

Lesson 5: Welding Out of Position

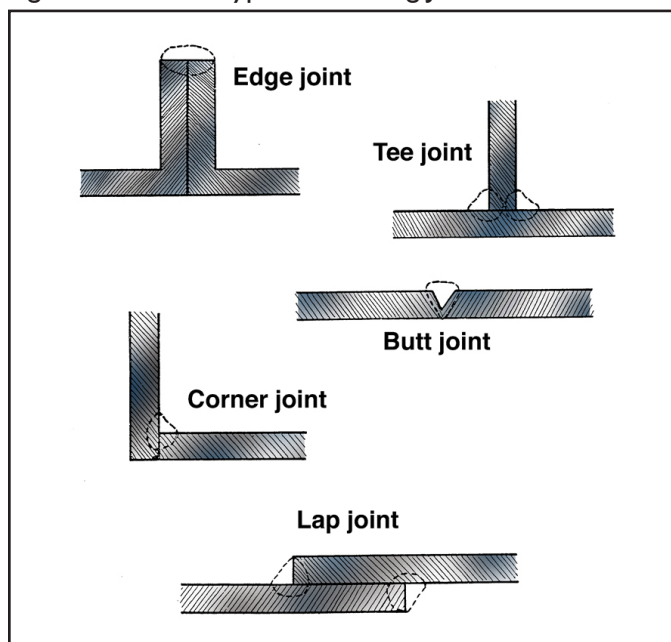
Arc welders in agricultural mechanics should be familiar with the various joint designs they will encounter in their work. They also need to understand the different welding positions and techniques used to improve weld quality in out-of-position welding. This lesson describes the basic types of welding joints and welding positions and discusses the techniques used in each position.

Basic Welding Joints

Welding projects in agricultural mechanics have various types of joints depending on the nature of the project. The five basic joint designs in arc welding are the edge, tee, butt, corner, and lap. See Figure 5.1. There are additional types of joints that are variations of these five basic designs. These variations are not discussed in this lesson. The basic designs are described below.

- **Edge joint:** This joint is formed by positioning pieces parallel or nearly parallel to each other and joining them edge to edge. It is welded on one or more edges.
- **Tee joint:** In this joint, pieces are joined at an angle to form a “T” shape. It is welded on one side or both sides.

Figure 5.1 – Basic Types of Welding Joints



- **Butt joint:** In this joint, the pieces are joined edge to edge in the same plane.
- **Corner joint:** This joint is formed by joining pieces at the edges at an angle (usually a right angle). The welding is done outside or inside the corner joint or on both sides.
- **Lap joint:** This joint is created by overlapping one piece of metal on another. It is welded on one side only or on both sides of the joint, depending on job requirements.

The edges of the joints may be prepared by using various techniques (beveling, squaring, flaring, etc.) to improve penetration and produce a better weld. To keep joints in correct alignment for welding, the pieces are secured in a clamp and/or tack welded.

Arc Welding Positions

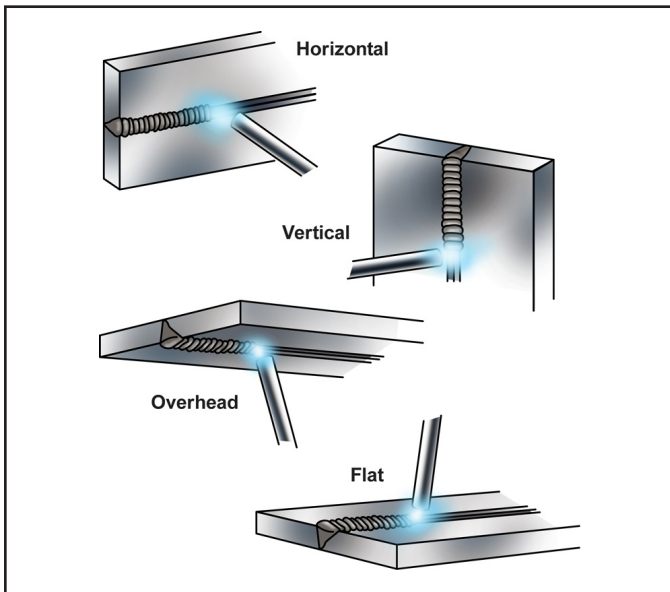
The position of the joints in a welding project may require the welder to weld in various positions. The four basic positions are flat, horizontal, vertical, and overhead. See Figure 5.2. A flat weld is done with the weld axis (imaginary line through the center of the weld) and weld face (surface of the weld on the welding side) in a flat position in front of the welder. Whenever possible, welds should be made in the flat position, because in other positions the welder is working against the force of gravity, which will draw the molten metal out of place. However, welds cannot always be moved. For example, it may be impractical to reposition the joints in a large piece of farm equipment.

