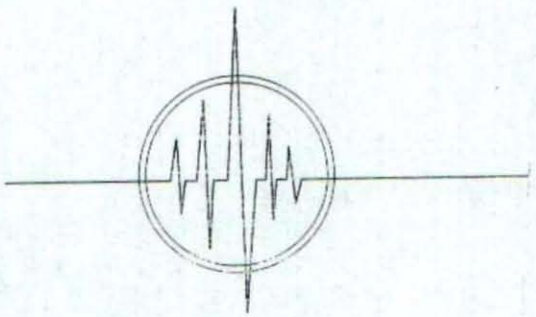

Eurovac

varian

# instructions
## ion bombardment gun

**model 981-2043**

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# ILLUSTRATIONS

# DESCRIPTION

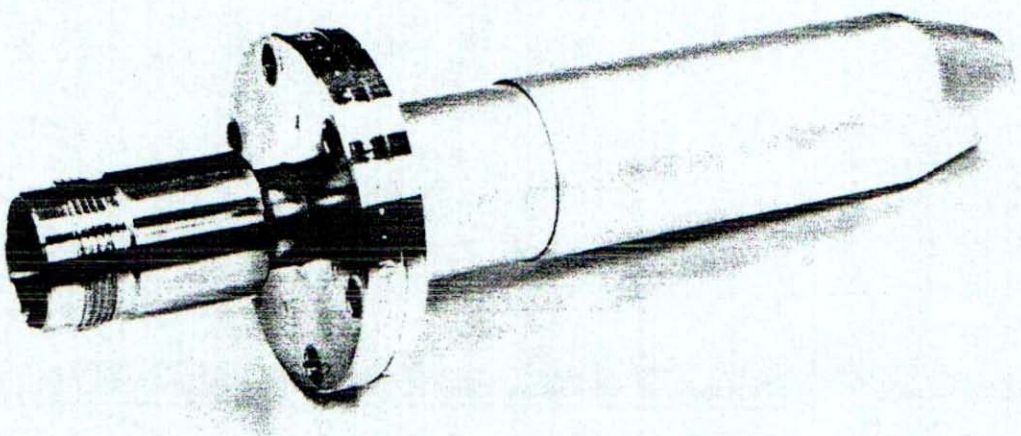
## General

The Varian Ion Bombardment Gun, Model 981-2043, provides a high density ion beam for cleaning sample surfaces and for depth profiling for Auger surface analysis or similar research work. See Figure 1. Power for the gun is provided by Control Unit, Model 981-2046 (refer to manual No. 87-400 345).

The operating beam energy of the gun is variable from 0 to 3000 V and feedback regulation of the emission current ensures beam current stability. A lens system provides acceleration and beam focusing. Deflection plates allow precise manual beam positioning as well as high frequency scanning in both the X- and Y-axes.

