## Welding Terminology

To become a skilled welder, you first need to learn the technical vocabulary ‘(language) of welding. The sections in this chapter introduce you to some of the basic terms of the welding language. Once you understand the language of welding, you will be prepared to interpret and communicate welding information accurately.

## FILLER METALS

When welding two pieces of metal together, you often have to leave a space between the joint. The material that you add to fill this space during the welding process is known as the filler metal, or material. Two types of filler metals commonly used in welding are welding rods and welding electrodes.

The term *welding rod* refers to a form of filler metal that does not conduct an electric current during the welding process. The only purpose of a welding rod is to supply filler metal to the joint. This type of filler metal is often used for gas welding.

In electric-arc welding, the term *electrode* refers to the component that conducts the current from the electrode holder to the metal being welded. Electrodes are classified into two groups: consumable and nonconsumable. Consumable electrodes not only provide a path for the current but they also supply fuller metal to the joint. An example is the electrode used in shielded metal-arc welding. Nonconsumable electrodes are only used as a conductor for the electrical current, such as in gas tungsten arc welding. The filler metal for gas tungsten arc welding is a hand fed consumable welding rod.

## FLUXES

Before performing any welding process, you must ensure the base metal is clean. No matter how much the base metal is physically cleaned, it still contains impurities. These impurities, called oxides, result from oxy-gen combining with the metal and other contaminants in the base metal. Unless these oxides are removed by using a proper flux, a faulty weld may result. The term *flux* refers to a material used to dissolve oxides and release trapped gases and slag (impurities) from the base metal; thus the flux can be thought of as a cleaning agent. In performing this function, the flux allows the filler metal and the base metal to be fused.

Different types of fluxes are used with different types of metals; therefore, you should choose a flux formulated for a specific base metal. Beyond that, you can select a flux based on the expected soldering, brazing, or welding temperature; for example, when brazing, you should select a flux that becomes liquid at the correct brazing temperature. When it melts, you will know it is time to add the filler metal. The ideal flux has the right fluidity at the welding temperature and thus blankets the molten metal from oxidation.

Fluxes are available in many different forms. There are fluxes for oxyfuel gas applications, such as brazing and soldering. These fluxes usually come in the form of a paste, powder, or liquid. Powders can be sprinkled on the base metal, or the fuller rod can be heated and dipped into the powder. Liquid and paste fluxes can be applied to the filler rod and to the base metal with a brush. For shielded metal arc welding, the flux is on the electrode. In this case, the flux combines with impurities in the base metal, floating them away in the form of a heavy slag which shields the weld from the atmosphere.

You should realize that no single flux is satisfactory for universal use; however, there are a lot of good general-purpose fluxes for use with common metals. In general, a good flux has the following characteristics: It is fluid and active at the melting point of the fuller metal.

- It remains stable and does not change to a vapor rapidly within the temperature range of the welding procedure.
- It dissolves all oxides and removes them from the joint surfaces.
- It adheres to the metal surfaces while they are being heated and does not ball up or blow away.
- It does not cause a glare that makes it difficult to see the progress of welding or brazing.
- It is easy to remove after the joint is welded.
- It is available in an easily applied form.

**CAUTION**

Nearly all fluxes give off fumes that may be toxic. Use ONLY in well-ventilated spaces. It is also good to remember that **ALL** welding operations require adequate ventilation whether a flux is used or not.

## WELD JOINTS

The *weld joint* is where two or more metal parts are joined by welding. The five basic types of weld joints are the butt, corner, tee, lap, and edge, as shown in figure 3-6.

A **butt** joint is used to join two members aligned in the same plane (fig. 3-6, view A). This joint is frequently used in plate, sheet metal, and pipe work. A joint of this type may be either square or grooved. Some of the variations of this joint are discussed later in this lesson.

**Corner** and **tee** joints are used to join two members located at right angles to each other (fig. 3-6, views B and C). In cross section, the corner joint forms an L-shape, and the tee joint has the shape of the letter *T*. Various joint designs of both types have uses in many types of metal structures.

A **lap** joint, as the name implies, is made by lapping one piece of metal over another (fig. 3-6, view D). This is one of the strongest types of joints available; however, for maximum joint efficiency, you should overlap the metals a minimum of three times the thickness of the thinnest member you are joining. Lap joints are commonly used with torch brazing and spot welding applications.

