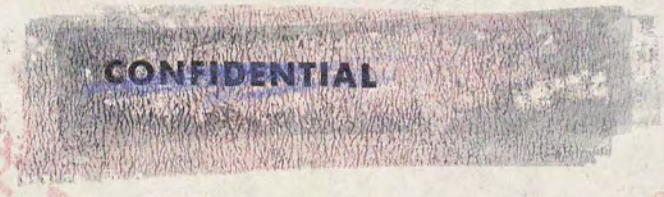
INSTRUCTION BOOK

FOR

FREQUENCY METER BC-438

per auth: Ltr 7, May 1945

per auth WD Pam 11-3



This Instruction Book for Frequency Meter BC-438, published by General Electric Company on Order 81-SCRL-42, is furnished for the information and guidance of all concerned.

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INSTRUCTION BOOK
FOR
FREQUENCY METER BC-438

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GEI-17491

July 1943 (800)

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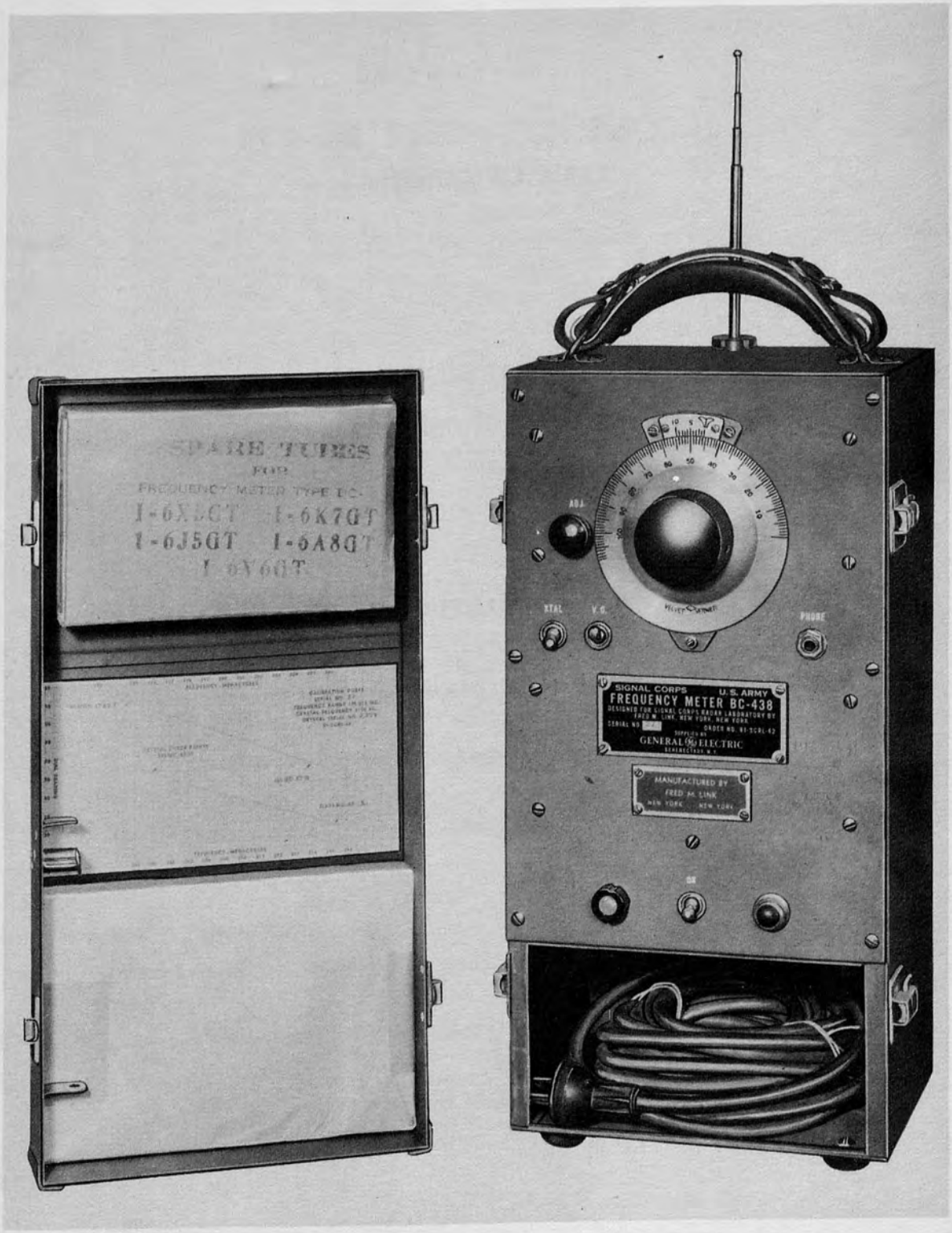

Frequency Meter BC-438, Front Oblique Right-side View, Cover Removed

FREQUENCY METER BC-438

1. General

The function of Frequency Meter BC-438 is the accurate measurement of frequencies between 195 and 215 megacycles. It is employed to check the frequency and the stability of frequency of Radio Transmitter BC-982-A, and to allow accurate resetting to 209 megacycles when necessary. It may also be used as a high frequency signal generator for tuning the r-f stages of the receiver and for other test purposes.

2. Operation

a. Plug the frequency meter into a 115-volt a-c source and allow a warm-up period of from 15 to 20 minutes.

b. Plug the earphones into the PHONE jack. The antenna need not be used in checking the transmitter frequency, but may be set up and plugged into the antenna jack when using the frequency meter for other purposes.

c. Throw the V.O. and XTAL switches upward to their on positions.

d. Make sure that no interfering frequencies are present, that is, that no other transmitter or tweeter is in operation in the vicinity. Then set the large condenser dial at exactly 50. Adjust the adjacent small vernier dial ADJ until the zero beat note is obtained. The zero beat note is the lowest tone pitch point between two high-pitched notes. The variable oscillator will then be aligned with the fifth harmonic of the 4100-kilocycle crystal and will be on 20.5 megacycles. The tenth harmonic of the variable oscillator, which is used for testing purposes, will then be on the calibration point of 205 megacycles. The frequency values for other points on the dial may then be read by referring to the calibration curve on the cover of the meter. See frontispiece.

e. Throw the XTAL switch downward to its off position.

f. Turn on the radio transmitter whose frequency is to be tested.

g. Turn the large tuning dial until a high-pitched hissing note is heard in the earphones.

h. Note the reading on the large tuning dial. From the chart on the inside of the cover of the frequency meter, determine the frequency of the radio transmitter being tested.

i. If the frequency is off, retune the radio transmitter, checking the frequency after each tuning.

