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INSTRUCTION AND OPERATING MANUAL

FOR

MODEL 204A

AUDIO OSCILLATOR
(Portable)
Serial 186 and Above

HEWLETT-PACKARD COMPANY
395 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

General Description

The Model 204A Audio Oscillator is a compact, lightweight, precision instrument with a self-contained battery power supply. It is enclosed by a sturdy, splashproof metal case.

This oscillator, which has a range of from 2 to 20,000 cycles/sec., is very useful for checking telephone or remote broadcast lines, laboratory use where a completely hum-free audio voltage is desired, and for geophysical use.

Parts Substitutions

Difficulties in procuring some of the parts used in this instrument may cause the electrical or physical values to deviate from those shown in this instruction manual. These substitutions have been made so as not to impair the performance of this instrument. Whenever replacement of any of these parts is necessary, either the substitute value or the original value may be used.

CAUTION

In order to obtain maximum useful life from the batteries in this instrument, always turn off the POWER switch when the instrument is not in use.

INSTRUCTIONS

MODEL 204A

AUDIO OSCILLATOR
(Portable)

Specifications

Frequency Rating --

Frequency Range - 2 to 20,000 cycles/sec.
Dial Calibration - 2 to 20
Ranges -

X1	2 to 20 cycles/sec.
X10	20 to 200 cycles/sec.
X100	200 to 2000 cycles/sec.
X1000	2000 to 20,000 cycles/sec.

Calibration Accuracy - ±2%
Frequency Response - ±1 db from 2 to 20,000 cycles/sec.
Frequency Stability - Within ±3% including calibration error, normal tube aging, and normal battery aging. Aging of batteries causes not more than 1% change in frequency.

Output Rating --

Rated Output - 5 volts across a 10,000 ohms resistive load
Distortion - Less than 1%, 10 to 20,000 cycles/sec.
Less than 2% below 10 cycles/sec.
Rated Load Impedance - 10,000 ohms, resistive

Power Source (Self Contained) --

Filament - 5 Burgess No. 2 (or equivalent) flashlight batteries (1-1/2 volts each)
Plate - 3 Burgess No. 5308 (or equivalent) batteries (45 volts each)
Battery Life - 60 hours total when used at the rate of 4 hours daily.

Overall Dimensions --

10-1/2" high x 10-1/2" wide x 11" deep

Weight --

Approximately 25 lbs including batteries.

Operating Instructions

Inspection --

This instrument has been thoroughly tested and inspected before being shipped and is ready for use when received.

After the instrument is unpacked, it should be inspected for damage received in transit. If any shipping damage is found, follow the procedure outlined in the "Claim for Damage in Shipment" page at the back of the instruction book.

Controls and Terminals --

AMPLITUDE - This control is a variable voltage divider which is used to control the amount of oscillator voltage applied to the input of the amplifier section and, therefore, the amplitude of the output voltage. The output voltage increases as the control is rotated clockwise. This control is calibrated from "0" to "100" in arbitrary units.

FREQ. RANGE - This rotary switch changes resistance values in the frequency determining sections of the instrument. The position of this switch determines the multiplying factor that must be used to convert the frequency dial indication to the actual output frequency of the instrument.

FREQUENCY - This control varies the capacity in the frequency determining circuits of the instrument.

The frequency dial is calibrated from 2 to 20 and its indication multiplied by the factor indicated by the position of the FREQ. RANGE switch will give the actual output frequency of the oscillator.

POWER - This rotary switch controls the power supplied to the instrument from the batteries. When the switch is in the OFF position, the two filament circuits and the two high voltage wires from the batteries are opened. When the instrument is turned on, the neon lamp on the control panel will flash periodically.

OUTPUT - The two binding posts, located in the lower left corner of the control panel, are the output terminals of the oscillator. The binding post marked G is connected to the instrument chassis and case.

Operation --

The procedure for operating the Model 204A Audio Oscillator is as follows:

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1. Release the latches on either side of the case cover and remove the cover.

2. Connect the equipment under test to the OUTPUT binding posts. Use the rated load impedance for best results.*

3. Set the FREQUENCY dial and FREQ. RANGE switch so that their indications, when multiplied together, equal the desired frequency. For example, if a frequency of 700 cycles/sec. is desired, set the FREQUENCY dial to 7 and the FREQ. RANGE switch to X100.

4. Turn the POWER switch to ON and adjust the AMPLITUDE control for the desired output voltage.

* Although the rated load impedance for this instrument is 10,000 ohms (resistive), higher or lower impedance loads may be used without damage to the instrument. Load impedances higher than the specified load impedance will result in lower power output. Lower load impedances will increase the percentage of distortion in the output voltage.

Information on when and how to replace batteries will be found in the Maintenance Section of this book.

Circuit Description

The Model 204A Audio Oscillator consists of an oscillator section, an isolating amplifier, and dry batteries to supply the filament and plate voltages.

The oscillator section consists of tubes V1 and V2 which are connected to form a two stage resistance coupled amplifier. Two feedback circuits are connected around this amplifier--a positive feedback circuit to produce oscillations and a negative feedback circuit to minimize distortion and maintain constant amplitude of oscillation.

The positive feedback circuit contains a fixed resistance (R1-R8) and variable capacity network (C1-C4). Oscillations are produced when there is zero phase shift through this feedback network and the oscillator frequency is determined by the circuit constants of this network.

The negative feedback network in the oscillator section minimizes changes in oscillator amplitude with changes in frequency. This network is composed of R12, R17, and R11. R11 is a 3 watt incandescent lamp. This lamp has a temperature-resistance characteristic such that its resistance will increase in direct proportion to the voltage applied to it. Changes in the resistance of this lamp will change the percentage of negative feedback in the oscillator circuit. When the oscillator voltage rises more voltage is applied to the lamp (R11), the increased voltage will raise the temperature and resistance of the lamp which in turn increases the percentage of negative feedback in the oscillator circuit. Increasing the percentage of negative feedback will tend to decrease the oscillator output voltage to its normal operating point. The action will be reversed if the oscillator output voltage decreases, the negative feedback voltage will decrease lowering the voltage across the lamp (R11) which will lower its resistance thus lowering the percentage of negative feedback and tending to raise the oscillator output to its normal operating point. The thermal inertia of the lamp is great enough so that its resistance will not vary in accordance with the sine wave voltage at the lowest frequencies involved.

