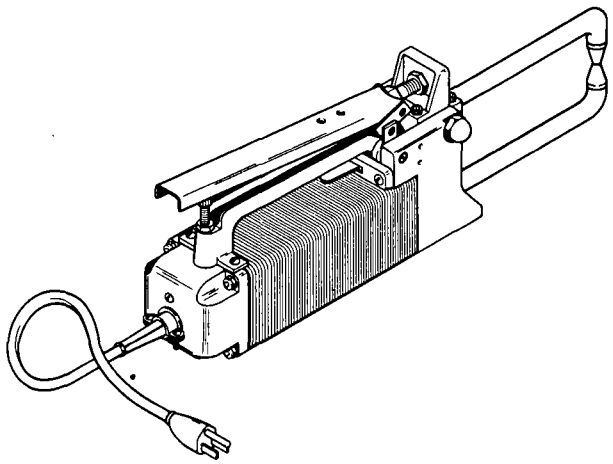
Dec. 1987 FORM: OM-118 044

Effective With Serial No. JH318063

IMPORTANT: Read and understand the entire contents of this manual, with special emphasis on the safety material throughout the manual, before installing, operating, or maintaining this equipment. This unit and these instructions are for use only by persons trained and experienced in the safe operation of welding equipment. Do not allow untrained persons to install, operate, or maintain this unit. Contact your distributor if you do not fully understand these instructions.

MODEL

AUTO ARC
AASW 1510M



OWNER'S MANUAL

AUTO ARC

MILLER ELECTRIC MFG. CO.
718 S. BOUNDS ST, P.O. Box 1079
APPLETON, WI 54912 USA

ADDITIONAL COPY PRICE 50 CENTS

NWSA CODE NO. 4579
PRINTED IN U.S.A.

ONE YEAR LIMITED WARRANTY

COVERAGE - Miller Electric Mfg. Co. warrants to the buyer who purchases this Auto Arc Welder ("Welder") for personal, family or household purposes ("Consumer") that this Welder will be free from defects in material and workmanship for a period of one year from the date of purchase. This warranty covers only the original purchaser of this Welder. Miller Electric does not authorize any party, including its authorized distributors, to offer any other warranty on behalf of Miller Electric. Upon expiration of the warranty period, Miller Electric shall have no further liability related to the Welder, except on warranty claims made during the warranty period.

THIS WARRANTY IS OFFERED IN LIEU OF ANY OTHER EXPRESS WARRANTY; AND, EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, THE DURATION OF ALL IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IS LIMITED TO THE DURATION OF THIS WARRANTY.

Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Except as specified below, Miller's warranty does not apply to components having normal useful life of less than one (1) year, such as spot welder tips, relay and contactor points, parts that come in contact with the welding wire including nozzles and nozzle insulators where failure does not result from defect in workmanship or material.

Miller shall be required to honor warranty claims on warranted Equipment in the event of failure resulting from a defect within the following periods from the date of delivery of Equipment to the original user:

1. Arc welders, power sources, and components ..... 1 year
2. Original main power rectifiers ..... 3 years (labor - 1 year only)
3. All welding guns, feeder/guns and plasma torches ... 90 days
4. Replacement or repair parts, exclusive of labor .. 60 days

WHAT IS NOT COVERED - This warranty does not extend to any Welder subjected to misuse, neglect, accident, or in-warranty repair by anyone except Miller Electric. Further, this warranty only extends to those purchasing the Welder for personal, family or household purposes. Commercial and industrial users are given a different warranty.

REMEDY FOR DEFECTIVE WELDER - Upon receipt of any defective Welder, Miller Electric will, at its option, repair or replace the defective Welder at its expense, refund or credit the purchase price (less reasonable depreciation based on actual use), or reimburse the Consumer for the cost of repair or replacement at an approved Miller Electric warranty station, provided that the purchaser of that Welder has followed the procedure for obtaining warranty performance set forth below. The Welder so repaired or used as a replacement will be shipped to the purchaser of the defective Welder, with transportation charges prepaid to any destination in the continental United States (transportation charges on shipments to Alaska or Hawaii will be paid only to the nearest port of export).

THE PURCHASER'S REMEDIES FOR A DEFECTIVE WELDER, TO THE EXTENT PERMITTED BY APPLICABLE LAW, ARE LIMITED TO THE REMEDY PROVIDED BY THIS WARRANTY: AND, TO THE EXTENT ENFORCEABLE UNDER APPLICABLE LAW, MILLER ELECTRIC SHALL IN NO EVENT BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES ARISING OUT OF THE USE OF, OR INABILITY TO USE, THE WELDER, WHETHER BASED ON BREACH OF THIS WARRANTY, MILLER ELECTRIC'S NEGLIGENCE OR OTHER TORT, OR ON ANY THEORY OF STRICT LIABILITY.

Some states do not allow the exclusion or limitation of consequential or incidental damages, so the above limitations may not apply to you.

PROCEDURE FOR OBTAINING WARRANTY PERFORMANCE

As soon as any defect in a Welder becomes known, the purchaser of the Welder must, within thirty (30) days, notify an approved Warranty Station or Miller Electric in writing of the defect. The purchaser must then, within the one year warranty period, return the Welder to Miller Electric at the following address:

Miller Electric Mfg. Co.
718 South Bounds Street
P.O. Box 1079
Appleton, Wisconsin 54912

All transportation charges to Warranty Station or Miller Electric must be prepaid.

December 12, 1989 FORM: OM-118 044

ERRATA SHEET

After this manual was printed, refinements in equipment design occurred. This sheet lists exceptions to data appearing later in this manual.

AMENDMENT TO SECTION 9 – PARTS LIST

Amend Parts List as follows:

**	Dia. Mkgs.	Part No.	Replaced With	Description	Quantity
12-4		087 182	023 659	HARNESS, wiring-switch (Eff w/JK727617)	1
13-26	S1	024 253	011 746	SWITCH, control	1
13-		024 254	011 292	TOGGLE, switch	1
13-39	T1	+095 347	+095 345	TRANSFORMER, pwr-main (Fig 9-2)	1
13-41		605 370	026 763	TUBING, No. 7 x 2.500	3
13-45		094 499	099 469	CORD SET, pwr 125V 16 ga 3/c 10ft	1

**First digit represents page no - digits following dash represent item no.
+When ordering a component originally displaying a precautionary label, the label should also be ordered.
BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.

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SECTION 1 - SAFETY RULES FOR OPERATION OF PORTABLE RESISTANCE SPOT WELDING EQUIPMENT

1 - 1. INTRODUCTION - The following safety rules cover general safe practices which as a minimum should be employed when using resistance spot welding equipment.

Establishment of an attitude of safety consciousness is necessary for the protection of personnel and property. Do not install, operate, or maintain this equipment before reading this manual.

1 - 2. INSTALLATION - All equipment should be installed by qualified personnel in conformance with local, state, and federal codes.

