22-J

NOVEMBER 1966

INSTRUCTION MANUAL

for the use of

BIDDLE

DIELECTRIC TESTING EQUIPMENT

FOURTH EDITION

NOVEMBER 1966

JAMES G. BIDDLE CO.

Electrical Testing and Speed Measuring Instruments

PLYMOUTH MEETING, PENNSYLVANIA 19462

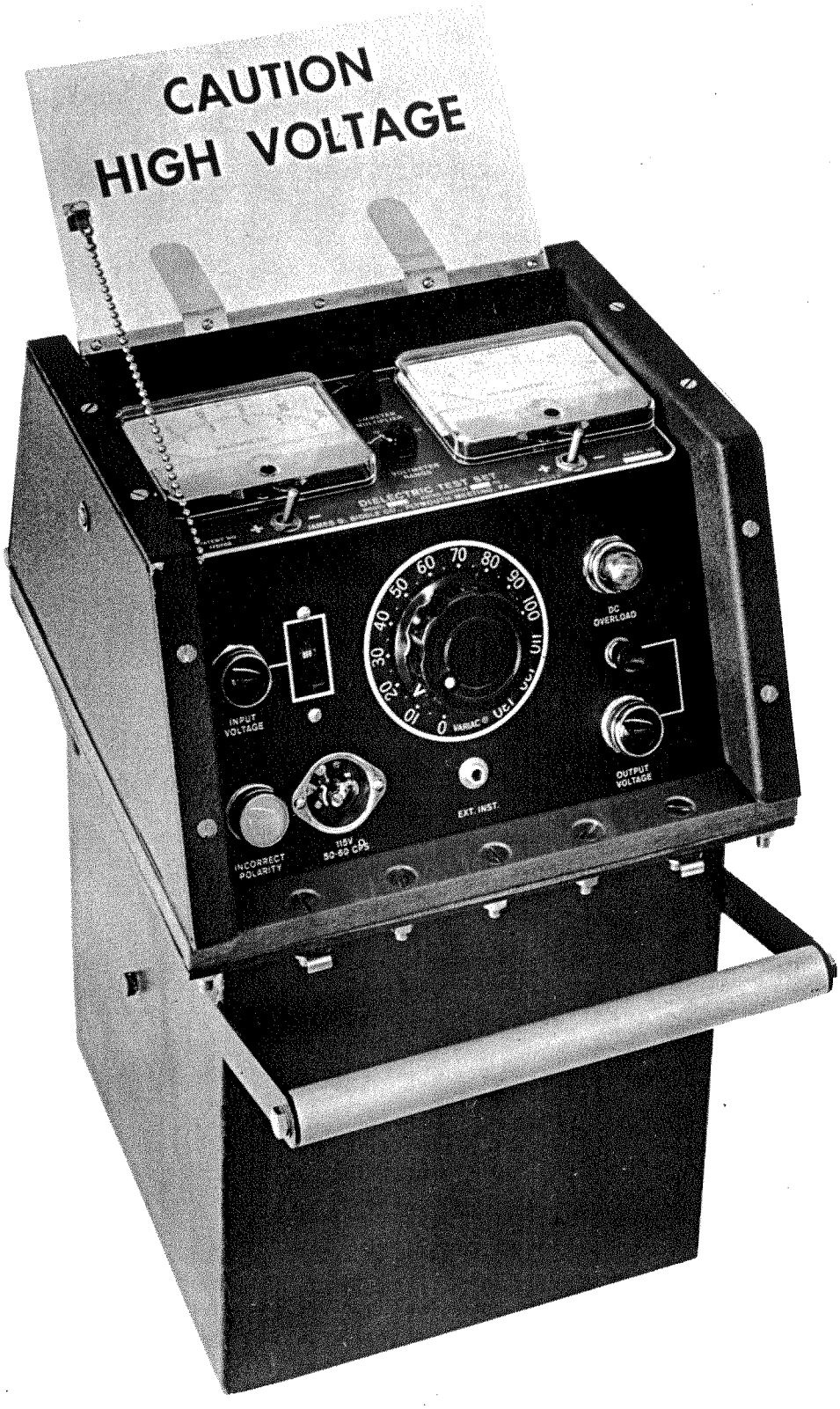


Figure 1 - Catalog Nos. 22040 and 22040-1

S E C T I O N A

1. INTRODUCTION

This Instruction Manual is published as a guide to the operation and maintenance of Biddle Dielectric Test Sets 22040 and 22040-1, rated at 40 kv d-c, 22100 and 22100-1, rated at 100 kv d-c. Unless otherwise specifically stated all information given in this manual applies to both models.

These sets are transportable field devices used to apply direct voltages as maintenance proof tests to the insulation of equipment such as generators, transformers, bushings, cable, etc. They are also equipped to measure the leakage and absorption currents resulting from the application of such proof test voltages. See Biddle Technical Publication 22T1.

2. SAFETY PRECAUTIONS

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 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 the test activities by suitable barriers, barricades or warnings.

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.

DESCRIPTION

3. 22040 and 22040-1

The 40 kv test set is shown in Figure 1. Electrically, it consists of a high-voltage rectifier circuit with necessary control and instrument circuits. All high-voltage components of the rectifier circuit are oil immersed in the tank. Controls and instruments are mounted on a superstructure and protected in transit by a detachable cover. The electrical circuit is arranged to permit full-voltage output at either polarity. The rectifier circuit is completely guarded. Instruments are protected against breakdown of the test specimen at any current range or at any

voltage up to its rating. When the set is in operation a transparent barrier is raised between the instrument and control panel and the output terminals to protect the operator. When the transparent barrier is lowered, after a test has been completed, the output terminals become short circuited and grounded. Schematic diagram shown in Figure 10, for 22040 and 22040-1, is in the back of this manual.

4. 22100 and 22100-1

The 100 kv test set is shown in Figure 2. Electrically, it consists of a high-voltage rectifier circuit with necessary control and instrument circuits. All high-voltage components of the rectifier circuit are oil immersed in the tank. Controls and instruments are mounted in a separate case and protected in transit by a detachable cover. The electrical circuit is arranged to permit full-voltage output at negative polarity. The rectifier circuit is completely guarded. Instruments are protected against breakdown of the test specimen at any current range or at any voltage up to its rating. An automatic grounding switch is provided which short circuits the output terminals through a resistor when the control is de-energized. Schematic diagram shown in Figure 11, for 22100 and 22100-1, is in the back of this manual.

5. EQUIPMENT SUPPLIED

The following items are included with each model.

22040 and 22040-1

1. Test set assembly complete and ready for operation.
2. One fifty foot supply cable.
3. One fifteen foot grounding cable.
4. One Instruction Manual 22-J.
5. One Technical Publication 22T1.
6. One package kilovolt-megohm plotting paper.

22100 and 22100-1

1. One test set assembly complete and ready for operation including separate control and high-voltage units.
2. One fifty foot supply cable.
3. One fifteen foot grounding cable.
4. One twenty-five foot interunit ground cable.
5. One twenty-five foot interunit control cable.
6. One Instruction Manual 22-J.
7. One Technical Publication 22T1.
8. One package kilovolt-megohm plotting paper.

High-voltage output test cables for both models may be purchased as accessories.

