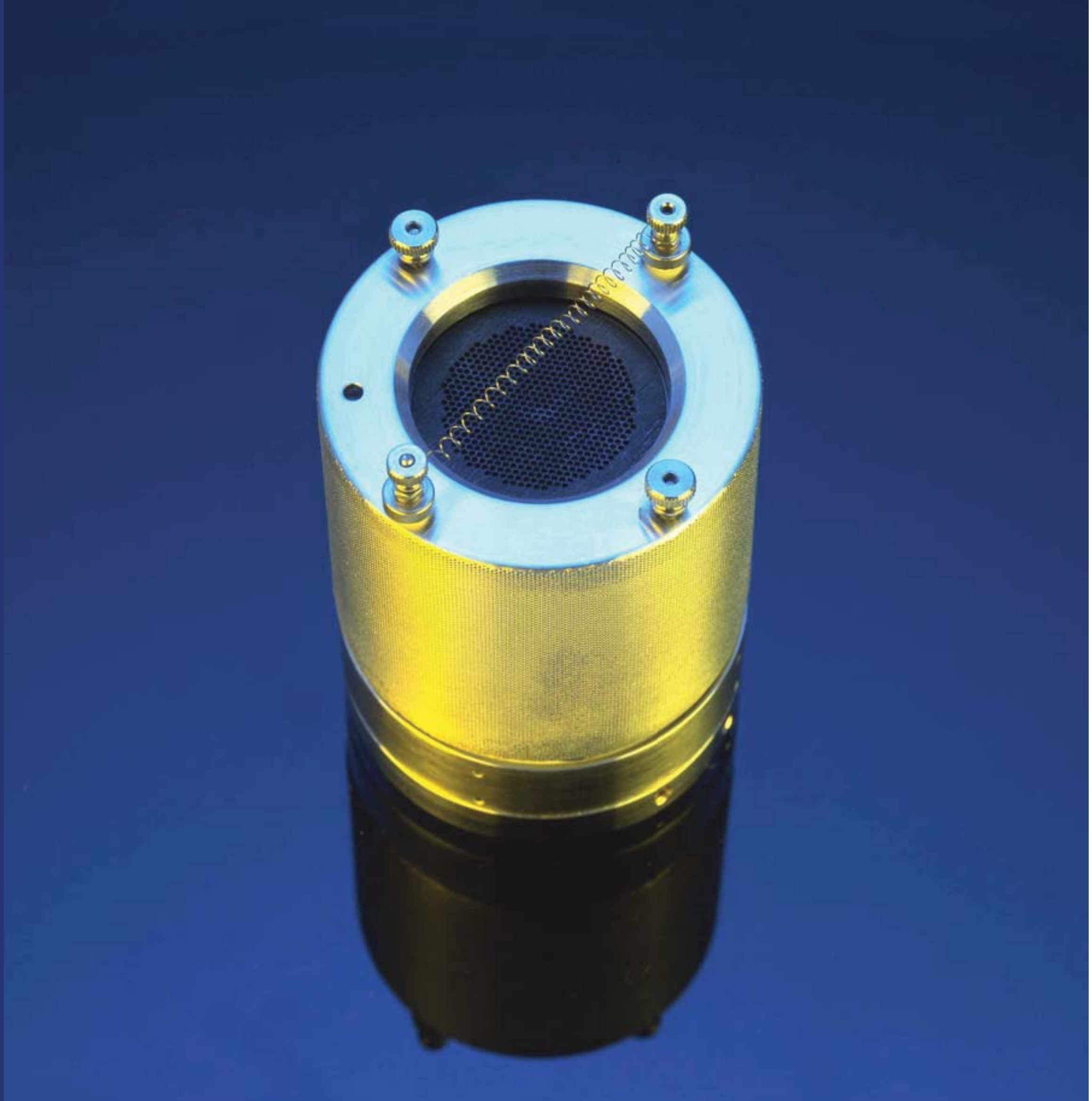

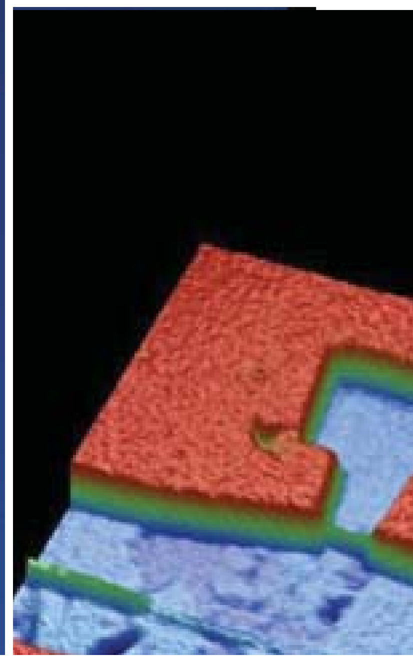

3cm DC Ion Source

Filament Cathode (ITI)

Technical Manual
9312-001

Veeco

Solutions for a nanoscale world.™

3cm DC Ion Source

Filament Cathode (ITI)

Technical Manual

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Chapter 1: Safety

Understanding the correct installation, operation, and maintenance procedure is necessary for safe and successful operation. This alert symbol precedes safety messages in this manual, along with one of the three signal words explained below. Obey the messages that follow these words to avoid possible injury or death.

DANGER

This symbol marks an imminent hazard which will kill or injure if ignored.

WARNING

This symbol marks a potential hazard which may kill or injure if ignored.

CAUTION

This symbol marks a potential hazard which may cause minor injury if ignored.

CAUTION

This symbol marks a potential hazard which may cause damage if ignored.

Please read the following before continuing:

WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures, before repairing or replacing any electrical devices.

It is recommended that only trained, qualified persons using established safety procedures perform any work related to the installation, start-up, operation or maintenance of this system.

Obtain, read and understand the Material Safety Data Sheet (MSDS) for any chemicals and materials referenced in this technical manual. Follow all local procedures in the safe handling and use of these materials, including the use of any required personal protective equipment.

WARNING

To avoid electrical shock, check that all hardware interlocks are working. Keep all guards and panels in place during routine system operation.

Complete ion beam systems from Veeco Instruments Inc. are supplied with hardware interlocks and software safeguards at various points in the system. Whenever components or retrofits are added to existing systems, a local review of system safety is recommended.

Chapter 2: Overview

This 3cm ion source is a compact, radiantly cooled DC design, available with filament neutralization or optional plasma bridge neutralizer. It is well suited for cleaning, etching, texturing, sputtering or assisted deposition processes.

Gas is introduced into the upstream end of the ion source through the gas feed tube where it is ionized. Refer to "Drawings" on page 45. When starting the discharge, the initial electron emission from the cathode is enhanced by having all surrounding surfaces at anode-potential, which is accomplished by a patented starting resistor circuit. As the electron emission rises towards operating levels, the voltage drops across the starting resistor and approaches the anode-cathode potential difference (the discharge voltage). During operation, most of the electron emission goes directly to the anode without passing through the starting resistor.

The magnetic field from the pole pieces forces the electrons to follow lengthy paths before reaching the anode. This path length increases the probability of ionizing collisions with gas atoms in the chamber. Some of the ions that are produced in the discharge reach the two grids and are focused by the positive screen grid and accelerated through the apertures in the negative accelerator grid. The accelerated ions form the directed beam of energetic ions. The neutralizer provides electrons to the positive ion beam. The neutralizing electrons are readily distributed within the conduction plasma of the beam to give a near uniform potential for most operating conditions.

Voltages and currents required by the ion source are furnished by the DC power supply. Refer to the power supply technical manual for additional information.

Discharge Chamber

The discharge chamber is filled with conducting plasma, composed of nearly equal numbers of electrons and ions, in a background of neutral atoms. Electrons have a small mass and high velocity and as a result, preferentially escape to any discharge chamber surface that is not negative relative to the plasma. The discharge chamber plasma is self-biased +5V of the most positive discharge chamber surface, which is the anode.

NOTE

At this potential, the plasma's electron loss rate is reduced to equal the ion loss rate.

The small potential difference between the plasma and the anode is usually ignored in ion energy calculations (the ions are assumed to originate at anode potential). The ions are lost to all boundaries of the discharge chamber. An increase in uniformity is acquired by drawing beam ions from only the central 80% of the discharge chamber diameter. The ion beam current is nearly proportional to the ion production rate and the plasma density in the discharge chamber. This relationship permits the ion beam current to be operated independently of ion energy or accelerating voltage within the extraction capability of the grids.

Filament Cathode

The cathode is a multiturn helical filament supported by two posts in the discharge chamber. Refer to "Drawings" on page 45. The recommended filament material is 0.25mm (0.010 in.) OD tungsten wire. This wire's approximate operating heating current is 4A.

CAUTION

Avoid using a larger diameter wire, which may cause overheating and possible source damage.

The cathode is typically operated at –30 to –70V relative to the anode; the exact value depends on the gas type used. Filament lifetime is determined by sputtering due to ions from the discharge chamber plasma. The filament lifetime should be 80 hours for the following characteristics:

- gas – argon
- filament – tungsten wire, 0.25mm (0.010 in.) OD
- maximum beam current – 75mA
- discharge voltage – 38V

NOTE

Higher discharge voltages will significantly shorten filament lifetime.

Operating with a low gas pressure (or low flow rate) in the discharge chamber may require increased cathode emission, which reduces the lifetime. A cathode emission space-charge limitation may be encountered if the discharge chamber pressure is low enough, as indicated by the slower increase of discharge current with increasing cathode heater current. An attempt to increase the cathode emission current will typically result in an early cathode failure due to excessive filament temperatures.

The presence of oxygen and other reactive process gases will likely reduce cathode lifetime versus an argon only atmosphere. When such gases are present in high concentrations, cathode replacement is recommended after every run.

CAUTION

Operating on 100% oxygen causes the following:

- filament lifetime will be reduced to an hour or less
- severe anode oxidation occurs
- early accelerator system failure (10s of hours).

Operating on argon with oxygen background partial pressures of up to 6.7×10^{-2} Pa (5×10^{-5} Torr) in the process chamber is acceptable and will have minimal effect on filament life.

Accelerator System

The ion beam extraction system consists of two closely spaced perforated electrodes. Refer to "Drawings" on page 45. The screen grid (innermost or upstream electrode) acts as a focusing electrode. Ions escape the discharge chamber by passing through the screen grid apertures; ions are collimated into beamlets for passage through the accelerator grid (outer or downstream electrode) apertures. During typical operation, the screen grid is at cathode potential (–30 to –70V relative to the anode). The anode is assumed to be the potential at which ions originate, and may be as much as +1000V relative to ground and target potential. The accelerator grid may be biased as much as –1000V relative to ground, so that the total accelerating potential difference V_{total} is greater than the anode potential relative to ground V_{net}. The ion energy in eV is numerically equal to V_{net} for single ionized atoms. Ions leaving the discharge chamber are accelerated by the potential difference V_{total}, then decelerated to a net potential difference V_{net}.

Without a negative potential barrier (V_{accel}), neutralizer electrons would backstream through the accelerator system and give a false indication of ion current. The acceleration/deceleration process is used to increase ion beam current, which, for a given accelerator system, varies as $(V_{total})^{3/2}$. Use of a large accelerator voltage increases the ion current substantially for a given value of V_{net}.

NOTE

Using a large negative accelerator voltage has the adverse side effect of increasing the beam spread.

A high beam current capacity at moderate voltages requires closely spaced grids with many small apertures. In particular, maintaining a small uniform spacing requires mechanically stable grids. The small holes and close grid spacing of Veeco grids permit current densities greater than 10mA/cm^2 at 1000eV argon ion energies, without resorting to large negative accelerator voltages.

Neutralization

Filament Neutralizer (Immersed Wire)

The neutralizer is a multiturn helical filament stretched across the edge of the ion beam. Refer to "Drawings" on page 45. The recommended filament material is 0.25mm (0.010 in.) diameter tungsten wire. The approximate heating current for this wire is 5A.

CAUTION

Substituting a larger diameter wire will raise the heating current which damages the connection hardware.

The neutralizer lifetime is determined by sputtering from impinging beam ions. Using argon gas, 0.25mm (0.010 in.) OD tungsten wire, 500eV, and 75mA beam, the lifetime should be at least six hours. The lifetime will be reduced when:

- the ion beam energy increases
- the ion beam current increases
- oxygen is used in place of some or all of the argon.

NOTE

The presence of oxygen and other reactive process gases will likely reduce neutralizer lifetime versus an argon only atmosphere. When such gases are present in high concentrations, neutralizer replacement is recommended before every run.

