CHAPTER

Three-View, Plan View and Elevation View Drawings

Technical drawings are the language engineers and architects use to communicate their ideas and designs to journeymen. It is a language based on lines and symbols that have specific meanings. Journeymen must possess the skill to interpret these symbols and lines, so that they may install and maintain piping systems.

This chapter discusses the use of three-view drawings, section drawings, and schematic drawings, and introduces some special-purpose drawings, such as exploded drawings and wiring diagrams.

The photograph in Fig. 2-1 clearly depicts the over-all appearance of a concrete block. A three-view drawing will most clearly show the appearance as well as the exact size and other details of construction of an object.

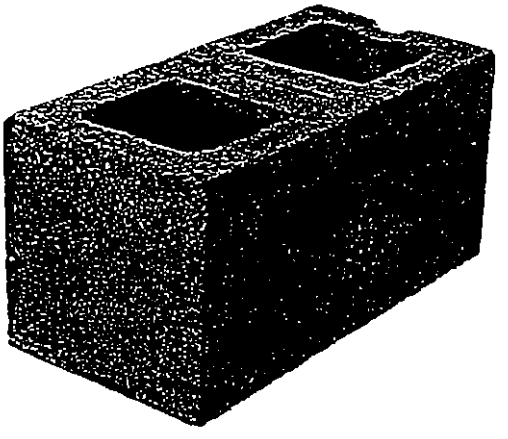
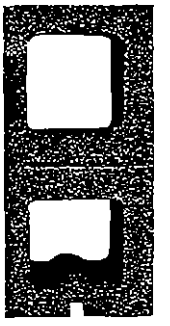


Fig. 2-1

The three-view drawing of the concrete block shown in Fig. 2-2 is a drawing with the Top View positioned directly above the Front View and the Right-Side or Left-Side View positioned directly to the right or left of the Front View.

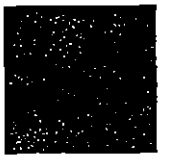
The Front View of the concrete block in Fig. 2-2 does not show what is normally considered the Front View.

The Front View in a 3 View drawing does not necessarily show the "front" of an object.



Top View

Front View



Right-Side View

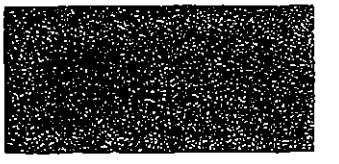


Fig. 2-2

Also, the Right-Side View in Fig. 2-2 does not represent what is usually considered the "Right-Side" of the concrete block.

The key to understanding the relationship of the views in a three-view drawing is the Front View. The Front View locates the object directly in front of the viewer. See Fig. 2-3.

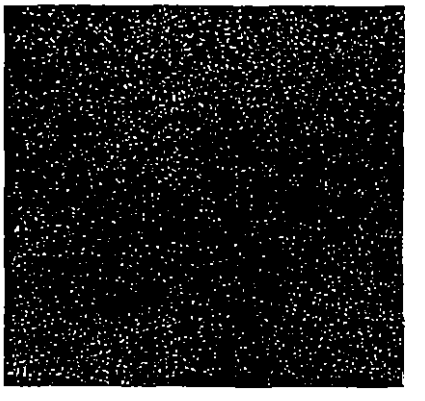
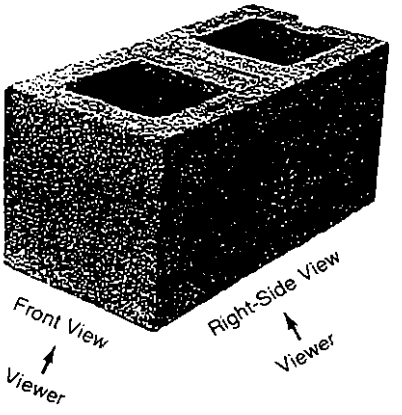


Fig. 2-3

How, then, is the Right-Side View related to the Front View?

With the Front View directly in front of the viewer, the Right-Side View is what the viewer would see if he or she were to walk to their right until the right side of the object was directly in front of them. See Fig. 24.



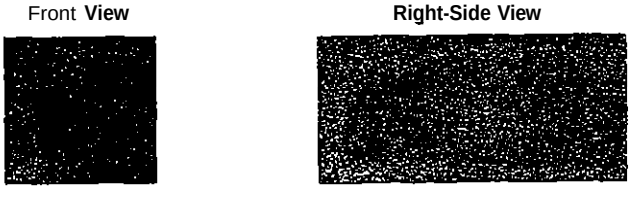


Fig. 2-4

How would the Top View be related to the Front View?

The Top View in Fig. 2-5 shows the object as the viewer would see it when they stand at the Front View, as shown in Fig. 24, and look directly down on the object.

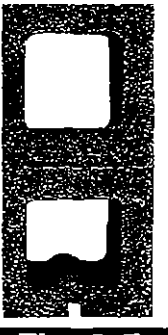


Fig. 2-5

*Fig. **2-6** is a three-view drawing of a concrete block.*

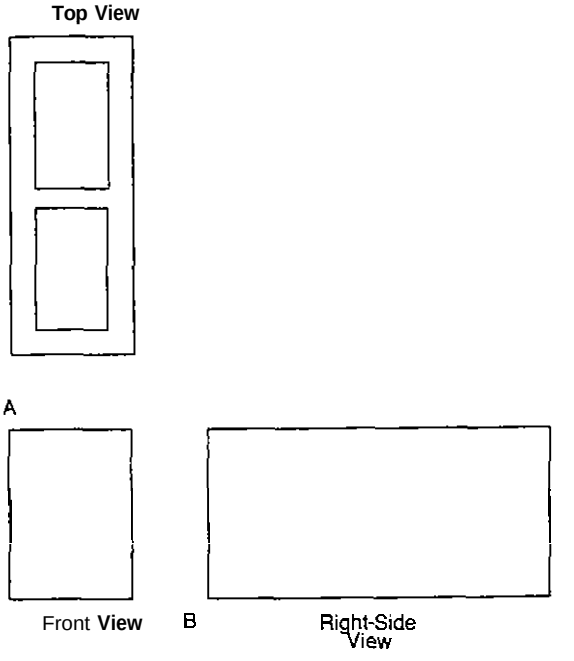


Fig. 2-6

***On** squared **block paper,** sketch the **concrete** block in three views as shown in **Fig. 2-6. Use a straight edge and a** medium-weight pencil. Note the equal spacing at "A" and "B." Save these sketches for future reference.*

The drawing in Fig. 2-6 does not give a complete understanding of the object. Only the visible details in each view are shown.

In a three-view drawing, solid lines are used to represent the details of an object which can be seen in each view.

Broken lines are used to illustrate the openings which are "hidden" in the Front and Right-Side Views. See Fig. 2-7.

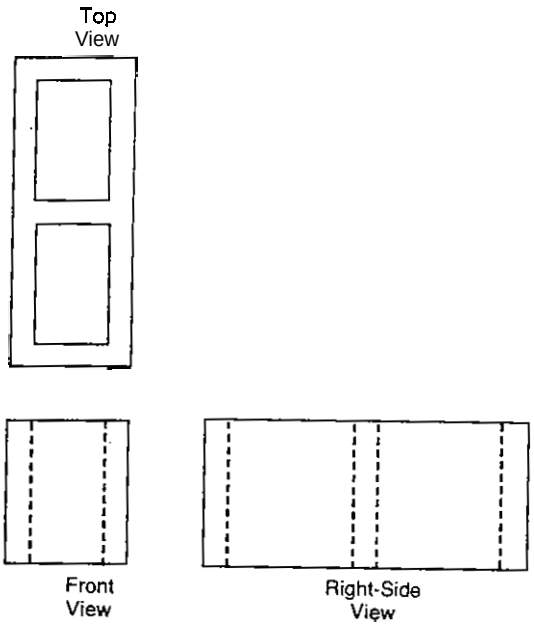


Fig. 2-7

The Front View, Top View, and the Right-Side View in Fig. 2-7 must be compared to get a true picture of the "hidden" details.

On squared block paper, make a three-view drawing of the concrete block with the Front View being what is normally considered as the front of the block. Compare your drawing with the one shown in Fig. 2-8.

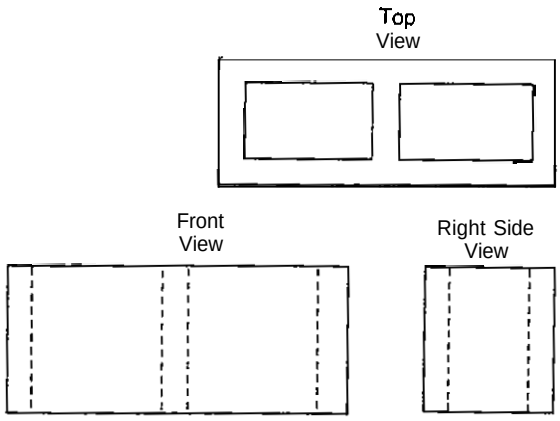


Fig. 2-8

Using the Top View shown in Fig. 2-8 as the Right-Side View, make a second sketch and compare it with Fig. 2-9.

The three-view drawings which have been discussed are generally accepted as standard in the United States and

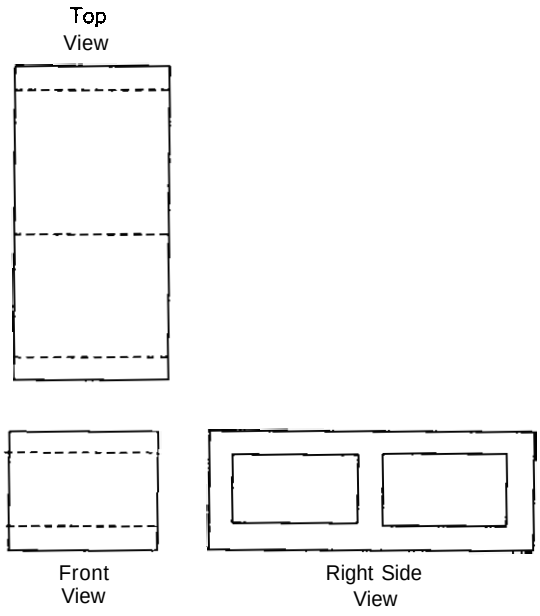


Fig. 2-9

Canada, but other views may be shown which would better illustrate the object. See Fig. 2-10.

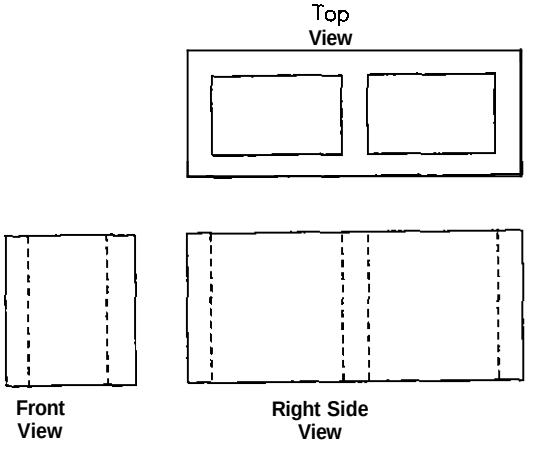


Fig. 2-10

The water closet shown in Fig. 2-11 is taken from an actual rough-in book.

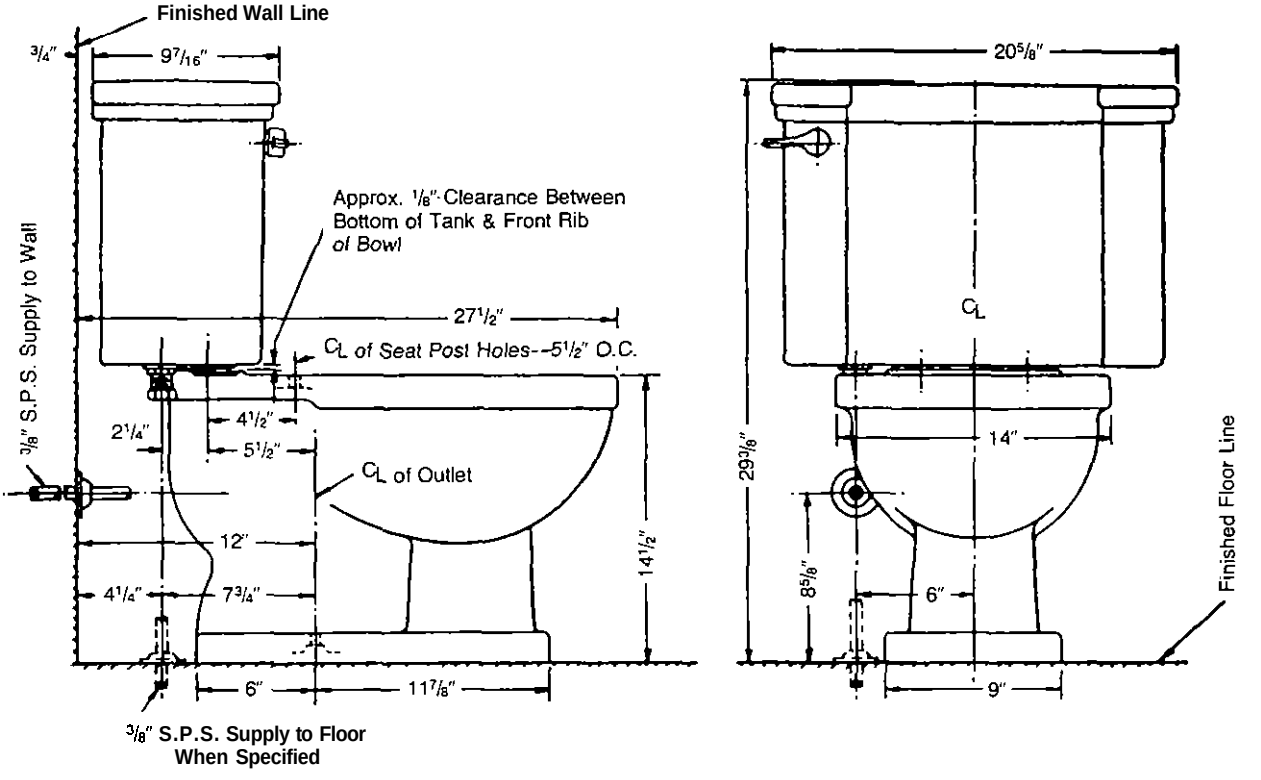
The Front View of the drawing in Fig. 2-11 shows the left side of the fixture.

In Fig. 2-11, the left side of the fixture was chosen as the Front View because the left side of the fixture contains the ballcock and the rough-in could best be shown by this view.

The Top View of the fixture in Fig. 2-11 was omitted because the Front View, Right-Side View, and related notes provide sufficient information to rough-in this particular type water closet.

Technical drawings don't always show three views or all of the hidden lines and the exact outside shape of an object.

If space is at a premium, the draftsman may use symbols to represent objects such as valves or pipe fittings.



NOTE: This Water Closet is Designed to Rough-in at a Min. Dimension of 12" From Finished Wall to ℄ of Outlet

Fig. 2-11

Fig. 2-12-A, B and C are drawings of a 90° elbow shown in three views. An example of a 90° elbow is shown in Fig. 2-12-B and C using symbols.

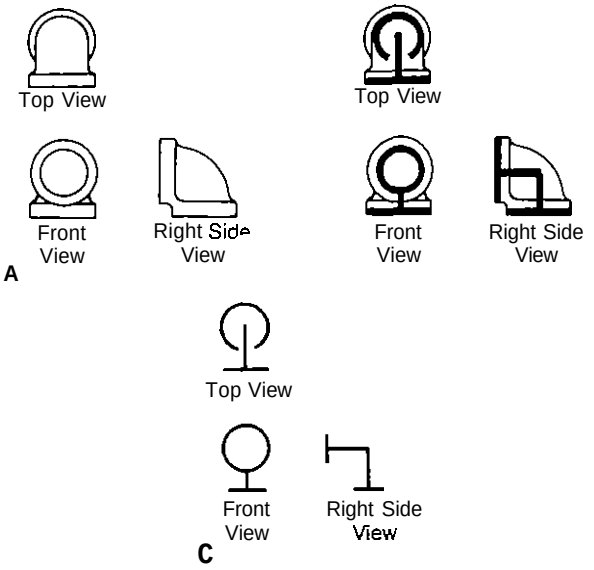


Fig. 2-12

In the process of making a drawing of a complicated piping system, the use of symbols similar to the types shown in Fig. 2-13 obviously saves time and space. You must know what these symbols stand for if you are to understand what the draftsman is trying to convey in a drawing.

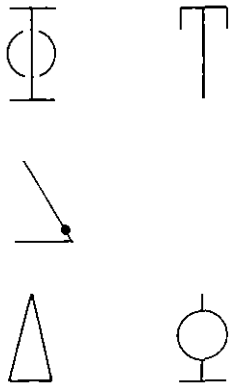


Fig. 2-13

Each symbol in Fig. 2-13 is both correctly identified and pictured by a double line drawing in Fig. 2-14.

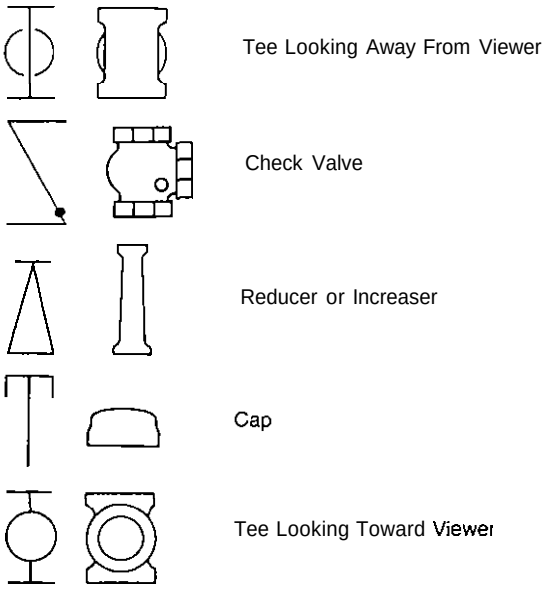


Fig. 2-14

On squared block paper, sketch a three-view drawing, using fitting symbols, to illustrate the piping arrangement shown in Fig. 2-15.

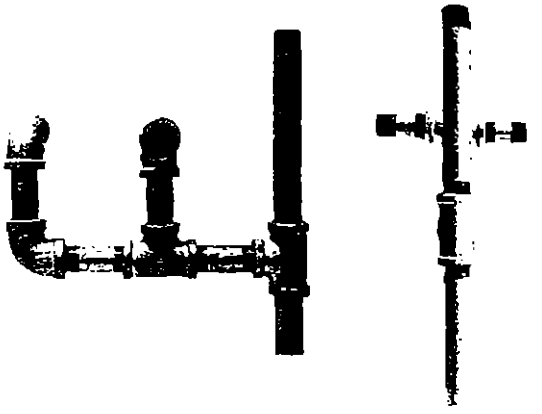
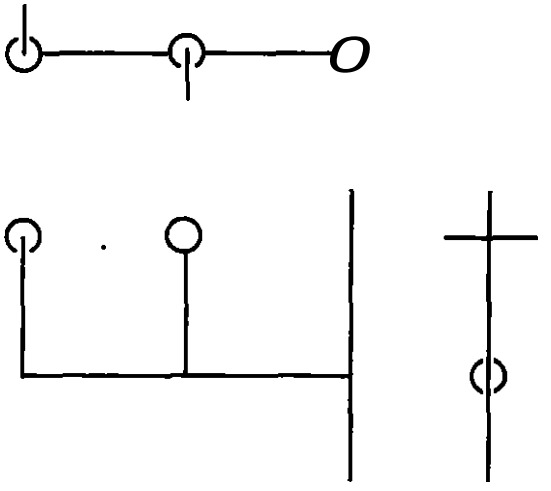


Fig. 2-15

Compare your sketch with the one shown in Fig. 2-16.



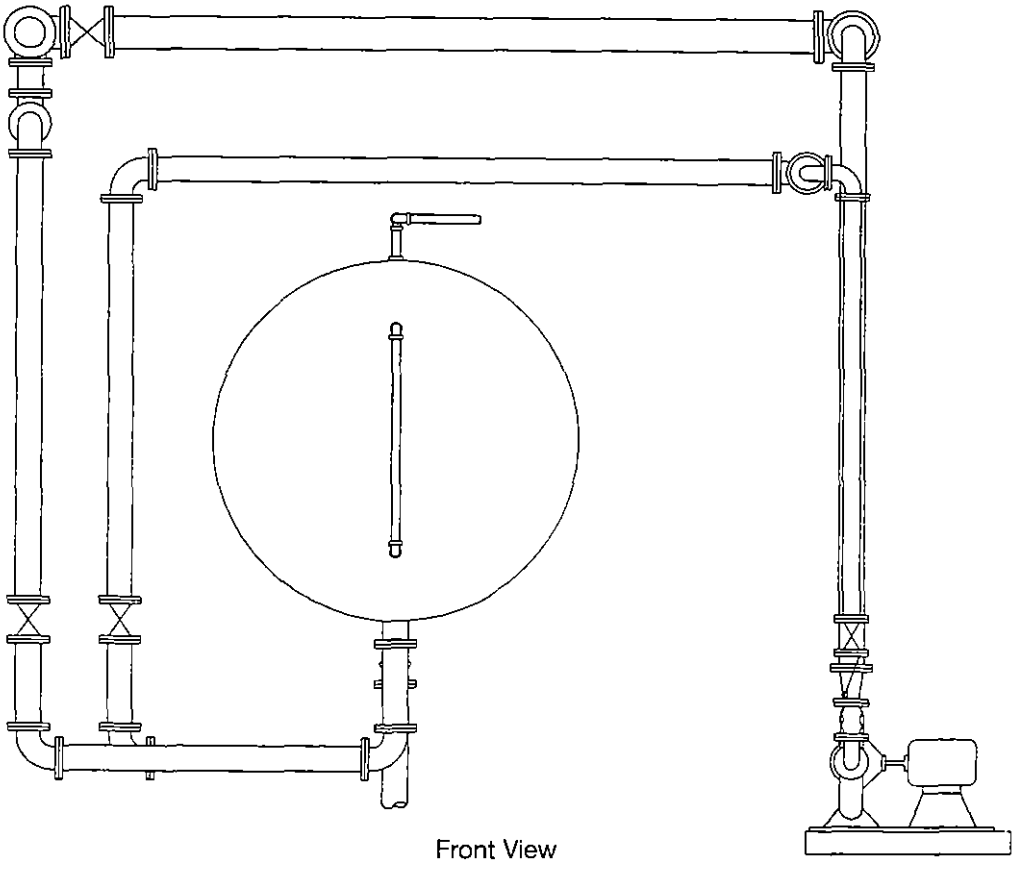
Note: The "Fitting Face Marks" are omitted in Fig. 2-16.

Fitting Face Marks should only be used on a sketch or drawing when they are needed for clarification.

Figs. 2-17, 2-18 and 2-19 are the front, right side, and top views of a pneumatic water booster system. Fig. 2-20 is the same system drawn in an isometric view with the use of fitting symbols.

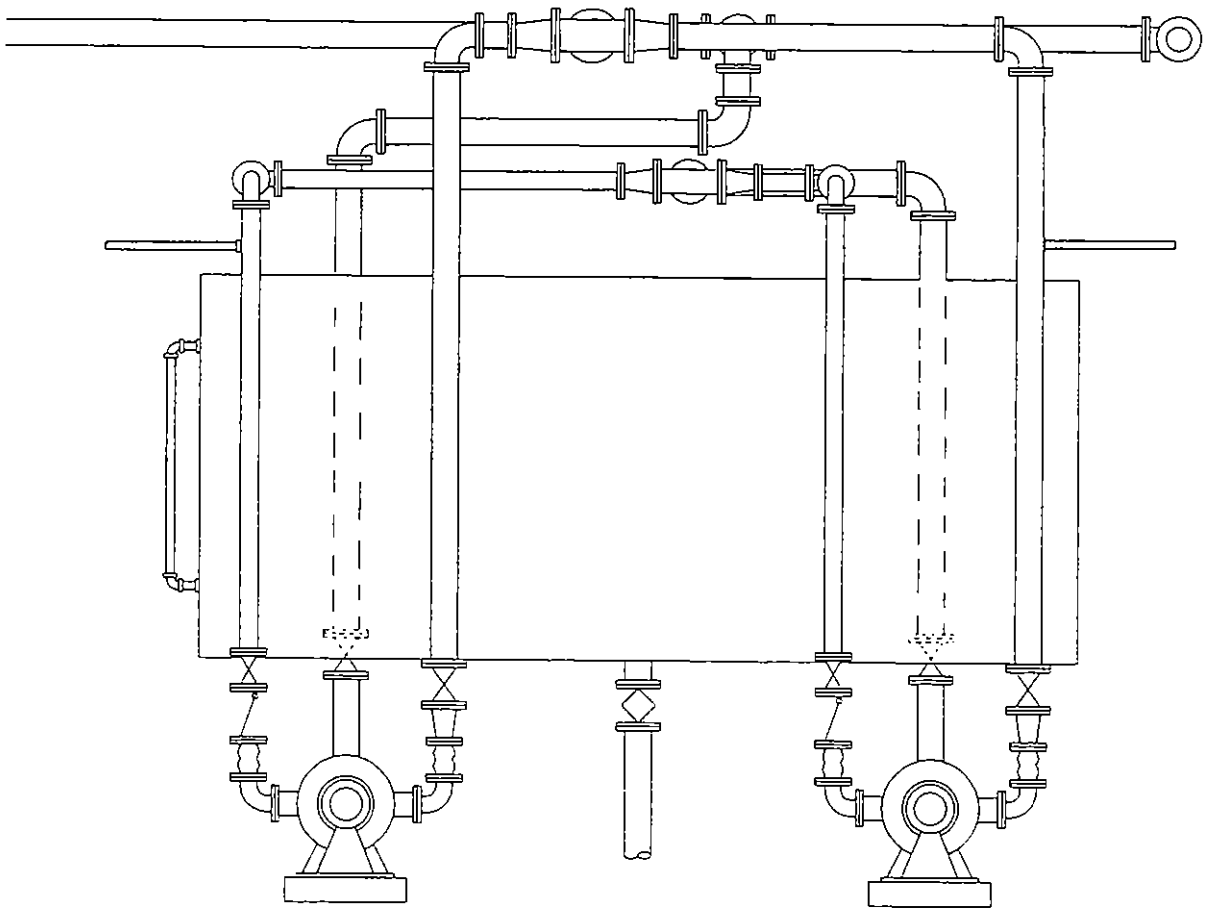
Symbols are used in Fig. 2-20 which represent the pumps, valves and fittings. From observation it becomes obvious that the use of symbols require far less effort than drawing each item in the three views of the pneumatic water booster system shown in Figs. 2-17, 2-18 and 2-19.

Fig. 2-16



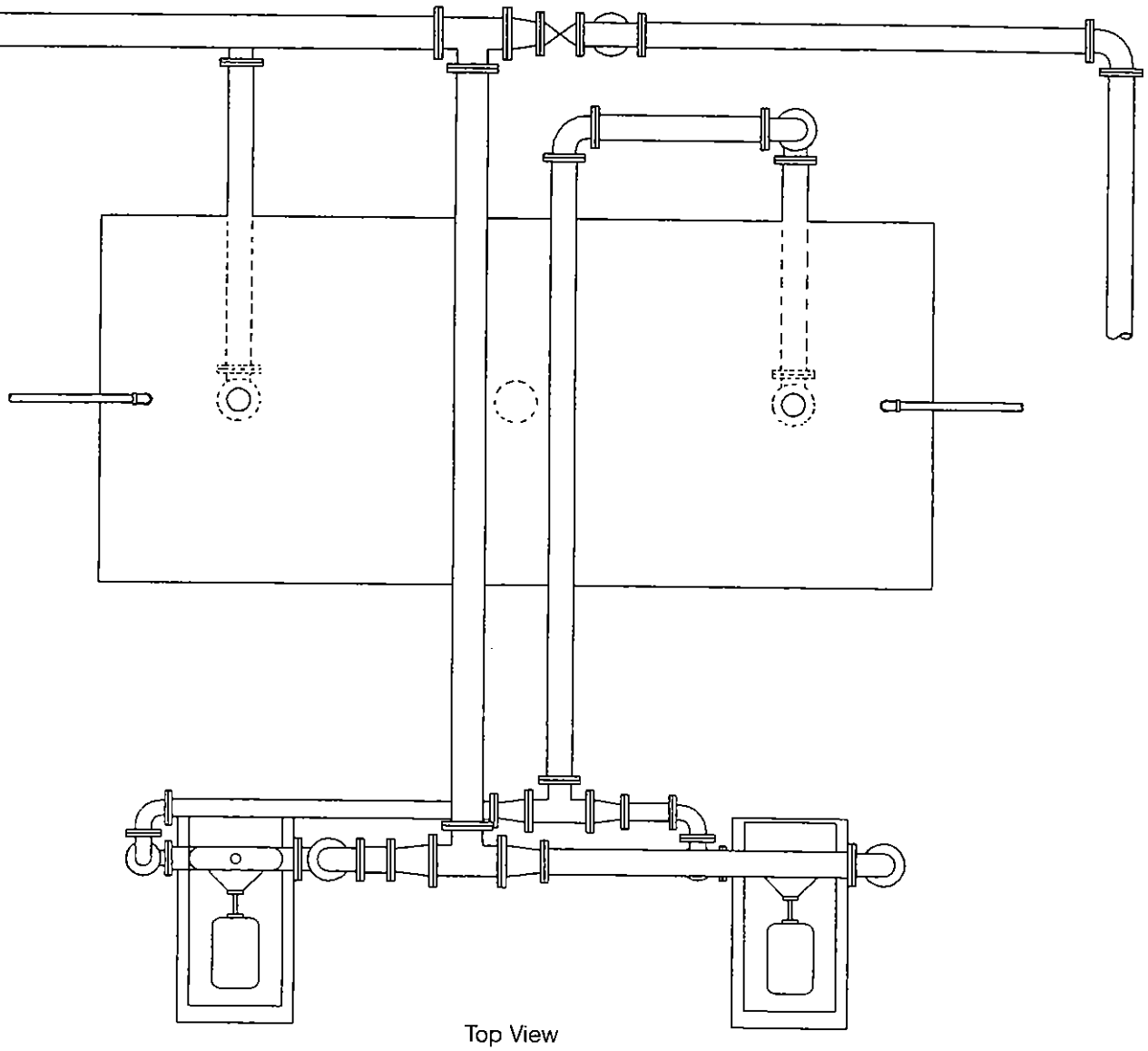
Front View

Fig. 2-17



Right Side View

Fig. 2-18



Top View

Fig. 2-19

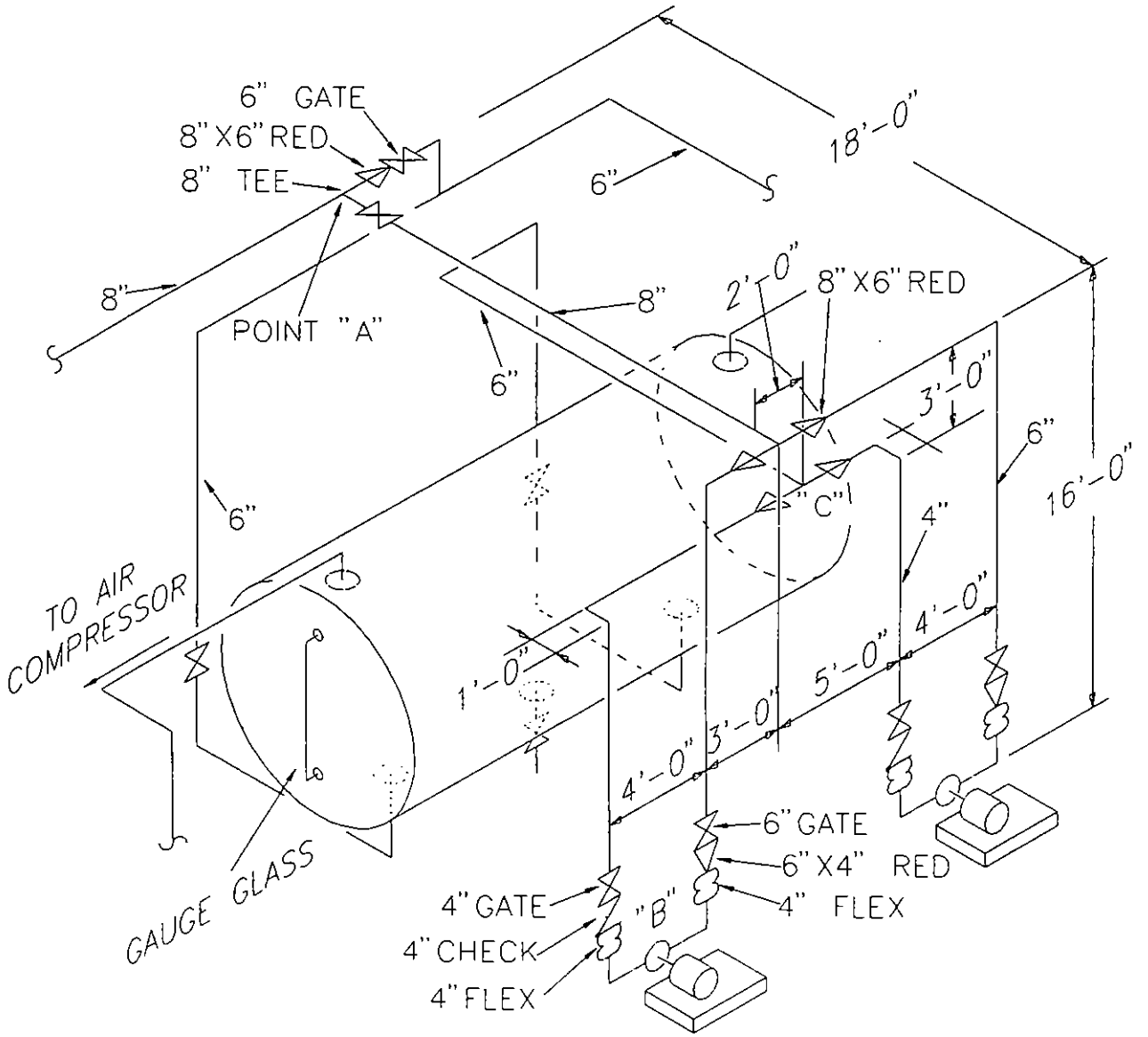

6" GATE
8" X6" RED
8" TEE
6"
18'-0"
8"
POINT "A"
8"
2'-0"
8" X6" RED
6"
3'-0"
6"
6"
"C"
4"
16'-0"
TO AIR COMPRESSOR
1'-0"
5'-0"
4'-0"
3'-0"
4'-0"
6" GATE
6" X4" RED
4" FLEX
GAUGE GLASS
4" GATE
"B"
4" CHECK
4" FLEX

Fig. 2-20

The type of drawings most commonly used on job sites are plan and elevation views. Usually the plan and one elevation view are used to fully describe an object, however in some instances more than one elevation view is needed. Explain.

The plan view is the view as seen from *above* the object, looking down on it or the top view.

The elevation view is the view from one side of the object. Fig. 2-21 is an example of this type of drawing, showing the plan view, four elevation views and the bottom view.

Each one of these views shows two of the principle dimensions and can show only two. The front view or front elevation shows the *width* and *height* of the front of the object. The top view or plan view shows the *width* and *length* of the top.

The right side view or right elevation shows the *length* and *height* of the right side. The left view or left elevation shows the *length* and *height* of the left side. The rear view or rear elevation shows the *width* and *height* of the rear side.

The bottom view is not a plan view, but rather it is a view from beneath the object looking up. This view shows the length and width of the underside of the object. This view is not often used in pipe drawings, but is sometimes used to show the bottom side of such things as vessels, turbines, etc. You must remember that this view is from the bottom looking up.

The plan view is often used to show the floor plan of a building or equipment room. Usually the plan view shows the building with the roof removed and the observer is looking down at the floor or floor plan.

Fig. 2-21 shows the correct method for arranging these six views. When sketching pipe, how should these rules be observed?

1. The top view or plan view should be placed directly above the front view.
2. The bottom view should be drawn directly below the front view.
3. The right view should be drawn directly to the right of the front view.
4. The left view should be drawn directly to the left of the front view.
5. The rear view should be drawn to the left of the left view or if necessary to the right of the right view.

While some views can be omitted: no view should be drawn in any other position.

Fig. 2-22 is a pictorial drawing of a simple piping situation using screwed pipe and fittings with the fittings *numbered* and the pipe *lettered.* To give a complete description of this piping situation using a plan and elevation view, at least *two* views as in Fig. 2-23 would be needed.

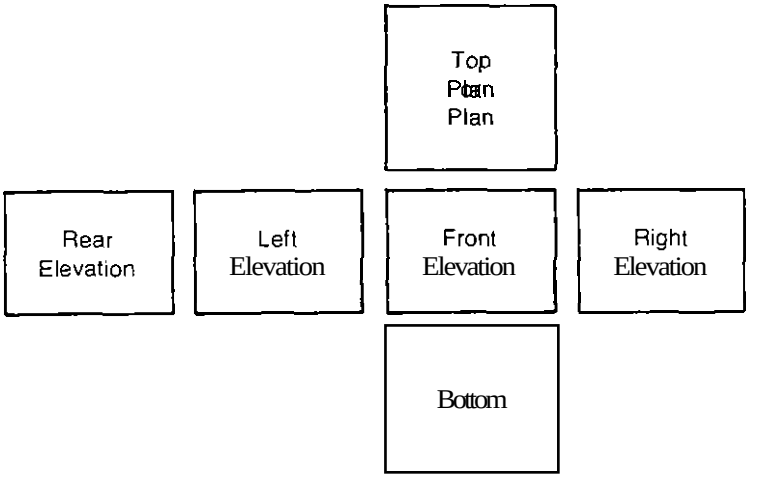


Fig. 2-21

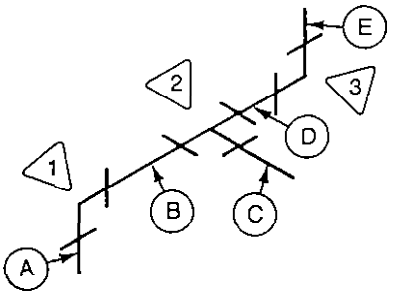


Fig. 2-22

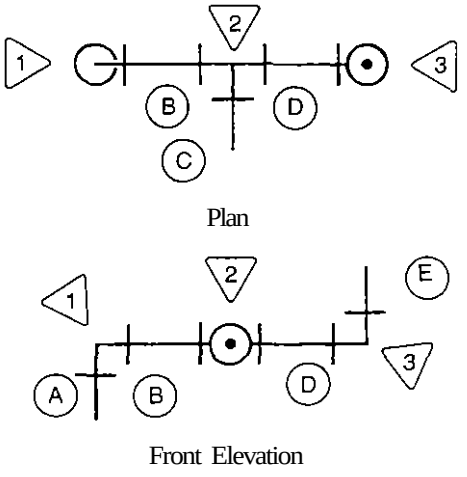


Fig. 2-23

Starting at the left side of the plan view you will see the symbol for the 90-degree ell 1 turned down. From this ell going to the right, you will see nipple (B) which connects to tee 2. The side outlet of the tee is in the horizontal position with a piece of pipe (C) screwed into it. (the right side of the tee is another piece of pipe (D) which connects to a 90-degree ell 3 turned up.

This plan view shows most of the information needed, but not all of the information needed. It does not show the length of the nipples (A) and (E). To get these lengths you must refer to the front elevation view in Fig. 2-23.

Starting at the left side of the elevation view you will see nipple (A) connected to the 90-degree ell 1 which is now shown as a side view. Moving to the right from the 90-degree ell 1 you can see nipple (E), which is connected to ell 3.

The symbol used to show the tee is the symbol for a tee turned up or side outlet up. You know from the plan view that the side outlet of the tee is horizontal. This symbol shows that you are looking into the side outlet or the side outlet is facing you.

Fig. 2-24 shows the five views possible for the piping situation in Fig. 2-22. The bottom view is not used.

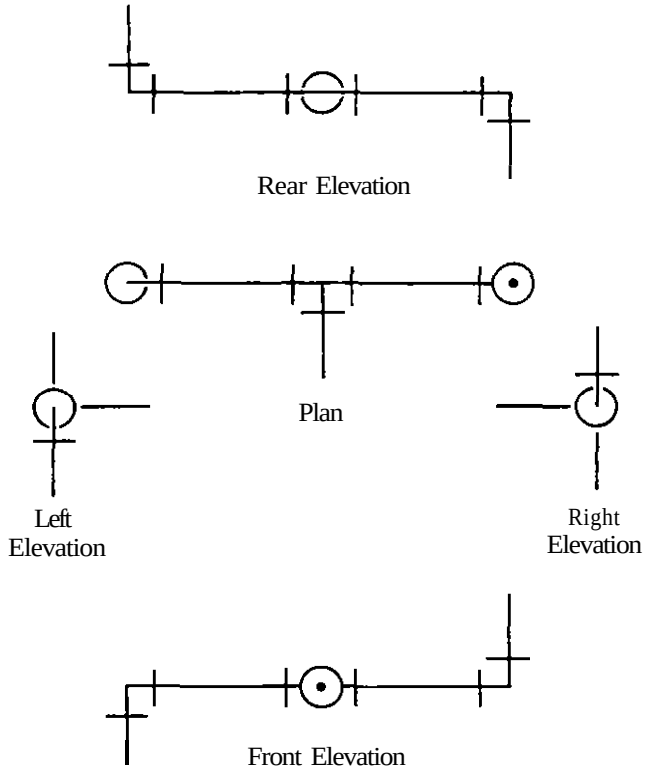


Fig. 2-24

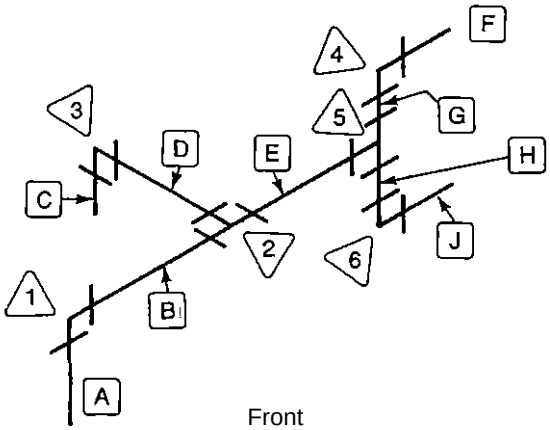
To be able to draw the four elevation views you must rotate the pictorial drawing in Fig. 2-26 in your mind's eye. If this were a piping situation already fabricated it would be simple to walk around to the rear side to see how it looks, but most drawings or sketches are made to show how the pipe is to be fabricated rather than to show existing pipe fabrications.

EXERCISE 2-1

Fig. **2-25** is a pictorial drawing with the fittings numbered and the pipe lettered. Fig. **2-26** consists of a plan and four elevation views of the same piping situation.

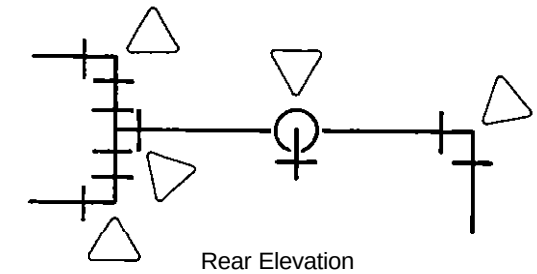
Study the pictorial drawing in Fig. **2-25.** Fill in the correct numbers in the triangles next to each fitting in the plan and elevation views in Fig. **2-26.** Fill in the correct letter in the square next to each piece of pipe.

In Fig. **2-26** which elevation view would be the best one to use?

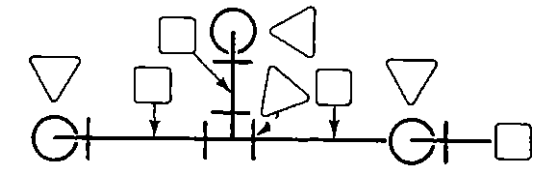


Front

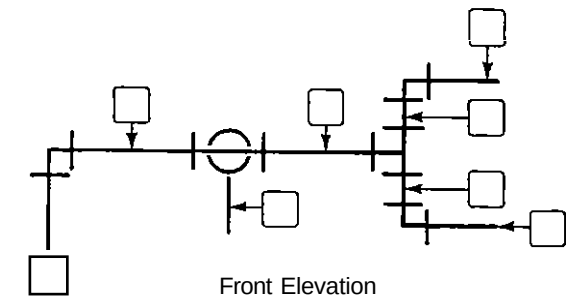
Fig. 2-25



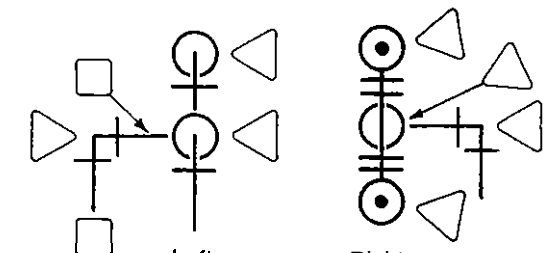
Rear Elevation



Plan View



Front Elevation



Left Elevation

Right Elevation

Fig. 2-26

EXERCISE 2-2

Draw the plan view and front elevation view of the piping situation in Fig. 2-27 on a piece of squared block paper. Use a drawing board and T-Square. Use screwed fitting symbols. Make the drawing approximately twice the size shown in Fig. 2-27.

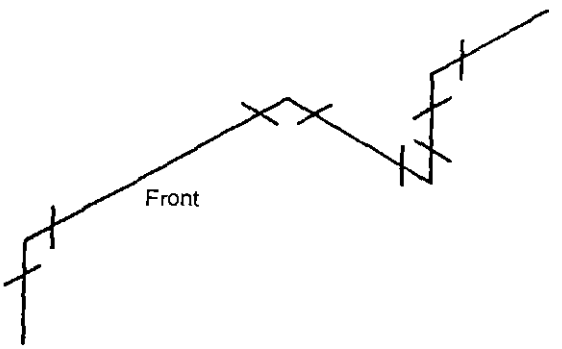
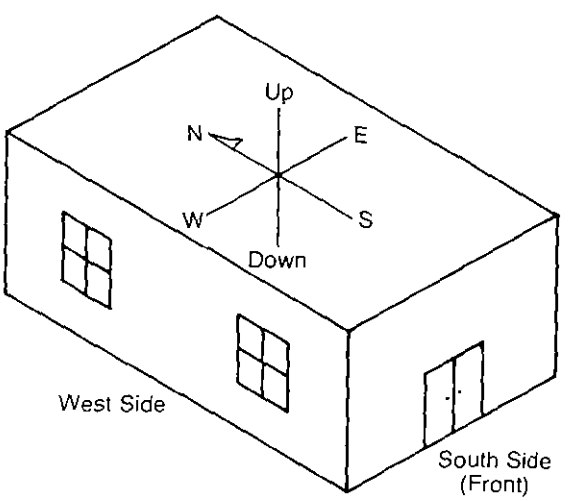


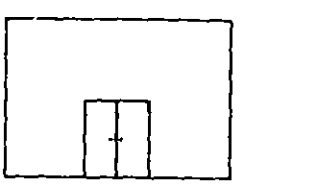
Fig. 2-27

The terms front elevation view, rear elevation view and side elevation view refer to the side from which you are viewing the object. When drawing the front elevation view of a building, this would be the view where the journeyman is standing in front of the building and looking at the front.

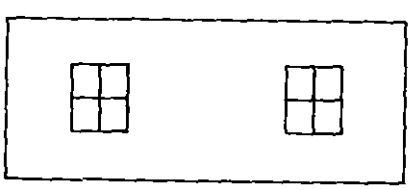
The terms front, rear, and side are not often used in pipe work, especially in industrial applications. These terms are replaced by the terms east elevation, west elevation, north elevation and south elevation.

The front view of a building would be called the south elevation view as shown in Fig. 2-28.





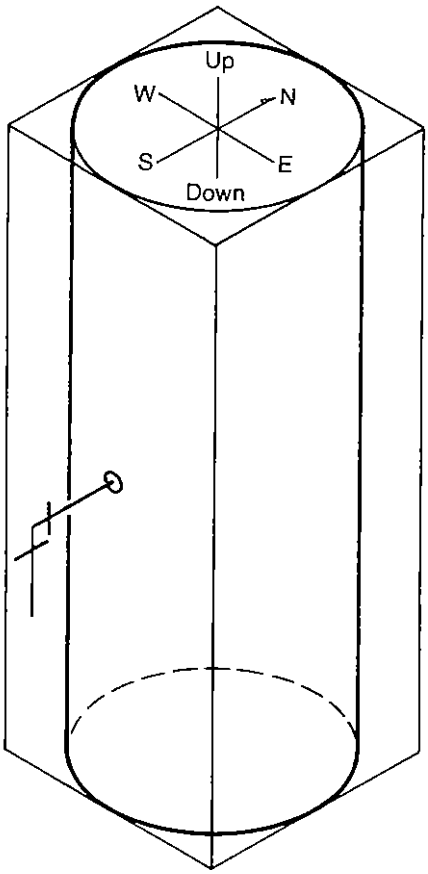
South Elevation

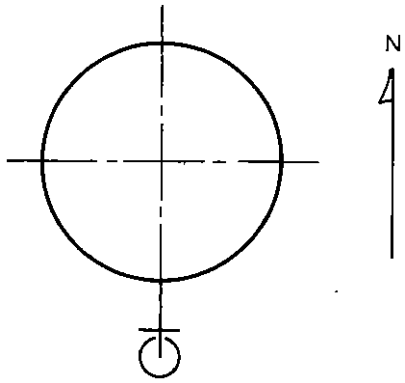


West Elevation

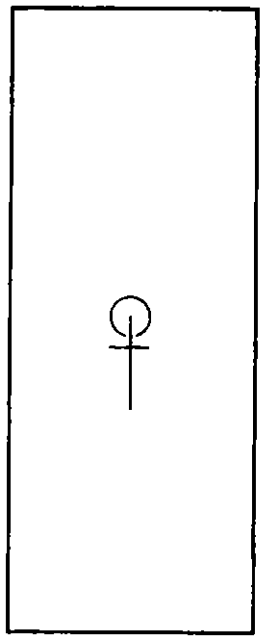
Fig. 2-28

Fig. 2-29 shows a pictorial view of a cylinder and a three view drawing of the same cylinder. Piping diagrams normally use the points of the compass to describe the elevations. Note that the South Elevation is the south side of the tank and would be seen when you are facing north.

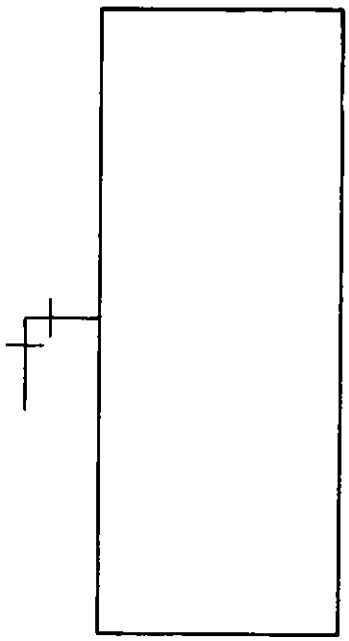




Plan



South Elevation



East Elevation

Fig. 2-29

The elevation views of piping would be named in the same manner Fig. 2-31 shows the plan view and the four elevation views of the piping arrangement in *Fig.* 230.

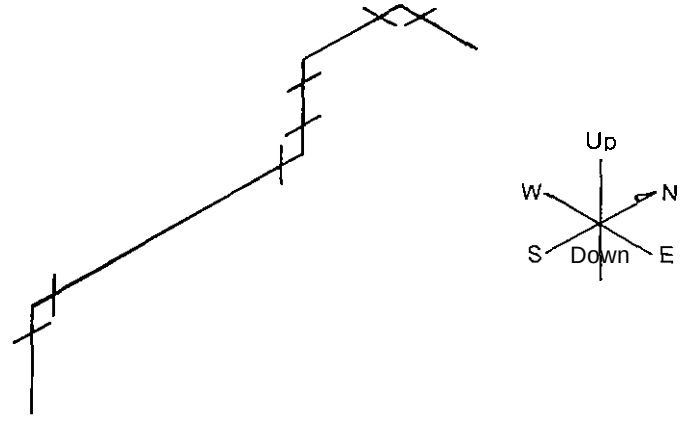


Fig. 2-30

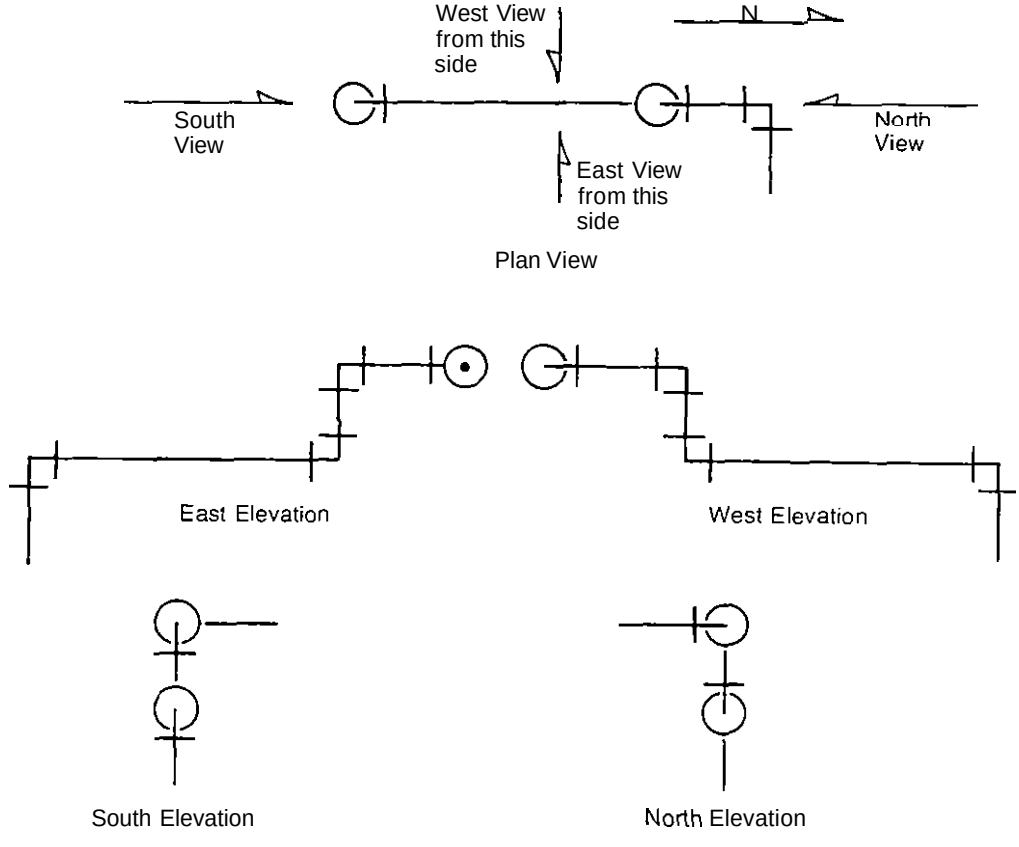


Fig. 2-31

EXERCISE 2-3

On squared block paper draw a Plan View and East Elevation View of the piping arrangement in Fig. 2-32.

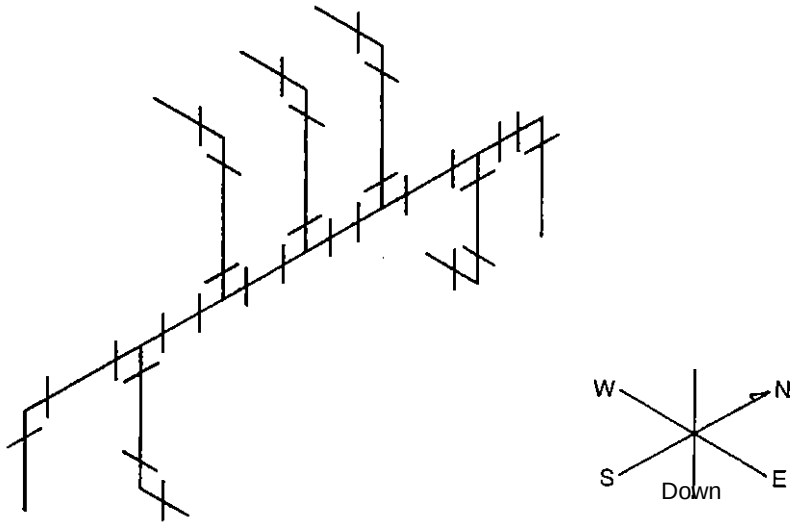


Fig. 2-32

EXERCISE 2-4

Draw a Plan View and West Elevation View of Fig. 2-33.