3. Detailed Description of Electrical Circuits

Frequency Meter BC-438 measures frequencies by matching a known against an unknown frequency. This is accomplished by combining the known frequency with the unknown in a vacuum tube, so that a third frequency is produced. This third frequency is a measure of the difference between the frequencies being compared. The known frequency is then varied, and when the known and the unknown frequencies are practically the same, the third frequency enters the audible range. This audio signal is simplified and impressed upon the headphone receivers. The frequency of the unknown signal may then be determined by reference to the calibration chart.

Frequency Meter BC-438 contains four stages: a variable oscillator, a crystal oscillator, a detector, and an amplifier. In addition, a self-contained power supply provides these stages with the proper voltages. Refer to Fig. 7.

a. Variable Oscillator

The first stage, employing a Type -6K7GT vacuum tube, is a self-excited variable oscillator which may be varied in frequency between 19.5 and 21.5 megacycles. The tenth harmonic from this stage is matched with the frequency from the radio transmitter under test, by applying both to the Type -6A8GT detector tube. The calibration chart on the cover of the meter shows the tenth harmonic of the output frequency of the variable oscillator. This oscillator is operative only when the V.O. switch S1 is thrown upward to the on position.

b. Crystal-controlled Oscillator

The second stage, employing a Type -6J5GT vacuum tube, is a crystal-controlled oscillator operating at 4100 kilocycles. This oscillator is used as a standard for setting the tenth harmonic of the output of the variable oscillator on its 205-megacycle calibration point. With the V.O. and XTAL switches in their upward positions, the output of this stage, together with the signal from the variable oscillator, is applied to the Type -6A8GT detector tube. The frequency of the variable oscillator may then be adjusted to match the fifth harmonic of the crystal frequency by turning the vernier dial ADJ. In this way the variable oscillator is set on the reference point indicated on the calibration chart. The crystal stage is operative only when the XTAL switch S2 is thrown upward to the on position. It should be in this position only when calibrating the variable oscillator.

c. Detector

The detector stage employs a Type -6A8GT tube. This stage combines the signals of the two frequencies being matched, and generates a third frequency in its output which is equal to the difference of the two input frequencies. When the two input frequencies are brought sufficiently close together, audible frequencies will be produced in the output of this stage.

d. Audio Amplifier

The audible components from the detector stage are amplified by a Type -6V6GT tube. Ordinary resistance coupling is used between the two stages. The amplified audio signal is applied to an output transformer, which in turn supplies the signal for the actuation of the earphones.

e. Power Supply

A Type -6X5GT vacuum tube in the power supply provides full-wave rectification for the high-voltage winding of the power transformer. The filter system is a conventional two-choke, three-condenser unit.

4. Maintenance

a. General Trouble Shooting

The following tests are for use in locating trouble in Frequency Meter BC-438. Since no color codes are used in the wiring of the frequency meter, all leads must be traced with the aid of Fig. 7.

(1) No Tone in Earphones

The absence of tone in the headset when making a test of an unknown frequency is probably an indication of trouble in the circuit of the variable oscillator, or else that the strength of the signal to be measured is too weak, or that its frequency is outside the range of the meter. If, however, a tone is heard when making frequency determination, but none is heard when checking the variable oscillator against the crystal-controlled oscillator, it is an indication that the trouble is in the crystal oscillator section of the circuit. If no tone is heard on either check, the trouble may be in the audio amplifier, detector, or in the power supply.

(*a*) If L2 is open there is no beat against the external signal and the check beat is weak. When the antenna is touched, a loud hum is heard in the phones.

(*b*) To check the variable oscillator, touch its grid cap. If a loud squeal is heard in the earphones, then the plate and screen circuits are not the cause of trouble. To check if the tube is oscillating, touch the stator of C1. A loud click heard in the earphones indicates cessation of oscillation. If no click is heard look for shorted turns on L1, open or shorted C3, open by-pass condenser C6, or a defective Type -6K7GT oscillator tube.

(2) Visual Inspection

After the chassis has been removed, before any connections or tests are made, and with all power off, make a careful visual inspection of all wiring and apparatus. Look for burnt parts, visible shorts, wax melted from condensers or coils, foreign material such as pieces of loose wire scraps or solder chips, and for damage to parts. Check for the smooth mechanical operation of all controls.

(3) Power Supply

If the performance of the frequency meter indicates that there is trouble in the power supply system, make a test of the resistances and voltages to ground at the rectifier tube socket terminals, and at the filament leads before making any other tests.

b. Trouble-Shooting Data

The following data is provided as an aid in locating trouble.

(1) Table of Tube Socket Voltages

The table of tube socket voltages lists typical d-c voltages from vacuum tube terminals to ground, and typical a-c voltages across socket terminals connected to the transformer. These values are taken with the power on. They are based on using a 20,000-ohm per volt voltmeter for d-c measurements and a 1,000-ohm per volt voltmeter for a-c measurements. Analyzer I-167-A (Weston-772) is such a meter. The voltage values will vary slightly with the condition of the tubes and circuits, and the readings given should therefore be considered as approximate.

(2) Table of Tube Socket Resistances

The table of tube socket resistances lists approximate resistance values from tube terminals to ground with no power applied to the circuit, and using Analyzer I-167-A or equivalent as an ohmmeter.

(3) Continuity Test Tables

The following table gives the resistance values across various miscellaneous terminals with no power connected to the circuit and using Analyzer I-167-A or equivalent as an ohmmeter.

