

INSTRUCTION MANUAL  
FOR  
BIDDLE STABILIZED DIELECTRIC TEST SET  
CATALOG NO. 222060

HIGH VOLTAGE EQUIPMENT

PLEASE READ CAREFULLY  
BEFORE OPERATING

Safety is the responsibility of the user

APARATO DE VOLTAJE ALTO

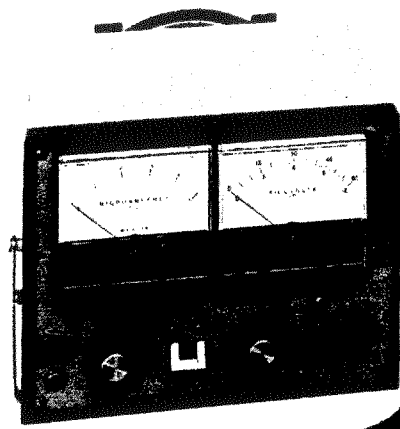
SIRVANSE LEER ESTE LIBRO CONCUIDAD  
ANTES DE OPERARLO

La seguridad es el cargo del operador

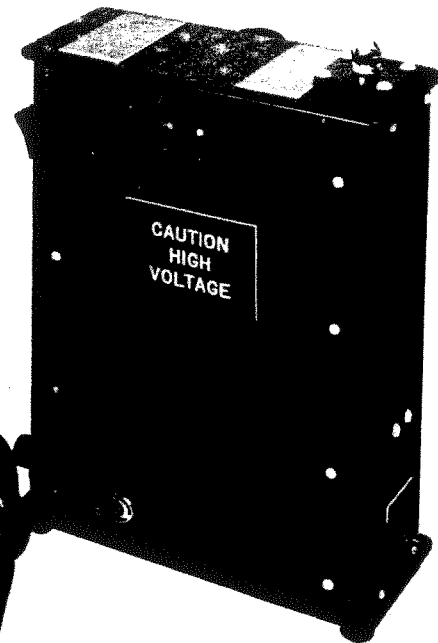
JAMES G. BIDDLE COMPANY  
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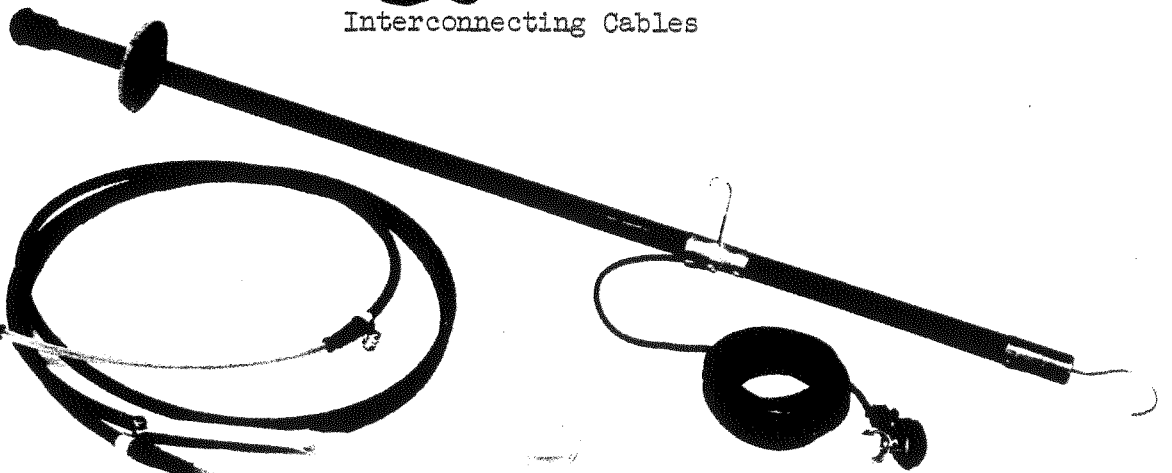
Control Unit



High Voltage Unit



Interconnecting Cables



Output Cable,  
Option Cat. No. 222060-60

Discharge Stick  
Option Cat. No. 22260-62

ACCESSORIES



Control unit in carrying case

FIGURE 1:

## BIDDLE STABILIZED DIELECTRIC TEST SET

### SECTION A

#### INTRODUCTION

This Instruction Manual is intended as a guide to the operation and maintenance of this portable, stabilized Dielectric Test Set.

The instructions and suggestions of this manual anticipate the normal use of the Dielectric Test for dc proof tests of electrical insulation in such equipment as motors, generators, bushings, and cables; and the measurement of leakage and absorption currents. Such tests are able to provide important guides as to the condition of a given electrical insulation system and are based on observation of the applied voltage, the resultant current flow and the manner that current varies with time. Very often this information is plotted on graph paper such as Biddle kilovolt-megohm paper (Cat. 22000). The shape of the curve made by connecting the observed points becomes significant. Such data presentation aids in the evaluation of the specimen. For additional information on the interpretation of observed data and guides for test voltage and time see Biddle Technical Publication 22T1 and the Application section of this manual.

## SECTION B

### SAFETY PRECAUTIONS

- SAFETY IS THE RESPONSIBILITY OF THE USER -
- LA SEGURIDAD ES EL CARGO DEL OPERADOR -

The Test Set and the specimen to which it is connected are a source of high-voltage electrical energy and all persons making or assisting in the tests must use all practical safety precautions to prevent contact with energized parts of the test equipment and associated circuits.

Persons actually engaged in the test must stand clear of all parts of the complete high-voltage circuit unless the set is de-energized and all parts of the test circuit are grounded.

Any persons not directly associated with the work must be kept away from test activities by suitable barriers, barricades or warnings.

When energized at 60 kV a test setup may induce a static voltage charge on nearby insulated objects, including people. To avoid such a condition all insulated objects must be grounded or kept at least six feet from the energized structure.

On termination of a test, after the power source has been shut down, the kilovoltmeter will gradually return to zero indicating the specimen and Test Set are approaching discharge condition at which time the Test Set and specimen must be short circuited by means of a safety ground ("hot-stick") to solidly ground all live parts. Ground bonds should then be applied and left in place.

If the set is properly operated and all grounds correctly made, no rubber gloves are necessary. As a routine safety procedure, however, some users require the use of rubber gloves, not only in making connections to the high-voltage terminals, but in manipulating the controls. The James G. Biddle Co. considers this to be an excellent safety practice.

A safety bond between the Output Terminal and Guard on the High-Voltage unit is additional safety insurance during transportation and storage.

## SECTION C

### SPECIFICATIONS

Maximum Output Voltage: 60 kV dc.  
Maximum Output Current: 5 mA, continuous.  
Output Polarity: Negative with respect to ground.  
Supply Voltage: 110-130 volts, 50/60 Hz, single phase, grounded.  
Max. Supply Current (normal operation): 9 amperes.  
Ripple, full load (resistive): 2%  
Time to charge capacitive specimen to 98%: 42 seconds/0.1 microfarad.  
Time to discharge to 2% (through internal resistance): 1.3 minutes/0.1 microfarad  
Regulation: Less than 1% for all loads up to 3 mA.  
Less than 3% for all loads up to 5 mA.  
Voltmeter: 4 1/2" taut band, 2 ranges: 0-12 & 0-60 kV.  
Current Meter: 4 1/2" taut band, 5 ranges: 0-5/50/500  $\mu$ a, 5/50 mA.  
Meter Accuracy:  $\pm$ 3% of full scale.  
Overload Protection: Magnetic circuit breaker in input line.  
  
Separate fuses for auxiliary power supply and fan.  
  
Crowbar circuit on the main rectifier supply tripped by line voltage in excess of 130 V or by specimen short-circuit.  
  
Voltmeter and Current Meter internally protected.  
  
High voltage ballast resistor to limit ground-loop currents so that control unit remains essentially at ground potential in the event of specimen failure.  
  
Control Circuit: Pushbutton start and stop sequence, zero start interlock.  
Input line ground indicated by pilot lamp.  
Rate of rise automatically limited and independent of control knob manipulation.  
Jack provided for external current meter.  
  