Electrons produced by the neutralizer provide space charge neutralization of the ion beam and prevent the build up of damaging surface potentials on targets and substrates. The neutralizing electrons present in the ion beam typically have a Maxwellian distribution with a temperature of 5 to 10 eV.

- Doubling ion density will give an ion beam potential difference of 3.5 to 7V.
- A target potential variation of 3.5 to 7V will change the electron arrival rate by a factor of two.

These small potential variations will have a negligible effect on the trajectories of ions with energies of several hundred eV, but are sufficient to ensure an adequate electron flux to prevent surface charging.

NOTE

Precise neutralization is not necessary. The rough equality of electrons and ions is sufficient to result in a sputtering target being within a few volts of ground potential, even if that target is an insulator.

The conducting nature of the ion beam plasma permits the neutralizer to move to a wide range of locations. But the neutralizer must at least be within the ion beam fringe.

Position the neutralizer at the ion beam's edge, to reduce:

- Neutralizer sputter erosion.
- The view factor of the neutralizer to the sputtering target. This reduces contamination with neutralizer material.

If the ion beam area is reduced by a mask, the neutralizer may be moved closer to the mask to reduce the target's view factor of the neutralizer to zero.

If the neutralizer is moved completely outside of the ion beam, however, the coupling will be degraded. This means that a large potential difference is required between the neutralizer and ion beam. Because the neutralizer is typically grounded, this potential difference results in the ion beam being well above ground potential (as much as several hundred volts). This large voltage may easily affect the ion trajectories and, as a result, affect ion current density at the target.

NOTE

Difficulty in obtaining adequate neutralizer emission current is an indication that the neutralizer filament is not sufficiently immersed in the beam.

Plasma Bridge Neutralizer (Option)

The *plasma bridge neutralizer* (PBN) provides another method of ion beam neutralization. The PBN is located outside the periphery of the ion beam, thereby eliminating neutralizer ion impingement damage and forward sputtered contamination. The electrons are obtained by passing a flow of argon through a small chamber containing a biased filament emitter. A discharge is produced between the emitter and walls, forming a plasma. The plasma is extracted through a small orifice at the chamber's end, and electrically couples to the ion beam. This coupling, or bridging, is aided by biasing the PBN negative with respect to the beam. Typically, coupling voltages of 20V allow adequate electron currents to be obtained. Refer to the PBN technical manual for installation and operation information.

Chapter 3: Installation

General

The ion source is available in two mounting configurations: flange mount and internal mount. Refer to "Drawings" on page 45.

Pumping System

The vacuum pumping system should be able to maintain a process chamber pressure of 6.7 x 10^{-2} Pa (5 x 10^{-4} Torr) or less with a gas load of 4sccm of argon for each ion source and external PBN (if provided).

- Ion sources operating in vacuum systems unable to maintain this pressure may experience electrical breakdown between the high voltage leads.
- Sources operating at pressures above 6.7 x 10^{-2} Pa experience increased accelerator (downstream) grid erosion as a result of sputtering from charge-exchange ions. As the pressure rises above 6.7 x 10^{-2} Pa, the charge-exchange ion density and sputtering increases rapidly.

Operating at pressures below 2.7 x 10^{-2} Pa (2 x 10^{-4} Torr) should minimize these effects.

NOTE

The accelerator system acts as a gas baffle so that for moderate flow rates, the ion source's internal pressure is high enough to sustain a stable plasma discharge.

As a result, the ion source is relatively insensitive to operating background pressure. As long as there is sufficient gas flow through the source, the ion source will operate at as low a background pressure as the pumping station may maintain or the process will tolerate. Refer to "Specifications" on page 44. This is in contrast to other pressure sensitive sputter deposition and etching processes that require a relatively high process chamber pressure 10^{-1} Pa (10^{-3} Torr) to sustain a discharge.

Gas Supply and Control

The gas flow rate through the source should be controlled through a micrometer valve or an electronic gas flow controller (available separately). The ion source's design includes internal high voltage isolation to separate the high potential of the source from the grounded gas flow system. The PBN (if provided) gas line has an in-line electrical isolator and is grounded at the vacuum feedthrough.

NOTE

The ion source was designed to operate with argon; it will also operate with other process grade inert gases, as well as on hydrogen, nitrogen, and hydrocarbon compounds.

CAUTION

Source operation on 100% oxygen causes the following:

- filament lifetime will be an hour or less
- severe anode oxidation will occur
- early accelerator system failure (10s of hours).

Cooling

The ion source is cooled by conduction through its mechanical mounting and by radiation to its surroundings. A cooling water supply is not required.

NOTE

Avoid tightly covering the perforated metal shroud.

This shroud is designed to enhance the radiative heat transfer from the discharge chamber as well as to provide venting of the enclosed volume around the discharge chamber.

Electrical

The DC power supply provides the currents and voltages required for ion source operation. The electrical connection between the power supply and the ion source/vacuum interface is through multi-conductor cables. Refer to the power supply technical manual and to "Drawings" on page 45. for installation and connection instructions.

There are several cable termination schemes used with Veeco sources that depend on vacuum system installation. Flange mount ion sources and sources mounted in custom vacuum enclosures are typically supplied with a high voltage cover internally wired to the vacuum feedthroughs.

Flange mount source cables are terminated with female multipin connectors which mate with a bulkhead fitting on the high voltage cover. Internal mount source's cables are terminated with #10 ring lugs for connection directly to the vacuum feedthroughs.

Safety Interlocks

WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before repairing or replacing any electrical devices.

Some sources may utilize mechanical connections which operate at high voltage. Refer to "Safety" on page 1 and to the power supply technical manual for additional information.

WARNING

To avoid electrical shock, check that all hardware interlocks are working. Keep all guards and panels in place during routine system operation.

Electrical Shielding

The ion source produces a low density conductive plasma that fills the process chamber during operation. This results from the interaction (charge exchange) between some of the directed beam ions and the background gas in the chamber.

Low density plasma provides a conductive path that leads to an electrical discharge (breakdown) between any exposed high voltage surface or electrical lead and facility ground. All energized electrical connections (over 100V) within the process chamber must be shielded by an insulating surface or a ground shield, including (but not limited to): quartz lamps, heaters, electron beam guns, and ion source leads.

NOTE

The probability of electrical discharge (breakdowns) at high voltage connections increases with increasing process chamber pressure; operate at a low background pressure to reduce these effects.

Fabricate ground shields from aluminum or stainless steel shim stock, fine mesh screen, or perforated metal. Aluminum foil is useful for fabricating temporary shielding.

NOTE

Clean household variety aluminum foil with acetone and/or alcohol to remove any vegetable oil residue left during manufacturing.

Shields should be vented to facilitate pumping enclosed volumes. Venting holes should have a maximum diameter of 1.5mm (0.060 in.) to provide adequate electrostatic shielding.

Custom Equipment

This section (when provided) covers installation, operation, drawings, maintenance, custom flanges, internal mount interfaces or other details unique to the equipment and options purchased.

NOTE

This section is only included in manuals covering custom or non standard equipment.

Ion Source

Flange Mount Installation

1. Bolt the ion source mount flange to the process chamber mating port.

NOTE

Make sure the appropriate seal is installed and correctly seated.

2. Connect the gas supplies to the source gas fittings on the high voltage cover.
3. Install the power supply in a convenient location.
4. Connect the female end of the seven conductor ion source cable to the ion source. Connect the power supply cable to the external PBN (if provided).
5. Perform a continuity check. Refer to "Ohmmeter Check" on page 40.
6. Connect the male end of the seven conductor ion source power supply cable and the four conductor PBN cable (if provided) to the power supply's rear panel.

7. Attach the #6 lugs from the power supply external interlock cable to the two 6-32 binding posts on the ion source high voltage cover. Interlock connection polarity is not important.

CAUTION

Any additional switches that are wired in series to this interlock circuit must be at ground potential. Connection to a powered circuit will result in power supply damage.

⚠WARNING

All ion source electrical leads operate at high voltages. To avoid electrical shock, keep clear of "live" circuits. Do not override the interlock or operate the ion source with the high voltage cover removed.

8. Remove the clear plastic grid protector plate and red caution tag from the downstream end of the ion source.
   a. Loosen and remove the hardware holding the plate to the source.
   b. Reinstall the neutralizer filament and replace the hardware.
9. Evacuate the process chamber.
10. Purge the gas supply lines; refer to "Preparation" on page 15.
11. The ion beam source is ready for operation (refer to "Operation" on page 15).

Internal Mount Installation

1. Securely mount the ion source inside the process chamber using: the backplate's four 10-32 tapped holes or a stainless steel band clamp.

NOTE

Do not cover the vent holes or any portion of the perforated metal shroud.

2. Install the gas/electrical feedthrough(s) at a convenient location in the process chamber.
3. Connect the ⅛ in. OD gas line between the ion source and the gas feedthrough using the ⅛ in. Swagelok® brand unions provided.
4. Connect the gas supply to the gas feedthrough.
5. Install the power supply in a convenient location.

6. Connect the beaded electrical leads from the source to the matching pins on the electrical feedthrough(s) (A to A, B to B). Refer to "Drawings" on page 45.

7. Connect the lugged end of the seven conductor ion source cable to the electrical feedthroughs according to the same lead designations.

8. Shield the high voltage electrical connections and the gas lines on the vacuum side of the feedthrough(s) with insulator sleeves or a metal ground shield to prevent electrical breakdown (refer to "Electrical Shielding" on page 11).

9. Remove the clear plastic grid protector plate and red caution tag from the downstream end of the ion source.

   a. Loosen and remove the hardware holding the plate to the source.

   b. Reinstall the neutralizer filament and replace the hardware.

10. Perform a continuity check. Refer to "Ohmmeter Check" on page 40.

11. Connect the male end of the seven conductor ion source power supply cable and the four conductor PBN cable (if provided) to the power supply's rear panel.

12. Evacuate the process chamber.

13. Purge the gas supply lines; refer to "Preparation" on page 15.

14. The ion beam source is ready for operation (refer to "Operation" on page 15 for detailed instructions).

PBN Installation

Refer to the PBN technical manual for installation instructions.

Chapter 4: Operation

This chapter is intended for the new user of the equipment. Operating experience helps many users find that minor changes to gas flow rates or to initial power settings improve the efficiency for a particular application or process.

Preparation

WARNING

All ion source electrical leads operate at high voltages. To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/ tag-out procedures before continuing.

1. Verify correct installation of the gas and electrical connections. Refer to "Installation" on page 9, "Drawings" on page 45 and to the power supply technical manual.
2. Evacuate the chamber to 1.3 x 10^{-2} Pa (1 x 10^{-4} Torr) or lower.
3. Purge the gas supply lines before initial start-up or after disconnecting.
   a. Open the gas control valves.
   b. Evacuate the supply lines back to the high purity gas supply.
   c. Leak check the supply lines and connections.
   d. Back fill the lines by simultaneously closing the gas control valve and opening the gas supply valve.
4. Repeat step 3. two or three times; this is particularly important for new gas lines, lines exposed to the atmosphere for a time, or after a gas supply change.
5. Adjust the source gas flow rate; refer to the "Specifications" on page 44 and the source run data sheet provided with the source.
6. Adjust the PBN gas flow rate (if provided); refer to the neutralizer technical manual.

DC Power Supply

A compatible DC power supply was used for the ion source pre-shipment check. Operating conditions were programmed into the power supply's memory at that time. These operating parameters are recorded on the *source run data sheet* shipped with the source. These parameters may be used to verify ion source operation.

Complete the steps in "Preparation" on page 15 and then follow these steps:

1. Turn on the **POWER** switch on the power supply's front panel. The power supply will complete a self-test.

2. Recall the appropriate value using the **MEMORY** button and press **ENTER**.

3. Set the **MODE** button to **LOCAL**.

4. Press the **SOURCE** button on the power supply. The discharge should start after a few seconds as indicated by the presence of a discharge current.

NOTE

Although the power input is near the typical operating value, the material sputtered will be insignificant in the absence of a beam.

If the process chamber is not heated before use, a longer warm-up may be necessary. During this time, adsorbed air and water vapor layers are driven from the process chamber wall before the sputter-deposition operations begin. Etching is typically less sensitive to these impurities.

NOTE

For graphite grid equipped sources, follow the steps under "Graphite Grid Bake Out" on page 30 **before continuing.**

5. Press the **BEAM** button. A beam extraction occurs after a few seconds and automatically adjusts to the programmed condition.

6. Allow the source to warm-up for 5 to 10 minutes.

7. Use the **MEMORY** button to recall the alternate memory to operate the other preprogrammed conditions.
    - Toggling the switch once recalls the memory for preview.
    - Toggling the switch a second time enters the stored conditions as operating parameters.

