in Problems 16–18. Draw and dimension the necessary views for each problem. Include offset sections as indicated.

Intermediate

16. Right-Hand Cap

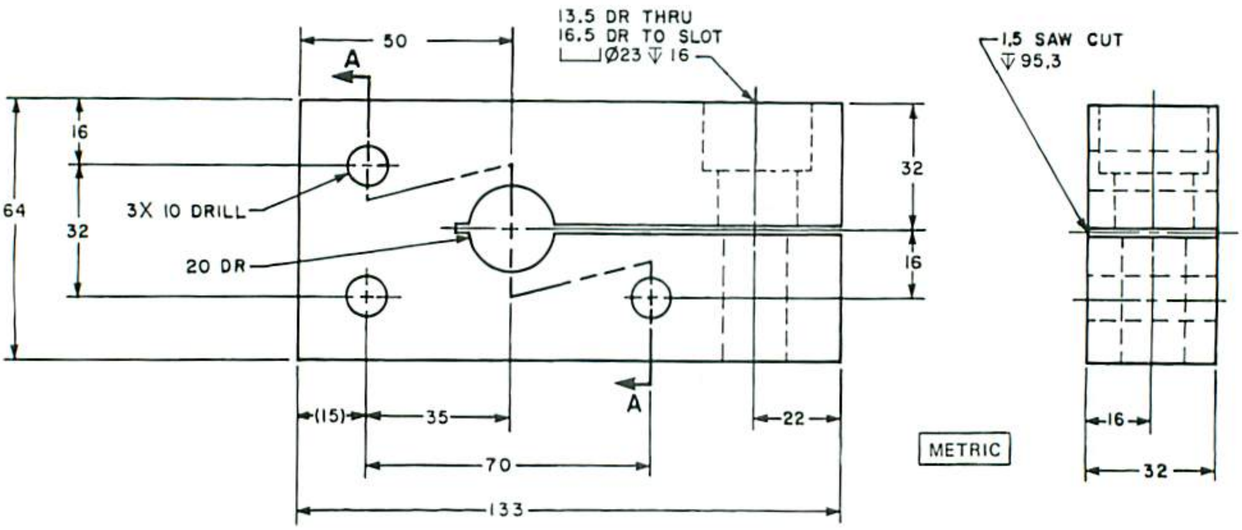


17. Pitot Override Cover



Intermediate

18. Arm Clamp

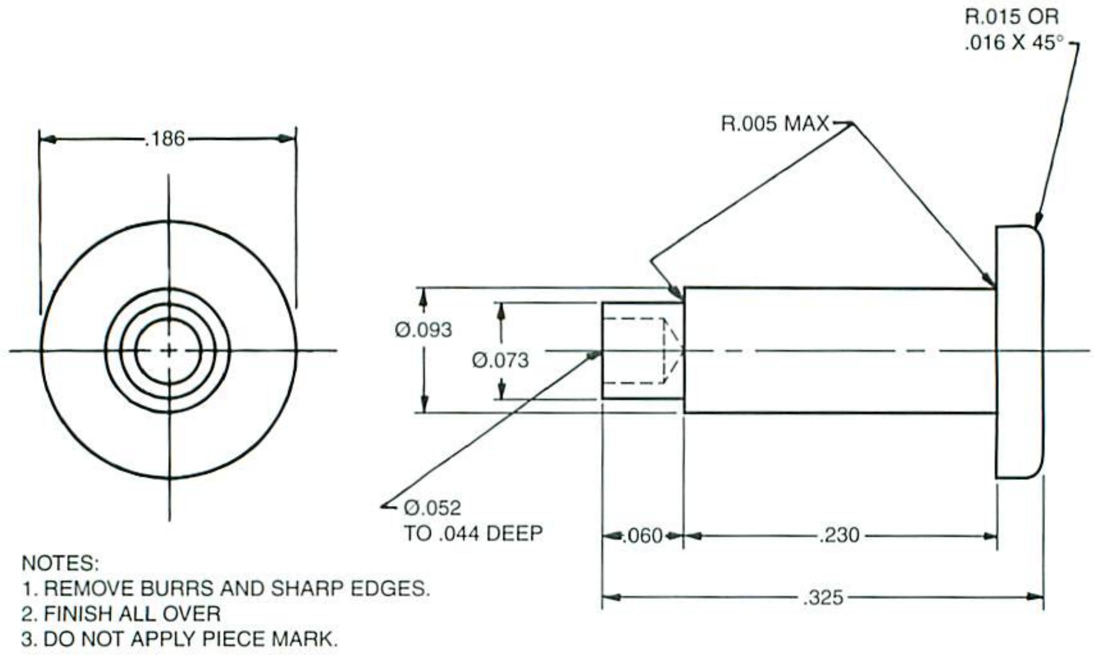


Broken-Out Sections

