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ABSTRACT This packet, part of the instructional materials for the Oregon apprenticeship program for millwright training, contains 16 modules covering drafting. The modules provide information on the following topics: types of drawing and views, sketching, blueprint reading/working drawings, working drawings for machines and welding, machine and welding symbols, basic blueprint reading and drafting, machine features for drafting, measurement, and visualization. Each module consists of a goal, performance indicators, student study guide, introduction, information sheets illustrated with line drawings and photographs, a self-assessment test with answers, and a post-assessment test. (KC)

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ED254719

APPRENTICESHIP

MILLWRIGHT

RELATED TRAINING MODULES

5.1-5.16 DRAFTING


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APPRENTICESHIP
MILLWRIGHT
RELATED TRAINING MODULES

SAFETY

- 1.1 General Safety
- 1.2 Hand Tool Safety
- 1.3 Power Tool Safety
- 1.4 Fire Safety
- 1.5 Hygiene Safety
- 1.6 Safety and Electricity
- 1.7 Fire Types and Prevention
- 1.8 Machine Safeguarding (includes OSHA Handbook)

ELECTRICITY/ELECTRONICS

- 2.1 Basics of Energy
- 2.2 Atomic Theory
- 2.3 Electrical Conduction
- 2.4 Basics of Direct Current
- 2.5 Introduction to Circuits
- 2.6 Reading Scales
- 2.7 Using a V.O.M.
- 2.8 OHM'S Law
- 2.9 Power and Watt's Law
- 2.10 Kirchoff's Current Law
- 2.11 Kirchoff's Voltage Law
- 2.12 Series Resistive Circuits
- 2.13 Parallel Resistive Circuits
- 2.14 Series - Parallel Resistive Circuits
- 2.15 Switches and Relays
- 2.16 Basics of Alternating Currents
- 2.17 Magnetism

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- 3.1 Digital Language
- 3.2 Digital Logic
- 3.3 Computer Overview
- 3.4 Computer Software

TOOLS

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- 4.3 Holding and Fastening Tools
- 4.4 Fastening Devices
- 4.5 Basic Science - Simple Mechanics
- 4.6 Fasteners

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- 5.1 Types of Drawing and Views
- 5.2 Sketching
- 5.3 Blueprint Reading/Working Drawings
- 5.4 Working Drawings for Machines and Welding
- 5.5 Machine and Welding Symbols
- 5.6 Blueprint Reading, Drafting: Basic Print Reading
- 5.7 Blueprint Reading, Drafting: Basic Print Reading
- 5.8 Blueprint Reading, Drafting: Basic Print Reading
- 5.9 Blueprint Reading, Drafting: Basic Print Reading
- 5.10 Blueprint Reading, Drafting: Basic Print Reading
- 5.11 Blueprint Reading, Drafting: Basic Print Reading
- 5.12 Blueprint Reading, Drafting: Basic Print Reading
- 5.13 Blueprint Reading, Drafting: Basic Print Reading
- 5.14 Drafting, Machine Features
- 5.15 Drafting, Measurement
- 5.16 Drafting, Visualization

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- 6.2 Feedback
- 6.3 Individual Strengths
- 6.4 Interpersonal Conflicts
- 6.5 Group Problem Solving
- 6.6 Goal-setting and Decision-making
- 6.7 Worksite Visits
- 6.8 Resumes
- 6.9 Interviews
- 6.10 Expectation
- 6.11 Wider Influences and Responsibilities
- 6.12 Personal Finance

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- 7.1 Boilers - Fire Tube Types
- 7.2 Boilers - Watertube Types
- 7.3 Boilers - Construction
- 7.4 Boilers - Fittings
- 7.5 Boilers - Operation
- 7.6 Boilers - Cleaning
- 7.7 Boilers - Heat Recovery Systems
- 7.8 Boilers - Instruments and Controls
- 7.9 Boilers - Piping and Steam Traps

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- 8.2 Steam Turbines - Components
- 8.3 Steam Turbines - Auxillaries
- 8.4 Steam Turbines - Operation and Maintenance
- 8.5 Gas Turbines

PUMPS

- 9.1 Pumps - Types and Classification
- 9.2 Pumps - Applications
- 9.3 Pumps - Construction
- 9.4 Pumps - Calculating Heat and Flow
- 9.5 Pumps - Operation
- 9.6 Pumps - Monitoring and Troubleshooting
- 9.7 Pumps - Maintenance

COMBUSTION

- 10.1 Combustion - Process
- 10.2 Combustion - Types of Fuel
- 10.3 Combustion - Air and Fuel Gases
- 10.4 Combustion - Heat Transfer
- 10.5 Combustion - Wood

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- 11.1 Generators - Types and Construction
- 11.2 Generators - Operation

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- 12.1 Feedwater - Types and Equipment
- 12.2 Feedwater - Water Treatments
- 12.3 Feedwater - Testing

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- 13.2 Air Compressors - Operation and Maintenance

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- 14.2 Steam - Types
- 14.3 Steam - Transport
- 14.4 Steam - Purification

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- 15.2 Installation - Alignment
- 15.3 Circuit Protection
- 15.4 Transformers
- 15.5 Trade Terms

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- 16.2 Whole Numbers
- 16.3 Additional and Subtraction of Common Fraction and Mixed Numbers
- 16.4 Multiplication and Division of Common Fractions and Whole and Mixed Numbers

- 16.5 Compound Numbers
- 16.6 Percent
- 16.7 Ratio and Proportion
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- 16.9 Circumference and Wide Area of Circles
- 16.10 Area of Plane, Figures and Volumes of Solid Figures
- 16.11 Metrics

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- 17.1 Hydraulics - Lever
- 17.2 Hydraulics - Transmission of Force
- 17.3 Hydraulics - Symbols
- 17.4 Hydraulics - Basic Systems
- 17.5 Hydraulics - Pumps
- 17.6 Hydraulics - Pressure Relief Valve
- 17.7 Hydraulics - Reservoirs
- 17.8 Hydraulics - Directional Control Valve
- 17.9 Hydraulics - Cylinders
- 17.10 Hydraulics - Forces, Area, Pressure
- 17.11 Hydraulics - Conductors and Connectors
- 17.12 Hydraulics - Troubleshooting
- 17.13 Hydraulics - Maintenance

METALLURGY

- 18.1 Included are ILS packets:
 - W 3010
 - W 3011-1
 - W 3011-2
 - MS 9001 (1-3-4-8-9-6-7-5-2-9)
 - MS 9200, 9201

POWER DRIVES

- 19.1
 - 101. A-B-C-D-E
 - 102. C-D-E
 - 103. B-C-D-E
 - 104. A-C-E-F-G-H-I-J
 - 107. A
 - 108. A

WELDING

- 20.1
 - 602. A-B-C-D-G-I-L-M
 - 603. A-B-F-G-I
 - W. 3011-1 refer to Metallurgy 18.1
 - WE. MA-18

MILLWRIGHT
SUPPLEMENTARY REFERENCE DIRECTORY

Note: All reference packets are numbered on the upper right-hand corner of the respective cover page.

<u>Supplementary Packet #</u>	<u>Description</u>	<u>Related Training Module</u>
1.8	Concepts & Techniques of Machine Safeguarding, U.S.D.L., O.S.H.A.	1.8 Machine Safeguarding
12.1	Correspondence Course, Lecture 1, Sec. 2, Steam Generators, Types of boilers I, S.A.I.T., Calgary, Alberta, Canada	7.1 Boilers, Fire Tube Type
12.2	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Types of Boilers II, S.A.I.T., Calgary, Alberta, Canada	7.2 Boilers, Water Tube Type
12.3	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Boiler Construction & Erection, S.A.I.T., Calgary, Alberta, Canada	7.3 Boilers, Construction
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fittings II, S.A.I.T., Calgary, Alberta, Canada	7.4 Boilers, Fittings
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fitting I, S.A.I.T., Calgary, Alberta, Canada	7.4 Boilers, Fittings
12.5	Correspondence Course, Lecture 10, Sec. 2, Steam Generation, Boiler Operation, Maintenance, Inspection, S.A.I.T., Calgary, Alberta, Canada	7.5 Boilers, Operation
12.7	Correspondence Course, Lecture 3, Sec. 2, Steam Generation, Boiler Details, S.A.I.T., Calgary, Alberta, Canada	7.7 Boilers Heat Recovery Systems
		<u>PUMPS</u>
13.1	Correspondence Course, Lecture 9, Sec. 2, Steam Generator, Power Plant Pumps, S.A.I.T., Calgary, Alberta, Canada	9.1 Types & Classifications
13.2		9.2 Applications
13.4		9.4 Calculating Heat & Flow
13.6		9.6 Monitoring & Troubleshooting
13.7		9.7 Maintenance
13.3	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Pumps, S.A.I.T., Calgary, Alberta, Canada	9.3 Construction
13.5		9.5 Operation

Supplementary Packet #	Description	Related Training Module
14.3 12.8	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Steam Generator Controls, S.A.I.T., Calgary, Alberta, Canada	14.3 Steam Transport 7.8 Boilers, Instruments & Controls
14.4	Correspondence Course, Lecture 11, Sec. 2, Steam Generators, Piping II, S.A.I.T., Calgary, Alberta, Canada	14.4 Steam Purification
15.1	Correspondence Course, Lecture 1, Sec. 4, Prime Movers, & Auxiliaries, Steam Turbines, S.A.I.T., Calgary, Alberta, Canada	8.1 Steam Turbines, Types
15.2	Correspondence Course, Lecture 4, Sec. 3, Prime Movers, Steam Turbines I, S.A.I.T., Calgary, Alberta, Canada	8.2 Steam Turbines, Components
15.3	Correspondence Course, Lecture 2, Sec. 4, Prime Movers & Auxiliaries, Steam Turbine Auxiliaries, S.A.I.T., Calgary, Alberta, Canada	8.3 Steam Turbines, Auxiliaries
15.4	Correspondence Course, Lecture 6, Sec. 3, Prime Movers, Steam Turbine Operation & Maintenance, S.A.I.T., Calgary, Alberta, Canada	8.4 Steam Turbines, Operation & Maintenance
15.5	Correspondence Course, Lecture 8, Sec. 3, Prime Movers, Gas Turbines, S.A.I.T., Calgary, Alberta, Canada	8.5 Gas Turbines
16.2	Boilers Fired with Wood & Bark Residues, D.D. Junge, F.R.L., U.S.U., 1975	10.2 Combustion Types of Fuel
16.2	Correspondence Course, Lecture 5, Sec. 2, Steam Generators, Fuel Combustion, S.A.I.T., Calgary, Alberta, Canada	10.2 Combustion Types of Fuel
16.3	Correspondence Course, Lecture 5, Sec. 2, Plant Services, Fuel & Combustion, S.A.I.T., Calgary, Alberta, Canada	10.2 Combustion Types of Fuel
17.1	Correspondence Course, Lecture 12, Sec. 3, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	12.1 Feedwater, Types & Operation
17.2	Correspondence Course, Lecture 12, Sec. 2, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	12.2 Feedwater, Water Treatments

<u>Supplementary Packet #</u>	<u>Description</u>	<u>Related Training Module</u>
17.3	Correspondence Course, Lecture 7, Sec. 2, Steam Generators, Boiler Feedwater Treatment, S.A.I.T., Calgary, Alberta, Canada	12.3 Feedwater, Testing
18.1	Correspondence Course, Lecture 2, Sec. 5, Electricity, Direct Current Machines, S.A.I.T., Calgary, Alberta, Canada	11.1 Generators, Types & Construction
18.1 18.2	Correspondence Course, Lecture 4, Sec. 5, Electricity, Alternating Current Generators, S.A.I.T., Calgary, Alberta, Canada	11.1 Generators, Types & Construction 18.2 Generators, Operation
19.1	Correspondence Course, Lecture 5, Sec. 4, Prime Movers & Auxiliaries, Air Compressor I, S.A.I.T., Calgary, Alberta, Canada	13.1 Air Compressors, Types
19.1	Correspondence Course, Lecture 6, Sec. 4, Prime Movers & Auxiliaries, Air Compressors II, S.A.I.T., Calgary, Alberta, Canada	13.1 Air Compressors, Types 13.2 Air Compressors, Operation & Maintenance
20.1	Basic Electronics, Power Transformers, EL-BE-51	15.4 Transformers
21.1	Correspondence Course, Lecture 6, Sec. 5, Electricity, Switchgear & Circuit, Protective Equipment, S.A.I.T., Calgary, Alberta, Canada	15.3 Circuit Protection
22.1	Correspondence Course, Lecture 10, Sec. 3, Prime Movers, Power Plant Erection & Installation, S.A.I.T., Calgary, Alberta, Canada	15.1 Installation Foundations

RECOMMENDATIONS FOR USING TRAINING MODULES

The following pages list modules and their corresponding numbers for this particular apprenticeship trade. As related training classroom hours vary for different reasons throughout the state, we recommend that the individual apprenticeship committees divide the total packets to fit their individual class schedules.

There are over 130 modules available. Apprentices can complete the whole set by the end of their indentured apprenticeships. Some apprentices may already have knowledge and skills that are covered in particular modules. In those cases, perhaps credit could be granted for those subjects, allowing apprentices to advance to the remaining modules.

We suggest the the apprenticeship instructors assign the modules in numerical order to make this learning tool most effective.

SUPPLEMENTARY INFORMATION

ON CASSETTE TAPES

Tape 1: Fire Tube Boilers - Water Tube Boilers
and Boiler Manholes and Safety Precautions

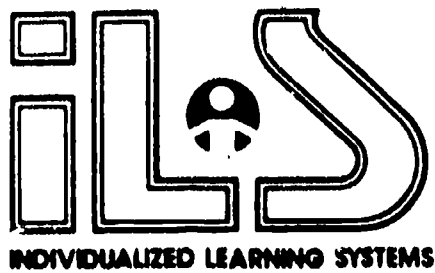
Tape 2: Boiler Fittings, Valves, Injectors,
Pumps and Steam Traps

Tape 3: Combustion, Boiler Care and Heat Transfer
and Feed Water Types

Tape 4: Boiler Safety and Steam Turbines

NOTE: The above cassette tapes are intended as additional
reference material for the respective modules, as
indicated, and not designated as a required assignment.

Modules 18.1, 19.1, and 20.1 have been omitted because they contain dated materials.



5.1

TYPES OF DRAWINGS AND VIEWS

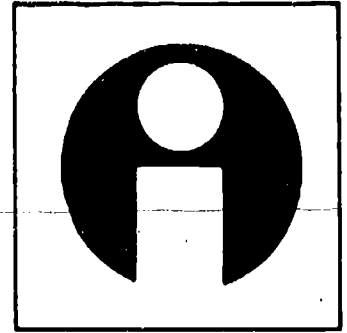
Goal:

Upon completion of this module, the student will have a working knowledge of orthographic, pictorial and isometric drawings and types of lines, and will be able to identify them and understand how they are applied in reading blueprints.

Performance Indicators:

The student will complete a Self Assessment exam and a Post Assessment exam covering the topics, and will also complete an assignment consisting of six orthographic and isometric drawings.

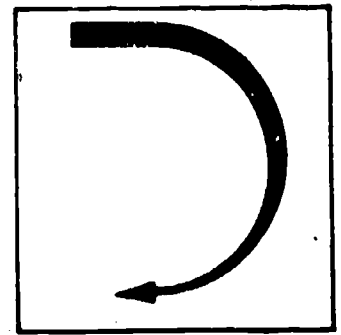
Study Guide



For successful completion of this module, complete the tasks in the order listed below. Check each one off as you complete it.

1. Read the Goal and Performance Indicators on the cover of this module. This will explain what you can be expected to learn from the module and how you will demonstrate it.
2. Read the Introduction section and study the Information section. In these sections you will acquire the knowledge necessary to pass the Self and Post Assessment exams.
3. Complete the required assignments on the Assignment pages. Turn them in to your instructor for review.
4. Complete the Self Assessment exam. This will show how well you can expect to do on the Post Assessment exam. Compare your answers with those on the Self Assessment Answer Sheet found immediately following the exam. If you scored poorly, re-study the Information section or ask your instructor for help.
5. Complete the Post Assessment exam. Turn the answers in to your instructor. It is recommended you score 90% or better before continuing with the next module.

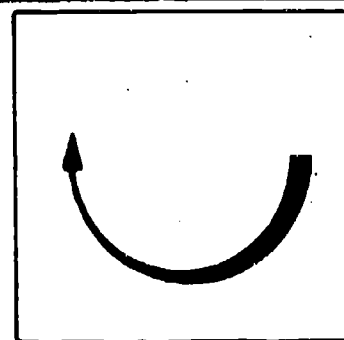
Introduction



One of the problems in all drawing is how to depict a three-dimensional object on a two-dimensional sheet of paper. Any attempt at showing all three dimensions on a single drawing will result in foreshortened lines that will not represent true dimensions of the object. To show an object's true shape, the draftsman must make two or more related drawings, each of which depicts the object in two of its principal dimensions only--width and depth, width and height, or height and depth. Almost without exception, working drawings are made this way.

Sometimes, however, it is desirable to portray the object more nearly as an observer would normally see it--that is, to show all three principal dimensions at once. Several methods are employed for making drawings of this picture-like type, and all are useful for illustrating the overall shape and general features of technical objects. However, all of these pictorial drawing methods have a common disadvantage that makes them generally unsuitable for the production of working drawings: the true measurements of the object.

Information



ORTHOGRAPHIC PROJECTION

The drawing method almost universally employed in the making of architectural and engineering working drawings is called orthographic projection; the drawings produced in this way are called orthographic or "true" drawings, as opposed to the picture-like drawings made by pictorial drawing methods. Unlike most pictorial drawings, orthographic drawings are drawn to scale, and true measurements can be taken from them.

An orthographic view shows one face or side of an object to the extent that it would be seen by an observer looking squarely at that side or face. No pictorial techniques are employed for an orthographic drawing, the object being shown in its actual form, not its apparent form. This makes it possible for the draftsman to indicate, in a series of related orthographic views, the true size, shape, and location of every part of the object and to present dimensions in a clear and precise way.

VISUALIZING THE OBJECT FROM ORTHOGRAPHIC WORKING DRAWINGS

The orthographic-projection drawing method (also called "three-view" or "multiview" drawing) can best be understood from a study of the three most common orthographic views--top, front, and side views--as they are employed in mechanical drawings to represent a simple object, as for example in Fig. F-13.

Each of the three orthographic views in Fig. F-13 reveals the shape of the object as perceived from a particular viewing direction. Collectively, the three views provide a complete illustration of the object. The top view shows it in width and depth. The front view, which is obtained by rotating the object 90° on its vertical axis away from the front view, shows it in height and depth. If additional orthographic views are required to complete the description of an object, they will be developed by further 90° rotations, and thus will bear right-angle relationships to the

top, front, and side views. Front, side, and rear views are called elevations. Hidden features are indicated on orthographic drawings by means of dotted lines, as in the front and side views in Fig. F-14.

In an orthographic drawing, only those object lines that are perpendicular to the observer's direction of view--that is, parallel with the picture plane--are shown in their true scale length. The oblique line A-B is drawn in true proportion in the top view in Fig. F-15. In the front view, however, the line A-B is drawn shorter than its true scale length and therefore is not shown in true proportion.

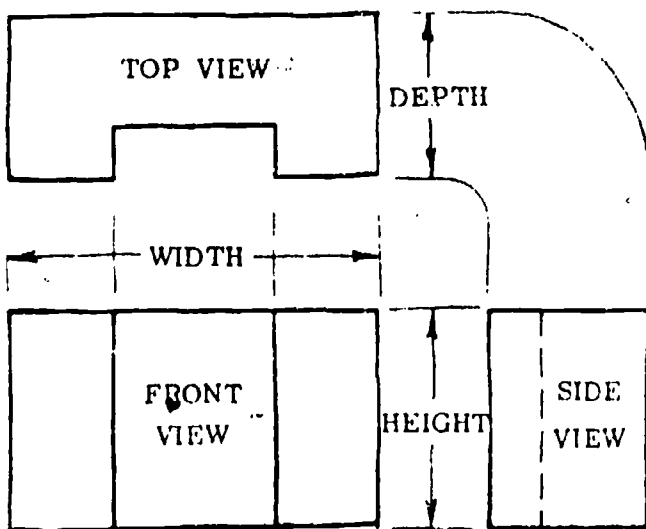


Fig. F 13
Orthographic (multiview) projections

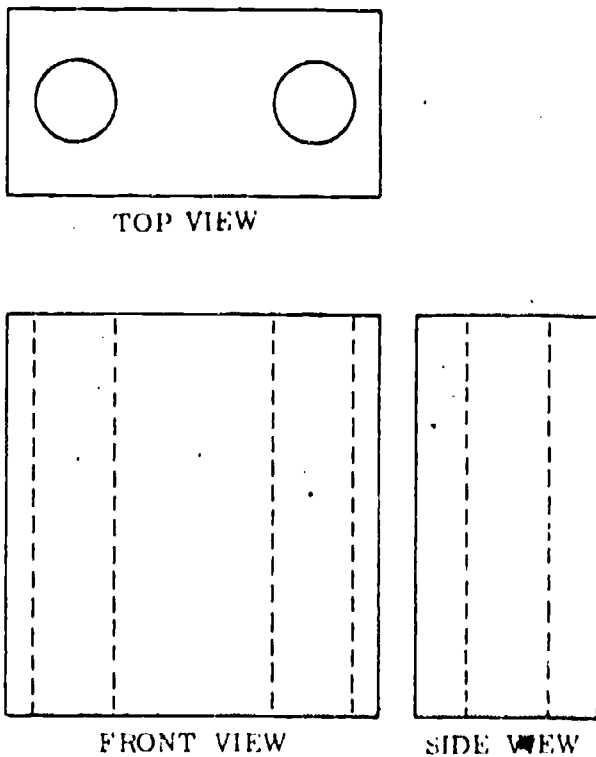


Fig. F-14
Hidden lines in orthographic views

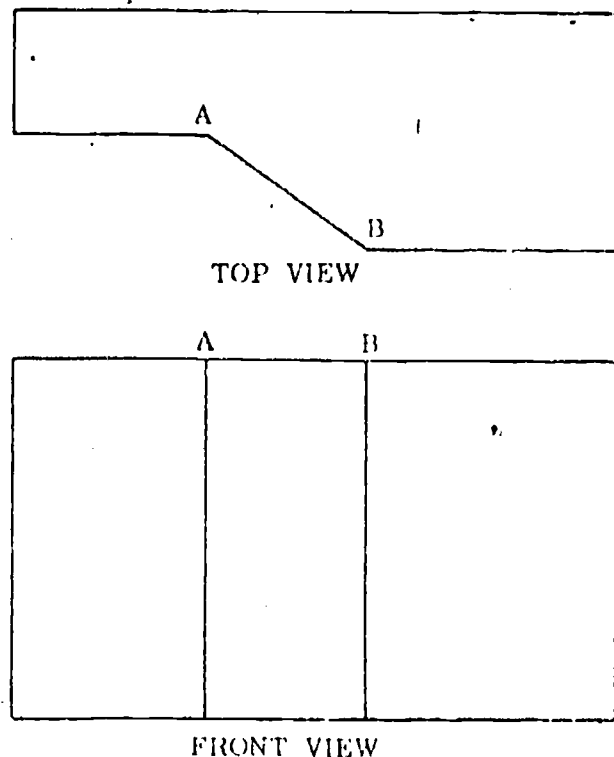


Fig. F-15
Oblique lines in orthographic projection

From this discussion, it will be seen that the shape of an object cannot be visualized from a single orthographic view; all the related views must be studied together. The importance of this rule will become apparent as more complex working drawings are encountered.

TYPES OF LINES IN WORKING DRAWINGS

Several types of lines, each having a specific meaning, are employed in the making of working drawings; some lines are thicker than others, some are solid, and some are broken. Some of the more common types of lines with an example of their application, are shown in Fig. F-16. Such a listing of conventional drafting lines is called an "alphabet of lines."

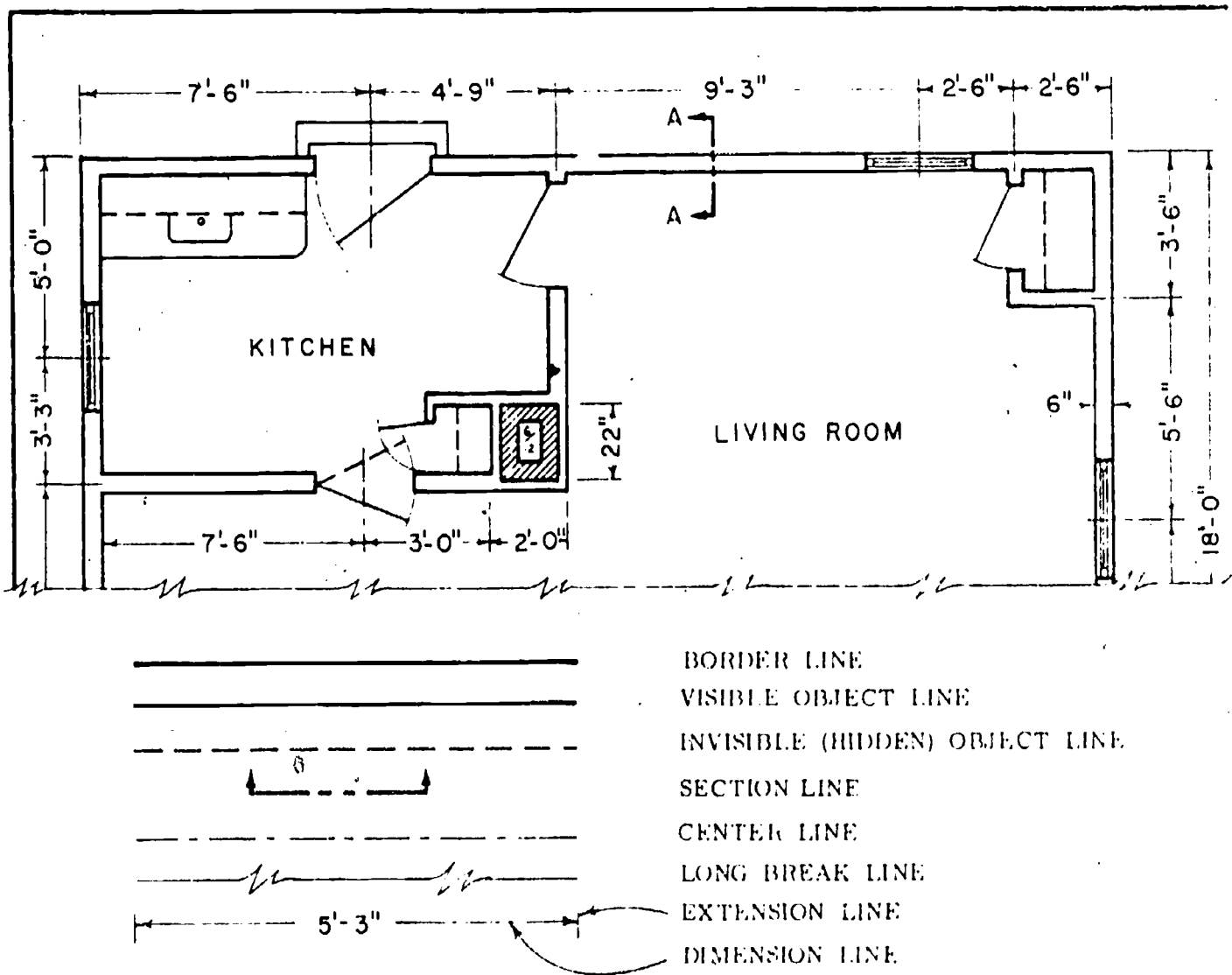


Fig. F-16. Lines used in working drawings.

PICTORIAL DRAWINGS

Because a pictorial drawing shows more than one face of the object, it can give more information about the shape of the object than would be possible with any single orthographic view. For this reason, persons without technical training find pictorial drawings the easier type to understand. The main disadvantage of pictorial drawings lies in their distortion of true object lines and angles; this makes them unsatisfactory for describing complete and detailed forms. However, they are useful in cases where the measurements of the image need not correspond exactly with those of the actual object. For example, the architect uses a pictorial drawing to show his or her client how the house will look when completed.

The two principal types of pictorial drawings are perspective and axonometric drawings. A third type, the oblique drawing, is partly axonometric and partly orthographic. Because of the distorted appearance of objects drawn by the oblique method, it is not widely used for pictorial representation and will not be discussed further here.

PERSPECTIVE DRAWINGS

The type of pictorial drawing that represents an object most clearly as it is seen by the human eye is the perspective drawing. The optical line relationships in a perspective drawing are like those in a photograph; that is, all lines that are parallel on the actual object tend to converge at some distant point on the drawing.

Perspective drawings are seldom used as working drawings; they are used mainly in sales and promotion work and as architectural "presentation" drawings.

AXONOMETRIC DRAWINGS

The term "axonometric" refers to the class of pictorial drawings in which all the measurements necessary for making the drawing are made on the three principal axes of the object or on lines parallel with those axes. A rectangular solid drawing in this way consists of three sets of lines, each set being parallel to one of the principal axes, and reveals three of its faces. An infinite number of axonometric positions is possible, the choice of position depending upon how the object is to be viewed. (See Fig. F-17.) The isometric position, second from the right in the illustration, is the one most often employed. An axonometric drawing in the isometric position is called an isometric drawing.

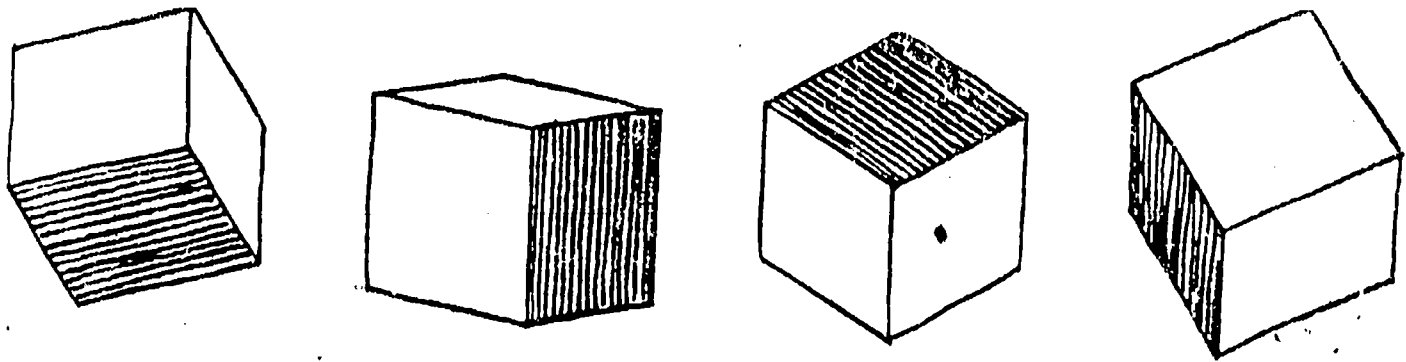


Fig. F-17. Axonometric drawings in several positions

THE THEORY OF ISOMETRIC DRAWING

The Theory of isometric drawing is that the object is viewed from the exact position in which three of its sides are seen equally foreshortened. In making an isometric drawing, the draftsman first lays out the three isometric axes--one vertical and other two tipped up 30° from a horizontal base line, as shown in Fig. F-18. The height, width, and depth of the object are measured off on these axis lines. Since all lines on or parallel with the isometric axes are foreshortened equally, they will be in true proportion; however, they will never appear as true scale lengths, as do the lines in orthographic drawings. The relationship of an isometric view and three orthographic views of an object is shown in Fig. F-19.

ANGLES IN ISOMETRIC DRAWINGS

Angles cannot be directly transferred from orthographic drawings to isometric drawings; this is so because angles do not appear in their true shape in isometric drawings. To transfer angles in making an isometric drawing from orthographic views, the draftsman first transfers the intersection points of the lines that form the angles, then draws the angles from the transferred points. (See Fig. F-20.)

CURVES IN ISOMETRIC DRAWINGS

Like angles, curves suffer distortion in being transferred from orthographic drawings to isometric drawings. To transfer a curve, the draftsman first plots points on the isometric drawing from similar locations along the curve on the orthographic drawing, then connects the points with a curved line. (See Figs. F-21 and F-22.) To simplify transferring the points, he or she may lay out a grid of rectangular coordinates on the multiview drawing and a corresponding isometric grid on the sheet for the isometric drawing.

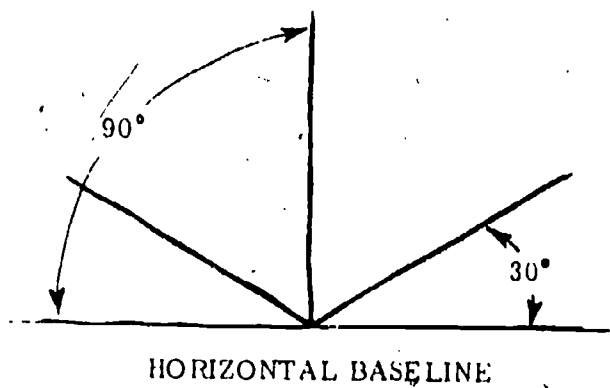


Fig. F-18. Layout of isometric axes

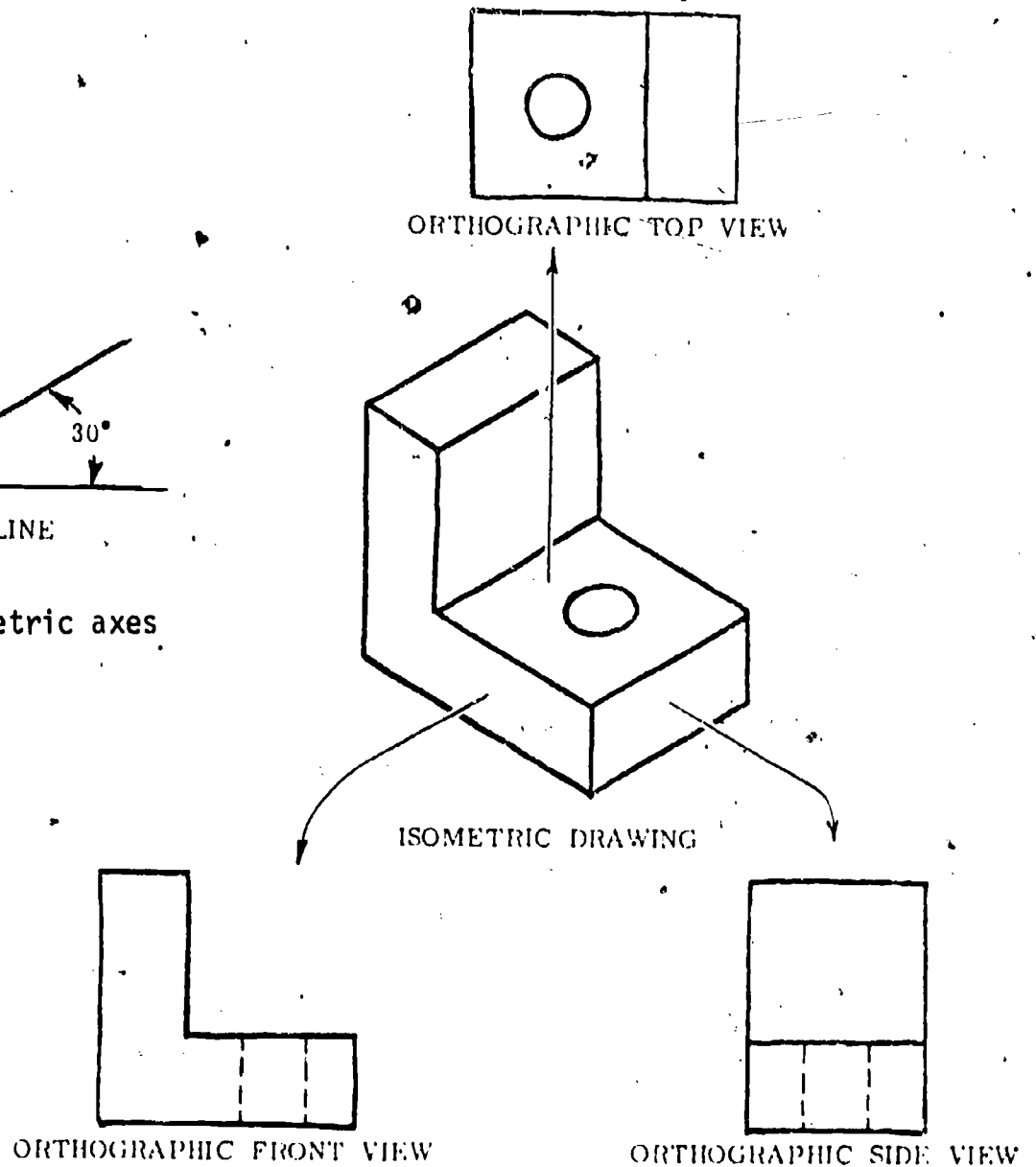


Fig. F-19

Isometric drawing and orthographic views of an object

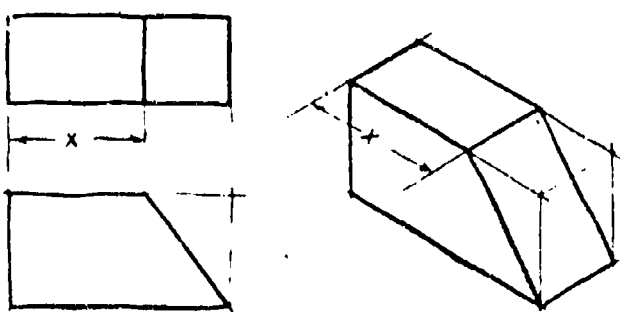


Fig. F-20

Orthographic projection and isometric drawing of an object with an angled surface

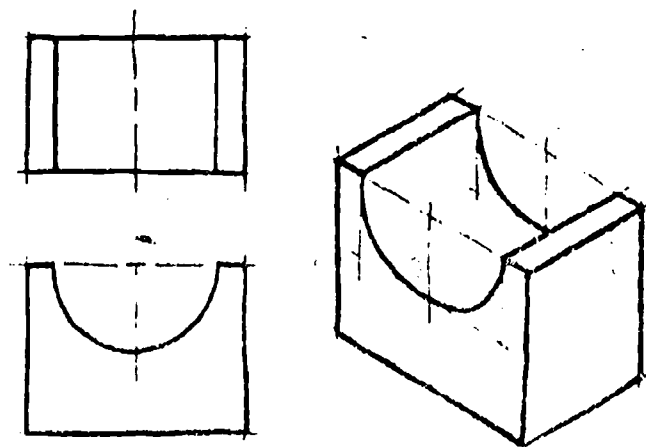


Fig. F-21

Orthographic projection and isometric drawing of an object with a curved surface

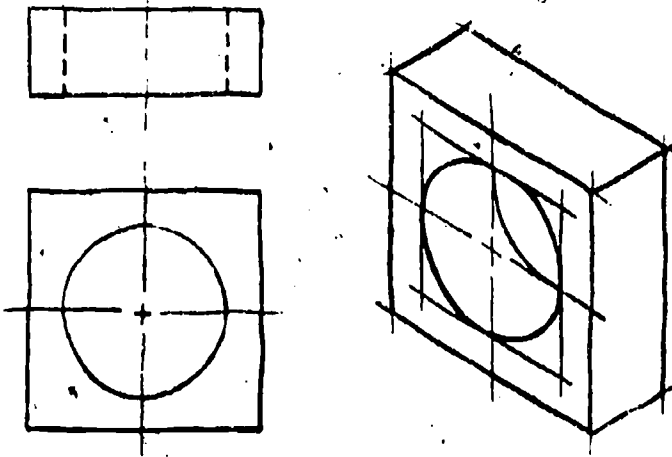
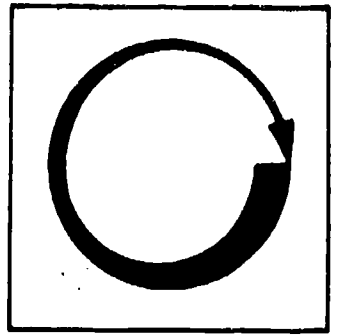


Fig. F-22

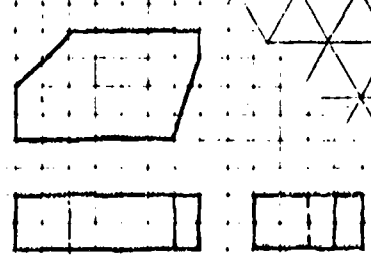
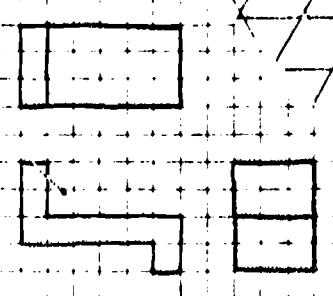
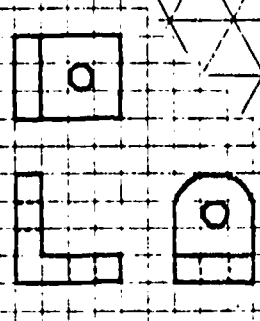
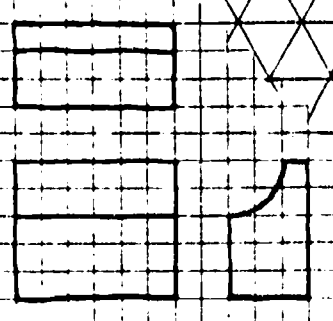
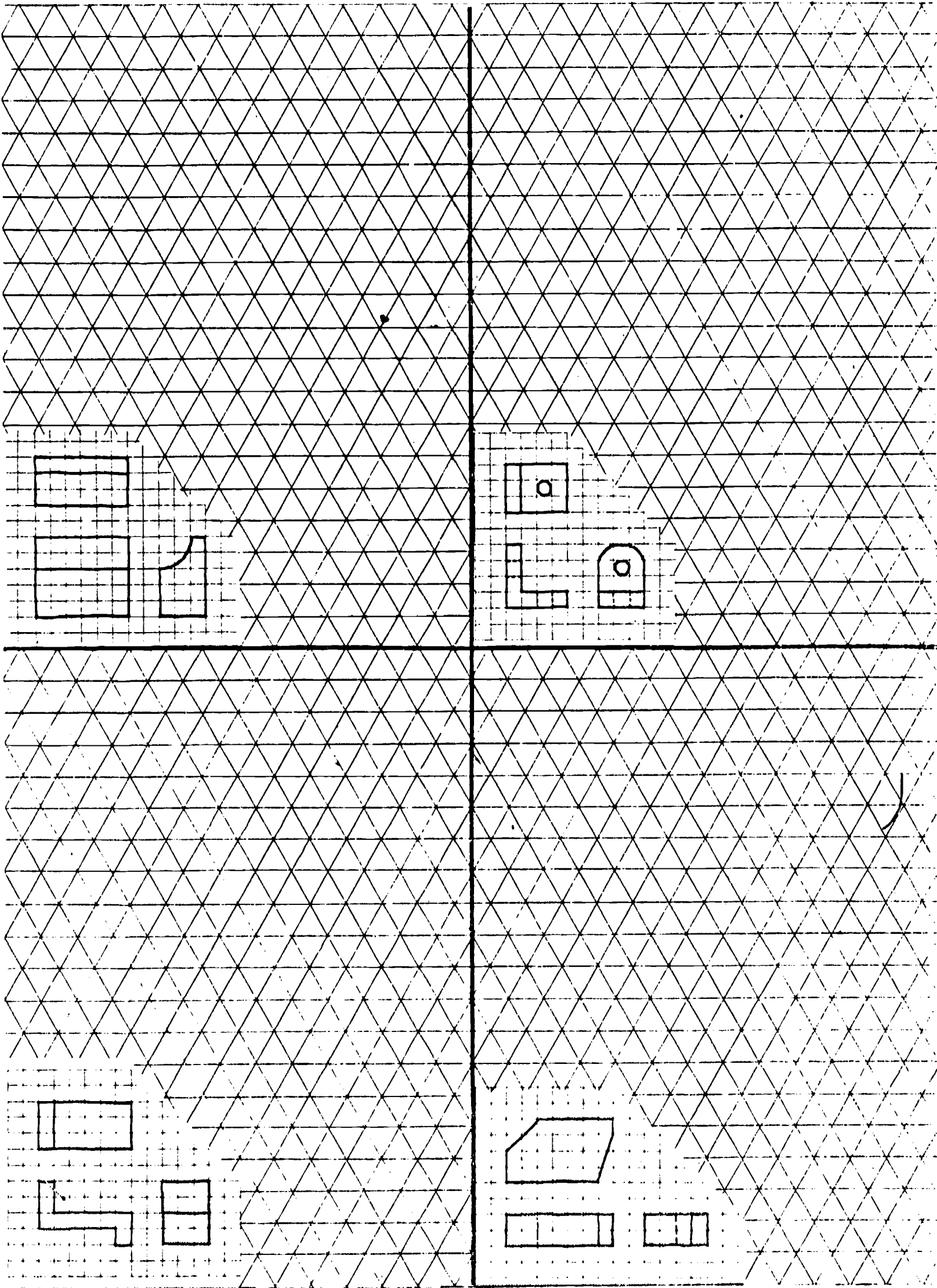
Orthographic projection and isometric drawing of an object with a center hole

Assignment

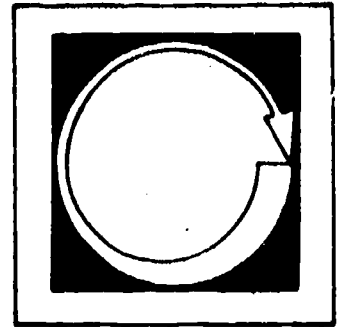


In each of the two rectangular grids on this page, sketch the top, front, and right side views of the object shown in the small isometric drawing. In each of the four isometric grids on the following page, make isometric sketches of the object shown in the small multiview drawing.

--	--



Self Assessment



After you have studied the material in the module, complete the exercises by writing in the word that belongs in each space.

1. The drawing method used for making most working drawings is called _____.
2. Orthographic drawings are drawn to _____ and _____ measurements can be taken from them.
3. An orthographic view shows only one _____ or _____ of an object.
4. In architectural drawings, a view from above is called a(n) _____ view.
5. A listing of conventional drafting lines used in the making of a working drawing is called a(n) _____ of _____.
6. The type of drawing that represents an object most nearly as it would be seen in a photograph is a(n) _____ drawing.
7. A pictorial drawing shows more than one _____ of an object.
8. The type of pictorial drawing in which all of the principal axes are equally foreshortened is the axonometric drawing.
9. In an isometric drawing, two of the three principal axes are tipped up _____ degrees from the horizontal; the third axis is _____.

SELF ASSESSMENT ANSWER SHEET

1. orthographic projection

2. scale, true

3. face, side

4. top

5. alphabet, lines

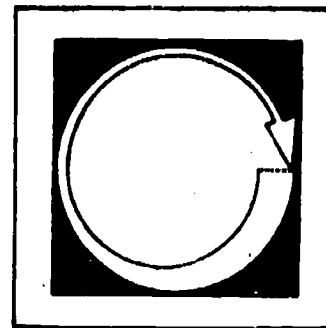
6. pictorial

7. view

8. axonometric

9. 30° , 90°

Post Assessment



Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

1. _____ The drawing method almost universally employed for making working drawings is called:

a. orthographic projection	c. perspective drawing
b. isometric projection	d. scaling

2. _____ One disadvantage of pictorial drawings is that in general they:
 - a. are too large for use on the job
 - b. are suitable only for exterior views
 - c. do not accurately represent object lines and angles
 - d. give a poor overall view of an object

3. _____ An isometric drawing is one kind of:

a. orthographic drawing	c. axonometric drawing
b. perspective drawing	d. multiview drawing

4. _____ An orthographic view shows how many sides or faces of an object?

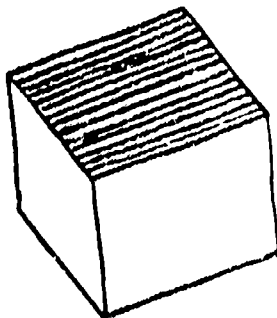
a. one	c. three
b. two	d. four

5. _____ The true shape of an object cannot be visualized from a single:

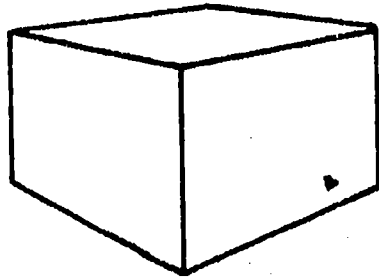
a. orthographic view	c. pictorial view
b. perspective view	d. axonometric view

6. _____ The drawing shown below is properly called:

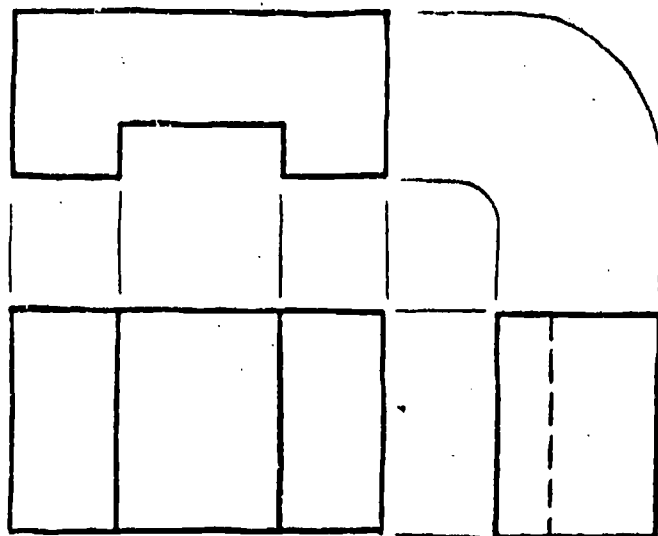
a. pictorial	c. multiview
b. orthographic	d. isometric



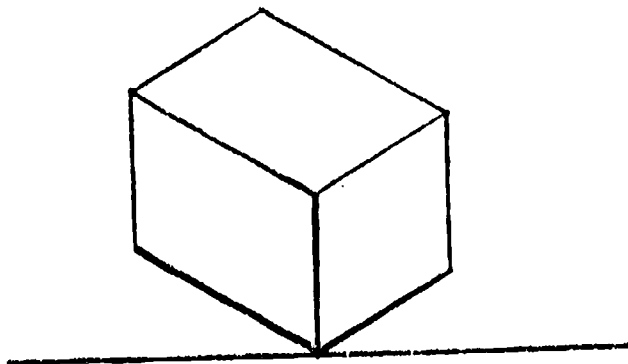
7. _____ The drawing shown below is properly called:
- a. perspective
 - b. isometric
 - c. axonometric
 - d. orthographic



8. _____ The drawing shown below is properly called:
- a. pictorial
 - b. perspective
 - c. axonometric
 - d. orthographic



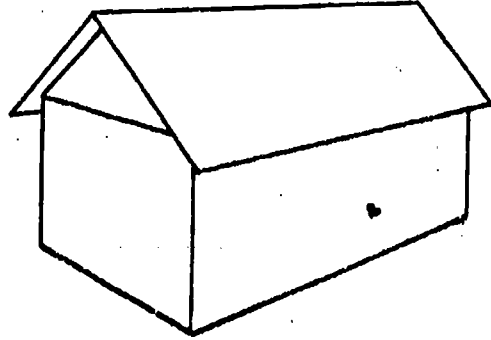
9. _____ The drawing shown below is properly called:
- a. multiview
 - b. orthographic
 - c. oblique
 - d. isometric



10. _____ The drawing shown below is properly called:

- a. pictorial
- b. multiview

- c. isometric
- d. orthographic





5.2

SKETCHING

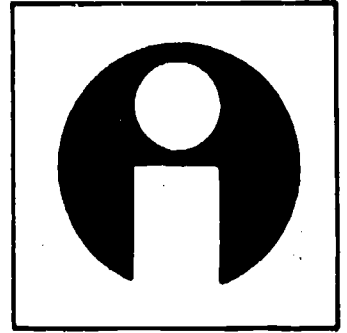
Goal:

The student will learn the elements of and reasons for sketching as an essential aid to understanding blueprints.

Performance Indicators:

The student will successfully complete a Self Assessment and a Post Assessment exam and will make assigned free-handed sketches.

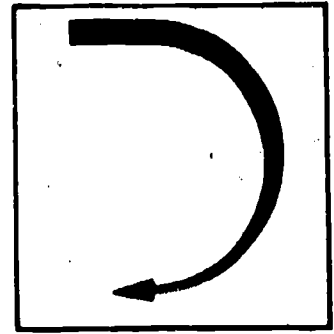
Study Guide



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4. Complete the Post Assessment exam. Turn the answers in to your instructor. It is recommended you score 90% or better before continuing with the next module.

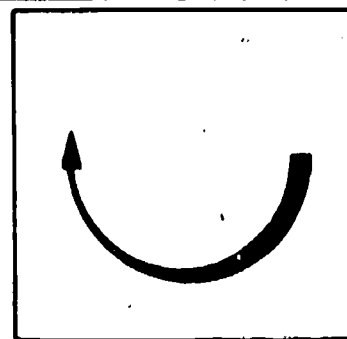
Introduction



For the skilled worker, the importance of being able to make quick, clear and accurate sketches cannot be overemphasized. Most mechanical and architectural ideas are expressed better by means of a sketch than by a verbal description. In general, once a technical problem has been put down as a picture, it is more clearly defined and its complications become more obvious. In some instances, sketches may take the place of regular working drawings; for example, a shop sketch made by the foreman or a journeyman may be the only drawing for a small job that is to be done in the shop.

In learning to sketch, the apprentice will not only acquire a needed job skill; he or she will also develop the ability to observe things more critically. Making an accurate sketch of an object requires that all its details and parts relationships be carefully studied and clearly understood.

Information



USES OF SKETCHES

The degree of perfection and the amount of detail required in a given sketch depends upon its intended use. Sketches made to organize ideas, or to develop or formulate various solutions to a given problem, may be rough or incomplete. An architect's quickly drawn preliminary floor plan, showing his or her ideas for room arrangement, is a good example of such a rough sketch. On the other hand, sketches intended for communicating important information in a precise way should be very carefully done. An example of this would be a detail sketch developed from an existing drawing, possibly to show necessary changes in construction or to give detailed information about size, materials, and installation.

MATERIALS FOR SKETCHING

The materials required for making sketches are few--usually only a pencil, some paper, and an eraser. The pencil should have a rather soft lead--a No. 2 in the ordinary pencil series or an HB or F in the drafting pencil series. End views of various drafting pencils, ranging from the very hard 9H to the very soft 7B, are illustrated in Fig. F-8. The harder drafting pencils are used where high accuracy is required; medium pencils are used for general sketching and lettering; and the softer pencils are used for making large freehand drawings. (Coordinate paper, which has crossed lines or grids, is helpful to the beginner; the grids may be used as guides for drawing lines and keeping proportions. The grids of such paper are either rectangular or isometric. (See Fig. F-9.)

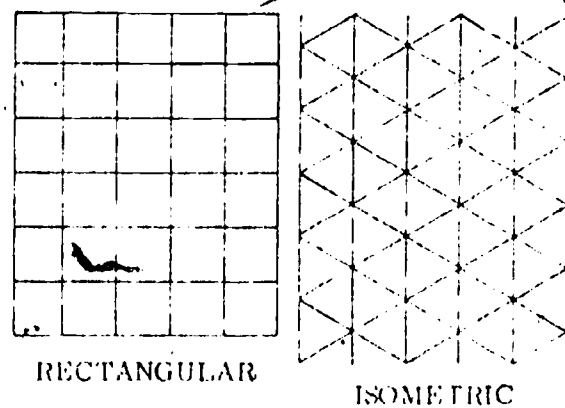
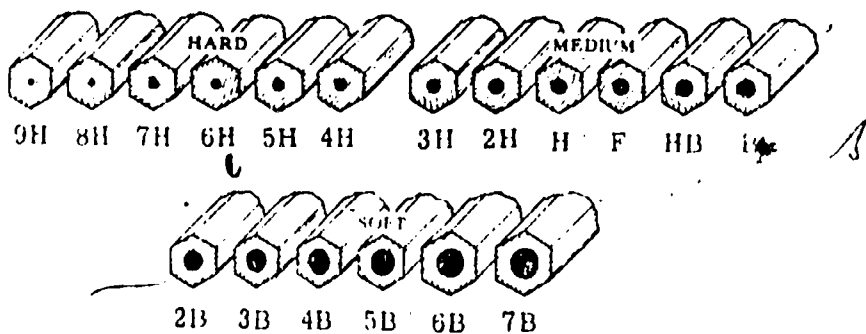


Fig. F-8. Hard, medium & soft drafting pencils Fig. F-9. Grids of coordinate paper

SIZE AND PROPORTIONS OF SKETCHES

In general, sketches are not made to any scale, but they should be as nearly in proportion as possible. Before a sketch can be started, the overall dimensions of the object to be drawn must be known; the size of the sketch can then be planned in accordance with the area available for it on the paper. When the desired size for the sketch has been determined, the proportions can be worked out from the dimensions of the object. In working out proportions, it is helpful to ask oneself questions like these: How many times greater is the height than the width (or vice-versa) of the object? If the object has openings, are their height and width greater than the spaces between them?

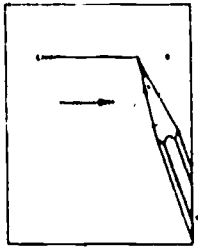
SKETCHING PROCEDURES AND TECHNIQUES

The term "sketch" is often misunderstood to mean a vague, crude drawing; however, if even a rough sketch is to be of any value, it must be done with reasonable care and accuracy. Speed in sketching is desirable, but the beginner should concentrate at first on developing accuracy. He or she should hold the pencil in the normal writing position, using wrist motion for sketching the shorter lines and forearm motion for the longer ones. All lines should be drawn with a free movement, without hesitation, and fairly fast.

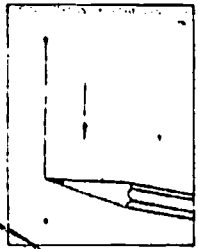
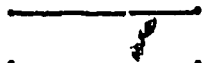
SKETCHING LINES

A group of exercises designed to develop skill in the sketching of lines is given on the next page. In doing these exercises, the apprentice should connect the dots in each set as shown, making each line with one firm, quick stroke and keeping his or her eye on the dot toward which the pencil is moving--not on the pencil point. Short, "hairy" strokes must be avoided; the pencil should be kept in contact with the paper for the entire length of the stroke. If the resulting line looks wavy, it was probably drawn too slowly; if the line misses the dots, it was probably drawn too fast. It is good practice to go through the motion of the stroke once or twice with the pencil raised slightly off the paper before actually drawing the line; when the stroke seems to be going where it should, the pencil point can be lowered onto the paper and the final stroke made.

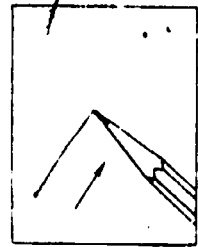
EXERCISES IN SKETCHING LINES



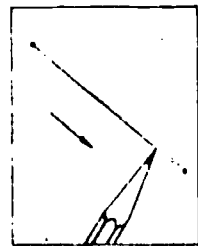
HORIZONTAL



VERTICAL



DIAGONAL



DIAGONAL



CURVED



BASIC FORMS IN SKETCHING

When you have become proficient in the freehand drawing of lines, you will be ready to try sketching the basic geometric forms--squares, rectangles, triangles, and circles--that singly or in various combinations represent the shapes of most objects.

Two simple ways to sketch rectangles or squares when the lines are parallel to the paper edge are shown in Fig. F-10. In the method illustrated at the left, points are laid out the required distance in from the paper edges, then connected with freehand pencil strokes. A strip of paper or cardboard can be marked and used as a gage for laying out the points. The method illustrated at the right can be employed if a sketching pad is being used; the pencil is held as shown, the fingertips being used to guide the hand along the edge of the pad.

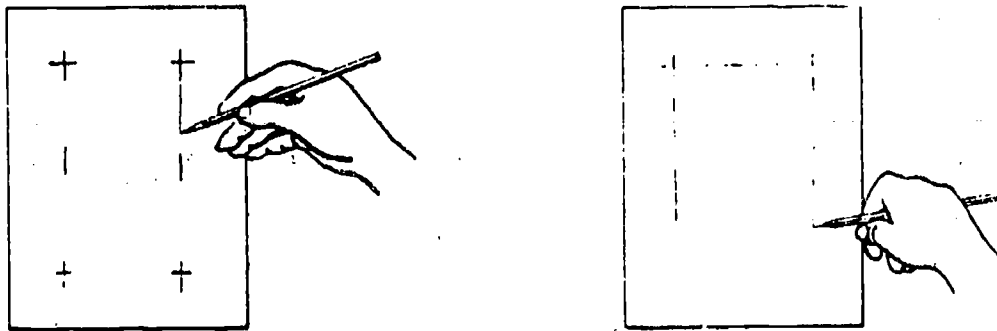
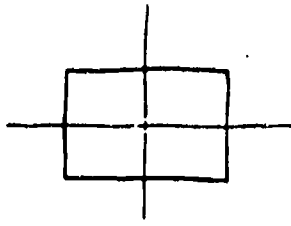
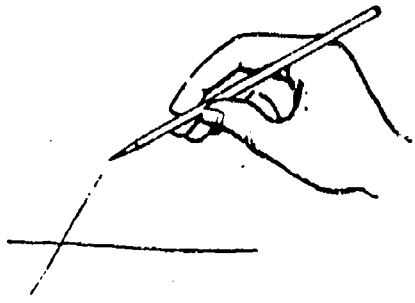


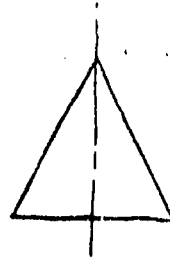
Fig. F-10. Two methods of sketching lines parallel to the paper edge

The sketching of squares, rectangles, triangles, and circles is made easier by laying them out on crosses (intersecting lines) that have been marked to provide reference points for the drawing. (See Fig. F-11.)

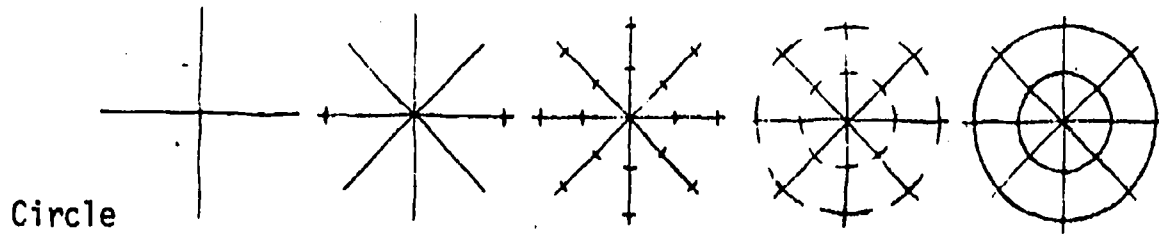
Circles and arcs, especially the larger ones, may also be drawn with fair accuracy by placing the tip of the little finger on the paper where the center of the circle will come, holding the pencil steady and with moderate pressure on the paper, then rotating the paper carefully. (See Fig. F-12.)



Rectangle



Triangle



Circle

Fig. F-11. Laying out figures from center lines

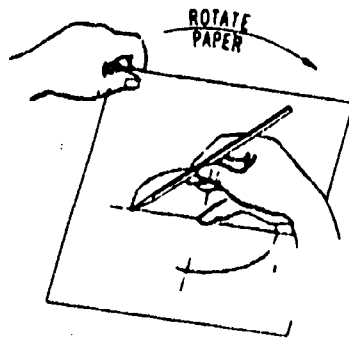
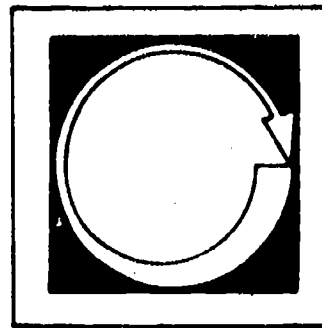


Fig. F-12. Another method of drawing a circle

Self Assessment



Read each statement and decide whether it is true or false. Write T if the statement is true; write F if the statement is false.

1. Sketching an object may compel a person to change his or her opinion of it in some way.
2. A sketch developed from an existing drawing to show a change in construction should be very carefully done.
3. To make a good-quality line for a sketch, one should use short, overlapping pencil strokes.
4. Sketches are usually made to some given scale.
5. Lines are employed in sketching to represent the surfaces, edges, and contours of objects.
6. Most right-handed persons find that the most natural direction for drawing horizontal lines is from left to right.
7. A ruler is an essential instrument in freehand sketching.
8. If the lines of a sketch are wavy, they were probably drawn too fast.

SELF ASSESSMENT ANSWER SHEET

1. T

2. T

3. F

4. T

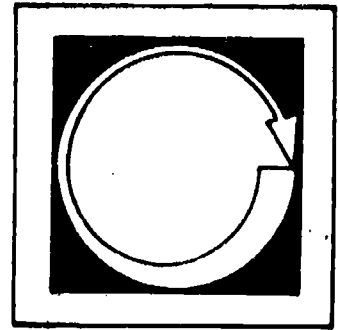
5. T

6. T

7. F

8. F

Post Assessment



Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

1. _____ Learning to sketch develops a technical student's ability to:
 - a. use drafting instruments
 - b. understand verbal instructions
 - c. observe things critically
 - d. use the tools of his or her trade

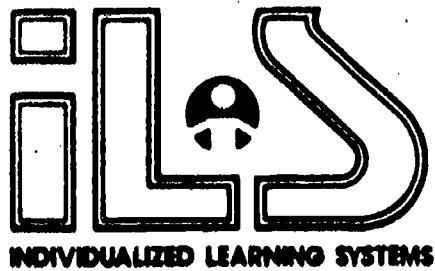
2. _____ Which of the following combinations of materials would be best for the beginner in sketching?
 - a. coordinate paper
 - b. charcoal and wood
 - c. unlined paper and any soft pencil having an eraser
 - d. typing paper, typewriter eraser, and HB drafting pencil

3. _____ In drawing a line freehand, one should use:
 - a. a series of short, overlapping strokes
 - b. a straightedge if the line is over 4" long
 - c. wrist motion only
 - d. a single pencil stroke

4. _____ The first step in learning to sketch is to practice drawing:
 - a. lines
 - b. rectangles
 - c. planes and contours
 - d. three-dimensional forms

5. _____ Coordinate tracing paper has:
 - a. no lines
 - b. vertical lines only
 - c. horizontal lines only
 - d. crossed lines or grids

6. _____ Sketches are usually made:
- a. to scale and in proportion
 - b. to scale but not in proportion
 - c. neither to scale nor in proportion
 - d. in proportion but not to scale
7. _____ The first step in making a sketch is to:
- a. draw the lines representing the top and bottom of the object
 - b. draw the lines representing the sides of the object
 - c. determine the overall dimensions of the object
 - d. determine all the dimensions of the object
8. _____ The degree of perfection and the amount of detail required in a sketch depends upon the:
- a. number of copies to be made
 - b. importance of the information given in the sketch
 - c. time available for sketching
 - d. cost of the item being sketched
9. _____ Which one of the following is essential equipment for sketching?
- a. drafting instruments
 - b. coordinate paper
 - c. blueprint machine
 - d. soft eraser
10. _____ If a freehand-drawn line looks wavy, it probably was drawn:
- a. with too soft a pencil
 - b. on the wrong paper
 - c. too rapidly
 - d. too slowly



5.3

BLUEPRINT READING WORKING DRAWINGS

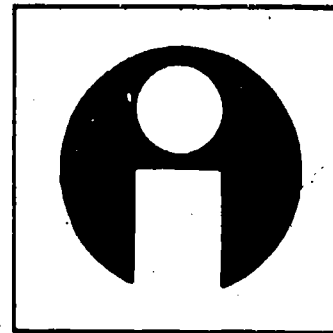
Goal:

The student will become familiar with the types of information, general and detailed, which may be found on working drawings.

Performance Indicators:

The student will refer to a set of working drawings to complete a Self Assessment and a Post Assessment exam.

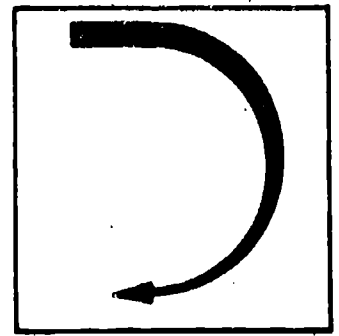
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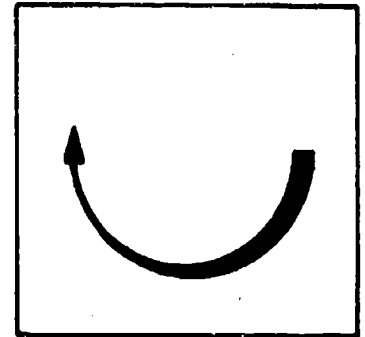
Introduction



Anyone entering any of today's trades or technical fields must have a thorough knowledge of the graphic language of blueprints. Learning this special language, like learning any other, demands careful and patient study of its theory and composition, its symbols, and its conventions. With practice, the apprentice will be able to read the new language without difficulty and employ it, through sketching, to express his or her technical ideas to others. As you acquire skill in blueprint reading, you will be able to visualize from its drawings how a technical object will look when completed and how its parts will fit together. The apprentice will also be able to determine from a study of the drawings what machines, equipment, and work processes will be needed to construct, erect, or install the object.

Working drawings--architectural or engineering drawings reproduced as blueprints--can be considered to be tools of every technical occupation. A skilled worker in any of the building trades, for example, must know how to get information from a set of working drawings quickly and accurately. To do this, the worker must be able to visualize the object from the line drawings on the blueprints. The worker must also understand the meanings of symbols and conventions, which are the "short-hand" means used by the draftsman to indicate materials, quantities, sizes, locations, and details of construction. When necessary, the worker must be able to get from written specifications information regarding the quality of materials, finish, and workmanship agreed upon by the contractor and the client.

Information



Many present-day buildings are very complex, and the complete set of working drawings for such a building usually includes separate sheets of drawings for the several crafts--structural, plumbing, heating and ventilating, electrical, and so forth--in addition to the usual architectural drawings. Although each worker will be primarily concerned with the working drawings for his or her own trade, he or she may also need to refer to other drawings in the complete set from time to time.

A set of working drawings, reduced in size, is included at the end of this module to illustrate the discussion that follows. The apprentice should study all the drawings carefully to get a clear idea of the kinds of information each provides about the construction project (a one-room elementary school). Reading working drawings like these is part of the day-to-day work of every skilled craftsworker in the building industry.

SITE DEVELOPMENT PLAN (SHEET 1)

The first drawing to be considered in a set of blueprints for a construction project is usually the site development plan or plot plan, which may also incorporate an area map and a site grading plan. Plot plans include the following essential information that must be known before any building can be erected: compass directions, property lines, contours (slopes), location of the building or buildings on the site, and locations of roads, trees, existing structures, and utilities. Approaches to the buildings and finished grade contours are also shown.

FOUNDATION PLAN (SHEET 2)

The foundation plan for a building shows the overall dimensions of the foundation walls and includes cross sections that show the width, depth, and the height of the footings at various locations. It also indicates the placement and sizes of steel reinforcing rods and anchor bolts and the location and dimensions (including thickness) of all concrete floor slabs and steps.

FLOOR PLAN (SHEET 3)

A floor plan shows the layout of a single floor of a building. It is in effect the view from above that would be revealed if the building were sliced through horizontally at a height that would best show interior features. The floor plan shows the arrangement, size, and shape of the rooms; the thickness of walls and partitions; the location of windows, doors, and other wall openings; and the size, shape, and location of plumbing fixtures and other mechanical fixtures.

