DEPARTMENT 0F THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE MANUAL

TEST SET, ELECTRICAL METER TS-656/U

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS, DEPARTMENT OF THE ARMY
1 September 1961

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 115-volt ac line connections or any of the output jacks. Serious injury or death may result from contact with these points.
When making test connections or when working inside the equipment after the power has been turned off, always discharge the electrolytic capacitors.

DON'T TAKE CHANCES!

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING CIRCUITS

DC VOLTS circuits	**500 volts dc.**
AC VOLTS circuits	**500 volts ac.**

CHANGE

No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *2 May 1966*

DS, GS, and Depot Maintenance Manual

TEST SET, ELECTRICAL METER TS-656/U

TM 11-6625-226-35, 1 September 1961 is changed as follows:

The title of the manual is changed as shown above.

Page 2, paragraph 1. Delete subparagraph c and substitute:

c. Reporting of Equipment Manual Improvements. The direct reporting by the individual user of errors, omissions, and recommendations for improving this equipment manual is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Publications) will be used for reporting these improvements. This form may be completed using pencil, pen, or typewriter and forwarded direct to Commanding General, U.S. Army Electronics Command, ATTN: AMSEL-MR-(NMP)-MA, Fort Monmouth, N.J., 07703.

Add paragraph 2.1 after paragraph 2.

2.1. Index of Equipment Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to this equipment. DA Pam 310-4 is an index of current technical manuals, technical bulletins, supply manuals (types 7, 8, and 9), supply bulletins, lubrication orders, and modification work orders available through supply channels. The index lists the individual parts (-10, -20, -35P, etc.) and the latest changes to and revisions of each equipment publication.

Page 31, chapter 4. Delete chapter 4 and substitute:

CHAPTER 4
DEPOT INSPECTION STANDARDS

22. Applicability of Depot Inspection 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.

23. Applicable References

a. Repair Standards. Applicable procedures of the Army depots performing these tests and the general standards for repaired electronic equipment given in TB SIG 355-1, TB SIG 3552, and TB SIG 355-3 form a part of the requirements for testing this equipment.

b. *Technical Publications*. The technical publications applicable to the equipment to be tested are indicated below:

Test Set, Electrical Meter TS-656/U	*Publication*
Operation and Organizational Maintenance.	TM 11-6625-226-12
Operator's and Organizational Maintenance Repair Parts and Special Tools List.	TM 11-6625-226 12P
Field and Depot Maintenance Repair Parts and Special Tools List.	TM 11-6625-226 35P

c. Modification Work Orders. Perform all applicable modification work orders (MWO) pertaining to this test set before making the tests specified. DA Pam 3104 lists all available MWO's. Use the applicable forms and records in accordance with instructions in TM 38-750 to record the MWO application.

TAGO 1801A-May 2000-475°-66

24. Test Facilities Required

The following items are required for testing:

Item	Technical manual	Common name
Meter Test Set TS 682A/GSM-1.	TM 11-2535B	Meter test set (used as standard).
Voltmeter, Meter ME-30A/U or Voltmeter, Electronic ME-30B/U, ME-30C/U, or ME-30E/U.	TM 11-6625-320-12	Ac voltmeter
Multimeter TS-352/U.	TM 11-5527	Multimeter
Double-pole, double-throw switch.		DPDT switch

25. General Test Requirements

Three tests are performed: DIR CUR test. DC VOLTS test, and AC VOLTS test. In each of these tests, the output from Test Set, Electrical Meter TS-656/U is compared against a precision source, Meter Test Set TS-682A/,GSM-1, WHICH SERVES AS A STANDARD). The comparison is effected by means of an ac and dc multimeter and an ac voltmeter, which monitor the output from the TS-682A/GSM-1, as compared with the same output from the TS-656/U. Testing will be simplified if connections and panel control settings are made initially and modifications are made as required for the initial tests.

a. Connect the equipment as shown in figure 14.1. The dashed lines indicate connections that will be specified in the test procedures.

b. Set the TS—656/U ON-OFF switch to ON.

c. Refer to the applicable technical manuals for the connections and operations applicable to dc and ac voltage and current operations.

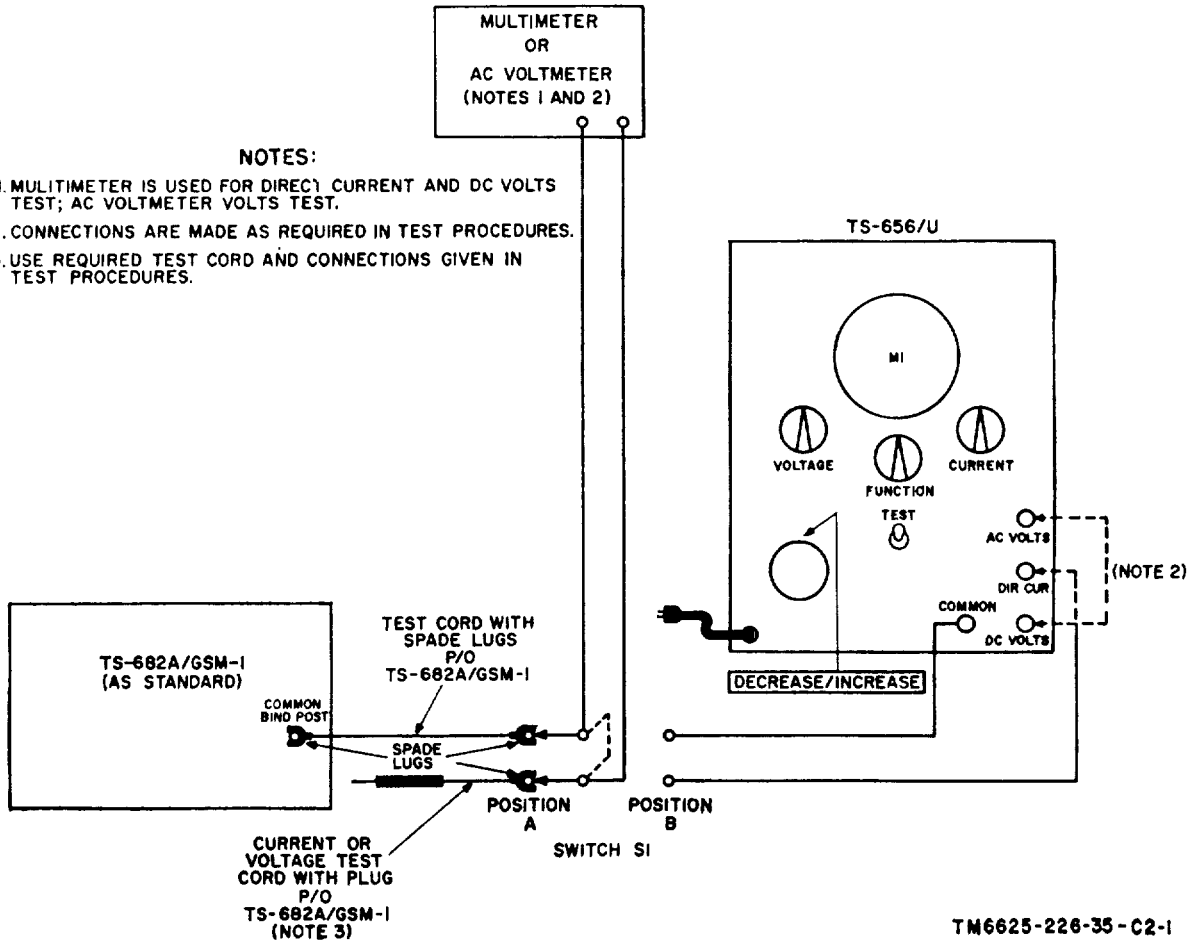

Figure 14.1. Test setup diagram, DIR CUR, DC VOLTS, and AC VOLTS tests.

26. DIR CUR Test

a. Connect the equipment as shown in figure 14.1. Turn on the TS-682A/GSM-1 and the TS-656/U.

(1) Connect the current test cord from the plug on the TS-682A/GSM-1 to the 100microampere jack.

(2) Connect the TS-656/U DC VOLTS binding post to switch S1.

(3) Connect the multimeter, arranged for document operation, to switch S1.

b. Set DPDT switch S1 in position A and adjust the standard TS-682A/GSM-1 for an 80-microampere indication on its panel meter.

c. Note the current indication on the multimeter.

d. Place the DPDT switch in position B.

e. On the TS-656/U, position the TEST switch up and adjust the INCREASE/DECREASE control for an indication on the multimeter identical to that obtained in *c* above. The indication on the TS-656/U meter should agree within ±3 percent of the TS-682A/GSM-1 indication obtained in *b* above. Release the TEST switch.

f. Repeat the procedures given in *a* through *e* above, using the TS-656/U CURRENT switch settings listed below, and setting the TS-682A/ GSM-1 to the de current indicated below. Adjust the multimeter for on-scale meter indications (dc) and connect the TS-682A/GSM-1 current test cord plug to the proper jack for the dc current output.

TS-656/U CURRENT switch setting		TS-682A/GSM-1 dc current indication	
250	MICRO-AMP	200	microamperes
500	MICRO-AMP	400	microamperes
1	MA	0.8	milliamperes
2.5	MA	2.0	milliamperes
5	MA	4.0	milliamperes
10	MA	8.0	milliamperes
25	MA	20.0	milliamperes
50	MA	40.0	milliamperes
100	MA	80.0	milliamperes
250	MA	200	milliamperes
500	MA	400	milliamperes
1	AMP	0.8	ampere

27. DC VOLTS Test

a. Connect the equipment as shown in figure 14.1.

(1) Connect the voltage test cord plug to the TS-682A/GSM-1 low-voltage dc jack to obtain on-scale voltage meter indication.

(2) Connect the TS-656/U DC VOLTS binding post to switch S1.

(3) Connect the multimeter, arranged for dc voltage operation, to switch S1.

b. Position the TS-656/U FUNCTION switch to DC VOLTS, and the VOLTAGE switch, to 2.5V.

c. Place the DPDT snitch in position A, and adjust the TS-682A/GSM-1 for 2.0-volt dc indication on its panel meter.

d. Note the voltage indication on the ac multimeter.

e. Place switch S1 in position B.

f. On the TS-656/U, position the TEST switch up and adjust the INCREASE-DECREASE switch for an indication on the multimeter identical with that obtained in *d* above. The indication on the TS-656/U meter should agree within 3 percent of the TS-682A/GSM-1 indication obtained in *c* above.

g. Repeat the procedures given in *a* through *f* above, using the TS 656/U VOLTAGE s settings given below and setting the TS-682A/GSM-1 to the dc voltage indicated below. Adjust the multimeter for on-scale meter indications (dc) and connect the TS-682A/GSM-1 voltage test cord plug to the proper jack for the dc output voltage.

TS-656/U CURRENT switch setting	TS-682A/GSM-1 dc current indication
5N	4
10V	8
25V	20
50V	40
100V	80
250V	200
500V	400

28. AC VOLTS Test

a. Connect the equipment as shown in figure 14.1.

(1) Connect the voltage test cord to the TS682A/GSM-1 and to the low-voltage ac jack to obtain on-scale voltage meter indication.

(2) Connect the TS-656/U AC VOLTS binding post to switch S1.

(3) Connect the ac multimeter, arranged for ac voltage operation, to switch S1.

b. Place DPDT switch S1 in position A and adjust the TS-682A/GSM-1 for 2.0-volt ac indication on its panel meter.

c. Note the voltage indication on the ac voltmeter.

d. Place switch S1 in position B.

e. On the TS-656/U, position the TEST switch up and adjust the INCREASE/DECREASE control for an indication on the ac voltmeter identical with that obtained in *c* above. The indication on the TS-656/U meter should agree within 3 percent, of the TS-682A/GSM-1 indication obtained in *b* above.

f. Repeat the procedures give in *a* through *e* above, using the TS-656/U VOLTAGE switch settings given below and setting the TS-682A/ GSM-1 to the ac voltage indicated below. Adjust the ac voltage for on-scale meter indications (ac) and connect the TS-682A/GSM-1 voltage test cord plug to the proper jack for the ac output voltage.

TS-656/U CURRENT switch setting	TS-682A/GSM-1 ac voltage indication
5V	4
10V	8
25V	20
50V	40
100V	80
250V	200
500V	400

Page 41, appendix. Add the following references to the appendix:

TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TM 11-2535B	Meter Test Set TS-682A/GSAM-1.
TM 11-5527	Multimeters TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-6625-320-12	Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Volt-meters, Electronic ME-30B/U, ME-30C/U, and ME-30E/U.
TM 38-750	Army Equipment Record Procedures.

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
7'he Adjutant General.

Distribution:

Active Army:

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USCONARC (2)
USAMC (2)
USAMICOM (2)
USAECOM (27)
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ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (2)
USASNMC (3)
USACDCEC (10)
USACDCCEA (1)
USACDCCEA (Ft Huachuca) (1)
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SAAD (6)
TOAD (6)
LEAD (7)
FTWOAD (5)
SHAD (3)
NAAD (5)
CHAD (1)
SVAD (5)
Gen Dep (1)
Sig Sec, Gen Dep (4)
Sig Dep (6)
USACRREL (2)
Sig FLDMS (1)
Units organized under following TOE's: 2 ea.

11-155	11-587
11-157	11-592
11-158	11-597

NG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 320-50.

Technical Manual

No. 11-6625-226-35

HEADQUARTER
DEPARTMENT OF THE ARPY
WASHINGTON 25, D. C., *1 September 1961*

TEST SET, ELECTRICAL METER TS-656/U

CHAPTER 1
THEORY

Section I. BLOCK DIAGRAM ANALYSIS

1. Scope

a. This manual covers field and depot maintenance for Test Set, Electrical Meter TS-656/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 paragraphs 2 through 8.

b. Operation and Organizational Maintenance for this equipment is included in TM 11-6625-226-12.

c. Forward comments concerning this manual to the, Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: SIGMS-PA2d, Fort Monmouth, N.J.

Note
For applicable forms and records, see paragraph 2, TM 11-6625-226-12.

2. DC VOLTS Circuit Block Diagram Analysis (fig. 1)

a. Input Circuit. The input power (115 volts, 60 cycles per second (cps)) is applied to ON-OFF switch S4. With ON-OFF switch S4 in the OFF position, the alternating current (ac) power is applied to the heater. The heater maintains the internal components of the tester at a constant temperature and keeps the humidity low when the tester is in the standby condition (connected to power, but not being operated). With ON-OFF switch S4 in the ON position, the heater is disconnected and the input power is applied to variable transformer T2. The output power of variable transformer T2 (variable from 0 to approximately 115 volts ac) is applied to power transformer T1.

b. Dc Voltage Circuit. The ac output voltage of power transformer T1 is applied to the bridge rectifier which consists of diodes CR3 through' CR10. The rectified output of the bridge rectifier is filtered and then applied to the voltage divider which consists of resistors R6 through R11. The direct current (dc) voltage output range is selected from the voltage divider by VOLTAGE range switch S1 and then applied to the output jacks and to meter M1. The desired dc voltage output is obtained by the adjustment of variable transformer T2. This action adjusts the input voltage to power transformer T1 and, in turn, the voltage applied to the voltage divider, the output jacks, and meter M1.