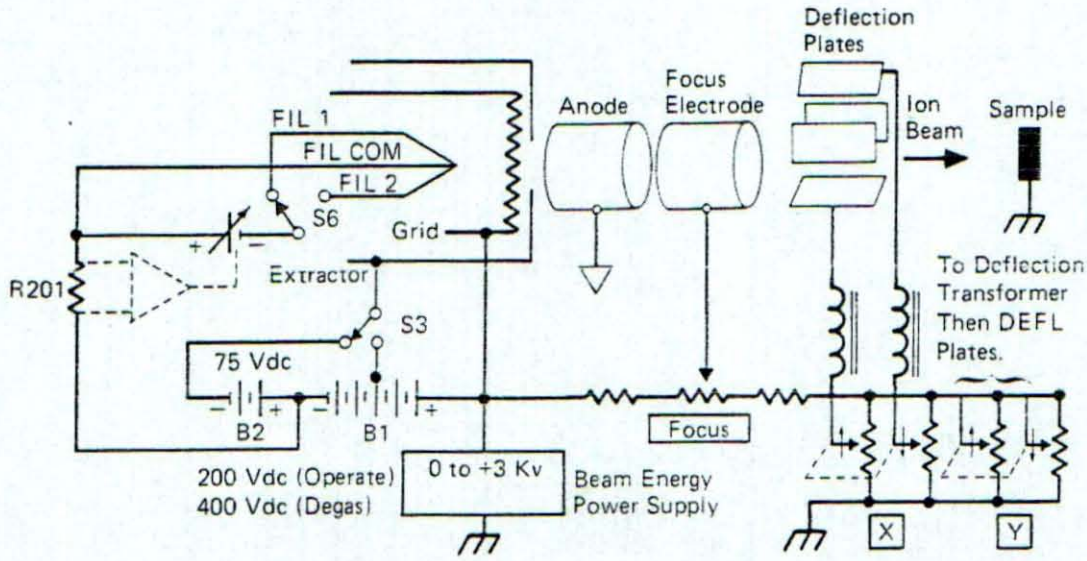
Scanning facilitates the uniform sputtering of a large area of the sample surface. The actual size of the scanned area will depend on the separation of the gun and sample, and their relative orientations. When depth profiling with the gun in an upper port of the vacuum chamber, and a sample holder tilting the sample through 30°, a few square millimeters of the sample can be sputtered with average current densities varying less than 5%.

The gun has a dual-filament assembly to allow for continued long-term operation. The filament assembly is field replaceable. The gun is mounted on a 2-3/4" OD ConFlat® Flange and is designed to mate to a similar-sized flange on a 1-3/4" OD port.



## Operating Principle

The ion gun has an electron impact ionization source and an electrostatic lens system for accelerating, focusing, and deflecting the ion beam. A schematic diagram of the ion gun is shown in Figure 2. The electrons emitted from the filament are accelerated into the cylindrical grid cage by a positive potential. Electron impact on the inert gas atoms within the grid cage produces ions that are accelerated towards the three-element lens by the extractor, then out of the gun assembly where they impinge on a sample surface.




*S3 shown in OPERATE mode.*

**Pin Diagram**

| Pin No. | Function |
|---|---|
| 1 | Filament |
| 2 | X-deflection |
| 3 | Y-deflection |
| 4 | Focus electrode |
| 5 | Extractor |
| 6 | Y-deflection |
| 7 | X-deflection |
| 8 | Filament |
| 9 | Filament common |
| 10 | Grid |

**Rear of Feedthrough**

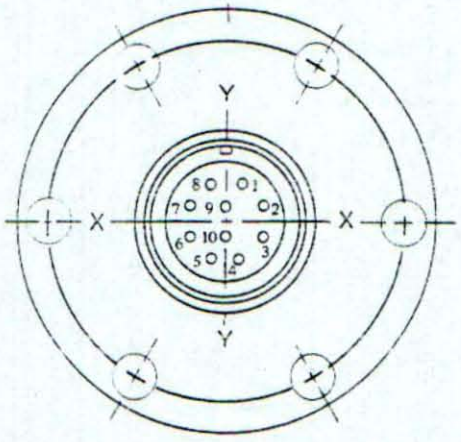



*Figure 2. Ion bombardment gun, schematic diagram.*

## Beam Probe Accessory

When used in conjunction with the ion bombardment gun, the accessory Beam Probe, Model 981-2505, facilitates highly reproducible, quantitative sputtering. The beam probe, a Faraday cup assembly, is also useful for alignment purposes, ensuring that the ion beam and the Auger gun electron beam intersect the same point on the sample under investigation. Refer to Varian manual, publication no. 87-400 346.

