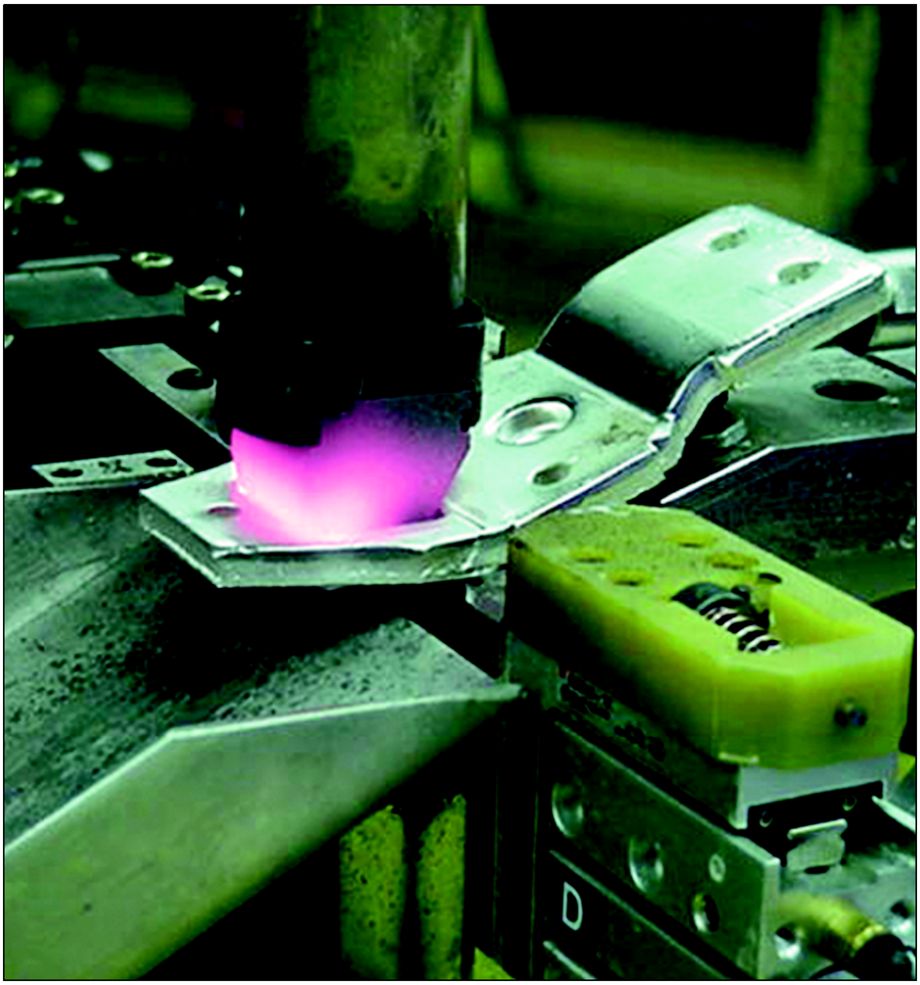
# CHAPTER 16

# RESISTANCE BRAZING

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## INTRODUCTION

Resistance brazing is a process in which heat is generated in the braze joint by means of resistance to an electric current flowing in a circuit that includes the components to be joined. The heat for resistance brazing is developed in either the components, the electrodes that contact the components, or both, when electric current passes through them.

Electrical resistance can be a source of heat in conductors because crystalline imperfections act as impediments to electron flow. These imperfections include vacancies, dislocations, solute atoms, and grain boundaries. Phonons—thermally induced quantized elastic waves in the crystal lattice—also hamper the movement of electrons within a conductor. These impediments to electron flow constitute the electrical resistivity of a conductor, an intrinsic physical property. Their combined action converts energy from each electron into heat.

Resistance heating is sometimes referred to as *$I^2R$ heating*. The amount of heat generated by the flow of electrons is directly proportional to the product of the base metal resistance and the square of the current. The total heat generated can be determined by factoring the time the current is applied. Additional energy input is required to some degree because, although the heating is rapid and localized, some heat loss occurs due to convection and radiation.

The rate of heating is very important in resistance brazing. During the initial heating, very high localized currents are found in the braze joint at discreet points of contact between the base metal and the brazing filler metal in the joint. Electrode pressure can alleviate some of this effect, but localized melting of the brazing material and base metal can occur until the contact area increases and the localized currents diminish.

Resistance brazing lends itself to applications in which rapid, localized heating is required and the braze joint can be designed to be part of an electric circuit. The process can be performed manually or using automation. It tends to be a low-temperature process, i.e., using brazing filler metals primarily from the silver (BAg) and copper-phosphorous (BCuP) classifications. This is due to the large temperature differences arising across the braze joint, components, and electrodes. In most applications, the heat for brazing is conducted from the electrodes through the base metal to the joint. The use of higher-melting-temperature brazing filler metals increases the likelihood of experiencing base metal melting and severe oxidation. In addition, at higher temperatures, heat loss due to radiation becomes severe, requiring excessive power input to bring the joint to brazing temperature.

### ADVANTAGES AND LIMITATIONS

No brazing process is universally applicable, as each has its unique advantages and limitations. Resistance brazing is most useful for joints requiring a heat source that is highly localized, flameless, noncontaminating, rapid, and closely controlled. Specific advantages are:

1. Resistance brazing can be cost effective. For example, a large motor stator or rotor may contain many small copper-to-copper braze joints. It would be uneconomical to furnace heat the entire assembly just to braze the small joints. The localized application of resistance heating is widely used to braze such joints;
2. Resistance heating can be applied to a small area, generally limited to the footprint of the electrode. In some electrical equipment and other applications, braze joints are situated close to temperature-sensitive components. The highly localized, flameless, and rapid application of resistance heating, limited to the joint area, prevents significant temperature rise in adjacent temperature-sensitive components;