When Induction Brazing Saves on Energy, Labor and Alloys

By Stanley Zinn, Induction Heating Consultants • June 2011

The three key factors most affecting factory brazing operations today are:

• Energy costs
• Labor costs
• Alloy costs

Along with maintaining joint quality, reducing overall cost per joint ranks with increased productivity as the biggest production problems. To realize how savings in these areas can be achieved with induction heating, let's discuss a typical application.

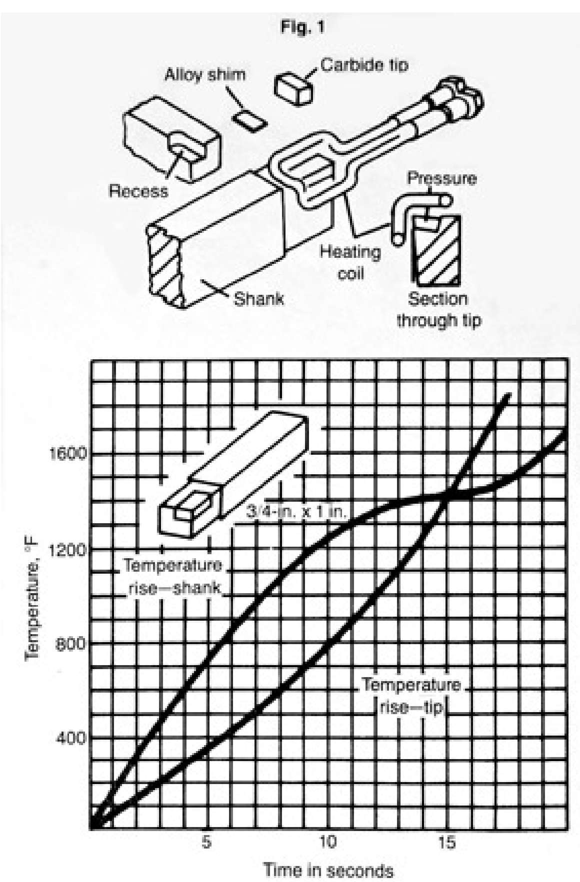

Figure 1

The key to proper coil placement is an effective balance between the relative mass of the two parts and the relative resistivity of the materials being joined. The relationship of coil to part must be arranged so that the larger mass and/or lower resistivity material is more closely coupled to the work coil. This is usually achieved by balancing the coupling distance between part and coil or by providing a larger number of coil turns to heat the larger part.

With respect to the single point tool shown, the open type construction couples more energy to the heavy tool shank than the carbide insert. The shape of the coil also tends to restrict the heat to the joint area.

With carbide tools, "puddling" or moving the tip during brazing operations is normally necessary to break down surface tension of the molten alloy. The use of open coil construction rather than a "basket" or fully encircling coil thus provides good operator accessibility.

With regard to production cost, the sudden rise in the world price of silver has caused considerable rethinking with regard to brazing operations. Where other joining techniques are feasible (spot welding, arc welding, shrink fitting) alternatives must be explored and parts redesigned, if necessary, to utilize less expensive processes. However, within the realm of joint quality, other alloys, if they have acceptable properties, should be considered. Particular attention should be paid to alloys with a lower silver content.

As a typical example, Governale Bros., Brooklyn, New York, has been induction brazing heavy malleable steel headers to copper bearing steel tubes for the manufacture of baseboard radiators and convectors (Fig. 2). Since the company used rings of 45 percent silver, alloy cost became a major concern. It was decided, therefore, to explore the possibility of using a brass brazing alloy for this operation.

Figure 2

Brass or bronze alloys have higher melting points than silver-bearing combinations. Accordingly, their flow point temperatures then approach that of the steel parts they are joining. Since a well designed joint will place the alloy where it will heat by conduction from the parts, the possibility exists of melting steel assembly components in trying to use a brass alloy.

In this instance, however, the header casting provided sufficient heat sink to permit balanced heating. Using a 50-kW, 10-kHz Cycle-Dyne generator, the three convector tubes are brazed to the casting with an 80-second heat cycle. Alloy cost savings achieved by switching to brass have averaged 90 percent per joint or more than $3.00 per radiator. As an additional benefit, the sluggish flow characteristics of the new alloy have reduced leaders to less than 1 percent of production, versus 14-15 percent with silver.

Large assemblies are not the only products that can achieve cost savings with induction. Where production warrants, induction heating, due to its "fixed time" processing, is easily automated. This "flame spreader" (Fig. 3), assembly line for a manufacturer of gas hot water heaters provides a multi-part assembly system that can be handled by a single operator.

The assembly is composed of two stampings, two screw machine parts and three alloy rings. The parts are assembled and fluxed right on the processing conveyor, with individual fixtures providing relative locations for accurate assembly. The parts proceed from the assembly station continuously through a channel type induction coil. The 10-kW induction

Figure 3

generator, operating a 450-kHz produces 1800 parts per hour with an automatic stripper removing parts from the conveyor at the exit end.

