Unit 5

Understanding Prints

After completing Unit 5, you will be able to:

- Identify and explain the significance of the principal views on a multiview drawing.
- Explain how the major types of section views are read and used on a print.
- Identify methods to read prints.

Key Words

auxiliary view	orthographic projection
broken-out section	partial auxiliary views
conventional break	principal views
crosshatching	removed section
cutting-plane line	revolved sections
first angle projection	section lining
full section	sectional views
half section	thin section
multiview drawings	third angle projection
offset section	title block

Introduction

A print shows a series of views that give the welder an exact shape and size description of an object, Figure 5-1. Additional information necessary to make or assemble the product is also included on the print.

The best way to read a print is to mentally break it into smaller parts. First, try to look at the shape of the part with the dimensions and notes removed. Second, try to determine the overall size of the part so you have some understanding of how big or small the part is. Third, look at the ***title block*** for information about the title part, material, scale, tolerance requirements, and other general pieces of information. Finally, read all of the notes on the drawing.

Multiviews

Most prints are in the form of multiviews. ***Multiview drawings*** are needed when more than one view is required to give an accurate shape description of the object. On most prints, the object is drawn in the operating position.

The views are arranged on the print in a systematic manner accepted as standard throughout industry. For example, in Figure 5-1, the top view appears above the front view. The right side view appears to the right of the front view.

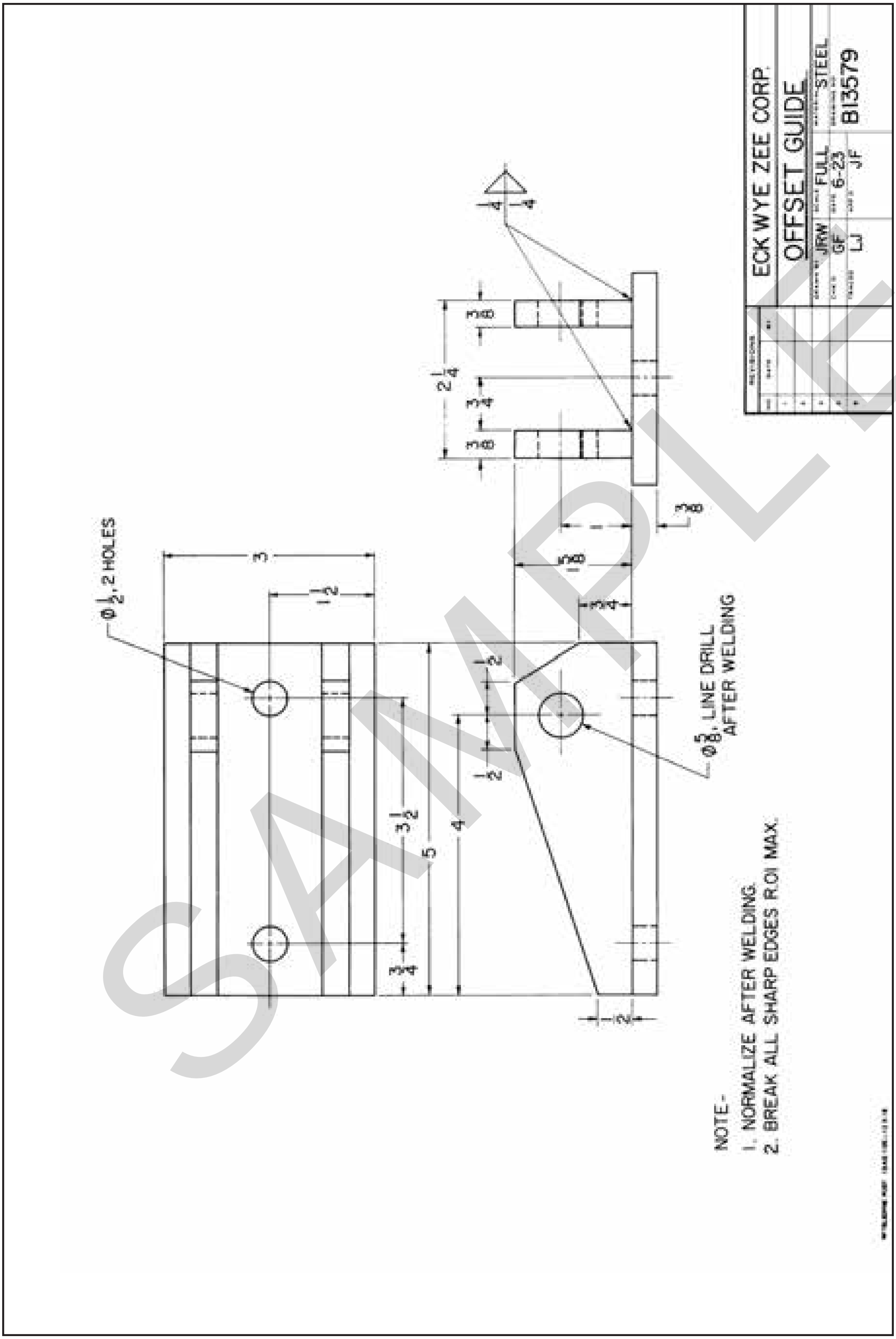

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Figure 5-1.
A print shows a series of views giving an exact shape and size description of a part.

This makes it easier for the welder to merge the views in his or her mind, and to form a mental picture of the object, Figure 5-2.

In developing the needed views, the entire object is normally viewed from six directions: front, top, left side, right side, rear, and bottom views, Figure 5-3. The same object is viewed separately from these various directions of sight, Figure 5-4.

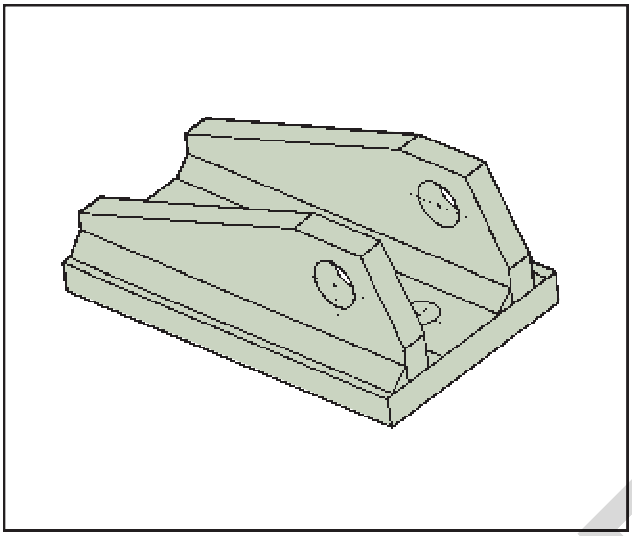

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Figure 5-2.
This is the same part as in Figure 5-1, but the views in Figure 5-1 are arranged in a systematic manner. This makes it easier to form a mental image of the weldment. Shown is a pictorial view.

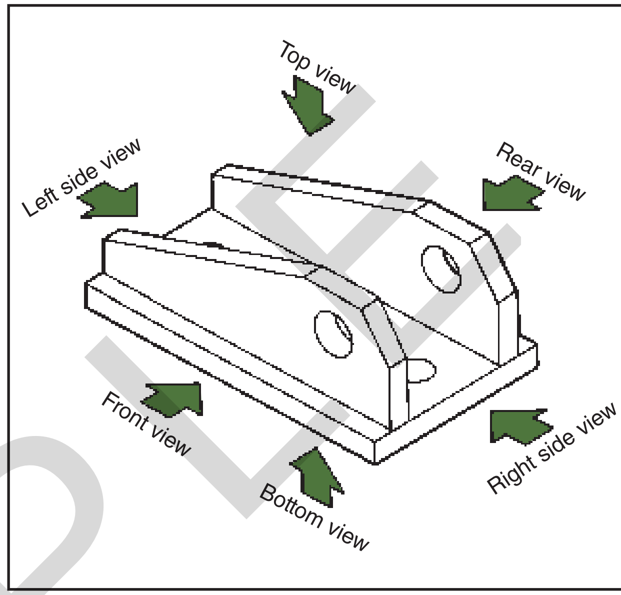

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Figure 5-3.
Six directions are normally considered when developing views for an object on a print.

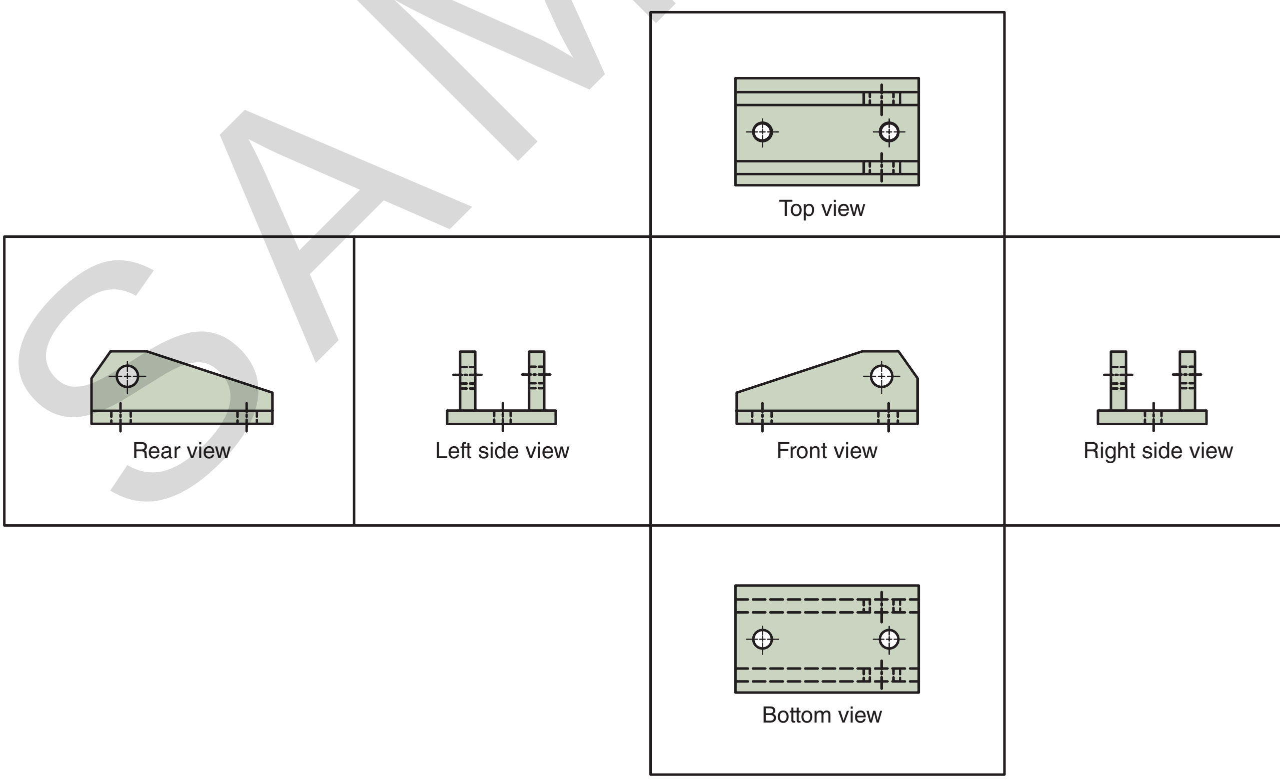

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Figure 5-4.
If an object is viewed from the six directions of sight, the views would look like the ones shown.

To obtain the views, think of the object as being enclosed in a hinged glass box. Study Figure 5-5 carefully. Imagine that the views are projected on the sides of the box. The top view of the object is seen on the top of the box, the front view on the front of the box, and so on for the remaining views. This technique is called ***orthographic projection.*** It permits a three-dimensional object to be described on a flat sheet of paper having only two dimensions.

As can be seen, at least six views will be developed. Not all of them, however, are needed. Only those views required to give an accurate shape description of the object are included on the print. A view that repeats the same shape description as another view is *not* used, Figure 5-6. The ***principal views*** commonly shown on a print are the front view, top view, and right side view.

In the United States and Canada, all engineering drawings are drawn in ***third angle projection,*** with the object drawn as viewed in the glass box and the views projected to the six sides of the box. The projected views are drawn to resemble views when the box is opened out. The top view is always directly *above* the front view. The right side view is to the *right* of the front view and in line with it. The left side view is to the *left* of the front view.

Drawings used in European countries are sometimes drawn in ***first angle projection,*** with the object drawn as if it were placed on each side of the glass box. Figure 5-7 shows both third angle and first angle projection. Compare the two. The main differences include how the object is projected and the arrangement of the individual views on the drawing. The type of projection angle is usually identified on the drawing by ISO (International Organization for Standardization) symbols, Figure 5-8.

Auxiliary Views

The true shape and size of objects having angular or slanted surfaces cannot be shown using the principal (top, front, side) views, Figure 5-9. The true length of the angular surface in Figure 5-9 is shown on the front view, but this view does not show its width. The true width of the angular surface is shown on the top and side views, but neither view shows its true length.