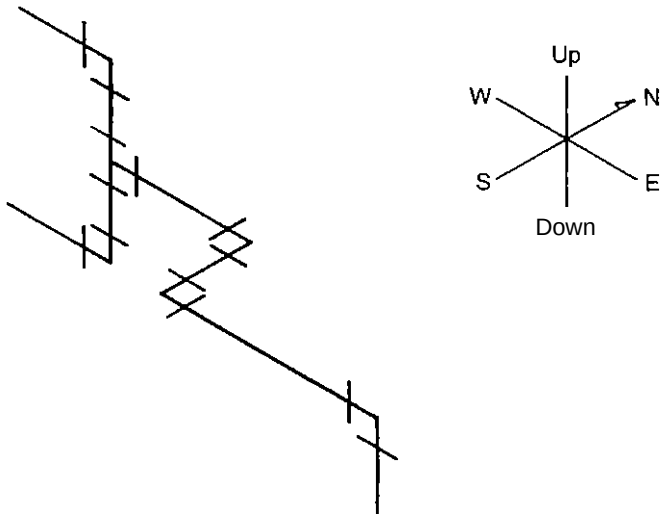


Fig. 2-33

CHAPTER

Graphic Symbols for Pipe Fittings and Valves

The use of symbols to represent fittings and valves on pipe drawings and sketches is necessary to show what types of fittings and valves are to be used. Without the use of these symbols the fittings and valves would have to be drawn to their actual shape or their types would have to be written on the drawing. What has the piping industry done to show the types of fittings and valves to be used?

The piping industry has developed a set of symbols to represent pipe fittings and valves. Most of these symbols are universal and the most common ones such as the standard symbols shown in Fig. 3-1 for gate valves, globe valves, and check valves are recognized throughout the industry. Some of the larger companies and some localities have their own symbols which they prefer to use, and this should be kept in mind.

Pages 31 through 37 show single-line graphic symbols as currently used in the piping industry. When drawing these symbols it is not necessary to attempt to scale the size of the symbol to correspond with the size of the valve or fitting represented. There is no rule regulating the size of these symbols. They must be large enough to permit easy and accurate reading.

Representation of single-line symbols may be compared to letting a single wire represent the pipe, and representing the connection of the pipe to the fitting by a disc centered on the wire (in the case of flanged fittings, two discs). See Fig. 3-2. This assembly when

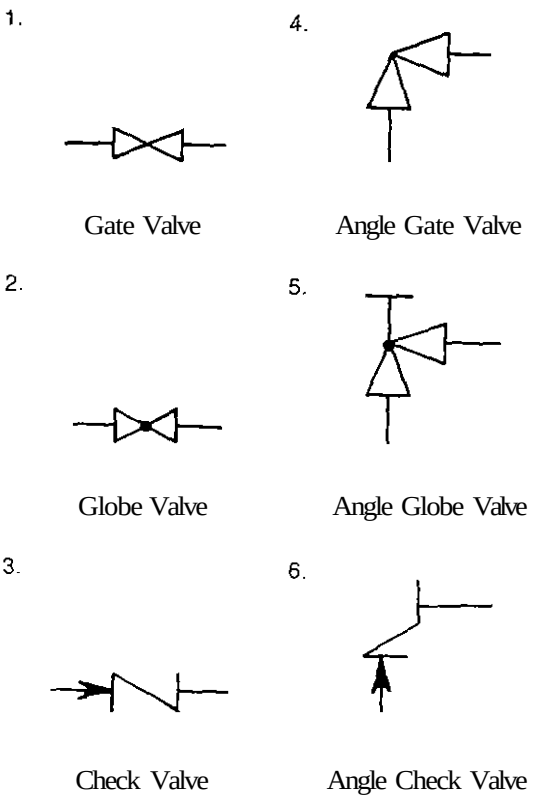
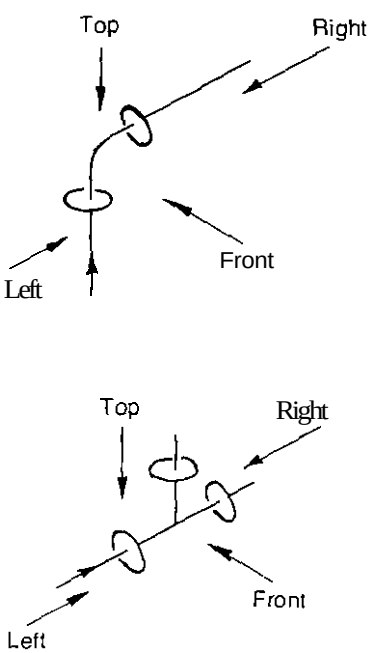


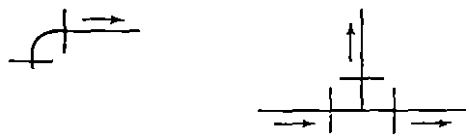
Fig. 3-1



Pictorial view of discs representing screwed fittings

Fig. 3-2

viewed from the top, front, or either end will give the appearance of a single-line symbol representing the fittings shown in Figs. 3-3 through 3-6.



Front view of fittings

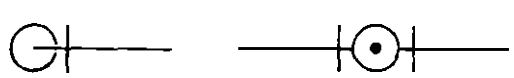
Fig. 3-3

Left side view of fittings

Fig. 3-4

Right side view of fittings

Fig. 3-5



Top view of fittings

Fig. 3-6

Why are fitting face marks currently used less in single line drawings than in years previous?

With the advent of "fast track" jobs, CAD (computer aided drawing), and the need to save time; fitting face marks are often omitted.

The symbols used to indicate the joining methods (such as welded, flanged, soldered, etc.) and the pressure rating of the fittings required in a piping system are also often omitted from drawings. The journeyman must refer to notes on the drawing, the job specifications, and the addenda in order to be sure of the types of materials to be used for each system.

Most charts refer to the position of the symbols as "in elevation, turned up, or turned down." In elevation means a view looking at the side of the symbol. List four examples of the position of symbols for fittings shown in a front view, left side view, right side view and top view in a piping drawing.

With the elbow or with the tee, the discs would appear as straight lines as in Fig. 3-3. These cross lines on the symbols are drawn so they appear to be lying in the plane formed by the bend in the pipe. When symbols overlap, the rear or overlapped symbol is usually omitted.

If the elbow is turned so the flow is away from the viewer (viewed from the left), one of the connecting discs would appear as a circle and the back of the elbow would appear as a line drawn to the center of the disc. See Fig. 3-4. The tee would appear as shown with the circle, dot, and line.

If the elbow is turned so the flow is toward the viewer (viewed from the right), one connection would appear as a circle, the other as a straight line. The end of the pipe would be shown as a dot in the center of the disc, as shown in Fig. 3-5.

Fig. 3-6 shows the appearance of the elbow and tee when they are viewed from above.

See Table 3-A. Provide a complete list of graphic symbols for pipe fittings and valves. Construct the list in table form which will include symbols for fittings and valves with flanged, screwed, bell and spigot, welded and soldered joints.

TABLE 3-A. GRAPHIC SYMBOLS FOR PIPE FITTINGS AND VALVES

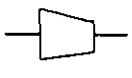
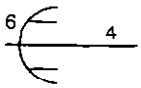
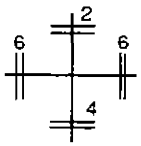
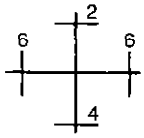
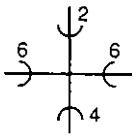
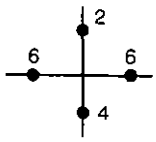
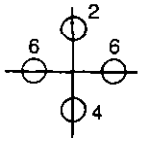
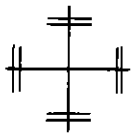
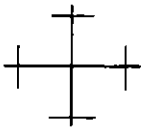
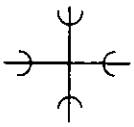
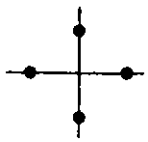
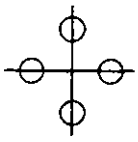
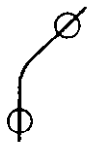
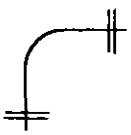
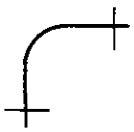
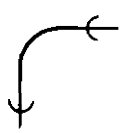
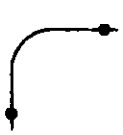
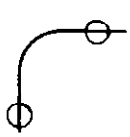
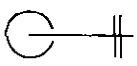
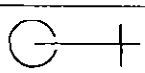
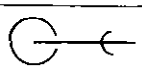
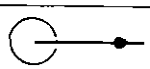
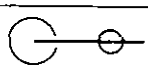
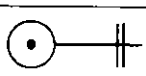
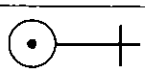
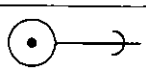
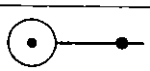
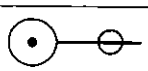
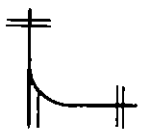
	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
1. BUSHING					
2. CAP					
3. CROSS					
3.1 REDUCING					
3.2 STRAIGHT SIZE					
4. CROSSOVER					
5. ELBOW					
5 1 45-DEGREE					
5.2 90-DEGREE					
5.3 TURNED DOWN OR AWAY FROM YOU					
5.4 TURNED UP OR TOWARD YOU					
5.5 BASE					
5.6 DOUBLE BRANCH					

TABLE 3-A (continued). GRAPHIC SYMBOLS FOR PIPE FITTINGS AND VALVES

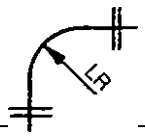
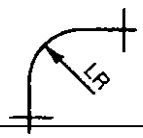
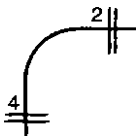
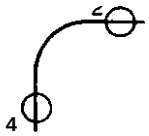
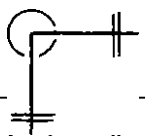
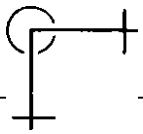
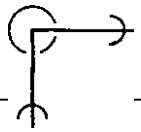
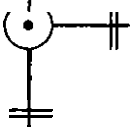
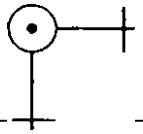
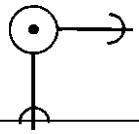
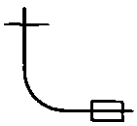
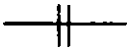
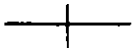
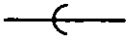
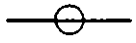
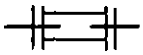
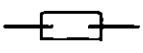
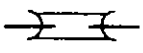
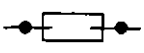
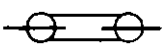
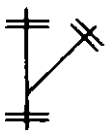
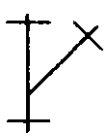
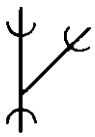
	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
5.7 LONG RADIUS					
5.8 REDUCING					
5.9 OUTLET (OUTLET DOWN OR AWAY FROM YOU)					
5.10 SIDE OUTLET (OUTLET UP OR TOWARD YOU)					
5.11 STREET					
6. JOINT 6.1 CONNECTING PIPE					
6.2 EXPANSION					
7. LATERAL					
8. ORIFICE FLANGE					
9. REDUCING FLANGE					

TABLE 3-A (continued). GRAPHIC SYMBOLS FOR PIPE FITTINGS AND VALVES

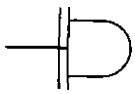
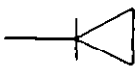
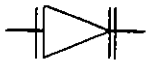
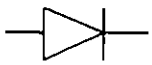
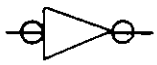
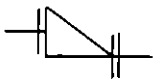
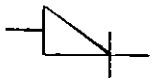
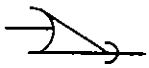
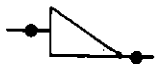
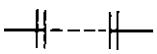
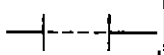
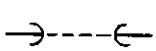
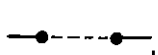
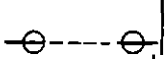
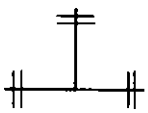
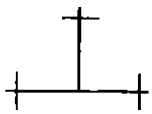
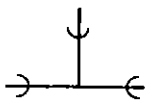
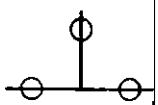
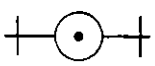
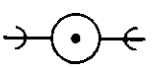
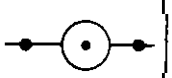
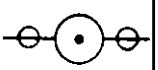
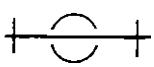
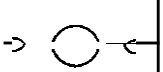
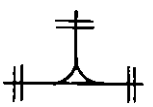
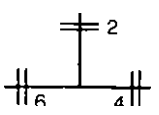
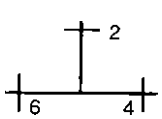
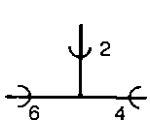
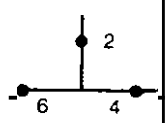
	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
10. PLUGS 10.1 BULL PLUG					
10.2 PIPE PLUG					
11. REDUCER 11.1 CONCENTRIC					
11.2 ECCENTRIC					
12. **SLEEVE**					
13. **TEE** 13.1 STRAIGHT SIZE					
13.2 OUTLET UP OR TOWARD YOU					
13.3 OUTLET DOWN OR AWAY FROM YOU					
13.4 DOUBLE SWEEP					
13.5 REDUCING					
13.6 SINGLE SWEEP					

TABLE 3-A (continued). GRAPHIC SYMBOLS FOR PIPE FITTINGS AND VALVES

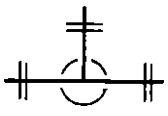
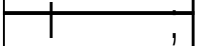
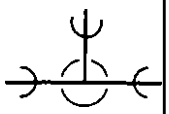
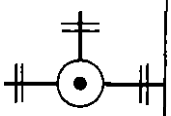
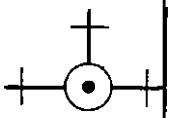
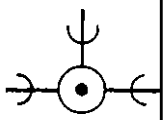
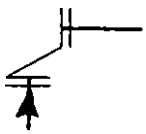
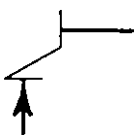
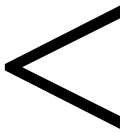
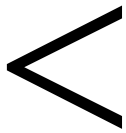
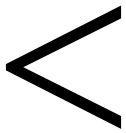
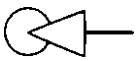
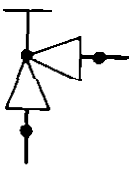
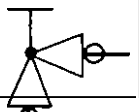
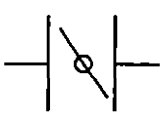
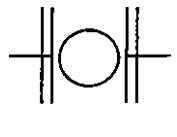
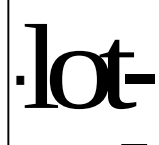
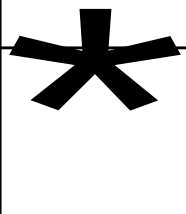
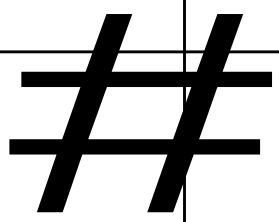
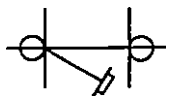
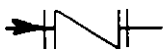
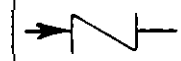
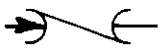
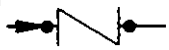
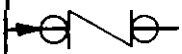
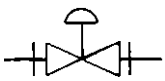
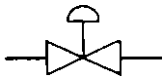
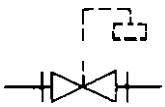
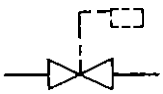
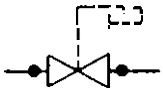
	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
13.7 SIDE OUTLET AWAY FROM YOU					
13.8 SIDE OUTLET TOWARD YOU					
14. UNION					
15. ANGLE VALVE 15.1 CHECK					
15.2 GATE (ELEVATION)					
15.3 GATE (PLAN)					
15.4 GLOBE (ELEVATION)					
15.5 GLOBE (PLAN)					
15.6 HOSE ANGLE	SAME AS	SYMBOL	23.1		
16. BUTTERFLY VALVE					

TABLE 3-A (continued). GRAPHIC SYMBOLS FOR PIPE FITTINGS AND VALVES

	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
17. BALL VALVE					
18. STRAINER					
19. CHECK VALVE 19.1 ANGLE CHECK **19.2** (STRAIGHT WAY)	SAME AS 	SYMBOL 	**15.1** 		
20. COCK					
21. DIAPHRAGM VALVE					
22. FLOAT VALVE					
23. GATE VALVE *23.1					
23.2 ANGLE GATE	SAME AS	SYMBOLS	**15.2& 15.3**		
23.3 HOSE GATE	SAME AS	SYMBOL	**23.2**		

'ALSO USED FOR GENERAL STOP VALVE SYMBOL WHEN SPECIFIED.

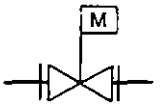
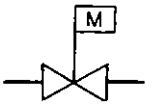
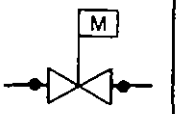
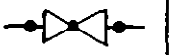
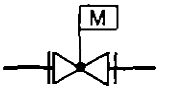
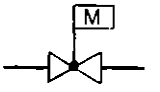
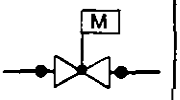
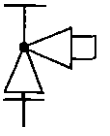
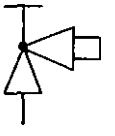
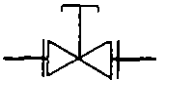
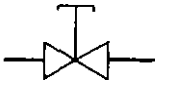
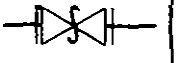
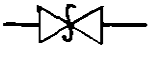
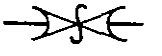
TABLE 3-A (continued). GRAPHIC SYMBOLS FOR PIPE FITTINGS AND VALVES					
	FLANGED	SCREWED	BELL & SPIGOT	WELDED	SOLDERED
23.4 MOTOR-OPERATED					
24. GLOBE VALVE 24.1					
24.2 ANGLE GLOBE	SAME AS	SYMBOLS	15.4 & 15.5		
24.3 HOSE GLOBE	SAME AS	SYMBOL	23.3		
24.4 MOTOR-OPERATED					
25. HOSE VALVE 25.1 **ANGLE**					
25.2 GATE					
25.3 GLOBE					
26. LOCKSHIELD VALVE					
27. QUICK OPENING VALVE					
28. SAFETY VALVE					
29. STOP VALVE	SAME AS	SYMBOL	**21.1**		

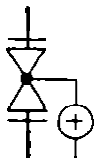
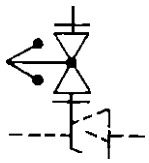
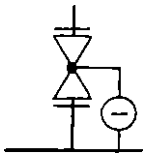
TABLE 3-A (continued). GRAPHIC SYMBOLS FOR FLANGED AUTOMATIC VALVES					
30. AUTOMATIC VALVE 30.1 BY PASS		30.2 GOVERNOR-OPERATED		30.3 REDUCING	

Fig. 3-7 shows a piping installation drawn with the two-line method. It gives a complete picture of the pipe, valves and fittings. What method is used in Fig. 3-8 which shows the same piping installation?

Fig. 3-8 shows the same piping installation as shown in Fig. 5 7, however the single-line method is used to represent the pipe and the proper symbols are used to represent fittings and valves. The fittings and valves in Fig. 5 7 and Fig. 3-8 are numbered and the pipe is lettered.

Study and compare both drawings for a better understanding of piping symbols.

A comparison **of** these two drawings illustrates the simplicity of the single-line type of drawing. Both drawings show the same piping installation, but the single line drawing is the easiest one to draw and the more practical one to be used in the field.

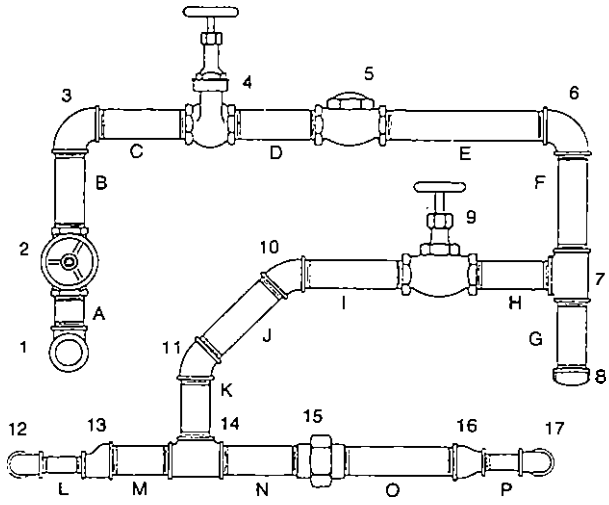


Fig. 3-7

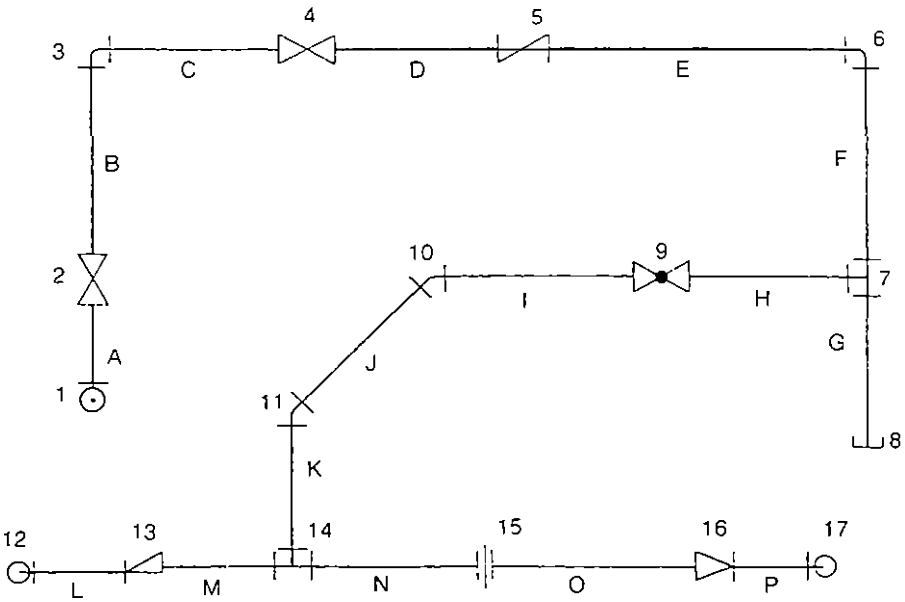


Fig. 3-8

Following are five exercises which require you to identify symbols for several types of valves and pipe fittings. Read the directions and furnish the correct information in each exercise.

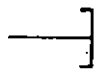
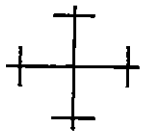
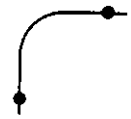
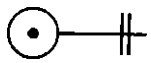
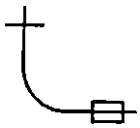
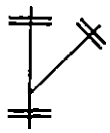
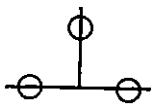
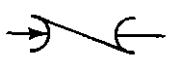
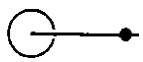
EXERCISE 3-1

Fill in the correct names of the fittings and valves shown in Fig. 3-8.

1.	**7.**	**13.**
2.	***8.***	**14.**
3.	**9.**	15.
4.	**10.**	16.
5.	11.	17.
6.	**12.**	

EXERCISE 3-2

Fill in the proper name of the symbols.

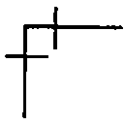
1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
11. 
12. 
13. 
14. 
15. 
16. 

1.	2.	3.	4.
5.	6.	7.	8.
9.	10.	11.	12.
13.	14.	15.	16.

EXERCISE 3-3

Draw or sketch the proper symbols in the spaces provided.

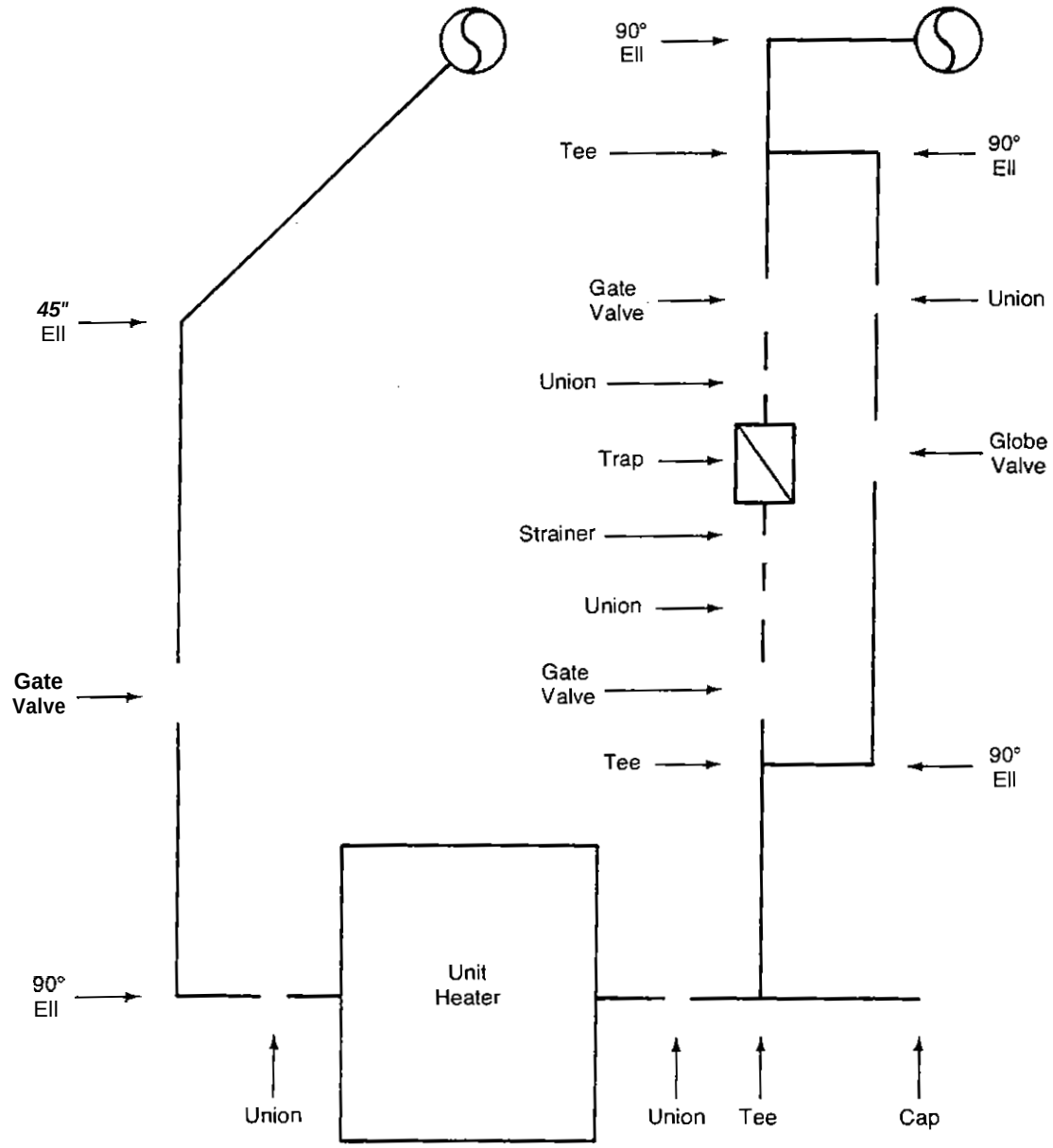
NOTE: The symbols may be drawn with straight lines ratherthan curved lines; for example, a 90-degree screwed ell may be drawn:



Tee Straight Size Soldered	Union Screwed	Check Valve Bell and Spigot	Gate Valve Screwed
90" Elbow Turned Up Welded	90° Street Elbow Screwed	Lateral Flanged	Concentric Reducer Welded
Gate Valve Flanged	Globe Valve Screwed	Tee Outlet Down Flanged	90" Elbow Turned Down Welded
Tee Outlet Up Screwed	Cross Straight Size Screwed	45" Elbow Soldered	90" Elbow Soldered

EXERCISE 3-4

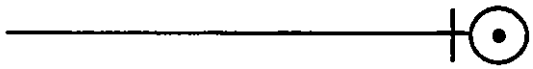
Add the proper symbols to this drawing using the symbols for screwed fittings.



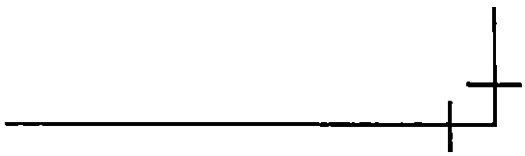
EXERCISE 3-5

Circle the number next to the correct answer.

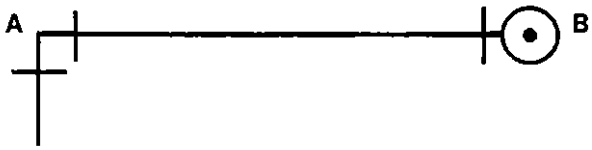
1. In this top view the elbow is turned:
   1. up or toward you.
   2. down or away from you.



2. This is a side view or elevation view of the same piping configuration as in Question 1. The elbow is a:
   1. 90° soldered ell.
   2. 45° street ell.
   3. 90" screwed ell.



3. In this top view there are two fittings. They are:
   1. two 90° weld ells.
   2. one weld and one screwed 90° ell.
   3. two 90° screwed ells.



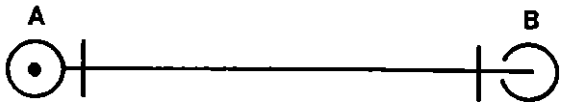
4. This is a side view (elevation view) of the piping configuration in Question 3. Elbow "A" is looking:
   1. toward you.
   2. away from you.

EXERCISE 3-5 (continued)

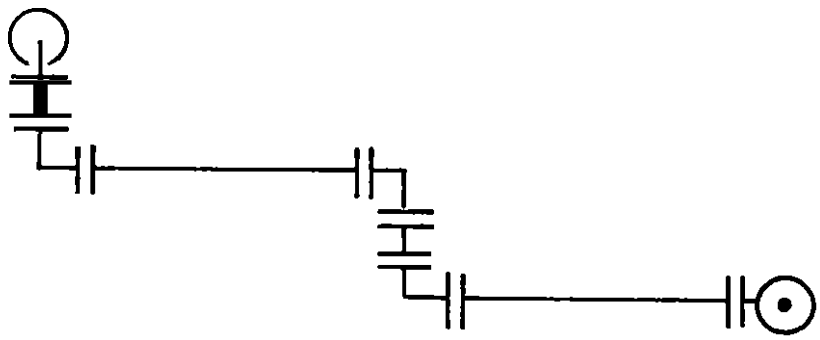
5. In this top view elbow "**A**" is turned:
   1. up.
   2. down

6. This view shows a piping configuration with two 90° ells. The ells are:
   1. both turned up.
   2. one is looking up and one is turned down.

7. This is an elevation view (side view) of the same piping configuration shown in Question 6. Elbow "**A**" is:
   1. turned away from you.
   2. turned up.
   3. turned toward you.



8. What kind of fittings are shown in this piping diagram?
   1. screwed.
   2. soldered.
   3. flanged.
   4. welded.



CHAPTER

Interpretation of Technical Drawings

Working drawings convey information about the construction of a building to the builder. These drawings try to give a three-dimensional view of the building. Orthographic and isometric drawings and mechanical plans make up the working drawings. Journeymen must interpret the working drawings to install the piping systems properly.

Orthographic drawings view a building by looking directly at the front, top, and side of it. These views are drawn to scale. All lines are true lengths and angles are not distorted.

Orthographic drawings are made of the elevations, floor plans, section views, and detail drawings of a building. Elevations show the front, rear, and side exterior views of the building. By passing a horizontal cut midway between each floor, a plan view or *floor* plan is seen. This cut passes through all doors, windows, and wall openings to show the room as it appears when looking directly down on it. If a vertical cut is made through the building, then a section view is shown. Section views show the interior of the building from the foundation to the roof when looking directly at its side. Since all views are drawn to scale, certain building features may be too small to see its construction.

The Side and Front Views of a building are usually called "elevations" and noted as North, South, East, or West. What is the relationship between the North Elevation of a building and the viewer?

In order to view the North Elevation of a building, the viewer must be positioned in front of the north elevation facing South.

The West Elevation in Fig. 4-1 is elevation A.

If the interior (invisible) details of an object are relatively simple, such as in the example of the concrete block; they can be represented by a series of short dashes (a broken line). A section drawing is used where the internal features are complicated and more detail is necessary.

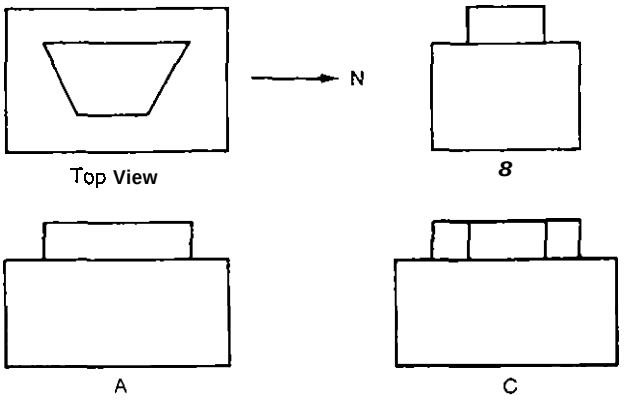


Fig. 4-1

A section drawing is a "cut-away" view of an object. What is the function of line AA in Fig. 4-2?

Line *AA* in Fig. 4-2 indicates the cutting plane (where the object is to be cut away) for a section. See Fig. 4-3.

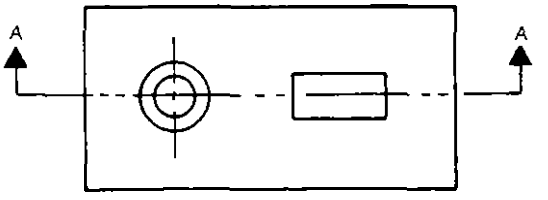
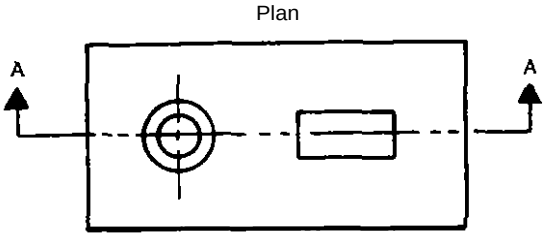


Fig. 4-2



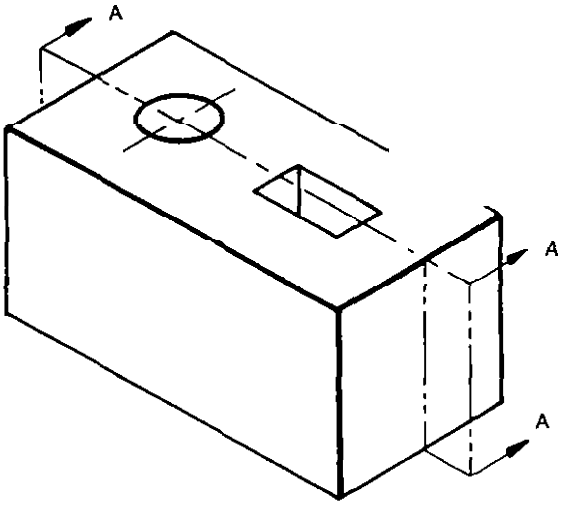


Fig. 4-3

On squared block paper, make a section drawing of the object shown in Fig. 4-4 and compare your sketch with Fig. 4-5.

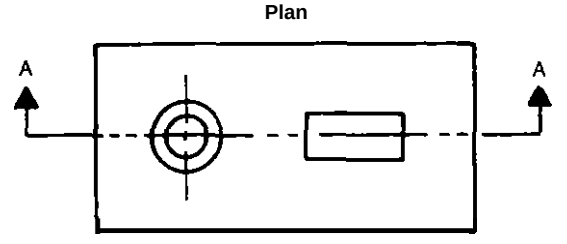


Fig. 4-4

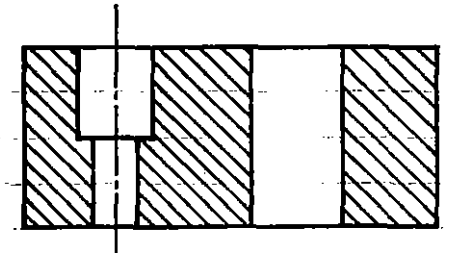


Fig. 4-5

The diagonal lines in Fig. 4 6 represent the solid portions of **the** object and the material of which it is made.

The line at Point **A** indicates the center line and is used to show the center axis of the **shaft.** In piping drawings, center lines are important because most piping measurements are taken to the center of **a** pipe, valve or fitting.

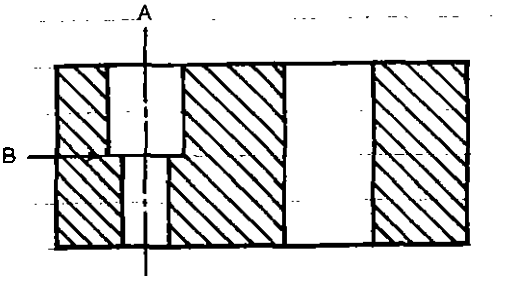


Fig. 4-6

The horizontal line at point B in Fig. 46 shows the shoulder formed when the diameter of the drilling was decreased.

An object familiar to Journeymen in the pipe trades is shown in Fig. 47. The section drawing in Fig. 4-7 provides you with a complete description of the deta of construction of a typical catch basin.

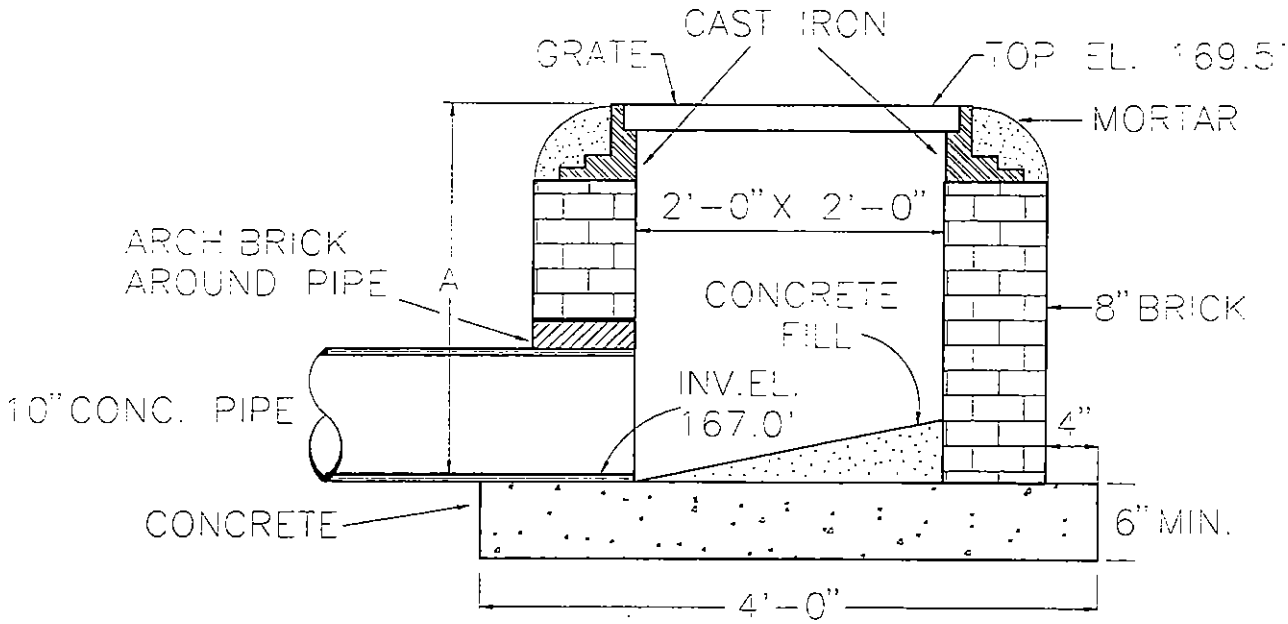


Fig. 4-7

Dimension A in Fig. 4 7 is taken from the invert elevation of the pipe to the top of the cast iron grate at elevation 169.5'.

The invert of a pipe is the lowest portion (bottom) of the inside of a horizontal pipe. The invert elevation of the pipe in Fig. 4-7 is 167.0'.

What is the distance from the invert of the 10" drain to the top of the cast iron catch basin grate in Fig. 4-7?

Top of Grate Elevation	=	169.5'
Invert Elevation of 10" pipe	=	167.0'
Dimension *A*	=	2.5' or 2'–6"

The distance is 2.5' or 2'–6

The types of materials to be used in the construction of the catch basin in Fig. 4-7 are shown as architectural symbols in this section drawing.

There are five types of material illustrated by architectural symbols in Fig. 4-7. The five types of materials are concrete, mortar cement, brick, cast iron and concrete pipe.

In addition to the use of architectural symbols which identify materials to be used for construction of an object or building, the notes on a drawing and related specifications must be examined to determine the ifi types f ials which will be required.

Fig. 4-8 is a section drawing of a pressure relief valve. (See 'Architectural Symbols" in the reference section at the end of this book.) It has been determined from the list of "Architectural Symbols" in Appendix A that the body of the valve is constructed of cast iron.

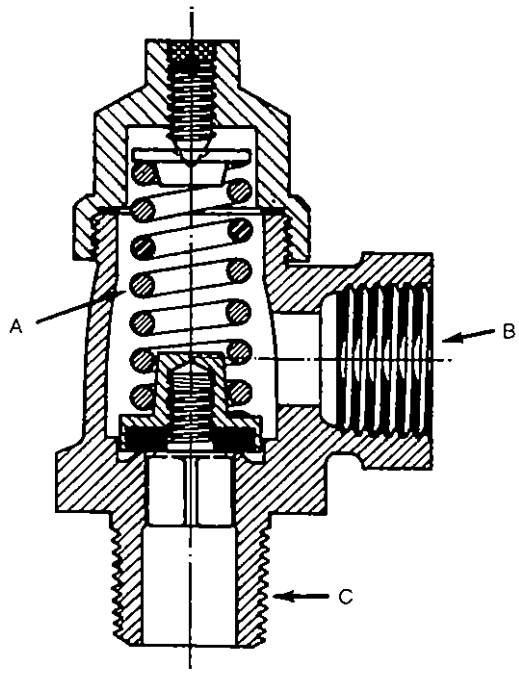


Fig. 4-8

Why are the two sets of lines drawn in different directions if both the top of the valve body and the bottom are made of cast iron? See Fig. 4-8.

By changing the direction of the lines, the draftsman has indicated that these parts are separate and can be disassembled at the point of the change. The draftsman has also indicated by use of arrows at points *A, B* and *C,* that there is a spring at point *A,* internal threads at point *B* and external threads at point C.

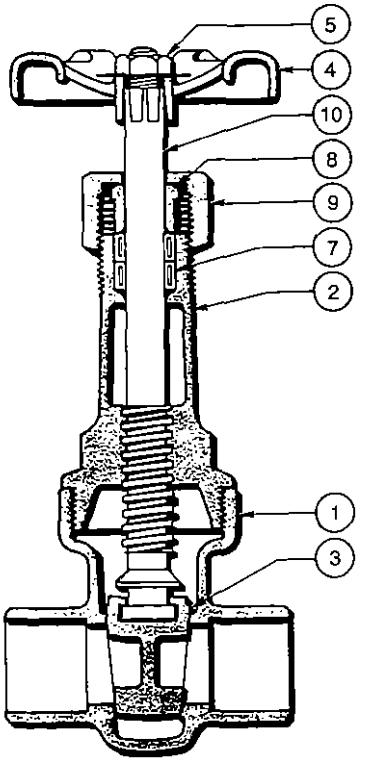


TABLE OF SPECIFICATIONS

No.	Description	Material
1	Body	Bronze
2	Bonnet	Bronze
3	Disc	Bronze
4	Handwheel	Aluminum (½"-1¼")
		Malleable Iron (⅜", 1½"-3")
5	Handwheel Nut	Brass
7	Packing	Teflon®
8	Packing Gland	Brass
9	Packing Nut	Bronze
10	Stem	Copper-Silicon Alloy

Fig. 4-9

A section drawing of a gate valve with solder joint ends is shown in Fig. 4-9. Architectural symbols were not used to show the materials of construction because they would make the drawing more confusing.

The types of materials of construction are Listed in the Table of Specifications in Fig. 4-9. **A** description of the numbered parts of the gate valve are also listed in the Table of Specifications.

Part number 9 in Fig. 4-9 is the packing nut. What is the packing nut made of?

The packing nut is made of bronze

There are drawings other than three view and section drawings which Journeymen must be able to interpret, such as schematic drawings. A schematic drawing is a diagram of a system without regard to scale or exact location.

Schematic drawings can be used as riser diagrams, stack drawings, and special drawings similar to those shown in Figs. 410 through 415.

A riser diagram of the water piping for a residence is shown in Fig. 4-10. What is shown on riser diagrams?

Riser diagrams indicate sizing, offsets, branches, and the floor or location at which they occur.

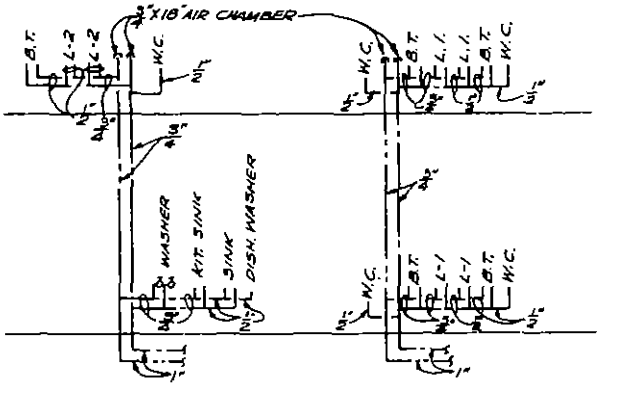


Fig. 4-10

Fig. 4-11 is a schematic drawing of a domestic hot water heating system

The location of the equipment to be installed cannot be determined from the drawing in Fig. 4-11. The valves, equipment and a large majority of the fittings can be listed from the schematic diagram. However, since location or the scale of the drawing is not shown, the exact amount of pipe and fittings cannot be determined.

Sketch the schematic drawing shown in Fig. 4-11 on squared block paper and compare your drawing with Fig. 4-11.

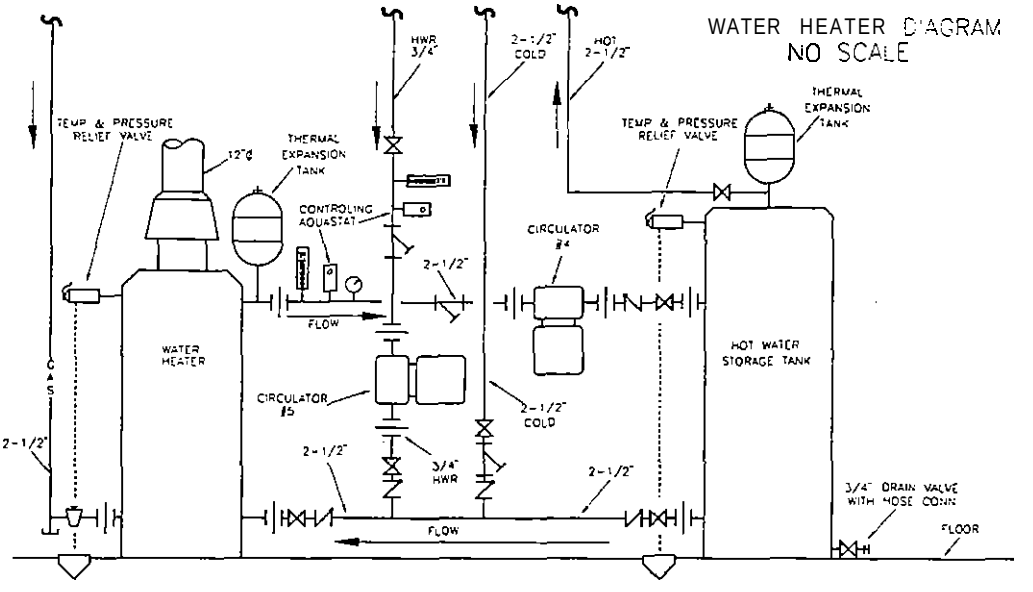


Fig. 4-11

The purpose of the schematic diagram of the evaporation cycle shown in Fig. 4-12 is to show the direction of flow, the sequence of operation of the equipment, and the resultant temperatures.

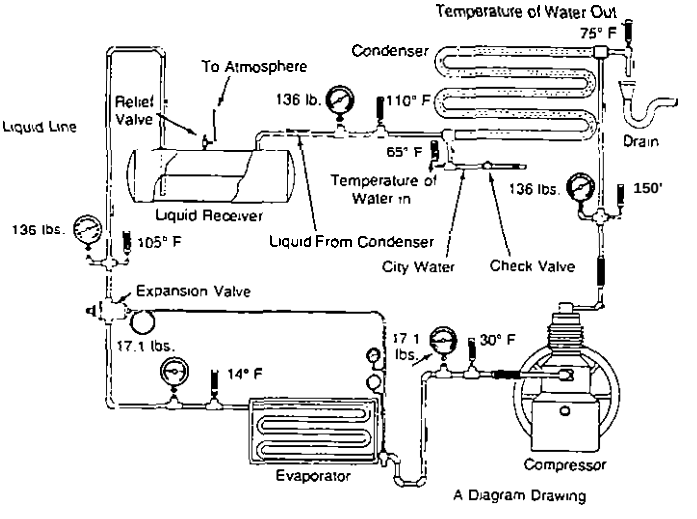


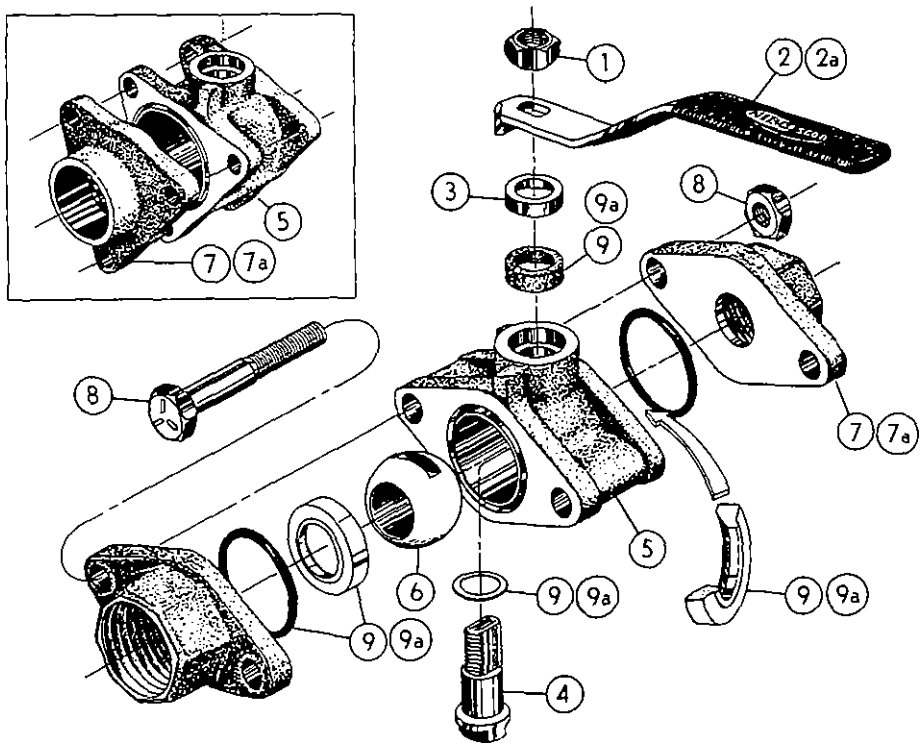
Fig. 4-12

Even though the arrangement of the piping and equipment can be determined from Fig. **4-12,** it is still not possible to list all of the fittings needed to install the piping system. The major fittings and equipment can be listed from Fig. **4-12,** but since the actual location is not shown, the number of fittings and the exact amount of pipe cannot be determined.

Fig. **4-13** is an "exploded view" diagram of a ball valve. Exploded view diagrams are primarily used for assembly, disassembly, parts replacement, maintenance, and trouble-shooting of equipment. Exploded view drawings and diagrams are usually included in the operation and maintenance manuals provided with equipment delivered to the job site.

The numbers on the drawing in Fig. **4-13** indicate the order of disassembly of the ball valve. The numbers also identify the numbered part when they are keyed to a specification sheet which is usually **part** of the operation and maintenance manual provided with the equipment.

The name of the part shown as number 7 in Fig. 4-13 is "iron pipe size body end." The model number, part number, **and** correct size can be identified from the specification sheet and must be given when ordering replacement parts.



Valve Part No, & Description

1. Handle Nut
2. Handle for -W valve (Buna-N seat)
2a. Handle for -Y valve (Teflon seat)
3. Packing Gland
4. Stem
5. Body
6. Ball
7. IPS Body end
7a. Solder Body end
8. Body Nuts & Bolts (per set)
9. Seat & Seal Kit for -W valve (Buna-N seat)

Contains

2—Buna-N seats
2—Buna-N body seals
1—Teflon thrust washer
I—Teflon stern packing

9a. Seat 8 Seal Kit lor -Y valve (Teflon seat)

Contains

2—Teflon seats
2—EPDM body seals
I—Teflon thrust washer
I—Teflon stern packing

Fig. 4-13

The diagram in Fig. 4-14 is used to show the types of welds which are required for each of the two piping applications.

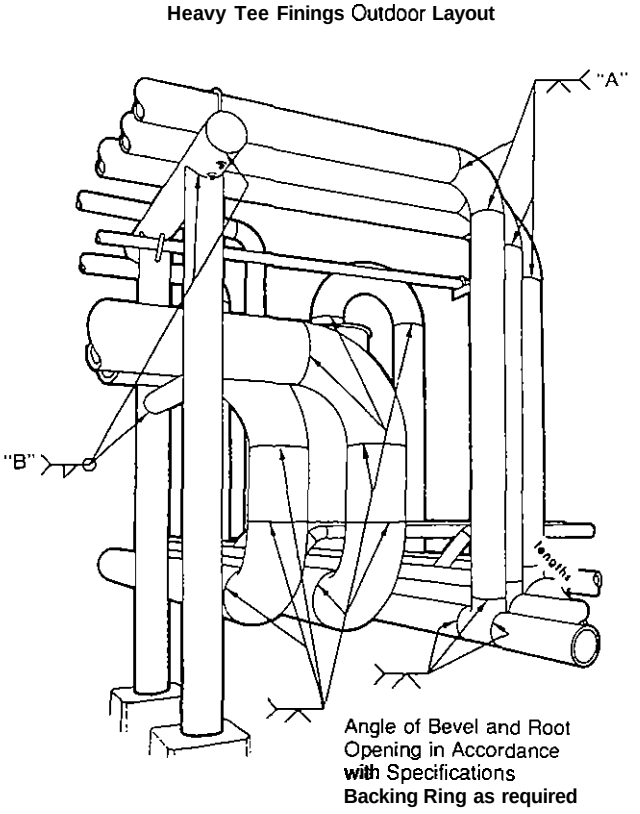


Fig. 4-14

What is meant by "the two piping applications"?

By examination of the diagram you can determine that some of the piping is to be used only for structural support. The remainder of the piping is to be used for the conveyance of some type of Auid or gas.

Welding, pipe welding in particular, is an important part of all U.A. apprentice and journeymen training. Understanding the symbols shown in a welding diagram are as important to the welding operator as what type of rod to use for a particular application. All U.A. journeymen are expected to be able to interpret welding diagrams. Study the welding symbols shown in Appendix **A.**

The symbol at Point "A" in Fig. 4-14 indicates that the weld at these ells is to be a single-V groove weld.

The symbol at Point "B" in Fig. 4-14 requires the welds at these locations be fillet welds, and that they be welded "All-Around."

A wiring diagram is shown in Fig. 4-15. When are wiring diagrams useful to pipe trades journeymen?

Wiling diagrams are useful in locating the cause of trouble in a piping system which includes electrical devices.

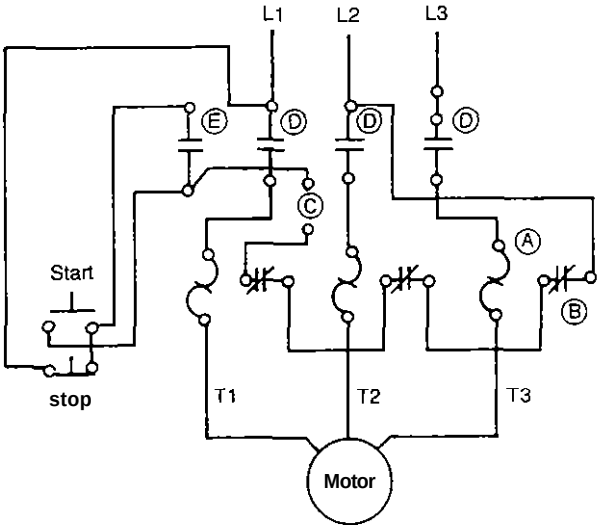


Fig. 4-15

Fig. 4-16 indicates the deionizer tank, resistivity meter, the instrumentation, valves, and piping needed to install a deionizer system. The direction of flow in the system is also shown. It should be noted however that a joumeyman can not tell from this drawing exactly how much piping or how many fittings are needed. This drawing does not indicate what part of the building it will be located in, on what floor, which direction it may face, etc. The journeyman must investigate other drawings that are related to the building such as the Architectural, Structural, etc. which would provide this type of information.

