WELD HEAD

508 SERIES

OPERATION MANUAL

990-111 REV F

Revision Record

Revision	EO	Date	Basis of Revision
A	18455	8/00	Production release.
B	19146	1/02	Added Unitek Peco logo.
C	21776	5/08	Updated to Miyachi Unitek Logo and added CAUTION information.
D	42860	10/13	Updated to Miyachi America name and logo.
E	43207	3/15	Updated technical information. Updated to Amada Miyachi America name and logo.
F	43866	8/15	Updated to Amada Miyachi America format.

FOREWORD

Thank you for purchasing a Miyachi Unitek™ 508 Weld Head.

Upon receipt of your equipment, please thoroughly inspect it for shipping damage before its installation. Should there be any damage, please immediately contact the shipping company to file a claim, and notify us at:

Amada Miyachi America
1820 South Myrtle Ave.
Monrovia, California 91017-7135

Phone: **(626) 303-5676**

FAX: **(626) 358-8048**

E-mail: **info@miyachiamerica.com**

The purpose of this manual is to supply operating, maintenance and service personnel with the information needed to properly and safely operate and service the Miyachi Unitek™ 508 Weld Head.

We have made every effort to ensure that the information in this manual is accurate and adequate. Should questions arise, or if you have suggestions for improvement of this manual, please contact us at the above location/numbers.

Miyachi America is not responsible for any loss due to improper use of this product.

SAFETY NOTES

This instruction manual describes how to operate, maintain and service the 508 Weld Head, and provides instructions relating to its SAFE use. A separate manual provides similar information for the Power Supply used in conjunction with the Weld Head. Procedures described in these manuals MUST be performed, as detailed, by QUALIFIED and TRAINED personnel.

For SAFETY, and to effectively take advantage of the full capabilities of the Weld Head and Power Supply, please read these instruction manuals before attempting to use them.

Procedures other than those described in these manuals or not performed as prescribed in them, may expose personnel to electrical, burn, or crushing hazards.

After reading these manuals, retain them for future reference when any questions arise regarding the proper and SAFE operation of the Weld Head and Power Supply.

Please note the following conventions used in this manual:

WARNING: Comments marked this way warn the reader of actions which, if not followed, might result in immediate death or serious injury.

CAUTION: Comments marked this way warn the reader of actions which, if not followed, might result in either damage to the equipment, or injury to the individual if subject to long-term exposure to the indicated hazard.

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LIMITED WARRANTY

1. (a) Subject to the exceptions and upon the conditions set forth herein, Seller warrants to Buyer that for a period of one (1) year from the date of shipment ("**Warranty Period**"), that such Goods will be free from material defects in material and workmanship.

(b) Notwithstanding the foregoing and anything herein to the contrary, the warranty set forth in this Section 1 shall be superseded and replaced in its entirety with the warranty set forth on **Exhibit A** hereto if the Goods being purchased are specialty products, which include, without limitation, laser products, fiber markers, custom systems, workstations, Seller-installed products, non-catalogue products and other custom-made items (each a "**Specialty Products."**

(c) EXCEPT FOR THE WARRANTY SET FORTH IN SECTION 1(A), SELLER MAKES NO WARRANTY WHATSOEVER WITH RESPECT TO THE GOODS (INCLUDING ANY SOFTWARE) OR SERVICES, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.

(d) Products manufactured by a third party and third party software ("**Third Party Product**") may constitute, contain, be contained in, incorporated into, attached to or packaged together with, the Goods. Third Party Products are not covered by the warranty in Section 1(a). For the avoidance of doubt, **SELLER MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO ANY THIRD PARTY PRODUCT, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.** Notwithstanding the foregoing, in the event of the failure of any Third Party Product, Seller will assist (within reason) Buyer (at Buyer's sole expense) in obtaining, from the respective third party, any (if any) adjustment that is available under such third party's warranty.

(e) Seller shall not be liable for a breach of the warranty set forth in Section 1(a) unless: (i) Buyer gives written notice of the defect, reasonably described, to Seller within five (5) days of the time when Buyer discovers or ought to have discovered the defect and such notice is received by Seller during the Warranty Period; (ii) Seller is given a reasonable opportunity after receiving the notice to examine such Goods; (iii) Buyer (if requested to do so by Seller) returns such Goods (prepaid and insured to Seller at 1820 South Myrtle Avenue, Monrovia, CA 91016or to such other location as designated in writing by Seller) to Seller pursuant to Seller's RMA procedures and Buyer obtains a RMA number from Seller prior to returning such Goods for the examination to take place; and (iii) Seller reasonably verifies Buyer's claim that the Goods are defective and that the defect developed under normal and proper use.

(f) Seller shall not be liable for a breach of the warranty set forth in Section 1(a) if: (i) Buyer makes any further use of such Goods after giving such notice; (ii) the defect arises because Buyer failed to follow Seller's oral or written instructions as to the storage, installation, commissioning, use or maintenance of the Goods; (iii) Buyer alters or repairs such Goods without the prior written consent of Seller; or (iv) repairs or modifications are made by persons other than Seller's own service personnel, or an authorized representative's personnel, unless such repairs are made with the written consent of Seller in accordance with procedures outlined by Seller.

(g) All expendables such as electrodes are warranted only for defect in material and workmanship which are apparent upon receipt by Buyer. The foregoing warranty is negated after the initial use.

(h) Subject to Section 1(e) and Section 1(f) above, with respect to any such Goods during the Warranty Period, Seller shall, in its sole discretion, either: (i) repair or replace such Goods (or the defective part) or (ii) credit or refund the price of such Goods at the pro rata contract rate, provided that, if Seller so requests, Buyer shall, at Buyer's expense, return such Goods to Seller.

(i) THE REMEDIES SET FORTH IN SECTION 1(H) SHALL BE BUYER'S SOLE AND EXCLUSIVE REMEDY AND SELLER'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH IN SECTION 1(A). Representations and warranties made by any person, including representatives of Seller, which are inconsistent or in conflict with the terms of this warranty, as set forth above, shall not be binding upon Seller.

Exhibit A
Warranty for "Specialty Products"

Limited Warranty

EXCEPT FOR THE WARRANTY SET FORTH BELOW IN THIS EXHIBIT A, SELLER MAKES NO WARRANTY WHATSOEVER WITH RESPECT TO THE GOODS (INCLUDING ANY SOFTWARE) OR SERVICES, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.

Warranty Period: The Warranty Period for Specialty Products is for one (1) year, and the Warranty Period for laser welders and laser markers is two (2) years (unlimited hours), and the Warranty Period for the laser pump diodes or modules is two (2) years or 10,000 clock hours, whichever occurs first (as applicable, the "**Warranty Period**"). The Warranty Period begins as follows: (i) on orders for Goods purchased directly by Buyer, upon installation at Buyer's site or thirty (30) days after the date of shipment, whichever occurs first; or (ii) on equipment purchased by a Buyer that is an OEM or systems integrators, upon installation at the end user's site or six (6) months after the date of shipment, whichever occurs first.

Acceptance Tests: Acceptance Tests (when required) shall be conducted at Amada Miyachi America, Inc., Monrovia, CA, USA (the "**Testing Site**") unless otherwise mutually agreed in writing prior to issuance or acceptance of the Acknowledgement. Acceptance Tests shall consist of a final visual inspection and a functional test of all laser, workstation, enclosure, motion and accessory hardware. Acceptance Tests shall include electrical, mechanical, optical, beam delivery, and software items deliverable under the terms of the Acknowledgement. Terms and conditions for Additional Acceptance Tests either at Seller's or Buyer's facility shall be mutually agreed in writing prior to issuance or acceptance of the Acknowledgement.

Performance Warranty: The system is warranted to pass the identical performance criteria at Buyer's site as demonstrated during final Acceptance Testing at the Testing Site during the Warranty Period, as provided in the Acknowledgement. Seller explicitly disclaims any responsibility for the process results of the laser processing (welding, marking, drilling, cutting, etc.) operations.

Exclusions: Seller makes no warranty, express or implied, with respect to the design or operation of any system in which any Seller's product sold hereunder is a component.

Limitations: The limited warranty set forth on this Exhibit A does not cover loss, damage, or defects resulting from transportation to Buyer's facility, improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the equipment, or improper site preparation and maintenance. This warranty also does not cover damage from misuse, accident, fire or other casualties of failures caused by modifications to any part of the equipment or unauthorized entry to those portions of the laser which are stated. Furthermore, Seller shall not be liable for a breach of the warranty set forth in this Exhibit A if: (i) Buyer makes any further use of such Goods after giving such notice; (ii) the defect arises because Buyer failed to follow Seller's oral or written instructions as to the storage, installation, commissioning, use or maintenance of the Goods; (iii) Buyer alters or repairs such Goods without the prior written consent of Seller; or (iv) repairs or modifications are made by persons other than Seller's own service personnel, or an authorized representative's personnel, unless such repairs are made with the written consent of Seller in accordance with procedures outlined by Seller.

Seller further warrants that all Services performed by Seller's employees will be performed in a good and workmanlike manner. Seller's sole liability under the foregoing warranty is limited to the obligation to re-perform, at Seller's cost, any such Services not so performed, within a reasonable amount of time following receipt of written notice from Buyer of such breach, provided that Buyer must inform Seller of any such breach within ten (10) days of the date of performance of such Services.

Seller shall not be liable for a breach of the warranty set forth in this Exhibit A unless: (i) Buyer gives written notice of the defect or non-compliance covered by the warranty, reasonably described, to Seller within five (5) days of the time when Buyer discovers or ought to have discovered the defect or non-compliance and such notice is received by Seller during the Warranty Period; (ii) Seller is given a reasonable opportunity after receiving the notice to examine such Goods and (a) Buyer returns such Goods to Seller's place of business at Buyer's cost (prepaid and insured); or (b) in the case of custom systems, Seller dispatches a field service provider to Buyer's location at Buyer's expense, for the examination to take place there; and (iii) Seller reasonably verifies Buyer's claim that the Goods are defective or non-compliant and the defect or non-compliance developed under normal and proper use.

All consumable, optical fibers, and expendables such as electrodes are warranted only for defect in material and workmanship which are apparent upon receipt by Buyer. The foregoing warranty is negated after the initial use.

No warranty made hereunder shall extend to any product whose serial number is altered, defaced, or removed.

Remedies: With respect to any such Goods during the Warranty Period, Seller shall, in its sole discretion, either: repair such Goods (or the defective part). **THE REMEDIES SET FORTH IN THE FOREGOING SENTENCE SHALL BE BUYER'S SOLE AND EXCLUSIVE REMEDY AND SELLER'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH IN THIS EXHIBIT A.** Representations and warranties made by any person, including representatives of Seller, which are inconsistent or in conflict with the terms of this warranty, as set forth above, shall not be binding upon Seller.

Products manufactured by a third party and third party software ("**Third Party Product**") may constitute, contain, be contained in, incorporated into, attached to or packaged together with, the Goods. Third Party Products are not covered by the warranty in this Exhibit A. For the avoidance of doubt, **SELLER MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO ANY THIRD PARTY PRODUCT, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.** Notwithstanding the foregoing, in the event of the failure of any Third Party Product, Seller will assist (within reason) Buyer (at Buyer's sole expense) in obtaining, from the respective third party, any (if any) adjustment that is available under such third party's warranty.

CHAPTER 1
DESCRIPTION

Section I: Features

Features

The 508 Weld Head, herein called the Weld Head, meets the needs of high-quality battery pack manufacturers. Its primary application is the welding of thin interconnecting tabs for a variety of battery technologies. The Weld Head is actuated by the patented EZ-AIR technology which brings a superior level of repeatability and functionality to force control.

