

PLUMBERS HANDBOOK

**A practical guide to
planning & installing
drainage, vent, waste,
fire protection, septic,
water and gas piping
systems and setting
plumbing fixtures**

HOWARD C. MASSEY

**Approved
reference
in most states
for plumbing
contractors
exam**

REVISED EDITION



Plumbers Handbook

Revised Edition

By

Howard C. Massey



Craftsman Book Company

6058 Corte del Cedro, P. O. Box 6500, Carlsbad, CA 92018

Acknowledgements

The author expresses his sincere thanks and appreciation

- to Mr. Boyd A. Arp, assistant county manager of Metropolitan Dade County, Miami, Florida, for granting permission to use excerpts from the plumbing sections of the South Florida Building Code to authenticate the information in this book.

- to Mr. A. T. Strother, Executive Director of the Plumbing Industry Program of Miami, Florida, for granting permission to use excerpts from his article "A History of Plumbing" which appeared in *The Florida Contractor Magazine*.

- to the Florida Energy Committee and the Environmental Information Center of the Florida Conservation Foundation, Inc. for pertinent information necessary to authenticate the thermosyphon and pumped solar water heating system.

- to Mr. David Leidel, Chief Plumbing Inspector, and Mr. Larry Glover, assistant plans examiner (plumbing), Metropolitan Dade County, Miami, Florida, for their expertise and assistance in interpreting the intent of certain sections of the plumbing code.

- to American Standard for providing the plumbing fixture roughing-in measurements (as illustrated in Chapter Sixteen).

- to Josam Manufacturing Company for providing the plumbing fixture carriers (as illustrated in Chapter Sixteen).

To my wife, Hilda, for her untiring assistance in editing and typing this manuscript.

Library of Congress Cataloging in Publication Data
Massey, Howard C.
Plumbers handbook.

Includes index.

1. Plumbing--Handbooks, manuals, etc.

I. Title.

TH6125.M37 1985 696'.1 85-9668
ISBN 0-910460-49-3

First Edition ©1978 Craftsman Book Company
Second Edition ©1985 Craftsman Book Company
Fifth printing 1994

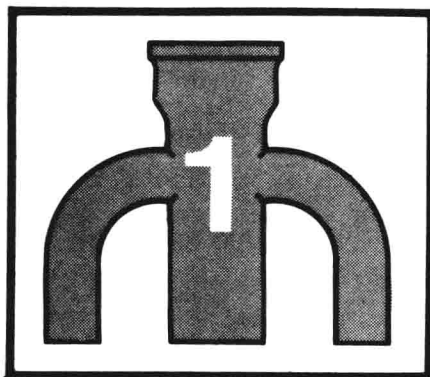
Illustrations by
Gretchen Egge, Bill Grote, and the author

Cover by
Ann B. Sweeney

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Plumbing And The Plumber

If you have chosen plumbing as your profession, you should find it one of the most challenging and satisfying of all construction trades. The possible variations in design, layout, and installation methods in any building can present a stimulating challenge to any professional plumber. Yet, lack of knowledge and failure to understand the minimum requirements of modern plumbing codes have left many would-be plumbers discouraged, frustrated, and confused.

Learning plumbing from a code book can be a very difficult task. This book is intended to help anyone interested in doing professional quality plumbing work grasp the important design and installation principles recognized as essential to the trade. What you learn here should be applicable nearly anywhere in the U.S. regardless of the model code adopted by the jurisdiction where your work is done. Reading and understanding what is written here should be much easier than reading and understanding the code for anyone who is just learning the fundamentals of plumbing. However, this book is not the plumbing code and every plumber will have to refer to his local code from time to time. The minor variations in model plumbing codes are emphasized throughout this book and should be easily recognized as you read and compare sections of this book with your local code. *The basic principles of sanitation and safety remain the same, regardless of the geographical location.*

The art and science of plumbing came into being through the struggle of mankind against disease. The history of civilization is the history of plumbing. At the dawn of civilization, when two or three families gathered together to make a tribe, man drank from springs and streams. He made no provisions for the disposal of sewage and garbage. We can assume that when his place of living became fouled with kitchen refuse and human waste, he moved to a fresh camping ground. When disease killed members of his tribe because they neglected the laws of sanitation, he may have concluded that the gods were offended by the place where the tribe lived, and they moved to a new area. He did not understand that lack of cleanliness breeds disease.

Archeologists, while digging in various parts of the world, have confirmed that some ancient civilizations had developed plumbing systems for protecting health. At Nippur, in Babylon, archeologists have uncovered an aqueduct made of glazed clay brick that dates back to 4500 B.C. This aqueduct contained three lines of glazed clay pipe. Each section was eight inches in diameter and two feet long with a flanged mouth. Other excavations have revealed glazed clay pipe in jar patterns, concave and cone shapes and a sewage system complete with manholes.

On the island of Crete, at Broad Knossos, some of the palaces of ancient sea kings were equipped with extensive water supply and

drainage systems. Evidence of plumbing fixtures constructed of hard clay were also discovered. The glazed clay pipe was found to be in perfect condition after 3500 years.

In ancient Greece further advances were made in cleanliness. Greek aqueducts took pure water from mountain streams into cities. Sewers, which exist to this day, carried away waste to the surrounding rivers.

While people may not have understood the causes of disease, and did not guard against pollution of the water supply, they did understand that bathing was a desirable habit. Greeks portrayed Hygeia, the goddess of health (from whose name we get the word "hygiene"), as supplying pure water to a serpent, the symbol of wisdom, signifying that wise people found health in a supply of pure water.

The ancient Egyptians realized the value of sanitation. Moses was acquainted with the sanitary science of the Egyptians and used it in the code of laws framed by him and found in the book of Leviticus.

The Romans in the time of Julius Caesar developed the principles of sanitation to a high art. Lead was unknown to the ancient Greeks and Egyptians, but it was a new substance to the Romans and was imported from the British Isles. The Romans called this substance *plumbum*. The words "plumbing" and "plumber" are derived from the Latin word for lead. The forefather of the modern plumber was called the "plumbarius," which meant a worker in lead. The uses to which lead was put by the Romans were much the same as today.

