LHC1000 ELECTRON SOURCE MANUAL

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VERSION 2

SERIAL # ________________________

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FIGURES

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1 SAFETY

Only technically qualified personnel should install, maintain, and troubleshoot the equipment described herein.

Troubleshooting and maintenance should be carried out only after grounding the components to be worked on and assuring that power cannot be applied to those components while working on them.

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2 INSPECTION AND INSTALLATION

This section describes how to install the Kaufman & Robinson, Inc., KRI^{TM} LHC1000 Electron Source assembly. Unpacking and inspection, physical description, hardware inventories and installation information is provided to assist in facilitating a successful installation.

2.1 Unpacking and Inspection

All electron source hardware was cleaned prior to shipment, use clean lint free gloves while handling all components to prevent contamination.

Prior to shipment, the electron source was inspected and tested and was shipped free of physical defects. As soon as the electron source has been completely removed from all packing materials a visual inspection should be made to determine if there has been any damage to the products during shipment. If any damage has occurred contact Kaufman & Robinson, Inc., in addition to the shipping company to report any damage, see Warranty section 9. Retain packaging materials for storage or returning the ion source and hollow cathode for maintenance or upgrades.

2.2 Physical Description

2.1.1 LHC1000 Electron Source The hollow cathode has been designed for ease of maintenance long lifetime. The cathode is fabricated primarily of stainless steel, alumina and tantalum and is shown in figure 2-1. Maintenance of the cathode has been made more efficient by utilizing small screws and nuts to attach most of the components to the cathode body, without the use of threaded holes in the components. In the event of seizing, they can be broken off and replaced with new screws. This approach prevents screws from seizing in the cathode body thus requiring less maintenance.

2.2.1 Vacuum Cables Vacuum cables have been supplied for the anode and cathode connections that are made from the electrical feedthrough to the ion source and the cathode. These cables have been fabricated using fiberglass loom, alumina insulators, and a copper conductor. These cables provide electrical shielding from grounded surfaces and prevent the accumulation of sputtered material on the enclosed insulator**s.**

2.3 Inventory

Table 2-1 outlines the required hardware necessary for installation and operation of the electron source.

Table 2-1. Inventory List.

Quantity	Description	Part Number
1	Hollow cathode assembly	LHC1000
1	Vacuum hollow cathode cable, cathode	CBL-A03A-VAC-HC-CA
1	Vacuum hollow cathode cable, keeper	CBL-A03A-VAC-HC-KP
1	Atmosphere cable hollow cathode	CBL-A06-ATM-HC-EH
1	Electrical feedthrough assembly	FDT-A100-ELE-EH
1	Feedthrough, gas	FDT-A102-GAS-HF-EH
1	Spare parts kit	SHC10-SP

2.4 INSTALLATION

The LHC1000 electron source is typically installed parallel to the ion source axis.

Contamination of the electron source is a consideration. Line-of-sight deposition on the surface of the source, such as from an e-beam evaporator, should be minimized.

2.4.1 Hollow Cathode Mounting The hollow cathode is attached to the ion source using the supplied a mounting bracket. This bracket should already be attached to the hollow cathode. The mounting bracket can be secured to the ion source using a cap nut.

2.4.2 Gas All of the fittings for constructing the gas circuit, were cleaned prior to shipment and should be handled using clean, lint free gloves. Use cleaned and capped tubing when fabricating and installing all gas lines. Failure to use clean gas lines and fittings can contaminate the ion source and hollow cathode electron source, resulting in premature failure of the electron source. Gas connections can be made with reference to figures 2-2 and 2-6.

The electron source requires high purity argon or xenon gas, at least 99.999% pure. The use of lower grade gases or leaks can reduce electron source lifetimes up to 97%.

The EH1000 source can be operated on different gases. These gases must also be 99.999% pure.

Gas connections are made to the hollow cathode electron source using compression fittings. Mass flow controllers are used to regulate the gas flow to the ion source and electron source. Once the gas circuit has been completed from the ion source and electron source to the gas bottles, the gas lines should be evacuated to prevent contamination of the gases and the ion and electron source.

While installing the mass flow controllers, gas bottles, and gas lines atmospheric gases can become trapped within the gas circuit. It is necessary to remove this trapped volume of gas in the correct manner.

Each time a gas bottle is changed or the gas circuit is modified; the following procedure should be used:

- A two-stage, high-purity pressure regulator should be used. Connections to the gas flow controllers and the vacuum-chamber wall should be made with **clean** stainless-steel tubing (not plastic tubing).
- Attach the gas bottle to the pressure regulator. **Do not open the valve on the gas bottle**.
- Evacuate the vacuum chamber to the base pressure.
- While keeping the gas-bottle valve closed, fully open the pressure regulator. Leaving the flow controller closed, open any other valves between the pressure regulator and the vacuum chamber.
- Slowly increase the gas flow from zero to maximum while monitoring the vacuum-chamber pressure. If the flow is increased too rapidly, the gas load may be sufficient to overload the pumping capability.
- If more than one flow controller is used on the same gas bottle, apply these instructions to all flow controllers and associated valves.

- Leave the flow controller open until the vacuum-chamber pressure has returned to the base pressure - typically 15 minutes.
- Close the pressure regulator and flow controller.
- Open the gas-bottle valve.
- Adjust the pressure regulator to give normal pressure after the regulator (usually about 140 kPa gauge or 20 psig).
- Adjust the flow controller to give a flow of at least 10 sccm (standard cubic centimeters per minute).
- Maintain this flow for at least 15 minutes.
- Stop the flow by reducing the flow with the flow controller. The gas bottle is now ready for normal operation.

2.4.3 Electrical Connections in the Vacuum System

2.4.3.1 Hollow Cathode Electrical connection to the hollow cathode is made using two cables. These cables are fabricated using a copper conductor with alumina bead insulators and fiberglass loom to provide electrical shielding as well as shielding of the beads from deposited materials.

2.4.3.1.1 Cathode Connection This cable connects from the hollow cathode at the gas line using a stainless steel female, as shown in figure 2-5. The other end of this cable connects to the electrical feedthrough assembly, see Electrical Feedthrough Connections, Vacuum Side. Section 2.4.5.1, below.

2.4.3.1.2 Keeper Connection This cable has a male connector on one end and an in-line connector on the other. The male connector will connect to a female connector located on the cathode body. The opposite end of this cable connects to the electrical feedthrough, see Electrical Feedthrough Connections, Vacuum side. Section 2.4.5.1, below.

2.4.4 Electrical Feedthrough Using standard vacuum practice, install the electrical feedthrough as shown in figure 2-2 through 2-5. To do so, loosen the four set screws on the safety enclosure, see figure 2-3a. The set screws near the connector end must be loose enough to allow the connector to rotate. Unscrew the safety enclosure from the electrical feedthrough. Remove the connector, anode wire and the two HCES wires from the feedthrough by loosening the screws on the inline connectors. Install the feedthrough in a 1 in. port of the vacuum chamber. **NOTE: The anode connection may not be used if the electron source was purchased as a stand alone item.** Then reinstall the wires and connector to the feedthrough. Refer to Fig. 2-3b for proper locations, and then reinstall the safety enclosure.

2.4.4.1 Electrical Feedthrough Connections, Vacuum Side Connections from the ion source and hollow cathode are made to the electrical feedthrough as follows with the use of figure 2-2 thru 2-4. When attaching the cables to the electrical feedthrough, first loosen the set screws on the feedthrough sputter cover and remove it from the feedthrough. Insert the cathode and keeper cables through the appropriate holes of the feedthrough sputter cover. Refer to figure 2-3b for orientation. Slide the feedthrough sputter cover and the loom of the cables back to expose the inline connectors. Attach the inline connectors to the feedthrough in the proper orientation. Stretch the fiberglass loom over the connectors and return the feedthrough sputter cover back in place on the feedthrough and tighten the set screws.

2.4.4.2 Electrical Connections at Atmosphere A cable has been provided for connection from the power supplies to the electrical connector attached to the safety enclosure. See fig. 2-3. The cable end uses a locking mechanism to secure the connectors. For electrical connections at the power supplies refer to the power supply manual.

