BRANSON

Ultrasonic Welders

models 8200, 8400, & 8600 Operating Manual

Glossary of Ultrasonic Terms

Actuator — The unit which houses the converter, booster, and assembly horn/in a rigid mounting allowing it to move up and down either mechanically or pneumatically to apply a predetermined pressure on the workpiece.

Booster — A one-half-wavelength long resonant metal section mounted between the converter and horn having a change in cross-sectional area between the input and output surfaces for mechanically altering the amplitude of vibration present at the driving surface of the converter.

Clamping Force — The pressure exerted by the horn on the workpiece.

Converter — An electromechanical transducer which converts electrical energy to mechanical energy.

Degating — The separation of a molded part from its runner system.

Energy Director — A triangular-shaped projection of plastic material at the joint interface of a plastic part which concentrates the ultrasonic energy.

Far Field Welding — Welding taking place at a distance greater than ¼" (6mm) from the point of horn contact with the workpiece.

Fixture — A device for locating and supporting the workpiece in position for assembly.

Flash — Material displaced from the joint area.

Forming — Reshaping a section of a thermoplastic part to a new configuration.

Frequency — The number of complete oscillations per second, or cycles, produced by the converter, booster, and horn, usually 20,000 Hz for plastics welding.

Gain — The ratio of output amplitude to input amplitude of a horn or booster.

Hold Time — The length of time clamping force is maintained on the workpiece after the cessation of ultrasonic energy to allow the plastic to solidify.

Horn — Usually a one-half-wavelength long resonant bar or metal section which transfers vibratory energy to the workpiece.

Horn Amplitude — The peak-to-peak displacement or excursion of the horn at its work face, equivalent to double the true amplitude.

Horn Down Switch — A switch which lowers the horn onto the workpiece without ultrasonics

Insertion — In general, the process whereby a metal component is imbedded in plastic.

Interface — The contact surface of two mating parts.

Joint — The weld surfaces.

Loading Meter — A meter which indicates the power drawn from the power supply.

Near Field Welding — Welding occuring within ¼" (6mm) from the point of horn contact with the workpiece.

Nest — Refer to Fixture.

Power Control — A variable control for altering the amplitude and output power of the power supply and converter.

Power Supply — The electronic instrument in an ultrasonic assembly system which transforms conventional 50/60 Hz electrical power into high frequency electrical power at 20,000 Hz.

Pre-Loading — Application of a predetermined load on a part prior to triggering ultrasonics.

Pre-Triggering — Initiation of horn oscillation prior to contacting the workpiece.

Programmer — The electronic module controlling the pneumatic and electronic functions.

Staking — The process of melting and reforming a stud to mechanically lock a dissimilar material in place.

Swaging — The process of capturing another component of an assembly by melting and reforming a ridge of plastic.

Thermoplastic — A polymer which undergoes a reversible change of state when subjected to heat.

Thermoset — A polymer which undergoes an irreversible chemical change when subjected to heat.

Tuning the System — Matching electrical operating frequency of the power supply to the mechanical resonant frequency of the converter, booster, horn assembly.

Ultrasonic Welding — The use of ultrasonic vibrations to generate heat and subsequent melt at the mating surfaces of two thermoplastic parts. When the ultrasonic vibrations stop, the molten material solidifies and a weld is achieved.

Ultrasound — Vibrations above the audible range of human hearing (18 kHz).

Velocity (Horn) — The rate of motion of the horn face.

Weld Time — The length of time ultrasonic energy is applied to the workpiece.

Operating Manual Ultrasonic Welding

Models 8200, 8400, & 8600

Contents

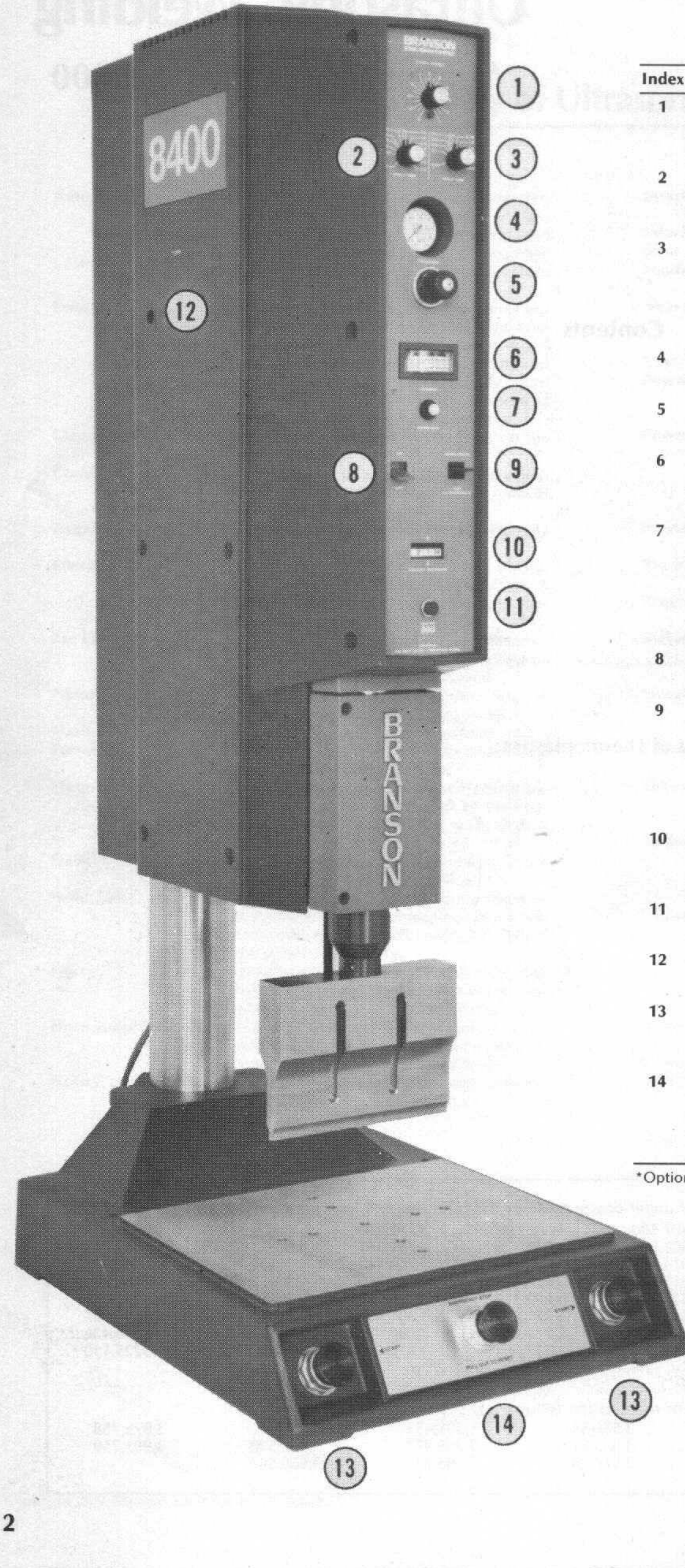
Branson Sonic Power Company equipment is manufactured under one or more of the following U.S. patents:

3,328,610	3.464,102	3,526,792	3,607,580	3,666,602	3,752,380	3,813,021	3,921,015
3,378,429	3,468,731	3,529,660	3,608,648	3,679,526	3,752,381	3,833,163	3,939,033
3,384,284	3,469,211	3,561,462	3,614,484	3,697,357	3,764,442	3,848,792	3,945,618
3,394,274	3,483,066	3,573,781	3,619,671	3,698,408	3,785,910	3,852,144	3,946,280
3,421,939	3,489,241	3,586,122	3,628,071	3,699,719	3,790,059	3,863,826	3,955,740
3,432,691	3,489,930	3,586,589	3,645,504	3,721,833	3,791,569	3,873,859	4,006,707
3,440,118	3,491,250	3,601,084	3,649,420	3,734,805	3,808,080	3,917,146	4,016,436
3,441,875	3,493,457	3,602,421	3,666,599	3,737,361	3,813,006	3,920,504	D225,110
3,443,130	3,524,085						

Processes described in this publication are covered by one or more of the following U.S. patents:

3,224,916	3,367,809	3,440,118	3,526,554	3,595,453	3,899,116	3,972,758
3,284,257	3,401,446	3,468,731	3,563,822	3,765,973	3,966,520	3,981,759
3,331,719	3,440,117	3,499,808	3,577,292	3,893,223	3,969,544	

Principal Components

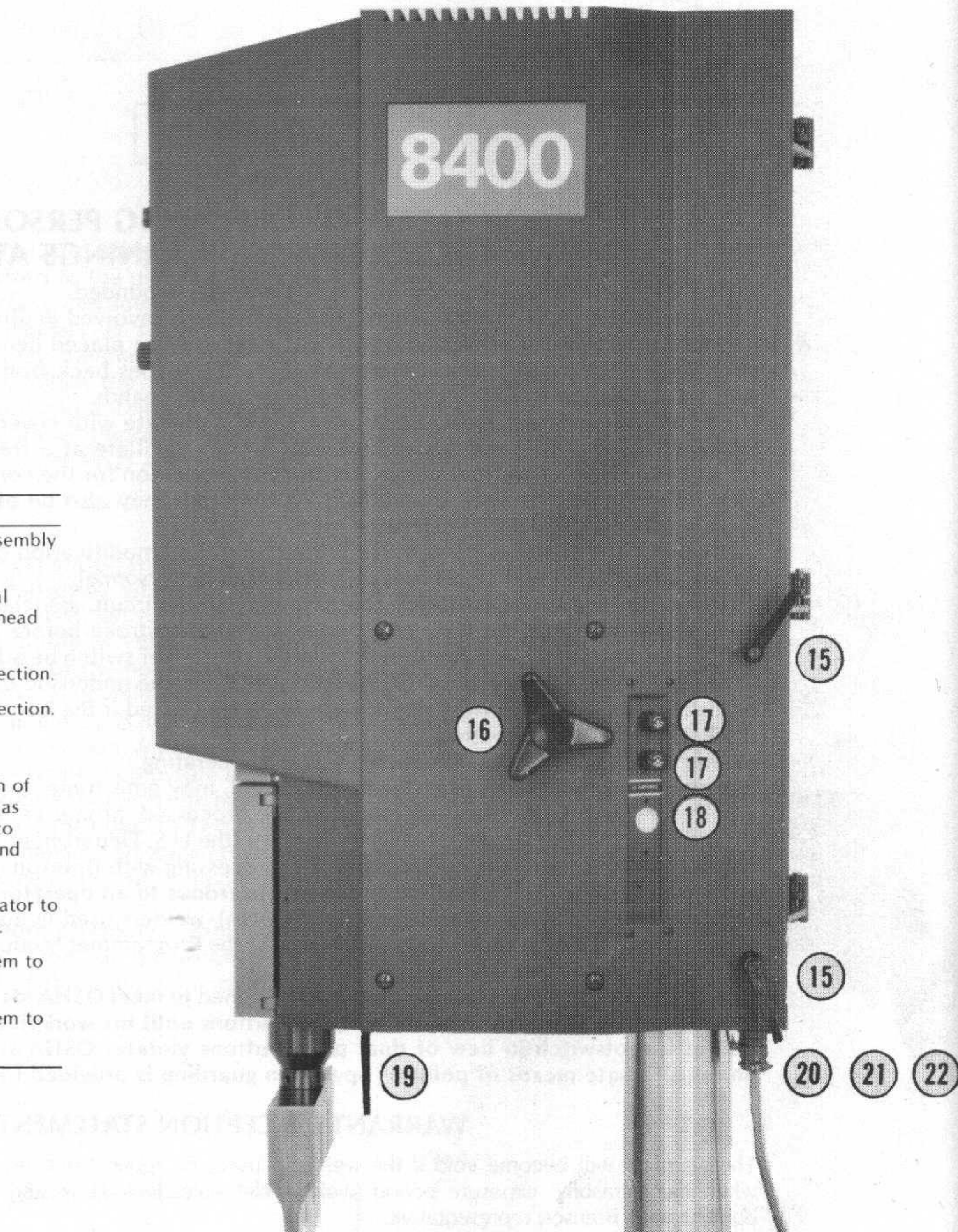


Index	Device	Function
1	Down Speed Control	Controls horn rate of descent. Return rate is fixed.
2	WELD TIME Control	Sets duration of ultrasonics (0.1 to 4 seconds).
3	HOLD TIME Control	Sets duration of clamping pressure on part after exposure to ultrasonics (.05 to 3 seconds).
4	PRESSURE Indicator	Indicates pressure applied to air cylinder.
5	PRESSURE Control	Adjusts pressure to air cylinder.
6	LOADING Meter	Indicates level of ultrasonics transmitted to horn.
7	OVERLOAD Indicator/ Reset Switch*	Indicates power supply overload. Also resets overload indicator when protection module is in the latching mode.
8	ON-OFF Switch	Applies main power to system.
9	HORN DOWN/TEST ULTRASONICS Switch	HORN DOWN position: Lowers Horn. TEST ULTRASONICS position: Energizes power supply for tuning purposes.
10	Dynamic Trigger Control	Controls clamp pressure prior to ultrasonic application.
11	Power ON/OFF Indicator	Indicates when main power is on or off.
12	Tuning Control	Optimizes power supply performance.
13	Non-Tie Down Palm Buttons	Activates the system when pressed simultaneously.
14	Emergency Stop Button	Ends welding cycle and causes horn to retract. Pull out to reset.

