

# Owner's Manual

## (Operations and Maintenance)

### (CE)

# AVD250

*Featuring "VS Technology"*

## Serial #77103



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# Declaration of Conformity for European Community

## (CE) Products:

**\*NOTE:** *This information is provided for units with CE certification*

Manufacturer: Thermion, Inc.  
PO Box 780  
Silverdale, Washington 98383  
USA  
Phone: 360-692-6469  
877-884-3428  
010-360-692-6469  
Email: info@thermioninc.com  
Service: Dean Hooks - 360-265-3649

Declares that the product: **AVD250**  
*featuring "VS Technology"*

Conforms to the following Directives and Standards:

- Machinery Directive: 89/368/EEC
- Low Voltage Directive: 73/23/EEC

*This machinery must be connected to a CE certified power supply.*

Certified by:   
Alan Rogers  
President of Thermion Inc.

# Important Safeguards



**MEANS WARNING - WATCH OUT!** There are possible hazards with this procedure! The possible hazards are shown in the below symbols. Your end user (applicator, operator or helper) should read and understand these safeguards. The operator should read and understand the operating and installation instructions provided with this Thermion Arc Spray System.

The arc spray process and Thermion Arc Spray equipment share similarities with welding processes and equipment. Improper use or maintenance may cause serious injury or death. Your end user should have training or experience in safe practices for the arc spray process before operating the arc spray equipment.



## **WARNING ELECTRIC SHOCK MAY KILL**

DO NOT touch bare conductors or terminals when energized. DO NOT work in wet or damp areas. Wear dry insulated gloves and dry protective clothing. Remember that when the power source is on, the electrode (wire) is electrically hot. DO NOT touch the wire with bare skin while touching the electrical ground. Install and maintain your electrical equipment using the correct electrical code standards appropriate for your requirements, a certified electrician should always hook primary leads to the electrical grid source with the appropriate safety disconnects.



## **WARNING ARC RAYS MAY INJURE EYES AND BURN SKIN**

The arc spray process produces extreme heat and strong ultraviolet rays. Never try to arc spray without a welding helmet equipped with the proper lenses. Protect helpers, observers and bystanders. Failure to protect may cause permanent damage to eyes. Also, protect skin from both arc rays and burns from heat. Always wear protective clothing which does not allow skin to become exposed.



## **WARNING FUMES AND GASES MAY BE DANGEROUS TO YOUR HEALTH**

Follow the precautions specified by the wire material manufacturers. Breathing any fumes created by the arc spray process may cause illness or death when there is not proper ventilation and protection. Keep your head out of the fumes. If ventilation is not adequate, wear approved respiratory protection.



## **WARNING WIRE FEED ROLLS CAN INJURE**

Keep clear of wire feed rolls, these gears are hazardous during operation. Keep clear of all moving parts, moving wire and rolling wire spools.



## **WARNING NOISE CAN BE DAMAGING TO YOUR HEARING**

Wear ear protection at all times. In some conditions double ear protection may be required.

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## Warranty Information

### Limited Warranty:

- Subject to the terms and conditions hereof, Thermion warrants to the user that all new and unused equipment furnished by Thermion is free from defect in workmanship and materials as of the time and place of delivery by Thermion or its agent. With respect to trade accessories or other items manufacture by others, such items are sold subject to the warranties of their respective manufacturers, if any.
- Thermion will honor an original user's warranty claim on warranted equipment in the event of failure resulting from a defect for a period of 90 (ninety) days from date of purchase.
- Thermion will honor an original user's warranty claim on component and any defects in workmanship on the wire feed unit for a period of 90 (ninety) days from date of purchase.

### Express Warranty:

- Any express warranty not provided herein and any implied warranty, guaranty or representation as to performance, and any remedy for breach of contract which, but for this provision, might arise by implication, operation of the law, custom of trade or course of dealing, including any implied warranty of merchantability or of fitness for particular purpose, with respect to any and all equipment furnished by Thermion is excluded and disclaimed by Thermion.

### Consumer:

- Except as expressly provided by Thermion in writing, Thermion products are intended for purchase and use by commercial/industrial users and for operation by persons trained and experienced in the use and maintenance of Thermal Arc Spray equipment and not for domestic use. Thermion warranties do not extend to, and no reseller is authorized to extend, Thermion warranties to any consumer.

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## Preface

This manual has been designed for experienced Thermal Arc Spray operators and must be read completely before using the equipment. If you lack experience or are unfamiliar with the practices and safe operation of welding equipment, please consult your foreman. Do not attempt to install, operate, or perform maintenance on this equipment unless you are qualified and have read and understood this manual. If in doubt about installing or operating this equipment, contact your distributor.

For the safe and successful use of this equipment, be sure the information contained in this manual reaches the operator. Extra copies of this manual are available upon request.

*Please provide part number and machine serial number, when seeking parts and service.*

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### **This manual is divided into nine sections:**

Section 1: Introduction

Section 2: Safety Measures

Section 3: System Assembly

Section 4: Start Up Settings

Section 5: Operation (General)

Section 6: Principals of Operation

Section 7: Liner Replacement

Section 8: Air Switch and Main Switch

Section 9: Component Diagrams

Section 10: General Troubleshooting

The information contained in this manual represents our best judgment; however, Thermion assumes no liability for its use.

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# I Introduction

## I.1 General Information and Safety

- General Information presented in this manual, in the Power Supply Manual, and on labels, tags and plates provided on the unit pertains to equipment design, installation, operation, maintenance, and troubleshooting. It should be read, understood, and followed for the safe and effective use of the equipment.
- The installation, operation, maintenance and troubleshooting of the arc spray equipment requires practices and procedures to ensure personal safety and the safety of others. Therefore, this equipment is to be installed and operated only by qualified persons in accordance with the manual and all applicable codes.
- Safety instructions pertaining specifically to this equipment appear throughout this manual and the Power Supply Manual, highlighted by signal words **DANGER**, **WARNING**, **CAUTION**, and **IMPORTANT**, which identify different levels of hazards.

**DANGER**: Indicates an operation procedure, which, if not followed, will cause SEVERE injury to the operator, service personnel or bystanders.

**WARNING**: Statements include hookup, operating and maintenance instructions and procedures which, if not followed carefully, could result in SEVERE personal injury or damage to the equipment.

**CAUTION**: Indicates an operation procedure, which, if not followed, may cause MINOR injury to the operator, service personnel and/or bystanders.

**IMPORTANT**: Highlights instructions, which need special emphasis to obtain the most efficient and safe operation of this equipment.

## I.2 Receiving and Handling

Prior to installing this equipment, remove all packing material from around the unit and carefully inspect for any damage, which may have occurred during shipment. Any claims for loss or damage that may have occurred during transit must be filed by the purchaser with the carrier.

When requesting information concerning this equipment, model description and serial number of the equipment must be supplied.

## I.3 General Description

The Thermion arc spray machine is a pusher type arc spray system that has a patented feature, which controls arc shorting. This equipment is designed to spray most wires, i.e., stainless, low alloy steels, bronzes, aluminum, zinc, zinc-aluminum, babbitt, etc.

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## **I Introduction (continued)**

### **I.3.1 Wire Feeder**

The feeder is compact with a carrying handle. The meters, dials, and switches are located on the front of the feed unit for ease of viewing and operation. The drive assembly is a four-roll heavy-duty drive unit.

### **I.3.2 Spray Gun**

The spray gun is simple, durable, and lightweight. The patented combination leads carry the atomization air, spray wire, and power to the spray gun from the feeder.

### **I.3.3 Automatic Speed and Arc Shorting Control**

This "patent pending" AVD system maintains a near perfect arc. The wire feed self-adjusts to arc conditions. If the voltage drops, the wire feed slows down to compensate for the voltage drop, conversely if the voltage increases the wire feed will increase, thereby holding the arc gap steady. The AVD principle will virtually eliminate shorted wires, preventing the wires from welding in the tip and heat build up in the liner system.

### **I.3.4 Auto Start Feature:**

On most twin wire arc spray systems, the two wires usually are left touching at the end of a spray cycle, therefore, causing a snap start, which propels chunks of hot metal toward the substrate. The automatic start feature, built into this system assures a soft start. The first thing that happens when the trigger is actuated is the wires reverse until an arc gap is established, then run forward creating a start as if the wires had been cut. If the arc fails to start, the feed again reverses, recreating a gap in the wire, then runs forward again. This start cycle will automatically continue until the arc is established and spray operation begins.



## 2 Safety Measures



**WARNING** Arc spraying can be hazardous because it requires the use of electric voltages and currents, hoses under high pressure, and potentially irritating or toxic spray materials. It may involve air contaminated by dusts, fumes, etc. However, it can be a completely safe process when performed by a capable operator with proper understanding of arc spraying practices and knowledge of the equipment, one who takes care in operation and follows the recommended precautionary measures.

Dust, smoke and high intensity light (sun type rays) are created by performing thermal spraying, therefore action must be taken to provide protection to the environment, bystanders, or to nearby equipment.

### 2.1 Reduction of Fire And Explosive Hazards



**WARNING** Remember that the stream of sprayed metal is HOT. Point the gun away from yourself and away from flammable materials. Carelessness in pointing the gun at paper, wood, or oily rags can result in fire.

**CAUTION** Be especially careful not to spray on the hoses when operating the gun. Hoses will burn. Keep them out of the way. All air lines, compressors, regulators, etc., should be inspected regularly for leaks and loose connections.

**Equipment Maintenance:** Maintain the arc spray equipment in first-class condition. Follow the maintenance recommendations in this Thermion instruction manual.

When the electric arc spray system is set up and operated in accordance with the instructions in this manual, the metalizing wires are electrically energized only when the gun is spraying. When the spray is shut off, electrical charge is removed from both metalizing wires.



**DANGER** While the gun is spraying, a person should **NEVER** touch both energized wires, or any part that the wire is in contact with or that person could receive an electrical shock, the volume and current of which are capable of developing a harmful or fatal electric shock or burns.

**DO NOT** clean the inside of the power supply unit with a wire brush or any other tool. Use clean, dry compressed air only.



**DANGER** All dust, having considerable caloric value, can be explosive. This dust includes: flour, starch, hard rubber dust, wood flour, aluminum dust, and the dust of other metals. Aluminum and magnesium dusts are particularly hazardous. The greatest care should be used in handling them. To minimize the danger of a dust explosion in an arc spray booth or other confined spaces, prevent the accumulation of fumes and dust. Ventilation and good housekeeping in the work area is essential. Inspect and clean regularly to assure that there is no potentially dangerous accumulation of dust.

Dust Collectors must be suitable for metal spray dust. All closed collectors must be provided with blowout holes or relief panels. All fans, pipes, dust arresters and motors should be electrically grounded. Motors should be external to the dust system.

When cleaning booths, pipes, etc., the ventilating fan should be kept running to prevent the accumulation of fumes or dust in the system. Non-sparking tools should be used in cleaning and repair operations.

When emptying the collector, all sources of ignition in the area should be eliminated. When making repairs on the ventilating or dust collecting equipment, no welding or cutting should be done before the equipment is washed down and all metal dust removed.

## 2 Safety Measures (continued)

### 2.2 Reduction of Respiratory Hazards



**WARNING** Shop work being performed by an operator requires either an air fed hood or a suitable spray booth with an adequate exhaust system to avoid the toxic or noxious effects of dust, fumes, for ordinary arc spray work, air at a velocity of 200 FPM (1.0m/s) should pass into the opening of and mists which may be generated by arc spraying. The following is for information only, the actual requirements should be determined by your Governmental Safety and Health Agency.

For ordinary arc spray work, air at a velocity of 200 FPM (1.0m/s) should pass into the opening if the spray booth. With the arc spray gun at the booth opening, the exhaust system must be able to exhaust 200 CFM (0.1m<sup>3</sup>/s) of air for every square foot of booth opening. If the booth has an opening of four square feet, (.37m<sup>2</sup>), a system that will exhaust 4 x 200 or 800 CFM (0.4m<sup>3</sup>/s) should be provided. If there is any question as to the effectiveness of the ventilating and exhaust system or as to the presence of airborne particles, which the operator might inhale, consult a competent industrial hygienist.