Welding in positions other than flat (that is, horizontal, vertical, and overhead) is called welding out of position. Welders must practice making out-of-position welds to ensure that these welds are as strong as and have the same appearance as those made in the flat position. Out-of-position welds are described below.

- A horizontal weld is made with the weld axis in a horizontal position and the weld face and base metal in a vertical (up and down) or nearly vertical position.
- With the vertical position, the weld axis and weld face are both approximately vertical. Welds in the vertical position can be done in an uphill (also called vertical-up) direction or a downhill (also called vertical-down)

Agricultural Mechanics

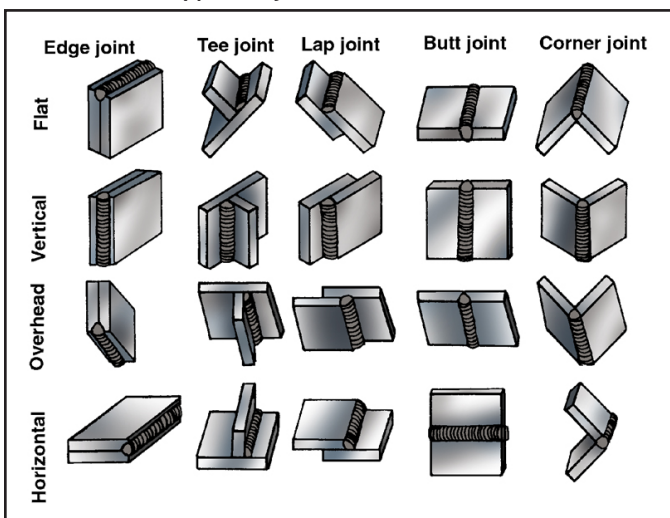
Figure 5.2 – Positions for Welding



direction. In the uphill direction, welding is done from the bottom of the joint to the top. In the downhill direction, welding is done from the top of the joint to the bottom.

- The overhead position is performed from the underside of the joint, with the weld axis and face approximately horizontal. This is the position in which gravity causes the greatest safety hazard and difficulty for the welder.
- With practice, high-quality welds can be produced on all joint designs and in all positions. See Figure 5.3.

Figure 5.3 – Welding Positions for the Five Basic Types of Joints



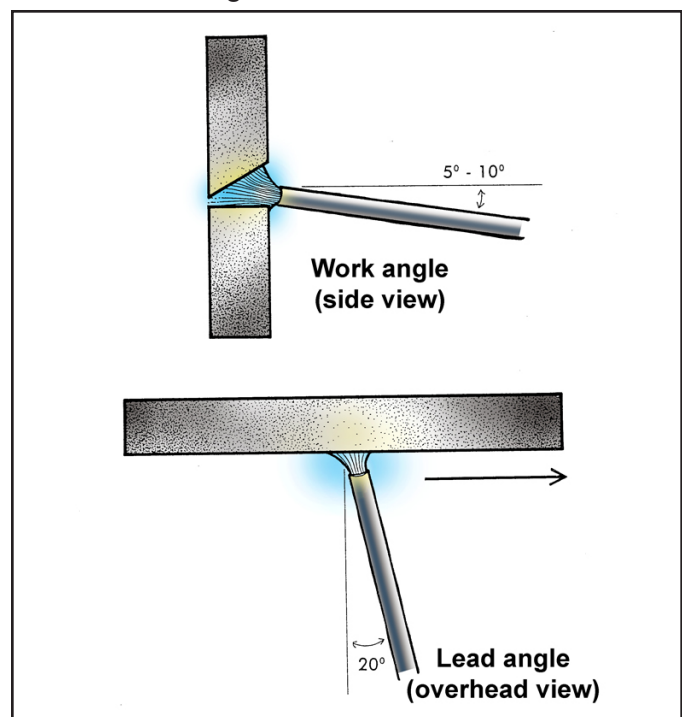
Techniques to Improve Out-of-Position Welds

When welding out of position, changes in welding technique are required to counteract the force of gravity. General guidelines for making out-of-position welds include using a smaller diameter electrode, which allows lower amperage to be used and makes a weld pool that is easier to manage because it is smaller. In addition, use of an electrode that deposits fast-setting filler (e.g., E6010, E6011, and E7018) provides the benefit of keeping the filler metal from sagging. The welder should adjust the electrode in the jaws of the holder to a convenient angle. The electrode itself should not be bent into position, because bending it could cause the flux to break off, resulting in a loss of shielding gas and substandard welds.