1 - 3. SAFETY DEVICES - Safety devices such as fuses should not be disconnected or shunted out.

1 - 4. PERSONAL SAFETY - Before installation, inspection, or service of equipment, disconnect input power and employ lockout/tagging procedures to prevent accidental turning on of power.

Always shut off power when leaving equipment unattended.

Disconnect provisions must be available near the equipment.

1 - 5. BURN PREVENTION - Wear long-sleeve shirt and cuff-less trousers in addition to gloves, hat, and high top shoes. Button shirt collar, pocket flaps, and sleeve cuffs to avoid entry of sparks.

Woolen clothing is preferable to cotton because it is not so readily ignited. Cotton clothing if used should be chemically treated to reduce its combustibility. Clothing treated with nondurable flame-retardent materials should be retreated after each wetting or cleaning.

Wear safety goggles or glasses with side shields. Use a face shield for severe exposure to flying sparks.

Avoid oils or greases on clothing which could be ignited by sparks and do not use flammable hair preparations.

Do not handle hot metal such as tong tips or workpiece without wearing gloves.

1 - 6. FUMES - Severe discomfort or illness can result from fumes and vapors produced by welding. Use adequate ventilation as described in ANSI Z49.1.

Lead-, cadmium-, zinc-, mercury-, and beryllium- bearing and similar materials when welded may produce harmful concentrations of toxic fumes. Adequate local exhaust ventilation must be used or each person in the area as well as the operator must wear an air-supplied respirator. Both must be used when beryllium is involved.

Metals coated with materials that emit toxic fumes should not be heated unless the coating is removed from the surface, the area is adequately ventilated, or the operator wears an air respirator.

1 - 7. FIRE PREVENTION - Flying sparks can pass through cracks, windows, doors, wall and floor openings, and along pipes.

If combustibles are nearby, do not weld. Move work if practicable to an area free of combustibles. If work cannot be moved, move combustibles to a safe location or protect against ignition with suitable and snug-fitting fire resistant covers or shield.

Walls, ceilings, and floors near the work area should be fire resistant or protected by fire resistant covers or shields.

Do not weld where atmosphere may contain flammable dust, gas, or liquid vapors (such as gasoline).

Do not exceed the equipment rated capacity.

After completion of work inspect area to ensure it is free of sparks, glowing embers, and flames.

1 - 8. PROTECTION OF OTHERS - Workers or other persons adjacent to the welding area should be protected by noncombustible or flame-resistant screens or shields or should be required to wear suitable eye protection. Booths and screens should permit circulation of air at floor level.

1 - 9. CORDS - Frequently inspect for wear, cracks, and damage. Immediately replace cords with excessively worn or damaged insulation to avoid possibly lethal shock from bared conductors. Keep cords dry, free of oil and grease and protect from hot metal and sparks.

1-10. HOSES - On water cooled equipment examine hoses and fittings regularly for leaks and loose connections. Repair or replace leaky hoses and fittings. Do not use tape to repair leaky hoses.

1-11. MAINTENANCE - Remove leaky or faulty equipment from service immediately for repair. Keep equipment clean and properly adjusted.

1-12. STANDARDS INDEX

1. ANSI Standard Z49.1 "Safety In Welding And Cutting", obtainable from the American Welding Society, 550 Le Jeune Rd., P.O. Box 351040, Miami, FL 33135.

2. NFPA Standard 70-1978, "National Electrical Code", obtainable from the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

3. OSHA "Safety And Health Standards", 29 CFR 1910, obtainable from the Superintendent of

Documents, U.S. Government Printing Office, Washington, D.C. 20402.

4. ANSI Standard Z87.1 "Safe Practices For Occupation And Educational Eye And Face Protection", obtainable from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

5. ANSI Standard Z41.1 "Standard For Men's Safety Toe Footwear", obtainable from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

6. ANSI Standard Z49.2 "Fire Prevention In The Use Of Cutting And Welding Processes", obtainable from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

7. NFPA Standard 51B, "Cutting And Welding Processes", obtainable from the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

8. NWSA booklet, "Welding Safety Bibliography", obtainable from the National Welding Supply Association, 1900 Arch Street, Philadelphia, PA 19103.

9. Code for Safety in Welding And Cutting, CSA Standard W117.2-1974.

Voltage Input 60 Hertz Single-Phase	Rated Output 50% Duty Cycle	Open-Circuit Voltage	Welder Dimensions Without Tongs			Weight	
			Height	Width	Length	Net	Ship
110 Volts AC	1.5 Kva	1.6	6 in. (152 mm)	3-1/4 in. (83 mm)	13 in. (330 mm)	22 lbs. (10 kg)	26 lbs. (12 kg)

		AASW 1510M		
	Tongs Length	6 in. (152 mm)	12 in. (305 mm)	18 in. (457 mm)
Secondary Short Circuited	Primary Volts	110		
	Primary Amps	82	70	60
	Secondary Amps ±10%	5500	4500	3600

Figure 2 - 1. Specifications

2 - 1. DUTY CYCLE - The duty cycle of a resistance spot welder is the percentage of a one minute period that a resistance spot welder can be operated without causing overheating or damage to the unit. This resistance spot welder is rated at 50% duty cycle, which means that it can be operated for thirty seconds out of every minute.

CAUTION: EXCEEDING DUTY CYCLE RATING will damage the resistance spot welder.

- *Do not exceed 50% duty cycle.*

2 - 2. GENERAL INFORMATION AND SAFETY

A. General

Information presented in this manual and on various labels, tags, and plates on the unit pertains to equipment design, installation, operation, maintenance, and troubleshooting which should be read, understood, and followed for the safe and effective use of this equipment.

B. Safety

The installation, operation, maintenance, and troubleshooting of resistance spot welding equipment requires practices and procedures which ensure personal safety and the safety of others. Therefore, this equipment is to be installed, operated, and maintained only by qualified persons in accordance with this manual and all applicable codes such as, but not limited to, those listed at the end of Section 1 - Safety Rules For Operation Of Portable Resistance Spot Welding Equipment.

Safety instructions specifically pertaining to this unit appear throughout this manual highlighted by the signal words **WARNING** and **CAUTION** which identify different levels of hazard.

WARNING statements include installation, operation, and maintenance procedures or practices which if not carefully followed could result in serious personal injury or loss of life.

CAUTION statements include installation, operation, and maintenance procedures or practices which if not carefully followed could result in minor personal injury or damage to this equipment.

A third signal word, **IMPORTANT**, highlights instructions which need special emphasis to obtain the most efficient operation of this equipment.

2 - 3. RECEIVING-HANDLING - Before installing this equipment, clean all packing material from around the unit, and carefully inspect for any damage that may have occurred during shipment. Any claim for loss or damage that may have occurred in transit must be filed **by the purchaser with the carrier.** A copy of the bill of lading will be furnished by the manufacturer on request if occasion to file claim arises.

