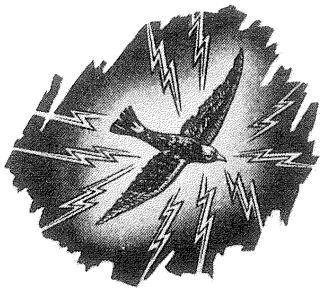
OPERATING AND MAINTENANCE MANUAL

for

RADIO FREQUENCY MILLIWATTMETER

Model 6250



BIRD ELECTRONIC CORPORATION
Cleveland, Ohio
April, 1956

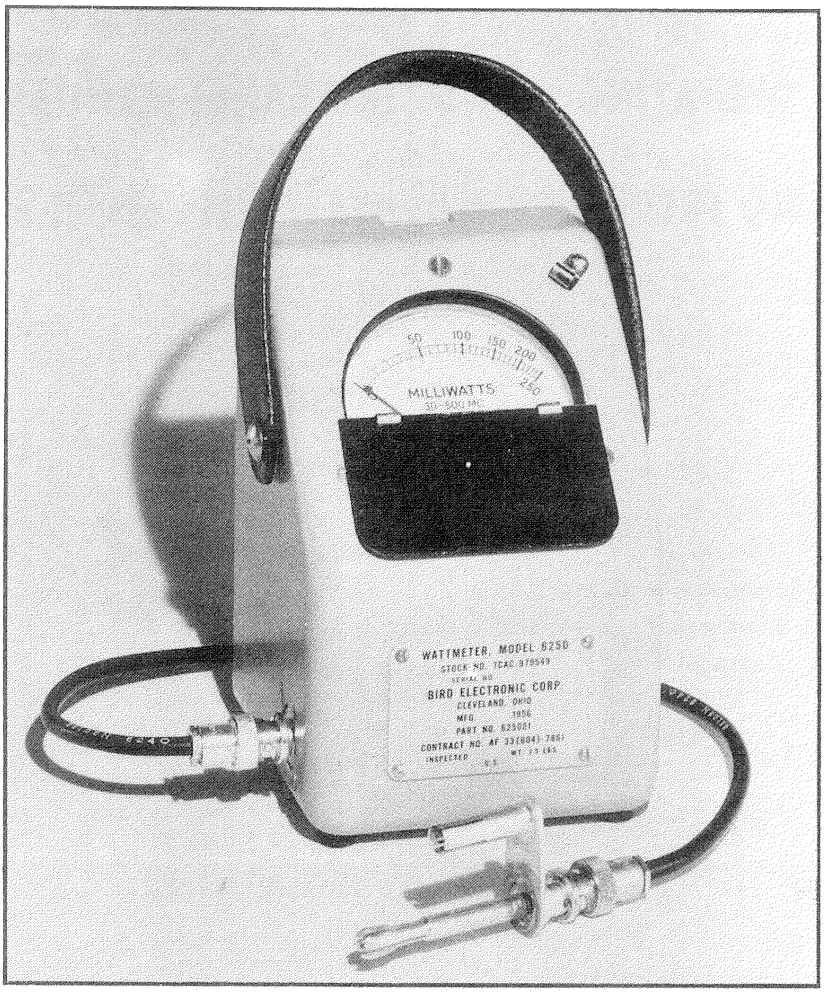


Fig. 1-1.
Model 6250 RF Wattmeter with cable and adapter

BASIC SUMMARY DATA

Type:	RF Wattmeter, Model 6250
Circuit:	51.5 ohms input impedance (Termaline)
Termination VSWR:	1.00 to 1.15 in specified frequency range
Type of Modulation:	CW or AM type signals, not designed for use on pulsed power, similar to radar.
Frequency Range:	30 - 500 megacycles per second
Power Range:	0 - 250 milliwatts
Power Accuracy:	±15%
Connectors:	BNC (female) jacks on load resistor and on Model 293 special Adapter. RF Power Cord has BNC (male) plugs at each end of 18-inch RG-58/U cable.
Weight:	2.2 pounds (equipment only) 2.8 pounds (packed for shipment)

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LIST OF ILLUSTRATIONS

Section 1 - GENERAL

1. SCOPE OF MANUAL

This instruction book covers the description, theory, operation, and maintenance of the Model 6250 RF Wattmeter (Milliwattmeter), Fig. 1-1.

2. PURPOSE AND APPLICATION

The Model 6250 is designed to measure the power output, and facilitate the tuning of the transmitters of low power output (up to 1/4 watt), specifically the AN/URC-4. The basic standards are listed on the summary sheet at the front of this manual. It may be used as a dummy load of 51.5 ohms characteristic impedance for radio frequency power as above.

