Engineering Drawing and Related Documentation Practices

ASME Y14.3-2003

[Revision of ASME Y14.3M-1994 (R1999)]

MULTIVIEW AND SECTIONAL VIEW DRAWINGS

An American National Standard

The American Society of Mechanical Engineers

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AN AMERICAN NATIONAL STANDARD

MULTIVIEW AND SECTIONAL VIEW DRAWINGS

ASME Y14.3-2003

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FOREWORD

This revision of ASME Y14.3M-1994 was initiated in response to industry and DOD requests that international practices and CAD capabilities be accommodated. The work on this revision of the standard began at the St. Louis meeting of the ASME Y14 Subcommittee 3 in October 2000.

Significant revisions include

(a) the International Organization for Standardization (ISO) practice of view identification was added as an alternative practice and is identified as the reference arrow method. This was added to permit compliance with this ASME Standard while working in an international market that may also require compliance with ISO standards.

(b) the utilization of true geometry views is shown as the preferred practice with conventional practices allowable. This revision is made to better utilize the solid modeling and view generation capabilities of CAD software.

(c) a representation of the solid geometry is included in many of the figures.

The successful revision of this Standard is attributed to the commitment of the committee members and the support of their sponsoring companies. The commitment of time and their contributed expertise are gratefully acknowledged.

Suggestions for improvement of this Standard are welcomed. They should be sent to The American Society of Mechanical Engineers, Attention: Secretary, Y14 Main Committee, Three Park Avenue, New York, NY 10016.

This Standard was approved as an American National Standard on April 24, 2003.

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ENGINEERING DRAWING AND RELATED DOCUMENTATION PRACTICES

MULTIVIEW AND SECTIONAL VIEW DRAWINGS

1 GENERAL

1.1 Scope

This Standard establishes the requirements for creating orthographic views for item description. The topics covered include the multiview system of drawing, selection, and arrangement of orthographic views, auxiliary views, sectional views, details, and conventional drawing practices. Space geometry and space analysis and applications are included in the appendices for informational purposes.

1.2 References

The following documents form a part of this Standard to the extent specified herein. The latest issue shall apply.

ASME Y14.1, Drawing Sheet Size and Format[1]
ASME Y14.1M, Metric Drawing Sheet Size and Format[1]
ASME Y14.2M, Line Conventions and Lettering[1]
Publisher: The American Society of Mechanical Engineers (ASME International), Three Park Avenue, New York, NY 10016-5990; ASME Order Department: 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300

ISO 128-30, Technical Drawings — General Principles of Presentation — Part 30: Basic Conventions for Views[1]
Publisher: International Organization for Standardization (ISO), 1 rue de Varembé, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse

1.3 Definitions

adjacent views: two adjoining orthographic views aligned by projectors.

related views: two views that are adjacent to the same intermediate view.

true geometry views: views that show the actual shape description, and when it is a section view it shows the actual shape cut by the cutting plane.

1.4 Orthographic Projection

Orthographic projection is a system of drawing composed of images of an object formed by projectors from the object perpendicular to desired planes of projection.

[1] May also be obtained from the American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036.

1.5 Orthographic View

An orthographic view is the figure outlined upon the projection plane by means of the system of orthographic projection. Such a view shows the true shape of a surface parallel to the projection plane (area ABCD with hole in Fig. 1). When an area is not parallel to the plane, the view of the area will be foreshortened (area BCEF in Fig. 1).

1.6 Projection Systems

The two internationally recognized systems of projection are third angle projection and first angle projection. Unless otherwise stated, this Standard features third angle projection.

1.6.1 Third Angle Projection. Third angle projection is the formation of an image or view upon a plane of projection placed between the object and the observer. Third angle projection is the accepted method used in the United States. See Fig. 2.

1.6.2 First Angle Projection. First angle projection places the object between the observer and the plane of projection. This method of projection used in some countries is herein described, in consideration of the need to interchange engineering drawings in an international market. See Fig. 3.

1.6.3 View Relationships. Note that the orthographic views of the object have the same configuration in both the first and third angle projections, but the placement of the views with respect to one another is different. The visibility of lines is always taken from the observer's point of view. See Figs. 4 and 5.

1.6.3.1 Alternative Practice, Reference Arrow Method. When it is desired to achieve compliance with ISO practices, reference arrows and view letters may be used for all views. These practices are in agreement with ISO 128-30. View identification for the reference arrow method does not include the word VIEW, and the identifying letter is placed above the view. Reference arrows may be shown in the CAD model, in an axonometric view, or on one of the principal orthographic views. When the reference arrow method is used, it shall be used for all views within the drawing. See Fig. 6. Reference arrow proportions are defined in Fig. 7.

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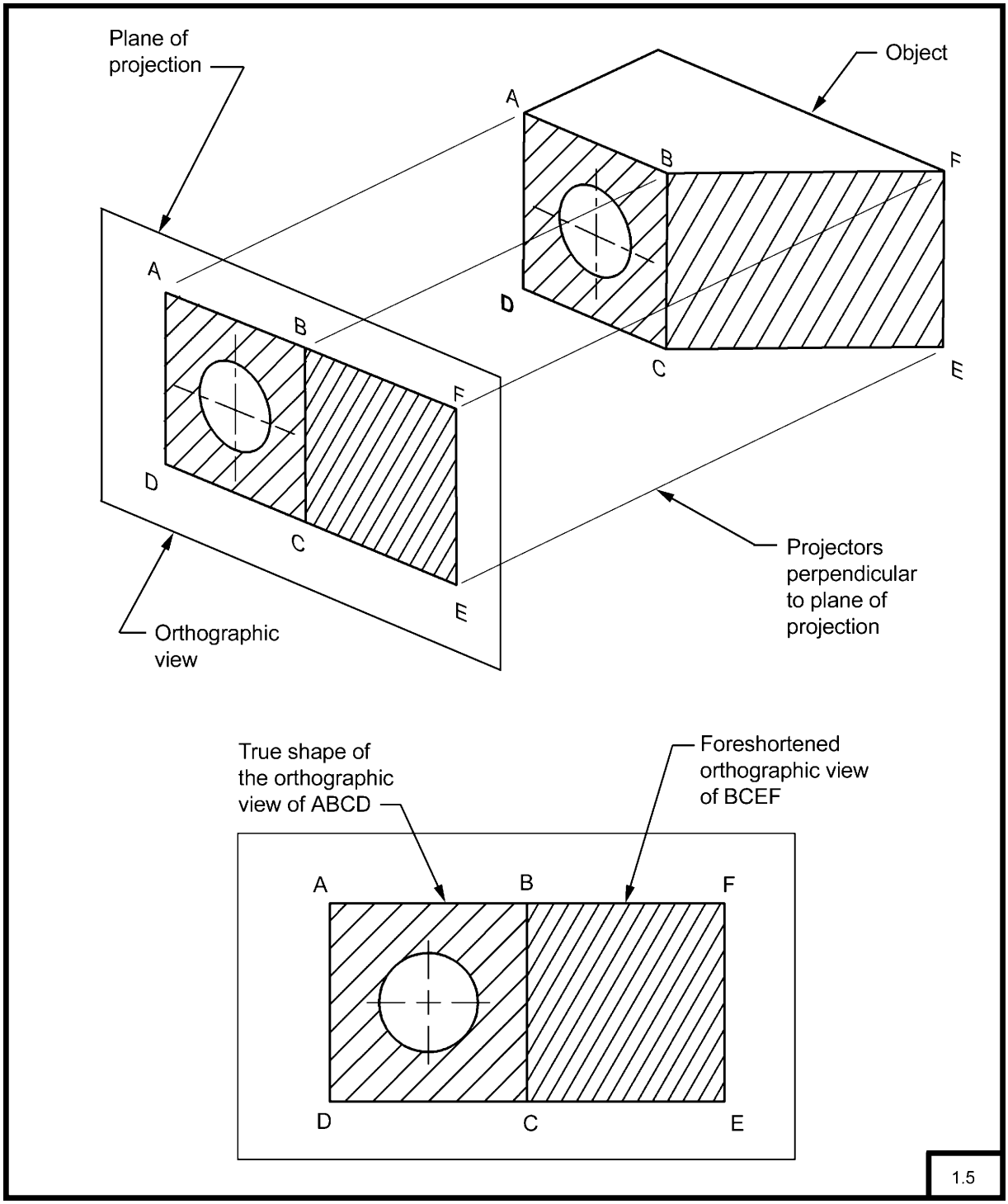


Fig. 1 Orthographic Projection to Form an Orthographic View

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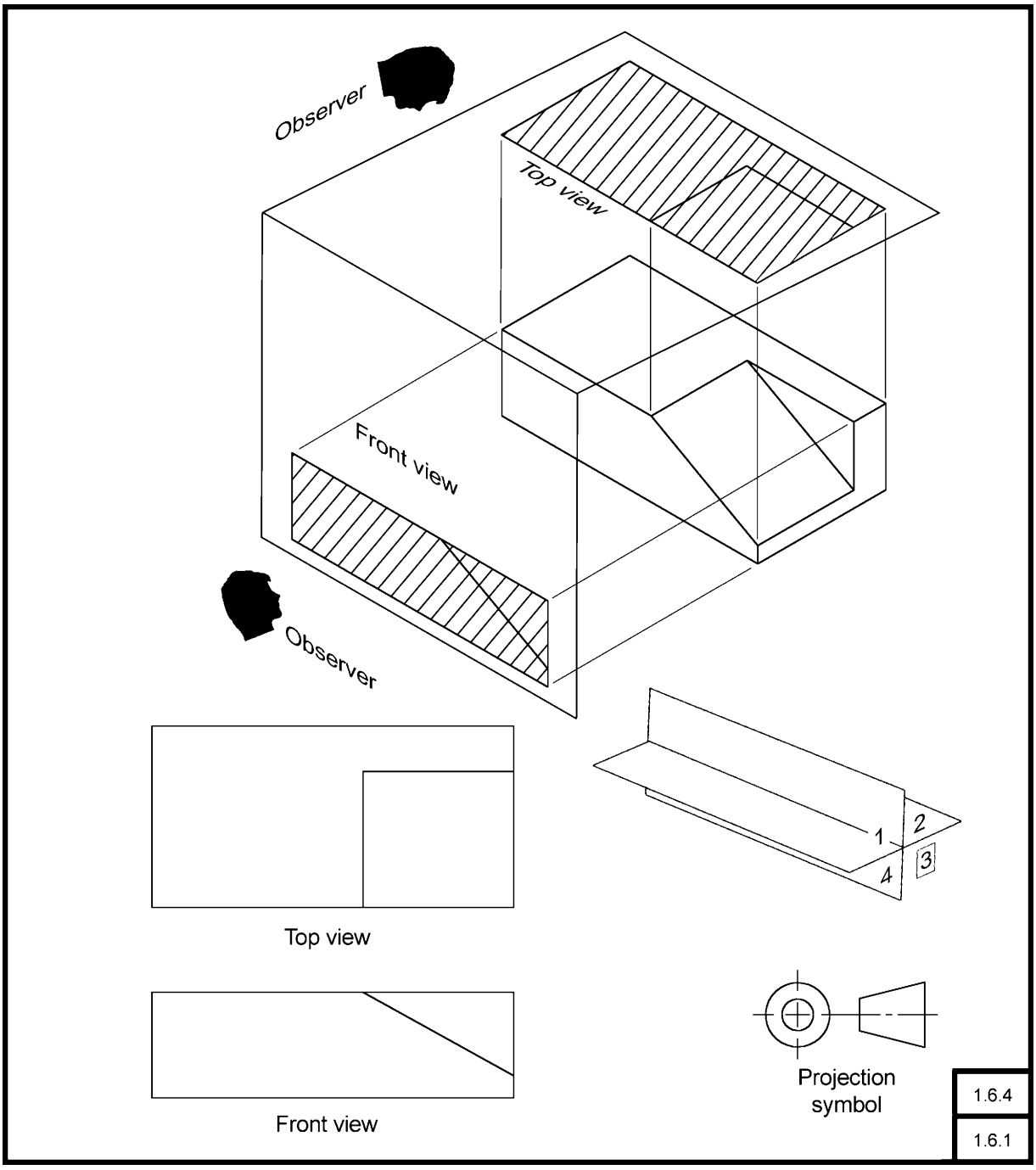


Fig. 2 Space and Orthographic Arrangement of Views (Third Angle Projection)

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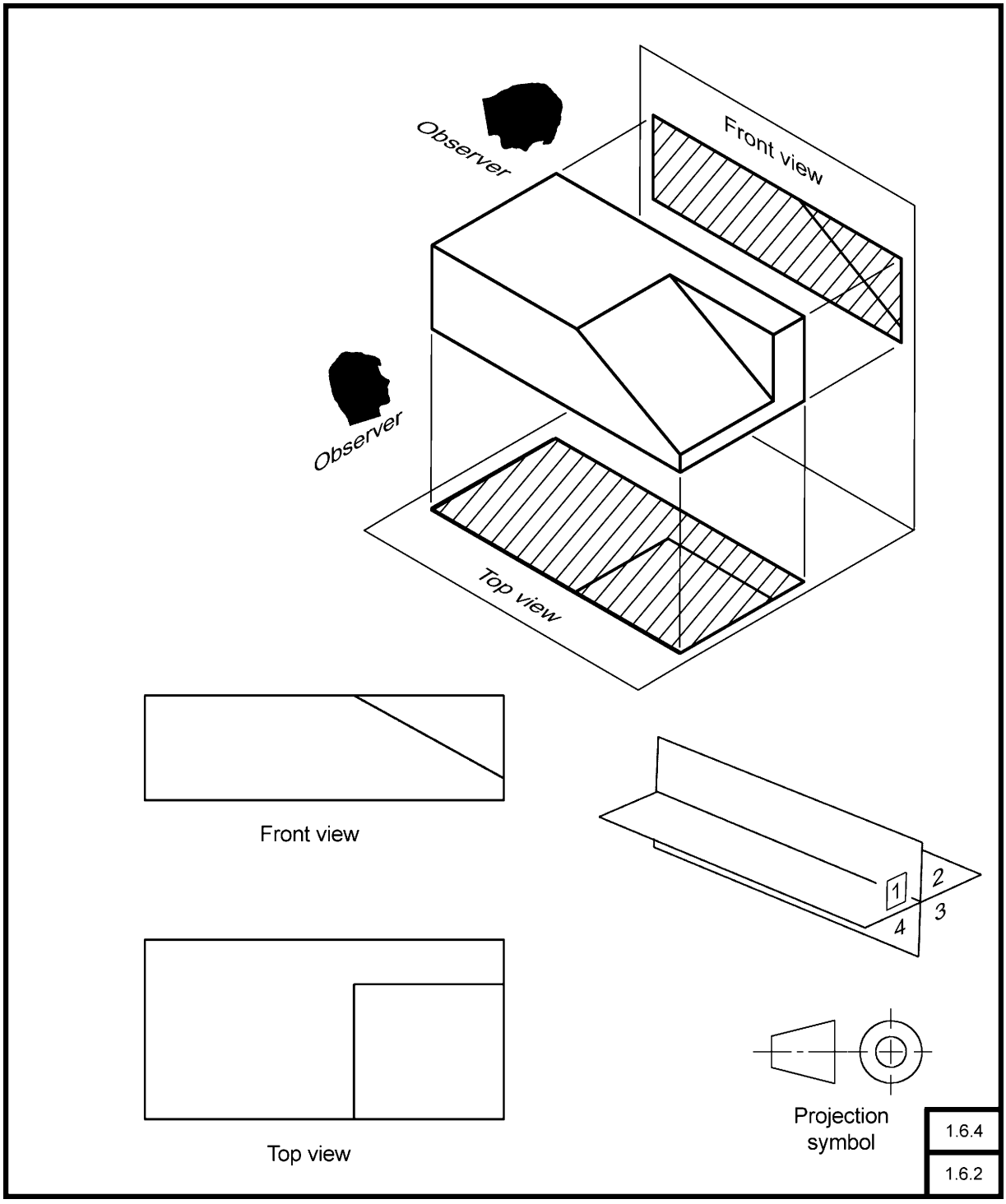


Fig. 3 Space and Orthographic Arrangement of Views (First Angle Projection)

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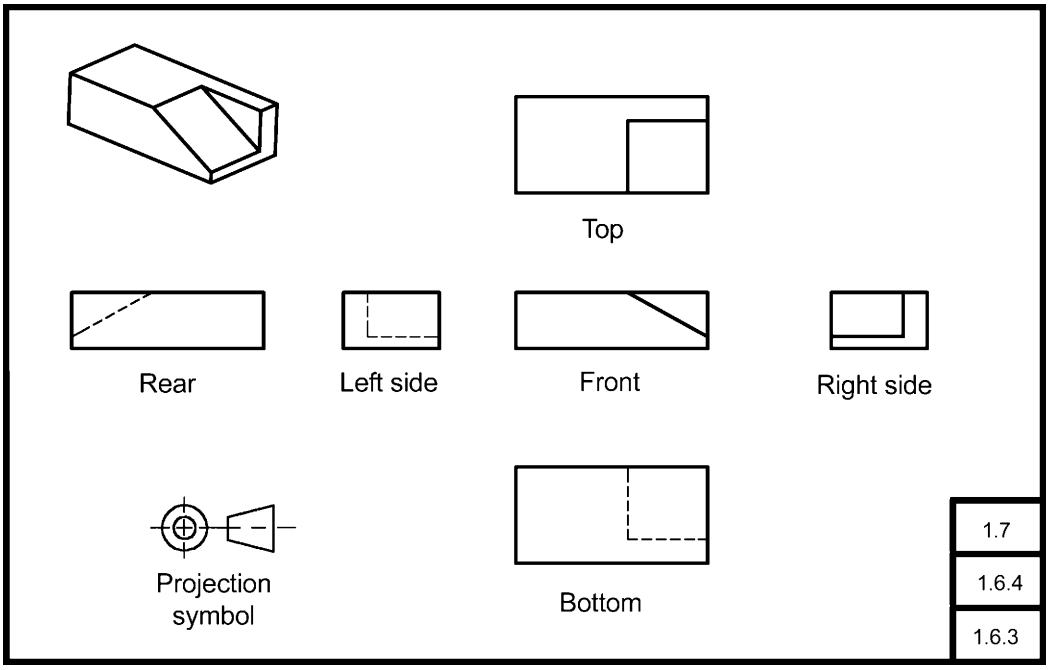


Fig. 4 Third Angle Projection Standard Arrangement of the Six Principal Orthographic Views

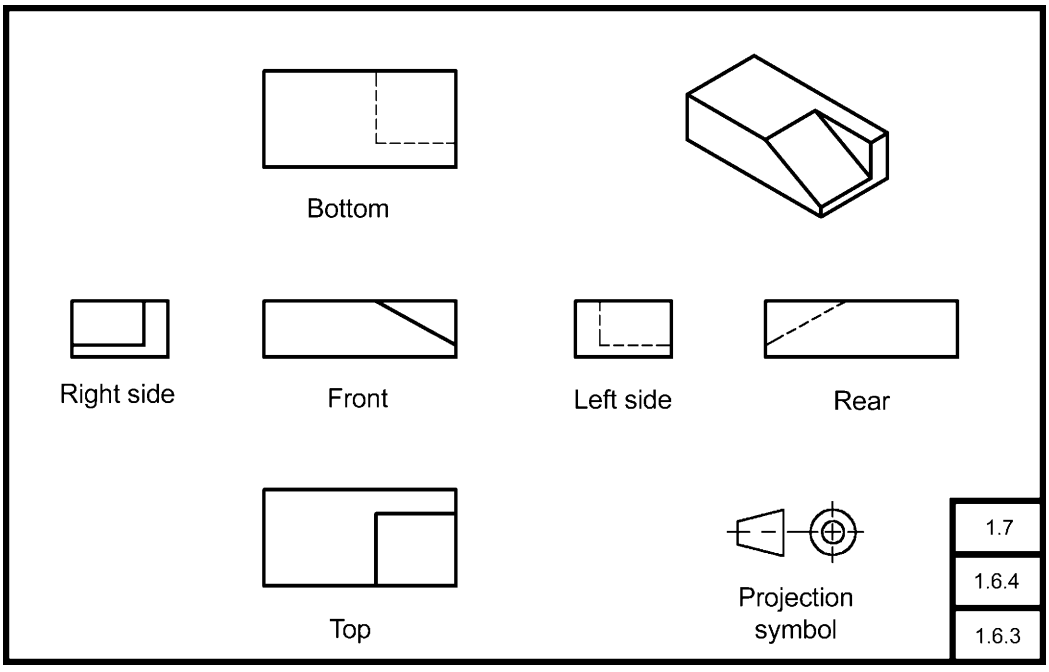


Fig. 5 First Angle Projection Standard Arrangement of the Six Principal Orthographic Views