**IMPORTANT** It is strongly recommended that complete and current information be obtained from your Governmental Health Agency. Because any finely divided material may damage the respiratory system, respirators are recommended for all thermal spraying.

Some materials, such as beryllium, tellurium, and their oxides, are dangerous to the respiratory system and should not be used at all except under the supervision of a competent safety engineer.

**Blasting And Spraying** both produce dust. Blasting of toxic materials should be considered to be hazardous, as is spraying such materials.

Completely sealed mask-type pressurized respirators are recommended for all applications of thermal spray. However, with proper ventilation that maintains proper threshold limits of hazardous material, element type filters of the proper type will protect satisfactorily.

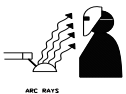
### 2.3 Threshold Limits For Air Concentration Of Hazardous Material



**WARNING** Obtain up to date, exact figures from your governmental health agency.

**SOLVENTS:** Certain solvents may decompose when exposed to ultra violet rays. Avoid exposing solvents, or parts when wet with solvent, to the radiation from the arc.

### 2.4 Personal Protection



**WARNING** The electric arc generated at the front of the gun is very bright and emits ultraviolet light rays. Eyes and skin must be guarded against these rays. Standard air fed welding, or sand blasting, personal protection equipment fitted with a dark lens, has proven to provide adequate protection for thermal spraying.



Possible allergic reaction of dust, fumes, and the like or other unknown causes of health impairment due to contact with the body cannot, in most cases, be predicted. To avoid such reaction, never permit spray dust to enter the eyes, mouth, cuts, scratches, or open wounds. Wash hands thoroughly after spraying, especially before eating or handling foods. Wear fireproof or flame resistant protective clothing if available. Protect eyes, ears, and skin through use of gloves, facemask, ear, and body protectors that are standard in the welding industry.

### 2.5 Reduction of Noise Hazards



Noise from a Thermion arc spray gun range between 80 and 120 decibels. At this level, most Governmental Health Agencies require ear protection and sometimes double ear protection.

## 2 Safety Measures (continued)

### 2.5 Reduction of Noise Hazards (continued)



**WARNING** The noise made by the arc spray gun is loud enough to cause the operator discomfort and can cause hearing damage. Adequate protection should always be used.

The operator and other personnel close to the arc spray operation must be protected from excessive noise. If possible, the spray operation should be isolated. Hearing protection should be used. Do not rely on wads of cotton for hearing protection. They are ineffective against high-intensity noise.

Noise level at any location depends on factors such as equipment operating parameters, background noise, work area size, and wall, floor, and ceiling materials. To determine the exact noise level, it is necessary to measure the sound level to determine the method needed for adequate protection.

### 2.6 Eye Protection (Standard Welding Shields and Lens)



**CAUTION** The hardened green (Shade 9) lens is within the shade range recommended for arc spraying. However, the choice of lens shade may be based on visual sensitivity and sharpness (acuity) and may vary widely from one individual to another. Check with your Government Health Agency for current and complete shade number recommendations.

Always wear proper eye protection when operating or watching the arc spray operation. Inspect the lens and cover plates frequently. Lenses and cover plates that are scratched, pitted, or damaged can impair vision and seriously reduce protection.

### 2.7 Environment

**DANGER** The thermal spraying operation can produce materials that are hazardous for plants, animals, fish, or water quality. Precautions must be taken to prevent any danger to the environment. Collect all residues from the metal spray operation and dispose of as hazardous material or determine that it is safe to the environment prior to disposal.

### 3 System Assembly



Shown with Running Gear Option

#### 3.1 Location

This Arc Spray System is close-coupled designed for shop work.

#### 3.2 Power Supply

Thermion's AVD250 is uniquely dependent on the power supply being a Miller brand product (Miller Electric Mfg. Co., An Illinois Tool Works Company, 1635 West Spencer Street, Appleton, WI 54914 USA).

**IMPORTANT** Refer to manufacturer's instruction manual for hook up and operation requirements for the power supply. The power supply manual should assist in selecting the correct output cables in relation to power source location, work site distance, and operational amperage.



## 3 System Assembly (continued)

### 3.3 Component Interconnection



This system provides 24 Volt AC power to the feeder unit when the power supply is in ON position. Spray current is provided when the contactor is actuated via the gun switch.

**WARNING** All connections to the feeder from the power supply should be performed with the power supply OFF.

#### 3.3.1 Wire Feeder Hook Up to Power Supply

Wire Feeder hook up to the power supply is performed by connecting the control lead and two welding cables. The polarity of the welding cable leads is not required. They can be connected to either side of the feeder and to either side of the power supply.

#### 3.3.2 Gun Hook Up



**WARNING** Electric shock can kill. The gun switch energizes the power supply. If the gun switch is off and the power supply is energized, a malfunction has occurred, and the problem requires immediate attention. The voltmeter is a good indicator for determining energized power; if voltage shows on the meter, the power supply is energized.

The gun leads are connected to the feed roll assembly. The gun switch is connected into a four-prong receptacle. This receptacle is low voltage, but avoid touching prongs.

#### 3.3.3 Gun Tip/Air Nozzle Alignment

Gun tip and air nozzle alignment are critical for proper operation. Refer to drawings in Section 6 to show proper alignment and arrangement for standard and jet spray heads.

**IMPORTANT** The contact tips must not touch each other or the center air nozzle.

#### 3.3.4 Service Air



Clean dry air is used as the atomizing gas and coolant for gun leads. 40 cfm of air volume must be available; a 3/8" IPS minimum supply line at 120 PSI maximum should be used to supply this air volume. Optimum regulated air pressure for general purpose spraying should be 95 PSI. Lower air pressures can be used to obtain special high profile rough coatings, i.e., non-skid applications. Air supply lines shall be connected with industrial approved connectors. When using quick disconnect fittings and flexible hoses, safety pins and safety lanyards shall be used.

## 4 Controls - Start Up Settings

Use these settings to initially start spraying then adjust to the desired voltage and amperage.

- **POWER SUPPLY:** The power supply must be set for gas metal arc welding (MIG), usually with all optional setting in the off position, i.e. pulsars, etc. The power supply voltage (for cv) or power (for cc) is controlled at the power unit, not at the feeder. Review the wire technical data for voltage and amperage settings. 1/16" zinc wires will operate at 22-26 volts and 1/16" aluminum at 30-32 volts for startup, then spraying can be fine-tuned for the desired spraying performance.
- **SETTINGS ON FEEDER:** Set the Amps Knob, (for wire feed speed control) at 30%. (50-100 amps for 1/16" zinc and 125-150 amps for 1/16" aluminum). It can be fine tuned to the desired setting during the spraying function.
- **AIR SUPPLY:** 80-100 PSI MIN., 40 CFM MIN.

### 4.1 Front Panel Settings for Start Up



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## 4 Start Up Settings (continued)

### 4.2 Voltage:

Voltage is controllable at the power supply unit. Being that the wire feeder is using the arc voltage for operations, the feed rate or amperage will automatically increase or decrease as the voltage is increased or decreased.

### 4.3 Amperage:

The amperage is controlled through the Amps Knob (for wire feed speed control), which is located on the wire feeder's front panel.

### 4.4 Wire Inch Jog Switch:

An inching switch located on the wire feeder's front panel allows running the wire feed motor, feeding wire through the liner to the head without energizing air or the power supply.

### 4.5 Fusing:

The wire feeder is fused on the power supply with a 15 amp circuit breaker.

### 4.6 Trigger Switch:

The trigger switch is located in the handle assembly (See Section 9.5). This switch energizes the power supply contactor, turns on atomization air, and starts wire feed.



**IMPORTANT** The power leads must be connected to the wire feeder to start wire feed when using the gun switch. The inch switch will feed wire without the power lead connection.

## 5 Operations (General)

### 5.1 Power Supply:

Refer to the owner's manual for the welding power supply for operation and maintenance.

### 5.2 Wire Loading:



**IMPORTANT** Lubrication, threading, and adjusting the feed roll pressures are important for smooth thermal spray operation. Proceed as follows:

- Hand feed the wire through the Fairlead and push onto the feed rolls, assuring your fingers are free of the rolls, jog the wire through the rolls and out the front of the feeder. At this time, adjust the wire straightener roll so that the wire is somewhat straight as it comes from the feed rolls. The feed roll tensions are preset and should not need adjustment.
- Lubricate the inside of each liner prior to threading each spool of wire by disconnecting the leads from the wire feeder. We recommend spraying 5-10 seconds of WD 40 into the feeder end of the liner, followed by 30 seconds of air to blow out the residual. This lubricates the entire liner and clears excess lubricant. Lubricate each liner in this manner when loading additional spools of metalizing wire.
- Round off the free end of the metalizing wire with a file prior to feeding into the liner. Sharp edges left on the wire will cut and damage liner.



## 6 Principles of Operation

With the system correctly connected and the power supply turned on, the operator turns on the main switch that energizes the wire feeder controls. The operator then loads the wire as explained in Section 5, adjusts the pressure regulator as specified in spray tables, sets the voltage on approximate settings given in tables, sets the rheostat (wire feed dial) at 70%, and is ready to fire up. After spraying begins, check dials and adjust according to spray table in next section.

**Arc Gap Control:** The feeder unit automatically controls the arc gap. As normal voltage variations occur in the system, the wire feed compensates striving to maintain a predetermined arc gap. An unchanging arc gap provides better atomization and smoother running arc characteristics.

### 6.1 Operating Parameters

**OPERATION:** Most materials will operate at a wide range of voltage and amperage settings. Excessive amperage may burn out chemical elements critical for the device intended and provide poor deposit efficiency.

**WIRE SIZE:** The AVD 250 is designed and set up for 1/16" zinc and aluminum.

**VOLTAGE:** Voltage controls arc gap. Normal range for low melting soft materials is between 25 and 34 volts. Normal range for higher temperature hard wires is between 32 and 36 volts.

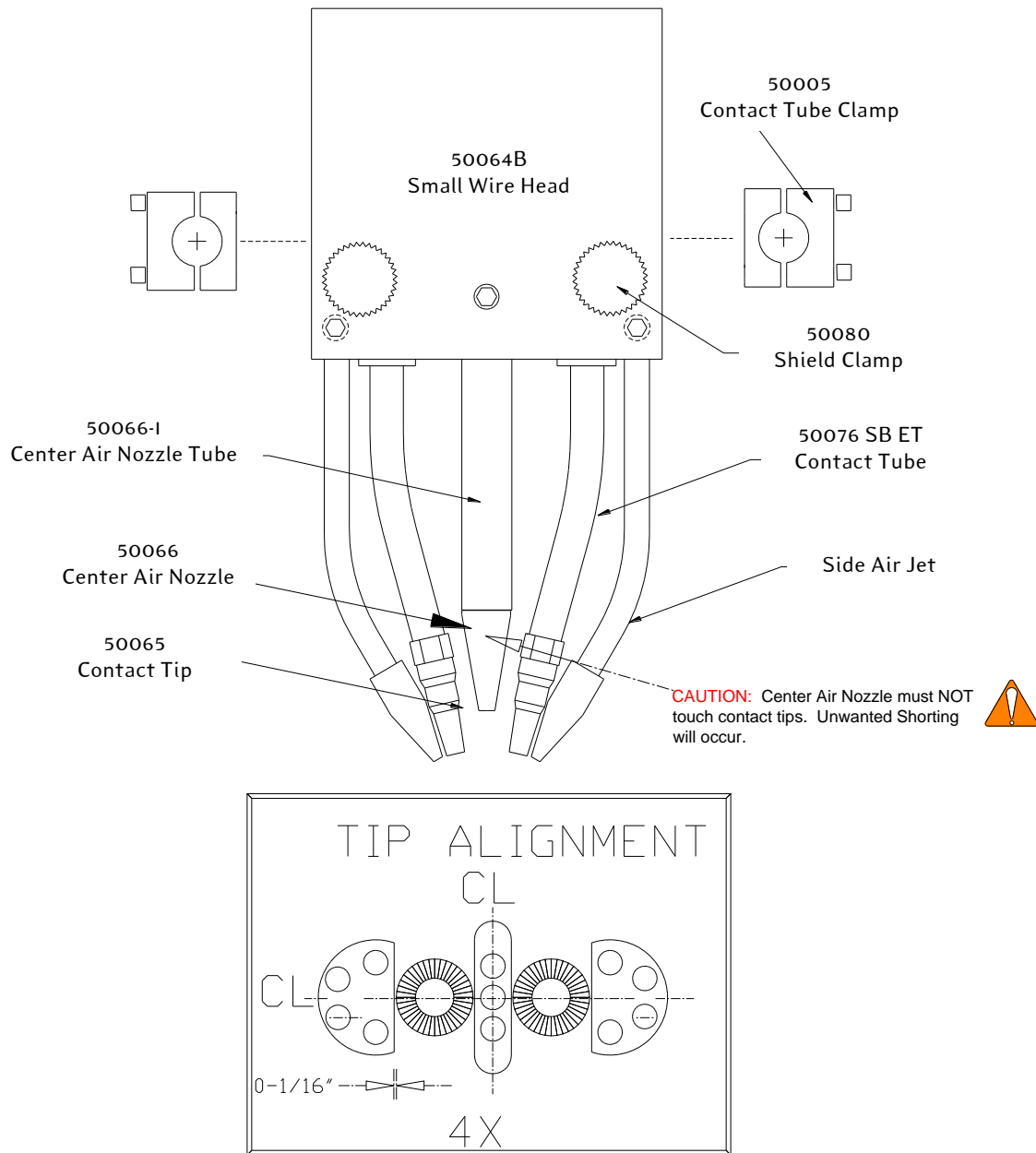
**AMPERAGE:** Amperage can be varied considerably for all materials. Non-alloyed materials, i.e. aluminum, zinc, tin, etc. can be operated without fear of de-alloying.

