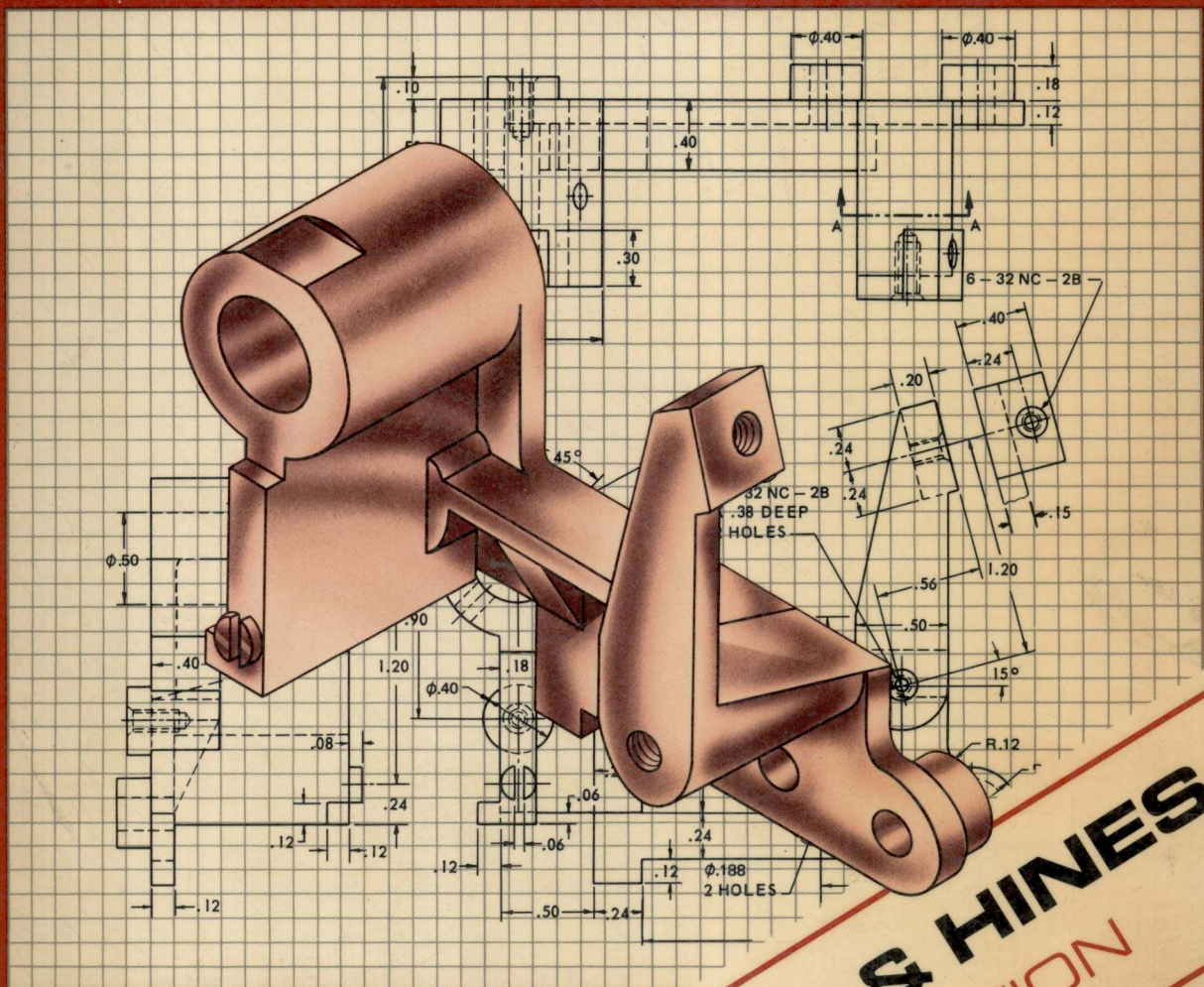


INTERPRETING ENGINEERING DRAWINGS



JENSEN & HINES
THIRD EDITION

INTERPRETING ENGINEERING DRAWINGS

THIRD EDITION

C. JENSEN • R. HINES

DELMAR PUBLISHERS INC.