The Weld Head has the following features:

- Compact design for bench top and automated use
- Includes stand and base plate assembly
- Weld head can be adjusted vertically on the stand
- Easy set up and maintenance
- Easy force adjustment with fine resolution
- Secure force setting with locking screw
- EZ-AIR prevents overforce
- EZ-Clean valve permits quick and easy electrode dressing
- Precise down speed control reduces impact force and eliminates damage to fragile battery cells
- L-shaped electrode holders with dual clamping screws uses 1.5 mm electrode rod (ES0250M) for fine positioning on small cells
- Fine electrode gap setting in a true horizontal plane
- Convenient adjustment of electrode gap, from 0 to 10 mm
- Independent control over each electrode force
- Ultra-flexible 4 gauge weld cable replaces conventional lamination type flexures
- High speed operation with advanced cylinder and slide combination

Section II: Major Components

Reference Publications

In addition to this manual, you will also have to refer to the manual provided with your power supply. If you need additional copies of any of these manuals, they can be procured from Amada Miyachi America.

Major Components

Figure 1-1 shows the major components of the unit. The function of each item is described below. The following figures and paragraphs describe the detail parts, controls, and indicators normally associated with operation.

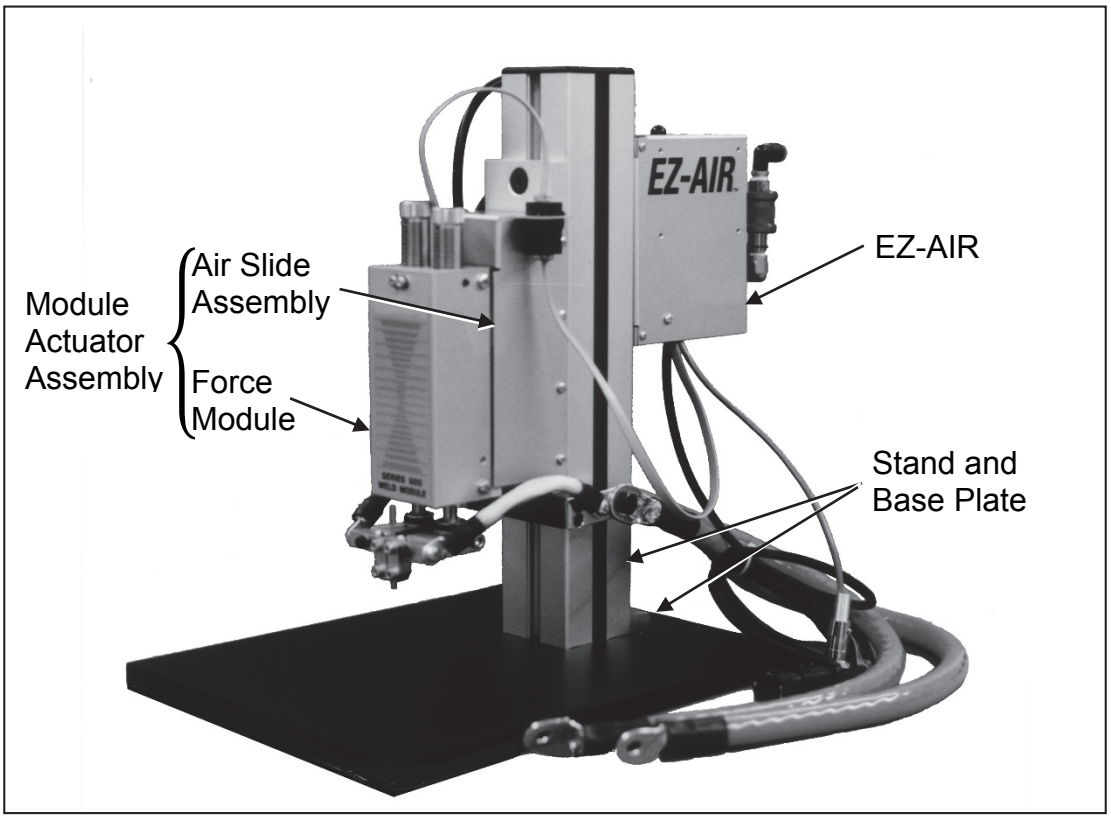

Figure 1-1. 508 Weld Head, Major Components

EZ-AIR. The EZ-AIR provides the pneumatic force to control the weld head. Upon receiving the down-stroke signal, the EZ-AIR moves the weld module down to the welding surface and maintains the pre-set pressure until the completion of the welding cycle (including squeeze and weld hold period). At that time the pneumatic pressure is released and the weld module returns to its up position.

Stand and Base Plate. The stand provides rigid mounting for the Force Module, Air Slide Assembly, and EZ-AIR, and permits vertical adjustment of the Module Actuator Assembly. The base plate provides a rigid surface for welding and will allow the mounting of part fixtures or jigs.

Air Slide Assembly. This assembly consists of a combination slide and twin pneumatic cylinders. Its function is to provide actuation of the Force Module.

Force Module. The Force Module is the main part of the Weld Head and controls the amount of force applied during the welding operation. The module has two independently adjustable force setting tubes, which compress individual force springs for each electrode assembly. The module contains an optical firing switch that senses when the set force is reached on each electrode. When this occurs, a firing signal is applied to the EZ-AIR which, in turn, provides the firing signal to the power supply.

NOTE: The Air Slide Assembly and Force Module are referred to, collectively, as the Module Actuator Assembly

Module Actuator Assembly Components and Controls

Figure 1-2 shows the Module Actuator Assembly components and controls, as described in the following paragraphs. Chapter 3, Operating Instructions, provides specific means of adjusting the controls.

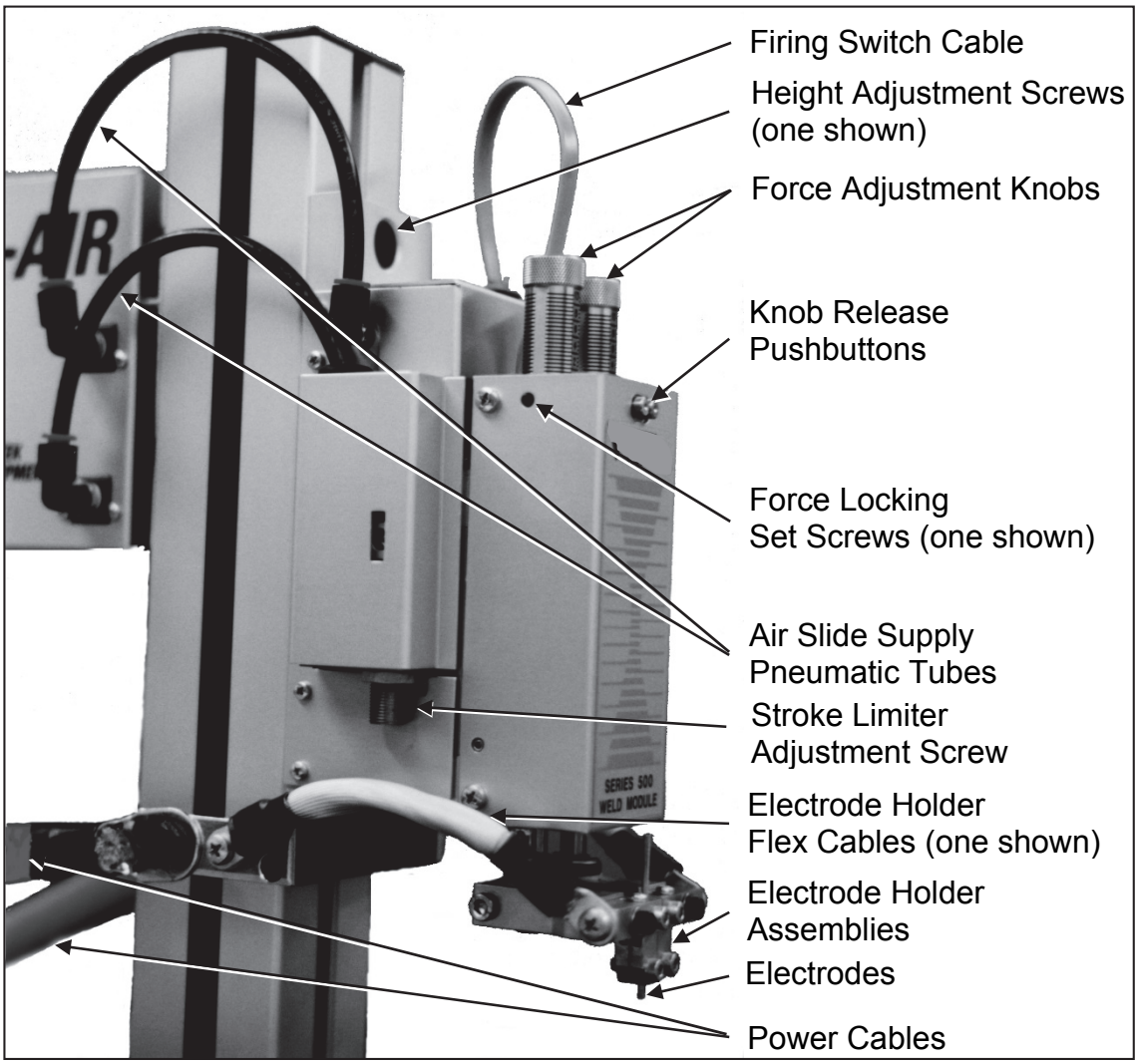

Figure 1-2. Module Actuator Assembly Components and Controls

Firing Switch Cable. This cable takes the firing signal from the Force Module to the EZ-AIR, when the force has been met on each electrode.

Height Adjustment Screws. Allen head screws that allow vertical adjustment of the Module Actuator Assembly on the mounting post. This allows the user to set the welding stroke of the electrodes to the parts for the welding operation. The bottom screw is not visible in figure 1-2.

Force Adjustment Knobs. These thumbscrews provide for independent adjustment of the weld force on each electrode. The numeric scale and fine lines provide an approximate indication of force settings. The numbers do not directly relate to a given force and serve as a numeric indicator only. Chapter 3 provides specific cross-reference data.

Knob Release Pushbuttons. The two spring-loaded release buttons, one for each force adjustment knob, must be pressed in order to turn the force adjustment knobs. The buttons hold the force adjustment knobs in place during welding to ensure that force does not change due to vibration.

Force Locking Set Screws. Two set screws, one for each force adjustment knob, protects against unauthorized operator adjustment of the force adjustment knobs.

CAUTION: Each set screw must be loosened prior to pressing the force adjustment pushbutton and adjusting the force adjustment knob.

Air Slide Supply Pneumatic Tubes. The tubes connect the air supply from the EZ-AIR to the Air Slide Assembly.

Stroke Limiter Adjustment Screw. This screw is factory adjusted for a one-inch maximum electrode stroke. It can be adjusted for a shorter stroke if desired.

CAUTION: Before making adjustment, loosen the locking nut on the screw. Re-tighten the nut after adjustment is completed.

NOTE: Do not use the stroke limiter as a downstop. Its only use is that of restricting the overall stroke of the electrode to one inch.

Electrode Holder Flex Cables. These cables carry the welding energy from the bus bars to the electrode holder assemblies.

Electrode Holder Assemblies. The electrode holder assemblies hold two 1.5 mm diameter electrode rods and provide horizontal gap adjustment of the electrodes to suit the application.

