

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TM 11-5043-35

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TO 33A1-6-20-2

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**FIELD AND DEPOT  
MAINTENANCE**

**ANALYZERS  
ZM-3/U  
AND  
ZM-3A/U**

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**DEPARTMENTS OF THE ARMY AND THE AIR FORCE  
SEPTEMBER 1958**

**WARNING**

**DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT**

Be careful when working on the low voltage (280 volts) power supply circuits, or on the 115-volt ac line connections. Serious injury or death may result from contact with these points.

**DON'T TAKE CHANCES!**

**EXTREMELY DANGEROUS VOLTAGES  
(600 VOLTS) EXIST IN THE HIGH  
VOLTAGE RECTIFIER CHASSIS  
AND AT THE LEAKAGE TERMINALS  
AND THE INSULATION RESISTANCE TERMINALS  
ON THE FRONT PANEL OF THE ANALYZER.**

CHANGE }  
No. 1 }

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 17 October 1967 -

DS, GS, and Depot Maintenance Manual  
ANALYZERS ZM-3/U AND ZM-3A/U

TM 11-5043-35, 4 September 1958, is changed as follows:

The title of the manual is changed as indicated above.

Page 2, paragraph 1. Delete and substitute:

**1. Scope**

a. This manual covers direct support (DS), general support (GS), and depot maintenance for Analyzers ZM-3/U and ZM-3A/U. It includes instructions appropriate to GS, DS, and depot categories for troubleshooting, testing, adjusting, and repairing the equipment. It also lists tools and test equipment required for DS, GS, and depot maintenance.

b. The complete instructions for this equipment include one other publication, TM 11-5043-12.

c. Report of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-ME-NMP-AD, Fort Monmouth, N. J. 07703.

**Note**

**For applicable forms and records,  
refer to paragraph 2, TM 11-5043-12.**

Add the following:

**1.1. Index of Publications**

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

Page 14, paragraph 9. Delete the chart and substitute:

<i>Item</i>	<i>Technical Manual</i>	<i>Common name</i>
Multimeter AN/URM-105	TM 11-6625-203-12	Multimeter
Test Se Electron Tube TV-7D/U	TM 11-6625-274-12	Tube tester
Test Set, Electron Tube TV-2/U (Depot only)	TM 11-6625-316-12	Tube tester
Capacitance	TM 11-2646A	Test set
Inductance		
Resistance		
Test Set AN/URM-90		
Crystal Rectifier Test Set TS-268E/U	TM 11-1242	Crystal test set
Meter Test Set TS-682A/GSM-1	TM 11-2535B	Meter test set
Tool Equipment TE-49		
Tool Kit, Radio and Radar Repairman TK-87/U		
Meter Test Set TS-682A-SM-I	TM 11-2535B	Meter test equipment
Tool Kit, Electronic Equipment TK-100/G		

## CHAPTER 5

### DEPOT OVERHAUL STANDARD

Page 35. After chapter 4, add:

#### 28. Applicability of Depot Overhaul Standards

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

#### 29. Applicable References

a. Repair Standards. Applicable procedures of the depots performing this test and the general standards given in TB SIG 355-1, TB SIG 355-2, and TB SIG 355-3 for repaired electronics equipment form a part of the requirements for testing this equipment.

b. Technical Publications. The only other publication applicable to the equipment to be tested is TM 1 1-5043-12.

c. Modification Work Orders. Perform all modification work orders to this equipment before making the tests specified. DA Pam 310-4 lists all available MWO's.

#### 30. Test Facilities Required

The following items are required for depot testing:

##### a. Test Equipment.

Item	Technical Manual	Common name
Electronic Multimeter TS-505A/U or Multimeter TS-352B/U	TM 11-6625-239-12	Vtvm
Impedance Bridge AN/URM-90	TM 11 625-366-15	Impedance bridge
Laboratory Standard AN/URM-2		Laboratory standard
Resistor, Decade ZM-16/U	TM 11-5102	Decade resistor
Resistance Bridge ZM-4/U	TM 11-2019	Resistance bridge

##### b. Additional Equipment.

- (1) Capacitor, fixed electronic.
- (2) Resistor, variable, wirewound, 7,500 ohms, 50 watts.
- (3) Resistor, variable, wirewound, 1,500 ohms, 5 watts.

#### 31. Requirements

All tests should be conducted under the following conditions:

- a. At normal room temperature.
- b. After a 5-minute warmup period.
- c. At input power of 105 volts to 125 volts, single phase, 50 to 60 cycles ac.

#### 32. Leakage Test

a. Adjust a variable resistor of 5-watt rating to obtain a nominal value of 1,200 ohms; use Resistance Bridge ZM4/U as a standard. Record the resistance to the nearest ohm.

b. Connect this resistor across the LEAKAGE terminals.

c. Connect a dc vtm such as the TS-505A/U or TS-352B/U across the LEAKAGE terminals in parallel with the test resistor noted in a above.

d. With the analyzer METER SWITCH held in the 50MA position, adjust the OPERATING VOLTAGE control until the panel meter reads SOMA. Record the vtm reading, then release the METER SWITCH and remove the resistor.

e. Compute the leakage current; use the values of measured resistance (a above) and voltage (d above) corrected for calibration. This current should be between 48.5 and 51.5 MA.

#### 33. Voltmeter Test

a. Connect the vtm to the LEAKAGE terminals. With the analyzer METER SWITCH held in the 60 VOLTS position, adjust the OPERATING VOLTAGE control until the panel meter reads 60 volts. Record the vtm reading; then release the analyzer METER SWITCH. The reading should be between 58.2 and 61.8 volts.

b. With the analyzer METER SWITCH in the 600 VOLTS position, adjust the OPERATING VOLTAGE control until the meter reads 600 volts.

c. Move the analyzer METER SWITCH to the 50MA position and hold it there while reading the vtm. The reading should be between 582 and 618 volts. Record this reading.

#### 34. Capacitance Test

Energize a 500 uf electrolytic capacitor for at least 30 minutes from a DC source to form the plates.

Immediately measure the capacitance with the Impedance Bridge. Use this capacitor to calibrate capacitance ranges 4 and 5 of Analyzer ZM-3/U; use the value (-) measured on the Impedance Bridge. The reading on the INDICATOR DIAL should be within the following limits when the bridge is balanced and using the listed capacitances connected to the CAPACITANCE terminals.

<i>Range</i>	<i>Standard capacitance</i>	<i>Indicator dial reading</i>
5 to 100 $\mu\text{mf}$	10 $\mu\text{mf}$	7 to 13 $\mu\text{mf}$
5 to 100 $\mu\text{mf}$	80 $\mu\text{mf}$	77 to 83 $\mu\text{mf}$
10 to 50,000 $\mu\text{mf}$	20,000 $\mu\text{mf}$	19,000 to 21,000 $\mu\text{mf}$
0.04 to 30 $\mu\text{mf}$	1.0 $\mu\text{f}$	0.95 to 1.05 $\mu\text{f}$
25 to 1,000 $\mu\text{mf}$	500 $\mu\text{f}$ (+)	Measure value $\pm 10\%$
250 to 10,000 $\mu\text{mf}$	500 $\mu\text{f}$ (+)	Measure value $\pm 20\%$

### 35. Insulation Resistance Test

*a. General.* Use resistors that are calibrated to  $\pm 1$  percent for insulation resistance. The following chart lists the resistance value to be used and the scale reading that should be obtained for each position of the analyzer megohm range switch.

<i>Megohm range switch pos</i>	<i>Resistance (megohms)</i>	<i>Scale reading</i>
MEGOHMS X1	2	1.6 to 2.4
MEGOHMS X1	80	64 to 96
MEGOHMS X100	150	1.2 to 1.8

AGO 916A

*b. Procedure.* Perform the following test for each position of the megohm range switch given in the chart in a above.

- (1) Set the controls for insulation resistance measurements (TM 11-5043-12).
- (2) Connect a resistor (a above) to the insulation resistance terminals.
- (3) Set the megohm range switch to MEGOHMS XI OR MEGOHMS X100, as required.
- (4) Depress the KEY and adjust the DIAL CONTROL until the balance condition (10 ma) is indicated on the meter.
- (5) Release the KEY and read the resistance value on scale 1 of the drum and scale assembly. The resistance must be within the limits given in the chart in a above.

### 36. Power Factor Test

The indicated reading of the POWER FACTOR dial at balance should be within the limits indicated in the chart below when the series-capacitor values are connected to the CAPACITANCE terminals:

<i>Capacitance</i>	<i>Resistance</i>	<i>Power factor dial reading</i>
0.1 $\mu\text{f}$ $\pm 1\%$	80 ohms $\pm 0.5\%$	4.5 to 5.5%
0.1 $\mu\text{f}$ $\pm 1\%$	160 ohms $\pm 0.5\%$	9 to 11%
0.1 $\mu\text{f}$ $\pm 1\%$	500 ohms $\pm 0.5\%$	27 to 33%

**APPENDIX**

**REFERENCES**

DA Pam 310-4.....Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.	TM 11-6625-203-35.....Field and Depot Maintenance Manual: Multimeter AN/URM-105, Including Multimeter ME-77/U.
DA Form 310-7.....U. S. Army Equipment Index of Modification Work Orders.	TM 11-6625-239-12.....Operator's and Organizational Maintenance Manual: Electronic Multimeters TI505A/U and TS505B/U; Multimeters TS-505C/U and S-505D/U.
TB SIG 355-1.....Depot Inspection Standard for Repaired Signal Equipment.	TM 11-6625-239-35.....Field and Depot Maintenance Manual: Electronic Multimeters TS-505A/U and TS-505B/U; Multimeters TS-505C/U and TS505D/U.
TB SIG 355-2.....Depot Inspection Standard for Refinishing Repaired Signal Equipment.	TM 11-6625-274-12.....Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-17/U,TV-7A/U,
TB SIG 355-3.....Depot Inspection Standard for Moisture and Fungus Resistant Treatment.	TM 11-6625-274-35.....DS, GS, and Depot Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-1242 .....Crystal Rectifier Test Sets TS-268/U, TS-268AU, TS-268B/U, TS-and TV-7/U 268C/U, TS-268D/U, and TS-268E/U.	TM 11-6625-316-12.....Operator and Organizational Maintenance Manual: Test Sets, Electron Tube TV-2/U, TV-2AU, TV-2B/U, and TV-2D/U.
TM 11-2019 .....Test Sets I-49, I-49A, and I-149B and Resistance Bridges ZM4A/U and ZM-4B/U.	TM 11-6625-316-35.....Field and Depot Maintenance Manual: Test Sets, Electron Tube TV-2/U, TV-2A/U, TV-2B/U, and TV-2C/U.
TM 11-2535B.....Meter Test Set TS-682A/GSM-1.	TM 11-6625-366-15.....Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352/U
TM 11-2646A.....Capacitance-Inductance-Resistance Test Set AN/URM-90.	TM 38-750 .....Army Equipment Record Procedures.
TM 11-5043-12 .....Operator's and Organizational Maintenance Manual: Analyzers ZM-3/U and ZM-3A/U.	
TM 11-5102 .....Resistors, Decade ZM-16U, ZM-16A/U, and ZM-16B/U. Maintenance Manual: Multimeter	
TM 11-6625-203-12 .....Operator and Organizational Maintenance: Multimeter AN/URM-105, Including Multimeter ME-77/U.	

By Order of the Secretary of the Army:

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*Chief of Staff.*

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NG: State AG (3)

USAR: None.

For explanation of abbreviations used, see AR 320-0.



DEPARTMENTS OF THE ARMY

AND THE AIR FORCE

WASHINGTON 25, D. C., 4 September 1958

TECHNICAL MANUAL  
No. 11-5043-35  
TECHNICAL ORDER  
No. 33A1-6-20-2

**ANALYZERS ZM-3/U AND ZM-3/U**

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\*This manual, together with TM 11-3043-12, supersedes TM 11-5043, 15 August 1952, Including C 1, 9 November 1954, and C 2, 20 October 1955.

## CHAPTER 1

### THEORY

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#### 1. Scope

a. This manual covers field and depot maintenance for Analyzers ZM-3/U and ZM-3A/U. It includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, adjusting, and repairing the equipment, replacing maintenance parts, and repairing specified maintenance parts. It also lists tools and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in the theory section.

b. The complete instructions for this equipment include one other publication -

TM 11-5043-12, Analyzers ZM-3/U and ZM-3A/U, Operator's and Organizational Maintenance Manual.

c. The maintenance allocation chart is located in TM 11-5043-12.

d. See SIG 7 & 8 ZM-3/U, Analyzers ZM-3/U and ZM-3A/U, for maintenance parts information.

e. Forward comments concerning this manual to the Commanding Officer, United States Army Signal Publications Agency, Fort Monmouth, N. J.

#### Note

**For applicable forms and records, see paragraph 2, TM 11-5043-12.**

#### 2. Block Diagram Analysis

a. *Leakage Current Circuit* (A, fig. 1). The electrolytic capacitor to be tested is connected to the leakage terminals. Meter M1, connected in series with the capacitor under test and high voltage rectifier V9, indicates the leakage current of the electrolytic capacitor under test. OPERATING VOLTAGE control R29 is used to adjust the output voltage of high voltage rectifier V9 to the working voltage of the electrolytic capacitor.

b. *Insulation Resistance Circuit* (B, fig. 1). The capacitor to be tested is connected to the insulation

resistance bridge through the insulation resistance terminals. The output from the insulation resistance bridge is applied to meter M1 through direct current (dc) amplifier V8. The drum and scale assembly is adjusted for an indication of 10 milliamperes (ma.) on meter M1. At this setting, the insulation resistance bridge will be balanced (par. 4). The insulation resistance value can then be read from scale 1 of the drum and scale assembly.

c. *Capacitance Circuit* (C, fig. 1). The capacitor to be measured is connected to the capacitance bridge through the capacitance terminals. Oscillator V1 supplies an alternating current (ac) voltage to the capacitance-bridge through amplifier V2. The output from the capacitance bridge is applied to meter M1 through capacitance bridge amplifier V3 and dc amplifier V8. The capacitance bridge is balanced when the drum and scale assembly is adjusted for a minimum indication on meter M1. The capacitance value can then be read from scale 2, 3, 4, or 5 of the drum and scale assembly.

#### 3. Leakage Current Circuit

(figs. 2 and 23)

a. *High Voltage Rectifier*. With SELECTOR switch S2 in the LEAKAGE position, high voltage rectifier V9 (tube type 807) is connected as a half-wave rectifier (fig. 23). The plate of high voltage rectifier V9 is connected to one side of the high voltage winding of transformer T2; the other side of the high voltage winding is grounded. Resistor R24 and OPERATING VOLTAGE potentiometer R29 are connected in series with each other and in parallel with the high voltage winding of transformer T2 (fig. 2). The arm of potentiometer R29 is connected directly to the screen grid and through resistor R25 to the control grid. The setting of potentiometer R29 determines the amount of voltage applied to the control grid and the screen grid. The voltage applied to the screen grid and the control grid determines the output voltage of high voltage rectifier V9. Resistor R24 limits

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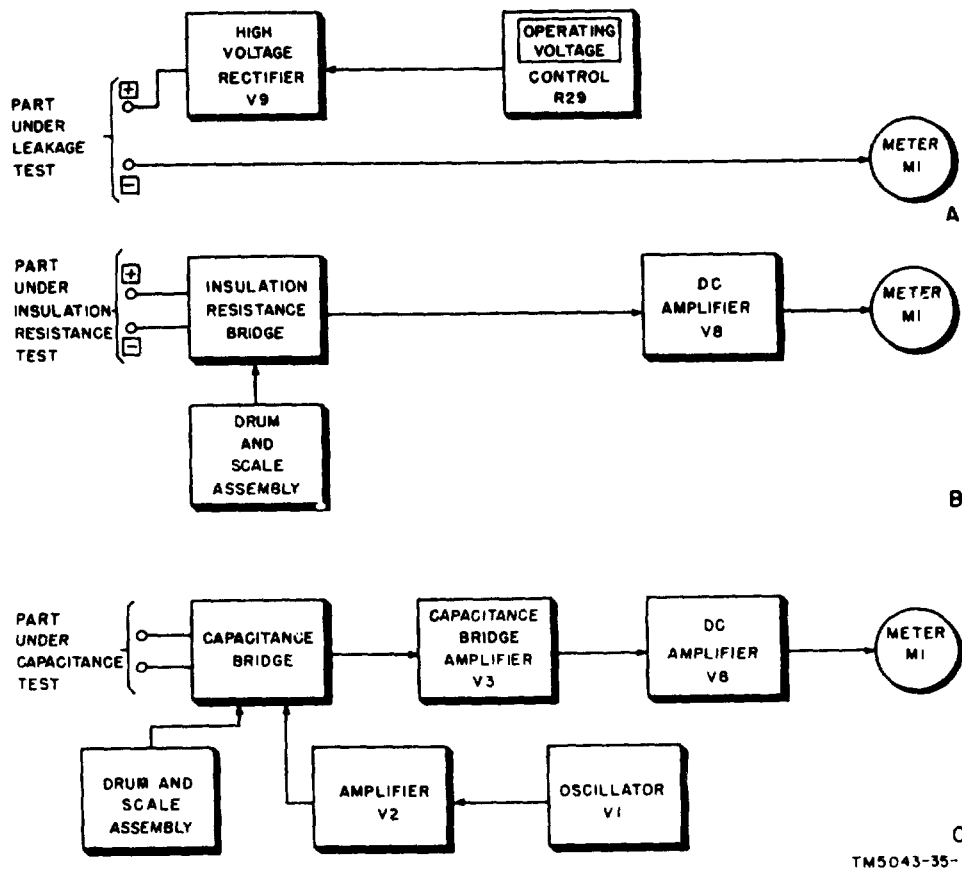


Figure 1. Analyzer ZM-3(\*)/U, block diagram.

the maximum output voltage. Capacitor C16 and lamp R38 are used as a filter. Lamp R38 also serves as a variable resistor to protect the circuit against overload. With no load connected to the leakage terminals, a small current flows through lamp R38 and bleeder resistor R26. At this value of current, the resistance and temperature of lamp R38 are low. If a shorted capacitor is connected to the leakage terminals, a high current will flow through lamp R38 and cause the resistance and temperature of the lamp to increase. This increase in resistance limits the current through the circuit and protects high voltage rectifier V9 and transformer T2. Bleeder resistor R26 provides a discharge path for capacitor C16.