A two-wheel hand truck 22040-T, for use with the 22040

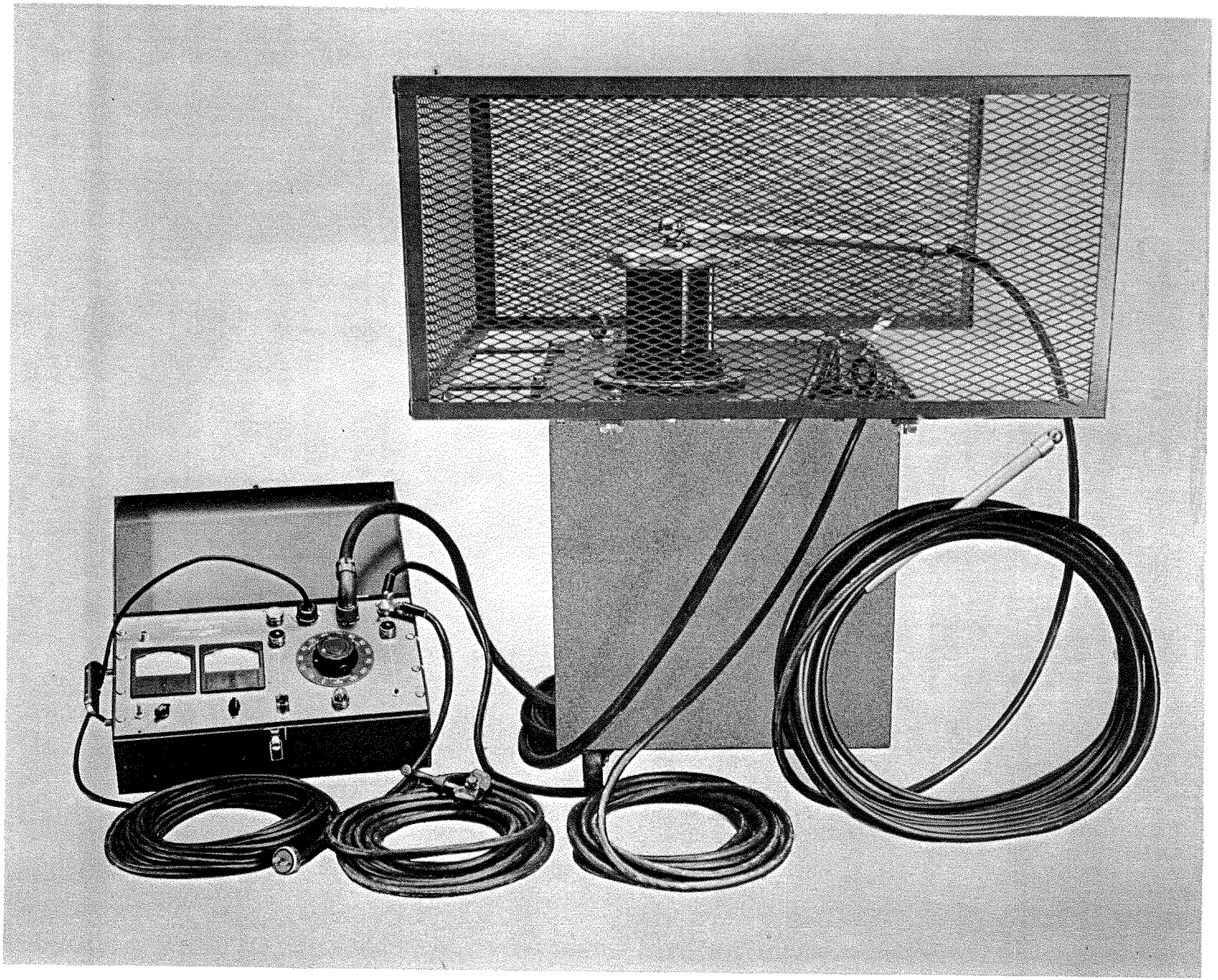


Figure 2 - Catalog Nos. 22100 and 22100-1

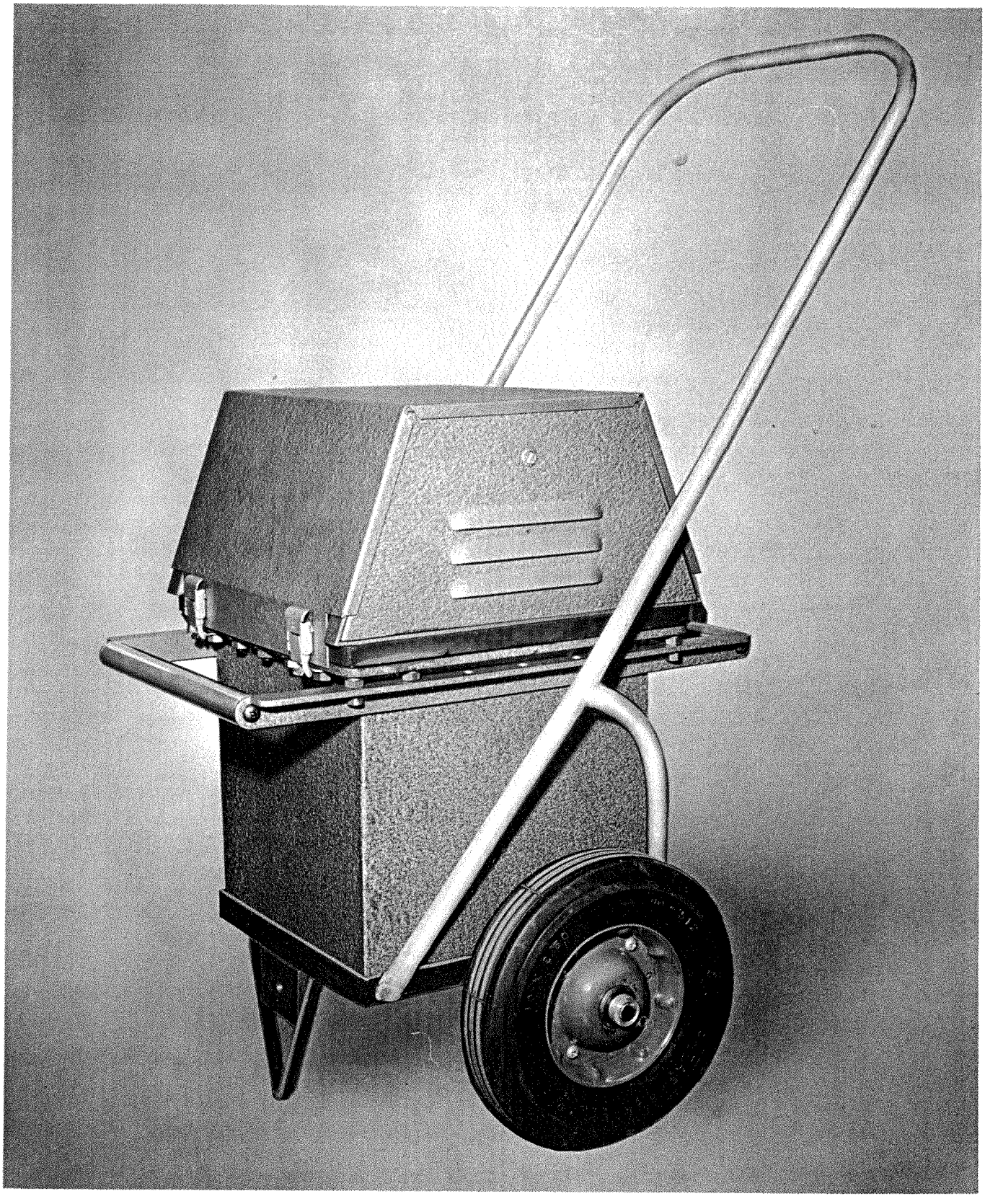


Figure 3 - Catalog Nos. 22040 and 22040-1. Both the 5 and the 15kv sets mount on a specially designed hand truck for easy one-man use.

and 22040-1, may also be purchased as an accessory.

Framed metal-screen safety barriers 22100-S for the high-voltage unit of the 22100 and 22100-1 may also be purchased as accessories.

6. SPECIFICATIONS

DIELECTRIC TEST SETS 22040 and 22040-1

INPUT: 115 volts, 50-60 cps, single phase, 60-700 va
OUTPUT VOLTS: Continuously adjustable in steps of 80 volts from 0.5 to 40 kv
OUTPUT CURRENT: 3 ma at 40 kv continuous
13 ma at 20 kv continuous
18 ma at 10 kv continuous
Maximum continuous power output, 250 watts at 55° rise, 40°C ambient
POLARITY: Negative (-) or Positive (+) available by simple jumper connection
RIPPLE: Less than 1% at 5 megohms, resistive load
KILOVOLTMETER: Ranges 5, 10, 25 and 50 kv full scale. Scale length 4 inches, accuracy ±3% of full scale, including multiplier.
MICROAMMETER: Ranges 5, 50, 500, 5,000 and 50,000 microamperes full scale depending on test set involved. Scale length 4 inches, approximately linear. Accuracy ±3% of full scale, including multiplier.
METER OUTPUT: Output jack in series with meter provides means of using high sensitivity auxiliary microammeters or recorders.
CIRCUIT: Full-wave vacuum-tube voltage doubler. Oil immersed.
TUBES: Two type 8013A Rectifiers
CAPACITANCE: 0.1 microfarad per stage or 0.05 microfarad overall
INTERNAL RESISTANCE: Approximately .7 megohm
TIME CONSTANT: Charge: (RC product per microfarad specimen capacitance) approximately .7 sec.
Discharge: (RC product of voltage soubler circuit per microfarad of specimen capacitance at zero supply voltage) approximately 30 sec.
OIL: 15 quarts of clean, dry, de-aerated transformer oil, Wemco C or equivalent
DIMENSIONS: Height 20½ inches, width 13½ inches, depth including handles 20 inches
WEIGHT: 120 pounds net
CABLES: Input, 50 feet
Ground, 15 feet
Output high voltage 22040-L, supplied as accessory on special order

DIELECTRIC TEST SETS 22100 and 22100-1

INPUT: 115 volts, 50-60 cps, single phase, 105-1300 va
OUTPUT VOLTS: Continuously adjustable in steps of 345 volts to 100,000 volts
OUTPUT CURRENT: 6 ma at 100 kv continuous
17 ma at 50 kv continuous
20 ma at 25 kv continuous
Maximum continuous output 850 watts at 55° rise, 40°C ambient
POLARITY: Negative (-)
RIPPLE: Less than 1% at 100 megohms, resistive load
KILOVOLTMETER: Ranges 25, 50 and 100 kv full scale. Scale length 4 inches, accuracy ±3% of full scale, including multiplier.
MICROAMMETER: Ranges 5, 50, 500, 5,000 and 50,000 microamperes full scale depending on test set involved. Scale length 4 inches, approximately linear. Accuracy ±3% of full scale.
METER OUTPUT: Output jack in series with meter provides means of using high sensitivity auxiliary microammeters or recorders.
CIRCUIT: Full-wave vacuum-tube voltage doubler. Oil immersed.
TUBES: Two type ML 141 rectifiers
CAPACITANCE: .015 microfarad per stage or .0075 microfarad overall
INTERNAL RESISTANCE: Approximately .7 megohm
TIME CONSTANT: Charge: (RC product per microfarad specimen capacitance) approximately .7 sec.
Discharge: (RC product of voltage doubler circuit per microfarad of specimen capacitance at zero supply voltage) approximately 88 sec. With automatic discharge switch closed approximately 1 sec.
OIL: Approximately 38 gallons of clean, dry, de-aerated transformer oil, Wemco C or equivalent
DIMENSIONS: High voltage unit: Height 37½ inches, width 27-7/8 inches, length 23-5/8 inches.
Control unit: Height 7¾ inches, width 19-5/16 inches, length 10¾ inches.
WEIGHT: High voltage unit: 635 pounds, net, including oil
Control unit: 46 pounds net
CABLES: Input, 50 feet
Control, 25 feet
Interunit ground, 25 feet
Ground, 15 feet
Output high voltage 22100-L, supplied as accessory

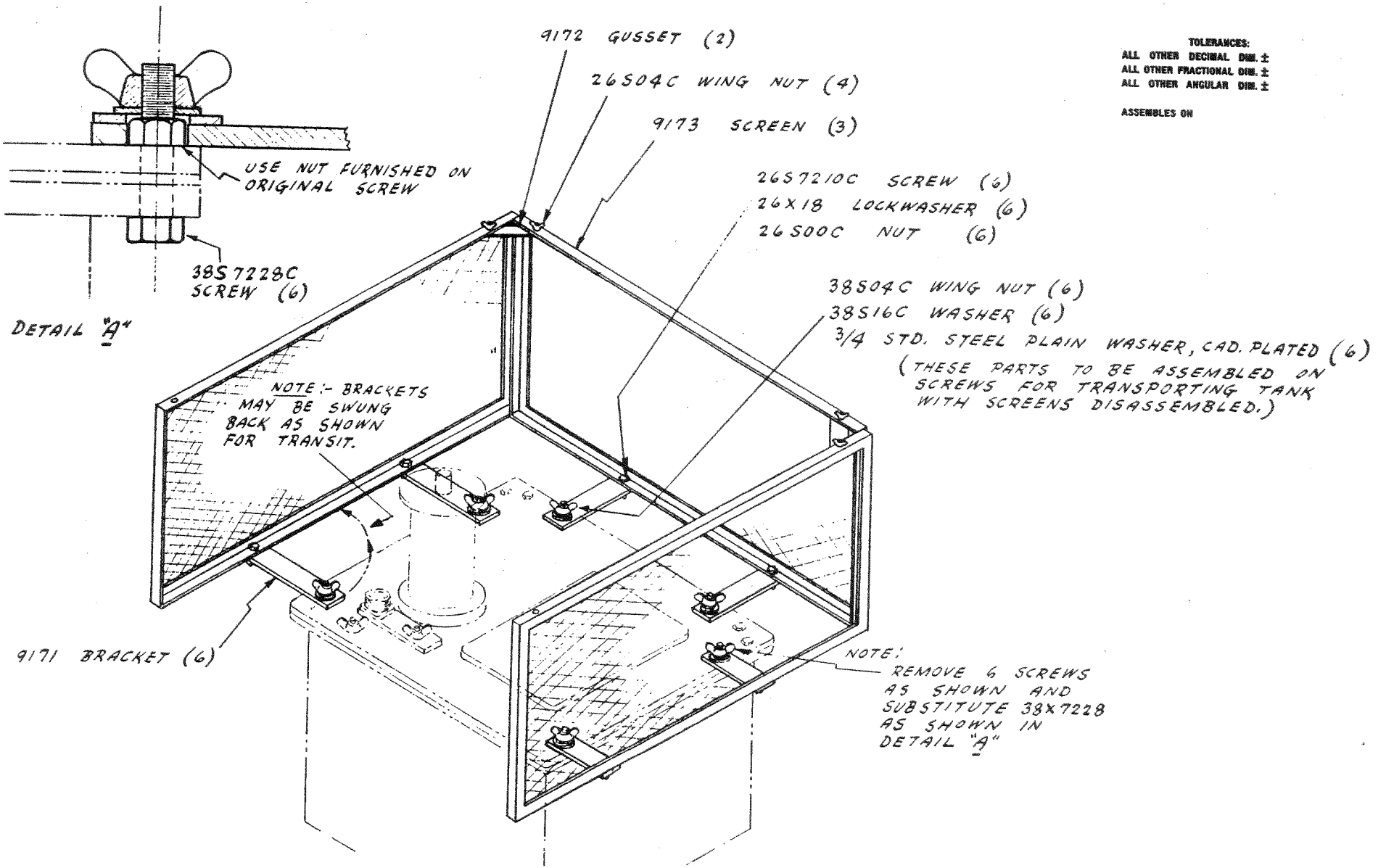


Figure 4 - Safety barrier for Catalog Nos. 22100 and 22100-1

S E C T I O N B

OPERATION

7. SETTING UP 22040, 22040-1 and 22100, 22100-1 TEST SETS

Select a location close enough to the apparatus to be tested so that the high-voltage connection can be easily made. If a bare wire is used for this connection the set must be arranged so that this lead can be as short and direct as possible and not introduce in the test any losses due to corona. Safety should be kept in mind when setting up a test. Read the "Safety Precautions" at the front of the manual.

If a Biddle high-voltage test cable is to be used, the location of the set can be as far away from the specimen as the length of the test cable permits. The test cable shield is practically at ground potential so that its jacket may touch grounded parts without affecting the test.

It will be also necessary to have a ground connection available within 15 feet of the set, and a supply outlet within 50 feet.

If the metal safety barriers were purchased for use on the high-voltage unit of the 22100 and 22100-1 sets, they should be installed as shown in Figure 4.

8. CONTROLS AND CONNECTIONS

GROUND CABLE (W201). A 15 foot cable with a spade lug on one end and a clamp on the other is used for connecting the ground stud of the set to the grounded frame or sheath of the specimen. It serves to ground the cases of the test sets for safety and provides a path for the output test current. Since the 22100-1 100 kv set is in two parts, the ground cable can be attached either at the Control Unit or the High-Voltage Unit, preferably the latter.

INTERUNIT GROUND CABLE (W203)--22100 and 22100-1, 100 KV SETS ONLY

A 25 foot cable with spade lugs on each end is used with the 22100-1 100 kv set for connecting together the ground studs (E) of the Control and High-Voltage Units.

GROUND CONNECTION. It is very important for safety reasons that good ground connections be made, not only to the grounded frame of the specimen under test but to earth as well. If it is known that the frame or sheath of the specimen has a metallic low resistance connection to earth then the Ground Cable (W201) can be connected to it only. The ground terminal for the 40 kv set is (E204). The ground terminal on the Control Unit of the 100 kv set is (E106), and (E204) on the High-Voltage Unit.

SUPPLY CABLE (W101). A 50 foot cord terminated at one end with a parallel-blade plug and on the other with a female "Twistlock" connector is used to energize the set.

