TM 11-6625-433-15

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORGANIZATIONAL, DS, GS, AND DEPOT MAINTENANCE MANUAL

WATTMETERS AN/URM-98 AND AN/URM-98A

(NSN 6625-00-566-4990)

This copy is a reprint which includes current pages from Changes 1 and 2. The title was changed by Change 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1967

CHANGE No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *17 August 1967*

ORGANIZATIONAL, DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

WATTMETERS AN/URM-98 AND AN/URM-98A (NSN 6625-00-566-4990)

*This manual supersedes TM 11-5124. 20 November 1956. Including all changes; TM 11-6625-433-20P, 26 April 1965; and TM 11-6625-433-45P. 29 July 1965.

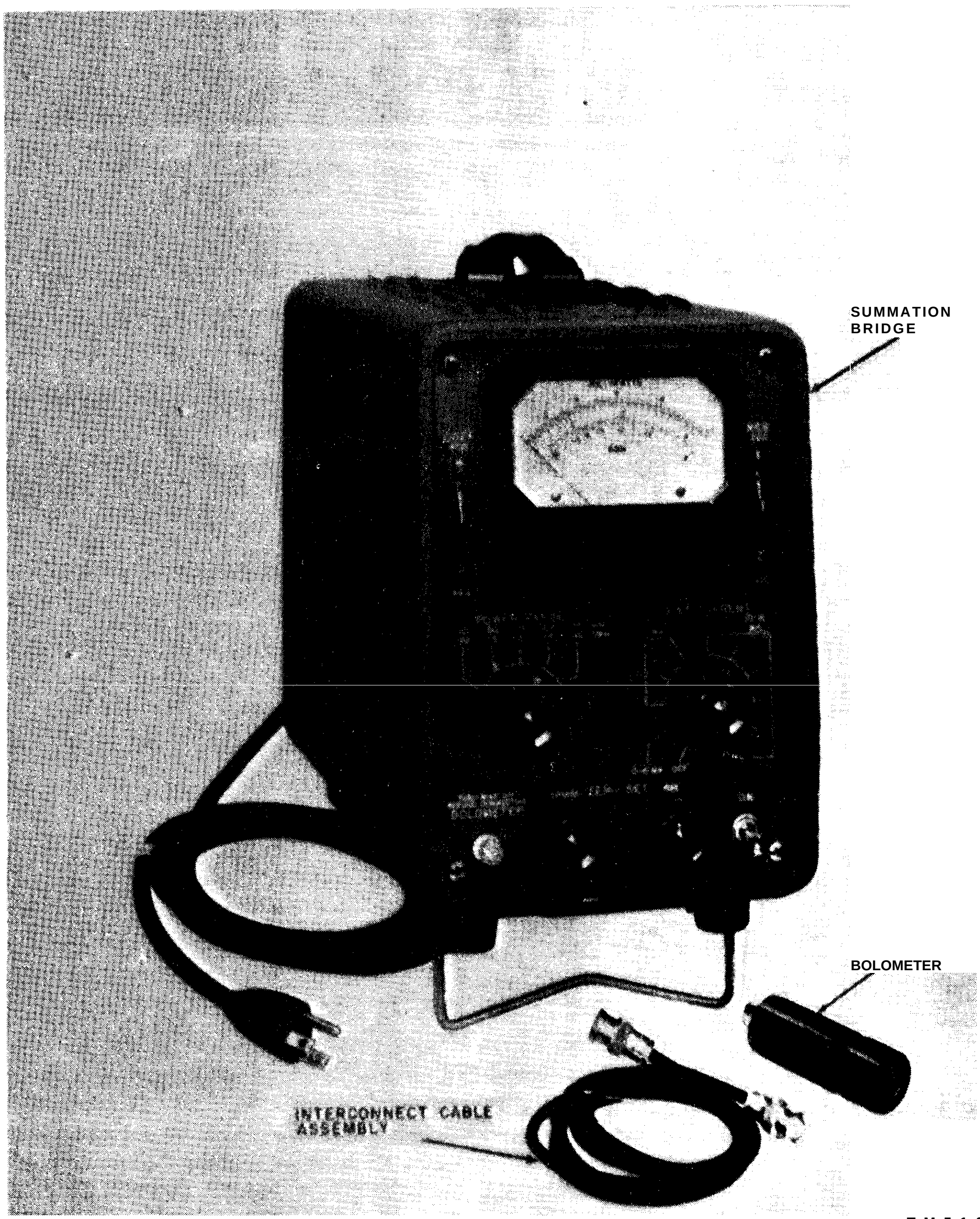


Figure 1-1. Wattmeter AN/URM-98.

CHAPTER 1
INTRODUCTION

Section 1. GENERAL

1-1. Scope

a. This manual contains instructions for the operator, organizational, general support, and maintenance of Wattmeters AN/URM-98 and AN/URM-98A. Also included is a discussion of the functioning of the wattmeters.

b. Official nomenclature followed by (*) is used to indicate all models of an equipment or item. Thus, Wattmeter AN/URM-98(*) indicates Wattmeters AN/URM-98 and AN/URM-98A. Test Set, Radio Frequency Power TS-779(*)/U indicates Test Sets, Radio Frequency Power TS-779/U, TS-779A/U, and TS-779B/U. Bolometer, Radio Frequency MX-2144(*)/U indicates Waveguide Probe MX-2144/U, Bolometer, Radio Frequency MX-2144A/U, Bolometer, R.F. MX-2144B/U, and Bolometer, R.F. MX-2144C/U. Cord CG-409(*)/U indicates Cords CG-409E/U and CG-409G/U.

1-2. Indexes of Publications

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

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DLAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

1-3.1. Reporting of Errors

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged, Reports should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms), and forwarded direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished direct to you.

1-3.2. Reporting Equipment Improvement Recommendations (EIR)

EIR's will be prepared using Standard Form 368, Quality Deficiency Report. Instructions for preparing EIR's are provided in TM 38-750, the Army Maintenance Management System. EIR's should be mailed direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished direct to you.

Section II. DESCRIPTION AND DATA

1-4. Purpose and Use

Wattmeter AN/URM-98(*) is a portable test set that consists of Test Set, Radio Frequency Power TS-779(*)/U, Bolometer, Radio Frequency MX-2144(*)/U, and Cord CG-409(*)/U. It is used to measure radio-frequency (rf) power either in milliwatts (row) from 0.001 to 10 milliwatt or in decibels referred to 1 milliwatt (dbm) from -20 to +10 dbm. It may be used at any frequency for which a bolometer exists and it measures either continuous or pulsed power with the thermistor or barretter-type bolometers.

1-5. Tabulated Data

a. Test Set, Radio Frequency Power TS-799(*)/U.

Frequency range	Depends on the associated bolometer used. May be used with bolometers which have either 100 or 200 ohms operating resistance and either positive or negative temperature coefficients.
Power range	Full-scale readings of 0.1, 0.3, 1, 3, and 10 mw. Also calibrated in dbm to give continuous

	reading from -20 dbm to +10 dbm (0 dbm = 1 row). All readings are for average power.
Dc bias current	Continuously adjustable and independent of bolometer resistance and power level range.
Accuracy	Within 5% of full-scale value for the TS-779/U and TS-779A/U. Within 370 for the TS-779B/U.
Power requirements	105 to 125 or 210 to 260 volts; 50/1,000 cps.
Number of tubes	10.
Weight	201b for the TS779/U and TS-779A/U, 14 lb for the TS779B/U.

b. Bolometer, Radio Frequency MX-2144(*)/U.

Frequency range	10 megacycles to 10 kilomegacycles.
Power range	0.01 to 10 mw when used with the TS-779(*)/U.
Bolometer element	Thermistor type, negative temperature coefficient, 200 ohms resistance.
Standing-wave ratio	Less than 1.5 to 1 full frequency range. (Less than 1.3 to 1 from 50 megacycles to 7 kilomegacycles for the MX-2144C/U and 5 kilomegacycles for all others).

1-6. Common Names of Components

The following chart lists the common names of components of Wattmeter AN/URM-98(*).

Nomenclature	*Common name*
Wattmeter AN/URM-98(*).	Wattmeter
Test Set, Radio Frequency Power TS-779(*)/U.	Summation bridge
Bolometer, Radio Frequency MX-2144(*)/U.	Bolometer
Cord CG-409(*)/U	Interconnect cable assembly

1-7. External Differences in Models

The components of Wattmeter AN/URM-98(*) are similar in purpose, operation, and appearance. The differences between the models that affect the operator and organizational repairmen are listed below.

Item	TS-779/U	TS-779A/U	TS-779B/U
Coefficient ±control	Control is marked COEF	BOLO TEMP COEF	BOLO TEMP COEF
Bolometer resistance control	RES	BOLO RES	BOLO RES
Power range selector switch.	POWER RANGE	RANGE	POWER RANGE
ON-OFF switch	ON position only is marked.	LINE POWER	LINE
Bolometer bias current selector switch	BIAS CURRENT	BOLO BIAS CURRENT	BIAS CURRENT RANGE.
Power on light	Located above ON-OFF switch.	Located Above ON-OFF switch.	Located between POWER RANGE AND BIAS CURRENT RANGE switches.

1-8. Description of Components

a. Test Set, Radio Frequency Power TS-779(*)/U. The summation bridge consists of a panel-chassis assembly that is contained in a steel housing. The housing is equipped with a letter carrying handle, four protective feet, and ventilating louvers on both sides, top, rear, and bottom. The support on the bottom of the housing holds the equipment at an angle for ease of operation. When not in use, the support may be folded up against the bottom of the housing. All operating controls and the input connector are located on the front panel. The power cord *is* attached to the chassis and extends through a hole in the back of the chassis. The power cord plug is polarized with two flat contacts and one round contact. (Refer to the note in para. 2-6.) A meter is mounted on the front panel and is calibrated in milliwatts and dbm.

b. Bolometer, Radio Frequency MX-2144(*)/U. The bolometer is a thermistor-type, temperature-sensitive device. It has a male type N-connector on one end and a Receptacle UG-1094/U on the other end. It contains two 100-ohm thermistors. The MX-2144/U and MX-2144A/U have phenolic bodies. The MX-2144B/U and MX-2144C/U have aluminum bodies.

c. Cord CG-409(*)/U. The interconnect cable assembly is a single-conductor, shielded Radio Frequency Cable RG-58/U with a connector Plug UG-88/U on each end. The CG-409E/U, procured as part of Wattmeter AN/URM-98, is a single-conductor, shielded cable RG-58C/U with a Connector Plug UG88D/U on each end. The CG-409G/U and CG-409E/U, procured as part of Wattmeter AN/URM-98A, are single-conductor, shielded Radio Frequency Cables RG-58C/U with a Connector Plug UG-883E/U on each end. Cord CG-409(*)/U is used to connect the MX-2144(*)/U to the TS-779(*)/U. Cord CG-409E/U, procured as part of Wattmeter AN/URM-98A, is 4 feet long. Cords CG409/U, CG409G/U, and CG-409E/U, procured as part of Wattmeter AN/URM-98, are 4 feet, 3 inches long.

1-9. Items Comprising an Operable Equipment

NSN	Qty	Nomenclature	Fig. No.
6625-00-566-4990	1	Wattmeters AN/URM-98 and AN/URM-98A Which include:	1-1
6625-00-519-2414	1	Bolometer, Radio Frequency MX-2144/U MX-2144A/U; MX-2144B/U; MX-2144C/U.	1-1
5995-00-503-0470	1	Cable Assembly, Radio Frequency CG-409E/U.	1-1
6625-00-739-1394	1	Test Set, Radio Frequency TS-779/U; TS-779A/U; TS-779B/U.	1-1

CHAPTER 2
INSTALLATION

Section 1. SERVICE UPON RECEIPT OF WATTMETER AN/URM-98(*)

2-1. Packaging Data

(Fig. 2-1)

When packaged for export shipment, the components of Wattmeter AN/URM-98(*) are packed as follows: The summation bridge is placed in an inner corrugated carton and blocked in place with corrugated pads. A sheet of wadding is placed on top of the summation bridge. The bolometer and interconnecting cable assembly are placed in a sealed plastic bag and stored in the carton with the running spares. This carton is placed on top of the sheet of wadding in the carton with the summation bridge and blocked in place with corrugated pads. The inner corrugated carton is sealed in a moisture-vaporproof barrier. The inner corrugated carton is then placed in an outer corrugated carton. The manuals are contained in a sealed waterproof bag and placed in the top of the outer carton. The outer carton is then inclosed in a waterproof harrier and placed in a wooden crate. The wooden crate cover is nailed on and secured with two metal straps that wrap completely around the crate. A typical component packed for export shipment is shown in figure 2-1. The wattmeter will be packed in a single crate. The packing crate dimensions are 16 1/4 inches high, 26 1/4 inches wide, 11 3/4 inches deep with a volume of 2.92 cubic feet and a weight of 55 pounds.

Caution

Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged.

2-2. Unpacking and Checking

a. Step-by-Step Instructions for Uncrating and Unpacking Export Shipments (fig. 2-1).

(1) Place the packing case on a table or workbench.

(2) Cut and fold back the metal straps.

(3) Remove the nails with a nailpuller. Remove the top and sides of the packing case. Do not attempt to pry off the sides and top; the equipment may become damaged.

(4) Carefully cut and remove the waterproof liner.

(5) Open the outer corrugated carton and remove the inner corrugated carton.

(6) Carefully cut and remove the moisture-vaporproof barrier.

(7) Remove the small corrugated carton that contains the cable assembly, bolometer, and running spares.

(8) Remove the corrugated cardboard and felt packing and lift the summation bridge out of the carton.

b. Checking Unpacked Equipment.

(1) Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6 (para 1-3).

(2) See that the equipment is complete as listed on the packing slip. If a packing slip is not available, check the equipment against paragraph 1-9. Report all discrepancies in accordance with TM 38-750. Shortage of a minor assembly or part that does not affect proper functioning of the equipment should not prevent use of the equipment.

(3) If the equipment has been used or reconditioned, see whether it has been

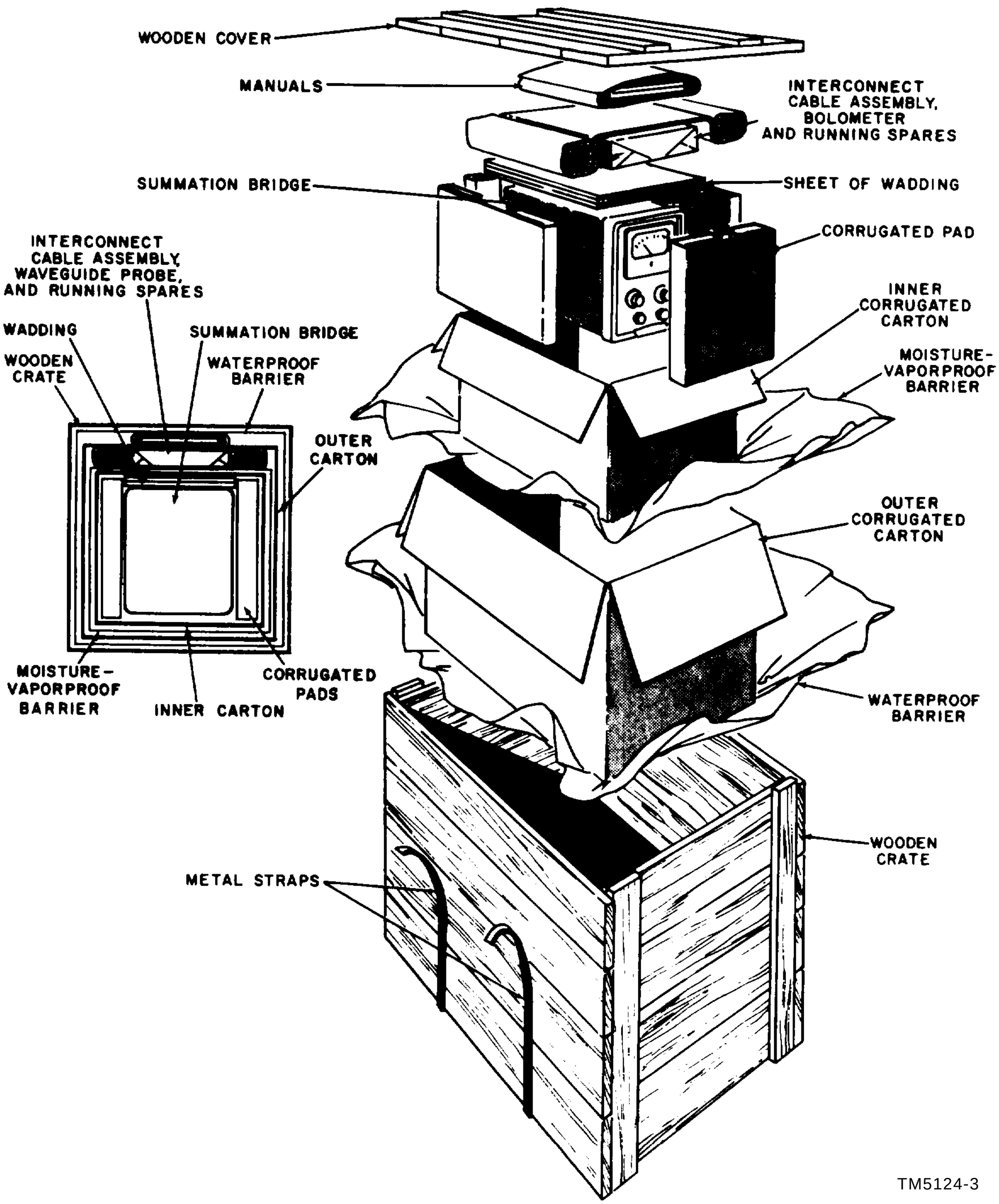


Figure 2-1. Wattmeter AN/URM-98(*), packaging diagram

changed by a modification work order (MWO). If the equipment has been modified, the MWO number will appear on the front panel near the nomenclature plate. If modified, see that any operational instruction changes resulting from the modification have been entered in the equipment manual.

Note. Current MWO's applicable to the equipment are listed in DA Pam 310-7.

c. Cleaning New Equipment. After the equipment has been thoroughly checked, clean all items with a soft cloth.

d. Unpacking Domestic Packing Cases. The wattmeter may be received in domestic packing cases. The instructions given in *b above* apply also to unpacking domestic shipments. Cut the metal bands. Open the cartons that protect the equipment, or, if heavy wrapping paper has been used, remove it carefully and take out the components. Check the contents of the packing case against the master packing slip.

Section II. INSTALLATION OF WATTMETER AN/URM-98(*)

2-3. Strapping Power Transformer T1 (figs. 11-5 and 11-6)

a. Strapping Power Transformer for 105- to 125-Volt Operation. The summation bridge is strapped at the factory for 105 to 125 alternating current (at) voltage operation. This strapping of power transformer T1, located on the summation bridge chassis (fig. 8-8, &9, and 8-10), is as follows:

(1) Connect a piece of No. 18 AWG solid bare wire from terminal 1 on power transformer T1 to terminal 8.

(2) Connect another piece of No. 18 AWG solid bare wire from terminal 2 on power transformer T1 to terminal 9.

(3) Use a l-ampere slow-blow fuse, type 3 AG, for 105- to 125-volt operation (fig. 2-2).

b. Strapping Power Transformer for 210- to 250-Volt Operation. If the equipment is to be operated from a 210-to 250-ac voltage power source, strap power transformer T1 on the summation bridge chassis as follows:

(1) Remove the bare wire connections between terminals 1 and 8 and terminals 2 and 9 on power transformer T1.

(2) Use a piece of No. 18 AWG bare wire and connect terminal 2 to terminal 8 on power transformer T1.

(3) Change fuse F1 to a 0.5-ampere slow-blow fuse (fig, 2-2).

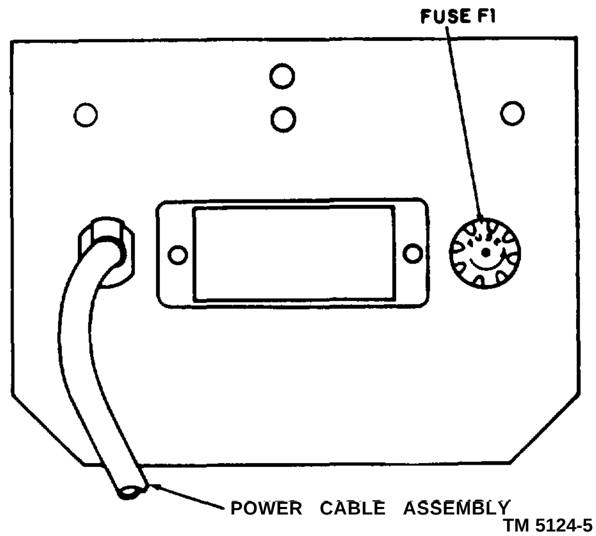


Figure 2-2. Rear panel, fuse location.

2-4. Bolometers

Two types of bolometers may be used with the summation bridges. Bolometers with barretter-type elements and bolometers with thermistor-type elements. Any barretter or thermistor-type bolometers may be used with the TS-779(*)/U if the meter on the summaion bridge can be zero set

a. Thermistor Type Bolometers. In terms of resistance change for a given amount of power, bolometers with thermistor-type elements are more sensitive than bolometers with the barretter type. They also possess much better overload and burn-out characteristics. Thermistor-type bolometers have a negative temperature coefficient in that the resistance of the thermistor decreases as its temperature increases. The bolometers supplied with the AN/URM-98(*) have a thermistor-type element.

b. Barretter-Type Bolometers. Barretter-type bolometers have a positive temperature coefficient in that their resistance increases with temperature. They are usually constructed of encapsulated platinum wire or resistive coatings on glass or mica. The power range of the barretter-type bolometers is limited in contrast to that of the thermistor but its response is more rapid because it has a shorter thermal time constant.

2-5. Test Cable Assembly
(fig. 2-8)

For some measurements, a special test cable assembly is required. This cable is not supplied with the equipment. It may be fabricated from a length of single-conductor, shielded Radio Frequency Cable RG-58/U with a type N female connector on each end. This cable should be short as possible, Long lengths of cable may cause impedance mismatch (para 3-4e).

2-6. Connections
(fig. 2-8)

Place the summation bridge close to the equipment being tested so that the test cable assembly will reach the equipment, Connect the power cable to the power source. See that line fuse F1, located on the rear panel, is not blown (fig. 2-2).

Note. The connector plug on the power cord has a round grounding terminal. If the ac power outlet will not accommodate this plug, pull out the grounding terminal with a pair of pliers. Further connections are given in paragraphs 3-3 and 3-4 with the operating procedures. These connections are given with the operating procedures because certain precautions and sequence of operation have to be followed.

2-7. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 2-2 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equip ment for tags or other indications pertaining to changes in wiring of the equipment. If any changes in wiring have been made, note the changes in this manual, perferably on the schematic diagram.

e. Check the operating controls for ease of rotation.

d. Perform the installation and connection procedures given in paragraphs 2-3 through 2-6.

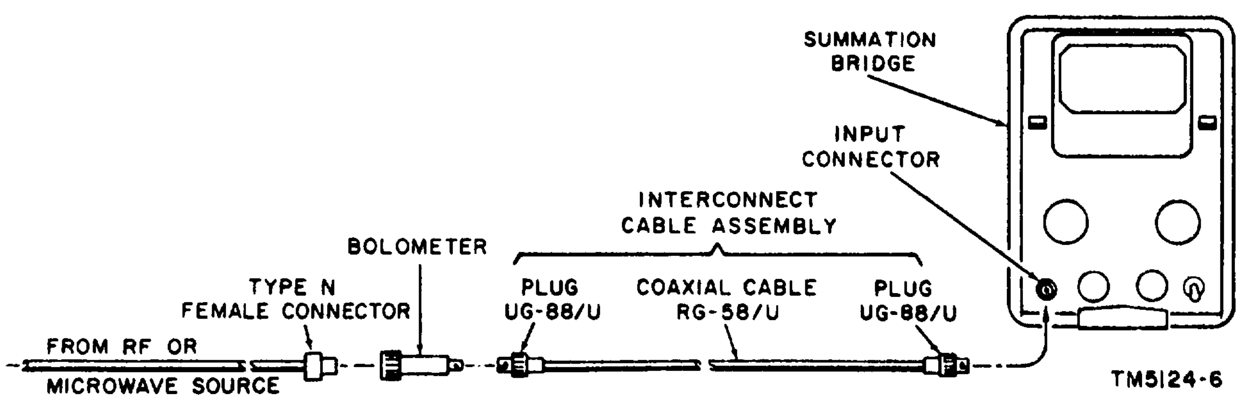


Figure 2-3. Connections for making power measurements.

CHAPTER 3

OPERATING INSTRUCTIONS

Section 1. OPERATOR'S CONTROLS AND INDICATORS

Note. This section covers controls and indication used by the operator; items used by maintenance personnel are covered in instructions for the appropriate maintenance category.

3-1. General

Haphazard operation or improper setting of the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch, POWER RANGE (RANGE) switch, COEF. POS-NEG. [BOLO TEMP COEF] switch, and RES. 200-100 [BOLO RES, 200Ω–100Ω] switch can cause damage to Wattmeter AN/URM-98(*). It is therefore important to know the function of every control and the meter on the equipment. The actual operating instructions are contained in paragraphs 3-3 through 3-5.

Note. Some of the panel markings on the front panel of the TS-779A/U and TS-779B/U are different, but the controls have the same functions as those on the TS-779/U. Where different, the panel markings of the TS-779A/U and TS-779B/U are inclosed within parentheses ( ) and brackets [ ] respectively.

3-2. Controls and Their Uses

The following chart lists the controls and indicators of the summation bridge (figs. 8-1 and 2-2) and indicates what they do:

Control	Function
ON (LINE POWER ON) [LINE ON-OFF] switch.--	Turns on equipment.
BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch S5.	Rotary switch for selecting & bias current range required by the bolometer for zero setting the instrument before actual exposure to a source of RF or microwave power. In addition to an OFF position, it contains 10 ranges as follows: 0-6 MA, 6-10 MA in three uncalibrated steps, and 10-16 MA in six uncalibrated steps.
ZERO SET controls:	Provides the following:
COARSE R33 - - - - - - - - - - - - -------	A coarse adjustment of the dc bias current when referencing the meter at zero scale reading before exposure of the bolometer to a source of RF microwave power.
FINE control R30 - - - - - - -- - - - - - - - - - - -	A fine adjustment of the dc bias current when referencing the meter at zero scale reading before exposure of the bolometer to a source of RF or microwave power.
POWER RANGE (RANGE) switch S3 - - - - - - - -	Rotary switch for selecting the desired power level range of measurements. Calibrate in milliwatts and dbm as follows: .10 mw (-10 dbm), .3 mw (-5 dbm), 1 mw (0 dbm), 3 mw (+5 dbm), and 10 mw (+ 10 dbm).
COEF. POS.-NEG. [BOLO TEMP COEF POS.-NEG.] switch S1.	Two-position switch for selecting bridge circuit connections corresponding to the temperature coefficient of the bolometer. (Barretter type requires a positive coefficient setting and thermistor type requires a negative coefficient setting.)

Control	Function
RES. 200-100 [BOLO RES. 200Ω -100 Ω] switch.	Two-position switch for selecting bridge arm resistances required to accommodate either a 100- or 200-ohm bolometer operating resistance. (Bolometer, Radio frequency MX-2144(*)/U requires a setting of 200 ohms.)
INPUT [BOLOMETER] connector J1.	Jack used to connect cable from bolometer into bridge circuit.
Power on light	Lights when primary power is on.

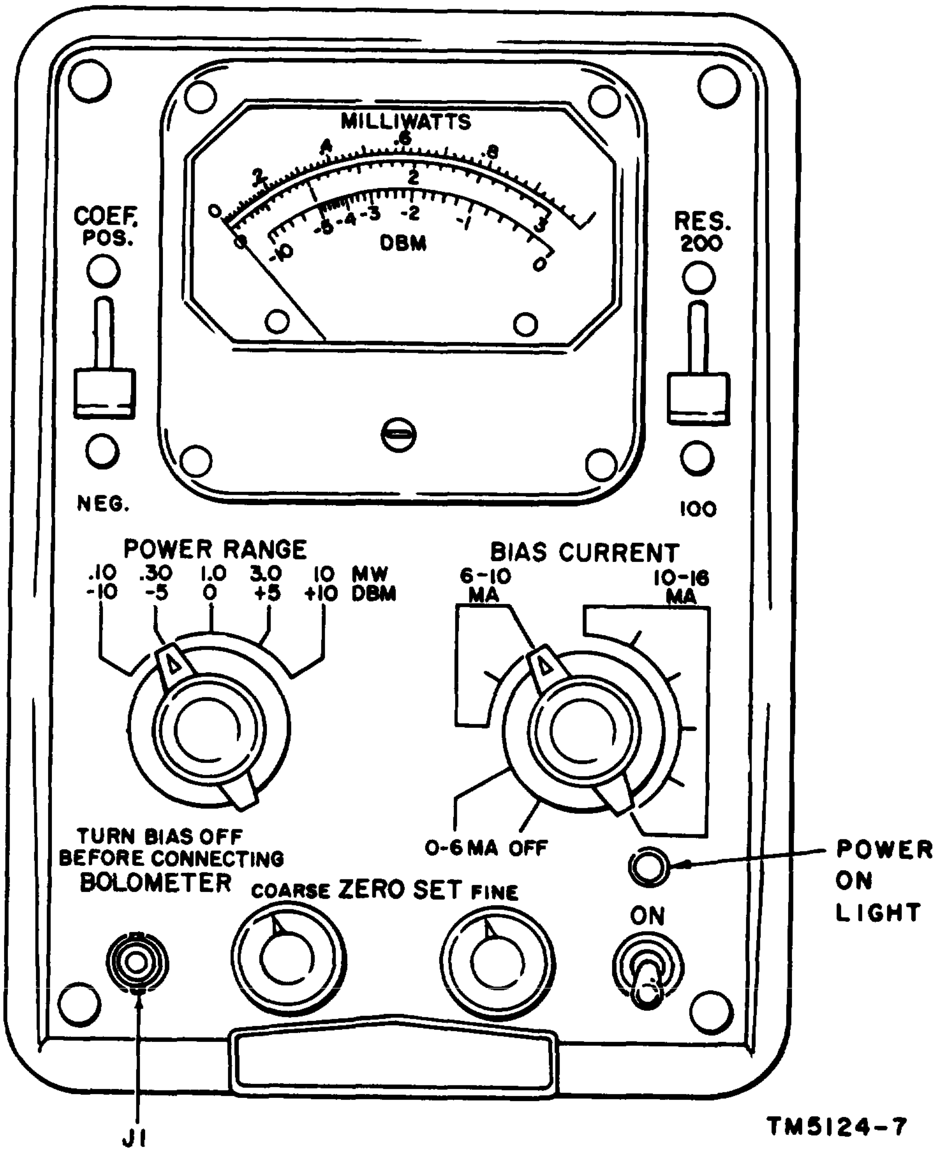
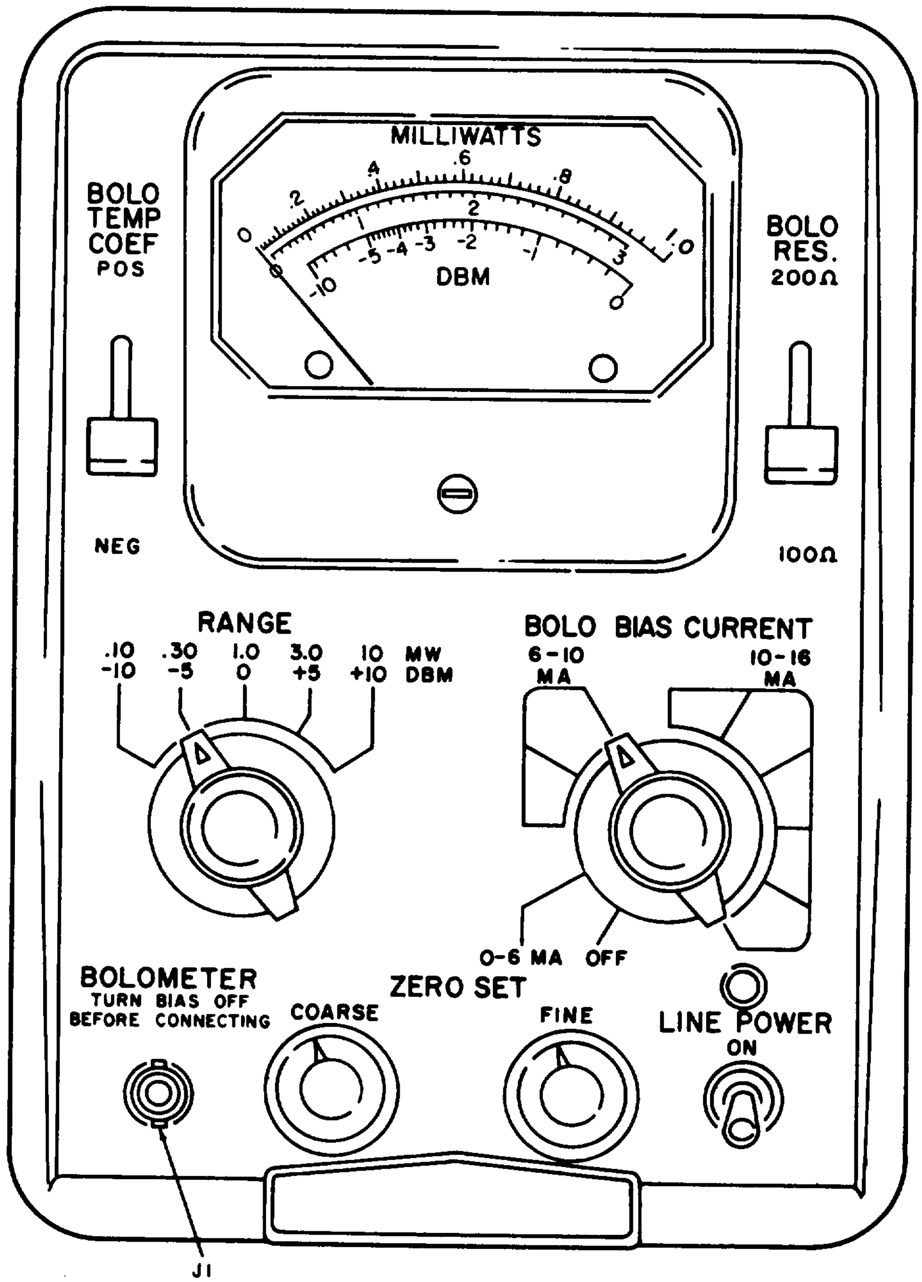


Figure 3-1. Test Set, Radio Frequency Power TS-779/U, control and indicators.