Delmar staff

Administrative Editor: Mark W. Huth
Project Editor: Marjorie A. Bruce
Production Editor: Frances Larson

For information, address Delmar Publishers Inc.
2 Computer Drive West, Box 15-015
Albany, New York 12212

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10 9 8 7 6 5 4 3 2 1

**LIBRARY OF CONGRESS CATALOG CARD NUMBER: 80-65469
ISBN: 0-8273-1936-3**

Printed in the United States of America
Published simultaneously in Canada by Nelson Canada,
A division of International Thomson Limited

PREFACE

New technological developments have created a need for well-prepared instructional material for persons both entering and engaged in technical positions in industry. In this revision of the popular 1972 edition, *INTERPRETING ENGINEERING DRAWINGS* provides instructional material for students, apprentices, journeymen, and others who need to know how to read and interpret engineering drawings.

This third edition includes previous unit material, plus several new units, with the addition of twenty-one new assignments which offer more basic problems at the beginning of the text before moving in logical sequence to advanced work. The text uses the most recent drafting conventions introduced by the American National Standards Institute in its ANSI Y14.5M standard on "Dimensioning and Tolerancing." This edition places special emphasis on the subject of true position and geometric tolerancing. Also included is expanded information on other forms of tolerancing, as well as new material on sketching secondary auxiliary views; development drawings with information on joints, seams, edges, straight line development, and piping drawings. The last unit in this edition expands on the subject of metric drawing practices. The use of a second color provides readability, contrast, and emphasis to the written material, illustrations, and assignments.

The written material and illustrations preceding the drawing assignments contain related technical information and principles of drafting necessary to interpret the new material on each drawing. In some instances, shop practices are defined and explained to clarify the meanings of operational notes which appear on shop drawings.

To distinguish between the illustrations used in the explanatory material and the assignments, the illustrations are given a unit and figure number, and the assignments are given a drawing number preceded by the letter "A." *Figure 1-1*, for example, is the first illustration in the book, and *Drawing A-1* is the first assignment.

Twenty-three selected tables and charts taken from handbooks and manufacturers' catalogs are in the back of the book in a newly added appendix. Eighteen of these tables are new over the previous edition. These tables comprise the reference material needed to solve the problems. Further information can be obtained by writing to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

Mr. Cecil H. Jensen has held the position of Technical Director of the McLaughlin Collegiate and Vocational Institute, Oshawa, Ontario, Canada, and has more than twenty-seven years of teaching experience in mechanical drafting. An active member of the Canadian Standards Association (CSA) Committee on Technical Drawings, Mr. Jensen has represented Canada at international (ISO) conferences on engineering drawing standards which took place in Oslo, Norway and Paris, France. He also represents Canada on the ANSI Y14.5M Committee on Dimensioning and Tolerancing. He is the successful author of many technical books, including *Drafting Fundamentals*, *Engineering Drawing and Design*, and *Home Planning and Design*. Before he began teaching, Mr. Jensen spent several years in industrial design. He has also been responsible for the supervision of the teaching of technical courses for General Motors' apprentices in Oshawa, Canada.

Mr. Raymond D. Hines contributes thirty-five years of experience in the field of electromechanical design to this text. As a Design Specialist with the General Electric Company, Guelph, Ontario Canada, he was responsible for the internal design layout of the largest high-voltage power transformer built in North America. He is especially interested in the advancement of the drafting design profession through the latest methods of drawing presentations.

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BASES FOR INTERPRETING DRAWINGS

Engineering or technical drawings furnish a description of the shape and size of an object. Other information necessary for the construction of the object is given in a way that renders it readily recognizable to anyone familiar with engineering drawings.

Pictorial drawings are similar to photographs, because they show objects as they would appear to the eye of the observer, figure 1-1. Such drawings, however, are not often used for technical designs. The drawings used in industry must clearly show the exact shape of objects. This usually cannot be accomplished in just one pictorial view, because many details of the object may be hidden or not clearly shown when the object is viewed from only one side.

For this reason, the drafter must show a number of views of the object as seen from different directions. These views, referred to as front view, top view, right-side view, and so forth, are systematically arranged on the drawing sheet and projected from one another, figure 1-2. This type of projection is called *orthographic projection*. The ability to understand and visualize an object from these views is essential in the interpretation of engineering drawings.

