Instruction manual

Number 0-2231

PWH/M-4A WELDING TORCH

THERMAL DYNAMICS CORPORATION

8/22/85

TABLE OF CONTENTS

INTRODUCTION

This manual is divided into five sections:

SECTION 1. GENERAL INFORMATION

Describes the Thermal Arc® PWH/M-4A Plasma Welding Torch. This section also includes theory of operation and the torch specifications.

SECTION 2. INSTALLATION

Provides detailed instructions for the assembly and inspection of new torches.

SECTION 3. OPERATION

Lists operating procedures, which include detailed instructions for using the equipment and tips for safe, efficient welding.

SECTION 4. SERVICE

Contains detailed troubleshooting guidelines combined with service and test procedures for the torch and components.

SECTION 5. PARTS LIST

Lists all components in the torch with catalog order numbers for ease of identification.

The information contained in this manual represents our best judgement but Thermal Dynamics Corporation assumes no liability for its use.

NOTES, CAUTIONS, AND WARNINGS

Throughout this manual, notes, cautions, and warnings are used to call attention to particular information.

The method used to identify these highlights, and the purpose for which each is used, are as follows:

NOTE:

An operation, procedure, or background information which aids the operator in efficient use of the machine, helps the serviceman in performing maintenance, or requires additional emphasis.

CAUTION

An operational procedure which, if not properly followed, may cause damage to the equipment.

WARNING

An operational procedure which, if not followed, may cause injury to the operator or others in the operating area.

Operation and maintenance of any plasma arc equipment involves potential hazards. Personnel should be alerted to the following hazards and precautions should be taken to prevent possible injury.

GASES AND FUMES can be dangerous and hazardous to your health.

- Ventilation must be adequate to remove the smoke during welding. (Threshold limit values and how to measure the amounts to assure adequate ventilation are found in publication (A), page iv).
- Vapors of chlorinated solvents can form the toxic gas Phosgene when exposed to ultraviolet radiation from an electric arc. All solvents, degreasers, and potential sources of these vapors must be removed from the welding area.
- Keep all fumes and gases from the breathing area.
- Use an air-supplied respirator if ventilation is not adequate to remove all fumes and gases.

ELECTRIC SHOCK can kill.

- Install and maintain equipment according to USA Standard C1, National Electric Code.
- Proper grounding procedures must be adhered to when using plasma welding equipment. The work or metal on which a person welds must be grounded to a good electrical ground.
- Do not contact electrically live parts.
- Insulate yourself from work and ground.
- Replace any cracked or damaged insulating parts, including torch bodies and hoses.
- Turn off primary power before working on torch parts, including changing cups and tips.
- When operating plasma welding apparatus in a damp or wet area, extra care should be taken.

ARC RAYS can injure eyes and burn skin.

- Use welding shield with #10 or darker filter.
- Wear proper protective clothing.
- Make sure others are protected from arc rays.

FIRE can be caused by hot metal and sparks.

- Remove flammable and combustible materials that might be ignited by sparks from the welding area or provide a fire watch.
- Do not weld containers that have held combustibles.

COMPRESSED GAS CYLINDERS

Compressed gas cylinders are potentially dangerous. Refer to supplier for proper handling procedures.

PUBLICATIONS

The following publications provide additional information on safety precautions:

(A) Bulletin No. C5.1-73 "Recommended Safe Practices for Plasma Arc Welding"

(B) American National Standard ANSI Z49.1-1983 "Safety in Welding and Cutting"

Both are available from:

American Welding Society Inc.
2501 Northwest 7th Street,
Miami, Florida 33125

Telephone (305) 443-9353

(C) OSHA Safety and Health Standards, 29CFR 1910, available from the U.S. Department of Labor, Washington, D.C. 20210

WARNING

Read and Understand this Instruction Manual and Your Employer's Safety Practices.

Declaration of Conformity

Manufacturer: Thermal Dynamics Corporation
Address: Industrial Park #2
West Lebanon, New Hampshire 03784
USA

The equipment described in this manual conforms to all applicable aspects and regulations of the 'Low Voltage Directive' (European Council Directive 73/23/EEU) and to the National legislation for the enforcement of this Directive.

Serial numbers are unique with each individual piece of equipment and details description, parts used to manufacture a unit and date of manufacture.

National Standard and Technical Specifications

The product is designed and manufactured to a number of standards and technical requirements among them are:

* CSA (Canadian Standards Association) standard C22.2 number 60-M1990 for Arc welding equipment.

* UL (Underwriters Laboratory) rating 94VO flammability testing for all printed-circuit boards used.

* ISO/IEC 60974-1 (BS 638-PT10) (EN 60 974-1) applicable to welding equipment and associated accessories.

* Extensive product design verification is conducted at the manufacturing facility as part of the routine design and manufacturing process. This is to ensure the product is safe, when used according to instructions in this manual and related industry standards, and performs as specified. Rigorous testing is incorporated into the manufacturing process to ensure the manufactured product meets or exceeds all design specifications.

Thermal Dynamics has been manufacturing products for more than 30 years, and will continue to achieve excellence in our area of manufacture.

Manufacturers responsible representative: David Ashworth
Vice President & Managing Director
Thermadyne Europe
Chorley England.

Statement of Warranty

LIMITED WARRANTY: Thermal Dynamics® Corporation (hereinafter "Thermal") warrants that its products will be free of defects in workmanship or material. Should any failure to conform to this warranty appear within the time period applicable to the Thermal products as stated below, Thermal shall, upon notification thereof and substantiation that the product has been stored, installed, operated, and maintained in accordance with Thermal's specifications, instructions, recommendations and recognized standard industry practice, and not subject to misuse, repair, neglect, alteration, or accident, correct such defects by suitable repair or replacement, at Thermal's sole option, of any components or parts of the product determined by Thermal to be defective.

THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF LIABILITY: Thermal shall not under any circumstances be liable for special or consequential damages, such as, but not limited to, damage or loss of purchased or replacement goods, or claims of customers of distributor (hereinafter "Purchaser") for service interruption. The remedies of the Purchaser set forth herein are exclusive and the liability of Thermal with respect to any contract, or anything done in connection therewith such as the performance or breach thereof, or from the manufacture, sale, delivery, resale, or use of any goods covered by or furnished by Thermal whether arising out of contract, negligence, strict tort, or under any warranty, or otherwise, shall not, except as expressly provided herein, exceed the price of the goods upon which such liability is based.

THIS WARRANTY BECOMES INVALID IF REPLACEMENT PARTS OR ACCESSORIES ARE USED WHICH MAY IMPAIR THE SAFETY OR PERFORMANCE OF ANY THERMAL PRODUCT.

THIS WARRANTY IS INVALID IF THE PRODUCT IS SOLD BY NON-AUTHORIZED PERSONS.

The limited warranty periods for Thermal products shall be as follows (with the exception of STAK PAK II and DRAG-GUN): A maximum of three (3) years from date of sale to an authorized distributor and a maximum of two (2) years from date of sale by such distributor to the Purchaser, and with the further limitations on such two (2) year period (see chart below).

The limited warranty period for STAK PAK II shall be as follows: A maximum of four (4) years from date of sale to an authorized distributor and a maximum of three (3) years from date of sale by such distributor to the Purchaser, and with the further limitations on such three (3) year period (see chart below).

The limited warranty period for DRAG-GUN shall be as follows: A maximum of two (2) years from date of sale to an authorized distributor and a maximum of one (1) year from date of sale by such distributor to the Purchaser, and with the further limitations on such two (2) year period (see chart below).

PAK UNITS, POWER SUPPLIES	PARTS STAK PAK II	PARTS DRAG-GUN	PARTS All OTHERS	LABOR
Main Power Magnetics	3 Years	1 Year	2 Years	1 Year
Original Main Power Rectifier	3 Years	1 Year	2 Years	1 Year
Control PC Board	3 Years	1 Year	2 Years	1 Year
All Other Circuits And Components Including, But Not Limited To, Starting Circuit, Contactors, Relays, Solenoids, Pumps, Power Switching Semi-Conductors	1 Year	1 Year	1 Year	1 Year
CONSOLES, CONTROL EQUIPMENT, HEAT EXCHANGES, AND ACCESSORY EQUIPMENT	1 Year		1 Year	1 Year
TORCH AND LEADS				
Maximizer 300 Torch	N/A		1 Year	1 Year
All Other Torches	180 Days	180 Days	180 Days	180 Days
REPAIR/REPLACEMENT PARTS	90 Days	90 Days	90 Days	None

Warranty repairs or replacement claims under this limited warranty must be submitted by an authorized Thermal Dynamics® repair facility within thirty (30) days of the repair. No transportation costs of any kind will be paid under this warranty. Transportation charges to send products to an authorized warranty repair facility shall be the responsibility of the customer. All returned goods shall be at the customer's risk and expense. This warranty supersedes all previous Thermal warranties.

