3. Mechanical drawings and specifications

Overview

Purpose

The mechanical drawing is a necessary tool in the gas industry. For example, mechanical drawings are the “maps” you need to understand exactly where you will install an appliance and where you will connect the gas piping is to be connected. The gas technician/fitter must have a good understanding of how to interpret these important drawings and the symbols used in them.

Objectives

At the end of this Chapter, you will be able to:

- describe basic drawing views;
- describe types of drawings;
- describe lines and symbols;
- describe supplements to a mechanical drawing; and
- interpret a mechanical drawing.

Terminology

Term	**Abbreviation (symbol)**	**Definition**
Scale		Proportional ratio of a linear dimension of the model to the same feature of the original

Basic drawing views

Buildings are three-dimensional objects. As such, there is no single view that can show an entire building and all the details you need to build it. For this reason, a set of construction drawings usually includes a variety of different views showing the building from different angles. This section introduces the basic types of drawings and the views for conveying construction information.

Pictorial drawings

Pictorial or perspective drawings are easy to understand because they show an object as it appears. Like photographs, pictorials show the length, width, and height of objects in a single view. Viewers quickly get a mental image of an object, even if they are inexperienced in reading

3) Match the list of Resources that can be referenced to the information requirement described:

a) Work order directs you to check out operation of the relay controlling heating/cooling thermostat:	Operator's Manual
b) New door switch required:	Operator's Manual
c) Customer lives in a remote area and inquires whether there is some reference he can use if dryer malfunctions on the weekend.	Piping Schematic
d) Customer wants to know how to program thermostat:	Common Problem Troubleshooting Guide
e) Customer inquiries if she can convert her pool heater to natural gas and run it from the existing house line:	Parts Assembly Chart including Parts Numbers
f) Customer inquiries whether it is okay to polish exterior of water heater:	Installation Instructions
g) If the Unit has to be level:	Wiring Schematic

4) Which of the following may be a possible reason why the pilot does not stay lit when the red button is released?
   a) Loose thermocouple
   b) High limit is open
   c) Thermostat not calling for heat

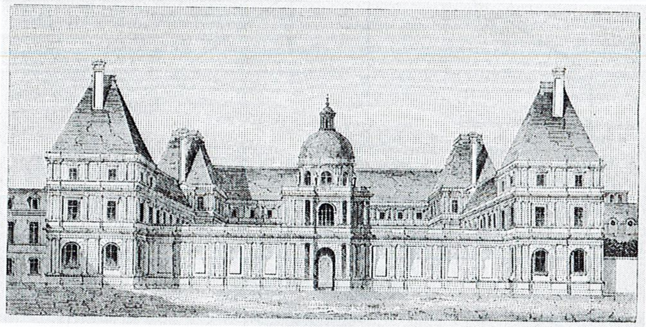
5) When a loose thermocouple is the reason why the pilot does not stay lit, what is the service requirement?
   a) Increase pilot size
   b) Change gas valve
   c) Replace the thermocouple

6) Which of the following may be a possible cause for a yellow flame and sooting problem?
   a) Scale on top of burner
   b) Gas pressure is too high
   c) Gas pressure is too low

7) When scale on top of the burner causes a yellow flame and sooting, what is the service requirement?
   a) Replace appliance
   b) Shut off heater and remove scale
   c) Replace burner

construction prints. Because of this, architects often use pictorial drawings to show the owner of a project how the final building will look. Figure 3-1 shows an example of a pictorial.

Figure 3-1
Pictorial drawings are like photographs, which show the object as it appears



Orthographic projections

While pictorial drawings give a quick mental image of what an object looks like, they are not the best for conveying precise information about the size and shape of objects. In pictorial drawings, at least part of the object is distorted to give it a three-dimensional look. A method of representation that you call *orthographic projection* aims to get around this problem. This drawing method shows separate but related two-dimensional views of an object on a single piece of paper to supply the information you need to fabricate the object.

The best way to understand the principle of orthographic projection is to imagine an object floating inside a glass box (see Figure 3-2). If you were to look at right angles through each side of the box and draw that view of the object on the glass, you would have a sketch like Figure 3-3. The view through each side of the glass box shows only one plane of the object, and all lines are straight and parallel. In other words, each view represents what you would see when you look at the object squarely.

