HP Archive

INSTRUCTION AND OPERATING MANUAL

FOR

MODEL 430B

MICROWAVE POWER METER

Serial 461 and Above

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

General Description

The Model 430B Microwave Power Meter is designed for instantaneous power measurements directly in decibels or milliwatts. The instrument can be used at any microwave frequency for which there are bolometer mounts. It can measure either continuous or pulsed power and operates with instrument fuses, barretters or thermistors of 100 or 200 ohm value.

Power can be read directly in milliwatts from .02 to 10 mw, or dbm from -20 to +10 dbm. Power which exceeds the rating of the instrument may be measured by adding attenuators or directional couplers to the microwave system.

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.

INSTRUCTIONS

MODEL 430B

MICROWAVE POWER METER

Specifications

Power Range --

Milliwatts	Decibels Above or Below 1 Mw.
.1	-10
.3	- 5
1.0	0
3.0	+ 5
10.0	+10

Accuracy --

±5% of full scale.

Required External Equipment --

Bolometer and mount. Bolometer 200 ohms at approximately 8.75 Ma. positive temperature coefficient, or 200 ohms at approximately 7.0 Ma., 100 ohms at approximately 12.0 Ma., negative temperature coefficient.

Power Supply Rating --

Voltage - 105 to 125/210 to 250 volts

Frequency - 50/60 cycles/sec.

Wattage - 75 watts

Cables --

	Type of Cable	Length	Termination
Input Cable	RG-58/U	3 ft.	UG-88/U Plug on one end, no termination other end.

Overall Dimensions --

12-1/4" wide x 9-3/4" high x 10-1/8" deep

Weight --

19 lbs.

Operating Instructions

Inspection --

This instrument has been thoroughly tested and inspected before being shipped.

After the instrument is unpacked, it should be carefully inspected for any 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 this instruction book.

Controls and Terminals --

ON - This toggle switch controls the power supplied to the instrument from the power line.

FUSE - The fuseholder, located on the control panel, contains a two ampere cartridge fuse, which may be replaced by unscrewing the fuseholder cap and inserting a new fuse. Use a one ampere cartridge fuse when the instrument is operated on 210 to 250 volts.

COARSE ZERO - This variable resistor provides a coarse adjustment of the meter zero indication.

FINE ZERO - This variable resistor provides a fine adjustment of the meter zero indication.

DBM-MW - This range switch is used to select the desired power measurement range of the instrument.

RESISTANCE - This switch is used to select the desired operating resistance of the bolometer.

COEFFICIENT - This switch is used to select the appropriate temperature coefficient of the bolometer.

Input Jack - This UG-185/U jack will fit any one of the BNC series of connectors.

CAL. - The binding posts marked CAL are located on top of the chassis and are connected to the input of the voltmeter. The binding post marked G is connected to the chassis. They are used to measure the calibrating voltages for the voltmeter.

Operation --

BEFORE THIS INSTRUMENT CAN BE OPERATED, A BOLOMETER MOUNT OF THE CORRECT CHARACTERISTICS MUST BE SELECTED.

CAUTION: THE MAXIMUM DC BIAS CURRENT AVAILABLE AT THE JACK NECESSARY FOR THERMISTOR OPERATION ON THE LOWER RANGES IS SUFFICIENT TO BURN OUT A BARRETTER. HENCE CARE SHOULD BE TAKEN TO SET THE COEFFICIENT AND RESISTANCE SWITCHES TO POS AND 200, RESPECTIVELY, BEFORE CONNECTING A BARRETTER.

The crystal diode CR1 is connected in a protective circuit to limit the surge voltage at the BNC jack in case the bolometer is connected after the instrument is turned on. However, there is some evidence to indicate that barretters may gradually change their characteristics if repeatedly connected and disconnected when the range switch is on the lower ranges. Eventually it may not be possible to zero-set the instrument on the top range with such a barretter. Hence to avoid this possibility, if it is necessary to connect a barretter with the instrument turned on, it is advisable to set the range switch to the top (10 Mw) range first. Fuses may be safely connected at any time provided the COEFFICIENT and RESISTANCE switches are set properly, while thermistors can be connected under any conditions.

The Model 430B is designed to operate with a bolometer which has a positive temperature coefficient, such as a Sperry type 821 barretter or a one-hundredth ampere instrument fuse, or with a bolometer which has a negative temperature coefficient, such as a Western Electric D166382 thermistor.

Any bolometer is suitable provided the meter indication can be brought to zero. A wide variation in DC bias is provided on every range in order to accommodate variations between individual bolometers. Because of the greater sensitivity on the lower ranges, some bolometers which may not be usable on

the top range will be usable on the lower ranges. The sole criterion is whether or not the meter can be zeroed. All normal barretters and Hewlett-Packard selected fuses can be used on all ranges. However, there is a wide variation among thermistors and some may not be usable on the top range. No thermistors will work at 200 ohms on the 10 mw range, however, as they take too little power to make 200 ohms.