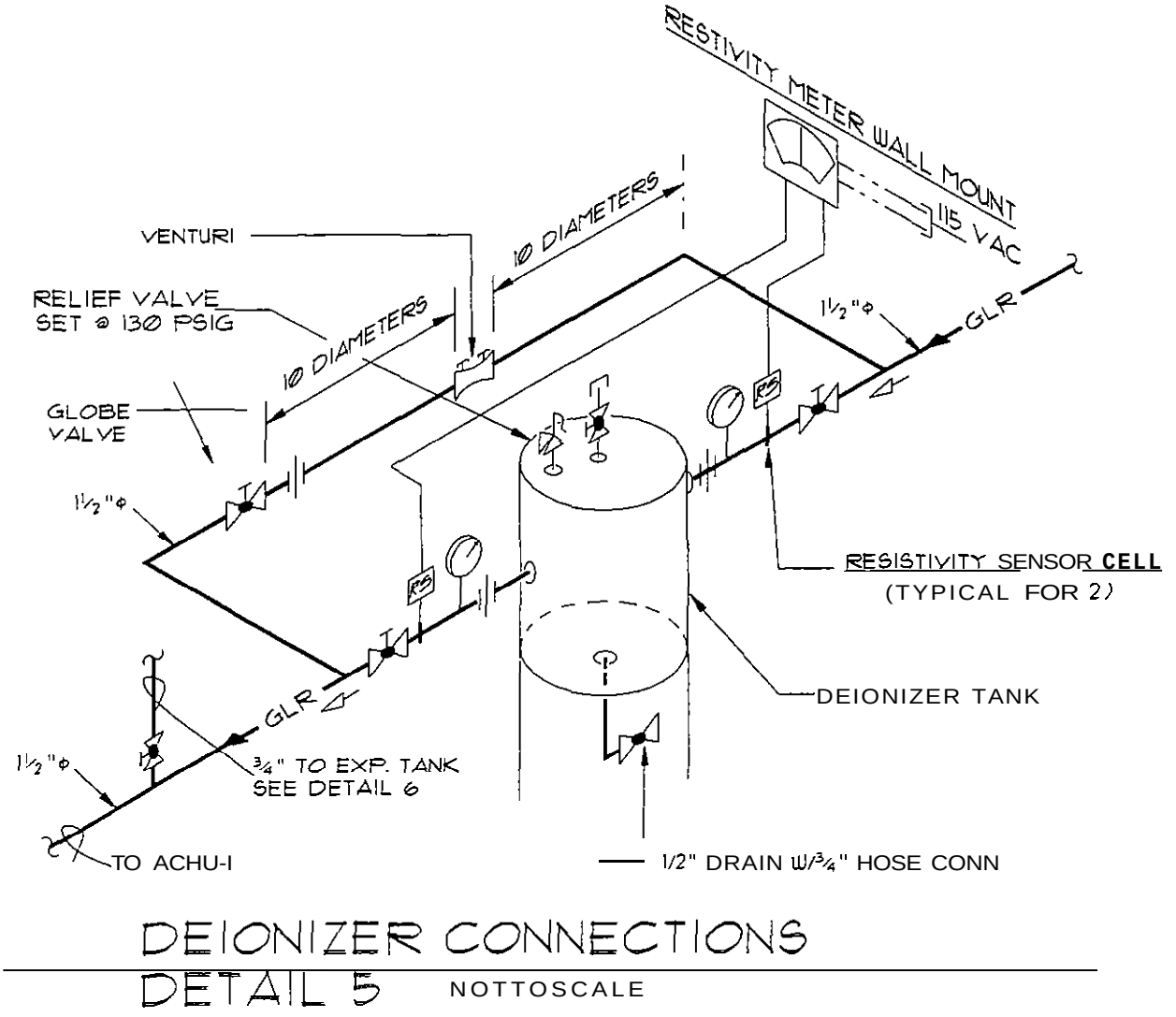


Fig. 4-16

The term 'flow sheet" is derived from the fact that these sheets are used to check the flow direction for piping systems. Sometimes the flow sheet is called a P. & LD., (Piping and Instrument Drawing). Other times it may be referred to as a schematic drawing.

What are other applications of a flow sheet and its use in the illustration and operation of a piping system?

The flow sheet gives a broad general picture of the operation of the system. Although it does not give the true proportion or the actual locations of lines and equipment, it does show the direction of flow of the various liquids and gases in the system. It also shows the sequence of operation and the function of each piece of equipment in a piping system.

Fig. 4-17 illustrates a part of the hot water heating system found on drawing SB-10 which is a plan view of the equipment room in the subbasement of a building. The difference behveen these two types of drawings is quite obvious. The flow sheet shows the types of valves, vessels and instruments in the system, and the order they are in. Flow sheets are usually referred to when there is doubt as to where a valve or instrument shou be placed, such as before a pump or after it.

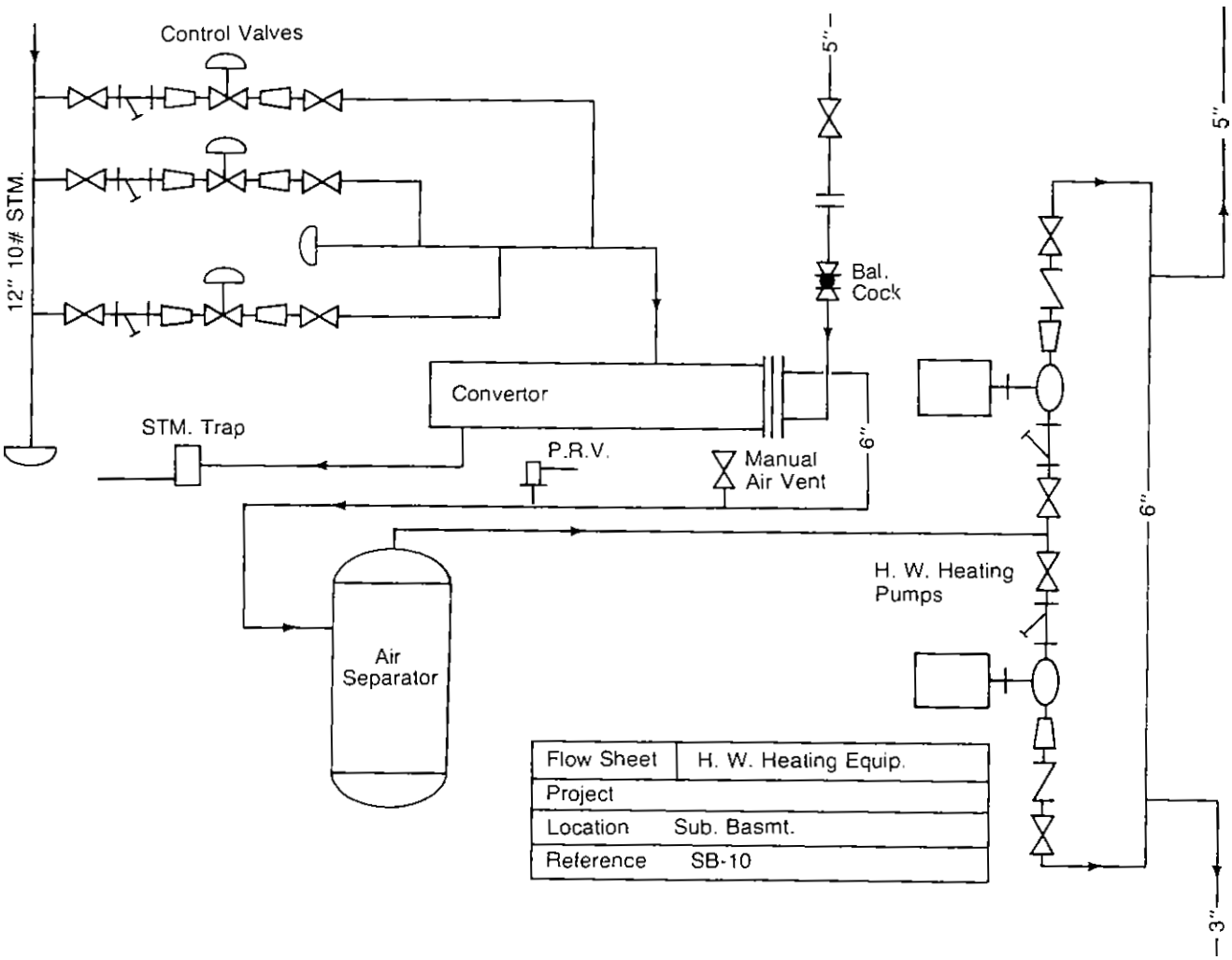
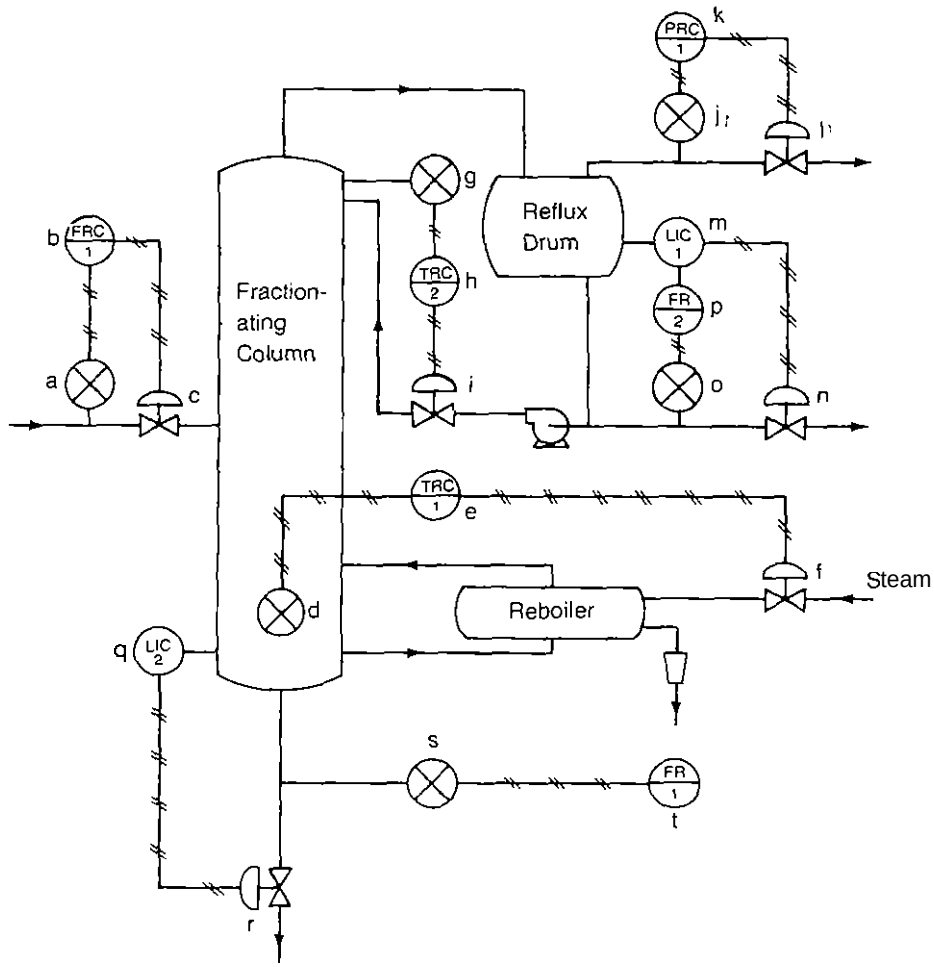

Control Valves
12" 10# STM.
5"
Bal.
Cock
Convertor
STM. Trap
P.R.V.
Manual
Air Vent
6"
5"
6"
H. W. Heating
Pumps
Air
Separator
3"
Flow Sheet
H. W. Heating Equip.
Project
Location
Sub. Basmt.
Reference
SB-10

Fig. 4-17

A Piping and Instrument Drawing (P. & I.D.) is shown in Fig. 4-18. This type of drawing is very important since it shows in a clear way which instruments are required and their function in the system.



Process Piping

Instrument Air Piping

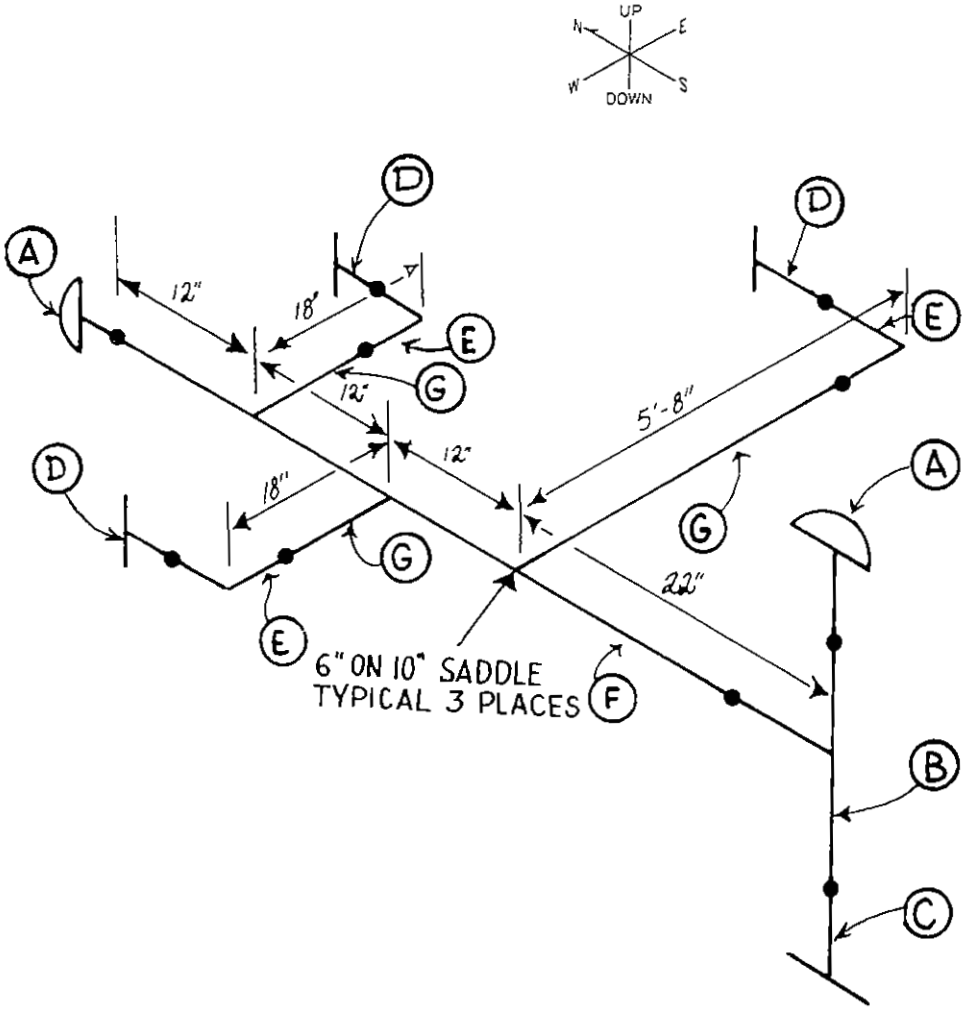
a. Flow Transmitter
b. Flow Recorder-Controller
c. Control Valve
d. Temperature Transminer
e. Temperature Recorder-Controller
f. Control Valve
g. Temperature Transmitter
h. Temperature Recorder-Controller
i. Control Valve
j. Pressure Transmitter
k. Pressure Recorder-Controller
l. Control Valve
m. Level Indicator-Controller
n. Control Valve
o. Flow Transmitter
p. Flow Recorder
q. Level Indicator-Controller
r. Control Valve
s. Flow Transmitter
t. Flow Recorder

Fig. 4-18

The isometric sketches used by journeymen to fabricate pipe for installation are sometimes called spool ***sheets,*** *Iso's*, or *shop* drawings.

What are spool sheets?

Spool sheets are drawings showing small sections of a piping system. The drawing shown in Fig. 4-19, is one of the spools in the hot water heating system shown on drawing SB-10. This particular spool sheet illustrates the 10-inch steam header located above the convertor. Notice that a material list is very often a part of a spool sheet. Also note that the direction of flow is not shown on a spool sheet.



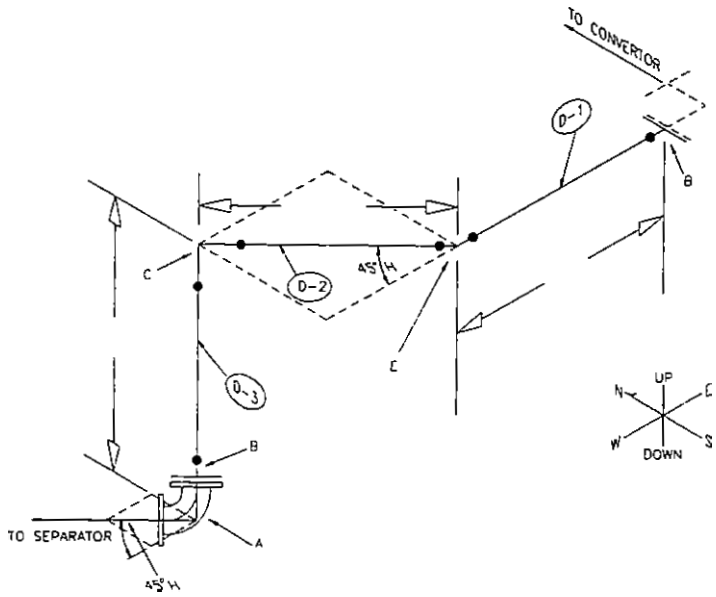
MATERIAL LIST		
Item	Qty.	
#		
A	2	10" SCH. 40
		Weld Caps
B	1	10" SCH. 40
		Weld Tee
C	1	10" SCH. 40
		150# W.N.
		Flange
D	3	6" SCH. 40
		150# W.N.
		Flange
E	3	6" SCH. 40
		S.L.R. 90°
		Weld Elbow
F	5'	10" SCH. 40
		A-105 C.S. Pipe
G	7'	6" SCH. 40
		A-105 C.S. Pipe
SK. #1 SB-10		
10" STM. Header		
for Convertor		

Fig. 4-19

EXERCISE 4-1

On the spool sheet shown in Fig. 4-20 write in the missing dimensions and draw in the pressure relief valve and the manual air vent. This is the section of piping from the convertor to the air separator on drawing SB-10. Also find the E-E lengths of the pieces of pipe **marked D-1, D-2 and D-3.**

NOTE: Always allow 1/8" for weld gaps and 1/16" for gaskets.

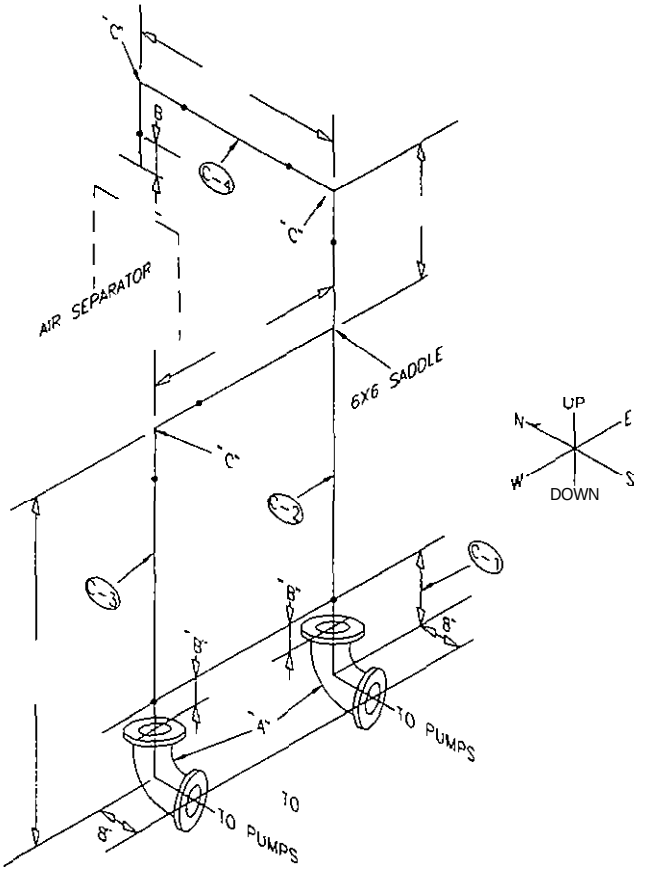


MATERIAL LIST		
ITEM	QTY.	
#	#	
A	1	6" 125# STD. FLGD. ELL
B		6" 125# R.F. WELD NECK
		FLANGES
C		6" SCH. 40 STD. L.R.
		WELD ELBOW
D		6" SCH. 40 A-106
		C.S. PIPE
E		6" SCH. 40 STD. L.R. 45°
		WELD ELBOW
D-1	1	
D-2	1	
D-3	1	
SK #2 SB-10 6"H.W. FROM CONVERTOR TO AIR SEPARATOR		

Fig. 4-20

EXERCISE 4-2

On the spool sheet shown in Fig. 4-21, write in the missing dimensions and complete the material list. Also draw in the thermometer and the manual air vent. This is the section of piping from the air separator to the pumps on drawing **SB-10.** Also find the E-E lengths of pieces of pipe **C-1**, **C-2**, **C-3** and **C-4**.



MATERIAL LIST		
ITEM #	QTY. #	
A	2	6" 125# STD. FLGO. ELLS
B	3	6" 125# R.F. WELD NECK
		FLANGES
C		6" SCH. 40 STD. L.R.
		WELD ELBOW
D		6" SCH. 40 A-105
		C.S. PIPE
C-1	1	
C-2	1	
C-3	1	
C-4	1	
SK# 3 SB-10 FROM AIR SEPARATOR TO PUMPS		

Fig. 4-21

Refer to the building drawings included along with this training manual. Find Section C-C on drawing A-2. In which direction (north, south, etc.) must you face to view what is shown in Section C-C?

To gain full view of the section shown at C-C, the viewer will be looking in an easterly direction. The arrows on the cutting plane C-C run at almost a right-angle to the directional arrow on drawing A-2.

Refer to drawing A-7, "Part Plan of Aluminum Windows at Living Room and Entry Hall." How can the part plan refer to both the living room and the entry hall?

Because of their similarity, the draftsman could use one part plan detail to refer to both areas. See drawing A-3.

In Section C-C on drawing A-7, on which side of the wall (north, south, etc.) is the drain tile located? Compare Section C-C on A-7 with drawings A-2 and A-3.

The drain tile is shown on the west side of the wall.

What is the bottom elevation of the drain tile as shown by C-C on A-7? Finished floor of Entry Hall = 170.74'. See drawing A-3 and A-6.

The bottom elevation is 160.07':

Finished floor of Entry Hall	=	170.74'
Difference to footing	=	10.67' (10'-8")
Bottom elevation of drain tile	=	160.07'

CHAPTER

Interpretation of Isometric Drawings

Communication is one of the most important tools of the piping industry! Communication may be accomplished in a variety of ways. Many times words alone are confusing. One word may have more than one definition, or possibly the correct word for a given situation may not be at the user's command. Likewise, pictures by themselves can be confusing if they are not thoroughly understood. Pictures are like a separate language. In this chapter the 'Picture-Language" is isometric *drawing.* This type of drawing best illustrates length, width, and height of apiping system in a single view.

The textbook definition of isometric *drawing* is: "the representation of an object in equal length projection." This helps the journeyman to realize why drawings of this type are useful. The key words in the definition are: "equal length projection." Most projection drawings represent distance by decreasing size and length, whereas isometric drawings are widely used to depict piping systems which may travel in several different directions. Once the fundamentals of isometric drawings are understood, the interpretations become relatively easy. An isometric drawing is a three dimensional drawing which shows length, width, and height.

Why does a journeyman need to know how to interpret isometric drawings?

Isometric drawing, or some other form of three dimension drawing, is often used to illustrate a piping system.

Isometric drawings give an overall view, or picture, of an object as the eye would see it. Three-view drawings require that the viewer compare each separate view with the other.

Because most piping drawings are single line; symbols must be used to indicate depth. In an isometric view, symbols can be eliminated and the pipe drawn as it is to be installed.

What is a true isometric drawing?

A true isometric drawing is one whose three major dimensions (length, width, and height) or axes are 1200 apart. See Fig. 5-1.

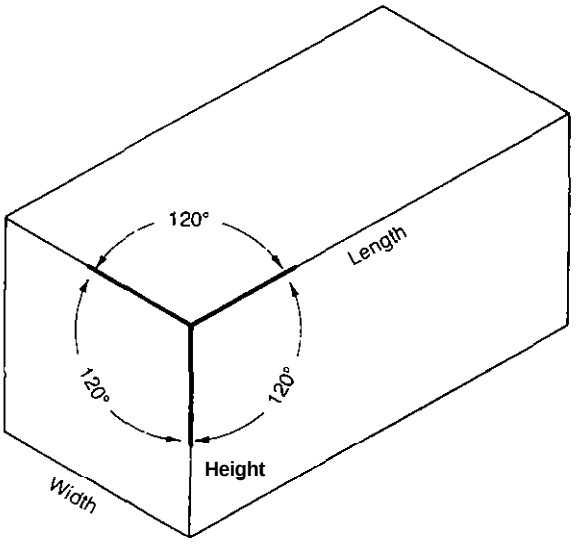


Fig. 5-1

In 'true isometric" drawings the vertical axis (height) is drawn vertically and the other two axes (length and width) are drawn using a 30°/60° triangle as shown in Fig. 5-2.

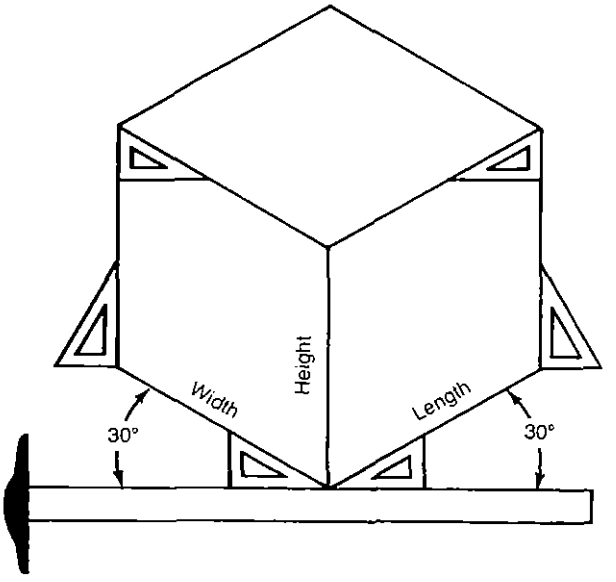


Fig. 5-2

Other types of drawings which are referred to as isometric are any three dimensional drawing which has the vertical axes drawn vertically and the length and width axes drawn at predetermined angles. See Fig. 5-3.

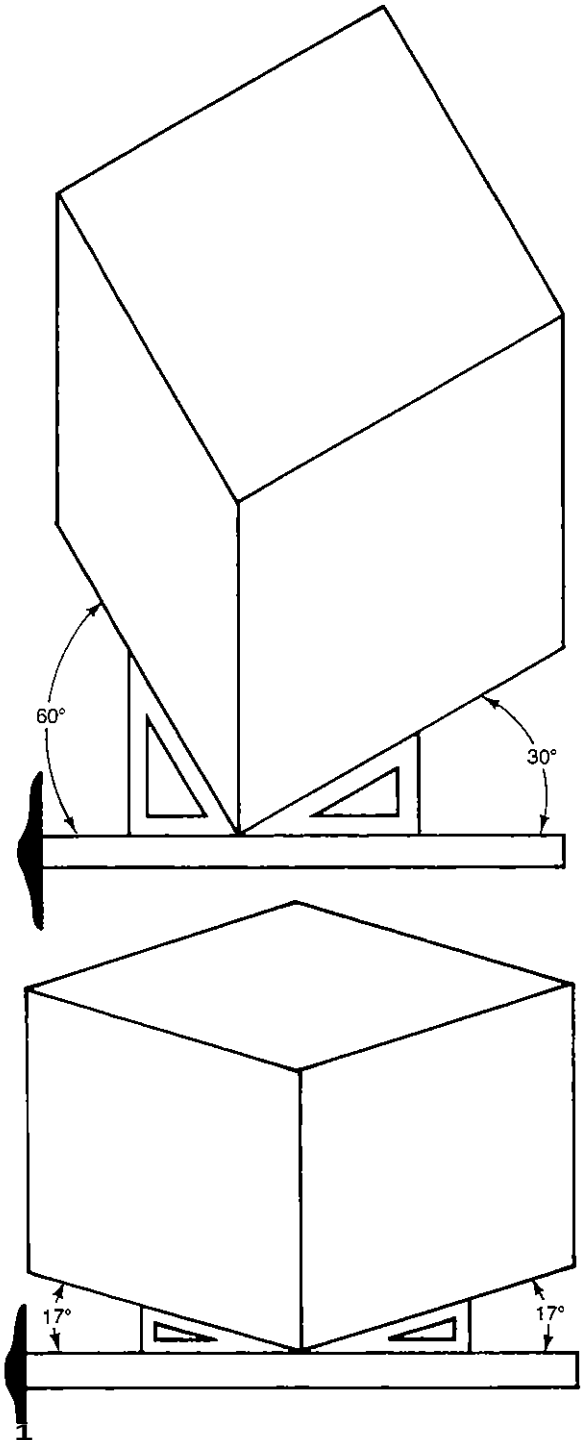


Fig. 5-3

Oblique drawing is another type of three dimensional drawing commonly used in piping work.

An oblique drawing has the vertical (height) axis drawn vertically, the length axis drawn horizontally, and the width axis drawn at any convenient angle from the horizontal

Study Fig. 5-4 and determine the difference between oblique and isometric drawing.

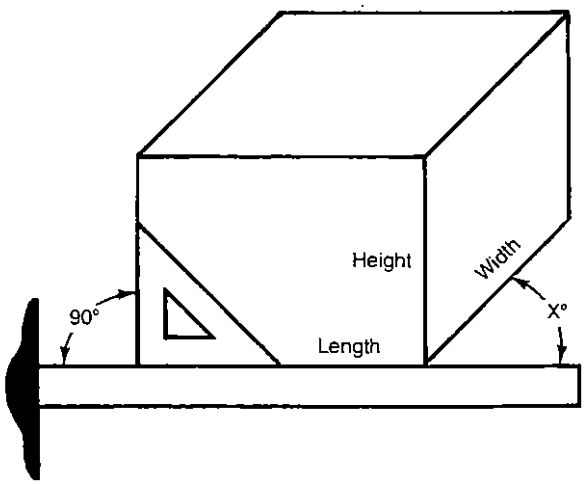


Fig. 5-4

An isometric line is either an extension of one of the major axes or a line parallel to a major axis.

Only lines which are extensions of the major axes, or parallel to a major axis, can be drawn to scale.

In an isometric drawing, any isometric line (extension or parallel to a major axis) can be accurately drawn to scale.

The rules for constructing and interpreting various types of three dimensional drawings do not vary.

The same general rules apply for each type of drawing, only the equipment and possibly the point of view will vary.

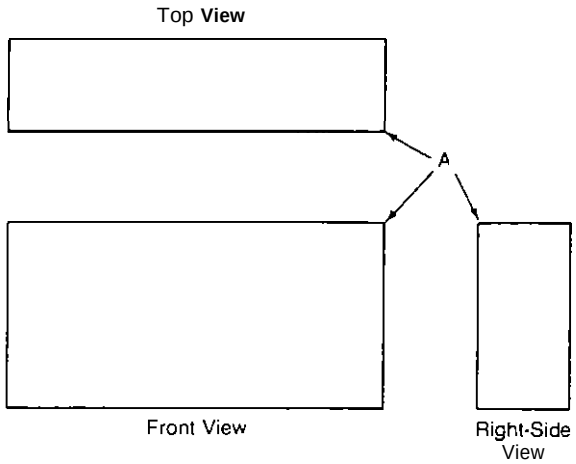
Since the general rules don't change, why should the major emphasis be placed on true isometric drawing in this chapter?

There are several reasons why the major emphasis should be placed on true isometric drawings:

1. this type of drawing most closely resembles an object as the eye would see it,
2. the other types of three dimensional drawings mentioned are derived from the true isometric drawing,
3. the availability of ruled 30" isometric paper, makes drawing quicker and simpler with a minimum amount of drafting equipment.

The relationship of one line to another is the same in an isometric view as in a three-view drawing. Lines which are parallel to each other remain parallel. Lies which are perpendicular are represented **as** being perpendicular.

In an isometric view the top view is shown as the top, the front view as the front, and the right side view **as** the right side. See Fig. 5-5.



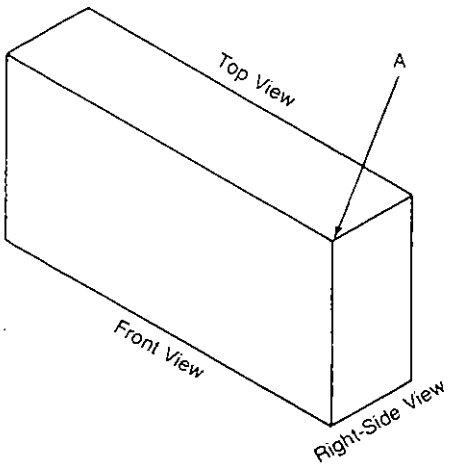


Fig. 5-5

In Fig. 5-6, list the lines which would be parallel to one another in an isometric view.

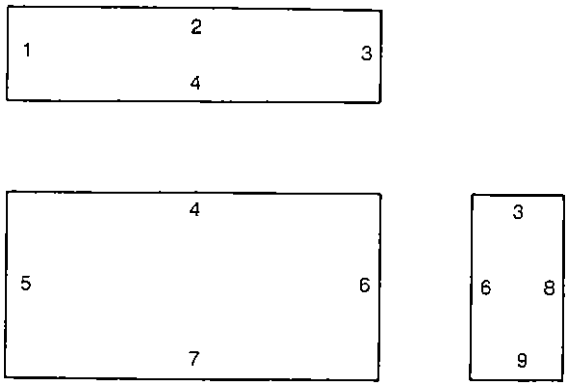


Fig. 5-6

The lines which would be parallel to one another are

(1, 3, and 9)

(2, 4: and 7)

(5, 6, and 8)

See Fig. 5-7.

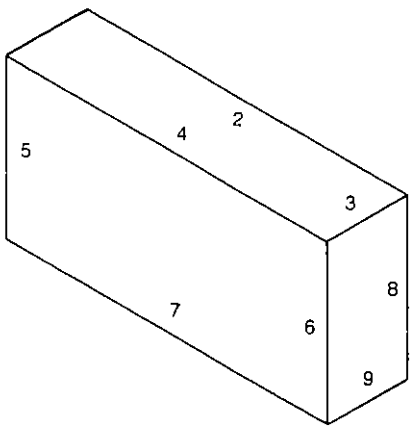


Fig. 5-7

How does the observation point vary between the front view in a three-view drawing and an isometric view?

Chapter 2 states that the side of an object directly in front of the viewer is the front view in a three-view drawing. In an isometric drawing the object is rotated one-eighth turn (45°). See Fig. 5-8.

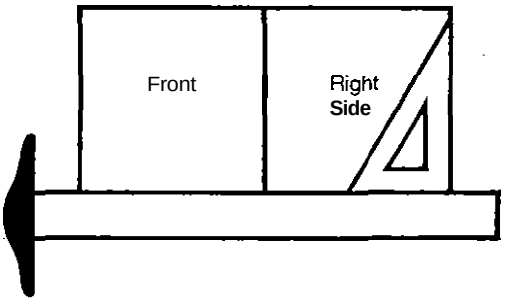


Fig. 5-8

When tipped up until the length and width axes are 30" from the horizontal, the three dimensional effect is produced as shown in Fig. 5-9.

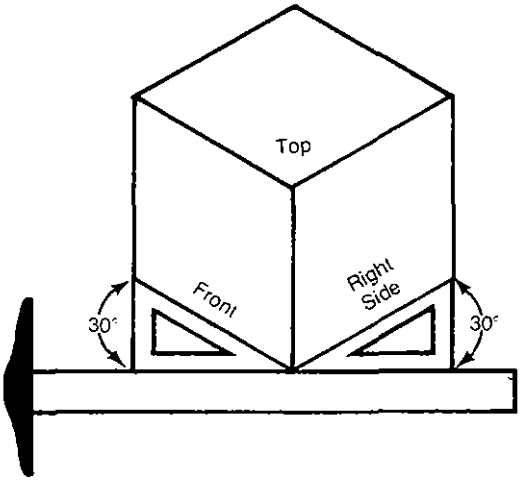


Fig. 5-9

Fig. 5-10 is a **full** scale isometric drawing of a 1" cube wherein each line of the cube is 1" long.

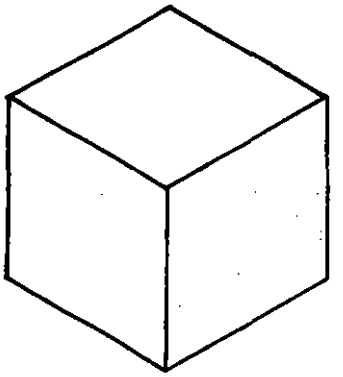


Fig. 5-10

On isometric paper, sketch the 1" cube shown in Fig. 5-10. Use a pencil and straight edge. Instead of measuring with a rule, count the units on the isometric paper (using one unit equals ¼") Fig. 5-11 shows the height, length, and width units.

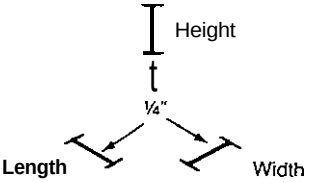


Fig. 5-11

Fig. 5-12 shows the cube drawn isometrically. Note the use of 4 height, 4 length, and 4 width units.

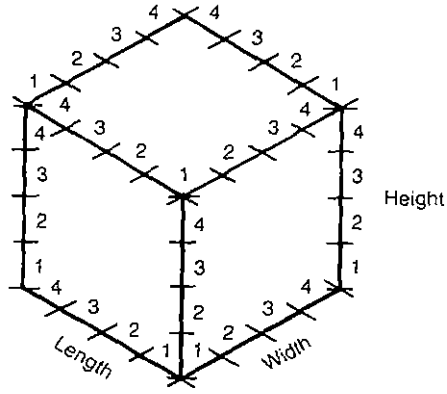


Fig. 5-12

It was mentioned earlier in this chapter that lines which are parallel to the major axes can be located and drawn to scale.

As stated, these lines can actually be scaled or measured so that their length presents no greater problem than in any other type of drawing. However, location of the line presents two problems:

1. Determining in which of the 3 sectors the lines fall. (Length, Width, & Height)
2. Determining the distance from each of the major axes.

Locating the correct sector is much the same as determining the proper view of a three-view drawing. Fig. 5-13 is a three-view representation of a concrete block.

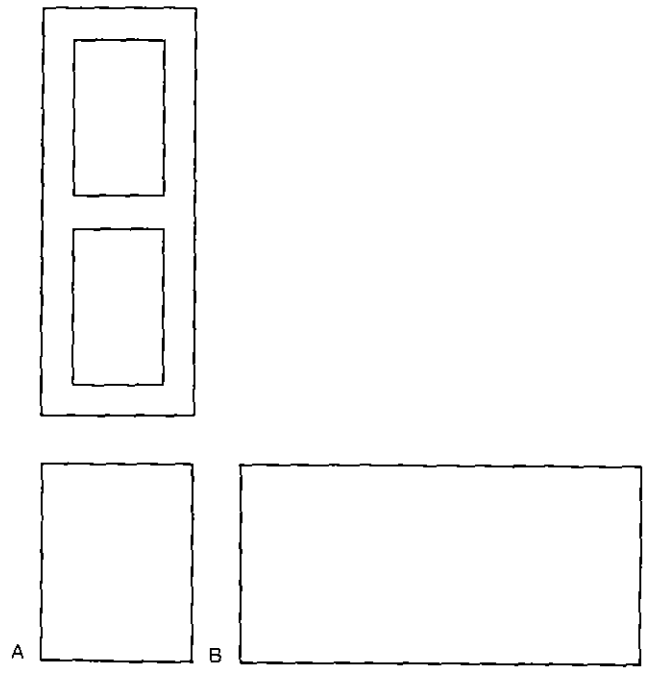


Fig. 5-13

On isometric paper sketch the block, using point A as the observation point. Locate the voids of the block by counting the distance from the major axes. Compare your drawing with the one in Fig. 5-14.

Cover Fig. 5-15 with a sheet of paper and repeat the sketch using point **B** *as the observation point. After completion, uncover and compare your drawing with Fig. 5-15.*

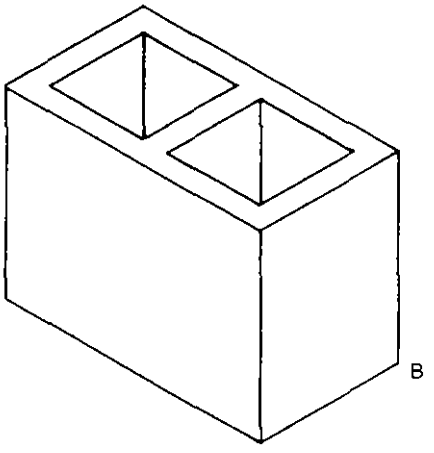


Fig. 5-14

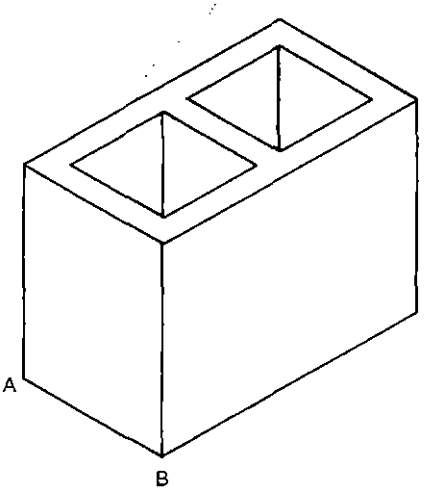


Fig. 5-15

So far, isometric views of solid figures have been discussed. The next step is to apply this information to a simple, single line piping system. What does a single line drawing of a pipe represent as far as the pipe itself is concerned?

The single line drawn, representing a pipe, is the center line of that pipe.

Fig. 5-16 is a three-view drawing of a simple pipe layout involving three fittings. Imagine that the pipe is installed in a transparent slab that permits one to see through from one side to the other.

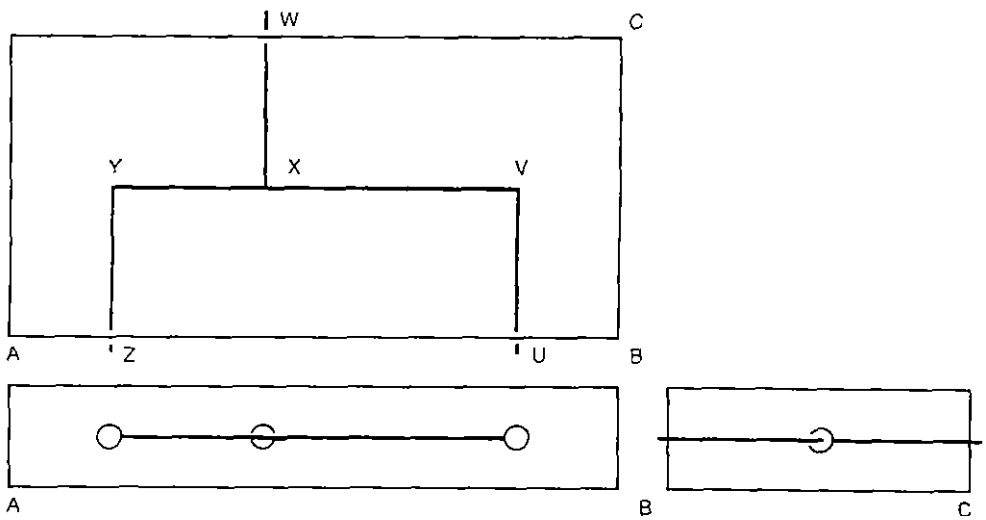


Fig. 5-16

Fig. 5-17 shows the isometric view of the slab and pipe as viewed from observation point A.

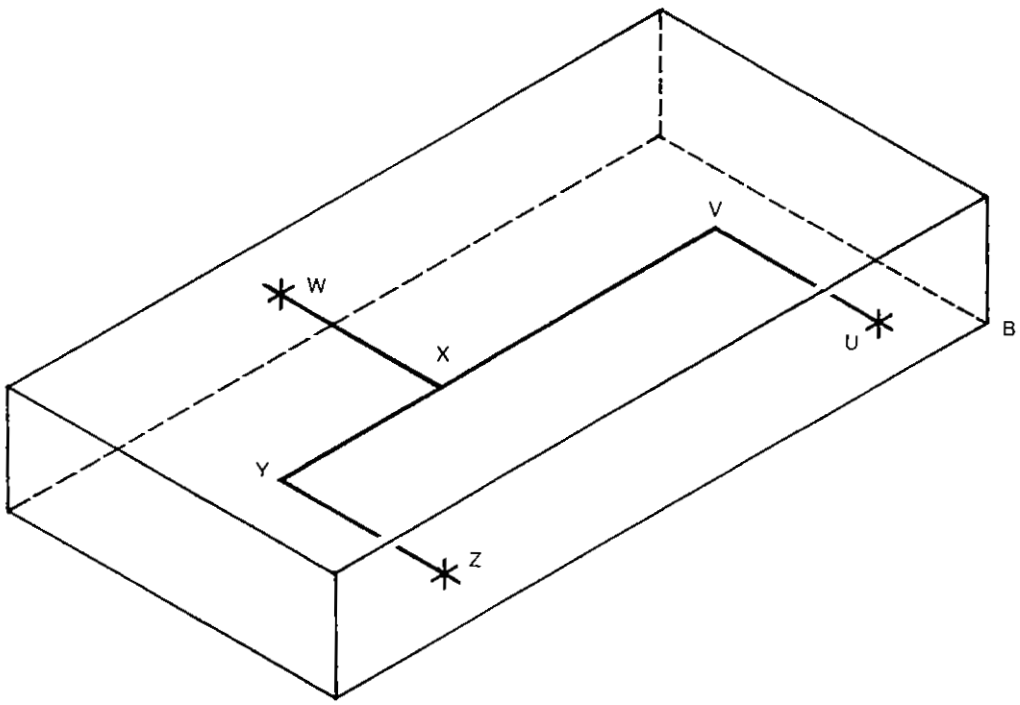


Fig. 5-17

Make an isometric drawing of the slab and pipe as viewed from the observation points A, B, and C. Add the letters u, v, w, x, y, and z, shown in the plan view, to the isometric drawings in the appropriate locations. Compare your sketch with Figs. 5-17, 5-18, and 5-19.

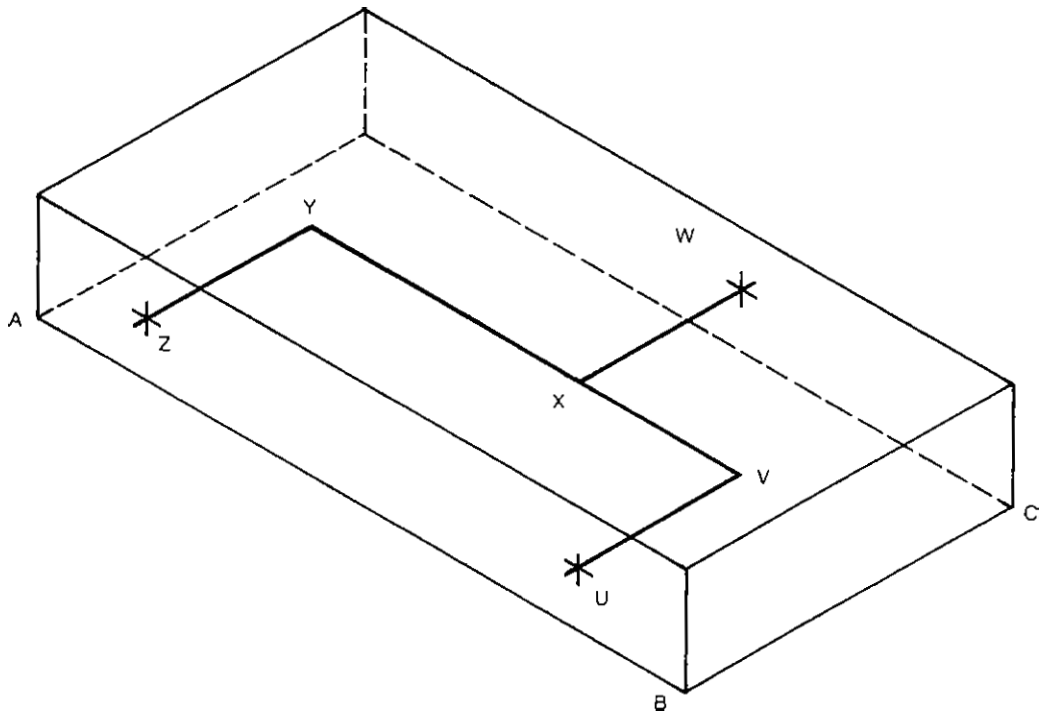


Fig. 5-18

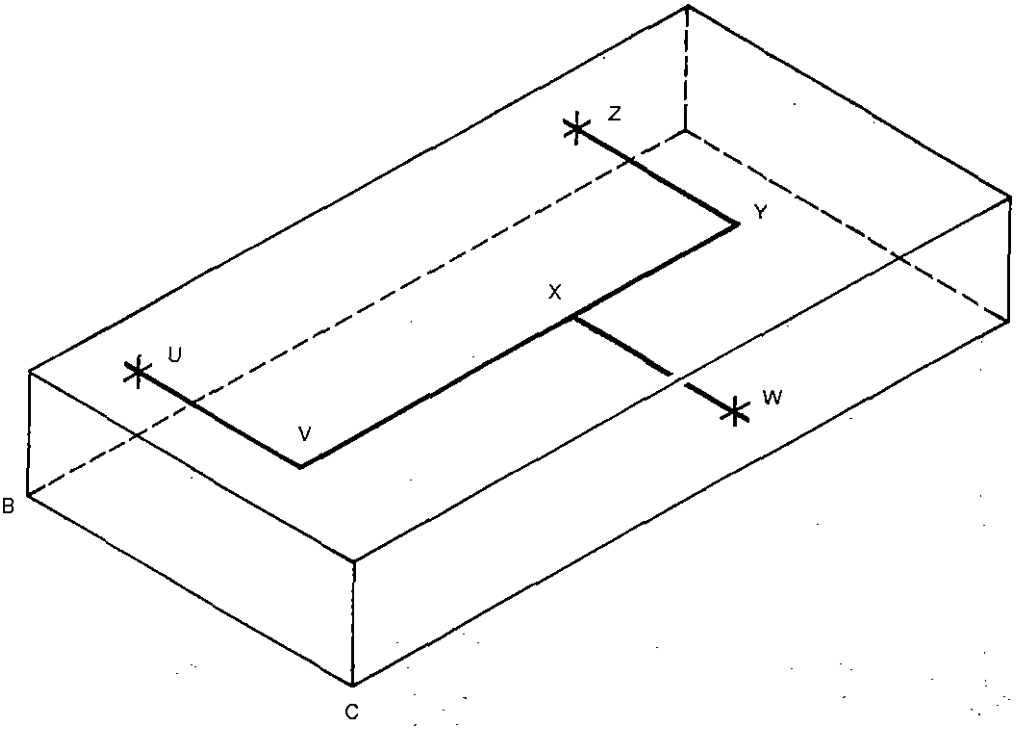


Fig. 5-

In Figs. 5-16 through 5-19, the fittiigs used at points v, and y are 90" elbows, and the fitting used at point x is a tee.

Earlier in this chapter it **was** stated that the first step in learning isometric drawing is an understanding of the three lines of dimension. These three lines are called the Isometric Axes. The isometric axes as in Fig. 5-20 shows each plane of dimension: length, width, and height.

These lines are laid out at a fixed pattern of 120 degrees to each other. ***The*** vertical line always represents height, while the other two depict length and width in the horizontal plane. The lines depicting horizontal lines are 30 ;ree t true h t Do *not* use the 60 degree side of th 30-60 t

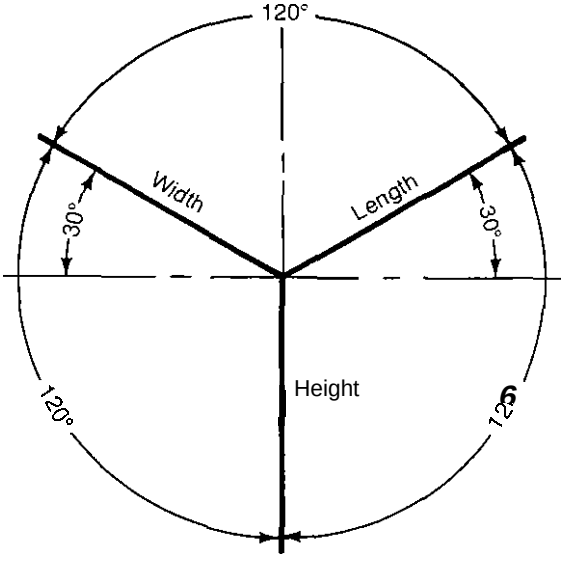


Fig. 5-20

What method should be used for pipe work when using the isometric axes?

To use the isometric axes for pipe work, use the single line method shown in Fig. 5-21. You now need six lines of direction; these are Up, Down, North, South, East and West. To get these lines of direction, you can simply extend the three lines of the isometric axes as in Fig. 5-22.

The vertical line still represents height or shows a pipe in the vertical position, but the horizontal lines each show a direction lather than length or width.

The isometric axes can now be called "lines of direction" or the isometric compass. What they are called is not as important as using them correctly. These lines of direction are the basis for three dimensional (3-D) CAD drawing.

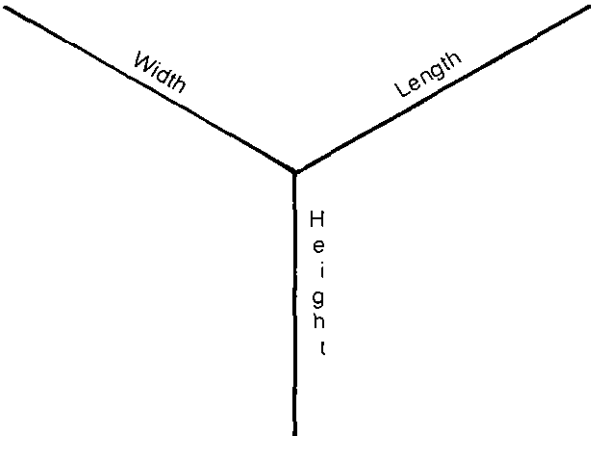


Fig. 5-21

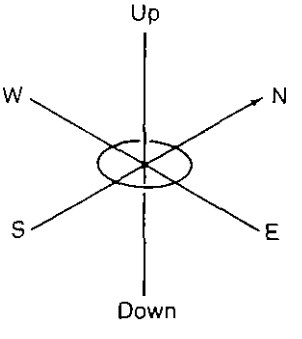
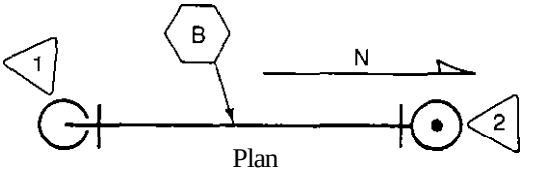


Fig. 5-22

What can be used to convert the plan and elevation drawing to an isometric drawing?

Fig. 5-23 is a Plan and Elevation view of a piping arrangement. You can use the "isometric compass" to convert the plan and elevation drawing to an isometric drawing.



East Elevation

Fig. 5-23

Starting at the south end of the elevation view nipple "**A**" is in the vertical position, so in the isometric drawing you would draw a line in the vertical position as in Fig. 5-24.

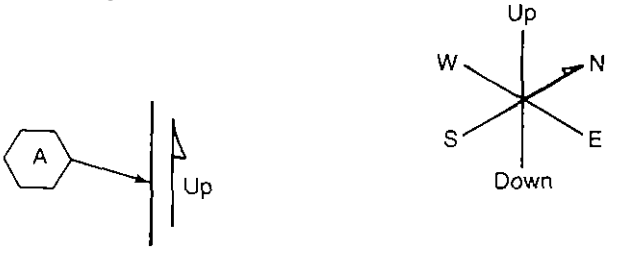


Fig. 5-24

Next you see, in the elevation view, a 90 degree ell turned to the north with nipple "B" running north. Then find North on the 'isometric compass" and draw a line in that direction as in Fig. 5-25.

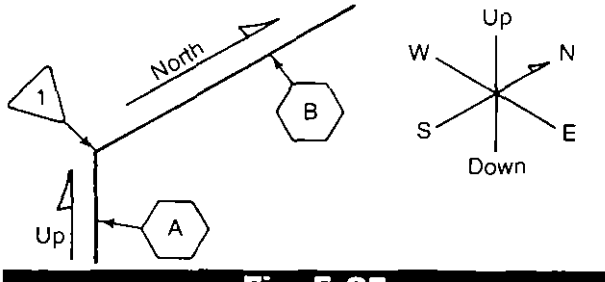


Fig. 5-25

At the end of nipple "B" is a 90 degree ell turned 'up" with nipple "C" connected to it. Draw a vertical line representing nipple "C" as shown in Fig. 5-26.