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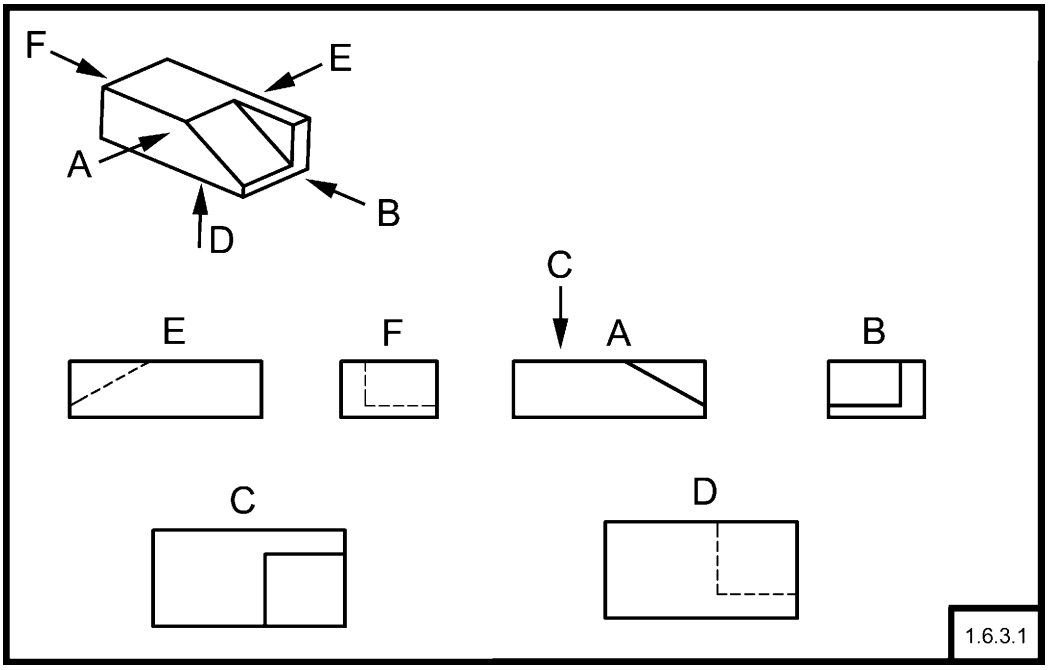


Fig. 6 Arrow Method — Principal Views

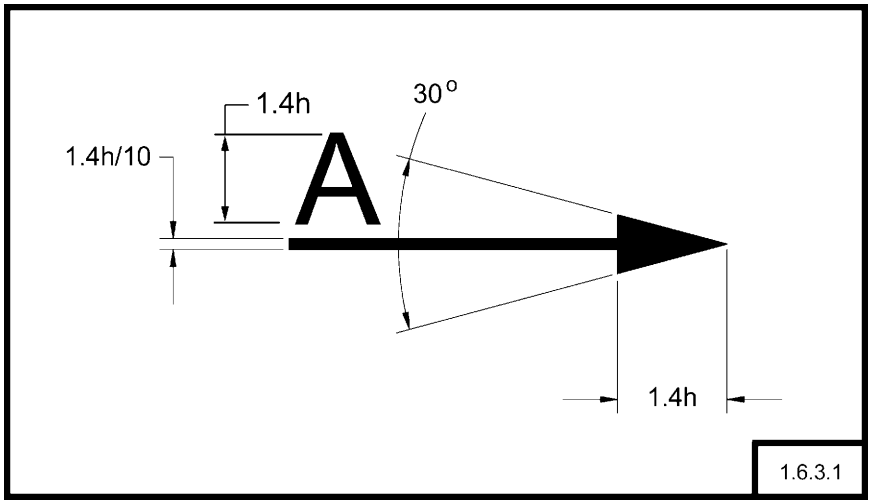


Fig. 7 Arrow Proportions

1.6.4 Projection Symbols. The projection symbols shown in Figs. 2, 3, 4, and 5 are internationally recognized. They may be used on drawings to be interchanged internationally to identify the projection method used in preparing the drawing. See Fig. 8 for proportional sizes and allowable orientations.

1.7 Principal Views

There are six principal views: top, front, bottom, right side, left side, and rear. The standard arrangement of all principal views in third angle orthographic projection is shown in Fig. 4. The standard arrangement of all principal views in first angle projection is shown in Fig. 5. A standard arrangement is not required when using the reference arrow method.

1.7.1 Placement and Orientation of Views. Alternative positions of views may be used to conserve space, but they should be properly oriented to each other. For example, the right- or left-side view might be placed adjacent to and in alignment with the top view. The rear

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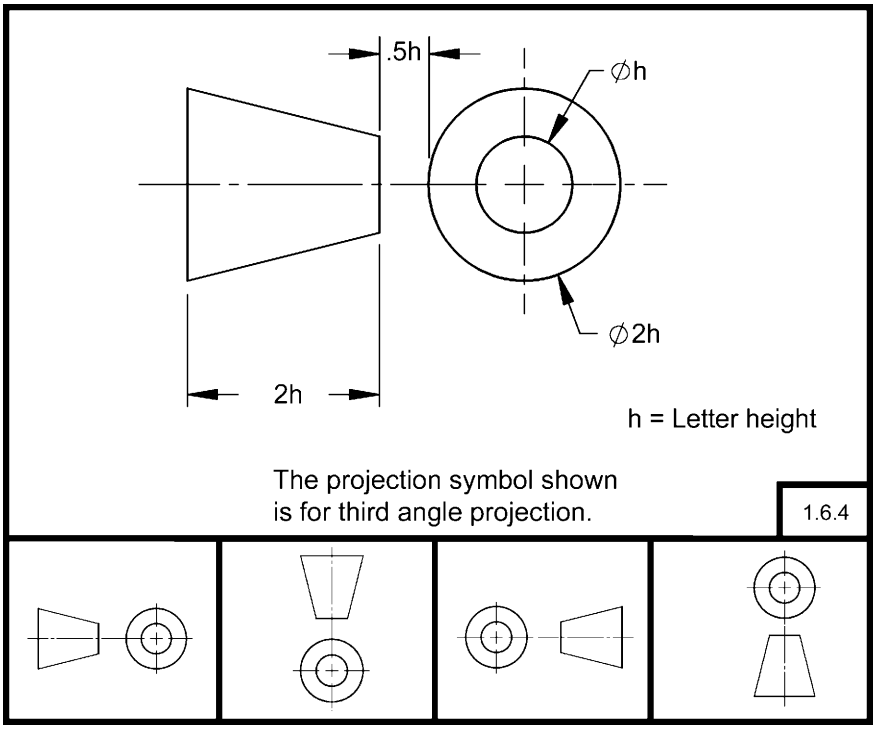


Fig. 8 Projection Symbol

view is sometimes placed in alignment with and to the right of the right-side view.

1.7.2 Removed Views. Under certain conditions it may be impracticable to place a view in its normal aligned position. In this instance, viewing indicators are used to indicate from where the view was taken, and the view is removed to another location on the field of the drawing. See Fig. 9. Removed views are preferably shown on the same sheet from which the view has been taken. The removed view is identified using the view letters. The removed view may be drawn at the same scale as the view from which it is taken, or it may be drawn at a noted scale. It is also permissible to use a combination of numbers and letters for removed view identification.

1.7.3 Identifying Removed Views. To relate the viewing plane or cutting plane to its removed view, capital letters such as A, B, C, etc., are placed near each arrowhead. The corresponding removed views are identified as VIEW A-A, VIEW B-B, VIEW C-C, etc. View letters should be used in alphabetical order excluding I, O, Q, S, X, and Z. When the alphabet is exhausted, additional removed views shall be identified by double letters in alphabetical order, as in AA-AA, AB-AB, AC-AC, etc.

1.7.4 Removed Views Alternative Practice. When using the reference arrow method, a single reference arrow and view letter are used to identify removed views. See Fig. 10.

1.7.5 Rotated Views. Due to the large size of depicted items and limitations on the height or width of the drawing format, a view may be rotated within the boundaries of a drawing sheet rather than maintain the orientation and split the view over two or more sheets. The angle and direction of rotation shall be placed beneath the view title. See Fig. 11.

1.7.6 Rotated Views Alternative Practice. When using the reference arrow method, the direction of rotation is indicated by an arc and arrow. The angle of rotation is noted adjacent to the arc. See Fig. 12. Arc and arrow proportions are shown in Fig. 13. The view letter is placed to the left, and the angle is placed to the right of the arc. Character sizes are in accordance with ASME Y14.2.

1.7.7 Cross-Referencing of Views. Cross-reference zoning may be used to indicate the location of an indicated view, and to reference a view back to the viewing location. When views are located on different sheets, the sheet number as well as the zone of the cross-reference location shall be indicated. See Fig. 14. One method of cross-referencing is shown in the figure. Additional methods of cross-referencing may be used.

2 MULTIVIEW DRAWING APPLIED

2.1 Purpose of Multiview Drawings

Multiview drawings represent the shape of an object using two or more views. These views, together with

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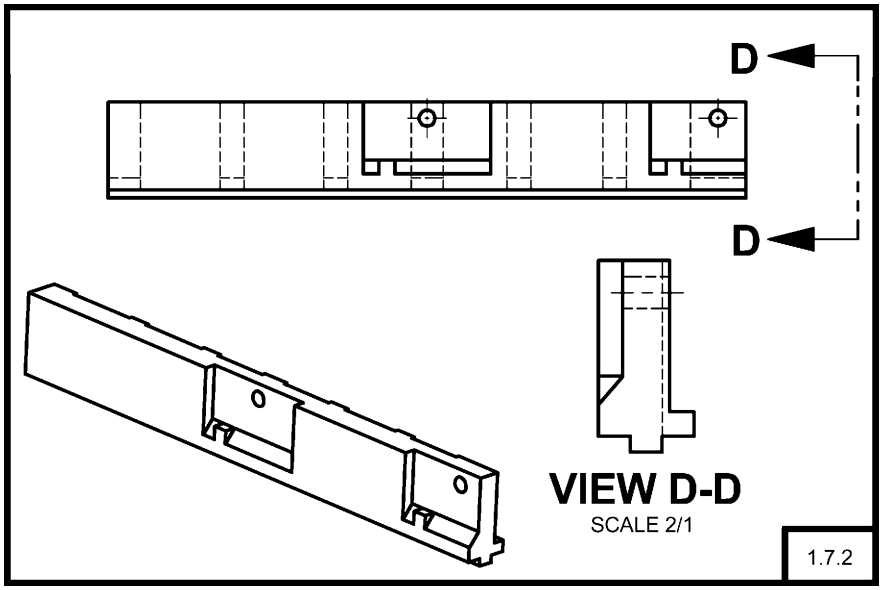


Fig. 9 Removed View

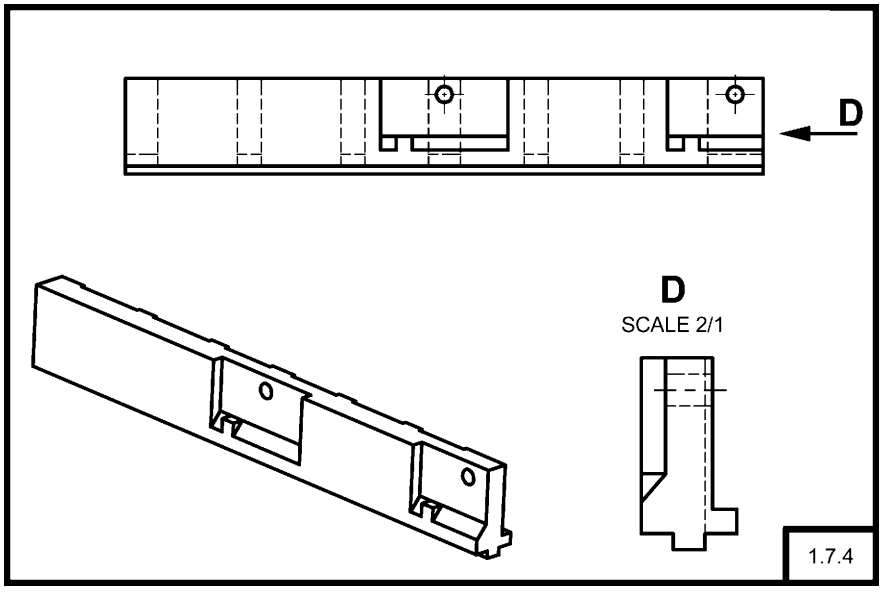


Fig. 10 Arrow Method — Removed View

necessary notes and dimensions, are sufficient for the part to be fabricated without further information concerning its shape. Consideration should be given to the choice and number of views that will completely define the true shape of the part.

2.2 Choice of Views

The front or principal view of the part is generally shown in a natural or assembled position. The minimum number of views necessary to describe the part are shown. Views are selected to show the fewest hidden lines and yet convey maximum clarity.

2.3 Necessary Views

The number of views required to describe a part is controlled by the complexity of the part. Simple parts may require only a short word description. Others may require one or two views. Three or more views may be required for more complex parts to facilitate reading

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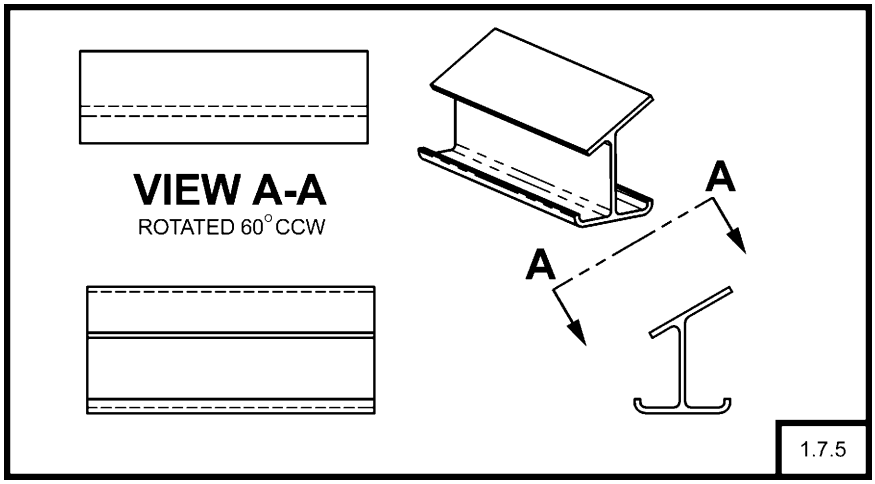


Fig. 11 Rotated View

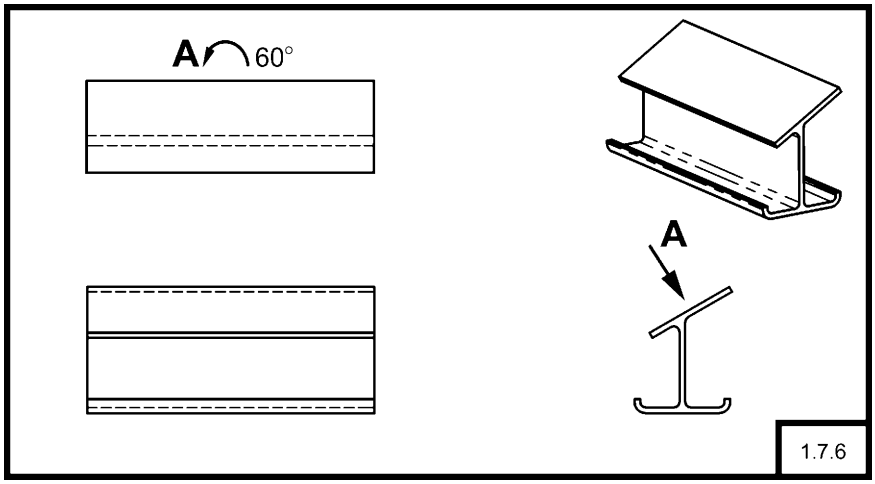


Fig. 12 Arrow Method — Rotated View

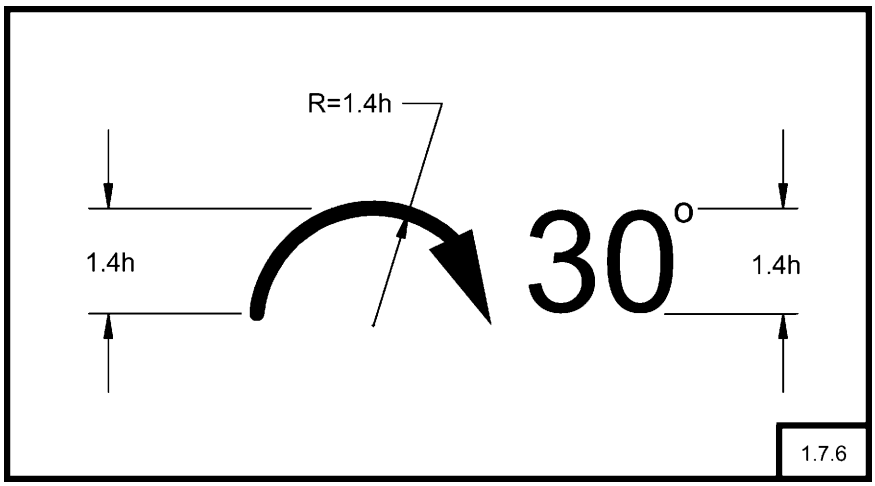


Fig. 13 Rotation Arrow

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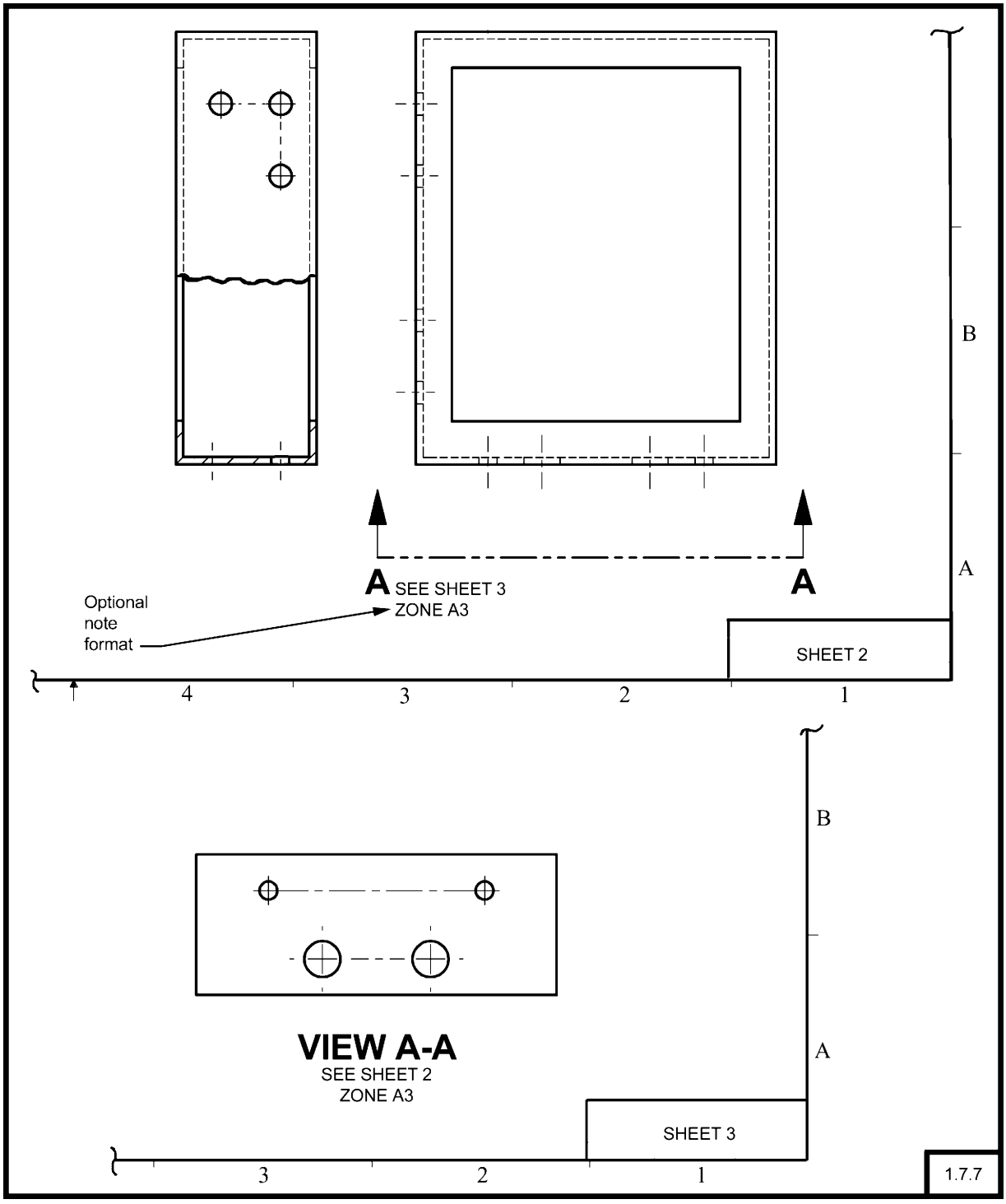


Fig. 14 Removed View on Multiple Sheet Drawing

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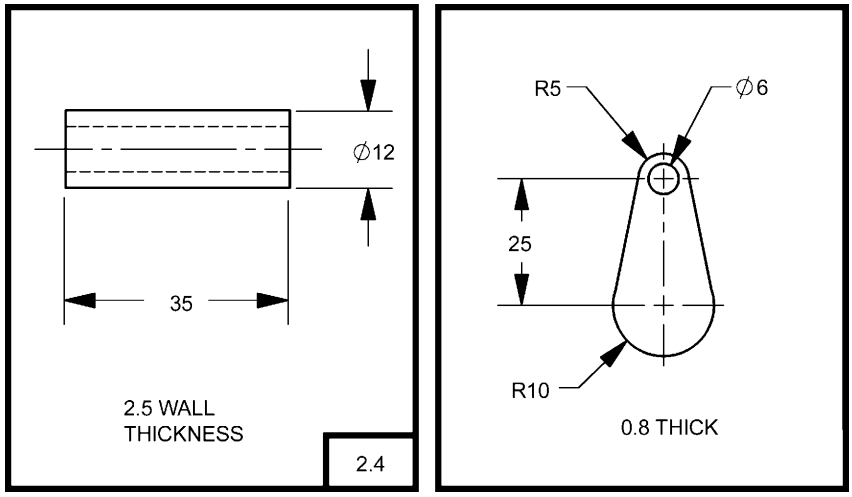


Fig. 15 One View Drawings

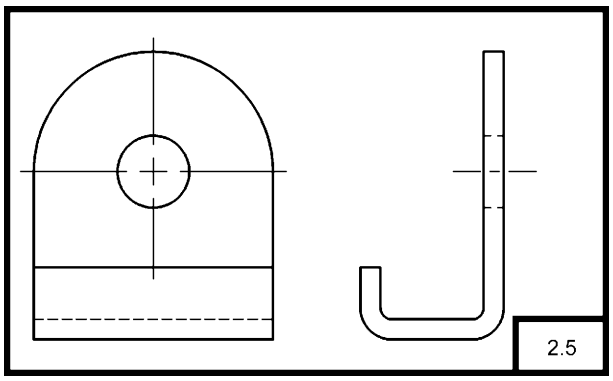


Fig. 16 Two View Drawing

and permit dimensioning to visible outlines in their true-shape view.