Effective May 19, 1998

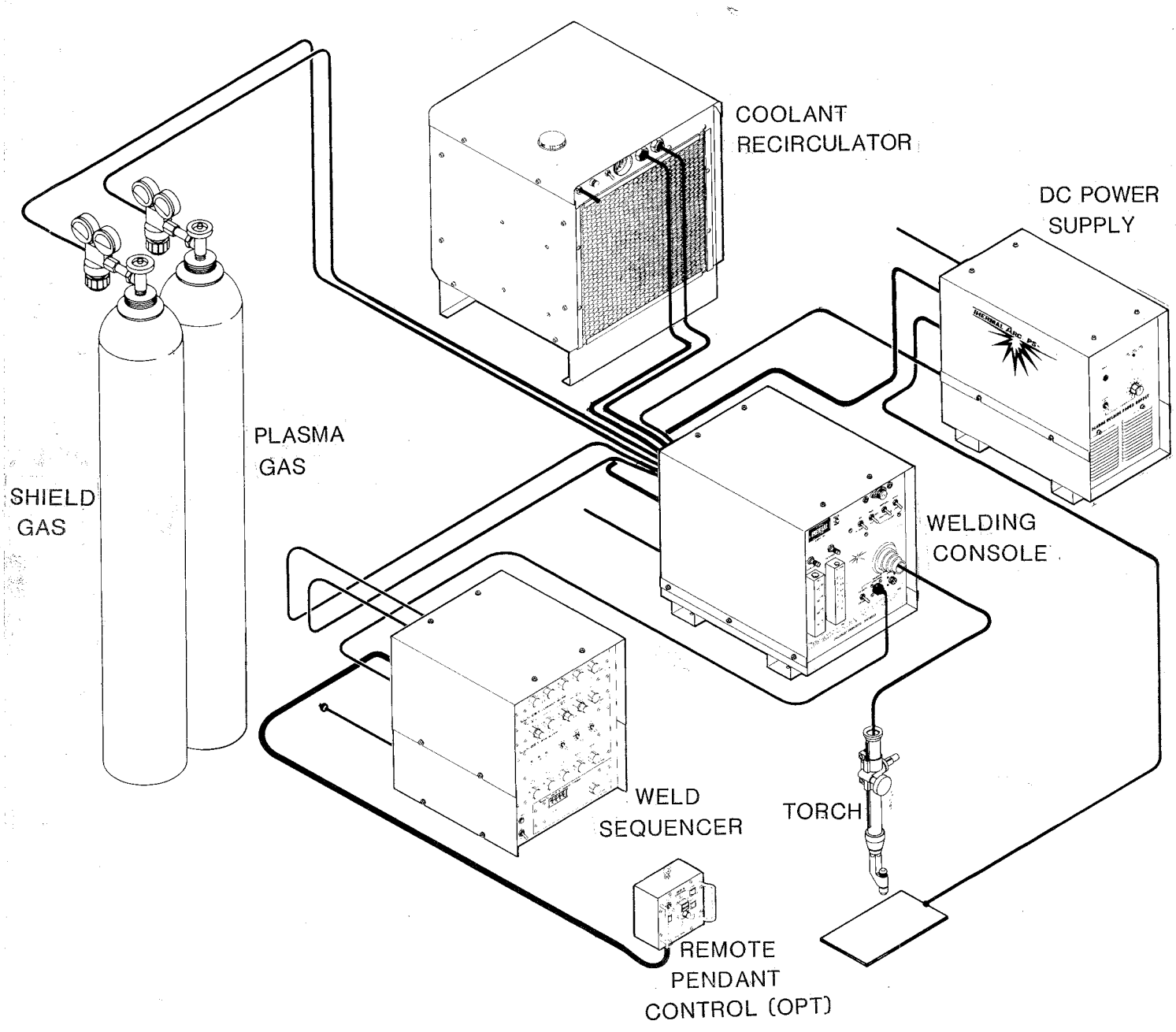


Figure 1-A Plasma Welding System

1.1. DESCRIPTION OF EQUIPMENT

The Thermal Arc PWH/M-4A Plasma Welding Torch is designed to use transferred plasma arc process for direct current (DC) welding of ferrous and non-ferrous metals. It is part of a welding system that includes the control console, DC power source, coolant supply and gas supply (see Figure 1-A).

1.2. SPECIFICATIONS

• Current Rating: (Straight Polarity)	220 amperes DC max.
• Plasma Gas:	Argon (Consumption: 0.5-7.0 SCFH (.24-3.30 lpm)
Shield Gas:	Argon or Argon/Hydrogen (Consumption: 10-20 SCFH (4.72-9.44 lpm)
• Cooling Requirements:	8,000 BTU/hr; 1/2 GPM TDC Torch Coolant @ 50 psi (1.9 lpm @ 3.7 kg/cm^2)
• Shipping Weight:	PWH-4A Hand Torch - 2 lb (.9 kg) PWM-4A Machine Torch - 3 lbs. (1.4 kg)

TORCH DIMENSIONS

Torch Configuration	A Inches (mm)	B Inches (mm)	C Inches (mm)	D Inches (mm)
PWH-4A (70°)	12.50 (318)	3.19 (81)	1.25 (224)	1.31 (33)
PWH-4A (90°)	12.25 (311)	3.19 (81)	1.25 (224)	1.31 (33)
PWM-4A1	21.00 (533)	1.75 (44)	11.25 (286)	1.38 (35)
			19.00 (482)	

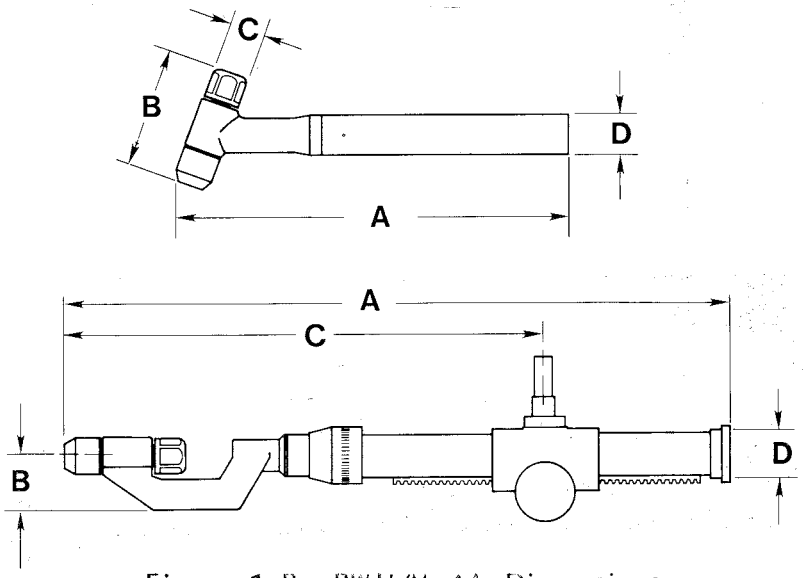


Figure 1-B PWH/M-4A Dimensions

1.3 THERMAL ARC® PLASMA

Plasma is a gas which has been heated to an extremely high temperature and ionized so that the gas becomes electrically conductive. The welding process uses this plasma to transfer an electric arc to the workpiece. The metal to be welded is melted by the heat of the arc.

In a Thermal Arc PWH/M-4A plasma torch, a cool gas such as Argon enters in Zone A, Figure 1-C. In Zone B a pilot arc between the electrode and the front of the torch heats and ionizes the gas. An arc transfers to the workpiece through a column of plasma gas in Zone C.

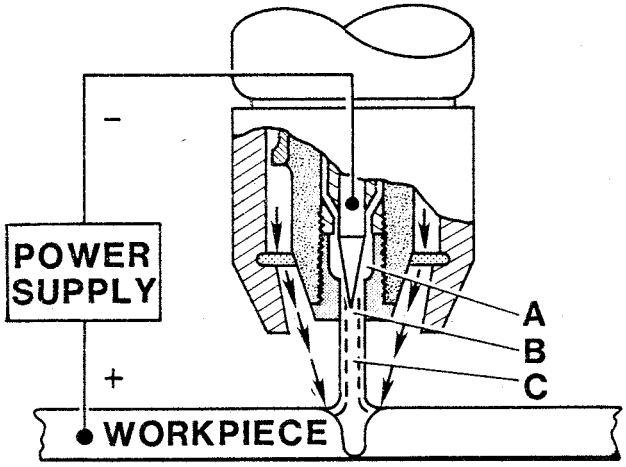


Figure 1-C Thermal Arc Plasma

By forcing the plasma gas and electric arc through a small orifice, Thermal Arc torches deliver a high concentration of heat to a very small area. The stiff, constricted plasma arc is shown in Zone C. Direct current straight polarity is used for plasma welding, as shown in the illustration.

The Dual-Flow design of Thermal Arc welding torches uses a shield gas, shown by the small arrows. The shield gas surrounds the plasma arc and channels it to the workpiece, shielding the weld puddle.

Coolant from the coolant recirculator flows through the liquid cooled power leads to the torch head and back.

The plasma arc is infinitely variable from soft to stiff. Most applications can best be accomplished with a soft arc (lower plasma) gas flow. Full penetration or "keyhole" welding requires a stiff arc (high plasma) gas flow.

1.4 THEORY OF OPERATION

TORCH CONNECTIONS

The plasma gas flows to the torch through the black lead, around the electrode and gas distributor and out through the tip orifice.

The shield gas flows through the yellow torch lead, around front end of the torch and out through the shield cup.

The torch coolant and negative (-) power flow to the torch through the green color coded lead.

The coolant return and positive (+) power for the pilot arc flow through the red color coded lead.

COOLANT

Coolant flows from the coolant recirculator to the welding console, out the negative torch lead to the torch head, and returns through the positive torch lead. If the coolant pressure falls below 20 psi the coolant pressure interlock shuts the system down.

HIGH FREQUENCY

A high voltage, high frequency current is superimposed on the direct current to establish the pilot arc.

PILOT ARC

When the torch is started, a pilot arc is established between the electrode and the welding tip. This pilot arc appears as a small "flame" at the front of the torch, serving to illuminate the workpiece and assisting in starting the main welding arc. It can also be left on while welding at low current levels to stabilize the welding arc.

WELDING ARC

The power supply provides the direct current (DC) for welding. The negative output is connected to the torch electrode through the negative liquid cooled lead. The positive output is connected to the workpiece through the work cable. The electrically charged plasma gas closes the electrical circuit and becomes the welding arc.

2.1. UNPACKING NEW EQUIPMENT

Unpack the torch, checking for possible damage during shipment. Check all items on the packing list.

WARNING

System power must be turned off.