Overall Size and Weight:  
Control Unit:  
11 x 12 x 8 1/2 inches (28.0 x 30.5 x 21.6 cm); 24.5 lbs. (11.1 kg).  
HV Unit:  
12 1/2 x 5 1/2 x 16 inches (31.8 x 14.0 x 40.5 cm); 22 lbs. (10 kg).



## SECTION D

### DESCRIPTION

The equipment is a stabilized dielectric test set for use in the field, shop or laboratory for measuring the electrical quantities of applied voltage and current flowing in specimens to which it is connected. Because it incorporates a stabilizing arrangement, measurement of variations in current with time are simplified. It is a very light weight design for convenient transportation and is constructed in two units.

Circuit operation is as follows: Refer to the block-diagram (Fig. 2, page D3 ). The relationship between the block-diagram and the schematic (Fig. 3, page D4), will be evident since the component symbols on the schematic have similar numbers on the block-diagram.

The basic power line control system is block (1) and controls the three power supplies (400).

The circuit action is controlled by feedback loops. Starting from the oscillator (201) a sawtooth wave of about 17.2 KHz is generated. In the error-signal-pulse-width logic (202) this is converted into two identical square wave trains of constant amplitude, and opposite polarities, having a frequency of about 8.6 KHz. These two wave trains are summed to form a complete square-wave.

The voltage control (601) acts on the pulse-width logic (202) to change the length of the ON period of both wave trains to effect control. This action can be followed starting with one wave train at the zero condition: after a time  $T_1$  the wave steps to its maximum amplitude and remains at this level for a period of time  $T_2$  when it returns to zero. In this way a waveform is obtained (as shown in Fig. 2) at the pulse shaper (203). Time  $T_1$  has a fixed minimum value of about 5 microseconds and the logic varies the time  $T_1$  and  $T_2$  under the action of the voltage control in such a way that Equation 1 always applies.

$$\text{Equation 1:} \quad 8.6 \text{ KHz} = \frac{1}{4T_1 + 2T_2}$$

The output of the pulse shaper feeds the drive amplifier (204) which reproduces in amplified form the basic waveform. (See Fig. 2, waveform inset, page D3).

This drive signal is used to control a transistor bridge switch (main power converter 300) that applies the dc from power supply (403) to the high voltage transformer primary included in block 500. The secondary voltage is rectified and multiplied by a factor of 4 to produce the output voltage. Control is effected by varying  $T_2$  from zero to the limit as previously explained.

The voltmeter (100) measures the actual output voltage and provides a signal to the error amplifier (602) that compares the setting of the voltage control with the actual output. If an error exists because the output is low, a signal is fed to the logic to increase  $T_2$ . When no error exists  $T_2$  tends to become zero or remains just sufficient to hold the desired output voltage to the value set on the voltage control, regardless of line voltage variations or variations in the current flowing in the specimen.

SECTION D (continued)

To limit the output current to the capabilities of circuit components it is necessary to provide an automatic limit to the growth rate of  $T_2$  when setting the voltage control. This is provided by the slew rate circuitry of (601).

The current meter (100) measures only the current flowing in the specimen. In the event of overcurrent, due to specimen failure or low impedance, the overcurrent trigger of block (300) trips the crowbar and very rapidly shuts the test set down, to prevent internal damage and to limit specimen damage.

As a protection against overvoltage surges in the main power supply the voltage trigger will shut the set down via the crowbar.

The high operating frequency reduces the internal stored energy and because regulation is on a per cycle basis close control is possible.

The heavy current solid state devices are cooled by a fan that comes on before these components are energized and remains on after they are shut down. In the event of fan failure or blockage of the ventilation the thermal switches act to shut the set down. The remainder of the control circuit is conventional and evident from the schematic.



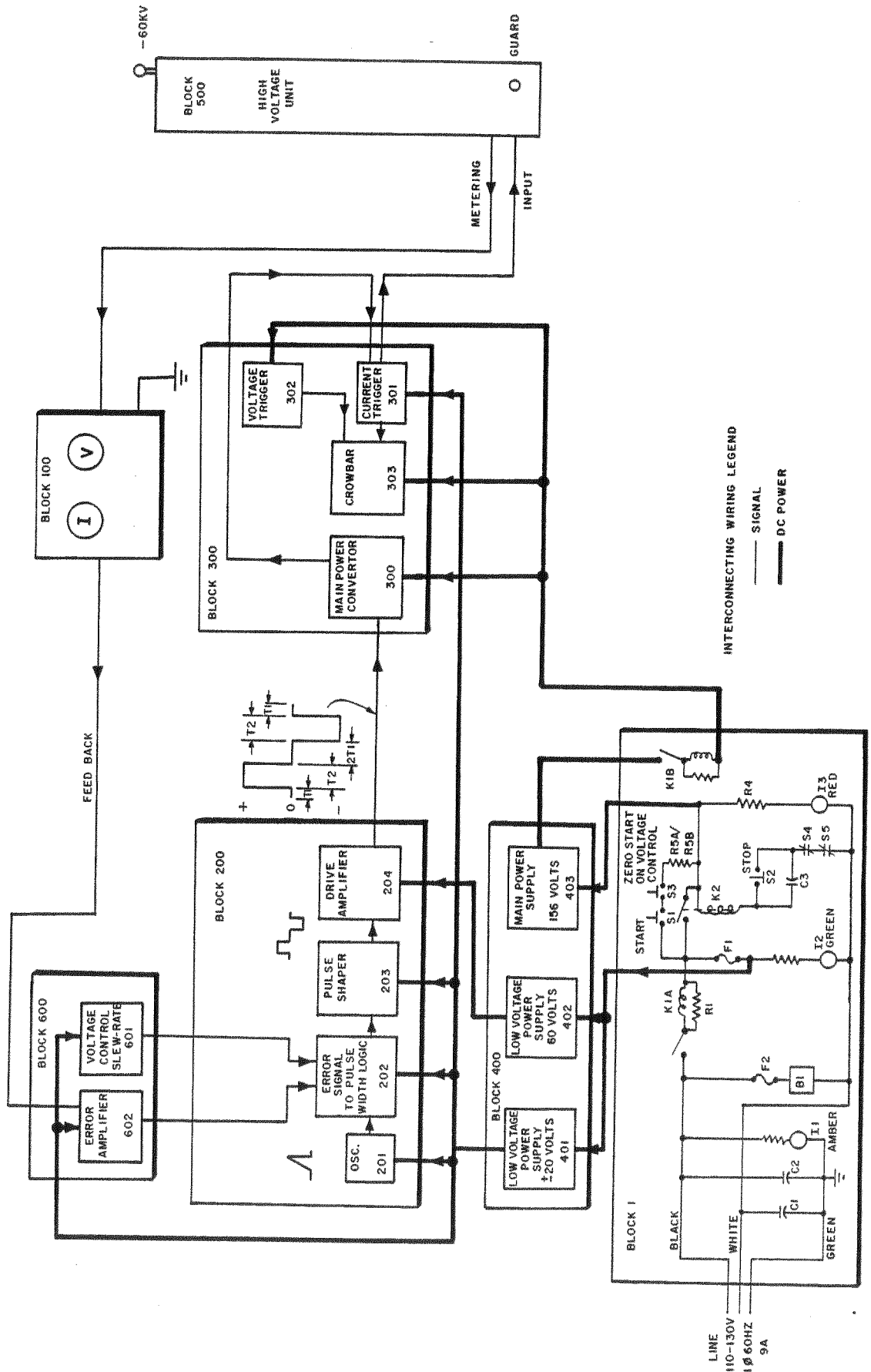


FIGURE 2 BLOCK DIAGRAM (WAVEFORMS)



## SECTION E

### SETTING UP

Refer to pictures of figure 4 page E3 and figure 5 page E4 of this manual for location of operating controls and cables.

Refer to pictorial drawings of figure 6 page E5 for representative connection of the set to typical specimens.

Insure that the specimen is in a safe condition and the area protected from intrusion by unauthorized persons. Position the High Voltage Unit so the top ball terminal can readily be connected to the high voltage terminal of the specimen (do not connect until later). The low voltage end of the specimen is to be connected to ground.

As a guide in setting up a test the minimum air clearances of Table I must be maintained <sup>1</sup> between the exposed energized conductor and any adjacent grounds in order to prevent arcover. Such accidental arcover may damage a specimen or cause a safety hazard.

