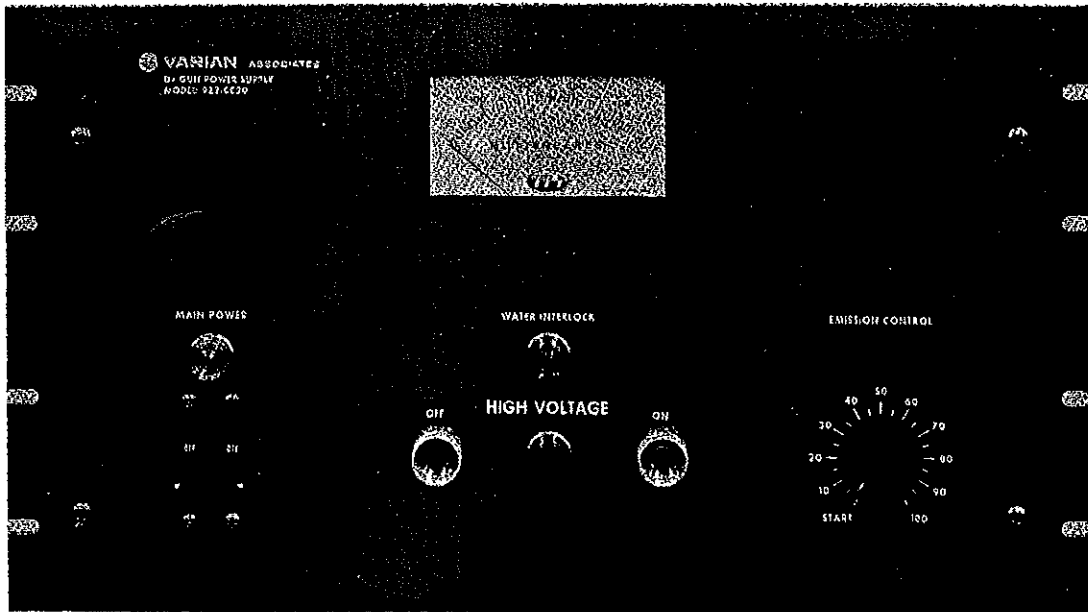


Allen
Newk
- MJE 3055 → transistor (2) 2N1482 (1) is used
- 2N174 → transistor (4)

87-400 114

JULY 1965



e-GUN* SOURCE CONTROL UNIT

MODEL NO. 922-0020

INSTRUCTION MANUAL

* Trademark

CONTENTS

I.	INTRODUCTION	page 1
II.	SPECIFICATIONS	2
III.	INSTALLATION AND CONNECTIONS	3
	A. Power	3
	B. Connections	4
IV.	OPERATING INSTRUCTIONS	6
	A. Operation	6
	B. Use of Hand-Held Potentiometer	9
	C. Use of Deposit Rate Control Unit	10
	D. Use of Thickness Control Monitor	10
	E. Use of Beam Adjust Unit	11
V.	MAINTENANCE AND TROUBLE	
	SHOOTING	12
	A. Maintenance	12
	B. Trouble Shooting	12
VI.	PARTS LIST	16
VII.	SERVICE INFORMATION	18
	A. Warranty Statement	18
	B. Field Service	18

SECTION I

INTRODUCTION

Electron beam heating is an efficient and practical way of achieving temperatures in excess of 3500°C (6300°F) for uniform thin film, optical coating and vacuum metallurgical processes. The Varian e-Gun* Electron Beam Evaporation Source evaporates all materials -- refractory, dielectric, magnetic and conductive. The e-Gun Source, which is bakeable to 250°C, and its Control Unit have been designed to be part of any high or ultra-high vacuum system. While the equipment will serve reliably for routine production work, its simplicity and non-contaminating operation make it equally suited for exacting research activities.

The e-Gun Source Control Unit provides convenient single-knob control of evaporation. The unit is current regulated and minor changes in line voltage do not affect the beam power. There is provision for connection of a water-flow interlock, a pressure interlock, a deposit rate controller and a thickness monitor.

Maximum output power of the e-Gun Source is 2000 watts. Output power may be read by multiplying the emission current displayed on the Control Unit panel meter by the constant output voltage of 4000 volts dc.