2.4 One View Drawings

Two adjacent views are normally considered the minimum requirement to describe a three dimensional object. However, the third dimension of some objects (washers, shafts, bushings, spacers, etc.) may be specified by a note and the drawing reduced to a single view. See Fig. 15.

2.5 Two View Drawings

Many items may be adequately described by showing only two views. These views shall be aligned in any standard position that will clearly illustrate the object. See Fig. 16.

2.6 Three View Drawings

The majority of multiview drawings consist of front, top, and side views arranged in their standard positions.

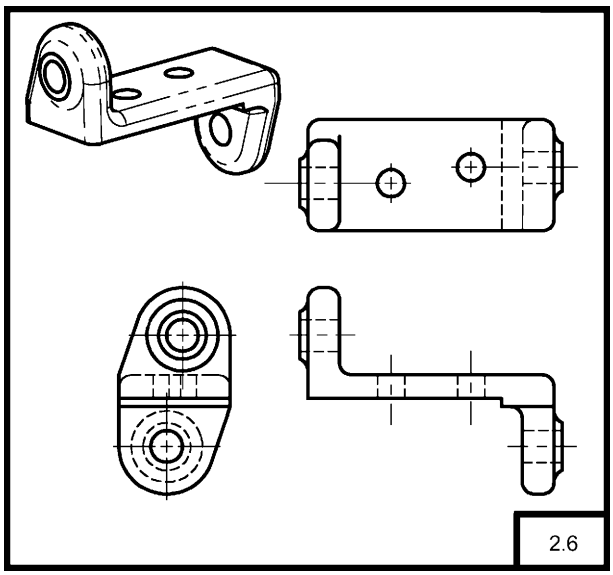


Fig. 17 Three View Drawing of a Casting

Any three adjacent views that best suit the shape of the part may be employed. See Figs. 17 and 18.

A partial third view may be used when the missing portion of the incomplete view is adequately described in other views. See Figs. 19 and 20.

2.7 Auxiliary Views

Auxiliary views are used to show true shape and relationship of features that are not parallel to any of the principal planes of projection. See Figs. 19, 20, 21, and 22.

2.7.1 Primary Auxiliary Views. A primary auxiliary view is one that is adjacent to and aligned with a principal view. Primary auxiliary views are identified as front

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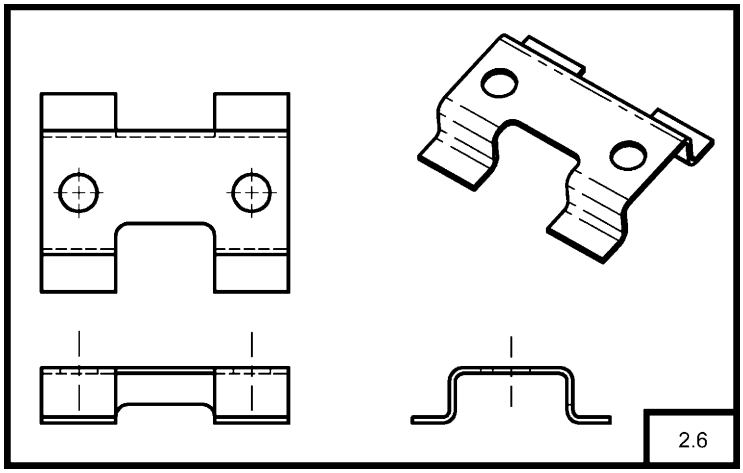


Fig. 18 Three View Drawing of a Stamping

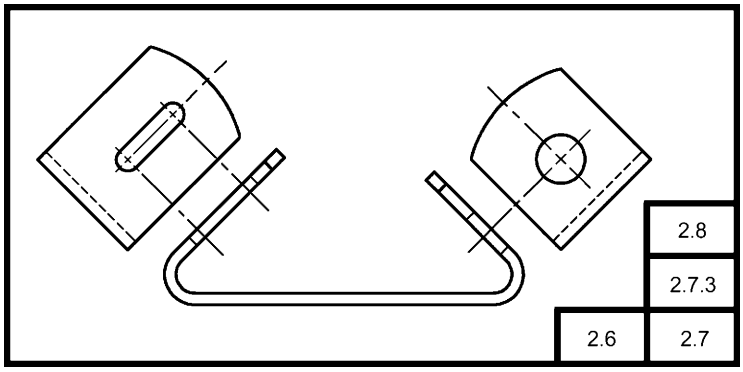


Fig. 19 Front View and Partial Auxiliary Views

adjacent, side adjacent, or top adjacent auxiliary views to indicate the principal view with which it is aligned. See Fig. 22.

2.7.2 Secondary Auxiliary Views. A secondary auxiliary view is one that is adjacent to and aligned with a primary auxiliary view or with another secondary auxiliary view. See Fig. 22.

2.7.3 Alignment of Auxiliary Views. Auxiliary views are aligned with the views from which they are projected. A center line or projection line may continue between the adjacent views to indicate the alignment. See Figs. 19, 20, 21, and 22. Alignment is not required in the case of a removed view or when using the reference arrow method.

2.8 Partial Views

Partial auxiliary views or partial principal views may show only pertinent features not described by true projection in the principal or other views. They are used in lieu of complete views to simplify the drawing. See Figs. 19, 20, 21, and 22.

2.9 Details

In areas where clarification is necessary or to better illustrate a complex configuration, a detail is shown elsewhere on the drawing to show small features at an increased scale and provide additional information. See Fig. 23.

Figure 23 shows a detail. It also shows additional information since the fastening device is included. View and zone referencing as described in paras. 1.7.2 and 1.7.7 may be used. The scale of the detail shall be noted.

2.10 Related Parts

Where the relationship between mating parts is important, the relative position of the detailed part to the related part is shown by using phantom lines to outline the related part. Notes may be added to indicate the functional relationship of these parts. See Fig. 24.

3 SECTIONAL VIEWS

3.1 Principles

3.1.1 Sectional Views. Sectional views, also called sections, are used to clarify interior construction that

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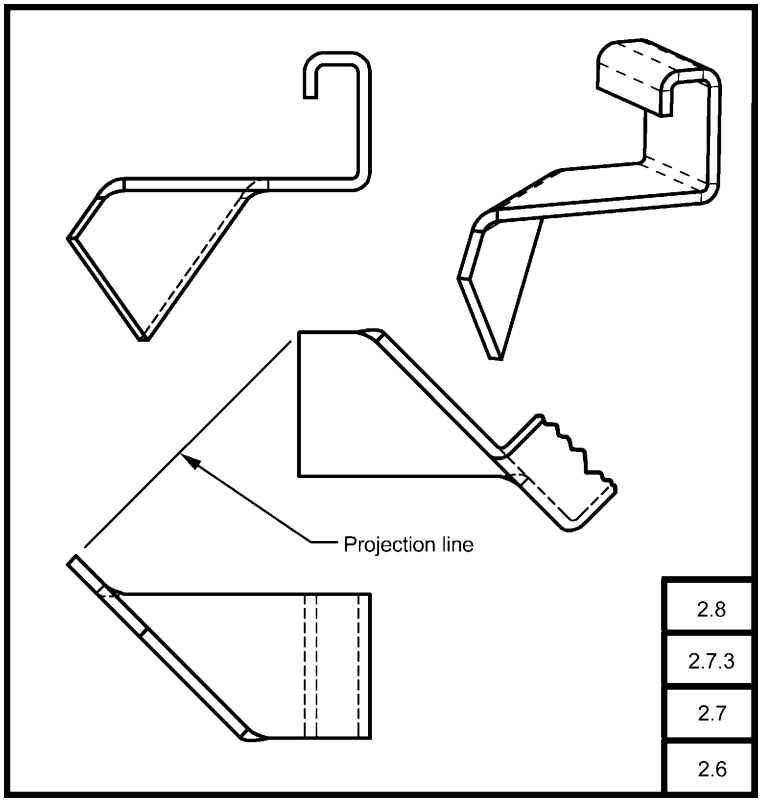


Fig. 20 Partial Auxiliary View

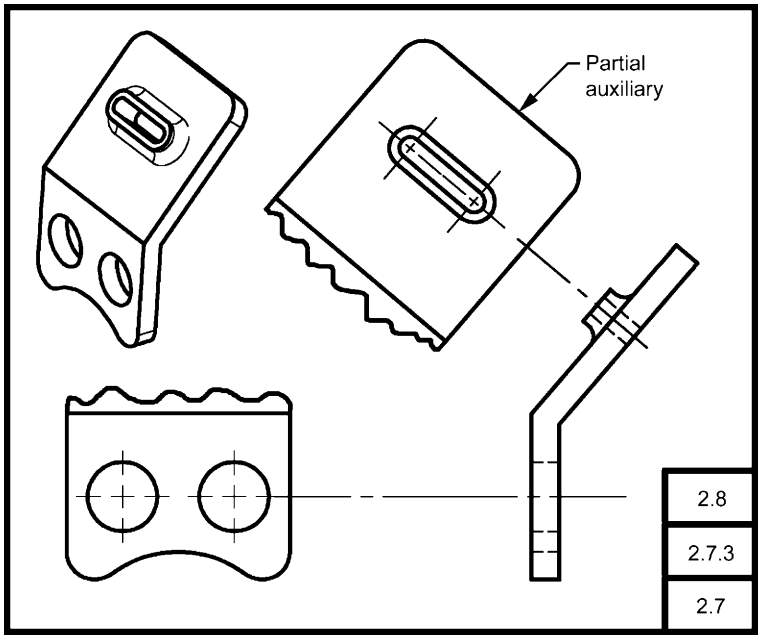


Fig. 21 Partial Auxiliary View, Partial Front View, and Right Side View

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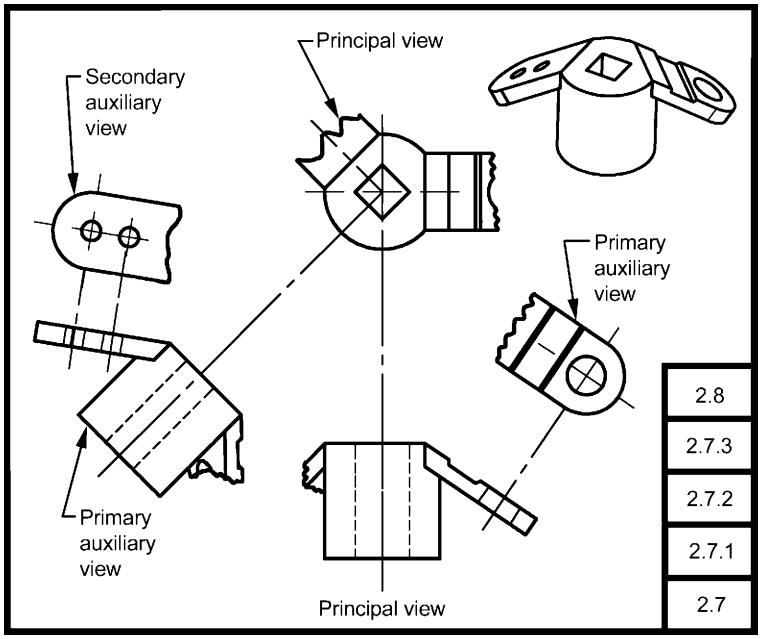


Fig. 22 Partial Primary and Secondary Auxiliary Views

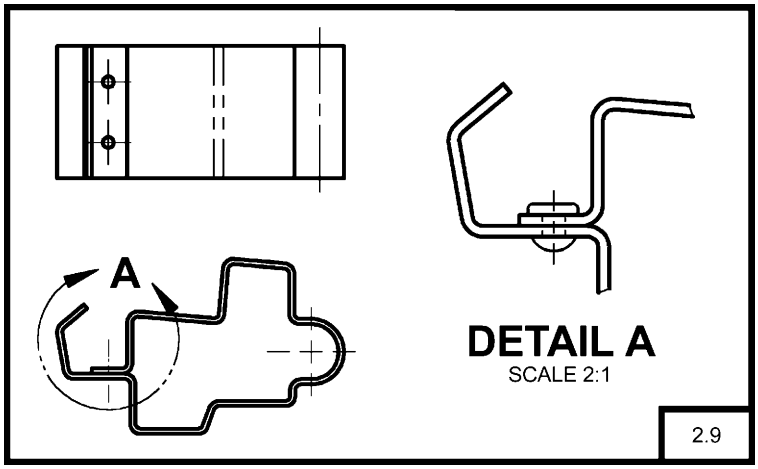


Fig. 23 Detail

cannot be clearly described by hidden lines in exterior views. A sectional view is obtained by an imaginary cutting plane passed through the object perpendicular to the direction of sight. The portion of the object between the cutting plane and the observer is assumed to be removed. When section lining is used, the exposed cut surfaces of the object are indicated by section lining (cross sectioning). See Fig. 25. The graphic depiction of the cut surface may be the exact part cross section, creating a true geometric view, or it may be modified according to conventions defined in this Standard. CAD practices usually result in the exact cross section while manual practices often rely on conventions. Section lining may be omitted where drawing clarity is not affected. See ASME Y14.2M.

3.1.2 Section View Location. A sectional view should appear on the same drawing sheet with the cutting plane view and be projected from and perpendicular to the cutting plane in conformity with the standard arrangement of views. This will result in the section view being placed behind the cutting plane in a properly projected position. Where space does not permit placement in the standard position, a removed or rotated section may be

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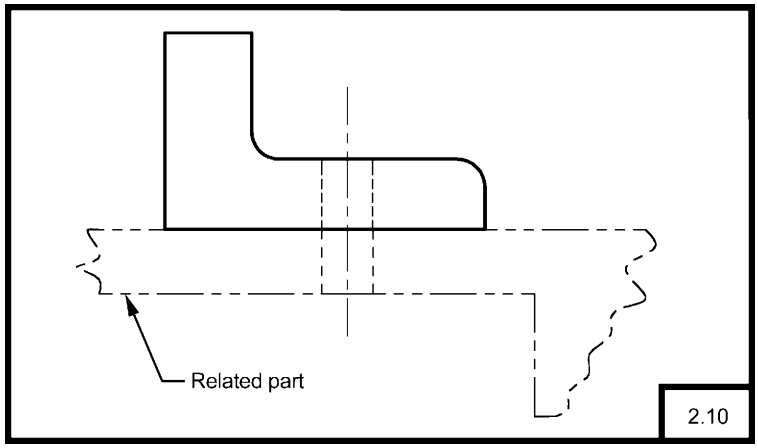


Fig. 24 Phantom Lines for Related Parts

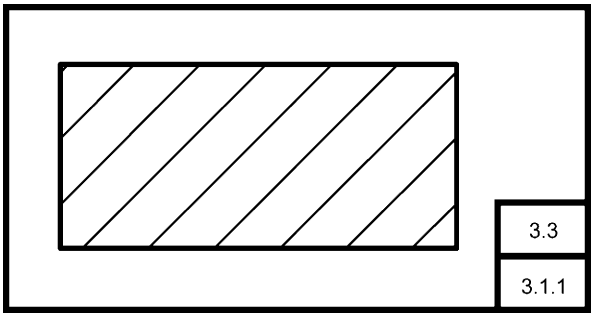


Fig. 25 Section Lining

used. Views shall be oriented according to the cutting plane orientation, unless clearly noted as described in paras. 1.7.5 and 3.8.

3.1.3 Cross-Referencing of Sections. Cross-reference zoning may be used to indicate the location of an indicated section, and to reference a section back to the viewing location. When sections are located on different sheets, the sheet number and zone of the cross-reference location shall be indicated. See Fig. 26. Sections shall be oriented according to the cutting plane orientation, unless clearly noted otherwise. The sheet number and zone cross reference may be in any format, provided that it is easily understood.

3.2 Cutting Plane

3.2.1 Cutting Plane Location. The location of the cutting plane is shown by a cutting plane line that represents the edge view of the cutting plane. The cutting plane may be omitted when its location is obvious as shown in Figs. 27 and 28.

3.2.2 Identifying Sections. To relate the cutting plane to its sectional view, capital letters such as A, B, C, etc., are placed near each arrowhead. Placement near one arrowhead is permitted when cutting planes are continuous between arrowheads and clarity is achieved. The corresponding sectional views are identified as SECTION A-A, SECTION B-B, SECTION C-C, etc. Section letters should be used in alphabetical order excluding I, O, Q, S, X, and Z. When the alphabet is exhausted, additional sections should be indicated by double letters in alphabetical order, as in AA-AA, AB-AB, AC-AC, etc. See Fig. 29. It is also permissible to use a combination of numbers and letters for sectional view identification.

3.2.3 Reference Arrow Method for Identifying Sections. Arrowheads are pointed toward the cutting plane line when using the reference arrow method. The view letters are placed at the ends of the cutting plane. The section view identification letters are placed above the view. See Fig. 30.

3.2.4 Section View Arrangement. When two or more sections appear on the same sheet, they should be arranged in positions determined by the relative locations of the cutting planes to the extent made possible by view geometry and drawing sheet size. See Fig. 29.

3.2.5 Showing Cutting Planes. The cutting plane line is always shown when the cutting plane is bent, offset, or when the resulting section is nonsymmetrical. See Fig. 31. The cutting plane should be shown through an exterior view and not through a sectional view.

3.3 Section Lining

Where section lining is used, a uniformly patterned appearance should be evident. In most cases, only the general purpose section lining (uniformly spaced lines) is shown on the drawing. See Fig. 25.

