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TM 11-2538
TO 33A1-5-25-1

WAVEMETER TEST SET

TS-117/GP

1

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

MARCH 1957

WARNING

HIGH VOLTAGE

is used in the operation of
the associated radar equipment.

DEATH ON CONTACT

may result if personnel fail to observe
safety precautions.

This test unit is used with high voltage equipment. Extreme caution should be used to avoid shock. All direct connections between the wavemeter and associated radar equipment should be made with all power turned off.

TECHNICAL MANUAL
No. 11–2538
TECHNICAL ORDER
No. 33A1–5–25–1

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

WASHINGTON 25, D. C. *28 March 1957*

WAVEMETER TEST SET TS–117/GP

*** This manual supersedes TM 11–2538, 15 November 1944, including C1, 21 January 1952, C2, 29 June 1954, C3, 15 February 1956.**

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains information on the operation, theory, maintenance, and repair of Wavemeter Test Set TS–117/GP (fig. 1).

b. Forward all comments on this publication directly to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N. J.

2. Forms and Records

a. Unsatisfactory Equipment Reports. Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to Commanding Officer, Signal Equipment Support Agency, Fort Monmouth, New Jersey, as prescribed in AR 700–38.

b. Damaged or Improper Shipment. Fill out and forward DD Form 6, (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

c. Preventive Maintenance Forms.

(1) Prepare DA Form 11–238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) (fig. 9), in accordance with instructions on the back of the form.

(2) Prepare DA Form 11–239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) (fig. 10), in accordance with instructions on the back of the form.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Wavemeter Test Set TS–117/GP is a portable instrument for measuring frequencies between 2,400 to 3,400 megacycles (mc). It is used to measure:

a. The frequency of radiated energy.

b. The frequencies of klystron oscillators and other equipment.

c. Relative field strengths.

4. Technical Characteristics

Frequency Range	2,400 to 3,400.
Q	1,000 to 2,000.

Calibration accuracy:

When used as a transmission type wavemeter ..... ±3 mc.

When used as an absorption type wavemeter ..... ±6 mc.

Sensitivity:

Absorption method ..... Sensitivity control set at 10. An input of 2 milliwatts will produce a full scale deflection on microammeter over the full frequency range.

Transmission method ..... Sensitivity control set at 10. A cw input of 3 mw will produce a full scale deflection over the full frequency range.

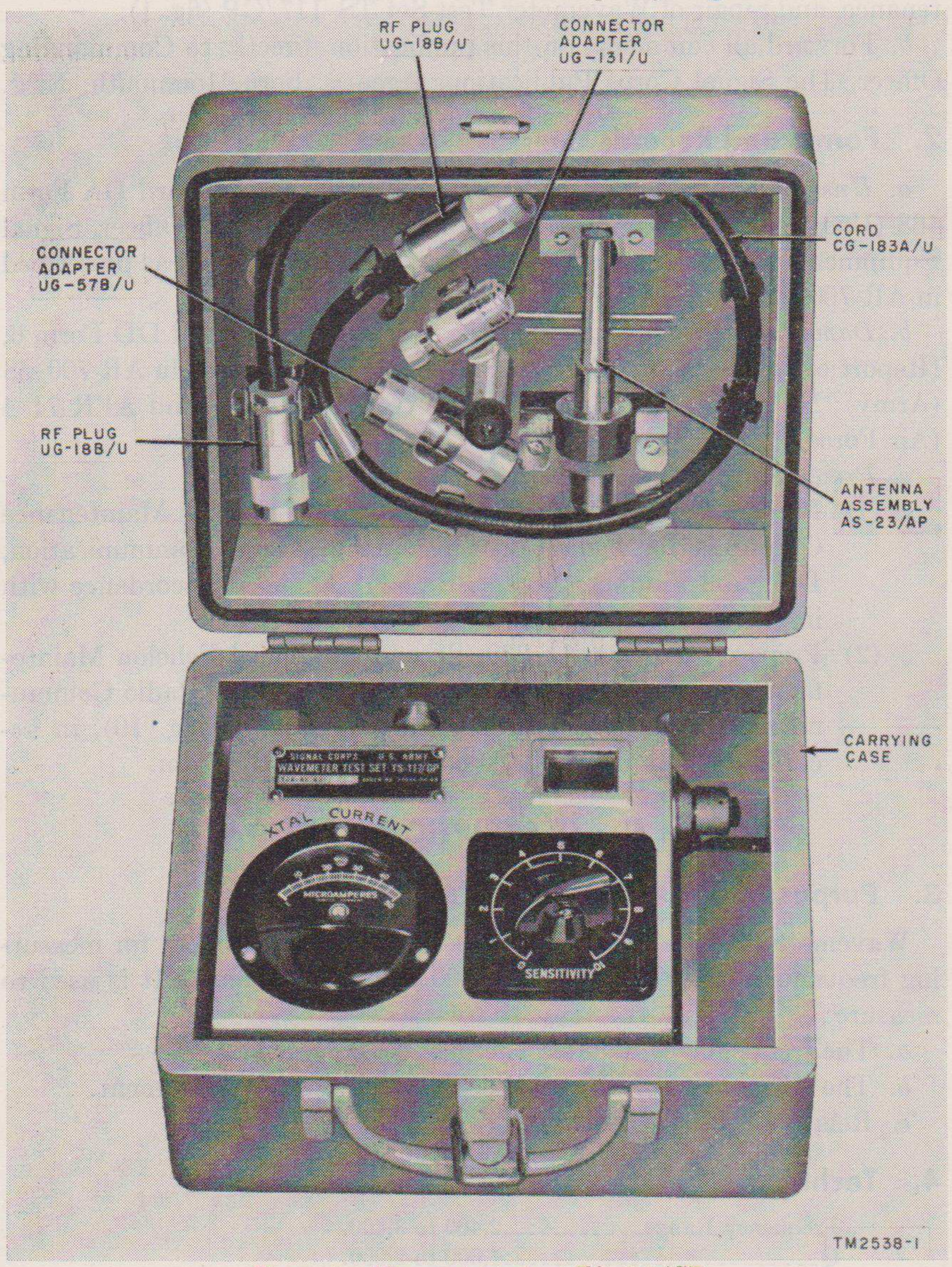


Figure 1. Wavemeter test set TS–117/GP.

5. Table of Components

a. Components. The compo
are listed in the following tabl

Quantity	Item
1	Wavemeter Test Set TS–117/GP including:
1	Carrying case
1	Cord CG–183A/U (26 in.)
2	Radio Frequency Plugs UG–21A/U or UG–18B/U.
1	Connector Adapter UG–57B/U.
1	Connector Adapter UG–131/U.
1	Antenna Assembly AS–23/AP.
1 set	Running spares (b below).
2	TM 11–2538.

b. Running Spares. The ru
units. They are mounted in t

6. Nomenclature and Co

A list of nomenclature assig
Test Set TS–117/GP us give
after each item.

Nomenclatu
Wavemeter Test Set TS–117/GP
Antenna Assembly AS–23/AP
Connector Adapter UG–57/U or U
Connector Adapter UG–131/U
Cord CG–183/U or CG–183A/U wi
Radio Frequency Plug UG–21

7. Description of Wavem

The wavemeter (fig. 1) is s
that requires no external sour
tion or transmission type wa
handle (fig. 2) protruding fro
micrometer dial, that is used

5. Table of Components

a. Components. The components of Wavemeter Test Set TS–117/GP are listed in the following table:

Quantity	Item	Height (in.)	Depth (in.)	Width (in.)	Unit weight (lb)
1	Wavemeter Test Set TS–117/GP including:	3½	5¼	6¾	3.36
1	Carrying case	6¼	5¾	8	3.51
1	Cord CG–183A/U (26 in.)				
2	Radio Frequency Plugs UG–21A/U or UG–18B/U.	11/16 (dia)	----------	1½ (lg)	
1	Connector Adapter UG–57B/U.	13/16 (dia)	----------	1½ (lg)	
1	Connector Adapter UG–131/U.	⅝ (dia)	----------	1 35/64 (lg)	
1	Antenna Assembly AS–23/AP.	3 13/16 (lg)	1⅛	2 3/16	
1 set	Running spares (*b* below).				
2	TM 11–2538.				

b. Running Spares. The running spares are two 1N21B silicon crystal units. They are mounted in the rear of the wavemeter (fig. 2).

6. Nomenclature and Common Name

A list of nomenclature assignments for the components of Wavemeter Test Set TS–117/GP us given below. A common name is indicated after each item.

Nomenclature	Common name
Wavemeter Test Set TS–117/GP	Wavemeter.
Antenna Assembly AS–23/AP	Antenna.
Connector Adapter UG–57/U or UG–57B/U	Rf adapter.
Connector Adapter UG–131/U	Klystron adapter.
Cord CG–183/U or CG–183A/U with:	Cord
Radio Frequency Plug UG–21A/U or UG–18B/U	Rf plug.

