

Weld Repair

The Right Choice

Tooling returns to production quicker, and lasts longer.

BY BRENT WILLIAMS

Tools and dies have a hard life, and even normal wear takes its toll. Tooling cracks, material wears away or a screwdriver is used one too many times to pry a part from a die. Soon, tooling no longer functions well or cannot hold the necessary tolerances.

Such problems lead customers to call on Five Star Tool Welding Corp., Butler, WI. "There aren't too many tool-and-die welding service houses around—we're probably one of five in the entire state," says Joe Canfield, Five Star president and owner. His firm focuses exclusively on tool and die welding, including microwelding.

Weld repair, notes Canfield, lowers part replacement cost, extends tooling service life and returns tooling to service faster than any other option. Rapid return to service even trumps price as a

Brent Williams is product manager for Miller Electric Mfg. Co., Appleton, WI; tel. 800/426-4553; www.millerwelds.com. Five Star Tool Welding can be reached at 800/894-5822, or e-mail jcanfield@five-startoolwelding.com.



consideration for metalformers.

“Metalformers and die shops come to us because they don’t want to build a new die, they want it repaired quickly,” Canfield says.

Tool repair also requires highly specialized knowledge—it’s a bit of a black art. When tool-steel companies produce a new grade of steel, such as the 9V and 10V crucible powdered metals (CPMs) or 300- and 400-series stainless steels, Five Star devises a welding procedure based on consultations with the material producer and its own experience.

“CPMs are a bear to weld because they’re so brittle, and are especially prone to cracking when the weld cools and puts pressure on the surrounding area,” says Canfield. “The first few times we welded CPMs we had no idea what awaited us. Steel manufacturers give recommendations, but we vary from those. After welding it three or four times and failing once or twice, we’ve got the process well under control as far as preheating and the type of welding rod to use.”

Five Star works with all grades of tool materials including H13, S7, D2, A2, all aluminum-bronze alloys, beryllium-copper alloys, copper, bronze, aluminum, magnesium and zinc. Parts repaired include stamping and forming dies, plastic-injection molds, diecast dies, blow molds, compression/transfer molds, Dynacast and Techmire dies and related components.

Precision Gas-Tungsten-Arc Welds

Five Star almost exclusively uses the gas-tungsten-arc-welding (GTAW) process. With the heat input (amperage) controlled by a foot pedal that functions similarly to a car’s accelerator, the operator can observe the area needing repair and adjust the amperage accordingly—down to 1 A DC or 5 A AC. Other welding processes do not provide this level of control over heat input or weld-bead width.

“With GTAW, we can pinpoint the arc at the area being welded,” says Steve Coleman, Five Star general manager. “We can direct the weld puddle so it doesn’t destroy the surrounding area



Joe Canfield, president of Five Star Tool Welding, microwelds a diecast insert for a lock mechanism. He dials power down to 1 A on his AC/DC gas-tungsten-arc/stick inverter to do this delicate work.

or require the customer to perform extra machining. Further, GTAW keeps tooling clean by not producing the spatter associated with gas-metal-arc welding.”

As an example of pinpoint control, Five Star once received from a competitor a micro-weld sample with a weld bead on top of the head of an ordinary shirt pin. Coleman placed a new weld bead on top of the competitor’s weld bead and mailed the pin back.

While Coleman performed that feat with a traditional Miller Electric Syn-crowave AC/DC GTAW power source, the company’s newer GTAW machines feature an advanced squarewave output and use inverter technology. This technology achieves greater penetration, narrows the weld bead, increases travel speeds by as much as 20 percent and may permit using smaller-diameter tungsten to more precisely direct the heat or make a narrower weld bead. It also reduces the size of the etched zone for improved cosmetics, and produces a more stable arc—the positive arc starts at 5 A or less, critical for micro-GTAW.