**Start-up Parameters:** Set both the Amp and Voltage dials (on the faceplate) to 50%. Depress the trigger to fire the gun off. If the gun does not fire off, increase the voltage dial by 10% and try again. Continue to increase until the gun fires off. Once the gun fires off, adjust both your amps and volts to the recommended values based on the material being sprayed.

Corrosion Wire				
<u>Materials</u>	<u>Size</u>	<u>Volts</u>	<u>Amps</u>	<u>Air Pressure</u>
Aluminum	1/16"	31-34	100-300	80-100 psi
Zinc	1/16"	25-32	100-300	80-100 psi
Zinc/Aluminum	1/16"	30-34	100-300	80-100 psi
Hard Wires				
<u>Materials</u>	<u>Size</u>	<u>Volts</u>	<u>Amps</u>	<u>Air Pressure</u>
Bronzes	1/16"	32-36	200-300	80-100 psi
Steels	1/16"	32-36	200-300	80-100 psi
Stainless	1/16"	32-36	200-300	80-100 psi
Nickels	1/16"	32-36	200-300	80-100 psi
Carbides	1/16"	32-36	200-300	80-100 psi

## 6 Principles of Operation (continued)

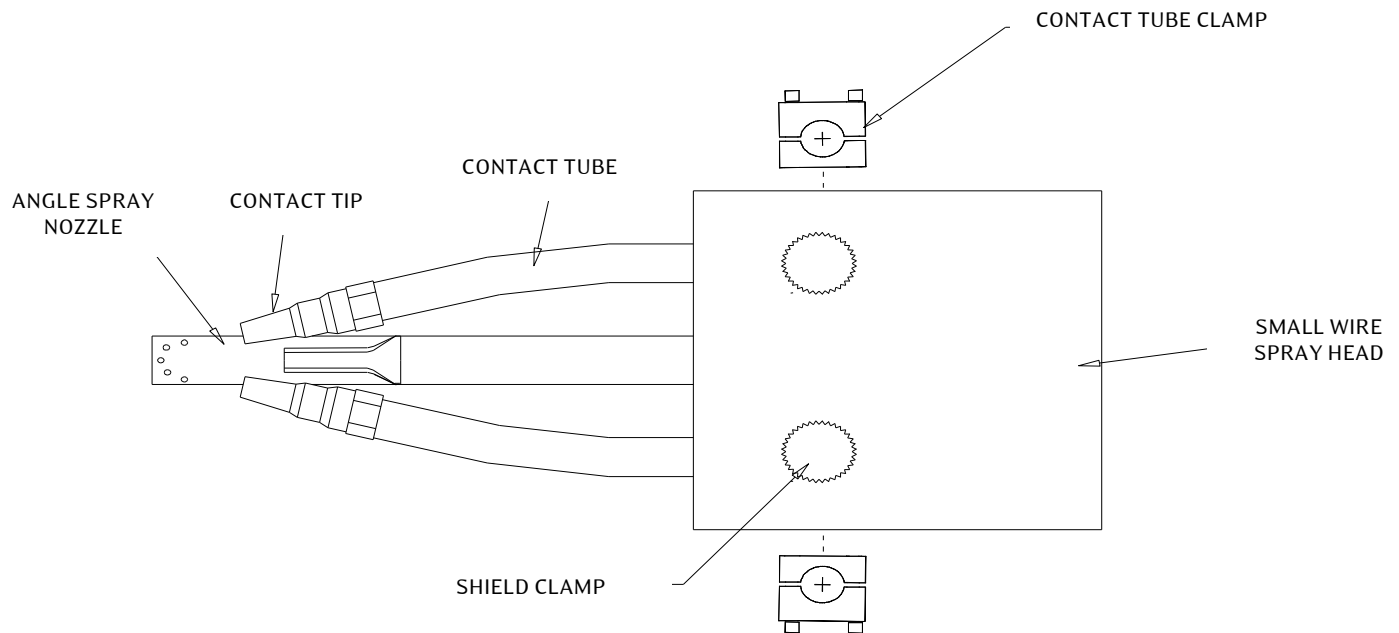
### 6.2 Air Nozzle Alignment



**Adjusting Contact Tips:** Adjust contact tubes to allow wire to converge as shown in this drawing. When adjusted correctly, the arc is smooth with a fine even spray .160"

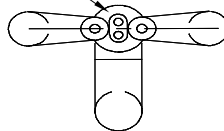
## 6 Principles of Operation (continued)

### 6.2.1 Angle Spray Nozzle Alignment



CAUTION: AIR NOZZLE MUST NOT TOUCH CONTACT TIPS, UNWANTED ARCING OR SHORTING WILLOCCUR

ANGLE SPRAY  
NOZZLE



FRONT VIEW



ADJUST CONTACT TUBES TO ALLOW WIRE TO CONVERGE AS SHOWN IN THIS DRAWING. WHEN ADJUSTED CORRECTLY, THE ARC IS SMOOTH WITH A FINE, EVEN SPRAY

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## 6 Principles of Operation (continued)

### 6.3 Spray Head/Parts Maintenance

**SPRAY HEAD:** The outer body of the spray head requires occasional cleaning to eliminate any possibility of metal dust that could cause arc shorting between the contact tubes. A small stiff brush or knife blade can be used to scrape off the accumulated metal dust. The head is a plastic material so use caution to avoid scraping away head material. Daily cleaning is recommended. At this frequency, all accumulated material can usually be wiped off with a rag, eliminating the possibility of head damage.

**CONTACT TUBE/TIPS:** During operations the wire may carry dust, dirt, lint, etc. into the liner system, which can accumulate behind the contact tip in the contact tube. This may cause enough friction to impair wire feed. Remove the contact tube from the head, and then remove the tip from the contact tube. Clean the tip manually then use an air blowgun and clean the contact tube. In extremely dusty conditions this should be done once a day. These items are considered consumable parts and require replacement due to wear.

**AIR NOZZLES:** The air nozzles do not normally require maintenance, except to keep alignment as shown in the prior sections of this manual. However, if the nozzles are aligned, and the spray is erratic or uneven, remove the air nozzles and with an air blowgun clean the holes by reverse blowing through the air jet holes. Visually inspect the nozzles for obstructions prior to reinstallation.

#### 6.3.1 Combination Leads:

**LINERS:** The liner inside the combination leads is considered consumable parts and requires periodic replacement due to wear or accumulation of dust or grit. Using methods to minimize the amount of dirt that gets into the system can extend the wear life. Cover the wire during idle periods, especially if the equipment is going to be in the area during surface preparation. You can also use a wiper on the wire prior to it going into the liners. The liners can be cleaned by spraying a solvent into the liner then blowing the material through the liner with a blow gun. The liner replacement technique is important to insure that air flows correctly through the leads and into the spray head, refer to section 7 for liner replacement technique.

**O-RINGS:** The O-rings at each end of the leads should be inspected and replaced if damaged. Lubricate the O-rings and socket with a light grease, prior to insertion. The grease is necessary for a good air seal at both the feeder end and at the head.

#### 6.3.2 Feeder Unit:

The feeder unit is low maintenance and mostly requires cleaning and inspections. Keeping the feed rolls and gearing clean of dust and grit will extend life and provide better service. A daily cleaning with an air blow gun is usually all that is required. During this cleaning, watch for any oil leaks from the motor. The motor will not require any oil fills unless it has leaked. Examine the feed gears to assure they align correctly and mesh over their full width. The feed gears roll on sealed bearings that are pre-lubricated and do not require maintenance.

#### 6.3.3 Control Cables:

The control cables require routine inspection for separation at the connectors and for cuts or breaks in the wire coverings. If any condition of abnormality is notice it must be remedied immediately.

## 6 Principles of Operation (continued)

### 6.4 Constant Operational Checks

**AIR NOZZLES** - At each shut down cycle, look at air nozzles and remove any buildup.

**SPRAY TEXTURE** - If the spray becomes course, or rough, check tip and air nozzle alignment.

**SPRAY PATTERN** - If the spray pattern changes, check tip and air nozzle alignment.

**AIR NOZZLE ADJUSTMENT** - The side air jet nozzles periodically may need adjustment. Remove the nozzle from the head and place into a vise. By hand bend the nozzle tube to required fit. To achieve an even spray pattern the right and left tube should be close to the same fit. See Section 6.2 for alignment requirements. **CAUTION:** Do not bend the tube while it is in the head, the plastic head may break.

**ERRATIC WIRE FEED** - Remove and clean contact tips and contact tubes. Lubricate liners from feeder to head. With the wire removed, spray WD-40 into liner at feeder end, then use an air hose to blow the lubricant through the liner to the head.

**SHIELD** - Clean shield as needed during operations.

**HEAD** - Clean head as needed during operations. Metal dust can cause shorting between the contact tubes.

#### 6.4.1 Daily Maintenance (8 Hours)



**CAUTION:** Perform all electrical work with power secured.

**SPRAY HEAD** - Wipe off all dust particularly at the front between the contact tubes.

**CONTACT TIPS** - Remove and clean dust and lint from behind the tip, this will help prevent a bind in the wire which may cause erratic feed.

**CONTACT TUBES** - When the tips are removed inspect the internal bore and remove any debris.

**LINERS** - Lubricate with WD-40, or use a non-petroleum based material. Spray WD-40 into liners at feeder end, and then use an air hose to blow the lubricant through the liners.

**FEED UNIT** - Clean the inside of the wire feed unit. Blowing it down with air is usually all that is required.

**FEED ROLL BEARINGS** - Check each feed roll bearing to make sure they roll free. Feed rolls with rough bearings may need replacement.

#### 6.4.2 Weekly Maintenance (40 Hours)



**CAUTION:** Perform all electrical work with power secured.

**CABLE CONNECTIONS** - Check all electrical lead connections from power supply to wire feeder. The connections must fit firmly; a loose fit will cause the leads to heat up.

**FEEDER CONNECTIONS** - Check the fittings inside the feed unit, tighten all bolts that connect the current to the wire feed assembly.