Electrodes. Two 1.5 mm diameter electrode rods are provided in the Ship Kit.

CAUTION

Do ***not*** modify the electrode holders or attach additional mechanisms to the moving parts of the head. Doing so may hurt welding performance, damage the head, and ***void the warranty***.

Power Cables. These cables provide the electrical connection between the power supply and the Weld Head and conduct the welding energy to the bus bar.

EZ-AIR Components, Controls, and Indicators

Figure 1-3 shows the EZ-AIR components, controls, and indicators as described in the following paragraphs. Chapter 3, Operating Instructions, provides specific means of adjusting the controls.

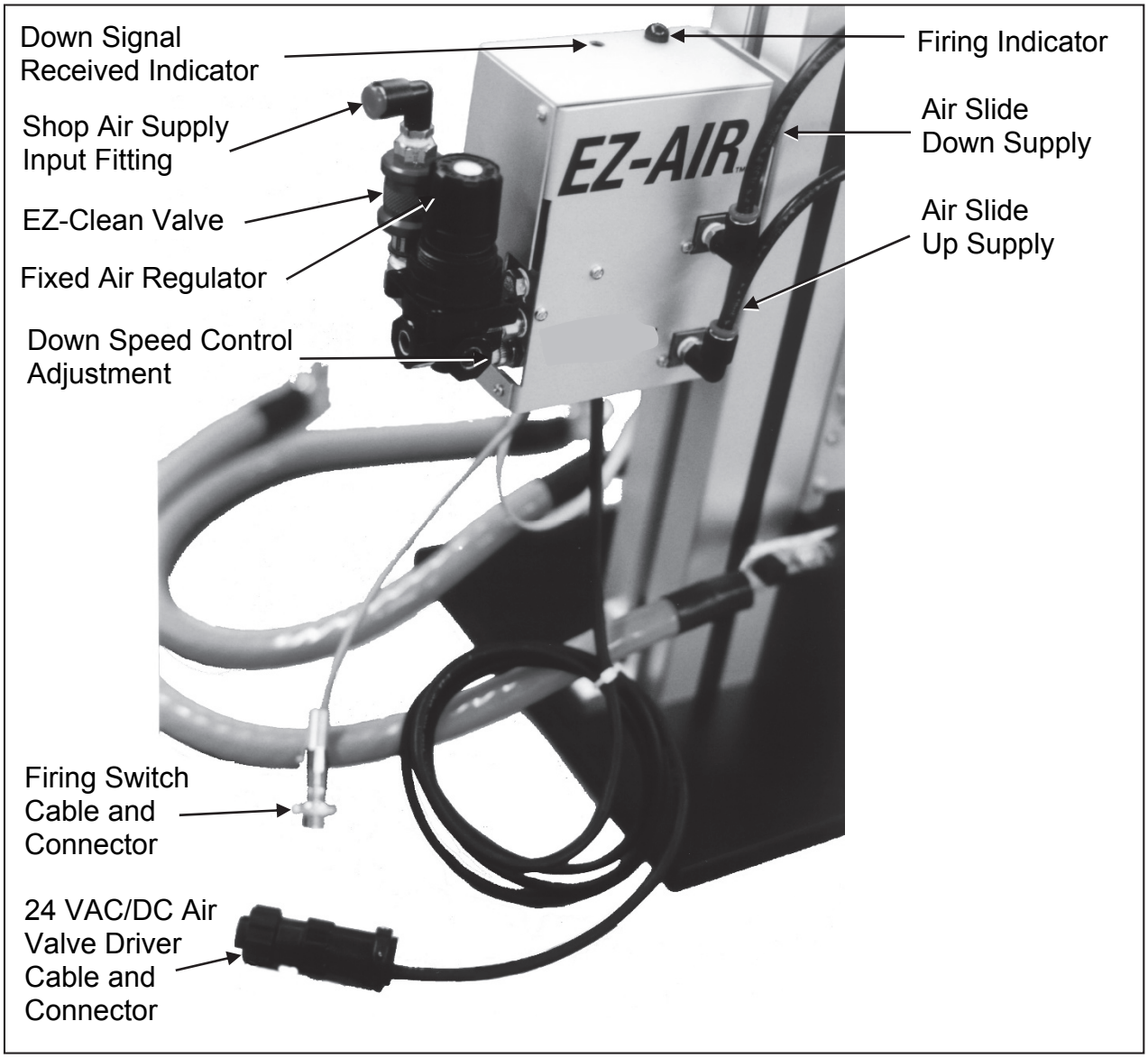

Figure 1-3. EZ-AIR Components, Controls, and Indicators

Firing Indicator. A green indicator that lights when the firing switch closes and stays lit until the end of the weld cycle. Thus, if a malfunction occurs, the operator can determine whether a firing signal is present.

Air Slide Down Supply. Male elbow fitting, ¼ inch OD tube to ⅛ inch male NPT brass. Connects controlled compressed air to weld head air cylinder top port.

Air Slide Up Supply. Male elbow fitting, ¼ inch OD tube to ⅛ inch male NPT brass. Connects controlled compressed air to weld head air cylinder bottom port.

24 VAC/DC Air Valve Driver Cable and Connector. Conducts 24 volt solenoid drive power from the power supply to the EZ-AIR.

Firing Switch Cable and Connector. Two-conductor male plug to connect firing signal to the power supply.

Down Speed Control Valve Adjustment. Operator adjustment that allows setting of the down speed of the Force Module to reduce part impact pressure.

Fixed Air Regulator. Controls pressure of air from shop air source into EZ-AIR. Regulator is factory set for 78 psi (538 kPa) and does not require any user adjustment.

EZ-Clean Valve. Allows bleeding of input air supply to permit dressing of electrodes.

Shop Air Supply Input Fitting. ¼ inch O.D. tube fitting for connecting shop compressed air to EZ-AIR. Shop air supply must be 85–130 psi . (586–897 kPa).

Down Signal Received Indicator. An amber indicator, visible through an inspection port in the EZ-AIR cover, that lights when the initialization signal is received from the power supply, and stays lit until the pre-set force has been reached. If a problem occurs, the operator can determine whether the start signal is being received from the power supply.

Section III: Sequence of Operation

As shown in figure 1-4, there are five components involved in operation of the system: Operator; Footswitch (1 level or 2 level), Power Supply, Weld Head, Parts

General Overview:

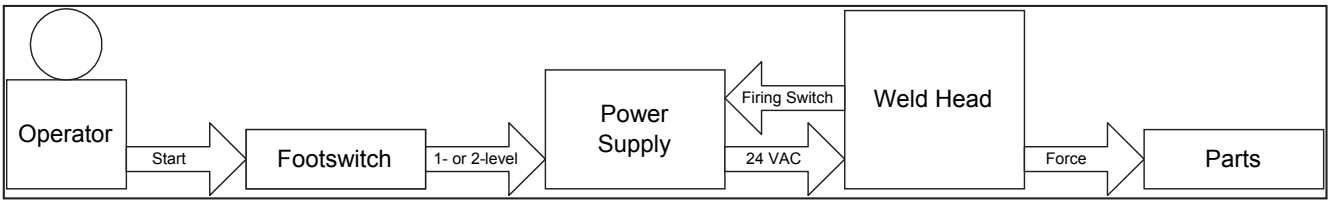

Figure 1-4. Welding Operations Components

The operator initializes the weld sequence by depressing the footwitch, which provides a start signal to the power supply. The power supply sends a 24 VAC/DC signal to the EZ-AIR, which triggers the valve to actuate the Slide and Cylinder Assembly and drive the Force Module downward. Once the set force has built up on both electrodes, the Force Module initiates a firing switch signal, sending it to the EZ-AIR. The EZ-AIR then closes two valves to lock the movement of the cylinder in the Valve and Cylinder Assembly. Simultaneously, the EZ-AIR sends the firing switch signal to the power supply to initiate the weld sequence. At the end of the weld sequence the EZ-AIR opens the valves to allow the slide to return the force module to its home position. A new operation can now begin.

There is a slight difference in sequence between a system running with a one-level or two-level footswitch, explained below:

Two-Level Foot Switch Operation

A weld sequence begins when the operator presses the foot switch to the first position. This sends a signal to the power supply, which begins the weld sequence by sending a signal to the EZ-AIR. (The operation of the EZ-AIR is described in more detail below.) The EZ-AIR moves the weld head electrodes to the welding surfaces. When the pre-set squeeze force is obtained, the Force Module sends a signal back to the EZ-AIR, which sustains that squeeze force. The operator can now check the items to be welded to verify proper placement. If satisfied with the placement, the operator presses the foot switch to the second position, and the power supply provides the complete pre-programmed weld cycle from squeeze through hold. (If unsatisfied, the operator needs only to release the foot switch, and the electrodes will rise, allowing realignment of the weld pieces.)

One Level Foot Switch Operation

The one-level foot switch operation works as above, but the entire sequence is actuated with the pressing of the foot switch. There is no pause to allow the operator to check the proper placement of the parts. This operation can be slightly faster but provides less control if part fixtures are not used.

Note: Most power supplies have a function called “footswitch weld abort.” If this function is turned on, the operator can abort the operation at any time in the sequence before the force is reached if postioning is incorrect. If the function is turned off, the operation cannot be terminated, but will continue through its completion.

Operation of the EZ-AIR

EZ-AIR uses a single four-way solenoid valve to direct air between the down solenoid valve and the up solenoid valve (figure 1-5), as described below.

① Initial Air Applied. Upon initial application of air (whether or not power is applied), air pressure is applied through the four-way solenoid valve and the up solenoid valve to the lower chamber of the cylinder, driving the piston up. Air is exhausted through the four-way solenoid valve.

② Down Stroke. During the electrode down stroke, air pressure is directed to the upper chamber of the cylinder, forcing the piston down. Waste air exhausts from the lower chamber through the up solenoid valve and the four-way solenoid valve.

③ Constant Force. When the electrode reaches weld force, the up and down solenoid valves close and air is trapped in both the upper and lower chambers of the cylinder. Weld force remains constant as the air cylinder piston cannot move. The four-way solenoid valve also switches to its off position, reversing the air connections to the up and down solenoid valves.

④ Up Stroke. At the completion of the weld, the up and down solenoid valves open. This causes the application of air pressure to the lower chamber of the cylinder, returning the piston to its up position.