3.4 Full Sections

When the cutting plane extends straight through the object, usually on the center line of symmetry, a full

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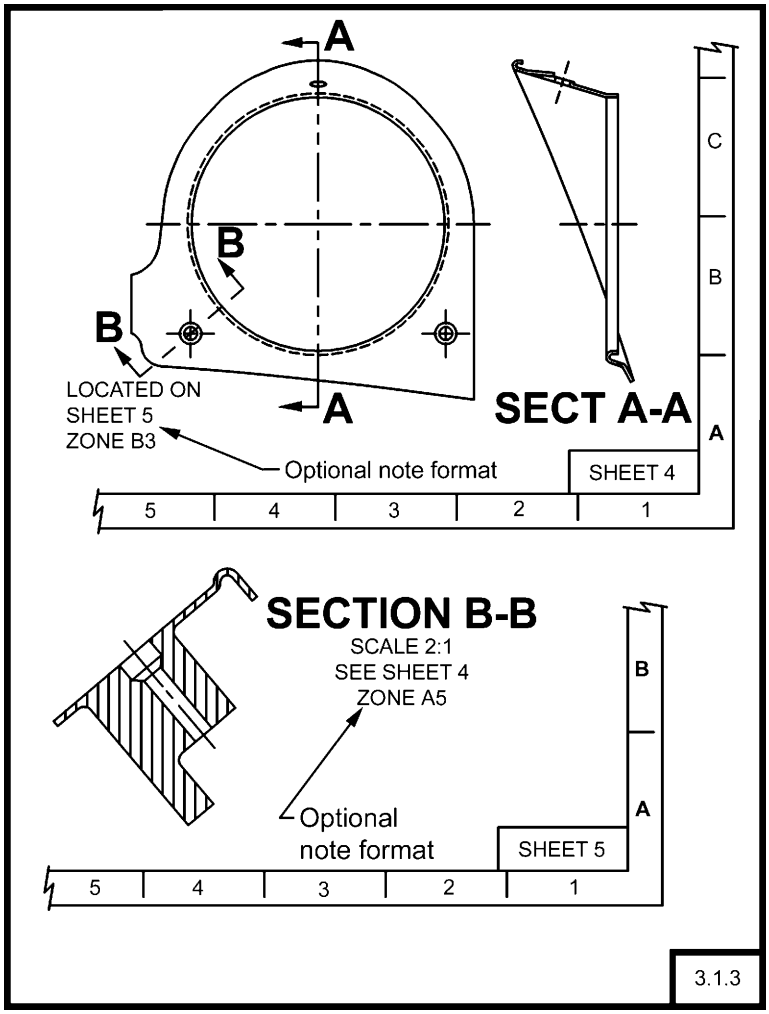


Fig. 26 Zone Referencing, Removed Section

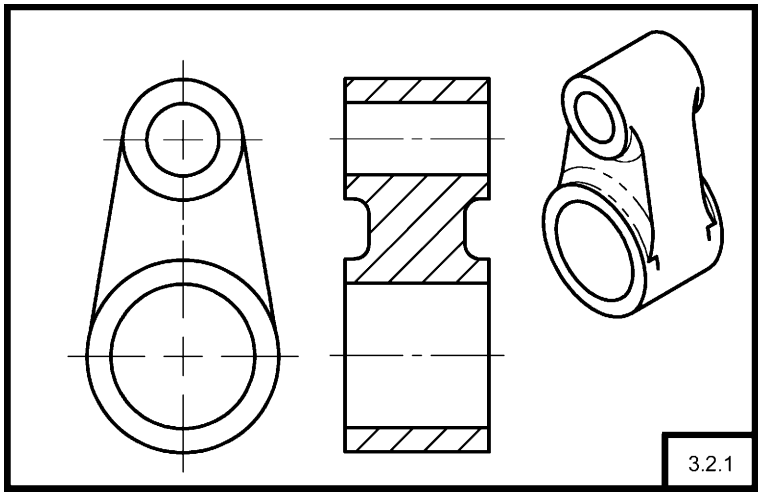


Fig. 27 Full Section, Cutting Plane Omitted

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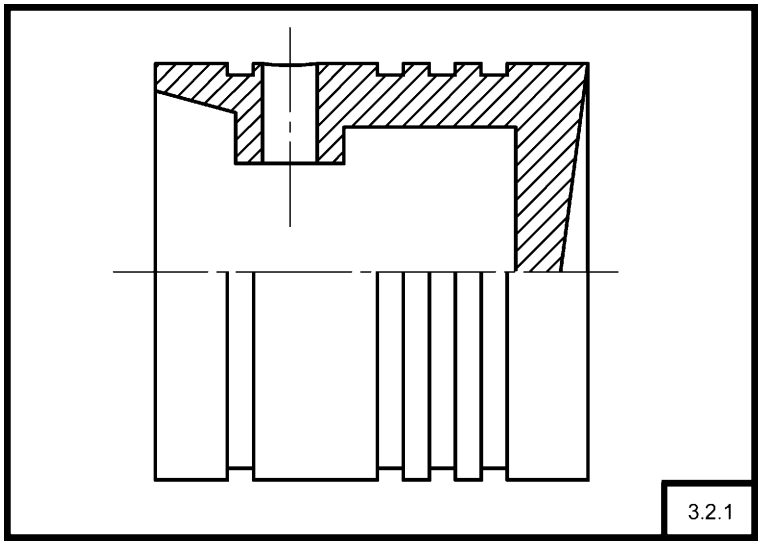


Fig. 28 Half Section, Cutting Plane Omitted

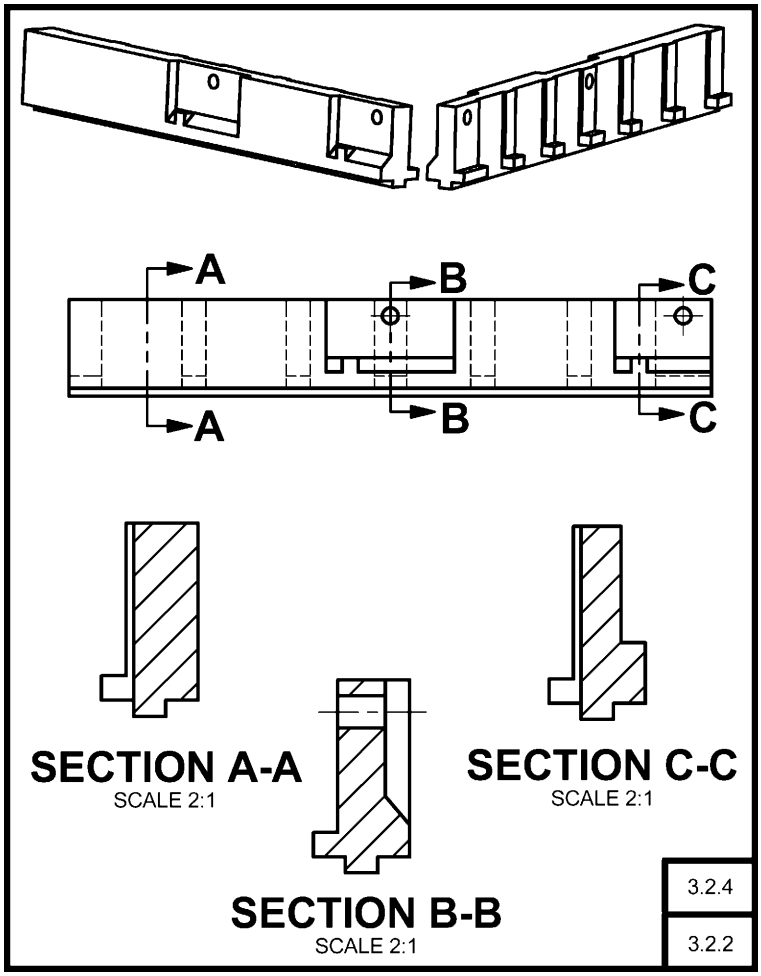


Fig. 29 Identifying Sections

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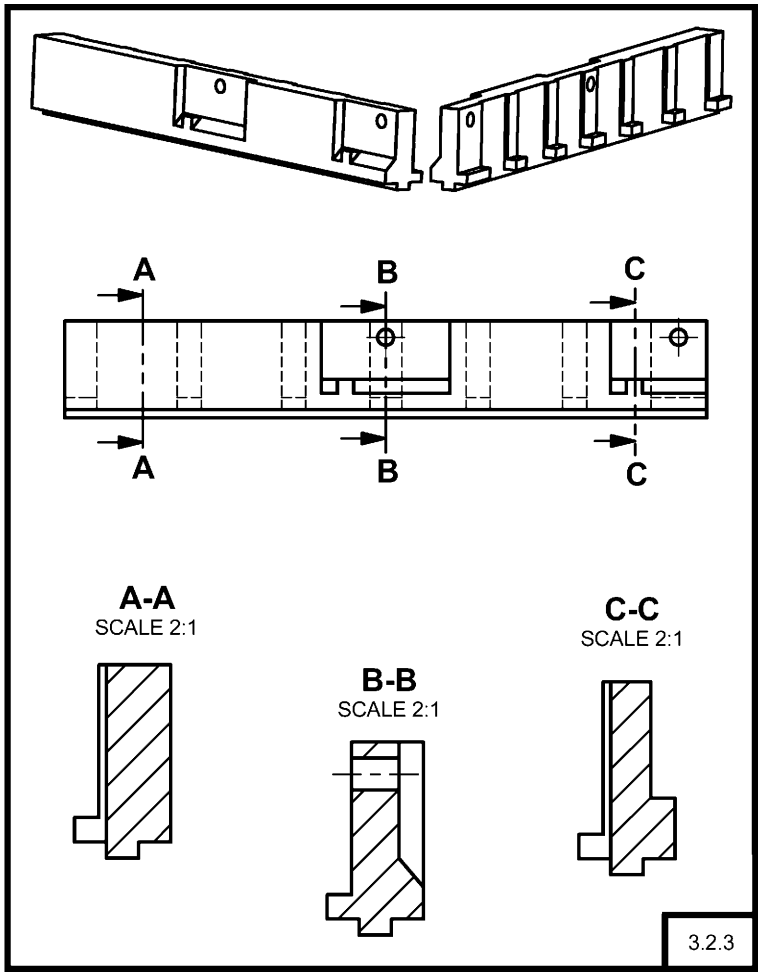


Fig. 30 Arrow Method — Identifying Sections

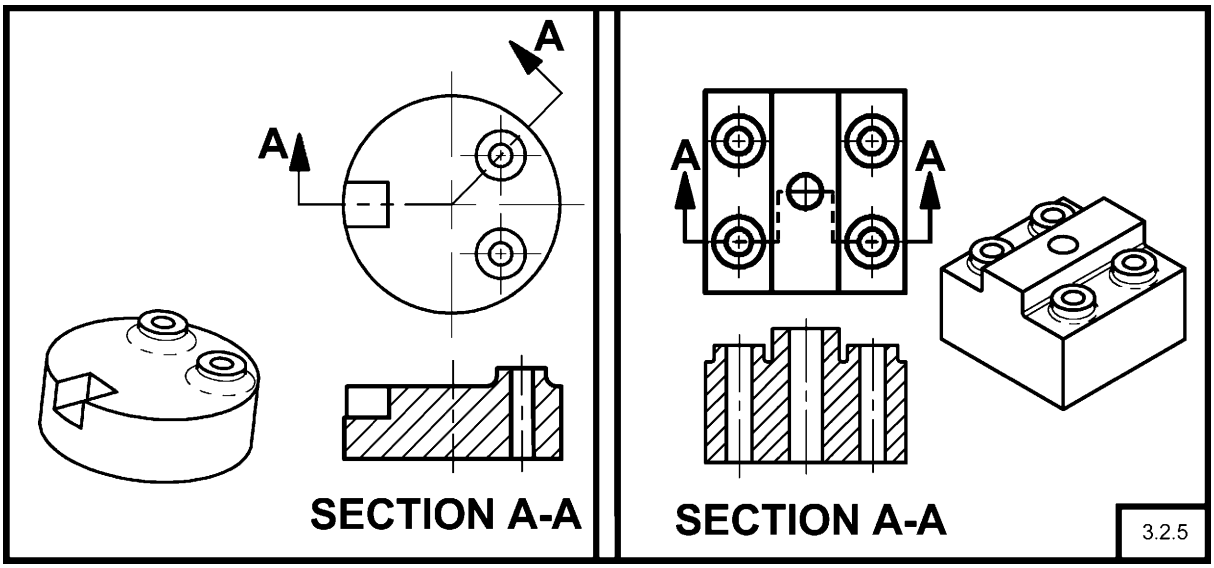


Fig. 31 Bent and Offset Cutting Planes

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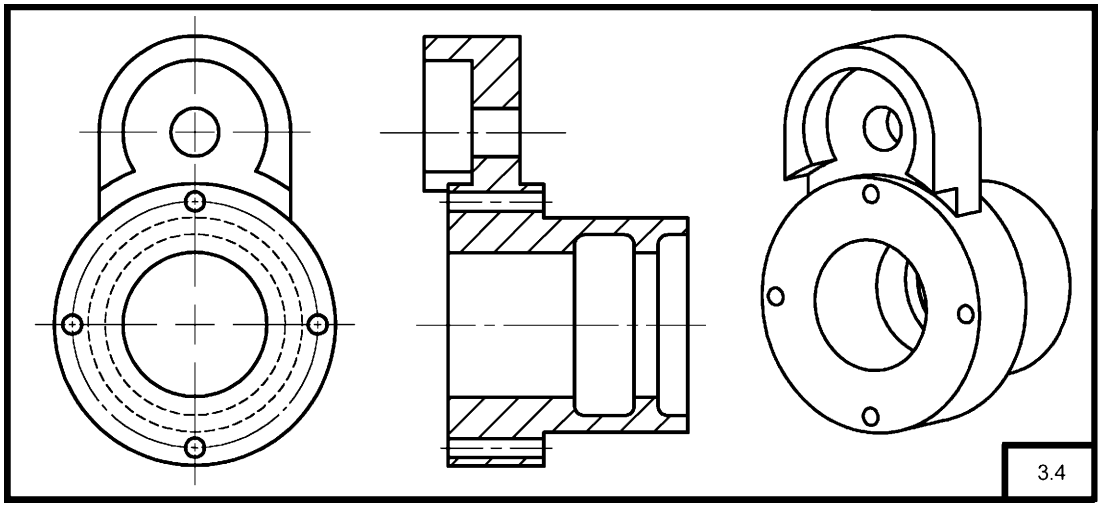


Fig. 32 Full Section

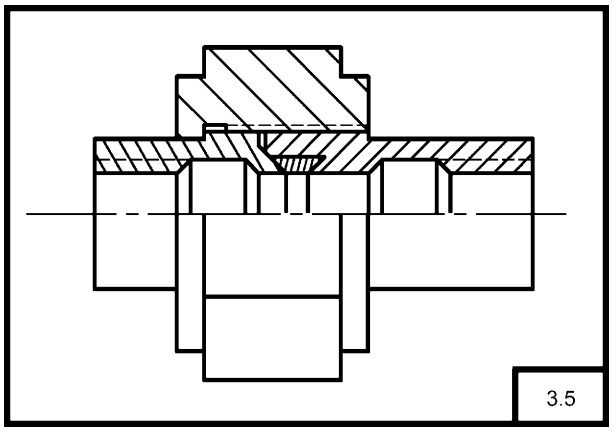


Fig. 33 Half Section, Assembly

section is obtained as in Fig. 32. In this figure, the representation of the cutting plane is omitted as its location is obvious. The portion of the object between the observer and the cutting plane is assumed to be removed exposing the cut surface and visible background lines of the remaining portion.

3.5 Half Sections

The view of a symmetrical object or one very nearly symmetrical which represents both the interior and exterior features by showing one-half in section and the other half as an external view is known as a half section. See Fig. 33 for a half sectioned assembly.

This half section is obtained by passing two cutting planes, at right angles to each other, through the object so that the intersection line of the two cutting planes is coincident with the axis of symmetry of the object. Thus, one-fourth of the object is considered removed and the interior exposed to view. Cutting plane lines, arrows, and section letters may be omitted where cutting planes are coincident with the center lines. A center line is used to divide the sectioned half from the unsectioned half of a half sectional view.

3.6 Lines Behind the Cutting Plane

3.6.1 Visible Lines. Visible lines behind the cutting plane are generally shown. Selected lines may be omitted when greater clarity is gained. For example, Spokes A and B in Fig. 34. It is permissible to display only the elements cut by the cutting plane.

3.6.2 Hidden Lines. Hidden lines behind the cutting plane are generally not shown. See Fig. 35. Hidden lines may be shown when greater clarity is gained.

3.7 Offset and Aligned Sections

3.7.1 Offset Sections. In order to include features not located in a straight line, the cutting plane may be stepped or offset (generally at right angles) to pass through these features. The section is drawn as if the offsets were in one plane. Such a section is called an offset section. The offsets are not indicated in any manner in the sectioned view. See Fig. 36.

3.7.2 Aligned Sections. When the features lend themselves to an angular change in the direction of the cutting plane (less than 90 deg), the sectional view is drawn as if the bent cutting plane and features were rotated into a plane perpendicular to the line of sight of the sectional view.

Such sections are called aligned sections, whether the features are rotated into the cutting plane or the cutting plane is bent to pass through them. See Fig. 37.

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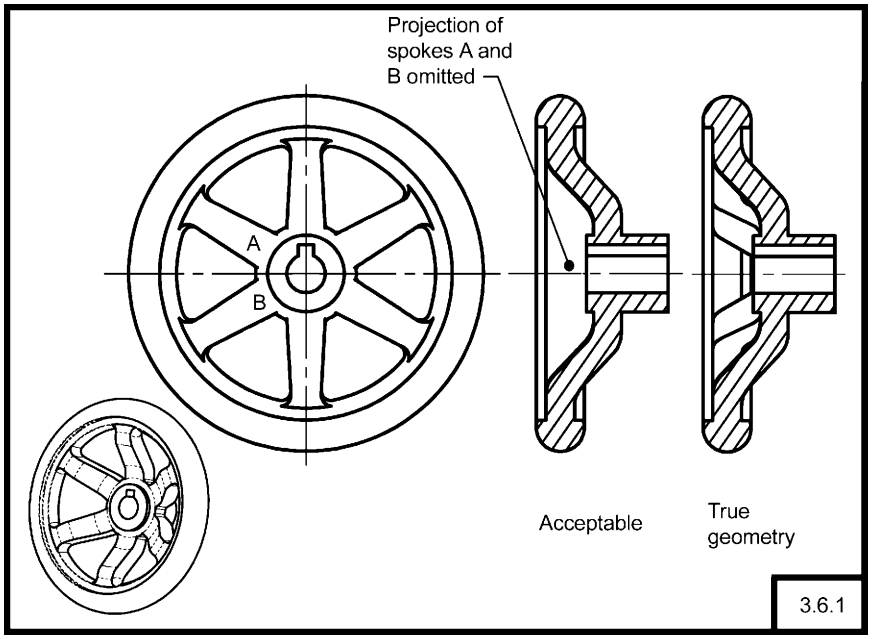


Fig. 34 Omission of Visible Lines

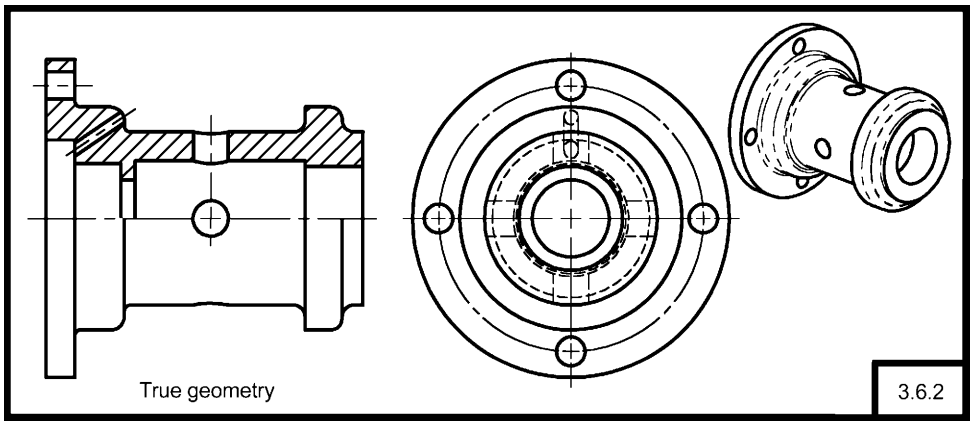


Fig. 35 Omission of Hidden Lines

3.8 Removed Sections

A removed section is not in direct projection from the view containing the cutting plane line, but displaced from its normal projection position.

(a) The section may be drawn at the same scale as the view from which it is taken, or it may be drawn at a noted scale. See Fig. 38.

(b) Removed sections that are symmetrical may be placed on center lines extended from the imaginary cutting planes. See Fig. 39.

(c) Removed sections are preferably shown on the same sheet from which the section has been taken. When it is not practicable to place the removed section on the same sheet of the cutting plane, cross referencing of removed section views shall be effected in the same manner as for removed views. See paras. 1.7.2 and 1.7.5.

3.9 Revolved Sections

When a cutting plane is passed perpendicular to the axis of an elongated symmetrical feature, such as a spoke, beam, or arm, and then revolved in place through 90 deg into the plane of the drawing, a revolved section is obtained. Visible lines on each side of the revolved section may be removed and break lines used. No cutting plane is indicated. See Fig. 40.