The isolating amplifier (tube V3) prevents the oscillator from being affected by the external load. A negative feedback circuit which is part of the amplifier, reduces any distortion caused by the amplifier.

Maintenance

Battery Replacement --

Measurement of Battery Voltage - The most convenient method of measuring the battery voltage is to unscrew the clear plastic cover and remove the neon glow lamp I1. Connect the negative terminal of a high resistance voltmeter to the chassis. Turn on the instrument and connect the positive terminal of the voltmeter to the shell or center contact (the contact producing the highest voltmeter indication) of the neon lamp socket. For satisfactory operation of the instrument this voltage should be 100 volts (filament voltage 1.1 volts) or more with the instrument in operation.

When the battery voltage drops below 100 volts, both the filament and plate supply batteries must be replaced. If the batteries are used after the voltage has fallen below 100 volts, distortion will increase, the frequency calibration will be less accurate, and the output voltage will fall. This is shown on the accompanying graph "Typical Battery Life Data".

The instrument is designed so that the plate and filament batteries will deteriorate at approximately the same rate. Therefore, the two sets of batteries must be replaced at the same time.

Battery Replacement Procedure - The procedure for replacing the batteries is as follows:

1. Remove the case cover and unscrew the two captive screws. Slide the instrument out of the case. (See Fig. 4)

2. Turn the instrument upside down. Remove the four screws which hold the bottom plate in place and remove. Loosen the battery terminals and remove all the wires from the batteries.

3. Lift out the batteries and replace with a set of fresh batteries. Connect the wires to the proper terminals. (See Fig. 4.) Replace the bottom plate.

4. Turn the instrument right side up and replace the filament supply batteries with fresh batteries.

5. Turn on the instrument and measure the battery voltages as described in the Measurement of Battery Voltage section. The plate batteries should be at least 135 volts under load and the filament batteries at least 1-1/2 volts when loaded. If the battery voltages are normal, then replace the instrument in the case.

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Tube Replacement --

Tubes V2 and V3 may be replaced with any tube having normal characteristics. Tube V1 is more critical because it operates (lowest frequency range only) with an extremely high resistance in its grid circuit. Therefore, if the replacement for tube V1 has gas current, the frequency calibration of the lowest frequency range will shift due to the gas current flowing through the grid resistor.

Replacement of Lamp R11 --

This lamp operates far below its rated power consumption and should have an infinite life. However, should the lamp fail it will be necessary to readjust resistor R12 after the replacement lamp is installed.

Install the replacement lamp and measure the oscillator voltage between the junction of C9 and R19, and the chassis. This voltage must be between 9 and 11 volts (RMS) with the oscillator set at 1000 cycles/sec. If this voltage is not within the specified range, then adjust R12 so that the correct voltage is obtained.

Lubrication of Tuning Capacitor Drive Mechanism --

The tuning capacitor drive mechanism should be lubricated once a year. Put one drop of light oil (#10) in each of the three oil holes in the tuning capacitor drive casting (See Fig. 3). Do not lubricate the gear teeth or the bearings in the capacitor.

Frequency Calibration --

If the frequency calibration has (except when due to a gassy tube V1) shifted, then the following procedure should be used to restore the calibration.

A vacuum tube voltmeter, an oscilloscope, and a source of accurate frequency voltage to cover the 200 to 2,000 cycles/sec. range are necessary for calibrating this instrument.

1. Unscrew the captive screws and remove the instrument from the case.

2. Rotate the FREQUENCY dial counter clockwise until it stops. The small dot beyond the high frequency end of the dial scale should then coincide with the index line on the window.

3. If the dot does not coincide, remove the knob just below the dial escutcheon. Loosen the four screws on the dial hub and rotate the dial, while holding the hub against the stop, until the dot coincides with the index. Tighten the screws.