3. DESCRIPTION

The essentials of the Model 6250 Radio Frequency Wattmeter equipment are relatively simple. It consists of three primary elements as follows: The Model 293 Adapter with a short rf power cord (for power pickup from AN/URC-4 Radio Receiver-Transmitter); rf load-resistor and detector unit; and a direct reading microammeter (in watts).

The Model 293 Adapter (P-603) has contact sleeves especially designed to reach the concealed antenna connection and to establish a secure ground to the transmitter case, respectively. The energy of the AN/URC-4 is fed thru rf cable assembly W-601 into the load resistor E-601 (thru BNC jack J-601).

The load-resistor unit is mounted inside the lower left hand side wall of the wattmeter housing A-601. Its output is thru dc jack J-602 on the top of the load-resistor block, and is fed thru cable W-602 directly into the microammeter M-601. The microammeter, of a sealed, ruggedized type and for which the detector units are specifically calibrated, is scaled to read dc current directly in rf milliwatts. The housing A-601 (and hinged dial flap) furnish additional physical protection for the microammeter.

The back of the housing A-601 has an access cover permanently hinged to the bottom edge of the box. This cover is fastened by a beryllium copper spring clasp at the top. Open the cover by pulling out firmly at the finger groove on the top of the housing. Brackets for the storage of the Adapter Model 293, P-603, and the RF Cable Assembly, W-601 are mounted inside of this cover. At the base of the housing is a special spring bracket for holding the Spare Crystal (see Maintenance Section). Across the top of the housing is a Strap 0-601 for carrying convenience.

TABLE 1-1 EQUIPMENT SUPPLIED

	Model	Overall Dimensions h	w	d	Vol. Cu. In.	Weight lbs.
1 RF Wattmeter	6250	5-7/8	4-1/4	3-5/8	92	2.2
Stored inside wattmeter case: 1 Power Cord	-	18 lg	5/8 d	-	7	2 oz.
Stored inside wattmeter case: 1 Adapter Plug	293	2-3/4	1-1/2	5/8	2.5	1 oz.
Stored inside wattmeter case: 1 Spare Crystal	G7C	3/4 lg	9/32 d	-	-	-
1 Operating Manual	-	9	6	1/16	3	1 oz.

Section 2 - THEORY

1. GENERAL

A traditional method of measuring transmitter power at low frequencies utilizes the basic relationship $W=E^2/R$, illustrated in circuit diagram, Fig. 2-1. E is the voltage drop across a power dissipating resistor R. Accuracy in this method requires that the voltmeter be connected directly across the resistor terminals as well as the obvious necessity that both the voltmeter and resistor be accurate and corrected for operating frequency.

The resistor and terminals in the Model 6250 are designed to have a constant characteristic impedance of 51.5 ohms over a wide frequency range.

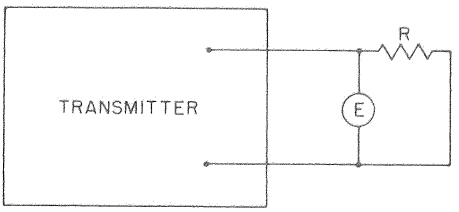

Fig. 2-1. Circuit diagram E^2/R method of power measurements

2. VOLTS vs. WATTS

The voltmeter of circuit in Fig. 2-1 may be equipped with a direct reading scale in watts, for use with a definite load resistance R. This scale would be linear in watts if the voltmeter were of the square law type similar to thermocouple or iron vane meters.

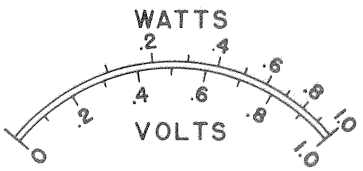

Fig. 2-2. Square law scale, watts vs. volts

When the voltmeter is a linear type, the watt scale will be as shown in Fig. 2-2. This compares equivalent voltage and power scales for a hypothetical 51.5 ohm, 1 watt, 1 volt instrument. Half full-scale deflection is obtained at one-fourth full scale power. The voltmeter used in the Model 6250 is approximately linear and the scale is of the type shown in Fig. 2-2.

3. VOLTMETER CIRCUIT, Fig. 2-3.

The adjustable tap on R_1 (load resistor) serves as a voltage divider across the input voltage of resistor R_1. The sample rf voltage so produced is fed to the germanium diode rectifier CR_1. Functioning as a half-wave rectifier, CR_1 charges capacitor C_1 to the peak rf voltage impressed on it by the R_1 voltage tap. The capacitance of C_1 is sufficiently low to maintain the proper time constant for the 30 - 500 mcs frequency range of this equipment. Resistor R_2 and Microammeter M-601 form a dc voltmeter circuit used to measure the dc voltage developed across charge capacitor C_1. The capacitor C_2 is of relatively large value with a minimum of residual inductance. C_2 is an rf bypass for the microammeter, protecting against the effect of any stray rf currents. The entire circuitry is carefully shielded for protection against induced currents caused by external rf fields.