Two thousand years ago the city of Rome had an adequate water supply and sewage disposal system. Water was piped from hills and mountains 50 miles distant from the city. To bring this water into Rome, great overhead aqueducts and underground tunnels were built of masonry.

Branch lines from the aqueducts to the individual buildings required the use of pipe. Water was piped into the homes of the upper class for use in private bathrooms long before the development of the great public baths. The baths of Pompeii consisted of an entire room with the floor and walls of marble. Brass, bronze and silver were used in the fixtures in addition to lead.

With the advent of the public baths, bathing became an important function. The public bath

became a form of family entertainment, an event much like going to the beach today. One of the most famous bath houses was a mile square and the basin could hold 3,200 people.

When Rome set out to conquer the world, they took their bathing habits with them. After taking what is now Great Britain from the Druids, the Romans built their own baths on the banks of the Avon River. As recently as 1875, in the city of Bath, archaeologists uncovered a Roman bath 110 feet long and 68 feet wide.

From as far back as 600 B.C. Rome had an elaborate drainage system called the *Cloaca Maxima*. This main was 13 feet in diameter and was joined by many laterals. It was constructed from three concentric rows of enormous stones piled one on the top of another without cement or mortar. It still exists and is used today in the drainage system of *modern Rome*.

In the 12th century, trade guilds were first organized in England. The first apprenticeship laws were passed in 1562 during the reign of Queen Elizabeth. These laws required an apprenticeship of seven years and made apprenticeship in all crafts compulsory. It was not until 1814 that the compulsory clause was removed and apprenticeship was made voluntary. The first known master plumbers' association was organized in England and incorporated in the College of Heralds of London.

With the discovery of the New World, man, like his ancient ancestors, sought to escape the dark and dirty cities of Europe for a fresh campground.

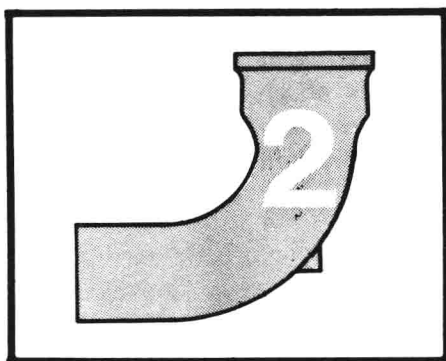
Although America has become a symbol of high standards in plumbing and sanitation, progress in the development of sanitation and plumbing was very slow. As the population of the early settlements increased, conditions deteriorated. Garbage and sewage dumped onto the ground and seepage from earth-pit privies polluted nearby wells.

Health conditions became so intolerable that eventually public sewers had to be installed underground and extended to each building. Although New York in 1782 installed the first sewer under the streets, Chicago is credited with having the first real city sewage system, constructed in 1855.

Plumbing as we know it today traces its roots back many centuries, but was not really perfected until the twentieth century. Even so, many of us were reared without the benefit of

indoor plumbing. The open well, the pitcher pump, the outhouse, and the Saturday night romp in the old wooden tub on the back porch are still with us. The modern bathroom, city water, and the sewer system of today are taken

for granted. Let us not forget — without today's "plumbarius" this would be a vastly different world in which to live. Truly, the plumber protects the health of our nation and the world.



Sanitary Drainage And Vent Systems

The private sanitary drainage system is the essential part of the plumber's work. It will be presented in this chapter as: (1) All the pipes installed within the wall line of a building and on private property for the purpose of receiving liquid waste or other waste substances (whether in suspension or in solution), (2) The pipes which convey this waste to a public sewer or other private, approved sewage disposal system, and (3) The vent system.

This whole drainage and vent system must be installed so that it is not a health or safety hazard to any individual or to the general public. Thus, most municipal authorities have adopted laws (codes) to protect the public health. Although sanitary drainage and vent arrangements are the heart of the plumbing system, most experts agree that this is the most complex, misunderstood, and misinterpreted section of the code. Professional engineers, master plumbers, and plumbing inspectors are frequently at odds on its intent and interpretation.

Interestingly enough, most of the questions asked and the isometric drawings required to complete the journeyman's and master's examinations are taken from this section of the code. It is worth noting also that the majority of cases coming before any Board of Rules and Appeals for clarification and resolution center on this same section of the code. Therefore it is important that you understand this section of the code.

Although details of plumbing installations vary, the basic principles of sanitation and safety remain the same, regardless of the code that has been adopted in your area. Any minor changes from the basic rules described here should be easily recognized and noted as you read and compare the sections of this book with the code used where you work.

Isometric Drawings

Before you can understand drainage and vent systems, you must be familiar with isometric drawings. Isometric drawings are the means of communication between plumbing professionals. They are used by the plumbing contractor to estimate the cost of new work and to show the job foreman how to *rough-in* a particular job. Anyone who deals with plumbing work must be able to make and interpret isometric drawings. You will quickly find that it is easy to read and make isometric illustrations.

Only three basic angles are needed to express the plumbing system: the horizontal pipe, the vertical pipe, and the forty-five degree angle pipe. Figure 2-1 can be a valuable guide in practicing these isometric angles. The only pieces of equipment necessary are a sharp No. 2 pencil and a 90-60 right triangle. By following the directions here and practicing the exercises in this chapter, you will be able to produce your own isometric projections or follow those made by others.

Directions For Practicing Isometric Drawings

First, draw a circle with a dot in the exact center. Place the letter *N* at the top of the page to designate the direction of north. See Figure 2-1. (Do not let the dotted line confuse you; it is used only to determine the proper angle necessary to illustrate the sanitary system as shown in unbroken solid lines.)

Using a 90-60 right triangle, square the short base with the right edge of your paper and draw line *A* through the center dot. (This represents *A*, the north-south horizontal pipe.)

Again, using the 90-60 right triangle, square the short base with the left edge of your paper and draw line *B* through the center dot. (This represents *B*, the east-west horizontal pipe.)

To arrive at the *C* vertical line, square the short base of the 90-60 right triangle with the lower edge of the paper and draw line *C*, using the long base for this vertical line connecting it with any of the horizontal lines, as desired.