7. Description of Wavemeter

The wavemeter (fig. 1) is a self-contained resonant-cavity type unit that requires no external source of power and may be used as an absorption or transmission type wavemeter. It is tuned by a micrometer handle (fig. 2) protruding from the right side of the wavemeter. The micrometer dial, that is used for tuning, is located behind a magnifying

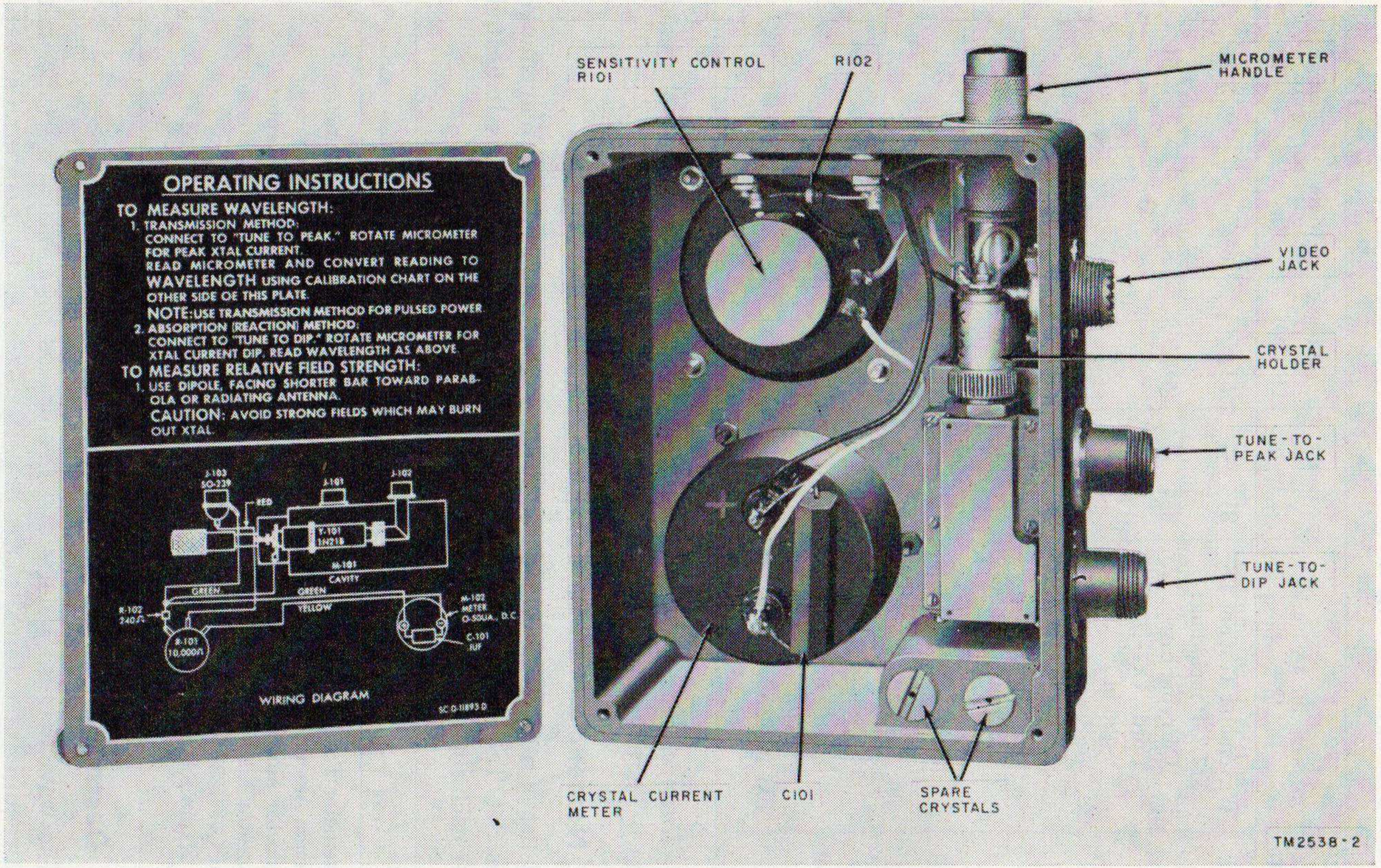


Figure 2. Wavemeter test set TS–117/GP, interior view.

lens on the front panel. A microammeter labelled XTAL CURRENT (fig. 1) indicates when the cavity is tuned to the frequency being measured. A calibration chart (fig. 5) is provided for converting the micrometer dial setting to frequency in megacycles. Input to the wavemeter is provided through jacks located on top of the case.

8. Differences in Equipments

a. There are minor differences between wavemeters procured on the various order numbers. Wavemeters procured on Orders No. 14694–Phila–48 and 25664–Phila–49 differ from wavemeters of early procurement, as follows:

(1) A round XTAL CURRENT meter is used instead of a square meter. The round meter may be used in wavemeters that were originally equipped with square meters.

(2) The location of R102 has been changed from the top of the case to the side of the case.

b. Wavemeters procured on Order No. 21789–Phila–50 differ slightly from those mentioned in *a* above, as follows:

(1) An hermetically sealed meter is used.

(2) The dimensions of the tune-to-dip jack entrance line have been changed slightly on the cavity side.

CHAPTER 2

OPERATION

Section I. SERVICE UPON RECEIPT

9. Unpacking

a. Packaging Data. When packed for shipment, four wavemeters are placed in a carton and packed in a wooden box. All accessories are stowed within the carrying case cover. The case with contents is cushioned and placed within a water-resistant, fiberboard box which is sealed with water-resistant, pressure-sensitive tape. A typical shipping box and its contents are shown in figure 3. The packed box is 29 inches high, 33 inches wide, and 24 inches deep. It weighs 48 pounds and has a volume of 1.6 cubic feet.

b. Removing Contents. Perform all the procedures given below when unpacking equipment from wooden boxes. When unpacking equipment in cartons, omit procedures (1) through (3)below.

(1) Cut and fold back the metal straps.

(2) Remove the nails from the top and one side of the box with a nail puller. Remove top and one side.

(3) Open the moistureproof container that covers the carton inside the box. Remove the carton.

(4) Open the carton and the moisture-vaporproof barrier within the carton. Remove inner carton. Open the inner carton and remove contents.

10. Checking Unpacked Equipment

a. Check the contents of the carton against the packing slip.

b. Inspect the front panel of the wavemeter for damage to glass windows on the meter and the micrometer-indicator dial.

c. Operate the micrometer; examine for looseness or binding.

Section II. OPERATING INSTRUCTIONS

11. Wavemeter Controls

Caution: Incorrect jack connections or improper setting of the SENSITIVITY control may cause permanent damage to the crystal within the wavemeter. It is important therefore to know the function of the SENSITIVITY control and the purpose of the jacks.

The following table lists the controls and jacks of the wavemeter and indicates their function.

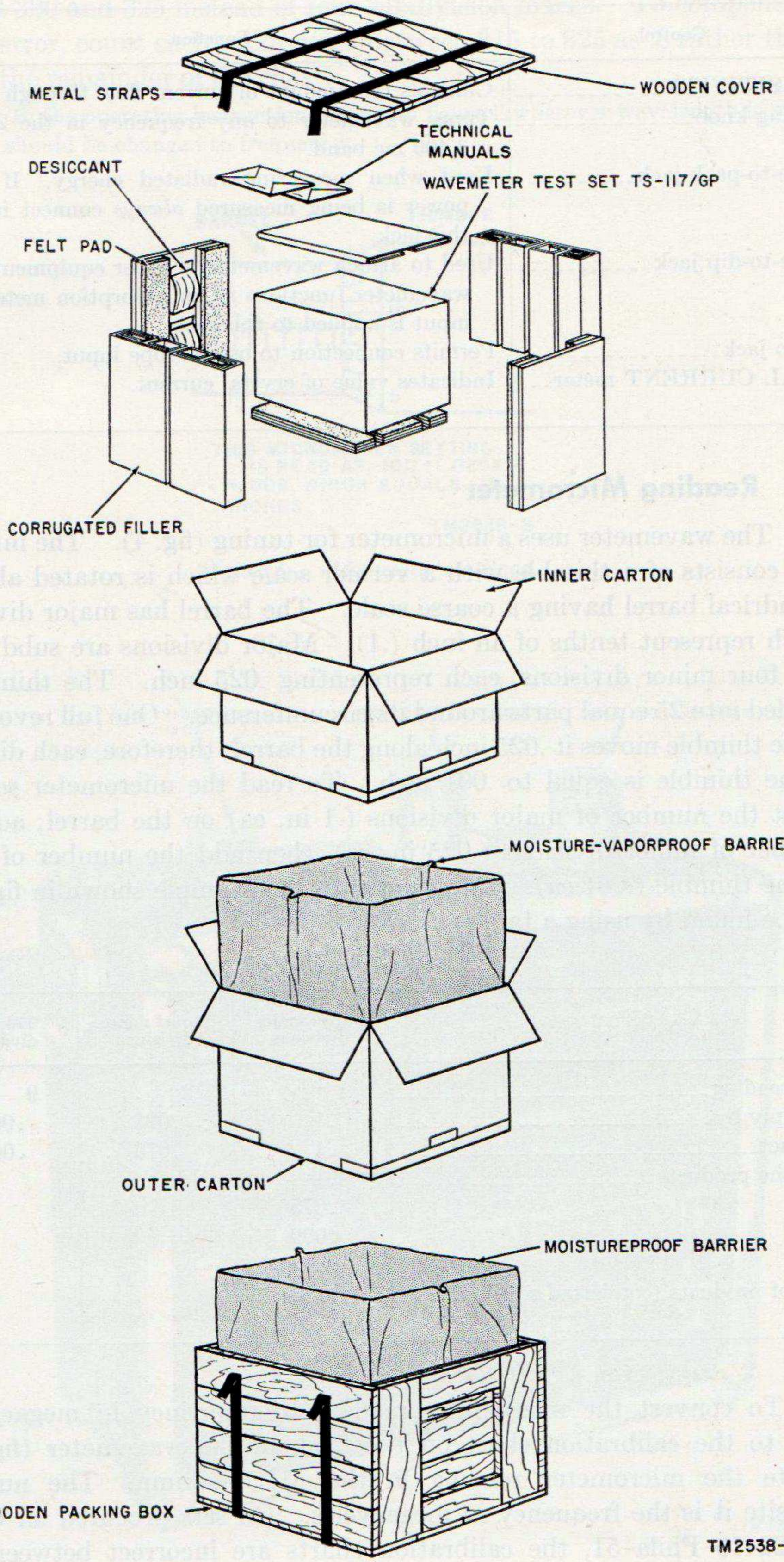


Figure 3. Typical packaging.

