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Welding fasteners: Spot or projection?

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Resistance spot welding offers flexibility, projection welding optimal quality

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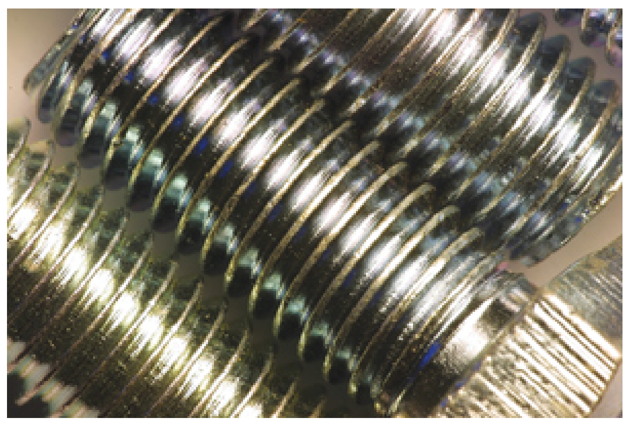

Both spot and projection weld fasteners have their place. Spot welding fasteners resistance-weld directly to a sheet with either a rocker-arm or a press-type resistance welding system (see **Figure 1** and **Figure 2**). Projection fasteners, which have small protrusions on the surface that fuse to the base metal, require a press-type machine. Fasteners that provide a hermetic seal have ring projections that circle around the flange of a weld screw, pin, or nut (see **Figure 3** and Figure 4).

Projection weld fasteners generally produce stronger, more precise welds than spot weld fasteners. The process uses two flat electrodes; the top one descends straight downward to produce complete compression, and the fastener projections turn to liquid nuggets and initiate fusion. Spot welding fuses fasteners without projections. The process shows its advantages when working in corners or other areas where a projection fastener wouldn't fuse properly, or in areas difficult for the electrodes on a press-type welder to reach.

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Fastener Welding Basics

All resistance welding requires a balance of heat (current), time, and pressure. Current can be adjusted by a regulator, which changes the ratio of primary to secondary voltage. The amount of heat generated increases with the square of the current, expressed as secondary amperes. The maximum rating shown on most machine nameplates, secondary amperes represent the current required to make the weld. They range from 5,000 to 15,000 amps for small fasteners, 15,000 to 25,000 for larger fasteners, and as high as

75,000 amps for large ring projections.

On low-carbon material, pressure settings are from 300 to 1,000 PSI for small fasteners, 1,000 to 2,000 PSI on larger sizes, and up to 4,000 PSI for larger ring projections. Stainless steel requires from 1,500 to 5,000 PSI.

Time in resistance welding—divided into squeeze time, weld time, and hold time—is measured in cycles, each of which represents 1/60 second. Weld time should be three to 10 cycles for small fasteners and 10 to 20 cycles for larger fasteners. Welding force should continue long enough to include 20 to 30 cycles of hold time to allow the weld to cool slightly.

When setting up a new job, start with pressure on the high side, use short weld cycle times, as well as low heat. As weld trials are made, increase the heat and weld cycles progressively until the machine produces good welds. This way, pressure can be lowered or increased as required without burning up the work and damaging the electrodes or equipment.

Without proper cooling, electrodes wear quickly. Flowmeters show how well fluid is moving throughout the welding machine. Insufficient cooling can be a problem especially with spot welding, because fasteners have no projections to dissipate the heat during the weld. But you should monitor water flow even when projection welding. Certain projection electrodes have internal water cooling coming to within ½ inch of the welding face. Hard-to-cool applications can use external water-cooling chambers, available in 5/8- and 1¼-in. diameters, to supplement internal cooling. Ideally, any resistance welding electrode should feel cool to the touch after welding.

Additionally, oil and dirt on the part can significantly reduce electrode life. Machine controls may have preweld options that burn off oil before performing the weld, but it's always better to start with the cleanest surface possible.

Dressing electrodes regularly ensures proper contact and better welds. For this, you should first remove electrodes per the machine manufacturer's instructions—never with a pipe wrench, which can damage the electrode surface. Most machines have electrodes with pin and rod assemblies inside the electrode holder; once you tap the tip of the rod in the holder, the electrode should kick out.

For spot welding, dress electrodes at the end of the shift using an electrode sharpener (never a coarse file); sharpeners approved by the Resistance Welding Manufacturing Alliance (RWMA) give the best results. Otherwise, the electrodes can erode or mushroom (see **Figure 5** and **Figure 6**). Although projection electrodes do not require such frequent dressing, they should be faced in a lathe frequently enough to maintain good weld quality and appearance.

Be sure to keep several sets of electrodes on hand to reduce downtime for electrode dressing. Also, the top and bottom electrode material should be the same to ensure consistent quality.

Projection Welding

Projection electrodes carry more current and weld thicker material than spot welding electrodes. For this reason, the projection process begins to show its advantages at about 0.035 in. and thicker (though it certainly can weld thinner metal). During the weld, the extra metal within each projection heats up into a liquid nugget, which in turn helps control and focus heat to initiate fusion. Proper fusion happens when both the weld fastener and the base metal reach the welding temperature simultaneously.