To determine the placement of line *E*, divide the area equally between the horizontal line *B* and the dividing dotted line. Then draw line *E* east and west through the center dot. (This is necessary to depict the change in direction assumed by the 45-degree fittings of either a wye or 1/8 bend.) The same procedure will, of course, yield *D* north and south. The lower portion of Figure 2-1 shows a simple isometric drawing using all three basic angles that are used in designing rough plumbing for any building.

Fittings Within An Isometric Drawing

The lines on isometric drawings represent pipe and fittings. Symbols are used to show the location of fixtures. The figures that follow represent 16 common fittings used with no-hub pipe. The symbols are the same regardless of the type of pipe used.

Figures 2-2, 2-3, and 2-4 show typical isometric drawings. Each fitting in these drawings is numbered to correspond with a drawing of the same fitting shown below. Look at Figure 2-2. You will see that the "horizontal twin tap sanitary tee" (also known as an "owl fitting") is the same as fitting number 14 at the top of the page. The purpose of this fitting is to permit two similar fixtures to connect to the same waste and vent stack at the same level. In this case it connects two lavatories.

Before anyone can become proficient in the plumbing trade, he must learn how to construct isometric layouts correctly.

Plumbing Fixture Abbreviations

Common abbreviations are often used to identify various types of plumbing fixtures in isometric drawings as well as floor plans.

For example, some writers will use the letter *L* to designate a lavatory. Others may use "LAV." We have selected the following abbreviations to identify the plumbing fixtures used in isometric drawings and floor plans in this book.

Plumbing Fixtures	Abbreviated Symbols
Water closet	W. C.
Bathtub	B. T.
Shower	SH.
Lavatory	L.
Kitchen sink	K. S.
Clothes washing machine	C. W. M.