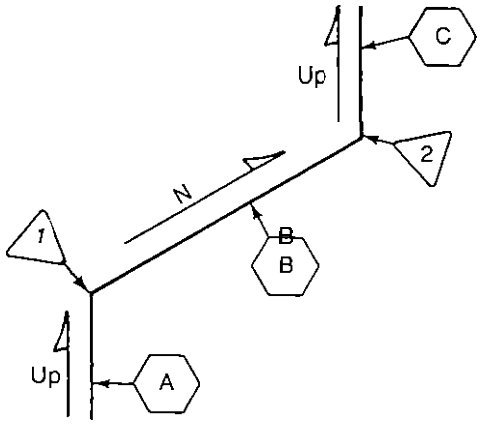
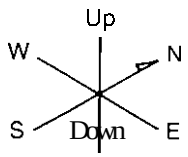


Fig. 5-26

Now that you have completed the piping, the next step is to add the symbol lines to indicate which type of fittings are used. The plan and elevation views show symbols for "screwed fittings so use the same type on the isometric as shown in Fig. 5-27. Note that the "symbols" on isometric drawings are shown isometrically.



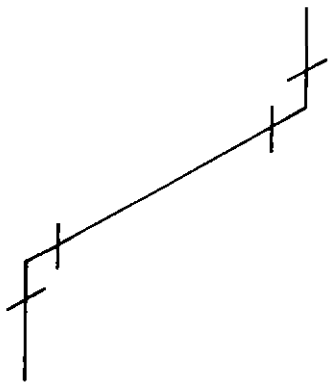
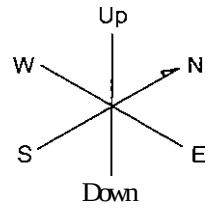


Fig. 5-27

The Isometric Compass should be included on all isometric drawings, usually in the upper right corner. Why should the isometric compass be included on all isometric drawings?

By comparing the lines of the drawing to the Isometric Compass, it is easy to see in which direction each line is going. Study Fig. 5-28.



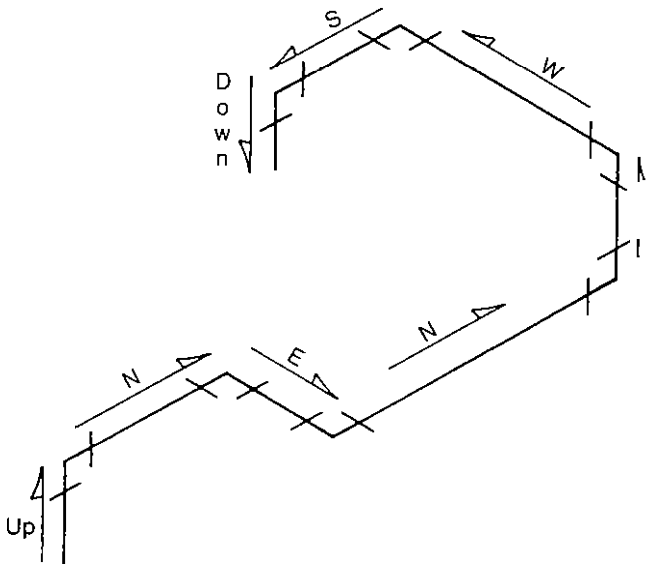


Fig. 5-28

Compare the isometric drawing in Fig. 5-28 to the Plan and Elevation views in Fig. 5-29.

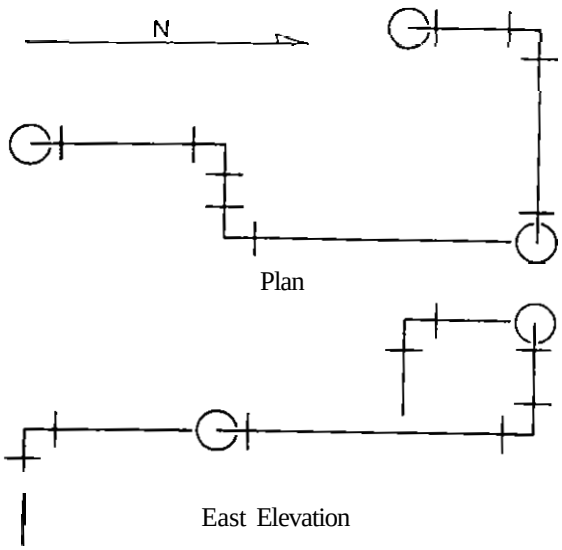
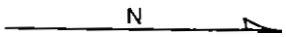


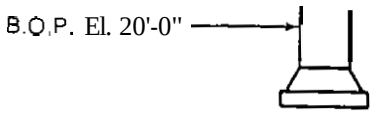
Fig. 5-29

Fig. 5-30 is a Plan view of **a** pipeline in a pipe rack. The fittings are weld elbows and weld neck flanges.

Fig. 5-31 is an isometric sketch of the same pipe and fittings. This sketch or "Spool Sheet," as they are often called, would be used by a journeyman to fabricate the pipeline shown in Fig. 5-30.



B.O.P. El. 24'-0"



B.O.P. = Bottom of Pipe Elevation

Fig. 5-30

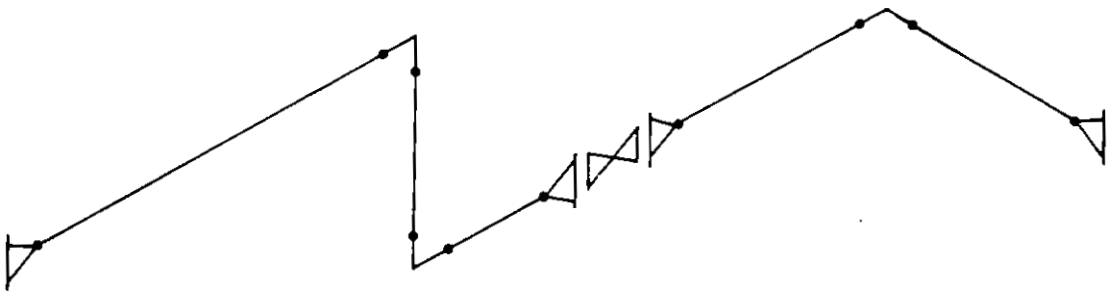


Fig. 5-31

Fig. 5-32 shows a plan and elevation view of a control valve station **and** two other lines.

Fig. 5-33 is **an** isometric of the control valve station.

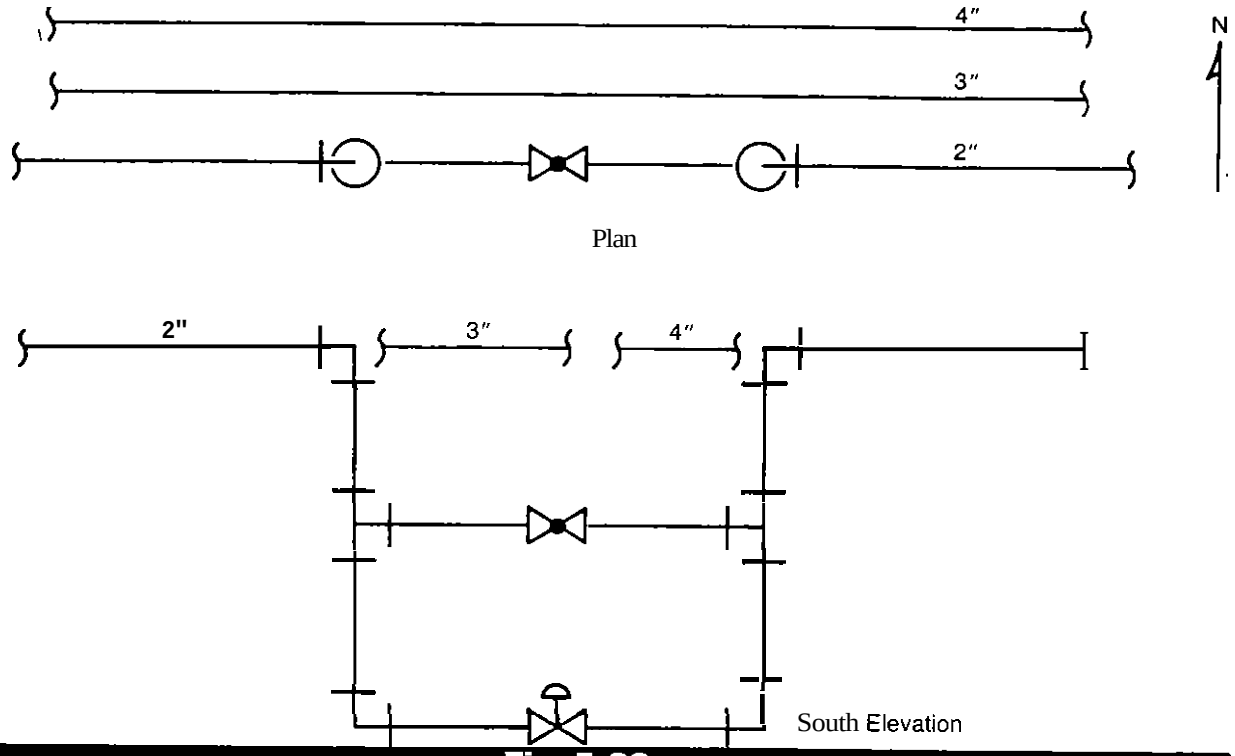


Fig. 5-32

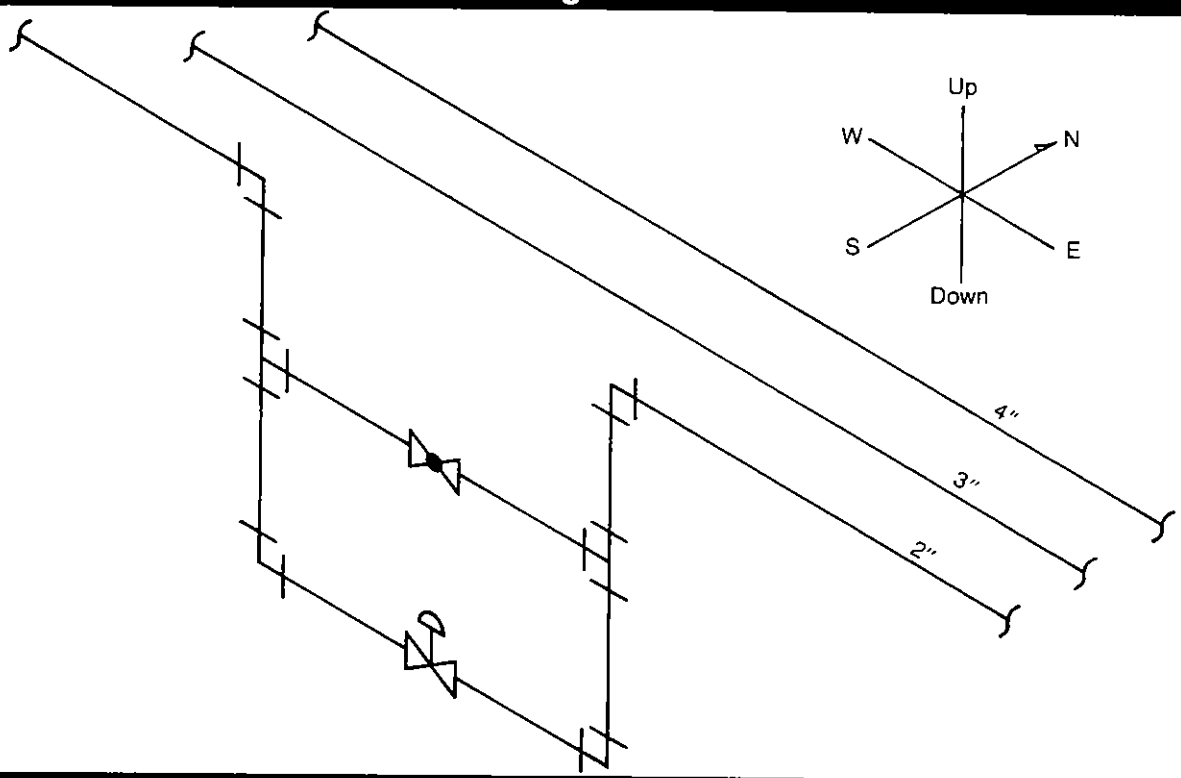


Fig. 5-33

List two steps in making an isometric drawing.

The first step in making an isometric drawing is to select the best view. This can be done by making rough freehand sketches to compare the views or to orient the drawings. After deciding on the best view and before starting the actual drawing, you should draw the Isometric Compass. To do this you should draw the axis lines first, as in Fig. 5-34.

The next step after drawing the axis lines is to add the directions of the compass, North, South, East and West, as in Fig. 5-35.

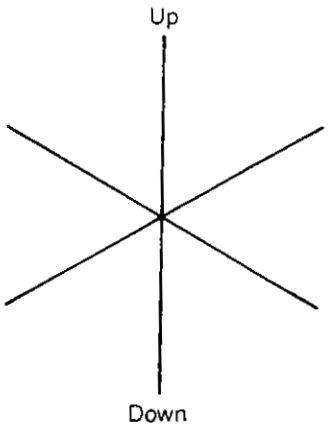


Fig. 5-34

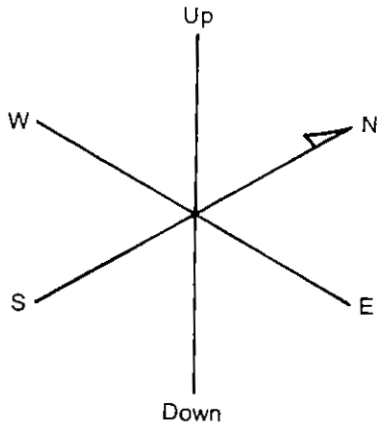


Fig. 5-35

EXERCISE 5-1

Study the plan and elevation views in Fig. 5-36. Convert them to an isometric drawing using the isometric compass shown in Fig. 5-35. Use a drawing board, T-Square and 30-60 degree triangle. Use the measurements given in the plan and elevation views to make the drawing.

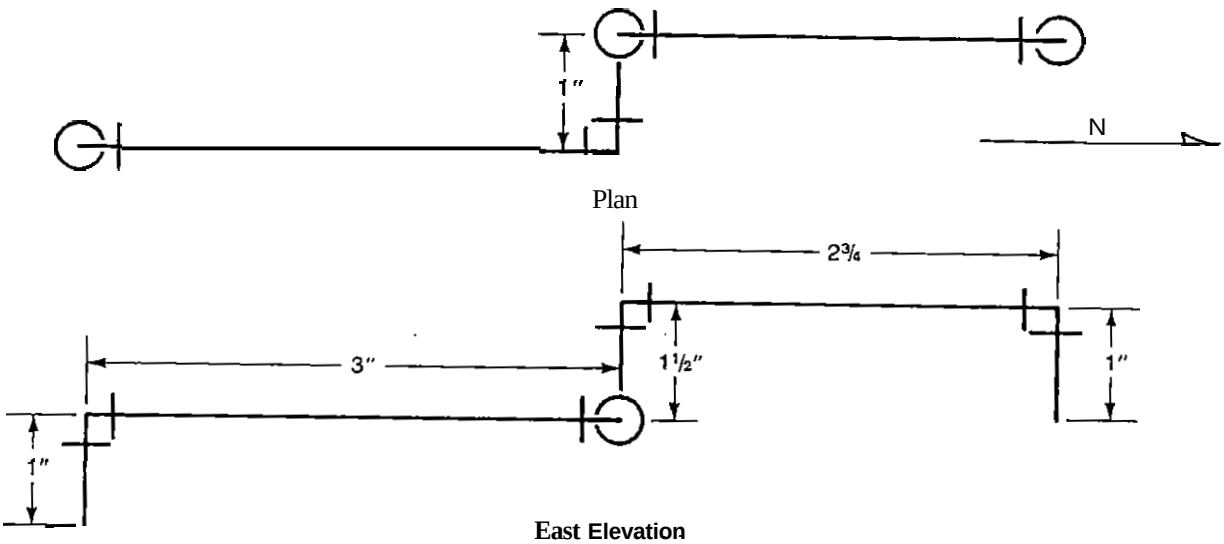


Fig. 5-36

Fig. 5-37 shows a Plan and Elevation view of a piping situation. Fig. 5-38 shows the four Isometric views.

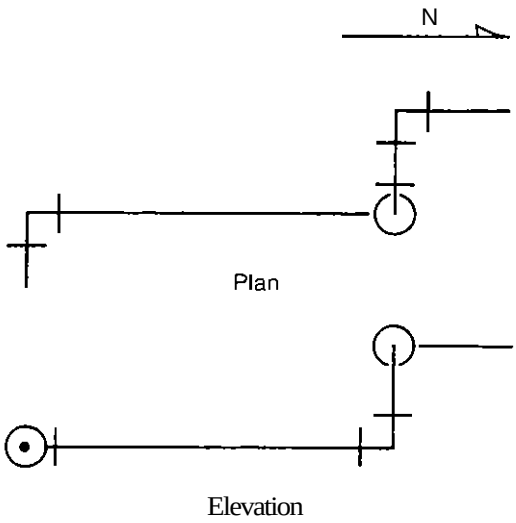


Fig. 5-37

The view to be used is the one that gives the clearest picture of the object or piping and also is the one most closely oriented to the Plan view. In Fig. 5-38 note that the Southeast view gives a clear picture and is most closely oriented to the Plan view A view where lines cross should be avoided "if possible." Note that in the Northwest view in Fig. 5-38 two lines cross.

In general, the practice of dimensioning an isometric drawing is quite similar to dimensioning a three-view drawing. How should isometric extension and dimension lines be drawn?

Isometric extension and dimension lines should be drawn in the isometric planes to which they apply. Dimension lines must always be shown parallel to the direction of measurement, and should apply, if possible, to a visible surface. The dimensions given should be those required to make the piping configuration. They should be without duplication and above all be legible.

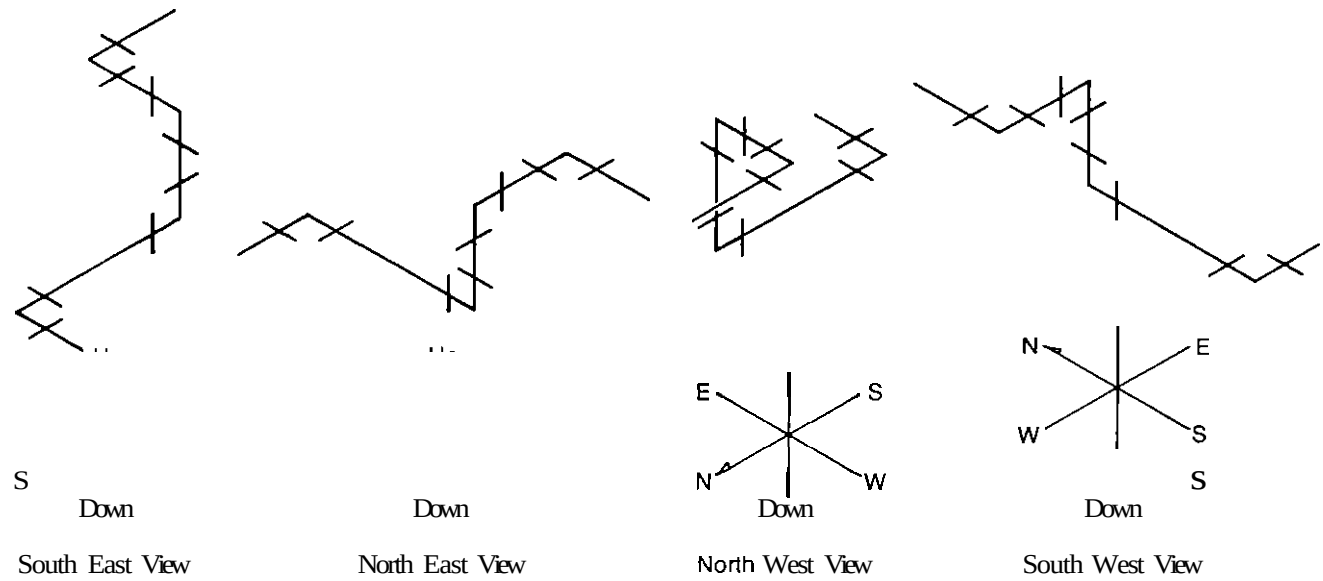


Fig. 5-38

EXERCISE 5-2

Draw all four Isometric views of the piping in Fig. 5-39.

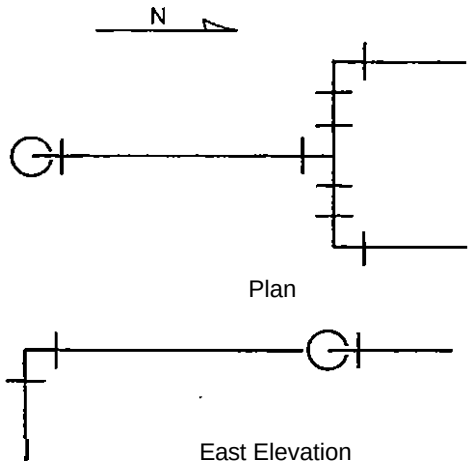


Fig. 5-39

EXERCISE 5-3

Draw the Southeast and Northwest isometric views of the piping shown in Fig. 5-40. Note: Draw the isometric views the same size as the plan and elevation views in Fig. 5–40.

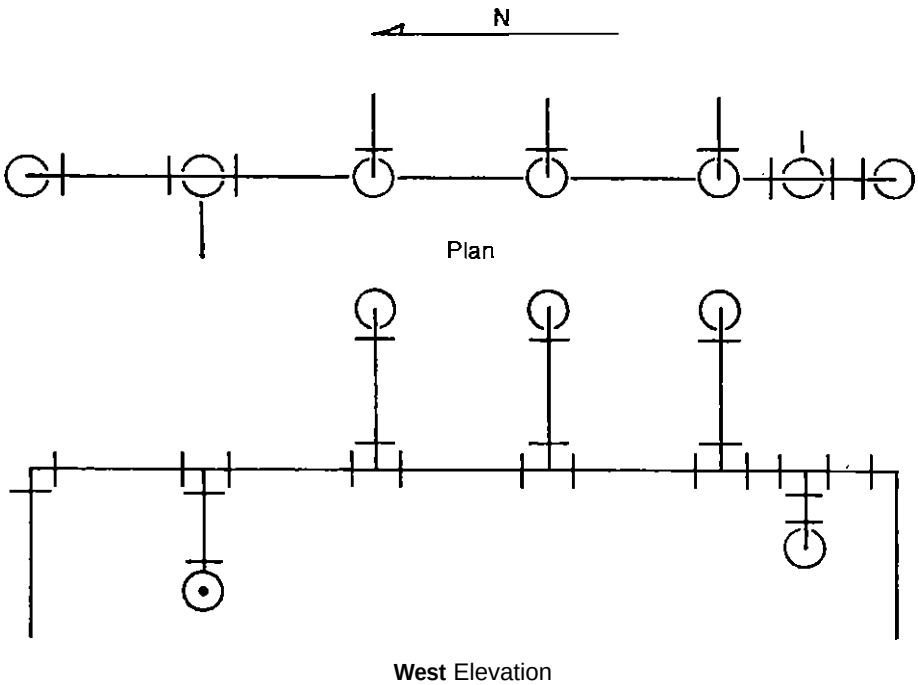


Fig. 5-40

Why is the method of dimensioning shown in Fig. 5-41 preferred?

The method in Fig. 541 is preferred because of its compactness. Those locations of dimensions shown in Fig. 5-42 and Fig. 543 are sometimes necessary for maximum clarity.

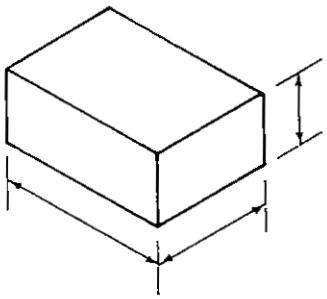


Fig. 5-41

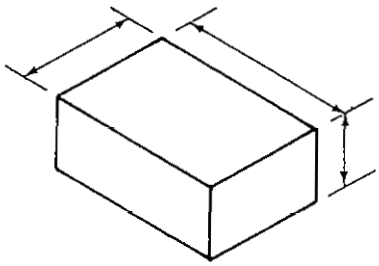


Fig. 5-42

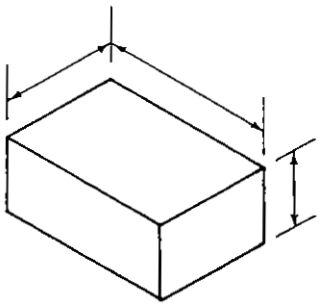


Fig. 5-43

As in three-view dimensioning the dimensions should be placed outside the boundaries of the drawing. Sometimes it is not possible to do this. In such cases, the forms shown in Figs. 5-44 and 545 are permissible.

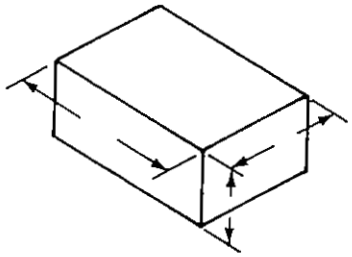


Fig. 5-44

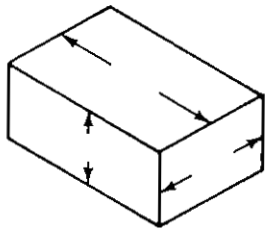


Fig. 5-45

Isometric extension and dimension lines should never be drawn as shown in Fig. 5-46 This is an example of a common mistake in the dimensioning of isometric drawings.

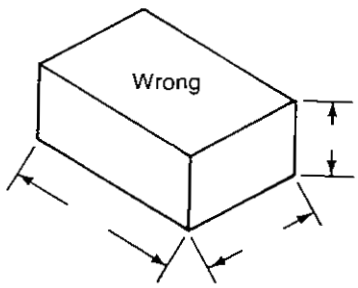


Fig. 5-46

Figs. 5-47 and 5-48 are some examples of correct and incorrect extension and dimension lines

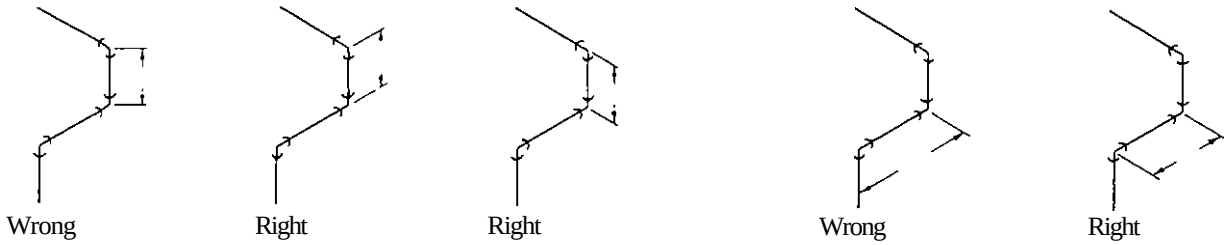


Fig. 5-47

Fig. 5-48

EXERCISE 5-4

Draw the Southeast and Northeast isometric views of the piping in Fig. 5-49. Draw the isometric views the same size as the Plan and Elevation views shown in Fig. 5-49. Add the extension and dimension lines.

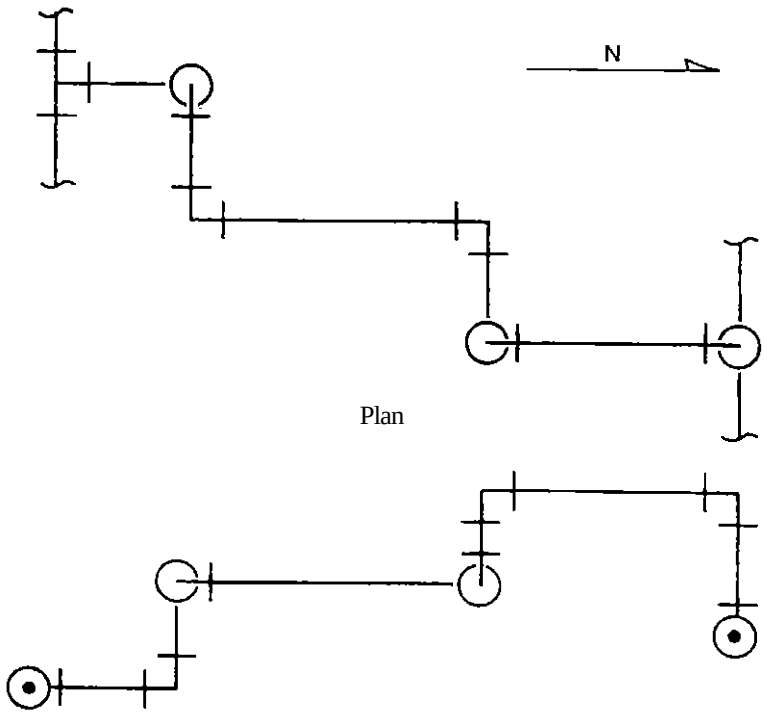
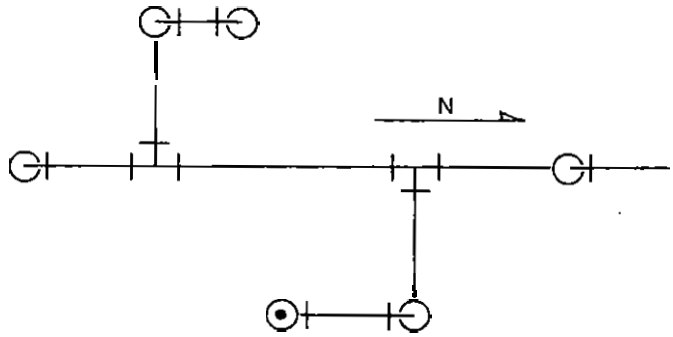


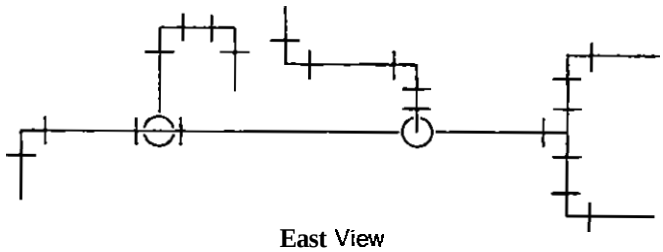
Fig. 5-49

EXERCISE 5-5

Draw the isometric view that gives the clearest picture of the piping situation in Fig. 5-50.



Plan



East View

Fig. 5-50

In making an isometric drawing you rarely use the Bottom view. Fig. 5-51 is an isometric drawing showing the Bottom view of a unit heater. You can see the Bottom and the piping coming out of it. The Front and Left sides can be seen also.

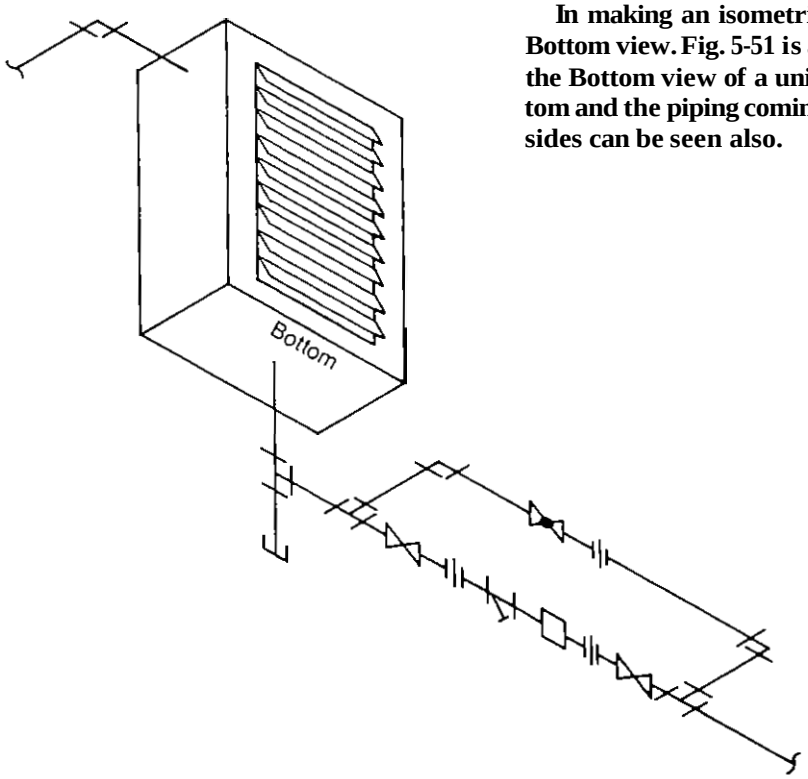
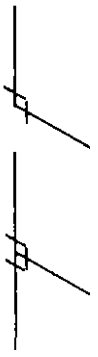


Fig. 5-51

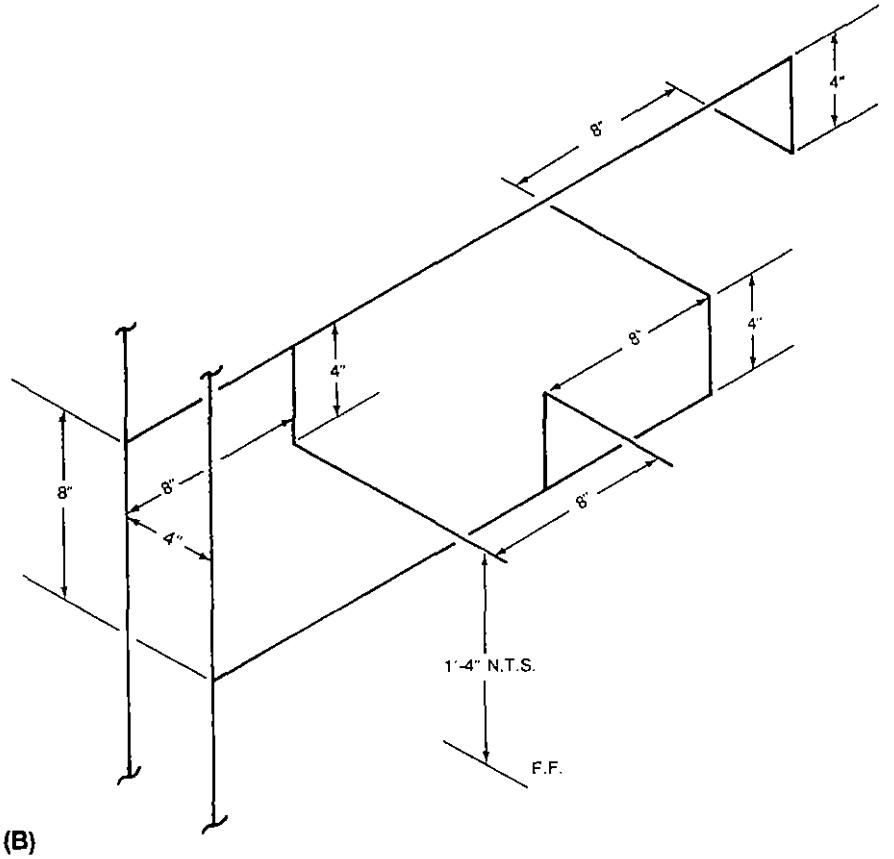
Fitting lines are drawn as perpendicular to the pipe line and generally parallel to the closest perpendicular pipeline. Notice the 90" ell and tee shown with fitting lines in Fig. 5-52-(A)



(A)

Fig. 5-52-(B) is an example of an isometric working sketch. Dimensions have been included. Notice that the dimensions are kept away from the actual pipe to avoid confusion. What is the distance above finished floor (F.F.) to the outlets as shown on the sketch?

The distance above finished floor to the outlets is 1'-4".



(B)

Fig. 5-52

In the pneumatic booster system shown in Fig. 5-53, the 8" pipe which supplies the pumps is not directly over the 6" discharge pipe that supplies the tank.

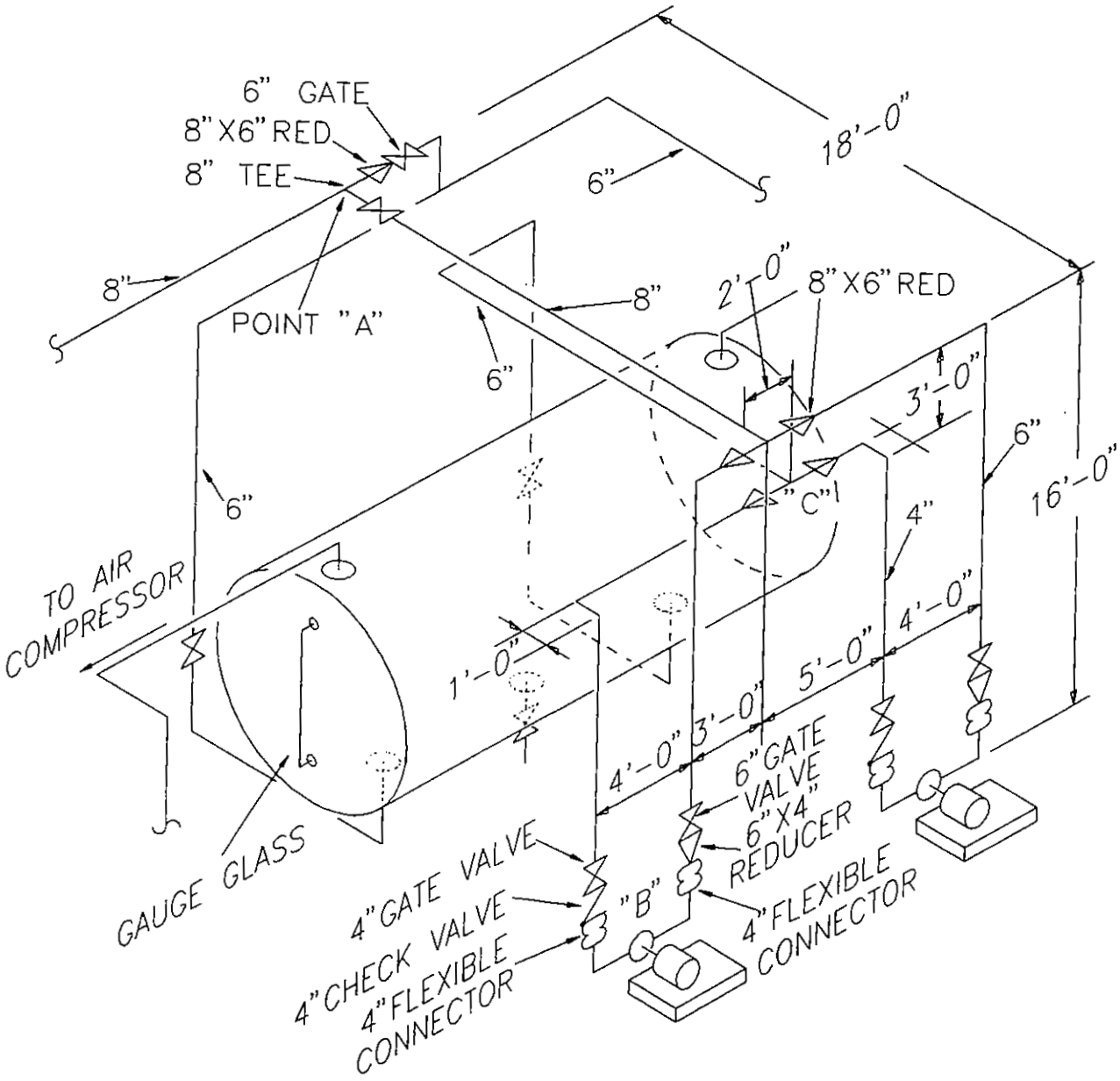
Notice the extension and dimension lines at point *C* depicting the 2'-0" horizontal distance.

List all of the 8", 6", and 4" fittings required to install the piping system shown in Fig. 5-53.

11 – 6" 90" elbows

8 – 4 90" elbows

2 – 8" tees



g. 5-5

2 – 6" tees

3 – 8 x 6" reducers

1 – 8" Gate Valve

5 – 6 Gate Valves

2 – 4" Gate Valves

2 – 4" Check Valves

4 – 6 x 4 Reducers

4 – 4" Flexible Connectors

What is the center to center measurement between the pumps?

The center to center measurement is 12'-0

2'-0" C-pump to C-4" 90° ell

3'0" C-6" ell to C-8 tee

5'-0" C-8" tee to C-4" 90° ell

2'-0" C-4" 90" ell to C-pump

12'4"

In Fig. 5-53 list the C-C measurements, size and fittings used from point A, through pump B to point C.

1. 8" – 18'-0" C-8 bullhead tee to C-8" bullhead tee over 8" gate valve
2. 6 – 3'-0" C-8" 90" tee to C-6" 90" ell over 8 x 6 reducer
3. 6" – 16'-0" 90" ell to C-4" 90" ell over 6 gate, 6 x 4 reducer, and 4" flexible connector
4. 4" – 2'-0 C-4" 90" ell to Gpump
5. 4" – 2'-0 C-pump to C 4 90" ell
6. 4" – 13'-0 C-4" 90" ell to C-4 90" ell over 4 flexible connector, 4 check valve, and 4" gate valve
7. 4" – 1'-0" C-4" 90" ell to C-4" 90" ell
8. 4" – 9'-0" C-4" 90" ell to C-6" tee over 6 x 4 reducer

Isometric drawings have their greatest use as working or job drawings or for presenting an overall view of an entire system

A journeyman will see the arrangement of piping as it is to be installed. It will be easy to list the quantity, size, and type of fittings required; and if dimensions are added, the piping can be cut prior to the actual installation.

The earlier discussion in this chapter on isometric drawing dealt with lines which could be drawn parallel to an "isometric axis," or lines which run Up, Down, North, South, East and West. This Chapter is also concerned with lines which do not follow the isometric axis or isometric "compass." Simple offsets using 45 degree ells and the more complex 'rolling offsets" will be covered next.

It was mentioned earlier that any true isometric line could be drawn to scale. A true isometric line is one that is parallel to an isometric axis. The Non-Isometric line is *not* parallel to an axis and *cannot* be drawn to scale.

What prevents a non-isometric line from being drawn to scale?

Following are simple objects which can be used to illustrate certain rules for drawing non-isometric lines.

Fig. 5-54 is a plan and elevation view of a wedge shaped object.

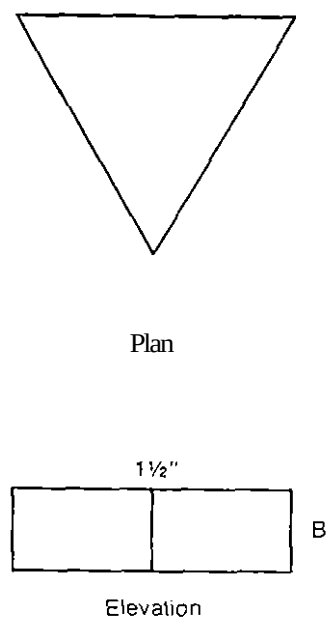


Fig. 5-54

The first rule to remember when drawing non-isometric lines is that all non-isometric lines must be 'boxed in." To "box in" a non-isometric line you must draw a true isometric box. To get the measurements for this "box" you can draw a box around the plan view.

Fig. 5-55 shows the wedge shaped object with a box drawn around it. The box should always be drawn with broken lines, or very light lines.

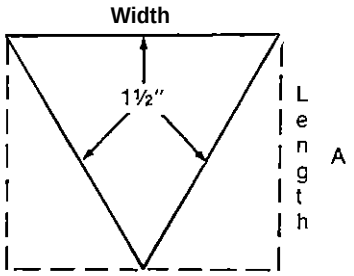


Fig. 5-55

Now looking at the obiect with the "box" around it you can draw the "box" using true isometric lines as in Fig. 5-56.

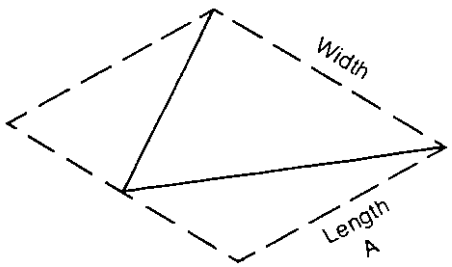


Fig. 5-56

The isometric box in Fig. 5-56 only shows two dimensions "length and width." To get the third dimension "height" measure the height in the elevation view and draw it onto the box as in Fig. 5-57.

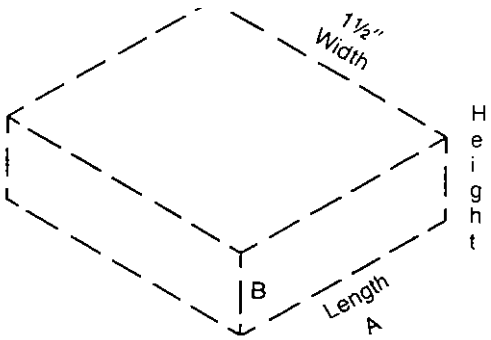


Fig. 5-57

The "point" of the wedge is exactly at the center of the front. On the front of the box you have drawn a vertical line at its center as in Fig. 5-58.

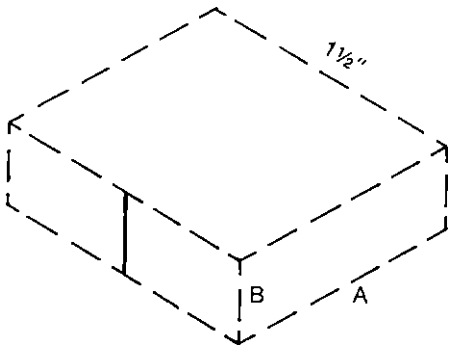


Fig. 5-58

Next draw in the angled lines from the front top of the box to the rear top of the box as in Fig. 559. Do the same for the bottom angled line, and complete the drawing.

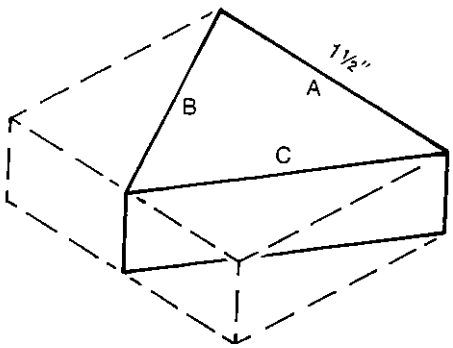


Fig. 5-59

The Plan view of the wedge shows that all sides are the same length; "1½ inches." Measure the sides in the isometric view in Fig. 559.

Side "A" is the only side drawn parallel to an isometric axis and is the only one of the sides that is drawn to true length. Sides B & C are both different length Note that the non-isometric lines cannot be drawn t true length accurately.

EXERCISE 5-6

Make a full-size isometric drawing of the object shown in Fig. 5-60.

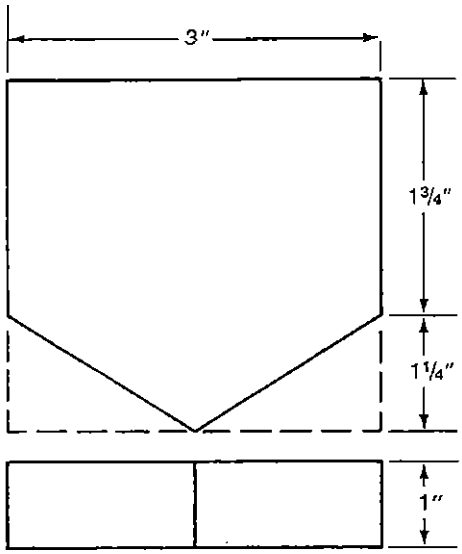


Fig. 5-60

EXERCISE 5-7

Make an isometric drawing of the object shown in Fig. 5-61 using the dimensions given.

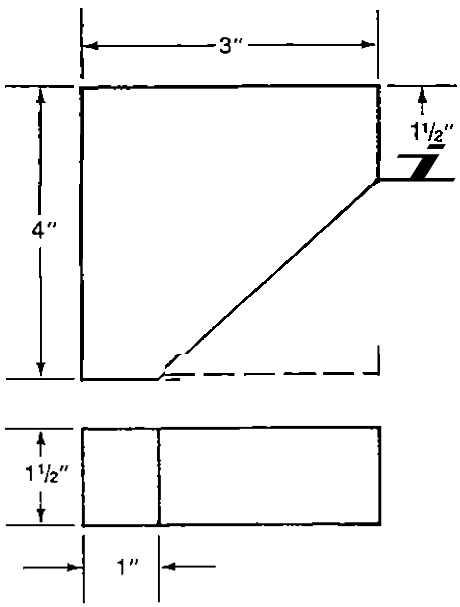


Fig. 5-61

EXERCISE 5-8

Make a full-size isometric drawing of the object shown in Fig. 5-62.

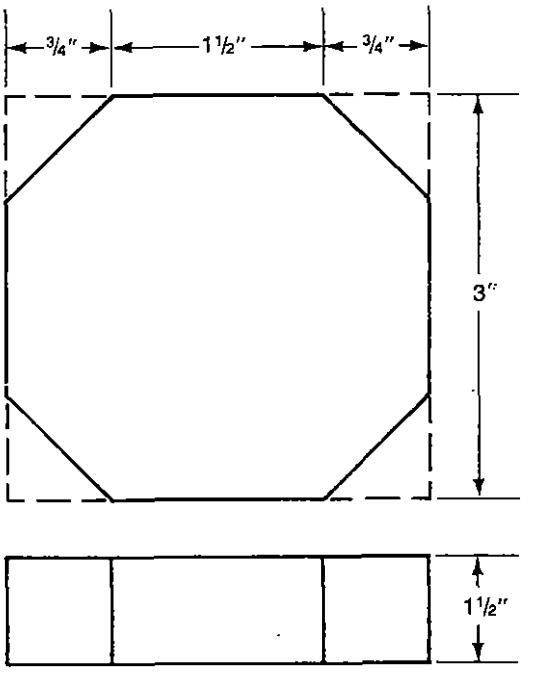


Fig. 5-62

What rules apply when making isometric drawings?

When making isometric drawings of piping situations, the same rules apply. Fig. *5-63* is a plan and elevation view of a piping situation with a 45 degree offset.

To make an isometric of this piping situation, the first step would be to "box" in the offset as in Fig. 5-64.

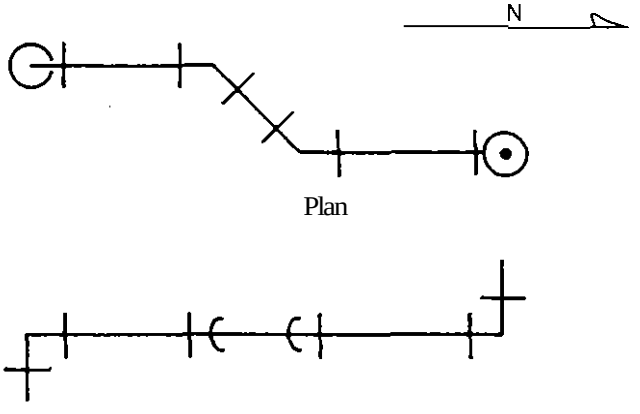


Fig. 5-63

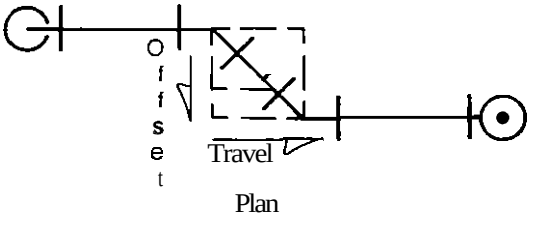


Fig. 5-64

Now you can draw all of the lines which follow an isometric axis as in Fig. 5-65.

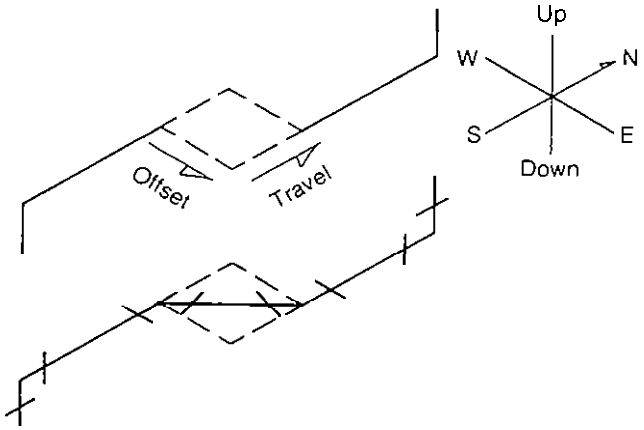


Fig. 5-65

Now fill in the Non-Isometric line of the drawing. Note in Fig. 5-65 the isometric box has no vertical lines in it. The lines lie in the horizontal plane

Fig. 5-66 is a drawing of the same piping situation drawn exactly to the same measurements, but without the isometric box added. It looks almost the same as the one in Fig. 5-65 except that you can't tell positively which way the offset goes.

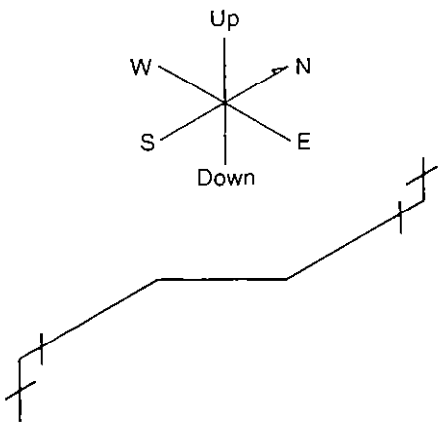


Fig. 5-66

To prove this point Fig. 5-67 is once again the exact same drawing but with the isometric box laid out in the vertical plane.

Note that the piping in Figs. 5-65 and 5-67 is drawn exactly the same, only the isometric box is changed. Consequently the offset is changed. It appears to offset "down."

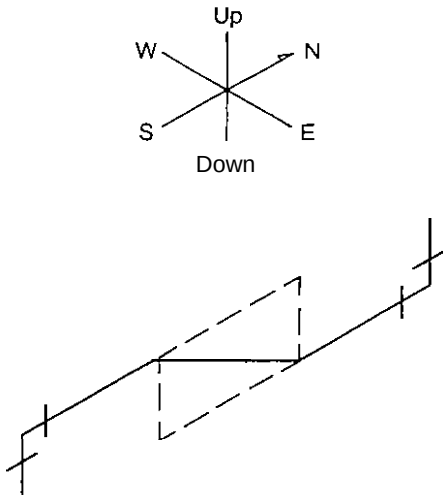


Fig. 5-67

The best method to show the offset in the horizontal plane is with the isometric box in the horizontal plane and with instructions added as in Fig. 5-68.

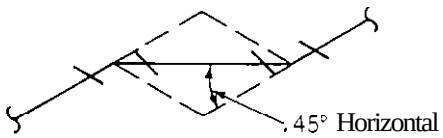


Fig. 5-68

Fig, 5-69 is an elevation view of an offset. The offset rises up and continues south.

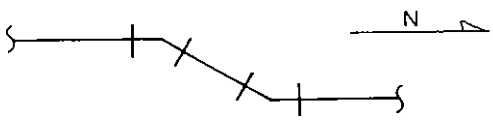


Fig. 5-69

You can "box" the offset in by continuing the lower horizontal line "**A**" as a broken line, as in Fig. **5-70.** Then m the broken line straight up to meet the other horizontal line "B" as in Fig. 5-71. Now close the box in completely as in Fig. 5-71.

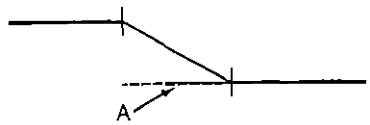


Fig. 5-70

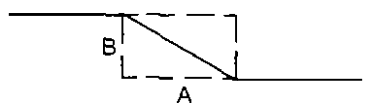


Fig. 5-71

The lines which follow an isometric axis and the box can now be drawn isometrically as in Fig. **5-72.** Now, with the "isometric box" completed, add in the non-isometric line or offset as in Fig. 5-73. Note once again that if you remove the "box," in Fig. 5-71, you cannot tell in which direction the offset is going.

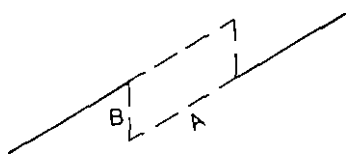


Fig. 5-72

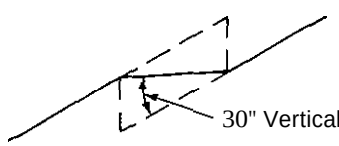


Fig. 5-73

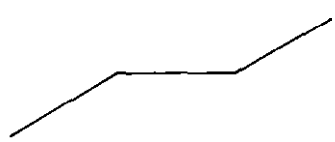
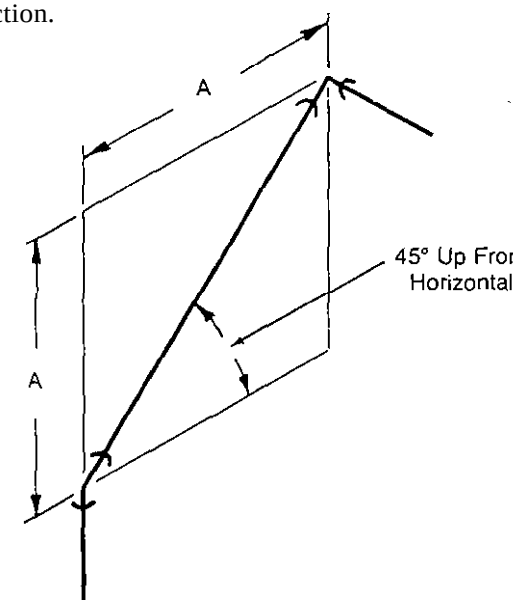
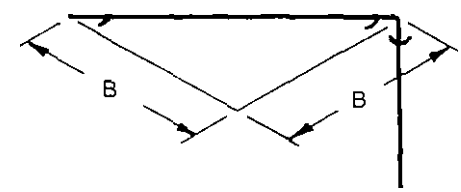


Fig. 5-74

See Fig. 5-75. An angle which is not **90** degrees must have a note indicating the size of the angle and the direction.



