TM 11-2637

AR DEPARTMENT TECHNICAL MANUAL

TEST SET
ESPEY MODEL 100)

AR DEPARTMENT 8 NOVEMBER 1945

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WAR DEPARTMENT,
Washington 25, D. C., 8 November 1945.

TM 11-2637, Test Set (Espey Model 100), is published for the information and guidance of all concerned.

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By Order of the Secretary of War:

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Chief of Staff

Official:

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Major General
Acting The Adjutant General

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WARNING ★★

HIGH VOLTAGE

**IS USED IN THE OPERATION OF
THIS EQUIPMENT**

DEATH ON CONTACT

**MAY RESULT IF OPERATING PERSONNEL
FAIL TO OBSERVE SAFETY PRECAUTIONS.**

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DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN— When ordered by your commander.

HOW — 1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut —Use axes, handaxes, machetes.

3. Burn —Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal —Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT— 1. Smash—Meter, knobs, controls, switches, wooden cabinet.

2. Cut —Cables, wiring.

3. Burn —Technical manuals, schematic diagrams, cabinet, cables and wiring.

4. Bend —Panel.

5. Bury or scatter—All of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

SAFETY NOTICE

BE CAREFUL TO AVOID CONTACT WITH HIGH-VOLTAGE CIRCUITS OR 115-VOLT A-C INPUT CONNECTIONS WHILE CHECKING OR SERVICING THE RADIO EQUIPMENT. MAKE CERTAIN THAT THE POWER IS TURNED OFF BEFORE DISASSEMBLING ANY PART OF THE RADIO EQUIPMENT.

DANGEROUSLY HIGH VOLTAGES ARE PRESENT IN THE POWER SUPPLIES OF THE RADIO EQUIPMENT. BEFORE MAKING ANY SERVICE CHECKS, MANUALLY DISCHARGE ALL HIGH-VOLTAGE CAPACITORS IN THESE CIRCUITS AFTER THE A-C POWER HAS BEEN REMOVED FROM THE COMPONENTS.

First Aid for Electric Shock

RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open,

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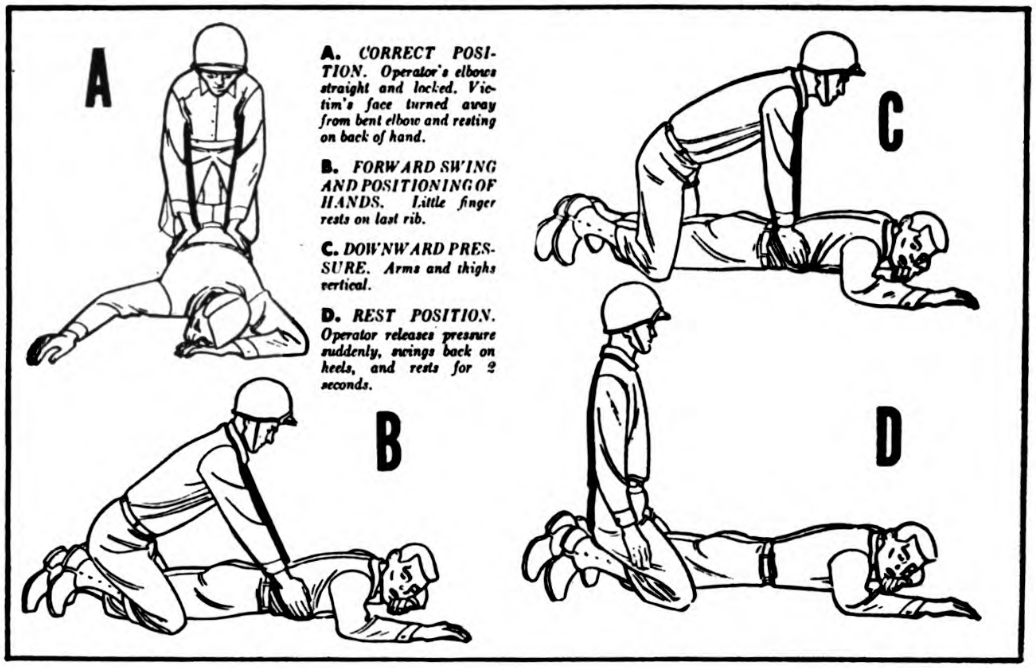

with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit on the heels.

(*3*) After 2 seconds, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4 seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence

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of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping

b. Keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

TL15338-C

Figure 1. Test set (Espey model 100).

PART ONE

INTRODUCTION

SECTION I. DESCRIPTION

1. PURPOSE AND USE.

Test set (Espey model 100), hereafter referred to as "the test set" is a multi-range combination test instrument designed to measure voltage, current, and resistance.

a. D-c Voltage Measurements. Direct-current (d-c) voltage as high as 6,000 volts may be measured over seven ranges. Meter sensitivity may be either 1,000 or 20,000 ohms per volt.

b. D-c Current Measurements. The test set has seven current ranges by which current values up to 12 amperes can be read.

c. A-c Voltage Measurements. Alternating-current (a-c) voltage as high as 6,000 volts may be measured over seven ranges at 1,000 ohms per volt. The frequency of the alternating current must be below 7,000 cycles per second (cps) for accurate measurement.

d. Output Measurements. The test set may be used as an output meter over all ranges of a-c voltage. An OUTPUT terminal on the meter panel connects a capacitor in series with one of the test leads.

e. Decibel Measurements. The same circuit that is used for a-c voltage measurements may be used for decibel measurements by using the bottom scale of the meter.

f. Resistance Measurements. The test set provides three resistance ranges. Resistances between 0 and 60 megohms (meg) may be measured.

2. APPLICATION.

The test set is designed for the maintenance and repair of radio and electronic equipment. Its chief use is in testing circuits for proper voltage, current, and resistance. It may also be used as an output indicator when aligning a receiver. Voice or tone levels may be measured by using the decibel scale.

3. TECHNICAL CHARACTERISTICS.

Voltage ranges:

A-c, 1,000 ohms per volt D-c, 1,000 or 20,000 ohms per volt	0 to 3 volts 0 to 12 volts 0 to 60 volts 0 to 300 volts 0 to 600 volts 0 to 1,200 volts 0 to 6,000 volts
D-c current range	0 to 60 microamperes 0 to 300 microamperes 0 to 3 ma 0 to 30 ma 0 to 120 ma 0 to 600 ma 0 to 12 amps
Resistance ranges	0 to 6,000 ohms 0 to 600,000 ohms 0 to 60 meg
Decibel ranges (500 ohm load)	—12 to +16 db +2 to +30 db +16 to +44 db +22 to +50 db +28 to +56 db +42 to +70 db
Output tests	same as a-c voltages above
Power source	Battery BA-2 and BA-30 (one each)

4. DESCRIPTION OF MAJOR COMPONENTS.

Basically, the test set consists of sensitive 50-microampere meter which is connected into the correct test circuits by switches and jacks on the front panel. All parts except the batteries are mounted on the meter panel and the entire unit is housed in a natural-finish walnut case. The case is provided with a carrying handle and a small compartment for storing the test leads and prods. The cover is held in place by two hinges and one hasp type catch.

5. LIST OF COMPONENTS.

The following table gives the weights, dimensions, and cubages of the major components of the test set.

NOTE: This list is for general information only. See appropriate publications for information pertaining to requisition of spare parts.

Quantity	Name of component	Dimensions (in)				Unit weight (lb)	Unit volume (cu ft)
		Height	Width	Depth	Length		
1	Test set (Espey model 100)	5½	9	10		6	0.287
2	Test leads				36	0.5	
2	TM 11-2637	5½	8½	⅛		0.5	

6. PACKAGING DATA.

NOTE: Items may be packaged in a different manner than shown, depending upon supply channels.

Packed for export shipment, test set (Espey model 100) is shipped in a heavy corrugated cardboard carton 13½ inches long, 12 inches wide, and 9 inches high. The volume is 0.84 cubic feet. Shipping weight is 11 pounds. See figure 2 for a typical dimensional drawing.

UNPACKING AND CHECKING TEST SET ESPEY MODEL 100

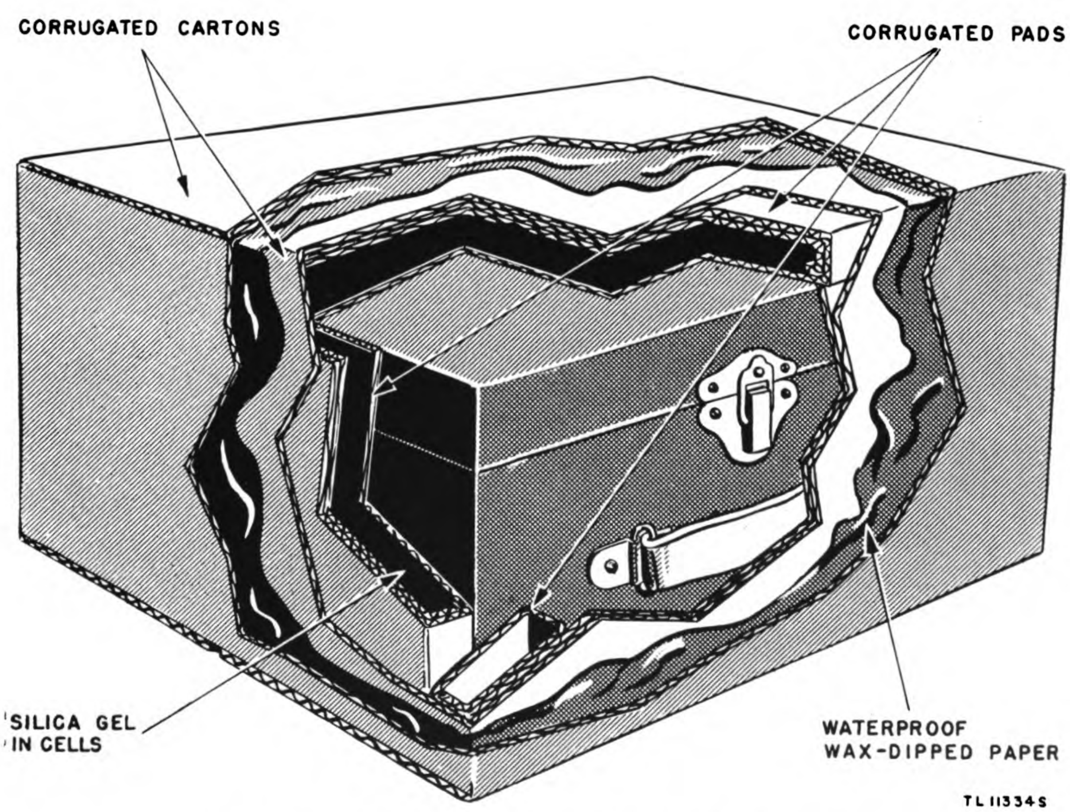

Figure 2. Test set (Espey model 100), packaging.

SECTION II. INSTALLATION AND ASSEMBLY

7. UNPACKING AND CHECKING.

NOTE: Take care when unpacking or handling the equipment. It can be damaged easily.

a. Unpacking.

(1) Place the box in a convenient place for opening.
(2) Tear open the top of the outer corrugated cardboard carton.
(3) Cut open the waxed paper covering and open the inner carton.
(4) Remove the dunnage and lift the test set from the inner carton.

b. Checking.

(1) Inspect the instrument carefully for damage. Pay particular attention to the meter glass and movement.

(2) Check the components against the packing slip and the list of components in paragraph 5.

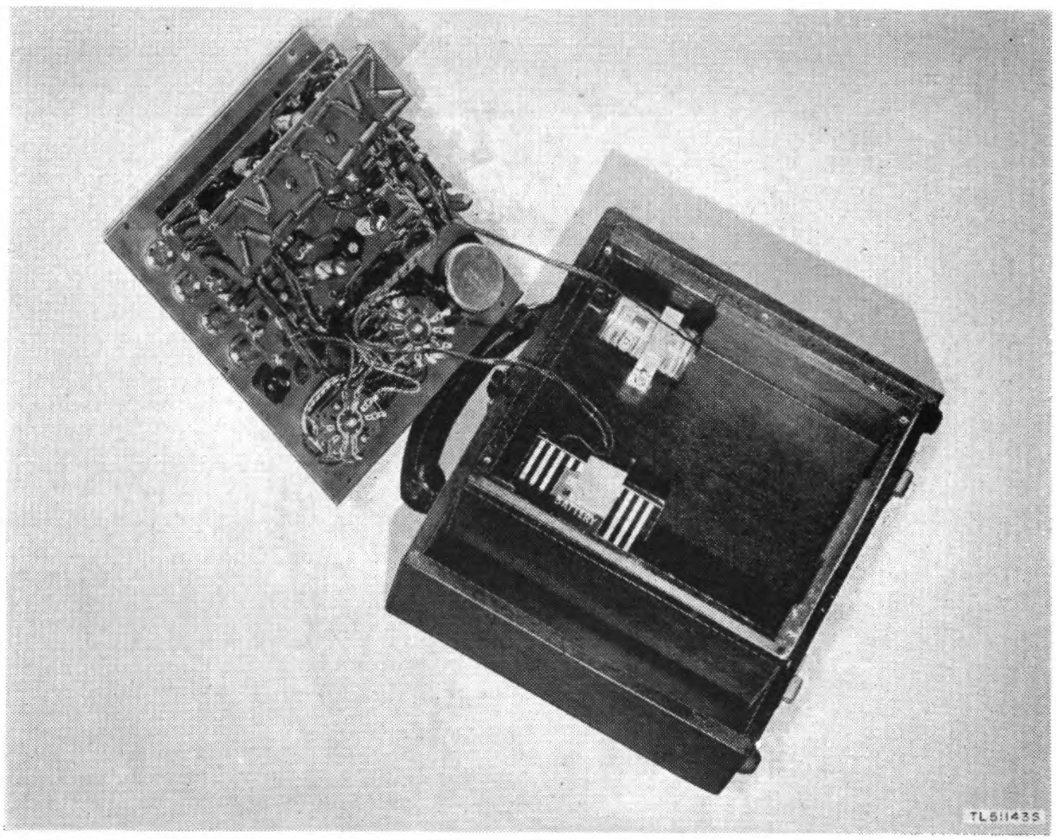

Figure 3. Battery installation.

