

Resistance Brazing Basics

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Brazing

Brazing is the process of joining one metal to another metal using a low temperature interface metal, called a brazing alloy, without melting the two primary metals. Brazing permits the joining of metals with very disparate melting temperatures, thermal loads, and crystalline structures. Common brazing examples include relay contacts, machine tool bits, and radiator assemblies. Brazing alloys typically melt at 400°C or higher.

Brazing methods include, furnace brazing for mass production, induction heating, block-and-flow, dip, infrared, torch, and resistance brazing. This microTip will focus on the resistance brazing of small electronic or electro-mechanical components.

Resistance Brazing

Resistance brazing is ideal for joining small electronic or electro-mechanical metal components that are thermally conductive, electrically conductive, thermally imbalanced, and cannot tolerate heat soaking for extended periods at the brazing temperature.

Resistance brazing involves passing a controlled electric current through one or more of the primary metals and possibly the brazing alloy. The brazing current must pass through at least one of the primary metals for the resistance brazing process to work. In some cases, the heat generated from one primary metal is sufficient to displace any insulation on the second primary metal, thus allowing the brazing alloy to wet to the both primary metals.

Opposed Electrode Configuration

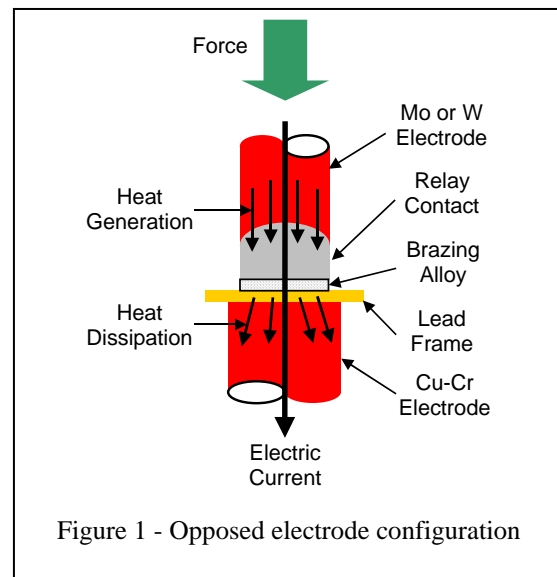
Figure 1 shows an opposed electrode, brazing configuration for brazing a very thin Beryllium-copper lead frame to a much thicker silver alloy relay contact. Furnace brazing would cause the highly tempered lead frame to lose its spring temper, rendering the final part assembly useless.

Passing a controlled electric current through the relay contact, brazing alloy, and lead frame for a very short period of precise duration quickly raises the temperature of these elements. The brazing alloy begins to soften and collapse under pressure from the brazing force and the heat generated in these parts.

This collapsing action in conjunction with the rising temperature helps to flow the surface oxides out of the brazing joint area.

Depending on the degree of primary metal oxide contamination, it may be necessary to use a brazing alloy containing flux to assist with the oxide breakup and removal. In some cases where the primary metal oxides are not a severe problem, the mechanical motion caused by the collapsing brazing alloy is sufficient to remove the oxides from the braze joint.

Upon reaching the melting temperature, the brazing alloy wets to both the relay contact and lead frame creating a strong bond with minimum diffusion between the brazing alloy and primary metals.



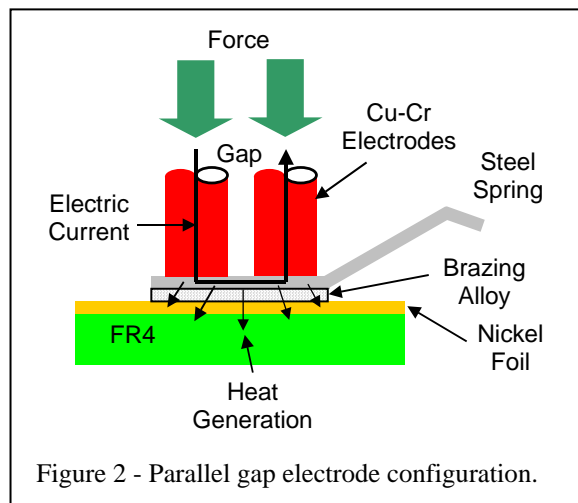
This particular brazing example has several inherent problems. First, the relay contact represents a large thermal load that is highly electrically conductive. To overcome this first problem, use an electrically resistive electrode made from molybdenum (Mo) or tungsten (W). Passing an electric current through this electrode material generates extra heat, which is absorbed by the thermally conductive relay contact, thus assisting the relay contact to reach the brazing temperature quickly.