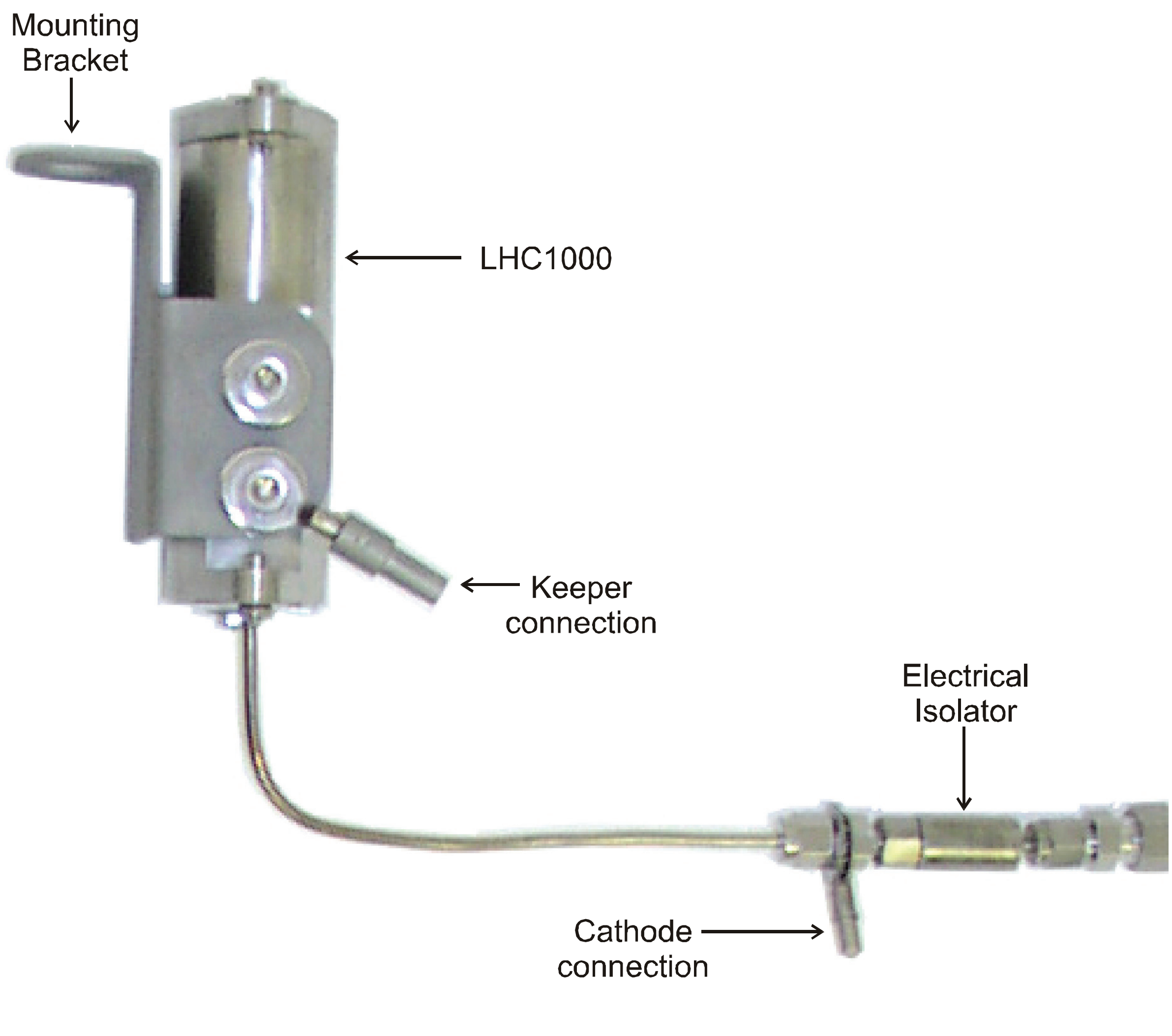


Fig. 2-1 The LHC1000 Electron source.

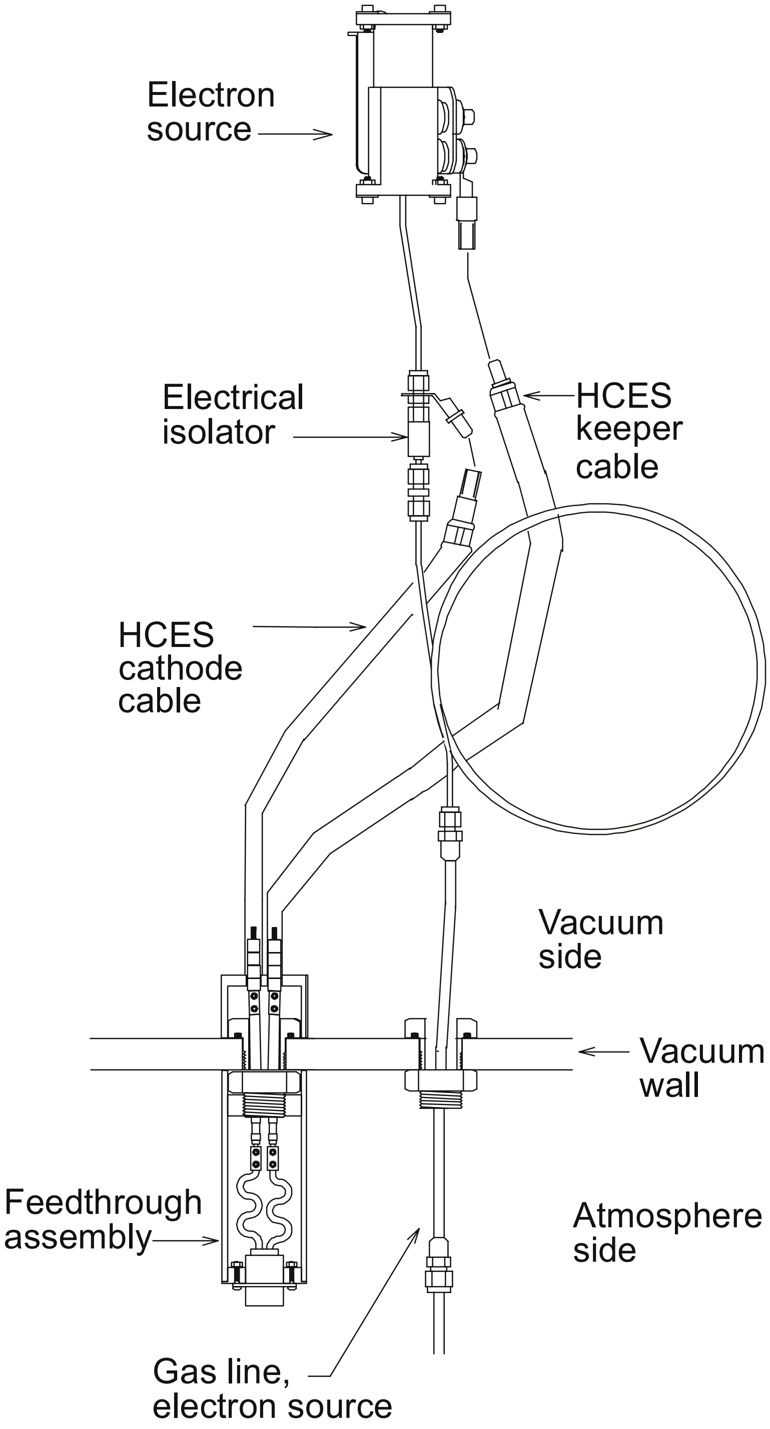
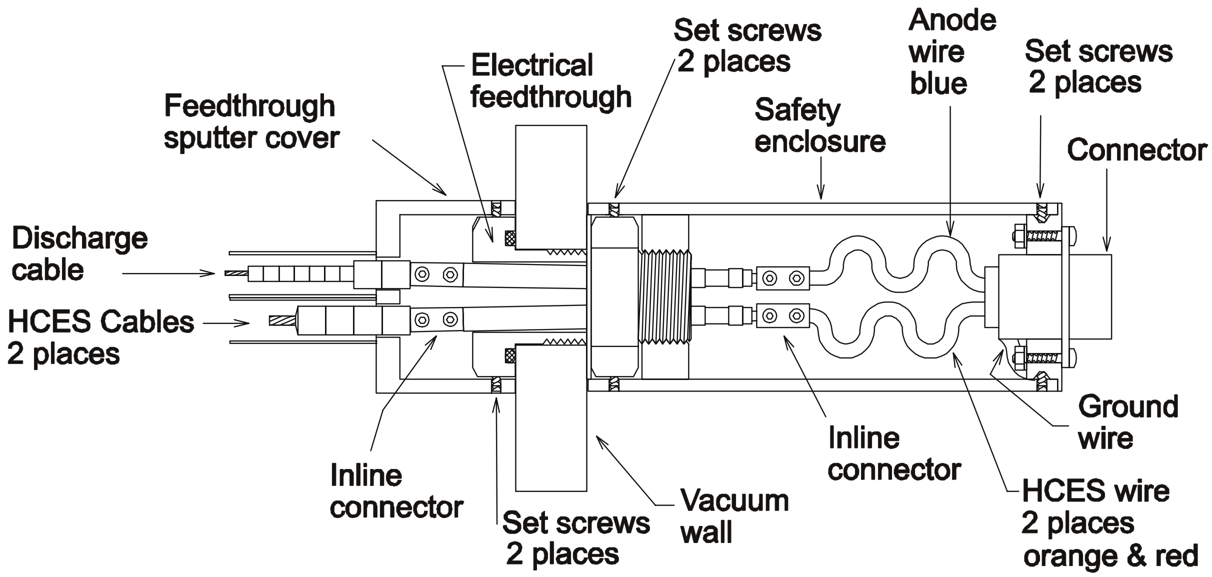
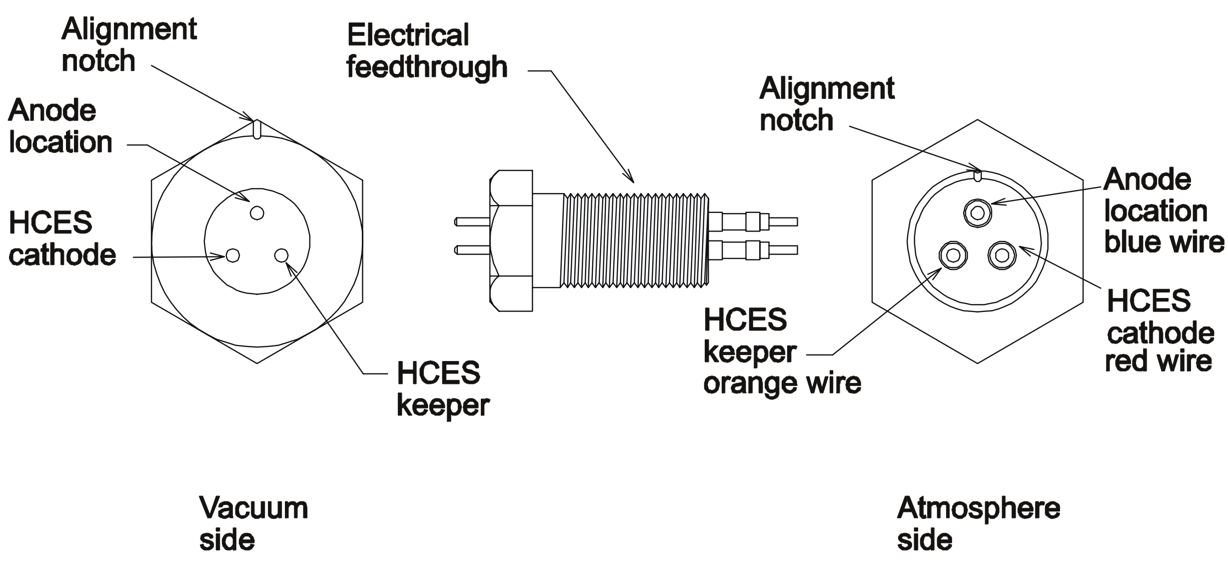