The principles of orthographic projection can be applied in four angles, or systems: first-, second-, third-, and fourth-angle projection. However, only two systems, first- and third-angle projection are used. *Third-angle projection* is used in the United States, Canada, and many other countries. *First-angle projection* is used mainly in Europe. Because world trade has brought about the exchange of both engineering drawings and products, drafters are now called upon to communicate in both types of orthographic projection, as well as pictorial representations.

THIRD-ANGLE PROJECTION

The third-angle system of projection is used almost exclusively on mechanical engineering drawings because it permits each feature of the object to be drawn in true proportion and without distortion along all dimensions. This system of projection also involves less time than other methods.

Three views are usually sufficient to describe the shape of an object. The views most commonly used are the front, top, and right-side. In third-angle projection the object may be assumed

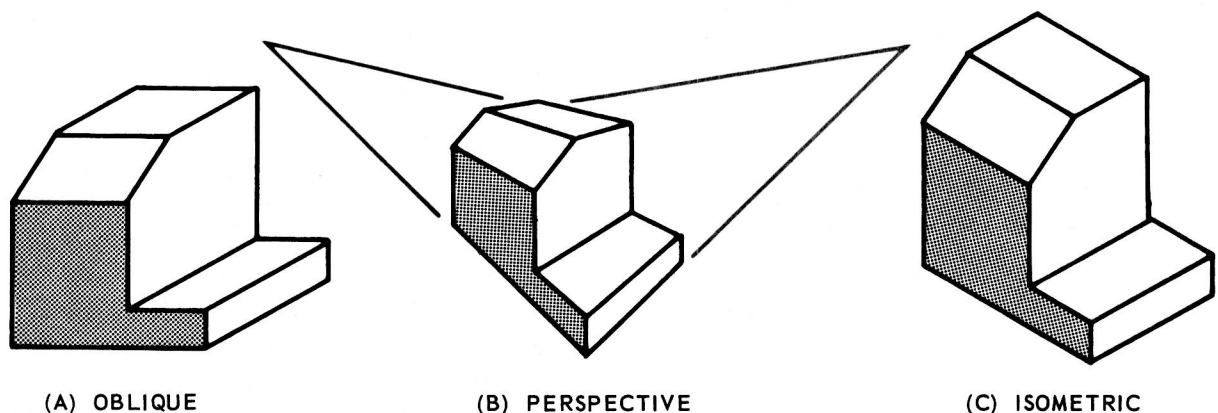


Fig. 1-1 Pictorial drawings

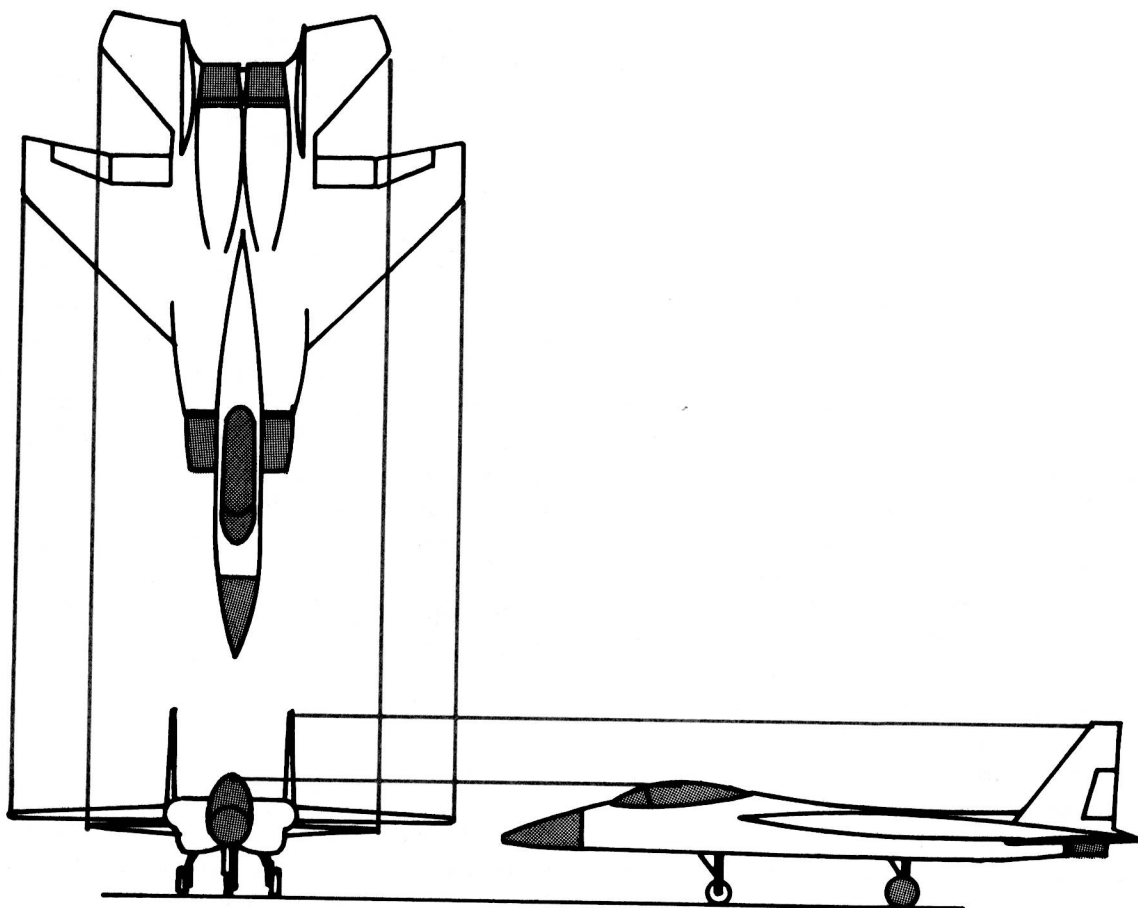


Fig. 1-2 Systematic arrangement of views

to be enclosed in a glass box, figure 1-3(B). A view of the object drawn on each side of the box represents that which is seen when looking perpendicularly at each face of the box. If the box were unfolded as if hinged around the front face, the desired orthographic projection would result, figure 1-3(C) and (D). These views are identified by names as shown. With reference to the front view:

- the top view is placed above.
- the bottom view is placed underneath.
- the left view is placed on the left.
- the right view is placed on the right.
- the rear view is placed at the extreme left or right, whichever is convenient.

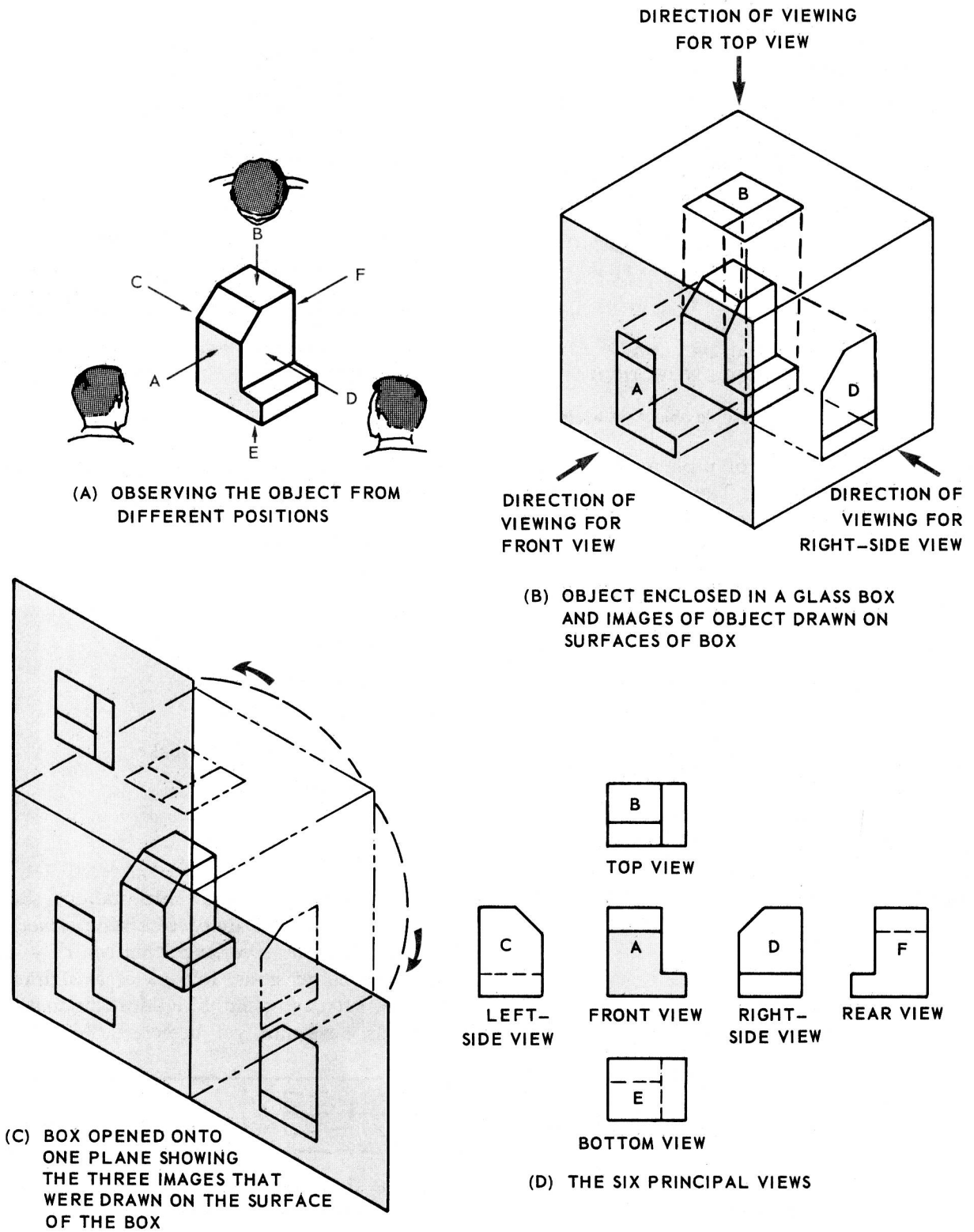
When referring to the overall size of an object, the terms *width*, *height*, and *depth* are