3. DIR CUR Circuit Block Diagram Analysis (fig. 2)

a. Input Circuit. The input circuit for the DIR CUR circuit is the same as that for the DC VOLTS circuit (para 2a).

b. Dc Current Circuit. The ac output voltage of power transformer T1 is applied to the rectifier which consists of diodes CR1 and CR2. The rectified output current of diodes CR1 and CR2 is filtered and then applied to current-limiting resistors R41 through R53. The current-limiting resistors determine the *maximum* dc current available at the output jacks. From the current-limiting resistors, the dc current is applied to sections A and B of CURRENT range switch S5. CURRENT range switch S5 selects the dc current output range and arranges the shunt and multiplier resistors for that range and for meter M1. Meter M1 indicates the value of the dc current output. The desired dc current output is obtained by the adjustment of variable transformer T2. This action adjusts the input voltage to power transformer T1 and, in turn, the current flow through the current-limiting resistors, the output jacks, and meter M1.

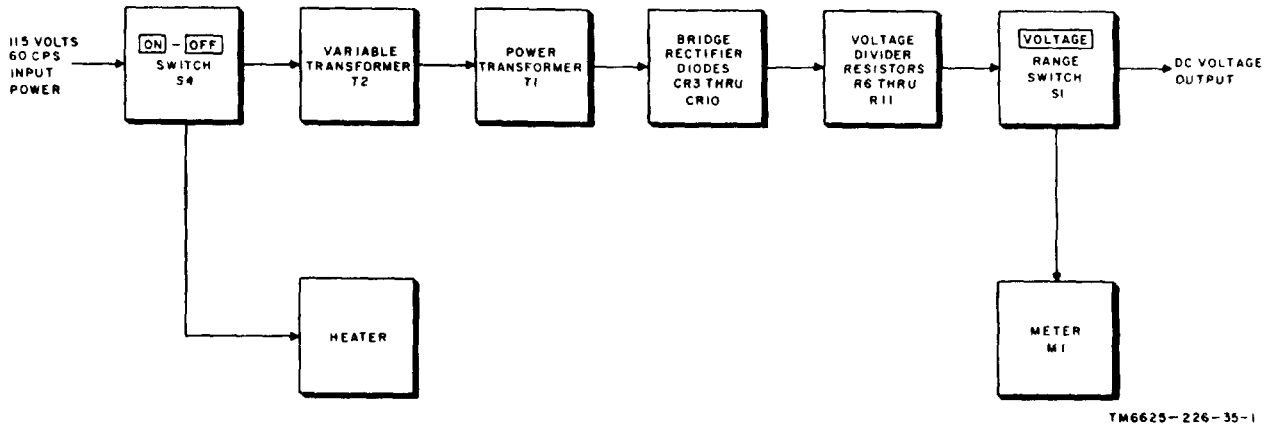


Figure 1. DC VOLTS circuit, block diagram.

4. AC VOLTS Circuit Block Diagram Analysis (fig. 3)

a. Input Circuit. The input circuit for the AC VOLTS circuit is the same as that for the DC VOLTS Circuit (para 2a).

b. Ac Voltage Circuit. The ac voltage output range of power transformer T1 is selected by section A of VOLTAGE range switch S1 and applied directly to the tester output jacks. The meter rectifier, which consists of diodes CR11 through CR14, rectifies a portion of the output voltage of power transformer T1 and applies the resultant dc voltage to meter M1. Meter M1 is calibrated so that it indicates the ac voltage output. The desired ac voltage output is obtained by the adjustment of variable transformer T2. This action adjusts the input voltage to power transformer T1 and, in turn, the ac voltage selected by section A of VOLTAGE range switch S1.

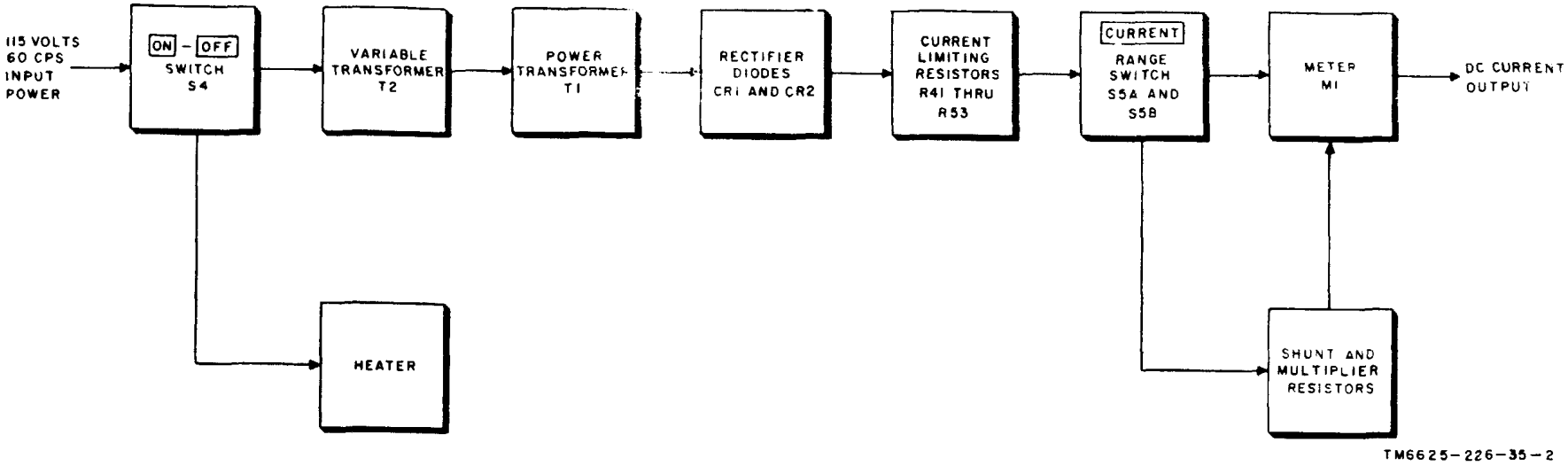


Figure 2. DIR CUR circuit, block diagram.

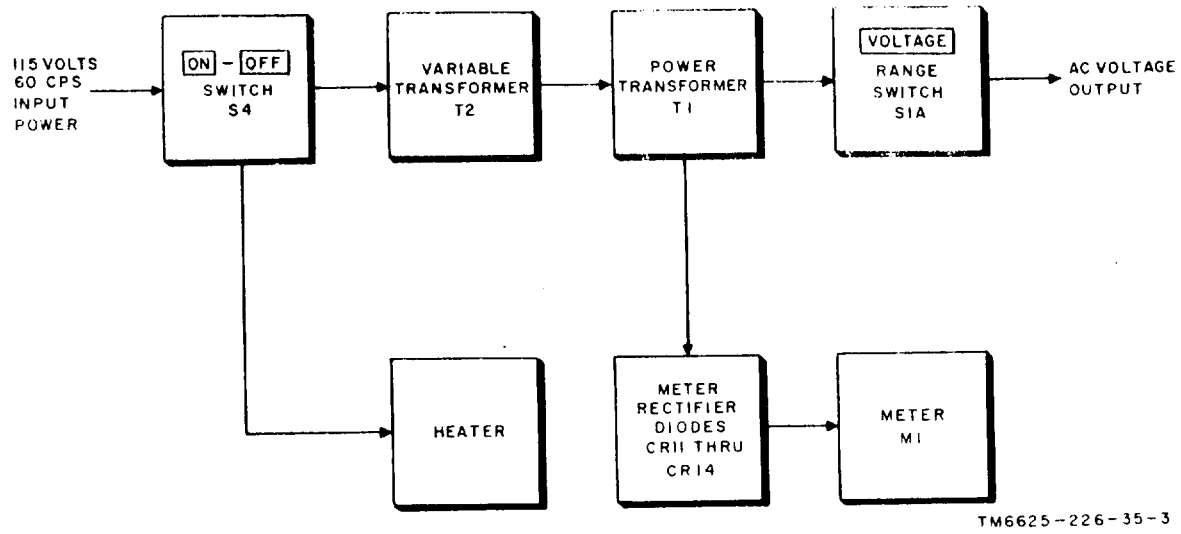


Figure 3. AC VOLTS circuit, block diagram.

Section II. DETAILED CIRCUIT ANALYSIS

5. Power Input Circuit Analysis (fig. 4)

a. Ac power (115 volts, 60 cps) is connected to input receptacle P1 and applied through fuse F2 and fuse F3 to ON-OFF switch S4.

(1) With ON-OFF switch S4 in the OFF position, power is applied to HEATER indicator DS2 and to resistors R27 andR28. Resistors R27 and R28 (10 watts each) dissipate enough heat to maintain the interior of the tester at a temperature that is sufficient to remove any humidity that may be present.

(2) With ON-OFF switch S4 in the ON position, power is removed from the heater circuit ((1) above) and applied to POWER indicator DS1 and variable transformer T2.

(3) Fuses F2 and F3 are line fuses that protect the tester from an overload.

b. Variable transformer T2 is the DECREASE-INCREASE control and has a range from 0 to approximately 115 volts ac.

(1) When moved in the DECREASE direction, variable transformer T2 decreases the amount of ac voltage applied to the primary of power transformer T1.

(2) When moved in the INCREASE direction, variable transformer T2 increases the amount of ac voltage applied to the primary of power transformer T1.

6. DC VOLTS Circuit Analysis (fig. 5)

The DC VOLTS circuits of the tester supply an output from 0 to 500 volts dc.

a. Power is applied to the primary of power transformer T1 from variable transformer T2 (para 5*b*). Power transformer T1 has a multitap secondary winding of which four taps (0, 100, 200, and 400) are used for the DC VOLTS circuits. Section B of VOLTAGE range switch S1 selects the desired secondary tap (range) and FUNCTION switch S2 connects the selected secondary tap to the bridge rectifier (diodes CR3 through CR10).

(1) When VOLTAGE range switch S1 is in the 2.5V, 5V, 10V, 25V, or 100V position, the 100-volt tap of power transformer T1 is connected to the bridge rectifier.

(2) When VOLTAGE range switch S1 is in the 250V position, the 200-volt tap of power transformer T1 is connected to the bridge rectifier; when VOLTAGE range switch S1 is in the 500V position, the 400-volt tap is connected to the bridge rectifier.

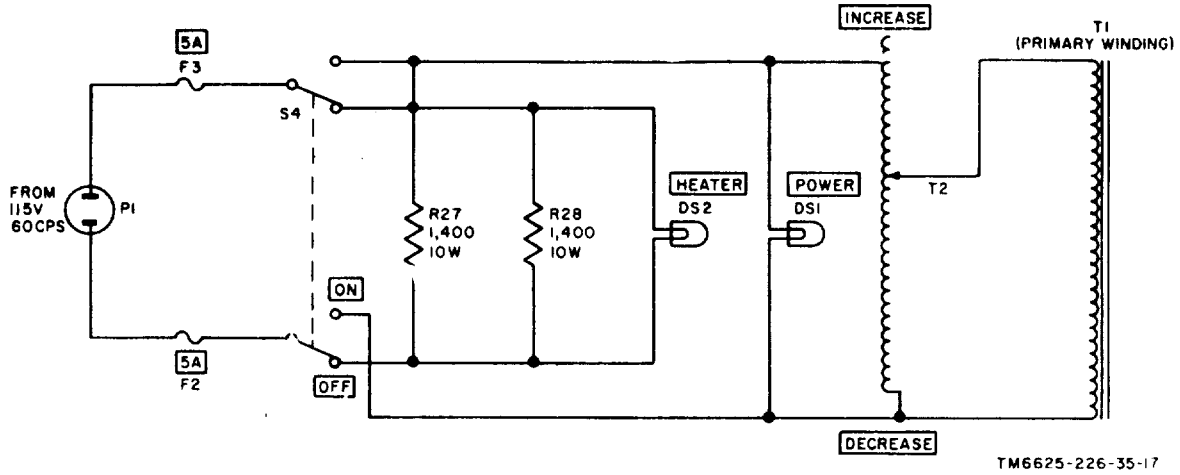


Figure 4. Tester power input circuit, partial schematic diagram.

(3) After rectification by the bridge rectifier, capacitors C3 through C6, and inductor L1 provide the necessary filtering. Each of the electrolytic capacitors (C3 through C6) is shunted by a resistor. These resistors (R2 through R5) help to keep the voltage across the capacitors equal.

(4) Fuse F1 in the common lead (0 tap) of power transformer T1 protects the transformer from an overload. Fuse F1 is used in both the DC VOLTS circuit and in the AC VOLTS circuit.

(5) Two diodes are used in each leg of the bridge rectifier (CR3 through CR10) to keep the inverse voltage across each diode within safe limits when VOLTAGE range switch S1 is in the 500V position.

b. The output for a dc voltage range between 2.5 and 100 volts is taken from a voltage divider network consisting of resistors R6 through R11. In addition, resistors R6 through R11 also provide a current load to help maintain voltage regulation on the low-voltage ranges of the tester. The dc voltage ranges avail6 able from the voltage divider network are:

(1) 2.5 volts at the junction of resistors R10 and R11.

(2) 5 volts at the junction of resistors R9 and R10.

(3) 10 volts at the junction of resistors R8 and R9.

(4) 25 volts at the junction of resistors R7 and R8.

(5) 50 volts at the junction of resistors R6 and R7.

(6) 100 volts at the junction of resistor R6 and section C of VOLTAGE range switch S1.

(7) On the 250-volt range and on the 500-volt range, the entire voltage divider network is disconnected from the output of the filter, and the dc voltage output of the tester is taken directly from the filter.

c. In all positions of VOLTAGE range switch S1, the dc voltage output of the tester is applied to TEST switch S3.

(1) In the normal (down) position, TEST switch S3 disconnects the positive output from DC VOLTS jack J3, and meter M1 indicates the output voltage before a load is connected.

(2) In the TEST (up) position, TEST switch S3 connects the positive output to DC VOLTS jack J3, and meter M1 indicates the output voltage being applied to the load.

d. The metering circuit is connected across the dc voltage output of the tester, ;and meter M1 indicates the value of the dc voltage output.