*b. Indicator Circuits.*

(1) *Voltage adjustments.* With METER SWITCH S4 in the 600 VOLTS position, multiplier resistor R27 is connected, through contacts 2 and 12 of S4, in series with meter M1. Meter M1 and multiplier resistor R27 are thus connected as a 600-

volt voltmeter R26, and across meter M1 indicates the output of high voltage rectifier V9. With METER SWITCH S4 in the 60 VOLTS position, multiplier resistor R28 is connected, through contacts 1 and 2 of S4, in series with meter M1. Meter M1 and multiplier resistor R28 are thus connected as a 60-volt voltmeter across the output of high voltage rectifier V9.

(2) *Leakage measurement.* With METER SWITCH S4 in the 50MA. position, resistor R37 (shunt) is connected through contacts 2 and 11 of S4, in parallel with meter M1; high voltage rectifier V9 is connected, through contacts 6 and 7 of S4, in series with the electrolytic capacitor under test. Meter M1 and shunt resistor R37 are thus in series with the electrolytic capacitor under test and with high voltage rectifier V9. Meter M1 indicates

the amount of leakage current. Resistor R36 is connected, through contacts, 6, 8, and 10 of S4, in parallel with the leakage terminals to discharge the electrolytic capacitor under test.

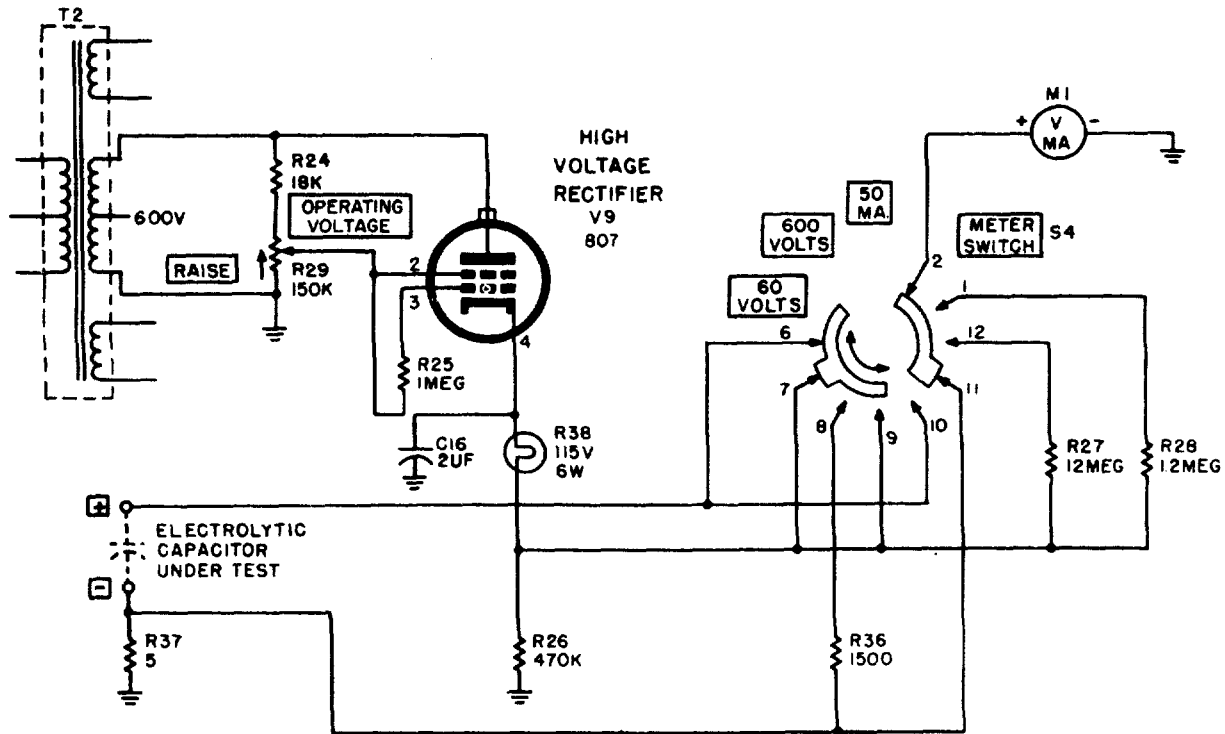
#### 4. Insulation Resistance Circuit

(fig. 3)

a. *Insulation Resistance Bridge.* With SELECTOR switch S2 (fig. 23) in the INSULATION RESISTANCE position, one leg of the insulation resistance bridge is made up of resistor R33 (fig. 3), DIAL CONTROL potentiometer R16, and INSUL RES COMP potentiometer R15. The other leg consists of a bridge multiplier resistor (R34 or R35) and the insulation resistance of the capacitor under test. (With megohm range switch S3 in the MEGOHMS X1 position, bridge multiplier resistor R34 is placed in the circuit through contacts 7 and 8, and potentiometer R15 is shorted out by contact 4 and 5; in the MEGOHMS X100 position, bridge multiplier resistor R35 is placed in the circuit through contacts 6 and 7 and potentiometer R15 is placed in the circuit by eliminating

the short circuit of contacts 4 and 5.) A regulated dc voltage (par. 6) is applied to the insulation resistance bridge from the junction of resistor R18 and voltage regulator V7 (fig 23). When a capacitor is connected to the insulation resistance terminals (fig. 3), a charging current flows through the bridge multiplier, resistor and the capacitor under test. When the charge on the capacitor reaches a steady state, the charging current stops. A second current, determined by the insulation resistance of the capacitor under test, will now flow through the bridge multiplier resistor and the capacitor under test. This current develops a voltage drop across the bridge multiplier resistor. Another voltage, from the arm of potentiometer R16 to ground, is developed by the current flow through the right leg of the bridge. Potentiometer R16 is adjusted until the two voltages are equal. When the two voltages are equal, the bridge is balanced.

b. *Indicator Circuit.* The balanced condition of the insulation resistance bridge is indicated



NOTE:  
**METER SWITCH S4**  
 SHOWN IN **50MA**  
 POSITION.

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Figure 2. Leakage current circuit, simplified schematic diagram.

by a constant reading on meter M1 when KEY 9:6 is depressed. The normal indication on meter M1 is 10 ma. The indicator circuit is made up of meter M1 in series with meter multiplier resistor R20, connected between the plates of dc amplifier V8.

- (1) When KEY S6 is in the normal position, the control grids are connected to ground through grid return resistors R31 and R41. No voltage is applied to the control grids of dc amplifier VS, and meter M1 indicates 10 ma. During calibration INDICATOR BALANCE potentiometer R23 is used to adjust the plate voltage of dc amplifier V8 so that the normal meter indication of 10 ma. can be obtained. During calibration, when megohm range switch S3 is in the MEGOHMS X100 position and KEY S6 is depressed, potentiometer R15 is adjusted to keep the control grid circuits balanced.
- (2) When KEY S6 is depressed, the control grids are connected to ground through the bridge. If the voltages obtained from the bridge are equal, the meter indication will not change. If the needle of meter M1 deflects to the right, potentiometer R16 is adjusted for a meter indication of 10 ma. to indicate that the bridge is balanced. When the bridge is balanced, the insulation resistance of the capacitor under test can then be read from scale 1 of the drum and scale assembly.
- (3) To protect the meter in case the capacitor under test is shorted, arrester R39 is connected between the plates of dc amplifier V8. Arrester R39 decreases in resistance as the voltage across it increases and prevents overloading meter M1. Resistors R21 and R22 are plate load resistors. Resistors R19 and R47 are cathode biasing resistors and capacitors C7 and C18 keep the control grids at ac ground potential. Resistors R31, R40, and R45 isolate the dc amplifier from the insulation resistance terminals and protect the circuit in case a shorted capacitor is connected to the terminals.

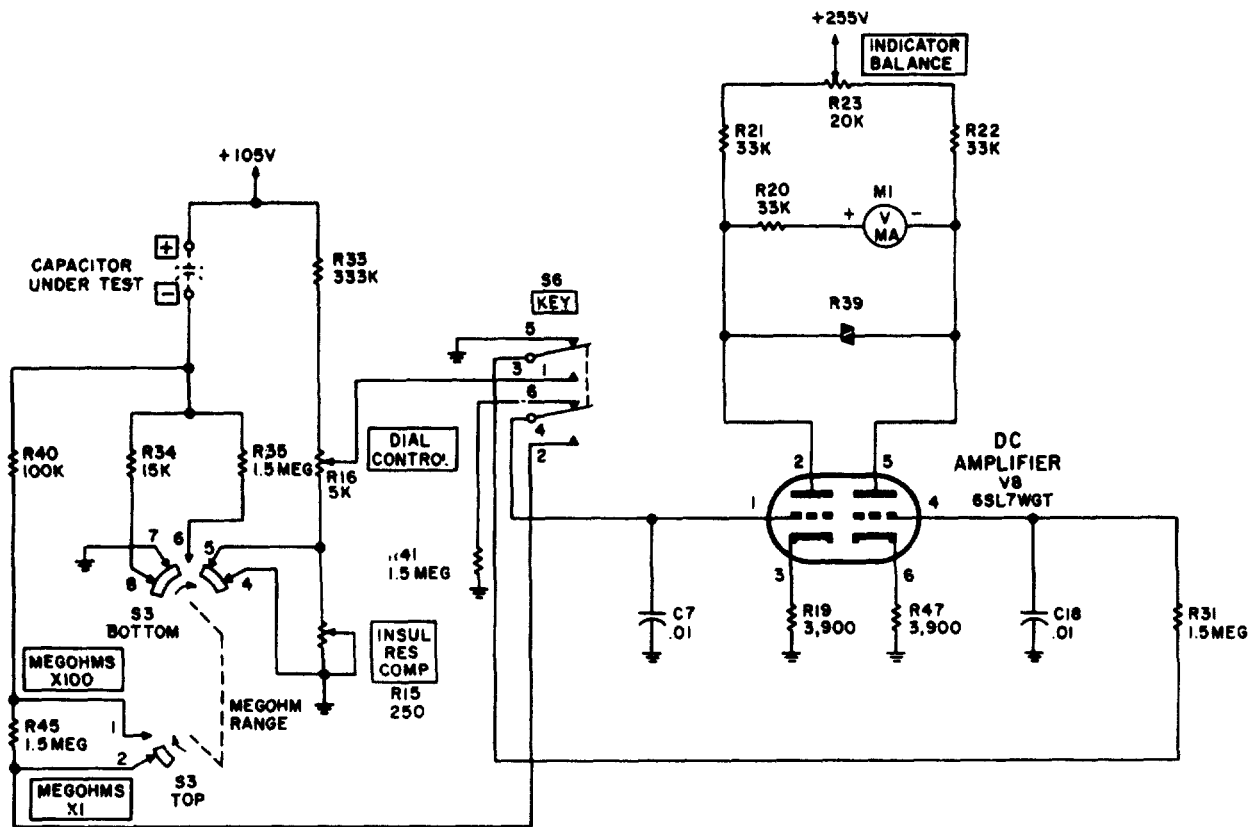
## 5. Capacitance Circuit

*a. Oscillator and Amplifier.* Oscillator V1 is a Wien-bridge oscillator that provides an ac voltage of 100 cycles per second (cps) or 1,000 cps for the capacitance bridge. The oscillator frequency is determined by a resistance-capacitance (RC) network in which the resistance (R1 and R2) is fixed and the capacitors (C1 and C3 or C2 and C4) are changed by switching (fig. 23). Lamp R4 (fig. 4), the cathode resistor, stabilizes the oscillator output.

- (1) When capacitance range switch S5D (fig. 23) is in the 5 to 100 MMF or 80 to 50000 MMF position, capacitors C1 and C3 (fig. 4) are placed in the RC network and the oscillator frequency is 1,000 cps.
- (2) When capacitance range switch S5D (fig. 23) is in the .04 to 30 MF, 25 to 1000 MF, or 250 to 10000 MF position, capacitors C2 and C4 are placed in the RC network and the oscillator frequency is 100 cps.
- (3) The output signal, developed across plate load resistor R3 (fig. 4), is applied to amplifier V2 through coupling capacitor C5. The output of amplifier V2 is applied to the capacitance bridge through transformer T1. Resistor R5 is the grid return resistor for amplifier V2.

*b. Capacitance Bridge.* The setting of capacitance range switch S3 determines the capacitance bridge circuit to be used for each capacitance range.

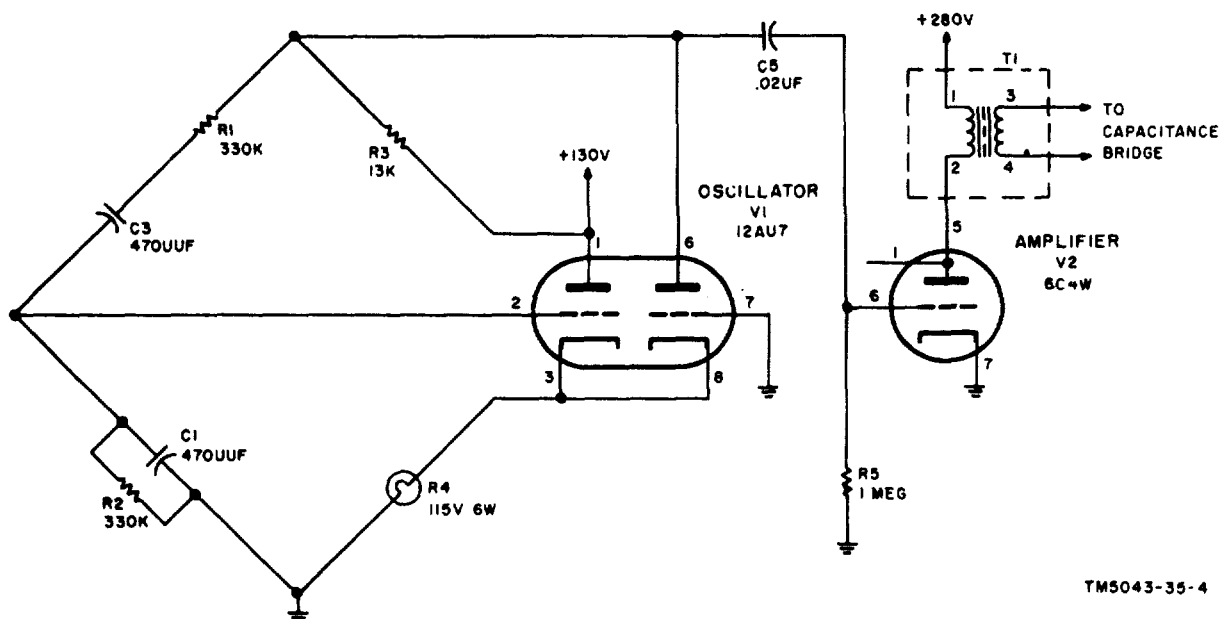
- (1) *5 to 100 MMF range (fig. 5).*
  - (a) The left leg of the capacitance bridge consists of capacitors C6, C12, and C19, and resistor R43. The right leg of the bridge consists of resistors R6 and RS. Capacitor C19 is used to adjust the left leg of the bridge so that the impedance ratio of capacitors C12 and C19 to capacitor C6 and resistor R43 is equal to the impedance ratio of resistor R8 to resistor R6.
  - (b) When the capacitor under test is connected to the capacitance terminals (in parallel with capacitors C12 and C19), the ratio of the left leg of



NOTES:  
 1 MEGOHM RANGE SWITCH S3 SHOWN IN MEGOHMS XI POSITION  
 2 KEY S6 SHOWN IN NORMAL POSITION

TM5043-35-3

Figure 3. Insulation resistance circuit, simplified schematic diagram.



TM5043-35-4

Figure 4. Oscillator and amplifier circuits, simplified schematic diagram.

the bridge is changed. As a result of this change, a voltage is developed across resistor R44 that is applied to the control grid of capacitance bridge amplifier V3. The DIAL CONTROL (capacitor C12) is then adjusted so that the impedance ratio of the left leg is equal to the impedance ratio of the right leg. The value of the capacitor under test is indicated on the drum and scale assembly. Resistor R9 limits the voltage applied to the capacitance bridge.

(2) 80 to 50000 MMF range (fig. 6).

- (a) The left leg of the capacitance bridge consists of potentiometer R16. The lower portion of the right leg of the bridge consists of capacitor C6 and resistor R43.
- (b) When the capacitor under test is connected to the capacitance terminals, the right leg of the bridge is complete and a voltage is developed across resistor R44. This voltage is applied to the control grid of capacitance bridge amplifier V3. The DIAL CONTROL (potentiometer R16) is then adjusted so that the

impedance ratio of the left leg is equal to the impedance ratio of the right leg. The value of the capacitor under test is indicated on the drum and scale assembly.

(3) .04 to 30 MF range (fig. 7).

- (a) The upper portion of the left leg of the capacitance bridge consists of potentiometer R30 and capacitor C8. The right leg of the bridge consists of potentiometer R16.
- (b) When the capacitor under test is connected to the capacitance terminals, the left leg of the bridge is complete and a voltage is developed across resistor R44. This voltage is applied to the control grid of capacitance bridge amplifier V3. The DIAL CONTROL (potentiometer R16) and the PER CENT POWER FACTOR control (potentiometer R30) are adjusted so that the impedance ratio of the left leg is equal to the impedance ratio of the right leg. The value of the capacitor under test is indicated on the drum and scale assembly.

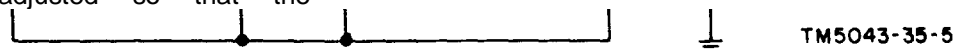


Figure 5. Capacitance bridge, 5 to 100 MMF range, simplified schematic diagram.

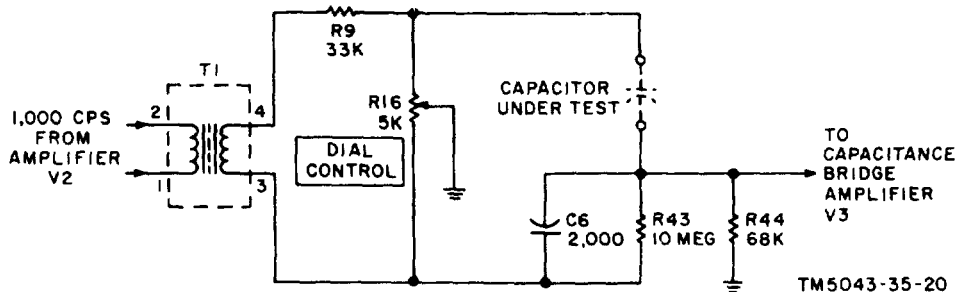


Figure 5. Capacitance bridge, 5 to 100 MMF range, simplified schematic diagram.