2.2. HAND TORCH INSTALLATION

If torch is not attached to leads, assemble as follows (See Fig. 2-A):

1. Remove the handle (2) from the head assembly (1).

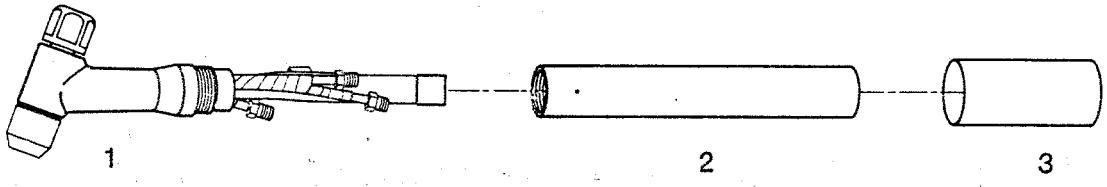


Figure 2-A Hand Torch Assembly

2. Feed the end of the leads with the torch fittings through the shrink tubing (3) and handle and connect to the torch, matching the lead to the torch fitting by color code. Do not overtighten.

3. Screw the handle onto the torch.

4. Slide the shrink tubing about half way on over the handle. With a heat gun shrink the tubing until it is snug on the handle and the leads (Fig. 2-B).

5. Connect the other end of the leads to the appropriate fittings on the plasma welding console.

2.3. MACHINE TORCH INSTALLATION

If torch is not attached to leads, assemble as follows (See Fig. 2-C):

1. Loosen the nut (2) and remove the positioning tube assembly (4).

2. Unscrew the sleeve adaptor (3).

3. Feed the end of the leads with the torch fittings through items 4, 3 and 2. Connect to the torch, matching the lead to the torch fitting by color code. Do not overtighten.

4. Pass the sleeve adaptor through the nut and screw onto the torch.

5. Slide the positioning tube onto the sleeve adaptor and secure with the nut (2).

6. Connect the other end of the leads to the appropriate fittings on the plasma welding console.

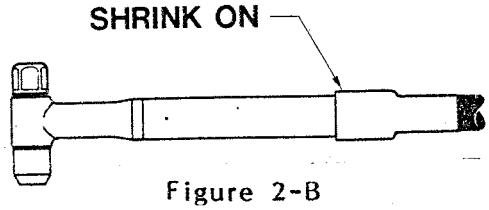


Figure 2-B

Check the instructions for the other components of the welding system to insure they are installed properly.

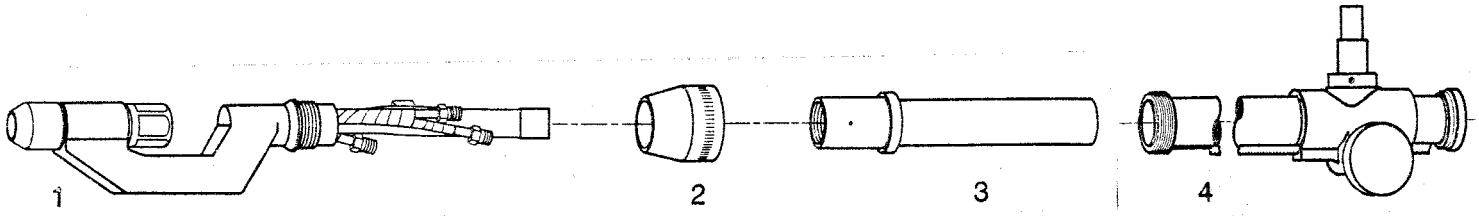


Figure 2-C Machine Torch Installation

3.1. PRE-OPERATION SET-UP

Selection of specific parameters for a given welding application depends on the type of material, the configuration of the joint, and the type of weld desired. Proper settings for a given joint have to be developed on the job.

The graphs in Figures 3-C and 3-D show starting parameters for various material thicknesses with mechanized non-keyhole fusion welds using a soft arc.

A softer, less constricted arc is obtained by decreasing the electrode setback (Figure 3-A). Minimum setback distance is obtained with the electrode point set flush with the face of the tip. This technique of setting the electrode allows the plasma gas flow rate to be decreased while maintaining higher current ratings of the tip. This normally provides a slightly larger weld bead and in most cases allows for increased travel speeds.

The graphs in Figures 3-E and 3-F provide starting parameters for fusion keyhole welds using a stiff columnated arc. With this technique the arc becomes more constricted, requires less current, increases penetration, and in most cases reduces the travel speed. The weld bead becomes smaller in size and base material distortion can be minimized. Typically this technique is used for square butt welds on material thicknesses from .093 to .187 requiring 100% penetration in a single pass.

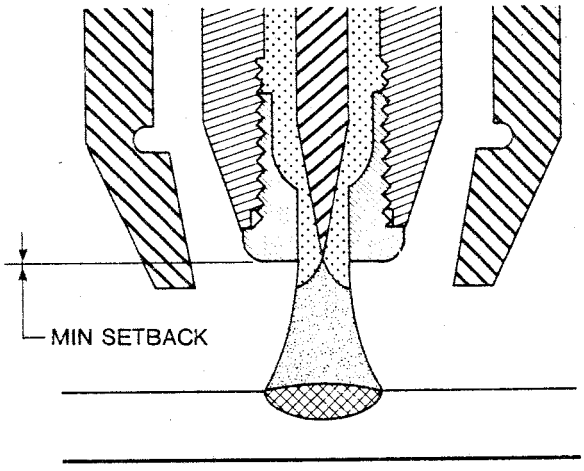


Figure 3-A

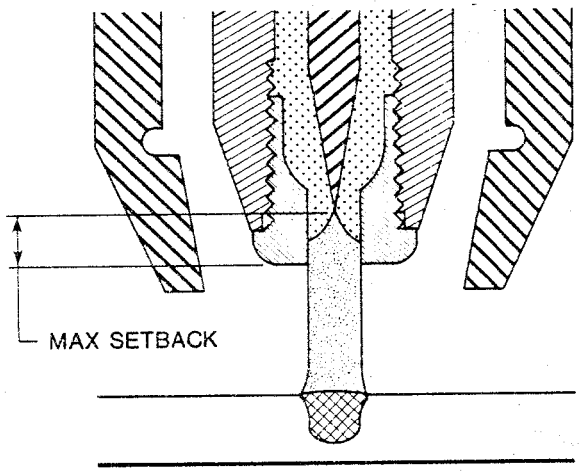


Figure 3-B

This section contains suggested parameters and they may have to be varied to achieve optimum performance.

NOTE: The information in this section represents our best judgement but Thermal Dynamics Corporation assumes no liability for its use. The parameters listed in the following pages may be varied to optimize performance.

Suggested Starting Parameters for Mechanized (Non-Keyhole) Circumferential, Seam, and Spot Fusion Welds

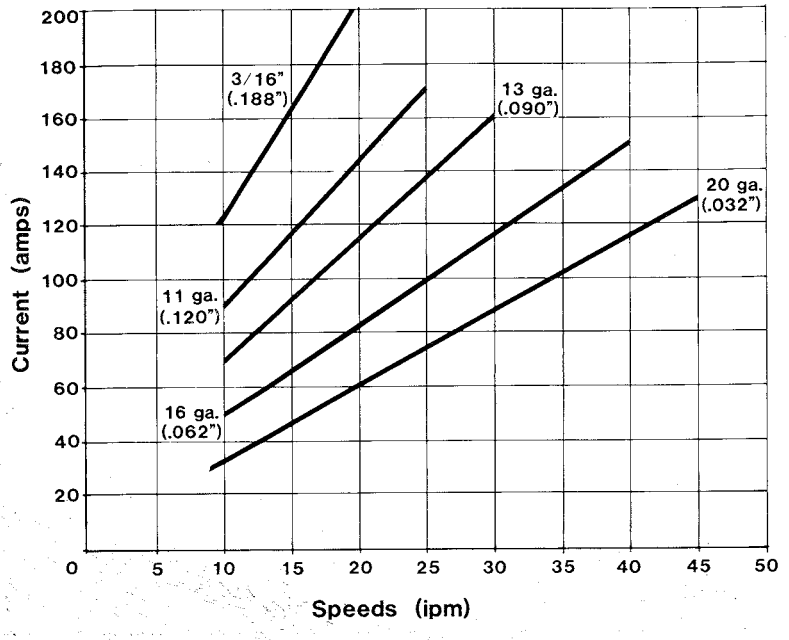


Figure 3-C Current Levels

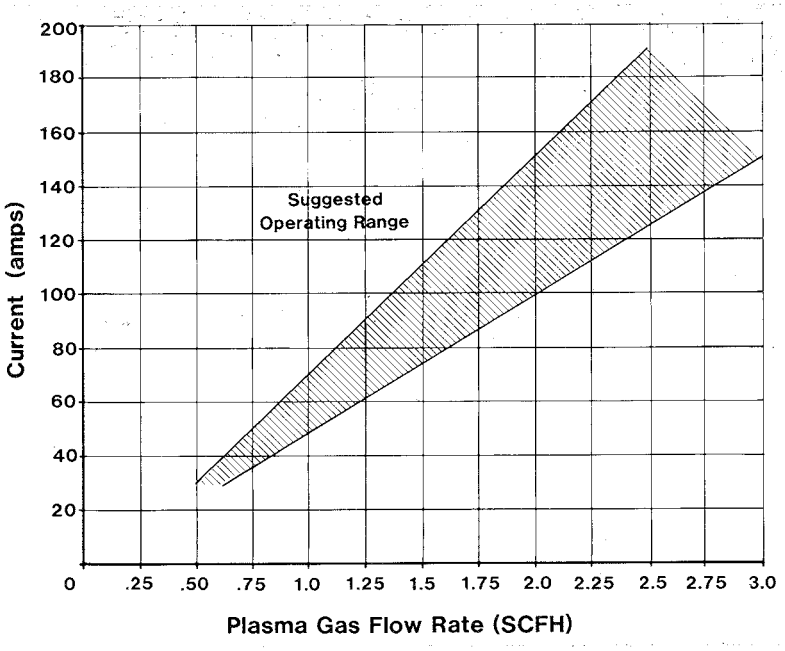


Figure 3-D Plasma Gas Flow Rates

Materials

Stainless Steels
Carbon Steels
Alloy Steels
Nickels

Joint Types

Butts
Corner*
Edge*
Flanged*

Electrode setback at minimum.

