NAVSHIPS *92197*

INSTRUCTION BOOK

for

MULTIMETER

AN/USM-34

Manufactured by

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 Dupont Avenue

Cleveland 8, Ohio

BUREAU OF SHIPS

NAVY DEPARTMENT

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LIST OF EFFECTIVE PAGES

PAGE NUMBERS	CHANGE IN EFFECT	PAGE NUMBERS	CHANGE IN EFFECT
Title Page	ORIGINAL	3-1 to 3-4	ORIGINAL
A to C	ORIGINAL	4-1 to 4-7	ORIGINAL
i to iii	ORIGINAL	5-0 to 5-1	ORIGINAL
1-0 to 1-2	ORIGINAL	6-0 to 6-4	ORIGINAL
2-1 to 2-8	ORIGINAL	7-1 to 7-27	ORIGINAL

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 993-100
7 April 1954

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Multimeter AN/USM-34 NAVSHIPS 92197

1. This is the instruction book for the subject equipment and is in effect upon receipt.

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W. D. LEGGETT, JR.
Chief of Bureau

LIST OF ILLUSTRATIONS

SECTION 1 - GENERAL DESCRIPTION

SECTION 2 - THEORY OF OPERATION

SECTION 3 - INSTALLATION AND ADJUSTMENT

SECTION 4 - OPERATION

SECTION 6 - CORRECTIVE MAINTENANCE

LIST OF TABLES

SECTION 7 - PARTS LIST

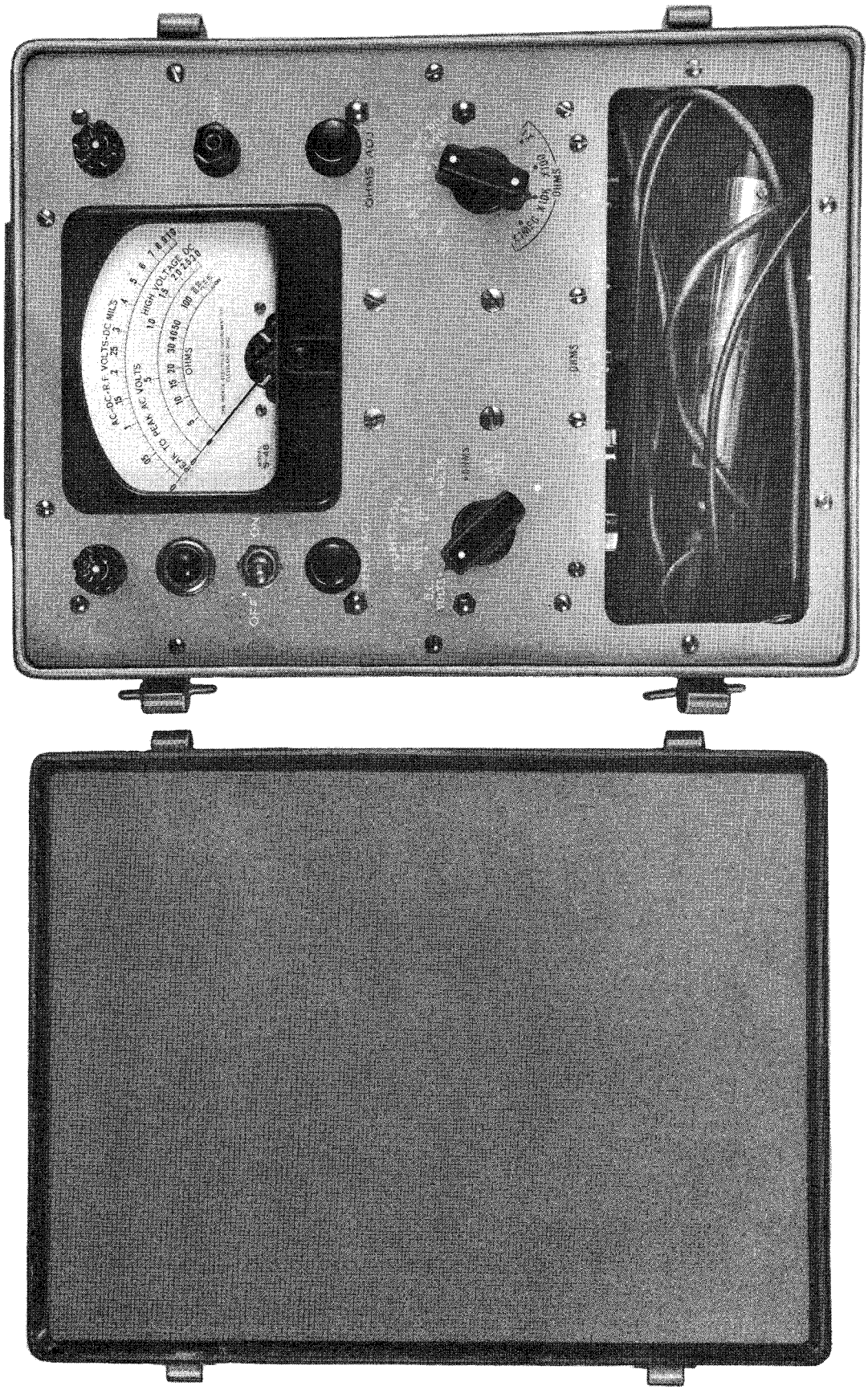


Figure 1-1. Multimeter AN/USM-34 with Cover Removed.

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE.

Multimeter AN/USM-34 is a portable combination electronic AC voltmeter for measurement of peak-to-peak and RMS voltages; DC voltmeter, ohmmeter and milliammeter which can be advantageously used wherever it is necessary to make current, resistance and voltage measurements with the use of only one equipment. Circuit design permits R.F. measurements from 1 KC to 100 megacycles, AC measurements from 50 CPS to 50 KC, electronic D.C. voltage measurements and electronic ohms measurements. In addition, electronic current measurements up to 1000 milliamperes may be made.

2. BRIEF DESCRIPTION.

a. PHYSICAL.--Multimeter AN/USM-34, as shown in Figure 1 - 1, has a smooth gray lacquer case with a gray panel and green and black designation. All switches and cables are clearly designated and the large meter has easily readable scales. The case is furnished with a steel bail-type handle at one end. A special compartment for carrying and storing all cables and test leads is in the case.

The AC power line cord and four leads are permanently attached. In addition, a special high voltage multiplier is also furnished. Two 48" unshielded leads are furnished for making resistance, current and AC measurements. One of these leads is red with a red test prod with screw-on alligator clip on the end. The other lead, common, is black and also has an alligator clip on the end.

A shielded test lead with a test prod on the end, incorporating a 3.3 megohm isolating resistor, is furnished for DC voltage measurements. A special high voltage multiplier incorporating a 25 megohm resistor is furnished for use in conjunction with the shielded DC test lead when utilizing the 3000 volt DC range.

An RF probe and shielded cable assembly is furnished for making RF voltage measurements up to 100 volts. This cable is 48" long with the RF probe on the end. The rectifier is housed in the probe. In addition to this, a 5" black ground lead is furnished with an alligator clip on one end and a threaded tip on the other which is connected directly into the special RF probe and used as a ground connection when measuring frequencies above 30 mc.

b. FUNCTIONAL.--MULTIMETER AN/USM-34 is designed to perform all the electrical functions of an equipment of its type with the light loading effect of a high impedance input:

(1) It will measure direct currents up to 1000 milliamperes.
(2) It will measure resistance up to 2000 megohms.
(3) It will measure DC voltages up to 3000 volts.
(4) It will measure RF voltages up to 100 volts with the RF probe and cable assembly.
(5) It will measure AC voltages up to 3000 volts.

c. ELECTRICAL.--The basic principle of the meter circuit is an electronic bridge similar to the Wheatstone bridge in principle with the resistance of two arms being the resistance of two triode sections of a twin triode tube, V-102. The meter is electrically balanced across the tube by the remainder of the meter circuit. Input to the grids is through a voltage dividing network, then through a cathode follower circuit which serves to isolate the voltage dividing network from the meter circuit. Input to the grid effectively unbalances the circuit and causes the meter to read. (See Section 2, paragraph 2 for complete circuit analysis.)

DC for the ohmmeter measurements is obtained by rectifying the AC filament supply from the secondary of T-101, making it unnecessary to use a battery.

An RF probe is used to rectify RF for such voltage measurements and a duodiode tube is used to rectify the AC voltage for AC peak-to-peak measurements. The milliammeter circuit is electronic, making it impossible to burn out the indicating meter by accidentally connecting the Multimeter into a circuit carrying current in excess of 1000 milliamperes.

CAUTION

WHILE METER MOVEMENT IS PROTECTED AGAINST DAMAGE DUE TO CURRENT OVERLOAD, THE EQUIPMENT AS A WHOLE (PARTICULARLY THE CURRENT SHUNT RESISTORS R-102, R-110, R-111, R-129 AND R-144) CAN BE DAMAGED BY EXCESSIVE CURRENT.

3. REFERENCE DATA.

a. Nomenclature: Multimeter AN/USM-34 (Electronic Volt-Ohm-Milliammeter).
b. Contract Numbers: NObsr-52719 and NObsr-57494.
c. Contractor: The Hickok Electrical Instrument Company.
d. Cognizant Naval Inspector: Inspector of Naval Material, Cleveland, Ohio.
e. Number of Packages Involved per Complete Shipment of Equipment, including Equipment Maintenance Repair Parts Boxes: One.
f. Total Cubical Content:
Crated: 2816 cubic inches
Uncrated: 543 cubic inches (less E.M.R.P.)
Uncrated: 591 cubic inches (with E.M.R.P.)
g. Total Weight:
Crated: 34 lbs.
Uncrated: 11 lbs. (less E. M. R. P.)
Uncrated: 11-1/2 lbs. (with E. M. R. P.)
h. Frequency Range: 50 cycles to 100 mc.

i. Characteristics of Power Supply Required for Operation:

(1) Voltages: 105-125 volts, 50-1000 cycles AC.
(2) Wattage: 12 watts.

j. Input Impedance:

(1) DC: 13.3 megohms with H.V. Multiplier test prod 38.3 megohms.
(2) RF: 8 mmf shunted by 13 megohms on 100 V. range.
(3) AC: 100 mmf shunted by 14 megohms.

k. Overall Accuracies:

The error shown in the table is the actual percentage deviation allowable between the actual value of test potential and the value indicated by the meter.

D.C. VOLTAGE	
Ranges up to 1000 volts	±4%
Over 1000 volts (with probe extension)	±6%
A.C. VOLTAGE (Freq. Range 50 CPS to 50 KC)	
Ranges up to 100 V	±6%
Ranges over 100 V	±7%
R.F. VOLTAGE (Freq. Range 1 KC to 100 MC)	
Ranges up to 100 V	±6%
D.C. CURRENT	±5%
RESISTANCE	±5 degrees of arc

Special Features of Multimeter AN/USM-34:

Features found in the AN/USM-34 not found in the earlier series equipments, such as the ME-25 series, are as follows:

1. A.C. Voltage indications are based and calibrated on peak-to-peak value of the voltage being measured.
2. R.F. Voltage indications are based on the peak value of the voltage being measured and calibrated as the R.M.S. value. These measurements are accurate for sine waves only. For complex wave forms use A.C. VOLTAGE function.
3. Electronic milliammeter circuit.
4. Self-contained ohmmeter power supply.
5. Logarithmic indicator scale.
6. Tolerances based on input voltage rather than full scale.
7. Test leads permanently attached.
8. Watertight construction when used with cover.
9. All ranges in multiples of ten.

SECTION 2
THEORY OF OPERATION

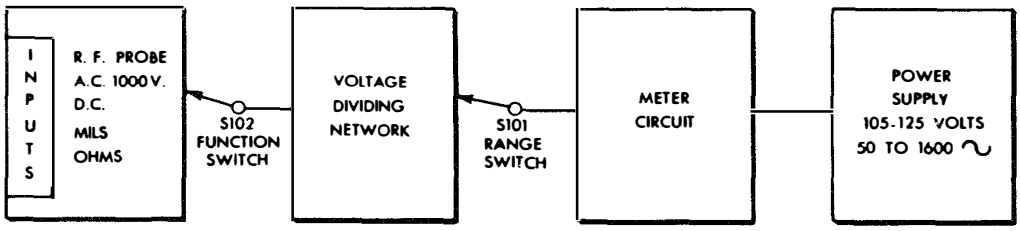


Fig. 2-1. BLOCK DIAGRAM

1. GENERAL.

During the following discussions, reference to the block diagram of Multimeter AN/USM-34 Figure 2-1 and the schematic wiring diagram, Figure 6-4 will facilitate the understanding of the basic operation of the circuits used in this equipment.

a. METER CIRCUIT. (See Fig. 2-2).

A type 5814-A tube, V102, is connected in an electronic bridge circuit, and with voltages applied to one grid; the deflection of the meter, which is connected in the plate circuits, will be proportional to the DC voltage applied to the grid. A 5751 tube, V101, is connected as a cathode follower to isolate the meter circuit from the voltage divider.

b. DC VOLTMETER CIRCUIT. (See Fig. 2-3)

The input to the DC voltmeter circuits is taken through the DC probe incorporating an isolating resistor, and applied through the RANGE SELECTOR network to the metering circuit.

c. RF VOLTMETER CIRCUIT. (See Fig. 2-4)

The RF probe is used for the measurement of RF voltages up to 100 volts, generally at frequencies from 1 KC to 100 mc. A 9006 tube, V103, in the probe rectifies the RF voltage and the resulting DC is applied to the meter circuit through a voltage dividing network. The meter indicates the RMS value of RF voltages being measured.

d. AC VOLTMETER CIRCUIT. (See Fig. 2-5)

AC voltages up to 1000 volts are applied to the OHMS-MILS-AC VOLTS probe which in turn is applied to the 5726 tube, V104, through a voltage divider. The 5726 tube is connected as a voltage doubler and the resulting DC voltage is applied to the metering circuit through a voltage divider. Calibration of the meter circuit is such that an indication is based and calibrated on the peak-to-peak value of AC voltage being measured.

e. OHMMETER CIRCUIT. (See Fig. 2-6)

The 6.3 volt AC filament voltage is rectified by CR102 and the DC output is used in connection with a voltage dividing network to permit the measurement of resistances throughout the range of the equipment. The voltage output from this dividing network is applied to the metering circuits and the indication made proportional to the value of the resistance being measured.

f. MILLIAMMETER CIRCUIT. (See Fig. 2-7)

Milliamper readings up to 1000 milliamperes are made by measuring the voltage drop across the calibrated shunts by applying this voltage to the input of the meter circuit. The OHMS-MILS-AC VOLTS probe and COMMON leads are used for this measurement.

g. POWER SUPPLY CIRCUIT. (See Fig. 2-8)

A selenium rectifier, CR103, is connected as a half-wave rectifier to supply DC operating potentials to the metering circuit. A 6.3 volt