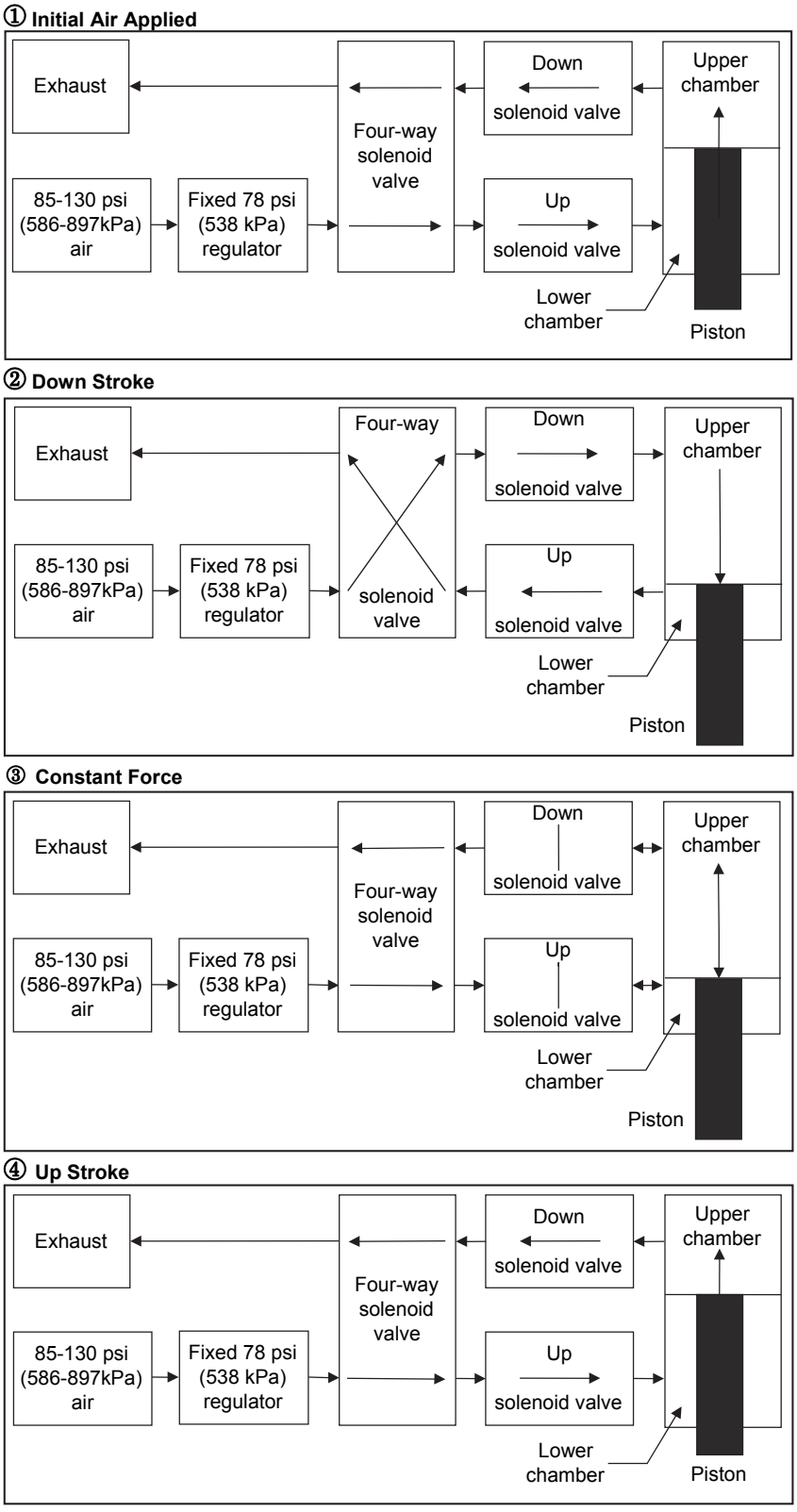

Figure 1-5. EZ-AIR Sequence of Operation

CHAPTER 2
GETTING STARTED

Section I: Planning for Installation

The Weld Head comes fully assembled from the shipping box. The only installation requirements are planning the work space, installing the electrodes, and connecting the unit to the appropriate power supply with the cables provided in the Ship Kit.

Space Requirements

An outline drawing of the Weld Head is included in Appendix A. Additional space must be allowed for the power supply. The specific dimensions of the Weld Head are:

Width:	10.0 in. (25.4 mm)
Depth	17.25 in. (43.82 mm)
Height	15.0 in. (38.1 mm) maximum
Weight	21 lb. (10 kg)

Power Requirements

The Weld Head requires 24 VAC/DC -5%/+10%, ½A, which may be available from the power supply. In addition, the weld head requires welding current from the power supply. Refer to the power supply user's manuals for power requirements of that unit.

Compressed Air Requirements

The EZ-AIR requires a 1/8 inch F'NPT fitting connected to a shop air source of 85–130 psi (586–897 kPa). It is recommended that an auto drain air filter with a 5-micron element (Amada Miyachi America Part Number 10-373-01, catalog number ADAF) be placed in the air line.

CAUTION: A shop air compressor using synthetic oil will cause damage to the EZ-AIR. Petroleum-based oil only is recommended.

Section II: Weld Head Set-up

Unpacking

Unpack the Weld Head from its shipping box and verify that all components of the Ship Kit, shown in table 2-1 are present. The Weld Head comes from the shipping box completely assembled except for the electrodes. They are installed and adjusted in accordance with directions given in Chapter 3, Operating Instructions.

NOTE: Carefully put the packing materials back in the packing boxes and store for future shipping.

Table 2-1. Components of Ship Kit

Item	Component	Amada Miyachi America Part Number	Qty
1	Bolt, hex hd, M8-1.25 x 16 mm	160-048	2
2	Brochure, accessories	991-161	1
3	Cable assy, 2/0	4-35386-01	2
4	Electrode, 1.5 mm	4-35686-01	2
5	Fitting, ¼ in. tube, 1/8 in. M'NPT	325-185	1
6	Gauge, electrode adjustment	4-35675-01	1
7	Hex key set	770-034	1
8	Installation drawing	4-35684-01	1
9	Nut, hex, M8-1.25	465-206	2
10	Polishing disk	4-04688-01	1
11	Screw, cap, socket hd, M8x1.25	625-893	2
12	Ship Kit drawing	4-35714-01	1
13	Terminal ring, #6	700-103	2
14	Tubing, plastic, ¼-in. diam OD	050-138	6 ft
15	User's manual	990-111	1
16	Washer, Flat, 5/16	755-044	4
17	Wrench, Allen, 5 mm, short	770-027	1
18	Wrench, Allen, 5 mm, ball	770-042	1

Installation

Installation consists of setting the assembled Weld Head on the work bench, connecting the power and signal cables, and connecting the shop air pneumatic tubing. See figure 2-1.

Pneumatic Connection

The Ship Kit contains a fitting for shop air (item 5) with a 1/8 in. M'NPT thread. Connect the fitting to the shop air fitting.

NOTE: The pneumatic tubing end cuts must be smooth and square. We recommend using an SMC TKA-1 tube cutter. Do not use pliers, wire nippers or scissors.

Cut the pneumatic tubing in the Ship Kit (item 14) to the appropriate length and using the push-in fittings, connect the shop air pneumatic tubing to the Weld Head air supply input.

NOTE: Be sure the tubing is pushed in all of the way to prevent leakage.

NOTE: Be sure the EZ-Clean (red) valve is in the down position

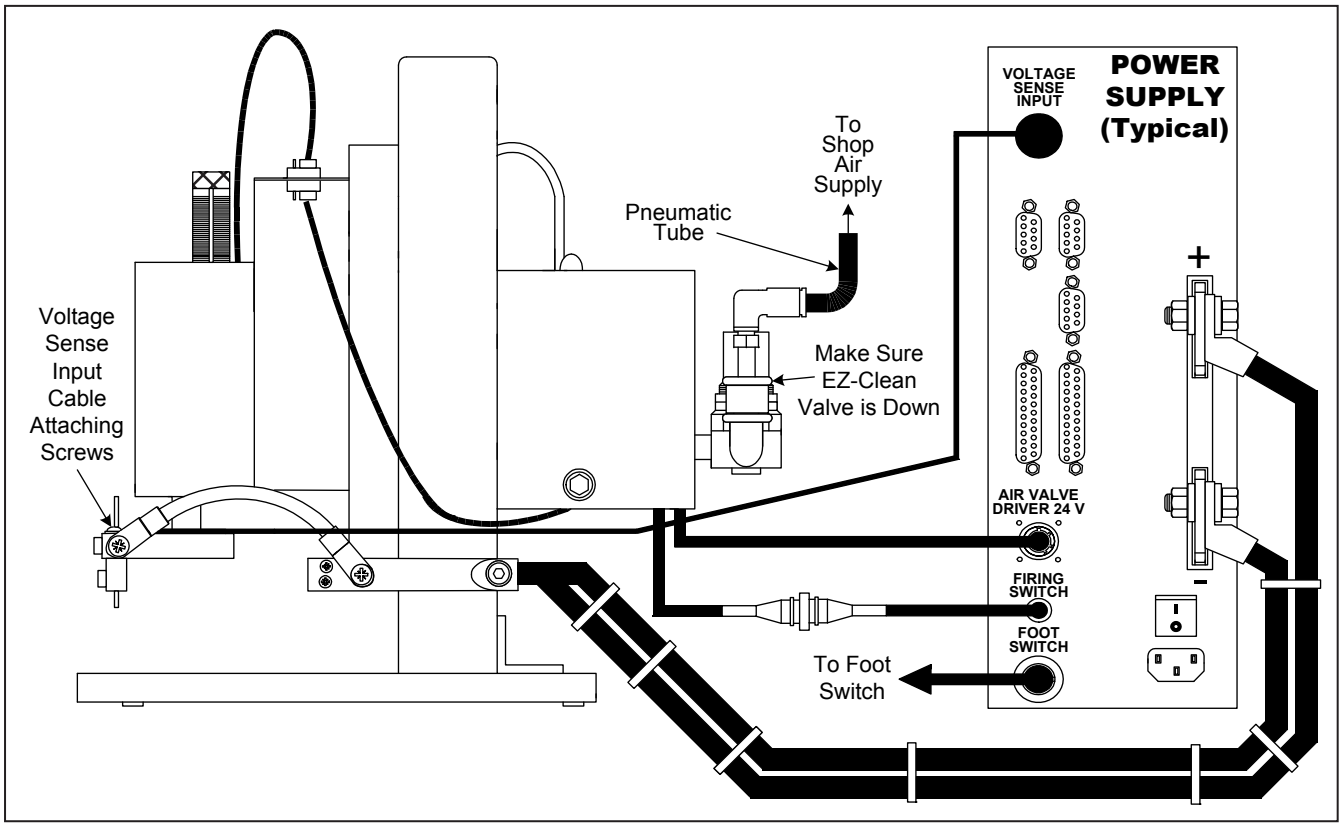

Figure 2-1. Weld Head Installation Connections

Power and Signal Connections

1 Connect the 24 VAC/DC air valve driver cable to a 24 VAC or 24 VDC power source. (All current models of Miyachi Unitek power supplies have 24 VAC or 24 VDC available on the rear of the power supply.)

2 Connect the firing switch cable connector to the firing switch connector on the power supply.

3 Locate the power supply voltage sense input cable. If it is equipped with any termination (other than with #6 terminal rings), remove those terminations, and crimp the #6 terminal rings from the Ship Kit (item 13) to the two wires. Attach the two wires to the top of the electrode holder assemblies with the screws already installed on the assemblies.

4 Connect the welding cables (item 3) in the Ship Kit between the power supply and the Weld Head. Route the cables parallel to each other and secure them together to prevent inductive loss. The cables are attached to the power supply with the two bolts (item 1), four washers (item 16), and two nuts (item 9) from the Ship Kit. The cables are attached to the Weld Head with the two cap screws (item 11).

5 Connect the foot switch cable to the power supply.

6 We recommend the use of 50 to 150 ms “squeeze time,” if that program feature exists on your power supply.

CHAPTER 3
OPERATING INSTRUCTIONS

Section I: Operating Precautions

General Operator Safety

WARNINGS

Always wear safety glasses any time you are operating the Weld Head.

Never wear loose clothing or jewelry when operating the Weld Head. It could be caught in the mechanism.

Before operating a Weld Head, read both this manual and the manual on the power supply. Particularly note the specific hazards associated with those components.

Section II: Preparing for Operation

Pre-Operational Checks

Before operating the equipment, verify that the power and compressed air connections are made to the Weld Head, as described in Chapter 2, Getting Started, and to the power supply, as described in its manual. Verify that all pneumatic connections are secure and that there are no air leaks.

