PERKIN-ELMER
ULTEK DIVISION

MARCH 1972 C-1503

OPERATION AND MAINTENANCE MANUAL

ION PUMP CONTROL UNIT

MODELS 222-0410 222-0560
222-0460 222-0600
222-0510 222-0650

P/N 112122000

WARRANTY

Products of the Perkin-Elmer Corporation are warranted to be free from all defects in material and workmanship. The liability of the Perkin-Elmer Corporation under this warranty is limited to servicing, adjusting, or replacing defective parts. The warranty on this power unit is effective for one year after the date of delivery of the unit to the original purchaser when:

1. The product is returned to the factory or a designated repair shop, transportation charges prepaid.
2. The product appears, to the satisfaction of Perkin-Elmer, to be defective through no fault of the user.

Expendable parts, such as mercury cells, fuses, and vacuum tubes, are excluded from the liability.

The warranty will apply only if the equipment is operated in strict accordance with the instruction set forth in this manual and any other instructions which may be provided by the Perkin-Elmer Corporation.

If the product has become defective through misuse or abnormal operating conditions, repair costs will be submitted and authorization awaited before repairs are made.

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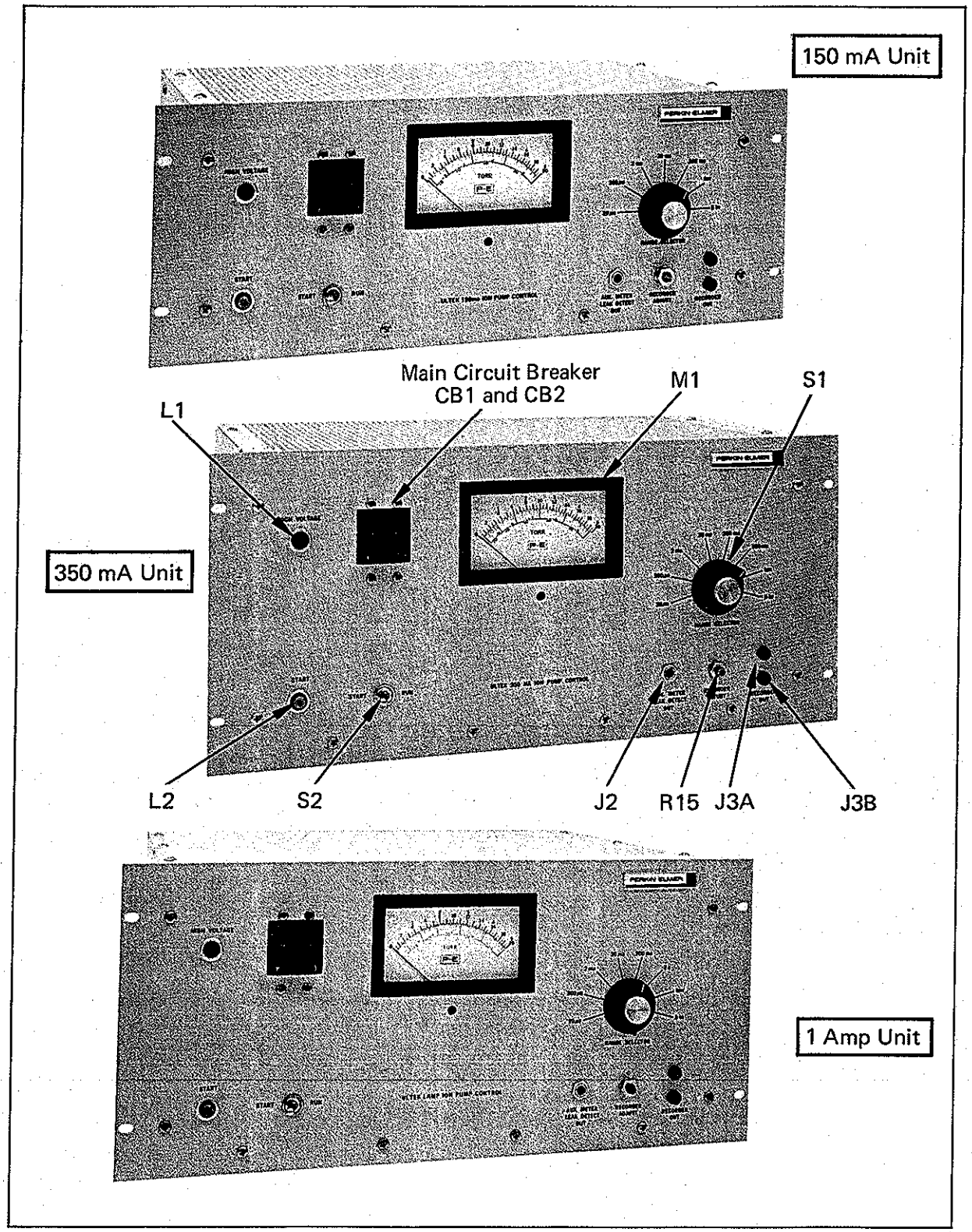


Figure 1. Ion Pump Control Units

GENERAL DESCRIPTION

The ion pump control unit is basically a high voltage current-limited operating power source for Ultek ion pumps of various pumping capacities. It also provides a means by which the operator can continuously monitor the operating conditions in the ion pump and thereby know, for example, the approximate pressure in the vacuum system (in addition to the more accurate pressure obtained with an ion gauge). The ion pump control unit has test points to which various test equipment can be connected to check out the operation of the vacuum system or to obtain a continuous recording of pressure vs time in the system.

Three ion pump control units are described in this manual. The units have similar construction but different power output ratings:

Model 222-0410 + 222-0460 150 mA
Model 222-0510 + 222-0560 350 mA
Model 222-0600 + 222-0650 1 Amp

All three units are illustrated in Figure 1. Input power requirements and applications are given in Table 1.

TABLE 1. IDENTIFICATION OF ION PUMP CONTROL UNITS

MODEL NO.	INPUT POWER FREQUENCY	OUTPUT POWER	ION PUMP CAPACITY	ULTEK STOCK NO.
222-0410	60 Hz	150 mA	50 L/S or	401-338-700
222-0460	50 Hz	150 mA	less	401-338-800
222-0510	60 Hz	350 mA	50 L/S to	401-340-400
222-0560	50 Hz	350 mA	200 L/S	401-340-600
222-0600	60 Hz	1 Amp	200 L/S to	400-955-010
222-0650	50 Hz	1 Amp	2400 L/S*	401-142-010

*Two ion pump control units are required for 1200 L/S and 4 units for 2400 L/S pump.

Each control unit is housed in a chassis suitable for mounting in a standard 19-inch-wide rack cabinet, or for use as a desk top unit. All operating controls of the unit are located on the front panel and cable connections at the rear. The meter on the front panel indicates voltage and current flow in the pump, and pressure.

COMPONENT DESCRIPTION

Within the chassis there is a large leakage inductance type power transformer, a full wave diode rectifier bridge, and capacitors and resistors that are part of the power output circuit. In addition, there are other components associated with the metering and test voltage output circuits. The 1 Amp unit also has a cooling fan in the back panel of the chassis, adjacent to an

auxiliary power output connector. Each unit has two circuit breakers that protect the control unit and the ion pump from excessive current flow. The components are illustrated in Figure 2.

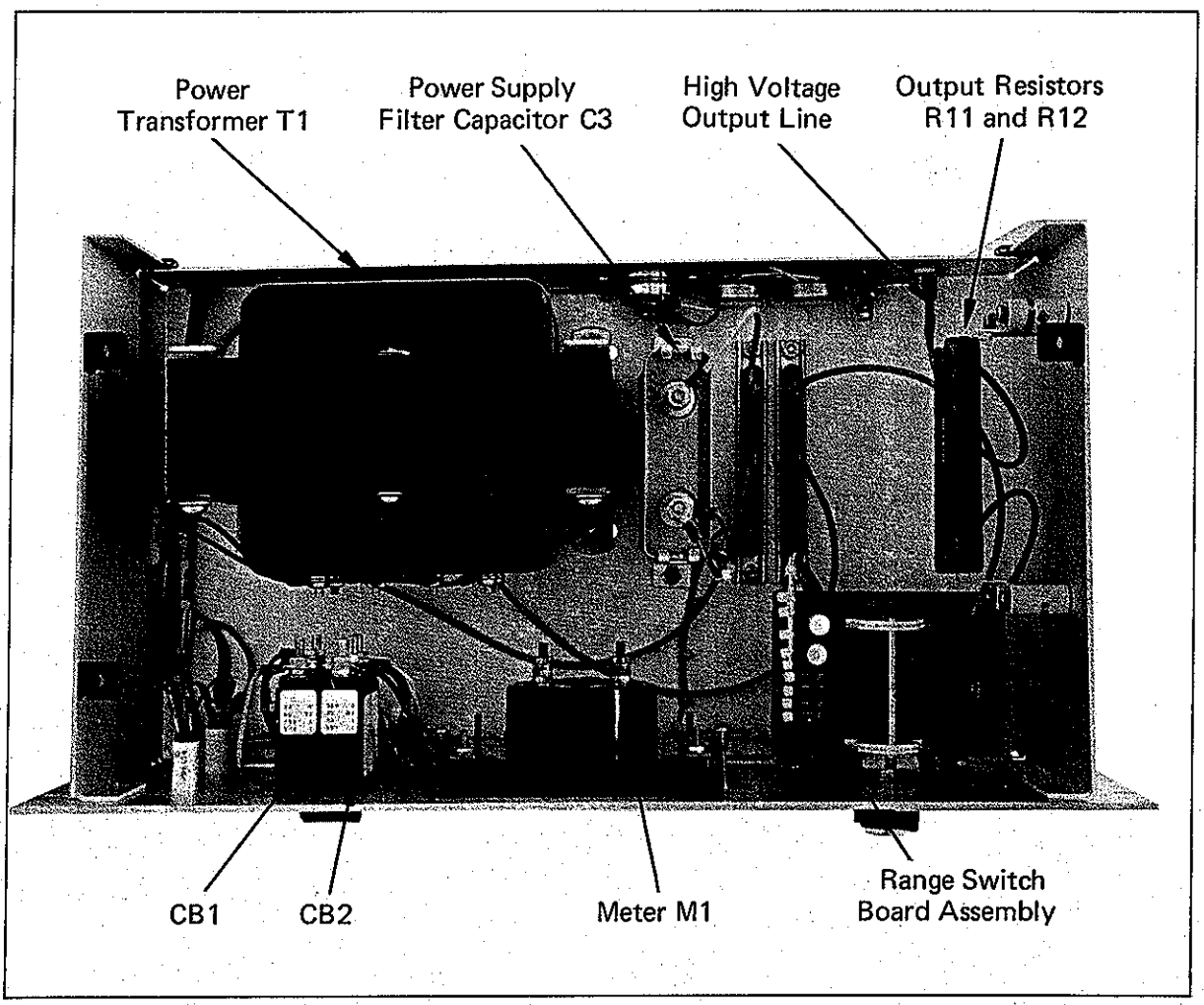


Figure 2. Components of the Ion Pump Control Unit (150 mA Unit Shown)

ACCESSORIES

The accessories that may be used with the ion pump control unit are:

Recorder – for recording the pressure in the ion pump at all times.
Leak Detector – for testing for leakage in the vacuum system (Ultek Model 603-4000).
Current Sensing Relay – for controlling a pressure-sensitive alarm device, the bakeout heaters in the ion pump, or other similar devices (Ultek Model 225-2050).
Auxiliary – for monitoring system current, pressure, and voltage at a remote location.