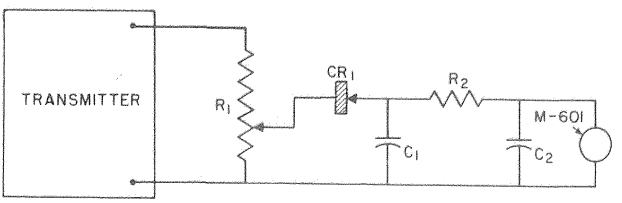

Fig. 2-3.
Schematic circuit diagram, Model 6250

Section 3 - INSTALLATION & OPERATION

1. INSTALLATION

The RF Wattmeter Model 6250 is a portable instrument with no provision for fixed mounting, and may be used in any desired location. The housing should be used in upright position wherever possible. See Fig. 3-1 for dimensional outline of wattmeter.

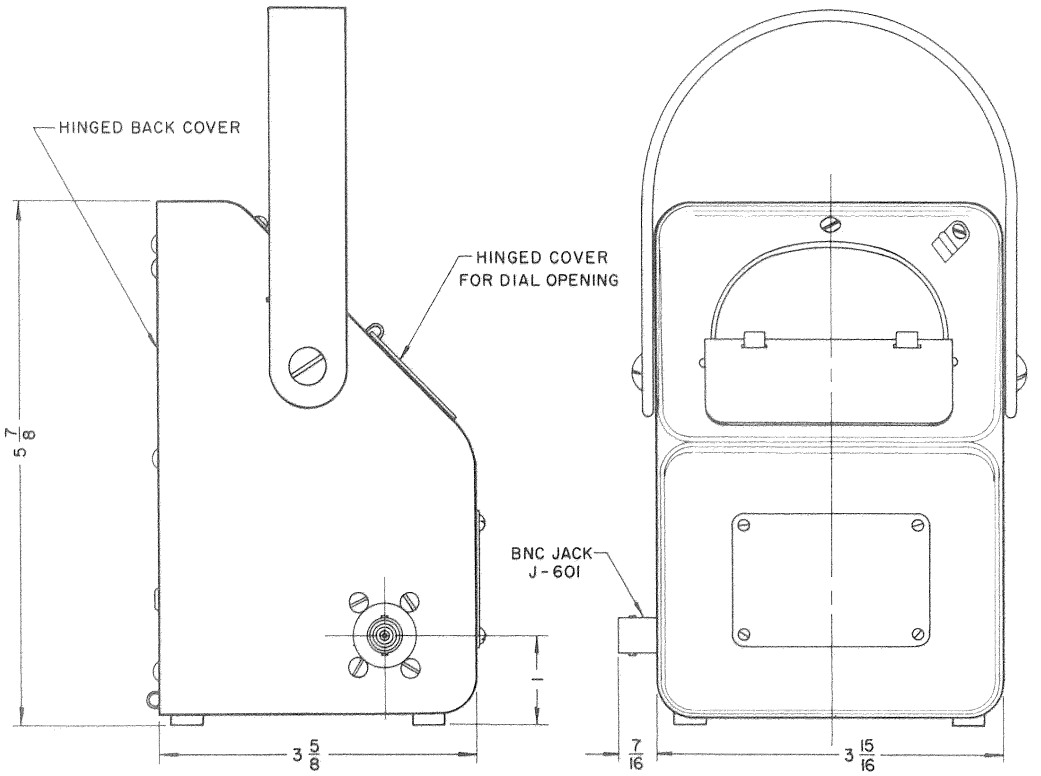

Fig. 3-1.
Outline drawing, Model 6250 Wattmeter

Remove the RF Cable W-601 and the Model 293 Adapter from their holders inside the rear cover. See sec. 1, par. 3. Attach plugs of RF Cable W-601 to respective BNC connectors on the Adapter and Load Resistor (J-601).

Take the URC-4 Transmitter and pull the white plastic antenna control button to the "release" position. Now lift up the red cap assembly a few inches, to secure free access to the antenna rods beneath. Referring to underside of the cover, per Fig. 3-2, turn the two outer studs in a counter-clockwise direction until both studs are freed from the cover assembly. Grasping the main body of each of the two center rods, pull the entire cover assembly off. Placing the transmitter down flat with the label side up, remove the large slotted screw head from the (right hand side) lower end of case. Take out small spacing sleeve from this hole, see Fig. 3-2, and gently push or tap out the entire rod from the top, removing completely. The rod opposite may be removed in a similar manner, if desired.