CAUTION

Continuous ion source operation at discharge power in excess of 110W may cause overheating and anode damage.

NOTE

Discharge power is the product of discharge current and discharge voltage. A discharge current of 2.75A and a discharge voltage of 40V produces a discharge power of 100W.

Refer to the power supply technical manual for information on changing parameters, error message explanation, and troubleshooting.

Accelerator Current

The accelerator grid current is indicated by a display on the power supply front panel. This value is somewhat process dependent.

NOTE

Avoid a rapid rise in accelerator current with increasing beam current.

The following contribute to accelerator current:

- Background current, due to low-energy charge-exchange ions; this increases with process chamber pressure and beam current.
- Direct impingement of high energy ions on the accelerator grid.

As the beam current increases at a constant beam voltage, the diameters of the beamlets passing through the accelerator grid holes also increase. When these beamlets become large enough to impinge on the sides of the accelerator grid holes, any further increase in beam current results in a rapid increase in measured accelerator current.

NOTE

Reduce the beam current if the accelerator current cannot be lowered by adjusting the accelerator voltage.

Sustained operation at a high impingement condition increases the accelerator grid material wear and may cause contamination from sputtered accelerator material. Serious accelerator wear takes many hours of high impingement operation.

Once a maximum beam current has been established at specific beam and accelerator voltages, that value is fairly reproducible. As the accelerator system accumulates operating time, the maximum beam current increases slightly and the accelerator current decreases.

Discharge Voltage

The discharge voltage that appears on the power supply is the potential difference between the source anode and filament cathode. It is an independently controlled parameter and may be programmed from the power supply's front panel. Filament wear is primarily due to sputter erosion by discharge chamber ions and increases as discharge voltage increases. The source should be operated with as low a discharge voltage as practical. For argon, the typical operating range for the discharge voltage is 35 to 55V.

NOTE

To maximize useful filament lifetime and minimize discharge power, operation at 38V is recommended.

The discharge voltage affects beam divergence slightly. At higher discharge voltages (55V for example), the beam spot size is about 10% less and the maximum (beam center-line) current density is about 15% greater than for a 38V discharge. It may be necessary to operate at higher discharge voltages for applications requiring a minimum spot size. This causes a significant reduction in filament lifetime, however.

For a 75mA/1000eV beam operating on argon at a flow rate of 4sccm:

Table 4.1: Discharge Voltage vs. Filament Life

V	Life, hours
38	80
55	12

Operating with gases other than argon, may require higher discharge voltage. For example, nitrogen operation requires a discharge voltage of 55 to 65V.

Shutdown

Follow these steps to turn off the source:

1. Press the **SOURCE** button to turn off the ion source.

2. Press the **POWER** button to turn off the power.

3. Allow the source to cool at least 15 minutes before venting the vacuum system.
    - Leave on the argon flow if the shutdown is less than one hour.
    - Turn off the argon flow if the shutdown is more than one hour.

Chapter 5: Disassembly and Reassembly

Source Disassembly

Refer to "Drawings" on page 45 for source assembly information.

WARNING

All ion source electrical leads operate at high voltages. To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/ tag-out procedures before continuing.

1. Turn off all power to the ion source.

CAUTION

The grids are fragile. Avoid damaging the grids when handling them.

2. Remove the two 4-40 thumb nuts and lock washers from the source tie rods.
3. Unplug the source assembly from the electrical pin locator block.
4. Place the source, grid end up, on a clean, hard work surface. Check that the source rests securely on the male electrical connector pins.
5. Disconnect the gas line and electrical leads from the PBN and remove the assembly and mount bracket (if provided).
6. Remove the two 2-56 thumb nuts securing the neutralizer filament and remove the old filament.

CAUTION

The tungsten filament wire becomes very brittle after operating at emission temperatures. Filament fragments may puncture the skin and break off, leaving pieces of imbedded wire.

7. Remove the 2-56 nut, lock washer, cup, and insulator from each of the two neutralizer posts.

NOTE

The threaded rod may loosen from the connector pin while removing the 2-56 nut. Make sure the rod is fully threaded onto the connector pin before reassembling.

8. Remove the shroud by lifting straight up and sliding the shroud off the ion source assembly, which should be left standing grid end up on the work surface.

CAUTION

The grids are fragile. Avoid damaging the grids, which are exposed during the following steps.

9. Turn the ion source assembly over and carefully place it on the work surface so that it rests on the grid insulator.

10. Remove the two neutralizer posts and alumina spacer tubes from the ion source assembly.

11. Loosen the 4-40 socket cap screw that secures the screen grid connector strap to the downstream pole piece.

12. Remove the source body assembly from the grid assembly:

    a. Tilt the source body to disengage the accelerator connection pin.

    b. Slip the body free of the screen grid connector strap.

13. Place the grid assembly out of the way on a clean surface free of tools and loose objects.

⚠ CAUTION

The tungsten filament wire becomes very brittle after operating at emission temperatures. Filament fragments may puncture the skin and break off, leaving pieces of imbedded wire.

14. Remove the two 4-40 socket cap screws securing the cathode flange and separate the flange from the source body assembly.

15. Loosen the anode connector pin from the anode post and remove the alumina body insulator ring.

16. Remove the 6-32 nut, cup, and insulator from each of the three anode posts.

17. Loosen the three 6-32 anode posts from the anode and remove the anode from the chamber.

18. Follow the steps in “Grid Alignment Check and Inspection” on page 24 and “Maintenance” on page 27 for component and subassembly servicing.

Source Reassembly

Reassemble the ion source; reverse the steps in "Source Disassembly" on page 20 and use the following additional guidelines.

NOTE

The anode's outer surface is engraved with an arrow and the word GRIDS.

1. Install the anode with the arrow pointing downstream (toward the grids).
2. When installing the anode in the discharge chamber, check that:
   - the anode posts are flush with the anode's inside surface
   - the anode is centered in the discharge chamber after tightening the anode connections.

NOTE

Install the neutralizer posts through the smaller diameter holes in the body and grid insulators.

3. After installing the grid assembly, check that:
   - the neutralizer posts are fully threaded into the connector pins and pass through the ceramic spacer tubes
   - the accelerator pin is mated with the accelerator connector's socket.
4. Replace the cathode and neutralizer filament. Refer to "Maintenance" on page 27.
5. Tighten all copper connector pins finger tight.
6. Check that the shoulders on the pins protruding from the alumina body insulator ring are fully seated against the ring's upstream surface.
7. Check each electrical connection pin with respect to every other pin and to the shroud, using a multimeter. All pins should be open to the shroud; refer to Table 8.7: on page 42 for values between pins.

NOTE

The resistance shown between the two cathode pins and two neutralizer pins indicates that filaments are present.

8. Plug the source assembly into the pin insulator block. It should slip easily over the tie rods and seat smoothly. DO NOT force it.

9. Reinstall the PBN assembly (if provided):

    a. Fit the mount bracket over the source tie rods.

    b. Fasten the two 4-40 thumb nuts.

    c. Reconnect the gas feed line and electrical leads.

Chapter 6: Grid Alignment Check and Inspection

General

Pyrolytic graphite grids are particularly susceptible to handling damage. Make sure the work area is clean of tools and loose objects. Wear clean lint-free gloves or finger cots when handling grid components.

CAUTION

The grids are fragile. Keep the work area clear of tools and objects to avoid grid damage.

1. Remove and place the grid assembly on a clean, flat work surface. Refer to "Source Disassembly" on page 20.

2. Loosen the accelerator pin connection from the 0-80 post on the grid assembly's upstream side.

3. Place the assembly upstream side down on a clean work surface.

4. Check the grid alignment by carefully inserting a grid alignment pin (size supplied: #46 drill rod/2.06mm/0.081 in.) into the grid alignment holes.

   If the grids are correctly aligned, the pins should pass easily through the alignment holes in both grids without binding. DO NOT force; use a gentle rotating motion.

5. Loosen the three 4-40 screws holding the grid stack together.

   - If only grid alignment is required, proceed to Step 9. on page 26.
   - If complete disassembly and cleaning is necessary, proceed to Step 6.

6. Remove the three 4-40 screws holding the grid stack together.

NOTE

Use the ¼ in. nut driver from the tool kit (supplied) to keep the grid mount ring tabs from turning when the screws are loosened. This prevents grid mount ring distortion.

7. Remove the 0-80 nut on the accelerator post.

8. Inspect the grids for pits or deposits as a result of arcing or sputtered material from the workpiece. Deposits on the downstream side of the accelerator grid are generally unimportant unless they are loose enough to fall into the workpiece. If contaminants are present, refer to “Grid Cleaning” on page 29.

NOTE

Arcing is usually indicated by a deposited graphite projection on the screen grid’s downstream side and a corresponding pit on the adjacent accelerator grid surface. It may also appear as matching irregular patterns on adjacent grid surfaces, which are darker than the surrounding area.

Grid Spacers and Insulators

Inspect the grid spacer and grid insulator for arc tracks around the edges and for conductive coatings which might bridge the grid sputter-break grooves. Some coating is typical around the insulator edges but it should not extend over the flat faces to contact the adjacent grid surface.

Clean or replace coated insulators that provide a conductive path between the grids or from the accelerator grid to the shroud. Use a bead blaster to clean the insulators. Refer to “Coated Insulators” on page 28.

Assembly and Alignment

NOTE

If the grids are already assembled and only need alignment, proceed to Step 9.

For ease of assembly, the accelerator grid, screen grid, and alumina grid insulators are each marked on the upstream surface with an index mark about 0.4mm (0.015 in.) deep near the outside edge. The accelerator grid has a 0.25mm (0.010 in.) deep annular groove on both sides.

1. Hold the accelerator grid’s index mark at the 12 o'clock position and the upstream (index mark) face up.

NOTE

The accelerator connection hole is a small opening at the one o'clock position.

2. Place the alumina grid spacer on top of the accelerator grid; align the accelerator connection holes.

3. Insert an 0-80 screw through the accelerator connection hole from the downstream side and install a 0-80 lock washer and nut.

4. Center the grid spacer on the accelerator grid and tighten the 0-80 nut.

CAUTION

Tighten the 0-80 nut just enough to compress the lock washer. DO NOT over tighten; this may fracture the grid or ceramic spacer.

5. Assemble the grid mount ring, screen grid, grid spacer, and accelerator grid. Refer to "Drawings" on page 45. Make sure the index marks are aligned and on the upstream surface.

6. Place the grid insulator on the grid stack, aligning the relief for the accelerator connection over the head of the accelerator connection screw.

7. Install three 4-40 screws to loosely hold the assembly together; DO NOT tighten.

8. Center the grid mount ring on the assembly; check that the ring's downstream edge is seated in the counterbore on the screen grid's upstream surface.

9. Insert a grid alignment pin (size supplied: #46 drill rod/2.06mm/ 0.081 in.) into each of the grid alignment holes.

10. Tighten the three 4-40 screws firmly, while holding all the pins in parallel alignment. Use the ¼ in. nut driver to keep the grid mount ring tabs from turning.

11. Remove the alignment pins.

12. Thread the #20 male pin over the 0-80 accelerator connection post and finger tighten.

13. Install the grids to the ion source following the steps in "Source Reassembly" on page 22.

Chapter 7: Maintenance

General

⚠WARNING

All ion source electrical leads operate at high voltages. To avoid electrical shock, keep clear of “live” circuits. Follow all local lock-out/tag-out procedures before continuing.

Routine maintenance involves:

- removal of loose flakes of sputtered material
- cleaning sputtered insulating material from anode surfaces
- filament replacement (cathode and/or neutralizer).

The source’s current densities permit large amounts of material to be sputtered. These deposits may require periodic removal, especially when flakes dislodge and cause shorts.

Loose Flake Removal

Layers of sputtered material build up during routine operation and detach when exposed to air. Depending on system geometry, flakes of sputtered material may fall from the ion source onto the sputtered surface, resulting in uneven material removal (for sputter machining) or undesirable contamination (for sputter deposition).

To avoid flaking problems, brush off the external surfaces of the ion source and PBN (if provided) before evacuating the process chamber.

- Use a stainless steel wire brush on most ion source surfaces.
- Use a soft bristle brush on the accelerator system grid.

A flake of sputtered material may become lodged between the accelerator system grids or between the accelerator grid and source shroud resulting in a continuous high voltage short. This type of short may be confirmed by increasing the beam and/or accelerator voltage; large beam and accelerator currents appear even when the source discharge off. Refer to “Shorts Removal” on page 29.