The use of these accessories is described in other sections of the manual.

REFERENCE TABLES

The operating characteristics and performance specifications of the ion pump control units and accessories are described in Tables 1 and 2.

TABLE 2. PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	CONTROL UNIT		
	150 mA Unit	350 mA Unit	1 Amp Unit
POWER OUTPUT			
CURRENT (short circuit)	150 mA ±7%	350 mA ±7%	1 Amp ±7%
VOLTAGE (open circuit)	4750 V ±7%	4750 V ±7%	4750 V ±7%
METER CIRCUITS			
CURRENT RANGES	0 – 20 μa 0 – 200 μa 0 – 2 mA 0 – 20 mA 0 – 200 mA accuracy: ±7% full scale	0 – 20 μa 0 – 200 μa 0 – 2 mA 0 – 20 mA 0 – 200 mA 0 – 500 mA accuracy: ±7% full scale	0 – 20 μa 0 – 200 μa 0 – 2 mA 0 – 20 mA 0 – 200 mA 0 – 2 Amp accuracy: ±7% full scale
VOLTAGE RANGE	0 – 4750 Vdc, ±7% full scale	0 – 4750 Vdc, ±7% full scale	0 – 4750 Vdc, ±7% full scale
TORR RANGE (logarithmic)	10^{-4} to 10^{-9} torr (mm of Hg) ±10% of linear current and calibration curve value	10^{-4} to 10^{-9} torr (mm of Hg) ±10% of linear current and calibration curve value	10^{-4} to 10^{-9} torr (mm of Hg) ±10% of linear current and calibration curve value
RECORDER OUTPUT			
VOLTAGE	adjustable 0 to –200 mV on all scales proportional to meter deflection	adjustable 0 to –200 mV on all scales proportional to meter deflection	adjustable 0 to –200 mV on all scales proportional to meter deflection
IMPEDANCE	2 mΩ	2 mΩ	2 mΩ
AUXILIARY METER AND LEAK DETECTOR OUTPUT			
CURRENT	0 – 150 mA	0 – 350 mA	0 – 1 Amp
VOLTAGE	1 Vdc maximum	1 Vdc maximum	1 Vdc maximum
OVERLOAD PROTECTION			
PUMP (power output)	automatic circuit breaker trips after approximately 2 minutes of sustained 50 mA current (in run mode only)	automatic circuit breaker trips after approximately 2 minutes of sustained 150 mA current (in run mode only)	automatic circuit breaker trips after approximately 2 minutes of sustained 250 mA current (in run mode only)
POWER INPUT	automatic circuit breaker trips at 6 Amps ac	automatic circuit breaker trips at 18 Amps ac	automatic circuit breaker trips at 25 Amps ac
INPUT POWER			
VOLTAGE (domestic)	115 V (±10%), 60 Hz, single phase	115 V (±10%), 60 Hz, single phase	208 or 230 V (±10%), 60 Hz, single phase
VOLTAGE (foreign)	220 V, 50 Hz	220 V, 50 Hz	208/230 V, 50 Hz
CURRENT	10 Amps max. (during start mode)	18 Amps max. (during start mode)	25 Amps max. (during start mode)
DIMENSIONS			
WIDTH	19 inches	19 inches	19 inches
HEIGHT	7 inches	8¾ inches	8¾ inches
DEPTH	9¾ inches	10½ inches	17 inches
WEIGHT			
NET	32 pounds	58 pounds	105 pounds
SHIPPING	37 pounds	70 pounds	131 pounds

INSTALLATION PLANNING

The control unit may be located adjacent to any other laboratory equipment at normal room temperature and humidity. Since the unit operates at high voltages, all high voltage equipment precautions must be observed when planning the installation. It may be used as a desk top unit or mounted in a rack cabinet; the only requirement is that a free flow of air is allowed around the unit for cooling. The 1 Amp unit has a cooling fan in the rear panel of the chassis and care must be taken that adequate air space is allowed behind the fan when the ion pump control unit is mounted in a rack cabinet.

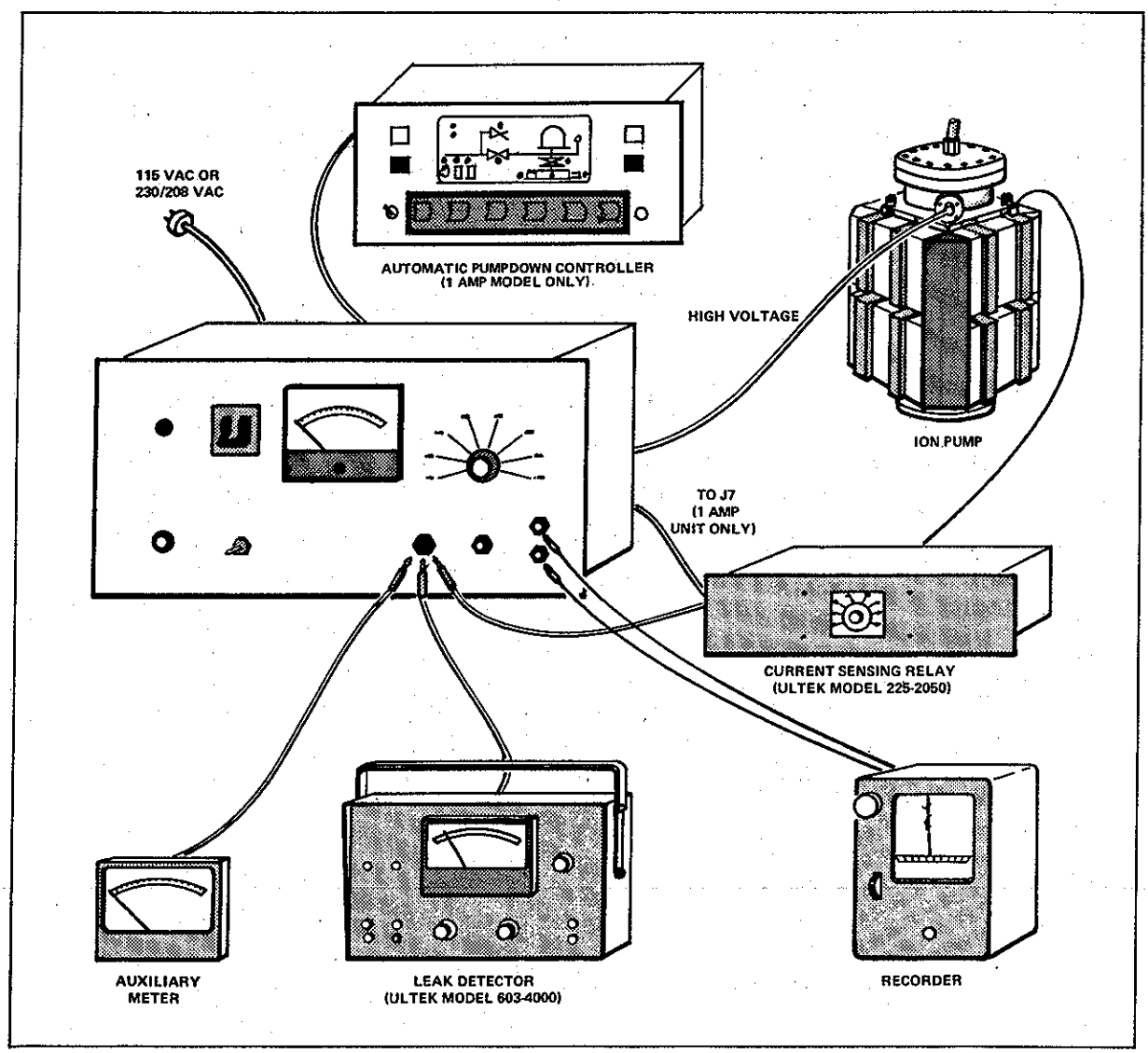


Figure 3. Equipment Interconnecting Diagram

Location of the control unit is also determined by the cabling between equipment. The high voltage power output cable connecting to the ion pump is nominally 10 feet long, and thus restricts the location of the control unit. The power input cable is equipped with a three-terminal plug, one terminal of which is connected to the chassis of the control unit. It is intended that this power plug be inserted in a receptacle whose ground terminal is connected to the power system ground. If such a receptacle is not available, a method of grounding the ion pump control unit chassis to the power system ground must be devised and installed. When selecting a power source, make sure also that the input voltage will not vary more than ±10% from specified values. Damage to the diode module may otherwise result. Power requirements are given in Table 2 and a typical installation diagram is shown in Figure 3.

RECEIVING AND UNPACKING

The control unit is shipped in a special packing case that should be saved if reshipment is planned.

As the equipment is unpacked, care should be exercised to prevent damage to the finished surfaces. All parts should be inspected for evidence of damage during shipping and if damage is evident, a claim should be filed with the carrier (with one copy to Perkin-Elmer, Ultek Division). If the equipment must be returned for inspection or repair, authorization must be obtained from the Ultek Division, Palo Alto, prior to reshipping. Instructions for return will be provided.