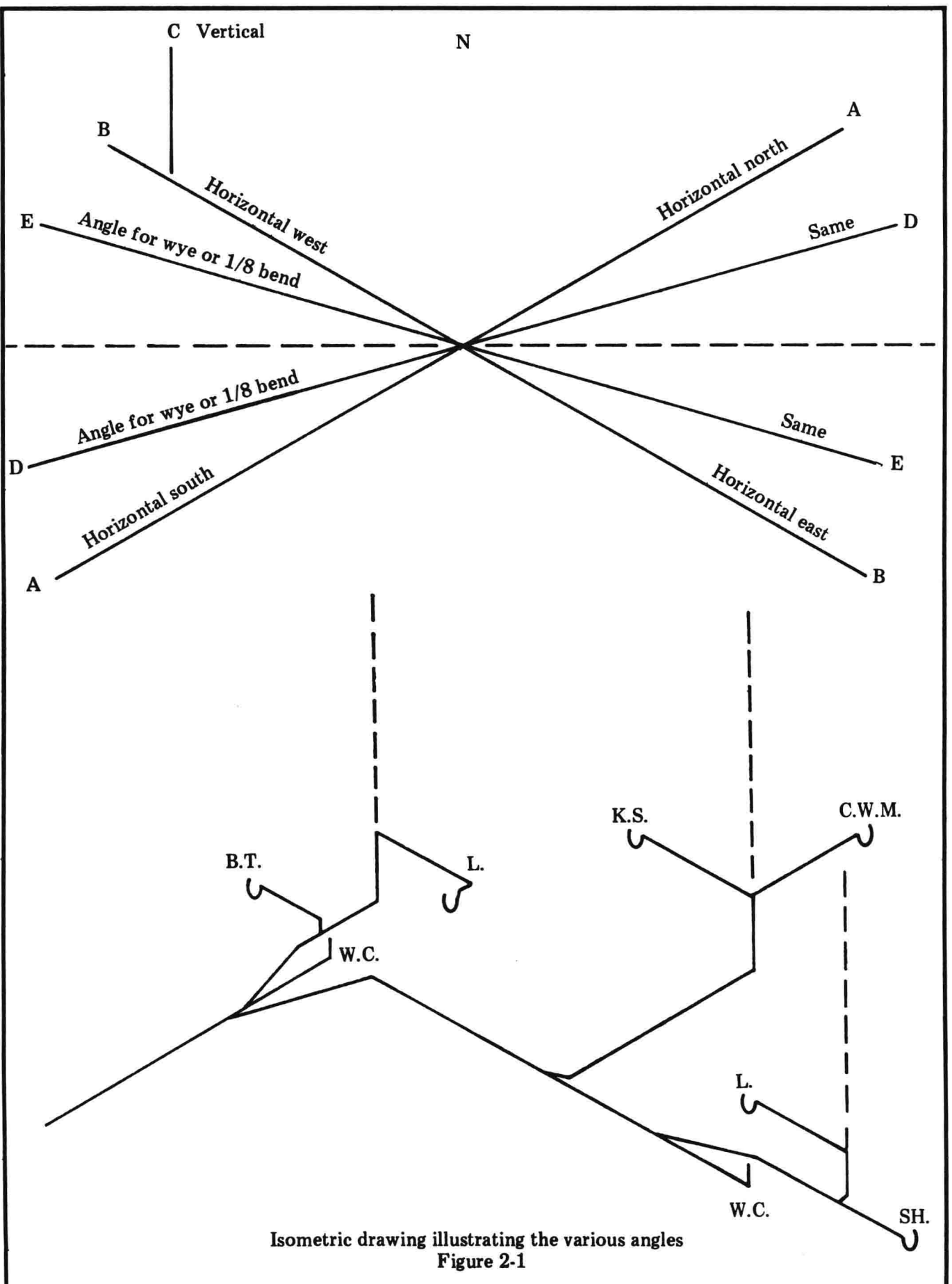
Typical plumbing fixture abbreviations

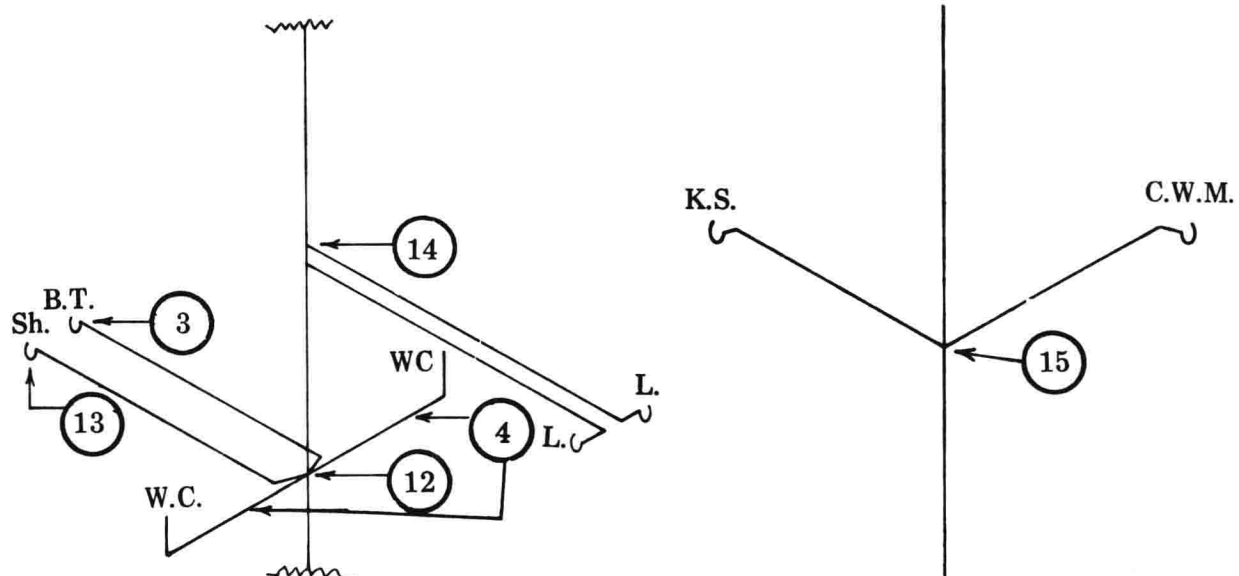
A more detailed and complete section on abbreviations, definitions and symbols is included in Chapter 18.

Definitions and Illustrations

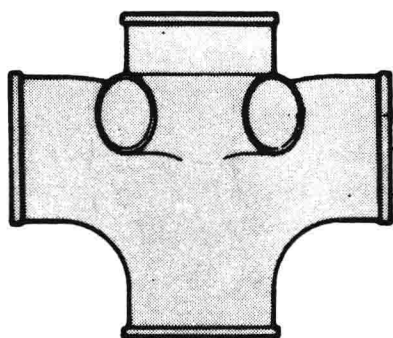
One of the first steps in learning the plumbing process is identifying the basic piping arrangements as defined in your local code. Without this knowledge, you won't be able to design, lay out or install pipes and fittings. Figures 2-5, 2-6 and 2-7 show three sanitary isometric drawings which include all the major definitions of the basic drainage and vent systems. The important terms are shown in graphic symbol coding in the illustration, thus relating its use to other piping in the overall drainage and venting system.

Figure 2-5 is the sanitary isometric drawing of a typical two bath house, including a kitchen and utility room. Figure 2-5 is an installation on the *flat* connected to a public sewage system. Figure 2-6 is a typical one bath house, including a kitchen and utility room. This figure illustrates an installation on a *stack* system connected to a private sewage disposal unit (a septic tank). Figure 2-7 shows a typical battery of plumbing fixtures often found in a two story public building.

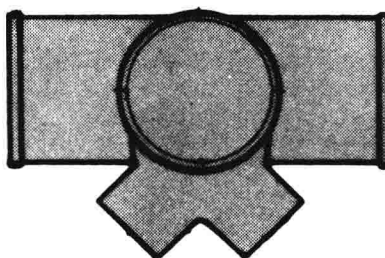




Isometric illustration



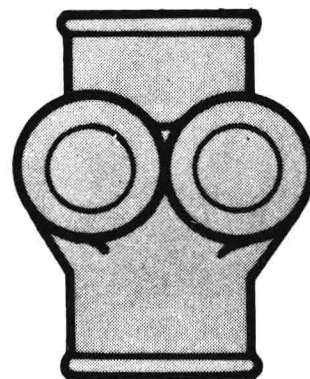
Side view



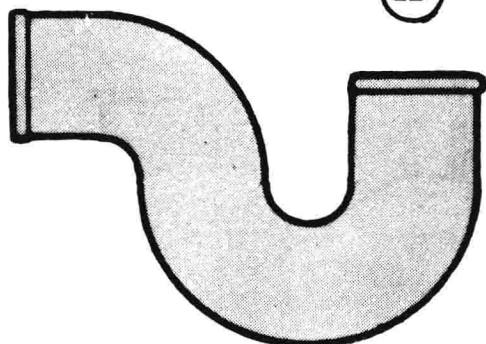
Top view

San. cross w/two 2" san.
45° inlet

(12)

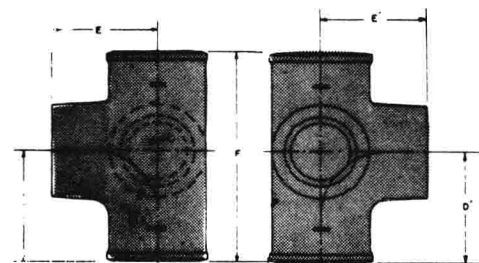
Horizontal twin
tap san. tee

(14)