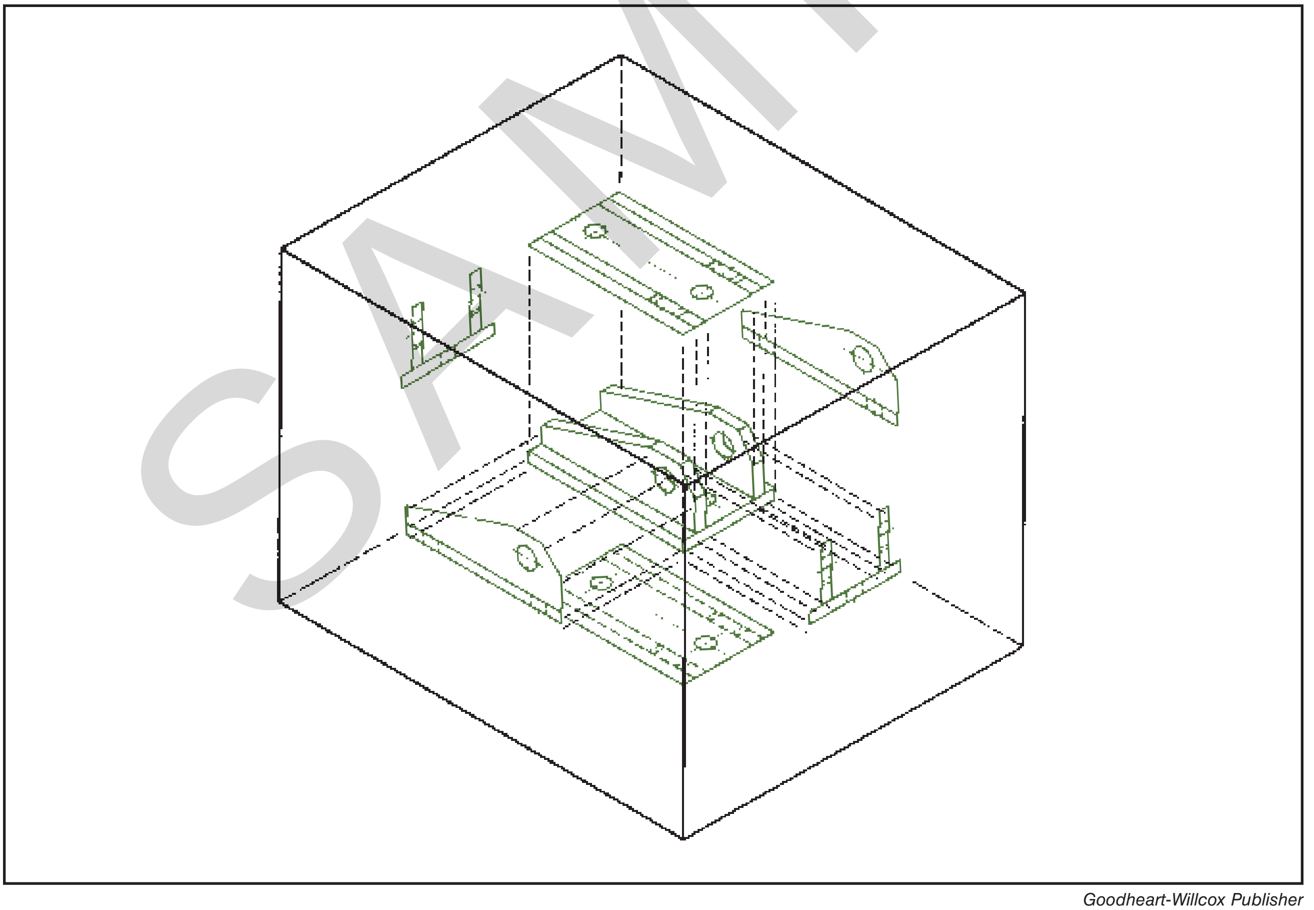

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Figure 5-5.
Note relationships among views by thinking of the object as enclosed in a hinged glass box.

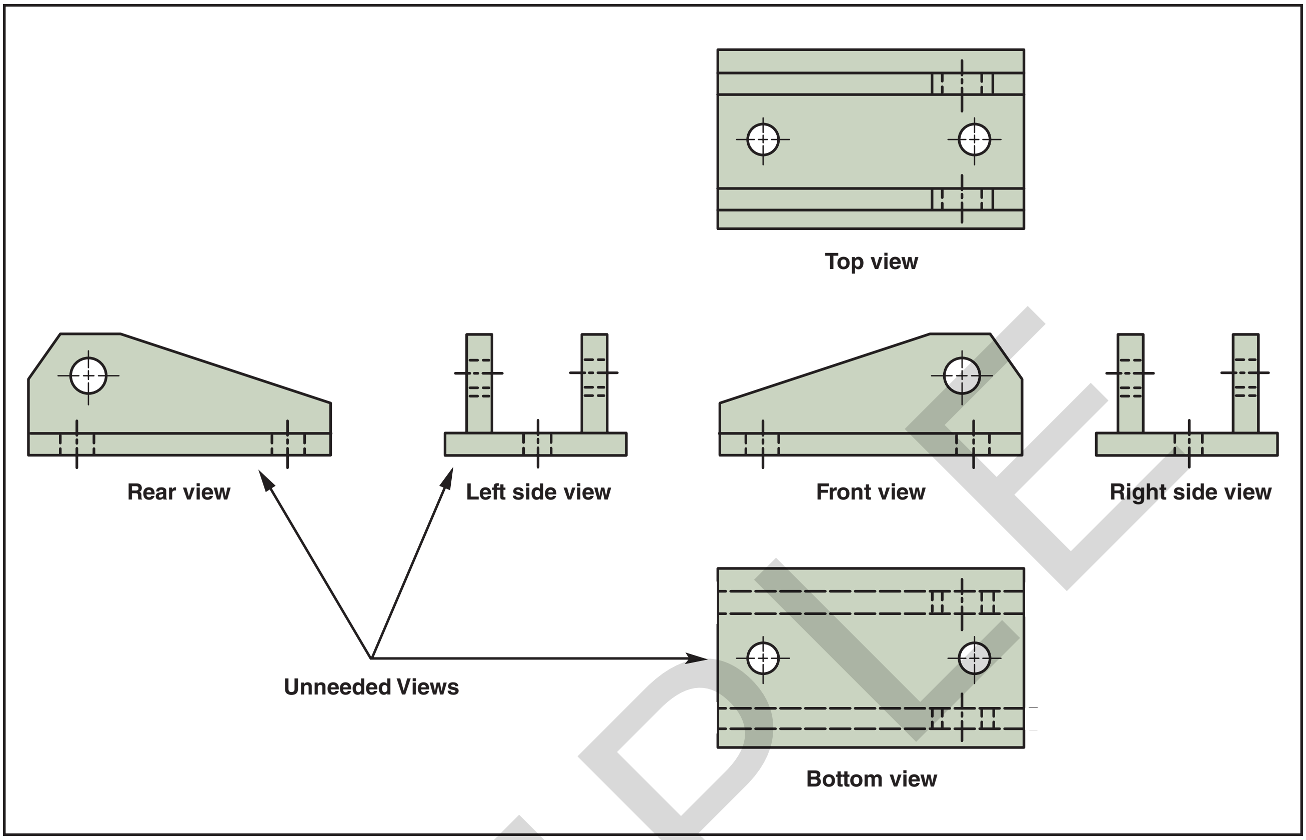

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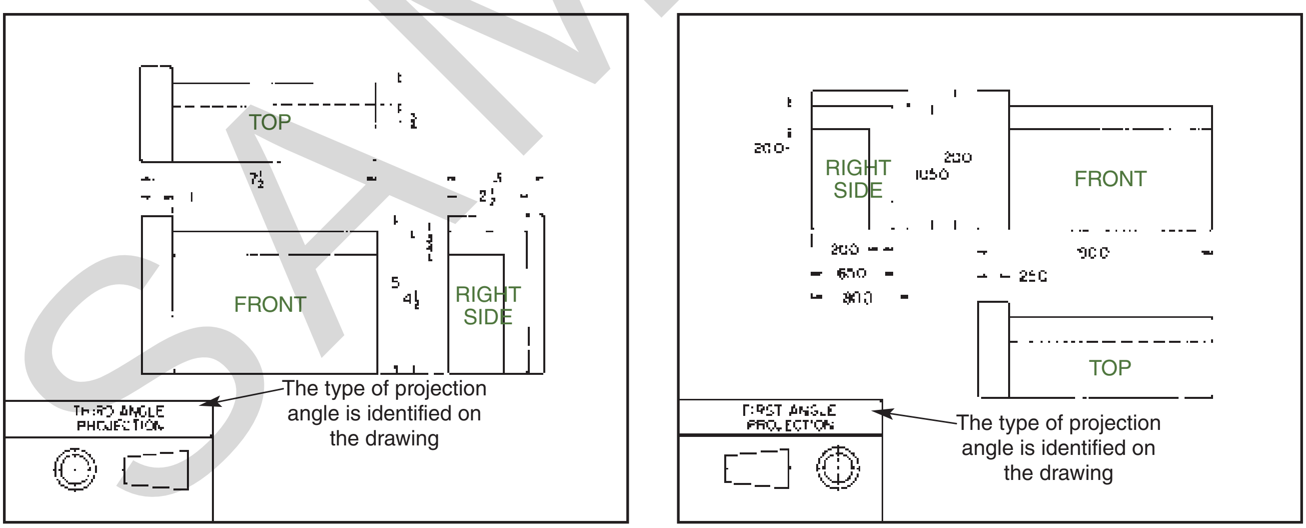
Figure 5-6.
Some views are seldom used on a print since they repeat the same shape description as another view.



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A **B**

Figure 5-7.
Study third and first angle projection. A—Drawings made in the United States use third angle projection, which has views arranged as shown. B—Drawings used in European countries use first angle projection.

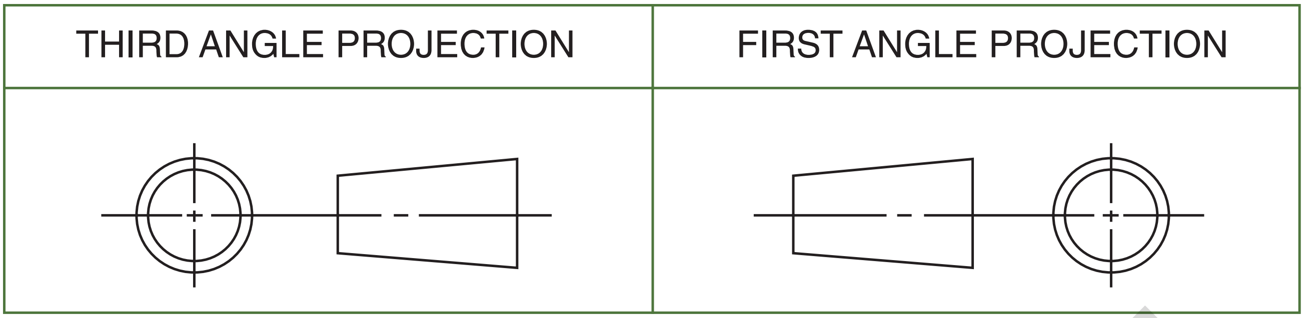

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Figure 5-8.
A block with ISO symbols is normally on a print to identify the angle of projection.

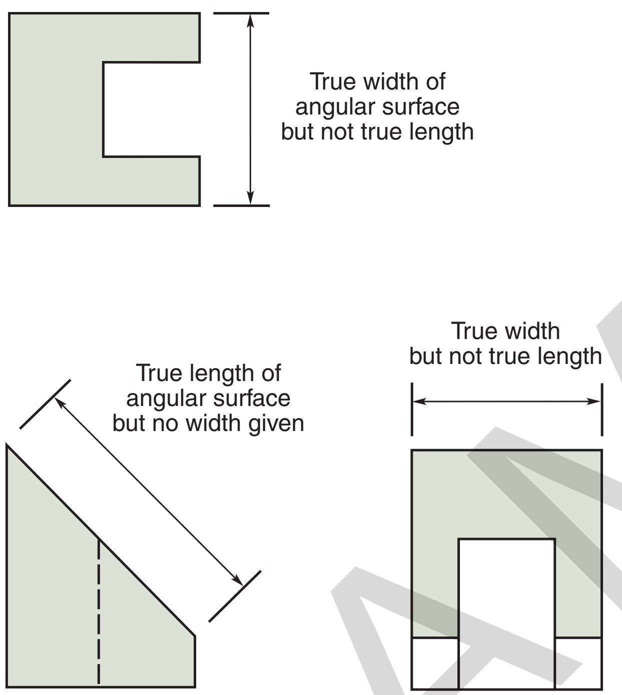

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Figure 5-9.
The regular top, front, and side views do not show true shape and size of angular or slanted surfaces.