Control	Function
SENSITIVITY	Controls the amount of current flow through crystal.
Tuning knob	Tunes wavemeter to any frequency in the 2,400 to 3,400 mc band.
Tune-to-peak jack	Used when measuring radiated energy. If pulsed power is being measured *always* connect input to this jack.
Tune-to-dip jack	Used to attach wavemeter to other equipment. The wavemeter functions as an absorption meter when input is applied to this jack.
Video jack	Permits connection to oscilloscope input.
XTAL CURRENT meter	Indicates value of crystal current.

12. Reading Micrometer

a. The wavemeter uses a micrometer for tuning (fig. 4). The micrometer consists of a thimble with a vernier scale which is rotated about a cylindrical barrel having a coarse scale. The barrel has major divisions which represent tenths of an inch (.1). Major divisions are subdivided into four minor divisions, each representing .025 inch. The thimble is divided into 25 equal parts around its circumference. One full revolution of the thimble moves it .025 inch along the barrel; therefore, each division of the thimble is equal to .001 inch. To read the micrometer setting, count the number of major divisions (.1 in. ea) on the barrel; add the number of minor divisions (.025 in. ea), then add the number of units on the thimble (.001 ea). The answer to the example shown in figure 4 can be found by using a table as follows:

	Barrel major divisions	Barrel minor divisions	Thimble divisions
Dial reading	1	3	9
Multiply by	.1	.025	.001
Product	.1	.075	.009
Add the products	.1		
	.075		
	.009		
Sum of products (converted reading)	.184		

b. To convert the micrometer reading to frequency in megacycles, refer to the calibration chart on the back of the wavemeter (fig. 5). Locate the micrometer reading in the MIC column. The number opposite it is the frequency in megacycles. On sets procured on Order No. 22419–Phila–51, the calibration charts are incorrect between the numbers 315 to 325. There are five subdivision marks between 315 and

320 and 320 and 325 instead of four subdivision marks. To compensate for the error, count each subdivision between 315 to 325 as .8 rather than 1 as on the remainder of the chart.

Note. In the operating instructions shown in figure 2 wherever wavelength is mentioned it should be changed to frequency.

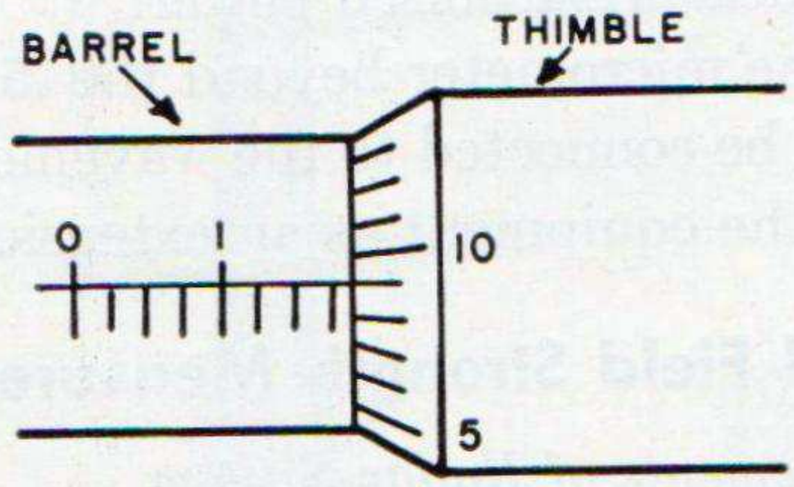


Figure 4. Micrometer readings.

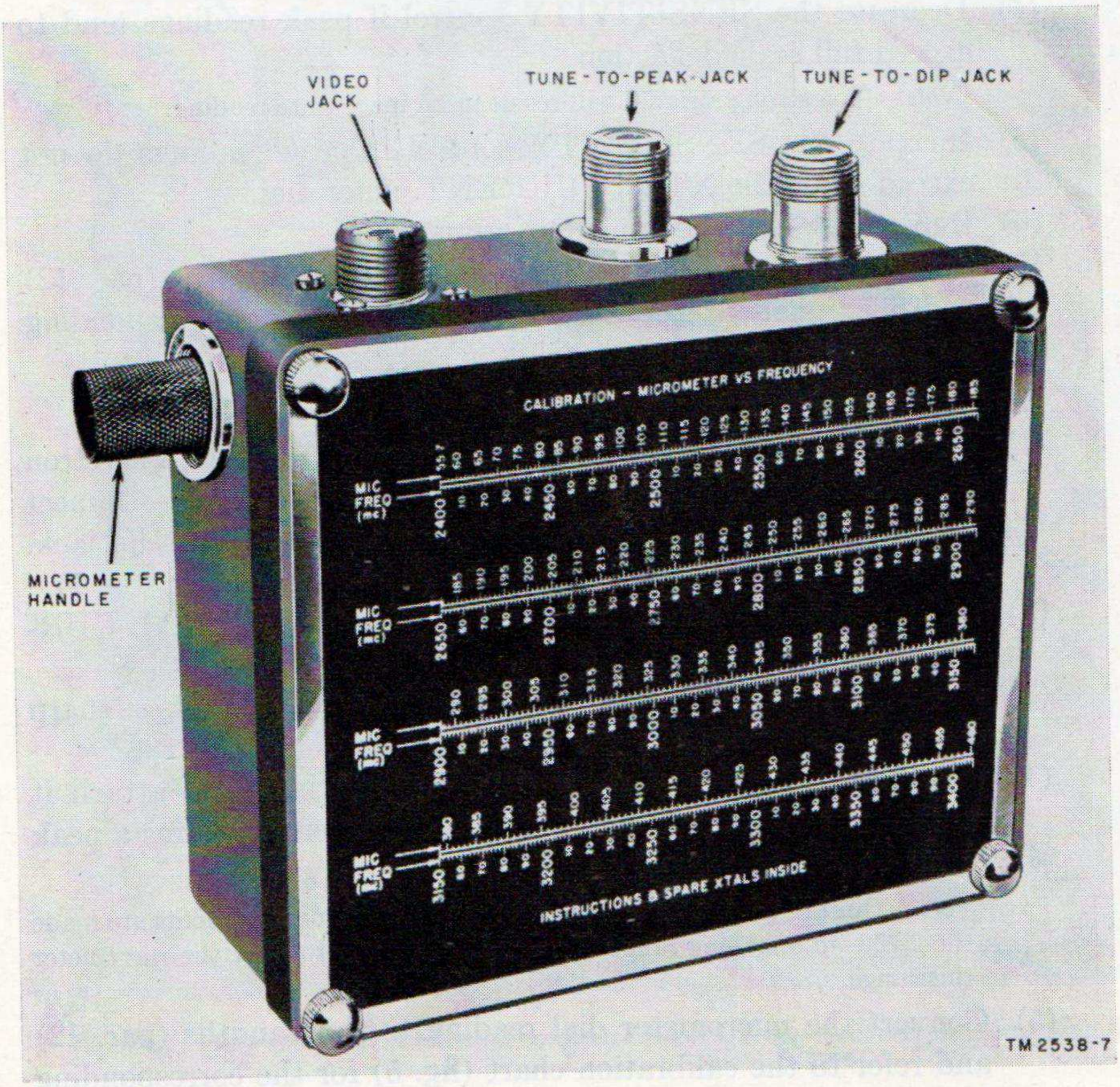


Figure 5. Wavemeter calibration chart.

13. Cautions and Suggestions

a. To protect the crystal from damage, use the tune-to-peak jack for pulsed power. This prevents high current pulses from damaging the crystal.

b. To further protect the crystal, place the wavemeter in as weak a field as possible when measuring pulsed power.

c. Do not unscrew the micrometer beyond the .5 inch reading.

d. The antenna may be connected to the wavemeter by using the cord (fig. 1) provided with the equipment as an extension.

14. Frequency and Field Strength Measurements

a. Frequency Measurements of Radar System.

(1) Use the RF adapter to connect the antenna to the tune-to-peak jack. Position the antenna as shown in figure 6.

(2) Place the wavemeter in the radar field with the back facing the origin of the field.

(3) Adjust the micrometer for a peak reading on the XTAL CURRENT meter.

(4) Decrease the SENSITIVITY control if peak readings tend to exceed full scale deflection.

Note. Too strong a signal will result in an inaccurate reading.

(5) Increase the SENSITIVITY control if peak readings do not exceed 10 on the XTAL CURRENT meter dial.

(6) Repeat step (3) above for fine adjustment.

(7) Convert the micrometer dial reading to thousandths (par. 12) and refer to the calibration chart (fig. 5) for the corresponding frequency in megacycles.

b. Measurement of Klystron Frequency.

(1) Use the cord provided with the equipment and attach a klystron adapter to one end and an RF adapter on the other. Connect the end of the cord with the RF adapter to the tune-to-dip jack. Attach the other end to the receptacle on the klystron (fig. 7).

(2) Adjust the micrometer for a current dip on the XTAL CURRENT meter.

(3) Adjust the SENSITIVITY control until meter shows a sharp dip as the micrometer is tuned through resonance.

(4) Disconnect the cord from the tune-to-dip jack and attach it to the tune-to-peak jack. Readjust the micrometer for a peak current reading.

Note. Omit step (4) above of this operation when measurements are made in the 2,700- to 3,200-mc range because it is difficult to peak the wavemeter in this range.

(5) Convert the micrometer dial reading to thousandths (par. 12) and refer to the calibration chart (fig. 5) for the corresponding frequency in megacycles.