Symbols are employed to represent mechanical features and details where this results in the simplification or clarification of the floor plan. The apprentice should give careful attention to the various uses made of symbols not only on the floor plan but on all the other working drawings of this set as well. If the meaning of a symbol, a term, or an abbreviation on the drawing is not clear, he or she should ask the instructor to explain it.

EXTERIOR ELEVATIONS (SHEET 3)

An exterior elevation is a view of one side or the front or back of a structure, showing its shape, the size and location of openings, and other features as roof details and exterior finishes.

INTERIOR AND SECTIONAL ELEVATIONS (SHEETS 5 AND 6)

Interior elevations show the placement and relationship of interior parts of the building. Sectional elevations are detailed interior elevations that represent the building, or some part of it, as if it were sliced through vertically. Many interior and sectional drawings may be needed to provide all the essential information about such items as wall construction, joinery, and interior openings in a complex structure.

DETAIL DRAWINGS (SHEETS 4 AND 7)

When a construction detail is shown with insufficient clarity or completeness in a floor plan, elevation, or other small-scale drawing, the detail is presented elsewhere drawn to a larger scale. The detail drawing is keyed to the smaller-scale drawing by means of an identifying number or letter.

SHOP DRAWINGS

Shop drawings are an exception to the general rule that the architect or engineer

shall provide all the working drawings needed for bringing the construction project to completion. (No examples of shop drawings are included in this module.) A shop drawing is a blueprint that may be supplied by a manufacturer of special equipment--commercial cabinets and fixtures, for example--to show how the equipment is constructed and how it should be installed. Shop drawings must have the approval of the architect or engineer.

NOTES AND SCHEDULES (SHEETS 3 and 4)

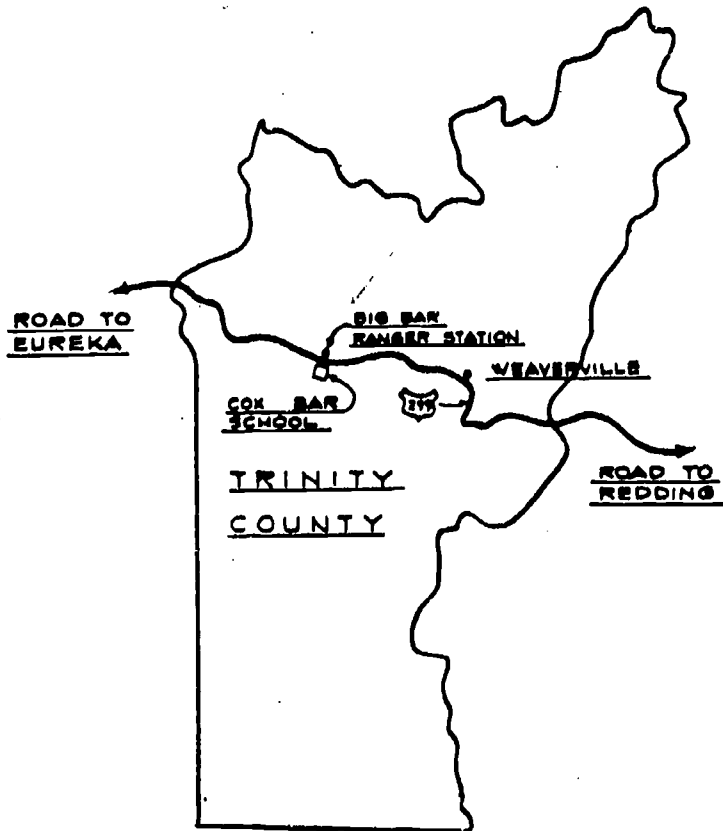
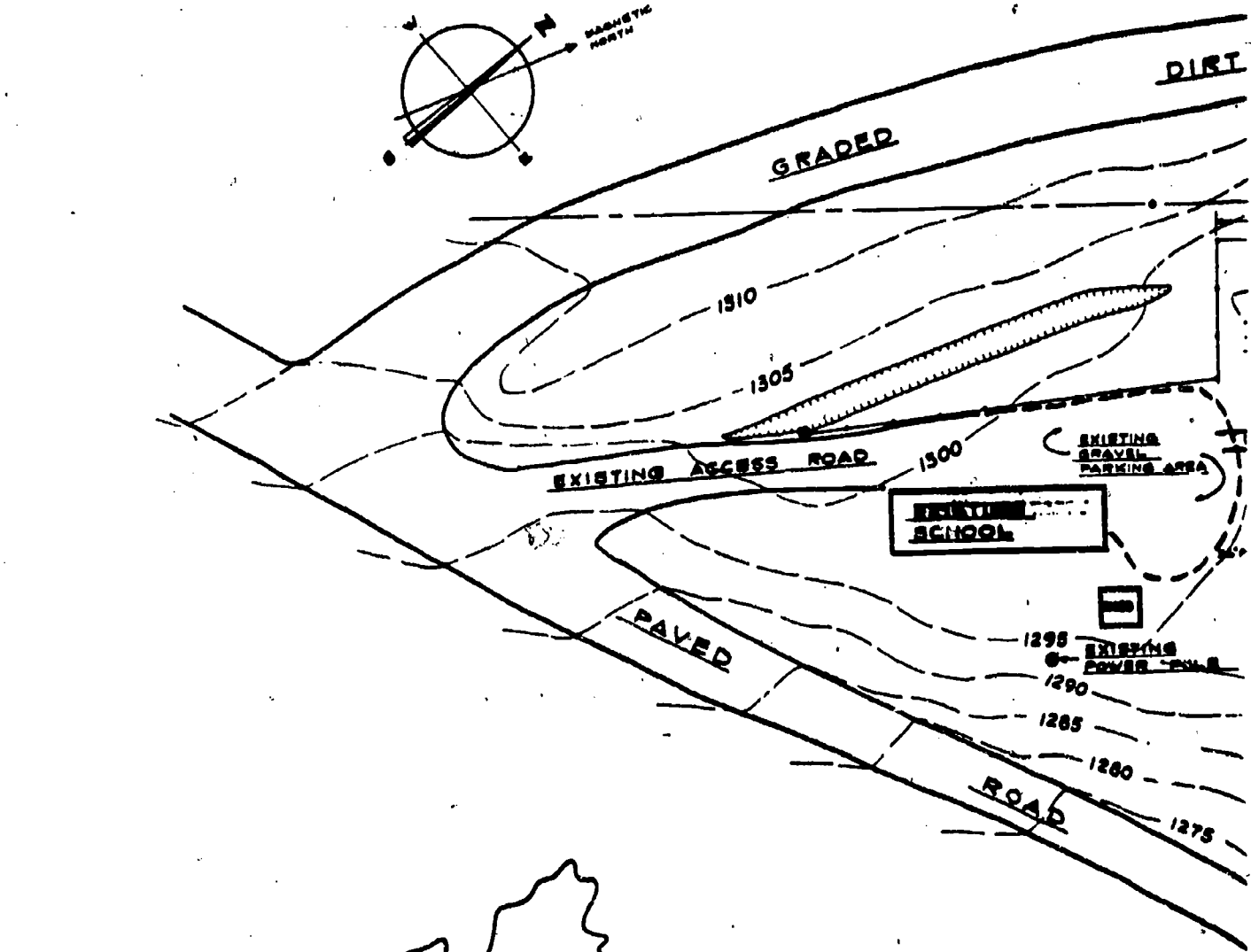
The working drawings that make up a complete set are interrelated, and they must be read together if they are to be used effectively. Information given on one drawing often clarifies information given on another, and a separate set of written specifications backs up the drawings. Also, most working drawings contain brief notes referring to other drawings or to information in the specifications that cannot well be shown by a symbol. In addition, many working drawings also include schedules--charts or tables containing data on doors, windows, special equipment, and the like.

SPECIFICATIONS AND THE CONTRACT

The written specifications that accompany a set of working drawings present all the information about the construction project that cannot be shown conveniently on the drawings. They give a detailed account of the quality of workmanship and materials that apply in every phase of the project, spell out the responsibilities of the contractor, the subcontractors, and the owners.

Drawings and specifications should agree in all details, but if they are found to be in conflict in any way, the specifications are to be followed.

WORKING DRAWINGS



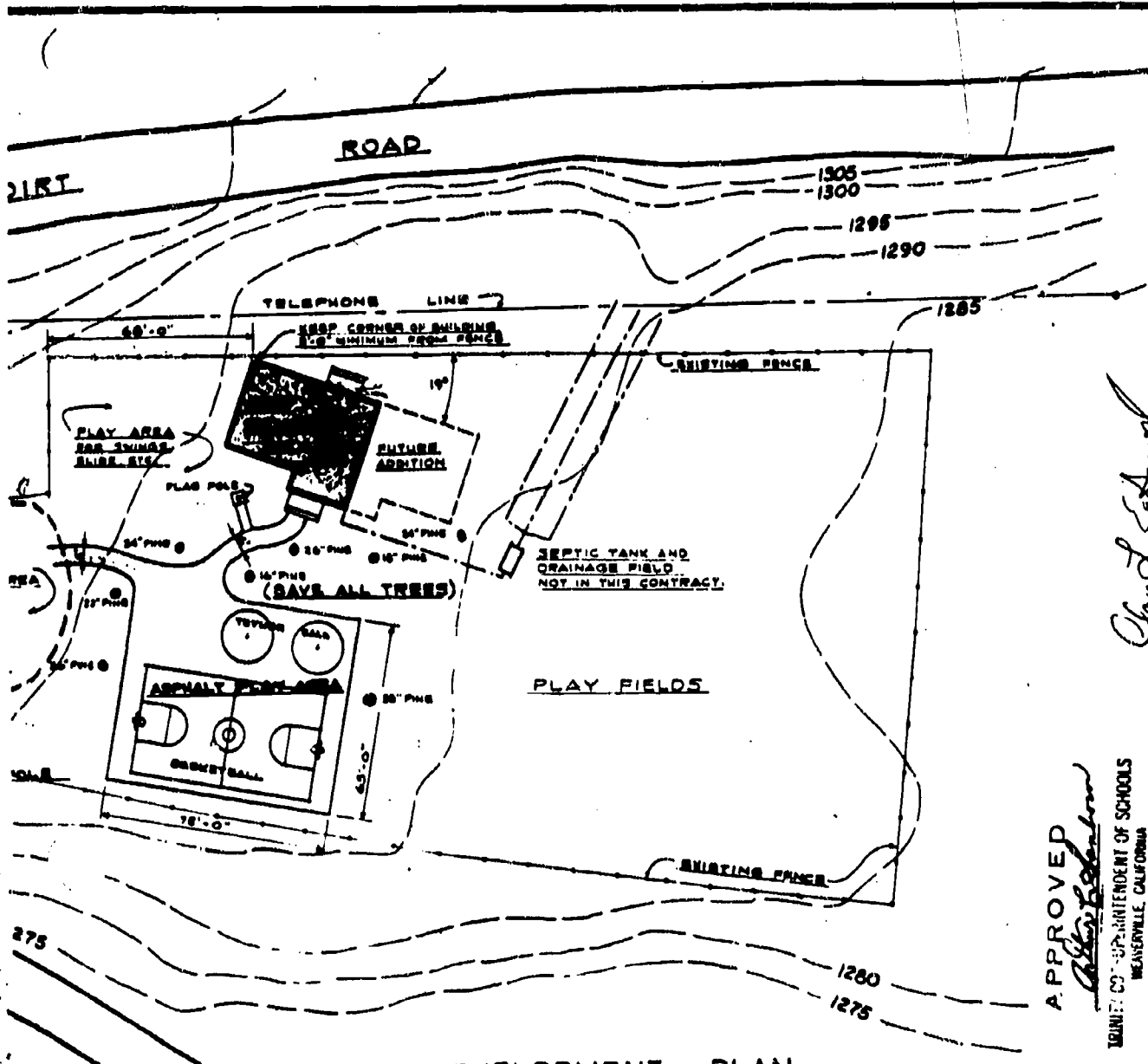
AREA MAP - NO SCALE

GENERAL NOTE

1. CLEAR AND GRADE AND ASPHALT PL.
2. PROVIDE PAD FOR
3. PAVE HARDCOURT AND TETHERBALL
4. FINISH GRADE ALL

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Working Drawings



SITE DEVELOPMENT PLAN
SCALE 1" = 30'-0"

- NOTES:** CONTRACTOR SHALL -
- 1. MAKE SITE ONLY AS REQUIRED TO CONSTRUCT NEW SCHOOL, WALKS, PLAY AREA.
 - 2. PROVIDE FOR NEW SCHOOL AND POSSIBLE FUTURE ADDITION.
 - 3. COURT PLAY AREA AND WALKS AS SHOWN. INSTALL BASKETBALL BALL STANDARDS.
 - 4. ALL AREA WITHIN 40 FEET OF NEW SCHOOL.

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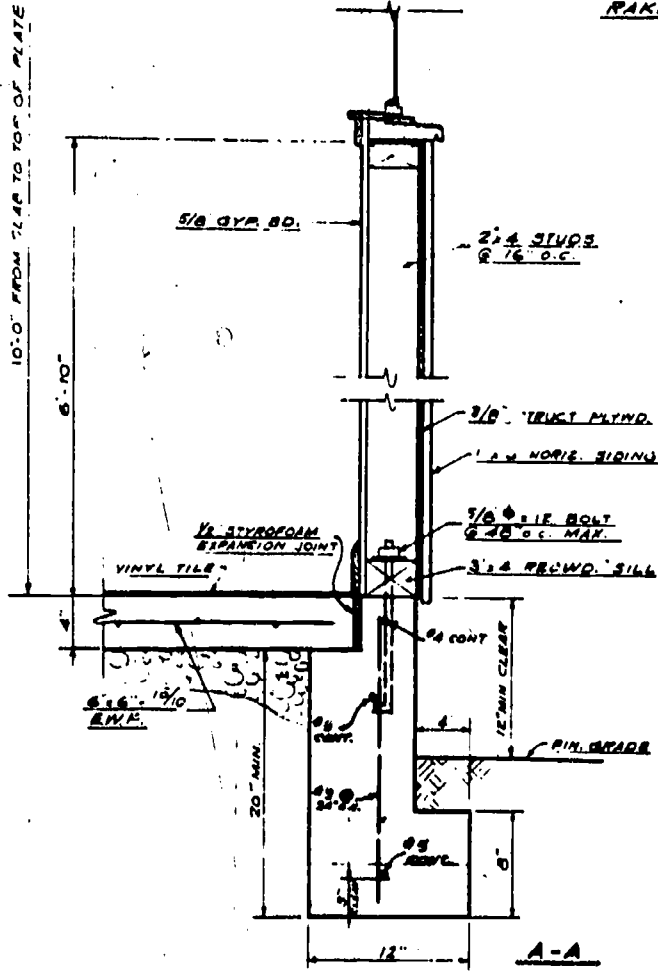
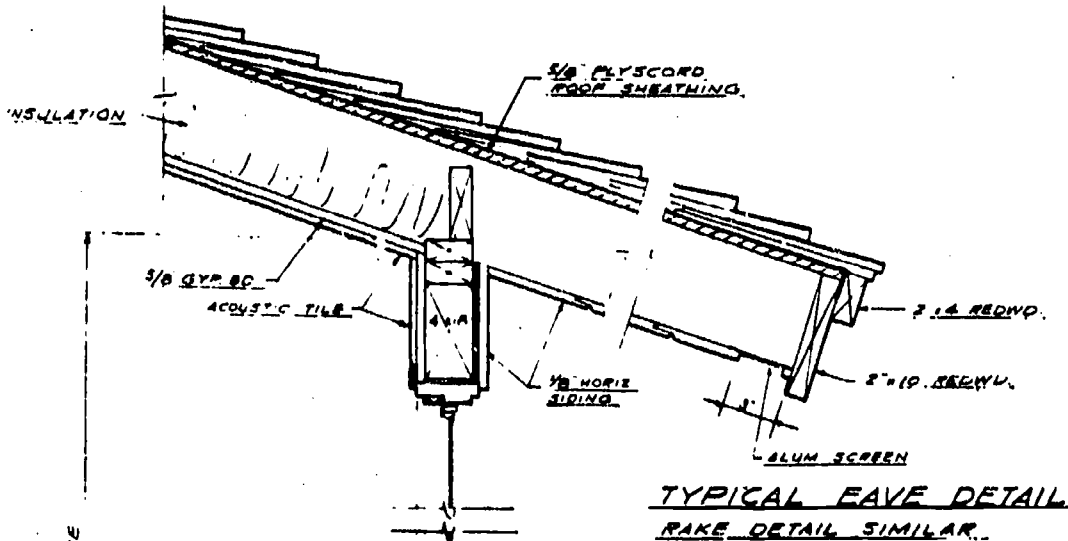
THIS PLAN IS NOT TO BE USED UNTIL LEGAL REQUIREMENTS ARE MET AND AUTHORIZATION TO PROCEED WITH CONSTRUCTION HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE

CALIF. STATE DEPT. OF EDUCATION
BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATON, JR., ARCHITECT
DATE: FEBRUARY, 1963

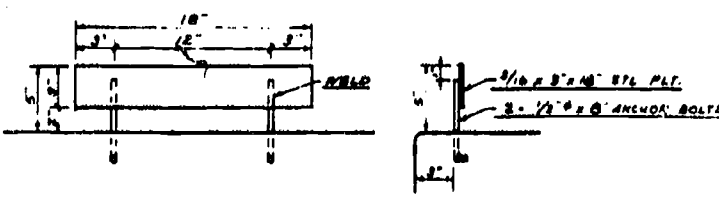
APPROVED
Alvin E. Johnson
SUPERINTENDENT OF SCHOOLS
MENDOCINO COUNTY, CALIFORNIA

APPROVALS
Richard J. ...
...

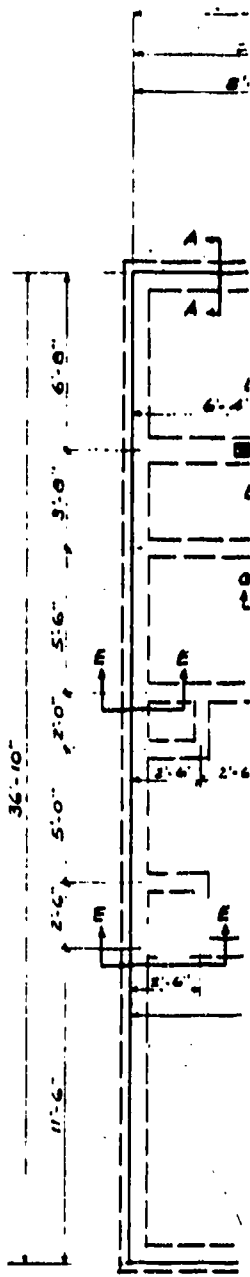
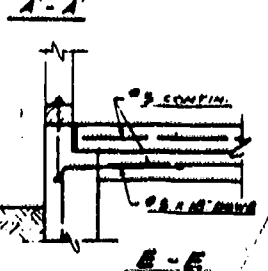
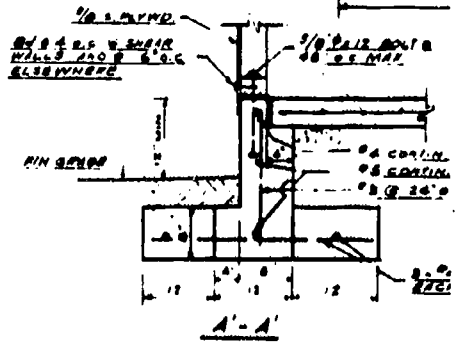
SITE DEVELOPMENT PLAN
COX BAR ELEMENTARY SCHOOL



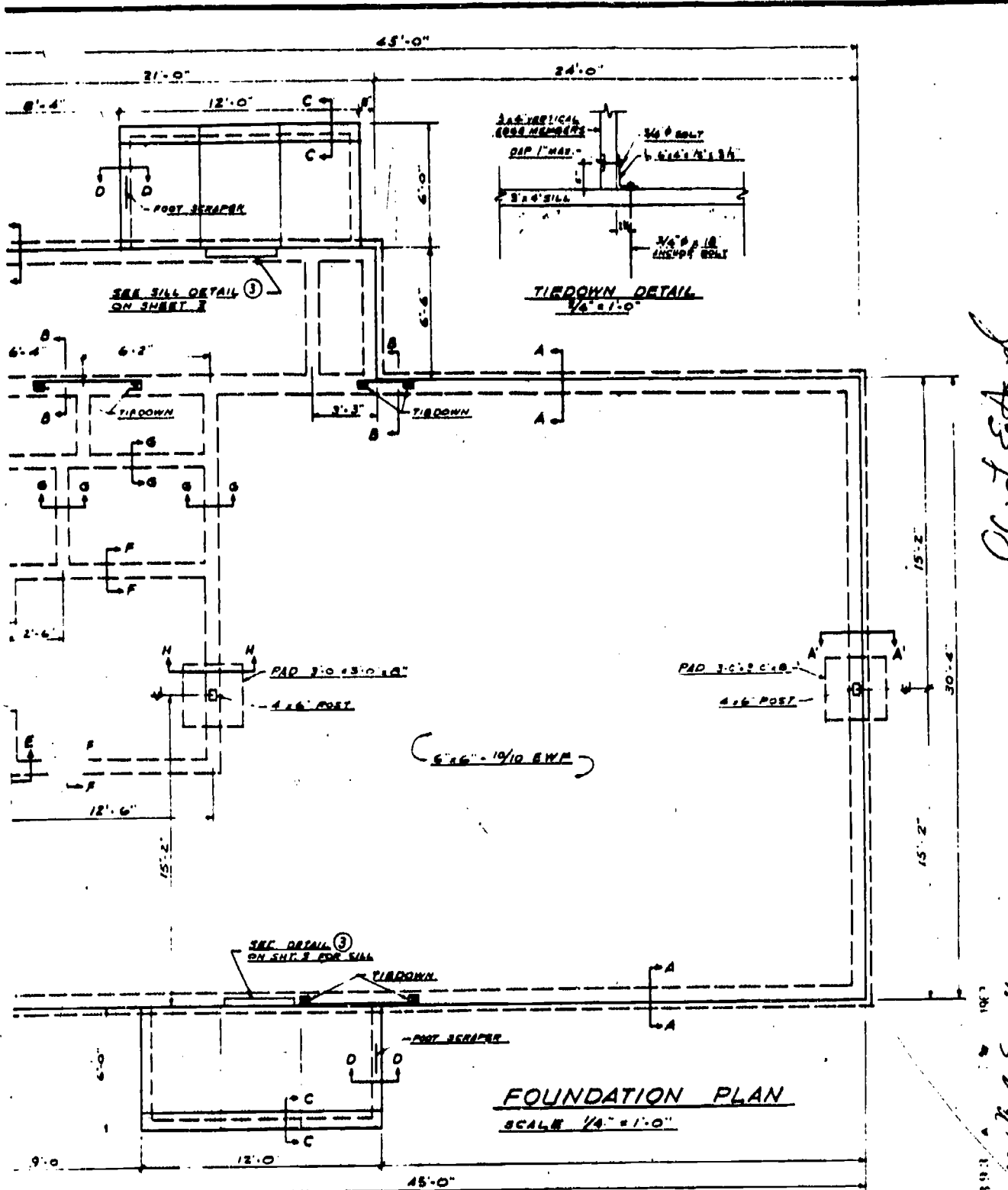
TYPICAL SECTION THRU WALL
1 1/2" x 1'-0"



FOOT SCRAPER DETAIL
1 1/2" x 1'-0"



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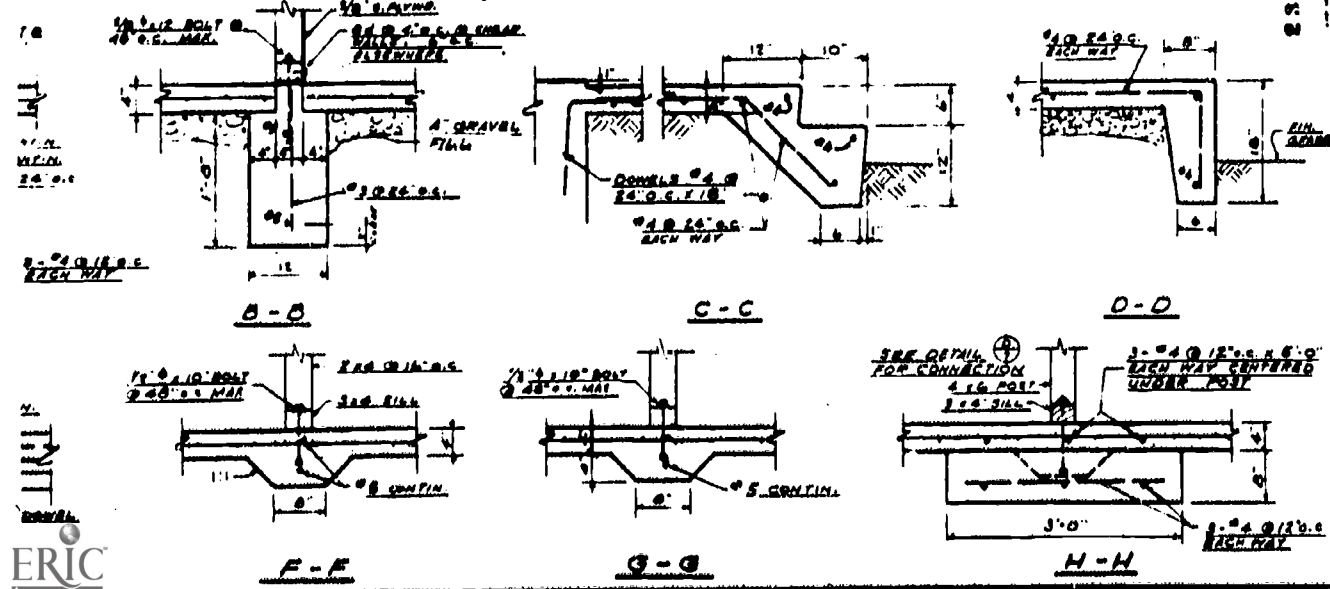
THIS PLAN IS NOT TO BE USED UNTIL LEGAL REQUIREMENTS ARE MET AND AUTHORIZATION TO PROCEED WITH CONSTRUCTION HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE.

Clair S. Safford
 CALIF. STATE DEPT. OF EDUCATION
 BUREAU OF SCHOOL PLANNING
 731 CAPITOL AVENUE
 SACRAMENTO 14, CALIF.
 C. L. EATOUGH, ARCHITECT
 DATE: FEBRUARY, 1963

APPROVALS

FOUNDATION PLAN AND DETAILS &
 TYPICAL WALL SECTION
 ONE ROOM ELEMENTARY SCHOOL

2

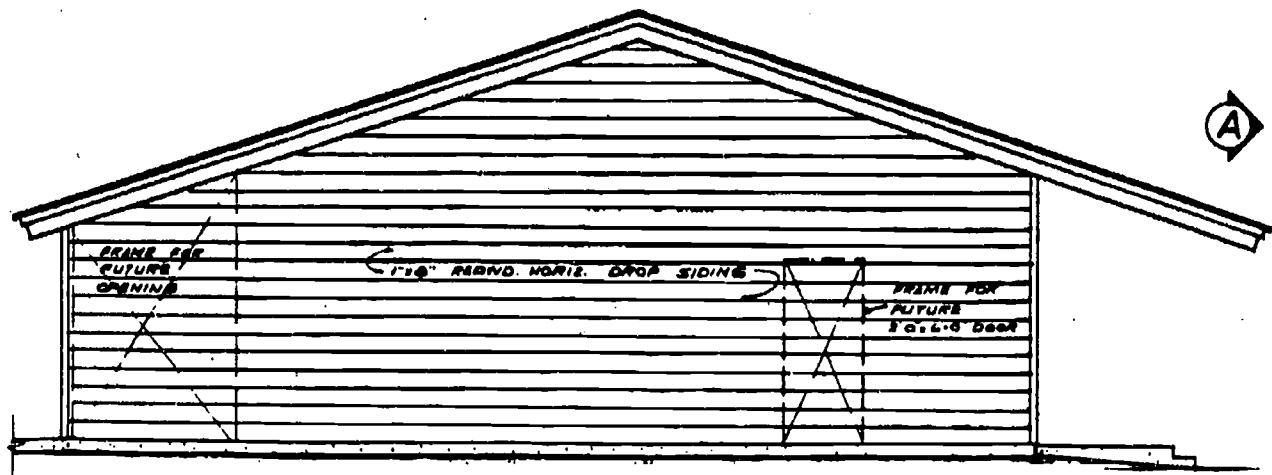


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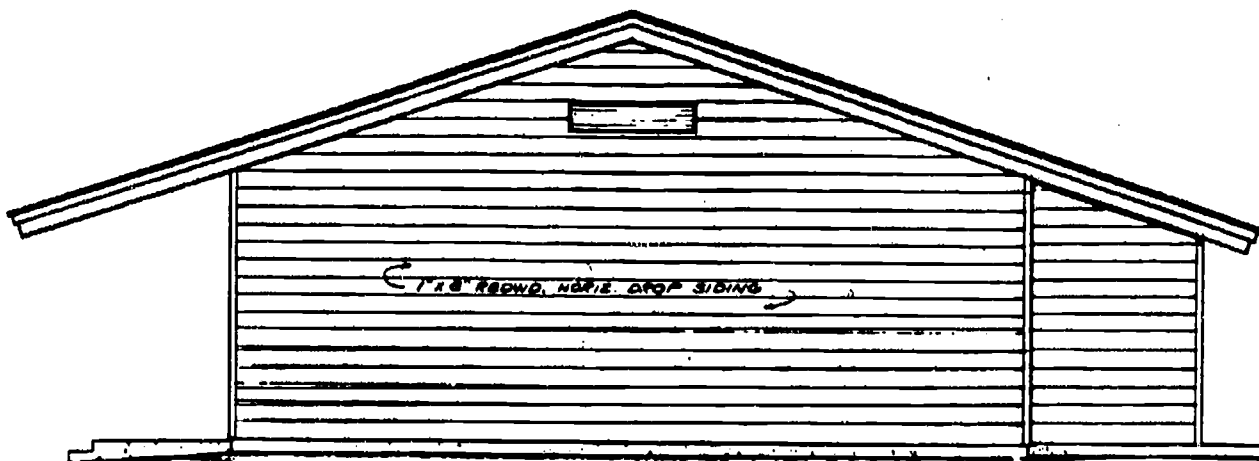
SPECIAL EQUIPMENT SCHEDULE

NOTE: THESE ITEMS ARE NOT IN THE CONSTRUCTION CONTRACT. THE SCHOOL DISTRICT MAY PURCHASE ITEMS DIRECT FROM SUPPLIER.

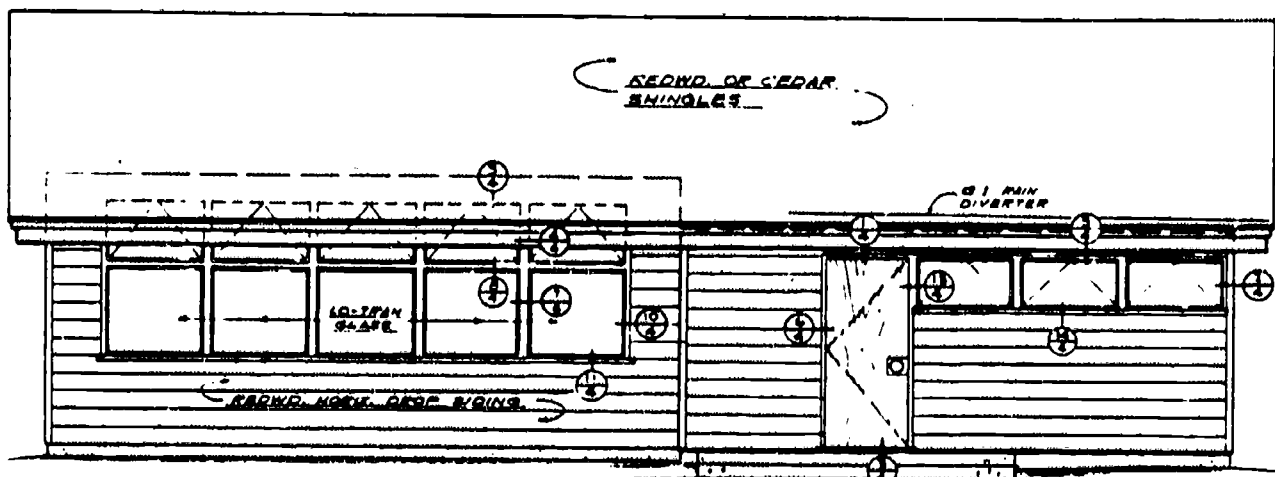
ITEM	SYMBOL	SIZE	MANUFACTURER & REMARKS
RANGE	A	HT. 36", WIDTH 30", DEPTH 30"	HOTPOINT MODEL HPG 200
REFRIGERATOR	B	HT. 73 1/2", WIDTH 52", DEPTH 31"	PUFFER HUBBARD MODEL 31-2TC
FOLDING TABLE	C	OPEN 10' WIDE, 7'9" DEEP, CLOSED 11'-0" DEEP	BRUNSWICK
MOVABLE STOVE COUNTER	D	36" x 48" x 30"	EDUCATORS # 405
MOVABLE DOUBLE BODY SINKS	E	36" x 48" x 30"	EDUCATORS # 407
WATER STORAGE	F	28" x 48" x 34"	EDUCATORS # 409
PORTA-BENCH	G	30" x 48" x 32"	EDUCATORS # 431



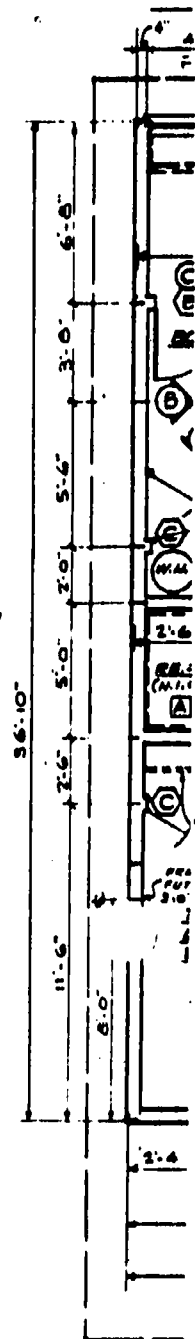
ELEVATION A



ELEVATION C

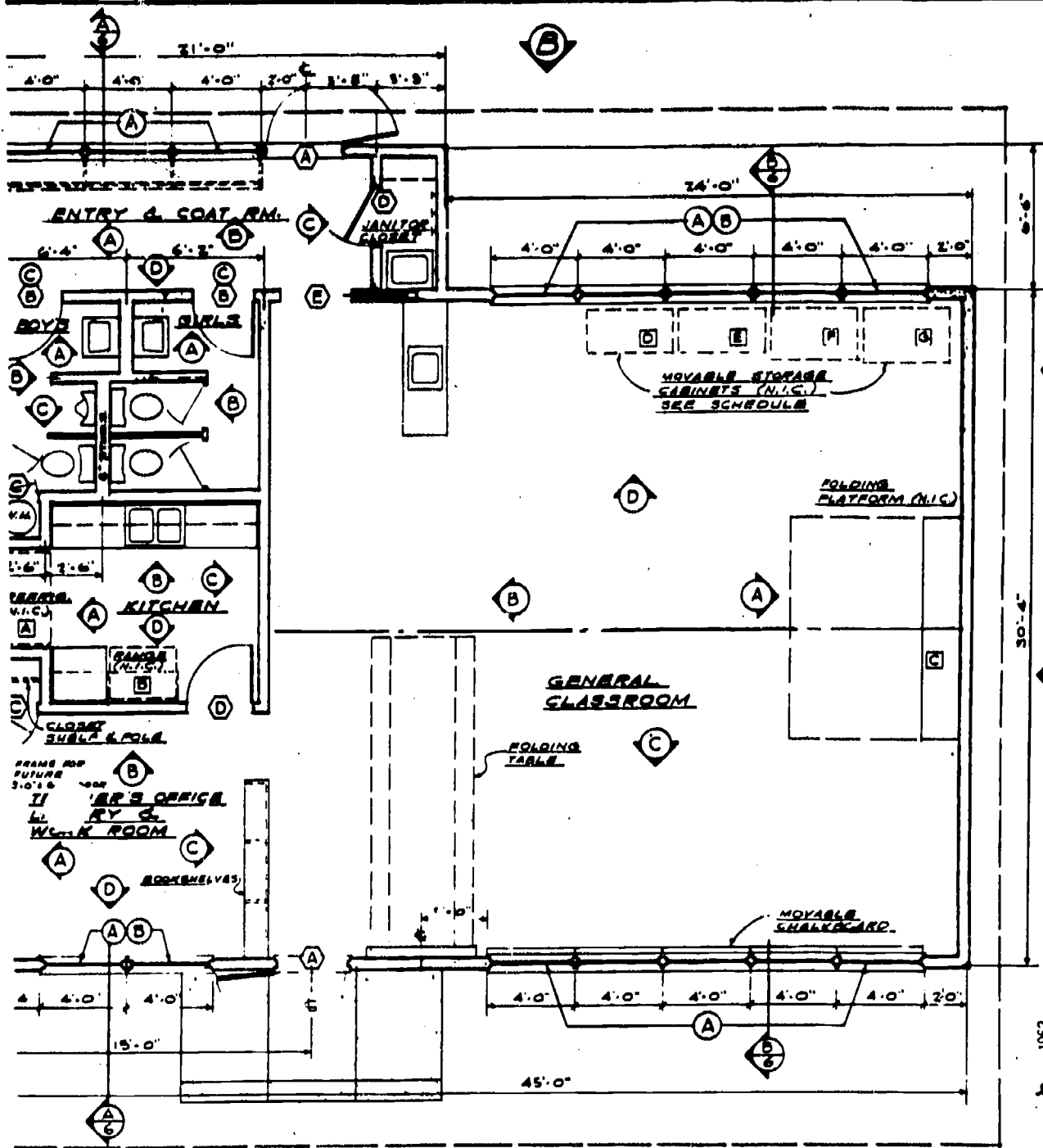


ELEVATION B

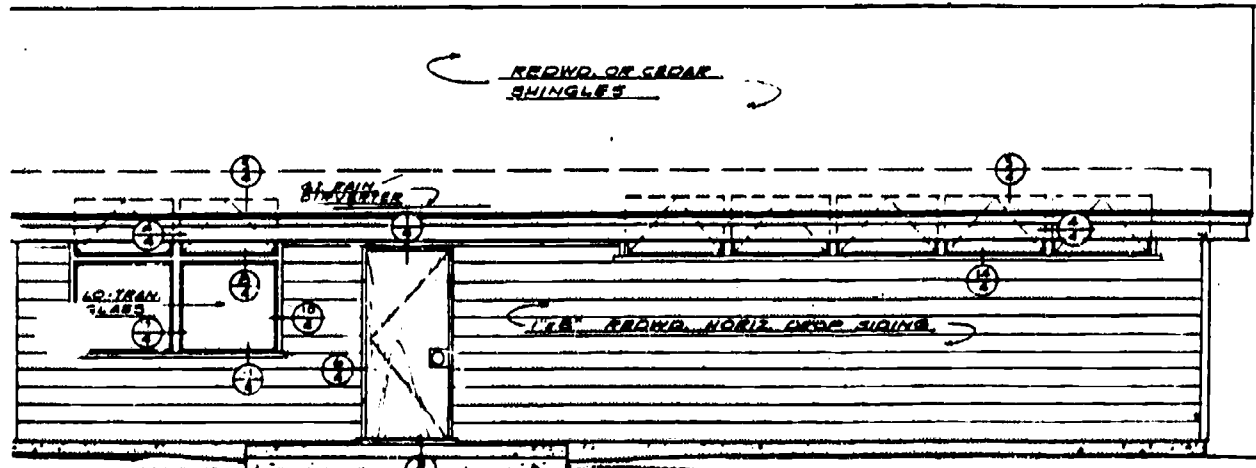


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Working Drawings



FLOOR PLAN SCALE 1/8" = 1'-0"



ELEVATION D

THIS PLAN IS TO BE USED UNLESS LEGAL OPINIONS TO THE CONTRARY ARE OBTAINED FROM THE ARCHITECT. THE ARCHITECT HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE.

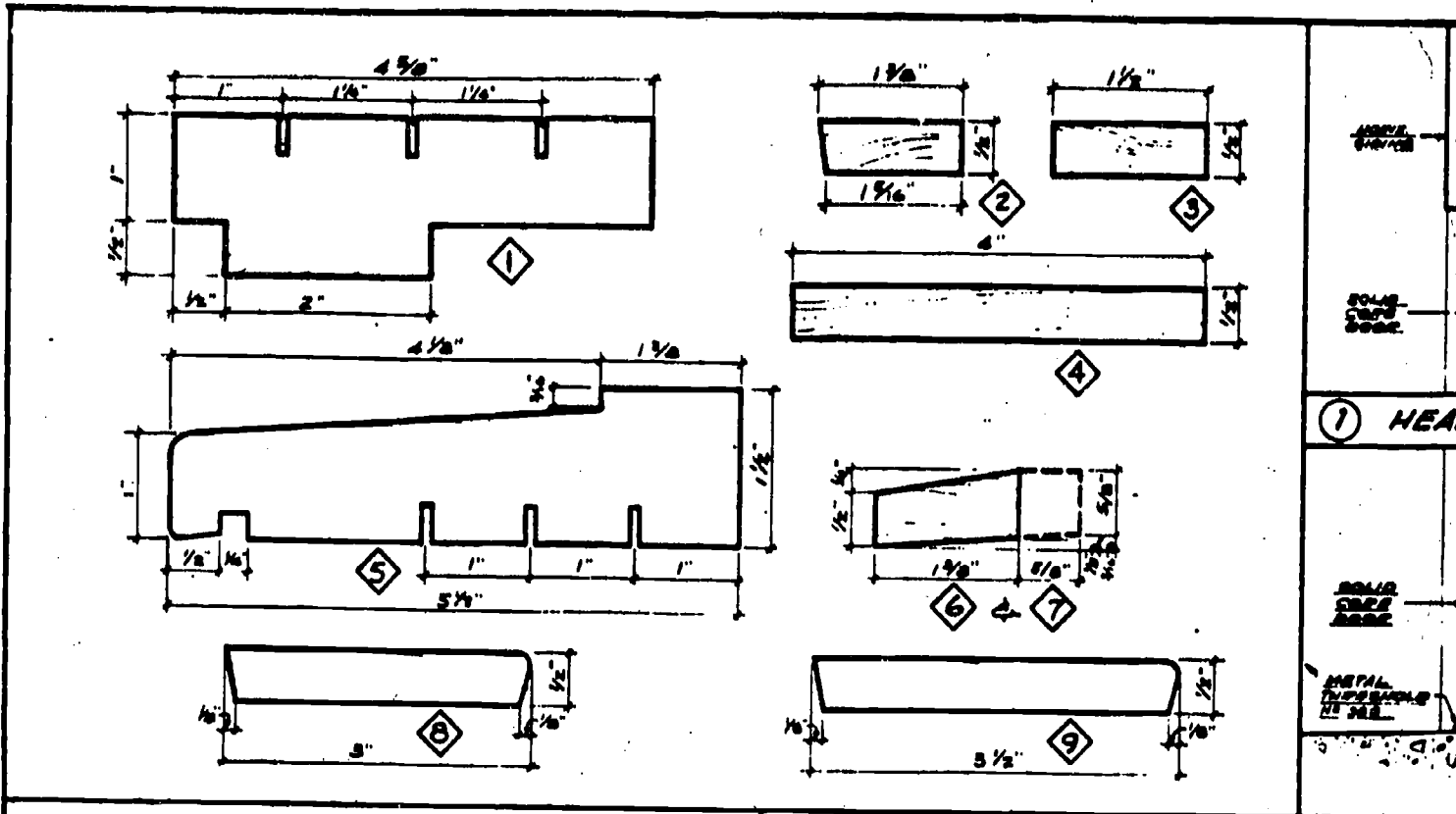
APPROVALS

CLAYTON S. EATOUGH
 CALIF. STATE DEPT. OF EDUCATION
 BUREAU OF SCHOOL PLANNING
 721 CAPITOL AVENUE
 SACRAMENTO 14, CALIF.
 C. L. EATOUGH, ARCHITECT
 DATE: FEBRUARY, 1963

FLOOR PLAN &
 EXTERIOR ELEVATIONS
 ONE ROOM ELEMENTARY SCHOOL

3

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MILLWORK SECTIONS - FULL SIZE

MILLWORK SPECIFICATIONS

EXTERIOR MATERIAL - SHALL BE CLEAR, KILN-DRIED PONDEROSA PINE, TREATED WITH WATER-REPELLENT PRESERVATIVE, OR SHALL BE NO. 1, CLEAR, KILN-DRIED REDWOOD. ALL MILLWORK SHALL BE PRIMED ALL SIDES WITH WHITE LEAD PRIMER. GALVANIZED NAILS TO BE USED ON ALL EXTERIOR WORK.
 INTERIOR MATERIAL - MAY BE NO. 1 CLEAR, KILN-DRIED DOUGLAS FIR. ALL MILLWORK SHALL CONFORM TO THE STANDARDS OF THE WOODWORK INSTITUTE OF CALIFORNIA.

DOOR SCHEDULE

SYMBOL	SIZE	DOOR	HARDWARE						
			BUTTS	SIZE	LOCKSETS	CLOSER	KICKPLATE	THRESHOLD	
(A)	3'-6" x 7'-0"	GLASS SURFACE SOLID CORE	BIRCH SURFACE WEATHERSTRIP	1 1/2 PR @ 4 1/2 x 6 1/2"	NO 955	400 SIZE 4	1 PER DOOR	" 3/8" B	
(B)	2'-6" x 6'-8"	GLASS SURFACE SOLID CORE	"	1 1/2 PR @ 4" x 6"	NO 910	400 SIZE 3	1 PER DOOR	"	
(C)	1'-10" x 6'-8"	BUILT-UP FRAME	"	1 PR @ 3 1/2 x 3 1/2"	NO 955	"	"	"	
(D)	2'-6" x 6'-8"	SOLID CORE	"	1 1/2 PR @ 3 1/2 x 3 1/2"	NO 910	"	1 PER DOOR	"	
(E)	3'-0" x 6'-8"	SOLID CORE	"	SLIDING TYPE	NOT REQUIRED	"	"	"	

DOOR & HARDWARE SPECIFICATIONS

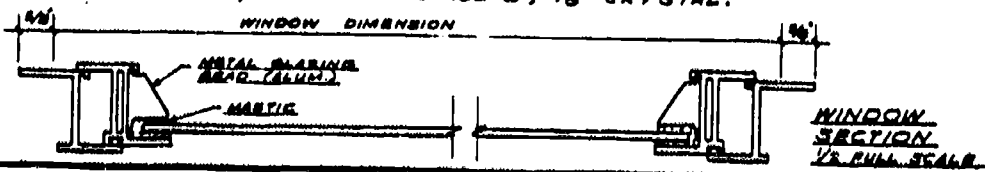
- EXTERIOR DOORS TO BE PRE-FINISHED WELWOOD 'STAY-STRATE' DOORS, 1 1/2" THICK.
- LOCKSETS TO BE 'CORBIN' (SEE SCHEDULE) 'SPARTAN' DESIGN SERIES. INTERIOR DOORS ARE 1 3/8".
- DOOR CLOSERS TO BE 'CORBIN' (SEE SCHEDULE).
- EXTERIOR BUTTS SHALL HAVE BALL BEARING UNITS WITH NON-REMOVABLE PINS, BONDORIZED AND PRIME COATED. USE 'STANLEY' OR EQUAL.
- INTERIOR BUTTS TO BE DULL CHROME WITHOUT BALL BEARINGS.
- TRACK FOR SLIDING DOORS SHALL BE 'GRANT' - #1200 WITH NYLON ROLLERS. USE 'GRANT' ALUMINUM FLUSH RECTANGULAR PULLS.
- THRESHOLDS FOR EXTERIOR DOORS SHALL BE 'ACCURATE' ALUM. SILLS (SEE SCHEDULE).
- KICKPLATES TO BE 14-GA., U.S.-TS, SIZE 12" HIGH BY 1 1/2" LESS THAN DOOR WIDTH. BEVEL ALL SIDES. INSTALL ON PUSH SIDE OF DOORS.
- FINISH - ALL HARDWARE SHALL BE U.S. STANDARD Z&D UNLESS OTHERWISE INDICATED.
- CONTRACTOR SHALL FURNISH AND INSTALL HARDWARE AS REQUIRED.

WINDOW SCHEDULE

SYMBOL	SIZE	WINDOW	GLAZING	MANUFACTURER	REMARKS	HARDWARE	
						CATCH	SCREENS
(A)	3'-6" x 2'-0"	ALUMINUM	CLEAR	'SOULE' SERIES 900	PROJECT IN, TOP HINGED	NO 9P-15	"
(B)	"	FIXED	LOW TRAN	"	SET IN WOOD STOPS	"	"
(C)	"	FIXED	NONE	"	SCREEN IN WOOD FRAME	"	ALUM. SCREEN

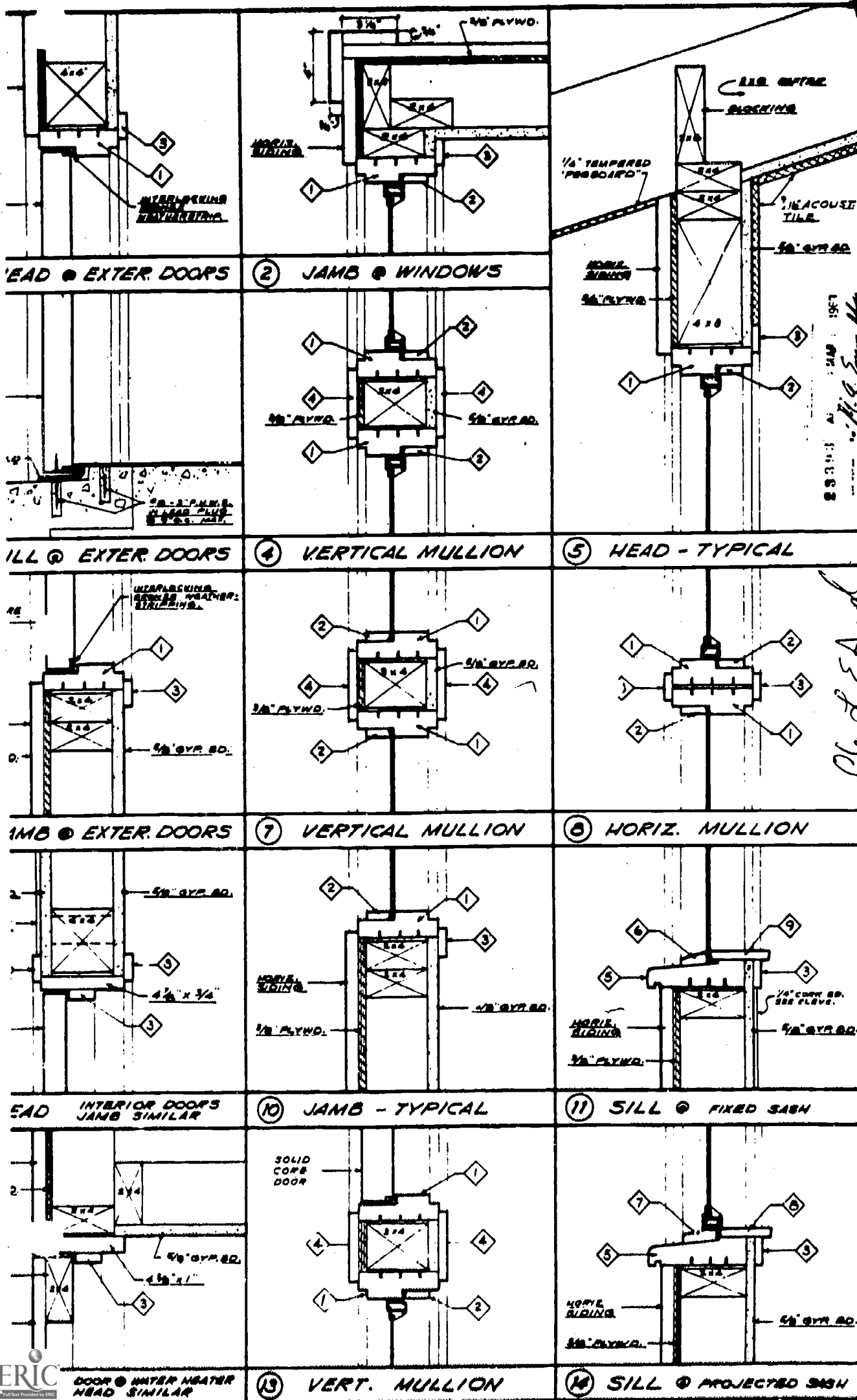
WINDOW & GLAZING SPECIFICATIONS

- WINDOWS SHALL BE 'SOULE' SERIES 900 ALUMINUM WINDOWS OR APPROVED EQUALS. CONTRACTOR SHALL ORDER WINDOWS TO DIMENSIONS SHOWN ON THE SCHEDULE AND SHALL NOTE THAT WINDOWS ARE VENTED TO PROJECT INWARD AND HINGED AT THE TOP.
- ALL GLAZING OF ALUM. SASH SHALL USE SNAP-IN METAL BEADS. ALL GLASS SHALL SET IN A MASTIC BED. MAKE WATER-TIGHT. (SEE 1/2" FULL SIZE DETAIL, THIS SHEET).
- LIGHT REDUCING GLASS (ALL FIXED SASH) SHALL BE FIRST QUALITY AS MANUFACTURED BY PITTSBURGH GLASS CO. USE GRAYLITE NO. 14 GLASS. ALL GLASS SHALL BE SET WITH THE WAVE RUNN HORIZONTALLY.
- CLEAR GLASS (ALL VENTS 15H) SHALL BE GRADE B, 1/8" CRYSTAL.



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Working Drawings



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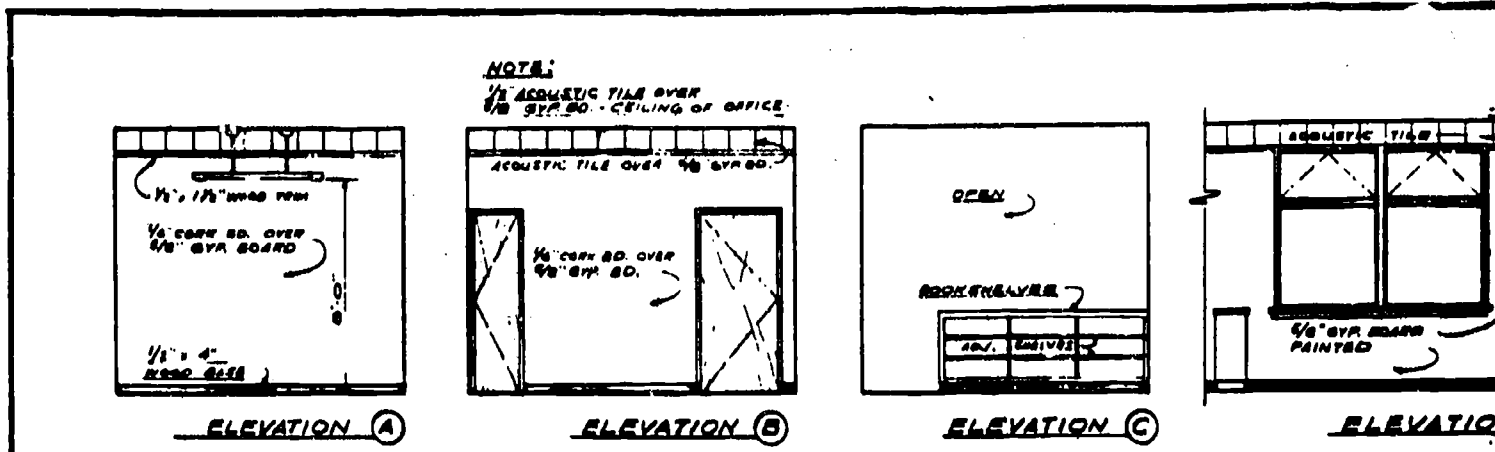
APPROVALS

DOOR & WINDOW DETAILS AND MILLWORK SECTIONS

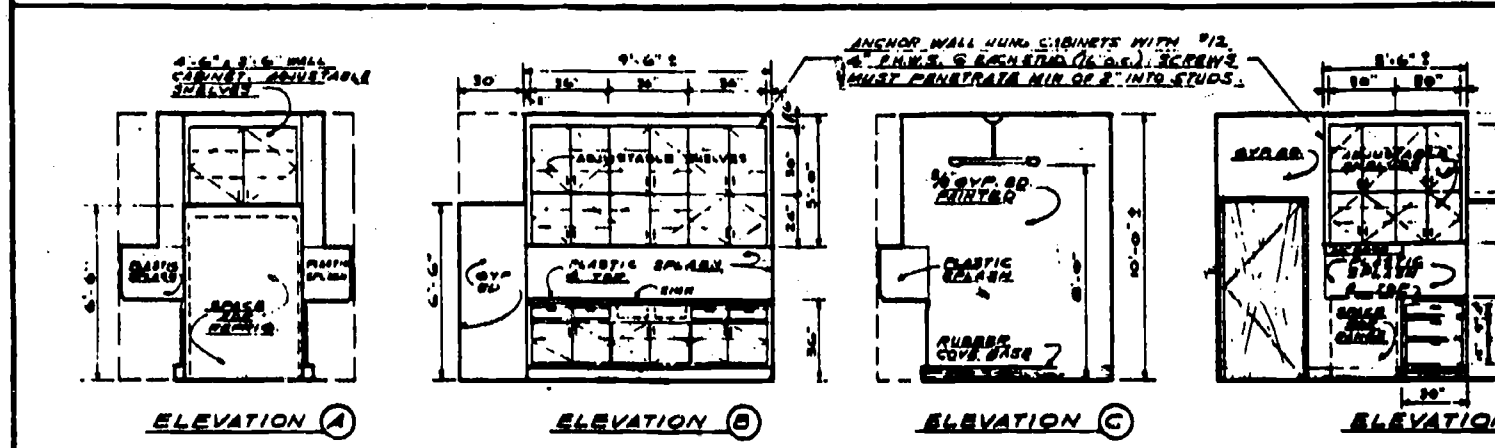
ONE ROOM ELEMENTARY SCHOOL

4

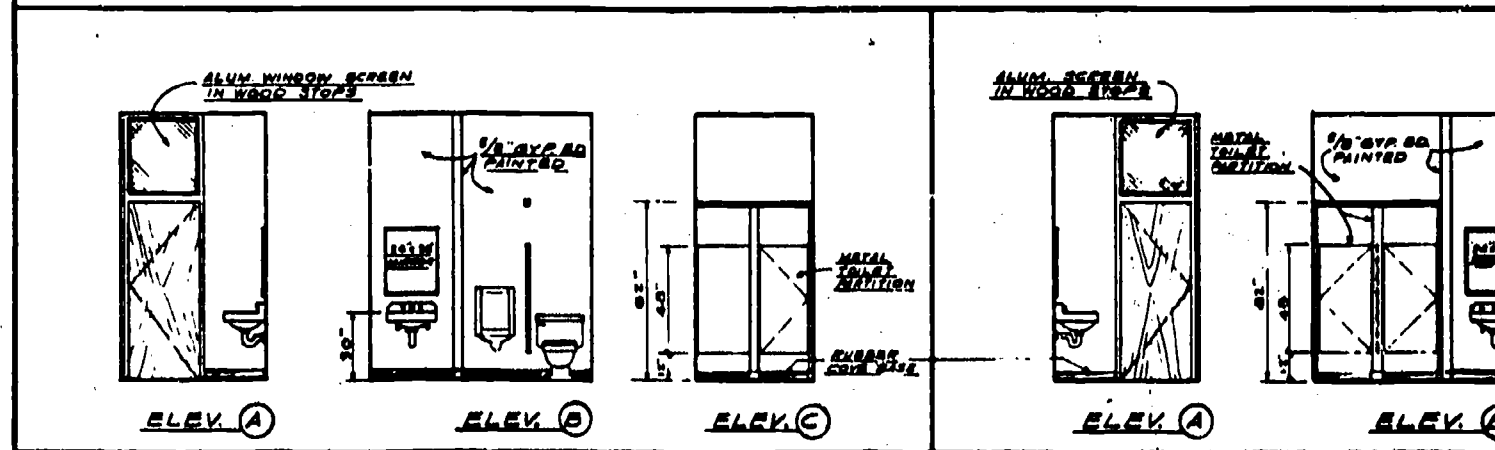
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OFFICE - WORKROOM AREA

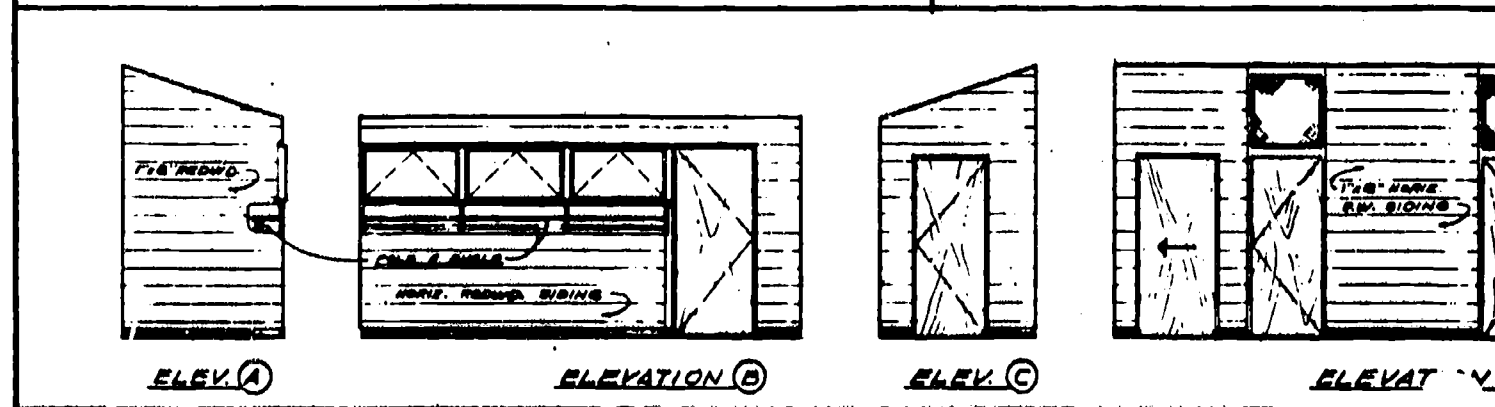


KITCHEN



BOYS' TOILET RM.

GIRLS' TOILET

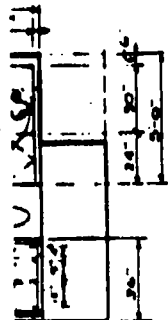


ENTRY & COAT ROOM

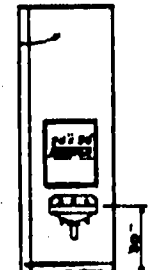
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SECTION ①

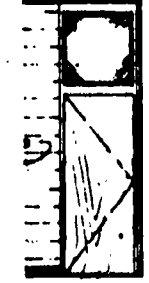


SECTION ②

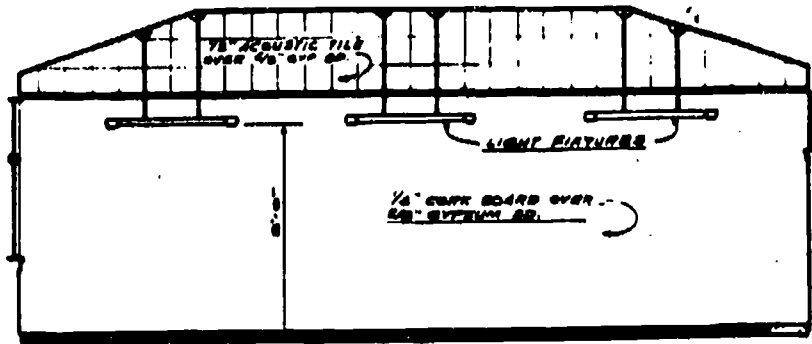


SECTION ③

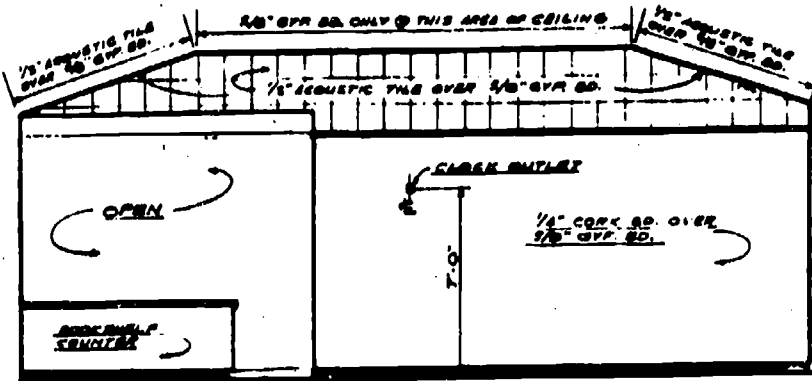
ET RM.



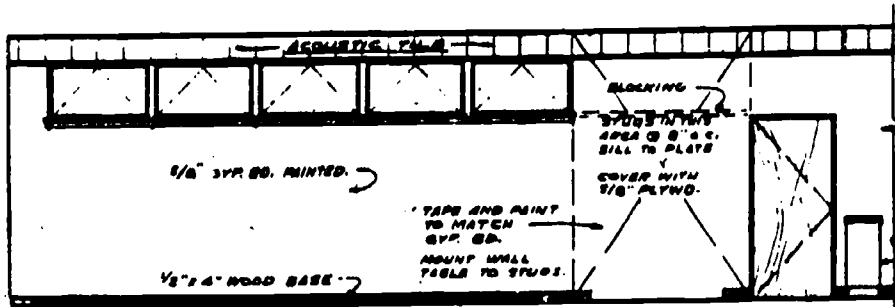
SECTION ④



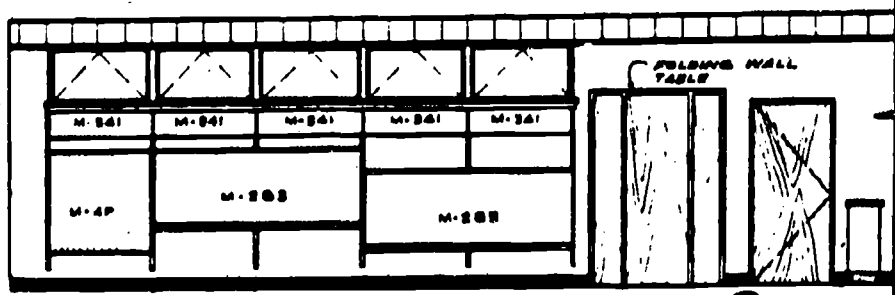
ELEVATION A



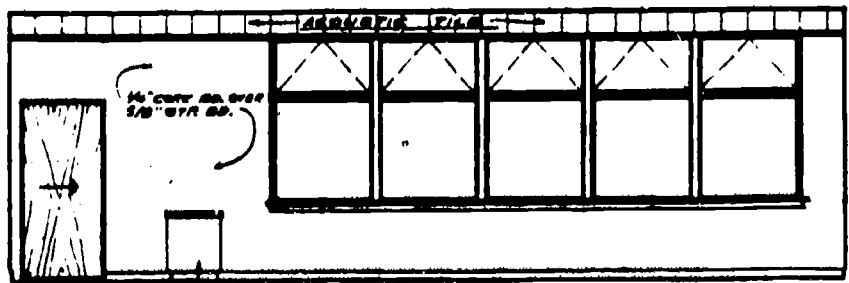
ELEVATION B



ELEVATION C



ELEVATION D
SAME AS C SHOWING CHALKBD. MOUNTING.