*Optional.

Index	Device	Function
15	Column Clamp	Locks head assembly into position.
16	Elevation Handle	Permits vertical movement of head on column.
17	Fuse	Overload protection.
18	Circuit Breaker (Model 8600 only)	Overload protection.
19	Mechanical Stop	Controls Depth of weld and acts as safety device to protect horn and fixture.
20	Base Cable Connector	Connects actuator to base assembly.
*21	Line Cord	Connects system to main power.
*22	Air Hose	Connects system to air supply.

*Optional.



WARNING

FOR SAFETY OF OPERATING PERSONNEL OBSERVE THE FOLLOWING WARNINGS AT ALL TIMES

1. A shock hazard may exist if the unit is not properly grounded.
2. Keep hands out from under the horn. Since pressure is involved in ultrasonic assembly, it is most important that during operation, hands or arms never be placed beneath the horn.
3. The base of the system should be located four (4) inches back from the edge of the bench to prevent activation of unit by body portion other than hands.
4. High voltage is present in the equipment. Do not operate with cover open.
5. When welding large plastic parts, the plastic may oscillate at a frequency within the audible range and with enough intensity to warrant ear protection for the comfort and protection of the operator. Baffles and acoustical absorbing materials may also be placed in the vicinity of the system. (See Appendix)
6. The welder has been designed for safe operation. Any modification of the control circuitry may cause malfunction and result in injury to operating personnel.
7. The pre-trigger switch overrides the safety control circuit associated with the palm button switches, and causes the horn to vibrate on the downstroke before the horn contacts with the workpiece. For safety, it is imperative that the pre-trigger switch be adjusted so as to be triggered only when the clearance between the workpiece and the underside of the horn is 1/4 inch (6mm) or less. The pre-trigger switch might have to be readjusted if the horn or workpiece is changed or the head is raised or lowered.
8. Do not touch the horn tip when the system is operating.
9. Certain plastic materials, when being processed, may emit fumes and/or gases hazardous to an employee's health. Where such materials are processed, proper ventilation of the work station should be provided. Inquiry should be made to the U.S. Department of Labor concerning OSHA regulations for a particular plastic prior to processing with Branson ultrasonic equipment.
   NOTE: Processing of PVC materials can be hazardous to an operator's health.
10. For operator safety and compliance with (OSHA), welders used in automatic systems utilizing a trigger switch for actuation require a change of the Programmer Module when used as a manually operated (bench type) welder.
    NOTE: The 419/519 programmer* has been designed to meet OSHA standards, Section 1910.212. It is necessary to depress and hold both palm buttons until the workpiece is contacted by the horn. Use of a footswitch in liew of dual palm buttons violates OSHA standards, Section 1910.212, unless alternate means of point of operation guarding is provided by the user.

WARRANTY EXCEPTION STATEMENT

The warranty will become void if the welder is used for applications requiring metal-to-metal contact, when the ultrasonic exposure period (weld cycle) exceeds 1-1/2 seconds. For additional information, contact your Branson representative.

Horns fabricated by Branson for use in equipment described in this manual are manufactured to exacting parameters, and tuned to vibrate at 20,000 Hz. Since an out-of-tune horn can cause undue stress and damage to the converter and power supply, the warranty may become void if the equipment is used with horns not properly tuned for the equipment.

Contact your Branson representative or Branson Sonic Power Company, Danbury, Connecticut, should you have any questions concerning horn qualification. The warranty, or exchange policy when applicable, does not cover circuit modules which have been subjected to faulty repair, misuse, accident, modification or improper installation.

*Units designed for export or special system may incorporate a 414 or 514 programmer.

PRINCIPLE OF OPERATION

Ultrasonic welding of thermoplastic parts is accomplished by applying high frequency vibrations to the pieces being assembled. The vibrations, through surface and intermolecular friction, produce a sharp rise in temperature at the joint. When the temperature is high enough to melt the plastic, there is a "flow" of material between the parts. When the vibrations stop, the material solidifies under pressure and a uniform weld results.

Most plastic welders operate above the range of human hearing at 20,000 cycles per second (20 kHz) and are thus called "ultrasonic".

Principal Components

A **power supply,** or ultrasonic generator, supplies high frequency electrical energy to the **converter** which converts it to mechanical or vibratory energy. Attached to the converter is a **booster** which dictates the amplitude of vibration produced at the face of the horn. The function of the horn is to transfer the ultrasonic vibrations to the parts being welded.

The converter-booster-horn assembly is lowered and raised over the workpiece by a **pneumatic system,** which brings the horn in contact with the part at a predetermined pressure and velocity.

Many welding applications require that pressure be built up on the part before the ultrasonics are introduced. This is the function of the **dynamic trigger mechanism,** an adjustable pressure actuated device located between the air cylinder and the converter.

The converter, booster and horn assembly is mounted in the **carriage,** a movable housing in front of the welder. Figure 1 shows the general arrangement of the principal components.

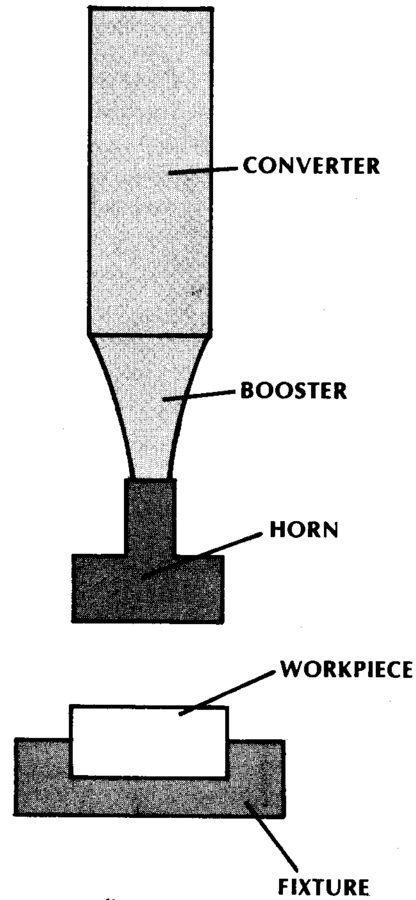


figure 1

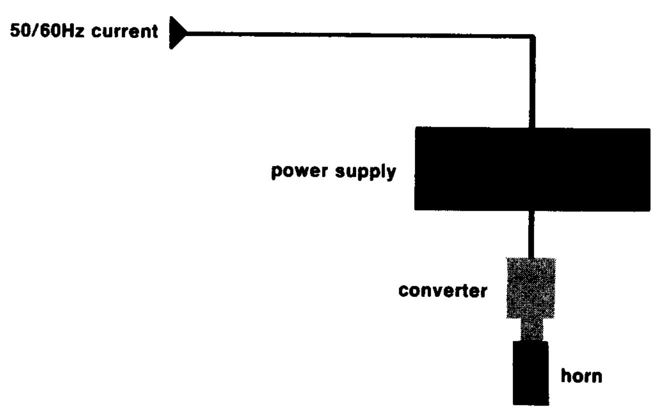


figure 2

PREPARATION FOR USE

Unpack the Ultrasonic Welder as soon as it arrives. Inspect the controls, indicators and surface for signs of damage. Open the side access door and see if any component has become loose during transportation. If damage has occurred, notify the shipping company immediately. Important: fill out and return the warranty card to Branson Sonic Power Company.

Place the Welder on a sturdy surface not less than 6″ from the nearest wall or other surface. Make sure that the air exhaust at the top of the housing is free from obstruction.

CAUTION: Before operating the Welder, measure the line voltage and set the transformer tap to the voltage nearest to that measured.

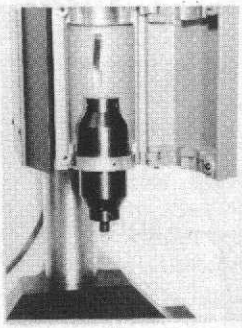


figure 3

Connections

1. Set the ON-OFF switch to OFF.
2. Set the HORN DOWN/TEST ULTRASONICS switch to the center position.
3. Connect the electrical cord to a single-phase, three-wire 50/60 Hz power source. Check the label on the back of the housing for voltage requirements. Make sure the system is grounded.
4. Connect the air line to a clean (5 micron) unlubricated dry compressed air supply at a maximum of 100 psig (690 kPa).
5. Set the DOWN SPEED control to 1. Set PRESSURE REGULATOR to 20.

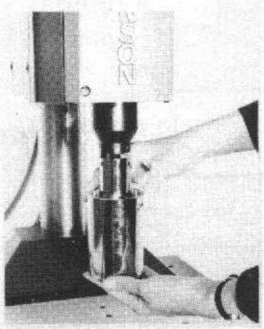


figure 4

Assembly of Converter, Booster and Horn

If the converter and booster are not assembled:

1. Raise the welding head by loosening the upper and lower column clamps and turning the elevation handle.
2. Open the carriage door by loosening the two captive screws.
3. Clean the mating surfaces of the converter and booster, as well as the threaded stud and hole. Assure the stud is tight. (See below for recommended torque requirements.) Coat only one of the mating surfaces with a thin film of silicone grease. **DO NOT APPLY GREASE TO THE THREADED STUD.**
4. Place the booster with the stud facing downward in the housing with the mounting ring resting on the lower support lip [Figure 3].
5. Close the carriage door, tighten the two screws and hand assemble the converter to the booster [Figure 4]. Tighten the converter securely with the spanner wrench (220 inch-lbs./24, 85 newton-meter). **DO NOT OVERTIGHTEN.**
6. While holding the converter to prevent it from dropping, loosen the two screws and open the carriage door. Reverse the assembly so that the converter is on top. [Figure 5].
7. Forcefully lift the converter/booster assembly (acorn contact terminal facing up) into the converter housing behind the carriage guard, and slide the bottom of the booster clamp ring onto the two support washers located on the underside of the carriage casting.

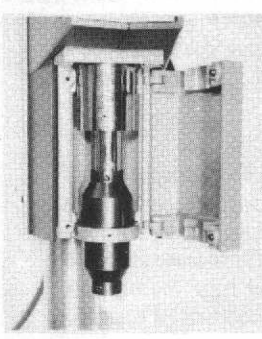


figure 5

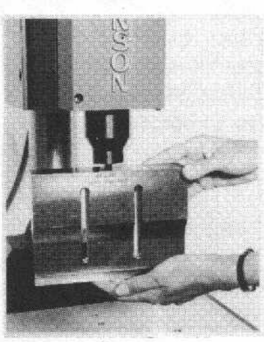


figure 6

NOTE: If necessary, hold the assembly with your left hand and gently rap the bottom of the assembly up with the palm of your right hand.

Press the assembly in, close the access door and tighten the two clamp screws. Do not overtighten the screws. It is normal for a space to remain between the door and the casting.

8. Clean the mating surfaces of the booster and horn as in Step 3 and apply a thin film of silicone grease to only one of the surfaces. Assure the stud is tight.
9. Hand assemble the horn to the booster (Figure 6) and tighten with the spanner wrench (or appropriate tool) as in Step 5. **Do not** apply tool to lower part of horn.

CAUTION: When separating a horn and booster outside the carriage, use the spanner wrenches. Never remove a horn or converter by holding the converter in a vise. If necessary secure the largest section of the horn in a soft jawed vise. Use a soft jawed vise to remove square or rectangular horns.

NOTE: 1/4-20 threaded tip should be tightened at 90 inch-lb./10, 16 newton-meter.

1/4-28 threaded tip should be tightened at 110 inch-lb./12, 42 newton-meter.

3/8-24 threaded tip should be tightened at 180 inch-lb./20, 33 newton-meter.