* Trademark

SECTION II

SPECIFICATIONS

Input Power	208 or 230 volts, 50 or 60 cycles, single phase, 20 amperes. NOTE: Maximum input current is 14 amperes during normal operation. The e-Gun Source can draw line currents up to 20 amperes during arcing.
Output, High Voltage	4000 volts (Negative) dc unregulated.
Output, Current	Variable 0-500 mA; regulated by feedback control.
Output, Gun Filament	0-6 volts, 0-25 amperes. Both filament leads at high voltage.
Metering	0-500 mA, full scale; accuracy $\pm 2\%$ of full scale.
Water-Flow Interlock Lead	12 ft. To connect to customer-supplied 1/2 gallon per minute water-flow interlock, which should operate with the following conditions: Maximum voltage 110 volts; maximum current 1 ampere, closed with water flow.
High Voltage, High Current Leads	10 ft.
Remote Control	Hand-held potentiometer; 12 ft. lead
Panel Space	Width 19 in. Height 10-1/2 in. Depth 20 in.
Weight	150 pounds

SECTION III
INSTALLATION AND CONNECTIONS

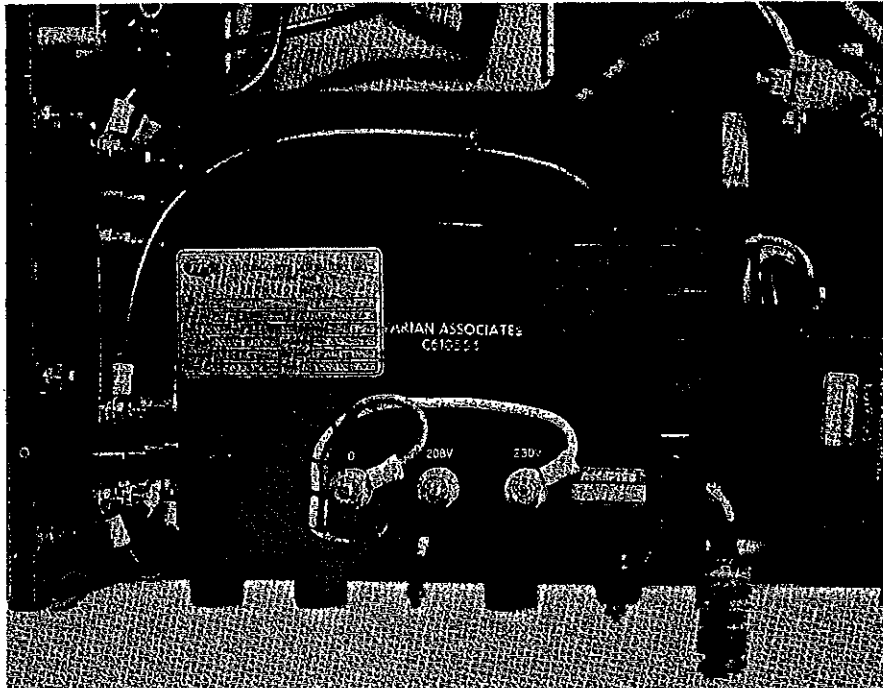


FIGURE 1. TRANSFORMER TERMINAL BOARD

A. POWER

The e-Gun Source Control Unit is set for operation with 230-volt, 50 or 60 cycle electrical input. To operate on 208-volt input, remove the top cover and change the connection on the transformer terminal board from the 230 V to the 208 V position.

Mount the e-Gun Source Control Unit in a standard rack.

WARNING
VOLTAGES USED IN THIS EQUIPMENT
ARE DANGEROUS. USE CAUTION DURING
OPERATION AND MAINTENANCE. ADHERE
STRICTLY TO GROUNDING PROCEDURES.



FIGURE 2. REAR PANEL

B. CONNECTIONS

1. One of three cable connectors -- depending upon the mode of operation -- must be inserted in the REMOTE CONTROL & RATE SIGNAL receptacle.
 - a. For control at the front of the unit, use the jumpered cable connector supplied.
 - b. To use the hand-held potentiometer, insert the cable connector from the hand-held potentiometer in this receptacle.
 - c. If a deposit rate controller is used, insert the rate controller cable connector in this receptacle. Refer to Section IV, C, and to the Schematic Diagram for proper cable connector pin wiring.