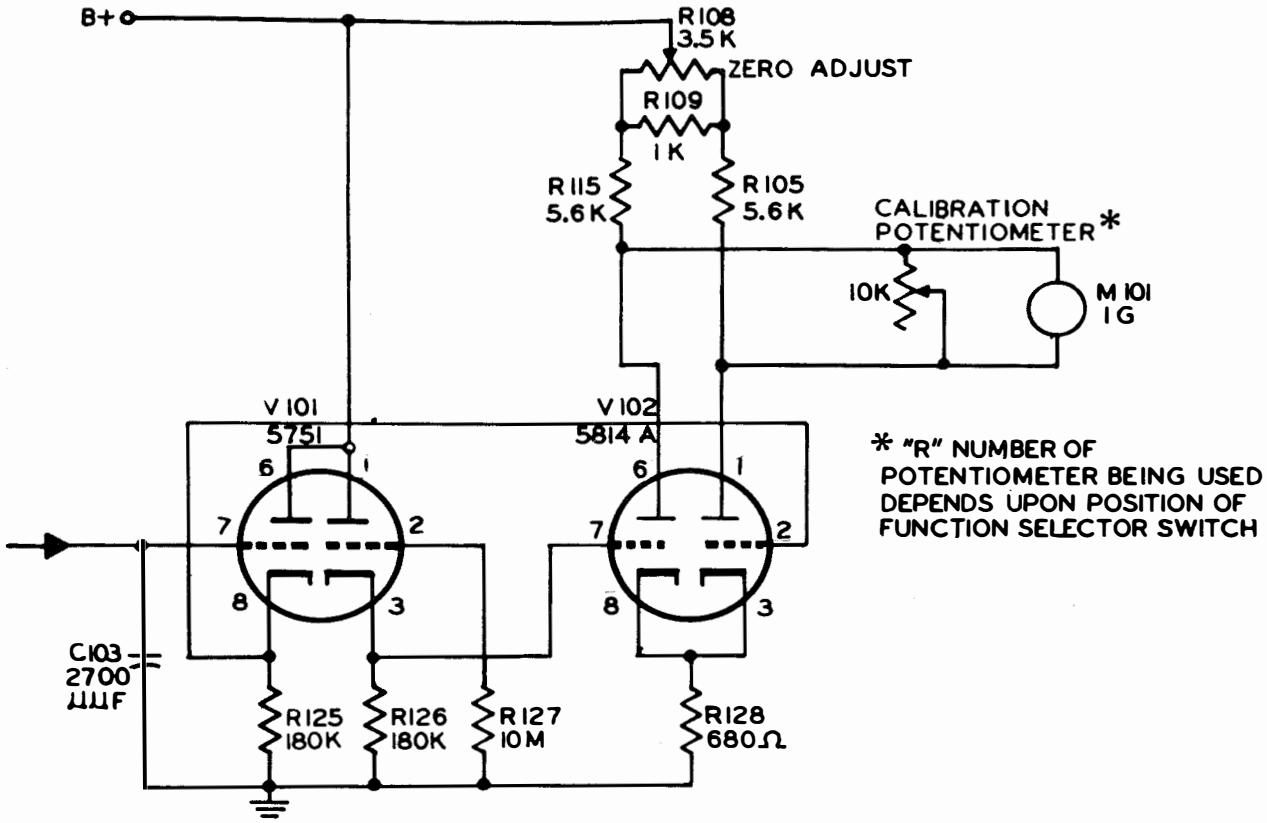


Fig. 2-2. BASIC METER CIRCUIT

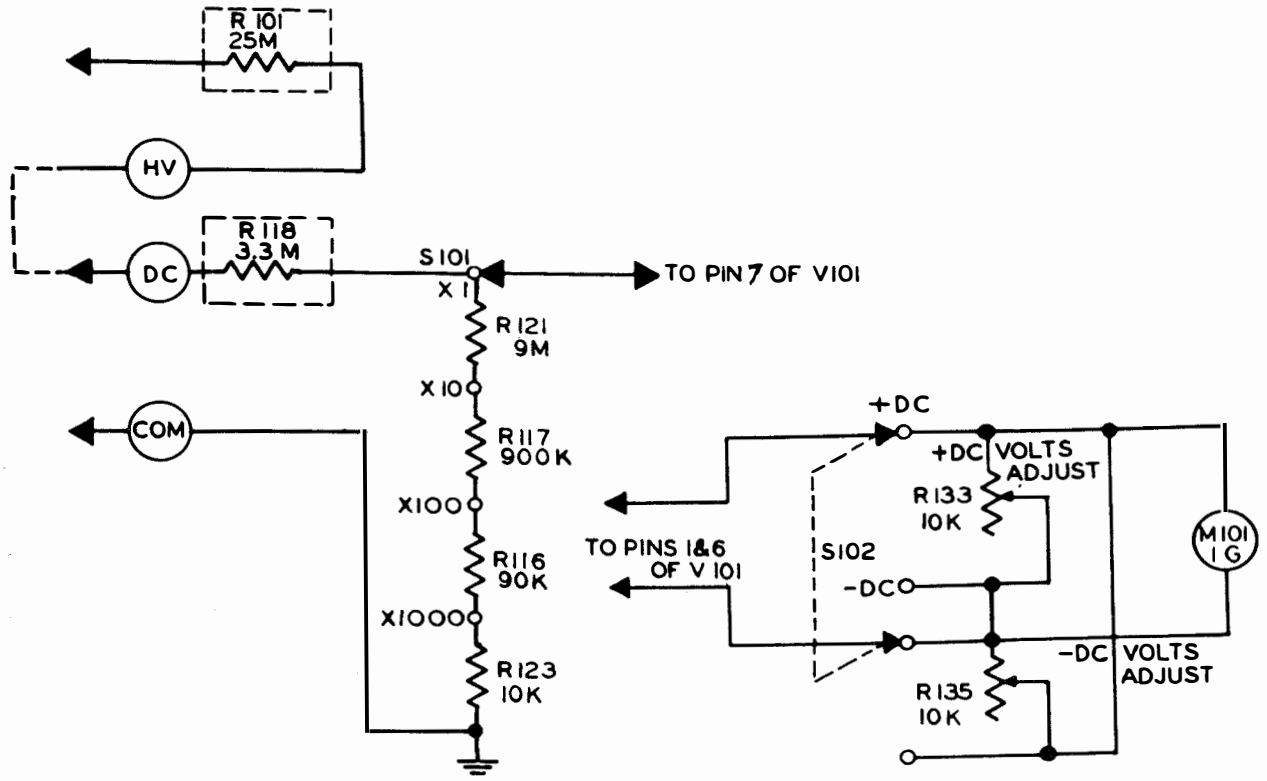


Fig. 2-3. D.C. VOLTMETER CIRCUIT

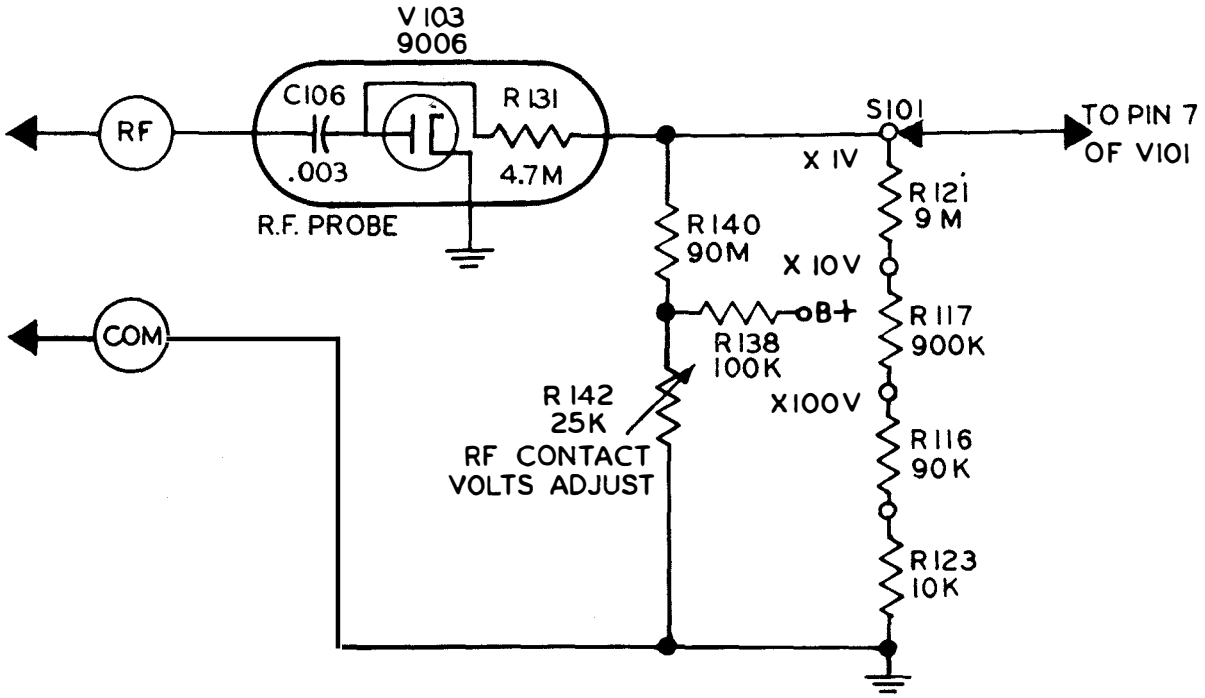


Fig. 2-4. R. F. VOLTMETER CIRCUIT

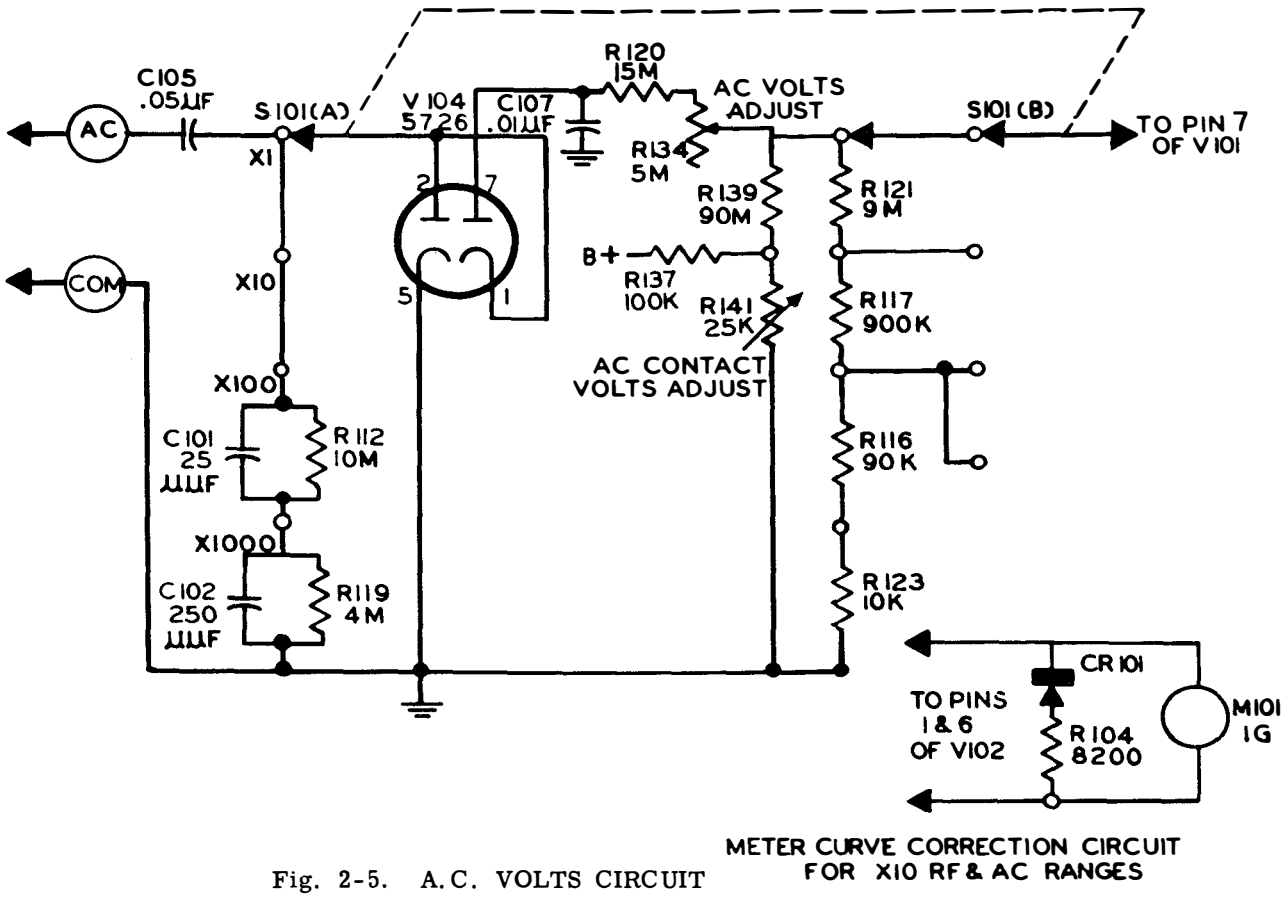


Fig. 2-5. A.C. VOLTS CIRCUIT

filament winding supplies the pilot light and the filament voltages for the tubes as well as AC voltage which is rectified and used in the ohmmeter circuit for resistance measurements. The primary of the transformer, T-101, is fused by F-101 and F-102, both located on the front panel. A ballast tube, R-143 is in the primary circuit of transformer, T-101, to maintain a nearly constant voltage input to the primary.

2. CIRCUIT ANALYSIS.

a. BASIC METER CIRCUIT.

Figure 2-2 illustrates the basic meter circuit for all measurements. A twin triode, 5751, V-101 is connected as a cathode follower and a twin triode, 5814-A, V102, is connected in a bridge circuit as shown. With no voltage applied to pin 7 of V-101, the ZERO ADJUST control, R-108, is set so the meter reads zero. With a negative voltage applied to grid (pin 7) of V-101, there is a decrease in current through that triode section and the cathode voltage decreases. Cathode (pin 8) of V-101 is coupled directly to grid (pin 2) of V-102. The decreasing voltage on cathode pin 8 of V-101 causes the voltage on the grid (pin 2) of V-102 to decrease, which causes a decrease in current through that section of the triode. The decrease in current causes the cathode voltage of that section of V-102 to decrease. The voltage applied to the meter from plate (pin 1) of V-102 will increase. The decrease in voltage of cathodes, (pins 3 and 8) of V-102 is effectively the same as an increase in voltage of the grid (pin 7) of V-102 which causes that section of the triode to draw more current causing voltage on plate (pin 6) to decrease. The combination of plate (pin 6) decreasing and plate (pin 1) increasing causes an unbalance and current is forced through the meter causing it to read up scale. If a positive voltage were applied to grid (pin 7) of V-101, the meter would read in a reverse direction.

Grid (pin 7) of V-102 is connected to the cathode (pin 3) of V-101 in the same manner as grid (pin 2) of V-102 is connected to the cathode (pin 8) of V-101. This is done in order that voltage fluctuation in B voltage will affect both sections of V-102 in the same manner and will prevent errors due to a difference in potential on the two grids with no signal applied, thereby, eliminating the need for readjusting the zero set should a variation in B+ occur.

Separate calibration resistors are used for calibration of +DC, -DC, AC, RF volts and MILS measurements.

The purpose of the by-pass capacitor, C-103, is to prevent any possible stray AC from reaching the meter circuit and affecting the calibration.

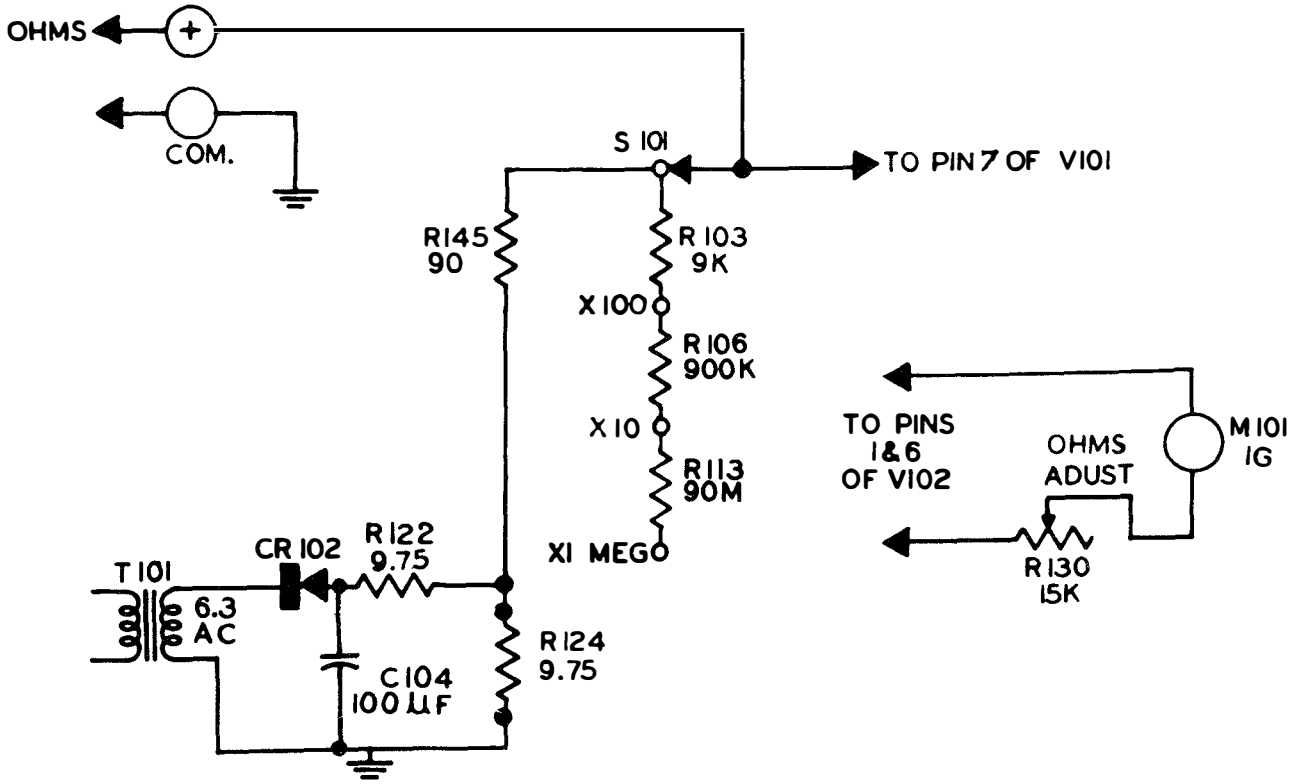


Fig. 2-6. OHMMETER CIRCUIT

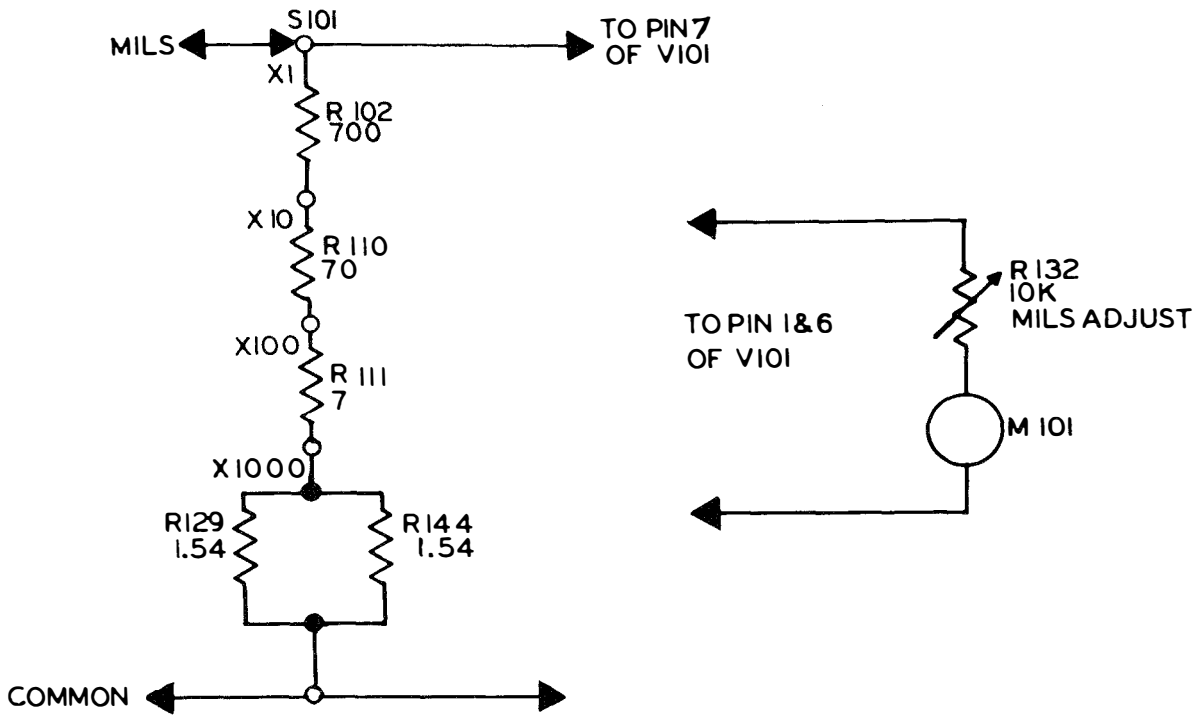


Fig. 2-7. MILLIAMMETER CIRCUIT

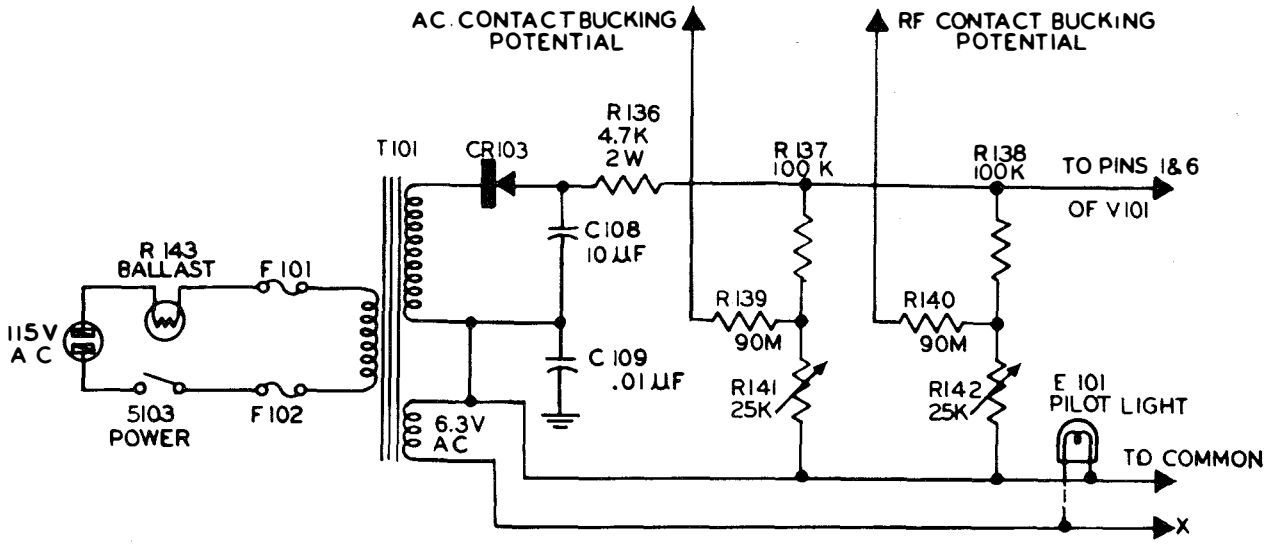


Fig. 2-8. POWER SUPPLY

b. DC VOLTMETER CIRCUIT.