ELEVATION E

GENERAL CLASSROOM

Clara J. E. School

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CALIF. STATE DEPT. OF EDUCATION
BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT
DATE: FEBRUARY, 1963

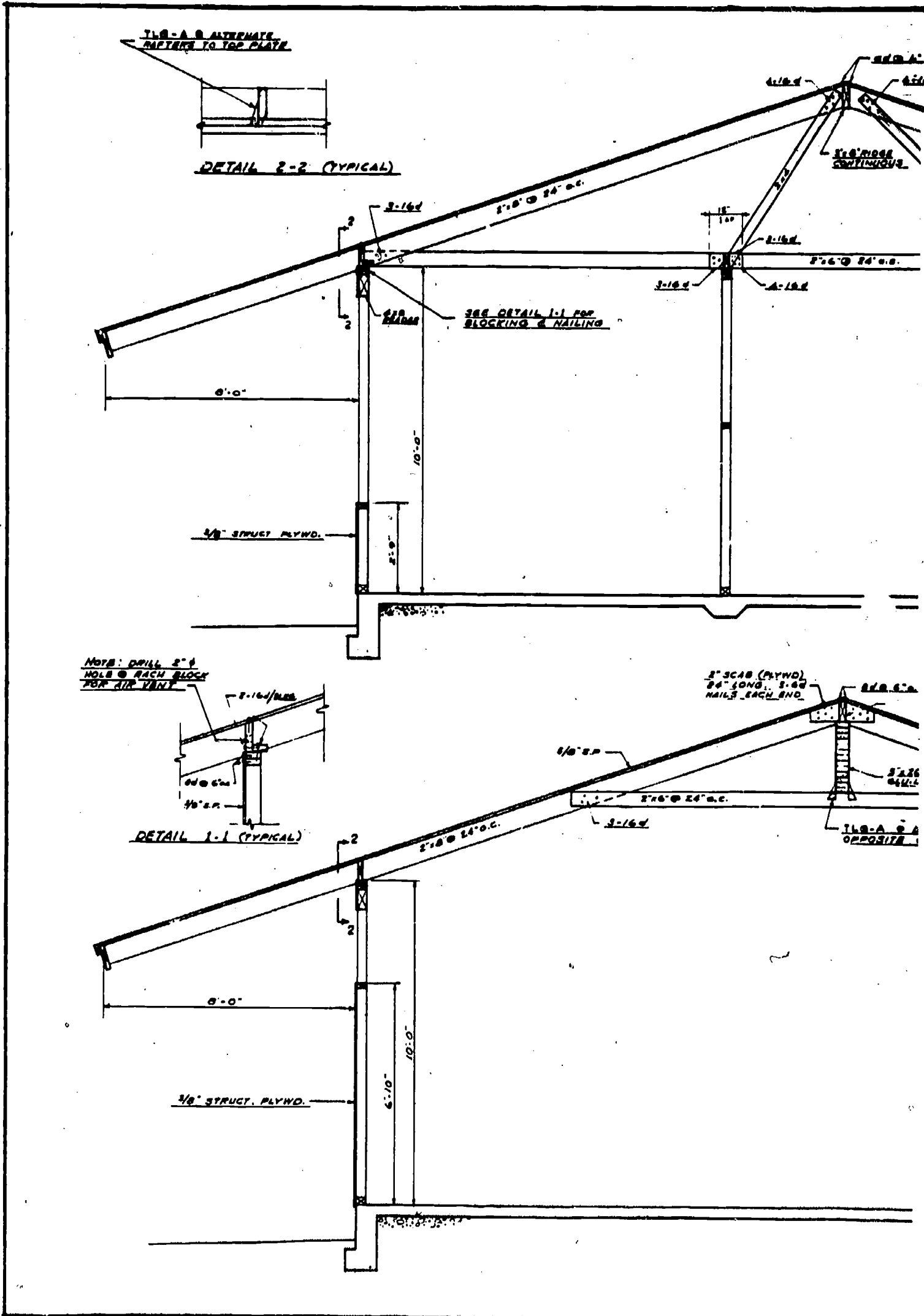
APPROVALS

INTERIOR ELEVATIONS
ONE ROOM ELEMENTARY SCHOOL

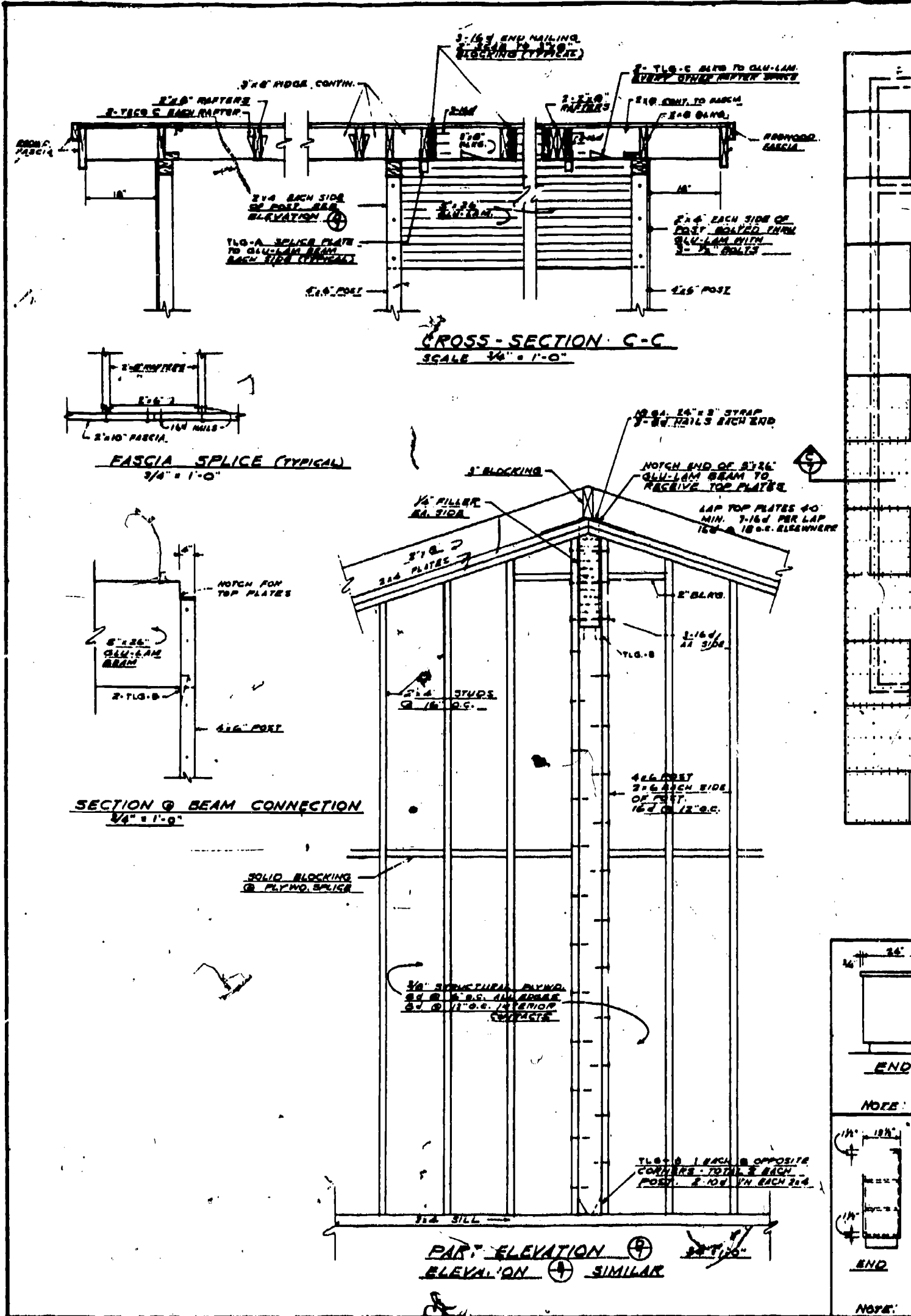
25391 2 11/2 1963
M. A. ...

5

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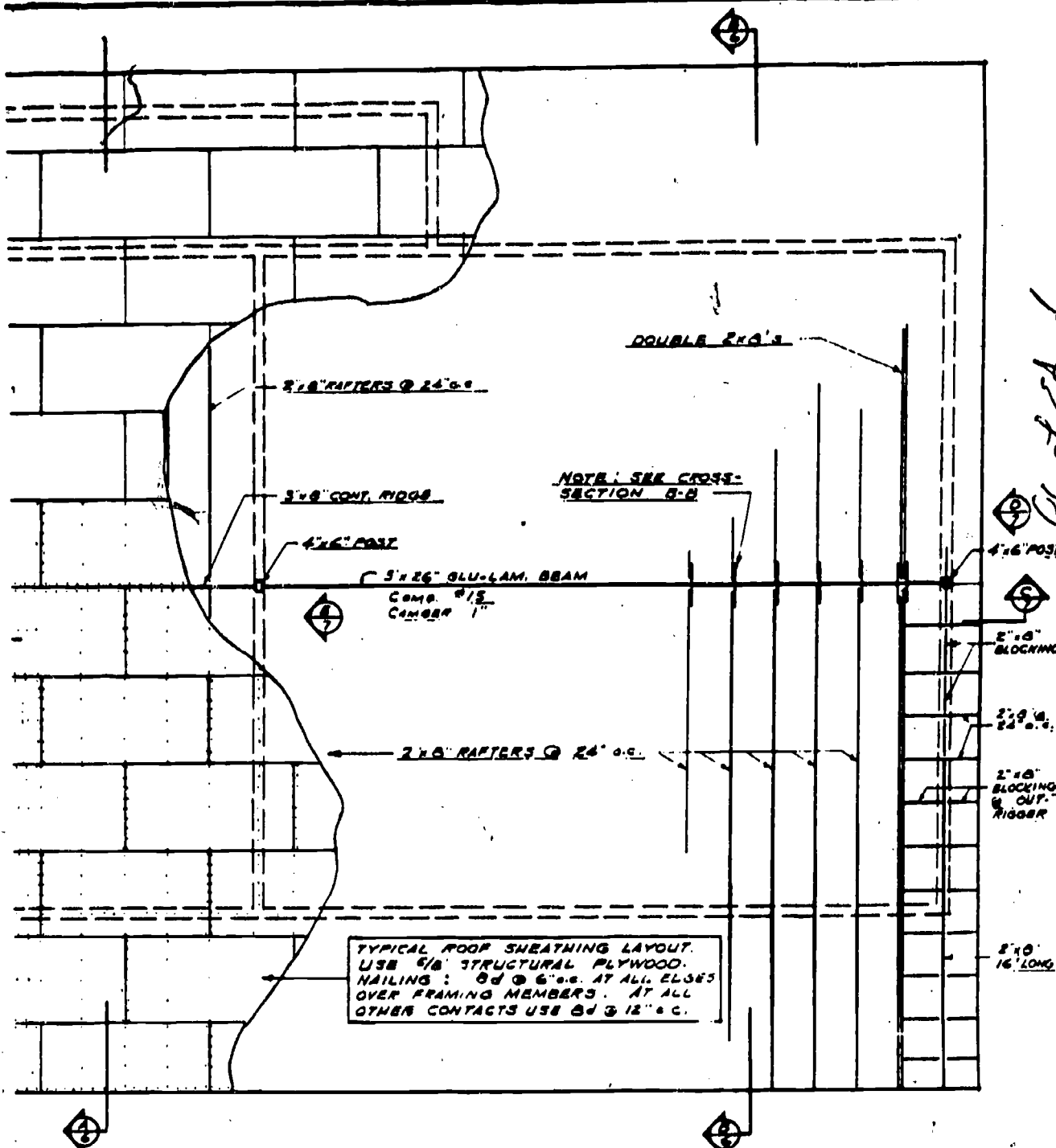


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Working Drawings



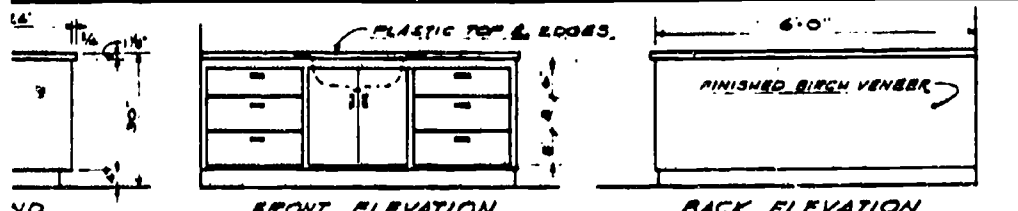
ROOF FRAMING PLAN SCALE 1/8" = 1'-0"

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DATE: FEBRUARY 1963

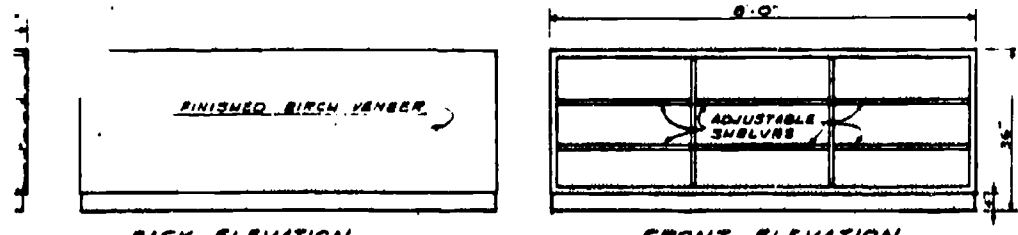
APPROVALS

ROOF FRAMING, STRUCTURAL
DETAILS AND MILLWORK DETAILS
ONE ROOM ELEMENTARY SCHOOL



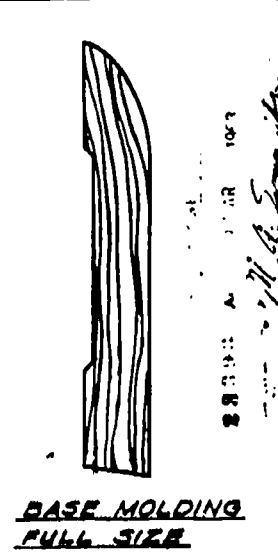
CLASSROOM SINK CABINET SCALE 1/2" = 1'-0"

DETAILS SHALL CONFORM TO M.I.C. STANDARD FOR CUSTOM GRADE



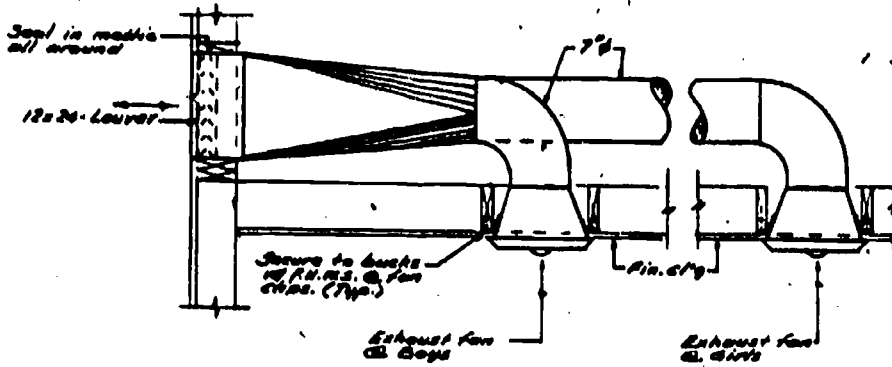
BOOKSHELVES SCALE 1/2" = 1'-0"

DETAILS SHALL CONFORM TO M.I.C. STANDARDS FOR CUSTOM GRADE

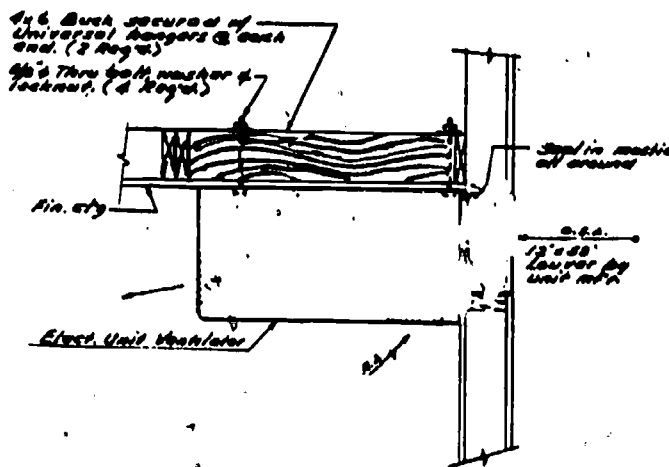


7

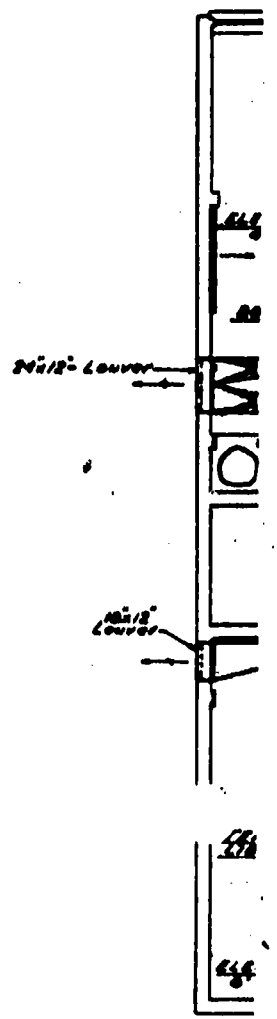
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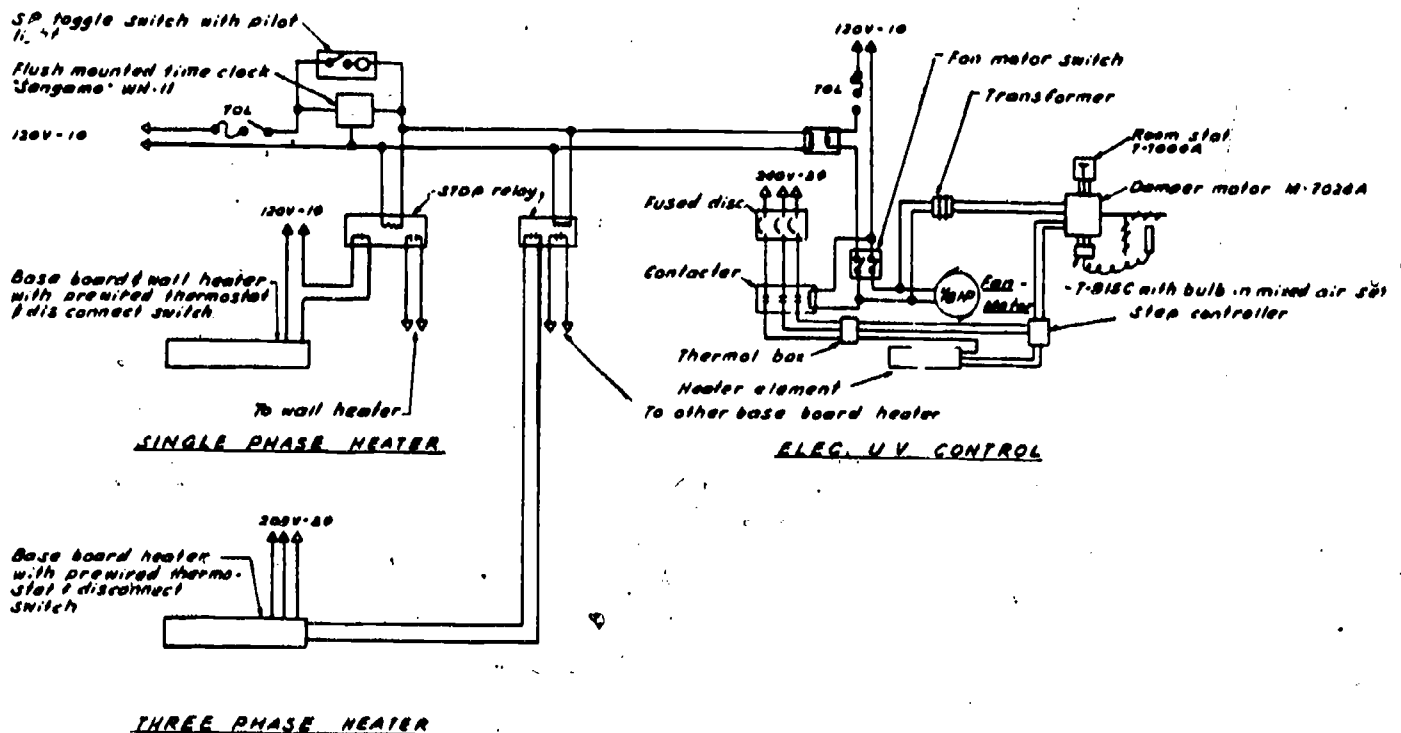
TOILET EXHAUST DETAIL SCALE 1 1/4"=1'-0" (A)



ELECTRIC UNIT VENTILATOR MOUNTING DETAIL SCALE 1 1/2"=1'-0" (B)

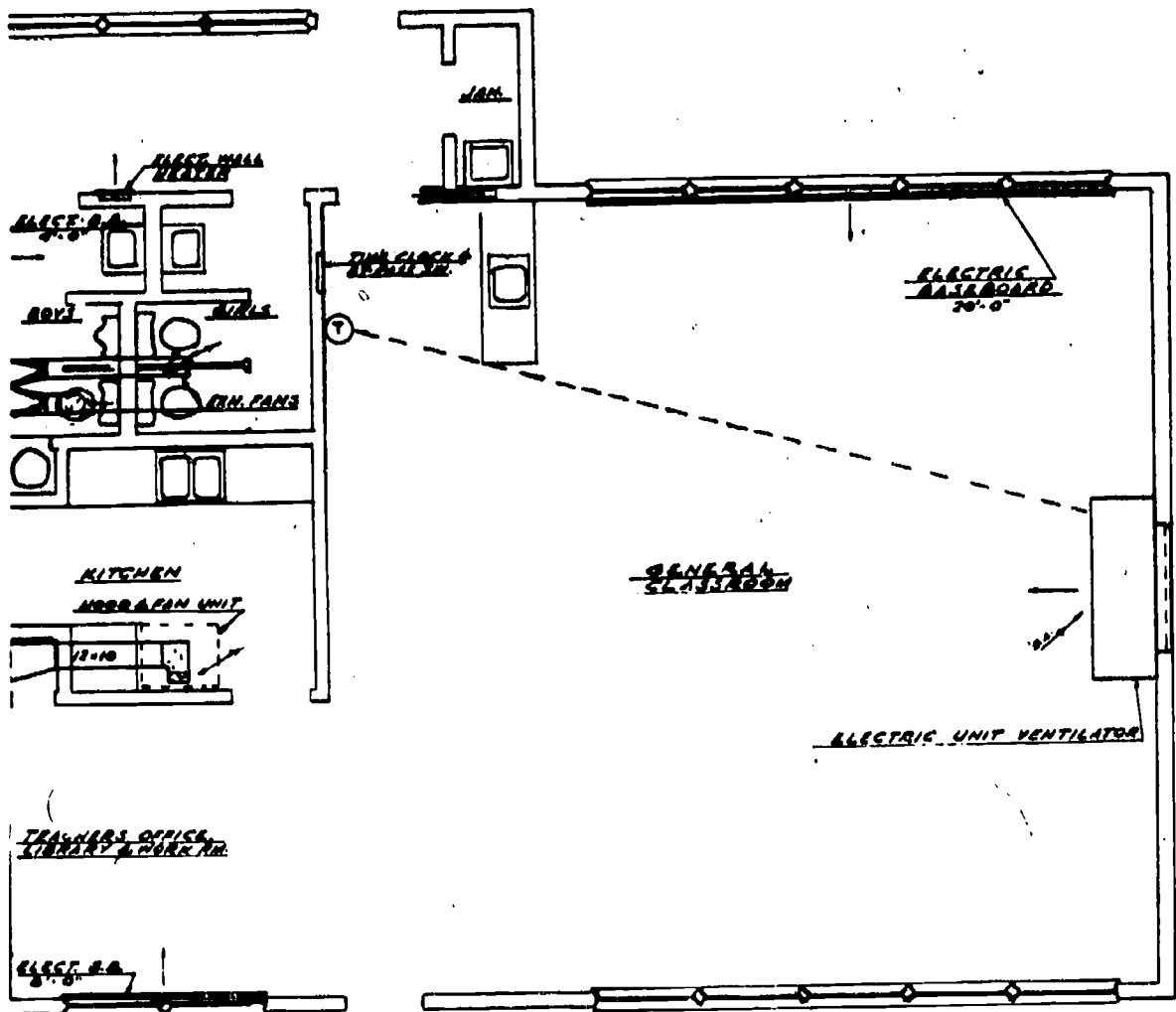


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CONTROL DIAGRAM (C)

NO SCALE



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721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C.L. BAUGHN, ARCHITECT
DATE: FEBRUARY, 1963

Clair L. Esch

APPROVALS

HEATING & VENTILATING
ONE ROOM ELEMENTARY SCHOOL

John A. O'Meara
LESTER A. O'MEARA, INC.
Mechanical Engineering
Sacramento, California
No. 2162
State of California
No. 10000

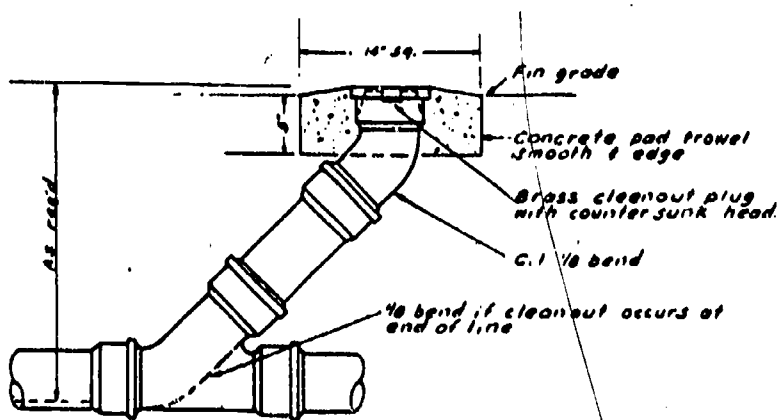
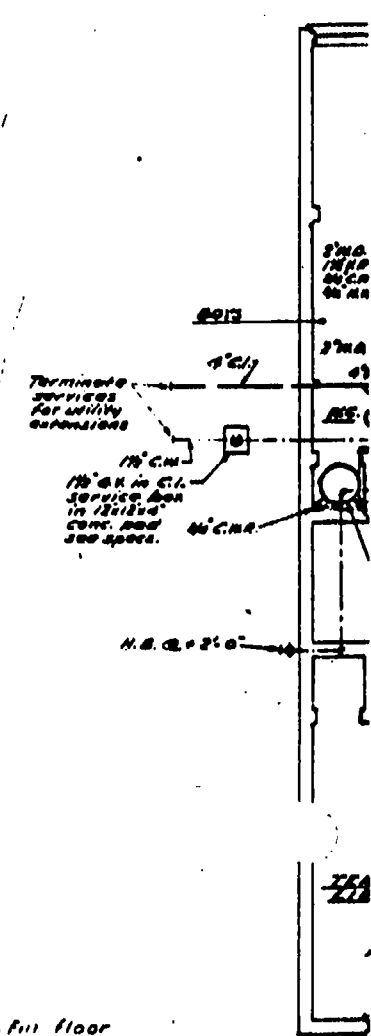
8

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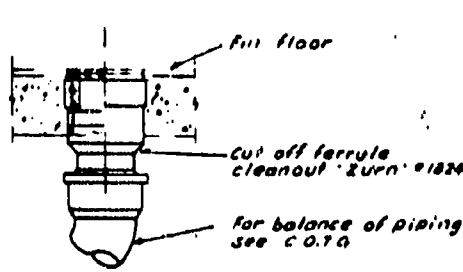
FIXTURE SCHEDULE								
FIXTURE	SYMBOL	WASTE			COLD WATER		HOT WATER	
		BRANCH	OUTLET	VENT	BRANCH	OUTLET	BRANCH	OUTLET
Water closet	W.C.	4"	4"	3"	1 1/2"	1"		
Lavatory	L.	2"	1 1/2"	1 1/2"	3/4"	3/4"	3/4"	1/2"
Urinal	U.R.	2"	2"	1 1/2"	1"	3/4"		
Service Sink	S.S.	2"	2"	2"	3/4"	3/4"	3/4"	3/4"
Floor drain	F.D.	2"	2"	2"				
Nose bibb	N.B.				3/4"	3/4"		
Sink	S.	2"	1 1/2"	1 1/2"	3/4"	3/4"	3/4"	1/2"

PLUMBING LEGEND	
	Soil, waste above grade
	Soil, waste below grade
	Sanitary vent
	Cold water
	Hot water
	Vent vent riser, vent thru roof.
	Hot water riser (drop)
	Cold water riser (drop)
	Cleanout thru floor
	Cleanout to grade
	Under floor
	Overhead
	Cast iron
	Waste drain

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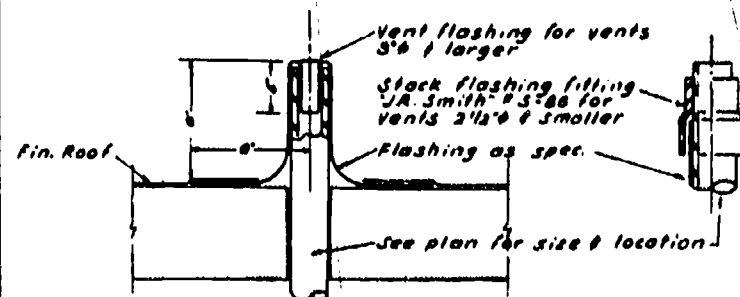


C.O.T.G.

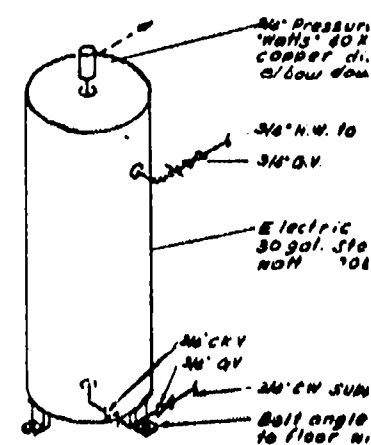


C.O.T.F.

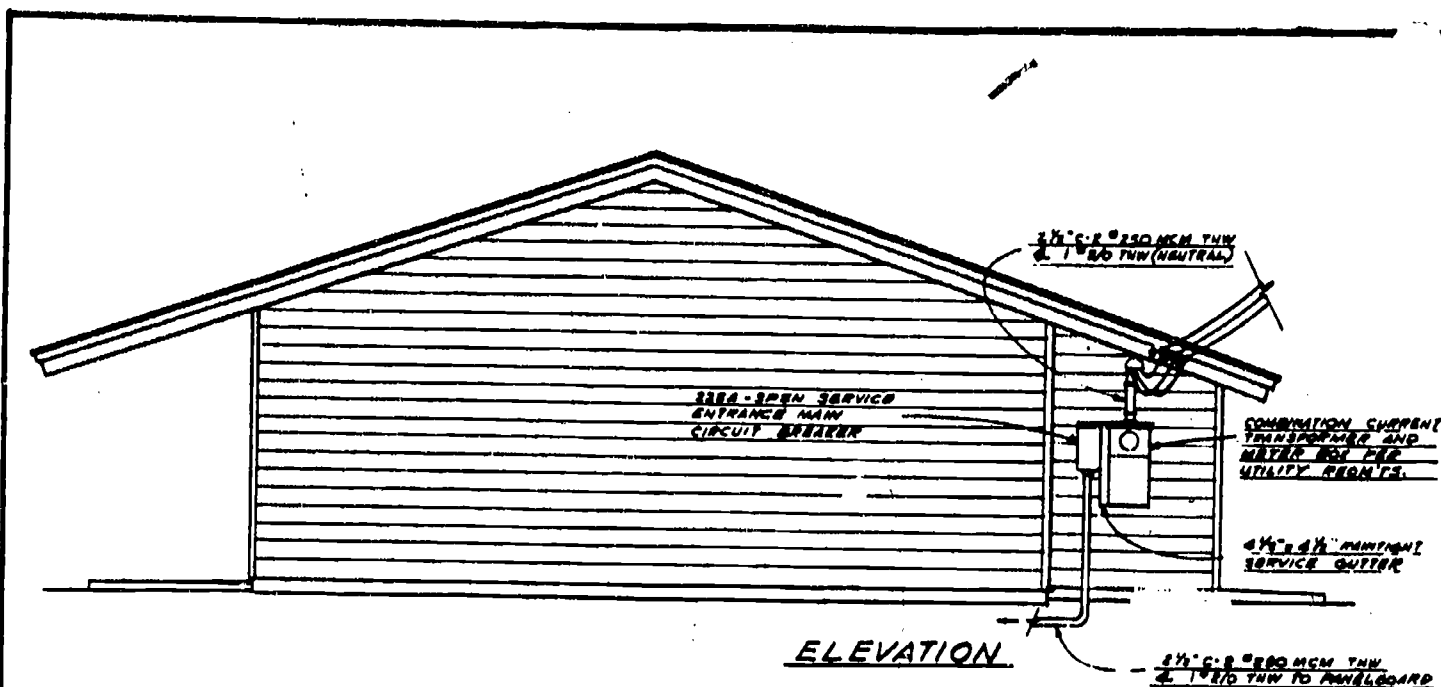
CLEANOUT DETAILS - (A)
SCALE 1/2" = 1'-0"



VENT PIPE FLASHING - (B)
SCALE 1/2" = 1'-0"



ELECTRIC WATERHEATER
SCALE 1/2" = 1'-0"



FIXTURE SCHEDULE

FIXTURE SYMBOL	MANUFACTURER	CATALOG NUMBER	LAMPS	MOUNTING	REMARKS
(A)	SUNBEAM	P132/48C-98RS	6-F96T12/NO/WW	SUSP TO 8'-0"	
(B)	SUNBEAM	P132/48N-98RS	2-F96T12/NO/WW	SUSP TO 8'-0"	
(C)	SUNBEAM	P2801/48RS	4-F40/T-12/WW	CEILING	
(D)	SUNBEAM	P2702/48RS	2-F40/T-12/WW	CEILING	
(E)	PRESCOLITE	1010-6616	1-100A	RECESSED	W/TAMPER PR SCREWS & PLASTER FRAME
(F)	HOLOPHANE	415	1-100A	WALL	
(G)	CROUSE HINDS	ARB-31	1-60A	CEILING	WITH OPAL GLOBE

SYMBOL SCHEDULE

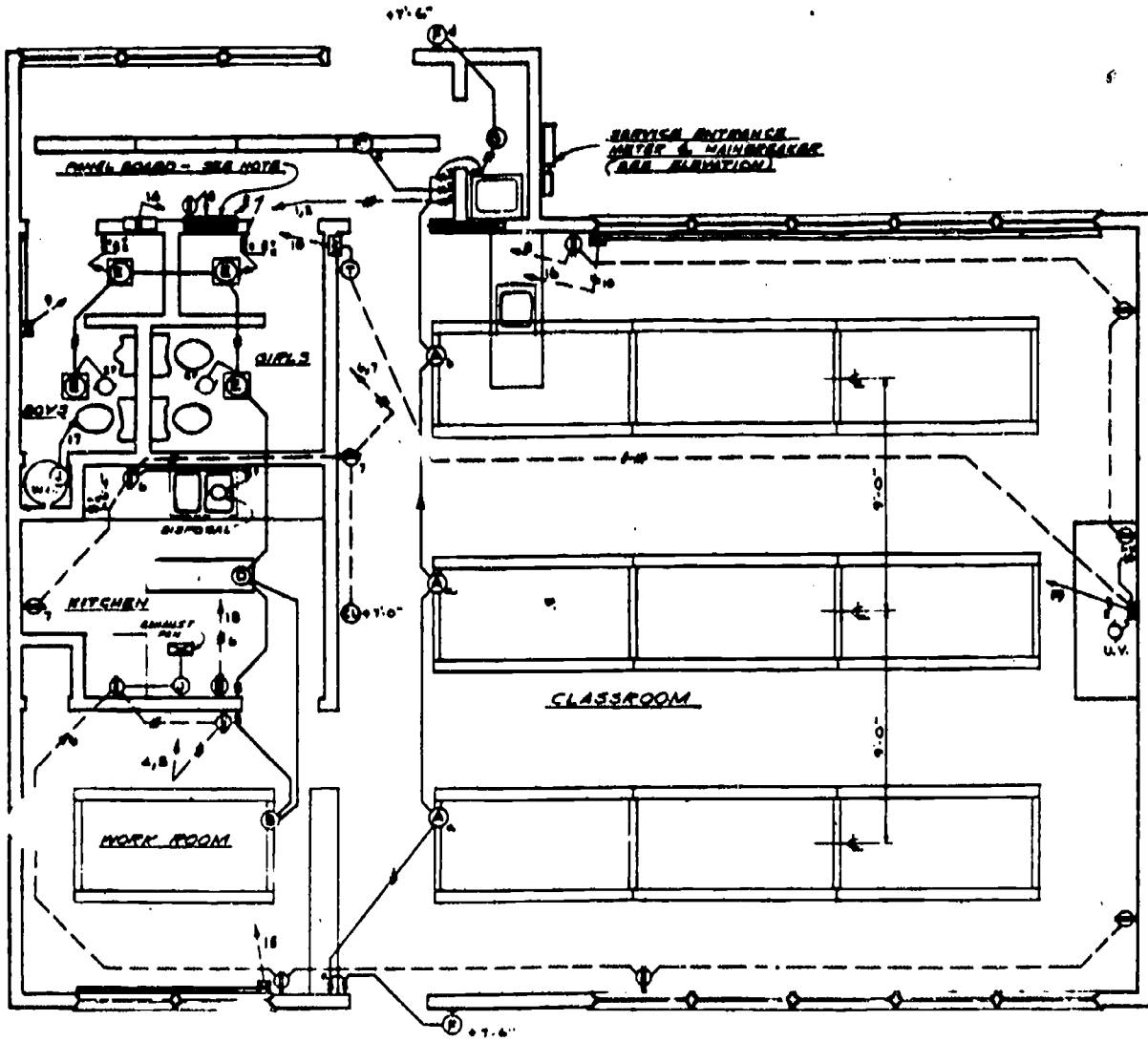
- FLUORESCENT LIGHTING FIXTURE
- INCANDESCENT FIXTURE - CEILING MOUNTED
- INCANDESCENT FIXTURE - RECESSED
- INCANDESCENT FIXTURE - WALL MOUNTED
- SINGLE POLE TOGGLE SWITCH 3" x 48" UNLESS NOTED OTHERWISE
- THERMAL OVER SWITCH, SIZE AS REQUIRED, 6'-0" UNLESS NOTED, KEY OPERATED.
- SWITCH SUBSCRIPTS: A-LTS SWITCHED, K-KEY OPERATED.
- SPEED SWITCH. SUPPLIED BY MECHANICAL CONTRACTOR, CONNECTED BY ELECT. CONTR.
- DUPLEX RECEPTACLE 3" x 18" UNLESS NOTED. (A&N #5252)
- CLOCK OUTLET (A&N #5708)
- JUNCTION BOX, SIZE AS REQUIRED.
- BASE BOARD HEATER, NOT IN ELECTRICAL CONTRACT, CONNECTED BY ELECT. CONTRACTOR
- WALL HEATER
- UNIT VENTILATOR TIME CLOCK & BY-PASS SUPPLIED BY MECH CONTR. CONNECTED BY ELECT. CONTR.
- MOTOR. N.I.E.C., CONNECTED BY ELECT. CONTR.
- CONTROL EQUIPMENT. N.I.E.C., CONNECTED BY ELECT. CONTR.
- PANEL BOARD
- CONDUIT RUN CONCEALED IN FLOOR
- CONDUIT RUN CONCEALED IN CEILING OR WALL
- RANGE OUTLET 50AMP 4 WIRE RECEPTACLE & PLATE (A&N #5155) AND CORD SET (A&N #5114B)
- THERMOSTAT N.I.E.C., CONNECTED BY ELECT. CONTR.
- HOMERUN TO PANEL BOARD. ANY CIRCUIT WITHOUT FURTHER DESIGNATION INDICATES A 2-1/2 WIRE CIRCUIT. 3 1/2 WIRE IS SHOWN AS ---; 4-1/2 WIRE AS ---; ETC. OTHER WIRE SIZES SHOWN AS FOLLOWS: --- 3-0; --- 4-0; --- 3-6; ETC.

PANEL BOARD

- WESTINGHOUSE TYPE NQC-NOP-3L 255 FLUSH WITH
- 14-20A-1P CBR CIRCUITS 1 THRU 13
- 4-20A-2P CBR CIRCUITS 14, 15, 17
- 1-30A-2P CBR CIRCUIT 16
- 1-50A-2P CBR "E" FRAME CIRCUIT 18
- 1-100A-2P CBR "E" FRAME CIRCUIT 19
- FULL WINGED LOCKABLE DOOR 20" WIDE MINIMUM

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Working Drawings



FLOOR PLAN

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THIS PLAN IS NOT TO BE USED UNTIL LEGAL REQUIREMENTS ARE MET AND AUTHORIZATION TO PROCEED WITH CONSTRUCTION HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE.

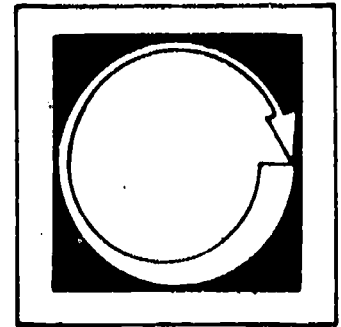
Charles E. Stoughton
 CALIF STATE DEPT OF EDUCATION
 BUREAU OF SCHOOL PLANNING
 721 CAPITOL AVENUE
 SACRAMENTO 14, CALIF.
 C.L. EATOUGH, ARCHITECT
 DATE: FEBRUARY, 1963

APPROVALS

ELECTRICAL
 ONE ROOM ELEMENTARY SCHOOL

10

Self Assessment



After you have read the Information material, answer the questions below, referring to the working drawings at the back of the module as directed. Write each answer in the space provided at the right of the question.

LOOK AT THE AREA MAP ON SHEET 1, AND ANSWER QUESTIONS 1-2.

1. In what county is the school to be located?

2. What scale is used for the area map?

LOOK AT THE SITE DEVELOPMENT PLAN ON SHEET 1, AND ANSWER QUESTIONS 3-4.

3. What are the dimensions of the asphalt play area?

4. The main entrance to the school faces in what direction?

LOOK AT THE FOUNDATION PLAN ON SHEET 2, AND ANSWER QUESTIONS 5-9.

5. Anchor bolts of what size are to be used to fasten the sill to the pad?

6. What is the scale of the foundation plan?

7. Bolts of what size are to be used to anchor the foot scrapers?

8. How thick is the floor slab?

9. What is the height from the slab to the top of the plate?

LOOK AT THE FLOOR PLAN AND ELEVATIONS ON SHEET 3, AND ANSWER QUESTIONS 10-12.

10. What material is to be used for the exterior siding?

11. How many exterior doors are there?

12. Approximately how many square feet of floor area does the teacher's office have? _____

LOOK AT THE DOOR AND WINDOW DETAILS ON SHEET 4, AND ANSWER QUESTIONS 13-14. REFER AGAIN TO PREVIOUS SHEETS AS NECESSARY.

13. What material is specified for the outside doors? _____

14. What type of door is specified for the kitchen? _____

LOOK AT THE INTERIOR ELEVATIONS ON SHEET 5, AND ANSWER QUESTION 15.

15. What material is to be used to finish the walls in the coatroom? _____

LOOK AT THE STRUCTURAL FRAMING AND ROOF FRAMING SECTIONS (SHEETS 6 AND 7), AND ANSWER QUESTIONS 16-17.

16. Nails of what size are to be used on the roof sheathing? _____

17. How deep is the classroom sink cabinet from front to back? _____

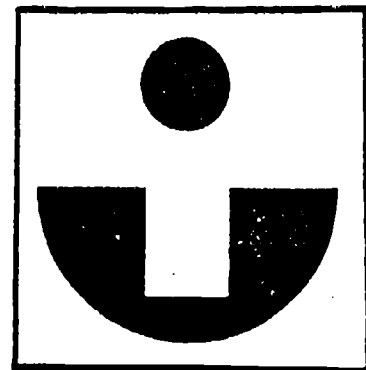
LOOK AT THE HEATING AND VENTILATING, PLUMBING, AND ELECTRICAL PLANS (SHEETS 8, 9 AND 10), AND ANSWER QUESTIONS 18-20.

18. In what room is a thermostat to be located? _____

19. What means of ventilation is provided in the lavatories? _____

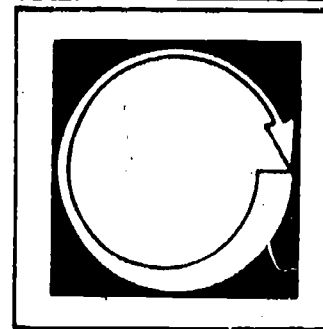
20. In how many places are hot water taps to be located? _____

Self Assessment Answers



1. trinity
2. 1" = 30'
3. 75' x 65'
4. south
5. 3/4"
6. 1/4" = 1'
7. 1/2" x 8"
8. 4"
9. 6"
10. 1" x 8" redwood
11. two
12. 175 sq. ft.
13. weldwood
14. solid core birch surface
15. horizontal redwood siding
16. 8d
17. 24"
18. general classroom
19. 12" x 24" louvred opening
20. three

Post Assessment



Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

1. _____ Which one of the following kinds of information could a worker expect to find in a set of working drawings for a building?
 - a. grades of lumber to be used
 - b. quality of paint required
 - c. separate sheets of details for the different crafts
 - d. the time limit for completion of the project

2. _____ Which one of the following kinds of information would normally appear in the specifications for a building?
 - a. locations of utilities at the site
 - b. quality of plumbing fixtures required
 - c. dimensions of footings
 - d. grade contours

3. _____ On which one of the following kinds of working drawings could a carpenter expect to find information about roof structure?
 - a. plot plan
 - b. exterior elevations
 - c. foundation plan
 - d. floor plan

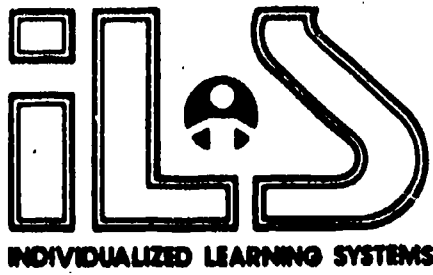
4. _____ The arrangement of rooms is shown on a:
 - a. site development plan
 - b. floor plan
 - c. detail drawing
 - d. shop drawing

5. _____ The symbol (T) on an electrical plan indicates a:
 - a. timer
 - b. thermostat
 - c. duplex receptable
 - d. junction box

6. _____ A chart appearing on a working drawing giving the names, sizes, and manufacturers of special equipment is called a:
 - a. schedule
 - b. specification
 - c. detail
 - d. cross section

7. _____ Before placing electrical outlets in a new building, the electrician will consult the:
 - a. architect
 - b. general contractor
 - c. building superintendent
 - d. electrical plan

8. _____ A characteristic of a plan view (floor plan or foundation plan) is that it:
- a. shows more detail than any other type of working drawing
 - b. shows the interior construction of partitions
 - c. reveals the structure as it would be viewed from above
 - d. includes all necessary specifications for the project
9. _____ An exterior elevation is a view of one side or face of a building from a viewpoint:
- a. slightly above and to the right of the side shown
 - b. slightly below and to the left of the side shown
 - c. directly in front of the side shown
 - d. that reveals the maximum number of building details
10. _____ Contour lines are normally found on the:
- a. plot plan
 - b. foundation plan
 - c. floor plan
 - d. elevations



5.4

WORKING DRAWINGS FOR MACHINING AND WELDING

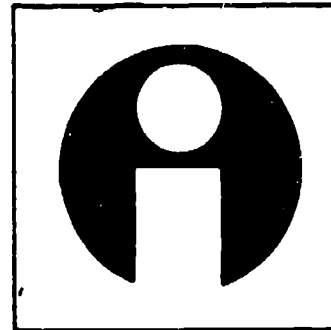
Goal:

Upon completion of this module, the student will be acquainted with the lines, fundamental dimensions and materials symbols necessary to understand simple blueprints used in the trades.

Performance Indicators:

The student will demonstrate an understanding of the subject by:

- 1) completing a short Self Assessment exam, which tests comprehension of the subject
- 2) completing a Post Assessment exam which requires the student to look at a simple working drawing and a figure and answer 12 problems.

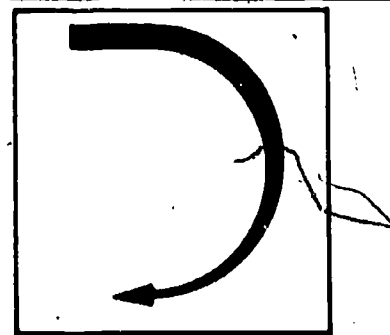


Study Guide

In order to successfully complete this module, do the following tasks in the order in which they are presented. Check them off as you complete them.

1. Familiarize yourself with the Goal and Performance Indicators presented on the cover of this module. This will inform you of what you are expected to gain from the study of this module, as well as how you will be expected to demonstrate your competence.
2. Study the Introduction and Information sections. These will provide you with the knowledge necessary to complete the Self and Post Assessment exams.
3. Complete the Self Assessment exam, referring to the Information section or asking your instructor when necessary. Compare your answers with those found on the Self Assessment Answer Sheet immediately following the exam. This will demonstrate how well you can expect to do on the Post Assessment exam.
4. Take the Post Assessment exam and turn your answers in to your instructor for grading. It is recommended that you score 90 percent or better before going on to another module.

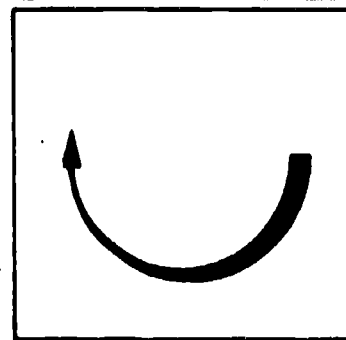
Introduction



From the past modules in the subject, you have seen the importance of prints in general, and what they may contain, of views of an object and how they may be rendered on paper, and of the types of drawings and how they are dimensioned.

This module takes a closer look at the fine points of working drawings for the machining and welding trades.

Information



A working drawing must give the worker exact information as to the size and shape of an object, as well as any other information necessary to finish the product. All of these concepts are done in lines, dimensions, and notes or symbols. Module 3 of this section, "Types of Drawings and Views," introduced some of the types of lines used in print making.

The following examples refer to the machine and welding trades:

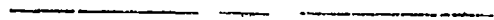
Object line, used to show visible edges or contour of an object.



Hidden line, used to show the hidden features of an object.



Center line, used to show axes of symmetrical parts, and aid in dimensioning.



Extension line, used to indicate the termination of a dimension.



Dimension line, used to indicate the extent and direction of dimensions.



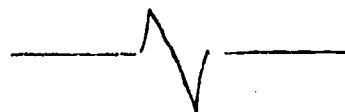
Cutting plane or viewing plane line, used to indicate the location where an imaginary cut is made through an object and the viewing position of the piece removed. The arrowhead points in the direction in which the section should be viewed.



Short break line, used to indicate a short break on a partial section of an object in order to conserve space on a drawing.



Long break line, used to show long breaks.



Phantom line, used to show adjacent parts, alternate positions, and lines of motion.



Section lines, used to show cut surfaces of an object.



Leader, used to point to a surface for the purpose of dimensioning or adding a note.

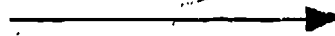


Fig. G-1 on the following page demonstrates the types of lines used in a typical working drawing.

As you'll recall, dimensions were another of the necessary components of a working drawing. Dimensions indicate the size of an object or any part of an object, and are written three ways: 1) as a fraction - $4 \frac{1}{2}$ ", $1 \frac{7}{16}$ ", etc., 2) as a decimal - .5", .9917", etc. 3) as an angle - 45° , 36° , etc. The angular measurement may be broken down further into minutes (') and seconds (") for more exact measure. A minute is $1/60$ of a degree and a second is $1/60$ of a minute. Therefore, an angle greater than 45 degrees but less than 46 degrees could be expressed $45^\circ 30' 30''$. This would represent a measurement of about $1/100$ of a degree larger than $45 \frac{1}{2}$ degrees. Fig. G-1 on the following page demonstrates dimensions used in a typical working drawing.

Dimensions usually allow for a very slight acceptable error. It is demonstrated by a plus (+) sign on top of a minus (-) sign, like this $\pm .001$ ", which means the print allows for an error of dimension up to $1/1000$ of an inch too large or too small, but no greater or less.

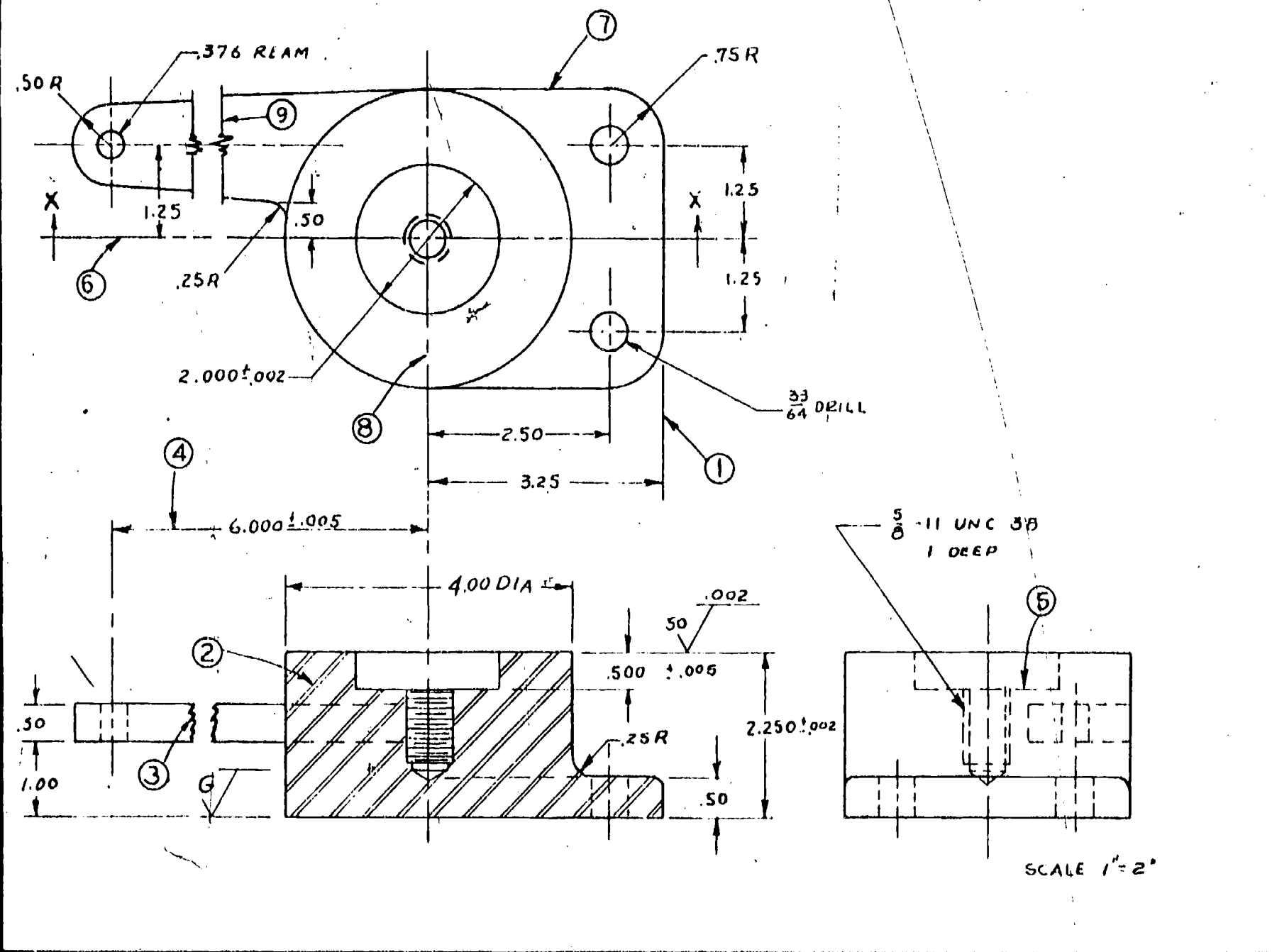


Fig. G-1

The third part of a working drawing is comprised of symbols and notes. Fig. G-2 shows some of the more commonly used symbols. It is not the intent of this module to list all of the metal trades symbols but they are used to denote the roughness or smoothness of the ground piece, the thread measurements if the piece is to be connected by bolts, or screws, and the type of material to be used.

The more commonly used materials in machine and welding trades include the following:

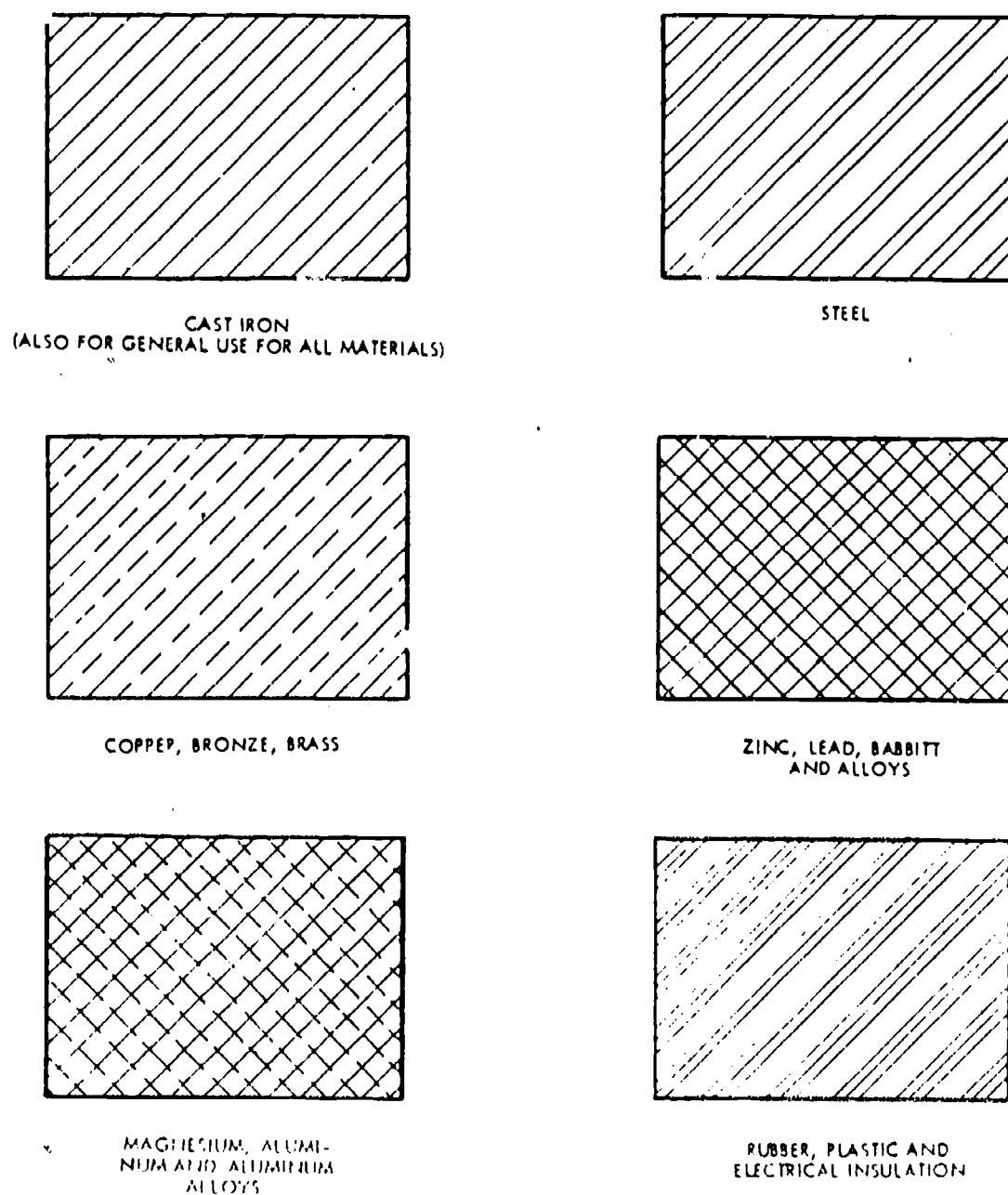
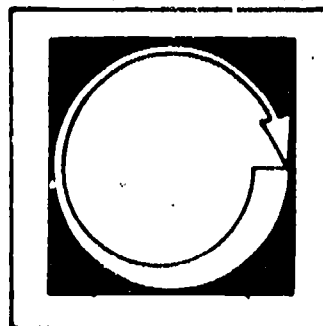



Fig. G-2

Self Assessment



Complete the following statements by filling in the correct word or words.

1. Working drawings must show the shape and _____ of an object by using object and _____ lines.
2. A tolerance of $1/100$ of an inch too large or too small would be shown on a working drawing as _____.
3. The dimension which uses minutes and seconds is _____.
4. The material symbol  would represent the use of which metal?

5. The lines on working drawings which have arrowheads are _____ lines.

SELF ASSESSMENT ANSWER SHEET

1. size, dimension

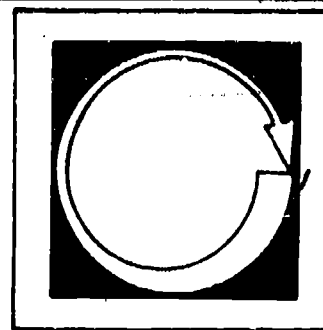
2. $\pm .001$

3. angular

4. cast iron

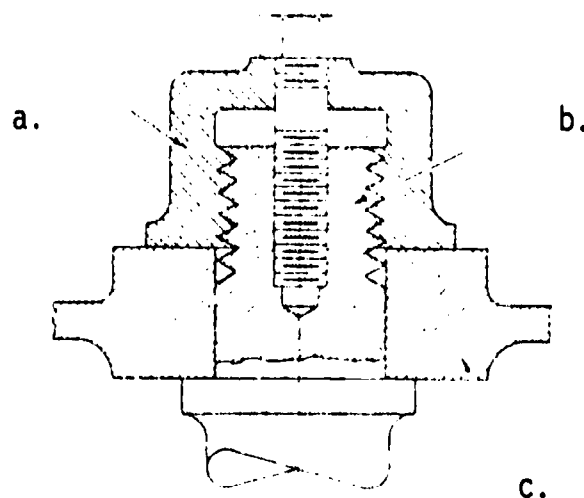
5. dimension

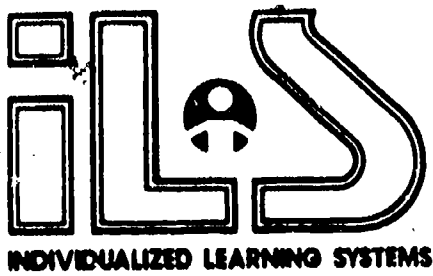
Post Assessment



Referring to Fig. G-1 in the Information section of this module in which the different types of lines are labeled by circles numbers, describe what is represented by the following numbers:

1. extension line
2. steel
3. short break line
4. dimension line
5. hidden line
6. center line
7. object line
8. center line
9. long break line
10. Using the following small diagram, decide what material is being called for:
 - a.
 - b.
 - c.





5.5

MACHINE AND WELDING SYMBOLS

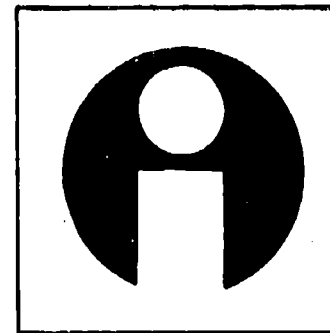
Goal:

Upon completing this module the student will be familiar with the common working drawing symbols used to denote metal finish work and welds, and how they are presented on a working drawing.

Performance Indicators:

The student will demonstrate knowledge in the subject by successfully completing a Self Assessment and a Post Assessment exam.

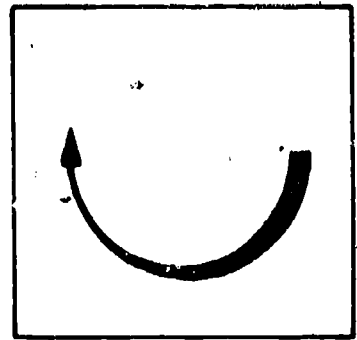
Study Guide



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2. Study the Information section. This will provide you with the knowledge necessary to complete the Self and Post Assessment exams.
3. Complete the Self Assessment exam, referring to the Information section or asking your instructor when necessary. Compare your answers with those found on the Self Assessment Answer Sheet immediately following the exam. This will demonstrate how well you can expect to do on the Post Assessment exam.
4. Take the Post Assessment exam and turn your answers in to your instructor for grading. It is recommended that you score 90 percent or better before going on to another module.

Information



The fifth module of this section, "Working Drawings for Machining and Welding," explained that three elements are found in working drawings: lines, dimensions and symbols or notes. That module discussed lines and dimensions as they apply to the machine and metal trades; this module will discuss the symbols and notes.

MACHINE SYMBOLS

Machined materials most often must be ground to a desired degree of smoothness or roughness in order to meet the specifications called for by the draftsman.

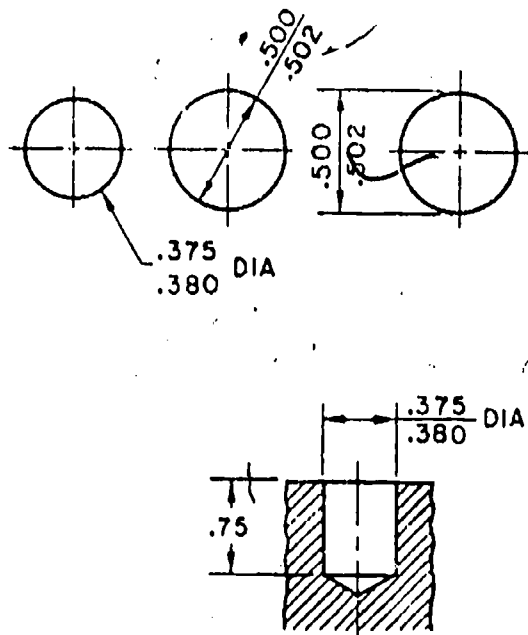
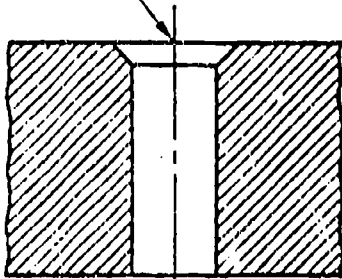
Surface finish symbols are as follows:

- ✓ or V = smooth finish, with the following letters placed in the V
- ^R✓ = rough machining
- ^S✓ = smooth machining
- ^G✓ = ground surface

When the surface is to be more exactly controlled than simply a rough or smooth designation, the check mark (✓) with a number placed in it is used. The number refers to the microinches (or millionths of an inch) of roughness height. An example: ⁵⁵✓, means that the machined surface can have flaws of only 55/1,000,000 in height or depth.

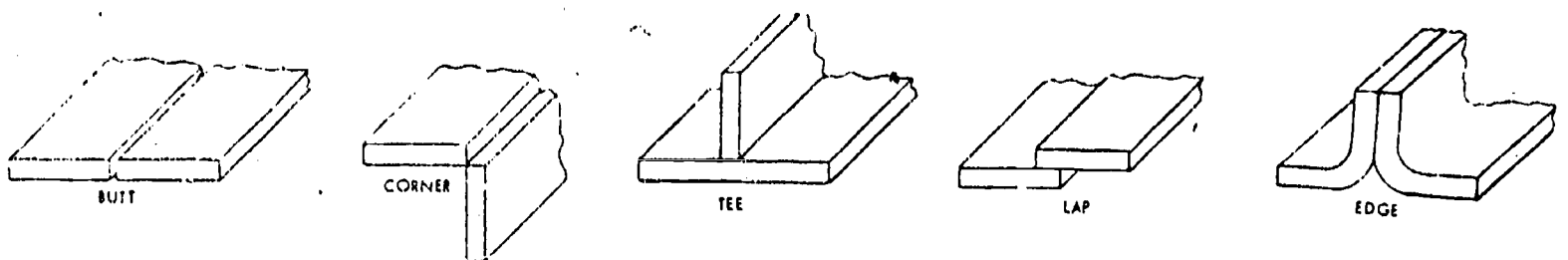
In addition to surfaces, holes for keys, bolts and screws must also be specified in many machined parts. Several typical hole drawings and dimensions are shown below in figure H-1.

$\frac{1}{4}$ DIA
82° CSK .395 DIA
4 HOLES



WELDING SYMBOLS

There are two important factors which welding symbols provide. First, the symbols point out the type of weld to be made; secondly, they point out on what side or sides of a joint that particular type of weld is to be made. Figure H-2 illustrates the common types of weld joints.



Certain types of welds may be used on each of these basic joints. The common types of welds include seam, groove, flange, fillet, spot and others. Each of these types has its own specific symbol. The spot weld symbol is a circle: \bigcirc ; the seam weld symbol is a circle with horizontal lines through it: \bigcirc ; the fillet weld symbol is a right triangle: \triangle ; and so on. It is not the intention here to present all of them; seek complete information from this module's Supplementary Reference section.

The second main factor in welding symbols, you will recall, is the symbol used to point out the location of the weld, or on which side of the joint the weld is to

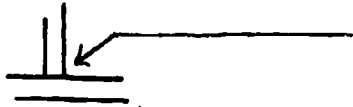
be made.

The main part of a welding symbol is the reference line with an arrow at one end.

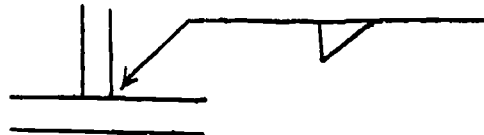
Example:



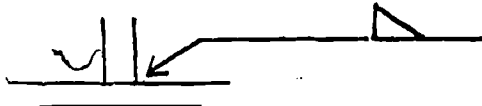
The location of the weld is pointed out by the arrow like this:



If the weld is to be made on only the side the arrow is pointing to, the appropriate weld symbol (in this instance, we'll assume it to be a fillet weld) will be placed below the reference line, like this:



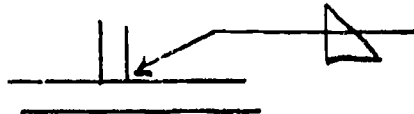
If the weld is to be made on the side opposite of where the arrow is pointing, the appropriate symbol will be placed above the reference line, like this:



If the weld is to be made on both sides, then the appropriate symbol will be placed both above and below the reference line, like this:

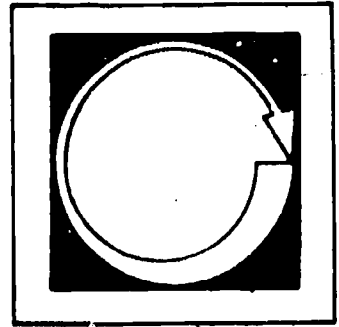


If it doesn't really matter on which side of the joint the weld is to be made, the symbol would be placed in the middle of the reference line, like this:



Obviously, there are many more symbols and numbers used on and along the reference line to point out spacing of welds, size of welds or weld combinations, etc. Consult the Supplementary Reference section for more complete information.

Self Assessment



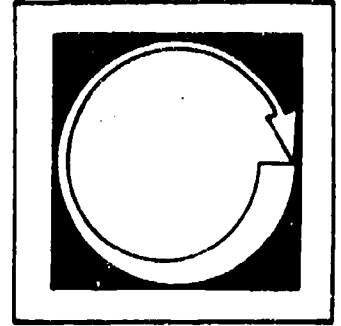
Decide if the following statements are true (T) or False (F) and place the appropriate letter in the space to the left of the statement.

1. Machined materials never have finished surfaces.
2. The term microinch refers to millionths of an inch.
3. The symbol \sqrt{S} indicates a rough finish is desired.
4. Bolt hole dimensions are seldom given, relying usually on the letters B, F, or D.
5. There are about 1,500,000 common weld joints.
6. A lap joint refers to the fact that one piece overlaps another.
7. The symbol for a spot weld is a circle.
8. Welding symbols are different from all other symbols in that welding symbols have arrows on both ends of the reference line.
9. The positioning of the welding symbol with respect to the reference line indicates where the weld is to be located.
10. A butt joint means that one piece will be welded at a 90 degree angle to another piece.