Standoff from work at 3/32-5/32".

Use .093 tip up to 125 amps, above 125 amps use .125 tip.

Argon- Plasma Gas
Argon-Hydrogen- Shield Gas (10-20 SCFH)

Most steels require approximately 10-15% higher current at equal travel speed.

* Faster travel speeds may be required for these welds.

See page 10 for gas selection information.

The maximum current rating of each tip is established using maximum electrode setback and maximum plasma gas flow rates. Lower plasma gas flow rates can be used with the maximum current rating of the tip if the electrode setback is set at minimum.

Suggested Starting Parameters for Mechanized Circumferential and Seam Keyhole Welding

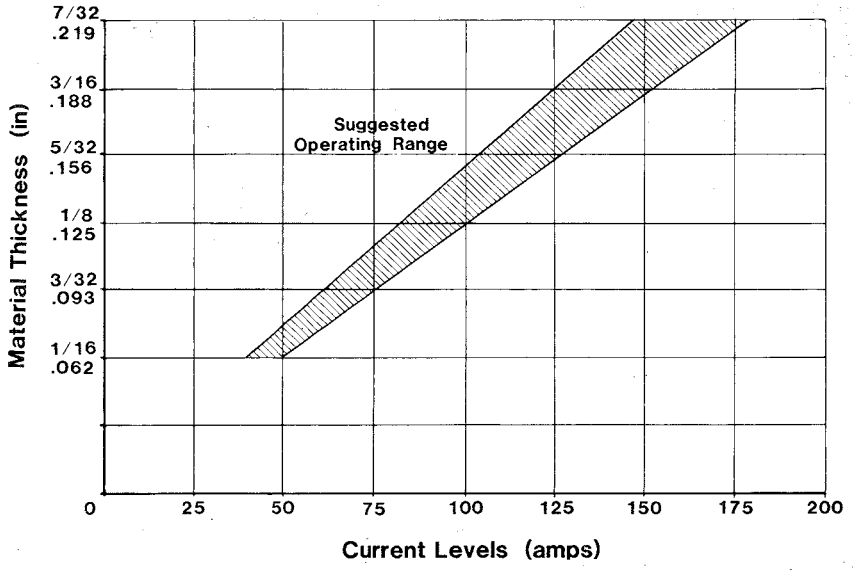


Figure 3-E Current Levels

Materials

Stainless Steels
Carbon Steels
Alloy Steels
Nickels

Joint Types

Square Butt

Electrode setback set at maximum.

Standoff from work set at 1/8-1/4".

Use .062 tip up to 100 amps, use .093 tip up to 180 amps, use .125 tip above 180 amps.

Argon- Plasma Gas
Argon/Hydrogen- Shield Gas (10-20 SCFH) with travel speeds approx. 10-12 ipm.

Most steels require approx. 10-15% higher current at equal travel speeds.

See page 10 for gas selection information

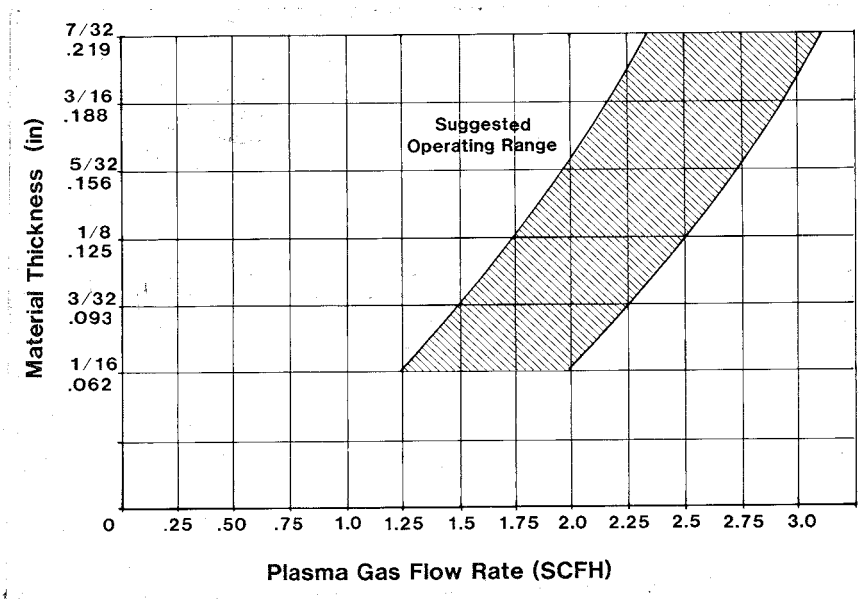


Figure 3-F Plasma Gas Flow Rates

The maximum current rating of each tip is established using maximum electrode setback and maximum plasma gas flow rates. Lower plasma gas flow rates can be used with the maximum current rating of the tip if the electrode setback is set at minimum.

Figure 3-G PWM/H-4A Tip Operating Ranges

Tip	Size	Type	Maximum Current Rating	Electrode Setback Max.	Min.
9-1846	.046	Std.	50	1	3 or Flush
9-1847	.062	Std.	100	1	3 or Flush
9-1848	.093	Std.	180	1	3 or Flush
9-1849	.125	Std.	220	1	3 or Flush
9-1889	.046	Long	75	5	Flush
9-1890	.062	Long	90	5	Flush
9-1891	.093	Long	150	5	Flush
9-1892	.125	Long	180	5	Flush

Maximum current rating of each tip is established using maximum electrode setback at the maximum plasma gas flow rates. Lower plasma gas flow rates can be used with maximum current rating of the tip if electrode setback is set at minimum.

To obtain a stiff columnated arc, insert the electrode gage into the front of the torch and loosen the electrode cap (13) slightly. Push back on the electrode with the gage until the shoulder of the gage seats against the front of the torch. While holding the gage in this position tighten the electrode cap. Insert the proper tip into the liner assembly and tighten moderately.

If a soft arc is desired, insert the proper tip into the liner assembly. Loosen the back cap slightly, allowing the electrode point to protrude through the orifice opening. Use a flat surface (or thumb) to push the electrode back until flush with the tip face. Tighten back cap.

The electrode gage will establish the maximum electrode setback, and a flat surface against the tip face will determine the minimum setback. A setting between these may produce optimum results for some applications. A depth micrometer or pin gage should be used to determine the electrode setting.

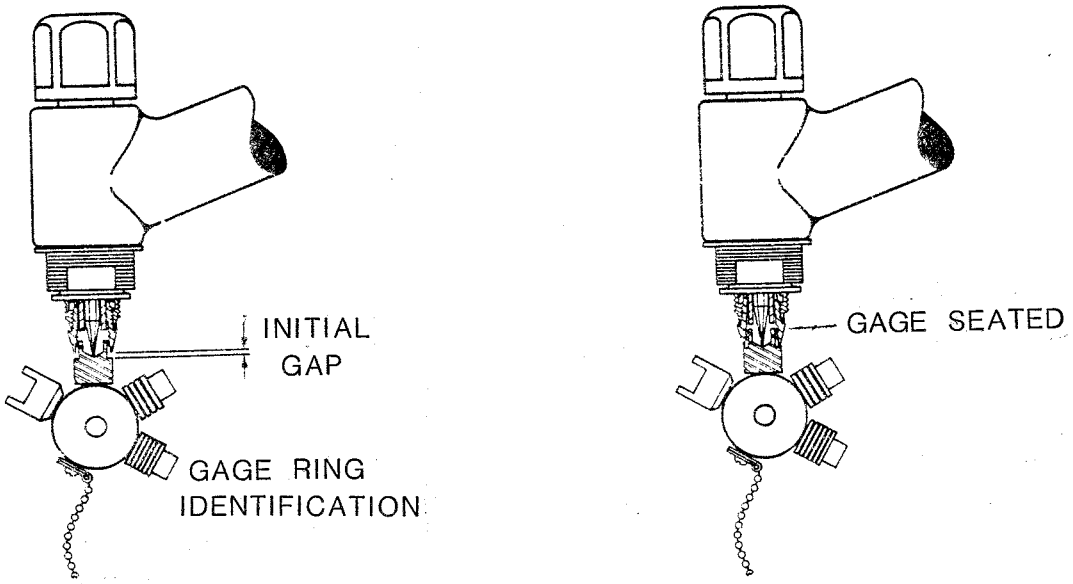


Figure 3-H Electrode Gaging

3.2 GAS SELECTION FOR PLASMA ARC WELDING

PLASMA GAS

ARGON	ARGON/HYDROGEN
. Most commonly used . Reliable starting . Dependable pilot arc . Most stable pilot arc . Effective cleaning action at lower current levels . Uniform high quality welds . Flow rates- See pages 7 and 8	. Provides hotter arc . Better penetration on high alloyed nickels

SHIELD GASES

ARGON	HELIUM
. Can be used on all metals . Good arc stability at low levels . Effective cleaning at low levels . High quality welds on titanium and reactive metals . May not optimize at higher arc voltages . Flow rates of 10-20 SCFH	. Provides hotter arc . Better penetration . Faster speed and equal current levels . Used for aluminum, copper alloys, thicker titanium, and reactive materials . Flow rates 15-40 SCFH
ARGON/HYDROGEN (95%/5%)	**ARGON/HELIUM (25%/75%)**
. Most popular . Higher heat input . More fluid weld puddle . Recommended for stainless steel, machine steel and nickel . Assists in reducing surface tension . Can use up to 15% H_2 . Allows increased travel speeds . Cleaner welds . Not recommended for aluminum, copper alloys, titanium or reactive metals . Flow rates 10-20 SCFH	. Higher heat input . Used where Argon and Helium alone do not optimize . Less than 40% Helium: Characteristics of Argon . Over 75% Helium: Characteristics of Helium . Flow Rates 15-40 SCFH
	ADDITIONAL SHIELDING . Trailing Shield . Chamber

CAUTION

Decreasing the electrode standoff can only be done with tip orifice diameters of .046 and larger.

