ENGINEERING DRAWING AND
RELATED DOCUMENTATION PRACTICES

ASME Y14.4M-1989
[REVISION OF ASA Y14.4-1957(R1987)]

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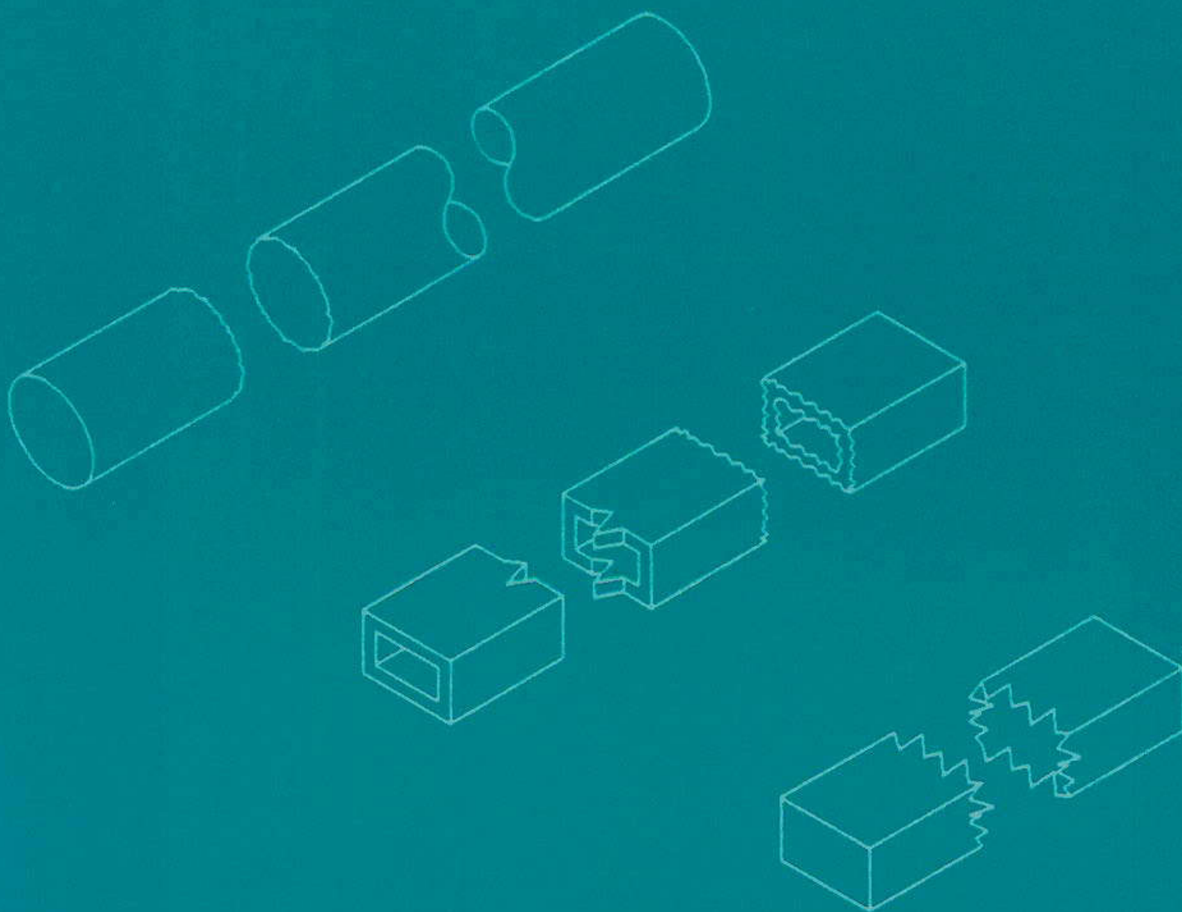
PICTORIAL DRAWING



AN AMERICAN NATIONAL STANDARD

The American Society of
Mechanical Engineers

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PICTORIAL DRAWING

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[REVISION OF ASA Y14.4-1957(R1987)]

The American Society of
Mechanical Engineers

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FOREWORD

(This Foreword is not a part of ASME Y14.4M-1989.)

Since the first national standard for engineering drawings, Standards for Cross-Sections, was published by ASME in 1914, the field of engineering documentation has steadily become increasingly versatile and sophisticated. Pictorial Drawing, considered a frivolous waste of time by many engineering people in those early days, emerged and proved itself a strong and viable technical communication medium during World War II, and it has further reinforced its position in that area since that time. Ultimately, the first Pictorial Drawing standard was published in 1957.

Recognizing that engineering documentation is a dynamic process, this revision endeavors to set forth coherent and useful standards of practice, based on the progress achieved in this interesting profession. It is hoped and assumed that user groups will recognize and accept the importance of standardization and realistic uniformity in pictorial documentation practices, while at the same time thoughtfully and consistently augmenting and supplementing these basics to satisfy the distinctive needs and applications at the many and varied individual user levels.

Following approval by the Y14 Committee and ASME, this Standard was approved as an American National Standard by ANSI on July 19, 1989.

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Engineering Drawing and Related Documentation Practices

(The following is the roster of the Committee at the time of the approval of this Standard.)

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PICTORIAL DRAWING

1 GENERAL

1.1 Scope

This Standard establishes definitions for and illustrates the uses of various kinds of three-dimensional view pictorial mechanical drawings. It also addresses the kinds of pictorial views commonly used on engineering drawings. Methods of constructing the different kinds of pictorial drawings are beyond the scope of this Standard. Methods are described in detail in engineering drawing textbooks.

1.2 History and Uses

Pictorial drawing is the oldest form of recorded communication known to man and has evolved over the years to its current form. Pictorial drawings are used instead of or, as a supplement to, multiview orthographic drawings. They are useful in design, construction or production, erection or assembly, service or repair, and sales. They are used for the following purposes:

(a) to explain complicated engineering designs to those who have difficulty understanding conventional multiview drawings;

(b) to help the designer to work out problems such as clearances and inferences;

(c) to train new employees;

(d) to speed up and clarify the assembling of parts or the ordering of new parts;

(e) to transmit information from one person to another, as from shop to shop or from salesperson to purchaser;

(f) as an aid in developing the power of visualization.

1.3 Applicable Documents

1.3.1 References in Text. When the following American National Standards referred to in this Standard are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply.

American National Standards

ANSI Y14.2M-1979(R1987), Line Conventions and Lettering

ANSI Y14.3-1957(R1987), Multi and Sectional View Drawings

ANSI Y14.5M-1982(R1988), Dimensioning and Tolerancing

1.4 Units

The International System of Units (SI) is featured in this Standard. It should be understood that U.S. customary units could equally have been used without prejudice to the principles established.

2 TYPES OF PICTORIAL DRAWINGS

2.1 Introduction

There are three basic types of pictorial drawings: axonometric, oblique, and perspective. These three differ in the fundamental scheme of projection, that is, the spacial relationship between the object, the point of sight, the plane of projection, and the projectors, or lines of sight, which create the pictorial view on the plane. Figure 1 shows the projection of each type of pictorial view: axonometric in sketch (a), oblique in sketch (b), and perspective in sketch (c). These examples are third angle projections in that the plane of projection is placed between the object and the observer. The views are three-dimensional since all three principle dimensions — width, height, and depth — appear in a single view. Figure 1 also shows a front view in each case for comparison, and brings out the fact the axonometric projection is a special case of orthographic projection.