## Specifications

| | |
|---|---|
| Ion beam energy | Variable, 0–3 keV |
| Ion beam current density | >300 $\mu A/cm^2$ at 5 cm from end of gun with $6 \times 10^{-5}$ torr of Ar and 3 keV energy |
| Sputtering rates | >200 Å/min for $Ta_2O_3$ for the above conditions |
| Ion beam diameter | ~2.5 mm at 3 keV and 5 cm from gun |
| Focus | Tracking and adjustable from 4 to 10 cm from end of gun |
| Filaments | Field replaceable dual, tungsten wire filament assembly. Filament selection from rear of power supply. |
| Emission current | 30 mA typical, 40 mA maximum |
| Degas current | 20 mA (rear panel adjustment) |
| Automatic degas | Timed for 5 min while gun energy switched to zero |
| Operating pressure | Up to $10^{-4}$ torr inert gas |
| Mounting | 2-3/4" OD ConFlat® Flange (requires > 1.45" ID tubulation) Flange to sample ≥ 8". |
| Bakeability | Up to 250°C |
| Dimensions | 6.0" from flange face to end of gun; 1.44" gun OD |

Note: *For highest ion beam current density, recommended operating parameters are 3 kV, 30 mA, $6 \times 10^{-5}$ torr argon. While there are slight variations in the parameters from gun to gun for the maximum current density, the current density obtained with these recommended parameters should be within 30% of the maximum.*

# INSTALLATION

## Unpacking

The ion gun is cleaned and degassed before shipment; therefore, the components on the vacuum side of the flange should be handled with clean, lint-free gloves, finger cots, or with degreased tools.

To prevent damage or contamination during shipment, the ion gun is shipped in a formed, clam-shell plastic container. To remove the ion gun, carefully remove the staples holding the package shut, open the clam-shell, and lift out the ion gun by its mounting flange.

Check the ion gun for shipping damage. Using an ohmeter and the pin diagram of Figure 2, check the gun for:

1. Filament continuity: pins 1, 8, and 9 should indicate less than 1 Ω between any pair.
2. Pin-to-pin shorts: no pins should be shorted to one another except pins 1, 8, and 9.
3. Pin-to-ground shorts: none of the ten pins should show less than 1 MΩ to ground (to the flange).

Check that the tapered end of the shield is aligned with the ends of the deflection plates, i.e., that the shield has not slipped off or too far on during shipment.

Shipped with the ion gun is the lens removal jig, which should be stored for use when replacing the filaments or grid.

## Installation

1. The ion gun is mounted onto a mating 2-3/4" flange with an inside clearance of 1.45". The sample to mating flange face distance should be at least 8". The ion beam current density at the sample decreases as the distance from the sample to the end of the gun increases. Therefore, it is usually desirable to mount the gun as close to the sample as possible without interfering with other instruments in the chamber.
2. Connect the control unit cable to the gun.
3. After pumping the system down to $10^{-7}$ torr, outgas the ion gun before turning on the high voltage. (Set OPERATE-DEGAS switch to DEGAS, POWER ON; refer to power supply manual.)

## Inert Gas Source

It is necessary to install a clean source of inert gas (Ar, Kr or Xe) on the vacuum system for the ion gun. A simple installation method is described here. The Variable Leak Valve (Model 951-5100) has a flare fitting gas inlet port. The inert

gas is research grade, in a size 7 (or larger) cylinder. The regulator and valve must be compatible with high purity gases and must allow pumping a vacuum up to the cylinder valve (Matheson Gas Products, Model 19–580, for example).

Copper tubing (clean, OFHC, 1/4" OD) is flared and attached to the leak valve. The flare nut *must* be lubricated (Fel-Pro C-100 High Temperature Lubricant) and tightened with two wrenches. (Do *not* get lubricant on the flare surfaces or inside the tubing.) The tubing is attached to the regulator valve fitting.

The vacuum system is rough-pumped with the VacSorb™ Pumps. The leak valve and regulator valve are fully opened to evacuate the tubing and regulator up to the *closed* cylinder valve to 1 micron pressure. The leak valve is closed, the cylinder valve is opened, and the regulator adjusted for 15 psig. The cylinder valve is closed and leak valve opened to complete the purge.