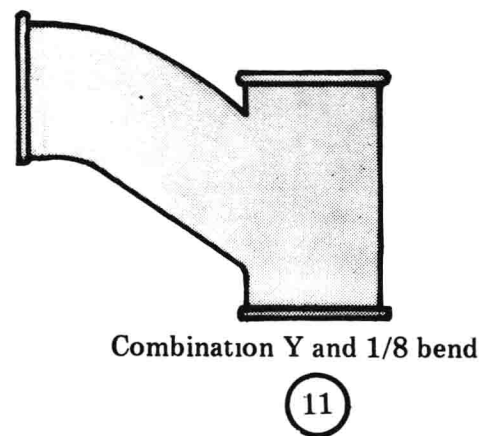
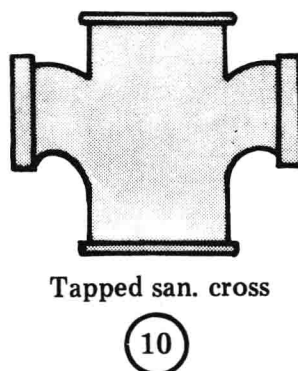
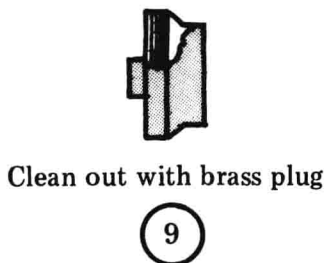
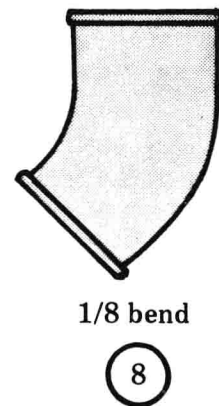
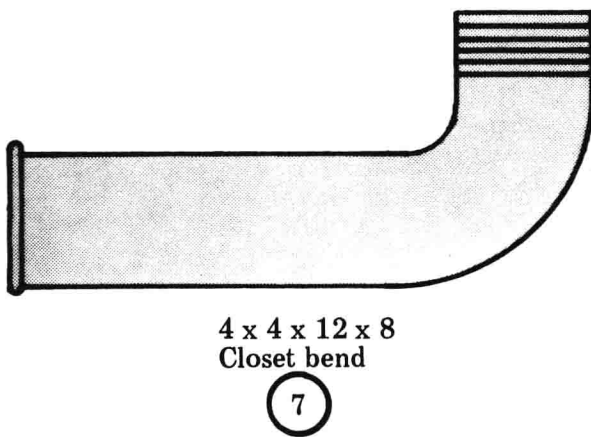
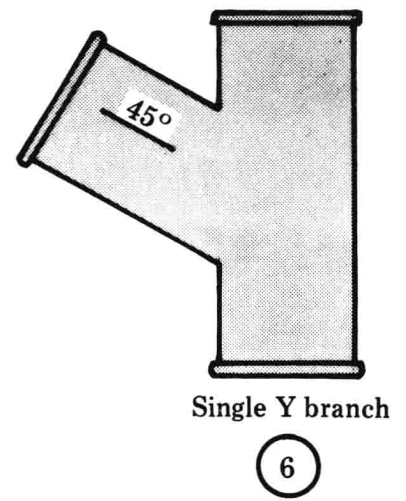
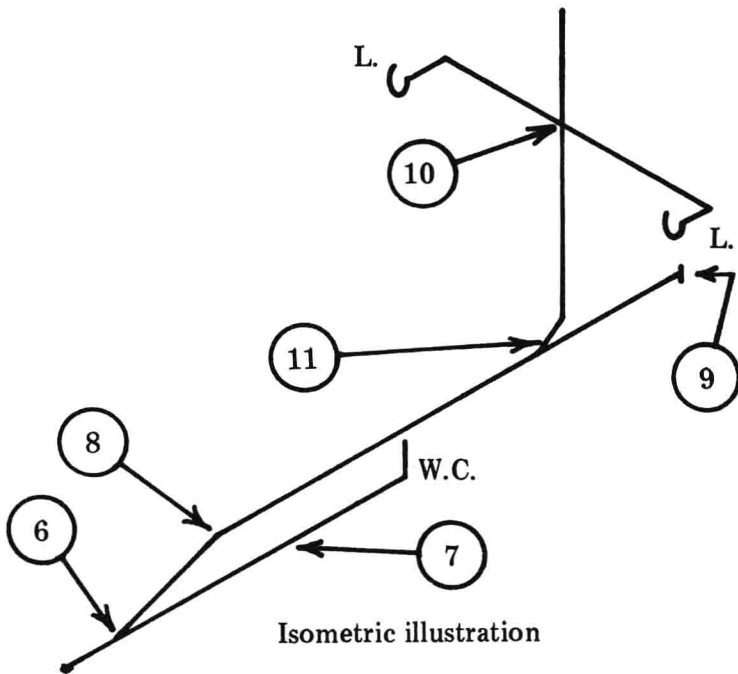
P trap

(13)