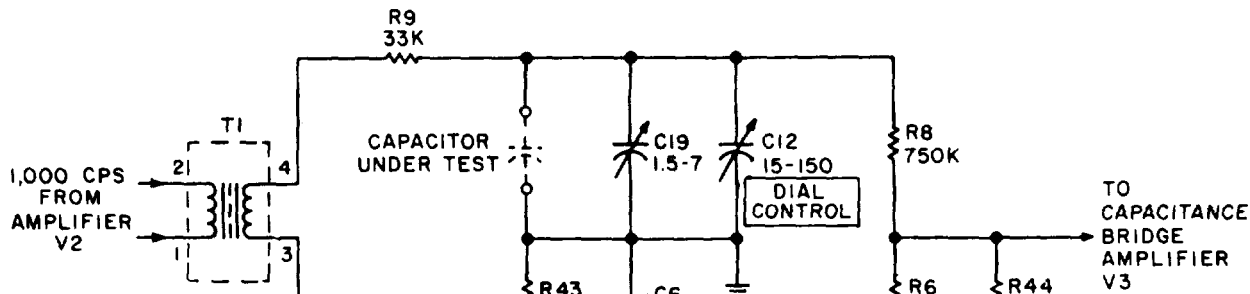


Figure 6. Capacitance bridge, 80 to 50000 MMF range, simplified schematic diagram.

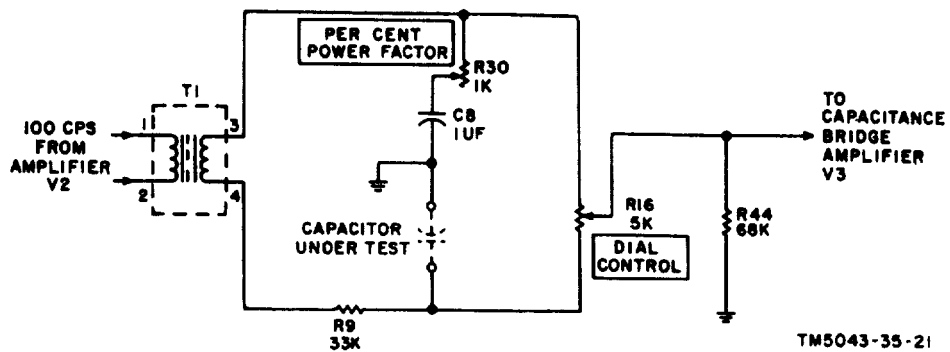


Figure 7. Capacitance bridge, .04 to 30 MF range, simplified schematic diagram.

(4) 25 to 1000 MF range (fig. 8).

- (a) The upper portion of the left leg of the capacitance bridge consists of potentiometer R30 and capacitor C8. The right leg of the bridge consists of potentiometer R16 and resistor R46.
- (b) The action of this bridge is similar to the action discussed in (3) (b) above, except that resistor R46 has been added to the right leg to increase the range of the circuit.

(5) 250 to 10000 MF range (fig. 9). This capacitance bridge is similar to the bridge discussed in (4) above, except that a larger

resistor, R7, is used to further increase the range of the circuit.

c. *Capacitance Bridge Amplifier* (fig. 10).

(1) The output of the capacitance bridge (b above), developed across resistor R44, is applied to the control grid (pin 1) of capacitance bridge amplifier V3 through coupling capacitor C9. The output of V3, coupled through capacitor C10, is rectified (negative peaks eliminated) by crystal rectifier CR1. As a result of this rectification, only positive dc voltage is applied to the grid (pin 4) of the next stage, dc amplifier V8.

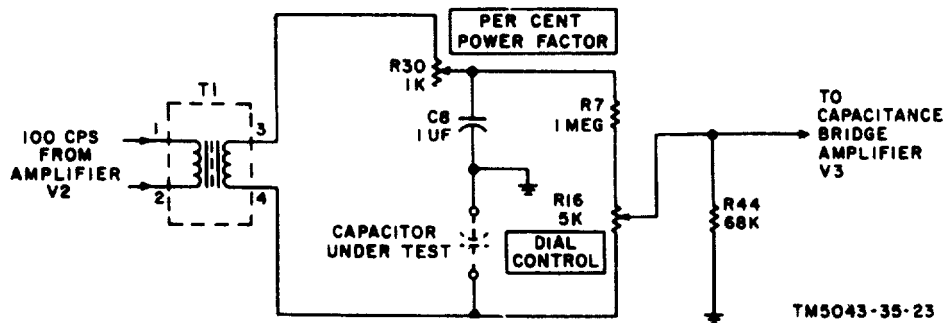


Figure 8. Capacitance bridge, 25 to 1000 MF range, simplified schematic diagram.

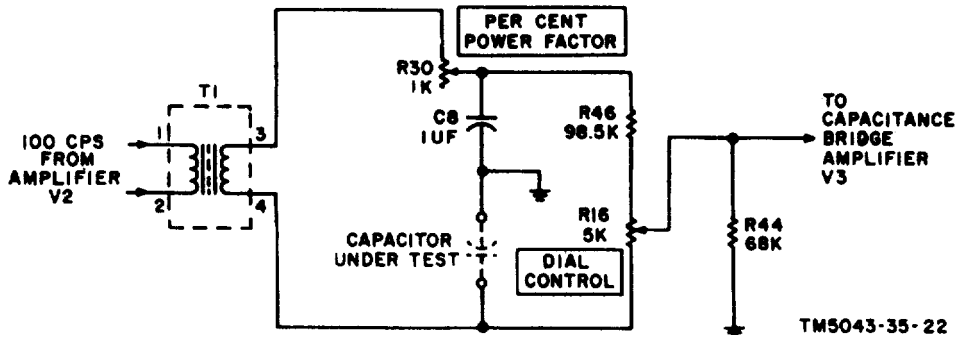
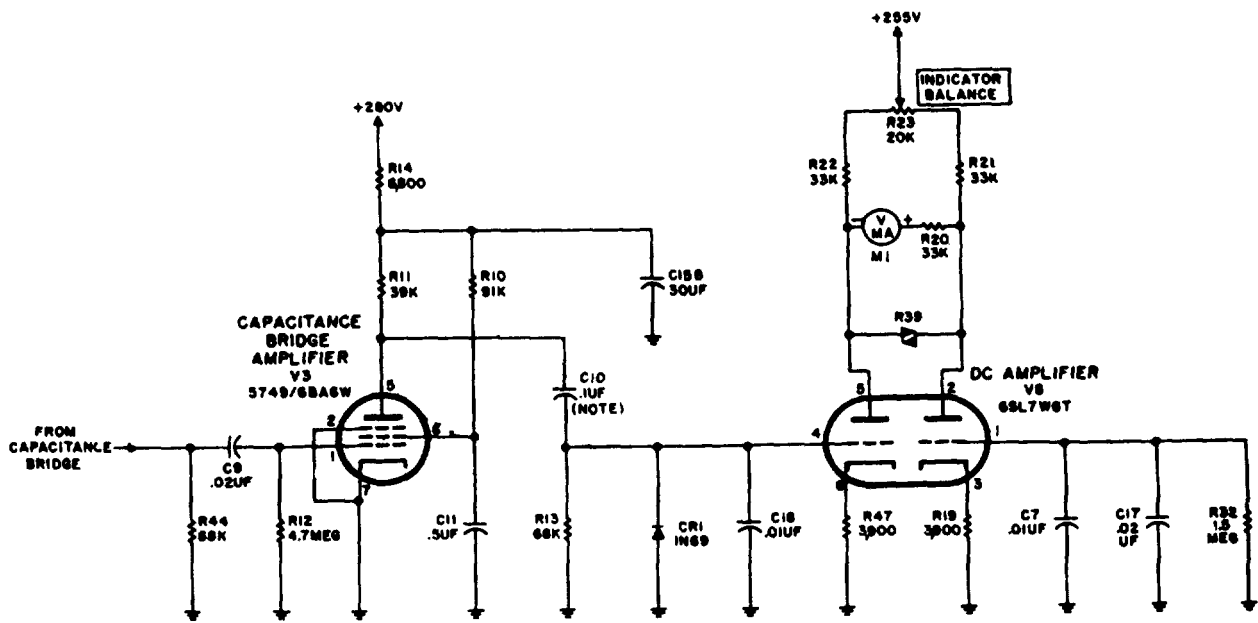


Figure 9. Capacitance bridge 250 to 10000 MF range, simplified schematic diagram.





NOTE:  
ON THE ZM-3A/U, CAPACITOR  
C10 IS 02UF.

TM5043-38-6

Figure 10. Analyzer ZM-3A/U, capacitance bridge amplifier and dc amplifier, simplified schematic diagram.

- (2) Resistor R12 is the grid return resistor. Screen dropping resistor R10, together with capacitor C11, forms a screen decoupling network; resistor R14, together with capacitor C15B, forms a plate decoupling network. Resistor R11 is the plate load resistor.

d. *Meter Circuit* (fig. 10). The balanced condition of the capacitance bridge is indicated by a minimum reading on meter M1. The indicator circuit is made up of meter M1, in series with multiplier resistor R20, connected between the plates of dc amplifier V8.

- (1) With no output from the capacitance bridge, no signal is applied to dc amplifier V8 and the meter indication is minimum. However, with an output from the capacitance bridge (b above), a positive voltage is applied to the control grid (pin 4) of dc amplifier V8. The resultant change in plate current causes the meter needle to move to the right. The capacitance bridge is balanced when the DIAL CONTROL (drum and scale assembly) is adjusted or a minimum indication on meter M1. The value of the capacitor under test can then be read from the setting of the drum and scale assembly.

- (2) Resistors R13 and R32 are grid return resistors. Capacitors C7, C17, and C18 keep the control grids at ac ground potential. The plate and cathode circuits of dc amplifier V8 are covered in paragraph 4b.

## 6. Low Voltage Power Supply Circuit

(fig. 11)

a. *Ac Input Circuit*. When connector P1 is connected to the power source, ac voltage is applied to the equipment.

- (1) With POWER switch S1 in the OFF position, the ac voltage is applied to heater resistor HR1 or HR2 depending on the input voltage (110 volts or 220 volts) and the position of change-over switch S7.
- (2) When POWER switch S1 is in the ON position, ac voltage is applied to the primary of transformer T2. With change-over switch S7 in the 110V position, half of the primary winding is used. With change-over switch S7 in the 220V position, the complete primary winding is used. Fuses F1 and F2 protect the analyzer from overloads. Filter capacitor C13 prevents

radiation from the analyzer back into the ac line.

*b. Output Circuit.* Low voltage rectifier V4 is connected as a full-wave rectifier. Capacitors C14 and C15A and center tapped resistor R17 form a filter for the dc output voltages.

- (1) The plate of amplifier V2 and the plate and screen grid of capacitance bridge amplifier V3 obtain their dc voltages from the center tap on resistor R17. Voltage regulators V5 and V6 are connected in series and supply a regulated dc voltage to the plates of dc amplifier V8.
- (2) When SELECTOR switch S2D is in the INSULATION RESISTANCE position, resistor R18 and voltage regulator V7 are

connected in parallel with voltage regulators V5 and V6. The voltage from the junction of resistor R18 and voltage regulator V7 is applied to the insulation resistance bridge.

- (3) When SELECTOR switch S2D is in the CAPACITANCE position, resistors R18 and R42 are connected in parallel with voltage regulators V5 and V6. The voltage from the junction of resistors R18 and R42 is applied to the plates of oscillator V1.
- (4) Capacitor C15C is a decoupling capacitor for oscillator V1. Pilot lamp E1 is connected in parallel with the lower 6.3-volt winding of transformer T2 and lights when POWER switch S1 is in the ON position.

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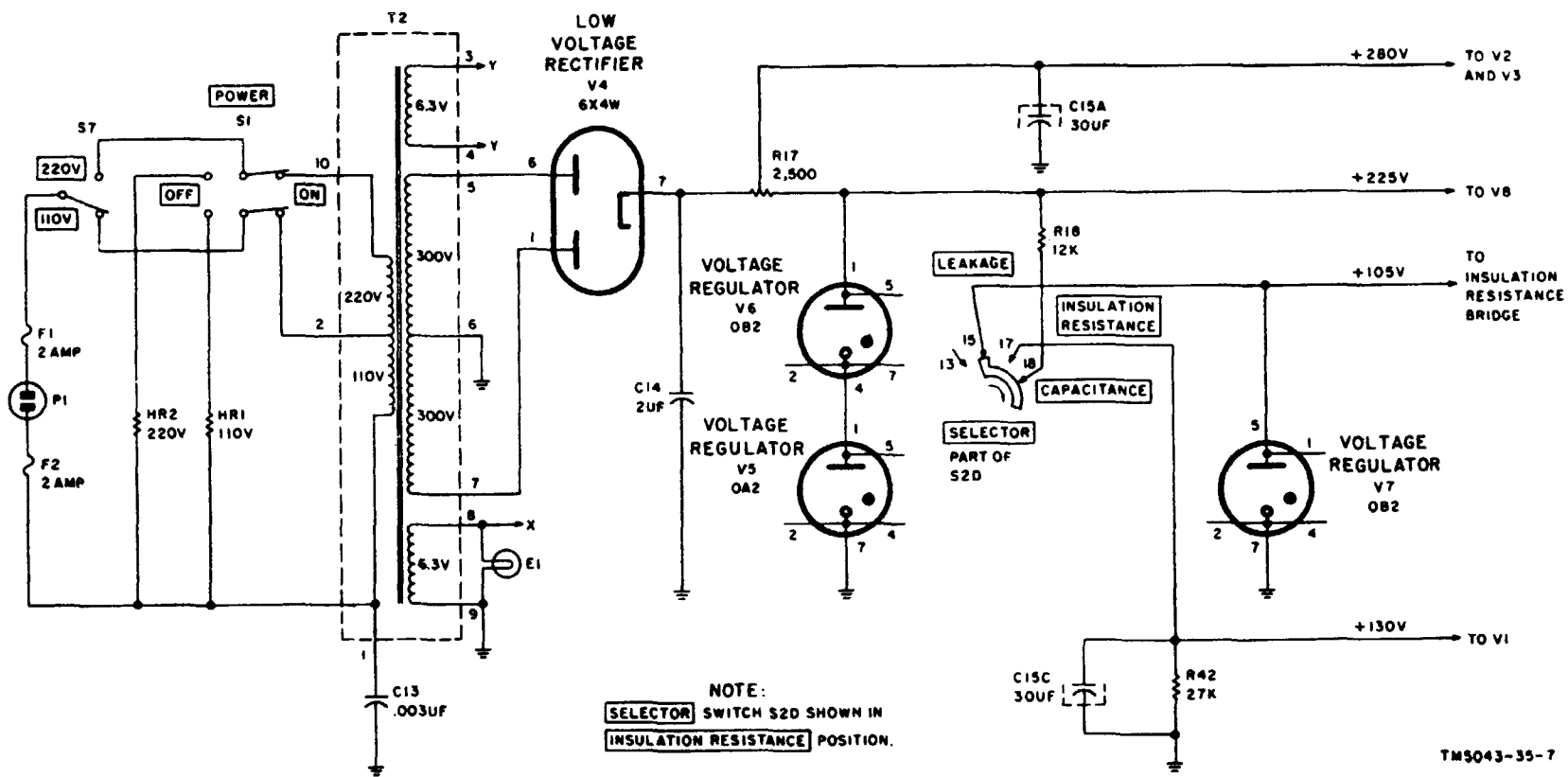


Figure 11. Low voltage power supply circuit, simplified schematic diagram.

## CHAPTER 2

### TROUBLESHOOTING

---

#### Section I. GENERAL TROUBLESHOOTING TECHNIQUES

##### Warning

**When servicing the analyzer, be extremely careful because voltages as high as 600 volts are present internally. Always disconnect the power cable from the power source before touching any internal part.**

#### 7. General

Troubleshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in TM 11-5043-12. The systematic troubleshooting procedure, which begins with the operational checks that can be performed at the organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques.

#### 8. Troubleshooting Procedures

*a. General.* The first step in servicing a defective analyzer is to sectionalize the fault. Sectionalization means tracing the fault to a major assembly responsible for abnormal operation. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors and arcing or shorted transformers, can often be located by sight, smell, or hearing. The majority of faults, however, must be localized by checking voltages and resistance.

*b. Sectionalization* (fig. 12). Analyzer ZM3(\*)/U consists of five major assemblies: the drum and scale assembly, the high voltage rectifier chassis, the low voltage power supply chassis, the voltage regulator chassis, and the oscillator chassis. The first step in tracing trouble is to locate the assembly or assemblies at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. Meter readings or other visual signs should be observed and an attempt made to sectionalize the fault to a particular assembly.

(2) *Operational test.* Operational tests frequently indicate the general location of trouble. In many instances, these tests will help in determining the exact nature of the fault. The operational check list (TM 11-043-12) is a good operational test.

*c. Localization and Isolation.* The tests listed below will aid in isolating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements. Use the troubleshooting chart (par. 10) for localization of troubles.

(1) *Voltage and resistance measurements.* These measurements will help locate the individual component part at fault. Use resistor and capacitor color codes (figs. 21 and 22) to find the value of the components. Use the voltage and resistance diagram (fig. 18) to find normal readings and compare them with the readings taken.

(2) *Troubleshooting chart.* The trouble symptoms listed in the troubleshooting chart (par. 10) will aid in localizing trouble to a component part.