Coated Anode

Over time, sputtered insulating material may be deposited on the anode; some material may later flake away. As long as the source remains hot, the insulating material conducts well enough for routine operation. Problems may develop during start-up, when this layer is cold and has a high resistivity. A longer start-up (one to two hours) may be required to heat the layer to a conducting temperature. The start-up time may be reduced by using a higher discharge voltage. Replace or clean the anode to avoid longer start-ups. Refer to "Anode Cleaning" on page 33.

Coated Insulators

Insulators in the accelerator system may become coated with conducting material during routine operation (typically several hundred hours), resulting in current leakage at high voltages. Leakage is indicated if increasing the beam and/or accelerator voltage with the source discharge off results in small to moderate beam and accelerator currents. Leakage currents are typically larger when the source is at operating temperature than when it is cold. Disassemble the grids and clean or replace the insulators when grid leakage currents approach 10% the typical accelerator current. Refer to "Disassembly and Reassembly" on page 20 and "Insulator Cleaning" on page 32).

Plasma Breakdown or Arcing

Plasma breakdown or arcing is indicated by a sudden drop in the beam and accelerator voltage accompanied by a large increase in beam and accelerator current. This condition only occurs when a discharge is present in the source's discharge chamber. It disappears when the cathode current is turned off. Plasma breakdown or arcing is generally as a result of operating at a high beam voltage with an elevated gas flow rate. Initially, this may be corrected by reducing the gas flow rate and/or beam voltage.

Breakdowns between grids may result in the growth of conical projections on the grid surface and/or arc tracks on the grid insulator. These deposits increase the likelihood of future breakdown and may eventually result in a continuous short between the grids. When this occurs, disassemble and clean the grids and insulator. Refer to "Disassembly and Reassembly" on page 20, "Grid Alignment Check and Inspection" on page 24 "Grid Cleaning" on page 29 and "Insulator Cleaning" on page 32).

Shorts Removal

A short between the accelerator grid's downstream surface and the source shroud may be cleared by removing any loose flakes using:

- a soft bristle brush
- a blast of compressed, dry nitrogen.

If there are flakes between the grids, it may be necessary to disassemble the grids to clean them. Refer to "Disassembly and Reassembly" on page 20, "Grid Alignment Check and Inspection" on page 24 and "Grid Cleaning" .

Grid Cleaning

Arcing may be caused by contamination from oils, salts or moisture. Grid cleaning methods depend on the grid type and the contamination present. Use one of the following procedures, depending on the grid material in use.

Pyrolytic Graphite Grid Cleaning

These steps are most successful when performed before the graphite grids are heavily coated (especially inside the grid holes). Contact "Service Support" on page 43 for information on grid cleaning services available from Veeco.

CAUTION

Never attempt to bead blast a pyrolytic graphite grid; immediate and permanent damage will result.

1. Remove the grid assembly from the source. Refer to "Source Disassembly" on page 20.
2. Use a soft bristle brush to remove any loose, flaking material.
3. Remove any remaining projections or deposits:
   a. Gently wipe the grid surface with a household variety nylon fiber scour pad (green Scotch-Brite® brand pad, or equivalent). Discontinue wiping as soon as the grid's natural graphite color appears.
   b. Wash away any dust or loose particles with a clean scour pad and a solution of liquid dishwashing detergent and hot water.

NOTE

Replace the grids if any strongly adhered sputtered deposits remain after wiping.

4. Remove fingerprints or other oily contamination:
   a. Place in an ultrasonic cleaner with hot water and residue-free detergent or an ammonia based cleaning solution (MICRO-90® brand, or equivalent) for 15 minutes.
   b. Rinse very thoroughly in hot water.

c. Blow off water immediately using compressed, dry nitrogen.

d. Dry in an oven at 300°C (570° F) or under a 250W heat lamp at a distance of 15 to 20cm (6 to 8 in.) for at least 60 minutes.

Graphite Grid Bake Out

After grid cleaning, a bake out under vacuum is strongly recommended before initial use. This will remove any residual water and trace contaminants which may cause premature shorts:

1. Turn the power supply's **SOURCE** button on for 15 to 30 minutes, but leave the **BEAM** button off.

2. After this interval, enter high voltage (500 to 750V), low beam current (25ma) settings. Press the **BEAM** button. Operate the source for another 15 minutes.

NOTE

It is only necessary to bake out graphite grids when they are brand new or immediately after they are cleaned.

Molybdenum Grids, Metal and Alumina Parts

CAUTION

Follow these recommendations to avoid grid damage.

Support the grids during bead blasting to avoid bending them. Move the nozzle slowly and evenly across the entire surface to avoid distorting the grid. Avoid stopping on any area. Use only the media type and grit recommended below.

Equipment/Materials used

- Trinco Dry-Blast Model #36/BP with Nozzle 340-S
- aluminum-oxide media, 89 micron diameter average, ±50 micron (150 Grit)
- ultrasonic cleaner
- heat lamp or oven
- soft brush
- lint free task wipes
- acetone solvent, or isopropyl alcohol

- ammonia based cleaning solution (MICRO-90® brand, or equivalent)
- compressed, dry nitrogen
- microscope
- Dial indicator and surface plate (dished grids only)

⚠WARNING

Acetone is flammable. Obtain, read and understand its Material Safety Data Sheet (MSDS). Follow local safe handling procedures, including using all recommended personal protective equipment.

Part Cleaning

Use this method to clean metal and alumina parts. Move the nozzle slowly and evenly across metal part surfaces to avoid warping. Avoid stopping on any specific area. Use only the media type and grit recommended below. Refer to "Pyrolytic Graphite Grid Cleaning" on page 29 for graphite grids.

NOTE

Before cleaning dished grids, place each one flat on the surface plate. Measure and record the dome height at the grid center using a dial indicator.

1. Bead blast at 205 to 275kPa (30 to 40 psi) using the media and equipment listed. Support the part while blasting. Vary the nozzle angle and position to cover all surfaces, including the inside surface of all holes. Avoid prolonged blasting of threaded holes.

NOTE

It may be necessary to adjust the pressure, depending on nozzle size.

2. Inspect the perforated section of the grid with a microscope to confirm that the coating has been removed from all surfaces. If the coating is still present, repeat Step 1.

3. Perform the following step on dished grids only:
   a. Measure the dome height of each grid using a dial indicator.
   b. Check that the dome height is within 0.127mm (0.005 in.) from grid to grid and within 0.127mm (0.005 in.) of the height before cleaning.

NOTE

The original dome height is also recorded in the documentation packaged with the grids.

4. Wet clean:
    a. Wash with a mild solution of dishwashing detergent and water; use a soft brush to remove residual media from crevices if necessary. Rinse thoroughly with water after washing.
    b. Place in ultrasonic cleaner with water and residue free detergent or ammonia based cleaning solution (MICRO-90® brand or equivalent) for 15 minutes.
    c. Remove and rinse very thoroughly with hot water.
    d. Blow off water using compressed, dry nitrogen.
5. Immediately wipe down the surface thoroughly using isopropyl alcohol and a clean, lint free task wipe.
6. Dry in an oven at 300°C (570°F) or under a 250W heat lamp at a distance of 15 to 20cm (6 to 8 in.) for at least 60 minutes.
7. Reassemble the grids with clean or new insulators.

Insulator Cleaning

NOTE

Wear gloves or finger cots when handling insulators.

1. Determine if any of the insulators are coated with conductive material and identify insulators that need servicing. Refer to "Shorts Troubleshooting" on page 41.
2. Remove the coated insulators by following the steps in "Source Disassembly" on page 20).
3. Clean the insulators by following steps 1., 4. and 6. under "Part Cleaning" on page 31.
4. Replace any damaged or uncleanable insulator.
5. Reassemble the source by following the steps in "Source Reassembly" on page 22.

Anode Cleaning

1. Remove the anode by following the steps in "Source Disassembly" on page 20.

2. Clean the anode by following steps 1. and 4. though 6. under "Part Cleaning" on page 31.

NOTE

The anode's outer surface is engraved with an arrow and the word GRIDS. Replace the anode in the source with the arrow pointing downstream (toward the grids).

3. Reassemble the source following the steps in "Source Reassembly" on page 22.

Filament Replacement

⚠ CAUTION

The tungsten filament wire becomes very brittle after operating at emission temperatures. Filament fragments may puncture the skin and break off, leaving pieces of imbedded wire.

Cathode Filament

⚠ WARNING

All ion source electrical leads operate at high voltages. To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing.

1. Turn off all power supplies.

2. Loosen and remove the two 4-40 thumb nuts from the source tie rods.

3. Unplug the source assembly from the electrical pin locator block.

4. Place the source on a clean, padded work surface; loosen and remove the two 4-40 socket cap screws securing the cathode flange to the upstream pole piece.

5. Separate the cathode flange from the upstream pole piece.

6. Loosen the two 6-32 socket cap screws securing the filament to the support posts; remove the old filament.

7. Cut a length of 0.25mm (0.010 in.) OD tungsten filament wire about 25cm (10 in.) long.

8. Use the filament mandrel (supplied in the tool kit) to wind a 14 to 16 turn helical coil and form the ends. Refer to "Drawings" on page 45.

NOTE

Wrap the helical coil 16 to 18 turns around the mandrel. This compensates for the relaxation that occurs when the ends are released and the mandrel is removed from the coil.

9. Position the filament on the two support posts and tighten the two 6-32 cap screws.

10. Reattach the cathode flange to the source using the two 4-40 socket cap screws.

11. Plug the source assembly back onto the electrical pin locator block.

12. Secure the source to the block with the two 4-40 thumb nuts.

NOTE

The source assembly should slip easily over the tie rods and seat smoothly into the electrical pin locator block. DO NOT force it.

Neutralizer Filament

1. Loosen the two 2-56 thumb nuts securing the neutralizer filament; remove the old filament.

2. Cut a length of 0.25mm (0.010 in.) OD tungsten filament wire about 30.5cm (12 in.) long.

3. Use the filament mandrel (supplied in the tool kit) to wind a 25 to 30 turn helical coil and form the ends. Refer to "Drawings" on page 45).

4. Attach the filament between the two support posts and tighten the thumb nuts.

PBN Filament (Option)

Refer to the PBN technical manual for filament replacement instructions.

Chapter 8: Troubleshooting

⚠WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before repairing or replacing any electrical devices. Disconnect the power supply's main power before replacing any fuse or troubleshooting any electrical connection.

Table 8.1: General

Problem	Possible Cause	Remedy
The power supply's front panel display does not light, fan does not come on.	The power cable is disconnected.	Connect the power cable.
	The circuit breaker is tripped.	Close the circuit breaker on the power supply's rear panel.
	One or more of the external interlocks are open.	Close the interlock circuit.
An E20 error message appears on the power supply's display.	One or more of the external interlocks are open.	Close the interlock circuit.

Table 8.2: Cathode

Problem	Possible Cause	Remedy
There is no cathode filament current indicated. An E08 error message appears on the cathode current display.	The source's electronics cable is disconnected.	Connect the electronics cable.
	The cathode filament is open.	Replace the filament (refer to "Filament Replacement" on page 33).
	The cathode lead is open.	Connect the cathode lead.
There is no discharge current indicated. An E03 error message appears on the power supply's discharge current display.	An anode connection is open.	Connect the anode lead.
An E05 error message appears on the power supply's discharge current display.	The anode and cathode leads are shorted.	Locate and remove the short.

⚠WARNING **To avoid electrical shock, keep clear of “live” circuits. Follow all local lock-out/tag-out procedures before continuing. Disconnect the controller’s main power before troubleshooting any electrical connection.**

Table 8.3: Source Discharge

Problem	Possible Cause	Remedy
A discharge will not start: • The cathode filament current is typical but there is no discharge current. • The power supply displays a discharge voltage over 150V.	The discharge chamber pressure is too low to initiate discharge (low gas flow).	Increase the gas flow.
	The gas line between the vacuum feedthrough and source is disconnected (no gas flow).	Connect the gas line.
	The anode lead is open.	Connect the anode lead.
	The body lead is open.	Connect the body lead.
	An insulating coating is present on the anode.	Clean the anode (refer to “Anode Cleaning” on page 33).
Cathode filament current is typical, but there is a low or pulsing discharge current. The power supply’s discharge voltage varies from the requested value to the starting value (>150V).	There is low gas flow, causing low discharge chamber pressure and space-charge limit of cathode emission.	Increase the gas flow (if the cause is low gas flow, any improvements will be immediate).
	Hydrocarbons or other contaminants are poisoning the cathode filament.	Eliminate contaminant and replace the cathode filament. If contamination is severe, the source may require cleaning (refer to “Maintenance” on page 27).
	There is an insulating coating on the anode.	Allow the source to warm-up for 30 minutes to two hours without extracting a beam. This increases coating conductivity by raising its temperature. Some anode sputter cleaning may also be achieved by operating at a high discharge voltage (70 to 100V) during this time. Clean the anode (refer to “Anode Cleaning” on page 33).

