AMI

ARC MACHINES, INC.

M96 WELD HEAD

OPERATION MANUAL

MODEL 96
TUBE TO TUBESHEET WELD HEAD
OPERATION MANUAL

NOTICE

The information in this document has been carefully reviewed and is believed to be accurate.

Information and instructions in this document are subject to change and Arc Machines, Inc. reserves the right to change specifications and data without notice.

 **WARNING** 

The nature of the GTAW process creates some POTENTIAL HAZARDS. In accordance with international safety regulations the EXCLAMATION SYMBOL indicates that this equipment is considered HAZARDOUS until an operator has been made aware of these POTENTIAL HAZARDS by reading the appropriate Arc Machines, Inc. Power Supply and/or Weld Head Operation Manual. The LIGHTNING FLASH SYMBOL indicates that there are potential electrical hazards. The use and display of these symbols make it the OPERATOR'S RESPONSIBILITY TO INSURE THAT HE HAS READ AND/OR BEEN MADE AWARE OF ALL OF THE SAFETY-RELATED ITEMS CONTAINED IN THESE MANUALS.

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1.0 INTRODUCTION

The Model 96 Weld Head is designed for Tube to Tubesheet fusion welding, using the GTAW process. Tubes can be flush, slightly projected above, or recessed below the tubesheet. It is designed to accommodate tube sizes from 0.37 (9.4mm) I.D. to 2.12" (53.8mm) O.D., and works in conjunction with all Arc Machines power supplies. The (optional) cooling unit (available with all AMI fusion Power Supplies) is required for use with the Model 96 weld head.

A pneumatically operated expanding mandrel (integral to the weld head) is used to hold it firmly in position, and concentric to the weld joint. Each mandrel will accommodate a specific tube I.D. size range. A fixed electrode maintains a constant electrode to work (arc gap) distance as it rotates around the joint.

A gas chamber surrounds the arc and weld joint providing excellent shielding gas coverage. This chamber can be clear or opaque. For initial set up and weld schedule development, a clear (transparent) chamber may be used, allowing viewing of the arc.

(BE SURE TO USE APPROPRIATE EYE PROTECTION).

For production purposes it is recommended that the opaque chamber be used.

Attached to the end of the gas chamber is a nose ring which is designed to sit directly onto the tubesheet, providing a repeatable and consistent arc gap. A standard (generic) nose ring is supplied with the Model 96. This ring has a large hole in the end to accommodate a wide variety of tube sizes and tube spacing. For more gas sensitive applications (such as when welding Titanium), where shielding gas coverage is more critical, special application-specific nose rings are available.

1.0 INTRODUCTION (cont'd.)

Electrode holders to fit 1/16" (1.6mm) and 3/32" (2.4mm) diameter electrodes come standard with the Model 96. A 0.040" (1.0mm) electrode holder as well as an extended (3/32") holder for tube over 2.00" (50.8mm) O.D. are optional. The design is such that when the correct length electrode is properly installed into the electrode holder, the arc gap (distance from electrode tip to tube) is automatically set. The electrode holder is mounted on a pivot arm which swings in or out to accommodate various tube diameters.

The integral 10ft. (3 meter) cable contains electrode power, shielding gas, motor (electrode rotation) control, coolant (in/out) and a ground cable.

CAUTION
A thorough understanding of the Arc Machines Power Supply being used is required before installation or operation is attempted.

2.0 UNPACKING

When unpacking the weld head use extreme caution in removing the plastic bag covering the cable connectors. Tools such a knife of other sharp object can cut the cables.

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3.0 CABLE HOOK UP

CAUTION
Always turn the power supply off before making any cable connections.

The Model 96 weld head comes supplied with an integral 10ft (3 m) cable. This cable is NOT connected directly to the power supply. It must be mated to the power supply via an adapter pig-tail or adapter cable. Extension cables may also be used. The use of an extension cable does not eliminate the requirement for an adapter. If an extension cable is used, it is connected between the power supply and the adapter. After making connections, to prevent power and ground connectors for coming in contact with each other, slide the rubber boots together. See fig. 6

3.1 Connect the power and ground fittings by pulling the brass ring back and inserting the male fitting into the female fitting, until it is fully seated. If it is not fully seated, it will leak water or potentially come apart. See fig. 1.