2. Connect the two 10-foot high voltage cables to the control unit receptacles (rear panel) labeled FILAMENT and to the e-Gun Source electrical feed-throughs.
3. Connect the two ground lugs, which are a part of the high voltage cables, and the braided chassis ground cable to the vacuum system - preferably at the same point. The vacuum system MUST be grounded to an earth ground. This is essential to prevent damage to transistors caused by voltage fluctuations.
4. Connect a water-flow interlock to the WATER INTERLOCK receptacle. A water-flow interlock MUST be used to insure that the e-Gun Source crucible is not damaged during operation. (Recommended: Hays "Shur-Flow," Part No. 2600-1011, 1/2 gallon per minute. This interlock will adapt to 1/2-inch, 1/4-inch and 3/8-inch pipe.)
5. A pressure switch should be connected in series with the water-flow interlock to prevent operation of the e-Gun Source when the vacuum system is at atmospheric pressure. Suitable pressure switches are: Ion Gauge Control Unit (Varian Model No. 971-0003) or a thermocouple gauge control with a relay.
6. A deposit thickness monitor may be connected in series with the water-flow interlock. See Section IV-D.
7. Insert the jumpered plug in the BEAM ADJUST receptacle if the beam adjust accessory will not be used. The beam adjust accessory may be connected here to vary the position of the electron beam impingement on the evaporation source.
8. Insert the input power plug into the electrical outlet.

SECTION IV

OPERATING INSTRUCTIONS



FIGURE 3. FRONT PANEL

A. OPERATION

1. Check that the e-Gun Source, sample, and substrate are in the desired position in the vacuum system.
2. Check that the high voltage cables and chassis ground cable are properly grounded to the vacuum system and that the system is connected to an earth ground. This is essential to prevent damage to transistors caused by voltage fluctuations.
3. BE SURE the pressure interlock is functioning properly. The control unit delivers 2 kw at 4 kv and exposure to a hot circuit could prove fatal.
4. BE SURE the water-flow interlock is connected and energized.

5. Pump the vacuum chamber to below 1×10^{-4} torr (mm Hg). At higher pressures there is a glow discharge when high voltage is applied to the e-Gun Source and it is inoperative, though undamaged.
6. Turn on the breaker labeled MAIN POWER. The amber light above it will go on ONLY if the water interlock (and/or the pressure interlock in series) is NOT energized.
7. Turn the EMISSION CURRENT knob counterclockwise to START and push the ON button. The HIGH VOLTAGE red light will glow, indicating that 4000 volts are applied to the e-Gun Source and it is ready for operation.
8. Slowly adjust the EMISSION CONTROL for evaporation of the source material. The meter should show full scale when the EMISSION CONTROL is set at 100. See Table I for some general evaporation characteristics. Note that the source-to-substrate distance used in the table is 10 inches.
9. To shut down:
 - A. Turn the EMISSION CONTROL knob to START.
 - B. Press the OFF button.

TABLE I
EVAPORATION CHARACTERISTICS

	Material	Power Level % of Full Power	Deposition Rate in A°/Minute at 10"
10 ⁻⁶ °C 812	Aluminum	100	800
	Al	80	240
		60	30
	Aluminum on Ta thermal isolation sheet; w/some alloying	60	9,000
		40	3,000
857	Copper	100	1,150
	Cu	60	215
		40	22
947	Gold	100	460
	Au	60	200
		30	25
1820	Molybdenum	100	2,000
	Mo	80	1,150
		70	1,000
		50	125
	Platinum	100	250
		70	200
		40	55
	Quartz	100	19,000
		60	8,000
		30	2,500
		20	1,300
	Sapphire	60	4,300
		20	250
1147	Silicon	100	2,000
		80	850
		60	600
	Tantalum	100	300
		78	250
1290	Tungsten	100	300
		60	3