DC Voltages up to 1000 volts are applied directly through the DC probe as illustrated in Figure 2-3. The probe carries an isolating resistor of 3.3 megohms to prevent capacity loading of the circuits under test. For 3000 volt DC measurements, the high voltage multiplier, W-107, illustrated in Figure 2-9, is screwed on the end of the regular DC probe. This high voltage multiplier contains a 25 megohm voltage dropping resistor. Voltages to be measured are applied from the multiplier to the voltage dividing network as illustrated in Figure 2-3. Voltages from this network are taken to grid (pin 7) of V-101. Negative DC voltages are measured by reversing the meter by means of S-102 as illustrated in Figure 2-3.

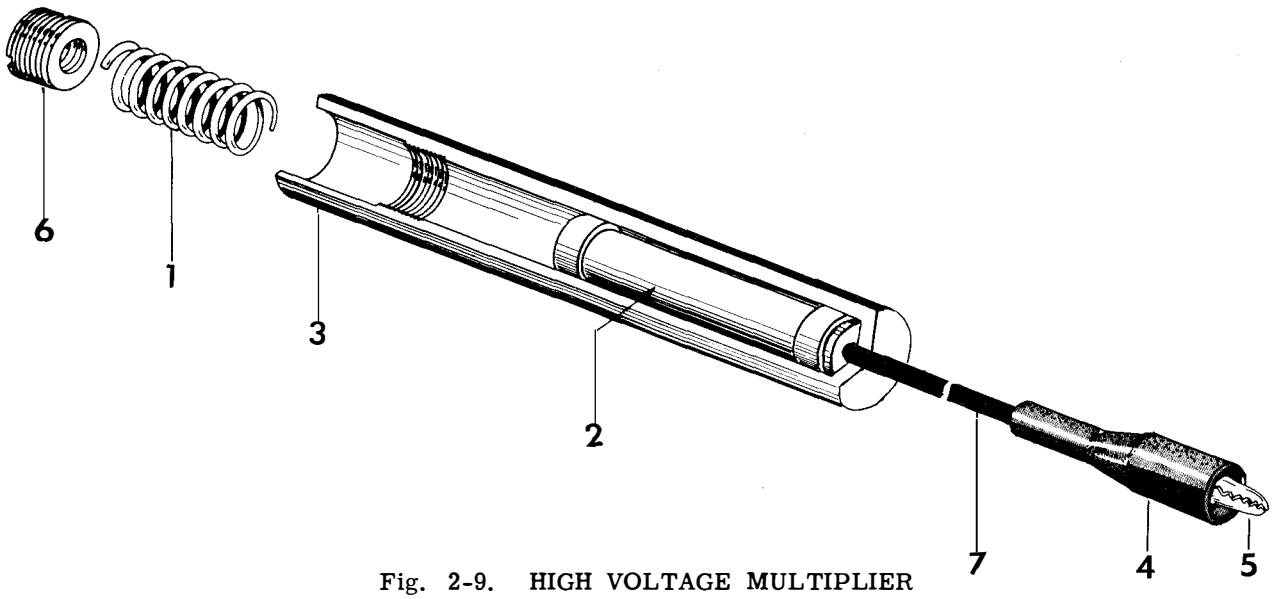


Fig. 2-9. HIGH VOLTAGE MULTIPLIER

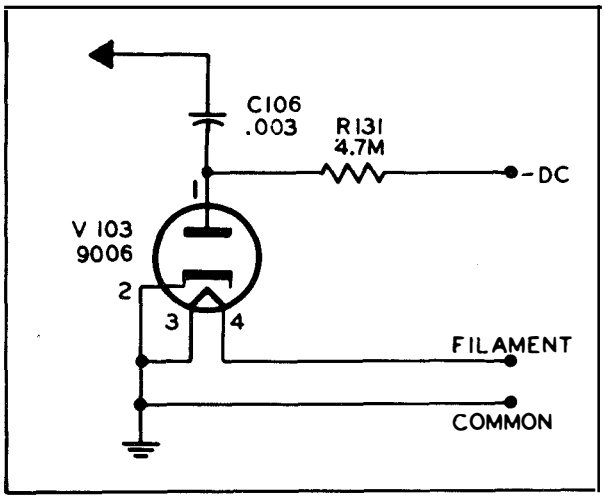


Fig. 2-10. ELECTRICAL CIRCUIT OF R. F. PROBE

c. RF VOLTMETER CIRCUIT.

AC voltages up to 100 volts may be measured by using the RF probe in circuits where capacity loading cannot be tolerated. Generally, the RF probe should be used for the measurement of AC voltages ranging in frequency from about 1 KC to 100 MC. The RF probe, W-104, illustrated in Figure 2-10, contains a coupling capacitor, C-106, a 9006 tube, V-103, connected as a half wave rectifier and decoupling resistor, R-131. The DC voltage output from the probe is applied to the voltage dividing network, then to Pin 7 of V-101 of the meter circuit. A bucking voltage is applied to the input of the voltage dividing network from the network comprising R-138, R-140 and R-142. R-142 is adjusted so that the bucking voltage effectively bucks out contact potential developed at Pin 1 of V-103. Therefore, when changing ranges, it is not usually necessary to readjust the ZERO ADJUST control, R-108.

d. AC VOLTMETER CIRCUIT.

AC voltages up to 1000 volts may be measured with the use of the OHMS-MILS-AC VOLTS probe. The AC probe may be used for AC measurements from 50 CPS to 50 KC. AC Voltage, as illustrated in Figure 2-5, is applied through coupling capacitor, C-105, to a first voltage dividing network S-101 (A) as shown. No voltage division is affected on the X1, X10 and X100 positions, but full voltage is applied to the 5726 tube, V-104, which is connected in a voltage doubler circuit.

Figure 2-11 illustrates the electrical circuit which provides for the indication of the indicating meter to be proportional to the peak-to-peak value of the voltage being measured.

For illustration purposes it is assumed that the positive portion of the AC Voltage being tested appears across the input during the first half cycle. During this first half cycle C-105 charges to the peak value of the voltage under test through V-104A and with a negative polarity in respect to ground. C-105 remains charged at this peak value during the next half cycle. During the negative half cycle, the negative peak voltage applied to the input is of the same polarity as the charge on C-105, therefore, these two peak potentials are in series and are added.

Due to the negative polarity of the charge on C-105, V-104A appears as an open circuit and the negative potential is applied to the cath-

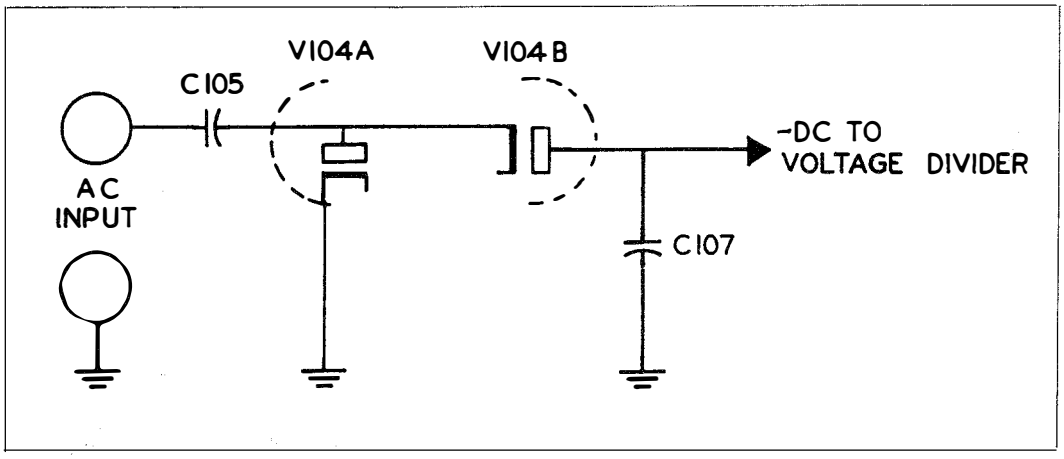


Fig. 2-11. A.C. INPUT CIRCUIT

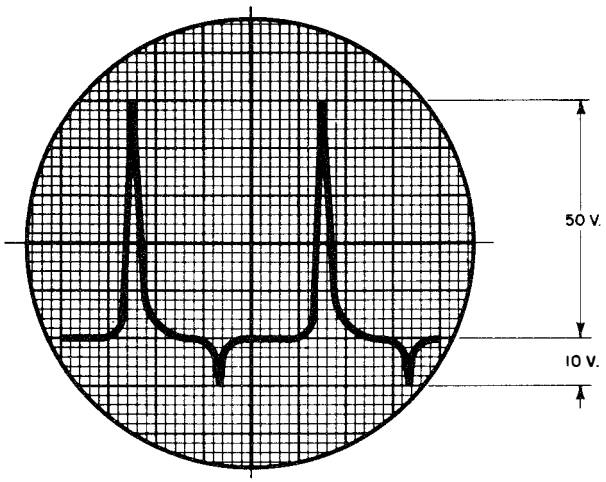


Fig. 2-12. TYPICAL ASSYMETRIC WAVE

ode of V-104B. This charges C-107 to a negative DC potential that is directly proportional to the peak-to-peak value of the voltage under test. This DC potential is then applied to the grid of V-101 through a series of voltage dividers, depending on the range being used.

Due to the direct relationship between RMS (root mean square) and peak-to-peak values of a sine wave, (RMS is peak-to-peak divided by 2.82) when the AC input is a sine wave, the RMS value may be read on the O-1 volt range, using the same multiplier as the peak-to-peak range.

In Figure 2-12, the wave is non-sinusoidal and the RMS indication would not be correct. However, only peak-to-peak indication for this type of wave form is significant.

A voltage dividing network comprising R-137 and R-139 provides a bucking voltage applied to the high end of S-101(B) at the junction of R-134 and R-121. R-141 is adjusted so that this potential effectively bucks out the contact potential developed at pin 7 of V-104. As a result, it becomes unnecessary to readjust the ZERO ADJUST control R-108 when changing ranges. The meter curve correction circuit, illustrated in Figure 2-5, corrects the curve on the X10 range of RF and AC volts.

e. OHMMETER CIRCUIT.

The OHMS-MILS-AC VOLTS probe and the COMMON leads are used for resistance measurements. See Figure 2-6.

The selenium rectifier power supply consisting of CR-102, R-122, R-124 and C-104 supplies a negative one and one-half unit potential through a series of reference resistors (R-145, R-103, R-106 and R113) to the grid of V-101. The reference resistors used are determined by the position of the RANGE selector switch S-101.

Any unknown resistor placed across the OHMS and COMMON test leads would provide for a return to ground for the negative potential on the grid (Pin 7) of V-101 and divide this voltage in proportion to the ratio of the reference resistors being used and the unknown resistor. This voltage drop is calibrated in terms of OHMS.

f. MILLIAMMETER CIRCUIT.

The milliammeter circuit illustrated in Figure 2-7, will measure current to 1000 milliamperes. Current is applied to the voltage divider circuit and the resulting voltage drop is fed to grid (pin 7) of V-101 of the meter circuit. The meter, M-101, is not connected into the circuit as a milliammeter and, therefore, excessive currents accidentally applied will not damage the meter.

CAUTION

WHILE METER MOVEMENT IS PROTECTED AGAINST DAMAGE DUE TO CURRENT OVERLOAD, THE EQUIPMENT AS A WHOLE CAN BE DAMAGED BY EXCESSIVE CURRENT.

g. POWER SUPPLY CIRCUIT.

All operating voltages including the AC supply for the ohmmeter circuit rectifier are obtained from the power supply using transformer, T-101. No batteries are required. The primary of the transformer is connected to the power supply line core through fuses F-101 and F-102 located on the front panel and also through the POWER OFF-ON switch also located on the front panel. In addition, ballast tube R-143 is in series with the transformer primary to maintain a nearly constant voltage input, essentially 95 volts.

Selenium rectifier CR-103 is connected in the secondary of T-101, as a half wave rectifier; C-108 and R-136 comprise the filter network. AC contact bucking potential is supplied from voltage dividing networks R-137, R-139, R-141 and R-138, R-140, R-142.

A 6.3 volt secondary winding is provided for operation of the pilot light, tube filaments, and the ohmmeter DC supply circuit.

The equipment is nominally designed to operate on a supply line voltage of 105 to 125 volts at a supply line frequency of 50-1000 cycles.

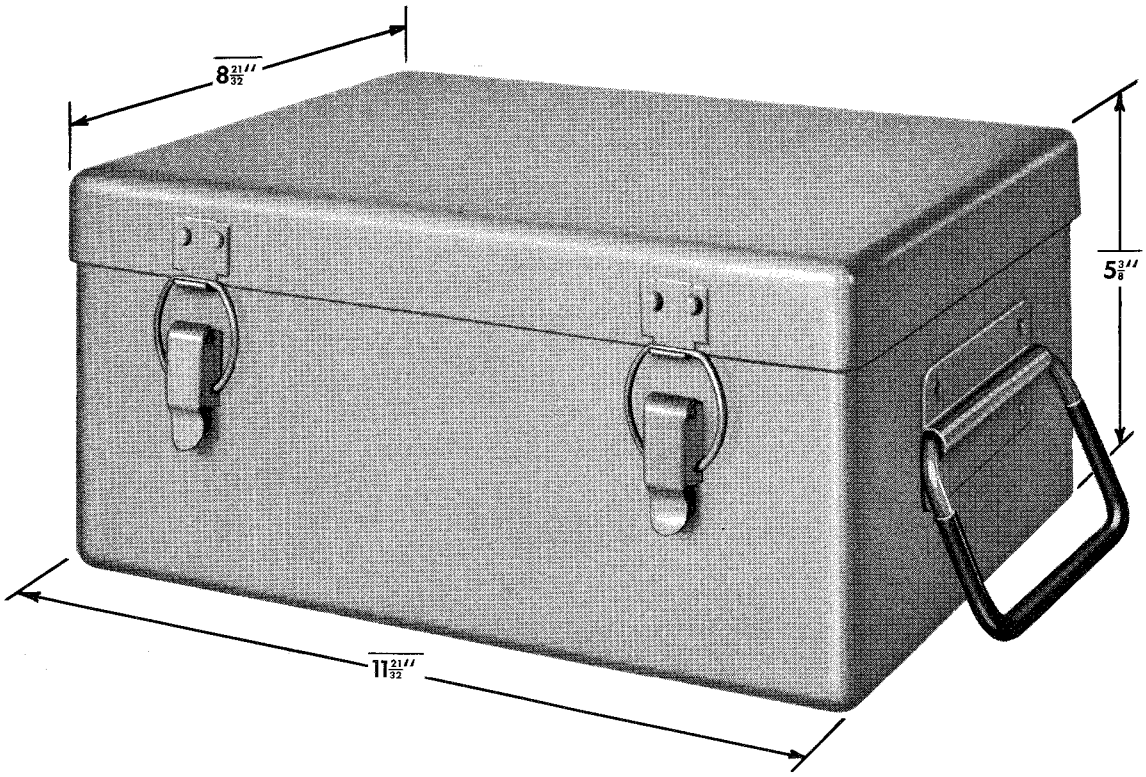


Fig. 3-1. MULTIMETER AN/USM-34 WITH COVER IN PLACE SHOWING OVERALL DIMENSIONS

SECTION 3
INSTALLATION AND ADJUSTMENT

1. INSTALLATION.

a. HOUSING.--Multimeter AN/USM-34 is housed in a case consisting of the main body with a cover secured in place by four draw bolts. Suitable space is provided within the case for storage of the operating cables, RF probe, DC extension probe and line cord. A rubber gasket is also provided between the main body and the cover.

b. UNPACKING.--As packed for over seas shipment each equipment is in a substantial wooden case which is sufficiently sturdy and affords sufficient protection to the equipment to permit it to remain exposed to the weather for an indefinite time. For domestic shipment a fibre board container is used. When opening the packing case and removing the equipment, care should be taken not to damage the equipment in any way.

c. OPERATING LOCATION.--In general any location where suitable AC input power is available will be satisfactory operating location for the equipment.

NOTE

The equipment has been designed to operate equally well in any convenient operating position, although it is characteristic of electrical indicating meters of high sensitivity to exhibit less pivot friction when operated with the pivots vertical. In this position the face of the meter is horizontal.

d. OPERATING CABLES.

(1) AC LINE CORD - A 6 foot AC line cord is permanently attached to the equipment and contains a standard 2-prong male AC line plug on the unattached end.

(2) TEST CABLES.

(a) Unshielded black test lead, W-101, with alligator clip on the end, is used as a COMMON connection for all DC, OHMS and low frequency AC measurements. This lead is also used in connection with milliampers measurements.

(b) For all DC voltage measurements the shielded DC cable, W-103, is used. For measurements to 3000 volts, Multiplier W-107 is attached to the end of this probe.

(c) For RF voltage measurements up to 100 volts, RF probe W-104 is used.

(d) A short black unshielded lead W-106 is supplied for use as a ground connection between the R.F. probe and ground at higher R.F. frequencies, above about 30 mc.

(e) For OHMS-DC-MILS and AC VOLTS up to 1000 volts, cable W-102 is used.

2. ADJUSTMENT.

WARNING

THE VOLTAGES WHICH ARE UTILIZED IN THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE. BEFORE REMOVING THE EQUIPMENT FROM ITS CASE FOR INSPECTION, THE AC LINE CORD SHOULD BE DISCONNECTED FROM THE AC SUPPLY. SHOULD IT BE NECESSARY TO TAKE VOLTAGE READINGS WITHIN THE INSTRUMENT, MAKE SURE HANDS ARE DRY, USE TEST PRODS INSULATED FOR AT LEAST 1000 VOLTS AND IN ALL POSSIBLE CASES MAKE ALL READINGS AND ADJUSTMENTS WITH ONE HAND IN A POCKET.

a. INSPECTION.--Before applying AC power to this equipment for the first time, inspect the entire equipment as follows:

(1) Make certain that all test leads, as illustrated in Figure 4-1, are in the compartment of the instrument. Carefully check for mechanical damage to cables.

(2) Loosen the ten screws securing the instrument to the case and inspect chassis to make certain that all tubes are undamaged and in their proper sockets.

(3) Give the entire equipment a careful mechanical inspection to make certain there are no damaged components.

(4) Replace equipment in case and fasten the screws.

b. TESTS PRECEDING OPERATION.--The following measurements should be made prior to placing the equipment in operation.