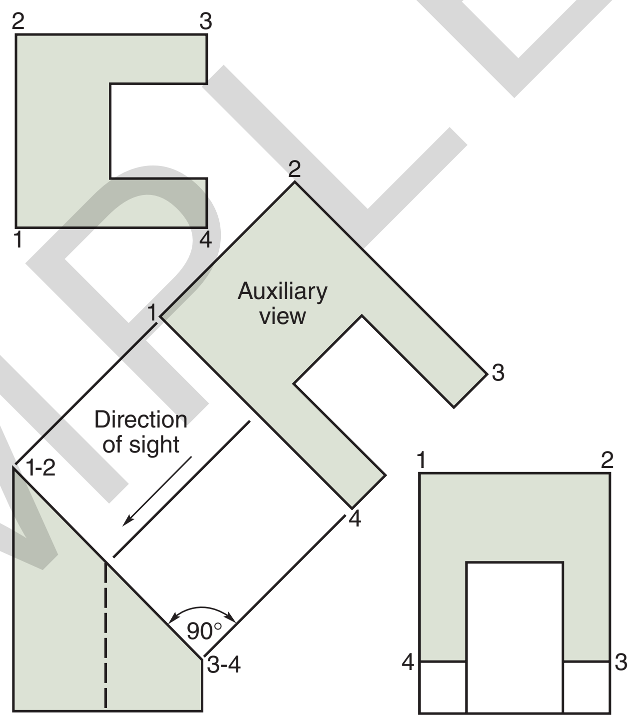

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Figure 5-10.
Dimensions of an angular surface are given by an auxiliary view.

An additional or ***auxiliary view*** is used to show the true shape and size of the angular surface, Figure 5-10. Because of the extensive use of angled surfaces, sheet metal and press-break drawings often use auxiliary views.

The auxiliary view is always projected at right angles (90°) from the principal view on which the angular surface appears as a line. Quite often with auxiliary views, it is possible to eliminate one of the principal views, as in Figure 5-11. To avoid confusion and unnecessary sections of the part, some auxiliary views are drawn as ***partial auxiliary views.*** Only the angular surface is shown in the auxiliary view, and break lines indicate where part of the view was removed.

Sectional Views

When an object is relatively simple in design, its shape can be described on a drawing without difficulty, Figure 5-12. For a complex object with many features obscured from view, however, it is often not easy to show its internal structure without a "jumble" of hidden lines, Figure 5-13. The drawing is hard to understand and interpret.

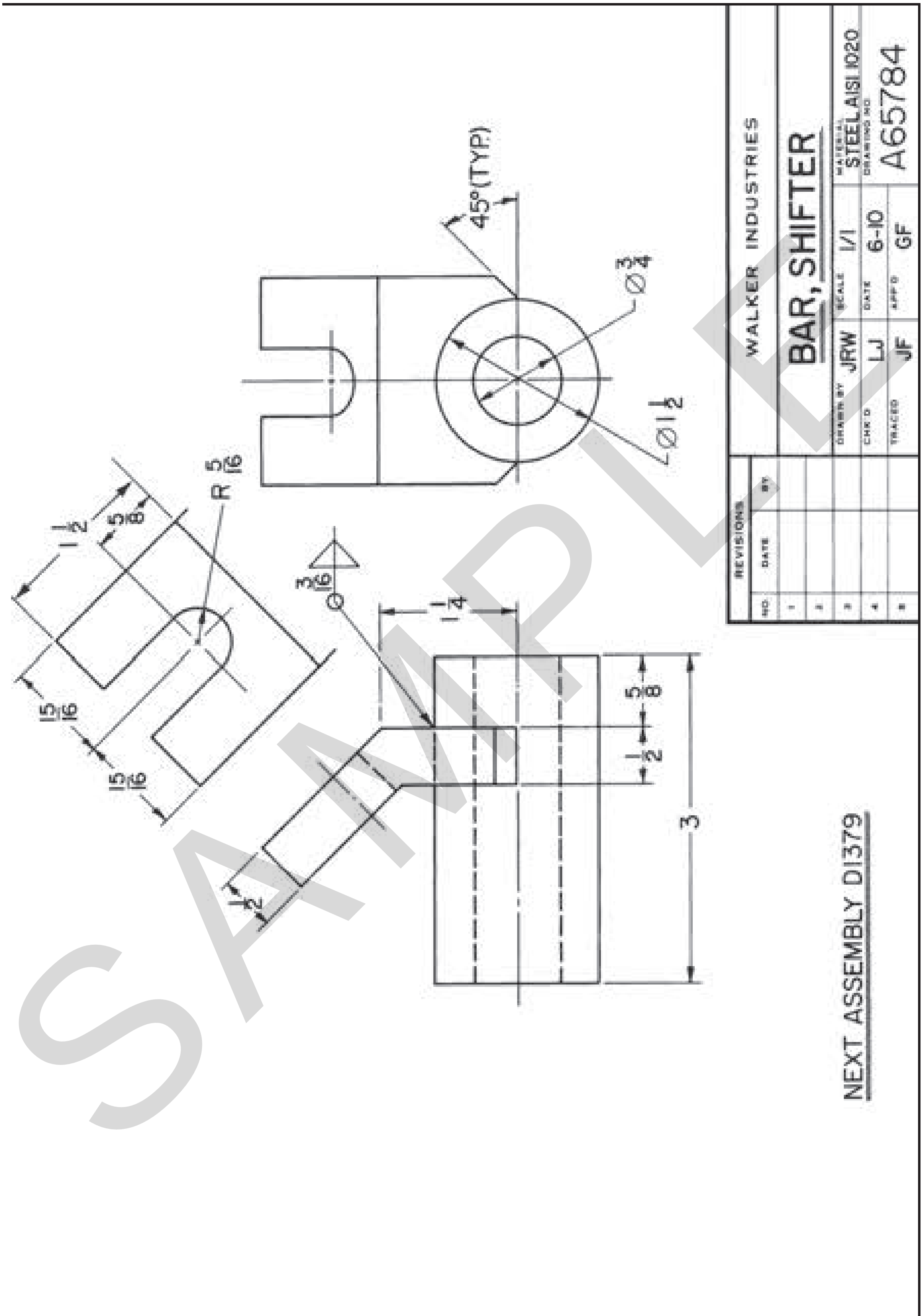

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Figure 5-11.
Notice how a print may not have one of the regular views when an auxiliary view is used.

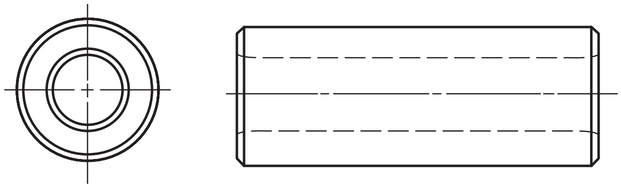

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Figure 5-12.
Only two views are needed on simple objects like this piston pin, which can be fully illustrated on a drawing with little difficulty.

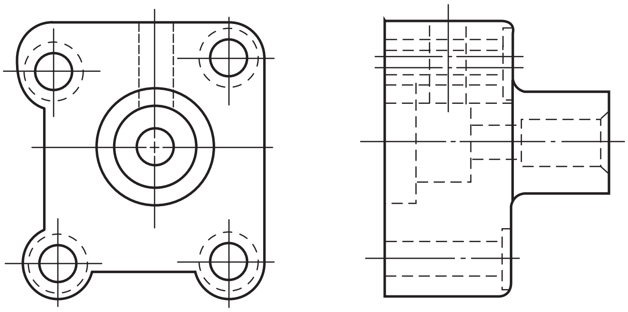

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Figure 5-13.
A complex object with many interior features may result in a drawing with a maze of confusing hidden lines.

Sectional views (or sections) permit the true internal shape of a complex object to be shown without the confusion caused by a myriad of hidden lines. A sectional view shows how the object would appear if an imaginary cut (known as the cutting plane) were made through the object perpendicular to the direction of sight. Shown in Figure 5-14, the section or portion of the object between the eye and the cutting plane is removed or broken away to reveal the interior features of the object. This makes the shape of the object more understandable.

Figure 5-15A shows the exterior surface of a pin. Notice that the interior features shown in Figure 5-15B are easier to visualize if a full section view is provided.

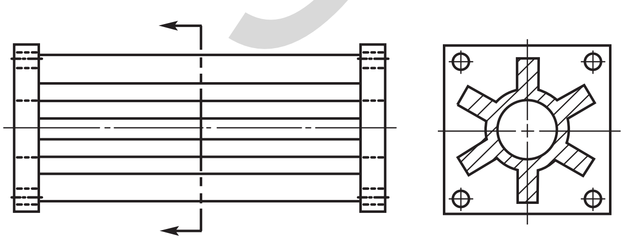

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Figure 5-14.
A sectional view shows how an object would appear if an imaginary cut were made through the object perpendicular to the direction of sight. This allows interior features to be seen without the confusion of many hidden object lines.

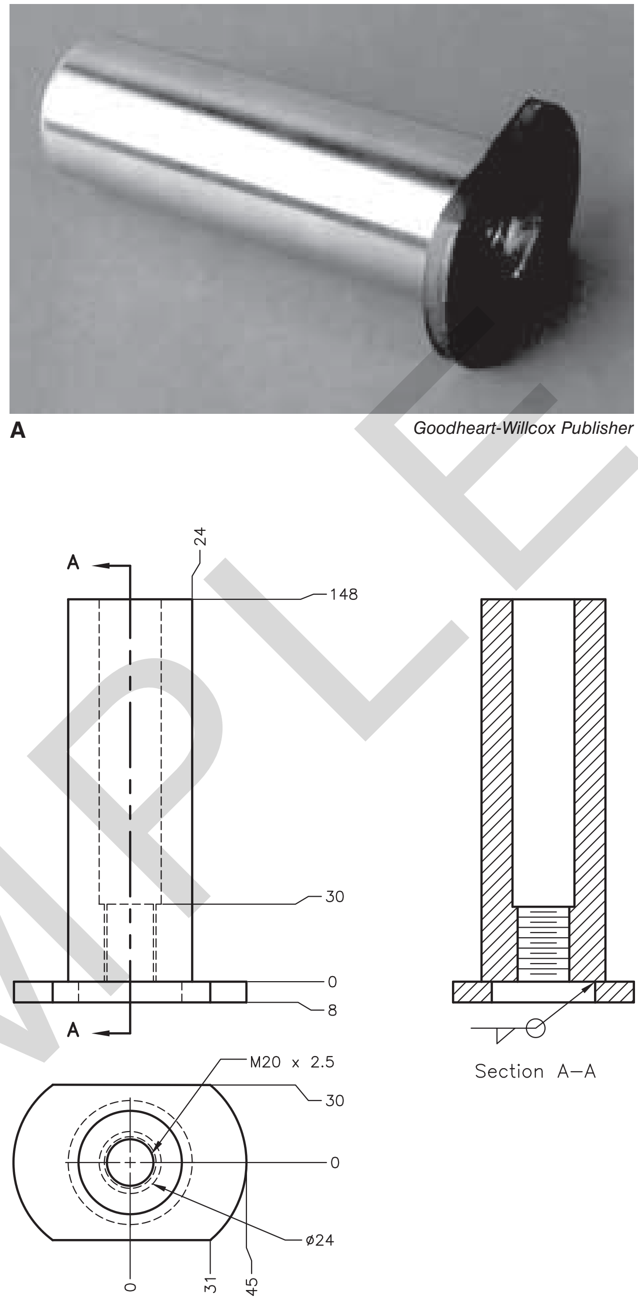

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Figure 5-15.
A—The exterior surfaces of a pin are shown. B—The interior features of a pin are shown.

Cutting-Plane Line

The cutting-plane line indicates the point from which the imaginary cut of the section is taken from the part, Figure 5-16. The arrows at the end of the cutting-plane line show the direction of sight for viewing the section.

Three forms of cutting-plane lines are accepted for general use, Figure 5-17. Sections are usually identified with bold capital letters (A-A, B-B, etc.) if they are moved to another position on the drawing.

Section Lining

Section lining, sometimes called ***crosshatching,*** represents the type of exposed cut surface of a section. The American National Standards Institute (ANSI) has recommended the symbols for section lining shown in Figure 5-18. The symbols depict the different types of material specifications. General-purpose section lining (cast iron) is usually used on drawings when exact material specifications are located elsewhere on the print.

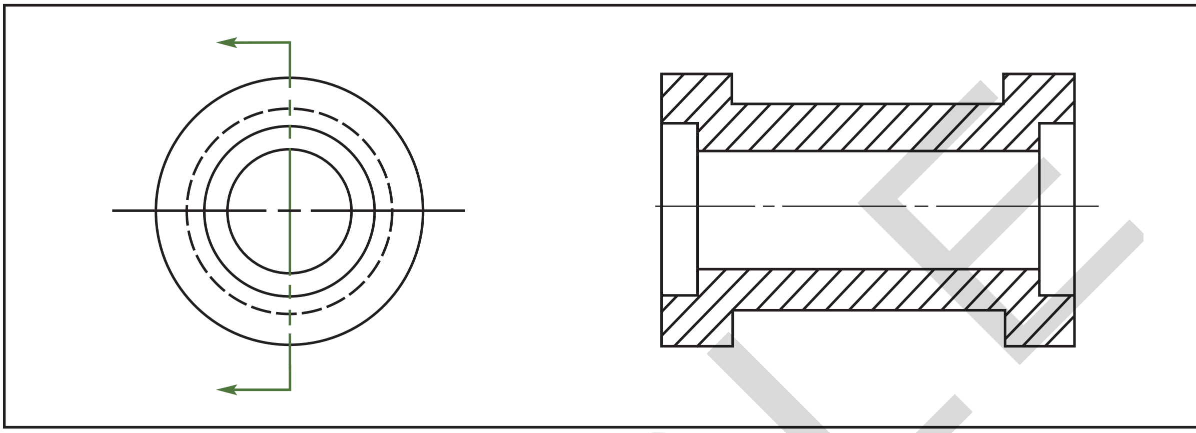

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Figure 5-16.
A cutting-plane line shows the point from which a section is removed from the part.

