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Ultrasonic Welding

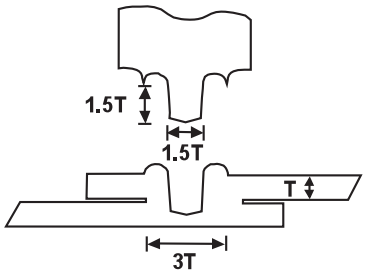

Figure 1. Standard Spot Welding Tip Design

Ultrasonic Spot Welding

General Description

Ultrasonic spot welding is an assembly technique for joining two similar thermoplastic components at localized points with no preformed hole or energy director. Spot welding produces a strong, structural weld and lends itself to large parts, sheets of extruded or cast thermoplastic, corrugated thermoplastic board, and parts with complicated geometry and hard-to reach joining surfaces. Most thermoplastics can be spot welded.

Mechanics of Ultrasonic Spot Welding

Vibrating ultrasonically, the pilot of the spot welding tip passes through the top component. The molten plastic displaced is shaped by a radial cavity in the tip and forms a neat, raised ring on the surface.

Simultaneously, energy is released at the interface producing frictional heat. As penetration of the bottom section is made with the tip, displaced molten plastic flows between the two surfaces into the surrounding interface area and forms a permanent molecular bond.

A general rule for spot welding is that the top sheet thickness should be less than or equal to the bottom sheet thickness. The standard tip produces a head having a diameter three times the thickness of the top layer. (See Figure 1.) The length of the protruding tip is one and one-half times the thickness of the top layer.

Advantages of Spot Welding

Ultrasonic spot welding offers several advantages over other methods in joining large parts, sheets, or extruded or cast thermoplastics, including:

- Fast cycle time – typically less than one second.
- Molded joint design is unnecessary.
- Elimination of consumable items such as screws, staples, rivets, or glues.

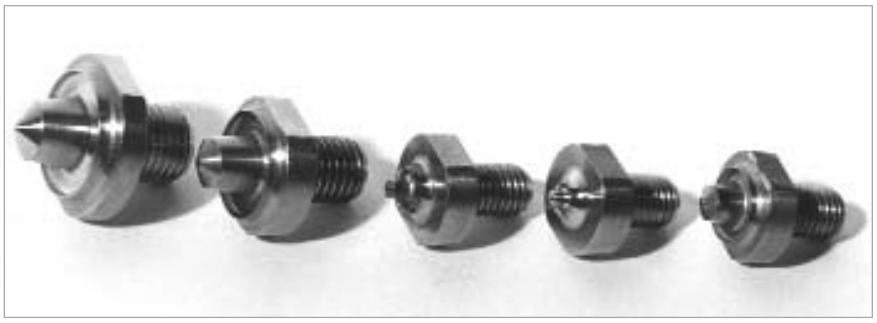

Figure 2. Standard Spot Welding Tips

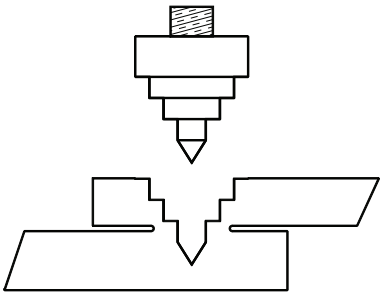

Figure 3. Custom Step Tip Design

- Generally no specific fixturing required.
- Excellent high-strength bonds.
- One side has a cosmetic surface, while the other has a neat, raised ring.
- Can be done using a hand-held welder.

Spot Welding Variation

Inverse spot welding, where the fixture is fitted with spot welding tips and a flat-faced bar horn contacts the outside of the part, may be used when part configuration precludes normal spot welding or when a blind spot is required. This method forms the spot welds on the inside surface.

Applications requiring a smooth top layer surface may be a candidate for a custom step tip design. While standard spot welding tips form the excess molten material above the surface, the step design forces excess material beneath the surface. (Figure 3.) (Note: this tip is custom and available on request.)

Equipment Requirements

Equipment for spot welding may be configured as a standard welder with spot welding tips on the horn or fixture, or as an ultrasonic power supply and a hand-held welding tool. (See Figure 4.) The hand-held tool is compact and lightweight, and may be designed with a pistol grip or a spring-loaded sleeve. Spot welding equipment is available in either 20 or 40 kHz.