The tubing and regulator are then pumped with the ion pumps to less than $10^{-8}$ torr system pressure. This outgasses the line and verifies that no leaks exist. (If $10^{-8}$ torr cannot be attained, tighten the fittings.) Next, close the leak valve. Open and close the cylinder valve to fill the tubing with gas. Pinch off the copper tube about 2 ft from the leak valve. (Apply glue and tape to the pinch-off to protect it and to prevent personal injury.) This inert gas source will fill the system to $6 \times 10^{-5}$ torr about 1000 cycles.

# OPERATION

## Operating Parameters

It is recommended that 20 to 30 mA emission be used with the lowest pressure of Ar (Kr or Xe) sufficient to give the desired current density. While not affecting ion bombardment gun operation, this will ensure longest electron gun filament life.

Since the sputtering yield and the maximum current density both increase nearly linearly with energy, the sputtering rate increases rapidly with energy. On the other hand, increased energy disorders the sample to greater depth. Usually, a high sputter rate is desired (using nearly maximum ion energy); but at other times it is preferable to carefully sputter a few layers with a minimum of damage (using a low energy beam).

## Sputtering Procedure

The chamber pressure should be $10^{-8}$ torr or lower and the ion gun outgassed according to the control unit instruction manual. The Titanium Sublimation Pump should then be flashed on for about 2 min at 48 A. The ion pumps are then shut off. The inert gas (Ar, Kr, or Xe) is let in through the leak valve to the desired pressure (about $6 \times 10^{-5}$ torr). The ion gun is then operated according to the control unit instruction manual.

At full power, the ion gun actually has a slight pumping action on the inert gas and the pressure will be reduced. If the gun is operated for long periods, additional inert gas must be let in.

If the vacuum system has been baked, the argon remains relatively clean (clean enough for depth profile measurements) in the system for around 4 hr before the ion pumps must be turned on again to restore a clean system.

# MAINTENANCE

## General

Field maintenance should be limited to replacement of a burned out filament assembly, replacement of a damaged grid, or removal of a simple electrical short.

Under normal operating conditions, each tungsten wire filament will last about 1000 hr before burnout. When a filament is open, the power supply will show no emission current. The filament switch on the rear of the power supply can then be switched to the second filament and operation can continue.

If a filament shorts to the grid, the grid will be damaged and must be replaced, along with the filament assembly. If such a condition exists, the emission meter on the power supply will indicate full scale (with the emission control turned counterclockwise).

During ion bombardment, a small amount of sputtered metal from inside the ion gun coats the ceramic electrical insulators. Electrical leakage after many hundreds of hours of operation (in inert gas) will change the gun characteristics. All ion gun pins should have at least 1 MΩ resistance to ground (the 2-3/4" flange). If electrical leakage is excessive, the ion gun should be rebuilt at the factory.

## Filament Replacement

1. Clamp the 2-3/4" flange in a vise with the lens assembly pointing upward.
2. Remove the shield by removing screw on cone, sliding it upward (Figure 3).