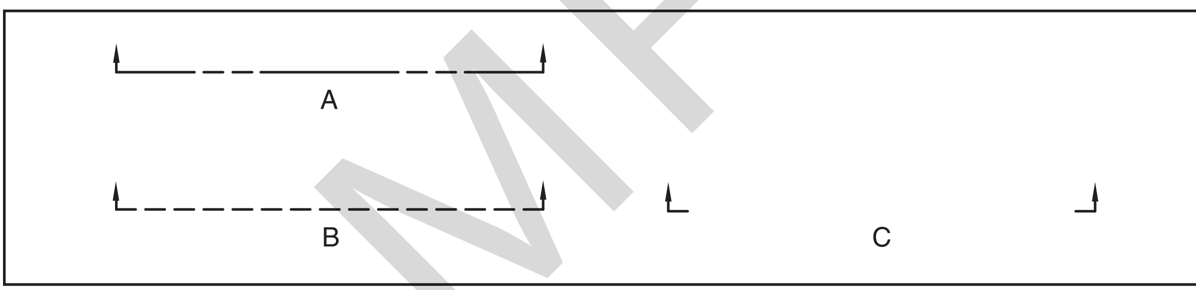

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Figure 5-17.
Any of three forms of cutting-plane lines can be found on a drawing. A—Cutting-plane line with long dashes and pairs of short dashes. B—Cutting-plane line with equal length short dashes. C—Cutting-plane line with only the ends and arrowheads.

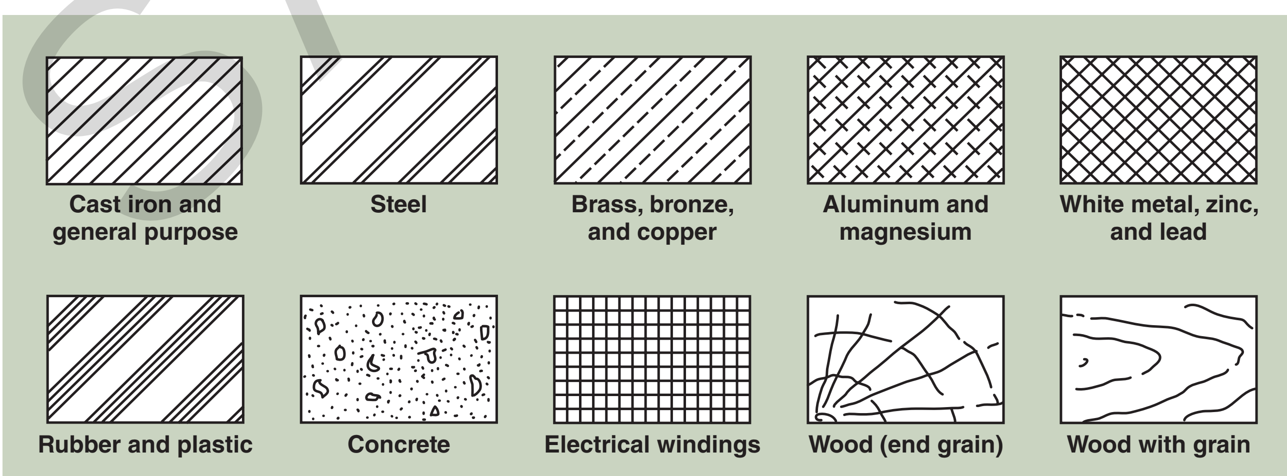

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Figure 5-18.
Standard code symbols exist for various materials in a section.

Thin Section

A ***thin section*** or section not thick enough for conventional section lining (sheet metal, gaskets, etc.) is shown as solid black lines, Figure 5-19.

Full Section

A ***full section*** is shown when the cutting-plane line passes entirely through the object, Figure 5-20. The interior features of the object are revealed.

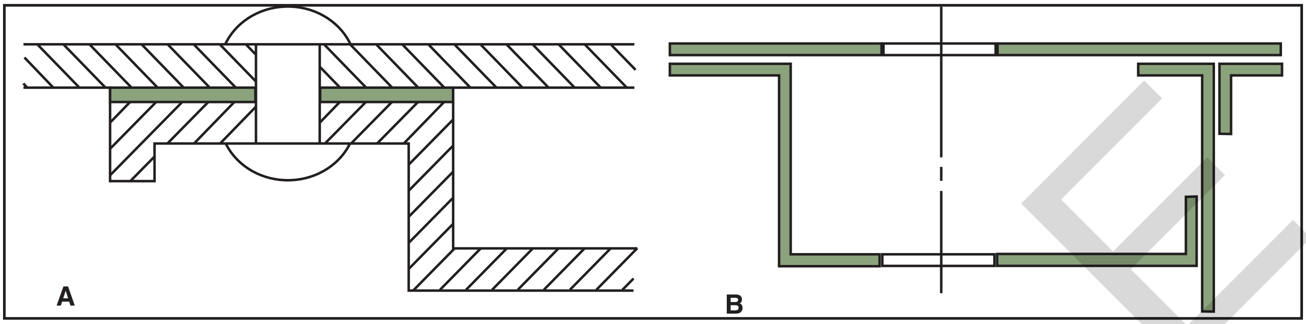

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Figure 5-19.
This shows a thin section. A—Sections too thin for conventional crosshatching are shown as solid black lines. B—Adjacent thin sections are separated by very narrow white spaces.

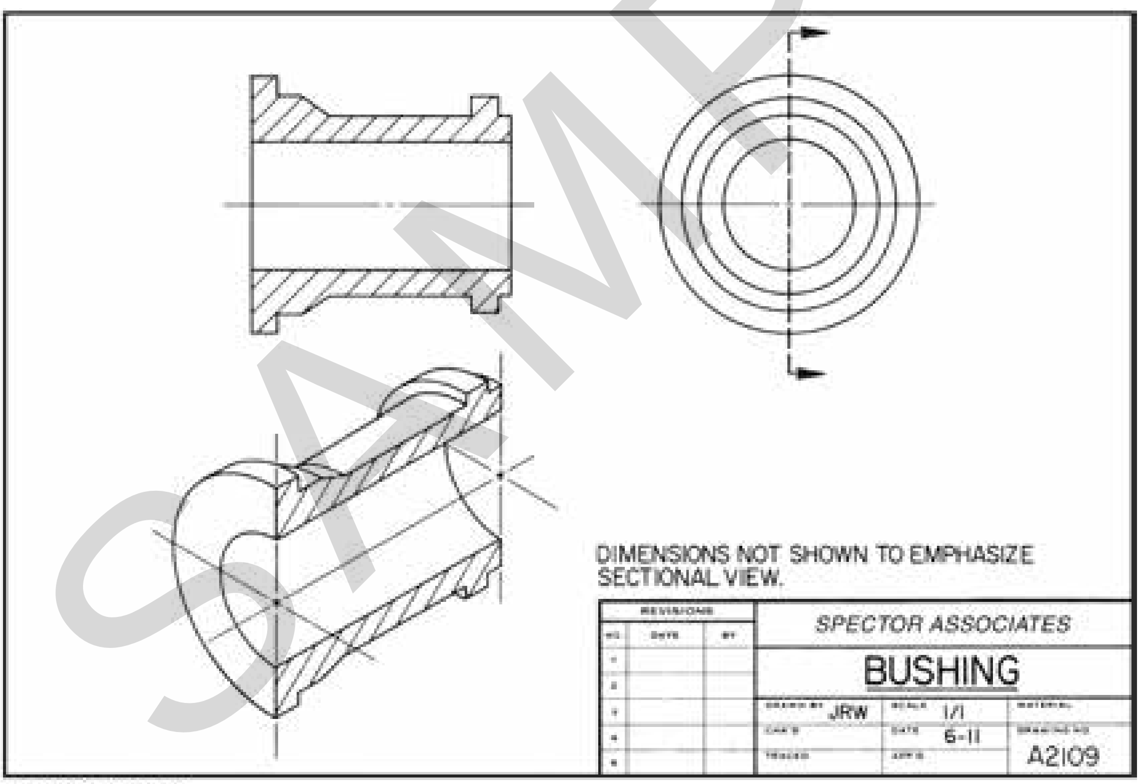

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Figure 5-20.
Note how the full section is shown when the cutting-plane line passes completely through the part.

Half Section

Half sections are primarily limited to symmetrical objects. The shape of one-half of the interior features and one-half of the exterior features of the object are shown in the ***half section,*** Figure 5-21. Cutting-plane lines are passed at right angles to each other. One-quarter of the object is “removed” and a half section view is exposed.

Revolved Section

Revolved sections rotate or turn the cut section 90°. They are primarily used to show the shape of such things as spokes, ribs, and stock metal shapes, Figure 5-22.

Removed Section

A ***removed section*** is used when it is not possible to show the sectional views on one of the principal views, Figure 5-23. The section is moved to a new location on the print, allowing it to be enlarged for clarity.

Offset Section

The ***offset section*** is used when a single straight cutting plane cannot show the needed information, Figure 5-24. In this case, the cutting-plane line is stepped or offset to pass through these features that lie in more than one plane.

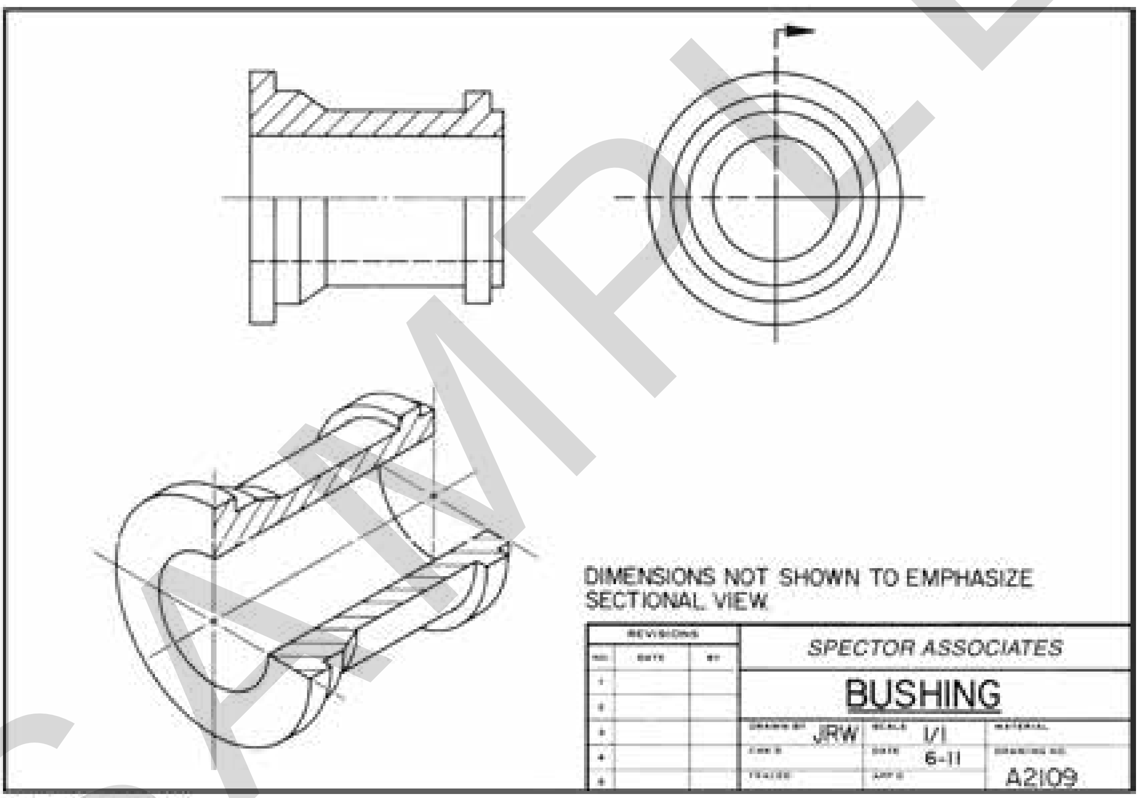

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Figure 5-21.
A half section shows the shape of one-half of the interior and exterior of the object.