Fig. 1

3.0 CABLE HOOK UP (contd.)

3.2 To connect the male to female (chrome) gas fittings, unscrew the (4-40) socket head screw to allow the latch to open far enough to fully seat the two fittings. Once the fittings are latched together, lightly tighten this screw to prevent accidental disconnection. See fig. 2.

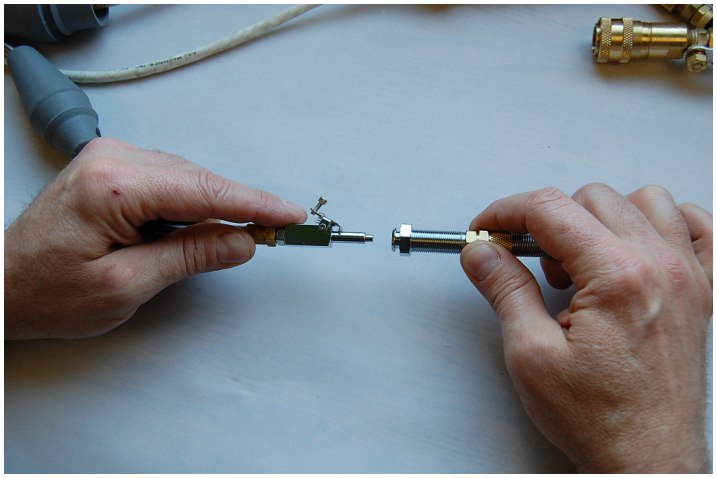

Fig. 2

3.3 Connect the motor control connector by aligning the key to the slot, and lightly tightening the outer ring. Be careful not to cross-thread this ring. See fig. 3.

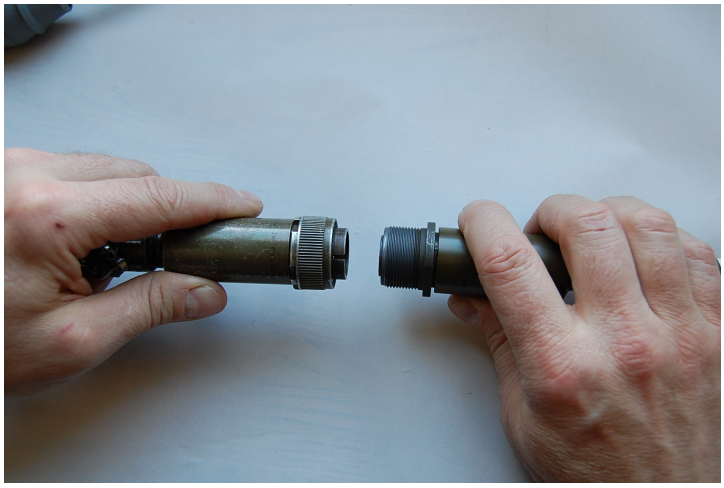

Fig. 3

2.0 **CABLE HOOK UP** (contd.)

Fig. 4

3.4 Slide the boots together securely to protect the connectors and fittings from dirt, and to prevent the power and ground connectors from coming in contact with each other. Fig. 4.

3.4 Before connecting the air line, first be sure that the air actuation switch on the handle is in the up (off, un-actuated) position. See fig. 6. Connect the air line to a clean, dry air source of 90-120 PSI (6.2 – 8.3 Bar).