2.2 Axonometric Projection

An axonometric projection is one in which the projectors are perpendicular to the plane of projection and parallel to each other. The principle surfaces and edges of a cube or other rectangular object are all inclined to the plane of projection. The angles between the principle edges, or axes, of the object shall not be 90 degrees on the drawing. The relationship between the three angles shall be such that the mutual perpendicularity of the axes on the object is maintained. See Figs. 2 through 5. The view direction should be one that gives the most information about the object unless other considerations, such as natural position or relation to other objects, take precedence. It should be noted that an axonometric projection can be obtained by constructing a secondary auxiliary view in which the desired line of sight appears as a point, or by revolving the object into the desired position and drawing a front view or other principle view. Axonometric is divided into isometric, dimetric, and trimetric projections.

2.2.1 Isometric Projection. An isometric projection is an axonometric projection in which the three axes of the object make equal angles with the plane of projection. Taken two at a time, the three axes make three equal angles of 120 deg. on the drawing (see Fig. 2). Linear dimensions along or parallel to any one of the three axes are measured full size or to scale. Linear dimensions, not along or parallel to an axis, and angular dimensions are not to scale and are not used. Height is measured vertically in Fig. 2. Width and depth are measured at 30 deg. angles with the horizontal. Other positions of the axes may be used provided the proper angles between the axes are maintained.

2.2.2 Dimetric Projection. A dimetric projection is an axonometric projection in which two axes of the object make equal right angles with the plane of projection and the third axis makes a different angle with the plane of projection. Two of the angles between axes are equal; the third angle is unequal (see Fig. 3). A dimetric view may be constructed by using one scale along or parallel to the two equally inclined axes and a different scale along or parallel to the third axis. Linear dimensions, not along or parallel to and axis, and angular dimensions are not to scale and are not used. Height is measured vertically in Fig. 3. Width and depth are measured at 15 deg. angles with the horizontal. These two equal angles shall be greater than 0 deg. and less than 45 deg., but not equal to 30 deg. Other positions of the axes may be used provided the proper angles between the axes are maintained.

2.2.3 Trimetric Projection. A trimetric projection is an axonometric projection in which all three axes of the object make unequal angles with the plane of projection. The axes make three different angles with each other on the drawing (see Fig. 4). A trimetric view may be constructed by using three different scales along or parallel to the three axes. Linear dimensions, not along or parallel to an axis, and angular dimensions are not to scale and are not used. Height is measured vertically in Fig. 4. Width is measured at 15 deg. with the horizontal. Depth is measured at 30 deg. with the horizontal. These two unequal angles shall each be greater than 0 deg. and their sum shall be less than 90 deg. Other positions of the axes may be used provided the proper angles between the axes are maintained.

2.2.4 Choice of Axonometric Axes. Axes should be chosen and axonometric views constructed so as to provide as true a decription of the object as possible. The appearance of distortion on a large flat surface may be decreased by increasing the angle which that surface makes with the plane of projection. The true outline of a more important surface may be shown more clearly by decreasing the angle which that suface makes with the plane. Figure 5, sketch (b) is preferable to Fig. 5, sketch (a) for the following reasons.

(a) The horizontal surface is less distorted.

(b) The vertical surface is shown in better detail.

The choice of axes may be simplified by the use of commercially available axonometric drawing systems.

2.3 Oblique Projection

An oblique projection is one in which parallel projectors, or lines of sight, make an angle other than 90 deg. with the plane of projection. A common practice is to position a principle surface of the object parallel to the plane of projection so that it and surfaces parallel to it show true shape. Two of the principle edges, or axes, of the object are parallel to the plane of projection and make a 90 deg. angle on the drawing. The receding axis may extend in any direction on the drawing not parallel to or at right angles with either one of the first two. See Figs. 6 and 7. Oblique is divided into cavalier, cabinet, and general oblique projections. They differ only in the comparative scales of the two frontal axes and the receding axis.

2.3.1 Cavalier Projection. A cavalier projection is an oblique projection on which the projectors make 45 deg. with the plane of projection. See Fig. 6, sketch (a) and Fig. 7, sketch (a). A cavalier drawing is constructed by measuring dimensions along or parallel to any one of the three axes full size or to the same scale. Other linear dimensions parallel to the plane of projection are also measured full size or to scale. An angular dimension in a surface parallel to the plane is measured full size. Other linear and angular dimensions are not to scale and are not used. Height and width are measured vertically and horizontally in Fig. 6, sketch (a). Depth is measured at 30 deg. with the horizontal. The depth angle shall be greater than 0 deg. and less than 90 deg. Other positions of the axes may be used provided the proper angles between the axes are maintained.

2.3.2 Cabinet Projection. A cabinet projection is an oblique projection in which the projectors make an angle with the plane of projection, which reduces distance along or parallel to the receding axis to one-half of that for cavalier projection. See Fig. 6, sketch (b). A cabinet drawing is constructed by using a scale for the receding axis which is one-half the scale for the other two axes. Other dimensions are measured in the same manner as on the cavalier drawing. Width and height are measured horizontally and vertically in Fig. 6, sketch (b). Depth is measured at 30 deg. with the horizontal. The depth angle shall be greater than 0 deg. and less than 90 deg. Other positions of the axes may be used provided the proper angles between the axes are maintained.

2.3.3 General Oblique Projection. A general oblique projection is one which is not a cavalier and not a cabinet projection. The scale for the receding axis is not equal to one-half of the scale for the other two axes. See Fig. 7, sketch (b).

2.3.4 Choice of Form of Oblique Projection. The appearance of distortion in an oblique view may be decreased by reducing the scale on the receding axis. Oblique drawings are commonly used for objects which have a series of circles, curves, or irregular outlines in the same or parallel plane surfaces. The object is positioned with these planes parallel to the plane of projection so that the circles and outlines project in true shape. Cylindrical and conical objects should usually be drawn with their major axis (center line) on the receding axis to reduce distortion and facilitate documentation. See Fig. 7.

2.4 Perspective Projection

A perspective projection is one in which the projectors are not parallel and converge from points on the object to the point of sight located at a finite distance from the plane of projection. Any set of parallel edges or lines on the object converge, when extended, to a single vanishing point on the drawing. Perspective is divided into one-point, two-point, and three-point projections.

2.4.1 One-Point Perspective Projection. A one-point perspective projection is one in which the object is positioned with two of the principle axes of the object parallel to the plane of projection. The third axis is perpendicular to the plane. Width and height are shown horizontally and vertically in Fig. 8. Horizontal edges or lines which are parallel to the depth axis converge, when extended, to one vanishing point on the drawing horizon.

2.4.2 Two-Point Perspective Projection. A two-point perspective projection is one in which the object is positioned with one of the principle axes (usually the vertical axis) parallel to the plane of projection. The other two axes are inclined to the plane. Height is shown vertically in Fig. 9. Horizontal edges or lines which are parallel to the depth axis converge, when extended, to one vanishing point on the drawing horizon. Horizontal edges or lines which are parallel to the width axis converge, when extended, to a second vanishing point on the drawing horizon.

2.4.3 Three-Point Perspective Projection. A three-point perspective is one in which the object is positioned with all three of the principle axes inclined to the plane of projection. See Fig. 10. Each set of edges or lines parallel to an axis converges, when extended, to one of three vanishing points on the drawing.

