OPERATING INSTRUCTIONS
THERMIONICS MODEL 150-0030
e-GUN CONTROL UNIT

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SECTION I
INTRODUCTION

Electron beam heating is an efficient and practical way of achieving temperatures in excess of 3500°C (6300°F). The TLI e-Gun™ electron beam evaporation source evaporates all materials, i.e. 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 use of a saturable reactor control system allows a uniform current from zero to 750 mA, thus allowing a thin film for optical coatings and vacuum metallurgical processes.
The e-Gun™ source control unit provides convenient single knob control. The gun control may be operated from the front panel of the supply, or may be operated at the vacuum chamber by use of a 12 foot hand held remote control unit. This allows a direct view of the "melt" in the crucible.

The unit can be wired for either 208 volts A.C. or 230 volts A.C. single phase input power at 30 amperes. Three safety interlocks are used to protect the e-Gun and operator as follows: (A) A water flow interlock interrupts operation if cooling water falls below 1/2 gallon per minute. (B) A pressure interlock interrupts operation if the vacuum system pressure rises above 1.0×10^{-5} Torr. (C) A cabinet door interlock disconnects power if the cabinet door is opened.

The following items are included in the purchase of this power supply.

1. One complete e-Gun™ source control unit.
2. Three 12 foot interlock cables.
3. Two High Voltage High Current cables.
4. One hand-held remote emission control unit with cable.
5. One beam-adjust dummy plug.

THE COVER TO THE SOURCE CONTROL UNIT IS NOT INTERLOCKED, AND REMOVAL OF THE COVER, WHILE THE POWER LINE IS PLUGGED INTO A HOT LINE, MAY RESULT IN A FATAL SHOCK.

6. One remote control unit dummy plug.
7. Three safety interlock dummy plugs.
8. One instruction manual.

SECTION II
SPECIFICATIONS

INPUT POWER	208 or 230 volts, 50 or 60 Hertz, single phase, 30 Amperes NOTE: Maximum input current is 23 Amperes during normal operation. The e-Gun™ source can draw line currents up to 30 Amperes during arcing. Arcing may result from a blown melt or a shorted filament.
HV OUTPUT	4 kv (negative) DC. NOTE: The voltage is not regulated and may vary from 1.5 kv to 2 kv above the normal operating 4 kv. The open circuit ("no load") voltage is in the range 4.5kV - 6 kV.
EMISSION OUTPUT	Variable 0-750 mA. NOTE: This current is controlled by controlling the heater current.
HEATER CURRENT	Varies between 0-6 volts, (0-25 Amperes).
EMISSION METER	0-750 mA, full scale: accuracy 2% of full scale.
INTERLOCK LEADS	Three 12 foot leads (SJO 16/2 cable). Lug connectors on one end and standard NEMA ML1-15 male plugs on the other end. 1. Water flow interlock. (This should be connected to a water flow switch which closes with a minimum set flow of 1/2 gallon per minute.) 2. Vacuum interlock. (This should be connected to a vacuum gauge controlled swtich which closes when the chamber pressure is below 1 x 10^{-5} Torr.) 3. Cabinet door interlock. (This should be connected to a micro-switch or relay which closes when the rack cabinet door is closed.). NOTE: Each interlock switch must handle 120 VAC at 1 Ampere.
HV HC LEADS	Two 10 foot H.V. co-ax leads. Grounded sheath.
REMOTE CONTROL	Hand held potentiometer and switch on 12 ft. lead.
RACK SPACE	Width—19 inches. Height—10 1/2 inches Depth—20 inches.
WEIGHT	Approximately 180 pounds.

SECTION III
INSTALLATION AND CONNECTION

A. POWER & MOUNTING

The e-Gun™ source control unit is USUALLY factory set for 230 volt, 50 or 60 Hertz electrical input, single phase. Alternate wirings are for 208 volts and 200 volts (for units to be used in Japan.) There is a label on the back of the unit with model number and other data which also shows the factory set input voltage. The value indicated can be double checked by examining the power plug which goes to the wall (or rack) outlet.. If the unit is wired for 230 VAC, then the wall plug is a standard NEMA L6-30P, which has three prongs. If the unit is wired for 208 VAC, then the wall plug is a standard NEMA L21-30P, which has five prongs. (Units for Japan are wired with the three prong NEMA L6-30P plug.)

The wall plug must be inserted into a properly matching receptacle. That is, a NEMA L6-30P plug must go into a locking 250V 30 ampere 2-pole 3-wire grounding NEMA L6-30R receptacle. Similarly a NEMA L21-30P plug must go into a locking 3 phase 120/208V 30 ampere 4-pole 5-wire grounding NEMA L210-30R receptacle.

NEMA plugs and receptacles are designed so that a wrong plug will not fit in the wrong receptacle. Unfortunately that does not prevent people from occasionally miswiring the receptacles. If you have any problems with the e-Gun™ source control unit, or suspect ahead of time that the outlet might be miswired, have a qualified electrician check the outlet.

It may happen that for one reason or another you end up with a power outlet and an e-Gun™ source control unit that do not match. There are then several options. First, you can have an electrician rewire the outlet. (This is not always possible. Some locations have 230 volt single phase power available, but no 120/208 volt three phase power, and some locations have 120/208 volt three phase power available, but no 230 volt single phase.) Second, you can contact Thermionics Laboratory, Inc. and discuss sending back the unit for rewireing. (This always means delay and may mean added expense.) Third, ***if you are qualified for high voltage work,*** you can rewire the e-Gun source control unit yourself.

To change the unit from 208VAC operation to 230VAC operation, or vice versa, two simple changes must be made. First, the plug has to be changed to match the available power outlet. In all cases, the green wire must connect to the grounding prong of the plug. This connection for this prong is identified with a green screw inside the plug. This grounding prong is the center one on the five wire NEMA L21-30P, and the large hooked one on the NEMA L6-30P. The black and white wires must be connected to X and Y in the NEMA L6-30P, and to any pair X-Y, Y-Z, or Z-X in the NEMA L21-30. (Do not use the W prong in the NEMA L21-30, this is for a neutral return line, to which each of X, Y, and Z is at 115VAC.) Whichever connection is used, it does not matter if the black and white wires are reversed. BE WARNED THAT BOTH ARE "HOT" WIRES. (Note: the National Electrical Code™ of the National Fire Protection Association, article 400-22 specifies for flexible cords that a conductor intended as a grounded circuit [neutral return line] shall be marked with white or gray, but does not specifiy

that a conductor marked with white or gray is necessarily a grounded conductor. Article 400-23 specifies, on the other hand, that a green or green with yellow stripes conductor shall only be used as a grounding conductor [chassis ground], but does not say that a grounding conductor is necessarily green or green with yellow stripes.)

When conversion is made from 208VAC to 230VAC input, or vice versa, one change is needed inside the e-Gun™ source control unit. **READ ALL OF THE WARNINGS AND CAUTIONS IN THIS MANUAL BEFORE CONSIDERING MAKING THIS CHANGE.** The change itself is simple: for 230VAC operation, the left most (looking at the transformer from the front of the unit) wire to the high voltage transformer T102 must be connected to the 230V stud (left most stud) and for 208VAC operation, this same wire must be connected to the 208V stud (middle stud).

Japanese units use the NEMA L6-30P plug, as described, but the 208V transformer connection.

The other transformers do not need reconnection. A prior version of this manual indicated that T101 had to be reconnected, but it has been found that this is not necessary, and the separate tap for 208V input on T101 has been eliminated.

When the proper connections have been made for the desired line voltage, mount the e-Gun™ source control unit in a standard 19" electronics rack.

B. CONNECTIONS — FRONT PANEL

Connection for the remote emission control receptacle (J107) depends on how the e-Gun™ emission is to be controlled. Three options are available. If emission is to be controlled at the front panel — insert the shorted plug P107 A into the receptacle. This bypasses control via cable. If emission is to be controlled using the remote emission control — insert plug P107 B, which is the plug on the end of the twelve foot long remote emission control cable, into the receptacle. This bypases control via the front panel. Finally, if a deposit rate controller is to be used, it will generally be necessary to wire a plug to the rate controller cable, and plug this connector into this receptacle. Refer to Section IV, Part C, and to the schematic diagram, for the proper cable connector pin wiring. Note: you may re-wire the shorted plug for this purpose if no other plug is available.

C. CONNECTIONS — REAR PANEL

1. With the main power line disconnected, connect the two 10 foot high voltage cables to the control unit receptacle at the left rear of the cabinet (filaments). Connect the other ends to the e-Gun source electrical feedthroughs at the vacuum chamber. These two cables are H.V. co-ax, and the sheath is terminated with pig-tails having standard grounding lugs. These lugs must be **securely grounded** to the vacuum chamber.

2. Connect the 12 foot braided grounding cable attached to the rear of the control chassis to the vacuum system. The vacuum system must itself be **GROUNDED TO AN EARTH**

GROUND. This is essential both for safety and to prevent the damage to transistors which can be caused by voltage transients.

PROPER GROUNDING, INCLUDING CONNECTION OF THE GROUNDING WIRES ON THE CABLES, CONNECTION OF THE BRAIDED GROUNDING CABLE TO THE CHAMBER, AND THOROUGH EARTH GROUNDING OF THE CHAMBER ITSELF, ARE ESSENTIAL TO THE SAFE OPERATION OF THE SYSTEM. DO NOT IGNORE THIS!