4.0 ROTATION (SPEED) AUTO-CALIBRATION

Before welding, the electrode rotation motor must be calibrated to the power supply. Most power supplies include an auto calibration function in the software. Refer to the power supply operation manual for specifics on auto calibration. The Model 96 has a maximum travel speed of 10.0 RPM

Should the power supply indicate that the weld head requires calibration adjustment, the calibration potentiometer can be accessed through a hole to the right of where the cable is attached. See fig. 5

4.0 ROTATION (SPEED) AUTO-CALIBRATION (contd.)

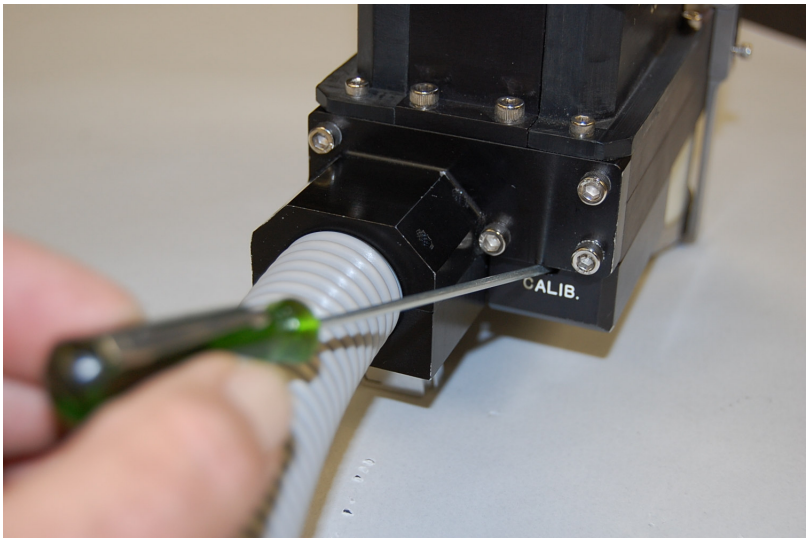

Fig. 5

4.1 ROTATION (SPEED) MANUAL CALIBRATION

Follow the instructions on your power supply in making adjustments to the potentiometer. Repeat this procedure until the power supply indicates that the head is calibrated.

For power supplies that do not have auto calibration software.

Some power supplies do not have auto calibration software. In this case, the weld head motor is manually calibrated by creating a weld program that should rotate the electrode 360 degrees. ie:1 RPM for a total of 60 seconds, 2 RPM for a total of 30 seconds, 3 RPM for a total of 20 seconds, etc. Select a speed (RPM) and corresponding time close to or equal to the speed that you intend on welding at to achieve the most accurate calibration.

4.2 The power supply must be in the “TEST” mode. Create a one level weld schedule at your selected RPM. Amperage and pulse rate settings may be set to any value, as during rotation calibration no arc will be established. Set rotation mode to “CONT” (continuous rotation). Set rotation delay and down slope times to 0.0.

4.1 ROTATION (SPEED) MANUAL CALIBRATION (contd.)

4.3 Add one additional level with a duration of 5 or more seconds, with the rotation mode set to “OFF”. This additional level (with rotation off) will hold the electrode at its stopped position allowing the operator to see if it traveled too far or not far enough.

4.4 Be sure the power supply is in the “TEST” mode. Make note of the electrode start location, and run the program. Should the electrode rotate too fast, stopping past the start location (traveling more than 360 degrees), slow it down by turning the potentiometer counter clockwise (CCW). Should the rotation be too slow, stopping before it reaches its start location, (rotating less than 360 degrees) turn the potentiometer clockwise (CW). Continue this procedure until the electrode stops after 360 degrees of travel.

5.0 MANDREL INSTALLATION

The Model 96 uses an I.D. expanding mandrel to position and hold the weld head firmly in place, and concentric to the tube being welded. Mandrels are available for any size tube I.D. from 0.375” (9.5mm) through 2.0” (50.8mm).

5.1 To install the mandrel, **first be sure that the air source is disconnected, and that the air actuation switch is in the “release” (UP) position.** This is to prevent accidental mandrel actuation, (expansion) and possible over-stretching of the collet. See fig. 6.

5.0 MANDREL INSTALLATION (contd.)

CAUTION!
Expanding the mandrel when it is not inserted into an appropriately sized tube can damage it.

Fig. 6
Mandrel release position.