⚠WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing. Disconnect the controller's main power before troubleshooting any electrical connection.

Table 8.4: Accelerator System

Problem	Possible Cause	Remedy
There is an elevated beam current with no discharge current and little or no beam voltage. An E05 error message may appear on the power supply's beam and accelerator current displays.	The anode or source body lead is shorted to facility ground.	Locate and remove short. Replace the power supply's fuse, if necessary. Refer to the power supply technical manual.
	There is a conducting flake between accelerator system grids.	Remove any loose flakes (refer to "Loose Flake Removal" on page 27).
	A glow discharge or an arc is present between accelerator grids.	A high gas flow rate may result in a pressure near the Paschen law minimum. Reduce the gas flow rate.
There is an elevated beam current that disappears when the discharge current stops or returns to normal when the beam voltage is lowered. Gas discharge glow or sparking may be visible with elevated beam current. An E05 error message may appear on the power supply's beam current display.	A glow discharge or arc is present between the source high voltage lead (or surface) and process chamber ground. This may be from defective insulation or lead shielding in the process chamber.	Identify the location or look for visible evidence of glow or arc. Repair insulation or add more shielding.
There is an elevated accelerator current with little or no accelerator voltage. An E05 error message appears on the power supply's accelerator current display.	The accelerator lead is shorted.	Locate and remove the short.
	There is a conducting flake between accelerator system grids.	Remove loose flakes (refer to "Loose Flake Removal" on page 27).

⚠ WARNING **To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing. Disconnect the controller's main power before troubleshooting any electrical connection.**

Table 8.4: Accelerator System (Continued)

Problem	Possible Cause	Remedy
There is an elevated accelerator current with little or no accelerator voltage. An E05 error message appears on the power supply's accelerator current display. The power supply's beam and/or accel displays show low currents (a few mA) when: • the discharge is off • the beam or accel voltage is on.	An alumina grid spacer has an arc track or a conducting coating; in this case, the measured resistance between the body and accel connections (pins B and F) is a few megohms or less (refer to "Ohmmeter Check" on page 40).	Clean or replace the grid spacer (refer to "Coated Insulators" on page 28).
	A conductive coating is present on a grid insulator, body insulator, or electrical pin locator; in this case, the measured resistance between the body (pin B) or accel (pin F) connection and ground is a few megohms or less (refer to "Ohmmeter Check" on page 40).	Disassemble source and clean or replace insulators (refer to "Disassembly and Reassembly" on page 20 and "Coated Insulators" on page 28).
There is no accelerator current.	The accelerator lead is not connected.	Connect the accelerator lead.

⚠ WARNING **To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing. Disconnect the controller's main power before troubleshooting any electrical connection.**

Table 8.5: Immersed Wire Neutralizer

Problem	Possible Cause	Remedy
There is no neutralizer filament current. An E08 error message appears on the power supply's neutralizer display.	The neutralizer cable is disconnected.	Connect the cable.
	The neutralizer filament is open.	Replace the filament (refer to "Filament Replacement" on page 33).
	The neutralizer lead is open.	Connect the lead.
A filament current is displayed but there is little or no emission current. Many small sparks may be observed to ungrounded surfaces in the process chamber.	The filament current is low.	Increase filament current.
	The neutralizer has been moved out of the ion beam. (This same sparking may be observed by turning the neutralizer current down or off.)	Position the neutralizer within the ion beam.
	There is an open neutralizer emission fuse resulting from a short between the neutralizer lead and the source body or facility ground.	Repair short and replace the power supply's fuse, if necessary. Refer to the power supply technical manual.

Table 8.6: Probe

Problem	Possible Cause	Remedy
There is no probe current (the probe fuse is open).	The probe lead may be shorted.	Repair short or attach leads with proper polarity; replace the probe fuse. Refer to the power supply technical manual.
	The probe lead polarity is reversed	

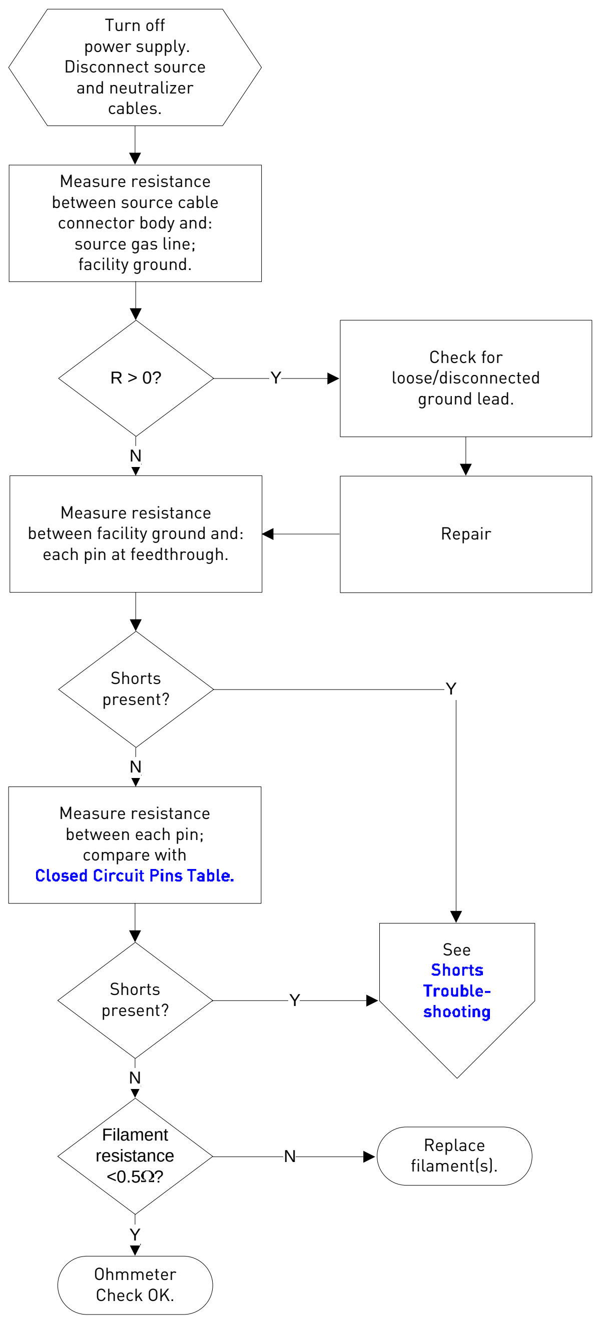
NOTE

Use the following flow charts, table and a multimeter to identify and correct shorts between ion beam source leads and components.

Ohmmeter Check

⚠WARNING

All ion source electrical leads operate at high voltages. To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing.



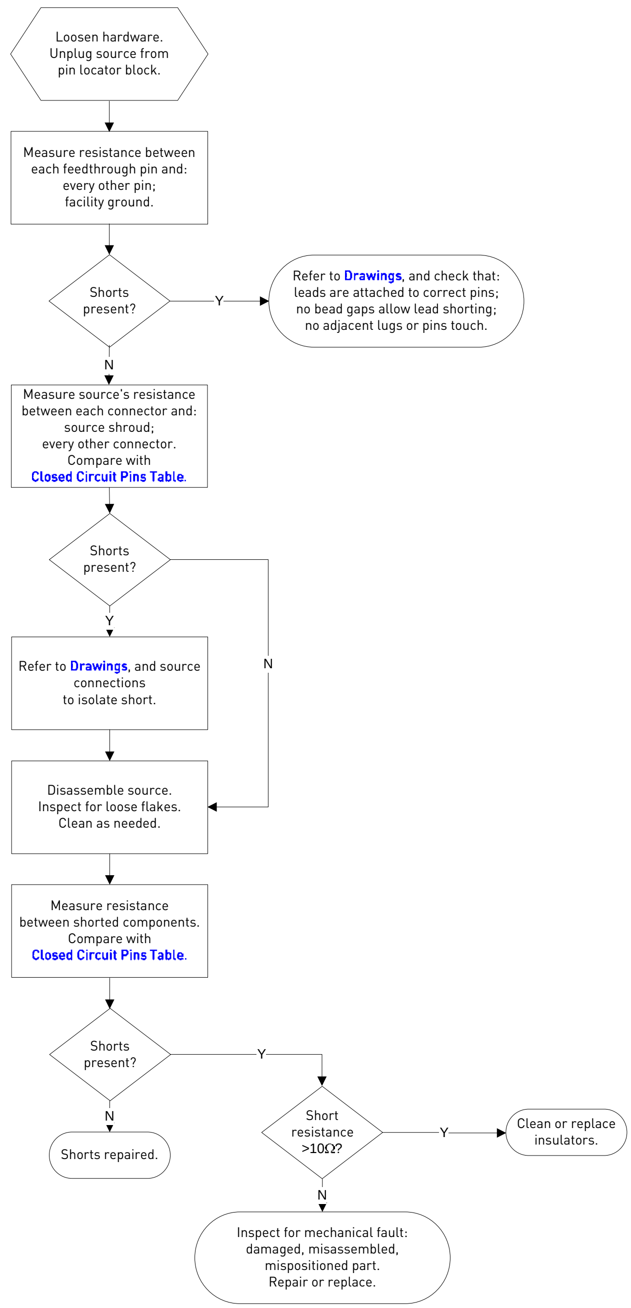
Shorts Troubleshooting

Some possible causes of shorts are:

Electrical – Improper or faulty connections are present in cables or leads on either side of the feedthrough.

Contamination – Loose flakes of conductive material are trapped between adjacent source components, or there are coated insulators.

Mechanical – There are damaged or improperly assembled source parts.



NOTE

The resistance values in Table 8.7: **indicate a continuous filament when the source is installed. All other pin combinations should indicate an open circuit.**

Table 8.7: Closed Circuit Pins

Component	Pins	Feedthrough	Resistance
Cathode Filament	A and E	Ion Source	<0.5Ω
Neutralizer Filament	D and G	Ion Source	<0.5Ω
PBN Filament (optional)	A and B	PBN	<0.5Ω

Chapter 9: Service Support

For service, contact:

Veeco Instruments Inc.
2330 East Prospect
Fort Collins, CO 80525
Phone: 1.888.221.1892
Fax: 970.493.1439
ftcsupport@veeco.com

When contacting Veeco Instruments Inc. for parts or service:

Provide the ion source model number, serial number, and grid serial number. The ion source model and serial number are engraved on the downstream surface of the grid mount plate. The grid serial number is engraved on the upstream surface of the grid.

Provide the ion source power supply model and serial number; a list of all operating parameters and/or error messages displayed by the power supply; gas flow rate; and process chamber pressure.

Appendix A: Specifications

Model Number: 03FC

Beam Size (at grids): 3cm (1.2 in.) beam diameter

Maximum Beam current: 100mA

Beam Energy: 50 to 1200eV

Gas Flow:

Device	Flow (sccm)
source	3 to 6
PBN (optional)	refer to PBN technical manual

Gas Use: Ar, Kr, Xe

Cooling Water Flow: none

Grid Configuration: Two grids

Grid Material: Flat pyrolytic graphite, dished molybdenum, or nickel

Beam Neutralization: Filament or PBN

Mounting Configuration: Internal or Flange

Compatible Power Supply: MPS-3000 FC or PBN

Weight (Internal Mount): 1.2kg (2.5 lbs.)

Weight (Flange Mount): 3.1kg (6.75 lbs.)

Tool/Spares Kit: Provided with the source

Appendix B: Drawings

Table B.1: Source Drawings

Drawing Number	Description
86-4413-2	"3cm Ion Source, Flange Mount"
86-4413-1	"3cm Ion Source, Internal Mount"
n. a.	"DC Source Controller Block Diagram"
90-5723-1	"Typical Internal Mount Ion Source Installation"
86-4527-1	"Internal Mount 3cm Ion Source Assembly"
0503-107/90-5843-1	"Cathode Filament for 2.5cm, 3cm, and 5cm Sources"
90-5843-2	"Neutralizer Filament for 3cm Source"

NOTE

Locate the Grid Mount Assembly Number and match that number with either the Drawing Number in the table below, or with one of the Grid Mount Assembly numbers on the drawing's second page.

