MODINE

ShopTalk

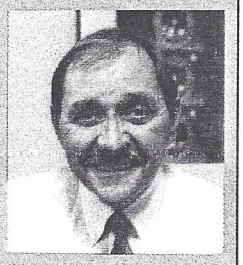
VOLUME 7, NO. 4 NOVEMBER/DECEMBER, 1994

TECHTOPICS

A new approach to aluminum repair

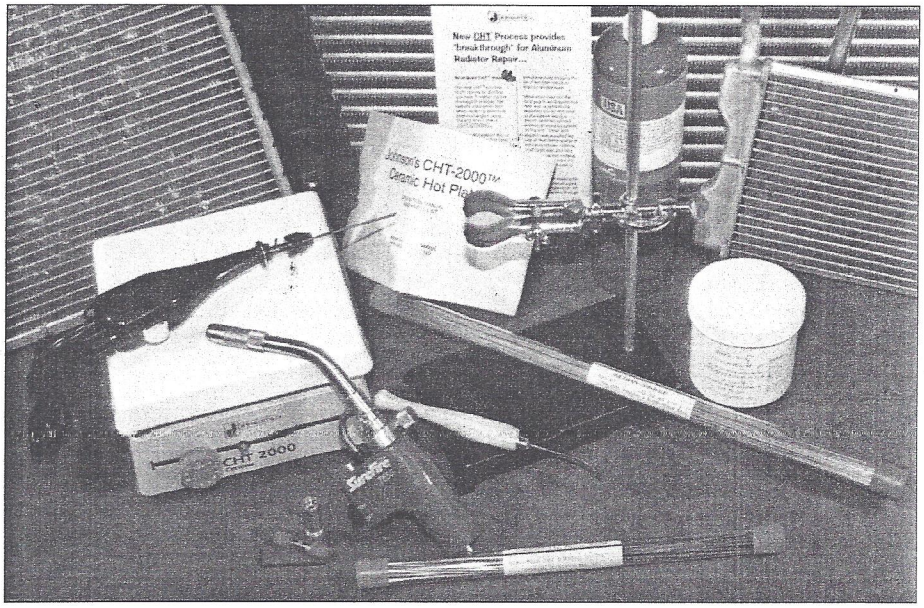
Repair of aluminum radiators, heaters and A/C condensers is an evolving art. Experience has not caught up with the changing technology, methods and tools. This month's installment of TechTopics, provided by Larry LePrevost, introduces you to a new repair method using new tools.

Larry, national sales manager for



Larry LePrevost

the Johnson Manufacturing Company, is well-known as a speaker at industry seminars nationwide. Questions on any of the subject matter that follows can be directed to Larry at the Johnson Manufacturing Company in Princeton, Iowa, (319) 289-5123. The observations of guest contributors in ***ShopTalk*** *do not necessarily reflect Modine's own viewpoint.*



The CHT™ 2000 kit can be used for repairs to aluminum radiators, heaters and A/C condensers.

After studying the various methods to repair aluminum radiators, one can't help feeling that there must be a better, cheaper, easier, faster and even safer way to accomplish this task. We've all read articles about aluminum repairs, and hopefully you've learned a lot from them. I've learned that aluminum brazing is not as easy as others make it look. So, here's the good news! I'd like to tell you about a recently developed alternative method for soldering aluminum radiators; one that is so easy even I can do it, and if I can do it, so can you.

Aluminum capacitors and utility poles

Once-upon-a-time, there were big aluminum capacitors containing PCBs mounted on utility poles all over the country. The federal government declared that all such units were hazardous and ordered them to be replaced with capacitors containing no PCBs. As a result, our sale of solder to capacitor manufacturers has been quite good over the years. Aluminum capacitors are soldered using a fluxless method called "swaging" which means scrubbing or abrading tin/zinc solder into the surface of the aluminum with a heated iron. This fluxless soldering method is used by the capacitor industry because it would be impossible to remove residues from the foil wrappings inside the capacitor. Even the slightest trace of flux would destroy the capacitor's ability to function.