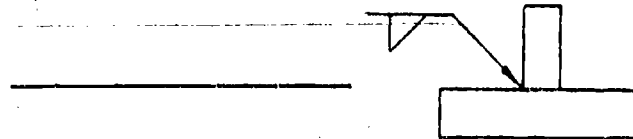
SELF ASSESSMENT ANSWER SHEET

1. F
2. T
3. F
4. F
5. F
6. T
7. T
8. F
9. T
10. F


Post Assessment



1. What does this weld symbol indicate? _____



2. Sketch the correct symbol for a seam weld.

3. The symbol  means that the surface must be machine smooth to a tolerance of 55 _____.

4. The main part of a welding symbol consists of a _____ and an arrow.

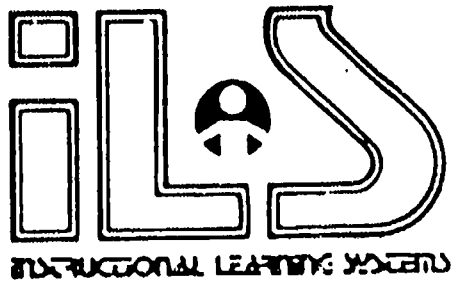
5. The letters R, S and G mean as follows:

R =

S =

G =





5.6

BLUEPRINT READING

Drafting: Basic Print Reading

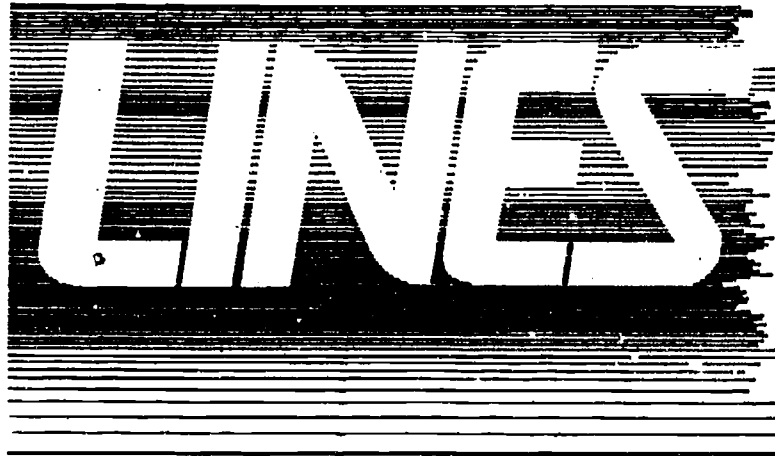
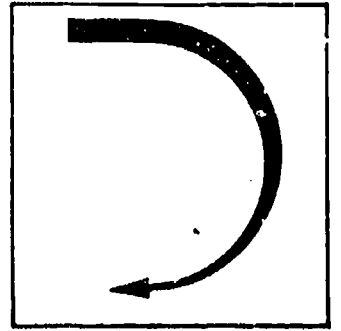
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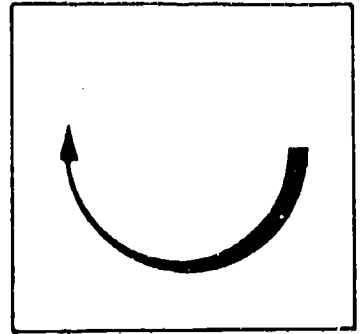
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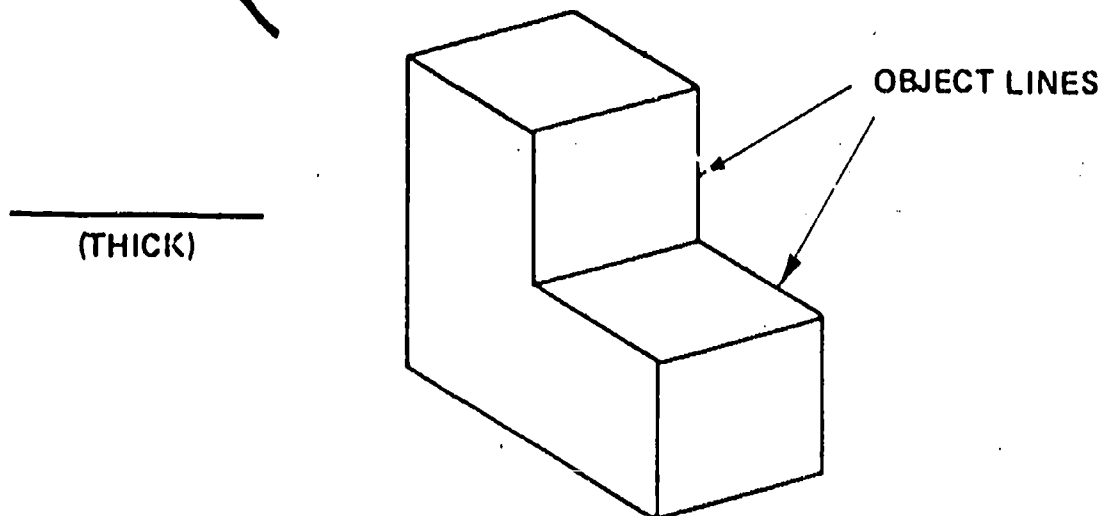
Information



The 11 lines used on prints are:

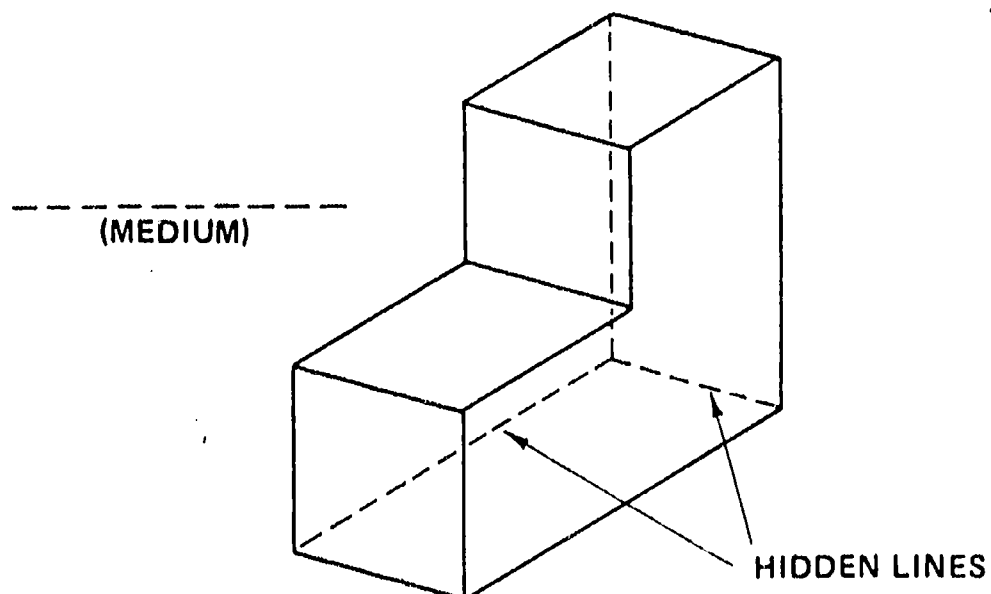
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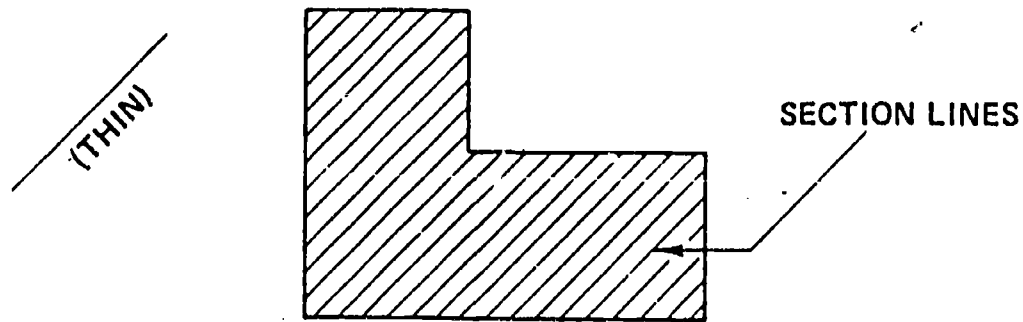
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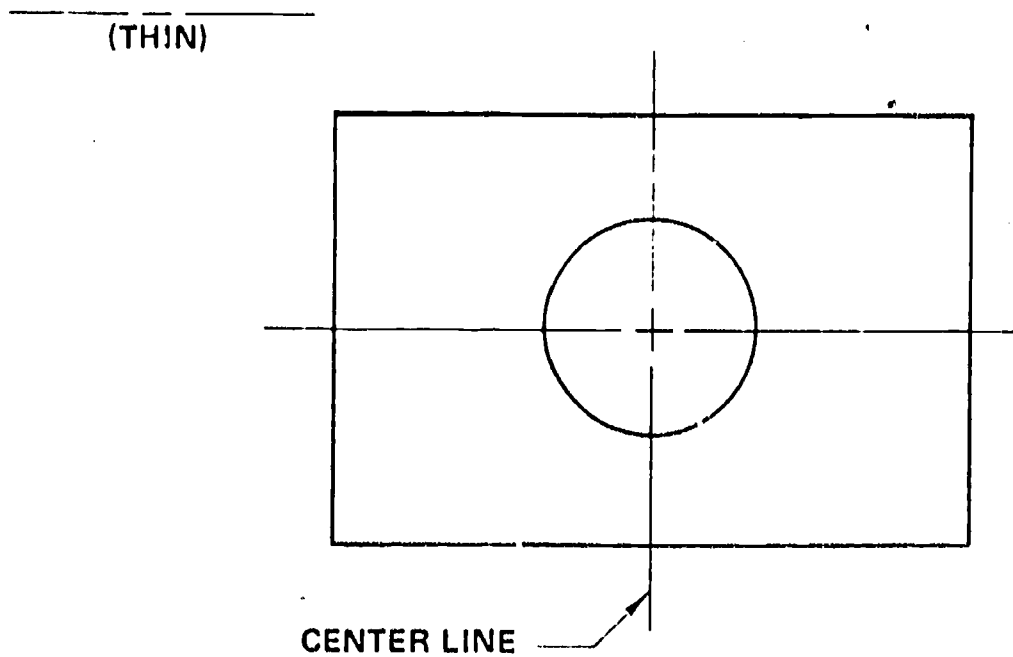
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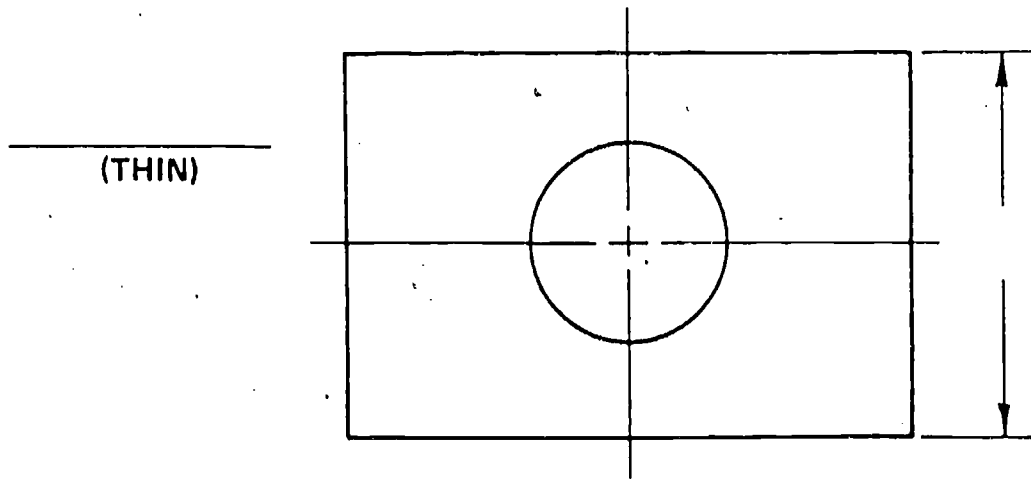
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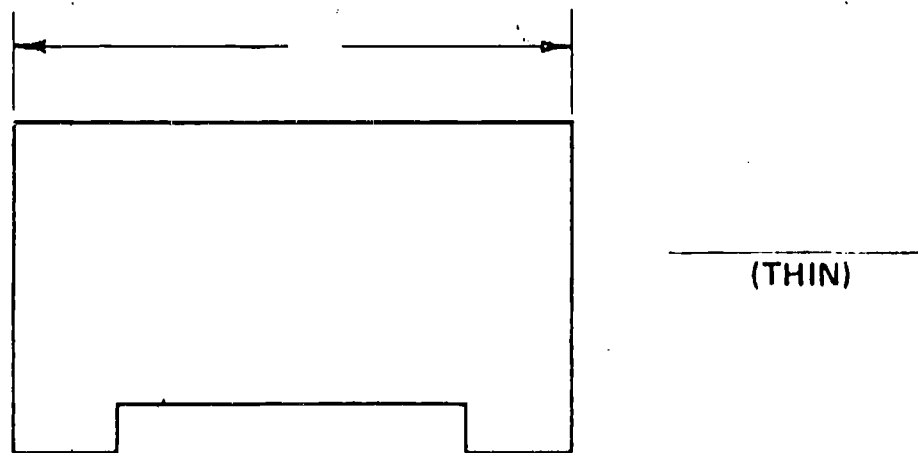
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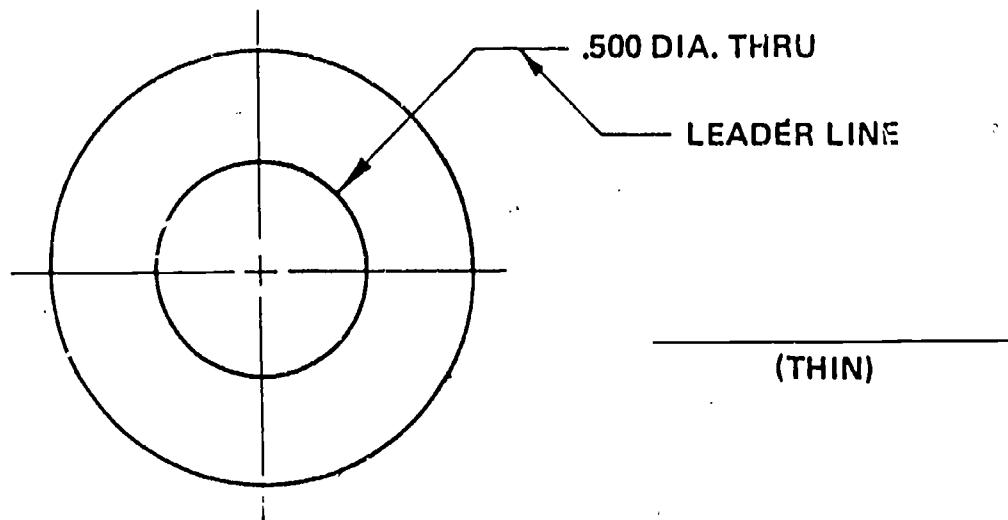
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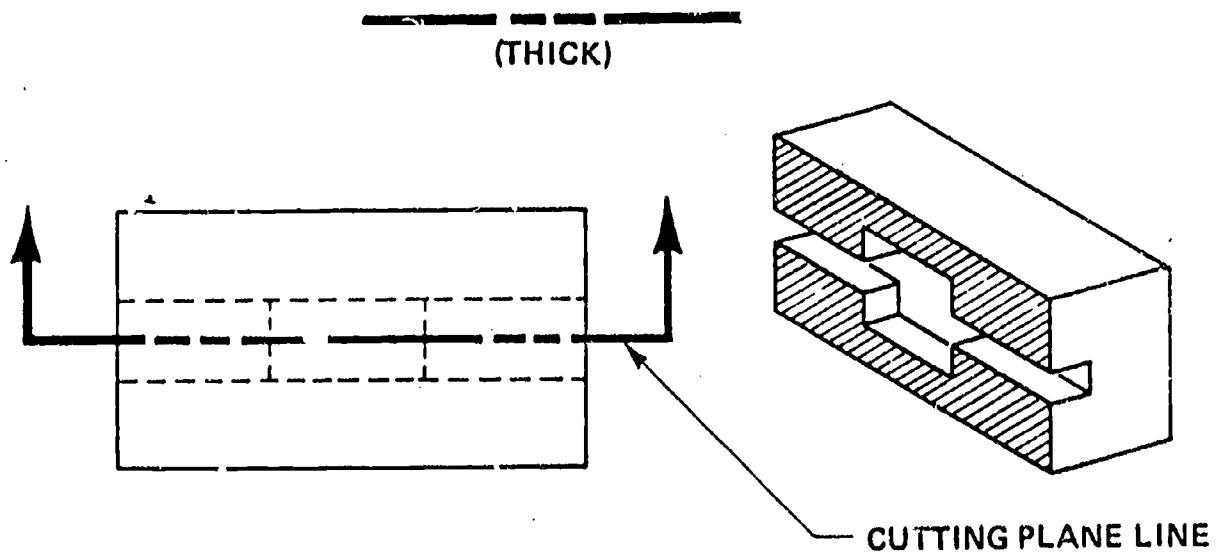
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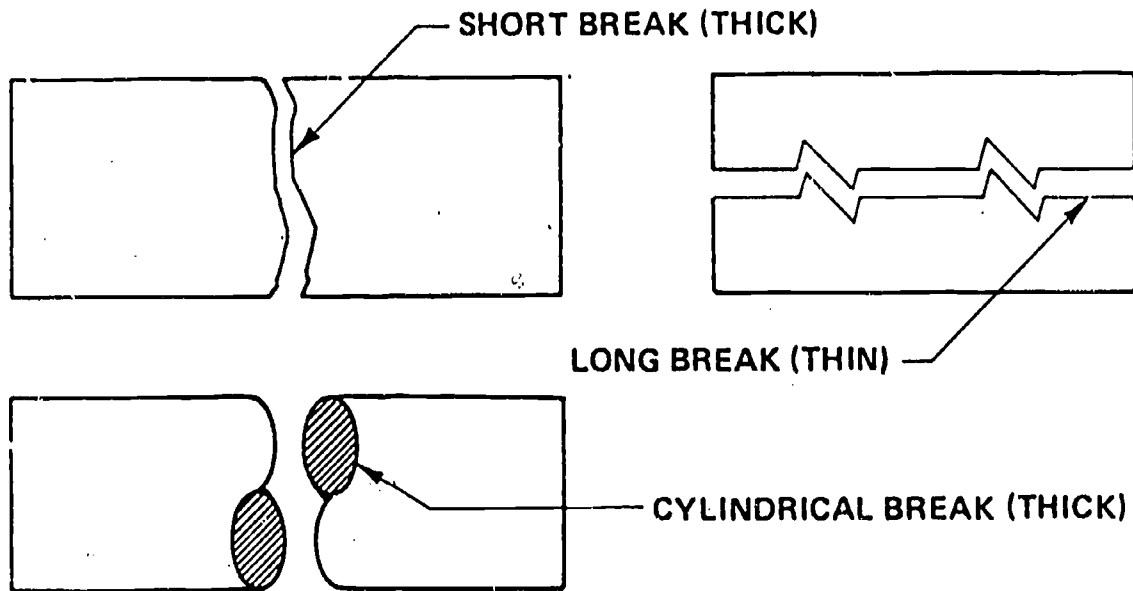
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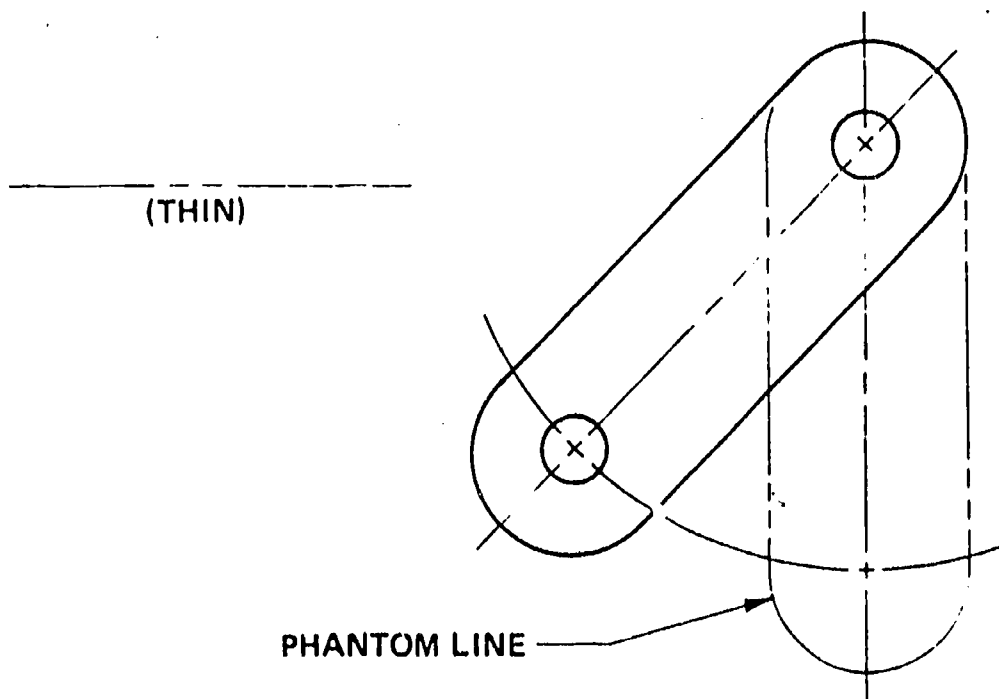
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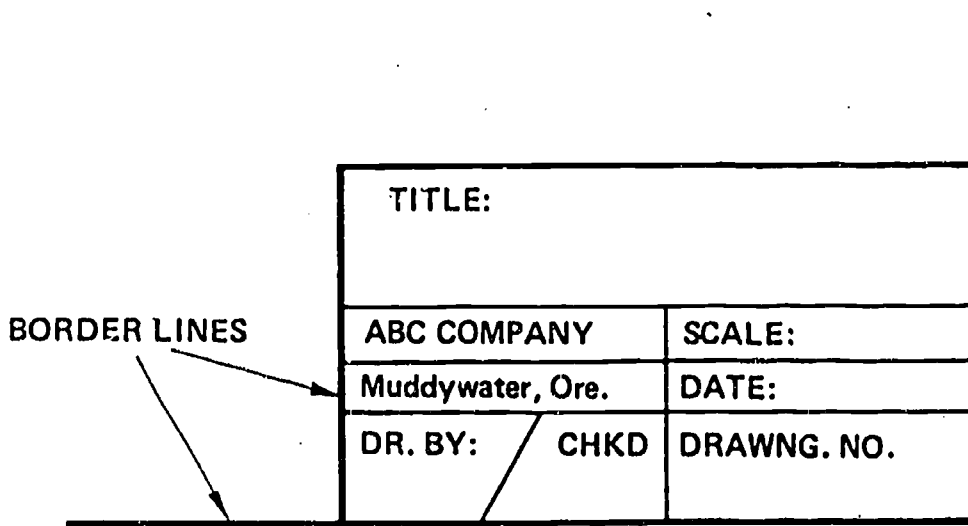
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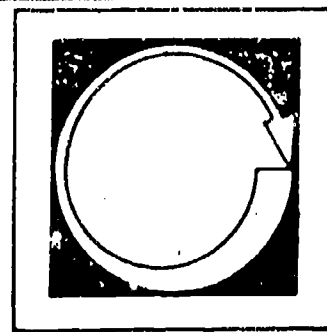
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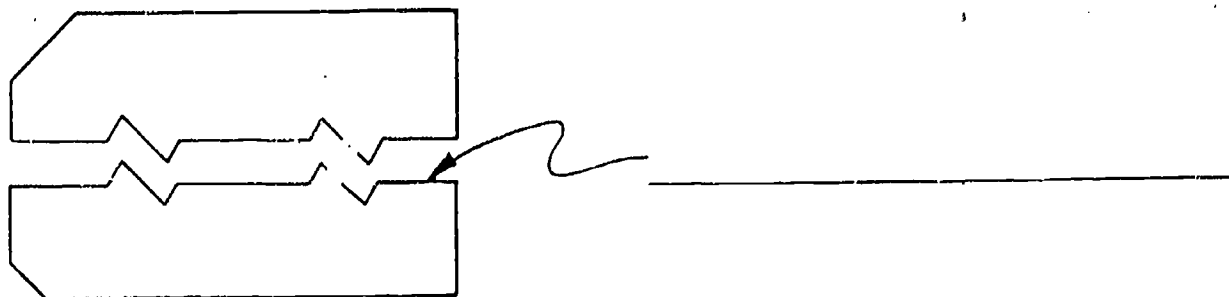
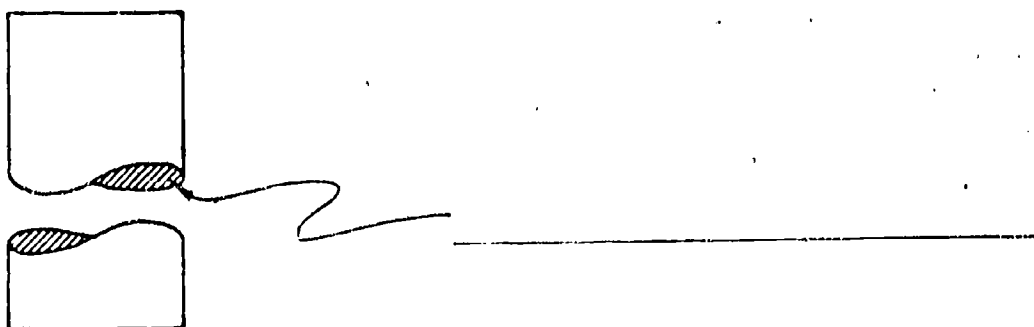
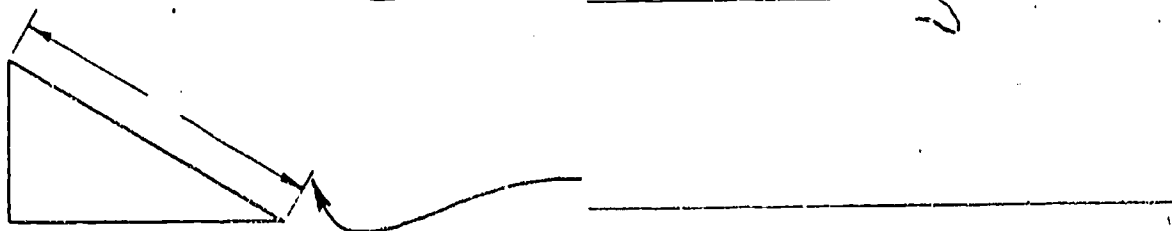
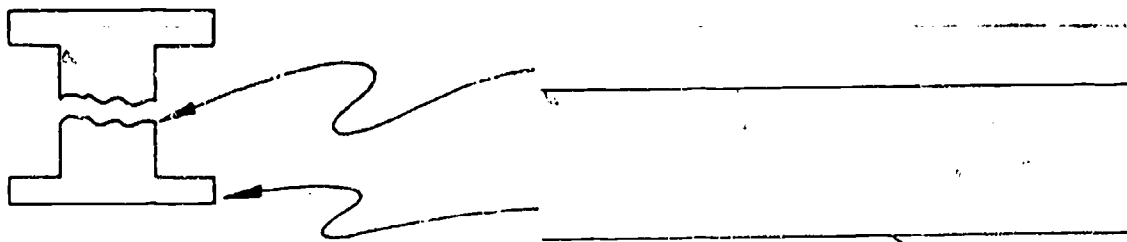
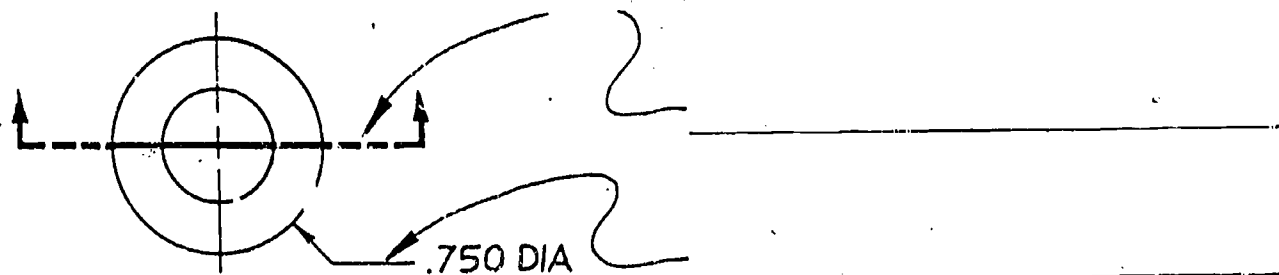


(MEDIUM THICK)

Self Assessment



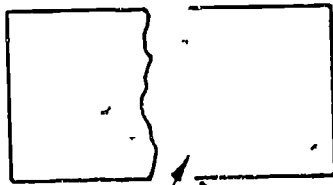
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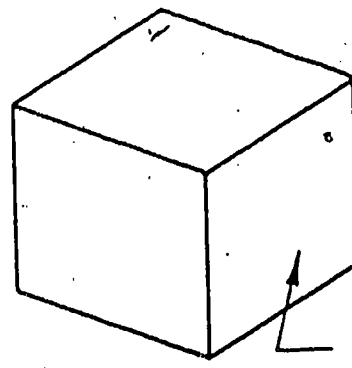
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LINE LANGUAGE REVIEW

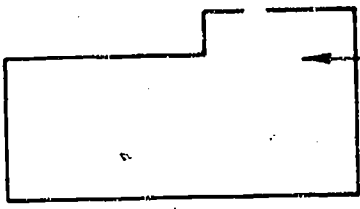
Directions: Draw the kinds of lines needed to complete the figures below.



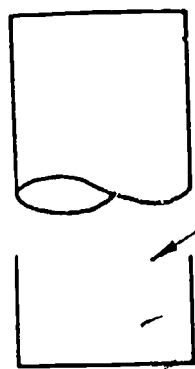
SHORT BREAK LINE



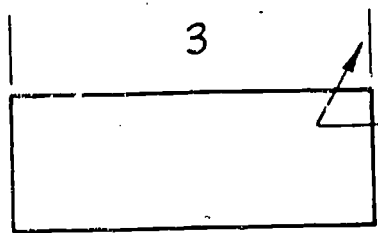
HIDDEN LINES



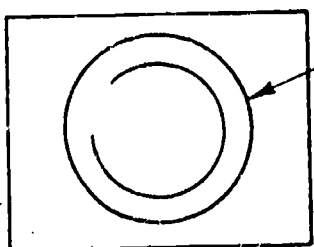
45° SECTION LINES



CYLINDRICAL
BREAK LINE



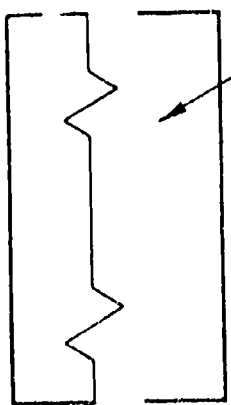
DIMENSION LINE
AND ARROWS



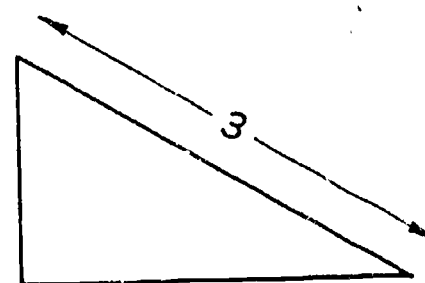
CENTER LINES



CUTTING PLANE
LINE



LONG BREAK LINE



EXTENSION
LINES



5.7

BLUEPRINT READING

Drafting: Basic Print Reading

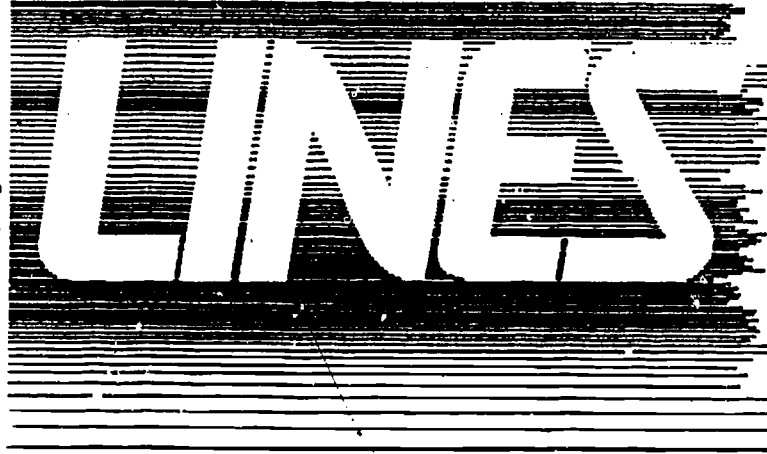
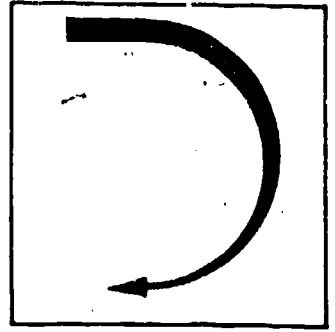
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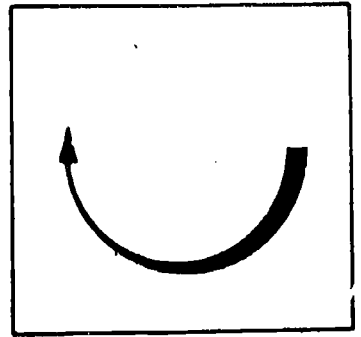
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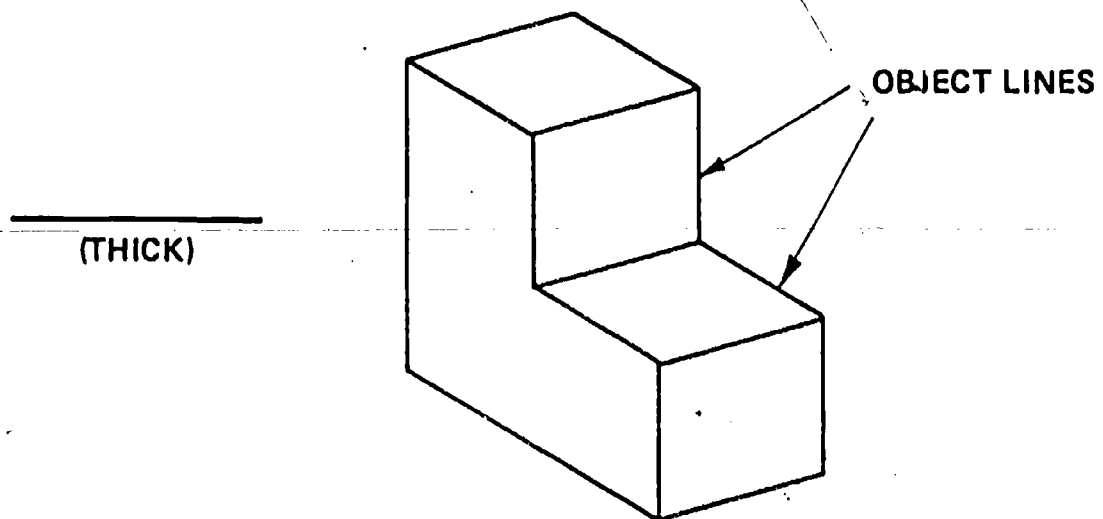
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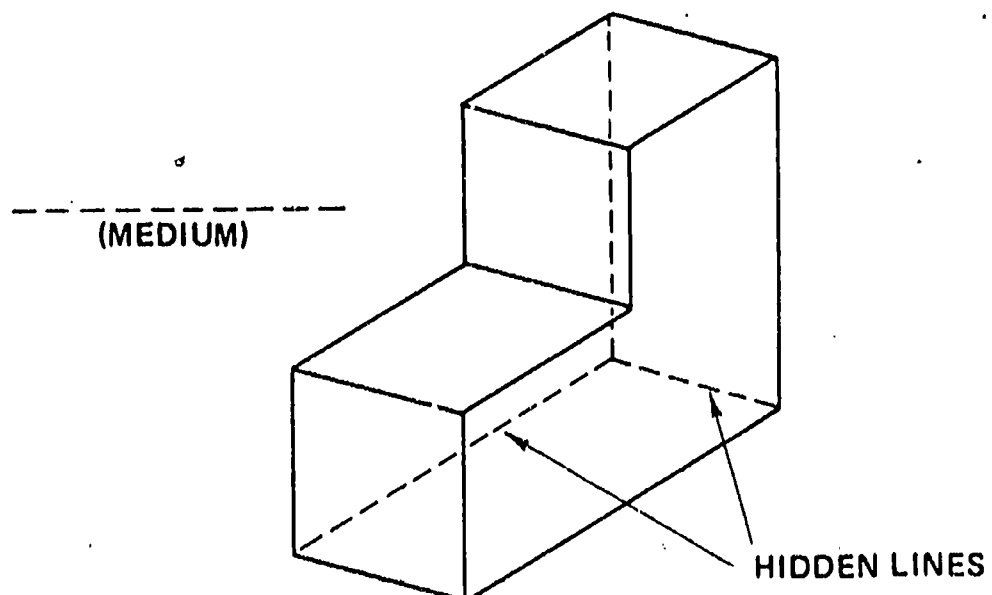
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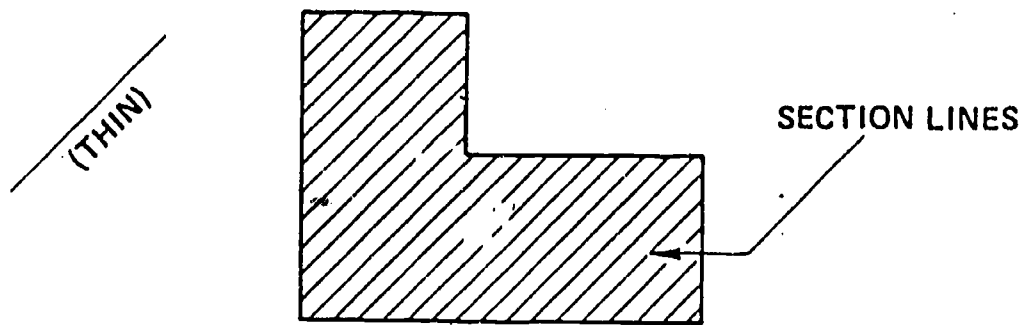
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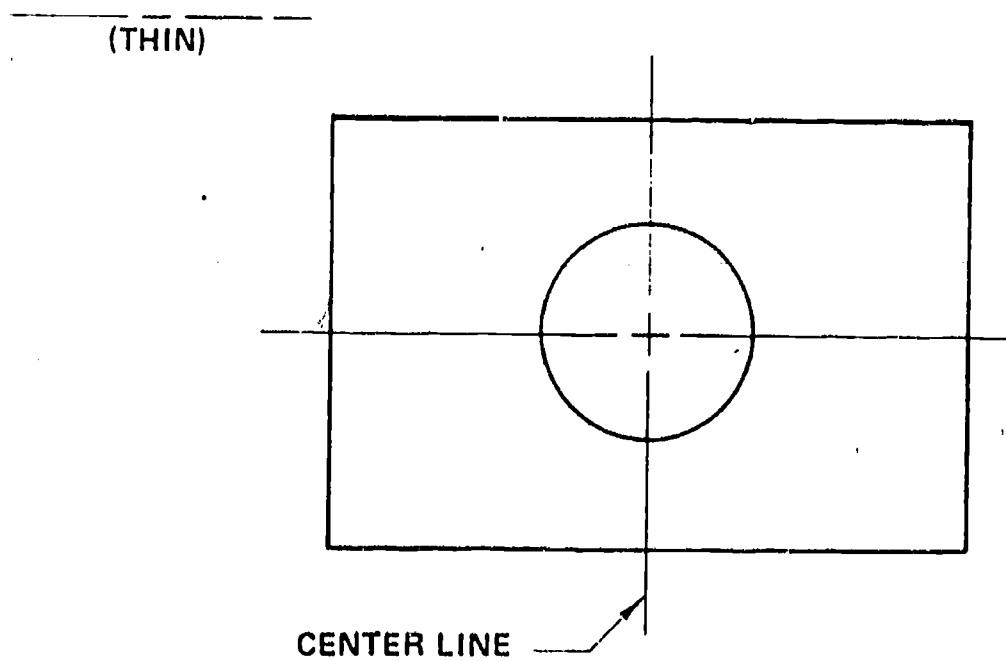
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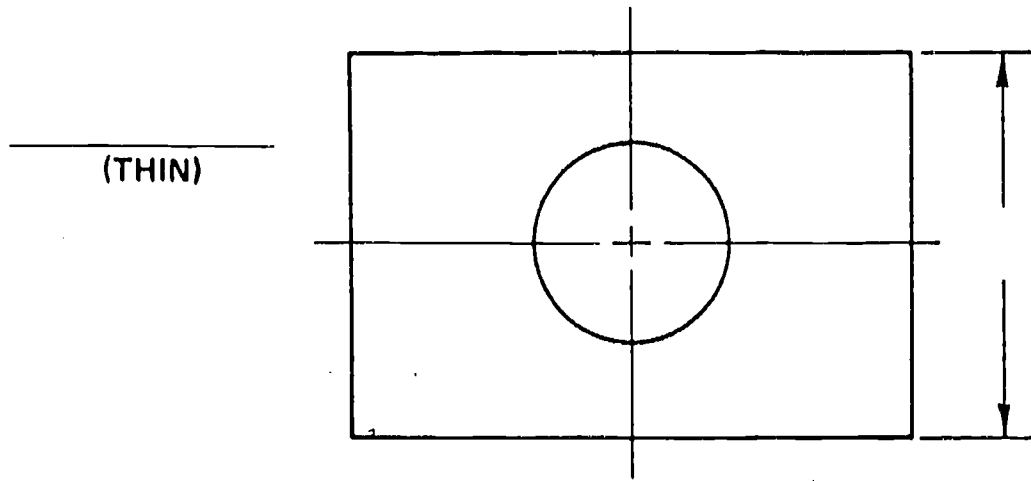
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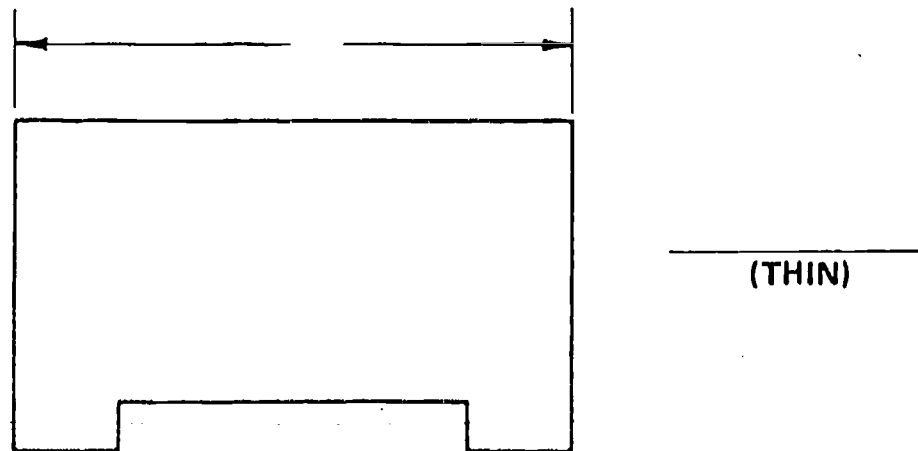
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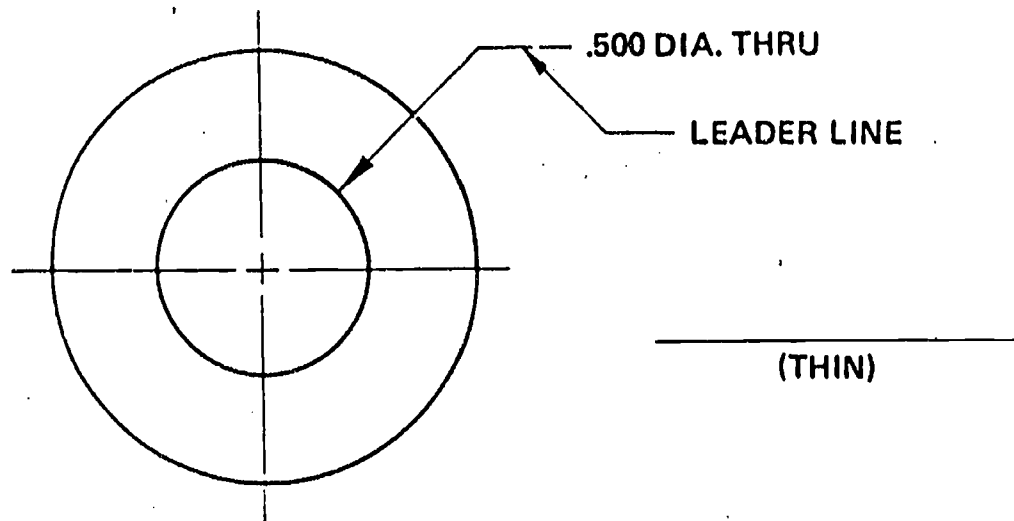
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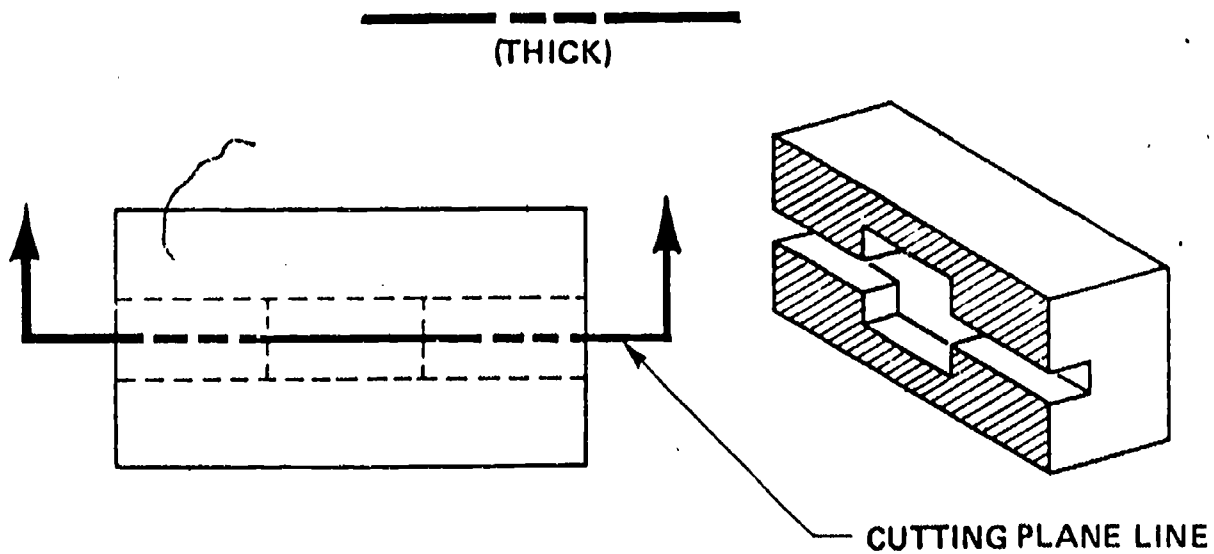
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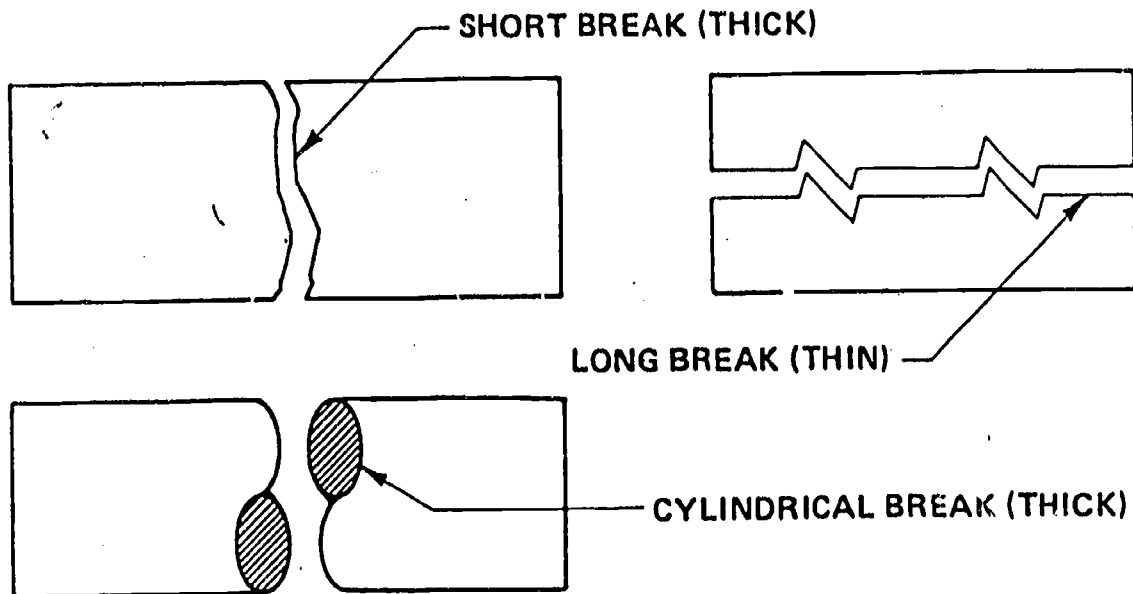
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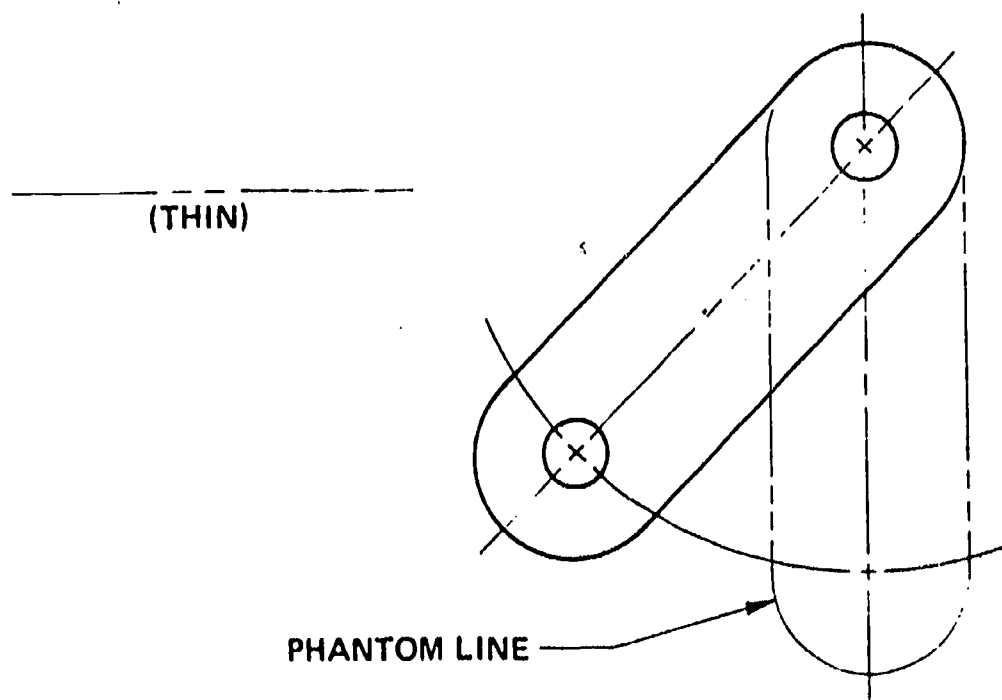
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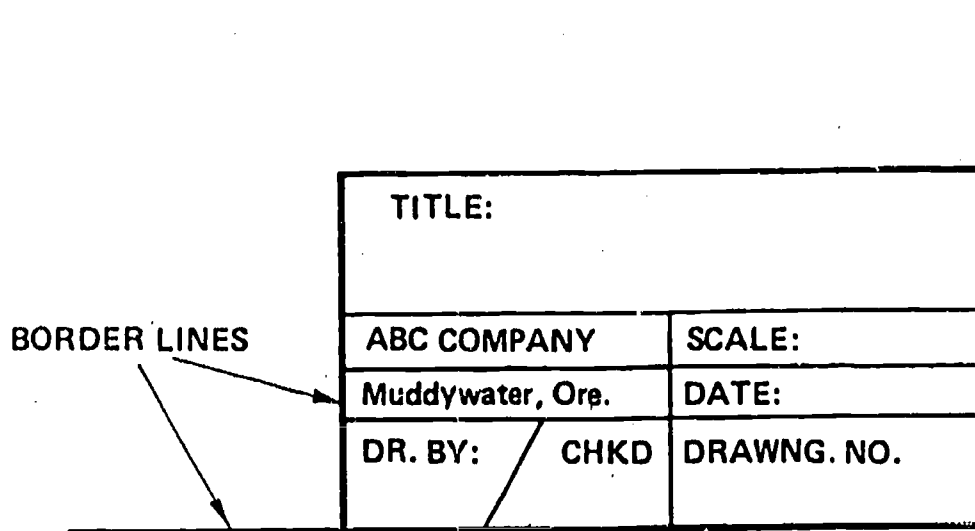
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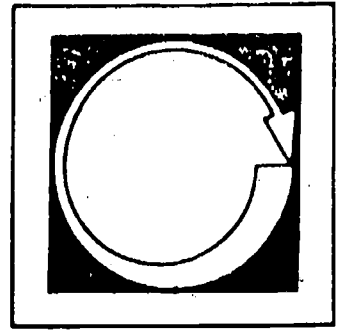
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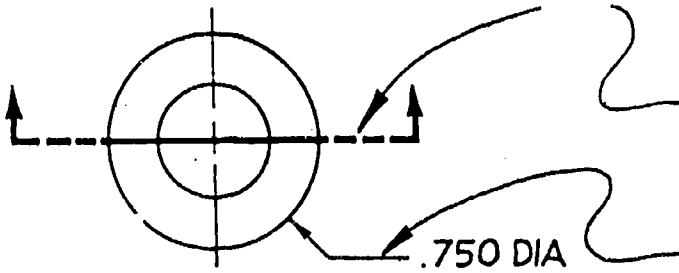


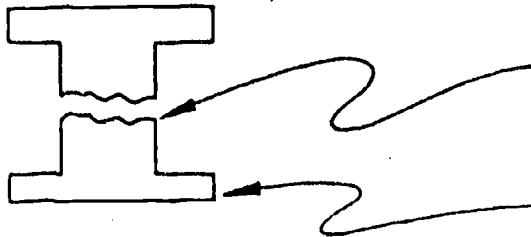
(MEDIUM THICK)

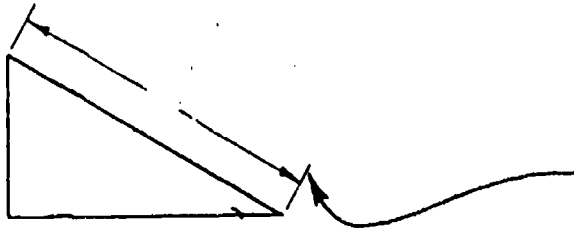
Self Assessment

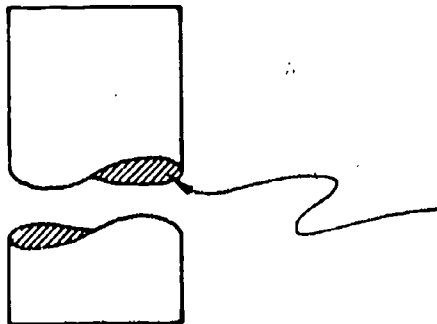


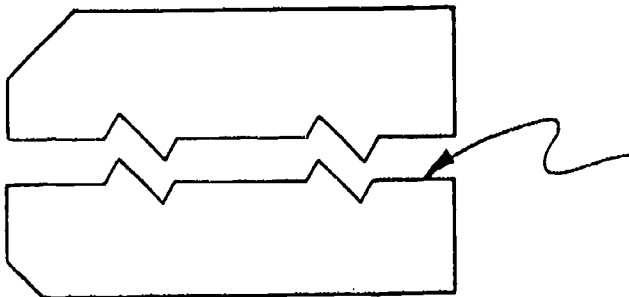
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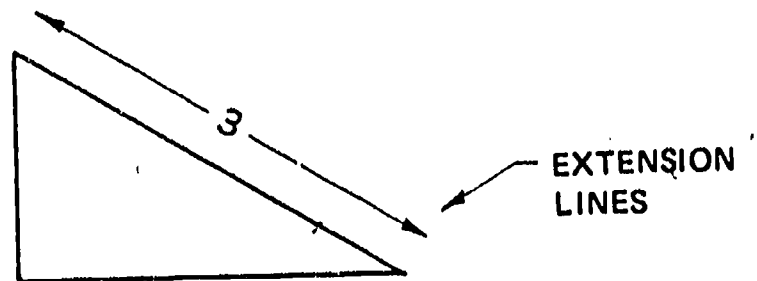
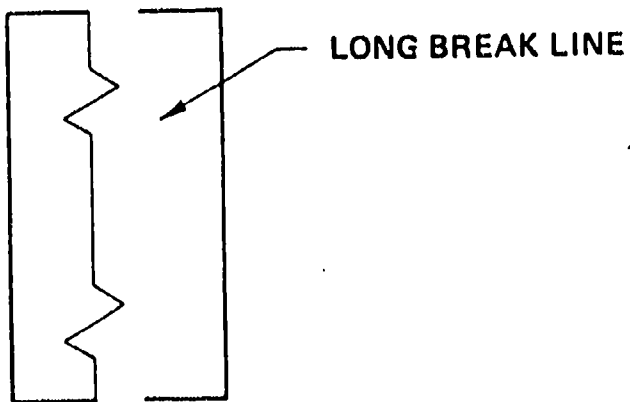
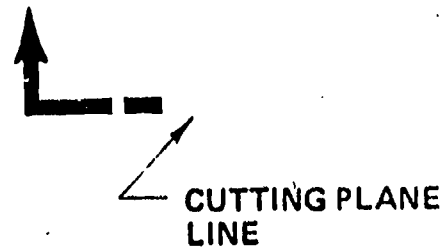
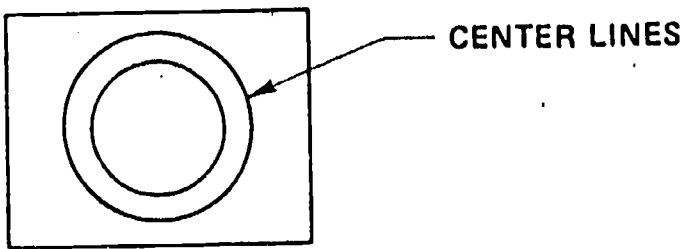
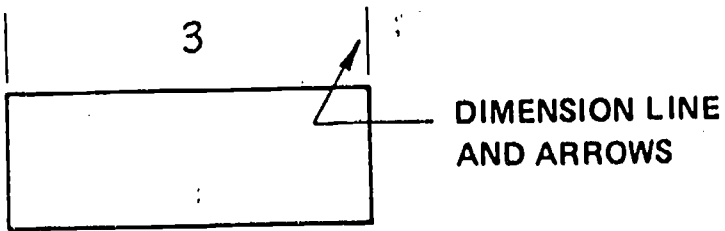
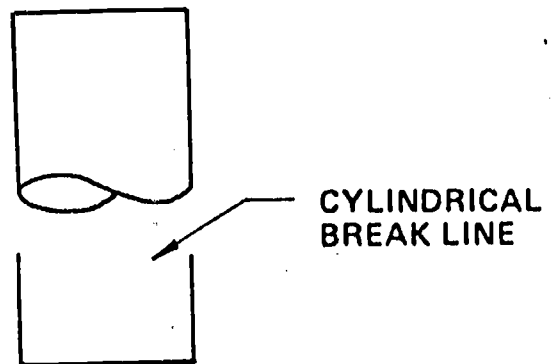
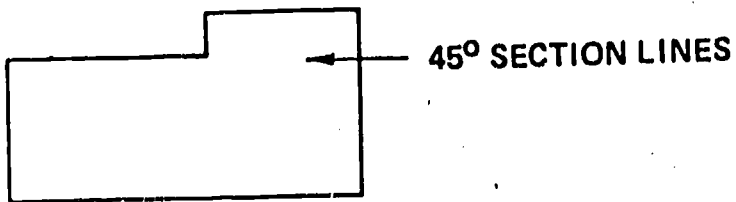
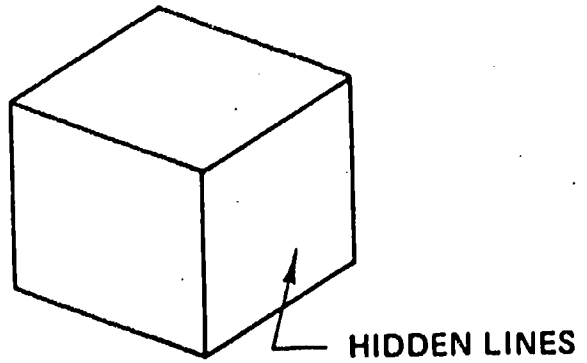
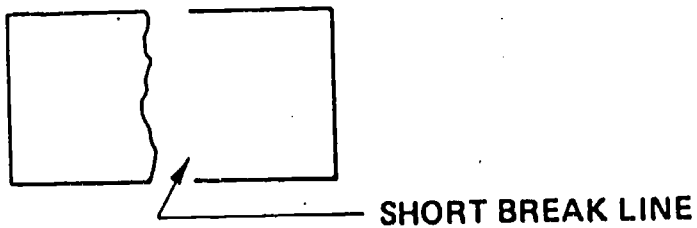




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LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.