(1) Resistors R12 through R18 are meter multiplier resistors. The required multiplier resistance is selected by section E of VOLTAGE range switch S1.

(2) Resistor R19 is in series with the resistance of meter M1. The two series resistance provide the basic dc voltmeter sensitivity of 2.5 volts at 100 microamperes.

(3) Resistor R20 and variable resistor R21 make up a shunt that is placed across both meter M1 and resistor R19 to change the circuit sensitivity to 1 milliampere. Variable resistor R21 is used to calibrate the metering circuit.

e. Variable transformer T2 permits continuous variation of the dc voltage output from 0 volt to the maximum voltage selected by VOLTAGE range switch S1. FUNCTION switch S2 provides the following circuit connections:

(1) Section S2A connects the common lead of power transformer T1 to the junction of diodes CR8 and CR9 of the bridge rectifier.

(2) Section S2B connects section B of VOLTAGE range switch S1 to the junction of diodes CR4 and CR5 of the bridge rectifier.

(3) Section S2C connects the negative output of the bridge rectifier to.

COMMON jack J4.

(4) Section S2D connects the negative terminal of meter M1 to COMMON jack J4.

(5) Section S2E connects the positive terminal of meter M1 to voltage-dropping resistor R19.

7. DIR CUR Circuit Analysis (fig. 6)

The DIR CUR circuits of the tester supply at output of from 0 to 1 ampere.

a. Power is applied to the primary of power transformer T1 from variable transformer T2 (para 5*b*). The dc current circuits of the tester obtain their power from a separate secondary winding on power transformer T1. The full-wave rectifier (diodes CR1 and CR2) rectifies the ac output of power transformer T1. Capacitors C1 and C2 and inductor L1 provide the necessary filtering. Resistor R1 is a bleeder resistor.

b. Resistors R41 through R53 are current-limiting resistors that limit the current in each range to protect meter M1 and diodes CR1 and CR2. Section C of CURRENT range switch S5 selects the required limiting resistor for each current range. The current-limiting resistors (R41 through R53) are connected to the meter shunt and the meter multiplier resistors (R29 through R40) as follows:

(1) When CURRENT rangeswitchS5is in the 1AMP position, resistor R40 is the meter shunt resistor, while resistors R29 through R39 and variable resistor R23 are the meter multiplier resistors. Thus, the output current flowing through resistor R40 produces a voltage drop (in the millivolt region) which is proportional to the output and is measured by meter M1.

(2) For other ranges of CURRENT range switch S5, the type of circuit is the same, except that the meter shunt and the meter multiplier resistors change. For example, with CURRENT range switch S5 in the 500MA position, resistors R39 and R40 are the meter shunt resistors, while resistors R29 through R38 and variable resistor R23 are the meter multiplier resistors.

c. In all positions of CURRENT range switch S5, the dc current output of the tester is applied to TEST switch S3.

(1) In the normal (down) position, TEST switch S3 shorts DIR CUR jack J2 to COMMON jack J4. This shorting permits meter M1 to indicate the output current before a load is connected.

(2) In the TEST (up) position, TEST switch S3 removes the short circuit, dc current is delivered to the load, and meter M1 indicates the value of this dc current.

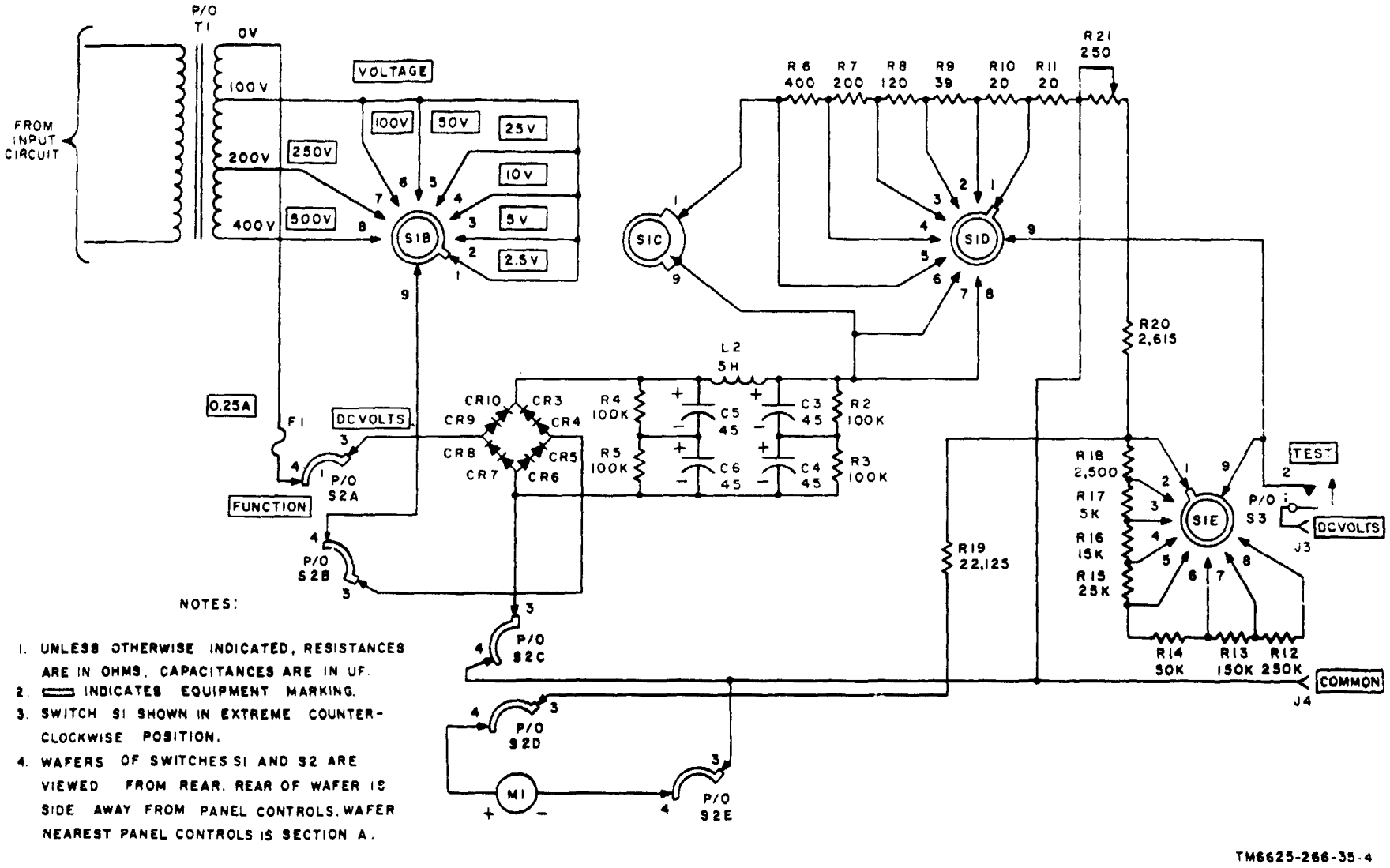


Figure 5. DC VOLTS circuits, schematic diagram.

d. The metering circuit is connected in series with the dc current output of the tester, and meter M1 indicates the value of the dc current output.

(1) On the 100MICRO-AMP range, the shunt and multiplier resistors are not used. The dc current passes through limiting resistor R41, variable resistor R23, and meter M1.

(2) Variable resistor R23 compensates for resistance errors (tolerances) in resistors R29 through R40 and in meter M1. In addition, the moving coil of meter M1 is temperature compensated by a thermistor (not shown).

Note. Variable resistor R3 has no effect in adjusting the metering circuit when CURRENT range switch S5 is in the 100-MICRO-AMP position.

e. Variable transformer T2 permits continuous variation of the dc current output from 0 ampere to the maximum current selected by CURRENT range switch S5. FUNCTION switch S2 provides the following connections:

(1) Section S2C connects the negative output of the full-wave rectifier to COMMON jack J4.

(2) Section S2D connects the positive terminal of meter M1 to variable resistor R23.

(3) Section S2E connects the negative terminal of meter M1 to DIR CUR jack J2.

8. AC VOLTS Circuit Analysis (fig. 7)

The AC VOLTS circuits of the tester supply an output of from 0 to 500 volts.

a. Power is applied to the primary of power transformer T1 from variable transformer T2 (para 5b). The ac voltage circuits obtain their power from nine taps of the multitap secondary winding. Section A of VOLTAGE range switch S1 selects the desired secondary tap (range) and applies its voltage to the output of the tester through TEST switch S3. The ac return path is from COMMON jack J4, through section A of FUNCTION switch S2, and then through fuse F1 to the 0-volt tap on the secondary of power transformer T1.

b. The metering circuit is connected across a portion of the output voltage and meter M1 is calibrated to indicate the value of the ac voltage output.

(1) The ac voltage output is always measured between the 0-volt tap and the 100V tap on the secondary of power transformer T1. The bridge rectifier (diodes CR11 through CR14) rectifies the ac voltage between these two taps.

(2) The dc voltage output of the rectifier is applied to meter M1.

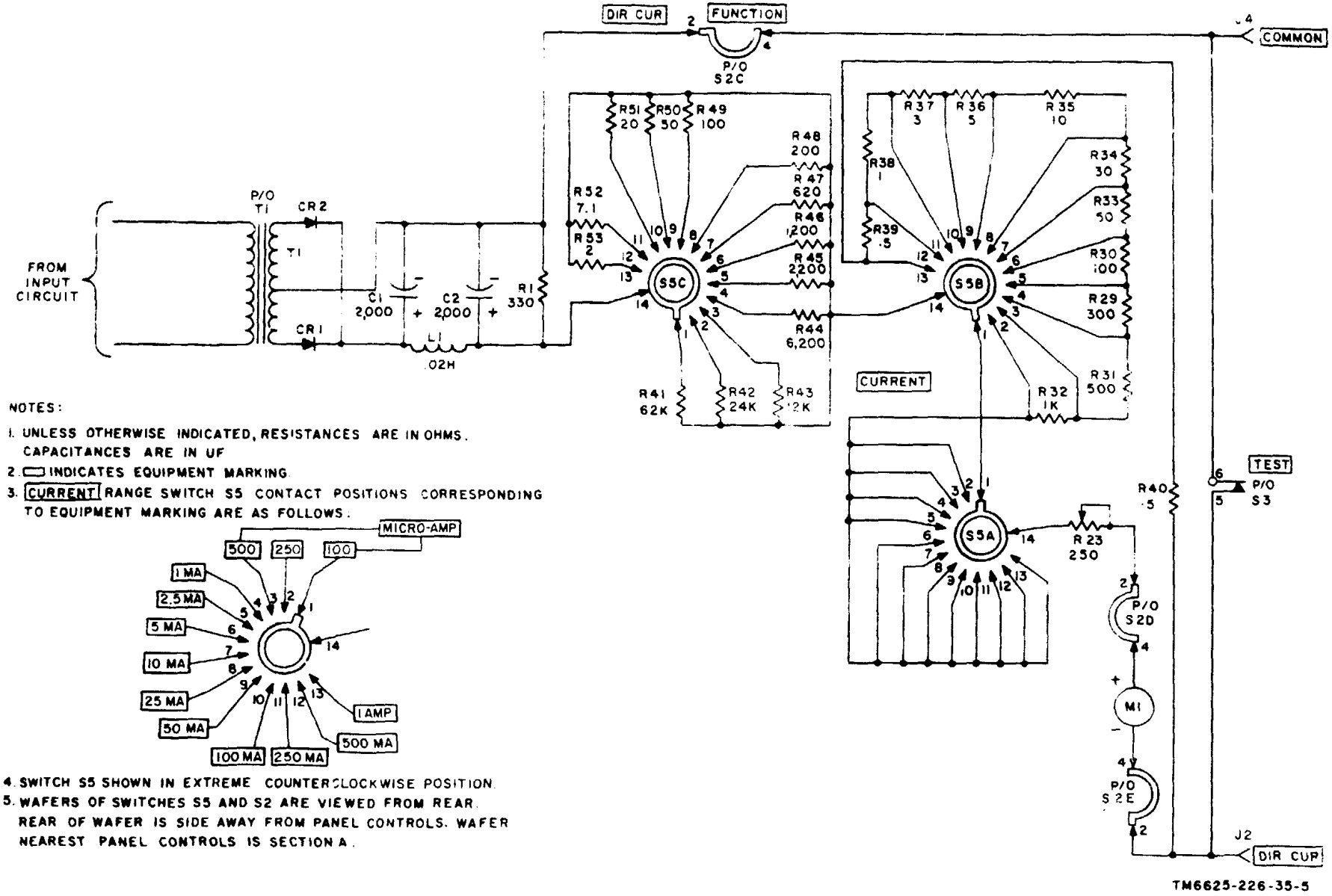
Although meter M1 is connected only between the 100V tap and the 0-volt tap, the meter scale is calibrated so that it indicates within each range as selected by VOLTAGE range switch S1.

(3) The accuracy of the ac voltage circuits depends on the accuracy of the number of secondary turns in power transformer T1. Therefore, replacement, repair and adjustments (para 19 through21) must be accomplished with precision-type instruments (para 18).

c. One side of the ac input to the bridge rectifier is connected by section C of FUNCTION switch S2 to COMMON jack J4. The other side of the ac input to the bridge rectifier is connected through multiplier resistor R22 to the 100V tap of power transformer T1. The dc output of the bridge rectifier is connected to meter M1 by sections D and E of FUNCTION switch S2. In addition, the de output of the rectifier is shunted by resistors R25 and R26 and variable resistor R24. These shunt resistors maintain the meter circuit sensitivity at 1 milliampere. Variable resistor R24 provides an adjustment that permits setting the current flow through the meter at 100 microamperes.

d. In all positions of VOLTAGE range switch S1, the ac voltage output of the tester is applied to TEST switch S3 (a above).

(1) In the normal (down) position, TEST switch S3 disconnects the positive output from AC VOLTS jack J1, and meter M1 indicates the ac voltage output before a load is connected.



NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS. CAPACITANCES ARE IN UF
2. ▭ INDICATES EQUIPMENT MARKING
3. CURRENT RANGE SWITCH S5 CONTACT POSITIONS CORRESPONDING TO EQUIPMENT MARKING ARE AS FOLLOWS:
4. SWITCH S5 SHOWN IN EXTREME COUNTERCLOCKWISE POSITION.
5. WAFERS OF SWITCHES S5 AND S2 ARE VIEWED FROM REAR. REAR OF WAFER IS SIDE AWAY FROM PANEL CONTROLS. WAFER NEAREST PANEL CONTROLS IS SECTION A.

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Figure 6. DIR CUR circuits, schematic diagram.