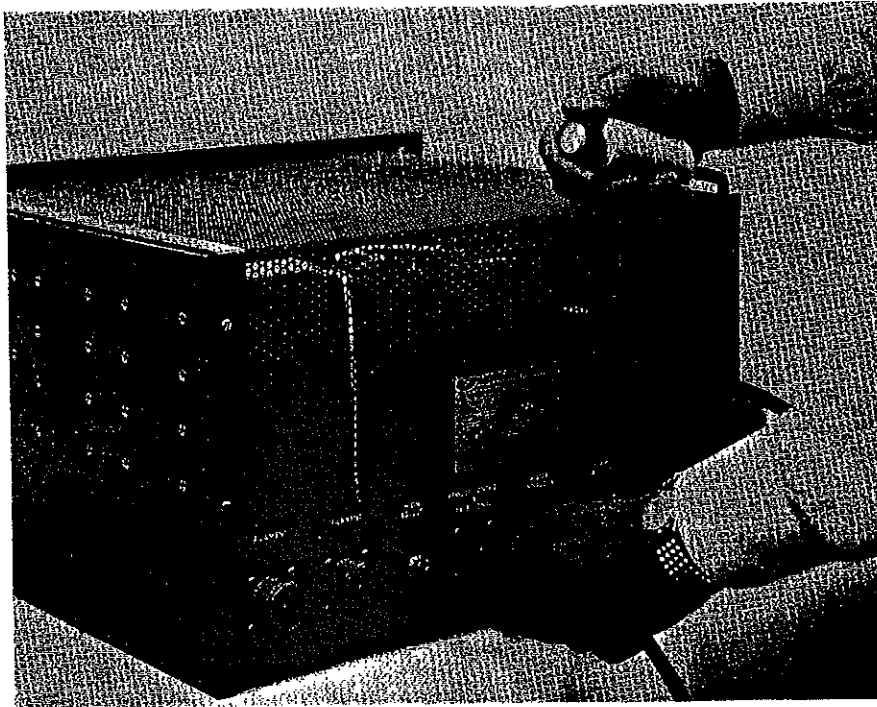
B. USE OF HAND-HELD POTENTIOMETER

FIGURE 4. HAND-HELD POTENTIOMETER

1. Go through OPERATION steps 1 through 5.
2. Substitute the cable plug of the hand-held potentiometer for the jumpered cable connector in the REMOTE CONTROL & RATE SIGNAL receptacle on the rear panel.
3. Set the hand-held potentiometer to 0, the start position. The start switch will click in the complete counterclockwise position.
4. Turn on the front panel breaker labeled MAIN POWER. The amber light above it will go on ONLY if the water interlock (and/or the pressure interlock, in series) is NOT energized.

OPERATING INSTRUCTIONS

5. Push the ON button. The HIGH VOLTAGE red light will glow, indicating that 4000 volts are applied to the e-Gun Source and it is ready for operation.
6. Slowly adjust the hand-held potentiometer for evaporation of the source material. The meter should show full scale when the potentiometer is set at 10. See Table I for some general evaporation characteristics.

C. USE OF DEPOSIT RATE CONTROL UNIT

Commercially available deposit rate controllers are compatible with this control unit. (Suggested: the Sloan Instrument Deposit Rate Control.)

1. The cable connector of the Deposit Rate Controller will probably have to be replaced by a Cannon connector (Cannon MS3106A-18-1P; Part P107A and P107B on the Parts List) to mate with the REMOTE CONTROL & RATE SIGNAL receptacle. If the e-Gun Source Control Unit will be used for some length of time with the Deposit Rate Controller, the P107A plug supplied can be modified and attached to the controller cable. Rewire the plug to conform to the wiring indicated on the schematic drawing: jumper A to C; connect two leads from the Deposit Rate Controller to I and J. Insert this modified Cannon connector into the REMOTE CONTROL & RATE SIGNAL receptacle.
2. Go through OPERATION steps 1 through 6.
3. Adjust the Deposit Rate Control unit to the desired evaporation rate using instructions supplied by the unit's manufacturer.

D. USE OF THICKNESS CONTROL MONITOR

1. Connect a deposit thickness monitor in series with the water-flow interlock to the WATER INTERLOCK receptacle.

2. Set the cut-off frequency on the deposit thickness monitor.
3. Operate the control unit either directly or with the hand-held potentiometer.

✓ E. USE OF BEAM ADJUST UNIT

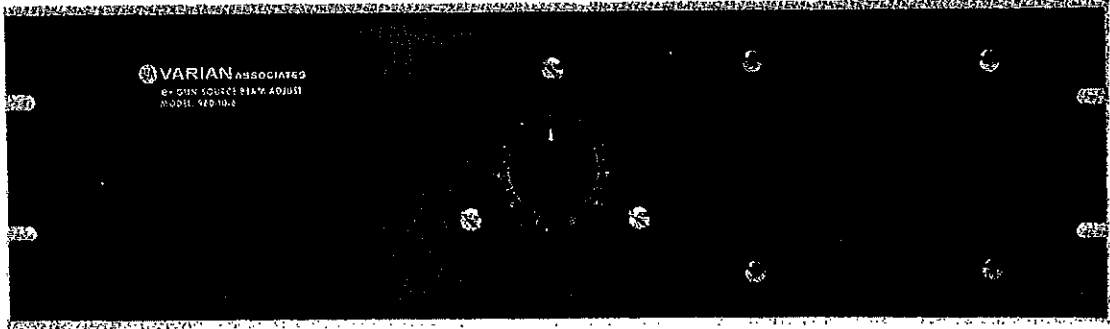


FIGURE 5. BEAM ADJUST

A Beam Adjust unit (Varian Model No. 980-1016) may be used to change the operating voltage and shift the target area of beam impingement. It is pre-set for operation with 230 volts, 50 or 60 cycles. To operate on 208-volt input, change the connection on the transformer from the 230 V tap to the 208 V tap.