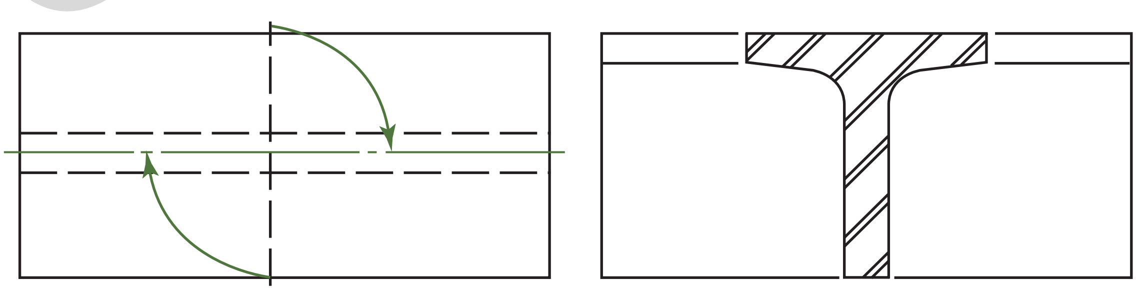

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Figure 5-22.
A revolved section helps show the shape of such things as spokes, ribs, and stock metal shapes.

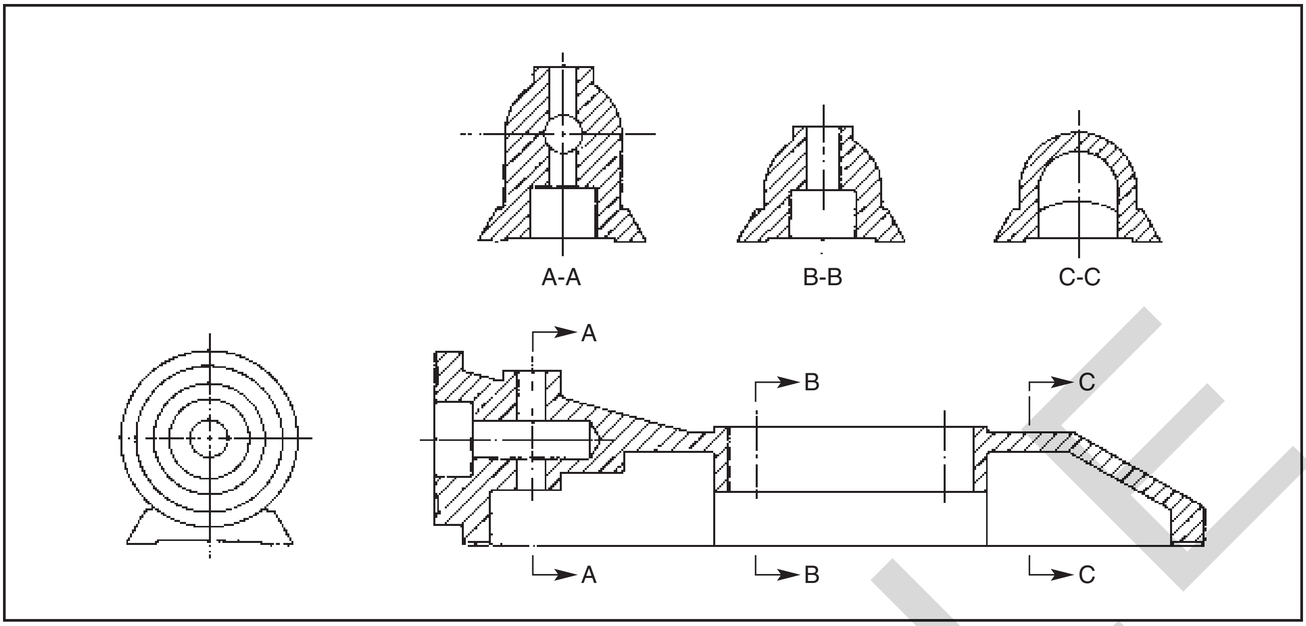

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Figure 5-23.
A removed section shows a sectional view taken from the object and shows it on another part of the print.

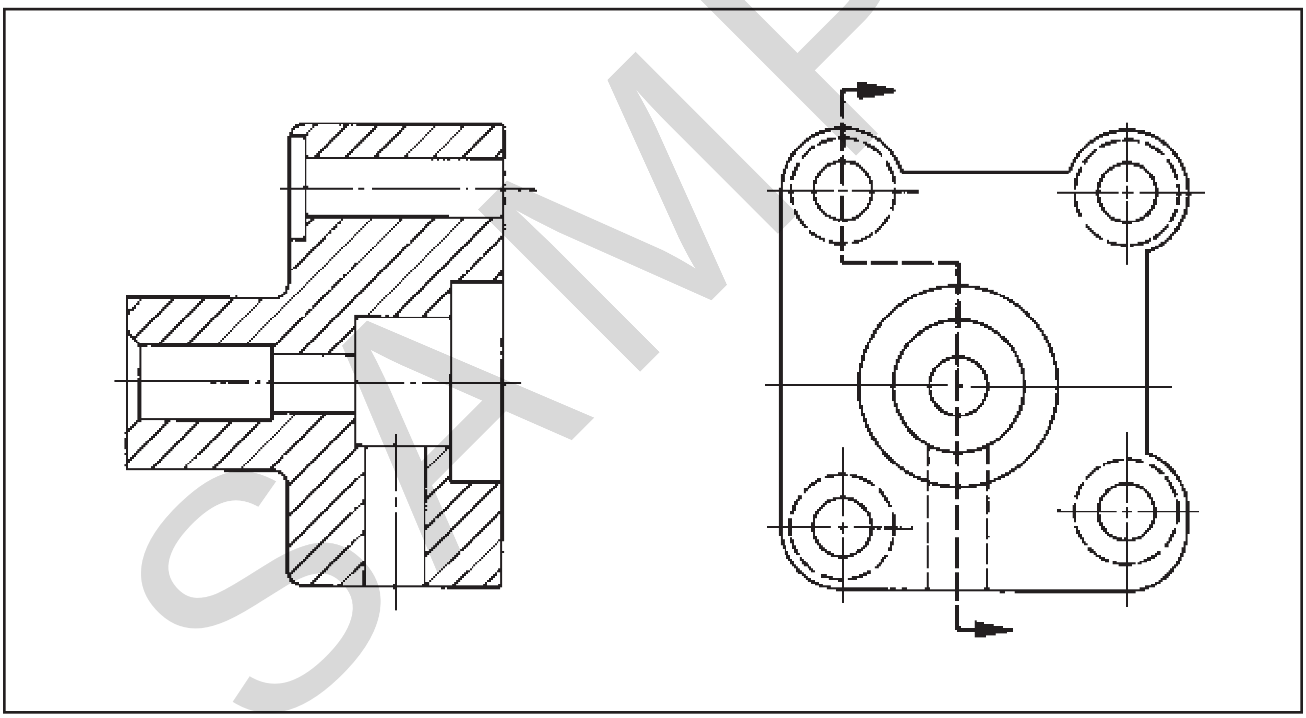

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Figure 5-24.
Notice how the offset section is used. It is needed when a single straight cutting plane cannot show information.

Broken-Out Section

The ***broken-out section*** is used when a small portion of a sectional view will provide the necessary information, Figure 5-25. Break lines define the section.

Conventional Break

A long, uniformly shaped object is sometimes difficult to present in a scale large enough to show its details clearly. A ***conventional break*** permits elongated objects to be shortened so a large enough scale can be used to present details with clarity, Figure 5-26.

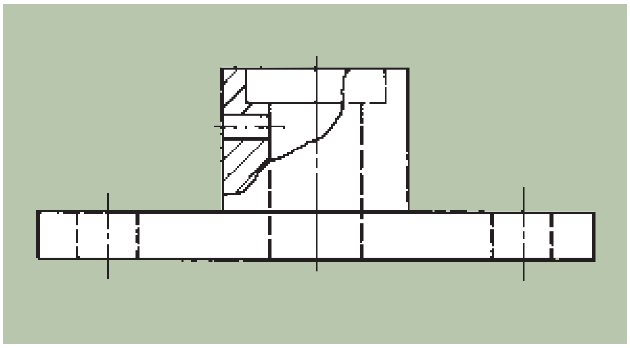

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Figure 5-25.
With a broken-out section, only a small portion of a sectional view will adequately show essential information.

Sections through Webs and Ribs

Webs and ribs are added to some objects to increase the part's strength and rigidity. Figure 5-27 shows how ribs and webs are represented in sectional views.

Rules on Reading Prints

There is no one best way to read a print or drawing. Most welders come up with their own method. The following rules are suggested to help you get started. Eventually, you will develop a method best suited to your own needs.

- Carefully review the print.
- Study one view at a time. Identify surface limits and lines that describe the intersection of surfaces. This will help you to visualize the shape of the object.
- Establish sizes from the dimensions.
- Review the other information (notes, title block, revisions, etc.) on the print.
- Determine what your responsibilities will be in producing the object and the sequence you will follow in performing the operations.
- Do not be afraid to ask for help if you do not understand something on a print. A mistake caused by not understanding something can be very costly to your employer and may cause injury to someone using the product at a later date.
- Practice print reading until it becomes second nature to you.

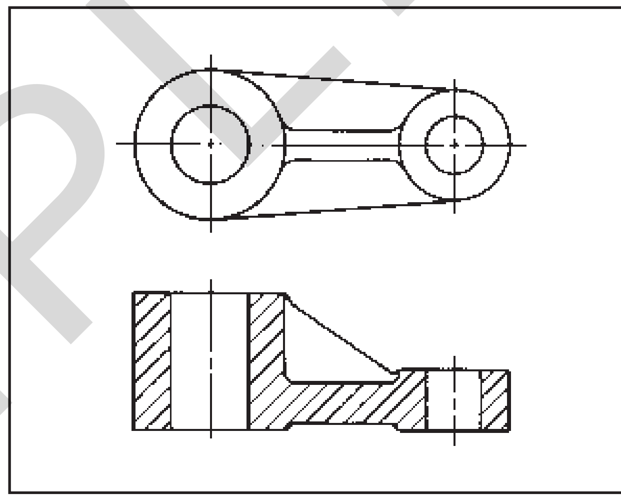

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Figure 5-27.
Note this section through a web or rib. Section lines are not drawn through webbed or ribbed areas.

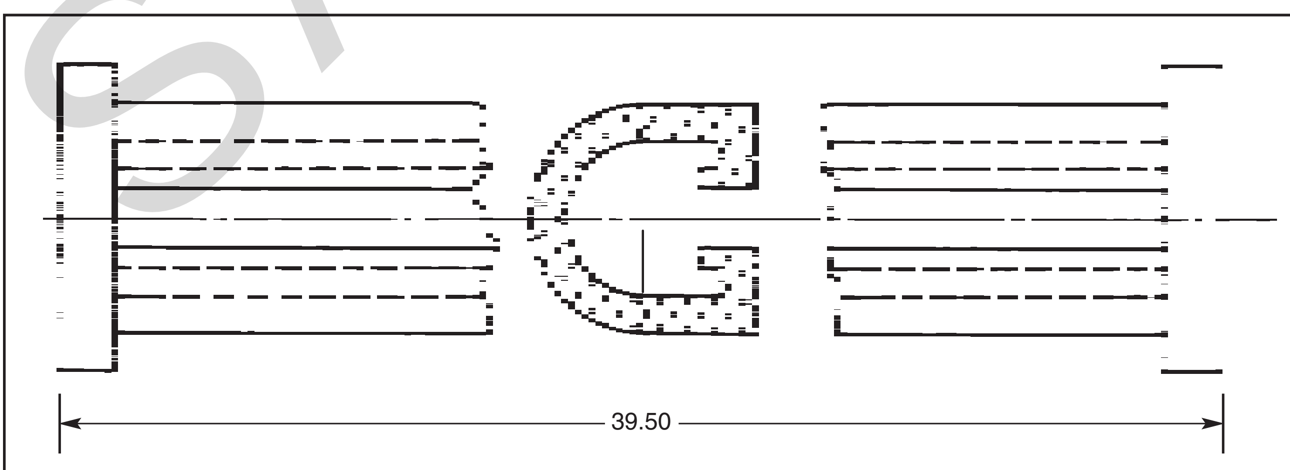

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Figure 5-26.
A conventional break allows elongated objects to be shortened so a larger scale can be used to show details more clearly.

Notes

Name ______________________________ Date ____________ Class ____________

Print Reading Activities

Study Figure 5-28 and answer the questions in Parts I, II, and III.

Part I

Use the pictorial view of the bracket and write in the dimensions indicated by each of the following letters.

1. A. ______________________
2. B. ______________________
3. C. ______________________
4. D. ______________________
5. E. ______________________
6. F. ______________________
7. G. ______________________
8. H. ______________________
9. I. ______________________
10. How many holes are specified? ______

Part II

Identify the types of lines indicated by the following letters.

1. J. ______________________
2. K. ______________________
3. L. ______________________
4. M. ______________________
5. N. ______________________

Part III

Answer the following questions.

