Ultrasonic Installation of Inserts in Thermoplastic Components

The basic principle of ultrasonic assembly involves conversion of high-frequency electrical energy to high-frequency mechanical energy in the form of reciprocating longitudinal motion which, when applied to a thermoplastic, generates frictional heat at the plastic/plastic or plastic/metal interface.

In ultrasonic insertion, a metal insert is placed in a cored or drilled hole which is slightly smaller than the insert. This hole provides a certain degree of interference and also serves to guide the insert into place. The vibrating ultrasonic horn contacts the insert and the ultrasonic vibrations travel through the insert to the interface of the metal and plastic. Heat, generated by the insert vibrating against the plastic, causes the plastic to melt, and as the horn advances, the insert is imbedded into the component. The molten plastic flows into the serrations, flutes, or undercuts of the insert and, when the vibrations terminate, the plastic resolidifies and the insert is securely encapsulated in place. In ultrasonic insertion, a slow horn approach, allowing the horn to develop a homogeneous melt phase, is preferable to "pressing" the insert.

Ultrasonic insertion provides the high performance strength values of a molded-in insert while retaining all of the advantages of post-molded installation. Inserts can be ultrasonically installed in most thermoplastics. Some of the advantages of ultrasonic inserting over other methods include rapid installation, minimal residual stresses in the component following insertion, elimination of potential mold damage, reduced mold fabrication costs and increased productivity as a result of reduced mold cycle times.

In some applications, multiple inserts can be imbedded simultaneously with special horns, increasing productivity and further reducing assembly and manufacturing costs.

Ultrasonic insertion is not restricted to standard-type threaded inserts. Inserts that can be installed ultrasonically include a variety of bushings, terminals, ferrules, hubs, pivots, retainers, feed-through fittings, fasteners, hinge plates, binding posts, handle-locating pins and decorative attachments.

Typically, the plastic component is fixtured and the insert is driven in place by the horn (**Figure 1**). However, in some cases, the part configuration might prohibit insert contact by the horn, and the horn is made to contact the plastic component instead of the insert (**Figure 2**). The functional characteristics or requirements of an application actually determine the insert and hole configuration. In all cases, a sufficient volume of plastic must be displaced to fill the under cuts, flutes, knurls, threads and/or contoured areas of the insert. Care should be exercised in selecting the proper inserts. Inserts are designed for maxi-

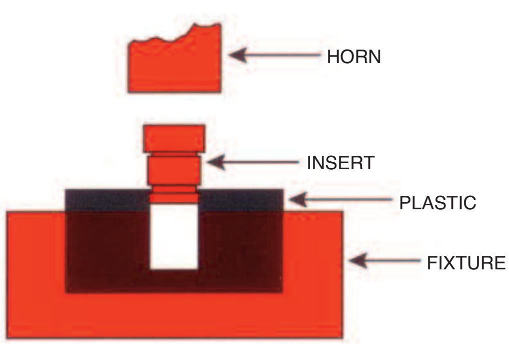

FIGURE 1

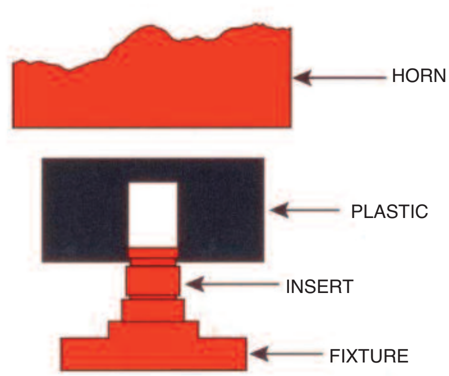

FIGURE 2

mum pull-out strengths, torque retention or some combination of both. Inserts with horizontal protrusions, grooves, or indents are usually recommended for high pull-out strength requirements. Inserts with vertical grooves, or knurls, are usually recommended for high torque retention. In regard to the hole configuration or insert selection, the recommendations provided by the insert manufacturer should always be observed.

Because the horn contacts the metallic insert, it is subjected to some wear. As a result, horns used for insertion are usually made of hardened steel or titanium. Carbide coating of titanium horns is also available.

for low volume applications, titanium horns with replaceable tips can be utilized.

Ideally, the diameter of the horn should be twice the diameter of the insert.