Study the drawing shown in Problem 19. Draw and dimension a two-view drawing of the Pivot Pin. Include a broken-out section.

Introductory

19. Pivot Pin

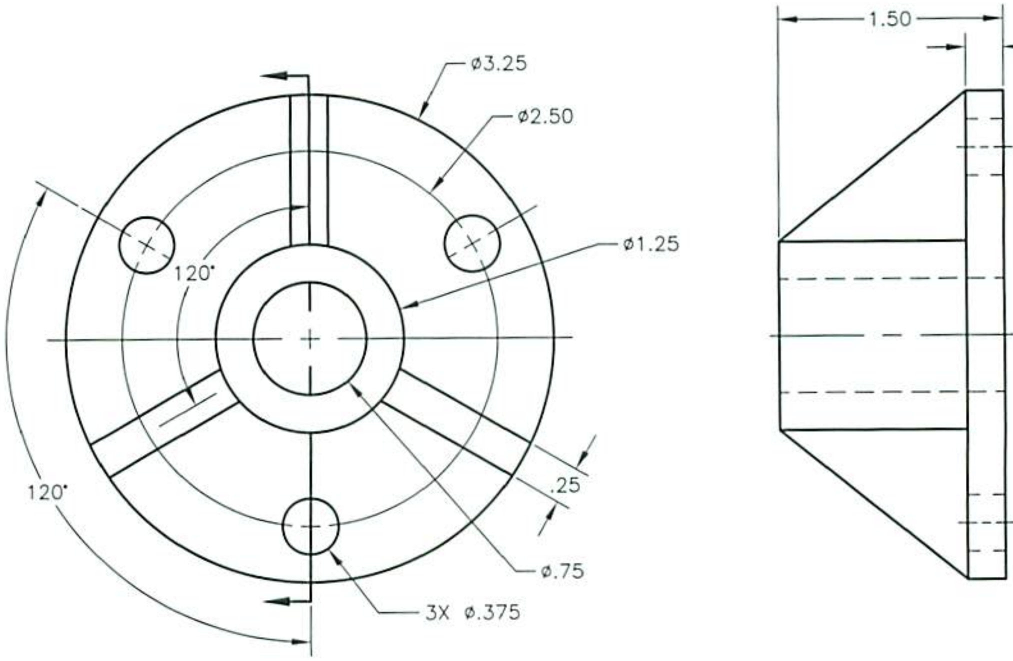


Aligned Sections

Study the drawings shown in Problems 20–22. Draw and dimension the necessary views for each problem. Include aligned sections as indicated.