3. Connect one of the three interlock cables to the WATER interlock receptacle at the rear of the chassis. Connect the other end to a water flow interlock switch that is connected to the water lines which provide cooling water to the e-Gun™. (A water flow switch is available from Thermionics.)

4. Connect another of the three interlock cables to the VACUUM interlock receptacle at the rear of the chassis. Connect the other end to a vacuum interlock set to open when the system vacuum is above 1 x 10^{-5} Torr. The vacuum interlock must be supplied by the customer.

5. Connect the last of the three interlock cables to the DOOR interlock receptacle at the rea of the chassis. Connect the other end to a door micro-switch or any type of activated switch that will turn off the power when the rear door to the rack is opened. This switch must also be supplied by the customer.

NOTE: Installation and usage of interlock devices are left to the discretion of the customer. If more than three interlocks are desired, then any number of interlock switches may be wired in series external to the power supply and connected to any one of the interlock receptacles. If fewer than three interlocks are to be used, shorted plugs (three are provided) may be used in place of the interlock cables. Of course, *if an interlock is not used then the safety feature which would be provided by that interlock does not exist.*

6. A deposit thickness monitor may be connected in series with the water flow or vacuum interlock. See section IV-D.

7. A beam adjust (PS 180-1030) accessory may be installed in the right rear receptacle of the power chassis to vary the electron beam on the Y axix plus or minus approximately 1/8 inch. If this accessory is not desired, install the shorted plug (TLI part No. A-10039) into the beam adjust receptacle.

8. Install the input power plug into the proper power outlet. Make certain the power supply voltage matches the source voltage. (Power is either 208 volts, or 230 volts, single phase — 30 amperes, 200 volts for units in Japan.)

SECTION IV
OPERATING INSTRUCTIONS

A. OPERATION

1. Install the e-Gun™ source in the vacuum chamber according to the instructions in the Evaporation Sources Instruction Manual. Connect the water supply lines and make certain there is at least 1/2 gallon per minute water flow through the gun. The gun should feel cold to the touch. Make certain the water - flow switch is functioning properly. Connect the e-gun source filaments to the two H.V. feedthroughs. A good connection is made using no. 12 single strand bare copper wire. Stripping the cover from standard house wire is suitable. After the covering has been removed you can anneal the wire with a torch and then connections may be made without putting a stress upon the filament assembly.
Note: These connections must be made very carefully. Undue stress upon the filament assembly will cause misalignment and the system will not operate properly. When the wires are inserted into the small holes of the filament posts you must be careful not to place the wires too far into the holes. If the wires extend beyond the inner edge of the posts they will short to the gun body and cause a malfunction of the equipment. One of the power diodes may be damaged.

2. Make certain the two power conductors are connected properly to the supply chassis and the vacuum chamber. Check the ground connections to the vacuum chamber and the power supply. Make certain the vacuum chamber has a good earth ground.

THE POWER SUPPLY PUTS 4000 VOLTS ON BOTH OUTPUT POWER CABLES. THIS VOLTAGE CAN BE INSTANTLY FATAL. (THIS POTENTIALLY LETHAL VOLTAGE IS PRESENT ON THE CENTER PINS OF THE POWER SUPPLY FILAMENT CONNECTORS WHEN THERE IS NO CABLE CONNECTED.)

3. The e-Gun™ crucibles have approximately 2 c.c. capacity. Place the source material into the crucible. The material should be in solid form, if possible. If the source material is in small pieces or powder, then be very cautious when power is applied to the gun. Too much power too soon will cause the material to blow out of the crucible, then the beam will cut a hole in the crucible and water will enter the vacuum chamber. Apply enough current to allow the material to become a ball. Keep enough material in the crucible to prevent the beam from hitting any portion of the crucible. CAUTION: Do not apply more current to the e-Gun than is necessary for proper evaporation of the material. Example: if aluminum is begin evaporated, it will require approximately 150 m.a. If the evaporation point is exceeded by much more current than that,

you will blow the material out of the crucible and damage the gun.

4. Pump the vacuum chamber to below 1 x 10^{-5} Torr. Check the vacuum interlock to be certain it is functioning properly.

5. Verify that the the input power cord of the source supply is plugged into a power outlet of the proper voltage and current capacity.

6. Turn the main power breaker of the source control to the "ON" position. The white light above this breaker should go "ON". If either of the other two lights go "ON", turn off the main breaker at once. If the "amber" light goes on, that means one or more of the interlock receptacles at the rear of the chassis is not connected properly. Check these receptacles and their components and make any adjustments necessary. If the "red" light goes on that means the main power relay is being energized and high voltage may already be produced. *That is an error at this point.* Turn off the main breaker at once. Check the circuit and determine why the relay is being energized.

7. With the main power breaker "ON" and the "red" and "amber" lights "OFF" then proceed by turning the emission current knob counterclockwise to the start position. Push the "ON" button. The high voltage red light should *now* go "ON". This indicates you have -4,000 volts applied to the e-Gun™ source. The e-Gun™ should be ready for operation.

8. The numbered range (0 - 100) on the emission control knob is a relative range and is not the actual current applied to the e- Gun. Because of the way the control circuit is built, there is a logarithmic relationship between control voltage and actual emission current. This results in a broad control band from 0 - 50, and a narrow control band from 50 to 100. The coarse emission control located on the left rear of the chassis works in conjuction with the fine control on the front of the panel. Normally the coarse control is factory set so that 100 on the front control results in a current of approximately 750 m.a. (full scale on the meter). If only low current materials are to be evaporated, (aluminum, chrome, gold, etc.), range (0 -450 m.a.) then it is a good idea to set the coarse range to 500 m.a. f.s. This will prevent serious problems if the emission dial is turned up to 100% by mistake. (Looking at the coarse control from the rear of the chassis, C.C.W. lowers the current range and C.W. raises the current range.)

Table 1 Evaporation Characteristics
Deposition Rate in Å / Minute at 100%

Material	Rate	Material	Rate
Aluminum	1260	Nickel	2250
Copper	1220	Tungseten	590
Gold	1550	Palladium	750
Tantalum	435	Silver	3000
Molybdenum	2290		

All measurements were taken with the substrate 10 inches (25.4 cm) directly above the crucible, in a vacuum of about 10-6 Torr. Each material was evaporated at the maximum power practical for the sample used. For example, aluminum at approximately 350 m.a., tungsten at approximately 700 m.a.

Due to the voltage variance of different localities, purity of the source material, degree of vacuum, (which may vary from 1 x 10^{-5} Torr 1 x 10^{-9} Torr) etc. it is impossible to make a chart for the actual current requirement of each material.

9. During the first evaporation run on a new material, a shutter should be used to protect the substrate from splatter and gaseous outbursts. (Very few materials are pure enough to be melted the first time without some splatter). This is especially true with powders and small pieces.

10. The most effective distance from the source-to-the-substrate is approximately 10 inches. This allows the evaporant to spread out into an even "fog". The coating will be more uniform and the thickness may be regulated better.

11. Once the preceeding adjustments are all made, the unit is ready to evaporate material. Slowly adjust the emission control. If a specific thickness is desired, a deposit thickness monitor should be used to watch the rate of deposit, and the thickness of the resulting film. Continue the evaporation until the deposit thickness monitor indicates the desired thickness.

12. To shut down: FIRST turn the emission control knob to start. THEN press the OFF button, turn breaker to OFF. CAUTION! Except in an emegency (such as sudden gas in the chamber) NEVER push the off button while current is being supplied to the e-Gun™. If the power supply is turned off while emission current is still being applied, the resulting spike will almost certainly damage the power transistors.

B. USE OF REMOTE EMISSION CONTROL

1. Initial procedures, up to but not including turning on the control unit, are the same. Refer to operation steps 1 through 5.

2. Substitute the cable plug of the remote emission control handset for the jumpered cable connector in the remote control & rate signal receptacle on the front panel.

3. Set the hand-held potentiometer to 0, the start position. The start switch built into the handset will click off in the complete coutnerclockwise position.

4. Turn on the front panel breaker labeled main power. The amber light will go on only if the water interlock (and/or the pressure interlock) is not energized.

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 1 for some general evaporation characteristics.

C. USE OF DEPOSIT RATE CONTROL UNIT

1. A deposit rate control unit measures the thickness of the film deposited and produces an output voltage which increases when the deposit rate is to be increased, and decreases when the deposit rate is to be decreased. Deposit rate controllers compatible with the 150-0030 e-Gun™ Source Control unit are commercial available. To be compatible, the deposit rate controller must produce a control output voltage of zero to negative nine volts DC, with the negative nine volts indicating to the e-Gun™ Source Control that

maximum power is requested.