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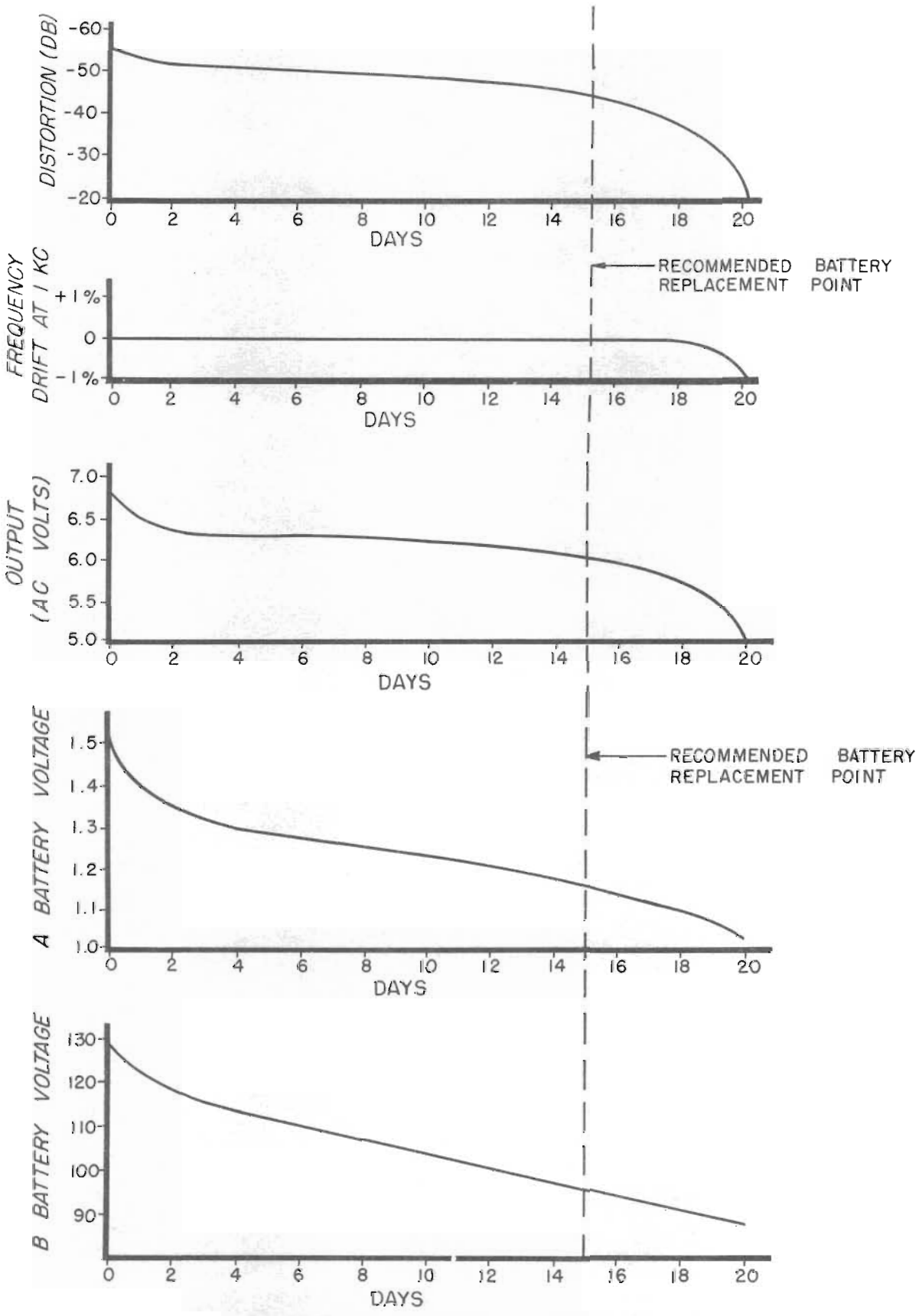
TYPICAL BATTERY LIFE DATA

(MEASURED AFTER 4 HOURS DAILY USE)



4. Connect the source of standard frequencies to the horizontal input terminals of the oscilloscope. The vertical input terminals of the oscilloscope, the vacuum tube voltmeter, and the rated load are connected to the OUTPUT terminals of the oscillator.

5. Set the oscillator FREQUENCY dial to the stop dot, the FREQ. RANGE switch to X100, and the AMPLITUDE control near maximum. Turn on the oscillator and measure its frequency (with the instrument in the case) by means of the Lissajous figures on the oscilloscope screen. The frequency should be 2400 cycles.

6. If the frequency is correct (2400 cycles/sec.) proceed to the next step. If not correct, then adjust C1 and C3 (See Fig. 2) simultaneously, with a non-metallic screwdriver, until a frequency of 2400 cycles/sec. is obtained. The instrument must always be put back into the case for frequency checking.

7. Now set the FREQUENCY dial to exactly "20". Do not change the FREQ. RANGE control. Adjust the AMPLITUDE control slightly so as to obtain a satisfactory indication on the voltmeter. This voltage should be noted and used as a reference level for flattening the oscillator response.

8. Set the FREQUENCY dial to exactly "2" and compare the oscillator frequency with the frequency standard. Also note the output voltage. If the frequency is not 200 cycles/sec. and the output voltage is not the same as it was at "20", then adjust C1 and C3 simultaneously to obtain the correct frequency and voltage.

9. Return to "20" and re-adjust C1 and C3 for the correct frequency and reference level.

10. Repeat steps 8 and 9. The oscillator frequency calibration and response should now be correct. If the frequency calibration is not correct on the other ranges, then the instrument should be returned to the factory where the calibration will be corrected for a nominal charge. See the Warranty Sheet in the back of this instruction book concerning proper packing and shipping instructions.

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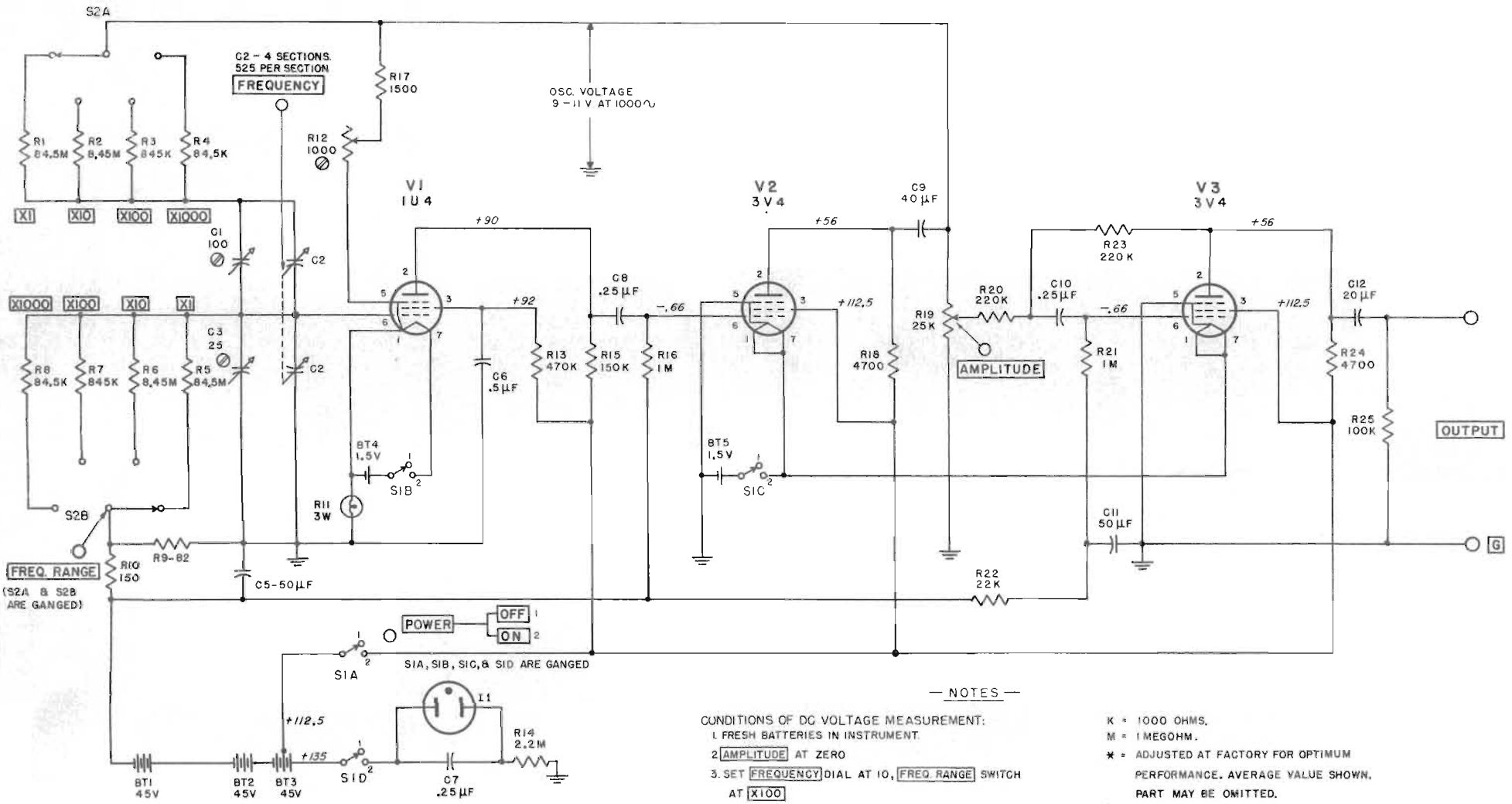
Trouble Shooting --

