JOINT DESIGNS FOR ULTRASONIC WELDING

Perhaps the most critical facet of part design for ultrasonic welding is design (the configuration of the two mating surface). It should be considered when the parts to be welded are still in the design stage, and incorporated into the molded part s. There are a variety of joint designs, each with specific features and advantages. Their selection is determined by such factors as type of plastic, part geometry, weld requirements, machining and molding capabilities, and cosmetic appearance.

BUTT JOINT with Energy Director

The butt joint with energy director is the most common joint design used in ultrasonic welding, and the easiest to mold into a part. The main feature of this design is a small 90° triangular shaped ridge molded into one of the mating surfaces. This energy director limits initial contact to a very small area, and focuses the energy at the apex of the triangle. During the welding cycle, the concentrated energy causes the ridge to melt and the plastic to flow throughout the joint area, bonding the parts together.

The size of energy director is dependent on the area to be joined. Practical considerations suggest a minimum height between .2 and .6 mm for easy to weld resins-amorphous polymers such as ABS, SAN, Acrylic and Polystyrene.

Crystalline polymers, such as Nylon, Thermoplastic Polyesters, Acetal, Polyethylene, PP and Polyphenylene Sulfide, as well as high melt temperature amorphous resins, such as Polycarbonate and the sulfones are more difficult to weld. For these resins, energy director with a minimum height of .5mm are generally recommended.

The energy director height should be at least 10% of the joint width, and the width at least 20% of the joint width. With thick-walled joints, two or more energy directors should be used, and the sum of their heights should equal 10% of the joint.

Part should be dimensioned to allow for the flow of the molten material from the energy director throughout the joint area.

To achieve hermetic seals when welding polycarbonate components utilizing an energy director joint, a modification of the basic energy director is recommended. For polycarbonate resins both the energy director height and width should be 25%-30% of the wall thickness, thus providing an included angle of approximately 60°. Figure-1 shows a butt joint with energy director.

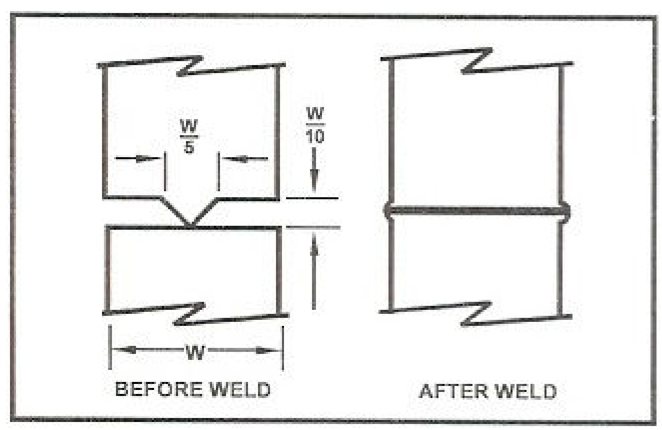

Figure-1 Butt joint with energy director

STEP JOINT
With Energy Director

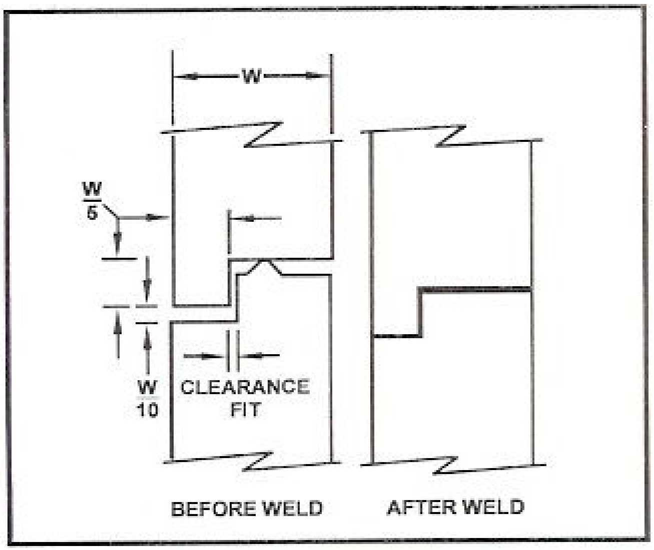

Fig-2 Step Joint with energy director

The step Joint with energy director is illustrated in fig-2. This joint molds readily, and provides a strong, well-aligned joint with a minimum of effort. This joint is usually stronger than a butt joint due to the fact that material flows into the vertical clearance. The step joint provides good strength in shear as well as tension, and is often recommended where good cosmetic appearance is required.