5.2 Remove the thumb nut and washer from the top of the mandrel and slide the mandrel shaft into the center hole next to the electrode holder. Slowly rotate the mandrel until the threaded end protrudes through the top of the weld head. Reinstall the washer and thumb nut, and gently hand-tighten.

CAUTION!
TO PREVENT OVER-STRETCHING OF THE MANDREL, DO NOT ACTUATE THE AIR CYLINDER UNLESS THE MANDREL IS INSTALLED INTO THE APPROPRIATE SIZE TUBE.

THE MANDREL IS SPRING-LOADED. DO NOT ATTEMPT TO DIS-ASSEMBLE IT WHILE IT IS INSTALLED IN THE WELD HEAD

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6.0 ELECTRODE GEOMETRY AND INSTALLATION

CAUTION

To prevent the possibility of electrical shock, the power supply must be turned off or set to the "TEST" mode before proceeding with electrode installation or removal.

6.1 The recommended electrode type is 2% Ceriated. (AWS Spec. A5.12/A5.12M, Orange tip). This type of electrode provides superior arc starting and longer life than 2% Thoriated electrodes. Other types can also be used. Consult factory for recommendations.

6.2 The Model 96 comes with electrode holders for both 1/16" (1.6mm) and 3/32" (2.4mm) diameter electrodes. A 0.040" (1.0mm) diameter electrode holder is available.

6.3 The design of the Model 96 is such that a 1.000" (25.4mm) long electrode, (properly installed in the electrode holder) will stick out the same distance as the feet or tabs on the nose ring, which sits on the surface of the tubesheet. Use this 1.000" (25.4mm) dimension to calculate the appropriate electrode length for a flush tube application.

ELECTRODE LENGTH FORMULA:

1.000" (25.4m) minus the arc gap = electrode length.

6. 4 Electrode geometry and Arc Gap are primarily based on the tube material and wall thickness. Although the Model 96 can accommodate a wide variety of materials and preps (recessed, flush or projected), the most common applications are stainless steel tube, inserted flush with the tubesheet. The following two charts are based on these types of applications.

Use this chart to establish a recommended electrode diameter.

Tube/Pipe Wall thickness	Electrode Diameter
0.015"–0.035" (.38 –.76mm)	0.040" or 1/16" (1.0 or 1.6mm)
0.036" – 0.083" (.91 – 2.1mm)	1/16" (1.6mm)
0.084" – 0.250" (2.1 – 6.3mm)	3/32" (2.3mm)

Fig. 7

6.0 ELECTRODE GEOMETRY AND INSTALLATION (Cont'd.)

6. 5 Use this chart to determine a recommended Arc Gap and electrode Tip Diameter.

Tube/Pipe Wall Thickness	Recommended Arc Gap	Recommended Tip Diameter
0.015"–0.035"(.38 –.89mm)	0.020"-0.030"(0.50-76mm)	0.010"-0.020" (.25-.50mm)
0.036"-0.083" (.91-2.1mm)	0.030"-0.050" (.76-1.3mm)	0.020" -0.030" (.50-.76mm)
0.084"-0.250" (2.1-6.3mm)	0.050"-0.070" (1.3-1.8mm)	0.030"–0.040" (.76- 1.0mm)

Fig. 8

6.6 Loosen the socket head electrode lock screw in the electrode holder.

6.7 Install an electrode, and be sure it is fully seated and bottomed-out in the holder. Tighten the lock screw. See fig. 9

CAUTION
DO NOT INSTALL AN ELECTRODE INTO AN OVER-SIZED ELECTRODE HOLDER.
ALWAYS USE THE CORRECT SIZE ELECTRODE HOLDER.