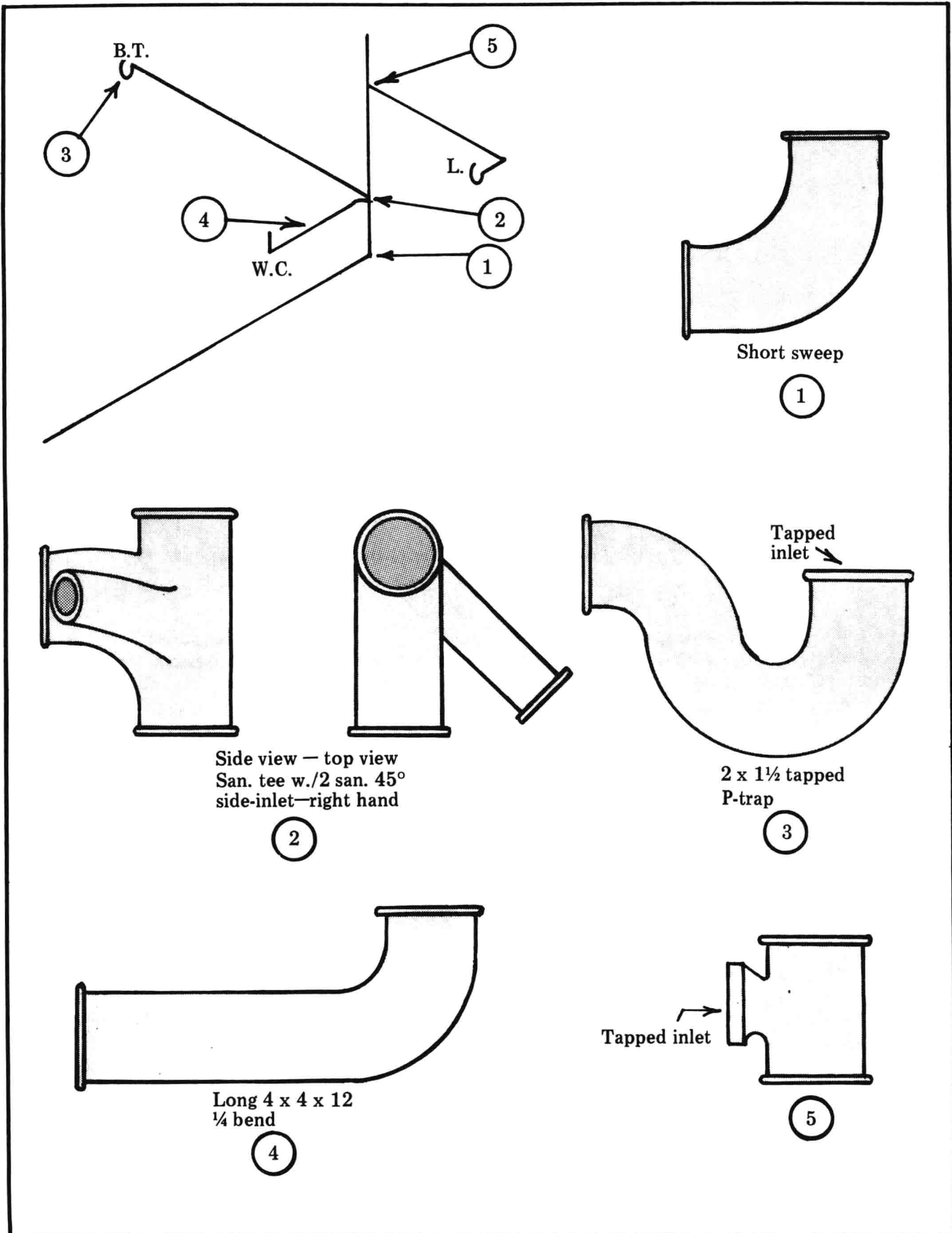
Tapped san. tee
angle pattern

(15)

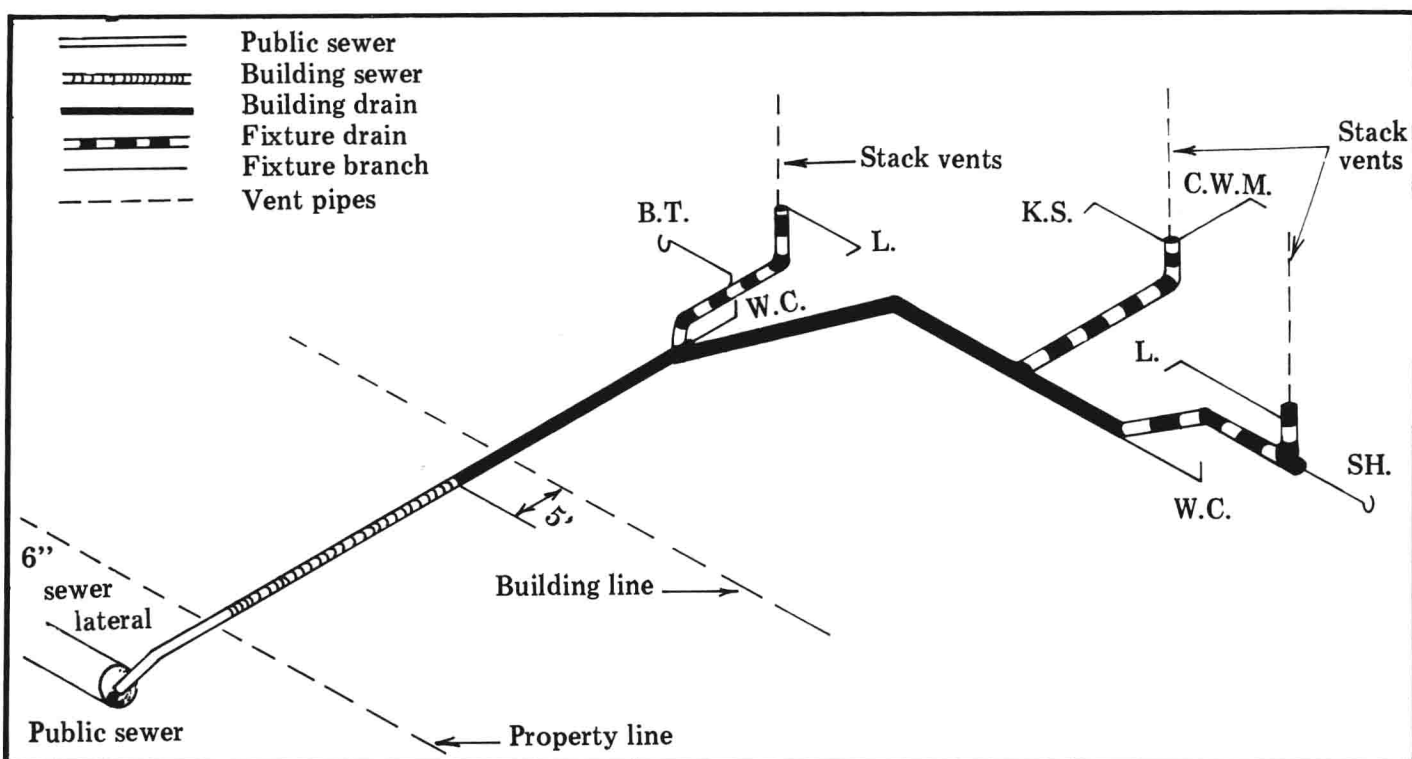
Fittings illustrated within isometric drawings
Figure 2-2



An isometric drawing and its fittings
Figure 2-3



An isometric drawing and its fittings
Figure 2-4



Graphic symbols of definitions
Figure 2-5

In defining the terms in Figures 2-5, 2-6 and 2-7, every effort has been made to use simple, easily understood language to clear up the complex and seemingly contradictory wording of the code. A particular section of pipe may be identified by several different terms with various definitions in the code. Here the terms have been grouped under a graphic symbol code to reduce confusion.