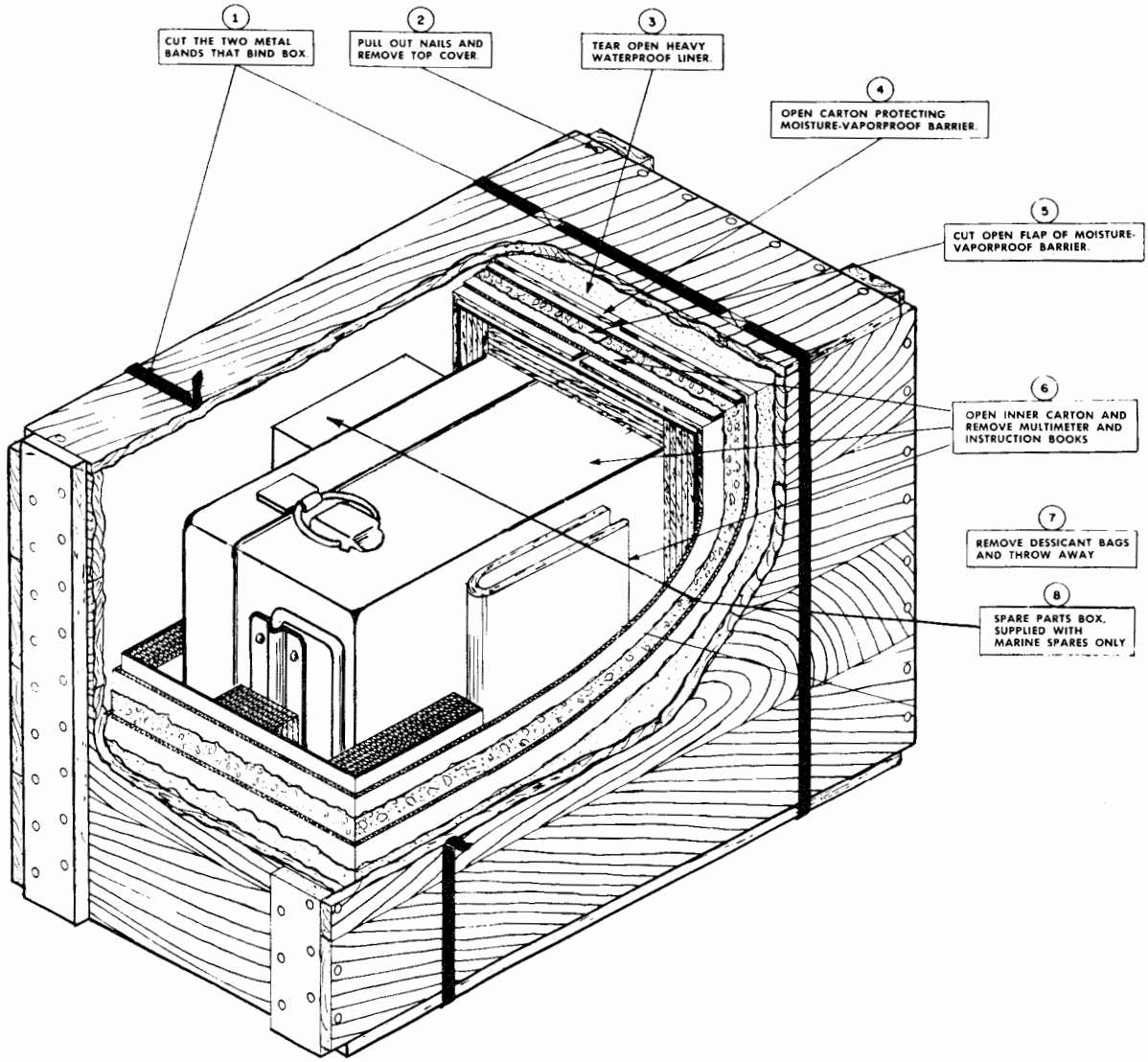


Fig. 3-2. EXPORT PACKING DIAGRAM

(1) With the POWER switch ON, an ohmmeter check of the resistance between the two plugs of the AC line supply should show approximately 50 ohms. If it should vary substantially from this value or show no continuity, inspect fuses and wiring for cause of the trouble.

c. INITIATING OPERATION.--With the AC line cord connected into any convenient source of 115 volts plus or minus 10%, 50 to 1000 cycles, AC, the equipment is put into operation by operating the POWER switch to ON. The PILOT light should come on immediately and after approximately ten minutes of warm-up time, the equipment should be stabilized and ready for operation.

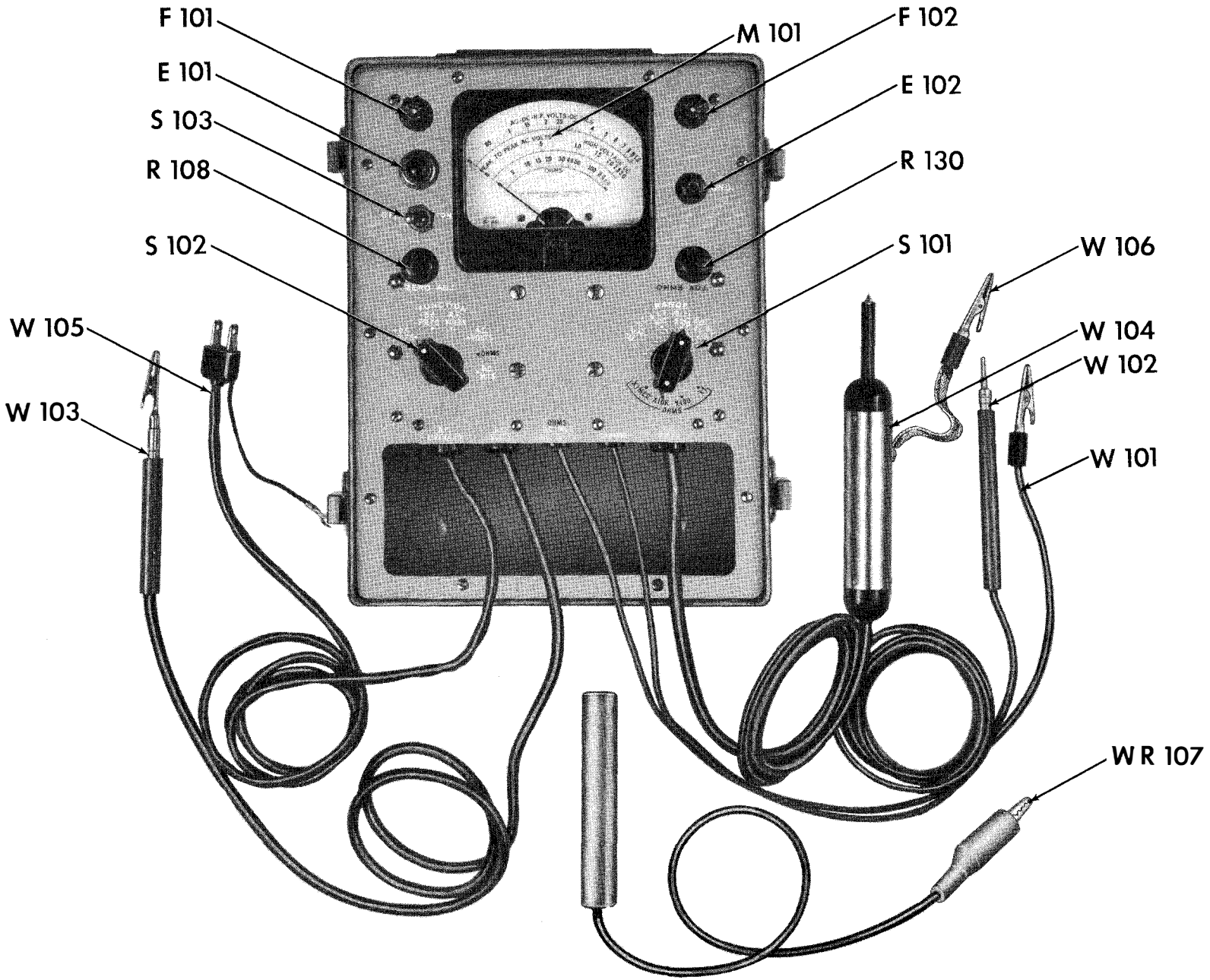


Fig. 4-1. MILTIMETER AN/USM-34 AND ACCESSORIES

SECTION 4
OPERATION

1. FUNCTION OF EQUIPMENT.

Multimeter AN/USM-34 is designed to permit the service technician to make measurements of AC voltages throughout the range of approximately 0.3 volt to 3000 volts. RF voltages from approximately 0.1 to 100 volts may be measured utilizing a high impedance probe which permits measurements to be made in the frequency range of approximately 1000 cycles to over 100 mc. Figure 4-2 is the correction to be applied on the RF X1 range. The capacity loading of the RF probe is approximately 8 mmf. AC voltages are measured in terms of peak-to-peak value and sine waves may be read in terms of either their RMS value or their peak-to-peak value. RF voltages are read in terms of their RMS value.

DC voltages from approximately 0.01 volt to 1000 volts may be measured without the use of the auxiliary high voltage multiplier probe. With the use of this probe the DC voltage ranges are extended to 3000 volts. The input impedance of the DC measuring circuits is approximately 13.3 megohms for measurements up to 1000 volts and approximately 38.3 megohms for measurements to 3000 volts.

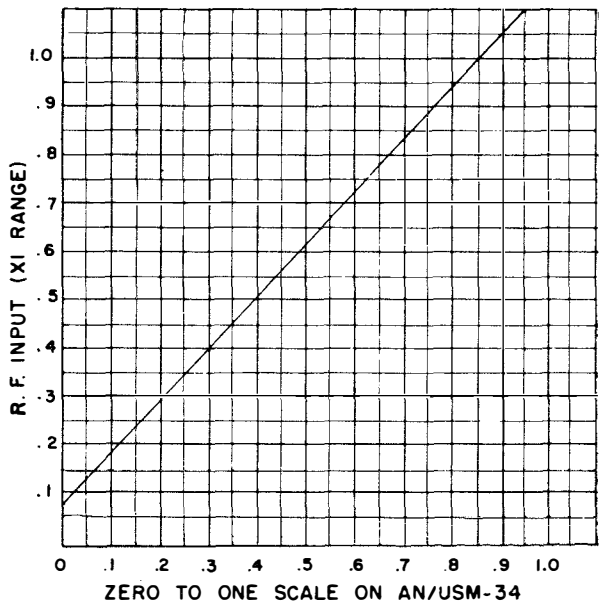


Fig. 4-2. CURVE CORRECTION CHART

Resistance measurements from approximately 0.5 ohms to 2000 megohms can also be made. Milliampere measurements from approximately 10 microamperes to one ampere are provided.

2. CONTROLS AND THEIR FUNCTIONS. (See Figure 4-1.)

a. POWER SWITCH.--Operating this control to the ON position connects the internal circuits to a suitable source of supply voltage for their operation when the line cord is plugged into such suitable source.

b. FUNCTION SELECTOR.--This control connects the internal measuring circuits to permit the measurement of:

(1) Positive DC voltages
(2) Negative DC voltages
(3) RF voltages
(4) AC voltages
(5) Resistance measurements
(6) Current measurements in milliamperes.

c. RANGE SELECTOR.--Permits the selection of various ranges of measurements as selected by the FUNCTION SELECTOR.

d. ZERO ADJUST.--This control permits the electrical adjustment of the indicating meter pointer to zero in connection with the measurement of RF VOLTS, AC VOLTS, DC VOLTS, OHMS and MILS.

e. OHMS ADJUST.--With test leads not connected across any source of resistance, this control is used to adjust the meter to full scale, or infinity ohms.

f. GND. TERMINAL.--Case ground only.

3. PRELIMINARY OPERATION.

a. The DC lead, OHMS-MILS-AC VOLTS lead, COMMON lead, RF probe and cable assembly and AC power line cord are permanently attached and placed in the compartment, as shown in Figure 1-1 for storage and carrying.

b. To insure accurate measurement, make sure that the meter needle rests at zero on

the scale when no power is applied. This adjustment is made mechanically by means of the Zero Adjust screw shown on the front of the meter in Figure 4-1. Adjust until the needle rests on zero.

c. Connect the AC power line cord to a source of 105-125 volts, 50-1000 cycles, AC.

d. Operate the POWER switch to ON. The PILOT light should light. Approximately ten minutes are required for the tubes to heat sufficiently for stable operation. As the power drain of the Multimeter is small, approximately 12 watts at 115 volts, it is advisable, if the unit is to be used intermittently, that it be left on.

4. CAUTIONS.

a. DO NOT ATTEMPT TO MEASURE RF VOLTAGES OVER 100 VOLTS THROUGH PROBE.

b. Voltage measurements are made with the meter across the circuit; current measurements with the meter in series with the circuit and resistance measurements with at least one terminal of the resistor free from any associated circuit.

5. DC VOLTAGE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the FUNCTION switch to +DC VOLTS.

c. Rotate the RANGE switch to the correct range for the voltage under test. If the voltage is unknown, use the highest range.

d. Check the electrical zero setting of the meter needle.

e. Connect the COMMON lead from the AN/USM-34 to the GROUND SIDE OF THE VOLTAGE UNDER TEST.

f. Make the other connection to the unknown voltage by means of the DC probe and read the value from the proper scale. If the meter deflects in the reverse direction, operate the FUNCTION switch to -DC VOLTS.

g. If the voltage to be measured is between 1000 and 3000 volts DC, attach the high voltage multiplier to the DC probe and set the RANGE switch to the 1000 position. Then read the voltage on the 0-3 scale.

The nominal input impedance for DC measurements up to 1000 volts is approximately 13 megohms. If the voltage being measured is of sufficient magnitude to be able to be read on the 3000 volt range, the installation of multiplier may be used to provide for an input impedance of approximately 38 megohms, thereby causing less loading on the circuit under test.

6. RF VOLTAGE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the FUNCTION switch to RF VOLTS.

c. Rotate the RANGE switch to the correct range for the voltage under test. If this voltage is unknown, use the highest range. Do not measure voltages with the RF probe in excess of 100 volts.

d. RF MEASUREMENTS.--Connect the COMMON lead from the Multimeter to the GROUND OF THE UNIT UNDER TEST (usually the chassis). It is desirable above 30 mc to use the short ground lead (W-106) from the probe housing to the chassis of the unit under test.

e. Make connection to the unknown voltage with the prod of the RF probe.

f. Read the value of RF voltage from the RF scale and multiply by the position of the range switch.

7. AC VOLTAGE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the FUNCTION switch to AC VOLTS.

c. Rotate the RANGE switch to the correct range for the voltage under test. If this range is unknown, choose the highest range.

d. Check the electrical zero setting of the meter needle. If further adjustment of this is necessary, rotate the ZERO ADJUST knob until the needle reads zero on the AC VOLTS scale.

e. Connect the COMMON lead from the Multimeter to the GROUND OF THE UNIT UNDER TEST.

f. Make connection to the unknown voltage, with the prod of the AC probe.

g. Read the value of the voltage from the AC scale and multiply by the position of the RANGE switch.

8. DECIBEL MEASUREMENTS

Figure 4-4 and Figure 4-5 show the relationship between decibels and voltage based on "O" DB being .001 watt at 600 ohms and .006 watts at 600 ohms. As an example, if a voltage measurement on the 600 ohm line were found to be 40 volts, the relative DB based on .001 watt level would be +35 DB. If the "O" DB level were to be based on .006 watt on a 600 ohm line, a 40 volt measurement would have indicated approxi-

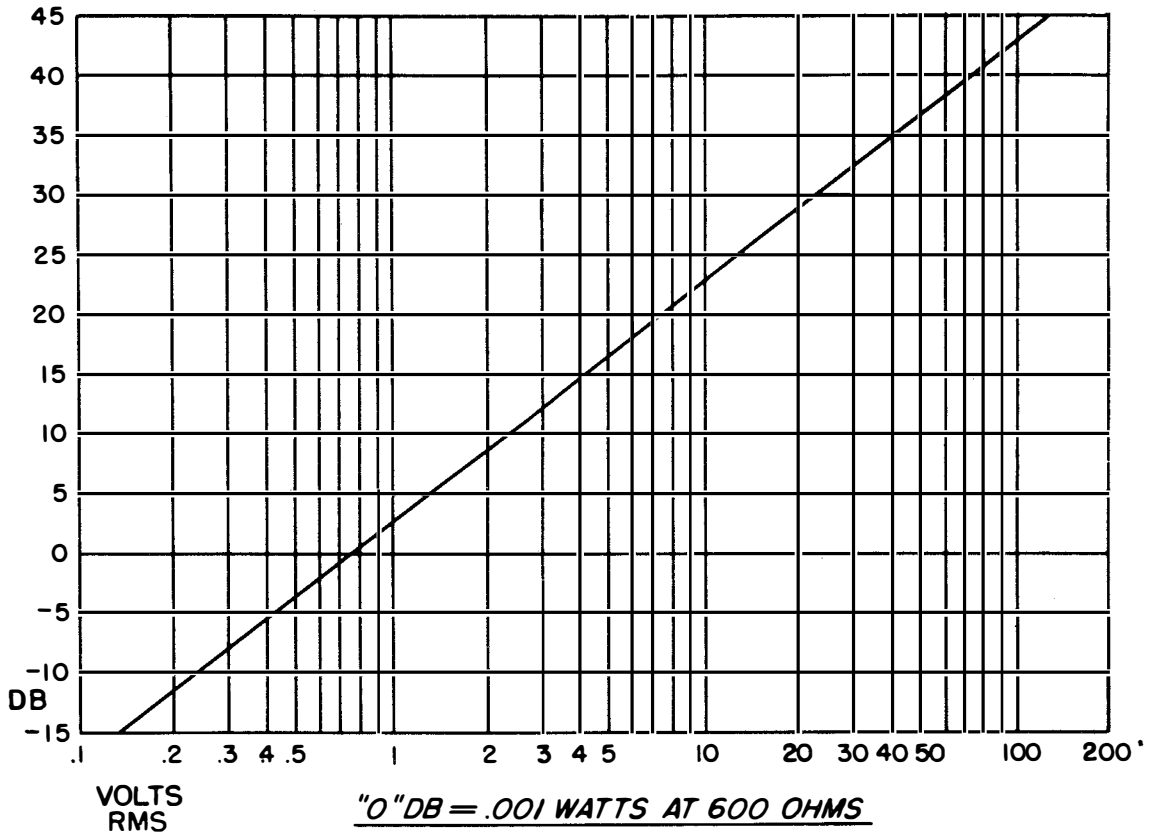


Fig. 4-4. D. B. CONVERSION CHART .001 WATTS AT 600 OHMS

mately +27 DB. In order to refer voltage measurements to other than the 600 ohm line, or to other than .001 or .006 watts, "O" DB reference, the following formula may be used:

$$DB = 20 \log \frac{E_2}{E_1}$$

In this formula E_1 represents the reference voltage at a reference impedance, and E_2 represents the measured voltage. As an example, assume that the reference wattage ("O" DB) is equal to 10 milliwatts, or .010 watts, and the reference impedance to be 5000 ohms. The formula

$$W = \frac{E_1^2}{R}$$

will permit the calculation of the reference voltage for "O" DB as follows:

$$E_1^2 = (5000)\ (.01) = 50$$

$$E = \sqrt{50} = 7.1$$

To find the voltage equivalent to a +10 DB level using the original basic formula would be as follows:

$$10 = 20 \log \frac{E_2}{E_1}$$

$$0.5 = \log \frac{E_2}{7.1}$$

$$E_2 = (3.16)\ (7.1) = 22.4 \text{ volts} = +10 \text{ DB}$$

9. CORRECTION FOR DUTY CYCLES - AC VOLTAGE MEASUREMENTS.

Duty Cycle - the product of pulse width in seconds and repetition frequency in cycles per second.