Most rate controllers provide a differential voltage output on screw terminals, rather than a cable compatible with the 150-0030 e-Gun™ Source Control. If such a controller is to be used, obtain the necessary length of two conductor cable (e.g.16 gauge 2 conductor junior service cord (oil resistant): 16/2 SJO), and a circular connector plug to fit the remove emission control socket (e.g. Amphenol MS3106A-1P) If the e-Gun source control unit will be used for some length of time with the deposit rate controller, the P107A plug supplied as the shorted plug, can be modified and attached to the controller cable. (Alternatively, the Remove Emission Control Cable can be rewired, removing the Remove Emission Control Handset.) Rewire the plug to conform to the wiring indicated on the schematic drawing: jumper A to C; connect two leads from the deposit rate controlelr to I and J. Insert this modified connector into the Remote Emission Control Receptacle. *NOTE: THE COMMONEST ERROR MAKING THIS HOOKUP IS TO REVERSE THE LEADS SO THAT THE e-GUN CONTROL UNIT GETS ZERO TO POSITIVE NINE VOLTS INSTEAD OF ZERO TO NEGATIVE NINE VOLTS. IF THAT MISTAKE IS MADE, NOTHING HAPPENS.*

2. Go through operation steps 1 through 6.

3. Adjust the deposit rate control unit to the desired evaporation rate using the instructions provided with the deposit rate control unit.

D. USE OF THICKNESS CONTROL MONITOR

1. A deposit thickness monitor measures the thickness of the film deposited and simply turns off a switch when the deposit has reached the right thickness. To use such a unit with the 150-0030 e-Gun™ Control Unit, wire the switch in series with one of the interlock controls.

2. Follow the instructions for the deposit thickness control to set the thickness at which the power will cut off..

3. Operate the control unit either directly or with the Remove Emission Control Unit.

E. USE OF THE BEAM ADJUST UNIT

The Beam Adjust Unit is an accessory may be used in conjunction with the e-Gun™ source control unit. The Beam Adjust Unit will move the beam along the "Y" axis of the crucible approximately ±1/8 inch across the "X" axis center line. This adjustment allows the user to utilize more of the source material without breaking the vacuum of the system to add more material to the crucible. This is important when time is valuable and the source material is a precious metal such as gold. The beam adjust unit is TLI Model No. 180-1030. Directions for installation and operation are in the Beam Adjust operating manual.

Another unit now available for the same purpose is the TLI 180-8383 Beam Sweep, which utilizes separate magnetic coils at the e-Gun™ to move the beam.

SECTION V
MAINTENANCE AND TROUBLE SHOOTING

A. MAINTENANCE

1. One of the most common problems encountered during the e-Gun evaporation of materials is an apparent limitation of emission current to 500 MA or less. This apparent problem is almost always due to improper alignment of the e-Gun filament assembly. The e-Gun is factory adjusted and should be ready for use as received. However, it is well worth the time to go through the adjustment procedure before the first operation since the equipment can go out of alignment during the shipping process by virtue of its being handled by untrained people. Improper alignment may also happen when a filament is replaced. To avoid frustration and wasted time, follow these procedures.

(A) As soon as the e-Gun evaporation source is received in the area in which it is to be used, check the gun for visual damage and then check the filament assembly as per the e-Gun evaporation source instruction manual.

(B) Follow this same procedure when removing an old filament and installing a new one.

2. Procedure for correlating the full scale (f. s.) meter reading with the 100% emission control index

THIS UNIT PUTS 4000 VOLTS ON THE HIGH VOLTAGE OUTPUT LINES. THIS VOLTAGE CAN BE INSTANTLY FATAL. IF THE COVER IS REMOVED SO THAT CHANGES CAN BE MADE, THIS VOLTAGE IS EXPOSED. WHEN THE POWER SUPPLY IS TURNED OFF, THIS 4000 VOLTS WILL REMAIN UNTIL THE BLEEDER RESISTORS DRAIN THE INTERNAL HIGH VOLTAGE CAPACITOR. THIS MAY TAKE SEVERAL MINUTES, BUT DO NOT TRUST ANY LENGTH OF TIME TO BE SUFFICIENT, GROUND THE CABLES WITH AN INSULATED HIGH VOLTAGE PROBE. CONNECTION, DISCONNECTION, OR OTHER HANDLING OF THIS CABLE SHOULD ONLY BE ATTEMPTED BY PERSONS FAMILIAR WITH HIGH VOLTAGE TECHNIQUES

(A) Load the e-Gun crucible with tungsten.

(B) Turn the "coarse emission control" at the left rear of the source control chassis fully counter-clockwise.

(C) Start the evaporation of the tungsten and turn the fine emission control knob on the front panel to 100%

(D) Have someone watch the front panel meter, then slowly adjust the "coarse" emission control potentiometer clockwise until the front panel meter indicates 750 m.a. Lower the front emission control knob to zero. Lock the coarse control with the locking nut being careful not to change the new setting.

3. If the evaporation equipment is used daily you should make the following equipment checkes each morning.

(A) Check the grounding on **ALL** parts of your system.

(B) Check all three interlocks, i.e. water-flow, vacuum, and electrical safety cabinet switches. (It is advisable to install a visual water-flow indicator in the return line of the e-Gun source equipment. You can then tell at a glance that you have a good water flow.

TROUBLE SHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	TEST PROCEDURE
1: Circuit breaker trips	Shorting or excessive arcing in chamber.	Turn emssion control to start. Reset the main power breaker. Push the high voltage on button.
2: Circuit breaker trips repeatedly.	Short in cable or chamber.	Turn off the power, disconnect the H.V. conductors at the power supply. (**SEE WARNING ABOVE.**) Turn on power supply. If the breaker does not trip, there is a short in the cable or chamber. Check chamber, and/or replace cable.
2a: ...chamber and cables are O.K.	Defective high current relay (K101).	Examine and try replacing high current relay.
2b: ...high current relay is O.K.)	Defective circuit breaker (CB101)	Replace circuit breaker.
2c: ...breaker is O.K.	Internal short in power supply.	Examine power supply for obvious shorts, call factory.
3: Beam not positioned correctly on e-Gun crucible.	Power supply input voltage too low.	Check connection at the power transformer. Input may be 208 volts rather than 230 volts.
3a: ...input power checked O.K.	e-Gun magnets reversed, or incorrect shims instaled.	Refer to e-Gun Operating Instructions for complete procedures.
4: No output, e-Gun™ filament does not come on.	e-Gun filament broken.	Disconnect power and remove P105 and P106. Check filament for continuity. If open, replace filament.

SYMPTOM	POSSIBLE CAUSE	TEST PROCEDURE
4a: ... filament O.K.	Transformer broken.	Disconnect power Check between J101 and J102 for transformer secondary continuity.
5: No output, but e-Gun™ filament does come on.	Circuitry	A. Remove one lead from T102 power transformer primary to eliminate high voltage. B. Check filament control circuit with power on. With a volt-ohmeter, check voltage across capactior C102. This voltage should be approximately 2 volts when emission control is at 100.
5a: ...no voltage across C102.		Check for 2.4 volts DC 10% across CR111.
5a1: ...voltage across CR111 is low, but not zero.	Bad diode	Replace CR111.
5a2: ...voltage across CR111 is zero.	Input power connections	Check across pins 4-6 of T101 for 12volts AC. If there is no voltage, check input power connections.

THERE IS VOLTAGE ACROSS THE PRIMARY T101 AS SOON AS THE INPUT CIRCUIT BREAKER CB101 IS ON, AND BEFORE PUSH BUTTONS ARE PRESSED.

SYMPTOM	POSSIBLE CAUSE	TEST PROCEDURE
5a3: ...voltage across CR111 is correct.	Bad transistor (Q301, Q302, or Q303)	Remove one lead from the primary of the high voltage transformer T102, then reconnect power. Momentarily clip a lead fron the common base connection of Q301 and Q302 to ground. See whether the filament goes on. (Do not prolong, or transistors and filament will be damaged.)
5a3a:...filament turns on at full power (glows brightly).	Bad transistor Q103 (Possible shorted CR113 as well)	Replace Q103. Also check for a short in CR113.
5a3b:..filament off or dim.	Bad transistor Q101 and/or Q102.	Replace Q101 and or Q102.
4: Excessive filament power (filament too bright, burns out too soon)	Q103 Shorted	Test and replace Q103.
5: Interlock lightgoes on.	Interlock condition failed. (I.e. water flow stopped, chamber lost vacuum, cabinet door open.)	Check and adjust interlocks
5a: ...all interlocks o.k.	Interlock plugs loose.	Check interlock plugs.
6. On button does not turn unit on.	Loose or missing plug in front panel Remote Emission Control receptacle.	Insert or tighten plug.
6a: ...plug o.k.	Switch S103 faulty.	Switch S103 and potentiometer R110 are one unit. Try replacement , or try using Remote Emission Control unit.

SYMPTOM	POSSIBLE CAUSE	TEST PROCEDURE
7: Unit turns on, but here is no high voltage.	Loose plug at rear panel Beam Adjust receptacle.	Tighten Beam Adjust plug.
7a: ...Beam Adjust plug tight.	Bad diode CR111, CR112, CR113, or CR114.	Check with power off and plug disconnected. Ohmeter should show some resistance in one direction (depending ohmeter polarity) and infinite resistance in the other direction.
7b: ...diode high in both directions, or low in both directions, but not open.	Bad diode(s).	Replace all bad diodes.
7c: ...any diode open.	Bad diode(s) and open circuit resistor R101, ..., or R107.	Check resistors with ohmeter, replace diodes and resistors.
7b: ..diodes o.k.	High Voltage transformer miss-connected or not working.	Check for AC voltages at transfomer primary (230VAC or 208VAC) and secondary (5000 volts!)
7c: ...transformer o.k.	Short in capacitor C101	Check capacitor and replace if faulty.