Fig. 2-2 Installation drawing for the LHC1000.



a) Cutaway view of the electrical feedthrough assembly.



b) Electrical feedthrough.

Fig. 2-3 Detailed view of electrical feedthrough assembly.

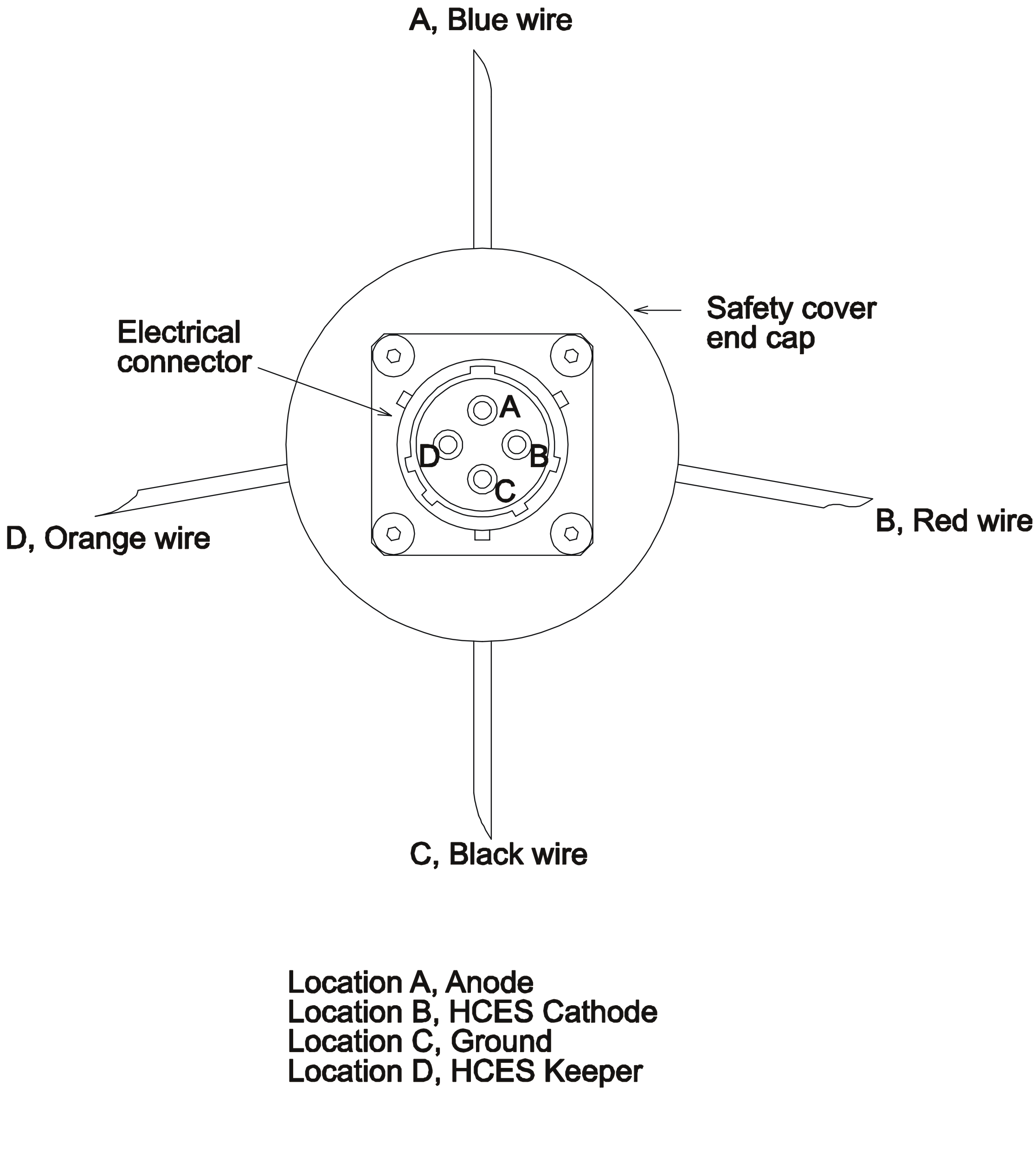


Fig. 2-4 Operating cable electrical connector.