The following information is designed to aid in trouble shooting a defective instrument:

Symptoms	Possible Cause	Test Procedure	Remedies
Instrument not operating, indicator lamp not flashing.	Exhausted batteries.	Remove the instrument from the case and measure the voltage of all batteries. Refer to the Battery Replacement section for voltage requirements.	Replace batteries if voltages are too low.
Instrument not operating, indicator lamp flashing.	Oscillator section not operating properly.	Measure the oscillator voltage as indicated on the schematic diagram. If oscillator voltage is not present, then proceed as follows:	
		1. Check to see if tubes V1 or V2 are defective.	1. Replace tubes V1 and/or V2. See Tube Replacement section.
		2. If the tubes are normal, measure the DC voltages in the oscillator circuit. These voltages should agree with the voltages indicated on the schematic diagram within ±10% and with allowance for the lower voltage due to partially exhausted batteries.	2. Replace circuit component causing the incorrect DC voltage.
		3. Short circuit in tuning capacitor C2 or associated trimmer capacitors C1, C3.	3. Clear short circuit. If foreign material is short circuiting the capacitor, remove carefully so as not to bend the plates. If plates have been bent so they are touching, carefully straighten the plates.

	Amplifier section not operating properly, oscillator voltage correct but no output from the instrument.	1. Check tube V3. 2. If tube V3 is not defective, then measure DC voltages as in the oscillator section.	1. Replace tube V3. 2. Replace circuit component causing incorrect DC voltages.
Instrument operating, large amount of distortion in output voltage.	Defective tube R12, defective lamp R11 (open filament)	1. Temporarily replace tubes V1, V2 and V3. Replace tubes one at a time and measure the distortion each time. If there is no improvement then return original tube to its socket.	1. Replace defective tube. See Tube Replacement section.
	Incorrect adjustment of variable resistor R12 or defective lamp R11.	2. Measure the oscillator voltage as shown on the schematic diagram. If the oscillator voltage is within the specified range, then the lamp is at fault.	2. Adjust R12 so that the oscillator voltage is within the specified limits. Replace lamp and adjust according to the procedure in the Replacement of Lamp R11 section.
Intermittent operation of instrument	Defective coupling capacitors C8, C9, C10 or C12. Defective tube	Determine the portion of the circuit that is operating intermittently by signal tracing with an oscilloscope or vacuum tube voltmeter.	Replace the defective component.
Lowest frequency range (X1) out of calibration	Gassy 1U4 tube (V1)		Replace tube. See Tube Replacement section.



— NOTES —

CONDITIONS OF DC VOLTAGE MEASUREMENT:

1. FRESH BATTERIES IN INSTRUMENT.
2. AMPLITUDE AT ZERO
3. SET FREQUENCY DIAL AT 10, FREQ. RANGE SWITCH AT X100
4. VOLTAGES MEASURED BETWEEN INDICATED POINTS AND CHASSIS WITH VOLTMETER OF 122 MEGOHMS INPUT RESISTANCE. (-hp- MODEL 410B)

ALL CAPACITANCE IN $\mu\mu F$, UNLESS OTHERWISE NOTED

ALL RESISTANCE VALUES IN OHMS.

K = 1000 OHMS.
M = 1 MEGOHM.
* = ADJUSTED AT FACTORY FOR OPTIMUM PERFORMANCE. AVERAGE VALUE SHOWN. PART MAY BE OMITTED.
⏚ = CHASSIS
○ = PANEL CONTROL
⊘ = SCREWDRIVER ADJUSTMENT