TABLE OF MISCELLANEOUS RESISTANCES

Reference Designation	Name of Part	Resistance Measured Across	Resistance in Ohms
Antenna	Jack	Jack to ground	22
115V A-c	Plug	Plug terminals	20, with switch S3 closed. Infinite, with switch S3 open
CH1	Choke	Winding	225
CH2	Choke	Winding	225
J	Jack	Jack terminals	100

(4) Possible Circuit Trouble and Their Causes

The following table gives certain indications of faulty operation together with the probable cause or causes.

INDICATIONS OF FAULTY OPERATION	PROBABLE CAUSES
1. Tube Terminal Voltages	
a. Voltage too low	(1) Low a-c power supply (2) Bleeder or load resistors of wrong value (3) Faulty filter system
b. Voltage too high	(1) High a-c power supply (2) Bleeder or load resistors of wrong value (3) Faulty filter system (4) Open bleeders or load resistors of other stages
c. No voltage	(1) No a-c power supply (2) Burned out fuse (3) Burned out transformer (4) Shorted filter system (5) Open resistor or circuit (6) Damaged rectifier tube
2. Pilot Light	
a. No light	(1) No a-c power (2) Open in S3 switch (3) Burned out fuse (4) Lamp loose in socket, burned out, or lead wires broken (5) Lamp socket shorted
3. No Tone or Weak Tone Heard	
a. No tone heard when making calibration check, but tone is heard in checking an unknown frequency.	(1) Trouble in XTAL oscillator stage (2) Crystal damaged or loose in socket (3) XTAL switch open (4) XTAL oscillator tube defective (5) C7 condenser open or shorted (6) R4 and R5 resistances open or shorted (7) Poor electrical contact between crystal nameplate and crystal clamp
b. No tone heard in checking unknown frequency, but tone heard in calibration test.	(1) Antenna not extended to full length (2) Distance from mount too great (3) Unknown frequency out of frequency range of meter (4) Coil L2 open
c. No tone on either external frequency or calibration checks.	(1) No power (2) Trouble in variable oscillator stage (3) Trouble in detector stage (4) Trouble in amplifier stage (5) Filter, bias, grid leak, or by-pass resistances and condensers open or shorted (6) Oscillator, detector, or audio amplifier tubes defective (7) Coupling condenser C5 or C11 open or shorted (8) L1 or L2 coils open or shorted (9) T1 transformer defective (10) Poor connection in output jack J (11) Variable condensers C1 or C2 defective

TABLE OF TUBE SOCKET RESISTANCES

Designation	Tube Type	Cap Grid	Ohms to Ground from Terminal No. 1	2	3	4	5	6	7	8
			Shell	Heater	Plate	Screen	Sup. Grid		Heater	Cathode
V.O. Oscillator	6K7GT (VT-86-B)	50,000	0	0	*60,000 **Infinite	*90,000 **Infinite	0	†40,000 **Infinite	0.3	0
							Grid			
XTAL Oscillator	6J5GT (VT-94-D)	—	0	0.3	†50,000 ††Infinite	*40,000	100,000	—	0	0
		Grid #4					Grid #1	Grid #2		
Detector	6A8GT (VT-151-B)	22	0	0.3	140,000	290,000	100,000	290,000	0	0
							Grid			
Audio Amplifier	6V6GT (VT-107-A)	—	0	0	40,000	40,000	500,000	40,000	0.3	2000
					Plate #1		Plate #2			
Rectifier	6X5GT (VT-126-B)	—	0	Infinite	210	—	210	—	Infinite	40,000

NOTE: Resistance from 3 to 4 of audio amplifier socket is 800 ohms.
Resistance from 2 to 7 of rectifier socket is 0.5 ohm.
Resistance between ungrounded terminals of each filter condenser is 250 ohms.

* V.O. switch on
** V.O. switch off
† XTAL switch on
†† XTAL switch off

TABLE OF TUBE SOCKET VOLTAGES*

Designation	Tube Type	Cap Grid	D-C Volts to Ground from Terminal No. 1	2	3	4	5	6	7	8
			Shell	Heater	Plate	Screen	Sup. Grid		Heater	Cathode
V.O. Oscillator	6K7GT (VT-86-B)	0	0	—	175	120	0	—	—	0
							Grid			
XTAL Oscillator	6J5GT (VT-94-D)	—	0	—	180	0	0	—	—	0
		Grid #4					Grid# 1	Grid #2		
Detector	6A8GT (VT-151-B)	0	0	—	180	27	0	27	—	0
							Grid			
Audio Amplifier	6V6GT (VT-107-A)	—	0	—	230	235	0	—	—	18
Rectifier	6X5GT (VT-126-B)	—	—	—	—	—	—	—	—	250

A-C Volts

Across any 2 to 7 connections (filament) of a tube	6.3 volts
Across 3 to 5 terminals of rectifier tube	420.0 volts

* All readings taken with V.O. and XTAL switches on.