Public Sewer (Figure 2-5)

A *public sewer* may also be known as a *municipal sewer*. This sewage collection system is located in either a street, alley or a dedicated easement adjacent to each parcel of privately owned property. Public sewers are common pipes installed, maintained and controlled by the local public authorities. Its cost is usually supported by the public through some form of taxation.

During the installation of this sewage collection system, a 6 inch sewer lateral is usually extended from the main several inches past the property line of each lot. This allows for easy connection by individual property owners. When a permit for a sewer connection is issued, either to a homeowner or a plumbing contractor,

the depth and location of the lateral are obtained from the local municipal engineering department.

Building Sewer (Figure 2-5)

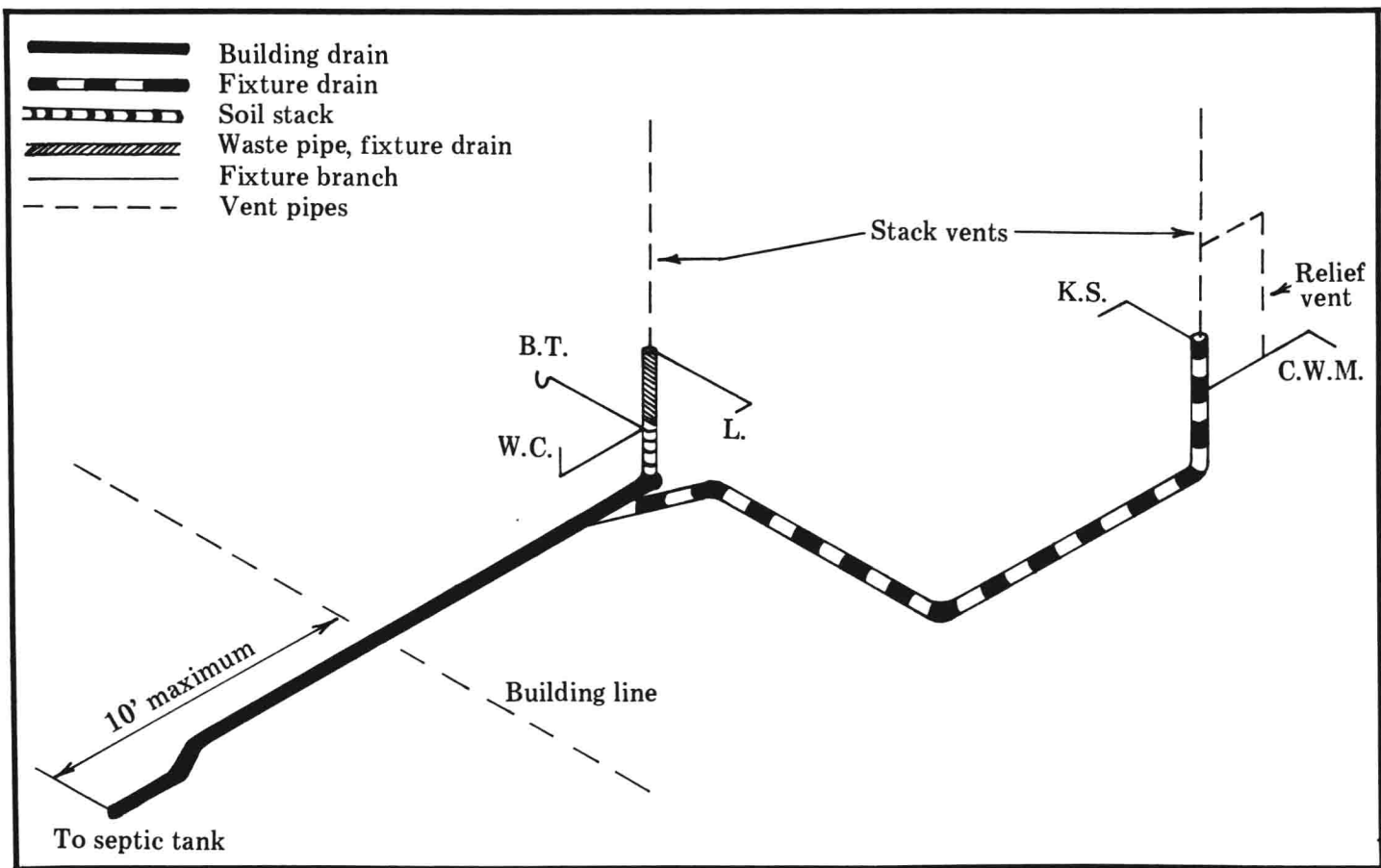
A *building sewer* is that part of the main horizontal drainage system that conveys sewage or other liquid waste substances from the building drain to the public sewer lateral. The building sewer begins at its connection to the 6 inch lateral a few inches within the property line. It terminates at its connection to the building drain five feet (less in some codes) from the outside building wall or line.

It is also known as a *private sewer*, as it is not controlled directly by the public authority. Its installation and maintenance is the responsibility of the individual property owner.

Sanitary sewer is another name for this section of piping in the code book, as it carries sewage that does not contain storm, surface, or ground water.

Building Drain (Figures 2-5 through 2-7)

The *building drain* is the main horizontal collection system, exclusive of the waste and vent stacks and fixture drains, and is located



Graphic symbols of definitions
Figure 2-6

within the wall line of a building. It conveys all sewage and other liquid waste substances to the building sewer which begins five feet (less in some codes) outside the building wall or line.

It is also considered a *main*, as it acts as the principal artery to which other drainage branches of the sanitary system may be connected.

Fixture Branch (Figures 2-5 through 2-7)

The *fixture branch* is that portion of the drainage system that is composed of the pipe from the fixture trap to the vent serving that fixture. It may connect directly to a vertical vent stack above the floor or, in the case of a shower or bathtub, to the horizontal wet vent section beneath the floor. It is often referred to by plumbers as the "sink arm" or "lavatory arm."