WARRANTY STATEMENT

Thermionics warrants each item it manufactures to be free from defects in workmanship and material for a period of one year from date of shipment. Minor deviations which do not affect the performance of the equipment shall not be deemed to constitute defects of workmanship or materials, or a failure to comply with the specifications.

Notwithstanding the foregoing, Thermionics shall have no warranty responsibility for expendable items such as vacuum tubes, diodes, transistors, batteries, lamps, mechanical pump shaft seals and oil, diffusion pump oil, gaskets, or filaments. In addition, all vacuum gauge sensing devices such as thermocouple tubes, Pirani tubes, ionization gauge tubes, etc. are warranted against defects in manufacture in normal use, as determined be seller's inspection, for a period of ninety (90) days from date of shipment, provided the defective gauge tube is returned to the seller's plant for inspection.

Equipment made or modified to Purchaser's specifications on special orders shall carry the above warranties with respect to material and workmanship, but shall be specifically excluded from any other warranties, express or implied, including those related to performance specifications, and any special components manufactured by others shall carry only the original manufacturer's warranties.

This warranty does not extend to any Thermionics products which have been subject to misuse, neglect, accident, or improper application, nor shall it extend to units which have been substantially altered outside the Seller's plant except by a Thermionics service engineer.

This warranty is expressly in lieu of all other obligations or liabilities on the part of Thermionics unless such additional warranty is either agreed to in writing, appears in a separate warranty statement provided to the customer, or appears in a warranty statement accompanying the product shipped to the customer. Under no circumstances will Thermionics be liable for consequential or resulting loss or damage, whether or not due to causes covered by Thermionics' warranty. Thermionics neither assumes nor authorizes any other person to make any other representation or warranty on its behalf, or to assume for it any liability in connection with the sale of its products.

WARRANTY REPAIR

Notice of any claim that a product is in any way defective shall be given to Thermionics immediately upon discovery. Before any items are returned for repair and/or adjustment, approval of Thermionics must be obtained by the customer. Written authorization for the return and instrucions as to how these items should be shipped will be provided. If any Thermionics products must be returned to the factory, they must be sent prepaid via the means of transportation indicated as being acceptable in the written authorization. Thermionics reserves the right to reject any warranty claim on any product that has been shipped by a nonacceptable means of transportation.

When Thermionics products are returned for examination and inspection, it is important that they be properly packed for shipment. Use the original packing material or the equivalent. The sender and the shipping agency must assume the responsibility for damage resulting from improper packing or handling, and for loss in transit.

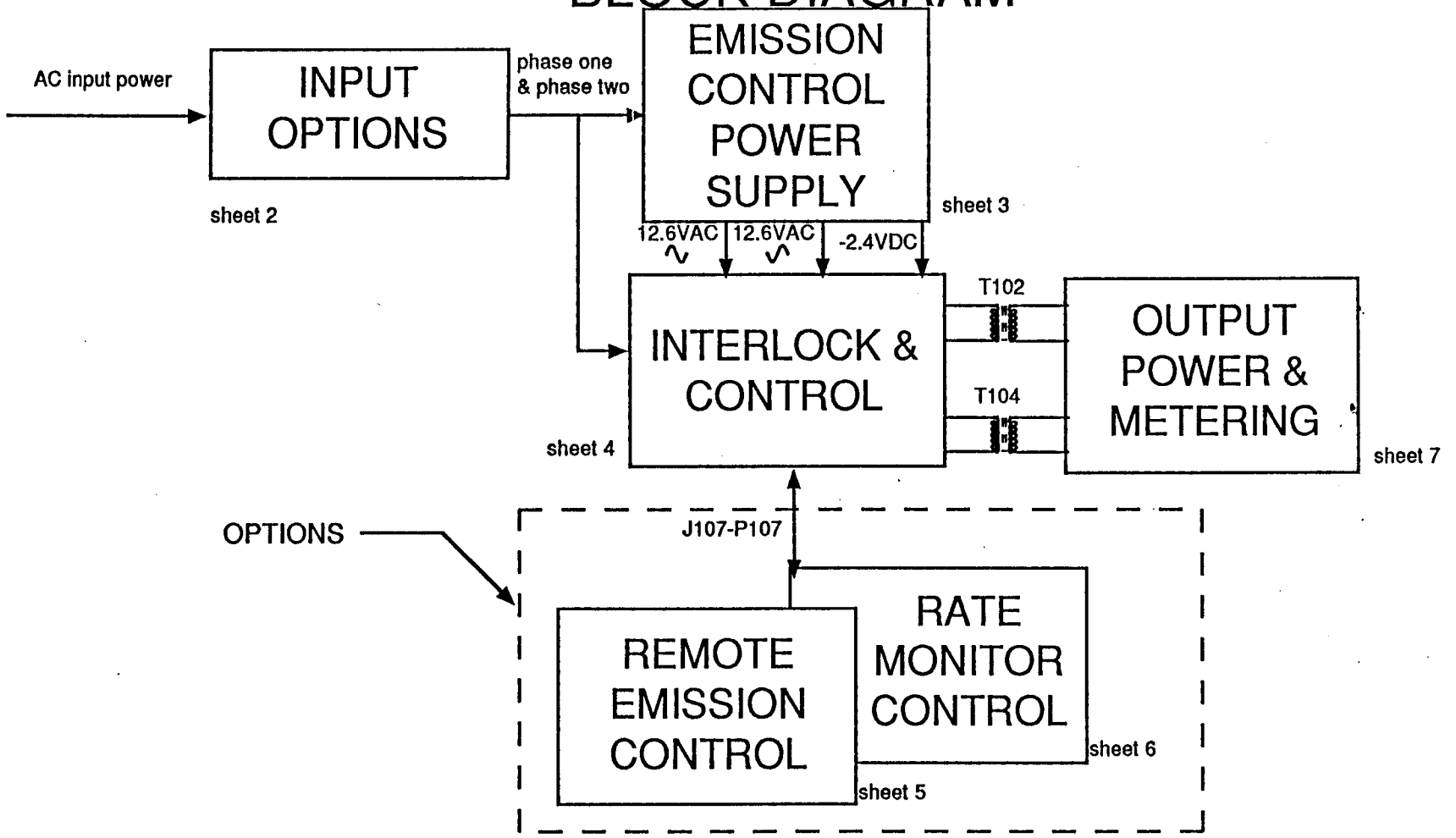
When products are returned, it is very important that the customer provide Thermionics with the data on operating conditions and any other pertinent information which will enable us to determine the cause of failure. In all cases, Thermionics has sole responsibility for determining the cause of failure, and sole discretion in determining the nature and extent of adjustment, if any, to which a customer may be entitled.

If it is found that our product has been returned without cause and is still serviceable, the customer will be notified and the product returned. All shipping costs on products returned for warranty repair shall be the customer's responsibility. Thermionics' sole liability hereunder shall be the correction and/or replacement of defective materials and workmanship.

Thermionics Laboratory, Inc.
P.O. Box 3711
22815 Sutro St.
Hayward, California 94541

(415) 538-3304

BLOCK DIAGRAM



ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

	DRAWN	TAM 07/31/89
	DESIGNER	
	CHECKED	
	APPROVED	
NEXT ASSEMBLY	RELEASED	
EXCEPT AS NOTED	MATERIAL: N/A	
SURFACE FINISH 63 ✓ / FRAC ±.015, .XX ±.010, .XXX ±.005 / ANGLES ± 1/2°	FINISH: N/A	
DO NOT SCALE DRAWING		

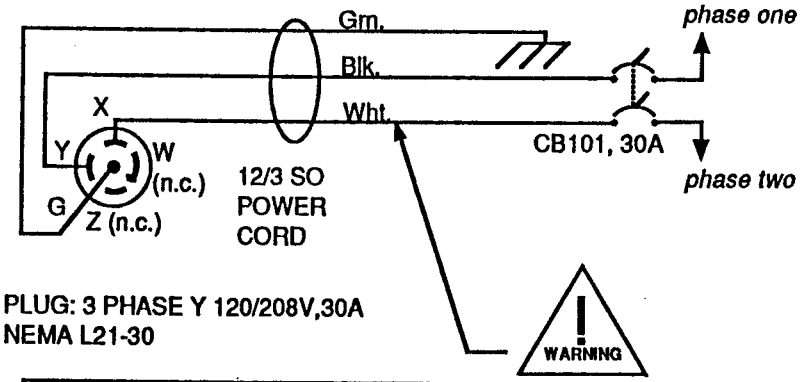
thermionics laboratory, inc.