1/2-20 threaded stud should be tightened into the booster at 500 inch-lb./56, 49 newton-meter, and 3/8-24 threaded stud should be tightened into the horn at 290 inch-lb./32, 76 newton-meter.

Adjusting Welding Head Height and Horn Alignment

The welding head should be positioned to produce the shortest down stroke compatible with the shape of the part and the ease with which it can be removed from the nest. As the maximum travel of the carriage is 2-7/8", care should be taken to ensure that the horn does not contact the part when the carriage is close to the limit of its travel. Under such conditions, the carriage may bottom out before the full depth of weld has been reached. Set welding head height as follows:

1. Position the fixture loosely on the base plate using the existing 3/8-16 threaded holes.
2. Loosen the two column clamps and adjust the height of the welding head for the desired stroke by using the elevating handle.
3. Place the part in the fixture and set gauge pressure to zero and manually lower the carriage until the horn contacts the part.
4. Loosen the access door screws and rotate the horn and head assembly until the horn is properly aligned with the part.
5. Tighten the fixture on the base plate, lock the two column clamps and tighten the carriage door screws.
6. Set the ON/OFF switch to ON. Hold the HORN DOWN switch down and depress one palm button to lower the horn. Check to ensure that the horn and part are properly aligned.

NOTE: When the horn has contacted the part and the dynamic trigger switch has been activated, the palm button can be released and the horn will stay in the down position as long as the HORN DOWN switch is depressed.

Mechanical Stop

The Mechanical Stop limits the downward travel of the horn to prevent contact with the fixture in the absence of a part. Install the Mechanical Stop as follows:

1. Slide the stop rod through the clearance hole at the bottom of the carriage [Figure 7].
2. Thread one of the three hex nuts onto the rod protruding through the hole and thread the rod 1/2"-3/4" (13-19mm) into the main support assembly.
3. Rotating the hex nut clockwise all the way, secure the stop rod in place.
4. Remove the part from the fixture and manually lower the carriage until the horn is just below the weld point. Thread other two hex nuts onto the stop rod until the upper nut contacts the carriage. Tighten the two bottom nuts against each other and replace the part in the fixture.

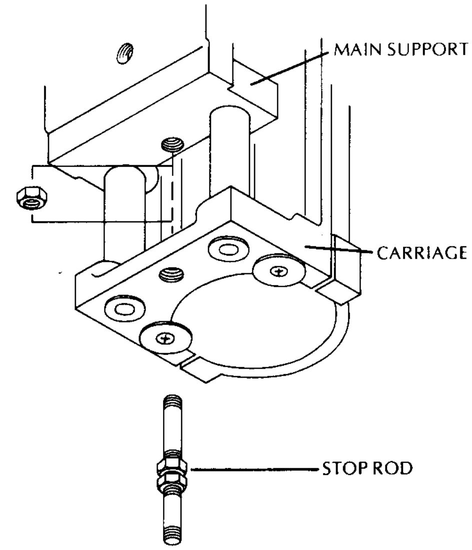


figure 7

OPERATION

Tuning:

Each combination of converter, booster and horn must be tuned to the power supply. If any of these components is replaced, the assembly must be retuned. Tune as follows:

1. Place ON-OFF switch ON.
2. Hold HORN DOWN-TEST ULTRASONICS switch in the TEST ULTRASONICS position, and using a screwdriver, adjust the TUNING CONTROL screw on the left side of the housing for the **lowest** reading on the LOADING METER.

NOTE: System Protection Monitor may deactivate the power supply during tuning. If this occurs, release the TEST ULTRASONICS switch, rotate the tuning screw toward mid-range and resume adjustment. If the power supply continues to deactivate, consult the Trouble Shooting Section of the Maintenance Manual.

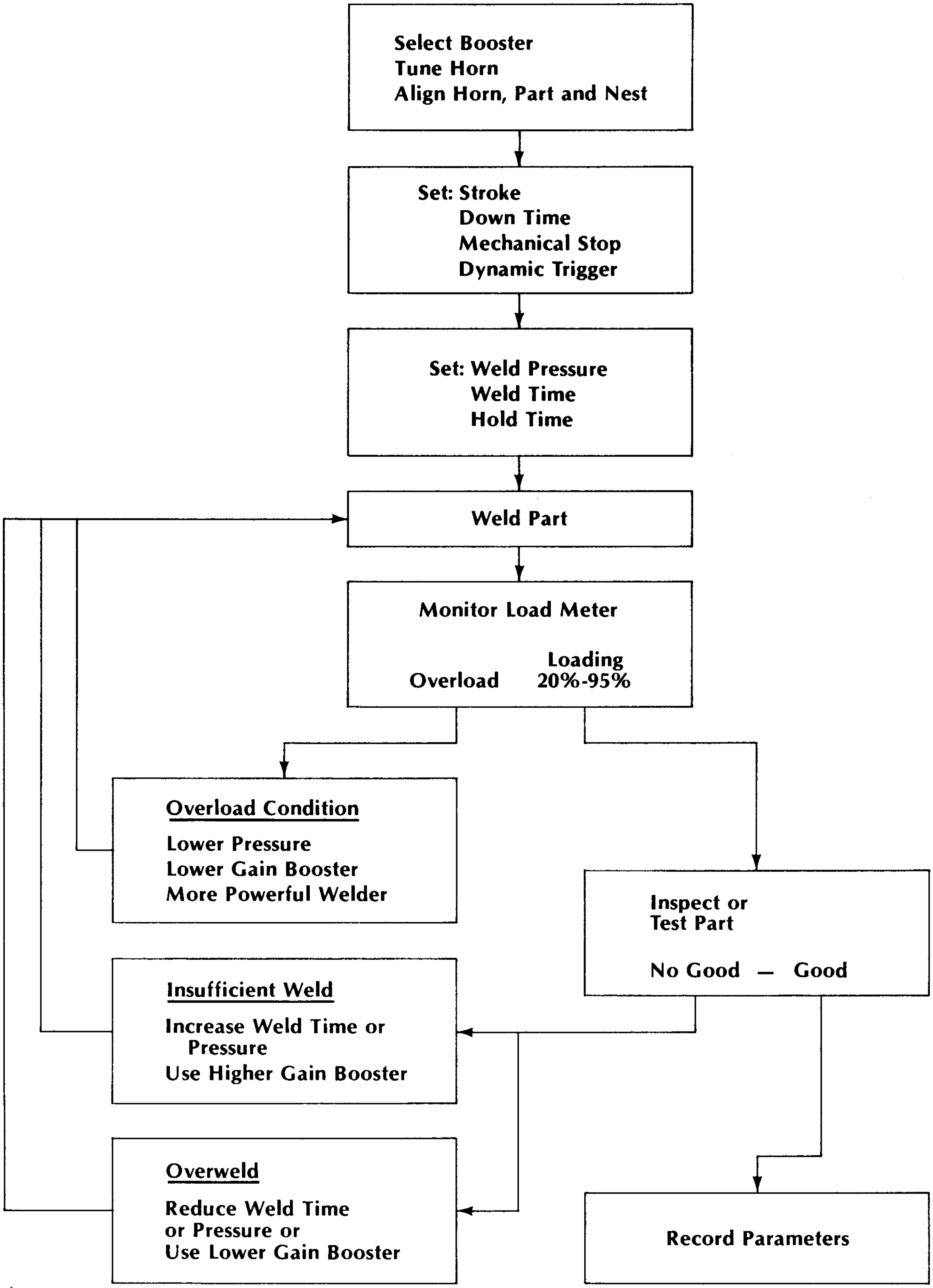
Precise tuning is required for proper operation of the System Protection Monitor. (Note that Model 8600 tunes higher in the scale over a wider range). If normal tuning cannot be achieved, consult the Trouble Shooting Section of the Maintenance Manual.

WARNING

Always observe these precautions when operating your Ultrasonic Welder:

1. Keep hands from under horn. High pressure and ultrasonic vibrations can cause injury to hands and fingers.
2. Place the base of the Welder at least 4" (10cm) back from bench edge to prevent accidental activation of palm buttons.
3. Large plastic parts may vibrate within the audible range when welded. If this occurs, use ear protectors to prevent possible injury.
4. Do not allow the horn when ultrasonically actuated to contact the metal base or a metal fixture.
5. Do not press the TEST ULTRASONICS switch when the converter is removed from the head.

Basic Procedure for Ultrasonic Equipment Set-up



Set-up Procedure

If your application has been analyzed in the Branson Applications Laboratory, consult the Branson Lab Report for the appropriate settings. Otherwise, starting conditions are generally as follows:

Air Pressure: 20 psig	Trigger Pressure: 1-5
Weld Time: 0.5 second	Down Speed: 1-5
Hold Time: 1 second	You are now ready to weld.

Check that the emergency stop button is not depressed. With a part in place, depress both palm buttons simultaneously. The horn will descend and contact the part. The ultrasonics will be activated (at which time release palm buttons) for the time selected on the WELD TIME control. The loading meter will indicate loading (usually in the 25 to 100 range). When the ultrasonics stop, the load meter will drop to zero. The horn will continue to clamp the part for the time selected on the HOLD TIME control. At the completion of the hold cycle, the horn will retract automatically and the welded part may be removed from the fixture.

NOTE: You may terminate the cycle at any time by pressing the EMERGENCY STOP button, causing the carriage to retract. Pull out the button to reset the Welder.

A few parts should be welded using the above parameters and checked for whatever desired properties are sought. Optimum results may not be obtained on the first try, but based on the quality of the weld obtained and the loading meter reading, the setups can be altered until satisfactory results are achieved (Refer to the chart on Page 9).

Only one setting should be changed at a time until a weld is produced in minimum time with maximum strength. Certain settings or combinations of variables may result in activation of the System Protection Monitor (SPM). For example, if the pressure selected or dynamic trigger pressure control settings are too high for the equipment capacity, automatic shutdown of the power supply will occur. Should the dynamic trigger pressure control setting result in automatic shutdown at minimum adjustment, use of the pre-trigger switch option may be indicated.

Pressure

In general, enough pressure should be applied to the work so that all mating surfaces contact each other. Low pressure can result in unnecessarily long weld time cycles, marking of the part or poor welding. High pressure can cause fracturing of the part, poor coupling of the joint interfaces, or overloading which results in automatic shutdown of the power supply.

The loading meter reading indicates the power delivered to the part. The higher the pressure, the more power will be drawn from the power supply and applied to the part. Most applications can be satisfied with loading meter readings between 70% and 75%. However, for very delicate parts load meter readings below 50 are more than adequate. To operate at those levels it may be necessary to use less pressure and/or decrease the amplitude.

Amplitude

Successful welding, staking and inserting depends on the proper horn amplitude. Booster horns are used to increase or decrease amplitude to obtain the proper degree of melt for various applications. See Page 26.

Weld Time

An overly long weld time can create flash and degrade the part, particularly those applications requiring hermetic seals. Also, melting and fracture of areas of the part away from the joint area may occur with longer weld times, especially at holes, weld lines and sharp corners.

Hold Times

Hold time is the period during which the welded parts are held together and allowed to solidify under pressure after the ultrasonics have stopped. Hold times of 0.3-0.5 seconds are usually sufficient for most applications.

Down Speed

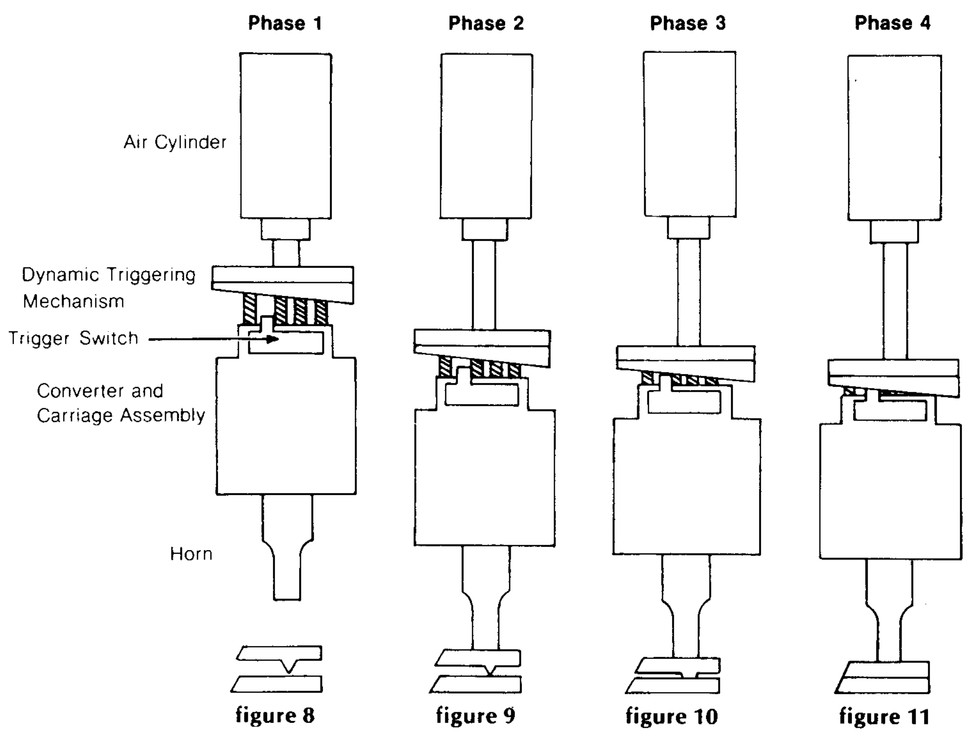
The Down Speed control governs the rate of descent of the horn. The rate of the return is fixed. Set down speed control for a medium rate of descent (1-5). Too fast a descent can cause the horn to strike the part resulting in possible damage to the part or equipment.