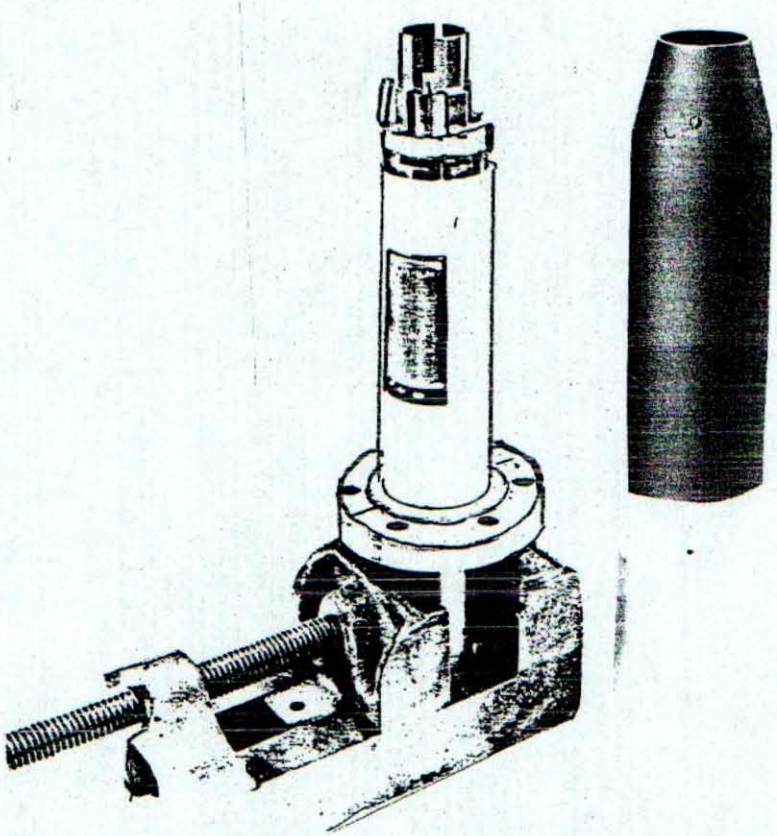


*Figure 3. Removal of cone.*

3. Remove the three 2-56 screws at the base of the lens assembly (Figure 4).

4. Reclamp the gun horizontally and pull the anode assembly from its socket (Figure 6).

5. Loosen the screws of the filament connectors with the #2 Bristol wrench. Remove the old filament assembly.

6. Insert the new filament assembly. Tighten the screw holding the center support rod on the filament assembly, making sure that the curved filament support member is concentric with the grid (Figure 7).

7. Tighten the screws holding the filaments, making sure that each filament is parallel to the grid.

8. Insert the lens assembly into the jig with the base with the side hole in the lens assembly rotated toward the filaments in the base assembly. Push the lens assembly down carefully until the top of the side hole is 1/4" from the top. (The pins are not engaged in the socket at this point.)