NOTE:

IN THE TS-779B/U, THE LINE POWER ON SWITCH IS THE LINE ON OFF SWITCH; THE RANGE SWITCH IS THE POWER RANGE SWITCH; THE BOLO BIAS CURRENT SWITCH IS THE BIAS CURRENT RANGE MILLIAMPERES SWITCH (WITH MA DELETED FROM THE THREE APPLICABLE POSITIONS); THE POWER ON LIGHT IS LOCATED BETWEEN THE POWER RANGE AND BIAS CURRENT RANGE SWITCHES.

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Figure 3-2. Test Sets, Radio Frequency Power TS-779A/U and TS-779B/U, controls and indicators.

Section II. OPERATION

3-3. Starting Procedure

Perform the starting procedures given in *a* and *b* below before using the operating procedure described in paragraph 3-4.

Caution: **Do not connect the power cord to the ac outlet until the strapping options for power transformer T1 (para 2-3) have been checked. Do not allow the power cord to drape across high voltage or RF circuits. Severe burns or shock and damage to the equipment may result.**

a. Preliminary (figs. 3-1 and 3-2). Set the front panel controls as follows:

Control	Position
ON (LINE POWER ON) [LINE ON-OFF] switch --	OFF.
BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch.	OFF.
COEF. POS.-NEG. [BOLO TEMP COEF POS.-NEG.].	To appropriate setting for type of bolometer used. Use the NEG position for the bolometer supplied.
RES. 200-100 [BOLO RES. 200Ω–100 Ω] switch.	To appropriate setting for type of bolometer used. Use the 200Ω position for the bolometer supplied.

Caution: **The BIAS CURRENT (BOLO BIAS CURRENT [BIAS CURRENT RANGE] switch must always be set in the OFF position before connecting the bolometer.**

b. Starting.

(1) Operate the ON (LINE POWER ON) [LINE ON-OFF] switch to ON. The power on light should glow. Allow the equipment to warm up for at least 5 minutes. Check to see that the pointer on the meter rests off scale at the high end.

(2) Set the POWER RANGE (RANGE) switch for the range of power under measurement, if known. If amount of power source is unknown, set the POWER RANGE (RANGE) switch to its highest range (10 MW).

(3) Check to see that the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch is in the OFF position and connect the bolometer to input connector J1: use the interconnect cable assembly. *Do not* connect the bolometer to the equipment under test.

(4) Place the ZERO SET controls fully clockwise.

(5) Place the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch in the 0-6 MA position. If the pointer on the meter remains off scale at the high end or moves down to a position on scale, follow the procedure in (6) below. If the pointer on the meter reverses its position and rests off scale at the low end, follow the procedures in (7) below.

(6) If the pointer on the meter remains off scale at the high end or moves down to a position on scale ((5) above), zero set the meter with the ZERO SET controls. Rotate the ZERO SET COARSE control counterclockwise until the pointer on the meter is as close as possible to zero. Rotate the ZERO SET FINE control counterclockwise until the pointer on the meter rests on zero.

(7) If the pointer on the meter reverses its position and rests off scale at the low end ((5) above), increase the BIAS CURRENT switch one step at a time until the pointer on the meter moves on scale or off scale at the high end. Zero set the meter with the ZERO SET controls as described in (6) above.

Note. If an abnormal result is obtained during the starting procedure, refer to the equipment troubleshooting chart (para 4-10).

3-4. Operating Procedure

The POWER RANGE (RANGE) switch may be set to increase or decrease the sensitivity of the meter. Each time the position is changed, the meter must be zero set as described in paragraph 3-3. Power readings may be made in milliwatts or dbm.

a. *Taking Dbm Readings.* Each setting of the POWER RANGE (RANGE) switch corresponds to a full-scale reading on the meter. When the switch is set to O DBM, power readings are read directly from the meter. Switch settings -5 and -10 DBM increase the sensitivity of the wattmeter by -5 and -10 dbm. When the switch is in one of these positions, the number of the position (-5 or -10) must be added to the indicated meter reading. *For example,* if the switch is set at -5 DBM, a meter indication of -3 would be added to -5 dbm so that the actual indicated power would be -8 dbm. The +5 and +10 DBM positions of the switch decrease the sensitivity of the meter by +5 and +10 dbm respectively. When the switch is in one of these positions, the number of the position (+5 or +10) must be algebraically added to the meter indication. *For example,* if the switch is in +10 DBM position, a meter indication of -3 would be added to + 10 to give and indicated power reading of +7 dbm.

b. *Taking Milliwatt Readings.* When taking power readings in milliwatts, the 1.0 MW position of the POWER RANGE (RANGE) switch corresponds to a full-scale reading of 1.0 mw so that power readings are read directly from the meter. The .10 and .30 MW positions of the switch change the full-scale readings to 0.10- and 0.30-mw, respectively. When the switch is in one of these positions, the actual power is the indicated meter reading times the equivalent percentage of the number of the switch position (0.10 or 0.30). *For Example,* if the switch is set at .10 MW, a meter indication of 0.3 mw would be multiplied by 0.10 to give an actual power reading of 0.03 mw. Likewise, if the switch is set at .30 MW, a meter indication of 0.3 mw would be multiplied by 0.30 to give an actual power reading of 0.09 mw. The O to 3 middle scale of the meter can be used only with milliwatts.

c. *Operation.* When the procedures described in *a* and *b* above have been completed, operate the wattmeter as described below. *For best results, make measurements as soon as possible after the meter has been zero set.* Readings are for *average power.*

Note. The power source to be measured must have a female type N connector on the cable used for connecting the bolometer.

(1) Connect the bolometer to the RF source to be measured. The bolometer may be connected to the RF source through the test cable assembly (para 2-5).

(2) If the range of the power to be measured is not known, set the POWER RANGE (RANGE) switch to 10 MW position.

(3) If there is only a small clockwise deflection of the meter, increase the sensitivity of the meter by rotating the POWER RANGE (RANGE) switch to a lower range. Each time the POWER RANGE (RANGE) switch is changed, the meter must be zero set as described in paragraph 3-3. Refer to *a* and *b* above for calculating the readings.

Note. When making measurements in the 0.1-mw range, allow 1 hour for the temperature to stabilize after turning on the instrument. Zero set the meter just before making the measurement.

(4) If the meter pointer pins against the right stop, reduce the meter sensitivity by rotating the POWER RANGE (RANGE) switch to a higher range. Zero set the meter as described in paragraph 3-3. Calculate the readings as instructed in *a* and *b* above.

d. *Temperature.* The bolometer is a temperature-sensitive device, and inconsistent results will be obtained when a cold bolometer is attached to a warm object. Always allow the temperature of the bolometer to reach that of the equipment under measurement.

e. *Error in Power Readings.* For most applications, the summation bridge will give useful readings. When extremely accurate readings are required, error in power readings may be determined if the voltage standing-wave ratio (vswr) of the RF source and the bolometer are known. Error in power readings may be caused by impedance mismatches between the RF source and the bolometer. If there is impedance mismatch, the power loss lies between two limits as shown in the chart in figure 3-3, To determine these limits, locate the point on the chart at which the voltage standing-wave ratio of the RF source and that of the bolometer intersect. At this point, find the nearest cross section of the solid and dotted diagonal lines. The number on the solid line represents the lowest possible power loss correction. The number on the dotted diagonal line represents the highest possible power loss corrections, Both power loss corrections are given in decibels (db). Refer to the decibel chart below to find the power ratios corresponding to these two db values. For the highest possible true power, multiply the meter reading by the highest of the two power ratios. For the lowest possible true power, multiply the meter reading by the lowest of these power ratios. All power readings are computed in milliwatts. After the highest and lowest true powers have been computed, they can be converted to dbm by referring to the meter scale.

Power ratio	Decibles	Power ratio	Decibels
l.0233--------	0.1	1.1749-------	0.7
1.0471 ------- --	0.2	1.2023 --------	0.8
l.0715________	0.3	1.2303 --------	0.9
l.0965________	0.4	1.2589--------	1.0
1.1220 ________	().5	1.3183--------	1.2
l.1482________	0.6	1.3804--------	1.4

f. Normal Standing-Wave Ratio. Normally the voltage standing-wave ratio of the bolometer will fall between 1.3 to 1 and 1.5 to 1 as given in the technical characteristics (pars 1-5). Using one of these values, depending on the frequency of the source, and using the voltage standing-wave ratio given for the equipment being measured, determine the minimum and maximum correction factors from the chart (fig. 3–3). The correct power values obtained (e above) are as accurate as normally required. If more accurate readings are necessary, the voltage standing-wave ratio of the source and the bolometer can be measured with Coaxial Slotted Line IM-92/U (TM 11-5109).

g. Mount Efficiency. In addition to the mismatch error *(e* and *f* above), a second error associated with thermistor mounts in power measurements exists. This error is best described by the term mount efficiency, When used with a bolometer bridge circuit, the ideal condition demands that the RF power absorbed by the bolometer should be as effective in heating the thermistors as an equal amount of bolometer bridge power. Two phenomena cause the bolometer to deviate from this ideal condition. The first of these is the result of absorption of RF power in the metallic conductors and dielectric supports of the bolometer as well as in the thermistor leads and contacts. The second of these is the nonequivalent heating of the thermistors by equal amounts of bolometer bridge power and RF power. The overall effect of these two errors is called effective efficiency.

h. Effective Efficiency. This effective efficiency varies with frequency and for the MX-2144C/U is typically at least 99 percent for frequencies up to 1 kilomegacycle and is greater than 92 percent over the band from 8.2 to 10 kilomegacycles. The effective efficiency of each MX-2144C/U is measured over the latter frequency range and a graph of the results is supplied. To compensate for the MX-2144 C/U effective efficiency, determine the value of effective frequency at the particular frequency under measurement and divide the power reading (including mismatch correction) by this value. *For example,* assume a reading of 0.95 milliwatt with a 0.1-db maximum mismatch error and an effective efficiency of 95 percent. Referring to the chart in e above, the power ratio for 0.1 db is 1.0233. Multiplying the meter reading by this yields 0.972135 milliwatt. Dividing this by 0.95 yields 1.0233 milliwatts as the true power.

3-5. Stopping Procedure

a. Turn the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch to OFF.

b. Turn the ON (LINE POWER ON) [LINE ON-OFF] switch to OFF.

c. Disconnect the special test cable assembly from the bolometer and the interconnect cable assembly from the bolometer and the input jack on the front panel.

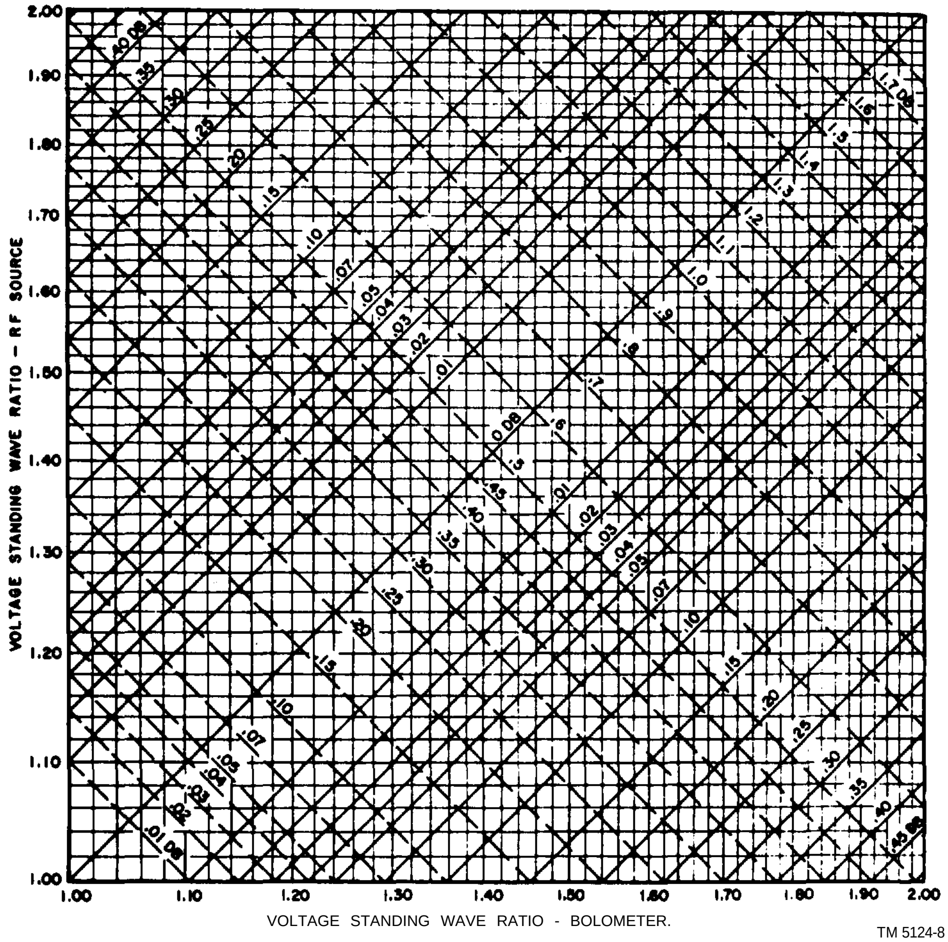


Figure 3-3. Waveguide Probe MX-2144/U; Bolometer, Radio Frequency MX-2144A/U; Bolometer, R.F. MX-2144B/U; Bolometer, R.F. MX-2144C/U, line mismatch loss.

d. Disconnect the line cord from the power outlet.

e. Store the summation bridge, bolometer, and interconnect cable assembly in the corrugated packing case.

CHAPTER 4

OPERATOR AND ORGANIZATIONAL MAINTENANCE

4-1. Scope of Maintenance

The maintenance duties assigned to the operator and organizational repairman of Wattmeter AN/URM-98(*) are listed below together with a reference to the paragraphs covering the specific maintenance functions. The tools and test equipment required are listed in appendix C.

a. Daily preventive maintenance checks and services (para 4-8).

b. Weekly preventive maintenance checks and services (pars 4-4).

c. Monthly preventive maintenance checks and services (pars 44).

d. Quarterly preventive maintenance checks and services (pars 4-.6).

e. Cleaning (pars 4-7),

f. Rustproofing and painting (pars 4-8).

g. Troubleshooting (paras 4-9, 4-10, and 4-11).

4-2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 4-3 through 4-8 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (paras 4-3 through 4-6) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the chart indicates what to check, how to check, and the normal conditions. The *References* column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective actions listed, higher category of maintenance *or* repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

4-3. Operator's Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be Inspected	Procedure	References
1	Completeness -----------	See that the equipment is complete (app C).	None.
2	Exterior surfaces ---------	Clean the exterior surfaces, including the panel and meter glasses (para 4-7). Check the meter glass and indicator lens for cracks.	None.
3	Connectors - - - - - - - - - -	Check the tightness of all connectors.	None.

Sequence No.	Item to be Inspected	Procedure	References
4	Controls and indicators --	While making the operating checks (sequence Nos. 5 through 11), observe that the mechanical action of each knob, dial, and switch is smooth and free of external or internal binding, and that there is no exececssive looseness. Also check the meter for sticking or bent pointer.	**None.**
5	ON (LINE POWER ON) [LINE ON-OFF] switch.	Set the switch to ON. The power on light should go on. The pointer on the meter should indicate on-scale or off-scale at the high end.	Pare 3-3b(1).
6	POWER RANGE (POWER) switch.	Set the switch to the range of power to be measured. If unknown, set to 10 MW.	Para 3-3b(2).
7	BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch.	Set the switch to OFF ----------	Pars 3-3b(3).
8	RES 200-100 [BOLO RES. 200Ω–100Ω] switch.	Set the switch as required. (Set to 200 for Bolometer, Radio Frequency MX-2144(*)/U.)	Para 3-3a.
9	COEF. POS.-NEG. [BOLO TEMP COEF POS.-NEG.] switch.	Set the COEF, POS.-NEG. switch as required. (Set to NEG. for BOLOMETER jack.	Para 3-3a.
10	Bolometer --------------	Connect the bolometer to the BOLOMETER jack.	Para 3-3b(3).
11	BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch and ZERO SET controls.	Using the switch and controls, zero the meter.	Para 3-3b(4) through (7)

4-4. Organizational Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be Inspected	Procedure	References
1	Cables --------------------	Inspect cords, cables, and wires for chafed, cracked or frayed insulation. Replace connectors that are broken, arced, stripped, or worn excessively.	None.
2	Handles ------------ ---	Inspect handles and hinges for looseness. Replete or tighten as necessary.	None.
3	Metal surfaces ------- ---	Inspect exposed metal surfaces for rust and corrosion, Touch up paint as required (para 4-8b).	None.

4-5. Organizational Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Pluckout items - - - - - - - - - -	Inspect seating of pluckout items. Make certain that the tube clamps grip tube bases tightly.	None.
2	Transformer terminals - - -	Inspect terminals on power transformer. There should be no evidence of dirt or corrosion,	None.
3	Terminal blocks - - - - - - -	Inspect terminal blocks for loose connections and cracked or broken insulation.	None,
4	Resistors and capacitors -	Inspect resistors and capacitors for cracks, blistering, or other detrimental defects.	None.
6	Gaskets and insulators - - -	Inspect gaskets, insulators, bushings, and sleeves for cracks, chipping, and excessive wear.	None.
6	Interior - - - - - - - - - - - -	Clean interior of chassis and cabinet.	None.

4-6. Organizational Quarterly Preventive Maintenance Checks and Services Chart

Sequence	Item to be inspected	Procedure	References
1	Publications - - - - - - - - - - -	See that all publication are complete, serviceable, and current.	DA Pam 310-4.
2	Modifications - - - - - - - - - - - -	Check DA Pam 9910-7 to determine if new applicable MWO's have been published, All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled.	TM 33-570 and DA Pam 310-7.
3	Spare parts - - - - - - - - - - - - -	Check all parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	App. B.

4-7. Cleaning

Inspect the exterior of Wattmeter AN/ URM-98(*). The exterior surfaces should be clean, and free of dust dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

Warning: **Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. *Do not* use near a *flame.***

b. Remove grease, fungus, and ground-in dirt from the cases; use a cloth dampened (not wet) with cleaning compound (Federal stock No. 7930-395-9542).

c. Remove dust or dirt from connectors with a brush.

Caution: **Do not press on the meter face (glass) when cleaning; the meter may become damaged.**

d. Clean the front panel, meter, and control knobs; use a soft clean cloth. If necessary, dampen the cloth with water and mild soap.

4-8. Rustproofing and Painting

a. Rustproofing. When the finish on either painted unit of the AN/URM-98(*) becomes badly scarred or damaged, rust and corrosion can be prevented by touching up the bare surfaces. Use No. 000 sandpaper to clean the surface down to the bare metal. Obtain a bright, smooth finish.

b. Painting. Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB SIG 364.

4-9. General Troubleshooting Information

Troubleshooting this equipment is based upon the operational check (para 4-3, sequence Nos. 5 through 11). To troubleshoot the equipment, perform all functions of the AN/URM-98(*) operation (paras 3-3 and 3-4) until an abnormal condition or result is observed. Note the abnormal condition, or result, and refer to the troubleshooting chart (para 4-10). Perform the checks and corrective actions indicated in the troubleshooting chart. If the corrective measures indicated do not result in correction of the trouble, higher maintenance category repair is required. Paragraph 4-11 (referenced in the chart) contains additional information and step-by-step instructions for performing equipment tests to be used during the troubleshooting procedures.

4-10. Troubleshooting Chart

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
1	With the ON (LINE POWER ON) [LINE ON-OFF] switch set to ON, the power on light does not go on.	*a.* Defective fuse *b.* Line cord on plug defective *c.* Transformer not wired properly *d.* Defective power on light	a. Replace fuse (fig. 2-2). *b.* Check line cord and plug. c. Check transformer wiring (para 2-3). *d.* Replace light.
2	The pointer on the meter rests off-scale at the low end.	*a.* BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch improperly eat. *b.* Defective tube	*a.* Advance switch one step at a time until there is an on-scale or high end off-scale indication. *b.* Check tubes V6 through V10 (para 4-11).
3	With the POWER RANGE (RANGE) switch set for the range of power under measurement (if unknown, set to 10 MW), the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch set to OFF, the RES. 200-100 [BOLO RES. 200Ω–100Ω] switch set as required (200 for the MX-2144(*)/U), the COEF, POS.-NEG. switch set as required (NEG. for the MX-2144(*)/U), and the bolometer connected	Defective tube	Check tubes V1 through V5 (para 4-11).

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
	to the BOLOMETER jack (J1), the meter cannot be zeroed with the BIAS CURRENT switch and ZERO SET controls.		

4-11. Electron Tube Replacement Techniques

To prevent the discarding of good electron tubes, follow the procedures given in *a* through *j* below when troubleshooting Wattmeter AN/URM-98(*).

a. Inspect all cabling, connectors, and the general condition of the wattmeter before removing the electron tubes.

b. Isolate the trouble, if possible, to a particular circuit of the summation bridge. (Use the troubleshooting chart (para 4-10) as a guide.)

c. If a tube tester is available, remove and test one tube at a time. Substitute new tubes only for those that are defective.

d. If a tube tester is not available, troubleshoot the summation bridge by the substitution method.

(1) Replace one of the suspected tubes with a known good tube.

(2) Check to see whether the summation bridge is operative. If the summation bridge is operative, discard the original tube. If the summation bridge is inoperative, remove the new tube and reinsert the original tube.

(3) Continue to check the suspected tubes, using the procedure given in (1) and (2) above, until the summation bridge becomes operative or until all the suspected tubes have been checked.

e. If the summation bridge is inoperative after the procedure outlined in *a* through *d* above is completed, continue as follows:

(1) Replace the suspected tubes, one at a time, with known good tubes until the summation bridge becomes operative or until all the suspected tubes are replaced by new ones. Note the sockets from which the original tubes were removed. If the summation bridge begins to operate, discard the last tube removed.

Note. Differential amplifier V1 may function with one tube and not another, even though both tubes are good, If practicable, retain a removed tube until its condition is checked by a suitable test instrument.

(2) Reinsert the remaining original tubes, one at a time, in the original sockets. If the summation bridge fails to operate at any time during this step, discard the original tube last reinserted. *Do not leave a new tube in a socket if the* AN/URM–98(*) *operates satisfactorily with the original tube.*

Note. If a replacement for a bad tube soon becomes defective, check the adjustment and condition of parts in the tube circuit. Otherwise, continued tube replacement will result in only temporary repair, and more serious troubles may result.

f. If the tube substitution does not correct the trouble, *reinsert the original tubes in the original socket* before forwarding the defective summation bridge for higher category repair.

g. Discard tubes when—

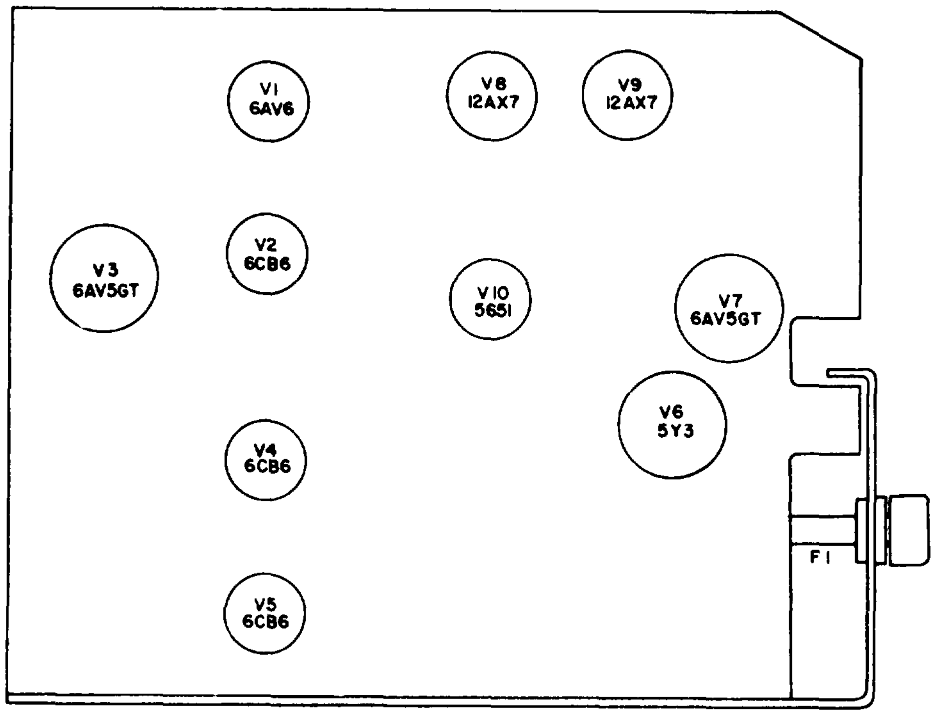
(1) A test by a tube tester or other instrument shows that they are defective.

(2) The tube defect is obvious. *For example*, the glass envelope is broken or a connecting prong or lead is broken.

h. *Do not* discard tubes merely because the tubes have been used for a specified length of time. *Satisfactory operation in a circuit is the final proof of tube quality*. The tube in use may work better than a new one.

i. *Do not* discard tubes merely because they fall on, or slightly above, the minimum acceptable value when checked in a tube teeter. Some new tubes fall near the low end of the acceptable range; yet these tubes may provide satisfactory performance throughout a long period of operational life at this *near limit* value.

j. Be careful when withdrawing a minature tube from its socket. *Do not* rock or rotate the top when removing it from its socket; pull it straight out. The external pin and the wire lead sealed in the glass base are of two different metals that are butt-welded together where the pin appears to enter the glass. Rocking or rotating the tube causes bending, which bends to break this weld or causes a resistance or intermittent joint to develop.



NOTE:
IN THE TS-779A/U AND TS-779B/U, V3 AND V7 ARE TYPE 6AU5GT TUBES; HOWEVER, THE TYPE 6AV5GT MAY ALSO BE USED.

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Figure 4-1. Tube location.

CHAPTER 5

FUNCTIONING OF EQUIPMENT

5-1. Block Diagram
(fig. 5-1)

Wattmeter AN/URM-98(*) consists of Test Set, Radio Frequency Power TS-779(*)/U, Bolometer, Radio Frequency MX-2144(*)/U, and Cord CG-409(*)/U. It is used for measuring power in radiofrequency circuits and microwave systems. The TS-779(*)/U is the major component. This unit contains three functionally distinct circuits: a bridge circuit, a voltmeter circuit, and a power supply. Figure 5-1 is a block diagram for the TS-779(*)/U and MX–2144(*)/U.

a. Bridge Circuit. The bridge circuit is basically an oscillator with a resonant bolometer bridge inserted in the positive feedback loop. The oscillator consists of tubes V1, V2, and V3. When the summation bridge is turned on, noise conditions in the circuit are amplified in differential amplifier tube V1 and passed to bridge amplifier tube V2. The signal is amplified in tube V2 and passed to cathode-follower tube V3. Output voltage obtained at the cathode of tube V3 is fed back through the bolometer bridge and is applied to the input of tube V1. Feedback voltage is amplified in tubes V1 and V2 and returned to the input of tube V1 from the cathode of V3. Oscillation occurs when the amplified signal from V3 is returned to the input of tube V1. This oscillation frequency of 10,8 kilocycles (kc) is determined by a series-resonant arm in the bolometer bridge. The bridge circuit has a fixed arm, an adjustable arm, a series-resonant arm, and a variable arm. The variable arm is formed by the externally connected bolometer. The oscillator generates less power as the bolometer bridge approaches a balanced condition, and more power when the bridge is not balanced. The element in the bolometer is a temperature-sensitive thermistor. When rf power is applied to the thermistor, the resistance of the thermistor decreases and the bridge is driven toward a balanced condition, thereby attenuating the positive feedback. Consequently, the bridge circuit functions as a 10.8-kc oscillator which generates less power as the element in the bolometer is exposed to a stronger field. Output voltage obtained at the cathode of tube V3 is also applied to the voltmeter circuit.

b. Voltmeter Circuit. The voltmeter circuit is basically a vacuum tube voltmeter (vtvm) which monitors the output level of the bridge circuit. The voltage-divider circuit associated with POWER RANGE (RANGE) switch S3 adjusts the voltage applied to the voltmeter amplifier circuit. Incoming voltage is amplified by tubes V4 and V5 and passed to meter M1. The polarity of meter M1 is connected so that microwave power readings appearing on the meter scale increase with clockwise deflection of the meter pointer despite the fact that the bridge circuit oscillates with less strength as the RF or microwave power received by the associated bolometer increases. This is done by passing current from the B+ supply continuously through the meter to make it deflect clockwise while the rectified oscillator current tends to make it deflect counterclockwise.

c. Power Supply. The power supply furnishes the electrode and filament voltages required by the tubes in the bridge and voltmeter circuits and the current required to make the meter deflect clockwise. Rectified voltage is supplied to voltage regulator tube V7 by rectifier tube V6. The regulated B + voltage supplied by tube V7 is governed by the bias on the control grid of the tube. This bias is

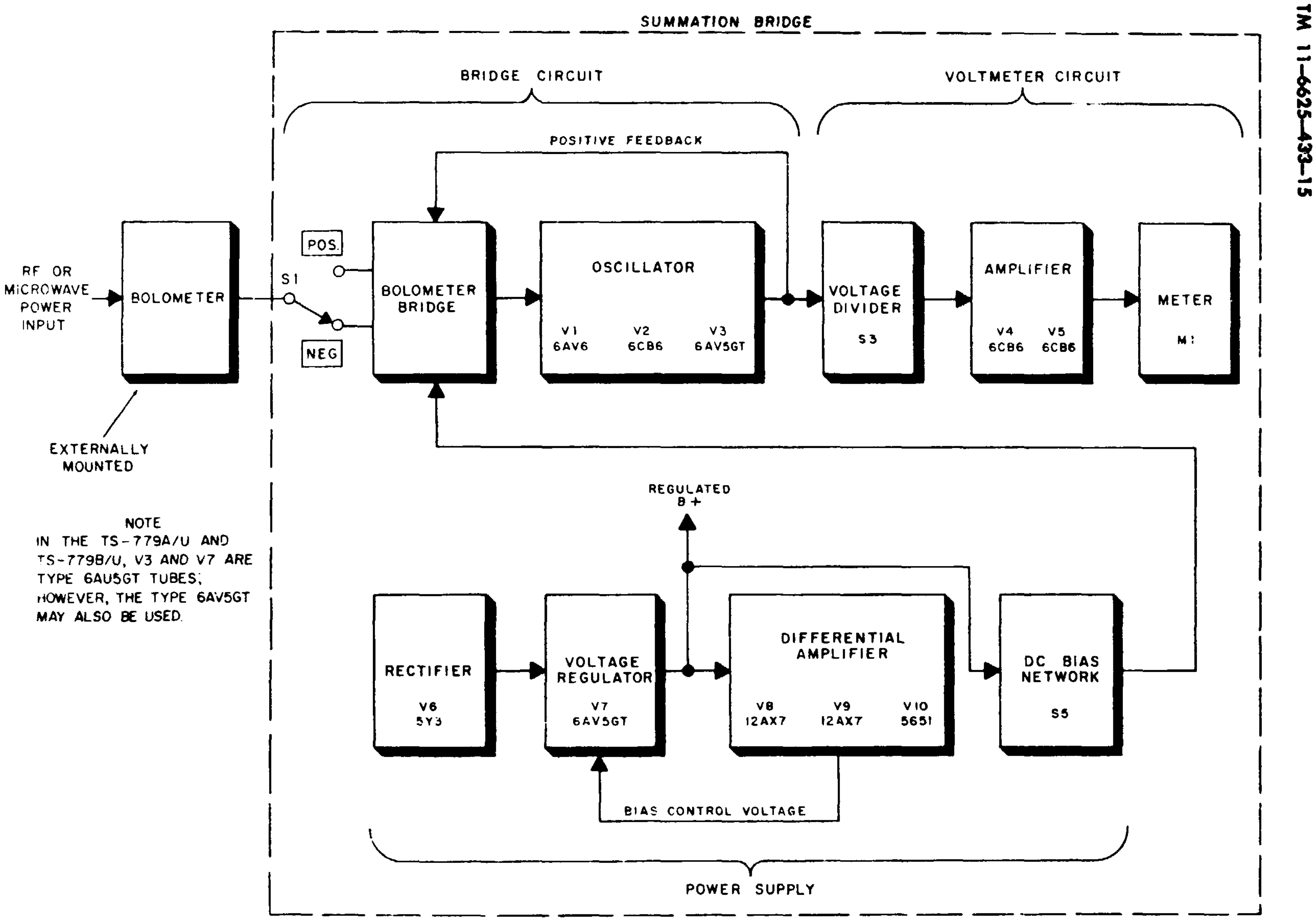


Figure 5–1. Wattmeter, functional block diagram.

provided by a two-stage differential amplifier consisting of tubes V8 and V9. B+ voltage obtained at the cathode of tube V7 is passed through a voltage-divider network which controls the grid bias of tube V9B. The grid bias of tube V9A is provided by reference tube V10. Tube V9 applies control grid bias to both sections of tube V8, When the dc bias voltages at the grids of V9A and V9B are equal, identical plate currents flow in both sections of the tube. When the grid bias voltages of tube V9 are not equal, an error signal in the form of unbalanced plate voltages is supplied by tube V9 to the grids of tube V8. This error voltage is further amplified in tube V8 and impressed as cathode-to-grid bias on tube V7. This bias voltage varies the direct current (dc) resistance of tube V7 so that the condition responsible for the existence of the error voltage is counteracted and tube V7 always supplies the same amount of B+ voltage. Regulated B+ voltage from tube V7 is also supplied to a dc bias network associated with BIAS CURRENT switch S5. The dc bias network governs the amount of dc bias current applied as balancing current to the bolometer commuted to the bridge circuit.

d. Bolometer, Radio Frequency MX-2144(*)/U. The bolometer is connected externally to the summation bridge. It contains two 100-ohm thermistors arranged so that they are in parallel for RF and in series for the dc bias current and 10.8-kc bridge oscillator frequency in the bridge circuit. It operates in the frequency range from 10 megacycles to 10 kilomegacycles. When connected to the summation bridge, it forms one arm of the bridge circuit, The thermistors are heat sensitive and provide less resistance as the temperature increases. When radiant energy, such as RF or microwave power, is applied to the bolometer, the temperature of the thermistors increases and lowers their resistance. This brings the bridge circuit closer to balance, which lowers the output of the oscillator, and, in turn, produces a higher meter reading.