2.4.4 Location of Plane of Projection and Point of Sight. A common practice is to locate the plane of projection to pass through the front face of a rectangular object in a one-point perspective, the front edge of the object in a two-point perspective, and the front corner of the object in a three-point perspective. Dimensions within the plane of projection may then be measured full size or to scale. The point of sight should be located so that the cone of projectors, which has its apex at the point of sight and includes the whole object, has an angle at the apex not greater than 30 deg. See Fig. 11. A larger angle adds to distortion in the perspective view. Best results are obtained if the point of sight is located centrally in front of the object and is high enough to show the top surfaces of the object.

3 DETAIL REPRESENTATION ON PICTORIAL DRAWINGS

3.1 Depiction

Individual details may be shown in numerous ways on conventional drawings. However, on pictorial drawings, the guidelines in the following paragraphs are recommended. The object is to present the details in universal and easily understood methods.

3.2 Line Conventions and Lettering

Line conventions and letttering shall follow the requirements and guidelines defined in ANSI Y14.2M, Line Conventions and Lettering.

3.2.1 Hidden Lines. Hidden lines shall be omitted on pictorial drawings except where necessary to describe the shape of the object or to add clarity to the drawing. See Fig. 12.

3.2.2 Break Lines. Break lines, when used to shorten the length of a detail or assambly, shall reveal the characteristic shape of the cross section in each case. Break lines may be drawn free-hand or with aids. See Fig. 13.

3.3 Sectional Views

Sectional views shall follow the requirements and guidelines defined in ANSI Y14.3, Multi and Sectional View Drawings.

3.3.1 Arrangement. The object shall be positioned in a sectional pictorial view so that the cutting plane does not appear edgewise. See Figs. 14 and 15.

3.3.2 Half Section. Section lining shall be drawn in a pictorial half section view so that the lines would appear to coincide if the cut surfaces were to be folded together about the center line of the object. See Fig. 14, sketch (a).

3.4 Fillets and Rounds

Fillets and rounds appear in pictorial drawings as highlights as shown in Fig. 16, sketch (a). The representation of fillets and rounds by straight or curved lines, as shown in Fig. 16, sketches (b) and (c), is accepted as a substitute.

3.5 Intersections

Intersections of surfaces are shown in pictorial drawings as a line or by shading (see para. 3.9). See Fig. 17.

3.6 Thread Representation

Threads shall be represented in a pictorial drawing by a series of ellipses or circles uniformly spaced along the center line of the thread. Shading may be used. See Fig. 18. Threads are equally spaced, but the distance between adjacent threads does not have to equal the actual pitch.

3.7 Dimensioning and Tolerancing

Dimensioning and tolerancing shall be per ANSI Y14.5M.

3.7.1 Plane of Dimension Lines. The dimension lines, extension lines, and the lines being dimensioned shall lie in the same plane.

3.7.2 Dimensions and Notes. It is recommended that all dimensions and notes be unidirectional, reading from the bottom of the drawing and located outside the view whenever possible. See Fig. 19.

3.8 Symbols

Symbols for surface texture, welds, and other requirements shall reflect their respective standards. See Fig. 19.

3.9 Shading

Shading may be used on pictorial drawings. The type of shading depends on the purpose of the drawing and method of reproduction. See Fig. 20.

3.9.1 Shading of Engineering Drawings. It is recommended that pictorial views on engineering drawings not be shaded. Object lines of variable width may be used to improve the visualization quality of the drawing and vary the emphasis on individual details.

3.9.2 Shading of Catalog Illustrations. Some form of overall shading is recommended for catalog illustrations. Air brush rendering and commercially available shading media may be used for this purpose. See Fig. 21.

3.10 Phantom Drawings

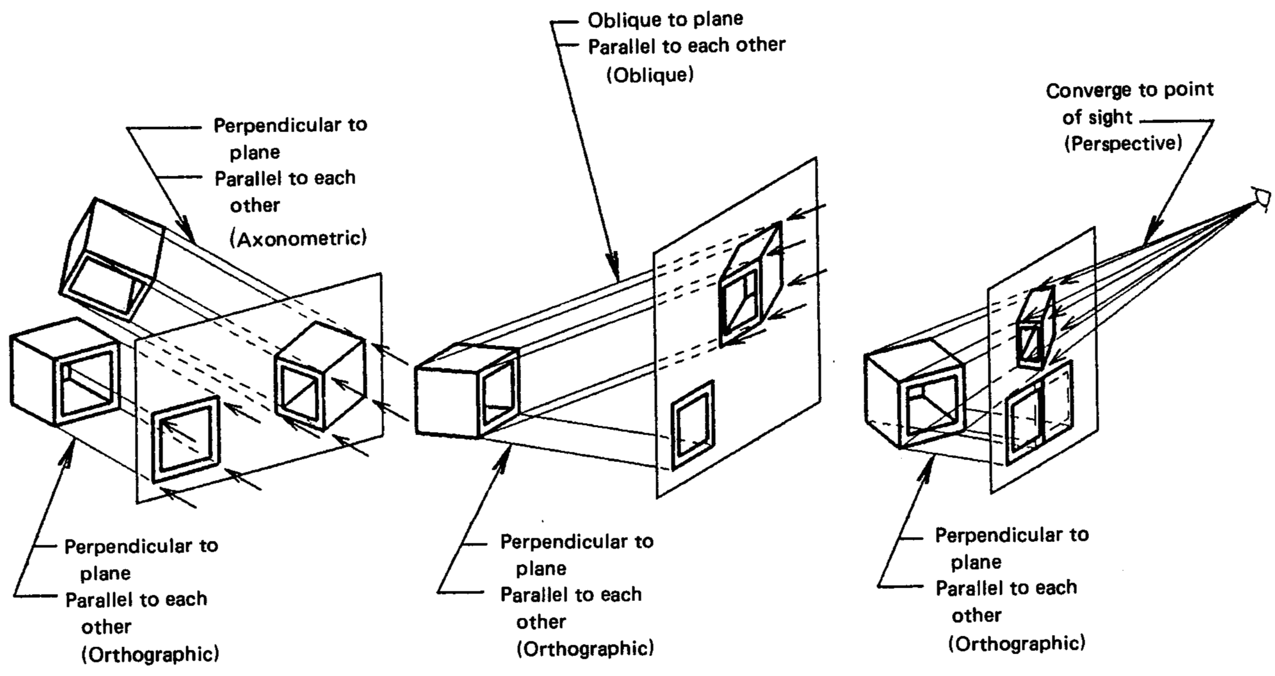
A phantom drawing is a pictorial drawing which shows the outer shell or covering and, at the same time, the interior part of an assembly. The outer parts or covering materials are shaded in light tones and the interior parts are shaded in darker tones. See Fig. 22.

3.11 Exploded Pictorial Assembly Drawings

An exploded pictorial assembly drawing shows the parts of an assembly separated but in proper position and alignment for reassembly. Exploded views are used extensively in service manuals and as aids in assembling or erecting machines or structures. Any kind of pictorial drawing may be used for this purpose. Figure 23 is an example of dimetric pictorials exploded for use in assembling or ordering parts.