This procedure should be followed at the beginning of each shift:

WARNING

Check to be sure the main disconnect switch is open.

1. Check the torch to be sure that it has the proper components (see Section 4.1) and is adjusted properly (see Figure 3-G).

2. Close the main disconnect switch supplying power to the welding system.

3. Turn the system on.

4. Set the gas supply pressure regulator at 30 psig. Adjust the gas flow rates as required (see Figure 3-G).

5. Purge the plasma gas line for approximately three minutes by letting the plasma gas run. This will remove any condensation of moisture that may have accumulated in the torch while it was shut down.

6. Select the welding mode.

7. Set the current to the selected amperage level.

The welding torch is now ready for operation.

WARNING

Read and understand the precautions listed in the front of this manual. Be sure the operator is equipped with proper gloves, clothing and eye protection and that proper ventilation is provided.

3.3 HAND TORCH OPERATION

1. Set the welding system to the operating mode.

CAUTION

The pilot arc is established in the torch at this time. Keep the torch tip pointed in a safe direction.

2. Lower the welding helmet and position the torch at the beginning of the weld zone. The light from the pilot arc will help to find this position. Hold the torch approximately 3/16" from the workpiece and activate the control switch. When the welding arc transfers, adjust the torch standoff and amperage until the desired penetration is achieved. Follow the line of the weld, controlling the speed to create the weld puddle and achieve the desired weld quality.

3. Deactivate the control switch.

4. Switch the welding system to the standby mode (post purge).

5. Allow torch to cool 5 minutes before shutting the system down.

3.4 MACHINE TORCH OPERATION

1. Locate the torch at the required starting position for the weld. Adjust the height as required.

2. Activate control switch.

3. The rate of travel depends on the material and type of weld, as determined by the operator.

4. After the weld is completed, deactivate the control switch.

5. Put the welding system in the standby mode (post purge).

6. Allow torch to cool five minutes before shutting the system down.

The Service Section is divided into four sections:

4.1. Torch Maintenance
4.2. Torch Leads
4.3. Troubleshooting Guide
4.4. Test Procedures

4.1. TORCH MAINTENANCE

WARNING

Check to be sure the main disconnect to the welding system is open before disassembling the torch.

Torch Disassembly and Inspection

CAUTION

The electrode cap and liner have an O-ring seal to prevent gas leakage. It is important to observe the following precautions for the O-ring:

1. Make sure that the groove and the surface that the O-ring seals against are clean and free of nicks and scratches.

2. Check to see that the O-ring is not cut or cracked.

3. Lubricate O-ring with a light coating of Cat. No. 8-4025 O-ring lubricant. Use enough to make the O-ring slippery, but not enough to accumulate in the torch.

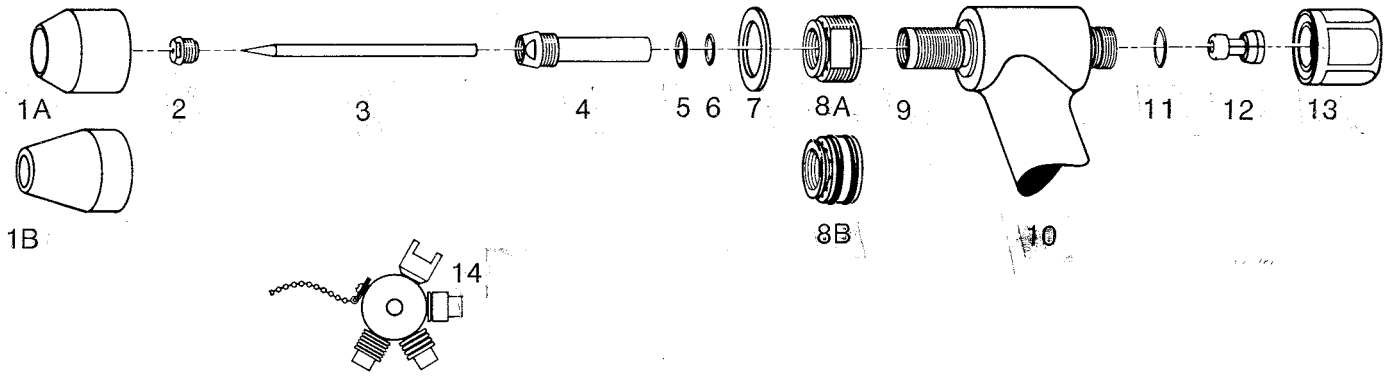
Disassemble the torch as follows:

1. Unscrew ceramic shield cup (1).

2. Using the tip wrench (14), unscrew the tip (2).

3. Unscrew the electrode cap (13).

4. To remove the collet (12), push the electrode (3) back into the torch slightly. This pushes the collet out the back of the torch (See Fig. 4-B).



1a. Standard Shield Cup
1b. Push-on Shield Cup
2. Tip
3. Electrode
4. Liner/Gas Distributor
5. O-ring- red
6. O-ring- black
7. Gasket (Shield Cup)
8a. Shield Gas Diffuser
8b. Shield Gas Diffuser (Push-on Shield Cup)
9. Collar
10. Basic Head Assembly
11. O-ring
12. Collet
13. Electrode Cap
14. Wrench & Gage Assembly

Figure 4-A Torch Parts Explosion

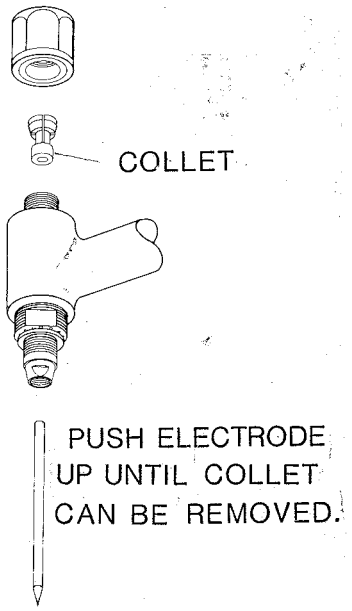


Figure 4-B Electrode & Collet Removal

5. Remove the electrode (3) from the front of the torch.

NOTE:

It is not necessary to further disassemble the torch for normal parts change. Check the tip (2) and electrode (3). If the tip of the orifice is out of round or appreciably deformed, the tip should be replaced. The electrode should be resharpened if there is a flat larger than 1/4 of the diameter of the electrode on the end. The point is 10° (20° included angle) and must be concentric with the outside diameter of the electrode.

To completely diassemble the torch:

6. Remove the liner/gas distributor (4) using 7/16" open end wrench.

7. Remove the red O-ring (Fig. 4-C) from inside the front of the torch using the hook end of the O-ring removal tool.

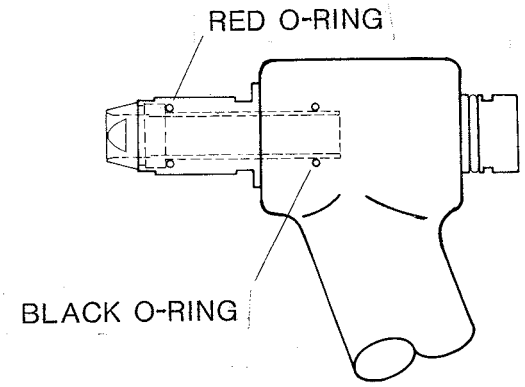


Figure 4-C O-Ring Locations

8. Remove the black O-ring (Fig. 4-A) from further inside the torch by spearing it with the point of the O-ring removal tool and dislodging from the groove. Remove from the torch using the hooked end of the O-ring removal tool.

NOTE:

To get the point of the O-ring removal tool into position, slide the point down the inside of the torch from the front end. To miss other slots in the torch, hold the tool against the side of the torch (See Fig. 4-D).

9. The collar (9) can be forced off by unscrewing the shield gas diffuser (8).

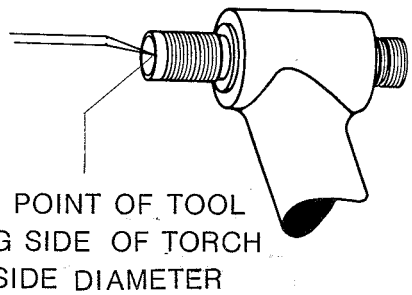


Figure 4-D O-ring Removal

TORCH ASSEMBLY

WARNING

Primary power to the welding system must be disconnected before assembling the torch.

If only partial disassembly (steps 1-5) was performed, begin at step 7.

CAUTION

Lubricate all O-rings as described in Step 3, page 13.

1. Install the black O-ring (6, Fig 4-A) into the torch (Fig. 4-C) using the O-ring installation tool. Put the O-ring over the pointed end of the center section of the tool and slide it inside of the sleeve section as shown in Fig 4-E.

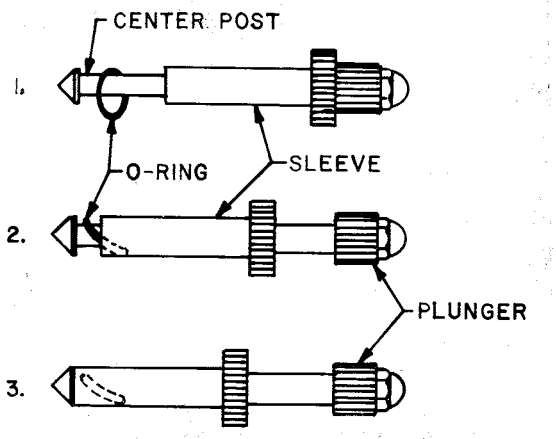


Figure 4-E O-ring Installation Tool

Pull the center section of the tool back until the pointed part is against the front of the sleeve section.

While holding the center section of the tool back, carefully insert the sleeve section of the tool into the torch until the shoulder of the sleeve section comes up against the front of the torch.

Holding the shoulder of the sleeve section against the front of the torch, push the plunger of the tool against the O-ring. The plunger should be tapped and turned against the O-ring until the shoulder of the plunger contacts the rear shoulder of the sleeve section spring back.