First insert long prong of the Model 293 pickup adapter into hole with insulated bushing at top of transmitter, and then insert the short grounding sleeve in adjacent hole, and push down to bottom. The adapter will not fit on the transmitter in

any other manner. It is important to bottom the adapter, as pickup contact will be made only when the Model 293 Adapter is fully pushed in. Refer to Fig. 3-3 for completed rf cable hookup.

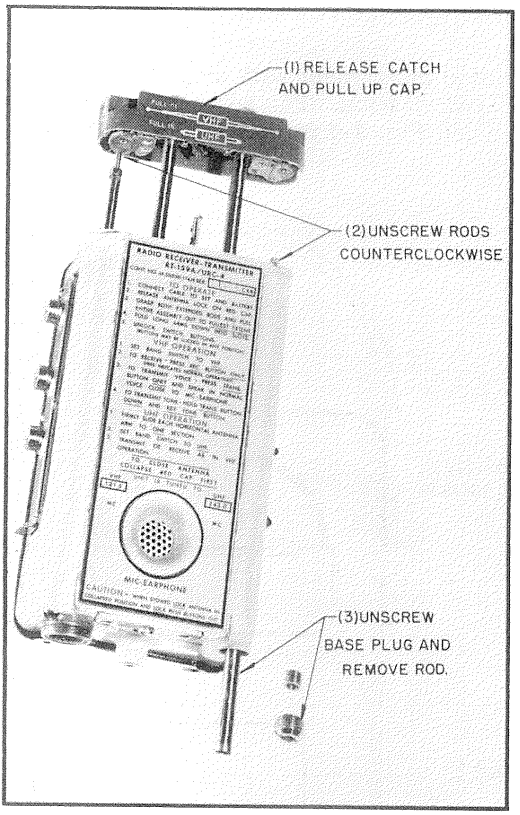

Fig. 3-2. Releasing antenna rods URC-4 Radio Receiver-Transmitter

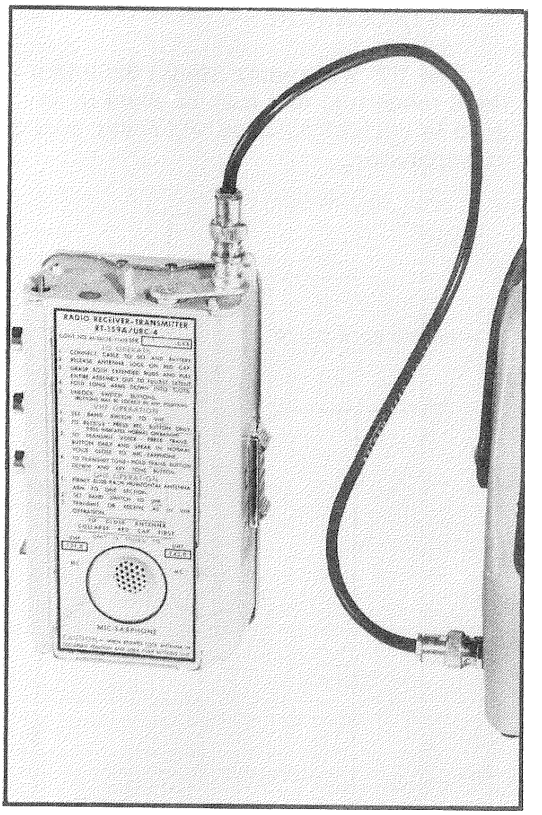

Fig. 3-3. Setup AN/URC-4 and Model 6250

2. OPERATION

The equipment is now ready for measurements. With the equipment attached as described above, operate the URC-4 Transmitter according to instructions pertaining to it.

No switching, calibrating or tuning of the Model 6250 Wattmeter is required. Before applying power, check zero position of meter pointer. If required, adjust pointer by inserting small screwdriver in hole underneath meter flap and slightly twisting screw to move the pointer to zero position. Now turn on transmitter power and pull down meter flap on slant face. Read RF output directly in milliwatts. The accuracy of the instrument ±15% applies over the specified frequency range. For interpretation of greater accuracy the typical instrument measurements deviate slightly as follows: Approximately 3% low at 30 mc, even calibration at 250 mc, and approximately 5% high at 500 mc. A curve that may be used for the correction of readings at interpolated frequencies is shown in Fig. 3-4.

When the Meter M-601 is attached to the load resistor, take care not to subject the unit to more than 1/2 watt input power, or injury to the meter may result from overloading. Also be careful not to subject the load resistor to rf power of more than 1 watt, as damage to the crystal may readily result.

