Chapter 12

Arc welding applications

The spot welding process described in Chapter 11 is not suited to all welds, especially long-path joints needing a gas-tight seal between the two surfaces being joined. However an alternative electric welding technique exists for such situations in the form of electric arc welding. In this process the heat required to fuse the metal surfaces together is derived from an electric arc. This is no more than a sustained ‘spark’ or electrical discharge between two terminals, which in this case are the work and a metal welding electrode.

When the arc is struck, the temperature in the vicinity rises rapidly to as much as 6500 degrees Fahrenheit. At such high temperatures, a small pool of molten metal forms in the work, and the end of the electrode also melts to contribute additional metal to the pool. Obviously the electrode material must be electrically conducting and compatible with the metal forming the part being welded. A typical electrode is in the form of a metal wire, continuously fed at the correct rate to replace electrode material consumed by the welding process.

Arc welding process

Originally electric arc welding was performed using a carbon rod electrode which sustained the discharge but supplied no material to the weld. Indeed it was usually of importance that the amount of carbon particles finding their way into the weld be minimized since their presence could impair the quality of the join. By playing the arc back and forth across the area to be welded, the workpiece was maintained in a molten condition, and if additional metal was needed it was supplied by means of a separate filler rod.

The carbon arc method has now been largely abandoned in favor of more sophisticated procedures. One of these is to use a metal rod coated with a flux material as the electrode. The welder inserts the rod into a holder, and the heat from the arc melts the flux which flows freely over the area of the weld, preventing oxidation. When the rod is used up, another is inserted. The method is simple and suited to portable welding units which can be taken to the site of the weld.

A more advanced technique is the so-called Heliarc welding process.
in which a single electrode such as tungsten is again used solely to provide and sustain the arc, as in the carbon electrode method. Since tungsten has a high melting point, it does not melt and therefore provides no material to the weld. A filler rod must again be utilized to provide any ‘make-up’ material required.

What distinguishes the process from the carbon arc method is the fact that during the weld, the area surrounding the arc is flooded with an inert gas such as helium (hence the name Heliarc, although argon is also used), and this gas continuously protects the weld from the atmosphere to inhibit oxidation. The method is useful in welding metal such as aluminum and its alloys, copper, magnesium and stainless steel, and is known as the Tungsten Inert Gas process (TIG).

In factory welding installations used on production-line fabrication the most commonly used method is currently the Metal Inert Gas technique (MIG), also known as Gas Metal Arc Welding (GMAW). It uses the shielding effect of inert gases found in TIG, combined with a continuously fed metallic electrode, usually in the form of a wire coiled on a drum. The electrode material is selected for the particular weld since it provides filler metal.

Modern electric arc welding equipment comprises a gas line (flexible tubing) through which the electrode wire is threaded. The line and the wire terminate in a welding gun, the wire protruding to form a convenient tip with which to trace out the line of the weld. Control equipment propels the wire through the gas tube and governs its rate of travel. The voltage applied between the work and the electrode is monitored and used to sense the weld conditions so that control signals can be generated to make the operation as automatic as possible. Figure 12.1 illustrates a typical electric welding gun.

Whereas alternating current is almost always used in spot welding, the electric arc method operates from direct current, usually in the range 100 to 200 amperes at 10 to 30 volts. Conventionally the positive side of the supply is connected to the electrode, and the work goes to the negative terminal.

When a manual operator uses arc-welding equipment he will clip the work to one side of the supply, the other side being already connected through the control system of the machine to the electrode. The electrode is then simply a wire, and with power on, the operator touches this wire on to the work at the point where welding is to commence. This virtually short-circuits the supply, and generates a good deal of local sparking and heat generation.

By withdrawing the electrode an appropriate distance from the work, the operator is able to initiate and maintain an arc discharge between the electrode and the work. Human judgement is required throughout the weld, to position the electrode at an optimum distance from the work, and to move it along the line of the weld at an even rate to