Step-by-Step Operating Procedure:

1. Connect the bolometer and mount to the input cable supplied with the Model 430B. DO NOT APPLY RF POWER YET.

2. Set the COEFFICIENT and RESISTANCE switches to the appropriate settings for the bolometer being used.

3. Set the range switch to the 10 Mw range.

4. Turn on the instrument and allow at least five minutes warm-up.

5. Set the range switch to the desired range and adjust the FINE ZERO, COARSE ZERO controls for an approximately zero meter indication.

6. Apply RF power to the bolometer. Adjust the tuning device on the bolometer mount, if any, for maximum meter indication.

7. Switch off the RF, zero-set the meter precisely, and switch on the RF. The resultant meter indication is the power output of the RF source in milliwatts and db above one milliwatt.

NOTE: Always adjust zero-set immediately before taking a reading, as the meter may drift slowly, especially on the lowest ranges, before the instrument is thoroughly warmed up or after switching ranges.

It will be noted that with no bolometer connected and the NEG-POS switch in NEG position the meter reads downscale, indicating oscillation. This condition is quite normal. In the POS position the circuit acts to increase the bolometer resistance up to the operating value by adding audio power. Since an open circuit at the jack is practically infinite resistance, there is no tendency to oscillate. In the NEG position, however, the circuit acts to decrease the bolometer resistance down to the operating value. Hence it oscillates with no bolometer connected, building up to a value limited by tube overload.

Circuit Description

The Model 430B Microwave Power Meter consists of a self-balancing bridge oscillator, a DC bias circuit, a voltmeter circuit, and a regulated power supply (See Fig. 1).

The oscillator includes the circuit associated with V1, V2, and V3. The output of the bridge is fed into the input of V1. V1 and V2 amplify the signal, while V3 is a cathode follower capable of supplying the necessary power. The output of V3 is fed back to the bridge in phase with the input to V1, so that the system oscillates. The frequency of oscillation is set by the tuned circuit (L1, C3) in the bridge and is approximately 10.6 Kc.

One arm of the bridge is the bolometer, a non-linear resistor. Its resistance is determined by the total amount of power being dissipated in it. Further, its resistance determines the output of the bridge. If the resistance is too low, say less than 200 ohms in the case of a positive temperature coefficient and 200 ohms operating resistance, the bridge output increases and the level of oscillation increases, increasing the audio power in the bolometer up to a point where the resistance is increased to 200 ohms. If it is too great, the audio level decreases to the point where the resistance is again 200 ohms. The action is such as to keep the bolometer at its operating resistance at all times.

In order to calibrate the instrument, it is necessary to be able to set the audio level to a definite value on each range. This is accomplished by substituting DC power for all the power required above the given audio level. The zero-set circuit provides the bias DC power and enables the user to set the proper audio level on each range. Sufficient DC power is available on each range to compensate for differences between individual bolometers and for variations in ambient temperature.

In measuring RF power, the circuit action is the same as when varying the DC power. Application of RF power to the bolometer causes the oscillator level to decrease automatically so that the change in audio power is exactly equal to the applied RF power and the total power in the bolometer remains constant. A voltmeter measuring the change in audio voltage can therefore be calibrated in terms of the RF power.

The voltmeter circuit consists of V4 and V5 and a full-wave rectifier and meter. Since the addition of RF power to the bolometer causes the audio voltage to decrease, a special metering circuit was devised to make the meter read upscale. A DC current flows through the meter in the forward direction, of such magnitude as to cause a reading higher than full-scale. The rectified audio is then applied in the reverse direction, bucking down the DC. As the audio decreases, the bucking action decreases and the meter reads upscale.

The power supply for the instrument includes a full-wave rectifier circuit and a degenerative voltage regulator circuit which maintains constant plate supply voltage.

Maintenance

Cover and Bottom Plate Removal --

The cover of the instrument is removed by unscrewing the four screws at the back of the instrument and sliding the top of the cover away from the panel.

The bottom plate comes off when the four screws in the plate are removed.

Tube Replacement --

When replacing tubes in the Model 430B, any tube of average characteristics can be used. However, when V4, V5, or V9 are replaced, it may be necessary to adjust their associated circuits. The adjustments are performed as follows:

Replacement of V4 or V5 -

When replacing V4 or V5, it is desirable to check the gain of the voltmeter circuit as this may affect the accuracy of the instrument. The procedure is as follows:

1. With a bolometer connected, set the range switch to the 3 Mw range.
2. Connect an accurate voltmeter to the CAL. binding posts on the deck.
3. Adjust the FINE ZERO, COARSE ZERO controls so that the external voltmeter reads .465 volts.
4. If the Model 430B meter does not indicate zero, adjust R34 so that it does.
5. Adjust the FINE ZERO, COARSE ZERO controls so that the external voltmeter reads .190 volts.
6. If the Model 430B meter does not indicate full scale, adjust R41 so that it does.
7. Repeat steps 3, 4, 5, and 6 as a check.