5.8

BLUEPRINT READING

Drafting: Basic Print Reading

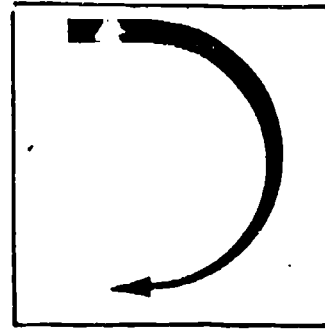
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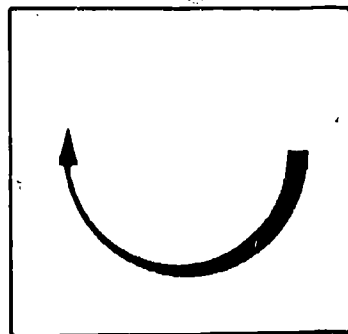
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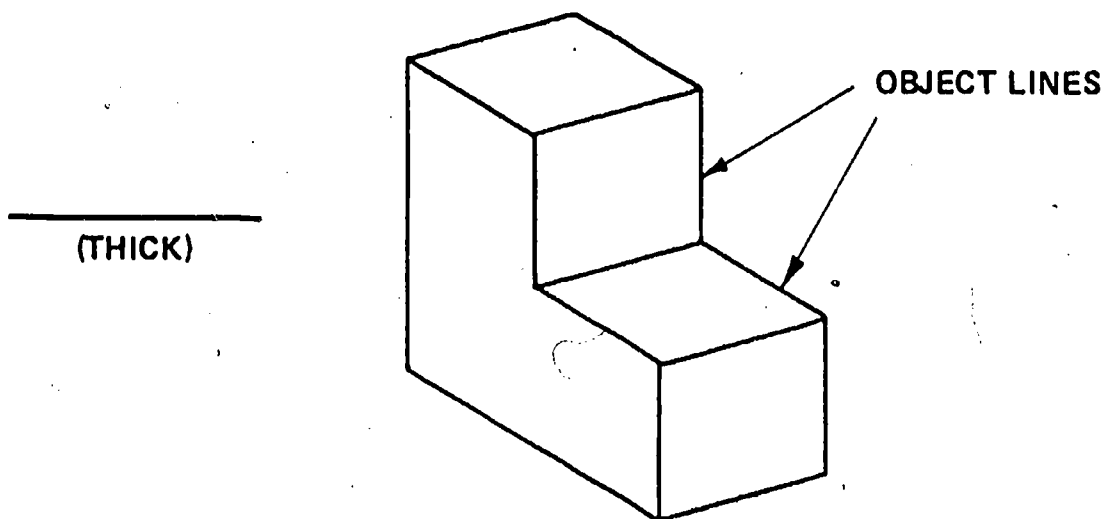
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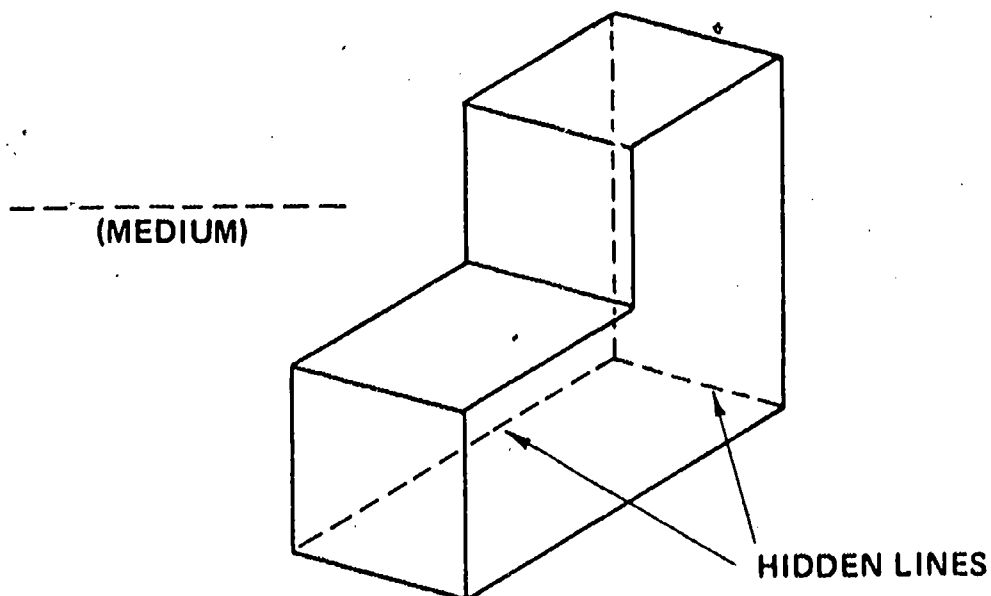
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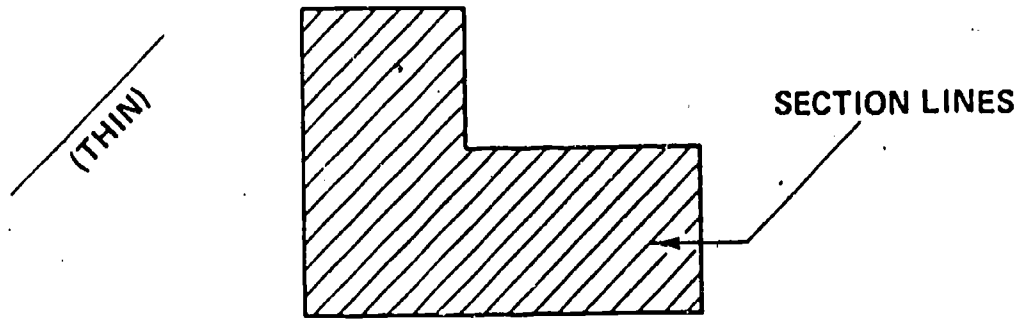
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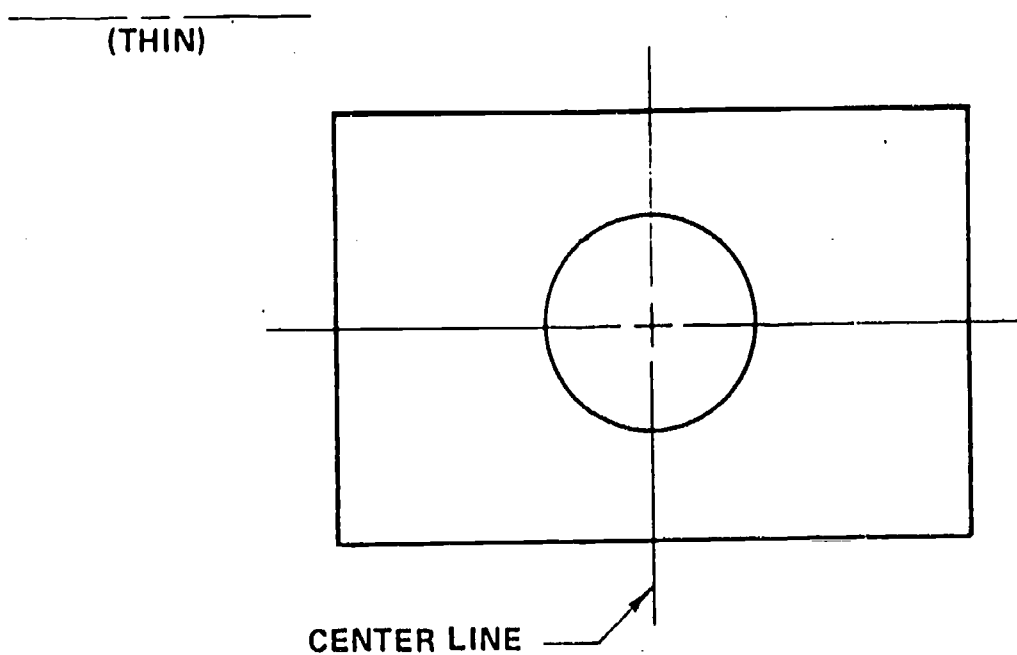
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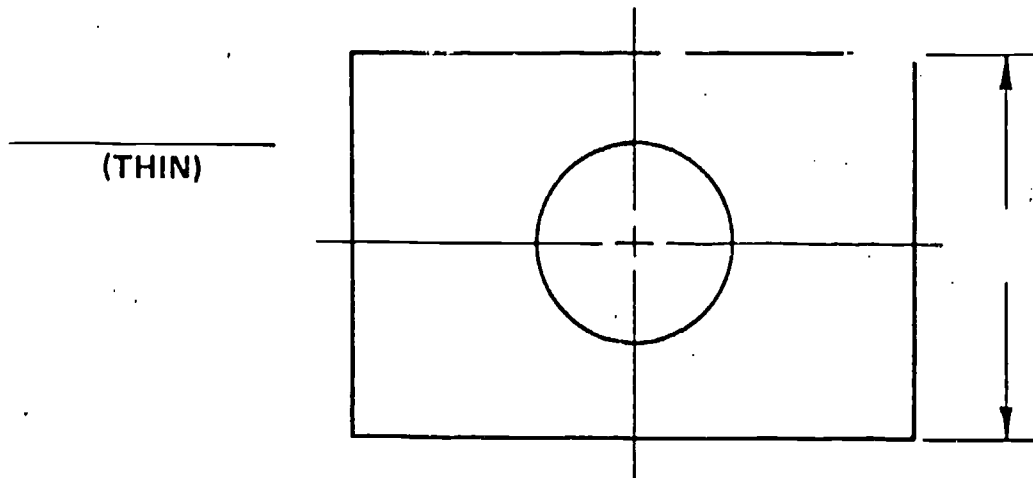
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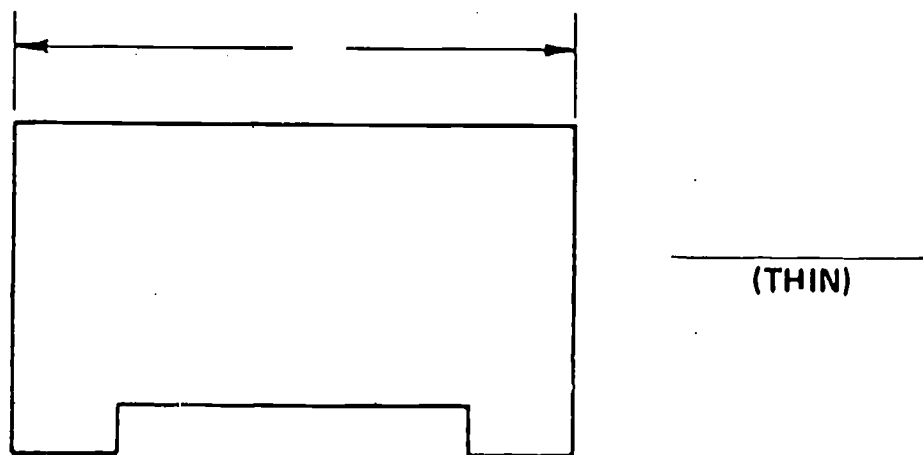
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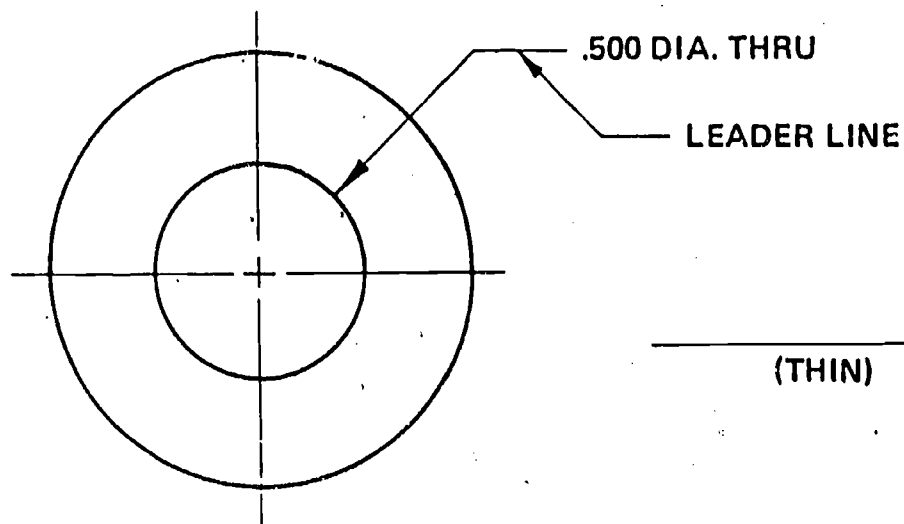
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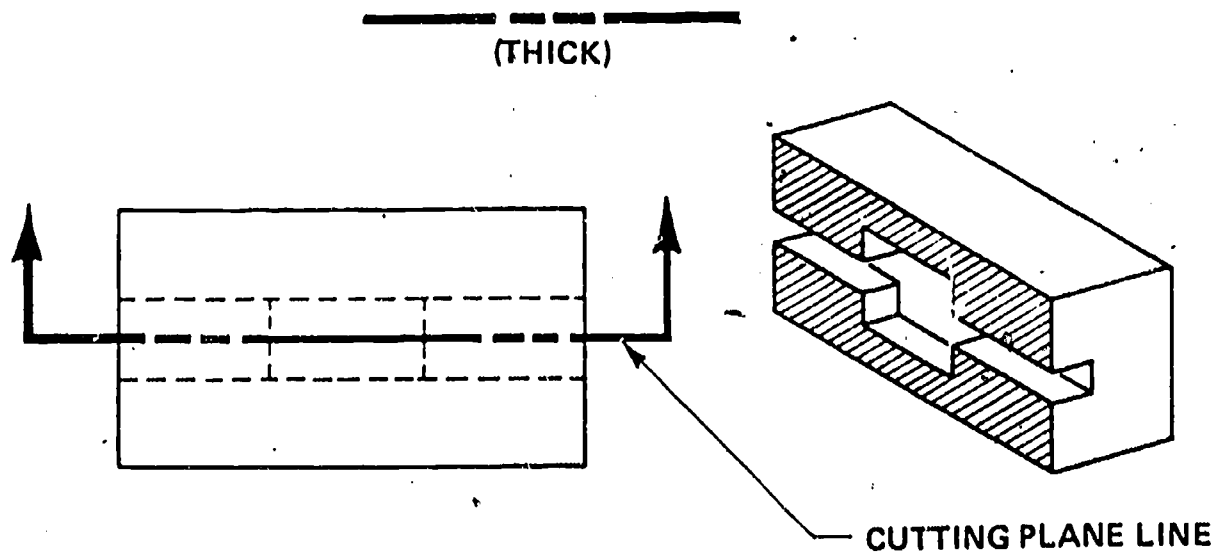
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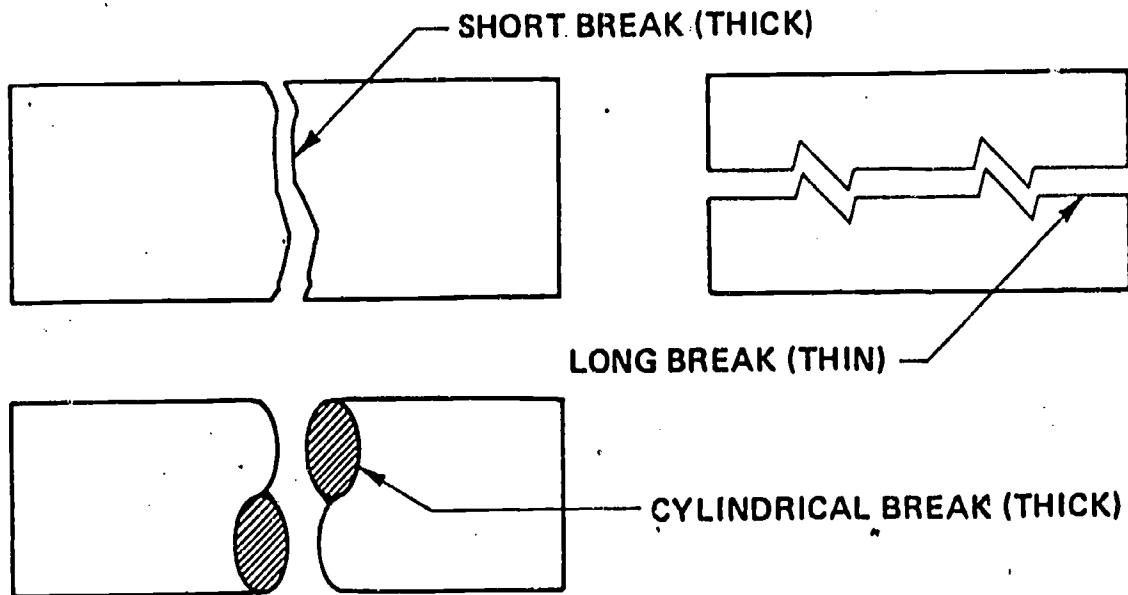
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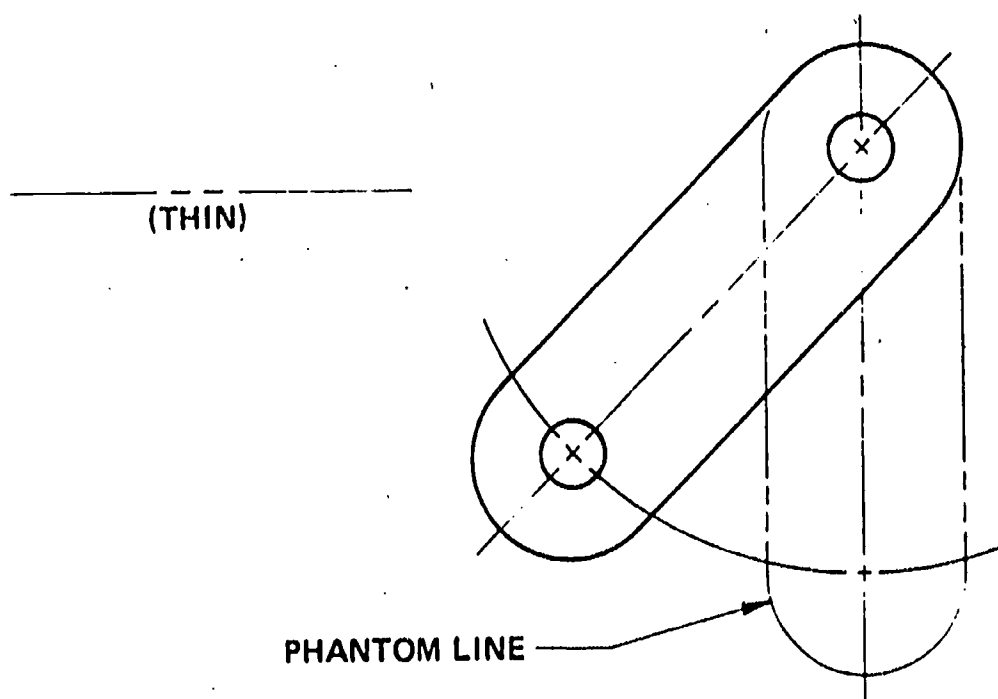
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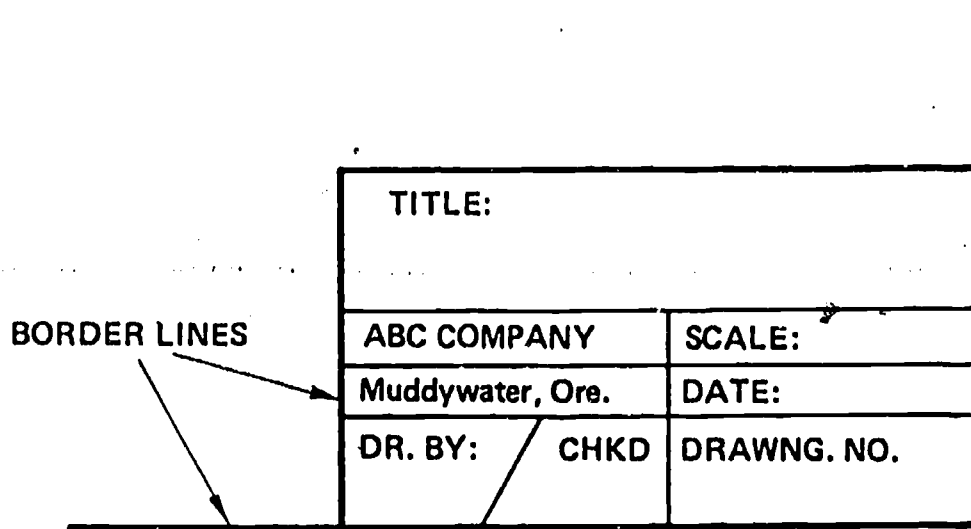
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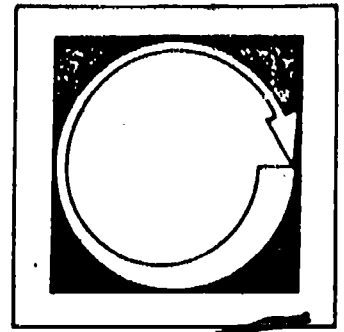
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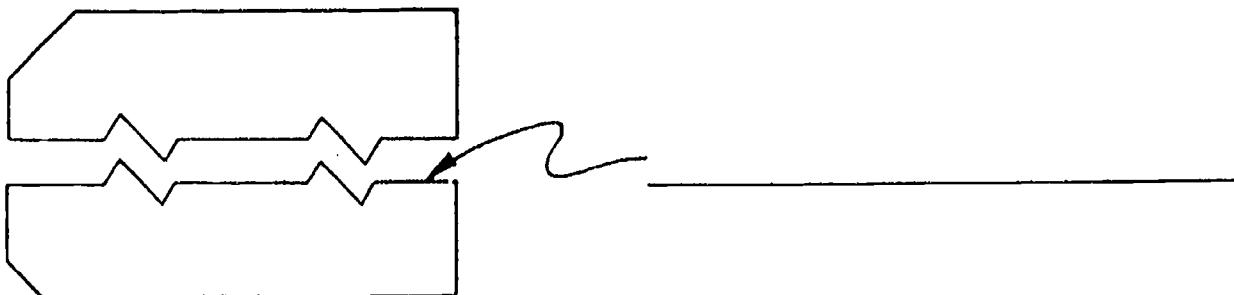
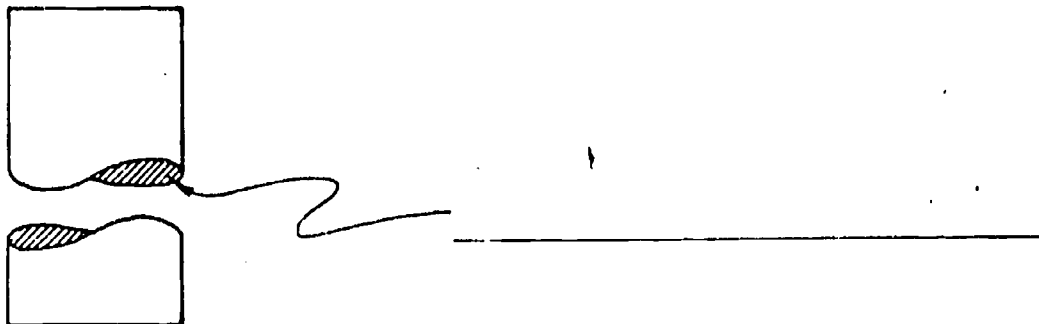
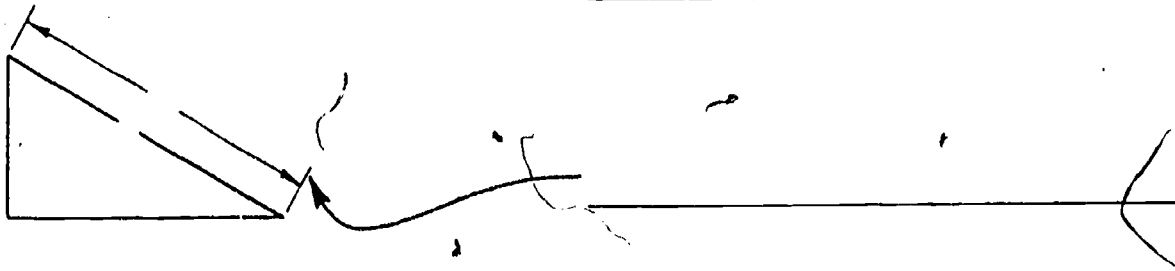
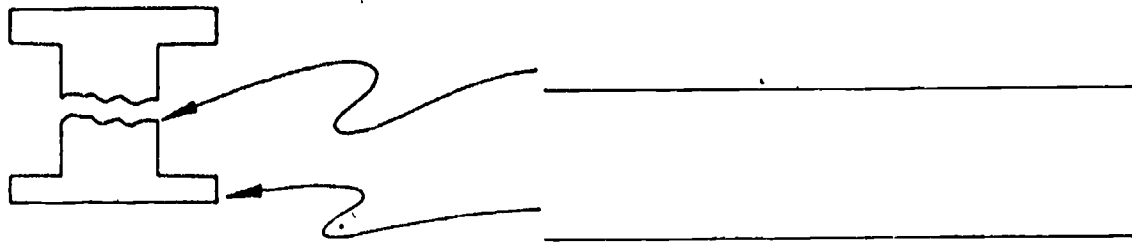
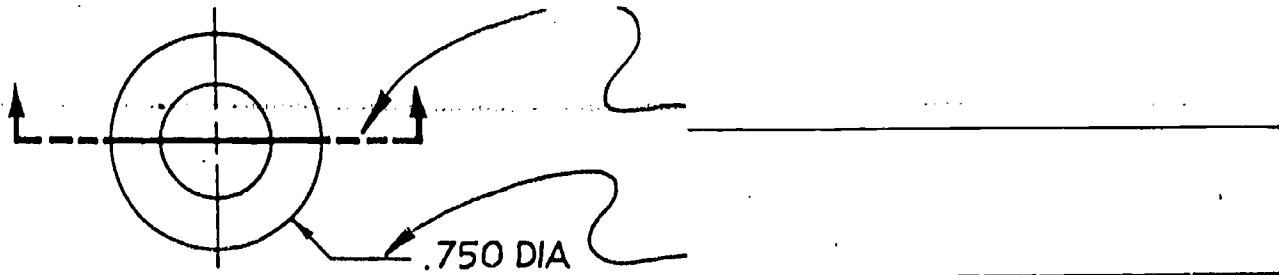


(MEDIUM THICK)

Self Assessment



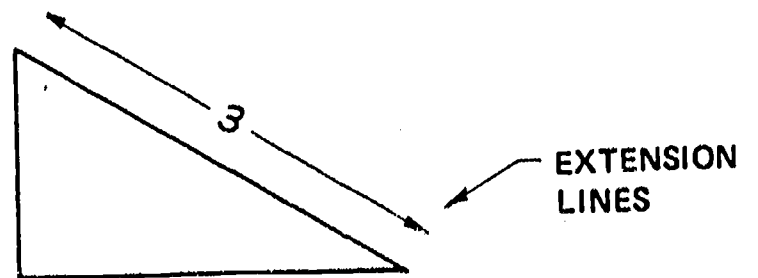
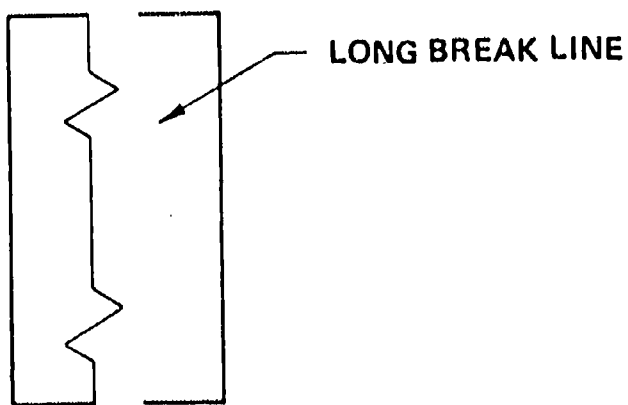
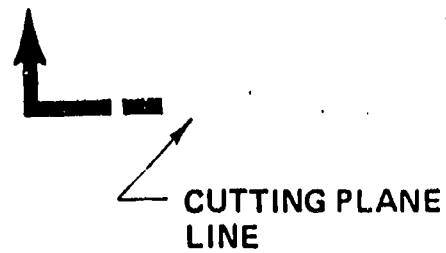
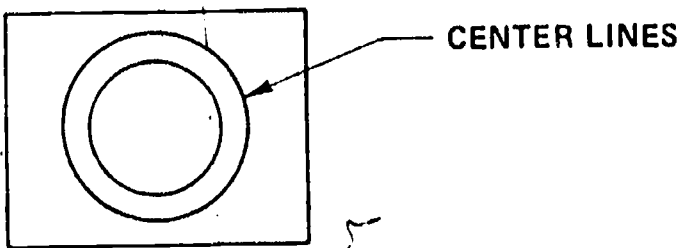
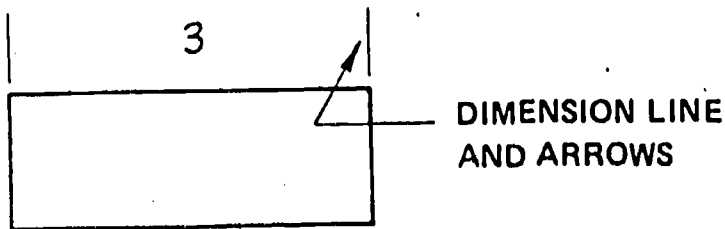
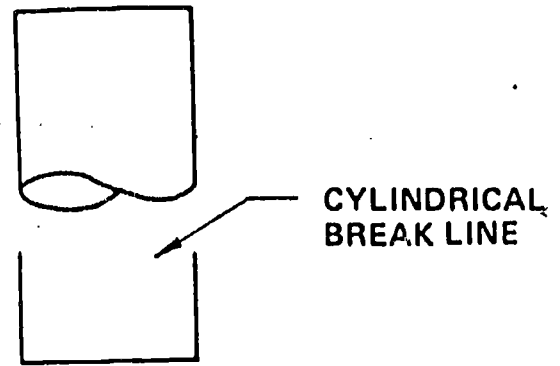
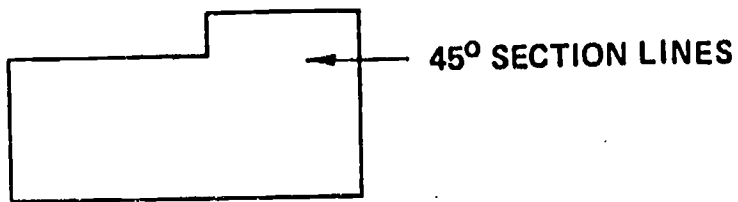
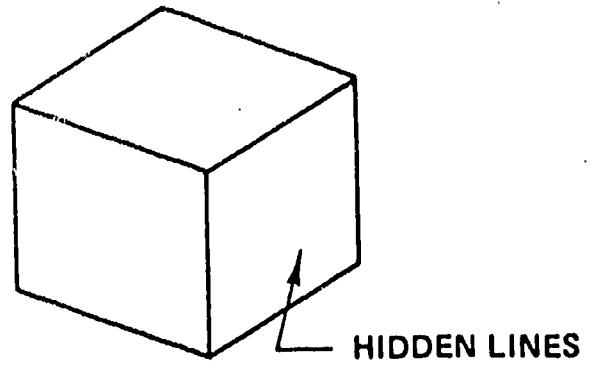
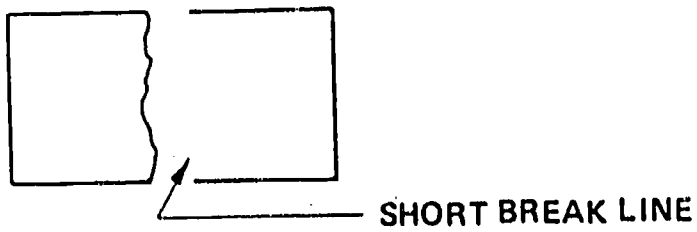
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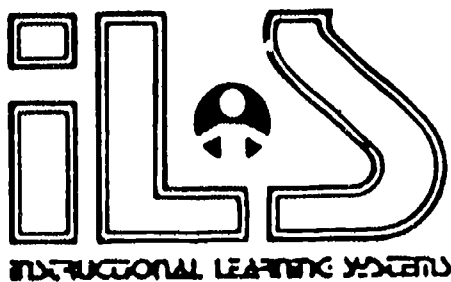


Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
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 7. Long break.

LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.





5.9

BLUEPRINT READING

Drafting: Basic Print Reading

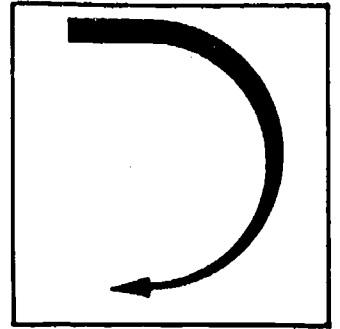
Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
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Introduction



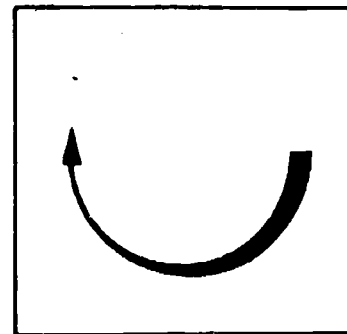
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It is important to remember, as you study blueprint reading, that you are learning to communicate with the graphic language. Lines are part of the language.

Since technical drawings are made of lines, it is logical that the first step in learning to "read" a drawing is to learn the meaning of each kind of line. Generally, there are 11 basic types of lines. Each kind of line has a definite form and "weight." Weight refers to line thickness or width. When combined in a drawing, lines provide part of the information needed to understand the print.

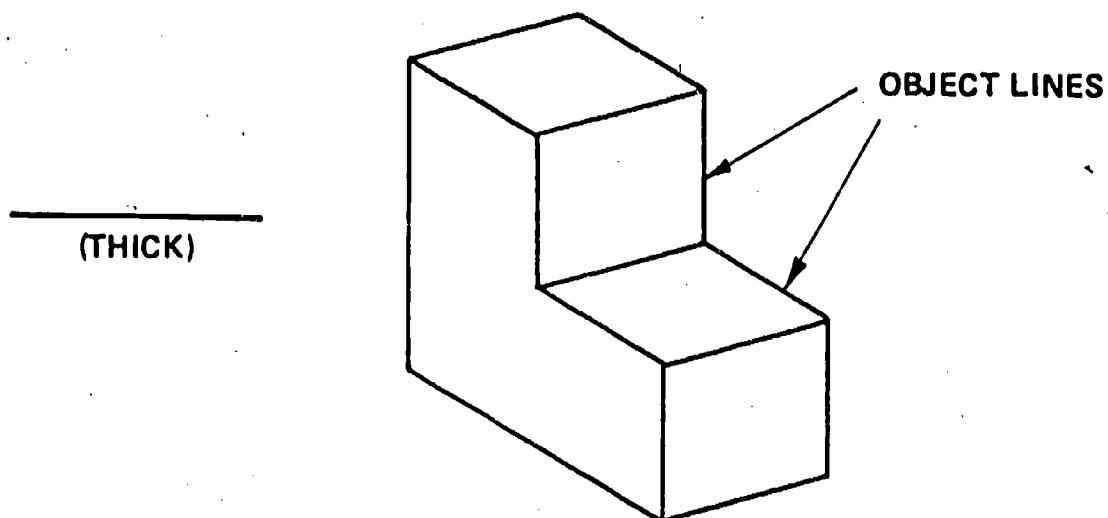
Information



The 11 lines used on prints are:

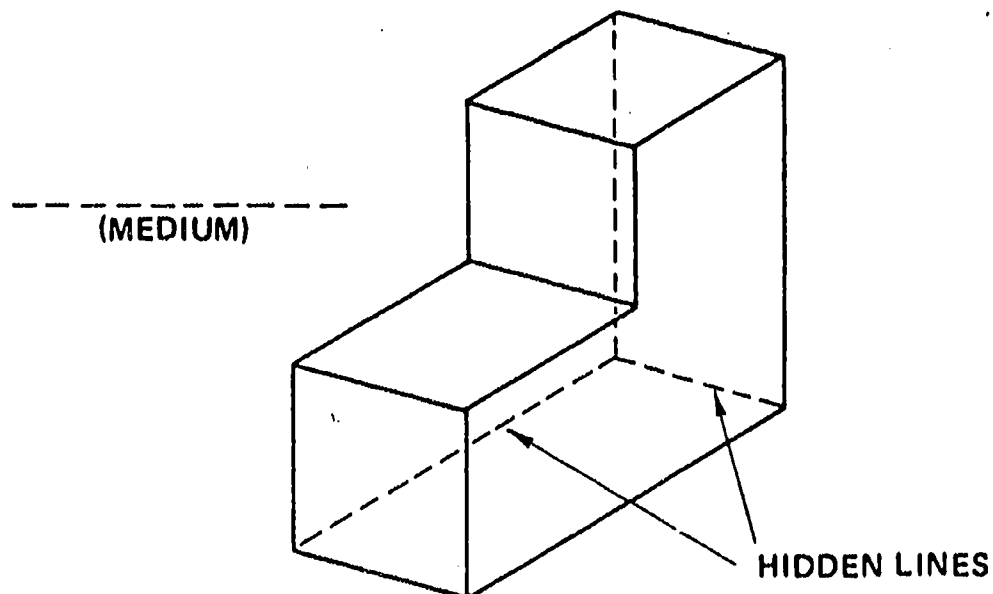
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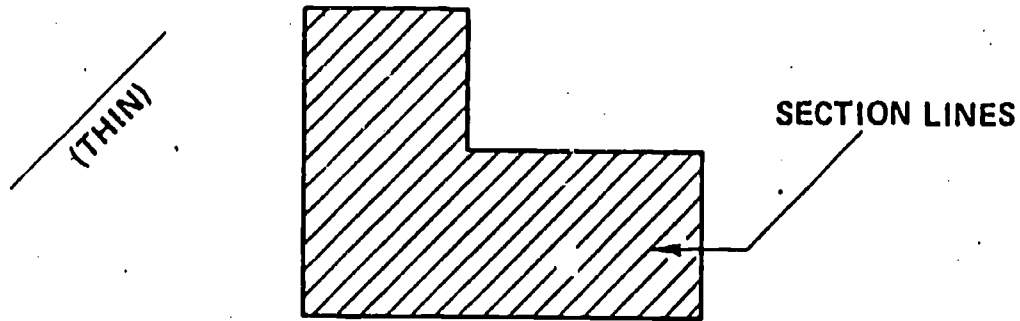
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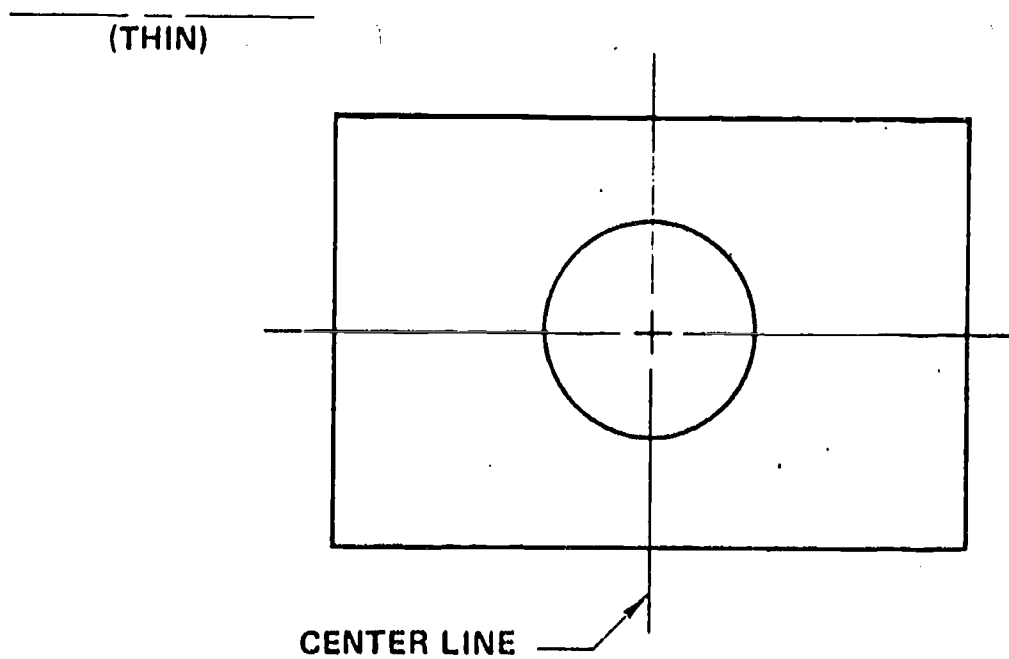
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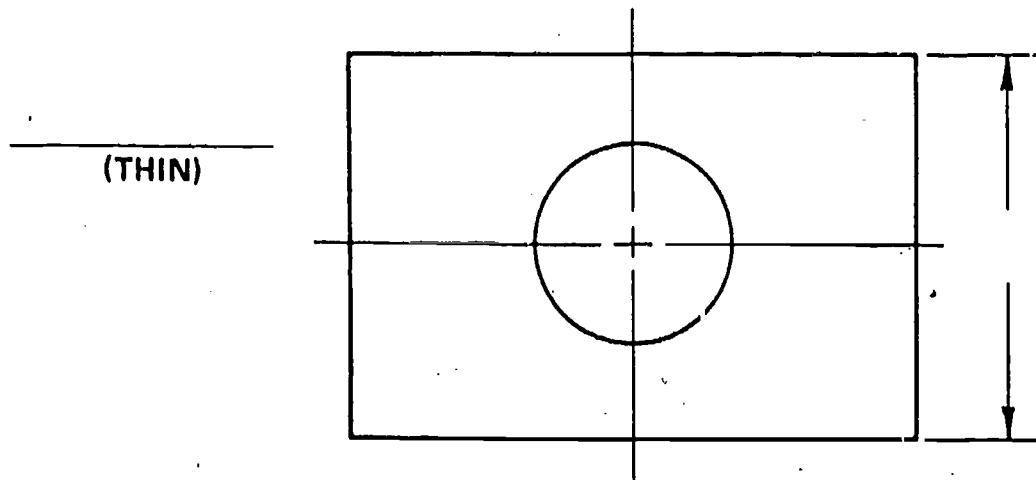
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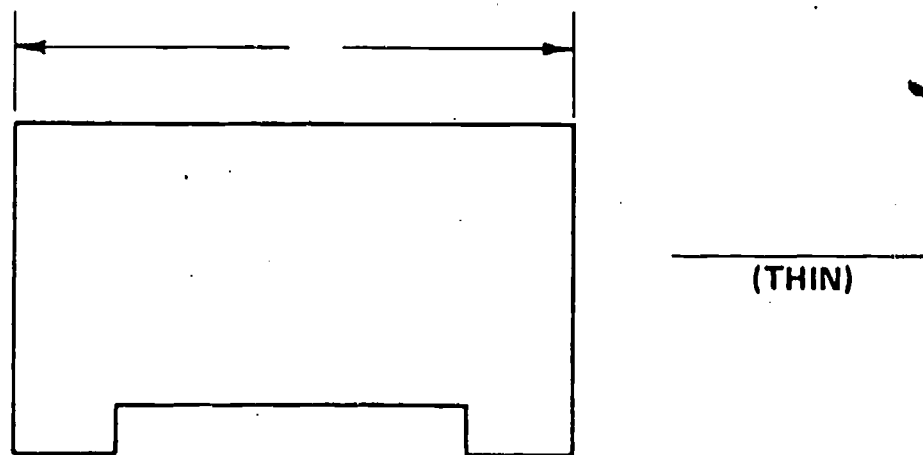
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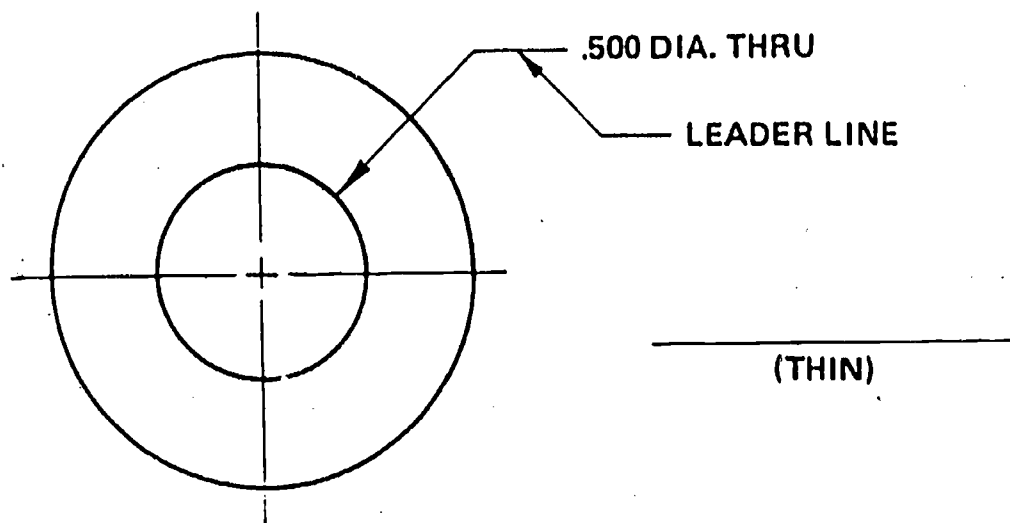
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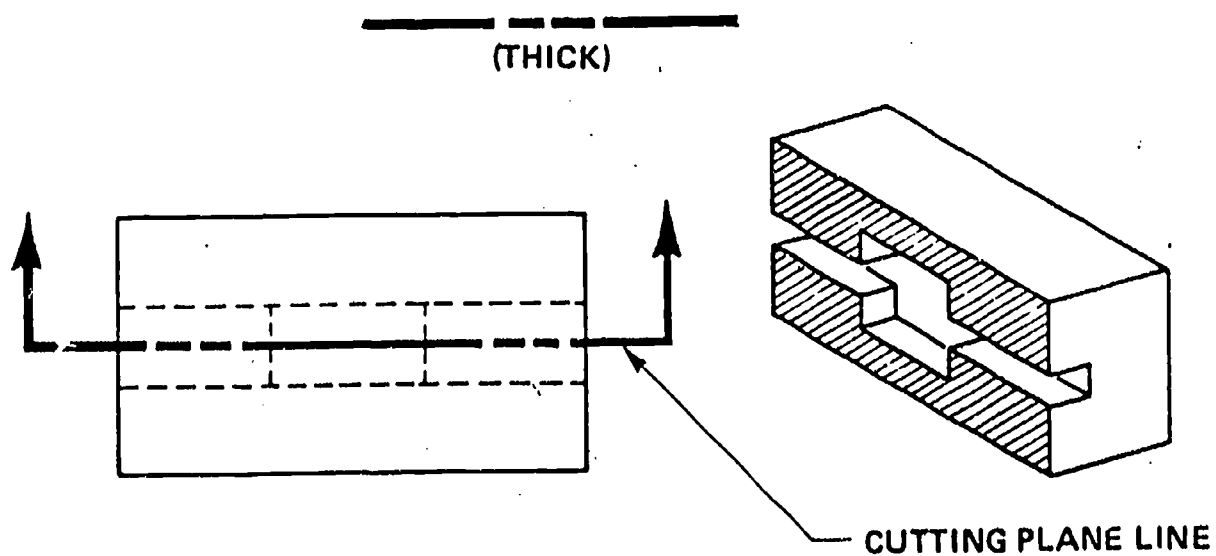
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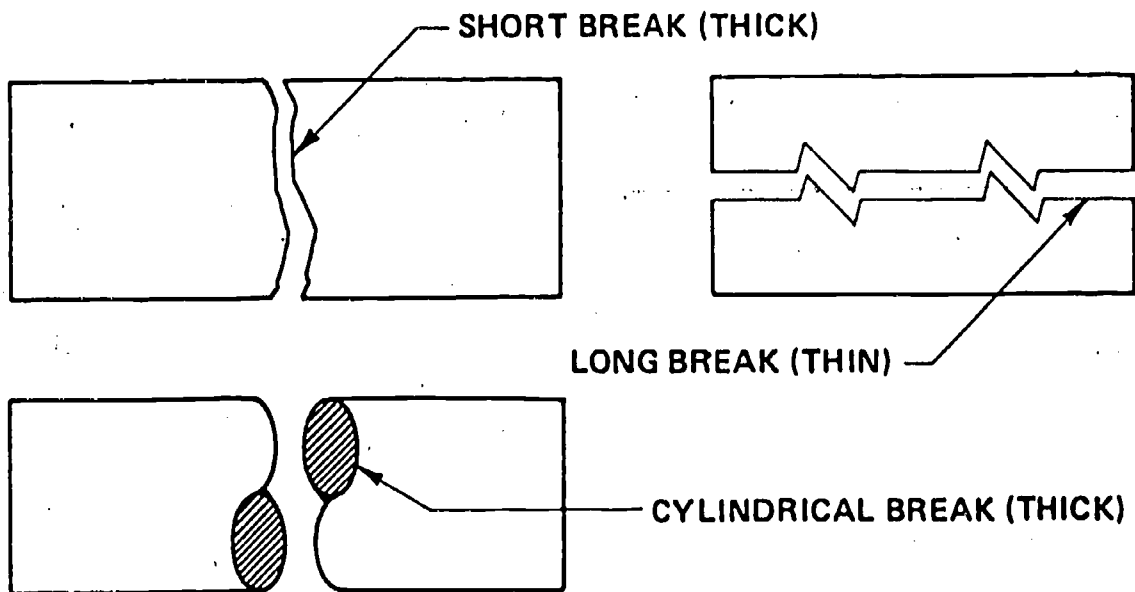
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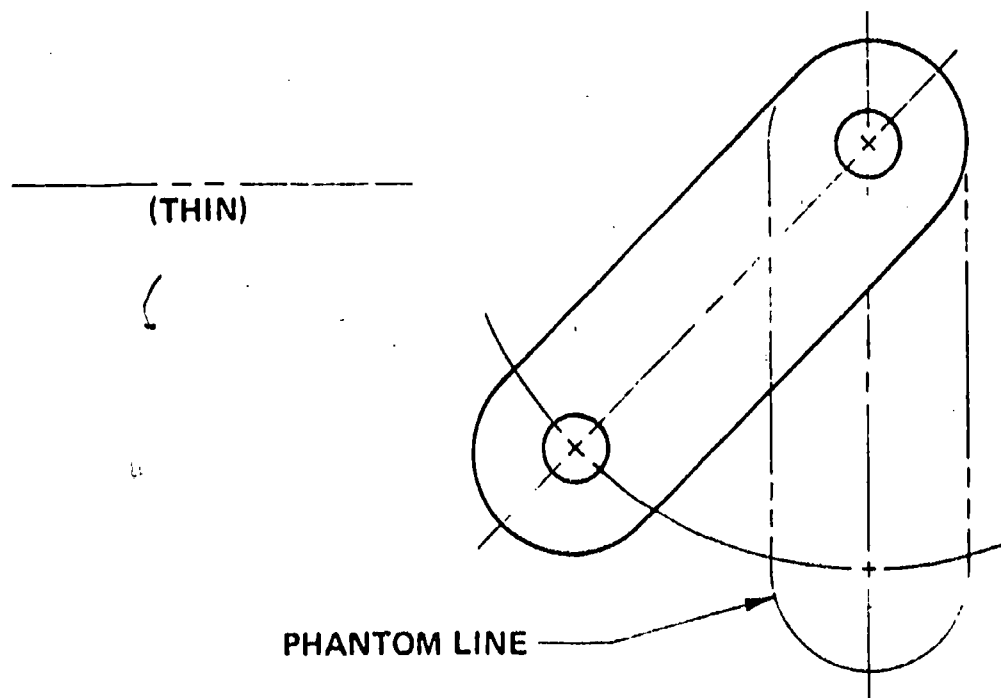
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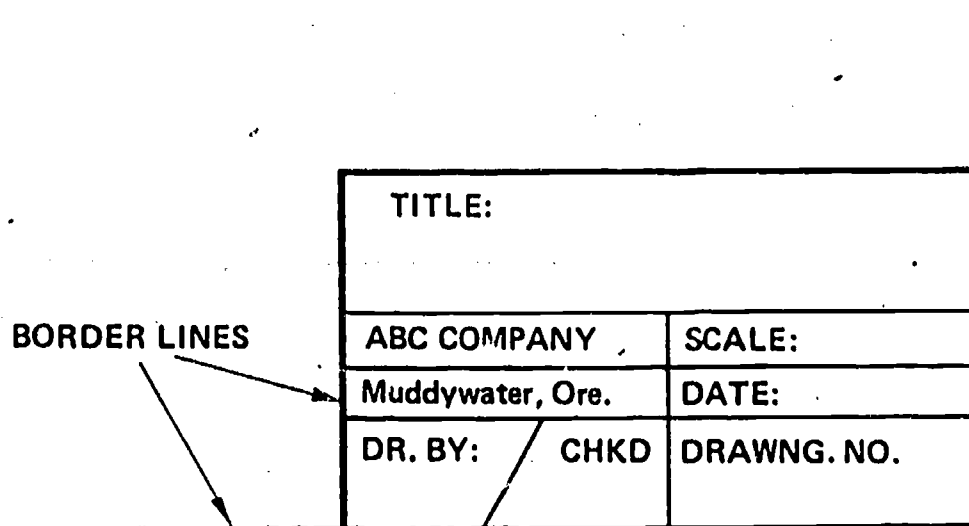
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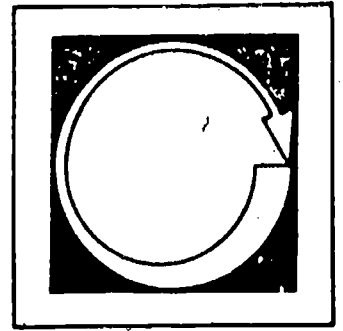
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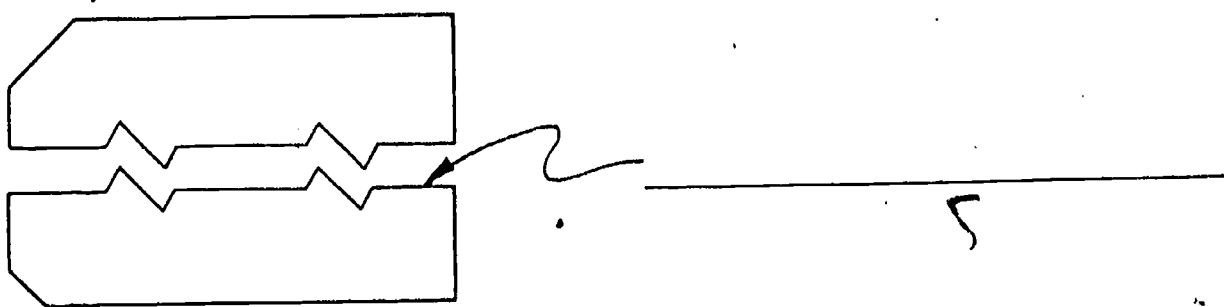
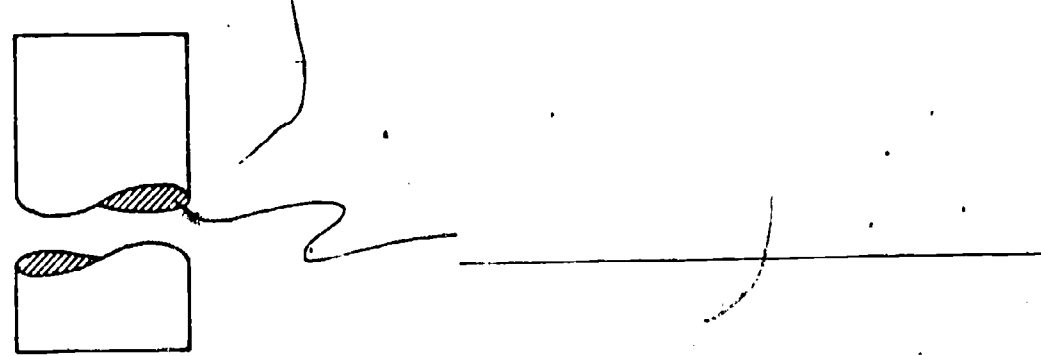
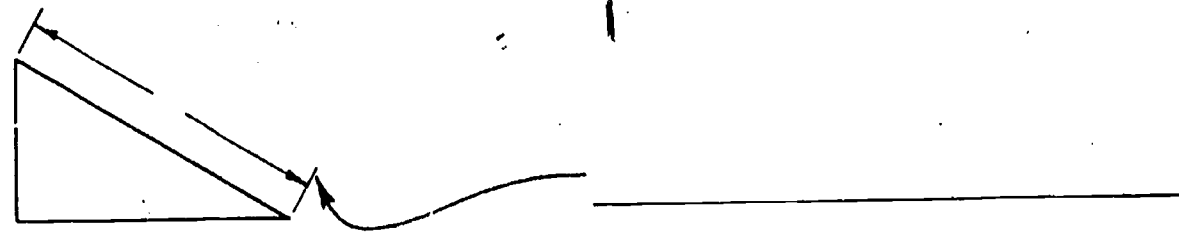
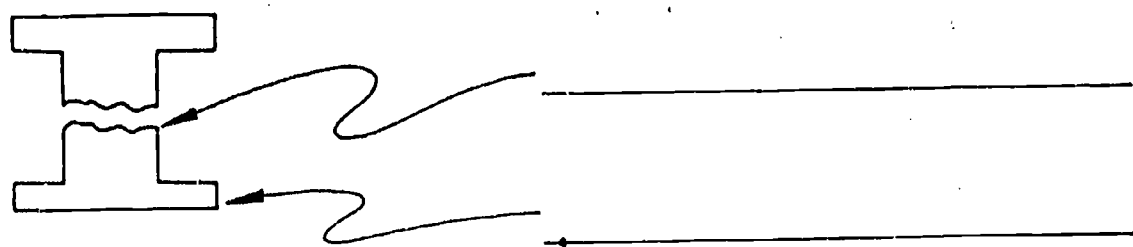
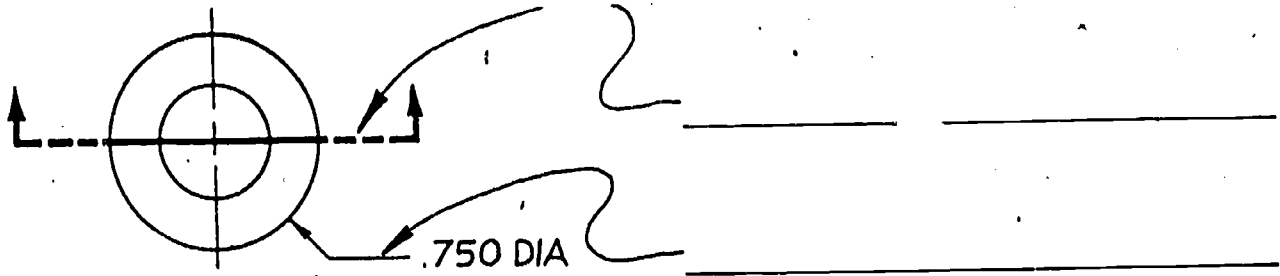


(MEDIUM THICK)

Self Assessment



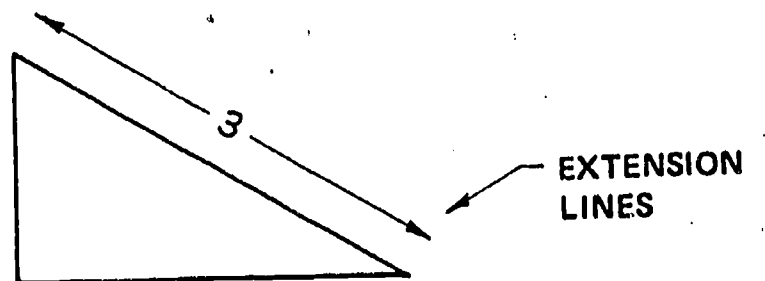
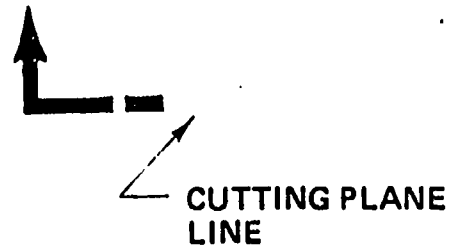
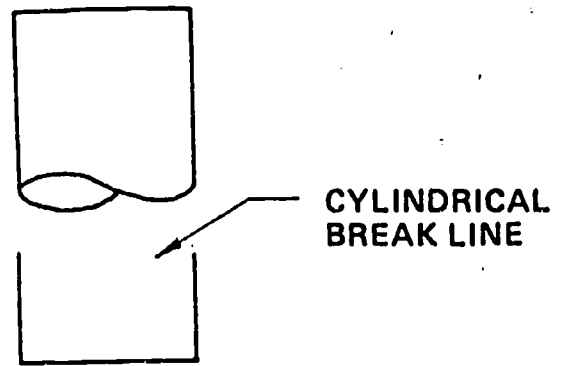
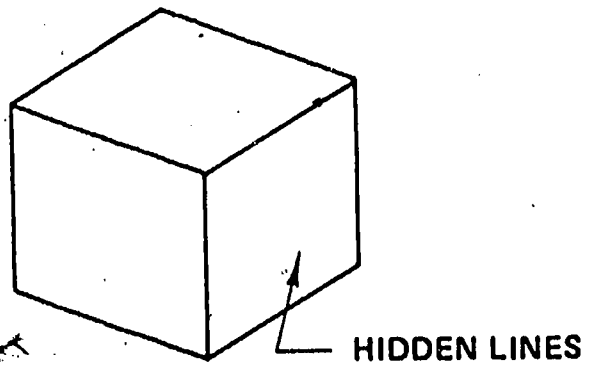
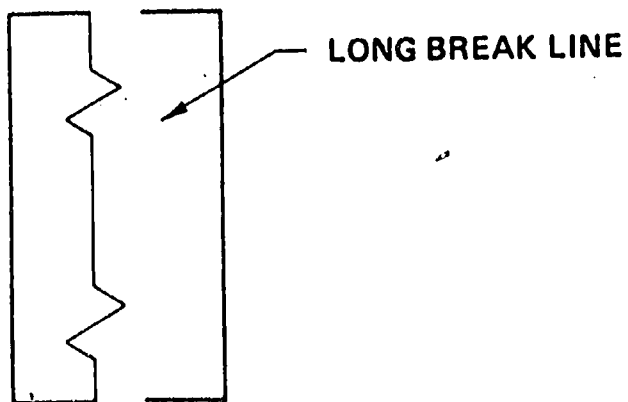
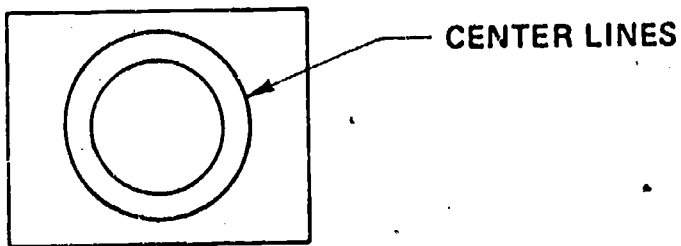
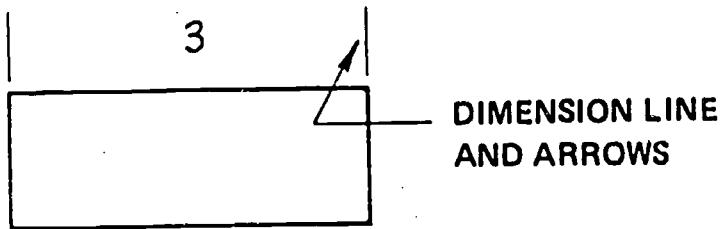
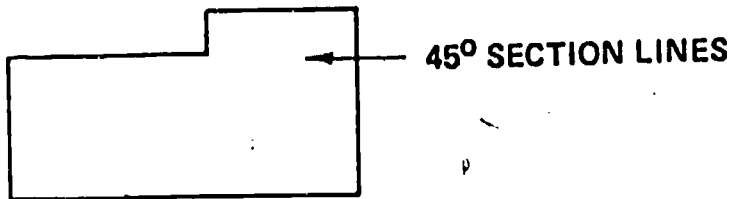
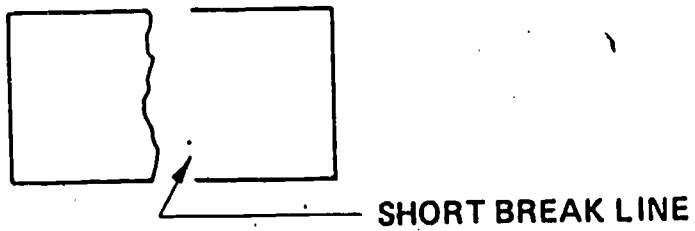
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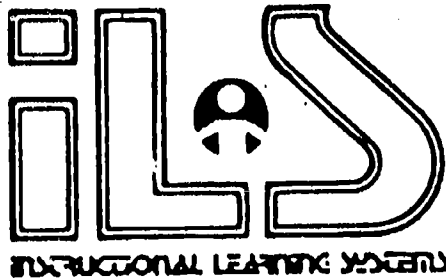


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5.10

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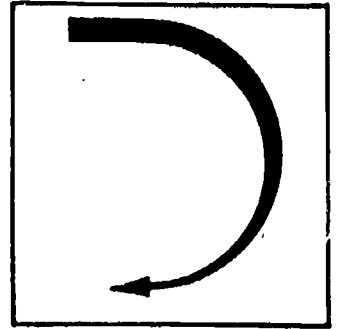
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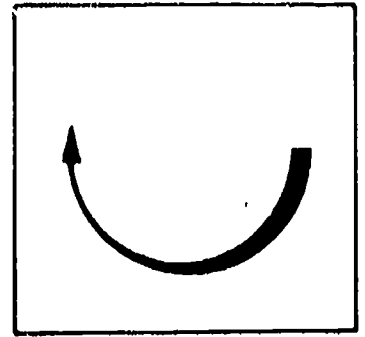
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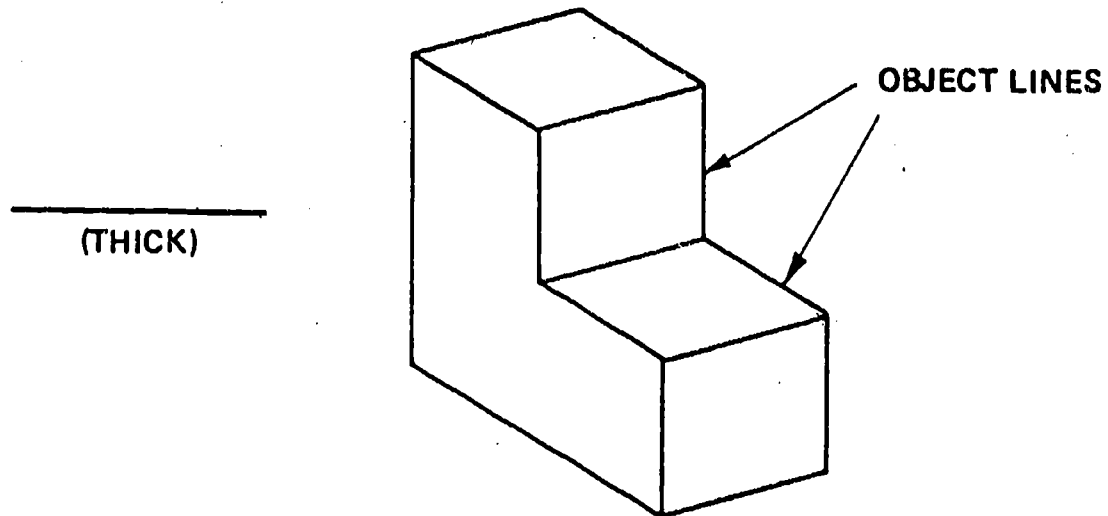
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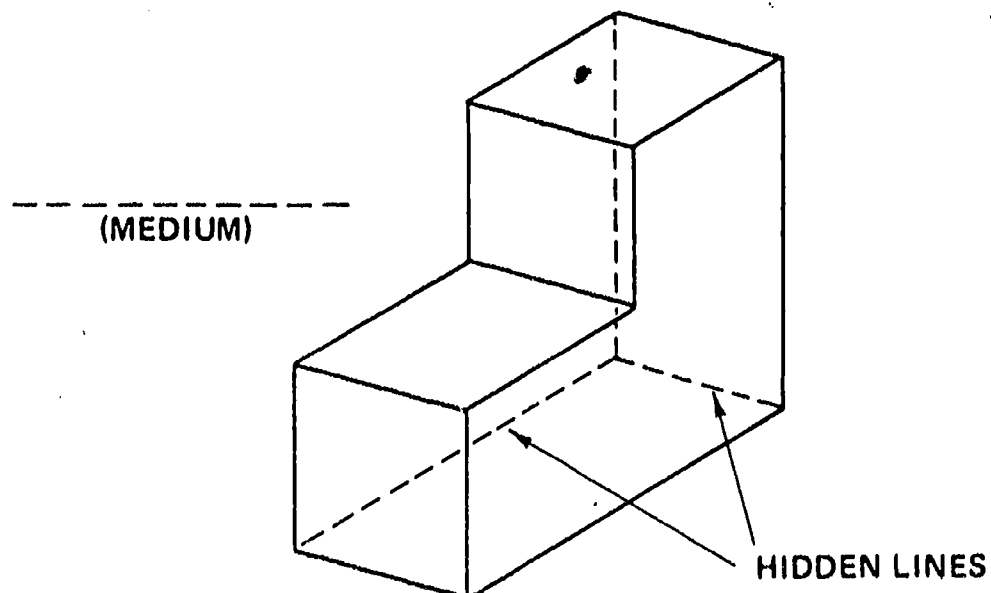
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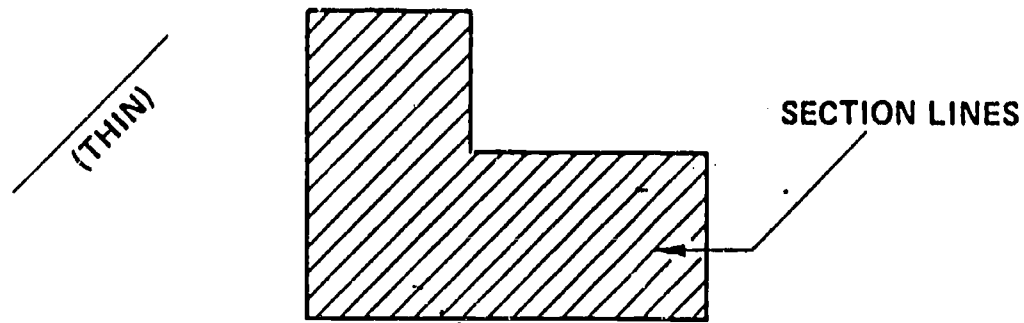
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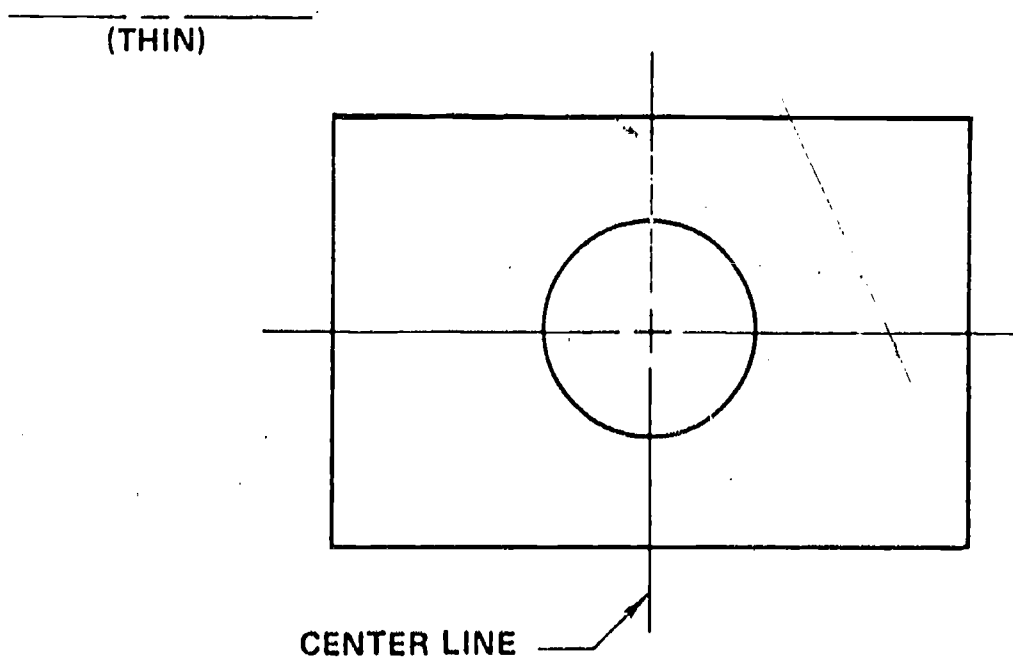
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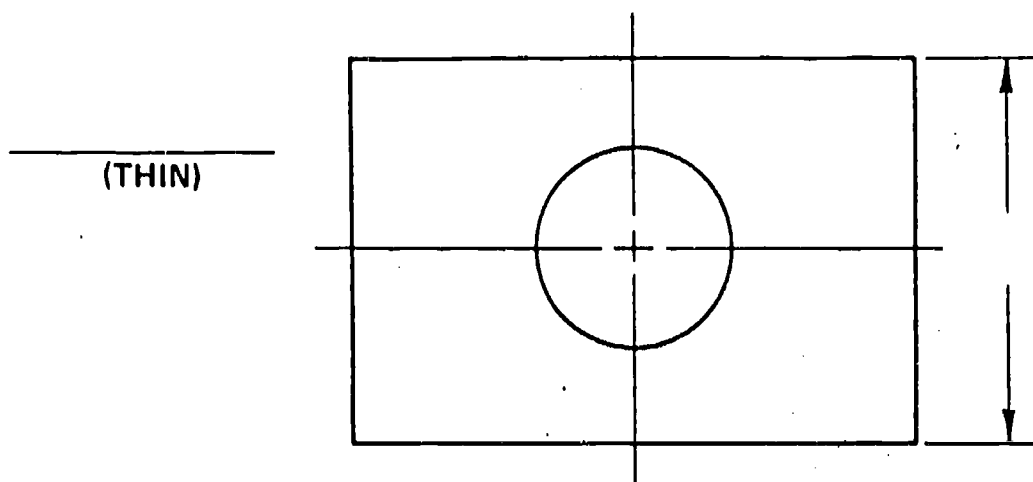
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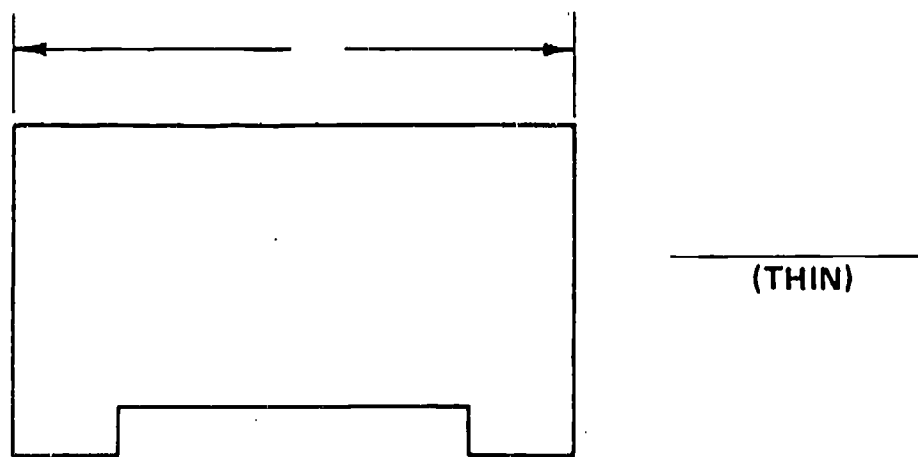
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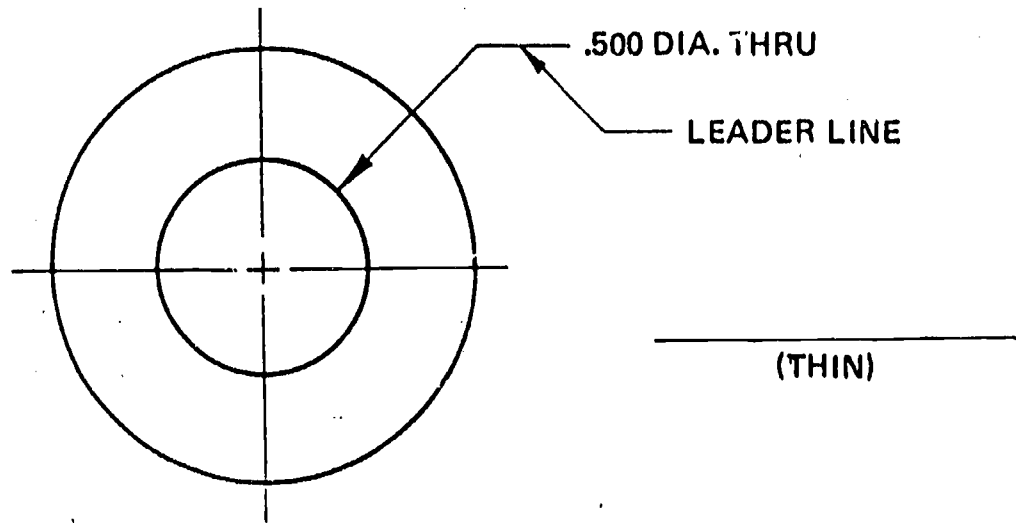
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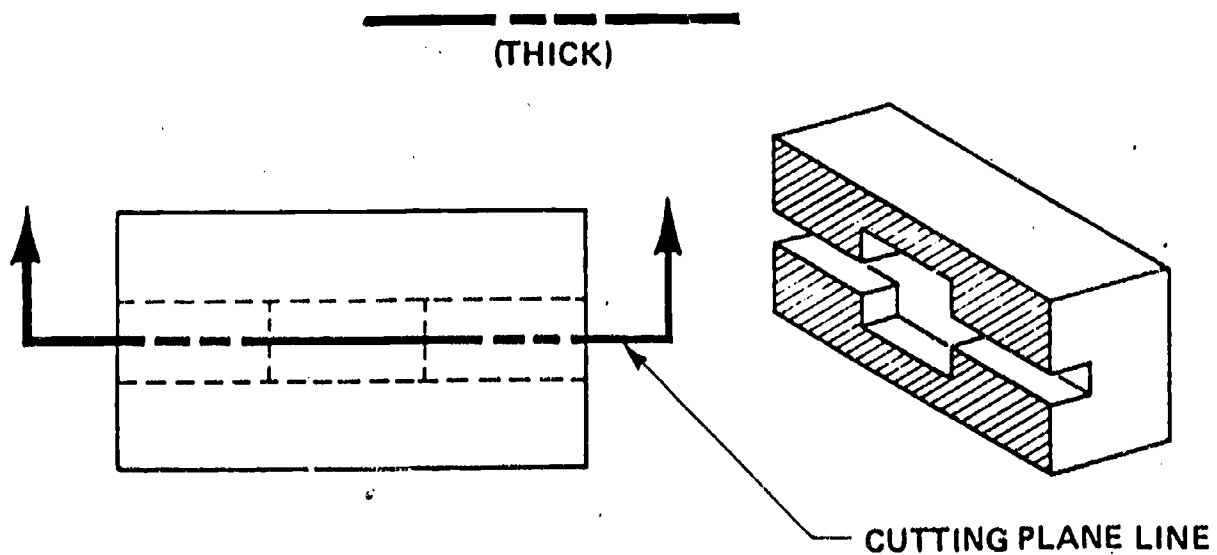
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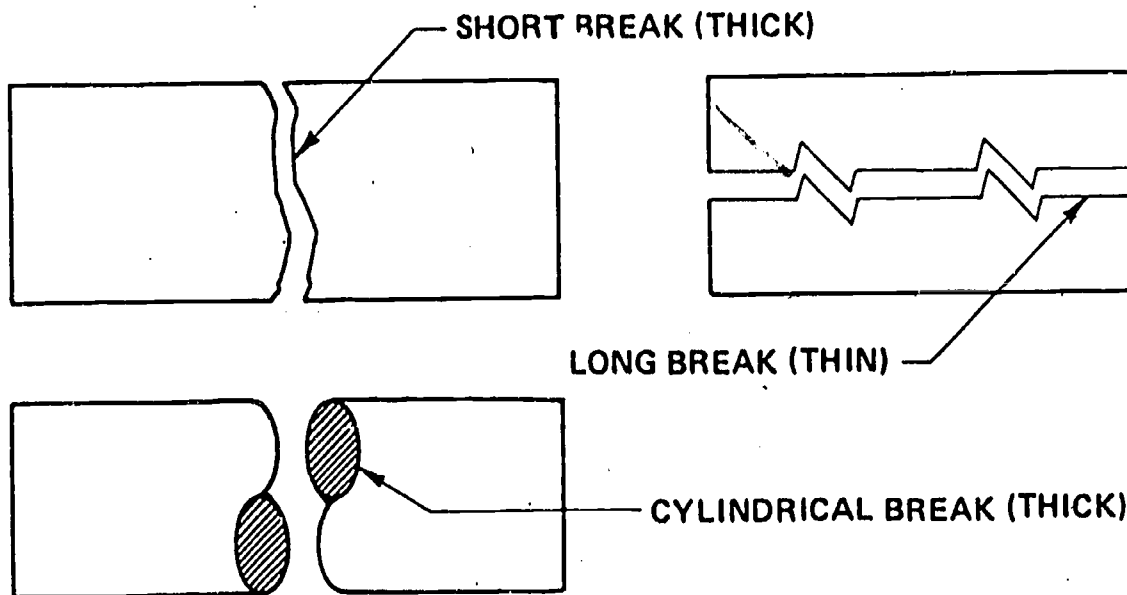
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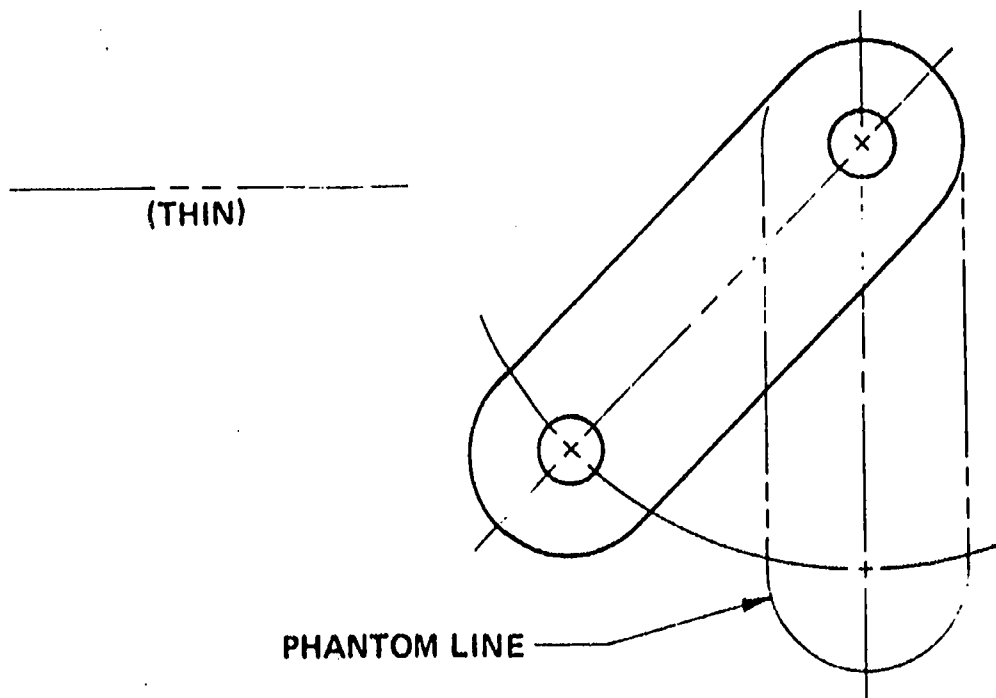
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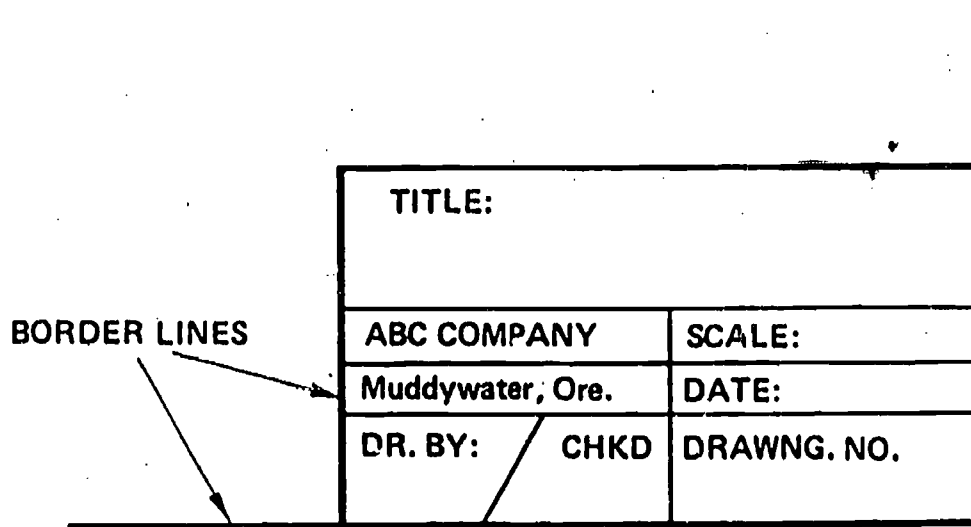
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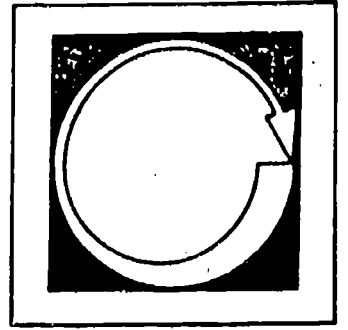
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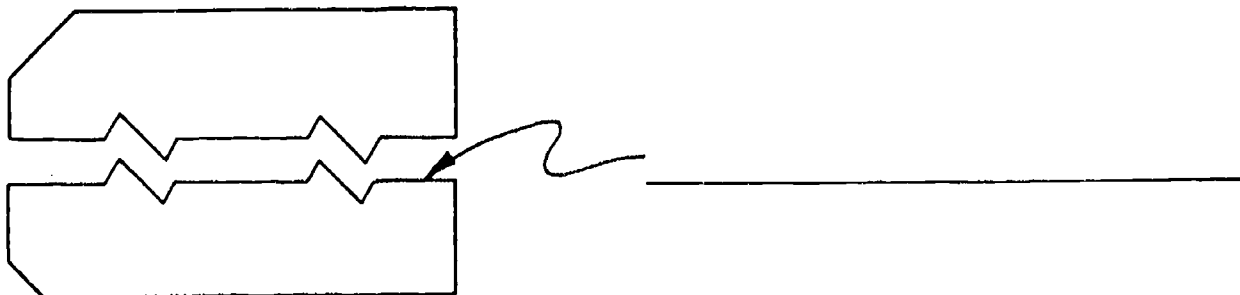
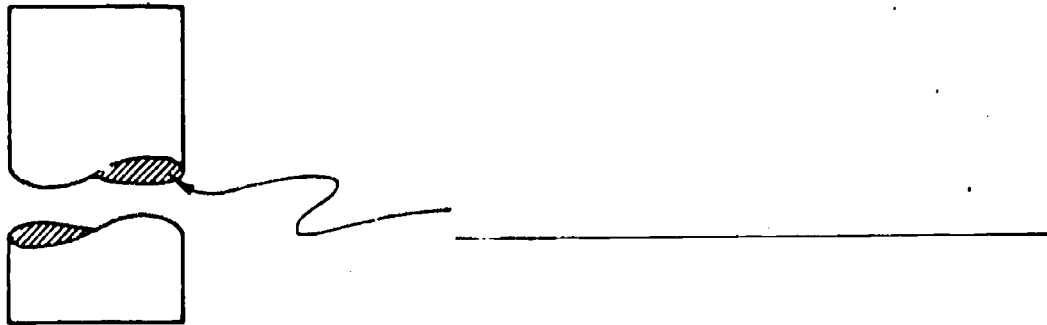
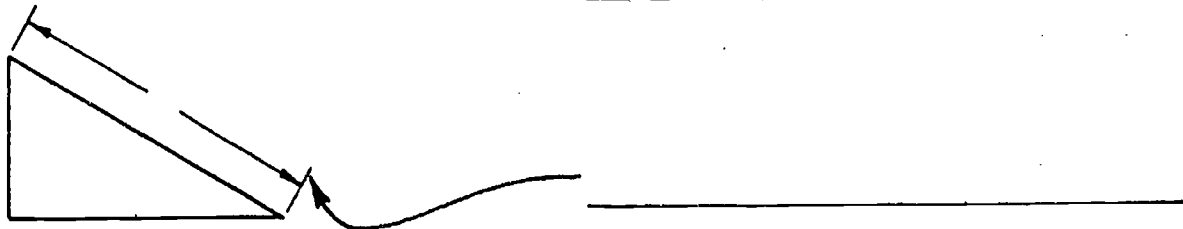
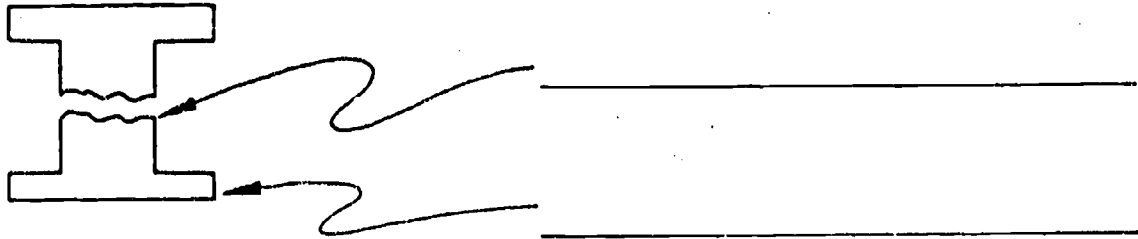
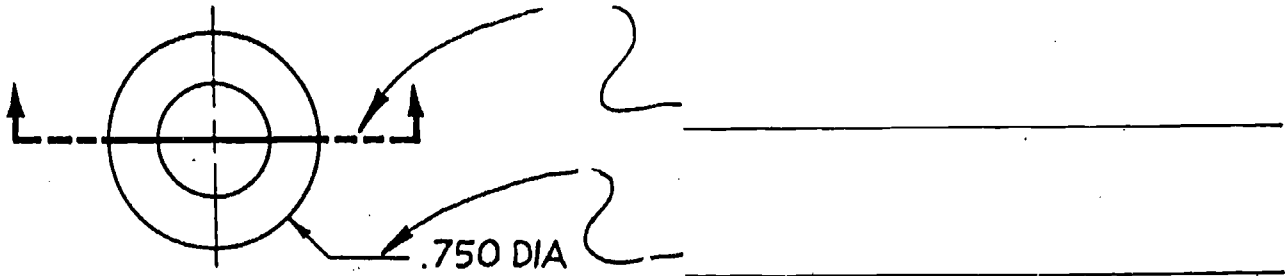