An **edge** joint is used to join the edges of two or more members lying in the same plane. Inmost cases, one of the members is flanged, as shown in figure 3-6, view E. While this type of joint has some applications in platework, it is more frequently used in sheet metal work An edge joint should only be used for joining metals 1/4 inch or less in thickness that are not subjected to heavy loads.

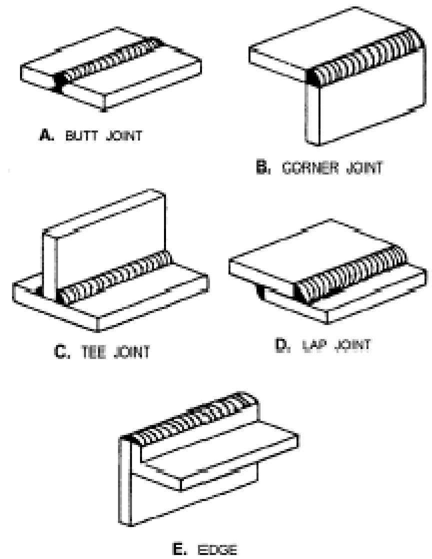

Figure 3-6.–Basic weld joints.

The above paragraphs discussed only the five basic types of joints; however, there are many possible variations. Later in this lesson, we discuss some of these variations.

## PARTS OF JOINTS

While there are many variations of joints, the parts of the joint are described by standard terms. The **root** of a joint is that portion of the joint where the metals are closest to each other. As shown in figure 3-7, the root may be a point, a line, or an area, when viewed in cross section. A **groove** (figure 3-8) is an opening or space provided between the edges of the metal parts to be welded. The **groove face** is that surface of a metal part included in the groove, as shown in figure 3-8, view A. A given joint may have a root face or a root edge. The **root face,** also shown in view A, is the portion of the prepared edge of a part to be joined by a groove weld that has not been grooved. As you can see, the root face has relatively small dimensions. The **root edge** is basi-cally a root face of zero width, as shown in view B. As you can see in

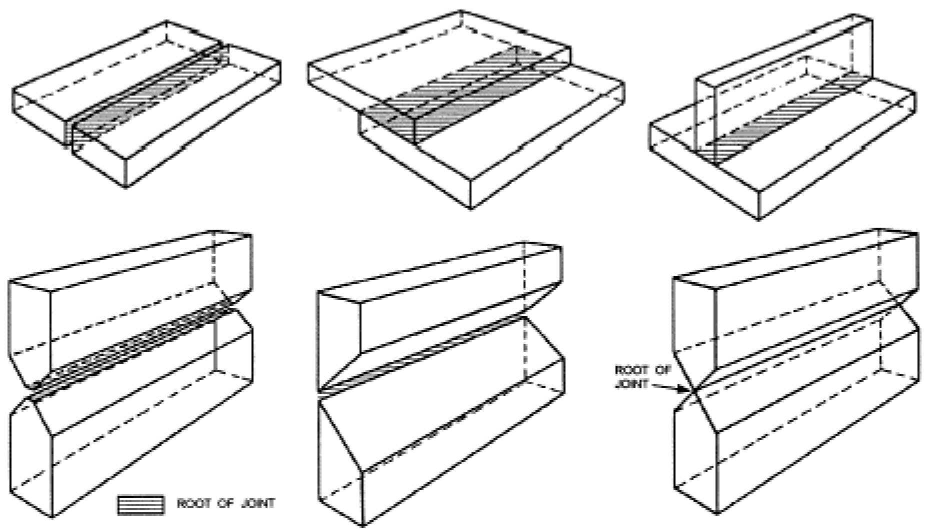


Figure 3-7.—Root of joint.