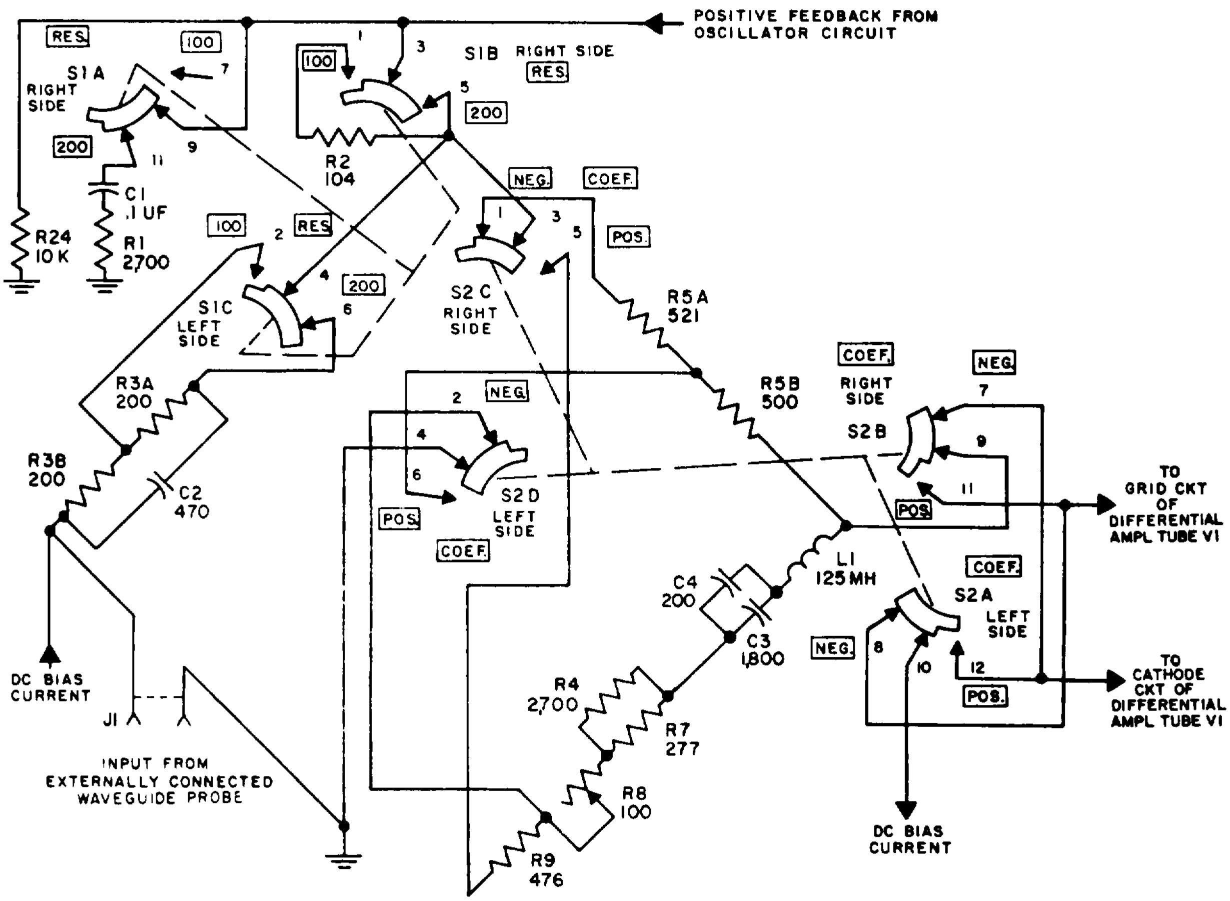
5-2. Bridge Circuit

(figs. 5-2 though 5-5)

The bridge circuit consists of a bolometer bridge and an amplifier that functions as an oscillator. The bolometer bridge controls the output of the oscillator amplifier circuit. When the bolometer bridge is in a state of unbalance, the strength of oscillations increases. As the bolometer bridge becomes closer to balance, the output of the oscillator decreases. A temperature-sensitive element in an externally connected bolometer forms one arm of the bolometer bridge and determines the state of bridge balance. The circuit is designed to operate with a thermistor-or barretter-type bolometer. Thermistor-type bolometers have a negative temperature coefficient in that resistance decreases as their temperature increases. Barretter-type bolometer have a positive temperature coefficient in that resistance increases as their temperature increases. A two-position rotary switch (S2) transposes the series-resonant arm and the fixed arm of the bridge so that the bridge circuit operates essentially the same for either type operation.

a. Figure 5-4 is an equivalent-circuit diagram showing the arrangement of the bridge circuit for thermistor operation. In this arrangement, positive feedback from cathode-follower tube V3 is applied to the bolometer bridge at the junction of the fixed and adjustable arms. A portion of the positive feedback is applied across the grid and cathode of tube VI from the bridge output. The grid and cathode circuits are composed of the variable arm and the series-resonant arm.

b. Figure 5-5 is an equivalent-circuit diagram showing the arrangement of the bridge circuit for barretter operation. In this arrangement, positive feedback from cathode-follower tube V3 is applied to the bolometer bridge at the junction of the series-resonant and adjustable arms. A portion of the positive feedback is applied to the grid of tube V1 at the junction of the adjustable and variable arms and to the cathode of tube V1 at the junction of the fixed and series-resonant arms.



NOTES:

1 SWITCHES S1 AND S2 SHOWN IN POSITION FOR OPERATION WITH THERMISTOR TYPE BOLOMETER.

2 IN THE TS-779A/U, C4 MAY BE OMITTED.

3 IN THE TS-779B/U, C4 AND R4 ARE OMITTED; R7 IS 243 OHMS, R5A IS R5, R5B IS R6; R3A IS R3; R3B IS R4.

4 IN THE TS-779A/U AND TS-779B/U.

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Figure 5-2. Bolometer bridge circuit, simplified schematic diagram.

c. Switch S1 is used to adjust the adjustable arm of the bridge to maintain the proper bridge arm impedance relationship with the variable arm, It is set in the 100 position when waveguide probes with 100-ohm internal resistance are used and in the 200 position when bolometers with 200-ohm internal resistance are used.

d. Figure 5–2 is a simplified schematic diagram of the bolometer bridge circuit and figure 5-3 is a simplified schematic diagram of the oscillator circuit. When the summation bridge is turned on, switching transience and electrical noise are produced in oscillator tubes VI, V2, and V3. This noise shock excites reactor L1 and capacitors C3 and C4 in the bolometer bridge, which produces damped oscillations at the resonant frequency of 10.8 kc. These signals are passed through coupling capacitors C5 and C6 to both the grid and cathode of differential amplifier tube V1 in the oscillator. At tube VI, dc bias voltage is developed across resistor R13 and is applied to the control grid through the series combination of resistors R11

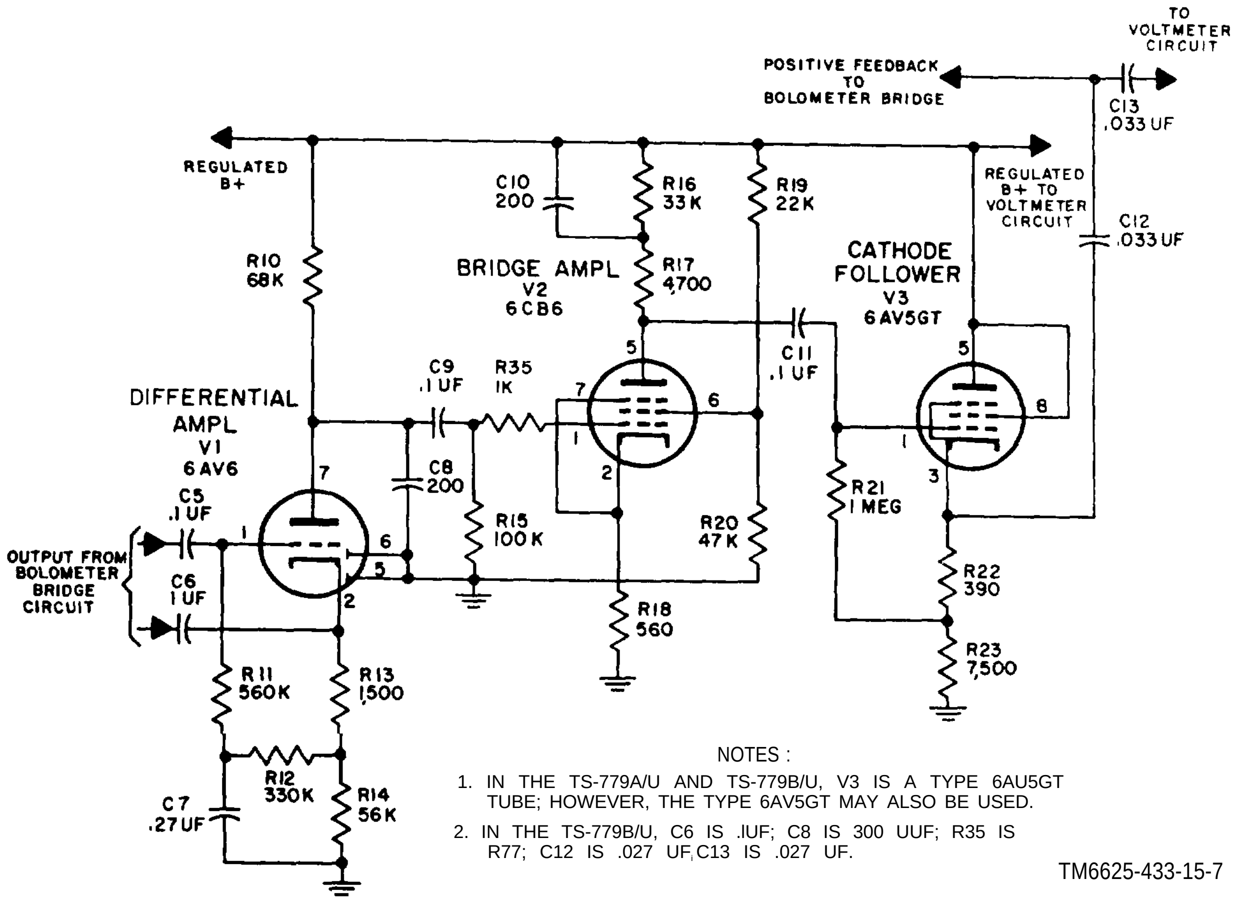


Figure 5-3. *Oscillator amplifier circuit, simplified schematic diagram.*

and R12, Resistors R11 and R12 form the grid return resistance. Resistor R14 and capacitor C7 improve the phase-gain characteristics of the amplifier. Plate load for tube V1 is provided by resistor R10.

Note. Capacitor C4 is not required in the TS-779B/U.

e. The amplified output of tube V1 is passed to bridge amplifier tube V2 through a coupling network consisting of capacitors C8 and C9 and resistors R15 and R35. Capacitor C9 provides ac coupling and dc isolation between the plate of tube VI and the grid of tube V2. Resistor R15 is the grid return resistor for tube V2. Capacitor C8 improves the phase-gain characteristics of the amplifier, Resistor R35 is a limiting resistor to prevent overloading of tube V2. Operating grid bias for tube V2 is provided by resistor R18. Resistors R16 and R17 form a plate load resistance for tube V2. Capacitor C10 bypasses higher frequencies and generally improves the phase-gain characteristics of the amplifier. Screen grid voltage is supplied by a voltage-divider network consisting of resistors R19 and R20.

Note. Resistor R35 is designated R77 in the TS-779B/U.

f. The amplified output of tube V2 is coupled to cathode-follower tube V3 through capacitor C11. Resistor R21 is the grid return and resistor R22 provides the dc bias for tube V2. Resistor R23 limits the dc through this tube. Positive feedback voltage is obtained at the cathode of tube V3 and passed through dc blocking capacitor C12 to the bolometer bridge and returned to the input of tube V1. The

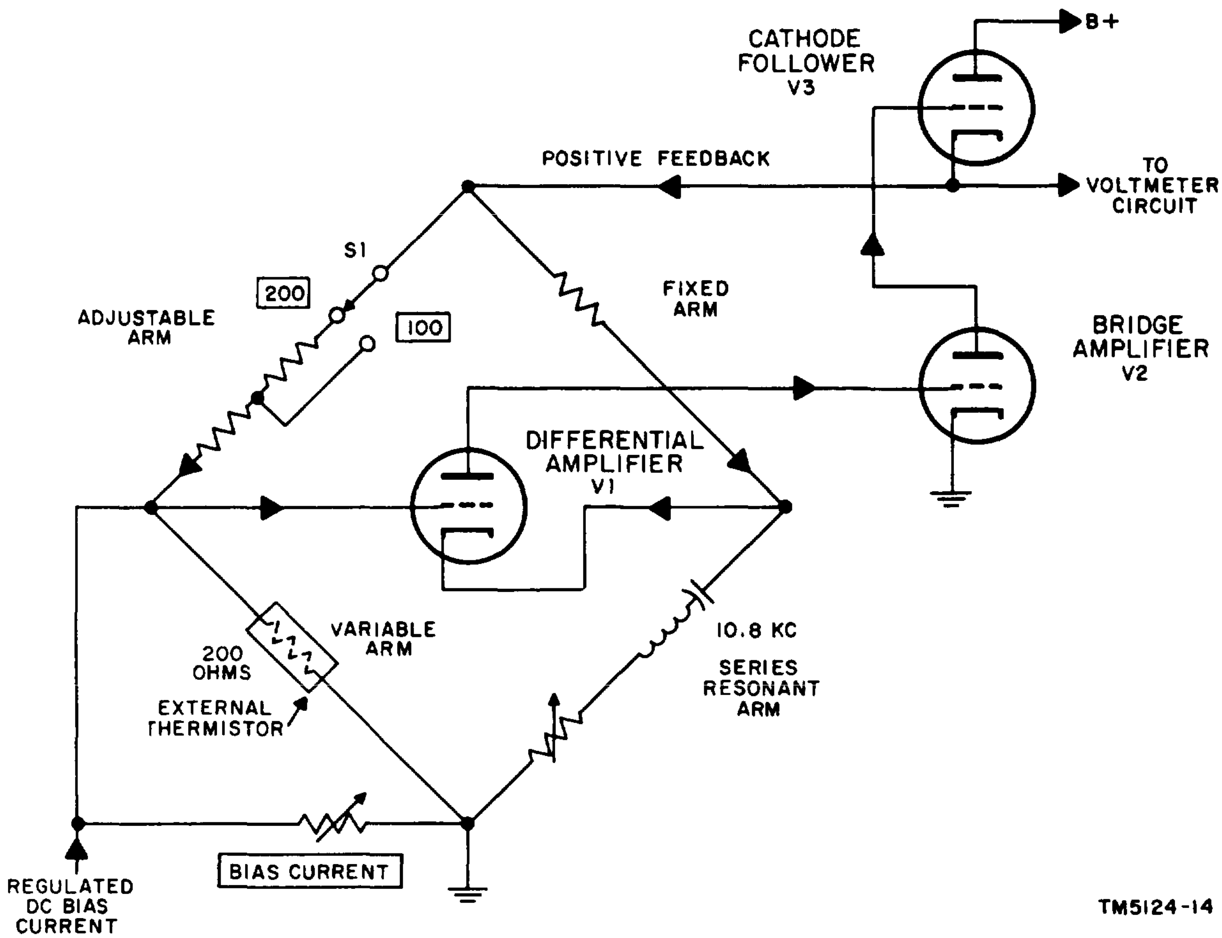


Figure 5-4. Bridge circuit using thermistor-type bolometer, equivalent-circuit schematic diagram.

positive feedback voltage reinforces the original 10.8-kc signal. The reinforced signal is again amplified in the oscillator amplifier and returned to the input. This cycle of events is cumulative and results in a rapid buildup of the level of the 10.8-kc signal. The amplitude attains a level determined by the limiting characteristics of the tubes, and self-sustained oscillations exist.

g. The bolometer bridge balance is determined by the effective impedances of the four arms of the bridge. At resonance, reactor L1 and capacitors C3 and C4 have low impedance; therefore, the impedance of the series-resonant arm of the bridge is governed by resistors R4, R7, R8, and R9. Resistor R8 is used to adjust the impedance of this arm of the bridge.

Note. Capacitor C4 and resistor R4 are not required in the TS-779B/U.

h. Elements in the bolometers have either a 100- or 200-ohm resistance. Switch S1 is used to adjust the adjustable arm of the bolometer bridge for operation with either 100- or 200-ohm bolometer elements. When a 100-ohm bolometer element is used, switch S1 is set to the 100 position. This action removes capacitor C2 and resistor R3A from the circuit. In this switching position, resistor R3B forms this arm of the bridge and resistor R2 is brought into the bridge circuit to limit the feedback voltage from the oscillator, which preserves operating conditions identical with the 200 switch position operation. When switch S1 is in the 200 position, resistors R3A and R3B and capacitor C2 are connected to form the adjustable arm

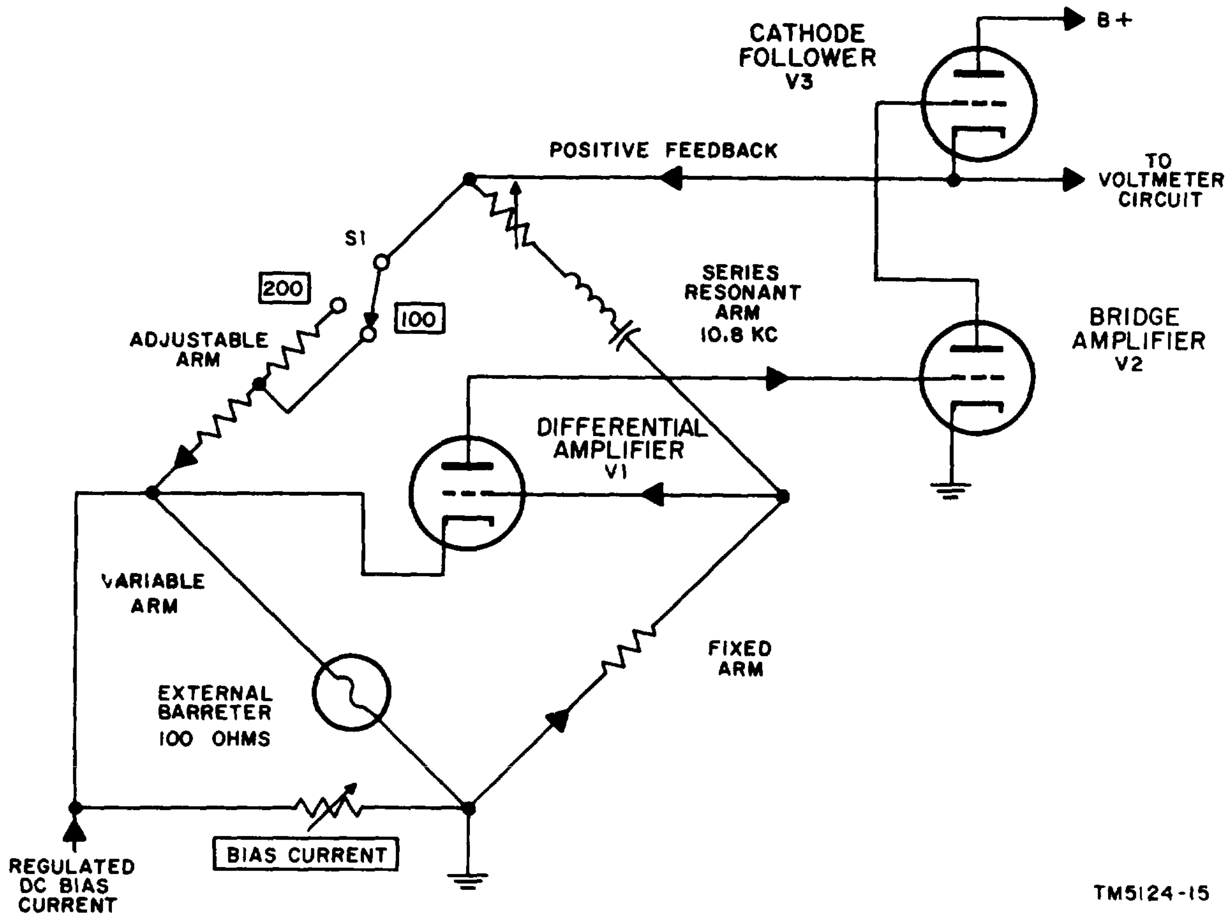


Figure 5-5. Bridge circuit using barretter-type bolometer, equivalent-circuit schematic diagram.

of the bridge and resistor R2 is removed from the circuit.

Note. Resistors R3A and R3B are designated R3 and R4, respectively, in the TS-779B/U.

i. The fixed arm of the bolometer bridge consists of resistors R5A and R5B. When the summation bridge is being operated with a bolometer that has a negative temperature coefficient (thermistor type), both resistors R5A and R5B are brought into the circuit through the switching action of switch S2. When a bolometer with a positive temperature coefficient is being used (barretter type), switch S2 is turned to the POS. position and resistor R5A is removed from circuit. In this position, resistor R5B forms the fixed leg of the bridge. When switch S2 is in the NEG. position, feedback voltage from tube V3 is applied to the bridge at the junction of the adjustable and fixed arms. When switch S2 is in the POS. position, the relative positions of the fixed and series-resonant arms of the bridge are transposed and feedback voltage from tube V3 is applied to the bridge at the junction of adjustable and series-resonant arms. Transposing the series-resonant and fixed arms allows the bridge always to be driven toward a balanced condition when the bolometer element in the bolometer is heated. Switching of S2 also interchanges the grid and cathode connections of tube VI to maintain proper phase conditions for either negative or positive bolometer elements.

Note. Resistors R5A and R5B are designated R5 and R6, respectively, in the TS-779B/U.

j. The variable arm of the bolometer bridge is formed by an externally connected bolometer. The elements in the bolometer may be either thermistor of barretter type. The thermistor type has a negative temperature coefficient so that heating the thermistor decreases its resistance. The barretter type has a positive temperature coefficient so that heating the barretter increases its resistance. For thermistor-type operation, an increase in resistance drives the bridge closer to balance. For barretter-type operation, an increase in resistance drives the bridge closer to balance.

k. Feedback energy developed by the oscillator is passed through the adjustable arm of the bridge to the variable arm (fig. 5-4). Dc bias current is supplied to the bridge circuit from the power supply. This dc bias current is adjustable by front panel controls BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] S5, ZERO SET COARSE (R33), and ZERO SET FINE (R30, fig. 6-1). The dc bias current, in conjunction with the sc feedback current from the oscillator, raises the operating temperature of the bolometer element in the bolometer (fig. 5-4). This drives the bridge closer to a balanced condition. As the bridge approaches a balanced condition, the output level of the oscillator decreases. The dc bias current is adjusted so that when no source of RF or microwave power is applied to the bolometer element, a near state of bridge balance is attained. Specifically, a degree of balance is obtained which corresponds to an arbitrary zero reading on meter Ml in the voltmeter circuit. In this way, the effect of the surrounding air temperature upon the bolometer element is circumvented,

Note. Resistors R30 and R29 are designated R30A and R30, respectively, in the TS-779B/U.

l. Resistor R24 in the bolometer bridge circuit dissipates excessive 10.8-kc oscillatory power when the bridge is extremely unbalanced. This condition exists when the summation bridge is turned on and the bolometer is not connected into the bolometer bridge.

m. Resistor R1 and capacitor C1 in the bolometer bridge circuit absorb switching transients produced by the actuation of switch S1.

5-3. Voltmeter Circuit

(fig. 5-6)

a. Figure 5-6 is a simplified schematic diagram of the voltmeter circuit. A 10.8-kc input signal is supplied to the voltmeter circuit from the cathode of tube V3 in the oscillator circuit. This input voltage is passed through coupling capacitor C13 to an adjustable voltage-divider network consisting of multisection resistor R49 in conjunction with POWER RANGE (RANGE) switch S3A. Resistor R49 adjusts the applied voltage to the voltmeter circuit and enables measurement to be made over different amplitude ranges.

Note. Multisection mister R49 is replaced by resistors R49 through R53 in the TS-779B/U.

b. The adjusted voltage is passed through limiting resistor R54 to the control grid of tube V4. Dc operating bias for tube V4 is supplied by the series combination of resistors R57, R58, and R59. Resistor R55 provides the plate load and resistor R56 is the voltage-dropping resistor for the screen grid of tube V4. Capacitor C15 is the screen grid bypass capacitor for tube V4.

c. The output of tube V4 is coupled through capacitor C14 to the control grid of second amplifier tube V5. Plate load for tube V5 is provided by resistor R61. Resistor R60 is the grid return resistance and resistor R62 provides dc operating bias for tube V5.

d. The output of V5 is coupled through capacitor C16 to a diode bridge consisting of rectifiers CR1 through CR4, Negative feedback is derived from the output of tube V5 at the junction of rectifiers CR3 and CR4. This feedback is applied through capacitor C18 to variable resistor R58 in the input circuit of first amplifier tube V4. ZERO ADJ. resistor R58 is used to adjust the amount of negative feedback and therefore the overall gain of the two-stage amplifier circuit. Meter Ml is connected between the junction of rectifiers CR1 and CR3 and the junction of rectifiers CR2 and CR4. This connection provides full-wave rectification of the 10.8-kc signal for application to the meter.

e. Resistors R64 and R65 supply a residual dc bias current to the meter. The polarity of the meter is connected so that the dc bias

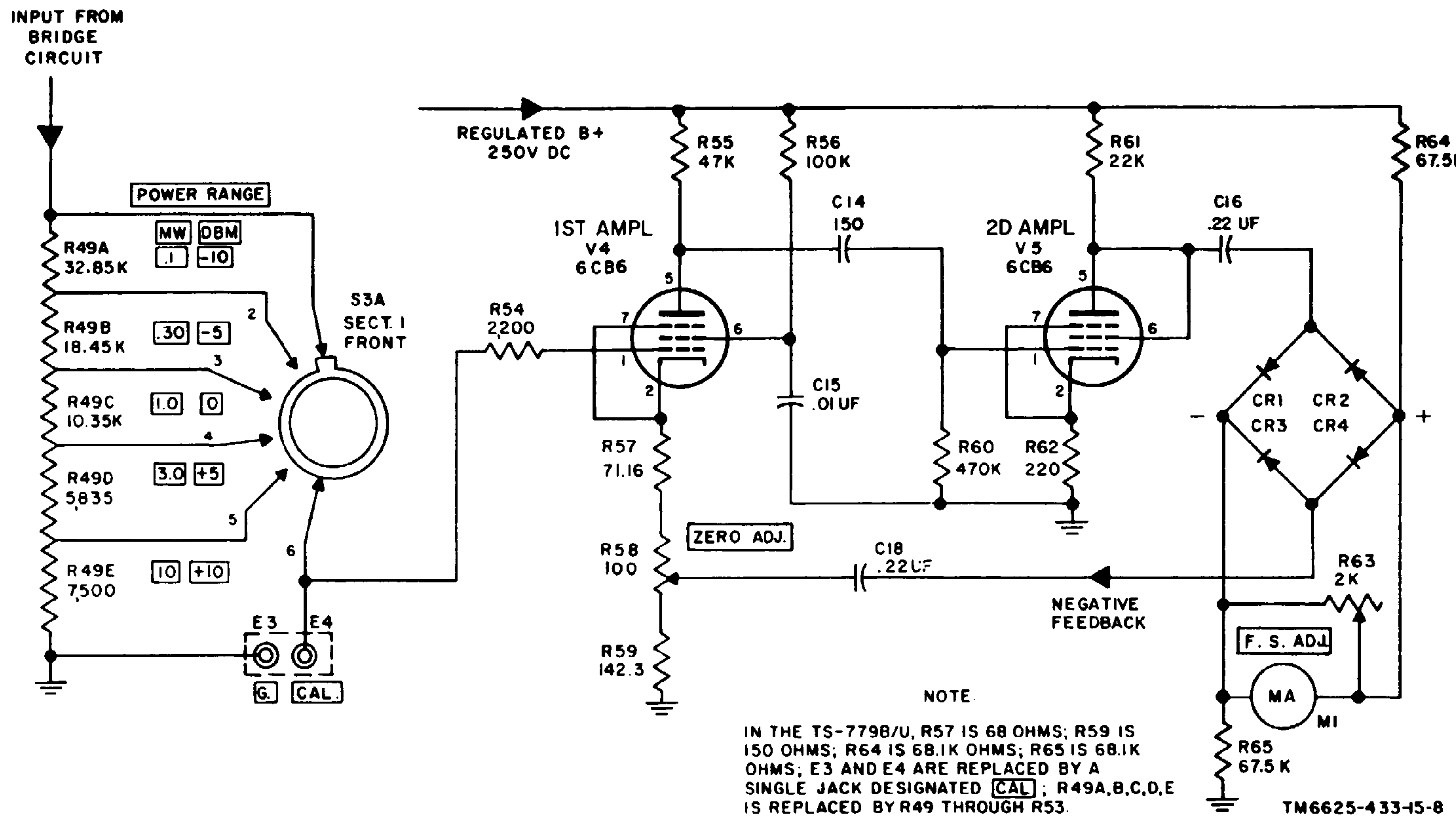


Figure 5-6. Voltmeter circuit, simplified schematic diagram.

current drives the pointer on the meter towards full-scale deflection. The rectified 10.8-kc signal appears at the meter terminals in opposite polarity from that of the dc bias current and tends to drive the pointer on the meter toward a zero or left-hand deflection. F. S. ADJ. R63 is used to adjust the full-scale reading of the meter by diverting part of the dc applied to the meter. Since the dc bias current always remains at a fixed value, the higher the output level of the bridge circuit the more the pointer on the meter moves toward *zero.* Exact zeroing of the meter is accomplished through adjustment of BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch S5, ZERO SET COARSE control (R33), and ZERO SET FINE control (R30) (figs. 11-5 and 11-6). These controls adjust the amount of dc bias current supplied to the bolometer connected to the bolometer bridge circuit.

Note. Resistors R30 and R33 are designated R30A and R30, respectively, in the TS-779B/U.

f. The amount of bias current that flows through the bolometer element of the bridge is determined by BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch S5 and the ZERO SET controls. It is not necessary to have an exactly calibrated setting of switch S5 because this is adjusted by the ZERO SET controls. Switch S5 gets the bias current in a range that can be controlled by the ZERO SET controls. For this reason, only a rough calibration of the switch is given. The steps in switch S5 are used to give rough estimates of the amount of bias current needed. If the meter reads off-scale at the low end, switch S5 is moved clockwise until the meter reads on-scale, If the meter reads off-scale on the high end and cannot be zeroed by the ZERO SET controls, switch S5 is moved counterclockwise until the meter can be zeroed, regardless of the setting of switch S5.

g. The meter is deflected clockwise by the current obtained through resistors R64 and R65. It is deflected counterclockwise by the rectified feedback voltage supplied by the vtvm circuit. The result is that as rf or microwave power is applied to the bolometer, it heats the element which drives the bridge closer to balance. When the bridge approaches balance, it decreases the output level from the oscillator. The lower the output level from the oscillator, the greater the clockwise deflection of the meter (a higher meter reading is obtained).