1. Surface X indicates which view of the bracket?
____
2. Surface Y indicates which view of the bracket?
____

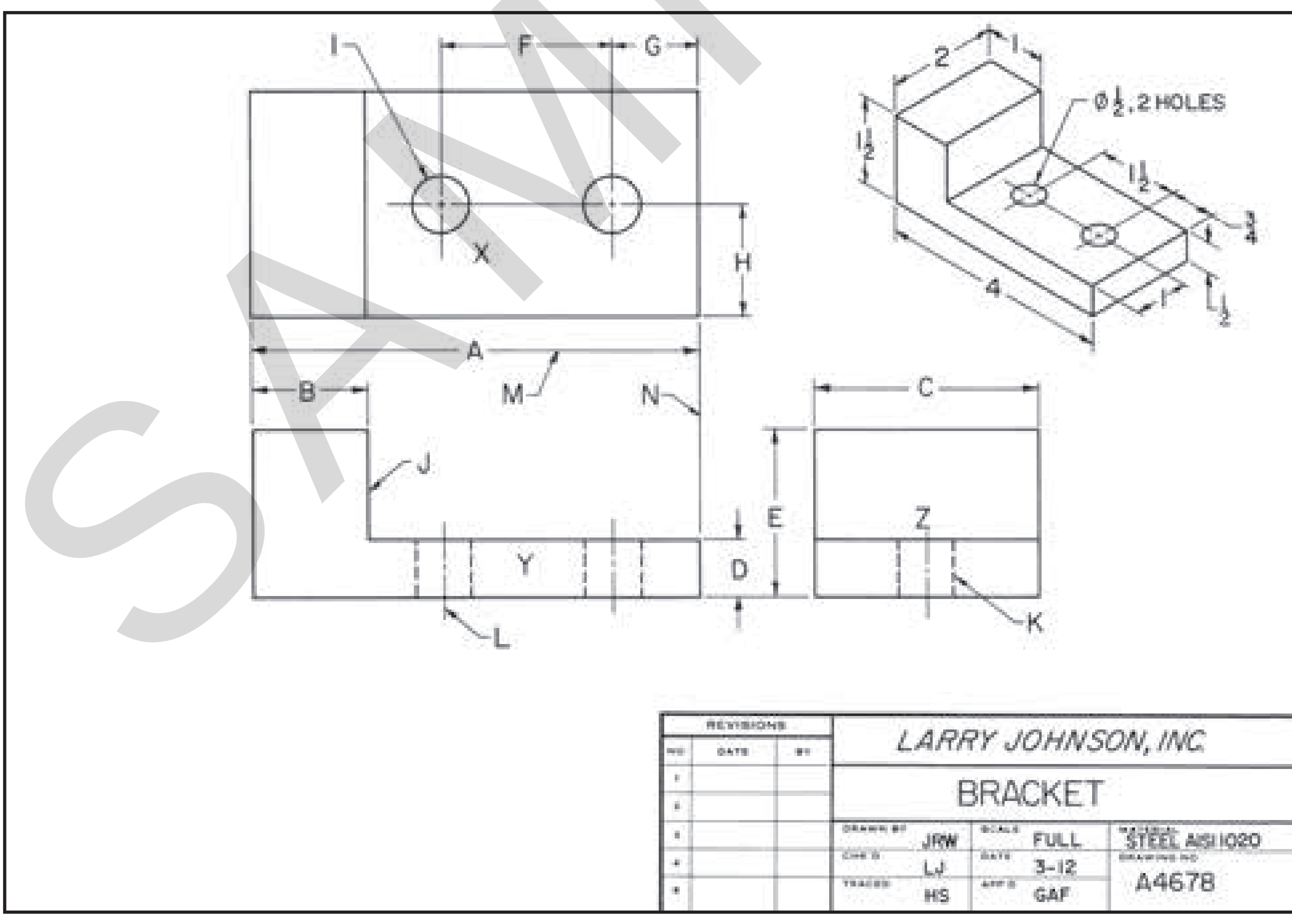

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Figure 5-28.
Use this print of a bracket to answer questions in Parts I, II, and III of the Print Reading Activities.

3. Surface Z indicates which view of the bracket?

____

4. What is the print number?

____

5. What material is specified?

____

Part IV

Study the pictorial drawing of the shifter shown in Figure 5-29 and write in the dimensions indicated by the following letters on the orthographic views.

1. A. ______________________________
2. B. ______________________________
3. C. ______________________________
4. D. ______________________________
5. E. ______________________________
6. F. ______________________________
7. G. ______________________________
8. H. ______________________________
9. I. ______________________________
10. J. ______________________________
11. Surface L indicates which view?

____

12. Surface K indicates which view?

____

13. What is the scale of the original drawing?

____

14. What is the drawing number?

____

15. What material is specified?

____

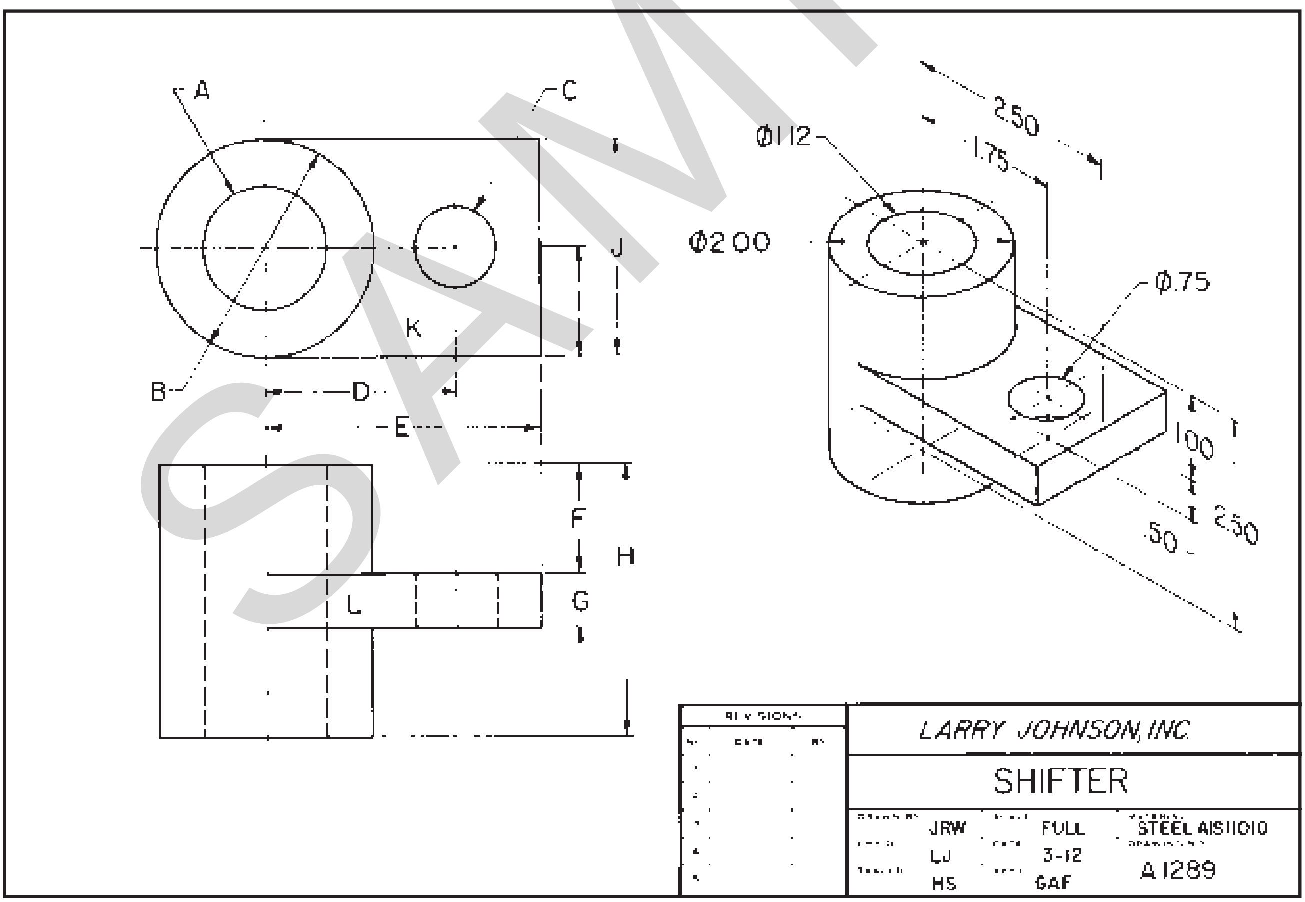

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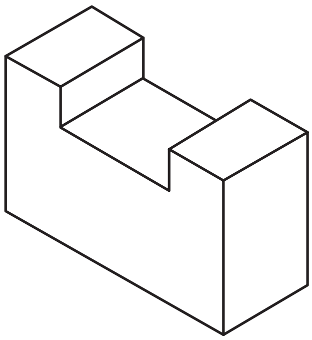
Figure 5-29.
Use this print of a shifter to answer questions in Part IV of the Print Reading Activities.

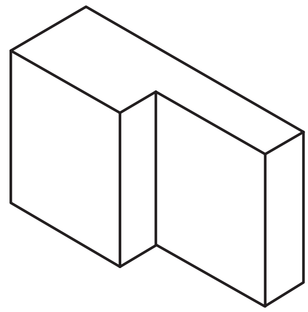
Name ____

Part V

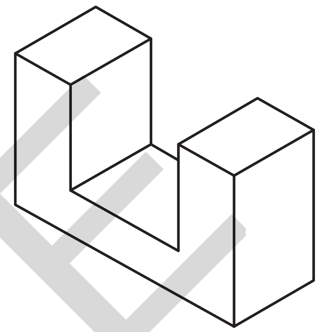
Study the pictorial views and match each orthographic drawing with its pictorial drawing. Place the correct letter in the space provided.



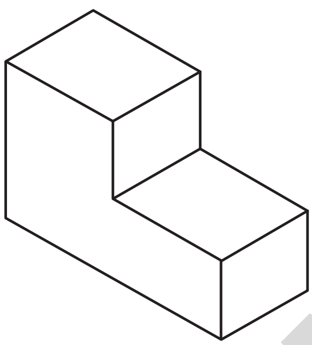
A.



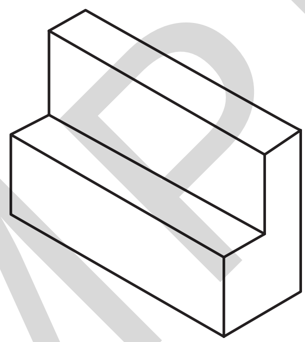
B.



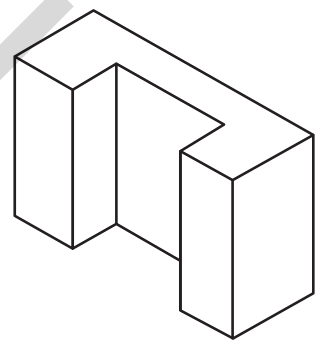
C.



D.

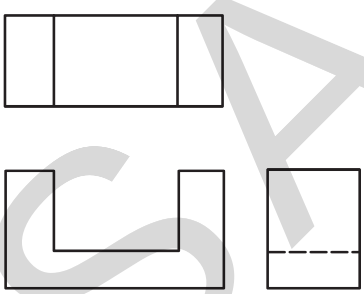


E.

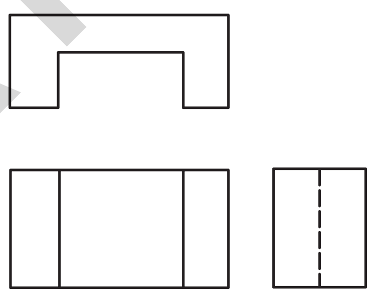


F.