These values apply to the direct air path at the point of closest approach to ground.

The position of the exposed conductors with respect to ground can often be conveniently established by using clean nylon rope to tie the conductor in place. Table I also gives lengths for the use of such rope if it is connected to the high voltage. Note that a leakage current flows down the rope which will be included in the total current measured by the test set unless guarded. If the rope is tied to the cable shield, lengths are not critical provided they do not intrude into the direct air path.

TABLE I

<u>Voltage of Test</u>	<u>Direct Air Path</u>	<u>Path Along Dry Nylon Rope</u>
5 kV	1 1/4 inch	1 inch
10 kV	1 9/16 inch	2 1/4 inches
15 kV	1 7/8 inch	3 1/2 inches
20 kV	2 1/4 inches	5 inches
30 kV	2 7/8 inches	7 1/2 inches
40 kV	3 1/2 inches	10 inches
50 kV	4 1/4 inches	13 inches
60 kV	5 inches	16 inches

<sup>1</sup> See operation notes (G)

SECTION E (continued)

Locate the control unit in a safe position within 10 ft. of the High Voltage Unit and interconnect it to the High Voltage Unit. The position chosen must be within ground cable reach (10 ft.) of a low resistance ground. Make the ground connection. The input cable must also reach (10 ft.) a 120 V service outlet, preferably of the standard 3-wire form.

Provide cover to protect both units from rain and avoid locating on very wet surfaces.

The specimen may now be connected (see application notes of this manual) <sup>1</sup>; insert the power cord in the service outlet.

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<sup>1</sup> See application notes (H)

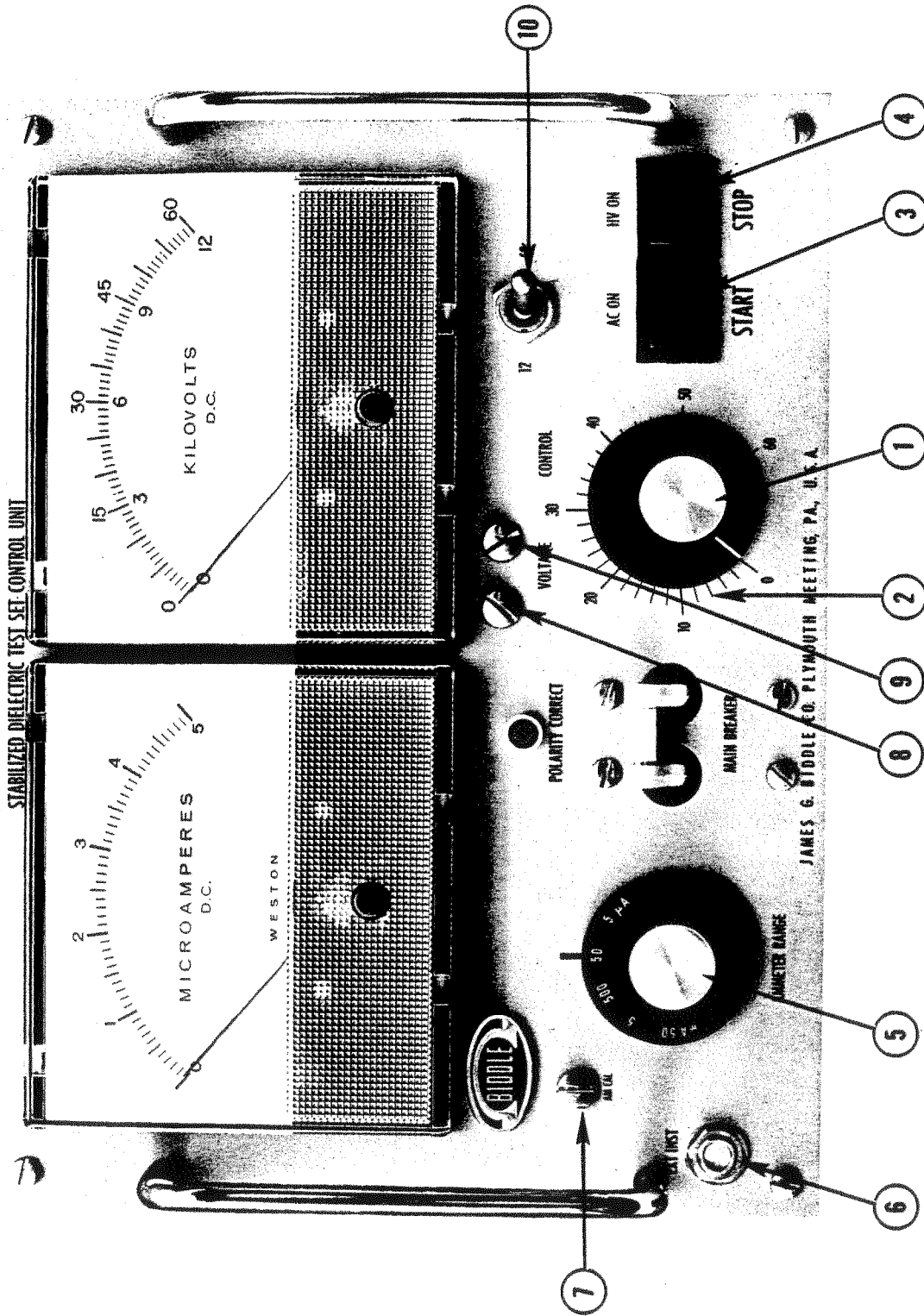


FIGURE 4: FRONT PANEL

1. Voltage Control
2. Voltage Setting Scale in KV
3. Start Button/green lamp
4. Stop Button/red lamp
5. Current Meter Range Switch
6. External Instrument Jack
7. Cover Screw - Current Meter Calibration
8. Cover Screw - 12 KV Voltmeter Calibration
9. Cover Screw - 60 KV Voltmeter Calibration
10. Voltmeter Range Selector Switch