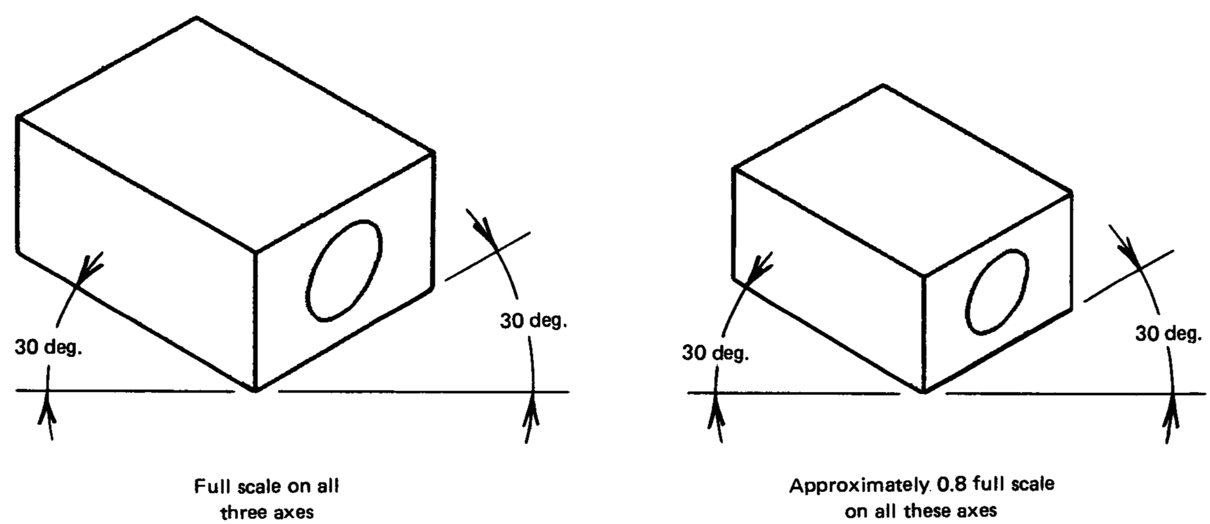
3.12 Photographic Drawings

Pictorial illustrations for single parts and for exploded views may be prepared by photography. Photographs and line details may be combined into a single drawing. See Fig. 24.



(a) Axonometric (b) Oblique (c) Perspective

FIG. 1 KINDS OF PROJECTION



(a) Isometric Projection (b) Isometric Projection (Foreshortened)

FIG. 2 ISOMETRIC PROJECTION

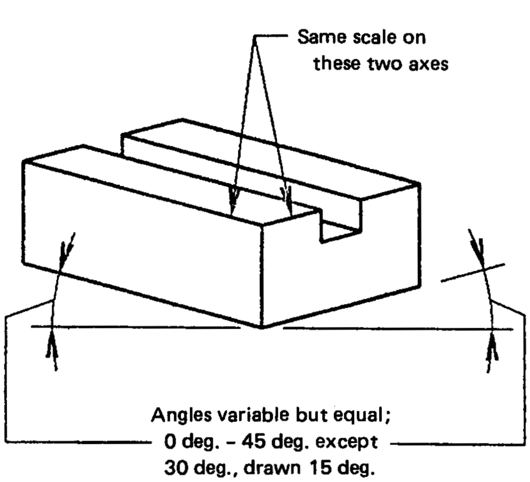


FIG. 3 DIMETRIC PROJECTION

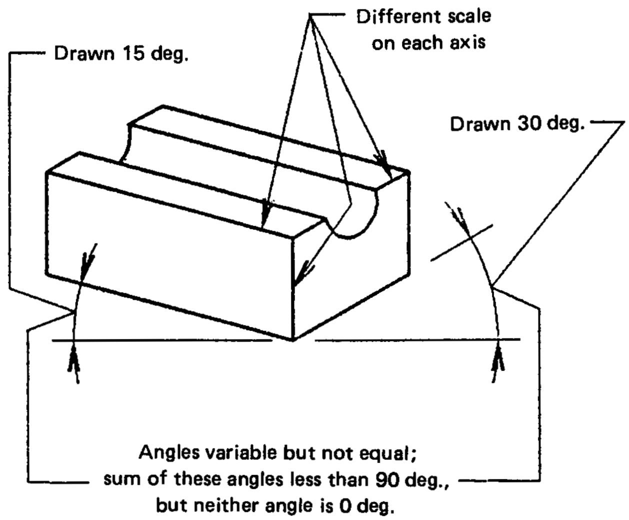
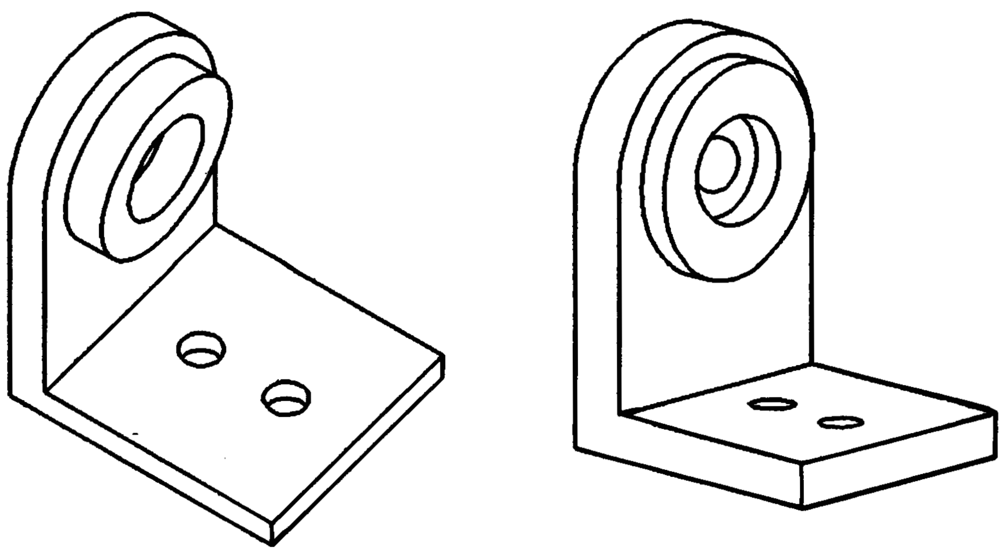