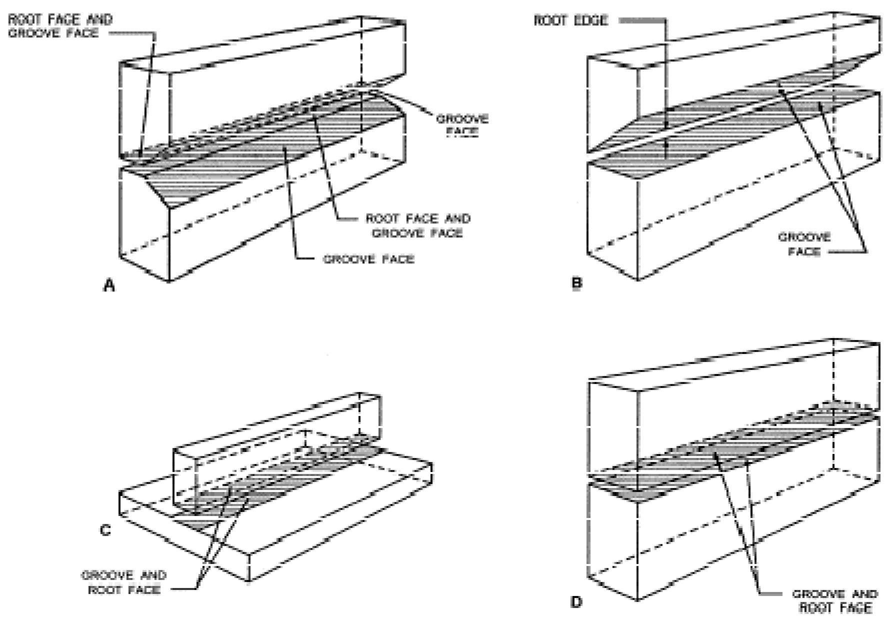


Figure 3-8.—The groove face, root face, and root edge of joints.

views C and D of the illustration, the groove face and the root face are the same metal surfaces in some joints.

The specified requirements for a particular joint are expressed in such terms as *bevel angle, groove angle, groove radius,* and *root opening.* A brief description of each term is shown in figure 3-9.

The **bevel angle** is the angle formed between the prepared edge of a member and a plane perpendicular to the surface of the member.

The **groove angle** is the total angle of the groove between the parts to be joined. For example, if the edge of each of two plates were beveled to an angle of 30 degrees, the groove angle would be 60 degrees. This is often referred to as the "included angle" between the parts to be joined by a groove weld.

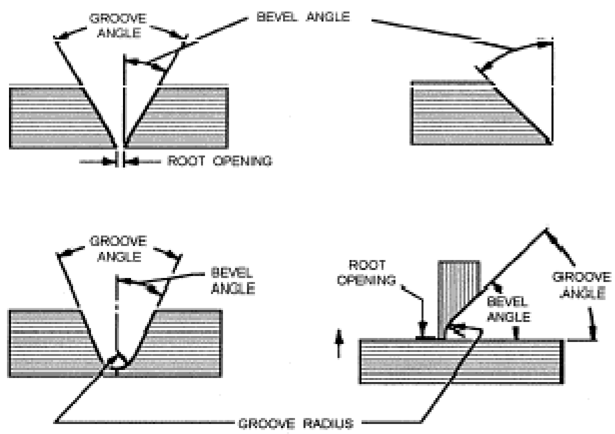


Figure 3-9.—Bevel angle, groove angle, groove radius, and root opening of joints for welding.

The **groove radius** is the radius used to form the shape of a J- or U-groove weld joint. It is used only for special groove joint designs.

The **root opening** refers to the separation between the parts to be joined at the root of the joint. It is sometimes called the "root gap."

To determine the bevel angle, groove angle, and root opening for a joint, you must consider the thickness of the weld material, the type of joint to be made, and the welding process to be used. As a general rule, gas welding requires a larger groove angle than manual metal-arc welding.

The root opening is usually governed by the diameter of the thickness filler material. This, in turn, depends on the of the base metal and the welding position. Having an adequate root opening is essential for root penetration. Root penetration and joint penetration of welds are shown in figure 3-10.

