BY ROGER HIRSCH

Q: I am trying to make resistance welding seams using a single-phase constant current welding control and am having a hard time holding the tolerance required for this military project. We are using a 150-kVA seam welding machine with ⅜-in.-wide welding wheels on 0.040-in. CRS. The welding transformer tap switch is set to the #1 position. I checked the learn table in the control and see that we are in the 25–30% range so I know I am not overworking the welding machine. Do you have any suggestions?

A: The problem here is a misunderstanding of how a resistance welding machine works. Because you are using the control in this very low heat percentage range, the output of the welding transformer is a series of very small heat pulses and a lot of spaces in between. This makes control of the process very sensitive. No matter how good your control is, it will be very difficult to achieve the desired results with this welding machine.

Welding machine size is also often misunderstood. The idea that you need a

Fig. 1 — 99% weld heat.

Fig. 2 — 50% weld heat.

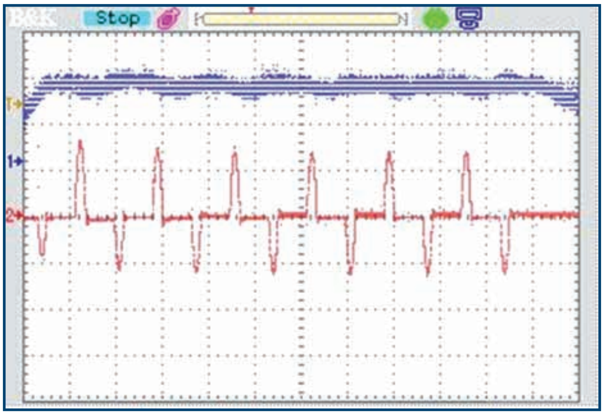

Fig. 3 — 30% weld heat.

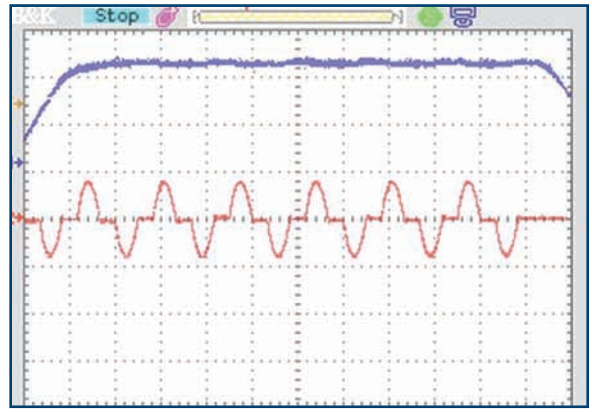

Fig. 4 — 460-V welding machine operating on a 230-V line at 60% weld heat.

welding machine large enough to join the thickest metal can also mean it will be way too large to do the smaller thickness combinations. Some of this problem can be overcome by using the welding machine with the transformer tap switch set at the high settings for the thicker metal welding, and then going to the low tap switch setting for thin metals. Sadly, many of the newer U.S.-made welding machines and most of the imported welding machines do not have a transformer tap switch and, therefore, lose this ability.

To understand why using a welding machine at a very low heat percent setting is a problem, you have to understand how a welding control provides heat in response to the program settings. The process is called *phase shifting*. This is accomplished by having the welding control fire the SCR contactor (solid-state switch that conducts voltage to the welding transformer) at different time delays in each half cycle of the line power.

If you want to use all of the line voltage, the control will turn on the SCR contactor just after the current in the welding transformer goes to zero. Since a welding transformer is an inductive device, this will happen a little after the line voltage goes to zero.

Figure 1 shows a welding machine operating at a 99% heat setting. The lower red trace shows the current going into the welding transformer primary. Note that the current is conducted over the entire sine wave of line power less a small notch at each zero crossing. This would be about the same as if you shorted the SCR contactor and put the entire available line voltage into the welding machine transformer. The upper blue scan shows the RMS current created by this AC firing. This RMS current is proportional to the output of the welding transformer.

Figure 2 shows a current scan for a heat setting of 50%. Note that about half of the sine wave is being used, and the other half has no heat. The upper scan shows the RMS current that results from this firing.

Figure 3 shows what happens with a heat setting of 30%, which is similar to your setup. Note that the amount of time that voltage is being conducted to the welding transformer is very small compared to the time of no voltage flow in each half cycle. The upper scan shows the RMS current from this setting. A very small change in this heat setting makes a large change in the RMS current, and a control working in this range will be unstable and cannot be accurate.

A good rule of thumb is to use a resistance welding machine with a transformer tap switch setting that will produce the desired RMS welding current when the control's heat setting is between 60 and 90%. The recommended upper limit of 90% is to allow the welding control to have the ability to increase heat to compensate for incoming line voltage variations. It also allows for changes in the welding machine secondary impedance as ferrous metal of the part is being pushed into the welding machine throat.

There are several solutions to this type of control problem:

The first is to set the welding machine transformer tap switch to a lower number and then use a higher weld heat setting. Unfortunately, in your case, you are already at the lowest setting.

Next, use the correct size welding machine for the job. If you have a smaller kVA seam welding machine, move the job there. As an example, a 75-kVA seam welding machine will probably find the proper heat setting in the 60% range to give control back to the system.

If this is not possible, and if you are working on a 460-V power line, connect the welding machine to a 230-V line with the results as shown in Fig. 4. Be sure to change the voltage select jumpers in the control to 230 V. Now you will be in the 60% range since the line voltage amplitude will be lower and you will be using more of each ½ cycle of this line voltage to create the desired RMS current for welding. This will not increase the load on the power lines since the turns ratio of the welding transformer will remain the same.

Note that you can operate a 460-V transformer on a 230-V line, but you cannot operate a 230-V transformer on a 460-V line without damaging the transformer.

Compare this to Fig. 3, which shows the same transformer operating on 460 V at a 30% weld heat setting. You can easily see how much more stable the process is when more of each half-cycle of current is being used.

Q: I have a project to join a small hanger strap to the top bell of a fire extinguisher. The hanger strap has two flat welding tabs. Each tab has a flat welding area of about ½ × ¾ in. The drawing specifies four small spot welds on each tab. I tried doing this and cannot get very strong welds. What am I doing wrong?

A: The problem here is in the hands of the designer. Many people who design sheet-metal parts do not have a full understanding of how spot welding works and, as a result, specify parts that cannot be successfully welded. This part seems to be such a case.

When you make the first of the four small spot welds, you fuse the metal to form a nugget. When you try to make the second spot weld, some of the voltage being conducted from the upper to the lower electrode finds an easy path through the fused metal of the first weld nugget. This is called *shunting*. Because of shunting, the second weld will be considerably weaker than the first weld. When you do the third and fourth welds, the same problem continues, but at an even greater level of strength loss.

Making four welds this close together will, if you are lucky, produce a total strength of about 1½ times that of a single weld. And since the diameter of each weld nugget will be small enough to fit into this tab, the total strength of all four welds will be very low as you have observed.

The solution is to use welding projections on the tabs. This will allow the welding current to make good separate welds at each projection in one pass of the welding machine, and the strength of the overall joint will be much closer to the strength of a single projection multiplied by the number being used.

In this case, since you are welding a flat tab to a curved surface, it would be best to use two oval-shaped projections placed at right angles to the radius of the part. This will allow the maximum weld area and compensate for any slight misalignment of the parts.

Another big advantage to using projections on this part is that you can use flat electrodes. These electrodes will have much longer life than a small spot welding electrode, and weld strength will not be dependent on how well the electrodes are dressed.◆

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 Doral Blvd., Suite 130, Doral, FL 33166.*