

## Welding, Brazing, Soldering.....What's the Difference?

By *Frank Hermanek MMR #360*

I guess that every one of you recognize that each of the above terms - welding, brazing and soldering relate to some form of joining metals. That's great, but how are they similar to each other and yet different?

Let's start with "welding". Many of us have seen some form of welding being performed whether it be by stick, torch or arc. Car manufacturers' ads show automated lines filled with robots spot (resistance) welding car bodies together. Regardless of which welding process is used it will share one common trait with the others - each uses heat to locally *Melt* and join two pieces of metal together. Sometimes a filler metal is added to give the joint strength.

Prototype railroads use all of the welding processes noted plus one that is referred to as *Thermit Welding*™. Thermit Welding is used to join rails; here's how it works. Two rail ends are butted together and encased in a ceramic mold. The mold is filled with iron oxide and aluminum powders. Highly flammable magnesium powder, contained within a sleeve, is wrapped around the mold. A flare is lit and plunged into the magnesium powder that immediately begins to burn. The heat causes a chemical reaction between the iron oxide and aluminum powder. This reaction is *exothermic*, that is it gives off heat, heat hotter than the melting temperature of either the aluminum or iron oxide powders. The iron oxide-aluminum liquid produced is superheated, reaching temperatures of about 5,600 degrees F - 'way in excess of the melting temperature of the iron track. The butted rail ends melt and fuse to form a strong, tight welded joint.

Soldering and brazing, unlike welding, do not melt the metals being joined. Both processes are more like "hot gluing". They use non-ferrous *filler metals* that melt at temperatures substantially below that of the metals being joined. Typical braze filler metal alloys are aluminum, silver, copper, nickel and gold. Yes, gold! Gold alloys are used by jet engine manufacturers in joining components for operation in the hot sections of the engine. Expensive, but required.

Filler metals for soldering are generally alloys of tin that contain temperature suppressants such as lead, antimony, cadmium and zinc. Suppressants, based on their individual melting temperature, can depress the melting temperature of an alloy several hundred degrees. Each of these suppressants, when the alloy is melted, vaporizes and produces fumes harmful to your health. **STAY AWAY FROM THEM.** Find alternative lead, zinc, etc. free substitutes. I've been working with one that's sold as "silver solder"; it's not silver solder because "silver solder" is a silver/copper alloy used in brazing. What it is, is a tin alloy containing 5% silver. It melts at 483 degrees F and produces joints harder and much stronger than those obtained from a tin/lead or tin/zinc alloy. It's also available as either wire or in paste form. The paste or binder also performs the function of flux. Paste enables the alloy to be dispensed in a syringe type cartridge through hypodermic needles. The needles come in various sizes so the amount being dispensed can be controlled in both quantity and location. As an aside, I often apply some of the alloy to a joint, clamp the assembly, and pop it into the kitchen oven for ten to fifteen minutes at 500 degrees F. Produces good fit-up with no messy after clean up.

Getting back to the subject. Brazing is performed at temperatures above 842 degrees F; suffice to say, soldering is performed below 842 degrees F. All three joining processes require the use of considerable heat to complete a joint. Welding requires the most heat, sometimes hotter than 3,000 degrees F, as it melts the pieces being joined. These temperatures will affect the properties of the parts being welded - they'll be less strong and softer than they were before being welded. Properties can only be recouped by a follow-up thermal treatment.

Brazing also requires considerable heat and in some cases the use of complex, highly sophisticated and expensive, furnaces. Soldering on the other hand, can be performed at your workbench, with a torch or an iron. Even, as noted, in the kitchen oven. Think of soldering as hot gluing but using cold glue and applying the heat afterwards.

When soldering metals don't limit yourself to the standby iron. Explore, investigate. Try joining brass and copper parts with both the newer (lead free) and older alloys. Try a mini-butane torch and, above all, the "resistance" soldering tool.

*Frank*