Table B.2: Grid Assembly Drawing

Drawing Number	Description
419498	"3cm Grid Assy, 2-Grid"

3cm Ion Source, Flange Mount

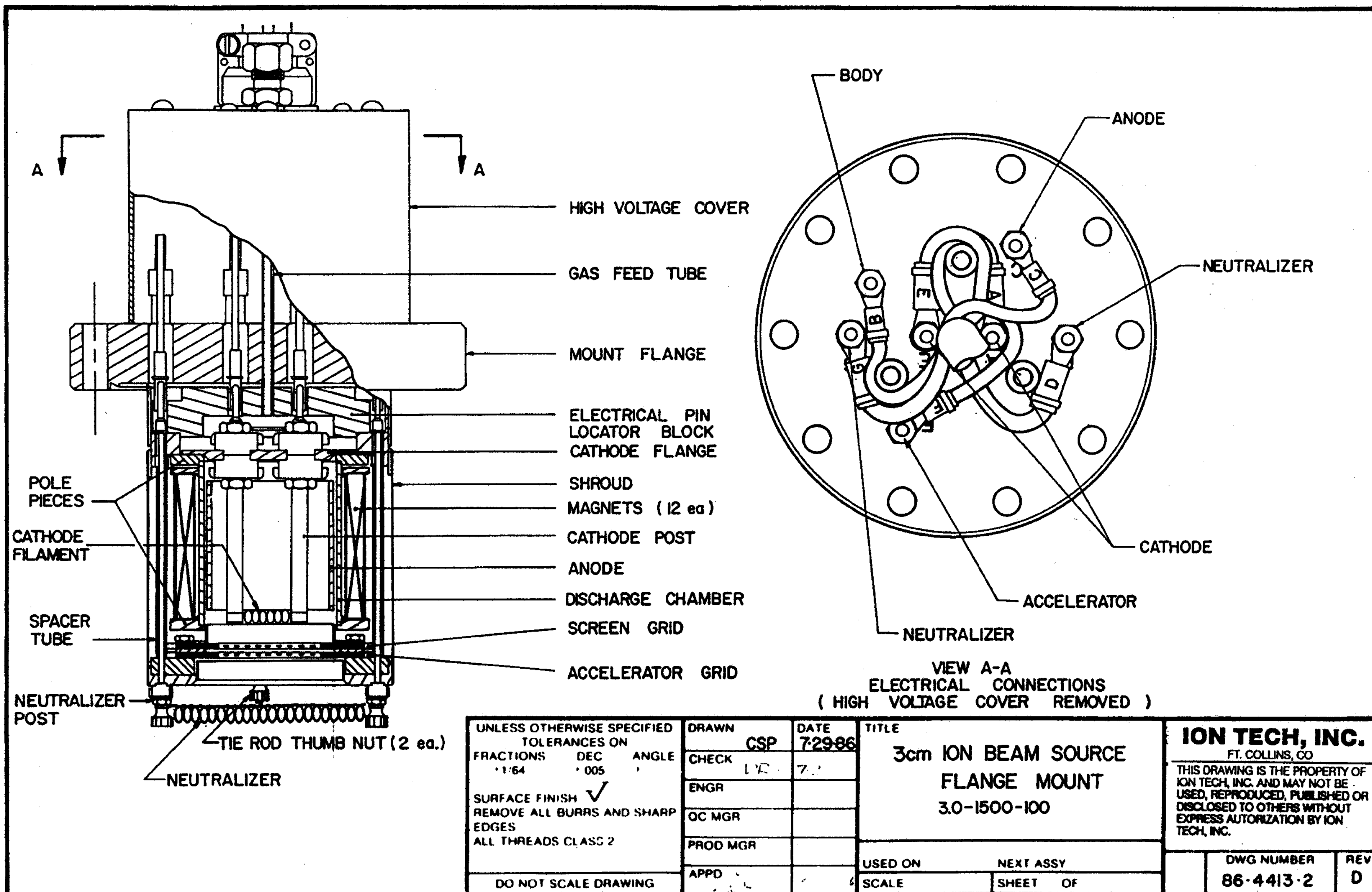


FIGURE 1A

3cm Ion Source, Internal Mount

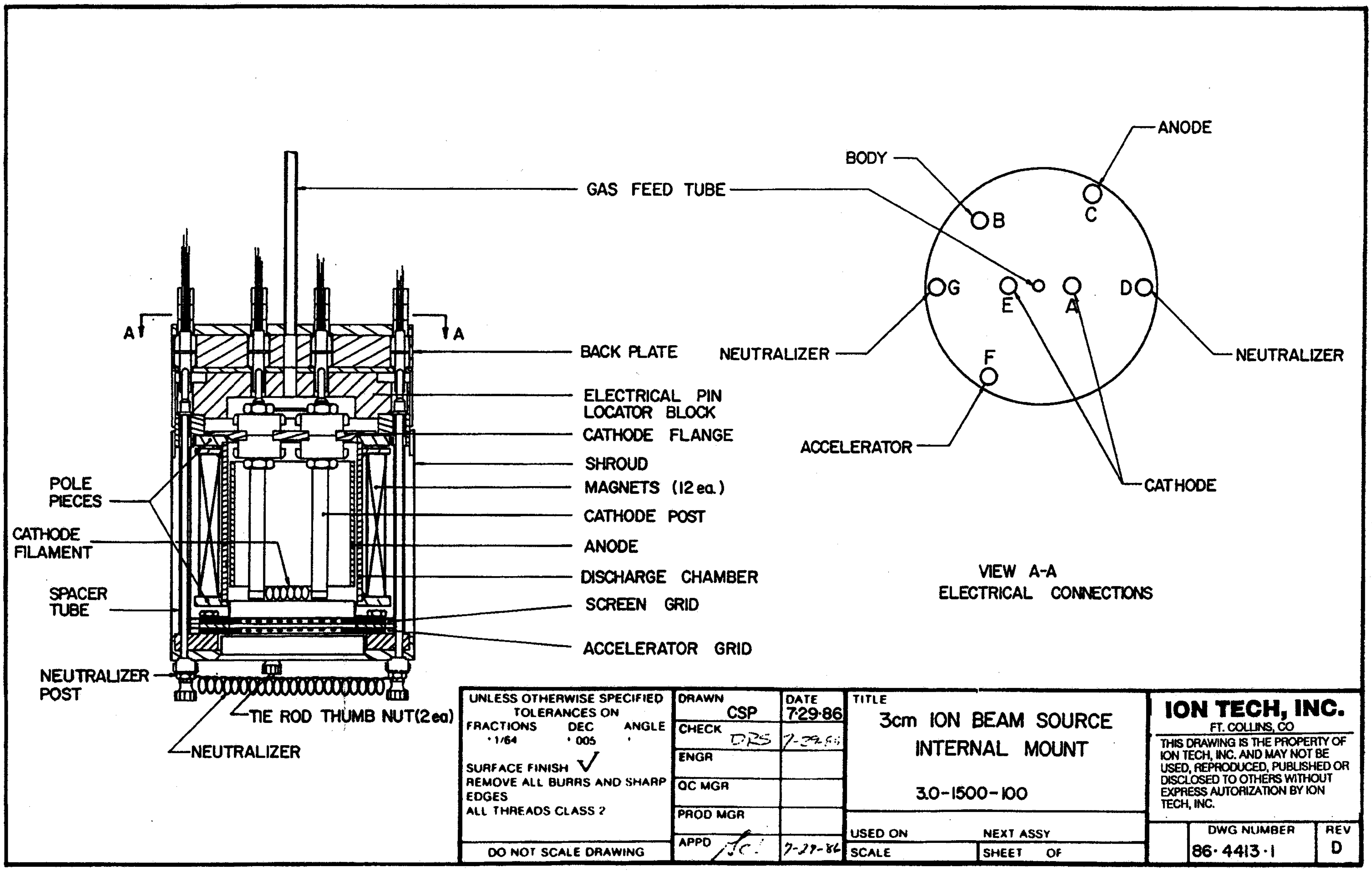
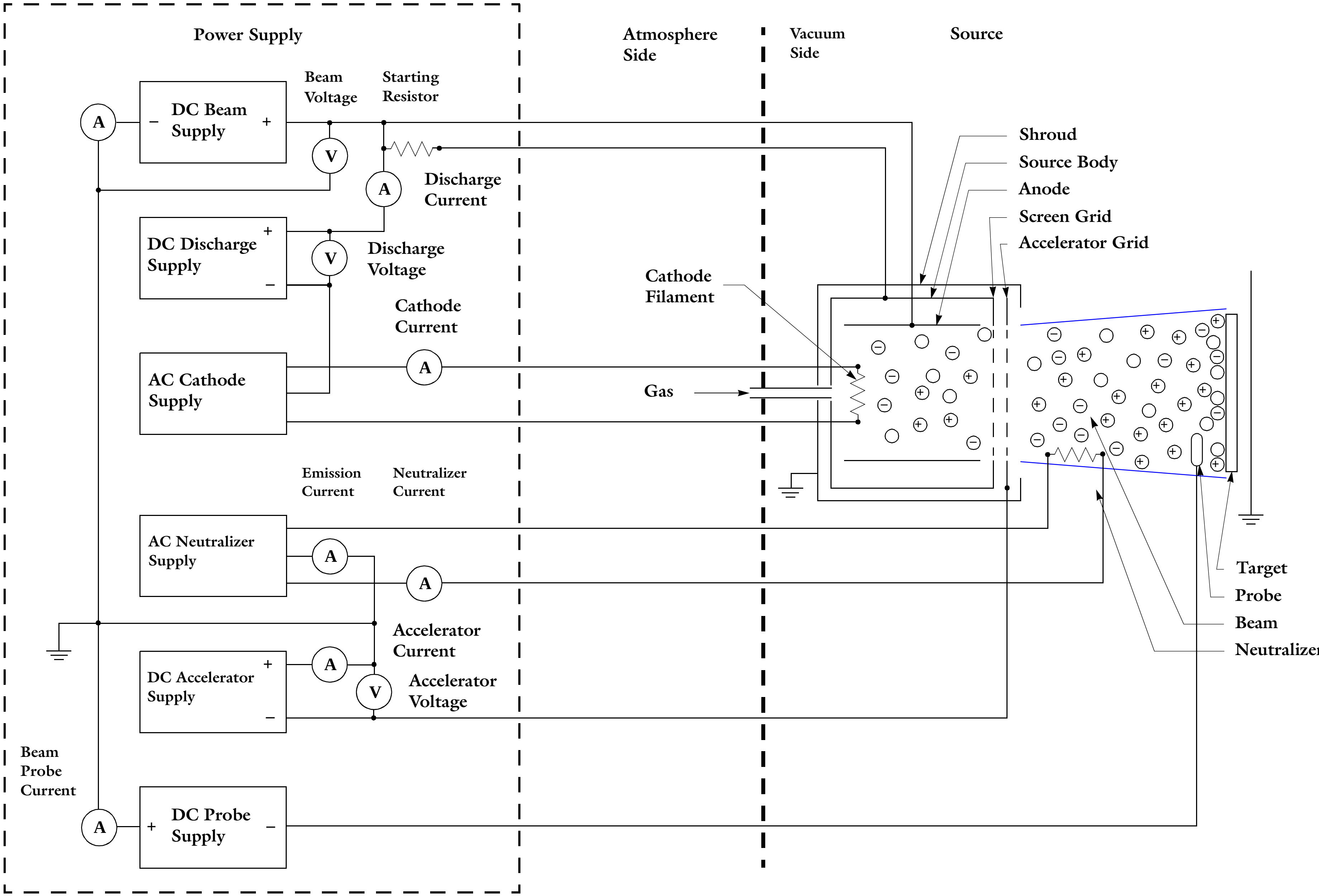


