about ½ to ¼ of the weld time.

Four methods exist for welding galvanized steels. Although **pulsation welding** will create a longer weld sequence per weld, it provides for a much longer electrode life, usually greatly offsetting the longer weld sequence time. Total production is actually increased, sometimes up to 100 percent, over a simple spot sequence, because maintenance on electrodes is greatly reduced.

Second, **dispersion-strengthened copper electrode caps** can further extend electrode life.

Third, **weld current steppers** are also used to help extend electrode life by advancing the weld current in predetermined increments at predetermined times. They are empirically matched to increase the current to the change in current density required to overcome the mushrooming of the electrodes.

Fourth, **upslope control** can also be used successfully for welding galvanized steel. The upslope function allows starting the weld current at a low enough level to allow the electrodes to melt through the zinc, then subsequently increasing the current to a value sufficient to make the steel-to-steel weld.

Some fabricators combine two, three, or all four methods when welding galvanized steels.

Projection Welding

Pulsation welding techniques can be applied to projection welding, particularly to help set down large or multiple projections. When welding large or multiple projections, the current requirements may be quite high.

Unfortunately, the pressure system of the welder might not be able to follow up and properly set down the larger projection at the rate the current through the projection is melting the material (see **Figure 6**). The result is often a poor weld with a large amount of metal expulsion (flashing).

By using pulsation techniques, the total heat energy of the weld will be applied over a longer time, allowing the pressure system of the machine to provide the mechanical follow-up necessary to set down the projection properly to make a good weld (see **Figure 7**). Upslope control can also be used with projection welding.

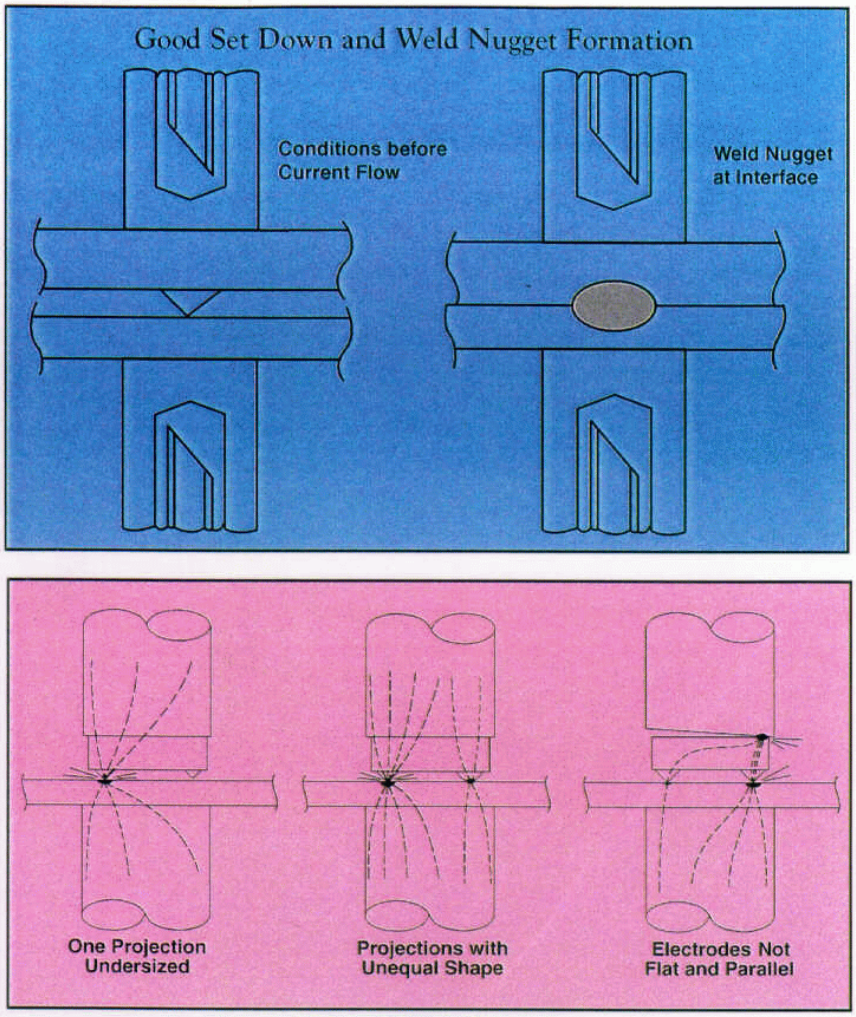

Figure 8

With multiple projections, it is often difficult to maintain tooling that will provide absolutely equally shaped projections. Although the differences in height or size of the projection may be small, the potential for unequal, parallel current paths through the projections is significant.

With multiple projections, it is often difficult to maintain tooling that will provide absolutely equally shaped projections. Although the differences in height or size of the projection may be small, the potential for unequal, parallel current paths through the projections (Kirchoff's Law of Distributed Networks) is significant (see **Figure 8**).

If the current paths are not reasonably equal, the resulting total weld may not meet specifications and may cause extensive expulsion at one or more of the projections. This effect can shorten electrode life and cause a personnel hazard as well.

Again, pulsation welding techniques may help to assure a more equal and uniform set down of the projections to create properly formed weld nuggets at each projection.

Welding with an Undersized Transformer

A third use of pulsation welding can be to increase the effective capacity of a welding transformer. A pulsation sequence, weld and cool, provides a cooling period in the welding machine transformer that can essentially reduce the effective thermal duty cycle of the transformer.

In this manner, the capability of a machine designed to meet the production requirements of welding 16-gauge

material could possibly be extended to weld 14-gauge or heavier material without damage to the welding transformer. Production rates, of course, will be lower.

Although this may not be the most efficient long-term use of a machine, the technique may be used when short production runs are necessary in job shop applications, when the investment in a larger, properly sized machine cannot be justified.

A pulsation sequence can be programmed into most microprocessor-based controls and can add greatly to the overall efficiency and production capacity of the welding machine.

Conclusion

Multiple impulse (pulsation) welding techniques can be used successfully to overcome, or simplify, the welding of many ferrous-based products, as described previously.

Because of the high conductivity of nonferrous metals, multiple impulse welding cannot be used effectively for joining aluminum or copper-based products, for example. Also, it is not recommended to use constant current functions with multiple impulse welding. ■

Robert Cuff is Chairman of Entron Controls, 465 E. Randy Rd., Carol Stream, IL 60188, phone 630-682-9600, fax 630-682-3374. Entron Controls is a manufacturer of a complete line of microprocessor-based resistance welding controls. The company is a member of the Resistance Welder Manufacturers' Association (RWMA), 1900 Arch St., Philadelphia, PA 19103-1498, phone 215-564-3484, fax 215-963-9785, Web site www.rwma.org.