Second, the tempered lead frame represents a much lower thermal load and is moderately electrically resistive. To prevent the lead frame from overheating and losing its temper, use an electrically conductive electrode made from copper-chromium (Cu-Cr). Also use a large diameter tip to help dissipate the “waste” heat.

Parallel Gap Electrode Configuration

Figure 2 shows a parallel gap configuration using two top electrodes to braze a tempered steel spring to a nickel foil that is adhesively bonded to a FR4 substrate. Using a brazing furnace would cause the steel spring to lose its temper and could possibly degrade the adhesive bond between the nickel foil and the FR4 substrate. The opposed electrode configuration cannot be used in this application because the FR4 substrate is an electrical insulator. Both electrodes must be positioned on the steel spring.

Passing a short milli-second duration, controlled electric current, through the foot of the steel spring causes the steel to heat rapidly, melting the brazing alloy, and wetting the brazing alloy to the nickel foil below. The electric current and the brazing duration must be optimized to prevent the steel spring from losing its temper and deteriorating the adhesive between the nickel foil and FR4 substrate.



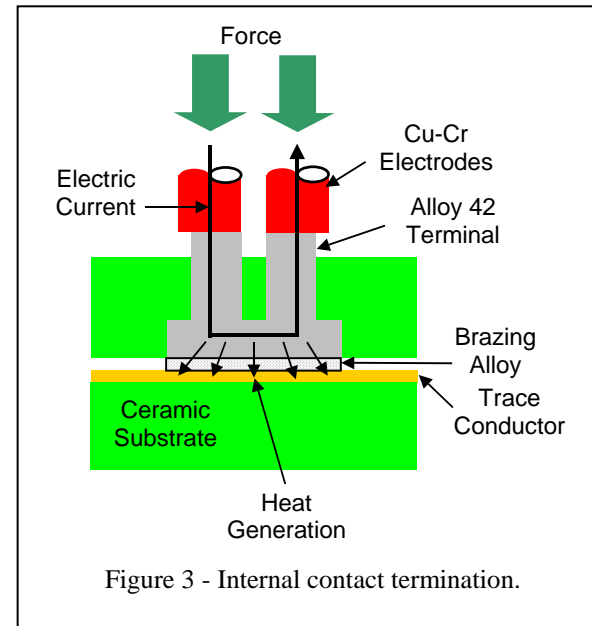
The primary problem with parallel gap resistance brazing is control of the electric current path through the parts. In addition to flowing through the steel spring, some of the electric current will pass through both the brazing alloy and the nickel foil.

The division of the electric current depends on the gap between the electrodes and the electrical conductivity of the brazing alloy and the nickel foil. If too much current flows through the nickel foil, the foil will blow out.

Terminal Contact Brazing

On occasion, a sealed electronic package may contain temperature sensitive components that preclude furnace brazing. This temperature limitation may present a problem with connecting external terminals to internal electrical circuit connections. Figure 3 shows a method for terminating a terminal within a ceramic package.

Passing a controlled electric current through the split terminal generates heat at the contact head of split terminal. This heat melts the brazing alloy, which then wets to the trace conductor. The terminal gap and depth control the heat generation. Like the parallel gap electrode configuration, controlling the division of the electric current can be a problem.



Summary

Resistance brazing is ideal for joining small temperature sensitive electronic or electro-mechanical metal components. In addition to working well with brazing alloys, this technique also works well with many lower temperature solder alloys.