FIGURE 1B

DC Source Controller Block Diagram



Notes

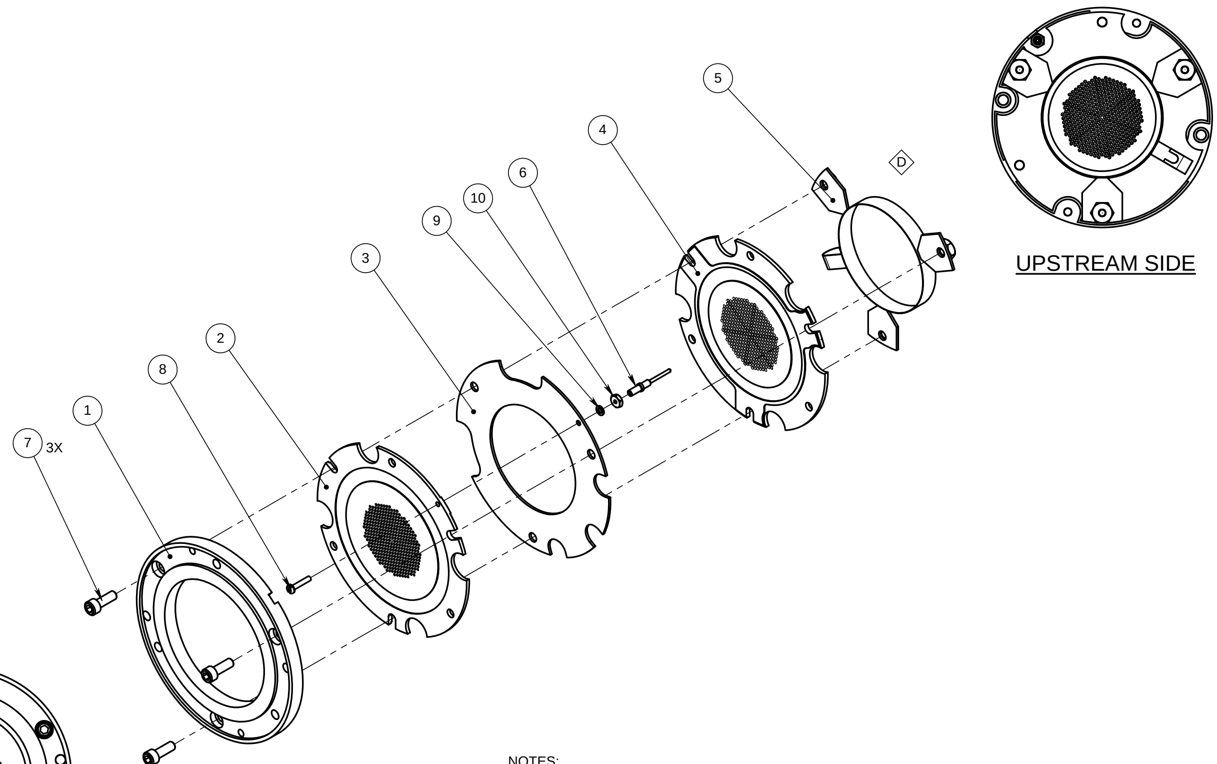
1. Target may or may not be attached to system ground.

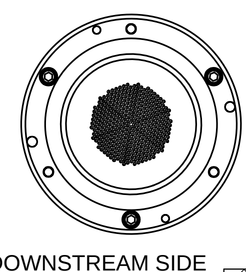
2. Refer to power supply technical manual for voltage, current and power specifications.

3. Refer to the power supply technical manual for source to power supply connections and cabling.

3cm Grid Assy, 2-Grid

	ITEM	VENDOR	VENDOR #	DESCRIPTION / MATERIALS	QTY
	1	VEECO	0503-006	INSULATOR, GRID, 3CM	1
	2	VEECO	SEE SHEET 2	GRID, ACCEL, 3	1
	3	VEECO	0503-009	GRID SPACER, 3CM SOURCE, TYPE 1	1
	4	VEECO	SEE SHEET 2	GRID, SCRN, 3	1
	5	VEECO	0503-060	GRID MOUNT RING ASSY, 3 CM SOURCE	1
	6	VEECO	0503-041	CONN, CRIMP PIN, #20, THREADED	1
	7	VEECO	426982	SCREW, 4-40 X .330 SHCS, SS	3
	8	VEECO	0201-SS-696	SCREW,0-80 X .3125 SLOTTED PAN HEAD, SS	1
	9	VEECO	0201-SS-712	WASH, SPLIT LOCK, .070 I.D. X .125 O.D. X .015 THK, SS (0-80)	1
	10	VEECO	0201-SS-501	NUT, 0-80 HEX, SS	1
NOT SHOWN	11	VEECO	0500-091	GRID ALIGN PIN, HSS, .081D X 2.125,	3





NOTES:

1. REFER TO SHEET 2 FOR GRID SPECIFICATIONS AND PART NUMBERS.
2. FOR CONVERGENT GRIDS, POSITION GRID DOME UPSTREAM.
   FOR DIVERGENT GRIDS, POSITION GRID DOME DOWNSTREAM.

THIRD ANGLE PROJECTION

REV	CHANGE	CHG / CHK	DATE
D	EC11948; ROTATED PART 0503-060 TO CORRECT POSITION; REDRAWN IN SW, ADDED 427468	ADF	04-17-08
C	EC11831; CHG FILISTER HD SCREW TO SOCKET HD CAP SCREW	ADF / JCS	04-26-06
B1	EC11473; CORRECTED PN ITEM 11	MEK / JJD	01-14-01
B	EC11095; DWG RESTRUCTURE	RAK / MEK	01-02-01
A	EC11009; DWG RESTRUCTURE	GWC / ML	10-16-00

UNLESS OTHERWISE SPECIFIED:
UNITS: ±INCHES [±mm]

TOL in.	TOL [mm]	SURFACE FINISH
.X .1	.X .5	32 FAO
.XX .02	.XX .13	
.XXX .005	.XXX .013	ANGLE ± 1 deg.
.XXXX .0005		

DIMENSIONED IN ACCORDANCE WITH ASME Y14.5M–1994 STANDARDS
REMOVE ALL BURRS AND SHARP EDGES
ALL THREADS CLASS 2

DRAWN	ADF	DATE 03/31/06
CHECK		DATE
ENGR	DES	DATE 08-17-87
MFG ENGR		DATE
PROJ MGR		DATE

TITLE
GRID ASSY,
3CM,
2-GRID

DO NOT SCALE DRAWING
SCALE 1:1 SHEET 1 OF 2

VEECO INSTRUMENTS

SIZE C | PART NUMBER 419498 | REV D

3cm GRID SPECIFICATIONS–TWO GRID SYSTEM

PATTERN DESCRIPTION	GRID MATERIAL	FOCAL POINT	SCREEN GRID	ACCEL. GRID	GRID ASSEMBLY
3cm, ROUND, FIL, FLAT, DIVERGENT, 5 DEG.	MOLYBDENUM	N/A	419494	419496	419498
3cm, ROUND, FIL, FLAT, STD.	MOLYBDENUM	N/A	419494	419497	419499
3cm, ROUND, FIL, FLAT, COLIMATED, 10 DEG.	MOLYBDENUM	N/A	419494	419495	419500
3cm, ROUND, STD.	PYROLYTIC GRAPHITE	N/A	418915	418924	418925
3cm, ROUND, COLIMATED	PYROLYTIC GRAPHITE	N/A	418915	418923	418926
3cm, ROUND, 1.5, COLIMATED	PYROLYTIC GRAPHITE	N/A	421176	421177	421178
3cm, ROUND, FIL, FLAT, COLIMATED, 2 DEG.	MOLYBDENUM	N/A	421220	421221	421222
3cm, ROUND, FIL, DS, CN, 1.5	MOLYBDENUM	9.8cm	420640	420641	421345
3cm, ROUND, FIL, CONVERGENT	MOLYBDENUM	9.8cm	420643	420642	421347
3cm, ROUND, FIL, DISHED, CONVERGENT, 1.5	NICKEL	N/A	420051	420052	420053
3cm, ROUND, CUSTOM, BLANK	PYROLYTIC GRAPHITE	N/A	417415	417414	417417
3cm, ROUND, FIL, DISHED, CONVERGENT	MOLYBDENUM	N/A	420643	420642	414576
3cm, ROUND, STD.	PYROLYTIC GRAPHITE	N/A	0503–008	0503–007	0503–083
3cm, ROUND, DIVERGENT	PYROLYTIC GRAPHITE	N/A	0503–008	0503–111	0503–113
3cm, ROUND, COLIMATED	PYROLYTIC GRAPHITE	N/A	0503–008	0503–112	0503–114
3cm, ROUND, LOW VOLTAGE	PYROLYTIC GRAPHITE	N/A	0503–120	0503–121	0503–122
3cm, ROUND, HYDROGEN, 2.5, STD.	PYROLYTIC GRAPHITE	N/A	424097	424098	424099
3cm, ROUND, ROTATED PATTERN, 2.5, COL	PYROLYTIC GRAPHITE	N/A	426467	427469	427468