**POWER SUPPLY** - Disconnect the power supply from the primary current. Remove the side covers then remove the dust from inside the machine with an air hose.

---

## 6 Principles of Operation (continued)

### 6.4.3 Monthly Maintenance (160 Hours)



**CAUTION:** Perform all electrical work with power secured.

**TIPS** - Replace.

**CONTACT TUBE** - Replace.

**LINERS** - Replace - See Section 7.

**FEED ROLLS** - Inspect the knurled surface for wear, replace if required.

**FEED ROLL BEARINGS** - Inspect feed roll bearings; these bearings will eventually require replacement (usually more than 2000 hours of operation).

**ELECTRICAL CONNECTIONS** - Inspect power lead connections for oxidation. Disconnect all fittings, sand clean with sandpaper or file, then replace.

## 7 Liner Replacement

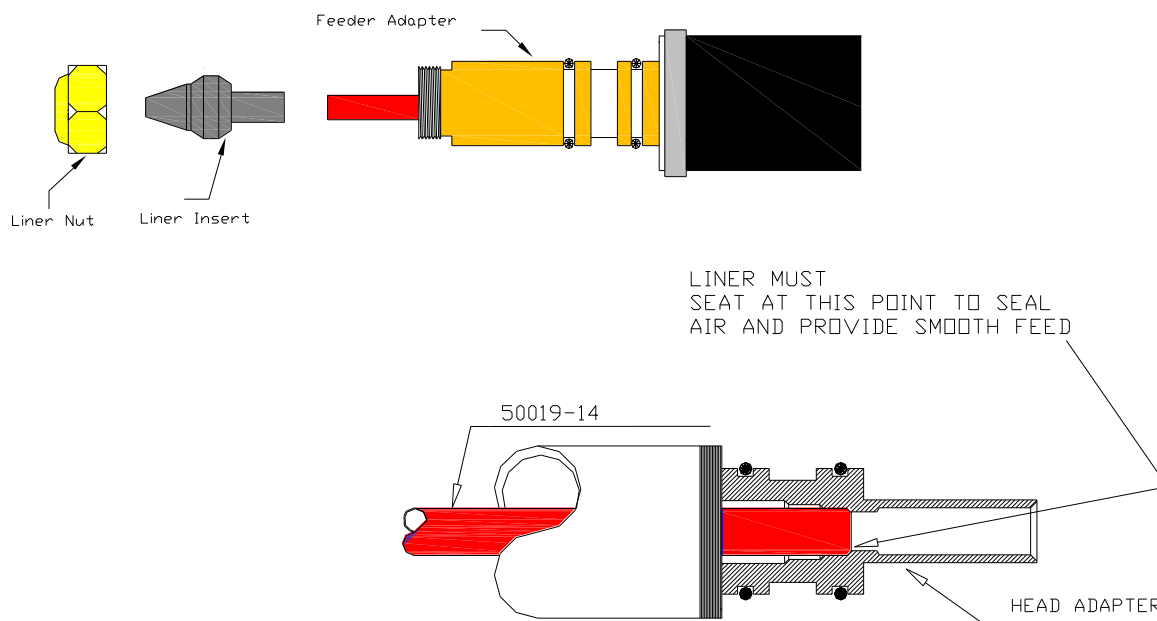
### 7.1 Replacement of Single Red Liner

When spraying the AVD 250, a single-liner system is used. The following instructions detail the liner change out process.

Refer to drawing in (Section 8.3.2)

Remove 59062-10LI combination leads from wire feeder and head assembly. Lay the lead assembly out flat and straight. Then remove liner clamp nut (50109), and insert (59018-A) (this is threaded on), this will expose the existing liner to allow it to be removed by pulling the liner out of the cable assembly.

Replace/install the red liner (50019-14). Push the red liner into the leads until it bottoms out on the head adapter. Leaving 1" out from the Feeder Adapter, cut excess liner off. Install the liner insert by threading it onto the red liner. File the end of the red liner so the threads on the liner insert will start, it should thread about  $\frac{1}{4}$ "; now push the liner insert into adapter. Now install the liner clamp nut. It should take some force to get the nut to the fitting. Now install all head parts and complete the head assembly. In this design, the red liner is held in place by the threaded insert, via the threads, the other end of the red liner, at the head, floats free, therefore eliminating any kinks that could occur by the wire forcing the liner forward.



## 8 Air Switch and Main Switch (54012-06A and 54012-07A)

Spring wires #54012-06/07S installed in #54012-6A and #54012-7A

- Loosen set screw (AlloySS054) in brass piece. Insert spring wire (54012-06/07S)
- Wire spring loop is horizontal to the handle body.
- Tighten set screw(AlloySS054).

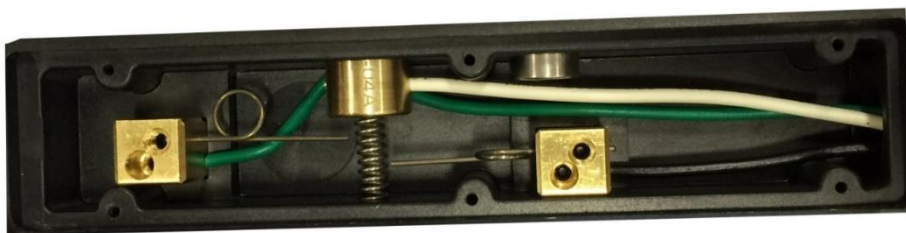
Air switch spring wire installed.



Main switch spring wire installed.



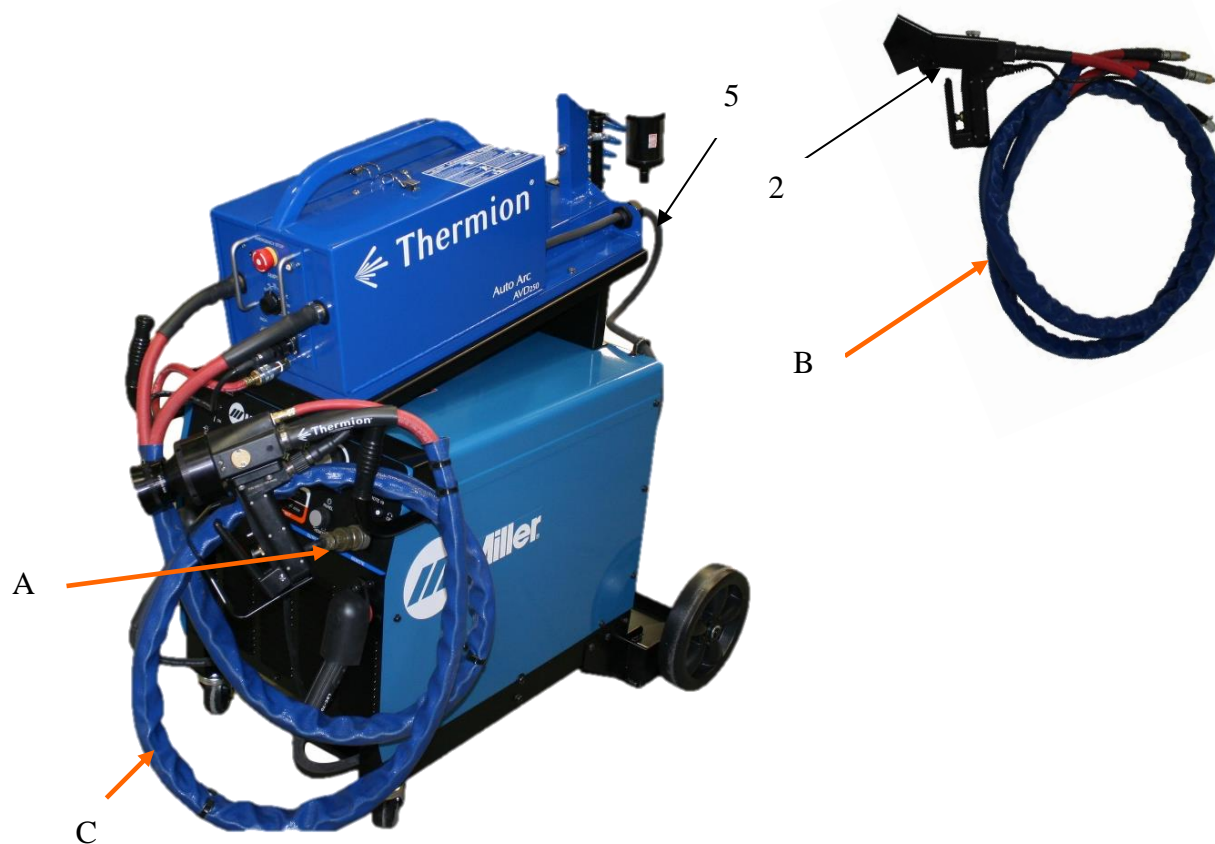
- Wire spring loop vertical to the handle body.
- Set in place, be sure it is snug against the body and does not interfere with plunger action.
- Press firmly to install in handle.
- Assure that the spring wires are not touching the contact spring (54012-17) - replace handle cover.





## 9 Components

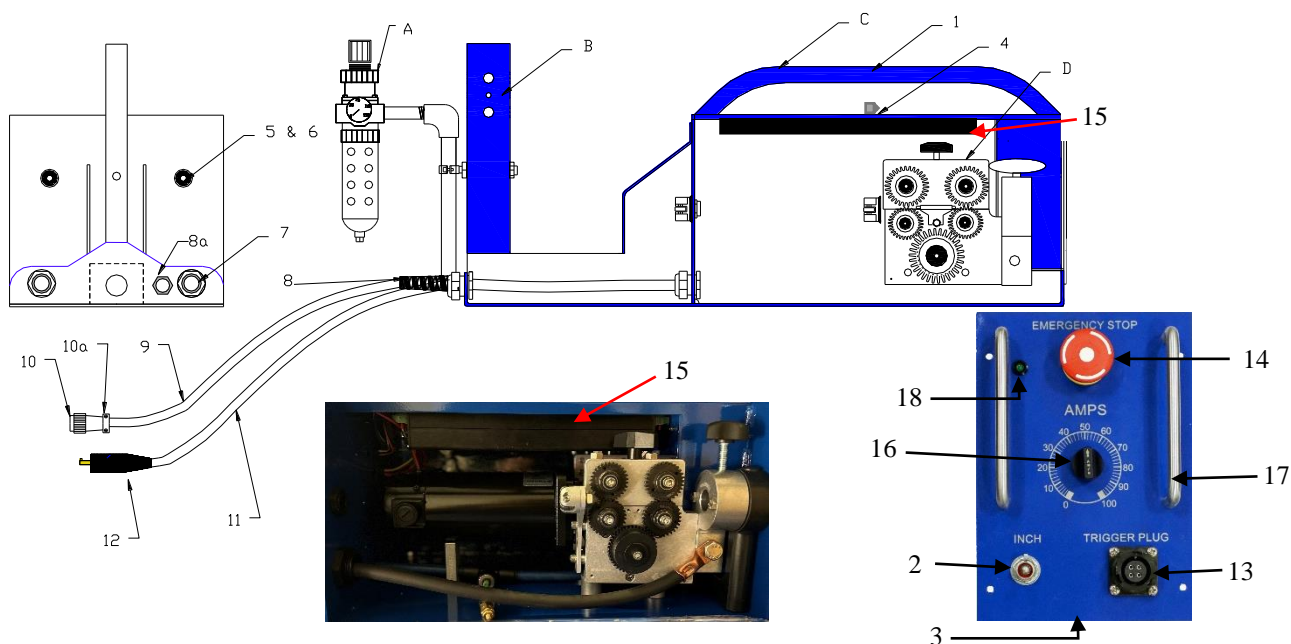
### 9.1 Cable Components



	Part Number	Description	
A	77060	Control Lead Assembly	
B	59116-1.6	Front End Assembly	(Parts 1, 2, 4)
C	59116-1.6 Jet	Front End Assembly Jet Nozzle	(Parts 1, 2, 3)
	See Section 9.3	Lead Assembly	
I	See Section 9.4	Spray Head Assembly	
	See Section 9.4.3	Trigger Cord Assembly	
2	59004-8	Weld Cable #1	
NS	54004-10	Female Dinse to 1/2" Lug Straight Connector	
Photo	80403	Power Supply Mounting Bracket	