(2) In the TEST (up) position, TEST switch S3 connects the output to AC VOLTS jack J1, and meter M1 indicates the ac voltage output being applied to the load.

e. Variable transformer T2 permits continuous variation of the ac voltage output from 0 volt to the maximum voltage selected by VOLTAGE range switch S1.

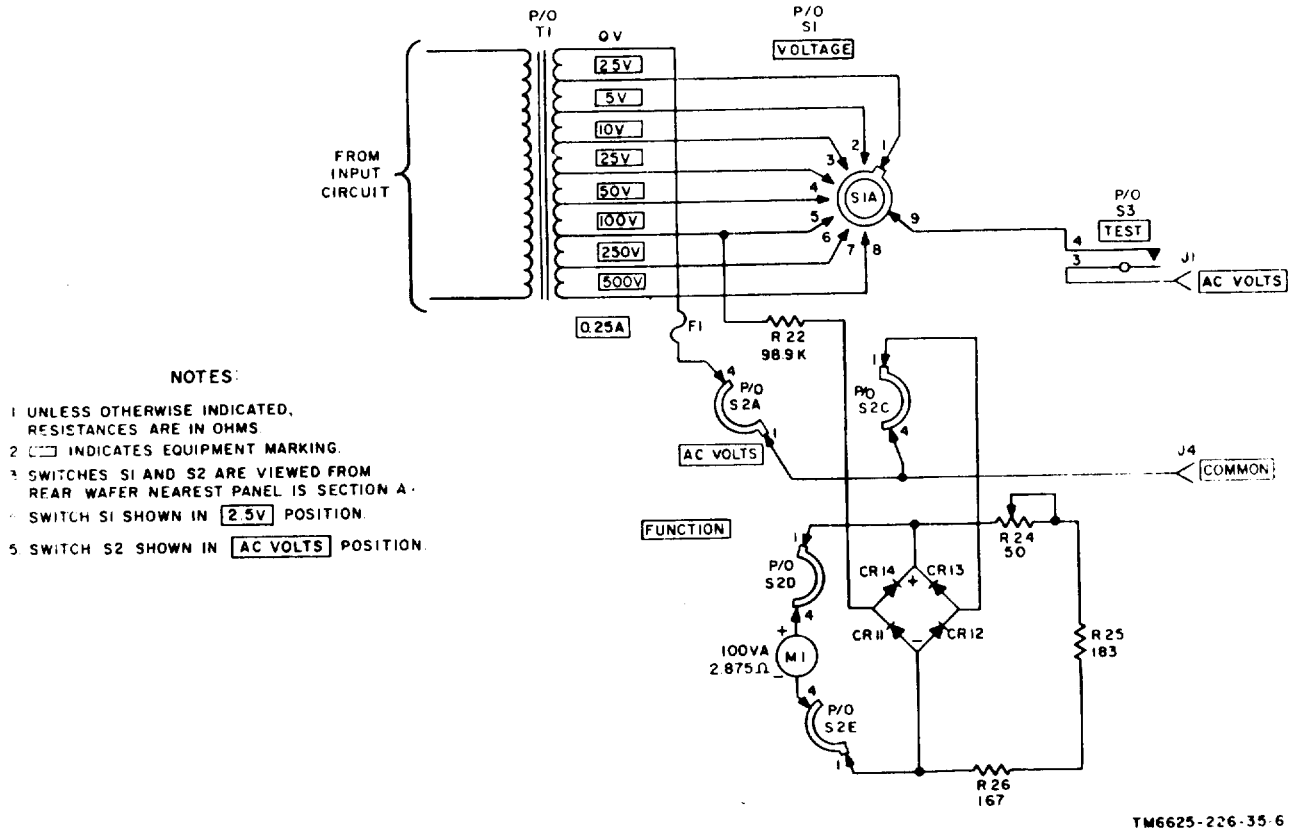

Figure 7. AC VOLTS circuits, schematic diagram.

CHAPTER 2
TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: Be extremely careful when troubleshooting the tester. Power transformer T1 develops voltages up to 500 volts ac. Death or injury could result if caution is not observed.

9. General Instructions

Troubleshooting at the field and depot maintenance level includes all the techniques outlined in TM 11-6625-226-12 and any special or additional techniques required to isolate a defective component. The field and depot maintenance procedures are not complete in themselves but must be supplemented by the procedures described in TM 11-6625-226-12. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks made at the organizational level, is completed by sectionalization, localization, and isolation checks made at the field and depot maintenance level.

10. Troubleshooting Procedures

a. General. The first step in servicing a defective tester is to sectionalize the fault. Sectionalization means tracing the fault to a major circuit. The second step is to localize the fault. Localization means tracing the fault to a defective subcircuit. The third step, isolation, means tracing the fault to a defective component. Some faults, such as burned-out resistors, and arcing and shorted transformers, can often be located by sight, smell, or hearing. The majority of faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. The tester consists of four major circuits: the power input circuit, the DC VOLTS circuit, the DIR CUR circuit, and the AC VOLTS circuit. The first step in tracing trouble is to locate the circuit or circuits at fault by the following methods:

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

(2) Operational tests. Operational tests frequently indicate the general location of trouble. In many instances, the tests will help to determine the exact nature of the fault. The equipment performance checklist (TM 11-6625-226-12) is a good operational test.

c. Localization and Isolation. The procedures below will aid in isolating the trouble. First, localize the trouble to a circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements.

(1) Resistance measurements. Resistance measurements will help to locate the individual component part at fault. Use the resistor color code (fig. 15) to find the value of a resistor. Use the resistance measurement data (para 14) to find normal indications, and compare these normal indications with the multimeter indications.

(2) Troubleshooting chart. The trouble symptoms listed in the chart (para 13c) will help to localize the 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 the tester. Check the wiring and connections of the tester (fig. 16 and 17).

11. Tools and Test Equipment Required

The following tools and test equipment are required to troubleshoot and repair the tester.

a. Tool Equipment TK-21/G.

b. Multimeter AN/URM-105 (Multimeter).

Section II. TROUBLESHOOTING TESTER

Caution: Do not attempt to repair, adjust, or replace parts before reading the instructions in paragraph 12 below.

12. Checking Tester

a. When to Repair. Repair the tester when one or more of the following conditions exist.

(1) New fuses burn out immediately.

(2) Meter M1 does not indicate on any function, even though output voltages and currents are available at the output jacks.

(3) Dc voltages are not present at the output jacks. Meter M1 may or may not indicate.

(4) Dc current is not present at the output jacks. Meter M1 mayor may not indicate.

(5) Ac voltages are not present at the output jacks. Meter M1 may or may not indicate.

(6) The accuracy of any or all ranges is less than that specified in paragraph 23, 24, or 25.

(7) Leakage resistance of less than 3 megohms exists from the case to DC VOLTS jack J3 with TEST switch S3 in the TEST (up) position.

Warning: When the above condition exists, the tester becomes a shock hazard because of electrolyte leakage from capacitors C3, C4, C5, or C6. Replace the defective capacitor. Be sure to clean the chassis.

b. Diagnosing Faults to a Circuit. The data in (1) through (7) below will aid in locating faulty circuits.

(1) Trouble in the DC VOLTS circuits (fig. 5) will affect the DIR CUR circuits (fig. 6) or the AC VOLI'S circuits (fig. 7). The same is true for the other functions with respect to the other outputs.

(2) Blown fuses F2 and F3 and/or defective switches S3 and S4, variable transformer T2, power transformer T1, or meter M1, will cause all circuits to be inoperative, (3) Continual blowing of fuses F2 and F3 indicates a possible short in variable transformer T2, power transformer T1, capacitor C1 or C2, or rectifier CR1 or CR2.

(4) Continual blowing of fuse Fl indicates possible defective rectifier diodes CR3 through CR10 or capacitors C3 through C6.

(5) A defective TEST switch (S3) can eliminate all voltages and currents at the output jacks. In this case, meter M1 will indicate on all voltage ranges and may or may not indicate on dc current ranges.

(6) Meter M1 may be defective when output voltages and currents are present at the output jacks and meter M1 does not indicate, or when all functions and ranges have the same error (5 percent or greater (para 24)).

(7) Slight errors in all ranges within a particular function can be corrected by adjustment of variable resistor R21 for the DC VOLTS circuits (fig. 5), variable resistor R23 for the DIR CUR circuits (fig. 6), or variable 'resistor R24 for the AC VOLTS circuits (fig. 7).

Caution: Do not readjust the tester unless the accuracy of the standardizing equipment is known and is at least twice the accuracy of the tester. Do not adjust the AC VOLTS circuits if the applied voltage to the tester has a waveform error greater than 1 percent, especially when magnetic regulators are used ahead of the tester.

13. Troubleshooting Chart

a. General. If the proper results are not obtained by performing the procedures in the equipment performance checklist (TM 11-6625-226-12), the trouble should be localized to an individual circuit. One or more of the localizing procedures will be necessary, depending on the nature of the operational symptoms. For parts location, refer to figures 8 through 11.

b. Use of Chart. The troubleshooting chart (c below) is designed to supplement the equipment performance checklist (TM 11-6625-226-12). If operational symptoms are not known, begin at item 1 of the equipment performance checklist and proceed as directed.

c. Chart. Before checking any of the symptoms listed in items 13 through 23, be sure to read the note following item 12.

Item	Symptom	Probable trouble	Correction
1	No output from tester for any position of FUNCTION switch S2; POWER indicator DS1 does not light.	ON-OFF switch S4 defective	Replace ON-OFF switch S4 (fig. 16 and 17).
2	No output from tester for any position of FUNCTION switch S2; POWER indicator DS1 lights.	a. Power transformer T1 defective.	a. Check power transformer T1 (para 14c) and replace if necessary (fig. 9).
		b. Variable transformer T2 defective.	b. Check variable transformer T2 (para 14c) and replace if necessary (fig. 8 and 10).
3	Meter M1 indicates 0 volt, or does not indicate correct output regardless of position of FUNCTION switch S2, VOLTAGE range switch S1 or CURRENT switch S5	Meter M1 defective	Replace meter M1 (fig. 8, 16, and 17)
4	Function switch S2 set To DC VOLTS. No output, or low output, for every position of VOLTAGE range switch S1	a. Rectifier circuit defective (diodes CR3 through CR10).	a. Check diodes CR3 through CR10 (para 14a) and replace as necessary (fig. 9).
		b. Filter circuit defective (capacitors C3 through C6, resistors R2 through R5, and inductor L2).	b. Check capacitors C3 through C6 (para 14b), resistors R2 through R5 (fig. 16), and inductor L2 (para 14c); replace defective component (fig. 9).
5	FUNCTION switch S2 set to DC VOLTS. No output from tester when VOLTAGE range switch Si is set to:		
	a. 2.5V, 5V, 10V, 25V, or 50V	a. Resistor R6 open	a. Replace resistor R6 (fig. 11, 16, and 17).
	b. 2. 5V, 5V, 10V, or 25V	b. Resistor R7 open	b. Replace resistor R7.
	c. 2.5V, 5V, or 10V	c. Resistor R8 open	c. Replace resistor R8.
	d. 2.5V or 5V	d. Resistor R9 open	d. Replace resistor R9.
	e. 2. 5V	e. Resistor R10 open	e. Replace resistor R10.
6	FUNCTION switch S2 set to DC VOLTS. Meter M1 indicates approximately 100 volts when VOLTAGE range switch S1 is set to 2.5V.	Resistor R11 open	Replace resistor R11.
7	FUNCTION switch S2 set to DC VOLTS; dc voltage available at output of tester. Meter M1 indicates 0 volt when VOLTAGE range switch S1 is set to:		
	a. 500V	a. Resistor R12 open	a. Replace resistor R12 (fig 11, 16, and 17).

Item	Symptom	Probable trouble	Correction
	b. 500V or 250V	b. Resistor R13 open	b. Replace resistor R13.
	c. 500V, 250V, or 100V	c. Resistor R14 open	c. Replace resistor R14.
	d. 500V, 250V, 100V, or 50V	d. Resistor R15 open	d. Replace resistor R15.
	e. 500V, 250V, 100V, 50V, or 25V	e. Resistor R16 open	e. Replace resistor R16.
	f. 500V, 250V, 100V, 50V, 25V, or 01V	f. Resistor R17 open	f. Replace resistor R17.
	g. 500V, 250V, 100V, 50V, 25V, 10V, or 5V.	g. Resistor R18 open	g. Replace resistor R18.
	h. 500V, 250V, 100V, 50V, 25V, 10V, 5V, or 2.5V.	h. Resistor R19 open	h. Replace resistor R19.
8	FUNCTION switch S2 set to DC VOLTS; dc voltage available at output of tester. Meter M1 indicates erroneous voltage value (other than 0 volt) when VOLTAGE range switch S1 is set to:		
	a. 500V	a. Resistor R12 shorted	a. Replace resistor R12 (fig. 11, 16, and 17).
	b. 500V or 250V	b. Resistor R13 shorted	b. Replace resistor R13.
	c. 500V, 250V, or 100V	c. Resistor R14 shorted	c. Replace resistor R14.
	d. 500V, 250V, 100V, or 50V	d. Resistor RI5 shorted	d. Replace resistor R15.
	e. 500V, 250V, 100V, 50V, or 25V	e. Resistor R16 shorted	e. Replace resistor R16.
	f. 500V, 250V, 100V, 50V, 25V, or 10V	f. Resistor R17 shorted	f. Replace resistor R17.
	g. 500V, 250V, 100V, 50V, 25V, 01V, or 5V.	g. Resistor R18 shorted	g. Replace resistor R18.
	h. 500V, 250V, 100V, 50V, 25V, 100V, 5V, or 2. 5V.	h. Resistor R19 shorted	h. Replace resistor R19.
9	FUNCTION switch S2 set to DC VOLTS; dc voltage available at output of tester. Meter M1pegson all ranges of VOLTAGE range switch S1.	a. Resistor R20 open	a. Replace resistor R20. (fig. 11, 16, and 17) and readjust dc voltage circuit (para 19).
		b. Variable resistor R21 open	b. Replace variable resistor R21 (fig. 9, 16, and 17) and readjust dc voltage circuit.
10	FUNCTION switch S2 set to DC VOLTS; meter M1 indicates voltage for all positions of VOLTAGE range switch S1. Dc voltage not available at output of tester.	TEST switch S3 defective	Replace TEST switch S3 (fig. 8, 10, 16, and 17).
11	FUNCTION switch S2 set to DIR CUR. No output, or low output, for every position of CURRENT range switch S5.	a. Rectifier circuit defective (diodes CR1 and CR2).	a. Check diodes CR1 and CR2 (para 14a) and replace as necessary (fig. 9, 16, and 17).
		b. Filter circuit defective (capacitors C1 and C2, resistor R1, and inductor L1).	b. Check capacitors C1 and C2 (para 14b), resistor R1 (para 14d), and inductor L1 (para 14c); replace defective component (fig. 9, 16, and 17).
12	FUNCTION switch S2 set to DIR CUR. No output from tester, and meter M1 indicates 0 ampere when CURRENT range switch S5 is set to:		
	a. 100MICRO-AMP	a. Resistor R41 open	a. Replace resistor R41 (fig. 11, 16, and 17).
	b. 250MICRO-AMP	b. Resistor R42 open	b. Replace resistor R42.
	c. 500MICRO-A MP	c. Resistor R43 open	c. Replace resistor R43.
	d. 1MA	d. Resistor R44 open	d. Replace resistor R44.
	e. 2.5MA	e. Resistor R45 open	e. Replace resistor R45.
	f. MA	f. Resistor R46 open	f. Replace resistor R46.
	g. 10MA	g. Resistor R47 open	g. Replace resistor R47.
	h. 25MA	h. Resistor R48 open	h. Replace resistor R48.
	i. 50MA	i. Resistor R49 open	i. Replace resistor R49.
	j. 100MA	j. Resistor R50 open	j. Replace resistor R50.
	k. 250MA .	k. Resistor R51 open	k. Replace resistor R51.
	l. 500MA	l. Resistor R52 open	l. Replace resistor R52.
	m. 1AMP	m. Resistor R53 open	m. Replace resistor R53.