150-0030 SCHEMATIC

A	925-712135	REV —

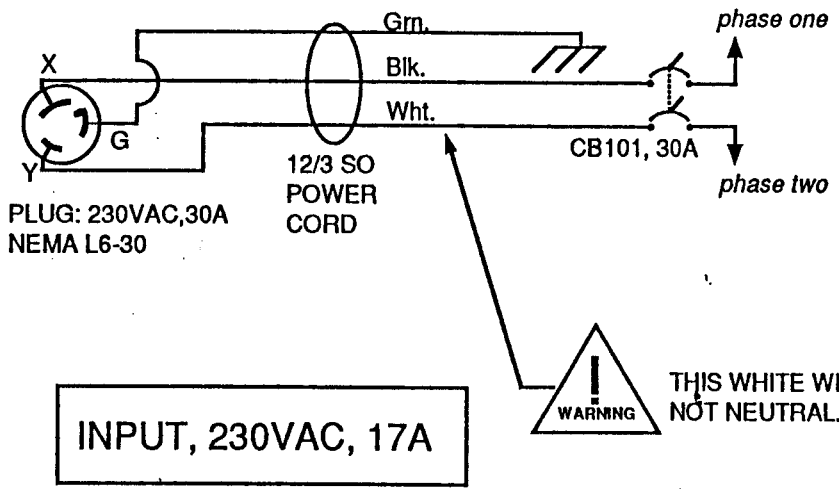
SCALE NONE SHEET 1 OF 7

INPUT OPTIONS



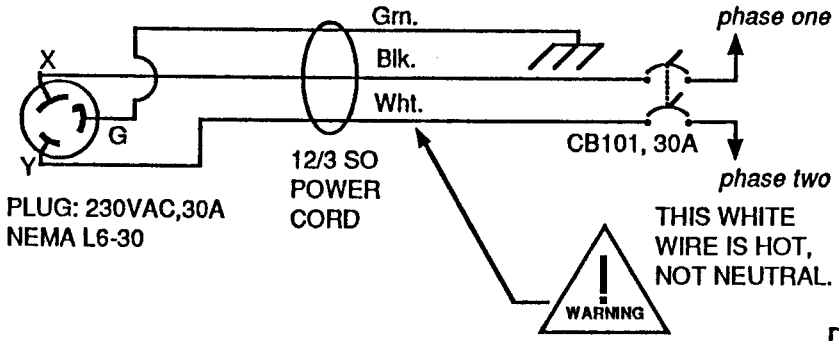
PLUG: 3 PHASE Y 120/208V,30A
NEMA L21-30

INPUT, 208VAC, 19A



PLUG: 230VAC,30A
NEMA L6-30

INPUT, 230VAC, 17A



PLUG: 230VAC,30A
NEMA L6-30

INPUT, 200VAC, 20A (JAPAN)

PHASE ONE, PHASE TWO, AND MIDPHASE

For each of the power input options, *phase one* and *phase two* are specified only as being AC power such that the difference between the two is as indicated in the box. Neither is specified as to voltage to ground.

Midphase, as used in this schematic, refers to a point tied to the middle of the primary on T101. This point is therefore approximately 115VAC from *phase one* and *phase two* for the 230VAC input power option, 104VAC from *phase one* and *phase two* for the 208VAC input power option, and 100VAC from *phase one* and *phase two* for the 200VAC input power option.

ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

	DRAWN	TAM 07/31/89
	DESIGNER	
	CHECKED	
	APPROVED	
NEXT ASSEMBLY	RELEASED	
EXCEPT AS NOTED	MATERIAL: N/A	
SURFACE FINISH 63 ✓ / FRAC ±.015, .XX ±.010, .XXX ±.005 / ANGLES ± 1/2°	FINISH: N/A	
DO NOT SCALE DRAWING		

thermionics laboratory, inc.

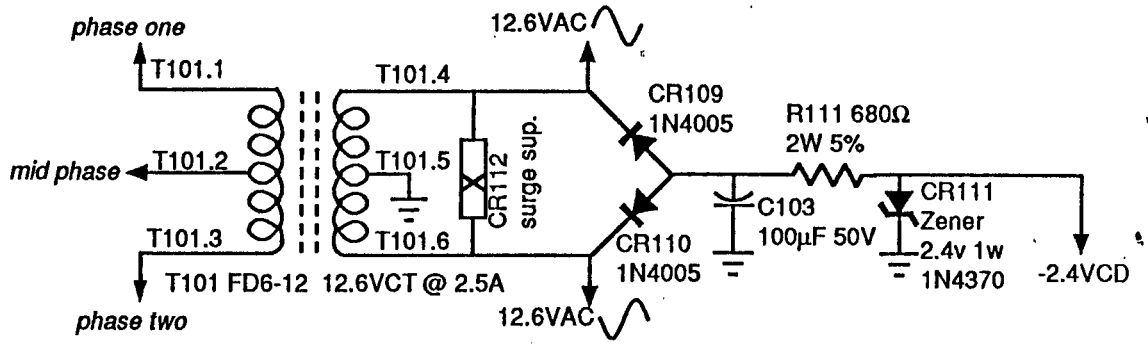
150-0030 SCHEMATIC

A	925-712135	REV —

SCALE NONE

EMISSION CONTROL POWER SUPPLY

NOTE: *phase one, mid phase,* and *phase two* are defined on the Input Options page of this schematic.



T101 connections schematic desig.	mfr's desig.
T101.1	1
T101.2	2&4
T101.3	5
T101.4	6
T101.5	8
T101.6	10

ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

	DRAWN	TAM 07/31/89
	DESIGNER	
	CHECKED	
	APPROVED	
NEXT ASSEMBLY	RELEASED	
EXCEPT AS NOTED	MATERIAL: N/A	
SURFACE FINISH 63 ✓ / FRAC ±.015, .XX ±.010, .XXX ±.005 / ANGLES ± 1/2°	FINISH: N/A	
DO NOT SCALE DRAWING		

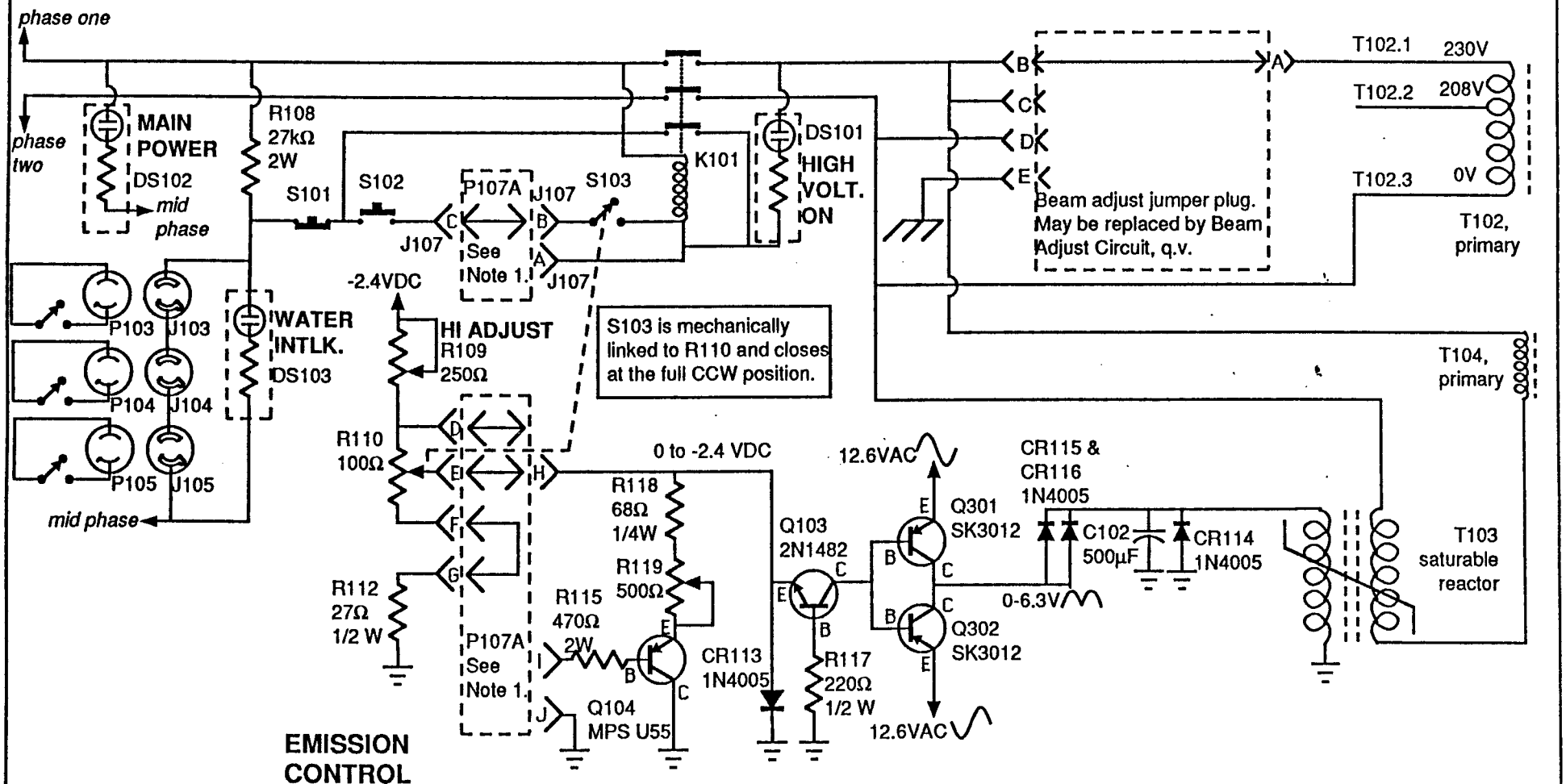
thermionics laboratory, inc.