With hand-held units, the ultrasonic welding cycle is initiated either by applying pressure against the parts being welded (using the spring-loaded unit) or by activating a trigger switch on the pistol-grip units. Welding duration is controlled by the operator or the power supply, depending on the equipment used. Some variation of the spot weld can be expected due to variations in the applied hand force.

In addition, the units may be used with a microprocessor-controlled power supply to enable welding in energy as well as time modes. Welding in energy would compensate for variations in pressure applied by the operator by adjusting the weld time. Using these power supplies also allows setting audible alarms for added control.

The horns used in ultrasonic spot welding are tapped to receive standard replaceable, threaded tips whose configurations and sizes are determined by the thickness of the material being assembled. (Figure 2 on the reverse side shows a variety of tips.) Tips are not limited to standard shapes; special configurations are available or may be made to order.

Automated or semi-automated systems may be utilized in production applications for spot welding. These systems may be configured as a “gang” welding unit with one or more spot welding heads ganged together.

Spot Welding Setup Parameters

The following basic guidelines should be used for ultrasonic spot welding:

- Medium to high amplitude is recommended.
- Low force (5 – 20 lbs) .
- Rigid support under the weld area.
- Slow stroke or downspeed of carriage assembly to allow melting to occur and prevent coupling of the parts.
- If using a hand-held welder, the energy mode is recommended for consistency.

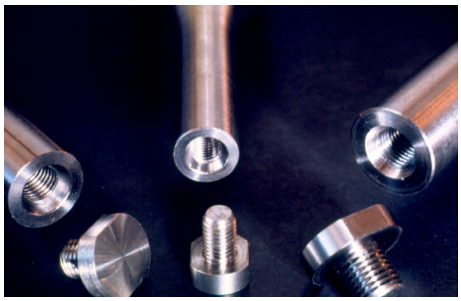

Figure 4. Equipment for Spot Welding: Hand-held Units (L top),Automation Integration Components (L bottom) or Standard Integrated Welder (R)

Standard Spot Welding Tips

Tip Dia.	Code Letter	Material Thickness Inch	Inch	mm	EDP No.
		For use with 20 or 40 kHz			
1/2”	A	1/32	0.031	0.793	101-148-050
1/2”	B	3/64	0.047	1.190	101-148-051
1/2”	C	1/16	0.062	1.587	101-148-052
1/2”	D	5/64	0.078	1.984	101-148-053
1/2”	E	3/32	0.093	2.381	101-148-054
1/2”	F	7/64	0.109	2.778	101-148-055
		For use with 20 kHz only			
3/4”	G	1/8	0.125	3.175	101-148-056
3/4”	H	5/32	0.156	3.969	101-148-057
3/4”	I	3/16	0.187	4.762	101-148-058
3/4”	J	7/32	0.219	5.556	101-148-059
1”	K	1/4	0.250	6.350	101-148-060
1”	L	9/32	0.281	7.144	101-148-061

Ultrasonic Welding

Characteristics of Thermoplastic Polymers for Spot Welding

The codes in the following table indicate relative ease of spot welding for the more common thermoplastic polymers. Use the table as a guide only, since variations in resins may produce slightly different results. Note: The ratings below do not relate to the strength of the weld obtainable. Refer to Technical Information Sheet PW-1 for detailed polymer information.

Material	Ease of Spot Welding
Amorphous Polymers	
ABS	1
ABS/polycarbonate alloy	2
Acrylic	2
Acrylic multipolymer	2
Butadiene-styrene	2
Phenylene-oxide based resins	2
Polycarbonate	2
Polystyrene (general purpose)	4
Polystyrene (rubber modified)	1
Polysulfone	4
PVC (rigid)	3
SAN-NAS-ASA	3
Xenoy (PBT/polycarbonate alloy)	2
Semi-Crystalline Polymers	
Acetal	4
Cellulosics	5
Nylon	4
Polyester, Thermoplastic	
PBT	3
PET	3
Polyethylene	3
Polymethylpentene	3
Polyphenylene sulfide	4
Polypropylene	1

Code: 1 = easiest, 5 = most difficult

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