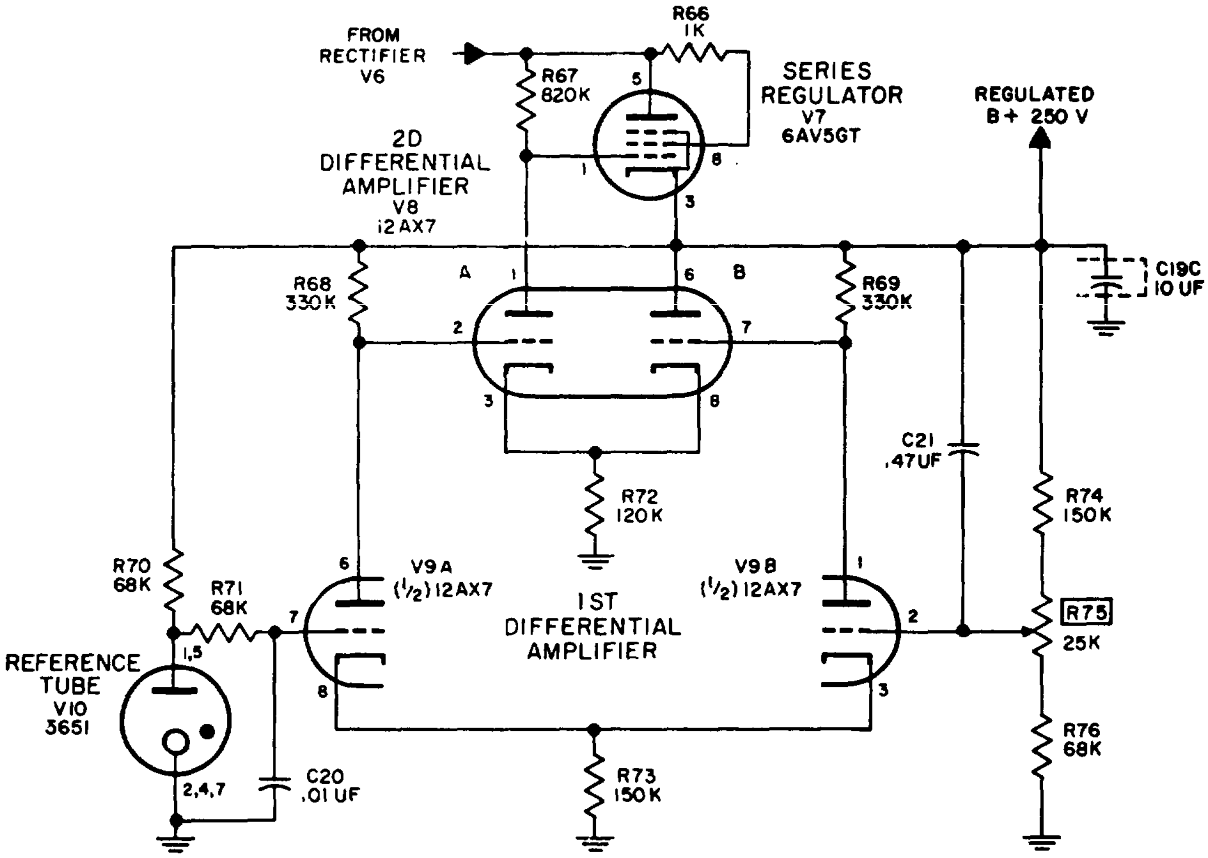
5-4. Power Supply

(fig. 5-7)

a. The power supply is designed to operate from either a 115- or 230-volt, 50- to 1,000-cycle-per-second (cps) ac power source. Power transformer T1 has strapping options for the type of line voltage used. Full-wave rectification of the transformer voltage is provided by rectifier tube V6 (figs. 11-5 and 11-6), The resultant dc voltage is applied to series regulator tube V7 (fig. 5-7). The dc voltage output of tube V7 is determined by the resistance the tube offers to passage of current. The effective dc resistance of tube V7 is controlled by bias voltage impressed at its control grid. This control bias is provided by a differential amplifier circuit consisting of tubes V8, V9, and V10. Figure 5-7 is a simplified schematic diagram of the power supply differential amplifier and voltage regulating circuits.

b. B+ voltage obtained at the cathode of tube V7 is divided by a voltage divider composed of resistors R74, R75, and R76 and is applied as grid bias to tube V9B. Variable resistor R75 is used to adjust the amount of voltage applied to grid tube V9B. Capacitor C21 speeds up the regulating process by coupling changes in the B + voltage to the grid of tube V9B.

c. Grid bias voltage for tube V9A is obtained from reference tube V10 through limiting resistor R71. Operating current for tube V10 is derived through resistor R70 from the cathode of tube V7, Capacitor C20 bypasses spurious signals generated by the ionization of tube V10. Resistor R73 is a mutual cathode resistor for the cathodes of tubes V9A and V9B. The voltage drop across resistor R73 develops negative grid bias for both sections of tube V9. The value of this grid bias is high enough so that the grid bias voltages are always negative despite the fact that positive grid bias voltage is supplied from tube V10 and



NOTES:
1. IN THE TS-779A/U AND TS-779B/U, V7 IS A TYPE 6AU5GT TUBE; HOWEVER, THE TYPE 6AV5GT MAY ALSO BE USED.
2. IN THE TS-779A/U, IOK OHM RESISTOR R79 IS ADDED BETWEEN PINS 3 AND 5 OF V7.
3. IN THE TS-779B/U.IOK OHM RESISTOR R81 IS ADDED BETWEEN PINS 3 AND 5 OF V7; R76 IS 68.1 K OHMS.

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Figure 5-7. Power supply differential amplifier and voltage regulation circuits, simplified schematic diagram.

voltage divider R75. Resistor R79 also provides dc degeneration, which stabilizes the operation of tube V9. Plate lead for tube V9A is supplied by resistor R68 and plate load for tube V9B is supplied by resistor R69.

d. When the dc bias voltage on the grids of V9A and V9B are equal, identical plate currents flow in these tube sections. Output voltage from tubes V9A and V9B are applied as control grid bias to the grids of tube sections V8A and V8B respectively, Resistor R72 is a mutual cathode-bias resistance for both sections of tube V8. This resistance always maintains the net grid bias voltages of tube V8 in the negative region. Resistor R72 also provides dc degeneration, which stabilizes the operation of tube V8. Resistor R67 provides plate load for tube section V8A.

e. The grid-to-cathode voltage of tubs V7 is governed by the relative conductive states of tubes V8A and V8B. Voltage applied to the grid and cathode of tube V7 from tube V8 varies the effective resistance of tube V7 and therefore, the voltage available at the output of tube V7. The change in resistance in tube V7 is always such that it counteracts the B+ voltage condition causing it.

f. Resistor R66 is the screen grid voltage-dropping resistor for tube V7. Filtering of the regulated B + voltage is provided by capacitor C19C.

g. The summation bridge, in resistors R78 and R79 (fig. 6-1, note 2) reduce plate dissipation in V7 at high line voltage. Resistor R77 in series with the pilot light is omitted because a No. 12 long-life pilot light is used.

h. In summation bridge, resistors R78 and R79 (fig. 6-1, note 3) are designated R80 and R81, respectively, and the pilot light is a type 61.

CHAPTER 6

TROUBLESHOOTING

***Warning:* Certain points throughout the chassis of the summation bridge operate at voltages above 250 volts. Do not touch these points while power is being applied to the summation bridge. Be very careful when handling or testing any part of the summation bridge while it is connected to the power source.**

6-1. General Instructions

Direct support, general support, and depot maintenance troubleshooting include all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part.

6-2. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective summation bridge is to sectionalize the fault. Sectionalization means tracing the fault to one of the three major circuits responsible for the abnormal operation: the bridge circuit the vacuum tube voltmeter circuit or the regulated power supply circuit. The second step is to localize the fault. Localization means tracing the fault to a particular stage or network within one of the three major circuits. The third step is to isolate the fault. Isolation means tracing the fault to the defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing, and shorted transformers, often can be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and resistances.

b. Component Sectionalization, Localization, and lsolation. Listed in (1) through (8) below is a group of tests arranged to simplify and to reduce unnecessary work and to aid in tracing a trouble to a specific component. Follow the procedure in the sequence given. A serviceman must be careful to cause no further damage to the wattmeter while it is being serviced.

(1) *Visual inspection.* The purpose of visual inspection is to locate any visible trouble. Through inspection alone, the repairman frequently may discover the trouble or determine the circuit in which the trouble exists. This inspection is valuable in avoiding additional damage to the summation bridge which occurs through improper servicing methods and in forestalling future failures.

(2) *Troubleshooting Amt.* The trouble symptoms listed in this chart (pars 6-5) will aid greatly in locating trouble.

(3) *Intermittents.* In all these tests, the possibility of intermittent conditions should not be overlooked. If present, this type of trouble often maybe made to appear by tapping or jarring the equipment. It is possible that some external connections may cause the trouble. Test wiring for loose connections and move wires and components with an insulated tool, such as a pencil or fiber rod. This may show where a faulty connection or component is located.

(4) *Resider and capacitor color code diagrams.* Color code diagrams for resistors and capacitors (figs. 11-2 and 11-4) provide pertinent resistance,

capacitance, voltage rating, and tolerance information.

6-3. Test Equipment Required

The items of test equipment required for troubleshooting Wattmeter AN/URM-98(*) are listed below. Technical manuals and common names associated with each item are also listed.

Test equipment	Technical manual	Common name
Test Set, Electron Tube TV-7/U.	TM 11-6625-274-12	Tube tester.
Voltmeter Meter ME-30A/U.	TM 11-6625-320-12	Vtvm.
Multimeter TS-352B/U.	TM 11-662&366-15	Multimeter.

64. Checking Filament B+ Circuits for Shorts

***Caution:* Do not attempt removal or replacement of parts before reading the instructions in paragraph 7-1.**

a. When to Check. When any of the following conditions exist, check for short circuits and clear the troubles before applying power.

(1) When abnormal symptoms reported from operational tests indicate possible power supply troubles.

(2) When sectionalizing procedures (para 8-2) have indicated possible power supply trouble.

b. Conditions for Tests. Prepare for the short circuit tests as follows:

(1) Remove the wattmeter from its case.

(2) Remove all tubes and indicator light.

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

Point of measurment	Normal indication	Isolating procedure
From pin 3 of power transformer T1 to ground.	126.5 ohms -------------------	If resistance is zero, check for a ground in the wire between the power transformer and tube V6. If resistance is infinite, replace the power transformer.
From pin 5 of power transformer T1 to ground.	126.6 ohms _ _ _ _ _ _ _ _ _ _ _	If resistance is zero, check for a ground in the wire between the power transformer and tube V6. If resistance is infinite, replace the power transformer.
From pin 2 of tube V6 to ground.	Infinite resistance --------------	If resistance is 100 ohms, cheek for shorted filter capacitor C19A, B. If resistance is zero, check for a ground in the wire between the power transformer and tube V6.
From pin 3 of tube V7 and ground.	8,000 ohms -------------------	If resistance is zero, check for shorted filter capacitor C19C or a short in the AN/URM-98(*) filament wiring. If resistance is low, ckeck for a shorted bypass capacitor or resistor in one of the plate or screen-grid circuits (fig. 6-1) or for leak-in one of the filler capacitors listed above. If resistance is high, check for an open resistor in one of the screen-grid circuits (fig. 6-1).

6-5. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the wattmeter. It lists the symptoms which the repairman observes, either visually or audibly, while making a few simple tests. The chart also indicates how to sectionalise trouble quickly to the bridge, vacuum tube voltmeter, or power supply circuits. After the trouble has been localized to a stage, a tube check and voltage and resistance measurement of this stage ordinarily should be sufficient to isolate the defective parts. Normal voltage and resistance readings are given in figures 6-2 through 6-5. Part locations are given in figures 6-6 through 6-10.

Symptom	Probable trouble	Correction
Line cord connected to power source and ON switch is in the ON position. The pilot lamp does not light.	Defective POWER ON lamp. Fuse F1 blown.	Replace lamp. Refer to *next* symptom.
Line cord connected to power source and ON switch in the ON position, Fuse F1 blows.	Transformer T1 not strapped properly.	Replace blown fuse F1. If replaced fuse blows, check terminal strapping of transformer T1 (para 2-3). Check for proper size fuse. Fuse should be 1 ampere for 115-volt operation and 0.5 ampere for 230-volt operation.
	Defective rectifier tube V6.	Check tube and replace if defective.
	Defective line cord or plug - - - - -	Check line cord and plug and replace if defective. Check for proper voltage at P1.
	Defective filter capacitor C19A, C19B, or C19C.	Check capacitor and replace if defective.
External bolometer connected to input connecator J1. Meter needle deflects to the right of O MW and cannot be zero set (para 3-3).	Defective bolometer - - - - - - - - - - - -	In the AN/URM-98, check the bolometer (fig. 7-1 and 7-2 and paras 7-3 and 7-4). Replace if defective. In the AN/URM-98A, check the bolometer (fig. 9-6 and 9-7 and paras 9-8 and 9-9). Replace if defective. Check associated interconnect cable assembly.
	Defective power supply tube V8 or V9.	Check to see that the voltage at pin a of tube V7 is 250 volts. Adjust variable rsistor R75 (fig. 6-6) if necessary until the 250-volt reading is obtained Check the power supply circuit (para 6-4).
	Defective oscillator tube V1, V2, or V8.	Check tubes and replace if defective
	Defective voltmeter tube V4 or V5.	Check tubes and replace if defective.
	Defective meter dM1 - - - - - - - - -	Replace if defective
	Vtvm circuit not adjusted properly.	Adjust vtvm circuit (para 7-7b),
	Defective switch contacts on S1, S2, S3, or S5.	Check switches. Clean contacts, Check for broken wires. Replace defective parts.
	DC bias circuit defective - - - - - - -	Check bias circuit (para 8-5).

Symptom	Probable trouble	Correction
External bolometer connectd to input connector J1. Meter needle deflects to left of 0 MW and cannot be zero set (para 3-3).	Defective bolometer - - - - - - - - - - - - -	In the AN/URM-98, check the bolometer (figs 7-1 and 7-2 and paras 7-3 and 74). Replace if defective. In the AN/URM-98A, check the bolometer (fig. 9-6 and 9-7 and para 9-8 and 9-9). Replace if defective. Check associated interconnect cable assembly.
	Defective resistor R64 pr R65 _ _ _	Check resistors and replace if defective (figs 7-7 and 6-8).
	Defective power supply tube V6 or V7.	Check tubes and replace if defec- ttive. Check power supply circuit (para 6-4).
	Variable resistor R63 or R58 not adjusted properly.	Check adjustment of variable resistors (para 7-7b.)
	Defective switch S1, S2, S3, or S5.	Cheek switches, Clean contacts Check for broken wires. Replace defective parts.
	ZERO SET control variable resistor R30 or R33 defective.	Check variable resistors Replace if defective,
	Dc bias circuit defective - - - - - - -	Check bias circuit (para 8-5).

6-6. Dc Resistances of Transformers and coils

The dc resistances of the transformers and coils in Summation Bridge TS-779(*)/U are listed below. Readings are taken with power disconnected. The normal resistance of replacu- ment transformers and coils may differ greatly from the values given in the chart.

Transformer or coil	Terminals	Ohms
T1 - - - - - - - - - -	1-2	8.96.
	8-4	126.5.
	4-5	126.6.
	6-7	Continuity.
	8-9	9.05.
	10-11	Continuity.
	12-13	Continuity.
L1 - - - - - - - - - - -	1-2	165.0.
L2 --- - - - - - - - - -	1-2	228.0.

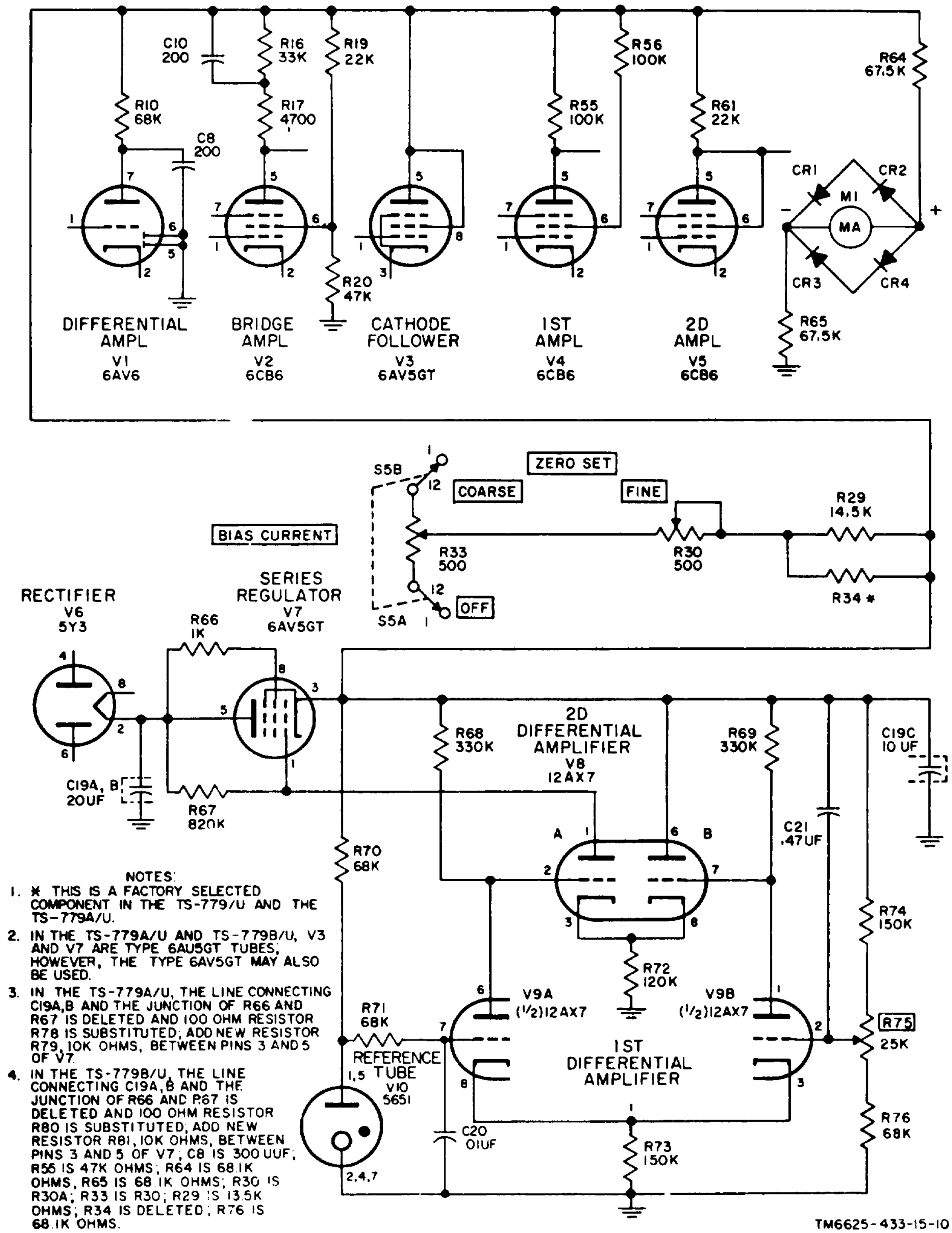
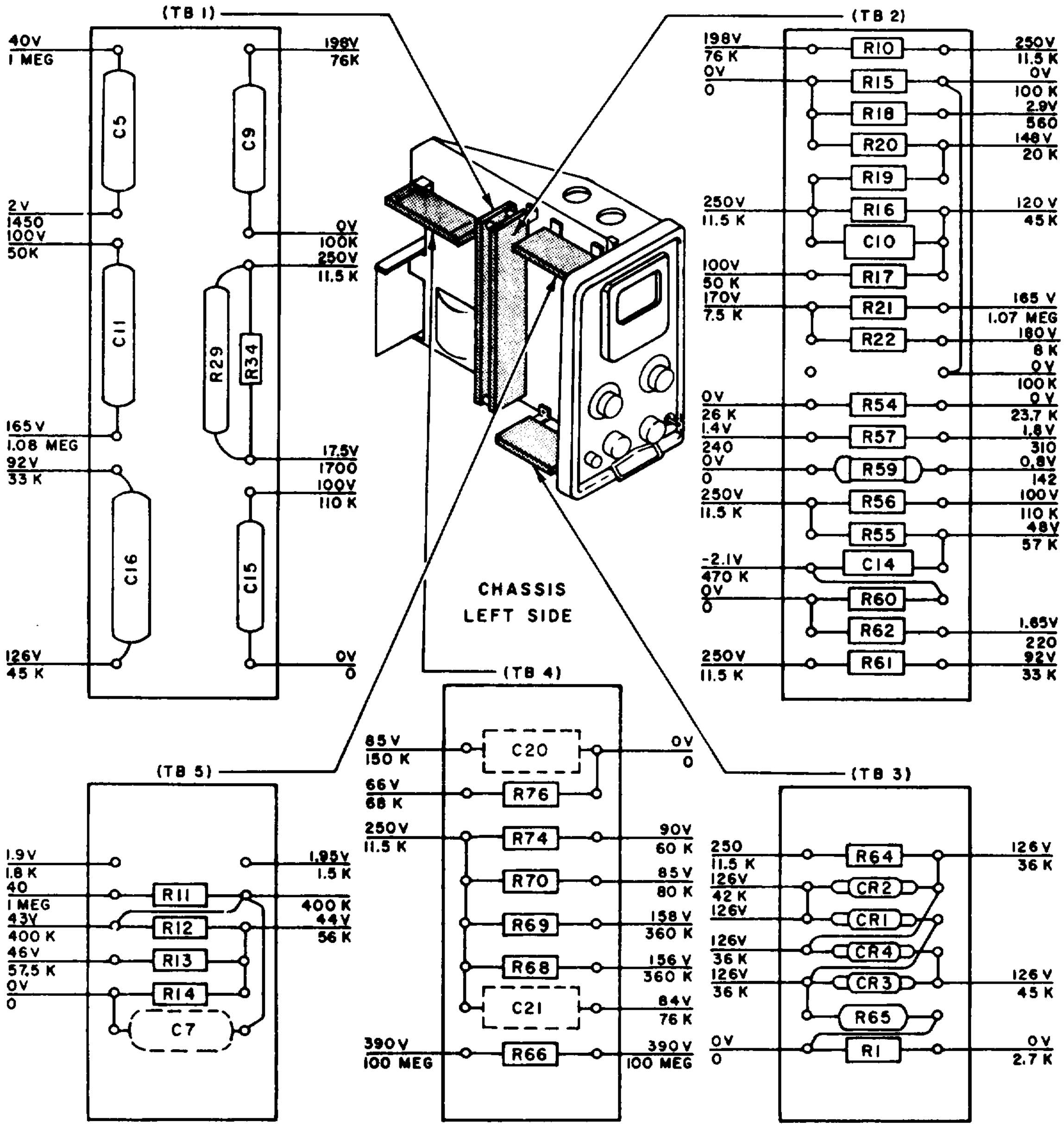


Figure 6-1. Summation bridge, B+ voltage distribution.



NOTES:

1. ALL VOLTAGES AND RESISTANCES MEASURED TO GROUND USING A 20,000 OHMS PER VOLT METER. RESISTANCES IN OHMS. ALL VOLTAGES DC UNLESS OTHERWISE SPECIFIED. K=1,000 MEG=1,000,000

2. PANEL CONTROLS SET AS FOLLOWS:
   - [BIAS CURRENT] TO [6-10MA] (S5, TERMINAL NO. 5)
   - [POWER RANGE] TO [1.0MW]
   - [COEF.] TO [NEG.]
   - [RES.] TO [200]
   - [ZERO SET]
     - [COARSE] TO FULL CLOCKWISE
     - [FINE] TO FULL CLOCKWISE

3. BOLOMETER [THERMISTOR TYPE-200 OHM) CONNECTED TO INPUT CONNECTOR J 1.

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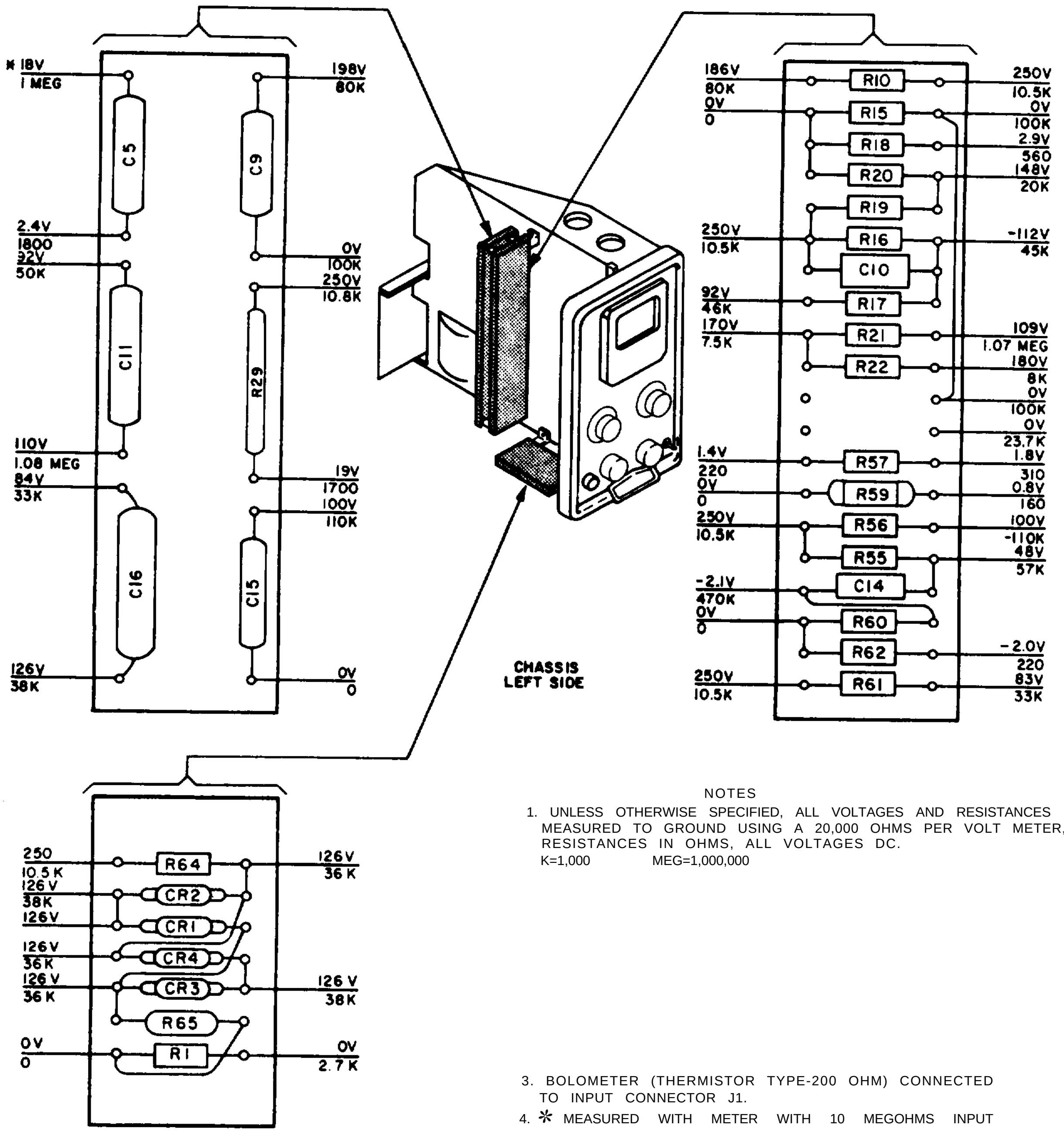
Figure 6-2. Test Sets, Radio Frequency Power TS-779/U and TS-779A/U; terminal board voltage and resistance diagram.



NOTES
1. UNLESS OTHERWISE SPECIFIED, ALL VOLTAGES AND RESISTANCES MEASURED TO GROUND USING A 20,000 OHMS PER VOLT METER, RESISTANCES IN OHMS, ALL VOLTAGES DC.
K=1,000 MEG=1,000,000

3. BOLOMETER (THERMISTOR TYPE-200 OHM) CONNECTED TO INPUT CONNECTOR J1.
4. * MEASURED WITH METER WITH 10 MEGOHMS INPUT IMPEDANCE.

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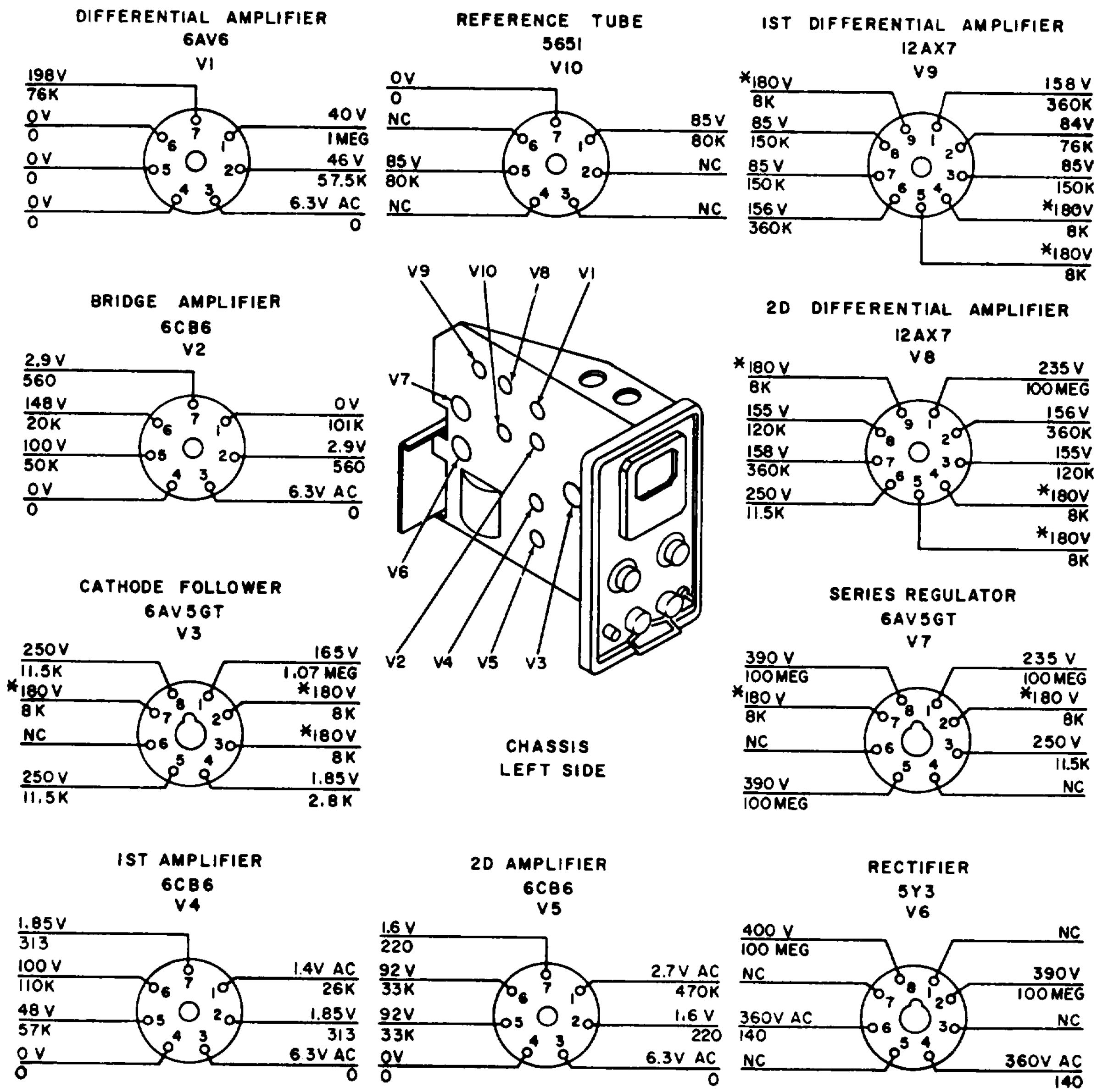
Figure 6-3. Test Set, Radio Frequency Power TS-779B/U, terminal board voltage and resistance diagram.



NOTES:

ALL VOLTAGES AND RESISTANCES MEASURED TO GROUND USING A 20,000 OHMS PER VOLT METER. RESISTANCES IN OHMS ALL VOLTAGES DC UNLESS OTHERWISE SPECIFIED. K=1,000 MEG=1,000,000

PANEL CONTROLS SET AS FOLLOWS:

BIAS CURRENT TO 6-10MA (S5, TERMINAL NO. 5)
POWER RANGE TO 10MW
COEF. TO NEG
RES TO 200
ZERO SET
COARSE TO FULL CLOCKWISE
FINE TO FULL CLOCKWISE

3. BOLOMETER (THERMISTOR TYPE-200 OHM) CONNECTED TO INPUT CONNECTOR J1.

4. * 6.3V AC BETWEEN PINS 5-9 AND 4-9 OF V8 AND V9, BETWEEN PINS 2-7 OF V3 AND V7, AND 3-7 OF V3.
5V AC BETWEEN PINS 2-8 OF V6

5. IN THE TS-779A/U, V3 AND V7 ARE TYPE 6AU5GT TUBES, HOWEVER, THE TYPE 6AV5GT MAY ALSO BE USED.

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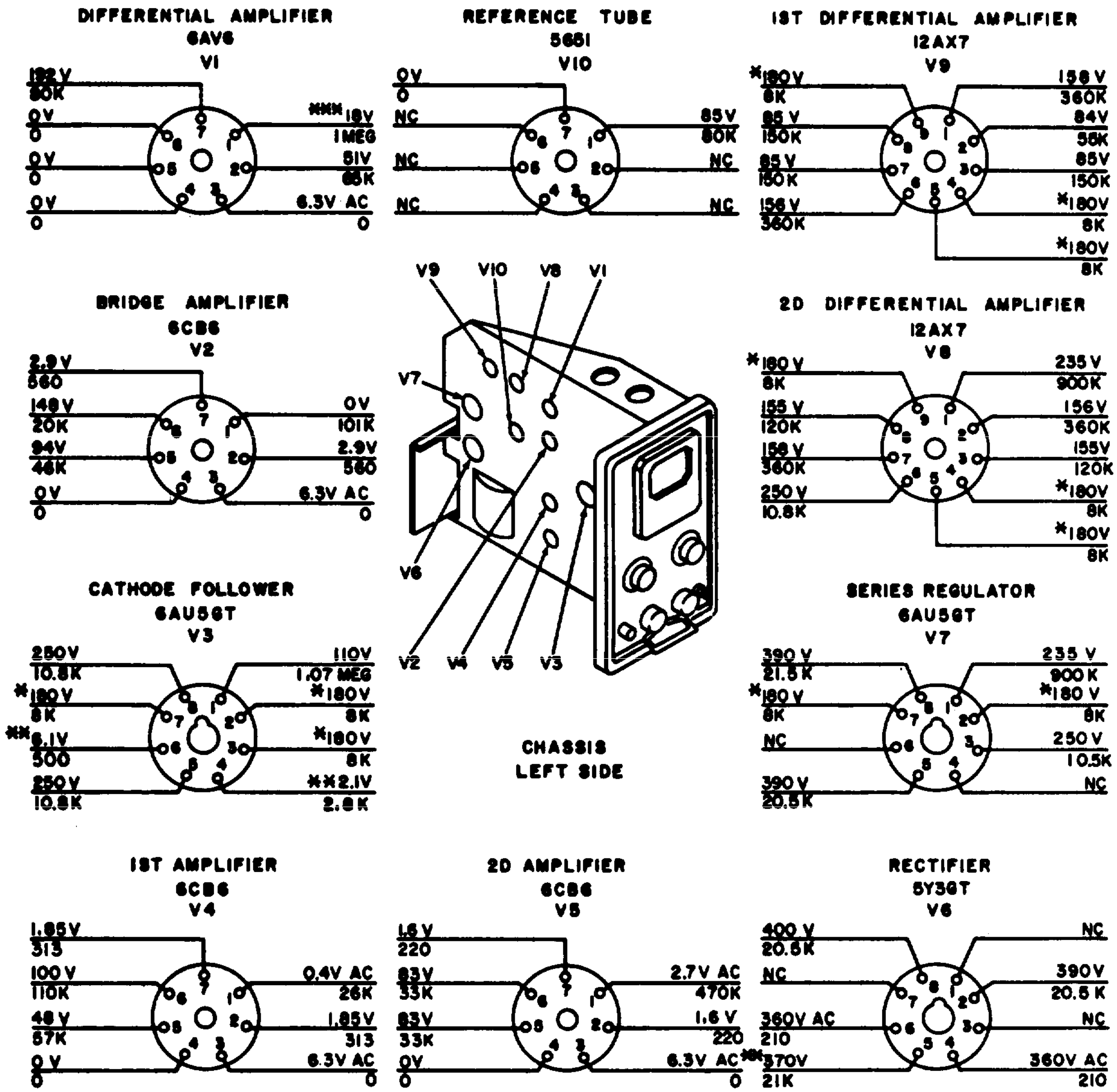
Figure 6-4,. Test Sets, Radio Frequency Power TS-779/U and TS-779A/U, tube socket voltage and resistance diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL VOLTAGES AND RESISTANCES MEASURED TO GROUND USING A 20,000 OHMS PER VOLT METER, RESISTANCES IN OHMS, ALL VOLTAGES DC. K=1,000 MEG=1,000,000

2. PANEL CONTROLS SET AS FOLLOWS:

   BIAS CURRENT RANGE TO 6-10 (S5, TERMINAL NO. 5)

   POWER RANGE TO 1.0 MW

   BOLO TEMP COEF TO NEG

   BOLO RES TO 200 Ω

   ZERO SET

   - COARSE TO FULL CLOCKWISE
   - FINE TO FULL CLOCKWISE

3. BOLOMETER (THERMISTOR TYPE-200 OHM) CONNECTED TO INPUT CONNECTOR J1.

4. * 6.3V AC BETWEEN PINS 5-9 AND 4-9 OF V8 AND V9. BETWEEM PINS 2-7 Of V3 AND V7, AND 3-7

   5V AC BETWEEN PINS 2-8 OF V6.