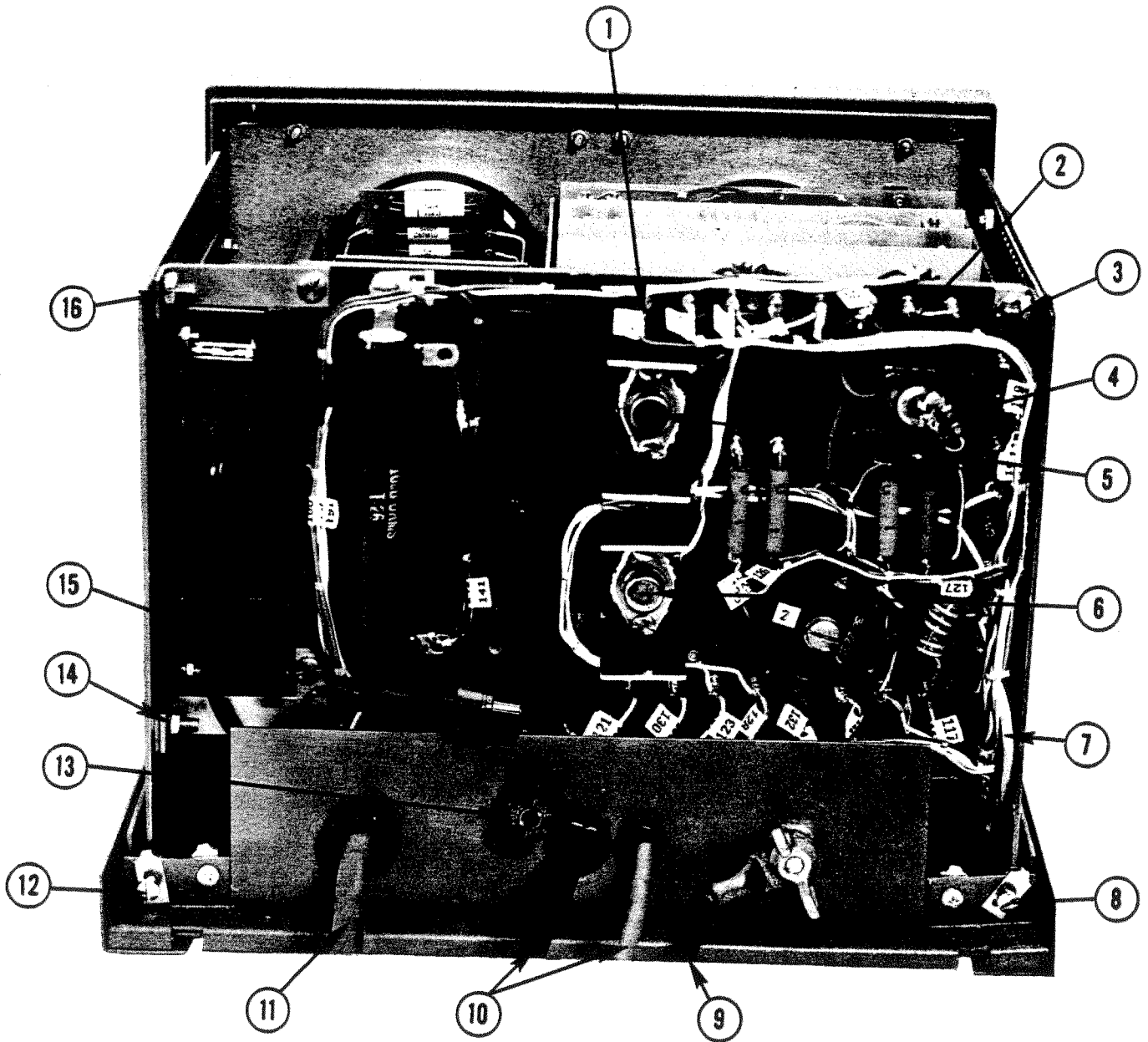


FIGURE 5: REAR VIEW

- |  |                                      |
|--|--------------------------------------|
| 1. Remove red lead to test driver circuit. | 9. Ground Cable                      |
| 2. Main Power Converter test link.         | 10. Interconnecting Cables           |
| 3. Main Circuit Board Holding Screw        | 11. Line Cord                        |
| 4. Crowbar SCR Q300                        | 12. Case Cover Screw                 |
| 5. Driver Transistor Q200                  | 13. Fuse F1                          |
| 6. Driver Transistor Q204                  | 14. Main Circuit Board holding screw |
| 7. Main Circuit Board holding screw        | 15. Fan Fuse F2                      |
| 8. Case Cover Screw                        | 16. Main Circuit Board holding screw |

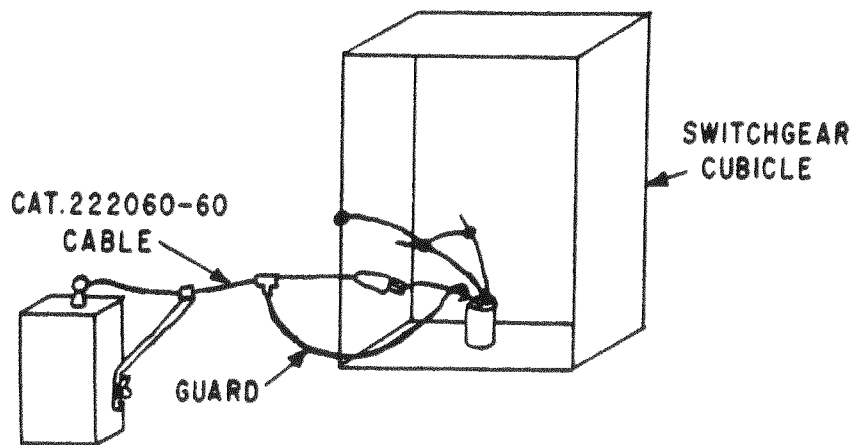
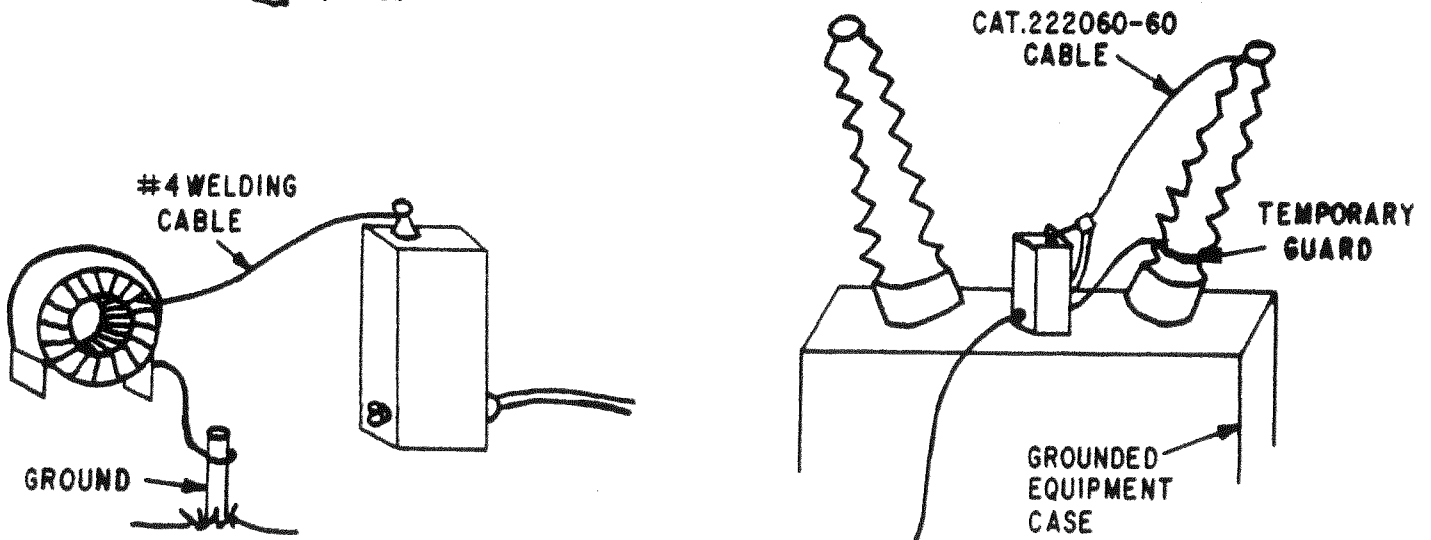
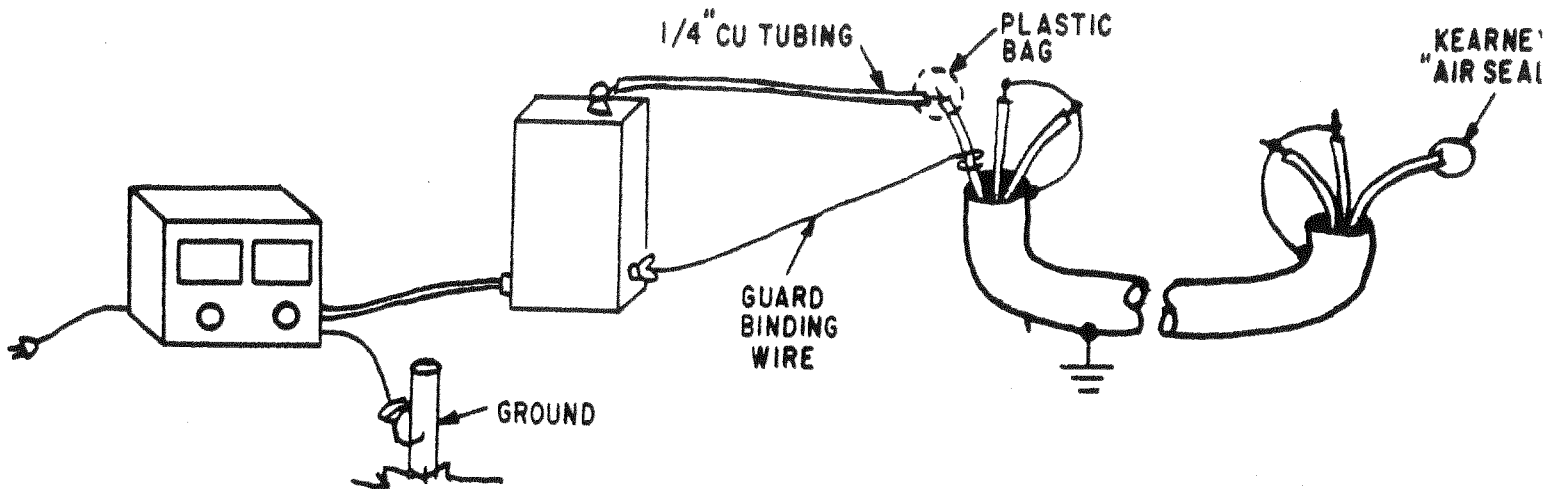


