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Ultrasonic Welding

Figure 1. 20 kHz Boosters and their Gain Ratios (upper row - titanium; lower row - aluminum) (D = amplitude decreasing; C = coupling, no change; I = amplitude increasing)

General Description: The booster is a one-half-wavelength long resonant section made of aluminum or titanium. It is mounted between the converter and the horn, and modifies the amplitude of vibration applied to the horn.

The success of an ultrasonic plastics assembly application is dependent on the required force, time, and velocity factor to obtain the correct energy level. The velocity factor is obtained by using the correct horn and booster combination to provide the optimum amplitude for the type of plastic, size of part, and type of assembly to be performed. Since it may be technically impractical to design the correct amplitude into the horn because of its shape, boosters are used to either increase or decrease the amplitude at the horn face to transmit the required energy to the joint interface.

To provide amplitude change, the booster will have different diameters and mass on either side of its center or nodal point.

Boosters

An amplitude increasing booster has a smaller mass at the end attached to the horn, while an amplitude decreasing booster has a greater mass at the end attached to the horn.

Booster Gain: Figure 1 shows available amplitude-modifying booster choices: three for increasing amplitude and one for decreasing amplitude. There is also a booster available which acts as a coupling bar and produces no change in amplitude at the horn face. The ratio of output amplitude to input amplitude of a booster is known as its "gain." Each booster is anodized with a coded color for easy gain identification (color of body for aluminum boosters and color of ring for titanium boosters).

Choosing the Correct Booster: When selecting a booster to be used for an application, it is recommended to use the lowest gain ratio possible that will provide acceptable application results. Refer to Branson TechnoLog TL-2 for correct amplitude values. This will help to operate the horns at lower fatigue levels, which increases tooling reliability.

Ultrasonic horns are designed to be operated with a maximum booster limitation so they will not exceed unreliable fatigue stress levels. The maximum booster limits for special horns are etched directly on the horn along with the horn identification numbers.

Types and Mounting of Boosters: Boosters are clamped at their nodal point and provide

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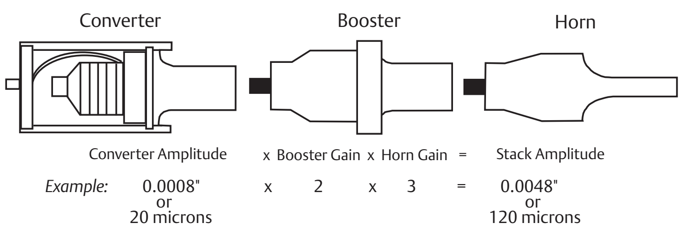

Figure 2. Calculation of Converter/ Booster/ Horn Stack Gain

rigid support for the converter/booster/ horn assembly.

There are three types of boosters with different mounting systems: 1) **standard moun**t; 2) **rigid mount** with square O-rings and removable clamp rings (which also is repairable); and 3) **solid mount** that provide improved rigidity. For continuous applications, solid mount boosters deliver more energy to the product, while in plunge applications, improved alignment is possible. For more information on solid mount boosters, refer to Branson TechnoLog TL-5. Applications resulting in high side loads on the converter/booster/horn stack should use o-ring boosters, as they absorb some of the side loads which would otherwise lead to premature failure of the horn in the stud area.

Stud Sizes: Aluminum 20 kHz boosters with ratios of 1:0.6, 1:1, 1:1.5, and 1:2 are available with the horn end drilled and tapped either 1/2-20 or 3/8- 24. Titanium 20 kHz boosters in all ratios, including 1:2.5, are available with 1/2-20 or 3/8-24 tap. Boosters for 40 kHz are available with the horn end drilled and tapped for M-8 threads. Titanium 40 kHz boosters are available with ratios of 1:1, 1:1.5, 1:2, and 1:2.5. Aluminum 40 kHz boosters are available in all ratios including 1:0.6.

Calculating Gain and Its Effects: Figure 2 is an example showing the calculation of converter/booster/horn stack gain, and how booster gain affects the total gain.

To further illustrate the effects of gain, a high amplitude horn might be compared to fifth gear in a car which produces high speed and low torque. Conversely, a low-amplitude horn – similar to first gear which produces low speed and high torque – has tremendous force capabilities and will vibrate under hundreds of pounds of load. It is relatively easy to "stall" a high-amplitude horn by operating it at high forces, just as it would be to stall a car motor starting up a steep hill in third gear. Each horn/booster combination must be tailored to the specific application to optimize performance.

The graph in Figure 3 illustrates how a set of three amplitude-increasing boosters can change the force required to obtain peak loading of a typical horn and power supply combination. With-lower amplitudes, greater force is required.

Changing Amplitude: Some conditions that suggest the need for altering the amplitude of a horn are listed below:

Increase amplitude when:

1. A poor weld is observed such as incomplete melting of the energy director.
2. Excessively long weld times (over 1-2 seconds).

Decrease amplitude when:

1. Power supply will not start or starts with difficulty (use of pretrigger required).
2. System overloads at low pressures.
3. Excessive meter reading (greater than 10%) occurs on power supply when pressing the test button.
4. Marking of parts occurs.
5. Overwelding (flash)
6. Diaphragmming or burnout of parts occurs.
7. Plastic parts or metal inserts fracture.
8. Excessive heat builds up near nodal area in horn.

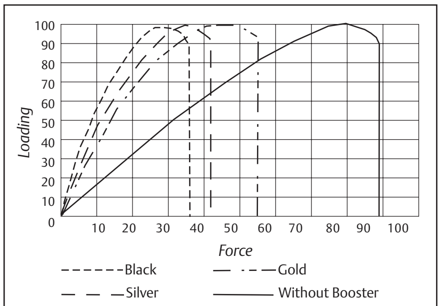

Figure 3. Boosters with Typical Horn.

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