(3) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring

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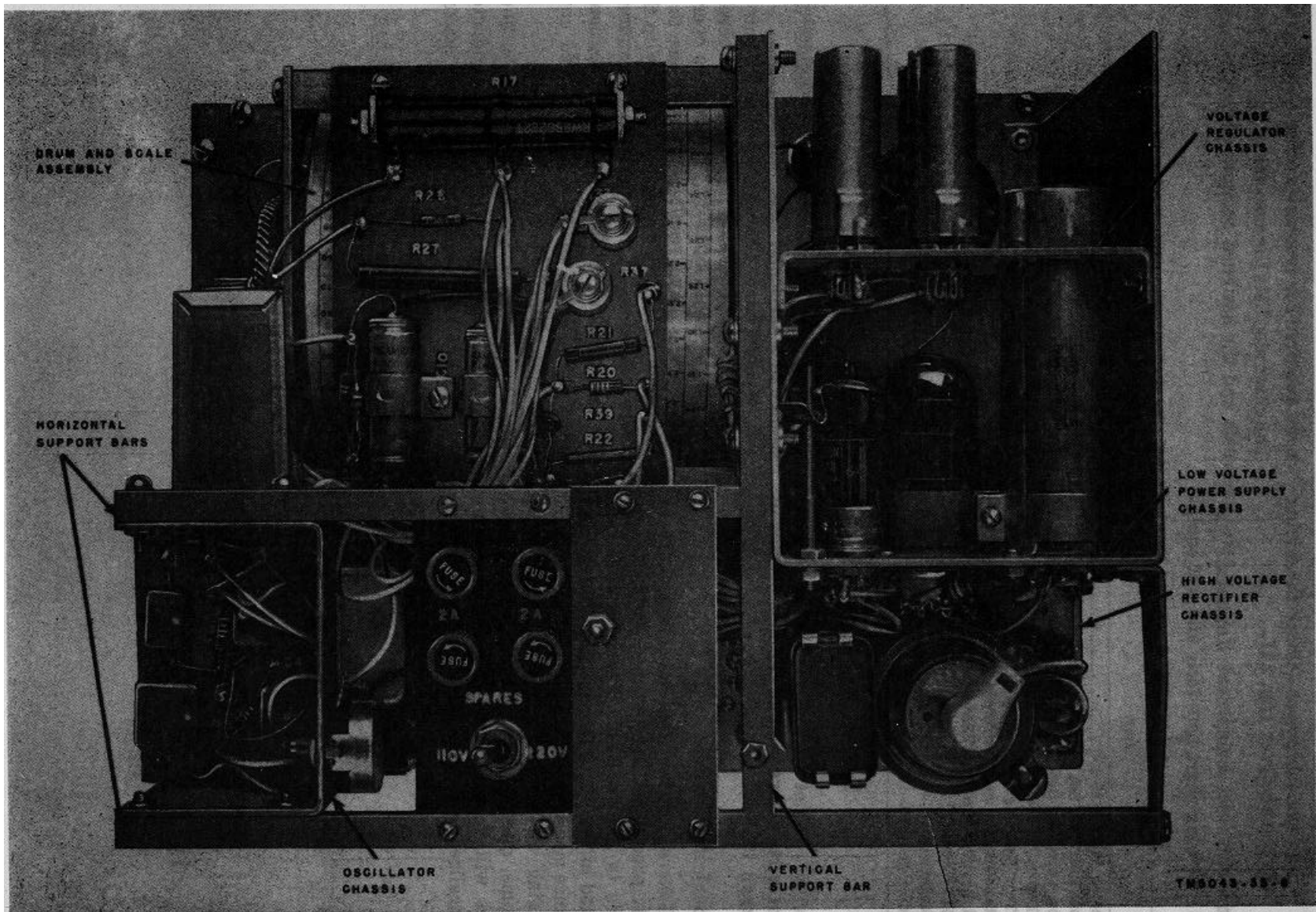


Figure 12. Analyzer ZM-3(\*)/U, location of major assemblies.

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the equipment. Check the wiring of the analyzer (fig. 24).

required for troubleshooting the analyzer. The chart also lists the associated technical manuals and the assigned common names.

**9. Tools and Test Equipment Required**

The following chart lists tools and test equipment

Item	Technical manual	Common name
Multimeter AN/URM-105 .....	.....	Multimeter.
Electron Tube Test Set TV-7/U.....	TM 11-5083.....	Tube tester.
Electron Tube Test Set TV-2/U (fifth echelon only) .....	TM 11-2661.....	Tube tester.
Meter Tester TS-656/U.....	.....	Meter tester.
Meter Test Equipment AN/GSM-1 .....	TM 11-2535.....	Meter test equipment.
Capacitance-Inductance-Resistance Test Set AN/URM-90 ..	TM 11-2646A .....	Test set.
Crystal Rectifier Test Set TS-268E/U.....	TM 11-1242.....	Crystal test set.
Tool Equipment TK-21/G .....	.....	.....
Tool Equipment TE-49 .....	.....	.....
Tool Equipment TE-113 .....	.....	.....

**Section II. TROUBLESHOOTING ANALYZER ZM-3(\*)/U**

**Caution**

**Do not attempt removal or replacement of parts before reading the instructions in paragraph 13.**

**10. Localizing Troubles**

*a. General.* In the troubleshooting chart (d below), procedures are outlined for localizing troubles in the analyzer. Parts locations are indicated in figures 13 through 17. Voltage and resistance measurements are shown in figure 18. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When trouble has been

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localized to a particular stage, use voltage and resistance measurements to isolate the trouble to a particular part.

*b. Use of Chart.* The troubleshooting chart is designed to supplement the operational checks detailed in TM 11-5043-12. If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the operational check list (TM 11-5043-12) and proceed until a symptom of trouble appears.

*c. Conditions for Tests.* All checks outlined in the troubleshooting chart are to be conducted with the analyzer connected to a-power source.

d. Troubleshooting Chart.

Item	Symptom	Probable trouble	Correction
1	Heater resistor does not warm up with POWER switch in OFF position.	No ac power applied to analyzer..... Defective power cable..... Defective fuse F1 or F2..... Defective-heater resistor HR1 (110 volts) or HR2 (220 volts). Defective switch S1 or S7.....	Check ac power source. Repair or replace power cable. Replace fuse. Replace heater resistor (fig. 16). Replace defective switch (fig. 13).
2	Pilot lamp and tube heaters do not light when POWER switch is turned to ON position.	No ac power applied to analyzer..... Defective power cable..... Defective switch S1 or S7..... Defective transformer.....	Check ac power source. Repair or replace power cable. Replace defective switch. Replace transformer.
3	Fuse blows when SELECTOR switch is in LEAKAGE position.	Shorted capacitor C16.....	Replace capacitor (fig. 14).
4	Fuse blows when SELECTOR switch is in INSULATION RESISTANCE or CAPACITANCE position.	Shorted capacitor C11.....	Replace capacitor (fig. 13).
5	No indication on meter; SELECTOR switch in LEAKAGE position.	Faulty high voltage rectifier stage..... Defective switch S2D or S4..... Defective meter M1.....	Check voltage and resistance at socket of tube 9 (fig. 18). Replace defective switch (fig. 13). Replace meter.
6	No meter indication in 60 VOLTS position of METER SWITCH.	Open resistor R28.....	Replace resistor (fig. 16).
7	No meter indication in 600 VOLTS position of METER SWITCH.	Defective switch S21 or S4..... Open resistor R27.....	Replace defective switch (fig. 13). Replace resistor (fig. 16).
8	Meter pegs right in 50 MA. position of METER SWITCH; electrolytic capacitor connected to leakage terminals	Defective switch S2D or S4..... Open resistor R37.....	Replace defective switch (fig. 13). Replace resistor (fig. 16).
9	Capacitor is not discharged when removed from leakage terminals.	Open resistor R36.....	Replace resistor (fig. 13).
10	No indication on meter; SELECTOR switch in INSULATION RESISTANCE or CAPACITANCE position.	Defective switch S4..... Faulty low voltage rectifier stage or dc amplifier stage. Defective switch S2B or S2D..... Open resistor R20 or potentiometer R23..... Shorted arrester R39..... Defective meter M1.....	Replace switch. Check voltage and resistance at sockets of tubes V4 through V8 (fig. 18). Replace defective switch (fig. 13). Replace resistor or potentiometer (figs. 14 and 16). Replace arrester (fig. 16). Replace meter (fig. 13).
11	Meter pegs right; SELECTOR switch in INSULATION RESISTANCE or CAPACITANCE position.	Open resistor R19 or R22.....	Replace defective resistor (figs. 13 and 16).

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Item	Symptom	Probable trouble	Correction
12	Meter pegs left; SELECTOR switch in INSULATION RESISTANCE or CAPACITANCE position.	Open resistor R21 or R47 .....	Replace defective resistor.
13	Meter pegs right; SELECTOR SWITCH in INSULATION RESISTANCE position and KEY in normal position.	Defective switch S6.....	Replace switch (fig. 17).
14	Meter pegs left; KEY in no. ,41 position.	Open resistor R41 .....	Replace resistor.
15	Meter pegs right when KEY is depressed: capacitor connected to insulation resistance terminals.	Defective switch S6.....	Replace switch.
16	Meter pegs left when KEY is depressed; capacitor connected to insulation resistance terminals.	Open resistor R31 .....	Replace resistor.
17	Meter pegs right; SELECTOR switch in CAPACITANCE position.	Defective switch S3 or S6.....	Replace defective switch.
18	Meter indication remains constant in all positions of capacitance range switch.	Open resistor R34, R35, R40, or R45 .....	Replace defective resistor.
19	Meter indication fluctuates in all positions of capacitance range switch.	Shorted capacitor C7.....	Replace capacitor (fig. 13).
20	Capacitance bridge cannot be balanced in 5 TO 100 MMF and 80 TO 50000 MMF positions of capacitance range switch.	Defective switch S6.....	Replace switch (fig. 17).
21	Capacitance bridge cannot be balanced in .04 TO 30 MF, 25 TO 1000 MF, and 250 TO 10000 MMF positions of capacitance range switch.	Open resistor R31 or R33 or potentiometer R16.	Replace defective resistor (figs. 16 and 17) or potentiometer (par. 15).
22	Capacitance bridge can be balanced only on 5 TO 100 MMF position of capacitance range switch.	Shorted capacitor C18.....	Replace capacitor (fig. 13).
23	Capacitance bridge can be balanced only on 25 TO 1000 MF and 250 TO 10000 MF position of capacitance range switch.	Open resistor R32 .....	Replace resistor (fig. 13).
24	Capacitance bridge cannot be balanced in 5 TO 100 MMF position of capacitance range switch.	Shorted capacitor C10.....	Replace capacitor (fig. 16).
		Faulty oscillator stage, amplifier stage, or capacitance bridge amplifier stage.	Check voltage and resistance at sockets of tubes V1 through V3 (fig. 18).
		Open resistor R1, R2, R3, R5, R10, R11, R12, R113, R14, or R44.	Replace defective resistor (figs. 15 and 16).
		Shorted capacitor C11, C15A, or C15B .....	Replace defective capacitor (fig. 13).
		Defective transformer T1.....	Replace transformer (fig. 15).
		Defective switch S2C or S5.....	Replace defective switch (figs. 13 and 15).
		Defective rectifier CR1.....	Replace rectifier (fig. 16).
		Defective capacitor C1, C3, or C6.....	Replace defective capacitor (fig. 15).
		Open resistor R43 .....	Replace resistor.
		Defective switch S5.....	Replace switch.
		Defective capacitor C2, C4, or C8.....	Replace defective capacitor.
		Defective switch S5.....	Replace switch.
		Open potentiometer R30 .....	Replace potentiometer (fig. 16).
		Open Potentiometer R16.....	Replace potentiometer (par. 15).
		Defective switch S2C or S5.....	Replace defective switch (figs. 13 and 15).
		Open resistor R9.....	Replace resistor (fig. 15).
		Defective switch S5.....	Replace switch.
		Open resistor R6 or R8 .....	Replace defective resistor.



Item	Symptom	Probable trouble	Correction
25	Capacitance bridge cannot be balanced In 25 TO 1000 MF position of capacitance range switch.	Shorted capacitor C12 or C19 .....	Replace defective capacitor (par. 15 and fig. 15).
26		Defective switch S5..... Open resistor R46 .....	Replace switch (fig. 15) Replace resistor.
	Capacitance bridge cannot be balanced in 250 TO 10000 MF position of capacitance range switch.	Defective switch S5..... Open resistor R7 .....	Replace switch. Replace resistor.
		Defective switch S5.....	Replace switch.

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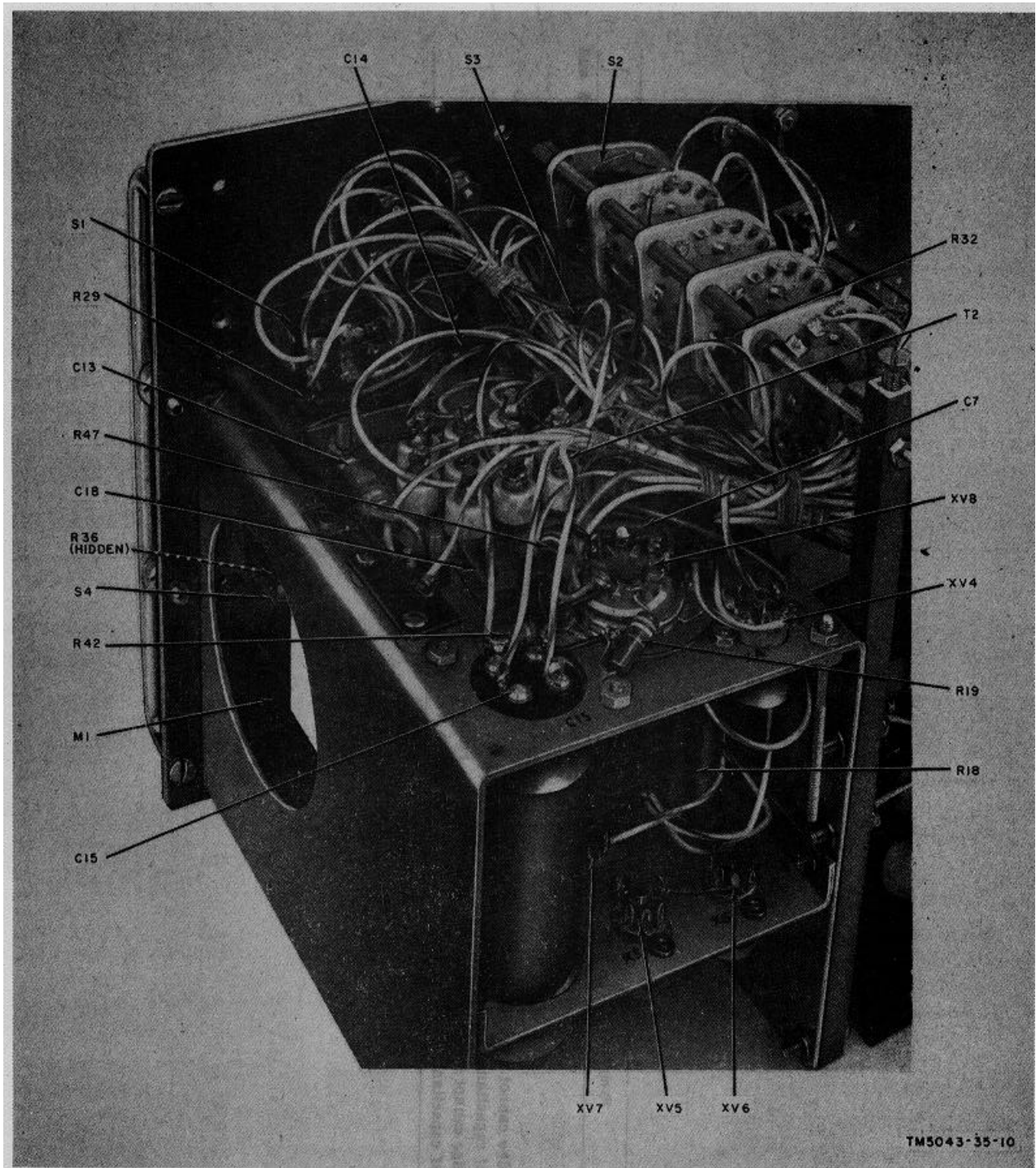


Figure 13. Low voltage power supply chassis and voltage regulator chassis, location of components.

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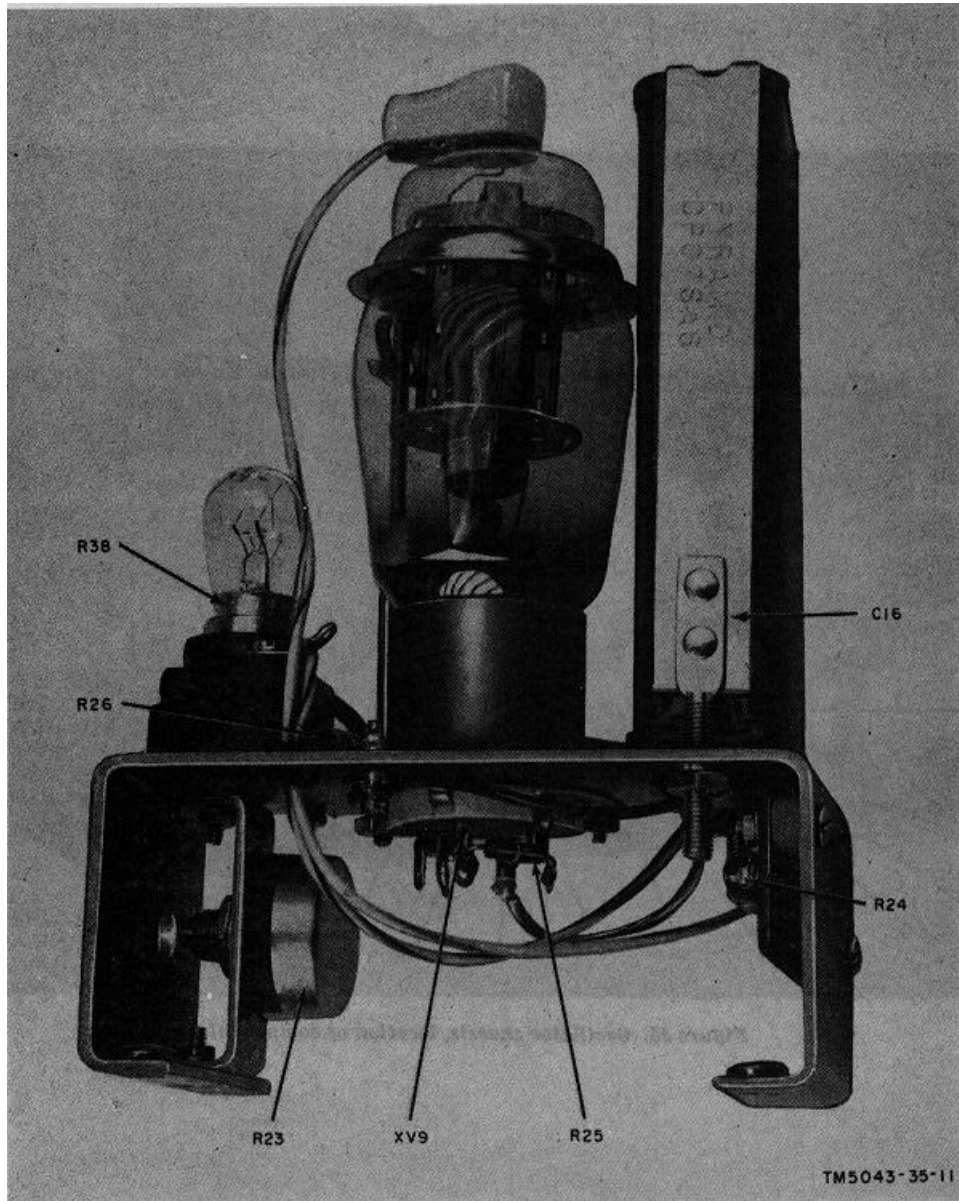


Figure 14. High voltage rectifier chassis, location of components.