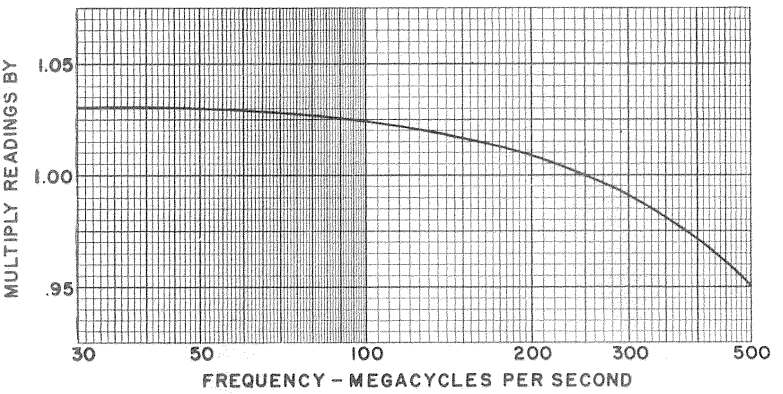

Fig. 3-4. Power correction curve

As an absorption load, the typical VSWR of this wattmeter is 1.02 at 30 mc, and 1.06 at 500 mc with a practically linear slope in between, refer to Fig. 3-5 for illustration of VSWR curve.

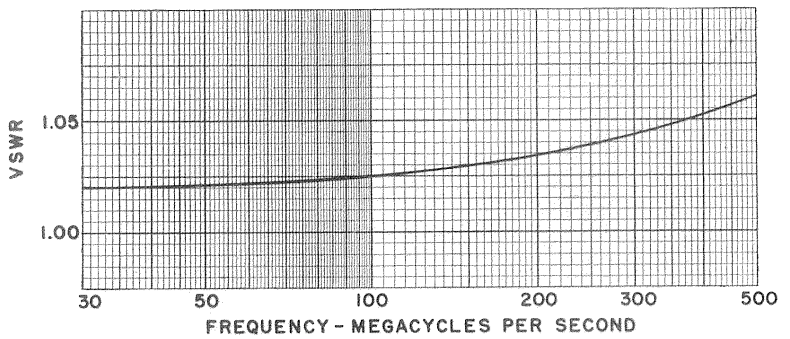

Fig. 3-5. VSWR curve

Section 4 - MAINTENANCE

1. GENERAL INSTRUCTIONS

The simplicity of this equipment makes its care and treatment relatively limited. DO NOT DROP THE WATTMETER. A bad drop or hard blow might upset the delicate mechanism of the microammeter or disturb the calibration of the pickup and detector circuit. The equipment should generally be kept clean, and the dc connections tight. The clamping nuts on the two dc plugs P-602 on Cable W-602 should be checked from time to time, making sure that the connections are sound. To improve the contact, swing the body of the plug back and forth a few times before retightening the nut.

The connectors, particularly the BNC plugs and jacks, should be kept covered as much as practicable. Do not leave these connectors around in dusty or dirty places. If the insides of the connectors become dirty, clean carefully with carbon tetrachloride on a cotton swab stick. Clean all contact faces and exposed areas. Note: Ventilate working area. BE CAREFUL - DO NOT BREATHE FUMES. When the Adapter and RF Power Cable are not in use, they should be kept in a protected place, or preferably restored to their correct holders inside the back cover of the Model 6250 Wattmeter. For protection of the equipment, the back cover of the housing and meter dial flap should be kept closed at all times. The symbol identification and location of all the replaceable parts are illustrated in Fig. 4-1.