## 9 Components (continued)

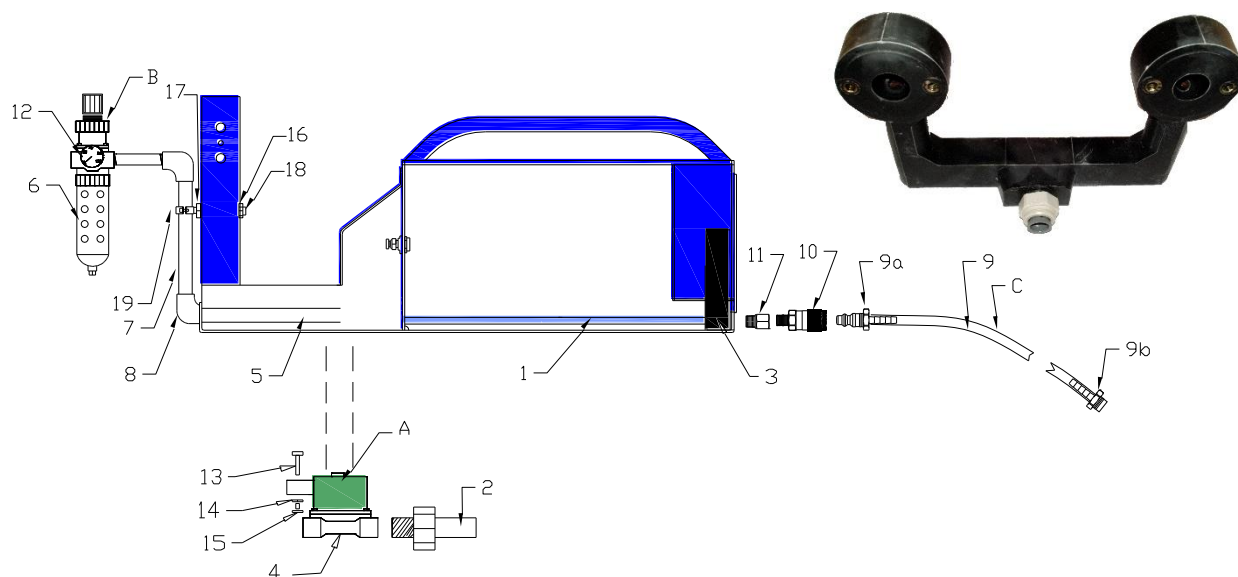
### 9.2 Feeder Components



	Part Number	Description
A	See Section 9.2.1	Air Supply Components
B	See Section 9.2.2	Wire Spindle Assembly
C	57036-Assy	Feeder Assembly
D	See Section 9.2.3	Wire Drive Components
I	57036	Feeder Frame Cabinet
2	50026	Inch Switch
3	58036-PC10A	Front Panel
4	57036-18	Door Latch and Strike
5	57956-1/16 Assy	Wire Inlet Fairlead
6	51045-2A	Fairlead Nut
7	AA045-4	Weld Cable Cord Grip-Dome
8	AA045-5	Control Cable Cord Grip
9	77060	Feeder Control Cable
10	50058-3	14 Pin Male Connector (Cord)
10a	50058-13	Water Tight Cable Clamp
11	57004-8	Power Cable Assembly Male Only
12	54004-9A	Male Dinse Connector LDC
13	54028	Trigger 4 Pin Base Mount Socket
14	57094-11	Emergency Stop Switch
15	7072R4 Assy	AVD Control Module: Assembly - VS
16	57022-A	Amp Knob
17	54094-2	Meter Panel Handle
19	56315	Indicator Light

## 9 Components (continued)

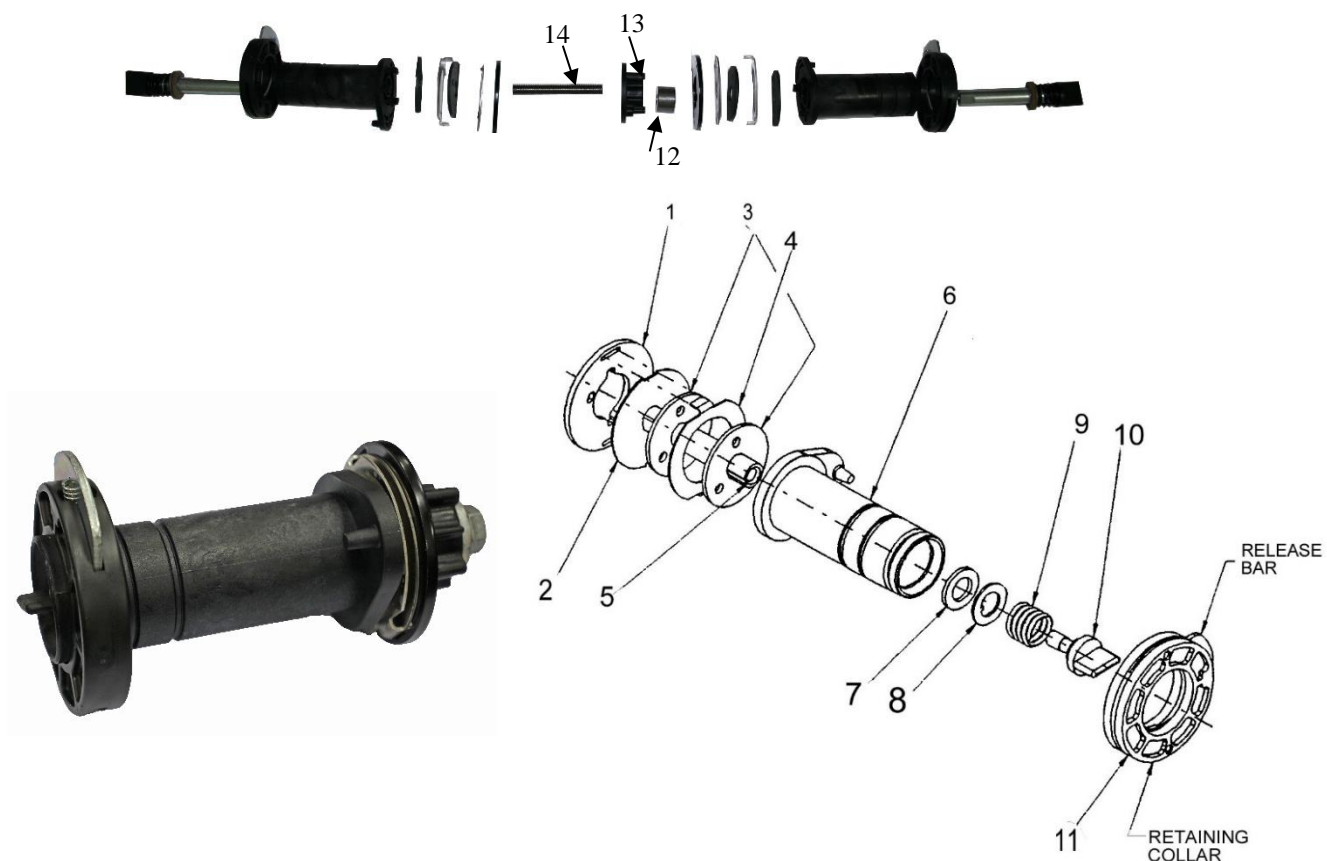
### 9.2.1 Air Supply Components



	Part Number #	Description
A	AA033	Air Valve Assembly
I	AA033-1	Air Line
2	50033-2	Acetyl Fitting
3	57036-10 Assy	Air Collar Assembly AVD Only
4	AA033	Air Solenoid Valve
5	57036-21B	Air Assembly Long Pipe
B	50043	Air Regulator Filter Combo w/Gauge
6	50043-1	Air Regulator w/out Gauge
7	57036-20B	Air Assembly Long Pipe
8	57036-22B	Air Assembly Elbow (2 Each)
C	59564-10	Jet Nozzle Center Air Hose
9	50009-1/4	Center Air Hose (No fittings)
9A	59064-3	Air Hose: Plug to Quick Disconnect
9B	59064-2	Air Hose: Hose to Head Nipple
NS	HW-4295	Center Air: Hose Crimp Ferrule
10	54036-2	Center Air: Quick Connect Fitting
11	54036-4	Air Collar Center Air Extension
12	50043-2	Air Regulator Gage
13	HW-4007	Air Valve Screw
14	AA003-1	Valve Stand off
15	HW-4124	Air Valve: Washer
NS	HW-4073	Air Valve: Washer
16/17	HW-4119	Air Valve: Nut (SS)
18	HW-4003	Pipe Hanger Mounting Stud
19	54036-12	Pipe Hanger

## 9 Components (continued)

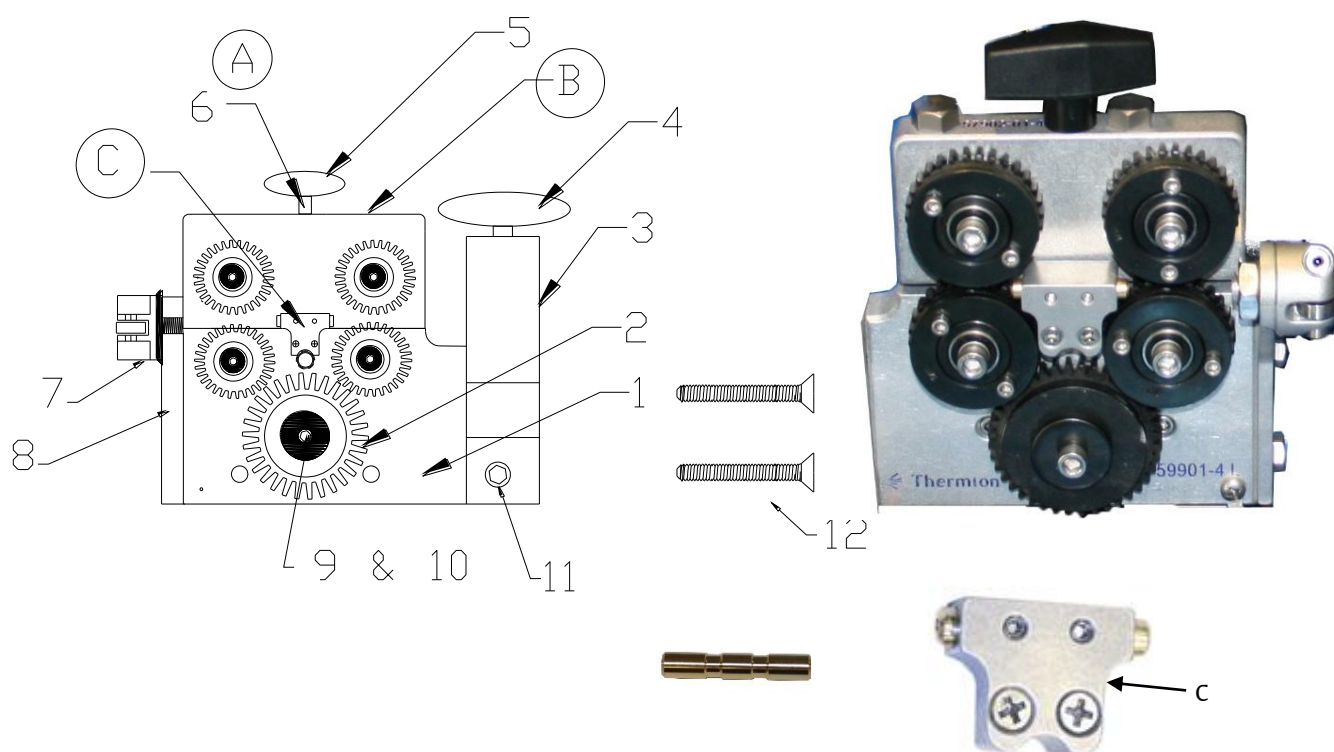
### 9.2.2 Wire Spindle Assembly



	Part Number	Description
A	AA038	Wire Spindle Assembly
1	HW-4295	Adapter Plate
2	HW-4296	Brake Plate
3	HW-4297	Friction Washer
4	HW-4298	Brake Plate Lock
5	AA038-01	Spindle Shaft
6	HW-4299	Spindle
7	HW-4300	Friction Washer
8	HW-4301	Keyed Washer
9	HW-4302	Compression Spring
10	HW-4303	Thumb Screw
11	HW-4304	Retaining Collar Assembly
12	HW-4305	Bushing
13	AA038-02	Spindle Spacer
14	HW-4006	Spindle Joining Stud
NS	HW-4306	Roll Pin