Aluminum has a well-earned reputation for being a difficult-to-solder metal, one that requires the use of a very aggressive (corrosive) flux to chemically remove its outer oxide layer. If so, what enables capacitor manufacturers to swage solder into aluminum without flux? The secret is in the tin/zinc solder. Both tin and zinc are highly attracted to most metals; tin cans and galvanized steel are both evidence of this. Then why haven't we told you about

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Putting Quality In Your Hands.

Aluminum repair *cont.*

tin/zinc solders for aluminum radiator repair long before now? The reason is that tin is so dissimilar to aluminum (ask any chemical engineer to explain) that, in the presence of moisture, galvanic corrosion can set in, causing the solder to pop off in just a short time. Tin/zinc solders work fine for capacitors because these units are filled with an anhydrous (without water) fluid, then sealed from any moisture whatsoever.

It must be the zinc

If not tin, the secret must be zinc! Zinc has a high affinity (strong attraction) for aluminum and is also quite close to aluminum on the periodic table of elements. This similarity implies that there is no danger of a galvanic cell (corrosion) forming between the two metals. Zinc offers other unique benefits. Zinc is safe, in fact the human body requires a certain amount of zinc for good health. Zinc deficiency in humans is actually a more serious concern than over-exposure. Zinc is strong; zinc-based solder joints are even stronger than the aluminum components. Zinc is hard, resistant to wear, and it has self-healing capabilities. Zinc-based solders offer bridging capabilities (to fill holes) not found with most other solders. Probably the most important characteristic of zinc, as it relates to swaging aluminum, is its sharp-edged crystalline structure which provides an effective means for scratching through aluminum's tough oxide layer. Zinc is perhaps the only element on earth that is abrasive enough, and safe enough to use for mechanically scrubbing through aluminum oxides during the soldering process. The need to chemically remove oxides with flux is thereby eliminated.

Zinc, miracle element that it is, does not solder aluminum all by itself. A zinc-based alloy called Penny Solder™ (because most repairs can be made with about a penny's worth of solder) is actually better suited to this purpose. This alloy melts and flows under 750°F of heat. Using a mechanical scrubbing (abrading) action to apply the solder to a heated aluminum surface allows it to cut through the oxides, and then instantly form a metallurgical bond with the raw aluminum. The abrading action is provided by means of a small electric abrading tool that features a unique chuck for holding the solder firmly during this process. Properly applied, the solder produces strong, durable, corrosion-resistant joints that will hold up during years of service. Pressure cycle tests confirm that the solder repairs do hold up. Tests were suspended after 38,000 pressure cycles, with no failures.

Comparison to conventional wisdom

What are some of the things that concern us about the conventional wisdom regarding aluminum radiator repair? Epoxies, for example, do well for certain types of repairs such as tanks or headers. However, no matter what brand or type of epoxy you may use, it adheres to the surface by means of a mechanical bond only, whereas an alloy repair forms a far more permanent, metallurgical bond by joining atoms throughout the substrate.

Properly done, the aluminum brazing process makes very strong repairs. Yet I've been in shops where some aluminum radiators look as though they've faced the "mother of all torches". The radiators have big holes in the fins, or sections of fins pulled out so that heat can be isolated to a tube(s). Surely, it can be done better.

Watch out for alloys with cadmium

Aside from the aluminum solders that contain tin, (these pop off in a short time, remember) some other low-temperature aluminum solders are downright dangerous to use. I'm talking about alloys that contain cadmium. The latest OSHA standard (1992) established the Personal Exposure Level (PEL) for airborne cadmium at only 5 mg/m^3, as compared to the PEL for lead which is 50 mg/m^3. Employers must establish "regulated areas" whenever airborne concentrations of cadmium exceed 5, or can be reasonably expected to exceed this level.

A regulated area must: (1) be set apart from other work areas in a way that establishes and alerts employees to the boundaries of this area; (2) be entered ONLY by authorized persons; (3) be entered ONLY by persons using proper respirators; and, (4) be accessible to employees who refrain from eating, drinking, smoking or chewing tobacco or gum, and applying cosmetics in such areas. Warning signs must be posted at all approaches to this regulated area. "DANGER, CADMIUM, CANCER HAZARD, CAN CAUSE LUNG AND KIDNEY DISEASE, AUTHORIZED PERSONNEL ONLY, RESPIRATORS REQUIRED IN THIS AREA."