8. INSTALLATION.

Space is provided inside the cabinet for two batteries used in resistance measurements. One Battery BA-30 and one Battery BA-2 or their equivalents are used. Install the batteries as follows:

a. Remove the six wood screws along the edge of the front panel and lift the instrument from the case.

b. Loosen the two hexagonal nuts holding the two battery clamps.

c. Solder the brown lead of the brown and red pair of wires to the negative terminal or case of Battery BA-30 and the red lead to the positive terminal.

d. Insert Battery BA-30 under the clamp on the left side of the cabinet with the positive terminal towards the carrying handle. Tighten the clamp.

e. The black and red pair of leads to the 22½-volt battery are terminated in spade tips. If the battery to be used does not have either Fahnstock clips or screw type terminals, solder the leads directly to the tips and wrap with tape. The red lead goes to the positive terminal and the black lead to the negative terminal of the Battery.

9. INTERCONNECTIONS.

Under ordinary conditions the only connection necessary is to insert the pin tips of the test leads in the correct tip jacks. When measuring voltages in the 1,200- and 6,000-volt range, ground the instrument panel by connecting it to a cold water pipe or other suitable ground.

10. REMOVAL FROM SERVICE.

When the set is not in use remove the test leads from the jacks. Coil the leads up neatly and place in the cabinet compartment. Replace the cover. If the equipment is to be stored for a period exceeding two weeks, remove the batteries. If batteries are not removed, severe damage to the interior of the test set may result from battery deterioration.

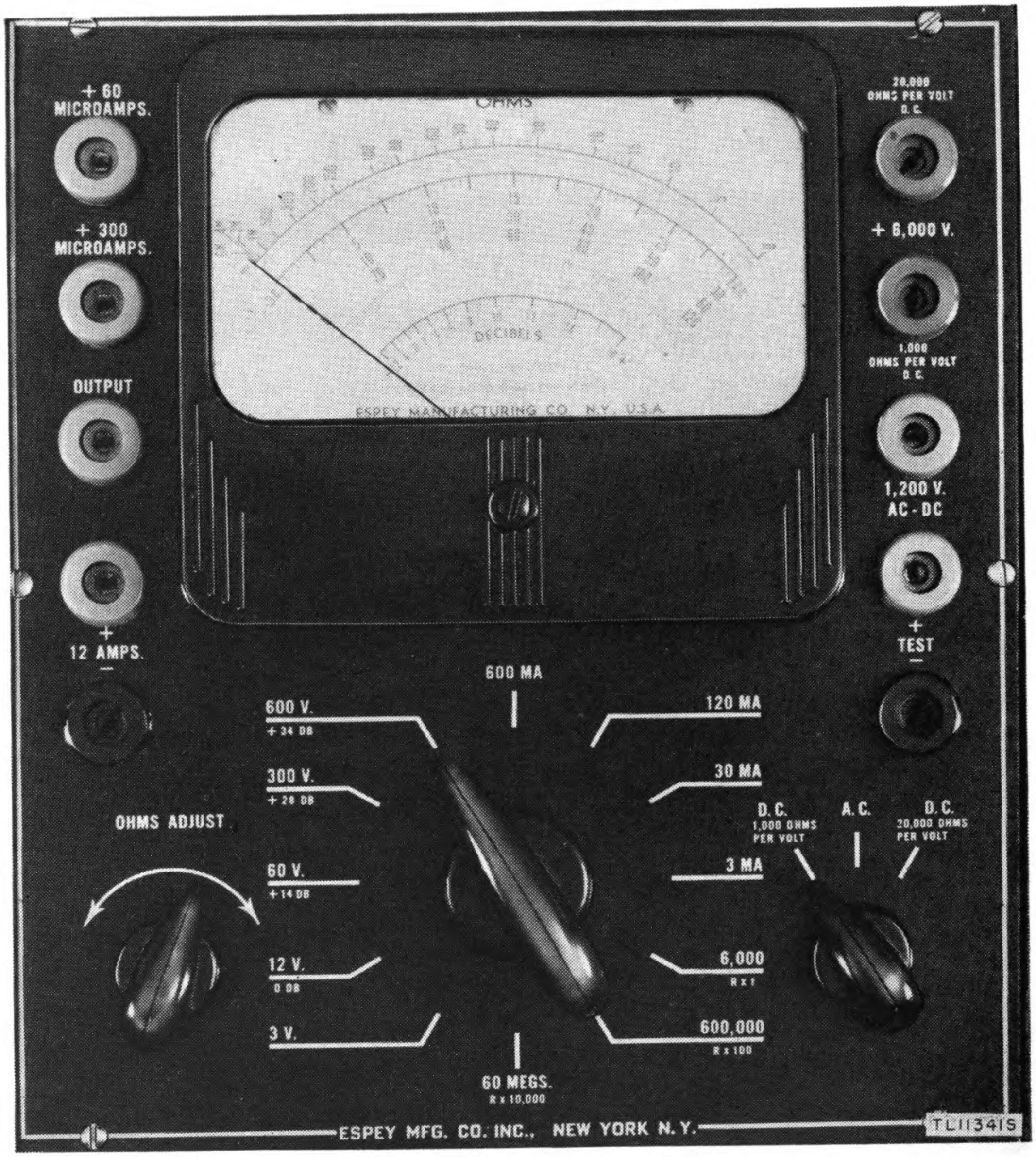

Figure 4. Front view.

PART TWO

OPERATING INSTRUCTIONS

NOTE: For information on destroying the equipment to prevent enemy use, refer to the destruction notice at the front of the manual.

SECTION III. CONTROLS AND THEIR USE

11. OHMS ADJUST.

The OHMS ADJUST control is used in calibrating the meter for resistance measurements. This control compensates for circuit differences in the three ranges and voltage changes due to battery deterioration.

12. RANGE SELECTOR.

This control located in the lower center of the panel, is a twelve-position four-gang switch used to select the voltage, current, and resistance ranges.

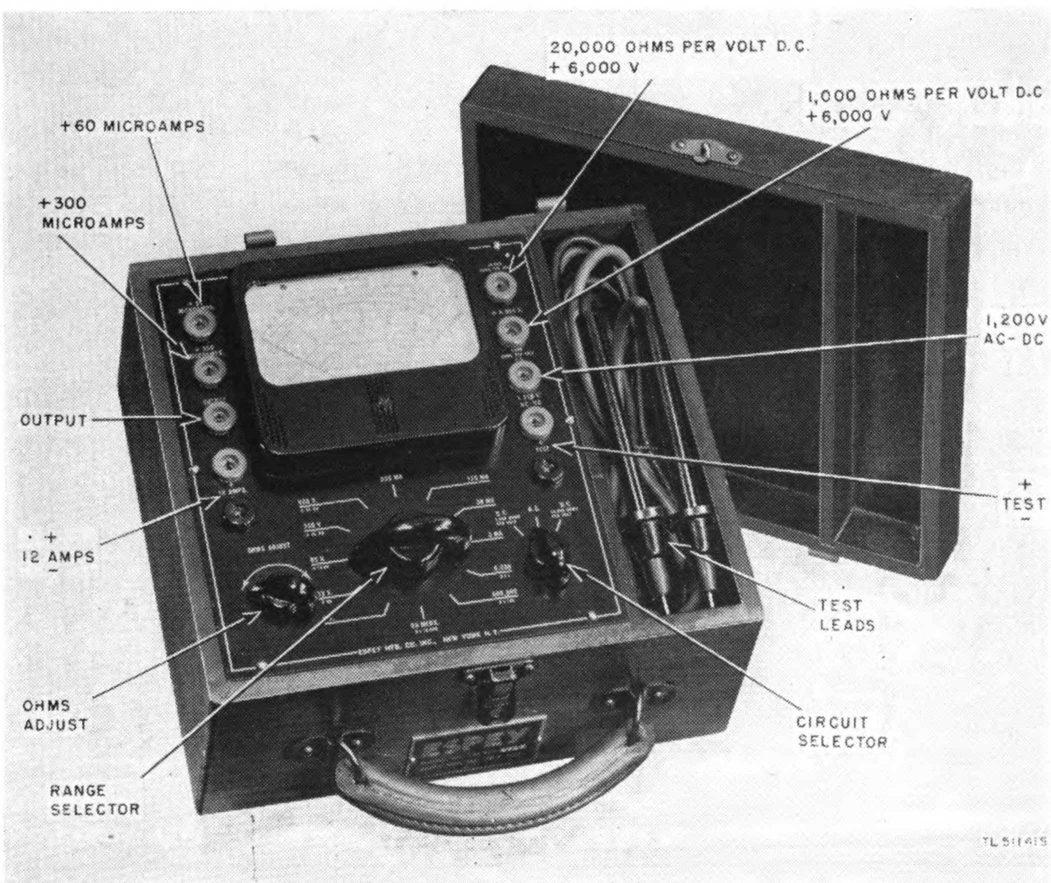

Figure 5. Controls.

This switch connects the twelve ranges marked on the panel to the plus and minus TEST jacks on the right side of the panel.

13. CIRCUIT SELECTOR.

The circuit selector switch on the lower right of the panel is used for a-c measurements and to select one of the two degrees of meter sensitivity possible. With the switch in the center position the meter reads a-c voltage, either in the + and — TEST jacks or in the higher voltage jacks. In the left hand position the meter has a sensitivity of 1,000 ohms per volt, while in the right hand position the sensitivity is 20,000 ohms per volt.

14. PIN JACKS.

In addition to the + and — TEST jacks used with the range selector switch for the more common measurements, there are eight jacks for measuring high voltage up to 6,000 volts, and extreme ranges of current from 1 microampere to 12 amperes. Also included is an output jack with a series capacitor used for measuring a-c voltage where there is also a d-c voltage present.

SECTION IV. PREOPERATIONAL PROCEDURES

15. PREPARATION FOR USE.

a. Using a small screwdriver, adjust the small bakelite screw head in the lower center of the meter case until the meter reads zero. The pointer should be directly over the zeros on the left of the meter face (par. 32).

b. Insert the two short pin tips of the test leads firmly into the jacks marked + — TEST.

c. Turn the circuit selector switch to D.C. 20,000 OHMS PER VOLT. Turn the range selector switch to 60 MEGS and touch the ends of the test leads together. The pointer should swing to the right.

d. Holding the leads together, adjust the OHMS ADJUST knob until the pointer is reading full scale to the right. Make this adjustment each time equipment is put in use or when changing to different resistance ranges.

SECTION V. OPERATION

16. D-C CURRENT MEASEUREMENT.

CAUTION: In order to protect the meter from damage, take current readings on the highest range first, then if the reading is less than the full scale value of the next lower range, proceed to the lower range. Use the same caution in going to other ranges.

For all current measurements, the test set should be connected in series with the load.

a. 12-ampere D-c Range.

(1) Set the circuit selector switch to the D.C. 20,000 OHMS PER VOLT position.

(2) Set the range selector switch to the 600 MA position.

(3) Insert the negative test lead into the —12 AMPS tip jack and the positive test lead into the +12 AMPS tip jack.

(4) Divide the reading on the black 0-120 D.C. scale by 10.

NOTE: Do not remove the test leads from the tip jacks while current is flowing. The resulting arc may cause charring of the tip jack if this precaution is not observed.

b. D-c Ranges 0 to 3 Ma, 0 to 30 Ma, 0 to 120 Ma, 0 to 600 Ma.

(1) Set the circuit selector switch to the D.C. 20,000 OHMS PER VOLT position.

(2) Set the range selector switch as follows:

0 to 3 ma	Set at 3 MA position
0 to 30 ma	Set at 30 MA position
0 to 120 ma	Set at 120 MA position
0 to 600 ma	Set at 600 MA position

(3) Insert the negative test lead into the —TEST tip jack and positive test lead into the +TEST tip jack.

(4) Read as follows:

0 to 3 ma	Divide reading on black 0 to 30 D.C. scale by 10
0 to 30 ma	Read directly on black 0 to 30 D.C. scale
0 to 120 ma	Read directly on black 0 to 120 D.C. scale
0 to 600 ma	Multiply reading on black 0 to 60 D.C. scale by 10

c. 0 to 60 and 0 to 300 Microamperes D-c Ranges.

(1) Set the circuit selector switch to the D.C. 20,000 OHMS PER VOLT position.

(2) Set the range selector switch to the 30 MA position.

(3) Insert the negative test lead into the —TEST tip jack and the positive test lead in the appropriate +60 MICROAMPERES or the +300 MICROAMPERES tip jack.

(4) For the 0— to 60— microampere range, read directly on the black 0 to 60 D.C. scale. For the 0— to 300— microampere range, multiply the reading on the black 0 to 30 D.C. scale by 10.

17. HIGH-VOLTAGE PRECAUTION.

High voltages are dangerous and can be fatal. When it is necessary to measure high voltages, observe the following rules:

a. Connect a ground lead to the panel of the test set.

b. Place one hand in your pocket. This eliminates the possibility of making accidental contact with either ground or another part of the circuit.

c. When voltages to be measured are greater than 300, turn off the power before making any test connections. After the power has been turned off, proceed as follows:

(1) Connect the test leads to the proper terminals on the test set.

(2) Connect the opposite ends of the test leads to the points at which the voltage test is to be made.

(3) Step away from the test set and leads, turn on the power and note the reading on the meter. Do not touch any part of the test set or leads during the period that the power is turned on .