Figure 3-2
Imagine an object floating inside a glass box

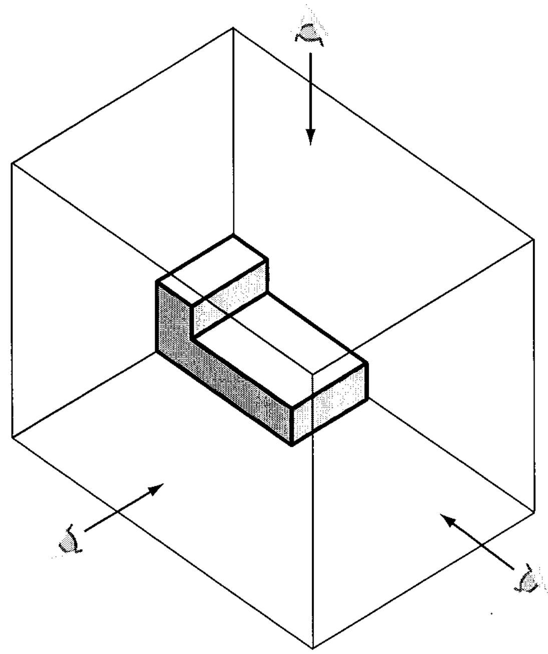
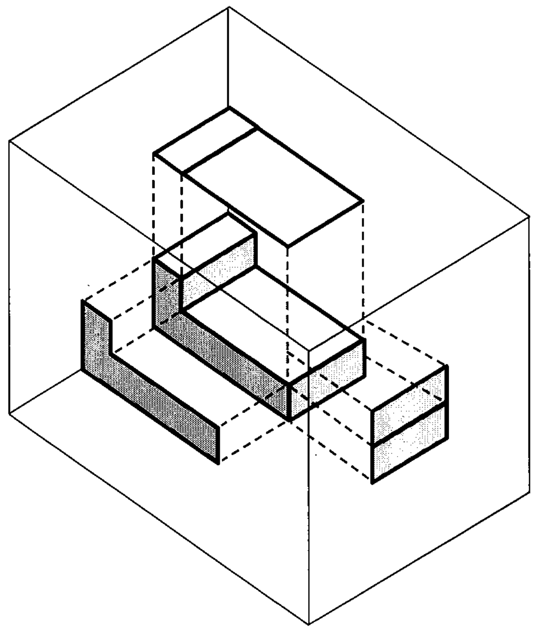
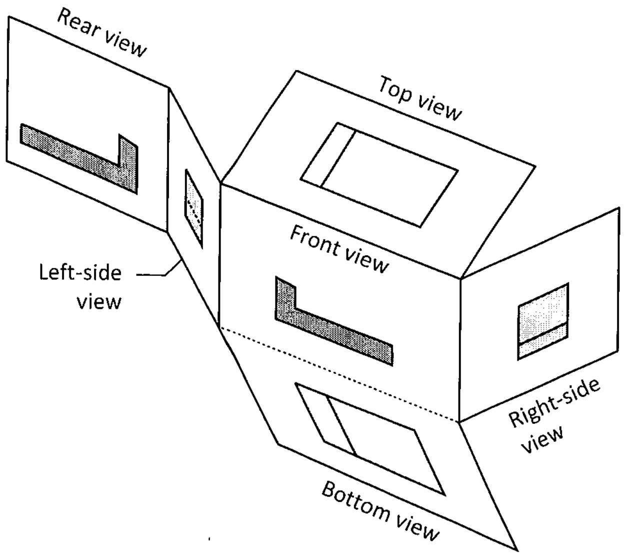


Figure 3-3
Each side of the glass box shows only one plane of the object and all lines are straight and parallel



If you were to open the imaginary glass box (see Figure 3-4), each view would be in the correct position for a true orthographic drawing. Each view has a name that reflects its position in relation to the other views.

Figure 3-4
If you were to open up the imaginary glass box, as shown in Figure 3-5, each view would be in the correct position for a true orthographic drawing



Next, flatten out the imaginary box (see Figure 3-5) and finally remove it completely (see Figure 3-6). The result is a standard six view orthographic projection.

Figure 3-5
Drawing with the glass box flattened out

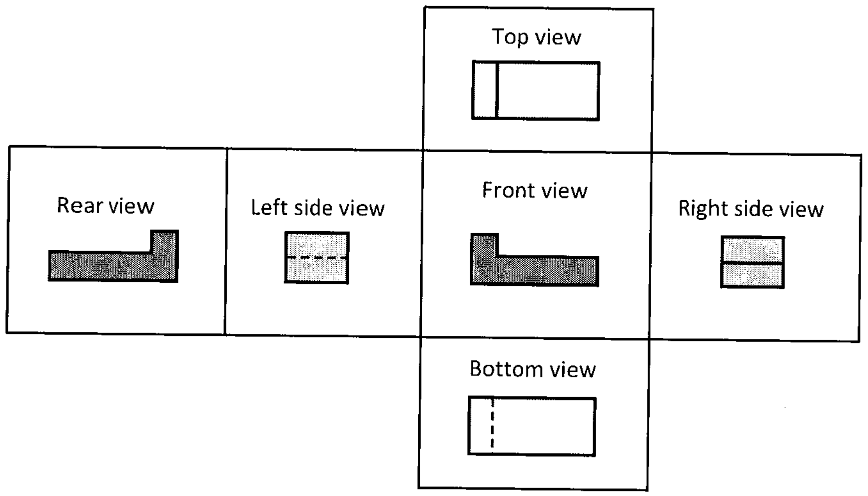
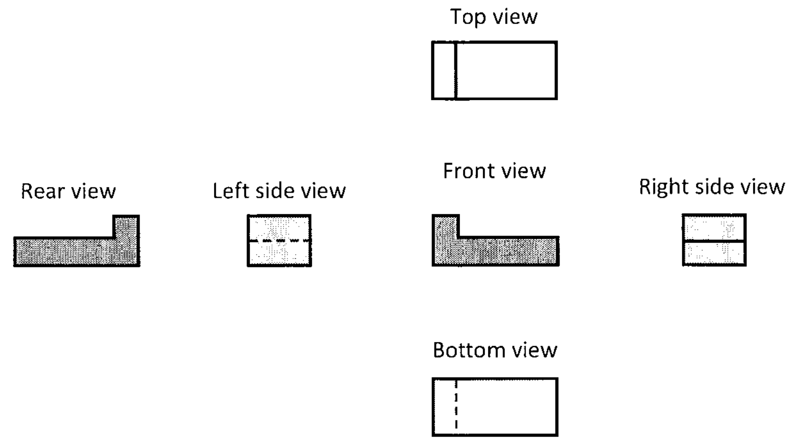
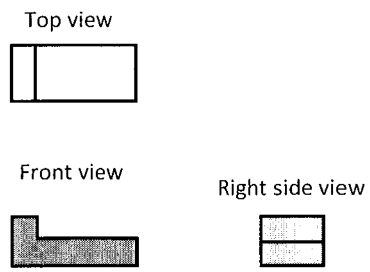