D

TITLE

Veeco
VEECO INSTRUMENTS

DO NOT SCALE DRAWING

SCALE N/A | SHEET 2 OF 2 | C | PART NUMBER 419498 | REV

Typical Internal Mount Ion Source Installation

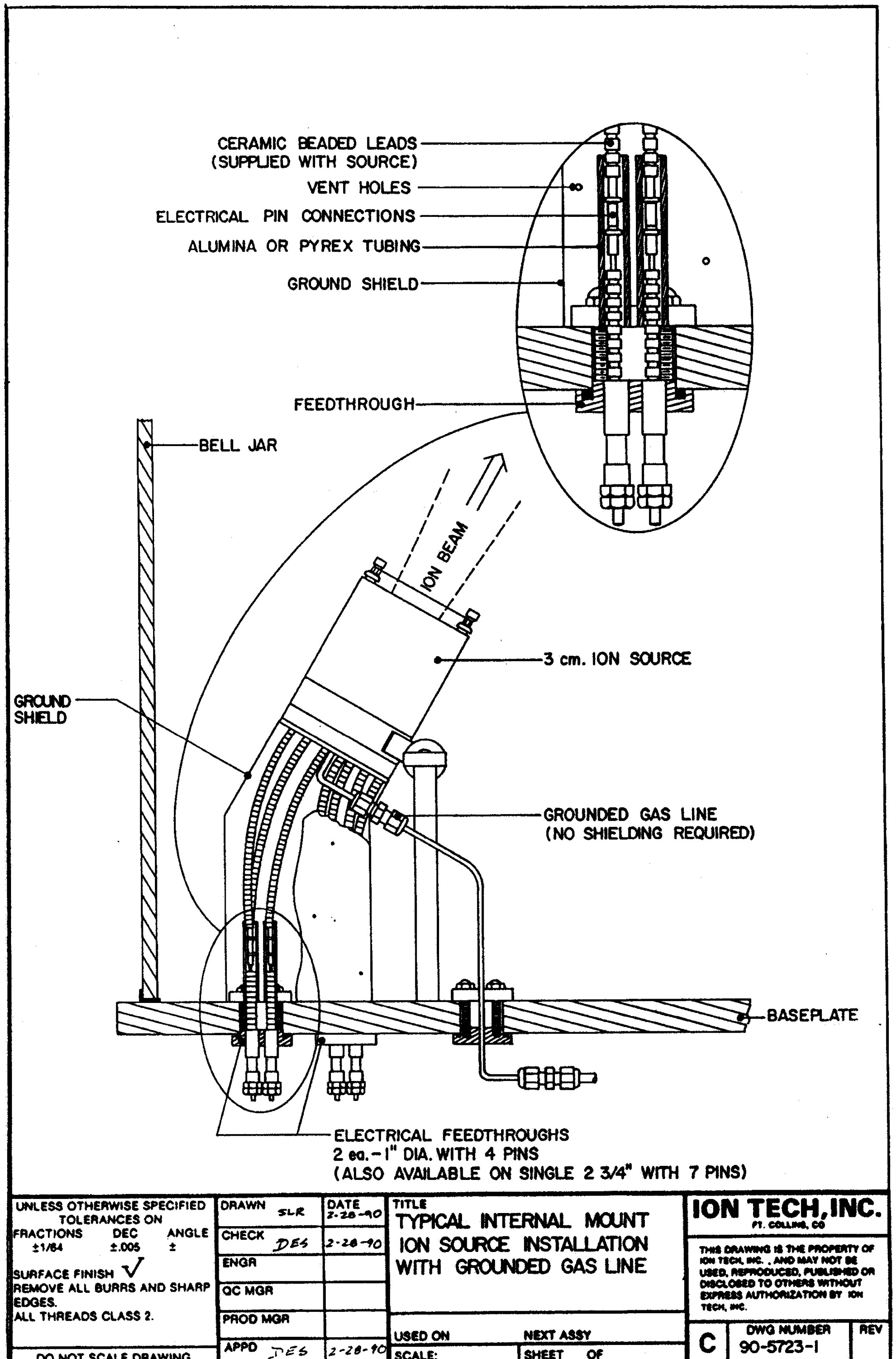


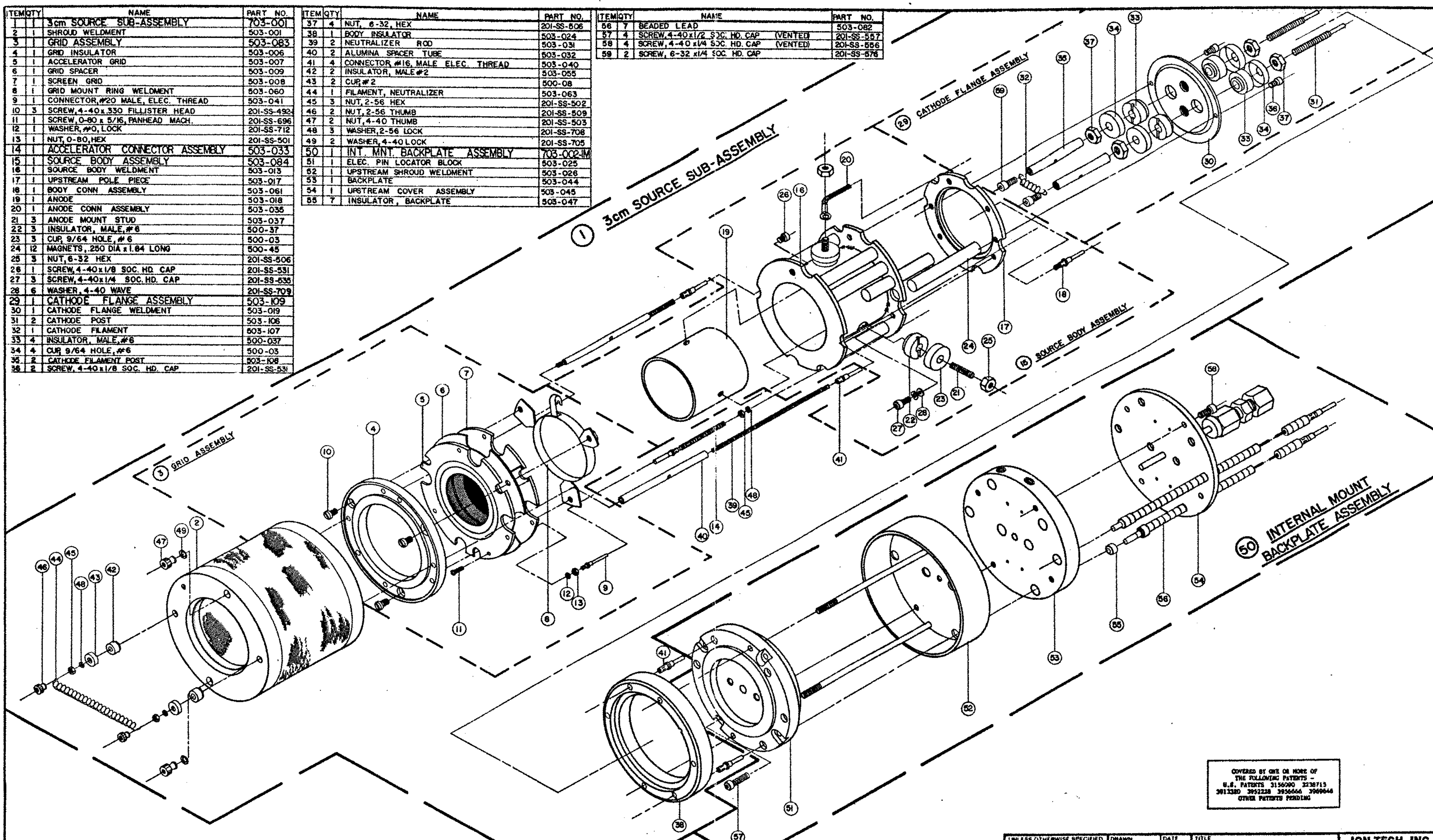
FIGURE 4

Internal Mount 3cm Ion Source Assembly

ITEM	QTY	NAME	PART NO.
1	1	3cm SOURCE SUB-ASSEMBLY	703-001
2	1	SHROUD WELDMENT	503-001
3	1	GRID ASSEMBLY	503-083
4	1	GRID INSULATOR	503-006
5	1	ACCELERATOR GRID	503-007
6	1	GRID SPACER	503-009
7	1	SCREEN GRID	503-008
8	1	GRID MOUNT RING WELDMENT	503-060
9	1	CONNECTOR, #20 MALE, ELEC. THREAD	503-041
10	3	SCREW, 4-40 x .330 FILLISTER HEAD	201-SS-492
11	1	SCREW, 0-80 x 5/16, PANHEAD MACH.	201-SS-696
12	1	WASHER, #0, LOCK	201-SS-712
13	1	NUT, 0-80, HEX	201-SS-501
14	1	ACCELERATOR CONNECTOR ASSEMBLY	503-033
15	1	SOURCE BODY ASSEMBLY	503-084
16	1	SOURCE BODY WELDMENT	503-013
17	1	UPSTREAM POLE PIECE	503-017
18	1	BODY CONN ASSEMBLY	503-061
19	1	ANODE	503-018
20	1	ANODE CONN ASSEMBLY	503-035
21	3	ANODE MOUNT STUD	503-037
22	3	INSULATOR, MALE, #6	500-37
23	3	CUP, 9/64 HOLE, #6	500-03
24	12	MAGNETS, .250 DIA x 1.84 LONG	500-45
25	3	NUT, 6-32 HEX	201-SS-506
26	1	SCREW, 4-40 x 1/8 SOC. HD. CAP	201-SS-531
27	3	SCREW, 4-40 x 1/4 SOC. HD. CAP	201-SS-535
28	6	WASHER, 4-40 WAVE	201-SS-709
29	1	CATHODE FLANGE ASSEMBLY	503-109
30	1	CATHODE FLANGE WELDMENT	503-019
31	2	CATHODE POST	503-106
32	1	CATHODE FILAMENT	503-107
33	4	INSULATOR, MALE, #6	500-037
34	4	CUP, 9/64 HOLE, #6	500-03
35	2	CATHODE FILAMENT POST	503-108
36	2	SCREW, 4-40 x 1/8 SOC. HD. CAP	201-SS-531

ITEM	QTY	NAME	PART NO.
37	4	NUT, 6-32, HEX	201-SS-506
38	1	BODY INSULATOR	503-024
39	2	NEUTRALIZER ROD	503-031
40	2	ALUMINA SPACER TUBE	503-032
41	4	CONNECTOR, #16, MALE ELEC. THREAD	503-040
42	2	INSULATOR, MALE #2	503-055
43	2	CUP, #2	500-08
44	1	FILAMENT, NEUTRALIZER	503-063
45	3	NUT, 2-56 HEX	201-SS-502
46	2	NUT, 2-56 THUMB	201-SS-509
47	2	NUT, 4-40 THUMB	201-SS-503
48	3	WASHER, 2-56 LOCK	201-SS-708
49	2	WASHER, 4-40 LOCK	201-SS-705
50	1	INT. MNT. BACKPLATE ASSEMBLY	703-002-IM
51	1	ELEC. PIN LOCATOR BLOCK	503-025
52	1	UPSTREAM SHROUD WELDMENT	503-026
53	1	BACKPLATE	503-044
54	1	UPSTREAM COVER ASSEMBLY	503-045
55	7	INSULATOR, BACKPLATE	503-047

ITEM	QTY	NAME	PART NO.
56	7	BEADED LEAD	503-082
57	4	SCREW, 4-40 x 1/2 SOC. HD. CAP (VENTED)	201-SS-557
58	4	SCREW, 4-40 x 1/4 SOC. HD. CAP (VENTED)	201-SS-556
59	2	SCREW, 6-32 x 1/4 SOC. HD. CAP	201-SS-576



COVERED BY ONE OR MORE OF THE FOLLOWING PATENTS – U.S. PATENTS 3156090 3238715 3613380 3952228 3956666 3969646 OTHER PATENTS PENDING

	CHANGE		DATE
	E/C Q125		
	E/C Q124		
	E/C B165		7-18-90
	E/C B148		
C	E/C B125		
	E/C B122		
	EC B120		

UNLESS OTHERWISE SPECIFIED TOLERANCES ON FRACTIONS ±1/64 DEC ±.005 ANGLE ±
SURFACE FINISH √
REMOVE ALL BURRS AND SHARP EDGES
ALL THREADS CLASS 2
DO NOT SCALE DRAWING

DRAWN CSP DATE 11-18-86
CHECK
ENGR
QC MGR
PROD MGR
APPD

TITLE: INTERNAL MOUNT 3cm ION SOURCE ASSY. P/N 703-001-IM

USED ON | NEXT ASSY
SCALE | SHEET OF

ION TECH, INC.
FT. COLLINS, CO

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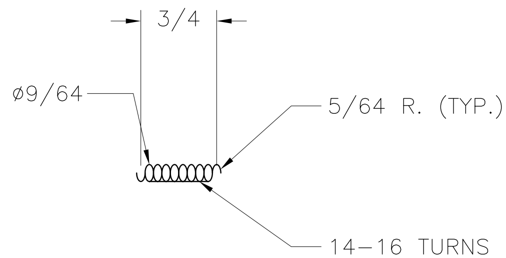
DWG NUMBER 86-4527-1 REV 0

FIGURE 6

Cathode Filament for 2.5cm, 3cm, and 5cm Sources



NOTES:

1. MATERIAL: .010" DIA TUNGSTEN WIRE, P/N 1551–201

A2	E/C 11684 –– DELTED NOTES AND PART NUMBERS	DA / JS	8–26–03
A1	E/C S–C001	SLR / DDS	10–1–90
	CHANGE	CHG / CHK	DATE

UNLESS OTHERWISE SPECIFIED TOLERANCES ON
FRACTIONS ±1/64 — DEC .XX .XXX .XXXX — ANGLE
SURFACE FINISH √ FAO
REMOVE ALL BURRS AND SHARP EDGES
ALL THREADS CLASS 2
DO NOT SCALE DRAWING

		DATE
DRAWN	SLR	6–28–90
CHECK	DDS	7–24–90
ENGR		

TITLE: CATHODE FILAMENT FOR 2.5cm, 3cm & 5cm SOURCES

SCALE N.T.S. — SHEET 1 OF 1

THIRD ANGLE PROJECTION

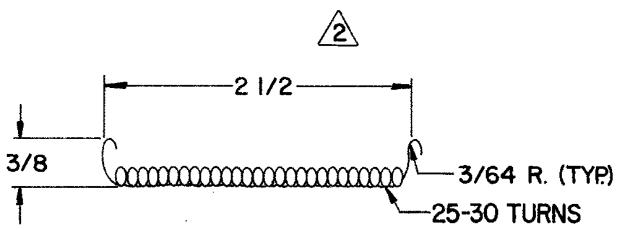
ION TECH, INC. 2330 E PROSPECT RD FT. COLLINS, CO 80525

	PART NUMBER	REV
B	0503–107	A2

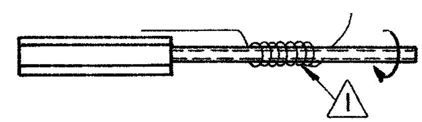
Neutralizer Filament for 3cm Source

ITEM	DRAWING NO	PART DESCRIPTION	FINISHED PART NO	UNFINISHED PART NO	STOCK	MATERIAL (MATERIAL LISTED IN FINISHED DIMENSIONS. EXCEPT AS NOTED) SPECIFICATIONS	DESCRIPTION	(MANUFACTURER)	REQD

MATERIAL: .010" DIA TUNGSTEN WIRE, P/N 1551-201



NEUTRALIZER FILAMENT
P/N 503-063



FILAMENT MANDREL
P/N 503-064

NOTES:

1. WIND FILAMENT WIRE THE INDICATED NUMBER OF TURNS, COUNTER-CLOCKWISE AROUND MANDREL, THEN UNTHREAD MANDREL FROM COIL.
2. STRETCH COIL TO LENGTH AND FORM ENDS AS SHOWN.
3. AVOID SHARP BENDS AND KINKS.

UNLESS OTHERWISE SPECIFIED TOLERANCES ON
FRACTIONS ±1/64 DEC ±.005 ANGLE ±
SURFACE FINISH √
REMOVE ALL BURRS AND SHARP EDGES.
ALL THREADS CLASS 2
DO NOT SCALE DRAWING

		DATE
DRAWN	SLR	6-28-90
CHECK	[illegible]	7/24/90
ENGR		
QC MGR		
PROD MGR		
APPD	DES	7-24-90

TITLE
NEUTRALIZER FILAMENT
FOR 3cm SOURCE

59

USED ON | NEXT ASSY
SCALE | SHEET OF

ION TECH, INC.
FT. COLLINS, CO

B | DWG NUMBER 90-5843-2 | REV

◇	CHANGE	CHG CHK	DATE