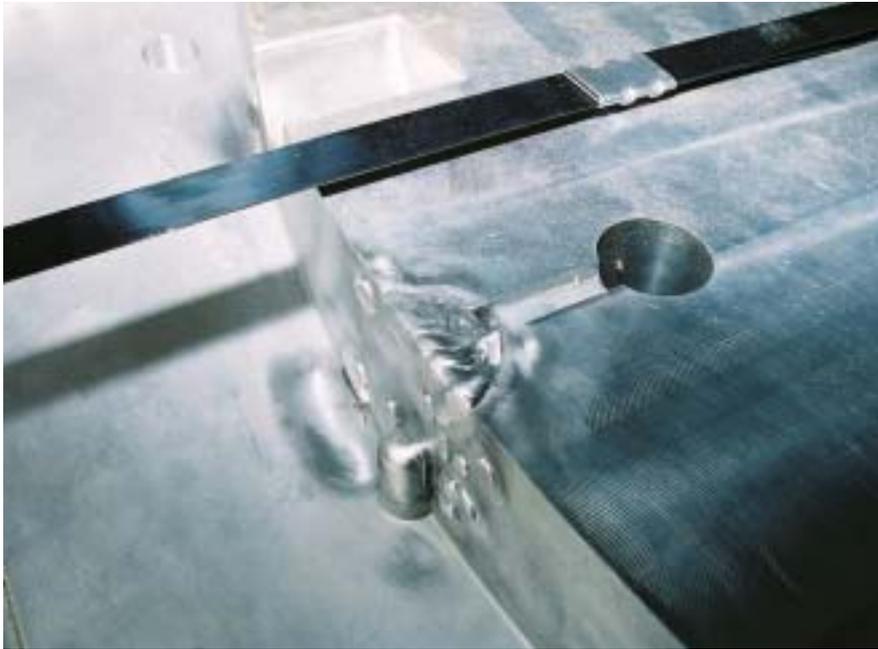
Most of Five Star’s GTAW equip-

ment comes from Miller, including Miller’s newest AC/DC GTAW inverter featuring Auto-Line technology. Auto-Line has brought particular benefit to Five Star, according to Canfield. The technology does not require continuous high frequency for AC welding, helping eliminate a problem that affected a computer Five Star had used for accounting. Also, notes Canfield, when wired for 460-V three-phase power, a Miller Dynasty power supply draws 7 A at rated output while Five Star’s traditional GTAW machines draw nearly 100 A. The low amperage draw reduces utility bills and allows Five Star to add more machines on the same breaker without changes to primary power.

Tips on Tool Weld Repair

To create a sound gas-tungsten-arc weld, Five Star operators strike an arc, establish a weld puddle and add filler metal as necessary. However, some special techniques and cautions are particularly important for tool weld repair:

Always use a gas lens—This screen inserted inside the cup prevents tur-



After Five Star weld-repairs tooling, customers can machine away this excess material to return tooling to original tolerances.

bulent gas flow and provides a wider area of shielding-gas coverage. It allows increased electrode extension, from ¼ to ¾ in. beyond the cup, which reaches into corners and improves weld-area visibility.

Shielding gas should be 100-percent argon for all materials, but thicker sections of aluminum may benefit from a

helium/argon mix. Consult with your local welding-supply distributor for specific shielding-gas information.

Mind tungsten selection and preparation—Select a 2-percent ceriated tungsten for all ferrous and nonferrous materials. Five Star has experimented with pure, thoriated, zirconiated and ceriated tungstens and has determined

that 2-percent ceriated tungsten best maintains a point on the end of the tungsten and provides more consistent arc starts and a narrow arc cone.

“We use 2-percent ceriated in different diameters,” says Coleman, “larger diameters (typically ⅛-in.) for AC welding, ⅜-in. for normal welding and ⅙-in. or 0.040-in. for microwelding.”

Proper tungsten preparation is critical. “We have a special sharpener with a diamond wheel that puts a smooth finish on the tip that we grind onto the tungsten,” Coleman says. “That ensures an even better start. “If the tip has any rough spots, the current will catch that rough spot and the arc will move somewhere else.”

“When I work on aluminum,” says Canfield, “I try to sharpen the electrode and place a small land on the end. Otherwise it balls up and wobbles. At high amperage, a wobbling electrode could blast right into the weld and contaminate it.”

Find the right filler—Matching the filler metal to the base metal seems like a straightforward task: just pick two materials of the same type. However, the parent material’s hardness and tempering current state throw a monkey wrench into that equation.

“When welding A2 steel,” says Canfield, “we use an M2 rod because it produces a finished weld with a Rockwell C hardness of 60 to 62. If we used an A2 rod in its hardened state, the weld would exhibit about a 54 Rc. Then customers would have to heat-treat the whole piece to obtain the right hardness, which they don’t want to do.”

Positive starts and control are musts—Five Star operators value positive arc starts more than any other GTAW-machine attribute.