Dynamic Trigger

Many welding applications require that pressure be built up on the part before the ultrasonics are activated. This is the function of the Dynamic Trigger Mechanism, a pressure actuated device located between the air cylinder and the converter. As the pressure builds up on the part, springs in the mechanism are compressed until at a preselected pressure they cause the ultrasonics to be activated.

The amount of pressure applied to the work before welding begins is selected by rotating the control numbered 1 through 24. The higher the number, the greater the pressure. Pressures range from 15 lbs. (67N) to 165 lbs. (734N).

Lower trigger pressures are generally used unless there is a need to overcome warpage or to compress internal components such as springs, diaphragms or seals. Unless otherwise indicated in the Branson Lab Report, set the dynamic trigger control initially on 4.



This illustration shows the relative position of the air cylinder, dynamic triggering mechanism, horn and plastic parts during a weld cycle.

Figure 8 — Position of the equipment before the weld cycle begins.

Figure 9 — The cycle has been initiated. The carriage assembly has descended and the horn is in contact with the part. The trigger springs have not yet compressed and the trigger switch is still open.

Figure 10 — the springs are compressed sufficiently to close the trigger switch which activates the ultrasonics. The energy director has begun to melt. Any interruption in force at this time could result in less power to the part and an inadequate weld.

Figure 11 — The energy director has melted, ultrasonic energy is switched off and the hold cycle begins. The trigger springs have not yet fully compressed, so a heavy spring load is exerted on the part during the hold cycle when it is cooling.

APPLICATIONS

Joint Design for Ultrasonic Welding

An important factor in ultrasonic plastics assembly is the fixturing used to hold the parts. The primary purpose of fixturing is to hold and align the parts with the horn while providing proper support to the assembly. Factors such as the material to be welded, part geometry, wall thickness, and part symmetry can affect transmission of energy to the interface area and must be considered when designing a fixture.

Certain applications such as staking and insertion require rigid fixturing directly below the area of horn contact. Aluminum fixturing provides the necessary rigidity. Chrome plating may be added to prevent part marking and increase wear resistance.

In some applications, the fixture must possess a degree of elasticity to assure an out-of-phase condition at the joint area. An out-of-phase condition will usually occur at the point of poorest coupling, which is the area to be welded; however, depending upon the material and geometry of the part, the two sections may act as one, vibrating up and down simultaneously. If this condition occurs, a change from a rigid to a resilient nest material or a change of durometer from one flexible material to another is often sufficient to re-establish an out-of-phase condition at the joint area.

Simple prototype fixtures can be constructed from wood, epoxy, or plaster of paris. For more precise, longer lasting fixtures, materials such as aluminum, steel, brass, cast urethane, or other flexible materials will be required. Fixture designs range from quick-release clamping devices to simple metal plates. Application requirements and production rates usually dictate fixture design.

Fixturing

The ultrasonic welding of two thermoplastic parts requires that ultrasonic vibrations be transmitted through the horn into the top half of the assembly and travel to the joint or interface of the two halves. Here vibratory energy is converted to heat which melts and fuses the plastic. When the vibrations stop, the plastic solidifies under pressure producing a weld at the joining surfaces.

The configuration of the two joining surfaces, referred to as the joint design, is very important in achieving optimum results. There are a variety of joint designs, each with specific features and advantages. Their use depends on factors such as type of plastic, part geometry, and the requirements of the weld, i.e., tack, strength, hermetic seal, etc.

Welding

The diagrams in Figure 12 show time-temperature curves for a simple butt joint, and the more ideal joint incorporating an energy director which permits rapid welding while achieving maximum strength. The material within the director flows throughout the joint area as indicated.

Figure 13 illustrates a butt joint modified with energy director with desired proportions before weld and the resultant flow of material. Parts should be dimensioned to allow for the dissipation of the material from the energy director throughout the joint area as illustrated. Practical considerations suggest a minimum height of 0.010" (0.25mm) for the energy director for easy-to-weld resins. Larger energy directors, 0.020" (0.5mm) may be necessary for certain high-energy-requiring resins, i.e. crystalline, low stiffness, or high melt temperature amorphous (e.g. polycarbonate, polysulfone) resins. Means for alignment between the parts, such as a pin and socket, should be included in the part design.

It should be noted that joints designed for solvent sealing can generally be modified to meet ultrasonic welding requirements.

TO BE AVOIDED: A typical mistake with energy director design is beveling one joint face at 45° angles. Figure 14 shows the result if this practice is followed.

Figure 15 illustrates a step joint used for alignment and for applications where excess melt, or flash, on the side would be objectionable.

A tongue and groove joint (Figure 16) is used primarily for scan welding and prevention of flash both internally and externally. The need to maintain clearance on both sides of the tongue, however, makes this more difficult to mold. Draft angles can be modified concurrently with good molding practices, but interference between elements must be avoided.

Figure 17 illustrates basic energy director joint variations suitable for ultrasonic welding. These are suggested guidelines for typical joint proportions. Specific applications may require a slight modification.

Figure 18 shows the shear joint used when a strong hermetic seal is needed, especially for the crystalline resins (nylon, acetal, thermoplastic polyester, polyethylene, polypropylene, and polyphenylene sulfide). Since crystalline resins change rapidly from a solid to molten state over a narrow temperature range, an energy director type of joint may not be optimum because the molten resin from the director will rapidly solidify before it is able to fuse with the adjoining surfaces. With the shear joint, welding is accomplished by first melting the small initial contact area, and then continuing to melt with a controlled interference along the vertical walls as the parts telescope together. A lead-in is required for self locating, and a flash trap can be incorporated if necessary.

The strength of the joint is a function of the vertical dimension of the joint (depth of weld) and can be adjusted to meet the requirements of the application. For joint strength exceeding the part strength, a depth of 1.25x wall thickness is suggested.

Typical interference for the joint is given in the table below:

Maximum Part Dimension	Interference per Side (Range)	Part Dimension Tolerance
Less than 0.75" (18mm)	0.008" to 0.012" (0.2 to 0.3mm)	±0.001" (±0.025mm)
0.75" to 1.50" (18mm-35mm)	0.012" to 0.016" (0.3 to 0.4mm)	±0.002" (±0.05mm)
Greater than 1.50" (35mm)	0.016" to 0.020" (0.4 to 0.5mm)	±0.003" (±0.075mm)

The walls of the bottom section must be supported at the joint by the holding fixture, which must conform closely to the outside configuration of the part, to avoid outward deflection under welding pressure. The top part should be as shallow as possible, in effect just a lid to avoid inward deflection. For a midwall joint, the tongue and groove variation in Figure 19 is preferred. It is also useful for large parts. Figure 20 shows variations of the basic shear joint design.

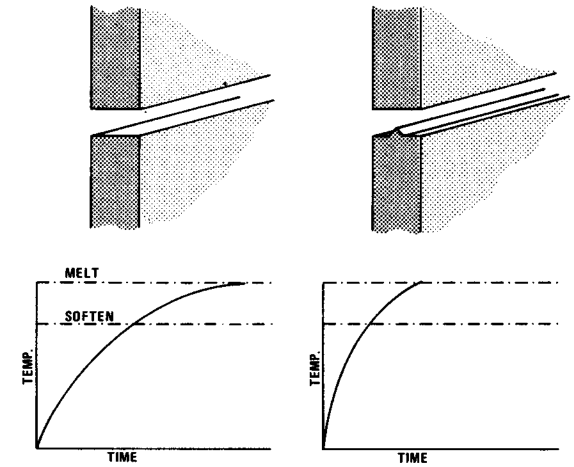


figure 12

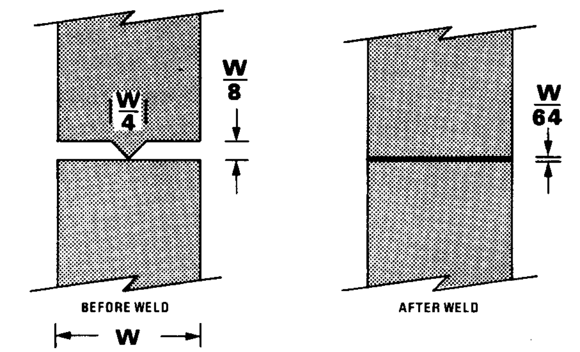


figure 13

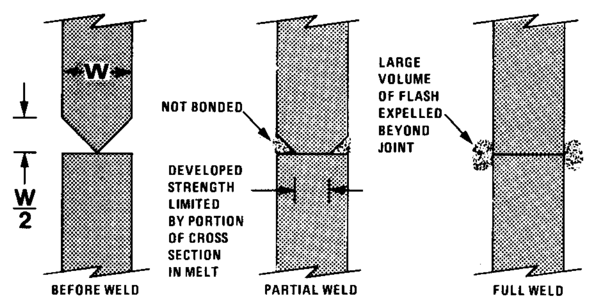


figure 14

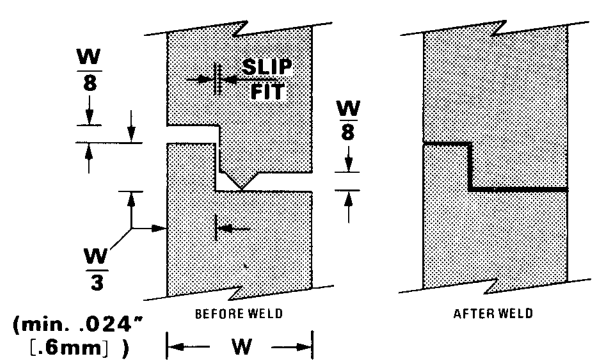


figure 15

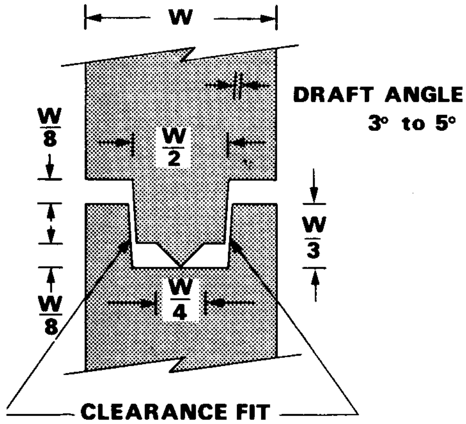


figure 16

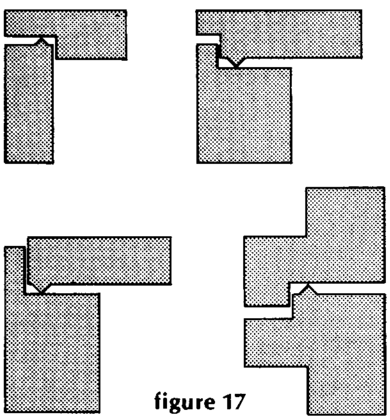


figure 17

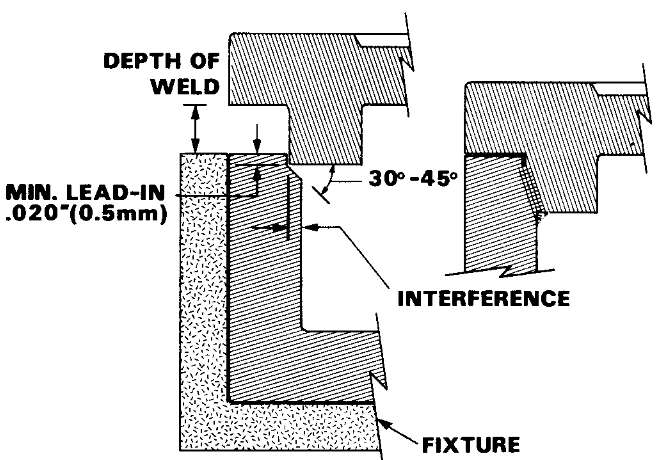


figure 18

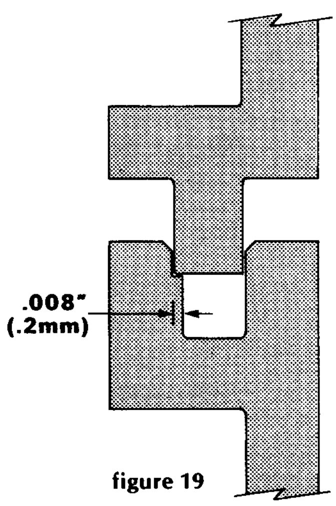


figure 19

Insertion

Insertion is the process of embedding metal components in a thermoplastic part. In ultrasonic insertion, a hole slightly smaller than the insert it is to receive is molded into the plastic part. This hole provides a certain degree of interference and also serves to guide the insert into place. The metal insert is usually designed with knurls, flutes, undercuts, or threads to resist loads imposed on the finished assembly. Several inserts can be driven simultaneously.