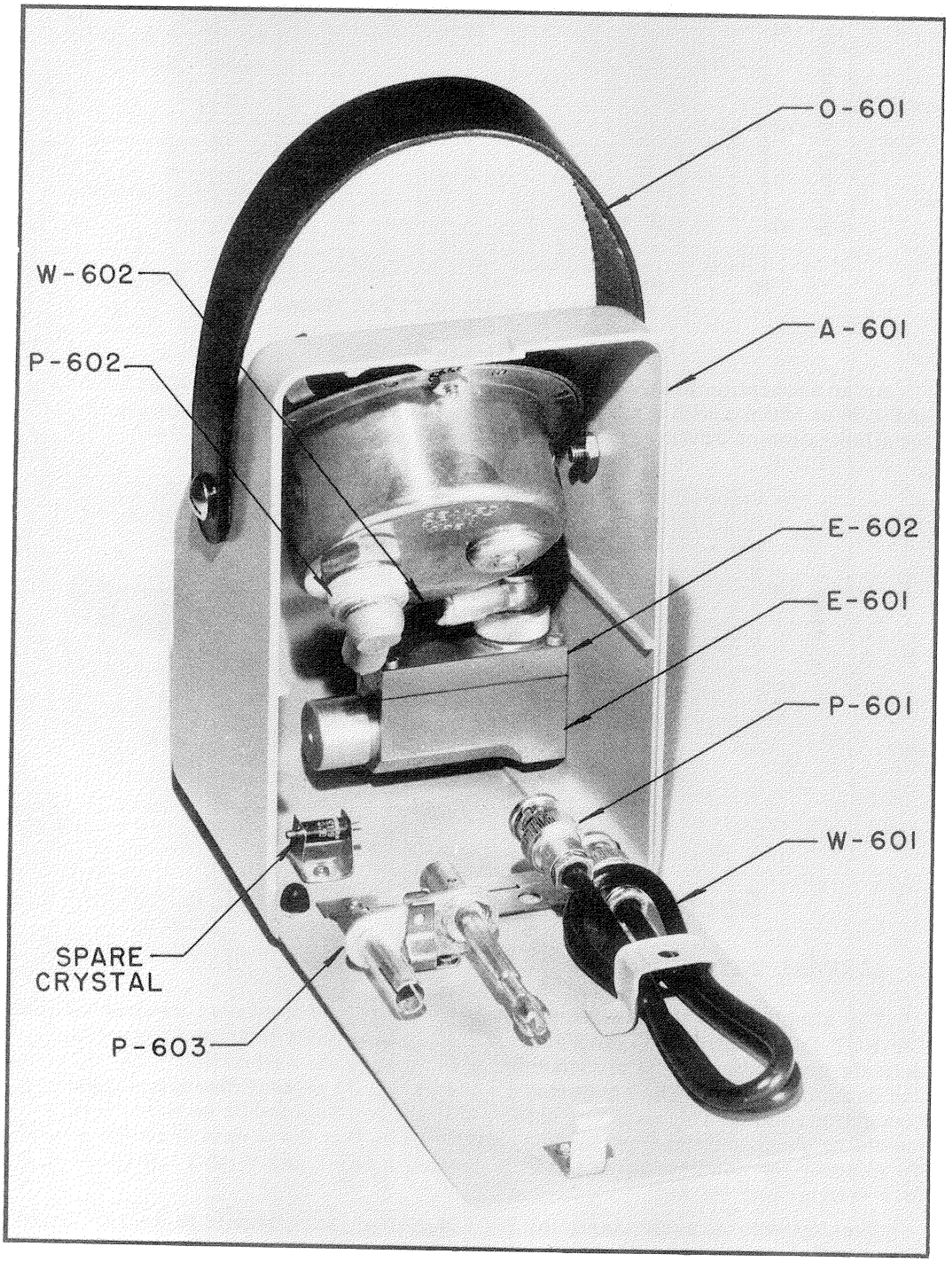

Fig. 4-1.
Parts identification photograph

2. CRYSTAL DIODE AND LOAD RESISTOR

If the meter readings become irregular or questionable, the crystal may be faulty. Check the installed crystal for uniformity of results against the spare furnished with the equipment. These two crystals are G7C germanium diode rectifiers assigned specifically as a pair to each respective wattmeter. Neither should be displaced or used in any other equipment. Activities having more than one Model 6250 Wattmeter must be especially careful to avoid mixups of crystals between units. Large errors in measurement may result when unassigned crystals are used. The spare crystal may be removed from the holder by gently pushing out the spring fingers of the holder.

To replace the crystal, remove all cable connections from the Load Resistor (RF Section) E-601, and with a small screwdriver unscrew the four #4 flat head screws from around the BNC connector on the outside of the housing. This releases the Load Resistor, which is removed from the housing. Again with the screwdriver, take out the four #4 fillister head machine screws situated on the top side of the Resistor Housing Cover E-602. The cover may now be lifted off, exposing the detector and calibrating circuitry of the load resistor unit. Do not tamper with setting of the pickup arm at the rear end of the load resistor. This will spoil the calibration, and the unit will have to be replaced or returned for recalibration.

To change crystal, insert the flat side of a small screwdriver under the outer terminal (small end of crystal, opposite identifying band) outside of lug, see Fig. 4-2, and lift up gently to snap crystal clear of lug. Push other end out sidewise in same manner or pull terminal backward thru lug. Insert replacement G7C by reversing the foregoing procedure, making sure that the crystal is replaced in the direction shown in Fig. 4-2. The hole layout insures that the cover may be fastened back only in the correct direction. Before securing Cover E-602 check and feel to make certain that the bent contact spring at the inside of the dc jack is in correct position per Fig. 4-2 and is making good contact with the button at the center of the by-pass capacitor. If contact pressure is insufficient, pull the tab down slightly, watching carefully to keep the spring in its proper location.