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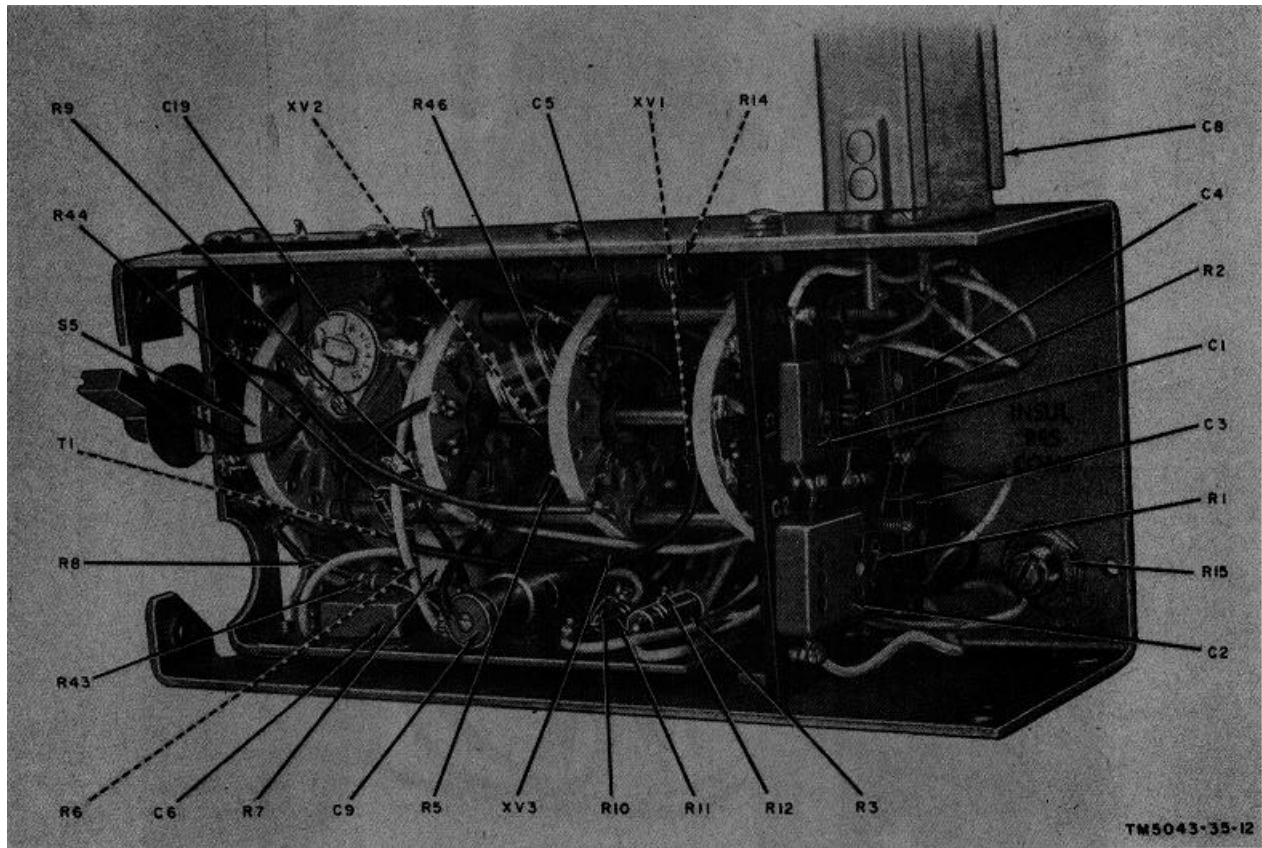


Figure 15. Oscillator chassis, location of components.

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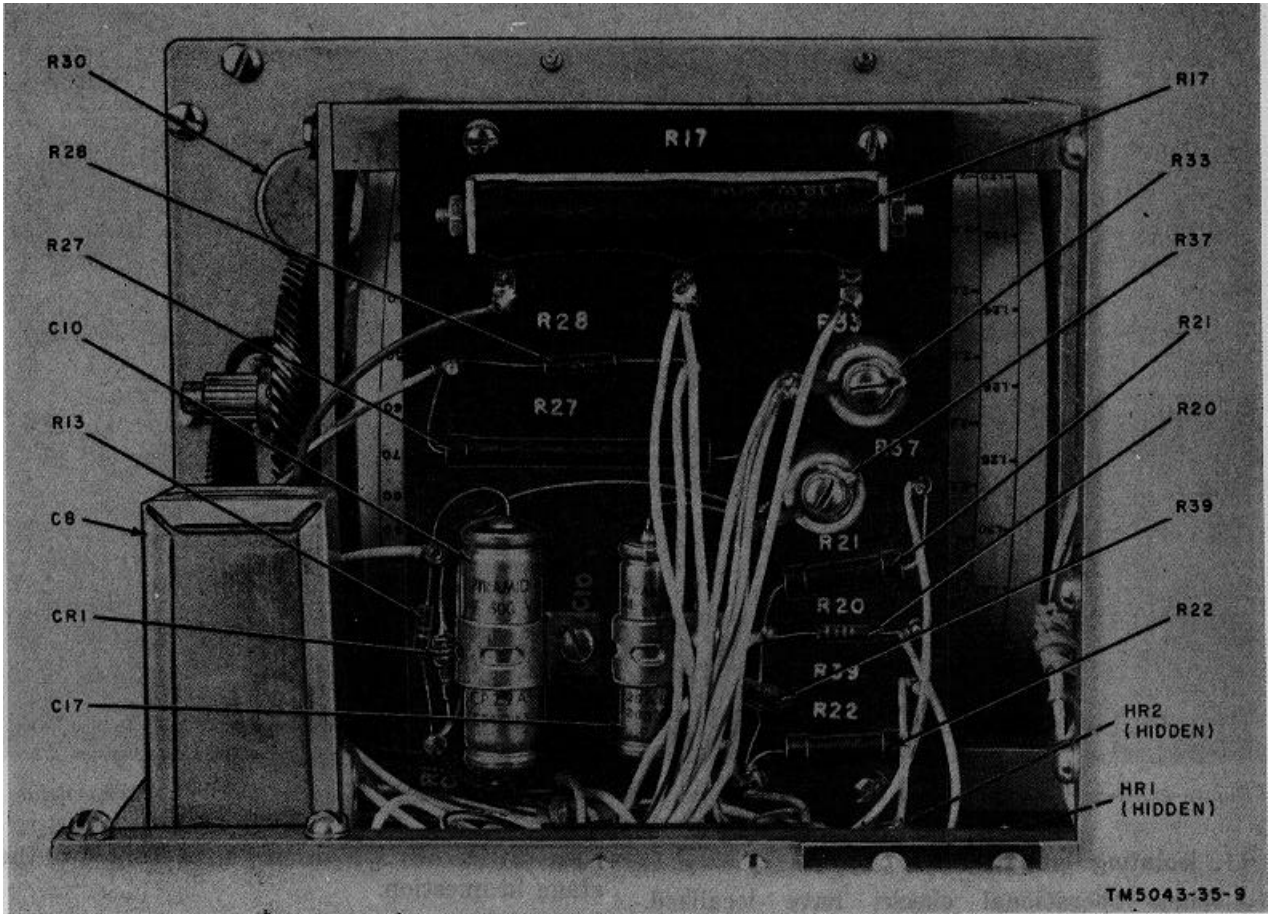


Figure 16. Drum and scale assembly, terminal board, location of components.

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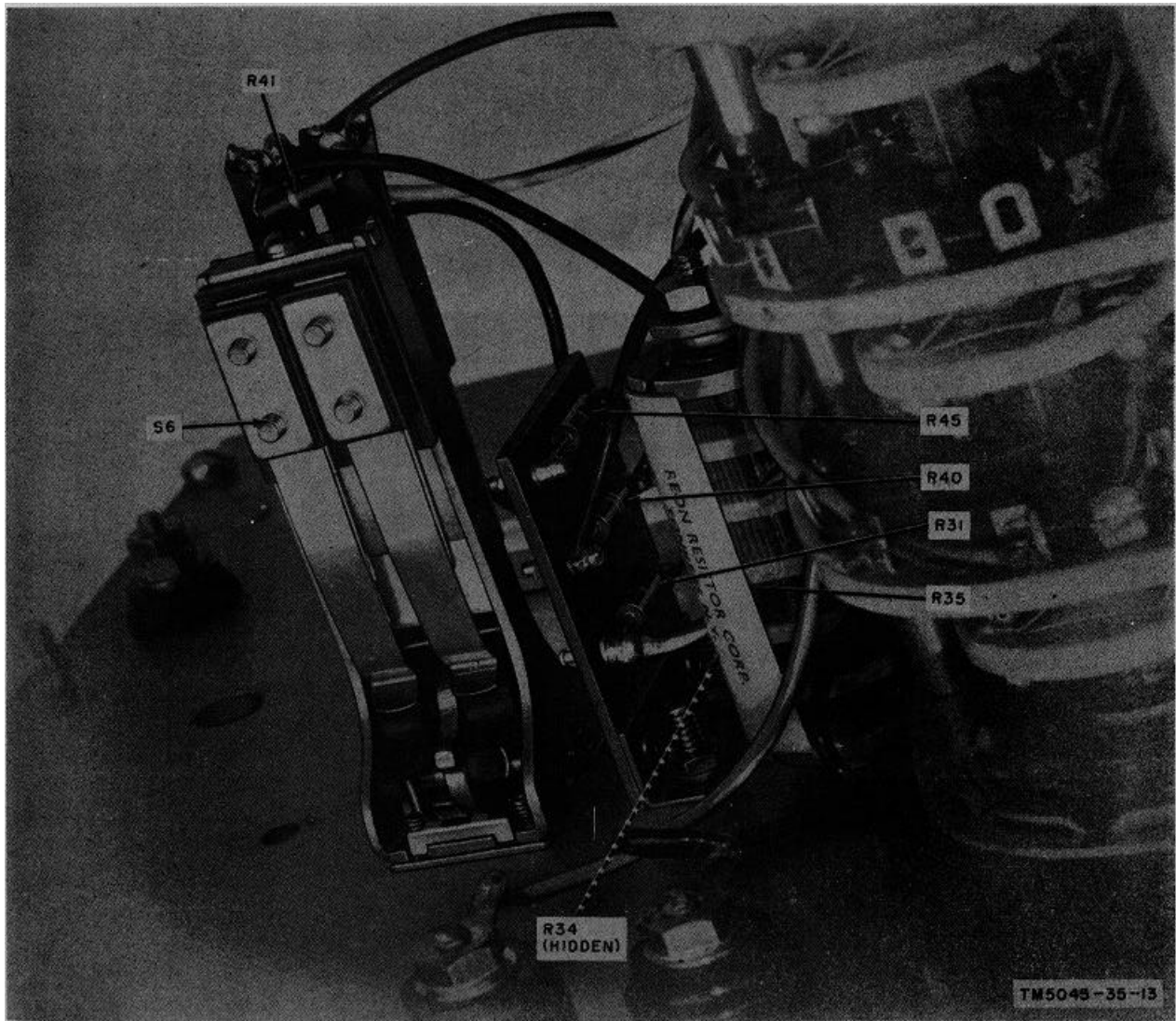


Figure 17. Front panel rear view, drum and scale assembly and oscillator chassis removed, location of components.

### 11. Isolating Troubles

When operational checks have localized trouble to a stage, use the following techniques to isolate the defective part.

a. Test the tube involved, either in a tube tester or by substituting a similar type tube which is known to be operating normally.

b. Take voltage measurements at the tube sockets (fig. 18) and other points related to the stage in question.

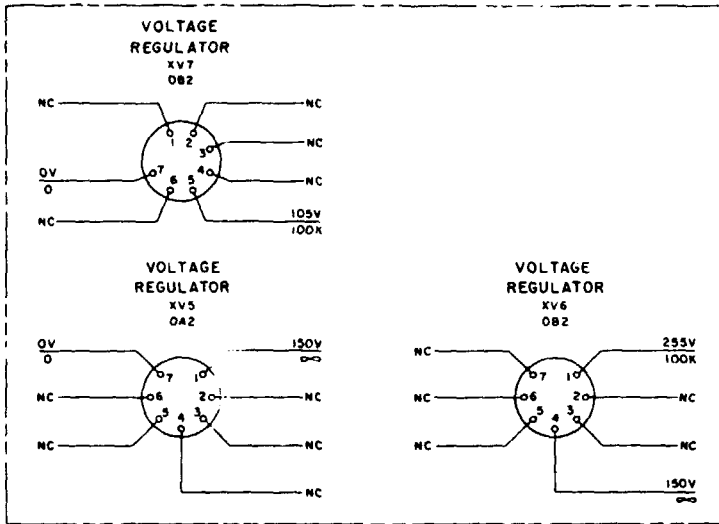
c. If voltage readings are abnormal, take resistance readings (fig. 18) to isolate open and short circuits. Refer also to the dc resistances of transformers (par. 12).

d. Use the wiring diagram (fig. 24) to trace circuits and to isolate the faulty component.

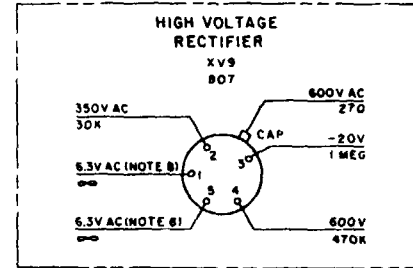
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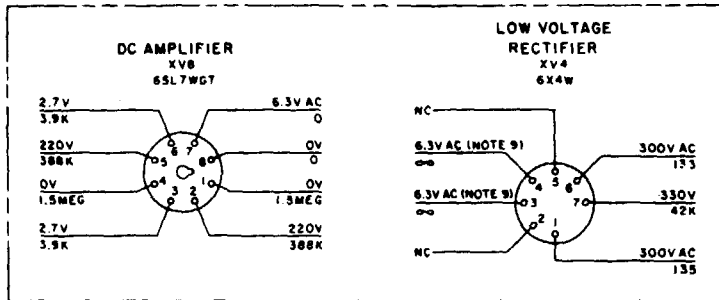
VOLTAGE REGULATOR CHASSIS  
(NOTE 6)



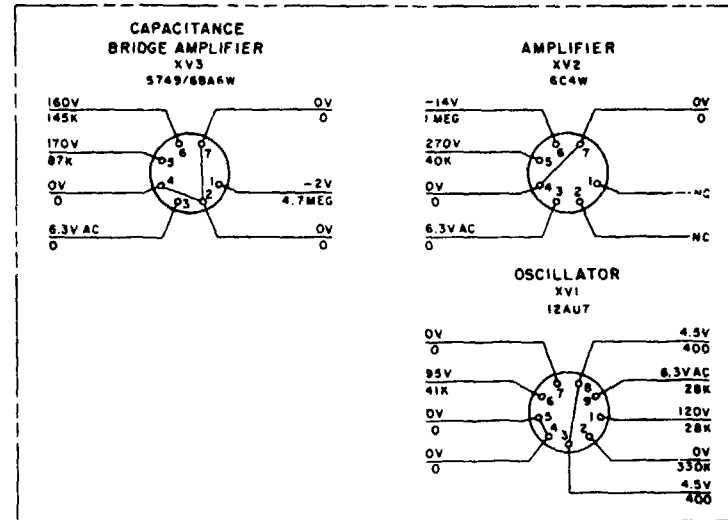
HIGH VOLTAGE RECTIFIER CHASSIS  
(NOTE 5)



LOW VOLTAGE POWER SUPPLY CHASSIS  
(NOTE 6)



OSCILLATOR CHASSIS  
(NOTE 7)



- NOTES:
1. VOLTAGES MEASURED WITH A 20,000 OHMS-PER-VOLT METER.
  2. VOLTAGE VALUES ARE ABOVE LINE AND ARE DC UNLESS OTHERWISE SPECIFIED
  3. RESISTANCE VALUES ARE BELOW LINE.
  4. MEASUREMENTS ARE MADE TO GROUND UNLESS OTHERWISE SPECIFIED.
  5. **SELECTOR** SWITCH S2 IN **LEAKAGE** POSITION AND **OPERATING VOLTAGE** CONTROL R29 ADJUSTED FOR 600 VOLTS ON METER M1.
  6. **SELECTOR** SWITCH S2 IN **INSULATION RESISTANCE** POSITION.
  7. **SELECTOR** SWITCH S2 IN **CAPACITANCE** POSITION
  8. MEASURED BETWEEN PINS 1 AND 5.
  9. MEASURED BETWEEN PINS 3 AND 4
  10. NC INDICATES NO CONNECTION.

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Figure 18. Tube-socket voltage and resistance diagram.

## 12. Dc Resistances of Transformers

The dc resistances of the transformer windings in the analyzer are listed below:

Transformer	Terminals	Ohms
T1	1-2	500
	3-4	50
T2	1-2	5
	2-10	5
	1-10	10
	3-4	Less than 1
	8-9	Less than 1
	6-6	130
	6-7	130
	5-7	260

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**CHAPTER 3**  
**REPAIRS AND ADJUSTMENTS**

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**Section I. REPAIRS**

**13. General Parts Replacement**

Most of the parts of Analyzer ZM-3(\*)/U can be reached and replaced without special procedures. However, to replace the parts that are mounted on the front panel it will be necessary to partially disassemble the analyzer.

a. For access to SELECTOR switch S2, megohm range switch S3, KEY S6, and resistors R31, R34, R35, R40, R41, and R45, remove the drum and scale assembly (par. 14a).

b. For access to POWER switch S1, remove the high voltage rectifier chassis (par. 14c).

c. For access to METER SWITCH S4, OPERATING VOLTAGE control R29, and resistor R36, remove the voltage regulator chassis and the low voltage power supply chassis (par. 14d).

d. For access to potentiometer R16 and variable capacitor C12, disassemble the drum and scale assembly (par. 15).