45' In



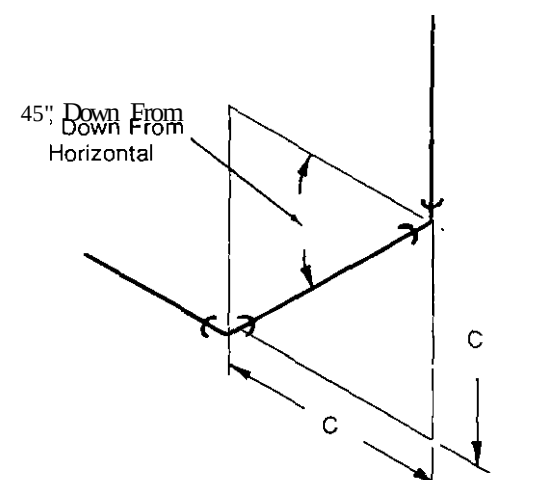


Fig. 5-75

EXERCISE 5-9

Draw the piping arrangement shown in Fig. ***5-76*** with the offset and box. Draw the broken lines for the box lightly so they can be erased. After the drawing is finished and looks like the one in Fig. ***5-76*** erase the box lines. Now without changing the piping, draw a box around the offset in the vertical plane. This will change the offset to the vertical plane **from** the horizontal plane.

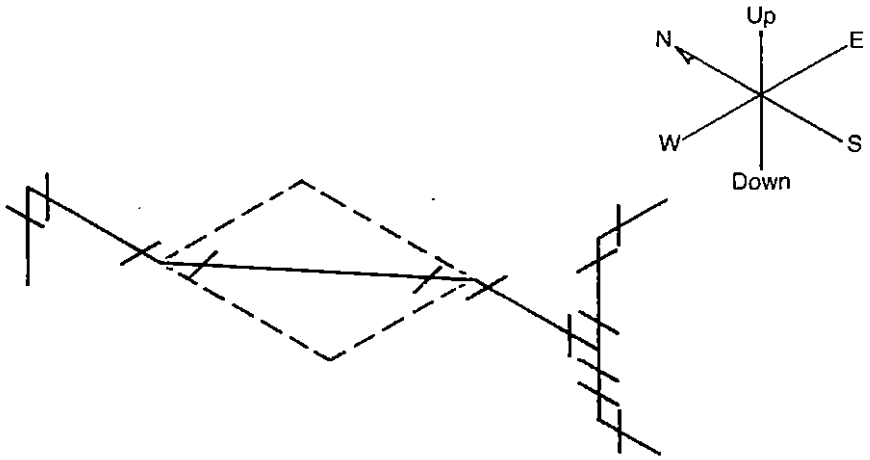


Fig. 5-76

EXERCISE 5-10

Using a drawing board and T-Square draw the elevation view shown in Fig. ***5-77.*** Draw **it** in the center of the paper to the measurements given here.

After drawing the elevation view, draw the four isometric views on the same sheet of paper.

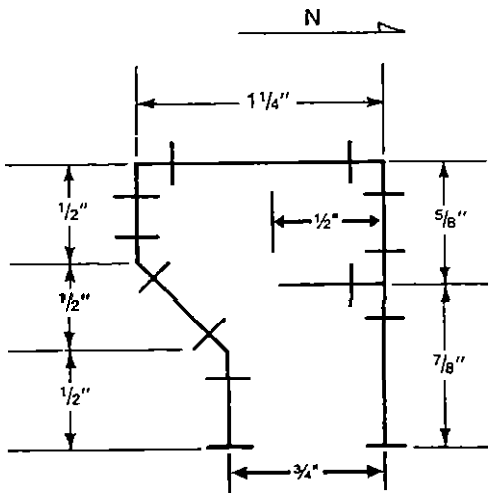


Fig. 5-77

As mentioned earlier, non-isometric lines cannot be measured or scaled. How can you usually overcome this problem?

To overcome this problem you can usually measure or scale the isometric box around the non-isometric line. Sometimes you cannot do this, but must depend on written measurements

Fig. 5-78 is a Southwest isometric view of a piping situation with a 45 degree offset in the horizontal plane on the north end.

Fig. 5-79 is a Northwest view of the same piping situation, but to be able to show it clearly using the Northwest view the isometric box must be elongated.

If the box were not elongated, but drawn square, the non-isometric line would appear as a vertical line.

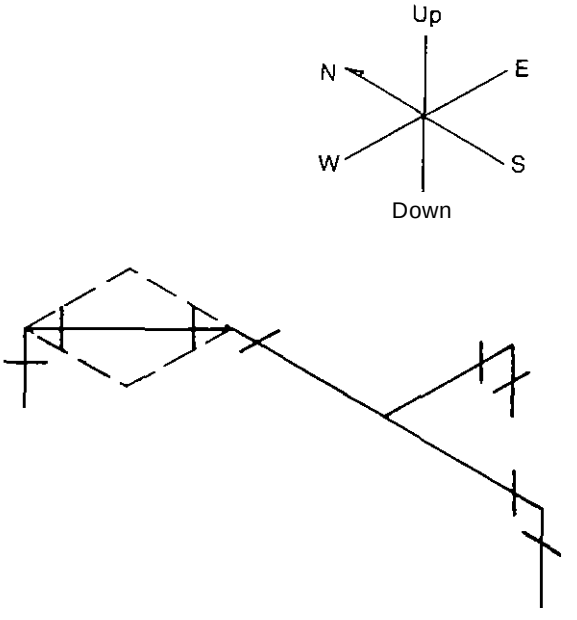


Fig. 5-78

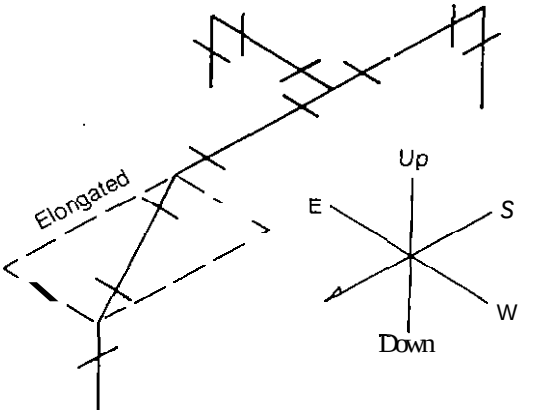


Fig. 5-79

EXERCISE 5-11

Draw a Northeast view and a Southeast view of the piping shown in Figs. 5-78 and 5-79.

EXERCISE 5-12

Draw a Southeast isometric view and a Southwest isometric view of the piping in Fig. 5-80.

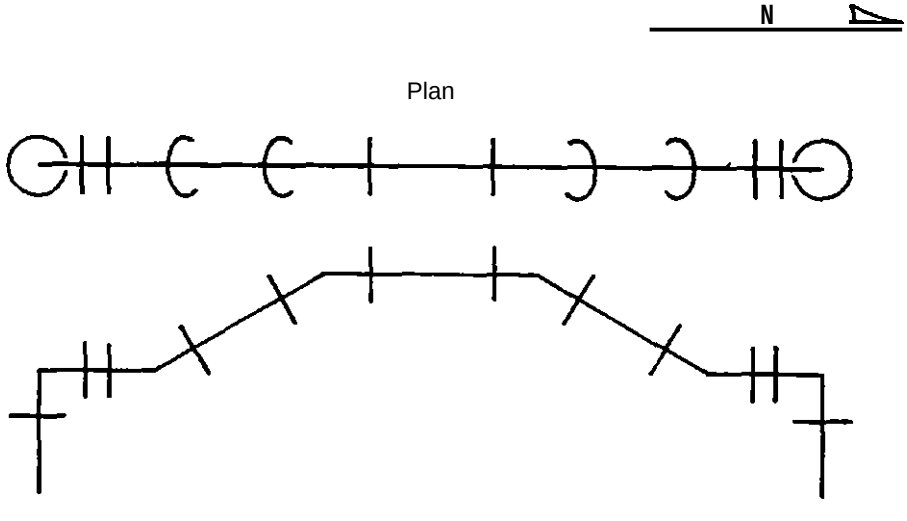


Fig. 5-80

EXERCISE 5-13

Draw a Northwest view and Northeast view of the piping in Fig. 5-81.

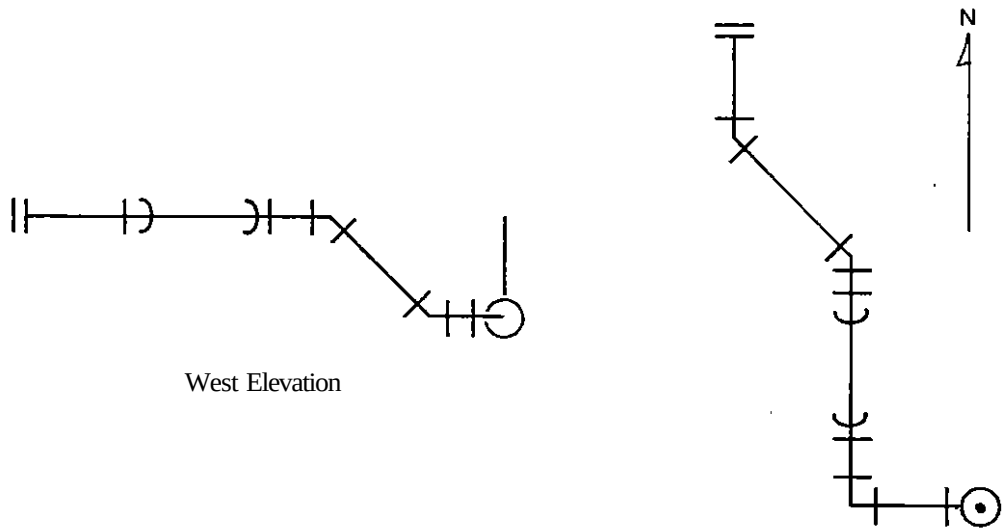


Fig. 5-81

The offsets or Non-Isometric lines which have been covered up to now have been simple offsets. What is the next step?

The next step is to draw a Rolling Offset. The simple offset box has only two dimensions or lines of direction. The offset in Fig. 5-82 "advances" South and "offsets" to the East.

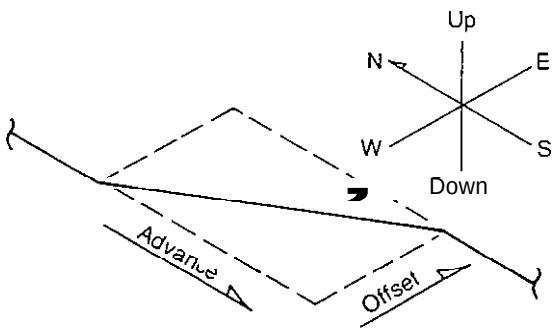


Fig. 5-82

The Rolling Offset has **three** dimensions which must be shown. They are Advance, Offset and Roll. Fig. 5-83 is an example of an isometric Rolling Offset. It is Advancing north, Offsetting up and Rolling to the west.

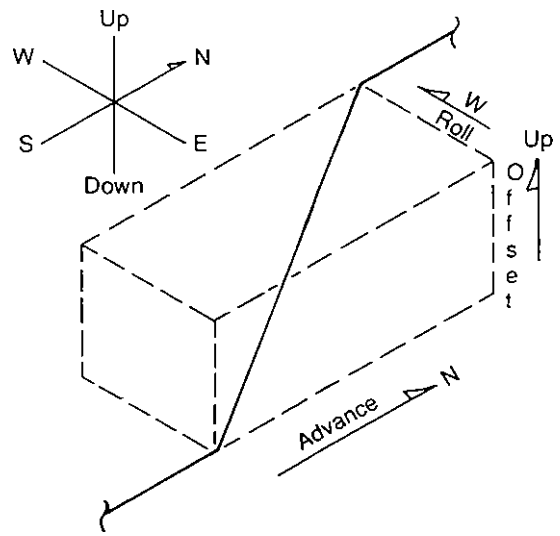


Fig. 5-83

The plan view and elevation view of a rolling offset might be confusing because they look alike as in Fig. 5-84.

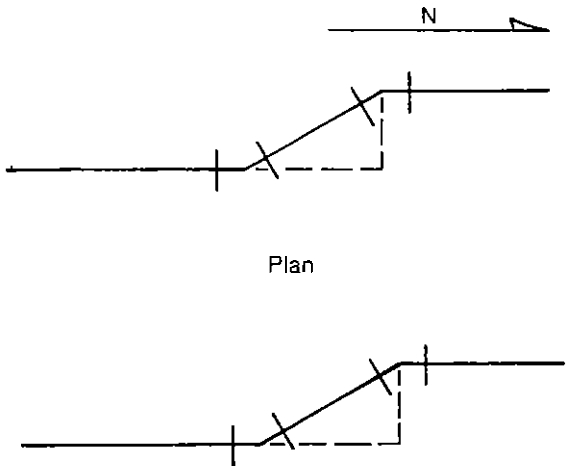


Fig. 5-84

The plan view shows the h e Advancing North and Offsetting West. To make the isometric box you would draw a h e 'A," then continue north with a broken h e "1" for the box as in Fig. 5-85.

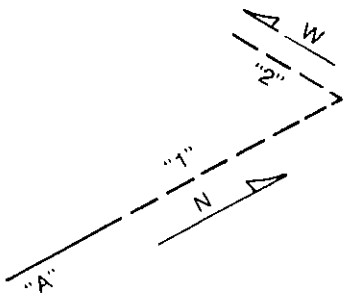


Fig. 5-85

The next step is to show the Westerly direction, line "2," which can be seen in the plan view.

You now have two lines of direction, North and West. You must refer to the elevation view to see if the li goes up or down.

The elevation view shows the h e advancing North and turning Up. Add this, line "3," to the isometric drawing shown in Fig. 5-86.

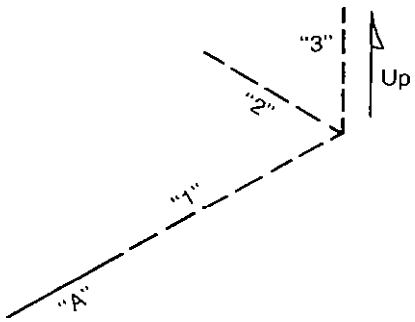


Fig. 5-86

Now complete the isometric box and add in the non-isometric line as in Fig. 5-87.

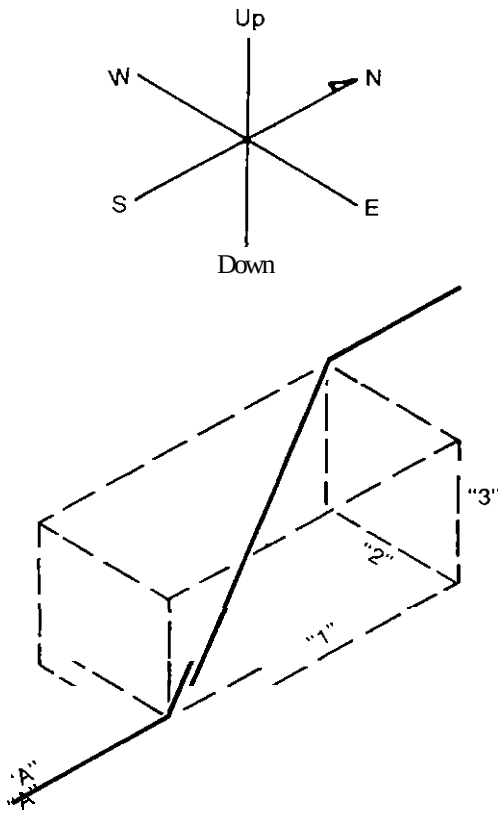


Fig. 5-87

Fig. 5-88 shows several rolling offsets.

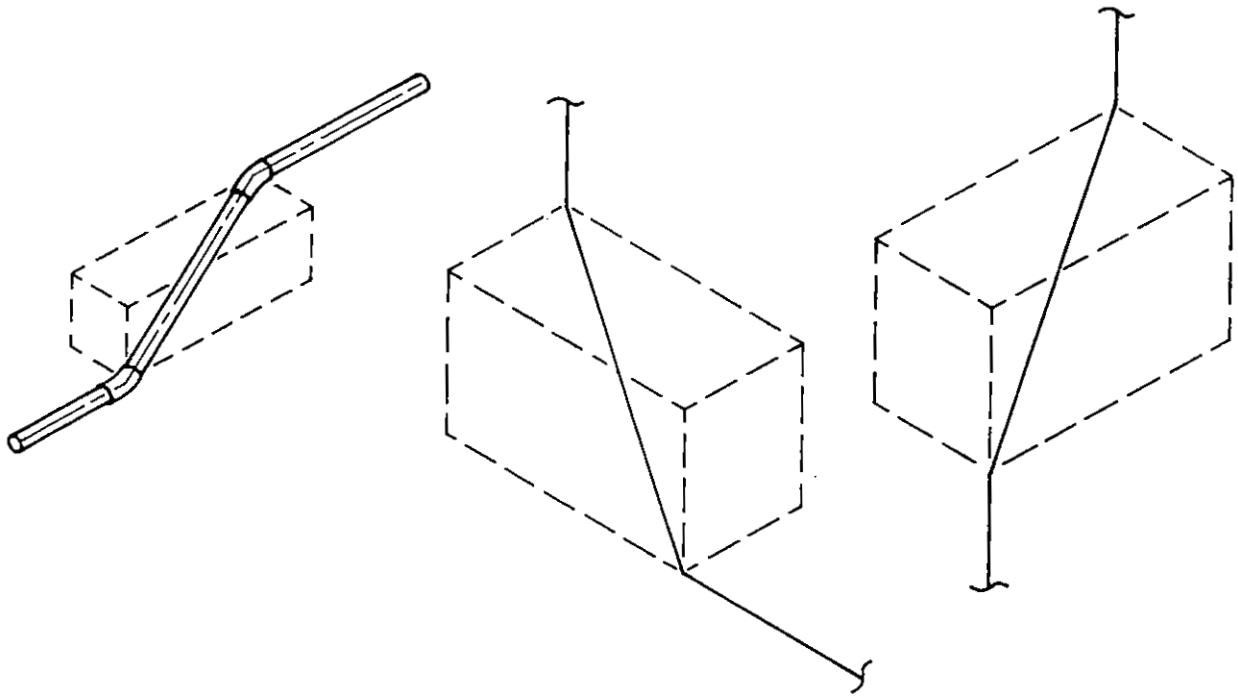


Fig. 5-88

EXERCISE 5-14

Draw a Southeast isometric and a Northeast isometric view of the piping in Fig. 5-89. include the extension and dimension lines and measurements. Draw to a scale of ⅜ inch = 1 foot.

Note: Two sheets of 8½" x 11" paper are required for this exercise.

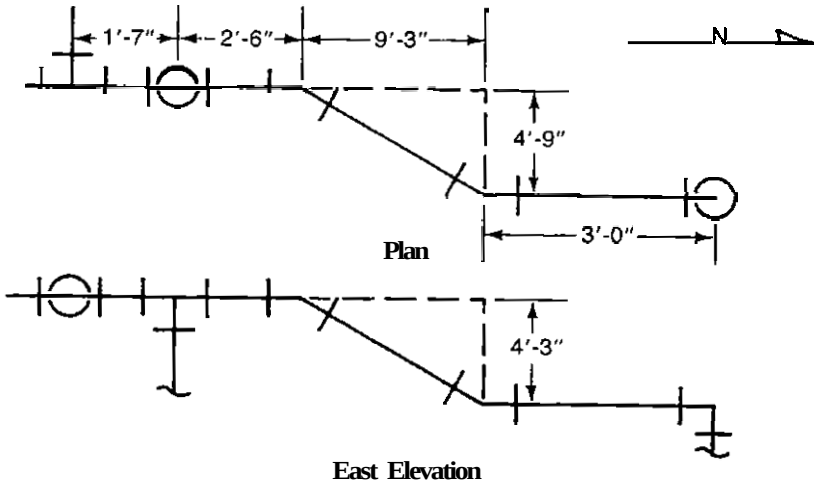


Fig. 5-89

If non-isometric lines cannot be measured on a sketch, how then, can they be drawn in the proper relationship to the rest of the drawing?

Non-isometric lines can be drawn in proportion by measuring the distance from the major axes to the end points of the non-isometric line.

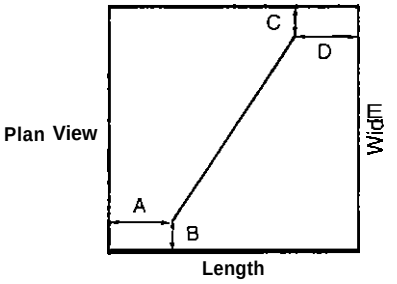


Fig. 5-90

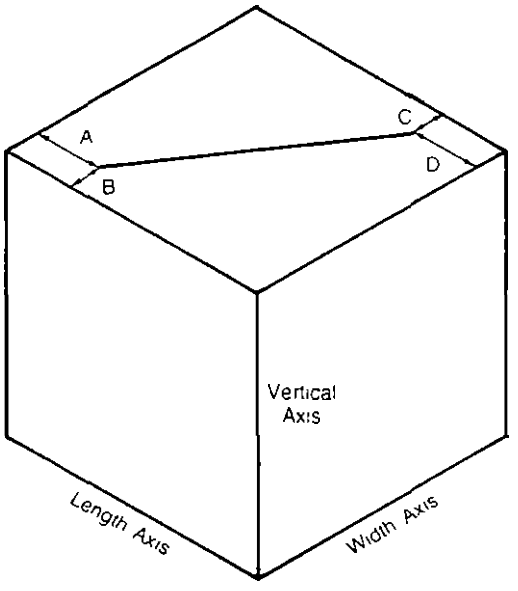


Fig. 5-91

Notice in Fig. 5-90 by measuring the distance of A from the width and B from the length axes on the plan view, one end point of the non-isometric line is located. Transfer dimensions *A* and B to the top view on the isometric drawing in Fig. 5-91.

After locating this end point, follow the same procedure with dimensions *C* and D to locate the other end point of the non-isometric line. When both end points have been located, merely draw a line connecting the two, thus the non-isometric line is drawn to proportion. See Fig. 5-91.

Fig. 5-92 represents an offset in a riser using 45" elbows, B through E, and 90" elbows at A and *F*.

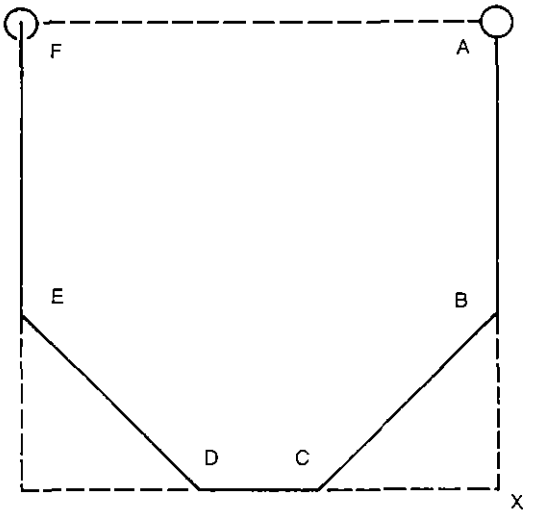


Fig. 5-92

Fig. 5-93 is an isometric view of the offset shown in the plan view in Fig. 5-92, as viewed from point X. Notice the positions of fittings A through F. Study the 45° pipe lines and make a determination.

The determination should be that in an isometric drawing, pipelines which represent a 45° angle in plan view, will be either vertical or horizontal in an isometric view.

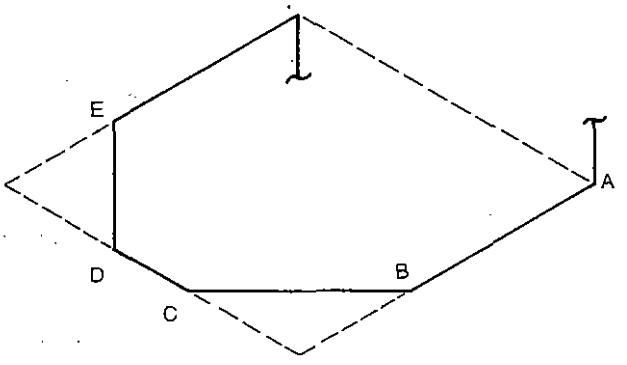


Fig. 5-93

Study Fig. 5-94, notice the fittings at points A, B, C, & D in the plan view. Using X as the observation point in Fig. 5-95 the most difficult fitting to locate in the isometric view is the 90" elbow at point D and the exact spot where the 45" line stops and the vertical line starts

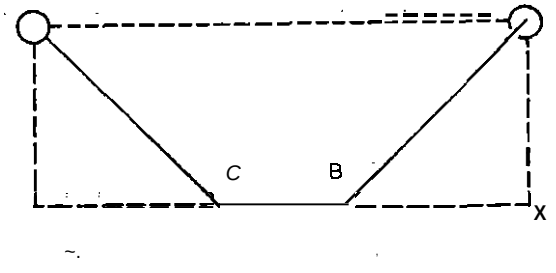


Fig. 5-94

How can a 45" angle be shown when the end points cannot be located readily or the illusion created is not satisfactory? In Fig. 5-95 use X as the observation point.

It is very difficult to interpret the second 45° pipe line *(C-D)* shown in Fig. 5-95 because the line, when drawn isometrically, is in the vertical plane making the 45° pipe line *(C-D)* correspond directly to the vertical riser.

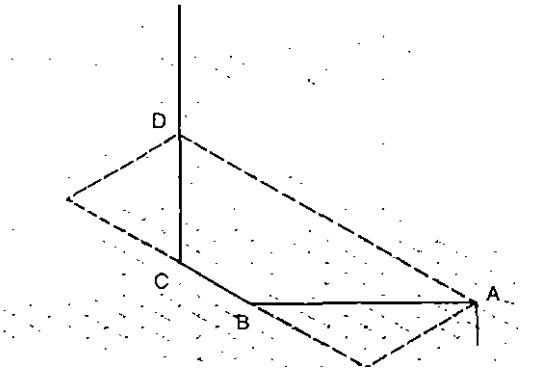


Fig. 5-95

On occasion a journeyman may have to draw an isometric view of a cylinder.

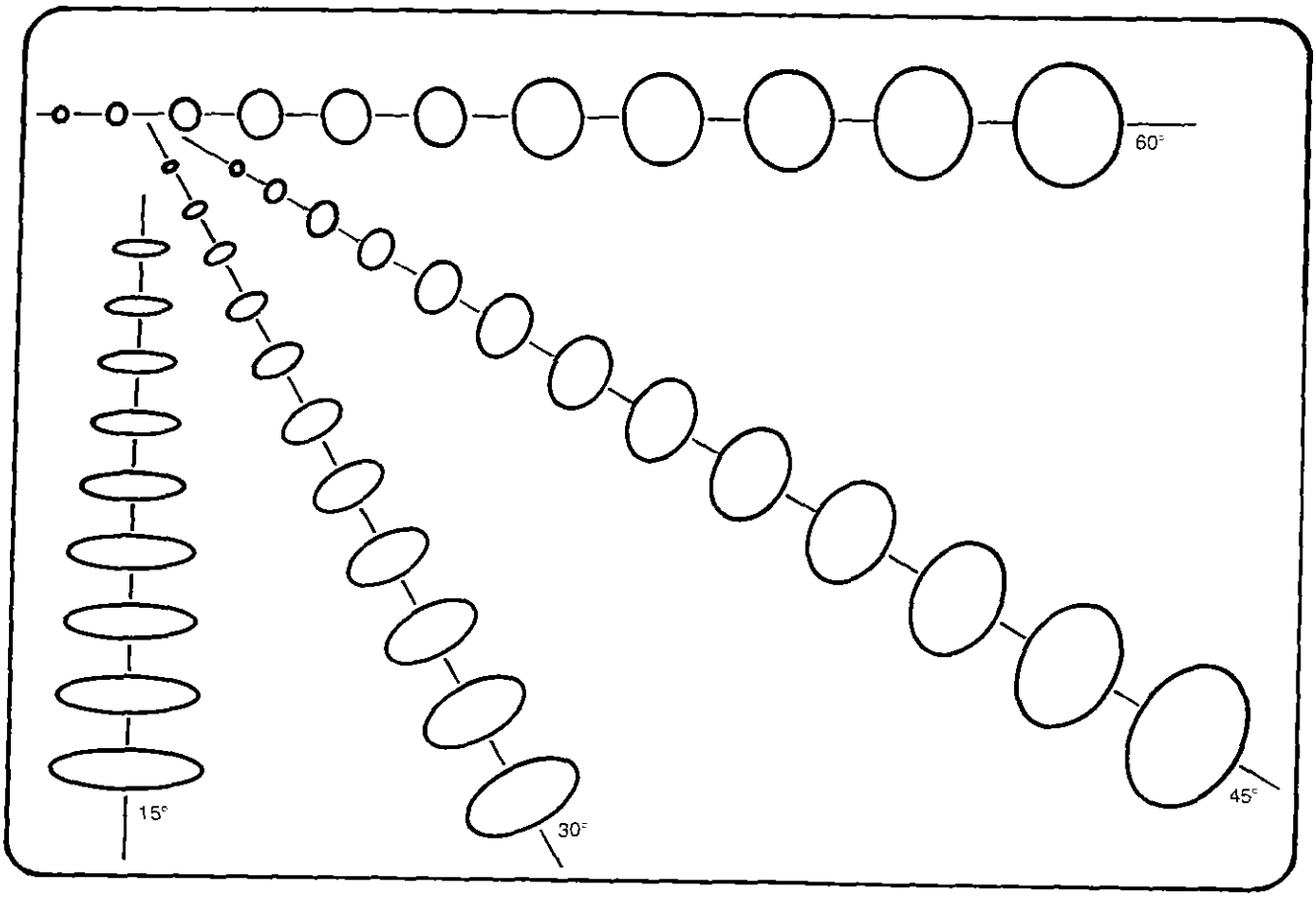
Water heaters, boilers, storage tanks, and expansion tanks are a few of the cylindrical shaped objects which may have to be drawn.

The journeyman must learn how to represent a circle isometrically.

A quick and simple way to draw a circle isometrically is with the use of an ellipse template.

Fig. 5-96 shows an ellipse template with 15°, 30°, 45° and 60" circles. An axis center is provided for positioning the template.

When a cylinder is to be drawn isometrically, using an ellipse template, the observation point must be known.



Using the principle that true isometric lines can be drawn to scale; Draw a 1" x 4" horizontal cylindrical tank on isometric paper following the steps outlined below:

1. With height and uidth center lines: locate the end points of the tank.
2. Determine the diameter of the tank ends on the center lines drawn in step one (4 spaces by 4 spaces).
3. Position the 30" ellipse template so that the height and u-idth axis lines are centered on the template and the tank diameter (4 spaces by **4** spaces) just Nls the template.
4. Draw in the end of the tank which will be totally visible with an object line.
5. Draw in the end of tank which is partially hidden with an object line and hidden line as in steps **3** and 4.
6. With object lines draw in the top and bottom of the **tank.**
7. Compare your sketch with Fig. 5-97.

Draw a 1" x 4" vertical cylindrical tank on isometric paper by following the steps outlined below:

1. With width and length center lines. locate the center of the tank bottom.
2. With width and length center lines, locate the center of the tank top (16 spaces directly above).
3. Determine the width and length of the tank top (diameter) isometrically (4 spaces by **1** spaces).
4. Position the ellipse template at the top end of the tank so that the width and length axes are centered and the tank diameter (4 spaces by **1** spaces) just fill the hole in the template.
5. Draw in the tank top with an object line.
6. Draw in the tank bottom with an object line for the portion which will be visible and a hidden line for the portion which will hidden.
7. With object lines, draw in the sides of the tank.
8. Compare your sketch with Fig. 5-98.

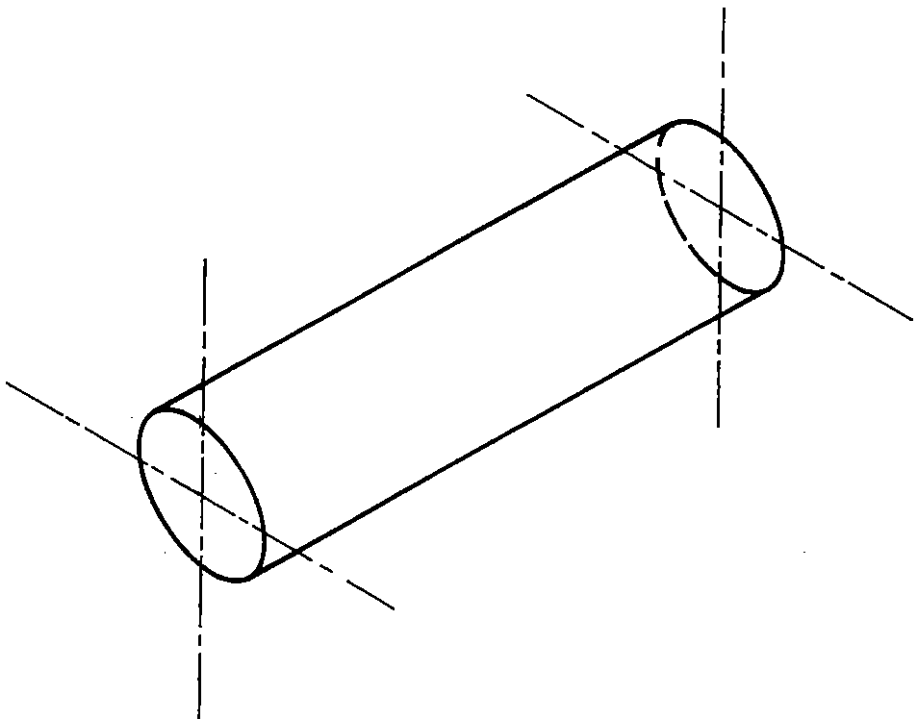


Fig. 5-97

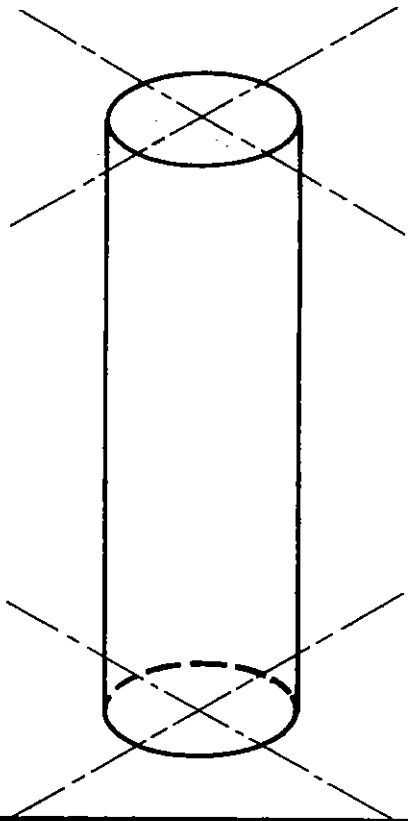


Fig. 5-98

How can the different views of a circle be drawn with an ellipse template?

See Fig. 5-99. Notice how the template is turned to draw the cylinder from a right hand observation point, a left hand observation point, and vertically.

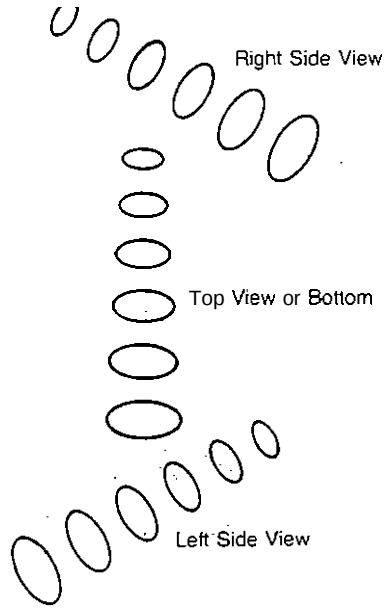


Fig. 5-99

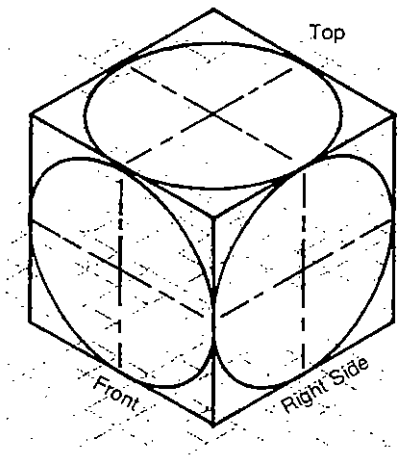


Fig. 5-100

Fig. 5-100 shows isometric circles in a cube as they would appear from the top, right side, and front views. This drawing also gives other information about the isometric circle.

Notice that the center lines shown inside of the circles would also be the center line of a cylinder.

When installing piping systems, quite often piping is connected to **tanks,** cylinders, heat exchangers and many othe round or cylindrical shaped objects. Because of this it is necessary for journeymen to be able to draw these shapes.

There are several methods of drawing isometric circles or cylinders which are included in this chapter. Fig. 5-101 shows a plan and elevation view of two cylindrical **tanks** in the horizontal plane and the connecting piping. Both tanks are cylindrical in shape, but the plan view and east elevation view do not show both of the tanks as being round.

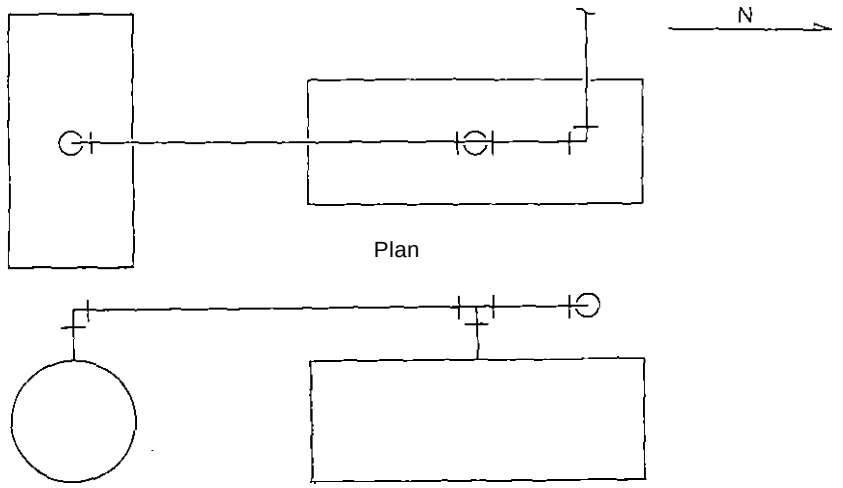


Fig. 5-

Another elevation view would be needed to show this. Fig. 5-102 is a Northeast isometric view of the two cylinders.

How would you draw a true isometric cylinder?

To draw a true isometric cylinder, it will be necessary for you to first learn how to develop isometric circles and from there develop isometric cylinders. Fig. 5-102 is a true isometric of two cylinders in the horizontal position and the connecting piping. Note that the cylinders are contained in isometric "boxes."

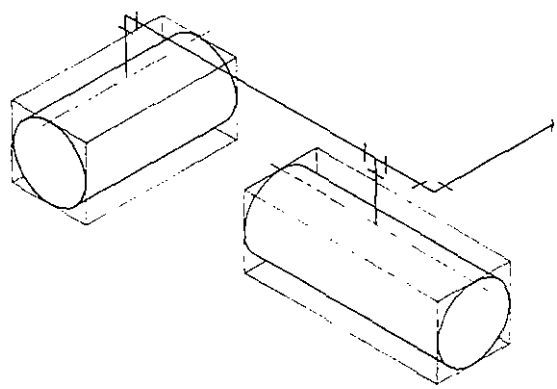


Fig. 5-102

Fig. 5-103 is a true isometric view of two cylinders, one in the horizontal position and one in the vertical position.

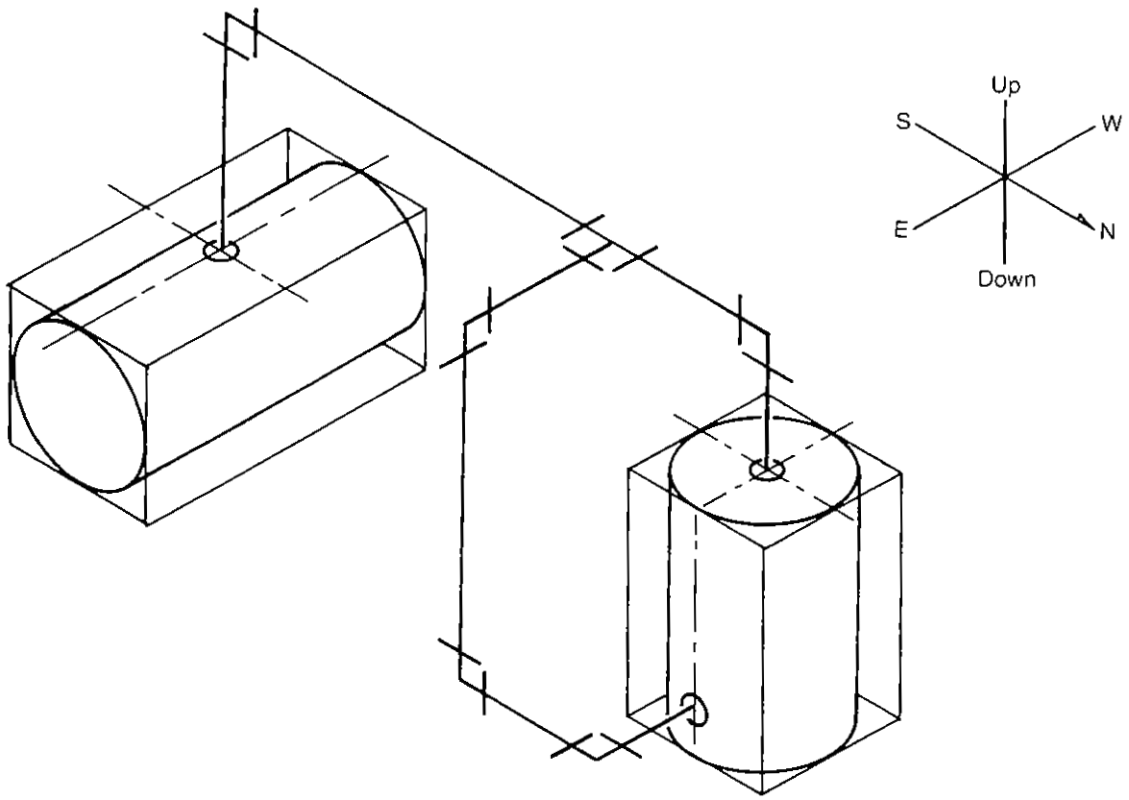


Fig. 5-103

Fig. 5-104 shows a plan view and four isometric views of a cylinder in the horizontal plane.

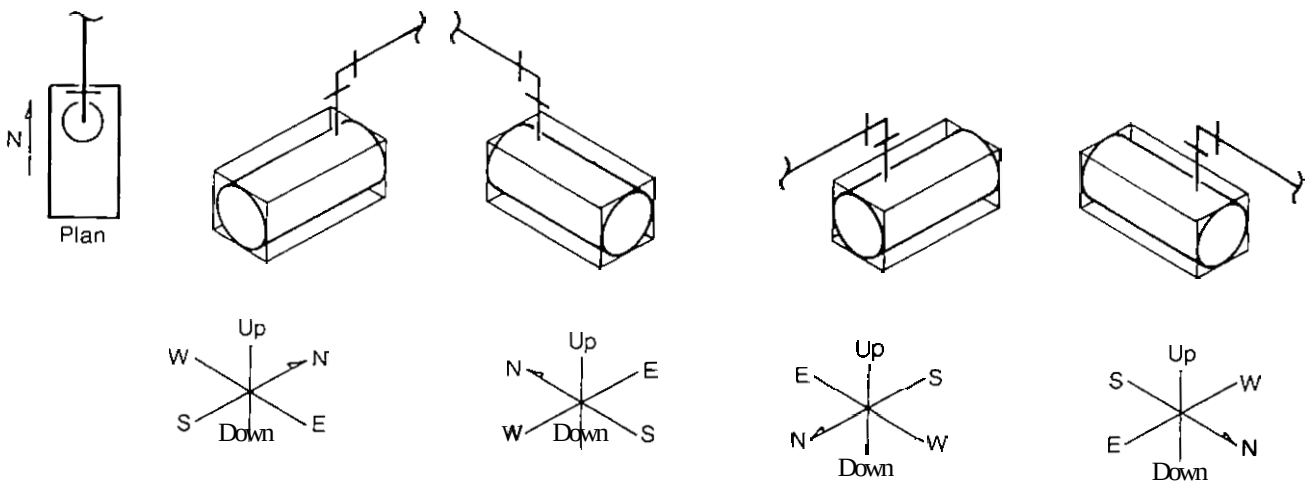


Fig. 5-104

Fig. 5-105 shows a plan and elevation view and four isometric views of a cylinder in the vertical position. Note that the piping ties into the center of the North side of the cylinder. Since the cylinder is drawn with non-isometric lines, it cannot be measured. The measurements are taken off the box.

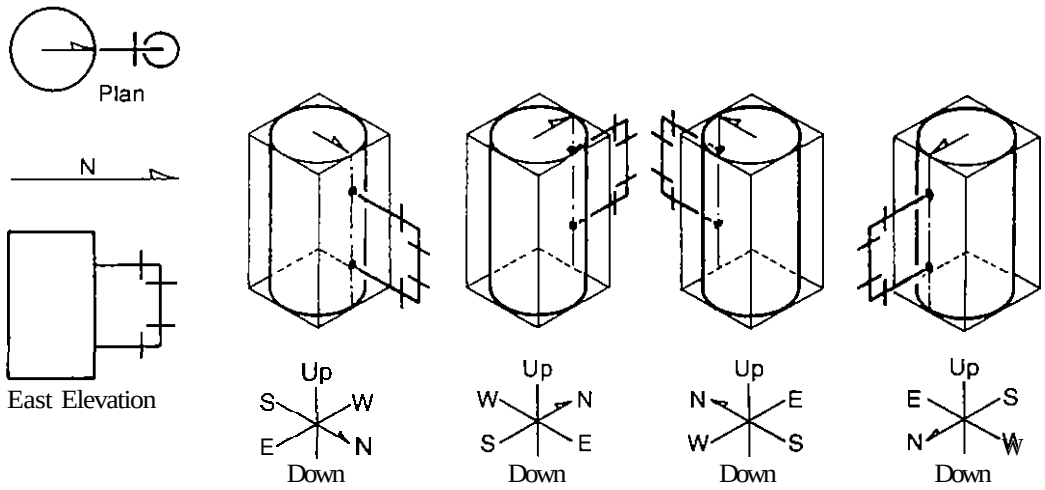


Fig. 5-105

Fig. 5106 shows examples of the right way and wrong way to tie piping into isometric cylinders

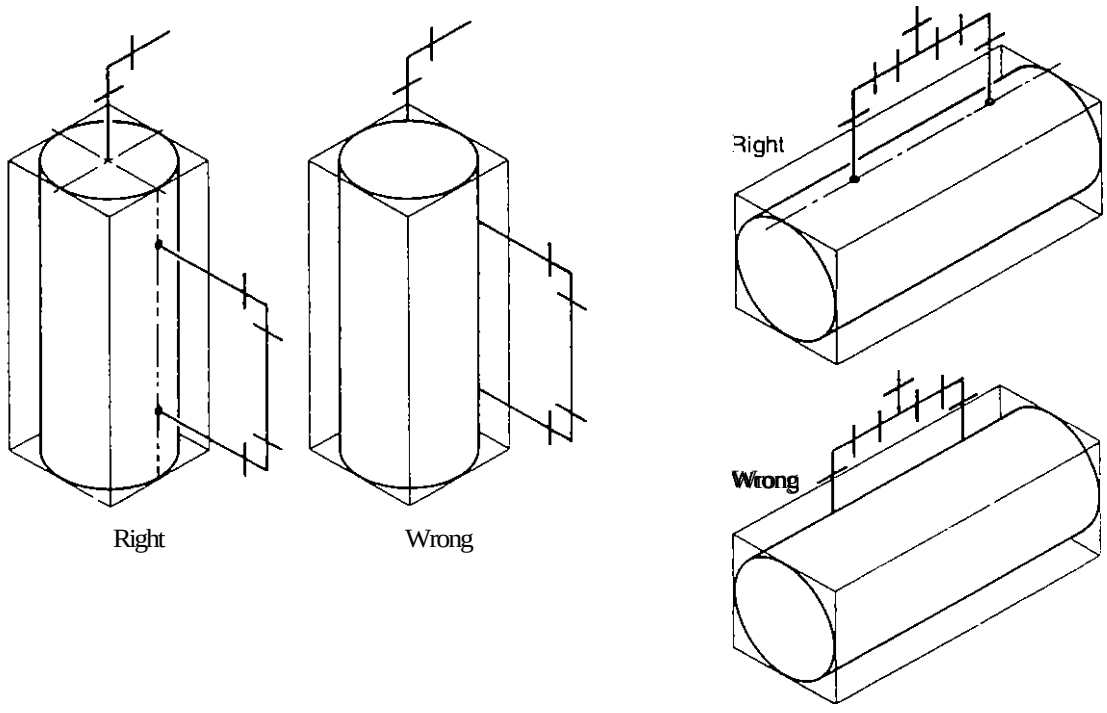
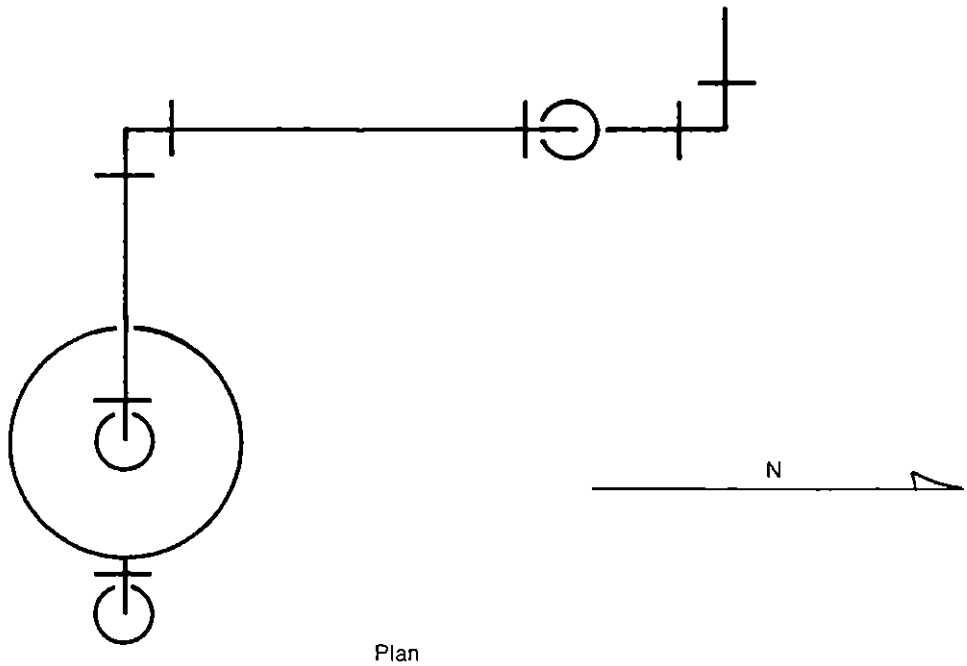


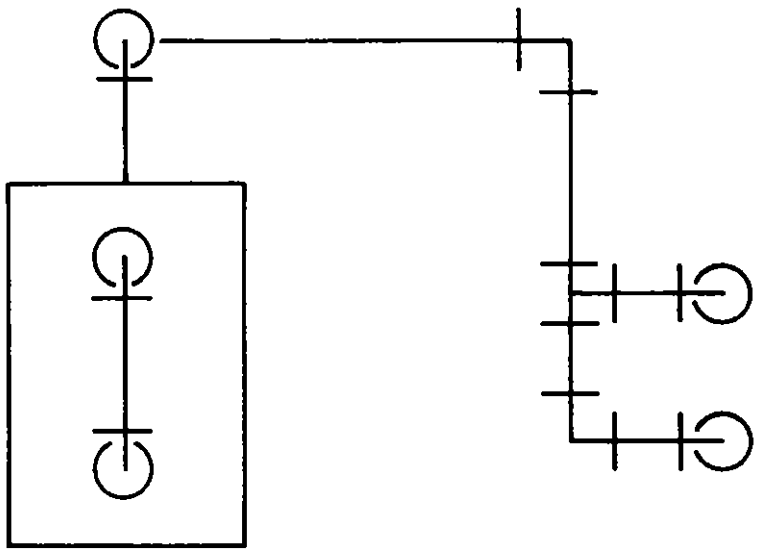
Fig. 5-106

EXERCISE 5-15

Draw a Southeast view of the cylinder and piping shown in the plan and elevation view in Fig. 5-107.



Plan



Elevation

Fig. 5-107

EXERCISE 5-16

Draw a Southeast isometric view of the two tanks and piping shown in Fig. 5-108. Draw the isometric view the same sire as the plan and south elevation view in Fig. 5-108. Add the extension and dimension lines.

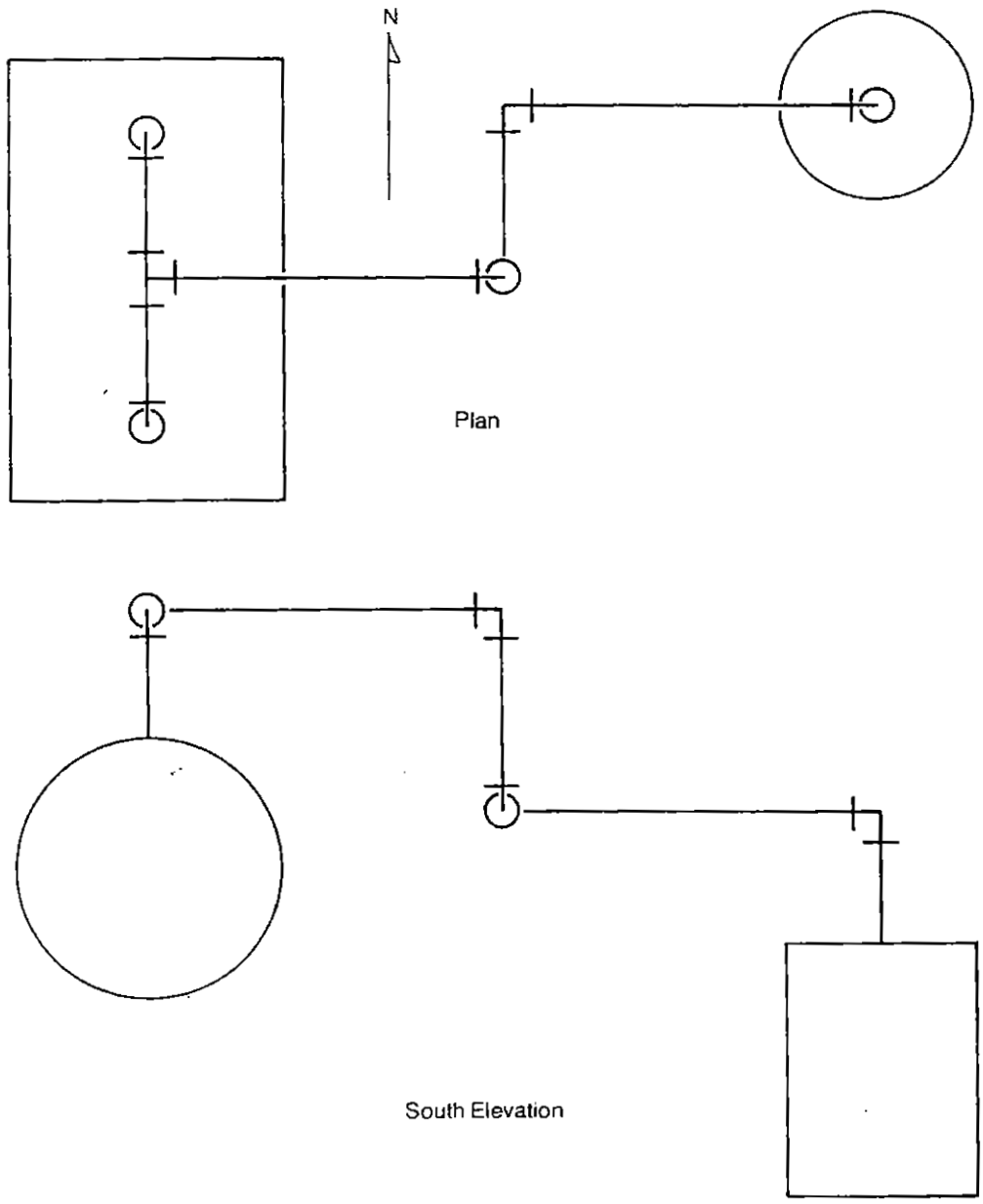


Fig. 5-108

CHAPTER

Interpretation of Building Plans

Accurate interpretation of building plans is essential to you as ajoumeyman. Building plans are tools of the trade, and you must be able to understand and use them properly. This chapter will help you gain a working knowledge of building plans and the specifications which accompany them.

The set of plans included in this section is for a residence which incorporates all elements of a typical construction job. The drawings include architectural plans, mechanical plans, electrical plans, and structural details that appear on the architectural plans.

There is no mysterious trick to reading building plans. Simply, the journeymen must be able to familiarize themselves with the general layout and content of a set of plans if they are to find the information they need to make the installation as required.