TONGUE AND GROOVE JOINT
With Energy Director

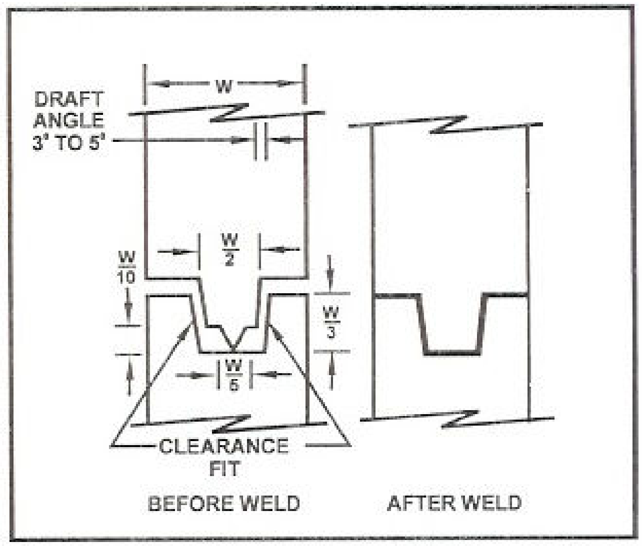

Fig-3 Tongue and groove joint with energy director

The tongue and groove joint with energy director is illustrated in fig-3. This joint is used primarily for scan welding, self-location and prevention of flash both internally and externally. It provides the greatest bond strength of the joints discussed so far.
Figure- 4 shows variations of the basic step joint design.