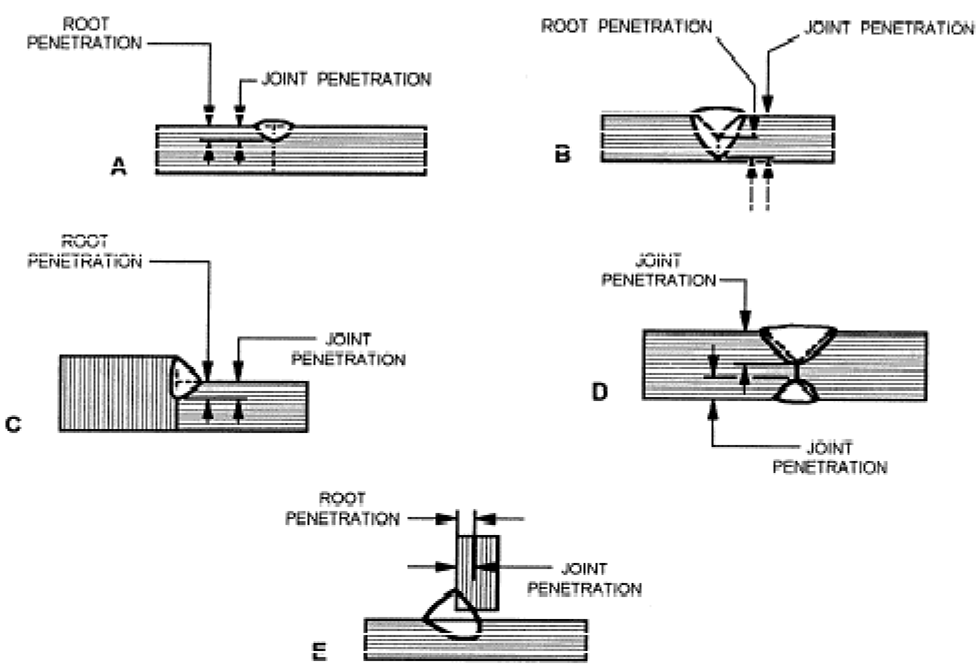


Figure3-10.—Root penetration and joint penetration of welds.

**Root penetration** refers to the depth that a weld extends into the root of the joint. Root penetration is measured on the center line of the root cross section. **Joint penetration** refers to the minimum depth that a groove (or

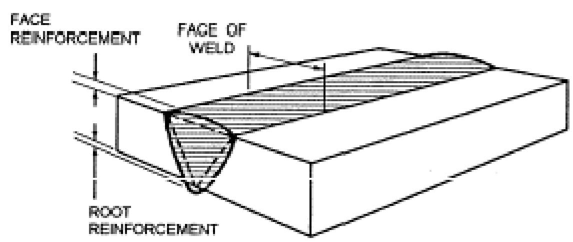


Figure 3-11.—Weld reinforcement.

a flange) weld extends from its face into a joint, exclusive of weld reinforcement. As you can see in the figure, the terms, *root penetration* and *joint penetration,* often refer to the same dimension. This is the case in views A, C, and E of the illustration. View B, however, shows the difference between root penetration and joint penetration. View D shows joint penetration only. *Weld reinforcement* is a term used to describe weld metal in excess of the metal necessary to fill a joint. (See fig. 3-11.)

**TYPES OF WELDS**

There are many types of welds. Some of the common types you will work with are the bead, groove, fillet, surfacing, tack, plug, slot, and resistance.

As a beginner, the first type of weld that you learn to produce is called a **weld bead** (referred to simply as a bead). A weld bead is a weld deposit produced by a single pass with one of the welding processes. An ex-ample of a weld bead is shown in figure 3-12. A weld bead may be either narrow or wide, depending on the amount of transverse oscillation (side-to-side movement) used by the welder. When there is a great deal of oscillation, the bead is wide; when there is little or no oscillation, the bead is narrow. A weld bead made with-out much weaving motion is often referred to as a **stringer bead.** On the other hand, a weld bead made with side-to-side oscillation is called a **weave bead.**

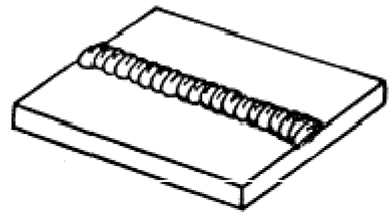

Figure 3-12.—Simple weld bead.