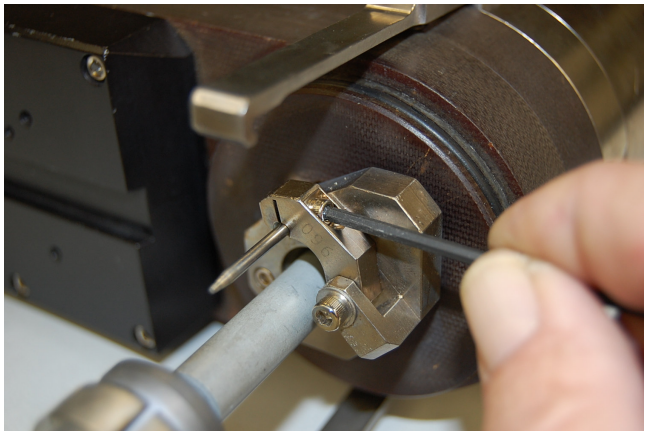

Fig. 9

6.0 ELECTRODE GEOMETRY AND INSTALLATION (Cont'd.)

6.8 Projected or recessed tubes.

If your tubes ends are projected above or recessed below the surface of the tubesheet, they can still be welded, however since there are so many possible combinations of materials, projection or recess dimensions, tube sizes and wall thicknesses, consult the factory for recommendations.

6.9 Electrode radial positioning.

The electrode must be positioned with respect to the tube O.D. Most applications work best with the centerline of the electrode either in line with the tube O.D., or slightly outside the tube O.D.

CAUTION
POSITIONING THE ELECTRODE TOO CLOSE TO THE TUBE I.D. CAN CAUSE THE WELD PUDDLE TO "ROLL" INTO THE TUBE I.D., PREVENTING THE REMOVAL OF THE MANDREL.
BEFORE WELDING YOUR TUBESHEET, VARIFY THE WELD HEAD SET UP AND WELD SCHEDLE ON A SACRIFICIAL TUBESHEET MOCK UP.

6.10 With a mandrel installed (see 5.0 for mandrel installation) slide a piece of tube (the same size as the tubes in the tubesheet) onto the mandrel, far enough to reach within 3/8" (10mm) of the electrode tip. Expand the mandrel by pressing the air valve down. Loosen the pivot screw in the electrode holder, and position the electrode with respect to the tube O.D., then tighten the pivot screw. See fig. 10.

6.0 ELECTRODE GEOMETRY AND INSTALLATION (Cont'd.)

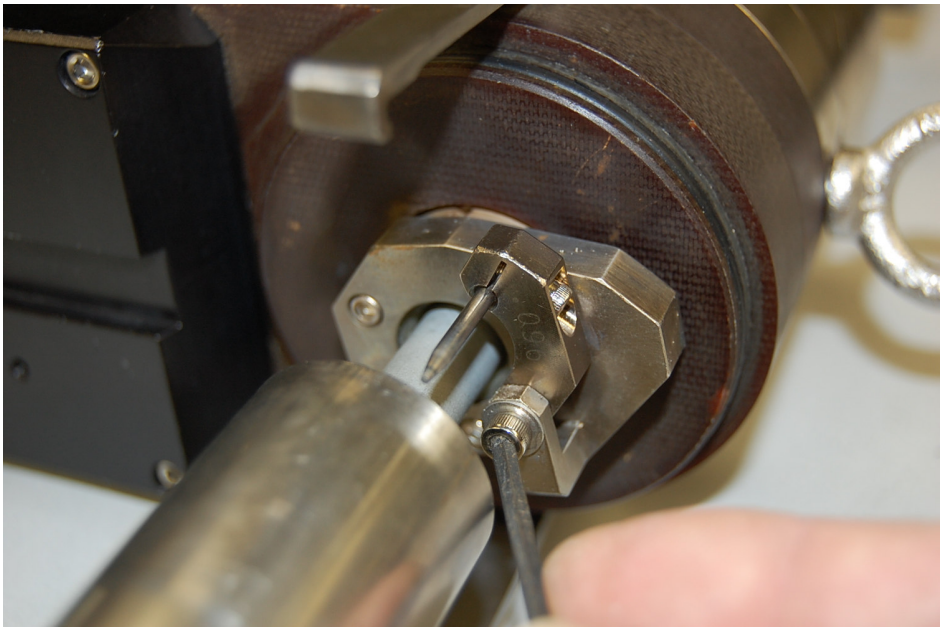

Fig. 10

6.11 Once the electrode is positioned properly you can measure the distance across the electrode and the mandrel using a veneer caliper (or other accurate measuring devise), and record this dimension for future welding of this application. See fig. 11.