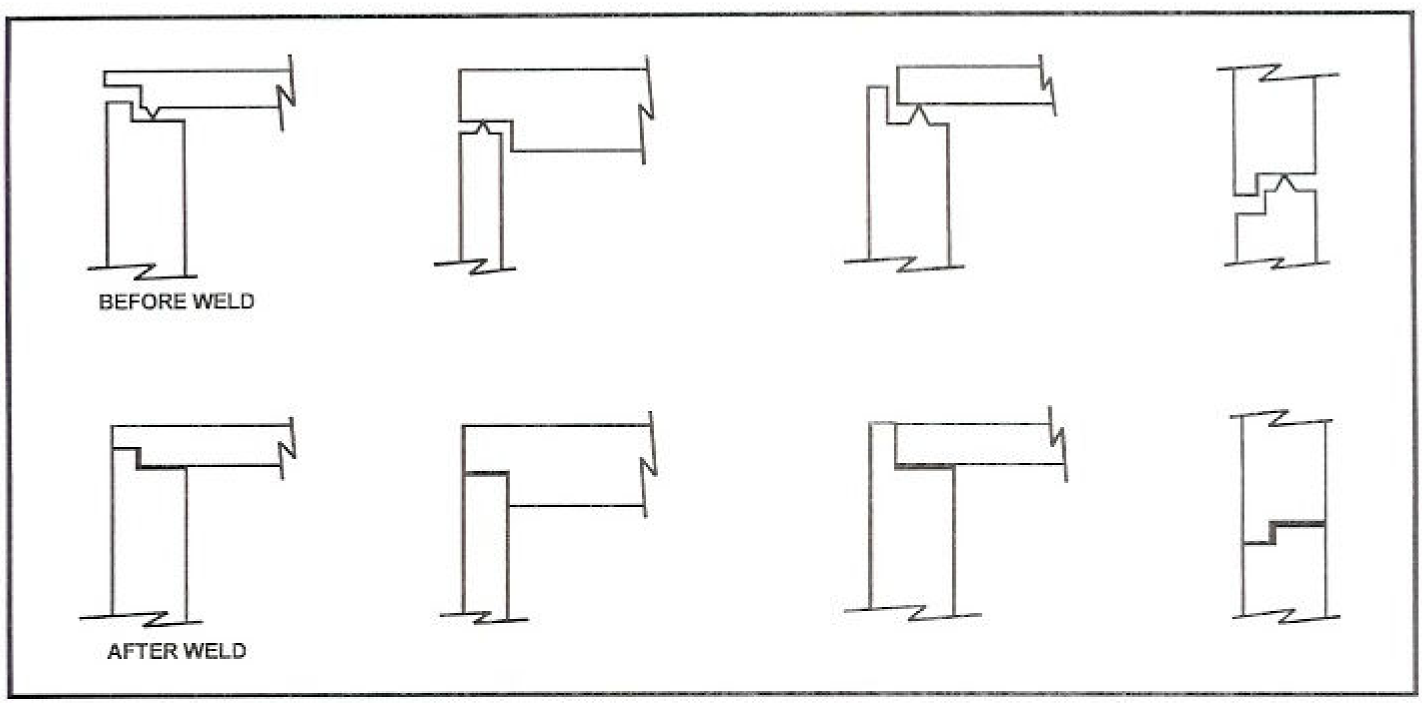

Fig-4 Step joint variations

Joint with energy director are not recommended for use with crystalline materials when high strength or repeatable hermetic seals are required.

SHEAR JOINT

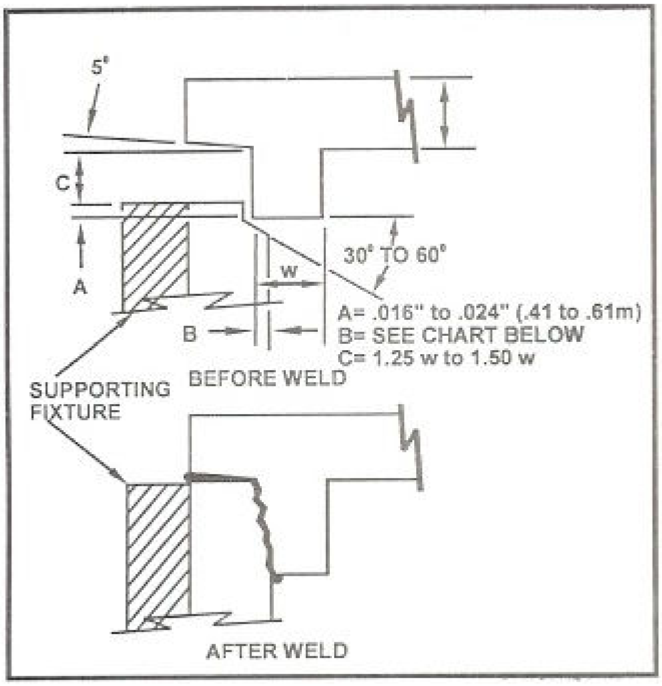

Figure-5 Shear joint

The shear joint or interference joint shown in figure-5 is generally recommended for high-strength hermetic seals on parts with square corners or rectangular designs, especially with crystalline resins.

Initial contact is limited to a small area which is usually a recess or step in either of the parts. The contacting surfaces melt first, then, as the parts telescope together they continue to melt along the vertical walls. The smearing action of the two melt surfaces eliminates leaks and voids, marking this the best joint for strong hermetic seals.

Several important aspects of the shear joint should be considered: 1) the part should be as shallow as possible 2) the outer walls should be well supported by a holding fixture, 3) the design should allow for a clearance fit, and 4) a lead in (A) should be incorporated.

When flash cannot be tolerated for aesthetic or functional reason, a well similar to the ones shown in figure-6 should be incorporated.

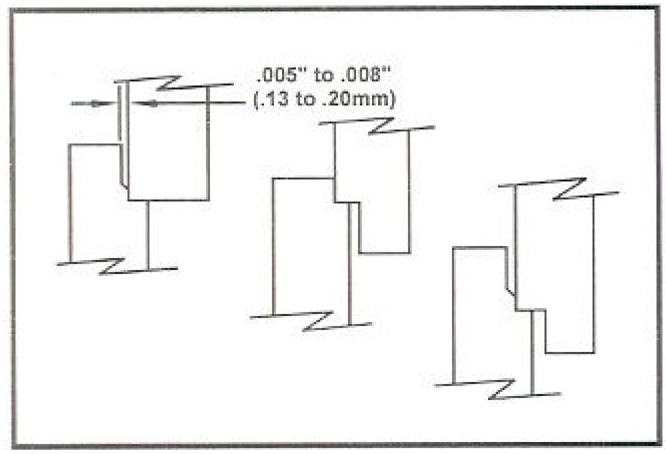

Figure-6 Shear joints with flash wells

Figure-7 shows variations of the basic shear joint design.