This chapter deals chiefly with basic processes and information necessary to the proper use of building plans. Section D, "Applied Drawing and Plan Reading," published by Joint Plumbing Apprentice & Journeymen Training, Inc. goes further into the use of plans in layout and coordination of piping systems. Read and follow all instructions carefully, and make every effort to complete the assignments to the best of your ability. This is a working chapter because the more you work with building plans, the more familiar you will become with their layout and use. Use the plans furnished with this training manual to check all references to the drawings.

A complete set of building plans normally consists of architectural, structural, plumbing, mechanical, and electrical plans. All five types of plans are used when installing a piping system to ensure the system is being installed correctly.

These five types of plans may be combined on one drawing or separated completely, depending upon the amount of information to be shown on each plan.

What is meant by "combined" architectural, structural, mechanical, plumbing and electrical plans?

On smaller jobs, such as houses and small business establishments where there is not much piping or electrical work, the architectural plans may include the piping and electrical diagrams with the structural features of the building, as shown in Fig. 7-1.

On large jobs all of the various types of information could not possibly be crowded onto one set of plans. A floor plan of a large job would be unreadable if the elements of all types of plans were shown on one sheet.

Note: Because the interpretation of building plans is easier to learn from separate plans, the information presented in this chapter will be based primarily on separate drawings for each type.

Give a brief description of the five types of separate plans.

Architectural plans, incorporating Plot plan, Floor plan, Elevation drawings, Section drawings and detailed drawings, are the plans according to which a structure is to be built. Architectural plans indicate the Architects design necessary to give the owner what is desired in the structure. These plans are normally designated by the letter *"A."* Each individual sheet is numbered consecutively as "A-1," "A-2," etc.

The purpose of a set of architectural plans is to give the complete picture of the structure to be built; it's location, the type of construction, and the dimensions of its total and intermediate sections.

Structural plans are the plans by which the supporting structure (skeleton) of a building is constructed. These plans include section drawings and detailed drawings and are normally designated by the letter *"S".*

Mechanical plans show location and size of HVAC piping and equipment in a building. Mechanical plans also incorporate the use of Plot plans, Floor plans, Elevation drawings, detailed drawings, section drawings and piping diagrams. These plans are normally designated by the letter *"M."*

Plumbing plans show location, size of piping, location of equipment, and plumbing fixtures. Plumbing plans incorporate the use of Plot plans, Floor plans, Elevation drawings, detailed drawings, section drawings and piping diagrams. These plans are normally designated by the letter *"P."*

However when a job is relatively small, both Plumbing and Mechanical are usually combined on the same drawing.

Electrical plans show location and type of light fixtures, switches, receptacles, wiring and electrical equipment in a building. Electrical plans also incorporate the use of Plot plans, Floor plans, detailed drawings, riser diagrams and equipment schedules. These plans are normally designated by the letter *"E."*

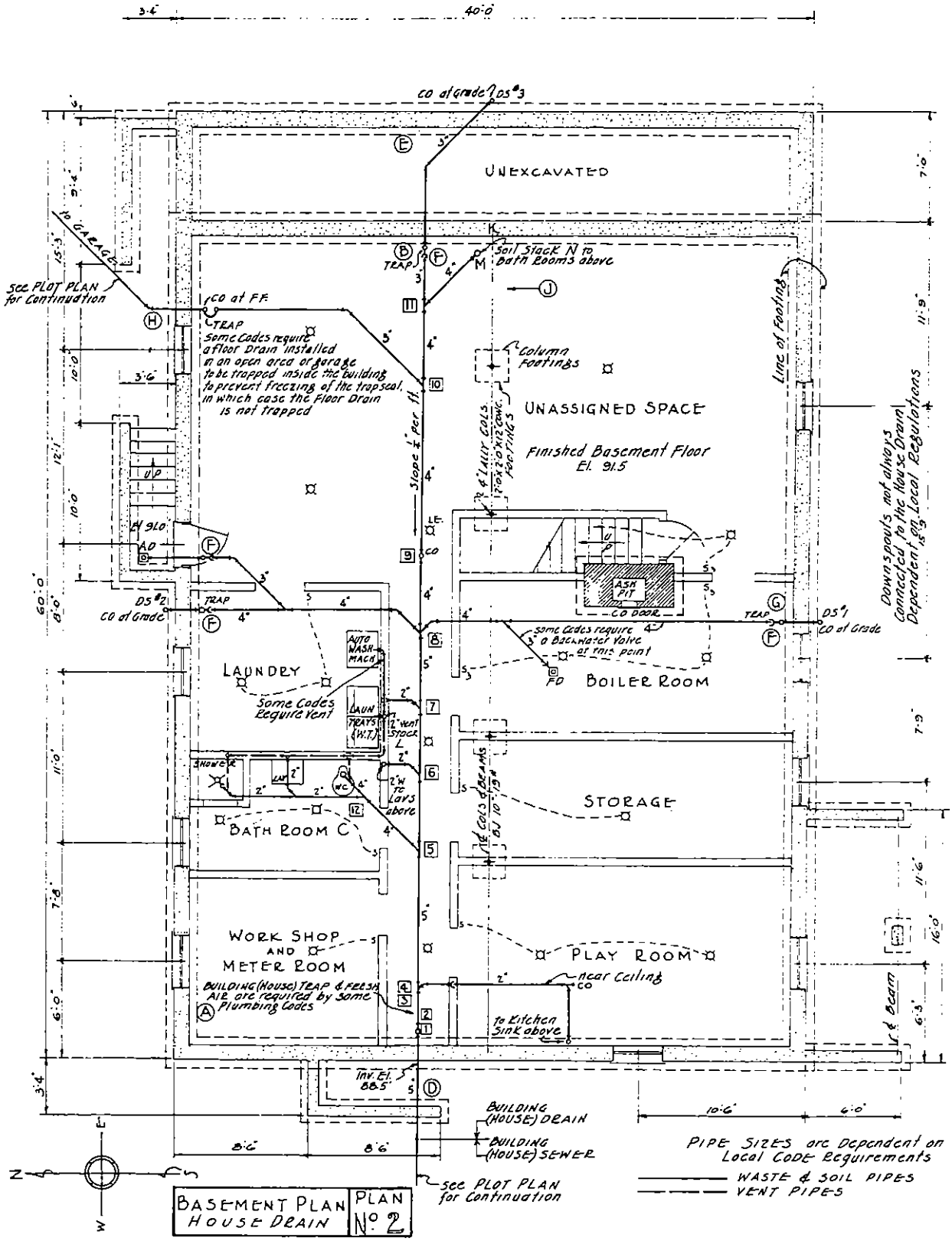

UNEXCAVATED
UNASSIGNED SPACE
Finished Basement Floor
El. 91.5
LAUNDRY
BOILER ROOM
STORAGE
BATH ROOM C
WORK SHOP AND METER ROOM
PLAY ROOM
ASH PIT
CO DOOR
Column Footings
Line of Footings
Slope ¼" per ft.
CO at Grade
DS #3
DS #2
DS #1
Soil Stack N to Bath Room 3 above
CO at FF.
TRAP
Some Codes require a Floor Drain installed in an open area or garage to be trapped inside the building to prevent freezing of the trapseal, in which case the Floor Drain is not trapped
See PLOT PLAN for Continuation
Some Codes Require Vent
12" vent stack
2"W to Lavs above
Some Codes require a Backwater Valve at this point
Downspouts not always connected to the House Drain Dependent upon Local Regulations
Building (House) Drain
Building (House) Sewer
Inv. El. 88.5
Building (House) Trap & Fresh Air are required by some Plumbing Codes
to Kitchen Sink above
near Ceiling
CO
Pipe Sizes are Dependent on Local Code Requirements
WASTE & SOIL PIPES
VENT PIPES
BASEMENT PLAN HOUSE DRAIN
PLAN No 2

Fig. 7-1

What is common to all five type of plans previously mentioned?

All five types of plans previously mentioned, incorporate the use of Plot plans, Floor plans, Elevation drawings, section drawings, detailed drawings, etc.

The location of a structure to be built is shown on what is called the "Plot Plan." See drawing A-1 of the Building Plans to be used with this chapter.

In addition to location of the proposed structure, the plot plan also shows the over-all building dimensions, the finished grade elevations, building entrances, sidewalks, roadways, parking areas, and landscaping features.

When a job is large, plot plans are separated to show Architectural features on the Architectural plot plan. Mechanical features on the Mechanical plot plan, Plumbing features on the Plumbing plot plan, and Electrical features on the Electrical plot plan. Why is drawing A-1 in the Building Plans a combined drawing?

Drawing A-1 is combined because the job is relatively small and all features can be easily read on one plot plan. Although these building plans have the structural plans included with the architectural plans, most sets of building plans have a separate set of structural plans for each floor with section drawings and detailed drawings for clarity

In order to interpret any drawing, you must first know what the different lines and symbols indicate.

Most building drawings have legends or notes either on each sheet or on separate sheets which show how special lines and markings are identified on the entire set of drawings.

The legend on drawing A-1 indicates which trees are to remain and which are to be removed: it also identifies three stumps that are to be removed. In addition, it defines which lines are existing contour lines and which are revised to reflect finish grade. The property line is shown as a broken line.

Besides the legend, other very important lettered information, such as notes are likely to be found on drawings?

Notes are used to assist the plan reader in the proper interpretation and use of a drawing. They usually describe special conditions, refer the reader to other drawings, or give references to the building specifications.

Building specifications are prepared by the architect to dictate by what method the building is to be constructed and what materials are to be used.

Building specifications are usually divided into several sections. Check these features in the specifications furnished with this chapter.

The architectural section of building specifications usually stipulates the types of building materials and the methods of installation.

List four important elements in architectural specifications that a journeyman should check before starting to work on a job and will need to recheck as work progresses.

Four important elements are:

1. Types of wall construction.
2. Types of floor construction
3. Roof construction
4. Ceiling construction. (Some ceilings are removable tile so that all work above ceilings is accessible).

Mechanical specifications identify types of materials to be used and the installation procedures for plumbing, heating, cooling, and electrical work. Consult the specifications which supplement the residential drawings for this chapter and find the items comparable to the types of building materials, wall construction, roof construction, and the types of floor and ceiling construction.

Building specifications dictate the types of piping materials and equipment the journeyman is to install. In some cases the methods of installation for these materials are also specified.

A journeyman must refer to the portions of the specs dealing with pipe sizes, types of piping materials, sleeves, testing and waterproof flashings. Check the specs furnished with this chapter for these items.

A journeyman must check other sections of the specifications to determine the various types of con-

struction which may affect the installation of the piping systems. Typical references in the accompanying specs which would affect the piping systems are:

1. Section 2-18 — Building Code — Code conditions can affect piping.
2. Section 7-2 — paragraph B — Roof insulation governs setting of equipment
3. Section 15-3 — the sky — light domes, according to the second floor plan and roof framing plan on A-4 which show the domes located approximately over all three bathrooms, govern where piping may pass through the roof.

Drawing A 4 is a plan of the second floor, along with the roof framing plan (upper center). Where can a check be made concerning the construction of the flitch-plate beams called for in the roof framing plan?

The specifications, Section 5 — "Carpentry and Millwork" — paragraph 5.8 summarizes both the method and the materials to be used constructing the flitch-plate beams.

The building specifications furnished with this chapter are a typical, complete set of specs. Such specs must be used constantly as a reference while a building is being constructed. Because of the time thorough study would take, in this chapter, the specs cannot be used fully as they would be on an actual construction job. How can they be of further help to you?

Read the building specifications which accompany this chapter and become familiar with their content. Other specifications may give more or less information, but, in general, their content and make-up will be the same. When reading specifications, check all cross-references to other sections to be sure your work will or will not be affected.

The specifications being studied here may also be used as a comparison to specs encountered on the job.

Architectural plans usually include finish schedules which show what materials are to be used to finish a room, or rooms, or an area.

Finish schedules either are included on each individual floor plan, as shown in drawing A-2, or are included in the building plans as a separate sheet covering the entire structure.

How are finish schedules constructed?

Fig. 7-2 shows a finish schedule as it might appear on some floor plans. For example, the symbol F-1 in the finish schedule specifies plaster board (sheet rock) walls, acoustic tile ceiling, and vinyl tile floor. Therefore, any room on the floor plans which carries the label F-1 is to be finished in this manner.

Note: The finish schedule shown in Fig. 7-2 differs from the finish schedules found in the residential drawings for this section in order to illustrate another type of finish schedule that you may encounter in reading building plans.

Finish No.	Floor	Base	Walls	Ceiling
F-1	Vinyl tile	Rubber	Plaster board	Acoustic tile
F-2	Ceramic tile	Rubber	Plaster board	Acoustic tile
F-3	Quarry tile	Ceramic tile	Ceramic tile — 4' up: plaster board above	Plaster board
F-4	Grade-1 Oak	*O-G* molding	Plaster board	Plaster board
F-5	Concrete	—	Concrete block. painted	

Fig. 7-2

When all the finish schedules for an entire building are combined on one sheet, the information is presented on separate finish schedules which are usually organized as shown in Fig. 7-3. Each room is identified by number, and its finish is read from left to right in columns marked 'Floor," "Ceiling: 'Walls," etc. When the word 'Same" appears in a finish schedule, it means the finish is to be that shown in the the preceding column, reading from left to right.

First Floor					
Room No.	Floor	Base	Walls	Ceiling	Notes
121-123 126-129 130-131	Ceramic tile	Same	Ceramic tile 4' up; plaster board above	Plaster board, painted	Ceramic wainscot to have flat return cap.
116-118 124-125	Quarry tile	Same	Plaster board, painted	Plaster board. painted	———
112-113 132-135	Vinyl tile	Rubber	Plaster board, with fabric covering	Plaster board, painted	Wall covering color to be determined on site
All other rooms	Concrete	Rubber	Concrete block. painted	Exposed concrete	Floors to be sealed
Second Floor					
202-205	Vinyl tile	Rubber	Glass block	Acoustic tile	Ceiling access panels to be removable tile
209-212 Corridors 214-225 Corridors	Vinyl tile	Rubber	Plaster board, painted	Plaster board. painted	———
[illegible]	[illegible]	Same	Ceramic tile	Plaster board, painted	Tile walls to be full height
238-242 246	Vinyl tile	———	Glazed brick	Acoustic tile	Glazed brick to be stack bond
All other rooms	Vinyl tile	Ceramic tile	Plaster board, painted	Acoustic tile	Ceiling grid to be set for removable tile

Fig. 7-3

The note in the upper left portion of the plot plan on drawing A-1 indicates that the property slopes to the river which is the east property line. See Fig. 7-4.

Contour lines on a drawing indicate the grade level of the ground surface. They usually show both existing and proposed finish grade.

Refer to the south property line of the plot plan on drawing A-1. What do the figures 190, 180, 170, 160, 150, and 140 represent?

The figures listed above are the existing contour elevations in 10' intervals. The 180 level is 10' lower than 190, 170 is 10' lower than 180, and so on.

What do the dotted lines between contour lines 180 and 190 represent?

Each dotted line is an existing contour line shown in 1' elevation intervals. The dotted line to the left of 190 is 189 and is 1' lower than 190.

Follow the existing 190 contour line from the south property line north to the new roadway. What does the solid line represent as it connects to the dotted line and swings west over the roadway?

The solid line is the proposed new contour (or finished grade) which calls for the roadway to be 190' in elevation approximately 26' west of the existing 190' contour.

Fig. 7-4

Why are seepage pits used in the sewer system rather than drain fields?

The existing contours in the area of the seepage pits, shown on drawing A-1, indicate a steep grade. The finished contours call for an even steeper rate of slope. If drain fields were used, all the waste would flow directly to the ends of the fields and come to the surface rather than percolate into the ground.

***A** section view of a yard drain is shown on the upper right portion of drawing **A-I.** This yard drain is not shown on the plot plan, but the proposed contour lines for the yard in front of the house do indicate a low spot where a yard drain should be installed to drain away storm water. Locate the low spot in the front yard which is the logical place to install a yard drain.*

The section view of the yard drain, on drawing A-1, shows the top elevation of the yard drain to be 172.00'. The proposed contours which could serve this elevation for drainage must be a little higher than 172.00'. Locate the center line of the parking area in front of the house and follow it west to the stone wall. A point which lies immediately west of the stone wall at center line and between two proposed contour lines shown as "172 + 4" is the only point in the yard that could grade to 172.00'.

The area between the two 172 + 4 contour lines is also just east of contour 174.00'. The yard drain must be located as shown in Fig. 7-5.

*Study the section drawing of the roadway inlet shown on drawing **A-1.** How far below finished grade is the invert of the **10" C.P.** (concrete pipe)?*

The plot plan shows a section of the roadway inlet with a top elevation of 169.5'. The invert elevation of the 10" C.P. is given as 167.0'. 169.5' minus 167.0' = 2'-6". The invert of the 10" C.P. is 2'-6" below finished grade.

*What percent of grade should be used in installing the **10"** concrete pipe from the inlet in order for the invert elevation to be **166.0'** at the head wall, as shown on the plot plan?*

The invert elevation of the concrete pipe at the inlet shown on the plot plan A-1 is 167.0', it is 166.0' at the headwall.

167.0' I.E @ Inlet
- 166.0' I.E @ Headwall
1.0' Total fall in **40'** (scale 1" = 32')

$$\text{Grade} = \frac{\text{Total Fall}}{\text{Distance}} \times 100$$

$$G = \frac{T\text{-}F}{D} \times 100$$

$$G = \frac{1}{40} \times 100 = \frac{100}{40} = 2.5\%$$

Grade = 2.5%

The plot plan shows existing and proposed grade elevations and the location and depth of utilities. By checking the plot plan, it is possible for the journeyman properly layout the ditch work for underground piping.

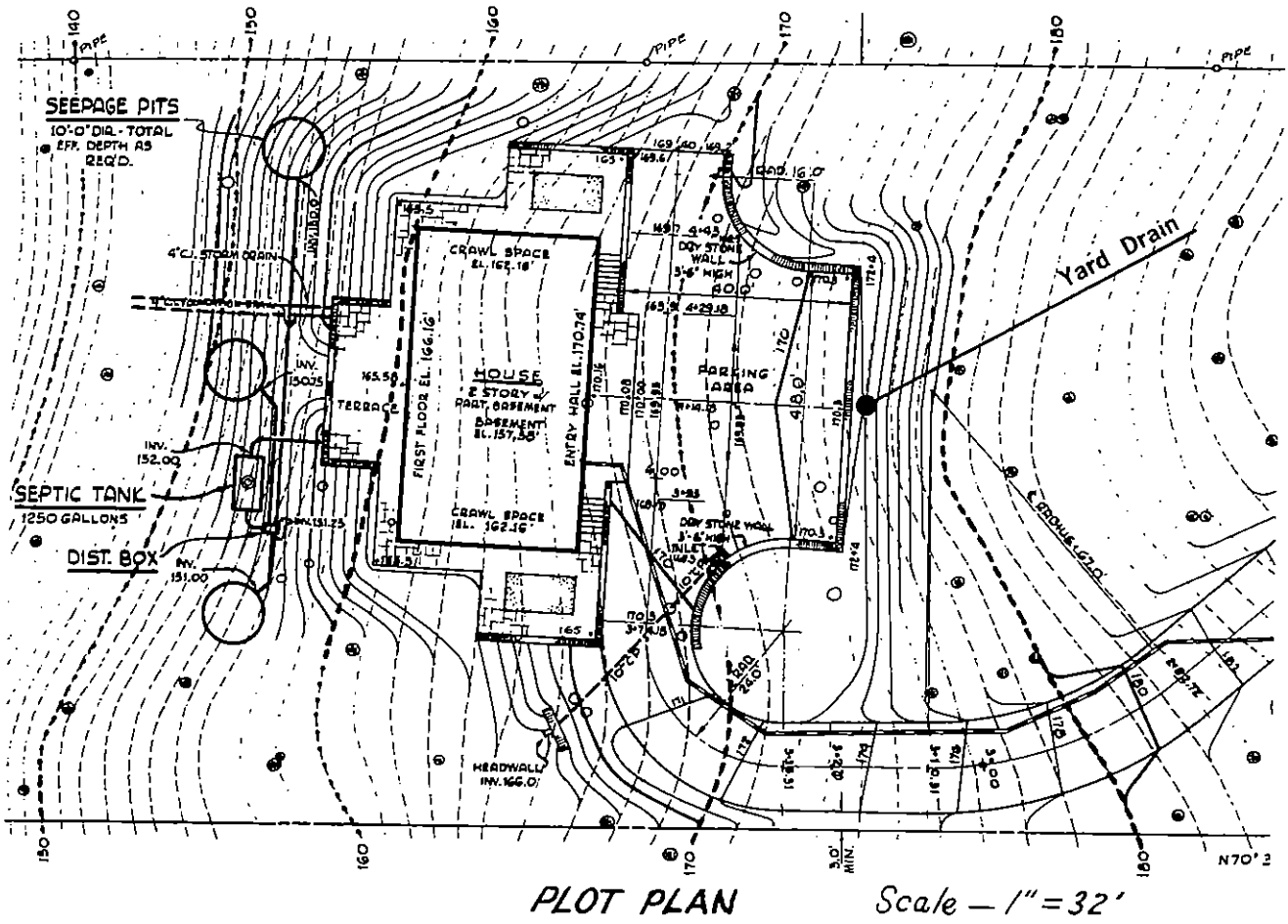


Fig. 7-5

Turn to drawing M-2 of the building plans. Since no elevation is given for the fuel oil lines at the point where they enter and leave the building, one should be established. How can this elevation be determined from other drawings in the set of ***Building*** *Plans?*

The first step in determining the elevation of the fuel oil lines is to find the location and elevation of the underground fuel oil tank. Refer to drawing M-2. The underground fuel oil **tank** is shown **8'-0** west of the courtyard retaining wall to by scale. The North end of the **tank** is in line with the north retaining wall of the courtyard. No elevation is assigned to the **tank** so place top of **tank** 3'0" below finished grade of 170.3'.

170.3' — Finished grade
3.0' — Cover over **tank**
167.3' — Elev. top of **tank**

What will be the elevation of the fuel oil lines now that the top of the tank is at elevation 167.3'?

The fuel oil lines should have a minimum of 12" cover and should pass under the 9" x 12" duct in the ceiling of the mechanical room. The 9" x 12" duct when held tight to the plaster board ceiling would be 11" (including insulation) below the ceiling. Place the fuel oil lines 2¼" to their center line below the 9 x 12" duct at elevation 168.66'.

170.74' Entry hall finished floor 1¼"
− 1.89' flooring, 9½" actual size of
168.85' 2" x 10" joist, 1" double layer of ½" plasterboard, and 11" for duct work.

168.85'
− .19' 2¼" to ℄ below duct
168.66' = Elev. to ℄ fuel oil lines

On squared block paper, make a vertical section drawing of the west wall of the mechanical room showing entry hall elevation, flooring, wood joists, duct work, fuel oil lines, mechanical room finished floor elevation, basement floor elevation and footings. Compare your sketch with Fig. 7-6.

The footings under the house and terrace are not all at the same elevation. Refer to **drawing A-5,** East elevation. The bottom elevation of the footing supporting the house and terrace is el. 154.66. Plan **A-6,** North elevation, shows bottom of footing for house to be el. 161.33.

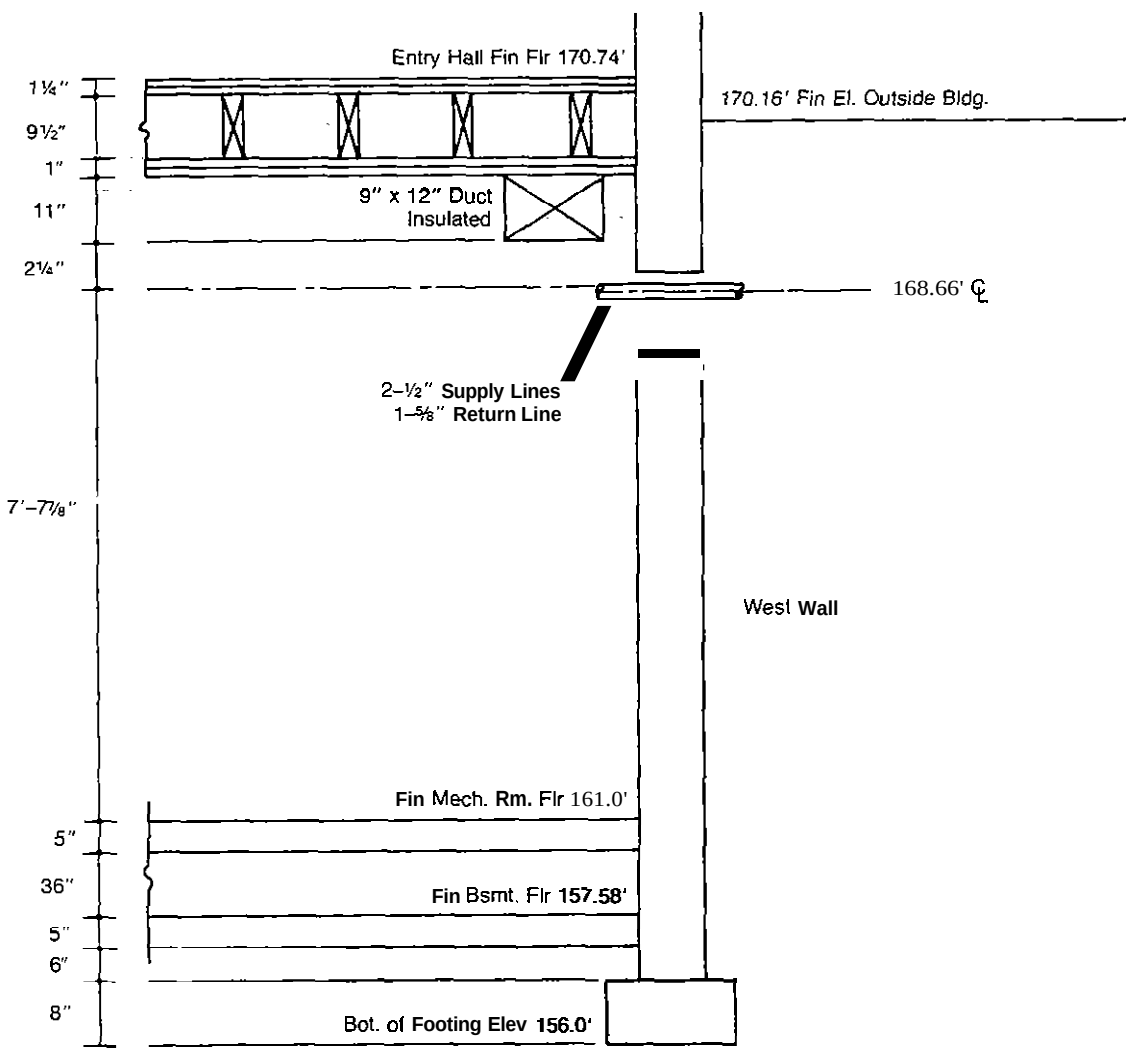


Fig. 7-6

Why must journeymen be concerned with the different elevations of the footings?

Journeymen must be aware of the different elevations of the footings so that underground piping systems can be coordinated with the footings, avoiding any conflict during construction.

Earlier in this chapter reference was made to the different drawings contained in the architectural plans, such as; floor plans, elevation drawings, sectional drawings and detailed drawings. What is the purpose of an architectural floor plan?

Architectural floor plans generally locate walls, doors, windows and stairways, as well as give aview of the floor as a finished product, with specific dimensions. Drawing A-2, the basement and foundation plan, shows the kind of information typically given on an architectural floor plan. Drawing A 3 is the first floor and entry hall floor plan.

The section labeled "A-A" of the drawing near the upper right of drawing A-2 is related to the floor plan. On the upper center portion, on the east wall. of the building floor plan, two arrow heads are shown and marked "A." If a section of this east wall were cut out at the point marked "A-A," it would look like Section 'A-A" which is a cross section of the wall. Sections "B-B," "C-C" and "D-D" are read in a similar manner.

Each wall section drawing shows how that portion of a wall will look in its completed state and gives the detailed dimensions pertaining to it.

The upper portion of drawing A-3 shows some "elevations."

An 'elevation" is a drawing of the finished product as seen from a given point. A 'section" drawing presents the finished product sliced through and viewed from the point where the cut was made.

How are detailed elevations coordinated with the floor plan drawings?

On the floor plan of drawing A-3, in the kitchen an arrow in front of the range is labeled "1."The upper left hand drawing on A-3 shows Elevation #1. Elevation #1 is a view of the kitchen seen from in front of the range. The other elevations are read in a similar manner.

Most architectural dimensions are laid out to the rough wall.

"Rough wall" means wall before finish is applied, such as plaster board, tile, paneling, etc. When dimensioning rooms, the finish must be allowed for Some allowances may be, ¾" for plaster board (sheet rock), 1¼" for tile, ⅝" for paneling. Therefore, a room shown on a floor plan as 10' wide would, after installing plaster board, be 9'-10%"in the finish. (¾" for each wall = 1%").

It was mentioned earlier in this chapter that finish schedules are sometimes shown on an individual drawing. On drawing A-3, check the finish schedule and list the finishes for the entry hall.

The entry hall finishes are:

1. Floor — resilient tile
2. Base — wood
3. Walls — Plaster Board (sheet rock)
4. Ceiling — Plaster Board (sheet rock)

Below the finish schedule, on drawing A-3, is a door schedule. What purpose does a door schedule serve?

A door schedule is primarily a guide for the builder in detennining the proper size and type of door. A journeyman, too, may have to consult the door schedule for the exact size of a particular door in order to obtain unobstructed passage for a pipe line or to lay out a room.

Drawings A-5 and A-6 *are elevation drawings of the outside of the proposed building structure. What purposes are served by elevation drawings of the outside of a proposed structure?*

Elevation drawings show the completed structure in elevation from all sides and specifies the finished elevations of each level of the structure as well as its physical appearance as a finished product.

Drawings A-7, A-8, and A-9 are wall section drawings.

Wall section drawings are vertical or horizontal drawings of a cut-through portion of a wall blown up large enough to show such structural details as type of materials used and their relationships to surrounding beams, columns, and floors, and includes detailed dimensions.

Architectural detail drawings portray particular portions of a building which require special handling in layout. A detail drawing is usually in larger scale than the floor plan and shows the item in elevation as well as plan view. The drawings will also include detailed dimensions of the room or rooms shown.

Why do detailed drawings take precedence over other drawings in a set of building plans?

Detail drawings take precedence over other building drawings because they show specific details of a particular area and the intent of the architect in a clear, incisive manner, with great attention to dimensions and construction. Any conflict between detail drawings and any other drawing in a set of building plans is almost always settled in favor of the detail drawing.

How are masonry items such as brick, concrete block, stone, and the like identified on architectural drawings?

Masonry items are identified by the use of common construction symbols like those illustrated in the appendix section at the end of this manual.

Symbols are used to identify nearly all types of building materials.

The United States of America Standards Institute has produced a set of architectural symbols which are standardized and accepted in most localities. See the appendix section at the back of this manual for samples of standard symbols.

In some cases a symbol that a draftsman has put on a plan may not agree with the Architectural specifications and therefore must be verified. The specifications take precedence.

Structural plans are developed by structural engineers to meet the requirements specified by the architect.

Structural plans show the skeleton of a building, to which rough and finished materials are to be added to produce a finished product.

Why must journeymen be able to interpret and become familiar with structural plans?

Before journeymen can make provisions for piping in a building it is essential that they know:

1. The thickness of the slabs.
2. The size and location of beams.
3. The size and location of columns.
4. The depth, size and location of footings, grade beams and walls.
5. The type of construction (pan, slab, block tile, etc.)

Most structural plans include:

1. Footing and grade beam drawings
2. Floor plans.
3. Column and beam schedules.
4. Section and detail drawings.
5. Elevation drawings.

Why are structural plans, showing the location and size of footings, important to journeymen when they are laying out underground piping systems?

Because footings are below grade and carry the weight of the columns and upper decks which the columns support, they are large and in some cases relatively deep. Any ground work (underground piping) must be installed to miss the footings, and special care must be exercised not to undermine (dig under) the footings in any manner, at any point where they must provide support.

Grade beams are beams located at or below grade to support loads such as heavy equipment, structural members, or the grade slab.

Journeymen must check the location and size of glade b e a k by consulting the structural plans. If the elevation and location of underground piping is such that it must pass through a grade beam, the beam must be sleeved to allow passage of the underground piping.

What information do structural section and detail drawings convey?

Structural section and detail drawings show the construction of decks, walls, beams and columns in relation to exterior portions of the building as well as the relation of these structural members to openings and stair wells. In addition they show detailed portions of decks, walls, beams, and columns with dimensions and the type of materials to be used in their construction.

The depth of beams must be checked against the ceiling heights shown on the architectural plan to determine how much space is available for the installation of concealed pipe work above ceilings.

Plumbing and Mechanical plans showing the pipe and duct work to be installed in a building are prime tools of the journeyman. In order to complete a job successfully the journeyman must be able to read and interpret the plumbing and mechanical plans accurately. What types of drawings are usually found in a set of Plumbing and Mechanical plans?

Most Plumbing and Mechanical plans contain plot plans, floor plans, riser diagrams, elevations, and detail drawings.

The mechanical and plumbing plans are schematic plans showing size and location of piping and duct work; the location and types of plumbing fixtures and appliances and heating ventilation, and air conditioning equipment; and the relationship of equipment, fixtures and appliances connected to the piping.

The plumbing and mechanical specifications for a given structure stipulate the types of pipe and fittings to be used for the various piping systems as well as the equipment and fixtures, etc., to be installed.

The mechanical specs also indicate the type of code to be followed, the workmanship required, and the type of test to be used on each piping system.

The plans picture how a building will look in its rough and finished stages. The specs state how the building is to be constructed.

The building is shoun on plumbing and mechanical plot plans in relationship to surrounding areas. Underground utilities, heating and gas services are shown from their connection with main lines to their entrances in the building. Outside piping, catch basins and manholes are shown and elevations are given for all underground piping systems.

Drawings are usually provided when jobs have a large amount of outside underground work.

Profile drawings are elevation drawings of sectional details of underground utilities. Piping and grade elevations are noted in detail.

Mechanical and plumbing floor plans show (1) the location of piping and equipment in relation to floors, ceilings, walls, and openings (2) the size of pipe and **(3)** the types of fixtures and equipment.

On small jobs mechanical, plumbing and architectural features are usually shown on the same combined drawing as in Fig. 7-1. If a combination of all of these features were included on the drawings of largerjobs, it would make the drawings unreadable.

On a mechanical and plumbing floor plan risers and stacks are shown as circles.

Risers and stacks — up and down piping — are shown in separate riser diagrams. The purpose of riser diagrams is to show the offsets, tie-ins, or unusual complexities of a piping system. (See drawing P-1.)

Riser diagrams are not drawn to scale. They are schematic renditions of a piping system, showing pipe sizes and the general manner of distribution and location. However, they give a reasonably clear view of what the risers and stacks will look like in elevation.

On a plumbing and mechanical floor plan some areas are heavily congested with pipe work.

A congested area is usually shown in amplified form on a detail drawing drawn to a larger scale.

What types of detail drawings can be found on plumbing and mechanical plans?

Detail drawings can be found in floor plan, sectional, elevation, isometric and diagrammatic form depending on the amount and type of information the Engineer needs to convey

Detail drawings usually dimension the size of equipment and the distance between pipe or equipment and a structural or architectural member.

Sometimes pipe trades journeymen must refer to the electrical plan. Explain.

A journeyman would refer to the electrical plan to check the location of underground and above-ground electric feeders (mains), under floor electric duct (poured in the concrete), lighting fixture size and location and size and location of electric panels in order to avoid conflict during construction.

NOTES

CHAPTER

Building Specifications

SECTION LISTING

Specifications constitute a very important part of drawing interpretation and plan reading. They are a set of rules laid down by architects and engineers to govern the types of materials to be used on a building and in some cases the method of installation. The specifications in this chapter were written for the Building Plans which form a part of the, 'Drawing Interpretation and Plan Reading course for Apprentice and Journeyman Training." Not all of the information in the specifications is pertinent to the installation of the plumbing and mechanical piping systems, just as all of the information on drawings is not pertinent to these systems. However, both the specifications and plans are presented in their entirety in order to give you the realistic job of sorting out the information that is needed to install the plumbing and mechanical piping systems as intended by the architect and engineer.

SECTION 1
General Conditions

1-1. The general conditions of the contract for the construction of buildings, A.I.A. Document No. A-201, latest Edition, as prepared by the American Institute of Architects, shall be considered an integral part of these specifications and the basis for all contracts executed in connection with the work. Failure on the part of the Contractor or Subcontractors to read and fully comprehend the full intent of the same shall in no way waive any right or responsibility on the part of either or both in the execution of the several items of work hereinafter specified in detail.

1-2. See Section 2 for Supplementary General Conditions and for modifications to certain articles of the above-referenced General Conditions.

SECTION 2
Supplementary General Conditions

2-1. Insurance —

A. *Contractor's liability insurance* — Article 27 of General Conditions shall be modified as follows: The amount of Contractor's Liability Insurance shall be $500,000.00 for one person and $1,000,000.00 for one occurrence.

B. Owner's *liability insurance* — Article 28 of the General Conditions shall be modified as follows: The Contractor shall pay for and maintain Owner's contingent Liability insurance as described in Article 28. The amount of Owner's contingent liability insurance shall be $500,000.00 for one person and $1,000,000.00 for one occurrence.

C. *Fire insurance with extended coverage* — Article 29 of General Conditions shall be modified as follows: The Contractor shall pay for and maintain fire insurance in the amount of 100 percent of the insurable value of the entire structure, as described in Article 29, and, in addition, the Contractor shall maintain insurance to protect the owner from damage by hail, tornado, and hurricane upon the entire work to 100 percent of the insurable value thereof. Such insurance shall be written on the "Builder's Risk Completed Value Form."

D. The Contractor shall not commence work under this contract until all insurance required has been obtained and such insurance has been approved by the Owner, nor shall the Contractor allow any subcontractor to commence work on his or her subcontract until all similar insurance required by the subcontractor has been so obtained and approved. The cost of the premiums for all insurance shall be included in the contract sum. The Contractor shall forward insurance certificates to the Owner through the Architect for the Owner's approval covering all of the insurance herein before specified.

2-2. Drawings — The following drawings form a part of the Contract Documents:

Drawing No.	*Title*
A-1	Site Plan and Utility Plot Plan
A-2	Basement and Foundation Plan
A-3	Entry Hall and First Floor Plan
A-4	Second Floor Plan
A-5	Exterior Elevations
A-6	Exterior Wall Sections
A-7	Exterior Wall Sections, and Details
A-8	Interior Details — fireplace, stair, and bookcase details
A-9	Interior Details — cabinet and closet details
P-1	Basement Floor Plan — Plumbing
P-2	First and Second Floor Plan — Plumbing
M-1	Basement Floor Plan — Mechanical
M-2	First Floor Plan — Mechanical
M-3	Second Floor Plan — Mechanical
E-1	Basement Floor Plan — Electrical
E-2	First Floor Plan — Electrical
E-3	Second Floor Plan — Electrical

2-3. Subcontractors — All subcontractors must be approved by the Architect before the contract is signed.

2-4. Time of completion — The Contractor must state in his proposal the number of working days, from the date of signing the contract, in which he will guarantee to complete the work.

2-5. Cash allowances — Contractor shall include the following cash allowances in his or her bid. See Article 41 of General Conditions. All installation of hardware and lighting fixtures is included in construction contract.

A. Finish hardware (including all cabinets and closet hardware) $400.00

B. Lighting fixtures $500.00

2-6. Examination of premises — The Contractor shall carefully examine the premises before submitting his or her bid. No allowance will be made for lack of full knowledge of all conditions, except such underground conditions as are indeterminable before the commencement of the work.

2-7. Permits — The Contractor shall obtain and pay for all permits and inspectors' fees required, without extra cost to the Owner.

2-8. Temporary utilities — The Contractor shall make arrangements for and fumish, at his or her own expense, all water, lighting, and electric service necessary for construction purposes.

2-9. Toilet facilities — The General Contractor shall provide a temporary toilet facility with proper enclosure, meeting all local Sanitary Code requirements. This shall be removed on completion of the work and the premises left in perfect condition.

2-10. Cutting — All cutting, patching, and repairing of work shall be done without extra charge by the Contractor or subcontractor whose work is to be cut.

2-11. Protection of materials — All materials in or designed for the work shall be at all times suitably housed or protected, particular care being taken of all finished parts.

2-12. Cleaning up — Article 44 of General Conditions shall be supplemented as follows: In addition to removal of rubbish and leaving the building broom clean, the Contractor shall clean all glass; replace any broken glass; remove stains, spots, marks, and dirt from all decorated work; clean all hardware; remove paint spots and smears from all surfaces; clean all fixtures and floors, making alterations as necessary to leave the building ready for occupancy.

2-13. Release of liens — Article 32 of the General Conditionsshall be supplemented as follows: The Contractor shall fumish the Owner, before a final payment is made, a full release of liens, signed by all subcontractors and suppliers of material associated in any way with the work.

2-14. Distribution of work — It is the intent of these specifications to describe the material and work under the proper trade; but when material or work is described under one trade, which for any reason should be described under some other trade, the General Contractor shall make the required change so that no controversy shall arise among the trades or the progress of the work be delayed.

2-15. Alternate prices — The Contractor shall furnish to the Architect the following alternate prices:

A. Bituminous pavement in lieu of crushed stone for driveway and parking area. See Section 16.

B. Old Virginia Colonial white brick, standard size, as distributed by United Clay Products in lieu of face brick specified in Section 6.

C. Hollow core wood doors, 1⅜" thick, in lieu of solid wood core doors, 1¾" thick. See Section 5.

D. For omission of ½" plywood floor underlayment in First Floor, Entry Hall, and through Second Floor.

2-16. Substitutions —

A. Where materials, methods, or equipment are specified or noted on the drawings by trade names, manufacturers' name, or catalog numbers, the Contractor's proposal shall be based on the specific brands and quality specified or noted, without any substitutions.

B. If the Contractor desires to make substitutions for materials, methods, or equipment other than those specified, he or she shall submit a request in writing to the Architect. Such request shall give the name of the manufacturer of the material or equipment or describe in detail the method proposed, and shall state the cost of the proposed substitute together with the cost of the specified item. No change or substitution shall be made without written approval of the Architect and the Owner.

2-17. Separate contracts —

A. The Owner will award separate contracts for kitchen and laundry equipment, which will proceed simultaneously with this contract. The Owner will supply the Contractor with roughing-in drawings for kitchen and laundry equipment. The Gen-

eral Contractor shall provide all electrical and plumbing connections required for proper connections and furnish wood grounds where shown on roughing-in drawings.

B. Seeding, sodding, and landscape work will not be part of this contract.

2-18. Building code — All work performed under this contract shall conform to — County/City Building Regulations. See also Section 1.1 of the General Conditions.

SECTION 3
Excavating and Grading

3-1. General —All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

3-2. Stakes and batter-boards — Layout the building accurately and set such stakes, batter-boards, etc., as may be necessary. Layout to be approved by Architect.

3-3. Clearing — All trees are to be preserved as far as possible. Only trees which interfere with construction are to be removed. No trees or dead branches are to be burned on the site. No earth or material of any kind is to be deposited around trees which are to remain except as shown on site plan.

3-4. Protection of trees and shrubbery — Protect, all existing trees that are likely,to be damaged during the progress of the work.

3-5. Stripping and storage of topsoil — Strip topsoil from all areas affected by the excavation, grading, and paving work and store where directed by Architect for reuse. Do not disturb topsoil around trees which are to remain except as shown on site plan.

3-6. General excavation — Excavate for footings, foundation walls, areas, and such other work as may be necessary, to the depths shown on drawings. All trenches for footings must have solid, level, and undisturbed bottoms. The excavations shall be kept as free as possible from surface draining. Excavation for plumbing work is specified in Section P1.

3-7. Gravel bedding — Place where indicated crushed stone or gravel beds, sized from %inch to 1% inches.

3-8. Grading — Earth removed from excavations shal be used for backfill and for fill around the building in areas shown on the drawing and shall then be covered over with 4" of topsoil. Fill over steep slopes shall be installed over stepped grading cuts to prevent slippage. Spread fill in 8" layers and compact each layer to maximum density. All earth not used for fill or backfill is to be carted away by this Contractor unless otherwise directed. Topsoiling shall be done with topsoil stored on the site. Bring topsoil to grades shown on the drawings.

SECTION 4
Concrete

4-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

4-2. Work included — Under this section is included all poured concrete work. See other sections for precast concrete work and setting beds for tile and store.

4-3. Materials for poured concrete — All gravel stone used in plain concrete shall be good hard stone, of sizes for ½ inch to 1½ inches, free from dust and dirt. Sand shall be type I portland cement. Water shall be potable.

4-4. Protection from weather — All concrete work shall be discontinued during freezing weather All work recently built must be properly protected from the elements. All work injured by the weather must be taken down and rebuilt.

4-5. Proportioning of poured concrete — All poured concrete shall be mixed in the volume proportions of 1 part portland cement, 2 parts sand, and 3 parts gravel.

4-6. Strength of concrete — All concrete shall be controlled concrete with a minimum ultimate compressive strength of 2,500 lbs. per square inch at the end of 28 days.

4-7. Reinforcing — All basement Mechanical Room and sidewalk slabs shall be reinforced with 6 by 6 — 10/10 wire mesh. Terrace slab over storeroom shall have No. 5 bars top and bottom, spaced as shown on drawings. Retaining wall bars to be of size and spacing shown on drawings.

4-8. Placing reinforcement — Special care must be taken that reinforcing members be placed exactly in the positions indicated on the drawings.

4-9. Concrete finishes — Concrete to receive settiig beds shall receive a roughened float finish. Exposed concrete floor slabs shall be steel troweled. Cured floor slabs shall be treated with 'Lapidolith" liquid floor hardener in accordance with manufacturer's directions.

4-10. Vapor barrier — Under basement and mechanical room concrete slabs place one layer of 2 mil thick polyethylene film (Visqueen or equal). All laps shall be six inches.

SECTION 4A
Architectural Concrete

4A-1. General —

A. Extent — The work required under this section includes all architectural concrete and related items necessary to complete the work shown on drawings and specified. The work in general shall include, but is not limited to, the following:

1. Precast architectural concrete including sills, window surrounds, cornice, and chimney cap as shown on the drawings.
2. Dovetail anchors, dowels, clip angles, and bolts to install the precast units.
3. Erection of items above.
4. Sealing of joints in precast architectural concrete.
5. Mortar joints where required.
6. Cleaning of precast architectural concrete
7. All labor, materials, equipment, and expense of every kind required for erection and completion in place, complete in every detail.

B. Related work in *other* sections —

1. Flashing, Section 7.
2. Termite shield, Section 7
3. Aluminum doors and windows, Sections 8 & 9.
4. Wood trim, Section 5

C. Refer to the General Conditions and the Supplementary General Conditions sections. They are applicable to this section and shall form a part of each subcontract.

D. Manufacturer — Precast poured and applied architectural concrete shall be manufactured and installed by Earley Studio, Inc., Manassas, Virginia, or Arban and Carosi Inc., Alexandria, Virginia.

E. Samples — Manufacturer shall submit 12" X 12" samples of all types of architectural concrete to obtain Architect's approval before any work is begun. Work must match approved samples in every respect. Forms are to be approved by the Architect at the factory before fabrication of precast sections. Guide sample will be furnished by the Architect.

F. Shop drawings — Shop drawings showing details of forms, construction, reinforcement, inserts in other work, elevations showing jointing, dimensions, and arrangement of sections and methods of installation and anchoring shall be submitted to the Architect for approval.

4A-2. Materials —

A. Coarse *aggregates for* facing *mix* — Hard, durable quartz, quartzite, or granite aggregates carefully selected and graded as selected by Architect.

B. Fine *aggregates* for facing *mix* — Manufactured sands made from the same material as the course aggregates. In no case shall ordinary building or concrete sands be permitted in the facing mixes.

C. Concrete *for* backing ***mix*** — Mixed in approximately the same proportion as the facing concrete except that it shall be made of gray portland cement and river sand and gravel or other approved siliceous aggregate. Coarse aggregate shall be ¼" to ½" size and may be crushed or have rounded surfaces.

D. Wire mesh reinforcement — Precast sections shall be reinforced with cold-dram #4 steel galvanized wire. Wires shall be spaced and welded together 4 inches on center in both directions except in locations where closer spacings of wires are necessary. Heavy reinforcing rods and/or tie wires for connecting reinforcement will not be permitted. The reinforcing assembly in each section shall be prefabricated and welded into a single complete rigid unit of the proper size and shape. Approved means for holding the reinforcement firmly and accurately in the molds or forms shall be provided, The steel reinforcement shall be kept ¾ inch away from the edges and exterior surfaces of panels.

E. Anchors — Furnish as required. Anchorage as shown on the drawings is intended to indicate minimum requirements. If supplemental anchorage is required, it shall be furnished. Final anchorage details are subject to the Architect's approval. Dowels shall be ¾" galv. steel dovetail anchors and slots shall be Eradyo zinc. Tie wires shall be stainless steel. Paint ferrous members with two coats red lead and oil.

F. Mortar for setting beds and grouting shall match mortar for face brick.

G. Cement — Portland type 1, gray or white, to exactly match approved samples.

H. Sealant — Compound shall be 'Monolastomeric," color to blend with panels, as manufactured by the Tremco Manufacturing Co., or Rubber Caulk as manufactured by Products Research Corporation. Manufacturer shall furnish evidence of installations in cast stone free of staining. Further, manufacturer will be required to give written guarantee that, when installed in accordance with recommendations, staining will not occur. Submit samples for color.

I. Cornice joint gaskets — Expanded closed-cell neoprene or rubber templated to fit cross-section of cornice. Gaskets shall have an overall thickness of ¼" conforming to mortar joints. Set with manufacturer's pressure sensitive adhesive. Hold gasket ⅜" back from face of joint for caulking.

4A-3. Concrete —

A Precast *items* — Concrete shall have a compressive strength of 7,500 lbs. per sq. inch at 28 days. Absorption of all precast concrete shall not exceed 6%.

4A-4. Precast manufacture —

A. Dimensions — Sizes and shapes will be as shown on drawings. The finished sections shall be straight; true to size and shape: with exposed edges and comers sharp, straight, and square; and with all flat surfaces in a true plane. Warped, cracked, broken, spalled, stained, or otherwise defective panels shall not be used.

B. *Finish* — Aggregates in exposed surfaces of section shall be exposed as soon after casting as practicable by powder sanders, wire brushes, or other approved means. At suitable intervals, the faces of panels shall be given one or more washings with a weak solution of muriatic acid to clean thoroughly the exposed aggregate. After each washing with the acid solution, the panels shall be washed with fresh clean water to remove all traces of the acid.

C. Proportions — Concrete shall be mixed in the appropriate proportions of 94 pounds of cement, 110 pounds of fine aggregate, and 300 pounds of coarse aggregate. The amount of water used in the mixture shall be the minimum necessary for good manufacture.

D. Curing — Precast concrete shall be kept continuously above 70 degrees F and damp for not less than 6 days before removing forms. Following the cure, panels shall be further allowed to dry for a minimum of 4 days before transporting to the job site.

4A-5. **Handling and** storing —

A. In accordance with manufacturer's directions and under their supervision with regard to transit, unloading, storing, protecting, and placing.

B. Do not remove shipping braces until panel is to be placed. Handle and store in a vertical position. Store on a level surface, free of the ground.

C. Place celotex wrapped in plastic under panels, wood blocks of even thickness wrapped in plastic as spacers between panels, and cover panels with canvas or plastic sheeting to protect from dirt and dust.

4A-6. Setting precast work —

A. Setting — All surfaces to receive precast sections and all panel edges shall be cleaned of all dust, **dirt,** and other foreign substances immediately before setting. Each panel shall be set level and true to line with uniform joints of dimensions shown on drawings. All necessary precautions shall be taken to protect precast panels from being damaged after they have been installed. Wedges, spacers, or other appliances which are likely to cause staining, used in setting panels, shall be removed from the joints as soon as practicable. All anchorage shall be securely fastened.

B. *Joints* —

1. At all vertical cornice joints, insert neoprene or rubber joint gasket with a blunt tool. Insert to a depth of ⅜ inch, and face caulk with sealant.

2. Prime joints mith primer, recommended by sealant manufacturer Protect panel faces from primer. Primer shall be guaranteed not to stain precast work.

3. Seal horizontal reglet joint and vertical cornice joints to a depth of ⅜ inch with sealant. Protect precast work from sealant. Finish joints in a neat workmanlike manner.

4. Precast sections where required shall be set in mortar beds and joints. Mortar will be one part non-staining portland cement and 2½ parts sand.

C. Cleaning and protection — After erection, clean all sections with a weak solution of muriatic acid and water using a brush to remove any foreign matter and stains. All traces of acid must be imme-

diately removed by the free use of clear fresh water and brush. Protect until completion of contract. Brick-work is to be protected against acid during cleaning.

SECTION 5
Carpentry *and Millwork*

5-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

5-2. Related work — See Section 7 for roof insulation.

5-3. Storage and protection — Stack lumber and plywood to insure proper ventilation and drainage and protection from the elements. Protect millwork against dampness during and after delivery. Store under cover in a well-ventilated shelter and where not exposed to extreme changes of temperature or humidity. Do not store or install millwork in any part of building until concrete and masonry work is dry.

5-4. Rough hardware — Provide and install all rough hardware, metal fastenings, and anchors as shown on drawings, specified herein or required for proper installation of carpentry millwork. Nails, anchors, spikes, screws, bolts, clips, and similar items shall be of sizes and types to rigidly secure members in place. All nails shall be galvanized steel.

5-5. Grading requirements —

A. Moisture *content* — Except as otherwise specified, the moisture content shall not exceed 19 percent for framing lumber and 12 percent for millwork.

B. *Grade* and *trademark* — Required on each piece of lumber (or bundle in bundled stock); use only the recognized official marks of Association under whose rules it is graded. Grade and trademarks will not be required if each shipment is accompanied by certificate of inspection issued by Association.

C. Quality — Lumber must be sound, thoroughly seasoned, well manufactured and free from warp. Woodwork exposed to view shall be dressed smooth and free from defects of growth or manufacture that will show through the finish. Architect reserves the right to reject any piece for excessive checking.

5-6. Materials: lumber and woodwork —

5-6.A. The grade and species of lumber and millwork shall be as follows, except that grades and species hereinafter specified for specific items shall govern.

1. *For joists, flitch-plate* beams, stair stringers, studs, ***plates,*** bucks and headers — construction grade or better Douglas fir.
2. For bridging *and* furring — standard grade Douglas fir, ponderosa pine, Engelman spruce, or white fir or No. 1 common Virginia pine.
3. For wood *subflooring* — ¾" ponderosa pine, Douglas fir, Engelman spruce, western white pine, white fir.
4. For exterior plywood fascias — Douglas Fir Plywood Association (DFPA) High Density Overlaid Exterior Plywood.
5. For stair *treads* and risers — No. 1 construction yellow pine.
6. For wood bases and trim — C select and better white pine. Wood base: Morgan Millwork Co. No. M-7352. Wood trim: ¾" x 1¾" Morgan's hanging stile No. M-8430½. Shoe mould: Morgan's No. M-8064.
7. For *subflooring* — DFPA ¾" Plybase with ½" Plypanel underlayment. See Section 2 for Alternate Price (E) for omission of plywood underlayment.
8. For roof sheathing — DFPA ⅝" Plyscord roof sheathing.
9. For shelving 12" wide and less — C select or better grade white pine. All other shelving: A-B white pine plywood with hardwood nosing.
10. Cabinetwork ***generally*** — Plywood generally shall be A-B white pine or red gum. All exposed edges of plywood shall be bound with solid material of same species of wood. All plywood shall be sound on all exposed faces. Shelves less than 12" shall be solid white pine or white spruce, clear and free from knots. Drawers to have pine or spruce fronts and sides with ¼" fir plywood bottoms. All drawers shall have Grant No. 335 metal drawer glides.
11. For screen doors — sugar pine.
12. Plastic tops, edges, and *splashbacks*, where noted on drawings shall be constructed as follows — Counter tops shall have 1/16"-thick plastic on upper surface. This covering shall be equal to Formica, of color and finish selected by Architect. Counter top core shall be made of 3 ply particle board, 1½" thick. All tops shall be self-edged.

5-7. Wood grounds, blocking, and shims — Provide wood grounds and blocking of size and shape required for securing other work or equipment in place. Set grounds true to line, level, or plumb and well secured. Wood grounds shall also be provided for securing equipment furnished under separate contracts. Wood grounds and blocking in contact with masonry or concrete shall be preservative treated.

5-8. Flitch-plate beams — Build up of two 3 by 10's with ½" by 9" structural steel plate between. Steel plate to span full length of beam. Use 2⅝" Teco Shear Connectors and ½"ø bolts 24" on center as shown on drawings.

5-9. Framing —

A. Wood framing shall be cut square on bearings, closely fitted, accurately set to required lines and levels, and rigidly secured in place. Do not use shims for leveling on wood or metal bearings.

B. Frame headers and trimmers for openings in roof. Joists shall be doubled where shown on drawings. Joists shall have double herringbone bridging, 2 rows for each 12' span at quarter points of span. Bridging shall be 1" by 3" board nailed with 2 8d nails at each end. Bottom ends shall not be nailed until after roof sheathing is in place. Joists resting on masonry walls must have at least a 4" bearing. All joist, beam, and header connections shall be made using Teco "Trip-L Grip" Type C joist and beam metal framing anchors.