Item	Symptom	Probable trouble	Correction
	Note. in items 13 through 23 below, FUNCTION with S2 is set to DIR CUR, dc current is available at output of tester, and meter M1 indicates normally when CURRENT range switch S5 in set to 100MICRO-AMP or 250MICRO-AMP position.		
13	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 500MICRO-AMP, 1MA, 2.5MA, 5MA, 10MA, 25MA, 50MA, 100MA, 250MA, 500MA, or 1AMP;	Resistor R32 open	Replace resistor R32 (fig. 11, 16, and 17).
14	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 1MA, 2.5MA, 5MA, 10MA, 25MA, 50MA, 100MA, 250MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP position.	Resistor R-31 open	Replace resistor R31.
15	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 2.5MA, 5MA, 10MA, 25MA, 50MA, 100MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP and 1MA.	Resistor R29 open	Replace resistor R29.
16	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 5MA, 10MA, 25MA, 50MA, 100MA, 250MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP, 1MA, and 2.5MA.	Resistor R30 open	Replace resistor R30.
17	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 10MA, 25MA, 50MA, 100MA, 250MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP, 1MA, 2.5MA, and 5MA.	Resistor R33 open	Replace resistor R33.
18	Meter indicates 0 ampere with CURRENT range switch S5 set to 25MA, 50MA, 100MA, 250MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP, 1MA, 2.5MA, 5MA, and 10MA.	Resistor R34 open	Replace resistor R34.
19	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 50MA, 100MA, 250MA, 500MA, or 1AMP; indication Is high for 500MICRO-AMP, 1MA, 2.5MA, 5MA, 10MA, and 25MA.	Resistor R35 open	Replace resistor R35.
20	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 100MA, 250MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP, 1MA, 2.5MA, 5MA, 10MA, 25MA, and 50MA.	Resistor R36 open	Replace resistor R36.
21	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 250MA, 500MA, or 1AMP; indication is high for 500MICRO-AMP, 1MA, 2.5MA, 5MA, 10MA, 50MA, and 100MA.	Resistor R37 open	Replace resistor R37.
22	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 500MA or 1AMP; indication is high for 500MICRO-AMP, 1MA, 2.5MA, 5MA, 10MA, 25MA, 50MA, 100MA, and 250MA.	Resistor R38 open	Replace resistor R38.
23	Meter M1 indicates 0 ampere with CURRENT range switch S5 set to 1AMP; indication is high for	Resistor R39 open	Replace resistor R39.

Item	Symptom	Probable trouble	Correction
	500MICRO-AMP, 1MA, 2.5MA, 5MA, 10MA, 25MA, 50MA, 100MA, 250MA, and 500MA.		
24	FUNCTION switch S2 set to DIR CUR and CURRENT range switch S5 set to 1AMP. Meter M1 pegs and low dc current available at output of tester.	Resistor R40 open	Replace resistor R40.
25	FUNCTION switch S2 is set to DIR CUR. Dc. current available at output of tester for all positions of CURRENT range switch S5; meter M1 does not indicate.	Resistor R23 open	Replace resistor R23 (fig. 9, 16, and 17) and readjust DIR CUR circuit (para 20).
26	FUNCTION switch S2 set to DIR CUR. Meter M1 indicates correct current for all positions of CURRENT range switch S5; no dc current available at output of tester.	TEST switch S3 defective	Replace TEST switch S3 (fig. 8, 10, 16, and 17).
27	FUNCTION switch S2 set to AC VOLTS. Ac voltage available at output of tester for all positions of VOLTAGE range switch S1; meter M1 does not indicate for any range.	a. Resistor R22 open ..... b. Meter rectifier (diodes CR11 through CR14) defective.	a. Replace resistor R22 (fig. 16 and 17) and readjust AC VOLTS circuit (para 21), b. Check diodes CR11 through CR14 (para 14a) and replace as necessary (fig. 9, 16, and 17); readjust AC VOLTS circuit (para 21).
28	FUNCTION switch S2 set to AC VOLTS. Ac voltage available at output of tester for all positions of VOLTAGE range switch S1; meter indicates higher than normal for all ranges.	Resistor R24, R25, or R26 open.	Check for open resistor (fig. 16) and replace as necessary (fig. 16 and 17); readjust AC VOLTS circuit (para 21).
29	FUNCTION switch S2 set to AC VOLTS. Meter M1 indicates correct voltage for all positions of VOLTAGE range switch S1; no ac voltage available at output of tester.	TEST switch S3 defective	Replace TEST switch S3 (fig. 8, 10, 16, and 17).
30	Line cord connected to power source, and ON-OFF switch S4 set to OFF; HEATER indicator DS2 does not light and no heat is applied to internal components of tester.	ON-OFF switch S4 defective	Replace ON-OFF switch S4 (fig. 8, 10, 16, and 17).
31	Line cord connected to power source, and ON-OFF switch S4 set to OFF; HEATER indicator DS2 lights, but insufficient heat applied to internal components of tester.	a. Heater resistor R27 defective. b. Heater resistor R28 defective.	a. Replace resistor R27 (fig. 16 and 17). b. Replace resistor R28.

14. Additional Troubleshooting Data

a. Forward and Reverse Resistances of Diodes. The forward and reverse resistances of the diodes as measured with the multimeter are listed in the chart below.

Diode	Forward resistance (ohms)	Reverse resistance
CR1 and CR2 (1N253)	24	Above 10 megohms
CR3 through CRI0 (PTS40)	1,150	Above 10 megohms
CR11 through CR14 (1N66)	70	500,000 ohms

b. Electrolytic Capacitor Resistance Measurements. The chart below lists the resistance measurements for each electrolytic capacitor in the tester. The leakage resistances are measured with the capacitors disconnected. The resistance to chassis measurements is made with the capacitors connected in the circuit.

Caution: Be sure that the capacitors are filly discharged before making resistance measurements.

Capacitor	Leakage resistance (ohms)	Resistance to chassis (megohms)
C1	100,000 or greater	
C2	100,000 or greater	
C3	100,000 or greater	Above 3
C4	100,000 or greater	Above 3
C5	100,000 or greater	Above 3
C6	100,000 or greater	Above 3

c. Dc Resistance of Transformers and Inductors. The dc resistances of the transformer windings and of the inductors are listed below.

Transformer or inductor	Terminals	Resistance (ohms)
T1	Br A to Red A	4.2
	Orn A to Yel A	Less than 1
	Orn A to Grn A	Less than 1
	Blu A to Vio A	Less than 1
	Blu A to Gy A	Less than 1
	Blu A to Brn B	1.2
	Blu A to Red B	2.5
	Blu A to Orn B	5
	Blu A to Yel B	10
	Blu A to Grn B	20
	Blu A to Blu B	25
	Blu A to Vio B	42
	Blu A to Gy B	54
T2	2 to 4	1.9
L1		1.7
L2		150

d. Resistance Measurements. When measuring the value of a resistor, set up the tester as indicated in the appropriate procedure in (1), (2), or (3) below. These procedures eliminate the necessity for disconnecting a resistor or removing the instrument panel from the instrument frame. To measure the value of a resistor, remove the instrument from the case (para 16a(1)(a)), set the switches to the positions indicated, and make the measurement. Refer to figure 15 for resistor color code markings.

Note. The resistance of precision resistors R12 through R20, R22, R26, R26, and R29 through R40 cannot be accurately measured with the multimeter However, the multimeter can be used on these resistors to measure the approximate value.

(1) *DC VOLTS circuit*. If the resistor to be measured is in the DC VOLTS circuit, set FUNCTION switch S2 to the AC VOLTS position, and VOLTAGE range switch S1 to the 250V position.

(2) *DIR CUR circuit*. If the resistor to be measured is in the DIR CUR circuit, set FUNCTION switch S2 to the AC VOLTS position, CURRENT range switch S5 to the 100MICRO-AMP position, and TEST switch S3 to the TEST position.

(3) *AC VOLT circuit.* If the resistor to be measured is in the AC VOLTS circuit, set FUNCTION switch S2 to the DIR CUR position.

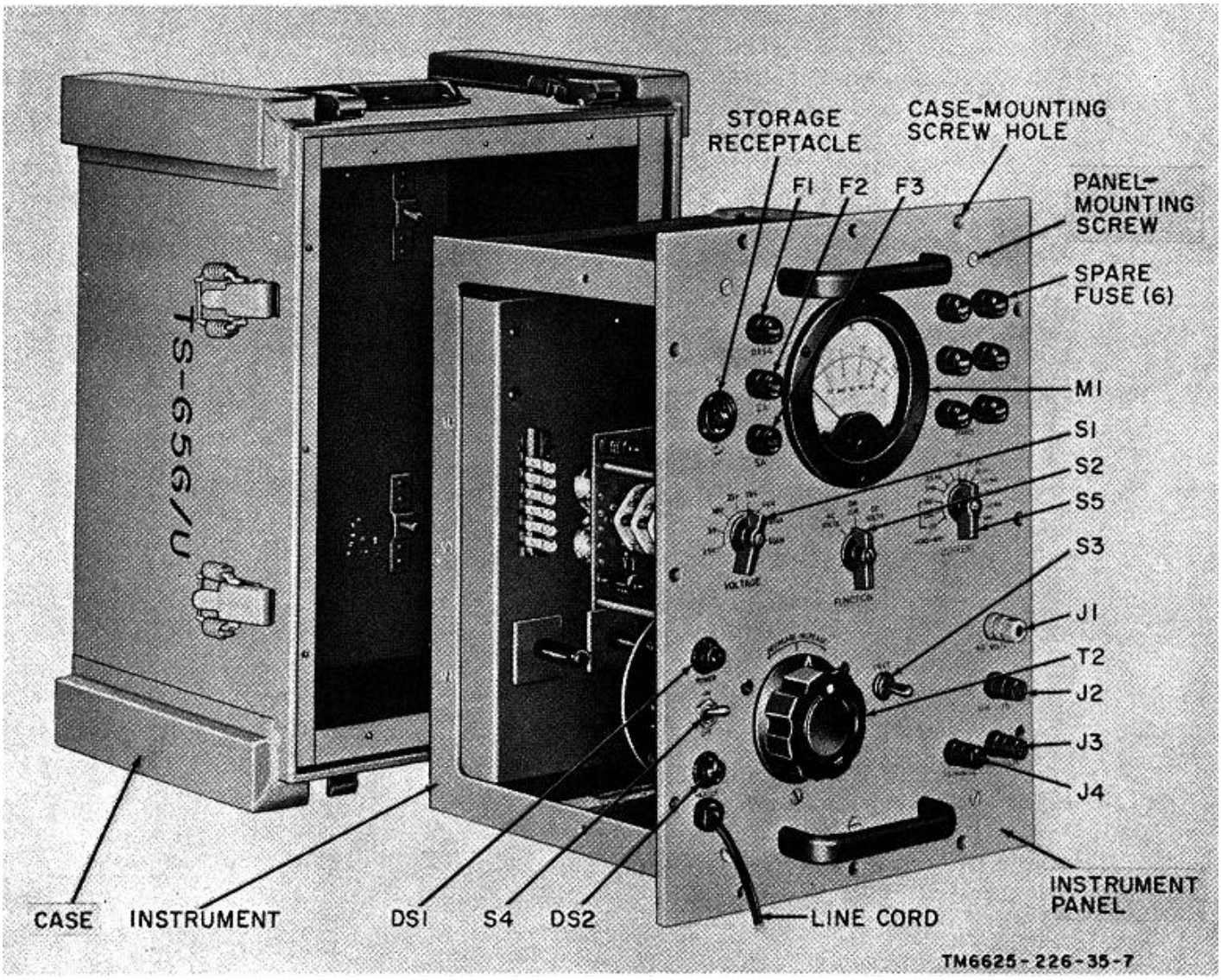

Figure 8. Tester separated from case.