Projection welds use two flat electrodes large enough to cover the entire face of the fastener, and the projections themselves help absorb heat, thereby producing a clean weld without discoloration. The result: The process produces strong welds that are close to being cosmetically perfect.

The large tooling has another benefit: The more bearing surface, the longer the electrode life. Projection welding electrodes also can have a harder copper facing that extends their life even more. And unlike spot welding electrodes, projection electrodes can weld a wide range of sheet thicknesses, reducing changeouts between different runs.

The process requires even contact and pressure between the base metal and projections on the fastener. Excessive electrode pressure actually reduces the resistance between the fastener and material being welded, causing weak, incomplete welds or no weld at all. Insufficient pressure can cause flashing, burning, and discoloration.

The positions of fastener projections can vary, and each has its pros and cons. Some fasteners have projections located at the center of the head or, for nuts or screws, the midpoint of the flange. This helps concentrate heat in the center of the fastener itself or its flange, preventing excessive heat at the edges and eliminating spatter. Other designs place projections near the edge of the fastener. For fasteners with external threads, projections near the edge concentrate heat farther away from those threads, reducing distortion. However, because those projections are near the flange edge, spatter can be an issue.

For through-hole applications, insulated locating electrodes help protect threads. Locating electrodes have a hole in the center where the screw's threads are inserted (see **Figure 7** and **Figure 8**). These electrodes come with an insulated sleeve designed to protect threads from the weld current.

Welding projections require the fastener to be aligned perpendicular to the flat electrodes, and to the centerline of the piston cylinder that sits directly above the top electrode holder. Even pressure and contact are paramount. If the electrodes have more wear on one side, they probably are misaligned or nonparallel (see **Figure 9** and **Figure 10**).

You can measure projection electrode alignment with a carbon-paper test. Insert carbon paper between the electrodes, cycle the machine without current, and the electrodes will produce an impression. A half-moon impression shows misalignment, which means the electrode holders need to be adjusted.

Problems arise when the fastener does not align parallel to the part surface, or if the weld is close to a corner or edge, where the welds can have excess spatter from overheating. For these and similar circumstances, spot welding may be a better alternative.

Spot Welding

Spot welding fasteners work well with material less than 0.035 in. thick. In fastener applications, a spot welding system applies heat and pressure directly on the sheet and fastener. The electrode tip diameters control the size of the weld area (see **Figure 11**).

Picture a sheet and fastener inserted between two spot welding electrodes; the fastener can be thinner or thicker than the base metal. Typically, the electrode with a thicker diameter makes contact with the thinner material, while the smaller-diameter electrode contacts the thicker material. The smaller electrode emits a greater concentration of current, which better fuses the thicker metal.

Some spot weld nuts have electrode target areas, consisting of an indentation on the offset tab of the fastener (see **Figure 12**). These not only help locate the electrodes, they also create a more favorable balance of material thicknesses between the fastener and sheet metal. This is especially helpful if the fastener is being welded onto lighter stock.

When welding nuts with through-hole alignment pilots, if the electrodes do not hit the fastener at a consistent position, pressure misalignment can cause an offset nut to rock out of the hole. The more centered the electrode contacts are, using consistent pressure, the easier it will be to hold the nut in position.

Longer rocker-arm systems have a tendency to apply uneven pressure on the top and bottom electrodes, because of the long distance between the tips and the air piston cylinders applying the pressure. In these cases, offset electrode tips, bent slightly so the two electrode faces are perpendicular at the contact point, can improve alignment.

Spot welding has advantages for hard-to-reach areas. For instance, a spade screw, which has a flat section jutting perpendicularly at the top, can be spot-welded in tight corners and confined spaces (see Figure 4 and 11).

Spot welding has a few tendencies to consider. The process can discolor the material, mainly from excessive heat. Backing off on amperage, voltage, or pressure can help control this. The process also tends to mar the material because the electrodes put pressure directly against the surface of the fastener and the material itself. This is difficult to avoid. However, if a slightly marred surface doesn't affect overall part integrity and meets the application's quality standards, spot welding can be a cost-effective option.

Which to Use?

Choosing whether to projection- or spot-weld fasteners often hinges on what equipment a shop has. Most have a rocker-arm spot welding system (usually less expensive than a press-type welder), and if the rocker arm attaches fasteners with spot welds of sufficient quality, then it may suffice.

If a shop has both a spot and press-type welding system, other factors enter into the equation. If the fastener can be located perpendicular to the top and bottom electrodes, projection welding usually will produce better results. But if you cannot locate the weld projections because of difficult geometries (such as a weld against an edge or corner), spot welding would be the better choice.

Also, if your operation involves welding with and without fasteners, spot welding may be the way to go, if the application meets several criteria: First, spot welding must provide sufficient weld quality for the product; second, all materials must be of similar thickness to avoid electrode changeouts. If these criteria are met, you can use the same electrode set for both fastener and nonfastener jobs. If you were to projection-weld the fasteners, you would need to switch out electrodes between welds, extra setups that can add some serious time at the end of the day.

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