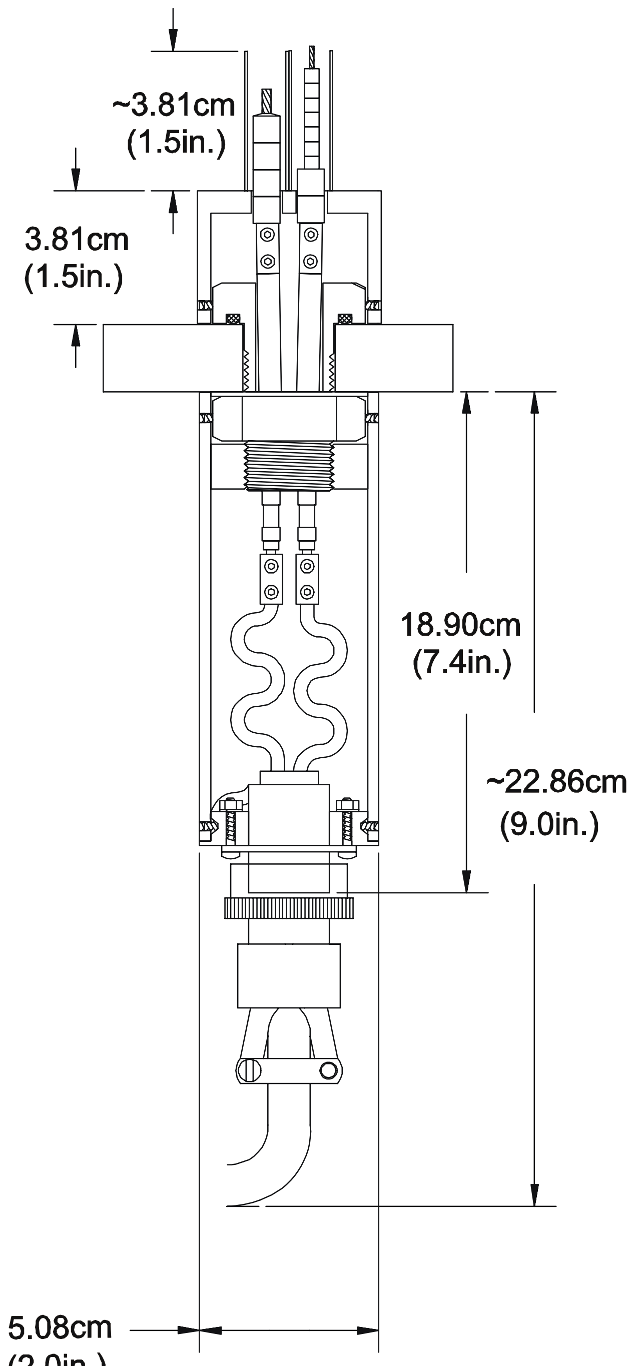


Fig. 2-5 Electrical feedthrough dimensions.

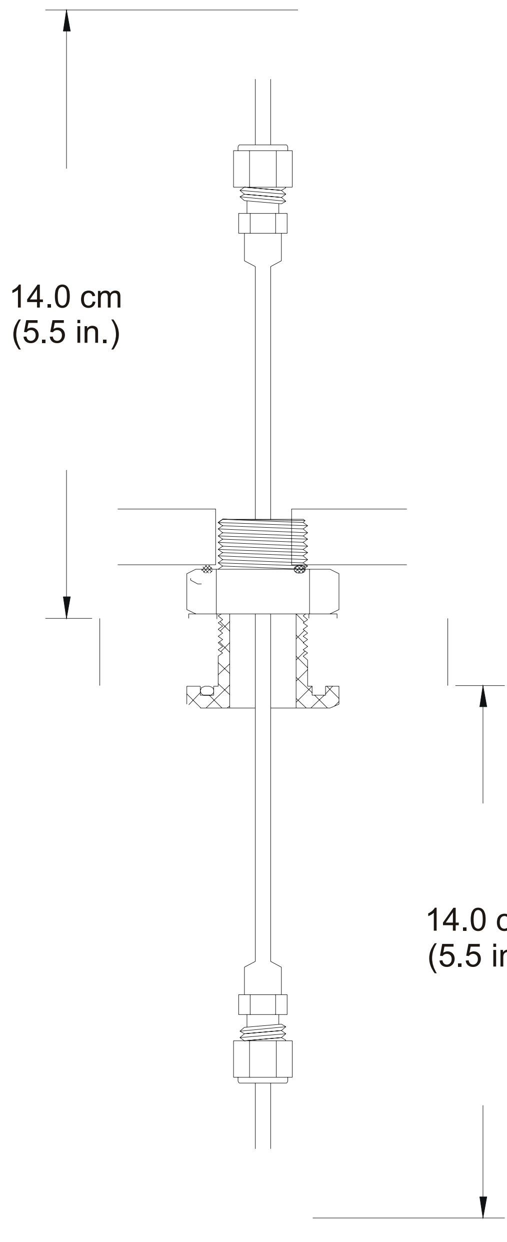


Fig. 2-6 Gas feedthrough dimensions.

3 ELECTRICAL DESCRIPTION

The information presented in this section should be adequate for a general understanding of the operation of the LHC1000 electron Source. More detailed information on the Power Supply is presented in the manual for the Power Supply.

3.1 Schematic Diagram

Operation of the LHC1000 electron source is described in summary form, it can be generally understood by reference to the block diagram of Fig. 3-1. Operation of the hollow cathode starts with argon introduced through the end of the hollow cathode tip. The keeper Power Supply generates a high voltage between the cathode tip and the keeper, which starts a discharge. The discharge increases the temperature for operation. At the point of discharge, the hollow cathode has been started which reduces the voltage and increases the current. The low voltage maintains the discharge. After the hollow cathode has been started, an emission is established by the bias power supply.

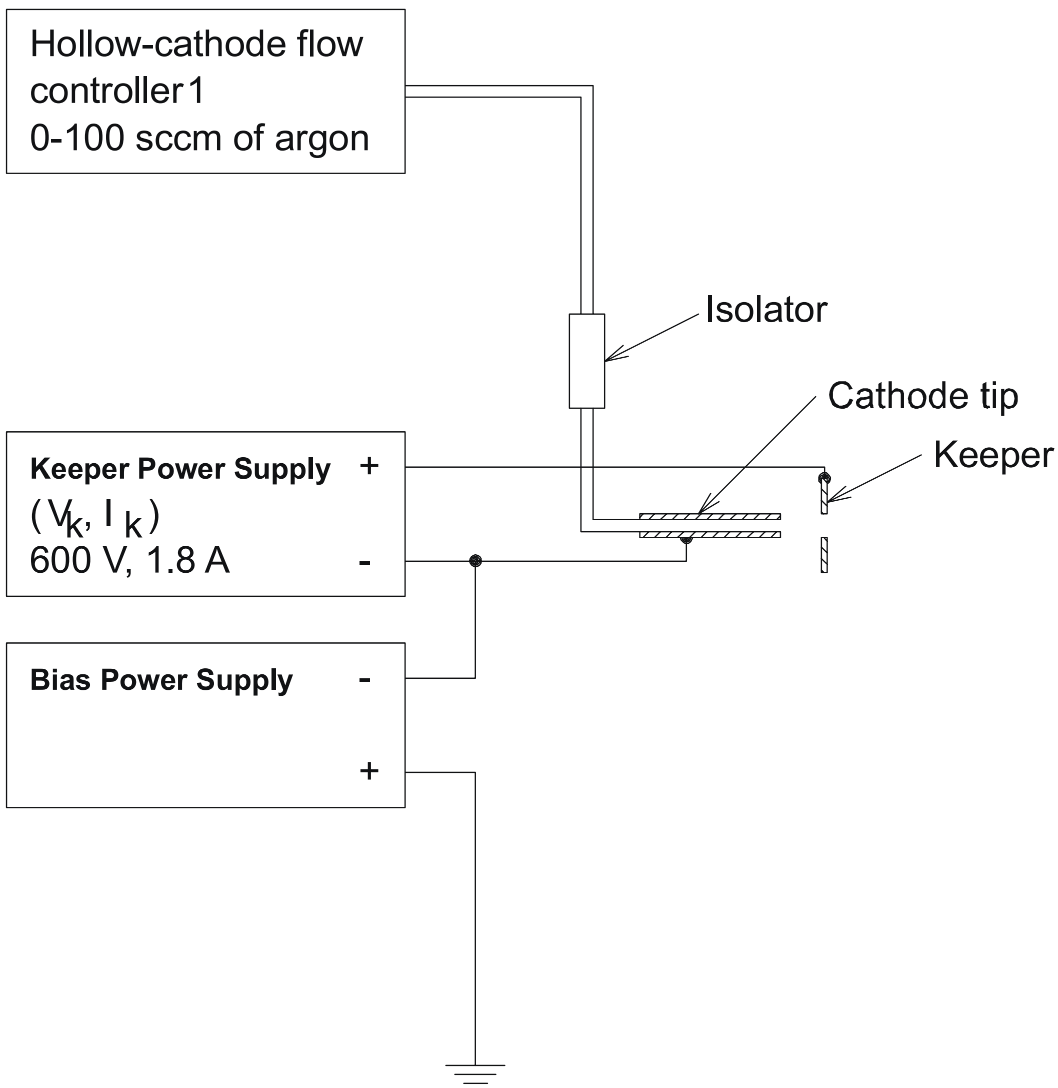


Fig 3-1 Schematic diagram of the LHC1000 electron source.