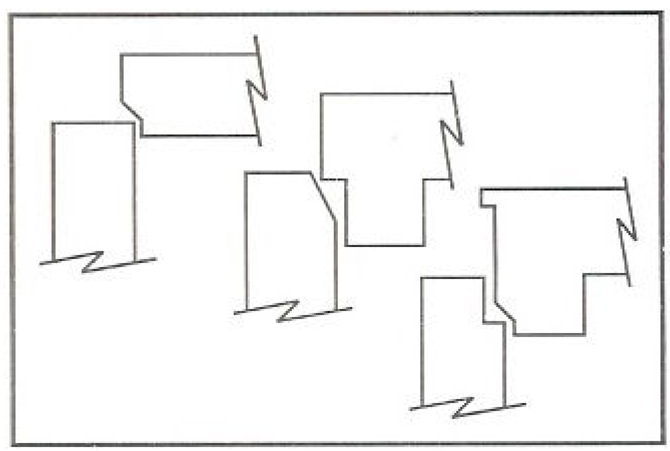

Figure-7 Shear joint variation

Modified shear joints, such as those shown in figure-8, should be considered for large parts or for parts where the top piece is deep and flexible.

Maximum Part Dimension	Interference (B)
Less than 0.75'' (19mm)	0.008'' to 0.012'' (0.2 to 0.3mm)
0.75'' to 1.50'' (19 to 38mm)	0.012'' to 0.016'' (0.3 to 0.4mm)
Greater than 1.50'' (38mm)	0.016'' to 0.020'' (0.4 to 0.5mm)

The shear joints requires weld times in the range of 3-4 times that of other joint designs because larger amounts of resin are being melted. In addition a certain amount of flash will be visible on the surface after welding.