**Groove welds** are simply welds made in the groove between two members to be joined. The weld is adapt-able to a variety of butt joints, as shown in figure 3-13. Groove welds may be joined with one or more weld beads, depending on the thickness of the metal. If two or more beads are deposited in the groove, the weld is made with multiple-pass **layers,** as shown in figure 3-14. As a rule, a multiple-pass layer is made with stringer beads in manual operations. As a steelworker, you will use groove welds frequently in your work

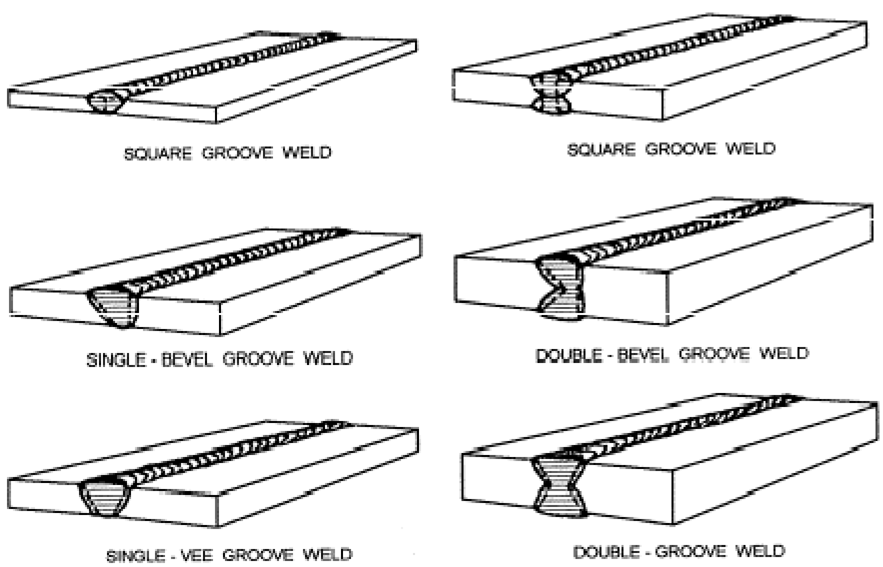


Figure 3-13.—Standard groove welds.

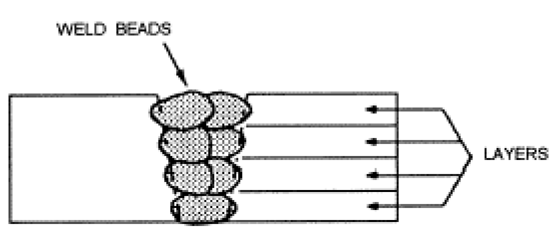


Figure 3-14.—Multiple-pass layers.

Another term you

should be familiar with, when making a multiple-pass weld, is the **buildup sequence,** as shown in figure 3-15. Buildup sequence refers to the order in which the beads of a multiple-pass weld are deposited in the joint.

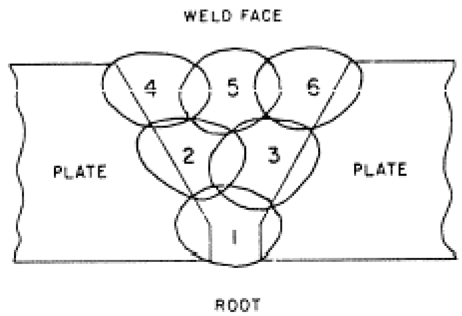


Figure 3-15.—Weld layer sequence.

**NOTE**

Often welding instructions specify an interpass temperature. The ***interpass temperature*** refers to the temperature below which the previously deposited weld metal must be before the next pass may be started.

After the effects of heat on metal are discussed, later in the chapter, you will understand the significance of the buildup sequence and the importance of controlling the interpass temperature.

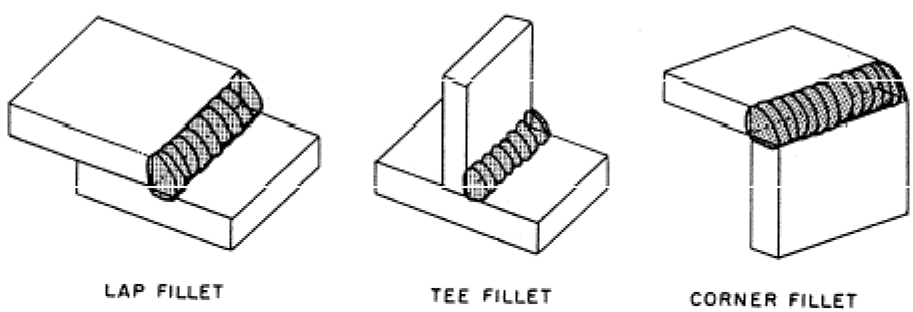


Figure 3-16.—Fillet welds.