## 9 Components (continued)

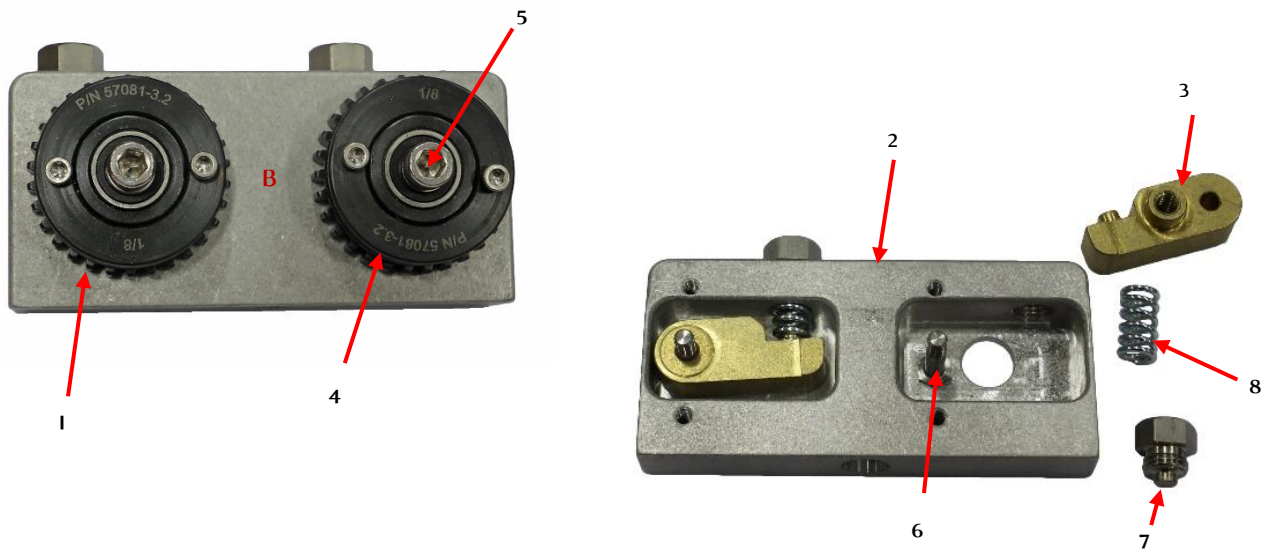
### 9.2.3 Wire Drive Components 4 Roll



	Part Number	Description
A	59900 Assembly	4 Roll Wire Drive Assembly
B	57902-4	See Section 9.2.3
C	57913-20 Assy	1.6 Center Guide Assembly
I	59901-4	Main Plate
2	59910	Insulated Gear
3	57912	Lead Adapter Plate
4	57207	Lead Clamp
5	57207	Feed Roll Clamping Knob 150
6	57206-01	Top Plate Clamp Stud
7	59956-1/16 Assy	Feed Roll Fairlead
NS	54207	Fairlead Nut
8	59957-A	Wire Inlet Guide Bearing Assembly Arm
9	HW-4140	Insulated Gear Washer
10	HW-4009	Insulated Gear Screw
11	HW-4195	Set Screw: Lead Adapter Plate
12	HW-4157	Lead Adapter Plate Mounting Screw
NS	AA9515	Feed Roller Parting Spring
NS	HW-4158	Screw: Attaches Fairlead Arm

## 9 Components (continued)

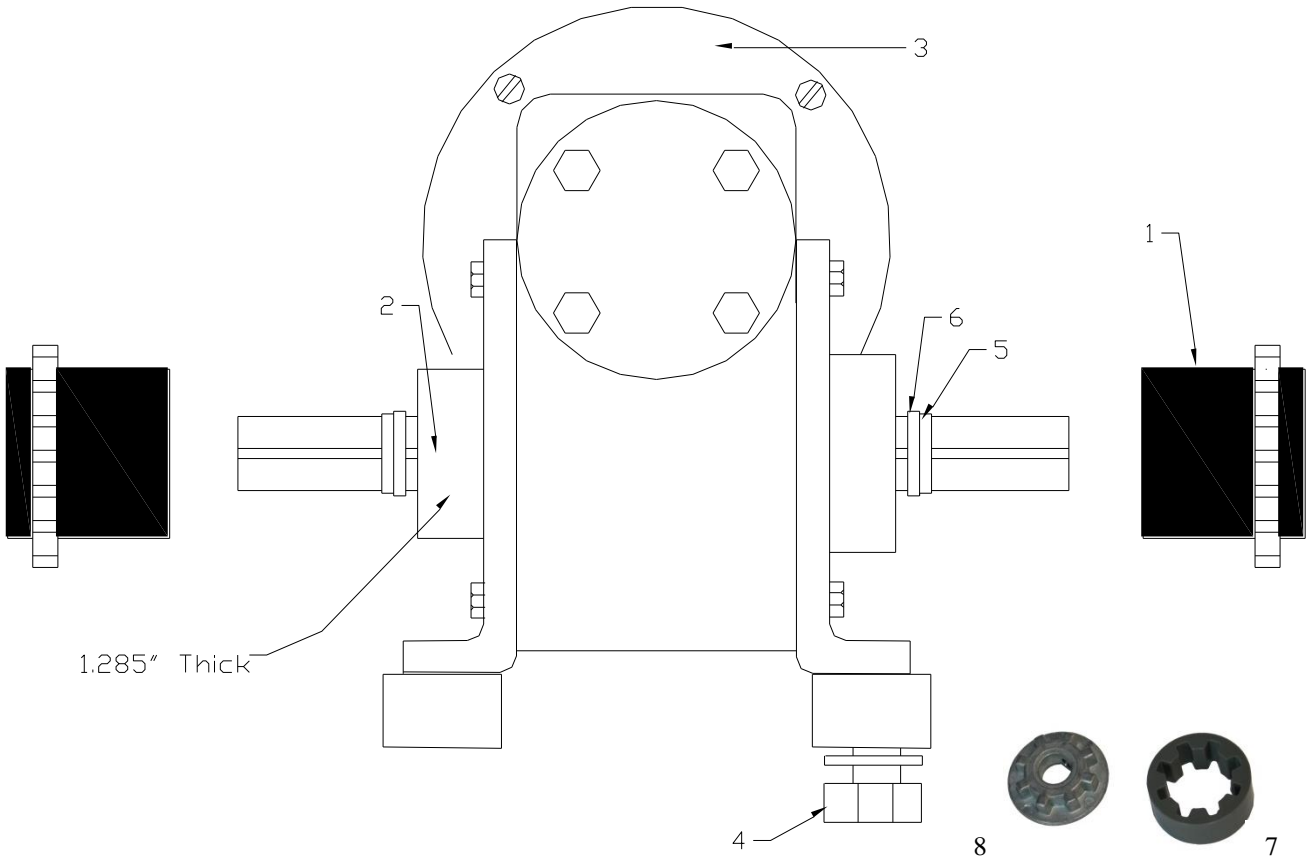
### 9.2.3.1 Wire Drive Upper Plate Assembly



	Part Number	Description
B	57902-4	Upper Plate Assembly (Feed Rolls Sold Separately)
1	57909	Wire Drive A Feed Gear Assembly
2	57902-01	Wire Drive A Upper Plate
3	57903	Wire Drive A Pivot Arm
4	57081-1.6	Feed Rolls 1/16"
5	HW-4008	Wire Drive Gear Mounting Screw
6	57903-05	Wire Drive A Pivot Stud
7	57904-B	Wire Drive A Spring Adjust Screw
8	57902-07	Wire Drive A Pivot Spring
NS	HW-4224	Wire Drive A Feed Screw Spacer
NS	57902-02	Wire Drive A Cover Plate (Not Sold Separately)
NS	HW-4116	Wire Drive A Pivot Nut
NS	HW-4072	Wire Drive A Cover Plate Screw

## 9 Components (continued)

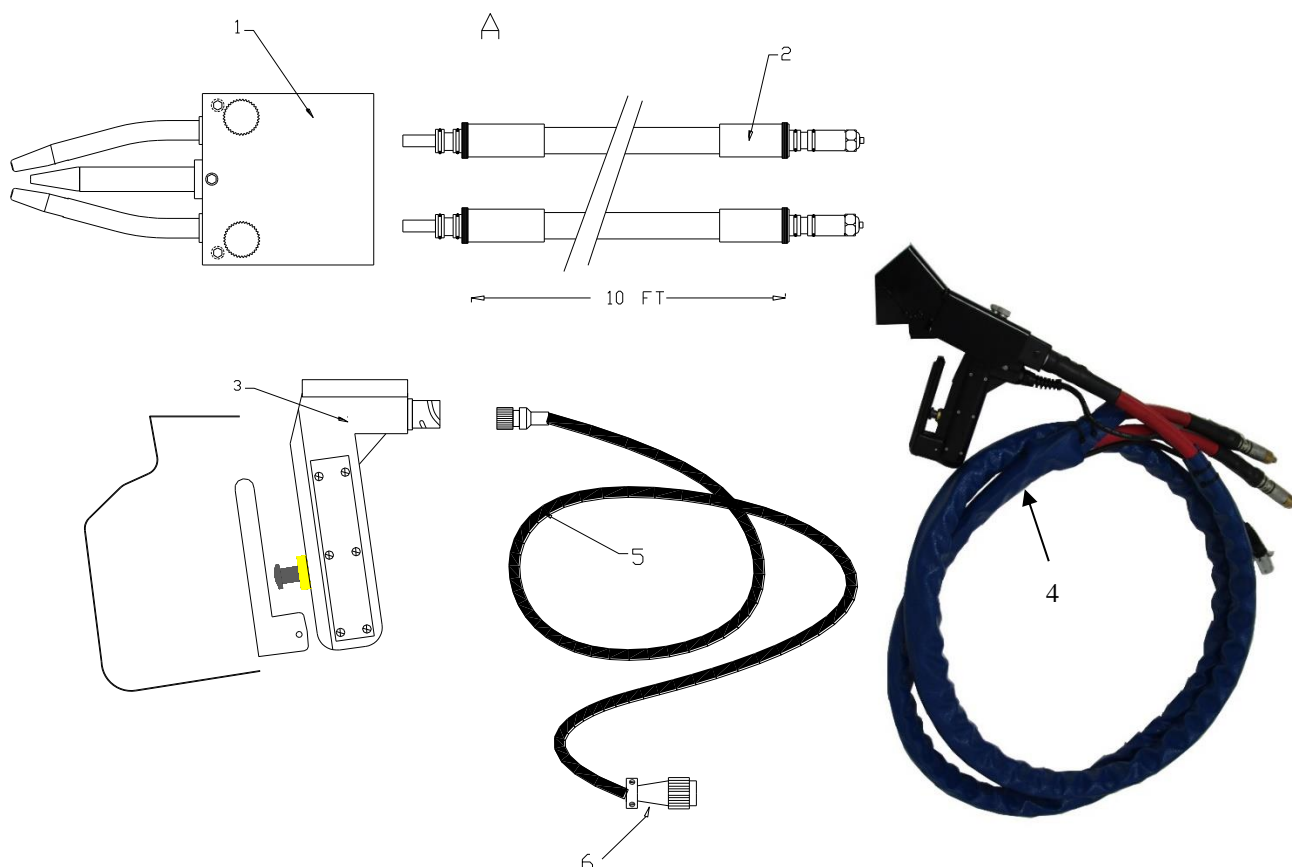
### 9.2.4 Motor Components



	Part Number	Description
1	59910	Insulated Gear
2	59901	Motor Adaptor
3	59035	Motor
4	HW-4000	Motor Mount Bolts
5	59035-1	Retaining Ring
6	59035-2	Motor Shaft Shim
7	54035-1	Coupling Sleeve (Plastic)
8	54035-2	Coupling (Metal)