6.0 ELECTRODE GEOMETRY AND INSTALLATION (Cont'd.)

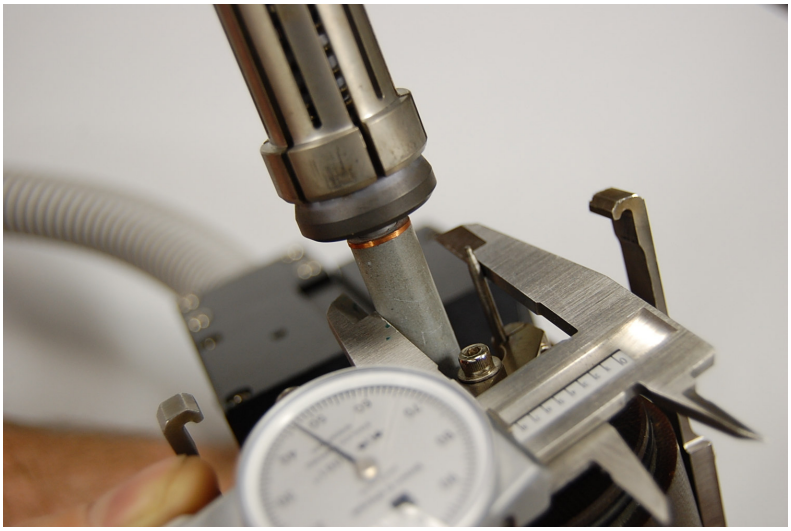

Fig. 11

7.0 GAS CHAMBERS

The Model 96 features a cylindrical gas chamber to surround the weld, providing excellent gas coverage. The weld head comes with an opaque chamber. A clear glass chamber that can aid in weld schedule development (as it allows the operator to see the weld puddle being formed), is available as an optional accessory.

7.1 To remove the chamber, first release the two side latches, and remove the nose ring. Grip the chamber and twist it while pulling it away from the weld head.

7.2 Install the gas chamber by pressing it onto the O-ring in the housing. Be sure it is fully seated. Applying a very thin film of light oil or O-ring lube to the top of the chamber (on the I.D.) or to the O-ring will make installation and removal easier.

7.0 GAS CHAMBERS (Cont'd.)

7.3 Attach the nose ring to the end of the gas chamber, and lock it in place with the two side latches. See fig. 12.

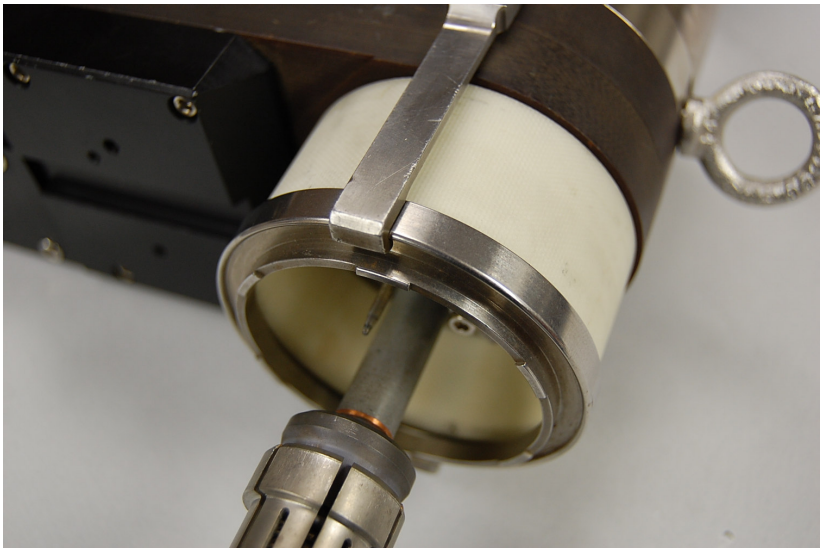

Fig. 12

8.0 NOSE RINGS

The Model 96 uses feet or tabs on the bottom of the nose ring to rest on the tubesheet. The nose ring that comes standard with the head is considered a generic nose ring, and can be used for multiple applications. Shown in Fig. 12.