Across-sectional view of a **fillet weld** (fig. 3-16) is triangular in shape. This weld is used to join two surfaces that are at approximately right angles to each other in a lap, tee, or comer joint.

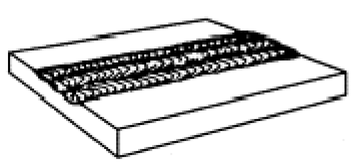

Figure 3-17.—Surfacing welds.

**Surfacing** is a welding process used to apply a hard, wear-resistant layer of metal to surfaces or edges of worn-out parts. It is one of the most economical methods of conserving and extending the life of machines, tools, and construction equipment. As you can see in figure 3-17, a surfacing weld is composed of one or more stringer or weave beads. Surfacing, sometimes known as **hardfacing** or **wearfacing,** is often used to build up worn shafts, gears, or cutting edges. You will learn more about this type of welding in chapter 6 of this training manual.

A **tack weld** is a weld made to hold parts of an assembly in proper alignment temporarily until the final welds are made. Although the sizes of tack welds are not specified, they are normally between 1/2 inch to 3/4 inch in length, but never more than 1 inch in length. In determining the size and number of tack welds for a specific job, you should consider thicknesses of the metals being joined and the complexity of the object being assembled.

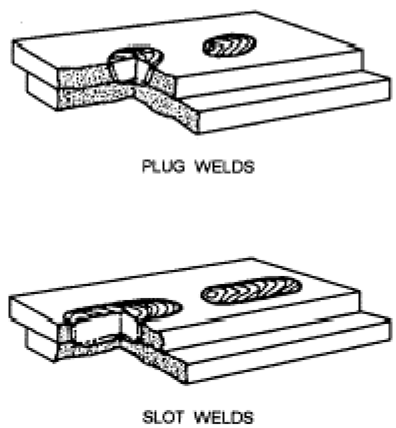


Figure 3-18.—Plug and slot welds.

**Plug** and **slot welds** (fig. 3-18) are welds made through holes or slots in one member of a lap joint. These welds are used to join that member to the surface of another member that has been exposed through the hole. The hole may or may not be completely filled with weld metal. These types of welds are often used to join face-hardened plates from the backer soft side, to install liner metals inside tanks, or to fill up holes in a plate.

**Resistance welding** is a metal fabricating process in which the fusing temperature is generated at the joint by the resistance to the flow of an electrical current. This is accomplished by clamping two or more sheets of metal between copper electrodes and then passing an electrical current through them. When the metals are heated to a melting temperature, forging pressure is applied through either a manual or automatic means to weld the pieces together. **Spot** and **seam** welding (fig. 3-19) are two common types of resistance welding processes.

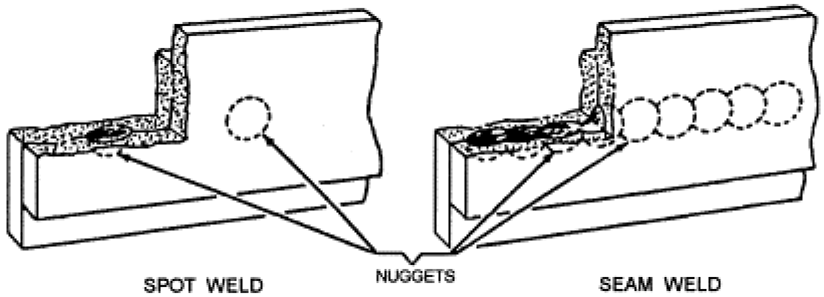


Figure 3-19.—Spot and seam welds.

**Spot welding** is probably the most commonly used type of resistance welding. The material to be joined is placed between two electrodes and pressure is applied. Next, a charge of electricity is sent from one electrode through the material to the other electrode. Spot welding is especially useful in fabricating sheet metal parts.