INSTALLATION SEQUENCE

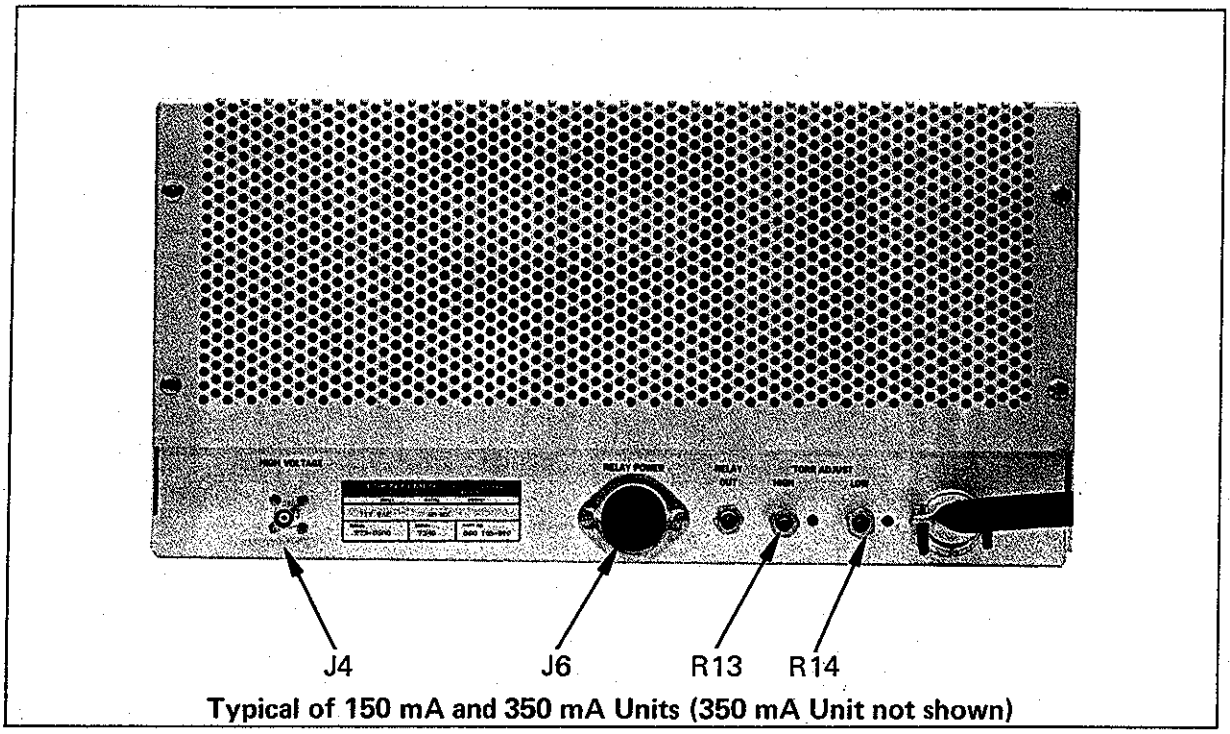
Installation of the ion pump control unit should be performed in the following sequence. Refer to Figures 3 and 4 while completing the installation.

WARNING

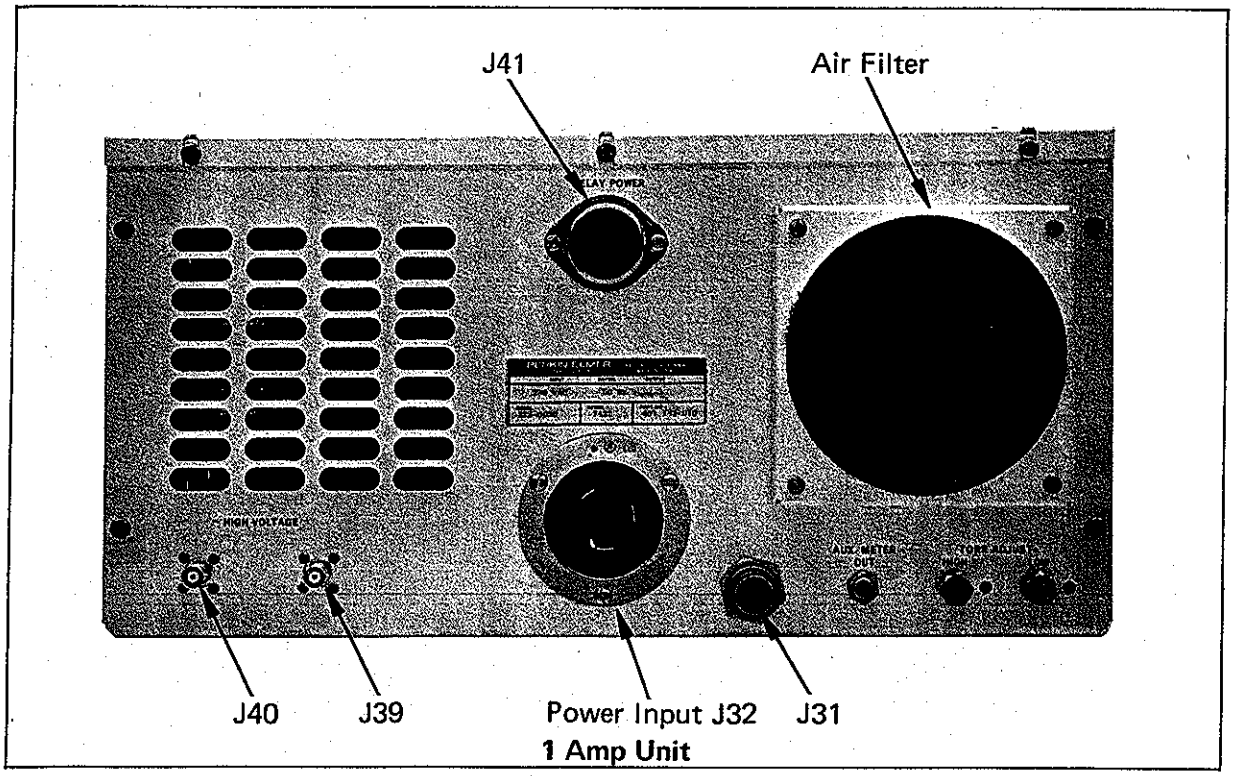
Do not disconnect the high voltage cable while the power is turned on. After turning off power, allow 1 minute for the filter capacitor to discharge.

A. Place the unit in its location and secure as necessary.
B. Complete grounding connections with the power source and the ion pump, as discussed above.
C. If a 208 Vac power source is to be used with the 1 Amp unit, reconnect the wire from terminal 3 to terminal 2 on the transformer.
D. Connect the high voltage cable at the pump. On the 1 Amp unit, cap the spare high voltage connector on the rear panel of the unit.
E. Connect the power input cable.
F. The control unit can be turned on now, and its proper operation verified.
G. The metering circuit for the pressure (**torr**) scale has been adjusted initially at the factory to read correctly with one size ion pump only. If the unit is used with a different size pump, the circuit must be readjusted according to the procedure in Section 5. Factory settings are as follows:

150 mA unit is set for 11 L/S pump
350 mA unit is set for 50 L/S pump
1 Amp unit is set for 400 L/S pump



Typical of 150 mA and 350 mA Units (350 mA Unit not shown)



1 Amp Unit

Figure 4. Rear Connector Panel of the Ion Pump Control Units

CONTROLS AND INDICATORS

The control unit is operated entirely from the front panel, although monitoring or data recording functions may also be carried out at a remote location. The function of each control and indicator is described below.

RANGE SELECTOR (S1) A seven or eight position rotary selector switch that is used to select the readout on the adjacent meter. When the switch is in any one of the first six positions (five on the 150 mA unit), the current output to the ion pump is read on the meter. The lowest of the current scales is 20 μA and the highest is either 200 mA, 500 mA or 2 Amps (150 mA, 350) mA, and 1 Amp units, respectively). In the **torr** position, the meter reads pressure in the ion pump and in the 5 kV position it reads the output voltage to the ion pump.

METER (M1) A 20 μA high impedance meter whose functions are controlled by the **RANGE SELECTOR** switch, described above. The current and voltage are read on the linear scale (marked in black) and the pressure (**torr**) is read on the red logarithmic scale. Note that there is a meter zero adjustment (mechanical) directly below the meter scale.

MAIN CIRCUIT BREAKER (CB1, CB2) Consists of two mechanically interconnected circuit breakers (one will simultaneously trip the other). CB2 protects the input power circuit and will trip at 101% to 125% of rated current (refer to Table 2). The inductance coil in the circuit breaker will permit a high flash inrush current, but only a very short time delay on continuous overloads. CB1 protects the output circuit and, therefore, the ion pump. This circuit breaker will also trip at between 101% and 125% of rated current, but will allow an overload condition to exist for approximately 2 minutes. CB1 is bypassed when the mode switch directly below it is in the START position. When the circuit breakers are closed, power is applied to the primary coil of the transformer, one or both of the indicator lights, and, in the 1 Amp unit, to the cooling fan.

MODE SWITCH (S2) A two-position toggle switch that selects the mode of operation of the control unit. When the switch is in the START position, an overload condition can exist in the output circuit, without the main circuit breaker tripping (note in Table 2 that the specified overload current is much smaller than the rated output of the unit, because the ion pump requires maximum current only during startup). The amber **START** light is illuminated when the switch is in this position. When in RUN, no overload condition can exist in excess of 2 minutes before the main circuit breaker trips. This is the normal operating mode of the unit and the switch should be left in the RUN position except when actually starting the ion pump. If the ion pump is subjected to continuous current above the operating level, it may be damaged.

The auxiliary **POWER RELAY CONNECTOR (J41)** (or J6) is energized when the switch is in the RUN position.

HIGH VOLTAGE (L1) A red indicator light that is illuminated whenever the main circuit breaker is closed and power is supplied to the primary coil of the power transformer.

START (L2) An amber indicator light that is illuminated whenever the main circuit breaker is closed and the mode switch is in the START position. It indicates that the equipment is operating in the START mode and that there is no overload circuit protection in the output circuit.

AUX METER LEAK DETECT OUT (J2) A phone jack connector to which an auxiliary meter (see Table 2 for specifications) may be connected to obtain the current readings at a

remote location. Alternately, a **LEAK DETECTOR** (Ultek Model 603-4000) or a **CURRENT SENSING RELAY** (Ultek Model 225-2050) may be connected to this connector for maintenance purposes, as described later in this section.