When requesting information concerning this equipment, it is essential that Model Description and Serial Number of the equipment be supplied.

2 - 4. DESCRIPTION - This unit is a hand-held resistance spot welder designed for use in sheet metal fabrication where portability, speed, and strength of weld are important.

The spot welder consist of the power transformer, start switch, and hand lever for operating the tongs.

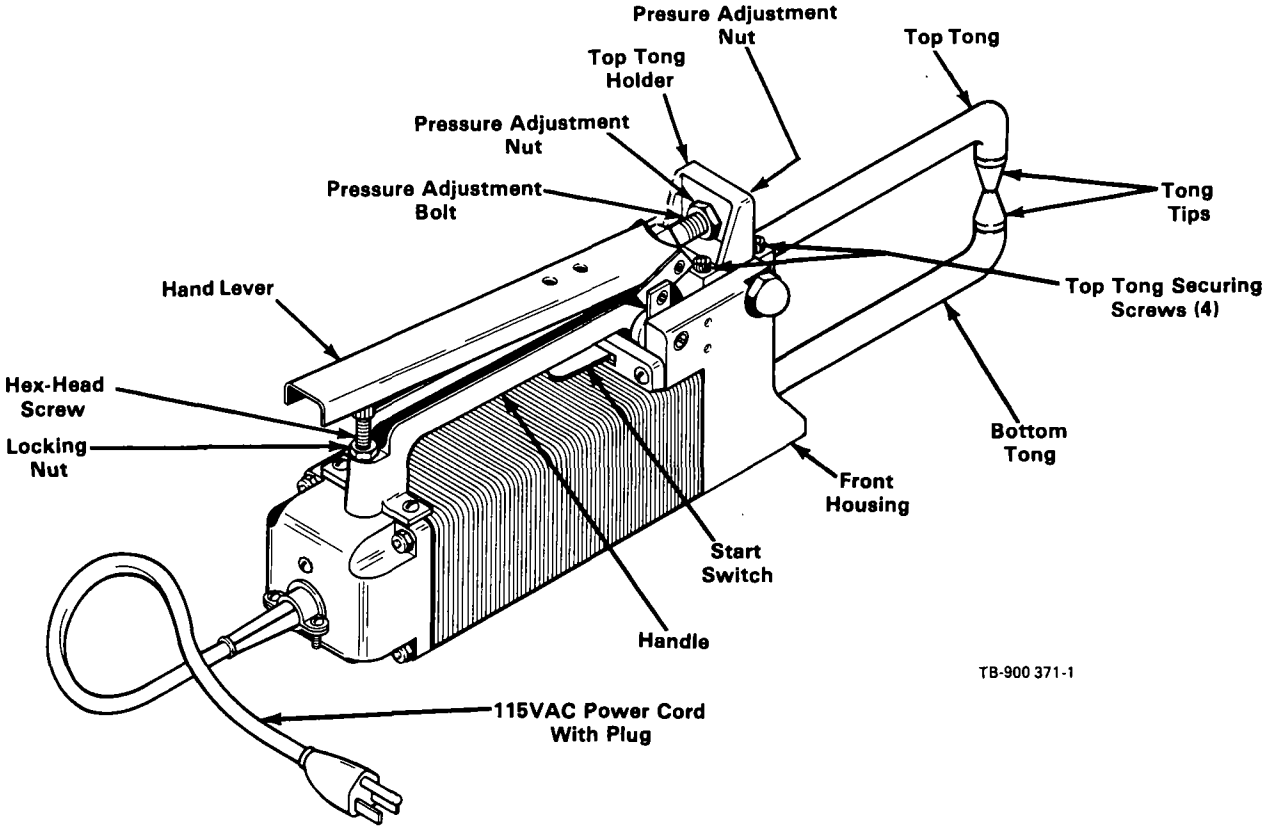


Figure 3 - 1. Resistance Spot Welder Components

3 - 1. TONG TIP AND TONG INSTALLATION (Figure 3-1)

WARNING: ELECTRIC SHOCK can kill; HOT SURFACES can burn skin.

- *Do not touch live electrical parts.*
- *Disconnect input power cord plug from power supply receptacle before installing tongs or tips.*
- *Allow tongs and tips to cool before touching.*

IMPORTANT: *Be sure that ends of tongs and tips are clean and free of corrosion before installing.*

1. Coat tong tip threads with heat sink compound.
2. Install tips into tongs, and tighten.
3. Loosen four hex-head machine screws on bottom of front housing.
4. Insert bottom tong into front housing, as far as it will go, and tighten screws.
5. Loosen four hex-head machine screws on top tong holder.
6. Insert top tong into top tong holder.
7. Align top tong tip with bottom tong tip, and tighten screws on top tong holder.

3 - 2. TONG PRESSURE ADJUSTMENT (Figure 3-1)

WARNING: ELECTRIC SHOCK can kill; HOT SURFACES can burn skin.

- *Do not touch live electrical parts.*
- *Disconnect input power cord plug from power supply receptacle before inspecting, maintaining, or servicing.*
- *Allow tongs and tips to cool before touching.*

CAUTION: EXCESSIVE TONG PRESSURE can damage tong tips.

- *Do not use the tongs as a clamp or vise to hold workpiece together.*

If the two pieces of material to be welded do not make good contact at the point of the intended weld, clamp material to provide good contact between surfaces.

IMPORTANT: *Correct tong pressure is necessary to create a quality weld and to prevent damage to tong tips.*

Excessive tong pressure causes the weld nugget area to dimple, material to splash out around the nugget area, and molten material to eject from the weld area.

If tong pressure to too weak, parts are loose when the tongs are closed, severe arcing occurs between all material interfaces, and no weld can be made.

IMPORTANT: *Tong pressure is adjustable, and must be checked and/or adjusted before operation.*

To adjust tong pressure, proceed as follows:

A. Increasing Tong Pressure

1. Loosen nut on front of top tong holder.
2. Tighten nut on rear of top tong holder until both nuts are snug against top tong holder.
3. Check tong pressure.

B. Decreasing Tong Pressure

1. Turn nut on rear of top tong holder back on the pressure adjustment bolt.
2. Tighten nut on front of top tong holder until both nuts are snug against top tong holder.
3. Check tong pressure.

3 - 3. HAND LEVER ADJUSTMENT (Figure 3-1)

WARNING: ELECTRIC SHOCK can kill; HOT SURFACES can burn skin.

- *Do not touch live electrical parts.*
- *Disconnect input power cord plug from power supply receptacle before inspecting, maintaining, or servicing.*
- *Allow tongs and tips to cool before touching.*

The hand lever can be adjusted so that the tongs lock onto the material to be welded or so that the tongs touch the material to be welded, depending upon welding application.