To prevent a “jack-out” condition, the top of the seated insert should be flush or slightly above the surface of the part.

Rigid fixturing should be placed directly under the insert.

In most instances, it is necessary to initiate ultrasonic vibrations prior to horn contact with the insert.

To maintain an accurate depth of insertion, the total distance the horn travels should be limited either mechanically by a positive stop, or electrically by a lower-limit linear encoder, or both.

CAUTION: When inserting, do not use weld time in excess of 1-1/2 seconds.

Ultrasonic Insertion Troubleshooting Guide

PROBLEM	SOLUTION
Insufficient pull-out or torque strength	Decrease pressure. Increase weld time. Increase amplitude (change booster). Decrease down speed. Increase insert interference Insert is too small or hole is too large. Increase hole depth. Decrease screw length.
Damage to insert	Decrease weld time or energy. Decrease amplitude (change booster). Increase pressure. Increase down speed.
Plastic cracks	Confirm that ultrasonics is on. Decrease pressure. Walls surrounding hole are too thin. Increase weld time or energy. Decrease amplitude (change booster). Decrease down speed. Enlarge hole diameter.
Partial insertion	Increase pressure. Decrease down speed. Decrease amplitude (change booster). Increase weld time or energy. Increase hole depth. Adjust positive stop. Check fixturing. Horn is at the end of its stroke.

Ultrasonic Insertion Troubleshooting Guide (Continued)

PROBLEM	SOLUTION
Inserting time is excessive	Decrease weld ti me or energy. Decrease hold time. Decrease amplitude (change booster). Increase pressure. Increase down speed. Insert is too large or hole is too small. Improper fixturing. Power required exceeds capability of power supply.
System overloads	Decrease pressure. Decrease down speed. Decrease amplitude (change booster). Tune power supply. Check for loose studs. Check coupling between horn and booster. Power required exceeds capability of power supply.
Insert does not remain inserted	Increase hold time.
Plastic fills the threaded bore of the insert	Increase hole depth. Insert is too large or hole is too small. Insert is too long.
Horn wears prematurely	Use hardened steel or carbide faced horn. Decrease amplitude (change booster). Insert is too large or hole is too small. Plastic is too abrasive.
Application is noisy	Start the ultrasonics just prior to the horn contacting the insert. Decrease amplitude (change booster). Increase pressure. Increase down speed. If possible contact plastic rather than insert. Use sound enclosure or hearing protectors.
Plastic flows over the top of the insert	Adjust positive stop to limit depth of insertion. Decrease weld time or energy. Insert is too large or hole is too small.
Horn heats up	Decrease amplitude (change booster). Air cool the horn. If possible contact plastic rather than insert. Check coupling between horn, booster and converter.

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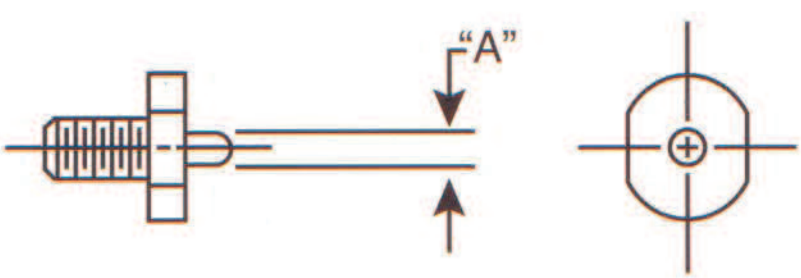
Inserting Tips

Insert Size	Inside Diameter Of Insert	Pilot Diameter Of Tip (Dim. A-inches)
SAE		
4-40	0.088	0.078
6-32	0.106	0.096
8-32	0.133	0.123
10-24	0.147	0.137
10-32	0.160	0.150
1/4-20	0.200	0.190
1/4-28	0.211	0.201
5/16-18	0.262	0.252
METRIC		
2.5 x 0.45	0.079	0.069
3 x 0.5	0.097	0.087
3.5 x 0.6	0.114	0.104
4 x 0.7	0.129	0.119
5 x 0.8	0.165	0.155
6 x 1	0.195	0.185
8 x 1.25	0.265	0.255



NOTE: Specify insert size (SAE or Metric) when ordering inserting tip.

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