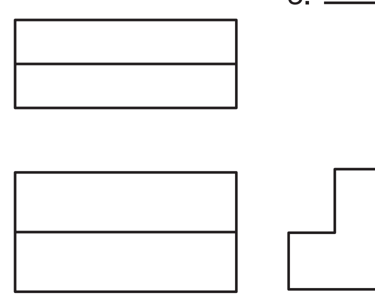
1. _____



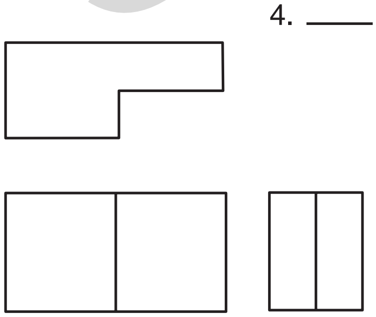
2. _____



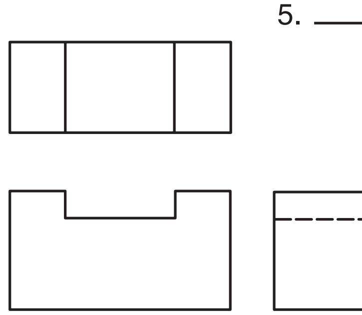
3. _____



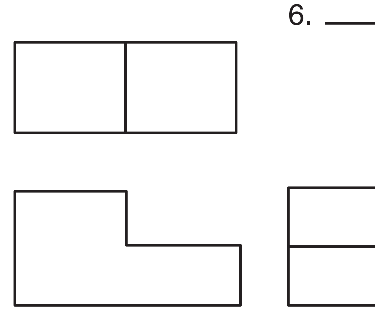
4. _____



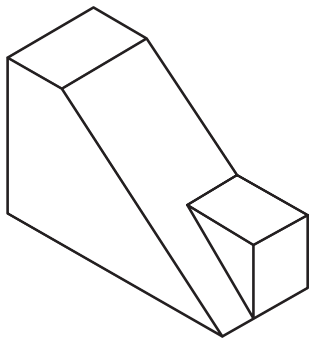
5. _____



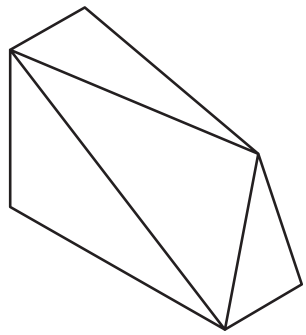
6. _____



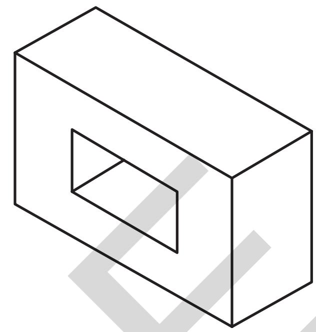
Part V (continued)



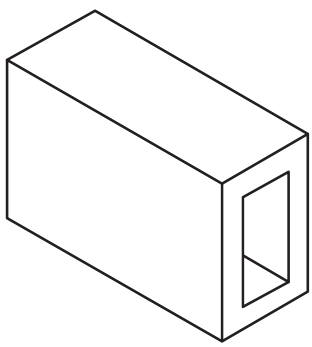
G.



H.



I.



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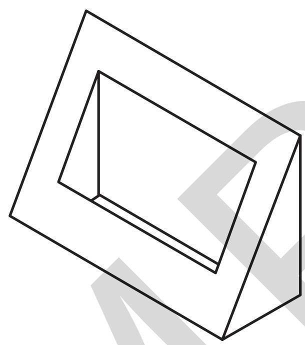

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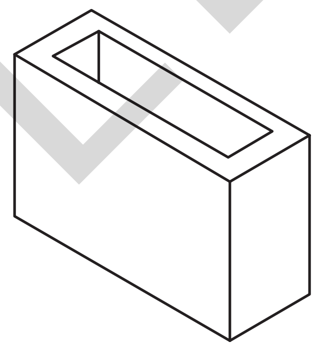
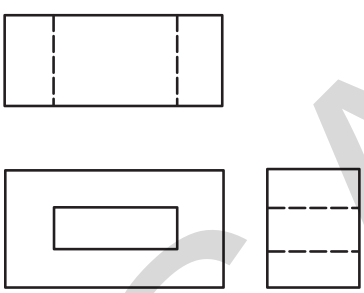
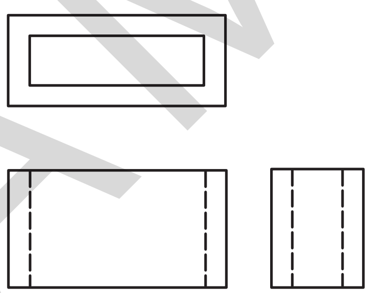


L.

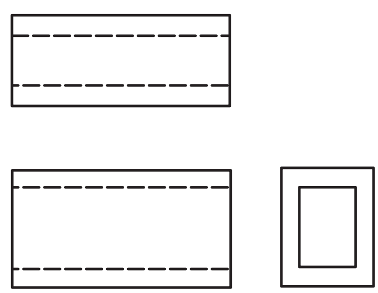
7. ____



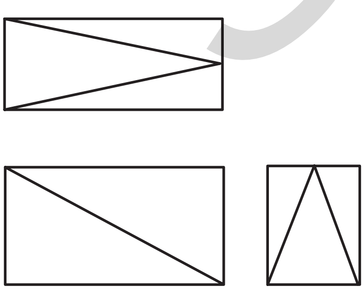
8. ____



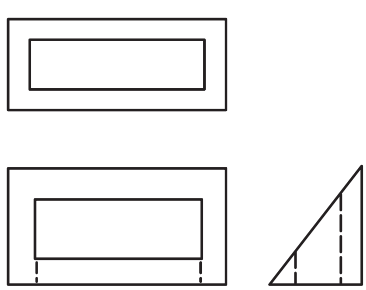
9. ____



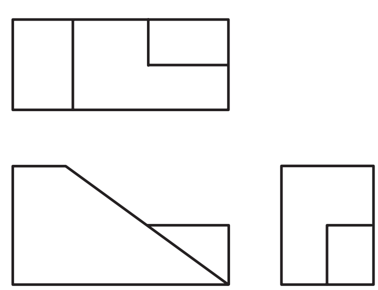
10. ____



11. ____



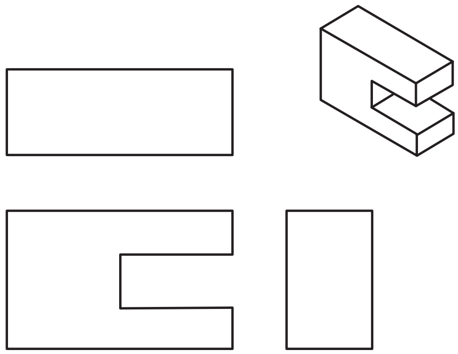
12. ____



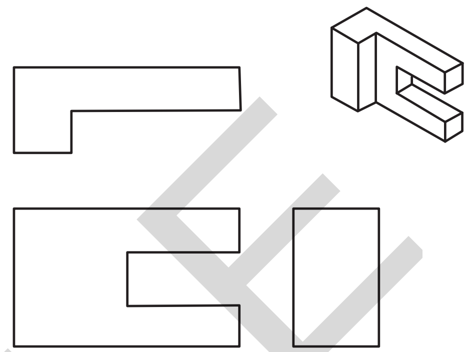
Name ____

Part VI

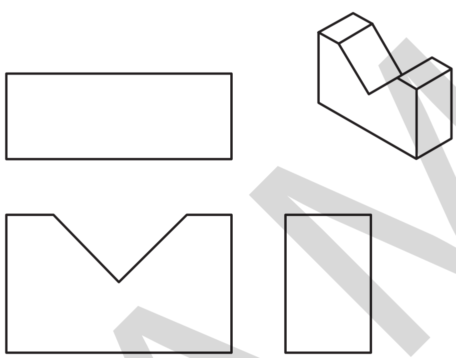
Sketch in the correct missing lines in the orthographic projection drawings.



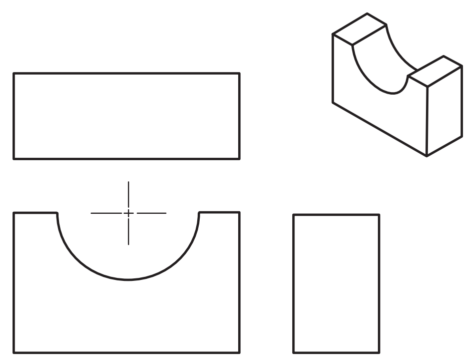
1.



2.



3.



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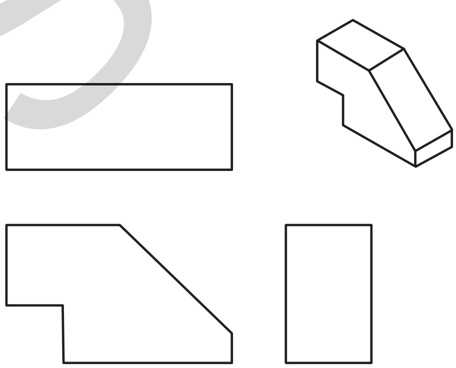

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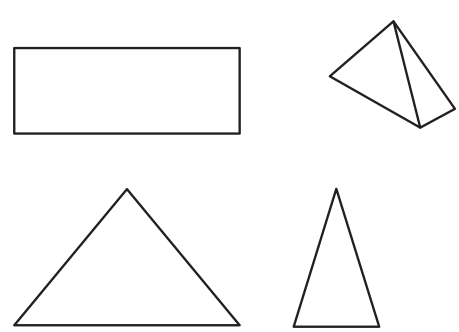
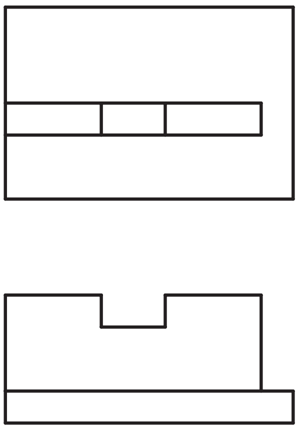


6.

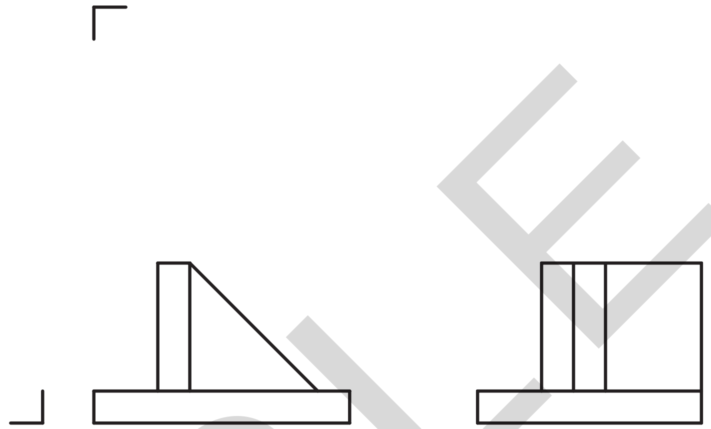
Part VII

Complete the missing view for each.

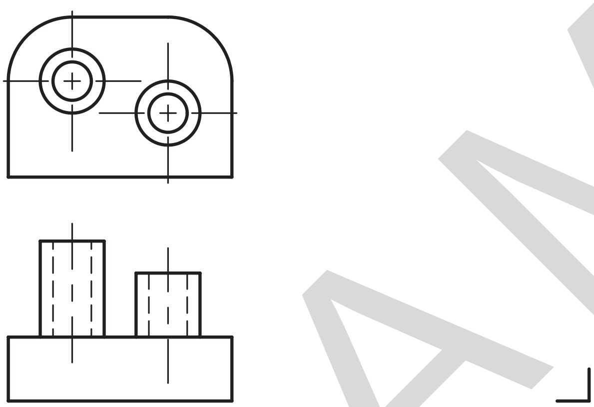
1.



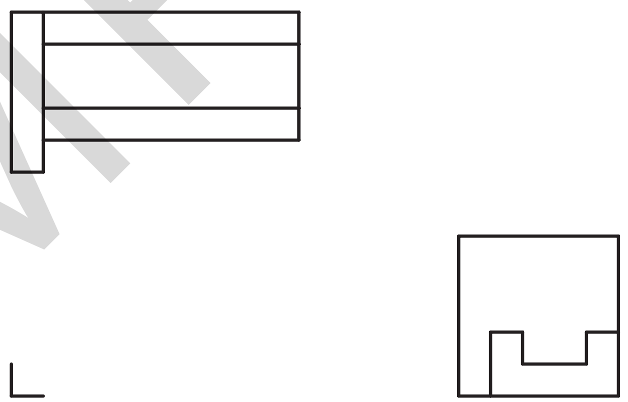
2.



3.



4.