Fixture Drain (Figures 2-5 and 2-6)

This is the drainage pipe that conveys liquid waste not containing body waste from a fixture branch to the junction of any other drain pipe. In the code it is also called a *waste pipe*, as it does not carry the waste from water closets, urinals,

or bed pan washers.

Another term for this pipe is the *wet vent*, for it often conveys liquid waste from plumbing fixtures, excluding water closets, to the building drain and serves as a vent for these fixtures as well.

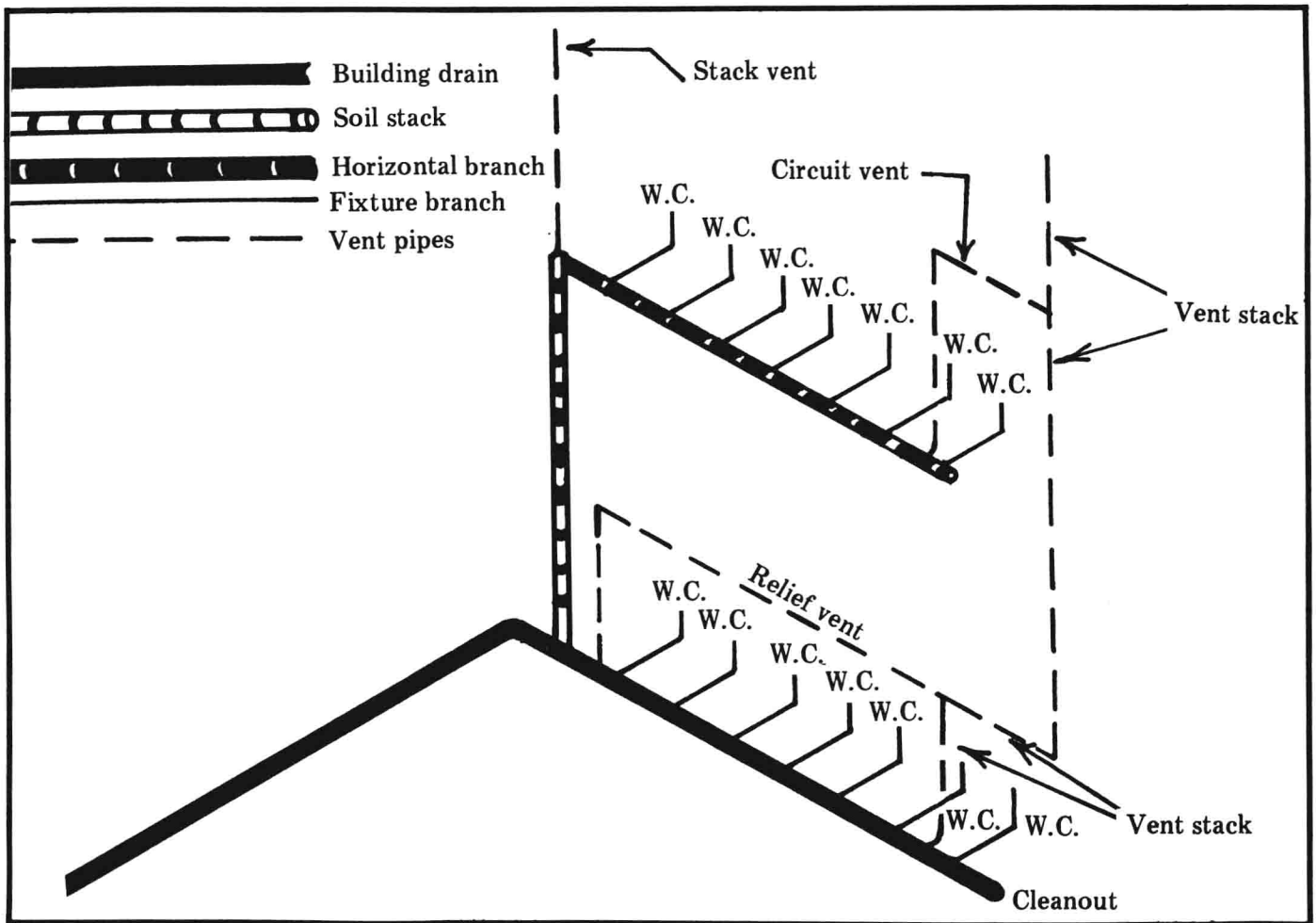
Soil Stack (Figures 2-6 and 2-7)

A *soil stack* is the vertical section of pipe of a plumbing system that receives the discharge of water closets, with or without the discharge from other fixtures, and conveys this waste substance, usually to the building drain.

The *branch interval* performs the same function as the soil stack and becomes an integral part of the soil stack. The only difference is in its vertical height. It usually corresponds to a story height but in no case can it be less than eight feet in length. Stacks also include any vertical pipe including the waste and vent piping of a plumbing system.

Horizontal Branch (Figure 2-7)

A *horizontal branch* is that portion of a drain



Graphic symbols of definitions
Figure 2-7

pipe extending laterally from a soil or waste stack that receives the discharge from one or more fixture drains. (See Figure 2-7.)

Common Vent (Figure 2-5)

A *common vent* is a vertical vent that serves two fixture branches that are installed at the same level. In Figure 2-5 this is the sink and clothes washing machine.

Continuous Vent (Figures 2-32, 2-33, 2-38)

A *continuous vent* is the vertical portion that is a continuation of the drain to which it is connected. It is also known as an *individual vent*.

Vent Header (Figures 2-30 and 2-31)

A *vent header* is a single pipe that receives the connection of two or more vent pipes and is then connected to the main vent stack or is extended to the atmosphere separately at one point.

Yoke Vent (Figures 2-34 and 2-35)

A *yoke vent* is a pipe connecting upward

Fixture Type	Fixture unit value as load factor	Minimum size of trap in inches
Bathtub (with or without overhead shower)	2 F.U.	1½
Shower stall, domestic	2 F.U.	2
Lavatory, domestic	1 F.U.	1¼
Water closet, tank operated	4 F.U.	3
Kitchen sink, domestic	2 F.U.	1½
Automatic clothes washer	3 F.U.	2

Note: Fixture units and trap sizes may vary from those listed above. Check local code requirements.

Fixture units per fixture
Table 2-8