The inputs to the AC and RF circuits contain capacities which are charged by the input voltage. These capacities have a definite discharge time depending on the circuit design. When the input test voltage is a pulse of very short duration as compared to the time between pulses, it

is possible that the capacities in the input circuits may begin to discharge before another pulse is applied to the input; thus the capacity will not become fully charged and an error in the indicated voltage will result.

Figure 4.6 is a correction chart for these errors plotted against duty cycle.

10. RESISTANCE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the FUNCTION switch to OHMS.

c. Rotate the RANGE switch to the correct range for the resistance under test.

d. Make sure that power is disconnected from the equipment being checked. Use the OHMS and COMMON leads. Short the two leads and adjust the needle of the meter to zero position by means of the ZERO ADJUST control. Open the leads and adjust to full scale (INF) with the OHMS ADJUST control. Normally the infinity adjustment remains constant for all ranges. Should V-101 develop any gas, it may be necessary to readjust to infinity for the highest, or X1 megohm range.

e. Connect the resistance, making sure that one end of the resistance has been disconnected from any associated circuits.

f. Read the value of resistance from the OHMS scale and multiply by the position of the RANGE switch.

CAUTION

BE SURE THAT THE OHMMETER CIRCUIT IS NOT CONNECTED ACROSS ANY SOURCE OF VOLTAGE.

11. CURRENT MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the FUNCTION switch to MILS.

c. Rotate the RANGE switch to the correct range for the measurement to be made.

CAUTION

IF THE CURRENT IS UNKNOWN, ALWAYS START WITH THE HIGHEST MILS RANGE.

d. Use the MILS and COMMON leads.

e. Read the value of the current from the MILS scale and multiply by the position of the RANGE switch.

SECTION 5
PREVENTIVE MAINTENANCE

1. GENERAL.

Preventive maintenance is the removing of possible trouble which might later cause the equipment to become inoperative. Primarily, this includes periodic inspection, checking, cleaning and tightening of contacts and components. Certain suggestions can be made for such a program, but local conditions will largely determine the exact details.

The guide to the program will be found in Table 5-1, ROUTINE MAINTENANCE CHART. By carefully following this chart, troubles can be detected and remedied before causing actual breakdown of the equipment.

2. LUBRICATION.

No lubrication is required.

3. CLEANING.

WARNING

DISCONNECT POWER CORD

a. GENERAL.--The chassis is best blown out with dry compressed air or cleaned with a dry cloth and a soft dry paint brush of suitable size. It may be necessary to use dry cleaning solvent 140F(SNSN G51-S-4718-10) for 5 gallon drum on a cloth to clean ceramic high voltage insulators. On chassis surfaces, however, dry cleaning solvent 140F(SNSN G51-S-4718-10) should not be used as there is danger of softening the tropicalizing paint which covers them. Dust should be cleaned off thoroughly, both inside and outside the case.

Inspection should be combined with cleaning, since every part of the equipment can be observed at that time, and cleaning may inadvertently break or loosen a connection.

All exposed lug and screw connections, plug and socket connections, and electron tube pins should be checked for tightness. Cable ends should be properly dressed to prevent short circuits or strain on wires and lugs.

CAUTION

FAULTY ELECTRICAL CONTACTS CAN CAUSE EQUIPMENT FAILURE AT A CRITICAL TIME. EVIDENCES OF HEATING OR BREAKDOWN SUCH AS CARBONIZED SURFACES, OVERHEATED RESISTORS WITH DISCOLORED SURFACES, AND DISCOLORED METAL PARTS SHOULD BE NOTED. THOUGH THERE MAY BE NO DAMAGE, POTENTIAL TROUBLE IS INDICATED.

ROUTINE MAINTENANCE CHART.

ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO REQUIREMENTS OF CHAPTER 67 OF THE "BUREAU OF SHIPS MANUAL" OF THE LATEST ISSUE.

It is presumed that all maintenance operations will be scheduled by the Electronics Officer. The following table is given as a basis for such a schedule.

WARNING

BEFORE REMOVING THE CASE, DISCONNECT THE POWER CABLE. AFTER REMOVAL OF THE CASE, DISCHARGE ANY CAPACITORS IN THE POWER SUPPLIES.

Monthly

a. Remove fuses one at a time. Clean and burnish ends and clips as needed.

b. Check tube pins and socket contacts for corrosion. Clean as needed.

c. Check operation of all panel controls.

d. Blow out dust with dry compressed air. CAUTION: Air from a compressed air system using a piston-type compressor may contain oil vapor. Care should be taken to prevent formation of an oil film on the equipment.

e. Check for rust and corrosion. Clean and ouch up with paint as needed.

All knobs should be checked for looseness and tightened if necessary. Occasionally knobs become loose and fail to rotate their controls; thus, a loose knob may give the impression of fault in a variable circuit.

Rough handling of the equipment will sometimes jar parts or wires out of position or abrade them; such damage should be repaired. Rust or corrosion on painted surfaces should be cleaned and sanded smooth, and the spot covered with touchup paint. Unpainted surfaces will not ordinarily corrode unless exposed to salt water or some other corrosive agent. Should corrosion occur, it should be cleaned off thoroughly, taking care not to let the scrapings fall into the unit, and the spot touched up with clear varnish or tropicalizing paint. Paint or varnish should not be used too close to switch or tube socket contacts.

b. TUBES.

Compressed air or a brush will usually suffice to remove dust from the tubes. Be careful to clean tubes that operate at a high temperature, as a layer of dust would interfere with heat radiation and raise the operating temperature. After cleaning, make sure that all tubes are properly seated in their sockets and all tube clamps locked.

Any dirt and corrosion found around tube socket pins should be removed from the pins with crocus cloth and from socket contacts with the round blade of a burnishing tool.

c. FUSES.

Fuses should be removed and checked for corrosion and looseness, either of which can cause eventual trouble. A clean cloth moistened with dry cleaning solvent 140F(SNSN G51-S-4718-10) will usually suffice for cleaning the fuses and clips, but in some cases it may be necessary to use crocus cloth or fine sandpaper. When replacing, make sure that the fuses are tight in their clips.

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, from NAVGEN 1025, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest District Printing and Publication Office.

SECTION 6
CORRECTIVE MAINTENANCE

1. REMOVAL OF CASE.

a. Remove the ten screws from the front panel.

b. Remove the case from the chassis and panel. Figures 6-1 and 6-2 are internal views of the unit showing the location of tubes and component parts.

2. TUBE MAINTENANCE.

a. In case of failure of the type 9006 tube in the probe, it will be impossible to adjust the meter to zero for RF voltage measurements on the RF ranges. This tube is readily replaced by first removing the ground clamp screw and the three small screws at each end of the metal sleeving. Then the rear plug and metal sleeving may be moved back far enough to permit removal of the tube.

b. Replace any tubes not functioning properly. The location of these tubes is shown in Figure 6-1. Any good tube of the same type as that employed may be used for replacement.

3. CALIBRATION.

a. Remove the case in the same manner outlined in paragraph 1.

b. Support the equipment with the panel in a vertical position while making calibration adjustments.

c. Mechanically reset the meter needle to zero if necessary.

d. Plug the unit into a 105-125 volt, 50-1000 cycle AC power source. Allow a ten minute warm-up period.

e. DC VOLTS CALIBRATION.

(1) Set the FUNCTION switch to +DC volts.
(2) Set the RANGE switch to the known +DC voltage to be applied.
(3) Set the ZERO ADJUST control, R-108, so that the meter reads zero.
(4) Apply the known +DC voltage. If the meter does not indicate the proper voltage adjust potentiometer R-133 (See Figure 6-1) until the meter indicates the applied voltage.
(5) To calibrate -DC volts, set the FUNCTION switch to -DC volts, reverse the known DC voltage and follow the procedure above for the +DC voltage calibration except that potentiometer R-135 is adjusted until the meter indicates the applied voltage.

f. RF VOLTS CALIBRATION.

(1) Set the FUNCTION switch to the RF VOLTS position.
(2) Set the RANGE switch to the X10 position.
(3) Adjust the meter needle to zero with the ZERO ADJUST control R 108.
(4) Apply a known AC voltage of less than 10 volts and a frequency of over 1000 cycles.
(5) Adjust R 107 until the meter indicates the value of the known voltage.
(6) Set the RANGE switch to the X100 position.
(7) Apply a known voltage of less than 100 volts and a frequency of over 1000 cycles.
(8) Adjust potentiometer R 114 until the meter indicates the value of the known voltage.

g. RF CONTACT POTENTIAL ADJUSTMENT.

(1) With the FUNCTION switch set to the RF VOLTS position, set the RANGE switch to the X100 position.
(2) Adjust the meter needle to zero with the ZERO ADJUST control R 108.
(3) Turn the RANGE switch to the X1 position. If the meter deflects either up or down scale, adjust R 142 until the meter needle indicates zero.

h. AC VOLTS CALIBRATION.

(1) Set the FUNCTION switch to the AC VOLTS position.
(2) Set the RANGE switch to a position corresponding with the value of standard AC voltage selected for calibration.
(3) Set the ZERO ADJUST control R 108 until the meter needle indicates zero.
(4) Apply the known AC voltage and adjust R 134 until the meter indicates the proper peak-to-peak value.

i. AC CONTACT POTENTIAL ADJUSTMENT.

(1) With the FUNCTION switch set to the AC VOLTS position set the RANGE switch to the X1000 position.
(2) Set ZERO ADJUST control R 108 until the meter needle indicates zero.
(3) Set the RANGE switch to the X1 position.
(4) If the meter needle deflects up or down scale, adjust R 141 until the meter needle indicates zero.

j. OHMS CALIBRATION.

No calibration is necessary on OHMS except in case of resistor failure in the dividing network. Calibration may be checked by the use of a known precision resistor.

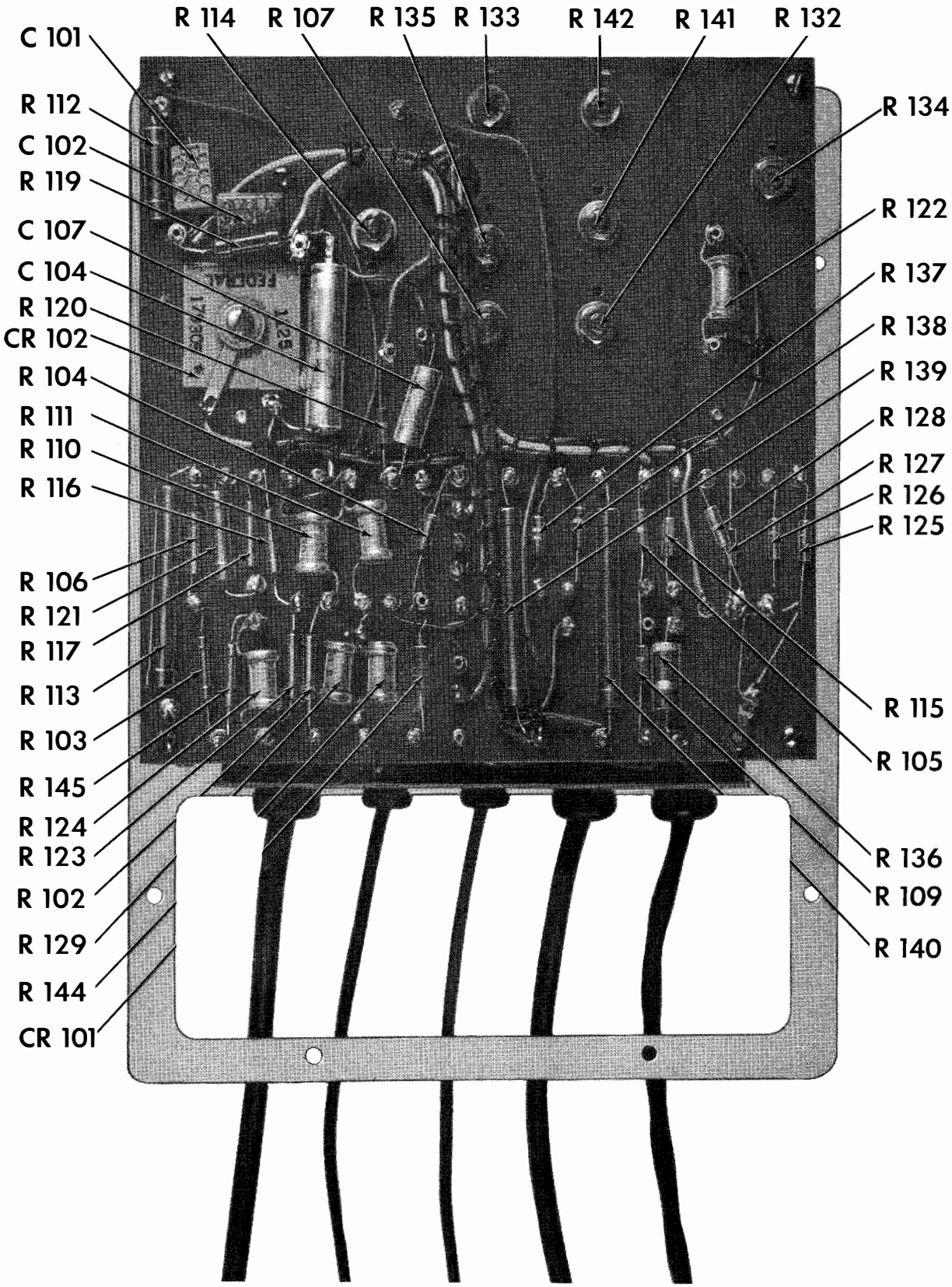


Fig. 6-1. MULTIMETER AN/USM-34 REAR VIEW OF CHASSIS WITH TERMINAL BOARD REMOVED

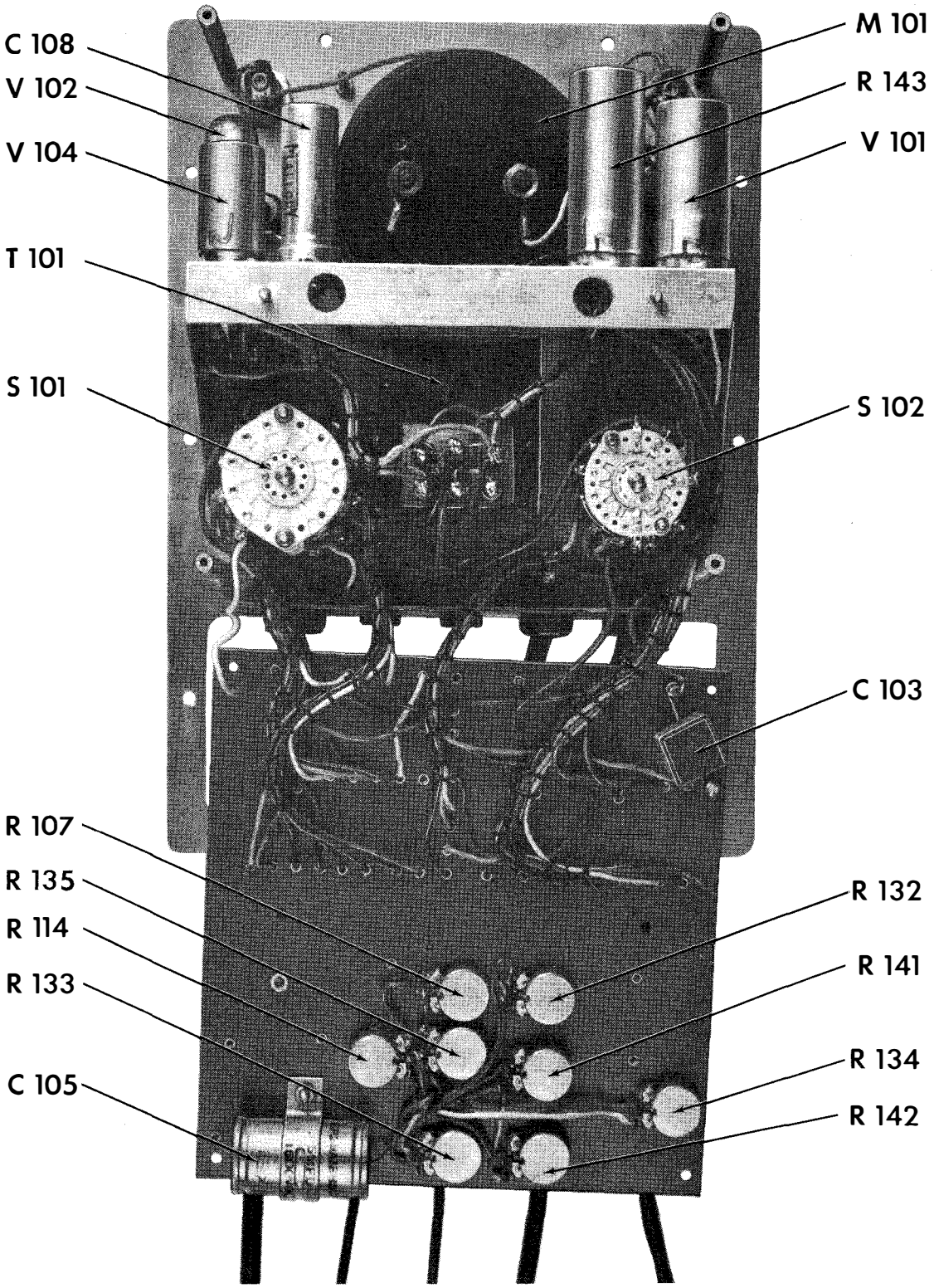


Fig. 6-2. MULTIMETER AN/USM-34 REAR VIEW WITH CASE REMOVED

k. MILS CALIBRATION.

(1) Set the FUNCTION switch to the MILS position.

(2) Set the RANGE switch to a position corresponding to the value of known current to be applied.

(3) Set the ZERO ADJUST control R 108 so that the meter needle indicates zero.

(4) Apply the known current and adjust R 132 until the meter indicates the value of the known current.

l. BASIC CALIBRATION TECHNIQUES FOR AC, RF, PLUS DC, MINUS DC VOLTS AND MILS.

(1) Apply accurate source of voltage, or current if calibrating mils, equal to approximately 50% of full-scale value.

(2) Adjust calibration potentiometers until meter indicates the correct value.

(3) Switch ranges and maintain input of approximately 50% of each range. Note accuracy of various ranges and if some ranges are high and some low, adjust calibration potentiometers to minimize error by dividing the error between the two ranges having the largest opposite errors. If the error on any range is still out of allowable tolerance, the voltage dividing network should be checked using a Resistance Bridge ZM-4/U or equivalent.

(4) For allowable tolerances, See page 1-2. .