Remove the tool from the torch. If the center section of the tool does not come out easily, the O-ring has not seated. A few extra taps with the plunger should seat the O-ring.

2. Install red O-ring (5) in the front of the torch (Fig. 4-C).

3. Install the shield gas diffuser (8 or 8a) onto the front end of the torch as shown in Fig. 4-A.

4. Push collar (9) onto front end of torch.

5. Install liner/gas distributor (4) into front end of torch. Tighten liner with moderate pressure, about 35 inch pounds. Do not overtighten.

6. Assemble gasket (7) over the shield gas diffuser (8) and tighten up against the torch body.

7. Insert the collet (12) into the back of the torch. Hold in place with finger.

8. Insert electrode (3) into front end of torch and into collet. The point of the electrode should be left far enough out of the torch so that the electrode gauge will contact the electrode before the shoulder of the gauge contacts the front of the torch (See Fig. 4-F).

9. Tighten the electrode cap (13) firmly into place.

10. If a stiff columnated arc is desired, insert the electrode gage into the front of the torch and loosen the electrode cap (13) slightly. Push back on the electrode with the gage until the shoulder of the gage seats against the front of the torch. Tighten the electrode cap while holding the gage in this position. Insert the proper tip into the liner assembly and tighten moderately. See page 10 for gage settings.

11. If a soft arc is desired, insert the proper tip into the liner assembly. Loosen the back cap slightly, allowing the electrode point to protrude through the orifice opening. Using a flat surface (or thumb) push the electrode back until it is flush with the tip face. Tighten the back cap.

The electrode gage establishes maximum electrode setback, and a flat surface against the tip face determines minimum setback. Setting between these may produce optimum results for some applications. Use a depth micrometer or pin gage to determine the electrode setting.

12. Install shield cup (1) onto shield gas diffuser (8) until seated against gasket (7).

Check the assembled torch tip and orifice for signs of moisture or possible leakage before operating. Turn on the torch coolant recirculator and turn the plasma gas to "SET" position, watching the gas stream for moisture. Do not attempt to operate the torch until the source of the moisture has been identified and corrected (page 21). Purge torch and system for 3-5 minutes prior to operation.

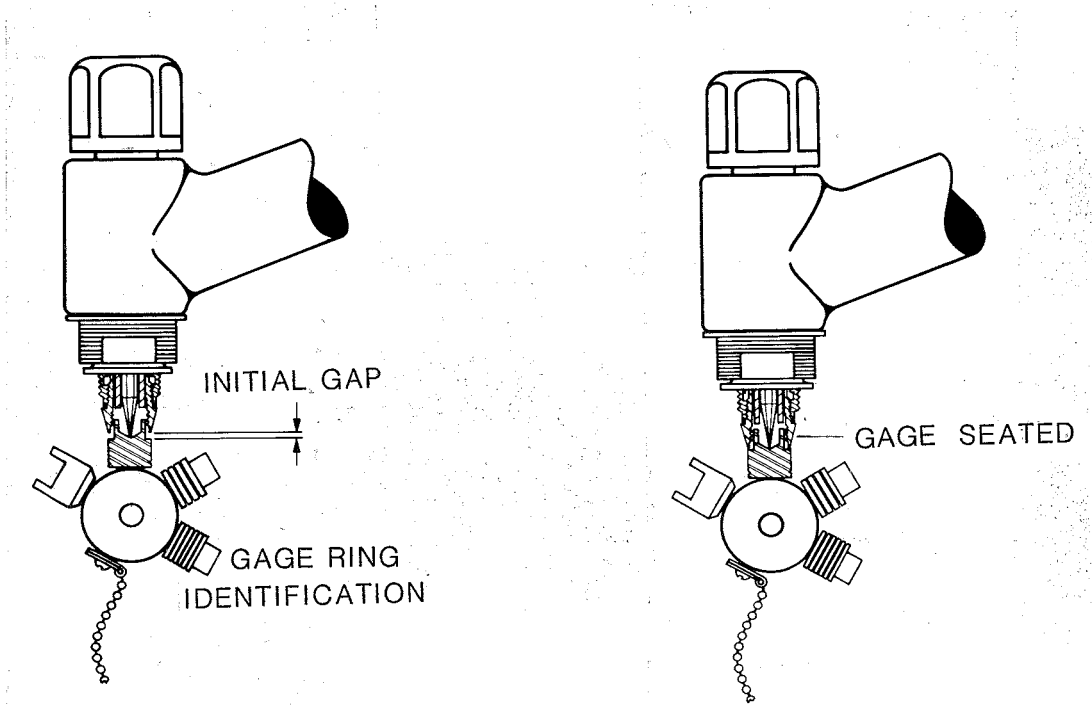


Figure 4-F Electrode Gaging

4.2. TORCH LEADS REPLACEMENT

Hand Torch

1. Cut off the shrink-on tubing from the end of the handle and leads sleeving.
2. Unscrew the handle from the torch.
3. Disconnect the four hoses from the torch.
4. Remove the handle from the old leads and insert on new leads.
5. Connect the new leads to the torch, making sure the leads match with the color coded torch fittings. Do not overtighten.
6. Screw the handle back onto the torch.
7. Slide the new shrink-on tubing halfway on over the handle. Shrink the tubing with heat (not flame) until it is firm around the handle and sleeving.

Machine Mounted Torch

1. Unscrew the nut holding the positioning tube to the torch assembly. Slide the positioning tube back away from the torch.
2. Unscrew the sleeve adaptor from the torch. Slide up the leads until the torch fittings are accessible.
3. Disconnect the four hoses from the torch.
4. Remove the nut, sleeve adaptor and positioning tube from the old leads and install on the new leads at the torch end in the same order.
5. Connect the new leads to the torch, making sure the leads match with the color coded torch fittings. Do not overtighten.
6. Screw the sleeve adaptor back onto the torch.
7. Slide the positioning tube over the sleeve adaptor and secure with the nut.

Torch Leads Repair

WARNING

System power must be turned off.

To repair the console end of the leads, disconnect at the console. To repair the torch end, disconnect according to the type of torch (see preceding section) and proceed as follows:

Positive and Negative Leads (Torch End)

1. To replace fittings at the torch end, cut the hose (only) just behind the ferrule. Grip the fitting and slide the hose back 4 to 6 inches. Clamp the wire lead at the hose end to prevent the hose from sliding back down over the fitting. Cut the old fitting off where the wire lead goes in.
2. Slide the new ferrule onto the wire lead.
3. Insert the wire lead into the small end of the new fitting up to but not beyond the stop.
4. Crimp wire lead in place with a 18-22 AWG crimping tool. Crimp the length of the solid diameter from the slot to the end.

5. To insure proper coolant flow, crimp the wire stop in the slot out of the way.

6. Remove the clamp from the wire lead and push the hose over the glands onto the fitting.

7. Slide the ferrule onto the hose and fitting until it rests over the glands. Crimp with a 3/8" diameter crimping die (Scovill No. 44 or equivalent).

Positive and Negative Leads (Console End)

1. To replace the fittings on the console end, cut the hose (only) just behind ferrule. Grip fitting and slide hose back 4-6 inches. Clamp the wire lead at the end of the hose to prevent the hose from sliding back down over fitting. Cut the old fitting off where the wire lead goes in.

2. Slide the new ferrule onto the wire lead, followed by the nut.

3. Insert the wire lead into the small end of the new fitting up to but not beyond the stop.

4. Crimp wire lead into place with a 10-12 AWG crimping tool. Crimp the entire length of solid diameter from the slot to the end.

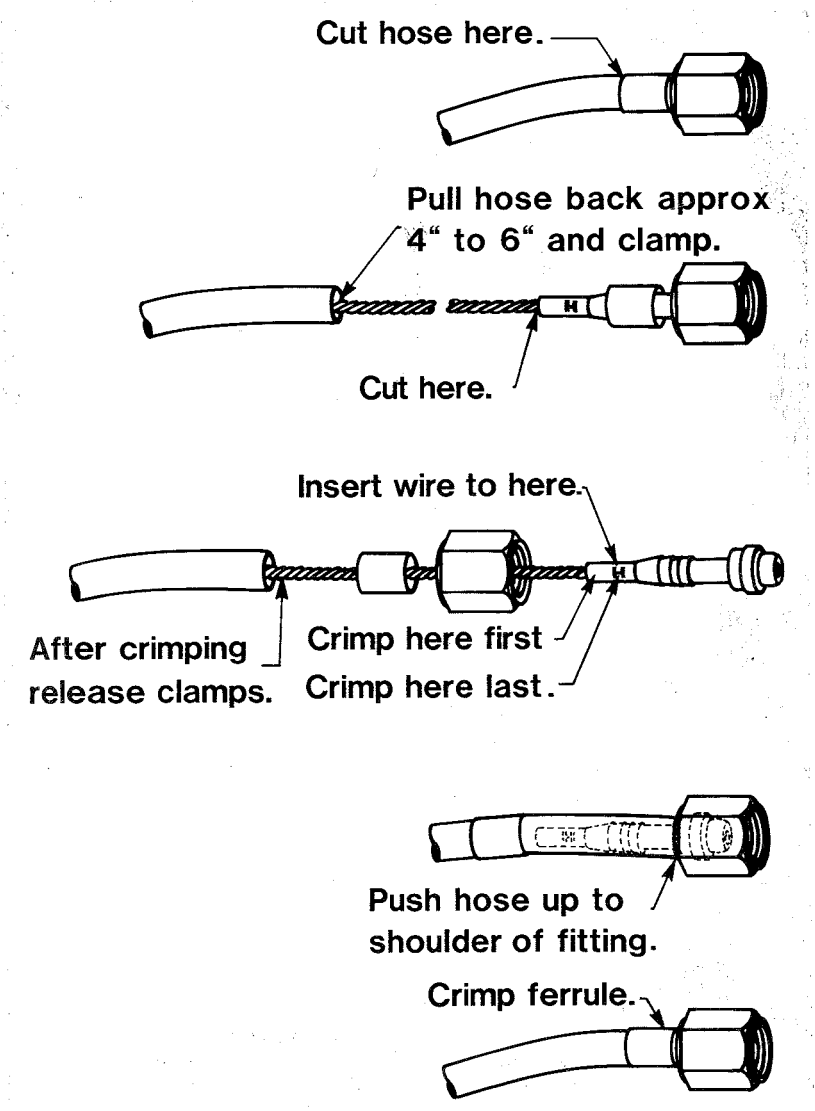


Figure 4-G Leads Fitting Replacement

5. Use the crimping tool to crimp the wire stop in the slot out of the way. This is necessary to insure proper coolant flow.