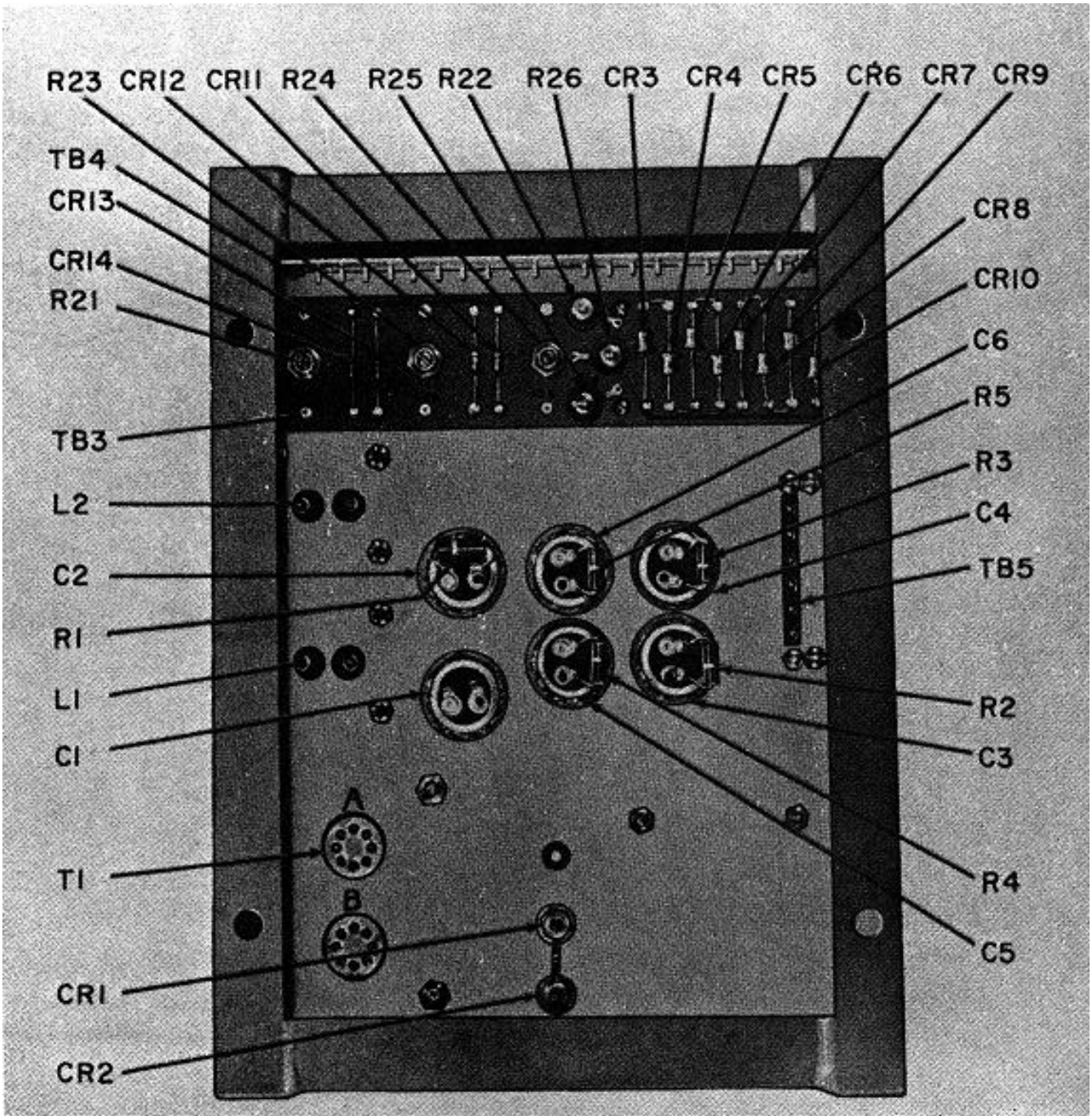

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Figure 9. Tester chassis, bottom view.

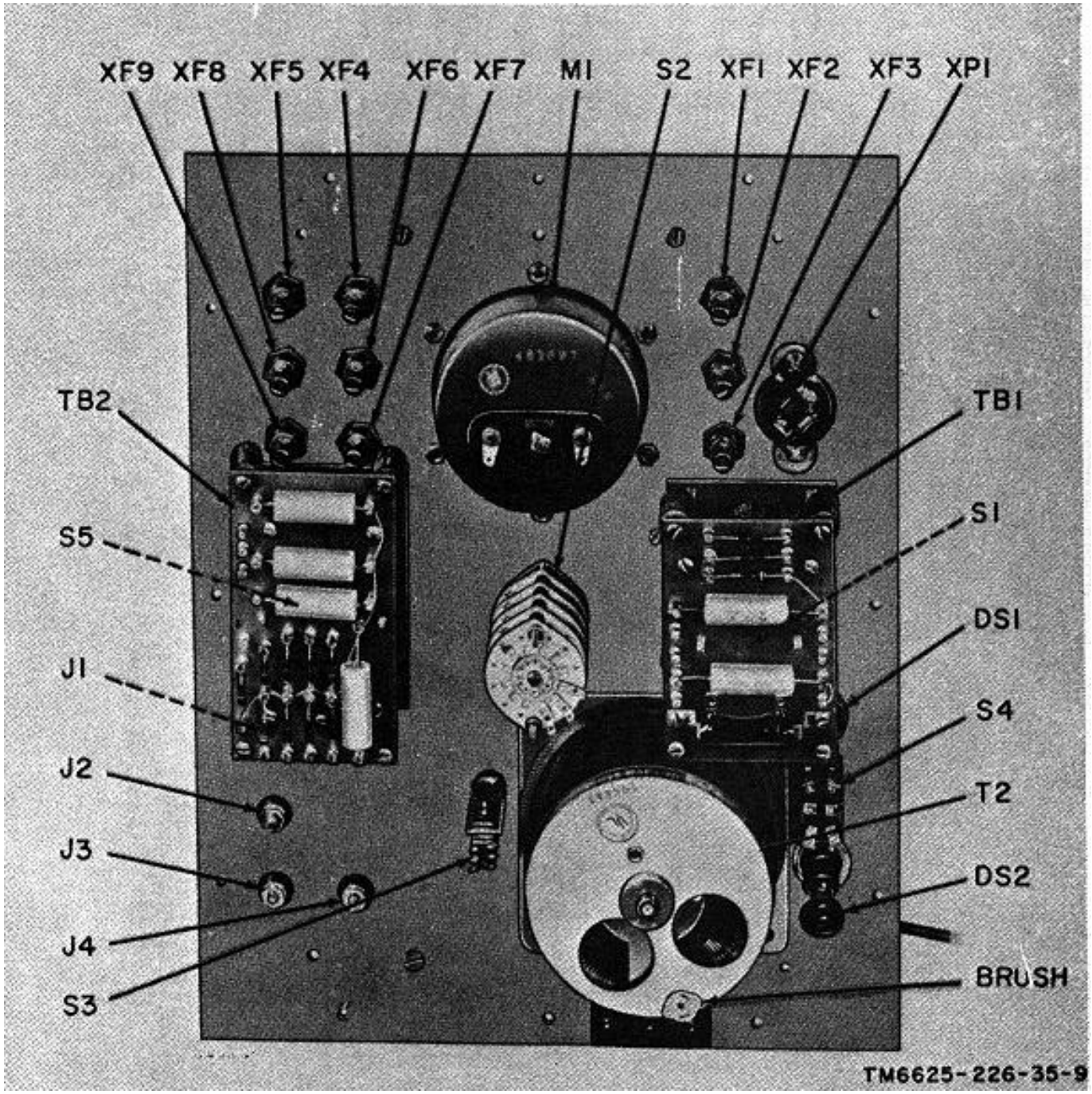

Figure 10. Tester instrument panel, rear view.

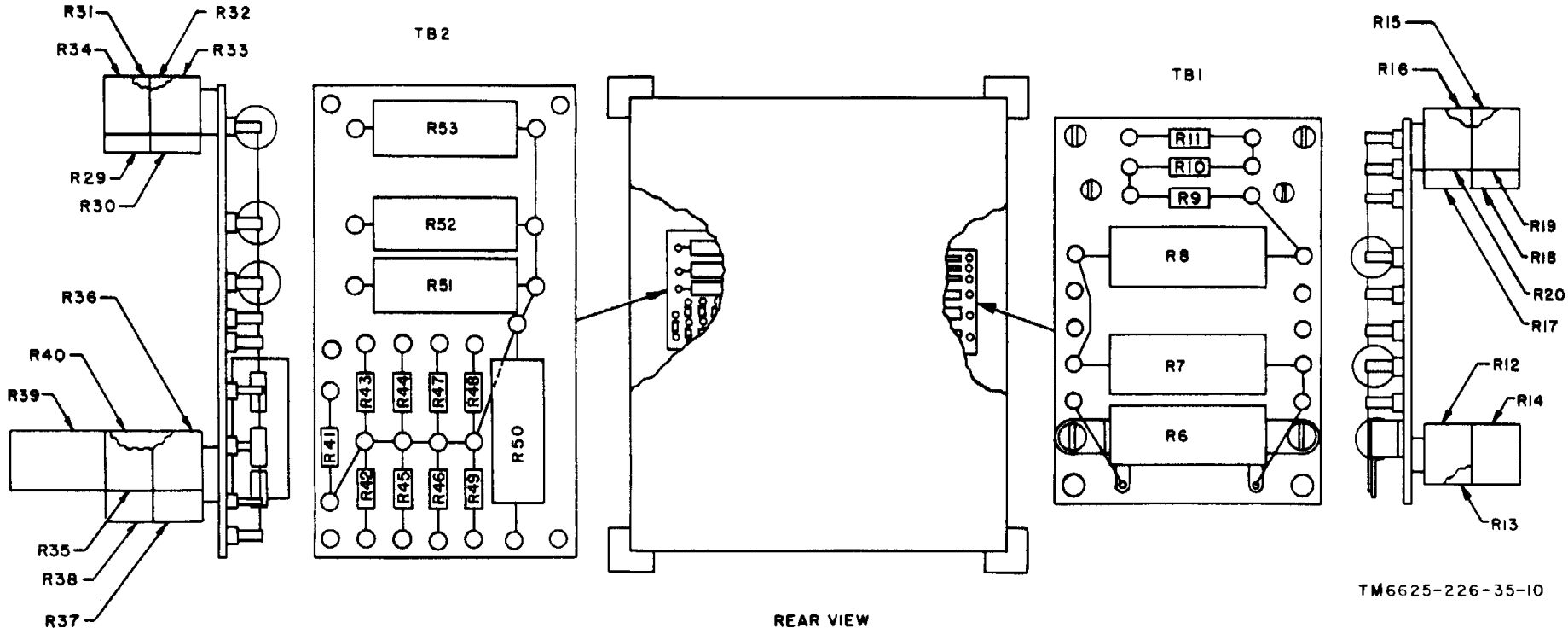

Figure 11. Tester chassis, showing location of terminal boards TB1 and TB2.

CHAPTER 3
REPAIRS AND ADJUSTMENTS

Section I. REPAIRS

15. General Repair Instructions

a. Most of the components of the tester can be replaced without any special procedures. Resistors on the terminal boards (fig. 11) are accessible when the case is removed. Special procedures that are required are given in paragraph 16.

b. The tools and test equipment required for repairing the tester are listed in paragraph 11.

16. Parts Replacement

a. Removal and Replacement of VOLTAGE Range Switch S1.

(1) Removal.

(a) Remove the 12 case-mounting screws and slide the instrument (fig. 8) out of the case.

(b) Disconnect the fanning strip from terminal board TB4 (fig. 9 and 17).

(c) Disconnect the fanning strip from terminal board TB5.

(d) Remove the six panel-mounting screws (fig. 8) and separate the instrument panel from the instrument frame.

(e) Tag and disconnect all wires connected to VOLTAGE range switch S1 (fig. 17).

(f) Remove the switch from the instrument panel (fig. 8 and 10).

(2) *Replacement*. To replace VOLTAGE range switch S1, reverse the procedures given in (1) above.

b. *Removal and Replacement of FUNCTION Switch S2*.

(1) *Removal*.

(a) Remove the instrument panel (a(1)(a) through (d) above).

(b) Tag and disconnect all wires attached to FUNCTION switch S2 (fig. 17).

(c) Remove the switch from the instrument panel (fig. 8 and 10).

(2) *Replacement.* To replace FUNCTION switch S2, reverse the procedures given in (1) above.

c. Removal and Replacement of CURRENT Range Switch S5.

(1) Removal.

(a) Remove the instrument panel (a(l)(a) through (d) above).

(b) Tag and disconnect all wires attached to CURRENT range switch S5 (fig. 17).

(c) Remove the switch from the instrument panel (fig. 8 and 10).

(2) *Replacement*. To replace CURRENT range switch S5, reverse the procedures given in (1) above.

Section II. ADJUSTMENTS

17. General Adjustment Instructions

a. After the tester has been repaired, adjustment may be required. Refer to procedures (1) through (4) below:

(1) Replacement of meter M1 will require all circuits (DC VOLTS, DIR CUR, and AC VOLTS) to be adjusted (para 19, 20, and 21).

(2) If resistor R20 or variable resistor R21 is replaced, the DC VOLTS circuit must be adjusted (para 19).

(3) If variable resistor R23 is replaced, the DIR CUR circuit must be adjusted (para 20).

(4) If resistor R6, R22, R25, variable resistor R24, or any one of diodes CR11 through CR14 is replaced, the AC VOLTS circuit must be adjusted (para 21).

b. If adjustment is required, remove the instrument from the case (para 16a(1)(a)) and proceed as directed.

Warning: All adjustments (para 19, 20, and 21) are made with power applied to the tester. Be extremely careful. Voltages as high as 500 volts are present internally. Death or injury could result if all safety precautions are not observed.

18. Tools and Test Equipment Required for Adjustments

The following chart lists the tools and test equipment required for adjustment of the tester.

Item	Common name
Standard cell, Weston model 4, or equal.	Standard cell
Potentiometer, Leeds and Northrup (L & N) type K-3, or equal.	Potentiometer
Shunt box, L & N catalogue No. 4385, or equal.	Shunt box
Volt box, L & N catalogue No. 7592, or equal.	Volt box
Galvanometer, L & N catalogue No. 2420C. or equal.	Galvanometer
Ac-dc voltmeter, Weston No. 341, or equal (0-150).	Dynamometer
Tool Equipment TK-21/G	----------
Battery, dry-cell, 1-1/2-volt (2 each).	Battery

19. DC VOLTS Circuit Adjustment

a. Connect the tester to the test equipment as shown in figure 12. Set the FUNCTION switch on the tester to DC VOLTS and the VOLTAGE range switch to 100V.

b. Standardize the potentiometer current as follows:

(1) Turn the RANGE (D) dial to STD.

(2) Adjust the COARSE (F) and FINE (E) current dials while tapping GA SENS key No. 1, until the galvanometer indicates no deflection.

(3) Tap GA SENS keys No. 1, No. 2, and No. 3 (in sequence) while adjusting the FINE (E) current control, until the galvanometer indicates no deflection when key No. 4 is tapped.

(4) Turn selector dial G to EMF.

c. Adjust the potentiometer for exactly 100 volts as follows:

(1) Set the volt box to the 150-volt range.

(2) Set dials A, B, and C on the potentiometer to exactly .0100000.

(3) Set the RANGE (D) dial to 0.1611 volts.

d. Adjust the tester as follows:

(1) Set the ON-OFF switch to ON.

(2) Rotate the DECREASE-INCREASE control until meter M1 indicates approximately 100 volts.

(3) Operate the TEST switch to the TEST position, tap GA SENS key No. 1 on the potentiometer, and rotate the DECREASE-INCREASE control on the tester until the galvanometer indicates no deflection.

(4) Adjust variable resistor R21 (fig. 9) until meter M1 indicates exactly 100 volts.

e. Shut down the tester, disconnect the test equipment, and replace the instrument in the case (fig. 8).