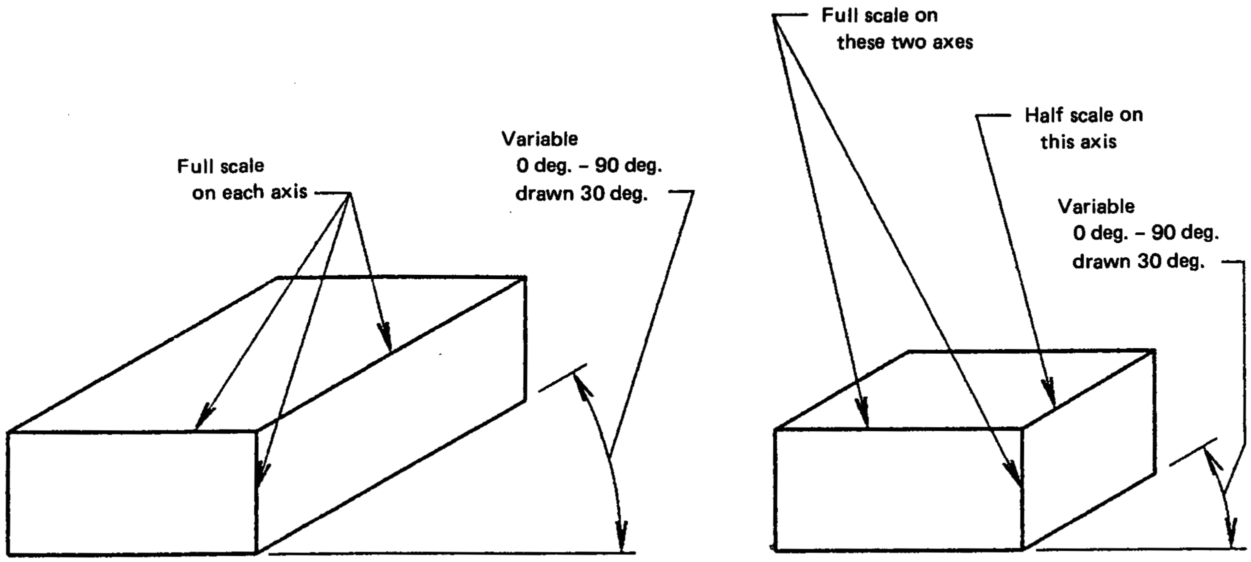
FIG. 4 TRIMETRIC PROJECTION



(a) Distortion in Horizontal Face

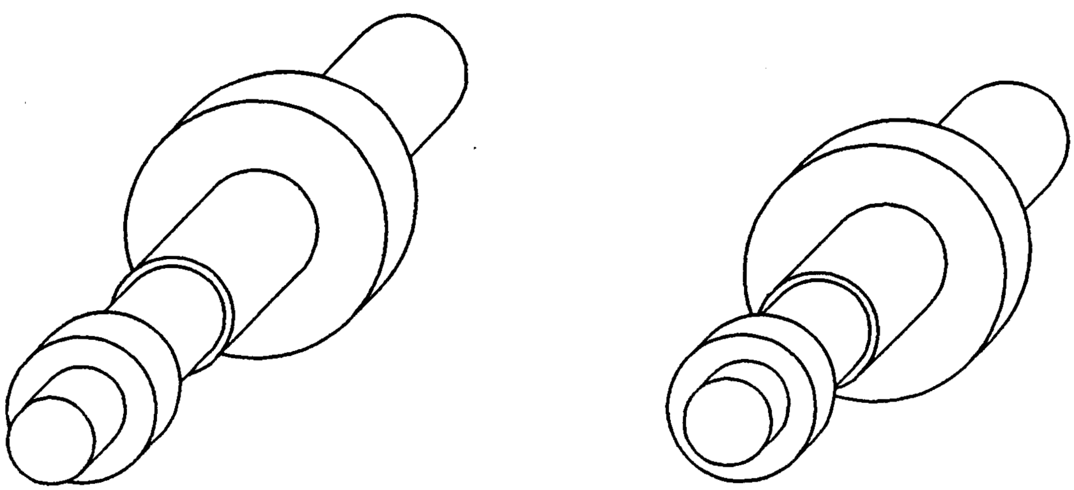
(b) Shows More Detail in Vertical Part

FIG. 5 CHOICE OF AXONOMETRIC VIEW



(a) Cavalier (b) Cabinet

FIG. 6 OBLIQUE PROJECTION



(a) Cavalier – Not Foreshortened (b) General – Foreshortened

FIG. 7 TYPE OF OBJECTS DRAWN IN OBLIQUE AND EFFECT OF FORESHORTENING

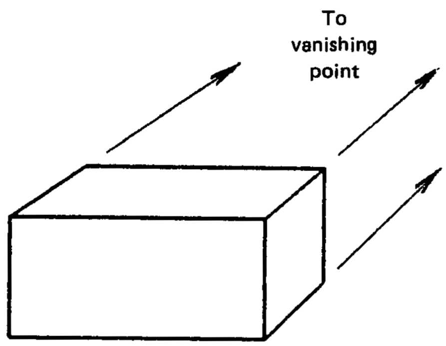


FIG. 8 ONE-POINT PERSPECTIVE

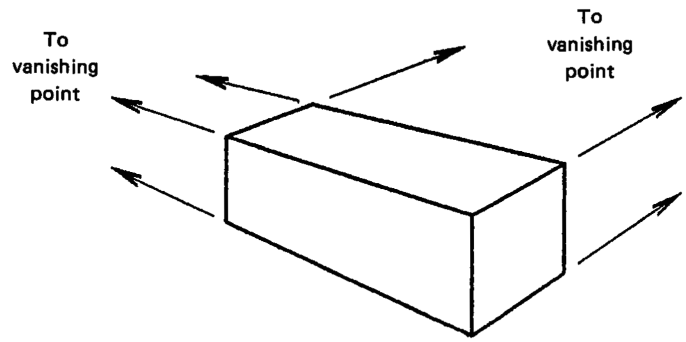


FIG. 9 TWO-POINT PERSPECTIVE

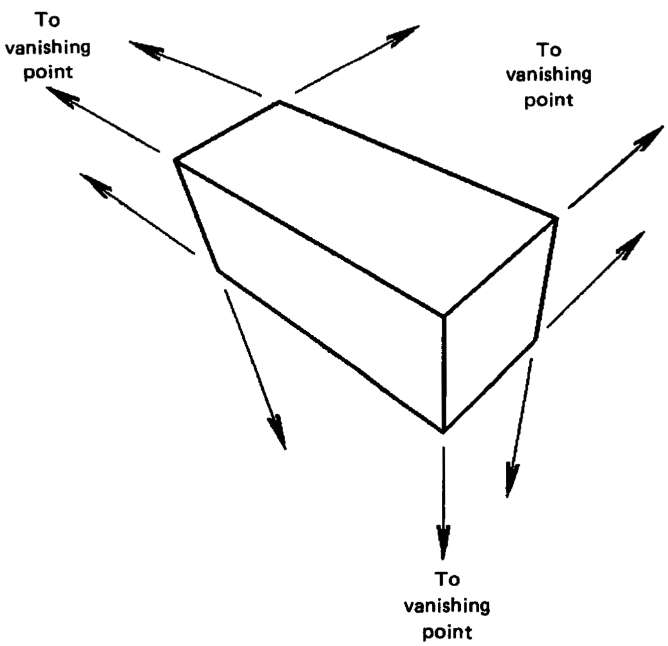


FIG. 10 THREE-POINT PERSPECTIVE

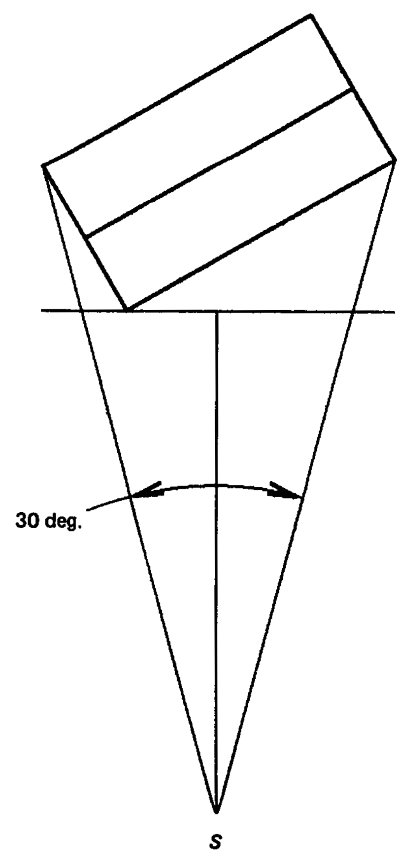


FIG. 11 LOCATION OF POINT OF SIGHT IN PERSPECTIVE

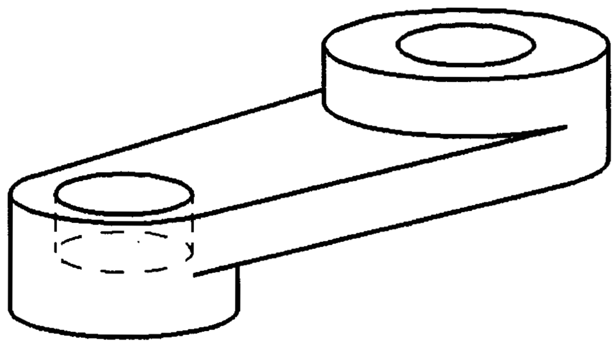


FIG. 12 USE OF HIDDEN LINES IN PICTORIAL

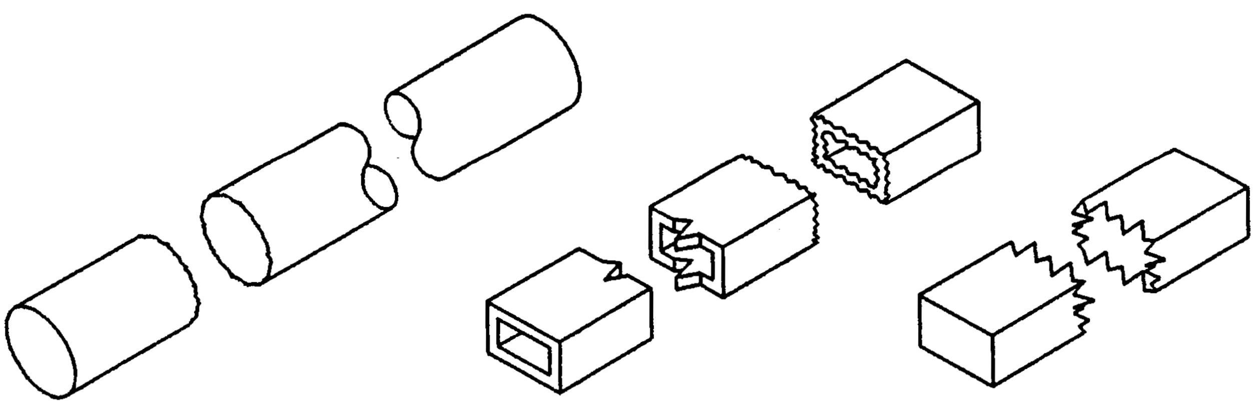
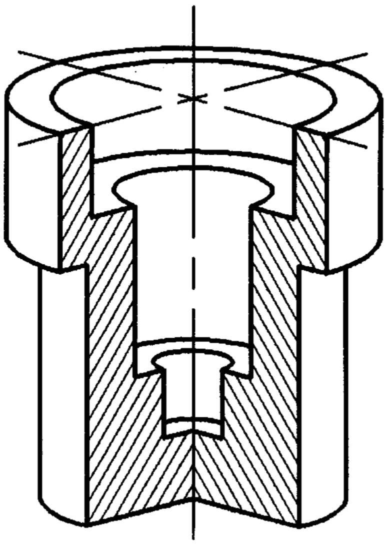
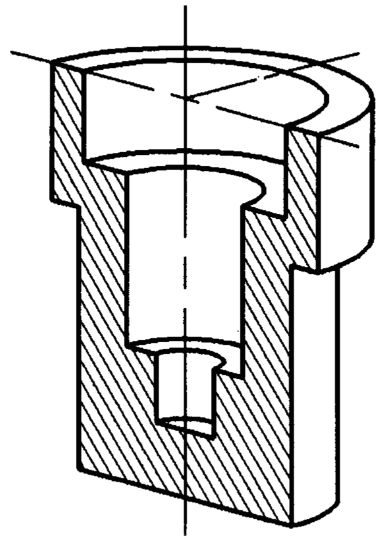