FIGURE 6 TEST CONNECTIONS TO SPECIMENS



## SECTION F

### OPERATION

For actual operation follow the steps below:

- A) Observe that the polarity lamp glows at normal brilliance and fan runs.<sup>1</sup>
- B) Clear all personnel.
- C) Close circuit breaker.
- D) Set and hold OUTPUT CONTROL at zero.
- E) Press "START" button to obtain red light.
- F) Set current meter to 50 mA range.<sup>1</sup>
- G) Raise output voltage to desired value using the dial setting, verify by reading voltmeter and make current measurement, selecting current meter range as required.<sup>1</sup>
- H) Return OUTPUT VOLTAGE control to zero.
- J) Press "STOP" button (red light) to put out red light and return to ready condition.
- K) Open circuit breaker to put out green light. Stand by.
- L) Allow voltage on set and specimen to return to zero or safe value. (May be hastened by use of discharge resistance hot stick; option 222060-62.)
- M) Apply specimen safety ground and observe voltmeter to read zero.
- N) Remove line cord.
- P) Disconnect set from specimen.
- Q) Remove all grounds except a permanent safety ground across the specimen.

Items "A" through "Q" define a normal procedure that can be modified to accommodate the type of test and specimens under consideration. At any time a test can be interrupted by pressing the red button or opening the circuit breakers or returning the output voltage control to zero. This will not remove the voltage stored in the Test Set and specimen by capacitance and it is necessary to reduce this stored

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<sup>1</sup> See operation notes (G)

SECTION F (continued)

energy by waiting for the internal resistance of the Test Set to discharge the system or to hasten the discharge by applying a parallel resistance to ground, using hot-stick techniques. In general, it is not desirable to apply a short-circuit to the system unless the voltage has been reduced to half the voltage of the test to prevent transients which may damage the specimen.

At the conclusion of a test a short-circuit should be applied to the specimen, observing the precautions outlined in the previous paragraph, and left in place until all energy stored in the specimen has been dissipated.

In the event that a specimen has excessive leakage or if for any reason current is taken in excess of the rating limit of the Test Set, the circuit-breaker will trip.

Because of the zero start sequence any trip-out will require that the start procedure of steps A through G be repeated to re-energize the test.

The discharge stick cat. 222060-62 has a series discharge resistor built in and in use when contact is made to the tip of the stick. The direct grounding of a specimen after discharge can be made by moving the stick so that the hook near the middle is connected to the specimen. Before using the discharge stick connect the ground cable to a low resistance ground.

## SECTION G

### OPERATION NOTES

The letter preceding each note refers to the operating instruction step in Section F (Operation).

- (A) When the set is connected to an energized socket having one leg grounded, the polarity lamp will glow. If this does not occur either the socket is not energized or the line ground is incorrect or does not exist. This condition should be corrected.
- (F) It is good practice to habitually leave the current meter range switch on the 50 mA range except when actually making a measurement.
- (G) The voltage control scale can be used to set the output voltage within 11 kV under normal circumstances. By using this feature it is not necessary to "inch" the control or to follow the indicated voltage. This feature will be found very helpful in making step voltage tests or when setting-up a test at a pre-determined voltage. By following the Voltage Control scale setting, over-volting a specimen can be avoided.

For all normal use no special care is necessary in the rate at which the voltage control is increased, but it is recommended that it be done reasonably slowly to prevent any possibility of tripping the input breaker. The circuit was designed to charge specimens up to 1  $\mu$ fd under the automatic control of the slew-rate circuit.

The output voltage will appear to lag behind the control because of the slew-rate circuit, the extent of this lag depends on the capacitance of the specimen.

The action to be expected is for the voltage to rise relatively slowly to the value set on the Voltage Control and then to accurately maintain this value.

During this rising voltage period the current normally will be maintained at a rather high level. Once the voltage reaches the desired value, the current will slowly decrease until the geometric capacitance has been essentially charged. The current will then very slowly decrease in time to follow the leakage plus absorption current values (see Technical Publication 22T1).

Specimens greater than 1  $\mu$ fd can be charged by advancing the Voltage Control so as to follow the output voltmeter rise. This is a special condition and results in charging the specimen at a rate just below the rate that will trip the circuit breaker. This charging rate is slower than normal and in general the larger the specimen capacitance the longer it will take to build voltage up on the specimen.

The largest capacitance that can be tested thus depends on the time factor of the test in progress (see Technical Publication 22T1 and section H of this manual).

## SECTION H

### APPLICATION NOTES

A typical test procedure is described as a guide for the application of the test set. Assume as a specimen one phase of a new polyethylene power cable 300 ft. long rated 15 kV and of 2/0 conductor size. Based on 22T1 the following test is specified:

Five 10 kV steps for 1 minute each and a final 5 kV step for 5 minutes. From this specification the cable must be tested at 10, 20, 30, 40 and 50 kV remaining at each step for 1 minute and a final test at 55 kV for 5 minutes.

To perform this test the set and specimen are made ready per section E (also see remaining application notes) and the set is operated per section F following steps A through F.

It is assumed that the operator has a watch or clock with a sweep second hand. The operator sets the voltage control to 10, then when the voltmeter reaches 10, he notes the time, selects the range on the current meter and reads the current after an elapsed time of 1 minute. The operator sets the voltage control to 20, records his previous current reading and after an elapsed time of 2 minutes, notes the current, moves the control to 30 and so on. At the end of the test the operator follows the shut-down procedure of section F steps G through Q. The data is then transferred to the kilovolt megohm paper, the feeder number and other pertinent data recorded and the test points connected. This presents the data for evaluation.

Specimen failures will normally not damage the test set regardless of the meter ranges in use.

This set features a crowbar system that acts to cut off the test set very rapidly if a specimen fails and, because of the small internal energy storage, limits possible specimen damage to the energy stored in the specimen.

It is not recommended that a failure in a specimen be located by repeatedly raising the specimen to failure since the test set may be thermally overloaded unless a considerable period is allowed between flashovers (say 1 discharge every 10 minutes) or an external series resistor is used to limit the current to 5 mA.

The High Voltage Unit normally can be located quite close to the specimen terminal because of its small size and light weight. This permits connection to the specimen using a short jumper made out of 1/4" soft copper tubing or #4 welding cable, or by using the output cable, option 222060-60.

If the terminals of the specimen present sharp points or corners, the adjacent air may be ionized by electrical stress when energizing the specimen. This appears as leakage current and since such currents can be significant they may tend to mask the true specimen currents. To minimize this, increase air clearance or cover such points to prevent ionization. One method is to use KEARNEY AIR SEAL or similar compounds. Another method is to wrap the area with a thin vinyl or plastic film. The thin plastic bags or wrappings used for food storage may be found convenient.



## SECTION H (continued)

This Test Set is equipped with a Guard Terminal on the High Voltage Unit. This is a stud wing nut terminal located near the bottom of the case on the side opposite the cable connectors. This must not be grounded or the current meter will not read.

Since Guard is close to ground potential, a specimen surface-current to be eliminated from the measurement is intercepted by a temporary electrode attached to the specimen surface close to ground. This electrode is connected to the High Voltage Unit Guard.

The High Voltage Unit does not have a Ground connection made to it. It can be placed on a grounded surface or near a vertical ground. It is recommended that a minimum clearance of 15 inches be maintained to smooth grounded verticals. The High Voltage Unit can be operated in any attitude, but is balanced for base-down position and may require additional support for other attitudes. Clean, dry nylon safety rope can be used for this purpose or the web belt carrying handle can be used.