5-10. Insulation —

A. 2"-thick batt-type aluminum faced mineral wool. Install between studs in all exterior walls above grade and in 4" partition at north and south walls of living room and entry hall, as shown on drawings.

B. 1"-thick rigid polystyrene board insulation. Install between 1"-thick wood furring strips on west wall of kitchen and maid's room and at exterior walls of crawl spaces. Do not install at basement walls of crawl space.

C. Roof Insulation: see Section 7.

5-11. Wood doors —

A. Wood doors shall be of sizes, designs, thickness, and types shown and scheduled on the drawings. Finished doors shall be sanded smooth and be free from defects or machine marks which will show through the finish.

B. Stile & rail wood doors — 2⅝"-thick paint grade birch veneer stile and rail construction with mortice and tenon joints. Adhesive shall be fully waterproof. See drawings for dimensions. Living room doors to be glazed with '/a"-thick A quality heavy sheet glass using glazing compound and held in place with projecting solid wood stops as shown on drawings. Door bottoms shall be rabbeted to accommodate interlocking metal thresholds. All doors to have integral astragals. Weatherstrip at heads and jambs using Chamberlin Company's ¼" x ½" urethan self-adhesive stripping No. 800-AS Altemate E applied to door stops of tubular aluminum frames.

C. Solid core wood doors — Residential type solid core wood doors with paint grade birch veneer equal to Roddis Standard Solid Core or Morgan Company's Solid Flush door. Front doors: 2¼" thick. *All other* doors: 1¾" thick. Exterior doors to employ waterproof glue.

D. Screen doors — 1⅜" thick wood. Stiles and top rails — 4⅝" wide. Bottom rails — 8" wide. Mortise and tenon comers. Brace with ⅜"ø brass rod. 14 x 18 fiber glass screening. Submit shop drawings.

E. Altemate price *(D)* — This alternate price required by Section 2 is for hollow core wood doors, 1⅜" thick, residential type, paint grade birch veneer in lieu 1¾" solid core doors.

5-12. Plaster board walls and ceilings —

A. ½" "Tapered Edge Sheetrock." Reinforce and conceal at joints with the "Pelf-A-Tape Joint System," using both tape and spackle in accordance with the recommendations of U.S. Gypsum. Nail plasterboard with 1¼" long sheet rock screws directly to wood frame, spaced 8" on walls and 7" on ceilings.

B. All exposed and untrimmed edges of gypsum board shall be concealed with U.S. Gypsum No. 301 "Pelf-A-Trim" edging. All exposed comers shall be reinforced with U.S. Gypsum No. 100 "Perf-A-Bead" comer reinforcement.

C. Install plaster board on all walls and ceilings except where ventilating acoustical tile is called for on second floor ceilings where shown on drawings.

5-13. Acoustical ceilings —

A. *Materials* —All tile shall be Armstrong Cork Company's 12" x 12" x ⅝" fissured ventilating Fire Guard with self-leveling square edges.

B. *Installation* — Install directly to wood framing using 25 gage galvanized steel Z runners 12" on center attached to wood framing with nailing clips. Install wall channel mold of 24 gage steel factory painted white at all walls. Install tile symmetrically about center lines of ceilings with tile against walls not less than ½ tile width.

5-14. Wood preservative treatment — First floor joists and headers above crawl space and plates at top of foundation walls shall be given one coat of "Woodlife" brushed on according to manufacturer's recommendation.

5-15. Priming — All surfaces of wood exposed to weather shall be primed on all sides and edges with lead and oil paint before installation.

5-16. Hanging doors shall have 1/16" clearance at sides and top, and 3/8" clearance at bottom.

5-17. Application of hardware —

A. *General* — All finished hardware, including cabinet and closet hardware, shall be included in the hardware allowance. See Section 2.

B. *Keys* — Upon completion of the work, all hardware shall be demonstrated to work freely, all keys shall be fitted into their respective locks and, upon acceptance of the work, all keys shall be tagged and delivered to the Owner.

5-18. Shop drawings — Before proceeding with the work, prepare and submit to the Architect for approval, shop drawings of all cabinet work. Drawings shall indicate kind of material, edge banding details, size of members, method of securing members together and to adjacent work, and electrical and ductwork connections.

SECTION 6
Masonry and Stonework

6-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

6-2. Materials —

A. *Face brick* shall be standard size Calvert "Rose Full Range" manufactured by Victor Cushwa & Sons. See Section 2 for alternate price brick.

B. *Concrete masonry units* shall be slag, high pressure steam cured. Block for foundation walls: 75% solid, ASTM C145, Grade A. *All* other block: hollow, load-bearing, ASTM C90, Grade B.

C. *Fire brick* shall be high heat duty type, of sizes required. Use fire brick for lining inside of fireplace.

D. Flue *lining* — Sound, hard burned, terra cotta of size indicated.

E. *Wall anchorage* — Tied brick and block walls: Continuous rectangular galvanized metal ties with 9 gage side rods and cross rods of 3/16" wire as manufactured by Dur-O-wal. Galvanized shall be done after forming. Reinforcement shall be 2" less than thickness of walls. Where brick is backed with concrete block, width of reinforcement shall be 2" less than total thickness of brick and block. Furred masonry walls: corrugated metal ties, galvanized, 7/8" wide by 7" long, 18 gage.

6-3. Mortar materials —

A. *Portland cement* — A.S.T.M. Specification C150-56 for masonry mortar.

B. *Lime* — Type S hydrated.

C. *Sand* — Clean washed sand conforming to A.S.T.M. Specification C144-52T. Color of sand for facing brick mortar shall be a light color to match background of brick and shall be approved by Architect.

6-4. Mortar —

A. *Mortar for fire brick* shall be a specially prepared fire clay that will withstand high temperatures and be of proper consistency to spread easily after mixing with water.

B. *Mortar for above-grade masonry* shall be composed of one bag portland cement, two bags type S hydrated lime, and 9 cubic feet of sand, with the addition of sufficient clean water to produce a mass of satisfactory consistency.

C. *Mortar for below-grade masonry* shall be composed of one bag portland cement, one bag type S hydrated lime, 6 cubic feet of sand, and sufficient clean water to produce a mass of satisfactory consistency.

D. *Mortar for all above-grade work* shall be of a color suitable to the Architect. The Contractor shall lay up a sample panel (which may become a part of the finished work) for the Architect's approval before proceeding with the work.

6-5. Laying brick —

A. All brickwork shall be laid true to dimensions, plumb and properly anchored, with all courses level and joints of uniform width. Brick shall be laid without masonry bond. Continuous rectangular reinforcement shall be placed in every sixth brick course. See Paragraph 6-6C below for installation of metal reinforcement and ties to be placed in walls. No header courses to be used in any house walls, chimney walls, or retaining walls above grade.

B. Brick shall be laid in a full mortar bed with shoved joint. All joints shall be filled completely with mortar or grout. Horizontal brick joints shall be ⅜". Brick to be laid 3 courses to 8" vertically, and shall begin 2 courses below fin grade.

C. Where exterior walls are faced with brick, parge the back of the face brick with ⅜"-thick coating of mortar before back-up is laid.

D. Face joints on exterior shall be finished with a metal tool to close all hair cracks and crevices and form a grapevine joint, as directed by Architect.

E. Set terra cotta flue linings in full beds of mortar and slush joint between lining and backing full with mortar.

6-6. Laying concrete masonry **units** —

A. All block shall be laid true to dimensions, plumb, square, and properly anchored. Courses shall be level and in alignment.

B. All block shall be set with cells vertical with full mortar coverage on vertical and horizontal face cells. Vertical joints shall be shoved tight. First course of block shall be set in full bed of mortar All block subject to strain shall be filled solid with setting mortar.

C. Galvanized metal ties shall be placed in every second block course vertically and 16" on centers horizontally and be nailed to **studs** with galvanized nails.

D. Parge exterior of foundation walls below grade as indicated on drawings.

6-7. Pointing **and** cleaning —

A. Cut out defective mortar joints, refill solidly with mortar and tool as specified.

B. All brick shall be cleaned in accordance with manufacturer's recommendations. No acid is to be used without permission of the Architect.

6-8. Flagstone —

A. Flagstone shall be 1⅜"-thick Ridgeway Philadelphia stone in selected color. All flagstone shall have split face exposed top surface with heavy projections removed. Stone shall be of random rectangular shape, and of size not less than 1 sq. ft. per stone.

B. Lay stone to approved patterns in full ¾" beds of stiff mortar consisting of 1 part portland cement, 10 percent lime putty, and 3 parts sand by volume. Pound stone down to proper level with heavy wood block. Any stone having a hollow sound shall be removed and reset. Make joints approximately ¾" wide and neatly point flush with mortar.

6-9. Slate hearthstone —

A. *Material* — Hearthstone shall be a single piece of natural black structural slate reasonably clear, 2" thick, free of ribbons, and with hones finish on all exposed-to-view surfaces.

B. *Installation* — Lay hearthstone in ¾" setting bed of 1 to 3 mix of sand and cement. Sponge exposed surfaces of slate with clean water while laying to remove mortar stains. Any mortar stains left on surface shall be removed with weak acid solution.

6-10. Dry stone **wall** —

A. **Dry** stone wall at parking area to be random rubble quarry stone from local quarry. Stones are to be well keyed, with joints reasonably tight.

B. Wall is to be back-filled, as it is laid, with bank run gravel and trimmings from stonework. A weak **mix** of sand and cement may be used in lieu of bank run gravel.

C. Samples of stone are to be submitted to the Architect for approval. Final approval of the subcontractor is to be based on inspection of previous work.

D. All the above work is to be done according to details shown on drawings and in accordance with _____ County/City Building Regulations.

SECTION 7
Roofing, Roof Insulation, and Sheet Metaf

7-1. General —

A. Extent — Work required under this section includes all roofing, roof insulation and sheet metal, and related items necessary to complete work shown on drawings and specified herein.

B. *Related work included in other sections* —

1. Ventilating roof dooms, Section 15.
2. Furnishing, setting, and flashing roof drains and inside conductors, Section P1.
3. Thermal insulation other than roof insulation, Section 5.

C. ***General*** — Refer to the General Conditions and the Supplementary General Conditions sections. They are applicable to this section and shall form a part of each subcontract.

7-2. Rooting **and** roof insulation —

A *Vapor barrier* — Cover deck with rosin-sized sheathing paper, lapped 2" at joints and nailed sufficiently to hold in place. Lay two plies of 15 lb. tarred felt lapped 1 9 **with** solid mopping of pitch between plies. Laps shall be backnailed on 18" centers.

B. Roof insulation — Celotex Impregnated Fiberboard Roof Insulation in two 1" layers. Hold insulation 1" away from cornice and chimney at all edges. Keep dry before, during, and after application. Lay each ply in a solid mopping of pitch. Cant strip shall be Celotex Fiberboard Cant Strip.

C. Roofing — Lay 3 plies of 15 lb. tarred felt in hot pitch equal to Barrett 20 year bond roof complying with Barrett specification number 120-1NS. Roofing bond will not be required.

D. Felt *base flashing* — Shall be equal to Barrett's Type AA, 20 year bond type (bond not required), consisting of 4 plies of 15 lb. felt with a mineral surfaced cap sheet, laid in roofing cement.

E. Roof surfacing — Equal to "Reflect-O-Lite" calcite aggregate *as* produced by Genstar Corporation. Apply chips uniformly and use not less than 500 pounds per 100 square feet. Bed surfacing in a heavy coating of pitch. Chips shall be graded from ¼" to ⅝" size.

7-3. Sheet metal work —

A Sheet ***metal*** — All sheet metal shall be 16 ounce cold-rolled copper except for 20 ounce cornice cap flashing.

B. Solder — Shall be composed of 50 percent pig lead and 50 percent block tin.

C. Termite shield — Extend beyond wall as shown. Fold both exposed bottom edges back ¼ inch on underside for stiffeners.

D. *Cornice cap flashing* — Use 20 oz. copper. Where flashing turns into reglet wedge with metal, pack with lead wool and caulk with elastic caulking compound guaranteed not to stain cornice.

E. Workmanship — Sheet metal work shall conform to standard details and recommendations of the Copper and Brass Research Institute.

SECTION 8
Aluminum Windows

8-1. General — All work included herein shall be subject to the General and Special Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

8-2. Extent — The work required under this section includes all aluminum windows shown in east and west elevations and items related thereto including all clips, anchors, and other accessories required for anchorage of windows.

8-3. Related work included in other sections —

A. Glass and glazing, Section 10

B. Caulking, except as specified herein, Section 14

C. Cleaning of aluminum, Sections 1 & 2.

D. Aluminum sliding doors, Section 9

E. Screen doors, Section 5

F. Hardware, Section 2

8-4. Shop drawings — Submit complete shop drawings of window and related work to Architect and obtain approval prior to manufacturing. Shop drawings shall show full-size sections of window members, thickness of metal, details of construction, hardware, reinforcement at heads of double doors, method of anchoring, as well as connection of windows with adjacent work.

8-5. Finishes on **aluminum** — The surfaces of all aluminum window members and other aluminum members and shapes furnished with the windows shall be given ALCOA No. 204-A1-R1 anodized finish.

8-6. Protective coatings — Before shipment from the factory but after anodizing, the finished surfaces of aluminum shall be given two coats of clear, water-white, methacrylate lacquer that will protect the metal against stain, discoloration, and other surface injuries.

8-7. Manufacturer — 1¾" x 5" tubular window frames shall be either Northrop Architectural Systems Series 20-261 (distributed locally by Jas. A. Cassidy Co. Inc.) or Cupples Products Corporation's Framing System 175-5.

8-8. General construction requirements for all windows —

A. *Materials and alloys*

1. Screws, nuts, washers, bolts, rivets, and reinforcement used in fabrication shall be aluminum, non-magnetic stainless steel, or other materials not harmful to aluminum and of sufficient strength for the purpose as used. Plated or coated materials are not permitted.

2. All anchors necessary to adequately secure windows shall be provided and installed and shall be aluminum, non-magnetic stainless steel, or zinc-coated steel when in direct contact with aluminum members. Angles for securing frames to architectural concrete at all jambs and heads shall be continuous aluminum angles of size shown on drawings or nylon members to receive snap-on glazing beads.

3. All framing sections shall be extruded sections of 6063-T5 aluminum alloy.

4. Window frames shall be tubular aluminum sections 1⅝"x 5".

B. *Glazing beads* — Framing sections shall have aluminum snap-on glazing beads for securing glass in place. Glazing beads shall be secured in place by continuous aluminum or nylon members. Windows shall be designed to receive ¼"-thick glass. Beads shall be similar to those in Arcadia's Series 800 window wall system.

C. *Door stops* — Stops shall be aluminum tubes and be secured with concealed fastenings. Size shall be such as to accommodate a ⅜"-thick wood screen door without weatherstripping on the outside and a weatherstripped (see paragraph 5-11B) 2¼" wood door on the inside. Door stops shall have same face dimension as glazing beads.

D. Welding — If welded, remove flux and excess metal, and dress welds smooth so that no discoloration will show after finishing.

E. Hardware — Door frames shall be reinforced and fitted at factory to receive hardware to be furnished under hardware allowance.

F. *Reinforcement at heads* Reinforce framing member with steel channels at heads of doors as required to insure rigidity and as approved on shop drawings.

G. *Glazing gaskets* — Furnish extruded vinyl neoprene gaskets, aluminum in color, for installation of glass under Section 10.

H. *Construction* — All frame comers shall be mortised, tenoned, riveted, and welded watertight. All principal horizontal and vertical frame members shall be mortised and tenoned and securely heliarc welded at ends and intersections. Caulking eompound shall be applied on the interior of all principle frame intersections as specified in the following paragraph.

8-9. Caulking — Caulking of metal to metal joints between members of metal windows and metal frames is included herein. Caulking compound shall be a polysulphide type, aluminum in color.

8-10. Installation of windows —

A. *General* — Installation shall be done by the window manufacturer or an authorized representative, using only skilled window mechanics. Set windows plumb, level, and in alignment; properly brace frames to prevent distortion.

B. *Anchors* — Anchor windows to adjacent wall and mullion construction as shown on details and approved shop drawings.

C. *Aluminum work* shall be handled and protected against lime mortar stains, discolorations, surface abrasions, and other construction abuses in accordance with Alcoa publication "Care During Construction," latest edition. Damaged members shall be corrected or replaced at Contractor's expense.

SECTION 9
Aluminum Sliding Doors

9-1. General — All work included herein shall be subject to the General and Special Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

9-2. Extent — Work required under this section includes all aluminum sliding doors and frames shown in north and south elevations and related items as specified herein, including all anchors, clips, and all other components complete and ready for operation.

9-3. Related work included **in** other sections —

A. Glass and glazing, Section 10.

B. Hardware, Section 2.

C. Caulking (except for caulking between aluminum members), Section 14.

D. Aluminum windows, Section 8.

E. Final cleaning of aluminum. Sections 1 & 2.

9-4. Shop drawings — Submit shop drawings to ~ r - chitect for approval, showing in detail the various portions of the work, the kind and thickness of materials, size of members, and method of securing the different members together and to the work of other trades. Work shall not be started until shop drawings have been approved.

9-5. Measurements — Before beginning work, the Contractor shall take and verify the governing dimensions at the building and shall be responsible for same.

9-6. Protection of aluminum — Frame members shall be protected during construction and until acceptance of the work against all damage.

9-7. Finish on **aluminum** — All exposed surfaces of aluminum shall be given an Alcoa 202-R1 finish.

9-8. Manufacturer — Aluminum sliding doors shall be Arcadia Series **700,** 3⅝" jamb, as manufactured by Northrop Architectural Systems and distributed locally by Jas. **A.** Cassidy Co. Inc.

9-9. Construction — Manufacturer's standard construction. Reinforce tubular sections as required to insure rigidity and as approved on shop drawings. *Hardware:* Provide standard hardware on all doors, with Schlage 5-pin exterior cylinder locks furnished on the first floor doors only. Glazing channel and glazing beads shall accommodate ¼"-thick glass. First floor doors to have applied aluminum fin at head.

9-10. Glazing gaskets — Furnish extruded vinyl gaskets, aluminum color, for installation of glass under Section 10.

9-11. Screens — Furnish standard inside sliding screens with **14 x 18** fiber glass mesh.

9-12. Installation — Installation shall be in strict accordance with the manufacturer's directions and approved shop drawings and shall be made by competent craftsmen, experienced in such installations. Frames shall be plumb and in true alignment. Upon completion, doors shall be adjusted to work properly.

SECTION 10
Glass and Glazing

10-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

10-2. Material —

A. All glass in aluminum sliding doors at north and south elevations shall be ¼"-thick B quality heavy sheet glass as manufactured by Pittsburgh Glass Company or Libby-Owens-Ford Company.

B. Glass in fixed windows and hinged doors at east and west elevations shall be ¼"-thick. A quality heavy sheet glass as manufactured by Pittsburgh Plate Glass Company or Libby-Owens-Ford Co.

10-3. Installation of glass —

A. All glass shall be secured in place with metal beads and glazing materials as specified in Sections **8** and 9. All glazing shall be done in strict accordance with recommendations of aluminum door and window manufacturer, as indicated on the shop drawings.

B. At completion of work, glass must be whole, free from cracks and rattles.

10-4. Related work — Glass in living room doors, Section 5.

SECTION 11
Ceramic Tile

11-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

11-2. Materials —

A. Portland cement — Waterproof type, of standard manufacture; gray or white as required.

B. Sand — Sharp, washed clean, and uniformly graded from fine to coarse as follows: For pointing mortars, **100** percent passing No. **30.**

C. Metal lath shall be **3.4** pound flat expanded or flat rib lath.

D. Glazed wall tile — Standard grade, 4¼" by 4¼" face, with cushion edges and a colored satin glazed finish, as manufactured by the Mosaic Tile Co. or equal.

E. Glazed wall tile trim shapes — External edges shall be 4¼" x 4¼" bullnose, internal corners square; include all shapes necessary to a complete installation, including recessed soap holder with grab bar for each tub.

11-3. Setting and grouting tile — Set, grout, and clean wall tile in accordance with basic specifications K-400 of Tile Council of America's "Tile Handbook." All tile shall be set in mortar setting bed. Leave finished work clean and free from cracked, chipped, or broken edges.

11-4. Samples — Submit samples of tile to Architect and obtain approval before proceeding with tile work.

SECTION 12
Resilient Flooring

12.1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

12-2. Materials —

A. *Vinyl Tile* — Homogeneous vinyl tile equal to Armstrong Cork Company's Imperial Custom Corlon 9 by 9 by 3/32" thick, in terrazzo pattem.

B. Sheet rubber — ⅛", of same pattem as rubber tile above, shall be used for stair risers.

C. *Adhesive* — Water resistant type as recommended by tile manufacturer for the purpose intended.

D. Underlayment — See Carpentry and Millwork (Section 5) for ½" plywood underlayment.

E. *Colors and patterns* — Architect *will* fumish Contractor schedule showing location of colors and pattem selected. Contractor shall submit samples as requested by Architect for approval. Different color borders will not be required.

12-3. Preparation of floor —

A. Remove grease, dirt, and other substances from floors. Inspect floor surfaces for holes, cracks, and smoothness; do not proceed with laying until surfaces are smooth and holes and cracks filled.

B. Maintain 70 degrees F minimum temperature in rooms for 24 hours before and during time of laying and for 48 hours after laying. Stack tile in rooms at above temperature 24 hours before laying.

12-4. Laying —

A. *Vinyl tile* — Lay vinyl tile in accordance with recommended specifications of the manufacturer; use only experienced workmen. Lay tile with joints tight and in true alignment. Cut tile to fit accurately at joining with other material. Lay tile symmetrically about center lines of rooms or spaces with tile against walls not less than 6 wide. Tile against wall shall be same width on each side of room when possible.

B. Cleaning — Upon completion, leave floor clean, smooth, and free from air bubbles, waves, buckles, loose joints, or smears of adhesive. Protect floors against damage from subsequent building operations.

SECTION 13
Miscellaneous Metal

13-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

13-2. Related work included in other sections — Anchors for architectural concrete, Section 4A. Reinforcement for concrete work, Section 4. Reinforcement for masonry work, Section 6. Anchors and stiffening for aluminum frames, Section 8 and 9.

13-3. Shop painting — All ferrous metal items shall be cleaned and given manufacturer's shop coat of zinc chromate or other approved rust resisting primer.

13-4. Structural steel — Provide structural steel for flitch-plate beams specified in Carpentry and Millwork section. See drawings for size.

13-5. Steel angles, anchor bolts —

A. Provide steel lintel angles, size as shown on drawings.

B. Provide bolts for anchoring wood plates at top of foundation walls, size as shown. Seal around each anchor bolt through termite shield with coal-tar pitch.

13-6. Fireplace damper shall be Donnelly Bros. cast iron No. 242, fitted with concealed ratchet poker control handle.

13-7. Clothes poles — Extension type round rods with bright nickel-plate finish, Knape-Vogt KV-2.

13-8. Louvered access panels — All access panels from basement and mechanical room to crawl space are to be fixed aluminum louvers in aluminum frames. Louvers and frames are to be similar to "Construction Specialties" thin-line louvers 2" in depth and of sizes shown on drawings. Louver blades to be similar to 'Construction Specialties" Type "N" blade with type "L" frames. Frame is to be attached to masonry with screws so as to be removable for access to crawl space. All access panels are to be backed with ½" 18 x 14 aluminum mesh bird screens in extruded aluminum frames.

13-9. Handrails (interior and exterior) — Julius Blum & Co. Inc. (Carlstadt, N.J.) aluminum No. 6930 with square end pieces type "N" supported by 1¼" x ½" x ⅛" hot rolled bar size channel. Handrail brackets to be Julius Blum No. 302 aluminum attached with ⅜" x 3" steel hanger bolts. Exterior brackets to be bolted into expansion shields for ⅜" diam. hanger bolts.

13-10. Stair **nosings** — "Trimedge" aluminum safety butt type No. A-229-H as manufactured by Wm. L. Bonnell Co. for ⅛" resilient flooring. Distributor is Roberts Co., Washington, D.C. Provide aluminum nosings for all treads including top step.

SECTION 14
Painting and Caulking

14-1. General —

A. All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

B. *Prime coals* specified herein will not be required on items delivered with prime and shop coats already applied. (See other sections of the specifications.)

C. *Related work* — Caulking of precast concrete work, Section 4A.

14-2. Paint materials generally —

A. Paint shall be top grade lead free made by one of the following manufacturers: Pratt and Lambert, Martin-Senour, or Benjamin Moore. All other painting material shall be of comparable quality

B. All paint shall be delivered to site in manufacturer's sealed, labeled containers. Labels shall give manuiacturer's name, brand, type of paint, color of paint, and instructions for reducing. Thinning shall be done only in accordance with directions of manufacturer. Job mixing or job tinting may be done when approved by the Architect for sample colors.

14-3. Colors and samples — Paint colors shall be as selected by the Architect. Before any work is done the Architect will furnish the Contractor with color chips and a schedule showing where the various colors shall go. The Contractor shall then prepare samples at the job for approval by the Architect.

14-4. Preparation of surfaces —

A. Do not begin painting on any surface until it has been inspected and is in proper condition to receive the paint as specified. Should any surface be found unsuitable to produce a proper paint finish, the Architect shall be notified, and no material shall be applied until the unsuitable surfaces have been made satisfactory

B. Sandpaper to smooth and even surface and then dust off. After priming but before second coat has been applied, thoroughly fill nail and other holes, plywood edges, and cracks with putty.

C. Before painting, remove hardware, accessories, plates, lighting fixtures, and similar items, or provide ample protection for such items. Upon completion of each space, replace above items. Remove doors to paint bottom edge. Use only skilled mechanics for removing and connecting above items.

14-5. Application —

A. Do not apply exterior paint in damp, rainy weather or until the surface has thoroughly dried from the effects of such weather. Do not apply paint when temperature is below 50 degrees.

B. Surface to be stained or painted shall be clean, dry, smooth and adequately protected from dampness. The prime coat of paint shall be slightly different shade from the following coats. Allow each coat to dry (at least 48 hours) before subsequent coat is applied.

C. Finished work shall be uniform, of approved color, shall completely cover, be smooth and free from runs, sags, clogging, or excessive flooding. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping. Where high gloss enamel is used, lightly sand undercoats to obtain a smooth finish coat.

D. At completion, touch up and restore finish where damaged and leave in good condition.

14-6. Schedule of painting —

A. Exterior ferrous metal —

1. *First coat:* Oil base primer
   Second and third coats: Exterior metal finishing paint
   Extent: Channels at stair railings
2. *First coal:* Shop coat oil base primer
   Second coat: Field touch-up followed by full field coat of oil base paint
   Extent Angle anchors, lintel angles, and beam plates.

B. Interior woodwork to be enameled —

Back prime: Suitable wood primer
First coat: Suitable wood primer
Second coal: Enamel undercoat mixed with semi-gloss enamel
Third coal: Semi-gloss enamel
Sanding: Rub after first and second coats with fine steel wool or sandpaper
Extent: All trim, all shelving, all interior wood doors, and all exposed surfaces of wood cabinetwork, except insides of drawers.

C. *Plasterboard* —

1. *First coat:* Primer sealer
   Second coat: Flat wall enamel
   Third coat: Flat wall enamel
   Extent: All plasterboard walls and ceilings except as noted in (2) below

2. *First coat:* Primer sealer
   Second coat: Semi-gloss enamel
   Third coat: Semi-gloss enamel
   Extent: Plasterboard walls and ceilings in kitchen and bathrooms

D. *Interior ferrous metal* —
   First coat: Zinc chromate or iron oxide primer
   Second coat: Enamel undercoat
   Third andfourth coats: Gloss enamel
   Extent: Steel channel beneath stair railings

14-7. Caulking —

A. Apply caulking compound around all sliding door and window frames in exterior walls and fill all other joints or spaces indicated to be caulked.

B. Use Tremco's "Mono-Lasto-Meric" for caulking at exterior cornice joints. For caulking at all other exterior locations where indicated, use an oleoresinous caulking compound as manufactured by DAP, Tremco, Pecora, or H. B. Fred Kuhls.

C. Joints and spaces to be caulked shall be clean, free from dust, and dry Joints more than ¾" deep and joints where a suitable backstop has not been provided shall be packed with rope yam to within ½" of surface before applying caulking. Caulk joints before final coat of paint is applied to adjacent work. Apply compound in accordance with manufacturer's recommendations. Fill all voids and joints solid; remove excess caulking and leave surfaces neat, smooth, and clean. All caulked joints shall be watertight.

SECTION 15
Miscellaneous Items and Equipment

15-1. General —

A. All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

B. Catalog cuts or samples shall be submitted for each item in this section. No work shall be done toward the shipment of any items hereunder until the Architect has approved the catalog cuts or samples. Approved samples may be installed in the work.

15-2. Bathroom accessories —

A. *Schedule* — Accessories shall be constructed of brass with a polished chromium plate finish applied over nickel plating, or shall be of stainless steel with a bright polished finish as specified. Thickness of metal shall be sufficient for the purpose intended and stock with the manufacturer. Item number referred to below are Hall-Mack.

Master bathroom —

1. Mirror, with ⅜" x ⅝" 19 ga. chromeplated frame, of size shown on drawing.
2. Concealed vanity shelf, No. 341.
3. Paper holder, No. 676.
4. Towel bars, No. 694, 36" long
5. 2 robe hooks, single hooks No. 681.

Related work specified in other sections — Ceramic soap holder for tub, Section 11. Curtain rod for tub shower, Section P1.

Baths #2, **3,** *4 &* 5

1. 1 Medicine cab. = No. P1826L (with side lights)
2. 2 Towel bars = No. 694 — 3 0 long
3. 1 Soap, tumbler, and toothbrush holder = No. 635
4. 1 Paper holder, No. 676
5. 1 Robe hook, No. 481-T

Related work specified in other sections — Ceramic soap dish and grab bar, Section 11. Curtain rod for tub shower, Section P1.

B. Installation of bathroom accessories — Accessories shall be located on the job as directed by the Architect. Where accessories are set with screws, provide the necessary grounds, inserts, screws, and bolts as required to provide suitable anchorage. Use brass screws or bolts for securing where exposed.

15-3. Ventilating light domes — Install where shown Wasco Light Duty Ventdomes No. LV2424 with white (W10) acrylic plastic domes complete with single motor and 8" fan as manufactured by American Cyanamid Company, Building Products Division, Cambridge 38, Mass. Domes shall have aluminum frames and be complete in all respects, including 15¾" high insulated aluminum roof curbs, and shall be installed in accordance with manufacturer's instructions.

SECTION 16
Driveway and Parking Area

16-1. General — All work included under this heading shall be subject to the General Conditions and Sup-

plementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

16-2. Materials —

A. Bank run gravel

B. Crushed bluestone.

16-3. Laying —

A. Lay 8 of bank run gravel compacted in two 4" layers with 10-ton roller.

B. Apply one layer of crushed bluestone, 2" deep, as topping.

C. No curbs required.

16-4. Alternate — Alternate Price (A) shall be for bituminous pavement as specified below in lieu of the crushed stone driveway and parking area specified above.

A. Base course same as above. Topping shall be 2" thickness of hot plant-mix bituminous concrete compacted with 10-ton roller in lieu of 2" crushed stone. Provide moulded bituminous concrete curbs where indicated on site plan.

SECTION P1
Plumbing

P1-1. Scope of work — The work includes the furnishing of all labor, material, tools, equipment, and services necessary for the complete installation of the plumbing systems as specified herein.

P1-2. Ordinances — All work shall be executed and inspected in accordance with all laws, ordinances, rules, and regulations of authorities having jurisdiction. All fees in connection therewith shall be paid by the Contractor.

P1-3. Quality — All material shall be new, first quality and shall fully comply with specifications.

PI-4. Guarantee — All material and workmanship shall be fully guaranteed against any and all defects for a period of two years from date of final acceptance of the work.

P1-5. Excavation and backfill — Necessary trenching and backfill shall be performed under this section.

P1-6. Piping —

A. Hot and cold waterpiping —

1. Above ground shall be type "L" copper tubing with wrought copper solder joint fittings using lead free solder.
2. Underground shall be type "K" copper tubing with wrought copper fittings with brazed joints.

B. Soil, *waste, and* vent piping —

1. Above ground shall be no-hub cast iron soil pipe and fittings.
2. Underground shall be service weight cast iron soil pipe and fittings with neoprene gaskets.

C. *Storm* water piping —

1. Above ground shall be galvanized steel pipe with galvanized malleable iron fittings.
2. Below ground shall be service weight cast iron soil pipe and fittings with neoprene gaskets.

P1-7. Fixtures — Shall be American Standard

A. Water closets shall be Heritage™ EL 1.6/PA No. 2061.016, white vitreous china-one piece with flexible chrome supply, stop, china bolt caps and design matched seat.

B. Lavatories: Lavatories, generally shall be Lexington™ Pedestal No. 0178.014, 24¼" (610 mm) x 18¼" (464 mm), white vitreous china with No. 2077.101X ceratop faucet with pop-up drain, chrome flexible supplies, stops and 1¼" O.D. "P" trap.

C. Lavatories (2) for master bath shall be Tulip™ No. 0403.043, 1 9 (483 mm) x 16" (406 mm) white vitreous china-self rimming, each with a No. 2000.100 ceramix faucet with pop-up drain, ⅜" chrome flexible supplies, stops and 1¼" O.D. "P" trap.

D. Bathtubs shall be white Monarch™ Idealcast™ with chrome ceramix pressure balanced bath/shower faucet No. 2000.502 and full threaded waste and overflow fittings.

P1-8. Curtain rods — Furnish 1" chrome shower curtain rod over tubs.

P1-9. Traps and stops — Exposed traps, supplies, and stops shall be chrome plated. All fixtures shall be furnished with approved traps and stops.

P1-10. Kitchen and laundry equipment — Furnish labor and materials for rough-in of kitchen sinks, laundry sink and all other kitchen and laundry equipment furnished by others. This contractor shall furnish and install supplies, stops, traps, faucets, bibbs, etc., for kitchen and laundry equipment.

P1-11. Hose bibbs — Shall be non-freeze type wall hydrants for standard hose connection, with approved backflow preventer and with hand wheel control.

P1-12. Floor drains — Cast iron body with integral "P" trap, sediment bucket and nickel plated lift out strainer, J.R. Smith or equal.

P1-13. Roof drains — Cast iron body with flashing ring and beehive strainer, Zurn Industries or equal.

P1-14. Footing drain — Furnish and install 4 drain tile or other type of material approved by local code authorities. This contractor to furnish and place gravel for footing drain in accordance with requirements of local authorities.

P1-15. Septic tank and seepage pits —

A. Provide and install in accordance with requirements of local authorities having jurisdiction, an approved installation consisting of a septic tank and seepage pits.

B. Septic tank shall have minimum size of 1500 gallons. If larger size is required by local authorities, contractor shall allow in his or her bid for such increased size.

C. Seepage pits (3 required) 10'-0" diameter x 10'-0" deep each. Constructed and installed in accordance with the requirements of local authorities having jurisdiction.

P1-16. Electric hot water heater — State Industries, Inc., Model No. TCL-66-2LRT lifetime turbo 66 gallon capacity with 240 V.A.C. (interlocking) 4500 watt upper and lower elements.

P1-17. Water supply — Make connection to existing well on property in accordance with requirements of local authorities having jurisdiction. Furnish and install 120 gallon pressure tank (24" x 60") complete with air charger, air control and sight glass.

P1-18. Sleeves and flashings —

A. Provide all pipes passing through footings, floor slabs, and masonry walls with steel pipe sleeves, the inside diameter of which shall be at least ½" greater than the outside diameter of the pipe and covering passing through it. Sleeves in exterior walls, slabs on earth, or in any slab which may be wet (after completion of the building) shall be Schedule 40 PVC pipe and shall have the space between the pipe and the sleeves caulked watertight.

B. All sleeves shall be properly supported to prevent displacement during construction.

C. Wherever pipes are exposed or pass through walls. floors, partitions, or the ceilings of finished rooms, they shall be fitted with heavy cast brass escutcheons, nickel-plated, polished, and then chrome-plated; they shall be securely held in place with set screws or other approved device. Where pipes are covered, escutcheons shall fit over the covering snugly and shall be securely held in place.

D. The flashing of floor drains and vent sleeves in the roof will be done by this Contractor and the drains and sleeves furnished under this section shall be fitted with suitable flashing rings.

SECTION M1
Mechanical — Heating, Ventilating, and Air Conditioning

M1-1. General — Include the furnishing of all labor, materials, supplies, permits, equipment, devices, controls, appliances, valves, and performing all operations necessary for the installation of a complete heating, ventilating, and air conditioning system and satisfactory operation of all heating, ventilating, and air conditioning work as shown on the drawings and/or hereinafter specified.

M1-2. Scope —

A. Provide and install heating and cooling equipment as called for herein complete with necessary connecting piping, duct, grilles, control and starting equipment.

B. Obtain all necessary permits and pay all related fees.

C. Upon completion, turn over installation to Owner or authorized representative, ready for operation.

D. Provide instruction for Owner's representative in operation and maintenance of equipment.

E. Provide two-year guarantee on all workmanship and material.

F. Verify existing conditions by examination of the job site.

M1-3. System — System shall use two oil fired warm air furnaces with bonnet type evaporator coils and outdoor condensing units. Provide exhaust fans, Ilg size 70, or equal, for interior baths.

M1-4. Cutting —

A. This Contractor shall be responsible for all cutting in connection with this work.

B. Patching shall be by others.

M1-5. Piping —

A. Refrigeration piping: Type ACR copper tubing with wrought copper fittings using brazed silver solder joints.

B. Drip pan waste, same as above but with 95-5 solder.

C. Oil piping — Copper tube in accordance with requirements of local code authorities for both under and aboveground installations.

M1-6. Underground fuel oil storage tank — Furnish labor and materials to install underground fuel oil tank and accessories shown on drawing M-2 in accordance with the requirements of local code authorities and EPA regulations concerning the installation of underground fuel oil storage tanks and related piping. Tank to be sized and delivered to job site by building owner's designated fuel oil supplier.

M1-7. Sheet metal work (install as shown) —

A. Provide neoprene flexible connection to fans and air handling units.

B. Registers shall be Barber Coleman STBR GVOL, extruded aluminum.

C. Ducts shall be fabricated of galvanized sheet steel in the following gauges:

1. Up to 2 0 width, No. 24.
2. 21" to 35" width, No. 22.

D. Turning vanes in elbows shall be Tuttle and Bailey ducturns or equal.

E. Air exhaust and retum grilles shall be Tuttle and Bailey T110 prime coat painted steel

M1-8. Insulation — Supply and retum ducts in basement spaces and equipment room shall be covered with Armstrong Armaglas flexible duct insulation 1" thick with aluminum facing. Tape all joints in accordance with manufacturer's instructions to assure positive vapor banier and to prevent sweating. See drawing for lined ducts. Cover refrigerant piping and drain pan condensate piping with foam plastic ARMCOFLEX.

M1-9. Electric wiring —

A. Electric wiring for control of heating and cooling equipment shall be wired complete under this section from disconnects furnished under the Electrical section.

B. Materials and workmanship shall conform to requirements of the Electrical section.

M1-10. Flashing and caulking — Provide necessary flashing and caulking where ducts and pipes pass through roof and walls.

M111, Coil units — Trane Co. Model RK with dx coil, expansion valve, cabinet, insulation, galvanized drain pan, and baked enamel cabinet linish.

M1-12. Air cooled condensing units (2) — Air cooled condensing units shall be Trane Co. series "RUA," each complete with compressor, condensing coil, propeller fan, belt drive, standard controls in accessible control box, drier, and room thermostat. The room thermostat shall be MH model with heat-off-cool sub-base, fan, and automatic switch. Provide necessary support base for unit at court as approved.

M1-13. Warm air furnaces (2) — Each Trane Co. up-flow oil fired warm air furnace.

M1-14. Tests —

A. Heating system — The entire heating system shall be tested at the completion of the building, and it shall be established that all controls are performing satisfactorily and that all units are heating satisfactorily The system shall be checked for vibration and excessive noise and all such conditions corrected.

B. Air conditioning system — The entire air conditioning system shall be tested at the first summer weather following the completion of the building; and it shall be established that all controls are performing satisfactorily and that all units are cooling satisfactorily. The system shall be checked for vibration and excessive noise and all such conditions corrected.

SECTION E I
Electrical

E1-1. General — All work included under this heading shall be subject to the General Conditions and Supplementary General Conditions. The subcontractor for this portion of the work is required to refer especially thereto.

E1-2. Drawings and specifications —

A. The drawings which constitute a part of this contract indicate the general arrangement of circuits and outlets, location of switches, panelboards, conduit, and other work. Data presented on these drawings are as accurate as preliminary surveys and planning can determine, but in the event accuracy is not guaranteed, field verification of all dimensions is directed. Specifications and drawings are for assistance and guidance; but exact locations, distances, and levels will be governed by actual field conditions. This contractor shall also review architectural, structural, plumbing, heating, and ventilating plans and shall adjust his or her work to conform to all conditions shown thereon. All items not specifically mentioned herein which are obviously necessary to make a complete working installation shall be included at no extra cost.

B. All outlets shall be located uniformly with respect to beams, partitions, ducts, openings, etc., and the general locations shall be checked with the Architect before installing. Should there be any interference between the electrical outlets and other trades, the Contractor shall notify the Architect so that the proper location may be decided upon. No outlets shall be installed in back of ducts, grilles, or in other inaccessible places.

C. Should any structural difficulties prevent the setting of cabinets, running conductors, etc., at points shown on the plans, the necessary minor deviations therefor, as determined by the Architect, may be permitted and must be made without additional cost.

El-3. Scope — The work includes the furnishing of all labor, materials, supplies, permits, equipment, devices, appliances, and performing all operations necessary for the installation of a complete electrical system and satisfactory operation of all electrical work as shown on the drawings and/or hereinafter specified, including:

A. The underground electrical service, service equipment, secondary feeders, panels, branch and control wiring, outlets, and connections complete.

B. Provision and installation of all disconnect switches and the installation only of all other controls.

C. The wiring of equipment or material provided by other trades or the Owner shall be the responsibility of this contractor, except where specifically indicated otherwise.

D. Electrical apparatus such as motors, etc., shall be set in place at the expense of the Contractor furnishing the equipment, but shall be completely wired by this Contractor.

E. Provision and installation of all lighting fixtures and lamps.

F. Upon completion of the work, all equipment shall be thoroughly cleaned and left in first-class condition.

G. This Contractor shall be responsible for the protection of all equipment under this section until the final acceptance of the job.

El-4. Work included under other sections —

A. All starters and controls will be fumished under "Plumbing" and 'Heating, Ventilating, and Air Conditioning" sections of the specifications.

B. Telephone Company will provide and install all o. the wire and instruments required for the telephone system.

C. All temperature control wiring will be done under "Heating, Ventilating, and Air Conditioning" section of the specifications.

D. All kitchen equipment will be furnished and installed and connected by the Owner. The electrical contractor shall rough-in all work in accordance with the kitchen equipment supplier's drawings.

El-5. General —

A. The installation shall comply with all laws applying to the electrical installations in effect _____ County/City, the National Electrical Code, and the _____ Electric Power Company.

B. All electrical materials shall be new and as approved by the Underwriters' Laboratories, Inc., except as otherwise specified herein. Defective equipment damaged in the course of installation or test shall be replaced or repaired in a manner meeting the approval of the Architect.

C. The materials to be furnished under this specific: tion shall be the standard products of manufactu ers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.

D. The Contractor shall obtain all permits and certificates of inspection for the installation of the work herein specified. Cost of same shall be included in his or her estimate.

E. Workmanship shall be first-class throughout and shall be performed at all times by experienced mechanics, under the direct supervision of a competent and capable foreman, who shall have been delegated complete authority by this Contractor to make, in his or her absence, all decisions necessary for the diligent advancement of the work.

El-6. Current characteristics —

A. The service shall be 1-phase 200 amp, 3-wire, 1201240 volts.

B. The Contractor shall arrange with the power company for service and shall be responsible for verification of same, and shall *pay all* service ***charges.***

El-7. Manufacturers' drawings — The Contractor shall submit six (6) copies of manufacturers' drawin; on panelboards, lighting fixtures, and any special elec-

trical equipment to be installed on this job for the Architect's approval before ordering same for installation.

E1-8. Panels and cabinets —

A. Panels shall be as shown on the drawings and shall be of dead front safety type made up of bakelite sections, and arranged so that each section can be easily removed without disturbing the others.

B. Panels shall be so designed that the branch circuit connections to the main busbar provide sequence (full distributed) phasing.

C. Cabinets shall be of code gauge galvanized steel, and shall have a priming coat of lead free paint. The doors shall be blanked out to leave a trim of proper width around door. Doors shall have concealed hinges and shall be provided with flush type combination latch and lock.

D. All panelboards shall be equipped with locks and two **(2)** keys per panel. All panels shall be keyed alike.

E. A typewritten schedule of circuits, approved by the Architect, shall be glass or plastic covered and mounted in a suitable frame on the inside of each panel cabinet door.

E1-9. Conduit and armored cable —

A. All feeders and motor branch circuit wiring shall be installed in rigid steel conduit, galvanized or sherardized.

B. All lighting and receptacle branch circuit wiring shall be armored cable installed concealed.

C. No conduit shall be smaller than ½". All conduit laid underground shall be encased in **3**" of concrete. Conduit shall be Nepco, G.E., Youngstown, or Walker.

D. Armored cable shall be **2-, 3-,** or 4-wire, type AC or ACT, with grounding conductor, as manufactured by Nepco, Simplex, General Cable; or approved equal.

E1-10. Wire and cable —

A. Wire shall be as manufactured by Anaconda, General Cable, General Electric, or Simplex.

B. Branch circuit wiring shall be type TW. Feeders shall be type RHW.

C. No wire smaller than No. **12** B. & S. gauge shall be used, and all wire No. 8 B. & S. gauge and larger shall be stranded, double braid, unless otherwise specified.

E1-11. Outlet boxes —

A. Ceiling and wall boxes shall be the knockout type, of not less than No. 12 B. & S. gauge pressed steel.

B. Boxes for lighting outlets shall be equipped with integral fixture studs.

E1-12. Switches —

A. Where more than one switch occurs in the same location, they shall be installed in gang-type outlet boxes under one plate.

B. Wall ***switches*** —

Single pole switches:	P & S No. **2221** — gray
Three-way switches:	P & S No. **2223** — gray
Four-way switches:	P & S No. **2224** — gray

E1-13. Receptacles —

A. Duplex receptacles shall be P & S No. **5242** — gray.

B. Dryer receptacle shall be P & S No. 3835.

C. Weatherproof receptacles shall be P & S No. 5242-WP with #4500 cover.

E1-14. Cover plates — For all wiring devices shall be satin finish stainless steel, P & S Type "**302.**"

E1-15. Floor boxes — Shall be R. & S. adjustable type with:

A. P & S No. **525** for single receptacle.

E1-16. Feeders, branch, and control wiring —

A. Provide and install feeders complete to the terminals on the panels.

B. Provide and install a complete branch and control wiling system between panels and various outlets.

C. All motors will be provided and set in place under other sections of the specifications, but connected under this section.

D. All disconnects shall be furnished by this Contractor All starters and controls will be furnished under the "Plumbing" and "Heating, Ventilating, and Air Conditioning" sections of these specifications.

E. "Heating, Ventilating, and Air Conditioning" section of the specifications shall be consulted in connection with branch power and control wiling.

F. All temperature control wiring will be done under 'Heating, Ventilating, and Air Conditioning" section of the specification.

E1-17. Lighting fixtures and lamps — An allowance, as indicated on the drawings and listed under Supplementary General Conditions, shall be made for all lighting fixtures and lamps. Fixtures specified on

drawings are to designate type and quality of fixtures which will be used. Fixtures will be chosen at later date by Owner.

El-18. Testing — On completion of the work, the installation shall be entirely free from grounds and short circuits. All circuits shall be rung out as ticketed.

El-19. Guarantee — The Contractor shall guarantee against mechanical defects in any or all material and workmanship covered by these specifications and shall make good, repair or replace, at his or her own expense, any defective work, material or part which may show itself within a period of two years after final acceptance of the work.

APPENDIX A

LIST OF TABLES

Introduction to Abbreviations and Letter Symbols

Appendix A contains information about abbreviations and symbols for electrical heating, ventilating, refrigeration, air conditioning, and plumbing which are usually found on drawings used by journeymen in the pipe trades.

Abbreviations are shortened forms of names and expressions used in drawings, texts, and computer programs. *A letter symbol* represents *a* quantity or a unit, not its name, and is independent of language. Because of this, use of a letter symbol is preferred over abbreviations for unit or auantitv terms.

Abbreviations are never used when a mathematical sign is involved, such as the equality sign (=) or division sign (/), except in computer programming, where the abbreviation takes on the function of a letter symbol. Mathematical operations are performed only with symbols. Abbreviations should be used only where necessary to save time and space.

Graphical symbols in Appendix A are easy to draw and recognize and were selected to save engineering drafting time. Symbols of piping, ductwork, fittings, and in-line accessories can be used on scale drawings and diagrams.

Abbreviations for Texts, Drawings, and Computer Programs

Abbreviations for text and drawings have been compiled from *Abbreuiations for Use on Drawings and in Text*, ANSI Y1.1-72. Table 16 gives some of these abbreviations, as well as others commonly found on mechanical drawings and abbreviations (symbols) used in computer programming.

Additional abbreviations used on drawings can be found in the Graphical Symbols section of this appendix.

The abbreviations (symbols) used for computer programming for the heating, ventilating, refrigeration, and air conditioning industnes have been developed by the ASHRAE Technical Committee 1.5, Computer Applications. These symbols identify computer variables, subprograms, subroutines, and functions commonly applied in the industry. Use of these symbols enhances comprehension of the program listings and provides a clearly defined nomenclature in applicable computer programs.

Certain programming languages differentiate between *real numbers* (numbers with decimals) and *integers* (numbers without decimals). This is done by reserving certain initial letters of a variable for integer numbers. For instance, in Fortran, any variable beginning with the letters H through N is defined by the computer as an integer. Many of the symbols listed in this section begin with these letters and, in order to make them real numbers, must be prefixed with a noninteger letter Thus, HP would become XHP if the programmer wanted to define horsepower as a decimal value.

Many symbols have two or more options listed. The longest abbreviation is the preferred one and should be used if possible. However, it is sometimes necessary to shorten the symbol to further identify the variable. For instance. the area of a wall cannot be defined as WALLAREA because most computer languages restrict the number of letters in a variable name. Therefore, a shorter variable symbol is applied, and WALLAREA becomes WALLA or WAREA.

In Table A-16, the same symbol is sometimes used for different terms. This liberty is taken because it is highly unlikely that the two terms would be used in the same program. If such were the case, one of the terms would require a suffix or prefix to differentiate it from the other.

Letter Symbols

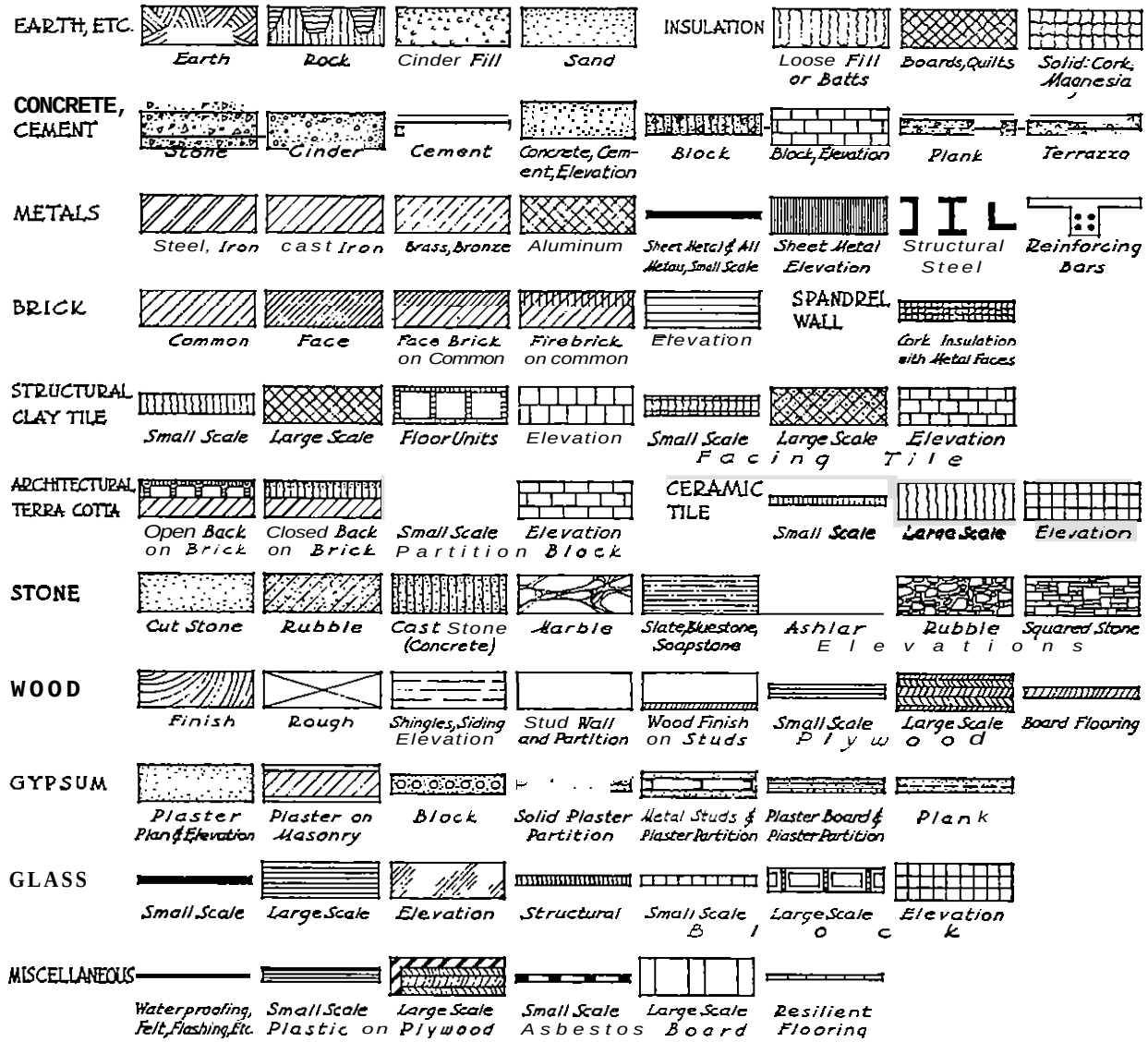
Letter symbols include symbols for physical quantities (quantity symbols) and symbols for the units in which these quantities are measured (unit symbols). *Quantity symbols*, such *as I* for electric current, are listed in this Appendix and are printed in italic type. A *unit symbol* is a letter or group of letters such as mm for millimeter. or a special sign such as ° for degrees, and is printed in Roman type. Subscripts and superscripts are governed by the same principles. Letter symbols are restricted mainly to the English and Greek alphabets.

Quantity symbols may be used in mathematical expressions in any way consistent with good mathematical usage. The product of two quantities, *a* and *b*, is indicated by *ab*. The quotient is &, or ab^{-1}. To avoih misinterpretation, parentheses must be used if more than one slash (/) is employed in an algebraic term, such as, (*a/b/c* or *a/b/c*), but not *a/b/c*

Subscripts and superscripts, or several of them separated by commas, may be attached to a single basic letter (kernel), but not to other subscripts or superscripts. A symbol which has been modified by a superscript should be enclosed in parentheses before an exponent is added $(X_a)^3$. Symbols can also have alphanumerical marks such as ' (prime), + (plus), and * (asterisk).

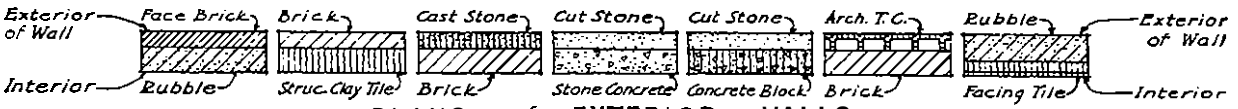
The letter symbols have, in general, been taken from the following American National Standards Institute (ANSI) standards: Letter *Symbols for Mechanics and*

TABLE A-1. ARCHITECTURAL MATERIALS, SYMBOLS AND EXAMPLES



All Symbols are for Plans and Sections, unless marked "Elevation".