Ultrasonic vibrations travel through the driven component to the interface of the metal insert and plastic. Heat, generated by the metal insert vibrating against the plastic, causes the plastic to melt momentarily, permitting the insert to be driven into place. The molten material flows into the serrations and undercuts of the insert and, when the plastic solidifies, the insert is locked in place.

In most ultrasonic insertion applications, the plastic component is fixtured and the insert driven into place by the horn. However, the horn may contact the plastic, driving it over the insert [Figures 21 and 22]. In either case several inserts can be embedded simultaneously.

Because of the high wear situation in most insertion applications (metal contacting metal), hardened steel or carbide-faced horns are recommended. For low volume applications, titanium horns with replaceable tips can be utilized.

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 is necessary directly under the insert.

Pretriggering is recommended when inserting large diameter inserts, 3/8" (10mm) or greater, or multiple inserts. 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 switch, or both.

Ultrasonic insertion is not restricted to standard-type round inserts. Other types of inserts include eyeglass hinges, machine screws, threaded rods, metal bezels, metal inner shells as in lipstick tubes, roll pins, metal shafts, metal mesh or screens, decorative trim, electrical contacts, and terminal connectors.

Staking

Ultrasonic staking is an assembly method which uses the controlled melting and reforming of a plastic stud to capture or lock another component usually of a different material.

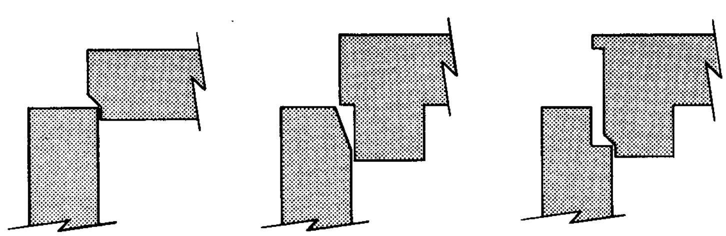


figure 20

The plastic stud protrudes through a hole in the component to be locked in place. Ultrasonic vibrations are imparted to the top of the stud, which melts and fills the volume of the horn cavity. The progressive melting of plastic under continuous but generally light pressure forms the head.

Unlike welding, staking requires that out-of-phase vibrations be generated between the horn and plastic surfaces. Light initial contact pressure is therefore required for out-of-phase vibration within the limited contact area.

The integrity of an ultrasonically staked assembly depends upon the geometric relationship between the stud and horn cavity and the ultrasonic parameters used when forming the stud. Proper stake design produces optimum strength with minimum flash.

Several configurations for stud/cavity design are available. The requirements of the application and physical size of the stud(s) determine the design to be utilized. The principle of staking is the same for each: the area of initial contact between the horn and stud must be kept to a minimum, thus concentrating the energy to produce a rapid melt.

The standard profile stake (Figure 23) satisfies most applications. It is designed to stake studs with flat heads and is recommended for studs 1/16"(1.6mm) O.D. or larger. The standard profile stake is ideal for staking non-filled thermoplastics.

The dome stake (Figure 24) is preferred for small diameter studs, approximately 1/16" (1.6mm) or less O.D. The top of the stud should be pointed to ensure minimum initial contact. Dome staking is preferred for staking filled abrasive thermoplastics. Alignment between the horn and the stud is not as critical as with the standard profile.

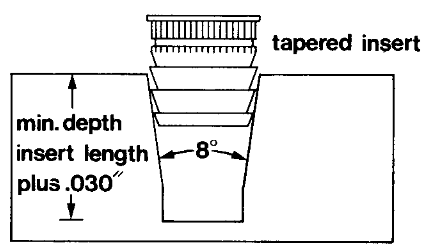
The knurled stake (Figure 25) is used in applications where appearance and strength are not critical. Multiple stakes may be made without concern for precise alignment or stud diameter. It may be used on all thermoplastics and is ideal for staking with hand held ultrasonic units.

Flush Stake

For applications requiring a flush surface where the held down piece has sufficient thickness for a chamfer or counterbore, the flush stake (Figure 27) is ideal. The top of the stud is pointed and is contacted by a flat faced horn. Flush staking may be used for all thermoplastics.

Hollow Stake

Studs having a large O.D. (5/32" 4mm-or larger) should be hollow (Figure 26). Staking a hollow stud produces a strong head without having to melt a large volume of material and reduces cycle time. Hollow studs also offer advantages in molding, because they prevent surface sinks and internal voids. Disassembly for repair can be made by breaking away the formed stud head for access and self-tapping screw for reassembly.



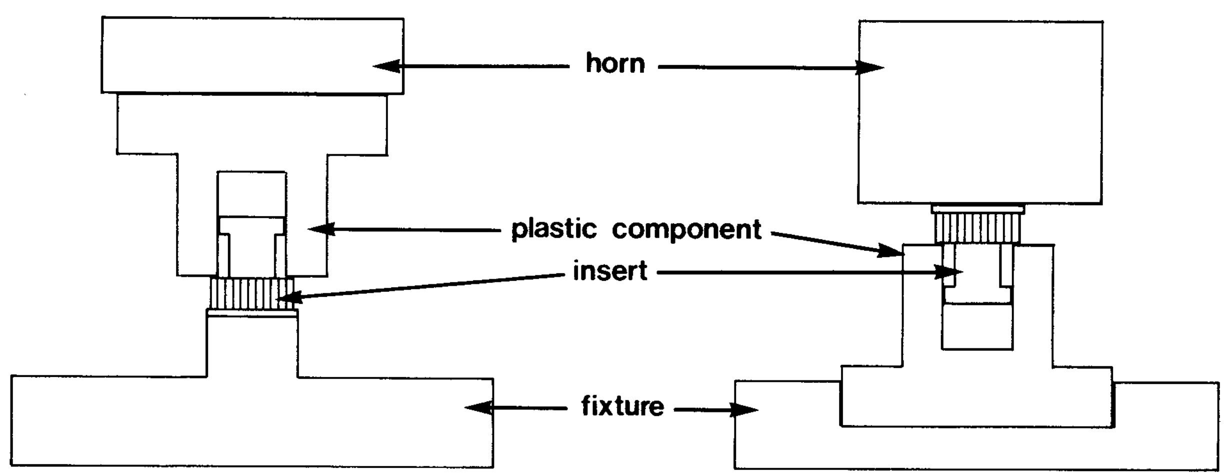
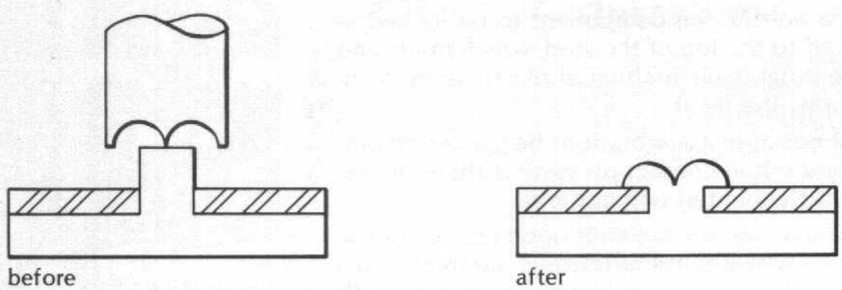
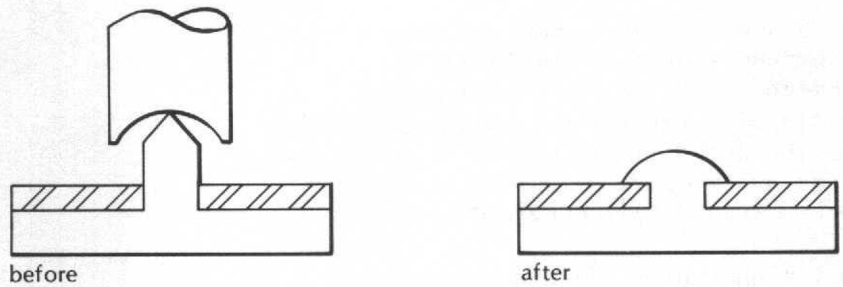


figure 21

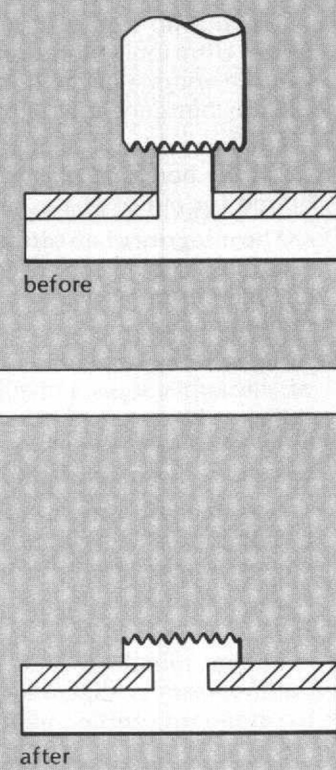
figure 22



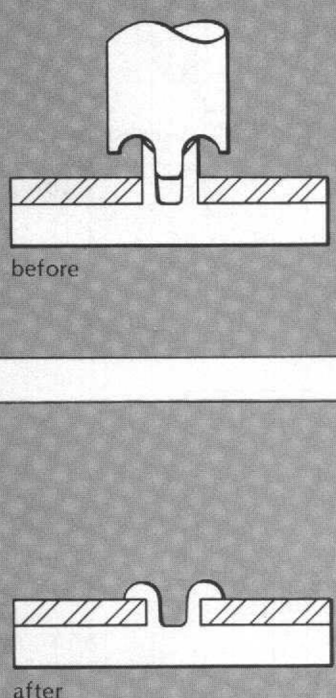
CONVENTIONAL STAKE
figure 23



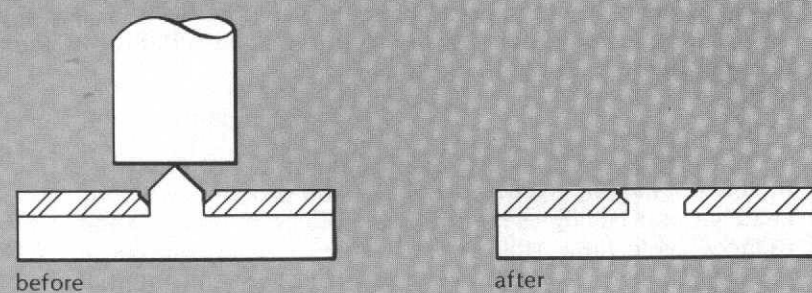
DOME STAKE
figure 24



KNURLED STAKE
figure 25



HOLLOW STAKE
figure 26



FLUSH STAKE
figure 27

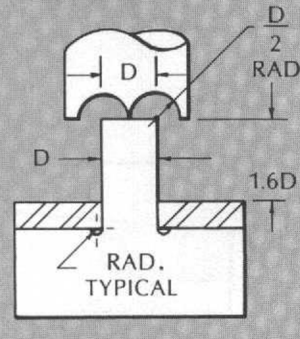


figure 28

Hollow Stake (cont'd)

For ultrasonic staking, high amplitudes and low pressure are generally required. Some high melt temperature materials, especially crystalline resins, tend to form a weak, brittle head. In these cases, using the standard profile staking tip, high pressure, high amplitude, and high trigger pressure may give best results.