20. DIR CUR Circuit Adjustment

a. Connect the tester to the test equipment as shown in figure 13. Set the FUNCTION switch on the tester to DIR CUR and the CURRENT range switch to 100MA.

b. Standardize the potentiometer current (para 19b(1) through (4)).

c. Adjust the potentiometer for 100 milliamperes as follows:

(1) Set the shunt box to the 0.15-ampere range.

(2) Set dials A, B, and C on the potentiometer to exactly .1500000.

(3) Set the RANGE (D) dial to 0.1611 volts.

d. Adjust the tester as follows:

(1) Set the ON-OFF switch to ON.

(2) Rotate the DECREASE-INCREASE control until meter M1 indicates approximately 100 milliamperes.

(3) Operate the TEST switch to the TEST position, tap GA SENS key No. 1 on the potentiometer, and rotate the DECREASE-INCREASE control on the tester until the galvanometer indicates no deflection.

(4) While holding the TEST switch in the TEST position, adjust variable resistor R23 (fig. 9) until meter M1 indicates exactly 100 milliamperes.

e. Shut down the tester, disconnect the test equipment, and replace the instrument in the case (fig. 8).

21. AC VOLTS Circuit Adjustment

a. Connect the tester to the dynamometer as shown in figure 14. Set the FUNCTION switch on the tester to AC VOLTS and the VOLTAGE range switch to 100V.

b. Set the ON-OFF switch to. ON.

c. Operate the TEST switch to the TEST position, and rotate the DECREASE-INCREASE control until the dynamometer indicates exactly 100 volts.

d. While holding the TEST switch in the TEST position, adjust variable resistor R24 (fig. 9) until meter M1 indicates exactly 100 volts.

e. Shut down the tester, disconnect the test equipment, and replace the instrument in the case (fig. 8).

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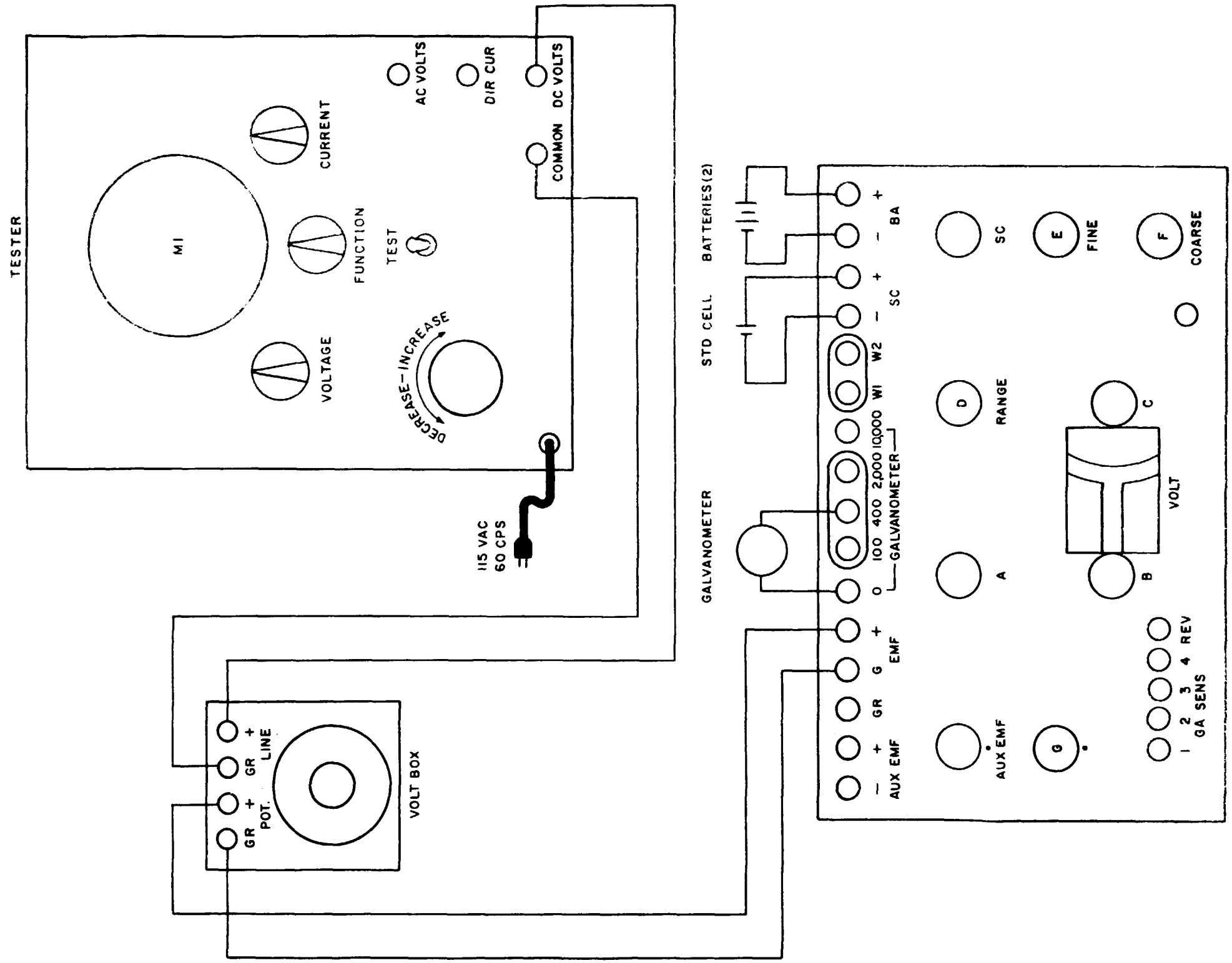

Figure 12. Test setup for adjusting DC VOLTS circuits of tester.

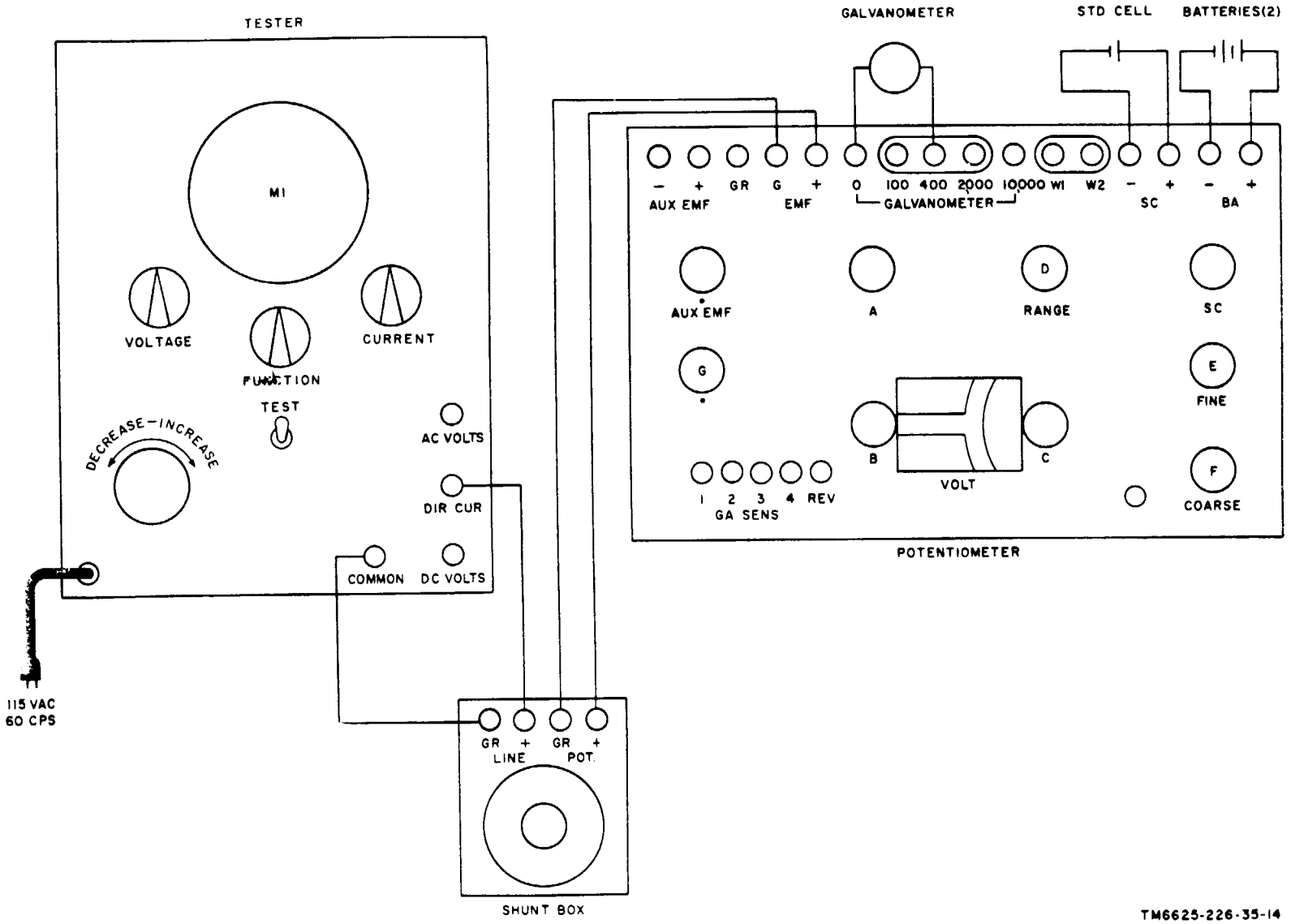

Figure 13. Test setup for adjusting DIR CUR circuits of tester.

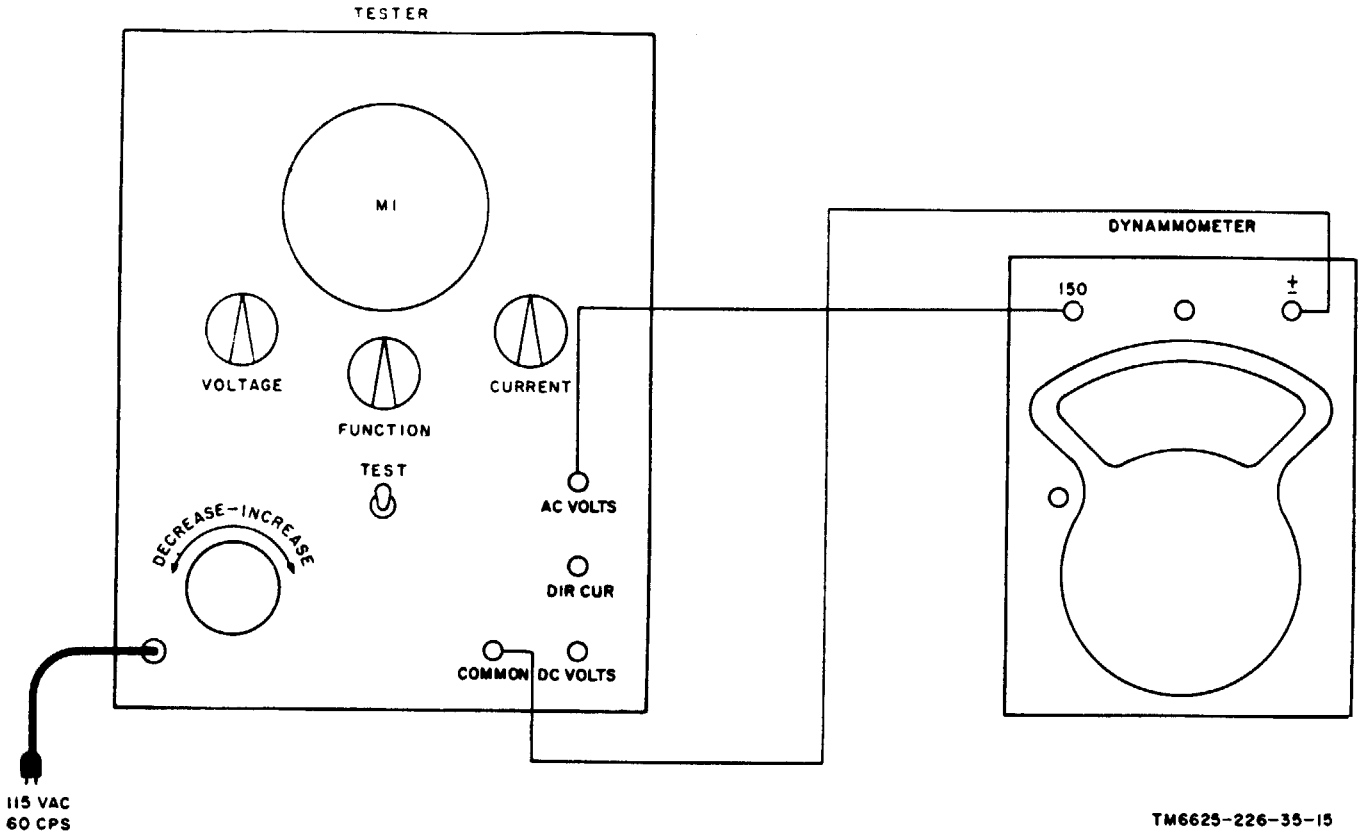

Figure 14. Test setup for adjusting AC VOLTS circuits of tester.

CHAPTER 4

FINAL TESTING

22. Purpose of Final Testing

a. 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.

b. The test equipment required for final testing of the tester is the same as that required for the adjustment procedures (para 18).

23. DC VOLTS Circuit Final Testing

a. Connect the tester to the, test equipment as shown in figure 12.

b. Standardize the potentiometer current (para 19b).

c. Set the FUNCTION switch on the tester to DC VOLTS.

d. Use the chart in e below and test each dc voltage range of the tester as follows:

(1) Set the VOLTAGE range switch on the tester to the position indicated in column 1.

(2) Set the volt box to the range indicated in column 2.

(3) Balance the galvanometer by setting dials A, B, and C on the potentiometer to the settings indicated in column 3. Be sure that the RANGE (D) dial is set as indicated.

(4) Operate the TEST switch on the tester to the TEST position and rotate the DECREASE-INCREASE control until meter M1 indicates full-scale deflection; note and record the meter M1 indication.

(5) Rebalance the galvanometer by adjusting dial C on the potentiometer until the galvanometer indicates exact balance; note and record the setting of dials A, B, and C when the galvanometer is balanced.