1. Loosen the locking nut on the hex-head machine screw at the rear of the handle (see Figure 3-1).
2. Adjust the screw up or down to provide the proper tong closing. Be sure that the lever can easily be raised to open the tongs.
3. Tighten locking nut.

3 - 4. ELECTRICAL INPUT CONNECTIONS - A cord with plug attached is provided on this unit. Check nameplate for input voltage requirement, and connect the plug to a properly grounded and protected (fuses or circuit breakers) 115 volt ac receptacle capable of supplying 15 amperes. Be sure that the building supply and receptacle comply with National Electrical Code standards and any additional state and local codes.

IMPORTANT: *The supply wiring for the resistance welder must be capable of handling a 15 ampere load. The resistance welder must be the only load connected to the supply circuit. Poor unit performance or frequently opening line fuses or circuit breakers can result from an inadequate or improper supply.*

SECTION 4 - SEQUENCE OF OPERATION

4 - 1. OPERATOR CONTROLS (Figure 3-1)

A. Start Switch

The Start switch is a spring-loaded, momentary-contact lever which provides on/off control of the weld output. Moving the lever to either side and holding it against spring tension starts weld output. The switch must be held closed for the desired weld time. Releasing the switch shuts off weld output.

B. Hand Lever

The hand lever is used to open and close the tongs. Closing the hand lever secures the pieces to be welded between the tong tips. If adjustment is necessary, see Section 3-3.

4 - 2. SPOT WELDING

WARNING: ELECTRIC SHOCK can kill; IMPROPER AIR FLOW AND EXPOSURE TO ENVIRONMENT can damage internal parts.

- *Do not touch live electrical parts.*
- *Keep all covers in place while operating.*

Warranty is void if resistance welder is operated with any portion of the outer enclosure removed.

HOT METAL AND SPARKS can cause fire and burns.

- *Wear correct eye, ear, and body protection.*
- *Allow equipment and work to cool before handling.*
- *Watch for fire.*
- *Have a fire extinguisher nearby, and know how to use it.*

FUMES AND GASES can seriously harm your health.

- *Ventilate to keep from breathing fumes and gases.*
- *If ventilation is inadequate, use approved breathing apparatus.*

MOVING PARTS can cause serious injury.

- *Keep clear of pinch points.*

MAGNETIC FIELDS FROM HIGH CURRENTS can affect pacemaker operation.

- *Wearers should consult with their doctor before going near welding operations.*

WELDING CURRENT can damage automotive electronic parts.

- *Disconnect both battery cables before welding on a vehicle.*

See Section 1 - Safety Rules For Operation Of Portable Resistance Spot Welding Equipment for basic welding safety information.

1. Install and connect unit according to Section 3.

CAUTION: OVERHEATING can damage the resistance spot welder.
- *Do not spot weld mild or stainless steel over 1/8 in. (3.2 mm) combined thickness, or two pieces of heavier than 20 gauge (1.8 mm) galvanized metal.*
- *Do not exceed 50% duty cycle.*

2. Position material to be welded between tongs. Clamp if necessary to provide firm contact between pieces.

CAUTION: EXCESSIVE TONG PORESSURE can damage tong tips.
- *Do not use tongs as a clamp or vise to hold material together.*

If the two pieces of material to be welded do not make good contact at the point of the intended weld, clamp material to provide good contact between surfaces.

3. Close hand lever to bring tong tips into contact with the workpiece.

CAUTION: ARCING can damage tong tips.
- *Do not release hand lever while the Start switch is closed.*

4. Move Start switch lever to either side and hold for the desired weld time.

5. Release Start switch to stop weld output.

6. Release hand lever and remove workpiece.

4 - 3. SHUTTING DOWN

1. Stop welding.

2. Disconnect input power cord plug from receptacle.

SECTION 5 - MAINTENANCE & TROUBLESHOOTING

5 - 1. ROUTINE MAINTENANCE

IMPORTANT: *Every six months inspect the labels on this unit for legibility. All precautionary labels must be maintained in a clearly readable state and replaced when necessary. See Parts List for part number of precautionary labels.*

WARNING: ELECTRIC SHOCK can kill.
- *Do not touch live electrical parts.*
- *Disconnect input power cord plug from power supply receptacle before inspecting, maintaining, or servicing.*

HOT SURFACES can cause severe burns.
- *Allow cooling period before servicing.*

Troubleshooting of internal parts to be performed only by qualified persons.

A. Power Cord

Every three months inspect cord for breaks in insulation. Repair or replace cord if insulation breaks are present. Clean grease and moisture from cord at each inspection.

B. Tong Maintenance

Keep tongs clean and free of grease and moisture. Fine steel wool or crocus cloth can be used to polish tongs.

Any bonds or nicks in the area of the tong end which impair proper contact with the tong holder can reduce the maximum capacity and efficiency of the resistance spot welder. Replace damaged tongs (see Section 3-1).

5 - 2. TIP DRESSING

WARNING: ELECTRIC SHOCK can kill.
- *Do not touch live electrical parts.*
- *Disconnect input power cord plug from power supply receptacle before inspecting, maintaining, or servicing.*

HOT SURFACES can cause severe burns.
- *Allow cooling period before servicing.*

MOVING PARTS can cause serious injury.
- *Keep clear of pinch points.*

Obtain tip dresser, and use according to its instructions.

Dress the tong tips when they become misshaped to the point that they are unable to produce quality welds. Some materials, such as anodized and galvanized metals, produce oxides during welding which coat the tips; as a result, the tips must be cleaned frequently. Machining the tips is the most efficient dressing method. DO NOT hand file tips. Filing often leads to tip mismating, which results in poor quality welds. A file, however, can be effectively used to remove the "mushroom" from tips if filing is confined to tapered sides.

5 - 3. TROUBLESHOOTING

WARNING: ELECTRIC SHOCK can kill.
- *Do not touch live electrical parts.*
- *Disconnect input power cord plug from power supply receptacle before inspecting, maintaining, or servicing.*

HOT SURFACES can cause severe burns.
- *Allow cooling period before servicing.*

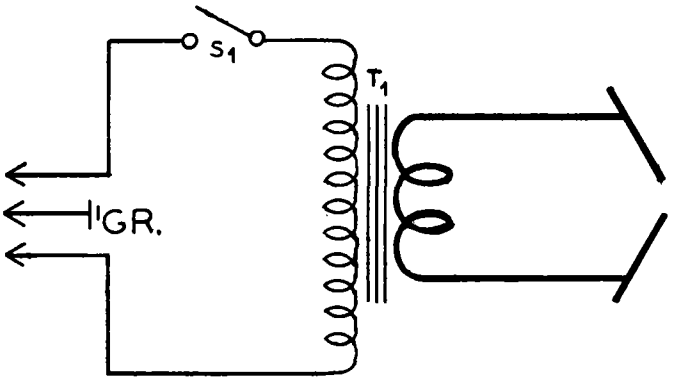
MOVING PARTS can cause serious injury.
- *Keep clear of pinch points.*

Troubleshooting to be performed only by qualified persons.