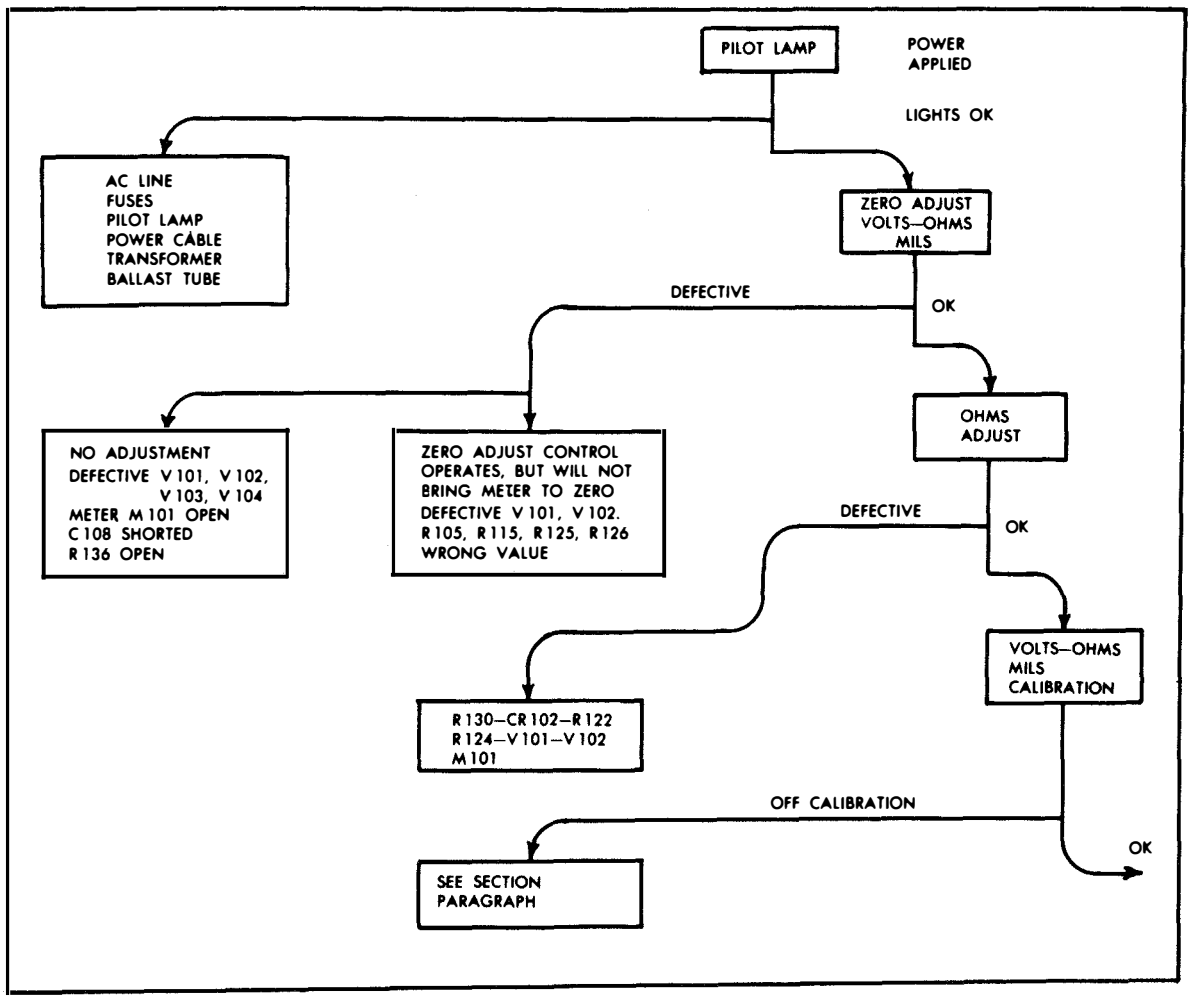
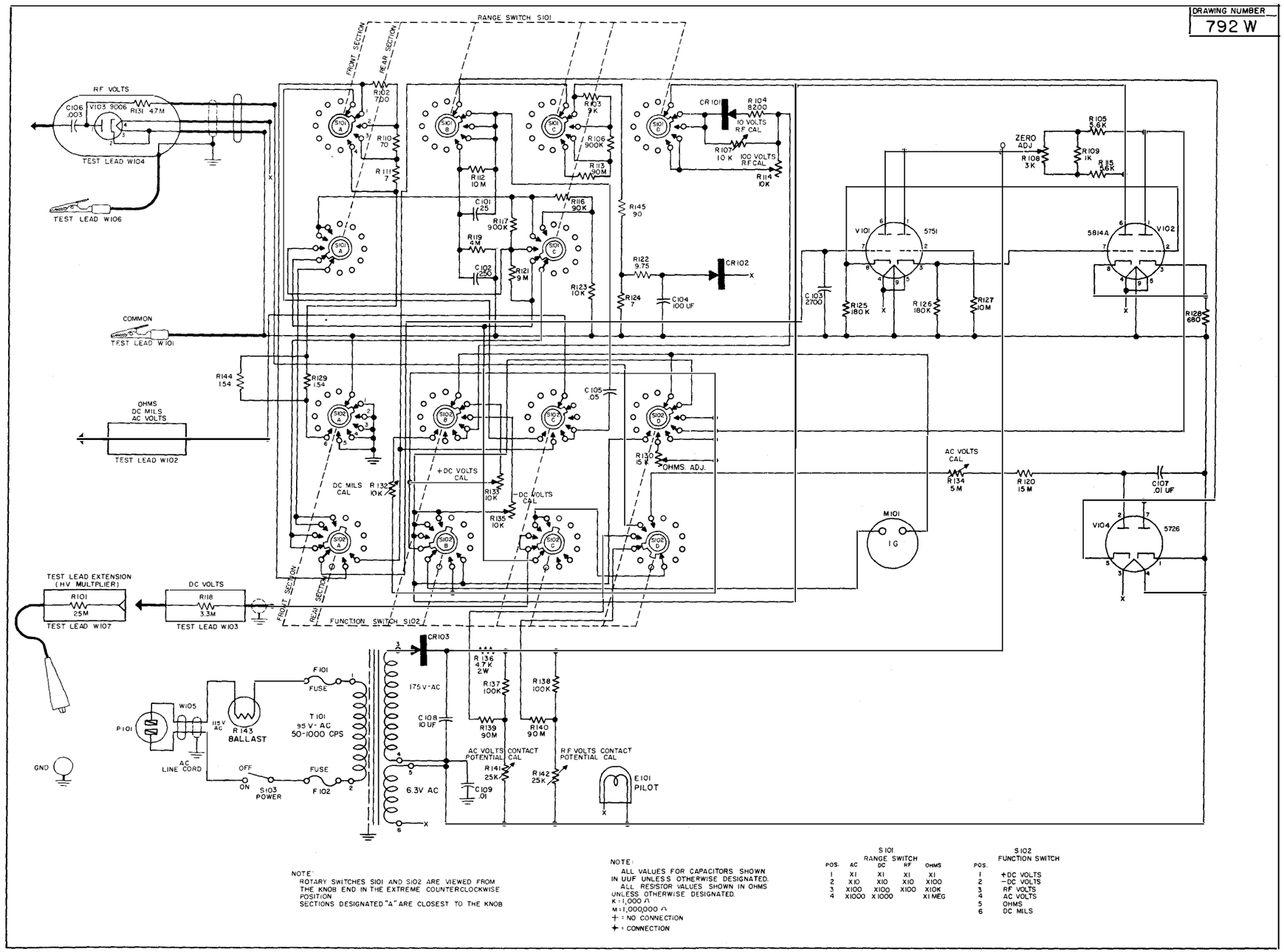


Fig. 6-3. TROUBLE SHOOTING CHART



NOTE:
ROTARY SWITCHES S101 AND S102 ARE VIEWED FROM THE KNOB END IN THE EXTREME COUNTERCLOCKWISE POSITION.
SECTIONS DESIGNATED "A" ARE CLOSEST TO THE KNOB

NOTE:
ALL VALUES FOR CAPACITORS SHOWN IN UUF UNLESS OTHERWISE DESIGNATED.
ALL RESISTOR VALUES SHOWN IN OHMS UNLESS OTHERWISE DESIGNATED.
K = 1,000 Ω
M = 1,000,000 Ω
┼ = NO CONNECTION
✦ = CONNECTION

S101
RANGE SWITCH

POS.	AC	DC	RF	OHMS
1	X1	X1	X1	X1
2	X10	X10	X10	X100
3	X100	X100	X100	X10K
4	X1000	X1000		X1 MEG

S102
FUNCTION SWITCH

POS.	
1	+DC VOLTS
2	-DC VOLTS
3	RF VOLTS
4	AC VOLTS
5	OHMS
6	DC MILS

Fig. 6-4. SCHEMATIC WIRING DIAGRAM, MULTIMETER AN/USM-34

SECTION 7
PARTS LISTS

TABLE 7-1. MAJOR UNIT

SYMBOL GROUP	NAME OF MAJOR UNIT	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS
100	MULTIMETER AN/USM-34 Consists of Accessories and and 1 MULTIMETER ME-81/USM-34	

TABLE 7-2
TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
A101	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A.	CASE: enclosure for Multimeter ME-81/USM-34; aluminum, light gray enamel finish; dimensions 11-21/32 in. high x 8-21/32 in. wd. x 5-9/16 in. deep; metal carrying handle; compartment for leads and accessories; cover secured by 4 pull down catches; watertight gasket. Hickok Part/Dwg. No. 3145-295.	1	Combination instrument and transit case for equipment.
A102	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A.	PANEL: P/O Multimeter ME-81/USM-34; aluminum; light gray enamel finish; etched lettering filled in black and green; rectangular 11-1/8 in. h. x 8-1/8 in. wd. x .093 in. thick; all holes punched for mounting components. Hickok Part/Dwg. No. 16024-231.	1	Front panel of equipment.
C101		CAPACITOR, FIXED, MICA: 25 mmf p/m 10%; 1500 vdcw; molded low loss phenolic case, 45/64" lg. x 29/64" wd. x 3/16" thk; 2 axial wire leads; terminal mounted. Aerovox Type 1468L-HV. Hickok Part No. X-3095-59.	1	Capacitor in AC voltage divider circuit.
C102		CAPACITOR, FIXED, MICA: 250 mmf p/m 10%; 1500 vdcw; molded low loss phenolic case; 45/64" lg. x 29/64" wd. x 3/16" thk; 2 axial wire leads; terminal mounted. Aerovox Type 1468L-HV. Hickok Part No. X-3095-60.	1	Capacitor in AC voltage divider circuit.
C103	N16-C-32145-5164 3K3027221	CAPACITOR, FIXED, MICA: 2700 mmf p/m 10%; 500 vdcw; molded low loss phenolic case; temp. coef. B; 53/64" lg. x 53/64" wd. x 9/32" thk; 2 axial wire leads; terminal mounted. Spec. JAN-C-5 Type CM30B272K. Cornell Dubilier No. CD-CM30B272K. Hickok Part No. X-3095-41.	1	Bypass on grid pin 2 of V101.
C104		CAPACITOR, FIXED, ELECTROLYTIC: 100 mfd, -10% + 250% tol; 6 vdcw; one section; -40 to +65 working temp. range; tubular metal case 3/8" dia. x 1-5/8" lg.; 2 axial wire leads; neg. terminal grounded internally; terminal mounted. Aerovox Type SREN. Hickok Part No. X-3085-64.	1	Filter capacitor in DC voltage supply circuit for resistance measurements.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
C105	For replacement use SNSN N16-C-44262-6441	CAPACITOR, FIXED, PAPER: 1 section 50,000 mmf, p/m 20%; 1500 vdcw; herm. sealed tubular metal case; 1 in dia. x 1-7/8 in. lg; 2 axial wire leads; mineral oil impregnated; no internal ground; mtg. bracket with single mtg. hole. Spec. MIL-C-25A Type CP29A1EH503M. Cornell Dubilier Type CD-CP29A1EH503M. Hickok Part No. X-3105-183.	1	AC input coupling capacitor to V104.
C106		CAPACITOR, FIXED, CERAMIC: disk type; 3000 mmf, GMV; 600 vdcw; insulated Durez coating; 3/8" dia. x 1/8" thk; two radial wire leads; terminal mounted P/O W104. Centralab Type DD. Hickok Part No. X-3110-44.	1	Input capacitor to V103 of diode probe.
C107		CAPACITOR, FIXED, CERAMIC: disk type; 10,000 mmf, -20 + 50%; 1000 vdcw, insulated, phenolic coating; 3/4 in. dia. x 1/8 in. th.; two radial wire leads; terminal mounted. Erie Resistor Corp. Type 828. Hickok Part No. X-3110-56.	1	Bypass in rectified AC circuit from diode V104.
C108	N16-C-19568-7337 3DB10-62	CAPACITOR, FIXED, ELECTROLYTIC: 1 section; 10 mfd, -10 + 50%; 450 vdcw; -20 to +65°C working temp. range; tubular metal case 3/4" diam. x 2" lg. one solder lug term. on mtg. end; mounted by 2 twist lugs, one lug pierced for negative connection. Mallory Type FP-S142. Hickok Part No. X-3085-25.	1	Filter capacitor in DC power supply circuit from anode of CR103 to B-.
C109	For replacement use SNSN N16-C-42767-5243	CAPACITOR, FIXED, PAPER: 1 section; 10,000 mmf; p/m 20%; herm. sealed tubular metal case, 5/16 in. dia. x 13/16" lg; 2 axial wire leads; Vitamin Q synthetic impregnation; no internal ground; terminal mounted. Sprague Catalog No. 81P10306. Hickok Part No. X-3105-194.	1	Bypass B- to ground.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
CR101	N16-T-51748.	CRYSTAL UNIT, RECTIFYING: germanium type; 50 ma max continuous forward current; 150 ma max peak forward current; 85V peak inverse voltage; 8 mmf shunt capacitance; approx. 1/2 in. lg. x .220 in. dia. excluding terminals; 2 axial wire leads. General Electric Type 1N-48. Hickok Part No. X-3870-29.	1	Rectifies AC input to bridge circuit tube V102.
CR102		RECTIFIER, METALLIC: selenium: single phase half wave type; max. input 20 VRMS max output VDC @ 150 ma max. rectangular shape 1-9/32 in. lg. x 1-13/64 in. x 1/4 thk; single axial mtg. hole 5/32" diam; two solder lug terminals at opposite ends of stack. Federal Telephone & Radio Corp. No. 1125-179305. Hickok Part No. X-18150-27.	1	Provides rectified DC voltage for resistance measurements.
C103		RECTIFIER, METALLIC: selenium; single phase voltage double type; max input voltage 260VRMS; max peak inverse volts 720 R19S; output 20 ma dc; o/a dim. excluding terminals 1/2 in. x 1/2 in. x 7/8 in. high; single axial mtg. hole for No. 6 machine screw; 3 solder lug terminals on one side. Selectron Div. of Radio Receptor Co. Type 16Y1. Hickok Part No. X-18150-21.	1	Provides rectified DC voltage for plate supply.
E101	G17-L-6297 2Z5952.	LAMP, INCANDESCENT: 6 to 8 volt @ .15 Amp; miniature bayonet base; bulb type T-3-1/4, clear; 1-1/8" lg. o/a; C-2 filament; burn any position. Sylvania Products Type 47. Hickok Part No. 12270-12.	1	Pilot lamp. Mounted behind lens of I-101
E102	N17-P-69136-2412	POST, BINDING: molded black phenolic cap and base; o/a height above mtg. surface 1-1/32 in. max. open, 13/16" closed; 5/8 OD of post; mounting stud 25/32 in. lg. threaded 10-32; 3/32 diam. wire hole; nonremovable cap, with 5/32" dia. hole in top for banana plug, s/w 2 mtg. nuts and insulating washer for rear of panel. Superior Electric Type DF30BC. Hickok Part No. 2360-57.	1	Ground connection for panel and case.

E103	Low Failure item if required requisition from ESO referencing NavShips 900-180A.	TERMINAL BOARD: laminated phenolic; 60 feed through type miniature swaged stud type terminals; w/o barriers; o/a dim. including terminals 7-1/8 in. lg. x 7" wd. x 3/4 in. thk; 4 mtg. holes 5/32 in diam. on 6-1/2 x 6-5/8 in. mtg. centers; marked with symbol designations of components to be mounted. Hickok Part/Dwg. 2420-215.	1	Insulated mounting for circuit components.
E104	N17-F-74266-9053	FUSEHOLDER: extractor post type; rated 15 amps @ 250 volts; accomodates 1 cartridge type fuse 1-1/4 in. lg. x 1/4 in. dia; molded black phenolic body; beryllium copper contacts; 2 solder lug terminals; o/a dim. excluding terminals 1-41/64" lg. x 11/16" dia; mounts in single 1/2" diam. hole. Littlefuse Type A-342003. Hickok Part No. X-8825-51.	2	Mounting receptacles for line fuses F101 and F102.
E105		Same as E-104.		
E106	For replacement use SNSN N17-C-945001-376	INSULATOR, CLIP: molded black vinyl acetate, for use with Mueller No. 60 alligator type test clip. P/O W107. Mueller Electric No. 62 Black. Hickok Part No. 9720-39.	1	Insulating cover for alligator clip of multiplier lead W107.
E107	N17-P-84923-8791 3Z4220-5.1	PROD, TEST: phone tip 0.080 in. dia; red plastic handle 4 in. lg; wire attached to tip by knurled nut; 3/8 in. dia. x approx. 5 in. lg. o/a. American Radio Hardware No. 145. Hickok Part No. 16975-1 P/O W-102.	1	General purpose insulated test prod. Replacement part for W102.
E108	N17-P-84825-6001 3F3705-6.4	PROD, TEST: phone tip 0.080 in. dia; red plastic handle 3" lg; wire attached to tip by knurled nut; 7/16 in. dia. x approx. 4 in. lg. o/a; ID of handle 17/64 in. Hickok Part No. 16975-21 P/O W-103.	1	Insulated test prod. Replacement part for W103.
E109	Shop Manufacture.	TIP, TEST PROD: contact point for diode test probe; brass; nickel plated; 5/32 in. dia. x 1-3/16 in. lg; threaded 8-32 on one end, conical point on other end. Hickok Part No. 16976-32. P/O W-104.	1	Metal prod point. Replacement part for W104.
E110	Shop Manufacture.	INSULATING SLEEVE: flexible black rubber 1/8 in. ID; 1/8 in. wall thickness; 7/8 in. lg. Hickok Part No. 9720-41 P/O W-104.	1	Insulating cover for Prod Tip E109. Replacement part for W104 diode probe lead.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
E111	N16-S-34520-3864	SHIELD, ELECTRON TUBE: brass, nickel plated; cylindrical; 1-3/8 in. lg. x .810 in. ID; bayonet type mtg; includes tension spring. Spec. JAN-S-28A - Type TS102-U01. Hickok Part No. X-19155-136.	1	Shield and cover for V104.
E112	N16-S-34576-6513 2Z8304.183	SHIELD, ELECTRON TUBE: brass, nickel plated; cylindrical; 1-15/16 in. lg. x .950 in. ID; bayonet type mtg; includes tension spring. Spec. JAN-S-28A - Type TS103U02. Hickok Part No. X-19155-140.	2	Shield and cover for V101.
E113	N16-S-34621-5205	SHIELD, ELECTRON TUBE: brass, nickel plated; cylindrical; 2-3/8 in. lg. x .950 in. dia; bayonet type mtg; includes tension spring. Spec. JAN-S-28A - Type TS103U03. Hickok Part No. X-19155-141.	1	Shield and cover for ballast resistor R-143.
E114	N17-T-28218-4116 3Z12072-53.1	TERMINAL, STUD: insulated solder connection; brass silver plated; 13/16 in. lg. o/a, 5/16 in. hex base; mounts by 6-32 threaded shank 1/4 in. lg; ceramic insulation. Cambridge Thermionic X-1581-B. Hickok Part No. 20340-16.	1	Insulated terminal connection.
E115		Same as E112.		Shield and cover for V102.
F101	N17-F-16320-25	FUSE, CARTRIDGE: 1/2 Amp, 250 volts; time delay, 135% for 1 hr; 200% for 60 seconds max, 5 seconds minimum; ferrule type terminals 1/4 in. dia. x 1/4 in. lg; enclosed glass body 1-1/4 in. lg. x 1/4 in. dia. o/a; one time operation. Littlefuse Inc. Type 3AG. Cat. No. 313.500. Hickok Part No. 6900-15.	2	Protective fuses in primary circuit of power transformer T101.
F102		Same as F101		Same as F101.