(4) When the reading has been noted or the test completed, turn off the power before removing any connections.

18. VOLTAGE MEASUREMENTS.

CAUTION: In order to protect the meter from damage, take voltage readings on the highest range first; then, if the reading is less than full scale value of the next lowest range, proceed to the lower range. Use the same caution in going to other ranges. For voltage readings, the test leads should always be placed across the points where voltage is to be measured.

a. A-c Voltage Ranges 0 to 3, 0 to 12, 0 to 60, 0 to 300, 0 to 600 Volts, 1,000 Ohms Per Volt.

(1) Set circuit selector switch to A.C.

(2) Set range selector switch as follows:

0 to 3 volts	Set to 3 V. position
0 to 12 volts	Set to 12 V. position
0 to 60 volts	Set to 60 V. position
0 to 300 volts	Set to 300 V. position
0 to 600 volts	Set to 600 V. position

(3) Insert the negative lead into the —TEST tip jack and the positive lead into the +TEST tip jack.

(4) Read as follows:

0 to 3 volts	Read directly on red 0-3V A.C. scale only
0 to 12 volts	Divide reading on red 0-120 A.C. scale by 10
0 to 60 volts	Read directly on red 0-60 A.C. scale
0 to 300 volts	Multiply reading on red 0-30 A.C. scale by 10
0 to 600 volts	Multiply reading on red 0-60 A.C. scale by 10

b. A-c Voltage Ranges 0 to 1,200 Volts, 0 to 6,000 Volts, 1,000 Ohms Per Volt.

(1) Set circuit selector switch to A.C.

(2) Set the range selector switch to 600 V. position.

(3) Insert one test lead into the —TEST tip jack and the other test lead into the appropriate 1,200 V. AC-DC or 6,000 V., 1,000 OHMS PER VOLT D.C. tip jack.

(4) For the 0-1, 200-volt range multiply on red 0-120 A.C. scale by 10. For the 0-6,000-volt range, multiply reading on 0-60 red A.C. scale by 100.

c. D-c Voltage Ranges, 0 to 3, 0 to 12, 0 to 60, 0 to 300, 0 to 600 Volts, 1,000 or 20,000 Ohms Per Volt.

(1) Set circuit selector switch to D.C. 1,000 OHMS PER VOLT or the 20,000 OHMS PER VOLT position as required.

(2) Set range selector switch as follows:

0 to 3 volts	Set to 3 V. position
0 to 12 volts	Set to 12 V. position
0 to 60 volts	Set to 60 V. position
0 to 300 volts	Set to 300 V. position
0 to 600 volts	Set to 600 V. position

(3) Insert the negative test lead into —TEST tip jack and positive test lead into +TEST tip jack.

(4) Read as follows:

0 to 3 volts	Divide reading on black 0-30 D.C. scale by 10
0 to 12 volts	Divide reading on black 0-120 D.C. scale by 10
0 to 60 volts	Read directly on black 0-60 D.C. scale
0 to 300 volts	Multiply reading on black 0-30 D.C. scale by 10
0 to 600 volts	Multiply reading on black 0-60 D.C. scale by 10

d. D-c Voltage Ranges 0 to 1,200, 0 to 6,000 Volts, at 1,000 or 20,000 Ohms Per Volt.

(1) Set the circuit selector switch to D.C. 1,000 OHMS PER VOLT or the 20,000 OHMS PER VOLT position as required.

(2) Set the range selector switch to the 600 V. position.

(3) Insert the negative test lead into the —TEST tip jack and the positive test lead into the appropriate 1,200 V AC-DC or the 6,000 V 1,000 OHMS PER VOLT or 20,000 OHMS PER VOLT tip jack as required.

NOTE: There are two tip jacks for the 0 to 6,000-volt range. The upper one is used for 20,000 ohms per volt, the lower one for 1,000 ohms per volt.

(4) For the 0 to 1,200-volt range, multiply the reading on the black 0-120 D.C. scale by 10. For the 0 to 6,000-volt range, multiply the reading on the black 0-60 D.C. scale by 100.

19. RESISTANCE MEASUREMENTS.

If the resistor is connected in a circuit, always disconnect one end of the resistor from the circuit before making measurements. This precaution will prevent erroneous readings due to other resistors in the circuit shunting the resistor to be measured.

a. Set the circuit selector switch to D.C. 20,000 OHMS PER VOLT.

b. Set the range selector switch as follows:

0 to 6,000 ohms	6,000 / R x 1
0 to 600,000 ohms	600,000 / R x 100
0 to 60 megohms	60 MEGS / R x 10,000

c. Place one test lead in the —TEST tip jack and the other test lead in the +TEST tip jack.

d. With the leads shorted, rotate the OHMS ADJUST control until the meter reads full scale on the range to be used. This adjustment has to be made before using any ohmmeter range. Now place test leads across the resistor to be measured.

e. Read as follows on ohms scale:

0 to 6,000 ohms	Read directly
0 to 600,000 ohms	Multiply by 100
0 to 60 meg	Multiply by 10,000

The instrument contains one Battery BA-30 (1½-volt) and one BA-2 (22½-volt). These batteries should be replaced when the OHMS ADJUST no longer can be used to give full scale deflection with the test leads shorted.

20. OUTPUT METER.

The a-c voltage ranges make possible the use of the test set as an output meter. If the voltage output reading is obtained by placing the test leads across the secondary of an output transformer or across the voice coil, only alternating current is present and the usual procedure followed in making a-c voltage measurements may be used. If the voice coil or secondary transformer output leads are not accessible, the meter should be connected from the plate of the output tube to the ground. It will be necessary to use the OUTPUT terminal. A 0.1-mf 600-volt blocking capacitor is incorporated in the tester in series with the OUTPUT tip jack. The procedure is the same as in a-c measurements except that the OUTPUT tip jack is used instead of —TEST tip jack for the negative test lead. The effect of adjusting trimmer capacitors and other semiadjustable circuit elements can be noted on the output meter.

21. DECIBEL METER.

When power levels across known impedances are to be measured it is convenient to have a scale calibration directly in decibels. The initial scale calibration (—12 to +16 db) is based on a zero level of 6 milliwatts (mw) (or 1.73 volts) across a 500-ohm load. This calibration holds only for a 500-ohm impedance. Conversion tables for other impedances can be found in many textbooks and radio manuals. A decibel conversion chart makes it possible to find the actual power, voltage, power ratios and voltage ratios from the readings on the decibel scale. See figure 6.

a. Decibel Ranges (—12 to +50 Db).

(1) Set the circuit selector switch to A.C.

(2) Set range selector switch as follows:

—12 to +16 db	Set at $\frac{\text{12 V.}}{\text{0 DB}}$

DECIBEL CONVERSION CHART

Power Level DB	Power Ratio to 0 DB	Power .006 Watt at 0 DB Watts	Voltage Ratio to 0 DB	Volts—Based on .006 Watt at 0 DB in	
				500 ohms	600 ohms
—10	0.1000	0.0006000	0.31623	0.5477	.6000
— 9	0.1259	0.0007553	0.35481	0.6145	.6732
— 8	0.1585	0.0009509	0.39811	0.6895	.7554
— 7	0.1995	0.0011972	0.44668	0.7737	.8475
— 6	0.2512	0.0015071	0.50119	0.8681	.9509
— 5	0.3162	0.0018975	0.56234	0.9740	1.0670
— 4	0.3981	0.0023886	0.63096	1.0928	1.1972
— 3	0.5012	0.0030071	0.70795	1.2262	1.3433
— 2	0.6310	0.0037857	0.79433	1.3758	1.5071
— 1	0.7943	0.0047660	0.89125	1.5437	1.6910
0	1.0000	0.0060000	1.00000	1.7321	1.8974
+ 1	1.2589	0.0075535	1.1220	1.9434	2.1289
+ 2	1.5849	0.0095093	1.2589	2.1805	2.3886
+ 3	1.9953	0.0119716	1.4125	2.4466	2.6801
+ 4	2.5119	0.0150713	1.5849	2.7451	3.0071
+ 5	3.1623	0.0189747	1.7783	3.0801	3.3741
+ 6	3.9811	0.0238865	1.9953	3.4559	3.7867
+ 7	5.0119	0.030071	2.2387	3.8776	4.2477
+ 8	6.3096	0.037857	2.5119	4.3507	4.7660
+ 9	7.9433	0.047660	2.8184	4.8816	5.3475
10	10.0000	0.060000	3.1623	5.4772	6.0000
11	12.589	0.075535	3.5481	6.1455	6.7321
12	15.849	0.095093	3.9811	6.8954	7.5536
13	19.953	0.119716	4.4668	7.7368	8.4752
14	25.119	0.150713	5.0119	8.6808	9.5094
15	31.623	0.189747	5.6234	9.7400	10.670
16	39.811	0.238865	6.3096	10.9285	11.972
17	50.119	0.30071	7.0795	12.2620	13.433
18	63.096	0.37857	7.9433	13.7582	15.071
19	79.433	0.47660	8.9125	15.4369	16.910
20	100.000	0.60000	10.0000	17.3205	18.974
21	125.89	0.75535	11.220	19.434	21.289
22	158.49	0.95093	12.589	21.805	23.886
23	199.53	1.19716	14.125	24.466	26.801
24	251.19	1.50713	15.849	27.451	30.071
25	316.23	1.89747	17.783	30.801	33.741
26	398.11	2.38865	19.953	34.559	37.867
27	501.19	3.0071	22.387	38.776	42.477
28	630.96	3.7857	25.119	43.507	47.660
29	794.33	4.7660	28.184	48.816	53.475
30	1000.00	6.0000	31.623	54.772	60.000
31	1258.9	7.5535	35.481	61.455	67.321
32	1584.9	9.5093	39.811	68.954	75.536
33	1995.3	11.9716	44.668	77.368	84.752
34	2511.9	15.0713	50.119	86.808	95.094
35	3162.3	18.9747	56.234	97.400	106.70
36	3981.1	23.8865	63.096	109.285	119.72
37	5011.9	30.071	70.795	122.620	134.33
38	6309.6	37.857	79.433	137.582	150.71
39	7943.3	47.660	89.125	154.369	169.10
40	10000.0	60.000	100.000	173.205	189.74
41	12589.2	75.535	112.20	194.34	212.89
42	15848.9	95.093	125.89	218.05	238.86
43	19952.6	119.716	141.25	244.66	268.01
44	25118.9	150.713	158.49	274.51	300.71
45	31622.8	189.747	177.83	308.01	337.41
46	39810.7	238.865	199.53	345.59	378.67
47	50118.7	300.71	223.87	387.76	424.77
48	63095.7	378.57	251.19	435.07	476.60
49	79432.7	476.60	281.84	488.16	534.75
50	100000.0	600.00	316.25	547.72	600.00

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Figure 6. Decibel conversion chart.

+2 to +30 db	Set at $\frac{60 \text{ V.}}{+14 \text{ DB}}$
+16 to +44 db	Set at $\frac{300 \text{ V.}}{+28 \text{ DB}}$
+22 to +50 db	Set at $\frac{600 \text{ V.}}{+34 \text{ DB}}$

(3) Place on test lead into the —TEST tip jack and the other test lead into the +TEST tip jack.

(4) Read as follows:

—12 to +16 db	Read directly on DECIBEL scale
+2 to +30 db	Add +14 to reading on DECIBEL scale
+16 to +44 db	Add +28 to reading on DECIBEL scale
+22 to +50 db	Add +34 to reading on DECIBEL scale

b. Decibel Ranges, +28 to +56 and +42 to +70 db.

(1) Set circuit selector switch to AC.

(2) Set range selector switch to 600V.

(3) Insert one test lead into the —TEST tip jack and the other either into 1,200V AC-DC tip jack for the +28 to +58 db range, or into the 6,000V, 1,000 OHMS PER VOLT D.C. for the +42 to +70 db range.

(4) For the +28- to +55-db range, add +40 to the reading on the DECIBEL scale. For the +42- to +70-db range, add +54 to the reading on the DECIBEL scale.

22. MEASUREMENT OF LEAKAGE IN ELECTROLYTIC CAPACITORS.

The leakage in an electrolytic capacitor may be measured in terms of the current (per microfarad) flowing through the capacitor when d-c voltage is applied. All electrolytic capacitors have some current leakage.

a. Approximate allowable leakage are as follows:

(1) For capacitors rated at 300 volts or more, leakages of approximately 0.5 ma per microfarad (μf) are permissible.

(2) For capacitors rated between 100 to 275 volts, permissible leakage is approximately 0.2 ma per μf.

(3) For capacitors rated below 100 volts, permissible leakage is approximately 0.1 ma per μf.

b. The correct procedure is as follows:

(1) Disconnect the capacitor to be measured from the circuit.

(2) Check capacitor for short using 0 to 600,000 ohms range. See paragraph 19 on resistance measurements for procedure. Observe polarities. A very low resistance reading or a constant full scale deflection indicates a shorted capacitor. All shorted capacitors should be rejected without further test.

(3) Set circuit selector switch to D.C. 20,000 OHMS PER VOLT position.

(4) Set range selector switch to the 120 MA position.

(5) When an electrolytic capacitor is incorporated in a radio receiver to be tested, the necessary rated voltage is automatically applied. To test electrolytic capacitors not incorporated in a radio set, an external d-c power supply with voltage taps for the various d-c voltages required, will be needed. For a capacitor incorporated in a radio receiver, remove lead from positive (+) terminal of capacitor. Connect this lead to the +TEST tip jack and also connect the negative test lead from the —TEST tip jack to the positive (+) terminal of the electrolytic capacitor with a proper limiting resistor in series. For a capacitor not incorporated in a radio receiver, connect the positive terminal of d-c power supply to the +TEST tip jack, and connect the negative tip jack to the positive (+) terminal of the capacitor with a proper limiting resistor in series. For voltage above 100 volts, the limiting resistor should be approximately 4,000 ohms, while for voltages below 100 volts, the value of the limiting resistor should be approximately 900 ohms. Do not omit the limiting resistor. The voltage supply, test set, and electrolytic capacitor are in series.