**14. Disassembly and Reassembly of Analyzer**

**ZM-3(\*)/U**

(fig. 19)

*a. Removal of Drum and Scale Assembly.*

- (1) Loosen the setscrews (1) and remove the DIAL CONTROL knob (2) from the shaft of the drum and scale assembly (5).
- (2) Remove the machine screws (3) and lockwashers (4) that secure the drum and scale assembly (5) to the front panel (37).
- (3) Remove the roundhead machine screws (6), lockwashers (7), terminal board (8), and spacers (9) from the drum and scale assembly (5).
- (4) Remove the nuts (not shown) that secure the capacitor (10) to the oscillator chassis (11); remove the capacitor from the oscillator chassis.

- (5) Slide the drum and scale assembly (5) back until the shaft clears the front panel; then, lift the drum and scale assembly out of the analyzer.

*b. Removal of Oscillator Chassis.*

- (1) Remove the machine screw (12) and capacitance range switch knob (13) from the oscillator chassis (11).
- (2) Remove the machine screws (14) and lockwashers (15) that secure the oscillator chassis (11) to the front panel (37).
- (3) Remove the roundhead machine screws (16), lockwashers (17), and flathead machine screws (18) that secure the oscillator chassis (11) to the support bars (19).
- (4) Slide the oscillator chassis back until the shaft of the switch clears the front panel; then slide the oscillator chassis to the side to remove it from the analyzer.

*c. Removal of High Voltage Rectifier Chassis.*

- (1) Remove the machine screws (20) and lockwashers (21) that secure the high voltage rectifier chassis (22) to the front panel (37).
- (2) Slide the high voltage rectifier chassis (22) away from the front panel, being careful not to break the leads.

*d. Removal of Voltage Regulator Chassis and Low Voltage Power Supply Chassis.*

- (1) Remove the roundhead machine screws (23), lockwashers (24), spacers (26), and hexagonal nuts (not shown) that secure the terminal board (25) to the voltage regulator chassis and low voltage power supply chassis (27).
- (2) Compress the grommet (28) and slide the grommet and the power cable (29)

from the front panel (37); remove the grommet from the power cable.

- (3) Remove the machine screws (30) and lockwashers (31) that secure the voltage regulator chassis and low voltage power supply chassis (27) to the front panel (37).
- (4) Remove the roundhead machine screws (32) and lockwashers (33) that secure the voltage regulator chassis and low voltage power supply chassis (27) to the support bars (19).
- (5) Remove the machine screw (34) and lockwasher (35) that secure the support bracket (36) to the support bars (19).
- (6) Slide the voltage regulator chassis and low voltage power supply chassis (27) away from the front panel. Be careful not to break the leads.

*e. Replacement of Voltage Regulator Chassis and Low Voltage Power Supply Chassis.*

- (1) Position the voltage regulator chassis and low voltage power supply chassis (27) on the front panel (37).
- (2) Secure the voltage regulator chassis and low voltage power supply chassis to the front panel (37) with the machine screws (30) and lockwashers (31).
- (3) Attach the voltage regulator chassis and low voltage power supply chassis (27) to the support bars (19) with the roundhead machine screws (32) and lockwashers (33).
- (4) Attach the support bracket (36) to the support bars (19) with the machine screw (34) and the lockwasher (35).
- (5) Position the grommet (28) on the power cable (29); compress the grommet and insert the grommet with the power cable into the opening on the front panel (37).
- (6) Position the terminal board (25) and spacers (26) on the voltage regulator chassis and low voltage power supply chassis (27); secure the terminal board with the roundhead machine screws (23), lockwashers (24), and nuts (not shown).

*f. Replacement of High Voltage Rectifier Chassis.*

- (1) Position the high voltage rectifier chassis (22) on the front panel (37).
- (2) Secure the high voltage rectifier chassis (22) to the front panel (37) with the machine screws (20) and lockwashers (21).

*g. Replacement of Oscillator Chassis.*

- (1) Position the oscillator chassis (11) on the front panel (37).
- (2) Secure the oscillator chassis (11) to the front panel (37) with the machine screws (14) and lockwashers (15).
- (3) Secure the oscillator chassis (11) to the support bars (19) with the roundhead machine screws (16), lockwashers (17), and flathead machine screws (18).
- (4) Install the capacitance range switch knob (13) on the shaft of the capacitance range switch; secure the capacitance range switch knob with the machine screw (12).

*h. Replacement of Drum and Scale Assembly.*

- (1) Position the drum and scale assembly (5) on the front panel (37).
- (2) Secure the drum and scale assembly to the front panel with the machine screws (3) and lockwashers (4).
- (3) Secure the terminal board (8) to the drum and scale assembly (5) with the roundhead machine screws (6) and lockwashers (7); Position the terminal board (8) and the spacers (9) on the drum and scale assembly (5).
- (4) Install the DIAL CONTROL knob (2) on the shaft of the drum and scale assembly (5); secure the DIAL CONTROL knob with the setscrews (1).
- (5) Position the capacitor (10) on the oscillator chassis (11); secure the capacitor to the oscillator chassis with the nuts (not shown).

**15. Disassembly and Reassembly of Drum and Scale Assembly**

(fig. 20)

*a. Disassembly.*

- (1) Remove the drum and scale assembly from the analyzer (par 14a).

- (2) Loosen the setscrew (1) and remove the antibacklash gear (2) from the shaft of the variable capacitor (25).
- (3) Remove the machine screw (3) and the dial cord (4) from the antibacklash gear (2).
- (4) Loosen the setscrews (5) and remove the spur gear (6) from the shaft of the potentiometer (45).
- (5) Loosen the setscrews (7) and remove the helical gear (8, from the shaft of the potentiometer (15).
- (6) Remove the helical extension spring (12) from the roundhead machine screw (13) from the left end plate (20).
- (7) Remove the machine screw (9) and the lockwasher (10) that secure the slide rod (11) to the left end plate (20).
- (8) Remove the roundhead machine screws (17), lockwashers (18), and flat washers (19) that secure the support bracket ( 48) to the left end plate (20).
- (9) Remove the machine screws (14), lockwashers (15), and left end plate (20) from the support bars (16).
- (10) Remove the scale market (49) from the slide rod (11).
- (11) Remove the lock ring (22) from the shaft of the variable capacitor (25).
- (12) Remove the nut (23), lockwasher (24), and the variable capacitor (25) from the right end plate (21).
- (13) Remove the machine screws (29)) and lockwashers (10) from the left and right drive shaft blocks (27 and 28).
- (14) Remove the anchor pins (26) from the left and right (drive shaft blocks (27 and 28); remove the left and right shaft blocks, with the drive shaft attached, from the right end plate (21).
- (15) Remove the left drive shaft block (27), spacer (31), and flat washer (32) from the drive shaft (33).
- (16) Remove the roundhead machine screw (14) and nut (35) from the right drive shaft block (28).
- (17) Remove the right drive shaft block (28), flat washer (36), and drum and scale assemble stops (37) from the drive shaft (33).
- (18) Remove the anchor pin (38) that secures the spacer (39) to the drive shaft (33).
- (19) Remove the anchor pin (40) and the setscrew (50) that secure the drive gear (41) to the drive shaft (33).
- (20) Remove the spacer (39) and the drive gear (41) from the drive shaft (33).
- (21) Locate the hole in the drum (42); insert a thin rod through the hole and drive out the anchor pin (43) that secures the shaft E) of the potentiometer (45) to the drum (42). Remove the setscrew (44).

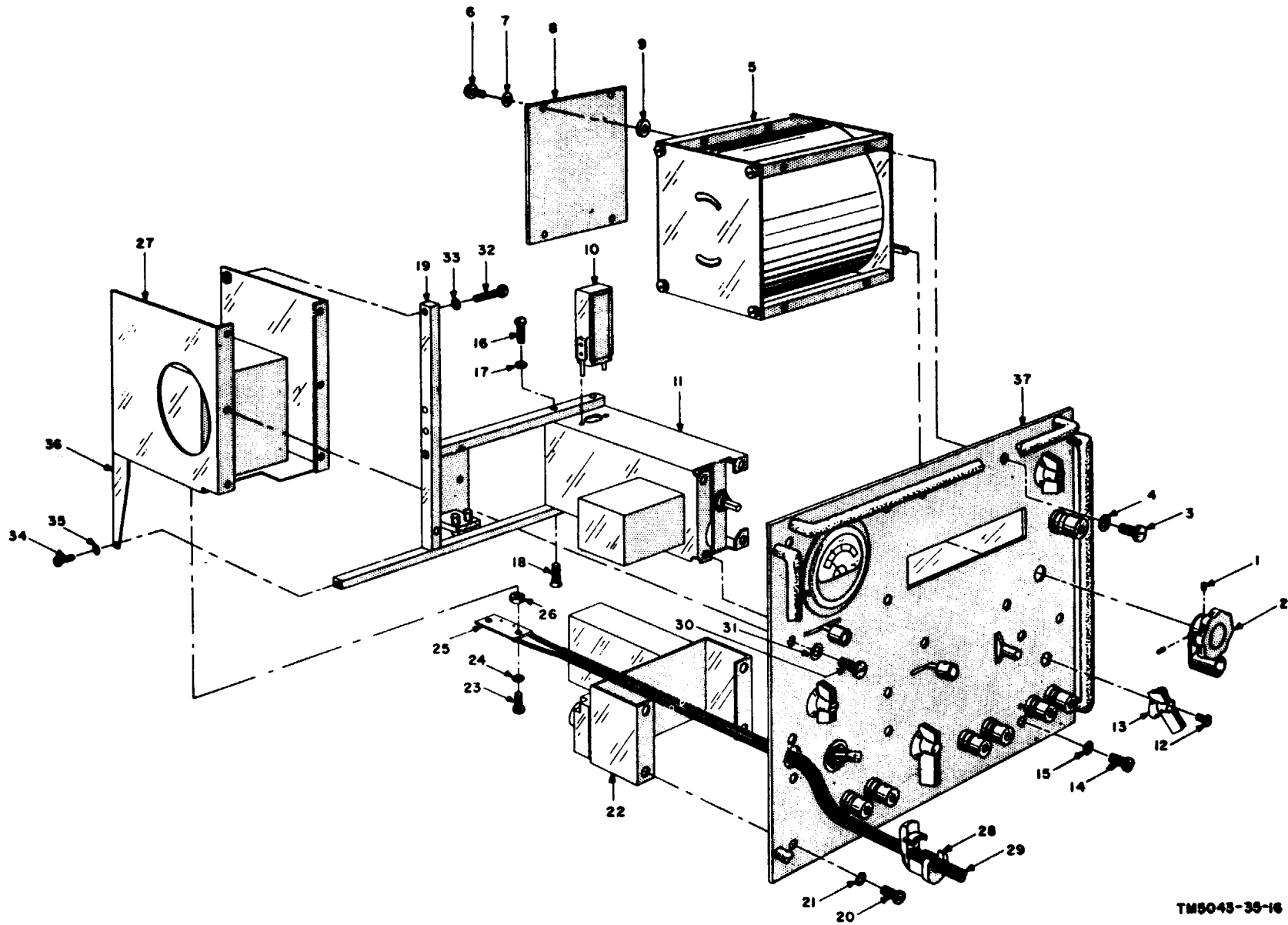
**Note**

**On some models of the analyzer, a locknut is used to secure the shaft of the potentiometer (1.5) to the drum (42).**

- (22) Remove the drum (42) from the shaft of the potentiometer (45).
- (23) Remove the lock ring (51) from the shaft of the potentiometer (45).
- (24) Remove the nut (46), lockwasher (47), and support bracket (418) from the shaft of the potentiometer (45).

*b. Reassembly*

- (1) Position the support bracket (48) on the shaft of the potentiometer (45) so that the yellow dot on the potentiometer is visible through the hole in the support bracket; secure the support bracket to the potentiometer with the lockwasher (47) and nut (46).
- (2) Insert the lock ring (51) in the slot on the shaft of the potentiometer (45).
- (3) Install the drum (42) on the shaft of the potentiometer (45).
- (4) Position the drum (42) so that the hole in the drum lines up with the hole in the shaft of the potentiometer (45); secure the drum to the shaft of the potentiometer with the anchor pin (43) and setscrew (44).
- (5) Position the drive gear (41) on the drive shaft (33), secure the drive gear to the drive shaft with the anchor pin (40) and setscrew (50).
- (6) Position the spacer (39) on the drive shaft (33); secure the spacer to the drive shaft with the anchor pin (38).
- (7) Install the drum and scale assembly stops (37), flat washer (36) and right



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Figure 19. Analyzer, exploded views.

- 1 Setscrew
- 2 DIAL CONTROL knob
- 3 Machine screw
- 4 Lockwasher
- 5 Drum and scale assembly
- 6 Roundhead machine screw
- 7 Lockwasher
- 8 Terminal board
- 9 Spacer
- 10 Capacitor (C8)
- 11 Oscillator chassis
- 12 Machine screw
- 13 Capacitance range switch knob
- 14 Machine screw
- 15 Lockwasher
- 16 Roundhead machine screw
- 17 Lockwasher
- 18 Flathead machine screw
- 19 Support bars
- 20 Machine screw
- 21 Lockwasher
- 22 High voltage rectifier chassis
- 23 Roundhead machine screw
- 24 Lockwasher
- 25 Terminal board
- 26 Spacer
- 27 Voltage regulator chassis and low voltage power supply chassis
- 28 Grommet
- 29 Power cable
- 30 Machine screw
- 31 Lockwasher
- 32 Roundhead machine screw
- 33 Lockwasher
- 34 Machine screw
- 35 Lockwasher
- 36 Support bracket
- 37 Front panel

**Figure 19-Continued.**

- drive shaft block (28) on the drive shaft (33).
- (8) Install the roundhead machine screw (34) and the nut (365) in the right drive shaft block (28).
  - (9) Install the flat washer (32), spacer (31), and left drive shaft block (27) on the drive shaft (33).
  - (10) Position the left and right drive shaft blocks (27 and 28), with the assembled drive shaft, on the right end plate (21); secure the left and right drive shaft blocks to the right end plate with the anchor pins (26), machine screws (29), and lockwashers (30).
  - (11) Position the variable capacitor (25) on the right end plate (21) ; secure the variable capacitor to the right end plate with the nut (23) and lockwasher (24).
  - (12) Insert the lock ring (22) in the slot on shaft of the variable capacitor (25).

- (13) Install the scale marker (49) on the slide rod (11).
- (14) Position the support bracket (48) with the potentiometer (45) attached on the left end plate (20) so that the lugs on the potentiometer are towards the top of the left end plate; secure the support bracket (48) to the left end plate with the roundhead machine screws (17), lockwashers (18), and flat washers (19).
- (15) Position the left end plate (20) on the support bars (16); secure the left end plate to the support bars with the machine screws (14) and lockwashers (15).
- (16) Secure the slide rod (11) to the left end plate (20) with the machine screw (9) and lockwasher (10).
- (17) Install the roundhead machine screw (13) in the left end plate (20).
- (18) Insert the end of the helical extension spring (12) in the hole on the roundhead machine screw (13).
- (19) Install the helical gear (8) on the shaft of the potentiometer (45); secure the helical gear with the setscrews (7).
- (20) Install the spur gear (6) on the shaft of the potentiometer (45); secure the spur gear with the setscrews (5).
- (21) Thread the dial cord (4) through the hole in the right end plate (21), over the pulley attached to the right end plate, over the pulley on the antibacklash gear (2), and through the hole in the antibacklash gear; secure the dial cord to the antibacklash gear with the machine screw (8).
- (22) Position the antibacklash gear (2) on the shaft of the variable capacitor (25). Allow sufficient clearance between the antibacklash gear and the helical gear (8) so that they do not bind. Secure the antibacklash gear to the shaft of the variable capacitor with the setscrews (1).
- (23) Install the drum and scale assembly in the analyzer (par. 14h).
- (24) Adjust the drum and scale assembly stops (par. 21).
- (25) Calibrate the drum and scale assembly (par. 21).

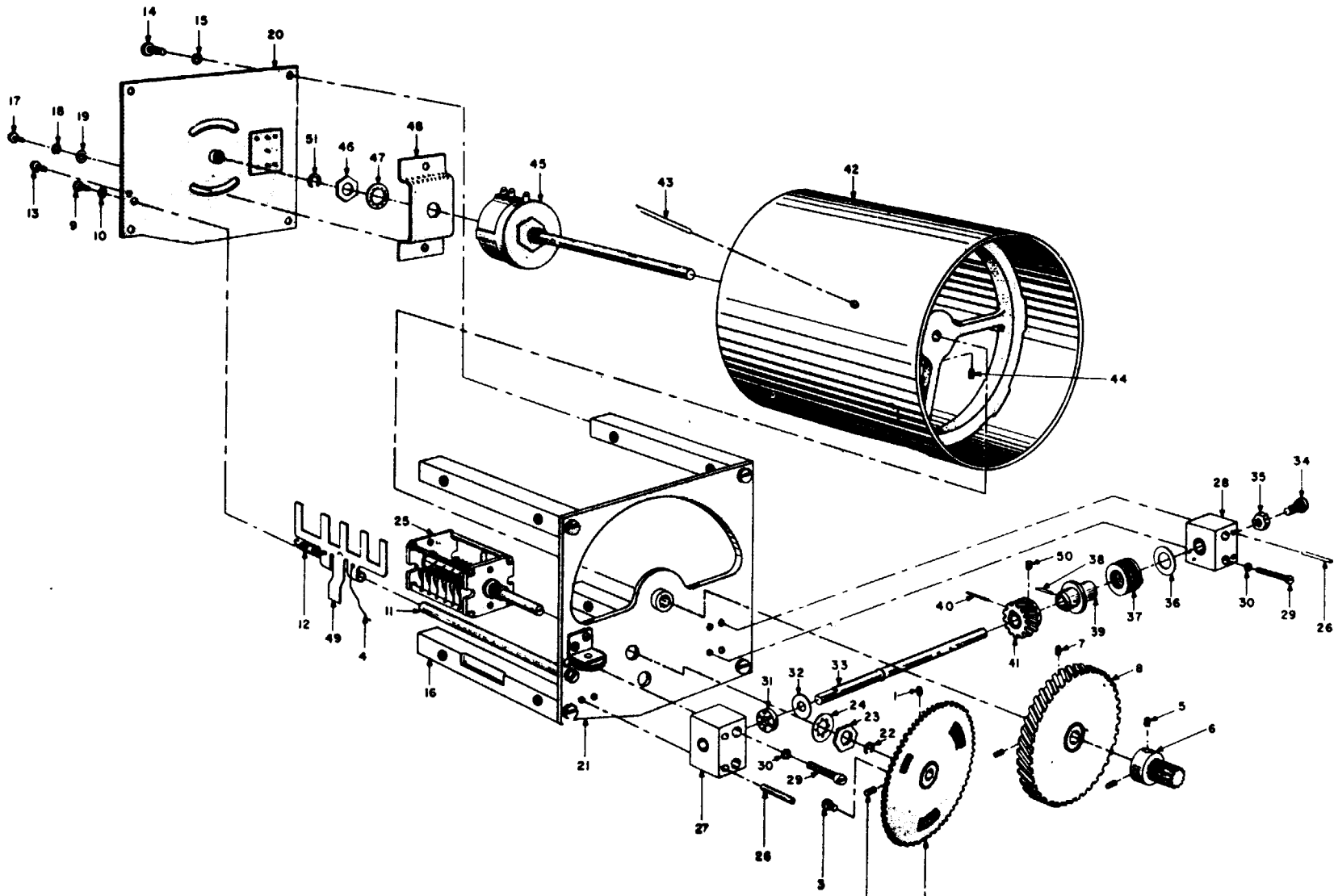


Figure 20. Drum and scale assembly, exploded view.