3.10 Broken-Out Sections

Where it is necessary to show only a portion of the object in section, the sectional area is limited by a break

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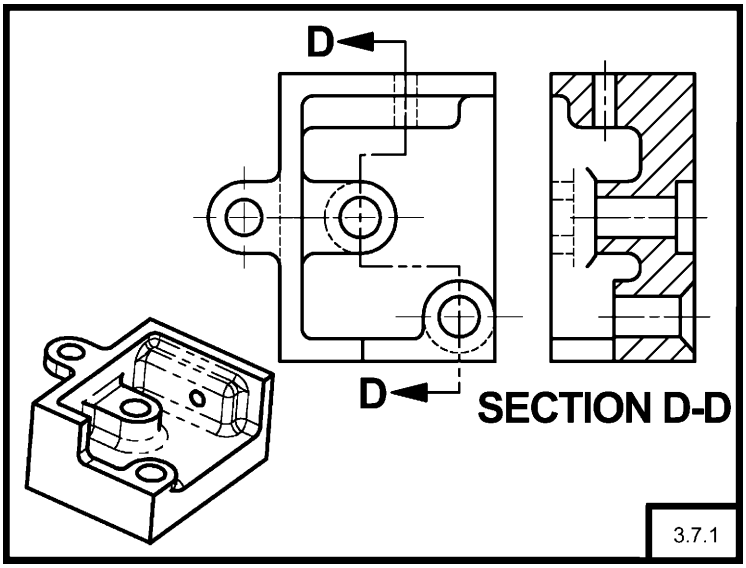


Fig. 36 Offset Section

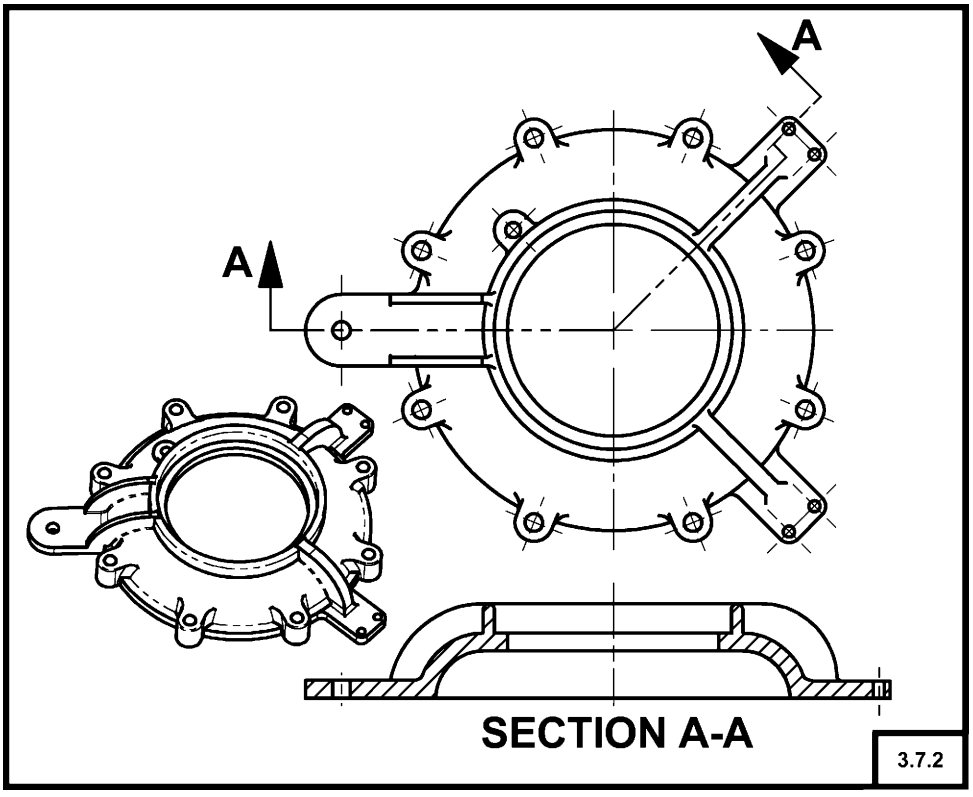


Fig. 37 Aligned Section

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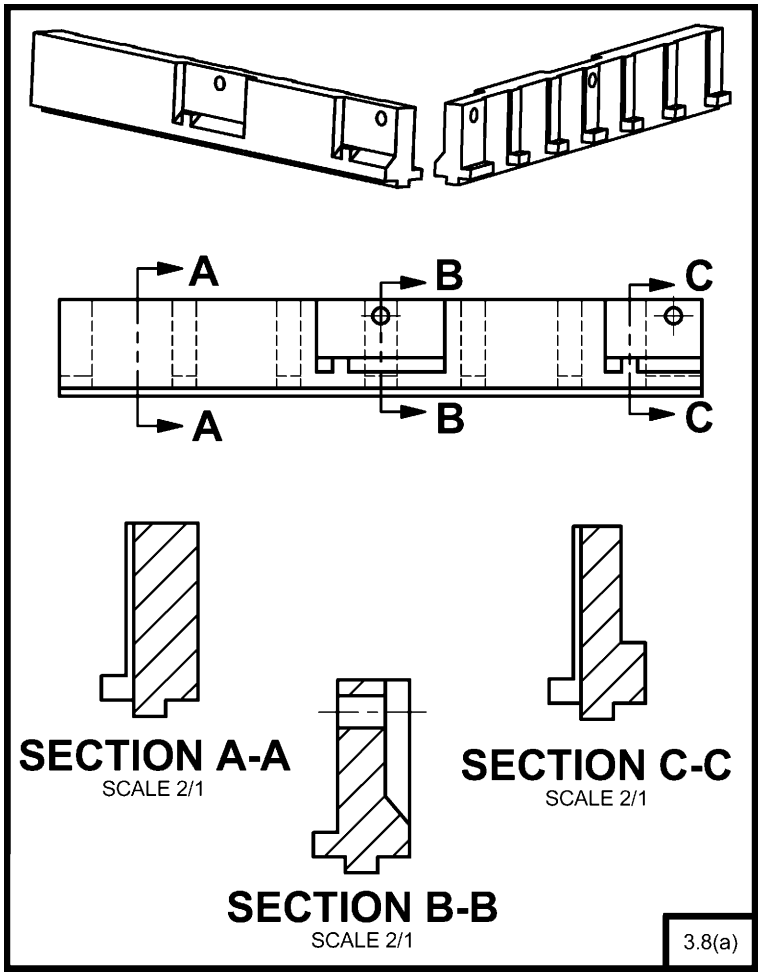


Fig. 38 Removed Section

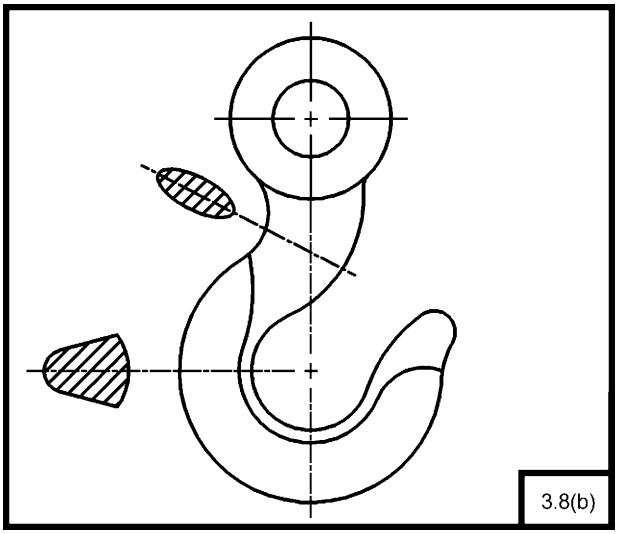


Fig. 39 Removed Sections on Center Lines

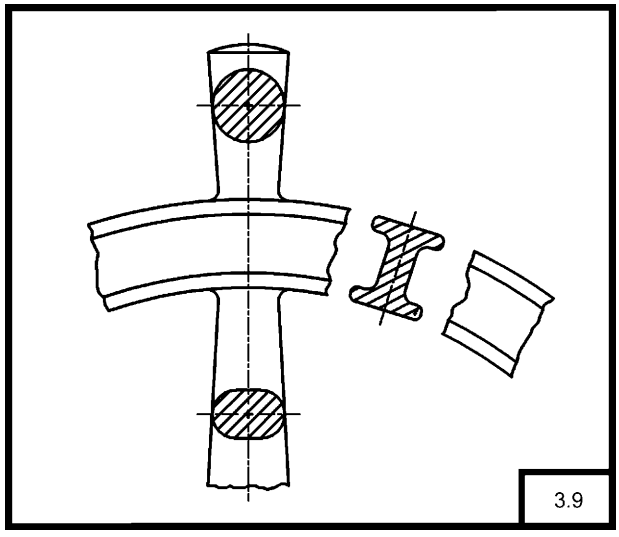


Fig. 40 Revolved Sections

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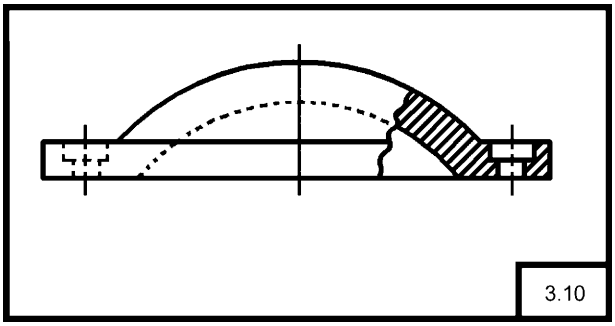


Fig. 41 Broken-Out Section

line, and the section is called a broken-out section. No cutting plane is indicated. See Fig. 41.

3.11 Auxiliary Sections

A sectional view appearing in other than a principal view is an auxiliary section. Rules for cutting planes and sectioning are the same as for other sectional views. See Fig. 42.

4 CONVENTIONAL REPRESENTATION

4.1 General

Conventional representation enhances drawing economy and clarity by using simplified representations of an object. While it does contain deviations from true orthographic projection, it consists of abbreviated delineations that are generally recognized and accepted as standard basic drawing practice. Conventional representation as defined by this Standard is only used when orthographic views are created and when true geometry representation is not desired.

4.2 Conventional Representation Applied to Sections

4.2.1 Sectioning Thin Elements. When the cutting plane passes along the length of a thin rib, lug, or other relatively thin element, the outline of the feature is drawn without section lines to aid in the interpretation of thickness variations of part features. See section views in Figs. 43 and 44. True geometry representation permits section lining of the entire area of a feature. This may require additional sectional views to provide adequate part description. See Fig. 45.

4.2.2 Sectioning Regular Features. Normal section lining procedures apply when the cutting plane cuts across, or is perpendicular to, such elements as ribs, lugs, bolts, and spokes. See Fig. 46.

4.3 Nonsectioned Items in the Cutting Plane

4.3.1 Sectioning Assembled Items. When the cutting plane lies along the longitudinal axis of items, such as shafts, bolts, nuts, rods, rivets, keys, pins, screws, ball or roller bearings, gear teeth, spokes, and the like, these parts are not sectioned except when internal construction is shown. See Fig. 47.

4.3.2 Conventional Section Lining of View. Where the cutting plane is perpendicular, or cuts across the items in para. 4.3.1, the sectional view is section lined in the usual manner.

4.4 Foreshortened and Aligned Features in Section and Exterior Views

4.4.1 Rotation of Inclined Elements. Where the true projection of a part results in foreshortening or in unnecessary drafting time, or both, inclined elements, such as lugs, ribs, spokes, arms, or similar elements, are rotated into a plane perpendicular to the line of sight of the

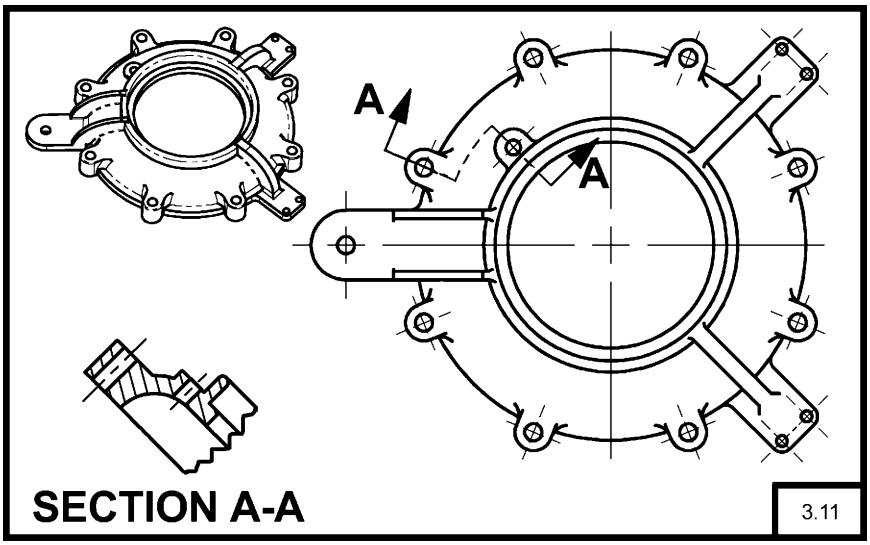


Fig. 42 Auxiliary Section

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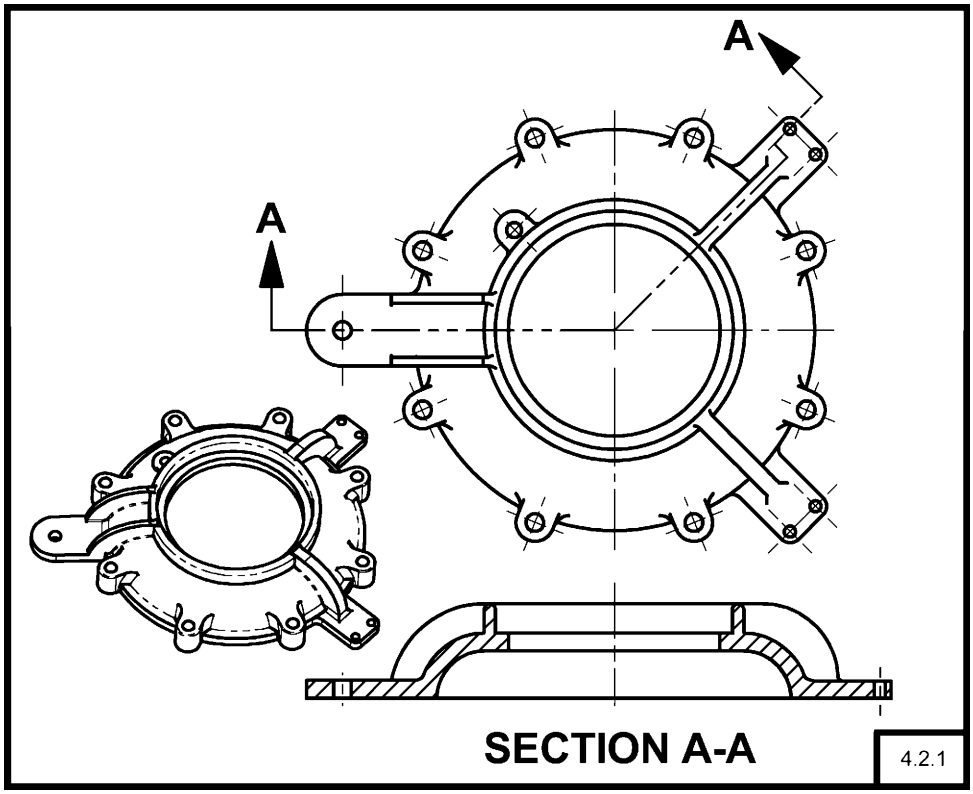


Fig. 43 Section Through Ribs

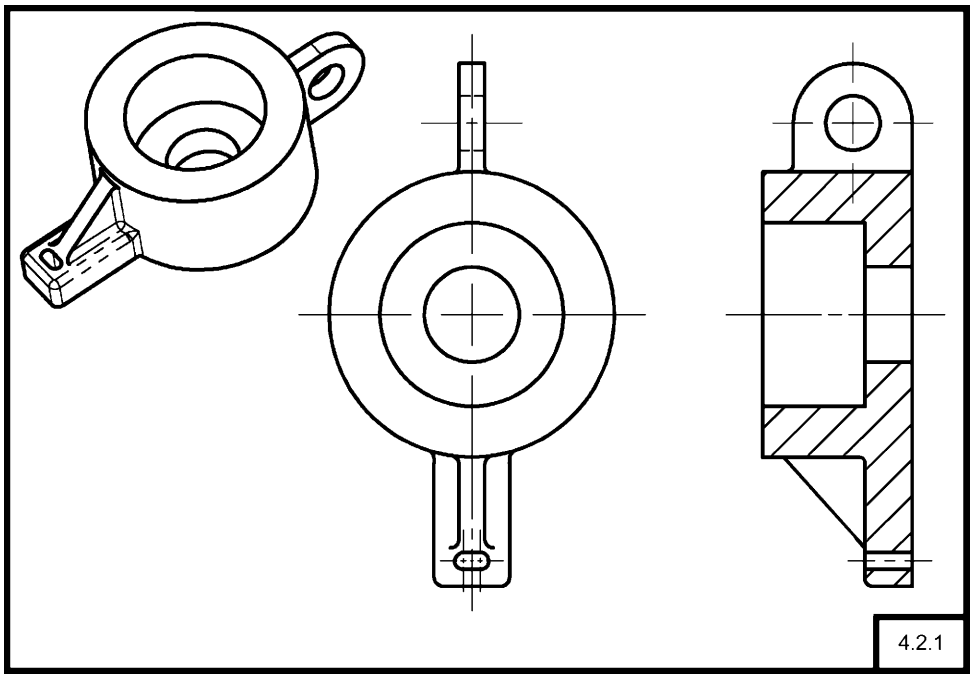


Fig. 44 Conventional Representation of Ribs

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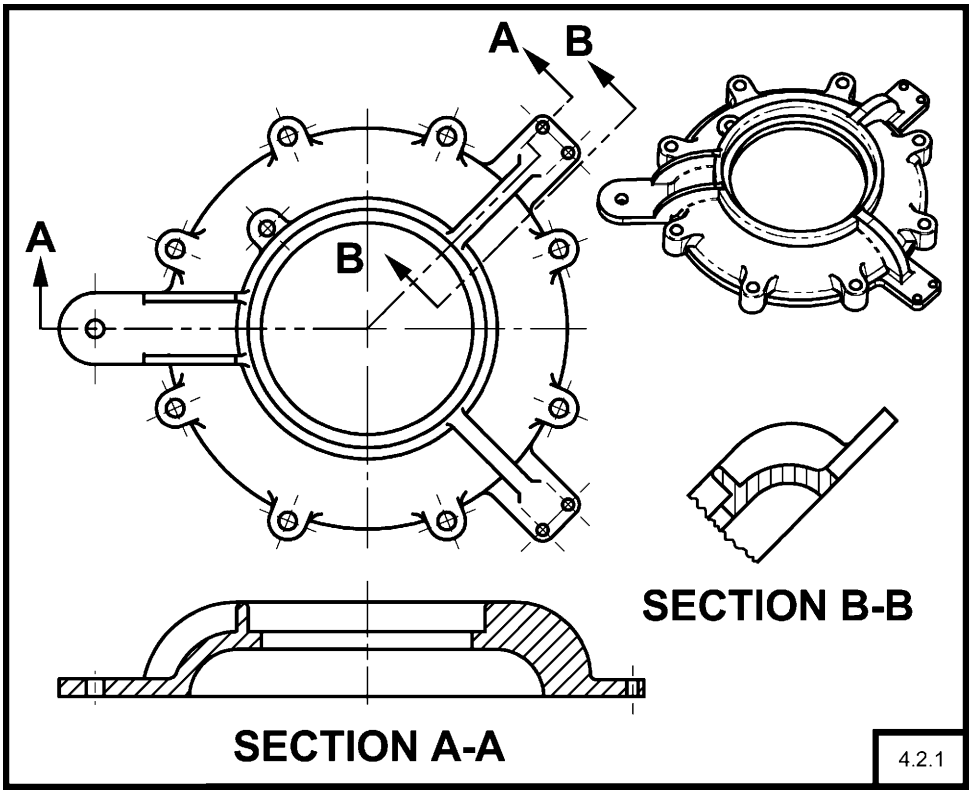


Fig. 45 True Geometry Through Ribs

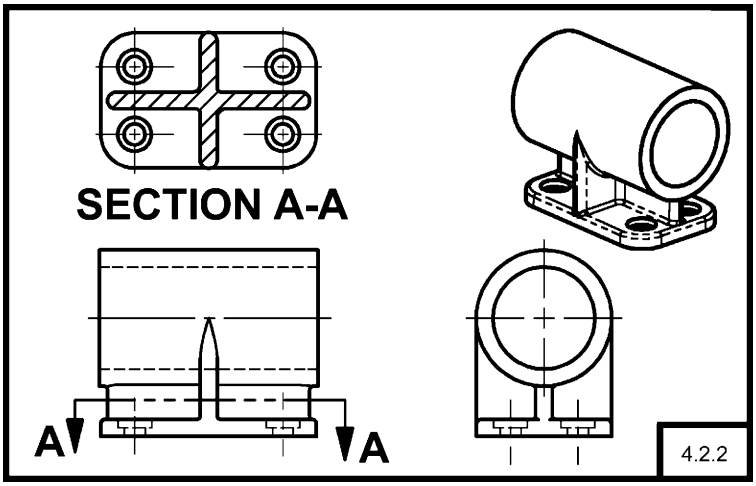


Fig. 46 Section Across Ribs

sectional view, or omitted. The elements are not section lined. See Fig. 48. True geometry representation may include section lining in the cut features and shows the true projection of all elements.