Figure 3-6
Standard six view orthographic projection



In most cases, it is not necessary to show all six sides of an object. Most orthographic projections show only the front, top, and right-side views (see Figure 3-7). Generally, designers only include as many views as needed to convey the information required to fabricate the object.

Figure 3-7
Typical orthographic projection shows only three views

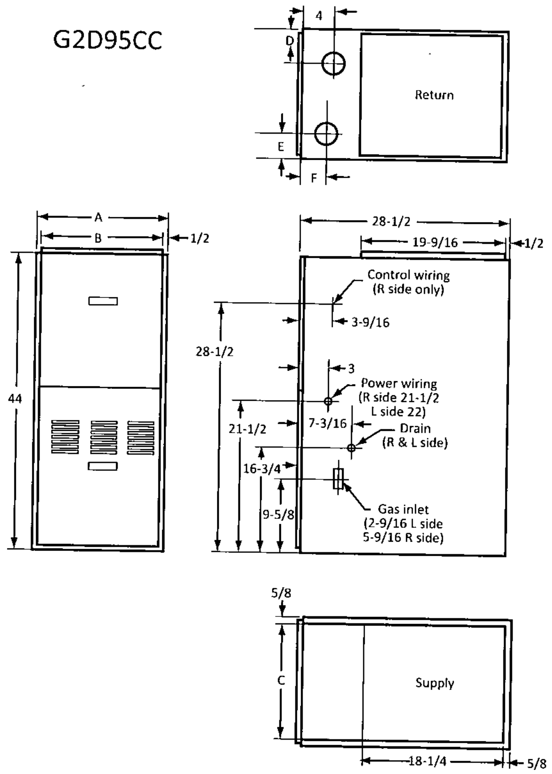


One common use of *orthographic projection* in manufacturer's instructions is to show the dimensions and optional layouts for the appliance or component. Figure 3-8 shows a typical use of an orthographic projection for an Armstrong gas furnace.

Figure 3-8
Orthographic projection of an Armstrong gas furnace

Dimensions (in.) Downflow

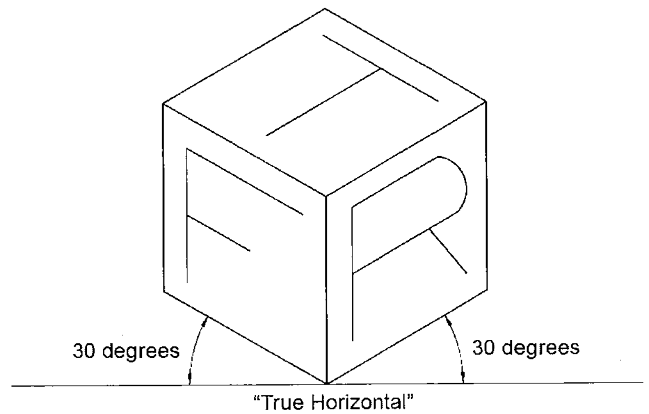
Model	A	B	C	D	E	F
G2D95CC040V12B	17-1/2	16-1/2	16-1/4	3-2/3	4-1/2	3
G2D95CC060V14B						
G2D95CC080V16C	21	20	19-3/4	5-2/3	6-1/4	3
G2D95CC080V20C						
G2D95CC100V20D	24-1/2	23-1/2	23-1/4	4-2/3	6-3/8	3-1/3
G2D95CC125V20D						