(6) Turn on the switch of the radio set or d-c power supply, as the case may be. The meter pointer will deflect to nearly full scale and then gradually recede toward the zero mark, after about 3 minutes. This procedure is known as "forming" the capacitor.

> **NOTE:** A steady meter pointer indication without receding to or near zero, after forming process, indicates a shorted or leaky electrolyte and the capacitor should be rejected without further testing.

(7) After "forming", short out the limiting resistor and read current leakage of capacitor under test directly on the 0- to 120-ma scale. If meter indicates under 30 ma set the range selector switch to the 30 MA position for a meter reading, and read on the 0- to 30-ma scale. Compute permissible leakage from subparagraph a above. Never test a shorted capacitor for leakage because of possible damage to the meter.

(8) AFTER THIS TEST IS COMPLETED, DISCONNECT THE NEGATIVE TEST LEAD FROM THE CIRCUIT BEFORE TURNING OFF POWER SUPPLY TO PREVENT DAMAGE TO THE METER POINTER DUE TO DISCHARGE OF CAPACITOR UNDER TEST.

23. QUALITATIVE PAPER CAPACITOR TESTS.

The insulation resistance of paper or mica capacitors is too high to be measured by the test for electrolytic capacitors. For this test, a high d-c voltage may be necessary. This d-c potential may be obtained from an external high-voltage d-c power supply or from the power output tube socket of a radio receiver. The plate prong of the socket will be the positive high-voltage lead and the negative return or ground will be the negative lead. Apply rated voltage to the capacitor.

a. Set circuit selector switch to D.C. 20,000 OHMS PER VOLT.

b. Set range selector to the appropriate range to read rated voltage.

c. With the power supply off, insert the power supply output leads into the instrument tip jacks, observing correct polarities and insert the capacitor to be tested in series with one of these leads.

d. Turn on the power supply. For a good capacitor, there will be an instantaneous deflection of the pointer due to the charging of the capacitor, after which the needle point will recede to zero. If the capacitor remains above the zero mark it will indicate that the capacitor has abnormal leakage. A constant deflection indicates a shorted capacitor. No movement of needle indicates that the capacity is too low in value to cause a noticeable deflection while charging.

PART THREE

MAINTENANCE INSTRUCTIONS

SECTION VI.
PREVENTIVE MAINTENANCE TECHNIQUES

24. MEANING OF PREVENTIVE MAINTENANCE.

Preventive maintenance is a systematic series of operations performed at regular intervals on equipment, when turned off, to eliminate major break-downs, unwanted interruptions in service, and to keep equipment operating at top efficiency. To understand what is meant by preventive maintenance, it is necessary to distinguish between preventive maintenance, trouble shooting, and repair. The prime function of preventive maintenance is to *prevent break-downs* and, therefore, the need for repair. On the other hand, the prime function of trouble shooting and repair is to locate and correct *existing* defects. The importance of preventive maintenance cannot be overemphasized. The entire system of communications depends upon the readiness and operating efficiency of each item of equipment when it is needed. In a similar manner, the test equipment by which this condition of readiness in communications equipment is realized must be kept in excellent operating condition at all times.

> **NOTE:** The operations in sections VI and VII are user maintenance operations.

25. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES.

a. General. Most of the electrical parts used in test set (Espey model 100) require routine preventive maintenance. This preventive maintenance varies. Some parts require a different kind of maintenance than others. Some require more, some less. Definite and specific instructions must be followed. Hit-or-miss techniques cannot be applied. This section of the manual contains these specific instructions to guide personnel assigned to perform the six basic maintenance operations: Feel, Inspect, Tighten, Clean, Adjust, and Lubricate. Throughout this manual the lettering system for the six operations will be as follows:

F — Feel*
I — Inspect
T — Tighten
C — Clean
A — Adjust
L — Lubricate*

The first two operations show if the other four are needed. Selection of operations is based on a knowledge of field needs. For example, dust encountered on dirt roads during cross-country travel filters into equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the necessary tightening, cleaning, and lubricating operations, equipment becomes undependable and subject to break-down when it is needed most.

b. Feel*. The feel operation is used most often to determine whether transformers, large capacitors, and bushings are overheated, and whether electrical connections carrying more than 5 amperes are overheated. The maintenance man **must** become familiar with the normal operating temperature of the various electrical parts, to recognize signs of overheating.

NOTE: It is important to perform the Feel operation as soon as possible after shut-down and always before any other maintenance is done.

c. Inspect. Inspection is the most important operation in preventive maintenance. A careless observer will overlook evidences of minor trouble. Although these defects may not at the moment interfere with performance of the equipment, invaluable time and effort can be saved if they are corrected **before** they lead to major and costly break-downs. To be able to recognize the signs of a defective set, make every effort to become thoroughly familiar with indications of **normal** functioning. Inspection consists of **carefully** observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc. Inspect for the following conditions:

(1) Overheating, as indicated by discoloration, blistering, or bulging of the parts or surface of the container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(2) Placement, by observing that all leads and cabling are in their original positions.

(3) Cleanliness, by carefully examining all recesses in the units for accumulation of dust, especially between connecting terminals and binding posts. Parts, connections, and joints should be free from dust, corrosion, and other foreign matter. In tropical and high-humidity areas, look for fungus growth and mildew.

* The Feel and Lubricate operations do not apply to test set (Espey model 100).

(4) Tightness, by testing any connection or mounting which appears to be loose.

d. Tighten, Clean, and Adjust. These operations explain themselves. Specific procedures to be followed in performing them are given wherever necessary throughout part three.

> **CAUTION: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Whenever a loose connection is tightened, it should be moistureproofed and fungiproofed again by applying the varnish with a small brush. See Section IX for details of moistureproofing and fungiproofing.**

e. Lubricate*. Lubrication refers to the application of grease or oil to bearings or rotating shafts. It may mean the application of light oil to door hinges or other sliding surfaces on equipment.

26. CAPACITORS.

a. Inspect (I). Inspect the terminals of capacitors for corrosion and loose connections. Carefully inspect the mountings to discover loose mounting screws, studs, or brackets. Examine the leads for poor insulation, cracks, and evidences of dry rot. Cut away frayed strands on the insulation. If the wire is exposed, wrap it with friction tape.

b. Tighten (T). Tighten loose terminals, mountings, and connections on the capacitors, when necessary.

c. Clean (C). Clean the cases of fixed capacitors and all connections that are dirty or corroded. The capacitor cases can usually be cleaned with a dry cloth. However, if the deposit of dirt is hard to remove, moisten the cloth in dry-cleaning solvent (SD).

27. RESISTORS.

a. General. Various types of resistors are used in test set (Espey model 100). The connections to the various resistors are either of the pigtail or solder-lug type.

b. Inspect (I). Inspect the coating of the vitreous-enameled resistors for signs of cracks and chipping, especially at the ends. Examine the bodies of all types of resistors for blistering, discoloration, and other indications of overheating. Inspect leads and all other connections for corrosion, dirt, dust, looseness, and broken strands in the connecting wires. Check the security of all mountings. Do not attempt to move resistors with pigtail connections, because there is danger of breaking the connections at the point where they enter the body of the resistor. Such defects cannot be repaired.

* The Lubricate operation does not apply to test set (Espey model 100).

c. Tighten (T). Tighten resistor connections and mountings whenever they are found loose. If a resistor is allowed to remain loose, vibration may break the connection or damage the body.

d. Clean (C).

(1) Clean all carbon resistors with a small brush.

(2) The vitreous-enameled resistors must be kept clean to avoid leakage between the terminals. Wipe them with a dry cloth. However, if the dirt deposit is unusually hard to remove, use dry-cleaning solvent (SD).

(3) Resistors with discolored bodies cannot be cleaned. Discoloration indicates that there has been overloading and overheating at some time prior to the inspection. The discoloration is probably due to circuit trouble which requires analysis and correction. Trouble-shooting procedures are described in section XI.

28. SWITCHES.

a. Inspect (I).

(1) Inspect the mechanical action of each switch and, while so doing, look for signs of dirt or corrosion on all exposed elements.

(2) Examine ganged switches S1 and S2 to see that they are properly lubricated and that the contacts are clean. Inspection is visual. Do not pry the leaves of the switch apart. The rotary members should make good contact with the stationary members; and as the former slides into the latter, a spreading of the stationary contact leaves should be visible. Switch action should be free. Wiping action of contact usually removes any dirt at the point of contact.

b. Clean (C). Clean the exterior surfaces of switches with a stiff brush, moistened with dry-cleaning solvent (SD).

29. RHEOSTATS.

a. Inspect (I).

(1) Inspect the mechanical condition of rheostat R21. The arm should be keyed tightly to the shaft, and the shaft should turn easily in the bushing which supports it.

(2) Inspect the assembly and mounting screws, set screws, and nuts.

(3) Examine all metallic parts for dust, dirt, and corrosion.

b. Tighten (T). Tighten loose assembly or mounting screws.

c. Clean (C).

(1) Clean the exposed connections whenever they are dirty or corroded.

(2) Remove grease and dirt from the rheostat parts with carbon tetrachloride.

(3) Clean the body of the rheostat with a brush or cloth.

30. TERMINAL BLOCKS.

a. Inspect (I).

(1) Inspect terminal blocks for cracks, breakage, dirt, loose connections, and loose mounting screws.

(2) Carefully examine connections for mechanical defects, dirt, and corrosion.

b. Tighten (T). Tighten loose screws, lugs, and mounting bolts. When tightening screws, be sure to select a screwdriver of correct size. Do not exert too much pressure. Tighten loose connections.

c. Clean (C). Clean terminal blocks, when they require it, with a dry brush. When necessary, use a cloth moistened with dry-cleaning solvent (SD). Thoroughly wipe the block with a cloth and then brush it to remove any lint.

31. TEST LEADS.

The leads in test set (Espey model 100) are the life line of the equipment. Condition of the test leads must be closely observed.

a. Inspect (I). Inspect the test leads for cracked or deteriorated insulaiton, frayed or cut insulation at the connecting points, and improper placement or kinks which place the cables or connections under strain.

b. Clean (C). Clean pin tips on the test leads when they are dirty or corroded. Clean corroded connectors with #0000 sandpaper.

32. METER.

The meter is an extremely delicate instrument and must be handled carefully. It requires very little maintenance. It is a precision instrument and ordinarily cannot be repaired in the field.

a. Inspect (I). Inspect the leads and connections of the meter. Look for loose, dirty, and corroded connections. Look for cracked or broken cover glass. Since the movement of a meter is extremely delicate, its accuracy will be seriously affected if the glass is broken and dirt and water filter through.

b. Tighten (T). Tighten all connections found loose. Any loose meter wires should be inspected for dirt or corrosion before they are tightened. The tightening of meter connections requires a special technique because careless handling can easily crack the meter case.

c. Clean (C). Meter cases can usually be cleaned with a dry cloth. If cleaning is difficult, dampen the cloth with dry-cleaning solvent (SD). Clean dirty connections with a small brush dipped in dry-cleaning solvent (SD), or with a small piece of cloth dipped in the solvent.

d. Adjust (A). Normally, the meter in test set (Espey model 100) should indicate zero when the equipment is turned off. Before deciding that a meter needs readjusting, tap the meter case *lightly* with the tip of one finger. This will help the needle to overcome the slight friction which sometimes exists at the bearings and prevents an otherwise normal unit from coming to rest at zero. If adjustment is needed, insert the tip of the thinnest screwdriver available into the slotted screw head located below the meter glass and *slowly* turn the adjusting screw until the pointer is at zero. Lightly tap the meter case again and view the meter face and pointer *full on* and not from either side. Avoid turning the screw too far, because the needle may be bent or the hairspring damaged.

33. JACKS.

Jacks require very little attention, and then only at infrequent intervals. Occasionally it will be necessary to tighten a mounting nut, clean the contacts, or increase the spring tension. Remove dirt with a brush and carbon tetrachloride; remove corrosion with a piece of crocus cloth followed by a clean cloth. Increase spring tension, when necessary. Try the action of the jack after each adjustment. Be sure to keep all soldered connections intact.

34. BATTERIES.

a. Inspect (I). Inspect dry cells for signs of bulging, leakage of compound, or signs of electrolytic action. Moisture soon ruins improperly sealed dry cells. Inspect to see that connections are tight.

b. Clean (C). Keep batteries free of dirt, dampness, and corrosion. Wipe with a dry cloth.

35. CABINET.

a. Inspect (I). Inspect the outside and inside of the cabinet thoroughly. Check all hinges and catches for rust and dirt.

b. Clean (C). Clean the outside and inside of the case with a stiff brush and a dry cloth. Remove rust from metal parts with fine sandpaper and repaint if necessary.

SECTION VII.
ITEMIZED PREVENTIVE MAINTENANCE

36. INTRODUCTION.

For ease and efficiency of performance, preventive maintenance on test set (Espey model 100) will be broken down into operations that can be performed at different time intervals. In this section the preventive maintenance work to be performed on the test set at the specific time intervals is broken down into units of work called items. The general techniques involved and the application of the FITCAL operations in performing preventive maintenance on individual parts are discussed in section VI. These general instructions are not repeated in this section. When performing preventive maintenance, refer to section VI if more information is required for the following items. After preventive maintenance has been performed on a given day, put the equipment into operation and check it for satisfactory performance.

37. PREVENTIVE MAINTENANCE TOOLS AND MATERIALS.

The following preventive maintenance tools and materials will be needed:

Common hand tools.
Clean cloth.
Carbon tetrachloride.
#0000 sandpaper.
Paste metal polish (Signal Corps stock No. 6G1516).
Dry-cleaning solvent (SD).