Verify that the Weld Head and power supply are properly connected.

Pre-Operational Adjustments

Pre-operational adjustments include the electrode height, electrode gap, force adjustment, and weld head height on the weld head; and down speed control valve adjustment on the EZ-AIR.

Electrode Height

Install, if necessary, two electrodes (item 4) from the Ship Kit. Verify, and adjust if necessary, the electrodes in the electrode holders. Each electrode should extend 1/4- inch below its holder. The Ship Kit contains a gauge (item 6) for making the adjustment. See figure 3-1. Note

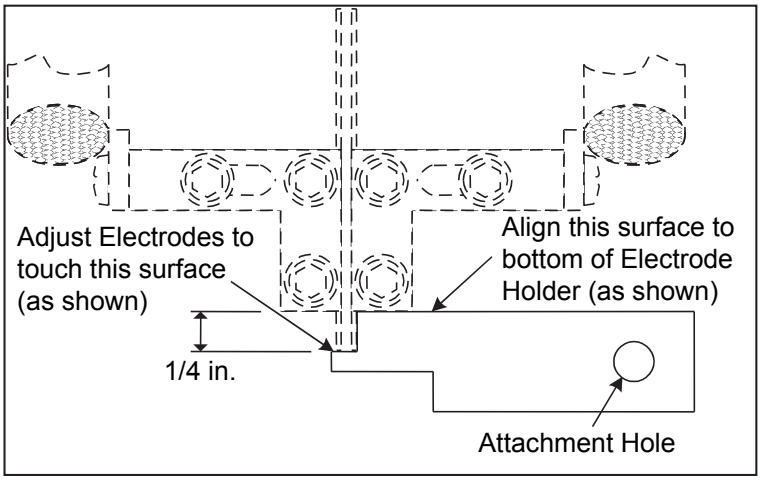

Figure 3-1. Use of Electrode Adjustment Gauge

that the gauge has a hole for convenient attachment to the Weld Head so that it is not misplaced.

To adjust the height of each electrode, loosen the two screws (figure 3-2) that secure the electrode, make the adjustment, and re-tighten the screws.

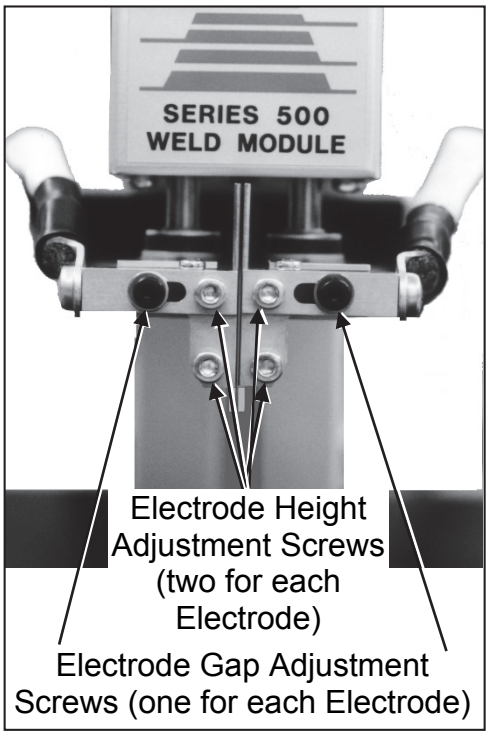

Figure 3-2. Electrode Adjustment Screws

Electrode Gap

Verify, and adjust if necessary, the electrode gap (the space between the electrodes) for your specific needs. The gap is adjustable to a maximum of 10 mm (0.0394 inch). A good starting point for most applications is a 1.5 mm gap.

To adjust the electrode gap, loosen the screw (figure 3-2) that secures each electrode holder, make the adjustment, and re-tighten the screw.

Force Adjustment

The force adjustment knobs allow the selection of separate weld forces for each electrode to produce equal size weld nuggets. The method of selecting force for each electrode is identical, so only one is described.

Refer to figure 3-3, and perform the following steps:

CAUTION: Before making adjustment, loosen the force locking set screw. **NOTE:** When unit is shipped from the factory, the set screw is <u>not</u> tightened against the force adjustment knob, so you will not initially need to loosen it. **However,** it is held in place by thread locking compound, so when you do tighten it you will feel resistance from the compound. Do not interpret this as the screw being tightened to the force adjustment knob.

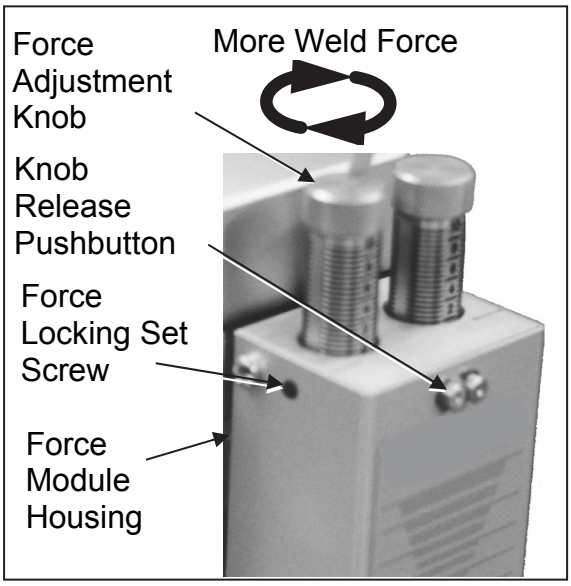

Figure 3-3 Weld Force Adjustment

1 Loosen the force locking set screw.

2 Press and hold in the knob release pushbutton.

3 Refer to figure 3-4 to determine the equivalent force adjustment knob setting for the desired electrode force

NOTE: The actual electrode force is affected by the down speed control adjustment (figure 1-3). A faster down speed setting results in a higher electrode force; a slower down speed setting results in a lower electrode force. For an exact weld force, we recommend that you use a separate force gauge (Amada Miyachi America Part Number FG20).

4 Turn the force adjustment knob until the desired force graduation mark is flush with the Force Module Housing surface, as in the examples shown in figure 3-5.

5 Release the knob release pushbutton.

NOTE: The adjustment knobs must be set so that the numbers face the front. This will assure that the flats on the shafts are on the side that will be secured with the force locking set screw. When the unit is shipped from the factory, the set screw is held in place by thread locking compound. Do not interpret the resistance from the compound as an indication that the screw is tightened to the force adjustment knob.

6 Re-tighten the force locking set screw to prevent unintentional adjustments.

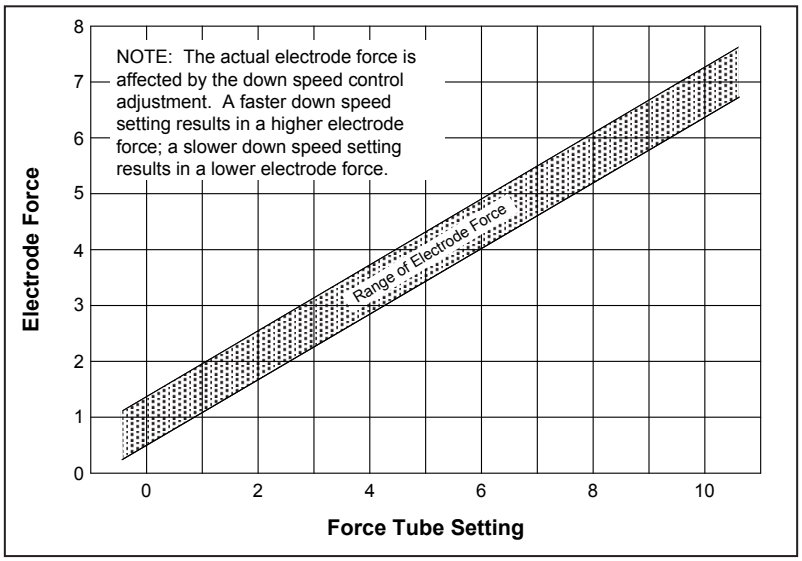

Figure 3-4. Electrode Force Adjustment Range

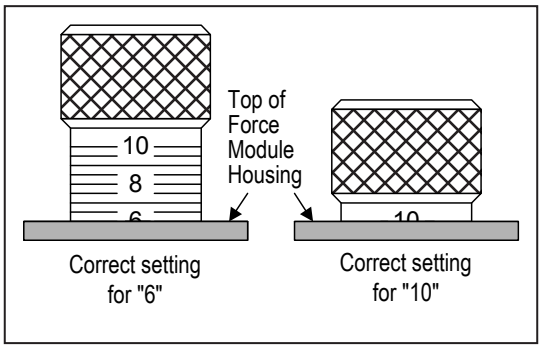

Figure 3-5. Proper Adjustments of Weld Force Adjustment Knobs

Module Actuator Assembly Height

To adjust the height of the Module Actuator Assembly, loosen the two Height Adjustment Screws (figure 1-2), adjust the height, and re-tighten the screws. A hex key set (item 7) and two 5 mm wrenches (items 17 and 18) are provided in the Ship Kit for these adjustments. Items 17 and 18 will be particularly useful for adjusting the bottom screw (not visible in figure 1-2). To do this, the Module Actuator Assembly must be pushed up. This will occur automatically when air is applied, or it can be done manually.

EZ-AIR Down Speed Control Valve Adjuster

To adjust the EZ-AIR Down Speed Control Valve Adjuster, perform the following steps:

NOTE: The equipment has to be operating before this adjustment can be made.

1 If the red EZ-Clean valve is in the purge position (up), push it all the way down.

2 Set the power supply so that the Weld Head can operate without performing a weld. For instance, on a Miyachi Unitek power supply, set the WELD/NO WELD switch to NO WELD.

3 Press the foot switch several times to operate the Weld Head and observe the down speed.

4 Set the Down Speed Control Valve Adjuster (figure 1-3) to provide an acceptable welding speed.

NOTE: Excessive electrode down speed causes excessive impact force on the parts. Electrodes should contact parts in a controlled manner. Most Miyachi Unitek power supplies have programmable squeeze time that allows force to stabilize prior to firing. A squeeze time setting between 50 and 150 ms is recommended.

Turning the Equipment On

To apply power to the unit, follow the directions in the respective power supply manual.

Section III: Operation

Once set-up is completed, there are no separate steps required during Weld Head operation except that the EZ-Clean valve (figure 1-3) can be actuated to purge the air during electrode dressing. To do so, push the EZ-Clean (red) slide valve up. To restore pressure, slide the valve down. See Chapter 4 , User Maintenance, for electrode dressing instructions.

CHAPTER 4
USER MAINTENANCE

Section I: Precautions

General Operator Safety

WARNINGS

Always wear safety glasses any time you are operating the Weld Head.

Never wear loose clothing or jewelry when operating the weld head. It could be caught in the mechanism.

Before operating the Weld Head, read this manual and the power supply manual. Particularly note the specific hazards associated with those components.

Section II: Operator Maintenance

Preventive Maintenance

The only preventive maintenance required is occasional lubrication of the EZ-Clean valve, whenever necessary. The valve should only be lubricated with a petroleum or lithium based grease.

CAUTION: Do not use synthetic oil. It will damage the EZ-AIR.

Routine Maintenance

The only routine maintenance is dressing the electrode tips periodically to remove oxides and welding debris This is simplified by the EZ-Clean valve which, when pushed to the purge (up) position, automatically allows the weld head to lower without disturbing any of the settings. To dress the electrodes, perform the following steps:

1 Fold a piece of 600 grit silicon carbide disk (item 10 in the Shipping Kit) over a *flat, rigid backing* with the grit surface facing outward. The rigid backing will maintain the flatness of the electrode face during dressing.

