BY ROGER HIRSCH

Q: I am trying to weld a 0.031-in.-thick steel ring to a 0.093-in.-thick steel oil filter thread ring — Fig. 1. The ring is about 3 in. in diameter and has six small projections. This is being done in one hit on a 250-kVA press welding machine. The part is in a nest to align components. The problem is that some of the projections are good; some are low on strength or have no fusion. We also noticed burn marks on the flat part near the projections.

Fig. 1 — An oil filter thread ring assembly.

A: Welding large parts with multiple projections can be a challenge. The last part in your question regarding burn marks near the weld zones gives me a clue as to what is happening. I am betting that the fixture holding the parts in line is actually preventing the two parts from completely coming together. This often happens when fixtures are used. It is important that the fixture does not restrict vertical movement of either part during the entire weld sequence.

If the lower electrode area in line with a projection has been eroded from welding on one spot, the welding current will find a better path for conduction outside the projection location and produce a poor weld. Careful dressing of the electrodes should cure this problem. Also, check to see which copper alloy is being used for the lower electrode (against the nonprojection side of the part). I usually recommend the use of RWMA Class 11 tungsten-copper for this application since it has the best balance of high surface hardness and electrical conductivity.

Another thing to check is the absolute parallel of the upper and lower electrodes when they are under full welding force. Your 250-kVA press welding machine, if properly maintained, should have a rigid ram guide system, but the rear part of the electrode (closest to the back of the welding machine's throat) will have higher force than the front part due to normal flexing of the machine's frame. This means the electrodes will have to be shimmed so that, when under full welding force, the front and back of the electrodes touch with the same force. Be sure the shimming is done so that welding current passes through solid copper surfaces.

One trick to get these electrodes parallel is to put soft solid-core solder on the areas between the electrodes and then close them under full welding force. Use a micrometer to see the thickness of the crushed solder. Shim until all thicknesses are the same.

One last thing to consider is movement of the welding machine's ram (upper moving part holding the electrode). When doing any projections, and especially multiple projections, it is important that the welding machine's ram is able to follow the part quickly as the projections fuse down. This is called low inertia. If it does not move fast enough, the hot projections will expel some of the metal outward away from the weld and reduce strength considerably. Adjust the ram guides or rollers, lubricate, and be sure the air cylinder has flexible seals. Rebuild the air cylinder if necessary. Chances are nobody has looked inside the welding machine's air cylinder in decades. If you remove all air from the welding machine, a properly set ram should drop quickly by its own weight.

Q: A prototype of a new part was just brought into the welding department to be welded and sent to our customer for approval prior to production. The problem is that two of the welds are on 14-gauge clips (Fig. 2) that have very small welding surfaces, which puts the weld area near the edge. Even with a ½-in.-diameter electrode that has a ¼-in. contact surface, we are getting metal spitting out the open edge of the clip. This leaves rough metal sticking out the side. We tried using a smaller diameter contact surface on the electrodes but could not achieve anywhere near the required weld strength.

A: Metal in a nugget-forming zone is molten at the time the nugget is being formed. The electrode force pushes the metal around the nugget zone down to keep this molten metal from being expelled (flash). And the metal mass around the edges of this molten zone acts as a heat sink that lowers the temperature around the nugget zone to a point below the liquidus temperature of the metal. Unfortunately, when you are that close to the edge of the part, there is not enough material to sink heat away, and since the molten metal cannot be contained, it spits out, forming the rough edges you are seeing.

If the design of the part cannot be changed to allow more surface area all around the nugget zone, then the only other solution is to use pulsation. This is a function in a welding control that breaks up the welding heat time into a group of smaller weld pulses that alternate with nonheat times (cool). This forms a heat-cool-heat-cool-heat-cool sequence.

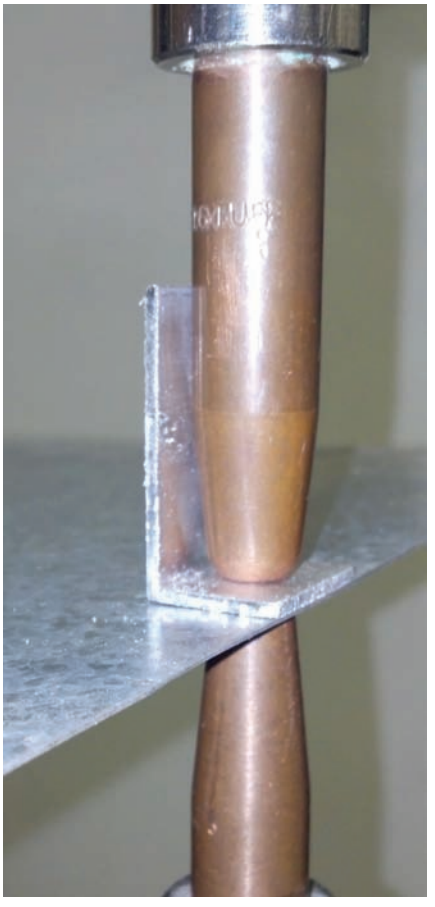

Fig. 2 — The prototype part has 14-gauge clips with small welding surfaces.

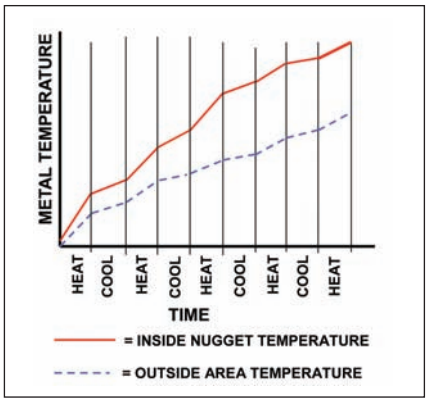

Fig. 3 — Heat rise during a pulsation weld.

Figure 3 shows what happens during a pulsation weld sequence. Temperature inside the nugget area rises during heat pulses, and continues to rise, but at a slower rate, during the cool phase. But during cool times, the area outside the weld nugget pulls heat away from the metal into the rest of the part and the electrode sucks heat out of the outer surface to slow down the temperature rise. If done properly, pulsation will form a deep nugget and minimize or eliminate expulsion from the edge of the part.

Typically, four or five heat pulses are used. As a start, divide the classical weld time obtained from an RWMA welding chart by the number of pulses that will be used. Add one cycle (or 17 ms) to each of these times. Then set the control with two to three cycles of cool time between the pulses. Finally, adjust the weld current as needed to get the desired nugget strength.

Pulsation is also useful when welding very thick metal with a welding machine that does not have the required secondary current available. It is also useful when welding 12 gauge or heavier galvanized steel parts. For both of these applications, use the heat/cool setting sequence as described previously.♦

ROGER HIRSCH is past chair of the RWMA, a standing committee of the American Welding Society. He is also president of Unitrol Electronics, Inc., Northbrook, Ill., a manufacturer of resistance welding controls and process water chillers. Send your comments and questions to Roger Hirsch at Roger@unitrol-electronics.com*, or by mail to Roger Hirsch, c/o Welding Journal, 8669 NW 36th St., #130, Miami, FL 33166.*

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