It is assumed that the unit was properly installed according to Section 3 of this manual, the operator is familiar with the function of controls, the resistance spot welder was working properly, and that the trouble is not related to the process. The following chart is designed to diagnose and provide remedies for some of the troubles that may develop in this resistance spot welder.

Use this chart in conjunction with the circuit diagram while performing troubleshooting procedures. If the trouble is not remedied after performing these procedures, contact the nearest Factory Authorized Service Station. In all cases of equipment malfunction, the manufacturer's recommendations should be strictly followed.

TROUBLE	PROBABLE CAUSE	REMEDY
No weld output.	Open line fuse or circuit breaker.	Replace line fuse or reset line circuit breaker.
	Weld circuit not complete.	Adjust tong pressure (see Section 3-2).
	Start switch S1.	Replace S1.
Longer than normal weld time.	Tongs and/or tips.	Clean or replace parts.
	Material to be welded dirty.	Clean material to be welded.
Burn through at point of weld.	Weld time too long.	Shorten weld time.
	Tong pressure.	Adjust tong pressure (see Section 3-2).
	Tips.	Clean or replace parts.



Circuit Diagram No. A-478-A1

Figure 5 - 1. Circuit Diagram

6 - 1. SAFETY REQUIREMENTS AND INTRODUCTION

WARNING: ELECTRIC SHOCK can kill.

- *Do not touch live electrical parts.*
- *Install unit according to Section 3 and all applicable codes.*
- *Keep all covers in place while operating.*
- *Wear dry insulating gloves and body protection.*
- *Disconnect all power before inspecting, maintaining, or servicing.*
- *Keep children away.*

HOT METAL AND SPARKS can cause burns and fire.

- *Wear correct eye, face, and body protection.*
- *Allow equipment and work to cool before handling.*
- *Do not use near combustible material.*
- *Watch for fire, and keep a fire extinguisher nearby.*

FUMES AND GASES can be hazardous.

- *Keep your head out of the fumes.*
- *Ventilate area, or use approved breathing device.*
- *Read Material Safety Data Sheet (MSDSs) and manufacturer's instructions for any material used.*

MOVING PARTS can cause injury.

- *Keep away from pinch points.*

WELDING CAN AFFECT PACEMAKERS.

- *Pacemaker wearers keep away. Consult doctor.*

WELDING CURRENT can damage automotive electronic parts.

- *Disconnect both battery cables before welding on a vehicle.*

See Section 1 - Safety Rules For Operation Of Portable Resistance Spot Welding Equipment for basic welding safety information.

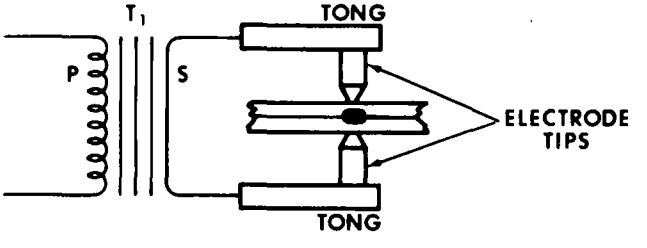


Figure 6 - 1. Resistance Spot Welding Unit With Work

Resistance welding is one of the oldest of the electric welding processes in use by industry today. The weld is made by a combination of heat, time, and pressure. As the name resistance welding implies, it is the resistance of the material to be welded to current flow that causes a localized heating in the part. The required amount of time current flows in the joint is determined by material thickness and type, the amount of current flowing, and the cross-sectional area of the welding tip contact surfaces. The pressure exerted by the tongs and electrode tips, through which the current flows, holds the parts to be welded in intimate contact before, during, and after the welding current time cycle.

6 - 2. FUNDAMENTALS OF RESISTANCE SPOT WELDING

A. HEAT

Resistance spot welding is accomplished when current is caused to flow through electrode tips and the separate pieces of metal to be joined. The resistance of the base metal to electrical current flow causes localized heating in the joint and the weld is made.

A modification of Ohm's may be made when watts and heat are considered synonymous. When current is passed through a conductor, the electrical resistance of the conductor to current flow will cause heat to be generated. The basic formula for heat generation may be stated:

$H = I^2R$ Where H = Heat
I^2 = Welding Current Squared
R = Resistance

The secondary of a resistance spot welding circuit, including the parts to be welded, is actually a series of resistances. The total additive value of this electrical resistance affects the current output of the resistance spot welding unit and the heat generation of the circuit.

The key fact is that although current value is the same in all parts of the electrical circuit, the resistance values may vary considerably at different points in the circuit. The heat generated is directly proportional to the resistance at any point in the circuit.

There are seven major points of resistance in the secondary circuit. They are:

1. The contact point between the electrode and top workpiece.
2. The top workpiece.
3. The interface of the top and bottom workpieces.
4. The bottom workpiece.
5. The contact point between the bottom workpiece and the electrode.
6. Resistance of the electrode tips.
7. Resistance of the tongs.

The resistances are in series and each point of resistance will retard current flow. The amount of resistance at point 3, the interface of the workpieces, will depend on the heat transfer capabilities of the material, its electrical resistance, and the combined thickness of the materials at the weld joint. It is at this part of the circuit that the nugget of the weld is formed.

The resistance spot weld is unique because the actual weld nugget is formed internally with relation to the surface of the base metal (see Figure 6-2).

Figure 6 - 2. Resistance Spot Weld Nugget

If the weld current is too low for the application, current density is too weak to make the weld. This condition will also overheat the electrode tips which can cause them to anneal, mushroom, and possibly be contaminated. Even though time is increased, the amount of heat generated is less than the losses due to radiation and conduction in the workpiece and thermal conduction of the electrodes. The result is the possibility, with the long weld times at low currents, of overheating the entire base metal area between the electrodes. This could cause burning of the top and bottom surfaces of the workpiece as well as possibly imbedding the electrode tips in the workpiece surface.

As current density is increased, the weld time is decreased proportionately. If, however, the current density becomes too high there is the possibility of expelling mollen metal from the interface of the joint thereby weakening the weld. The ideal time and current density conditions are somewhere just below the level of causing metal to be expelled.

It is apparent that the heat input cannot be greater than the total dissipation rate of the workpiece and the electrodes without having metal expelled from the joint.

An interesting discovery has been developed recently concerning the flow of current through the workpiece. Until recently, current was considered to flow in a straight line through the weld joint. This is not necessarily true when multiple thicknesses of material are being welded. The characteristic is for the current to "fan out" thereby decreasing the current density at the point of weld the greatest distance from the electrode tips. The illustration (Figure 6-3) shows the resistance spot weld heat zones for several thicknesses of metal. We note the uncontrollable variables (such as interface resistance, thermal conductivity, and interface contamination) are multiplied when resistance spot welding several thicknesses of material. Quality levels will be much lower for "stack" resistance spot welding which explains why such welding practices are avoided whenever possible.