OPERATION

Operation of the LHC1000 electron source can be accomplished with the use of the following information. Operating parameters for the electron source can be found in the Characteristics section 5 of this manual. Prior to operating the LHC1000 electron source, review all of the details outlined in the Inspection and Installation section 2 of this manual and the Installation section for the LHC1000 Power Supply to insure that correct installation has been done, and all procedures have been followed. This section assumes that the operator has completed the Initial Operation procedures outlined in the LHC1000 Power Supply manual and is familiar with Power Supply operation.

Caution: DO NOT operate electron source with out Argon gas flow. Damage to the electron source can occur.

4.1 Starting the HCES

If the electron source has not been operated previously or if the cathode has been at atmosphere with no argon flow through the cathode, a gas flow of 10-20 sccm should be maintained for 15 minutes prior to starting. This flow time is intended to allow the cathode to thoroughly outgas thus preventing premature failure of the cathode due to contamination. If the electron source has been exposed to atmosphere and a flow of argon gas was maintained at between 10 and 20 sccm through the cathode during its exposure only a few minutes of flow time is required prior to staring the cathode, after the vacuum facility has reached a normal base pressure for that system. The following is an example of a typical setting.

NOTE: Use 10 sccm argon gas flow up to 10 amps bias current. After 10 amps add 1 sccm for every 1 amp of bias current.

Example: If the bias current is at 15 amps the gas flow through the hollow cathode should be 15 sccm.

Prior to starting the electron source an argon gas flow of 75-100 sccm (standard cubic centimeters per minute) should be established into the electron source. This flow can be reduced after the hollow cathode starts.

- Adjust the voltage and current controls on the Keeper Power Supply to maximum.

- Turn on the power to the Keeper Power Supply. The electron source should start and the keeper current should rise to approximately 1.6-1.8 A. The preferred keeper current is between 1.45 and 1.55 A.

- Adjust the current control until the keeper current is in the 1.45-1.55 A range. The voltage control will remain at maximum, or full clockwise during operation.

- Reduce the argon flow through the electron source to 10 sccm.

- Set the voltage control on the Bias Power Supply to maximum, fully clockwise..

- Turn on the power to the Bias Power Supply.

- Slowly increase the current control on the Bias Power Supply until 10 amps is established. The bias current should always be equal to or slightly higher than the ion source anode current.

4.2 Adjustments

Once the electron source and ion source are operating, slight adjustments may be needed to achieve the desired operating conditions.

5 CHARACTERISTICS

This section includes typical performance characteristics for the KRI LHC1000 hollow cathode electron source. The data provided should be used as a guide for operating parameters of the ion source and the electron source.

5.1 Hollow Cathode Electron Source

The standard configuration for this hollow cathode electron source can operate up to 10 amps of emission current. A flow of 10 sccm of argon is recommended for 10 amps emission for optimum lifetime of the electron source. A flow of 20 sccm of argon is recommended for 20 amps emission for optimum lifetime of the electron source. With properly cleaned gas lines, uncontaminated gas, and the correct argon flow, the electron source can operate hundreds of hours when using inert gas. Using reactive gas for the ion source, the life time will be reduced. Refer to the Maintenance section 2 for proper gas procedures.

6 MAINTENANCE

Before maintenance steps are carried out, make sure the power supplies are shut off and disconnect the electrical cable from the feedthrough.

The source was designed for ease of maintenance. Threaded parts are mostly oversized and in some cases gold plated to prevent galling. Do not overtighten threaded parts. Finger-tightening is adequate for most threaded parts. Wrenches should be used only when there is unusual resistance. The threaded parts most likely to gall and seize were also made small enough that they can be broken off and replaced with new nuts and screws. All maintenance should be carried out while wearing clean lint free gloves.

6.1 Gas Line or Gas Bottle Replacement

If a gas bottle is replaced or gas lines have been disconnected proper procedure should be performed to avoid contamination. Refer to Inspection and Installation section 2 for the proper procedure.

6.2 Hollow Cathode Electron Source

Assuming proper installation and power to the electron source, maintenance is required when it will not start or when the emission is inadequate. If the hollow cathode will not start, proceed with the following steps to help locate the problem.

6.2.1 Continuity Checks

- Check continuity of the electrical isolator between the two compression fittings on each end (Fig. 6-1). If a resistance is present replace the electrical isolator.

- Check continuity between the hollow cathode body and the hollow cathode bracket. If a resistance is present the ¼-20M or ¼-20F insulators located between the body and bracket maybe coated or broken (Fig. 6-2).

- Check continuity between the cathode body and gas line (Fig. 6-2). If a resistance is present, either the LHC-03 insulators are coated or the gas line is in contact with the cathode body.

6.2.2 Disassembly Separate the hollow cathode from ion the source by removing the acorn nut that secures the hollow cathode bracket to the front plate (Fig. 6-3). Next unthread the 1/8 inch compression fitting nut located on the feedthrough end of the hollow cathode gas insulator (Fig. 6-3), unthread the ¼-20 1 inch screws that hold the body to the bracket and place the hollow cathode on a safe clean work surface.

Proceed with disassembly by taking the two 6-32 screws, washers and nuts from each end of the cathode that secure the main retainer and the keeper retainer to the body (Fig. 6-5). After the keeper retainer has been removed, the keeper may now be removed from the body (Fig. 6-5).

Next the cathode and the two insulators ¼-20F and LHC-03 may be removed from the bottom of the body (Fig. 6-6). Inspect the top insulator for coating and replace if necessary. Inspect the inner diameter of the keeper. If the ID is larger than 0.508 cm (0.2 inches), replace with a new keeper.

Make a general inspection of the cathode tip. If the quality of the tip appears to be poor such as; cathode hole eroded to a size larger than the keeper, cathode having holes through the side of the tube, or the cathode tubing is cracked; a replacement cathode is required. Contact KRI for replacement parts.

6.2.3 Assembly Proceed with the following steps if replacement of the cathode is necessary and assuming the old cathode as been removed by following previously outlined instructions. **Gently** insert the cathode assembly (Fig. 6-6). It is important to assure a proper fit of the ¼-20F insulator into the inside of the body. Next make sure the outer LHC-03 insulator is seated properly against the bottom 1/8" compression nut and slide the main retainer against the insulator. Center the cathode insert inside the body. Secure the outer main retainer to the body with the 6-32 screws, washers and nuts (Fig. 6-4). After these procedures have been carried out the main retainer should be approximately flush with the back of the body; this will insure the proper fit for the new cathode. If the main retainer doesn't rest inside the body reassemble until a proper fit is achieved.

Now that the new cathode is installed in the body it will now need to be aligned. Place the keeper into the top of the body and the keeper retainer on top of the keeper. Thread the 6-32 screws, washers and nuts into the body, but do not tighten. Next with a flashlight look though the hole in the keeper and locate the cathode tip. Move the keeper until the cathode tip and the hole in the keeper are lined up, and then tighten the 6-32 nuts to secure the keeper in place. See figures 6-7A through 6-7C for acceptable alignment. Now affix the mounting bracket, using the two ¼-20, 1 inch screws. Re-attach the hollow cathode assembly to the source with the acorn nut and tighten the cathode gas line to the electrical isolator.