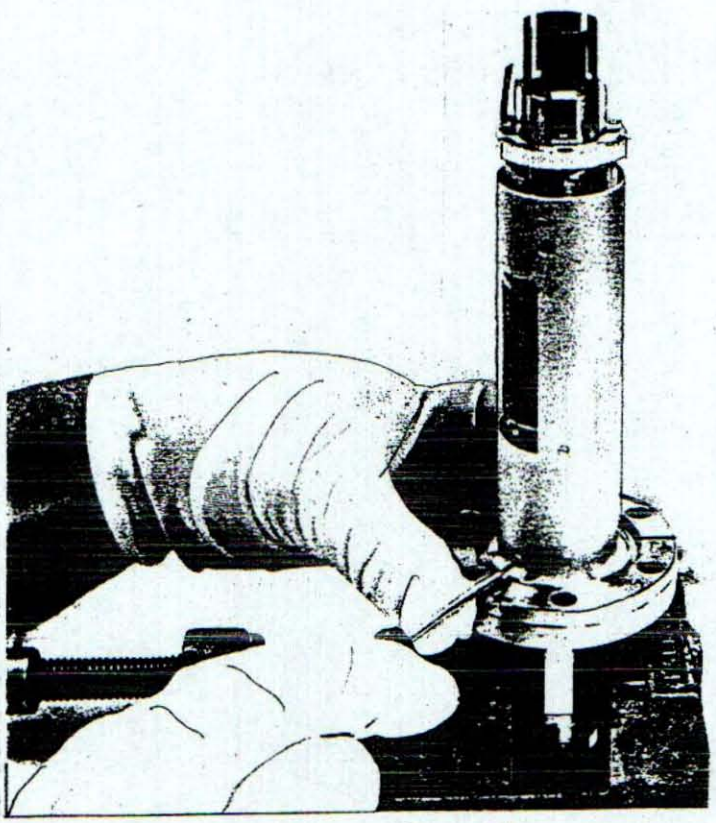


*Figure 4. Removal of screws in base of lens assembly.*

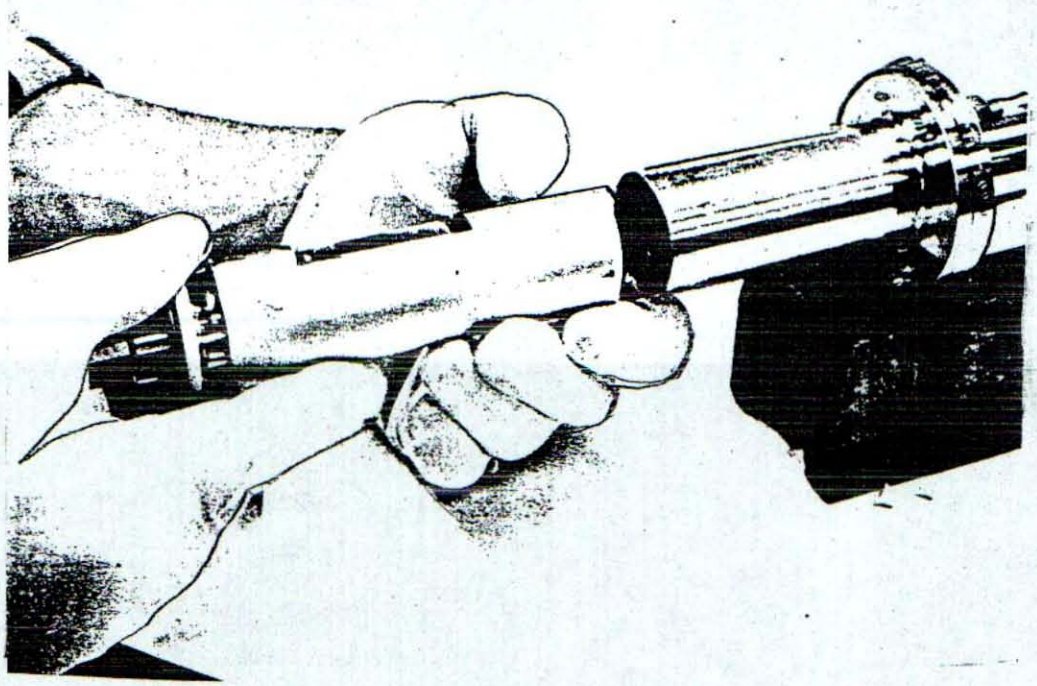


*Figure 6. Removal of anode assembly*

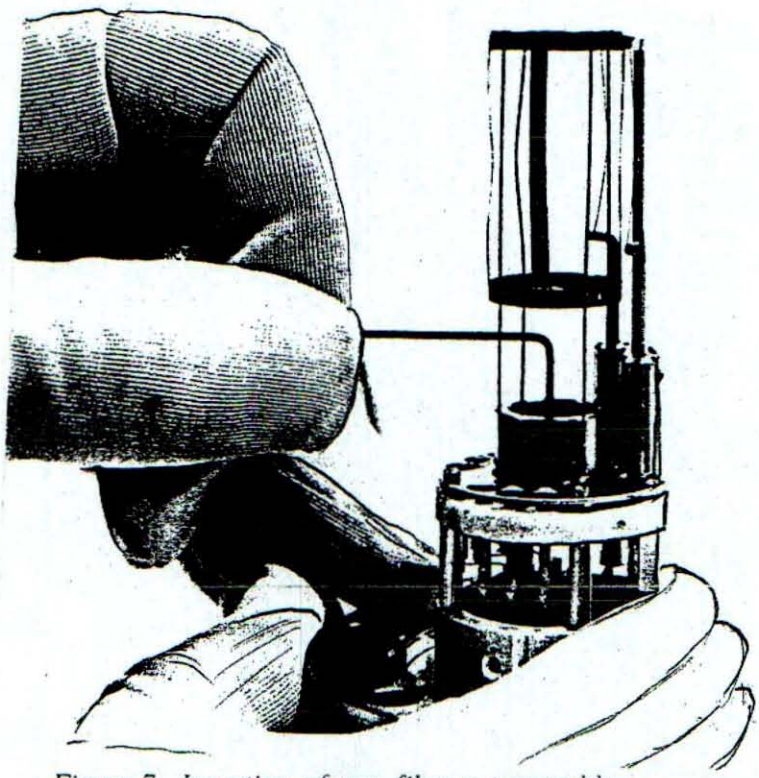


*Figure 7. Insertion of new filament assembly.*

9. Rotate the lens assembly slightly until the bolt holes at the base line up. Push the lens assembly down all the way, mating the connector pins inside.
10. Replace the three 2-56 screws at the base of the lens assembly.
11. Replace the flange gasket, then slide the shield back over the lens assembly. Line up the hole in the cone with the bracket and replace the screw.
12. Check for filament continuity and no shorts as indicated in Section II, *Installation*.