H101	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A.	CHAIN: bead type links approx. 1/8 in. dia; stainless steel 12 in. lg; excluding terminations; one end terminated in straight eyelet with swivel coupling other end terminated in offset eyelet with swivel coupling. Bead Chain Mfg. Co. Hickok Part/Dwg. No. 3180-1.	1	Secures instruction book to cover of case.
H102	N43-S-33965-2065 6L31129-13	TERMINAL STUD: brass nickel plated; 0.687 in. lg. x 0.156 in. dia. o/a; one end threaded 4-40 5/32 in. lg. other end drilled 3/8 in. deep x 0.078 in. dia; straight knurl section 1/4 in. lg. P/O W106. Hickok Part/Dwg. No. 19821-13.	1	Terminal to connect ground lead to shell of diode probe. Replacement part for W106.
I-101	Assemble from component parts.	LIGHT, INDICATOR, WITH LENS: 1/2 in. dia. ruby jewel frosted on back only; for miniature bayonet base lamp, T-3-1/4 bulb size; open frame, brass nickel plated; dim. behind mtg. surface 1-11/32 in. lg. x 1 in. x 7/8 in. jewel protrudes 5/8 in. in front of panel; horizontal mtg; maximum panel thickness 15/64 in.; lamp removable from front slotted jewel holder; polarized disk; two solder lug terminals. Drake Mfg. Co. Type 80-20-MIL. Hickok Part No. X-19350-199. Consists of I-101a and I-101b.	1	ON--OFF indicator. Illuminated by E101.
I-101a	N17-L-76655-8931	LIGHT, INDICATOR, SOCKET: p/o I-101. Drake Mfg. Co. Part No. 225A. Hickok Part No. X-19350-205		
I-101b	N17-L-250267-301	LENS, RUBY: p/o I-101. Drake Mfg. Co. Part No. 16 Ruby SFB. Hickok Part No. X-19350-206		

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
M101	N17-M-22707-2143	METER, ELECTRONIC MULTIMETER: panel mounting; basic sensitivity 400 UA for full scale deflection; scale calibration, AC volts, DC volts, RF volts and DC mils 0 to 1.0, ohms 0 to 2K, peak to peak AC volts 0 to 3; flange 4 in. wd. x 3-3/4 in. high x 5/8 in. thk. body 3-1/2 in. dia. x 1-1/2 in. deep excluding terminals; ohms scale green, volts and mils scales black, on white background, black pointer; four 6-32 mtg. studs 5/8 in lg. on 3-3/8 x 3-1/8 in. mtg. centers; 2 terminal studs 1/4-28 thread x 7/8 in. lg; designed only for use in Multimeter. ME-81/USM-34 which includes all necessary associated circuit components. Hickok Model S48G Style 481-132.	1	Indicating instrument for all measurements and ranges.
O-101	N16-K-700277-348 2Z5822-322.	KNOB: round, black phenolic; for round shaft 1/4 in. dia, shaft hole 7/16 in. deep; one 8-32 set screw; brass insert; no marking, 3/4 in. dia. x 9/16 in. h. o/a. Kurz-Kasch - Type No. 230-64. Hickok Part No. 11505-11.	2	Control knobs for ZERO ADJ. and OHMS ADJ.
O-102		Same as O-101.		
O-103	For replacement use SNSN N17-K-700073-551	KNOB: bar; black phenolic; for round shaft 1/4 in. dia, shaft hole 3/4 in. deep; one 8-32 set screw; brass insert; marked with white dot; 1-13/32 in. lg. x 7/8 in. wd. x 13/16 in. high o/a; small metal pointer on lower edge. Hickok Part/Dwg. No. 11500-31.	1	Control knob for FUNCTION switch.
O-104	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A.	KNOB: bar; black phenolic; for round shaft 1/4 in. dia; shaft hole 3/4 in. deep; one 8-32 set screw; brass insert; marked with 2 white dots; 1-17/32 in. lg. x 7/8 in. wd. x 13/16 in. high o/a; 2 small metal pointers on lower edge. Hickok Part/Dwg. No. 11500-32.	1	Control knob for RANGE switch.

O-105	N17-C-802555-801	CLIP; ELECTRICAL: alligator; steel, cadmium plated; 2 in. lg. x 1/2 in. wd. x 5/16 in. high; solder loop terminal; 3/8 in. max. jaw opening P/O W107. Mueller Electric Co. No. 60. Hickok Part No. 3300-8	1	Clip connection of multiplier lead. Replacement part for W107.
O-106	N17-C-802584-284 3Z1087-8.1	CLIP, ELECTRICAL: alligator; steel, cadmium plated; 2-1/4 in. lg. x 1/2 in. wd. x 3/8 in. high; solder loop terminal; 3/8 in. max. jaw opening; black plastic handle P/O W101 and W106. Mueller Electric Co. No. 60H. Hickok Part No. 3300-10.	2	Test clip. Replacement part for W101 and W106.
O-107		Same as O-106.		
O-108	N16-C-802600-101 3Z1087-15.	CLIP, ELECTRICAL: alligator; copper, nickel plated; 2-5/16 in. lg. x 1/2 in. wd. x 5/16 high; 10-32 threaded coupling on shank; 3/8 in. max. jaw opening U/W W103. Hickok Part/Dwg. No. 3300-23.	1	Screw on type test clip. Used with W103.
O-109	Shop Manufacture. 2Z8877.429.	SPRING: helical compression type; #18 music wire; silver plated, 9/32 in. dia. x 1-1/8 in. free length o/a; 9 turns; one end terminated in concentric loop 1/8 in. ID, other end unfinished, P/O W107. Hickok Part/Dwg. No. 19450-31.	1	Contact spring. Replacement part for W107.
O-110	Shop Manufacture. 2Z1409-199.	BUSHING: brass nickel plated; 1/4 in. lg; threaded 3/8-24 full length external and 10-32 full length internal; one end slotted 3/64 x 3/64 in. for screw driver. P/O W107. Hickok Part/Dwg. No. 2900-23.	1	Threaded coupling to connect multipler lead W107 to DC test lead W103. Replacement part for W107.
O-111	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A. 3G100-222.	BUSHING, STRAIN RELIEF: molded black nylon; round, 2 piece construction o/a dim. 0.725 in. dia. x 0.687 in. lg.; requires one panel mtg. hole 5/8 in. dia; grips wire or cable when compressed and inserted in panel hole, for cables up to .355 in. dia. in panel; .127 in. thick max. Heyman Mfg. Co. No. SR-6P. Hickok Part No. 3275-156.	2	Locking grommet to secure test leads W103 and W104 on chassis.
O-112		Same as O-111.		

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
O-113	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A.	BUSHING, STRAIN RELIEF: molded black nylon; round, 2-piece construction; o/a dim. .560 in. diam. x .438 in. lg; requires one panel mtg. hole .515 in. dia; grips wire or cable when compressed and inserted in panel hole; for wires up to .245 in. dia; .100 in. max. panel thickness. Heyman Mfg. Co. No. SR-5P. Hickok Part No. 3275-155.	1	Locking grommet to secure power cable W105 in chassis.
O-114	Low Failure item if required requisition from ESO referencing Nav-Ships 900-180A.	BUSHING, STRAIN RELIEF: molded black nylon; round, 2 piece construction o/a dim. .560 in. dia. x .438 in. lg.; requires one panel mtg. hole .437 in. dia.; grips wire or cable when compressed and inserted in panel hole; for wires up to .223 in. dia. in panel; .100 in. max. thick. Heyman Mfg. Co. No. SR-3P. Hickok Part No. 3275-186.	2	Locking grommet to secure test leads W101 and W102 in chassis.
O-115		Same as O-114.		
P101	N17-C-71425-4054 6Z7560-5.	*CONNECTOR, PLUG: 2 flat parallel blades straight o/a dim. excluding terminals 1-3/8 in. dia. x 1-5/6 in. lg. rated 15 amps 125 volts, 10 amps 250 volts, rd. rubber body, rubber insert, cable opening .260 in. to .312 in. dia. Bryant Type HRB. Hickok Part Number 16525-58. *REPLACEMENT PART FOR W105. NOT USED ON ORIGINAL EQUIPMENT.	1	Replacement plug for power cable W105.
R101		RESISTOR, FIXED, FILM: 25 meg ohms, p/m 1%; 2 watt; resistance temperature characteristic X; body dim. excluding terminals 2-1/16 in. lg. x 9/32" dia; uninsulated, resistant to humidity; silver plated ends caps, without leads. Electra Mfg. Co. Type DC-2. Hickok Part No. X-18575-132.	1	H. V. Multiplier resistor. Replacement part for W107.

R102		RESISTOR, FIXED, FILM: 700 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A Type RN20X7000F. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18530-6.	1	Resistor in voltage divider of milliammeter circuit.
R103		RESISTOR, FIXED, FILM: 9,000 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A Type RN20X9001F. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18530-2.	1	Resistor in ohms dividing network.
R104	N16-R-50236-431 3RC20BF822J.	RESISTOR, FIXED, COMPOSITION: 8200 ohms, p/m 5%; 1/2 watt; characterisitic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF822J of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18412-821.	1	Part of meter curve correction circuit, in series with CR101.
R105	N16-R-50164-431 3RC20BF562J.	RESISTOR, FIXED, COMPOSITION: 5600 ohms, p/m 5%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF562J of Spec. MIL-R-11-A. Allen Bradley Type EB. Hickok Part No. X-18412-561.	2	Plate load, bridge circuit tube V102.
R106		RESISTOR, FIXED, FILM: 900,000 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A - Type RN20K9003F. Electra Mfg. Co. Type DC-1/2A. Hickok Part Number X-18530-4.	2	Part of ohmmeter circuit, dividing network.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
R107		RESISTOR, VARIABLE: composition; one section; 10,000 ohms p/m 20%; .3 watt standard linear "A" taper; 3 solder lug terminals; enclosed metal case; body dim. 3/4" diam. x 23/64" deep; round metal shaft 1/8" dia. x 3/8" lg. from mtg. surface, slotted for screw driver; insulated contact arm; normal torque; no off position; 1/4-32 mtg. bushing 1/4 in. lg. Chicago Telephone Supply Corp. Type 70. Hickok Part No. X-16925-176.	5	RF calibration potentiometer.
R108		RESISTOR, VARIABLE: composition; one section; 3500 ohms p/m 10%; 1/2 watt; standard linear "A" taper; 3 solder lug terminals; enclosed metal case; body dim. 1-1/8 in. dia. x 1/2 in. deep; round flatted metal shaft 1/4" dia. x 3/4" lg. from mtg. surface; insulated contact arm; normal torque; no off position; 3/8-32 mtg. bushing 3/8" lg. Chicago Telephone Supply Corp. Type 35. Hickok Part No. 16925-187.	1	ZERO ADJ. Control.
R109	N16-R-49922-811 3RC20BF102K.	RESISTOR, FIXED, COMPOSITION: 1000 ohms, p/m 10%; 1/2 watt; characterisitic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia. insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF102K of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18412-102.	1	Zero adjust control shunt.
R110	For replacement use SNSN N16-R-73465-3076.	RESISTOR, FIXED, FILM: 70 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A, Type RN20X70R0F. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18530-7.	1	Part of milliameter dividing network.

R111	For replacement use SNSN N16-R-73452-1091	RESISTOR, FIXED, FILM: 7 ohms, p/m 1%; 1/2 watt; body dim. excluding terminals 5/8 in. lg. x 3/8 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Continental Carbon Company Type X-1/2. Hickok Part No. X-18525-540.	2	Part of milliameter dividing network.
R112	N16-R-51326-811 3RC20BF106K.	RESISTOR, FIXED, COMPOSITION: 10 meg ohms, p/m 10%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF106K of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18416-102.	1	Part of AC volts dividing network.
R113		RESISTOR, FIXED, FILM: 90 meg ohms, p/m 2%; 2 watt; body dim. excluding terminals 2-1/16 in. lg. x 9/32 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Wilkor Products Div. of Aerovox Corp. Type CP-2. Hickok Part No. X-18575-98.	1	Part of ohms dividing network.
R114		Same as R107.		RF calibration potentiometer.
R115		Same as R105.		Plate load bridge circuit tube V102.
R116		RESISTOR, FIXED, FILM: 90,000 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia. uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A. Type RN20X9002F. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18530-1.	1	Part of DC volts dividing network.
R117		Same as R106.		Part of AC voltage dividing network.
R118	N16-R-51110-811 3RC20BF335K	RESISTOR, FIXED, COMPOSITION: 3.3 meg ohms, p/m 10%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF335K of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18415-332.	1	Series Resistor in DC voltage probe.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO; PER EQUIP.	LOCATING FUNCTION
R119	For replacement use SNSN N16-R-73350-4152.	RESISTOR, FIXED, FILM: 4 meg ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18525-382.	1	Part of AC voltage dividing network.
R120	N16-R-51370-431 3RC20BF156J.	RESISTOR, FIXED, COMPOSITION: 15 megohms, p/m 5%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF156J of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18416-151.	1	Decoupling resistor on plate pin 2 of V104.
R121	For replacement use SNSN N16-R-73546-1151	RESISTOR, FIXED, FILM: 9 megohms, p/m 1%; 1 watt; resistance temperature characteristic X; body dim. excluding terminals 15/16 in. lg. x 9/32 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Electra Mfg. Co. Type DC-1. Hickok Part No. X-18550-127.	1	Part of DC voltage dividing network.
R122		RESISTOR, FIXED, FILM: 9.75 ohms, p/m 1%; 1/2 watt; body dim. excluding terminals 5/8 in. lg. x 3/8 in. dia. uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Continental Carbon Co. Type X1/2. Hickok Part No. X18525-446	1	Part of ohmmeter DC supply circuit.
R123		RESISTOR, FIXED, FILM: 10,000 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. x 11/64 in. dia. uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A Type RN20X1002F. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18530-5.	1	Part of DC voltage dividing network.
R124		Same as R111.		Part of ohms dividing network.

R125	N16-R-50696-811 3RC20BF184K.	RESISTOR, FIXED, COMPOSITION: 180,000 ohms, p/m 10%; 1/2 watt; characterisitic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF184K of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18414-182.	2	Cathode resistor of V101.
R126		Same as R125.		Cathode resistor of V101.
R127	For replacement use SNSN N16-R-73546-9751	RESISTOR, FIXED, FILM: 10 megohms, p/m 1%; 1 watt; resistance temperature characteristic X; body dim. excluding terminals 15/16 in. lg. x 9/32 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. . lg. Electra Mfg. Co. Type DC-1. Hickok Part No. X-18550-129.	1	Grid resistor of V101.
R128	N16-R-49840-431 3RC20BF481J.	RESISTOR, FIXED, COMPOSITION: 680 ohms, p/m 5%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia.; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF681J of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18411-681.	1	Cathode resistor in bridge circuit of V102.
R129		RESISTOR, FIXED, FILM: 1.54 ohms, p/m 1%; 1/2 watt; body dim. excluding terminals 5/8 in. lg. x 3/8 in . dia. uninsulated, resistant to humidity; 2 radial wire lead terminals 1-1/2 in. lg. Continental Carbon Co. Type X-1/2. Hickok Part No. X-18525-573.	2	Part of milliameter dividing network.
R130		RESISTOR, VARIABLE: composition; one section, 15,000 ohms, p/m 10%; 1/2 watt; standard linear "A" taper; 3 solder lug terminals; enclosed metal case; body dim. 1-1/8 in. dia. x 1/2 in. deep; round flatted metal shaft 1/4" dia. x 3/4" lg. from mtg. surface; insulated contact arm; normal torque; no off position 3/8-32 mtg. bushing 3/8" lg. Chicago Telephone Supply Corp. Type 35. Hickok Part No. X-16925-186.	1	OHMS ADJ. Control.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
R131	N16-R-51173-811 3RC20BF475K.	RESISTOR, FIXED, COMPOSITION: 4.7 megohms, p/m 10%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. P/O W104. Type RC20BF475K of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18415-472.	1	Decoupling resistor in RF probe.
R132		Same as R107.		Milliameter calibration pot.
R133		Same as R107.		+DC calibration pot.
R134		RESISTOR,VARIABLE, COMPOSITION: one section; 5 megohms, p/m 30%; .2 watt; standard linear "A" taper; 3 solder lug terminals; enclosed metal case; body dim. 3/4 in. dia. x 23/64 in. deep; round metal shaft 1/8" dia. x 3/8" lg. from mtg. surface; slotted for screw driver; insulated contact arm, normal torque; no off position; 1/4-32 mtg. bushing 1/4" lg. Chicago Telephone Supply Corp. Type 70. Hickok Part No. X-16925-177.	1	AC volts calibration potentiometer.
R135		Same as R107.		-DC calibration potentiometer.
R136	N16-R-50129-106 3RC20BF472J.	RESISTOR, FIXED, COMPOSITION: 4700 ohms, p/m 5%; 2 watt; characteristic F; body dim. excluding terminals 11/16 in. lg. x 5/16 in. dia.; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC42BF472J of Spec. MIL-R-11A. Allen Bradley Type HB. Hickok Part No. X-18432-471.	1	Part of power supply filter circuit.