150-0030 SCHEMATIC

A	925-712135	REV —

SCALE NONE SHEET 3 OF 7

INTERLOCK & CONTROL



ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

Note 1: J107 is shown here with P107A, which provides local emission control from the front panel. Other plugs, which provide for Remote Emission Control or Rate Monitor Interface are detailed on the Remote Emission Control Page of this schematic.

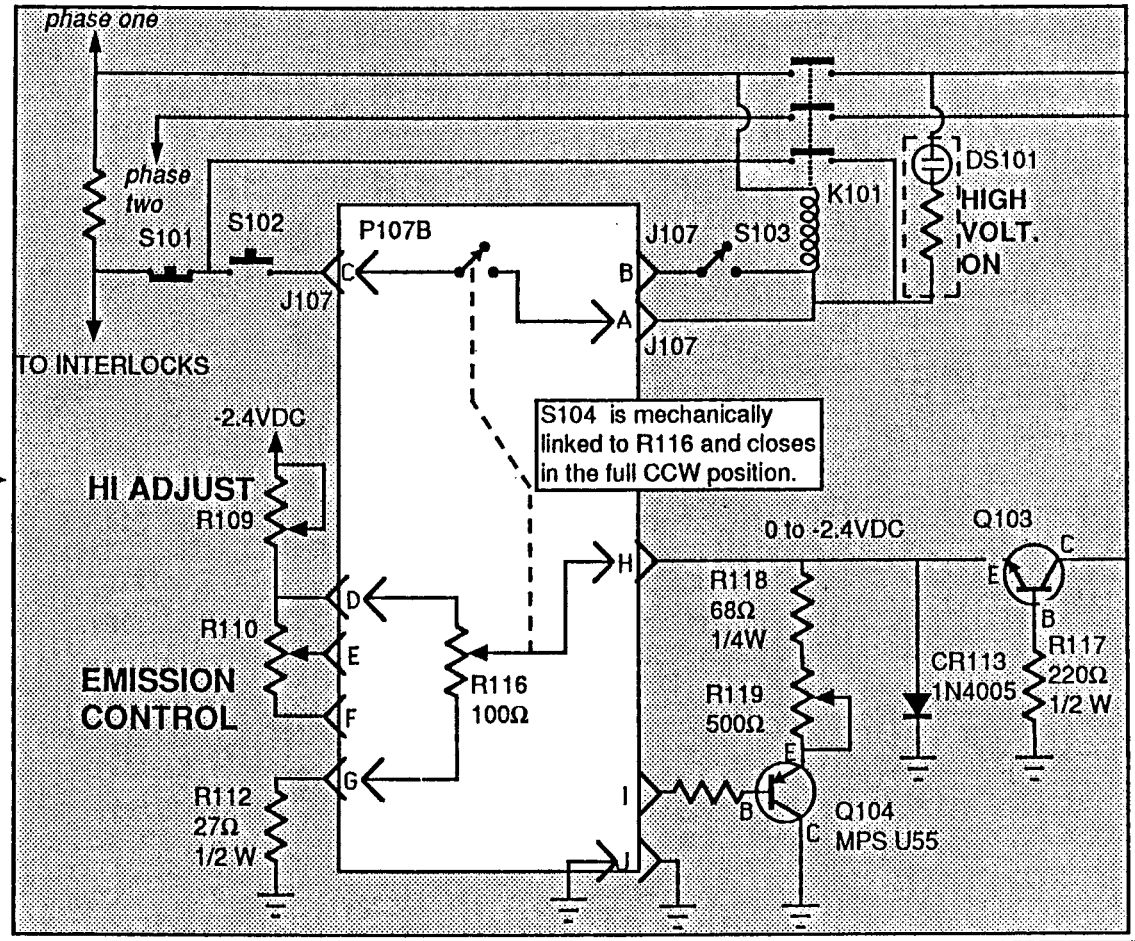
DRAWN	TAM 07/31/89
DESIGNER	
CHECKED	
APPROVED	
RELEASED	
NEXT ASSEMBLY	
EXCEPT AS NOTED	
SURFACE FINISH 63 ✓	FRAC ±.015, .XX ±.010, .XXX ±.005 — ANGLES ± 1/2°
DO NOT SCALE DRAWING	
MATERIAL: N/A	
FINISH: N/A	

thermionics laboratory, inc.

150-0030 SCHEMATIC

A	925-712135	REV —
SCALE NONE	SHEET 4	OF 7

REMOTE EMISSION CONTROL



GRAY AREA SHOWN FOR REFERENCE ONLY. ACTUAL SCHEMATIC ON SHEET 4.

ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

Note 1: J107 is shown here with P107B, which provides remote emission control via cable. R116 substitutes for R110 (the later is bypassed, and S104 substitutes for S103 (the later is bypassed.)

NEXT ASSEMBLY		
EXCEPT AS NOTED		
SURFACE FINISH 63 ✓	FRAC ±.015 .XX ±.010 .XXX ±.005	ANGLES ± 1/2°
DO NOT SCALE DRAWING		

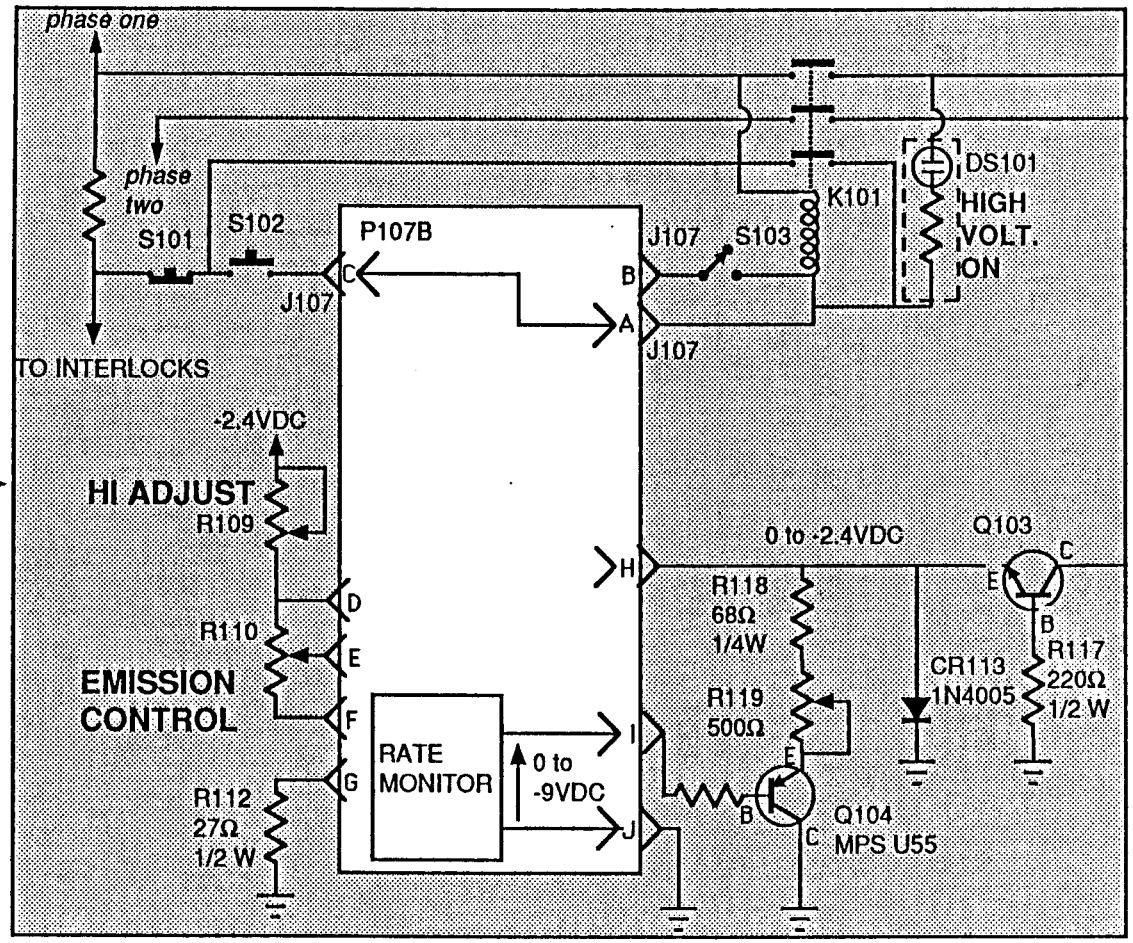
DRAWN	TAM 07/31/89
DESIGNER	
CHECKED	
APPROVED	
RELEASED	
MATERIAL: N/A	
FINISH: N/A	

thermionics laboratory, inc.

150-0030 SCHEMATIC

A	925-712135	REV —
SCALE NONE	SHEET 5	OF 7

RATE MONITOR CONTROL



GRAY AREA SHOWN FOR REFERENCE ONLY. ACTUAL SCHEMATIC ON SHEET 4.

ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

Note 1: J107 is shown here with P107C, which provides for control of the e-Gun™ by a rate monitor. Note that pin I must be negative with respect to pin J to produce emission. Most commercial Rate Monitors have floating outputs which can indeed be so connected.