Isometric drawings

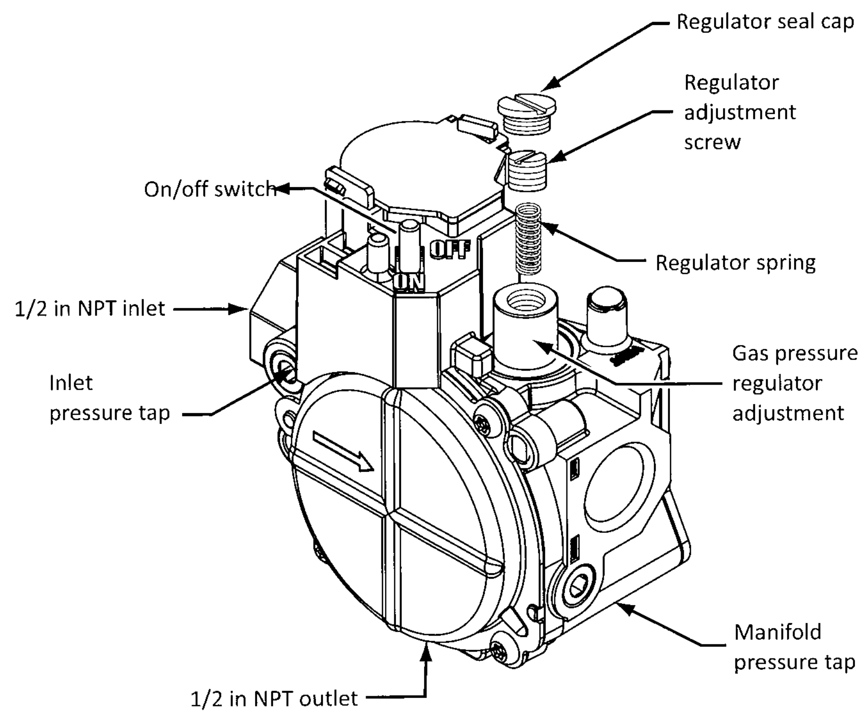
An isometric drawing is like a pictorial or perspective drawing, except that its front view is flat like the front view of an orthographic projection and the receding view is at a 30° angle. See Figure 3-9.

Figure 3-9
Isometric drawing
Image courtesy of IPTJTC, Inc. IPTJTC is a non-profit corporation sponsored by the United Association of Journeymen and Apprentices in the Plumbing and Pipefitting Industry of the United States and Canada, AFL-CIO. www.ua.org.



Manufacturer's instructions often include isometric drawings to show component parts. See Figure 3-10.

Figure 3-10
Example of isometric drawing of a gas valve



Types of drawings

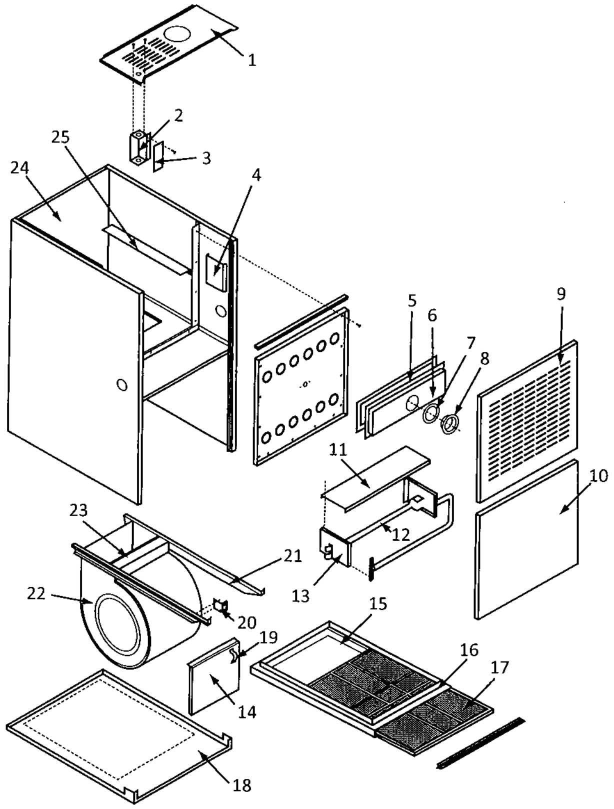
A tremendous number of blueprints and drawings exist on a work site: architectural, structural, mechanical, plumbing, and electrical drawings, as well as manufacturer's drawings. As a gas technician/fitter, note that only a few types of drawings are immediately relevant to your work. Below are detailed explanations of these types.

Detail and assembly drawings

A detail or assembly drawing is a detailed drawing of the components and hardware of an appliance (see Figure 3-11). These drawings are particularly useful when you need to disassemble, assemble, or repair an appliance on the job site.

As the name implies, a detail drawing shows a small part of the entire project in great detail. Often, you use a larger scale to include more detailed information in the drawing.