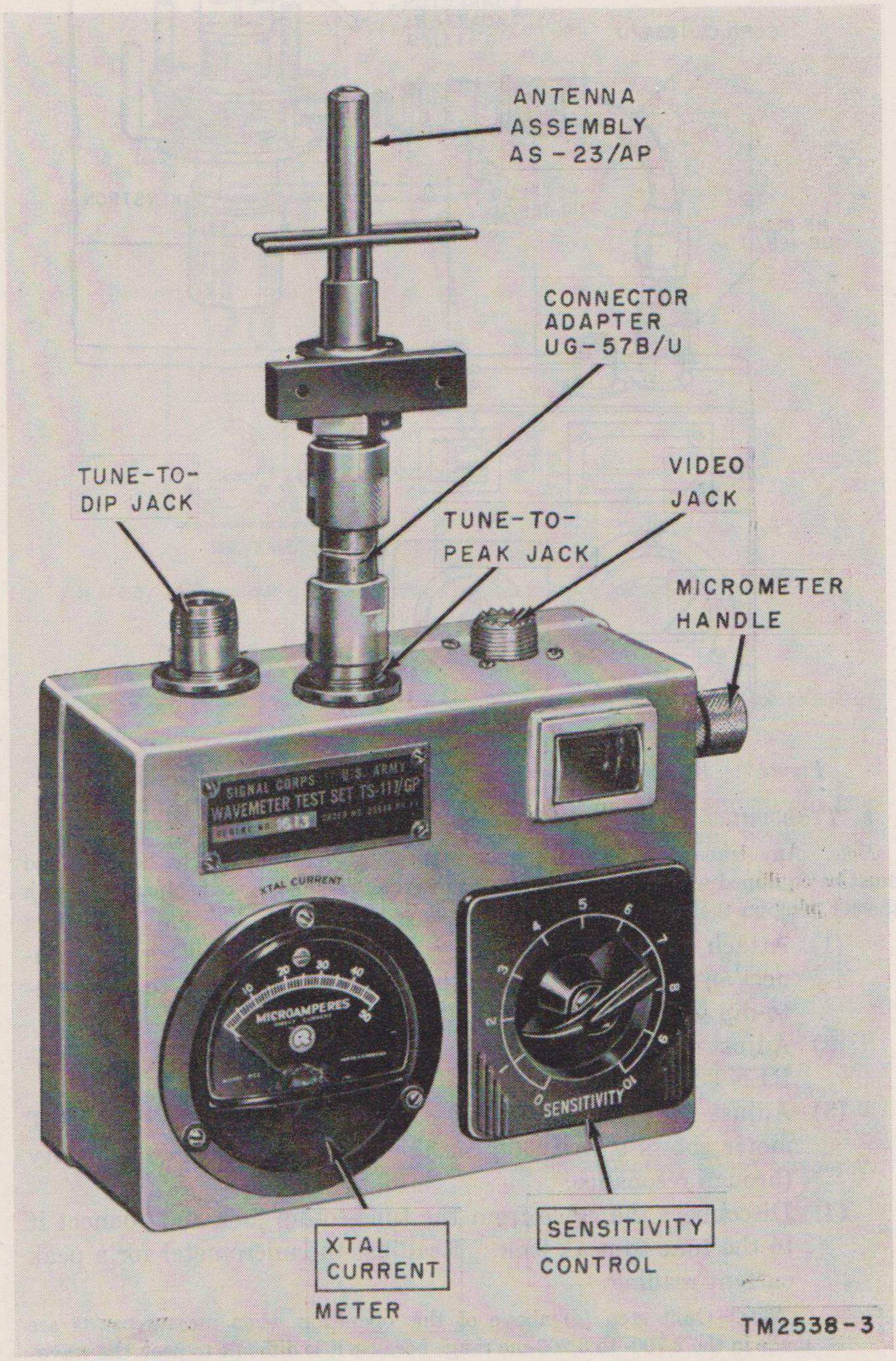


Figure 6. Wavemeter with antenna connected for frequency measurements in radar field.

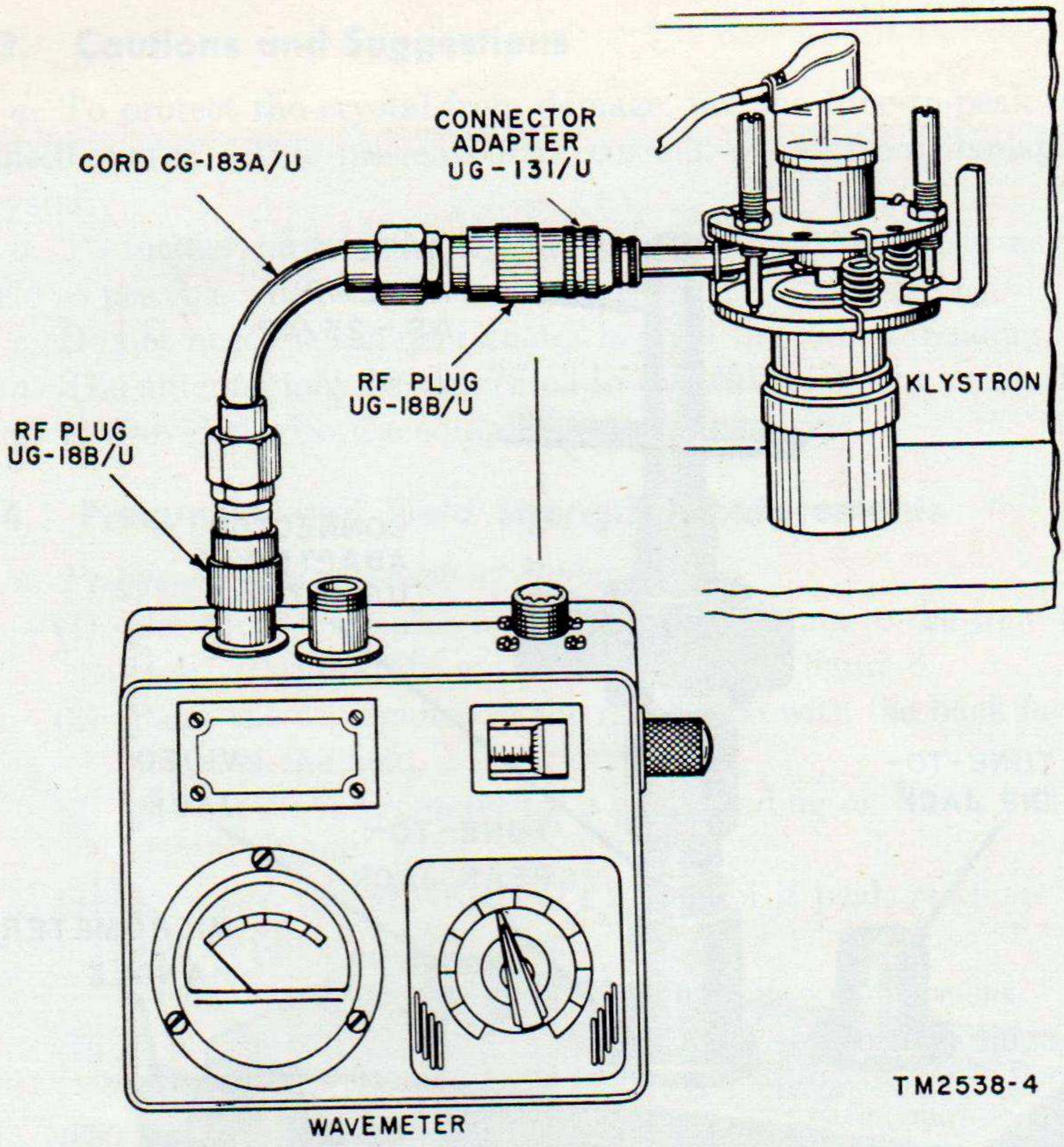


Figure 7. Wavemeter connections for measurement of klystron frequency.

c. Transmitter Frequency Measurements.

Note. Any transmitter or other apparatus whose frequency is to be measured must be equipped with a type N output connector. This type connector mates with the RF plug on the cord provided with the wavemeter.

(1) Attach one end of the cord to the type N connector and connect an RF adapter to the other end, then attach it to the tune-to-dip jack (fig. 8).

(2) Adjust the micrometer for a current dip on the XTAL CURRENT meter.

(3) Adjust the SENSITIVITY control until XTAL CURRENT meter shows a sharp dip as the micrometer tunes the cavity through resonance.

(4) Disconnect the cable from the tune-to-dip jack and connect it to the tune-to-peak jack. Readjust the micrometer for a peak current reading.

Note. Omit step (4) above of this operation when measurements are made in the 2,700- to 3,200-mc range because it is difficult to peak the wavemeter in this range.

(5) Refer to the calibration chart and convert the micrometer reading to frequency in megacycles.