**Seam welding** is like spot welding except that the spots overlap each other, making a continuous weld seam. In this process, the metal pieces pass between roller type of electrodes. As the electrodes revolve, the current is automatically turned on and off at the speed at which the parts are set to move. Seam welding is almost exclusively used in industrial manufacturing.

**PARTS OF WELDS**

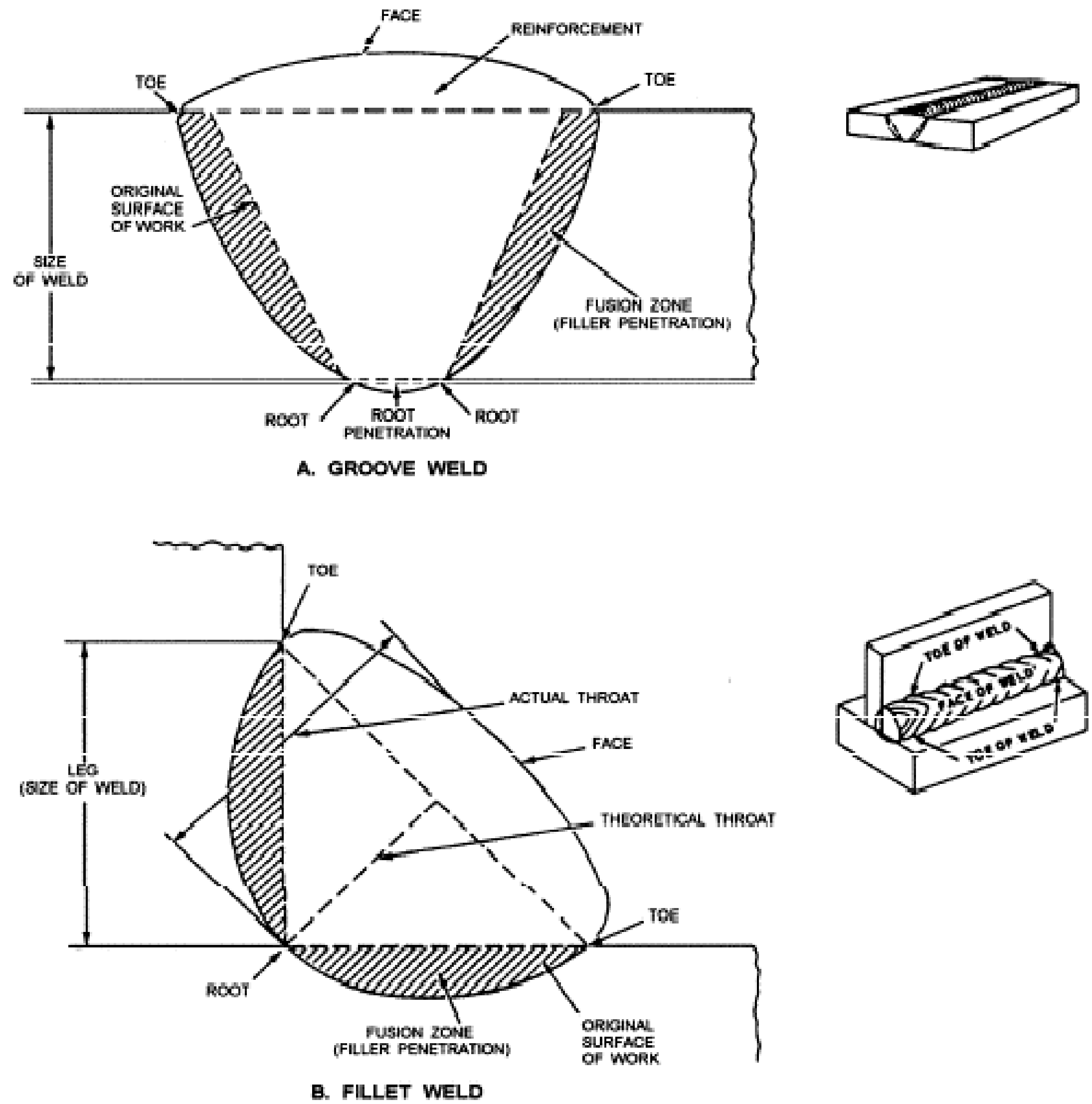


Figure 3-20.—Parts of a groove weld and fillet weld.