SCHEMATIC DIAGRAM OF MODEL 204A

SERIAL 186 & ABOVE

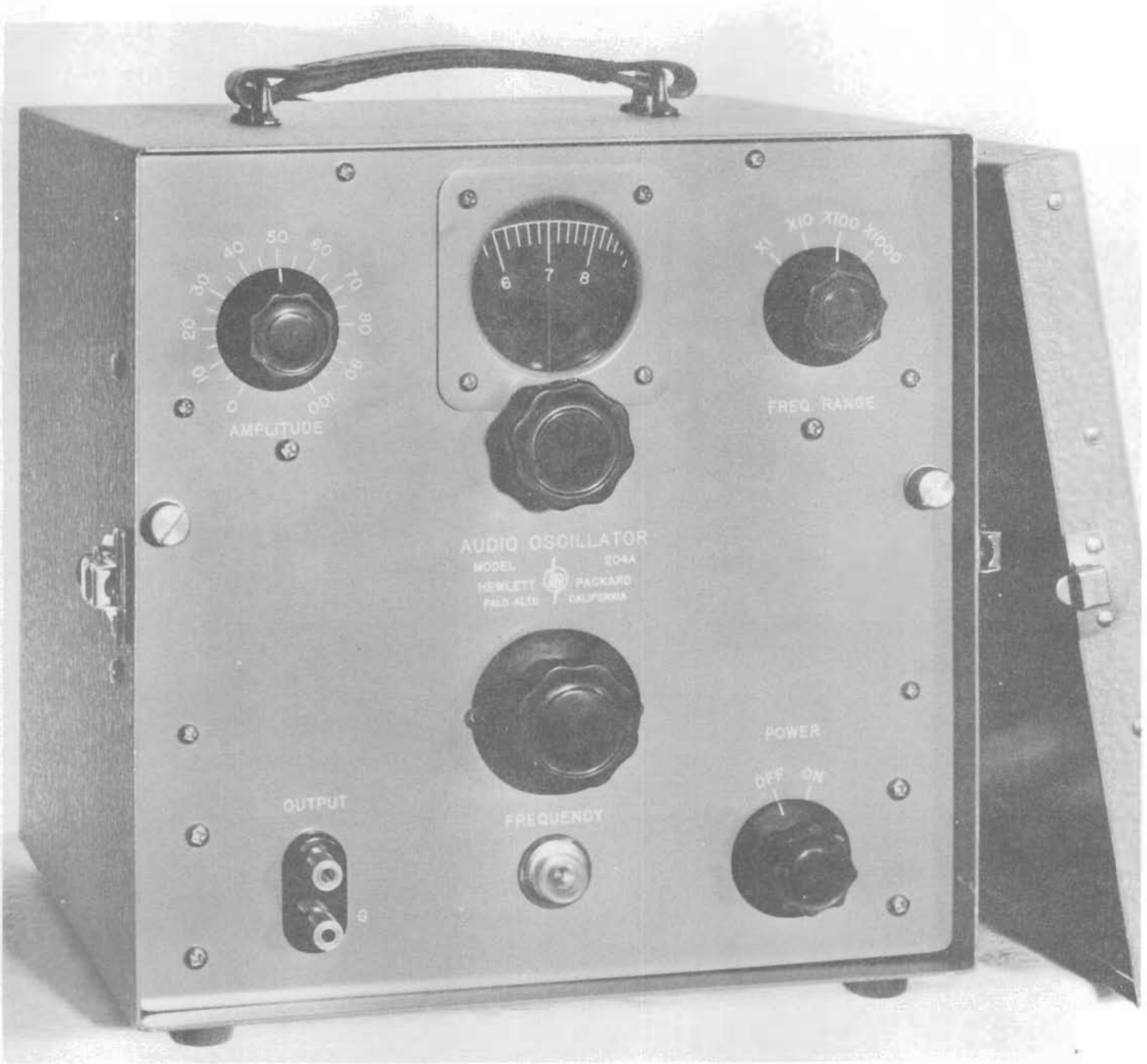


Fig. 1. Model 204A Audio Oscillator