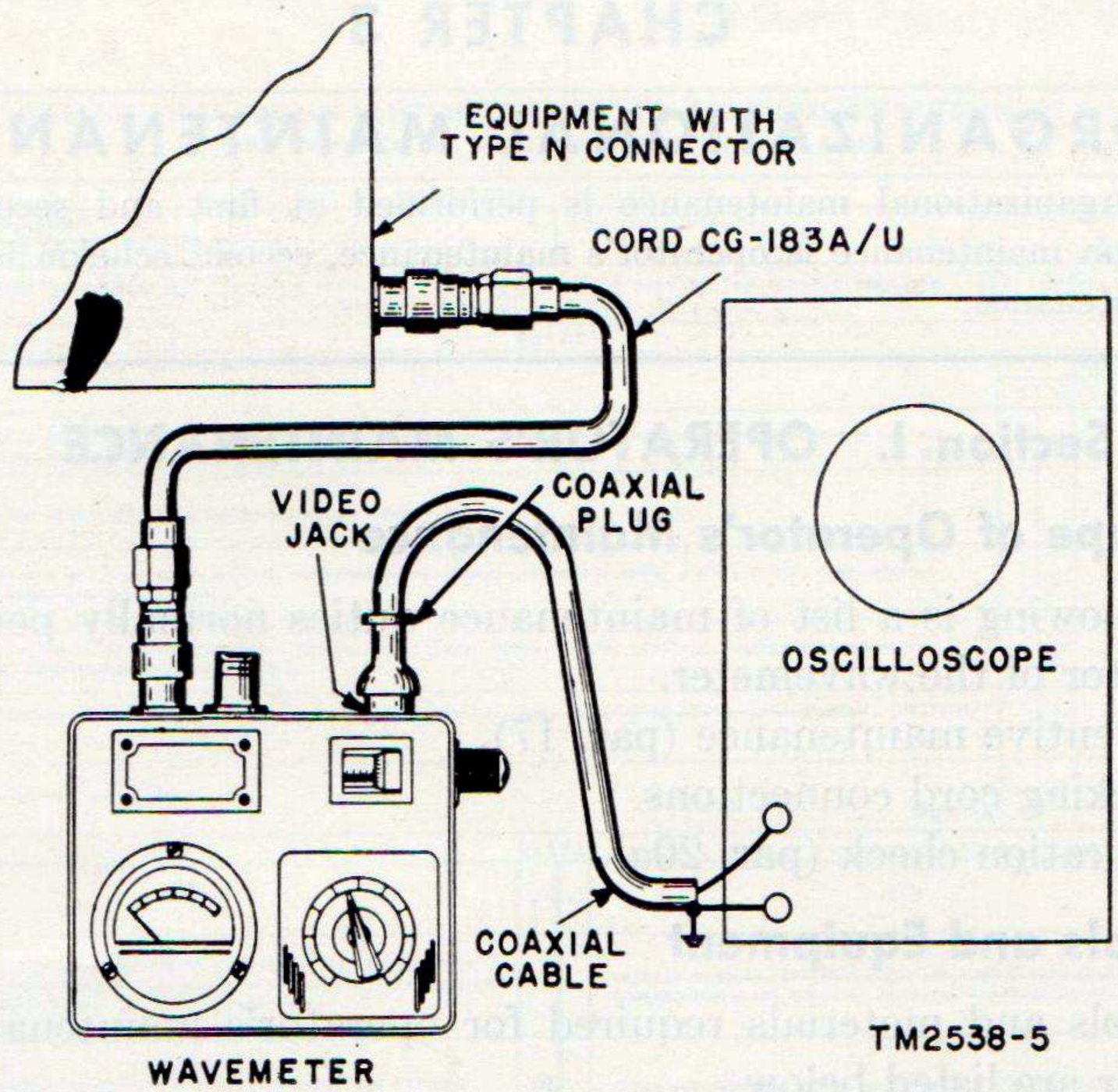


Figure 8. Wavemeter and oscilloscope connections for transmitter frequency measurements

(6) Connect an oscilloscope to the video jack if visual observation of modulated signals is desired (fig. 8).

d. Relative Field Strength Measurements.

(1) Connect the antenna to the tune-to-peak jack and make the first field strength measurement of a radar system whose field strength is known.

(2) Set the SENSITIVITY control for maximum reading on the XTAL CURRENT METER.

(3) Do not change the SENSITIVITY setting beyond this point.

(4) Tune in another radar signal. The field strength of this signal may now be determined by comparing the amount of deflection this signal causes on the XTAL CURRENT meter with that produced by the known signal.

Note. If a radar system with a known field strength is not available, the relative field strength of one system in respect to another can be compared.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Note. Organizational maintenance is performed at first and second echelons. First echelon maintenance is operator's maintenance, second echelon is unit repairman's maintenance.

Section I. OPERATOR'S MAINTENANCE

15. Scope of Operator's Maintenance

The following is a list of maintenance duties normally performed by the operator of the wavemeter.

a. Preventive maintenance (par. 17).
b. Checking cord connections.
c. Calibration check (par. 20*a*).

16. Tools and Equipment

The tools and meterials required for operator's maintenance on the wavemeter are listed below.

Screw driver, 6 inches.
Brush, paint, flat, 1 inch wide.
Cleaning Compound (Federal stock No. 7930–395–9542).
Cheesecloth, lint-free.

17. Operator's Preventive Maintenance

a. DA Form 11–238. DA Form 11–238 (fig. 9) is a preventive maintenance check list to be used by the operator. Items not applicable to the wavemeter are lined out in the figure. References in the ITEM block in the figure are to paragraphs that contain additional maintenance information pertinent to the particular item. Instructions for the use of the form appear on the back of the form.

b. Items. The information shown in this subparagraph is supplementary to DA Form 11–238. The item numbers correspond to the ITEM numbers on the form.

Item	Maintenance procedure
3	Use a clean cloth to remove dust, dirt, moisture, and grease from the antenna, jacks, and front panel control. If necessary, wet the cloth with cleaning compound, then wipe parts with a dry clean cloth.
5	The SENSITIVITY control should work smoothly. If the XTAL CURRENT meter shows intermittent increases or decreases in current as the control is rotated while a signal is being measured, apply cleaning compound so that it will run down the control shaft. Rock shaft several times.
8	Remove all rust from components and touch up bare spots with paint.
9	Repair any cuts in the insulation by covering them with rubber tape and then with friction tape. Replace or repair all broken cords.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: WAVEMETER TEST SET TS-117/GP

EQUIPMENT SERIAL NO.: 56

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receiver, transmitter, carrying cases, wire and~~ *cable,* ~~microphones, tubes~~, *spare parts, technical manuals and accessories).* PAR. 5		✓					
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE, HEADSETS, CHESTSETS, KEYS~~, JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS, COMPONENT PANELS.~~		✓					
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: ~~TUBES, LAMPS~~, CRYSTALS, ~~FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.~~		✓					
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS, MISALIGNMENT~~, POSITIVE ACTION.		✓					
6	CHECK FOR NORMAL OPERATION. PAR. 14		✓					

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND ~~CASES, RACK MOUNTS, SHOCK MOUNTS~~, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS.	✓	13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
8	INSPECT ~~CASES, MOUNTINGS~~, ANTENNAS, ~~TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	(X)	14	CLEAN ~~AIR FILTERS~~, BRASS NAME PLATES, DIAL AND METER WINDOWS, ~~JEWEL ASSEMBLIES~~.	(X)
9	INSPECT CORD, CABLE, ~~WIRE, AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	✓	15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	✓
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS ~~AND REFLECTORS.~~	✓	16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~	
11	INSPECT ~~CANVAS ITEMS, LEATHER, AND~~ CABLING FOR MILDEW, TEARS, AND FRAYING.	✓	17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: ~~SWITCHES~~, KNOBS, JACKS, CONNECTORS, ~~ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.~~	✓	18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 2538-6

Figure 9. DA Form 11–238.

18. Visual Inspection

a. When the wavemeter fails to perform properly, check all items listed below. It is important that the power is off in any equipment to which the wavemeter may be connected.

(1) Wrong adapter connection.
(2) SENSITIVITY control set too low (par. 14*a*(5)).
(3) Defective cord.
(4) Poor connection at jack.

b. If the above checks do not correct the wavemeter operation, proceed to the operational checklist (par. 19).

19. Operational Checklist

a. General. The following operational checklist will help the operator to quickly locate the trouble. The corrective measures are used to repair this trouble. If the measures suggested do not restore normal equipment performance, higher echelon repair is required. Note on the repair tag what corrective measures were taken and how the equipment performed at the time of failure.

b. Procedure. Place the wavemeter in operation (par. 14). Although the wavemeter does not require a warmup period, the equipment being measured does.

Action	Normal indication	Correction measures
1. Connect antenna to tune-to-peak jack (fig. 6) and place wavemeter in radar field.	XTAL CURRENT meter shows a peak reading when the micrometer tunes the cavity through resonance.	Check tune-to-peak jack and RF adapter. Check antenna connection for shorts. Turn up SENSITIVITY control.
2. Connect a klystron oscillator to tune-to-dip jack.	XTAL CURRENT meter shows a dip when the micrometer tunes the cavity through resonance.	Check tune-to-dip jack and RF adapter. Check connection to klystron oscillator.

20. Operator's Adjustments

a. The wavemeter may be checked for accuracy by comparing it with a standard cavity or a crystal controlled standard. UNDER NO CIRCUMSTANCES SHOULD RECALIBRATION BE ATTEMPTED. If the check indicates that the wavemeter requires recalibration, the entire unit should be turned in for higher echelon repair.

b. The transparent face of the meter may accumulate a static charge. This charge may deflect the meter needle. Breathing on the meter may eliminate the charge.

Section II. UNIT REPAIRMAN'S MAINTENANCE

21. Scope of Unit Repairman's Maintenance

Following is a list of maintenance duties performed by the unit repairman. The scope of these instructions is determined by the available tools, materials, test equipment, spare parts, and the MOS of the unit repairman, and consists of the following:

a. Replacement of defective crystals.

b. Preventive maintenance.

c. Repair of defective cord and connectors.

22. Tools, Materials, and Test Equipment

The tools, materials, and test equipment required for unit repairman's maintenance are listed below.

a. Tools. Tool Equipment TE–41.

b. Materials.

(1) Cleaning Compound (Federal stock No. 7930–395–9542).

(2) Cleaning cloth.

c. Test Equipment. Multimeter TS–352/U.

23. Unit Repairman's Preventive Maintenance

DA Form 11–239 (fig. 10) is a preventive maintenance check list to be used by the unit repairman. Items not applicable to the equipment are lined out in the figure. References in the ITEM block in the figure are to paragraphs that contain additional maintenance information pertinent to the particular item. Instructions for the use of the form appear on the back of the form.

24. Unit Repairman's Visual Inspection

Before operating the wavemeter inspect it for obvious defects (par. 18).