RECORDER ADJUST (R5) A potentiometer used for adjusting the output voltage on the adjacent **RECORDER OUT** connector. The use of this potentiometer is described later in this section.

AUTOMATIC CONTROLLER INTERLOCK (J31, 1 Amp SUPPLY ONLY) Provides remote switching to start position and senses the position of main power breaker (CB1 and CB2).

RECORDER OUT (J3A, J3B) A pair of connectors used for connecting a recording device in order to record the current, pressure, or voltage readings in the power output circuit. Refer to Table 2 for output voltage and impedance specifications.

GENERAL OPERATING NOTES

WARNING

The control unit operates at high voltage and safety precautions pertaining to high voltage equipment must be observed at all times. Before disconnecting the high voltage line or removing the cover panel, turn off all power and allow 3 minutes for the power supply capacitor to discharge.

During pump starting operations, the control unit voltage reading provides the most sensitive indication of pump behavior. Overload protection is bypassed and the pump can draw maximum

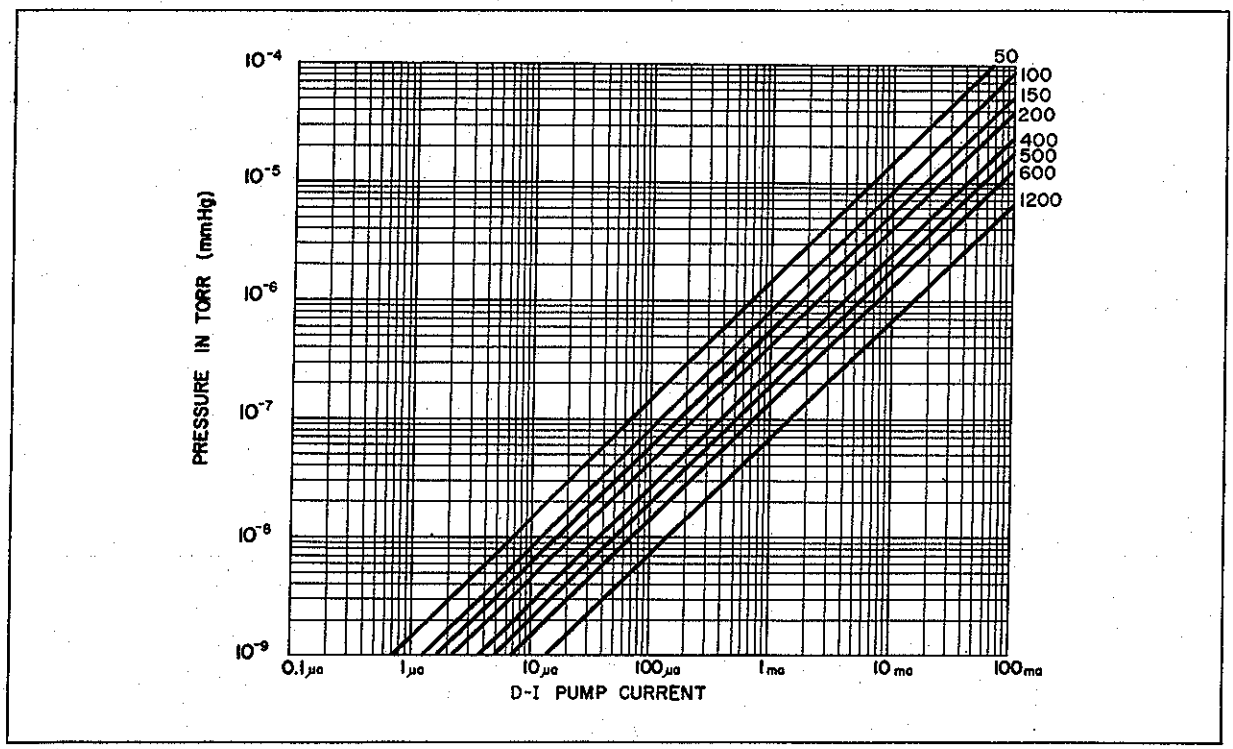


Figure 5. Current-to-Pressure Conversion Chart

current, enabling it to pass through the glow discharge region as fast as possible. Once the pump has started, the current flow is the most sensitive operating indicator. The voltage rises to above 4.75 kV and remains essentially constant. However, the voltage may also read 4.75 kV if the vacuum system pressure rises up to atmosphere, although the meter will indicate no current flow. To distinguish between ultra-high vacuum and atmospheric pressure, turn off the control unit for several minutes. Set the **RANGE SELECTOR** switch to the 2 mA or 20 mA current scale position and turn on the power. If the ion pump is at high vacuum, the current will rise momentarily and then drop back rapidly. If the pump is at atmospheric pressure, the current will remain at zero or will increase to a high level, where internal arcing occurs. In the latter case, turn off the control unit immediately.

Pressure Reading

When voltage is constant, the pressure in the pump may be obtained by reading the current and then converting it to pressure by means of the chart in Figure 5. The relationship between current and pressure is normally very accurate, but will be erroneous if current leakage exists somewhere in the equipment. Alternately, pressure can be read directly in torr on the red logarithmic **torr** scale, provided the torr circuit is adjusted for use with the corresponding pump.

OPERATING PROCEDURES

Starting Procedure

When turning on the control unit to start the pumping of a vacuum system, there are two different conditions that may exist in the system and which require somewhat different procedures. An isolated start occurs when the ion pump is isolated from the remainder of the system by a valve and thus can be started independently of the conditions in the system. An open system start occurs when there is no isolation of the ion pump and, therefore, the pressure of the entire system is open to the pump. The two starting procedures are given below and should be used in conjunction with those in the ion pump manual.

Before starting the ion pump, the operator should also be certain that the pump has been baked out properly, that there is no leakage or other source of contaminants in the system, and

NOTE

Although individual pumps, control units, and vacuum system installations have different starting characteristics, there are certain criteria that may prove useful in getting the ion pump to start readily. An approximate 400 V may be expected when power is first turned on (less if the pump is heavily contaminated) and, once the voltage goes above 3 kV, it can be assumed that the pump has started. If it does not start within several minutes (10 min. max.), great care must be exercised to avoid overheating the pump. A large power supply will cause overheating very rapidly, whereas the same pump may be allowed to be in glow discharge longer if a smaller power supply is used. Overheating generally occurs whenever the surface temperature of the box around the pump element exceeds 50°C. If the pump fails to start prior to overheating, it may be turned off, allowed to cool, and then turned on again. Initial heating may have baked out the pump enough to allow easy starting the second time. Playing the air stream of a large fan on the pump may sometimes be used to keep the temperature down. This latter method should be used with great care and only by experienced personnel. Generally, the ion pump should pass through the glow discharge period rapidly and failure to do so indicates a leak in the system or some other fault.

that electrical leakage is not present in the high voltage circuits of the control unit or the ion pump. The procedures for recognizing these conditions are given in the ion pump instruction manual and Section 5 of this manual.

Open System Start

A. Check to see that the control unit is properly connected and that the vacuum system is well sealed.
B. Turn on the roughing pump and open the roughing valve.
C. Turn the **RANGE SELECTOR** switch to the 5 kV position.
D. Set the mode switch in START position.
E. Pump the system with the roughing pump down to 5 microns of pressure (5×10^{-3} torr) or less. (The optimum pressure will be found as experience with the pump and vacuum installation is gained.)
F. Turn on the control unit circuit breaker. Operation will be indicated by illumination of the **HIGH VOLTAGE** and **START** lights. An intense blue glow discharge will appear in the pump.
G. Note the voltage indication on the meter – it should be 300 to 500 V.
H. Turn the **RANGE SELECTOR** switch to the highest current scale and observe the reading – it should be close to full rating of the control unit.
I. Turn the **RANGE SELECTOR** switch to the 5 kV position.
J. Wait for the ion pump to start. Depending on the degree of vacuum attained with the roughing pump and the cleanliness of the system, starting may occur immediately, in a few minutes or longer. As the pump starts, the voltage varies up and down and then begins to move up steadily; the glow discharge flickers and then goes out.
K. Isolate the roughing pump from the system immediately to prevent backstreaming of particles or other contaminants from the roughing pump.
L. Turn the **RANGE SELECTOR** switch alternately to a current scale and the voltage scale and monitor the increasing voltage and decreasing current.
M. Set the mode switch in the RUN position when the current has dropped below the critical level (see Table 2).
N. Turn the **RANGE SELECTOR** switch to the **torr** position and read the pressure in the system directly.
O. Switch to the 5 kV scale on the meter and note that the voltage has risen to above 4750 V and remains constant. From this point, the pump will continue to pump down the system without further attention. If the control unit is left unattended, leave the **RANGE SELECTOR** switch in the 5 kV position (or the upper current scale) to protect the meter movement in case a pressure rise should occur.

Isolated Start

The isolated start procedure is generally the same as the open system procedure, except that the pump will start more readily. Once steps A through I of the above procedure are completed, the valve isolating the pump from rest of the vacuum system may be opened slowly, maintaining the pressure in the pump below 5×10^{-5} torr.

OPERATION WITH A RECORDER

A recording device, such as a strip chart recorder, may be connected to the **RECORDER OUT** connectors on the front panel of the control unit for continuous graphic recording of system pressure vs time.

Voltage and impedance specifications for the recorder are given in Table 2. Prior to making data recordings, the recorder output must be calibrated as follows:

A. Remove any connections that are made to the **AUX METER** connector J2 (J6 on the 1 Amp unit).
B. Connect the recorder to the **RECORDER OUT** connectors J3A and J3B. (J38A and J38B)
C. Set the **RANGE SELECTOR** switch to the 5 kV position.
D. Turn the **RECORDER ADJUST** potentiometer fully counterclockwise.
E. Set the zero adjust of the recorder.
F. Adjust the **RECORDER ADJUST** potentiometer to produce a near full scale deflection of the recorder needle.
G. Lock the **RECORDER ADJUST** potentiometer in position with its concentric locking nut. The recorder now is ready for operation. Note that recorder deflection is directly proportional to meter deflection on the control unit.