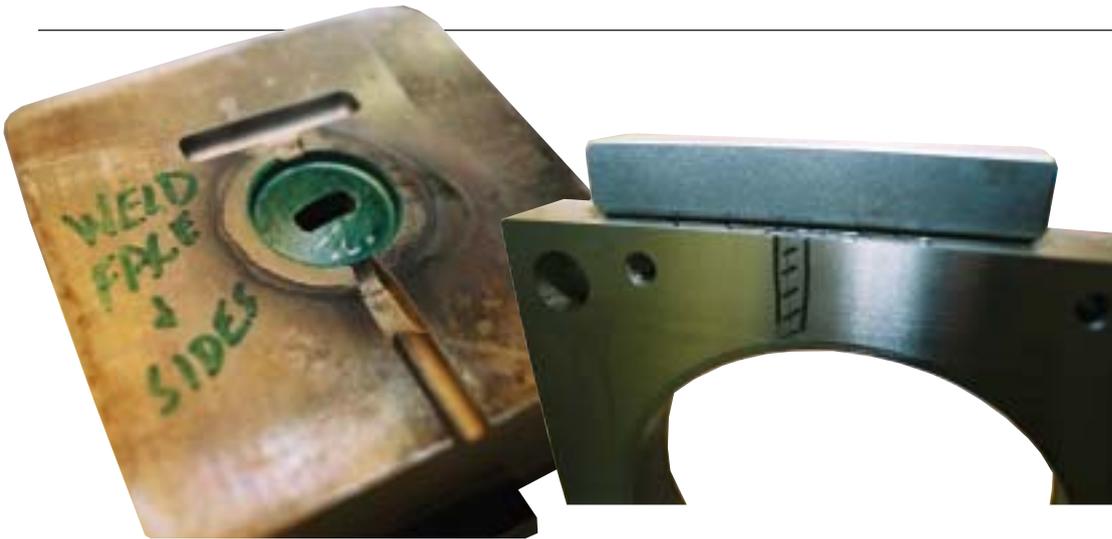
“The arc must start instantly and go precisely where I direct it,” Coleman says. “A misfired arc can do more harm than good.”

Also important is directional control. “If the arc dances around during a delicate repair in the bottom of a die cavity, it can damage fine edges or lead to excess machining,” Canfield says.

More Tooling Weld-Repair Tips

Here are some more weld-repair tips, courtesy of Joe Canfield, president of Five Star.

- Preheat the tool prior to welding to minimize the temperature difference between the weld and the surrounding area. With an extreme temperature difference, the sudden cooling and contracting of the weld pool may cause the tool to crack.
- To further reduce the chance of cracking due to temperature differences, keep welds as short as possible.
- When welding thin pieces, clamp the part to prevent warping.
- Peen the weld after each pass. This swages out the weld bead, relieving the material from shrinkage that occurs as the weld cools.
- If the steel type dictates, Canfield cannot over-emphasize the importance of post-weld heat-treatment in preventing cracking, especially for difficult-to-weld materials such as crucible powdered metals. A third party may perform this treatment, which involves heating a part, holding it at a specified temperature and cooling it at a precisely controlled rate.



Five Star uses a variety of gas-tungsten-arc-welding equipment to repair customer tooling. The tooling often arrives with marks that indicate cracks and worn edges or faces that need repair.

For positive arc starts at low amperages and for aluminum welding, a GTAW inverter provides the best results and improves directional control. Also, most of today's inverters and conventional GTAW machines allow operators to tailor arc starts for low-amperage welding.

Keep tooling clean and mind the heat—Remove all dirt, grease and foreign material from the tool. Use a neutral alcohol or acetone for grease or a sandblaster for hard coatings or gunk. To prevent damage to adjacent surfaces, protect them with masking tape before sandblasting. Also, remove excessively

rough crack edges with a hand grinder or carbide tool.

Cleaning the tool doesn't just prevent weld contamination, it also keeps smoky grease—any grease will smoke as tooling is preheated, usually to just below the last tempering temperature—from fouling the shop air.

“Suppose an S7 steel was last heated to 700 F,” offers Canfield. “We have to stay below that temperature or we'll soften the whole piece. But we can heat H13 to 1100 F without worrying about harming steel hardness.”

Customers generally indicate the type of tool steel to be repaired, but if not, follow Five Star's lead and perform a hardness test with a Rockwell hardness tester.

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