Horizontal Welds

Guidelines for butt welds include holding the electrode at a work angle of roughly 5 to 10 degrees below perpendicular, so that the electrode is pointed up at the weld. For the lead angle, the electrode should be leaned approximately 20 degrees in the direction of travel. See Figure 5.4.

Figure 5.4 – Angle of the Electrode for Horizontal Welding



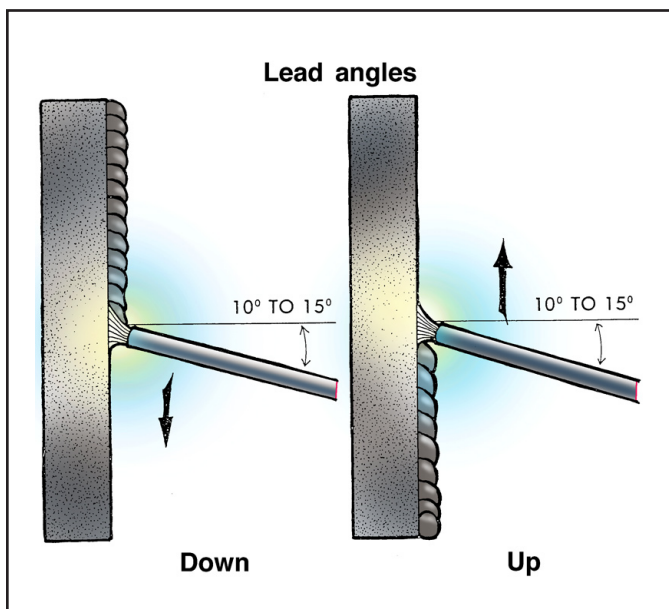
Unit II – Arc Welding

It may be necessary to reposition the electrode for other types of joints. Another recommendation is to maintain a shorter arc length, which creates a shorter distance for the filler metal to travel and in turn less chance for gravity to make it fall.

Vertical Welds

For welding a butt joint in the vertical position, the electrode should be held at a right angle to the base metal and inclined down approximately 10 to 15 degrees, so that the electrode is pointed up in relation to the base metal. It may be necessary to reposition the electrode for other types of joints. The vertical-up direction provides greater penetration and is best for thicker metal, whereas the vertical-down direction can be used for thinner metal. See Figure 5.5.

Figure 5.5 – Angle of the Electrode for Vertical-Down and Vertical-Up Welding



To keep the weld pool from getting too hot, the welder can use a flipping or whipping motion with the electrode. This motion involves moving the electrode forward, lifting it slightly, and bringing it back to the weld pool without breaking the arc. Like horizontal welding, vertical welding benefits from a shorter arc length to ensure better transfer of filler.

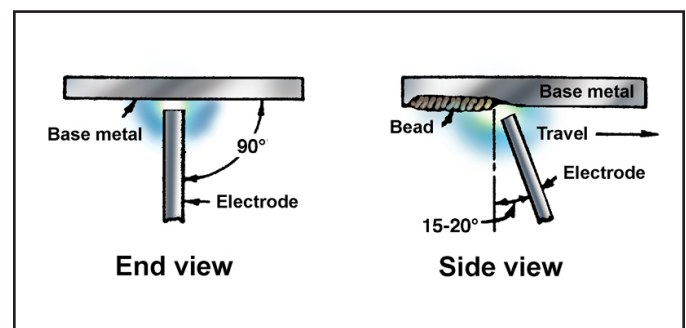
Overhead Welds

Welding in the overhead position is generally the most difficult of all the positions and causes the most safety concerns for the welder. In addition to the usual welding safety procedures, the welder must be sure to take extra steps to protect against falling molten metal. The welder should wear a fireproof cap, be sure that pant legs are cuffless and cover the tops of the shoes, and follow any other guidelines from the instructor.

For overhead butt welds, the electrode is held approximately perpendicular to the base metal and tilted 15 to 20 degrees in the direction of travel. See Figure 5.6.

It may be necessary to reposition the electrode for other types of joints. A flipping motion, the same as that used for the vertical position, can be used to control the weld pool and keep the filler from dropping out.

Figure 5.6 – Angle of the Electrode for Overhead Welding



Summary

The five basic joint designs that arc welders encounter are the edge, tee, butt, corner, and lap. Depending on the nature of the work, a welder will have to weld in various positions. The four positions are flat, horizontal, vertical, and overhead. The flat welding position is the best because the force of gravity is not a factor. Welding in the latter three positions is called out-of-position welding and requires the use of special techniques to keep gravity from causing the molten metal to fall.

Agricultural Mechanics

Credits

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