OPERATION WITH THE CURRENT SENSING RELAY

A current sensing relay (Ultek Model 225-2050) may be connected to the **AUX METER LEAK DETECT OUT** connector. The relay may be used to actuate an alarm device whenever the pressure in the vacuum system rises above a preselected value. The relay can also be used to control operation of the bakeout heaters. If, during the initial phases of bakeout, enough contaminants can be freed to stall the pump, the current sensing relay may be preset to turn off the heaters prior to reaching this critical level and turning them back on when the pressure has dropped down again. All control units have a relay power jack on rear panel to provide fail-safe power for the Model 225-2050 current sensing relay.

AUXILIARY METERS

One or more auxiliary meters may be connected to the control unit for monitoring pump operation at a remote location. Refer to Table 2 for specifications for the auxiliary meters.

LEAK DETECTOR

The leak detector (Ultek Model 603-4000) is used to detect leaks in a vacuum system. Its use with the power control unit is described in the leak detector instruction manual.

CIRCUIT DESCRIPTION

The control unit circuitry consists of a transformer/rectifier circuit, which provides the power output to the ion pump, and three metering circuits for current, pressure, and voltage. Except for component values, the circuitry is essentially the same in all three units and is illustrated in Figures 6, 7, 8, and 9. Any minor differences are described below.

The high voltage transformer, T1, is of the high leakage inductance type. As the load impedance decreases, the increase in primary current causes more magnetic flux to be shunted through the air gap of the transformer. Therefore, less flux is linking the secondary winding and the output voltage drops. The control unit can operate indefinitely under any load condition.

The primary side of transformer T1 is supplied with either 115 Vac (in the 150 mA and 350 mA units) or 230/208 Vac (in the 1 Amp unit) through circuit breaker CB2. Circuit breaker CB1 is on the return side of the transformer primary in the 150 mA and 350 mA units, but functions as a result of certain current values in the secondary side of the transformer. Specifically, CB1 will trip whenever current on the output side of the transformer is above the rated output current for the run mode of operation (refer to Table 2 for the values) and thus protect the ion pump from excessive current. In the start mode of operation, CB1 is bypassed through switch S2 and only CB2 determines the maximum current in the primary side of T1. In the 1 Amp unit CB1 performs the same function, but its trip coil is in the dc return path of the output circuit (secondary side of T1). By using a dc trip coil, the delay time of the breaker may be adjusted also by shunting the coil with a polarized capacitor, such as the aluminum electrolytic capacitor C1 (250 mF). This allows the 1 Amp unit to be operated with very large ion pumps whose intermittent starting phase current surges would otherwise cause unnecessary tripping of the circuit breaker.

Indicating lights L1 and L2 are wired to the primary side of T1 and, in the 1 Amp unit, the auxiliary power connector J7 as well as the cooling air fan F1 are also on the primary side.

The secondary side of T1 is rectified in the diode bridge circuit B1 and then filtered through capacitor C3 to give a nominal 4750 Vdc output. Resistors R11 and R12 have low resistance and high voltage characteristics and serve to limit surge currents in the output of the control unit. The return side of the output circuit is completed through high voltage connector and **RANGE SELECTOR** switch S1A (in the 1 Amp unit J6 and the coil of CB1 are also in the return line).

All three metering circuits use a common 20 μA meter M1, and the current and torr circuits use a common shunt diode CR2 to protect the meter against destructive overload currents.

Current values indicated on the current scales of the meter are read through S1A and S1B in the return line of the power output circuit. The **torr** scale is also read on the return line through diodes D3 and D4. The logarithmic characteristics of semiconductor diodes provide the logarithmic readout of the **torr** scale. Potentiometers R13 and R14 allow adjustment of this circuit for use with different pump sizes.

Voltage readings are obtained through resistor R8, that acts as a voltage divider network and meter shunt. The voltage is connected to M1 through S1B.

RECORDER OUT connector J3A has potentiometer R15 across it in order to shunt M1 and to adjust the output of J3A. Diode CR2, in the connector J2 (J37, 1 Amp supply) shunts the connector to provide protection to the leak detector and auxiliary meter output circuit.

PREVENTIVE MAINTENANCE

Preventive maintenance procedures consist of periodic cleaning of the control unit. Clean the interior of the unit with an industrial type vacuum cleaner to remove dust, dirt, and metal particles which may cause shorts. If a source of compressed clean dry air is available, it is recommended that the entire inside of the chassis be cleaned, paying special attention to areas such as the high voltage terminals and the **RANGE SELECTOR** switch. In the 1 Amp unit, remove the air filter element and wash in mild soap and water.

WARNING

Always turn power off before cleaning.

Of particular importance are the high voltage components, since they are susceptible to arcing. If the equipment is operated in the vicinity of oil diffusion pumps, oil vapor has a tendency to settle on components attracting dust that causes arcing. On the 1 Amp unit, the spare high voltage connector is most subject to this danger (therefore, it should be capped with the special cap provided when not in use). While cleaning the interior of the chassis, inspect all high voltage wire for wear and cracking. Wipe off all high voltage terminals, connectors, and the encapsulated diode rectifier bridge with a lint-free cloth moistened in trichlorethylene or another suitable solvent.

CHECKOUT AND ALIGNMENT

Voltage and Current Checkout

An overall checkout of the unit can be performed by checking the rated voltage and current output. Among individual units, these readouts may vary within the values given below.

A. Turn off the control unit and allow the filter capacitor 3 minutes to discharge.
B. Set the mode switch in START position.
C. Disconnect the high voltage connector from the ion pump and suspend it clear of any ground connection.

WARNING

Make sure that all personnel are clear of the high voltage connector when power is turned on.

D. Turn on the main circuit breaker and check that the red **HIGH VOLTAGE** light is on within 30 seconds. If it is not, check the line voltage and proceed to troubleshoot the unit.
E. Turn the **RANGE SELECTOR** to 5 kV and observe that the meter reads between 4.42 kV and 5.08 kV.
F. Turn off power and allow 3 minutes for the filter capacitor to discharge.
G. Short across the high voltage connector and turn on power.

H. Set the **RANGE SELECTOR** to the highest current scale and observe that it reads as follows:

150 mA unit	140 to 160 mA
350 mA unit	325 to 375 mA
1 Amp unit	0.93 to 1.07 Amp

I. Set the mode switch in the RUN position and observe the main circuit breaker trip within 2 minutes.
J. If the above current or voltage readings are not obtained, troubleshoot the unit.

Adjustment of Torr Range

To perform adjustment of the **torr** potentiometers, a variable voltage source is required (such as a Variac). The high voltage output connector must be shorted.

A. Turn off the main circuit breaker.
B. Set the variable voltage source to zero and connect the input power cable to it.
C. Turn the **TORR HI** and **TORR LOW** potentiometers (on the rear of the unit) to midrange.
D. From the conversion chart of Figure 5, determine the current for 10^{-5} torr and 10^{-8} torr.
E. Turn the **RANGE SELECTOR** to the current scale corresponding to the current determined above for 10^{-5} torr.
F. Turn on the main circuit breaker.
G. Set the mode switch to START.
H. Increase the voltage to the unit until the meter indicates the value determined above for 10^{-5} torr.
I. Turn the **RANGE SELECTOR** to the **torr** position.
J. Adjust the **TORR HI** potentiometer until the meter indicates 10^{-5} torr.
K. Turn off the main circuit breaker and set the voltage source to zero.
L. Set the **RANGE SELECTOR** to the current range for reading the current corresponding to 10^{-8} torr, as determined above.
M. Turn on the main circuit breaker and increase the source voltage until the meter indicates the current for 10^{-8} torr.
N. Set the **RANGE SELECTOR** to **torr** position.
O. Adjust the **TORR LOW** potentiometer until the meter indicates 10^{-8} torr.
P. Repeat steps H through O until the meter reads correctly for the high and low values.
Q. Secure the **TORR HI** and **TORR LOW** potentiometers by tightening the locking units.
R. Turn off power and disconnect the test equipment.

TROUBLESHOOTING

Troubleshooting procedures contained in this section are a list of malfunctions that may occur in this type of equipment. They do not constitute a complete systematic method of locating all defective components in the control unit – rather, they indicate an appropriate point to start troubleshooting by conventional voltage and current measurement techniques.

A. If the meter reads close to zero in the 5 kV range while the unit is connected to an ion pump, there may be a short in the pump. This will be associated with a maximum current output indication on the meter and can occur only when the mode switch is in the START position.
B. If the unit functions properly and open circuit voltage is normal, but no current is indicated when the ion pump is started or when the high voltage connector is shorted,

the meter circuit may be faulty. This may include a shorted diode CR1, capacitor C2, or switch S1. A faulty diode or capacitor will be indicated by the same problem in the **torr** range, whereas a faulty S1 will probably affect only one range on the meter.

C. Arcing in the pumps, cabling, or the control unit is usually indicated by erratic meter readings and tripping of the main circuit breaker.

D. If the meter reads zero on all scales, the diode rectifier module may be shorted, C3 may be shorted, or the transformer may be defective.

E. Any defect in the meter M1 may be located by connecting an auxiliary meter to connector J2 for comparison of readings. This does not conclusively rule out a defect in deck B of switch S1, however.

F. If erratic readings are obtained in the torr range only, adjustment of the related potentiometers should be checked first.

G. Leakage current in the vacuum system is indicated by current and pressure readings above those obtained when the system pressure is measured directly with an ion gauge.

H. A shorted diode CR2 will be indicated by the absence of output from the auxiliary meter connector J2.

I. A short in the transformer is indicated by the inability to close the main circuit breaker.

PARTS REPLACEMENT

Replaceable parts in the control unit are listed at the end of this manual. There are, however, certain parts you should not attempt to repair. These include the meter and transformer as well as minor components such as switches, encapsulated components, etc.

REPLACEMENT OF HIGH VOLTAGE CONNECTOR

The following instructions and Figure 6 show how to install the Model 225-0115 pump connector (Dwg. 600-315-600) and control unit connector (Dwg. 139-951-000) to the high voltage cable. Note that a special crimping tool is required in order to make the ground connection. The HV cable is of small diameter (.195"). It is 19.0 kV dielectric, irradiated PVC (cross linked for radiation environments) insulation.

Old style Model 225-0110 (Dwg. 061-024-02) HV connectors will be available for old style high voltage cable (RG58A/U) rubber covered jacket .250" O.D.