5. ** TIE POINT, NOT CONNECTION TO TUBE.

6. *** MEASURED WITH METER WITH 10 MEGOHMS INPUT IMPEDANCE

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Figure 6-5. Test Set, Radio Frequency Power TS-779B/U, tube socket voltage and resistance diagram.

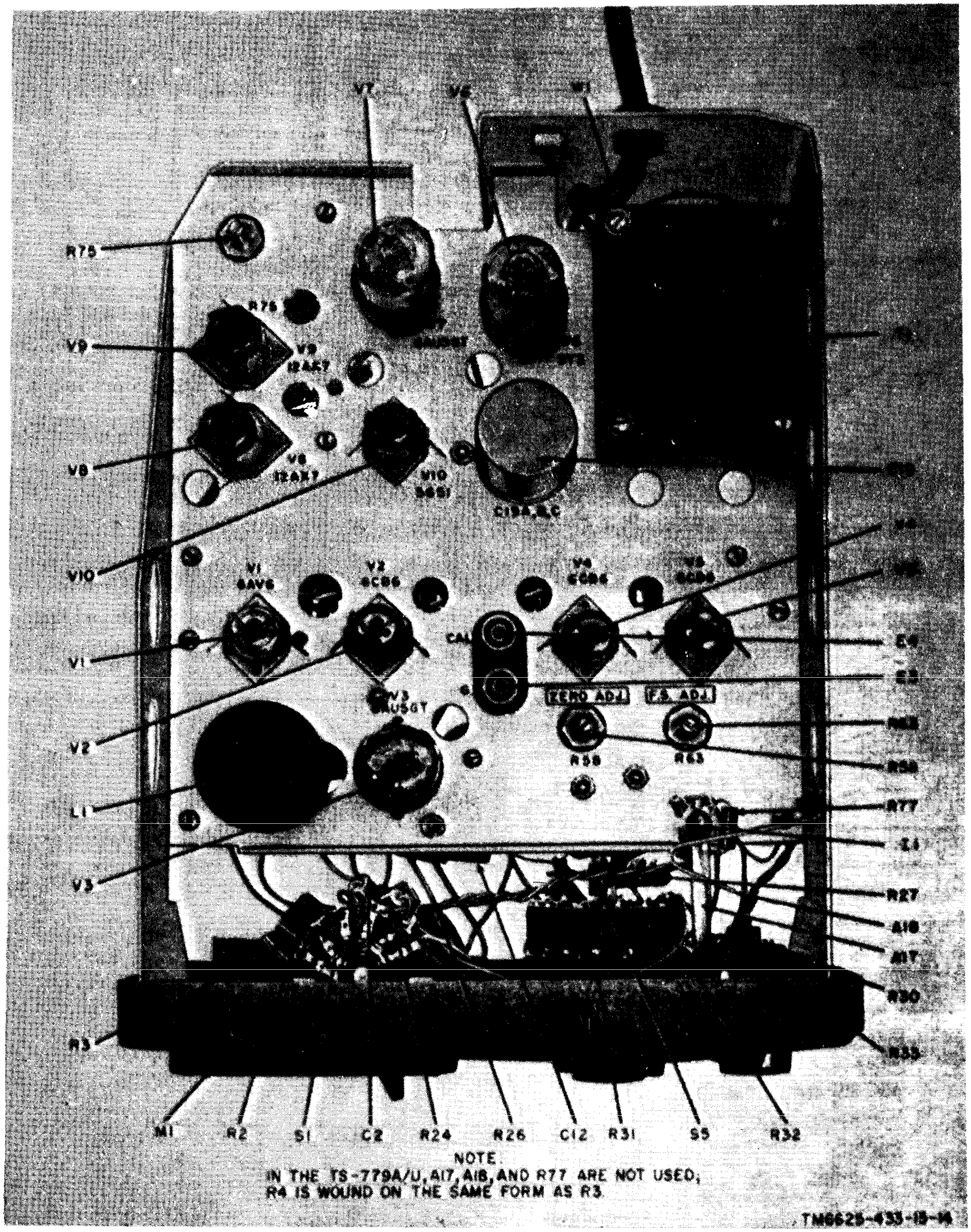


Figure 6-6. Test Sets, Radio Frequency Power TS-779/U and TS-779A/U, right-side view of chassis.

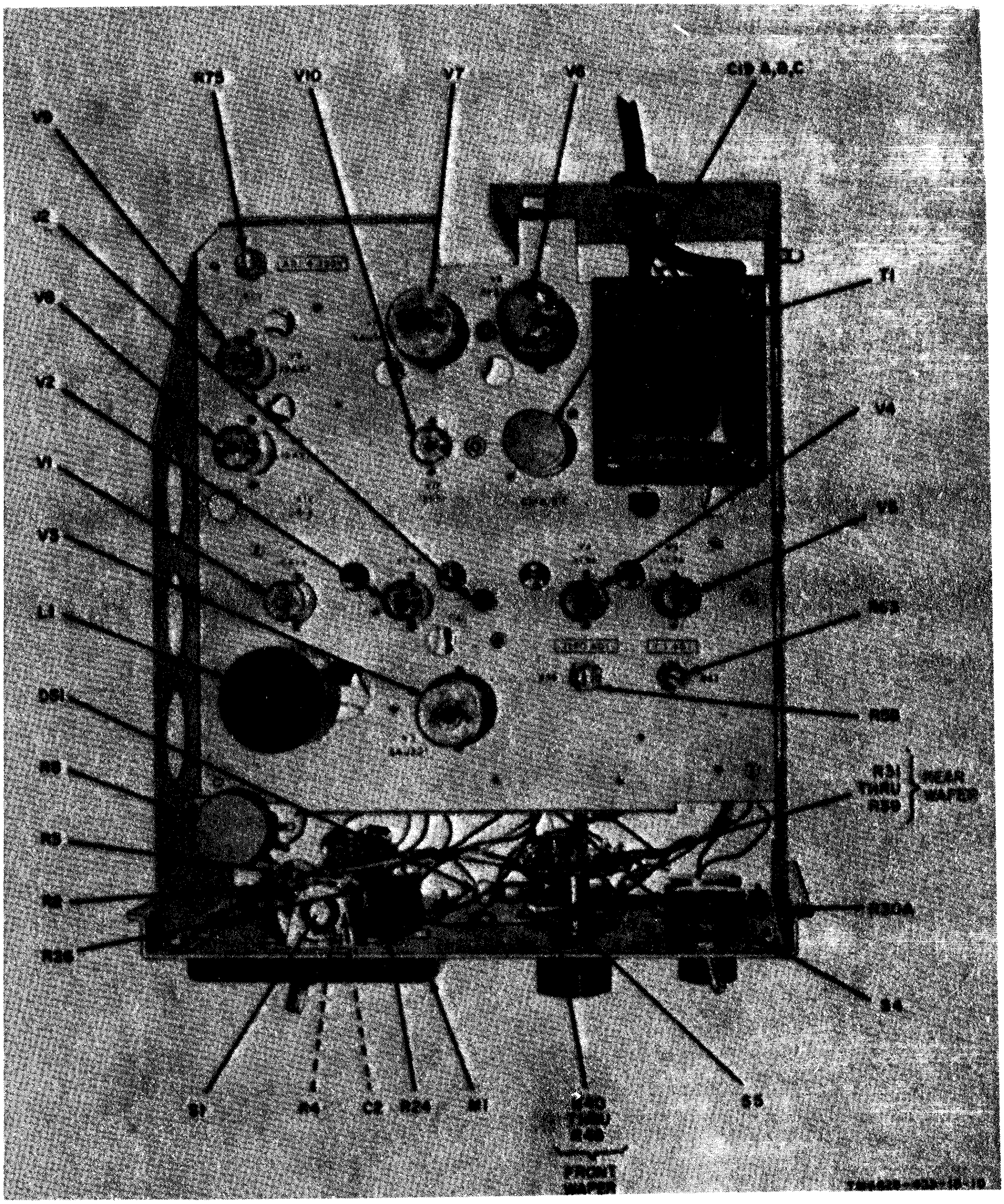


Figure 6-7. *Test Set, Radio Frequency Power TS-779B/U, right-side view of chassis.*

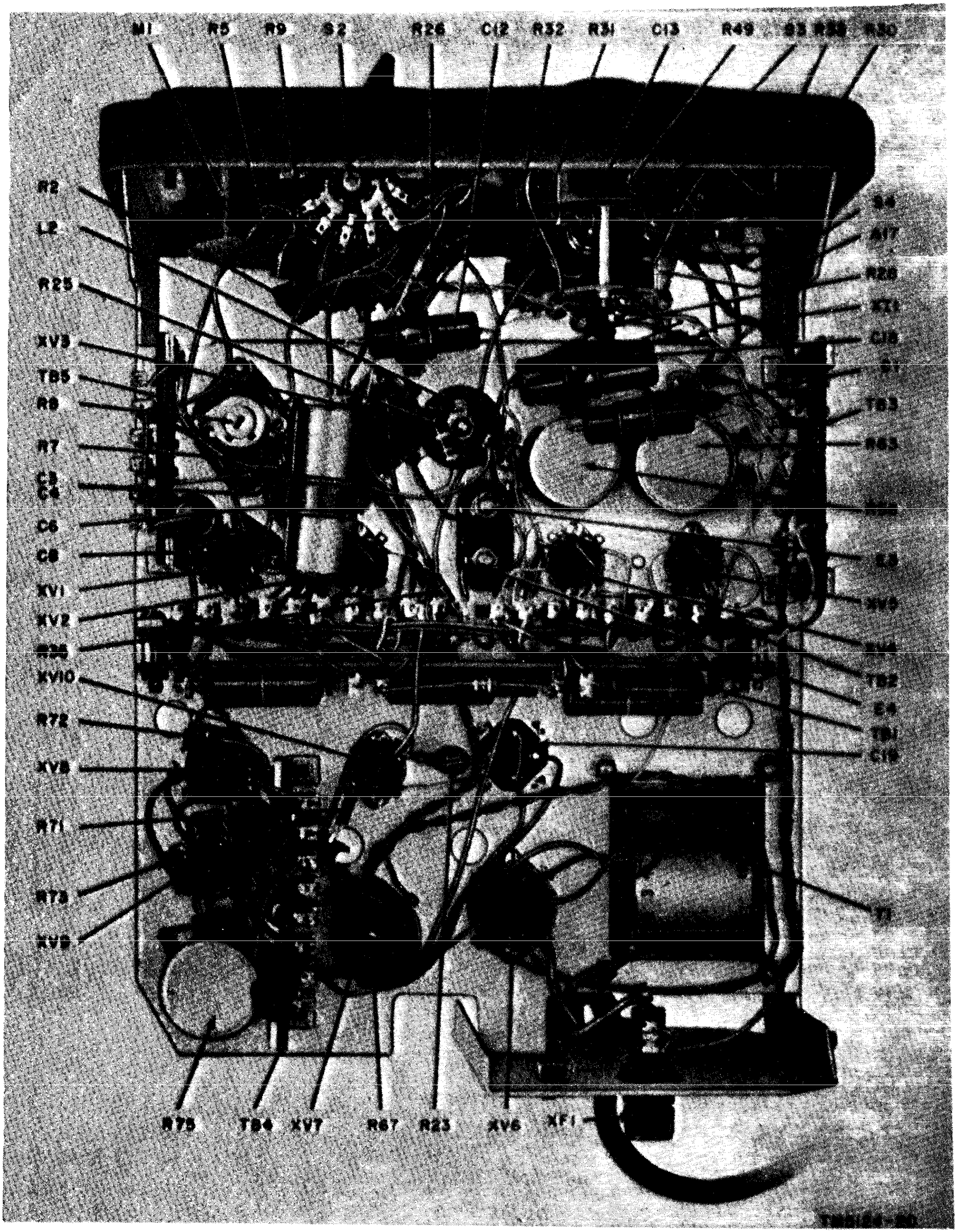
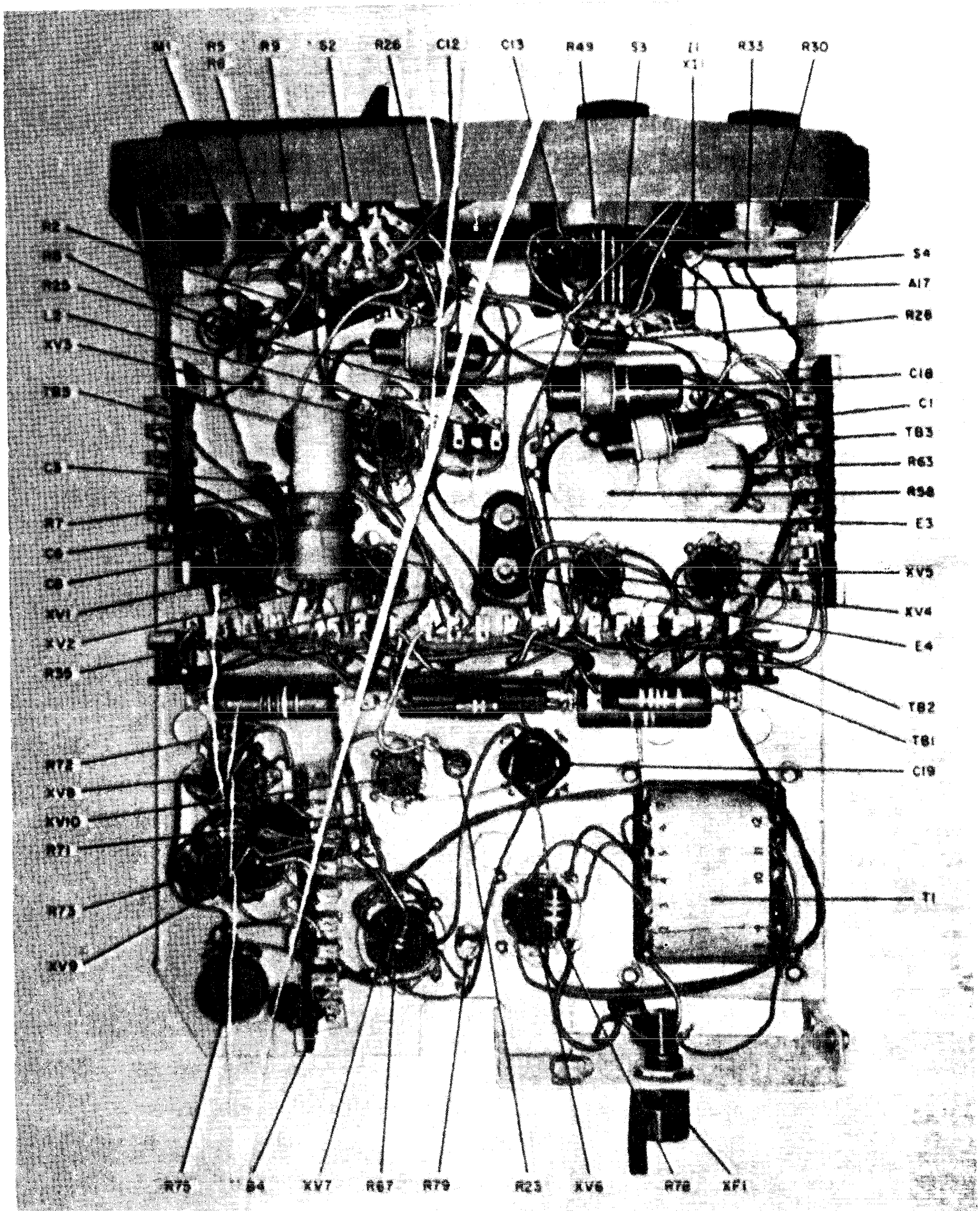


Figure 6-8. Test Set, Radio Frequency Power TS-779/U, left-side view of chassis.



TM 5124-CI-8

Figure 6-9. Test Set, Radio Frequency Power TS-779A/U, left-side view of chassis.

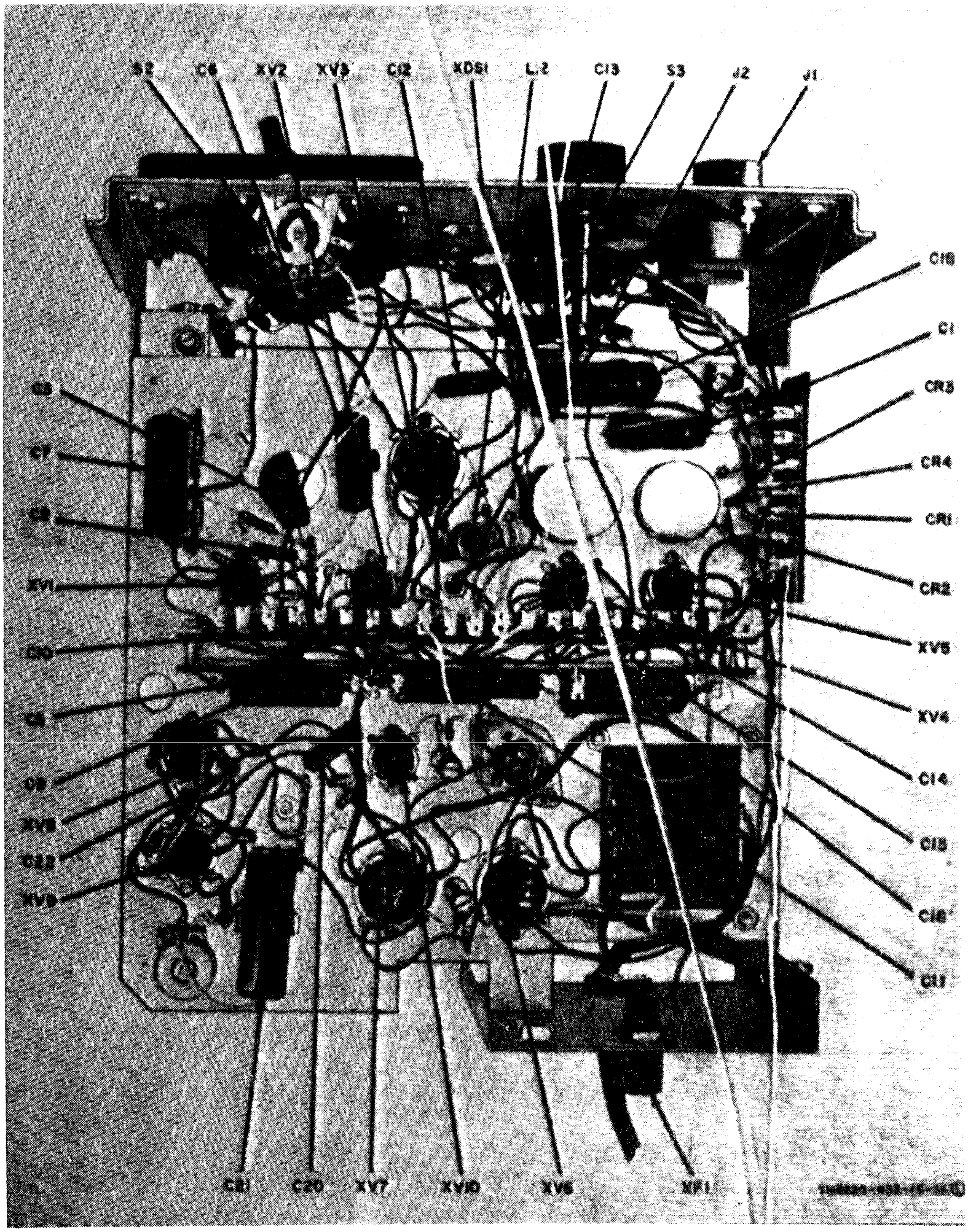


Figure 6-10 (1). Test Set, Radio Frequency Power TS-799B/U left-side view of chassis (part 1 of 2).

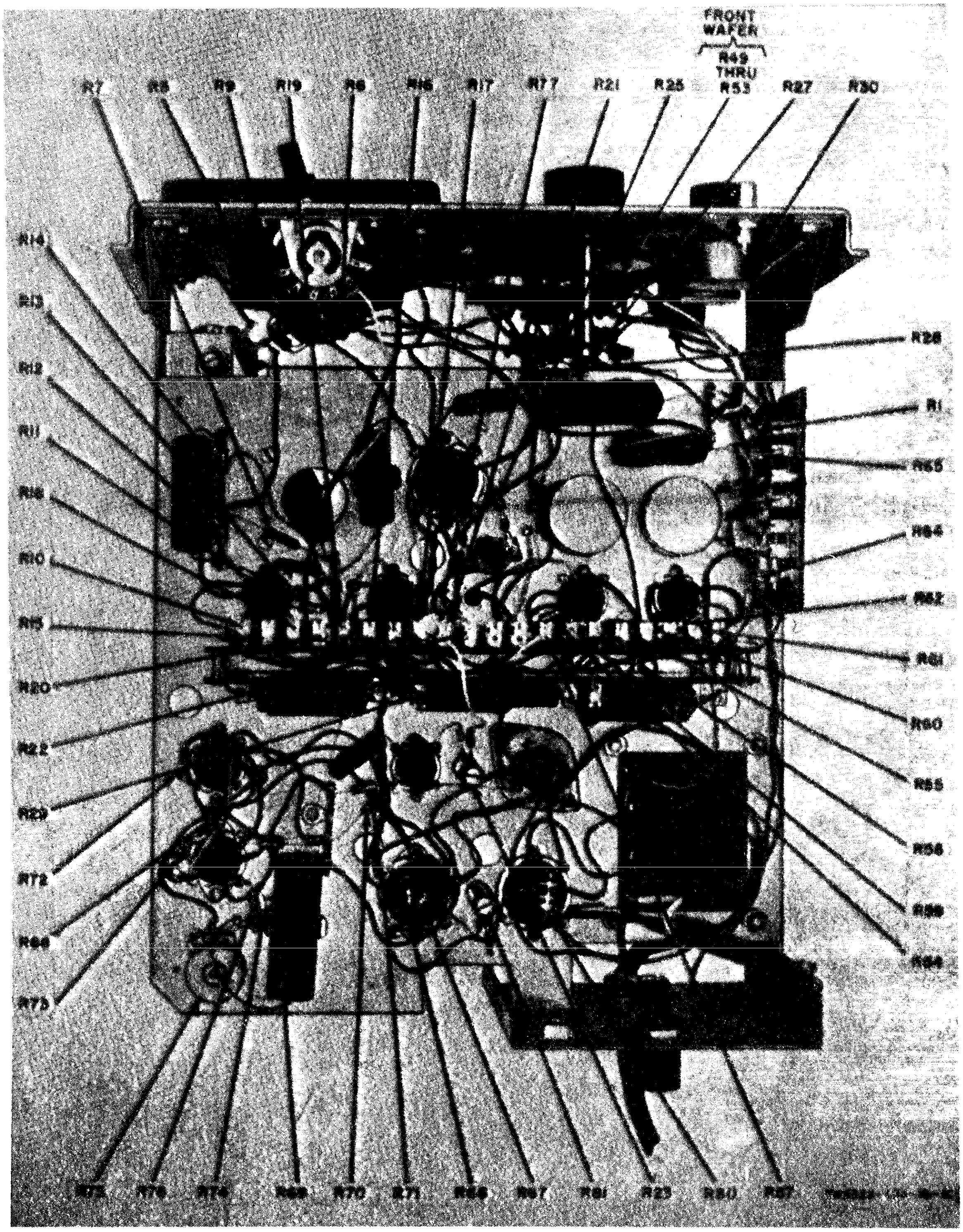


Figure 6-10 (2). Test Set, Radio Frequency Power TS-779B/U, left-side view of chassis (part 2 of 2).

CHAPTER 7

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Note. No direct support is authorized for this equipment.

Section L REPAIRS

7-1. General Precautions

Observe the following precautions carefully when servicing the wattmeter:

a. Be careful when the summation bridge is removed from the housing; dangerous voltages are exposed.

b. If the summation bridge has been operating for some time, use a cloth when removing metal tube clamps and a tube puller to remove the tubes to prevent burning the hand or fingers.

c. When servicing the chassis assembly, do not disturb the settings of the variable resistors located on the chassis R8, R58, R63, and R75 (figs. 6-6 through 6-10).

d. Do not overtighten screws when assembling mechanical couplings.

e. When changing a component that is held by screws, always replace the lockwashers.

f. Careless replacement of parts often makes new faults inevitable. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a power transformer, has a number of connections, tag each lead.

(2) Be careful not to damage other leads by pushing or pulling them out of the way.

(3) Do not use a large soldering iron when soldering small resistors or ceramic capacitors. Overheating of the small parts may ruin the component or change its value.

(4) Do not allow drops of solder to fall into parts of the chassis because they may cause short circuits.

(5) A carelessly soldered connection may create new faults. It is important to make well-soldered joints because a poorly soldered joint is one of the moat difficult faults to find.

(6) Replace parts in the circuit in exactly the same position occupied by the original part. A part that has the same electrical value but different physical size may cause trouble. Give particular attention to proper grounding when replacing a part; use the same ground as in the original wiring. Failure to observe these precautions may result is decreased output or parasitic oscillations.

(7) *Do not disturb* any of the alignment adjustments unless it definitely has been determined that the trouble is caused by an adjustment.

7-2. Replacement of Parts

Note. In the TS-779/U and TS-779A/U, several parts used have smaller tolerances than those used in most electronic equipments. Resistors R4 and R34 are precision parts. If these parts require replacement, use a part of the *exact* value of the part removed. If parts with slightly different values are used, the calibration of the summation bridge will be inaccurate. In the TS-779B/U, resistors R2 through R7, R9, R29, R49 through R53, R64, R65, R74, and R76 are precision parts. Use of the *exact* value of the part removed when replacing any of these resistors.

a. The components of Wattmeter AN/URM-98(*) are easily reached and replaced if found faulty. The transformer, reactors, and terminal boards are mounted securely to the chassis with hexagonal nuts and machine screws.

b. If any of the switch wafers require replacement, carefully mark the wires connected to the wafer with tags to avoid disconnection when the new switch is installed. Follow this practice whenever replacement requires the disconnection of numerous wires.

c. All knobs are secured by a setscrew. The knobs must be put on in the correct position so that they point in the right direction in relation to the controls they are turning. When removing a knob, make a note of the position of the pointer and shaft and replace the knob in the same position.

d. When replacing R31 in the TS-779/U and TS-779A/U, the trial and error method must be used. Select a resistor from those listed on figure 10-5 and attempt to zero the unit as described in paragraph 3-3. If the unit cannot be zeroed, try another resistor.

7-3. Disassembly and Reassembly of Waveguide Probe MX-2144/U

a. Disassembly. To disassemble Waveguide Probe MX-2144/U (fig. 7-1), follow the procedures in (1) through (7) below.

(1) The input connector (J101) is secured in plastic housing 0 106 by O-ring, 0 103. To remove connector J101 from the housing, grasp the housing firmly with one hand and the connector with the other hand and pull apart.

(2) If it is difficult to separate the connector and the housing, secure a type N female connector in a vise and screw connector J101 on it. Grasp the housing firmly and pull it away from the connector.

(3) When connector J101 is removed from the housing, it releases spring 0 105.

(4) Unscrew knurled nut E102 from conductor housing 0 101 and lift out washers E104 and E103, capacitor C102. and contact 0 102.

(5) Hold connector J101 with a 5/8-inch open-end wrench. Use another 5/8-inch open-end wrench to unscrew conductor housing 0 101.

(6) Unscrew E105 and remove thermistor assembly RT101 and capacitor C101.

(7) Hold housing 0 106 firmly and unscrew connector J102. Use a pair of pliers gently to loosen the connector. This releases nut E101.

b. Reassembly. Reassemble the MX-2144/U as follows:

(1) Place nut E101 in housing 0 106. The nut has four detents in the head that fit into molded ridges inside the housing.

(2) Place spring 0 104 over the contact end of connector J102. Insert the connector through the hole in the housing and screw it into nut E101. Tighten firmly, but be careful not to crack the plastic housing.

(3) Place thermistor assembly RT101 over the end of capacitor C101 and secure it with screw E105.

(4) Place capacitor C101 into the externally threaded end of connector J101. Screw conductor housing 0 101 onto connector J101 and tighten securely.

(6) Place capacitor C102 over the end of contact 0 102 and place the conductor, larger end first. into the conductor housing 0 101.

(6) Place split washer E103 over the protruding end of contact 0 102 followed by fiat washer E104.

(7) Screw nut E102 into conductor housing 0 101.

(8) Place spring 0 105 in housing 0 106. Press connector J101 into the-housing until the O-ring snaps into the groove inside the housing.

7-4. Disassembly and Reassembly of Bolometer, Radio Frequency MX-2144A/U

a. Disassembly. To disassemble Bolometer, Radio Frequency MX-2144A/U (fig. 7-2),

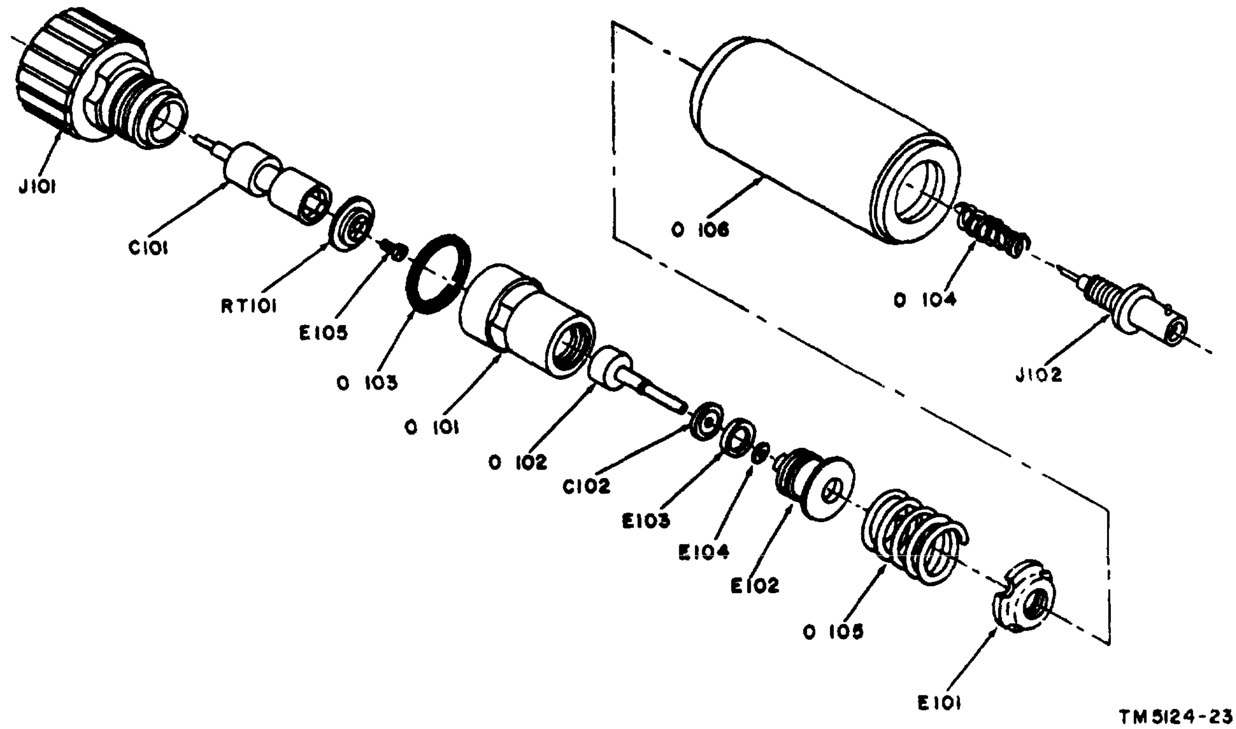


Figure 7-1. Waveguide Probe MX-2144/U.

follow the procedure given in (1) through (6) below.

(1) The input connector (J101) is secured in plastic housing 0106 by O-ring 0103. To remove connector J101 from the housing, attach J101 to a rigidly held, mating type N-connector. Grasp the housing firmly and pull the housing straight off the connector. If hand strength is insufficient provide a fulcrum and pry the housing off evenly from both sides; use two screw-drivers as levers.

Note. When connector J101 is removed from the housing, it releases spring 0106 and washer E104.

(2) With a No. 4 Allen wrench, remove retaining screws H1 and conductor housing MP1.

(8) Reach into the removed conductor housing MP2 and pull out contact 0102 with capacitor C102 and washer E103. Keep these parts together and absolutly clean.

(4) Loosen screw E106 two turns, grip connector J101 with an 11/16-inch end wrench, and unscrew conductor housing MP2 with a 5/8-inch end wrench.

(6) Unscrew E106 and lift thermistor assembly RT101 off connector J101; be careful to not damage the thermistor assembly. Capacitor C101 is not removable from J101.