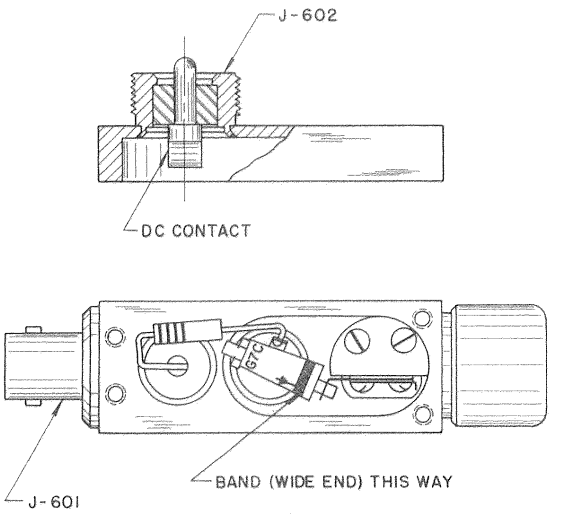

Fig. 4-2.
Voltmeter block E-601 and cover E-602

The other portions of the circuitry in the Load Resistor unit should not be changed or disturbed. These parts are assembled in a practically permanent manner, with special techniques and equipment. If all the other causes of fault (as outlined in Trouble Shooting, Table 4-1) have been investigated and the readings still do not show expected response after change of crystal, the entire load resistor E-601 will have to be replaced.

Reassemble parts by reversing procedure outlined at beginning of this paragraph. Be sure to tighten down the dc plug firmly.

3. DC CIRCUIT AND CABLE

If erratic or no readings are obtained, the dc cables and connectors should be removed and checked. Use a megger and ohmmeter to test dc cable W-602 for shorts or discontinuity. If the cable needs replacement, or connectors have to be refitted, proceed as follows:

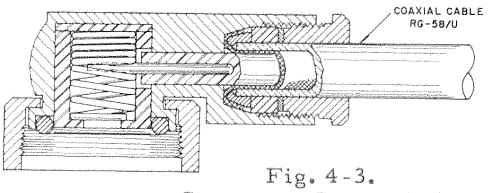

Fig. 4-3.
Connector Plug - P-602

Fig. 4-3 shows construction of the dc plugs P-602. Fig. 4-4 shows proper service of RG-58/U cable for these plugs. To remove cable from this plug unscrew the bushing and pull cable out. The center conductor of the cable makes tight contact between turns of the coil spring when assembled.

Assembly of the RG-58/U cable to DC Plug P-602 is as follows:

(1) Slip the bushing, washer, and grommet over end of cable.

(2) Remove outer insulation 9/16 inch from end.

(3) Slip collar over shielding (unbraided).

(4) Fold back braids and trim as illustrated, Fig. 4-4.

(5) Remove inside insulation to dimension shown.

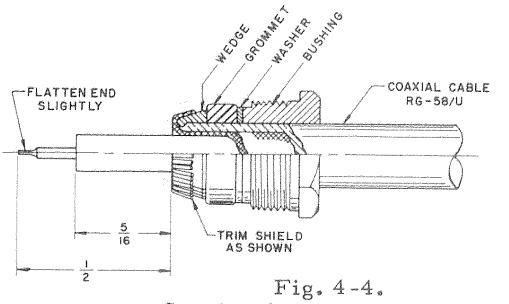

Fig. 4-4.
Service for Connector Plug

(6) Flatten end of center conductor to sharp chisel edge, push into DC Plug P-602, aligning edge with turns of coil spring.

(7) Push in grommet and washer and screw bushing down snugly.

If cables check OK, and an open circuit is still suspected, the spring contact on base of dc connector on resistor housing cover E-602 should be checked for contact on pickup button, see paragraph 4-2 above.

4. CABLE AND WATTMETER CHECK

Assuming a good load resistor, and dc connections all checked OK, then the RF Power Cable W-601 should also be checked for continuity; and perhaps verified by test against a substitute cable having UG-88/U plugs. The simplest test in the event of uncertainty of the condition of a wattmeter is to compare the equipment against the results obtained on another Model 6250 RF Wattmeter.

5. MICROAMMETER MAINTENANCE

If no readings are obtained, it is likely that the Meter M-601 is burned out, and consequently must be replaced. It may be tested by the following procedure:

CAUTION

DC Meter Tests - Testing of the meter should be attempted only by one familiar with circuitry and instruments for testing sensitive dc microammeters because of the danger of damaging it in unsuitable circuits. Test the meter as a microammeter in series with a low voltage battery, variable resistor and an external microammeter such as may be set up on Meter Test Set TS-682/GSM-1 or TS-682A/GSM-1. Full scale current should be 100 microamperes $\pm 2\%$.