## 9 Components (continued)

### 9.3 Front End Components



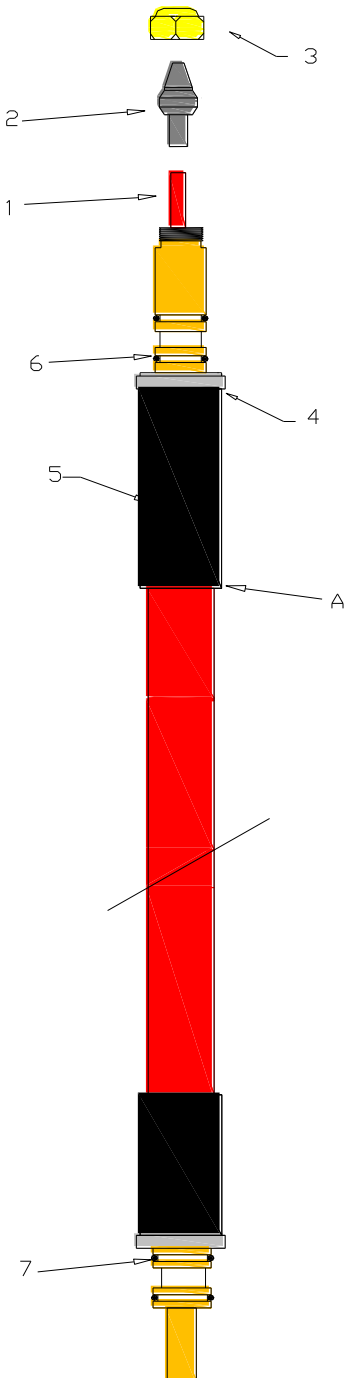
	Part Number	Description
A	59116-1.6	Front End Assembly - 1/16"
1	See Section 9.4	Fan Spray Assembly
2	See Section 9.3.1	Combination Lead: 10'
3	See Section 9.4.3	Handle and Trigger Assembly
4	51117-13, -15, -18, -20*	Comb. Lead: Protective Sleeve
5	54012-20A Assy	Cable: Trigger Cord 13' w/54045-1
	54012-21A Assy	Cable: Trigger Cord 16' w/54045-1
	54012-22A Assy	Cable: Trigger Cord 18' w/54045-1
6	54045-1	Trigger Cord Connector
B	59012-10	Handle: AVD w/10' cord

\*Note: Comb Lead Protective Sleeves will vary based on the length of leads a particular machine is sold with.



## 9 Components (continued)

### 9.3.1 Lead Components



	Part Number	Description
A	59062-10LI	Combination Lead: 10'
1	50019-14	Liner, Red
2	59018-A	Liner Insert 1/16"
3	50109	Liner Nut
4	50009-2	Shrink Tube Clamp
5	50062-3B	Shrink Tube
6	51014-1	O-Ring, Feeder Adapter
7	51016	O-Ring, Head Adapter

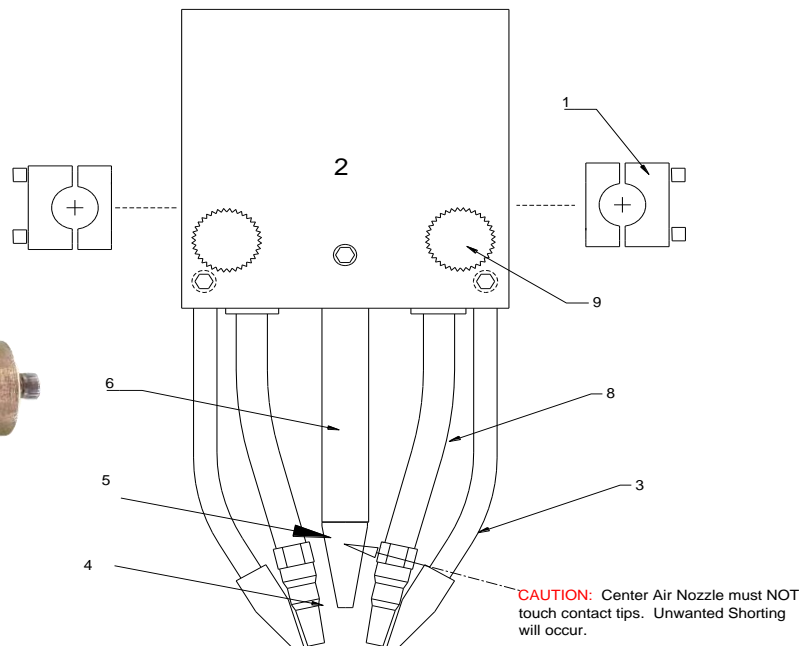
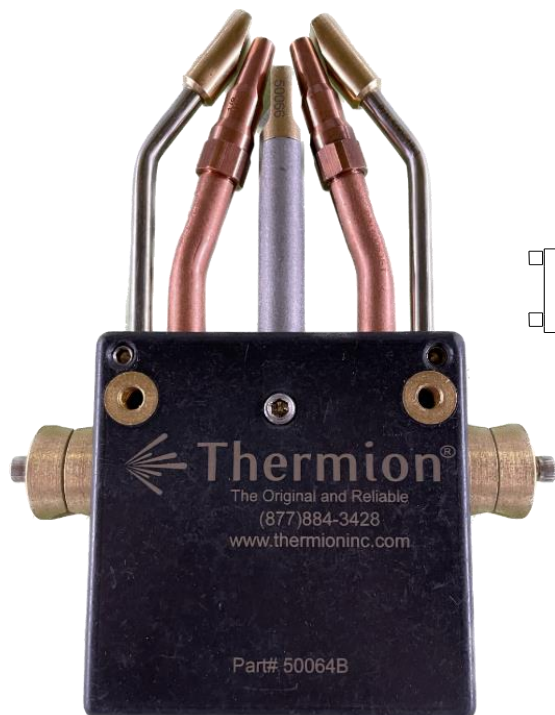


**CAUTION:** Care must be taken when disassembling Combination Leads. Please return to Thermion for repairs. It is not recommended for user to perform this repair.



## 9 Components (continued)

### 9.4 Spray Head Components Option



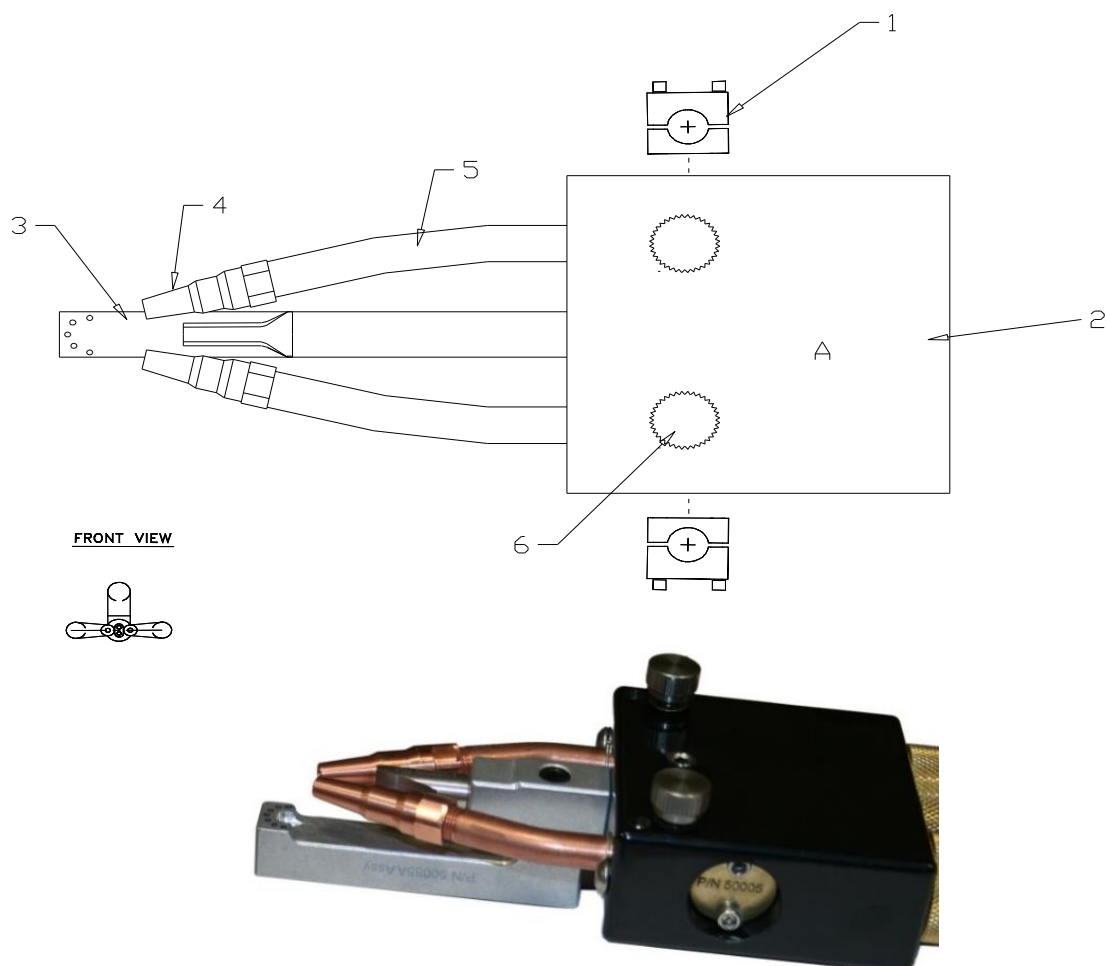
	Part Number	Description
A	50064-B Assembly 1/16"	Fan Spray Head Assembly
1	50005	Contact Tube Clamp
2	50064-B	Fan Spray Head
3	50064B-1	Side Air Jet
4	50065-1/16 IT	Contact Tip
5	50066	Center Air Nozzle, Tip
6	50066-1	Center Air Nozzle, Tube
NS	50066-2	Center Air Nozzle, O-Ring
NS	50066-3	Center Air Nozzle, Snap Ring
7	50076 SB ET	Contact Tube-1/8" (Zn/Al)
8	AA564-5B	Contact Tube Insert for 1/16" Zinc
9	50079	Shield
10	50080	Shield Clamp