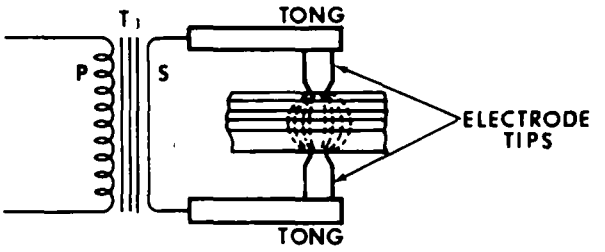


Figure 6 - 3. Resistance Spot Weld Heat Zones

B. TIME

Resistance spot welding depends on the resistance of the base metal and the amount of current flowing to produce the necessary heat for the spot weld. Another important factor is time. In most cases several thousand amperes are used in making the spot weld. Such amperages, flowing through a relatively high resistance, will create a lot of heat in a short time. To make good resistance spot welds, it is necessary to have close control of the time the current is flowing. Actually, time is tually, time is the only controllable variable in most single impulse resistance spot weld applications. Current is very often economically impractical to control.

Most resistance spot welds are made in a very shor time period.

Previously, the formula for heat generation was used. With the addition of the time element, the formula is completed as follows:

$H = I^2RTK$ Where H = Heat
I^2 = Welding Current Squared
R = Resistance
T = Time
K = Heat Losses

Control of time is important. If the time element is too long, the base metal in the joint may exceed the melting (and possibly the boiling) point of the metal. This could cause faulty welds due to gas porosity. There is also the possibility of expulsion of molten metal from the weld joint which could decrease the cross section of the weld joint weakening the weld. Shorter weld times also decrease the possibility of excessive heat transfer in the base metal. Distortion of the welded parts is minimized, and the heat affected zone around the weld nugget is substantially smaller.

C. PRESSURE

The effect of pressure on the resistance spot weld should be carefully considered. The primary purpose of pressure is to hold the parts to be welded in intimate contact at the joint interface. This action assures consistent electrical resistance and conductivity at the point of the weld. The tong and electrode tips should not be used to pull the workpiece together. The resistance spot weld unit is not designed as an electrical "C" clamp. The part to be welded should be in intimate contact before pressure is applied.

Investigations have shown that high pressures exerted on the weld joint decrease the resistance at the point of contact between the electrode tip and the workpiece surface. The greater the pressure, the lower the resistance factor.

Proper pressures, where there is intimate contact of the electrode tip and the base metal, will tend to conduct heat away from the weld. Higher currents are necessary with greater pressures, and conversely, lower pressure requires less amperage from the resistance spot weld unit.

The pressure exerted by the tongs and the electrode tips on the workpiece have a great effect on the amount of weld current that flows through the joint. The greater the pressure, the higher the weld current value will be, within the capability of the resistance spot weld unit.

Setting pressure on the spot weld is relatively easy. Normally samples of the material to be welded are placed between the electrode tips and checked for adequate pressure to make the weld. If more or less pressure is required, see Section 3-2.

6 - 3. MATERIALS TO BE WELDED

A. SURFACE CONDITIONS

All metals develop oxides which can be detrimental to resistance spot welding. Some oxides, particularly those of a refractory nature, are more troublesome than others. In addition, the mill scale found on hot-rolled steels will act as an insulator and prevent good quality resistance spot welds. Surfaces to be joined by this process should be clean, free of oxides and chemical compounds, and have a smooth surface.

B. MILD STEEL

Mild, or low carbon steel comprises the largest percentage of material welded with the resistance spot weld process. All low carbon steels are readily weldable with the process if proper equipment and procedures are used.

The carbon steels have a tendency to develop hard, brittle welds as the carbon content increases if proper post-heating procedures are not used. Quick quenching of the weld, where the weld nugget cools rapidly, increases the probability of hard, brittle micro-structure in the weld.

Hot rolled steel will normally have mill scale on the surface of the metal. This type of material is usually not resistance spot welded with smaller amperage units such as this.

Cold rolled steel (CRS) and hot rolled steel, pickled and oiled (HRSP & O), may be resistance spot welded with very little trouble. If the oil concentration is excessive on the sheet metal, it could cause the formation of carbon at the electrode tips thereby decreasing their useful life. Degreasing or wiping is recommended for heavily oiled sheet stock.

With magnetic materials such as mild steel, the current through the weld can vary substantially depending on how much of the magnetic material is within the tong loop. The tong loop is sometimes called the throat for the resistance spot weld unit.

For example, the part to be welded may have the largest amount of the base material within the throat of the unit for any one resistance spot weld and almost none of the base metal in the throat for the second spot weld. The current at the weld joint will be less for the first spot weld. The reason is the reactance caused by the ferrous material within the arc welding circuit.

In any material being resistance spot welded there is the possibility of shunt currents flowing through the previously made spot welds. This can rob the second spot weld of the welding current necessary for making the joint.

C. LOW ALLOY AND MEDIUM CARBON STEEL

There are some pertinent differences in resistance spot welding low alloy and medium carbon steels as compared to mild or low carbon steels. The resistance factor for the low alloy and medium carbon steels is higher, therefore, the current requirements are slightly lower. Time and temperature are more critical since metallurgical changes will be greater with these alloys. There is certainly more possibility of weld embrittlement than there is with mild steel.

Resistance spot welding pressures are normally higher with this material because of the additional compressive strength inherent in the low alloy and medium carbon steels. It is always a good idea to use longer welding times when welding these alloys to retard the cooling rate and permit more ductile welds.

D. STAINLESS STEEL

The chrome-nickel steel alloys (austenitic) have very high electrical resistance and are readily joined by resistance spot welding. The consideration of great importance with this material is rapid cooling through the critical range (800 - 1400 degrees Fahrenheit). The rapid quench associated with resistance spot welding is ideal for reducing the possibility of chromium carbide precipitation at the grain bounderies. Of course, the longer the weldment is held at the critical temperature, the greater the possibility of carbide precipitation.

E. COATED OR PLATED STEEL

WARNING: FUMES AND GASES can seriously harm your health.

- *Use enough ventilation to keep fumes and gases from the breathing zone.*
- *If ventilation is inadequate, use approved breathing apparatus.*
- *Wear correct body protection.*

Vaporized zinc, upon condensation into solid material, forms particles shaped like fishhooks. These particles will imbed themselves in the tissues of the body and can

cause irritation. Wear long sleeve shirts and protective face shields when working with coated or plated steels.

Other coated material, such as terne plate (lead-coated) may have varying degrees of toxicity. Adequate ventilation is mandatory when working with these materials.