(MEDIUM THICK)

Self Assessment



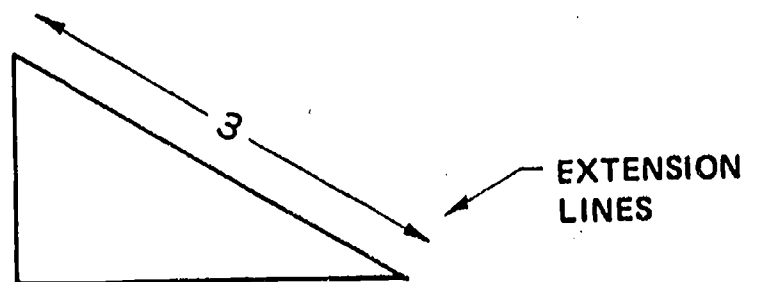
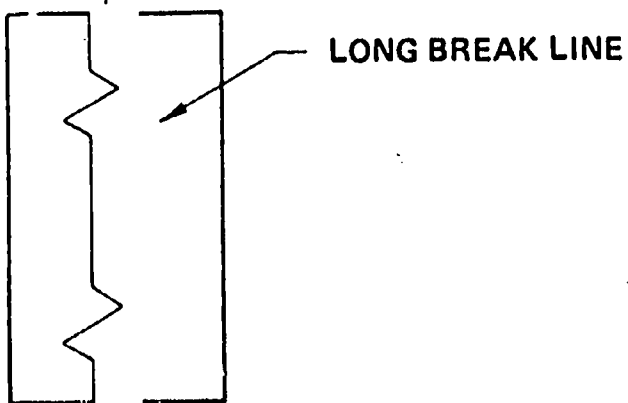
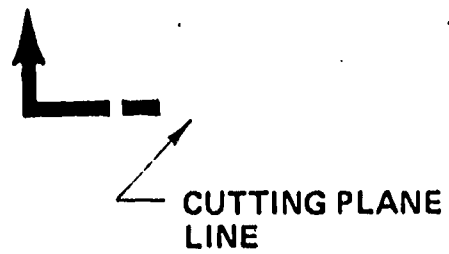
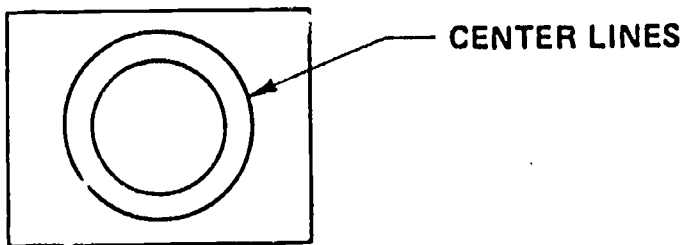
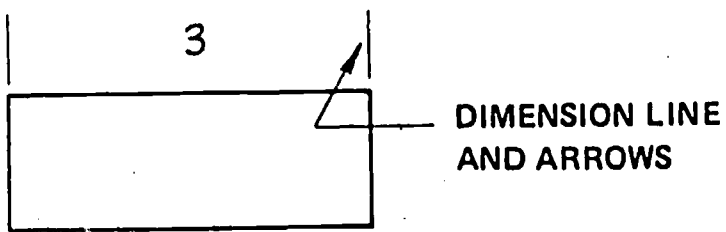
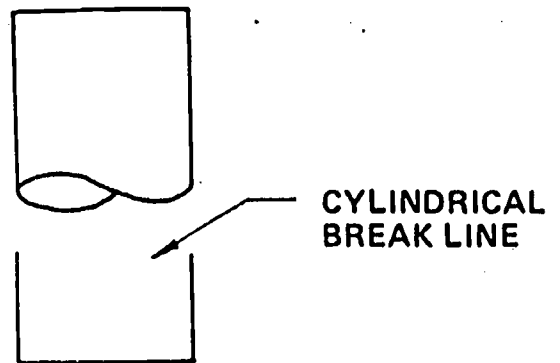
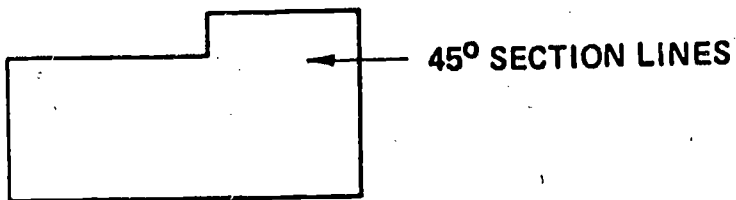
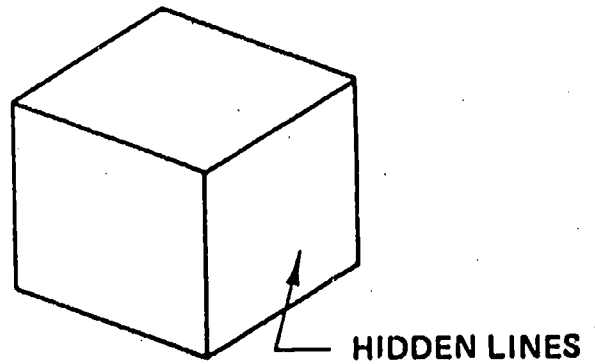
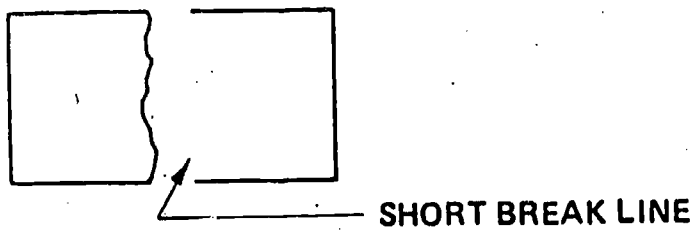
Directions: Name the types of lines shown below. Check your own answers.

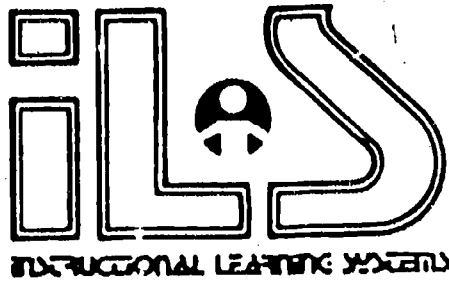


Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
 4. Object line; 5. Extension line; 6. Cylindrical break;
 7. Long break.

LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.





5.11

BLUEPRINT READING

Drafting: Basic Print Reading

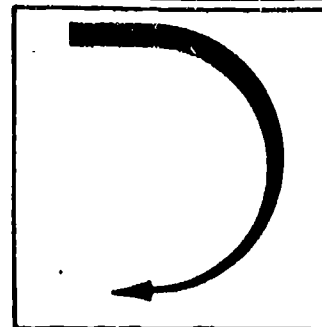
Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
2. Relate two dimensional drawings to three dimensional objects.
3. Utilize measurements and scales to interpret blueprints.
4. Identify the purpose and configuration of commonly used machine features.
5. Interpret notes on blueprints for dimensions and tolerances.

Introduction



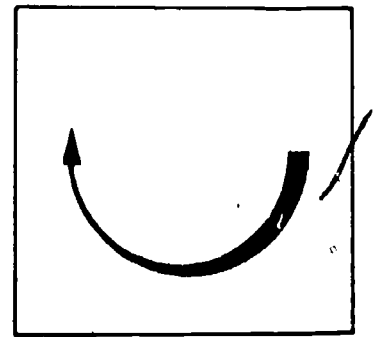
You have heard the saying that "a picture is worth a thousand words." This statement is particularly true in regard to technical drawings.

It would be nearly impossible for an engineer, designer, or architect to describe in words the shape, size and relationship of a complex object. Therefore, drawings have become the universal language used by engineers, designers, technicians, and craftspeople to communicate the information necessary to build, assemble and service the products of industry.

It is important to remember, as you study blueprint reading, that you are learning to communicate with the graphic language. Lines are part of the language.

Since technical drawings are made of lines, it is logical that the first step in learning to "read" a drawing is to learn the meaning of each kind of line. Generally, there are 11 basic types of lines. Each kind of line has a definite form and "weight." Weight refers to line thickness or width. When combined in a drawing, lines provide part of the information needed to understand the print.

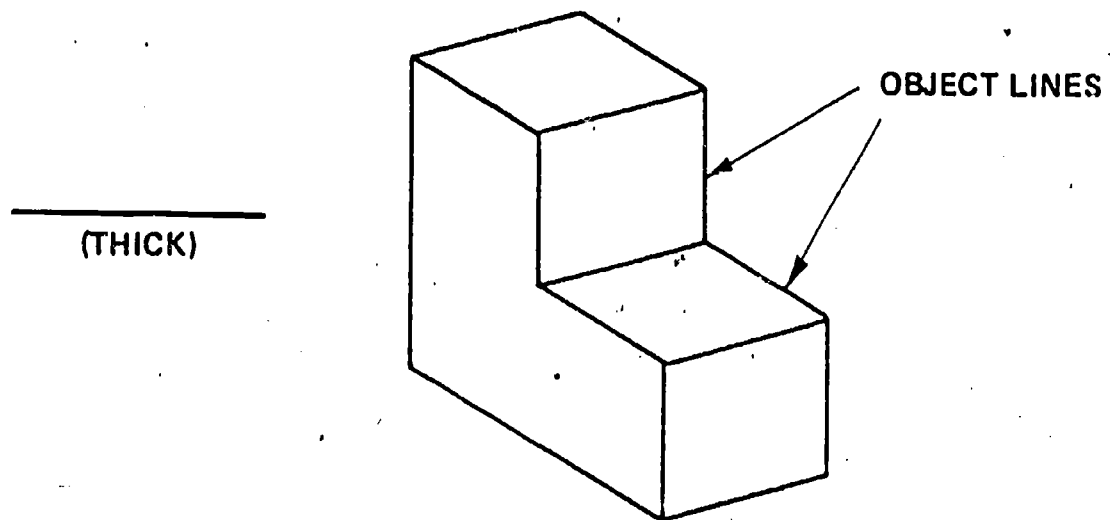
Information



The 11 lines used on prints are:

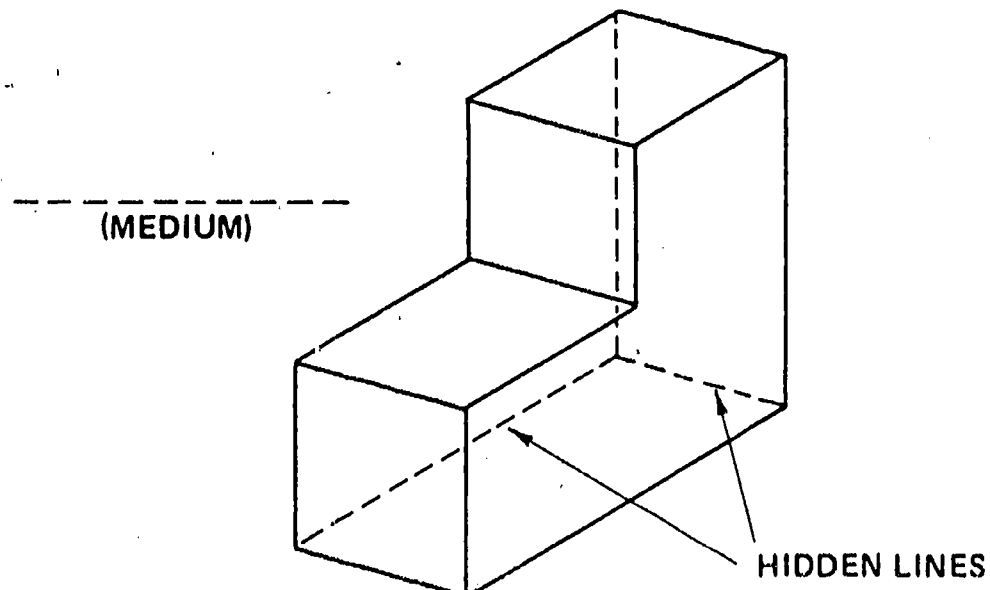
1. OBJECT LINE

An object line is a thick continuous line that indicates all the edges and visible surfaces of an object. An object line can also be called a visible line.



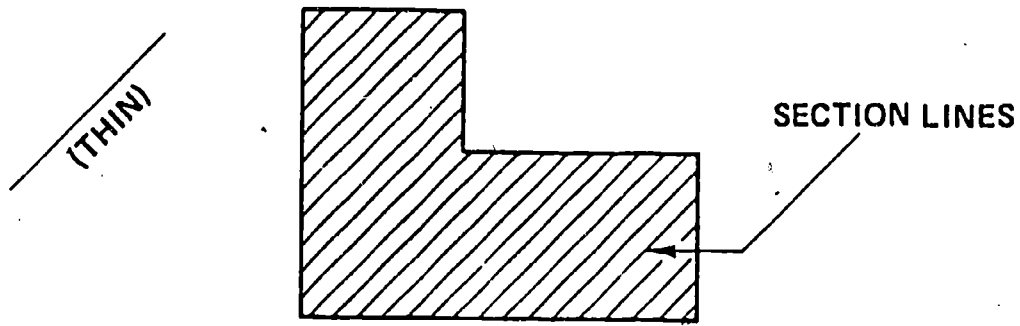
2. HIDDEN LINE

A hidden line is a medium weight line, made of short dashes, to show edges, surfaces and corners which cannot be seen. They are used to make a drawing easier to understand.



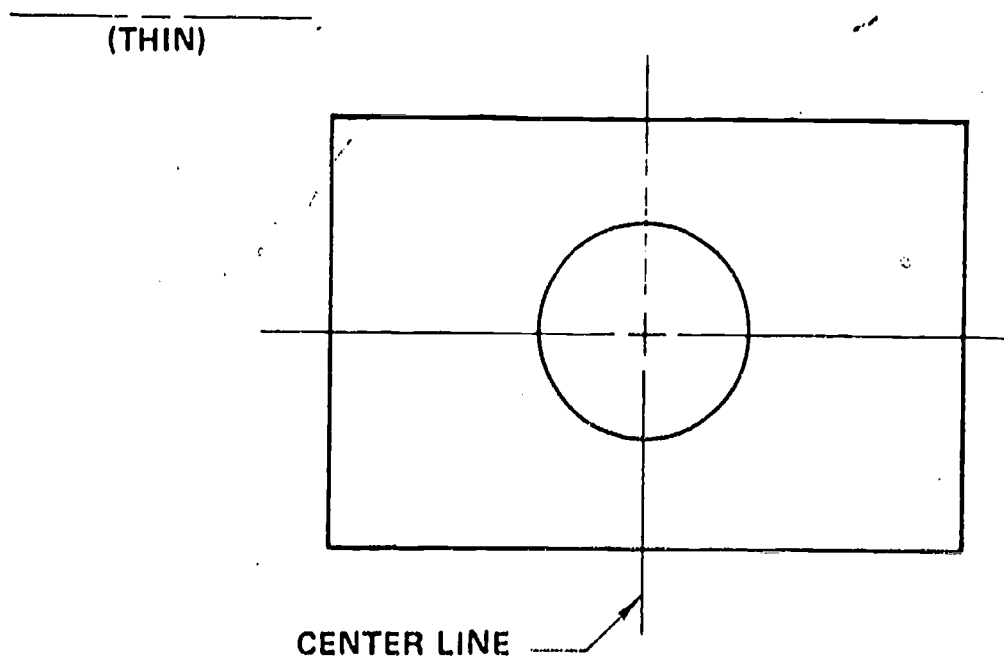
3. SECTION LINE

Section lines are used on a drawing to show how it would look if it were sectioned, or cut apart, to give a better picture of shape or internal construction. Section lines are very thin, and are usually drawn at 45 degrees. They show the cut surface of an object in sectional view. More on sections will be explained later.



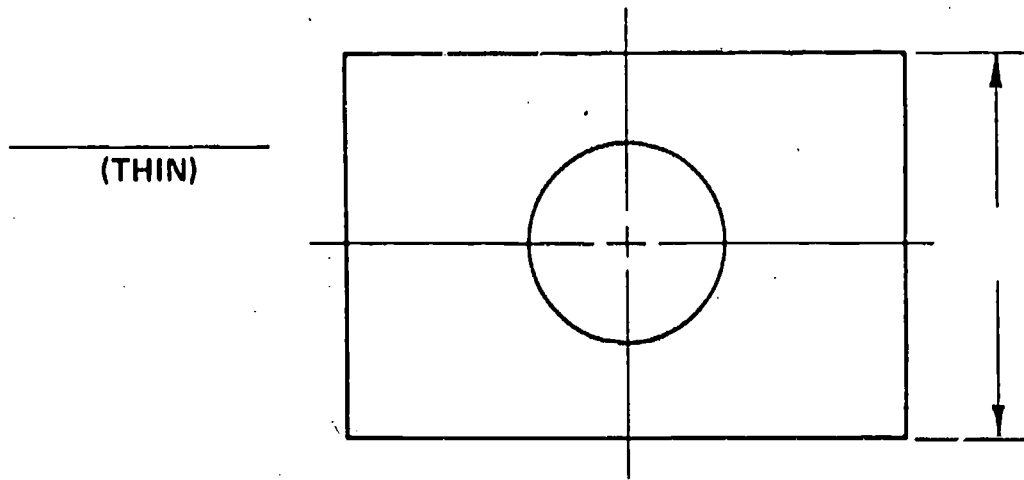
4. CENTER LINE

Center lines are used to indicate the center of holes, arcs, and symmetrical objects. They are very thin and consist of long-short-long dashes.



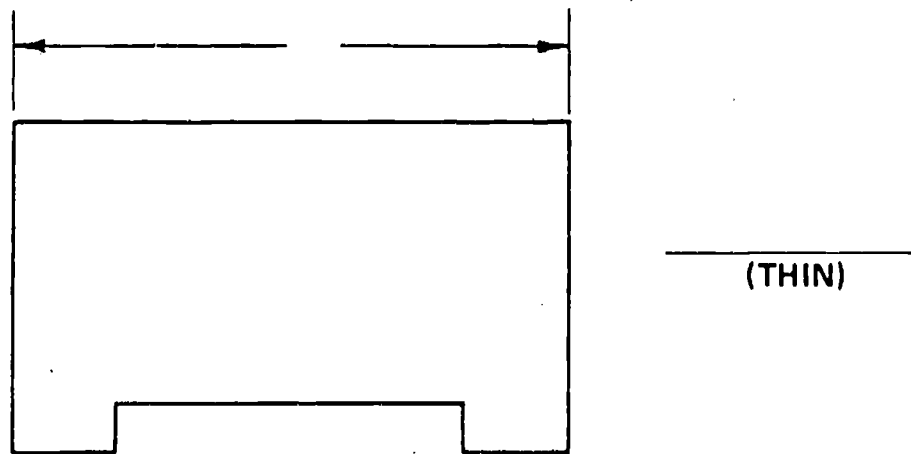
5. DIMENSION LINE

Dimension lines are thin lines used to show the extent and direction of dimensions on an object. Dimension lines usually end with an arrowhead.



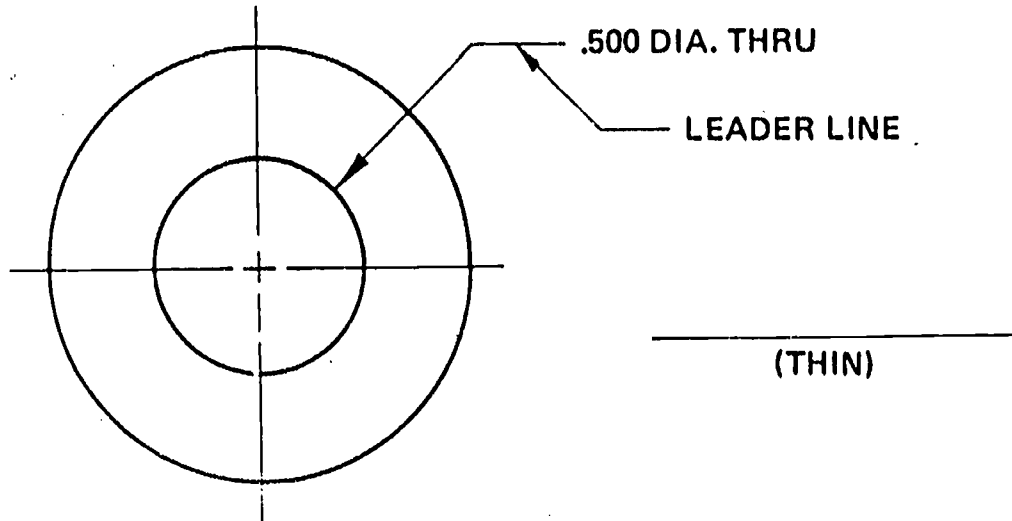
6. EXTENSION LINE

Extension lines are also thin lines showing the limits of dimensions. Dimension line arrowheads touch extension lines.



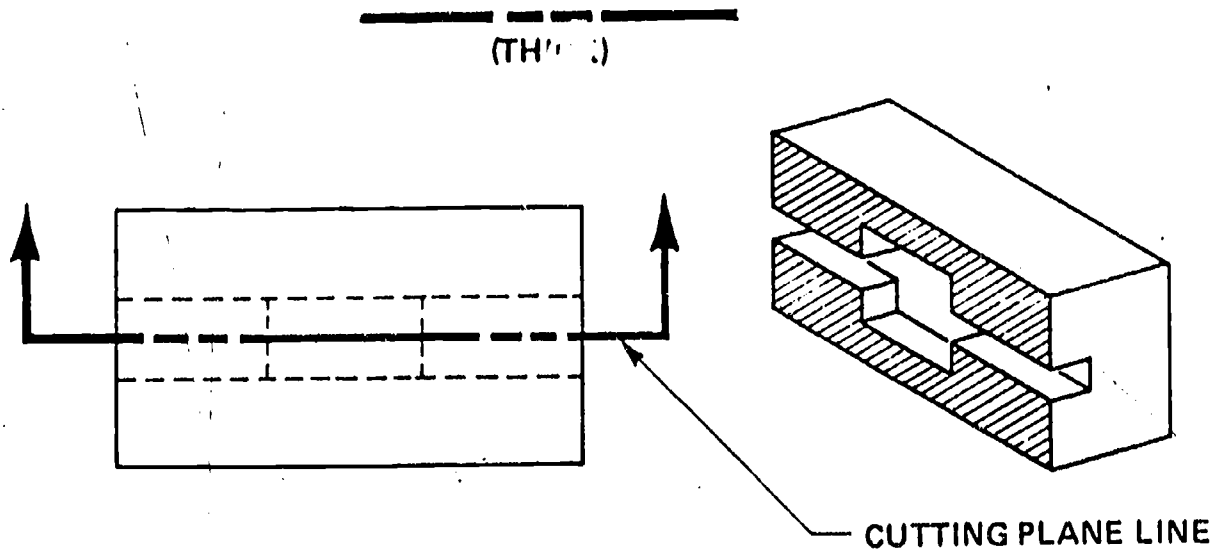
7. LEADER LINES

Leaders are more thin lines used to point to an area on a drawing requiring a note for further explanation.



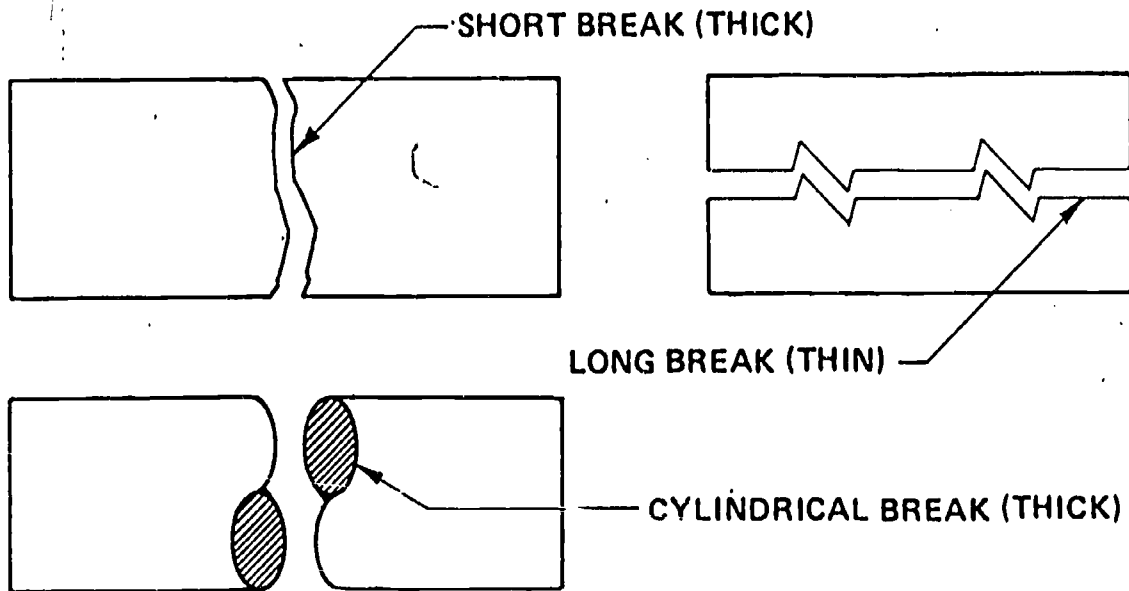
8. CUTTING PLANE LINE

A cutting plane line (very heavy) helps to show a reference for sectioning. It is a line showing the plane where an imaginary cut is made to expose the internal shape of an object.



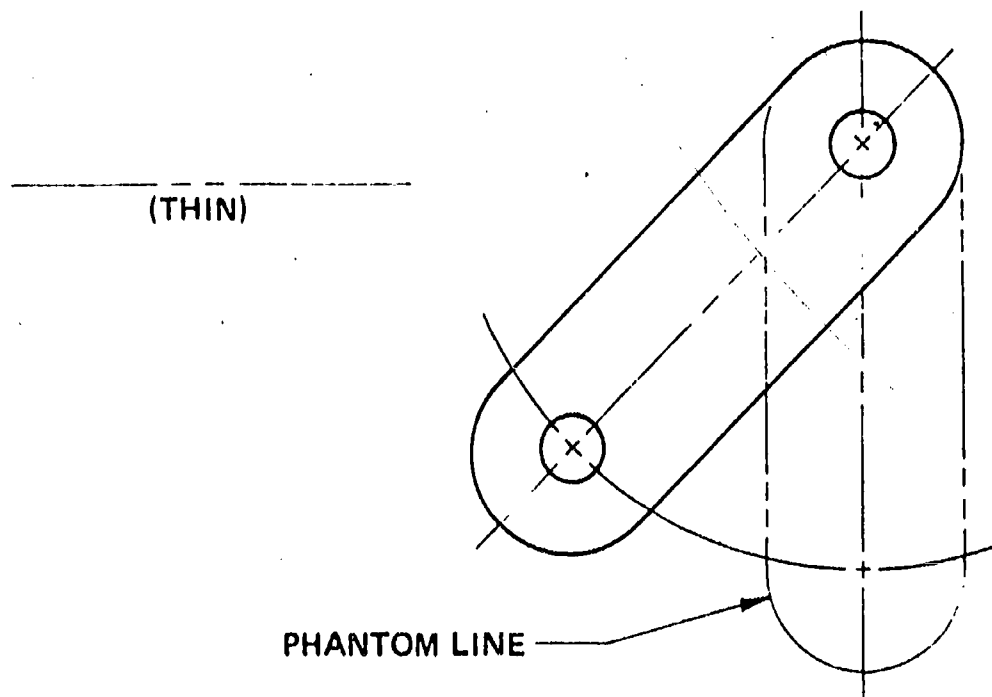
9. BREAK LINES (short, long, cylindrical)

There are three kinds of break lines used in drawings. They are used to remove or "break out" part of a drawing for clarity, and also to shorten objects which have the same shade throughout their length and may be too long to place on the drawing.



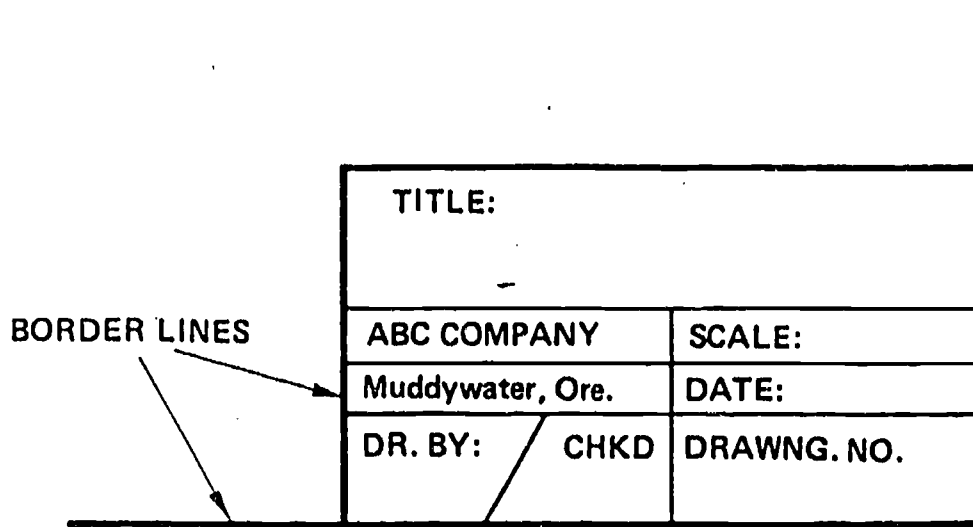
10. PHANTOM LINES

Phantom lines are thin, long-short-short-long lines most often used to show movement or travel of an object or part in alternate positions. It can also be used to show adjacent objects or features.



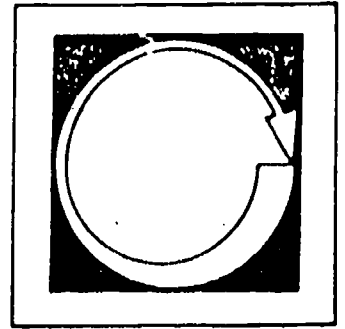
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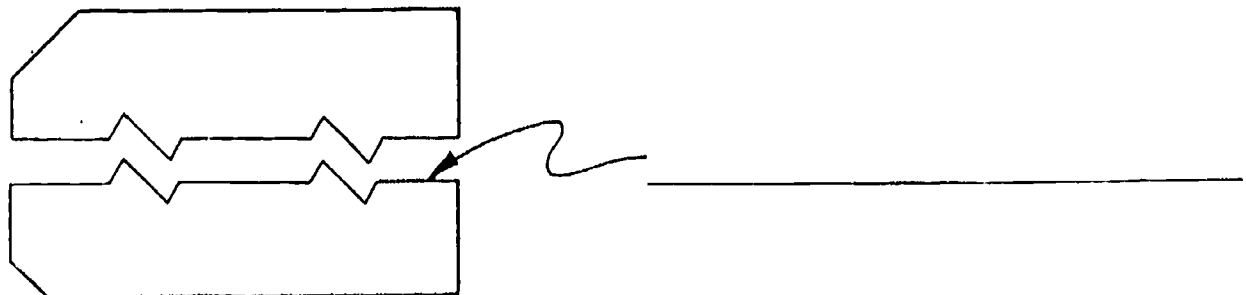
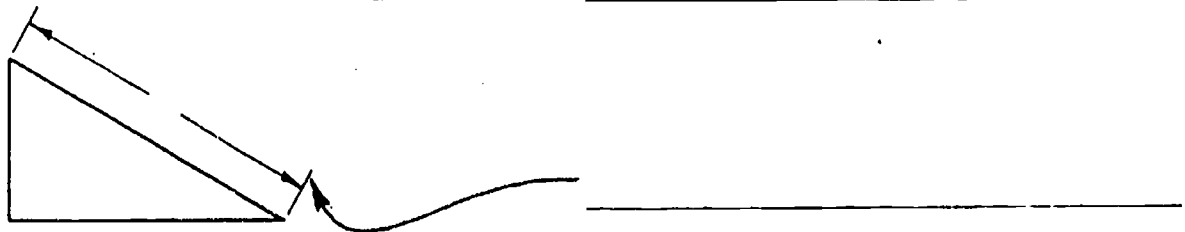
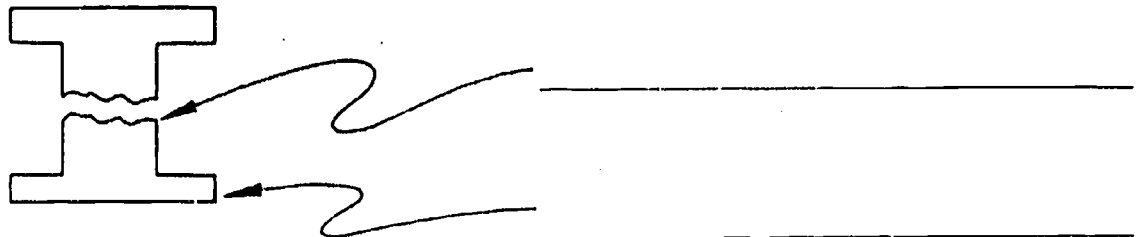
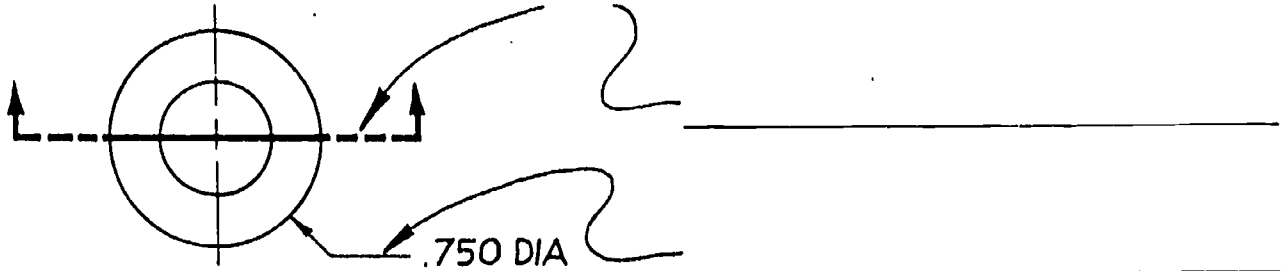


(MEDIUM THICK)

Self Assessment



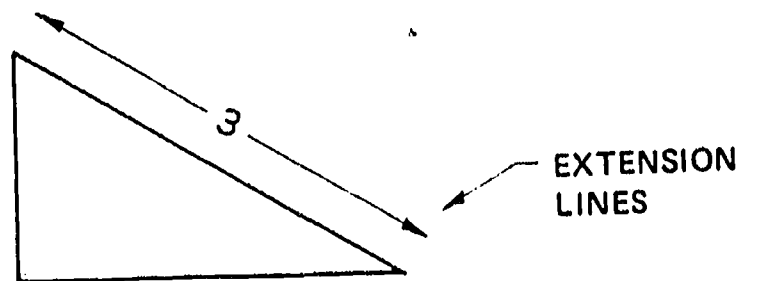
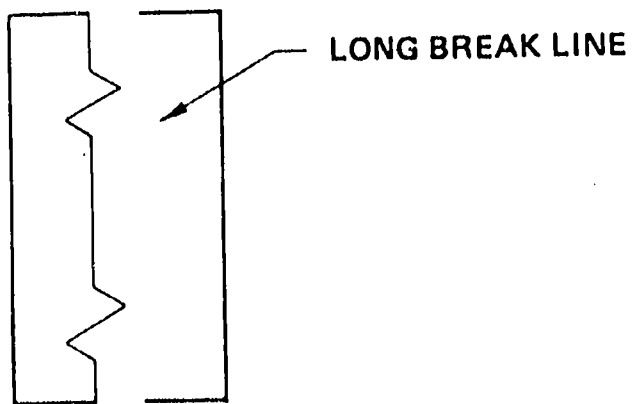
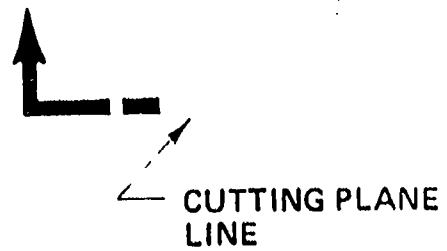
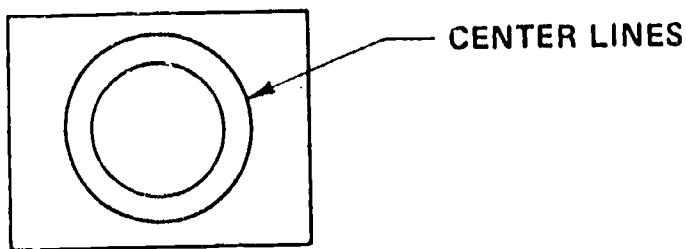
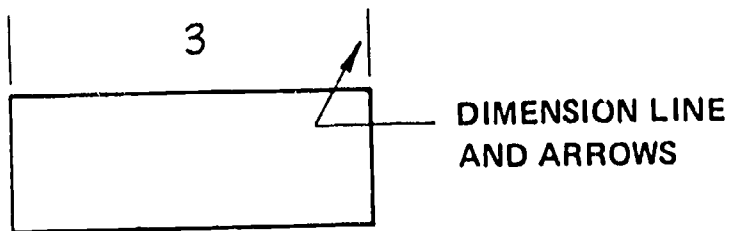
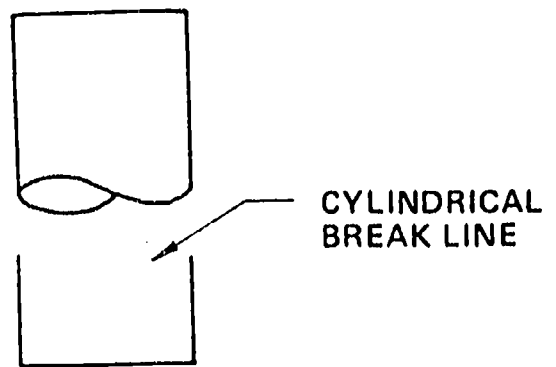
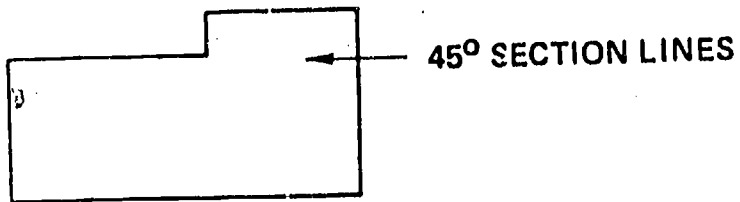
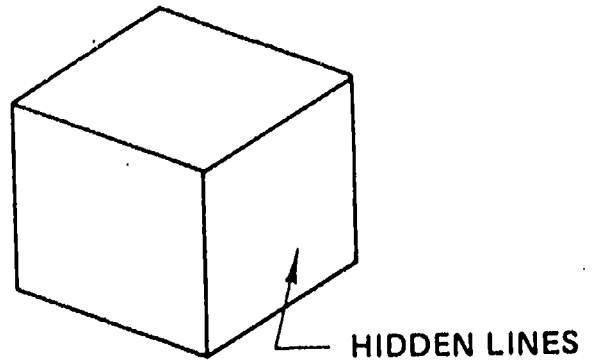
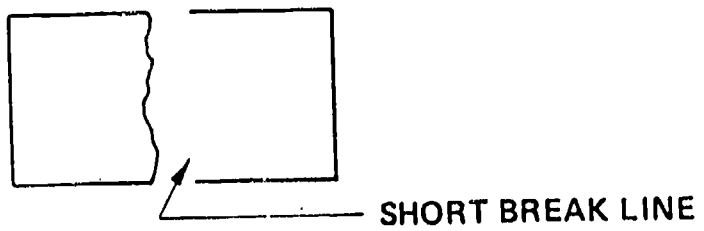
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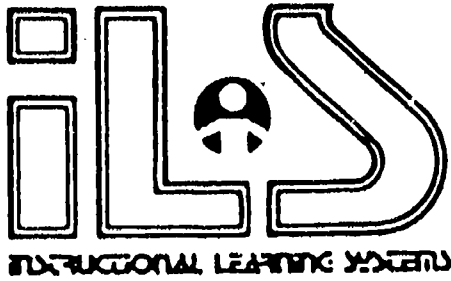


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5.12

BLUEPRINT READING

Drafting: Basic Print Reading

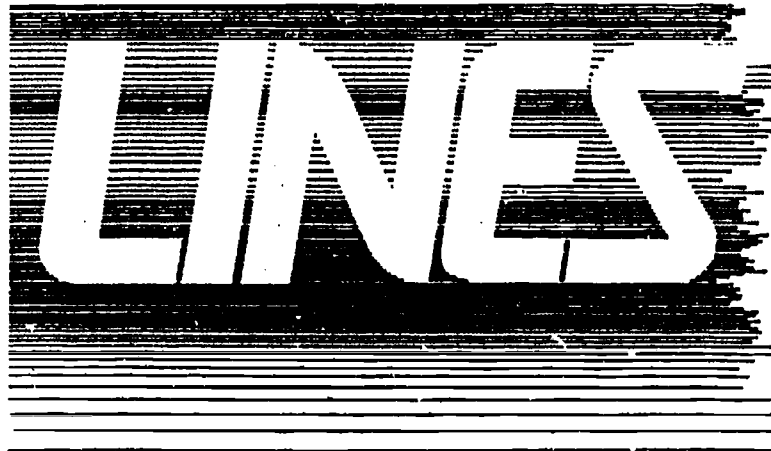
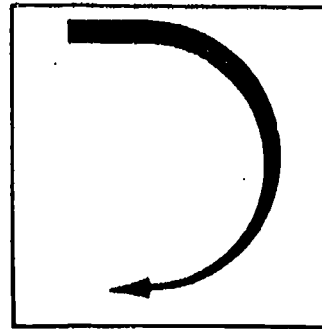
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Introduction



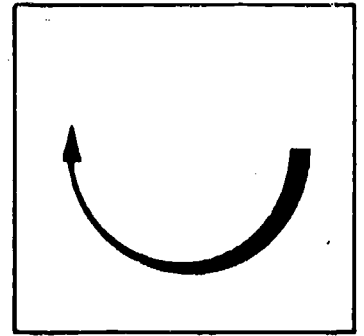
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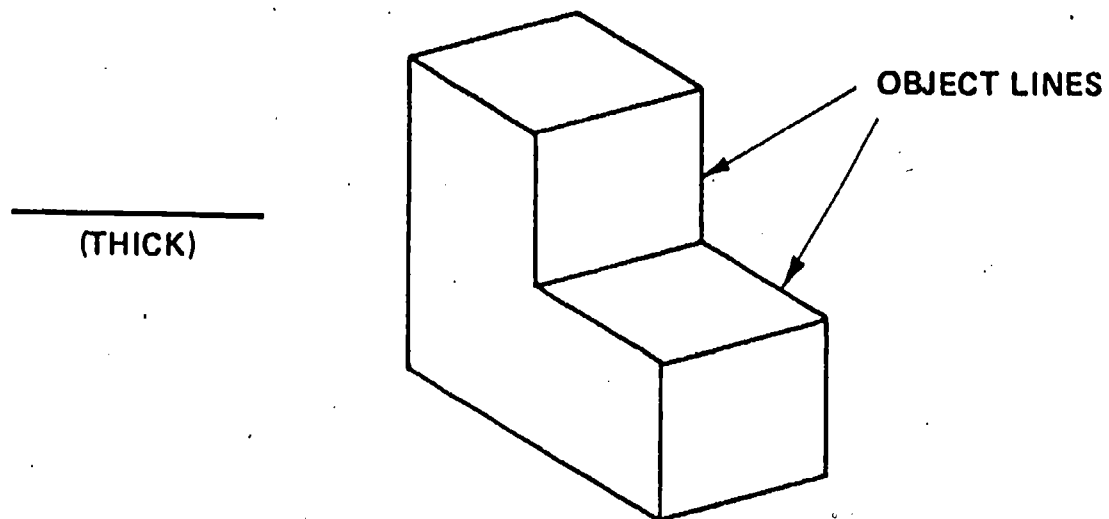
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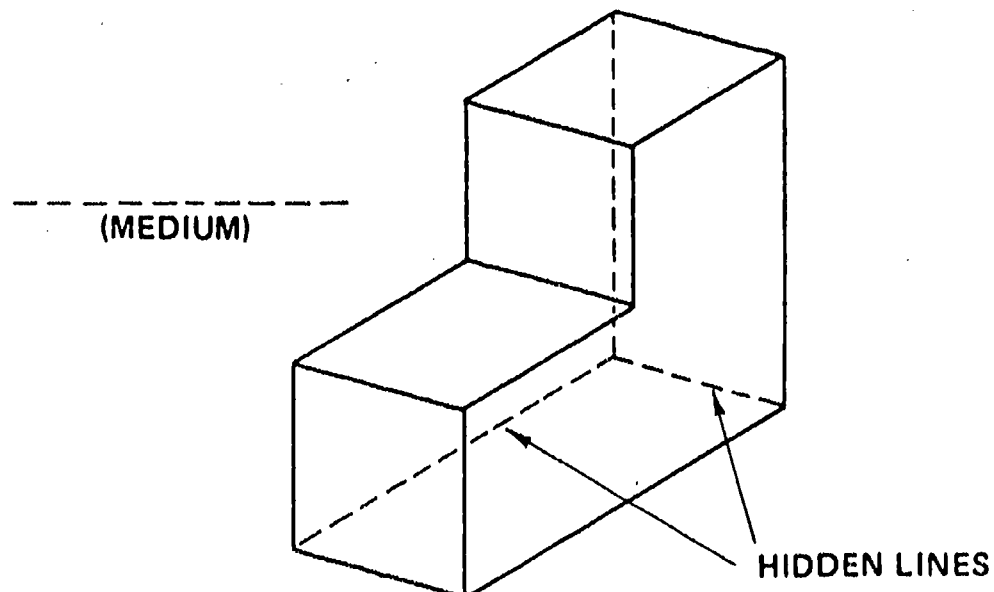
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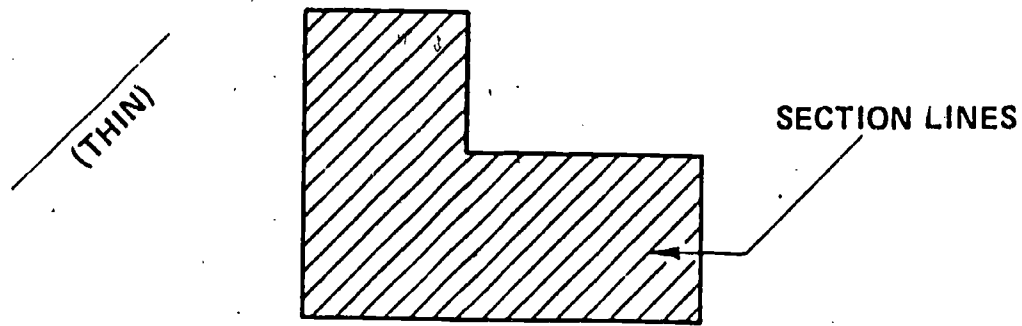
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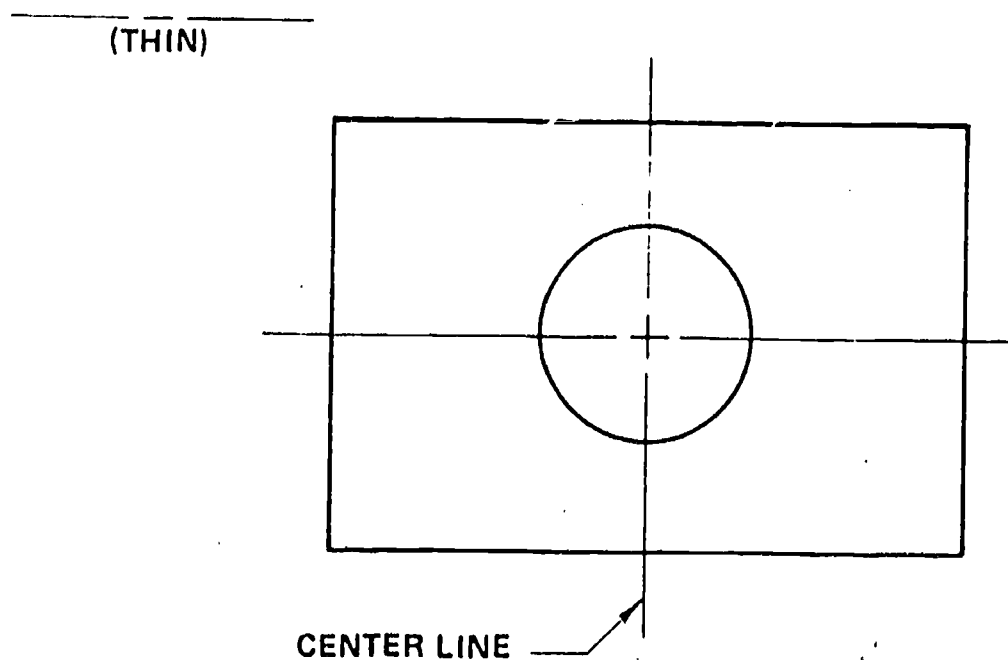
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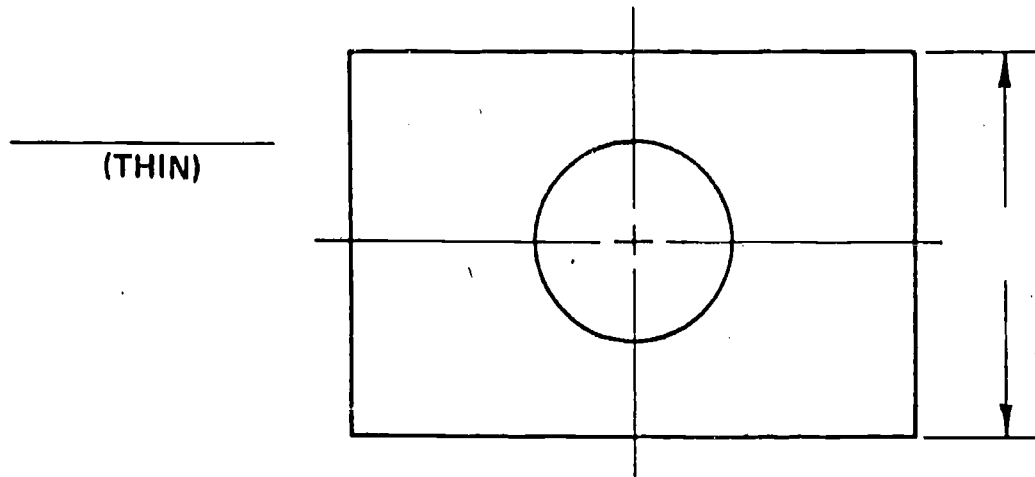
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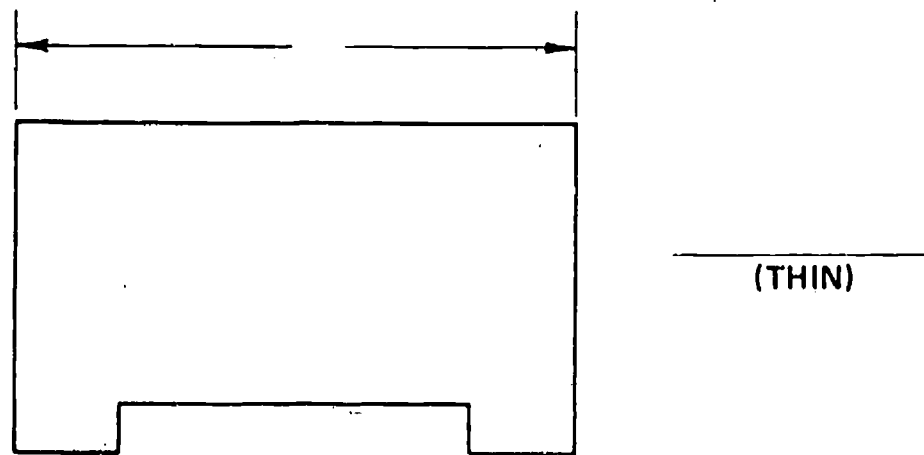
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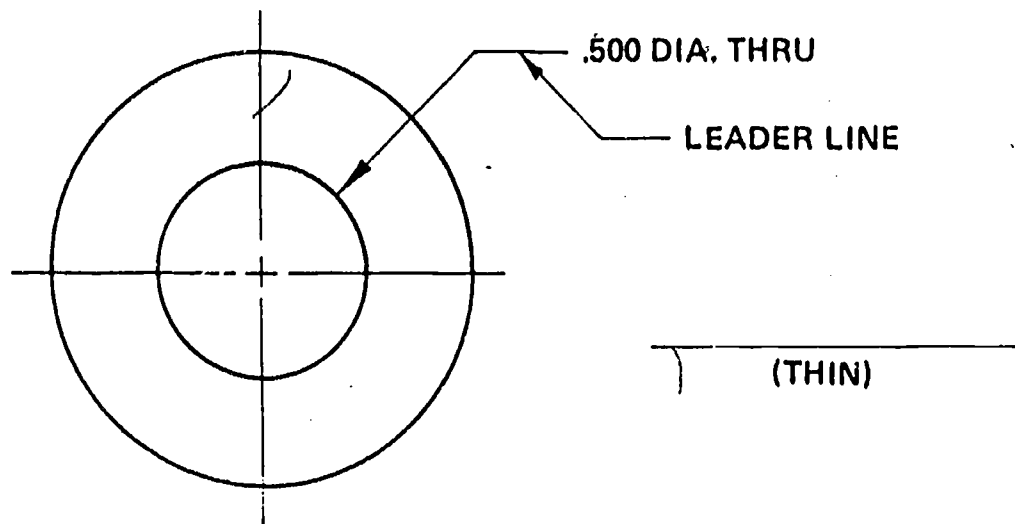
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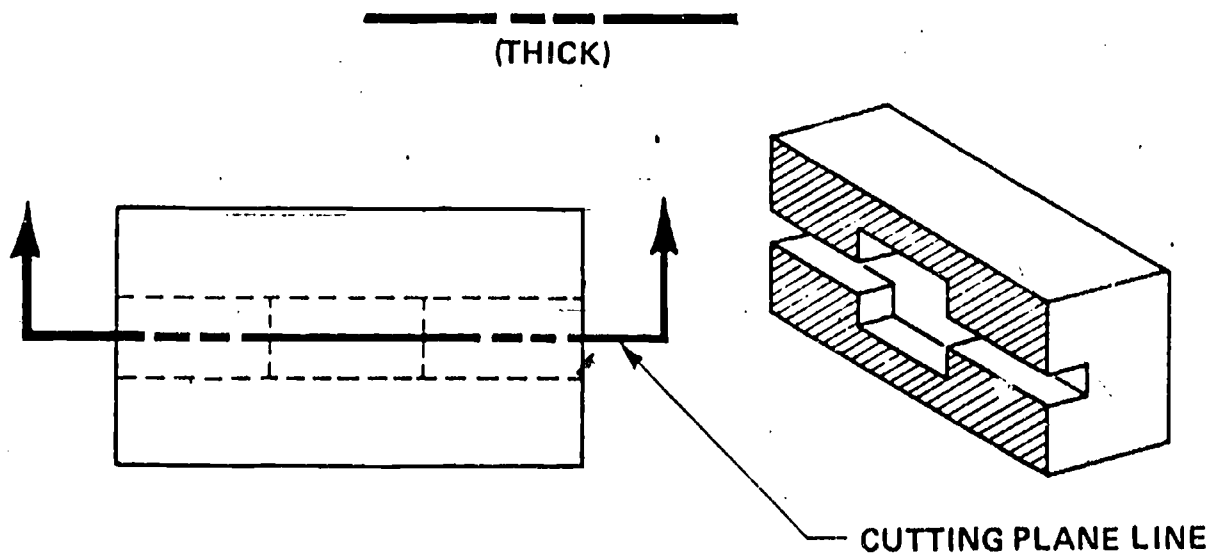
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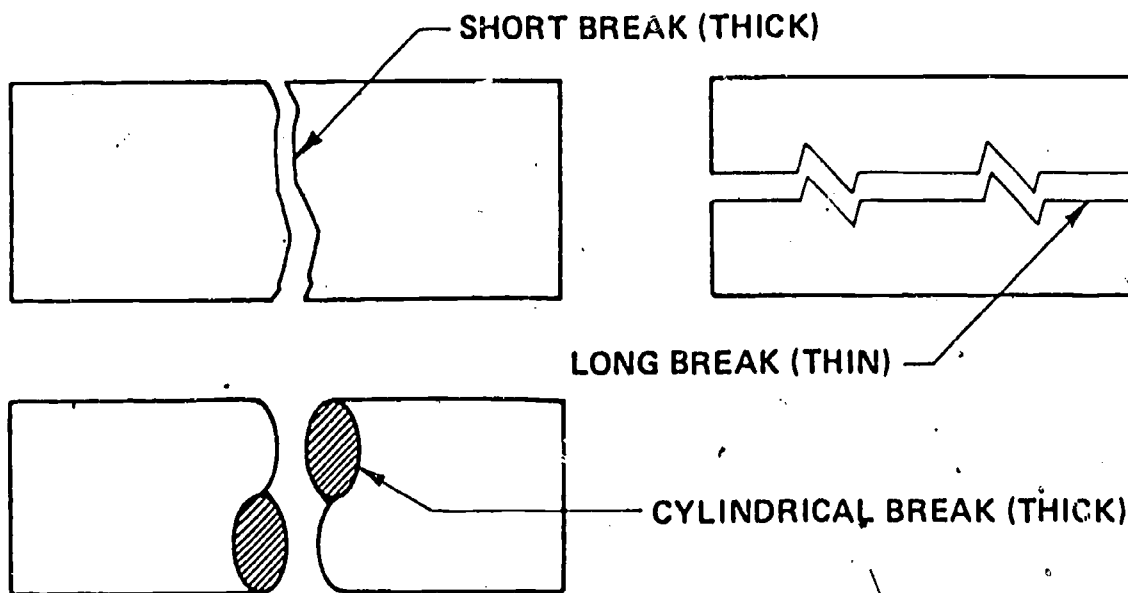
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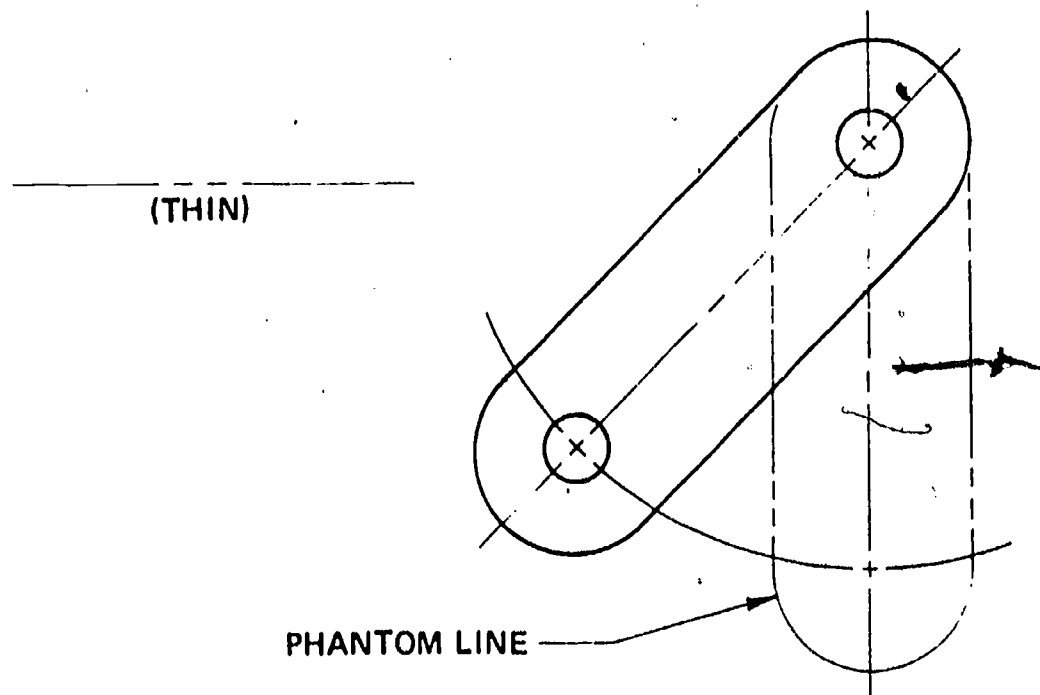
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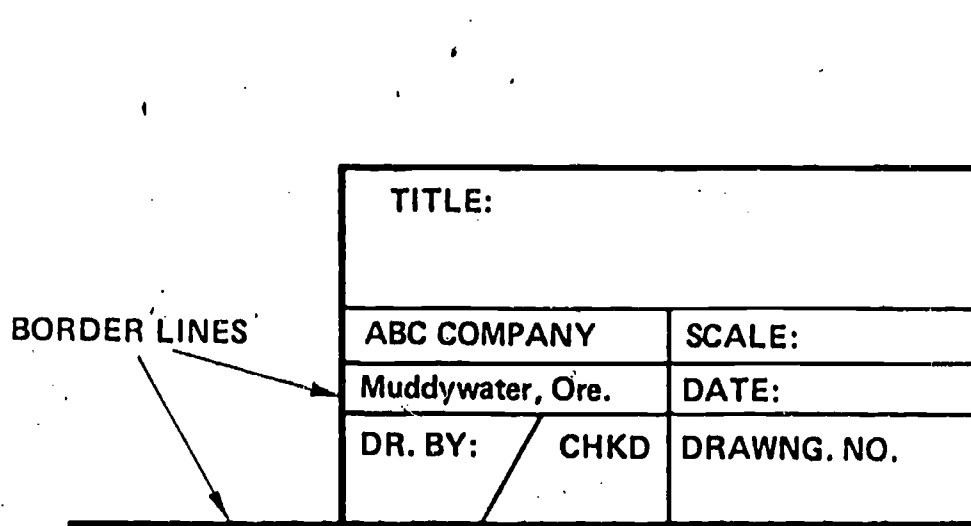
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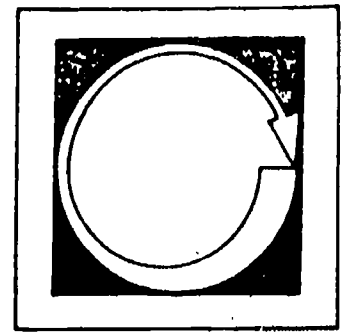
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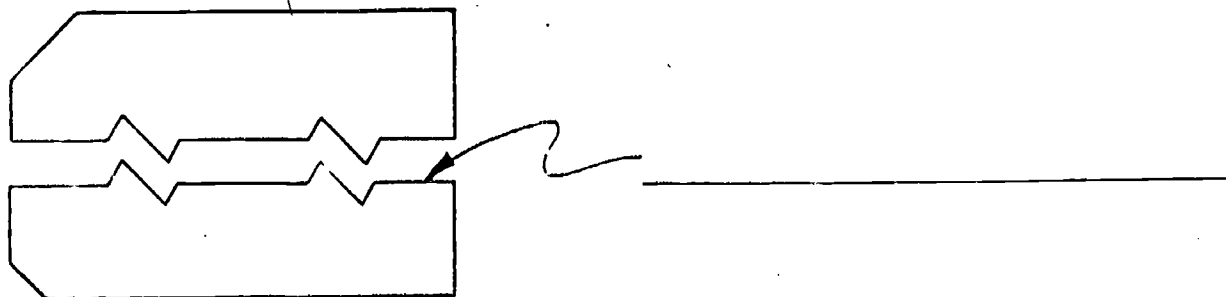
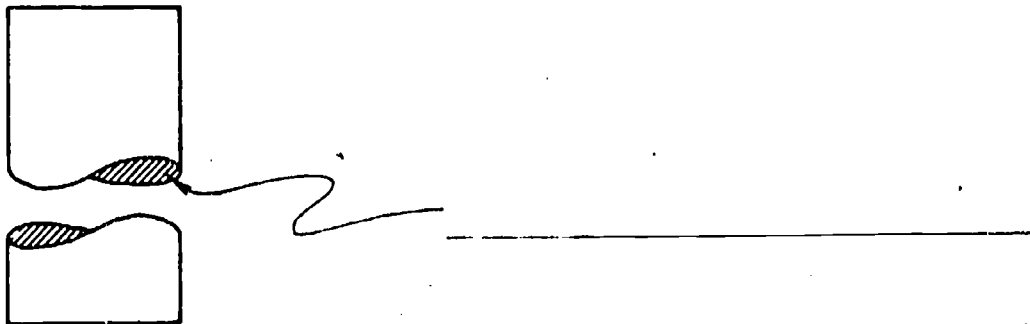
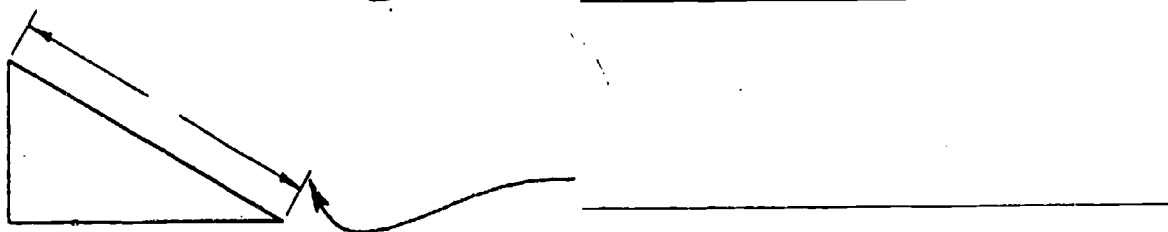
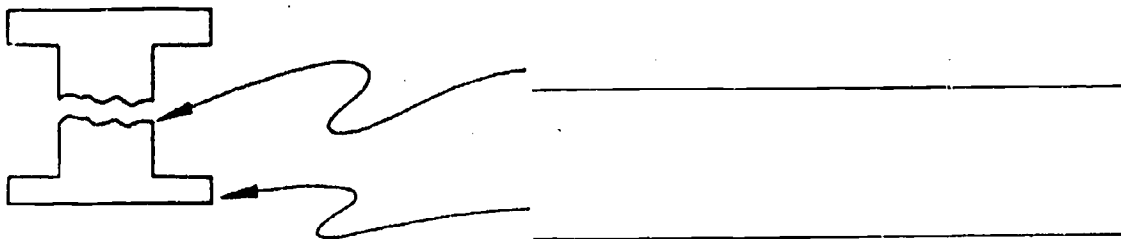
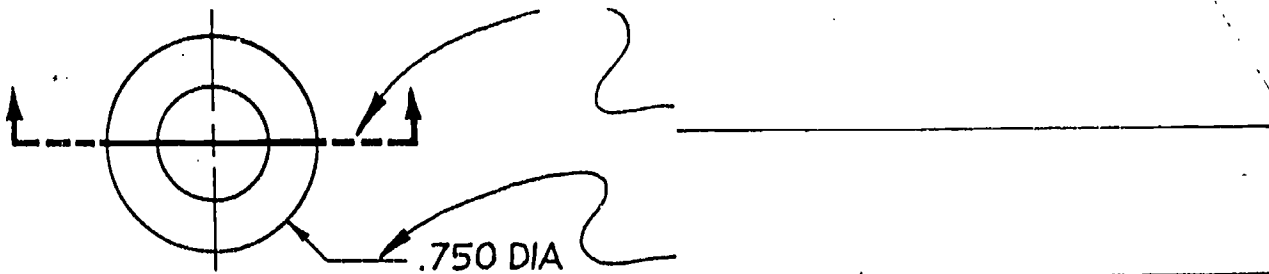


(MEDIUM THICK)

Self Assessment



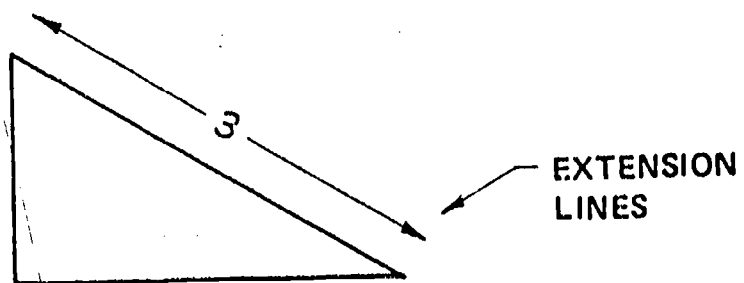
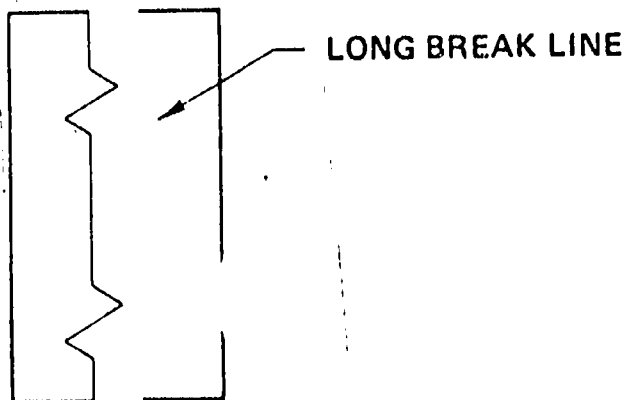
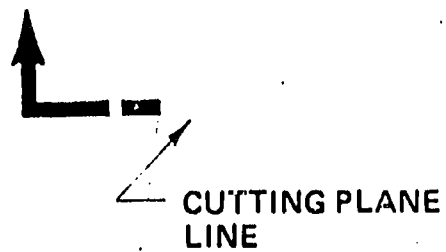
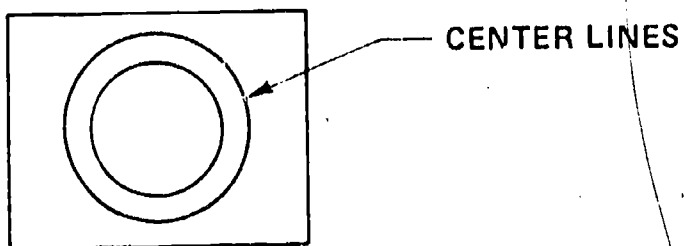
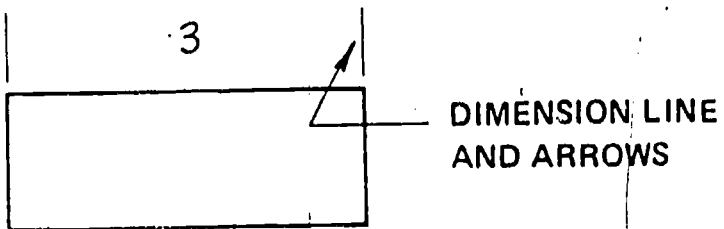
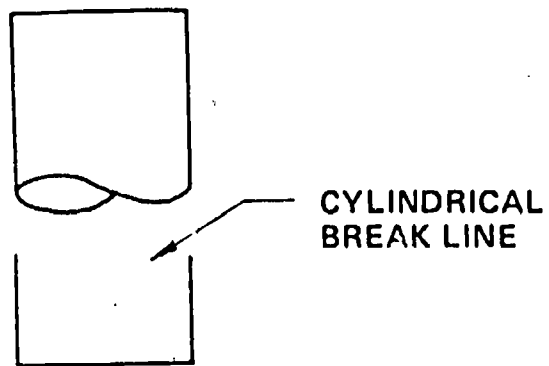
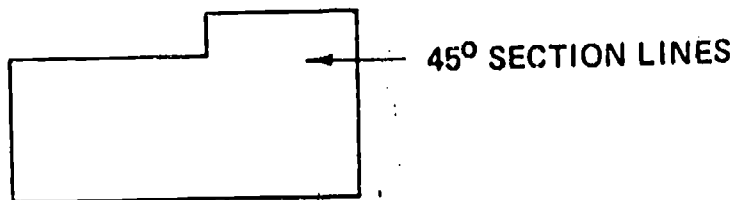
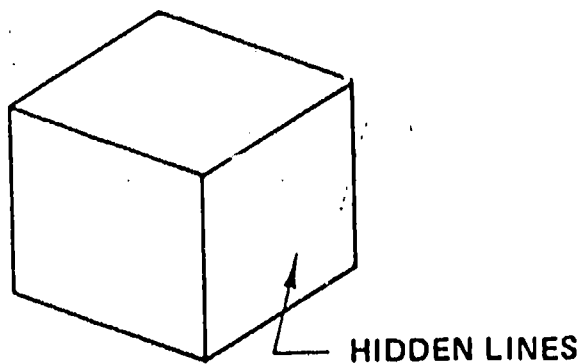
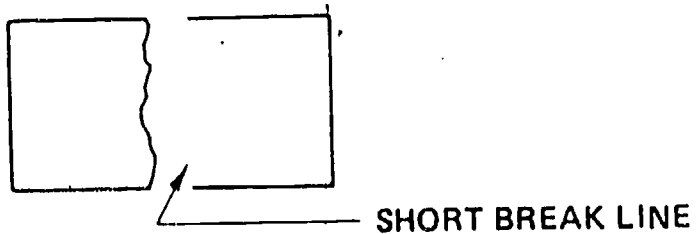
Directions: Name the types of lines shown below. Check your own answers.



- Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
 4. Object line; 5. Extension line; 6. Cylindrical break;
 7. Long break.

LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.





5.13

BLUEPRINT READING

Drafting: Basic Print Reading

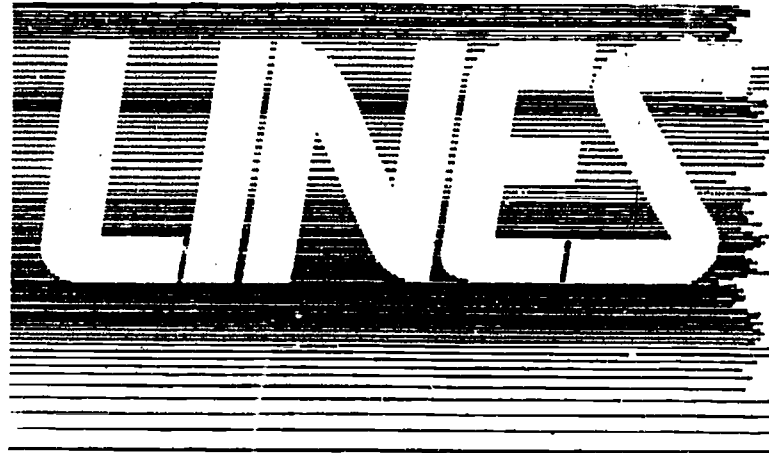
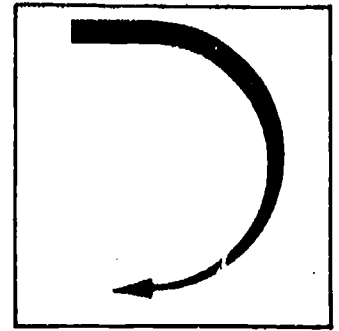
Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
2. Relate two dimensional drawings to three dimensional objects.
3. Utilize measurements and scales to interpret blueprints.
4. Identify the purpose and configuration of commonly used machine features.
5. Interpret notes on blueprints for dimensions and tolerances.

Introduction



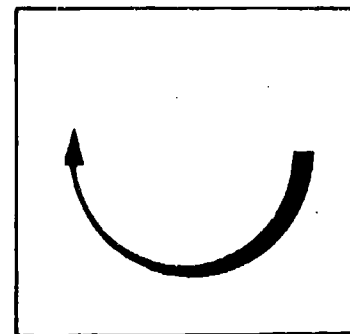
You have heard the saying that "a picture is worth a thousand words." This statement is particularly true in regard to technical drawings.

It would be nearly impossible for an engineer, designer, or architect to describe in words the shape, size and relationship of a complex object. Therefore, drawings have become the universal language used by engineers, designers, technicians, and craftspeople to communicate the information necessary to build, assemble and service the products of industry.

It is important to remember, as you study blueprint reading, that you are learning to communicate with the graphic language. Lines are part of the language.

Since technical drawings are made of lines, it is logical that the first step in learning to "read" a drawing is to learn the meaning of each kind of line. Generally, there are 11 basic types of lines. Each kind of line has a definite form and "weight." Weight refers to line thickness or width. When combined in a drawing, lines provide part of the information needed to understand the print.

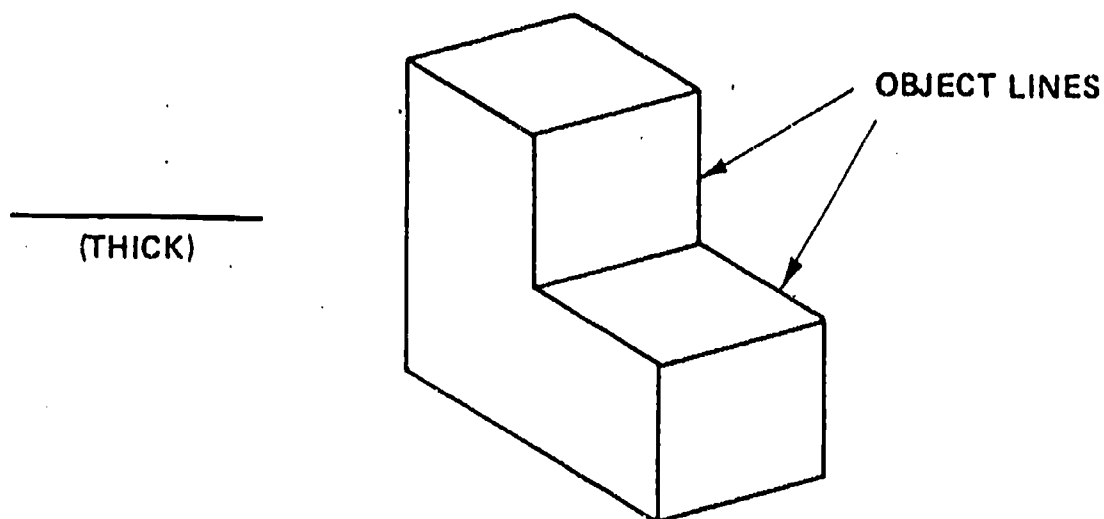
Information



The 11 lines used on prints are:

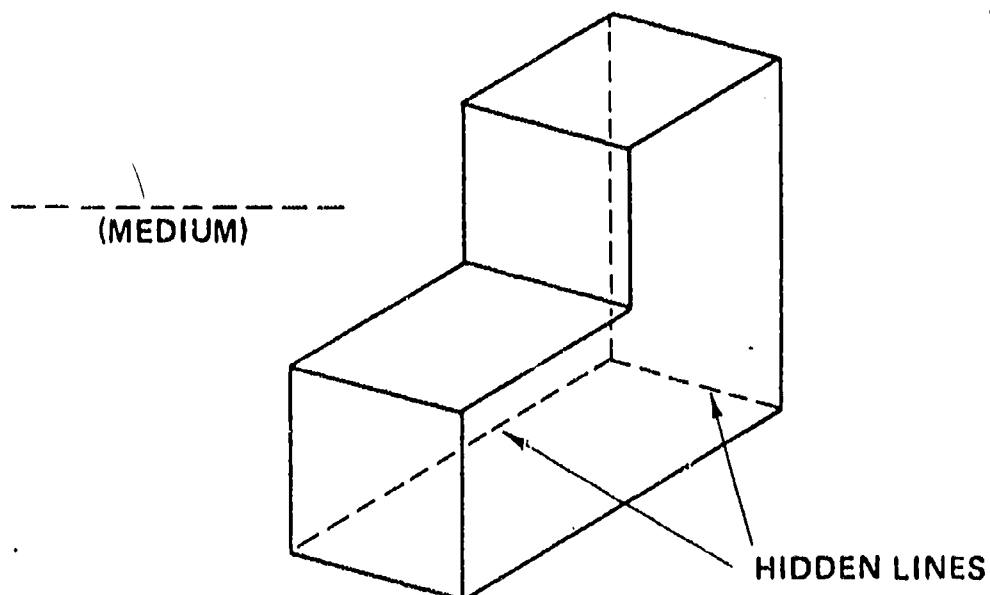
1. OBJECT LINE

An object line is a thick continuous line that indicates all the edges and visible surfaces of an object. An object line can also be called a visible line.



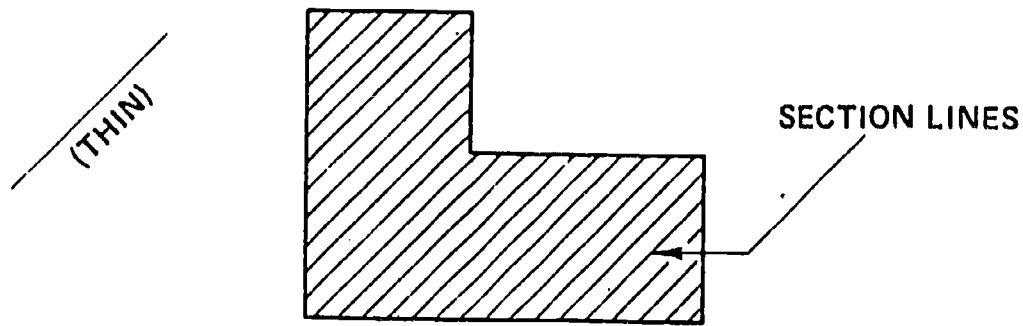
2. HIDDEN LINE

A hidden line is a medium weight line, made of short dashes, to show edges, surfaces and corners which cannot be seen. They are used to make a drawing easier to understand.



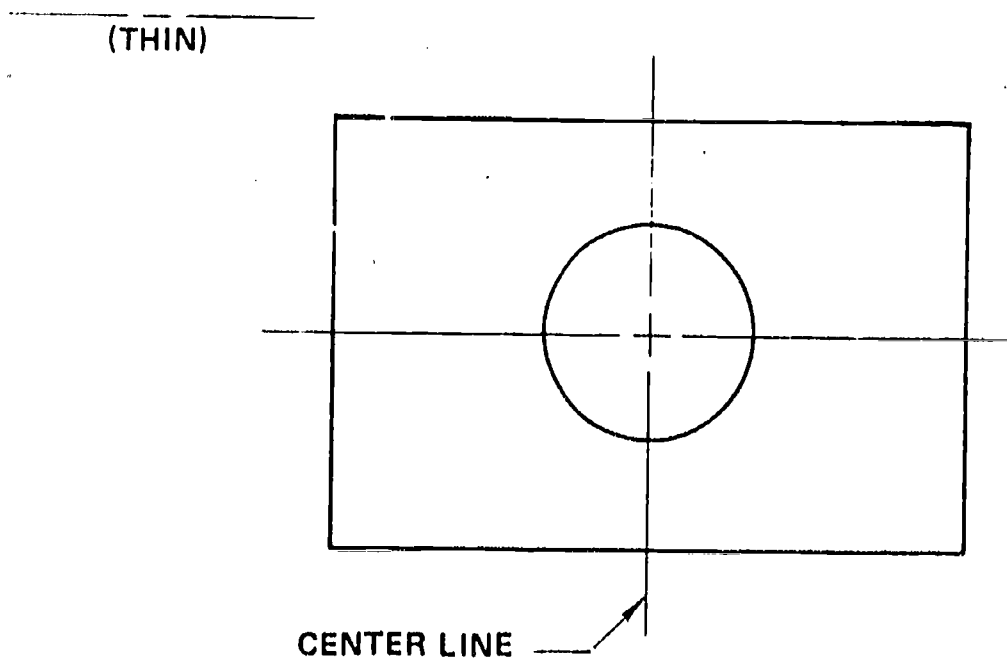
3. SECTION LINE

Section lines are used on a drawing to show how it would look if it were sectioned, or cut apart, to give a better picture of shape or internal construction. Section lines are very thin, and are usually drawn at 45 degrees. They show the cut surface of an object in sectional view. More on sections will be explained later.



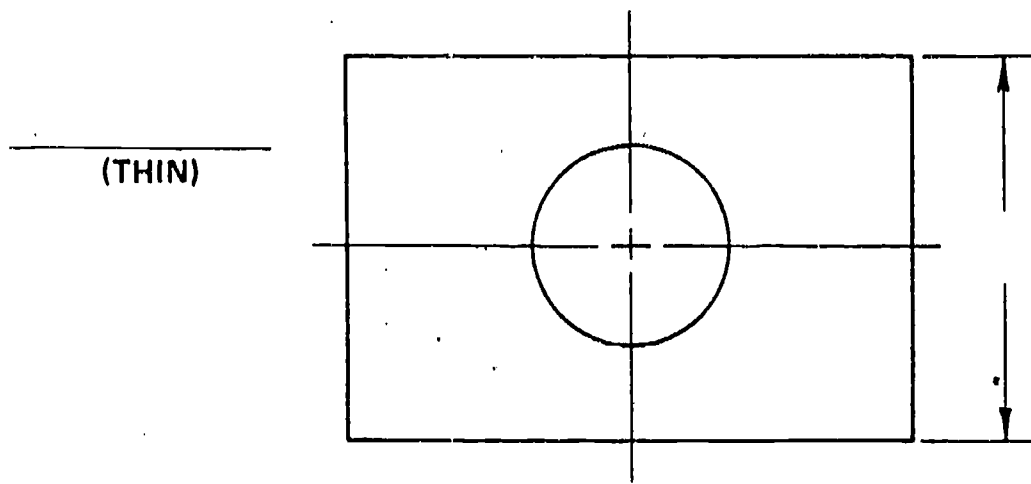
4. CENTER LINE

Center lines are used to indicate the center of holes, arcs, and symmetrical objects. They are very thin and consist of long-short-long dashes.



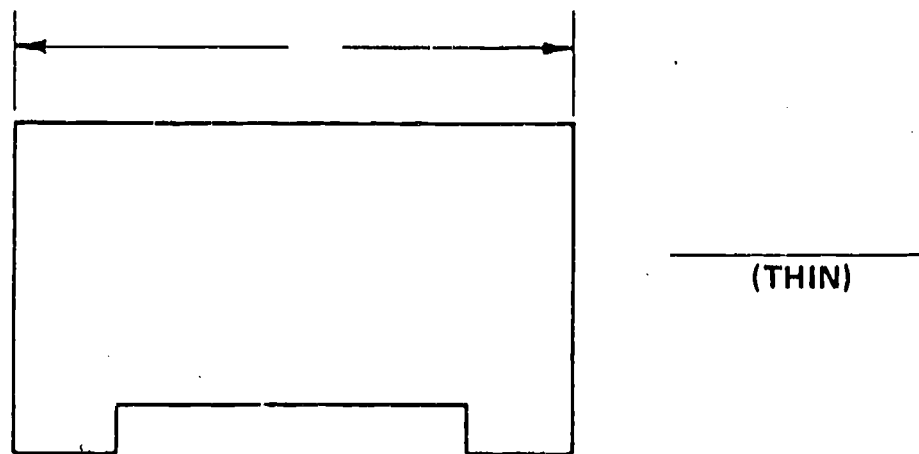
5. DIMENSION LINE

Dimension lines are thin lines used to show the extent and direction of dimensions on an object. Dimension lines usually end with an arrowhead.



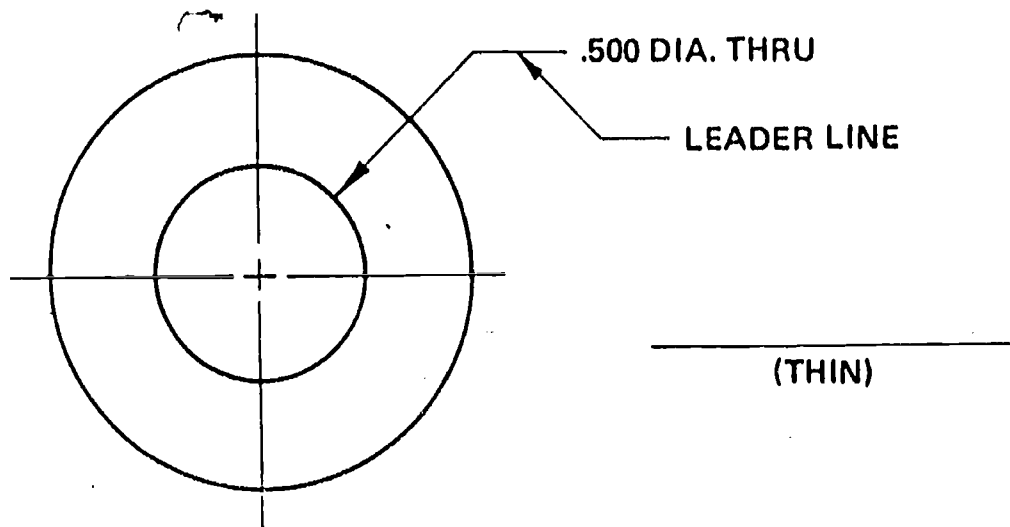
6. EXTENSION LINE

Extension lines are also thin lines showing the limits of dimensions. Dimension line arrowheads touch extension lines.



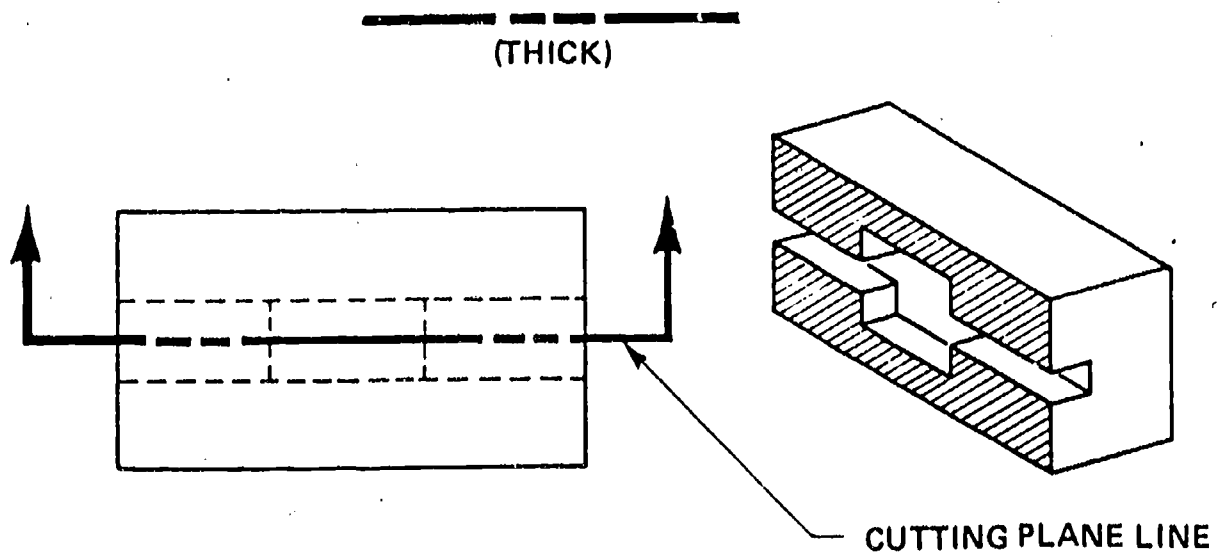
7. LEADER LINES

Leaders are more thin lines used to point to an area on a drawing requiring a note for further explanation.



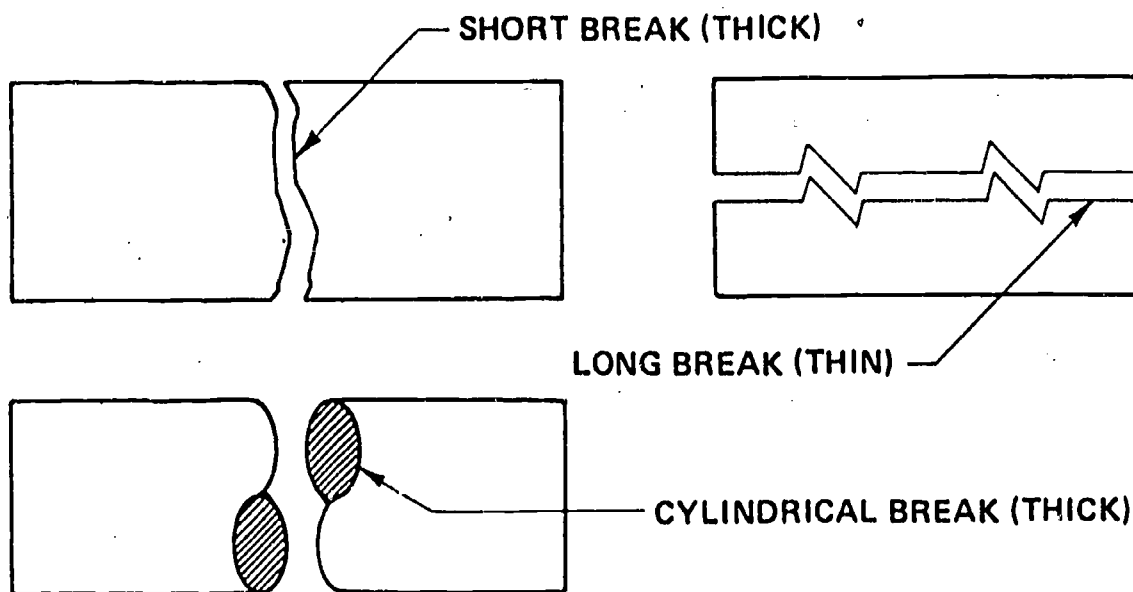
8. CUTTING PLANE LINE

A cutting plane line (very heavy) helps to show a reference for sectioning. It is a line showing the plane where an imaginary cut is made to expose the internal shape of an object.



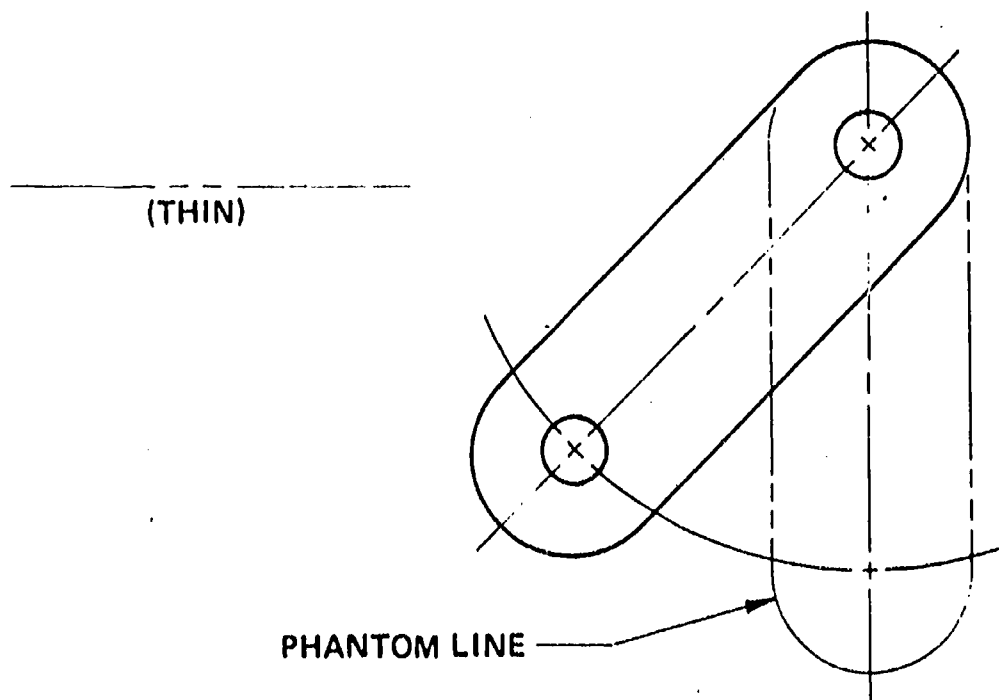
9. BREAK LINES (short, long, cylindrical)

There are three kinds of break lines used in drawings. They are used to remove or "break out" part of a drawing for clarity, and also to shorten objects which have the same shade throughout their length and may be too long to place on the drawing.



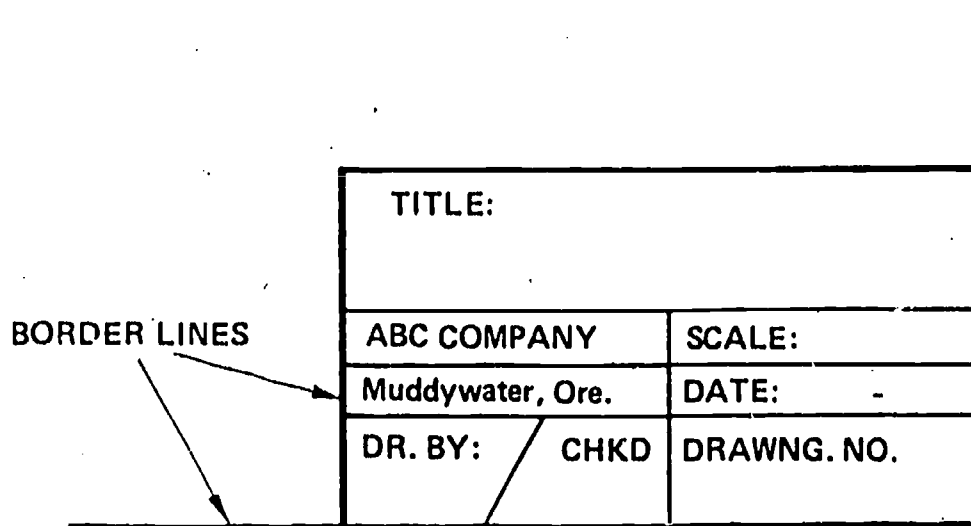
10. PHANTOM LINES

Phantom lines are thin, long-short-short-long lines most often used to show movement or travel of an object or part in alternate positions. It can also be used to show adjacent objects or features.



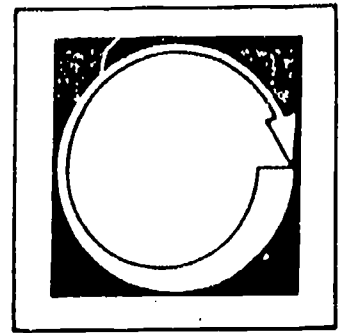
11. BORDER LINES

Border lines are medium thick, continuous lines used to show the boundary of the drawing or to separate different objects drawn on one sheet. They are also used to separate the title block from the rest of the drawing.

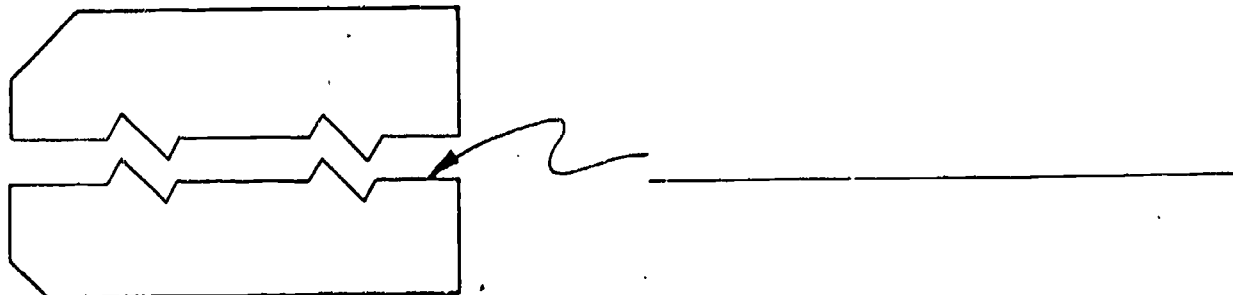
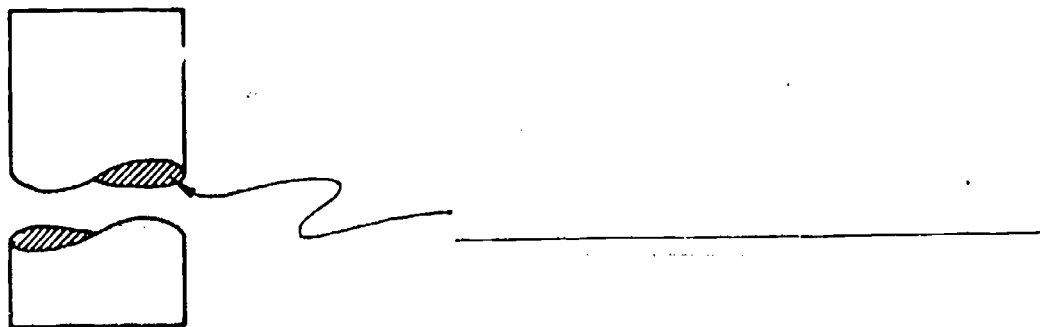
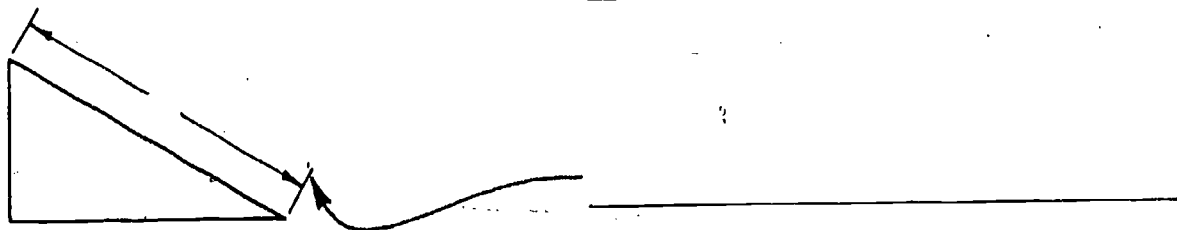
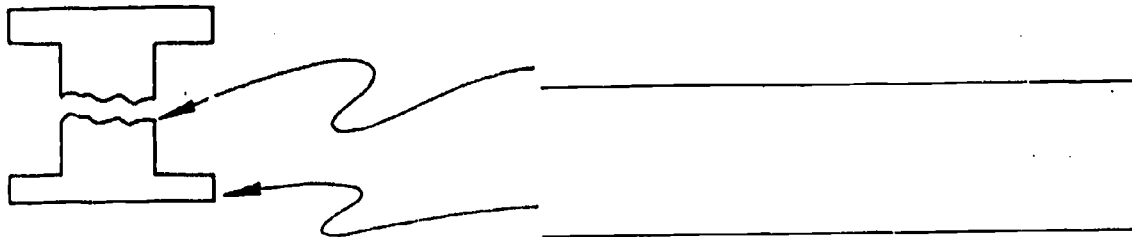
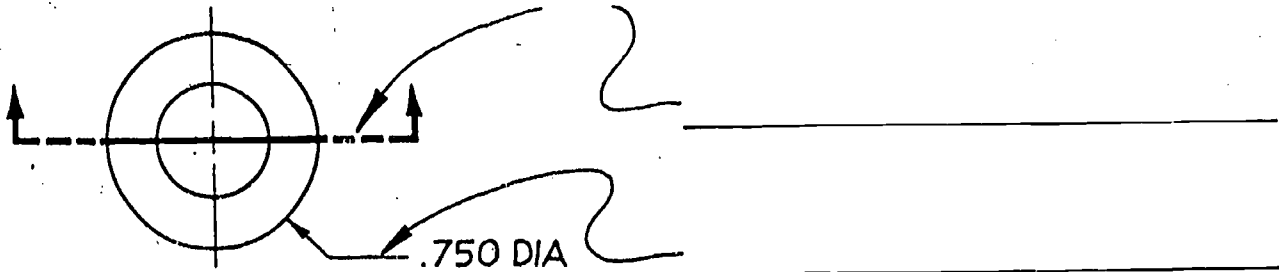


(MEDIUM THICK)

Self Assessment



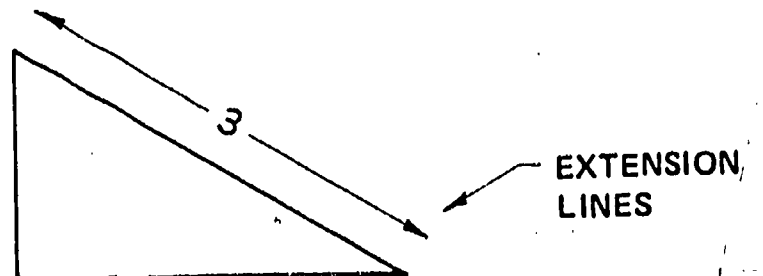
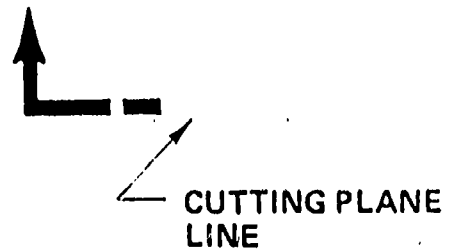
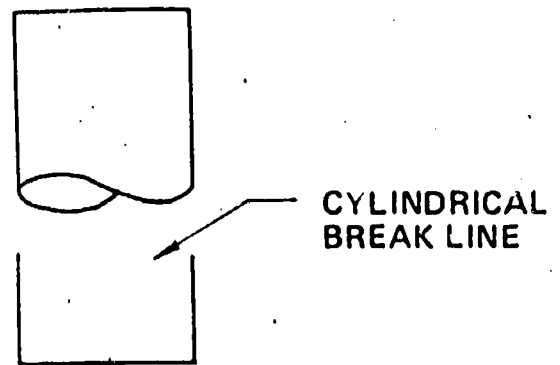
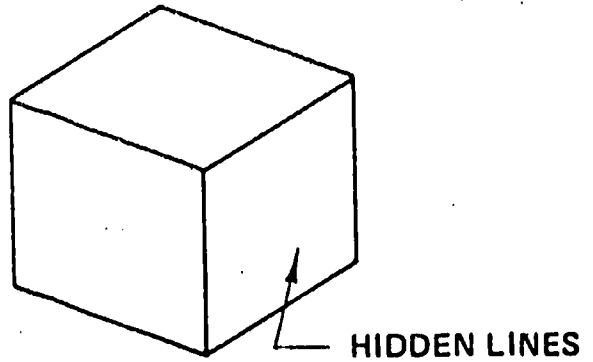
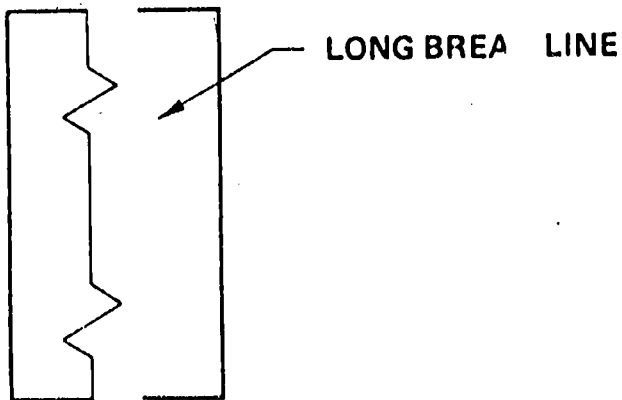
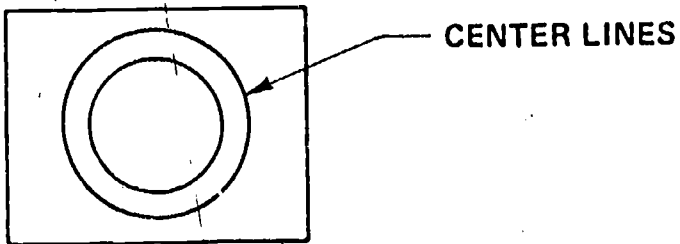
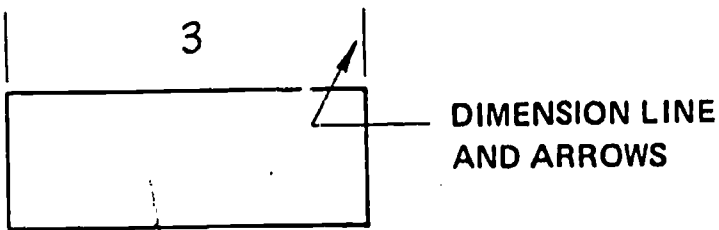
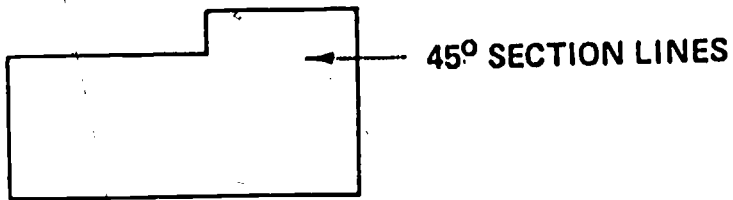
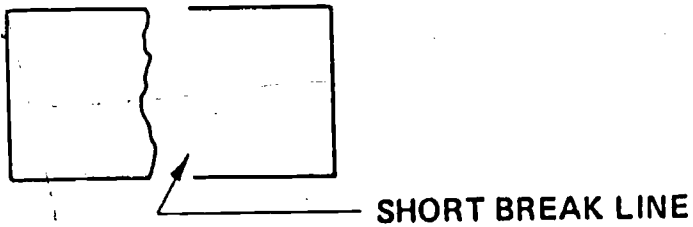
Directions: Name the types of lines shown below. Check your own answers.

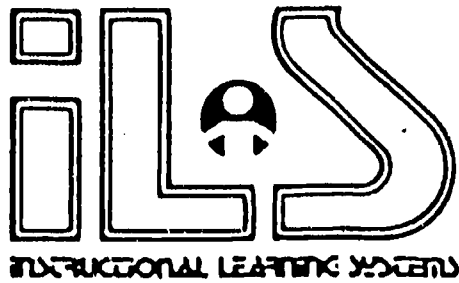


Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
 4. Object line; 5. Extension line; 6. Cylindrical break;
 7. Long break.

LIFE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.





5.14

DRAFTING

MACHINED FEATURES

Bevel	Keyseat
Boss	Knurl
Chamfer	Lug
Counterbore	Neck
Countersink	Pad
Dovetail	Round
Fillet	Spline
Kerf	Spot Face
Keyway	T-Slot

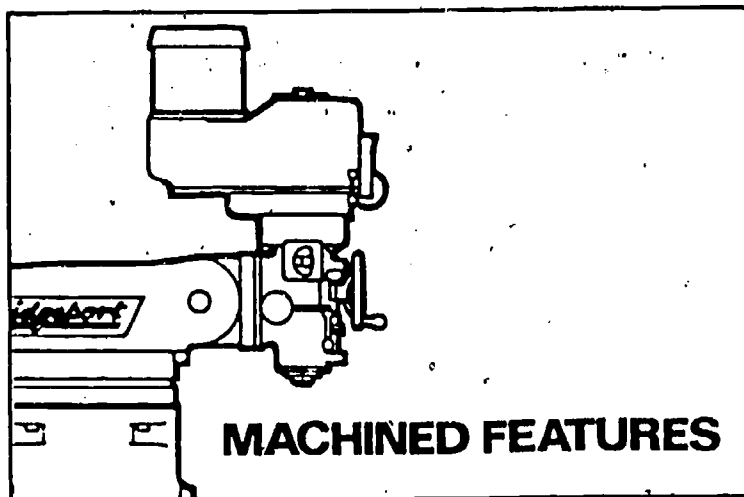
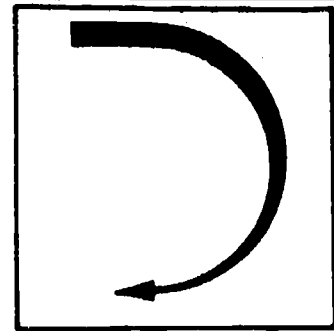
Goal:

The student will be able to identify the purpose and configuration of several commonly used machine features.

Performance Indicators:

Given a prepared worksheet, the student will identify various machined surfaces by name.

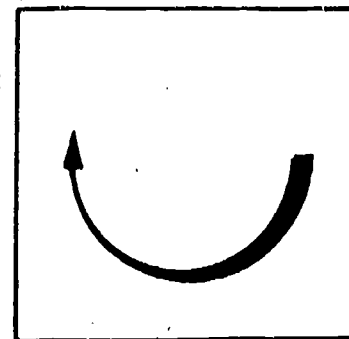
Introduction



INTRODUCTION:

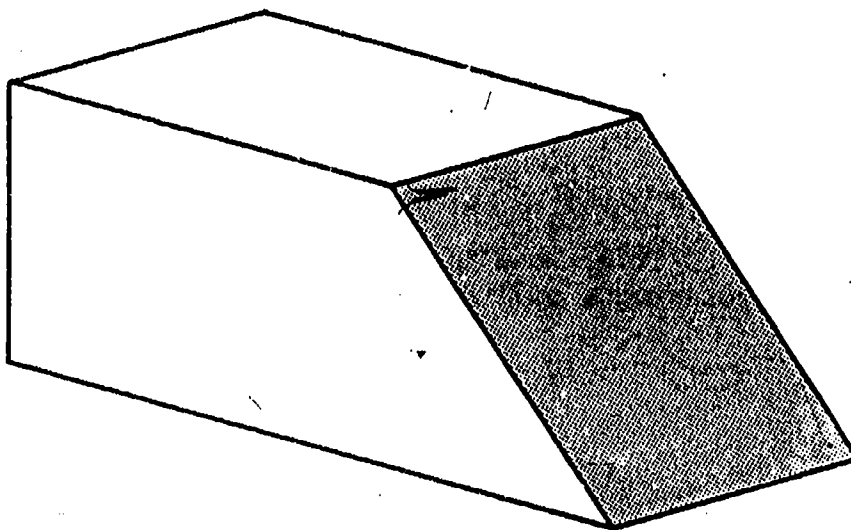
The machined features in this package are common terms related to basic industry processes. These terms are often found on prints; therefore, it is important to understand their use and purpose. This module will explain a little about each of these machined features.

Information



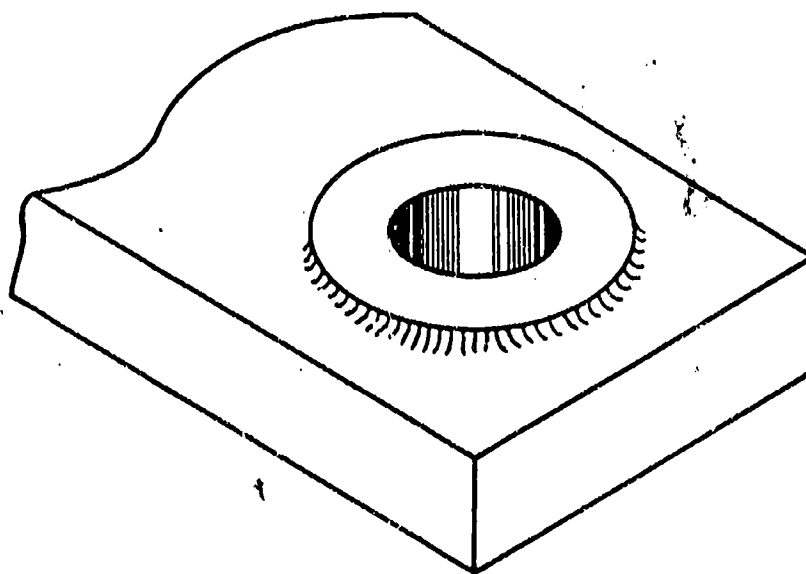
1. BEVEL

A surface cut at an angle.



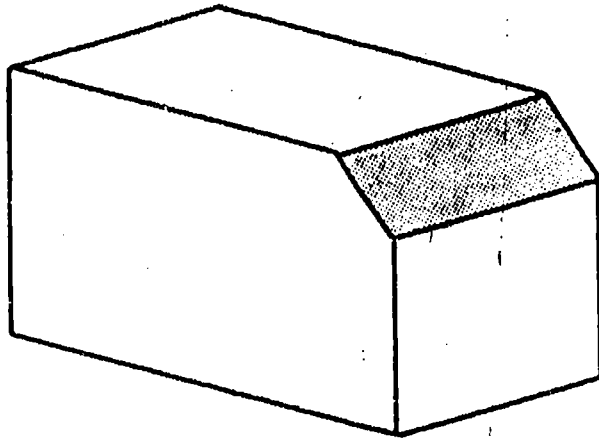
2. BOSS

A circular pad on forgings or castings which projects out from the body of the part. The surface of the boss is machined smooth for a bolt head to sit on and it has a hole drilled through to accommodate the bolt shank.



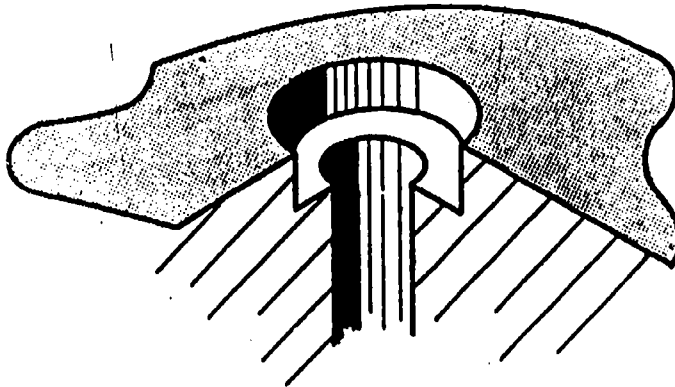
3. CHAMFER

The process of cutting away a sharp external corner or edge.



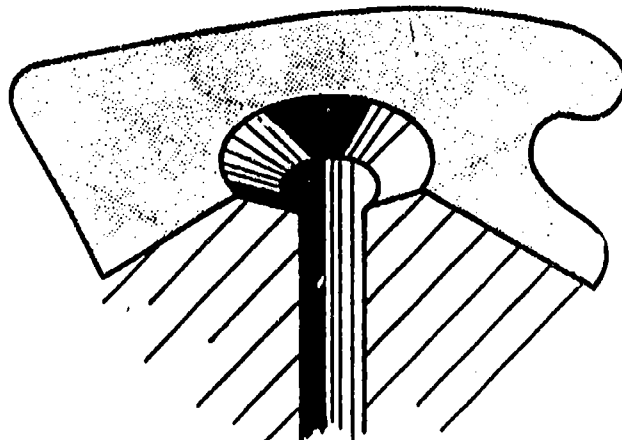
4. COUNTER BORE

To enlarge a drilled hole to a given diameter and depth. Usually done for recessing a bolt head.



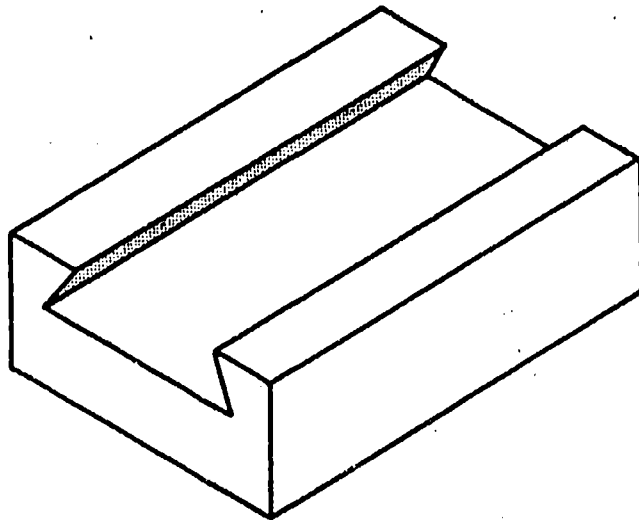
5. COUNTER SINK

To machine a conical depression in a drilled hole for recessing flathead screws or bolts.



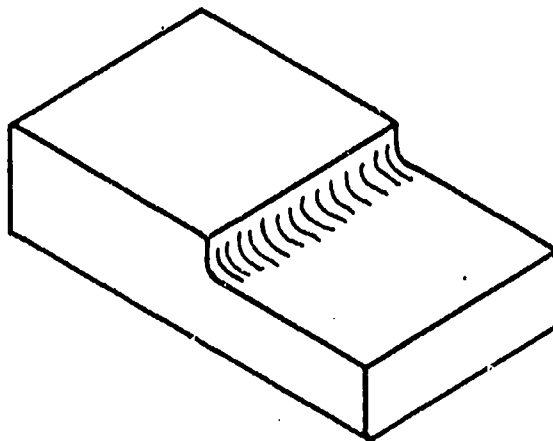
6. DOVETAIL

A slot of any depth and width which has angled sides. Used to allow another part to slide without separating from the dove-tailed part.



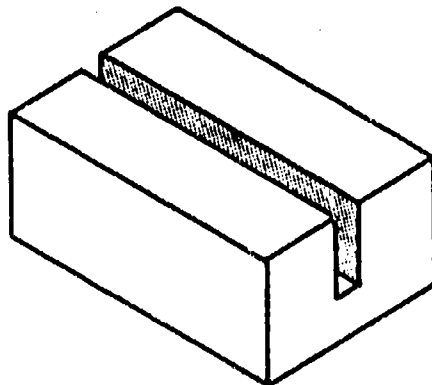
7. FILLET

A small radius filling formed between the inside angle of two surfaces.



8. KERF

The narrow slot formed by removing material while sawing or other machining.

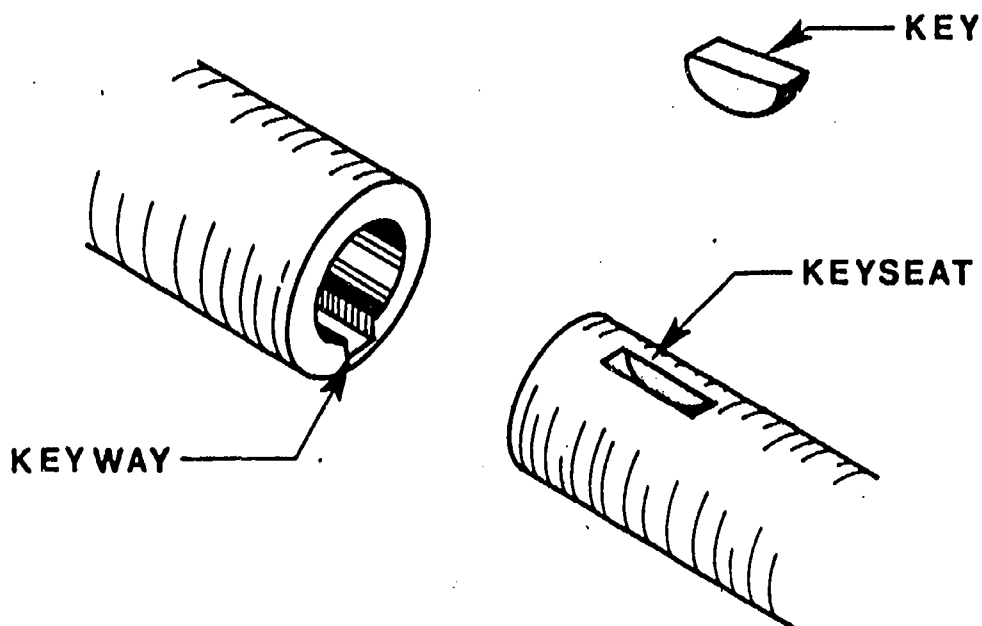


9. KEYWAY

A narrow groove or slot cut in the shaft hole of a sleeve, hub, or gear to accommodate a key.

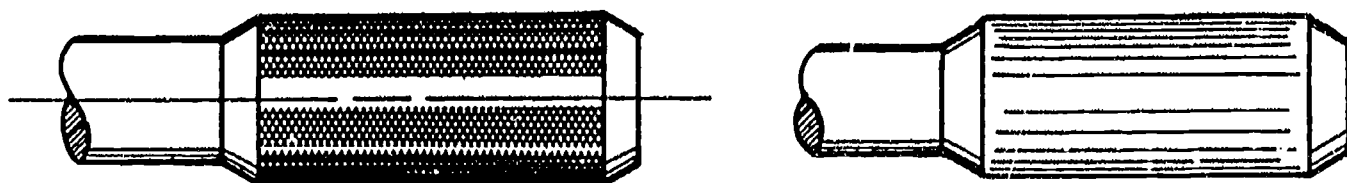
10. KEYSEAT

A narrow groove or slot cut in a shaft to accommodate a key.



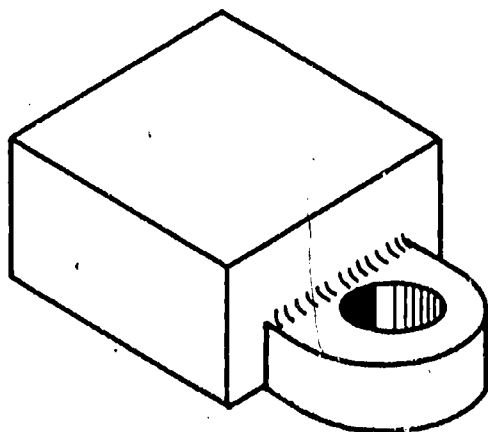
11. KNURL

To uniformly roughen, with a diamond or straight pattern, a cylindrical or flat surface.



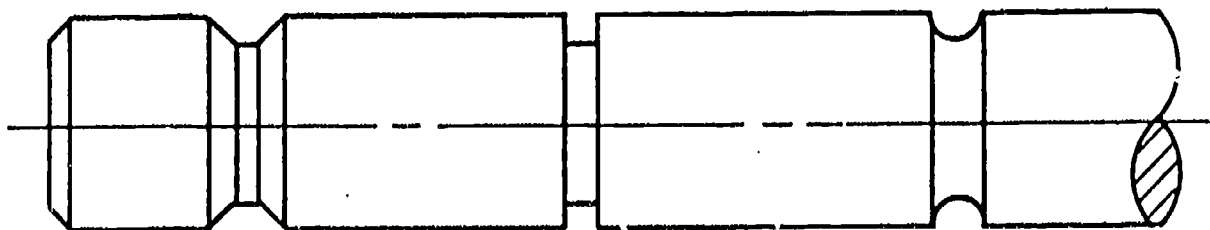
12. LUG

A piece projecting out from the body of a part, usually rectangular in cross-section with a hole or slot in it, used for mounting or securing.



13. NECK

A narrow machined groove on the cylindrical part of an object, used to hold a retaining ring.



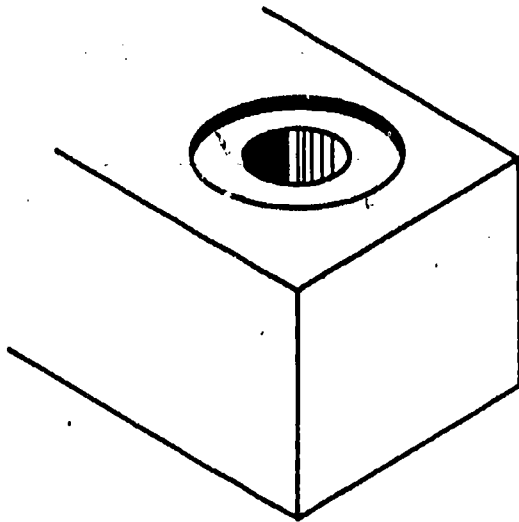
V-GROOVE

SQUARE

ROUND

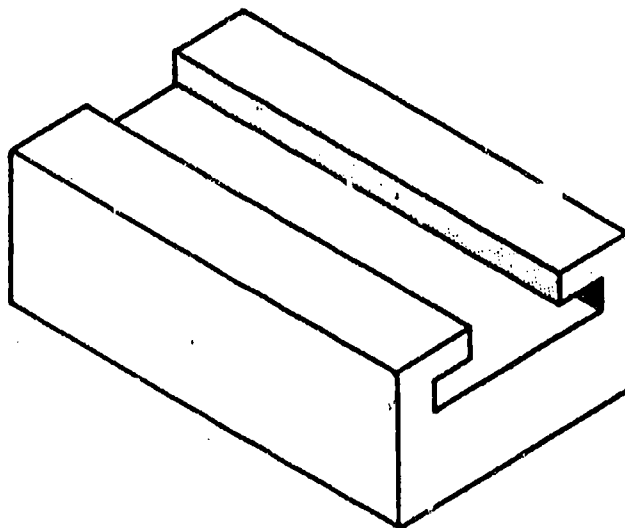
14. SPOT FACE

A round surface on a casting or forging for a bolt head.
Usually less than 1/16 of an inch deep.



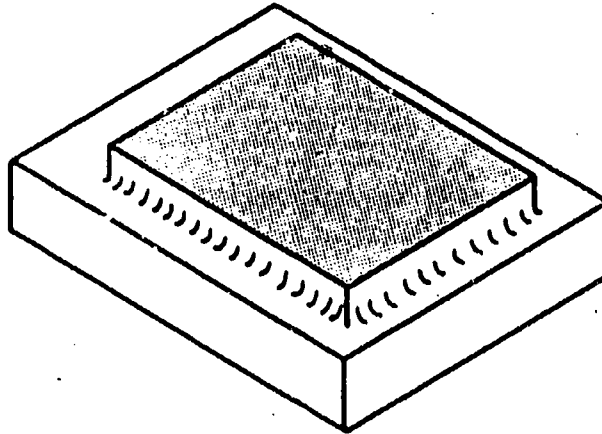
15. T-SLOT

A slot of any dimensions cut to resemble a "T." Used much like
a dovetail for locking pieces into position.



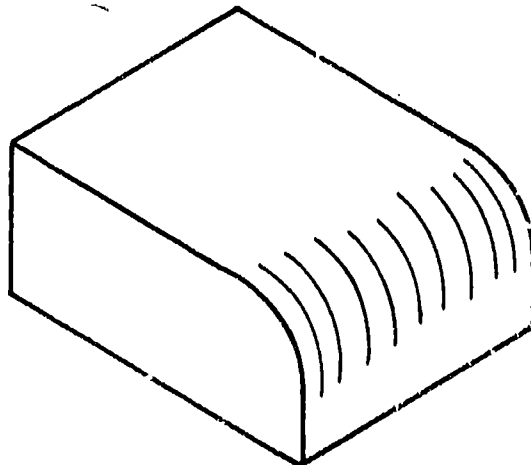
16. PAD

A slightly raised surface projecting out from the body of a part for bearing or surface wear. The pad surface can be any size or shape. (Remember, bosses are round and have a hole through them.)



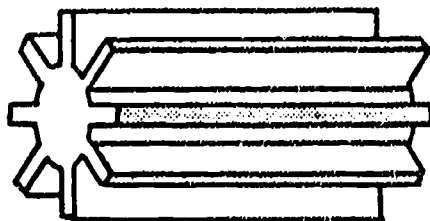
17. ROUND

A small radius, rounded, outside corner formed between two surfaces, to eliminate rough, sharp corners and reduce material usage.

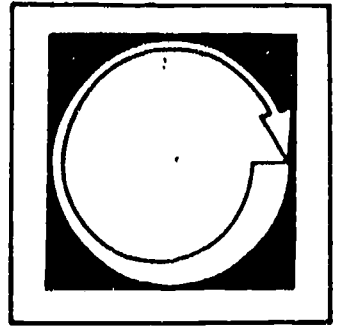


18. SPLINE

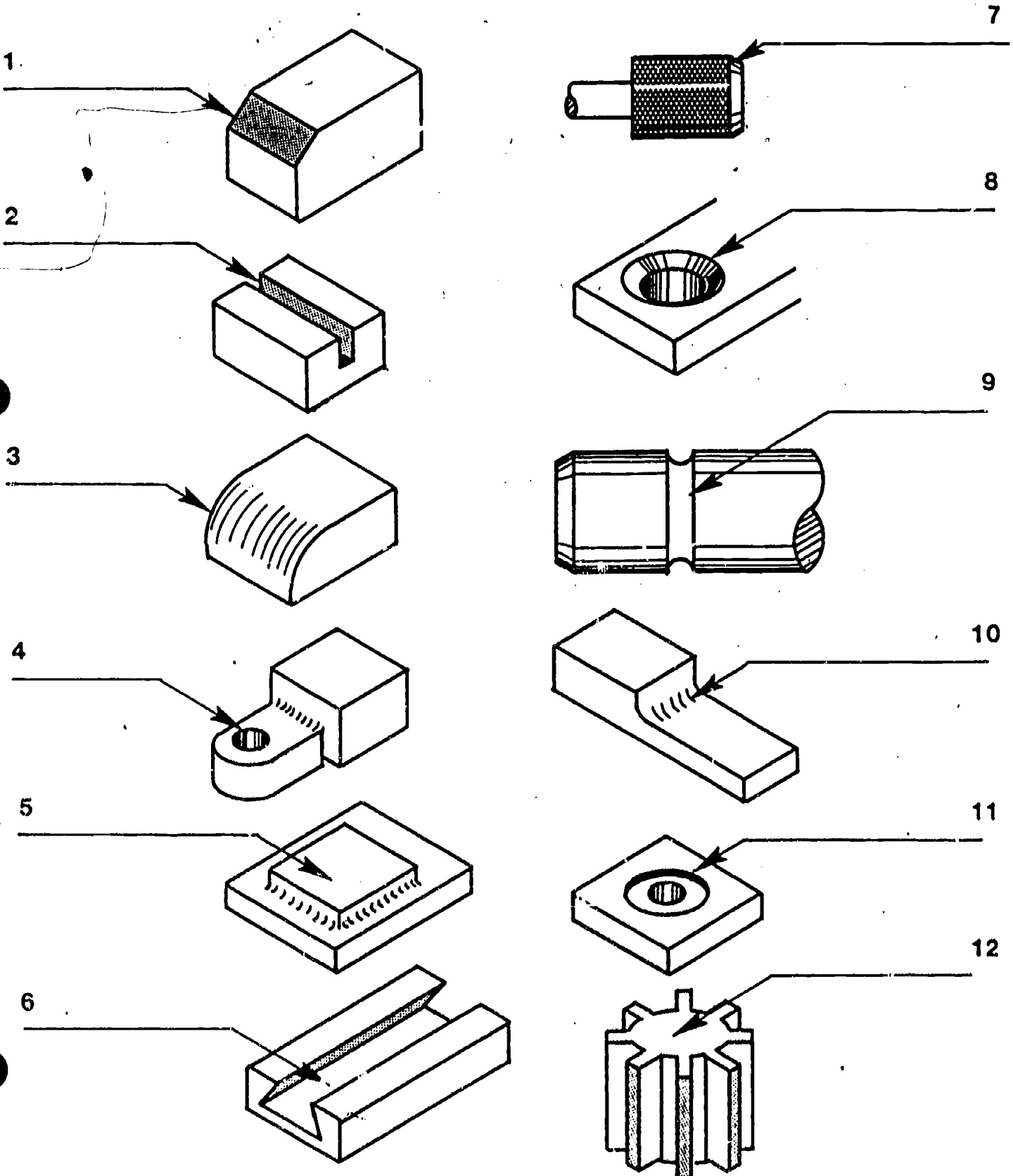
A gear-like serrated surface on a shaft, which takes the place of a key in special power transmission problems.



Self Assessment

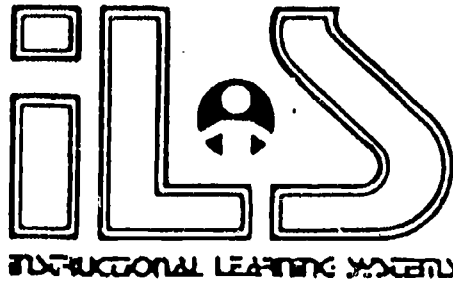


Directions: Write your answers in pencil in spaces provided.
Check your test with the answers on the next page.