4.4.2 Rotation of Features. Holes, slots, and other such features spaced around a bolt circle or cylindrical flange are rotated to their true distance from the center axis. See Figs. 49 and 50. True geometry representation shows the features in their true projection.

4.5 Intersections in Section

Conventional representation of intersections permit economy in manual drawing preparation, but it can

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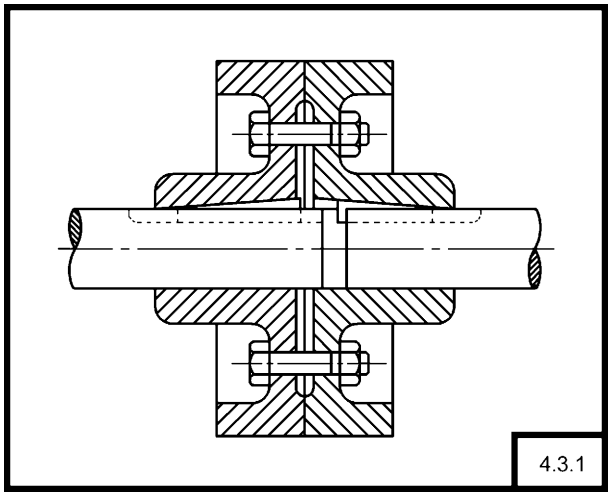


Fig. 47 Section Through Shafts, Keys, Bolts, Nuts, and Like Items

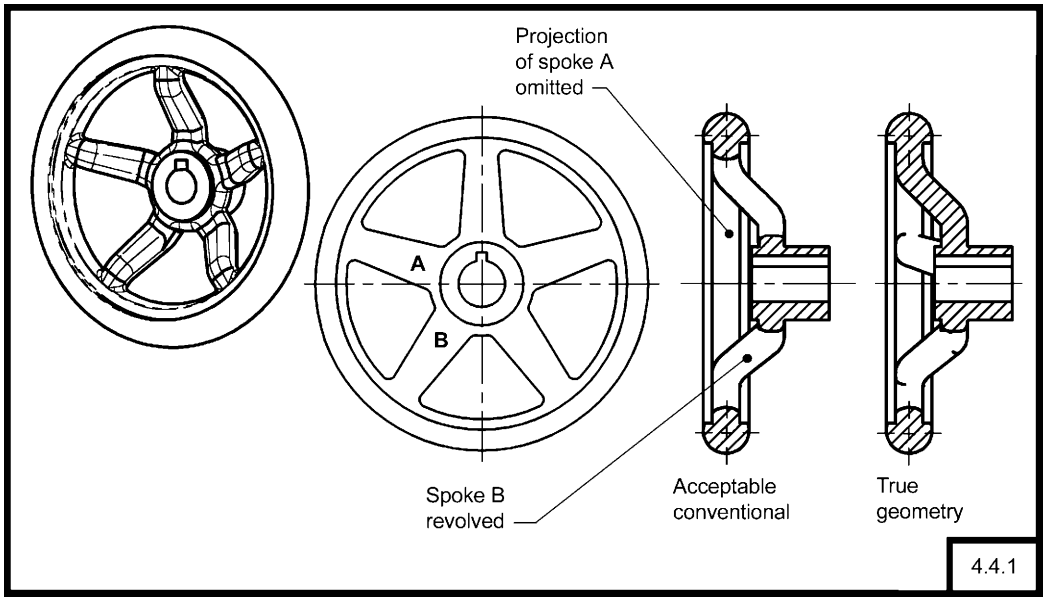


Fig. 48 Spokes in Section

increase preparation time when using CAD documentation methods. True geometry representation is permitted. Conventional representation and true geometry representation shall not both be applied to any one of the following feature types within one drawing, including CAD generated drawings.

4.5.1 Simplified Representation of Small Details. When a section is drawn through an intersection in which the true projection of the intersection is small, the true line of intersection may be disregarded. See Fig. 51 illustrations (a) and (c).

4.5.2 Conventional Representation of Large Details. Larger intersections are projected true as shown in Fig. 51 illustration (b), or approximated by arcs as shown in Fig. 51 illustration (d).

4.6 Conventional Representation Applied to Exterior Views

4.6.1 Orders of Precedence Between Lines. Visible lines take precedence over hidden lines and center lines. Hidden lines take precedence over center lines. Cutting plane lines take precedence over center lines when locating a cutting plane. See Fig. 52.

4.6.2 Rotation of Features and Elements to Show True Shapes. Features and elements, such as arms, ribs, lugs or other similar features, or portions of the object at

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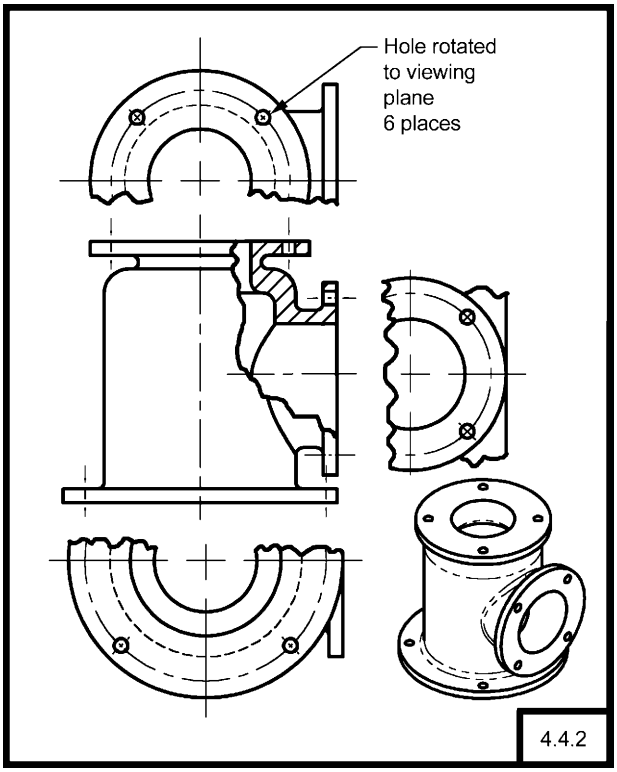


Fig. 49 Rotated Features

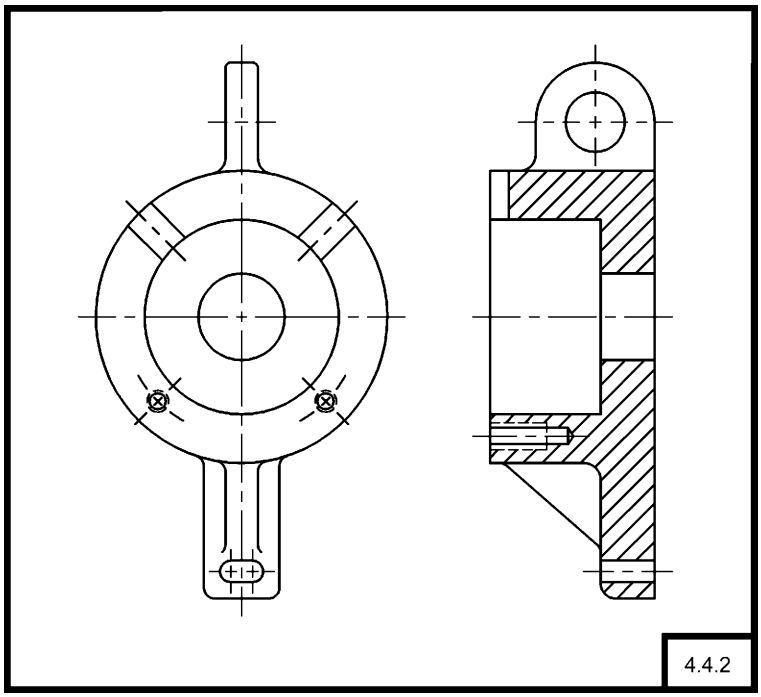


Fig. 50 Conventional Representation of Rotated Features

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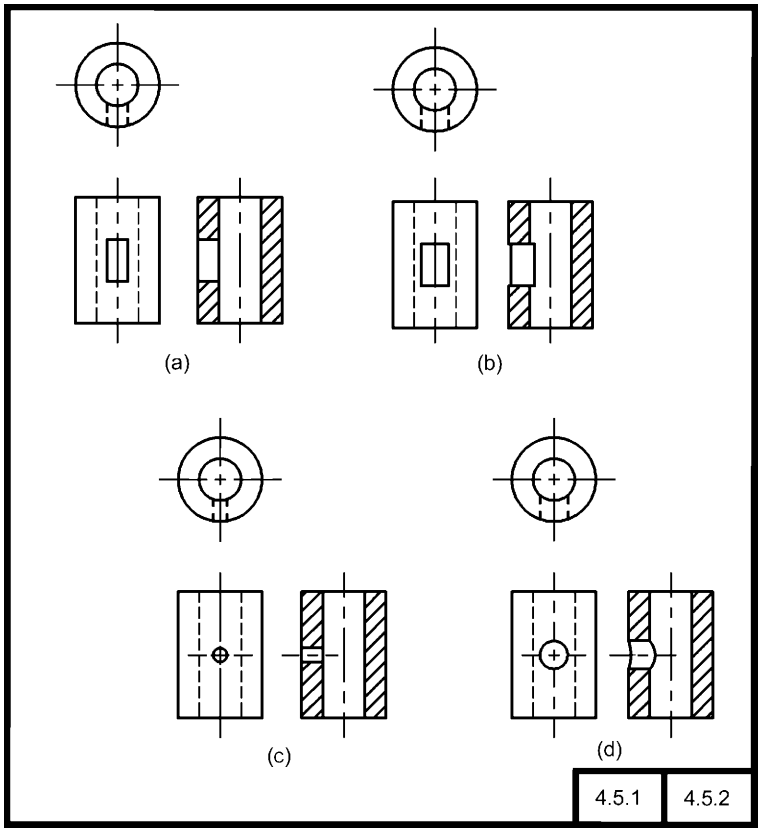


Fig. 51 Intersections in Section

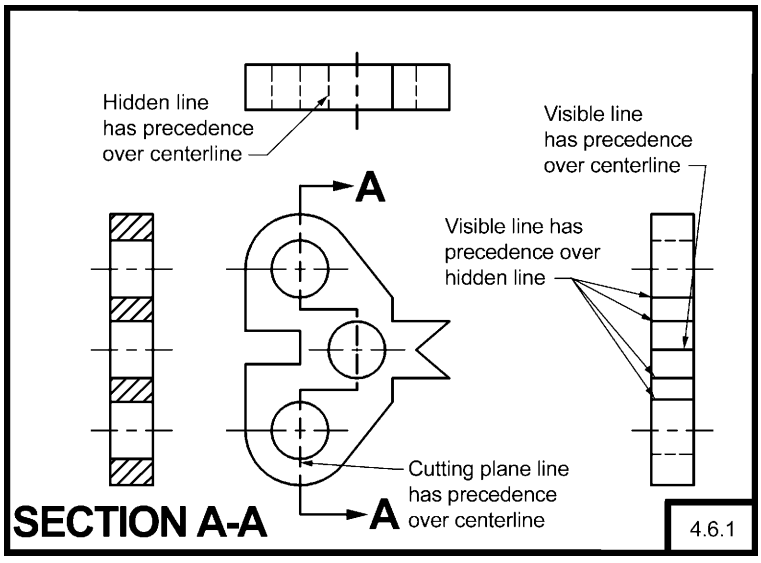


Fig. 52 Line Precedence

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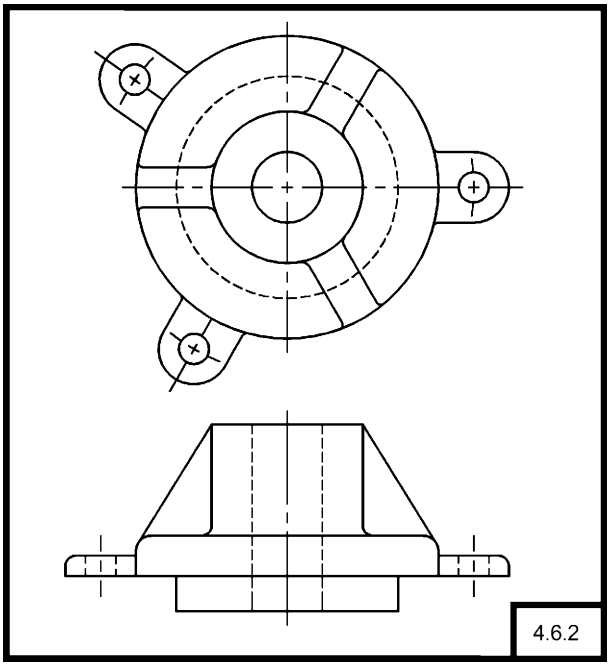


Fig. 53 Rotated Features to Show True Shape

angular positions are preferably aligned or rotated to show the true shape and proportion of these elements. See Fig. 53.

4.6.3 Simplified Representation of Small Details. Where the true projection of an intersection is small, the true lines of intersection may be disregarded. See Fig. 54.

4.6.4 Conventional Representation of Large Details. Where the true projection of an intersection is large,

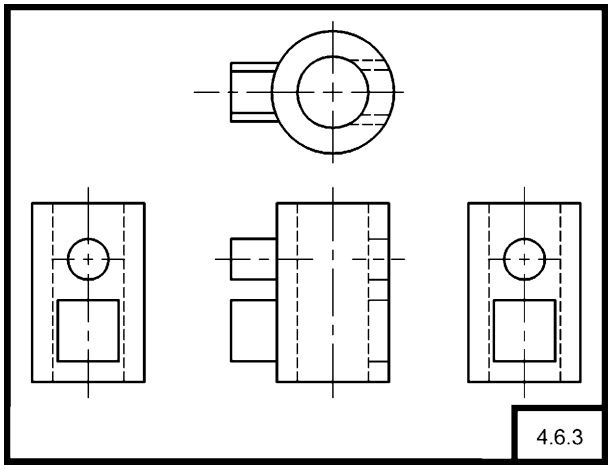


Fig. 54 Small Intersections

lines of intersection are approximated or projected true, as shown in Fig. 55.

4.6.5 Representation of Fillets and Rounds. Where sharp intersection lines of two surfaces are removed by fillets or rounds, the abrupt changes in surface directions are represented by a phantom line at the approximate intersection of the surfaces. See Fig. 56.

4.6.6 Depictions of Fillets, Rounds, and Runouts. Examples of fillets, rounds, and runouts for tangent and intersecting surfaces are shown in Fig. 57. Fillets and rounds may be defined by a note and omitted from the geometry representation.

4.6.7 Conventional Representations of Breaks. Examples of conventional representations of breaks, used to shorten a view of elongated features, are shown in Fig. 58.

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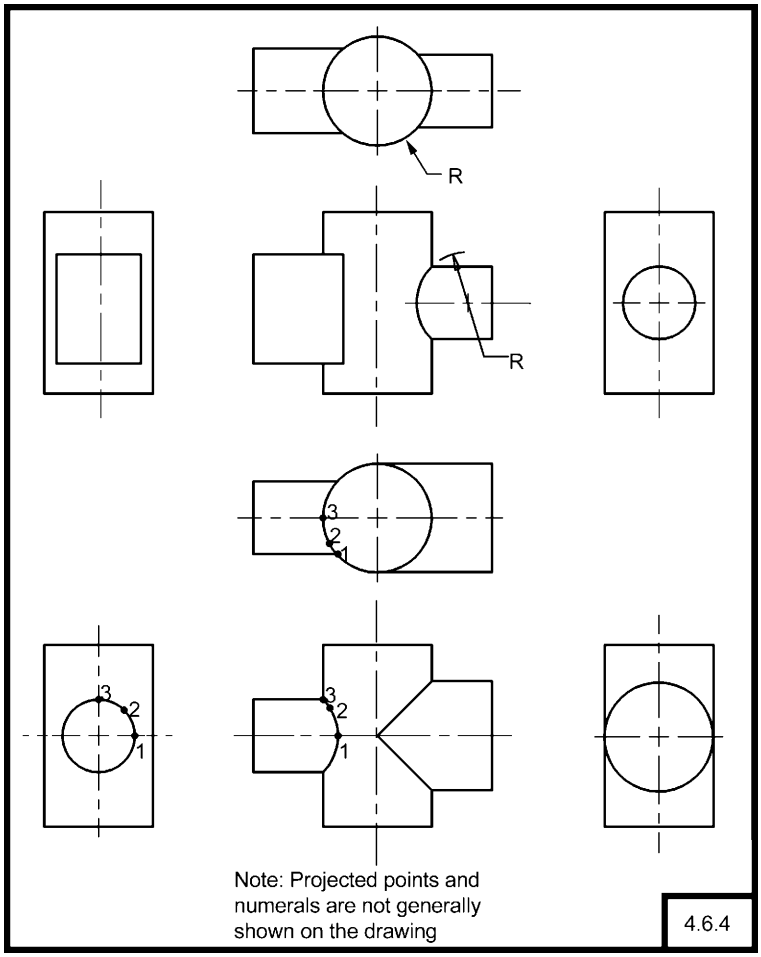


Fig. 55 Large Intersections

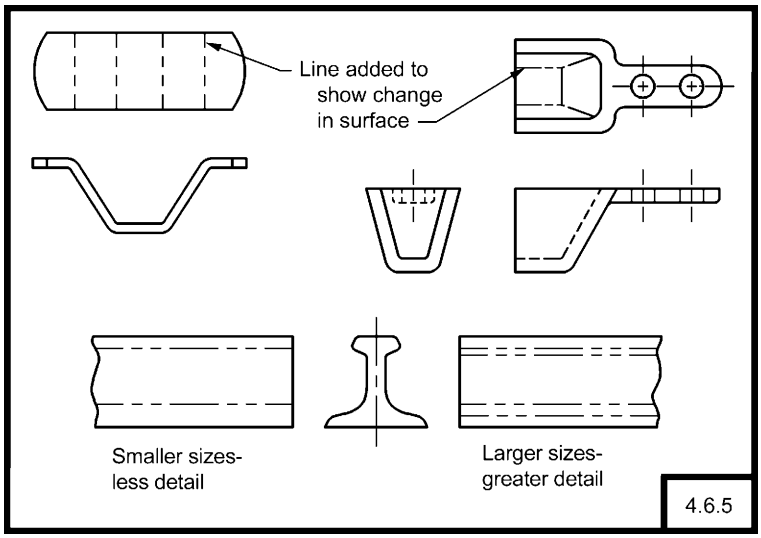


Fig. 56 Conventional Representation, Filleted and Rounded Corners

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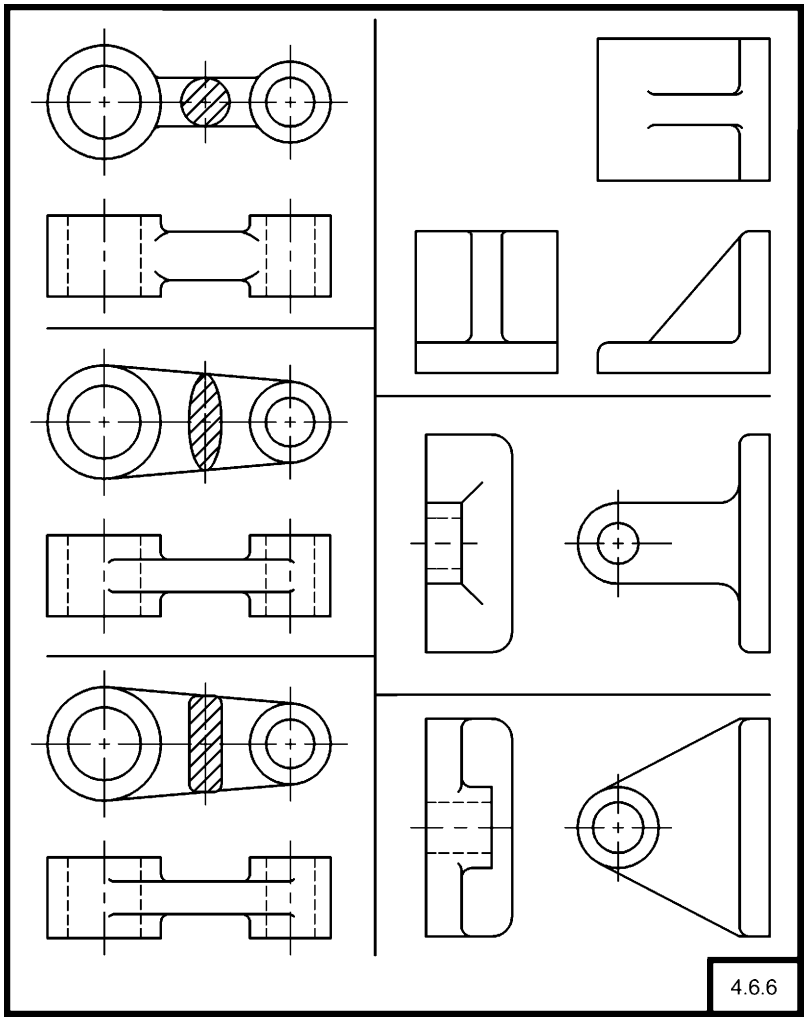