(6) Hold housing 0106 firmly and unscrew connector J102.

b. Reassembly. Reassemble the MX-2144A/U as follows:

(1) Place thermistor assembly RT101 flat side down on connector J101 and turn screw E105 into threads but do not tighten.

(2) Start threading conductor housing MP2 onto connector J101; look into the conductor housing to be sure that the thermistor assembly does not touch the conductor housing at any

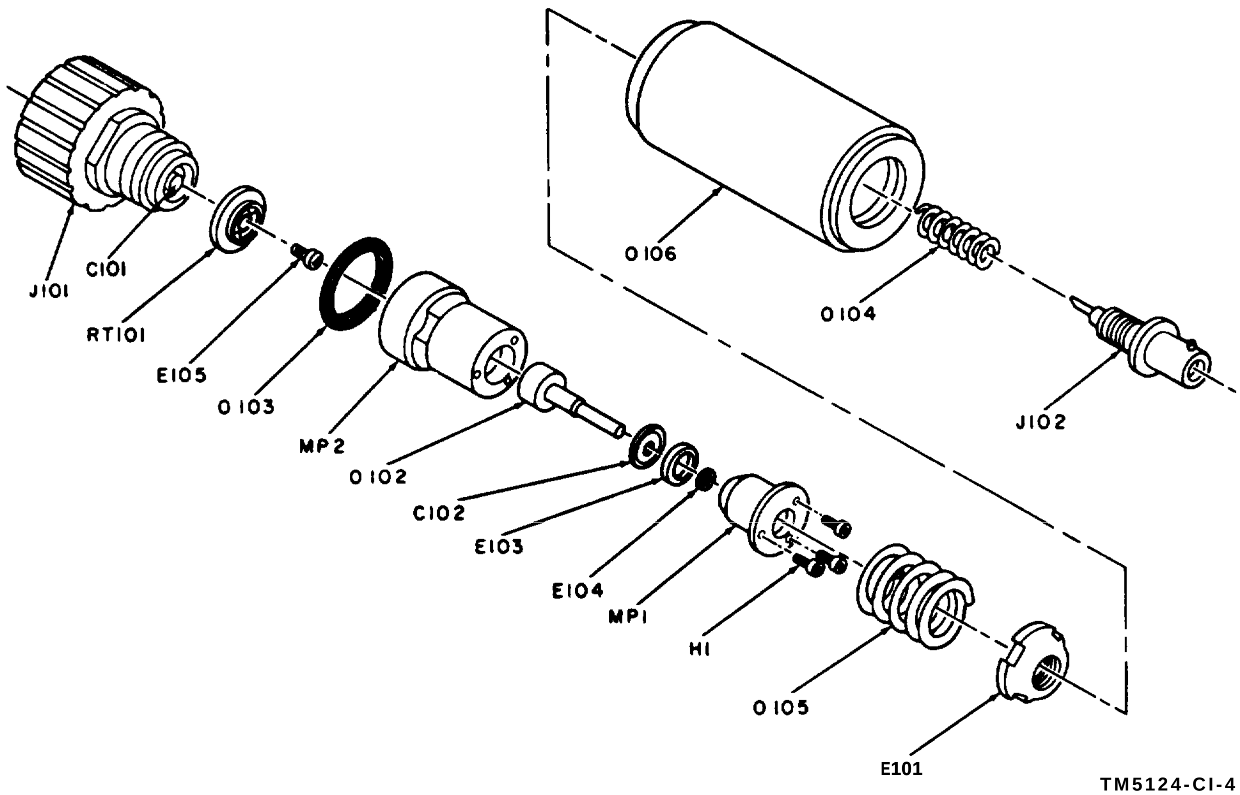


Figure 7-2. Bolometer, Radio Frequency MX-2144A/U.

point If the housing touches the assembly, loosen MP2 and shift the position of the thermistor assembly.

(3) When the conductor housing can be threaded onto J101 without touching the thermistor assembly, tighten the housing onto J101 with the wrenches specified in a(4) above.

(4) After making sure that the thermistor assembly is centered in the conductor housing, tighten screw E105.

(5) Place capacitor C102 and washers E103 and E104 on contact 0102 with the fully tinned side of C102 against contact 0102.

(6) Make sure that contact 0102 is absolutely free of any particles or dirt; slip 0102 with capacitor and washers into the conductor housing MP2; be very careful to prevent hitting the insulated outer edge of the contact on the side of the housing,

(7) Use an ohmmeter of a high enough range to limit its current to 1 milliampere maximum and measure the resistance between 0102 center and MP2. This resistance should be between 9,000 and 4,600 ohms. If the resistance is infinte, a thermistor is damaged, and the thermistor assembly must be replaced, or E106 is loose. If the resistance is 0, the insulation around 0102 is damaged and must be wound with 0.002-inch thick mylar tape, or RT101 is shorted to MP2 and must be recentered as instructed in (2) above.

(8) Fit MP1 into MP2 and secure with screws H1. Tighten the screws even! y so that the airgap is the same all

around; be careful not to crack C102 by excessive tightening.

(9) With nut E101 in housing 0106, install J102 with spring 0104 attached, Tighten J102 securely,

(10) Moisten O-ring 0103 on J101; press housing 0106 onto J101 by squeezing between the hands. When the O-ring snaps into the groove in J101, the assembly is complete.

7-5. Disassembly and Reassemble of Bolometers; R.F. MX-2144B/U and MX-2144C/U

a. Disassemble. Disassemble Bolometer, R. F. MX-2144B/U (fig. 7-3), as follows:

Note. It is necessary to disassemble only to the extent necessary to replace a defective part. *For example,* it is not necessary to disassemble the front body (10) ((3) through (13) below), to replace a defective BNC receptacle (18), which is a part of the rear body assembly (29).

(1) Remove the three machine screws (1) and separate the rear body assembly (29) from the front body assembly (lo).

(2) Remove the bolometer card (2) from the front body assembly (10) by sliding the bolometer card off the two headless straight pins (15).

(3) Using a hacksaw, cut through the rear portion of the coupling nut (3) and remove and discard the coupling nut. The rear portion of the coupling nut is the part closest to the front body (lo).

(4) Remove the gasket (4) and the flat washer (5) from the electrical connector plug (8).

(5) Press out the headless straight pin (6) from the electrical connector plug (8).

(6) Withdraw the conductor assembly (7) from the front body (10).

Note. Do not perform the next two steps if the disassembly procedure is being performed to replace a defective fixed ceramic dielectric capacitor (13).

(7) Pry off the electrical connector plug (8) from the front body (10).

(8) Remove the type N bead (9) from the electrical connector plug (8).

(9) Withdraw from the electrical contact (11) the remainder of the conductor assembly (7).

(lo) Unsolder the front conductor (12) from the fixed ceramic dielectric capacitor (13).

(11) Unsolder the rear conductor (14) from the fixed ceramic dielectric capacitor (13).

(12) Pry out the two headless straight pins (15).

(19) Unscrew the two special machine screws (16) and remove the identification plate (17) from the front body (10).

(14) Unscrew the BNC receptacle (18) from the rear body (29). Unsolder the compression spring (19) from the BNC receptacle.

(15) Remove the disk capacitor, the brass adapter, the spring, and the contact. (See note 1, fig, 7-3.)

(16) Punch out the insulator (21) from the rear body (29). It is glued in place and may have to be drilled out.

(17) Pry out the retainer (22).

(18) Remove the plunger (23) and the compression spring (24).

(19) Unscrew the machine screw (27).

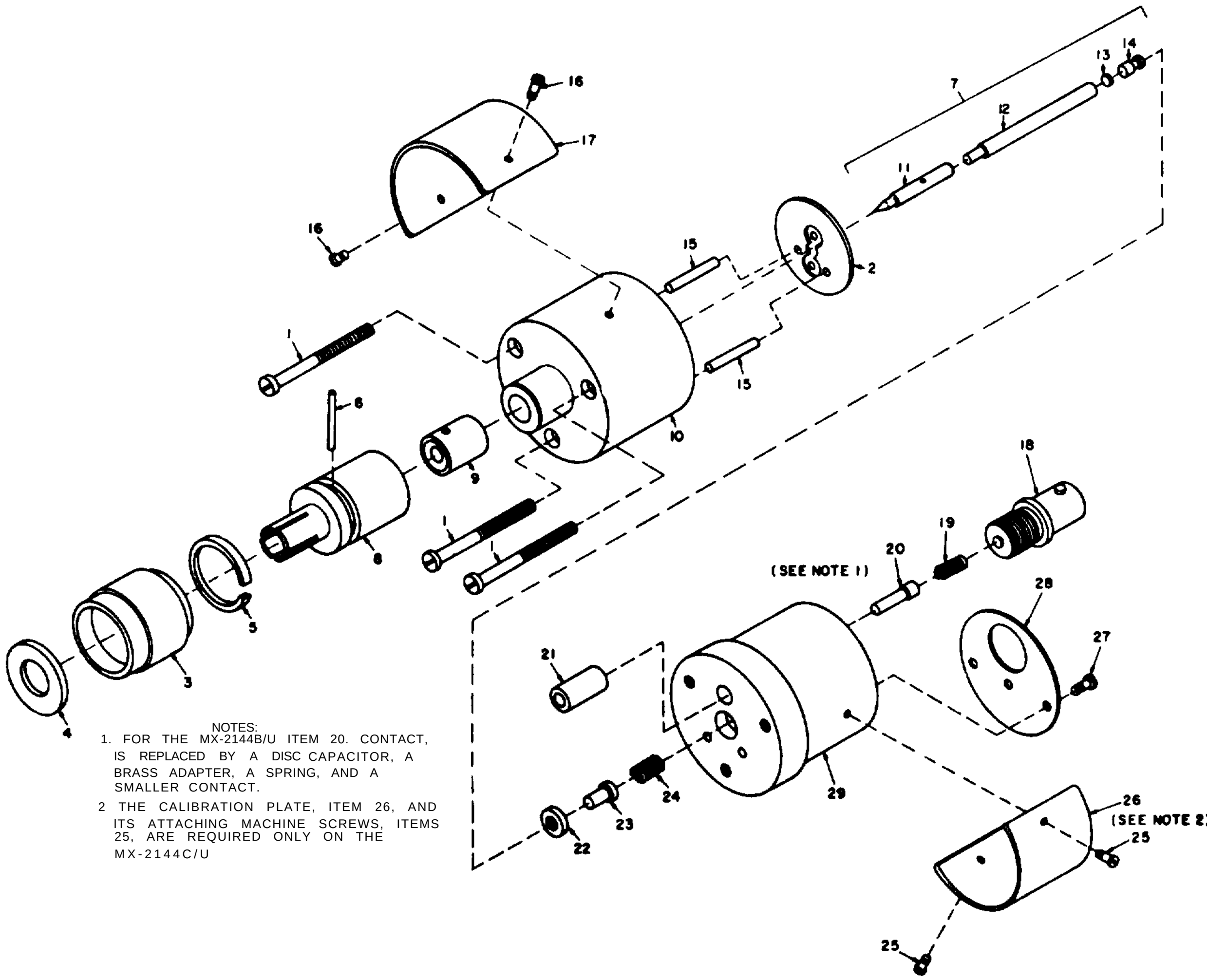
(20) Remove the nameplate (28) from the rear body (29).

b. Reassembly. Reassemble the MX-2144B/U and MX-2144C/U as follows:

(1) Press the type N bead (9) into the electrical connector plug (8). Insure that the holes in both items are aligned. To use a new type N bead, insert it into the electrical connector plug, and, with a 1/16-inch drill bit, drill through the old hole in the electrical connector plug. To use a new electrical connector plug, also use a new type N bead. In this case, make a 1/16-inch hole through both new items.

(2) Press the electrical connector plug onto the f rent body (10).

(3) Solder a new fixed ceramic dielectric capacitor (13) onto the front conductor (12).



NOTES:
1. FOR THE MX-2144B/U ITEM 20. CONTACT, IS REPLACED BY A DISC CAPACITOR, A BRASS ADAPTER, A SPRING, AND A SMALLER CONTACT.
2 THE CALIBRATION PLATE, ITEM 26, AND ITS ATTACHING MACHINE SCREWS, ITEMS 25, ARE REQUIRED ONLY ON THE MX-2144C/U

LEGEND

1. MACHINE SCREW, 4-40BY 1.3 IN USE
2. BOLOMETER CARD
3. COUPLING NUT
4. GASKET
5. FLAT WASHER
6. PIN, STRAIGHT, HEADLESS, 0.580 BY 0.055
7. CONDUCTOR ASSEMBLY
8. ELECTRICAL CONNECTOR PLUG
9. TYPE N BEAD
10. BODY FRONT
11. ELECTRICAL CONTACT
12. FRONT CONDUCTOR
13. FIXED CERAMIC DIELECTRIC CAPACITOR
14. REAR CONDUCTOR
15. PIN, STRAIGHT, HEADLESS, 0.438 BY 0.06,2 IN USE
16. SPECIAL MACHINE SCREW, 2 IN USE
17. IDENTIFICATION PLATE
18. SNC RECEPTACLE
19. SPRING, COMPRESSION
20. CONTACT
21. INSULATOR
22. RfTAINfR
23. PLUNOCR
24. SPRING, COMPRESSION
25. SPECIAL MACHINE SCREW, 2 IN USE
26. CALIBRATION PLATE
27. MACHINE SCREW, 2-56 BY 3/16
28. NAMEPLATE
29. BODY REAR

TM6625-433-125-17

Figure 7-3. Bolometers, R.F. MX-2144B/U and MX-2144C/U.

(4) Solder the rear conductor (14) onto the fixed ceramic dielectric capacitor (18).

(5) File away enough capacitor material to make the capacitor diameter equal the front and rear conductor diameters, Insure that no excess material remains. The resultant assembly must be a true cylinder.

(6) Press the cylinder into the electrical contact (11).

(7) Press the conductor assembly (7) into the front body (10) until the rear plane of the rear conductor (14) is

aligned with the rear plane of the front body (10). Align the. hole in the electrical contact (11) with the holes in the electrical connector plug (8) and the type N bead (9). To use a new electrical contact, also drill through the holes in the electrical connector plug and the type N bead with a 1/16-inch drill bit to make a hole in the new eletrical contact.

(8) Insert the headless straight pin (6) into the holes through the electrical connector plug (8), the type N bead (9), and the electrical contact (11).

(9) Snap the flat washer (5) into the groove of the electrical connector plug (8).

(10) Slide the gasket (4) onto the electrical connector plug (8).

(11) Compress the flat washer (5) in the groove of the electrical connector plug (8) and slide on a new coupling nut (3).

(12) Press the headless straight pins (15) in the front body (10).

(13) Using the special machine screws (16), attach the identification plate (17) to the front body (10).

(14) Insert the compression spring (24) into the rear body (29).

(15) Insert the plunger (28) in the position shown in figure 7-3.

(16) Press in the retainer (22).

(17) Apply epoxy to the insulator (21) and insert it into the rear body (29).

(18) Insert the contact and the spring, Insert the brass adapter into the disk capacitor and insert the resulting assembly, capacitor first, into the rear body (note 1, fig. 7-3).

(19) Solder the compression spring (19) onto the BNC contact (20). Screw in the resulting assembly.

(20) Using glue, apply the nameplate (28) to the rear body (29) so that the three holes are aligned with the three holes in the rear body.

(21) Screw the machine screw (27) in the THERM (NEG) hole & the nameplate (28).

(22) Slide the bolometer card (2) onto the two headless straight pins (16).

(22) Attach the rear body assembly (29) to the front body assembly (10) with the three machine screws (l).

Section II. ALIGNMENT

7-6. Test Equipment Required for Alignment

The following test equipment is requird for alignment of Wattmeter AN/URM-98(*):

Item	Technical manual
Multimeter ME-26(B)/U[a].	TM 11-6625-200-12
Transformer, Power, Variable CN-16/U.	

[a] Indicates Multimeters ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U.

7-7. Alignment Procedures

To align the summation bridge properly, the procedures in *a.* through *c* below should be followed in the sequence given. Power should be applied and the summation bridge allowed to warm up for 6 minutes before making these adjustments.

a. Regulated B+ Voltage. The regulated B+ voltage (+250 volts) contributes toward the stability of the summation bridge; therefore, it is important that this voltage be set correctly before further adjustments are made. Make this adjustment as follows:

(1) Connect the ME-26B/U between pin 3 of tube V7 and ground.

(2) Adjust resistor R75 until the ME-26B/U reads 250 volts.

(3) Vary the ac power source with the CN-16/U. Check the adjustment in (2) above while varying the voltage from 105 to 125 volts ac or 210 to 250 volts ac. The 250-volJt dc supply voltage should maintain itself throughout this line voltage range.

b. Voltmeter Circuit. Align the voltmeter circuit as follows:

(1) Connect the bolometer to input connector J1 on the summation bridge.

(2) Set the POWER RANGE (RANGE) switch to 1.0 MW

(3) Connect the CAL. vtvm to the CAL. binding post (figs. 6-6 and 6-7) located on the right-hand side of the main chassis.

(4) Adjust ZERO SET FINE and COARSE controls until the vtvm reads 0.465 volt. The meter (Ml) on the summation bridge should read zero. If the meter does not read zero, adjust ZERO ADJ, resistor R58. Resistor R58 is on the right-hand side of the main chassis (figs. 6-6 and 6-7).

(5) Adjust the ZERO SET FINE and COARSE controls until the vtvm reads 0.190 volt.

(6) Meter M1 on the summation bridge should now read full-scale.

(7) If the meter does not read full-scale, adjust F. S. ADJ. resistor R63 until the meter pointer is at full-scale deflection. Resistor R63 is located on the right-hand side of the main chassis (figs. 6-6 and 6-7).

(8) After adjusting R63, repeat the procedures in (1) through (6) above.

c. Bridge Circuit. Normally the bridge circuit does not require adjustment. It will be adjusted only if there is some doubt as to the accuracy of the results obtained in *b* above. Align the bridge circuits as follows:

(1) Turn the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch to OFF.

(2) Connect the bolometer to input connector J1 on the summation bridge.

(3) Set the COEF. POS.-NEG. [BOLO TEMP COEF POS-NEG] and RES. 200-100 [BOLO RES. 200Ω–100Ω] switches to the appropriate settings for the type of bolometer being used. (Set COEF. POS.-NEG [BOLO TEMP COEF POS-NEG] switch to NEG. and RES. 200-100 [BOLO RES 200Ω–100Ω] switch to 200 if Bolometer, Radio Frequency MX-2144(*)/U is used (para 3-3).)

(4) Set POWER RANGE (RANGE) switch to 1.0 MW.

(5) Turn the ZERO SET FINE and COARSE controls fully clockwise.

(6) In the TS-779/U and TS-779A/U, connect the vtvm to the blank terminal lug on terminal board TB5 (figs. 6-8 and 6-9) with the violet wire attached. In the TS-779B/U, connect the vtvm to the side of R2 that connects to switch S1 (fig. 6-10).

(7) Adjust the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch and ZERO SET FINE and COARSE controls until the vtvm reads 3 volts.

(8) In the TS-779/U and TS-779A/U, shift the vtvm test probe to the blank terminal lug on terminal board TBS with the green wire attached. In the TS-779B/U, shift the vtvm to the side of R4 that does not connect to switch S1. The multimeter should read 1 volt. If this reading is obtained, no adjustment is necessary.

(9) If the 1-volt reading was not obtained as instructed in (8) above, set the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch to OFF and the ZERO SET FINE and COARSE fully clockwise.

(10) Turn resistor R8 to the clockwise stop and back off one-eighth turn. Resistor R8 is located on the left-hand side of the main chassis (figs. 6-8, 6-9, and 6-10).

(11) With the vtvm connect as instructed in (6) above, advance the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] switch until the vtvm reads approximately 2 1/2 volts. Turn the ZERO SET controls FINE and COARSE counterclockwise until the vtvm reads exactly 3 volts.

(12) Connect the vtvm as instructed in (8) above and note the error from 1 volt. Adjudst resistor R8 to double the error in the same direction (that is, if the error is 1/4 volt low, adjust R8 so that the error is 1/2 volt low).

(18) Adjust the ZERO SET FINE and COARSE controls so that the vtvm reads exactly 1 volt

(14) Shift the vtvm test probe as instructed in (6) above. Adjust ZERO SET FINE and COARSE controls until the vtvm reads 3 volts.

(15) Repeat the procedure in (12) through (14) above until no error is present.

CHAPTER 8

GENERAL SUPPORT TESTING PROCEDURES

8-1. General

a. Testing procedures are prepared for use by Electronics field maintenance shops and Electronic service organizations responsible for general support of electronic repaired equipment to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment *must* meet before it is returned to the using organization. These procedures may also be used as a guide for testing equipment that has been repaired at direct support maintenance if the proper tools and test equipments are available.

b. Comply with the instructions preceding each chart before proceeding to the chart. Perform each step in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Control settings* columns; then perform each specific procedure and verify it against its performance standard.

8-2. Test Equipment Required

All the test equipment required to perform the testing procedures given in this chapter are listed in the chart in a below, and are authorized under TA 11-17 and TA 11-100 (11–17),

a. Test Equipment. Use the following equipment, or suitable equivalent.

Nomenclature	Technical manual
Resistor, Decade ZM-16/U.	TM 11-5102
Multimeter ME-26B/U.	TM 11-6625-200-12
Transformer, Power, Variable CN-16/U.	
Multimeter TS-352B/U.	TM 11-6625-366-15
Differential Voltmeter ME-202/U.	TM 11-6625-537-16

b. Materials. The only material required is Radio Frequency Cable RG-58/U (2 feet).

c. Other Equipment.

(1) Plug UG-88/U.

(2) Alligator clips (2),

8-3. Modification Work Orders

The performance standards listed in the tests (paras 8-4 through 8-6) are based on the assumption that all modifications have been performed. A listing of current modification work orders will be found in DA Pam 810-7.

8-4. Physical Tests and Inspections

a. Test Equipment and Materials. No test equipment or materials is rewired.

b. Test Conections and Conditions.

(1) No connections are necessary.

(2) Remove summation bridge chassis from its case.

c. *Procedure.*

Step No.	Control Settings		Test procedures	Performance standard
	Test equipment	Equipment under test		
1	None ---------- ----- --	Controls may be in any position - -	*a.* Inspect case and chassis for damage, missing parts, and condition of paint. *Note.* Touchup painting is recommended instead of refinishing whenever practical: screw heads, binding posts, receptacles and other plated parts will not be painted or polished with abrasives. *b.* Inspect all controls and Mechanical assemblies for loose or missing screws, bolts, and nuts. *c.* Inspect all connectors, sockets receptacles, holder, and meter for looseness, damage, or missing parts.	*a.* No damage evident or parts missing. External surfaces intended to be painted will not show bare metal. Panel lettering will be legible. *b.* Screws, bolts, and nuts will be tight. None missing. *c.* No loose parts or damage. No missing puts
2	None ----------------	Controls may be in any position - -	*a.* Rotate all panel controls throughout their limits of travel. *b.* Inspect dial stops for damage or bending, and for proper operation.	*a.* Controls wll rotate freely without binding or excessive looseness. *b.* Stops will operate properly without evidence of damage.

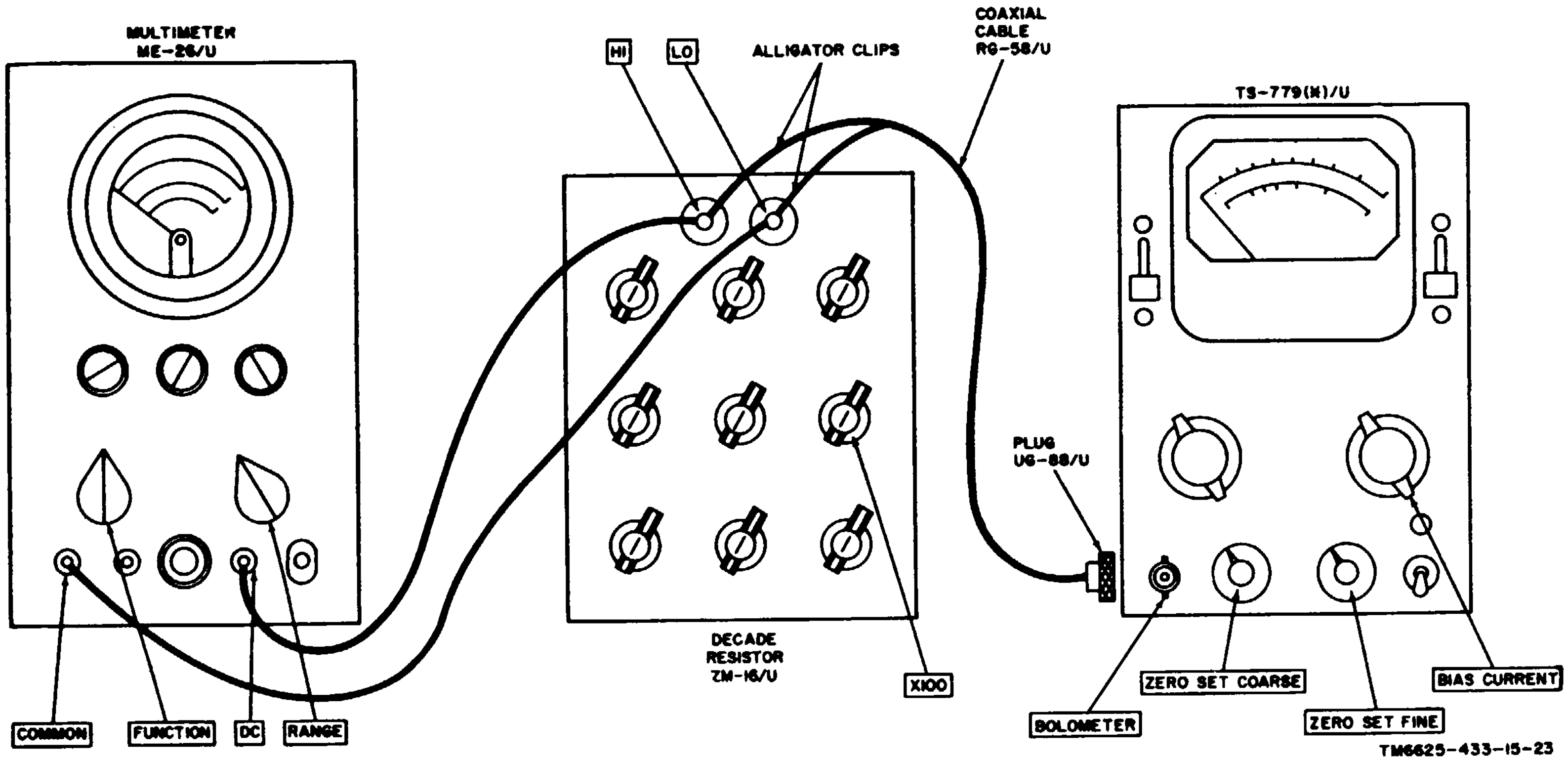


Figure 8-1. Dc bias current test connections.

8-5. Dc Bias Current Test

a. Test Equipment and Materials.

(1) Decade Resistor ZM-16/U.

(2) Multimeter ME-26B/U.

(3) Radio Frequency Cable RG-58/U (2 feet) with Plug UG-88/U and alligator clips.

b. Test Connections and Conditions. Connect the equipment as shown in figure 8-1.

c. Procedure.

Step No.	Control settings		Test procedures	Performance standards
	Test equipment	Equipment under test		
1	*ZM-16/U* *a. X100:2* *b.* Remainder: 0 *ME-26B/U* *a.*. FUNCTION: + *b.* RANGE: 3VW	*a.* BIAS CURRENT: OFF - - - - - - *b.* ZERO SET COARSE: Fully clockwise. *c.* ZERO SET FINE: Fully clockwise.	*a.* Turn on the test equipment and the TS-779(*)/U and allow a 1-hour warmup period before proceeding. *b.* Zero the ME-26B/U - - - - - - - - *c.* Connect Plug UG-88/-U to the BOLOMETER jack.	*a.* None. *b.* None *c.* None.
2	Same as step 1 ----------	BIAS CURRENT: 0-6 MA - - - -	Measure and record the dc voltage across the ZM-16/U terminals.	Dc voltage must be 1.1 volt or greater.
3	Same as step 1 ----------	BIAS CURRENT: 6-10 MA - - - -	Same as step 2 - - - - - - - - - - - -	Dc voltage must be 2.0 volts or greater.
4	Same as step l, except: ME-26B/U RANGE 10V	BIAS CURRENT: 10-16 MA - - - -	Same as step 2 - - - - - - - - -------	Dc voltage must be 3.2 volts or greater.
s	Same as at end of step 4.-	- -------	Rotate BIAS CURRENT switch one position at a time counter-clockwise and adjust ZERO SET COARSE and FINE controls from fully counterclockwise to fully clockwise each time BIAS CURRENT switch is rotated.	Dc voltage must overlap on each range.

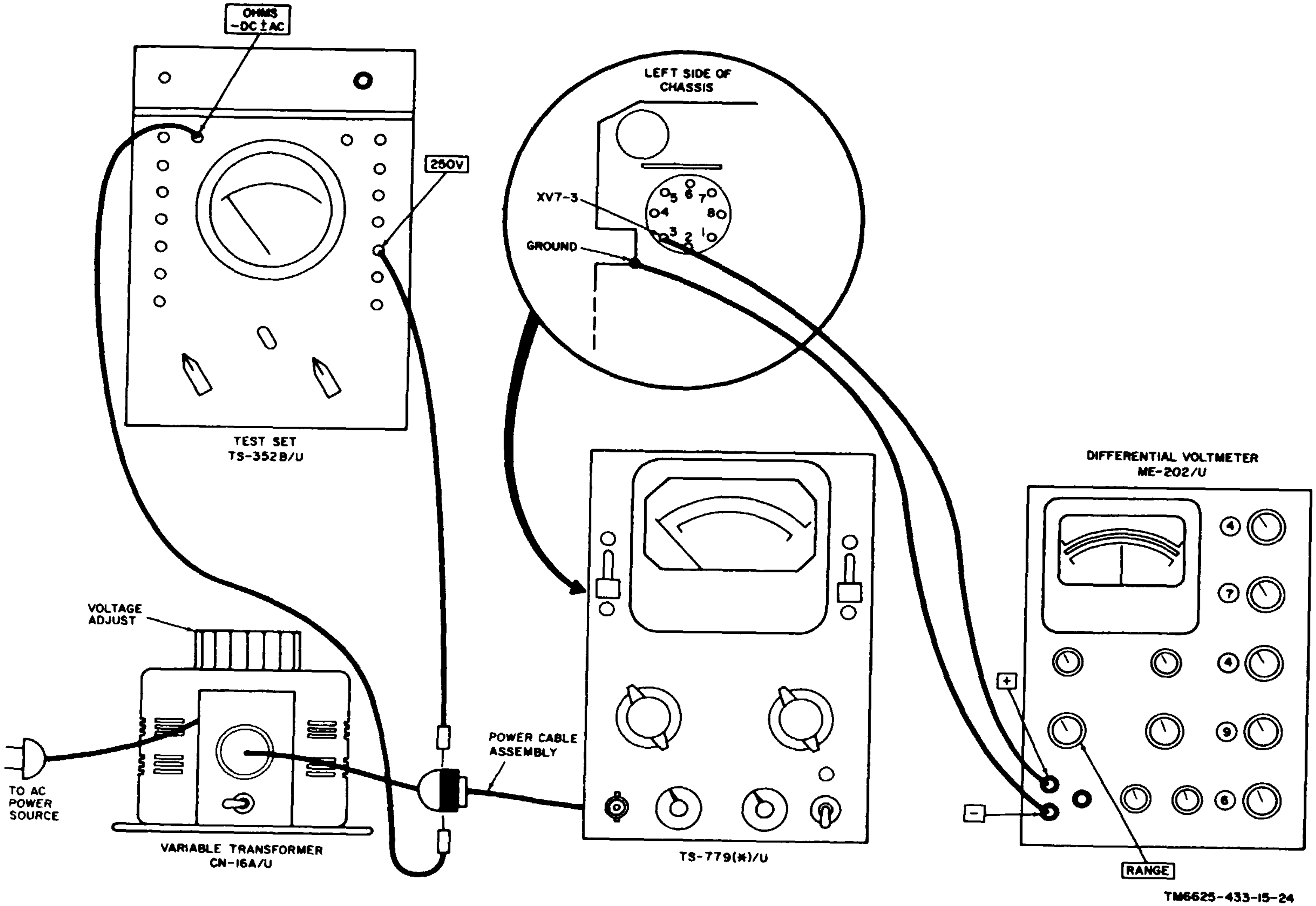


Figure 8-2. Bias drift with line voltage change test connections.

8-6. Bias Drift with Line Voltage Change Test

a. Test Equipment and Materials.

(1) Transformer, Power, Variable CN-16/U.

(2) Multimeter TS-3352B/U.

(3) Differential Voltmeter ME-202/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 8-2. If Test Set, Radio Frequency Power TS-779(*)/U is wired for 230-volt operation, wire it for 115-volt operation for this test only.

c. Procedure.

Step No.	Control settings		Test procedures	Performance standard
	Test equipment	Equipment under test		
1	*ME-202/U* RANGE: DC-500	- -	*a.* Turn on the test equipment and the TS-779(*)/U and allow a 10- to 15-minute warmup period before proceeding. 6. Zero the TS-352B/U and the ME-202/U.	*a.* None. *b.* None.
2	Same as step 1 - - - - -	- - - - - - - - - - - - - - - - - - - -	Vary the CN-16/U voltage adjust for an indication of 115 volts on the TS-352B/U.	None.
3	Same as step 1 - - - - - - - - - -	- -	Measure and record the dc voltage on the ME-202/U.	Dc voltage measured must be 250 Volts.
4	Same as step 1 - - - - - - - - - -	- -	*a.* Vary the CN-16/U voltage adjust for an indication of 105 volts on the TS-352B/U. *b.* Measure and record the dc voltage on the ME-202/U.	*a.* None. *b.* Dc voltage measured must be 250 Volts ±2.5.
5	Same as step 1 - - - - - - - - - -	- -	*a.* Vary the CN-16/U voltage adjust for an indication of 125 volts on the TS-352B/U. *b.* Measure and record the dc voltage on the ME-202/U.	*a.* Ac voltage measured must be 125 volts. *b.* Dc voltage measured must be 250 volts ±2.5.