In a similar installation, for an automotive manufacturer, carburetor fast idle cam assemblies are brazed at a rate of 1600 parts per hour. This system was initially designed to incorporate an automatic flux applicator. When installed, the spray heads fluxing should remove an additional manual function from the assembly line.

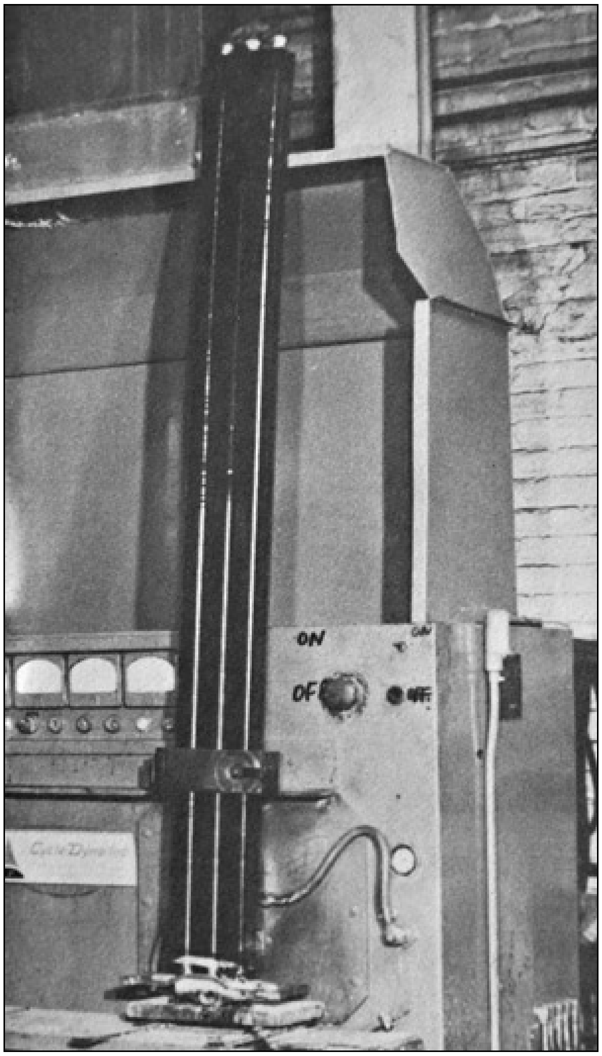

Figure 4: "Flame spreader" assembly line

At present, automatic part removal from the conveyor deposits brazed assemblies automatically in the first of a series of baths. These are designed to remove the brazing flux and apply a rust inhibitor to the components.

The ultimate in labor savings of course, is the robot-operated system. Induction heating, which can be tailored to match available machine index lines, lends itself readily to integration in modern automated systems. Figures 4 thru 7 show the brazing station on a robot operated line producing office copier rolls. Here, the brazing and cleaning operations had to be performed "in line" with the robot-fed machining operations.

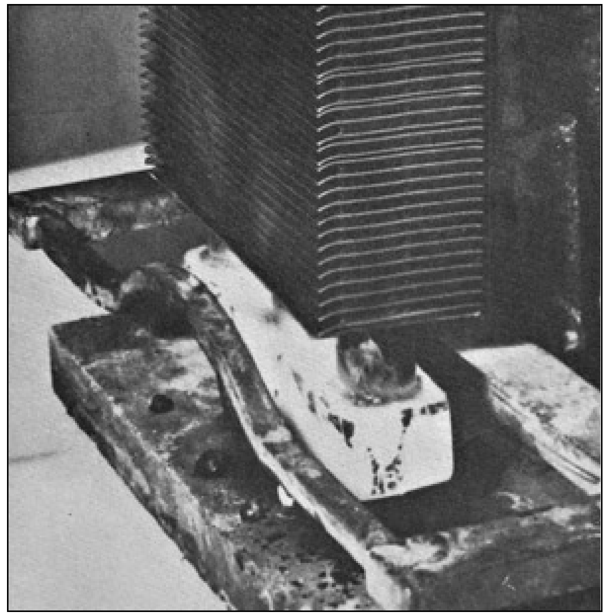

Figure 5: Copper sheet is induction brazed to 100 small tubes, and simultaneously, to the housing of marine coolers

The rolls are heavy copper tube approximately 3 inches in diameter. They have stainless steel hubs brazed in each end.

Production requirements of 60 parts per hour were met with an off line transfer system which lifts two parts at a time from the pallets on the conveyor and places them on a walking beam handling system. The beam transfers the parts to a work station where the ends are fluxed, the brazing rings inserted and the hubs placed in position.

Design of this operation was based upon the fact that the automated machining operations could maintain lose tolerance fits between the tube and hub components.

Initially it was thought the part would have to be held in a vertical plane so that the molten alloy would not run unevenly in the joint. However, this would have necessitated doing one joint at a time, then turning the roll end for end to complete the opposite joint. The double handling would have made the job cost prohibitive.