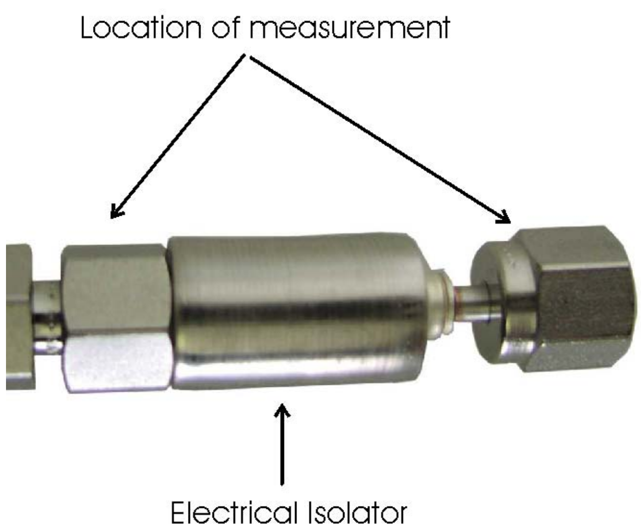


Fig. 6-1 Hollow cathode electrical isolator.

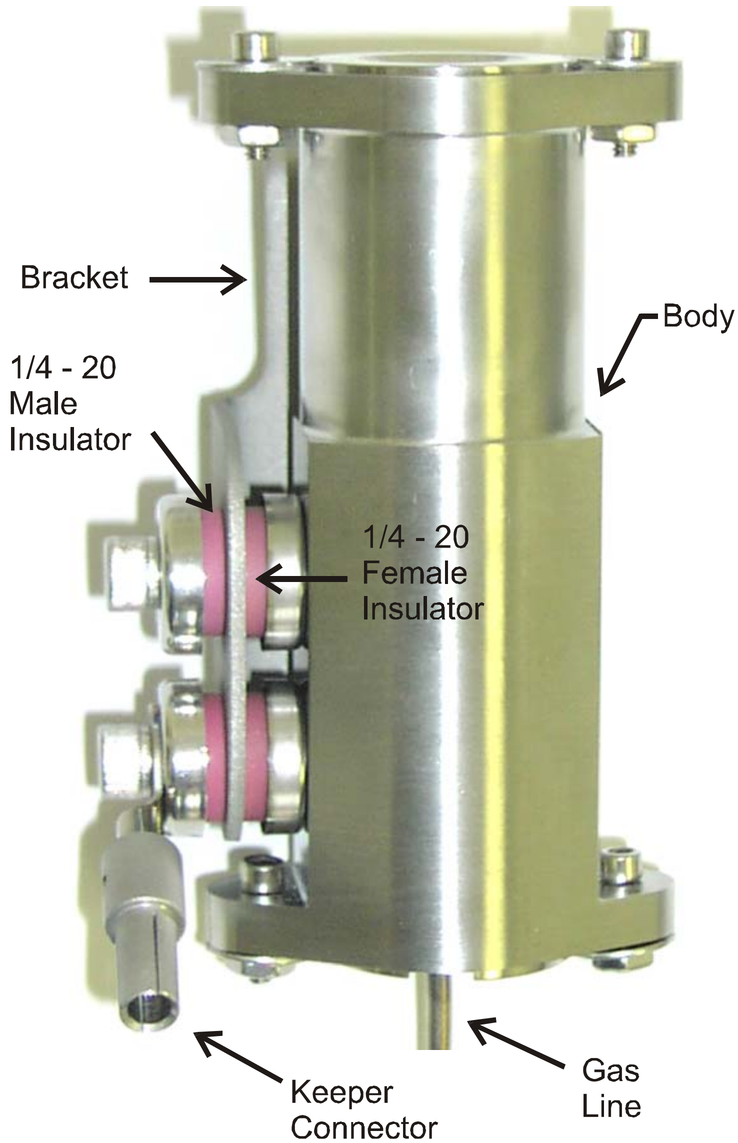


Fig. 6-2 Body, bracket, gas line and insulator.

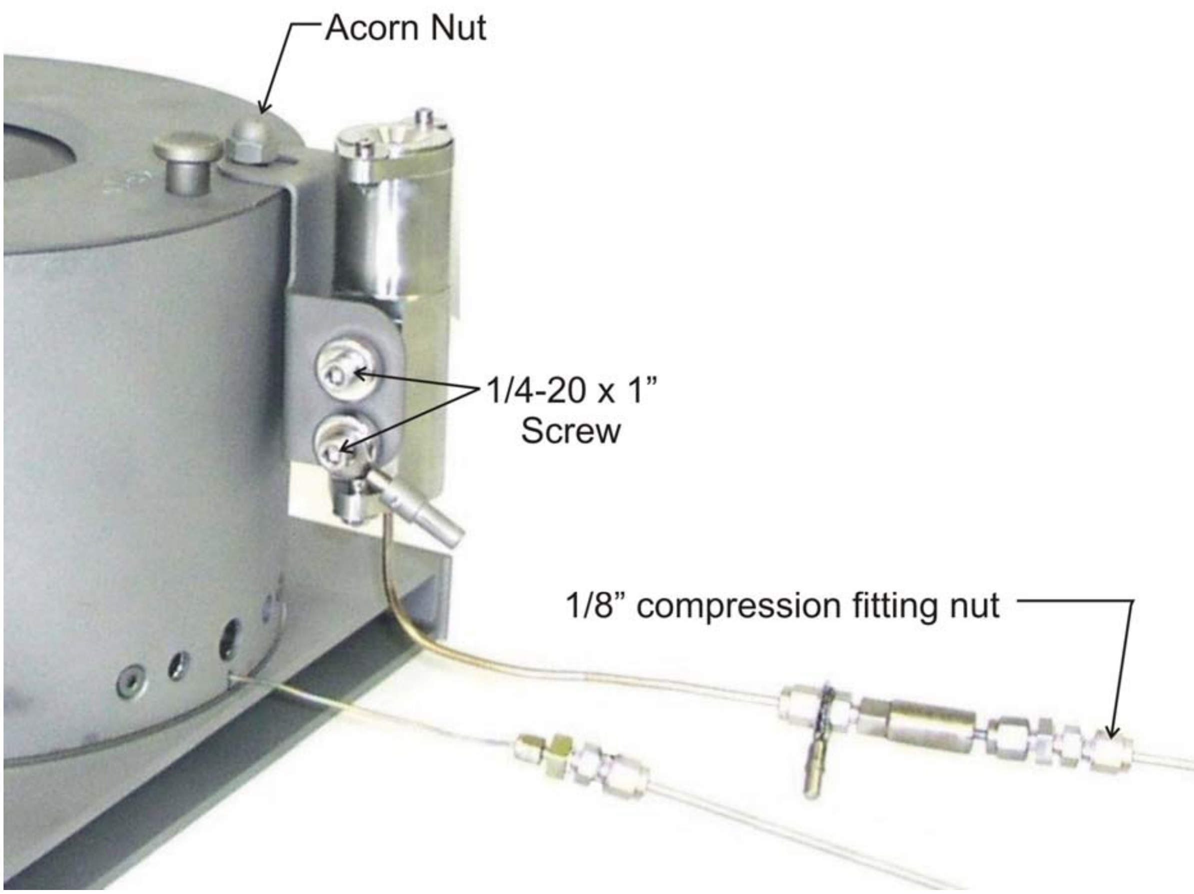


Fig. 6-3 Hollow cathode removal (EXAMPLE).