For you to produce welds that meet the job requirements, it is important that you become familiar with the terms used to describe a weld. Figure 3-20 shows a groove weld and a fillet weld. ‘The face is the exposed surface of a weld on the side from which the weld was made. The **toe** is the junction between the face of the weld and the base metal. The **root** of a weld includes the points at which the back of the weld intersects the base metal surfaces. When we look at a triangular cross section of a fillet weld, as shown in view B, the **leg** is the portion of the weld from the toe to the root. The **throat** is the distance from the root to a point on the face of the weld along a line perpendicular to the face of the weld. Theoretically, the face forms a straight line between the toes.

**NOTE**

The terms *leg* and *throat* apply only to fillet welds.

In determining the size of a groove weld (fig. 3-20, view A), such factors as the depth of the groove, root opening, and groove angle must be taken into consideration. The size of a fillet weld (view B) refers to the length of the legs of the weld. The two legs are assumed to be equal in size unless otherwise specified.

A gauge used for determining the size of a weld is known as a **welding micrometer.** Figure 3-21 shows how the welding micrometer is used to determine the various dimensions of a weld.

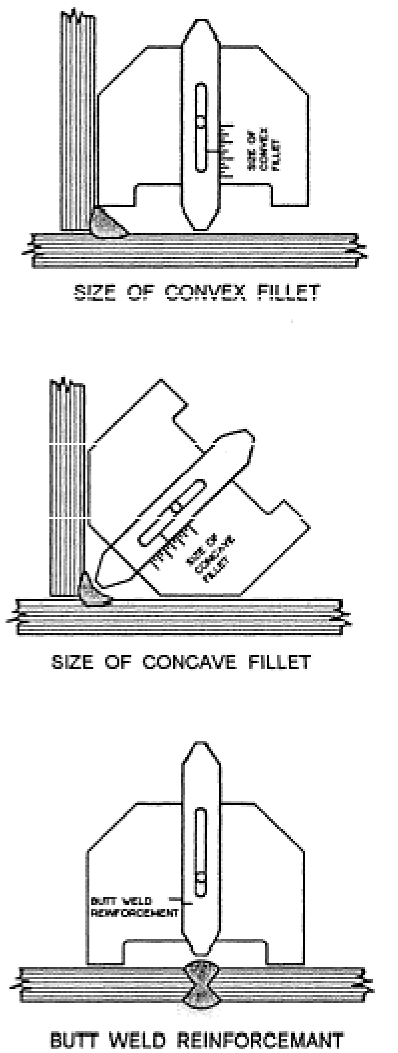


Figure 3-21.—Using a welding micrometer.

Some other terms you should be familiar with are used to describe areas or zones of welds. As we discussed earlier in the chapter, fusion is the melting together of base and/or fuller metal. The **fusion zone,** as shown in figure 3-22, is the region of the base metal that is actually melted. The depth of fusion is the distance that fusion extends into the base metal or previous welding pass.

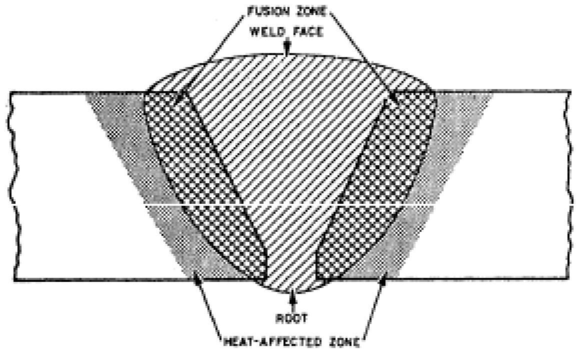


Figure 3-22.—Zones in a weld.

Another zone of interest to the welder is the **heat-affected zone,** as shown in figure 3-22. This zone includes that portion of the base metal that has not been melted; however, the structural or mechanical properties of the metal have been altered by the welding heat.

Because the mechanical properties of the base metal are affected by the welding heat, it is important that you learn techniques to control the heat input. One technique often used to minimize heat input is the intermittent weld. We discuss this and other techniques as we progress through this chapter; but, first we will discuss some of the considerations that affect the welded joint design