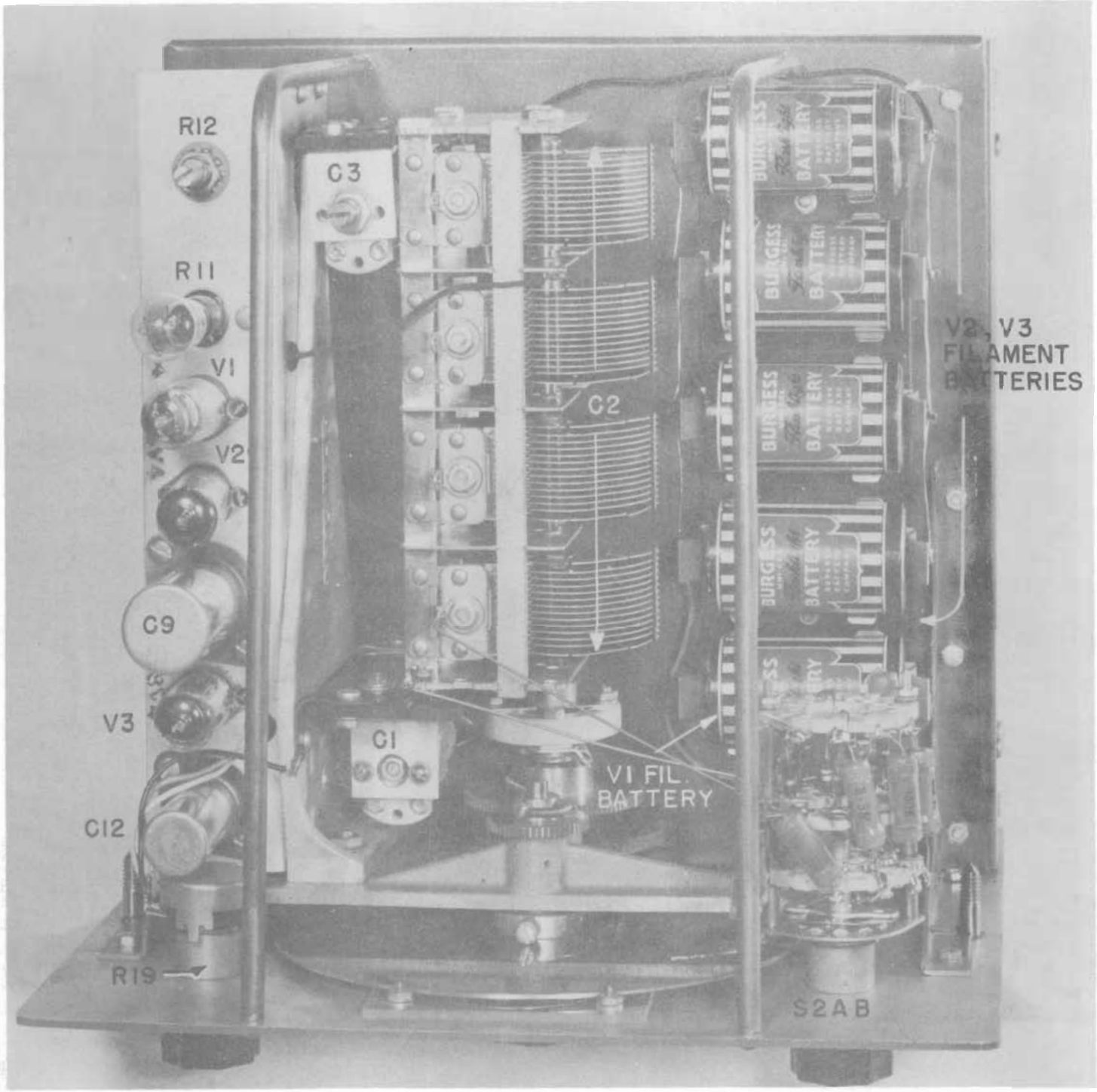


Fig. 2. Model 204A Top View Case Removed

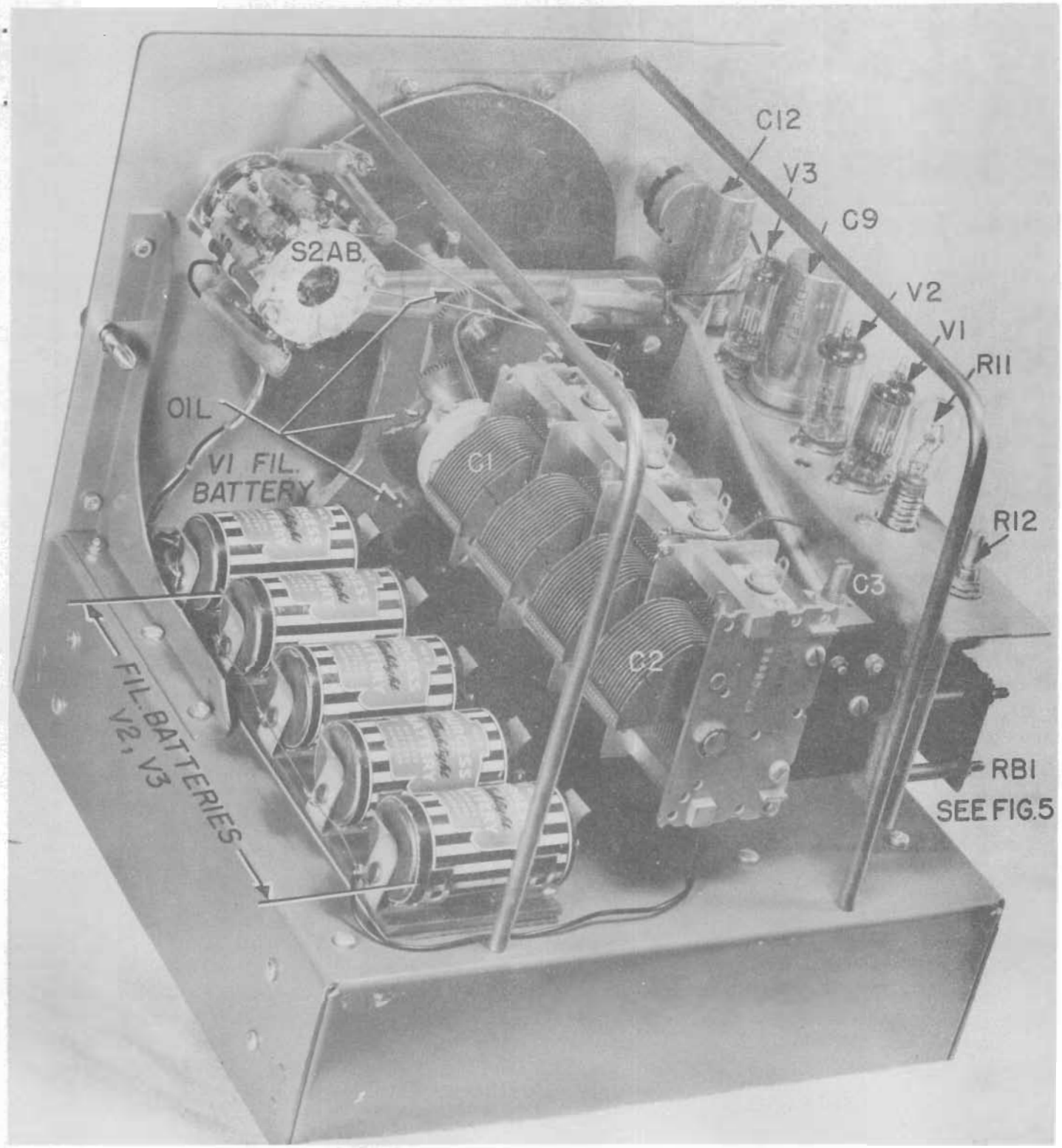