TABLE OF REPLACEABLE PARTS
FREQUENCY METER BC-438

Ref No.	Stock No.	Name of Part	Description	Function	Manufacturer	Mfr. Part No.
C1	3D9025-13	Capacitor	Air variable, 25 mmfd	Tuning	Nat. Radio	SSU-25
C2	3D9005-9	Capacitor	Air variable, 5 mmfd	Trimmer	Hammarlund Mfg. Co. or equal	HF-15 Special
C3		Capacitor	Silver mica, 50 mmfd	Frequency Determining	Erie Resistor Co.	MIK-50
C4	3D295	Capacitor	Mica, 50 mmfd	Coupling	Solar Mfg. Co.	MO-1410
C5	3D296	Capacitor	Mica, 400 mmfd, 600 volts working	Coupling	Solar Mfg. Co.	MT-1321
C6	3D347	Capacitor	Mica, 0.002 mfd, 600 volts working	By-pass	Solar Mfg. Co.	MW-1233
C7	3D295	Capacitor	Mica, 50 mmfd	By-pass	Solar Mfg. Co.	MO-1410
C8		Crystal Clamp	Crystal clamp	Crystal Clamp and Coupling Capacitor	Link Radio Corp.	C8
C9		Capacitor	0.1 mfd, 600 volts	By-pass	Industrial Condenser Co.	6BA-10
C10	3D347	Capacitor	Mica, 0.002 mfd, 600 volts working	By-pass	Solar Mfg. Co.	MW-1233
C11		Capacitor	0.1 mfd, 600 volts	Coupling	Industrial Condenser Co.	6BA-10
C12 to C15	3D9008-4	Capacitor	Electrodyne, 8x8x8x8 mfd, 450 volts working (with clamps)	Filter	Solar Mfg. Co.	CE-8450
C16	3D347	Capacitor	Mica, 0.002 mfd, 600 volts working	By-pass	Solar Mfg. Co.	MW-1233
C17	3D347	Capacitor	Mica, 0.002 mfd, 600 volts working	By-pass	Solar Mfg. Co.	MW-1233
F	3Z1927	Fuse	1 amp, Type 3AG	A-C Line	Littelfuse, Inc.	
J		Jack	Closed circuit, single $\frac{3}{8}$-in. hole mounting	Earphone	Utah Radio Co.	IJ-102
CH12	C1538/C1	Choke Coil	6 h, 75 ma, d-c	Filter	Link Radio Corp. by Chicago Transformer Co.	TR-957
CH22	C1538/C1	Choke Coil	6 h, 75 ma, d-c	Filter	Link Radio Corp. by Chicago Transformer Co.	TR-957
L1	2C1538/C1	Inductor	Special, 11 turns on $\frac{1}{2}$-in. lucite core	Oscillator	Link Radio Corp.	L1

TABLE OF REPLACEABLE PARTS
FREQUENCY METER BC-438

Ref No.	Stock No.	Name of Part	Description	Function	Manufacturer	Mfr. Part No.
L2		Choke Coil	2.5 mh	Coupling	F. W. Sickles Co.	12381
PL	2C1538/L1	Pilot Light	6–8 volts		G.E. Co.	47
R1		Resistor	50,000 ohms, ½ watt	Bias	Erie Resistor Co.	505
R2		Resistor	50.000 ohms, 1 watt	Screen Dropping	Erie Resistor Co.	518
R3		Resistor	20,000 ohms, 1 watt	Load	Erie Resistor Co.	518
R4		Resistor	100,000 ohms, ½ watt	Bias	Erie Resistor Co.	505
R5		Resistor	10,000 ohms, 1 watt	Load	Erie Resistor Co.	518
R6		Resistor	100,000 ohms, ½ watt	Bias	Erie Resistor Co.	505
R7		Resistor	250,000 ohms, ½ watt	Screen Dropping	Erie Resistor Co.	505
R8		Resistor	100,000 ohms, ½ watt	Load	Erie Resistor Co.	505
R9		Resistor	500,000 ohms, ½ watt	Grid Return	Erie Resistor Co.	505
R10		Resistor	2,000 ohms, ½ watt	Bias	Erie Resistor Co.	505
R11		Resistor	40,000 ohms, 5 watt, Type 5-K	Bleeder	Sprague Resistor Co.	
S1	3Z8933	Switch	Toggle, single-pole, single-throw	Variable Oscillator	Arrow-Hart & Hegeman Electric Co.	
S2	3Z8933	Switch	Toggle, single-pole, single-throw	Crystal Oscillator	Arrow-Hart & Hegeman Electric Co.	
S3	3Z8933	Switch	Toggle, single-pole, single-throw	A-C Main Power	Arrow-Hart & Hegeman Electric Co.	
T1	2Z9954	Transformer	Primary: 10,000 ohms at 10 ma Plate to secondary: 2,000-ohm headphones	Output	Link Radio Corp. by Chicago Transformer Co.	6212
T2	2Z9955	Transformer	Primary: 115 volts, 60 cycles Secondary: (1) 6.3 volts, 1.5 amps (2) 6.3 volts, 0.6 amp (3) 1/20 volt center tap 25 ma	Power Supply	Link Radio Corp. by Chicago Transformer Co.	6201

TABLE OF REPLACEABLE PARTS
FREQUENCY METER BC-438

Ref No.	Stock No.	Name of Part	Description	Function	Manufacturer	Mfr. Part No.
	2T-86 B	Vacuum Tube	6K7GT (VT-86-B)	Variable Oscillator		6K7GT
	2T-94 D	Vacuum Tube	6J5GT (VT-94-D)	Crystal Oscillator		6J5GT
	2T-151 B	Vacuum Tube	6A8GT (VT-151-B)	Detector		6A8GT
	2T-107 A	Vacuum Tube	6V6GT (VT-107-A)	Audio Amplifier		6V6GT
	2T-126 B	Vacuum Tube	6X5GT (VT-126-B)	Full Wave Rectifier		6X5GT
	2C1538/S1	Socket	Octal, isolantite (for Type -6K7GT Tube)	Variable Oscillator	American Phenolic Corp.	SS8
		Socket	Octal, isolantite (for Type -6J5GT Tube)	Crystal Oscillator	American Phenolic Corp.	SS8
		Socket	Octal, isolantite (for Type -6A8GT Tube)	Detector	American Phenolic Corp.	SS8
		Socket	Octal, isolantite (for Type -6V6GT Tube)	Audio Amplifier	American Phenolic Corp.	SS8
		Socket	Octal, bakelite (for Type -6X5GT Tube)	Rectifier	American Phenolic Corp.	MIP-8
		Socket	Pilot light with green jewel	For Pilot Light	Dial Light Co. of America	810-BS
		Cord	A-C line cord with plug; 25 feet	Line	Link Radio Corp.	25-AC
		Antenna	Collapsible whip	Antenna	Link Radio Corp. by L. S. Brach	GV-42
		Crystal	4100-kc Crystal	Sets Frequency of Crystal-controlled Oscillator	Link Radio Corp.	
		Bushing	Threaded lucite	Antenna Bushing	Link Radio Corp.	
		Dial	4-in. vernier	Calibration	Link Radio Corp. or Nat. Radio	Type N Scale 3