25. Equipment Performance Checklist

a. General. The equipment performance checklist is a procedure to systematically check wavemeter performance. All corrective measures which the unit repairman can perform are given in the *Corrective measures* column. When using the checklist, start at the beginning and follow each step in order. If the corrective measures shown do not fix the wavemeter, higher echelon repair is required. Note on the repair tag how the wavemeter performed and what corrective measures were taken.

b. Procedure. Place the wavemeter in operation (par. 14). Allow sufficient warmup time for any equipment the frequency of which is to be measured. Operate the wavemeter as shown in the check list following.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS —See other side

EQUIPMENT NOMENCLATURE: WAVEMETER TEST SET TS-117/GP

EQUIPMENT SERIAL NO.: 56

LEGEND FOR MARKING CONDITIONS: √ *Satisfactory;* X *Adjustment, repair, or replacement required;* ⊗ *Defect corrected.*

NOTE: *Strike out items not applicable.*

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receiver, transmitter, carrying cases,~~ *wire and cable,* ~~microphones, tubes,~~ *spare parts, technical manuals, and accessories*). PAR. 5	√	19	~~ELECTRON TUBES—INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS, INSUFFICIENT SOCKET SPRING TENSION, CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.~~	
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~		20	~~INSPECT FILM CUTOUTS FOR LOOSE PARTS, DIRT, MISALINEMENT, AND CORROSION.~~	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE, HEADSETS, CHESTSETS, KEYS,~~ JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS, COMPONENT PANELS.~~	√	21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION.	√
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: ~~TUBES, LAMPS,~~ CRYSTALS, ~~FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS, AND RESISTORS.~~	√	22	~~INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS, BURNED, PITTED, CORRODED CONTACTS, MISALINEMENT OF CONTACTS AND SPRINGS, INSUFFICIENT SPRING TENSION, BINDING OF PLUNGERS AND HINGE PARTS.~~	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, ~~EXCESSIVE~~ LOOSENESS, ~~WORN OR CHIPPED GEARS, MISALINEMENT,~~ POSITIVE ACTION.	√	23	~~INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALINEMENT OF PLATES, AND LOOSE MOUNTINGS.~~	
6	CHECK FOR NORMAL OPERATION. PAR. 14	√	24	INSPECT RESISTORS, ~~BUSHINGS,~~ AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION, AND MOISTURE.	√
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND ~~CASES, RACK MOUNTS, SHOCK MOUNTS,~~ ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES,~~ AND CABLE CONNECTIONS.	√	25	INSPECT TERMINALS OF LARGE ~~FIXED CAPACITORS AND~~ RESISTORS FOR CORROSION, DIRT, AND LOOSE CONTACTS.	√
8	INSPECT ~~CASES, MOUNTINGS,~~ ANTENNAS, ~~TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	√	26	CLEAN ~~AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND~~ INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE.	√
9	INSPECT CORD, CABLE, ~~WIRE, AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	√	27	~~INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS, AND BREAKS.~~	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS, ~~AND REFLECTORS.~~	√	28	~~CHECK SETTINGS OF ADJUSTABLE RELAYS.~~	
11	INSPECT ~~CANVAS ITEMS, LEATHER, AND~~ CABLING FOR MILDEW, TEARS, AND FRAYING.	√	29	~~LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: ~~SWITCHES,~~ KNOBS, JACKS, CONNECTORS, ~~ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.~~	⊗	30	~~INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.~~	
13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~		31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR ~~TRANSFORMERS, CHOKES,~~ POTENTIOMETERS, ~~AND RHEOSTATS.~~	√
14	CLEAN ~~AIR FILTERS,~~ BRASS NAMEPLATES, DIAL AND METER WINDOWS, ~~JEWEL ASSEMBLIES.~~	√	32	INSPECT ~~TRANSFORMERS, CHOKES,~~ POTENTIOMETERS, ~~AND RHEOSTATS~~ FOR OVERHEATING ~~AND OIL LEAKAGE.~~	√
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	√	33	~~BEFORE SHIPPING OR STORING, REMOVE BATTERIES.~~	
16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~		34	~~INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.~~	
17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~		35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT, AND GREASE.~~		36	~~INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.~~	
			37	~~MOISTURE AND FUNGIPROOF.~~	

38 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-239 Replaces DA AGO Form 419, 1 Dec 50, which is obsolete. 16—84382-2

TM2538-9

Figure 10. DA Form 11-239.

c. Check List.

Action	Normal indication	Corrective measures
1. Connect antenna to tune-to-peak jack and place wavemeter in radar field.	XTAL CURRENT meter shows a peak reading when micrometer tunes cavity through resonance.	Check items listed in paragraph 14. Remove crystal (par. 26*c*). Measure crystal resistance with Multimeter TS-352/U. Reverse ohmmeter leads and measure the resistance again. The ratio of the two resistances must be greater than 1 to 1. If in doubt, check crystal performance by substituting with a spare crystal.
2. Connect a klystron oscillator to tune-to-dip jack (par. 14*b*).	XTAL CURRENT meter shows a dip when the micrometer tunes the cavity through resonance.	Follow procedure listed in step 1.
3. Connect transmitter to the tune-to-dip jack (par. 14*c*).	XTAL CURRENT meter shows a dip when the micrometer tunes the cavity through resonance.	Check adapter connections. Check transmitter or apparatus being measured for normal operation. Check crystal as outlined in step 1.

26. Care of Crystal

a. Crystals should be handled with care and should not be dropped. In dry climates, handle a crystal as little as possible because static discharges from the fingers may damage a crystal. Do not allow a crystal to be left unshielded when near fields of radar energy. Such fields easily burn out crystals.

b. Crystals that are not satisfactory for use in radar systems, but are not burned out, may be in good enough condition for use in the wavemeter. If this type of crystal will give a full deflection of the XTAL CURRENT meter when installed in the wavemeter, it may be used to conserve crystal supply.

c. The crystal is removed by taking off the wavemeter backplate, unscrewing the knurled nut on the crystal fitting, and removing the crystal. One of the spare crystals can be put in place of the removed crystal or, if a supply of crystals is at hand, a new crystal can be put in place of the defective one. Screw the holder in place and replace the backplate.

CHAPTER 4

THEORY

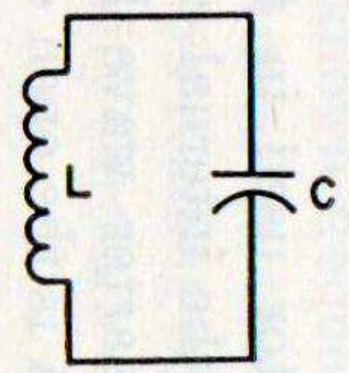
27. Cavity Resonators

(fig. 11)

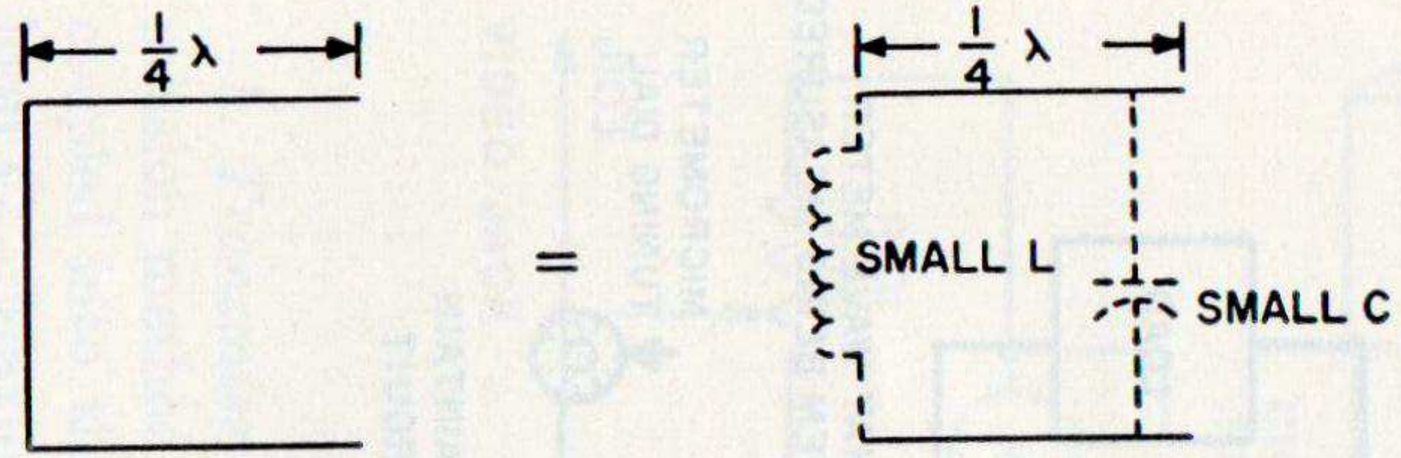
A common resonant circuit consists of a coil with a capacitor shunted across its terminals (A). To increase the frequency, either the inductance or the capacitance must be reduced. Eventually, a frequency is reached where the inductance is 1 turn of wire and the capacitor consists of distributed capacitance across the opposite sides of the same turn. A length of line (B) is cut to a quarter wave length representing a very small inductance-capacitance which is resonant to some high frequency. The resonant frequency cannot be further increased by the addition of quarter wave lines in parallel because the connections of parallel lines decreases inductance in the same proportion that capacitance is increased. However, an important benefit is gained by parallel lines because the resistance of the circuit is decreased and the Q is increased. Since the frequency is not affected by the number of quarter wave lines connected together at their open ends, the number of lines can be increased until the resonant circuit takes the shape of a cylinder with closed ends like a flat container (C, D, E). Any space completely inclosed with conducting walls can contain oscillating electromagnetic fields within it and possess certain resonant frequencies when excited by electrical oscillations. Resonators of this type are called cavity resonators and find extensive use as resonant circuits at extremely high frequencies. The simplest cavity resonators are half wave sections of waveguides shorted at each end.