8-7. Test Data Summary

Personnel may find it convenient to arrange the checklist similar to that shown below:

1. DC BIAS CURRENT TEST

a Dc voltage, 0-6 MA setting.	1.1 volt or greater.
b. Dc voltage, 6-10 MA setting.	2.0 volts or greater.
c. Dc voltage, 10-16 MA setting.	3.2 volts or greater.
d. Dc voltage, maximum clockwise setting of BIAS CURRENT switch and maxium counterclockwise settings of ZERO SET controls.	For reference only.
e. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counter-clockwise.	Greater than voltage in step *d* above.
f. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
g. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position. Counterclockwise.	Greater than voltage in step *f* above.
h. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
i. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counterclockwise.	Greater than voltage in step *h* above.
j. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
k. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counterclockwise.	Greater than voltage in step *j* above.
l. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
m. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counter-clockwise.	Greater than voltage in Step 1 above.
n. Dc voltage, maxi-mum counter-clockwise settings of ZERO SET controls.	For reference only.
o. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counterclockwise.	Greater than voltage in step *n* above.
p. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
q. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counterclockwise.	Greater than voltage in step *p* above.
r. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
s. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counter-clockwise.	Greater than voltage in step *r* above.
t. Dc voltage, maximum counterclockwise settings of ZERO SET controls.	For reference only.
u. Dc voltage, maximum clockwise settings of ZERO SET controls and BIAS CURRENT switch set one position counterclockwise.	Greater than voltage in step *t* above.

2. BIAS DRIFT WITH LINE VOLTAGE CHANGE TEST

a. Dc voltage, 115 volts ac.	250 volts
b. Dc *voltage*, 105 volts ac.	250 ±2.5 Volts
c. Dc voltage, 125 Volta ac.	250 ±2.5 volts

CHAPTER 9

DEPOT MAINTENANCE INSTRUCTIONS

9-1. Applicability of Depot Maintenance

a. General. All maintenance procedures associated with the AN/URM-98(*) can be performed at the general support maintenance category (ch. 7), except the disassembly and reassembly procedures for the MX-2144C/U. These procedures are given in paragraph 9-2.

b. Equipment Required.

Item	Technical manual	Common name
Resistor, Decade ZM-16/U - - - - -	TM 11-5102	ZM-16/U
Multimeter ME-26B/U - - - - - -	TM 11-6625-200-12	
Transformer, Power, Variable CN-16A/U.	------------------------------	CN-16A/U
Multimeter TS-352B/U - - - - -	TM 11-6625-366-15	TS-352B/U
Differential Voltmeter ME-202/U.	TM 11-6625-537-15	ME-202/U
Unit Regulated Power Supply GR 1201B.	----------------------------	GR 1201B
Unit Oscillator GR 1211B - - -	----------------------------	GR 1211B
Unit Oscillator GR 1214A - - -	------------------------------	GR 1214A
Cable GR 874-R22 --------------	------------------------------	GR 874-R22
Low-Pass Filter GR 874-F186 - -	------------------------------	GR 874-F185
GR/Type N Adapter GR 874-QNP.	------------------------------	GR 874-QNP
10 DB Attenuator PRD 1100C.	------------------------------	PRD 1100C
Standing Wave Detector PRD 219.	------------------------------	PRD 219
Standing Wave Ratio Indicator IM-157/U.	------------------------------	IM-157/U
Microwave Sweep Oscillator Micropower 220 with RF OSC Unit H712L.	------------------------------	Sweep oscillator
10 DB Attenuator GMC N101-10.	------------------------------	GMC N101-10
Adapter UG-57B/U ------------	------------------------------	UG-57B/U
Isolator E&M CX10P -----------	----------------------------	E&M CX10P
Probe Carriage H-P 809B -------	------------------------------	H-P 809B
Coaxial Slotted Section H-P 806B.	------------------------------	H-P 806B
Tunable Probe FXR B200A ------	------------------------------	FXR B200A
RMS Differential Voltmeter Fluke 931A.	------------------------------	Fluke 931A

Note. The abbreviations H-P. GR. PRD. GMC. and E&M stand for Hewlett-Packard, General Radio, PRD Electronics, General Microwave, and E&M Laboratries respectively.

9-2. Disassembly and Reassembly of Bolometer, R. F. MX-2144C/U

a. Disassembly. Disassemble Bolometer, R.F. MX-2144C/U (fig. 7-3) as follows:

Note. It is necessary to disassemble only far enough to replace a defective part. *For example,* it is not necessary to disassemble the front body (10) assembly to replace a defective BNC receptacle (18).

(1) Perform the procedures in paragraph 7-5a(1) through (14).

(2) Remove the contact (20) from the rear body (29).

(8) Perform the procedures in paragraph 7-5a(16) through (20).

(4) Unscrew the two special machine screws (25) and remove and discard the calibration plate (26).

b. Reassembly. Reassemble the bolometer as follows:

(1) Perform the procedures in paragraph 7-5b(1) through (17).

(2) Insert the contact (20) as shown in figure 7-3.

(3) Perform the procedure in paragraph 7-5b(19) through (23).

(4) Connect the equipment as shown in figure 9-1. Use the equipment shown, or suitable equivalents.

(5) Set both GMC 450A BIAS controls to OFF, both BOLO RES. switches to 200Ω, both BAL BIAS READ switches to BIAS, and both RANGE switches to 10 MW.

(6) Turn on all equipment. Adjust the GR 1264A for a minimum GR 1215A output. Remove the loop connector from the GR-1215A. A11ow a 15-minute warmup period,

(7) Slowly replace the loop connector into the GR 1215A. Continue to insert until the GMC 450A that is connected to the GMC 955 indicates approximately 10 mw. Adjust the GR 1264A if necessary.

(8) Adjust the GR 1215A frequency for an indication of 100 megacycles on the AN/USM-207.

(9) Remove the UG-107B/U, the UG-57B/U, and the AN/USM-207.

(10) Using the BIAS and ZERO SET COARSE and FINE controls, null both GMC 450A's.

(11) Set both GMC 450A BAL BIAS READ switches to READ.

(12) Connect the GR 874-QNP to the PRD 1100C.

(13) Adjust the GR 1264A for a 10-mw power level into the MX-2144C/U under test. (The indication on the GMC 450A connected to the NBS calibrated assembly is multiplied by the calibration factor of the NBS-calibrated assembly in the power level applied to the MX-2144C/U under test.)

(14) Measure and record the power level, in mw, on the GMC 450A connected to the GMC 955. This reading, multiplied by 100 percent is the efficiency of the MX-2144C/U. It must be at least 98 percent. With a hammer and a punch, stamp this value on a new calibration plate (26, fig. 7-3)

(15) Connect the equipment as shown in figure 9-2, basic configuration. Use the equipment shown, or suitable equivalents. Connect the GMC N607 in the reaction position.

(16) Set the GMC 450A BIAS control to OFF and the BAL BIAS READ switch to BIAS.

(17) Turn on all equipment. Adjust the GR 1264A power level and the GR 1218A output control for a minimum GR 1218A output level. A11ow a 15-minute warmup period.

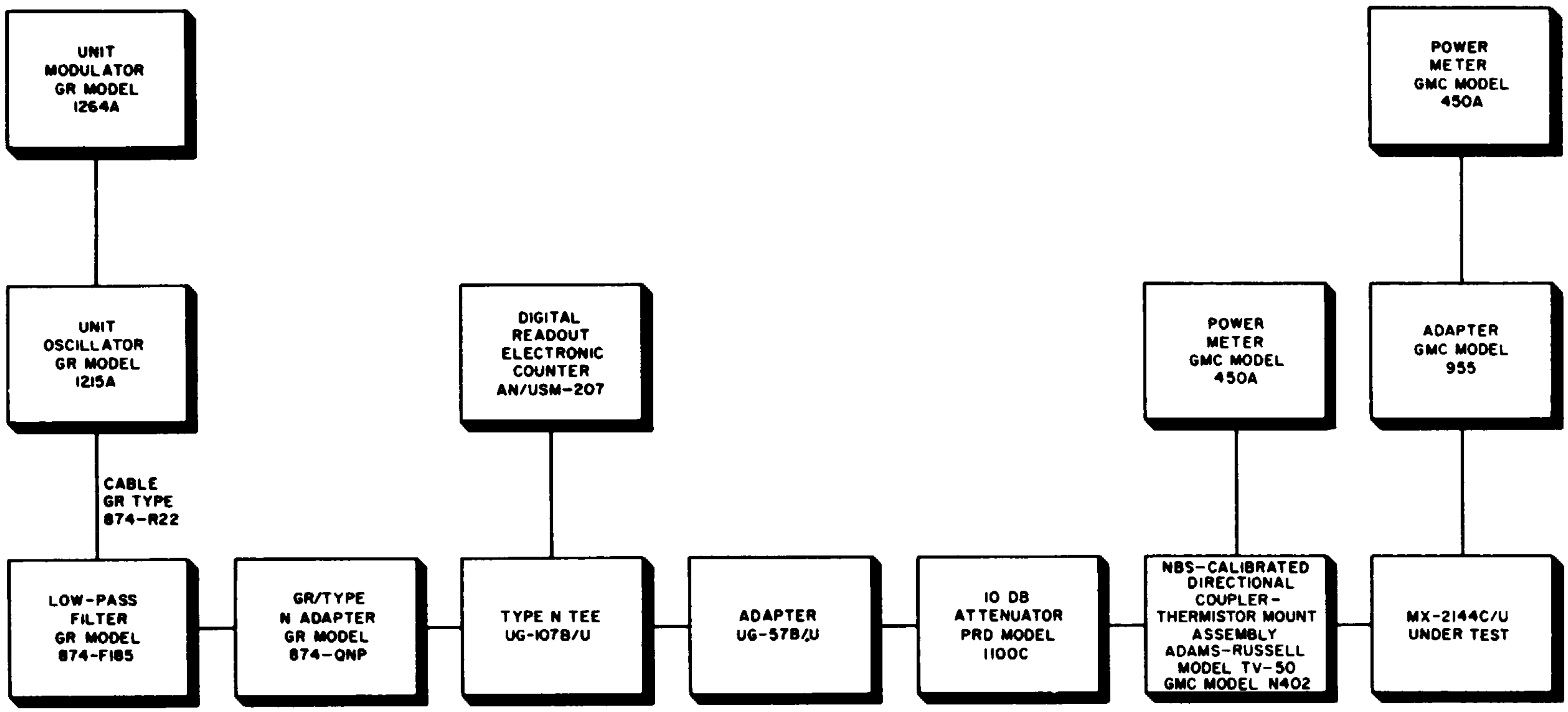
(18) On the H-P 431C, set the CALIB. FACTOR PERCENT switch to 100, the MOUNT RES switch to 200Ω, and the RANGE switch to NULL. Null the H-P 431C.

(19) Set the H-P 431C RANGE switch to 1 MW

(20) Zero the H-P 431C.

(21) Adjust the GR 1264A power level and the GR 1218A output control for an indication of approximately 1 mw on the H-P 431C.

(22) Adjust the GR 1218A frequency to 1 kilomegacycle as indicated on the GMC N607.



TM6625-433-15-25

Figure 9-1. 100-mc efficiency check connections

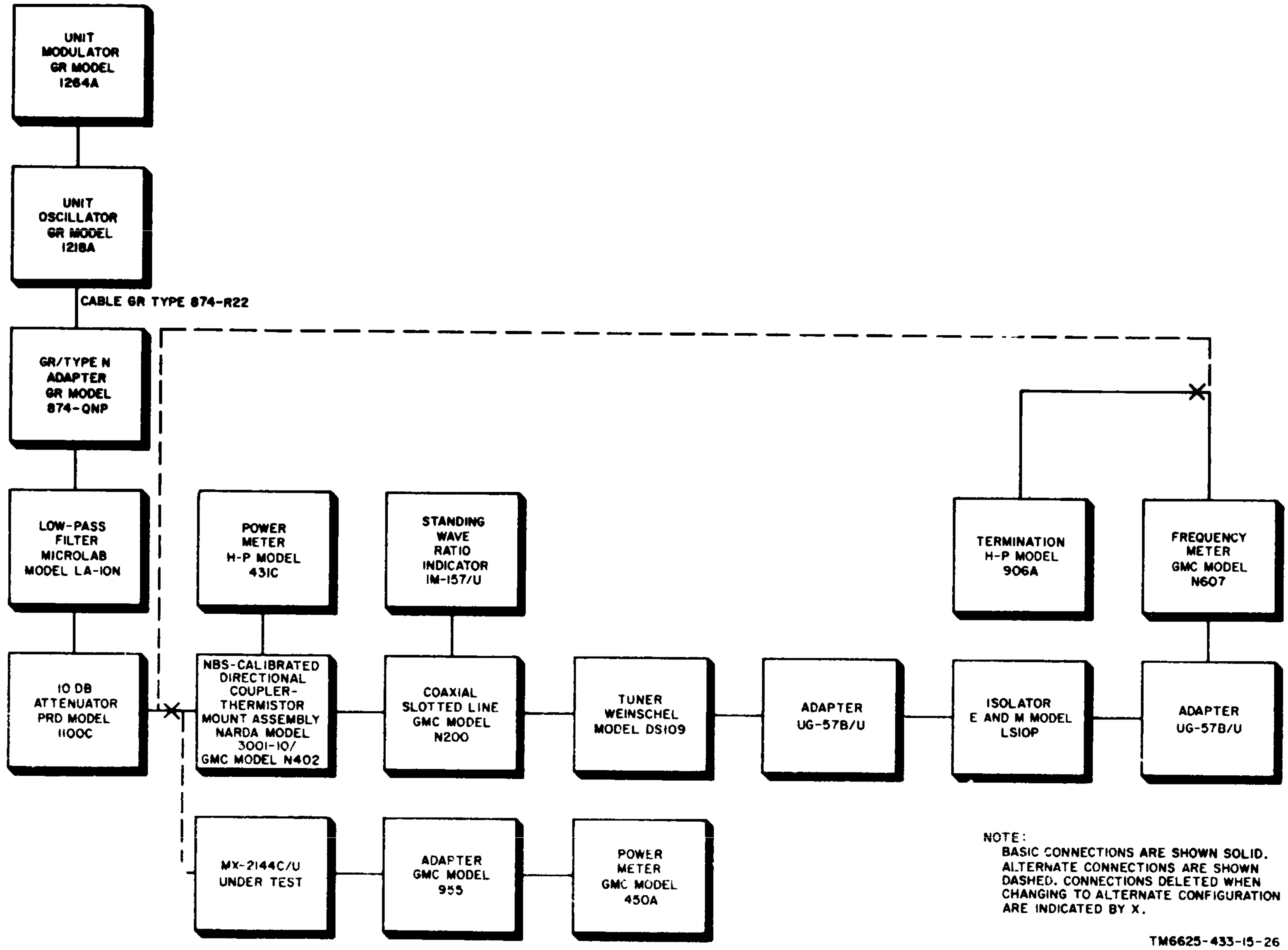


Figure 9-2. 1-kilomegacycle efficiency check connections.

(23) Detune the GMC N607.

(24) Using the GMC N200, measure the system standing-wave ratio (swr) as indicated on the IM–157/U.

(25) Adjust the Weinschel DS109 for a minimum swr indication on the IM–157/U. This must be less than 1.02:1.

(26) Remove the PRD 11OOC from the NBS-calibrated assembly.

(27) Using the BIAS and ZERO SET COARSE and FINE controls, null the CMC 450A.

(28) Set the GMC 450A BAL BIAS READ switch to READ.

(29) Connect the equipment as shown in figure 9–2. Do not change any equip ment control settings. Do not disconnect any equipment between the GMC N607 and the NBS-calibrated assembly.

(30) Adjust the GR 1264A power level and the GR 1218.4 output control for a 10 mw power level into the MX–2144 C/U under test. (The indication on the H–P 431C multiplied by the calibration factor of the NBS-calibrated assembly is the power level applied to the MX–2144C/U under test.)

(31) Measure and record the power level, in mw, on the GMC 450A. This reading, multiplied by 100 percent, is the efficiency of the MX–2144C/U. It must be at least 98 percent. With a hammer and a punch, stamp the value on the calibration plate used in (14) above.

(32) Connect the equipment as shown in figure 9–3. Use the equipment shown or suitable equivalents. Adjust the P“RD 159B for maximum attenuation. Use forced-air cooling to maintain the klystron temperature below 100° (212°F).

(33) Set the GMC 450A BIAS control to OFF and the BAT. BIAS READ switch to BIAS.

(34) Turn cm all equipment. Allow a 15-minute warmup period.

(35) On the H-P 431C, set the MOUNT RES switch to 100Ω and the RANGE switch to NULL. Null the H-P 431C.

(36) Set the H-P 431C RANGE switch to 1 Mw.

(37) Zero the H-P 431C.

(38) Adjust the PRD 159B for an indication of approximately 1 mw on the H-P 431C.

(39) Adjust the Varian X-13 frequency to 8.5 kilomegacycles as indicated on the H-P X532B.

(40) Using the H-P X81OB, H-P 809B, and the FXR B200A, measure the system swr as indicated on the IM–157/u.

(41) Adjust the FXR X312B for a minimum swr indication on the IM–157/U. This must be less than 1.02:1.

(42) Remove the PRD 159B from the NBS-calibrated assembly.

(43) Using the BIAS, ZERO SET COARSE and FINE controls, null the GMC 450A.

(44) Set the GMC 450A BAL BIAS READ switch to READ.

(45) Connect the equipment as shown in figure 9-3. Do not change any equipment control settings. Do not disconnect any equipment between the H-P X532B and the NBS-calibrated assembly.

(46) Adjust the PRD 159B for a 10-mw power level into the MX–2144C/U under test. (The indication on the H-P 431C multiplied by the calibration factor of the NBS-calibrated assembly is the power level applied to the MX-2144 C/U under test.)

(47) Measure and record the power level, in mw, on the GMC 450A. This reading, multiplied by 100 percent, is the efficiency. With a hammer and a punch, stamp the value on the calibration plate used in (14) above.

(48) Repeat the procedures in (32) through (47) above at 9.0 and 9.8 kilomegacycles.

(49) Attach the calibration plate (26, fig. 7–3) to the rear body (29); use the two special machine *screws* (25).

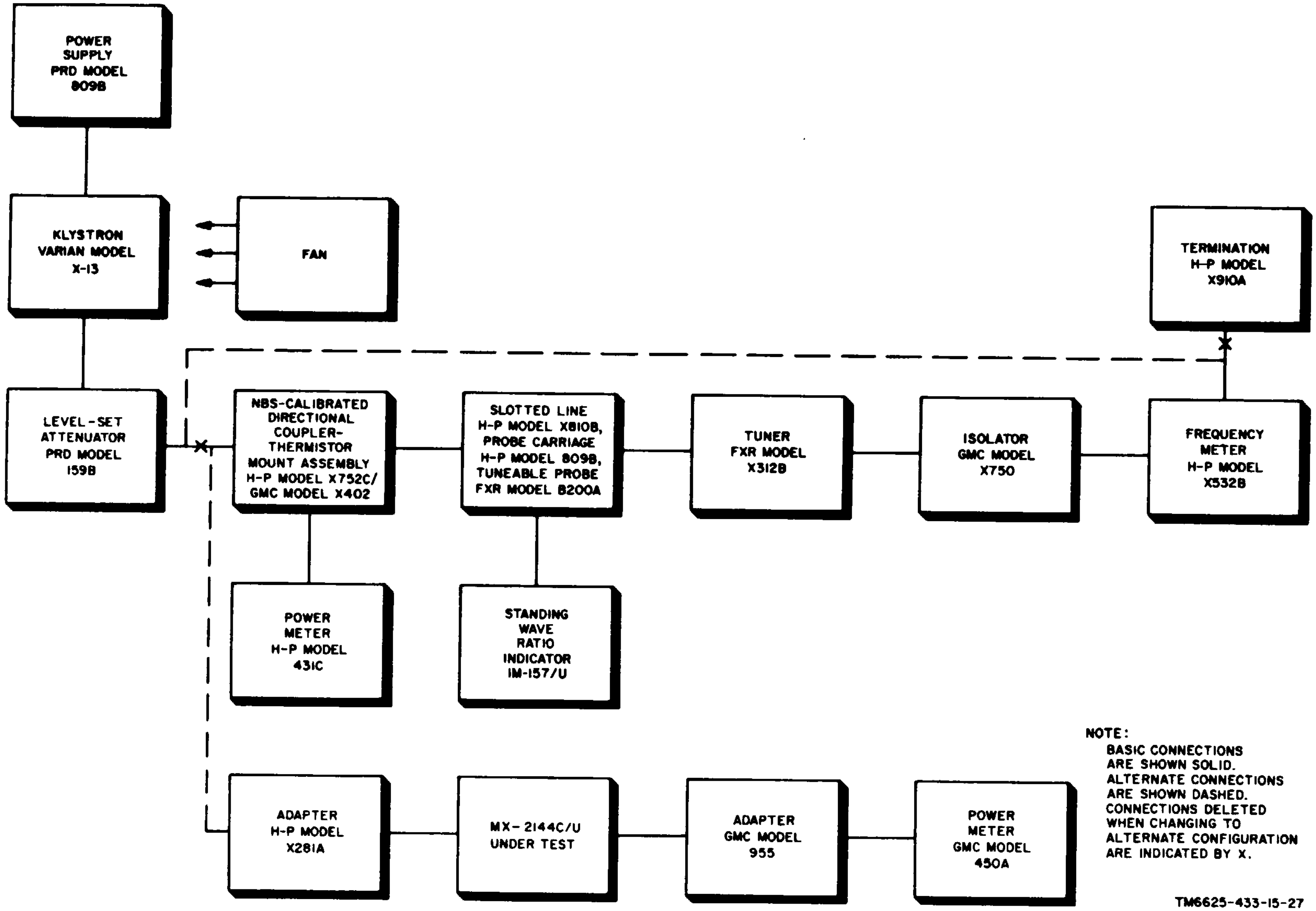


Figure 9-3. X-band efficiency check connections.

CHAPTER 10

DEPOT OVERHAUL STANDARDS

10-1. Applicability of Depot Overhaul Standards

The test outlined in paragraphs 10-6, 10-7, and 10-8 are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

10-2. Applicable References

a. Repair Standards. Applicable procedures of the depots performing these tests, and the general standards for repaired electronic equipment given in TB SIG 355-1, TB SIG 855-2, and TB SIG 355-3 form a part of the requirements for testing this equipment.

b. Modification Work Orders. Perform all modification work orders applicable to this equipment *before* making the tests specified. DA Pam 310-7 lists all available MWO'S.

10-3. Test Facilities Required

The following test equipments are required for depot testing.

Item	Technical manual	Common name
Resistor, Decade ZM-16/U - - - - - -	TM 11-5102	ZM-16/U
Multimeter ME-26B/U - - - - - - -	TM 11-6625-200-12	ME-26B/U
Transformer, Power, Variable CN-16A/U.	-----------------------------	CN-16A/U
Multimeter TS-352B/U - - - - - -	TM 11-6626-36&15	TS-352B/U
Differential Voltmeter ME-202/U	TM 11-6625-537-15	ME-202/U
Unit Regulated Power Supply GR 1201B.	-----------------------------	GR 1201B
Unit Oscillator GR 1211B - - - - - -	-----------------------------	GR 1211B
Unit Oscillator GR 1214A - - - - - - -	-----------------------------	GR 1214A
Cable GR 874-R22 - - - - - - - - - - - - -	-----------------------------	GR 874-R22
Low-Pass Filter GR 874-F185 - - -	-----------------------------	GR 874-F186
GR/Type N Adapter GR 874-QNP.	-----------------------------	GR 874-QNP
10 Db Attenuator PRD 1100C - -	-----------------------------	PRD 11OOC
Standing Wave Detector PRD 219.	-----------------------------	PRD 219
Standing Wave Ratio Indicator IM-157/U.	-----------------------------	IM-157/U
Microwave Sweep Oscillator Micropower 220 with RF OSC Unit H712L.	-----------------------------	Sweep oscillator
10 Db Attenuator GMC N101-10.	-----------------------------	GMC N101-10
Adapter UG-57B/U - - - - - - - - - - - -	-----------------------------	UG-57B/U
Isolator E&M CX10P - - - - - - - - - - -	-----------------------------	E&M CX1OP
Probe Carnage H-P 809B - - - - - -	-----------------------------	H-P 809B
Coaxial Slotted Section H-P 806B.	-----------------------------	H-P 806B
Tunable Probe FXR B200A - - - - - -	-----------------------------	FXR B200A
RMS Differential Voltmeter Fluke 931A.	-----------------------------	Fluke 931A

10-4. General Test Requirements

a. Tests of the wattmeter are conducted on two separate parts, Bolometer Radio Frequency MX-2144 (*)/U and Test Set, Radio Frequency Power TS-779 (*)/U.

b. Test Set, Radio Frequency Power TS-779/U and Test Set, Radio Frequency Power TS-779A/U are rated as having full-scale accuracies of ±5 percent. Test Set, Radio Frequency Power TS-779B/U is rated as having a full-scale accuracy of *8 percent. This means that the meter indication of audio power substituted in the bolometer for applied RF power will be within 5 and 3 percent, respectively, of the true power. These accuracy figures do not include errors in the bolometers.

c. The errors in the bolometers are caused by impedance mismatches between the RF source and the bolometer, absorption of RF power in the metallic conductors and dielectric supports of the bolometer as well as in the thermistor leads and contacts, and the non-equivalent heating of the thermistors by equal amounts of bolometer bridge power and RF power.

10-5. Tests

a. To determine if the summation bridge meets adequate performance standards for return to stock and reissue after rebuild or repair, perform the following tests in the indicated sequence:

(1) Physical tests and inspections (para 8-4).

(2) Dc bias current test (para 8-5).

(a) Bias drift with line voltage change (para 8-6).

(4) Alignment test (para 10-8).

b. To determine if the MX-2144/U and MX–2144A/U meet adequate performance standards for return to stock and reissue after rebuild or repair, perform the following tests in the indicated sequence:

(1) 7 kilomegacycle bolometer swr test (para 10-7).

(2) 8.5 kilomegacycle bolometer swr test (para 10-7).

(9) 10 kilomegacycle bolometer swr test (para 10-7).

c. To determine if the MX-2144B/U and MX-2144C/U meet adequate performance standards for return to stock and reissue after rebuild or repair, perform the following teds in the indicated sequence:

(1) SO megacycle bolometer swr teat (para 10-6).

(2) 7 kilomegacycle bolometer swr teat (para 10-7).

(3) 10 kilomegacycle bolometer swr test (para 10-7).

104. Verifying Swr of Bolometer at 50 Megacycles

a. This test verifies that the thermistors are not defective and present a good 50-ohm load at 50 megacycles to the TS-779 (*)/U coaxial input. Perform this test on all MX-2144B/U and MX-2144C/U units.

b. Connect the equipment as shown in figure 10-1. Use the equipment shown, or suitable equivalents. Set the summation bridge controls as follows:

(1) BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE]: OFF.

(2) COEF. POS.-NEG (BOLO TEMP COEF POS-NEG]: NEG.

(3) RES. 200-100 [BOLO RES. 200 Ω–100 Ω] 200 Ω.

(4) POWER RANGE (RANGE): 10 MW.

c. Set the GR 1214A OUTPUT switch to 1000.

d. Set the GR 1211B frequency to 50 mc.

e. Set the IM-157/U INPUT SELECTOR switch to XTAL 200 Ω and the RANGE switch to 10.

f. Turn on all equipment and allow a 10- to 15-minute warmup period before proceeding.

g. Using the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] and ZERO SET COARSE and FINE controls, zero the summation bridge.

h. Adjust the GR 1211B output level for an indication of approximately 10 mw on the summation bridge.

i. Using the PRD 1106A matched load that is furnished with the PRD 219, tune the PRD 219 for a minimum swr indication on the

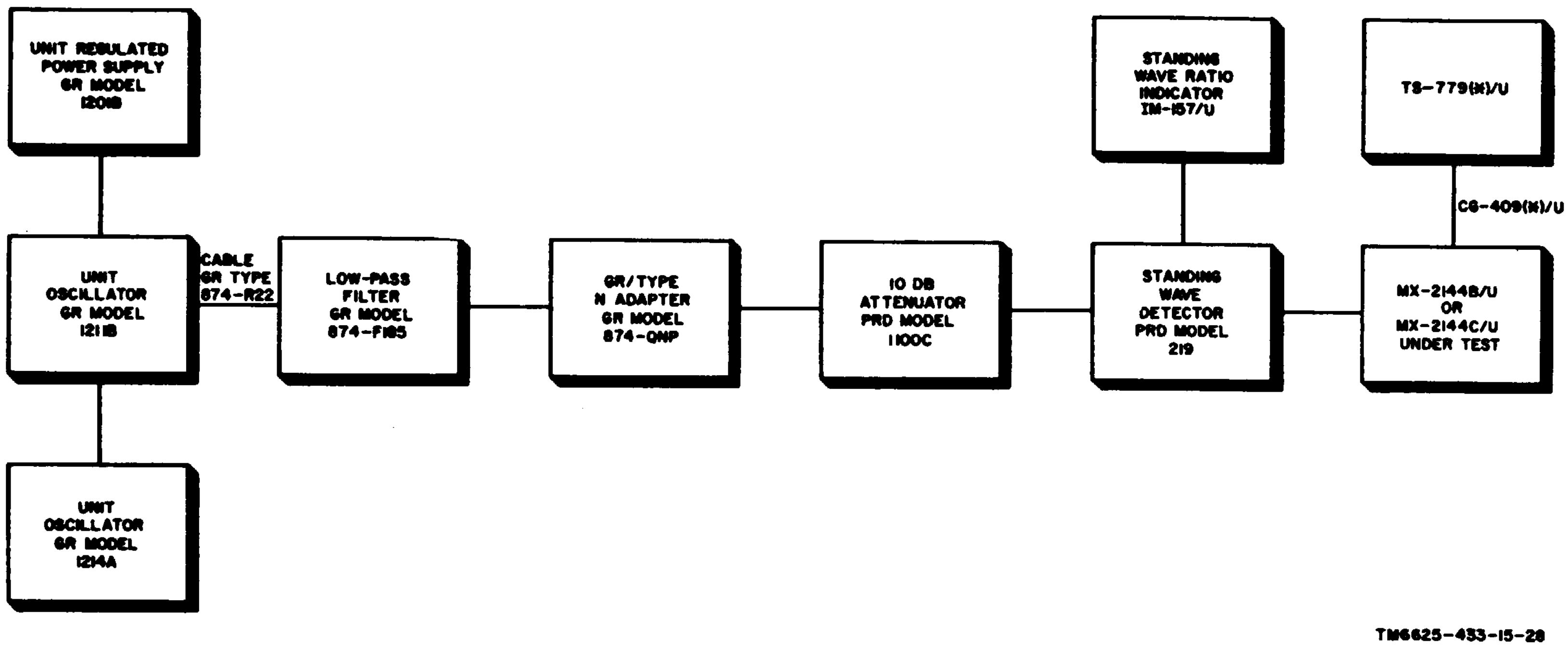


Figure 10-1. 50-mc bolometer swr test connections.

IM-157/U. Be careful not to exceed an indication of 10 mw on the summation bridge.

j. Adjust the GR 121lB output control for an indication of 10 mw *on* the summation bridge.

k. Measure the swr of the bolometer under test. The swr must be less than 1.5:1 for the MX-2144B/U and less than l.3:l for the MX-2144C/U.

10-7. Verifying X-Band Swr of Bolometer

a. This test verifies that the themnistors are not defective and present a good 50-ohm load at X-band frequencies to the summation bridge coaxial input. It is to be performed at 7.0, 8.5, and 10.0 kilomegacycles on all MX-2144/U's and MX-2144A/U's, and at 7.0 and 10.0 kilomegacycles on all MX-2144B/U's and MX-2144C/U's,

b. Connect the equipment as shown in figure 10-2. Use the equipment shown, or suitable equivalents. Set the summation bridge controls as follows:

(1) BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE]: OFF,

(2) COEF. POS.-NEG. [BOLO TEMP COEF POS-NEG]: NEG.

(3) *RES*. 200-100 [BOLO RES 200 W 100 W]: 100 W .

(4) POWER RANGE (RANGE) : 10 Mw.

c. Set the IM-157/U INPUT SELECTOR switch to XTAL 200 Ω and the RANGE switch to 30.

d. Set the sweep oscillator controls as follows:

(1) AMPLITUDE MOD: ⊓⊔.

(2) PRESET FREQ: fl.

(3) RF LEVELER: INT.

e. Turn on all equipment and allow a 10- to 15-minute warmup period before proceeding.

f. Set the test frequency as required. (See note on figure 10-3 or refer to *a* above.)

g. Using the BIAS CURRENT (BOLO BIAS CURRENT) [BIAS CURRENT RANGE] and ZERO SET COARSE and FINE controls, zero the summation bridge.

h. Set the sweep oscillator POWER switch to ON and the RF LEVEL control for an indication of 0.6 *mw on* the summation bridge.

i. Tune the FXR B200A for a peak indication on the IM-157/U.

j. Using the GMC 610 and verify that the test signal frequency is as required. Readjust the test signal frequency if required.

k. Detune the GMC 610.

1. Measure the swr of the MX-2144(*)/U under test, The swr must be less than 1.5:1 at all X-band frequencies.

m. Repeat this procedure in accordance with the note on figure 10-2 or as in a above.

10-8. Alignment Test

a. *General.* This test verifies that the substituted 10-kc audio power supplied by the power meter to the bolometer is within ±5 percent of the indicated full-scale value indicated on the power meter. It does *not include bolometer mount efficiency or mismatch errors. The* test is made by reading the 10-kc ac voltage at the bolometer BNC output terminal when the power meter pointer is at O and at full scale. The difference in audio power $\frac{V_1^2 - V_2^2}{200 \pm 3}$ is equivalent to the RF input power which does the same thing (Power $= \frac{V^2}{R}$). The ZERO SET controls change the dc bias. In turn, the power meter causes the sc voltage to maintain constant power in the bolometer. The bolometer and power meter thus behave exactly as if RF power were applied. The power reading is based on the power meter bridge circuit (of which the bolometer is one element) being exactly 200 ohms where

$$P = \frac{V^2}{R} = \frac{V_1^2 - V_2^2}{200}$$

V_1 = ac voltage when power meter reads zero and V_2 = ac voltage when power meter reads full scale. Since accuracy of this test is based on the measured 10-kc ac voltage at the bolometer, an accurate ac electronic voltmeter is necessary. Align the test voltmeter at 0.20, 0.50, 1.0, and 3,0 volts. Alignment correction information should make readings better than ±1 percent accuracy possible, even though the overall rated accuracy is 1 or 2 percent (depending on the instrument selected), A 1-percent error in the voltage reading causes a 2 percent error in the power calculation; hence, the desirability of precision measurements.