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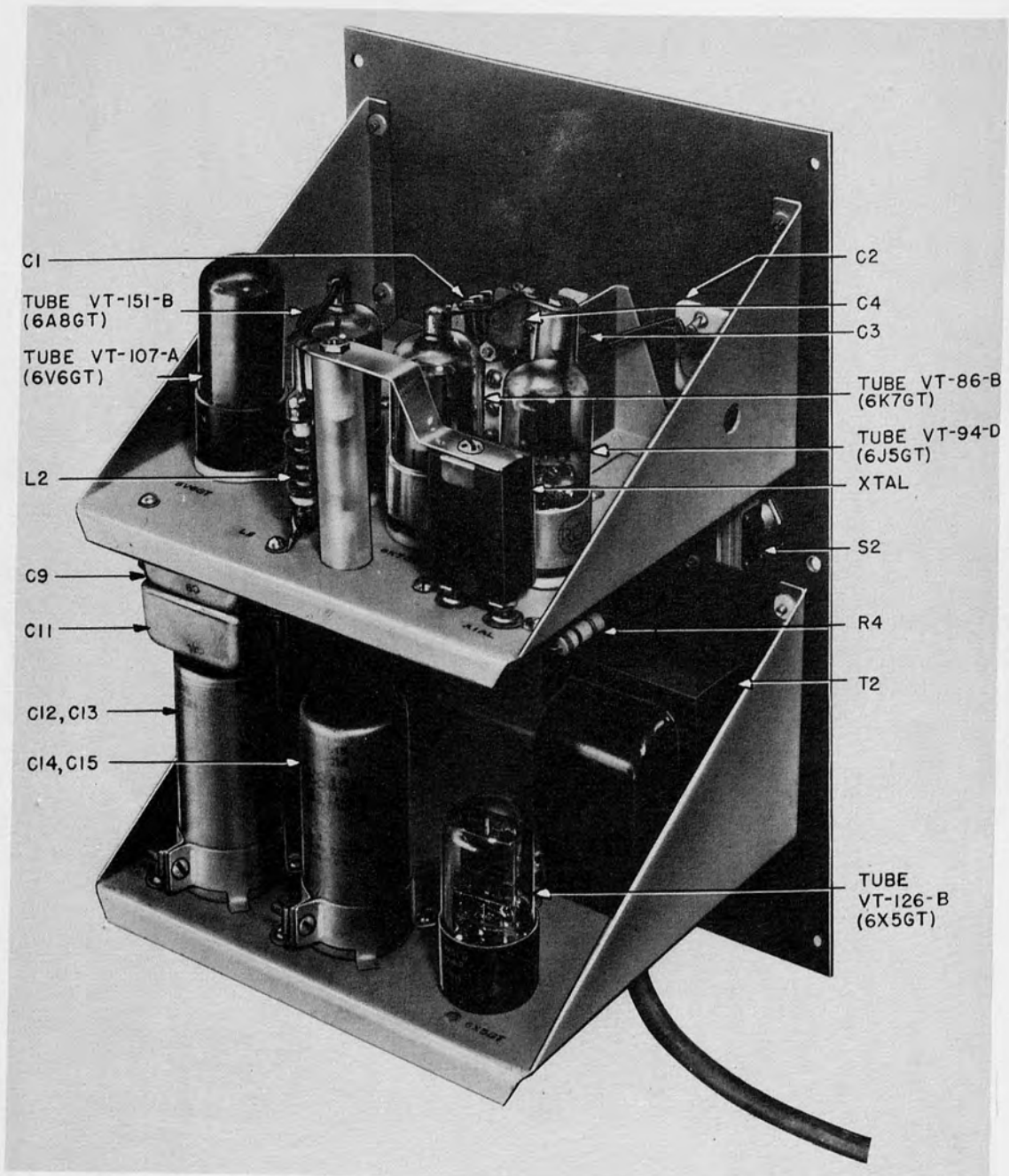