FIG. 13 BREAK LINES



(a) Half Section



(b) Full Section

FIG. 14 SECTIONAL VIEWS AND SECTION LINING

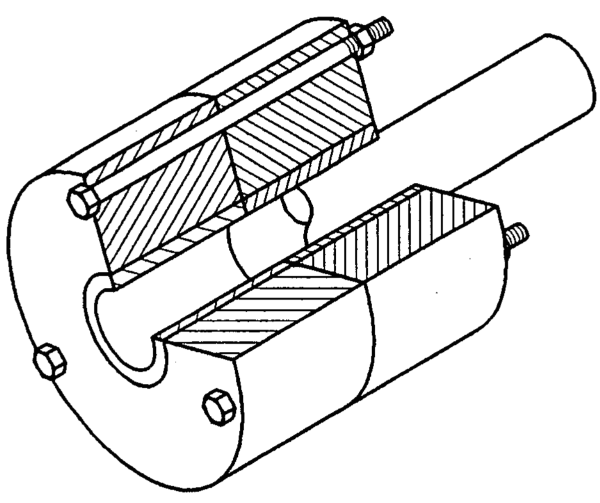


FIG. 15 SECTION THROUGH ASSEMBLY

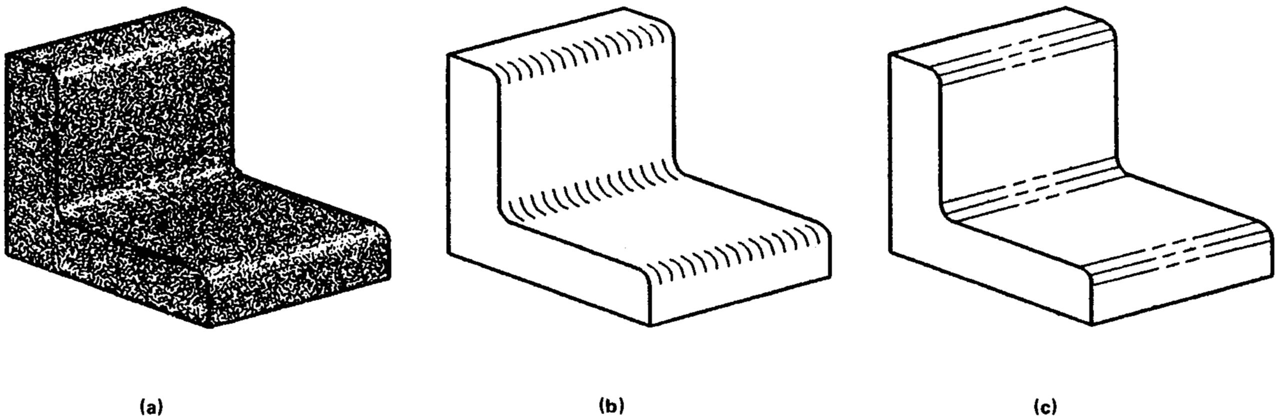


FIG. 16 FILLETS AND ROUNDS

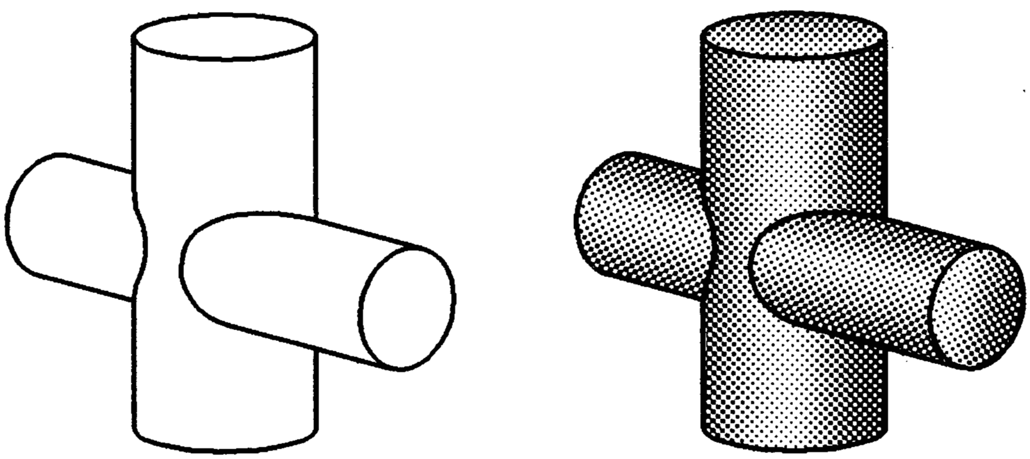


FIG. 17 INTERSECTIONS

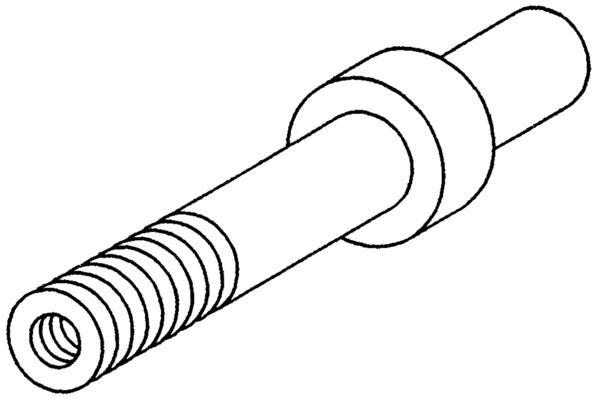