1. Rack mount the Beam Adjust unit.
2. Remove the jumpered plug from the BEAM ADJUST receptacle on the rear panel of the control unit and connect the cable from the Beam Adjust unit.
3. The control on the Beam Adjust unit adjusts beam impingement approximately 1/8 inch at full power.

SECTION V

MAINTENANCE AND TROUBLE SHOOTING

A. MAINTENANCE

1. High Adjust

After the e-Gun Source filament is changed, the front panel meter may not register accurately. It should indicate full scale (500) when the EMISSION CONTROL knob is set at 100. If it does not, adjust the screw labeled HIGH ADJUST on the rear panel. Lock after proper setting.

2. Water-Flow Interlock

Periodically check the flow of water through the water-flow interlock. It is essential that this equipment be functioning normally whenever the e-Gun Source is in operation. Follow the maintenance procedure recommended by the manufacturer of the water-flow interlock. Install a screen upstream of the flow switch if the water supply line tends to clog.

B. TROUBLE SHOOTING

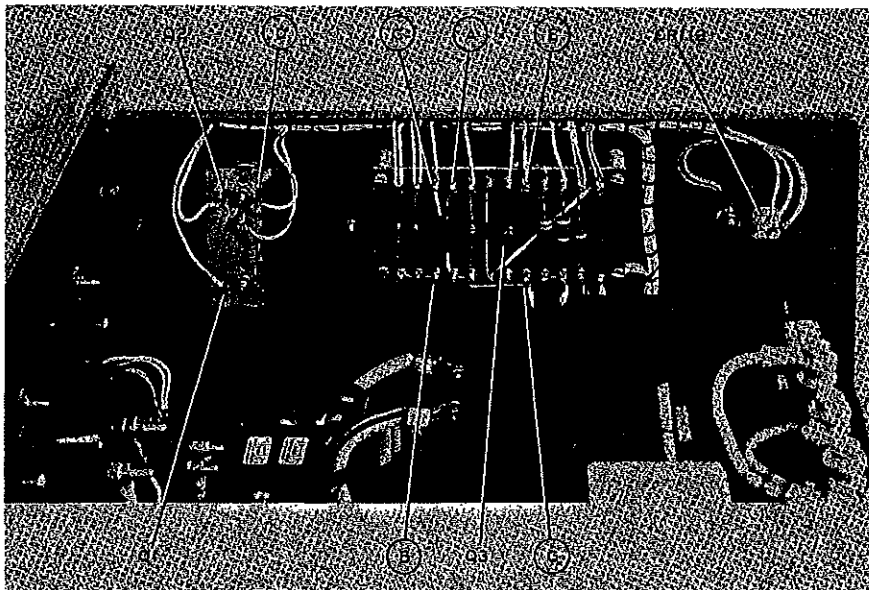


FIGURE 6. TERMINAL BOARD

NOTE

Disconnect all power sources before servicing.

Allow time for capacitance to discharge fully.

Refer to the Schematic Diagram for symbol designations.

SYMPTOM	POSSIBLE CAUSE	CORRECTION PROCEDURE
1. Circuit breaker trips.	Shorting or excessive arcing.	Turn EMISSION CONTROL to START. Reset the MAIN POWER breaker. Push the HIGH VOLTAGE ON button.
2. Beam not positioned correctly on e-Gun crucible.	Voltage too low.	Check connection at the power transformer. Input may be 208 volts rather than 230 volts.
3. No output.	Filament	<p>If filament is <u>not</u> on:</p> <ol style="list-style-type: none"> Disconnect power and remove P105 and P106. Check filament for continuity. If defective, replace filament. Check between J101 and J102 for transformer secondary continuity.
	Circuitry	<p>If filament was <u>on</u>:</p> <ol style="list-style-type: none"> Remove one lead from T102 power transformer primary to eliminate high voltage. Check filament control circuit with power on. With a volt-ohmmeter, check voltage across capacitor C102 (E in Figure 6). Voltage should be approximately 2 volts when EMISSION CONTROL is at 100. If there is no voltage at C102, check for 2.4 volts dc $\pm 10\%$ across CR111. If voltage is low, replace CR111. If voltage is correct, go to Step e below.