28. Resonant Frequency of Cavity Resonators

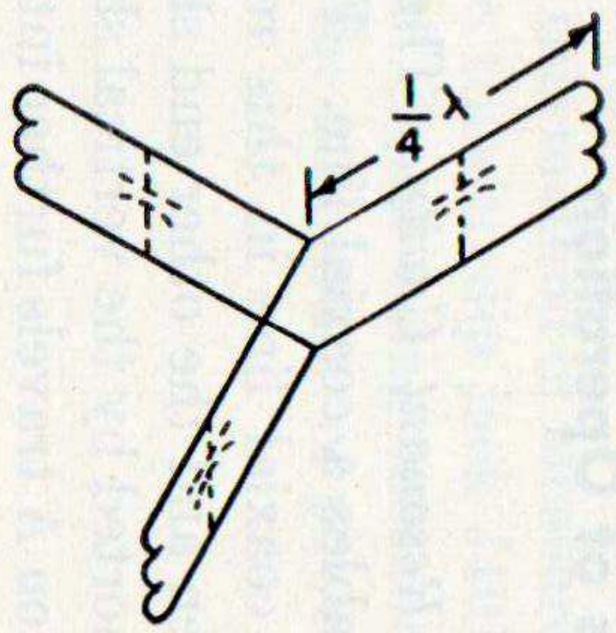
Any cavity is resonant at a number of frequencies. The resonance having the longest wavelength (lowest frequency) is the fundamental frequency. The resonant frequency of a cavity resonator can be changed by altering the mechanical dimensions. Small changes in mechanical dimensions may be achieved by flexing the cavity walls while large changes may be achieved by using a sliding member within the cavity. The latter method is used in the wavemeter described in this manual.



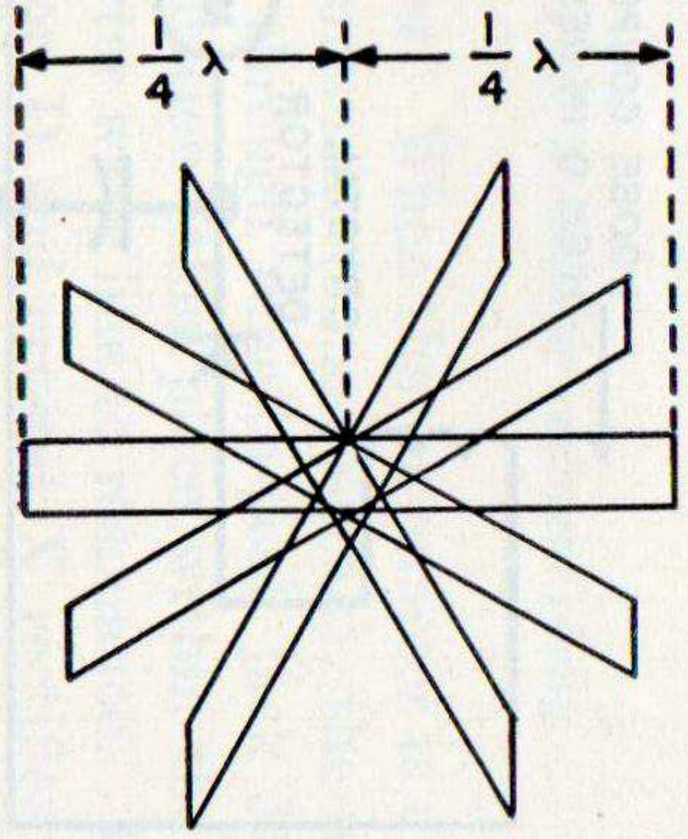
A. L-C CIRCUITS OF RADIO FREQUENCIES



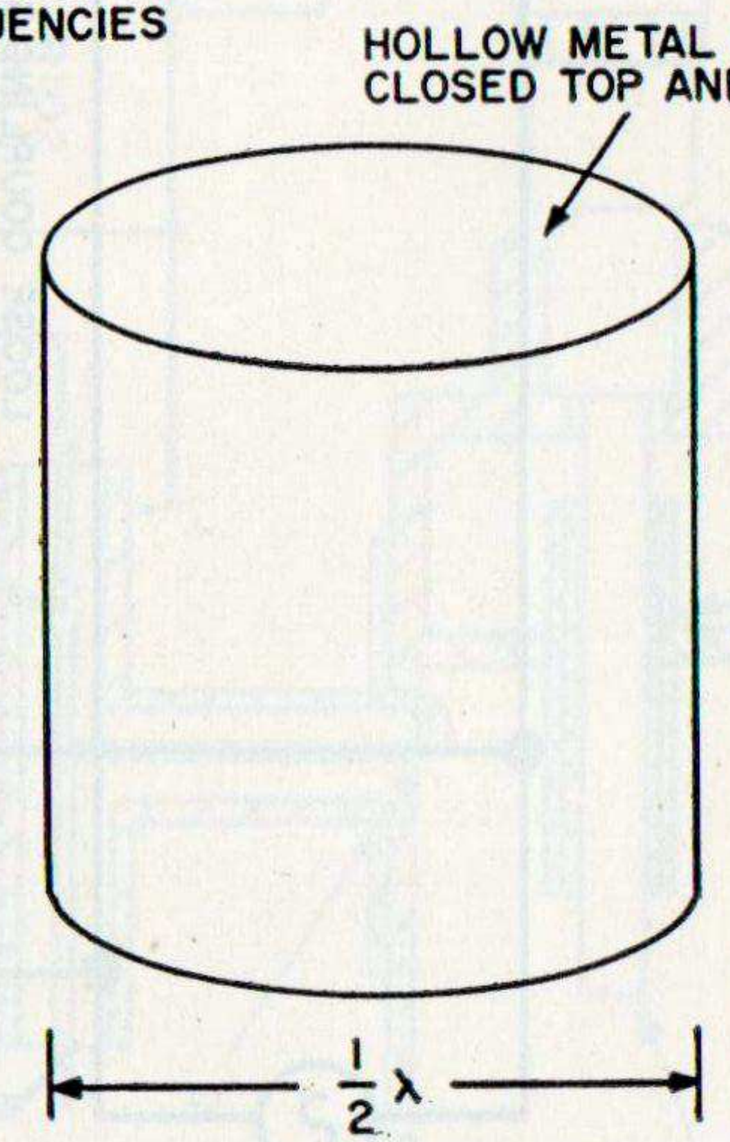
B. QUARTER-WAVE LINES OF HIGH RADIO FREQUENCIES



C. JOINING OF QUARTER-WAVE LINES



D. MANY QUARTER-WAVE LINES IN PARALLEL



E. PRACTICAL CAVITY RESONATOR

TM 2538-13

Figure 11. Resonant cavity development.

29. Coupling to Cavity Resonators

Coupling can be made to a cavity resonator by inserting a coupling loop. Magnetic coupling is obtained by a small coupling loop so oriented as to inclose magnetic flux lines. A current passing through such a loop will introduce oscillations within the cavity. Oscillations existing in the cavity will also induce a voltage in a coupling loop. Figure 12 shows an equivalent circuit when wavemeter coupling takes place.

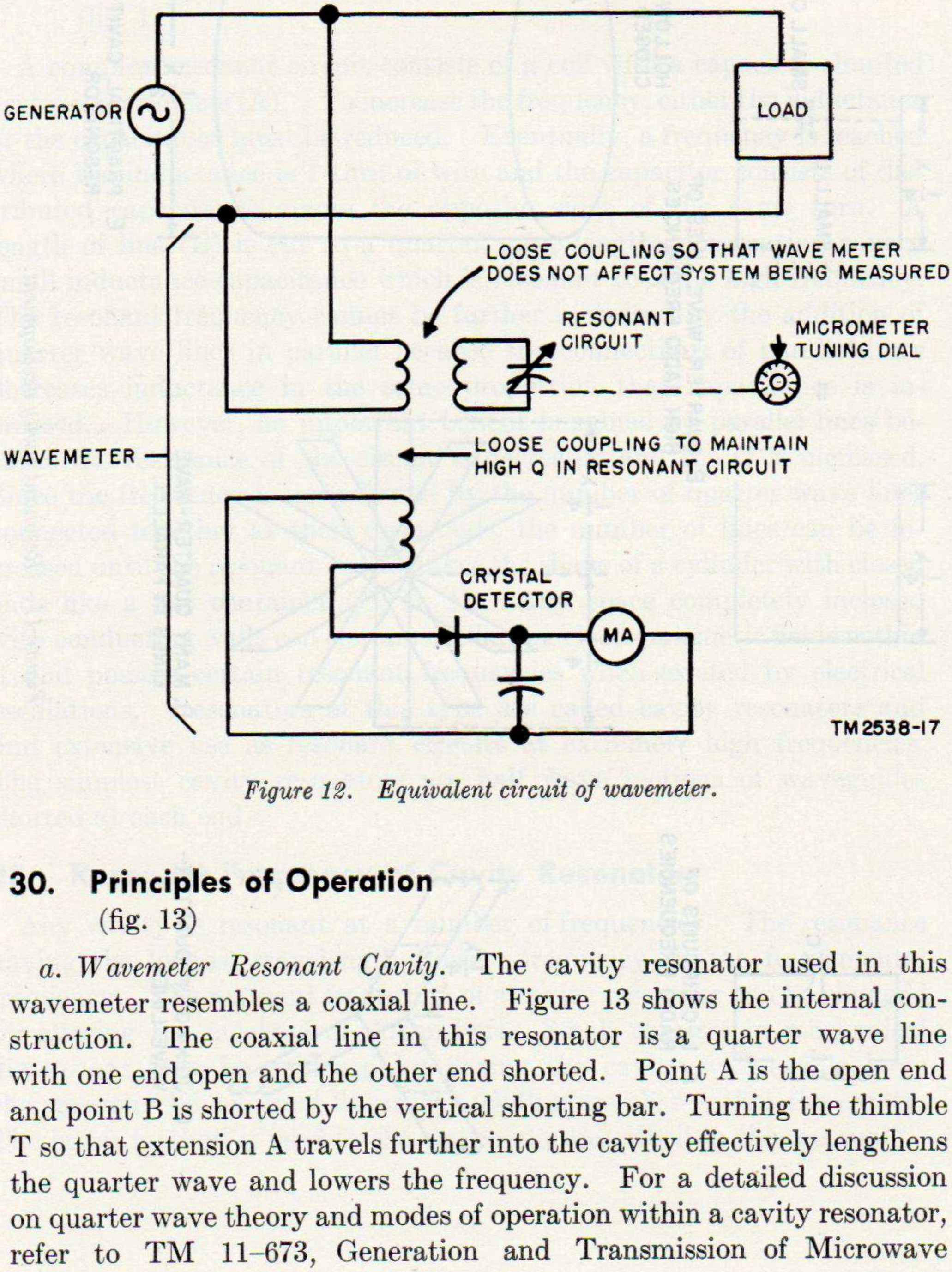


Figure 12. Equivalent circuit of wavemeter.