Fig. 3. Model 204A Rear View Case Removed

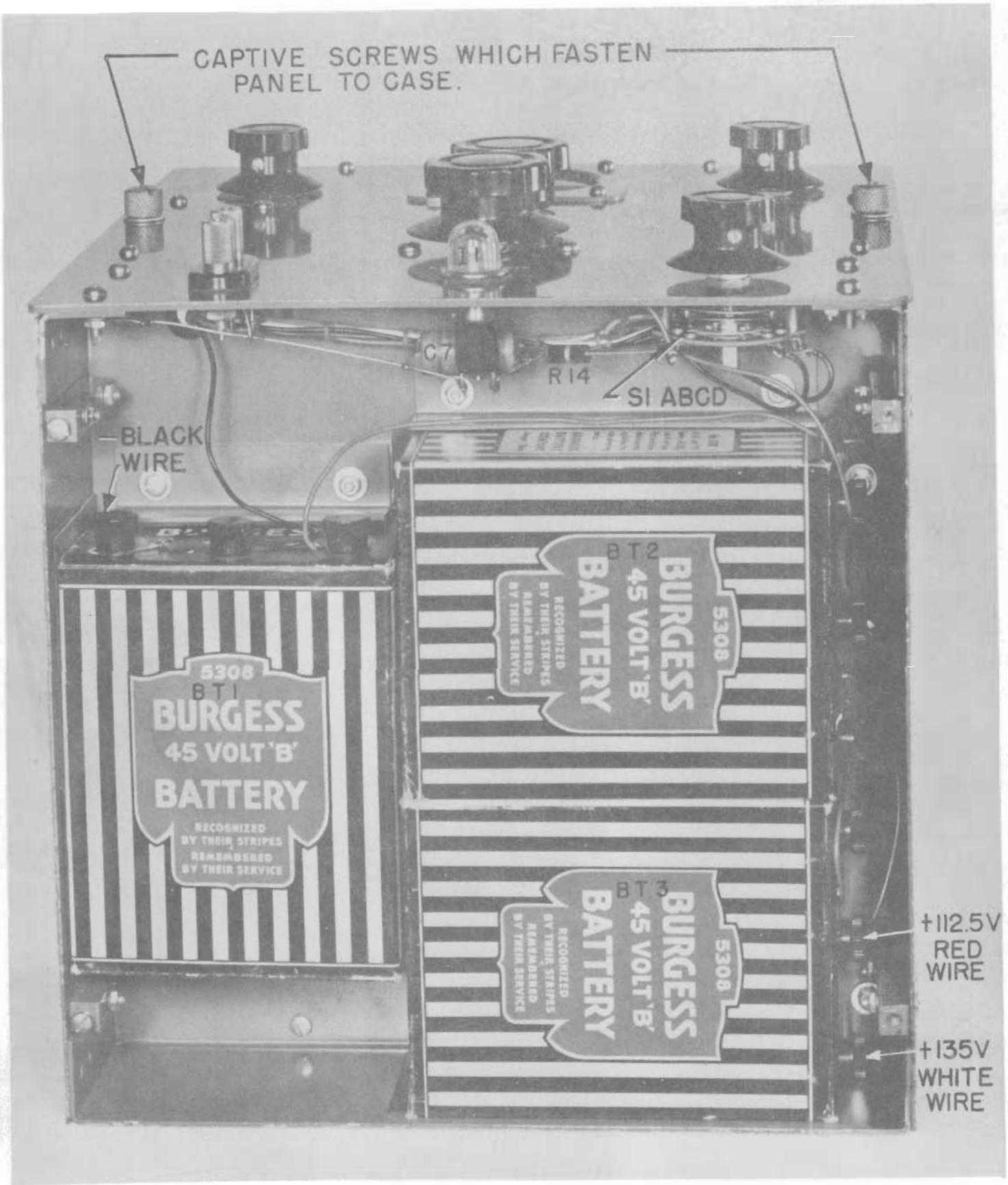
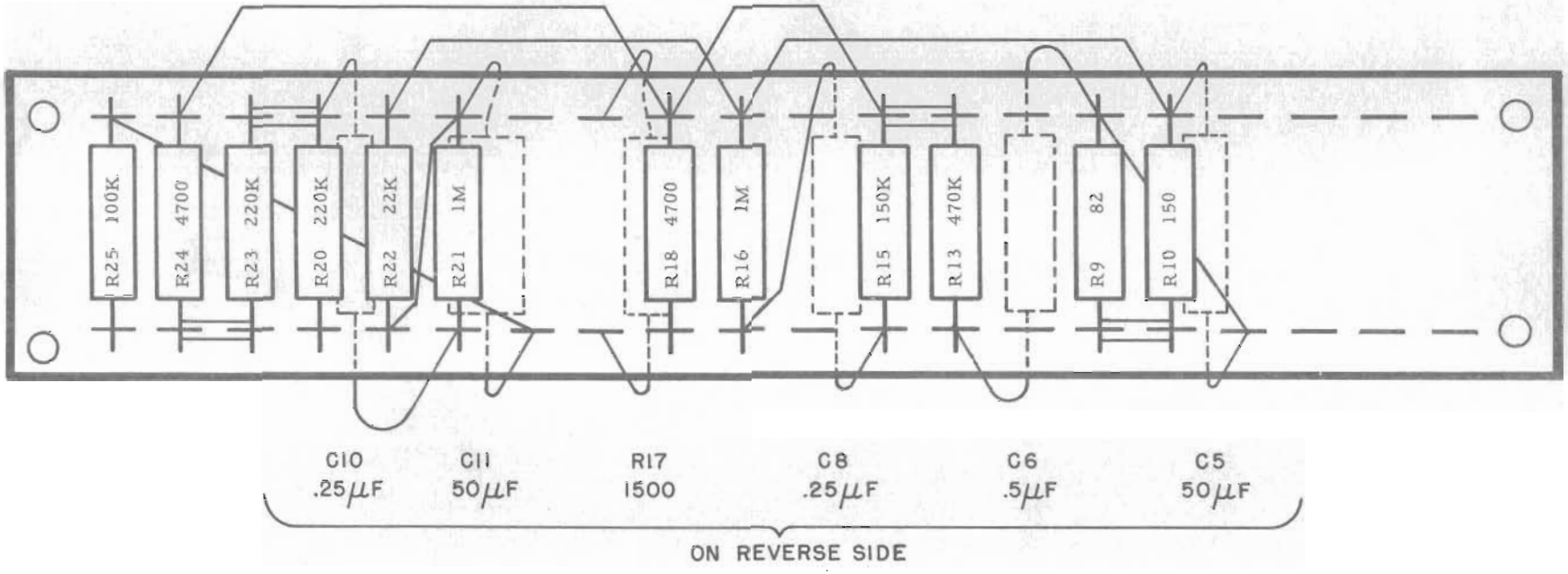