## Grid Replacement

1. Repeat steps 1 through 6 of the *Filament Replacement* procedure.
2. Unscrew the 0-80 screw holding the grid assembly to its base. Remove the damaged assembly.
3. Insert the new grid with one of its four supports opposite the center filament post to prevent obstruction of emission from the filament by a grid support post. Also, do not orient the grid with the mesh overlap in front of either filament.

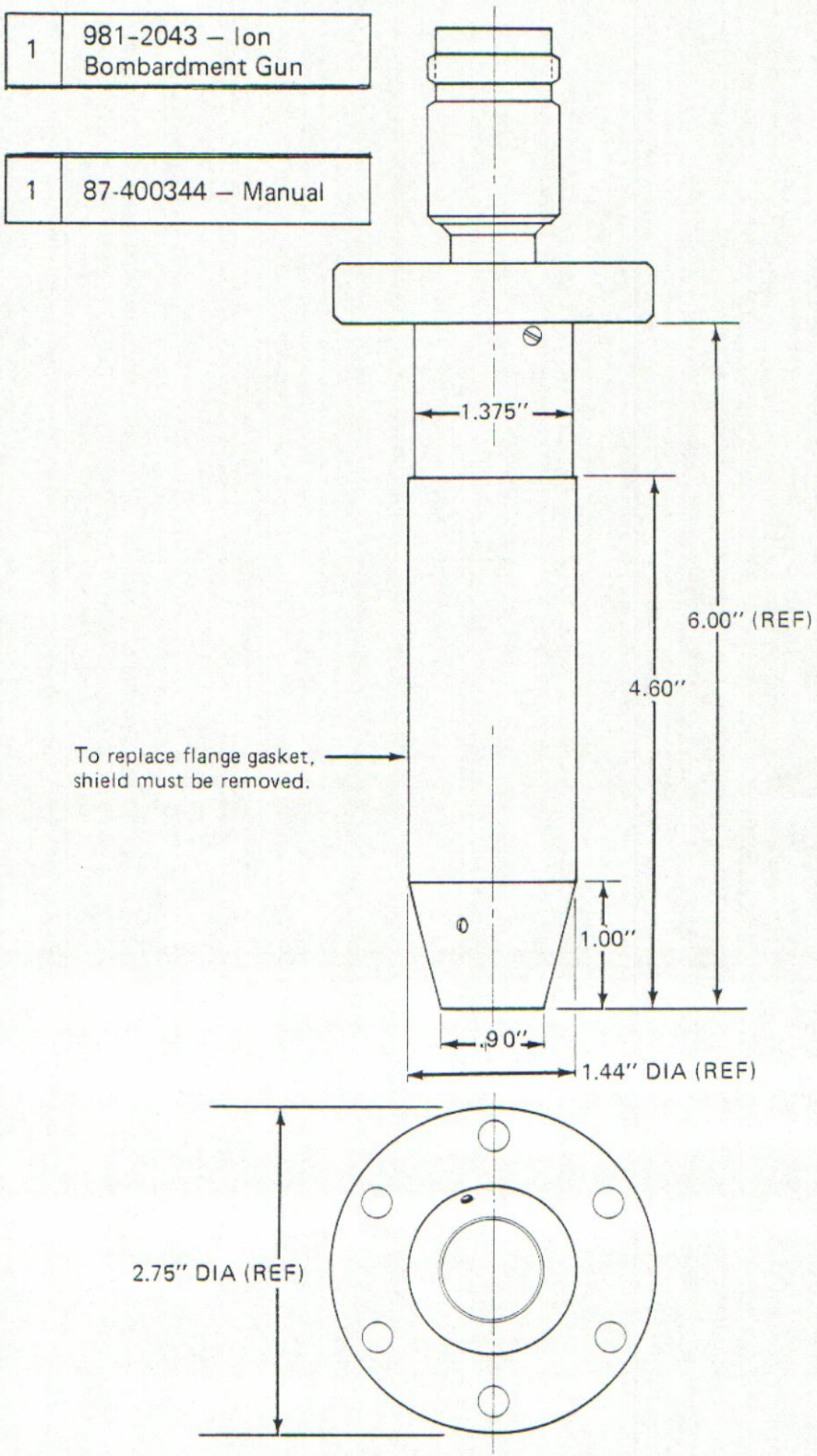



*Figure 8. Ion bombardment gun assembly*

| DASH NO. | TYPE OR MODEL | NEXT ASSEMBLY | REQ | PART NUMBER | DESCRIPTION OR MATERIAL | ITEM |
|---|---|---|---|---|---|---|
| | 981-2043<br>981-2042 | | | | | |

A 652959

DO NOT SCALE DRAWING

## INSTRUCTIONS FOR EXTRACTOR GRID REPLACEMENT KIT: 981-2042

(981-2043 Ion Gun)

Extractor Grid Replacement Kit: parts 652396 1 each and 652398 1 each.
(Refer to Figures of Ion Gun Instruction Manual)

1. Clamp the 2-3/4 inch flange in a vise with the lens assembly pointing upward.
2. Remove the shield by removing screw on cone, sliding it upward. (Fig. 3)
3. Remove the three 2-56 screws at the base of the lens assembly. (Fig. 4)
4. Slide the tubular jig (shipped with the gun) over the lens assembly and bolt it to the flange. (Fig. 5)
5. Reclamp the gun horizontally and carefully pull lens assembly from its socket. (Fig. 6)