(6) Compute the accuracy for each range by use of the formula-

$$\frac{X\,(Y \bullet Z)}{X}\ 100 = \%\ \text{error}$$

Where: X = Tester full-scale deflection indication ((4) above)

Y = Setting of dials A, B, and C ((5) above)

Z = Volt box range multiplier (column 2 of chart (*e* below))

Example: Assume that for full-scale deflection on the 100V range of the tester, the galvanometer is balanced when potentiometer dials A, B, and C are set at .1005000. Solve for percent of error.

$$\frac{X - (Y \bullet Z)}{X}\ 100 = \%\ \text{error}$$

$$\frac{100 - (.1005 \times 1{,}000)}{100} \times 100 = \%\ \text{error}$$

$$\frac{100 - 100.5}{100} \times 100 = \%\ \text{error}$$

$$\frac{-.5}{100} \times 100 = \%\ \text{error}$$

-.005 x 100 = -0.5% error

Note. The accuracy of each DC VOLTS range of the tester should be within +9.5 percent.

e. Use the following chart to test the DC VOLTS circuit of the tester (d above).

1	2		3	
VOLTAGE range switch position	Volt box setting		Potentiometer setting	
	Range (volts)	Range multiplier	Dials A, B, and C	RANGE (D) dial
500V	750	5,000	.1000000	0.1611
250V	300	2,000	.1250000	0.1611

1	2		3	
VOLTAGE range switch position	Volt box setting		Potentiometer setting	
	Range (volts)	Range multiplier	Dials A, B, and C	RANGE (D) dial
100V	150	1,000	.1000000	0.1611
50V	75	500	.1000000	0.1611
25V	30	200	.1250000	0.1611
10V	15	100	.1000000	0.1611
5V	7.5	50	.1000000	0.1611
2.5V	3	20	.1250000	0.1611

24. DIR CUR Circuit Final Testing

a. Connect the tester to the test equipment as shown in figure 13.

b. Standardize the potentiometer current (para 19*b*).

c. Set the FUNCTION switch on the tester to DIR CUR.

d. Use the chart in e below and test each dc current range of the tester as follows:

(1) Set the CURRENT range switch on the tester to the position indicated in column 1.

(2) Set the shunt box to the range indicated in column 2.

(3) Balance the galvanometer by setting dials A, B, and C on the potentiometer to the settings indicated in column 3. Be sure that the RANGE (D) dial is set as indicated.

(4) Raise the TEST switch on the tester to the TEST position and rotate the DECREASE-INCREASE control until meter M1 indicates full-scale deflection; note and record the meter Ml indication.

(5) Rebalance dial C on the potentiometer until the galvanometer indicates exact balance; note and record the setting of dials A, B, and C when the galvanometer is balanced.

(6) Compute the accuracy of each range by use of the formula -

$$\frac{X - (Y \cdot Z)}{X} \cdot 100 = \%\ \text{error}$$

Where: *X* = Tester full-scale deflection indication ((4) above)
Y = Setting of dials A, B, and C ((5) above)
Z = Shunt box r a n g e multiplier (column 2 of chart (e) below)

Example: Assume that for full-scale deflection on the 500MA range of the tester the galvanometer is balanced when potentiometer dials A, B, and C are set at .0999000. Solve for percent of error.

$$\frac{X - (Y \cdot Z)}{X} \cdot 100 = \%\ \text{error}$$

$$\frac{5 - (.0999 \times 5)}{.5} \times 100 = \%\ \text{error}$$

$$\frac{5 - 4995}{.5} \times 100 = \%\ \text{error}$$

$$\frac{.0005}{.5} \times 100 = \%\ \text{error}$$

$$.001 \times 100 = +0.1\%\ \text{error}$$

Note. The accuracy of each DIR CUR range of the tester, except the 100MICRO-AMP range, should be within +9.5 percent. The accuracy of the 100MICRO-AMP range should be within +9.2 percent.

e. Use the following chart to test the DIR CUR circuit of the tester (d above).

1	2		3	
CURRENT range switch position	Shunt box setting		Potentiometer setting	
	Range (amperes)	Range multiplier	Dials A, B, and C	RANGE (D) dial
1AMP	1.5	10	.1000000	0.1611
500MA	.75	5	.1000000	0.1611
250MA	.30	2	.1250000	0.1611
100MA	.15	1	.1000000	0.1611
50MA	.075	.5	.1000000	0.1611
25MA	.075	.5	.0500000	0.1611
10MA	.075	.5	.0200000	0.1611
5MA	.075	.5	.0100000	0.1611
2.5MA	.075	.5	.0050000	0.1611
1MA	.075	.5	.0020000	0.1611
500MICRO-AMP	.075	.5	.0010000	0.1611
250MICRO-AMP	.075	.5	.000b000	0.1611
100MICRO-AMP	.075	.5	.0002000	0.1611

25. AC VOLTS Circuit Final Testing

a. Connect the tester to the dynamometer (fig. 14).

b. Set the FUNCTION switch on the tester to AC VOLTS.

c. Set the VOLTAGE range switch to 100V.

d. Raise the TEST switch to the TEST position and rotate the DECREASE-INCREASE control until meter M1 indicates full-scale deflection; note and record the indication.

e. Note and record the indication on the dynamometer.

f. Compute the accuracy of the ac voltage circuits of the tester by use of the following formula-

$$\frac{X - Y}{X} \cdot 100 = \% \text{ error}$$

Where: X = Tester full-scale deflection (*d* above)
Y = Dynamometer indication (*e* above)

Example: Assume that for full-scale deflection on the 100V range of the tester the dynamometer indicates 100.5. Solve for percent error.

$$\frac{X - Y}{X} \cdot 100 = \% \text{ error}$$

$$\frac{100 - 100.5}{100} \times 100 = \% \text{ error}$$

$$\frac{-.5}{100} \times 100 = \% \text{ error}$$

-.005 x 100 = -0.5% error

Note. The accuracy of all ac voltage ranges is the same as for the 100V range and should be within +1 percent.

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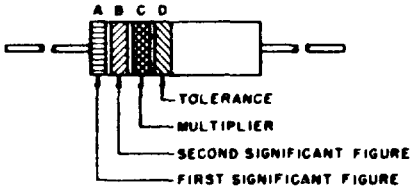
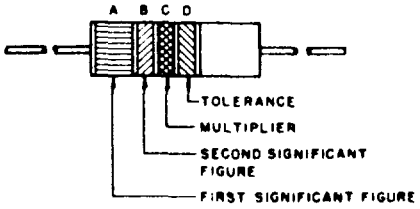
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS



BAND A— Double Width Signifies Wire-wound Resistor

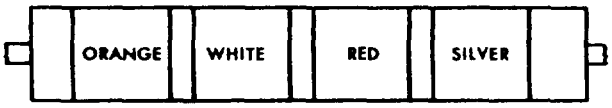
COLOR CODE TABLE

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

EXAMPLES OF COLOR CODING

BAND

A B C D*



3 9 X100 ± 10%

NOMINAL RESISTANCE 3,900 Ohms

RESISTANCE TOLERANCE ± 10 percent

BAND

A B C D*

3 6 X0.1 ± 5%

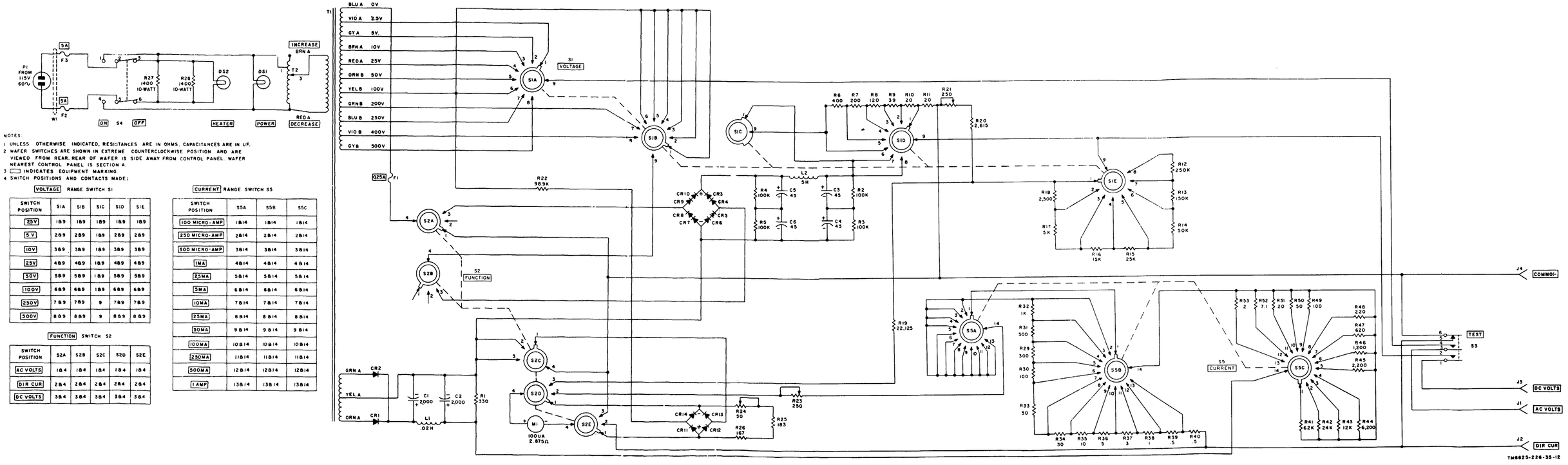
3.6 Ohms

± 5 percent

STD-R2

*If Band D is omitted, the resistor tolerance is ± 20%, and the resistor is not Mil-Std.

Figure 16. MIL STD resistor color code markings.



NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF.
2. WAFER SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION AND ARE VIEWED FROM REAR. REAR OF WAFER IS SIDE AWAY FROM CONTROL PANEL. WAFER NEAREST CONTROL PANEL IS SECTION A.
3. ▭ INDICATES EQUIPMENT MARKING.
4. SWITCH POSITIONS AND CONTACTS MADE:

VOLTAGE RANGE SWITCH S1

SWITCH POSITION	S1A	S1B	S1C	S1D	S1E
2.5V	1&9	1&9	1&9	1&9	1&9
5 V	2&9	2&9	1&9	2&9	2&9
10V	3&9	3&9	1&9	3&9	3&9
25V	4&9	4&9	1&9	4&9	4&9
50V	5&9	5&9	1&9	5&9	5&9
100V	6&9	6&9	1&9	6&9	6&9
250V	7&9	7&9	9	7&9	7&9
500V	8&9	8&9	9	8&9	8&9

FUNCTION SWITCH S2

SWITCH POSITION	S2A	S2B	S2C	S2D	S2E
AC VOLTS	1&4	1&4	1&4	1&4	1&4
DIR CUR	2&4	2&4	2&4	2&4	2&4
DC VOLTS	3&4	3&4	3&4	3&4	3&4

CURRENT RANGE SWITCH S5

SWITCH POSITION	S5A	S5B	S5C
100 MICRO-AMP	1&14	1&14	1&14
250 MICRO-AMP	2&14	2&14	2&14
500 MICRO-AMP	3&14	3&14	3&14
1MA	4&14	4&14	4&14
2.5MA	5&14	5&14	5&14
5MA	6&14	6&14	6&14
10MA	7&14	7&14	7&14
25MA	8&14	8&14	8&14
50MA	9&14	9&14	9&14
100MA	10&14	10&14	10&14
250MA	11&14	11&14	11&14
500MA	12&14	12&14	12&14
1AMP	13&14	13&14	13&14

Figure 16. Tester, schematic diagram.

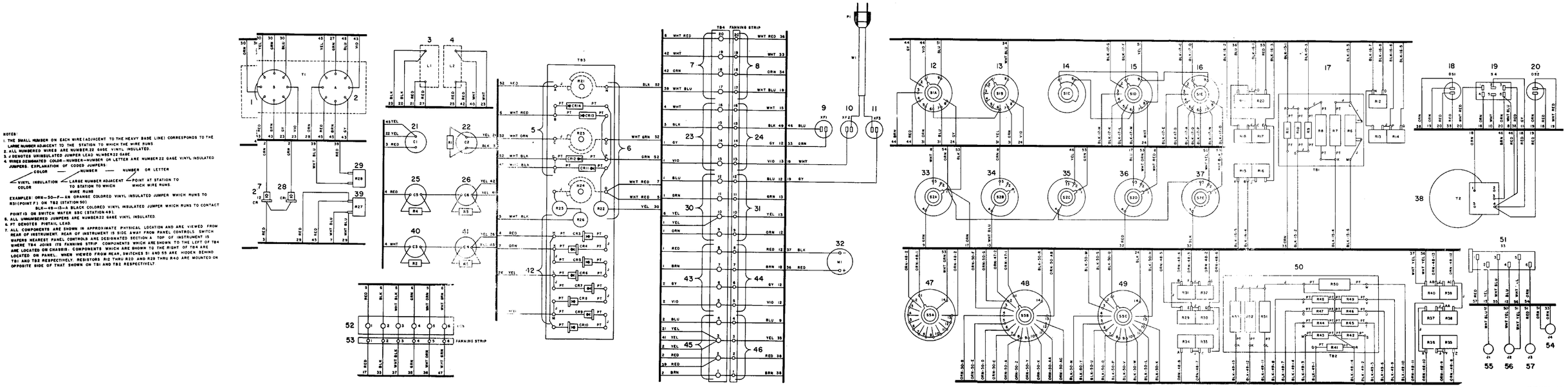


Figure 17. Tester, wiring diagram.

APPENDIX
REFERENCES

Following is a list of applicable references available for use by the field and depot maintenance personnel.

TM 11-664	Theory and Use of Electronic Test Equipment.
TM 11-6625-203-12	Operation and Organizational Maintenance: Multimeter AN/URM- 105, including Multimeter ME-77/U.
TM 11-6625-226-12	Operation and Organizational Maintenance: Electrical Meter Test Set TS-656/U.
TM 11-6625-226-12P	Operator's and Organizational Maintenance Repair Parts and Special Tools List for Test Set, Electrical Meter TS-656/U.
TM 11-6625-226-35P	Field and Depot Maintenance Repair Parts and Special Tools List: Test Set, Electrical Meter TS-656/U.

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USATC Armor (2)
USATC Engr (2)
USATC FA (2)
USATC Inf (2)
Svc College (2)
Br Svc Sch (2)
GENDEP (2) except
Atlanta GENDEP (None)
Sig Sec, GENDEP (5)
Sig Dep (12)
Ft Monmouth (63)
Instls (2)
AFIP (1)
WRAMC (1)
AFSSC (1)
USAEPG (2)
EMC (1)
USACA (2)
USASEA (1)
USA Carib Sig Agcy (1)
USA Sig Msl Spt Agcy (12)
USASSA (20)
USASSAMRO (1)
Army Pictorial Cen (2)
USAOMC (3)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
AMS (1)
Sig Fld Maint Shops (2)
JBUSMC (2)
Units org under fol TOE:
Two copies to each unit unless otherwise indicated:
11-7
11-16
11-57
11-97
11-117
11-155
11-500 (AA-AE) (4)
11-557
11-587
11-592
11-597

NG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 320-50.

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