An approach to obtain higher strength when staking crystalline resins uses the combination of high pressure, low amplitude, and high trigger pressure. A flat stud is contacted with a flat faced horn. The material yields under high pressure and heat generated by the ultrasonics, sets the mushroomed form just below the top of the stud with no flush or recovery.

When staking the stud should be properly located and rigidly supported from below to ensure that it is correctly aligned with the horn cavity, and that energy will be expended at the horn/stud interface rather than exciting the entire plastic assembly and fixture.

The horn should descend upon the stud with a moderately slow stroke speed, allowing time for the melt to occur and preventing the stud from being misformed by presssure.

Best staking results are obtained when ultrasonic vibrations are started prior to contact with the stud by using a pre-trigger switch. This prevents "cold forming" and allows staking to proceed in a gradual manner rather than with an interrupted motion.

To obtain consistent results, the total distance that the horn travels should be either mechanically or electrically limited by a positive stop or lower limit switch.

Swaging

The process of using ultrasonic energy to mechanically capture another component of an assembly by melting and reforming a ridge of plastic is referred to as swaging (Figure 29). A variation of swaging reforms plastic, such as tubing, into a variety of shapes although forming techniques are not limited to circular cross-sections.

In both swaging and forming, specially designed tooling is required. A cold flow of plastic is initiated by pressure from the ultrasonic horn and, when the ultrasonic energy is applied, the material is brought to its molten state and forced to flow into a cavity in the horn. When solidified, the part has been reformed to the required shape (Figure 30).

In general, the low to medium stiffness (low modulus of elasticity) resins can be formed more readily than high stiffness resins. This is due to the elastic nature of these resins; the plastic yields readily allowing the part to be partially cold formed before ultrasonic energy is applied. The materials that can be easily swaged or formed include polypropylene, polyethylene, polymethylpentene, ABS, impact polystyrene and the cellulosics. Rigid materials are not as easily swaged.

Swaging (before)

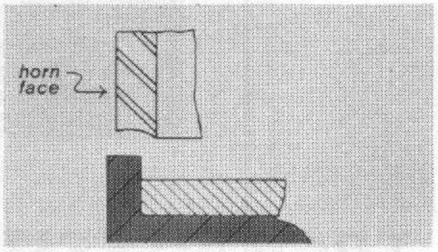


figure 29

Swaging (after)

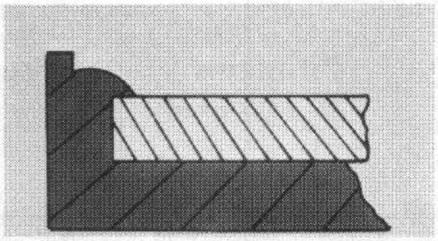


figure 30

Degating

Degating involves the separation of injection molded parts from their runner system by the horn contacting the runner or sub-runner. When ultrasonically excited, the thin gate sections reach high temperatures and melt due to a high degree of intermolecular excitation and internal friction. Plastics which are weldable, are usually degatable.

The horn contacts the runner or sub-runner. For best energy transfer, the horn width should at least equal the runner width, and horn length equal to the runner length. Single horns can accommodate runners up to 10" (25.4cm) long. Typical cycle times for such a runner are generally less than one second, including the total horn travel time. Typical pressure settings vary from 20 to 40 psig. (137.9 to 275.8 kPa). In general, gate cross sections which can fit into a .040" (1.2mm) diameter can be easily degated. Circular gates give the best results due to their uniform melt.

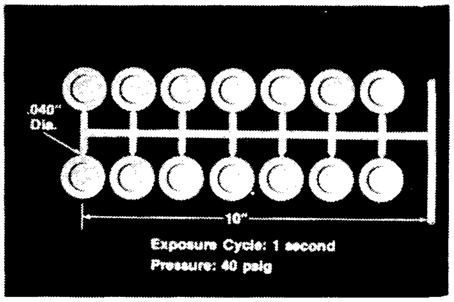


figure 31

TROUBLESHOOTING GUIDE

Welding

Problems	Probable Causes	Solutions
Overweld	Too much energy into the part.	Reduce pressure. Reduce weld time. Change to lower booster in order to reduce amplitude. Use power control (last resort). Slower down stroke.
Underweld	Insufficient energy into the part.	Increase pressure. Increase weld time. Change to a higher booster in order to increase amplitude. Use a higher powered welder. Energy loss into fixture — change type of fixture.
Non-uniform weld around the joint	Warped part(s).	Check part dimensions. Check processing conditions. Use higher trigger pressure.
	Energy director varies in height.	Make energy director a constant height.
	Lack of parallelism between horn, fixture, part.	Shim fixture where necessary. Make sure actuator is true. Check part dimensions.
	Wall flexure.	Add ribs to part. Modify fixture to prevent outward flexure.
	Knock-out pin location in joint area.	Move knock-out pin locations from joint area. Make sure knock-out pin marks are flush with surface.
	Insufficient support in the fixture.	Improve support in critical areas. Redesign fixture. Change to a rigid fixture. If large sections of urethane are deflecting, add rigid back-up.

TROUBLESHOOTING GUIDE (cont'd)

Welding

Problems	Probable Causes	Solutions
	Part tolerance.	Tighten-up part tolerances. Redimension part. Check processing conditions.
	Improper alignment.	Check for part shifting during welding. Check provisions for alignment in mating parts. Check for horn, part, fixture parallelism.
	Lack of intimate contact around joint area.	Check part dimensions. Check tolerances. Check for knock-out pin marks in the joint area. Check for misalignment of mating halves. Check for sinks.
	Non-uniform horn contact.	Check fit of part to horn. Check for proper support in fixture.
	Mold release.	Clean mating surfaces with Freon TF. If mold release is necessary use a paintable/printable grade.
	Fillers.	Check processing conditions. Reduce amount of filler.
Inconsistent weld results part-to-part	Mold release.	Clean mating surfaces with Freon TF.
	Part tolerances.	Tighten-up part tolerances. Check part dimensions. Check processing conditions.
	Cavity-to-cavity variations.	Run statistical study to see if a pattern develops with certain cavity combinations. Check part tolerances/dimensions. Check for cavity wear. Check processing conditions.
	Regrind/degraded plastic.	Check with molder. Check processing conditions. Reduce % of regrind. Improve quality of regrind.
	Changes in line voltage.	Use a voltage regulator.
	Drop in air line pressure.	Raise compressor output pressure. Add surge tank with a check valve.
	Filler content too high.	Reduce % of filler. Check processing conditions. Change type of filler, i.e. short to long glass fibers.
	Non-uniform distribution of filler.	Check processing conditions. Check mold design.
	Wrong joint design.	Redesign joint. Modify present joint.
	Degraded material.	Check processing conditions.
	Poor part fit.	Check part dimensions. Check part tolerances. Check processing conditions.
	Incompatible materials or resin grades.	Check PW-1 (back). Check with resin supplier. Check with BSP Danbury.
	Mold release.	Clean mating surfaces with Freon TF. If mold release is necessary use a paintable/printable grade.
	Regrind.	Check with molder. Check processing conditions.
	Moisture in molded part (usually nylon parts).	Receive parts dry-as-molded. Dry parts, then weld.

TROUBLESHOOTING GUIDE (cont'd)

Welding

Problems	Probable Causes	Solutions
Marking	Horn heats-up.	Check for loose stud. Check for loose tip. Reduce weld time. Cool horn. Check coupling between horn and booster. Check for cracked horn. If horn is titanium, change to aluminum. If horn is steel, reduce amplitude.
	Localized high spots in part.	Check part dimensions. Check fit of horn to part.
	Raised lettering.	Relieve horn. Use recessed lettering where possible.
	Improper fit of part to fixture.	Check for proper support. Redesign fixture. Check for cavity-to-cavity variations.
	Aluminum oxide (from the horn).	Chrome-plate horn and/or fixture. Use polyethylene film.
	Horn doesn't fit part correctly.	Check part dimensions. Obtain a new horn. Check for cavity-to-cavity variations.
	Improper horn contour.	Check part size. Check for cavity-to-cavity variations.
	To long weld cycle.	Reduce weld time by adjusting amplitude and/or pressure. Adjust dynamic triggering pressure.
	Lack of parallelism.	Check for parallelism between horn, part and fixture. Check horn/part fit. Check part/fixture fit. Shim fixture where necessary.
Flash (see also non-uniform welding)	Energy director too large.	Reduce size of energy director. Reduce weld time. Reduce pressure.
	Shear interference too great.	Reduce amount of interference.
	Weld time too long.	Reduce weld time.
	Non-uniform joint dimensions.	Redimension joint. Check processing conditions.
	Part fit or tolerances.	Loosen part fit. Loosen part tolerances.
Misalignment of welded assembly	Lack of proper alignment feature feature between mating parts.	Add alignment feature to the mating part halves (i.e. pins and sockets). If possible, design means of alignment into the tooling.
	Improper support in fixture.	Redesign fixture so that proper support is supplied. Shim fixture where necessary. If large sections of urethane are deflecting, add rigid back-up.
	Wall flexure.	Add ribs or gussets to part. If large sections of urethane are deflecting, add rigid back-up.
	Joint design not properly dimensioned.	Redimension parts.
	Part tolerance/poor molding.	Tighten-up part tolerances. Check processing conditions.
Part damage during welding		
1. Internal components damaged.	Excessive amplitude.	Reduce amplitude by changing to a lower booster.
	Long weld time.	Reduce weld time by adjusting amplitude and/or pressure. Adjust dynamic triggering pressure.
	Too much energy into the part.	Use power control. Reduce amplitude. Reduce pressure. Reduce weld time.
	Components improperly mounted i.e. mounted too close to joint area, etc.	Make sure internals are properly mounted. Isolate internal components from housing. Move components away from areas of high energy concentration. Use nodally mounted device to dampen energy locally.

TROUBLESHOOTING GUIDE (cont'd)

Welding

Problems	Probable Causes	Solutions
Part damage during welding		
2. Melting/fracture of part sections outside of joint.	Sharp internal corners.	Radius all sharp corners.
	Excessive amplitude.	Reduce amplitude by changing to lower booster.
	Long weld time.	Increase amplitude. Increase pressure. Adjust dynamic triggering pressure.
	Internal stress.	Check molding conditions. Check part design.
	Improper processing conditions.	Check processing conditions.
3. Diaphragming	Excessive amplitude.	Reduce amplitude.
	Long weld time.	Reduce weld time by increasing amplitude and/or pressure.
	Gate location.	Check gate placement. Check processing conditions. Change shape of gate. Add stiffening ribs to the part. Increase thickness of material on the underside of the gate area.
	Horn type and/or placement.	Change horns. Check for horn/part fit. Use a horn with a nodal plunger. Drill a hole in the horn (through the node) to break the vacuum.
4. Internal parts welding	Internal parts same material as housing.	Change material of internal parts. Lubricate internals.

Staking

Problems	Probable Causes	Solutions
Staked head is not uniform; it appears ragged. (See 1)	Staking cavity is too large or stud is too short.	Reduce cavity size or increase stud height.
Excessive flash around perimeter of staked head. (See 2)	Staking cavity is too small or stud is too high.	Increase cavity size or reduce height of stud.
	Stud is not centered in the cavity of the horn.	Check for proper alignment.
Staking head is slightly formed at top of stud; the base of the stud is melted and beginning to collapse. (See 3)	Clamp pressure is too high and/or amplitude is insufficient.	Reduce clamp pressure and/or Increase amplitude.
	Horn downstroke is too fast.	Use slower downstroke.
Severe marking and distortion on opposite side of staked head. (See 4)	Inadequate fixturing.	Try supporting fixture with metal under staking area.
	Clamp pressure is too high.	Reduce clamp pressure. Also, placing a metal disk between the stud and the fixture serves as a heat sink to reduce marking.
Parts are loose after staking.	Melted stud did not completely solidify before pressure was released.	Use longer hold time. External clamps or nodal plunger may be used for better containment.
	Positive stop or lower limit set too high.	Lower stop or limit switch.
Studs break off at base during staking (See 5)	Stress concentration at root of stud because of sharp corner.	Add radius to root of stud.
	Relationship of stud to horn tip is not square.	Check alignment.
Plastic flows between parts during staking causing distortion.	Metal part is not properly seated against the plastic.	External clamps or a nodal plunger may be used for better containment.
Stud not completely staked at end of cycle. (See 6).	Insufficient weld time.	Increase weld time.