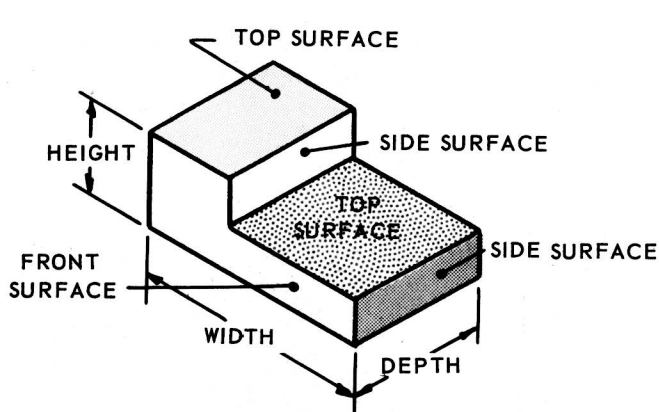
used to describe the views. The terms *length* and *thickness* are not recommended, because they do not apply in all cases.

It must be clearly understood that these terms are used to describe the shape of the views. The longest or smallest dimension can be the width, depth, or height dimension.

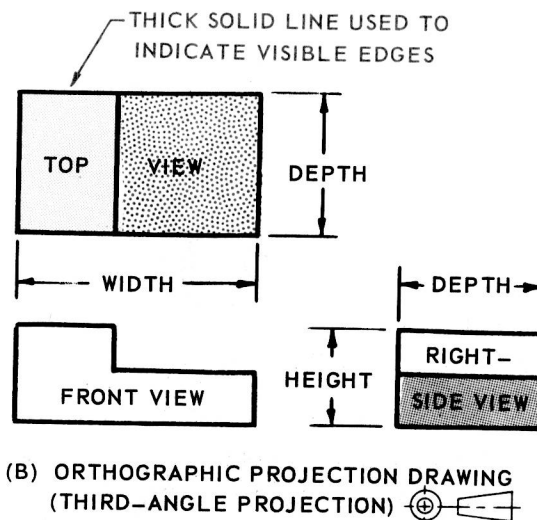
The height of the object is seen in the front, right-side, left-side, and rear views. The width of the object is depicted in the front, top, bottom, and side views. Seldom are more than three views necessary to completely describe the shape of an object. Therefore, the simple object shown in figure 1-4 can be used to illustrate the positions of these principal dimensions.