TROUBLE SHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTION PROCEDURE
No output (Cont.).		<p>d. If there is no voltage at CR111, check across pins 4-6 of T101 for 12 volts ac. If there is no voltage, check input power connections. CAUTION: There is voltage across the primary T101 as soon as the input circuit breaker CB101 is on, and before push buttons are energized.</p> <p>e. When CR111 voltage is correct, reconnect power, but remove one lead from the primary of the high voltage transformer T102. <u>Momentarily</u> clip a lead from the common base connection of Q101 and Q102 (D) to ground. See whether the filament goes on. (Do not prolong, or transistors and filament will be damaged.) If the filament goes on full, Q101 and Q102 are good and Q103 should be replaced. Also check for a short in CR113. If the filament is dim or does not go on, either or both Q101 and Q102 need replacement.</p>
4. Excessive filament power.	Q103 shorted.	Test and replace Q103.
5. WATER INTERLOCK light goes on.	Water-flow or pressure interlock not operating.	Check and adjust interlocks.
6 ✓ ON button does not turn unit on.	Loose or missing plug in rear panel REMOTE CONTROL & RATE SIGNAL receptacle.	Insert plug in REMOTE CONTROL & RATE SIGNAL receptacle.
	Switch S103 does not close.	✓ Replace potentiometer.

SYMPTOM	POSSIBLE CAUSE	CORRECTION PROCEDURE
7. Unit turns on but there is no high voltage.	Loose plug at rear panel BEAM ADJUST receptacle.	Tighten BEAM ADJUST plug.
		Check for ac voltage at terminal board of transformer primary and ac (5000 volt scale) at transformer secondary.
	Bad diodes CR101-104 CR105-108.	Check with power off and plug disconnected. Ohmmeter should show some resistance in one direction (depending on ohmmeter polarity) and infinite resistance in the other direction. Diodes are faulty if there is low resistance or high resistance in both directions. Replace bad diodes.
	One or more shorted diodes.	Replace faulty diodes.
	Short in capacitor C101	Check capacitor and replace if faulty.
	Open circuit resistors R101-R107.	If diodes show open, check resistors R101-R107 for an open circuit.

SECTION VI

PARTS LIST

e-GUN SOURCE CONTROL UNIT
MODEL 922-0020

SYMBOL NO.	DESCRIPTION	MFG. and CATALOG NO.	VARIAN PART NO.
C101	Capacitor 2 mfd, 10KVDCW	Chicago Cond. Corp. D-39	41-499 979
C102	Capacitor 50 mfd, 6VDCW	Sprague TVA-1103	41-506 755
C103	Capacitor 100 mfd, 25VDCW	Sprague TVA-1207	41-506 786
C104	Capacitor 0.01 mfd, 1KVDCW	Centralab DD 1032	41-279 898
CB101	Circuit breaker 20A, 250V, curve 5	Heinemann XAM33-20	71-639 936
CR101, 102, 103, 104, 105, 106, 107, 108	Silicon diode 10KV PIV (8)	Diodes, Inc. 1446-C # 45 ⁰³ 201	66-396 954
CR109, 110 113	Silicon diode 600V PIV (3)	Diodes, Inc. DI-56	66-396 950
CR111	Zener Diode 2.4V	Motorola 1/4M 2.4AZ10	66-395 003
CR112	Suppressor - Klipvolt	Sarkes-Tarzian S-236	43-599 890
DS101, 102, 103	Lamp - neon glow (3)	General Electric NE-51	67-449 999
XDS101	Lampholder - red lens	Dialight 135-408 1431	55-229 962
XDS102	Lampholder - clear lens	Dialight 135-408 1437	55-229 967
XDS103	Lampholder - amber lens	Dialight 135-408 1433	55-229 964
J101, 102	Connector-box mtg. (2)	Cannon MS3102A-18-420P	52-999 950
J103	Connector 10A, 250V	Hubbell 746B	51-432 990
J107	Connector-box mtg.	Cannon MS3102A-18-1S	53-211-810
J108	Connector-box mtg.	Cannon MS3102A-16S-8S	53-211 705
K101	Contactator 3 pole, size 0	A. H. Hegemann MVAA3000XXX	72-509 970
M101	Meter 0-500 MA D. C.	Weston 1941 (special)	
P101, 102	with connector-straight (2)	Cannon MS3106E-18-420S	53-965 991
P103	Connector 10A, 250V	Hubbell 7479	51-132 980
	Cable Assy. high voltage (2)	Varian Associates	B-612847

PARTS LIST (Cont.)