The High Voltage Unit case is made of a strong insulating material and coated to prevent the accumulation of static charges. While the coating is on both inside and outside surfaces, reasonable care should be taken to avoid scratches.

The test set should be protected from direct water entry by spray or rainfall. The jack J100 located in the lower left corner of the panel is to permit connection of external instruments of the current-indicating or recording type by using mating Standard phone plug (Mallory type 75 or equivalent) with the (-) terminal of the external instrument, connected to the plug frame and the (+) terminal to the plug tip. The specimen current so measured will be independent of the microammeter range selector switch setting. The internal resistance of instruments used at J100 should preferably not exceed 100,000 ohms. If the external instrument is of the potentiometer form, off balance potential should be held to less than 5 mV at the jack J100.

## SECTION I

### ROUTINE MAINTENANCE

Field service is a difficult environment for high voltage test equipment that can be offset by periodic inspection and cleaning. Performing such inspections and cleaning will increase the reliability of on-site operation.

Deposited dust is the principle problem since it impairs heat transfer from cooling surfaces and if conductive or hygroscopic it reduces insulation resistance.

Heat is evolved in the Control Unit and dissipated by heat-sinks and a relatively high velocity air stream. This was chosen because dust is blown through and deposits quite slowly on critical areas. DO NOT add an air filter to the ventilation system as this reduces air velocity and tends to clog with dust !

In the High Voltage Unit the precipitation action of the high voltage tends to deposit dust and reduce the effectiveness of the creepage paths provided.

Routine inspection and cleaning will be required at intervals depending on the field conditions encountered. As a guide, once every three months for sets operated indoors with normally dusty atmospheres and at the other extreme, weekly where the set is used daily outdoors with a heavy dust concentration that is conductive and hygroscopic.

The operating controls and indicating lamps warn when difficulties are developing and provide considerable information for trouble shooting when a defect does occur.

The High Voltage Unit uses a case made of an insulating material. Static bound charges are prevented from accumulating on the case surfaces by applying inside as well as outside a high resistance coating. This coating is tough and abrasion resistant but rough usage may result in major damage so that surface charges may accumulate.

### ROUTINE MAINTENANCE AND INSPECTION - PROCEDURE

Routine inspection and cleaning has been made simple and takes about one hour.

For cleaning, a clean soft bristled paint brush about one inch wide is convenient. A small vacuum cleaner with a small flexible pick up hose is better or if clean, dry, low-pressure air is available it can be used. A clean soft cloth is also helpful.

While cleaning, watch for loose connections or fittings.

To clean the High Voltage Unit, wipe the entire outside of the case, note any damage to the surface. Remove the side panels and remove any dust accumulated on the interior of the unit and side panels. Replace the side panels. As a safety precaution place a short-circuit jumper from the output terminal to guard terminal at least ten minutes prior to the work. After opening the case use an insulated jumper wire to short each capacitor.

## SECTION I (continued)

To clean the control unit, remove from its transportation case. Examine the leads for damage or wear and wipe them clean. Clean off the outer surfaces of the control unit case. Clean out the transportation case--especially the lead compartment.

To remove the control unit case cover, locate the two screws that retain it (see Fig. 5 page E<sup>4</sup>). Remove these, push the cover straight back from the front panel about 1/4 inch so the edge is visible and lift the cover off. Circuit cards can be removed and each is so keyed that it will only fit into the proper socket properly oriented. Be careful not to disturb the adjustment screws. Now clean the control unit interior. It can be shaken to locate any loose or foreign material lodged in regions hidden from direct view. Carefully clean the circuit cards and return to the appropriate sockets. Clean the fan, being sure that the blades are free and not obstructed. The fan motor is sealed and requires no lubrication. Replace the cover and retaining screws. Return the control unit to its transportation case.

The simplest inspection test is to operate the test set without load. Follow the operating instructions.

Note that the output voltmeter reading agrees with the setting of the voltage control and that at 60 kV the current meter indicates less than 0.2 microampere. If option 222060-60 cable is in use leakage may be as high as 0.5  $\mu$ A.



## SECTION J

### TROUBLE SHOOTING AND REPAIR

In the event of a defect developing in this set either return the set to the factory for repair or carry out the procedures outlined below to localize the problem. Consult parts list for replacement parts.

Problems are listed under lettered headings corresponding to the operating steps of section F under which they will most likely be encountered. Corrective steps are included.

A. Polarity lamp fails to glow and/or fan fails to run--

Look For: Defective input cable W1  
Defective polarity lamp I1  
Blown fuse F2 (commercial type MDL 3/16)

If the fan will not run when the set is plugged in, regardless of the position of the circuit breaker, the reason must be found before replacing the fuse. The most likely cause is connecting the set to a line with voltage in excess of 130V or into a dc source. The second most likely cause is a stalled fan motor, usually because foreign material has become lodged between blade and case. A third possibility is a defective fan motor.

NOTE: To gain access to the control section, disconnect all cables, slide it out of the transportation case and follow the procedure given in section I, Routine Maintenance.

B. Clear all personnel

Does not apply

C. Circuit breaker trips on closing and/or green lamp will not come on--

Look For: Chassis wiring failure if circuit breaker repeats trip out on closure.

Check chassis wiring using an ohmmeter. Refer to schematic diagram, fig. 3 page D4.

If breaker can be closed but green lamp does not come on--

Look For: Defective Lamp I2

NOTE: To replace either green or red lamp, remove the Bezel by pulling it straight out to expose the lamp. Extract the lamp and replace with Biddle Part or the standard commercial type 334 rated 28V at 0.04 amperes.

## SECTION J

### C. (continued)

F1 Fuse blown

**NOTE:** This fuse protects the low voltage auxiliary power supplies. The reason must be found since this indicates possible failure of the oscillator-drive and control circuitry.

**Look For:** To localize the trouble, expose the control unit chassis and remove all circuit cards. Replace the fuse with Biddle Part or commercial type MDL 1/2 ampere only. Connect the ground cable to a low resistance ground and plug set in. Close the circuit breaker and note if green lamp comes on and remains on. If the lamp does not stay on (F1 blows) the trouble is in the main chassis or in the driver transistors Q200 or Q204. See fig. 5 page E4. To localize further, remove the wire feed to these transistors as noted on the figure. Open the circuit breaker, wait 10 minutes, replace the fuse and try again. If the fuse holds, the transistors are probably defective and usually both must be replaced.

If the fuse fails, the problem is in the main chassis. The schematic diagram and normal circuit tracing techniques can be used to find the defect.

**NOTE:** To gain access to chassis wiring take the following additional steps on the chassis. Remove the four corner screws from the panel so that it is free. Invert the control unit but support the main chassis, remove the three screws holding the small rear cable panel and the four screws holding the main chassis to the case. Tilt the front panel and slide the case frame off. The underside of the main chassis is now exposed. Reverse this procedure for reassembly.

If main chassis and driver transistors are not at fault, the trouble is in one of the circuit boards. The symptom is a failure to hold the green lamp and/or the circuit breaker trips out when attempting normal operation but neither failure occurs when the circuit boards are removed. To localize the board shut the set down, wait 15 minutes then replace the board closest to the panel, also replace the fuse and re-energize. Continue adding circuit boards in this fashion making sure to advance the voltage control to 30 each time until the fuse fails. The last board added contains the defect.

To correct the difficulty it is recommended that a replacement circuit board be obtained from the factory since repair of these boards requires some special techniques. Replacement boards may not be adjusted for optimum performance so it is recommended that after the immediate test program is completed, the entire set be returned to the factory for tune-up and overhaul.

SECTION J (continued)

D. Hold output control at zero

Symptom -- Red lamp comes on without pressing start button

Look For: Stuck relay contactor K2

E. Press Start Button

Symptom -- Red lamp will not come on

Look For: Defective red lamp

Possible overheated power converter transistors if set was previously under load. Wait ten minutes with the fan running and try again. If the problem persists, or if the same condition exists with no load or without the High Voltage Unit connected, the set should be returned to the factory. Further localization must be done by competent skilled personnel. To go further, remove the test link shown in fig. 5 page E<sup>4</sup> marked Power Converted Isolation. Re-energize and if the red lamp now comes on, the problem is in the main power converter or crowbar circuits. The transistors of the main converter usually fail in pairs; these must be located and replaced only with Biddle Part No. 14041 not the commercial equivalent. The crowbar SCR can be isolated by removing the anode connection to distinguish between the main converter and crowbar types of failure. If the crowbar is defective it can be replaced by the Biddle Part Number or the commercial type 2N3896. The reason for the failure must be traced.