INTERUNIT CONTROL CABLE (W202) - 22100 and 22100-1 100 KV SETS ONLY. A 25 foot 9 conductor cable, with a female AN plug (P201) on the High-Voltage Unit end, and a male AN plug (J201) on the Control Unit end, is used to supply power to the High-Voltage Unit for the plate and filament transformers and the operating coil of the automatic grounding switch, and to supply the kilovoltmeter in the Control Unit from the high-voltage resistance multiplier in the High-Voltage Unit. Three spare conductors are available in the control cable.

INTERUNIT CONTROL CABLE RECEPTACLES (J103) AND (P203) - 22100 and 22100-1 100 KV SETS ONLY. AN receptacles are installed on the Control Unit and High-Voltage Unit for use with the Interunit Control Cable (W202).

SUPPLY RECEPTACLE (P101). A male "Twistlock" connector on the control panel receives one end of the supply cable.

CIRCUIT BREAKER (K101). A single-pole trip-free magnetic circuit breaker is mounted on the control panel. When in the ON position the rectifier-tube filaments are lit and either the WHITE, GREEN or RED indicator lamp is also lit, depending on the conditions as cited under WHITE INDICATOR LAMP (I103).

WHITE INDICATOR LAMP (I103). This lamp, when lit with breaker (K101) open, indicates incorrect input polarity.

The set is correctly grounded when the supply-system ground and tank ground are common. Reversing the system-supply plug will correct the polarity and (I103) will not light.

If the ground connection is poor and does not effectively short circuit the white lamp (I103), relay (K102) cannot be closed and the set cannot be operated. For no ground connection and with breaker (K101) closed, the tank will be practically at supply-line potential above the supply-system ground.

For correctly polarized conditions lamp indications are as follows, with and without tank ground, should the latter be accidentally removed.

SUMMARY OF LAMP INDICATIONS FOR CORRECT POLARITY

Breaker, Switch or Relay Position	Ground	Lamp Indications
K101 closed	Connected	White (I103) out Green (I101) lit
K101 closed	Removed	White (I103) lit Green (I101) out

Breaker, Switch or Relay Position	Ground	Lamp Indications
K101, S101, (K102) closed	Connected	White (I103) out Green (I101) lit Red (I102) lit
K101, S101 (K102) closed	Removed	White (I103) out Green (I101) lit Red (I102) lit

Opening K101 opens K102 and circuit cannot be restored without re-establishing an effective ground.

GREEN INDICATOR LAMP (I101). This lamp, when lit, indicates that the Circuit Breaker (K101) is ON and the rectifier filaments are lit. With Switch (S101) open, no voltage is applied to the rectifier plate transformer under these conditions regardless of the position of the voltage control.

HIGH-VOLTAGE START PUSH BUTTON SWITCH (S101). All standard test sets are equipped with a zero start switch. This requires that the VARIAC control knob be returned to the zero position before any voltage is applied to the rectifier plate transformer. After the VARIAC has been returned to zero depressing S101 energizes relay (K102) which in turn applies full input voltage to Voltage Control (T101) and energizes the Red Lamp (I102).

RED INDICATOR LAMP (I102). This lamp, when lit, indicates that the breaker is ON and that Switch (S101) has been closed, thus closing Relay (K102) which in turn APPLIED VOLTAGE TO THE RECTIFIER. When this lamp is lit, THE HIGH VOLTAGE TERMINALS OF THE SET ARE ENERGIZED.

VOLTAGE CONTROL (T101). This control adjusts the output voltage of the set by controlling the a-c voltage input to the rectifier circuit. Voltage is increased by turning the knob clockwise. The dial is calibrated to read actual volts applied to the input of the rectifier circuit when the supply voltage is 115 v.

KILOVOLTMETER (M101). This instrument indicates output voltage in kilovolts d-c measured from the output terminal to guard.

KILOVOLTMETER RANGE SELECTOR (S103). This selector switch changes the voltmeter range as required.

22040 and 22040-1 - 5, 10, 25 or 50 kv full scale
22100 and 22100-1 - 25, 50 or 100 kv full scale

KILOVOLTMETER POLARITY SWITCH (S105) - 22040 and 22040-1 ONLY. This switch selects the proper kilovoltmeter circuit for use when the polarity is either (+) or (-). It should always be switched to the position corresponding to the output polarity.

MICROAMMETER (M102). The microammeter indicates all the current that flows from the output terminal to ground.

MICROAMMETER RANGE SWITCH (S104). This selector switch changes the microammeter range as required in decade steps from 5 to 50,000 microamperes full scale. The switch is marked with the full scale value to be used for each range to obtain the measured current.

MICROAMMETER POLARITY SWITCH (S102). When this switch is in the position corresponding to output polarity, the microammeter measures charging current. When switched to the position indicating opposite polarity, the microammeter measures discharge current.

EXTERNAL INSTRUMENT JACK (J101). An output jack connected in series with the microammeter is mounted on the control panel. It may be used for connection of a d-c amplifier and recorder or other auxiliary direct current measuring instrument. It may also be used with a-c instruments for measuring ripple or corona current.

D-C OVERLOAD LAMP (E101). This is a glow lamp which serves the dual purpose of providing protection to the Microammeter (M102), and warning the operator that the test set is being overloaded. The microammeter will measure less than the actual output current when the lamp is glowing because the lamp is connected in parallel with the microammeter.

OUTPUT TERMINALS (E201,+) (E202,-) - 22040 and 22040-1 KV SETS ONLY. These high-voltage bushings mounted on guard rings are connected to the (+) and (-) terminals of the rectifier circuit. For normal operation one of these is always connected to the guard terminal (E203), using the guard strap provided. The other terminal is then used for output, and the full voltage of the rectifier appears between this terminal and guard. Since guard is practically at ground potential the output voltage is obtained between this terminal and ground. Note that for (+) output voltage the (-) terminal is connected to guard and vice versa.

OUTPUT TERMINAL (E202) - 22100 and 22100-1 KV SETS ONLY. This high-voltage bushing mounted on a guard ring is connected to the (-) terminal of the rectifier circuit.

GUARD TERMINAL (E203). The guard terminal on the 22040 and 22040-1 kv sets is mounted between the two output terminals. The guard terminal on the 22100 and 22100-1 kv sets is mounted on the cover of the High-Voltage Unit adjacent to the Control Cable Receptacle (P203).

HIGH VOLTAGE TEST CABLE (W301). (Not furnished with sets unless specified). This is a coaxial cable, the center conductor making the high-voltage connection between the output terminal of the test set and the specimen. The shield or outer conductor connects to the Guard Terminal (E203) of the test set to guard the cable itself and may be connected at the outboard end to a guard terminal of the specimen.

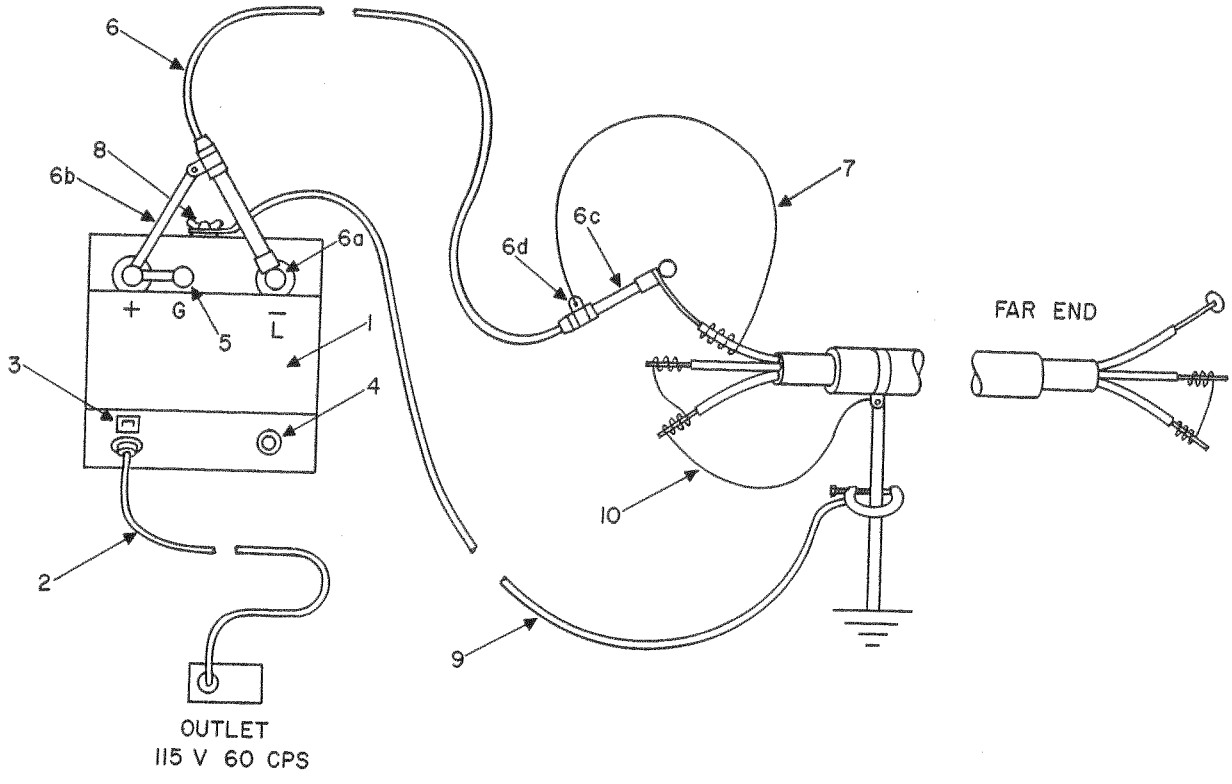


Fig. 5. Dielectric Test Sets 40 kv 22040 and 22040-1

The set is shown connected with a shielded 40 kv test cable 22040-L to one conductor of a lead sheathed, belted three-conductor cable for testing the insulation between this conductor and the other two conductors and the lead sheath with test voltage of negative polarity. The surface of the insulation of the conductor which is to be tested is shown guarded only on the one end of the cable. The guard is connected through the shield of the test cable to the guard terminal of the test set so that the leakage current flowing over the guarded surface is not measured by the microammeter in the test set.

1. Test sets 22040 and 22040-1
2. Supply cable (supplied with the set)
3. Circuit Breaker
4. High-Voltage start push button switch
5. Guard Terminal
5a. Metal strap connecting the guard terminal with the positive polarity output terminal
6. High-Voltage test cable 22040-L (supplied on order)
6a. Inboard high voltage terminal
6b. Inboard shield terminal with metal strap for connection to guard. Do not connect this terminal to ground because this would short circuit the microammeter and permit no leakage current indication.
6c. Outboard high voltage terminal
6d. Outboard shield terminal
7. Guard wire
8. Ground terminal
9. Ground Cable with heavy clamp (supplied with the set)
10. Ground wire

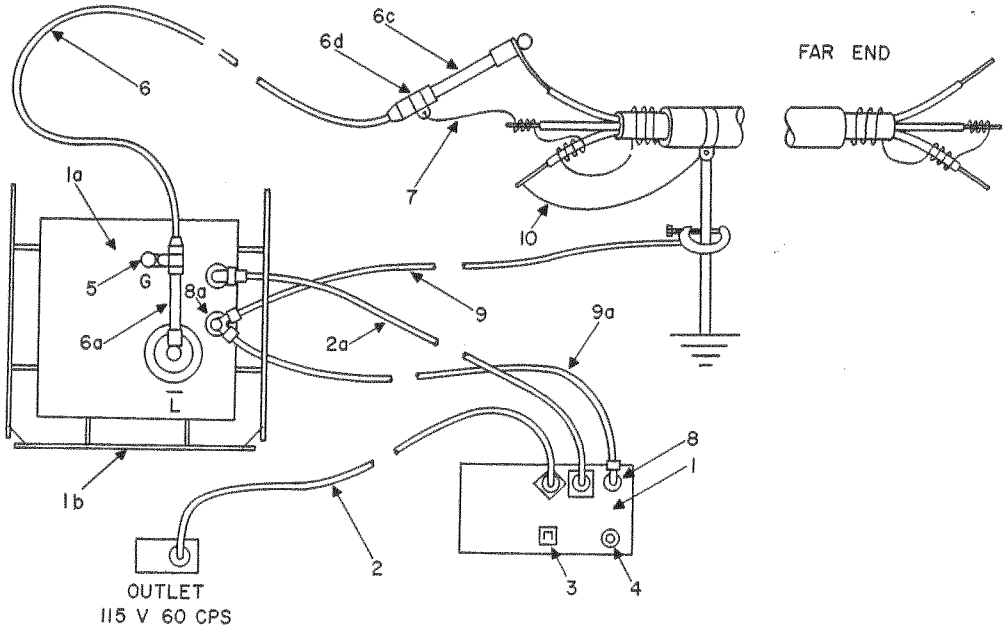


Fig. 6. Dielectric Test Sets 100 kv 22100 and 22100-1

The set is shown connected with a shielded 100 kv test cable 22100-L to one conductor of a lead sheathed, belted three-conductor cable for testing the insulation between this conductor and one of the two other conductors and the lead sheath with test voltage of negative polarity.