The overwhelming majority of material in this category is galvanized, or zinc coated steel. Although some galvanized steel is electroplated, dip-coated steel costs less and is in predominant use. The zinc coating is uneven in thickness on dip-coated steel. The resistance factor will vary from weld to weld, and it is very difficult to set conditions in chart form for the material.

It is impossible to maintain the integrity of the galvanized coating when resistance spot welding. The low melting point of the zinc coating, compared to the fusion temperature of the steel, causes the zinc to vaporized. Of course, there must be adequate pressure to force the zinc aside at the weld interface to permit steel to steel fusion. Otherwise, the strength of the resistance spot weld is open to question.

Materials are available to repair the external damage to the coating that may be incurred because of the welding heat. There is no remedy for the loss of coating material at the interfaces of the weld. In fact, the vaporization of the zinc can cause porosity in the weld and general weakening of the expected shear strength.

The vaporization of the coating material has a tendency to foul the electrode tips. The tips should be cleaned frequently to prevent the alloying of the lower melting materials with the copper tips. The tips may require cleaning and dressing every fourth or fifth weld to maintain quality in the product although for some galvanized applications the best welds are made after several spots blacken the tips. The use of short weld times will increase the possibility of good welds with the least amount of tip fouling.

6 - 4. TESTING PROCEDURES - The resistance spot weld should have shear strength equal to the base metal shear strength and should exceed the strength of a rivet or a fusion plug weld of the same cross sectional area. Shear strength is normally accepted as the criteria for resistance spot weld specifications although other methods may be used.

A. VISUAL TEST

Observe the deformation and shape of the surface contact points at both sides of the weld. Excessive "dishing" of the surface contact point indicates one or more of the following:

1. Excessive long pressure.
2. Weld time too long.
3. Misalignment of the electrode tips.

If the resistance spot weld does not have an even, concentric surface appearance, the problem could be misalignment of the electrode tips. Align electrode tips (see Section 3-1).

B. MECHANICAL TEST

A common practice is to "peel" two welded sample strips apart to see if a clean nugget is pulled from one piece. If it is, the resistance spot weld unit is properly set up for the material.

Place one end of the resistance spot weld sample in a vise. Use mechanical means to force the weld apart. One side of the weld should pull loose from the parent metal with a metal extension from the weld. Check for proper weld diameter.

(89 mm) 3½" STANDARD	6" (152 mm) **042 159** 12" (305 mm) **042 180**	Standard **042 161**	Flat **042 162**
(190 mm) 7½" G-7	8" (203 mm) **042 158**	Standard **042 161**	Flat **042 162**
(165 mm) 6½" TT-6	18" (457 mm) **042 157**	Standard **042 161**	Flat **042 162**

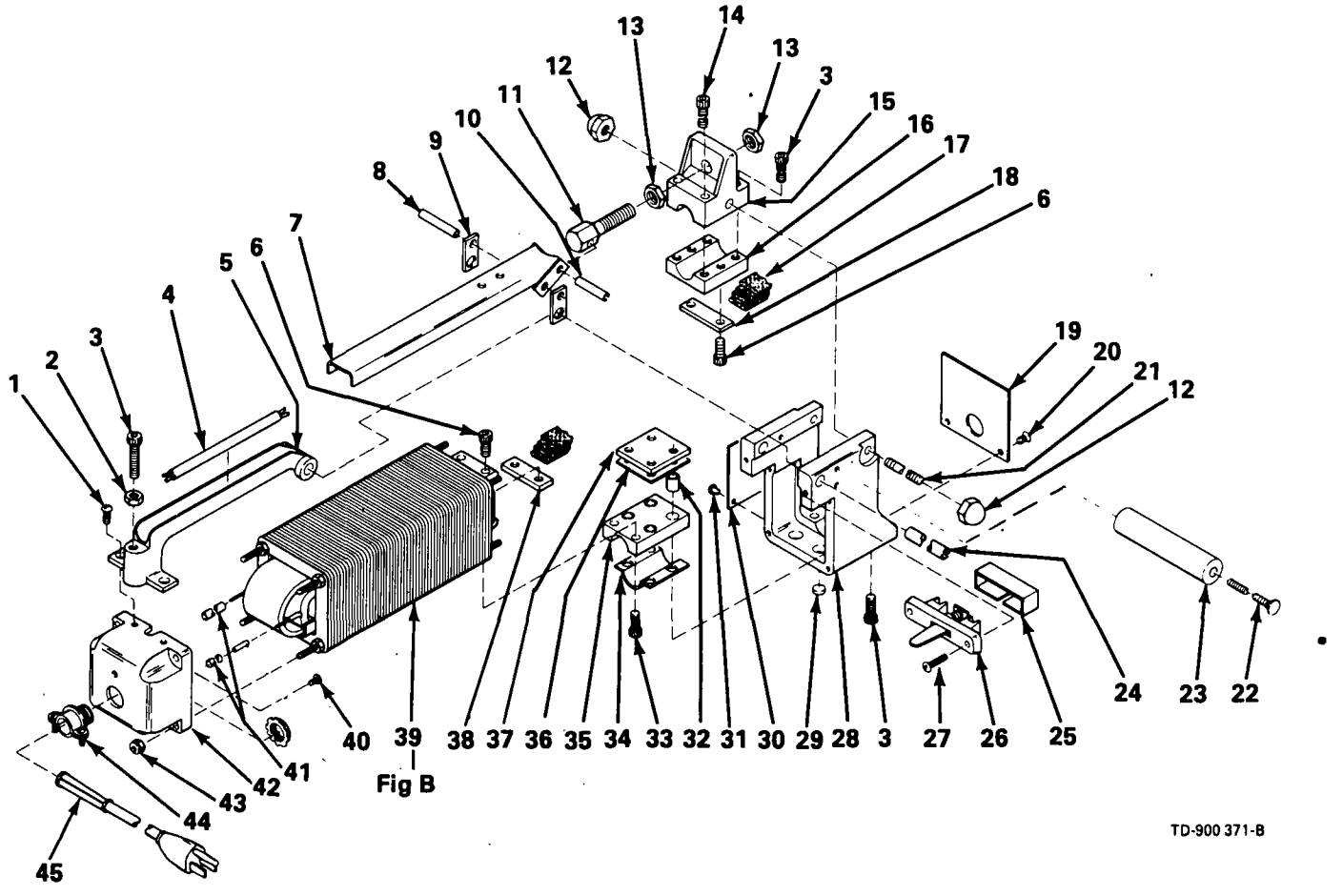


Figure A - Main Assembly

*Recommended Spare Parts.
+When ordering a component originally displaying a precautionary label, the label should also be ordered.
BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.