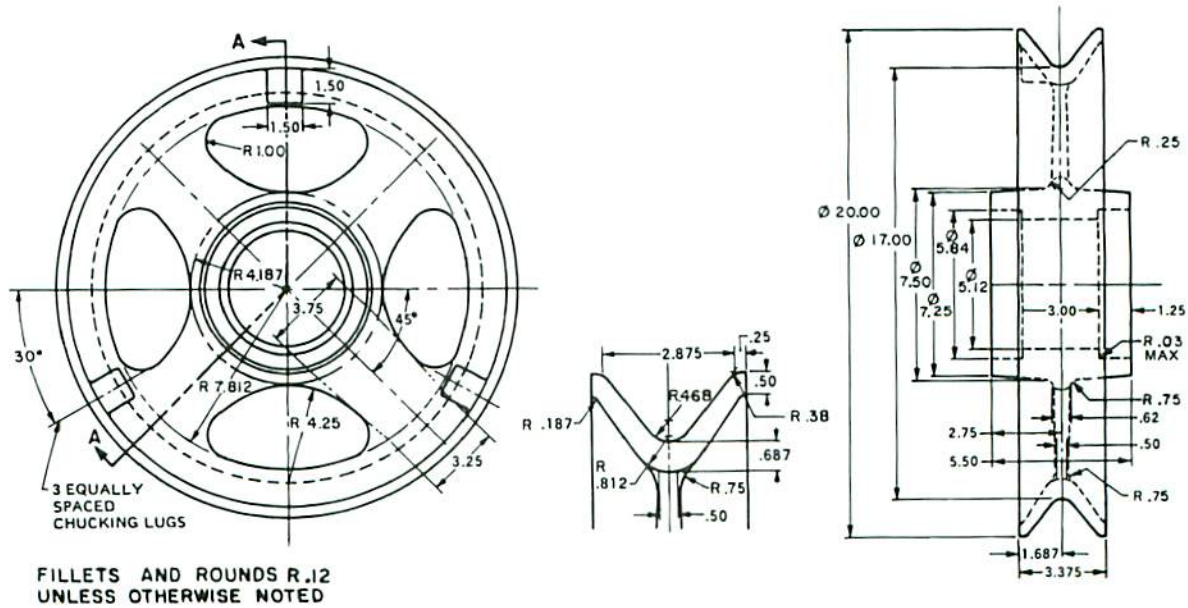
Intermediate

20. Hub



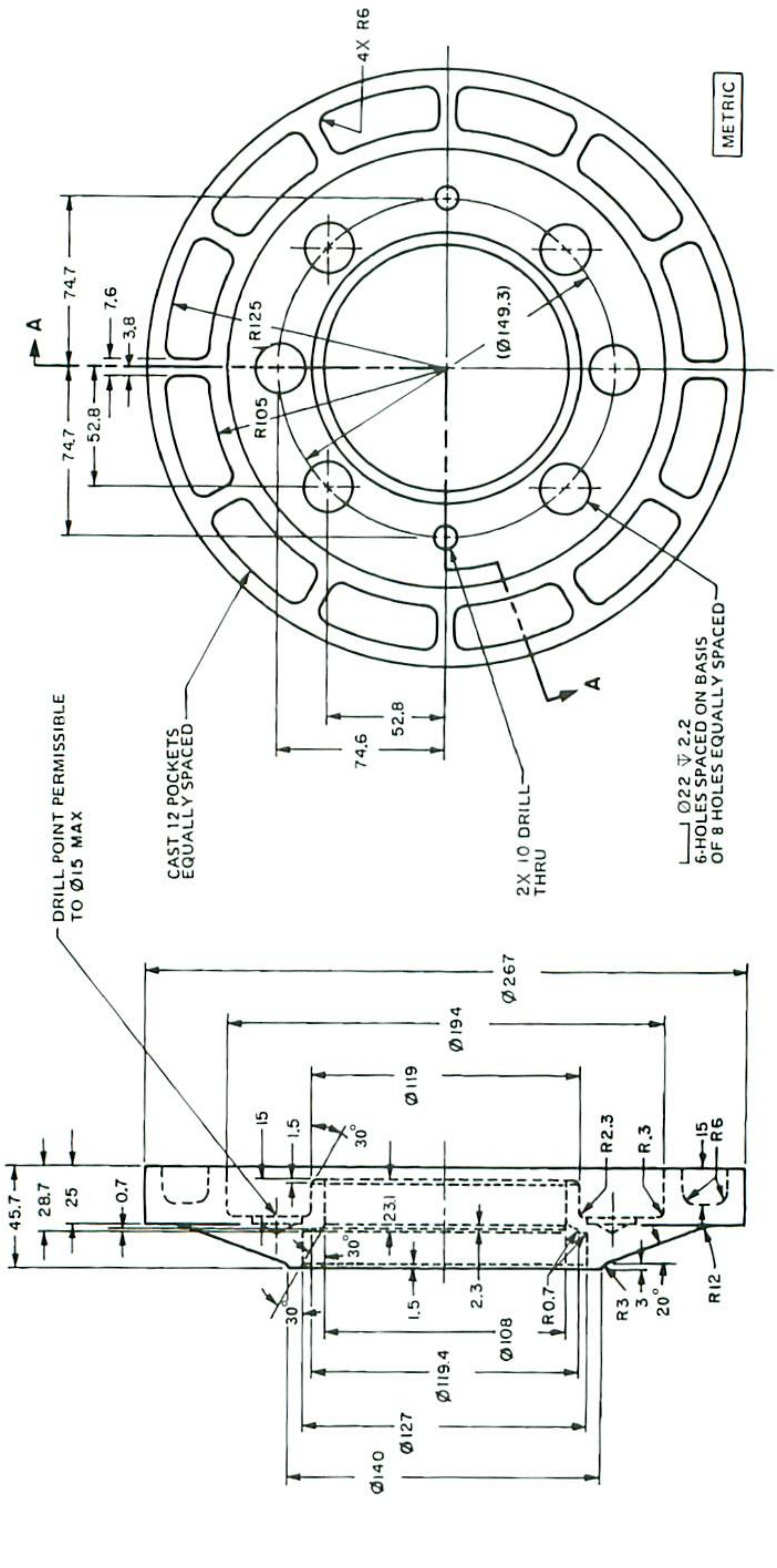
Advanced

21. Sheave



Advanced

22. Clutch Piston

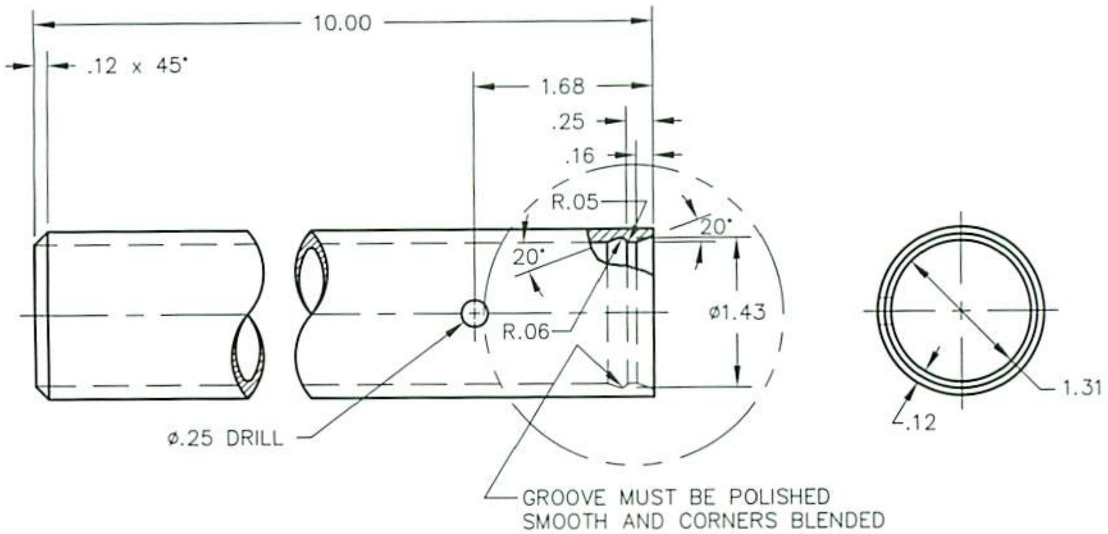


Conventional Sectioning Practices

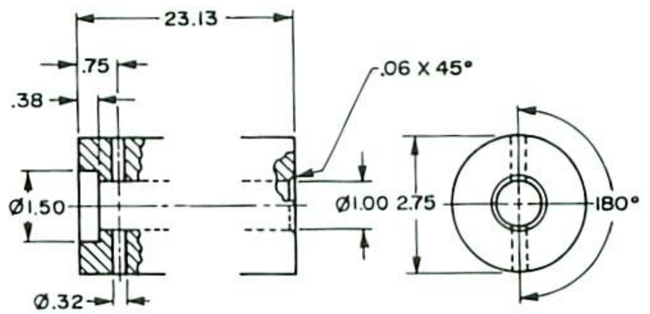
Study the drawings shown in Problems 23–26. Draw and dimension the necessary views for each problem. Use drafting conventions discussed in this chapter to represent conventional breaks and intersections.