EXAMPLES



PLANS of EXTERIOR WALLS

PLANS of PARTITIONS

SECTIONS of FLOOR FINISHES

USASI Standard Symbols

TABLE A-2. ARCHITECTURAL MATERIALS SYMBOLS

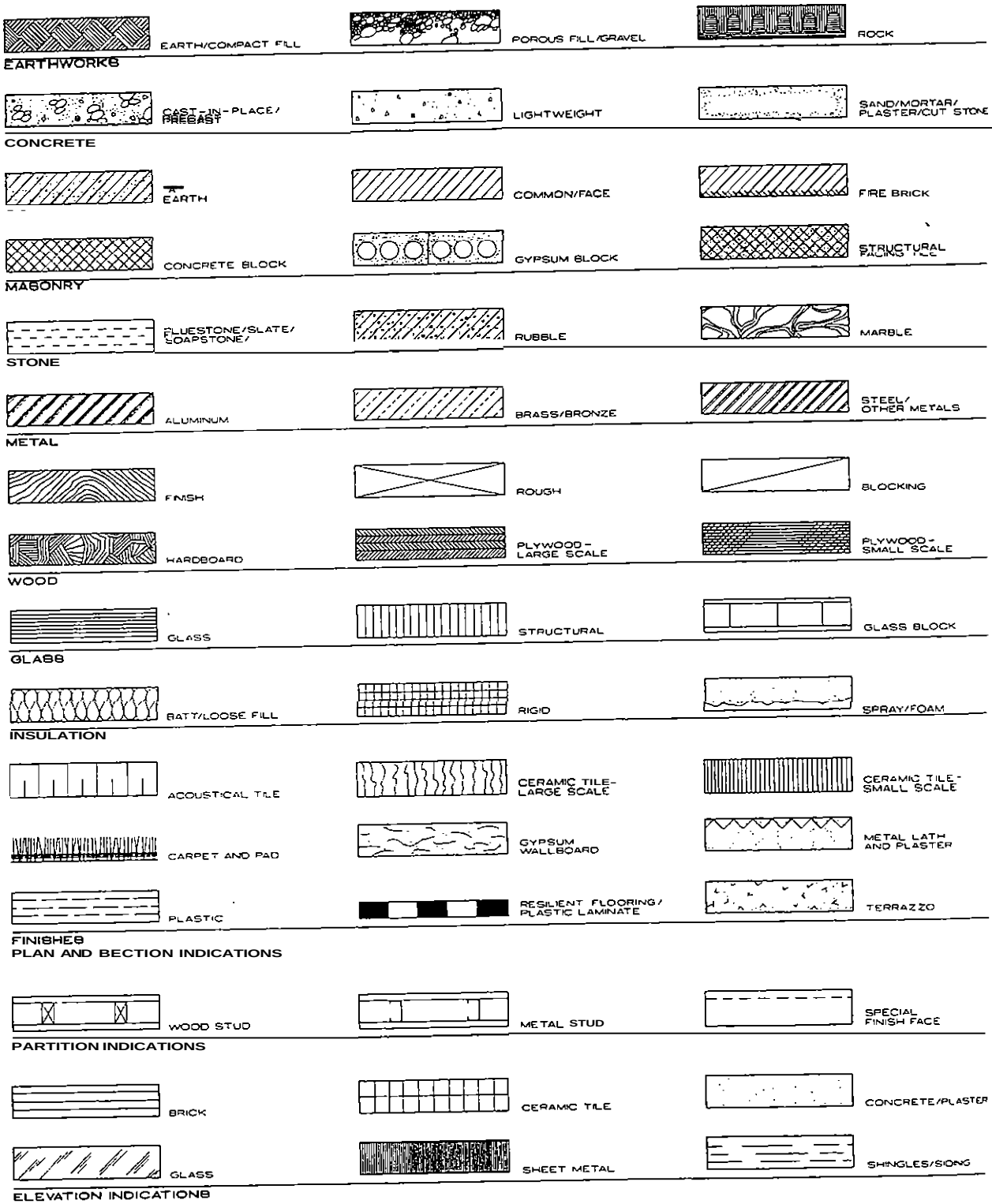


TABLE A-3. DRAWING CONVENTIONS AND SYMBOLS

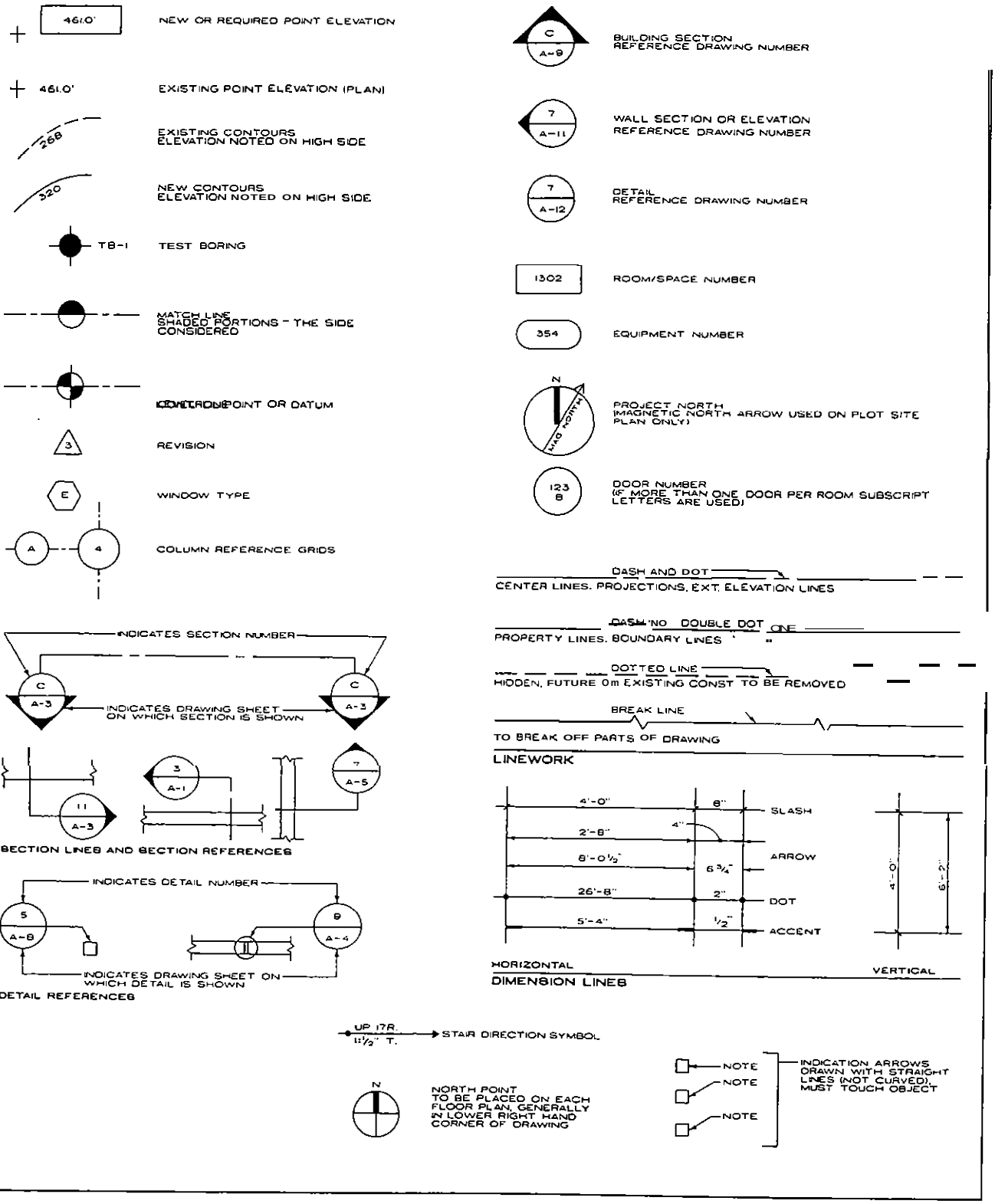
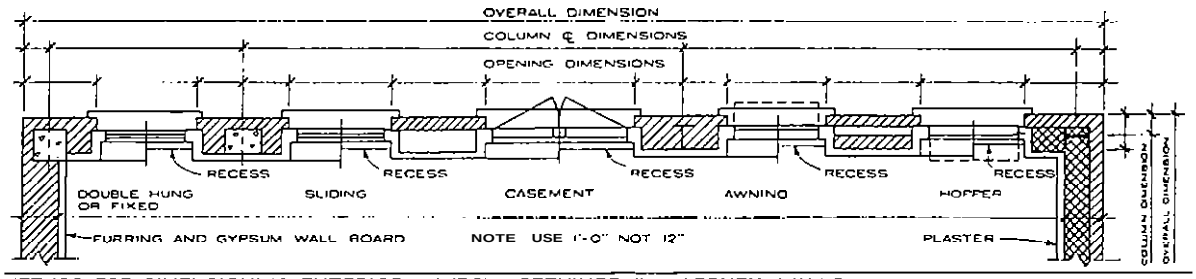
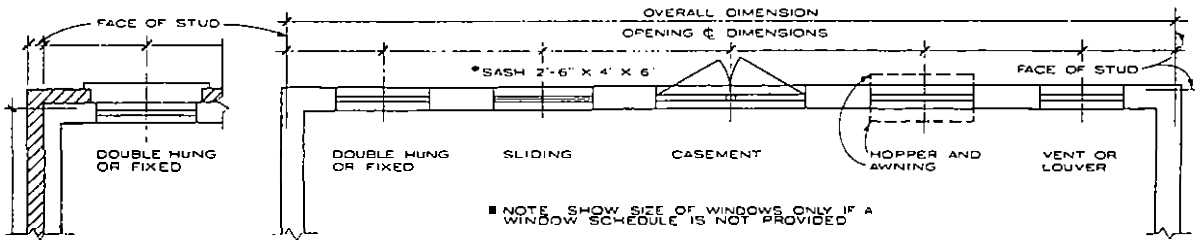


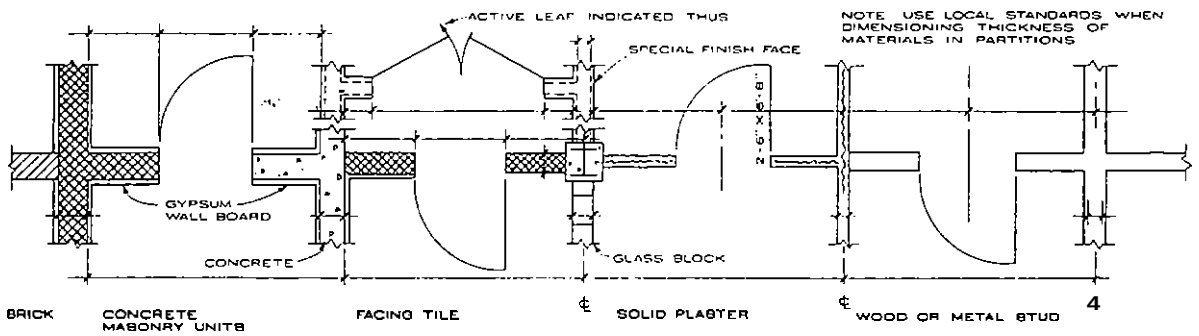
TABLE A-4. METHODS OF DIMENSIONING DOORS AND WINDOWS



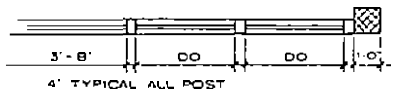
METHOD FOR DIMENSIONING EXTERIOR WINDOW OPENINGS IN MASONRY WALLS (DOORS SIMILAR)

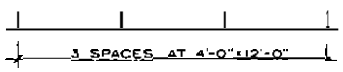


METHOD FOR DIMENSIONING EXTERIOR WINDOW OPENINGS IN FRAME WALLS (DOORS SIMILAR)

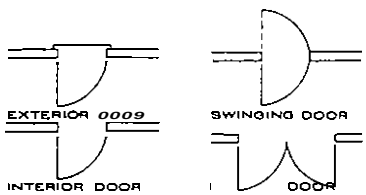


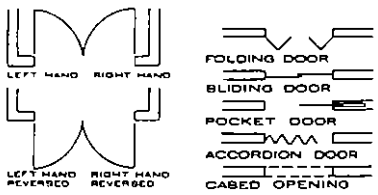
METHOD FOR DIMENSIONING AND INDICATIONS OF INTERIOR PARTITIONS AND DOORS





REPETITIVE DIMENSIONING





RECOMMENDATIONS

1. Dimensions under 1 ft shall be noted in inches. Dimensions 1 ft and ore. shall be expressed in feet.
2. Fractions under 1 in. shall NOT be preceded b r a zero. Fractions must ha.. a diagonal dividing line between numerator and denominator.
3. Dimension points to be noted with a short blunt 45° line. Dash to be oriented differently for vertical (↖) and horizontal (↗) runs of dimensions. Modular dimension points may be designated with an arrow or a dot.
4. Dimension all items from an established grid or reference point and do not close the string of dimensions to the next grid or reference point.
5. Dimension: to face of concrete or masonry work; to centerlines of columns or other grid points, to centerlines of partitions in nonmodular wood construction dimension to critical face of studs. When a clear dimension is required, dimension to the finish faces and note as such. Do not use the word "clear."
6. Dimension as much as possible from structural elements.
7. Overall readability, conciseness, completeness, and accuracy must be foremost in any dimensional system. It takes experience to determine how to use dimensions to the best advantage.

TABLE A-5. PIPING SYMBOLS: PLUMBING, HEATING AND AIR CONDITIONING

PLUMBING PIPING

SOIL, WASTE OR LEADER (ABOVE GRADE)

SOIL, WASTE OR LEADER (BELOW GRADE)

VENT

COMBINATION WASTE AND VENT — SV

ACID WASTE — AW

ACID VENT — AV

INDIRECT DRAIN — IW

STORM DRAIN — S

COLD WATER

SOFT COLD WATER — SW

INDUSTRIALIZED COLD WATER — ICW

CHILLED DRINKING WATER SUPPLY — DWS

CHILLED DRINKING WATER RETURN — DWR

HOT WATER

HOT WATER RETURN

SANITIZING HOT WATER SUPPLY (180°F)

SANITIZING HOT WATER RETURN (180°F)

INDUSTRIALIZED HOT WATER SUPPLY — IHW

INDUSTRIALIZED HOT WATER RETURN — IHR

TEMPERED WATER SUPPLY — TWS

TEMPERED WATER RETURN — TWR

FIRE LINE — F — F

WET STANDPIPE — WSP

DRY STANDPIPE — DSP

COMBINATION STANDPIPE — CSP

MAIN SUPPLIES SPRINKLER — S

BRANCH AND HEAD SPRINKLER

GAS - LOW PRESSURE — G — G

GAS - MEDIUM PRESSURE

GAS - HIGH PRESSURE — HG

COMPRESSED AIR — a

VACUUM — V

VACUUM CLEANING — VC

OXYGEN — O

LIQUID OXYGEN — LOX

NITROGEN — N

LIQUID NITROGEN — LN

NITROUS OXIDE — No

HYDROGEN — H

HELIUM — HE

ARGON — AR

LIQUID PETROLEUM GAS — LPG

INDUSTRIAL WASTE — INW

PNEUMATIC TUBES TUBE RUNS — PN

CAST IRON — CI

CULVERT PIPE — CP

CLAY TILE — CT

DUCTILE IRON — DI

REINFORCED CONCRETE — RCP

DRAIN - OPEN TILE OR AGRICULTURAL TILE

HEATING PIPING

HIGH PRESSURE STEAM — *-=

MEDIUM PRESSURE STEAM — MPS

LOW PRESSURE STEAM — LPS

HIGH PRESSURE RETURN — HPR

MEDIUM PRESSURE RETURN — MPR

LOW PRESSURE RETURN — LPR

BOILER BLOW OFF — BD

CONDENSATE Om VACUUM PUMP DISCHARGE — VPD

FEEDWATER PUMP DISCHARGE — PPD

MAKE "* WATER — MU

AIR RELIEF LINE — V

FUEL OIL SUCTION — FOS

FUEL OIL RETURN — FOR

FUEL OIL VENT — FOV

COMPRESSED AIR — A

HOT WATER HEATING SUPPLY — HW

HOT WATER HEATING RETURN — HWR

AIR CONDITIONING PIPING

REFRIGERANT LIQUID — RL

REFRIGERANT DISCHARGE — RD

REFRIGERANT SUCTION — RS

CONDENSER WATER SUPPLY — CWS

CONDENSER WATER RETURN — CWR

CHILLED WATER SUPPLY — CHWS

CHILLED WATER RETURN — CHWR

MAKE UP WATER — MU

HUMIDIFICATION LINE — H

DRAIN — D

BRINE SUPPLY — B

BRINE RETURN — am

TABLE A-6. REFRIGERATION SYMBOLS

THERMOSTAT, SELF-CONTAINED

THERMOSTAT, REMOTE BULB ...

PRESSURE SWITCH .....

EXPANSION VALVE, HAND.....

EXPANSION VALVE, AUTOMATIC.

EXPANSION VALVE, THERMOSTATIC .....

EVAPORATOR PRESSURE REGULATING VALVE, THROTTLING TYPE (EVAPORATOR SIDE)

EVAPORATOR PRESSURE REGULATING VALVE, THERMOSTATIC, THROTTLING TYPE

EVAPORATOR PRESSURE REGULATING VALVE SNAP-ACTION

COMPRESSOR SUCTION VALVE, PRESSURE LIMITING, THROTTLING TYPE (COMPRESSOR SIDE)

CONSTANT PRESSURE VALVE, SUCTION

THERMAL BULB .....

SCALE TRAP .....

DRYER .....

FILTER AND STRAINER ....

COMBINATION STRAINER AND DRYER

SIGHT GLASS

FLOAT VALVE HIGH SIDE

FLOAT VALVE LOW SIDE

GAUGE .....

COOLING TOWER .....

EVAPORATOR, FINNED TYPE, NATURAL CONVECTION

EVAPORATOR, FORCED CONVECTION .....

IMMERSION COOLING UNIT ....

CONDENSER, AIR-COOLED, FINNED, FORCED AIR

CONDENSER, WATER-COOLED, SHELL AND TUBE

CONDENSER EVAPORATIVE

HEAT EXCHANGER

CONDENSING UNIT AIR COOLED

CONDENSING UNIT WATER COOLED

PRESSURE SWITCH WITH HIGH PRESSURE CUT-OUT

COMPRESSOR

COMPRESSOR OPEN CRANKCASE RECIPROCATING, DIRECT DRIVE

COMPRESSOR RECIPCRANKCASBELTED

COMPRESSOR ENCLOSED CRANKCASE, ROTARY, BELTED

TABLE A-7. **GRAPHIC SYMBOLS FOR HEATING**

1. AIR ELIMINATOR

2. ANCHOR — PA

3. EXPANSION JOINT

4. HANGER OR SUPPORT — H

5. HEAT EXCHANGER

6. HEAT TRANSFER SURFACE, PLAN (INDICATE TYPE SUCH AS CONVECTOR)

7. PUMP (INDICATE TYPE SUCH AS VACUUM) — M

8. STRAINER

9. TANK (DESIGNATE TYPE) — REC

10. THERMOMETER

11. THERMOSTAT — T

12. TRAPS

12.1 BOILER RETURN

12.2 BLAST THERMOSTATIC

12.3 FLOAT — F

12.4 FLOAT AND THERMOSTATIC

12.5 THERMOSTATIC

13. UNIT HEATER ICENTRIFUGAL FAN), PLAN

14. UNIT HEATER (PROPELLER), PLAN

15. UNIT VENTILATOR, PLAN

16. VALVES

16.1 CHECK

16.2 DIAPHRAGM

16.3 GATE

16.4 GLOBE

16.5 LOCK SHIELD

16.6 MOTOR OPERATED — M

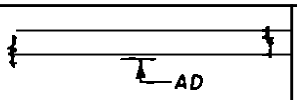
16.7 REDUCING PRESSURE

16.8 RELIEF (EITHER PRESSURE OR VACUUM) — R

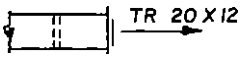
17. VENT POINT — VENT

TABLE A-8. GRAPHIC **SYMBOLS** FOR VENTILATING

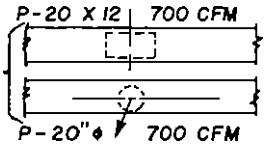
18. ACCESS DOOR



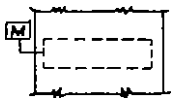
19. ADJUSTABLE BLANK OFF



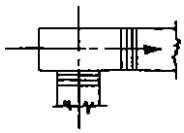
20. ADJUSTABLE PLAQUE



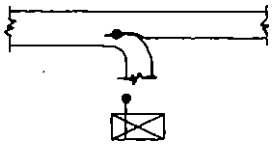
21. AUTOMATIC DAMPERS



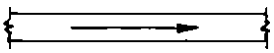
22. CANVAS CONNECTIONS



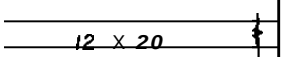
23. DEFLECTING DAMPER



24. DIRECTION OF **FLOW**



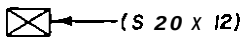
25. DUCT (1ST FIGURE, SIDE SHOWN; 2ND SIDE NOT **SHOWN**)



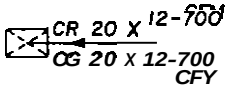
26. DUCT SECTION (EXHAUST OR **RETURN**)

(E OR R 20 X 12)

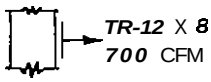
27. DUCT SECTION (SUPPLY)



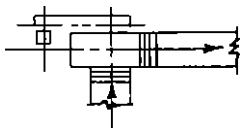
28. EXHAUST INLET CEILING (INDICATE **TYPE**)



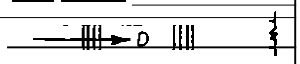
29. EXHAUST INLET WALL (INDICATE **TYPE**)



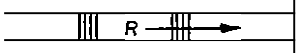
30. FAN AND MOTOR **WITH** BELT GUARD



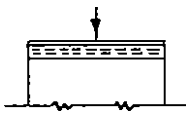
31. INCLINED DROP IN RESPECT TO AIR FLOW



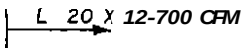
32. INCLINED **RISE** IN RESPECT TO AIR FLOW



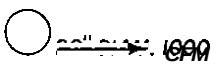
33. INTAKE LOUVERS ON SCREEN



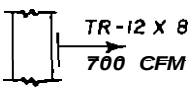
34. LOUVER OPENING



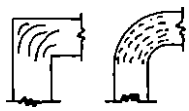
35. SUPPLY OUTLET CEILING (INDICATE **TYPE**)



36. SUPPLY OUTLET WALL **(INDICATE TYPE)**



37. VANES



38. VOLUME DAMPER

TABLE A-9. GRAPHIC SYMBOLS FOR AIR CONDITIONING

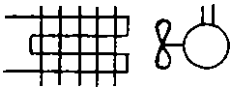
39. CAPILLARY TUBE 

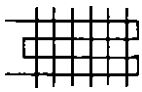
40. COMPRESSOR 

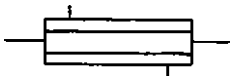
41. COMPRESSOR, ENCLOSED CRANKCASE, ROTARY, BELTED 

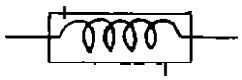
42. COMPRESSOR, OPEN CRANKCASE, RECIPROCATING, BELTED 

43. COMPRESSOR, OPEN CRANKCASE, RECIPROCATING, DIRECT DRIVE 

44. CONDENSER, AIR COOLED, FINNED, FORCED AIR 

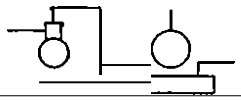
45. CONDENSER, AIR COOLED, FINNED, STATIC 

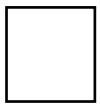
46. CONDENSER, WATER COOLED, CONCENTRIC TUBE IN A TUBE 

47. CONDENSER, WATER COOLED, SHELL AND COIL 

48. CONDENSER, WATER COOLED, SHELL AND TUBE 

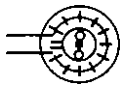
49. CONDENSING UNIT, AIR COOLED 

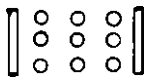
50. CONDENSING UNIT, WATER COOLED 

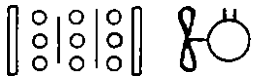
51. COOLING TOWER 

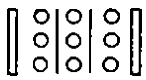
52. DRYER 

53. EVAPORATIVE CONDENSER 

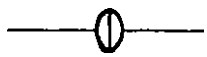
54. EVAPORATOR, CIRCULAR, CEILING TYPE, FINNED 

55. EVAPORATOR, MANIFOLDED, BARE TUBE, GRAVITY AIR 

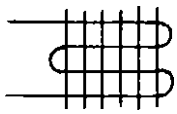
56. EVAPORATOR, MANIFOLDED, FINNED, FORCED AIR 

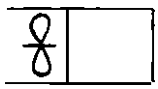
57. EVAPORATOR, MANIFOLDED, FINNED, GRAVITY AIR 

58. EVAPORATOR, PLATE COILS, HEADERED OR MANIFOLD 

59. FILTER, LINE 

60. FILTER & STRAINER, LINE 

61. FINNED TYPE COOLING UNIT, NATURAL CONVECTION 

62. FORCED CONVECTION COOLING UNIT 

63. GAUGE 

64. HIGH SIDE FLOAT 

65. IMMERSION COOLING UNIT 

66. LOW SIDE FLOAT 

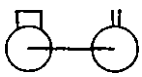
67. MOTOR-COMPRESSOR. ENCLOSED CRANKCASE, RECIPROCATING, DIRECT CONNECTED 

TABLE A-9 (continued). GRAPHIC SYMBOLS FOR AIR CONDITIONING

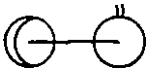
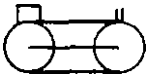
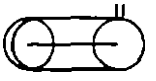
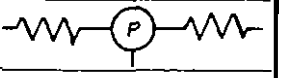
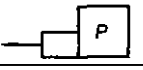
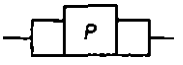
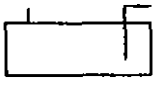
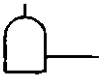
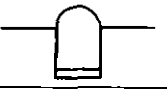
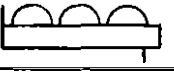
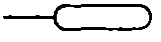
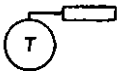
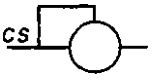
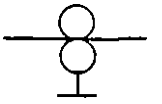
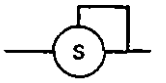
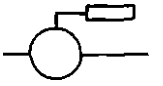
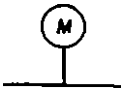
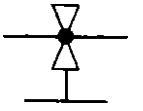
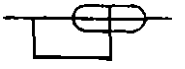
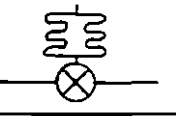
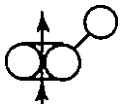
68. MOTOR-COMPRESSOR, ENCLOSED CRANKCASE, ROTARY, DIRECT CONNECTED	
69. MOTOR-COMPRESSOR, SEALED CRANKCASE, RECIPROCATING	
70. MOTOR-COMPRESSOR, SEALED CRANKCASE, ROTARY	
71. PRESSURESTAT	
72. PRESSURE SWITCH	
73. PRESSURE SWITCH **WITH HIGH** PRESSURE CUT-OUT	
74. RECEIVER, HORIZONTAL	
75. RECEIVER, VERTICAL	
76. SCALE TRAP	
77. SPRAY POND	
78. THERMAL BULB	
79. THERMOSTAT (REMOTE BULB)	
80. VALVES	
80.1 AUTOMATIC EXPANSION	
80.2 COMPRESSOR SUCTION PRESSURE LIMITING, THROTTLING TYPE (COMPRESSOR SIDE)	
80.3 CONSTANT PRESSURE, SUCTION	
80.4 EVAPORATOR PRESSURE REGULATING, SNAP ACTION	
80.5 EVAPORATOR PRESSURE REGULATING, THERMOSTATIC THROTTLING TYPE	
80.6 EVAPORATOR PRESSURE REGULATING, THROTTLING TYPE (EVAPORATOR SIDE)	
80.7 HAND EXPANSION	
80.8 MAGNETIC STOP	
80.9 SNAP ACTION	
80.10 SUCTION VAPOR REGULATING	
80.11 THERMO SUCTION	
80.12 THERMOSTATIC EXPANSION	
80.13 WATER	
81. VIBRATION ABSORBER, **LINE**	

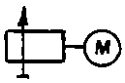
TABLE A-10. GRAPHIC SYMBOLS FOR HEAT POWER APPARATUS

1. COMPRESSOR

1.1 ROTARY

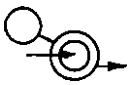


1.2 RECIPROCATING



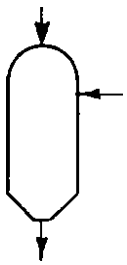
1.3 CENTRIFUGAL

M–Motor
T–Turbine

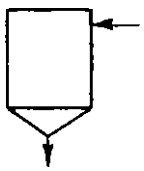


2. CONDENSER

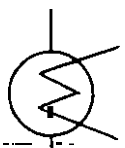
2.1 BAROMETRIC



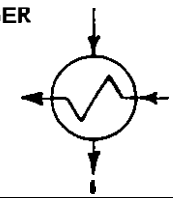
2.2 JET



2.3 SURFACE



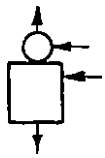
3. COOLER OR HEAT EXCHANGER



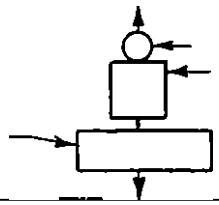
4. COOLING TOWER

5. DEAERATOR

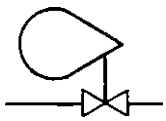
5.1



5.2 WITH SURGE TANK

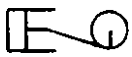


6. DRAINER OR LIQUID LEVEL CONTROLLER



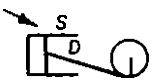
7. ENGINE

7.1 STEAM

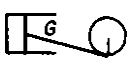


7.2

S–Supercharger
D–Diesel



7.3 G-Go.



8. EVAPORATOR

8.1 SINGLE EFFECT

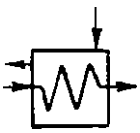
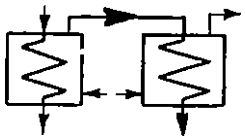
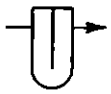


TABLE A-10 (continued). GRAPHIC SYMBOLS FOR HEAT POWER APPARATUS

8.2 DOUBLE EFFECT

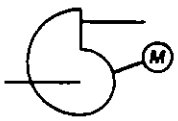


9. EXTRACTOR



10. FAN-BLOWER

M–Motor
T–Turbine



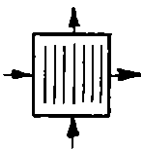
11. FILTER

12. FLOW NOZZLE

13. FLUID DRIVE

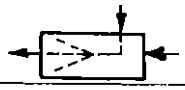
14. HEATER

14.1 AIR (Plate or Tubular]

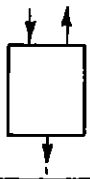


14.2 AIR (Rotating Type)

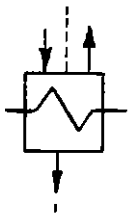
14.3 DESUPERHEATER



14.4 DIRECT CONTACT FEED-WATER



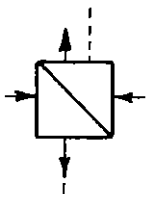
14.5 FEED WITH AIR OUTLET



14.6 FLUE GAS REHEATER

[Intermediate Superheater)

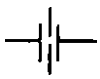
14.7 LIVE STEAM SUPERHEATER OR REHEATER



15. LIQUID LEVEL CONTROLLER

SEE ITEM 6.

16. ORIFICE



17. PRECIPITATOR

E–Electrostatic
M–Mechanical
W–Wet

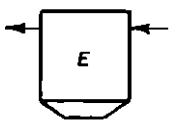
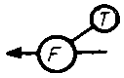


TABLE A-10 (continued). GRAPHIC SYMBOLS FOR HEAT POWER APPARATUS

18. PUMP

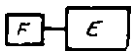
18.1 CENTRIFUGAL AND ROTARY



Letters Denote service
F–Boiler Feed
S–Service
D–Condensate
C–Circ. Water
V– A;.
O–Oil

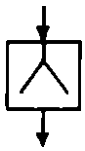
M–Motor
T–Turbine
E–Steam Engine
G-Gas *Engine*
D–Diesel Engine

18.2 RECIPROCATING



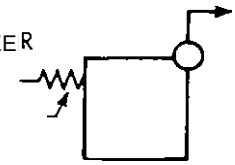
18.3 DYNAMIC (Air Ejector or Eductor)

19. SEPARATOR



20. STEAM GENERATOR

20.2 BOILER WITH ECONOMIZER

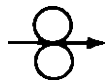


21. STEAM TRAP

22. STRAINER

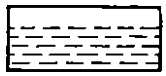
22.1 SINGLE

22.2 DOUBLE

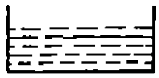


23. TANK

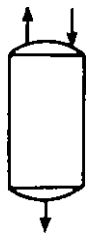
23.1 CLOSED



23.2 OPEN

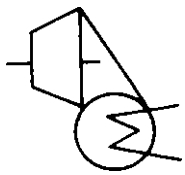


23.3 FLASH OR PRESSURE

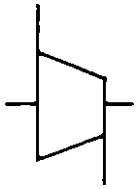


24. TURBINE

24.1 CONDENSING



24.2 STEAM TURBINE OR AXIAL COMPRESSOR



25. VENTURI TUBE

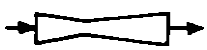
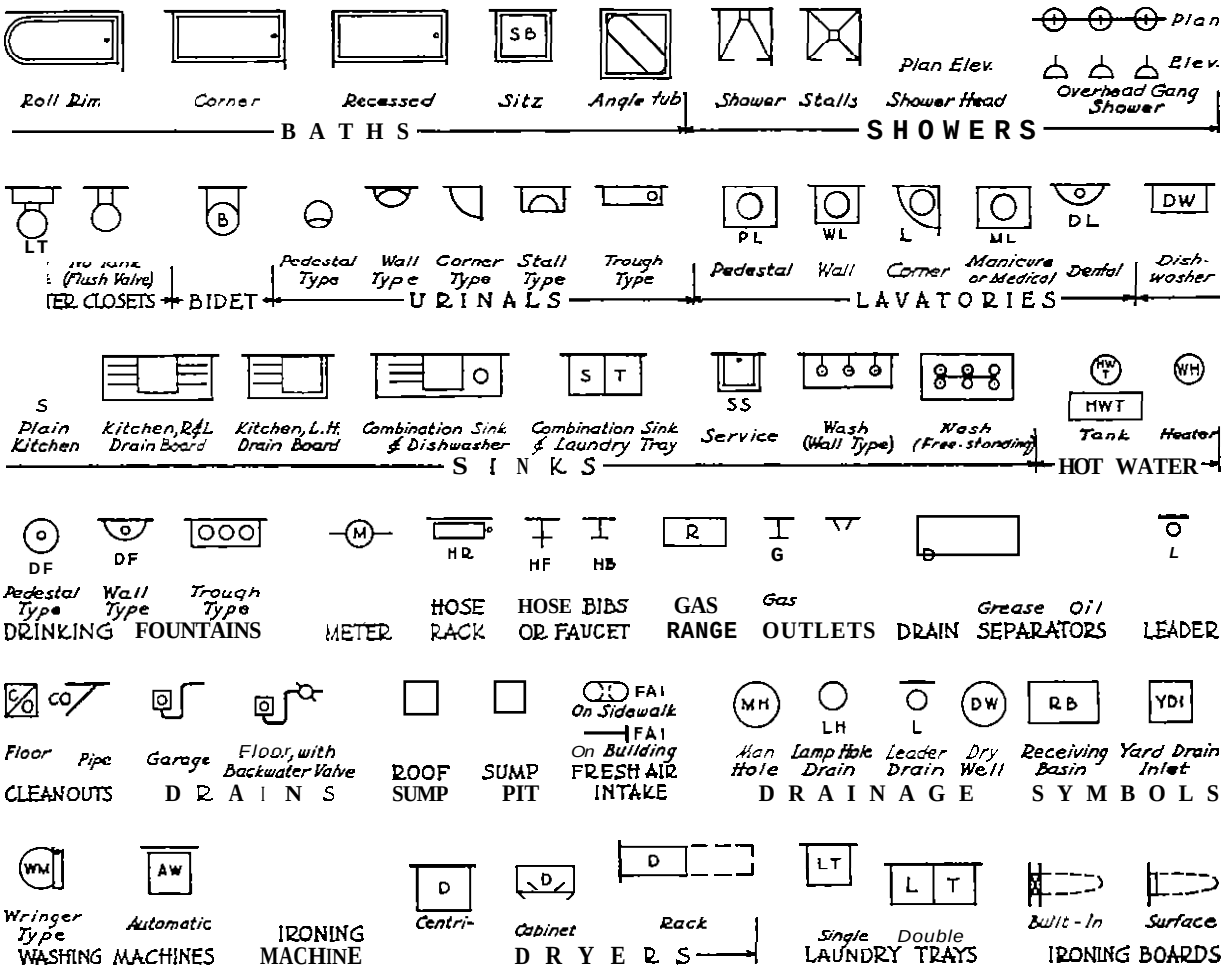


TABLE A-11. PLUMBING SYMBOLS

PLUMBING FIXTURE SYMBOLS



PIPING SYMBOLS

PLUMBING

- Soil, Waste or Leader (Above Grade)
- Soil, Waste or Leader (Below Grade)
- Vent
- Cold water
- Hot Water
- Hot water Return
- Fire Line — F — F
- Gas — G — G
- Acid Waste — ACID
- Drinking Water Flow
- Drinking Water Return
- Vacuum Cleaning — V — V
- Compressed Air — A

SPRINKLERS

- Main Supplies — S
- Branch and Head
- Drain — S — S

PNEUMATIC TUBES

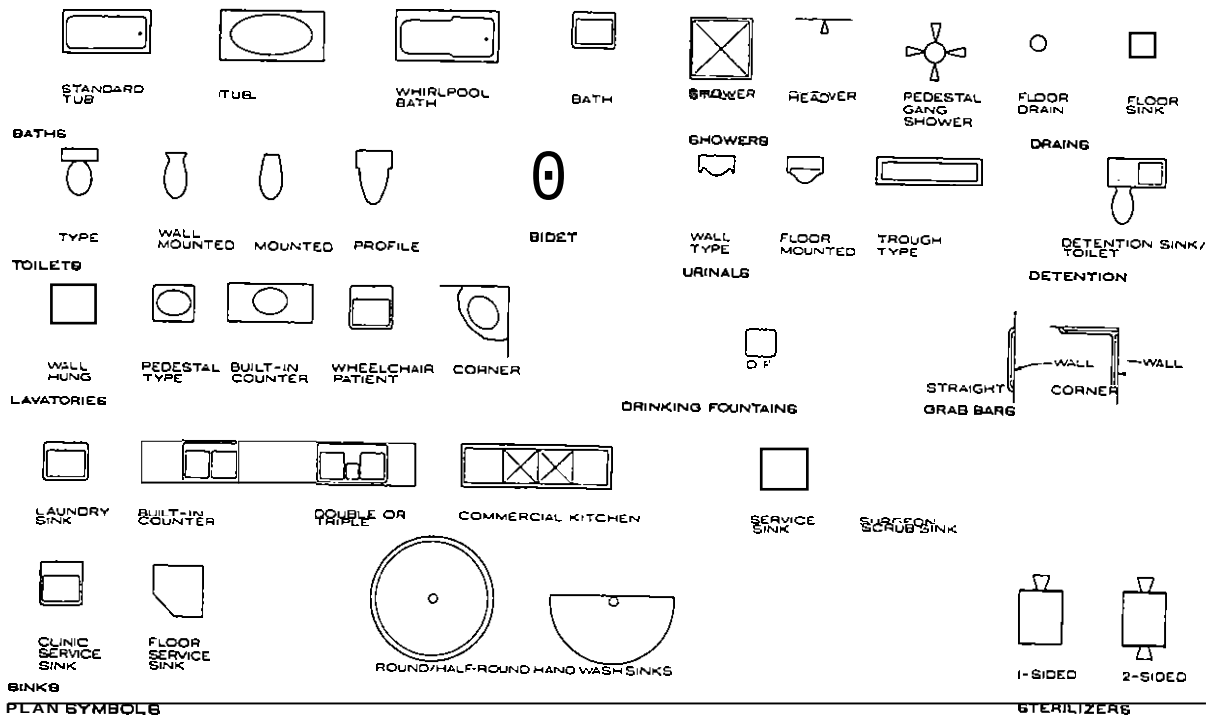
- Tube Runs

DRAINAGE*

- Sewer–Cast Iron — S-CI
- Sewer–Clay Tile, Bell & Spigot — S-CT
- Drain–Clay Tile, Bell & Spigot
- Drain–Open Tile or Agricultural Tile

USASI Standard Symbols

TABLE A-12. PLUMBING FIXTURE AND MISCELLANEOUS PLAN SYMBOLS



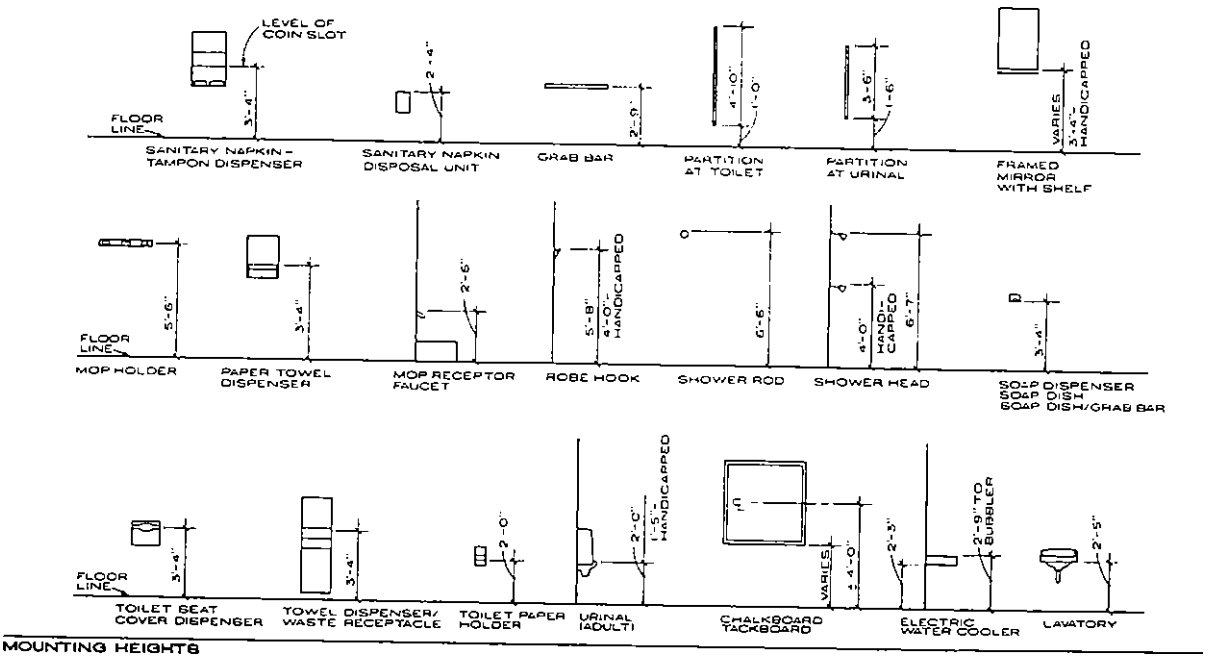


TABLE A-13. HVAC AND DUCTWORK SYMBOLS

HEATING AND VENTILATING SYMBOLS

HEAT TRANSFER SURFACE, PLAN

EXPOSED RADIATOR

RECESSED RADIATOR

ENCLOSED RADIATOR FLUSH

ENCLOSED RADIATOR PROJECTING

UNIT HEATER (PROPELLER), PLAN

UNIT HEATER (CENTRIFUGAL) PLAN

UNIT VENTILATOR, PLAN

STEAM (INDICATE TYPE)

F & T

BLAST THERMOSTATIC TRAP

FLOW METER, VENTURI

VFM

STRAINER, DUPLEX

REDUCING PRESSURE VALVE

AIR LINE VALVE

LOCK SHIELD VALVE

DIAPHRAGM VALVE

OR

AIR ELIMINATOR VALVE

STRAINER

THERMOMETER

PRESSURE GAUGE AND COCK

RELIEF VALVE

HEATING AND VENTILATING (CONT.)

AUTOMATIC AIR VENT — AV

AUTOMATIC 3-WAY VALVE

AUTOMATIC 2-WAY VALVE

SOLENOID VALVE — S

FLEXIBLE CONNECTOR

THERMOSTAT, ELECTRIC — T

THERMOSTAT, PNEUMATIC — T

DUCTWORK SYMBOLS

DUCT (1ST FIGURE, WIDTH; 2ND, DEPTH) — 12 X 20

DIRECTION OF FLOW

INCLINED DROP IN RESPECT TO AIR FLOW — D

INCLINED RISE IN RESPECT TO AIR FLOW — R

FLEXIBLE CONNECTION

DUCTWORK WITH ACOUSTICAL LINING

FIRE DAMPER WIT* ACCESS DOOR — FD AD

MANUAL VOLUME DAMPER — VD

AUTOMATIC VOLUME DAMPER

EXHAUST, RETURN OR OUTSIDE AIR DUCT SECTION — 20 X 12

SUPPLY DUCT SECTION — 20 X 12

SUPPLY OUTLET, CEILING DIFFUSER — 20" DIA CD 1000 CFM

SUPPLY OUTLET, CEILING DIFFUSER — 20 X 12 CD 700 CFM

LINEAR DIFFUSER — 96 X 6-LD 400 CFM

DUCTWORK (CONT.)

TOP REGISTER OR GRILLE — 20X12-TR 700CFM; 20X12-TG 700CFM

CENTER REGISTER OR GRILLE — 20X12-CR 700CFM; 20X12-CG 700CFM

BOTTOM REGISTER OR GRILLE — 20X12-BR 700CFM; 20X12-BG 700CFM

TOP AND BOTTOM REGISTER OR GRILLE — 20X12-T AND BR 700CFM EA; 20X12-T AND BG 700CFM EA.

FLOOR REGISTER — 20X12 FR 700CFM

MIXING BOX

ADJUSTABLE PLAQUE — 20X12-P 700 CFM; 20" Φ P 700 CFM

SPLITTER DAMPER

SPLITTER DAMPER, UP

SPLITTER DAMPER, DOWN

ADJUSTABLE BLANK OFF — 20X12TR

TURNING VANES

FAN AND MOTOR WITH BELT GUARD

LOUVER OPENING — 20X12-L 700CFM

INTAKE LOUVERS ON SCREEN

TABLE A-14. COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

Symbol	Description	Abbreviation
SD	STORM DRAIN. RAINWATER DRAIN	SD
SSD	SUB-SOIL DRAIN, FOOTING DRAIN	SSD
	SOIL, WASTE OR SANITARY SEWER	S, W, SAN
	VENT	V
AW	ACID WASTE	AW
AV	ACID VENT	AV
D	INDIRECT DRAIN	D
PD	PUMP DISCHARGE LINE	PD
	COLD WATER	CW
	HOT WATER SUPPLY (140°F)[1]	HW
	HOT WATER RECIRCULATING (140°F)[1]	HWR
TEMP	HOT WATER (TEMP. °F)[2]	TEMP. HW
TEMP	HOT WATER RECIRCULATING (TEMP. °F)[2]	TEMP. HWR
DWS	CHILLED DRINKING WATER SUPPLY	DWS
DWR	CHILLED DRINKING WATER RECIRCULATING	DWR
SW	SOFT WATER	SW
CL	CHLORINATED WATER	CL
DI	DISTILLED WATER	DI
DE	DEIONIZED WATER	DE

TABLE A-14 (continued). COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

Symbol	Description	Abbreviation
LS	LAWN SPRINKLER SUPPLY	LS
F	FIRE PROTECTION WATER SUPPLY	F
SP	AUTOMATIC FIRE SPRINKLER	SP
G	GAS — LOW PRESSURE	G
MG	GAS — MEDIUM PRESSURE	MG
HG	GAS — HIGH PRESSURE	HG
GV	GAS VENT	GV
FOS	FUEL OIL SUPPLY	FOS
FOR	FUEL OIL RETURN	FOR
FOV	FUEL OIL VENT	FOV
RG	REGULAR GASOLINE	RG
NLG	NON-LEADED GASOLINE	NLG
PG	PREMIUM GASOLINE	PG
DF	DIESEL FUEL	DF
GV	GASOLINE VENT	GV
LO	LUBRICATING OIL	LO
LOV	LUBRICATING OIL VENT	LOV
WO	WASTE OIL	WO
WOV	WASTE OIL VENT	WOV
OX	OXYGEN	OX
LOX	LIQUID OXYGEN	LOX
A	COMPRESSED AIR[3]	A
X#A	COMPRESSED AIR — X#[3]	X#A
MA	MEDICAL COMPRESSED AIR	MA
LA	LABORATORY COMPRESSED AIR	LA

TABLE A-14 (continued). COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

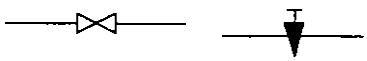
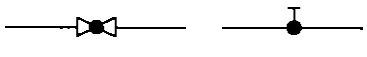
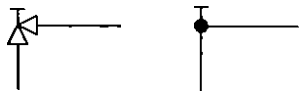
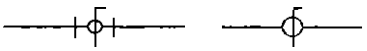
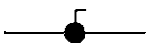
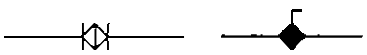
Symbol	Description	Abbreviation
V	VACUUM	VAC
MV	MEDICAL VACUUM	MV
SV	SURGICAL VACUUM	SV
LV	LABORATORY VACUUM	LV
N	NITROGEN	N
N_2O	NITROUS OXIDE	N_2O
CO_2	CARBON DIOXIDE	CO_2
WVC	WET VACUUM CLEANING	WVC
DVC	DRY VACUUM CLEANING	DVC
LPS	LOW PRESSURE STEAM SUPPLY	LPS
LPR	LOW PRESSURE STEAM RETURN	LPR
MPS	MEDIUM PRESSURE STEAM SUPPLY	MPS
MPR	MEDIUM PRESSURE STEAM RETURN	MPR
HPS	HIGH PRESSURE STEAM SUPPLY	HPS
HPR	HIGH PRESSURE STEAM RETURN	HPR
ATV	ATMOSPHERIC VENT (STEAM OR HOT VAPOR)	ATV
	GATE VALVE	
	GLOBE VALVE	
	ANGLE VALVE	
	BUTTERFLY VALVE	
	GAS COCK, GAS STOP	
	BALANCING VALVE (SPECIFY TYPE)	

TABLE A-14 (continued). COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

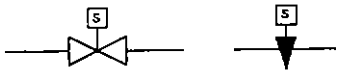
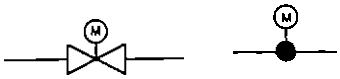
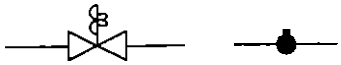
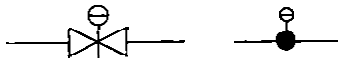
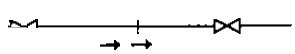
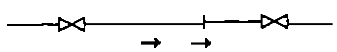
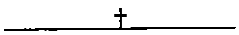
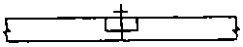
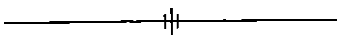
Symbol	Description	Abbreviation
	SUPERVISED VALVE	
	MOTOR OPERATED VALVE (SPECIFY TYPE]	
	SOLENOID OPERATED VALVE (ELECTRIC]	
	SELF-OPERATED VALVE (THERMO, VAPOR-PRESSURE)	SOV
	GAS PRESSURE REGULATOR	
	PRESSURE REDUCING VALVE	PRV
	PRESSURE RELIEF VALVE	RV
	TEMPERATURE-PRESSURE RELIEF VALVE	TPV
	REDUCED ZONE BACKFLOW PREVENTER	RZBP
	DOUBLE CHECK BACKFLOW PREVENTER	DCBP
	HOSE BIBB	HB
	RECESSED BOX HOSE BIBB OR WALL HYDRANT	WH
	VALVE IN YARD BOX (VALVE TYPE SYMBOL AS REQUIRED FOR VALVE USED)	YB
	UNION (SCREWED)	
	UNION (FLANGED)	
	STRAINER (SPECIFY TYPE)	

TABLE A-14 (continued). COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

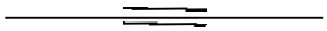
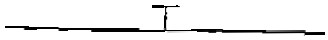
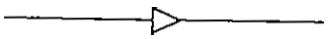
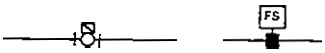
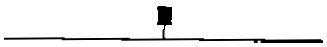
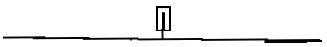
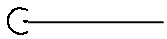
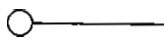
Symbol	Description	Abbreviation
	PIPE ANCHOR	
	PIPE GUIDE	
	EXPANSION JOINT	
	FLEXIBLE CONNECTOR	
	PLUGGED TEE	
	CONCENTRIC REDUCER	
	ECCENTRIC REDUCER	
	AQUASTAT	
	FLOW SWITCH	FS
	PRESSURE SWITCH	PS
	WATER HAMMER ARRESTER	WHA
	PRESSURE GAUGE WITH GAUGE COCK	
	THERMOMETER (SPECIFY TYPE)	
	AUTOMATIC AIR VENT	AAV
	VALVE IN RISER (TYPE AS SPECIFIED OR NOTED)	
	RISER DOWN (ELBOW)	
	RISER UP (ELBOW)	

TABLE A-14 (continued). COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

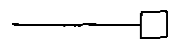
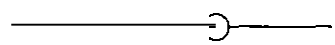
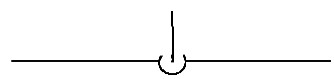
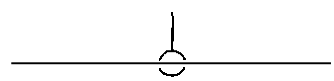
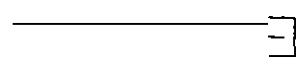
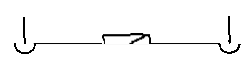
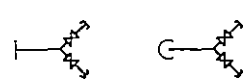
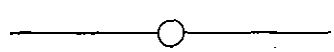
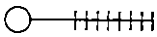
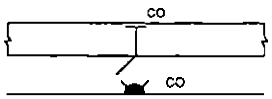
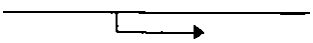
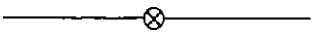
Symbol	Description	Abbreviation
	AIR CHAMBER	AC
	RISE OR DROP	
	BRANCH — TOP CONNECTION	
	BRANCH — BOTTOM CONNECTION	
	BRANCH — SIDE CONNECTION	
	CAP ON END OF PIPE	
	FLOW INDICATOR FOR STATIONARY METER	
	FLOW INDICATOR FOR PORTABLE METER (SPECIFY FLOW RATE)	
	SECTION VALVE	S.V.
	FIRE HYDRAM	FH
	FIRE DEPARTMENT CONNECTION (SPECIFY TYPE)	FDC
	FIRE PUMP TEST CONNECTION	
	UPRIGHT FIRE SPRINKLER HEAD	
	PENDANT FIRE SPRINKLER HEAD	
	SIDEWALL FIRE SPRINKLER HEAD	

TABLE A-14 (continued). COMBINED LIST OF SYMBOLS AND ABBREVIATIONS USED IN THE PIPE TRADES

Symbol	Description	Abbreviation
	AUTOMATIC SPRINKLER SYSTEM EXPRESS DRAIN	ED
	FIRE HOSE RACK	FHR
	FIRE HOSE CABINET (SURFACE MOUNTED)	FHC
	FIRE HOSE CABINET (RECESSED)	FHC
	CLEANOUT PLUG	CO
	FLOOR CLEANOUT	FCO
	WALL CLEANOUT	WCO
	YARD CLEANOUT OR CLEANOUT TO GRADE	CO
	DRAIN (ALL TYPES) (SPECIFY)	D
	PITCH DOWN DIRECTION OF ARROW	
	FLOW—IN DIRECTION OF ARROW	
	POINT OF CONNECT	POC
	OUTLET (Specify Type)	
	STEAM TRAP (ALL TYPES)	

Notes

[1]Hot Water (140 F) and Hot Water Return (140 F) -- Use for normal hot water distribution syslcrn, usually but not nescessary (140 F). Change temperature designation if required.

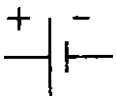
[2]Hot Water (TEMP. F) and Hot Water Return (TEMP. F) -- Use for any domestic hot water system (Examples: Tempered, sanitizing) required in addition to the normal system (See 1 above). Insert system supply temperature where "TEMP." is indicated.

[3]Compressed Air and Compressed Air XI: -- Use pressure designations. X#, when compressed air is lo bc distributed at more than one pressure.

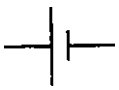
TABLE A-15 (continued). **ELECTRICAL SYMBOLS**

BATTERY

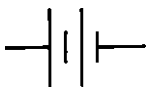
The long line is always positive, but polarity may be indicated in addition.



Polarity



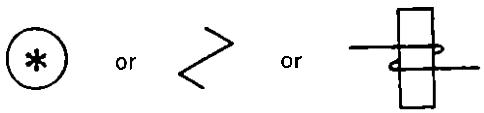
One cell



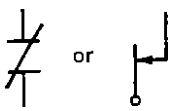
Multicell

COIL

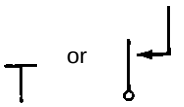
The asterisk is not a part of the symbol. Always replace the asterisk by a device designation.



CONTACTS



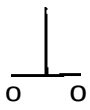
Closed contact



Open contact

FUSE

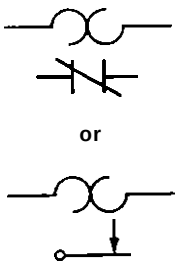
PUSH BUTTON



Depress button for Circuit closing (make)

Depress button for Circuit opening (break)

THERMAL RELAY



USASI Standard Symbo'