For applications that require higher levels of purge quality, either due to the material, (such as when welding Titanium) or in the case of close tube spacing (where some of the gas flows into adjacent tubes, diminishing the purge quality), application specific nose rings are available. These nose rings feature a smaller center hole as well as three screw-on feet.

8.0 NOSE RINGS (Cont'd.)

The feet are positioned in a pattern so when the head is rotated into the correct position on the tubsheet, all three feet will be positioned in the space between tubes, allowing the head to sit flat and parallel to the tubesheet.

CAUTION
Do not initiate a weld sequence unless all nose ring feet are sitting flat on the tubesheet, and not on adjacent welds.

9.0 SHIELDING GAS (Arc Gas)

The type of shielding gas used has a profound effect on the character of the arc and the depth of weld penetration. The most commonly used shielding gas used is Argon. Gas mixtures of 95% Argon/5% hydrogen or 75% helium/25% argon are sometimes used to achieve deeper penetration. Consult the factory for recommendations.

The Model 96 is designed to flow arc gas at 20 - 40 CFH (9.4 – 18.9 lPM). As a general rule, use lower flow rates for small diameter tube and higher flow rates for larger diameter tubes. This is because the larger the tube is, the more gas can escape down the tube.

Use the Manual Purge button on your power supply to open the solenoid, and set the flow rate at your flow meter.

Note: If the system is being hooked up for the first time, or if it has been a number of hours since it was last used, it's a good idea to initiate the Manual Purge button on the power supply to clear the lines of oxygen for a few minutes before initiating a weld sequence.

10.0 CLEANING AND MAINTENANCE

If the weld head is to be stored for more than 1 month, the residual water or water/coolant mix should be purged from the hoses and weld head to minimize internal corrosion. This is also important if the weld head is to be stored where the temperature might fall below freezing, as trapped water can freeze and damage weld head and/or hose internals.

Although you may not be storing the adapter and /or extension cables, leave them hooked up to the weld head when purging out the water.

10.1 To drain the coolant from the weld head and cables, use Arc Machines, Inc. fitting part number 294-PB-06. Unplug the water "supply" line from the cooling unit, (leaving the water "return" line connected to the cooling unit) and attach the (female) fitting (294-PB-06) to the disconnected "supply" line. See Fig. 13.

Fig. 13

10.2 Using a pressurized air source of maximum 20 PSI, (139 Kp) (1.38 Bar) blow air into the fitting to force the water out of the cables and weld head, and back into the cooling unit. See fig. 13.

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10.0 CLEANING AND MAINTENANCE

CAUTION, DO NOT USE AIR PRESSURE
ABOVE 20 PSI (139 Kp) (1.38 Bar)

10.3 To clean the weld head, use a lint-free cloth and alcohol to wipe down all surfaces.

11.0 STORAGE

11.1 Attach the dust cap to the electrical connector, and store the weld head in a clean, dust-free area.

11.2 Do not store the weld head for more than 1 month without first draining the coolant from the weld head and hoses. Refer to chapter 10.0 for coolant draining instructions.

12.0 TUBE & TUBESHEET PREPARATION CONSIDERATIONS

As with all welding applications, regardless of the welding process or the material being welded, cleanliness of the materials being welded is of upmost importance. Dirt, oil, paint, hydraulic fluid, oxidation, or any other contaminant must be removed from both the tube and the tubesheet prior to installing the tube into the tubesheet. Cleaning the joint after the tube has been installed will not be adequate, as contaminants trapped between the tube and tubesheet cannot be removed, and will cause weld defects and/or porosity. Additionally, contaminants can adhere to the electrode and contaminate it.

Fit up between the tube O.D. and the tubesheet hole I.D. is also very important. If the tube is not in good contact with the tubesheet, weld repeatability will suffer. Weld puddle characteristics will not be consistent if the fit up is not consistent. In order to get repeatable thermal transfer between the tube and the tubesheet, they must be in good contact with each other.