Fig. 1. Frequency Meter BC-438, Rear Oblique Left-side View, without Shields

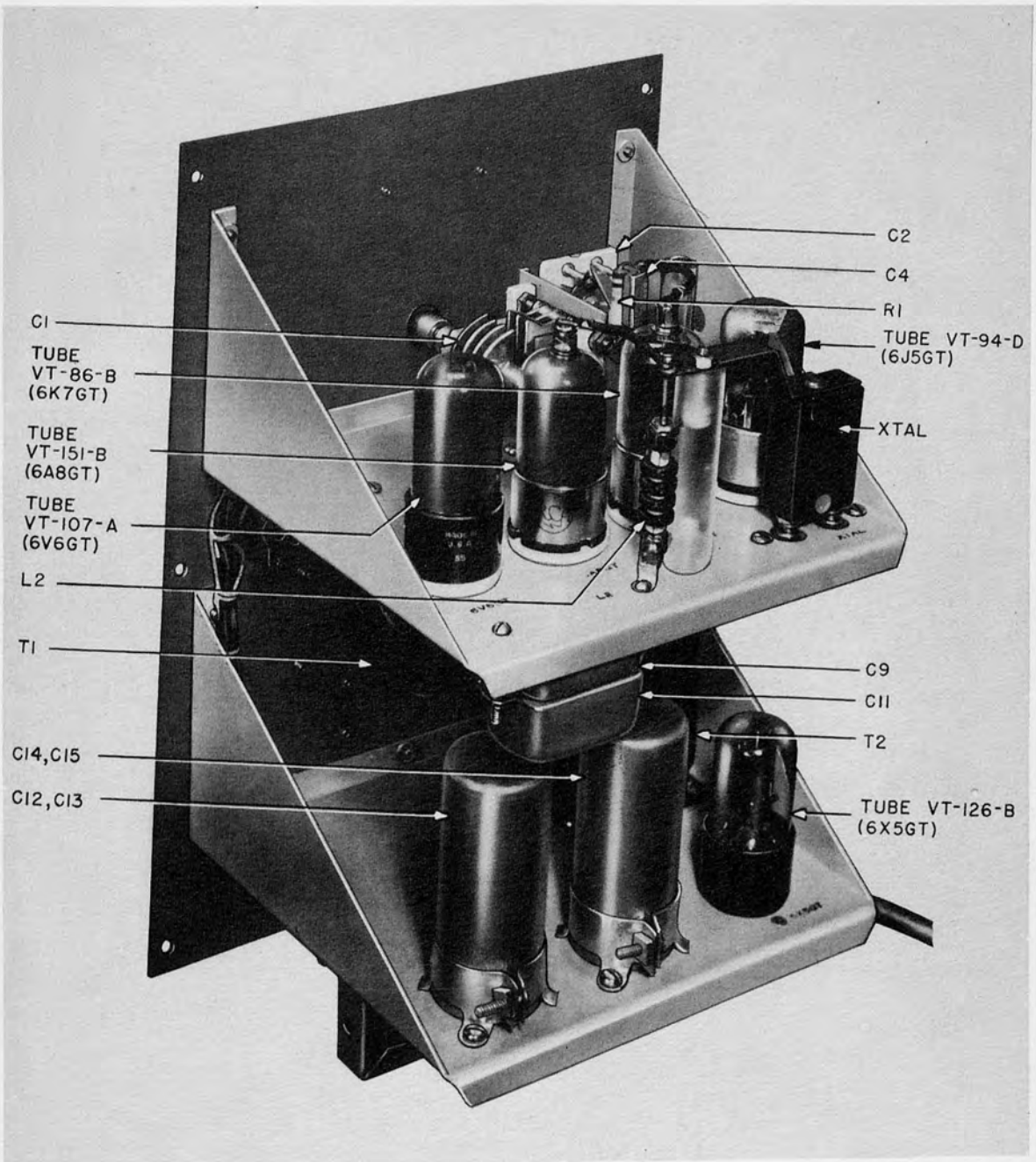

Fig. 2. Frequency Meter BC-438, Rear Oblique Right-side View, without Shields

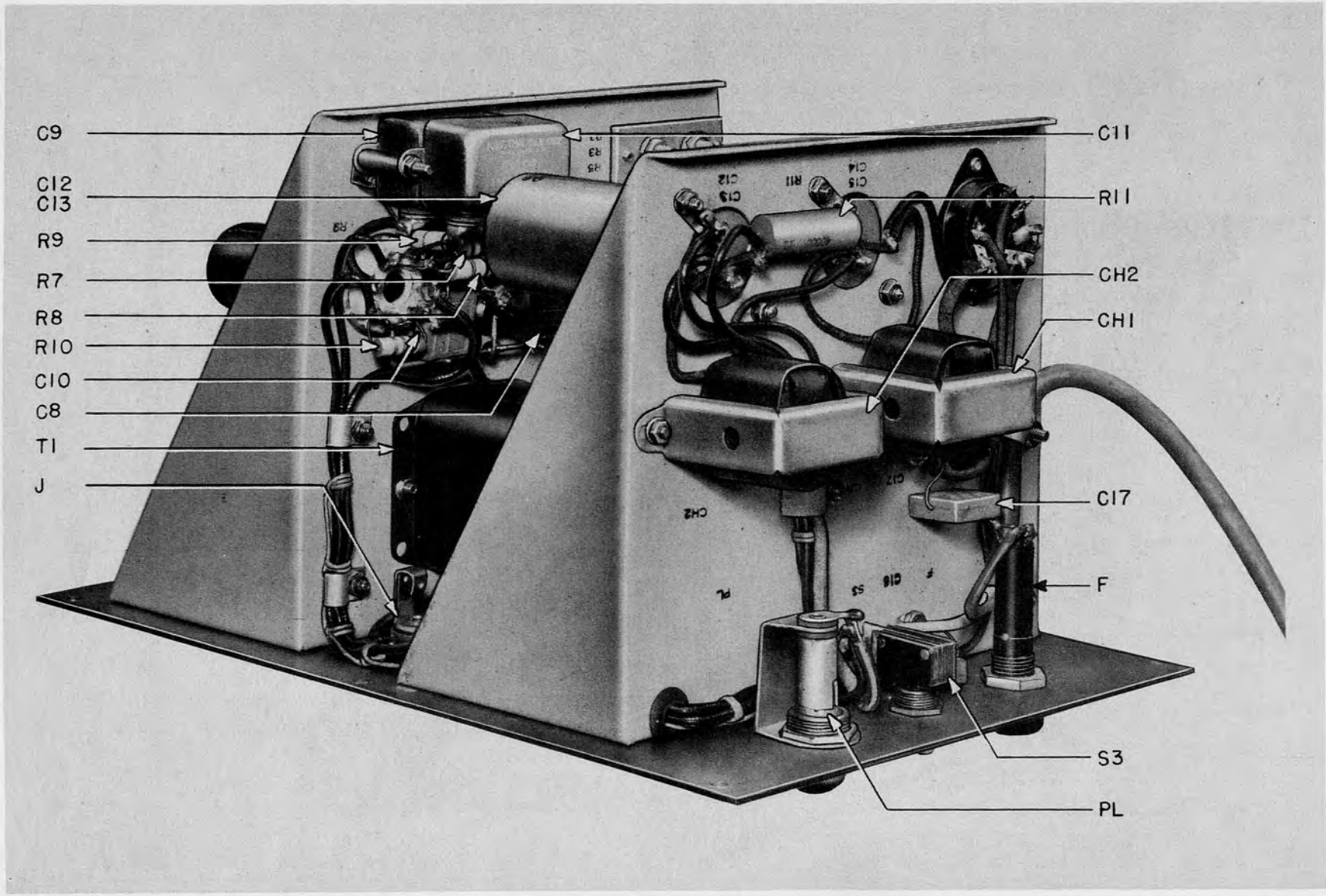