Figure 3-11
Typical detail and assembly drawing

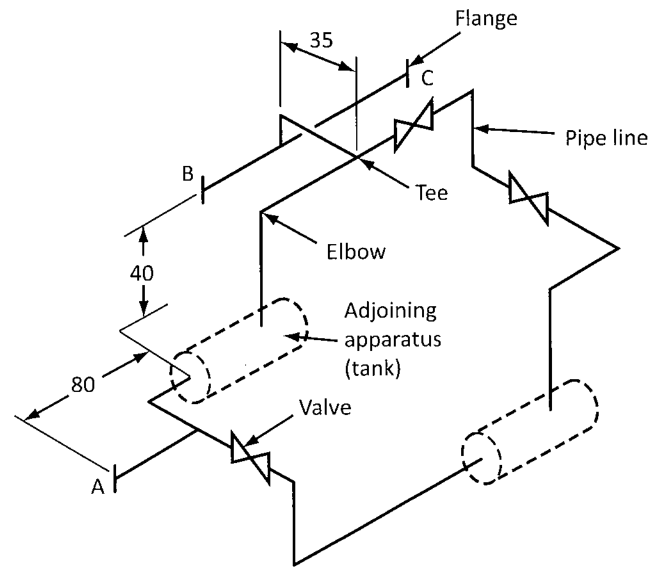


1 Top, gray
2 Field connect box
3 Cover, field connect
4 Control bracket
5 Gasket, collector
6 Collector
7 Gasket, combustion Blower
8 Restrictor, blower high altitude
9 Door, louvered
10 Door, blower
11 Shield, burner
12 Bracket, burner support
13 Manifold support bracket
14 Fan timer bracket
15 Filter rack wrapper
16 Filter rack front
17 Filter, 14X25X1 16X25X1
18 Base
19 Strap, capacitor
20 Bracket, door switch
21 Blower hanger
22 Blower housing
23 Blower cutoff
24 Casing, wrapper
25 Baffle, circulating air heat exchanger support

Piping drawings

Piping drawings can be orthographic or isometric. The typical isometric drawing in Figure 3-12 displays all the important pieces in symbol form like a schematic.

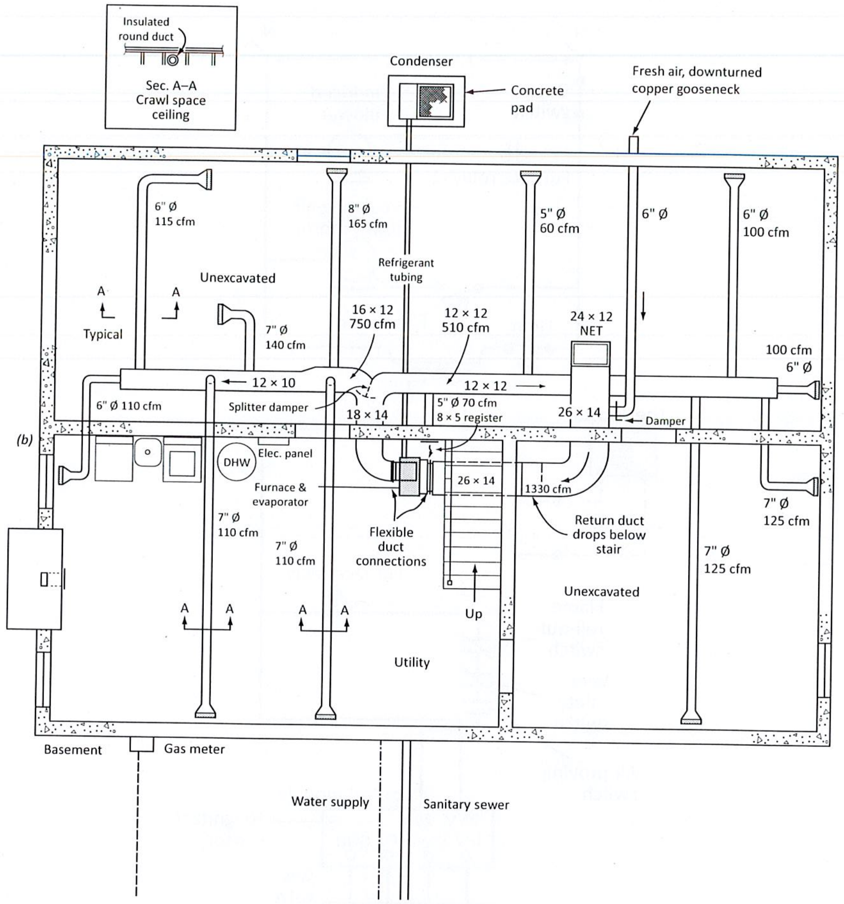
Figure 3-12
Typical example of a piping drawing



Mechanical drawings

The purpose of mechanical drawings is to illustrate the mechanical systems in a building. You draw them during the design of the building and review them during construction. Typically, the drawings include the building address, the location of mechanical equipment such as heating and cooling equipment, ventilation systems, electric panel locations, ductwork location, and sizes. Figure 3-13 is an example of a mechanical drawing.