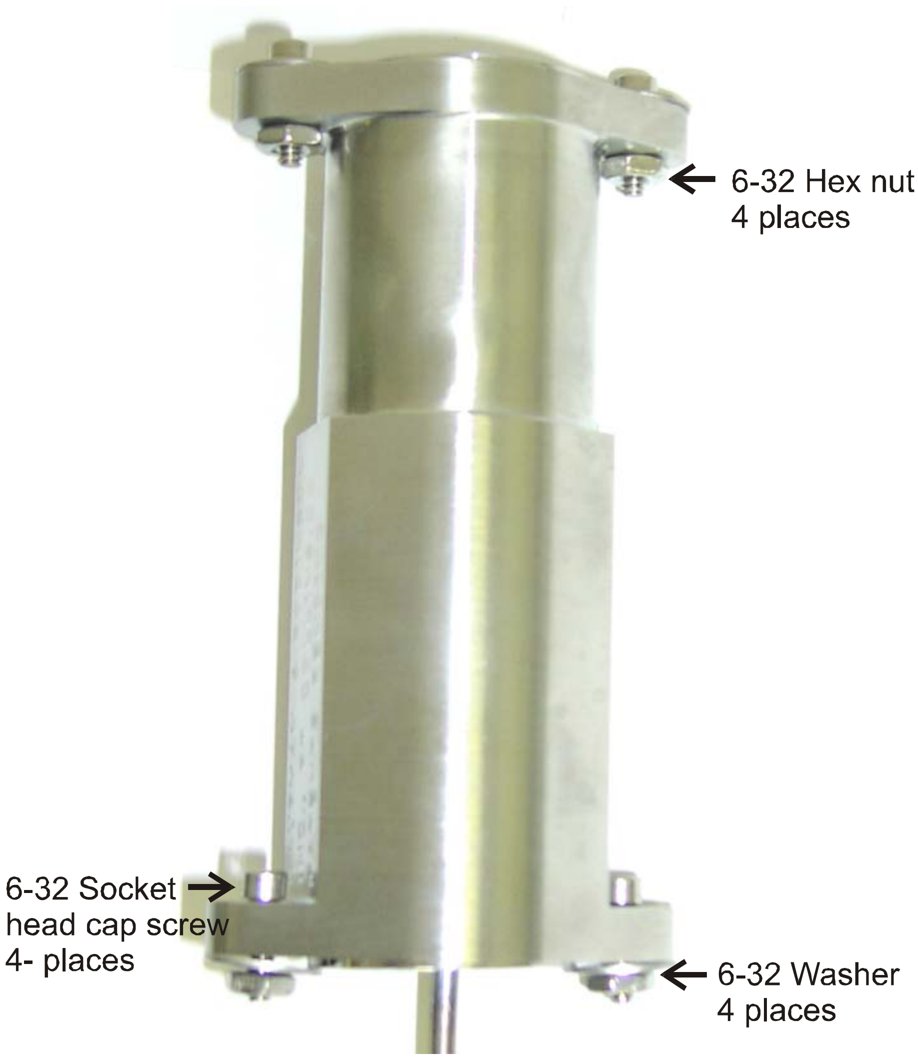


Fig. 6-4 6-32 Screws, washers and hex nuts.

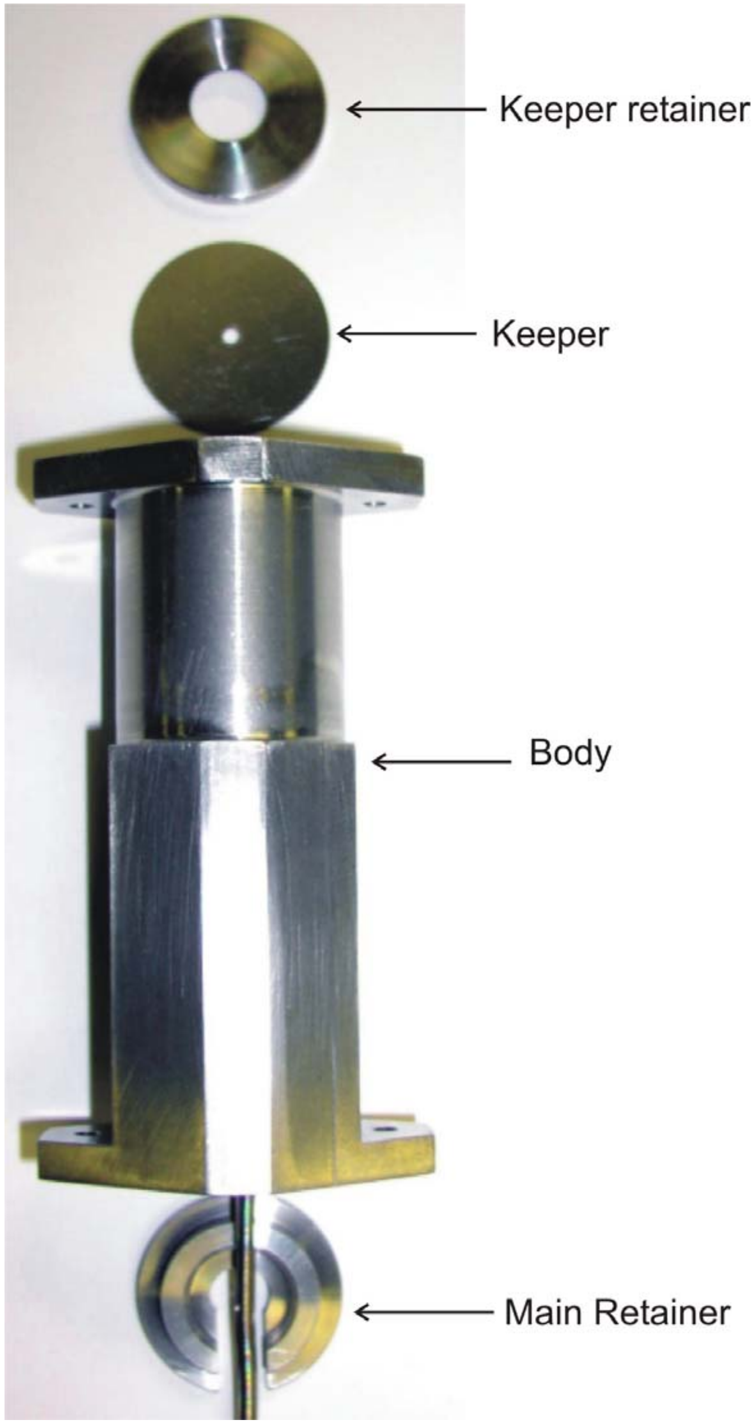


Fig. 6-5 Keeper, keeper retainer, inner and outer main retainer removed.

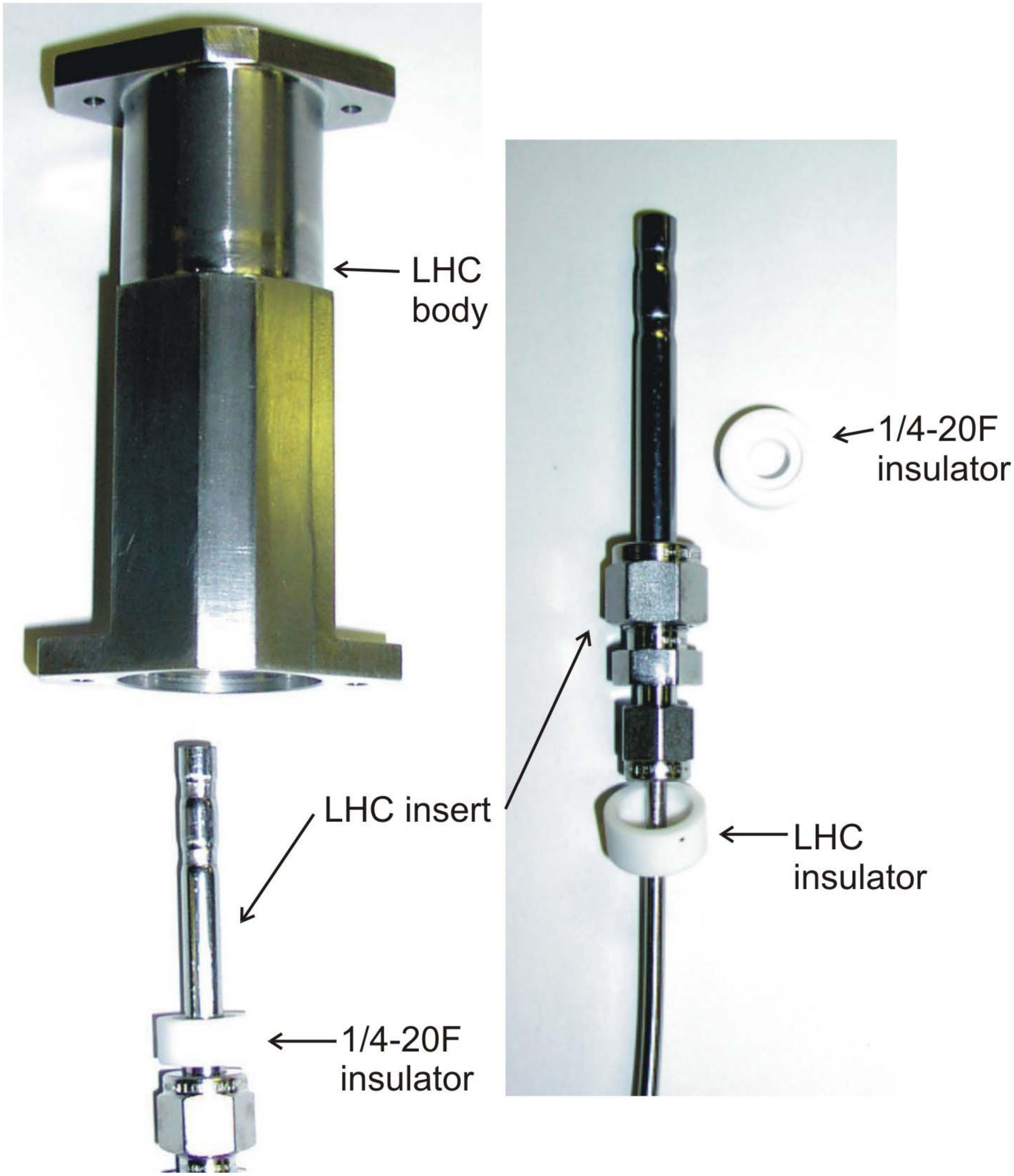


Fig. 6-6 LHC insert and LHC-03 insulators.