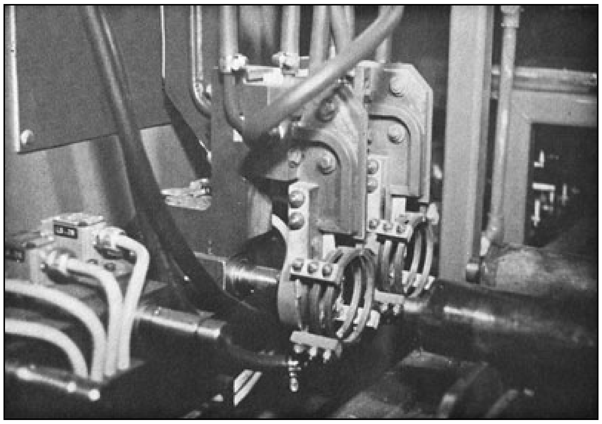

Figure 6: Brazing station on a robot-operated line making office copier rolls. Brazing and cleaning are done in-line.

By maintaining .002- .003-inch clearance between the hubs and the roll, the part can be held horizontally. Capillary action draws the alloy evenly through the joint, and 85 per-cent coverage of the joint area, by the alloy, is achieved.

In the next index position, an American Induction 40-kW, 1-kHz induction generator brazes two assemblies (four hubs) at a time. In this instance, two matching heat stations, each with a two-position coil, index into each side of the assembly to perform all brazing operations simultaneously.

It is interesting to note that though the tube is a heavy mass of low resistivity copper, the high power input capability of the induction heater can perform this function with a minimum of heat conducted down the tube.

The coils are designed to place most of the heat in the low resistivity copper tube. A smaller Field is generated in the stainless steel hub which, with conduction from the copper, comes to brazing temperature at the same time as the tube. The same machine then automatically washes the parts internally before replacing them on the pallet, at the next conveyor station.

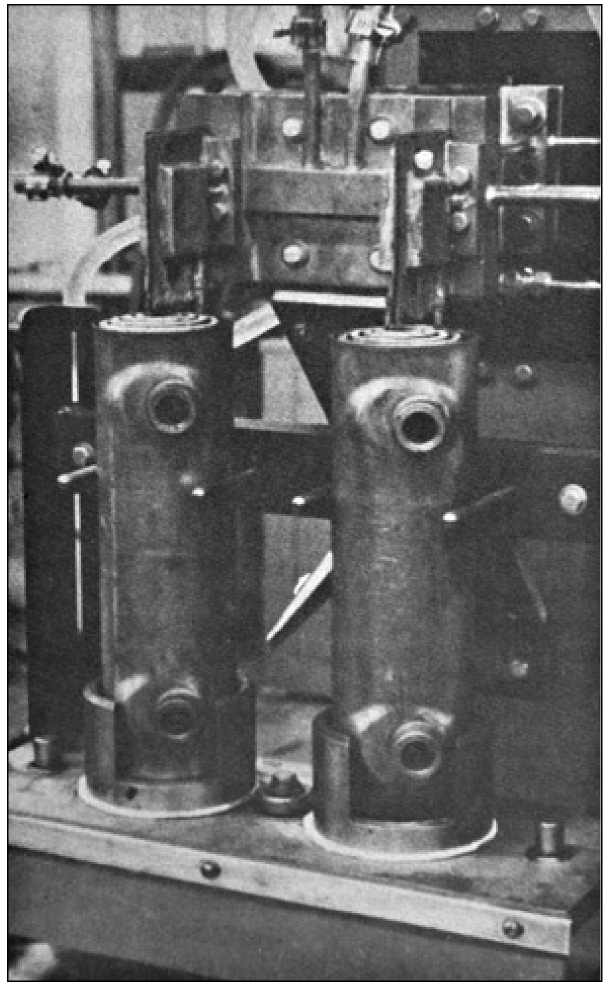

Figure 7: Heavy malleable steel headers are brazed to copper bearing steel tubes for a manufacturer of radiators.

With regard to energy costs, direct conversion of electrical power to heat at the joint is, today, considerably more cost efficient than that produced by gas flame. Restricting the heat to the joint area, the induction heater draws only sufficient power to heat the localized area for proper alloy flow.

Though induction processes are capital intensive (initial equipment cost is normally higher than that for an equivalent gas-fired unit), present gas costs are rising. Natural gas conversion efficiencies of 8-10 percent on operating installations are normal. Equivalent typical electric costs of .03 cents/kW hour coupled with line to load efficiencies of 55-65 percent have made operating costs highly competitive.

In any brazing process, the basics—

1. Part cleanliness
2. Proper fit for good capillary action
3. Balanced heat placement —

must be employed for structural integrity of the joint.

Within these constraints, analysis of the process can lead to the use of induction as a cost effective brazing tool.

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