NOTE: Gasoline will not be used as a cleaning fluid for any purpose. Solvent, Dry-cleaning, is available as a cleaning fluid through established supply channels. Oil, Fuel, Diesel, may be used for cleaning purposes when dry-cleaning solvent (SD) is not at hand. Carbon tetrachloride will be used as a cleaning fluid only in the following cases: on electrical equipment where inflammable solvents cannot be used because of the fire hazard, and for cleaning electrical contacts including relay contacts, plugs, commutators, etc.

38. ITEM 1, TEST LEADS.

OPERATIONS.

ITC	Prods
ITC	Cords
ITC	Pin tips

REMARKS. Inspect the insulation on the cords particularly where the cord enters the test prod. Damaged insulation may cause shock to the operator.

39. ITEM 2, INTERIOR OF TEST SET.

OPERATIONS.

ITC	Resistors
ITC	Capacitors
ITC	Rheostats and potentiometers
ITC	Terminal blocks
ITC	Switches
ITCA	Meter
ITC	Jacks
ITC	Batteries
ITC	Cabinet and chassis

40. ITEM 3, EXTERIOR OF TEST SET.

OPERATIONS.

ITC	Pin jacks
ICA	Meter
ITC	Knobs
IC	Cabinet
ITC	Hinges and catch

41. PREVENTIVE MAINTENANCE CHECK LIST.

The following check list is a summary of the preventive maintenance operations to be performed on test set (Espey model 100). The time intervals shown on the check list may be reduced at any time by the local commander. For best performance of the equipment, perform operations at least as frequently as called for in the check list. Operations are indicated by the letters of the word FITCAL. For example, if the letters ITCA appear in the operations column, the item to be treated must be inspected (I), tightened (T), cleaned (C), and adjusted (A).

Item No.	Operations	Item	When performed		
			Daily	Weekly	Monthly
1	ITC	Test leads		X	
2	ITCA	Interior of test set			X
3	ITCA	Exterior of test set	X		

NOTE: X indicates when operations are to be performed.

F	I	T	C	A	L
Feel*	Inspect	Tighten	Clean	Adjust	Lubricate*

SECTION VIII. LUBRICATION

Lubrication for test set (Espey model 100) is not required.

* The Feel and Lubricate operations do not apply to test set (Espey model 100).

SECTION IX.
MOISTUREPROOFING AND FUNGIPROOFING

42. GENERAL.

a. When equipment is operated in highly humid climates, excessive failure of parts and decreased operating efficiency are usually caused by the accumulated effects of moisture, rather than by inferior parts. Rapid temperature changes accompanied by fog, rain, dew, or high humidity promote such failures.

b. The effects of moisture on resistors, capacitors, coils, chokes, transformer windings, terminal boards, and insulating strips can be recognized in the form of corrosion, low insulation resistance, and flash-overs. Moisture also accelerates fungus growth which increases these effects.

43. REDUCING FAILURES.

a. A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. The treatment consists of applying a film of moisture- and fungi-resistant varnish to all susceptible parts of the equipment. This film provides a nonwetting surface. Equipments which have been treated have been marked with the letters MFP and the date of treatment. Equipments not marked should be examined, and if treatment has not been applied, the equipment should be returned to third or higher echelon maintenance units for treatment.

b. TB SIG 13 (and Changes), Moistureproofing and Fungiproofing Signal Corps Equipment, contains a detailed description of this treatment.

c. Re-treatment may be required after a period of use. Need for this re-treatment is indicated by ecxessive failures or by the effects listed in paragraph 42b.

44. TREATING TEST SET (ESPEY MODEL 100).

Use the procedure outlined in TB SIG 13 (and Changes) to moistureproof and fungiproof the test set. Refer to par. 8 of this manual for disassembly information.

45. TREATING EQUIPMENT AFTER REPAIRS.

If the coating of protective varnish has been punctured or broken during repair and if complete treatment is not needed to reseal the equipment, brush-coat the affected part. Be sure the break is completely sealed.

PART FOUR

AUXILIARY EQUIPMENT

NOT USED

PART FIVE

REPAIR INSTRUCTIONS

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report); by Army Air Forces, on Army Air Forces Form No. 54 (Unsatisfactory Report).

SECTION X. THEORY OF EQUIPMENT

46. GENERAL THEORY.

The basic component of the test set is a 50-microampere meter. By using a combination of series and shunt resistors with the basic meter, a wide range of voltage and current can be read.

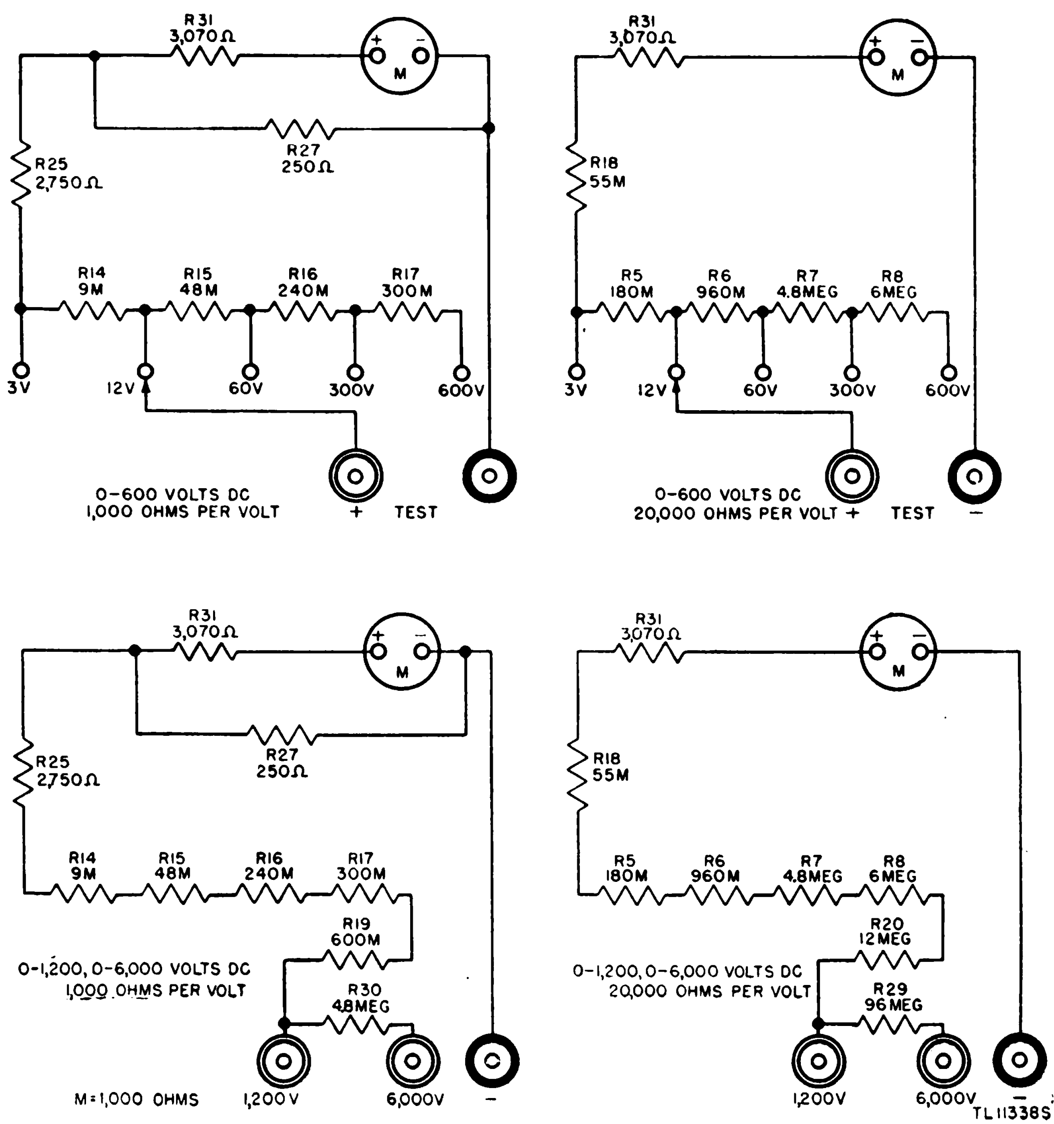
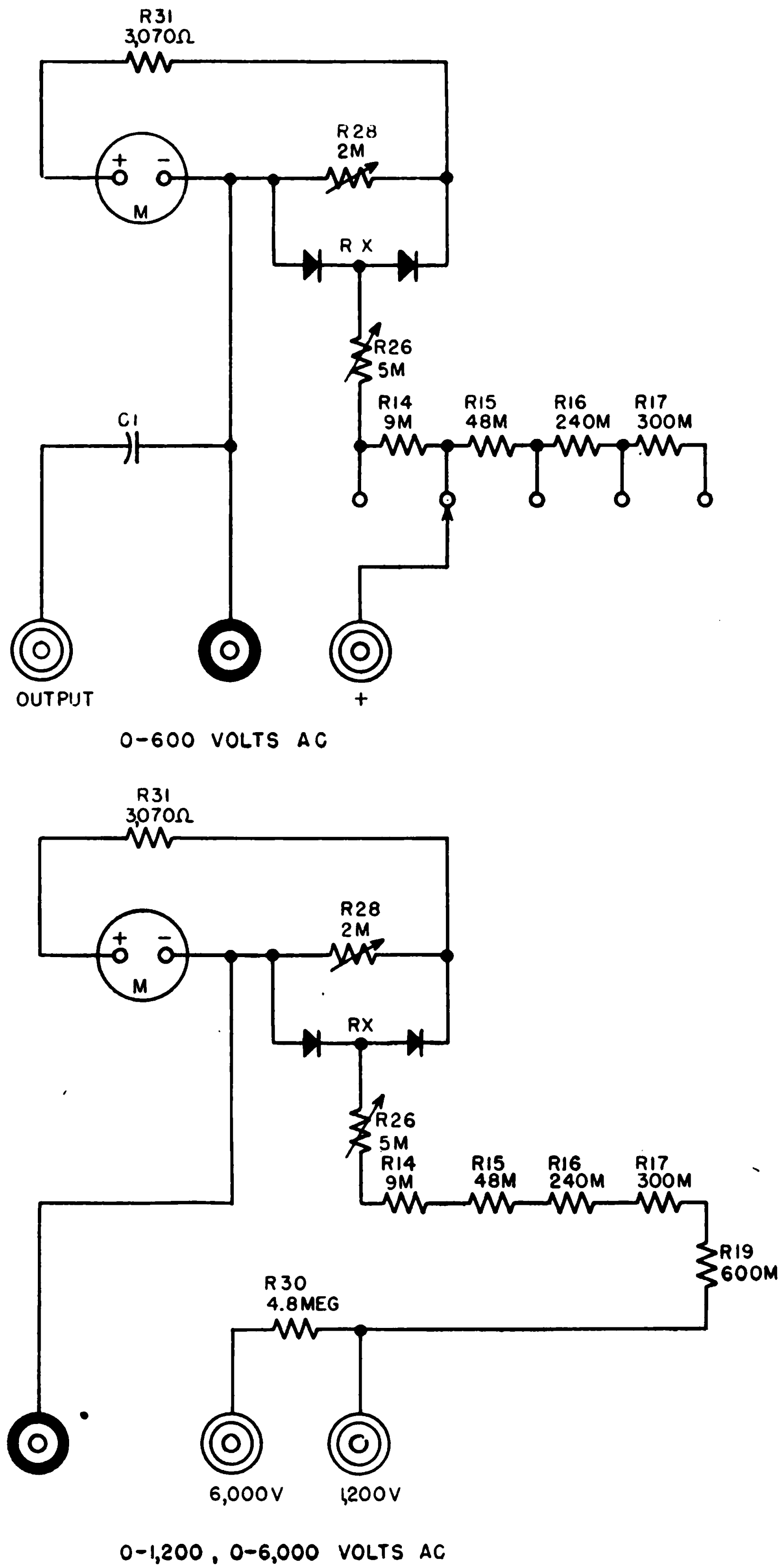


Figure 7. Simplified schematic of d-c voltage measuring circuits.



NOTE: ⊥ IS SYMBOL FOR FIXED CAPACITOR.