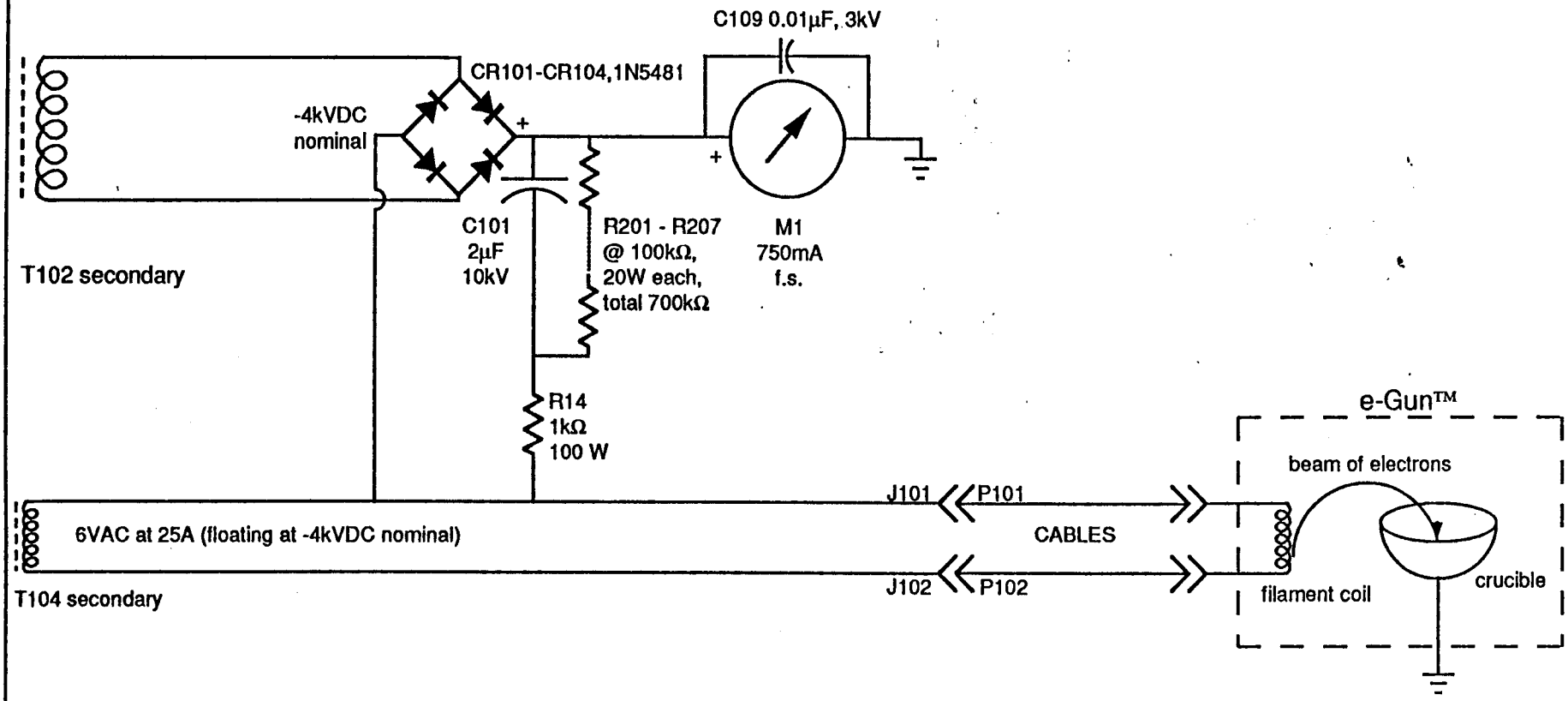
DRAWN	TAM 07/31/89
DESIGNER	
CHECKED	
APPROVED	
RELEASED	
NEXT ASSEMBLY	
EXCEPT AS NOTED	
SURFACE FINISH 63	FRAC ±.015, .XX ±.010, .XXX ±.005 / ANGLES ± 1/2°
DO NOT SCALE DRAWING	
MATERIAL:	N/A
FINISH:	N/A

thermionics laboratory, inc.

150-0030 SCHEMATIC

REV		
A	925-712135	—
SCALE NONE	SHEET 6 OF 7	

OUTPUT POWER & METERING



ITEM NO.	QTY	PART/IDENT NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS

DRAWN	TAM 07/31/89
DESIGNER	
CHECKED	
APPROVED	
RELEASED	

NEXT ASSEMBLY

EXCEPT AS NOTED

SURFACE FINISH	FRAC ±.015 .XX ±.010 .XXX ±.005	ANGLES
63 ✓		± 1/2°

DO NOT SCALE DRAWING

MATERIAL: N/A

FINISH: N/A

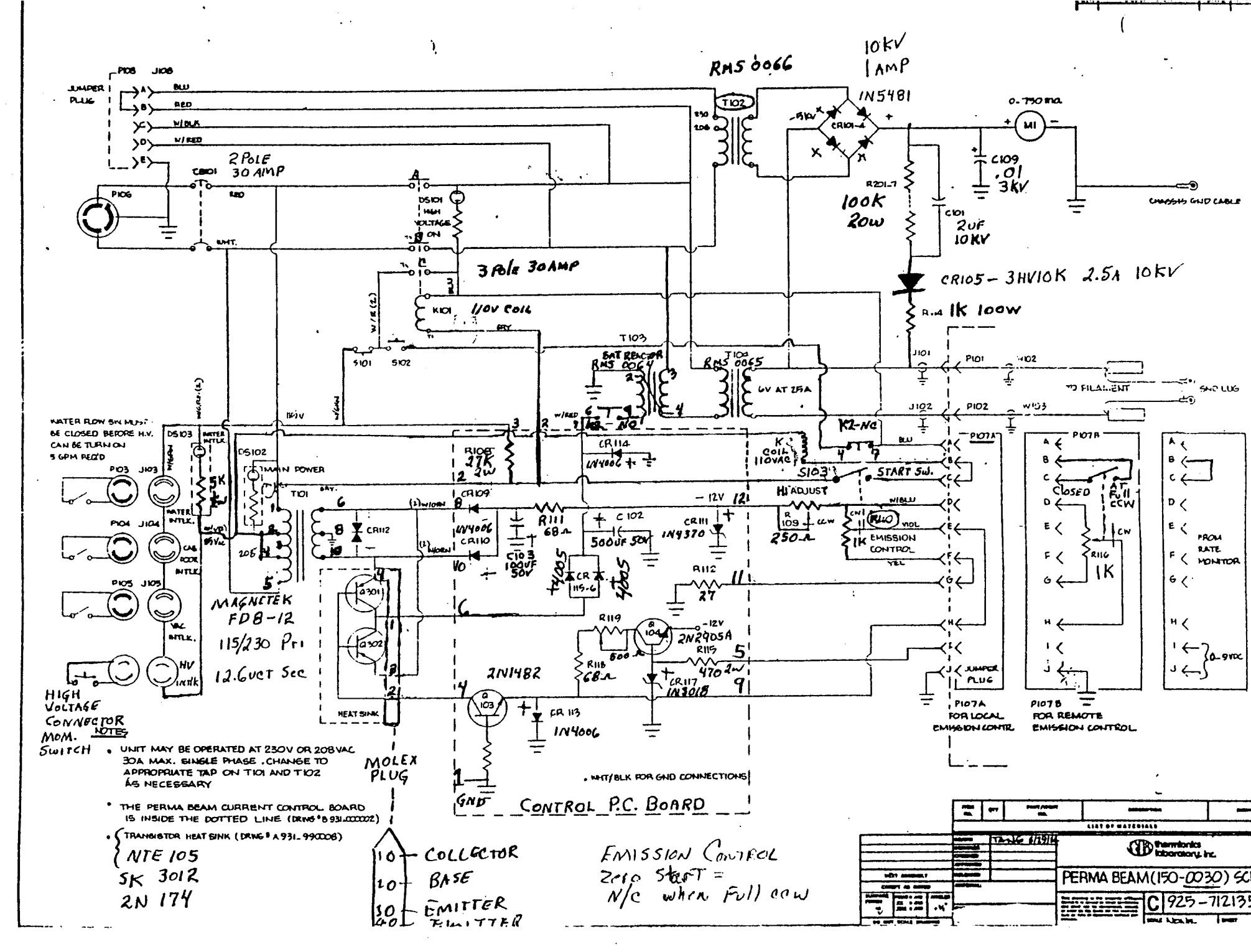
thermionics laboratory, inc.