Fig. 3. Frequency Meter BC-438, Bottom Oblique Right-side View, without Shields

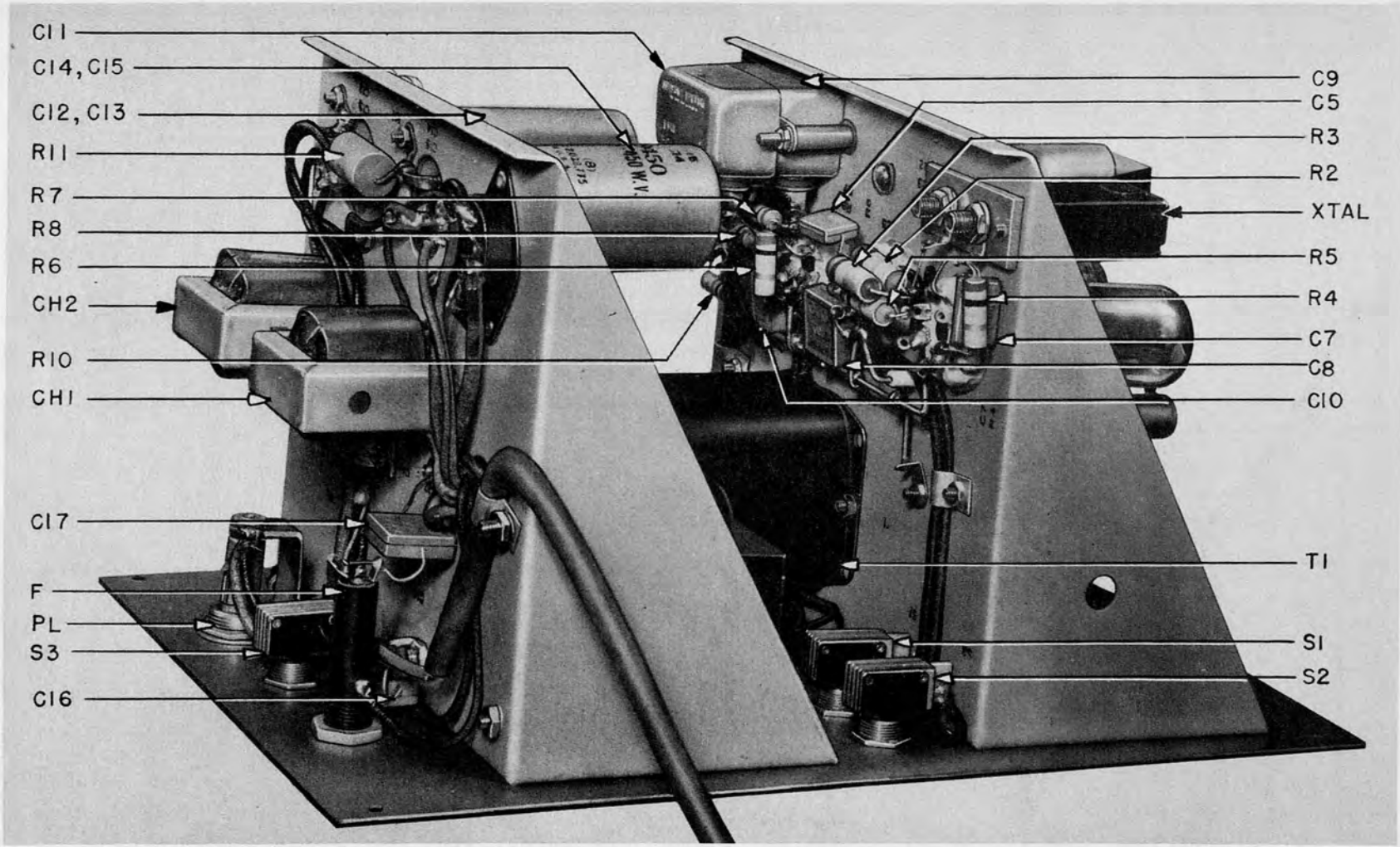

Fig. 4. Frequency Meter BC-438, Bottom Oblique Left-side View, without Shields.