Intermediate

23. Barrel

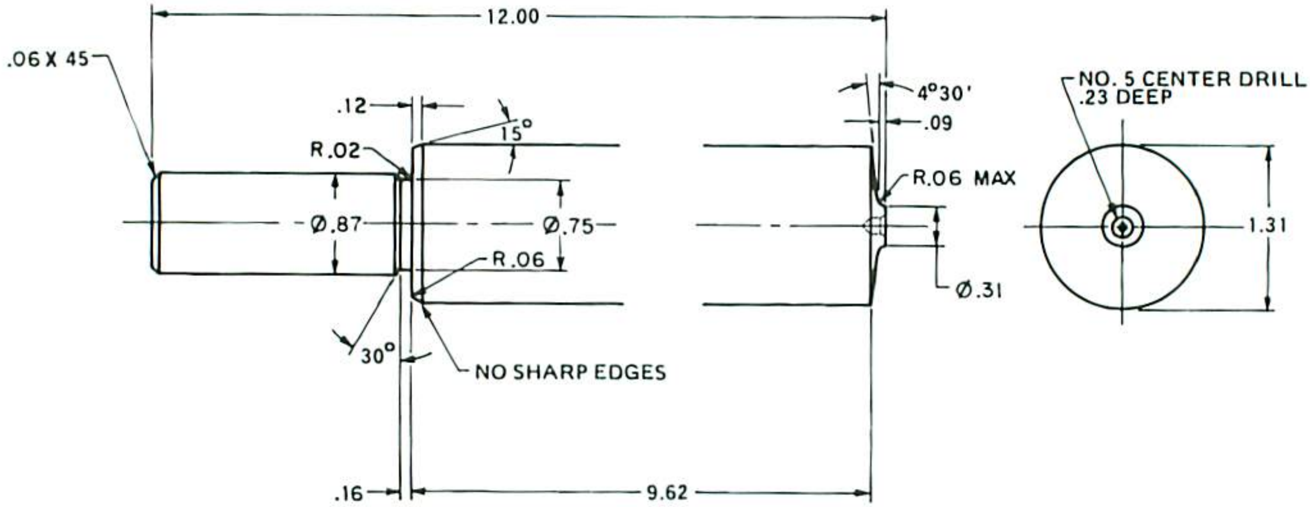


24. Barrel Blank



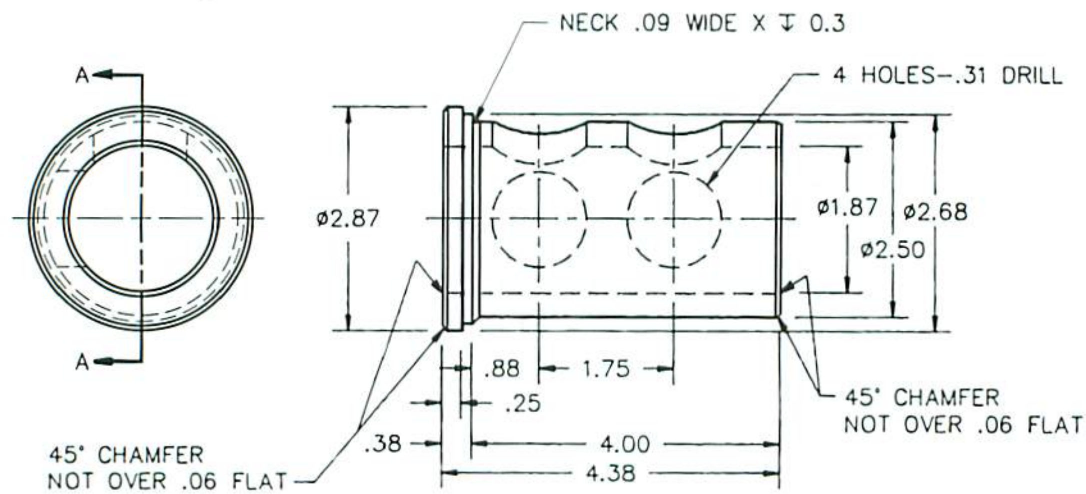
Intermediate

25. Rod



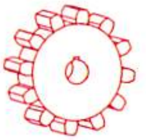
Advanced

26. Tool Holder Bushing



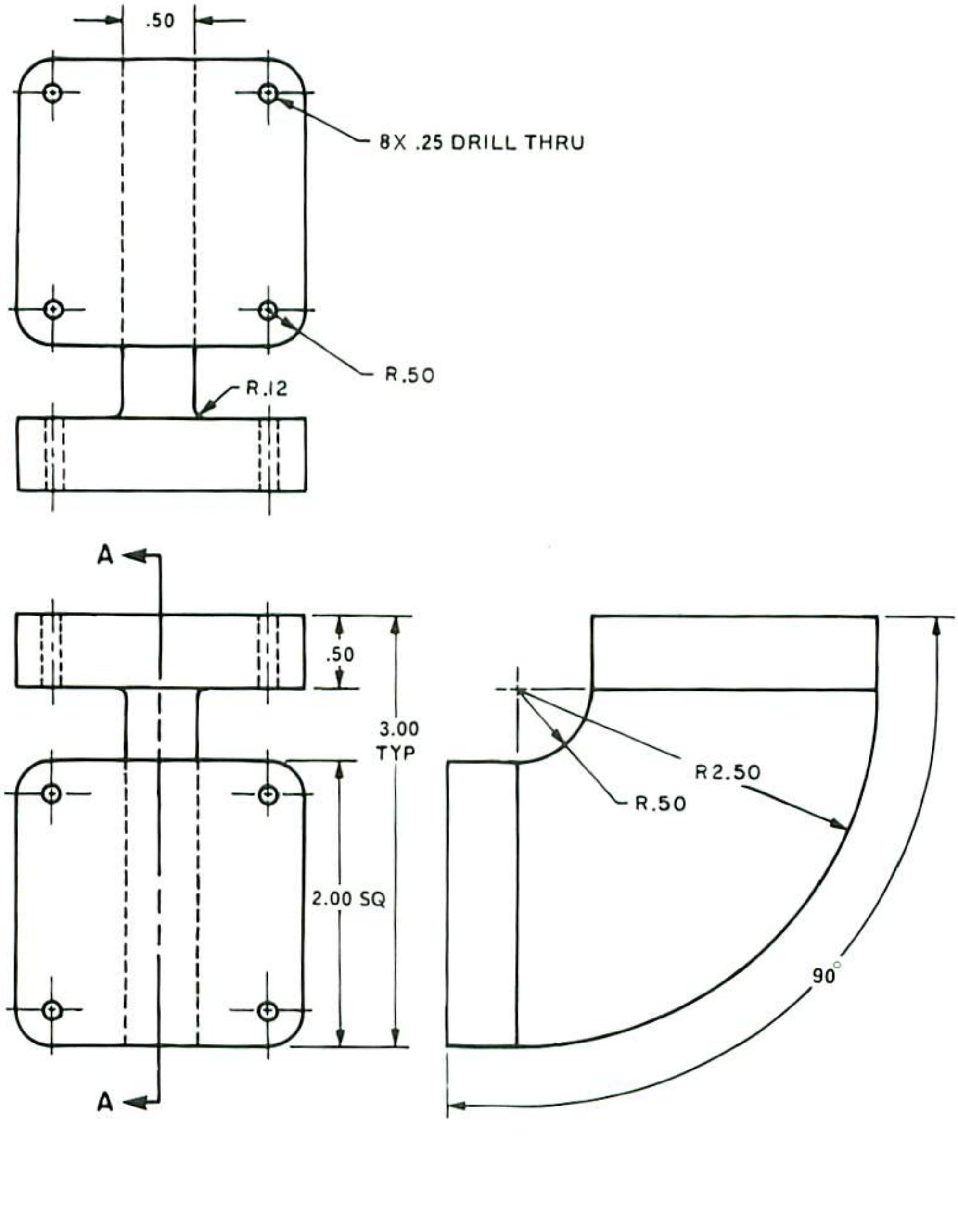
Drawing Webs in Section Views

Study the drawings shown in Problems 27 and 28. Draw and dimension the necessary views for each problem. Use drafting conventions discussed in this chapter to represent webs.



Intermediate

27. Angle Bracket



Advanced

28. Fan Bracket