M=1,000Ω

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Figure 8. Simplified schematic of a-c voltage measuring circuits.

a. Test Set as a D-c Voltmeter (fig. 7). When the test set is used on the 3-volt range (1,000 OHMS PER VOLT) (fig. 4), the + and — TEST jacks are connected to the meter through resistor R25, resistor R31 which is permanently connected in series with the meter, and resistor R27 which is shunted across the meter and resistor R31. The 12-, 60-, 300-, and 600-volt ranges are read by successively adding resistors R14, R15, R16, and R17 in series with the meter as multipliers. When using the test set with the circuit selector switch at 20,000 OHMS PER VOLT (fig. 5), the shunting resistor R27 is taken out of the circuit and a higher value of multiplying resistors R5, R6, R7, R8 are switched in series with the meter. The 6,000- and 1,200-volt range is reached through separate + / jack which connect R29 and R30 in series with the meter.

b. Test Set as an A-c Voltmeter (fig. 8). A-c voltage is read the same as d-c voltage except that rectifier Rx is connected in series with the meter to convert the alternating current to direct current. The same set of multiplier and shunt resistors are used as in the 1,000 ohms per volt d-c voltage measurement.

c. Test Set as an Ohmmeter (fig. 9). The two lower ranges of resistance, 6,000 and 600,000 ohms, are read by connecting the 1½-volt battery in series with resistors R11 and R12 and the resistance to be measured. The current flowing through the meter with the test leads shorted can be adjusted to full scale reading by the OHMS ADJUST potentiometer. Any resistance placed

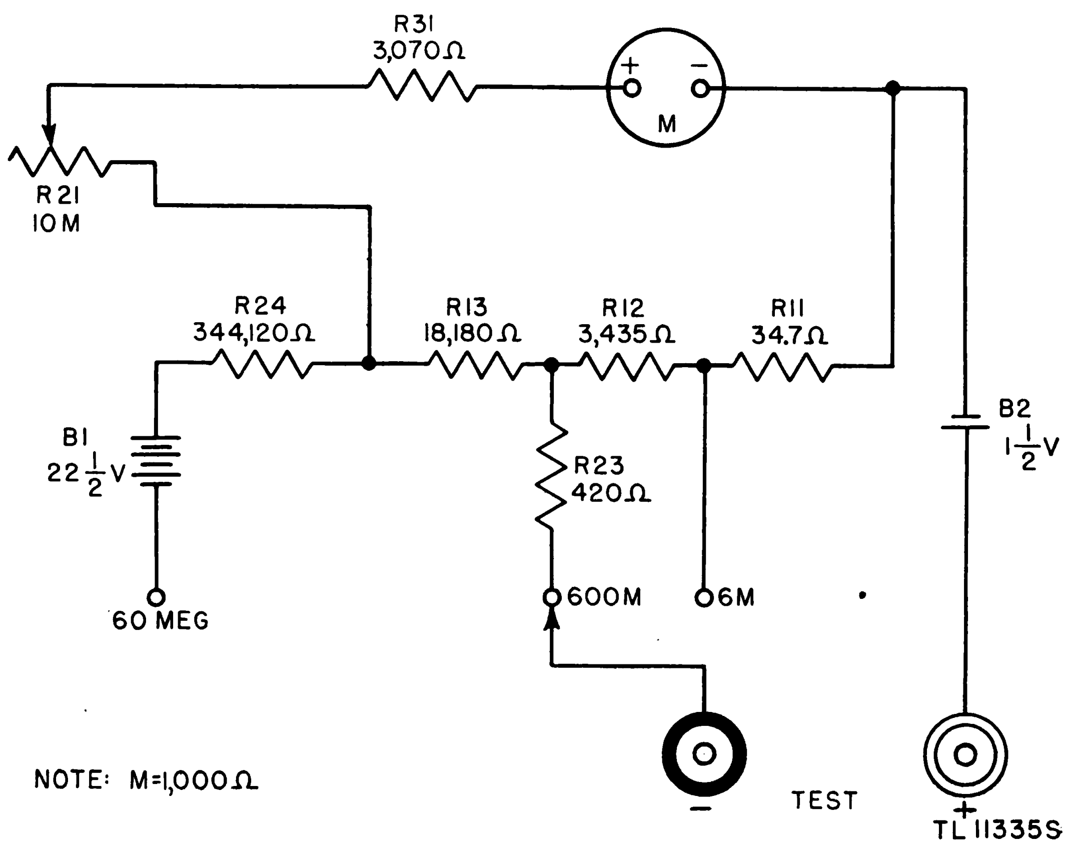

Figure 9. Simplified schematic of ohmmeter circuit.

across the + and — TEST jacks will cause a relative change in current flow through the meter and as the meter is calibrated in ohms the value can be read directly. For the 60-meg scale a 22½-volt battery and resistor R24 is added into the circuit.

d. Test Set as a Milliammeter (fig. 10). By using the current positions of the range selector switch, current as high as 600 ma can be read. This is accomplished by switching in resistors in shunt to the meter. The extremely high and low ranges of current are read in a similar manner except that the connections to the meter are brought out to special terminals.

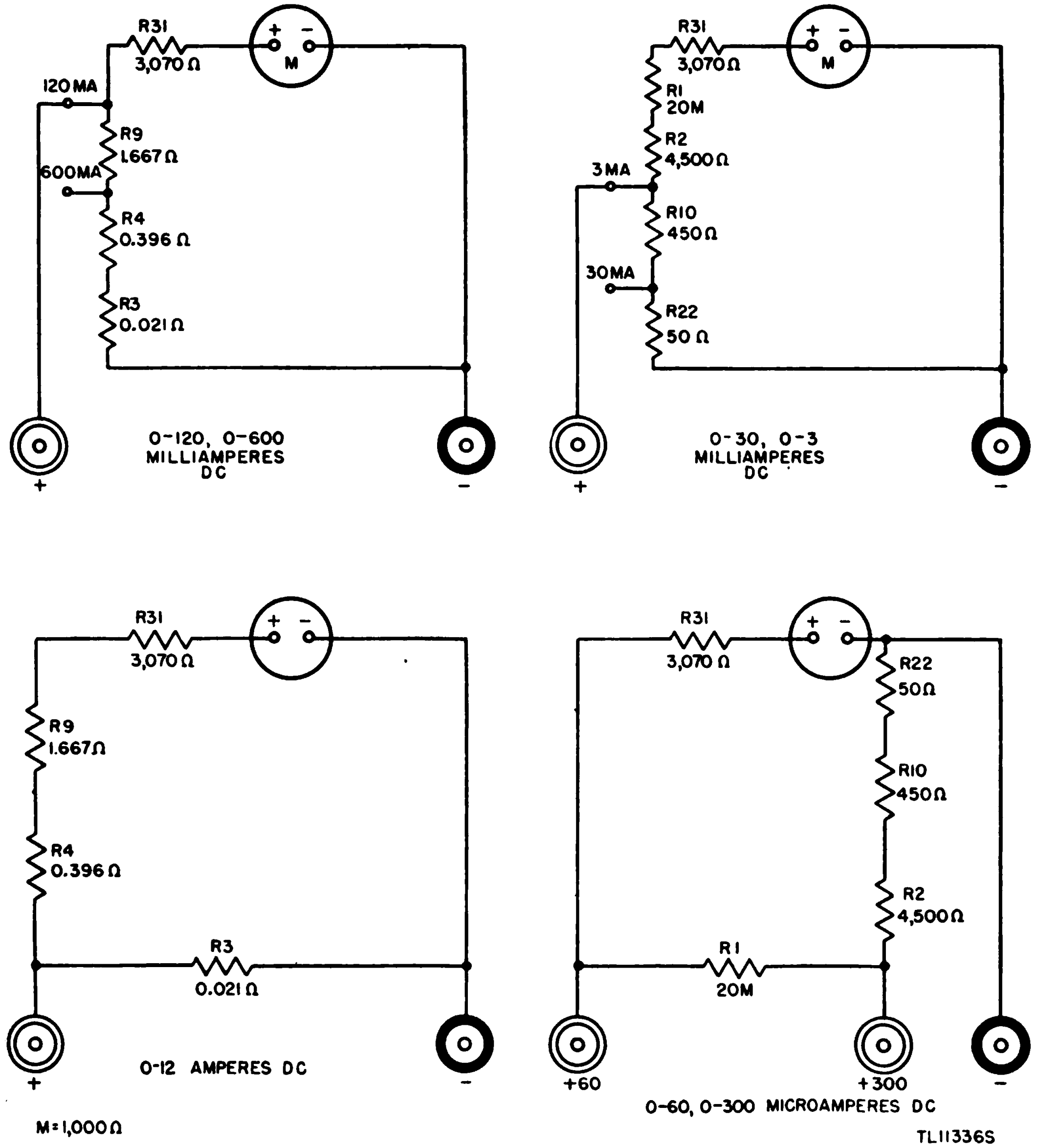

Figure 10. Simplified schematic of d-c current measuring circuits.

SECTION XI. TROUBLE-SHOOTING PROCEDURES

47. GENERAL TROUBLE-SHOOTING INFORMATION.

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in this highly important duty of trouble shooting.

a. Trouble-shooting Data. Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following trouble-shooting data:

(1) Complete schematic diagram (fig. 14).

(2) Simplified and partial schematic diagrams. These diagrams are particularly useful in trouble shooting, because the repairman can follow the electrical functioning of the circuits more quickly than on the regular schematics, thus speeding trouble location.

(3) Illustrations of components. Front, top, and bottom views which aid in locating and identifying parts.

b. Trouble-shooting Steps. The first step in servicing a defective set is to sectionalize the fault. Sectionalization means tracing the fault to the circuit responsible for the abnormal operation. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition.

48. METER TESTING.

To test the meter movement, take the following steps:

a. Remove the instrument from the cabinet.

b. Inspect the leads to the meter for breaks and loose or corroded connections. If they appear normal, disconnect them from the meter terminals.

c. Check the resistance between the two leads which were removed from the meter. If a short circuit is indicated, test the leads and the selector switches. If the leads and switches are normal, check the meter movement as explained below.

d. Connect a 60,000-ohm resistor, a 1.5-volt battery, and the meter in series, observing proper polarity. All other meter leads must be disconnected. The meter should show approximately half-scale deflection. If it does not, the meter is defective and must be replaced.

CAUTION: Never use a higher voltage or lower resistance than specified or the meter will be damaged.

49. TROUBLE-SHOOTING CHART.

A. SYMPTOM:

All meter ranges inaccurate or completely inoperative.

Probable Location of Fault	Procedure
1. Defective meter.	1. Refer to paragraph 48.
2. Defective series resistor.	2. Check resistor R31.
3. Open test leads.	3. Check test leads for continuity.

B. SYMPTOM:

Inaccurate or no reading on 0- to 3-, 0- to 12-, 0- to 60-, 0- to 120-, and 0- to 600-volt range.

Probable Location of Fault	Procedure
1. Defective range selector switch.	1. Check connections to range selector switch and examine contacts for weak or bent springs.
2. Defective circuit selector switch.	2. Check connections to circuit selector switch and examine contacts for weak or bent springs.
3. Defective shunt resistor.	3. Check resistor R27.
4. Defective multiplier resistor.	4. Check resistors R5, R6, R7, R8, R14, R15, R16, R17, R18, and R25. See figures 6 and 7.

C. SYMPTOM:

Inaccurate or no reading on 0- to 3-, 0- to 30-, 0- to 120-, 0- to 600-d-c current ranges.

Probable Location of Fault	Procedure
1. Defective range selector switch.	1. See b1 above.
2. Defective circuit selector switch.	2. See b2 above.
3. Defective shunt resistors.	3. Check resistors R9, R10, R22, R1, R2, R3, and R4.

D. SYMPTOM:

Inaccurate or no reading on 0- to 1-, 200-, and 6,000-volt d-c ranges only.

Probable Location of Fault	Procedure
1. Defective multiplier resistors.	1. Check chain of multiplier resistors making up R29 and R30. Check resistor R20 on 20,000-ohm-per-volt range and R19 on the 1,000-ohm-per-volt range.

E. SYMPTOM:

Inaccurate or no reading on a-c voltage ranges only.

Probable Location of Fault	Procedure
1. Defective rectifier.	1. Examine rectifier RX for signs of damage or overheating.
2. Defective calibration potentiometers.	2. Check resistor R28 and R26.

F. SYMPTOM:

Inaccurate or no reading on 0- to 60- and 0- to 300-microampere range only.

Probable Location of Fault	Procedure
1. Defective shunt resistors.	1. Check resistors R1 and R2.

G. SYMPTOM:

Inaccurate or no reading on 0- to 12-ampere range only.

Probable Location of Fault	Procedure
1. Defective shunt resistor.	1. Check resistors R3 and R4.

H. SYMPTOM:

Inaccurate or no reading on the ohmmeter ranges only.

Probable Location of Fault	Procedure
1. Defective batteries.	1. Check battery B1 and B2 for voltage under load.

2. Defective resistors.	2. Check resistors R11, R12, R13, and R23.
3. Defective OHMS ADJUST control.	3. Check resistors R21 and R24.

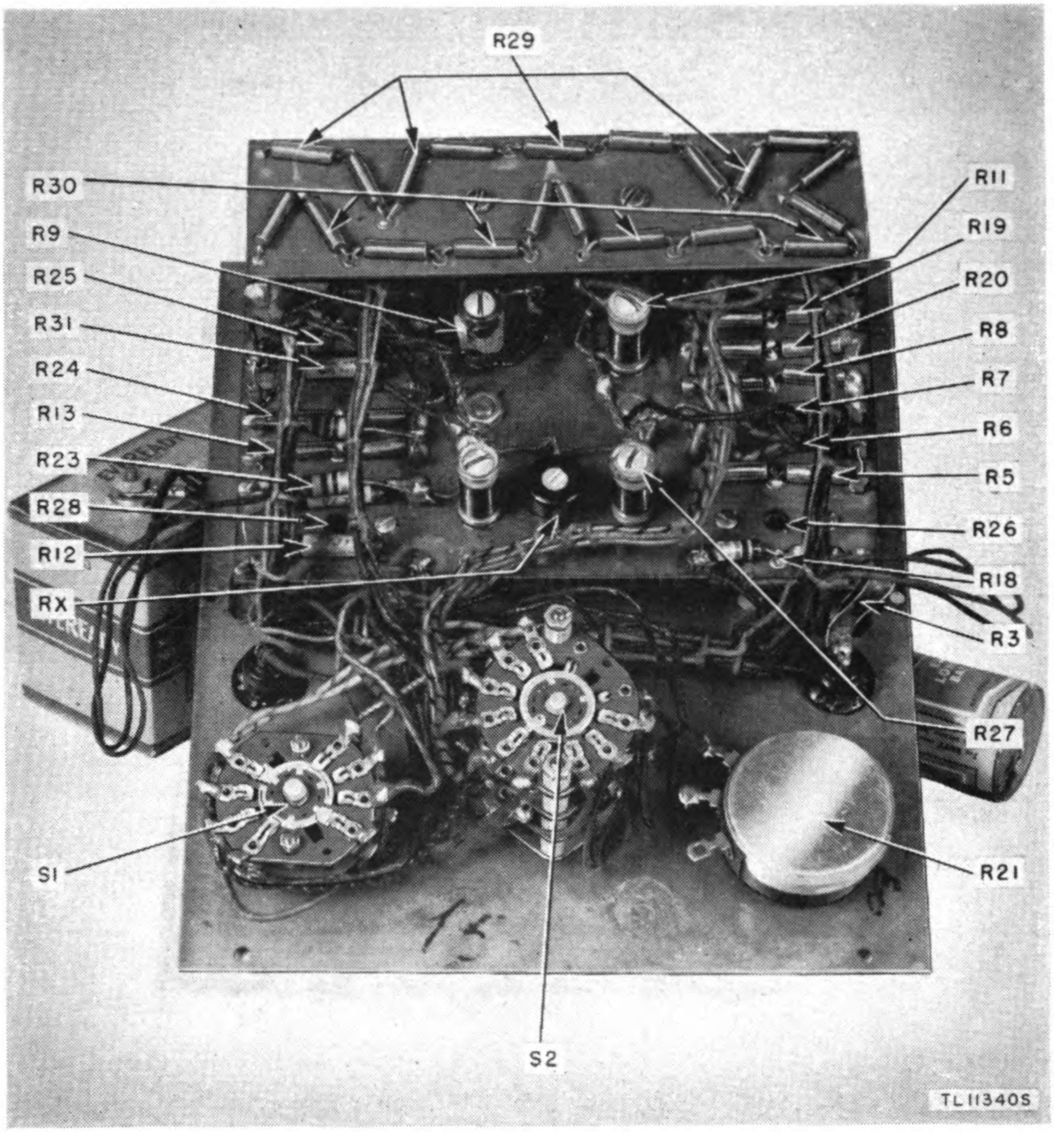

Figure 11. Bottom view of panel.