The surfaces of the insulation of one conductor which is not to be tested and of the belting is shown guarded on both ends of the cable. The guard at the far end of the cable is connected to the guard at the near end of the cable by the third conductor which is not to be tested, and which is connected to guard at the near end of the cable.

The guard is connected through the shield of the test cable to the guard terminal of the test set so that the leakage current flowing over the guarded surfaces and over the surface of the insulation of the conductor connected to the guard is not measured by the micro-ammeter in the set. The current flowing through the insulation of the tested conductor and the insulation of the conductor connected to the guard is also not measured by the microammeter.

1. Control Unit of Test Sets 22100 and 22100-1
1a. High-Voltage Unit of Test Sets 22100 and 22100-1
1b. Safety barriers mounted on the top of the High-Voltage Unit
2. Supply Cable (supplied with the set)
2a. Interunit Control Cable
3. Circuit Breaker
4. High-Voltage start push button switch
5. High-Voltage start push
6. High-Voltage Test Cable 22100-L (supplied on order)
6a. Inboard high voltage terminal
6b. Inboard shield terminal with metal strap for connection to guard
6c. Outboard high voltage terminal
6d. Outboard shield terminal
7. Guard wire (cold)
8. Ground terminal of the Control Unit
8a. Ground terminal of the High-Voltage Unit
9. Ground Cable with heavy clamp (supplied with the test set)
9a. Interunit Ground Cable (supplied with the test set)
10. Ground wire

CAUTION BARRIER (E103) - 22040 and 22040-1 KV SETS ONLY. This barrier, when lifted and fastened with the chain provided, permits safe operation of the controls and the reading of instruments at the front of the set. When lowered, it short circuits and grounds the high-voltage output terminals.

PROTECTIVE BARRIERS 22100 and 22100-1 100 KV SETS ONLY. (Not furnished with sets unless specified). Framed metal-screen barriers can be mounted on the High-Voltage Unit around all sides of the high voltage bushing except the side where the high-voltage test cable is attached.

9. OPERATION - 22040 and 22040-1 40 KV SETS ONLY

Remove the cover and raise the CAUTION barrier. Use the hook and chain provided to keep it raised. Connect the Ground Cable (W201) to the ground stud on the set tank and clamp the outboard end to the grounded frame or sheath of the specimen.

Determine whether the required output voltage is to have positive (+) or negative (-) polarity. Note that the (+) output terminal is on the same side of the set as the (+) marks on the instrument polarity switches (to the operator's left when viewing the instrument panel). When negative output is required, the guard strap should be arranged to connect the opposite (+) output terminal to guard. When positive output is required, this procedure is reversed.

Once the polarity has been established the instrument polarity switches should be set to the corresponding position. For (-) output voltage the kilovoltmeter polarity switch should be in the (-) position and the microammeter switch also in the (-) position if charging current is to be measured. When, as in this case, discharge current is to be measured while discharging a tested specimen, the switch must be in the + position.

10. OPERATION - 22100 and 22100-1 100 KV SETS ONLY

Open the Control Unit case and connect the Interunit Ground Cable (W203) between it and the High-Voltage Unit and the grounded frame or sheath of the specimen.

Connect the Interunit Control Cable (W202) between the Control and High-Voltage Units.

11. OPERATION - GENERAL

Check to see that the circuit breaker is in the OFF position. Check to see that the voltage control is in the zero position. Next, connect the supply cable to the receptacle in the control panel and plug the other end into a suitable 115 volt, 50 or 60 cps outlet. If the white lamp lights, reverse the supply plug.

With the set arranged as above, and with nothing connected to the high voltage terminal, make a preliminary test as follows:

Set the Kilovoltmeter Range Selector (S103) to the maximum range to be used in the test. Set the Microammeter Range Selector (S104) to the lowest current range. Switch the Circuit Breaker (K101) to ON. The GREEN lamp will light. Rotate the Voltage Control knob counter-clockwise to the zero position. Now depress Switch (S101). This should cause the RED lamp to light. It may, instead, cause the circuit breaker to open and both lights to go out. This happens when the switch is closed at the peak of the supply-current wave. In other words, when the transient inrush magnetizing current of the voltage control is a maximum. When this happens, reclose the circuit breaker until it stays in the ON position.

Increase voltage by turning the voltage control slowly clockwise while watching the instruments. Increase the voltage to the maximum required for the test or until some abnormal condition is noticed. Aside from small charging current transients at every increment of voltage, the microammeter should show no significant leakage. If the leakage is significant shut the set down as described below and wipe off the high-voltage terminal with a lintless cloth or paper towel.

12. SHUTTING DOWN - 22040 and 22040-1 40 KV SETS ONLY

To shut the set down, return the voltage control to zero and switch the circuit breaker to OFF. Let the set discharge while watching the kilovoltmeter. When the kilovoltmeter reads nearly zero, lower the CAUTION barrier which shorts and grounds both output terminals. The kilovoltmeter and microammeter are protected against damage when the full voltage is discharged at once, but this practice is not recommended as a regular procedure. The set should be allowed to discharge through its internal resistance to at least half voltage before shorting the output. This is particularly important when a specimen is connected to the set.

13. SHUTTING DOWN - 22100 and 22100-1 100 KV SETS ONLY

To shut the set down, return the voltage control to zero and switch the circuit breaker to OFF. This will automatically ground the high-voltage terminal through a resistor. Let the set discharge while watching the kilovoltmeter. When the kilovoltmeter reads nearly zero, the output terminal may be solidly grounded.

14. CONNECTION TO SPECIMEN

When connecting to a specimen with a bare conductor or one with inadequate insulation, care should be taken to use a conductor of sufficient diameter to prevent corona formation and it should be spaced from the metal parts of the set to prevent flashover. Sharp projections should be avoided at all high-voltage terminals.

15. USING ACCESSORY GUARDED HIGH-VOLTAGE TEST CABLE

The High-Voltage Test Cable (W301) supplied as an accessory on special order is for use at the full rated voltage of the test set. Since the shield of this cable is connected to the Guard terminal of the set, any leakage which may occur over the cable terminations or through the main insulation between the center conductor and the shield is not measured by the microammeter.

In using this cable, it is important to bear in mind that the microammeter in the set is connected between guard (cable shield) and ground. The cable jacket insulation resistance to ground is therefore in parallel with the microammeter. The microammeter circuit resistance in the most sensitive range is approximately 0.1 megohms. If the test cable is mishandled so that the jacket deteriorates, the effective insulation resistance to ground may reduce to only a few megohms and the accuracy of the microammeter may be affected. In extreme cases, the jacket may be ruptured and the shield or guard may contact ground, therefore short circuiting the microammeter. The same result will occur if the outboard guard terminal of the cable is allowed to rest on a grounded part.

The outboard end of this cable is terminated similarly to the inboard end except that a stud and ball nut is used instead of the spade lug, and no guard strap is provided. There is a hole in the stud to facilitate connection to the specimen terminal. In making the connection to specimen terminals of various designs, it is recommended that adapter plates be made and used. For example: a copper plate with a hole drilled at one end for the stud of a specimen terminal, and a hole in the other end to accommodate the stud and ball nut on the test cable, will provide a rigid connection. Such an adapter plate should have rounded corners and edges to prevent corona.

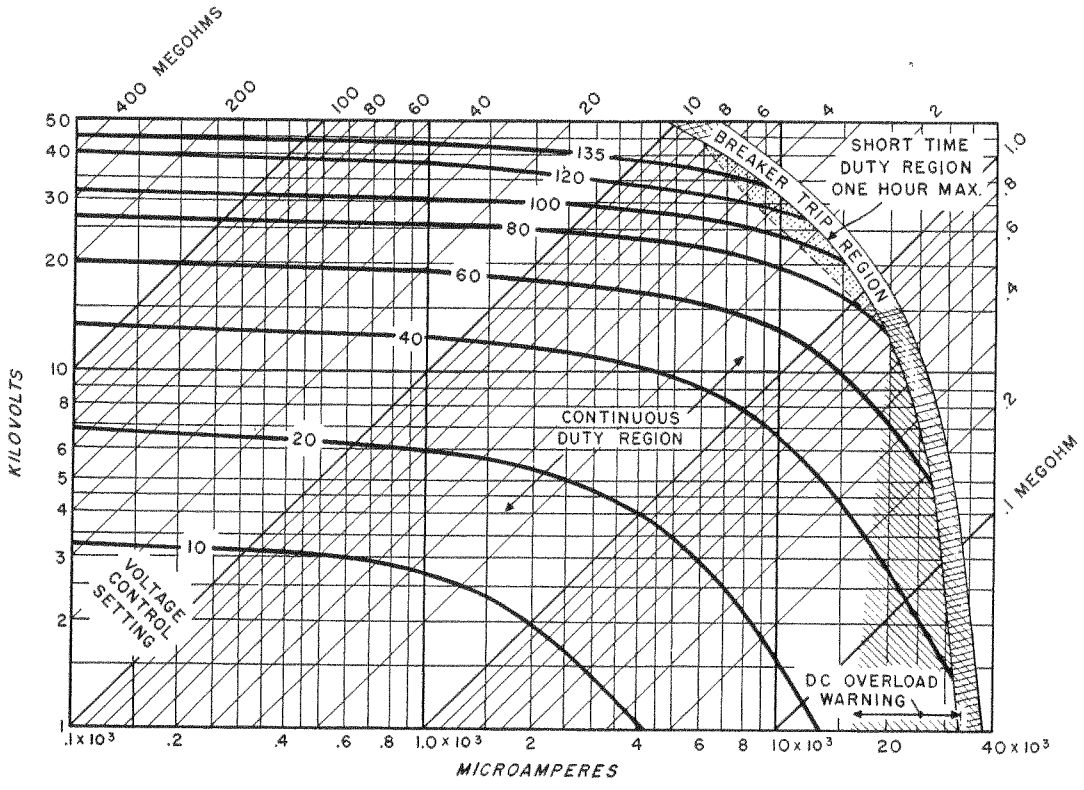
In using the outboard guard terminal of the test cable for making guarded measurements on the specimen, it is recommended that reference be made to AIEE NO. 62 "Proposed Recommended Guide for Making Dielectric Measurements in the Field".

16. CONNECTION OF GUARDED TEST CABLE TO THE 22040 and 22040-1 40 KV TEST SETS

The inboard end of the center or high-voltage conductor is terminated in a spade lug to be connected to the output terminal which is being used at high voltage. The guard or shield terminal of the cable on the inboard end (a bare metal strap with spade lugs) must be connected to the other output terminal of the set which is connected to the guard terminal of the set by the bare metal guard strap.