2 Place the silicon carbide disk and backing beneath electrodes, and slide the EZ-Clean (red) valve up. The electrodes should contact with the disk with a force that is low enough to allow the disk to be moved without damaging its surface.

3 Gently pull the emery paper forward one or two inches

4 Clean the electrode face with a small cotton swab saturated in alcohol.

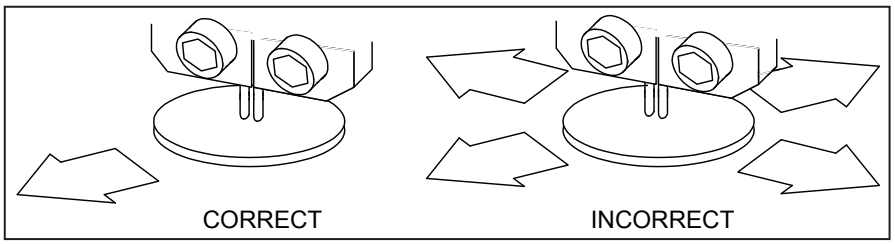

Figure 4-1. Dressing Electrodes

Corrective Maintenance

The only recommended user corrective maintenance is clearing foreign matter from the EZ-AIR that might jam a valve open. If the weld head fails to move up or down, refer to table 4-1 and perform the actions prescribed.

Table 4-1. Troubleshooting Table

NOTE: Table presumes all power and pneumatic connections are made and properly adjusted.

Fault	Check for:	Possible Cause	Action
Weld head does not move upward when air is first applied.		Problem with input shop air.	Verify correct input shop air pressure. See Chapter 2, Compressed Air Requirements.
		EZ-Clean valve is closed (in up position).	Open valve by pushing downward.
		Internal valve is stuck.	Contact company representative.
Weld head does not go downward when footswitch is pressed (first position for two-level foot switches).	Neither green firing indicator nor amber initialization signal received indicator light.	Problem exists in power supply, footswitch, or cable connections.	Check cable connections. Refer to appropriate power supply manual.
	Amber initialization signal received indicator is lit.	Internal valve is stuck.	Contact company representative.
		Down Speed Control valve is closed.	Turn valve counterclockwise to open.
Weld head moves downward too forcefully when footswitch is pressed (first position for two-level foot switches).		Down Speed Limiter valve requires adjustment.	Contact company representative.

Spare Parts

Table 4-2 lists the spare parts that we recommend that you have available for user maintenance. The quantities listed are those used in the assembly.

Table 4-2. Recommended Spare Parts List

Component	Amada Miyachi America Part Number	Qty
Bolt, hex hd, M8-1.25 x 16 mm	160-048	2
Cable assy, 2/0	4-35386-01	2
Cable, weld	4-35674-01	2
Electrode set (2), 1.5 mm	ES0250M	1
Gauge, electrode adjustment	4-35675-01	1
L-block, electrode holder (right)	4-35644-01	1
L-block, electrode holder (left)	4-35644-02	1
Mounting block, electrode holder	4-35643-01	2
Nut, hex, M8-1.25	465-206	2
Polishing disk (package of 50)	PD	1
Screw, cap, socket hd, M4x12mm	625-825	4
Screw, cap, socket hd, M4x18mm	625-941	2
Screw, cap, socket hd, M5x18mm	625-836	2
Screw, cap, socket hd, M8x1.25	625-893	2
Screw, pan hd, phillips, M5x10, w/ nylok	625-948	4
Tubing, plastic, ¼-in. diam OD	050-138	6 ft
Washer, flat, M4	755-318	2

Repair

If problems cannot be resolved using the above troubleshooting table, contact Amada Miyachi America at the address/telephone/fax shown in the Foreword.

APPENDIX A
SPECIFICATIONS

Table A-1. Specifications

ITEM	SPECIFICATION
Dimensions	Width: 10.0 in. (25.4 mm) Depth 17.25 in. (43.82 mm) Height 15.0 in. (38.1 mm) maximum
Weight	21 lb. (10 kg)
Power Requirements	24 VAC/DC -5% / +10%, ½A (From power supply)
Compressed air Requirements	85–130 psi . (586–897 kPa) An auto drain air filter with a 5-micron element (Amada Miyachi America Part Number 10-373-01, catalog number ADAF) is recommended. **CAUTION:** Compressor supplying air must not be lubricated with synthetic oil.
Operating Environment	60-113ºF (15.5-45ºC) 93% Relative Humidity (maximum) at 104ºF (40ºC)
Weld Force	1 - 7 lb (0.5 – 3.2 kg) (each electrode)
Gap Adjustment	up to 0.0394 in. (10 mm)

Outline Drawing

(Dimensions are in inches)

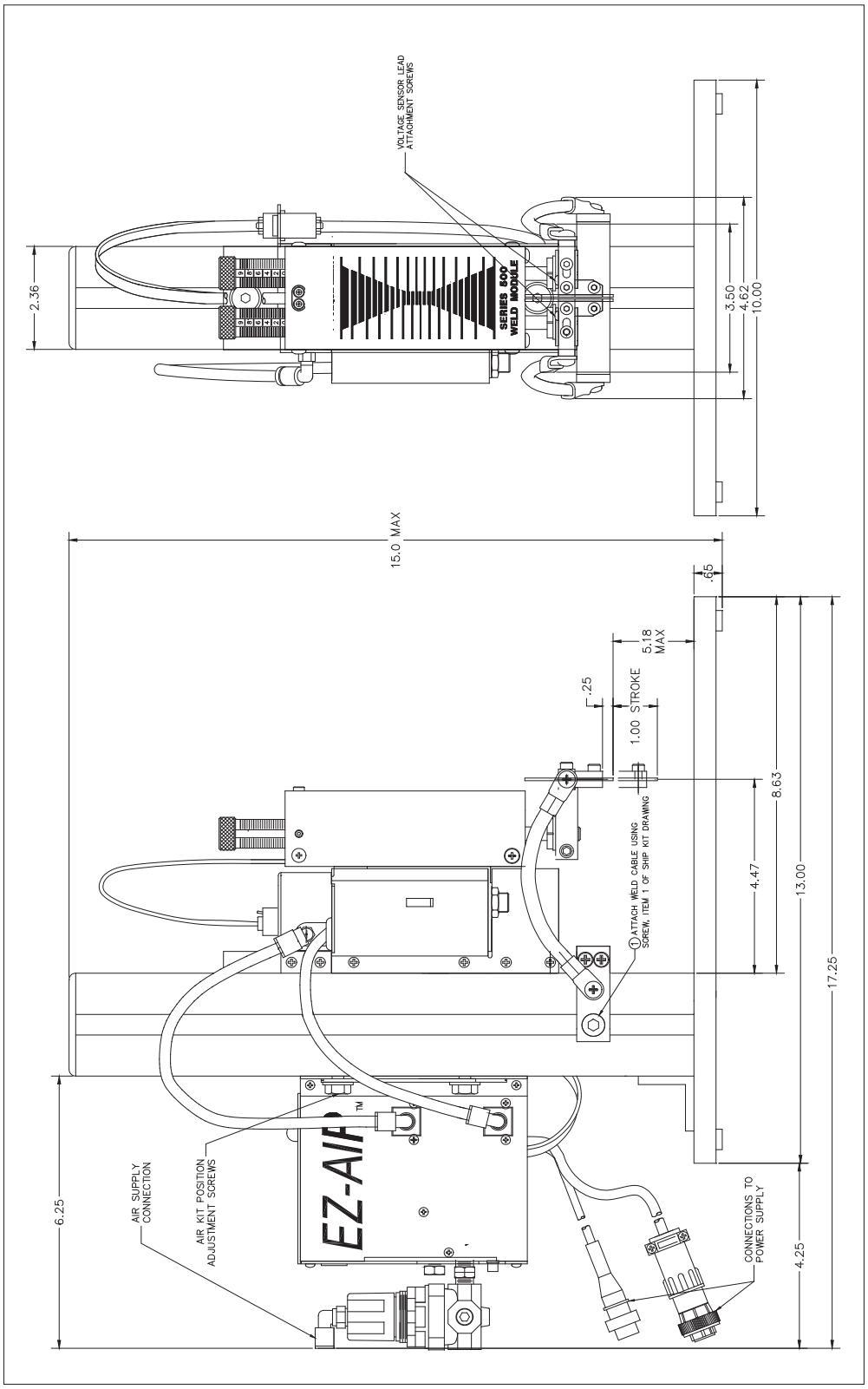

Figure A-1. Outline Drawing

APPENDIX B
THE BASICS OF RESISTANCE WELDING

Section I: General Data

Resistance Welding Parameters

Resistance welding heat is produced by passing electrical current through the parts for a fixed time period. The welding heat generated is a function of the magnitude of the weld current, the electrical resistance of the parts, the contact resistance between the parts, and the weld force applied to the parts. Sufficient weld force is required to contain the molten material produced during the weld. However, as the force is increased, the contact resistance decreases. Lower contact resistance requires additional weld current, voltage, or power to produce the heat required to form a weld.

1 The higher the weld force, the greater the weld current, voltage, power, or time required to produce a given weld. Low weld force usually results in lower bond strength. Increased weld force requires higher energy but usually results in a stronger bond. Weld Heat is proportional to the square of the welding current (I), the total electrical resistance (R_t), and the weld time (t) and is inversely proportional to the contact area (A). . Figure B-1 illustrates the effect of weld force on the parts.

Welding Parameter Interaction

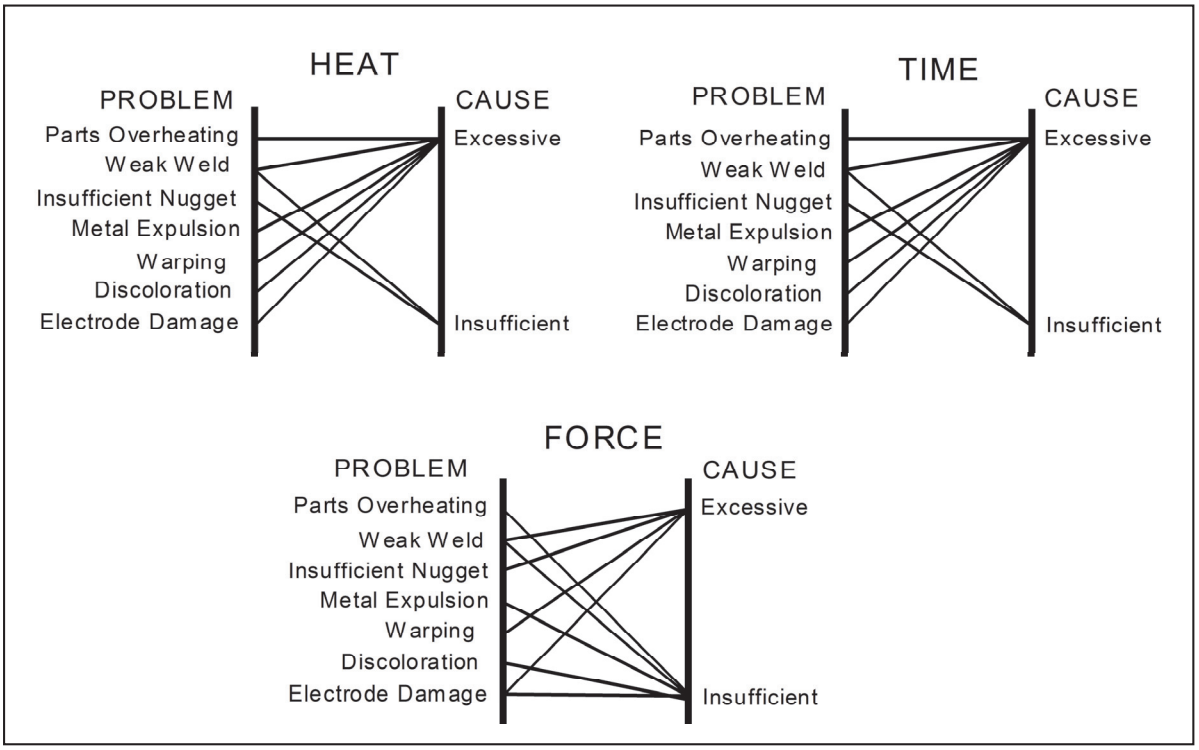

Figure B-1. Interaction of Welding Parameters

Electrode Selection

Correct electrode selection strongly influences how weld heat is generated in the weld area. In general, use conductive electrodes such as a RWMA-2 (Copper alloy) when welding electrically resistive parts such as nickel or steel so that the weld heat is generated by the electrical resistance of the parts and the contact resistance between the parts. Use resistive electrodes such as RWMA-13 (Tungsten) and RWMA-14 (Molybdenum) to weld conductive parts such as copper and gold because conductive parts do not generate much internal heat so the electrodes must provide external heat. Use the following Electrode Selection Table for selecting the proper electrode materials.