Staking

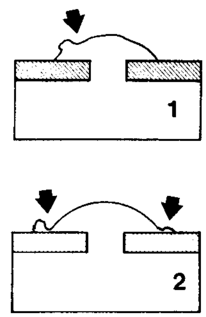


figure 32

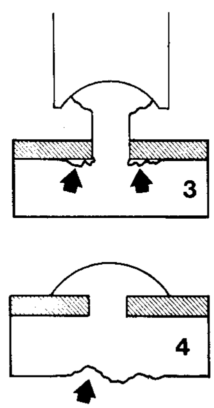


figure 33

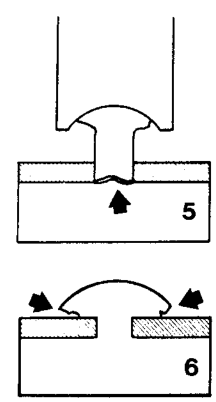
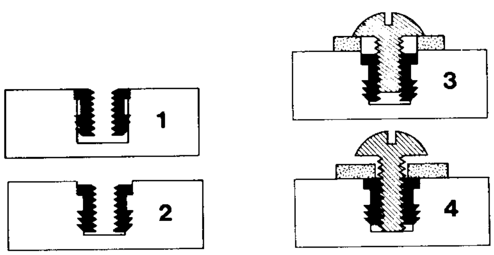
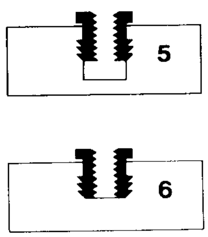


figure 34

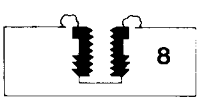
TROUBLESHOOTING GUIDE (cont'd)

Insertion

Problems	Probable Causes and/or Solutions
After insertion, plastic parts are stressed (which may lead to cracking).	Ultrasonics triggering too late — reduce trigger pressure or slow down carriage speed. No ultrasonics — insert is being cold pressed in. Use a pre-trigger. Too much interference. Pressure set too high — reduce pressure. Boss wall too thin.
Insert pulls out easily.  	Hole dimension incorrect — not enough interference, thus insufficient plastic to encapsulate insert. **(Fig. 1)** Horn continues to strike insert after it is fully seated. Reduce weld time. Reset the mechanical stop and/or lower limit switch. Jack-out conditions caused by: a. Insert seated below the surface. **(Fig. 2)** b. Retained member bearing only on the plastic component. **(Fig. 3)** c. Screw bottoming out in the acceptance hole. **(Fig. 4)** Insufficient interference in the design of the insert.
Insert backs out of part after insertion.	Certain resins may require a longer hold time to allow the plastic to solidify around the insert.
Insert not seated to desired depth. (Fig. 5)  	Ultrasonic cycle time too short. Carriage speed is faster than the rate at which plastic can melt. Insert is too long for the hole — insert bottoms out. **(fig. 6)** Insufficient pressure and/or power. Actuator at the end of its stroke. Mechanical stop and/or lower limit switch set too high.
Long cycle time required to drive insert in place.	Insufficient ultrasonic power. Too much interference — insert too large for the hole or hole too small. Increase hole dimensions or reduce the size of the insert. Carriage down speed too slow.

TROUBLESHOOTING GUIDE (cont'd)

Insertion

Problems	Probable Causes and/or Solutions
Long cycle time required to drive insert in place. (continued)	Insert mechanically locked into the boss, use pre-trigger and/or lower pressure. Improper support under the insert — energy is expended into plastic part away from the insert area. Fixturing should be rigid and should support the part directly under the boss.
Plastic filling up the threaded bore of insert. (Fig. 7) 	Insert is too long for the hole — or hole not deep enough. The insert bottoms out. Excessive interference — displaced molten plastic is filling up the bottom of the hole pushing material into the threaded bore.
Ultrasonic horn is showing severe wear after a short period of time.	A hardened steel or carbide-faced horn should be used for insertion applications to give extended wear life. Amplitude too high. Too much interference. Abrasive plastic.
Insertion application extremely noisy.	Since in most insertion applications metal contacts metal (horn to insert), it may be necessary for the part to be enclosed in a sound box during the ultrasonic cycle. Alternative is to provide the operator with ear protection equipment. Pre-trigger the ultrasonics, that is, start the ultrasonics just prior to the horn contacting the insert. Where possible, contact the plastic rather than the insert. Decrease the amplitude. Increase pressure and/or carriage down speed.
Plastic flows over the top of the insert. (Fig. 8) 	Use a lower limit switch and/or mechanical stop to limit depth. Too much weld time — adjust accordingly. Too much interference.
Horn heats up.	Too much amplitude. Because of the nature of this type of application it may be necessary to blow air across the face of the horn to keep it cool. Where possible, contact the plastic rather than the insert.

ULTRASONIC WELDING CHARACTERISTICS OF THERMOPLASTICS

Most commonly used injection-molded materials can be ultrasonically or vibration welded without the use of solvents, heat or adhesives. Ultrasonic weldability of these materials depends on their melting temperature, modulus of elasticity, impact resistance, coefficient of friction, and thermal conductivity. Generally, the more rigid the plastic, the easier it is to weld. Low modulus materials such as polyethylene and polypropylene can often be welded provided the horn can be positioned close to the joint area. Vibration welding is not as dependent upon resin characteristics to achieve a weld.

In staking, the opposite is usually true. The softer the plastic, the easier it is to stake. However, good results can be achieved with most plastics when the right amplitude and force combination is used.

The table below indicates relative weldability characteristics for the more common thermoplastics. The table on the opposite page shows the compatibility for welding of dissimilar materials.

	ULTRASONIC WELDING				
	Ease of Welding*				
Material	Near Field†	Far Field†	Swaging and Staking	Inserting	Spot Welding
Amorphous Resins					
ABS	E	G	E	E	E
ABS/polycarbonate alloy (Cycoloy 800)	E-G	G	G	E-G	G
Acrylic[a]	G	G-F	F	G	G
Acrylic multipolymer (XT-polymer)	G	F	G	G	G
Cellulosics — CA, CAB, CAP	F-P	P	G	E	F-P
Phenylene-oxide based resins (Noryl)	G	G	G-E	E	G
Poly (amide-imide)	G	F			
Polycarbonate[b]	G	G	G-F	G	G
Polystyrene, GP	E	E	F	G-E	F
Rubber modified	G	G-F	E	E	E
Polysulfone[b]	G	F	G-F	G	F
PVC (rigid)	F-P	P	G	E	G-F
SAN-NAS-ASA	E	E	F	G	G-F
Crystalline Resins[c]					
Acetal	G	F	G-F	G	F
Fluoropolymers	P				
Nylon[b]	G	F	G-F	G	F
Polyester (thermoplastic)	G	F	F	G	F
Polyethylene	F-P	P	G-F	G	G
Polymethylpentene (TPX)	F	F-P	G-F	E	G
Polyphenylene sulfide	G	F	P	G	F
Polypropylene	F	P	E	G	E

Code: E = Excellent, G = Good, F = Fair, P = Poor

*Ease of welding is a function of joint design, energy requirements, amplitude, and fixturing.

†Near field welding refers to joint ¼ in. (6.35mm) or less from area of horn contact; far field welding to joint more than ¼ in. (6.35mm) from contact area.

[a]Cast grades are more difficult to weld due to high molecular weight.

[b]Moisture will inhibit welds.

[c]Crystalline resins in general require higher amplitudes and higher energy levels because of higher melt temperatures and heat of fusion.

COMPATIBILITY OF THERMOPLASTICS

	ABS	ABS/polycarbonate alloy (Cycoloy 800)	Acetal	Acrylic	Acrylic multipolymer	Cellulosics (CA, CAB, CAP)	Fluoropolymers	Nylon	Phenylene-oxide based resins (Noryl)	Poly (amide-imide)	Polycarbonate	Thermoplastic Polyester	Polyethylene	Polymethylpentene	Polyphenylene sulfide	Polypropylene	Polystyrene	Polysulfone	PVC	SAN-NAS-ASA
ABS	■	■		■	○															○
ABS/polycarbonate alloy (Cycoloy 800)	■	■		○							■									
Acetal			■																	
Acrylic	■	○		■	○				○		○									○
Acrylic multipolymer	○			○	■												○			○
Cellulosics (CA, CAB, CAP)						■														
Fluoropolymers							■													
Nylon								■												
Phenylene-oxide based resins (Noryl)				○					■		○						■			○
Poly (amide-imide)										■										
Polycarbonate		■		○					○		■							○		
Thermoplastic Polyester												■								
Polyethylene													■							
Polymethylpentene														■						
Polyphenylene sulfide															■					
Polypropylene																■				
Polystyrene					○				■								■			○
Polysulfone											○							■		
PVC																			■	
SAN-NAS-ASA	○			○	○				○								○			■

■ Denotes compatibility

○ Denotes compatibility in some cases

Tables should be used as a guide only, since variations in resins may produce slightly different results.

BOOSTER HORNS

The success of welding and staking of plastic or inserting metal into plastic depends upon the proper amplitude of the horn tip. Since it may be impossible to design the correct amplitude into the horn initially because of its shape, booster horns are necessary to either increase or decrease the amplitude to produce the proper degree of melt or flow in the plastic part. The choice of plastic, the shape of the part, and the nature of the work to be performed all determine what the optimum horn amplitude should be.

Six amplitude-modifying booster horns are available: three for increasing amplitude and three for decreasing amplitude. Each horn is anodized with a coded color for easy identification.

Amplitude Increasing		Coupling Bar*		Amplitude Decreasing	
Ratio	Color	Ratio	Color	Ratio	Color
1 to 1.5	gold	1 to 1	green	1 to .6	purple
1 to 2.0	silver			1 to .5	blue
1 to 2.5	black				

Higher ratio boosters are available on special order but require approval for purchase from our engineering department. It should be noted that each horn has a limit to which its amplitude can be increased without fracturing the horn.

Figure 35 is a graph showing how the amplitude of a typical horn can be changed by using booster horns.

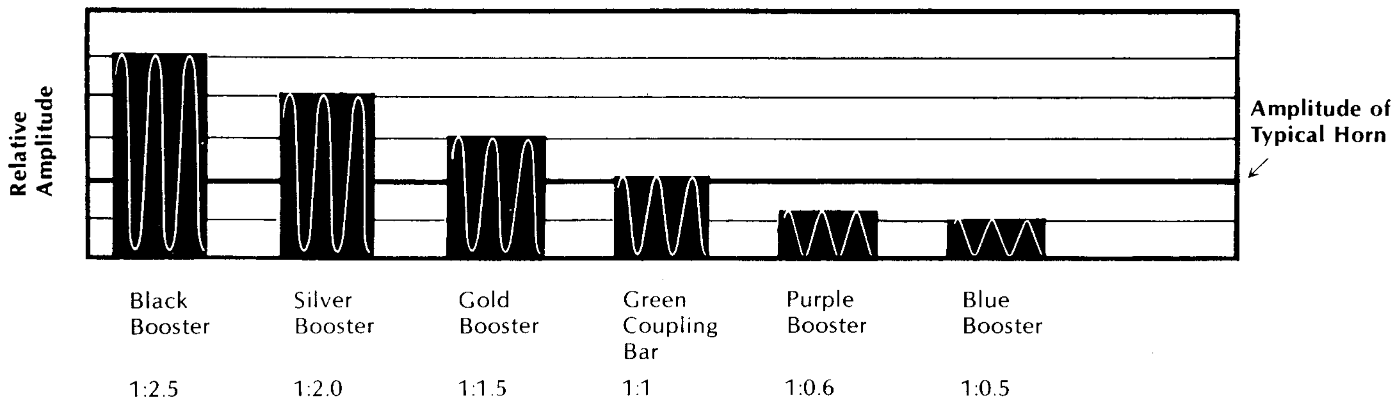


figure 35

*The coupling bar is not an amplitude-altering device. It is attached between horn and converter to achieve rigidity in mounting.

The conditions which suggest the need for altering the amplitude of a horn are listed below:

Increase Amplitude When:

1. There is difficulty getting energy to joint resulting in a poor or slow weld.
2. Energy is passing through joint (vibration can be felt in nested part; part may show marking from nest).
3. There is difficulty getting proper loading, or pressure required is beyond range of stand.
4. Diaphragming occurs. (Burnout of circular parts.)
5. If staking, melt occurs at base of stud instead of at surface.
6. Marking of parts occurs because of excessively long weld times.