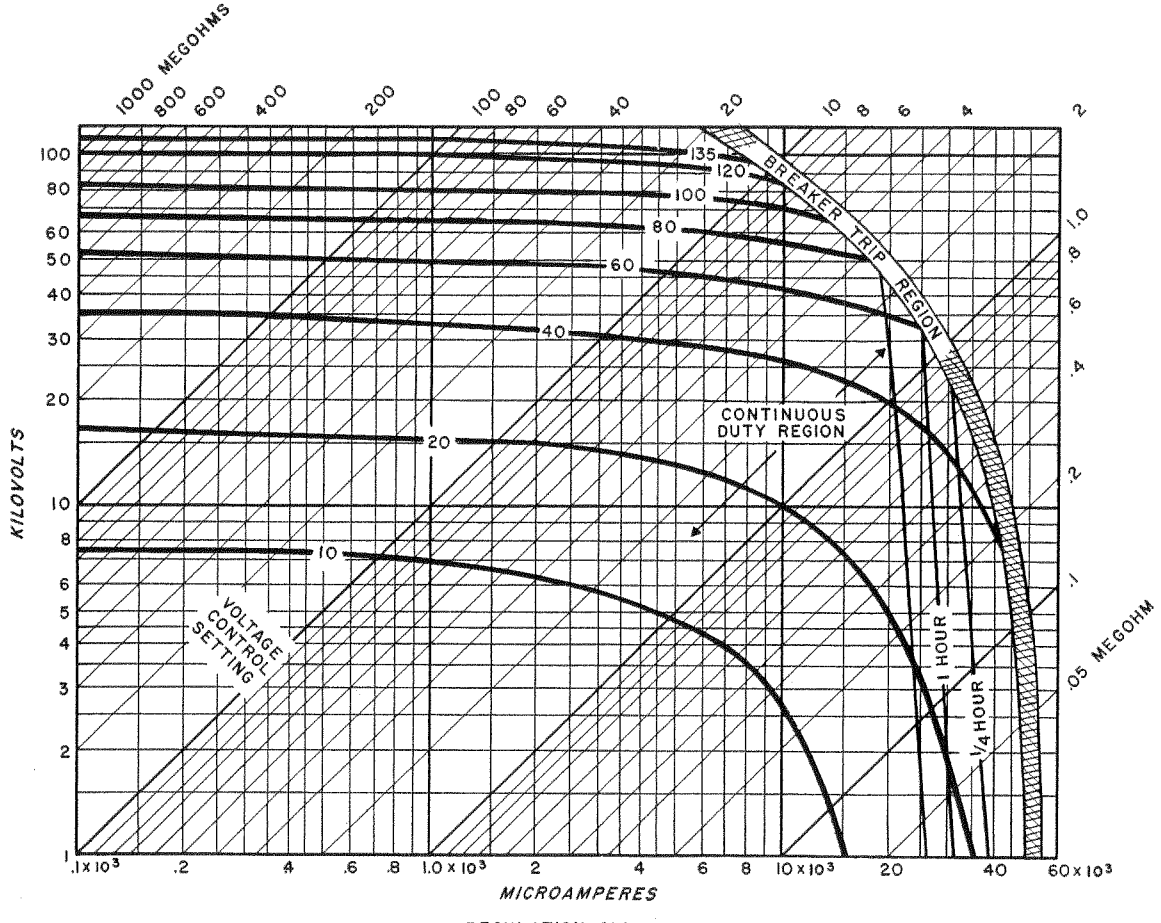
17. CONNECTION OF GUARDED TEST CABLE TO THE 22100 and 22100-1 100 KV TEST SETS

The inboard end of the center or high-voltage conductor is



REGULATION CURVES
AT 115 VOLTS AC, 50-60 CYCLES INPUT

Figure 7 - Voltage regulation curves for Catalog Nos. 22040 and 22040-1



REGULATION CURVES
AT 115 VOLTS AC, 50-60 CYCLES INPUT

Figure 8 - Voltage regulation curves for Catalog Nos. 22100 and 22100-1

terminated in a spade lug which is connected to the high-voltage output terminal. The guard or shield terminal of the cable on the inboard end is connected through a strap to the guard terminal (E203) mounted on the cover of the High-Voltage Unit, the strap serving a secondary function of bracing the test cable.

18. REGULATION

The regulation characteristics of the 40 kv and 100 kv sets are shown in Figures 6 and 7 respectively. These charts were prepared for 115 volts input. They can be used as a quick means of estimating values of insulation resistance when kilovoltmeter and microammeter readings are known. For example, if the kilovoltmeter reads 30 kilovolts and the microammeter reads 600 microamperes, the insulation resistance is 50 megohms. This is found on the chart by locating the intersection of the horizontal and vertical lines representing the voltage and current. The diagonal line passing through the intersection represents the resistance. It will be noted that all lines of constant voltage are parallel to each other. This is also true for lines of constant current and constant resistance. This makes it easy to interpolate values on the chart.

19. OUTPUT CURRENT STABILITY

As a result of frequent voltage transients in the supply circuit used to energize the test set when testing specimens having appreciable capacitance and relatively high insulation resistance, microammeter pointer excursions may be troublesome. In such cases, it is recommended that a commercial voltage regulator be used to stabilize the input voltage. See AIEE No. 62 "Proposed Recommended Guide for Making Dielectric Measurements in the Field".

20. EXTERNAL INSTRUMENT CONNECTIONS

The output jack on the control panel is connected in series with the microammeter. This connector may be used to measure ripple, to display the current on a cathode ray oscilloscope or to amplify and record the output current. The current flow through the jack varies from zero to full scale corresponding to the full scale range of the microammeter.

21. DISCHARGE MEASUREMENTS

The Microammeter Polarity Switch (S102), when in a position opposite to that of the polarity being used to charge the specimen, serves two purposes:

a. It permits the operator to observe the magnitude of any residual charge that may exist in the specimen before starting the actual test.

b. It provides means for making discharge measurements on a specimen for anyone interested in the dielectric absorption characteristics of the insulation being tested.

S E C T I O N C

MAINTENANCE

GENERAL

The components of Biddle Dielectric Test Sets are built to withstand usage of the type normally encountered in field testing for public utilities and industrial plants. With reasonable care, when in use and in storage, these sets should give long trouble-free service. However, repairs may at times be required and this section of the manual is intended to facilitate such repair work.

It is recommended that a superficial inspection be given these sets about once a month, and a complete inspection about every six months.

22. MONTHLY INSPECTION

This inspection requires no tools. Examine the structural parts for damage. See that the fastening devices are secure and in proper operating condition. Inspect the cables for damage at the terminals and examine the jackets for signs of rupture. Clean the case and instrument panel and carefully wipe off the terminal bushings with a lintless cloth or paper towel. Operate the set and observe critically the action of controls and meters. See Subsections 9 to 16. See that the no-load leakage is normal. Replace any burned-out indicator lamps.

23. SEMI-ANNUAL INSPECTION - 22040 and 22040-1 40KV SETS ONLY

a. With the supply cable disconnected, remove the panel on each side of the control structure and make a visual examination of all exposed components. Check the Microammeter Protective Gap (E105) with a feeler gauge to be between 0.0015" and 0.002". This gap is on the right side of the set just under the Control Panel.

b. Ground the unguarded high-voltage terminal to provide an output short circuit and follow steps given in subsections 9 and 11, except that the Microammeter Range Switch (S104) should be set to 50K (50,000 microamperes). The d-c Overload Lamp (E101) should start to glow when the microammeter reads approximately 24,000, $\pm$5,000 microamperes. If not, the glow lamp should be replaced and the test repeated. This step checks the proper operation of the microammeter protective circuit.

c. To check the operation of Circuit Breaker (K101) continue to turn the voltage control slowly clockwise until it trips. Since the d-c Overload Lamp (E101) short circuits the microammeter when it is glowing, it will not indicate the actual tripping current. To determine the tripping current, the test must be performed with (E101) removed from its socket. The actual trip current should be between about 30,000 and 37,000 microamperes.

d. To check the operation of the Voltmeter Switch Protective Neon Lamp (E102) remove the ground called for in subsection 22b, and re-energize the set up to 5 kv in accordance with subsections 9 and 11. Next operate the Voltmeter Polarity Switch (S105) several times while checking the Protective Lamp (E102). Replace (E102) if it does not flash during this test. This lamp is mounted on the right hand side just under the control panel and directly above the Microammeter Protective Gap (E105).

e. A desirable test to prove the proper overall operation of the set is to check its voltage regulation under load. To make a one point check on the regulation curves given in Figure 6, a resistor of the proper voltage and wattage rating is connected between the high-voltage terminal and ground. For example, a 1 megohm resistor rated at 15 kv and 225 watts would, based on a 115 volt input and a voltage control setting of about 77, check the 15 milliampere point on the chart in Figure 6.

f. After these tests are completed, remove the control structure and inspect the back of the control and instrument panel for signs of corrosion, insulation damage, loose screws, dirt or other deterioration. Check the brushes on the Voltage Control (T101) for wear. The control structure is held in place by eight bolts which go through the bottom flange of the end frames, the phenolic tank cover and the tank flange. Four of these bolts also hold the handles in place. All wiring connections between tank and panels are brought through a seven pin AN connector. The plug for the oil-filling hole, located near the rear center of the cover of the high-voltage tank, should be removed and the oil level in the tank checked. The level, as measured from the top surface of the cover, should be approximately 1-1/4 inches. If oil is added, be sure that it is new, clean and dry. The vent plug for the filling hole is of the porous metal type. It should be rinsed in a solvent and blown out with compressed air before replacement.

24. TUBE REPLACEMENT - 22040 and 22040-1 40 KV SETS ONLY

Inability of the set to produce more than about one-half normal voltage usually indicates the failure of one of the two rectifier tubes in the oil-filled tank.

Replacement of tubes is accomplished most easily by the method illustrated in Figure 8. Remove the side covers and then the control structure. Obtain two six inch lengths of 2 x 4 wood or equivalent.

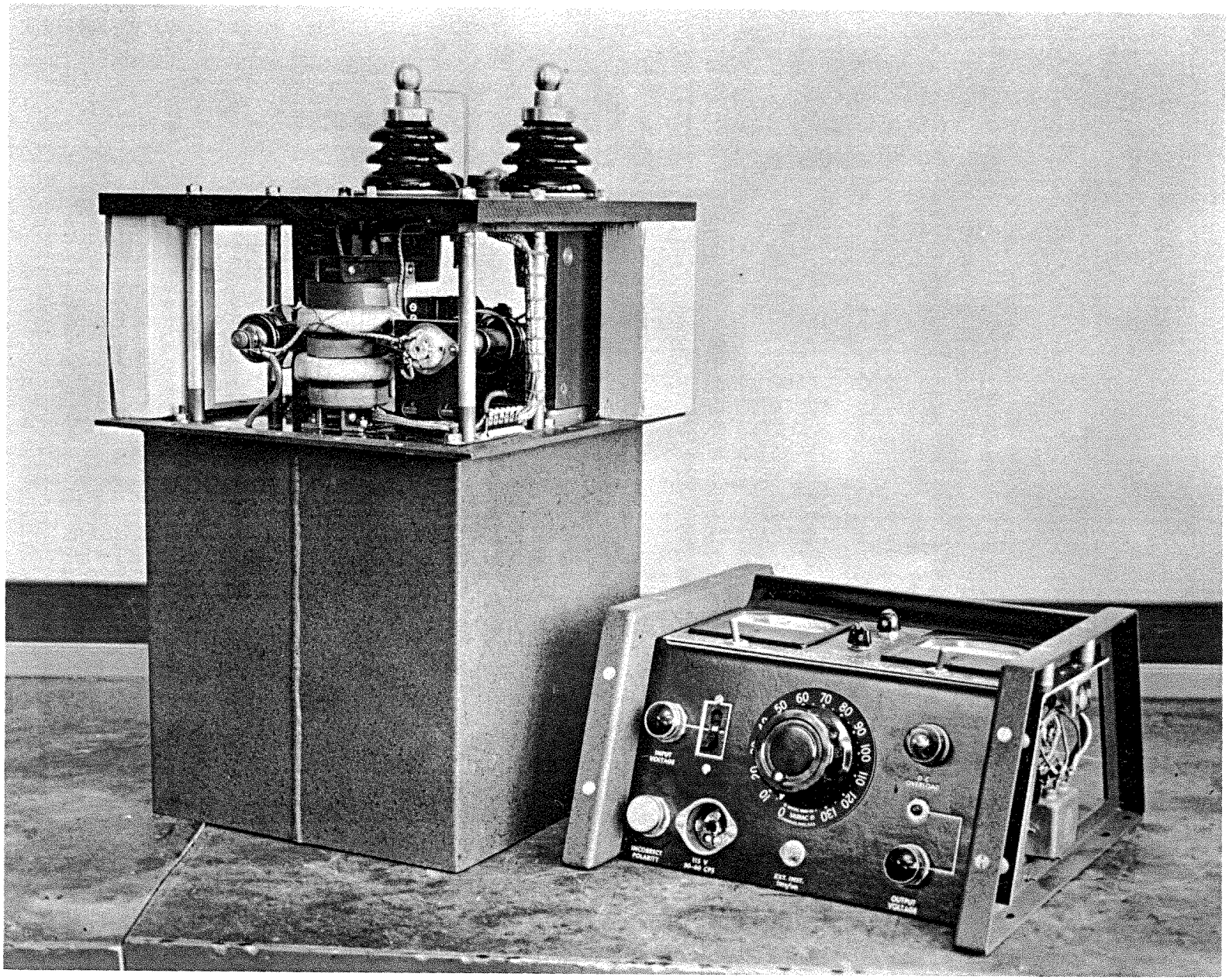


Figure 9 - Showing how, with the instrument panel or control structure removed, the tank cover assembly is raised to permit rectifier tube replacement.