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Alumel	-2	Alumel	-2
Alumel	-2	Chromel	-2
Alumel	-2	Dumet	-2
Aluminum	-1	Aluminum	-1
Aluminum	-1	Aluminum Alloys	-1
Aluminum	-1	Cadmium Plating	-1
Aluminum	-1	Tinned Brass	-14
Aluminum	-1	Tinned Copper	-14
Aluminum	-1	Gold Plated Dumet	-2
Aluminum	-1	Gold Plated Kovar	-2
Aluminum	-1	Kovar	-2
Aluminum	-1	Magnesium	-1
Aluminum	-1	Cold Rolled Steel	-2
Aluminum	-1	Stainless Steel	-2
Beryllium Copper	-2	Beryllium Copper	-2
Beryllium Copper	-2	Brass	-2, -14
Beryllium Copper	-2	Copper	-14
Beryllium Copper	-2	Tinned Copper	-14
Beryllium Copper	-2	Nickel	-2
Beryllium Copper	-2	Cold Rolled Steel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Beryllium Copper	-2	Stainless Steel	-2
Brass	-2, -14	Brass	-2, -14
Brass	-2, -14	Tinned Brass	-14
Brass	-2, -14	Consil	-2
Brass	-2, -14	Constantan	-2
Brass	-2, -14	Copper	-14
Brass	-2, -14	Tinned Copper	-14
Brass	-2, -14	Dumet	-2
Brass	-2, -14	Nichrome	-2
Brass	-2, -14	Nickel	-2
Brass	-2, -14	NiSpan C	-2
Brass	-2, -14	Paliney 7	-2
Brass	-2, -14	Silver	-11, -14
Brass	-2, -14	Cold Rolled Steel	-2
Brass	-2, -14	Stainless Steel	-2
Bronze	-2, -11	Bronze	-2, -11
Bronze	-2, -11	Tinned Copper	-14
Bronze	-2, -11	Iron	-2
Bronze	-2, -11	Nichrome	-2
Bronze	-2, -11	Nickel	-2
Chromel	-2	Chromel	-2
Chromel	-2	Constantan	-2
Chromel	-2	Copel	-2
Chromel	-2	Copper	-14

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Chromel	-2	Tinned Copper	-14
Chromel	-2	Dumet	-2
Chromel	-2	Nichrome	-2
Chromel	-2	Cold Rolled Steel	-2
Consil	-2	Consil	-2
Consil	-2	Tinned Copper	-14
Consil	-2	Dumet	-2
Constantan	-2	Constantan	
Constantan	-2	Copper	-14
Constantan	-2	Tinned Copper	-14
Constantan	-2	Iron	-2
Constantan	-2	Nichrome	-2
Constantan	-2	Nickel	-2
Copper	-14	Copper	-14
Copper	-14	Dumet	-2
Copper	-14	Invar	-2
Copper	-14	Karme	-2
Copper	-14	Manganin	-2
Copper	-14	Nichrome	-2
Copper	-14	Nickel	-2
Copper	-14	Paliney 7	-2
Copper	-14	Silver	-11, -14
Copper	-14	Cold Rolled Steel	-2
Copper	-14	Stainless Steel	-2
Dumet	-2	Dumet	-2
Dumet	-2	Nichrome	-2
Dumet	-2	Nickel	-2
Dumet	-2	Platinum	-2
Dumet	-2	Cold Rolled Steel	-2
Evanohm	-14	Copper	-14
Gold	-14	Gold	-14
Gold	-14	Kovar	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Hastalloy	-2	Titanium	-2
Inconel	-2	Inconel	-2
Inconel	-2	Kulgrid	-2
Invar	-2	Invar	-2
Iridium	-2	Iridium	-2
Iridium	-2	Platinum	-2
Iron	-2	Iron	-2
Karma	-2	Karma	-2
Karma	-2	Nickel	-2
Karma	-2	Platinum	-2
Kovar, Gold Plate	-2	Kovar, Gold Plate	-2
Kovar, Gold Plate	-2	Kulgrid	-2
Kovar, Gold Plate	-2	Nickel	-2
Kovar, Gold Plate	-2	Silver	-11, -14
Kovar, Gold Plate	-2	Stainless Steel	-2
Magnesium	-1	Magnesium	-1
Molybdenum	-2	Molybdenum	-2
Molybdenum	-2	Nickel	-2
Molybdenum	-2	Tungsten	-2
Nichrome	-2	Nichrome	-2
Nichrome	-2	Nickel	-2
Nichrome	-2	Cold Rolled Steel	-2
Nichrome	-2	Stainless Steel	-2
Nickel	-2	Nickel	-2
Nickel	-2	Cold Rolled Steel	-2
Nickel	-2	Stainless Steel	-2
Nickel	-2	Tantalum	-2
Nickel	-2	Tungsten	-2
Nickel Alloy	-2	Nickel Alloy	-2
Nickel Alloy	-2	Tinned Brass	-14

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Nickel Alloy	-2	Beryllium Copper	-2
Nickel Alloy	-2	Consil	-2
Nickel Alloy	-2	Tinned Copper	-14
Nickel Alloy	-2	Nichrome	-2
Nickel Alloy	-2	Nickel	-2
Nickel Alloy	-2	Cold Rolled Steel	-2
NiSpan C	-2	NiSpan C	-2
NiSpan C	-2	Cold Rolled Steel	-2
NiSpan C	-2	Stainless Steel	-2
Niobium	-2	Niobium	-2
Platinum	-2	Platinum	-2
Paliney 7	-2	Paliney 7	-2
Silver	-11, -14	Silver	-11, -14
Silver	-11, -14	Cadmium	-13

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Silver	-11, -14	Cold Rolled Steel	-2
Silver	-11, -14	Stainless Steel	-2
Cold Rolled Steel	-2	Cold Rolled Steel	-2
Cold Rolled Steel	-2	Stainless Steel	-2
Cold Rolled Steel	-2	Tantalum	-2
Stainless Steel	-2	Stainless Steel	-2
Stainless Steel	-2	Tungsten	-2
Tantalum	-2	Tantalum	-2
Titanium	-2	Titanium	-2
Tungsten	-2	Tungsten	-2
Tungsten	-2	henium	-2
Zinc	-14	Zinc	-14

Electrode Maintenance

Depending on use, periodic tip resurfacing is required to remove oxides and welding debris from electrodes. Cleaning of electrodes on the production line should be limited to use of #400-600 grit electrode polishing disks. For less critical applications, a file can be used to clean a badly damaged tip. However, after filing, polishing disks should then be used to ensure that the electrode faces are smooth. If this is not done, the rough surface of the electrode face will have a tendency to stick to the work piece.

Weld Schedule Development

Developing a weld schedule is a methodical procedure, which consists of making sample welds and evaluating the results. The first weld should be made at low energy settings. Adjustments are then made to each of the welding parameters ***one at a time*** until a successful weld is made.

1 Install the correct electrodes in the electrode holders on the Weld Head. See the preceding table for electrode material recommendations.

2 Use a flat electrode face for most applications. Use a "domed" face if surface oxides are a problem. If either of the parts is a wire, the diameter of the electrode face should be equal to or greater than the diameter of the wire. If both parts are flat, the face should be at least one-half the diameter of the electrodes. Pencil point electrodes cause severe electrode sticking to the parts, unexplained explosions, and increase the weld heat substantially because of the reduced electrode-to-part contact area.

3 Use the Force Adjustment Knob on the Weld Head to set the Firing Force and adjust the EZ-AIR per the detailed instructions found in Chapter 3: Operating Instructions. Figure B-1 illustrates the effect

of weld force on the parts.

4 Refer to the recommendations in Chapter 3, Operating Instructions, to make your first weld. Always observe safety precautions when welding and wear safety glasses.

5 Use pliers to peel the welded materials apart. A satisfactory weld will show residual material pulled from one material to the other. Tearing of base material around the weld nugget indicates a material failure NOT a weld failure. Excessive electrode sticking and/or "spitting" should define a weld as unsatisfactory and indicates that too much weld current, voltage, power, or time has been used.

6 If the parts pull apart easily or there is little or no residual material pulled, the weld is weak. Increase the weld time in 1 msec increments. Increase weld current, voltage, or power if a satisfactory weld achieved using 10 msec of weld time.

Note: Actual weld strength is a user-defined specification.

7 Polarity, as determined by the direction of weld current flow, can have a marked effect on the weld characteristics of some material combinations. This effect occurs when welding materials with large differences in resistivity, such as copper and nickel or when welding identical materials with thickness ratios greater than 4 to 1. The general rule is that the more resistive material or the thinner material should be placed against the negative (-) electrode. Polarity on the power supply can only be changed by reversing the weld cables.

Weld Strength Testing

Destructive tests should be performed on a random basis using actual manufacturing parts. Destructive tests made on spot welds include tension, tension-shear, peel, impact, twist, hardness, and macro-etch tests. Fatigue tests and radiography have also been used. Of these methods torsional shear is preferred for round wire and a 45-degree peel test for sheet stock.

Weld Strength Profiles

Creating a weld strength profile offers the user a scientific approach to determining the optimum set of welding parameters and then displaying these parameters in a graphical form.

1 Start at a low weld current, voltage, or power, making five or more welds, then perform pull tests for each weld. Calculate the average pull strength. Increase weld current, voltage, or power and repeat this procedure. Do not change the weld time, weld force, or electrode area.

2 Continue increasing weld current, voltage, or power until any unfavorable characteristic occurs, such as sticking or spitting.

3 Repeat steps 1 and 2 for different weld forces, then create a plot of part pull strength versus weld current, voltage, or power for different weld forces as shown in Figure B-2.

4 Repeat steps 1 through 3 using a different but fixed weld time.

Figure B-2 illustrates a typical weld strength profile. The 14 lb electrode force curve shows the highest pull strengths but the lowest tolerance to changes in weld current, voltage, or power. The 12 lb electrode force curve shows a small reduction in pull strength, but considerably more tolerance to changes in weld energy. Weld heat will vary as a result of material variations and electrode wear.