SYMBOL NO.	DESCRIPTION	MFG. and CATALOG NO.	VARIAN PART NO.
P104	with connector 20A, 250V	Hubbell 7311-G	51-133 980
P105, 106	with connector assy. (2)	Varian Associates	C-612846
P107A, 107B	Connector-straight plug (2)	Cannon MS3106A-18-1P	52-651 801
P108	Connector-straight plug (2)	Cannon MS3106A-16S-8P	52-611 705
	Cable Assy. - A.C. Line	Varian Associates	B-613060
Q101, 102	Transistor (2)	Delco 2N174	62-900 174
Q103	Transistor	RCA 2N1700	62-901 700
R101 thru 107	Resistor 100K-OHM 200W(7)		35-489 610
R108	Resistor 27K-OHM, 2W	Allen-Bradley HB-27000	34-402 527
R109	Resistor 100 OHM, 2W	Clarostat A43-100	37-595 310
R110, 116 S103, 104	Resistor-pot with Sw 100 OHM, 2W (2)	Clarostat 43-100S and AE-20SW	37-999 890
R111	Resistor 100 OHM, 2W	Allen-Bradley HB-100	34-402 310
R112	Resistor 33 OHM, 1/2W	Allen-Bradley EB-33	32-202 233
R113	Resistor 33 OHM, 2W	Allen-Bradley HB-33	34-402 233
R114	Resistor 1.5 OHM, 10W	Ward Leonard Type 10 XM	35-389 115
R115	Resistor 47 OHM, 2W	Allen-Bradley HB-150	34-402 247
S101	Switch - OFF black N.C.	Gray Hill 2202	71-219 961
S102	Switch - ON red N.O.	Gray Hill 2201	71-219 960
T101	Transformer - auto.	Varian Associates	C-612907
T102	Transformer	Varian Associates	C-610564
T103	Saturable reactor	Varian Associates	C-612908
T104	Transformer	Varian Associates	C-610565

BEAM ADJUST Model No. 980-1016

F201, 202	Fuse - 2 amps, 250V	Littelfuse 3AG, FAST BLO	67-133 420
P208	Connector - straight plug	Cannon MS3106A-16S-8P	52-611 705
T201	Transformer	Varian Associates	A-618275
VT201	Variable Transformer	Superior Electric 10B-2 Powerstat	44-179 985

SECTION VII

SERVICE INFORMATION

A. WARRANTY STATEMENT

The e-Gun Source Control Unit is warranted to be free of defects in materials and workmanship. The liability of Varian Associates under this warranty is limited to servicing, adjusting or replacing defective parts. This warranty is effective for one year after delivery and applies only when the unit is disclosed to be defective through no fault of the user, as determined by Varian Associates. If defects result from misuse or abnormal operating conditions, there will be a charge for repairs. Repair charges will be estimated and submitted for authorization before work begins.

B. FIELD SERVICE

Two service centers are staffed and equipped to provide prompt and thorough service throughout the United States.

Users east of the Mississippi River should contact:

Varian Eastern Service Center
Room 221
Greater Pittsburgh Airport
Pittsburgh, Pennsylvania
Tel: (412) 264-2545

Users west of the Mississippi River should contact:

Varian Western Service Center
Varian Associates
611 Hansen Way
Palo Alto, California
Tel: (415) 326-4000

Outside the United States, service engineers are available through Varian Associates' district offices.

Field service assistance covers:

1. **New installation assistance.** Engineering service is available during installation of vacuum systems to demonstrate proper operating techniques. No fee is charged for normal installation aid.
2. **Warranty.** Service is provided without charge to fulfill the provisions of Varian Associates' warranty.
3. **Special customer assistance.** Service, repair or maintenance will be provided upon request.

WARNING

Voltages developed in this unit are dangerous to life. Use caution during operation and maintenance. Adhere strictly to the grounding procedure given in the operating instructions.