In figure 1-4, the object is shown in (A) pictorial form, and (B) orthographic projection. The orthographic drawing uses each view to represent the exact shape and size of the object and the relationship of the three views to one





(A) PICTORIAL DRAWING
(ISOMETRIC PROJECTION)



(B) ORTHOGRAPHIC PROJECTION DRAWING
(THIRD-ANGLE PROJECTION)

Fig. 1-4 A simple object shown in (A) pictorial form, and (B) orthographic projection

another. This principle of projection is used in all mechanical drawings. The isometric drawing shows the relationship of the front, top, and right-side surfaces in a single view.

ISO PROJECTION SYMBOL

Since two types of projection, first- and third-angle, are used on engineering drawings, and since each has the same units of measurement, it is necessary to be able to identify the type of projection. The International Organization for Standardization (known as ISO) has recommended that one of the symbols shown in figure 1-5 be shown on all drawings. Its preferred location is in the lower right-hand corner of the drawing, adjacent to the title block, figure 1-6.

TITLE BLOCK

All drawings will have some form of title block, usually placed in the lower right-hand

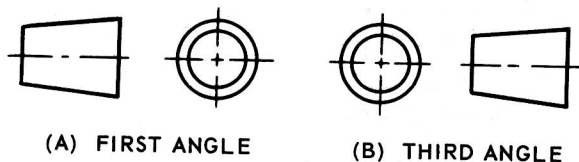


Fig. 1-5 ISO projection symbols

corner. A title block may contain such information as the

- name of the part.
- order number.
- date.
- drawing number.
- scale size used.
- name of the drafter.
- name of the drawing checker.
- material to be used.

DRAWING STANDARDS

The drawings and information shown throughout this text are based on the *American National Standard Drafting Practices Y-14*, and any approved revisions. In some areas of drawing practice, such as in simplified drafting, national standards have not yet been established. The

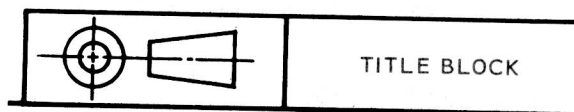


Fig. 1-6 The ISO symbol is located adjacent to the title block on the drawing

authors have, in such cases, adopted the practices used by leading industries in the United States.

VISIBLE LINES

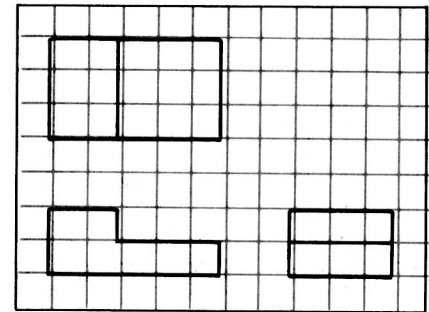
A thick solid line is used to indicate the visible edges and corners of an object. Visible lines should stand out clearly in contrast to other lines, making the general shape of the object apparent to the eye.



Fig. 1-7 Lettering for drawings

LETTERING ON DRAWINGS

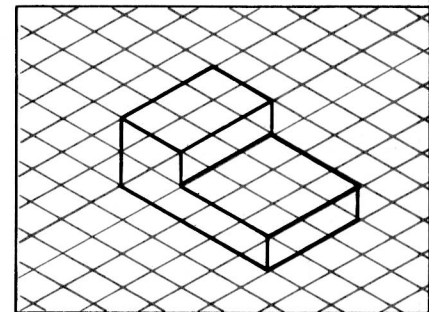
The most important requirements for lettering are legibility, reproducibility, and ease of execution. These requirements are best met by the style of lettering known as standard uppercase Gothic, as shown in figure 1-7. For these reasons it is used on mechanical engineering drawings. Vertical lettering is preferred, but sloping style may be used, though never on the same drawing as vertical lettering. Suitable lettering size for notes and dimensions is .10 inch (in.). Larger characters are used for drawing titles and number. They are also used where it may be necessary to bring some part of the drawing to the attention of the reader.



(A) COORDINATE SKETCHING PAPER USED FOR SKETCHING ORTHOGRAPHIC PROJECTION

SKETCHING

Sketching is a necessary part of the course of interpreting technical drawings since the skilled technician in the shop is frequently called upon to sketch and explain points to other people. Sketching also helps to develop a good sense of proportion and accuracy of observation. The most common types of sketching paper are shown in figure 1-8. Each square on the paper may represent .10 in., .25 in., 1.00 in. or one foot (ft.) of actual object length. Figure 1-8 illustrates the use of graph paper for sketching (A) orthographic projection, and (B) pictorial drawings.