Fig. 57 Conventional Representation, Fillets, Rounds, and Runouts

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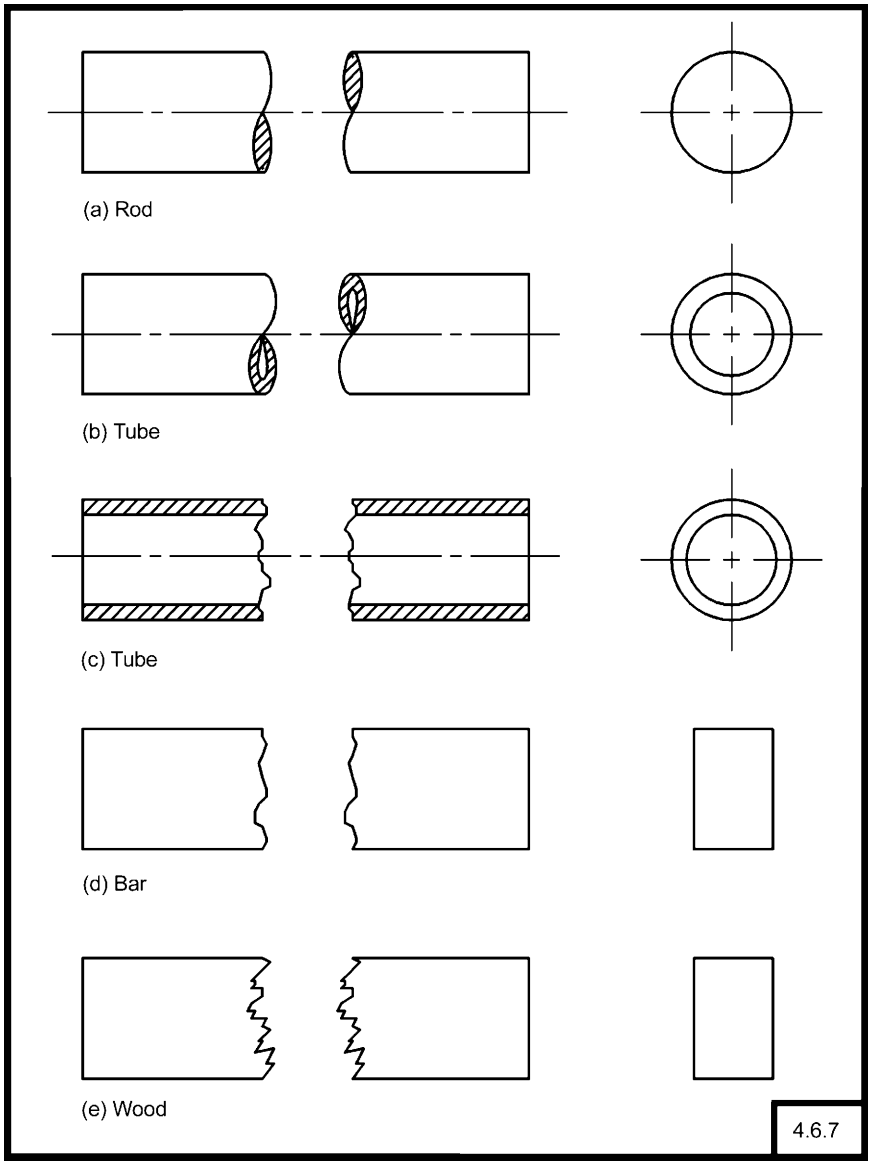


Fig. 58 Conventional Representation, Breaks in Elongated Features

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NONMANDATORY APPENDIX A
SPACE GEOMETRY

A1 DEFINITION

Space geometry is the science of graphically solving problems involving space distances and relationships. (Space geometry is also referred to as descriptive geometry or engineering geometry.) The most popular and practical method of solution is that in which the principal views are supplemented by auxiliary views. Four basic types of views are used

(a) the true-length view of a line
(b) the point view of a line
(c) the edge view of a plane
(d) the true view of a plane

A2 REFERENCE LINES AND NOTATION

A2.1 Reference Lines

A phantom line, used as a reference line between adjacent views, is

(a) an edge view of a plane of projection
(b) the intersection line of adjacent projection planes (a folding line or hinge line) or
(c) an artificial device employed as an aid in construction

NOTE: It is helpful in visualizing space relationships to think of each reference line as representing a 90° bend between the adjacent projection planes, or, in other words, the observer's direction of viewing has changed by 90° when going from one view to the adjacent view. The line may be labeled with letters or numerals as desired.

A2.2 Construction of Auxiliary Views

In the construction of auxiliary views the consistent and accurate transfer of distances from one related view to another is facilitated by the use of the reference lines. Several reference lines are shown in Fig. A1. A height dimension such as X, measured from the reference line, shall be the same in both the front view and the related top-adjacent view. Similarly, distance Y shall be the same in all views that are adjacent to the front view. Any side-adjacent view shall show the same width dimension W as that shown in the front view. Distance Z illustrates the correct measurement for an auxiliary-adjacent view.

A2.3 Identification of Views

The letters T, F, and S shown beside the reference lines and as subscripts for points, signify top, front, and side views, respectively, from which the auxiliary views are developed. The numbers 1, 2, 3, and 4 signify the auxiliary views projected from the top, front, or side views or from other auxiliary views.

A2.4 Symmetrical Items

For symmetrical items, the reference line is on an axis of symmetry. See Fig. A2.

A3 TRUE LENGTH VIEW OF A LINE

A3.1 True Length of a Line Segment

The true length of a line segment is the actual straight-line distance between its two end points. The projection of a line will be in true length when in the adjacent view, the projection of the line is parallel to the reference line between the views. A line that is in true length in a principal view is called a principal line (lines AB and CD in Fig. A3).

A3.2 Oblique Lines

An oblique line (line BC in Fig. A3) is not in true length in any principal view. Its true length is found in a primary auxiliary view, such as view 1 or 2 in Fig. A3, when the reference line is parallel to the line in the given views.

A4 POINT VIEW OF A LINE

A view with the direction of sight parallel to a straight line in space provides a point view of the line. See Fig. A3. A point view of a line is adjacent to a true length view, and the reference line is perpendicular to the true length projection of the line. The point view appears in a secondary auxiliary view as the line is in true length in a primary auxiliary view. See line B_1C_1, and point B_3C_3 in Fig. A3.

A5 EDGE VIEW OF A PLANE

(a) A view with the direction of sight parallel to a plane in space gives the observer a straight line or edge view of the plane. An edge view is obtained whenever any line in the plane appears as a point.

(b) When any line of the plane is in true length in one view (line A_TB_T or assumed line A_FE_F in Fig. A4), then a point view of that true-length line will also show the plane as an edge (view 1 or view 3 in Fig. A4).

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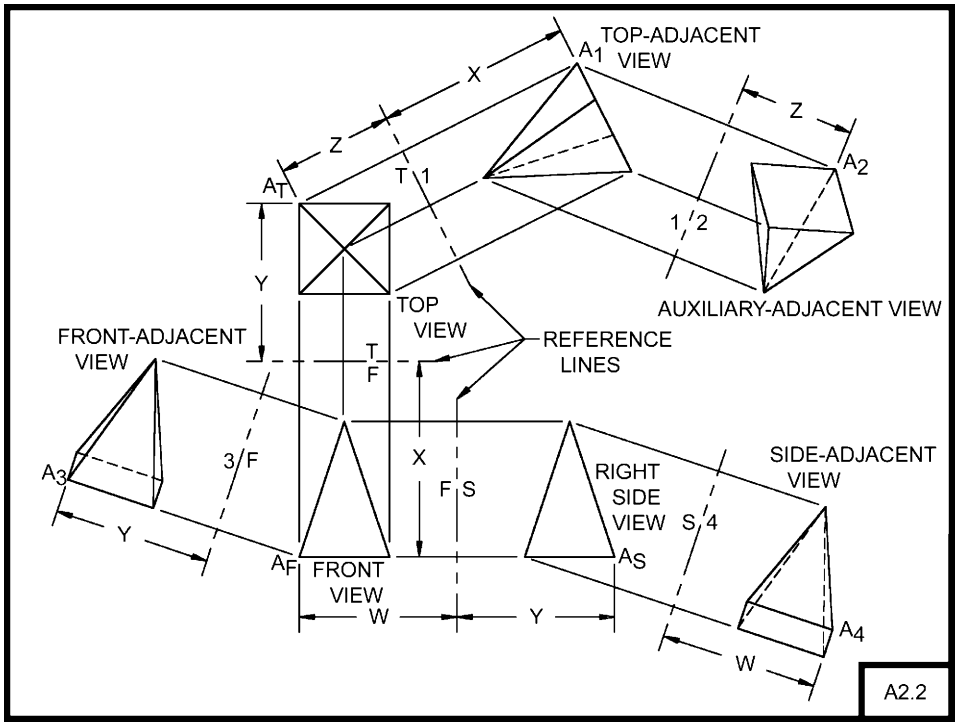


Fig. A1 Standard Use of Reference Lines Between Views

A6 TRUE VIEW OF A PLANE

A true view is the direction of sight perpendicular to a plane. See Fig. A4, views 2 and 4. A true view of a plane is adjacent to an edge view, and the reference line is parallel to the edge view.

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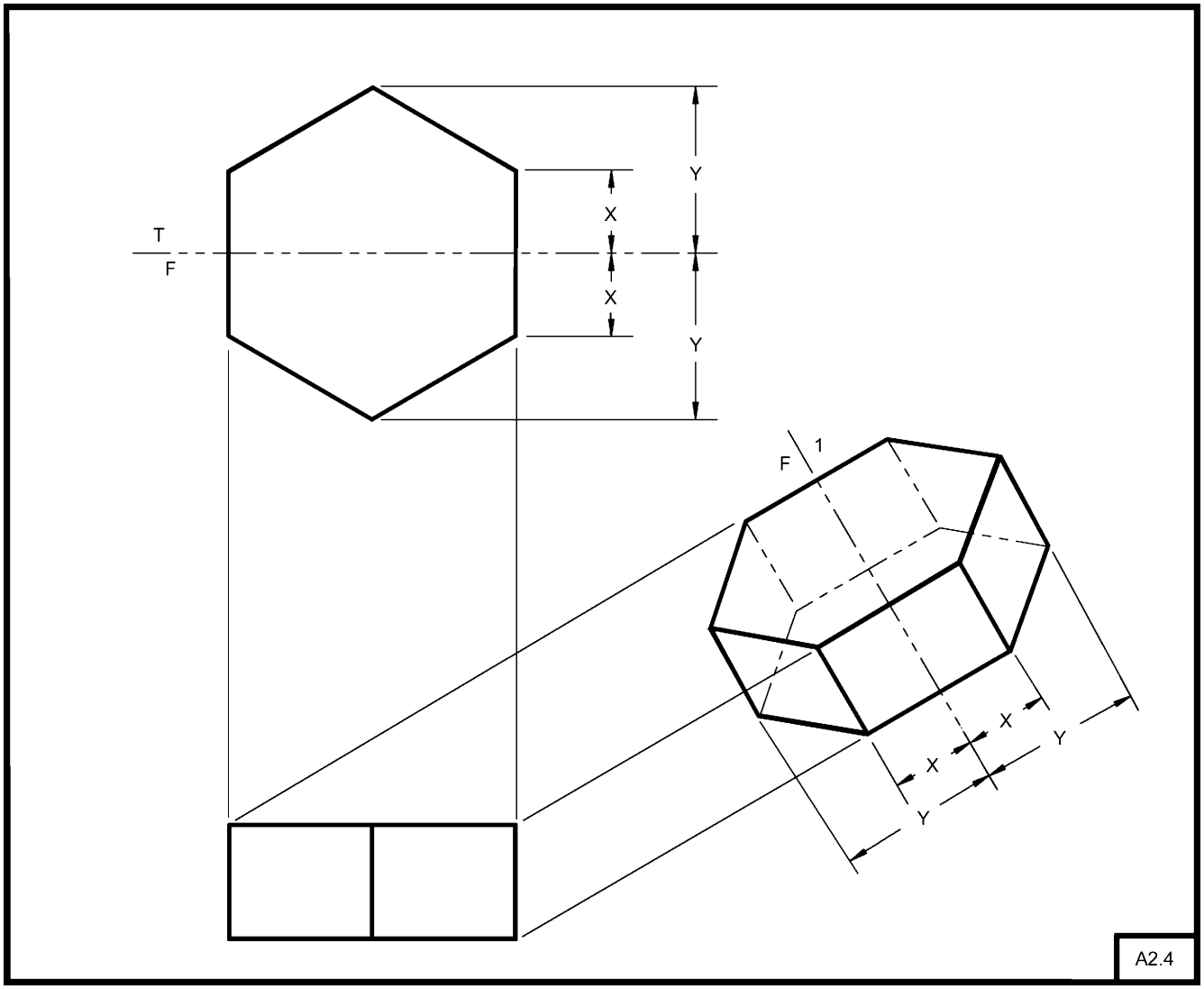


Fig. A2 Symmetrically Placed Reference Line

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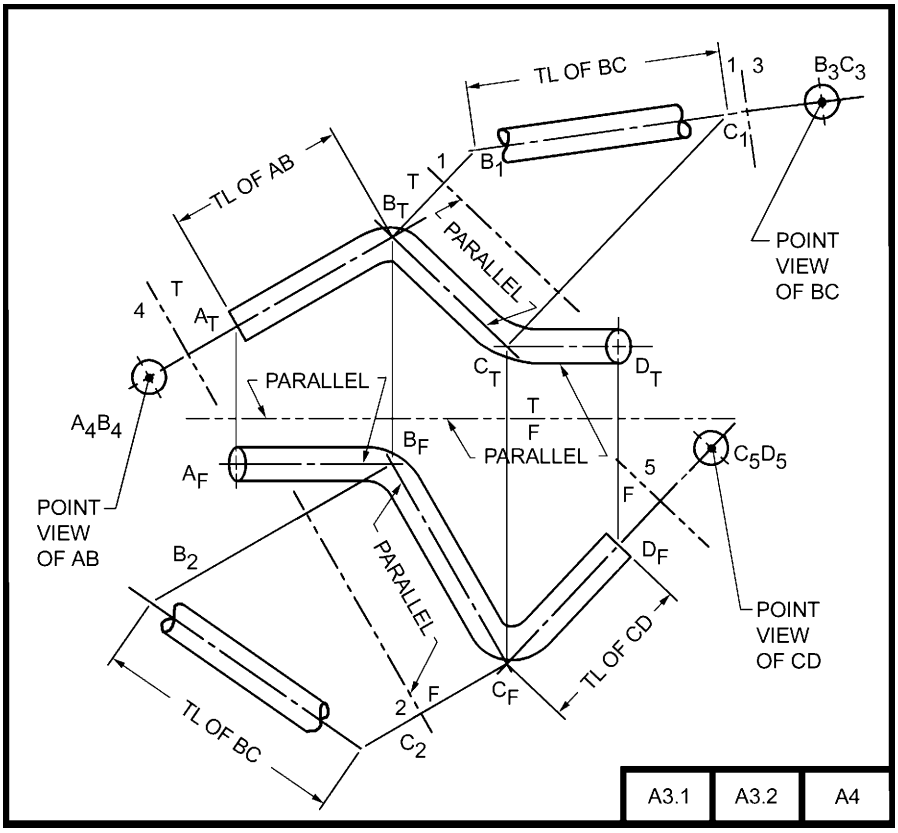


Fig. A3 True Lengths and Point Views of Lines

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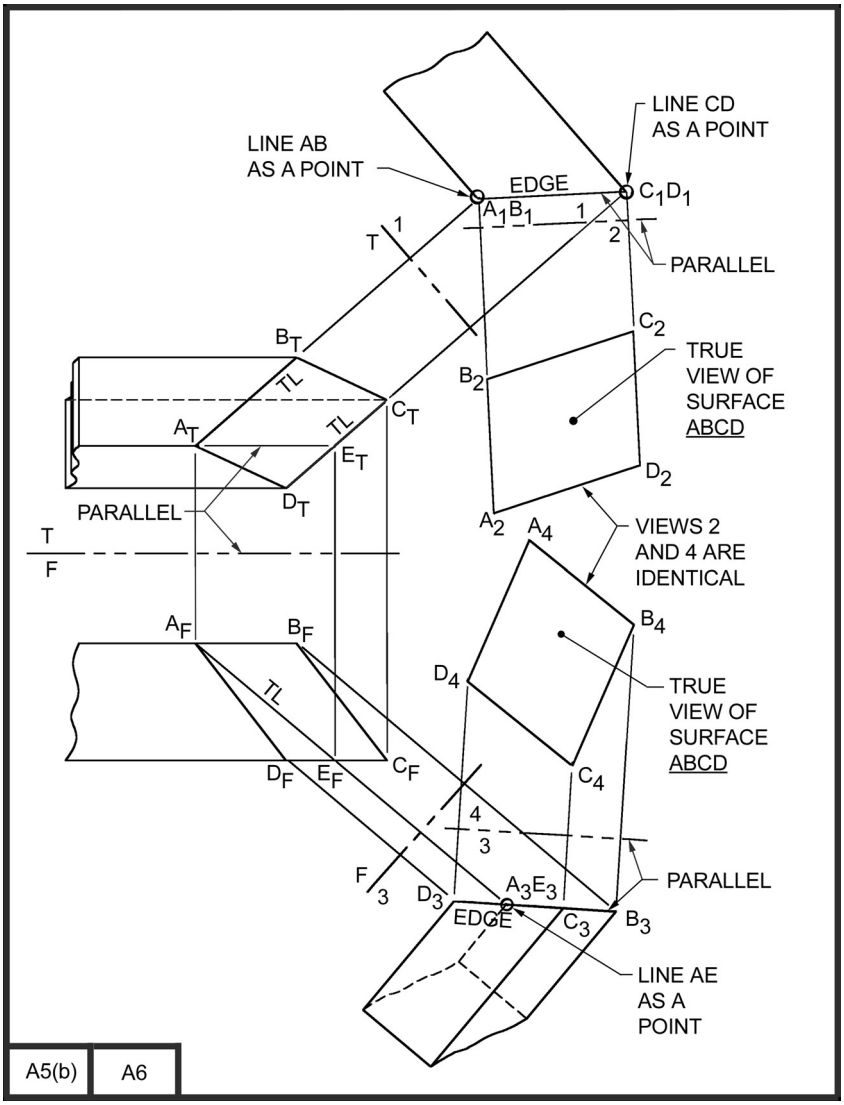


Fig. A4 Edge and True Size Views of a Plane Surface

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NONMANDATORY APPENDIX B
SPACE ANALYSIS AND APPLICATIONS

B1 GENERAL

To make a space analysis it is usually helpful to simplify the problem by reducing it to terms of points, lines, and planes. A pipe can be considered in terms of its center line, or a plane surface can be treated by using only three points, a point and a line, or two lines that lie in the plane surface.

B2 CLEARANCE BETWEEN A POINT AND A LINE

B2.1 Point Method

In a view of the point and line which shows the line as a point, the clearance between the line and point will be in true length. View 2 of Fig. B1 shows the clearance between oblique line AB and point C.

B2.2 Plane Method

By an alternative method, the point and line can be treated as a plane, and in the true view of the plane, the perpendicular distance from the point to the line is the clearance. See Fig. B2.