**CAUTION:** Center Air nozzle must not touch Contact Tip (unwanted arcing or shorting will occur).

## 9 Components (continued)

### 9.4.1 Angle Spray Head Components Option

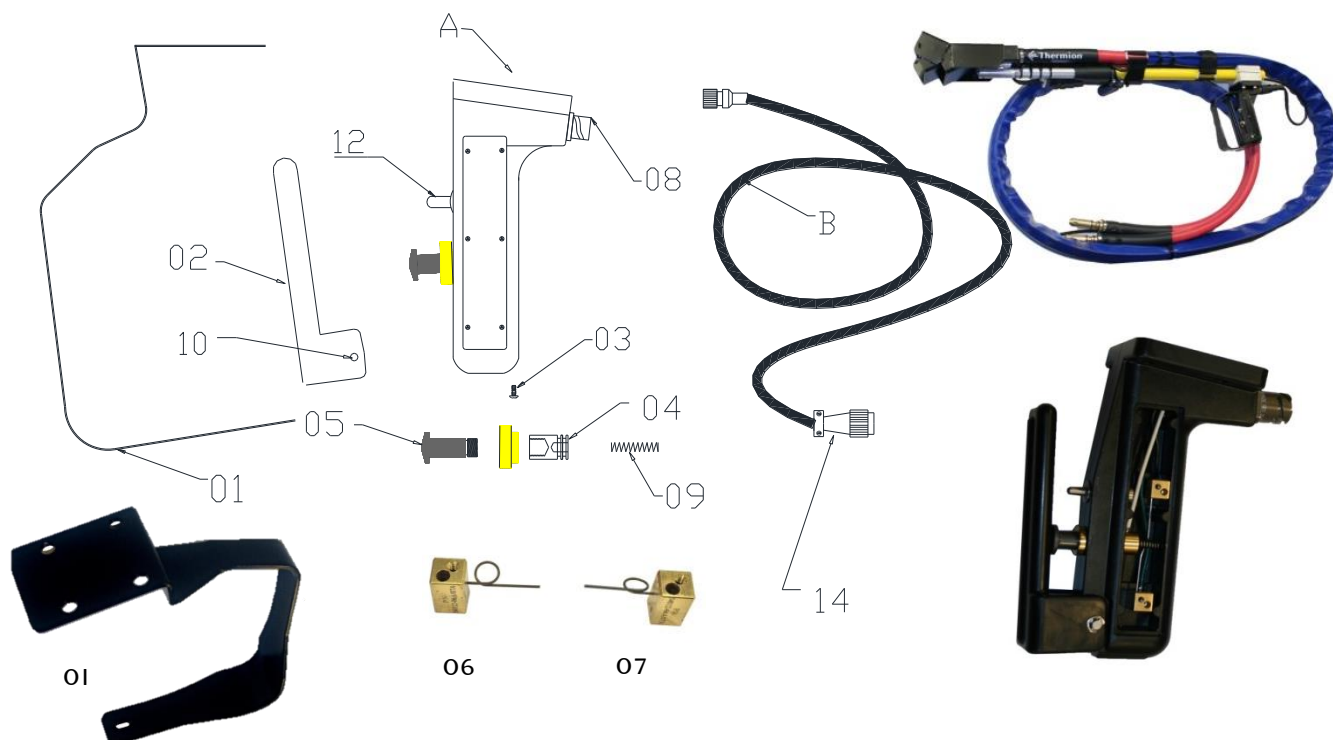


	Part Number	Description
A	50064 Assy	Angle Head Assembly
1	50005	Contact Tube Clamp
2	50064B	Fan Spray Head
3	50085A Assy	Angle Spray Nozzle Assembly
4	50065-1/16 IT	Contact Tip 1/16" IT
5	50076 SB ET	Contact Tube 1/8" (Zi/Al)
Option	AA564-5B	Contact Tube Insert 1/16" for Zinc
6	50080	Shield Clamp
NS	50064-2	Side Air Jet Plug

**CAUTION:** Center Air Nozzle must not touch Contact Tip (unwanted arcing or shorting will occur).

## 9 Components (continued)

### 9.4.2 Handle and Trigger Assembly



	Part Number	Description
A	54012-19A Assy	Handle ONLY
01	57079	Safety/Heat Shield
02	54012-02	Handle Lever
03	HW-4092	Heat Shield Mounting Screw (SS)
04	54012-04	Contact
05	54012-05	Handle Contact Plunger
06	54012-06A	Handle Air Switch
	54012-06/07S	Replacement wire for switches
07	54012-07A	Handle Main Switch
	54012-06/07S	Replacement wire for switches
08	54012-19A	Handle Trigger Cord Receptacle
09	54012-17	Handle Plunger Spring
10	54012-10A	Handle Lever Pin
12	54012-24 Assy	Handle Plunger for Switches
B	54012-20A Assy	Trigger Cord 13' w/54045-1
	54012-21A Assy	Trigger Cord 16' w/54045-1
	54012-22A Assy	Trigger Cord 18' w/54045-1
14	54045-1	Connector: (PA) cord
NS	HW-4146	Handle to Head Screw
NS	54012-18S	Cinching Straps for Handle Extension
Photo	54012-18	36 Inch Handle Extension
C	54012-16 Assy	Handle Trigger and Cord Assembly A + B

## /

## 9.5 System Wiring



**AVS150,250,350,450**

## 10 General Troubleshooting

Trouble	Possible Cause	Remedy	
No wire feed, no air with indicator light off	1. No 24 Volt to Feeder	1. Check Fuse/Breaker on Power Supply. 2. Broken wire in control lead. 3. Power supply might be off.	See Power Supply Manual
No wire feed at motor inch switch with indicator light on, air turns on with trigger switch	1. No incoming or outgoing power at switch	1. Check for broken wire on # 6 and 7 on front plug of module to switch. 2. Faulty Module Replace with Part No. 55972R5 3. Check for broken wire from #7 on rear plug to motor. 4. Check for broken wire from # 8 on rear plug and motor. 5. Check Open Circuit Voltage With trigger switch activated.	See Section 9.6
Wire feeds backwards with trigger switch. Stops when trigger released. Feeds with inch switch. Air activates with trigger.	1. Check that module is plugged in completely on the backside. 2. No Voltage/Arc Voltage 3. Contractor in Power Supply not being activated with trigger switch 4. Broken, burnt or loose wire	1. Check plug connection 2. a. Check for arc voltage by pulling the trigger and putting a meter on both drives. Should see a voltage reading. b. Check wires from each drive. Should be tight and in good working order 3. Check for Open Circuit Voltage. Switch toggle on power supply to panel, take a reading off +/- terminals. *Caution, in this mode everything is "LIVE" all the time. 4. Open control lead connector from back of feeder as well as both ends of the control cable and check for abnormalities /irregularities.	1. See Owner's Manual 2. See Power Supply Manual 3. See Power Supply Manual 4. See Owner's Manual
Wire feeds with motor Jog Switch, air turns on with Trigger Switch, no feed with Trigger Switch	1. Unconnected Power Cables 2. Power Supply Defective, Clue! No Voltage on Volt Meter or Low Open Circuit Voltage Reading 3. Loose Wire	1. Connect Power Cables 2. Service Power Supply 3. Inspect For Loose Component or Wire	See section 9.1
Wire feeds with Motor Jog, nothing on with Trigger Switch	1. Defective Trigger SW 2. Loose or Broken Wire Between Front Panel and Trigger SW	1. Replace Trigger SW 2. Replace Trigger SW and Cord Assembly or Repair Defective Part	See Section 9.5
Spraying begins then stops after a few minutes.	1. Low Voltage 2. Dirty liner 3. Debris behind air tips 4. Straighteners loose 5. Low air pressure 6. Center air inserted too far into head	1. Adjust voltage to 29 or higher 2. Lubricate and clean liner 3. Remove & clean air nozzles 4. Adjust and tighten straighteners 5. Confirm air pressure while machine is running 6. Check position of center air nozzle	See Section 4.1 See Section 7 See Section 6
Spray Pattern Rough, uneven, or odd shape distinctively different than normal. (FAN SPARY HEAD)	1. Low air pressure 2. Clogged air nozzles 3. Misaligned air nozzles/contact tips. 4. Defective air nozzles 5. Voltage too high 6. *Possible Feed Issue-see "L"	1. Increase air pressure (to above 90 PSI) while running. 2. Clean air nozzles by back blowing air 3. Re-align 4. Replace nozzle/tips 5. Lower voltage and verify setting	See Section 4.1 See Section 6.2 See Section 6.3
Spray Pattern Rough, distinctively different than normal (JET FORCE HEAD)	1. Low air pressure 2. Misaligned contact tips. 3. Voltage too high 4. Air Deflector missing *Possible Feed Issue-see "L"	1. Increase air pressure while running. 2. Re-Align Tips 3. Lower voltage and verify setting 4. Install deflector	See Section 4.1 See Section 6.2 See Section 6.3
Wire feed motor runs ho	1. Excessive friction in liners 2. Defective motor	1. Clean and lubricate liners more frequently, check wire alignment in leads, check friction knob on spool spindle holder, check feed rolls turn freely. 2. Replace motor	See Section 6.4.1 See Section 5.2 See Section 9.2.5

## 10 General Troubleshooting (continued)

Trouble	Possible Cause	Remedy	
Power leads heat up	<ol style="list-style-type: none"> <li>1. Loose /worn electrical connection</li> <li>2. Oxidized electrical connections</li> <li>3. Excessive current</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten or replace if necessary</li> <li>2. Clean electrical connections</li> <li>3. Lower amperage, confirm proper spray parameters</li> </ol>	<p>See Section 9.1</p> <p>See Section 6.1</p>
Wire feeds, cannot establish an arc	<ol style="list-style-type: none"> <li>1. Low voltage</li> <li>2. Wire feed (amperage) too high</li> <li>3. Power supply defective</li> </ol>	<ol style="list-style-type: none"> <li>1. Increase voltage</li> <li>2. Lower amperage</li> <li>3. Service power supply</li> </ol>	<p>See Section 6.1</p> <p>See Power Supply Manual</p>
Wire feeds but spray is erratic	<ol style="list-style-type: none"> <li>1. Loose electrical connection</li> <li>2. Check for excessive friction/dirty liners</li> <li>3. Debris floating in air nozzles</li> <li>4. Worn out /loose feed rolls</li> <li>5. Worn out gears</li> <li>6. Worn out or loose tips/contact tubes</li> <li>7. Heavy dust buildup in head.</li> <li>8. Debris in contact tube/ tips</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean and tighten all electrical connections</li> <li>2. Check feed rolls /liner for friction</li> <li>3. Remove air tips/nozzles - back blow with air. While removed pulse system with air.</li> <li>4. Tighten or replace</li> <li>5. Replace</li> <li>6. Replace or tighten</li> <li>7. Blow/ wipe down</li> <li>8. Remove and clean</li> </ol>	<p>See Section 9.1</p> <p>See Section 5.2</p> <p>See Section 6.4.2</p>
Air leaks at head /feeder	<ol style="list-style-type: none"> <li>1. Broken O-ring</li> <li>2. Dry O-ring</li> <li>3. Liner cut too short</li> <li>4. Hole in liner</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace O-rings</li> <li>2. Clean and lubricate</li> <li>3. Replace liner</li> <li>4. Replace liner</li> </ol>	<p>See Section 9.3</p> <p>See Section 6.3.2</p> <p>See Section 7</p>
Wire twists/ corkscrews in liner	<ol style="list-style-type: none"> <li>1. Low voltage</li> <li>2. Clogged contact tube/ tips</li> <li>3. Air nozzle inserted too far in the head</li> </ol>	<ol style="list-style-type: none"> <li>1. Raise voltage</li> <li>2. Remove and clean</li> <li>3. Remove, insure stop ring is in place</li> <li>4. LUBRICATE WIRE</li> </ol>	<p>See Section 4.1</p> <p>See Section 6.4</p>
Excessive dust and smoke	<ol style="list-style-type: none"> <li>1. Voltage too high</li> <li>2. Exceeding operating parameters</li> </ol>	<ol style="list-style-type: none"> <li>1. Lower voltage and verify</li> <li>2. Consult manual for proper operating parameters</li> </ol>	<p>See Section 4.1</p>
Split Spray Pattern	<ol style="list-style-type: none"> <li>1. Low voltage</li> <li>2. Air nozzles out of alignment</li> <li>3. Air pressure too high</li> <li>4. Air nozzle blockage</li> </ol>	<ol style="list-style-type: none"> <li>1. Raise voltage</li> <li>2. Re-align</li> <li>3. Lower air pressure to proper pressure while operating</li> <li>4. Remove air nozzles/ tips and back blow with air. Pulse air thru system while they are removed.</li> </ol>	<p>See Section 4.1</p> <p>See Section 6.2</p>
Various functions operating on their own	<ol style="list-style-type: none"> <li>1. Metal Dust in Switches or Connections</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace Switches</li> <li>2. Clean Between Pins of Control Cable Connections</li> </ol>	<p>See Section 6.4</p>



Thermion Inc. P.O. Box 780 Silverdale, WA 98383 Toll Free: 877-884-3428 Local 360-692-6469  
[www.thermioninc.com](http://www.thermioninc.com) email: [info@thermioninc.com](mailto:info@thermioninc.com)