PUMP END CONNECTOR

STEP 1

Strip cable as shown. Do not nick center conductor insulation. Tin center conductor with 63 Sn solder (Rosen flux). Remove all traces of flux from center conductor and insulation. If cable is to be of the bakeable variety, do not tin center conductor.

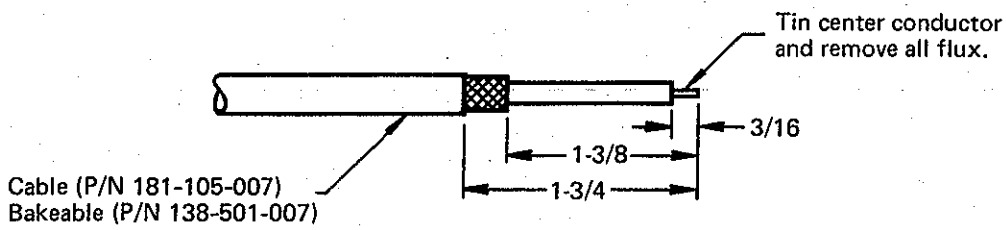
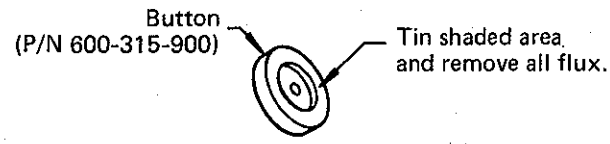


Figure 6. View of the High Voltage Connector

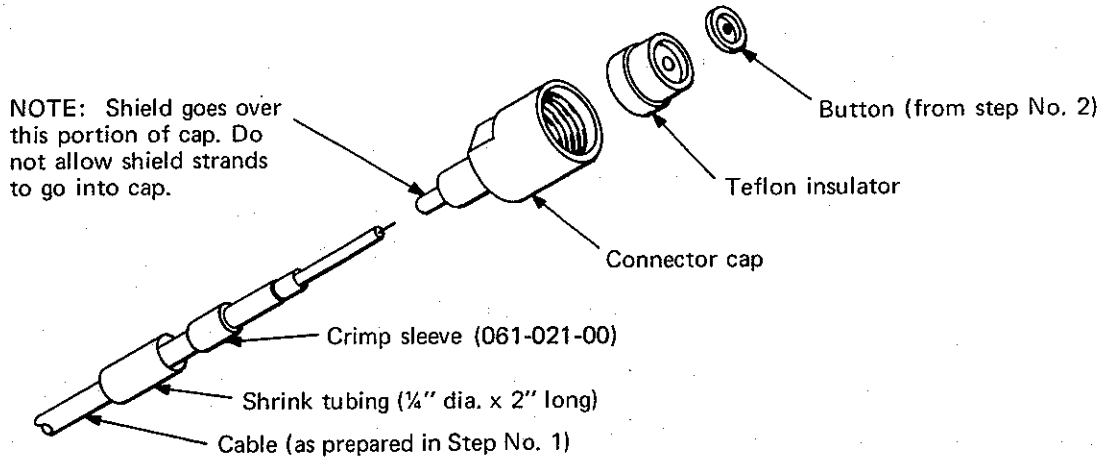
STEP 2

Tin button with 63 Sn solder (Rosin flux). Remove all traces of flux.
NOTE: If cable is to be of the bakeable variety, omit this operation.



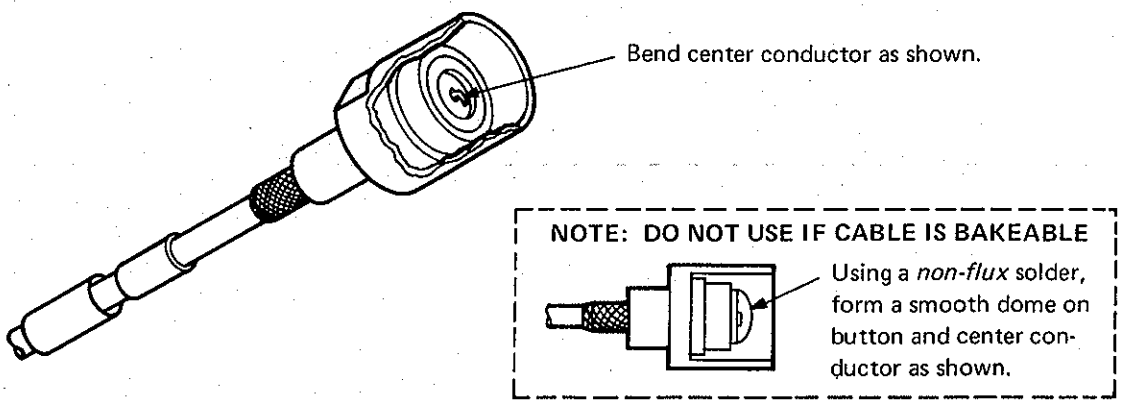
STEP 3

Clean Teflon insulator with alcohol. Assemble by placing tubing and crimp sleeve over cable. Install connector cap and Teflon insulator. Insert button so that center conductor passes through the hole in the center of the button. Press button into recess in Teflon insulator.



STEP 4

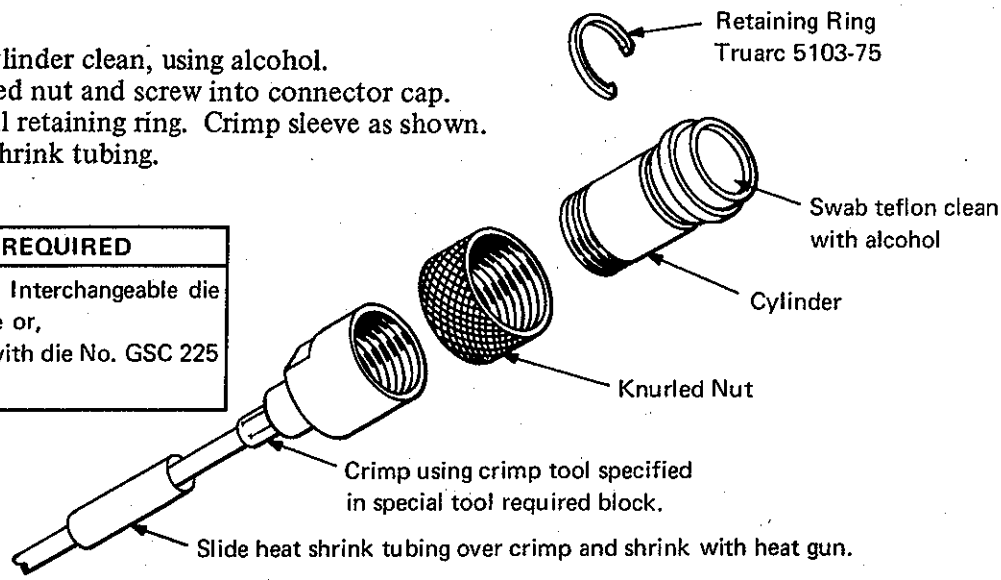
Bend center conductor as shown. Solder center conductor to button as shown, with a no-flux, 50-50 solder.
NOTE: If cable is to be of the bakeable variety, do not solder the center conductor to the button. button.



STEP 5

Swab Teflon sleeve in cylinder clean, using alcohol.
Slip cylinder into knurled nut and screw into connector cap.
Tighten securely. Install retaining ring. Crimp sleeve as shown.
Install and shrink heat shrink tubing.

SPECIAL TOOLS REQUIRED
Thomas & Betts WT-440 Interchangeable die crimp tool with No. 08 Die or, Thomas & Betts WT-230 with die No. GSC 225 Heat gun.

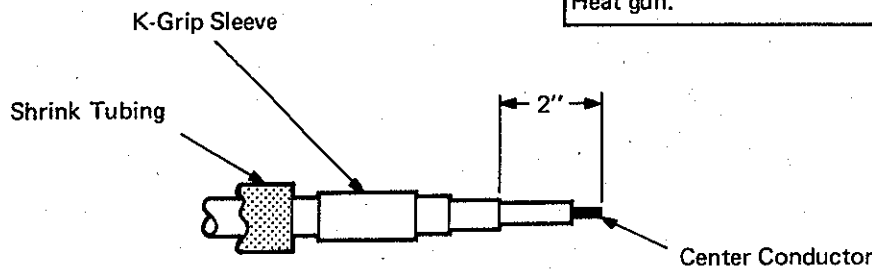


POWER SUPPLY END CONNECTOR

STEP 1

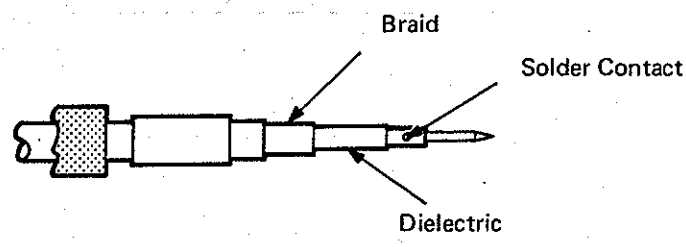
Prepare cable as shown. Install sleeve and shrink tubing.

SPECIAL TOOLS REQUIRED
Thomas & Betts WT-440 Interchangeable die crimp tool with No. 08 Die. Thomas & Betts WT-230 with die No. GSC 225 Heat gun.



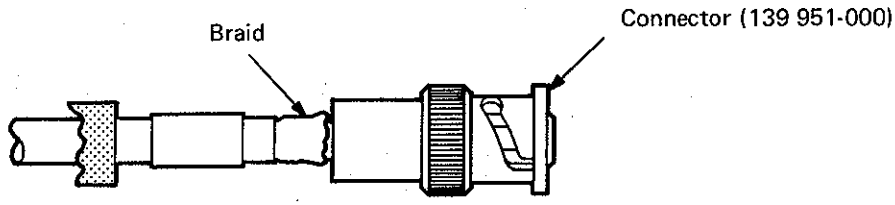
STEP 2

Solder center conductor contact as shown.