According the the Cadmium Council, an organization based in Reston, Virginia, heating cadmium to just 150°F, accelerates its release of toxic fumes. Approximately 40% of cadmium fumes that are inhaled, are retained in the body, while less than 5% of ingested cadmium is retained. This doesn't mean that you shouldn't worry about washing your hands, but rather it points out how critical it is for you NOT to breathe any cadmium fumes. Whether inhaled or ingested, cadmium builds up in your organs with each and every exposure. Furthermore, it is estimated that it can take over 25 years for the body to expel this toxin. All the while, a person may be seriously ill due to damaged or dysfunctional organs. Please check the OSHA Material Safety Data Sheet for any low-temperature aluminum solders in your shop, and for heaven's sake, don't use a 3000°F flame to melt solders that contain cadmium. Luckily, only a very small percentage (less than 1 percent) of solders used for brazing contain cadmium.

For high volumes, use GTAW

GTAW (Gas Tungsten Arc Welding) is also known as TIG welding. GTAW provides significant advantages for shops that repair a lot of aluminum heat exchangers, charge-air coolers, etc., but at a relatively high cost. With the average GTAW unit starting around $3,000, not to mention the training and supplies you will need, you must have a steady flow of repair work to pay for one of these units. GTAW units can be effectively utilized for the welding of tanks and headers; however, welding tubes can be very difficult. So what's the alternative? CHT!

For tubes, use CHT

CHT™ is an acronym for "Continuous Heat Transfer". Radiators are designed to dissipate heat. Aluminum radiators do it so well that it has been difficult to concentrate and maintain enough heat to make alloy repairs. Oxy/acetylene torches are frequently used. However, as one Texas shop owner who is experienced in the ways of brazing aluminum radiators recently told me, "If you don't watch what you're doing, you'll lose the whole crop."

When heating aluminum radiators

Aluminum repair *cont.*

with a single torch, most of the heat goes straight through the fins, only to be lost to the air moving across the underside of the core. Some heat spreads laterally through the core, but the boundary area continues to act like a heat sink, just slowing you down. This process is a little like knowing how much Thanksgiving turkey and dressing NOT to put on your plate. Increasing flame intensity is not the answer. Instead, using a continuous volume of heat is much more desirable and more easily controlled.

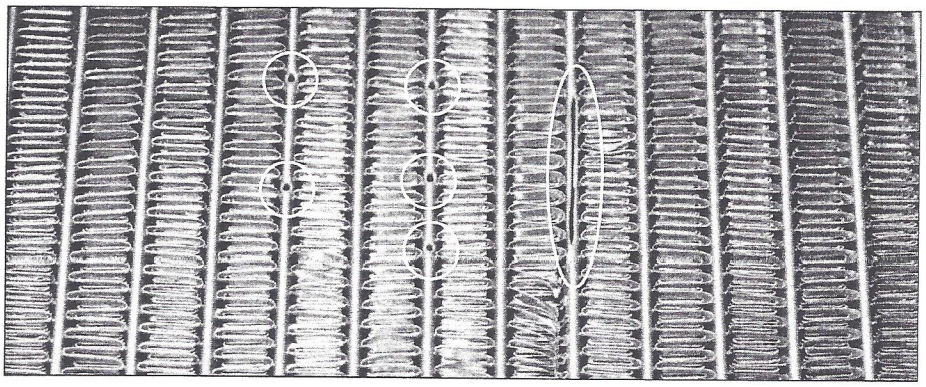
Using the CHT process, primary heat is applied from the underside and it rises through the core right to the point of repair. For this purpose we have selected an 1,100-watt laboratory quality hot plate with a ceramic top, capable of transferring up to 1000°F of continuous heat into the core. Secondary heat is provided by means of a self-lighting propane torch, equipped with a pencil-tip flame that is directed precisely at the point of repair, on the top side. Controlling heat this way is so easy, we can't ever conceive of "losing the whole crop".