Fig. 4. Model 204A Bottom View Bottom Plate and Case Removed



RB1

Fig. 5. Model 204A Resistor Board Detail

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
C1 - C4	Part of Capacitor and Drive Assembly		
C5	Capacitor: fixed, electrolytic, 50 µf, 50 vdcw	18-50	X TC-39
C6	Capacitor: fixed, paper, .5 µf, ±10%, 200 vdcw	16-37	CC 88P47492S4
C7	Capacitor: fixed, paper, .27 µf, ±10%, 200 vdcw	16-36	CC 88P27492S4
C8	Capacitor: fixed, paper, .27 µf, ±10%, 200 vdcw	16-36	CC 88P27492S4
C9	Capacitor: fixed, electrolytic, 40 µf, 150 vdcw	18-8	X #203208
C10	Capacitor: fixed, paper, .27 µf, ±10%, 200 vdcw	16-36	CC 88P27492S4
C11	Capacitor: fixed, electrolytic, 50 µf, 50 vdcw	18-50	X TC-39
C12	Capacitor: fixed, electrolytic, 20 µf, 150 vdcw	18-9	X
R1 - R8	Part of Range Switch Assembly		
R9	Resistor: fixed, composition, 82 ohms, ±10%, 1 W	24-82	B GB 8201
R10	Resistor: fixed, composition, 150 ohms, ±10%, 1 W	24-150	B GB 1511
R11	Lamp:	211-4	O
R12	Resistor: variable, wirewound, 1000 ohms, linear taper	210-5	G B2-030-277
R13	Resistor: fixed, composition, 470,000 ohms, ±10%, 1 W	24-470K	B GB 4741
R14	Resistor: fixed, composition, 2.2 meg ohms, ±10%, 1 W	24-2.2M	B GB 2251

*See "List of Manufacturers Code Letters For Replaceable Parts Table."

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TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R15	Resistor: fixed, composition, 150,000 ohms, ±10%, 1W	24-150K	B GB 1541
R16	Resistor: fixed, composition, 1 megohm, ±10%, 1W	24-1M	B GB 1051
R17	Resistor: fixed, wirewound, 1500 ohms, ±10%, 1W	26-1500	R Type BW
R18	Resistor: fixed, composition, 4700 ohms, ±10%, 1W	24-4700	B GB 4721
R19	Resistor: variable, composition, 25,000 ohms, linear taper	210-54	B
R20	Resistor: fixed, composition, 220,000 ohms, ±10%, 1W	24-220K	B GB 2241
R21	Resistor: fixed, composition, 1 megohm, ±10%, 1W	24-1M	B GB 1051
R22	Resistor: fixed, composition, 22,000 ohms, ±10%, 1W	24-22K	B GB 2231
R23	Resistor: fixed, composition, 220,000 ohms, ±10%, 1W	24-220K	B GB 2241
R24	Resistor: fixed, composition, 4700 ohms, ±10%, 1W	24-4700	B GB 4721
R25	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
	Dry Battery: 45V	312-97	Burgess Battery Co. #5308
	Dry Battery: 1-1/2V	312-112	Burgess Battery Co. #2
	Binding Post:	312-3	HP
	Indicator Lamp Assembly:	312-95	II, #911308-937
	Knob: 1-5/8" diam.	37-12	J.T. Hill Sales Co. S-309-64-B-522
	Knob: 1-1/2" diam.	37-11	HP
	Knob: 2" diam.	37-13	HP

*See "List of Manufacturers Code Letters For Replaceable Parts Table."

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
	Lamp: Neon glow	211-27	O, NE-51
	Lampholder:	38-89	Leecraft Mfg. 659-1
S1 ABCD	Rotary Switch: POWER	310-55	HP
S2 AB	Range Switch Assembly:	24A-19W	HP
V1	Tube: 1U4	212-1U4	ZZ
V2	Tube: 3V4	212-3V4	ZZ
V3	Tube: 3V4	212-3V4	ZZ

*See "List of Manufacturers Code Letters For Replaceable Parts Table."

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LIST OF MANUFACTURERS CODE LETTERS FOR REPLACEABLE PARTS TABLE

Code Letter	Manufacturer
A	Aerovox Corp.
B	Allen-Bradley Co.
C	Amperite Co.
D	Arrow, Hart and Hegeman
E	Bussman Manufacturing Co.
F	Carborundum Co.
G	Centralab
H	Cinch Manufacturing Co.
I	Clarostat Manufacturing Co.
J	Cornell Dubilier Electric Co.
K	Electrical Reactance Co.
L	Erie Resistor Corp.
M	Federal Telephone and Radio Corp.
N	General Electric Co.
O	General Electric Supply Corp.
P	Girard-Hopkins
HP	Hewlett-Packard
Q	Industrial Products Co.
R	International Resistance Co.
S	Lectrohm, Inc.
T	Littelfuse, Inc.
U	Maguire Industries, Inc.
V	Micamold Radio Corp.
W	Oak Mfg. Co.
X	P.R. Mallory Co., Inc.
Y	Radio Corp. of America
Z	Sangamo Electric Co.
AA	Sarkes Tarzian
BB	Signal Indicator Co.
CC	Sprague Electric Co.
DD	Stackpole Carbon Co.
EE	Sylvania Electric Products, Inc.
FF	Western Electric Co.
GG	Wilkor Products, Inc.
HH	Amphenol
II	Dial Light Co. of America
JJ	Leecraft Manufacturing Co.
ZZ	Any tube having RMA standard characteristics

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof (except tubes, fuses and batteries). This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number, type number and serial number. On receipt of this information, we will give you service instruction or shipping data.

2. On receipt of shipping instruction, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Railway Express. The instruments should be packed in a wooden box and surrounded by two to three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

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Laboratory Instruments *for Speed and Accuracy*
395 PAGE MILL ROAD PALO ALTO, CALIFORNIA