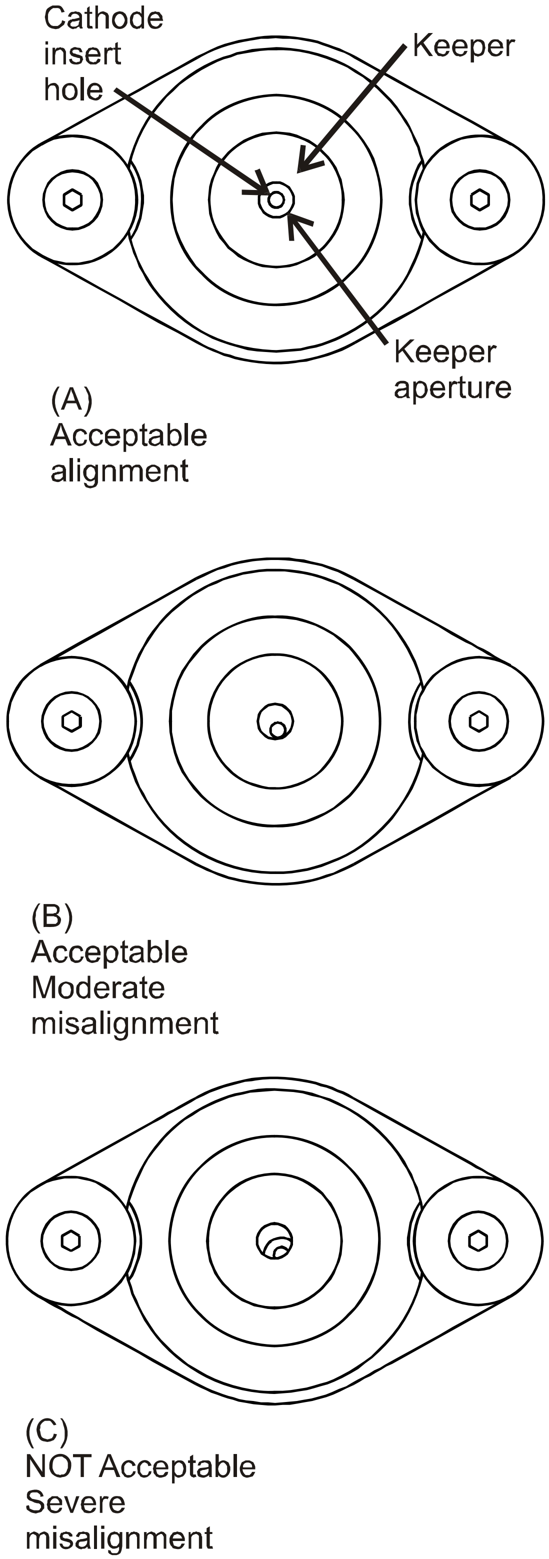


Fig. 6-7 Hollow Cathode Alignment.

7 DIAGNOSTICS

7.1 General

The following information is intended to facilitate troubleshooting and repair of the LHC1000 electron source. This information assumes that all controllers were connected to power and that all interconnects between the controllers and the electron source cable were made correctly. It is also assumed that all gas connections are in good condition and that the gas circuit is complete from the gas bottle to the ion source.

The electrical connections to the controllers must be disconnected from input power before diagnostics and maintenance.

7.2 LHC1000

If there are difficulties in starting the electron source or in the operation, tests can be conducted immediately with an ohmmeter at the electrical feedthrough to assist in diagnostics prior to venting the vacuum system to atmosphere. These ohmmeter tests would be to determine if there is any resistance between the cathode and the keeper (body of the cathode), and between the cathode and keeper to the grounded vacuum facility. Any resistance indicated less than maximum should be cause for maintenance on the HCES or the vacuum cables that connect to the HCES.

If the fault in operation is due to an open in the electrical circuit, the vacuum system may need to be vented to atmosphere to find the open circuit. Continuity checks can be made from the atmosphere side of the electrical feedthrough to the HCES body and cathode. If the resistance indicated on the ohmmeter is maximum an open circuit is evident.

Refer to the Diagnostics table 7-1 for assisting in failure analysis.

7.3 Diagnostic Table

The following table may be used to assist in determining faults and corrective action for the LHC1000.

Table 7-1. Diagnostic Table

Symptom	Possible Cause	Correction
Inability to start HCES	Gas flow too low or leakage in gas line	Increase gas flow or tighten fittings
	Failure of the HCES tip	Replace HCES tip and associated hardware
	Insulating coating on the cathode body and/or keeper	Perform maintenance on cathode, cleaning the keeper and body
	Keeper hole enlarged	Replace keeper
	Contaminated gas supply	Refer to Inspection and Installation section 2.4.3
Inability to achieve required bias current	Alignment of the cathode tip to the keeper is not correct	Align cathode tip to the keeper
High bias current, low bias voltage	Cathode shorted to ground	Inspect gas isolator, replace if necessary
		Inspect insulators located within the HCES body for coatings or damage.
	HCES body shorted to ground	Inspect insulators that isolate the cathode support from the ion source, replace coated or broken insulators
		Inspect electrical cable and feedthrough for possible damage

Symptom	Possible Cause	Correction
Bias voltage high, low to normal bias current	Insulating coating on chamber walls	Reduce bias current to equal the ion source. Clean anode and front plate of ion source. Add a grounding plate near the hollow cathode.
Keeper voltage normal, no keeper current	Open connection in the electrical circuit	Perform continuity tests with a ohmmeter to locate open
Bias voltage normal, no bias current	HCES not started Open in electrical circuit	Verify keeper voltage and current are normal Verify gas flow setting into the HCES Perform continuity tests with a ohmmeter to locate open
Lifetime of HCES is short	Contamination of the HCES Use of reactive gases within the vacuum environment	Refer to Inspection and Installation section 2.4.3 Increase gas flow to the HCES

8 WARRANTY

All equipment supplied by KRI, Kaufman & Robinson, Inc., for use with the LHC1000 and Power Supply are warrantied for one year against manufacturer defects in materials or workmanship. The warranty on the equipment is for one year, effective the date of the original shipment, provided that the equipment has been operated and maintained according to the operating procedures outlined. KRI will service and at its option repair or replace defective parts, free of charge during the one-year warranty period, at the KRI facility. This warranty excludes defects resulting from misuse or unauthorized modification. This warranty does not cover expendable parts; expendable parts are as follows:

Alumina Insulators
Hollow Cathode Tip
Hollow Cathode Keeper
Gas Line Isolator
Vacuum Cables

This warranty supersedes all other warranties expressed or implied. KRI assumes no liability for damages or loss of production. Report defects or problems to KRI immediately. For return of equipment for repair contact KRI to arrange for a return to vender (RTV) number prior to shipment of the equipment to KRI facilities.

For Service or Repair, contact KRI:

Kaufman & Robinson, Inc.
1306 Blue Spruce Dr. Unit A
Fort Collins, CO 80526
(970) 495-0183
(970) 484-9350 (FAX)

Please indicate the following items relating to the defect with the item to be returned:

Product
Serial Number
Detailed description of problem
Date of purchase
Name of Company with address, and contact person

9 REFERENCES

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