Remove all tank cover bolts and carefully break the gasket seal so that the gasket remains on the tank flange. Make sure that the tank is level and that oil absorbent material such as fuller's earth is placed on the floor in the area where the tank rests. Now raise the tank cover assembly and block it exactly as shown in the Figure. If done carefully, very little oil will leak over the tank flange. Allow the set to drain for 10 or 15 minutes before replacing the tube. It is recommended that both tubes be replaced whenever one is bad unless the cost of tubes outweighs the inconvenience of replacement operations.

Use care when installing a new tube so that the plate cap is not twisted or forced in any way. The plate lead-in seal may crack during rough handling and ultimately cause leaks. Be careful also in dressing the plate cap connecting wire so that it is well away from adjacent parts.

25. SEMI-ANNUAL INSPECTION - 22100 and 22100-1 100 KV SETS ONLY

a. With the supply cable disconnected, remove the control and instrument panel from the Control Unit case and make a visual examination of all exposed components. Check the Microammeter Protective Gap (E105) with a feeler gauge to be between 0.0025" and 0.003". This gap is mounted behind the panel and directly behind the microammeter and voltmeter.

b. Ground the high-voltage terminal of the High Voltage Unit to provide an output short circuit, and follow steps given in subsections 10 and 11 except that the Microammeter Range Switch (S104) should be set to 50K (50,000 microamperes). The d-c Overload Lamp (E101) should start to glow when the microammeter reads approximately full scale. If not, the glow lamp should be replaced and the test repeated. This checks the proper operation of the microammeter protective circuit.

c. To check the operation of Circuit Breaker (K101) continue to turn the voltage control slowly clockwise until it trips. Since the d-c Overload Lamp (E101) short circuits the microammeter when it glows, it will not indicate the actual tripping current. To determine the tripping current, the test must be performed with (E101) removed from its socket. The actual trip current should be approximately full scale or a little above 50,000 microamperes.

d. A desirable test to prove the proper overall operation of the set is to check its voltage regulation under load. To make a one point check on the regulation curves given in Figure 7, a resistor of the proper voltage and wattage rating is connected between the high-voltage terminal and ground. For example, a 1 megohm resistor rated at 15 kv and 225 watts would, based on a 115 volt input and a voltage control setting of about 30, check the 15 milliampere point on the chart in Figure 7.

e. The hand-hole cover in the main cover of the High-Voltage Unit should be removed and the oil level in the tank checked. The level, as measured from the top surface of the main cover, should be approximately 2-7/16". If oil is added, be sure that it is new, clean and dry. A vent plug of the porous metal type is mounted on the main cover. It should be removed, rinsed with a solvent and blown out with compressed air before replacement. While the hand-hole cover is off, a flashlight should be shown through the oil and all accessible parts visually inspected.

f. The ceramic high-voltage bushing (Output Terminal E202) is partially filled with the same kind of transil oil used in the main tank. The filling-hole plug on the top of the bushing should be removed and the oil level checked at approximately 7-1/4" from the top surface of the bushing cap.

26. TUBE REPLACEMENT - 22100 and 22100-1 100 KV SETS ONLY

Inability of the set to produce more than about one-half normal voltage usually indicates the failure of one of the two rectifier tubes in the High-Voltage Unit. The two tubes are mounted directly under the hand-hole cover and can be easily replaced by removing this cover.

27. REPAIRS WITHIN HIGH-VOLTAGE, OIL-FILLED POWER SUPPLY UNITS

When any extensive work is done on components within the oil-filled tank, it should be borne in mind that the plate and filament transformers were vacuum impregnated at assembly and prolonged exposure to air or even in poor oil may have a deleterious affect on them.

In cases where repairs are delayed for more than an hour or so, the high-voltage assembly should be replaced in the oil. Replacement high-voltage plate and filament transformers must be oil impregnated under vacuum before use.

LIST OF REPLACEMENT PARTS

The tables of parts that follow list only those parts which are likely to need replacement. They are normally stocked in small quantities and may be obtained direct from the factory. Those parts which are identified with a manufacturer's name and stock number are standard commercial items and may be obtained direct from their source. Wherever these parts can be obtained locally it will generally be more economical to do so.

22040 and 22040-1 40 KV SETS ONLY

Designation	Part & Manufacturer	Mfr's. Part or Cat. No.	JGB Co. Part No.
C 101	Capacitor, 1 muf, 600 v d-c P. R. Mallory & Co.	CB-605	7545
C 102	Capacitor, .005 muf, 600 v d-c Cornall-Dubilier Co.	4E-12050	7950
C 201 C 202	Capacitor, 0.1 muf, 20,000 v d-c General Electric Co.	28F351	7504
E 101 E 102	Lamp, Neon glow General Electric Co.	NE-48	8104-5
E 105	Spark Gap Contact		7305
E 201	High Voltage Output Bushing		9107-2
E 202	High Voltage Output Bushing		9107-2
E 203	Guard Terminal (Ball)		7530-4
E 204	Ground Terminal (Wing Nut)		5026
I 101 I 102 I 103	Lamp, Indicator, (lamp only) Candelabra screw base General Electric Co.	6S6	
J 101	Jack		8374
J 102	Connector, Female "Twistlock" Harvey Hubbel, Inc.	7696	8440
J 103	Connector, AN 3106-B-16S-1S Cannon Electric Co. with Cable Clamp Cannon Electric Co.	AN3106B-16S-1S AN3057-8	7544-2
K 101	Circuit Breaker		9131
K 102	Control Relay Potter & Brumfield	KR11A	3623
M 101 M 102	Kilovoltmeter (100 a) Microammeter (5 a) (50 a)		4975-3 4977 4978
P 101	Connector, Male, "Twistlock" Harvey Hubbel, Inc.	7524	8410
P 102	Connector, Male, "Twistlock"	7057	8439
P 203	Connector, AN 3102C-16S-1P Cannon Electric Co.	AN3102C-16S-1P	7544-1
R 101	Resistor, Wirewound, 2250 ohms $\pm$5%, 10 watts, Ohmite Mfg. Co. "Brown Devel"		8327-5

Designation	Part & Manufacturer	Mfr's. Part or Cat. No.	JGB Co. Part No.
R 101	Resistor, Wirewound, 2250 ohms ±5%, 10 watts, Ohmite Mfg. Co. "Brown Devil"		8327-5
R 102	Resistor, Wirewound, 8000 ohms ±5% 10 watts, Ohmite Mfg. Co. "Brown Devil"		8327-6
R 103	Resistor, Wirewound, 101 ohms ±0.5%, 1/4 watt		7543-5
R 104	Resistor, Wirewound, 1,018 ohms ±0.5%, 1/4 watt		7543-8
R 105	Resistor, Wirewound, 10,180 ohms ±0.5%, 1/4 watt		7543-9
R 106A	Resistor, Wirewound, 80K ohms 1/4 watt		7543-27
R 106B	Resistor, Adjustable 20K ohms		4418-3
R 107	Resistor, Wirewound, 500 ohms ±0.5%, 1/4 watt		7543-2
R 108	Resistor, Wirewound, 125 ohms ±0.5%, 1/4 watt		7543-6
R 109	Resistor, Wirewound, omitted in 50 a units 10.15 ohms ±0.5%, 1/2 watt omitted in 50 a units		7543-24
R 110	Resistor, Wirewound, 555 ohms ±0.5%, 1/4 watt		7543-7
R 201	Resistor Assembly, 50 megohms ±5%		9106-2
R 202	Resistor Assembly, 50 megohms ±5%		9106-1
R 203	Resistor Assembly, 50 megohms ±1%		9109
R 204	Resistor Assembly, 50 megohms ±1%		9109
R 205	Resistor Assembly, 100 ohms ±10%		9111
R 206	Resistor Assembly, 100 ohms ±10%		9111
S 101	Switch, Push button, D.P.S.T. Normally Open Arrow Hart & Hegeman	3392-A	7043
S 102	Switch, Toggle, D.P.D.T. Cutler-Hammer	8825-K-S	8406-1
S 103	Switch, Selector, 4 position, 3 circuit, shorting type P. R. Mallory Co.	3134J	7507-6
S 104	Switch, Selector, 4 position 3 circuit, shorting type (50 a) P. R. Mallory Co.	3134J	7507-6
	Switch, Selector, 5 position 1 circuit, shorting type (5 a) P. R. Mallory Co.	3115J	7507-1
S 105	Switch, Toggle, D.P.D.T. Cutler-Hammer	8825-K-S	8406-1
S. 106	Switch, S.P.D.T.		9235
T 101	Auto-Transformer, adjustable Ratio W-5 General Radio Co.		7219
T 201	Transformer, plate		7505
T 202	Transformer, filament		7503

Designation	Part & Manufacturer	Mfr's. Part or Cat. No.	JGB Co. Part No.
V 201 V 202	Tube, Rectifier Radio Corp. of America	8013-A	8013
W 101	Cable, Input		8438
W 201	Cable, Grounding		8099
W 301	Cable, High-Voltage (Not part of test set) Output, Shielded		22040-L
	Ball Nut, Terminal		7530-2
	Barrier Chain		
	Tube Socket Amphenol	148-101	8630
	Tube Clamp Millen Mfg. Co.	K 33087E	8632
	Oil, Wemco C Westinghouse Elec. Corp. or equivalent	Wemco "C"	8436
	Brush for T 101 General Radio Co.	VB-2	

22100 and 22100-1 100 KV SETS ONLY

Designation	Part & Manufacturer	Mfr's. Part or Cat. No.	JGB Co. Part No.
C 101	Capacitor, 1 muf, 600 v d-c P. R. Mallory & Co.	CB-605	7545
C 102	Capacitor, .005 muf, 600 v d-c Cornell-Dubilier Co.	4E-12050	7950
C 201 C 202	Capacitor, .015 muf Condenser Products Co.	AOB60M0015X	9092
E 101	Lamp, Glow General Electric Co.	NE-48	8104-5
E 104	Interlock		9024
E 105	Spark Gap Contact		7305
E 202	High Voltage Output Bushing (Ceramic) (Epoxy)		9098 9026
E 206	Jumper		9024
I 101 I 102 I 103	Lamp, Indicator (lamp only) Candelabra Screw Base General Electric Co.	6S6	
J 101	Jack		8374
J 102	Connector, Female, "Twistlock" Harvey Hubbel, Inc.	7696	8440
J 103	Connector, Female American Phenolic Corp.	AN3102A-20-18S	9018-1
J 201	Connector, Male American Phenolic Corp.	AN3108B-20-18P	9077-1
	Cable Clamp American Phenolic Corp.	AN3057-12	9093-1
K 101	Circuit Breaker		9016
K 102	Control Relay Potter & Brumfield	PR7AY	9027
K 201	Shorting Relay		9160
M 101	Kilovoltmeter		4975-4
M 102	Microammeter (5 a) (50 a)		4977 4978
P 101	Connector, Male, "Twistlock" Harvey Hubbel, Inc.	7524	8410
P 102	Connector, Male, "Twistlock" Harvey Hubbel, Inc.	7057	8439
P 201	Connector, Female American Phenolic Corp.	AN3108B-20-18S	9077-2
P 203	Connector, Male American Phenolic Corp.	AN3102C-20-18P	9018-2

Designation	Part & Manufacturer	Mfr's. Part or Cat. No.	JGB Co. Part No.
R 102	Resistor, 10.15 ohms 1/2 watt (omitted in 50 a units)		7543-24
R 103	Resistor, Wirewound, 101 ohms ±0.5%, 1/2 watt		7543-5
R 104	Resistor, Wirewound, 1,018 ohms ±0.5%, 1/4 watt		8543-8
R 105	Resistor, Wirewound, 10,180 ohms ±0.5%, 1/4 watt		7543-9
R 106A	Resistor, Wirewound, 80K ohms 1/4 watt		7543-27
R 106B	Resistor, Adjustable 20K ohms		4418-3
R 107	Resistor, Wirewound, 500 ohms ±0.5%, 1/4 watt		7543-2
R 111	Resistor, Wirewound, 10,000 ohms ±5%, 20 watts Ohmite Mfg. Co. "Brown Devil"		9390-1
R 112	Resistor, Wirewound, 166.7 ohms ±0.5%, 1/4 watt		7543-3
R 201	Resistor Assembly		9038
R 202	120 megohms ±1%		
R 204	Resistor Assembly, 125 megohms ±1%		9036
R 207	Resistor Discharge 1 Megohm ±15%		9344
S 101	Switch, Push button, D.P.S.T. Arrow, Hart & Hegeman Elec. Co.	3392-A	7043
S 102	Switch, Toggle, S.P.D.T. Cutler-Hammer	8825K5	8406-1
S 103	Switch, Selector 3 position, 2 circuit, shorting type P. R. Mallory & Co.	3123J	7507-4
S 104	Switch, Selector 4 position, 3 circuit, shorting type (50 a) P. R. Mallory & Co.	3134J	7507-6
	Switch, Selector 5 position, 1 circuit, shorting type (5 a) P. R. Mallory & Co.	3115J	7507-1
S 105	Switch, S.P.D.T.		9235
T 101	Auto Transformer, Adjustable Ratio V 20 General Radio Co.		8263-1
T 201	Transformer Plate		9001
T 202	Transformer, Filament		9000
V 201 V 202	Tube, Rectifier Machlett Lab., Inc.	ML-141	9002
W 101	Cable, Input		8438
W 201	Cable, Ground		8099
W 202	Cable, Interunit Control		9153
W 203	Cable, Interunit Ground		9154
W 301	Cable, High Voltage Output, Shielded (not part of test set)		22100-1