Figure 3-13
Sample of a mechanical drawing

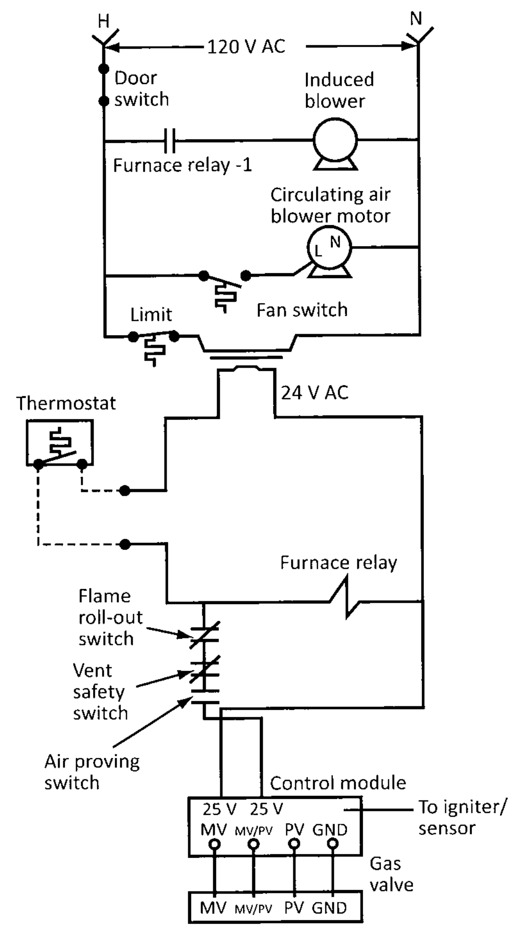


Schematic diagrams

The schematic diagram facilitates the tracing of hydraulic, pneumatic, or electrical lines and the components of each. It shows the relationship between the various parts of a system. It does not show the actual size, shape, or location of the components or devices within the system. Rather, it shows connections, functions, and flow.

Figure 3-14 shows the electrical components that make up an electrical circuit. Note that the figure does not take into account spatial considerations or their physical location. Only the parts and their functions are important.

Figure 3-14
A schematic diagram of a circuit



Wiring diagrams

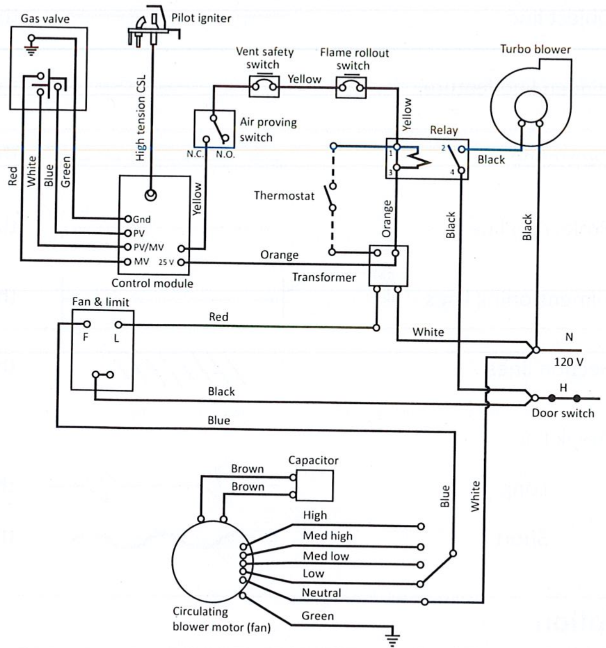
Unlike the diagrams described so far, wiring diagrams show how and where the wires are connected and how they run between devices.

Wiring diagrams are very useful for the initial wiring of a circuit and for tracing wires when troubleshooting. You commonly find them on the rear panel covers of major gas and propane appliances.

Usually, solid lines represent conductors that the manufacturer has wired in the factory, whereas broken or dotted lines represent wiring that you will apply in the field.

The wiring diagram in Figure 3-15 represents the same circuit as the schematic diagram in Figure 3-14.

Figure 3-15
Wiring diagram of an electrical circuit



Schedule

Wiring diagrams often come with a schedule. A schedule is usually a table that lists details such as:

- colours;
- terminal locations; and
- expected voltage.

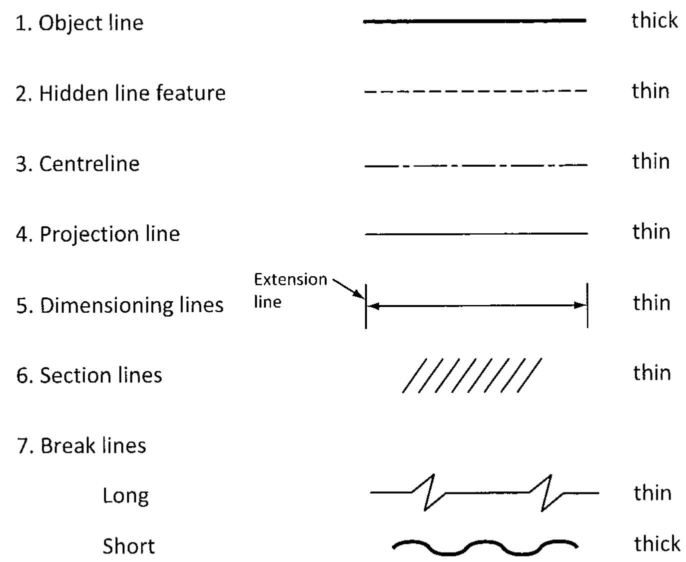
Lines and symbols

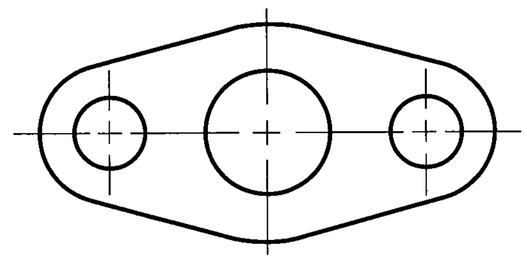
Lines and symbols are the language of the draftsperson. In gas or hydronic systems, they help visually represent pipes, fittings, valves, and components so that, when drawn together in their respective positions, they clearly illustrate a piping system and explain a great deal of how it operates.