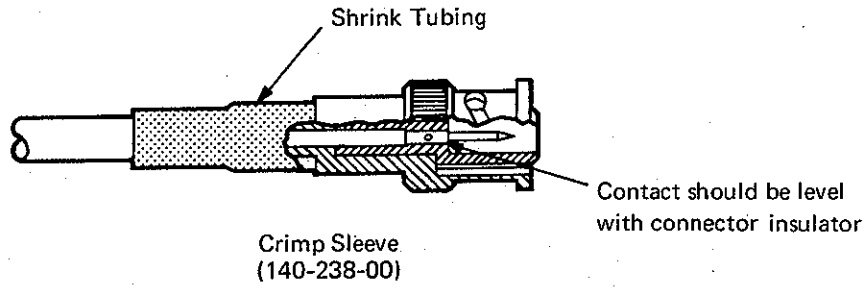
STEP 3

Install connector body as shown. Ensure that all braid goes over outside of body as shown.



STEP 4

Crimp sleeve using crimp tool specified in special tools required block. Slide shrink tubing in place and shrink using heat gun.



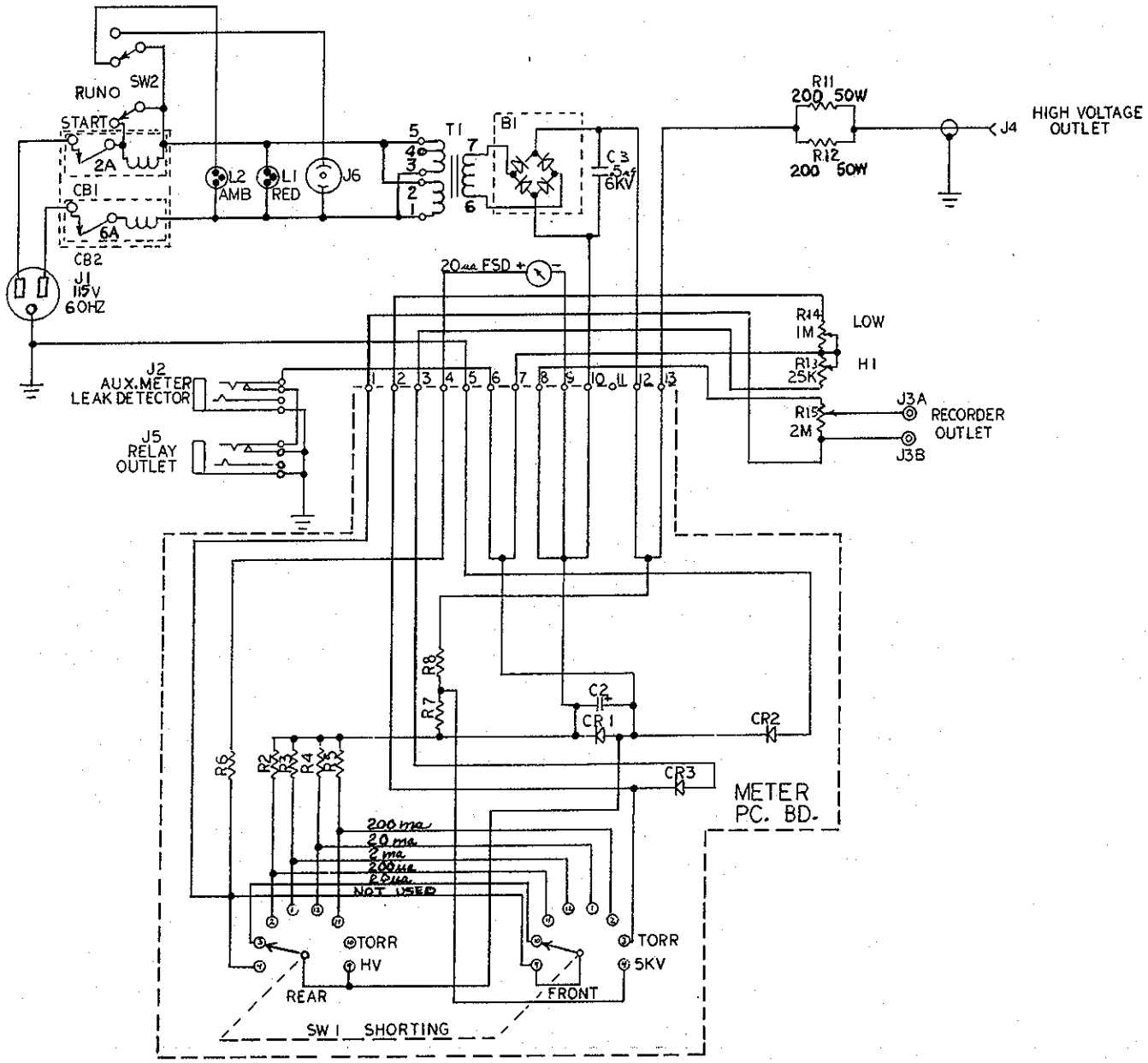


Figure 7. Schematic Diagram, 150 mA Unit

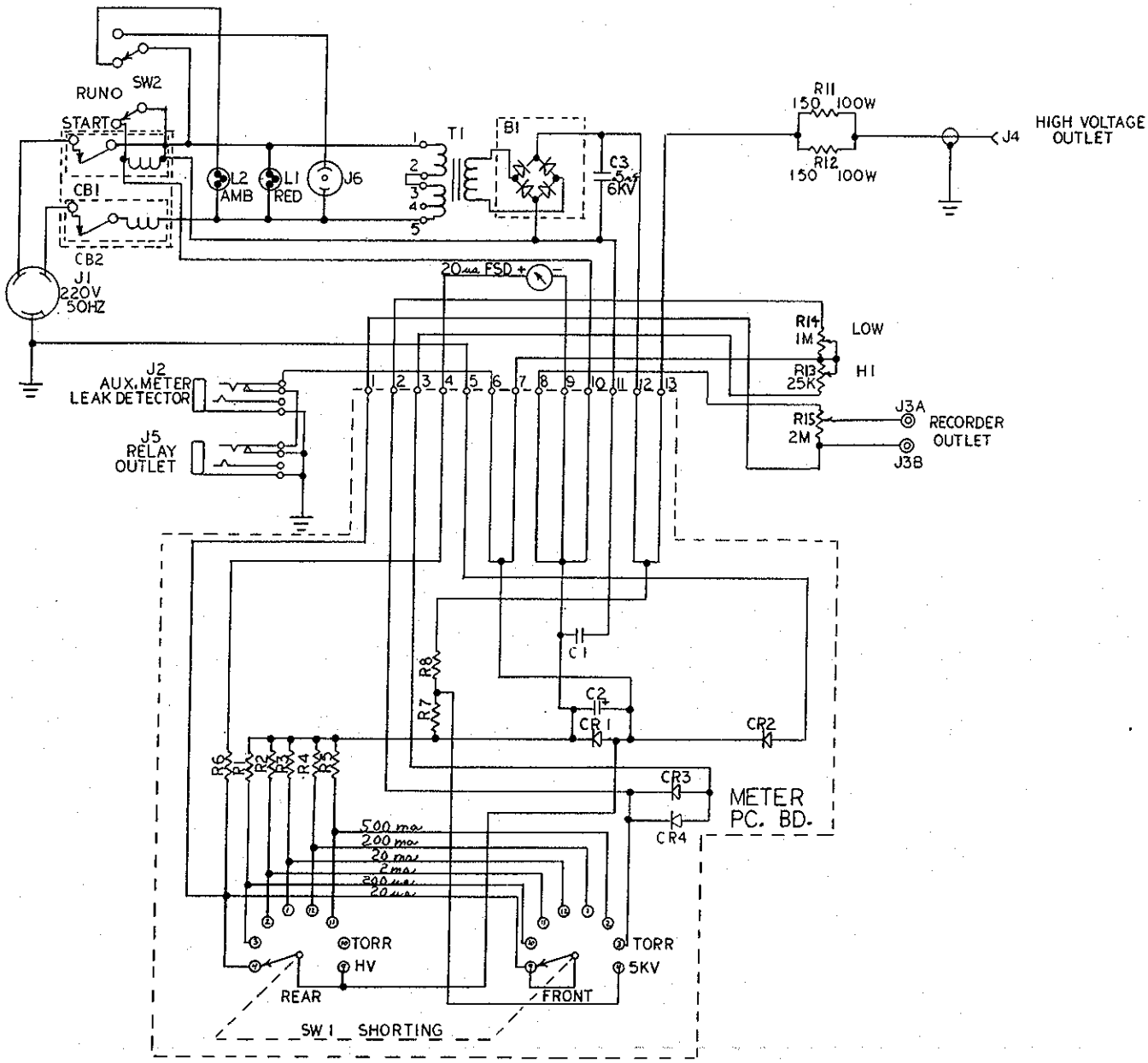


Figure 8. Schematic Diagram, 350 mA Unit

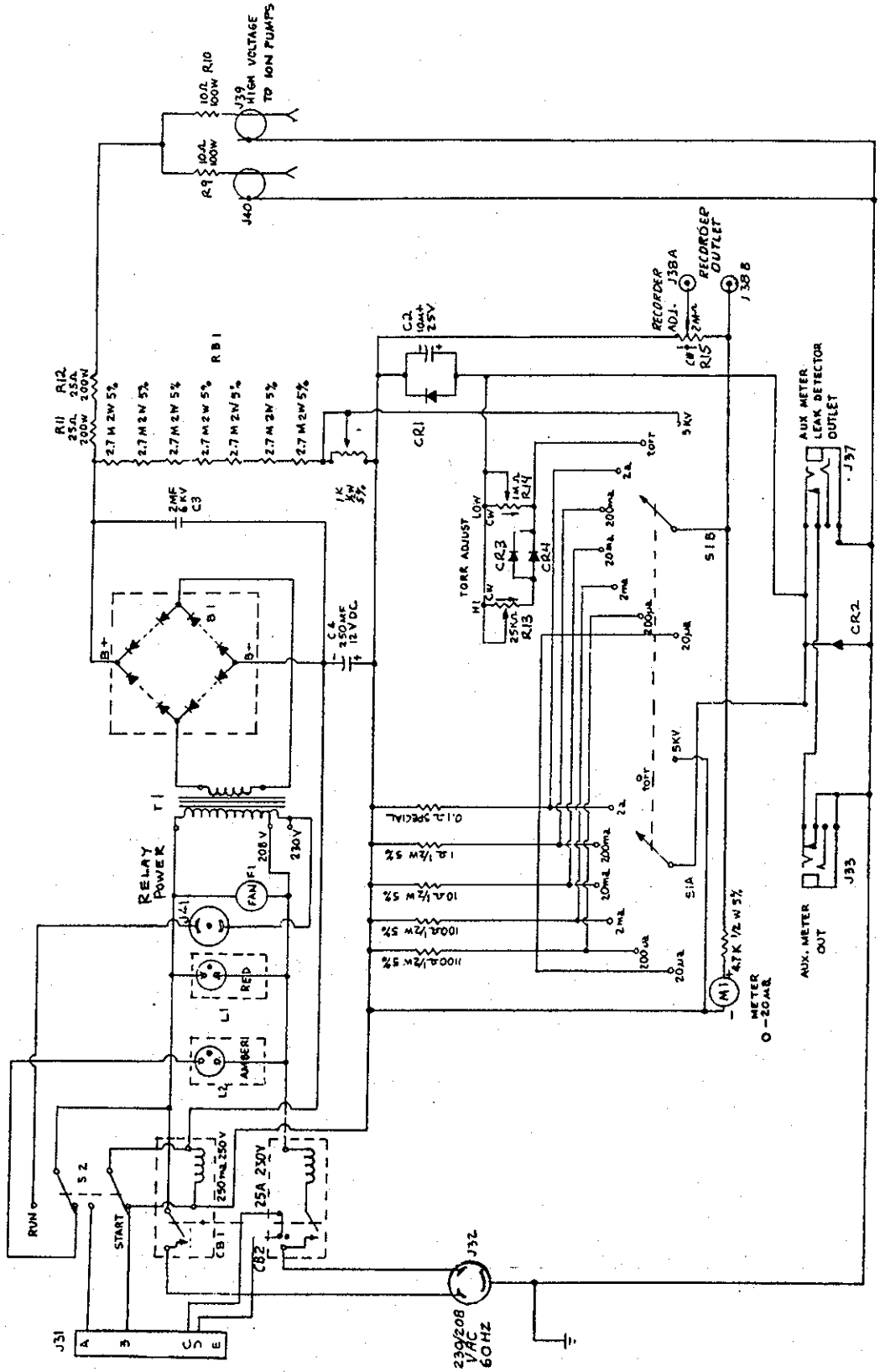


Figure 9. Schematic Diagram, 1 Amp Unit

150 mA Ion Pump Control Unit, Model 222-0410 (117 V) Assembly/Stock No. 401-338-700
222-0460 (220 V) Assembly/Stock No. 401-338-800

ITEM NO.	CIRCUIT REF. DES.	DESCRIPTION	STOCK NO.	TOTAL QTY.
1	T1	Power Transformer (117 V)	401-308-000	1
2		Power Transformer (220 V)	401-308-700	1
3	C3	Capacitor, 0.5 Mfd, 6 kV	113-062-000	1
4	R11,12	Resistor, 200 Ohm, 50 W	134-001-000	2
5	R13	Potentiometer, 25 KΩ, 2 W	134-510-000	1
6	R15	Potentiometer, 2 MegΩ, 2 W	134-522-000	1
7	R14	Potentiometer, 1 MegΩ, 2 W	134-523-000	1
8	S1	Range Switch, 117 V	401-339-900	1
9	S1	Range Switch, 220 V	401-340-100	1
10	S2	Switch, DPST, 6 A (117 V)	135-104-000	1
11	CB1	Circuit Breaker (117 V)	135-564-000	1
12	CB1	Circuit Breaker (220 V)	135-580-100	1
13	B1A, B1B	Diode Bridge	136-406-300	2
14	M1	Panel, Meter, 20 Microamp	137-312-000	1
15		Power Cable (117 V)	138-000-000	1
16		Power Cable (220 V)	401-315-900	1
17		Ceramic Standoff	139-010-000	4
18		Bracket Cap	139-375-000	2
19	L1	Indicator Light, 115 V, Red	139-158-000	1
20	L1	Indicator Light, 220 V, Red	139-156-000	1
21	L2	Indicator Light, 115 V, Amber	139-159-000	1
22	L2	Indicator Light, 220 V, Amber	139-157-000	1
23		Knob, Black, 1-1/2" Skirt	139-792-020	1
24	J3B	Jack, Banana, Black	139-962-000	1
25	J3A	Jack, Banana, Red	139-963-000	1
26	J2	Jack, Phone, 3-conductor	139-978-000	1
27		Cable Assembly, H.V.	138-462-010	1
28		Banana Jack Connector (220 V Only)	139-964-000	1
29		Phone Jack Connector (220 V Only)	139-979-900	1
30		Connector Twist Lock (220 V Only)	139-914-000	1
31		Cap Plug	139-840-000	1

350 mA Ion Pump Control Unit, Model 222-0510 (117 V) Assembly/Stock No. 401-340-400
222-0560 (220 V) Assembly/Stock No. 401-340-600

ITEM NO.	CIRCUIT REF. DES.	DESCRIPTION	STOCK NO.	TOTAL QTY.
1	T1	Power Transformer (117 V)	132-005-000	1
2	T1	Power Transformer (220 V)	400-626-000	1
3	C3	Capacitor, 0.5 Mfd, 600 V	133-062-000	1
4	R11,12	Resistor, 150 Ohm, 100 W	134-008-000	2
5	R13	Potentiometer, 25 KΩ, 2 W	134-510-000	1
6	R15	Potentiometer, 2 MegΩ, 2 W	134-522-000	1
7	R14	Potentiometer, 1 MegΩ, 2 W	134-523-000	1
8	S1	Switch, Range (117 V)	401-342-200	1
9	S1	Switch, Range (220 V)	401-342-300	1
10	S2	Switch, Toggle, DPST	135-104-000	1
11	CB1	Circuit Breaker, 115 V, 3 A	135-545-000	1
12	CB1	Circuit Breaker, 220 V, 2-Pole	135-569-000	1
13	CB2	Circuit Breaker (115 V, 18 A Only)	135-546-000	1
14	B1A, B1B	Diode Bridge	136-406-300	2