R137	N16-R-50633-811 3RC20BF104K.	RESISTOR, FIXED, COMPOSITION: 100,000 ohms p/m 10%; 1/2 watt; characteristic F; body dim. excluding terminals 3/8 in. lg. x 9/64 in. dia; insulated; 2 axial wire lead terminals 1-1/2 in. lg. Type RC20BF104K of Spec. MIL-R-11A. Allen Bradley Type EB. Hickok Part No. X-18414-102.	2	Part of AC volts contact bucking potential network.
R138		Same as R137.		Part of RF volts contact bucking potential network.
R139		RESISTOR, FIXED, FILM: 90 megohms, p/m 10%; 2 watt; body dim. excluding terminals 2-1/16 in. lg. x 9/32 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Wilkor Products Div. of Aerovox Corp. Type CP-2. Hickok Part No. X-18575-117.	2	Part of AC volts contact bucking potential network.
R140		Same as R139.		Part of RF volts contact bucking potential network.
R141		RESISTOR,VARIABLE, COMPOSITION: one section; 25,000 ohms, p/m 20%; .2 watt; standard linear "A" taper; 3 solder lug terminals; enclosed metal case; body dim. 3/4 in. dia. x 23/64 in. deep; round metal shaft 1/8 in. dia. x 3/8 in. lg. from mtg. surface, slotted for screw driver; insulated contact arm; normal torque; no off position; 1/4-32 mtg. bushing 1/4 in. lg. Chicago Telephone Supply Corp. Type 70. Hickok Part No. X-16925-178.	2	AC contact bucking potential adjustment.
R142		Same as R141.		RF contact bucking potential adjustment.
R143		RESISTOR, THERMAL: voltage drop 12 to 30 volts; current 150 to 160 Ma; designed for AC/DC operation; ballast tube type; T6-1/2L Bulb o/a lg. 2-3/8 in; miniature noval base for socket mounting. Amperite No. 1HTF10. Hickok Part No. X-20874-108.	1	Primary voltage regulator.
R144		Same as R129.		Part of milliameter dividing network.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
R145		RESISTOR, FIXED, FILM: 90 ohms, p/m 1%; 1/2 watt; resistance temperature characteristic X; body dim. excluding terminals 19/32 in. lg. 11/64 in. dia; uninsulated, resistant to humidity; 2 axial wire lead terminals 1-1/2 in. lg. Spec. MIL-R-10509A. Type RN20X90ROF. Electra Mfg. Co. Type DC-1/2A. Hickok Part No. X-18530-3.	1	Part of ohms dividing network.
S101	N17-S-59933-4645	SWITCH, ROTARY: 4 sections; 6 positions; 8 poles; 6 throws; silver plated brass contacts; ceramic sections; 2 in. lg. x 1-5/16 in. wd. x 1-1/2 in. high; 3/8-32 mtg. bushing 3/8 in. lg; flatted shaft 1/4 in. dia. x 7/8 in. lg; solder lug terminals. Centralab Type 20. Hickok Part/Dwg. No. 19912-274.	1	FUNCTION selector switch.
S102		SWITCH, ROTARY: 4 sections; 4 positions; 6 poles; 4 throws; silver plated brass contacts; ceramic sections; 2-5/16 in. lg. x 1-5/8 in. wd. x 1-7/8 in. high; 3/8-32 mtg. bushing 3/8 in. lg.; flatted shaft 1/4 in. dia. x 7/8 in. lg; solder lug terminals. Centralab Type H. Hickok Part/Dwg. No. 19912-253.	1	RANGE selector switch.
S103	N17-S-70777-8626 3Z9863-12A.	SWITCH, TOGGLE: SPST; 5 amps @ 125 volts; 2 amps @ 250 volts; phenolic body; 1-1/4 in. lg. x 11/16 in. wd. x 11/16 in. deep; bat handle 11/16 in. lg; two solder lug terminals on back; single hole mtg; 15/32-32 threaded bushing 15/32 in. lg. Spec. JAN-S-23 Type ST12A. Arrow Hart & Hageman No. 82301-B. Hickok Part No. X-19911-14.	1	ON-OFF power switch.

T101		TRANSFORMER, POWER, STEP DOWN AND STEP UP: hermetically sealed metal case; input 95 volts AC, 50 to 1000 cycles, single phase; output, No. 1 secondary 6.3 volts @ 1.3 Amps; No. 2 secondary 175 volts @ 12 ma; potted; 2-1/4 in. lg. x 2-1/8 in. wd. x 2-1/4 in. high; feed through type solder terminals; four 8-32 mounting bushings on 1-5/8 in. x 1-9/16 in. mtg. centers on end of case; two 8-32 mtg. studs on top of case spaced 1-9/16 in C to C. Hickok Part No. X-20800-130.	1	Supplies AC potentials for heaters and rectifier power supply.
V101	N16-T-75751 2J5751	ELECTRON TUBE: dual triode; glass envelope; 9 pin type terminations on bottom; amplifier; type 5751. Spec. MIL-E-1B. Hickok Part No. X-20874-111.	1	Cathode follower.
V102	N16-T-75814 2J5814	ELECTRON TUBE: dual triode; glass envelope; 9 pin type terminations on bottom; amplifier; type 5814A. Spec. MIL-E-1B. Hickok Part No. X-20874-110.	1	Electronic bridge tube.
V103	N16-T-79006 2J9006	ELECTRON TUBE: diode; glass; envelope; 7 pin type terminations on bottom; detector; type 9006 Spec. MIL-E-1B. Hickok Part No. X-20874-46.	1	Diode rectifier in high frequency probe lead W104.
V104	N16-T-75726 2J5726/6AL5W	ELECTRON TUBE: dual diode; 7 pin type terminations on bottom; glass envelope detector; Type 5726. Spec. MIL-E-1B. Hickok Part No. X-20874-109.	1	Voltage doubler rectifier for AC measurements.
W101	Assemble from component parts.	LEAD, TEST: one No. 18 AWG stranded copper conductor; 65 strands No. 36 AWG; .043 in. black rubber insulation; approx. 48 in. lg. excluding terminations; one end terminated in alligator clip, other end stripped 3/8" and tinned. Consists of W108 and O-106. Hickok Part/Dwg. No. 12450-264.	1	Common connection for all measurements and ranges.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
W102	Assemble from component parts.	LEAD, TEST: one No. 18 AWG stranded copper conductor, 65 strands No. 36 AWG; .043 in. red rubber insulation; approx. 48 in. lg excluding terminations; one end terminated in red test prod, other end stripped 3/8 in. and tinned. Consists of W109 and E107. Hickok Part/Dwg. No. 12450-263.	1	Positive test lead for Mils, Ohms and AC volts.
W103	Assemble from component parts.	LEAD, TEST: one No. 25 AWG stranded conductor, 3 No. 33 strands copper, 4 No. 33 strands steel, tinned; cellulose braid, rubber insulation, rayon braid, tinned copper braid shield; rayon wrap black rubber jacket; approx. 48 in. lg. excluding terminations; one end terminated in a red test prod with 3.3 megohm series resistor, other end stripped and tinned; Consists of W110, R118 and E108. Hickok Part/Dwg. No. 3030-80.	1	DC test lead for voltages up to 1000.
W104	Assemble from component parts.	LEAD, TEST: 3 No. 20 AWG stranded tinned copper conductor; 26 No. 34 AWG strands; cotton wrap, color coded rubber insulation on conductors; rayon braid, tinned copper braid shield; cotton wrap black rubber jacket; approx. 48 in. lg. excluding terminations; one end terminated in probe housing containing diode tube circuit, other end stripped and tinned. Consists of tubular metal housing and the following: C106, E109, E110, R131, V103, X103. Hickok Part/Dwg. No. 16970-29.	1	High frequency test probe lead for RF measurements. Terminated with diode input circuit in metal housing.
W105	Assemble from component parts.	CABLE ASSEMBLY, POWER: type RG 108/U shielded cable; 62 in. long o/a including molded male appliance plug on one end; other end stripped and tinned; flexible ground leads, attached to shield. Hickok Part/Dwg. No. 3030-81.	1	Power connection to AC supply line.

W106	N17-L-63386-8502	LEAD, TEST: one No. 18 AWG stranded copper conductor; 65 strands No. 36 AWG tinned; black rubber insulation .043 in. thk; approx. 4 in. lg. excluding terminations, Mueller No. 60 HS black alligator clip on one end; Hickok No. 19821-13 4-40 threaded-terminal stud on other end. Consists of W108, O-107, H102. Hickok Part/Dwg. No. 12450-165.	1	Ground lead for diode probe.
W107	Assemble from component parts.	LEAD, TEST: extension multiplier for High Voltage DC; single conductor No. 18 AWG stranded copper conductor; red rubber insulation; approx. 11 in. lg. excluding terminations; tubular phenolic housing on one contains 25 megohm series resistor and attaches to DC test lead W103 by means of a 10-32 threaded bushing, other end terminated with a Mueller No. 60 Alligator clip. Consists of E106, O-109, O-110, R101, W109 and phenolic housing. Hickok Part/Dwg. No. 16975-34.	1	High voltage multiplier. Attaches to end of regular DC test lead W103 to extend range to 5000 volts DC.
W108	N15-W-2195-5100 1B818.175	WIRE, ELECTRICAL, INSULATED: .140 O.D. overall; one No. 18 AWG copper conductor stranded, 65 strands No. 36 AWG cotton wrap, rubber insulation .043 in. thk; rated 5000 volts; black p/o W101 and W106. Belden Mfg. Co. No. 8899. Hickok No. 23900-288.	5 ft.	Replacement lead material for W101 and W106.
W109	For replacement use SNSN N15-W-2645-450. 1B818.151	WIRE, ELECTRICAL, INSULATED: 5-1/2 ft; .140 O.D. overall; one No. 18 AWG copper conductor; stranded, 65 strands No. 36 AWG, cotton wrap, rubber insulation .043 in. thk; rated 5000 volts; red P/O W102 and W107. Belden 8899. Hickok Part No. 23900-289.	5-1/2 ft.	Replacement lead material for W102 and W107.
W110	N15-C-32559-100 1B3022-1	CABLE, ELECTRICAL SPECIAL PURPOSE: one No. 25 AWG stranded conductor; 3 strands tinned copper and 4 strands tinned steel No. 33 AWG; cellulose yarn braid, rubber insulation; rayon braid, tinned copper braid shield; rayon wrap, black rubber jacket; nominal diam. 245 in. o/a; microphone cable. P/O W103. Belden Mfg. Co. No. 8410. Hickok No. 3025-27.	5 ft.	Replacement lead material for W103.

TABLE OF REPLACEABLE PARTS (Cont.)

SYMBOL DESIG.	STOCK NUMBERS STANDARD NAVY SIGNAL CORPS	ITEM NAME AND DESCRIPTION	NO. PER EQUIP.	LOCATING FUNCTION
W111	N15-C-32553-105 1B3022-32	CABLE, ELECTRICAL, SPECIAL PURPOSE: 3 No. 20 AWG stranded conductors; 26 No. 34 AWG strands tinned copper; cotton wrap, color coded rubber insulation, rayon braid, tinned copper braid shield, cotton wrap, black rubber jacket; nominal diam. .280 in o/a; microphone cable; P/O W104. Belden Mfg. Co. No. 8423. Hickok Part No. 3025-33.	5 ft.	Replacement lead material for W104.
W112	N15-C-12211-750	CABLE, RADIO FREQUENCY: twisted pair; nominal impedance 76 ohms; two stranded copper conductors No. 20 AWG, 7 No. 28 AWG strands; polyethylene dielectric; tinned copper braid; vinyl jacket; .230 in. nominal overall diam. Type RG-108/U. Amphenol No. 21-261. Hickok No. 3025-275.	5 ft.	Replacement lead material for W105.
X101	For replacement use SNSN N16-S-64063-6713.	SOCKET, ELECTRON TUBE: 9 silver plated beryllium copper contacts; miniature noval; shield base, brass nickel plated includes center shield 3/16 in. OD; oval shape 1-3/8" lg x 1-5/16 in. wd. x 7/8 in. high excluding terminals; molded mica filled phenolic body; saddle mtg. above chassis; 3/4 in. dia. chassis hole required, two mtg. holes 1/8 in. diam. spaced 1-1/8 in. C to C. Spec. JAN-S-28A Type TS103P01. Elco Corp. No. 169BC. Hickok Part No. X-19350-122.	3	Mounting receptacle for V101.

X102		Same as X101		Mounting receptacle for V102.
X103	N16-S-62601-5690	SOCKET, ELECTRON TUBE: 7 silver plated phosphor bronze contacts; miniature seven pin; includes center shield 3/16 in. dia; round; 45/64 in. dia. x 3/8 in high o/a excluding terminals; molded mica filled phenolic body; retainer ring mtg; 5/8 in. dia. mtg hole required. P/O W104. Amphenol No. 78-7PTM. Hickok Part No. 19350-67.	1	Receptacle for V103.
X104	N16-S-62603-6692 2Z8677.94	SOCKET, ELECTRON TUBE: 7 silver plated beryllium copper contacts; miniature seven pin; nickel plated brass shield base; includes center shield 3/16" diam; oval shape 1-3/32 in. lg. x 13/16 in. wd. x 15/32 in. high excluding terminals; molded mica filled phenolic body; saddle mtg. above chassis; 5/8 in. dia. chassis hole required; two 1/8 in. dia. mtg. holes spaced 7/8 in. C of C. Spec. JAN-S-28A Type TS102P01. Elco Corp. 235BC. Hickok Part No. X-19350-120.	1	Mounting receptacle for V104.
X-105		Same as X101.		Mounting receptacle for R143.

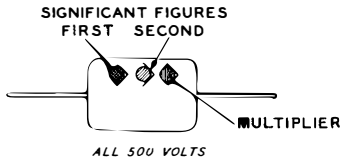
TABLE 7-3. MAINTENANCE PARTS KIT
MARINE CORPS EQUIPMENT SPARES

KEY SYMBOL	DESIGNATION	QUANTITY
CR101	CRYSTAL UNIT	1
E101	LAMP	1
F101	FUSE	10
R143	RESISTOR	1
V101	TUBE	1
V102	TUBE	1
V103	TUBE	1
V104	TUBE	1

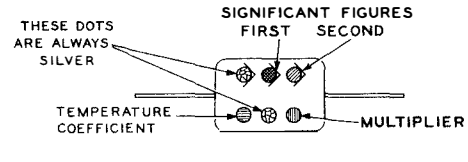
Supplied with Marine Corps Equipments Only

CAPACITOR COLOR CODES

RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



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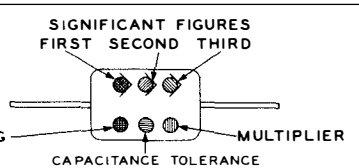

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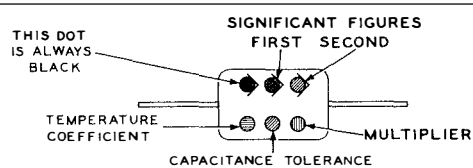
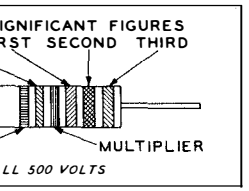


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

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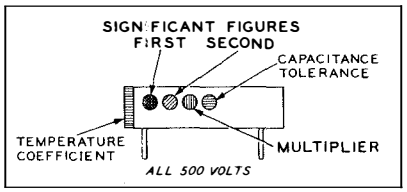

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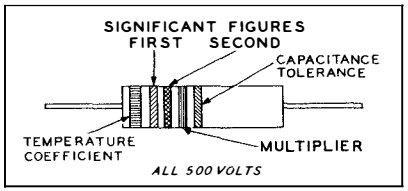


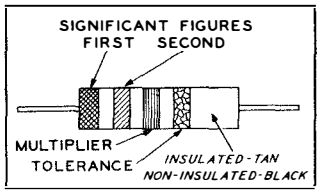
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS		CAPACITORS						
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE



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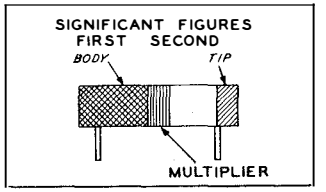
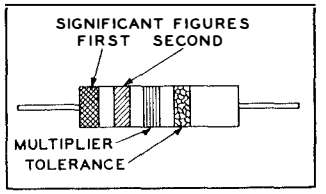


JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



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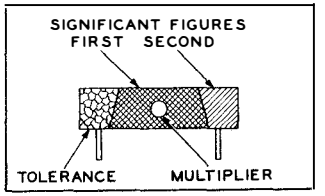

Table 7-4 Applicable Color Codes

ABBREVIATIONS	MFR'S. PREFIX	NAME	ADDRESS
Aerovox.....	CAW	Aerovox Corporation.....	742 Belleville Ave. New Bedford, Mass.
Allen-Bradley	CBZ	Allen-Bradley Co.....	118 W. Greenfield Ave. Milwaukee, Wisconsin
Amphenol	CPH	American Phenolic Corp.....	1830 S. 54th Avenue Chicago 50, Illinois
Amer. Radio Hdwe.	CMH	American Radio Hardware Co.....	152-4 MacQuesten Parkway, S. Mt. Vernon, New York
Amperite.....	CAGK	Amperite Company	561 Broadway New York, New York
Bead Chain	---	Bead Chain Mfg. Co.....	64 Mount Grove Street Bridgeport 5, Penna.
Belden.....	COG	Belden Manufacturing Co.....	P. O. Box 5070A Chicago, Illinois
Bryant.....	CYD	Bryant Electric Co.....	1421 State Street Bridgeport 2, Conn.
Cambridge	CAMQ	Cambridge Thermionic Corp.	445 Concord Avenue Cambridge, Mass.
Centralab	CBN	Central Radio Lab. Div. Globe Union .	900 E. Keefe Avenue Milwaukee, Wisconsin
Chicago Standard ..	---	Chicago Standard Transformer Co. ..	Addison & Elston Sts. Chicago 18, Illinois
Chicago Telephone.	CTC	Chicago Telephone Supply Corp.....	Elkhart, Indiana
Continental.....	CCC	Continental Carbon Co.	13900 Lorain Avenue Cleveland 11, Ohio
Cornell Dubilier...	CD	Cornell Dubilier Electric Corp.	1000 Hamilton Blvd. South Plainfield, N. J.
Drake.....	CAYS	Drake Manufacturing Co.	1713 W. Hubbard Street Chicago 22, Illinois
Eby.....	CEB	Hugh H. Eby, Inc.	4700 Stenton Avenue Philadelphia, Pa.
Elco.....	CAVT	Elco Resistors Co.....	114 W. 18th Street New York, New York
Electra	---	Electra Manufacturing Co.	2537 Madison Avenue Kansas City, Missouri

ABBREVIATION	MFR'S. PREFIX	NAME	ADDRESS
Erie	CER	Erie Resistor Corp.	644 W. 12th Street Erie, Penna.
Federal	CFT	Federal Telphone & Radio Corp.	100 Kingsland Rd. Clifton, New Jersey
G. E.	CG	General Electric Company	1 River Road Schenectady, New York
Heyman	---	Heyman Manufacturing Co.	1000 Michigan Avenue Kenilwort, New Jersey
Hickok	CHK	Hickok Electrical Instrument Co.	10514 Dupont Ave. Cleveland 8, Ohio
Kurz Kasch	CAUP	Kurz Kasch Incorporated.	1421 S. Broadway Dayton, Ohio
Littlefuse	CLF	Littlefuse, Incorporated.	4765 Ravenswood Avenue Chicago, Illinois
Mallory	CMA	P. R. Mallory & Company, Inc.	1941 Thomas Street Indianapolis, Indiana
Mueller	CBIT	Mueller Electric Company	1597 E. 31 Street Cleveland, Ohio
Oak	COG	Oak Manufacturing Company.	1200 N. Clybourne Avenue Chicago, Illinois
Selectron	CAFQ	Selectron Div. of Radio Receptor Inc.	251 W. 19th Street New York, New York
Sprague	CSF	Sprague Electric Company	North Adams, Mass
Superior	CABU	Superior Electric Company.	32 Harrison Street Bristol, Connecticut
Sylvania	CHS	Sylvania Electric Products Inc.	500 Fifth Avenue New York 18, New York

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