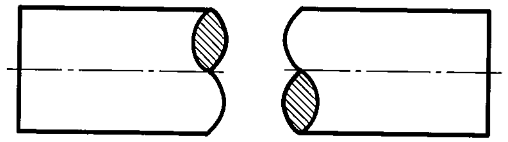
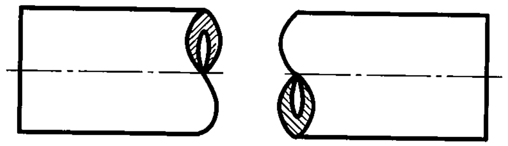
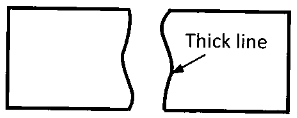
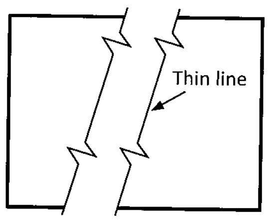
Lines

Lines on technical drawings provide exact information concerning the shape of an object and how it is connected to other objects and various circuits. A variety of lines help convey different meanings. Canadian standards define line thickness as thick or thin. Thick lines are at least twice as thick as thin lines. Figure 3-16 displays various types of lines used, and explanations follow.

Figure 3-16
Types of lines



Type	Description
Object line	Thick lines that trace the visible outline of an object
Hidden line	Thin, equally spaced, broken lines that show those surfaces and features of the object that are hidden in the chosen views
Centreline	Thin, broken lines, with long and short lines spaced alternately that indicate the exact centre of an object (Figure 3-17) **Figure 3-17** **Centerlines** 
Extension line	Thin lines that do not touch the object lines and extend the object lines out to a convenient space for dimensioning
Dimension line	Thin lines that terminate with arrowheads and touch the extension lines, giving the object's measured dimensions such as height, width, and length
Section lines	Hatch marks that identify a sectional view of an object in a drawing (Figure 3-18)

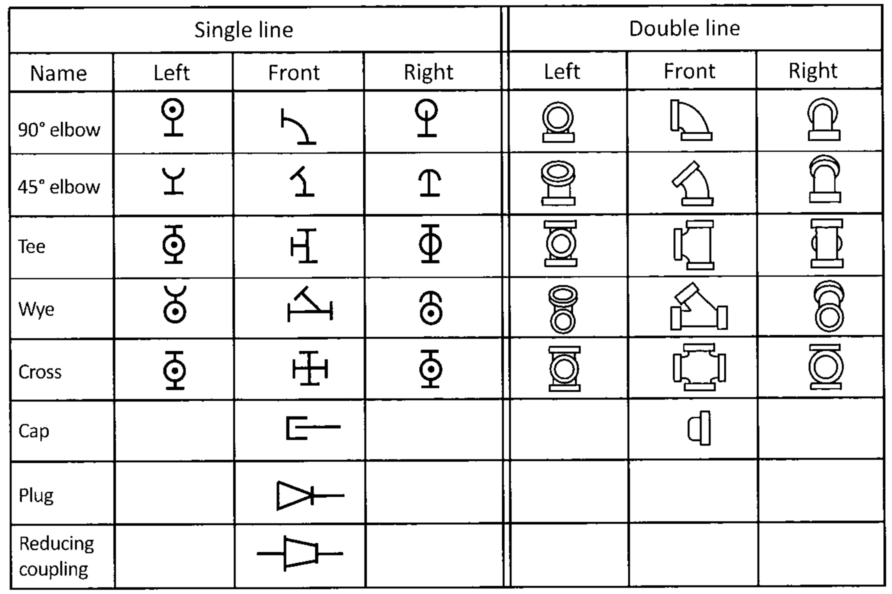
Type	Description
	Figure 3-18 **Section lines for hollow and solid cylinders**  Solid cylinder  Hollow cylinder
Break lines	Help shorten the view of long uniform sections Figure 3-19 shows the two types of break lines used on technical drawings. **Figure 3-19** **Break lines for short and long sections**  Short break – all shapes  Long break – all shapes

Piping symbols and lines

Symbols are the shorthand signs used on drawings. They are for the most part international, but some countries have different symbols. Organizations like the International Organization for Standardization (ISO), CSA Group (CSA), and the American National Standards Institute (ANSI) publish tables of symbols for welding, piping, surface texture, and electrical elements.

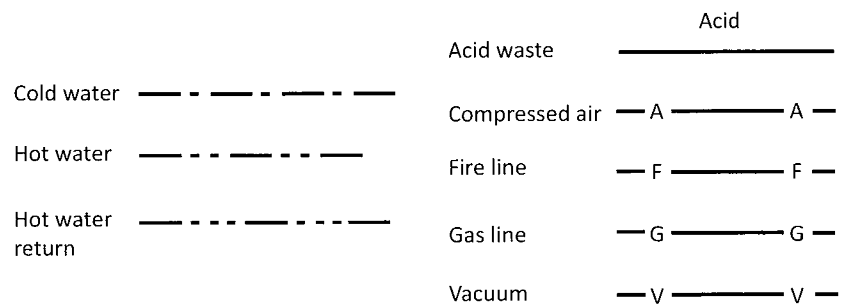
Figure 3-20 shows common fitting symbols.