150-0030 SCHEMATIC

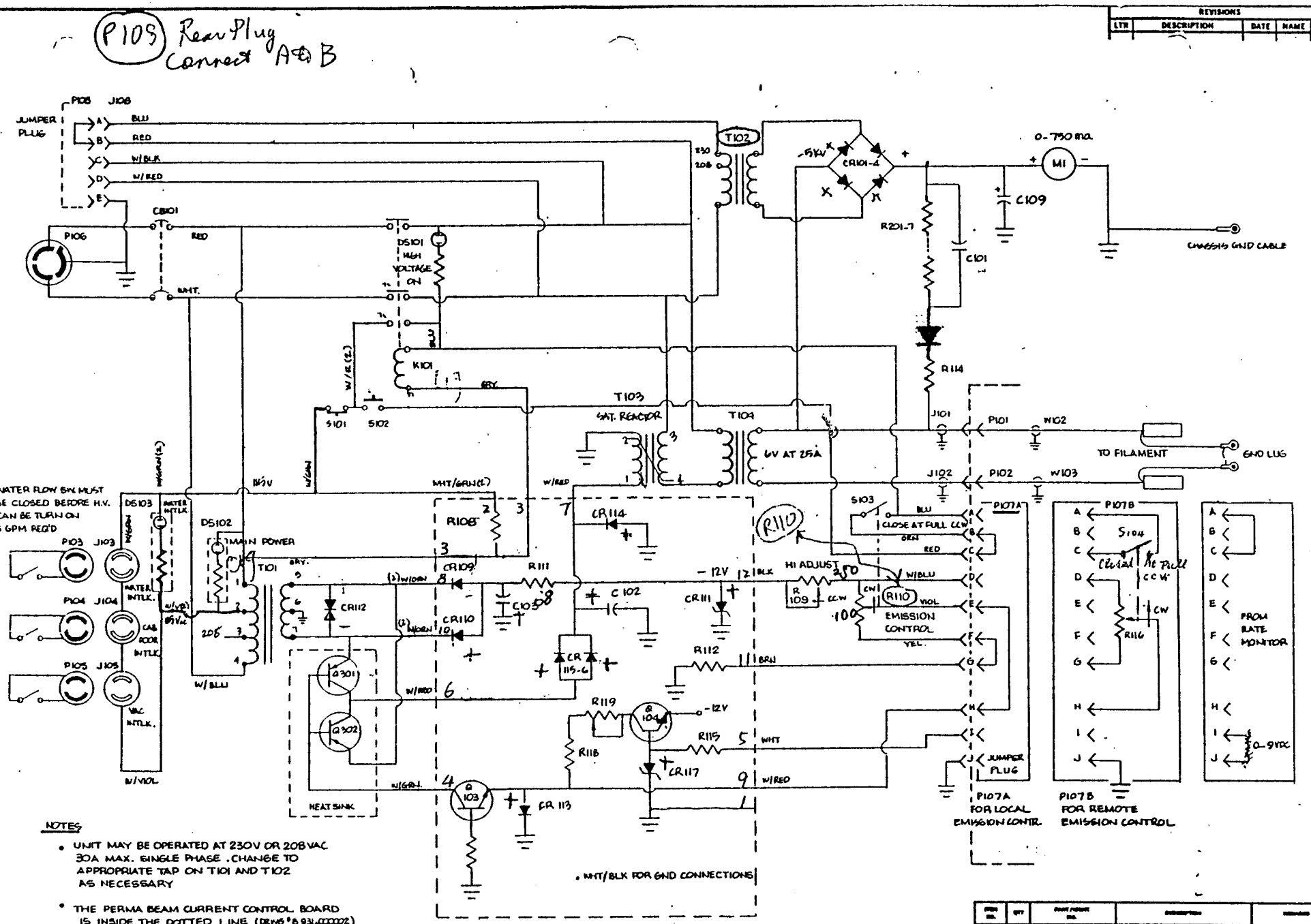
A	925-712135	REV —

SCALE NONE

SHEET 7 OF 7


RMS 0066
10KV
1 AMP
IN5481
2 POLE
30 AMP
3 POLE 30AMP
110V COIL
100K
20W
2UF
10KV
CR105 - 3HV10K 2.5A 10KV
1K 100W
RMS 0065
6V AT 25A
SAT REACTOR
K2-NC
K COIL 110VAC
START SW.
HI ADJUST
250Ω
1K EMISSION CONTROL
MAGNETEK
FD8-12
115/230 Pri
12.6vct Sec
2N1482
2N2905A
CONTROL P.C. BOARD
MOLEX PLUG
HIGH VOLTAGE CONNECTOR
MOM. SWITCH
NOTES
• UNIT MAY BE OPERATED AT 230V OR 208VAC 30A MAX. SINGLE PHASE. CHANGE TO APPROPRIATE TAP ON T101 AND T102 AS NECESSARY
• THE PERMA BEAM CURRENT CONTROL BOARD IS INSIDE THE DOTTED LINE (DRWG # B 931.000002)
• TRANSISTOR HEAT SINK (DRWG # A 931-990008)
NTE 105
SK 3012
2N 174
10 - COLLECTOR
20 - BASE
30 - EMITTER
40 - EMITTER
EMISSION CONTROL
Zero Start = N/C when Full ccw
P107A FOR LOCAL EMISSION CONTR.
P107B FOR REMOTE EMISSION CONTROL
FROM RATE MONITOR
0-9VDC
TO FILAMENT
CHASSIS GND CABLE
WATER FLOW SW MUST BE CLOSED BEFORE H.V. CAN BE TURN ON 5 GPM REQ'D
Thermionics Laboratory, Inc.
PERMA BEAM (150-0030) SC
925-712135

P109 Rear Plug Connect A & B



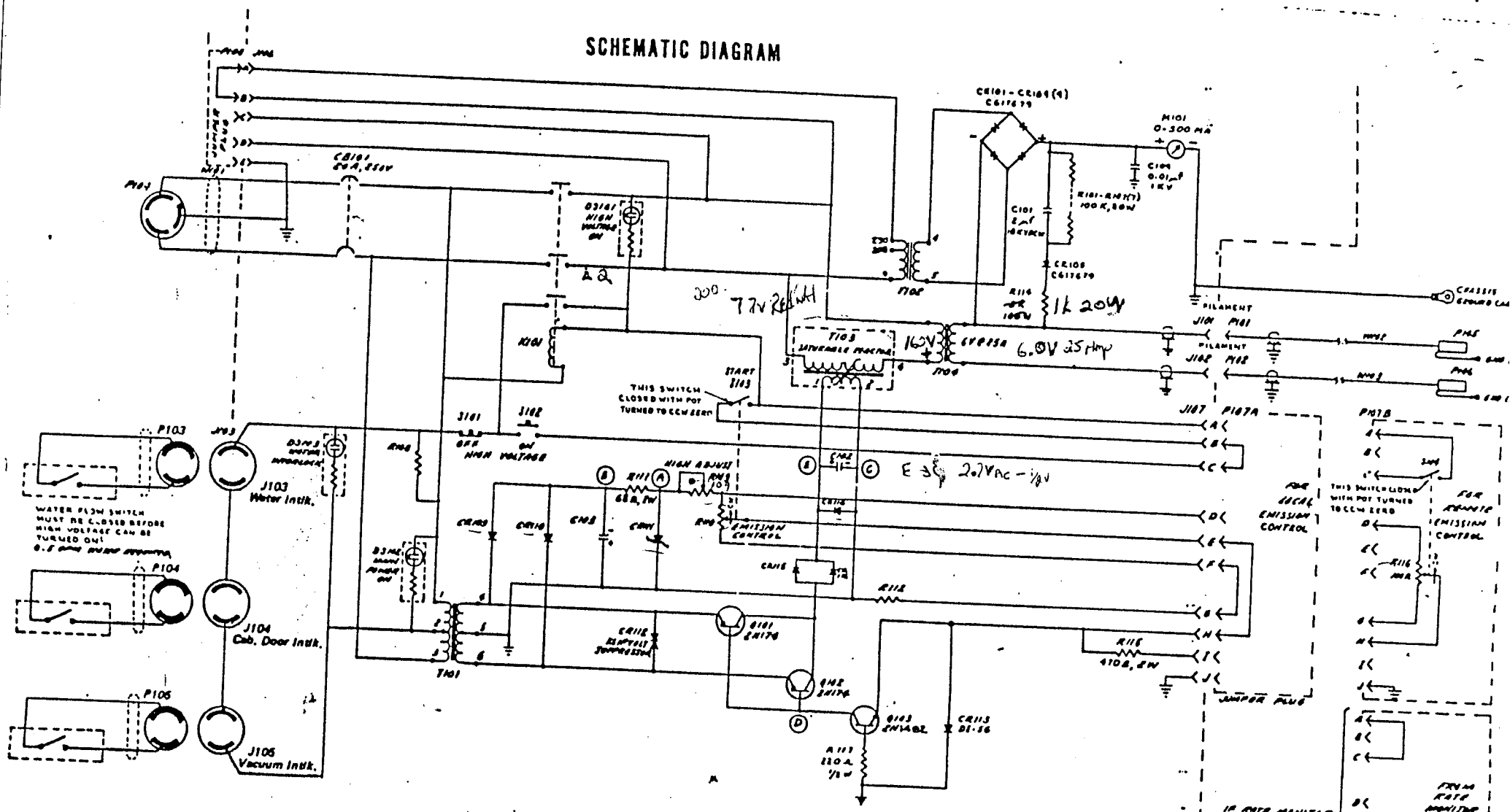
NOTES

- UNIT MAY BE OPERATED AT 230V OR 208 VAC 30A MAX. SINGLE PHASE. CHANGE TO APPROPRIATE TAP ON T101 AND T102 AS NECESSARY
- THE PERMA BEAM CURRENT CONTROL BOARD IS INSIDE THE DOTTED LINE (DRWG # B 931-000002)
- TRANSISTOR HEAT SINK (DRWG # A 931-990008)

LIST OF MATERIALS

thermionics laboratory, inc.

SCHEMATIC DIAGRAM



e-GUN* SOURCE CONTROL UNIT

MODEL NO. 150-0030

*Trademark

UNLESS OTHERWISE NOTED ALL RESISTOR TOLERANCE ± 5%.