Decrease Amplitude When:

1. System will not start or starts with difficulty.
2. System stalls with low pressure.
3. Excessive no load readings occur on power supply.
4. Going from solid to tapped horn.
5. Marking of parts occurs. Higher pressure provides better coupling of vibrations into plastic.
6. Plastic parts are shattered or metal insert fractures.
7. Excessive heat builds up near nodal area in horn.
8. Diaphragming occurs.

ACCESSORIES

Accessory Panel (EDP #101-063-108)

The accessory panel is required when using the following accessories:

- Energy Control Programmer
- Wattmeter
- Remote Overload Indicator
- J3 or J4 Power Control

The accessory panel can be ordered with the welder or supplied separately.

Protection Overload Indicator Module (EDP #101-063-115)

The protection indicator module provides two switch selective methods for indicating power supply overload.

The first mode provides the original momentary activation on the front panel overload indicator lamp. Simultaneously, a momentary relay closure is made available via a rear panel connector.

The second mode provides a continuous indication by latching and holding both the front panel lamp and the rear panel relay contacts.

A reset switch, located on the front panel, is provided to reset the module when used in the latching mode. A remote reset function is also available via the same rear panel connector used for the relay contacts. The relay contacts and the remote reset functions can be connected via a multi-conductor cable to remotely operate alarm functions such as lights, bells, solenoids, etc., notifying users of improper operation, or they may be connected to a reject mechanism.

Converter Protection Kit

When a Welder is used in certain applications requiring metal-to-metal contact, the converter generates voltage transients which, if left unsuppressed, can damage the converter or power supply. The protection circuit limits the amplitude of these voltage transients to a safe level.

For 8200 and 8400, use Converter Protection Kit EDP #101-063-120. For 8600, use Converter Protection Kit EDP #101-063-116.

Power Control

The power control is a variable transformer used with the Welder to control the amount of amplitude at the horn face. The power control provides fine adjustment and is used in conjunction with a booster.

For 8200 and 8400, use J3 Power Control EDP #101-144-003. For 8600, use J4 Power Control EDP #101-144-004.

A410 Wattmeter (EDP #101-137-002)

The A410 Wattmeter measures true power delivered to the converter by the power supply and is primarily used to monitor or test the power output of a system.

A310 Transistor Tester (EDP #107-140-008)

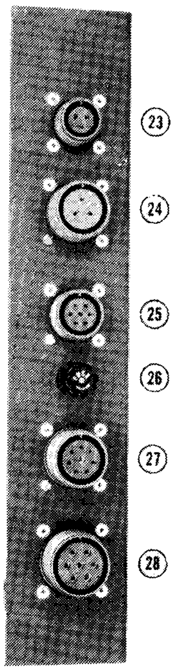
The Transistor Tester is used to test transistors without removing or unsoldering them from the heat-sink assemblies.

Index	Device	Function
23 (J16)	Energy Control Programmer Connector	Connects to energy control programmer.
24 (J15)	Wattmeter Connector	Connects to a Model A-410 wattmeter via cable #100-146-916.

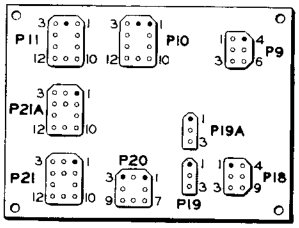
CAUTION: When using this connector, move harness plug from accessory board connector (P19) to accessory board connector (P19A). Reverse procedure when removing accessory from this connector.

Index	Device	Function
25 (J14)	Remote Overload Indicator	Connects to remote overload indicator via cable #100-146-720.
26 (F3)	External Solenoid Fuse	Overload protection.
†27 (J13)	External Solenoid, Upper Limit Switch, and J3 Power Control Connector	Connects to J3 power control. If upper limit switch and/or external solenoid are used in conjunction with the J3, use adapter #100-146-219. If upper limit switch is used, use cable supplied with kit. If upper limit and external solenoid are used, or external solenoid only is used, cable #100-146-437 must be substituted for cable #100-146-284 furnished with the upper limit switch kit.
†28 (J12)	J4 Power Control Connector	Connects to J4 power control.

†When using J3 or J4 power control, move harness plug from accessory board connector (**P21**) to accessory board connector (**P21A**). Reverse procedure when removing power control.



Accessory Panel



Accessory Board Connector

Upper Limit Switch (Kit EDP #101-063-110)

The Upper Limit Switch is used as a safety interlock switch on automated systems to prevent the movement of material handling equipment (indexing) when the horn is down.

Adjust the Upper Limit Switch as follows:

a. Lift the carriage all the way up.

b. Slide the switch assembly down on the bracket until the center of the switch roller rests on the outer surface of the cam just below the upper cam bevel. Secure switch assembly in place by tightening thumb screw.

c. Check switch actuation. If necessary, loosen the switch screws and adjust the switch as required to ensure positive actuation.

Lower Limit and Pre-Trigger Switches (Kit EDP #101-063-109)

The Lower Limit Switch terminates the weld cycle at a predetermined depth of weld regardless of the weld time control setting. The Pre-Trigger Switch initiates the weld cycle before the horn contacts the workpiece.

Adjust the Lower Limit and Pre-Trigger Switches as follows:

a. Push the carriage all the way down.

b. Slide the lower limit switch assembly down on the bracket until the center of the switch roller rests on the outer surface of the cam just above the lower cam bevel. Secure switch assembly in place by tightening thumb screw.

c. Check switch actuation. If necessary, loosen the switch screws and adjust the switch as required to ensure positive actuation.

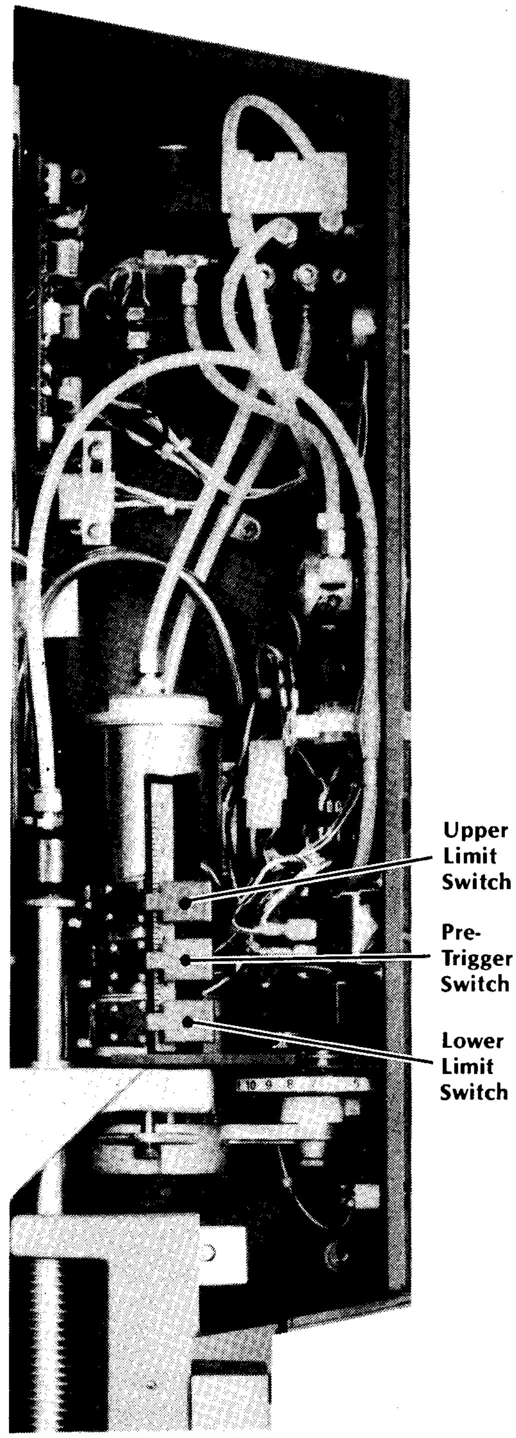
d. Slide the pre-trigger switch assembly down on the bracket until it is about 3/4" (19mm) above the lower limit switch.

e. Push the carriage down until the horn is 1/4" (6mm) above the part to be assembled.

f. Slide the pre-trigger switch assembly up or down as required until the center of the switch roller rests on the outer surface of the cam just above the lower cam bevel. Secure switch assembly in place by tightening thumb screw.

g. Ascertain that the pre-trigger switch clicks when the tip of the horn is 1/4" (6mm) or less from the part to be welded. If necessary, loosen the switch screws and adjust the switch as required to ensure positive actuation.

CAUTION: The pre-trigger switch should be positioned to activate when the horn is 1/4" (6mm) or less away from the part to be assembled.



SPECIFICATIONS

This system conforms in full with the requirements set forth in the F.C.C. Rules and Regulations, and meet OSHA standards section 1910-212.

Models 8200, 8400

Output power:	Model 8200: 450 electrical watts to converter 425 mechanical watts to load Model 8400: 900 electrical watts to converter 860 mechanical watts to load
Output frequency:	20 kHz
Output amplitude:	variable (with J3 control)
Weld cycle range:	0.1-4.0 seconds
Hold cycle range:	0.05-3.0 seconds
Maximum force on part:	440 lbs. @ 100 psig (1.96kN @ 690kPa)
Dynamic triggering range:	15 lbs. to 165 lbs. (67-734N)
Power requirements:	Model 8200: 100V, 7 Amp., 50/60 Hz 120V, 6 Amp., 50/60 Hz 200-250V, 3-1/2 Amp., 50/60 Hz Model 8400: 100V, 12 Amp., 50/60 Hz 120V, 10 Amp., 50/60 Hz 200-250V, 5 Amp., 50/60 Hz
Pneumatic Requirements:	Clean, dry unlubricated air @ 100 psig (690kPa)
Dimensions:	
Base:	Height: 3-11/16" (9,4 cm) Width: 16" (40,6 cm) Depth: 22-7/8" (58 cm)
Column:	Diameter: 3-1/2" (9 cm) Length: 36" (91,4 cm) — longer columns available on special order
Housing:	Height: 33-1/8" (84,1 cm) Width: 7-1/4" (18,4 cm) Depth: 20-1/2" (52 cm)
Stroke:	2-7/8" (7,3 cm)
Throat:	12-3/8" (31,4 cm) center of horn to center of column
Weight:*	Model 8200: 120V unit — 125 lbs. (56,7 kg) 200-250V unit — 138 lbs. (62,6 kg) Model 8400: 120V unit — 125 lbs. (56,7 kg) 200-250V unit — 138 lbs. (62,6 kg)

*Does not include converter, booster, or horn.

Model 8600

Output power:	1400 electrical watts to converter 1325 mechanical watts to load
Output frequency:	20 kHz
Output amplitude:	variable (with J3 control)
Weld cycle range:	0.1-4.0 seconds
Hold cycle range:	0.05-3.0 seconds
Maximum force on part:	440 lbs. @ 100 psig (1.96kN @ 690kPa)
Dynamic triggering range:	15 lbs. to 165 lbs. (67-743N)
Power requirements:	200-250V, 8-1/2 Amp., 50/60 Hz
Pneumatic Requirements:	Clean, dry unlubricated air @ 100 psig (690kPa)
Dimensions:	
Base:	Height: 6-1/4" (15.8 cm) Width: 16" (40,6 cm) Depth: 22-7/8" (58 cm)
Column:	Diameter: 3-1/2" (9 cm) Length: 36" (91,4 cm) — longer columns available on special order
Housing:	Height: 33-1/8" (84 cm) Width: 7-1/4" (18,4 cm) Depth: 20-1/2" (52 cm)
Stroke:	2-7/8" (7,3 cm)
Throat:	12-3/8" (31,4 cm) center of horn to center of column
Weight:*	152 lbs. (69 kg)

*Does not include converter, booster, or horn.

Dimensions apply to all models

3/8 — 16 TAP (9) ON A 4 7/16 (11.3 CM) AND 7 IN. (17.8 CM) DIA. BOLT CIRCLE

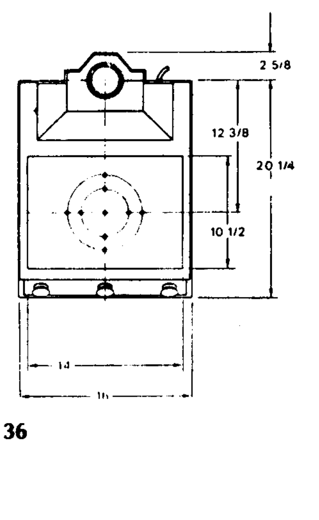


figure 36

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