A 10-step process

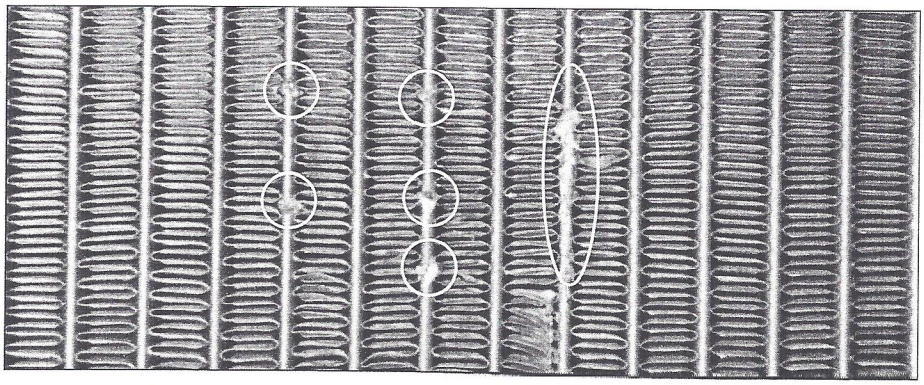
The preceding paragraphs have described the various components that are used in the CHT process. Now, let's talk about what you have to do to make it all happen:

1. Clean up the spot to be repaired using short bursts with a sand-blaster.
2. Correct physical damage by straightening tubes and fins if necessary.
3. Place the heat exchanger you want to repair down flat on the CHT hot plate for approximately five minutes, or until the repair area reaches 450 to 500°F.
4. Apply supplemental heat to the repair using a self-lighting propane torch, for five to ten seconds.
5. Remove flame and immediately start abrading penny solder, straight down (90° angle) into the hole using the electric abrader tool. Do not push; let the tool do the abrading.
6. Important: NEVER apply heat directly to the the solder, or let the flame spill over onto the solder! Heat only the repair, and then as you stop heating and quickly start to abrade the solder into the repair, the heat will transfer from the tube into the the solder, causing it to melt.
7. Alternate heating and abrading until you start to see a tinning effect. Don't stop.
8. Continue to heat and abrade alternately until wetting occurs.
9. Remove the radiator from the hot plate and allow it to air cool. Never quench!
10. To avoid discoloration, pressure test in a solution of Johnson Aluma-Test™ tank fluid and water.

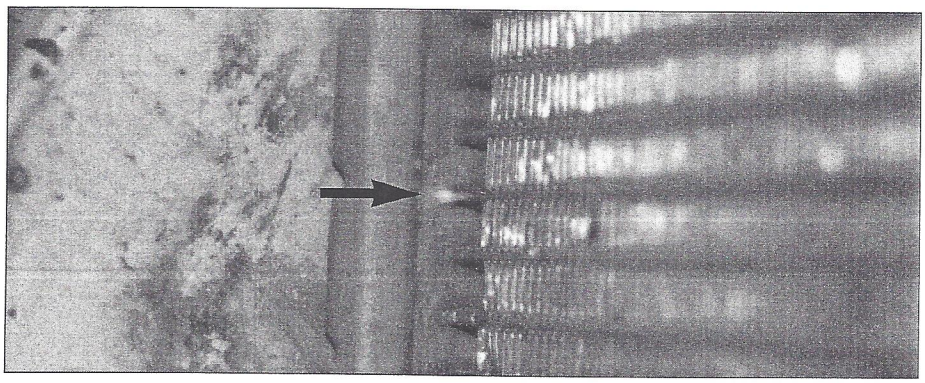
As a final comment, we are pleased to share all of this information with you, because we truly believe there is a need. We have worked hard to advance this process, and to assemble the very best components available to insure your success. Many repairs are possible using the CHT method, such as tube to header repairs, condenser repairs, and repairs done with brazing rods, etc. Most are covered by tips and techniques included in an instruction booklet packed with each kit. Perhaps they can be covered in a future issue of *ShopTalk*. CHT kits are available through your Johnson product source. Technical support is available weekdays from 8:00 AM to 5:00 PM Central Time, by calling Johnson Mfg. Co. directly at (319) 289-5123.



Note the holes in the tubes to the left and the long slit in the tube to the right.



Using the CHT process, the repairs are easily completed to seal the holes shown above.



Tube-to-header repairs can also be made using the CHT process.