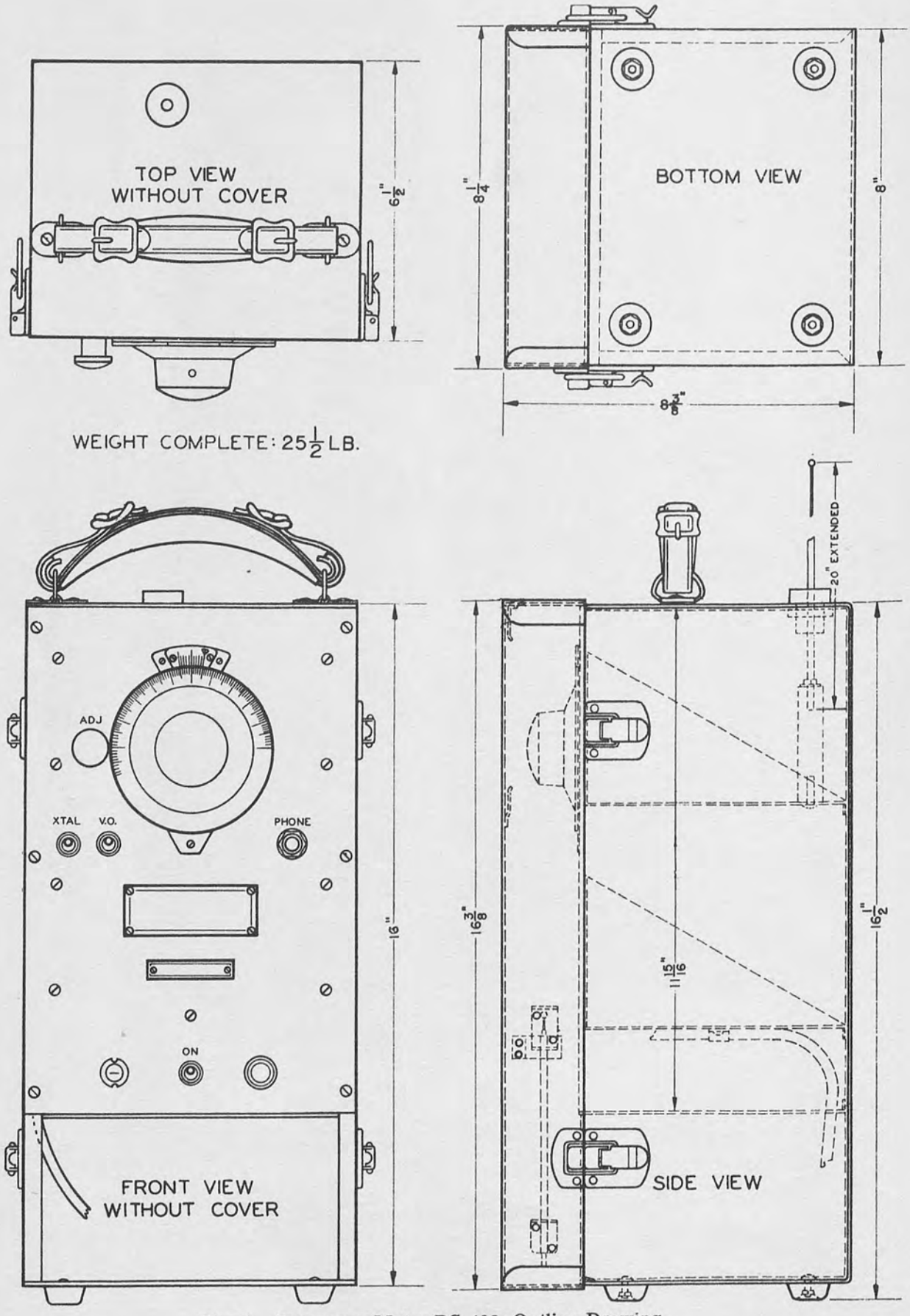

Fig. 5. Frequency Meter BC-438, Outline Drawing

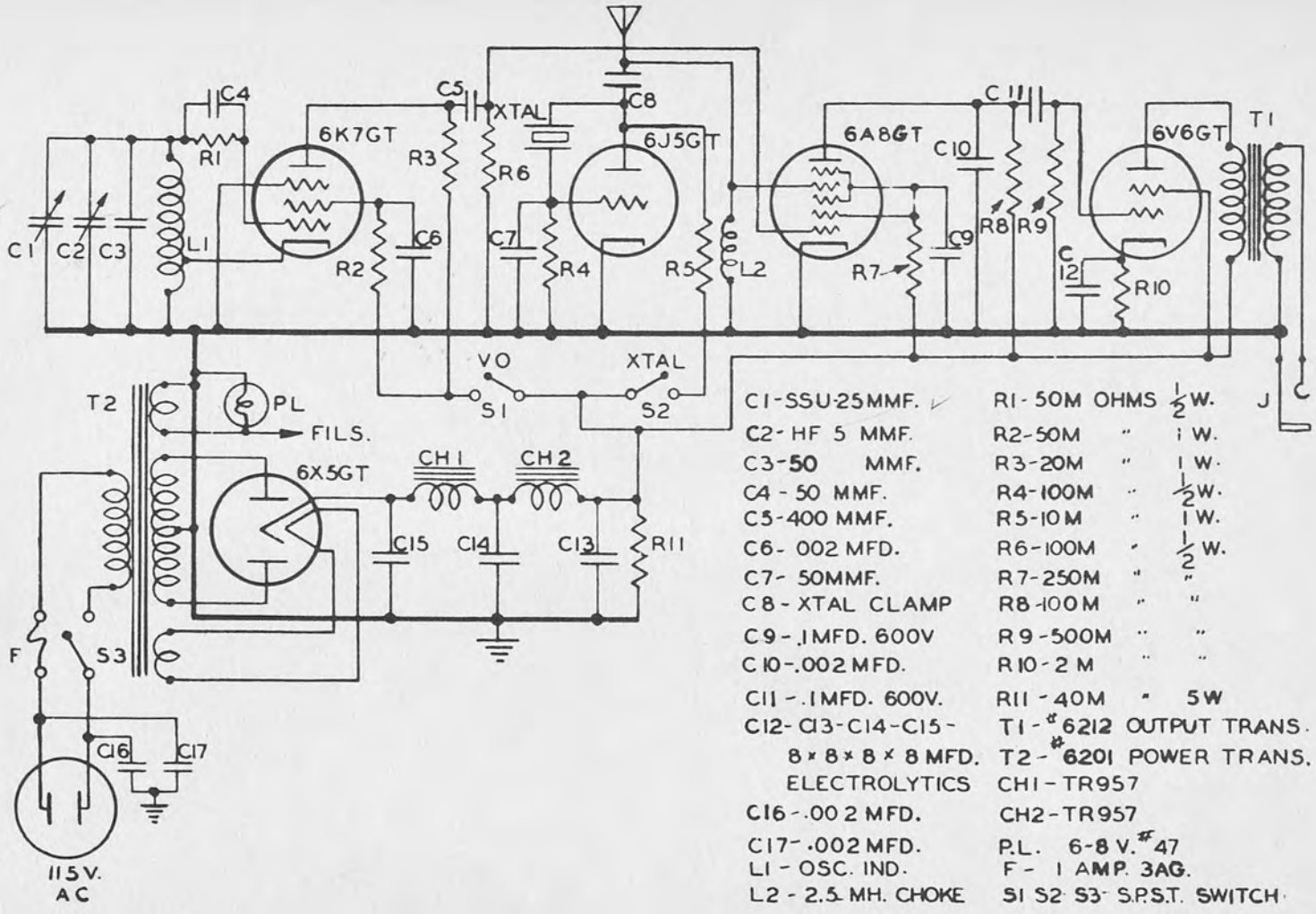

Fig. 6. Frequency Meter BC-438, Schematic Diagram