(B) ISOMETRIC SKETCHING PAPER USED FOR SKETCHING PICTORIAL DRAWINGS

Fig. 1-8 Sketching paper

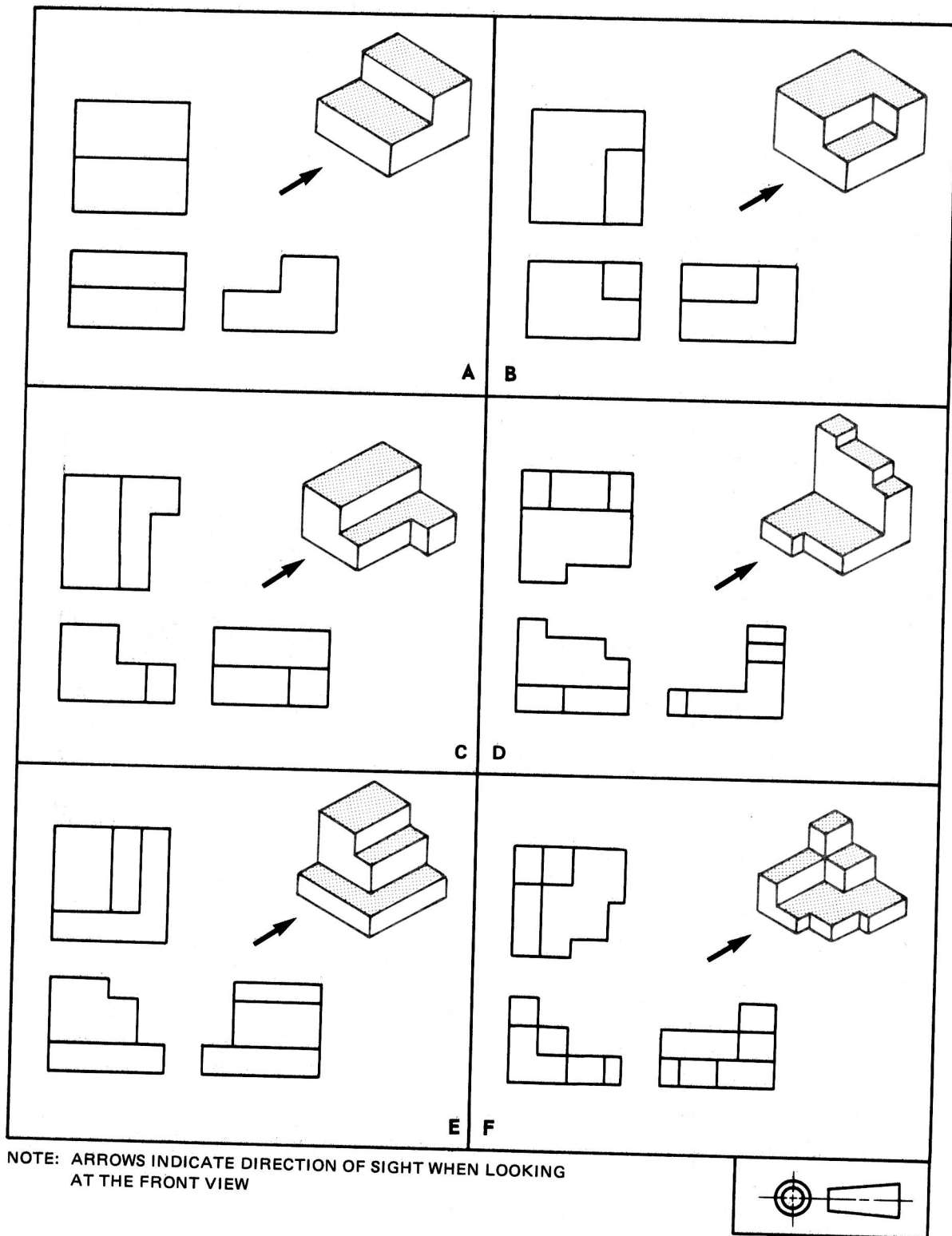


Fig. 1-9 Illustrations of simple objects drawn in orthographic projection