Designation	Part & Manufacturer	Mfr's. Part or Cat. No.	JGB Co. Part No.
	Brush for T 201 General Radio Co.	VBT-5	
	Oil, Wemco C Westinghouse Electric Corp. or equivalent	Wemco "C"	8436

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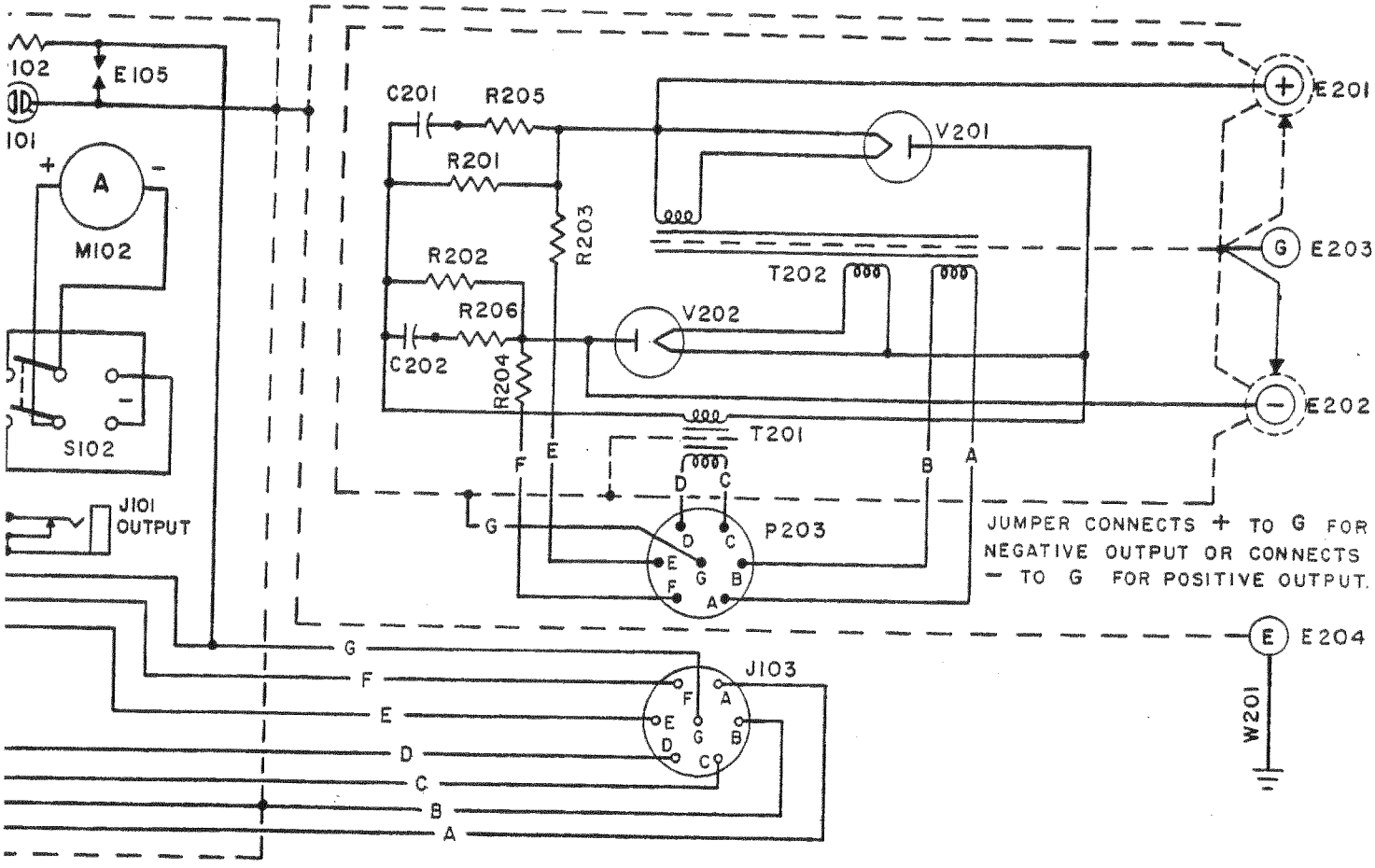


Figure 10 - Schematic diagram of Catalog 22040-1

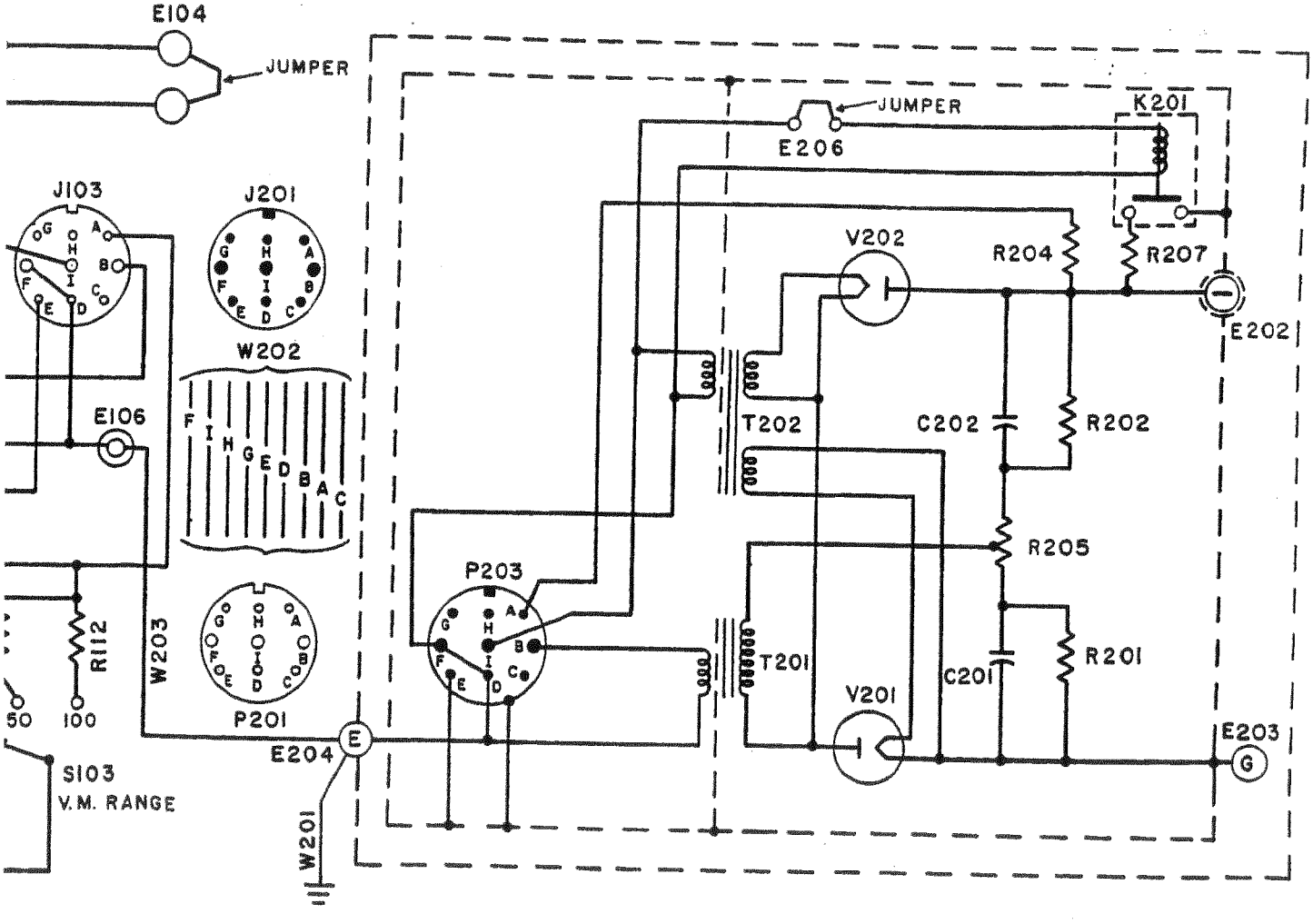
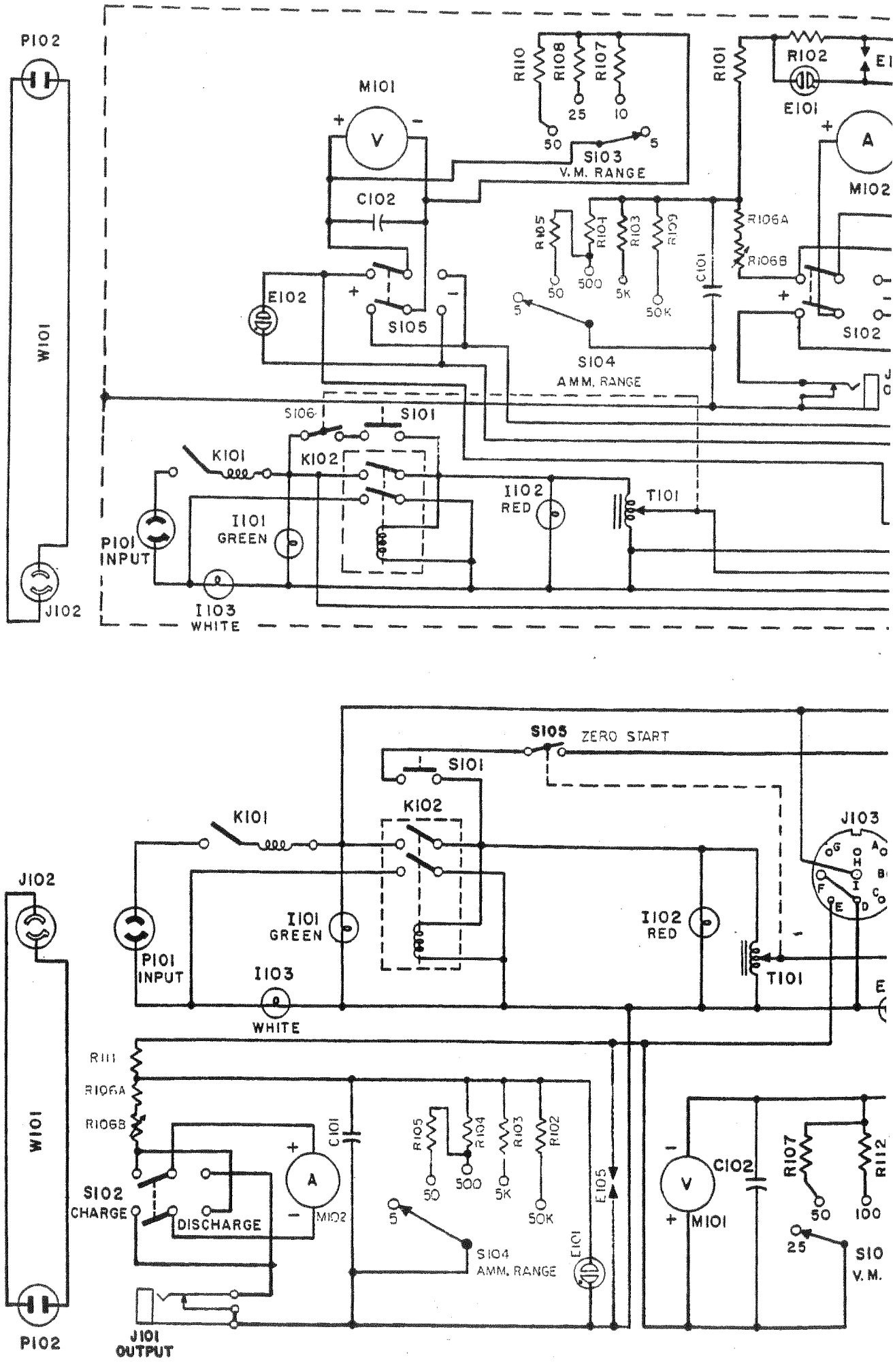