6. Slide the nut onto the fitting.

7. Remove the clamp from the wire lead and push the hose over the glands, onto the fitting.

8. Slide the ferrule onto the hose and fitting until it rests over the glands. Crimp with a 7/16" diameter crimping die (Scovill No. 42 or equivalent).

Gas Hoses (Torch End)

1. Cut the gas hose just behind the ferrule.

2. Assemble the nut (threaded end first) over the fitting.

3. Slide the new ferrule over the hose and slide the hose onto the fitting until it is approximately 1/4" past the last gland on the fitting.

4. Slide the ferrule over the hose and fitting until it rests over the glands. Crimp in place using a 1/4" diameter crimping die (Scovill No. 47 or equivalent).

Gas Hoses (Console End)

1. Repeat Steps 1-3 of the torch end procedure.

2. Slide the ferrule over the hose and fitting until it rests over the glands. Crimp in place using a 5/16" diameter crimping die (Scovill No. 46 or equivalent).

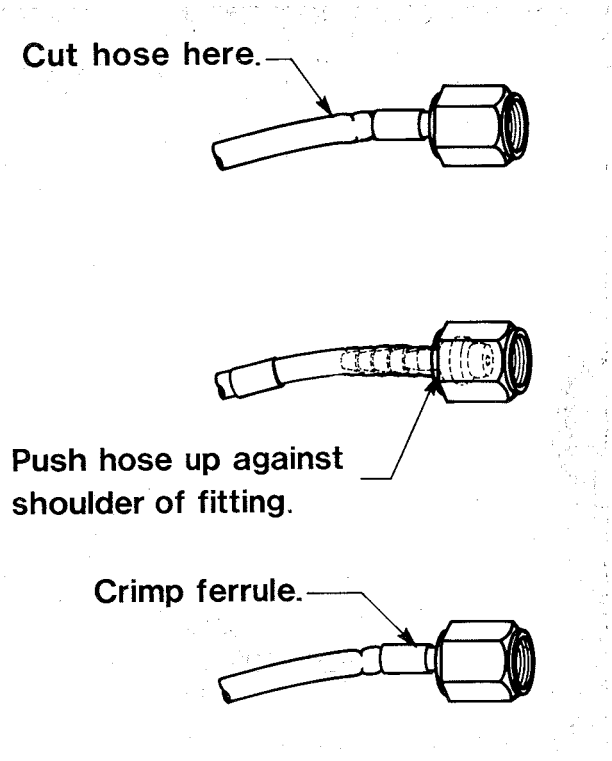


Figure 4-H Gas Fitting Replacement

4.3. TROUBLESHOOTING GUIDE

This guide lists the most common problems encountered with the PWH/M-4A plasma welding torch. The TROUBLE column is listed in the sequence of operation of the torch. The POSSIBLE CAUSE and REMEDY columns are listed beginning with the easiest to check and progressing to the more difficut to check. Most problems related to the torch can be corrected within this section.

TROUBLE	POSSIBLE CAUSE	REMEDY
A. Erratic or poor appearing pilot arc	1. Worn torch parts	1. Check and replace with new parts
	2. Improper electrode setting	2. Adjust electrode setting (See p.9)
	3. Contaminated plasma gas	3. Check (see A, p.21)
	4. Moisture in torch or leads	4. Check (see B, p.21)
	5. Contaminated coolant	5. Check (See C, p.21)
B. Welding arc will not transfer	1. Torch standoff too high	1. Reduce standoff (approx. 3/32-3/16" standoff for most applications)
	2. Power supply not properly connected	2. Check work lead, negative lead and contactor control cable
	3. Faulty electrode in torch	3. Check for sharp point and clean appearance of electrode
C. Welding tip damaged on start up	1. Improper installation of torch parts	1. Check (see p. 12)
	2. Improper electrode setback	2. Check (see p.9)
	3. Incorrect polarity	3. Check negative and positive leads for proper connection; check power supply range switch (see D, page 21)
	4. Plasma gas flow rate too low	4. Increase flow rate
	5. Excessive current level	5. Reduce current or use larger orificed tip
	6. Inadequate coolant flow	6. Check (see E, p.21)
	7. Contaminated gas	7. Check torch and system (see A, p.21)
	8. Moisture in torch	8. Check torch O-rings for coolant leaks; check gas hoses

(see B, page 21)

TROUBLE	POSSIBLE CAUSE	REMEDY
	9. Contaminated coolant	9. Check coolant (See C, p.21)
	10. Tip touching workpiece	10. Increase standoff
D. Tip damaged after a period of welding	1. Inadequate coolant flow	1. Check (see E, p.21)
	2. Excessive current level	2. Reduce current or use larger orifice tip
	3. Plasma gas flow rate too low	3. Increase flow rate of plasma gas
	4. Moisture in torch leads	4. Check torch O-rings for leaks; check gas hoses
E. Not getting required penetration	1. Plasma gas flow too low	1. Increase gas flow
	2. Current too low	2. Increase current
	3. Electrode setback at minimum	3. Increase electrode setback
	4. Travel speed too high	4. Decrease travel speed
F. Porosity in welds	1. Contaminates on material	1. Clean material
	2. Plasma gas flow rate too high	2. Reduce (if plasma gas flow is too high but 100% penetration is not occuring, gas porosity may appear)
	3. Inadequate shield gas coverage	3. Increase flow rate or use additional "trailer" shield to provide adequate gas shielding
G. Slight undercutting (in toe area of weld)	1. Travel speed too high	1. Reduce travel speed
	2. Plasma gas flow too high	2. Reduce flow rate (see p. 7 or 8)
	3. Tip orifice size too small	3. Use larger orificed tip
	4. Electrode set at max setback	4. Reduce setback (see page 9)
	5. Current level too low	5. Increase current level

4.4 SERVICE TEST PROCEDURES

The following tests correspond with the torch section of the trouble-shooting guide.

A. Contaminated plasma gas normally causes a bluing tint toward the front of the electrode. Check the plasma gas line for leaks by plugging the tip and letting gas flow with the console in "SET" position. Check the plasma gas line using a soap and water solution on each connection. Appearance of bubbles signifies a leak at the connection.

B. Moisture in the plasma gas may cause a black sooty material to appear on the electrode or in the tip. **Use of rubber hoses may be a cause of moisture entrapment.** For best results use Synflex tubing.

   To remove moisture from the torch, plug the tip and let gas pressure build before releasing. It may be necessary to repeat the procedure three or four times to remove contaminants.

C. Contaminated coolant gas can be caused by not using or maintaining proper coolant. Check the resistivity level of the coolant with a PT-25 water tester.

D. Reverse polarity operation causes excessive electrode deterioration which may cause formation of a large ball on the electrode tip.

E. Coolant flow for the PWH/M-4A torch is 1/2 gal/min @ 50 PSI. Inadequate coolant flow can cause excessive damage to the tip and liner. Check the "return" flow rate against the 1/2 GPM coolant requirement. If coolant flow is inadequate check the filter in the coolant recirculator. See instruction manual for that unit.

5.1 GENERAL ARRANGEMENT

The Parts List consists of illustrated parts lists of the following:

Fig. 5-1 4A Series Welding Torch
Fig. 5-2 PWH/M-4A Torch Assembly
Fig. 5-3 4A Torch Leads Assembly

An item number in parentheses indicates the item is located behind the item pointed to. An asterisk beside the item number indicates the part is a main assembly, not a component. Parts listed without item numbers are not illustrated, but may be ordered by the catalog number shown.

ORDERING INFORMATION

When ordering replacement parts, order by catalog number and complete description of the part or assembly, as given in the description column of the Parts List. Address all inquiries to your authorized Thermal Dynamics distributor.

RETURNS

In the event that a Thermal Dynamics' product must be returned for service, contact your Thermal Arc distributor. Material returned to Thermal Dynamics without proper authorization will not be accepted.