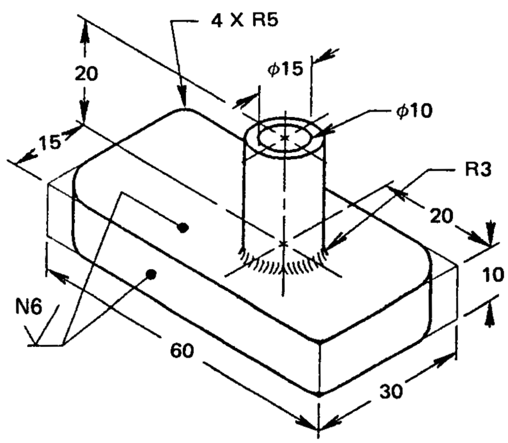
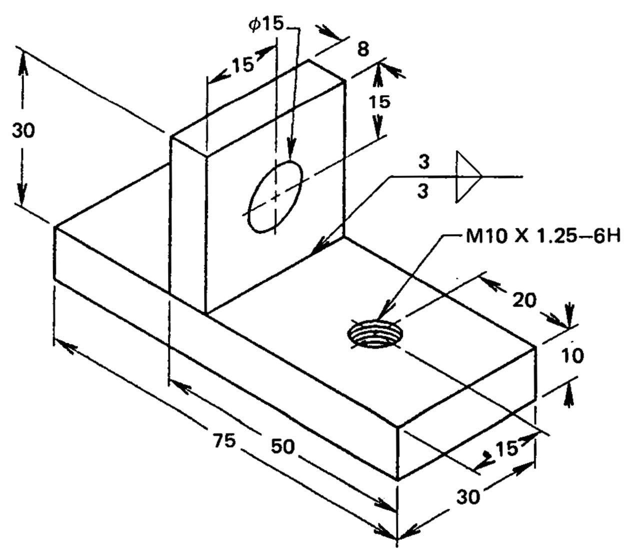


FIG. 18 REPRESENTATION OF THREADS



(a)



(b)

FIG. 19 UNIDIRECTIONAL DIMENSIONING

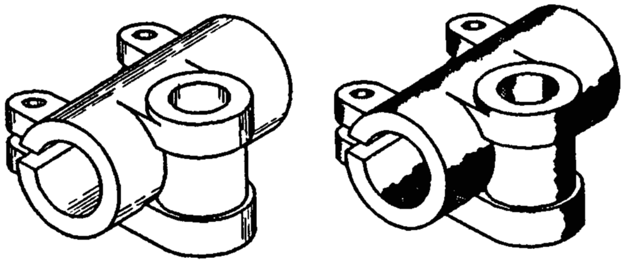


FIG. 20 SHADING

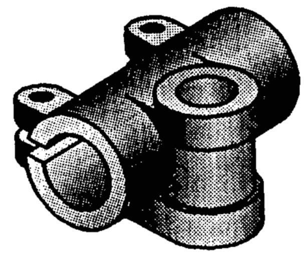


FIG. 21 AIR BRUSH RENDERING

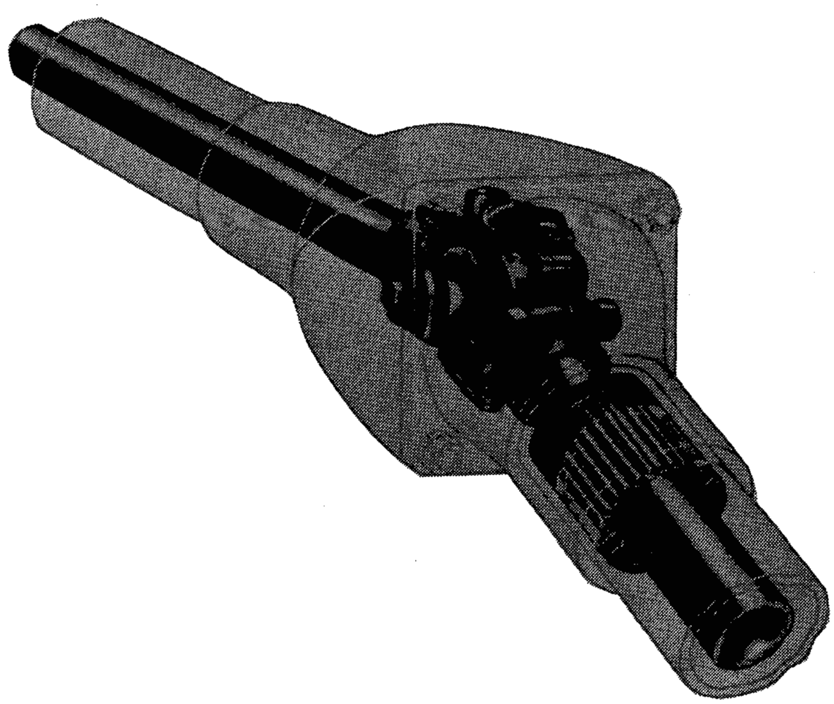
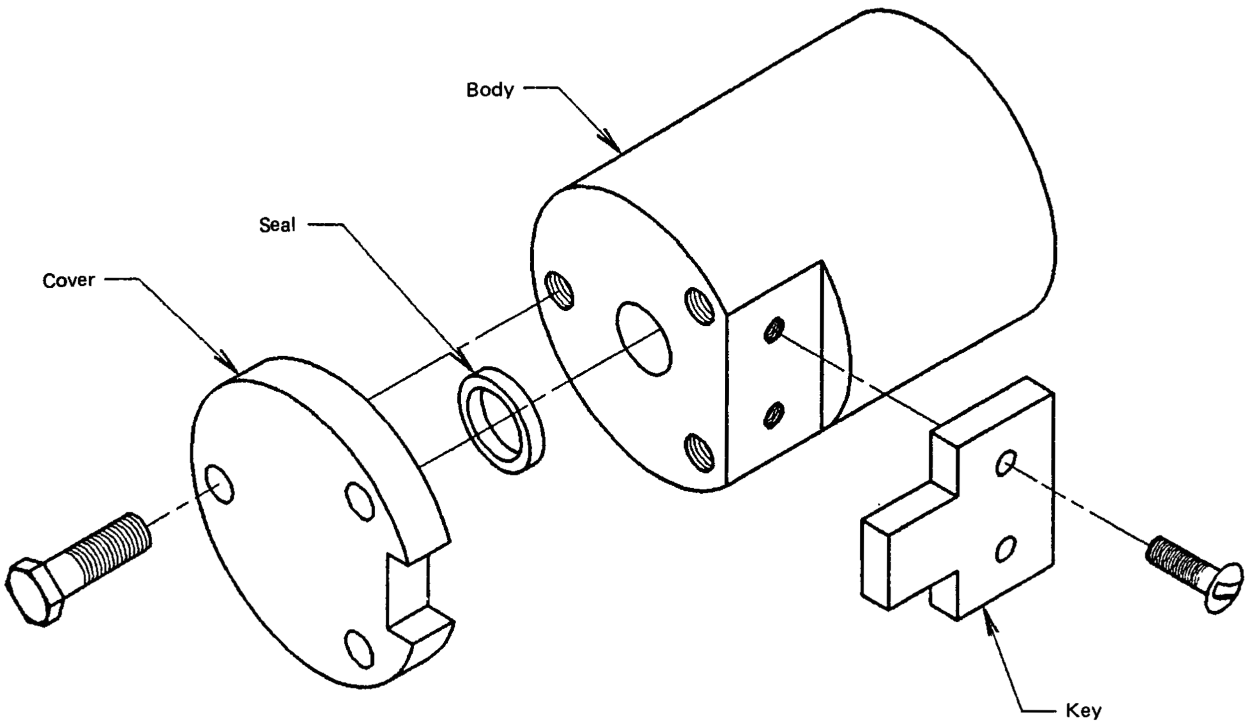