15	M1	Panel Meter, 20 μA	137-311-000	1
16		Ceramic Standoff	139-008-000	4
17	L1	Indicator Light, 115 V, Red	139-158-000	1
18	L1	Indicator Light, 220 V, Red	139-156-000	1
19	L2	Indicator Light, 115 V, Amber	139-159-000	1
20	L2	Indicator Light, 220 V, Amber	139-157-000	1
21		Clamp	139-414-000	1
22		Knob, Black, 1-1/2" Skirt	139-792-020	1
23	J3B	Jack, Banana, Black	139-962-000	1
24	J3A	Jack, Banana, Red	139-963-000	1
25	J2	Jack, Phone	139-978-000	1
26		Power Cable (115 V)	138-011-000	1
27		Power Cable (220 V)	401-315-900	1
28		Bracket, Capacitor	139-375-000	2
29		Banana Jack Connector (220 V)	139-964-000	1
30		Phone Jack Connector (220 V)	139-979-000	2
31		Cable Assembly, H.V.	138-462-010	1
32		Connector, Male UG-932	139-951-000	1
33		Cap Plug	139-840-000	1
34		Male Connector (220 V)	139-914-000	1

1 Amp Ion Pump Control Unit, Model 222-0600 (208/230 V) Assembly/Stock No. 400-955-010
222-0650 (208/230 V) Assembly/Stock No. 401-142-010

ITEM NO.	CIRCUIT REF. DES.	DESCRIPTION	STOCK NO.	TOTAL QTY.
1		Front Panel (60 Hz)	400-979-010	1
2		Front Panel (50 Hz)	401-320-000	1
3		Bottom Plate	400-978-000	1
4		Cover	400-101-000	1
5		Left Sidewall	400-100-010	1
6		Right Sidewall	400-100-020	1
7		Bracket, Capacitor	061-096-000	1
8	F1	Fan, 230 V, 14 W	132-310-000	1
9	C2	Capacitor, 10 Mfd, 25 V	133-050-000	1
10	C3	Capacitor, 2 Mfd, 6 kV	133-063-000	1
11	C1	Capacitor, 250 Mfd, 12 Vdc	133-067-000	1
12	R9,10	Resistor, 10 Ohm, 100 W	134-011-000	2
13	R11,12	Resistor, 25 Ohm, 200 W	134-050-000	2
14	R13	Potentiometer, 25 KΩ, 2 W	134-510-000	1
15	R15	Potentiometer, 2 MegΩ, 2 W	134-522-000	1
16	R14	Potentiometer, 1 MegΩ, 2 W	134-523-000	1
17	RB1	Subassembly, Resistor, Bank 7 X 2.7 MegΩ	134-901-000	1
18	T1	Transformer, Power (208/230 V, 50 Hz)	400-619-000	1
19	T1	Transformer, Power (208/230 V, 60 Hz)	400-942-000	1
20	S1	Range Switch	135-063-010	1
21	S2	Switch, DPDT, 230 V, 1 A	135-108-000	1
22	CB1,CB2	Circuit Breaker, 2-Pole	135-580-200	1
23	CR1 thru CR4	Diode, 1N4001	136-125-000	4
24		Frame, Filter	400-645-000	1
25	B1	Diode, Bridge, 9 kV	400-622-000	1
26	M1	Panel, Meter, 20 microamp	137-310-000	1
27		Cable, High Voltage	138-462-010	2
28		Cable, Power	138-463-000	1
29		Standoff, Ceramic	139-020-000	8
30	L1	Indicator Light, 230 V, Red	139-156-000	1
31	L2	Indicator Light, 230 V, Amber	139-157-000	1
32		Terminal Strip	139-520-000	1
33		Handle, Tie Kit	139-635-000	1
34		Filter, Air	400-703-000	1
35		Knob, Black, 1-1/2" Skirt	139-792-000	1
36	J32	Plug, Power	139-921-000	1
37	J40,39	Receptacle, H.V., BNC	139-952-000	2
38	J38B	Jack, Outlet, Black	139-962-000	1
39	J38A	Jack, Outlet, Red	139-963-000	1
40	J33,37	Jack, Phone, 3-conductor	139-978-000	2
41		Spacer Hex, 6–32 X 3/4"	121-012-000	4
42		Cap Plug	139-840-000	2
43		Rating Label	300-048-000	1
44	J41	Receptacle 10 A (220 V)	139-919-000	1
45	J31	Connector, Bulkhead	140-198-000	1
46		Nameplate Badge	300-047-010	1