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1	Setscrew	27	Left drive shaft block
2	Antibacklash gear (108 teeth)	28	Right drive shaft block
3	Machine screw	29	Machine screw
4	Dial cord	30	Lockwasher
5	Setscrew	31	Spacer
6	Spur gear (18 teeth)	32	Flat washer
7	Setscrew	33	Drive shaft
8	Helical gear (60 teeth)	34	Roundhead machine screw
9	Machine screw	35	Nut
10	Lockwasher	36	Flat washer
11	Slide rod	37	Drum and scale assembly stops
12	Helical extension spring	38	Anchor pin
13	Roundhead machine screw	39	Spacer
14	Machine screw	40	Anchor pin
15	Lockwasher	41	Drive gear (helical gear, 20 teeth)
16	Support bar	42	Drum
17	Roundhead machine screw	43	Anchor pin
18	Lockwasher	44	Setscrew
19	Flat washer	45	Potentiometer (R16)
20	Left end plate	46	Nut
21	Right end plate	47	Lockwasher
22	Lock ring	48	Support bracket
23	Nut	49	Scale marker
24	Lockwasher	50	Setscrew
25	Variable capacitor (C12)	51	Lock ring
26	Anchor pin		

Figure 20 - Continued

## Section II. ADJUSTMENTS

### 16. INDICATOR BALANCE Potentiometer

- a. Set the controls for insulation resistance measurements (TM 11-5043-12).
- b. Operate the DIAL CONTROL counterclockwise to its stop.
- c. Remove the plug button from the right side of the dust cover.
- d. Adjust INDICATOR BALANCE potentiometer R23 (fig. .4) for an indication of 10 ma. on meter M1.

### 17. INSUL RES COMP Potentiometer

- a. Adjust INDICATOR BALANCE potentiometer R23 (par. 16).
- b. Set megohm range switch S3 to the MEGOHMS X1 position.
- c. Depress KEY S6. The meter indication should remain at 10 ma.
- d. Release the KEY.
- e. Set megohm range switch S3 to the MEGOHMS X100 position.
- f. Depress KEY S6. The meter indication should remain at 10 ma.
- g. If the meter indication (f above) changes, adjust INSUL RES COMP potentiometer R15 (fig. 15) for an indication of 10 ma.
- h. Release the KEY.

### 18. Variable Capacitor

- a. Set the controls for capacitance measurements (TM 11-043-12).

- b. Set capacitance range switch S5 to the 5 TO 100 MMF position.

- c. Adjust the DIAL CONTROL for a scale reading of zero behind the hairline in the column indicated by the position of scale marker 2.

- d. Remove the plug button from the left side of the dust cover.

- e. Adjust variable capacitor C19 (fig. 15) for a minimum indication on meter M1. The minimum meter indication must be below midscale.

### 19. PER CENT POWER FACTOR Potentiometer

- a. Turn the PER CENT POWER FACTOR control knob to its maximum counterclockwise position.
- b. Loosen the rear mounting nut of PERCENT POWER FACTOR potentiometer R30 (fig. 16).
- c. Rotate the entire control until the control knob points to the calibration mark just below the zero position.
- d. Tighten the rear mounting nut; check to see that the control knob remains on the calibration mark.

### 20. Calibration of Drum and Scale Assembly

- a. *Variable Capacitor C12 (fig. 20).*
  - (1) Set the controls for capacitance measurements (TM 11-5043-12).
  - (2) Set capacitance range switch S5 to the 5 TO 100 MMF position.

- (3) Loosen the setscrews (1) in the antibacklash gear (2).
- (4) Adjust the DIAL CONTROL for a reading of zero behind the hairline in the column indicated by the position of scale marker 2.
- (5) With a screwdriver, turn the shaft of the variable capacitor (25) clockwise until the meter dips twice in one revolution; adjust the variable capacitor for the lowest reading of the second dip.
- (6) Tighten the setscrews (1) to secure the antibacklash gear (2) to the shaft of the variable capacitor (25).
- (7) Check the accuracy of the adjustment (par. 26).

*b. Potentiometer R16.* To calibrate potentiometer R16 on Analyzer ZM-A/U (Order No. 25664-Phila-54), follow the procedures given in (1) below. To calibrate potentiometer R16 on all other models of the analyzer, follow the procedures given in (2) below.

- (1) *Analyzer ZM-4A/U (Order No. 25664-Phila-54).*
  - (a) Loosen the thumb locking screw and the hexagonal-head screw on the left end plate.
  - (b) If the scale readings are too high, move the lever adjustment arm toward the front panel; if the scale readings are too low, move the lever adjustment arm away from the front panel.
  - (c) Tighten the hexagonal-head screw and thumb locking screw.
  - (d) Check the accuracy of the adjustment (pars. 25 and 26).
- (2) *Analyzer ZM-3(\*)/U, all models except Analyzer ZM-3A/U (Order No. 25664-Phila-54) (fig. 20).*
  - (a) Remove the drum and scale assembly from the analyzer (par. 14a).
  - (b) Loosen the roundhead machine screws (17) that secure the support bracket (48) to the left end plate (20).

- (c) If the scale readings are too high, move the roundhead machine screws (17) and the support bracket (48) counterclockwise; if the scale readings are too low, move the roundhead machine screws (17) and the support bracket (48) clockwise.
- (d) Tighten the roundhead machine screws (17) to secure the support bracket (48) to the left end plate (20).
- (e) Replace the drum and scale assembly in the analyzer (par. 14h).
- (f) Check the accuracy of the adjustment (pars. 25 and 26).

## **21. Drum and Scale Assembly Stops**

(fig. 20)

Incorrect setting of the drum and scale assembly stops may cause damage to potentiometer R16. When potentiometer R16 or variable capacitor C12 is replaced, or when the analyzer is calibrated, it is possible that the stops may be set incorrectly. Adjust the drum and scale assembly stops as follows:

- a. Turn the DIAL CONTROL counterclockwise to its stop.
- b. Check the drum and scale assembly stops. If the stops are tight, no adjustments are required. If the stops are loose, proceed as follows:
  - (1) Loosen the setscrews (7) that secure the helical gear (8) to the shaft of the potentiometer (45).
  - (2) While holding the helical gear (8), rotate the drum (42) slightly clockwise (approximately 1/16 inch).
  - (3) Tighten the setscrews (7) to secure the helical gear (8) to the shaft of the potentiometer (45).
  - (4) Perform the procedures given in a and b above. If necessary, repeat steps (1) through (3) above until the drum and scale assembly stops are tight.



**CHAPTER 4**  
**FINAL TESTING**

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**22. Purpose of Final Testing**

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation equivalent to that of new equipment.

**23. Test Equipment Required for Final Testing**

The test equipment required for final testing is the same as that listed for troubleshooting (par. 9). Refer to the appropriate technical manuals for instructions on the use of the test equipment.

**24. Leakage Test**

*a. Milliammeter.*

- (1) Set the controls for leakage current measurements (TM 11-5043-12).
- (2) Connect a variable resistor, 1,500 ohms, 5 watts, to the test set (TM 11-2646A). Using the test set as a standard, adjust the variable resistor to obtain a value of 1,200 ohms.
- (3) Remove the variable resistor from the test set and connect it to the leakage terminals of the analyzer.
- (4) Adjust the multimeter to measure dc voltages and connect the multimeter to the leakage terminals. in parallel with the variable resistor ( (2) above).
- (5) Hold the METER SWITCH in the 50 MA. position and adjust the OPERATING VOLTAGE control until the meter indicates 50 ma.
- (6) Record the voltage indicated on the multimeter and release the METER SWITCH.
- (7) Compute the leakage current using the resistance value ((2) above) and the measured voltage ((6) above). The leakage current must be between 48.5 and 51.5 ma.

- (8) Remove the variable resistor and disconnect the multimeter from the leakage terminals.

*b. Voltmeter.*

- (1) Connect the multimeter to the leakage terminals.
- (2) Hold the METER SWITCH in the 60 VOLTS position and adjust the OPERATING VOLTAGE control until the meter indicates 60 volts.
- (3) Record the voltage indicated on the multimeter and release the METER SWITCH.
- (4) The measured voltage ((3) above) must be between 58.2 and 61.8 volts.
- (5) With the METER SWITCH in the 600 VOLTS position, adjust the OPERATING VOLTAGE control until the meter indicates 600 volts.
- (6) Hold the meter switch in the 50 MA. position.
- (7) Record the voltage measured on the multimeter and release the METER SWITCH.
- (8) The measured voltage ((7) above) must be between 582 and 618 volts.
- (9) Disconnect the multimeter from the leakage terminals.

**25. Insulation Resistance Test**

*a. General.* Use resistors calibrated to -1 percent as a standard for insulation resistance measurements. The following chart lists the resistance value to be used and the scale reading that should be obtained for each position of the megohm range switch.

Megohm range switch	(megohms) Resistance value	Scale reading
MEGOHMS X1	2	1.6 to 2.4
MEGOHMS X1	80	64 to 96
MEGOHMS X100	150	1.2 to 1.8

b. *Procedure.* Perform the following test for each position of the megohm range switch given in the chart (a above).

- (1) Set the controls for insulation resistance measurements (TM 11-5043-12).
- (2) Connect a resistor (a above) to the insulation resistance terminals.
- (3) Set the megohm range switch to MEGOHMS X1 or MEGOHMS X100 as required.
- (4) Depress the KEY and adjust the DIAL CONTROL until the balance condition (10 ma.) is indicated on the meter.
- (5) Release the KEY and read the resistance value on scale 1 of the drum and scale assembly.
- (6) The resistance ((5) above) must be within the limits given in the chart (a above). If the resistance is not within the limits given in the chart, adjust potentiometer R16 (par. 20b).

**26. Capacitance Test**

a. *General.* Use capacitors calibrated to ±1 percent as a standard for capacitance measurements. The following chart lists the capacitance value to be used and the scale reading that should be obtained for each position of the capacitance range switch.

Capacitance range switch	Capacitance value	Scale reading
5 to 100 MMF	10µµf	7 to 13 1µµf
5 to 100 MMF	80 µµf	77 to 83 µµf
80 to 50000 MMF	20,000 µµf	19,000 to 21,000 µµf
.04 to 30 MF	1 µf	.95 to 1.05 µµf
25 to 1000 MF	500 µf	450 to 550 µµf
250 to 10000 MF	500 µf	450 to 550 µµf

b. *Procedure.* Perform the following test for each position of the capacitance range switch given in the chart (a above).

- (1) Set the controls for capacitance measurements (TM 11-5043-12).
- (2) Connect a capacitor (a above) to the capacitance terminals.
- (3) Set the capacitance range switch to the position that covers the capacitance value ((2) above) to be measured.

- (4) Adjust the DIAL CONTROL for a minimum indication on the meter. For capacitors larger than .04 microfarad (if), adjust both the DIAL CONTROL and the PER CENT POWER FACTOR control for a minimum indication on the meter.
- (5) Read the capacitance value on the proper scale as indicated by the position of the capacitance range switch.
- (6) The capacitance value ((5) above) must be within the limits given in the chart (a above). If the capacitance value is not within the limits given in the chart and the capacitance range switch is set to the 5 TO 100 MMF position, adjust variable capacitor C12 (par. 20a); for all other positions of the capacitance range switch, adjust potentiometer R16 (par. 20b).

**27. Power Factor Test**

a. *General.* Use resistors and capacitors calibrated to ±1 percent as a standard for power factor measurements. The following chart lists the capacitance value and the resistance value to be used and the dial reading (PER CENT POWER FACTOR control dial) that should be obtained for each capacitor-resistor combination.

Capacitance value (µf)	Resistance value (ohms)	Dial reading (percent)
1.0	80	4.5 to 5.5
1.0	160	9 to 11
1.0	500	27 to 33

b. *Procedure.* Perform the following test for each of the capacitor-resistor combinations listed in the chart (a above).

- (1) Set the controls for capacitance measurements (TM 11-5043-12).
- (2) Connect a capacitor and a resistor in series; connect this capacitor-resistor combination to the capacitance terminals.
- (3) Set the capacitance range switch to the .04 TO 30 MF position.
- (4) Adjust the DIAL CONTROL and the PER CENT POWER FACTOR control for a minimum indication on the meter.
- (5) Read the power factor value opposite the pointer on the PER CENT POWER FACTOR control dial.

(6) The power factor value must be within the limits given in the chart (a above). If the value read is not within the limits given in

the chart, calibrate the PER CENT POWER FACTOR control (par. 19).

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## APPENDIX

### REFERENCES

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Following is a list of applicable references available to the field and depot maintenance repairman of Analyzer ZM-3 (\*)/U.

TM 11-1242	Crystal Rectifier Test Set
TM 11-2535	Meter Test Equipment GSM-1.
TM 11-2646A	Capacitance-Inductance-Resistance Test Set AN/URM-90.

TM 11-2661

TM 11-5043-12

TM 11-5083

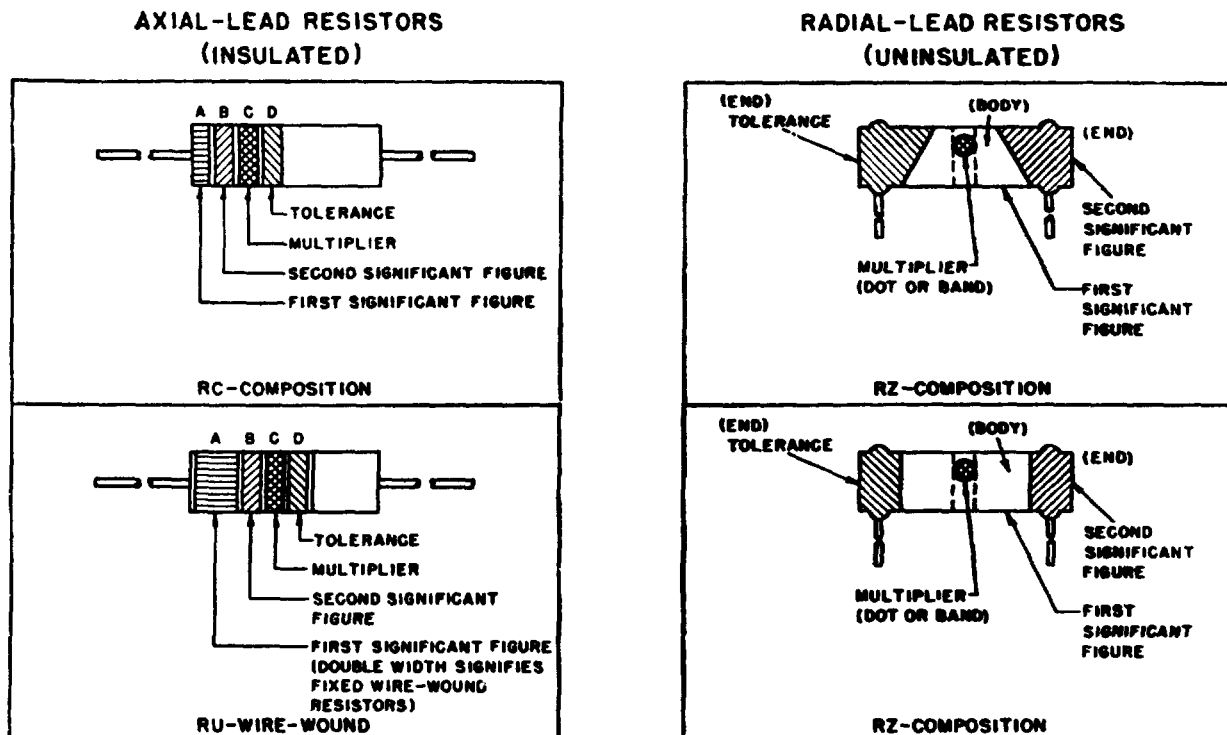
Electron Tube Test Sets TV-2/U and TV-2A/U.

Analyzer ZM-3/U and ZM-3A/U, Operational and Organizational Maintenance Manual

Electron Tube Test Sets TV-7/U, TV-7A/U, and TV-7B/U.