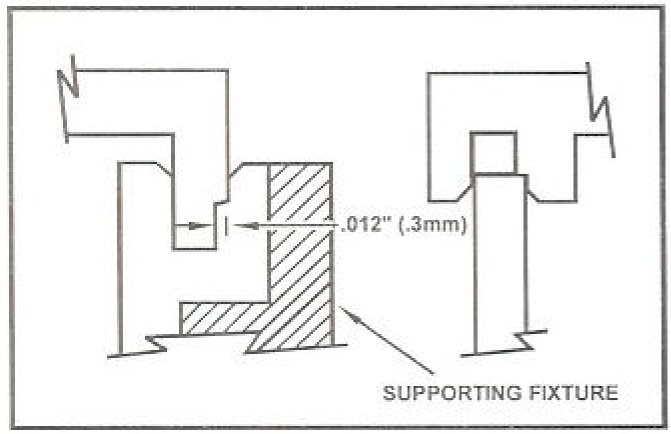

Figure-8 Shear joint variations for large parts

SCARF JOINT

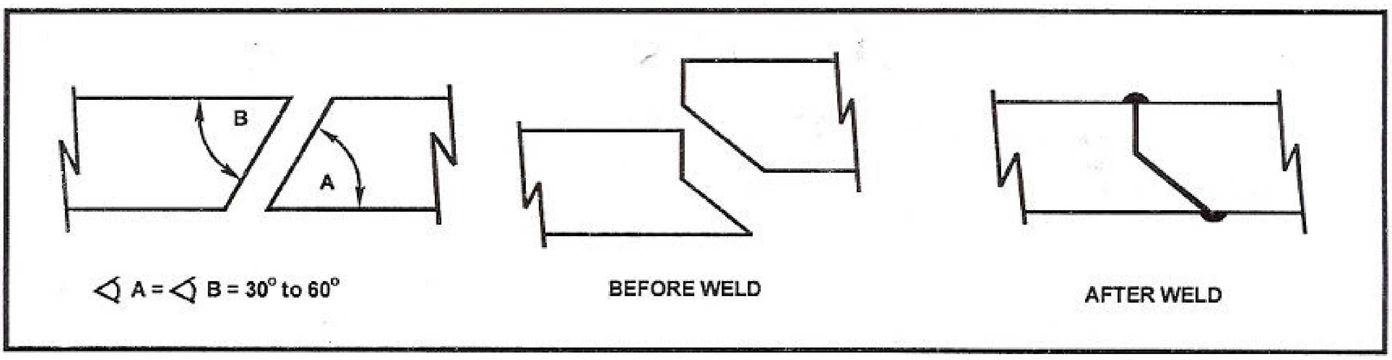

Figure-9 Scarf joint

The scarf joint, illustrated in figure-9, is generally recommended for high-strength hermetic seals on parts with circular or oval designs, especially with crystalline resins.

The scarf joint requires that the angles of the two parts be between 30° and 60° and be within one and one half degrees. If the wall thickness is .025'' (0.63mm) or less, an angle of 60° should be used. If the wall thickness is .060'' (1.52mm) or more, an angle of 30°should be used intermediate angles are recommended for wall thickness between .025'' and .060'' (.063 and 1.52mm).

A minimum wall thickness of .030''(0.76mm) at the outer edge of the scarf is recommended to prevent ''blowout'', or melting clear through the wall, during welding.

The scarf joint is not commonly used due to the difficulties encountered in maintaining component concentricity and dimensional tolerances. However, this joint is highly recommended when limited wall thickness preclude the use of a shear or modified shear joint.

A modified scarf joint is illustrated in figure 10.

As shown in figure 11, a flash well can be incorporated in the scarf joint to contain the excess molten material generated when the parts are welded. The length of the well should be at least equal to the cross sectional thickness of part being welded.

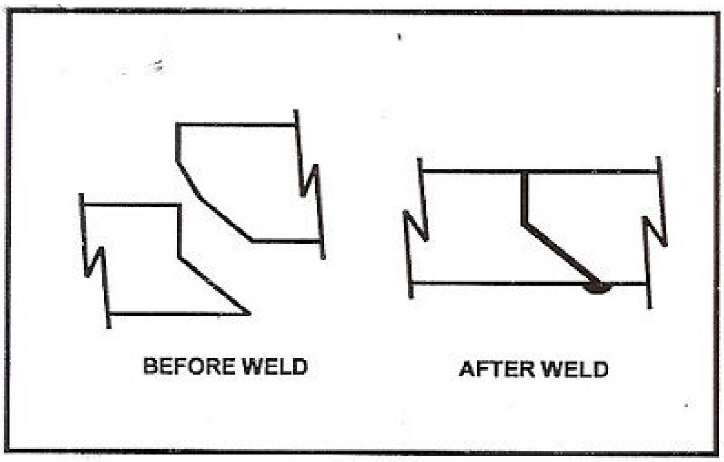

Figure-10 Modified scarf joint

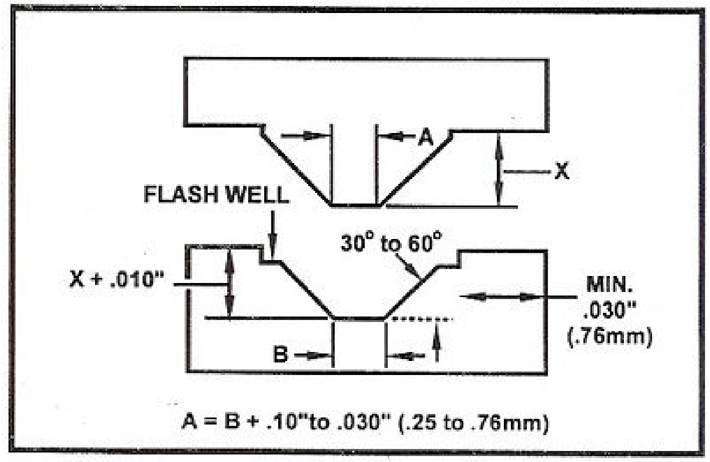

Figure-11 Scarf joint with flash well

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