B3 CLEARANCE BETWEEN TWO LINES

In a view of the two lines which shows one of the lines as a point, the clearance between the two lines will be in true length as the perpendicular distance from the point to the line. View 2 of Fig. B3 shows the clearance between oblique lines AB and CD.

B4 CLEARANCE BETWEEN A POINT AND A PLANE

In a view of the point and plane that shows the plane as an edge, the clearance will be in true length as a perpendicular distance from the point to the edge. View 1 of Fig. B4 shows the clearance between plane ABC and point X.

B5 POINT OF INTERSECTION OF A LINE AND A PLANE

(a) When a vertical plane, that is an edge in the top view, is passed through the given line, the line of intersection of this plane with the given plane, as observed in the front view, will intersect the given line at the piercing point. In Fig. B5, line MN is the line of intersection between the given plane ABC and the vertical plane passed through the given line XY. Line MN intersects line XY at the piercing point P. It is equally effective to pass a plane appearing as an edge in the front view through the given line.

(b) Alternative Method. A view of the line and plane showing the plane as an edge can be used to locate the point of intersection of the line and plane.

(c) The planes in Figs. B5, B6, B7, and B9 are considered to be opaque with a corresponding visibility of lines in each case.

B6 LINE OF INTERSECTION OF TWO PLANES

(a) When the points are determined where two lines in one plane pierce another plane, a line connecting the piercing points will be the line of intersection of the two planes. Figure B6 shows the line of intersection, PR, of planes ABC and DEFG as if plane ABC were extended in area. PS is the segment of the line of intersection common to the bounded planes.

(b) Alternative Method. A view of two planes showing one of the planes as an edge will locate the line of intersection. Figure B7 shows the line of intersection PR of planes ABC and DEFG by this method.

B7 ANGLE BETWEEN TWO INTERSECTING LINES

Two intersecting lines form a plane whose true view is found by the method of para. A6. The angle between the two lines will be shown in the true view. In Fig. B8, the true size of the angle ABC is found at B2.

B8 ANGLE BETWEEN A LINE AND A PLANE

A view in which the plane appears as an edge and the line appears true-length will show the true angle between the line and plane. Any view adjacent to a true view of a plane will show the plane as an edge. This principle is employed in Fig. B9 where reference line 2-3 is drawn parallel to X_2Y_2 to obtain a true-length view of XY and an edge view of plane ABC in view 3.

B9 ANGLE BETWEEN TWO PLANES

The line of intersection between two planes is first identified or found by the method of para. B6. A view of the two planes with the line of intersection appearing as a point will show the required angle. Both planes will appear as edges in this view. View 2 of Fig. B10 shows the angle between planes M and N.

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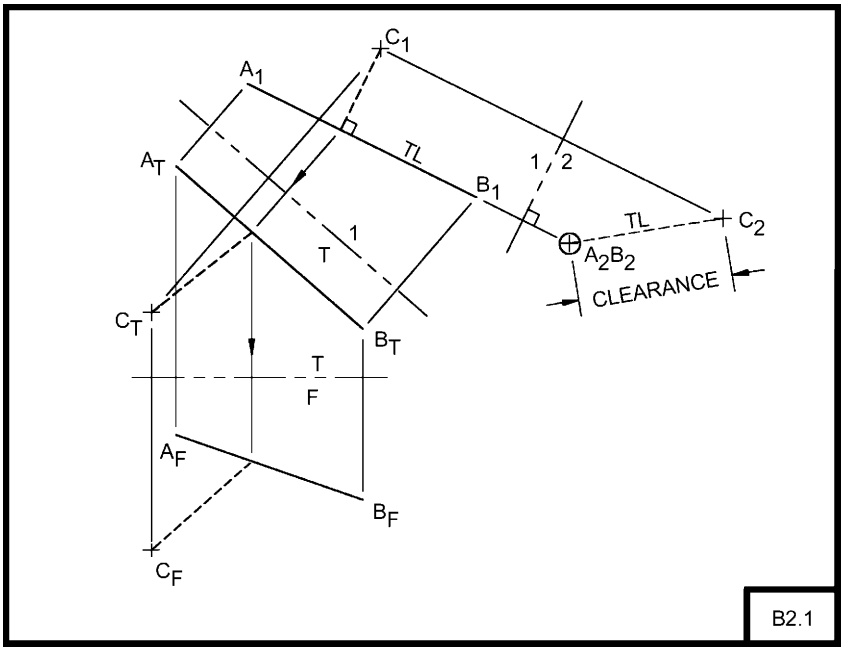


Fig. B1 Clearance Between a Point and a Line (Point Method)

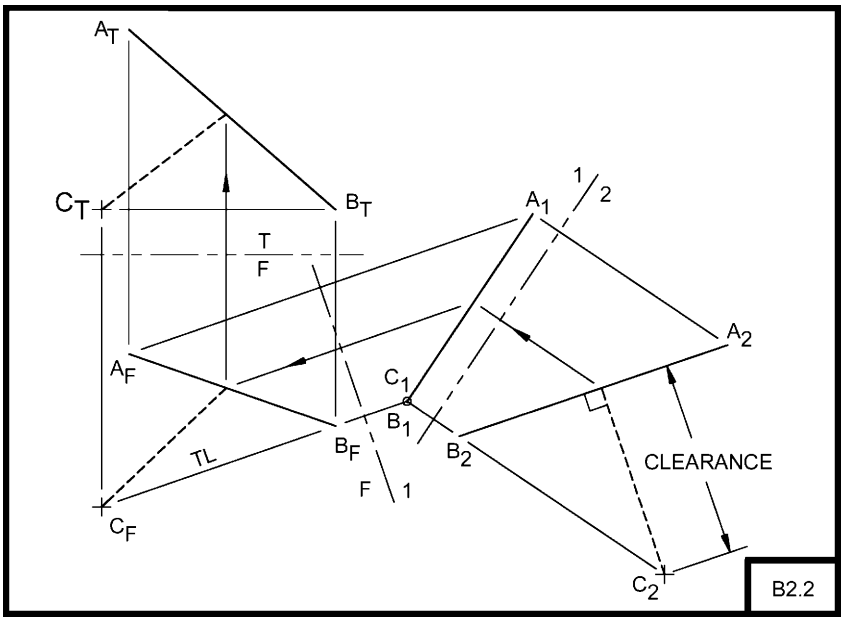


Fig. B2 Clearance Between a Point and a Line (Plane Method)

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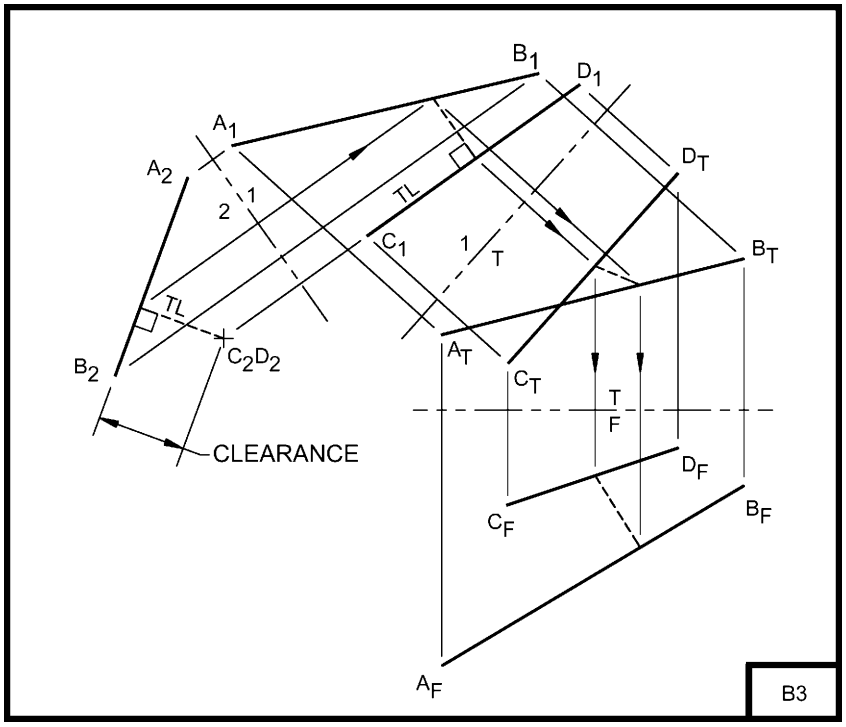


Fig. B3 Clearance Between Two Oblique Lines

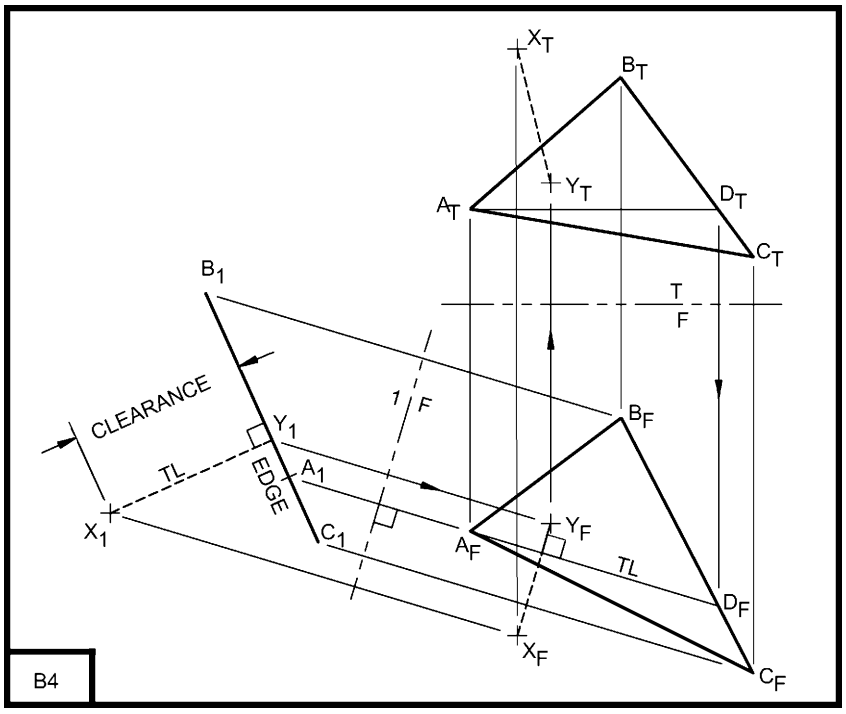


Fig. B4 Clearance Between a Point and a Plane

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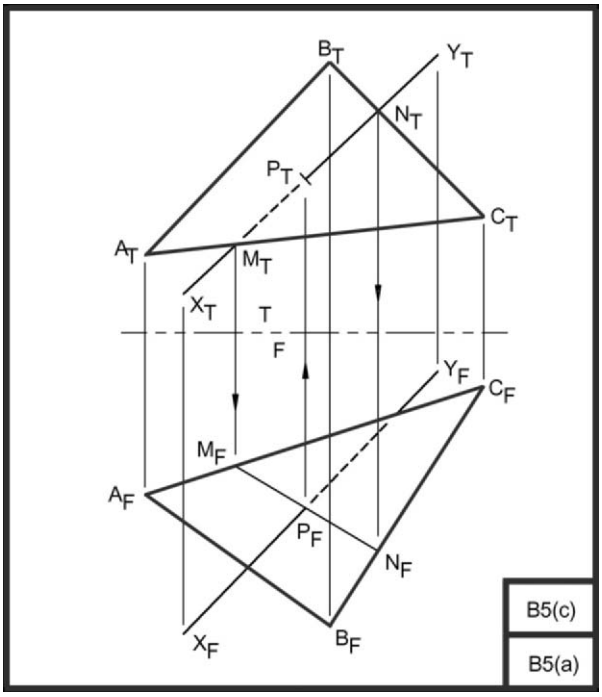


Fig. B5 Intersection of a Line and Plane (Piercing Point)

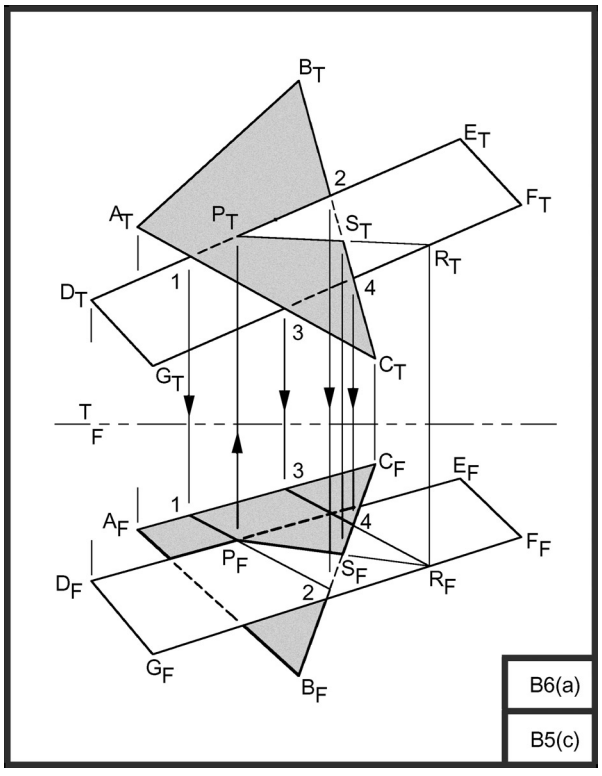


Fig. B6 Intersection of Two Planes

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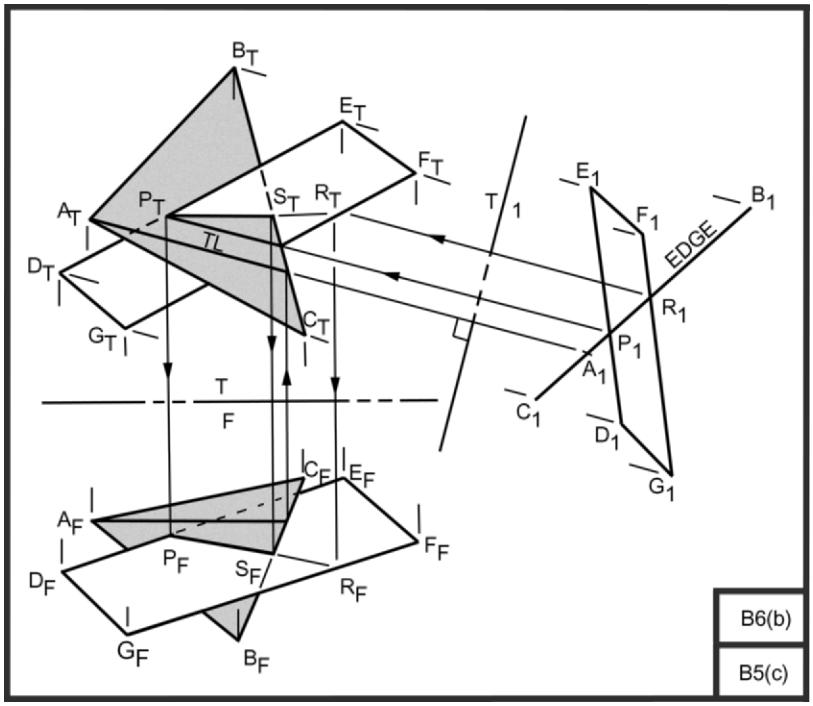


Fig. B7 Intersection of Two Planes (Alternative Method)

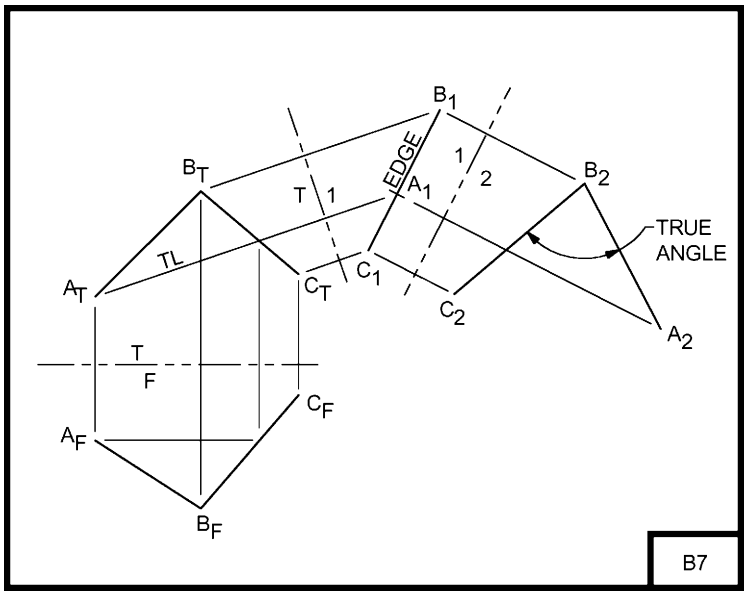


Fig. B8 Angle Between Two Intersecting Lines

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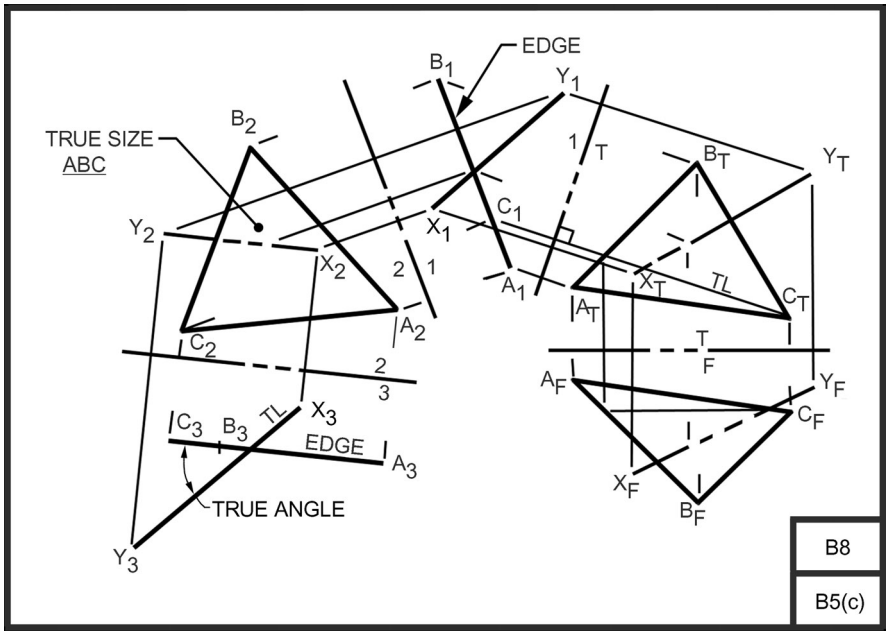


Fig. B9 Angle Between a Line and a Plane

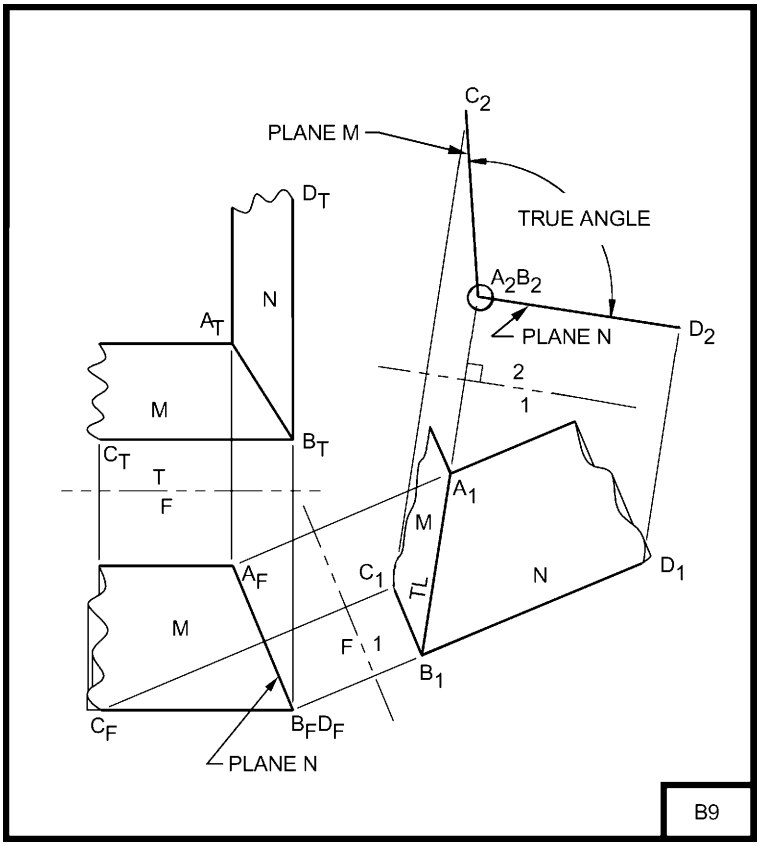


Fig. B10 Angle Between Two Planes

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