NOTE: To gain access to the components on the power converter board, locate the four screws, two on each side plate, that hold it in place, remove these and cut the tie-wrap holding the leads to the fan housing. The power converter board can now be folded out. Do not have the set plugged in when in this position.

An "in-circuit" transistor tester can now be used to locate defective transistors provided the base drive board (E301) is removed. Reverse the operation to restore the set.

Symptom -- With the power converter test link open the red lamp still does not come on.

Look For: A defect in the main chassis wiring or components particularly of the main power supply (403).

F/G. Metering

NOTE: The meters and components on the front panel are accessible by removing the four corner panel screws and folding down the panel.

## SECTION J

F/G (continued)

Symptom -- No current reading under load

Look For: Defective Zener on board E100  
Defective Meter

Symptom -- Incorrect current reading

Look For: Recalibration of current meter

The current meter can be recalibrated if a standard current meter is available and if a suitable load resistor is available. See fig.8 page J7 for connections. As an alternate, if a variable dc supply of 500V and 50 mA capability is available together with a standard current meter, calibration can be carried out without energizing the Test Set by connecting the standard current meter, a ballast resistance and the power supply in series and applying this between the test set ground and the test set Guard; Guard positive with respect to ground. Guard is available at the interconnecting cable plug terminal #D.

The current meters can then be compared over the full range of the Test Meter. See fig. 4 page E3 for location of current meter calibration adjustment located under a cover screw.

Symptom -- Suspected error in voltmeter

Look For: Recalibration of voltmeter

To adjust the voltmeter, a high accuracy dc kilovoltmeter drawing no more than 1 milliamperes is required. This is connected as a load and compared to the test set voltmeter. The adjustments are accessible after the screw plugs are removed (see fig. 4 page E3). Note that separate adjustments are provided for each range and calibration should be done at full scale after a 10 minute warmup period.

The remaining items are not associated with a particular operating step.

The circuit boards have adjustment potentiometers. See fig. 7 page J6.

The span control, R612 on circuit board 14114

The frequency control, R239 on circuit board 14113

The drive level control, R217 on circuit board 14113

The current trip level R307 on circuit board 14128



## SECTION J (continued)

All adjustments have been made at the factory and normally will not require attention unless a major repair requires component changes. Of these, only the span control can be readjusted in the field. All others must be considered as Factory-Only adjustments as they require special equipment and techniques.

Symptom -- Output voltage does not agree with voltage control setting

Look For: Adjustment of span control

To reset the span adjustment; operate the set with the control case cover removed but with the High Voltage Unit connected without load. Set the output voltage control to 60 kV and then adjust the span control so that the output voltmeter reads exactly 60 kV.

If the control unit is found to operate correctly but there is no high voltage output, the high voltage unit must be examined.

NOTE: Trouble shooting of the high voltage unit should be undertaken only by competent personnel since there may be shock hazard involved. A 1000 volt Megger<sup>®</sup> insulation tester is required.

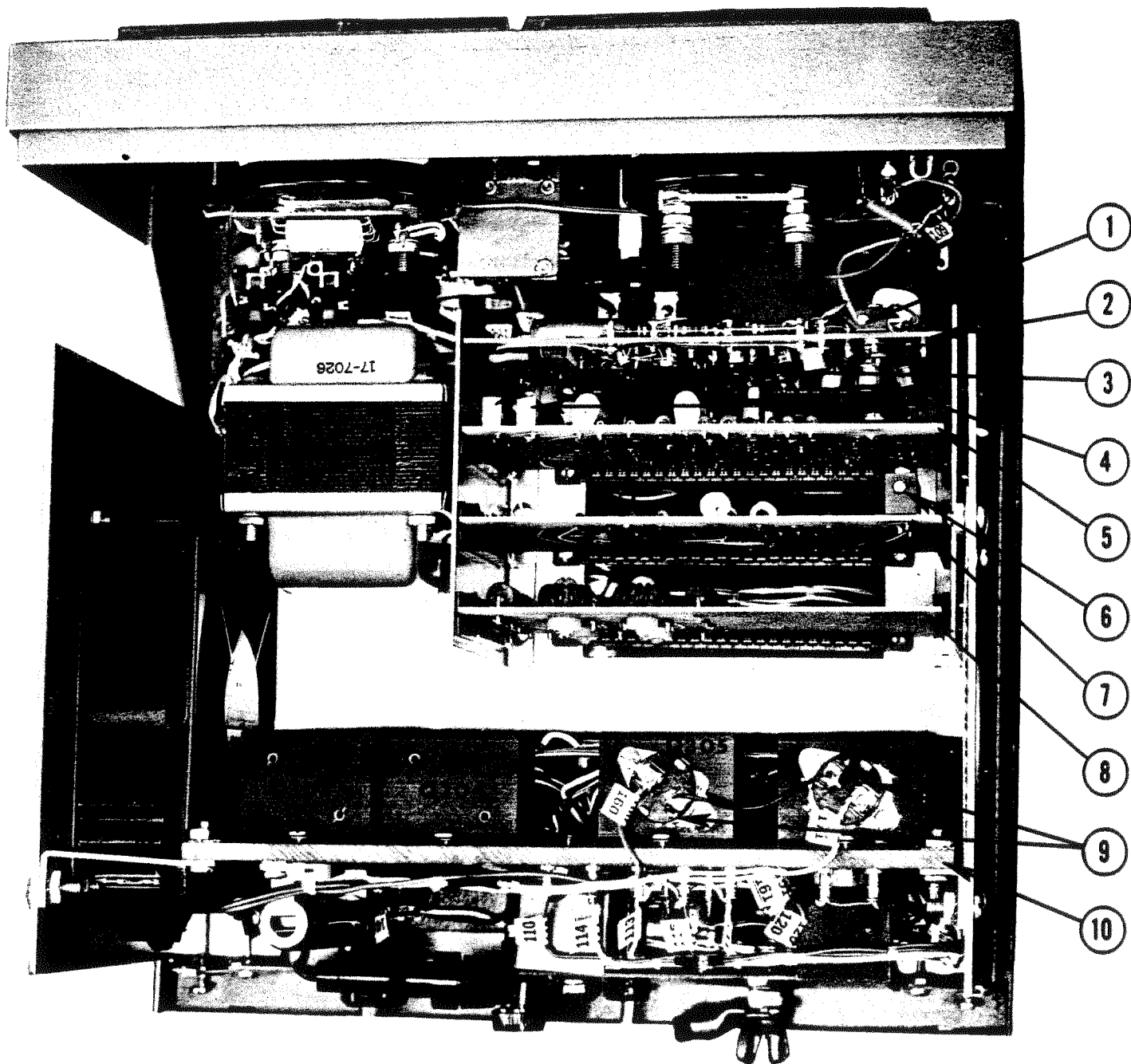
Remove the side plates and examine the wiring, including the interconnecting sockets, for obvious defects. If none exist, remove the capacitor/rectifier assembly as a unit for testing.

Using the Megger instrument, check each rectifier for a forward resistance of about 30,000 ohms and a reverse resistance of greater than 500 megohms. Check each capacitor of each bank; insulation resistance should be in excess of 5000 megohms. Check the output limiting resistor; resistance should be no more than 40,000 ohms. Replace defective components. See parts list for the Biddle Part Number.

The High Voltage transformer must not be excited from 60 Hz and should only be tested for continuity. The secondary will measure about 400 ohms, the primary about 0.05 ohms. The insulation resistance primary to secondary must exceed 5000 megohms at 1000 volts.

If it is suspected that external surface charge is accumulating, this can be determined by energizing the Test Set to full voltage, no load, for five minutes. Then shut down; wait until the voltmeter reads zero and explore the box surface with a grounded hot stick. A trapped surface charge will spark to the stick and produce a current meter kick.

If surface damage has occurred and is sufficient to be objectionable the defective member can be repaired or replaced. Consult Factory for procedure.