Figure 3-20
Piping fitting symbols



Plans for piping installations also contain special lines to distinguish the various types of pipes. Figure 3-21 shows an orthographic view of some common piping line symbols and what they represent.

Figure 3-21
Various piping line symbols



Supplements to mechanical drawings

A *specifications book*, a written description of future work, supplements the set of technical drawings for a project. The specification is an integral part of a contract document and is generally considered the most important document after the written agreement.

Other important supplemental information appears on the prints. Some of this information appears in special blocks; examples are the title block, the revision block, and the materials list block. The subsections below discuss these in greater detail.

Specifications

A specification normally accompanies the construction prints and can vary considerably in length depending on the size and complexity of the project. On smaller jobs, the specifications or specs may consist simply of a list of materials written on the same page as the drawings. On large projects, the specifications are printed in book or manual form, often spanning several hundred pages, and cover every aspect of the job from the initial bidding process to the final payment.

Precedence of specifications

The specification is an integral part of the contract documents and is generally considered the most important document after the actual written agreement. For example, if there is any disagreement between the specification and a drawing, you usually take the information in the specification to be correct. The reason is that the specifications usually come last in preparation and reflect final decisions. Written instructions also carry more weight in a court of law. However, if a discrepancy is found, you should report it should to the architect to confirm the correct information.

The scale

The scale is very important, although it does not occupy its own block. It makes it possible to describe details of large and small machines or components on standard sized paper. The size and complexity of the machine determine the scale. The first figure of a scale designation refers to the dimensions you used to draw the object. The second number refers to the actual size of the object.

For example:

Scale	Ratio example	Description
Actual scale	1:1	Drawing is actual size.
Reduced scale	1:10	One (1) Unit on the print represents 10 of the same measuring Units in the drawn object. That is, the drawing is 10 times smaller than the drawn object.
Enlarged scale	10:1	Ten (10) measuring Units on the print equals 1 Unit of the object. That is, the drawing is 10 times larger than the actual size.
In imperial measurement	1/8" = 1'0".	You can describe the scale in imperial measurements, such as 1/8" = 1'0".

Revision block

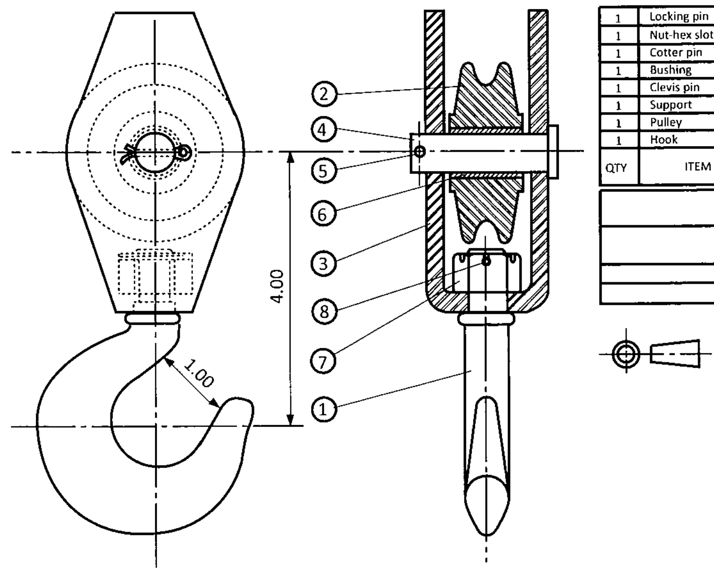
You may place the revision block either in the lower left- or upper right-hand corner of the print. The purpose of this block is to list any and all revisions made to the drawing after the initial drafting of the print.

Materials block

You can generally find the materials block just above the title block. You may also call the materials list the *bill of materials*. Figure 3-22 shows a materials list just above the title block.

You can identify all parts in a materials list by their part or stock number. The materials list also provides for the number and size of each part, including all fasteners such as bolts, washers, and nuts. This is a complete list of parts for that print or page.

Figure 3-22
Materials block



QTY	ITEM	MATL	DESCRIPTION	PT NO
1	Locking pin	STL		8
1	Nut-hex slotted	STL		7
1	Cotter pin	STL		6
1	Bushing	Bronze		5
1	Clevis pin	STL		4
1	Support	SAE 1020		3
1	Pulley	STL		2
1	Hook	STL		1

CRANE HOOK
Scale

Assignment Questions – Chapter 3

1) Which type of drawing uses separate, but related, two-dimensional views of an object?
   a) Ladder diagram
   b) Orthographic projection
   c) Blue print
   d) Schematic

2) Which three orthographic views of an object are most often projected?
   a) Bottom, rear, front
   b) Top, front, left side
   c) Rear, top, bottom
   d) Top, front, right side

3) Which type of diagram does not show the actual size, shape, or location of components within a system, only the connections, functions, and flow?
   a) Schematic diagram
   b) Ladder diagram