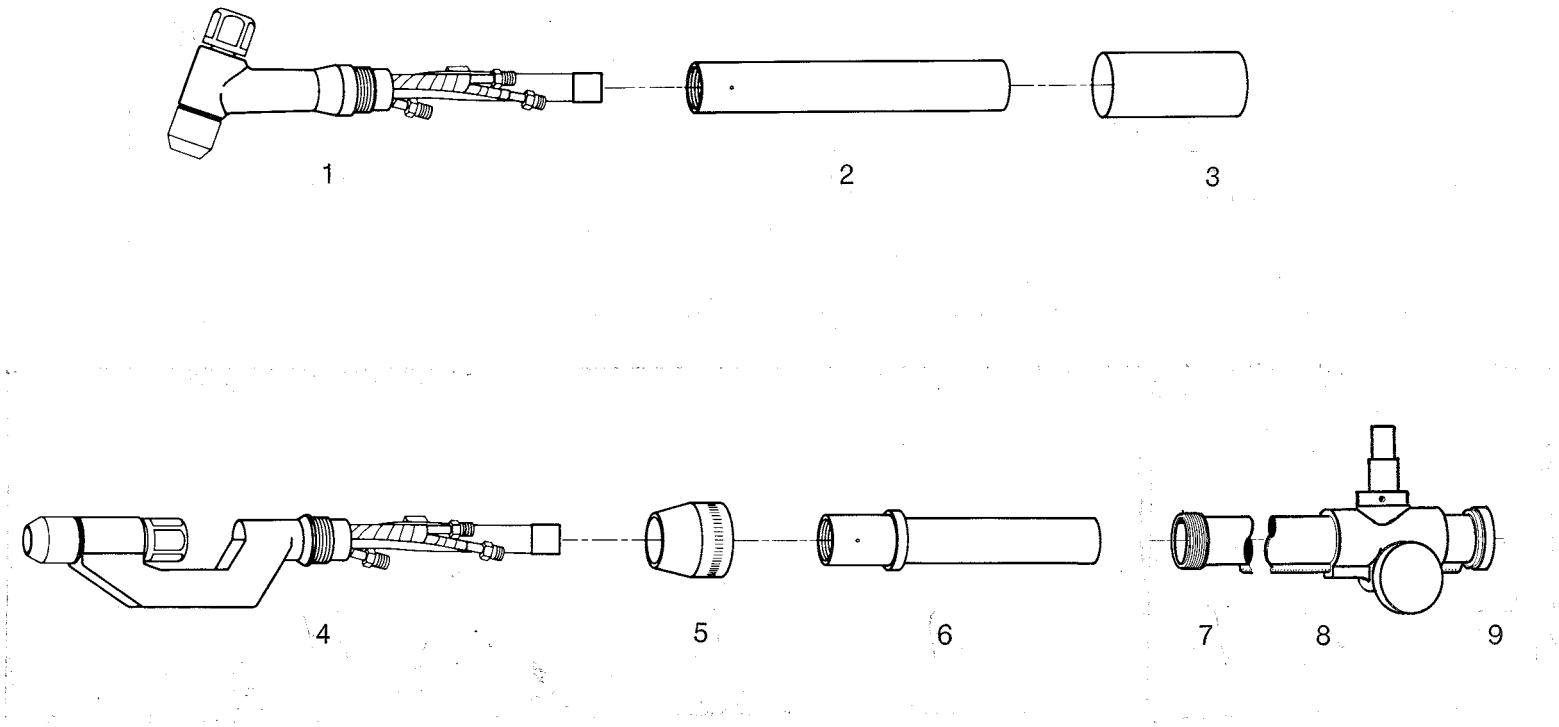


Figure 5-1 PWH/M-4A Welding Torch

Fig.	Item No.	Qty.	Catalog Number	Description
5-1	1	1	8-4014	PWH-4A 70° Torch Head (w/o parts)
5-1	1	1	8-4015	PWH-4A 90° Torch Head (w/o parts)
5-1	2	1	9-1824	Handle
5-1	3	1	8-1205	Shrink-on Tubing
5-1	4	1	8-4054	PWM-4A Machine Torch Head (w/o parts)
5-1	5	1	8-4018	Nut
5-1	6	1	9-1901	Sleeve Adaptor
5-1	7	1	8-5005	Positioning Tube
5-1	8	1	7-2827	Pinion Assembly
5-1	9	1	8-4204	Bushing

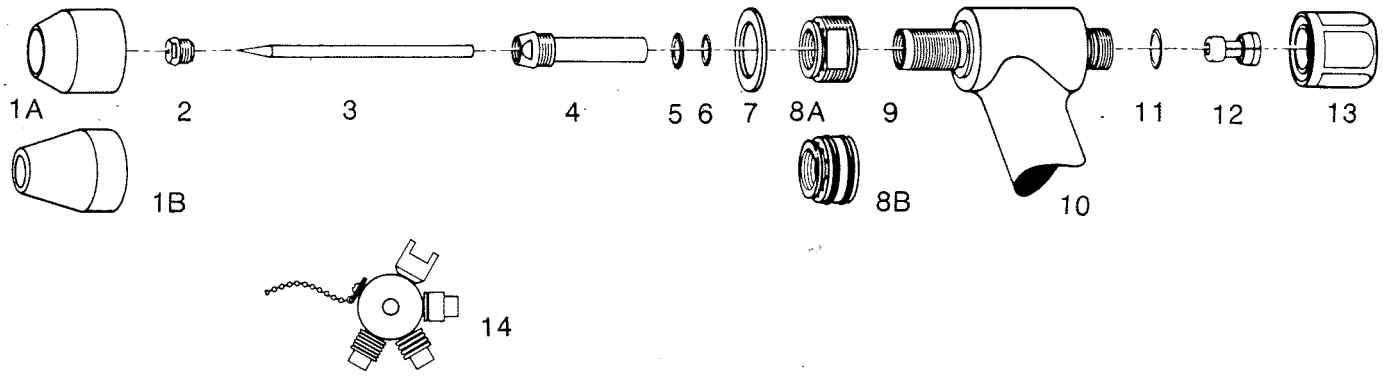


Figure 5-2 4A Torch Explosion

Fig.	Item No.	Qty.	Catalog Number	Description
5-2	1A	1	8-4064	Shield Cup- Standard
5-2	1B	1	8-4088	Push-On Shield Cup
5-2	2	1		Tip (Packaged in Lots of 10)
	Standard:		9-1846	Tip - .046, 50 amp
			9-1847	Tip - .062, 100 amp
			9-1848	Tip - .093, 180 amp
			9-1849	Tip - .125, 220 amp
	Long:		9-1890	Tip - .062, 90 amp
			9-1891	Tip - .093, 150 amp
			9-1892	Tip - .125, 180 amp
5-2	3	1	9-1827	Electrode
5-2		1	9-1834	Electrode-Extended
5-2	4	1	8-4012	Liner/Gas Distributor
5-2	5	1	8-0560	O-Ring-Red (incl. with Item 4)
5-2	6	1	8-0560	O-Ring-Black (incl. with Item 4)
5-2	7	1	8-4069	Gasket-Shield Cup
5-2	8A	1	8-4040	Shield Gas Diffuser- Standard
5-2	8B	1	8-4087	Shield Gas Diffuser- (for Push-On Shield Cup)
5-2	9	1	8-4024	Collar
5-2	10			Torch Head Assembly
			8-4014	PWH-4A 70° Torch Head (w/o parts)
			8-4015	PWH-4A 90° Torch Head (w/o parts)
			8-4054	PWM-4A Machine Torch Head (w/o parts)
5-2	11	1	8-0530	O-Ring-Electrode Cap
5-2	12	1	9-1876	Collet
5-2	13	1	8-4158	Electrode Cap-Standard
5-2		1	9-1877	Electrode Cap-Extended
5-2	14	1	9-1873	Gauge and Wrench Assembly

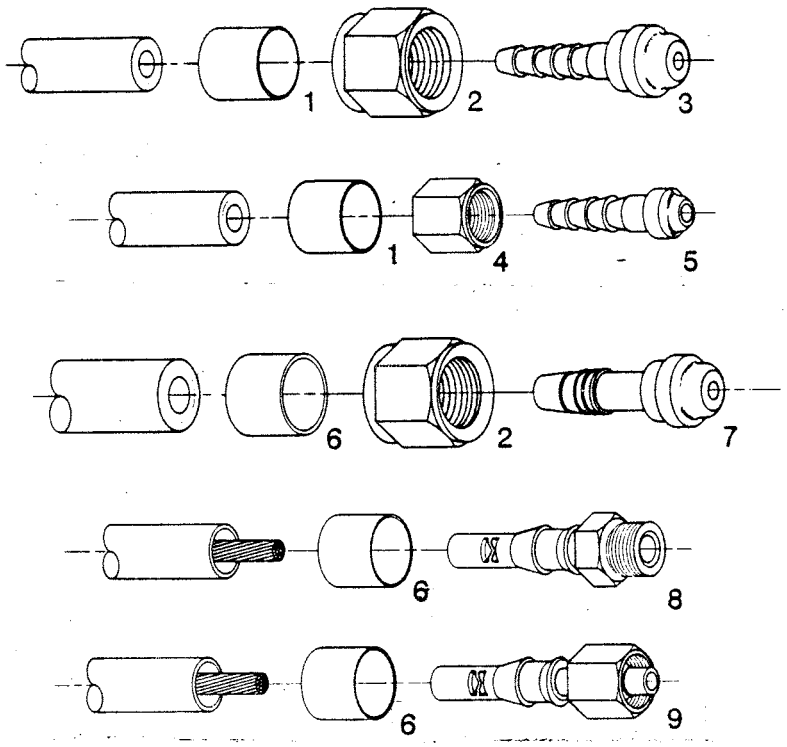


Figure 5-3 4A Torch Leads and Hose Fittings

Fig.	Item No.	Qty.	Catalog Number	Description
5-3		1	4-2525	4A Torch Leads - 12.5 ft.
5-3		1	4-2544	4A Torch Leads - 25 ft.
5-3		1	9-2079	Negative Torch Lead - 12.5 ft.
5-3		1	8-1398	Negative Torch Lead - 25 ft.
5-3		1	9-2081	Positive Torch Lead - 12.5 ft.
5-3		1	8-1399	Positive Torch Lead - 25 ft.
5-3		1	8-0142	Plasma Gas Hose - 12.5 ft.
5-3		1	8-1505	Plasma Gas Hose - 25 ft.
5-3		1	9-3086	Shield Gas Hose - 12.5 ft.
5-3		1	9-3088	Shield Gas Hose - 25 ft.
5-3		1	8-3138	Torch Leads Sleeving - 12.5 ft.
5-3		1	8-3139	Torch Leads Sleeving - 25 ft.
5-3		1	8-1204	Shrink-on Tubing (Console End)
5-3		1	8-1205	Shrink-on Tubing (Torch End)
5-3	1	1	8-5012	Ferrule - Console End
5-3	2	1	8-5015	Nut - Console End (+ & -)
5-3	3	1	8-0328	Fitting, Console End
5-3	4	1	8-0339	Nut, Torch End
5-3	5	1	8-0338	Fitting, Torch End
5-3	6	1	8-5013	Ferrule - Console End
5-3	7	1	8-5010	Fitting - Console End (+ & -)
5-3	8	1	8-5008	Fitting - Torch End (+)
5-3	9	1	8-5009	Fitting - Torch End (-)