13.0 Available Options

Description	Part Number
Gas Chambers	
Gas Chamber (clear)	42900703-01
Electrode holders	
Electrode Holder, 0.040" (1mm)	42960700-04
Electrode Holder, 3/32" (2.4mm) for tubes over 2.00" (50.8mm) O.D.	42960703-01
I.D. Mandrels	
0.37" – 0.40" I.D. (9.4 - 10.2mm)	13961004-02
0.40" - 0.44" I.D. (10.2 – 11.2mm)	13961004-31
0.42" – 0.46" I.D. (10.7 – 11.7mm)	13961004-10
0.47" – 0.52" I.D. (12.0 – 13.2mm)	13961004-39
0.48" - 0.53" I.D. (12.2 – 13.5mm)	13961000-03
0.53" – 0.60" I.D. (13.5 – 15.3mm)	13961000-08
0.61" - 0.66" I.D. (15.5 – 16.8mm)	13961000-05
0.64" – 0.70" I.D. (16.3 – 17.8mm)	13961000-04
0.68" – 0.74" I.D. (17.3 – 18.8mm)	13961000-06
0.74" – 0.80" I.D. (18.8 – 20.3mm)	13961000-09
0.80" – 0.84" I.D. (20.3 – 21.3mm)	13961001-08
0.83" – 0.88" I.D. (21.1 – 22.4mm)	13961001-02
0.88" – 0.93" I.D. (22.4 – 23.6mm)	13961001-01
0.92" – 0.97" I.D. (23.4 – 24.6mm)	13961001-14
0.93" – 0.98" I.D. (23.6 – 24.9mm)	13961001-11
0.97" - 1.02" I.D. (24.6 – 25.9mm)	13961001-03
1.04" – 1.09" I.D. (26.4 – 27.7mm)	13961001-09
1.10" – 1.15" I.D. (27.9 – 29.2mm)	13961001-04
1.19" – 1.21" I.D. (30.3 – 30.7mm)	13961001-13
1.34" – 1.39" I.D. (34.0 – 35.3mm)	13961001-05
1.40" – 1.45" I.D. (35.5 – 36.7mm)	13961001-38
1.43" – 1.48" I.D. (36.4 – 37.5mm)	13961001-35
1.52" – 1.57" I.D. (38.6 – 39.8mm)	13961001-37
1.55" – 1.60" I.D. (39.4 – 40.6mm)	13961001-12
1.60" – 1.65" I.D. (40.6 – 42.0mm)	13961001-06
1.76" – 1.81" I.D. (44.7 – 46.0mm)	13961001-36
1.85" – 1.90" I.D. (47.0 – 48.3mm)	13961001-07
1.92" – 1.97" I.D. (48.7 – 50.0mm)	13961001-10
1.97" – 2.03" I.D. (50.0 – 51.6mm)	13961001-39

13.0 Available Options (Cont'd.)

Nose rings

The Model 96 comes equipped with a universal nose ring. This nose ring will accommodate all tube diameters up to 2.12" O.D. (53.8mm). For critical applications, (such as when welding Titanium) or for applications with very close tube spacing, allowing excessive shielding gas to be diverted down adjacent tubes, specialized nose rings are available. These nose rings are designed for specific tube sizes, tube spacing and tube pattern, square or tri-pitch. Please contact the factory for recommendations.

Extension Cables

The use of an extension cable does not eliminate the requirement for an adapter. If an extension cable is used, it is connected between the power supply and the adapter cable. See 3.0, Cable hook up..

For use with Power Supply models 205, 207A or 307.

Description	Part Number
25 ft. (7.7m) Extension Cable	13090806-01
50 ft. (15.4m) Extension Cable	13090806-02
75ft. (23.1m) Extension Cable	13090806-03

For use with Power Supply models 227 and 415.

50 ft. (15.4m) Extension Cable	13090808-01
75ft. (23.1m) Extension Cable	13090808-02