SECTION XII. REPAIRS

50. SERVICING.

Be careful in maintaining and servicing this equipment. Servicing and repair other than the replacement of batteries should be performed only by competent personnel supplied with adequate tools and instruments. An inexperienced operator attempting to locate and repair troubles may damage the equipment to such an extent that shipment to a higher repair echelon will be necessary.

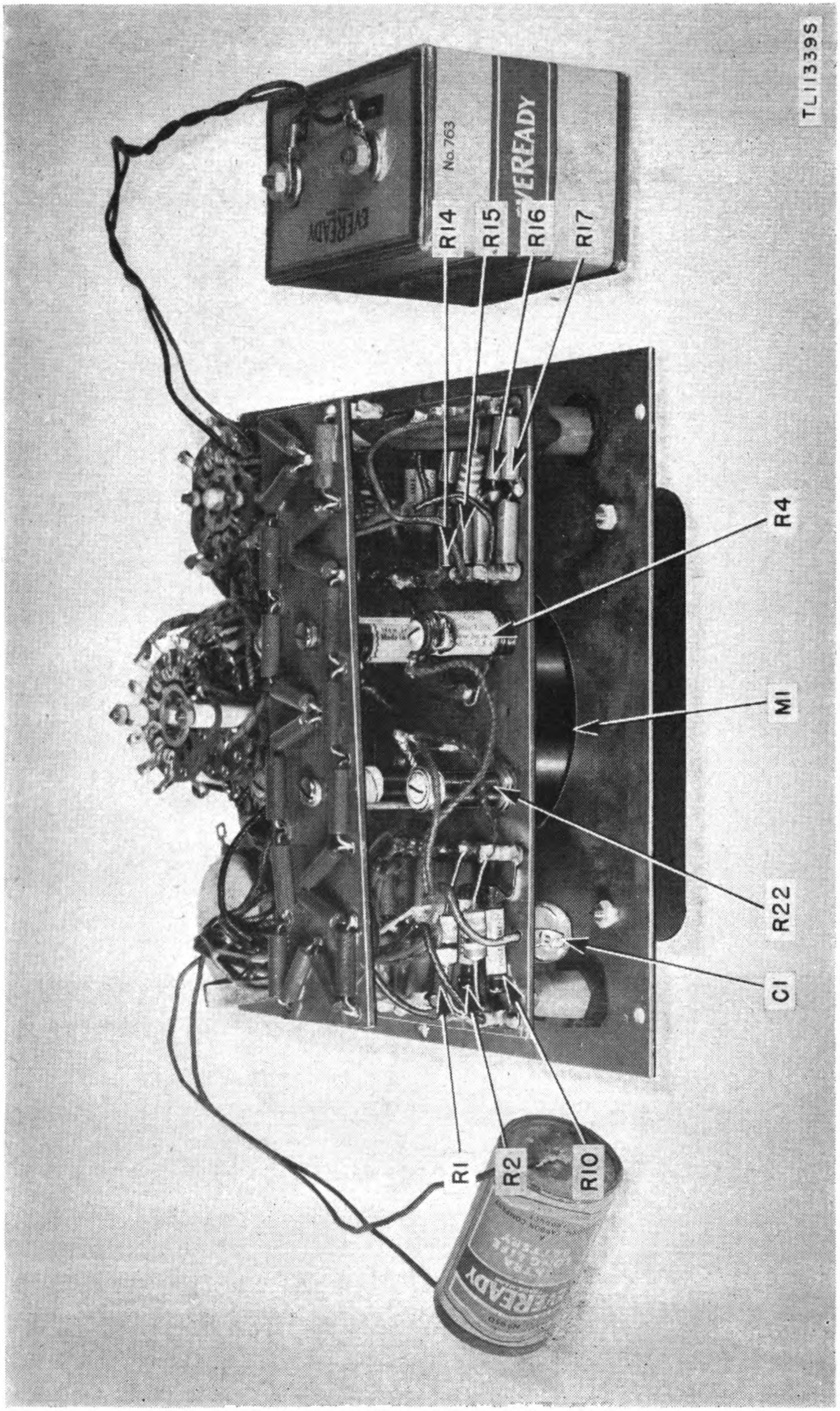

Figure 12. Bottom view of panel.

51. GENERAL REPAIR.

Removal and replacement of defective parts or circuit elements in this equipment are very difficult; great care must be taken to avoid further damage to the equipment or to the part being replaced. Before attempting repairs make every effort to obtain the proper tools for the job.

a. Identification of Leads. Often it may be necessary to remove other circuit elements to gain access to the defective part. To insure proper rein-

WAR DEPARTMENT

UNSATISFACTORY EQUIPMENT REPORT

FOR	TECHNICAL SERVICE: Signal Corps	**MATÉRIEL**	DATE: 1 Feb 45
FROM	ORGANIZATION: 175 Signal Repair Co		STATION: APO 102
TO	NEXT SUPERIOR HEADQUARTERS: Supply Sec, Hq Fourth Army Sig Sv	STATION: APO 110	TECHNICAL SERVICE: Signal Corps

COMPLETE MAJOR ITEM

NOMENCLATURE: Radio Transmitter BC-123-A	TYPE: Ground, vehicular		MODEL: A
MANUFACTURER: American Radio Corp	U. S. A. REG. NO. Order No. 1234-Phila-45	SERIAL NO. 12345	DATE RECEIVED: 5 Jan 45
EQUIPMENT WITH WHICH USED (If applicable): Radio Set SCR-456-A in Tank, Medium, M4			

DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE

PART NO. Sig C Stk No. 3E47-2	TYPE: Capacitor C20; fixed; 1-mf; 500 vdcw	MANUFACTURER: American Radio Corp	DATE INSTALLED: When manufactured

DESCRIPTION OF FAILURE AND PROBABLE CAUSE (If additional space is required, use back of form)

Capacitor C20 shorts out due to humid operating conditions

DATE OF INITIAL TROUBLE	TOTAL TIME INSTALLED			TOTAL PERIOD OF OPERATION BEFORE FAILURE					
	YEARS	MONTHS	DAYS	YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
15 Jan 45	-	-	-	0	0	5		-	-

BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN

Operation in tropics; heavy rainfall. Was replaced and set given moistureproofing and fungiproofing treatment, 20 Jan 45.

TRAINING OR SKILL OF USING PERSONNEL			RECOMMENDATIONS (If additional space is required, use back of form)
POOR	FAIR	GOOD	
		X	Substitute capacitor designed for tropical operation

ORIGINATING OFFICER

TYPED NAME, GRADE, AND ORGANIZATION	SIGNATURE
E.A. Wilson, 1st Lt, Sig C 175 Signal Repair Co	E. A. Wilson

FIRST ENDORSEMENT

TO CHIEF	TECHNICAL SERVICE	OFFICE	
NAME, GRADE, AND STATION		STATION	DATE

Instructions

1. It is imperative that the chief of technical service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.
2. This form will be used for reporting manufacturing, design, or operational defects in matériel, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of matériel.
3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records.
4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (change No. 3).
5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable.
6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.
7. This form will be made out in triplicate by using or service organization. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels.
8. Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468
30 August 1944

This form supersedes W. D., A. G. O. Form No. 468, 1 December 1943, which may be used until existing stocks are exhausted.

U. S. GOVERNMENT PRINTING OFFICE 16—41540-1

TL19589C

Figure 13. Sample of W.D.. A.G.O. Form 468.

stallation, make a record of the connections to each removed element and of the position of the element in the equipment.

b. Electrical Connections. When replacing leads, clip them as short as possible for satisfactory connection and use only enough solder to make a secure connection. A very slight amount of excess solder dropped accidentally inside the equipment may cause other circuits or circuit elements to be short-circuited. Some clearances are very small, and extreme care must be

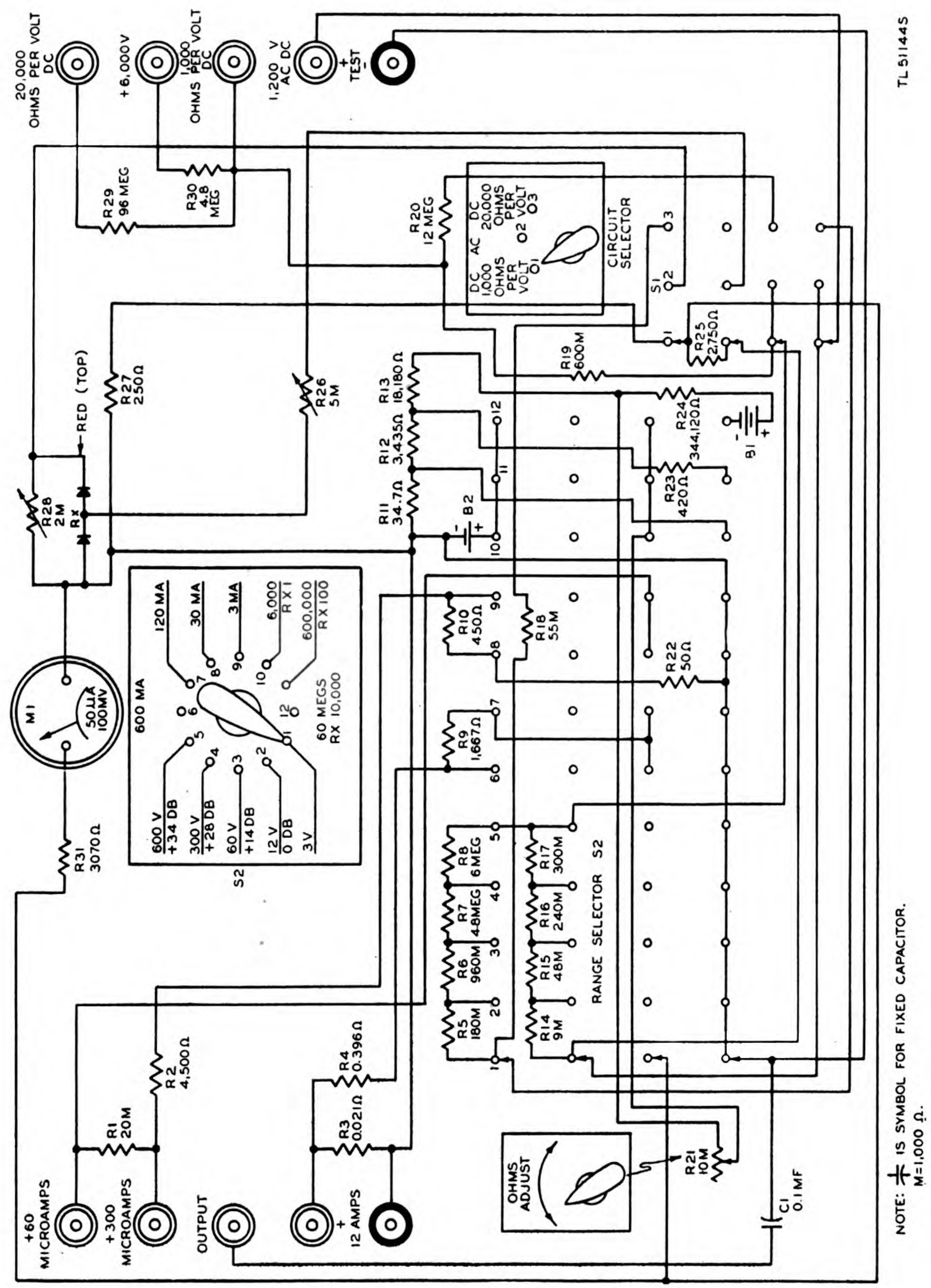

Figure 14. Test set, schematic diagram.

exercised in soldering. Do not heat the lug or connection more than is absolutely necessary; otherwise, near-by elements may be damaged.

52. UNSATISFACTORY EQUIPMENT REPORT.

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, War Department Unsatisfactory Equipment Report, W.D., A.G.O. Form No. 468 should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form No. 54 should be filled out and forwarded through channels.

APPENDIX

SECTION XIII. REFERENCES

NOTE: For availability of items listed, check FM 21-6 and ASF Catalog SIG 2. Also see FM 21-6 for applicable technical bulletins, supply bulletins, modification work orders, and Changes.