Answers to self test:

- | | |
|-------------|------------------|
| 1. Chamfer | 7. Knurl |
| 2. Kerf | 8. Counter sink |
| 3. Round | 9. Neck |
| 4. Lug | 10. Fillet |
| 5. Pad | 11. Counter Bore |
| 6. Dovetail | 12. Spline |



5.15

DRAFTING

MEASUREMENT

Scale Measurement
Full Size
Half Size
Quarter Size

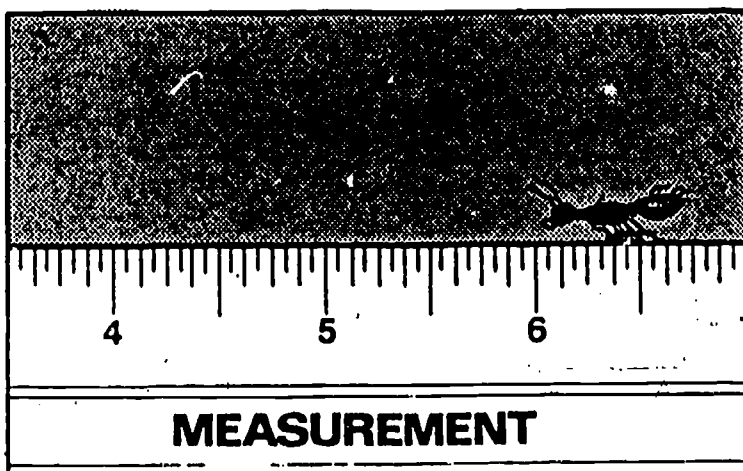
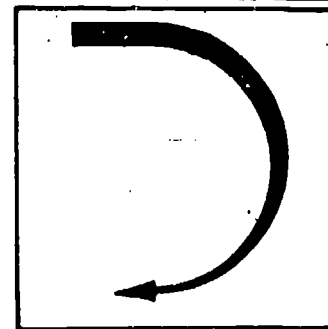
Goal:

The student will be able to use measurements and scales in working with blue prints for industry.

Performance Indicators:

Given prepared worksheets, the student will locate various fractional dimensions or typical drafting scales.

Introduction

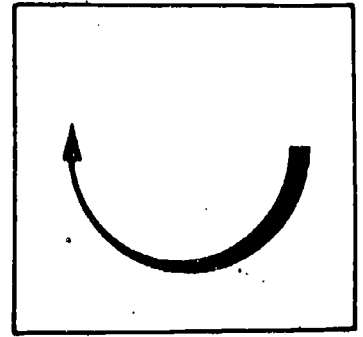


INTRODUCTION:

The ability to make accurate measurements is a basic skill needed by everyone who reads and uses blueprints. Since some students have had little need to measure accurately, these exercises will provide the practice they need. Others who have had more experience may find these exercises a worthwhile review.

Remember, if you need a dimension from a print that is unclear or not given, **DON'T MEASURE THE PRINT!** Since prints shrink, stretch, and may not be drawn to scale, you can easily come up with some very inaccurate dimensions.

Information



1. SCALE MEASUREMENT

A drawing of an object may be the same size as the object (full-size), or it may be larger or smaller than the object. In most cases, if it is not drawn full-size, the drawing is made smaller than the object. This is done primarily for the convenience of the users of the drawings. After all, who wants to carry around a full-size drawing of a locomotive? Obviously, with an object as small as a wristwatch, it would be necessary to draw at a larger scale.

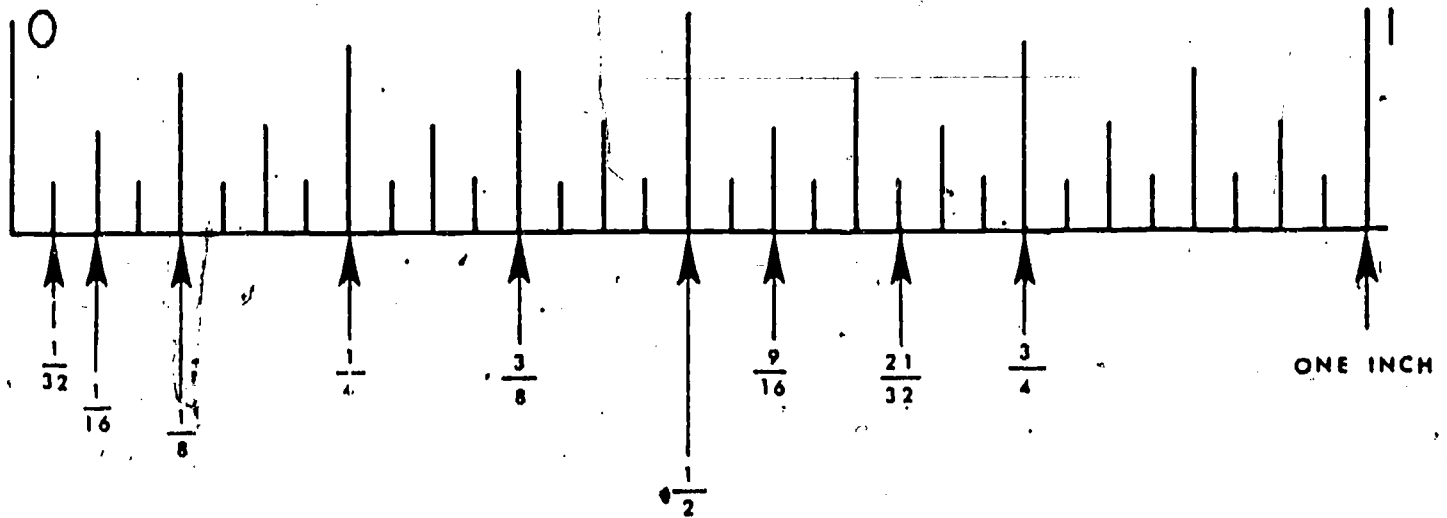
A machine part, for example, may be half size ($1/2" = 1"$); a building may be drawn 1/48th size ($1/4" = 1'-0"$); a map may be drawn 1/1200th size ($1 1/2" = 100'-0"$); and a gear in that wristwatch may be drawn ten times the size ($10" = 1"$).

There are numerous scales for different needs. Since each occupational group has its own frequently used scales, some practice or basic review will help you to work with the scales used in your technology.

2. FULL-SIZE

Full-size is simply letting one inch (or unit) on a ruler, steel rule, or draftsman's scale equal one inch (or unit) on the actual object. Rules of this kind are usually divided into sixteen units per inch or 32 units per inch.

Here is a "big inch." Each space equals $\frac{1}{32}$ of an inch.



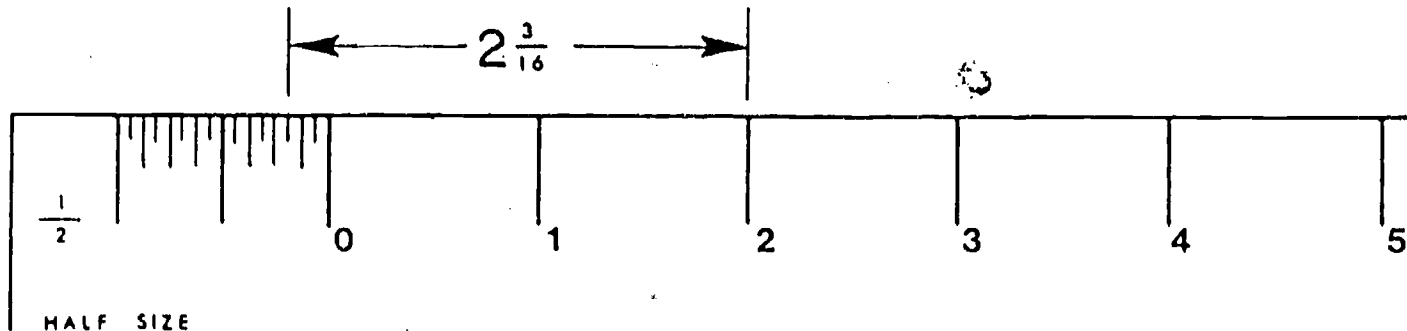
On the scale above, locate the following fractions.

- | | |
|--------------------|---------------------|
| 1. $\frac{5}{8}$ | 6. $\frac{7}{8}$ |
| 2. $\frac{3}{16}$ | 7. $\frac{11}{16}$ |
| 3. $\frac{7}{32}$ | 8. $\frac{5}{16}$ |
| 4. $\frac{15}{16}$ | 9. $\frac{31}{32}$ |
| 5. $\frac{25}{32}$ | 10. $\frac{19}{32}$ |

3. HALF SIZE

The principle of half size measurements on a drawing is simply letting one unit, such as $1/2$ inch on the scale, represent a larger unit such as 1 inch on the drawing. If the drawing is properly labeled, the words "half size" or $1/2" = 1"$ will appear in the title block.

Using the half size scale isn't difficult, but it does take some practice. To measure a distance of $2 \frac{3}{16}$ in half size you look first for the whole unit 2 then go backwards to the zero and count off the additional $3/16$. You measure this way for each dimension that has a fraction. Whole numbers (numbers without fractions) are measured in the usual way.



With the scale above, practice locating the following half size dimensions.

1. $4 \frac{3}{16}$

4. $13/16$

2. $2 \frac{1}{2}$

5. $3 \frac{3}{8}$

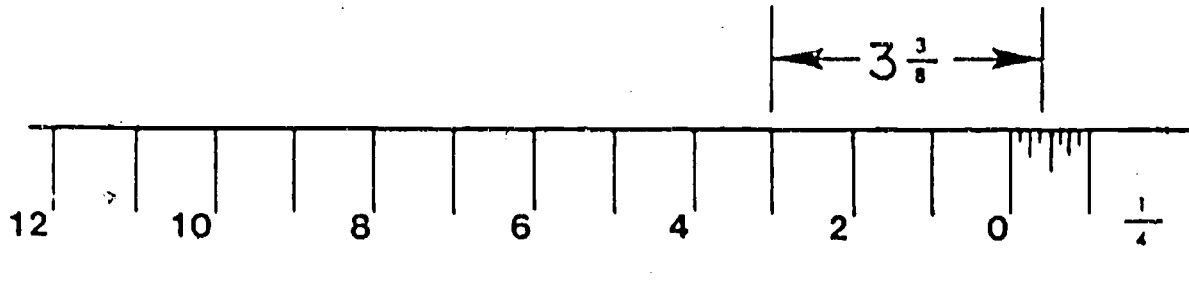
3. $5 \frac{3}{4}$

6. $4 \frac{13}{32}$

4. QUARTER SIZE

Quarter size is used and read in a similar way to half size, except that each unit, such as a quarter of an inch, represents a larger unit, such as one inch. If the drawing is properly labeled the words "quarter size" or "quarter scale" or $1/4" = 1"$ will appear in the title block.

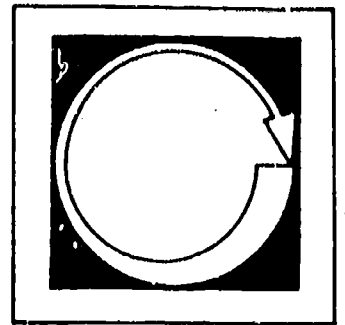
The example below shows a dimension of $3 \frac{3}{8}$ inches.



Using the scale above, practice locating the following dimensions.

1. $2 \frac{5}{8}$
2. $3 \frac{7}{8}$
3. $6 \frac{1}{4}$
4. $8 \frac{1}{8}$
5. $5 \frac{3}{8}$
6. $10 \frac{3}{4}$
7. $4 \frac{5}{8}$
8. $11 \frac{1}{4}$

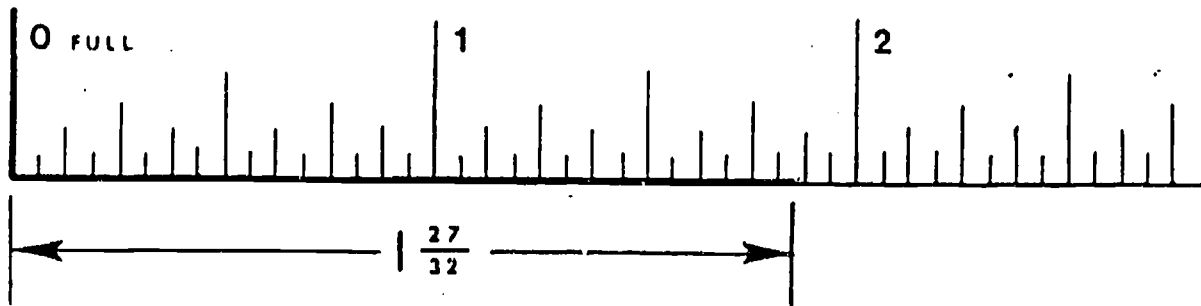
Self Assessment



Directions: Place the dimensions given above each scale to show that length. Check your answers. If you have 5 or more right, go on to the next section. If not, repeat this module. The first problem is done for you as an example.

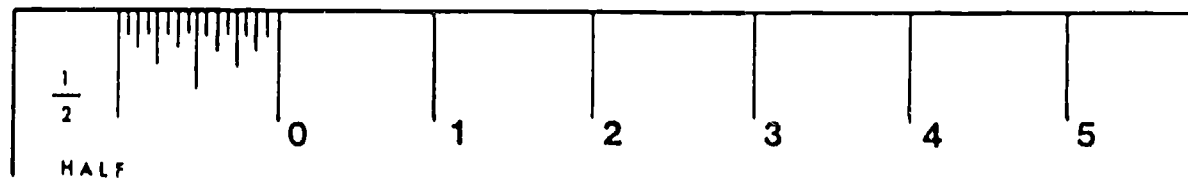
1.

$$1 \frac{37}{32}$$



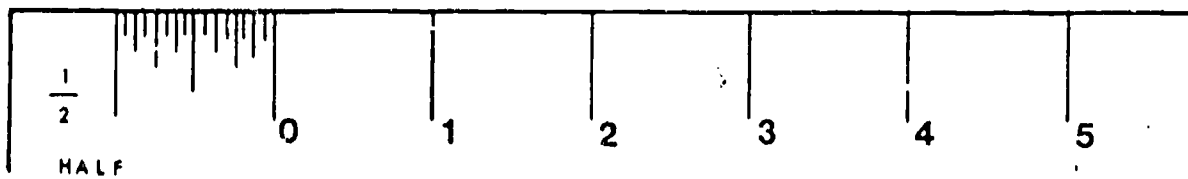
2.

$$4 \frac{7}{16}$$



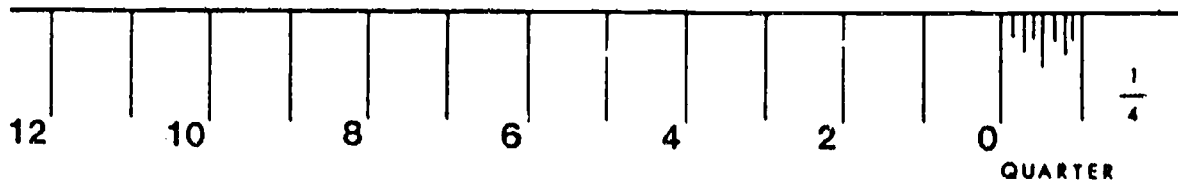
3.

$$3 \frac{19}{32}$$



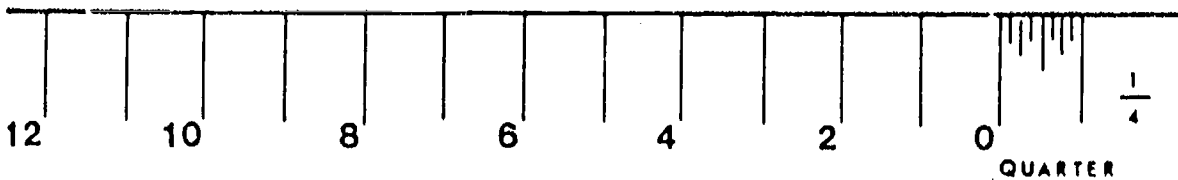
4.

$$11 \frac{5}{8}$$

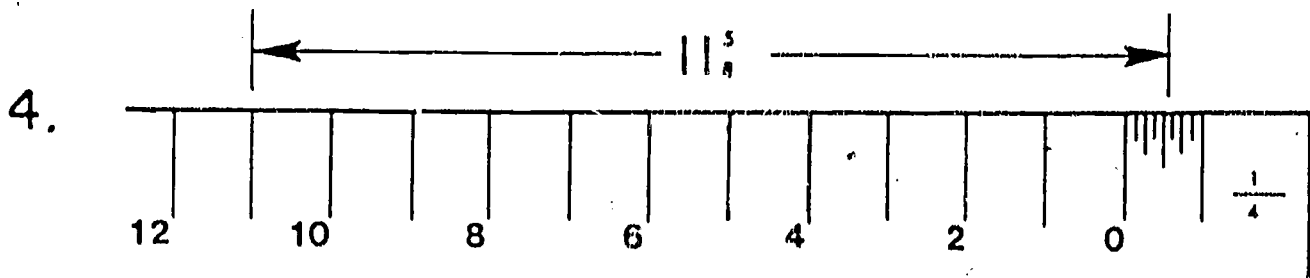
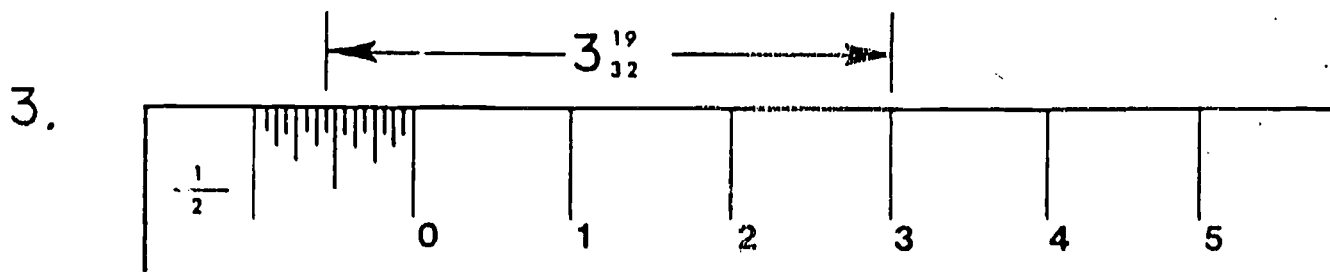
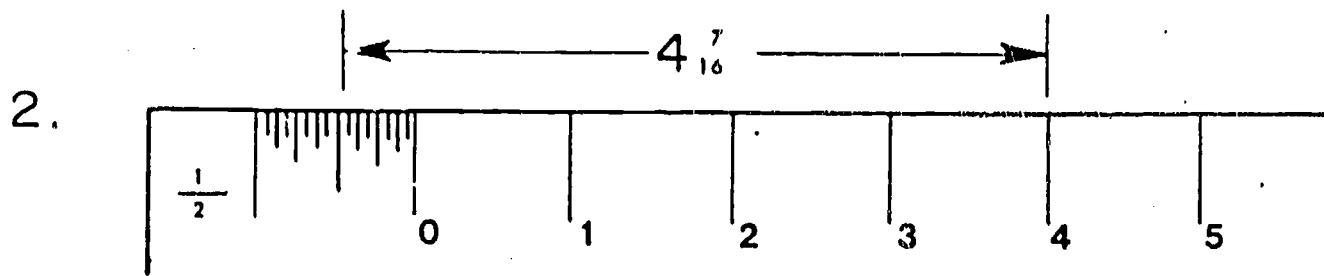
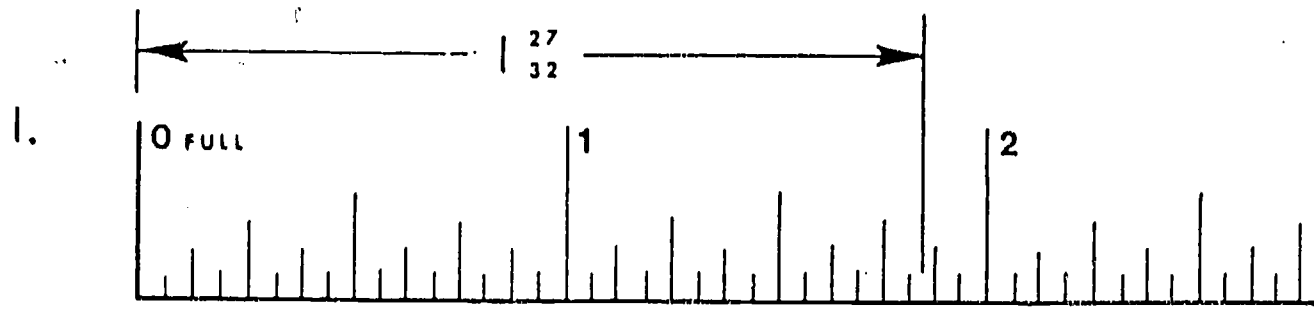


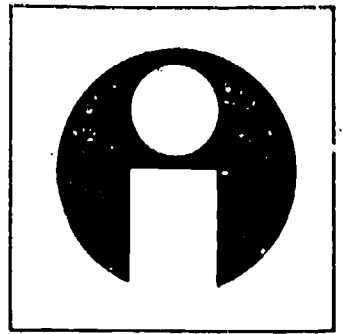
5.

$$2 \frac{3}{16}$$



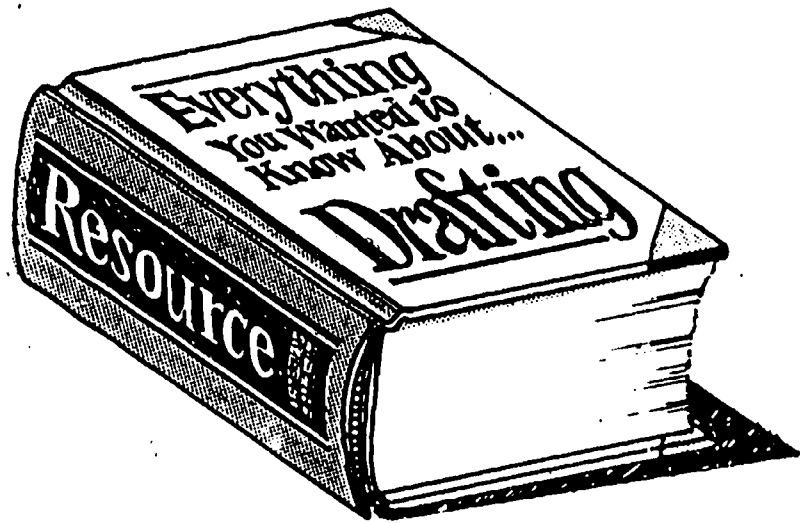
Answers to self test:





Study Guide

For Further Information:

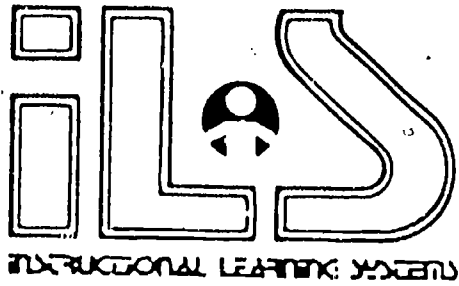


Drafting and Graphics, Giachino and Beukema, 2nd Edition, pp. 4-7.

Technical Drawing, Giesecke, et al, 6th Edition, pp. 30-35.

Drafting for Industry, Brown, 1974, pp. 31-33.

ILS Drafting: Measuring Instruments, article 7.00



5.16

DRAFTING

VISUALIZATION

Perspective
Oblique Drawing
Isometric Drawing
One-View Drawing
Two-View Drawing

Orthographic Projection
Hidden Surfaces
Curved Surfaces
Inclined Surfaces

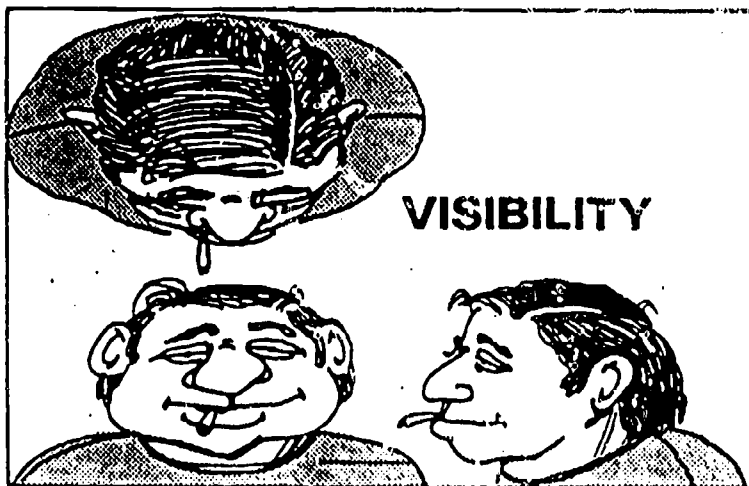
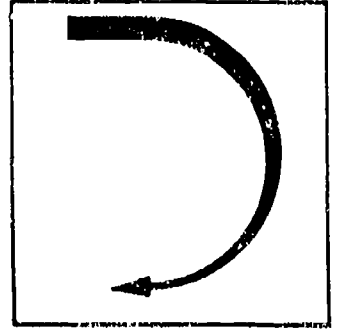
Goal:

The student will learn to be able to relate two-dimensional representations of three-dimensional objects.

Performance Indicators:

On a prepared worksheet, the student will fill in lines needed to complete a third view.

Introduction

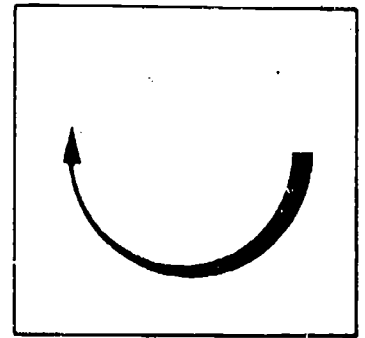


INTRODUCTION:

The ability to "see" technical drawings; that is, to "think in three dimensions" is the most important part of this course. Since most engineering and architectural prints utilize some form of orthographic projection (multi-view drawing), that type of drawing will be emphasized.

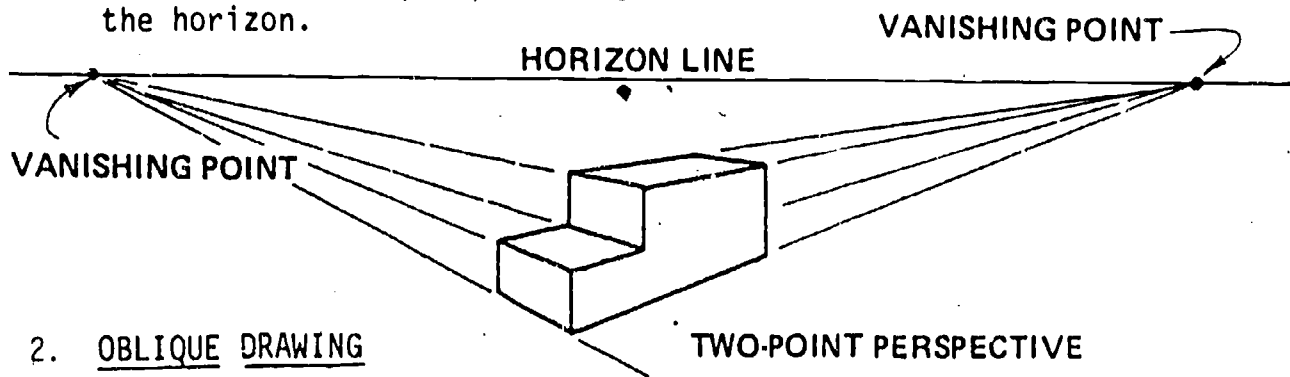
Before going into a study of orthographic projection, you should be able to recognize several other types of drawings. They are: (1) perspective drawing, (2) oblique drawing, and (3) isometric drawing. As a group, they are called pictorial drawings. They are found on prints and they are easy to visualize, so let's look at their differences.

Information



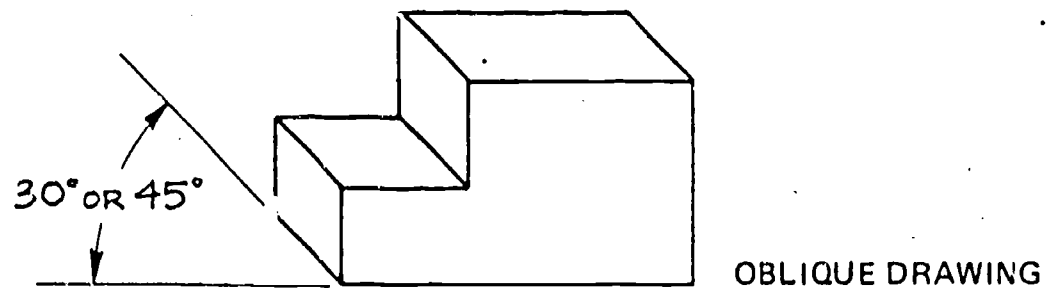
1. PERSPECTIVE

Perspective is the most realistic form of drawing. Artists use one-point perspective, two-point (shown here), and three-point to create visual depth. Perspectives are used by architects and for industrial pictorials of plant layouts, machinery, and other subjects where realism is required. Objects drawn in perspective grow smaller as they recede into the horizon.



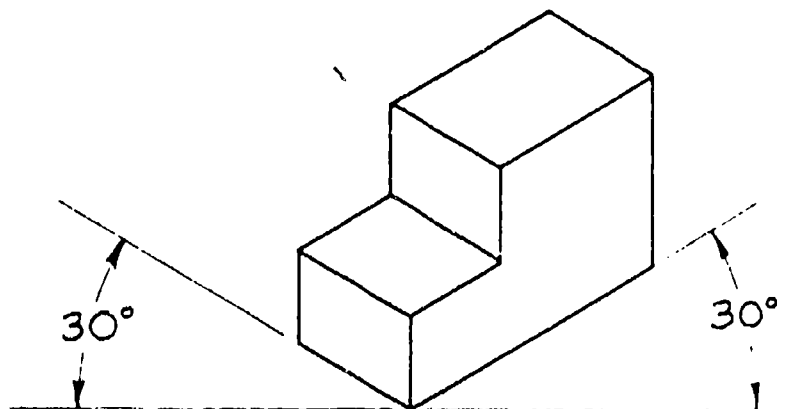
2. OBLIQUE DRAWING

Oblique drawings are made with one plane (front) of the object parallel to the drawing surface. The side, or other visible part of the object is generally drawn at 30 or 45 degrees. Note that only the side is on an angle.



3. ISOMETRIC DRAWING

Isometric drawings have less distortion than oblique drawings, and are used more frequently by industry for that reason. An isometric drawing has both visible surfaces drawn at 30 degrees.

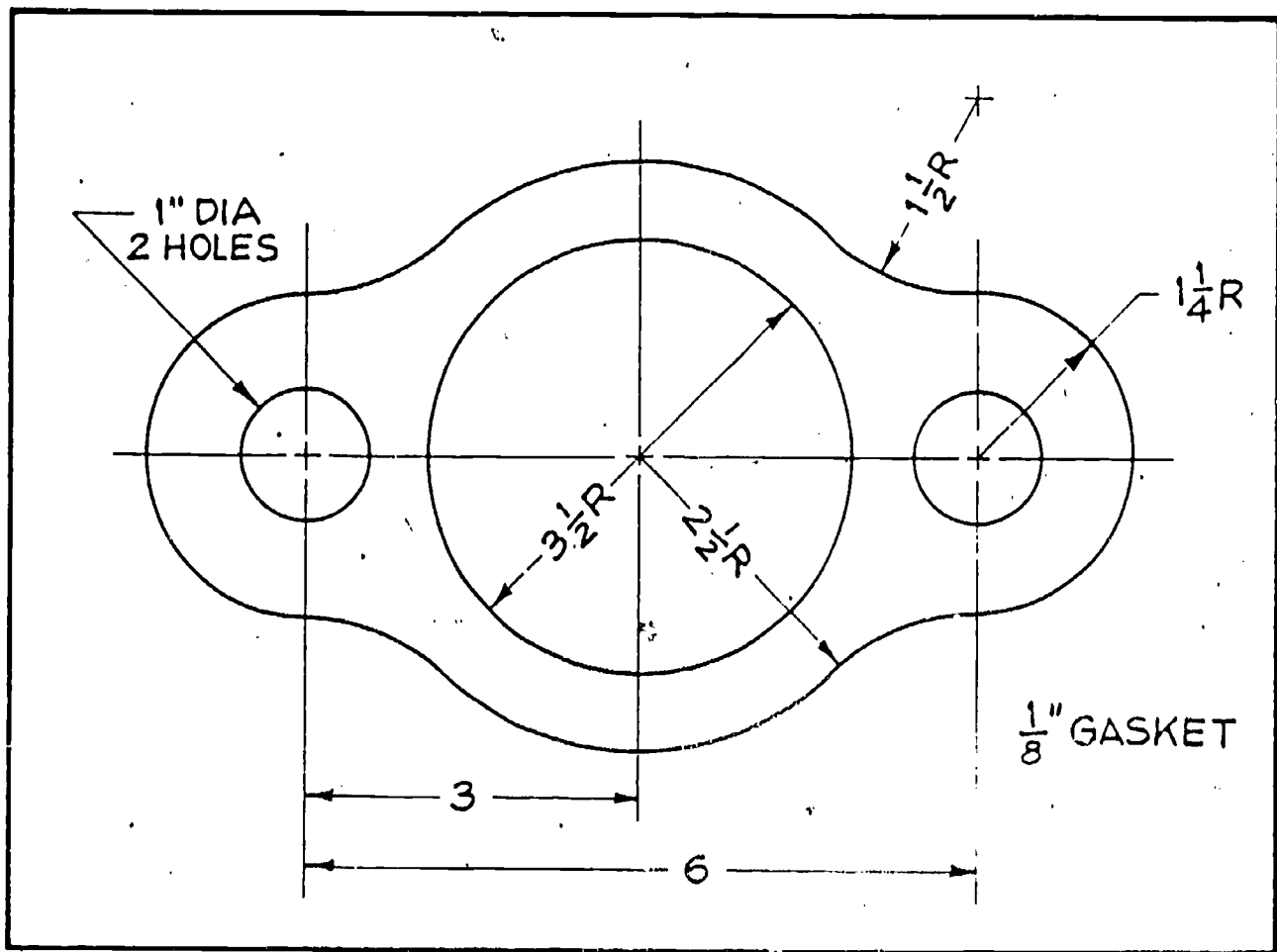


4. ONE-VIEW DRAWING

A single view of an object is sometimes all that is needed for a complete visual explanation. When dimensions, material, and other information is included, and object requiring only a single view is usually easy to understand.

Most one-view drawings are of flat objects, made from materials such as sheet metal and gasket stock. Spherical objects, such as a cannonball, would require only one view and a note indicating the material and diameter of the sphere.

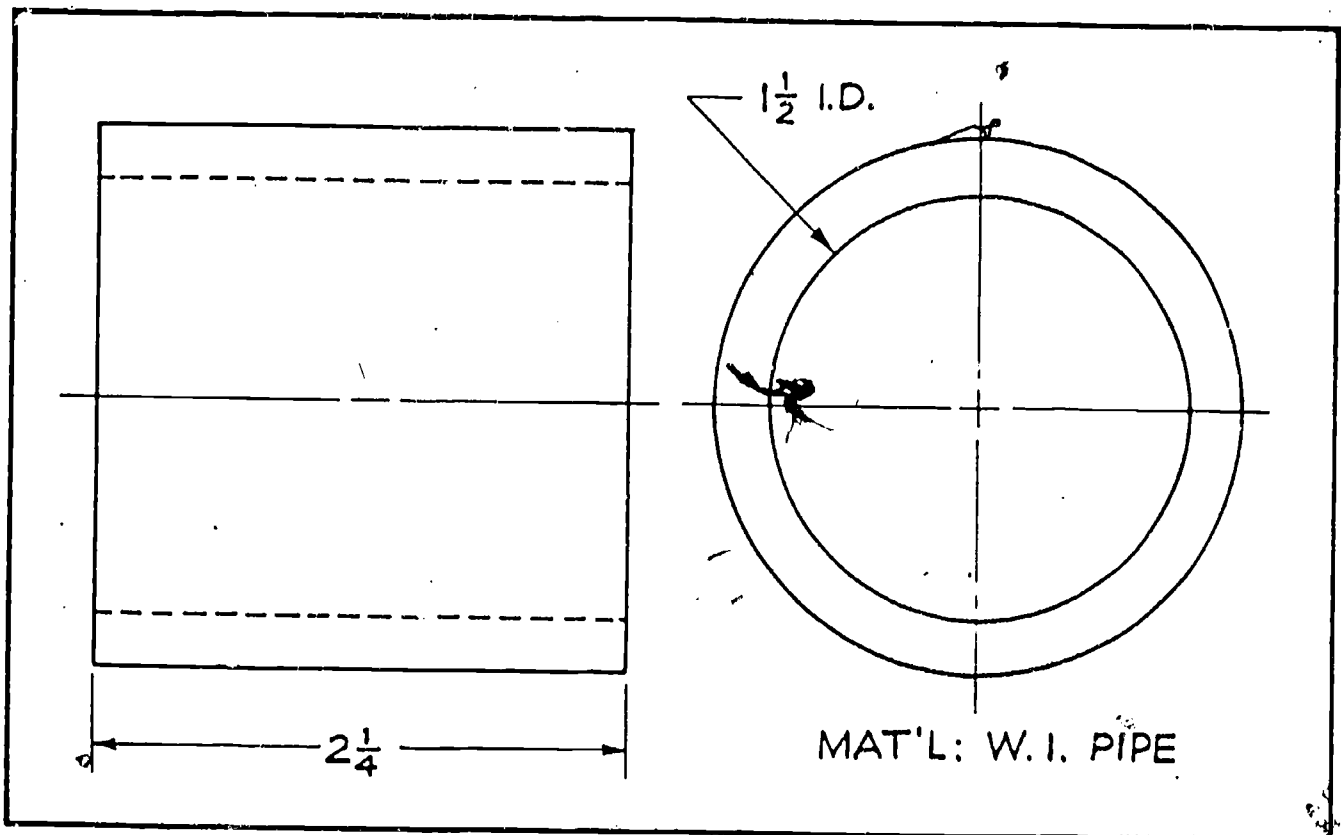
The object shown below could be made of any appropriate material that might be specified. In appearance, it is much like the gasket used in part of the cooling system of many cars.



ONE-VIEW DRAWING

5. TWO-VIEW DRAWING

Two-view drawings are sometimes found on prints since two views may be all that is needed to show the shape of an object. Objects which are cylindrical, such as the length of pipe, are usually shown on a print with two views. In such a case, two views are sufficient to explain the shape. Notice in the two-view drawing below that the length of pipe is shown in one view and the diameter is called out in the other. The hidden or dashed lines indicate the inside surface of the pipe which cannot be seen.

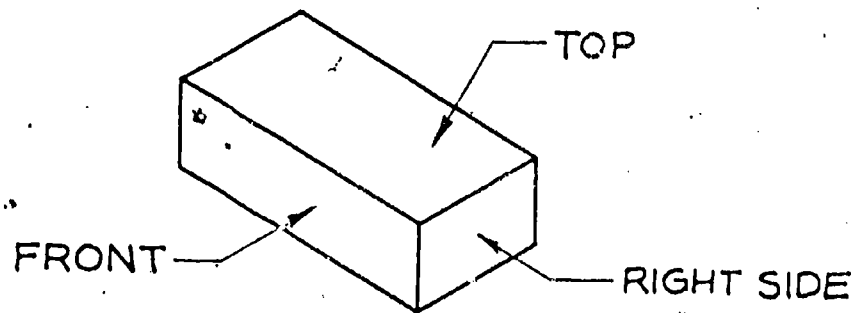


TWO-VIEW DRAWING

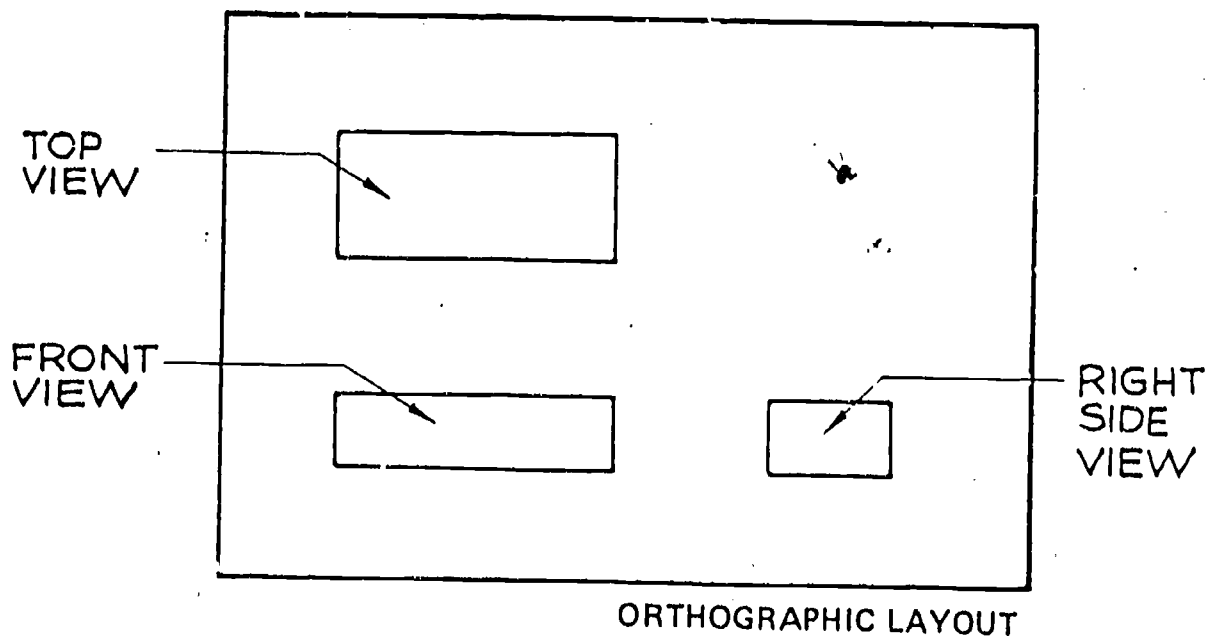
6. ORTHOGRAPHIC PROJECTION

Orthographic projection is a name given to drawings which usually have three views. Often, the three views selected are the top, front and right side. It's possible, when necessary, to select other views such as the left side or the bottom. Generally, though, the top, front and right side views are traditionally seen by the person reading prints.

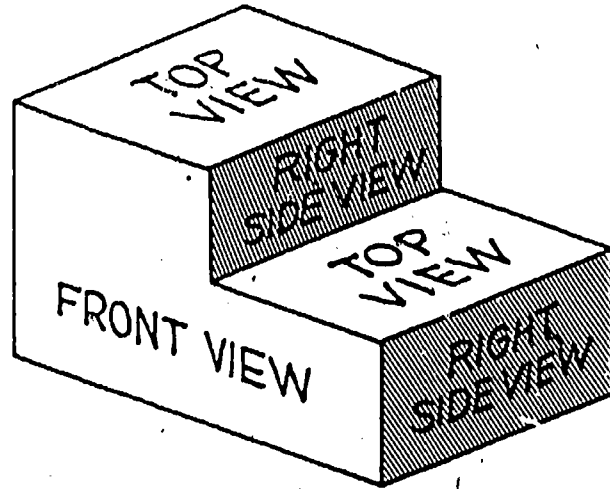
Since most prints make use of the orthographic projection system, and because the top, front and right side views are most often used, it's important that you know their order or arrangement on the print. To help you understand this system, think of a chalk board eraser, a short length of 2 x 4 lumber, or a common brick. It looks like this:



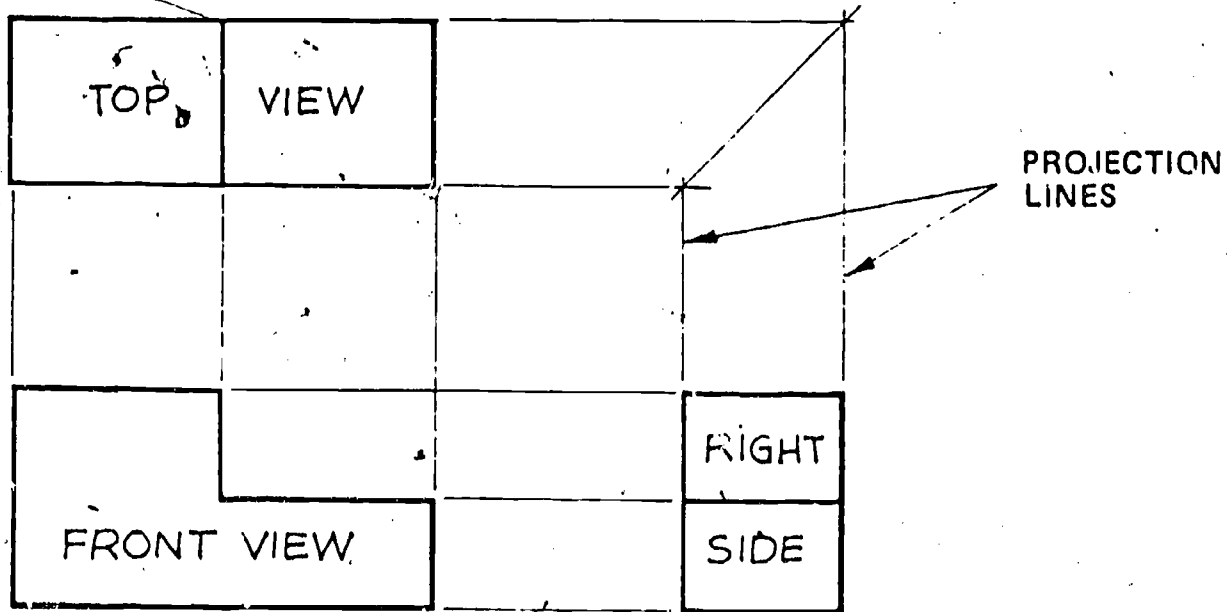
When seen on a print, using orthographic projection, it would look like this:



This system of orthographic projection may be difficult to understand or visualize at first, but you will grasp it with some practice. Here's a basic example of how it works, using a simple object.

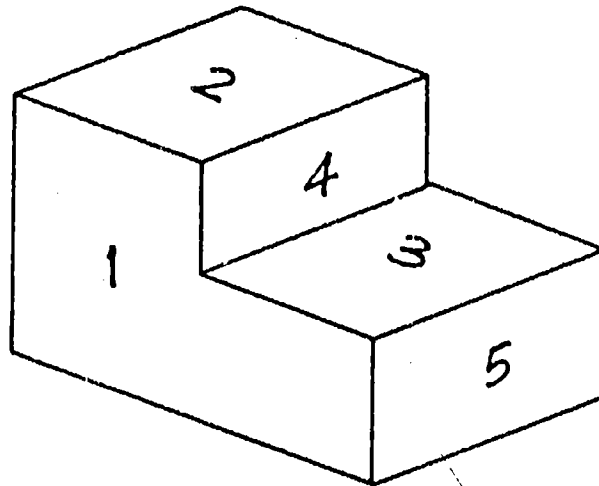


Orthographic projection does not show depth, so the object shown above will appear flat. With practice, however, you will learn to scan the three views and "read" depth into them. Remember that the location of the top, front and right side views does not change. The projection lines between the orthographic views below show the height, width and depth relationships that exist between each of the views.

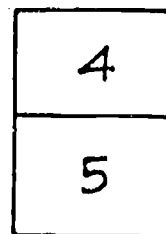
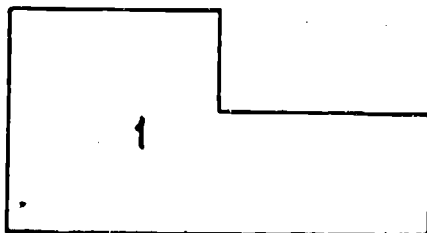
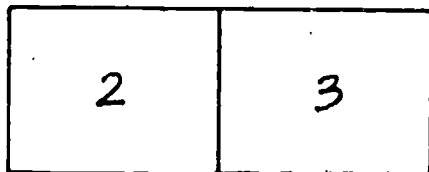


ORTHOGRAPHIC PROJECTION

In case you didn't understand the three-view on the last page, let's take another look at the same thing. This time numbers will be used for identification of the surfaces.



Using orthographic projection, the object with surfaces numbered appears like this:



Notice that the front view (1) is the key to the drawing because it most clearly shows the shape of the object. The other two views don't tell you much about the shape of the object by themselves. By looking at surface 1, however, you can see that 2 is taller than 3. Therefore, in "reading" the surfaces, 2 should appear to be closer to you than 3. Now look at 4 and 5. Which surface is projected closest to you?

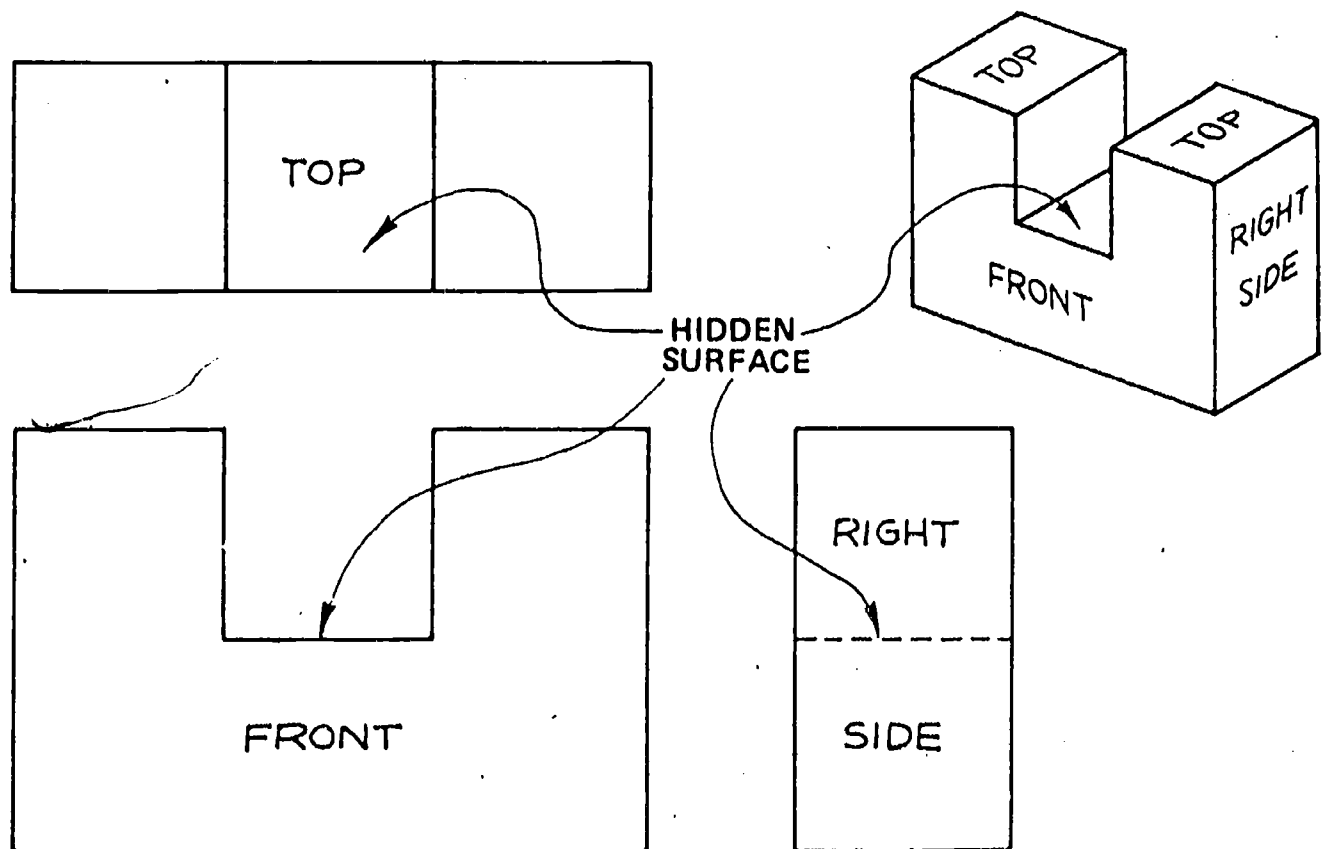
(Surface 5)

You may be wondering at this point why something like orthographic projection is used on prints when isometric or oblique drawings are so much easier to visualize. The answer is that isometric and oblique pictorials are used for relatively uncomplicated drawings. When an object is complex, neither pictorial can equal the orthographic system for a clear presentation of dimensions, notes, and configuration details.

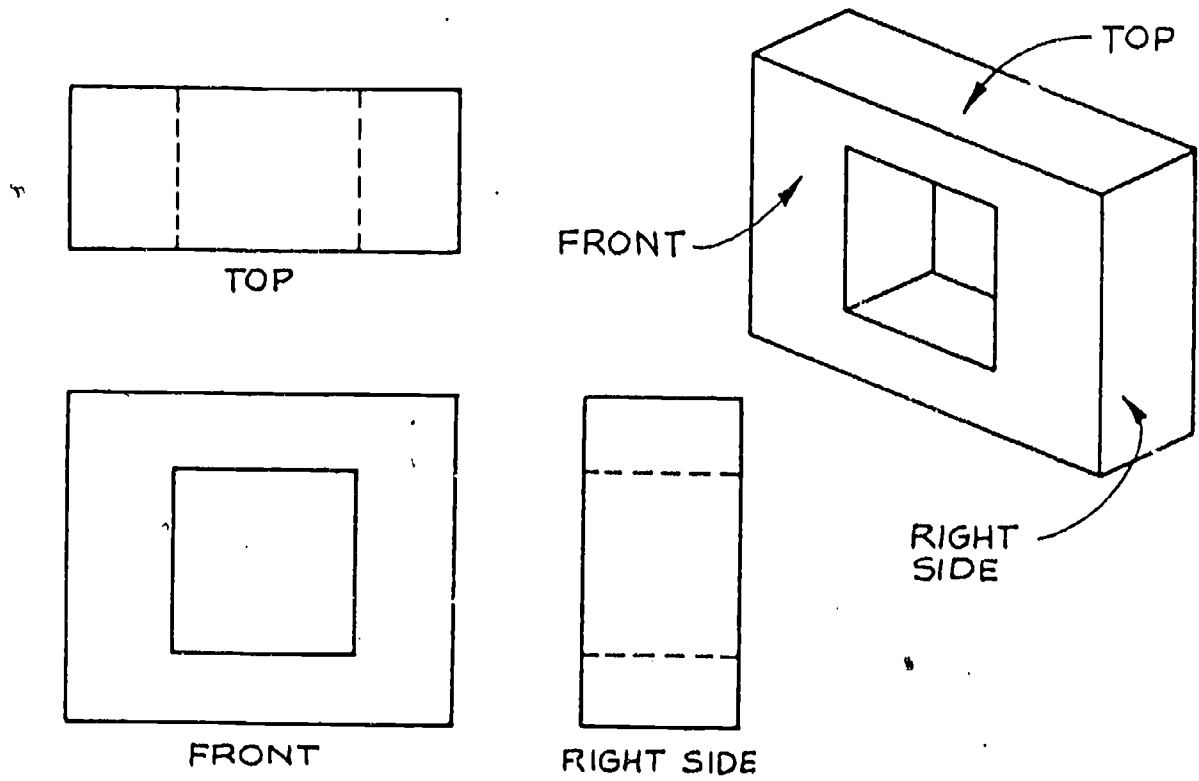
7. HIDDEN SURFACES

Another advantage of orthographic projection is that it allows the person reading the print to have the ability to see the inside, or surfaces of an object which normally could not be seen. With complicated objects in pictorial, this transparent viewing can become very useful in completely describing the object.

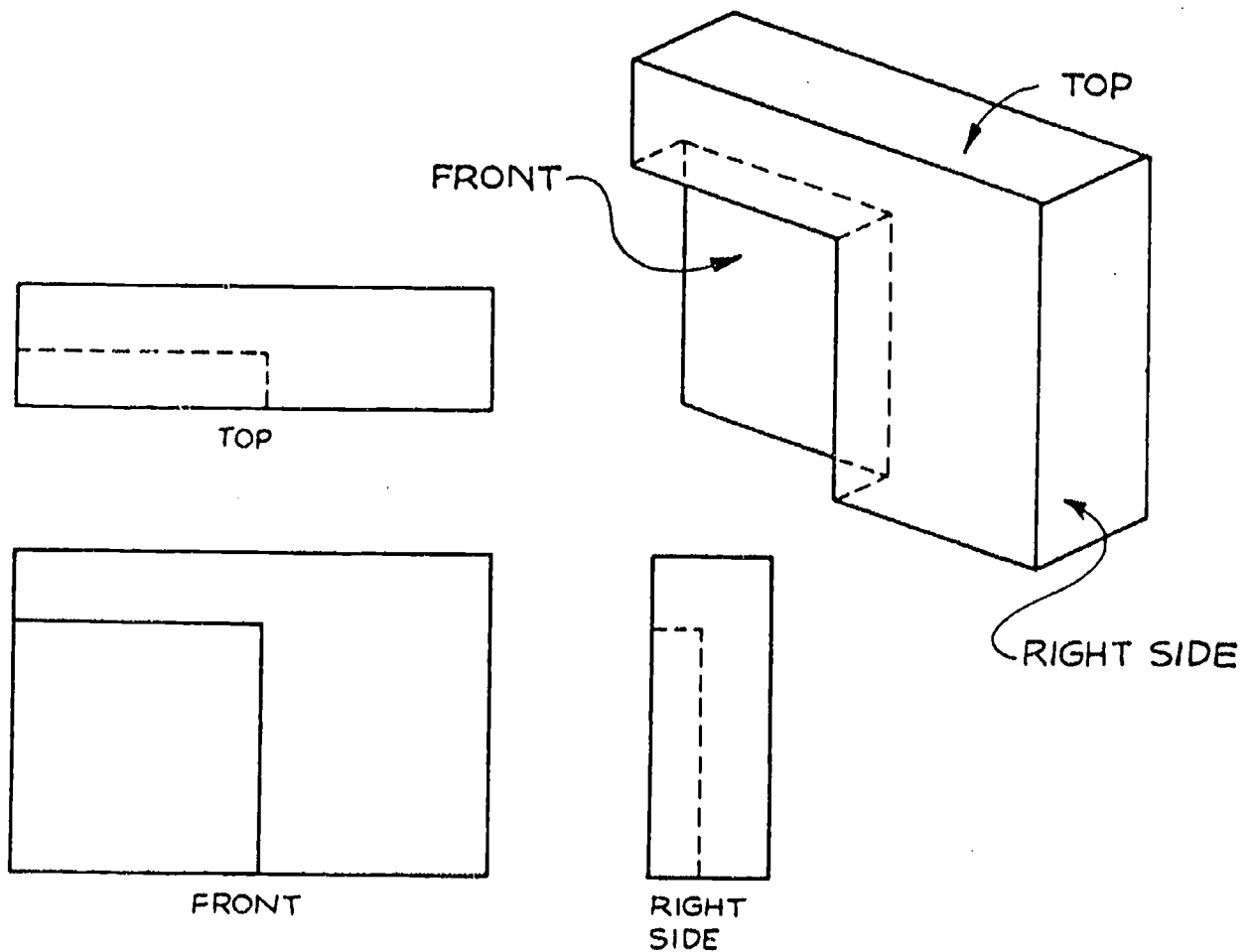
In the drawing below, the hidden line in the right side view represents the entire surface of the flat area between the two higher sides.



In this example, the hidden lines result from a square hole through the middle of the object.

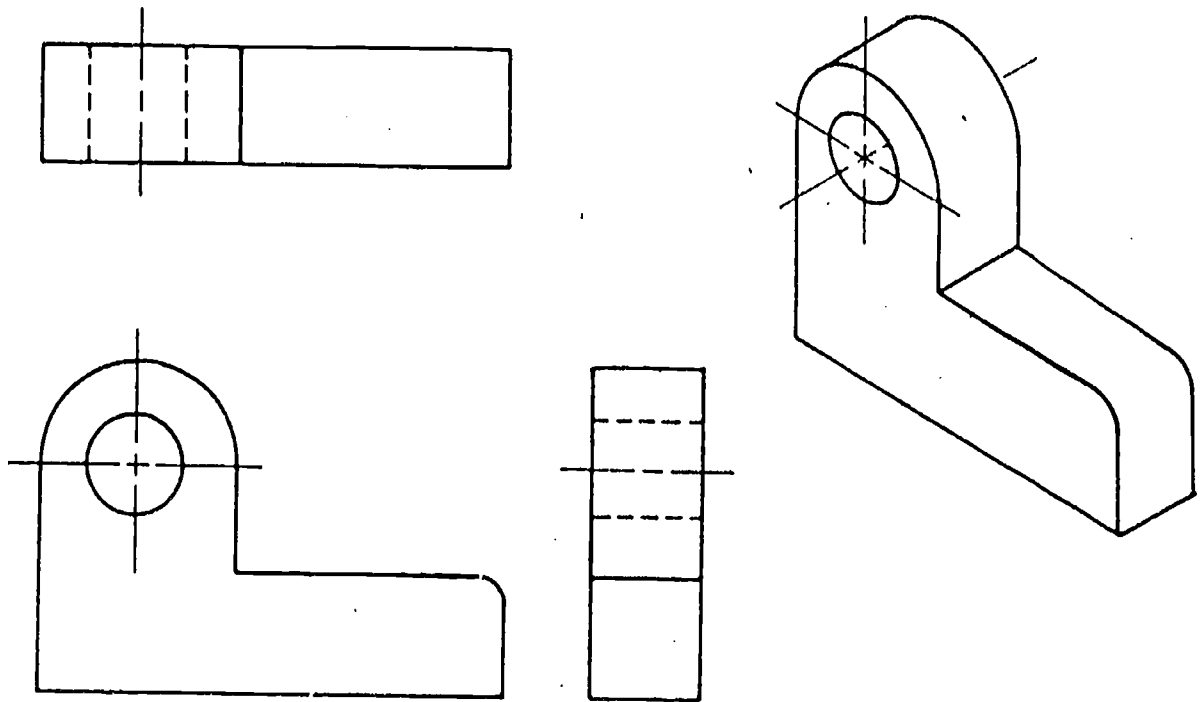


The hidden lines in this example are there because a part of one corner of the front surface has been cut away or recessed.

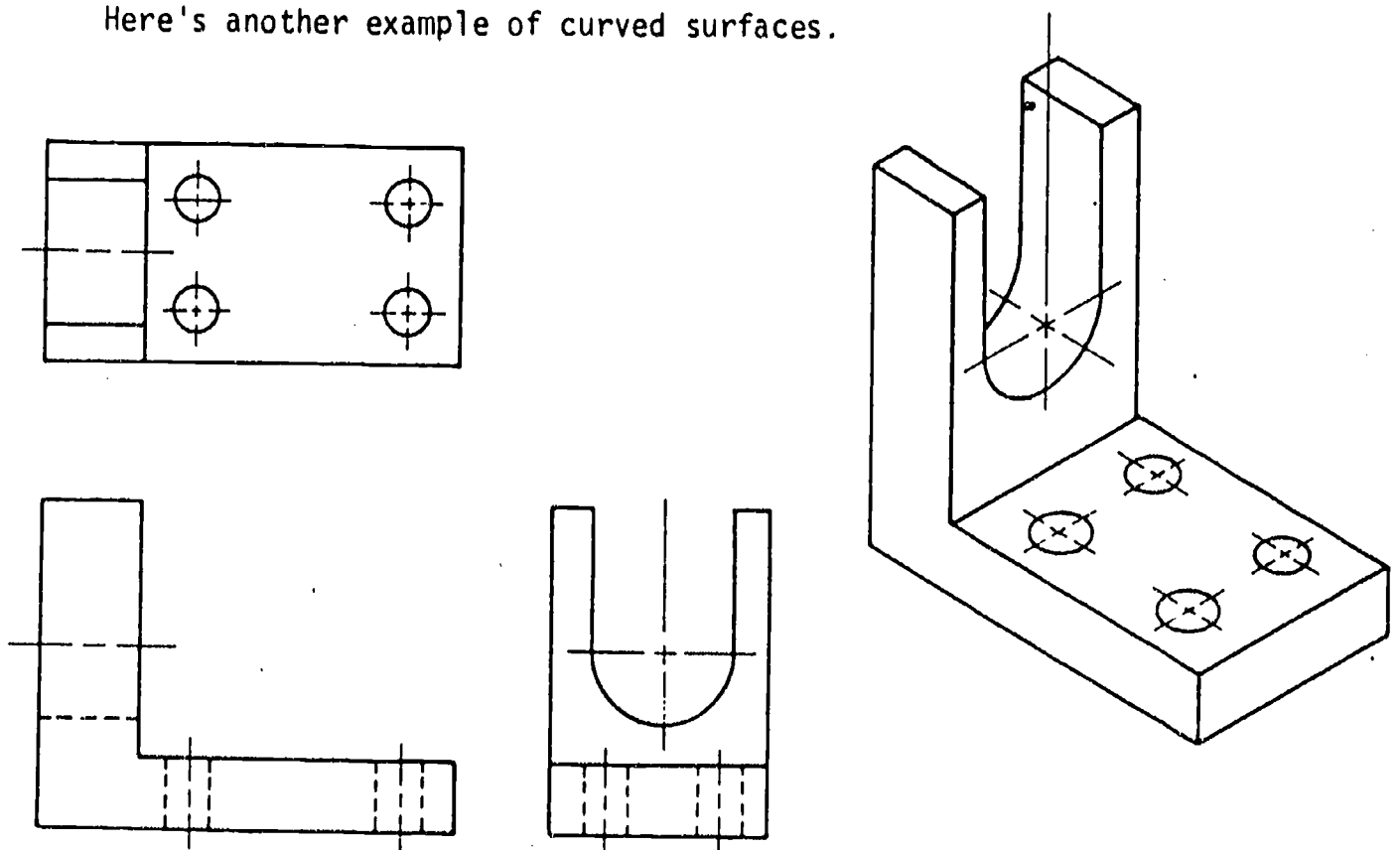


8. CURVED SURFACES

Curved surfaces are perhaps tricky to "see" until you remember that the curve is shown only in one view. You must put the curve in the other views yourself, through visualization.



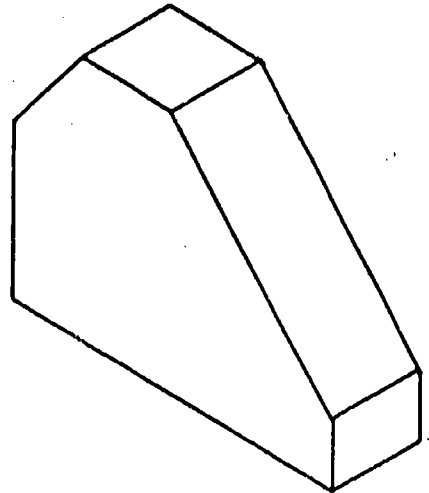
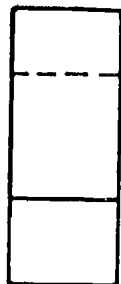
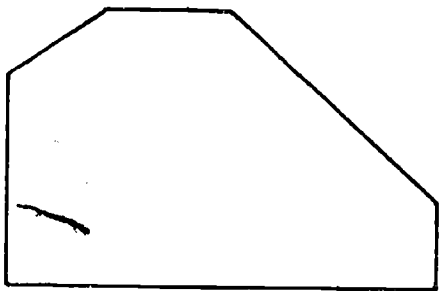
Here's another example of curved surfaces.



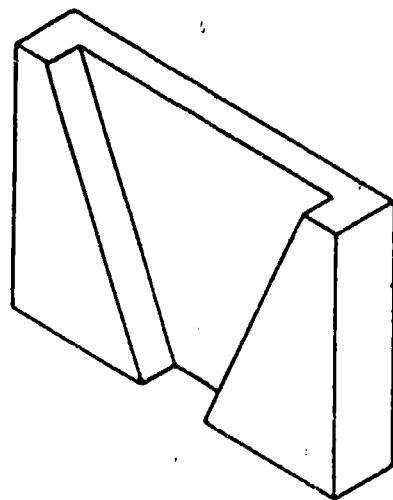
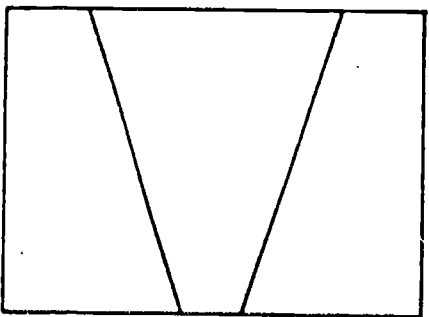
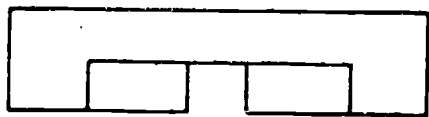
9. INCLINED SURFACES

Inclined surfaces are those which are at an angle, or slanted. In other words, they are surfaces which are neither horizontal nor vertical. In viewing orthographic drawings you need to be alert to angles and inclined surfaces, for they are often found on prints you will be reading later.

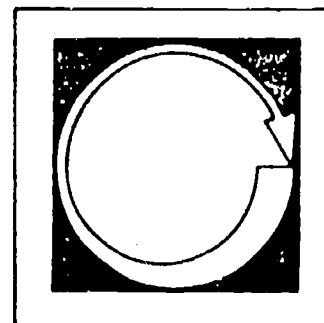
Notice the hidden line in the right side view created when the inclined surface joins the vertical end surface of this object.



Here is an object with two inclined surfaces.



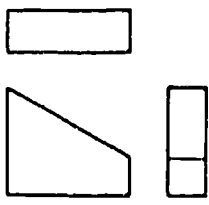
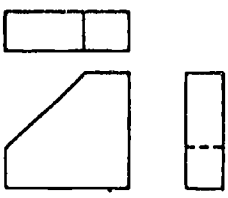
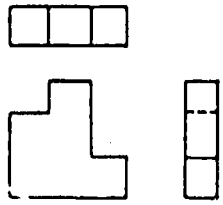
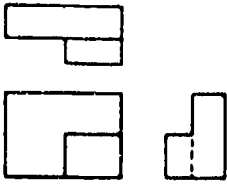
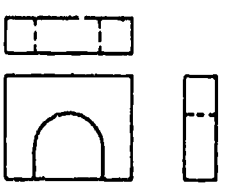
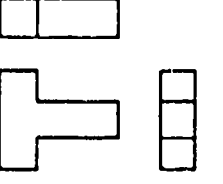
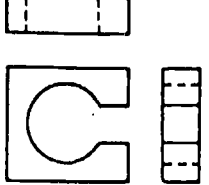
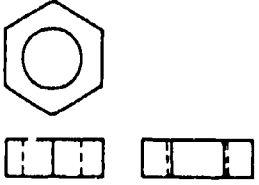
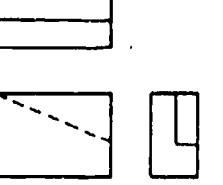
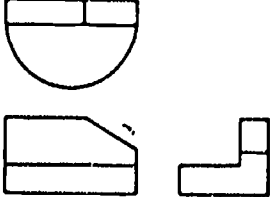
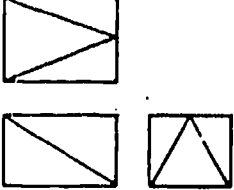
Self Assessment



Directions: With a pencil, draw the lines needed to complete the view.
 One view in each problem is incomplete. Grade your test.
 If you have 9 or more right go on to the next section.
 If less than 9, erase your answers and repeat this module.

<p>1</p>	<p>2</p>	<p>3</p>
<p>4</p>	<p>5</p>	<p>6</p>
<p>7</p>	<p>8</p>	<p>9</p>
<p>10</p>	<p>11</p>	<p>12</p>

Answers to self test:

<p>1</p> 	<p>2</p> 	<p>3</p> 
<p>4</p> 	<p>5</p> 	<p>6</p> 
<p>7</p> 	<p>8</p> 	<p>9</p> 
<p>10</p> 	<p>11</p> 	<p>12</p> 