Item No.	Dia. Mkgs.	Part No.	Description	Quantity
Figure A			**Main Assembly**	
1		059 146	SCREW, truss-hd 10-32 x 1/2	2
2		601 865	NUT, hex 1/4-20	1
3		602 009	SCREW, cap-socket 1/4-20 x 1-1/4	7
4		087 182	HARNESS, wiring-switch	1
5		019 643	HANDLE, carrying	1
6		602 008	SCREW, cap-socket hd 1/4-20 x 1	2
7		023 199	LEVER, operating	1
8		010 714	PIN, spring 5/16 x 1-3/4	1
9		010 712	LINK, toggle-connecting	2
10		010 713	PIN, spring 5/16 x 1-1/4	1
11		010 715	BOLT, pressure adjustment	1
12		601 854	NUT, hex 3/8-24	2
13		601 876	NUT, hex jam 7/16-20	2
14		010 668	SCREW, cap-socket hd 1/4-20 x 1-1/2	2
15		017 668	HOLDER, tong-top	1
16		010 709	CLAMP, top tong	1
17		010 623	BRAID, tong-set of four	1
18		010 716	CLAMP, connecting top tong braid	1
19		026 607	GUARD, spatter	1
20		602 090	SCREW, flat hd 10-32 x 3/8	2
21		095 297	STUD, 3/8 x 3-3/4	1
22		601 778	BOLT, carriage 1/4-20 x 4-1/2	1
23		602 262	HANDLE, wood	1
24		010 711	PIN, spring 3/8 x 3	1
25		070 017	INSULATION, switch	1
26	S1	024 253	SWITCH, control (consisting of)	1
		011 291	. CONTACT, assembly switch	1
		023 987	. CONTACT, switch	1
		024 254	. TRIGGER, switch	1
		070 035	. BASE	1
27		602 092	SCREW, fillister hd 10-32 x 1/2	2
28		017 667	HOUSING, front	1
29		026 759	INSULATOR, plug-secondary screw	2
30			NAMEPLATE (order by model and serial number)	1
31		602 024	SCREW, drive U 2/3/16	4
32		026 606	TUBING, fiber 1/4 ID x 3/8 OD x 1/2	4
33		602 004	SCREW, cap-socket hd 1/4-20 x 3/4	2
34		026 604	INSULATION, fiber 1/32 inch	2
35		010 707	CLAMP, bottom tong	1
36		026 605	INSULATION, bottom clamp	1
37		010 708	RETAINER, clamp tong	1
38		See Note	CLAMP, threaded-connecting tong braid	1
39	T1	+095 347	TRANSFORMER, power-main (Fig B Pg 14)	1
		045 124	LABEL, general precautionary	1
40		602 088	SCREW, round hd 10-32 x 1/4	1
		602 205	WASHER, lock-internal tooth No. 10	1
41		605 370	TUBING, No. 5 2-1/2 long	3
42		019 642	COVER	1
43		601 847	NUT, self-locking hex 10-32	4
44		115 104	CONNECTOR, clamp-cable 1/2 inch	1
45		094 499	CABLE, power 10 ft	1
		025 532	TONG, top-std 12 in	1
		025 533	TONG, bottom-std 12 in	1
		600 077	TIP, std	2
		024 130	BRACKET, mtg-handle	2
		089 799	SCREW, cap-flange hex hd 1/4-20 x 1/2	4
		602 207	WASHER, lock-split 1/4	4
		601 865	NUT, hex full 1/4-20	4
		117 652	LABEL, Auto Arc Spot Welder	1

NOTE: Item 38 is included when ordering item 11 shown in Figure B on page 10.
BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.

Replace Coils At Factory Or Factory Authorized Service Station.

Item No.	Dia. Mkgs.	Part No.	Description	Quantity
Figure B		**095 347**	**Transformer, Power-Main (Fig A Pg 13Item 39)**	
1		026 601	INSULATION, coil (consisting of)	1
2		026 772	. STRIP, 0.015 x 4-5/8 x 8	2
3		026 765	. TUBING, 1-1/4 x 1-7/8 long	1
4		026 774	. STRIP, 0.015 x 1-5/8 x 1-3/4	1
5		026 770	. STRIP, 0.015 x 5/8 x 7-7/8	2
6	T1	**095 312	COIL, primary	1
7		026 764	STRIP, 0.015 x 1-3/4 x 2-1/2	1
8		010 157	STUD, No. 10-32 x 8-1/8	4
9		601 863	NUT, hex 10-32	4
10		033 123	BAR, secondary	1

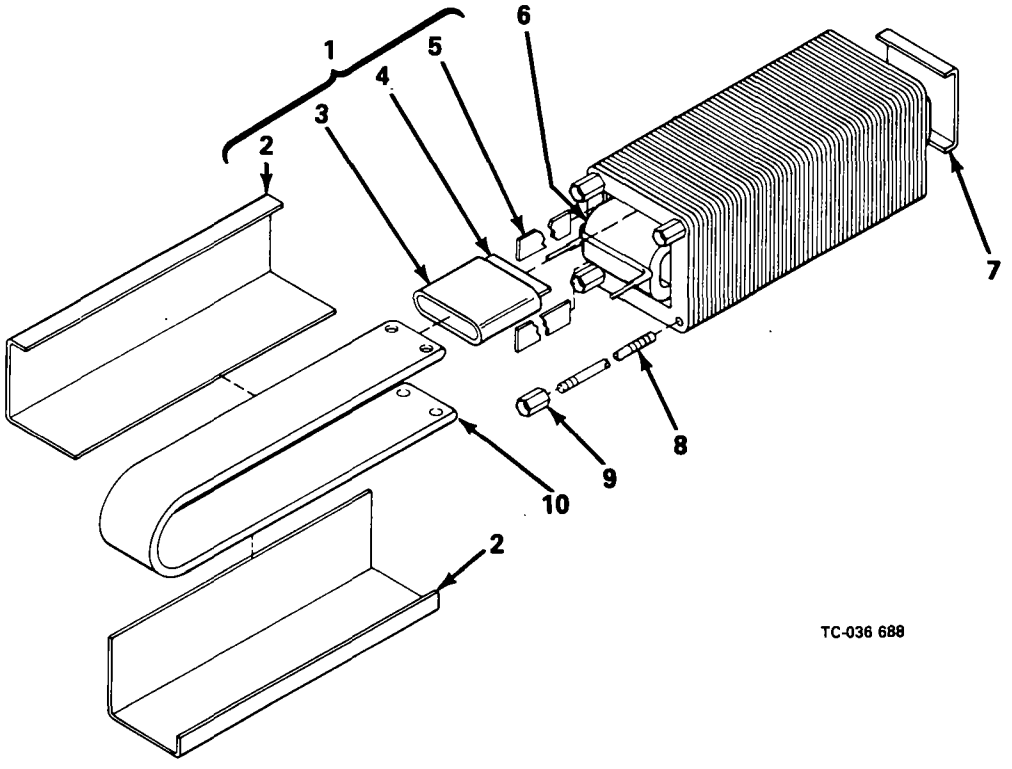


Figure B - Transformer, Power-Main

BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.