53. ARMY REGULATIONS.

AR 380-5	Safeguarding Military Information.

54. SUPPLY PUBLICATIONS.

SIG 1	Introduction to ASF Signal Supply Catalog.
SIG 3	List of Items for Troop Issue.
SIG 4-1	Allowances of Expendable Supplies.
SIG 4-2	Allowances of Expendable Supplies for Schools, Training Centers, and Boards.
SIG 5	Stock List of All Items.
SB 11-6	Dry Battery Supply Data.
SB 11-10	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.
SB 11-17	Electron Tube Supply Data.

55. TECHNICAL MANUALS ON AUXILIARY EQUIPMENT AND TEST EQUIPMENT.

TM 11-303	Test Sets I-56-C, -D, -H, and -J.
TM 11-321	Test Set I-56-E.
TM 11-472	Repair and Calibration of Electrical Measuring Instruments.
TM 11-2613	Voltohmmeter I-166.
TM 11-2626	Test Unit I-176.

56. PAINTING, PRESERVING, AND LUBRICATION.

TB SIG 6	A Method of Prolonging the Life of Dry Batteries.
TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.

57. SHIPPING INSTRUCTIONS.

U. S. Army spec No. 100-14A.	Army-Navy General Specification for Packaging and Packing for Overseas Shipment.

58. DECONTAMINATION.

TM 3-220	Decontamination.

59. DEMOLITION.

FM 5-25	Explosives and Demolitions.

60. OTHER PUBLICATIONS.

TB SIG 25	Preventive Maintenance for Power Cords.
TB SIG 66	Winter Maintenance of Ground Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.
TM 1-455	Electrical Fundamentals.
TM 11-310	Schematic Diagrams for Maintenance of Ground Radio Communications Sets.
TM 11-453	Shop Work.
TM 11-455	Radio Fundamentals.
TM 11-486	Electrical Communication Systems Engineering.
TM 11-496	Training Text and Applicatory Exercises for Amplitude-modulated Radio Sets.
TM 11-4000	Trouble Shooting and Repair of Radio Equipment.
TM 37-250	Basic Maintenance Manual.

61. FORMS.

W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report).
Army Air Forces Form No. 54 (Unsatisfactory Report).

62. ABBREVIATIONS.

a-c	alternating-current
amp	ampere
d-c	direct-current
db	decibel

JAN	Joint Army-Navy. (Also prefix designation for electrical components procured under Joint Army-Navy specifications.)
M	1,000 ohms
ma	milliampere
meg	megohm
mf	microfarad
v	volt
Ω	ohms

63. GLOSSARY.

Refer to glossary in TM 11-455, Radio Fundamentals.

SECTION XIV. MAINTENANCE PARTS

64. MAINTENANCE PARTS FOR TEST SET (ESPEY MODEL 100).

The following information was compiled on 10 October 1945. Maintenance parts are not authorized for Test Set (Espey model 100).

Order No. 53900-Phila-45-10; 1,260 copies; 8 Nov 45.

JOINT ARMY-NAVY TYPE DESIGNATION CODES FOR ELECTRICAL COMPONENTS

INTRODUCTION: Fixed and variable resistors and fixed capacitors manufactured under JAN specifications may be labeled with a *type designation code* instead of a color code or actual electrical value. For resistors and capacitors marked with the JAN type designation code, electrical values and other data can be determined by consulting the following information.

RESISTORS

FIXED, COMPOSITION

RC	10	AE	153	M
COMPONENT	STYLE	*CHARACTERISTIC	RESISTANCE	*TOLERANCE

COMPONENT: RC signifies *fixed, composition resistor.*

STYLE: A two-digit symbol indicates power rating and physical size.

Resistor style	Wattage
RC10, RC15, RC16	¼ WATT
RC20, RC21, RC25	½ WATT
RC30, RC31, RC35, RC38	1 WATT
RC40, RC41, RC45	2 WATTS
RC65	4 WATTS
RC75, RC76	5 WATTS

RESISTANCE: A three-digit symbol indicates the resistance value in ohms. The first two digits give the first two figures of the resistance value; the third digit gives the number of zeros which follow the first two figures.

RESISTORS

VARIABLE, WIRE-WOUND

RA	15	A	1	RH	103	A	K
COMPONENT	STYLE	SWITCH	*TORQUE	*SHAFT	RESISTANCE	*TAPER	*TOLERANCE

COMPONENT: RA signifies *variable, wire-wound resistor.*

STYLE: A two-digit symbol indicates power rating and physical size and shape.

SWITCH: Symbol A indicates no switch. Symbol B indicates a switch turned ON at start of clockwise rotation.

RESISTANCE: A three-digit symbol indicates the resistance value in ohms. The first two digits give the first two figures of the resistance value; the final digit gives the number of zeros which follow the first two figures. The letter *R* may be substituted to represent a decimal point; but when *R* is used, the last digit of the group becomes significant.

RHEOSTATS

WIRE-WOUND, POWER-TYPE

RP	35	2	FD	252	KK
COMPONENT	STYLE	OFF POSITION	*SHAFT	RESISTANCE	*TOLERANCE

COMPONENT: RP signifies all *rheostats.*

STYLE: Same as for variable, wire-wound resistors.

OFF POSITION:

Numeral	OFF position
1	None.
2	At end of counterclockwise rotation.
3	At end of clockwise rotation.

RESISTANCE: Same as for variable, wire-wound resistors.

*Items starred are of interest primarily to depot and higher echelon repair personnel.

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CAPACITORS

FIXED, MICA-DIELECTRIC

CM	20	B	511	K
COMPONENT	CASE	*CHARACTERISTIC	CAPACITANCE	*TOLERANCE

COMPONENT: CM signifies *fixed, mica-dielectric capacitor.*

CASE: A two-digit symbol identifies a physical case size and shape.

CAPACITANCE: A three-digit symbol indicates the capacitance value in micromicrofarads. The first two digits give the first two figures of the capacitance value; the final digit gives the number of zeros which follow the first two figures. When more than two significant figures are required, additional digits may be used, the last digit always indicating the number of zeros.

D-C WORKING VOLTAGE FOR CAPACITANCE RANGE

Case	Capacitance range	Vdcw
CM20	5-510 mmf	500
CM25	5-1,000 mmf	500
CM30	470-3,300 mmf	500
CM35	470-6,200 mmf	500
	6,800-10,000 mmf	500
CM40	3,300-8,200 mmf	500
	9,100-10,000 mmf	300

NOTE: Working voltages for capacitors above CM40 are stamped on the case.

The d-c working voltage of a capacitor can be determined from the above table when the case size and value of capacitance are known.

CAPACITORS

FIXED, MOLDED, PAPER-DIELECTRIC†

CN	36	A	302
COMPONENT	CASE	*CHARACTERISTIC	CAPACITANCE

COMPONENT: CN signifies *fixed, molded, paper-dielectric capacitor.*

CASE: Same as for fixed, mica-dielectric capacitors.

CAPACITANCE: A three-digit symbol indicates the capacitance value in micromicrofarads. The first two digits give the first two figures of the capacitance value; the third digit gives the number of zeros which follow the first two figures.

D-C WORKING VOLTAGE FOR CAPACITANCE RANGE

Case	Capacitance	Vdcw
CN35	3,000 mmf	800
	6,000 mmf	600
	10,000 mmf	400
CN36	3,000 mmf	400
	6,000 mmf	400
	10,000 mmf	300
CN40	3,000 mmf	400
	6,000 mmf	300
	10,000 mmf	300
CN41	3,000 mmf	600
	6,000 mmf	600
	10,000 mmf	400

The d-c working voltage of a capacitor can be determined from the above table when the case size and value of capacitance are known.

CAPACITORS

FIXED, CERAMIC-DIELECTRIC

CC	20	AH	100	G
COMPONENT	CASE	*CHARACTERISTIC	CAPACITANCE	*TOLERANCE

COMPONENT: CC signifies *fixed, ceramic-dielectric capacitor.*

CASE: Same as for fixed, mica-dielectric capacitors.

CAPACITANCE: Same as for fixed, molded, paper-dielectric capacitors.

NOTE: All fixed, ceramic-dielectric capacitors have a working voltage of 500 volts, d-c.

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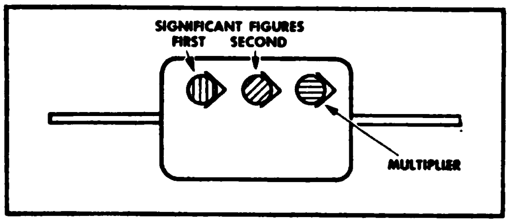
*Items starred are of interest primarily to depot and higher echelon repair personnel.

†This is not a JAN specification. These capacitors are covered by AWS C75/221.

TL 18142

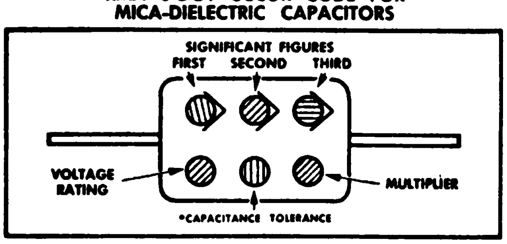
CAPACITOR COLOR CODES

RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

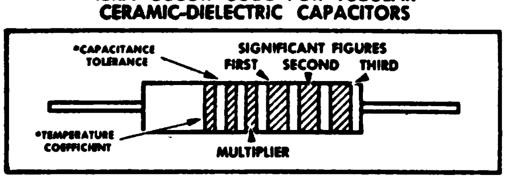


Capacitors marked with this code have a voltage rating of 500 volts.

RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



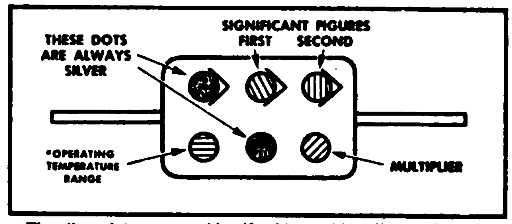
Capacitors marked with this code have a voltage rating of 500 volts.

RMA Radio Manufacturers Association JAN· Joint Army-Navy

Note These color codes give all capacitances in micromicrofarads.

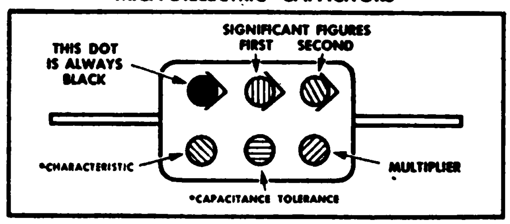
*Items marked with an asterisk are of interest primarily to depot and higher echelon repair personnel

JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



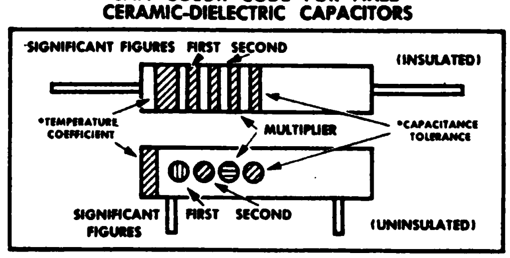
The silver dots serve to identify this marking. For working voltages see JAN type designation code.

JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



The black dot serves to identify this code. For working voltages see JAN type designation code.

JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS



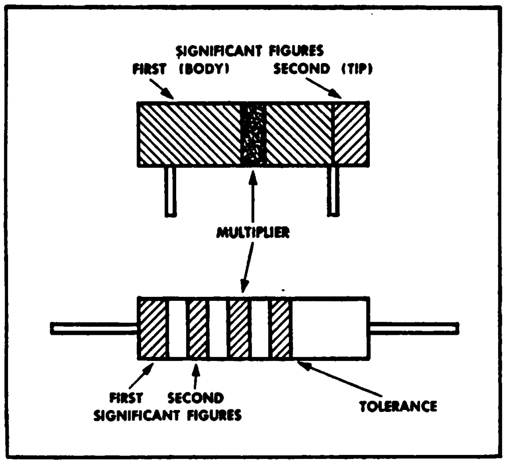
Capacitors marked with this code have a voltage rating of 500 volts. Either the band or dot code may be used.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER			RMA VOLTAGE RATING
		RMA MICA-AND CERAMIC-DIELECTRIC	JAN MICA-AND PAPER-DIELECTRIC	JAN CERAMIC-DIELECTRIC	
BLACK	0	1	1	1	
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000			400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD		0.1	0.1		1,000
SILVER		0.01	0.01		2,000
NO COLOR					500

TL 13417 A

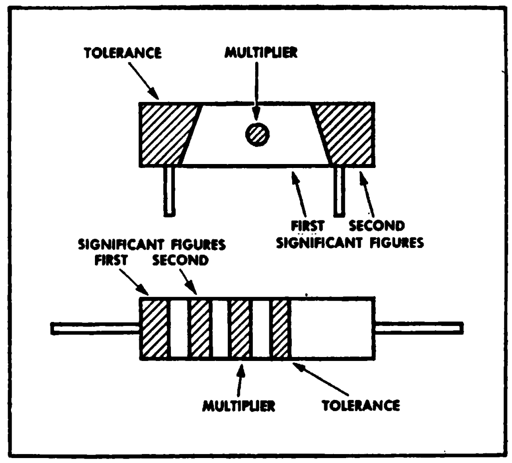
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS



Resistors with axial leads are insulated. Resistors with radial leads are uninsulated.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1,000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000*	
GRAY	8	100,000,000*	
WHITE	9	1,000,000,000*	
GOLD		0.1*	5
SILVER		0.01*	10
NO COLOR			20

*JAN ONLY

Example: A 50,000-ohm resistor with a standard tolerance of 20 percent (no color) would be indicated by a green ring (5), a black ring (0), and an orange ring (000)

RMA: Radio Manufacturers Association
JAN: Joint Army-Navy

TL 13418 A