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## RESISTOR COLOR CODE MARKING (MIL-STD RESISTORS)



### RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	$\pm 20$
BROWN	1	BROWN	1	BROWN	10	SILVER	$\pm 10$
RED	2	RED	2	RED	100	GOLD	$\pm 5$
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

\* FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

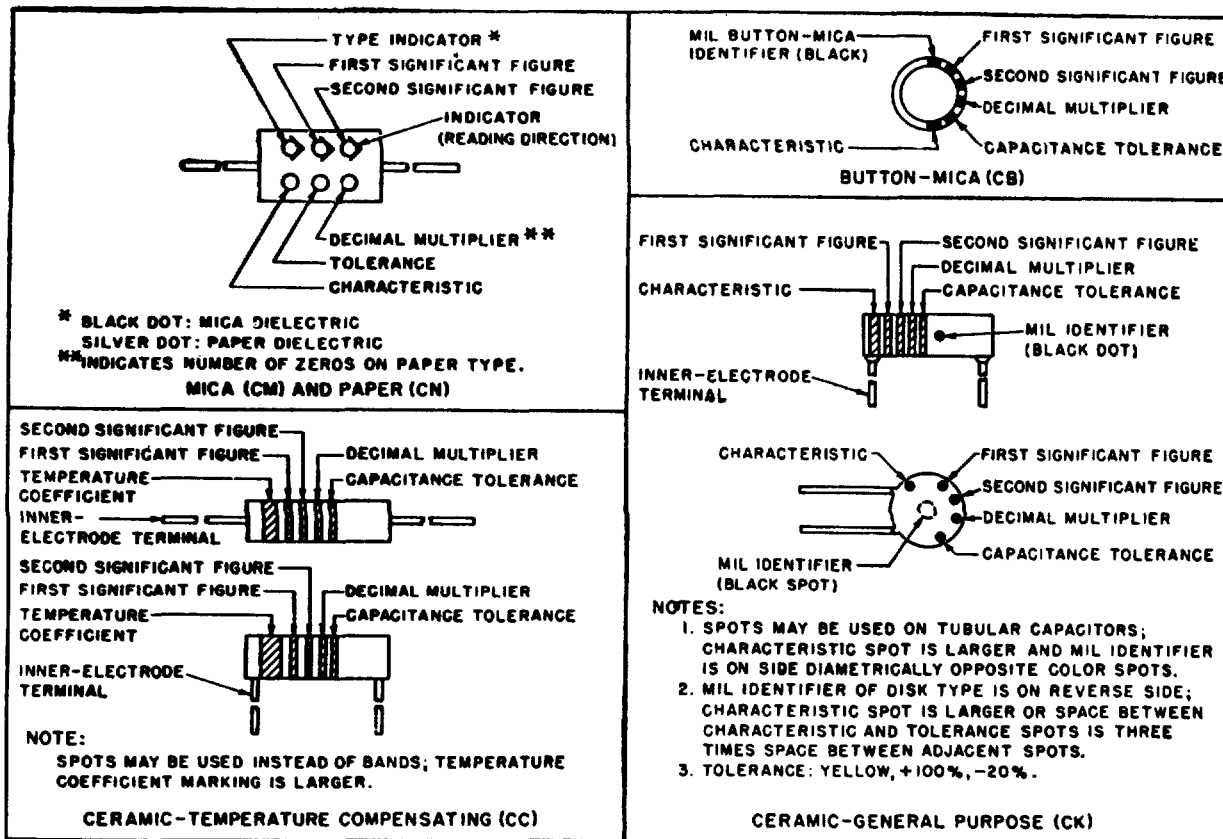
EXAMPLES (BAND MARKING):  
 10 OHMS  $\pm 20$  PERCENT: BROWN BAND A; BLACK BAND B;  
 BLACK BAND C; NO BAND D.  
 4.7 OHMS  $\pm 5$  PERCENT: YELLOW BAND A; PURPLE BAND B;  
 GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):  
 10 OHMS  $\pm 20$  PERCENT: BROWN BODY; BLACK END; BLACK DOT  
 OR BAND; BODY COLOR ON TOLERANCE END.  
 3,000 OHMS  $\pm 10$  PERCENT: ORANGE BODY; BLACK END; RED DOT  
 OR BAND; SILVER END.

STD-R1

Figure 21. MIL-STD resistor color-code markings.

## CAPACITOR COLOR CODE MARKING (MIL-STD CAPACITORS)



### CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC <sup>1</sup>				TOLERANCE <sup>2</sup>					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) <sup>3</sup>
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

Figure 22. MIL-STD capacitor color-code markings.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

MAXWELL D. TAYLOR,  
*General, United States Army,  
Chief of Staff.*

OFFICIAL:

HERBERT M. JONES,  
*Major General, United States Army,  
The Adjutant General.*

THOMAS D. WHITE,  
*Chief of Staff, United States Air Force.*

OFFICIAL:

J. L. TARR,  
*Colonel, United States Air Force,  
Director of Administrative Services.*

Distribution:

*Active Army:*

ASA (2)  
CNGB (1)  
Technical Stf, DA (1) except  
    CSigO (30)  
Technical Stf Bd (1)  
USA Arty Bd (1)  
USA Armor Bd (1)  
USA Int Bd (1)  
USA Air Def Bd (1)  
USA Abn & Elct Bd (1)  
USA Avn Bd (1)  
USA Armor Bd Test Sec (1)  
USA Air Def Bd Test Sec (1)  
USA Arctic Test Bd (1)  
USCONARC (5)  
US ARADCOM (2)  
US ARADCOM Rgn (2)  
OS Maj Comd (5)  
Log Comd (5)  
MDW (1)  
Armies (5)  
Corps (2)  
Div (2)  
USATC (2)  
Ft & Camps (2)  
Svc Colleges (5)  
Br Svc Sch (5) except  
    USASCS (25)  
Gen Depots (2) except  
Atlanta Gen Depot (None)  
Sig Sec, Gen Depots (10)  
Sig Depots (17)  
Fld Comd, AFSWP (5)  
Engr Maint Cen (1)  
Army Pictorial Cen (2)  
Sp Won Cen (5)

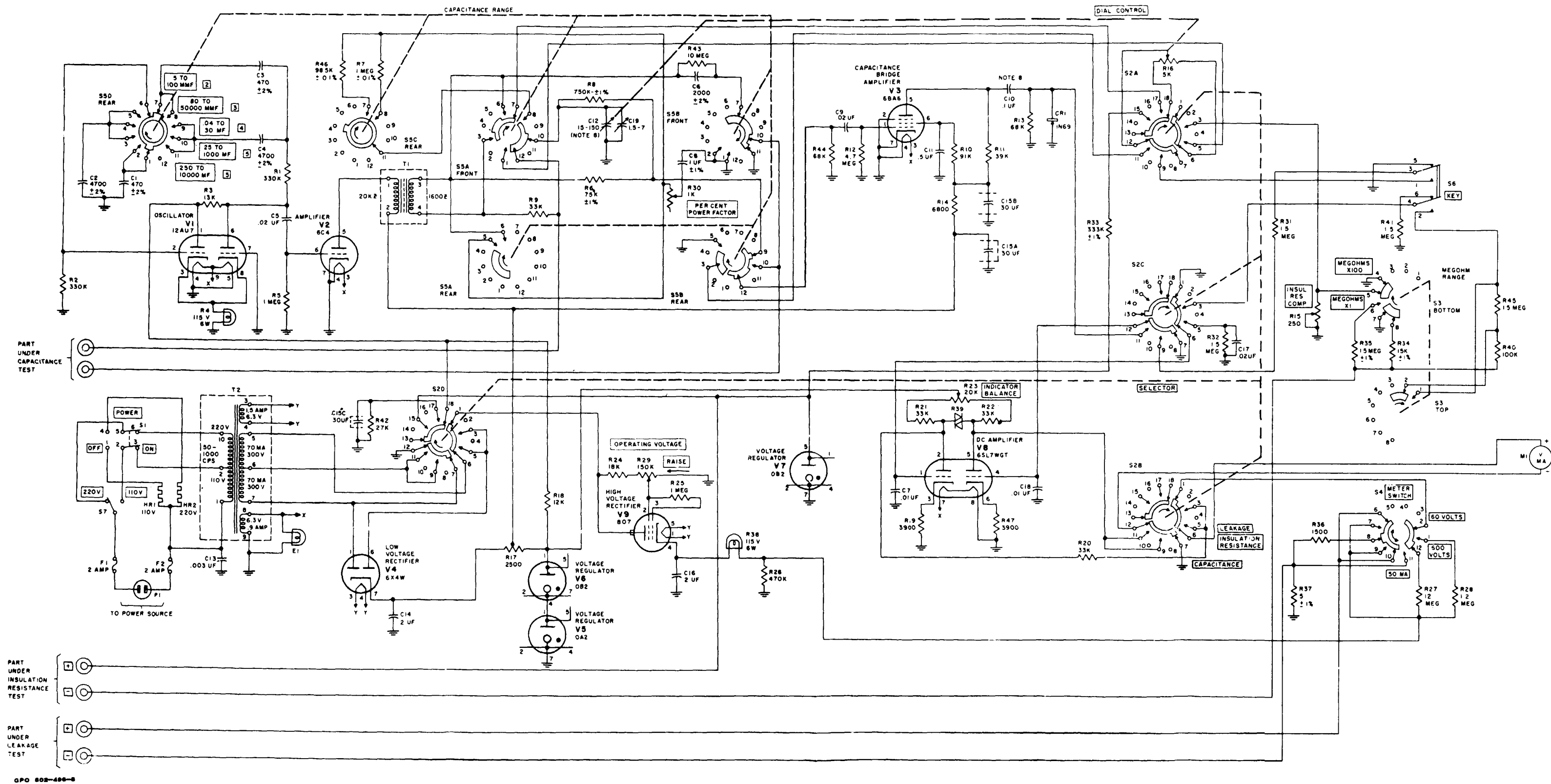
WRAMC (1)  
AFIP (1)  
AMS (1)  
Port of Emb (OS) (2)  
Sp Wpn Comd (5)  
OS Sup Agcy (2)  
USA Sig Pub Agcy (8)  
USA Corn Engr Agcy (1)  
USA Comm Agcy (2)  
TASSA (13)  
USA Sig Each Spt Agcy (2)  
USA White Sands Sig Agcy (13)  
Yuma Test Sta (2)  
Aberdeen PG (5)  
USA Elct PG (1)  
Sig Fld Maint Shops (3)  
Sig Lab (5)  
Mil Dist (1)  
USA Corps (Res) (1)  
Sectors, USA Corps (Res) (1)  
JBUSMC (2)  
Units org under fol TOE:  
    11-5 (2)  
    11-6 (2)  
    11-15 (2)  
    11-16 (2)  
    11-55 (2)  
    11-56 (2)  
    11-127 (2)  
    11-128 (2)  
    11-500 (AA-AE) (2)  
    11-537 (2)  
    11-557 (2)  
    11-587 (2)  
    11-592 (2)  
    11-597 (2)

NG: State AG (6); units-same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

**AGO 916A**



- NOTES
- INDICATES EQUIPMENT MARKING
  - UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF
  - SELECTOR SWITCH S2 SHOWN IN LEAKAGE POSITION AND IS VIEWED FROM FRONT WAFER NEAREST CONTROL KNOB IN SECTION A. SEGMENTS MOVE DISTANCE OF TWO CONTACTS FOR EACH POSITION. CONTACTS MADE IN EACH POSITION ARE:
 

POSITION	CONTACTS MADE			
	S2A	S2B	S2C	S2D
LEAKAGE		1, 6, 7, AND 12	1, 6, 7, AND 12	1, 6, 7, AND 12
INSULATION RESISTANCE	3, 6, 9, 12, 15, AND 18	3, 6, 9, AND 12	3, 6, 9, AND 12	3, 6, 9, 12, 15, AND 18
CAPACITANCE	5, 6, 11, 12, 17, AND 18	5, 6, 11, AND 12	5, 6, 11, AND 12	5, 6, 11, 12, 17, AND 18
  - MEG OHM RANGE SWITCH S3 SHOWN IN MEG OHMS X1 POSITION AND IS VIEWED FROM TOP OF EQUIPMENT. CONTACTS MADE IN EACH POSITION ARE:
 

POSITION	CONTACTS MADE	
	TOP	BOTTOM
MEG OHMS X1	4, 5, 7, AND 8	
MEG OHMS X100	1 AND 2	6 AND 7
  - METER SWITCH S4 SHOWN IN 600 VOLTS (CENTER) POSITION AND IS VIEWED FROM TOP OF EQUIPMENT. CONTACTS MADE IN EACH POSITION ARE:
 

POSITION	CONTACTS MADE
60 VOLTS	1, 2, 9, AND 10
600 VOLTS	2, 12, 6, 8, AND 10
50 MA	2, 11, 6, AND 7
  - CAPACITANCE RANGE SWITCH S5 SHOWN IN 5 TO 100 MMF POSITION AND IS VIEWED FROM FRONT FRONT OF WAFER. SECTION A CONTACTS MADE IN EACH POSITION ARE:
 

POSITION	CONTACTS MADE				
	S5A FRONT	S5A REAR	S5B FRONT	S5B REAR	S5C REAR
5 TO 100 MMF	10 AND 12		7, 10, AND 11	9 AND 12	1, 6, AND 7
80 TO 50000 MMF	1, 6, 7, AND 12		7 AND 10	3, 5, 10, AND 12	2, 6, AND 8
04 TO 30 MF	6, 7, 1, AND 12	5 AND 6	1, 10, AND 11	3 AND 12	3, 6, AND 9
25 TO 1000 MF	7, 8, 1, 3, AND 12	5 AND 6	2, 10, AND 11	3 AND 12	7 AND 11
250 TO 10000 MF	7, 8, 1, 3, AND 12	5 AND 6	1, 10, AND 11	3 AND 12	8 AND 11
  - KEY S6 SHOWN IN NORMAL POSITION
  - ON THE 2M-3/4U CAPACITOR C10 IS 02UUF AND CAPACITOR C12 VARIES FROM 9 TO 150UUF

Figure 23. Analyzer ZM-3A/U, schematic diagram.



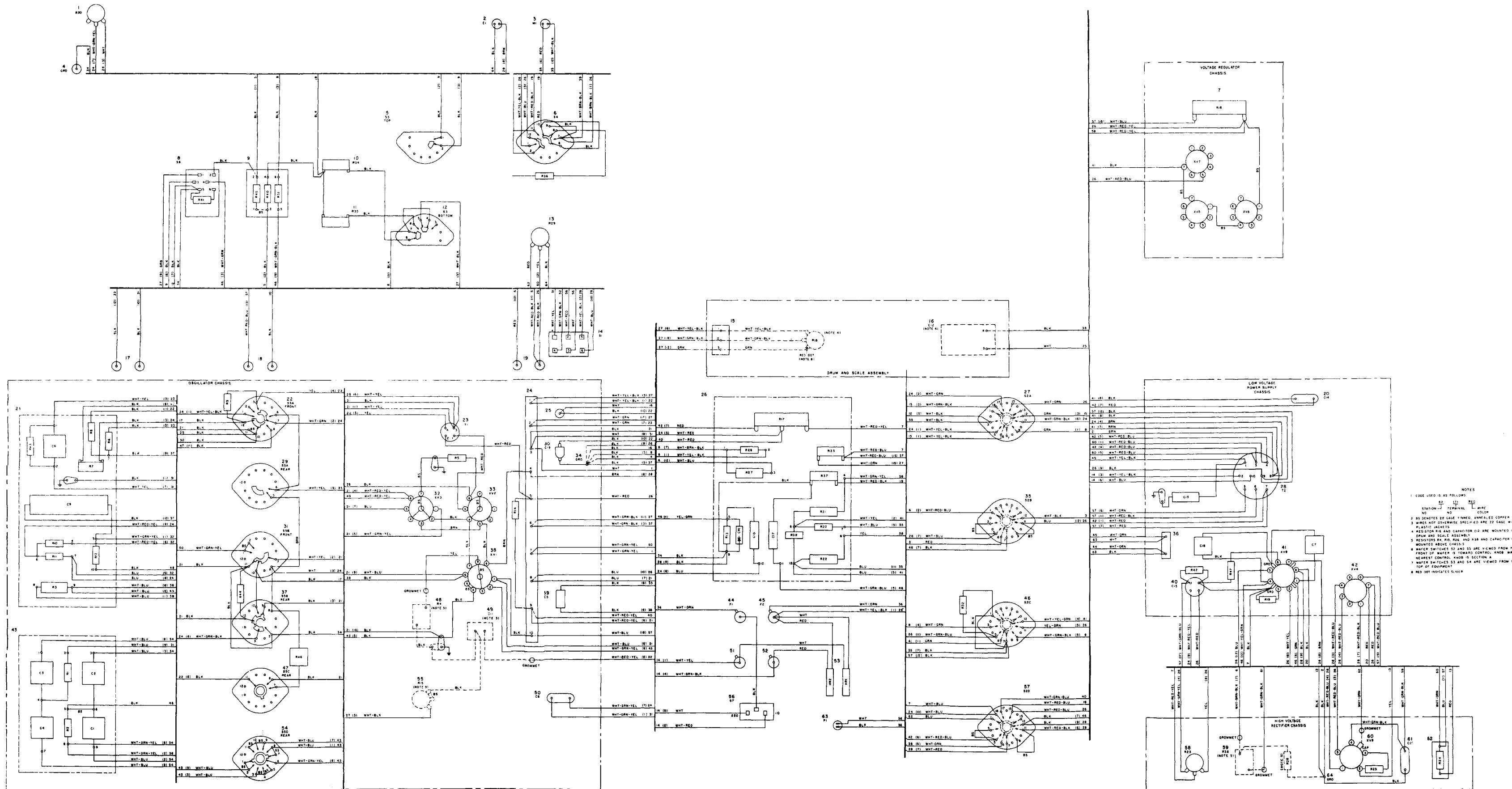


Figure 24. Analyzer ZM-3(\*)/U, wiring diagram.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER

PUBLICATION DATE

PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.

PARA-GRAPH

FIGURE NO.

TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

TEAR ALONG PERFORATED LINE

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER

SIGN HERE

# The Metric System and Equivalents

## Linear Measure

1 centimeter = 10 millimeters = .39 inch  
 1 decimeter = 10 centimeters = 3.94 inches  
 1 meter = 10 decimeters = 39.37 inches  
 1 dekameter = 10 meters = 32.8 feet  
 1 hectometer = 10 dekameters = 328.08 feet  
 1 kilometer = 10 hectometers = 3,280.8 feet

## Weights

1 centigram = 10 milligrams = .15 grain  
 1 decigram = 10 centigrams = 1.54 grains  
 1 gram = 10 decigrams = .035 ounce  
 1 dekagram = 10 grams = .35 ounce  
 1 hectogram = 10 dekagrams = 3.52 ounces  
 1 kilogram = 10 hectograms = 2.2 pounds  
 1 quintal = 100 kilograms = 220.46 pounds  
 1 metric ton = 10 quintals = 1.1 short tons

## Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce  
 1 deciliter = 10 centiliters = 3.38 fl. ounces  
 1 liter = 10 deciliters = 33.81 fl. ounces  
 1 dekaliter = 10 liters = 2.64 gallons  
 1 hectoliter = 10 dekaliters = 26.42 gallons  
 1 kiloliter = 10 hectoliters = 264.18 gallons

## Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch  
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches  
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet  
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet  
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres  
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

## Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch  
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches  
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

## Approximate Conversion Factors

To change	To	Multiply by	To change	To	Multiply by
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

## Temperature (Exact)

°F Fahrenheit temperature      5/9 (after subtracting 32)      Celsius temperature      °C

**PIN: 018694-000**