Figure 11 - Schematic diagram of Catalog 22100-1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K102
I102
RED
T101
P101
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GREEN
I103
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S105 ZERO START
J103
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OUTPUT

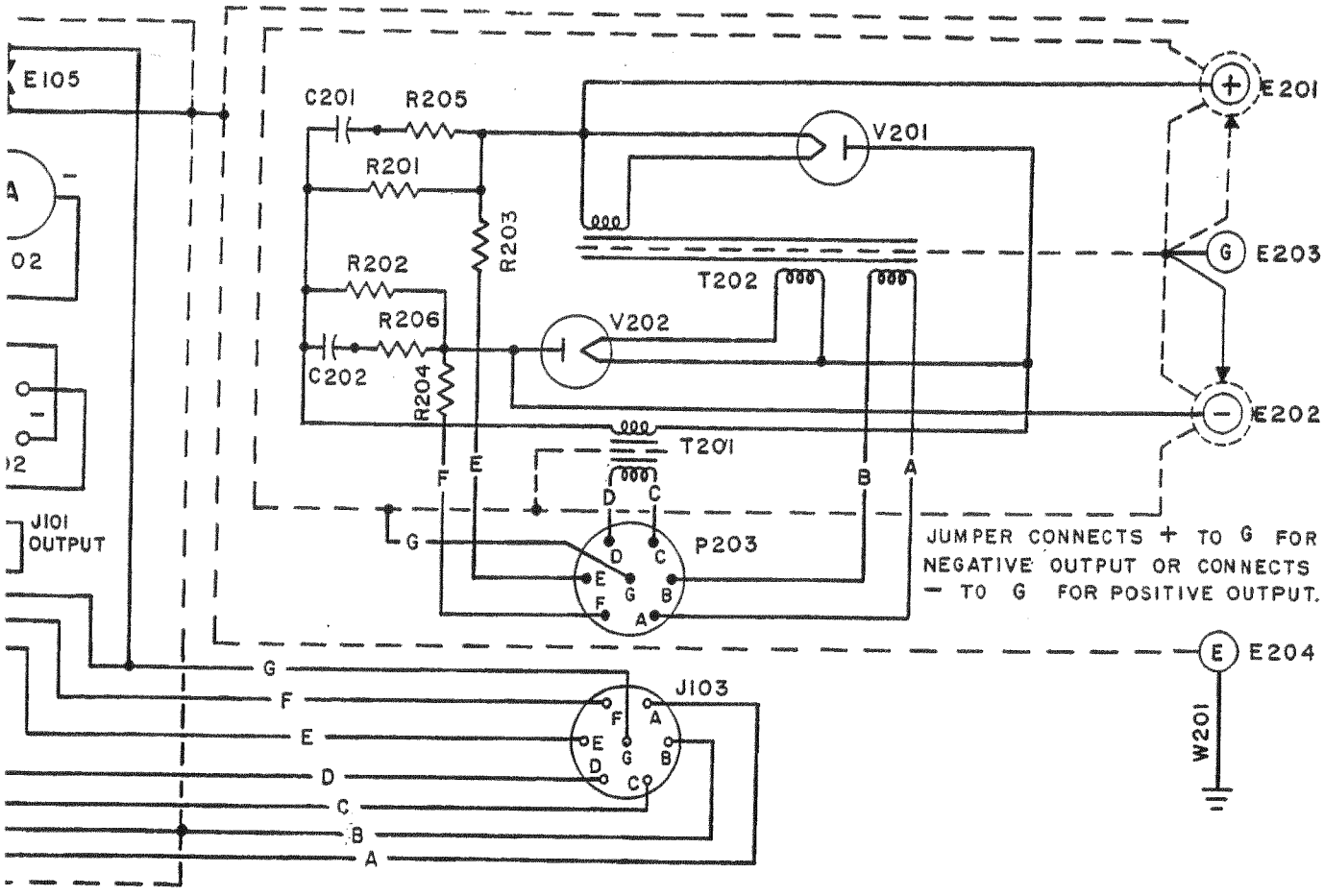


Figure 12 - Schematic diagram of Catalog 22040

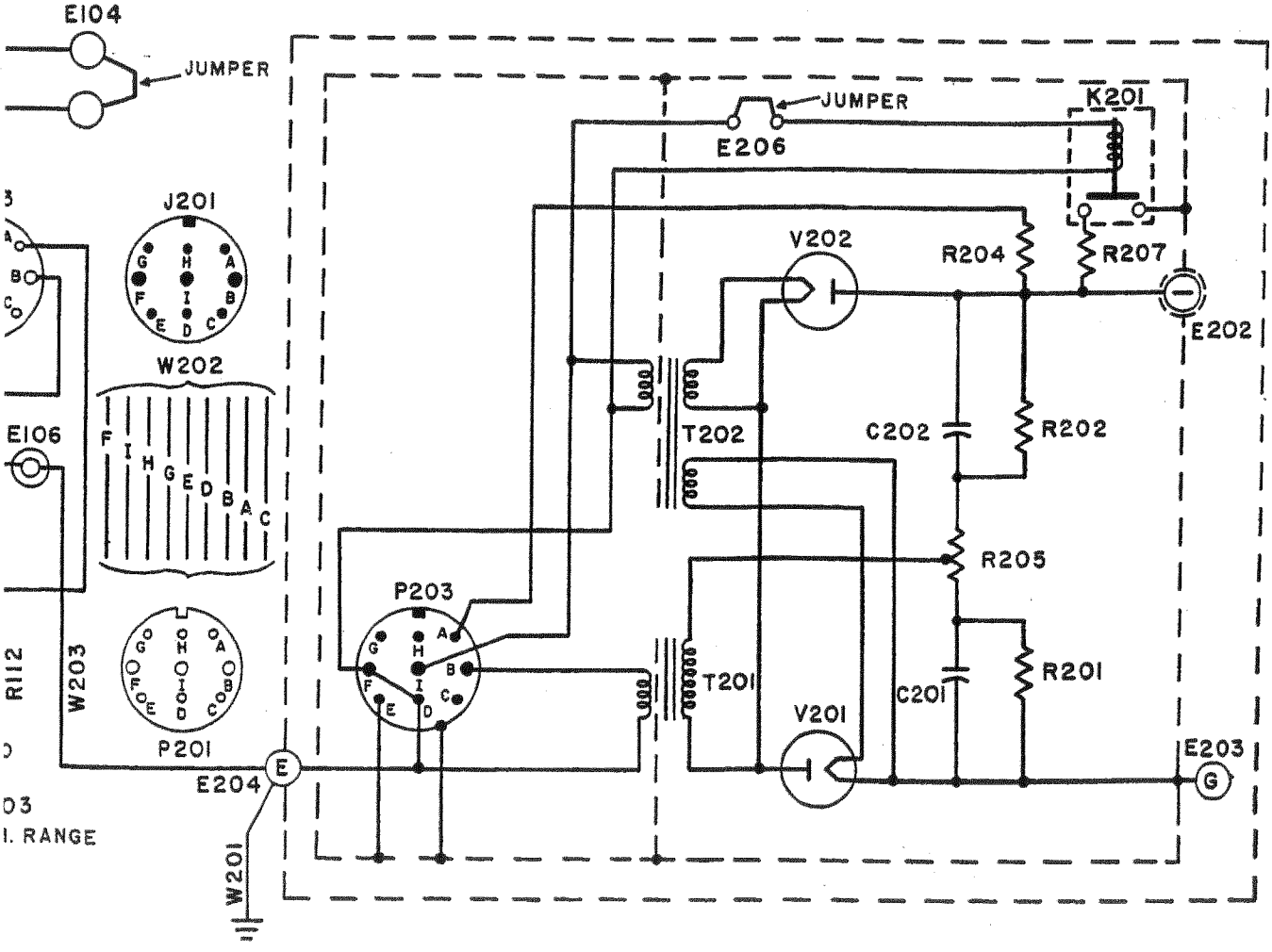
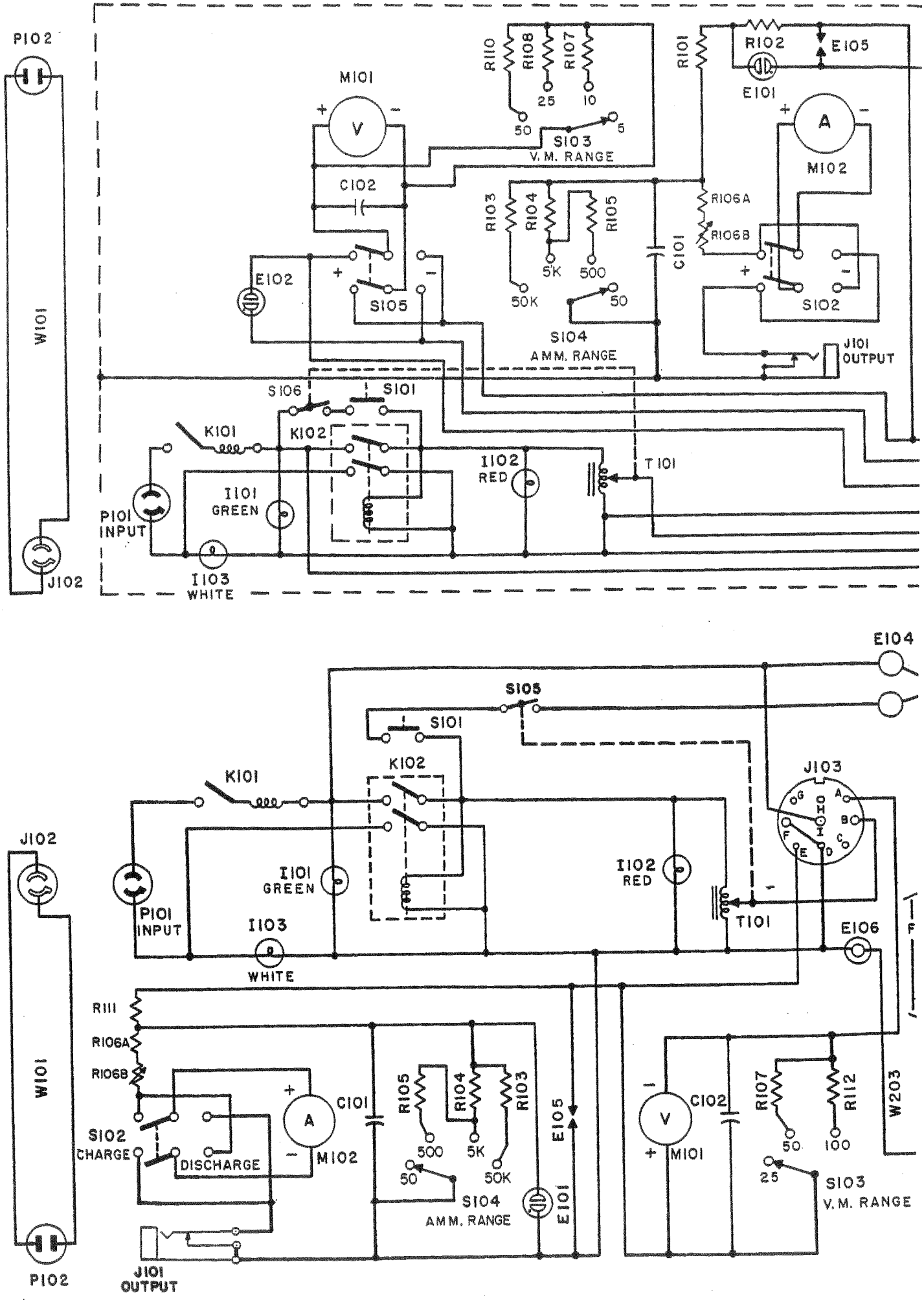


Figure 13 - Schematic diagram of Catalog 22100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W101
J102
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V
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10
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S103
V. M. RANGE
C102
R103
R104
R105
5K
500
50K
50
S104
AMM. RANGE
E102
S105
R101
R102
E105
E101
A
M102
R106A
R106B
C101
S102
J101
OUTPUT
S106
S101
K101
K102
I102
RED
T101
P101
INPUT
I101
GREEN
I103
WHITE
E104
J103
I102
RED
T101
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CHARGE
DISCHARGE
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M102
R105
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R103
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50K
S104
AMM. RANGE
E105
E101
C102
V
M101
R107
R112
50
100
25
S103
V. M. RANGE
W203
J101
OUTPUT
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