6. Holding lens assembly with deflection plates pointing down, reach into top of extractor area (the area with the 3/8" hole viewed from the end opposite the deflection plates) with a pair of tweezers (6" long) and insert tips into holes in snap-ring which is perpendicular to gridded apperature with 3/8" hole.
7. Squeeze tweezers, compressing snap-ring enough for withdrawal. (Dental-pick with 90° offset is useful at this point to facilitate removal in conjunction with tweezers)
8. Turn lens assembly upside down. Gridded washer will fall out.
9. Holding new gridded washer with tweezers, insert into extractor (taper part of washer facing operator) and seat next to shoulder.
10. Insert tweezers tip into holes of snap-ring and compress. Place snap-ring into extractor, making sure ring is properly seated next to gridded washer, thereby capturing it.
11. Repeat steps 1-6 in reverse order making sure that flange gasket is replaced before sliding shield back over lens assembly.

| DESCRIPTION OF CHANGE | ADDED PARTS LIST UPGRADE - A - | retyped ADD 4812042 | |
|---|---|---|---|
| NUM | | | |
| EO | 5898 | | |
| DFT | SW. | AKC | |
| CHK | B | | |
| DATE | 11-13-79 | Dec 3/79 | |
| REV | A | — | |

| DRAWN | DATE | APPROVED | DATE | CODE |
|---|---|---|---|---|
| EDmorgan | 7-7-96 | B Coffman | Dec 3/81 | |
| CHECKED | DATE | APPROVED | DATE | CLASS |
| | | | | A |

GRID REPLACEMENT INSTRUCTIONS

varian

NOT OTHERWISE SPEC: FRAC ± ANG ± SCALE

FIN. ✓ DEC .X ± .XX ± .XXX ±

| TFTD | A | 652959 | A |
|---|---|---|---|
| DIVISION | SIZE | DRAWING NO. | REV |

LITHO IN U.S.A. 0411-06-03 MAY66 P8/80