CAUTION

M-601 is a sensitive microammeter. Do not attempt to check it with an ohmmeter. Do not tamper with fastening nuts on back of case or attempt to repair its internal mechanism.

If the meter pointer becomes unseated, it may be possible to restore the meter, carefully tapping or jiggling it to get the pointer pivot back in its socket. If this is impossible, the meter will have to be replaced. Please note that M-601 meters are so scaled that they may be used in the Model 6250 with any good Load Resistor E-601, but that a crystal and spare crystal may be used only with assigned load unit. Meters are easy to change by removing dc plug connection and unscrewing the three #6-32 flat head screw and nut assemblies from the front face of the meter housing.

6. TABLE 4-1. TROUBLE SHOOTING CHART

Defect	Possible Causes	Remedy
A. No Indication	1. No radio frequency power.	1a. Check transmitter, switch on, refer operating instructions for URC-4. Sec. 3, Par. 2. b. Check Model 293 Adapter P-603 for good contact. Sec. 3, Par. 1. c. Check rf cable W-601 and connectors for continuity or short circuit. Sec. 4, Par. 4.
	2. Burned out crystal diode rectifier.	2. Replace with spare crystal. Sec. 4, Par. 2.
	3. Faulty dc cable.	3a. Check contacts of dc connectors P-602. Sec. 4, Par. 3. b. Check dc cable W-602 and connectors for continuity or short circuit. Sec. 4, Par. 3.
	4. Meter M-601 damaged or burned out.	4. Replace meter. Sec. 4, Par. 5.
	5. No contact, or fault in dc jack J-602 on cover E-602.	5. Check and repair or replace. Sec. 4, Par. 2.
	6. Load resistor E-601 burned out or faulty.	6. Replace load resistor (RF Section) E-601 entirely. Sec. 4, Par. 2.
B. Intermittent or inconsistent meter readings.	1. Faulty rf cable W-601.	1. Check rf cable with standing wave indicator IM-89/UR or by comparison with another cable into Model 6250 Wattmeter. Sec. 4, Par. 4.
	2. Sticky or defective meter M-601.	2. Test meter and replace if defective. Sec. 4, Par. 5.
	3. Faulty crystal diode.	3. Check against spare crystal. Sec. 4, Par. 2.
	4. Faulty load resistor unit E-601.	4. Replace unit. Sec. 4, Par. 2.
C. Readings apparently incorrect.	1. Same as above items B 1-4.	1. Same as above items B 1-4.
	2. High VSWR on load resistor.	2. Test load resistor E-601 with slotted line or standing wave indicator such as IM-89/UR.

Section 5 - PARTS LIST

Symbol	Part Name and Descritpion	Function	Drawing Number
A-601	Housing Assembly: Aluminum die casting, 5-7/8h x 4w x 3-5/8 rectangular case w/ hinged covers, slanted meter face. Medium gray enamel.	Case for equipment	625002
E-601	Load Resistor (RF Section): Brass block 1-9/16 x 3/4 x 3-3/32 w/BNC connector & dc jack. Silver plate. (Incl. spare crystal)	RF coaxial load resistor and rectifier circuit	625038
E-602	Cover, Resistor Housing: Brass block 11/16 x 3/4 x 2 w/dc jack. Silver plate.	p/o E-601	625019
M-601	Meter: Microammeter, Aluminum case 2-3/4D and 3-1/2D x 1-5/8, 100 micro-amps. fs ±2%, zero adjust. Black enamel mounting rim only.	Meter, reads in RF power, 0 to 1/4 watt	216003
0-601	Strap, carry: Leather 11 lg x 7/8 x 5/32. Smooth black finish.	Carries wattmeter	824104
P-601	Connector, BNC Male (UG-88/U): Brass .60 D max. x 1.00 lg. Silver plate.	p/o W-601 Plugs for RF Cable 625025 - 2 req.	5095
P-602	Connector, Plug DC: Brass 1-1/4 lg x 5/8h x 3/4D captive nut, Navy Type DS-491859. Silver plate.	p/o W-602 Plugs for DC Cable 75072 - 2 req.	75076
P-603	Adapter, Model 293: Brass and Beryl-lium Copper, 2-3/4 x 1-1/2 x 5/8 w/BNC (Female) connector attached. Silver plate.	Pickup output of AN/URC-4 transmitter.	293000
W-601	Cable Assy. RF: Vinyl cord RG-58/U, 18 lg w/two rf connectors (P-601). Black finish.	RF power cord	625025
W-602	Cable Assy. DC: Vinyl cord RG-58/U, 4 lg w/two dc connectors (P-602). Black Finish.	DC meter cord	75072