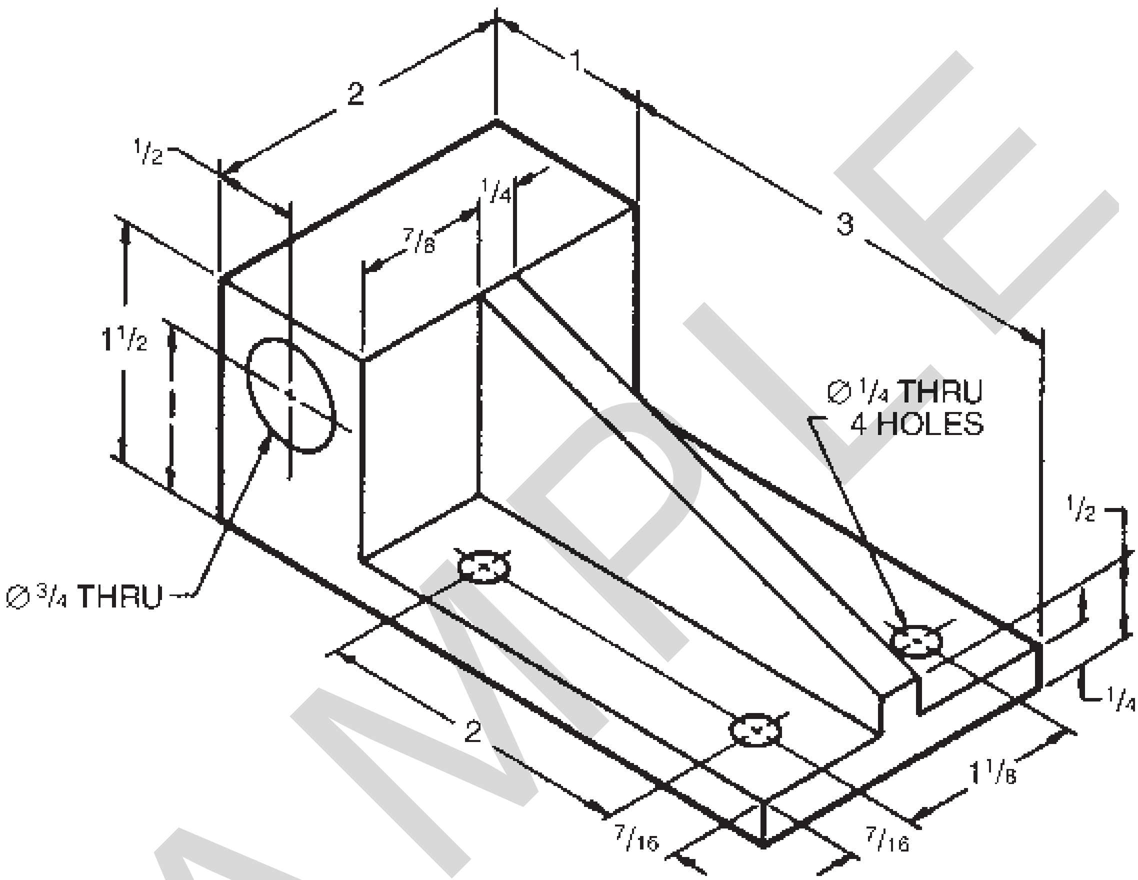


Name ____

Part VIII

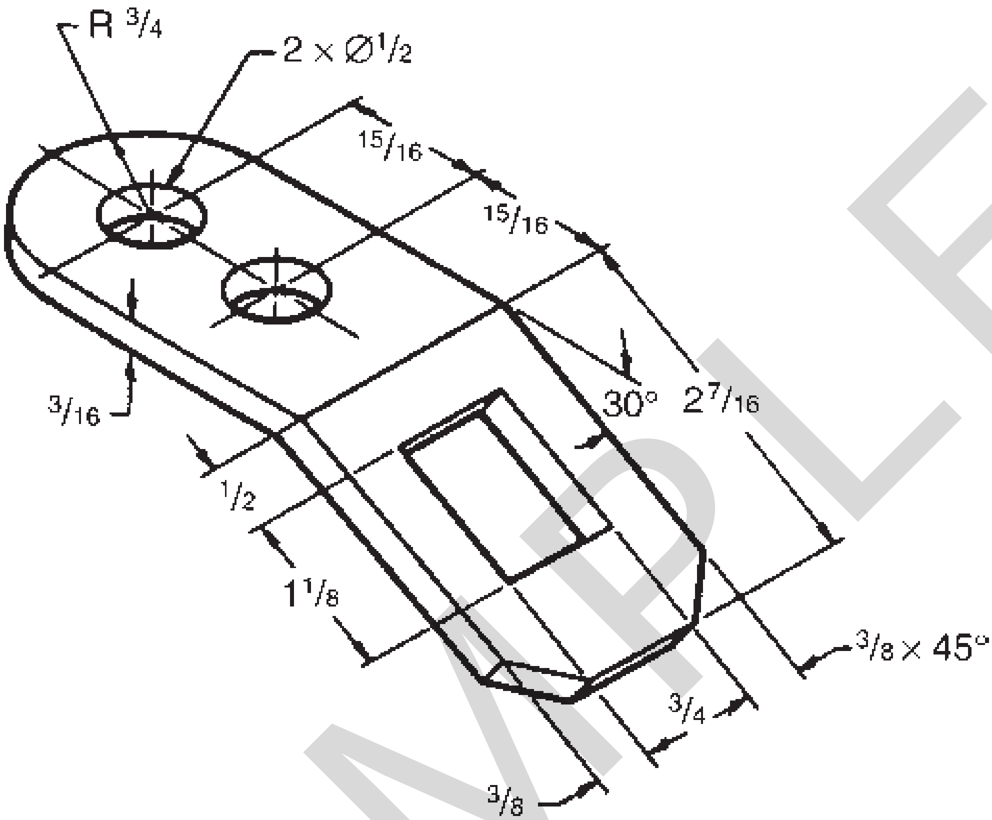
Study the pictorial drawings and sketch an orthographic projection (three views) for each.

1.



Part VIII (continued)

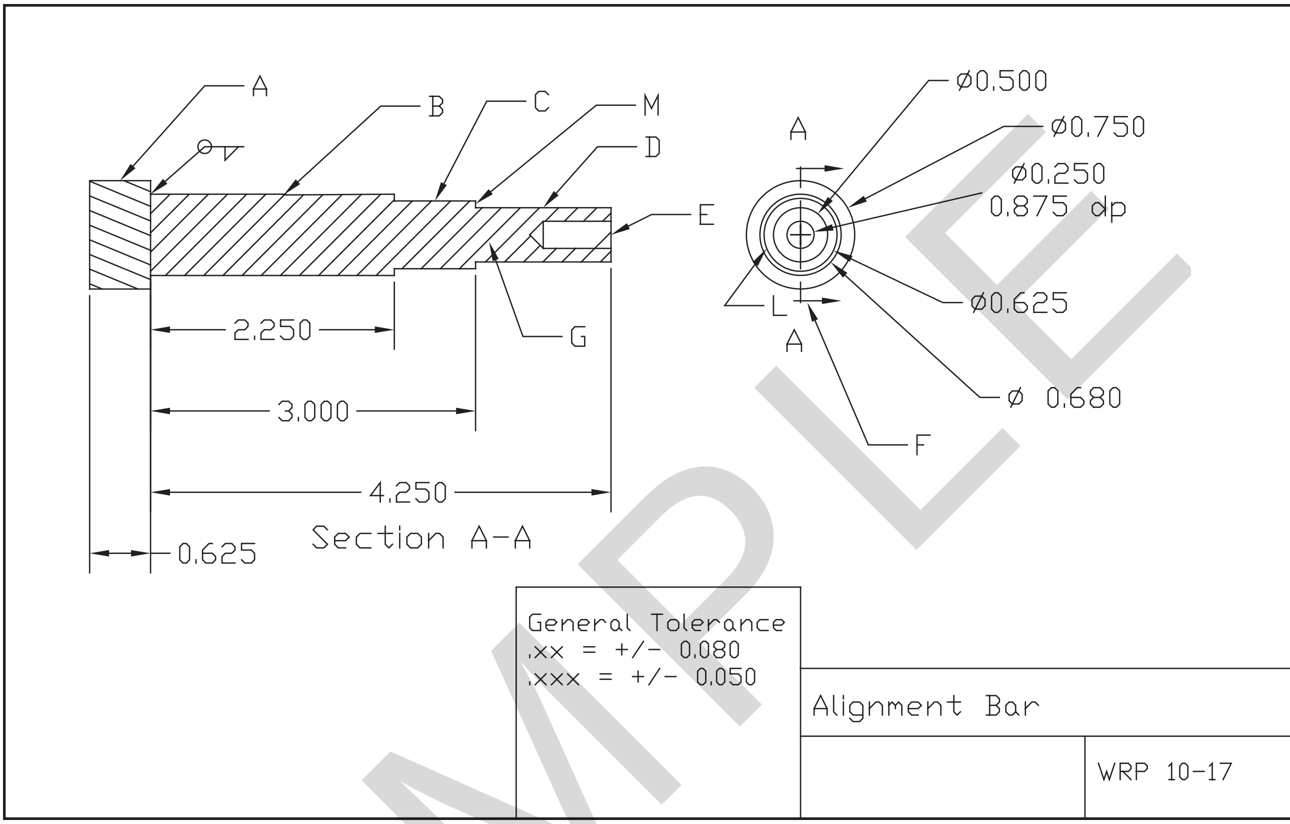
2.



Name ____

Part IX

Use the alignment bar drawing shown below to answer the questions in Part IX of the Print Reading Activities.



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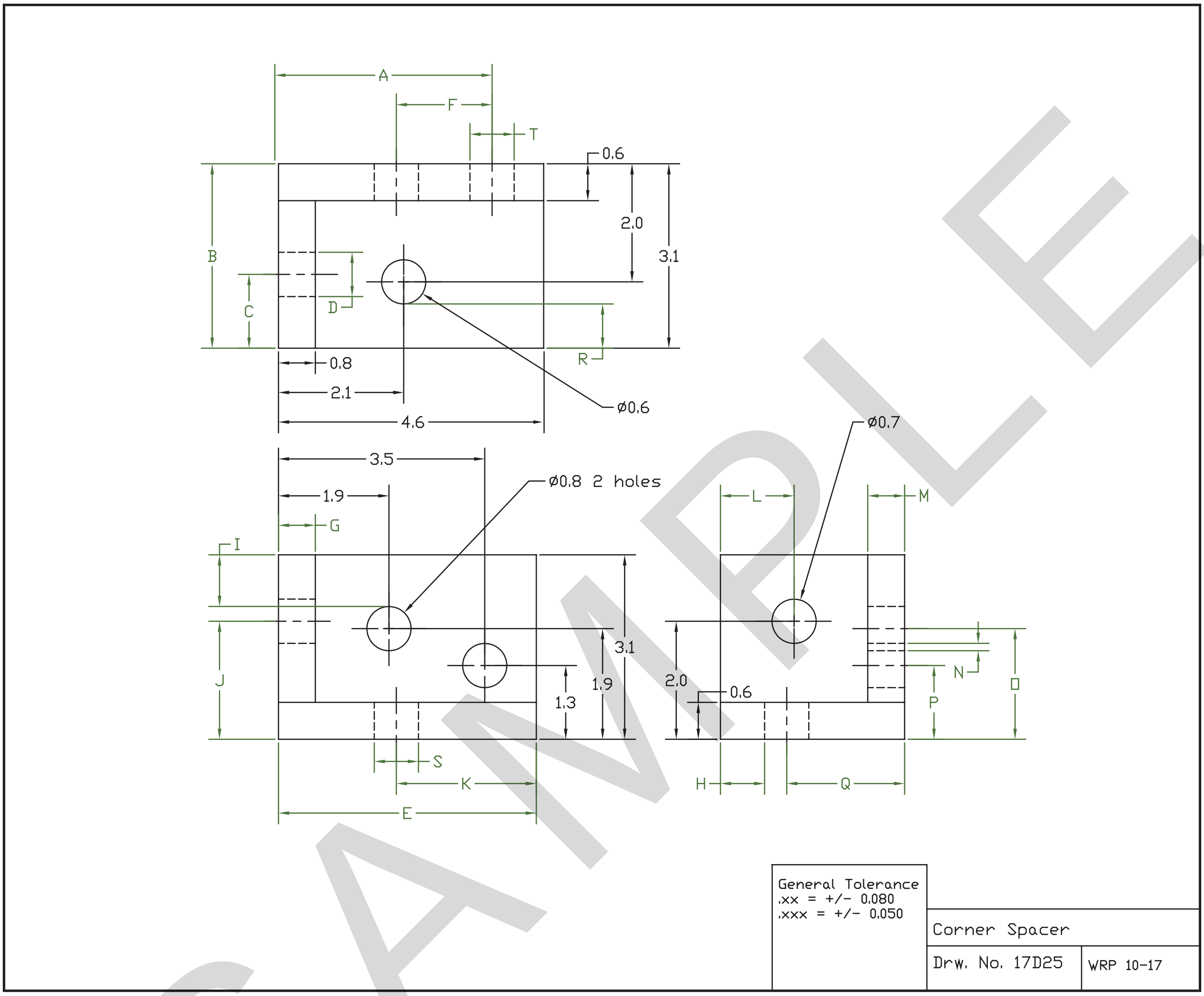
1. How many individual pieces are used to fabricate the alignment bar? __________
2. List the overall length of the alignment bar.
____
3. How deep is the hole drilled in the right end of the alignment bar? __________
4. List the diameter of Section A. __________
5. What type of line is at F?
____
6. What line in the top view represents line L?
____
7. What type of line is at G?
____
8. What type of weld is required for the assembly?
____
9. How many holes are required for the part?
____
10. What type of drawing is shown in the alignment bar drawing?
____
11. List the length of Section B plus Section C.
____
12. List the diameter of Section C. __________
13. What is the length of Section D? __________
14. What is the length of Section C? __________
15. What two views are shown in this drawing?
____

Part X

Use the corner spacer drawing shown below to answer the questions in Part X of the Print Reading Activities.



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1. A. ____________________
2. B. ____________________
3. C. ____________________
4. D. ____________________
5. E. ____________________
6. F. ____________________
7. G. ____________________
8. H. ____________________
9. I. ____________________
10. J. ____________________
11. K. ____________________
12. L. ____________________
13. M. ____________________
14. N. ____________________
15. O. ____________________
16. P. ____________________
17. Q. ____________________
18. R. ____________________
19. S. ____________________
20. T. ____________________