FIG. 22 PHANTOM DRAWING



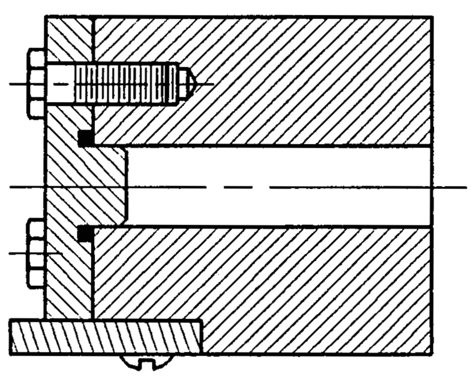
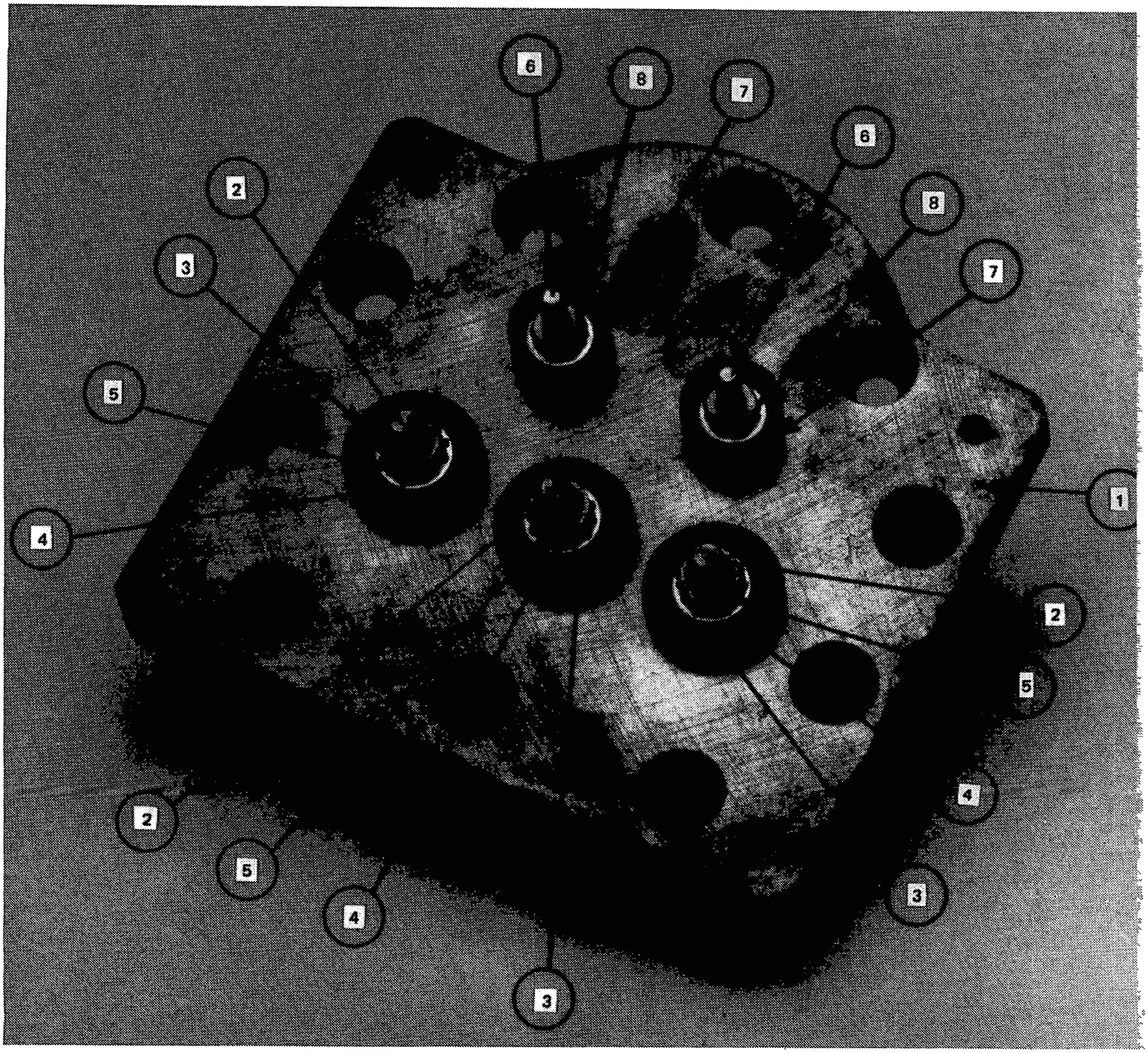


FIG. 23 COMPARISON OF STANDARD SECTION WITH EXPLODED ASSEMBLY



Parts List	
1	Plate
2	M6 × 1 stud
3	Insulator
4	Washer
5	M6 × 1 nut and lockwasher
6	M5 stud
7	Insulator
8	M5 nut and lockwasher

FIG. 24 PHOTOGRAPHIC DRAWING

RELATED DOCUMENTS

The ASME Publications Catalog shows a complete list of all the Standards published by the Society.

The catalog and binders for holding these Standards are available upon request.

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