30. Principles of Operation
(fig. 13)

a. Wavemeter Resonant Cavity. The cavity resonator used in this wavemeter resembles a coaxial line. Figure 13 shows the internal construction. The coaxial line in this resonator is a quarter wave line with one end open and the other end shorted. Point A is the open end and point B is shorted by the vertical shorting bar. Turning the thimble T so that extension A travels further into the cavity effectively lengthens the quarter wave and lowers the frequency. For a detailed discussion on quarter wave theory and modes of operation within a cavity resonator, refer to TM 11–673, Generation and Transmission of Microwave Energy.

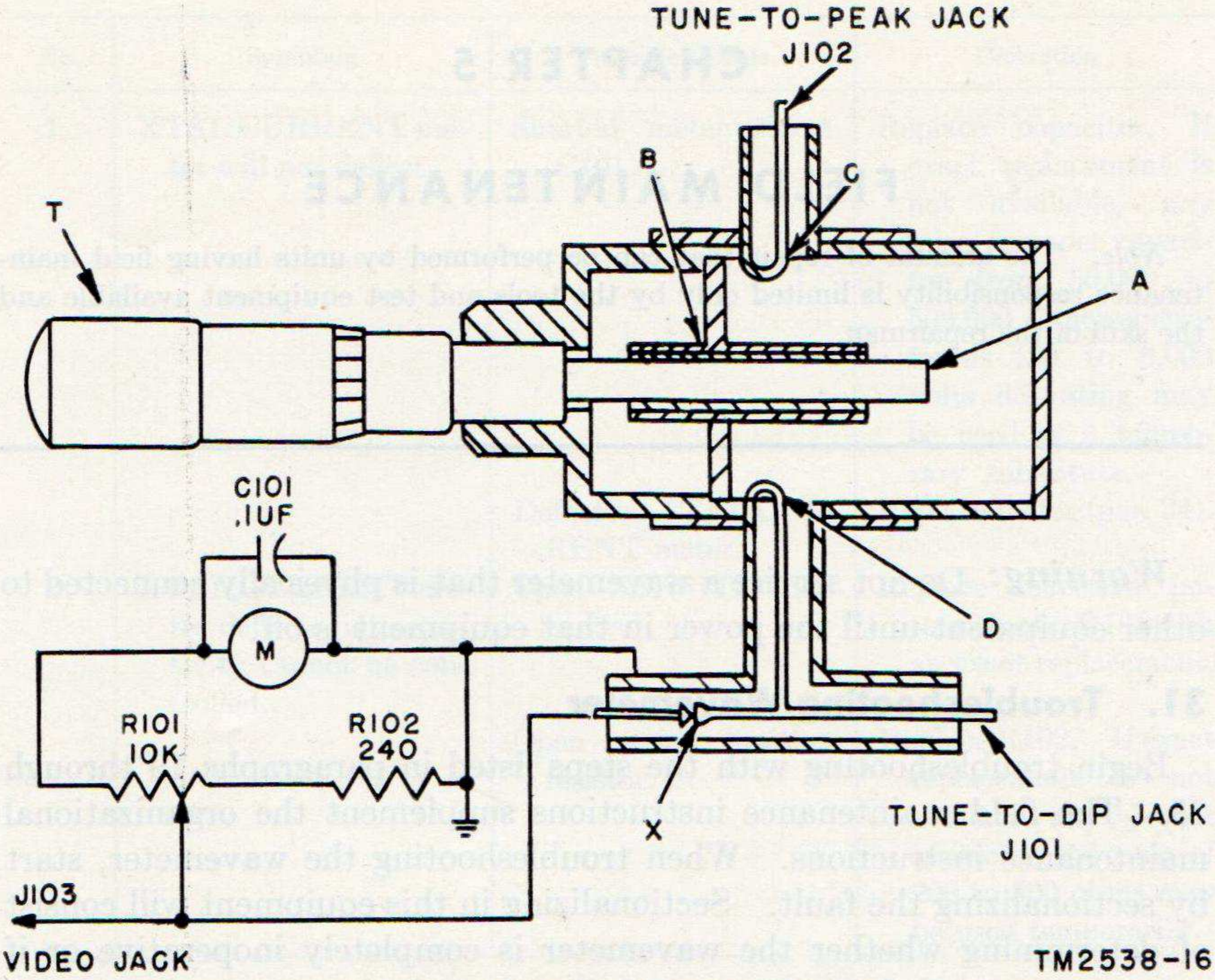


Figure 13. Wavemeter resonant cavity.

b. Transmission Method. When the wavemeter is used for the transmission method of measurement (tune-to-peak), the unknown signal is coupled into the cavity through tune-to-peak jack J102 and coupling loop C. Maximum oscillation takes place within the cavity when extension A tunes the quarter wave line to resonance. Energy is coupled out through coupling loop D and crystal X rectifies the signal. The rectified current flows through meter M and resistor R101 determines the maximum current permitted to flow through the meter. When meter M indicates maximum current, the wavemeter is tuned to the same frequency as the signal being measured.

c. Absorption Method. When this method of measurement is used the unknown frequency is applied to tune-to-dip jack J101. As the cavity is tuned to the frequency of the signal being measured, a dip in the meter reading occurs because of the absorption of power by the resonant cavity through coupling loop D.

CHAPTER 5

FIELD MAINTENANCE

Note. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and the skill of the repairman.

Warning: Do not service a wavemeter that is physically connected to other equipment until the power in that equipment is off.

31. Troubleshooting Wavemeter

Begin troubleshooting with the steps listed in paragraphs 19 through 25. The field maintenance instructions supplement the organizational maintenance instructions. When troubleshooting the wavemeter, start by sectionalizing the fault. Sectionalizing in this equipment will consist of determining whether the wavemeter is completely inoperative or if only one method of measurement is possible. Localizing means tracing the fault to a defective circuit and finally isolating the defective component.

32. Test Equipment Required

Nomenclature	Common name
Multimeter TS–352/U	Multimeter.
Oscilloscope OS–8A/U	Oscilloscope.
Crystal Rectifier Test Set TS–268/U	Crystal checker.
Frequency Meter TS–186A/UP	Frequency meter.

33. Troubleshooting Chart

The tests given in paragraphs 19 and 25 will prove to be effective in localizing troubles; performing these tests should be the first step in troubleshooting. The following chart is supplied as a further aid in locating trouble in the wavemeter. This chart lists the symptoms that the repairman observes while making simple tests. For each symptom, probable troubles and corrective actions are indicated.

No.	Symptom	Probable trouble	Correction
1.	XTAL CURRENT meter will not deflect.	Shorted meter shunt C101.	Replace capacitor. If exact replacement is not available, any mica or paper capacitor from 50,000 to 500,000 micromicrofarads 120 to 6,000 volts dc rating may be used as a temporary substitute.
		Defective XTAL CURRENT meter.	Replace meter (par. 34).
2.	XTAL CURRENT meter deflects but sensitivity cannot be controlled.	Open SENSITIVITY control.	Replace defective potentiometer R101 with an exact replacement.
		Open series limiting resistor.	Replace R102. If exact replacement is not available, any ½-watt resistor in the range of 200 to 500 ohms may be used temporarily.

34. Disassembly of Equipment to Replace Crystal

The following procedures are recommended as a guide for disassembling the wavemeter.

a. Loosen the four captive screws on the back of the meter.

b. Remove the backplate.

c. Unscrew the crystal housing and remove crystal Y101.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

35. Repacking for Shipment or Limited Storage

a. The exact procedure for repacking depends on the material available and the conditions under which the wavemeter is to be shipped or stored. Adapt the procedures outlined below.

b. With each wavemeter, pack two manuals in a close-fitting bag made of waterproof material. Seal the seams with water-resistant, pressure-sensitive tape.

c. Cushion the wavemeter on all surfaces with pads made of single-faced corrugated fiberboard to absorb shocks that might be caused by handling and shipping. Secure the cushioning with gummed paper tape.

d. Line the nailed wooden box with waterproof material. Leave enough material so that it may be sealed over the receiver when it is placed in the box.

(1) Place the packaged wavemeter and the packaged manuals in the box.

(2) Seal the waterproof material with the water-resistant, pressure-sensitive tape.

(3) Nail the top on the wooden box.

36. Authority for Demolition

The wavemeter and its accessories will be demolished only upon the order of the commander.

37. Methods of Destruction

Use any of the methods listed in *a* through *f* below to make the equipment completely useless.

a. Smash. Smash the controls, tuning mechanism, resonant cavity, meter, crystals, and antenna assembly; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut the RF cable and internal wiring; use an axe, a handaxe, or a machete.

c. Burn. Burn cable, adapters, and manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend the cabinet and the main frame.

e. Explode. If explosives are necessary, use firearms, grenades, or TNT.

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

[AG 413.6 (1 Mar. 57)]

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11–128
11–500
11–557
11–587
11–592
11–597
44–16
44–17
44–116
44–117

NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see SR 320–50–1.

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