(1) Connect the equipment as shown in figure 10-3. Allow a l-hour warm-up period.

(2) Rotate POWER RANGE switch to 0, l-row range and adjust BIAS CURRENT and ZERO SET controls to zero power meter.

(8) Read ac voltage at bolometer output terminal. Limits must be within those shown in chart in b below; record voltage.

(4) Rotate ZERO SET controls so power meter reads full scale on the top scale. Read ac voltage at bolometer output terminal. Limits must be within those shown in b below.

Note. The charts in b below assume bolometer resistance is 200.0 ohms and no error in reading voltage.

b. Data to Check Alignment.

(1) *10-mw range.*

Bolo 10-kc ac voltage at zero	Full scale		
	5% low	0%	5% high
1.50	0.387	0.500	0.592
1.52	0.459	0.557	0.641
1.54	0.521	0.610	0.687
1.55*	0.550	0.632	0.709
1.56	0.578	0.658	0.730
1.58	0.630	0.705	0.772
1.60	0.678	0.748	0.818

(2) *3.0-mw range.*

BOLO 10-kc ac voltage at zero	Full scale		
	-5%	0%	+5%
0.84345	0.21761	0.28116	0.33288
0.85469	0.25809	0.31320	0.36043
0.86594	0.29295	0.84300	0.38630
0.87156[a]	0.30926	0.35537	0.39867
0.87718	0.32500	0.36999	0.41047
0.88843	0.35424	0.39642	0.43409
0.89968	0.3812	0.42060	0.45714

[a]Optimum value for zero error.

(3) 1.0-mw range.

Bolo 10-kc ac voltage at zero	Full scale		
	-5% low	0%	+5% high
0.47430	0.12236	0.15810	0.18719
0.48062	0.14513	0.17612	*0.20268*
0.48694	0.16471	0.19288	0.21722
0.49011[a]	0.17391	0.19983	0.22418
0.49327	0.18276	0.20805	0.28082
0.49959	0.19920	0.22292	0.24410
0.50592	0.21438	0.23651	0.26707

[a]Optimum value for zero error.

(4) O.S-mw range.

Bolo 10-kc ac voltage at zero	Full scale		
	-5%	0%	+5%
0.26670	0.06880	0.06890	0,10626
0.27026	0.08161	0.09808	0.11896
0.27381	0.09268	0.10845	0.12214
0.27559	0.09779	0.11286	0.12606
0.27786	0.10276	0.11699	0.12879
0.28082	0.11201	0.12584	0.18726
0.28448	0.12054	0.19299	0.14466

[a]Optimum value *for zero error.*

(5) 0.1-mw range.

Bolo 10-kc ac voltage at zero	Full scale		
	-5%	0%	+5%
0.150	0.0387	0.0500	0.0592
0.152	0.0459	0.0557	0.0641
0.154	0.0521	0.0610	0.0687
0.155[a]	0.0550	0.0632	0.0709
0.156	0.0578	0.0658	0.0730
0.158	0.0630	0.0705	0.0772
0.160	0.0678	0.0748	0.0813

[a]Optimum value for zero error.

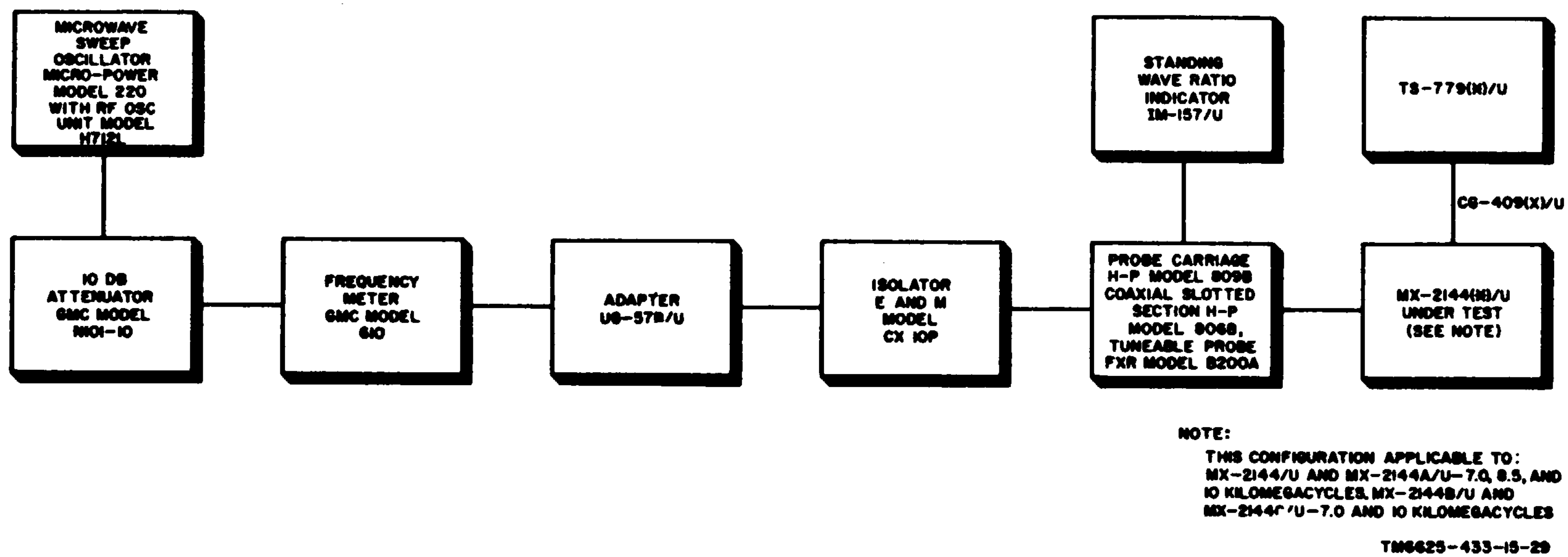


Figure 10-2. X-band bolometer swr test connections.

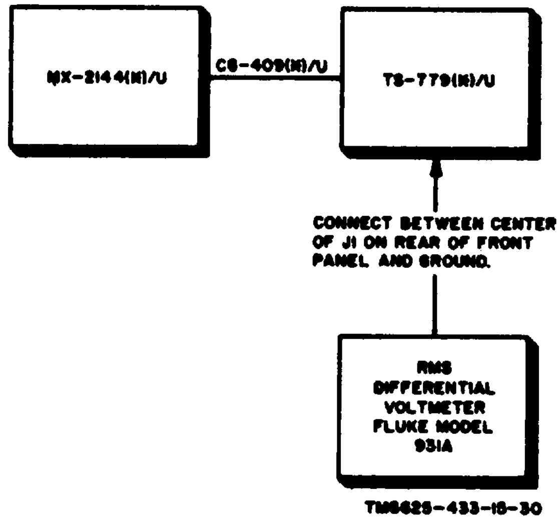


Figure 10-3. Alignment test connections.

CHAPTER 11

SHIPMENT, LIMITED STORAGE, AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

11-1. Disassembly of Equipment

To prepare Wattmeter AN/URM-98(*) for transportation and storage, disconnect the interconnect cable assembly and the bolometer. Roll up the power cord and tie with twine.

11-2. Repackaging for Shipment or Limited Storage

Figure 2-1 illustrates one method of repackaging the equipment. Specific directions for repackaging Wattmeter AN/URM-98 (*) are as follows:

a. Cushion the set on all surfaces with cells or pads fabricated of corrugated fiberboard. Place the cushioned wattmeter, together with technical manuals, within a close-fitting, slotted, corrugated box. Place the bolometer and interconnect cable assembly as shown in figure 2-1. Seal the entire closure with gummed tape and blunt all corners of the box.

b. Place the boxed wattmeter within a moisture-vaporproof barrier, and heat-seal the closure. Place the moisture-vaporproof wattmeter within a second close-fitting, slotted, corrugated fiberboard box and seal the entire closure with water-resistant tape or adhesive.

c. Overwrap the boxed equipment in waterproof barrier material. Completely seal all joints, seams, and closures with adhesive or other suitable seal equal in moisture resistance to that of the body material.

(1) Place the equipment, packaged as described above, within a nailed wooden box lined inside with a 2-inch thickness of excelsior compacted to 3 pounds per cubic foot. The shipping container should not be lined with a waterproof bag.

(2) For oversea shipment only, the shipping container should be strapped with metal straps as shown in figure 2-1.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

11-3. Authority for Demolition

The demolition procedures outlined in paragraph 11-4 will be used to prevent the enemy from using or salvaging this equipment Demolition of the equipment will be accomplished only upon order of the commander.

11-4. Methods of Destruction

a. *Smash.* Smash the controls tubes, coils, switches, capacitors, transformers, and meter.

b. Cut. Cut the output and power cord and cable assemblies.

Warning: Be extremely careful with explosives and incendiary devices. Use these items only when the need is urgent.

c. Burn. Burn cords and technical manuals.

d. Bend. Bend panel and cabinet

e. Dispose. Bury or scatter the destroyed parts in slit trenches, foxholes, or throw them into streams.

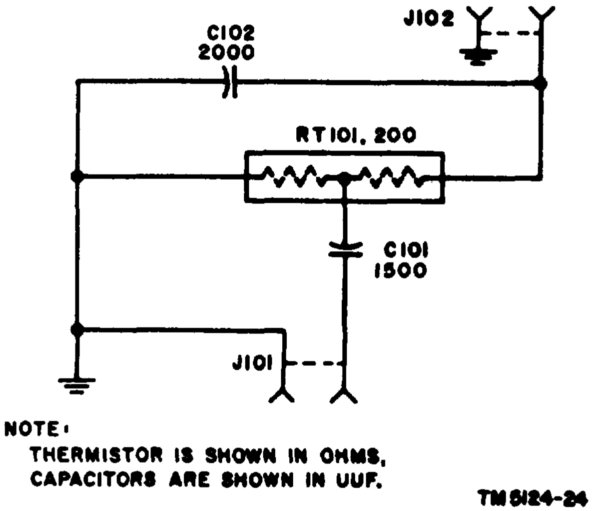


Figure 11-1. ***Waveguide Probe MX-2144/U and Bolometer, Radio Frequency MX-2144A/U, schematic diagram.***

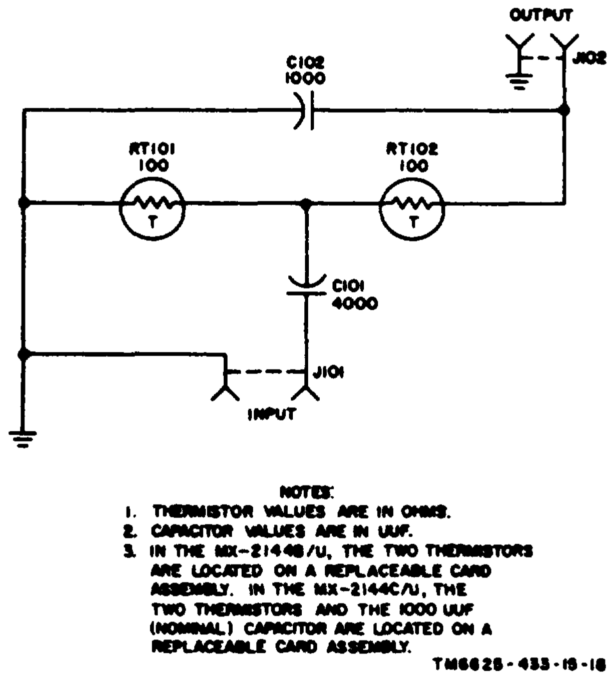
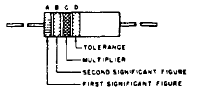


Figure 11-2. Bolometer, RF. MX-2144B/U and MX-2144C/U, schematic diagram.

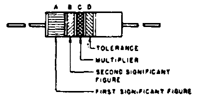
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A—Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS



BAND A—Double Width Signifies Wire-wound Resistor

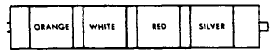
COLOR CODE TABLE

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

EXAMPLES OF COLOR CODING

BAND

A B C D*



3 9 X100 ± 10%

BAND

A B C D*

3 6 X0.1 ± 5%

NOMINAL RESISTANCE 3,900 Ohms 3.6 Ohms

RESISTANCE TOLERANCE ± 10 percent ± 5 percent

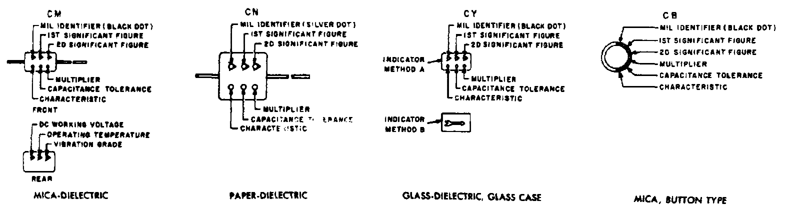
STD-R2

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

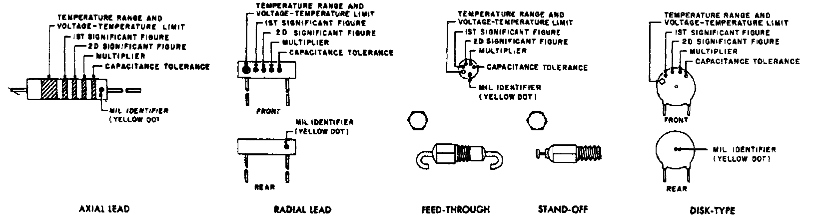
Figure 11-3. Color code marking for MIL-STD resistors.

COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

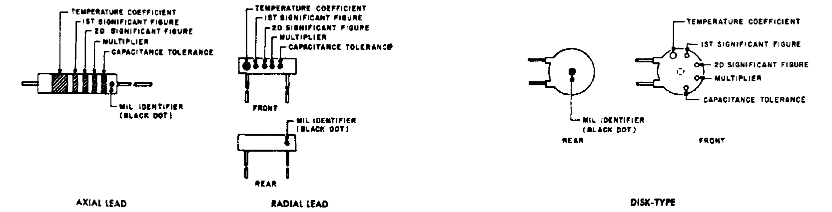
GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC



COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
BLACK	CM, CY CB	0	0	1			± 20%	± 20%		A				−55° to +70°C	10–55 cps
BROWN		1	1	10					B	E		B			
RED		2	2	100	± 2%		± 2%	± 2%	C		C			−55° to +85°C	
ORANGE		3	3	1,000		± 30%			D			D	300		
YELLOW		4	4	10,000					E					−55° to +125°C	10–2,000 cps
GREEN		5	5		± 5%				F				500		
BLUE		6	6											−55° to +150°C	
PURPLE (VIOLET)		7	7												
GREY		8	8												
WHITE		9	9												
GOLD				0.1			± 5%	± 5%							
SILVER	CN				± 10%	± 10%	± 10%	± 10%							

TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AY	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.

STD–C2

Figure 11-4. Color code marking for MIL-STD capacitors.

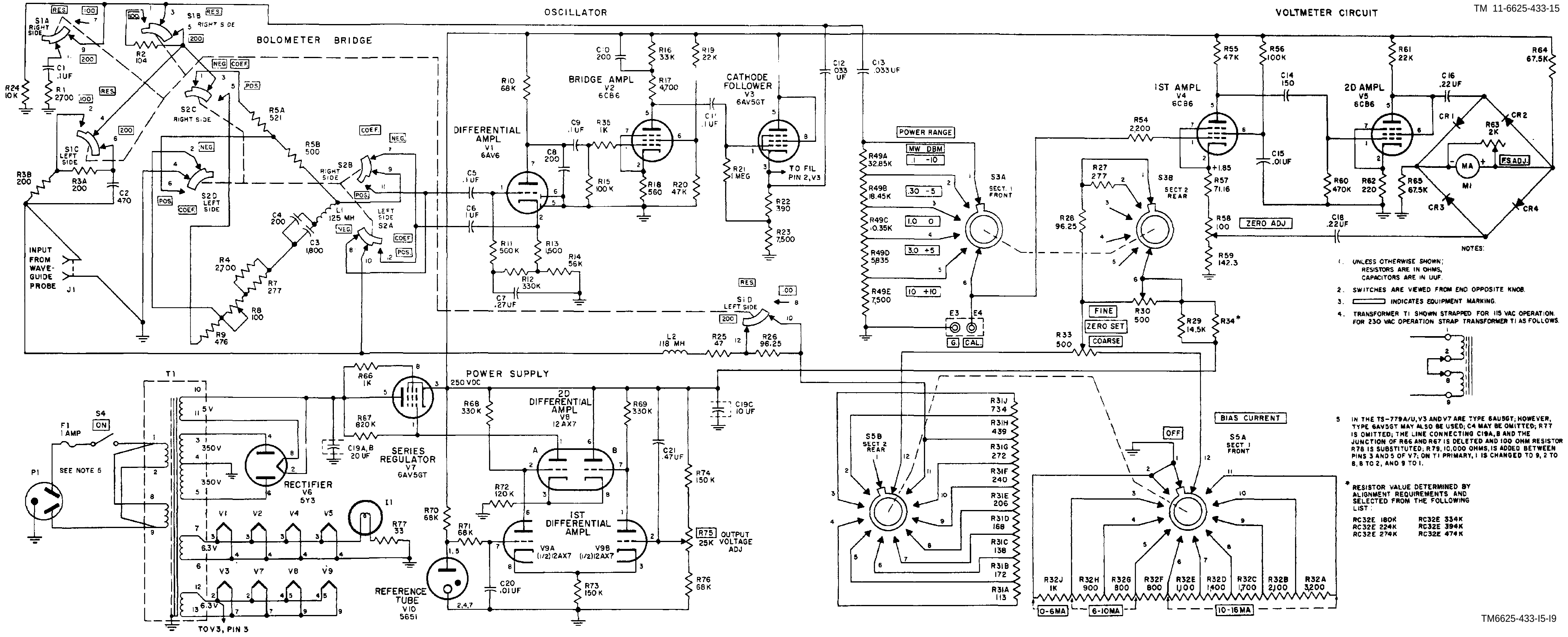


Figure 11-5. Test Sets, Radio Frequency, Power TS-779/U and TS-779A/U, schematic diagram.

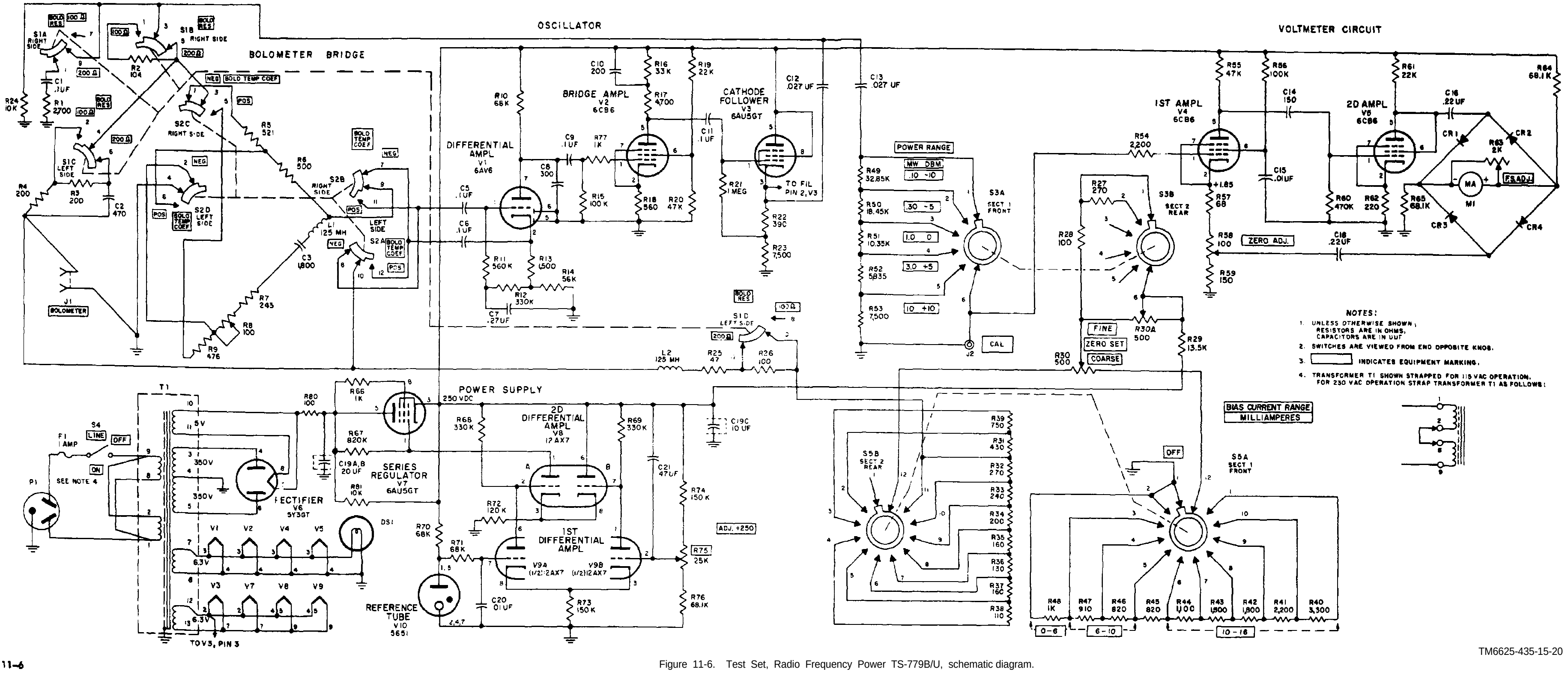


Figure 11-6. Test Set, Radio Frequency Power TS-779B/U, schematic diagram.

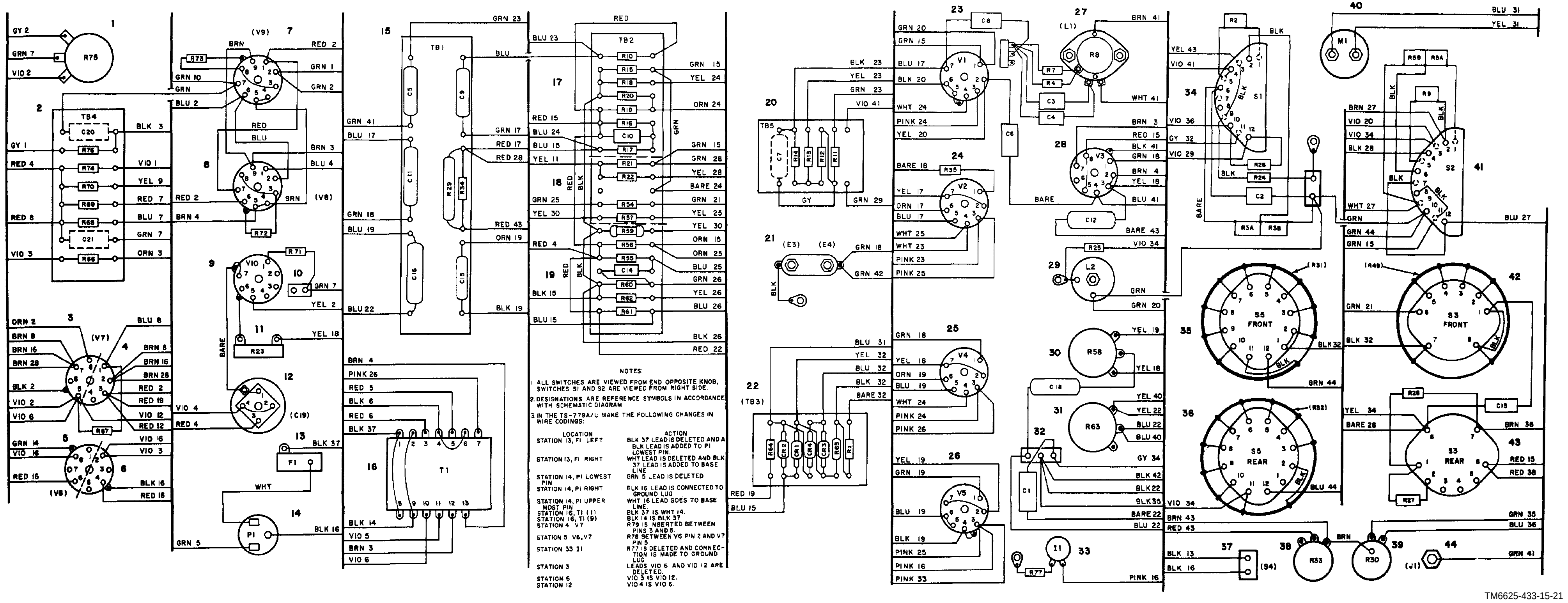


Figure 11-7. Test Sets, Radio Frequency Power TS-779/U and TS-779A/U, wiring diagram.

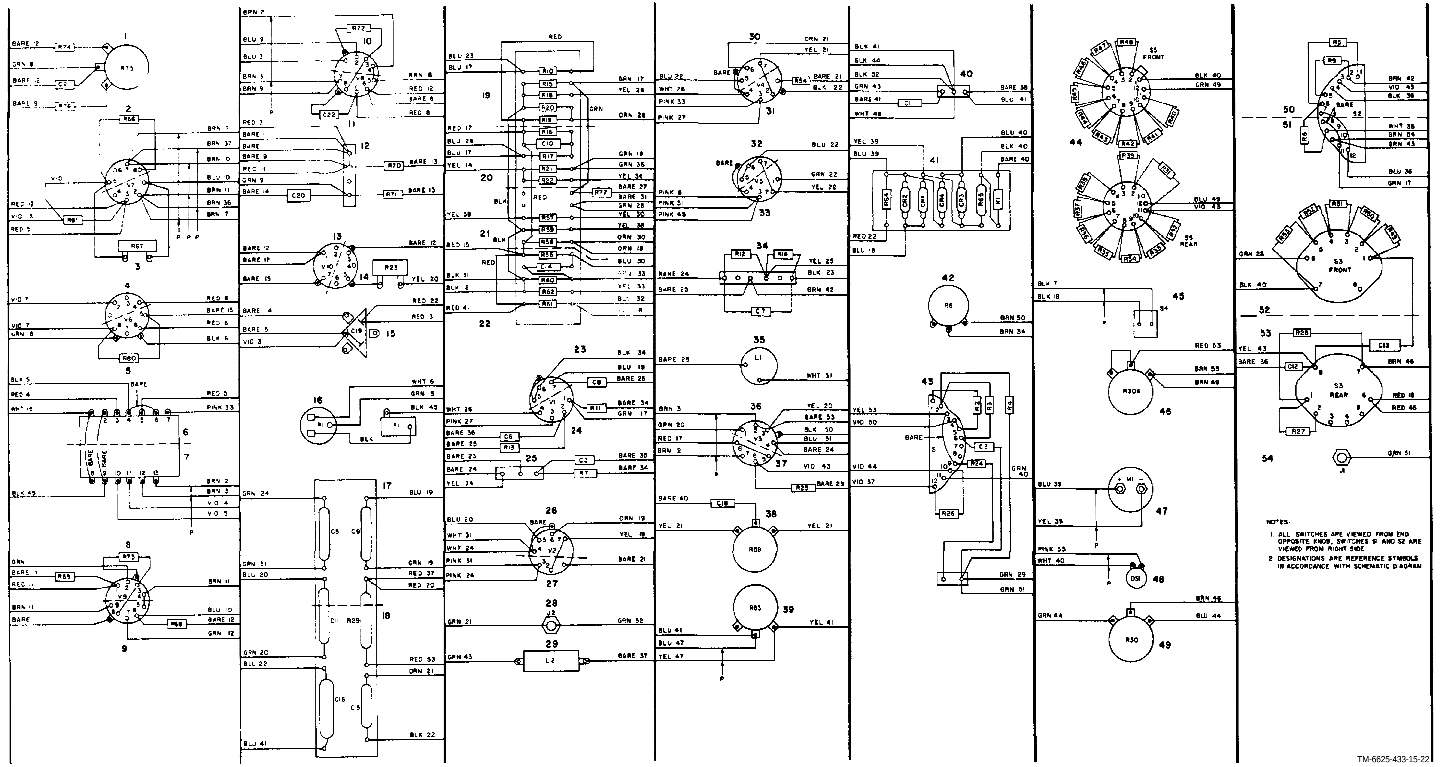


Figure 11-8. Test Set, Radio Frequency Power TS-779B/U, wiring diagram.

APPENDIXA

REFERENCES

DAPam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals, (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
SB 11-573	Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment.
TB SIG 355-1	Depot Inspection Standard for Rewired Signal Equipment.
TB SIG 355-2	De@ Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 9-213	Painting Instructions for Field Use
TM 11-5109	Coaxial Slotted Line IM-92/U
TM 11-6625-200-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-320-12	Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U, and ME-30E/U.
TM 11-6625-366-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352B/U.
TM 38-750	The Army Maintenance Management System (TAMMS)

(Next printed page is C-1)

APPENDIX C
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General.

This appendix provides a summary of the maintenance operations for AN/URM-98 and AN/URM-98A. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function.

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. *Adjust.* To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. *Align.* To adjust specified variable elements of an item to bring about optimum or desired performance.

f. *Calibrate.* To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. *Install.* The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. *Replace.* The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. *Repair.* The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. *Overhaul.* That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

C-3. Column Entries.

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. *Column 3, Maintenance Functions.* Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a “worktime” figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate “worktime” figures will be shown for each category. The number of task-hours specified by the "worktime” figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C - Operator/Crew
O - Organizational
F - Direct Support
H - General Support
D - Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column *6, Remarks.* Column 6 contains an alphabetic code which leads to the remark in section IV, Remarks, which is pertinent to the item opposite the particular code.

C-4. Tool and Test Equipment Requirements (Sect. III).

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. *Nomenclature.* This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. *Tool Number.* This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

C-5. Remarks (Sect. IV).

a. Reference Code, This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

SECTION II MAINTENANCE ALLOCATION CHART FOR WATTMETERS, AN/URM-98 AND AN/URM-98A

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
00	Wattmeters, AN/URM-98, AN/URM-98A	Inspect		0.5				Visual	
		Service		0.5				9	
		Test				1.0		1-7	
		Repair				1.0		1-7	
		Rebuild					2.0	1-6, 8,9	
		Repair		0.3				9	A
01	Test Set Radio Frequency Power TS-779A/U, TS-779B/U	Inspect		0.5				Visual	
		Service		0.5				9	
		Test				1.0		1-7	
		Repair				1.0		1-7	
		Replace		0.5				9	A
02	Cable Assembly Radio Frequency CG-409/U	Inspect		0.5				Visual	
		Test				0.5		1-7	
		Repair				1.0		1-7	
		Replace		0.5				9	A
03	Bolometer, Radio Frequency MX-2144A/U, MX-2144B/U and MX-2144C/U	Inspect		0.5				Visual	
		Service		0.5				9	
		Test				0.7		1-7	
		Repair				0.9		1-7	
		Rebuild					2.0	1-6, 8,9	
		Replace		0.5				9	A

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS FOR WATTMETERS AN/URM-98 AND AN/URM-98A

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL NATO STOCK NUMBER	TOOL. NUMBER
1	H,D	Resistor Decade ZM-16/U	6625-00-669-0266	
2	H,D	Multimeter ME-26B/U	6425-00-913-9781	
3	H,D	Multimeter TS-352B/U	6425-00-553-01117	
4	H,D	Differential Voltmeter ME-202/U	6625-00-709-0288	
5	H, D	Transformer Power Variable CN-16/U	5950-00-235-20136	
6	H, D	Tool Kit, Electronic Equipment TK-100/G	5180-00-605-0079	
7	H	Test Set Electron Tube TV-7D/U	6625-00-820-0064	
8	D	Test Set Electron Tube TV-2/U	6625-00-669-0263	
9	0	Tools and test equipment available to the repairman because of his assigned mission.		
		NOTE: Equipment required for depot maintenance is listed in DMWR.		

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	Replacement of knobs, limps, fuses and electron tubes, and Groups 01, 02, and 03.

INDEX

By Order of the Secretary **of the** Army:

CREIGHTON W. ABRAMS
General, United *States Army*
Chief of Stuff

Official:

VERNE L. BOWERS
Major General, United States Amy
The Adjutant General

Distribution:

Active Army:

USASA (2)
CNGB (1)
ACSC-E (2)
Dir of Trans (1)
COE (1)
TSG (1)
USAARENBD (1)
USAMB (10)
AMC (1)
MICOM (2)
TECOM (2)
USACC (4)
HISA (ECOM) (18)
TRADOC (2)
ARADCOM (2)
ARADCOM Rgn (2)
OS Major Cored (4)
LOGCOMD (3)
USACDCEC (10)
MDW (1)
Armies (2)
Corps (2)
Instl (2) except:
- Ft Gordon (10)
- Ft Huachuca (10)
- Ft Carson (5)

Svc Colleges (1)
USASESS (20)
USASATC&S (5)
USAINTS (3)
USAADS (2)
USAFAS (2)
USAARMS (2)
USAIS (2)
USAES (2)
Gen Dep (2)
Sig See, Gen Dep (2)
Sig Dep {2)
AD (2) except:
- SAAD (30)
- LBAD (14)
- TOAD (14)
- ATAD (10)

ATS (1)
MAAG (1)
WRAMC (1)
USARMIS (1)
USAERDAA (1)
USAERDAW (1)
Sig FLDMS (1)
Ft Richardson (ECOM Oft) (2)
Units org under fol TOE, 1 ea:

7
7-15
7-16
7-35
7-36
11-16
11-97
11-98
11-116
11-117
11-158
11-500(AA-AC)
17
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29-41
29-55
29-56
29-134
29-136
32-56
32-57
'32-500
37
55-89

ARNG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 310-50.

* U.S. GOVERNMENT PRINTING OFFICE : 1987 0 - 161-421 (60838)

PIN : 023282-000