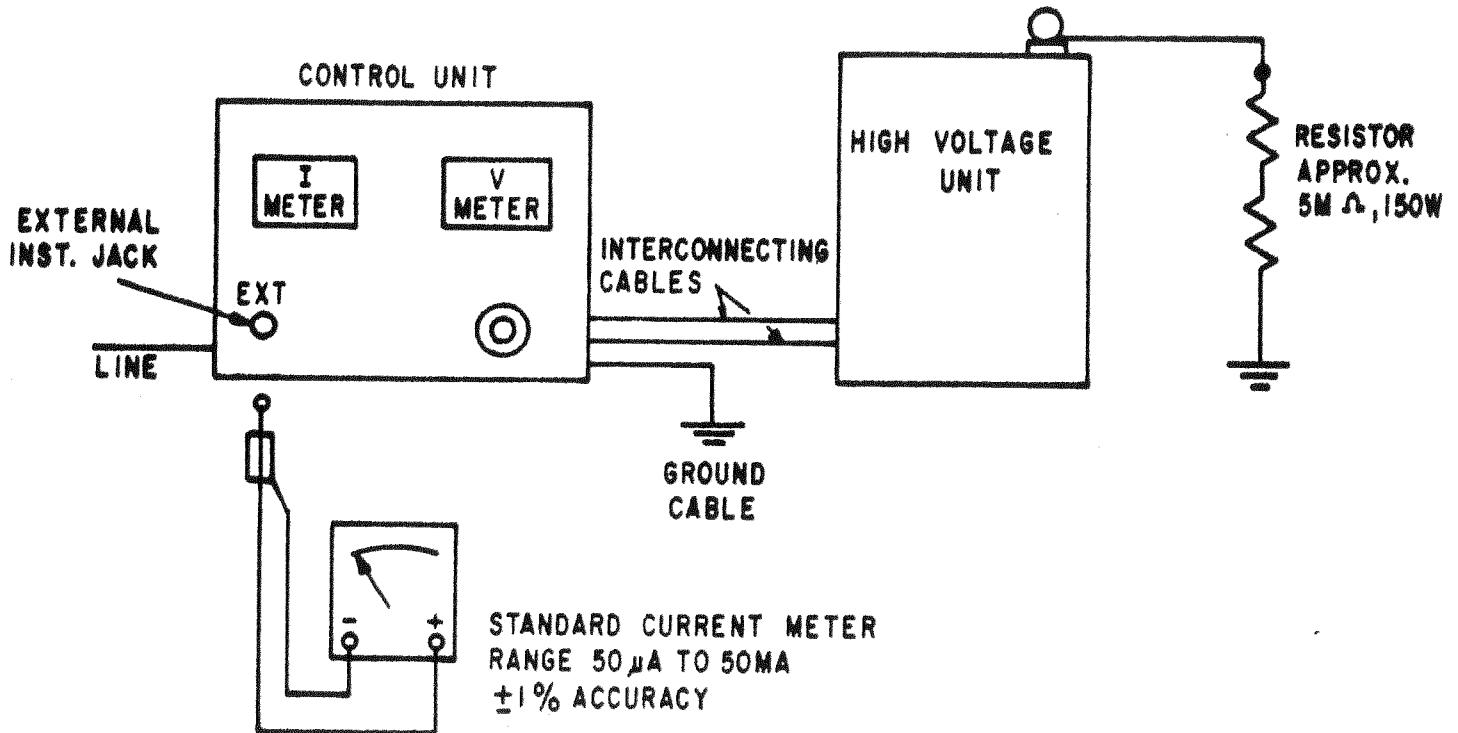


Q303, Q304, Q305, Q306  
 MAIN POWER CONVERTER

FIGURE 7: INTERIOR VIEW OF CONTROL UNIT

- |                         |                                |
|-------------------------|--------------------------------|
| 1. Span Control         | 6. Current Trip Adjustment     |
| 2. Circuit Board E600   | 7. Circuit Board E303          |
| 3. Frequency Adjustment | 8. Circuit Board E301          |
| 4. Drive Adjustment     | 9. Thermal Switches            |
| 5. Circuit Board E200   | 10. Power Converter Board E300 |

FIGURE 8 CALIBRATION TEST CONNECTIONS



H I G H V O L T A G E

OBSERVE ALL SAFETY PRECAUTIONS

1. Connect according to this sketch; observe safety precautions.
2. Standard current meter range selected to read 50  $\mu$ A, Test Set on 50  $\mu$ A range.
3. Energize Test Set, raise output until Standard meter reads 50  $\mu$ A and compare this with Test Set current meter reading for correlation to  $\pm 3\%$ .
4. Selecting each range 50, 500  $\mu$ A and 5 mA in turn, make comparison at full scale for an accuracy of  $\pm 3\%$ . Set current meter calibration adjustment for this.
5. Comparisons made at any other scale points will read the nominal value  $\pm 3\%$  of full scale.
6. With this test the base range of 5  $\mu$ A of the test set is assumed accurate--no provision is made for calibration. In this setup the 50 mA range cannot be checked at full scale since the Test Set is arranged to trip out a little above 5 mA.



SECTION KPARTS LIST

<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>JGB PART NO.</u>
W1	Cable, Input	4127
W2	Cable, Ground	4702
W3	Cable, Interconnecting	7749
W4	Cable, Interconnecting	6467
C1, C2	Capacitor, Dual .1μf, 600 V	8341-4
C400	Capacitor	12146-2
C401	Capacitor	7950-2
C402	Capacitor	4559-2
C403	Capacitor	12146-1
C404	Capacitor	4559-2
C500	Capacitor	14030-1
C501	Capacitor	14030-1
C502	Capacitor	14030-1
C503	Capacitor	14030-1
C504	Capacitor	14030-1
C505	Capacitor	14030-1
C506	Capacitor	14030-1
C507	Capacitor	14030-1
K1A/K1B	Circuit Breaker	6807-3
M101	Current Meter	4977
J500	Connector, 2 pins	9018-22
J501	Connector, 4 pins	9018-26
CRZ201	Diode, Zener	12074-6
J100	External Instrument Jack	4733-2
B1	Fan	9741
F1	Fuse, 1/2 Amp. S.B.	2567-16
F2	Fuse, 3/16 Amp. S.B.	2567-17
I2/I3	Lamps (2)	5297
I1	Lamp, Neon	4499-1
I2	Lens, Green	6847-3
I3	Lens, Red	6847-2
E600	P.C. Control Board	14114
E200	P.C. Board (Oscillator Driver)	14113
E303	P.C. Board (S.C.R.)	14112
E301	P.C. Board (Base Driver)	14097
E300	Power Convertor Board	14004
CRB400	Rectifier Bridge	14043-3
CRB401	Rectifier Bridge	14043-2
CRB402	Rectifier Bridge	14043-1
RCR500	Rectifier Assembly	14056
RCR501	Rectifier Assembly	14056
RCR502	Rectifier Assembly	14056
RCR503	Rectifier Assembly	14056
K2	Relay	9270
R1	Resistor	6869-2
R2	Resistor	6869-2
R3	Resistor	4505-1
R4	Resistor	4505-1

SECTION K (continued)

PARTS LIST

<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>JGB PART NO.</u>
R5A	Resistor	4500-29
R5B	Resistor	4500-29
R102	Resistor, Variable	4384-14
R104	Resistor, Variable	4384-12
R500	Resistor	4553-12
R501	Resistor Assembly	14055
R504	Resistor Assembly	14100
S1	Switch (Start)	6847-20
S2	Switch (Stop)	6847-20
S3	Switch (Zero Start)	6901
S4	Switch (Thermal)	14051
S5	Switch (Thermal)	14051
S100	Switch	8401-6
E100	Standard Current Meter Ckt.	14063
T400	Transformer	14050-1
T401	Transformer	14050-2
T500	Transformer (H.V.)	14040
M100	Voltmeter	14035
E102	Voltmeter Card Assembly	14084
L400	Choke	14089

## SECTION L

### WARRANTY

All products supplied by the James G. Biddle Co. are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

### REPAIRS

The James G. Biddle Co. maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.