The 12 lb electrode force curve is preferred. It shows more tolerance to changes in weld current, voltage, or power and has nearly the same bond strength as the 14 lb electrode force curve.

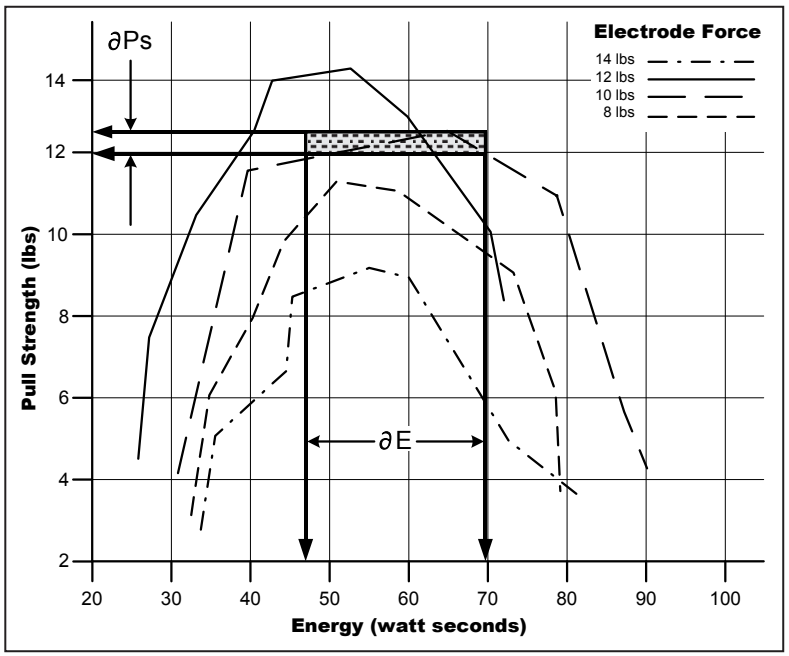

Figure B-2. Typical Weld Strength Profile Chart

A comparison of weld schedules for several different applications might show that they could be consolidated into one or two weld schedules. This would have obvious manufacturing advantages.

Section II: Basic Principles of Resitance Welding For Battery Pack Manufacture.

Two requirements must be met in order to form a weld. First, the oxide layer covering the surface of the metals must be displaced. Second, the irregular surfaces must be brought into intimate contact with each other. Resistance welding uses a combination of heat, time and pressure. Electrode pressure is used to force the materials together and controls the resistance between the two. Heat is generated by the resistance of the work pieces to the flow of electricity. When the current flow stops and the electrode force is maintained, the weld or molten zone is cooled and solidifies. A nugget is formed.

Refer to figure B-3. At the beginning of the weld the relatively rough surfaces of the metals when forced together form peaks. On the peaks where the contact pressure is sufficiently high, the oxide layer breaks down, forming metal to metal bridges. The weld current is distributed over a large area as it passes through the bulk metal (R5 and R8 in the example). As the current approaches the interface (R6 and R7) it is forced to flow through the metallic bridges. This “necking” down increases the current density, generating enough heat to cause melting. As the bridges melt, the resistance of the molten metal becomes higher than that of the new remaining bridges and the current flow transfers from bridge to bridge. This process continues until the entire surface is molten or until the current flow stops and the electrodes rapidly cool the metal.

Note: In the example there is significantly less resistance in path R1, R3, R5, R4, and R2 for current to flow than in current flowing though into R6, R8 and R7. Therefore the majority of the welding current shunts across the tab in the example given.

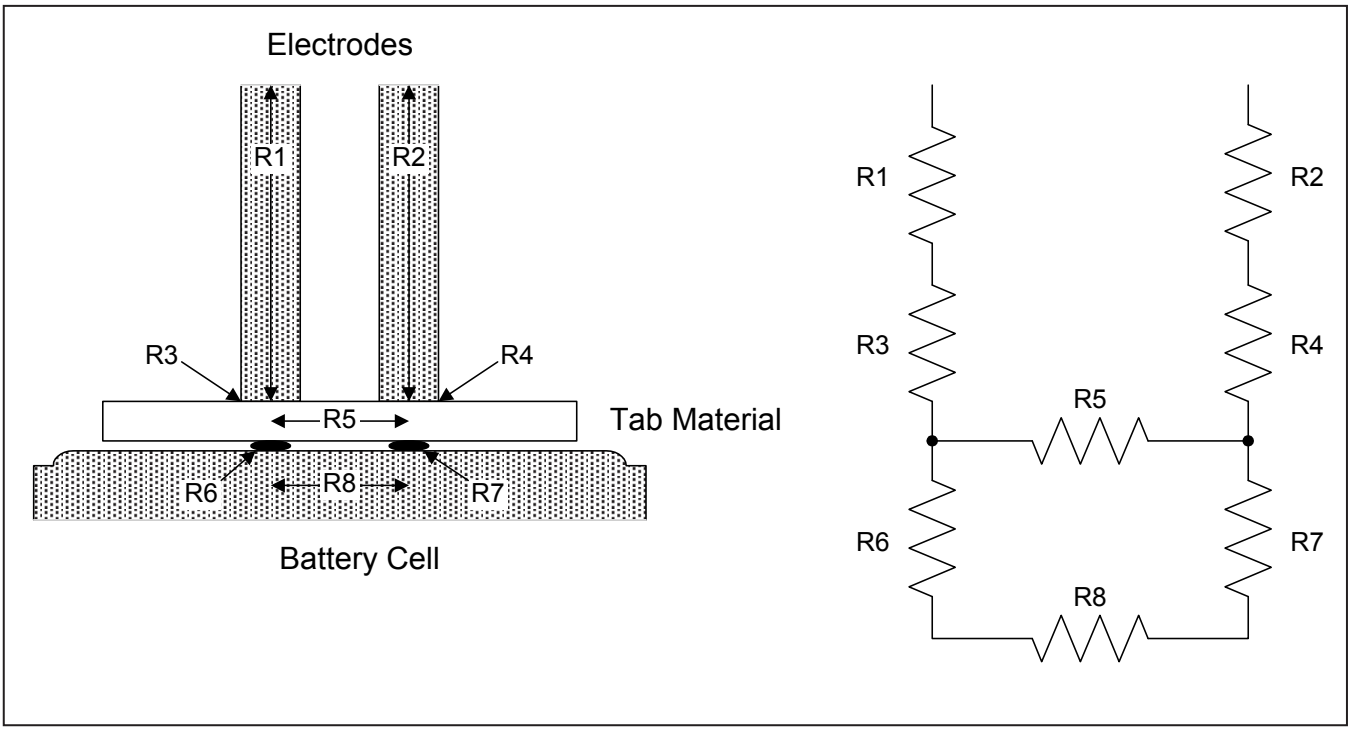

Figure B-3. Actual and Schematic Representation of Resistance Welding

Process Variables

Successful battery welding depends primarily on controlling four variables: materials, energy, time and force. Secondary factors include positioning, electrode diameter and shape, and finally operator training. Many users tend to focus on the energy and time variable to the exclusion of materials and the other secondary variables. Consistent positioning and good material and part design are vital to achieving a quality robust process.

Material Control

There are five main types of tab materials used in the battery industry:

- Pure nickel (Ni 200)
- Cold rolled steel (CRS)
- Ni plated CRS
- Ni plated CRS with brighteners
- Diffusion – annealed Ni plated CRS

Nickel 200 and cold rolled steel are easily welded, but nickel 200 is more expensive and cold rolled steel does not protect the material from oxide build up. Nickel plated steel is an obvious way to cut costs, but its use will not guarantee good results, particularly if brightening treatments are applied to either the tab or the cell.

Energy and Time Control

There are four main power supply technologies used for battery pack manufacture:

- Capacitor Discharge – open loop.
- AC (alternating current) – open loop.
- High Frequency Inverter – closed loop.
- Linear DC – closed loop.

In general all welding technologies are capable for battery pack manufacture. Capacitor discharge technology provides fast rise time and short weld time, which is ideal for many applications (repetition rates can be an issue for faster high-energy welds). AC or alternating current is a very flexible technology for many applications but lacks fine energy control and resolution of time control for more critical applications. Inverter and linear DC welding technology is preferred for critical applications that require the highest quality and repeatability. The closed loop feedback control can compensate for minor part and positional variables. A typical battery weld of 0.005" tab to cell will require between 1500 and 2100 amperes for 2-4 milliseconds.

Force Control

Force control is very important in the process as it controls resistance values R3, R6, R7, and R4. If too little force is applied Resistances R3 and R4 will be too high. This will cause the heat generated at these points to be high and will result in weld splash, electrode sticking and weak welds. If the force set is too high the resistances R6 and R7 will become too low. This will cause heat generation to be low and will result in weak welds. There needs to be enough force applied to minimize the contact resistances R3 and R4 while maintaining enough resistance at R6 and R7 to form sufficinet weld nuggets. A good starting point is 3-4 pounds force per electrode. Force may have to be adjusted for the positive and negative electrodes if polarity causes unequal nugget dimensions.

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AMADA MIYACHI CO., LTD.

http://www.amy.amada.co.jp/e/

AMADA MIYACHI AMERICA, INC.
1820 South Myrtle Ave., Monrovia, CA 91016, U.S.A.
TEL. +1-626-303-5676 FAX. +1-626-358-8048
http://amadamiyachi.com

AMADA MIYACHI CO., LTD.
200, Ishida, Isehara-shi, Kanagawa 259-1196, Japan

AMADA MIYACHI KOREA CO., LTD.
28, Dongtanhana 1-gil, Hwaseong-si, Gyeonggi-do, 445320, Korea
TEL. +82-31-8015-6810 FAX. +82-31-8003-5995

AMADA MIYACHI SHANGHAI CO., LTD.
Room01,15th Floor, SML Center, No.610 Xujiahui Road, Huangpu District, Shanghai 200025, China
TEL. +86-21-6448-6000 FAX. +86-21-6448-6550

AMADA MIYACHI EUROPE GmbH
Lindberghstrasse 1, DE-82178 Puchheim, Germany
TEL. +49-89-839403-0 FAX. +49-89-839403-10

AMADA MIYACHI TAIWAN CO., LTD.
Rm.5, 2F., No.9, Dehui St., Zhongshan Dist., Taipei 10461, Taiwan (R.O.C.)
TEL. +886-2-2585-0161 FAX. +886-2-2585-0162

AMADA MIYACHI VIETNAM CO., LTD.
M floor, 400 Nguyen Thi Thap Street, Tan Quy Ward, District 7, Ho Chi Minh City, Vietnam
TEL. +84-8-3771-7972 FAX. +84-8-3771-7974

AMADA MIYACHI (THAILAND) CO., LTD.
40/14 Bangna Tower C, 17th Floor, Unit B, Moo 12, T.Bangkaew, A.Bangplee Samutprakarn 10540, Thailand
TEL. +66-2-751-9337-8 FAX. +66-2-751-9340

AMADA MIYACHI INDIA PVT. LTD.
Ground Floor, Raj Arcade, 5th "A" 1st Cross, HRBR Layout, Kalyan Nagar, Bangalore-560 043, India
TEL. +91-80-4092-1749 FAX. +91-80-4091-0592

AMADA MIYACHI DO BRASIL LTDA.
Av. Tamboré, 965/973, Salas P22 e F11, 06460-000, Barueri, SP, Brasil
TEL. +55-11-4193-1187

AMADA MIYACHI AMERICA, INC.
1820 South Myrtle Ave., Monrovia, CA 91016, U.S.A.
TEL. +1-626-303-5676 FAX. +1-626-358-8048