430B 9/7/51 Serial 1 To

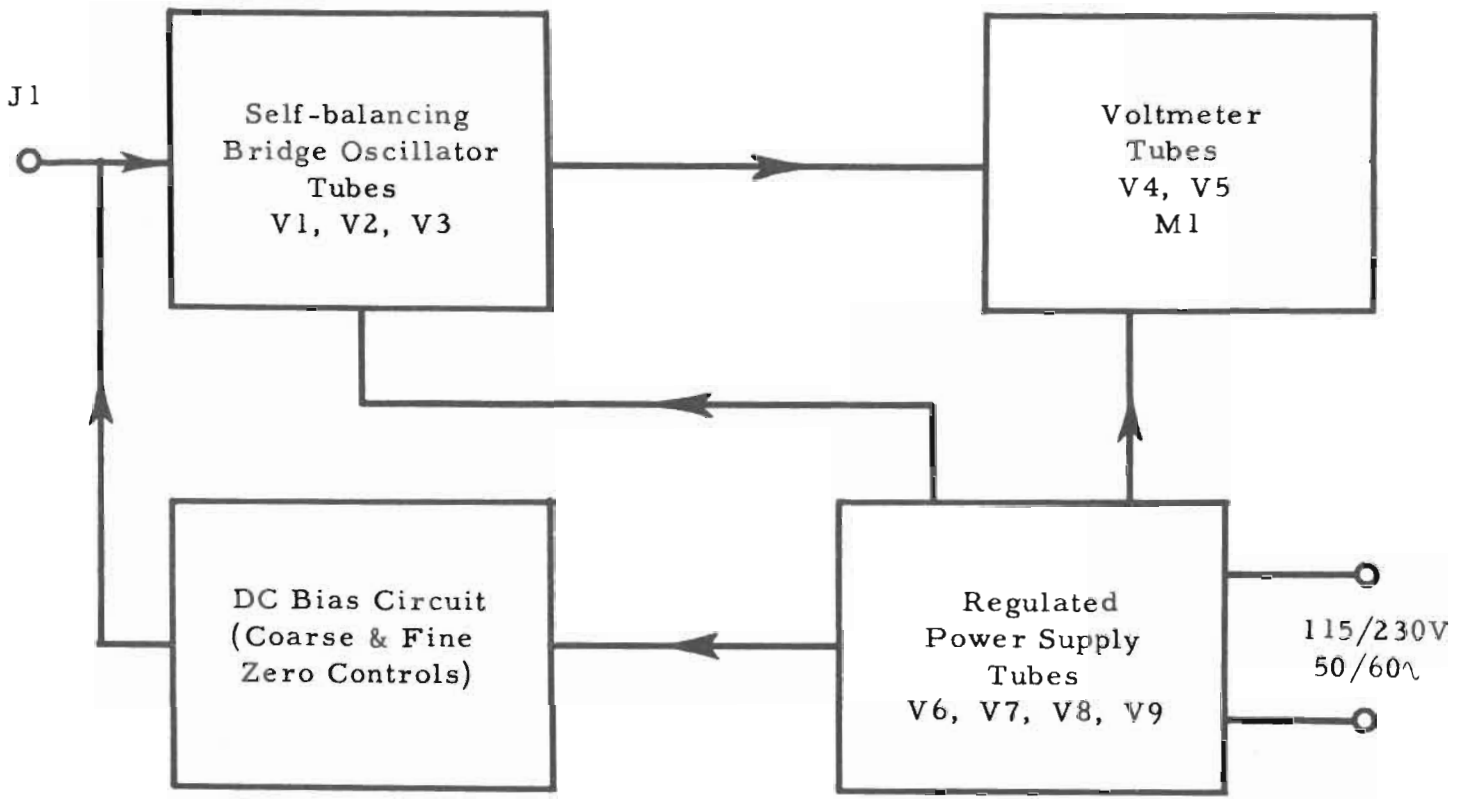


Fig. 1. Model 430B Block Diagram.

NOTE: The external voltmeter should be as accurate as possible (to ±2% or better) if the accuracy of the Model 430B is to be preserved. Ordinarily, gain adjustment is not necessary if the tube operating voltages are within ±10% of those shown on the schematic diagram.

Replacement of V9 - The voltage across V9 determines the value of biasing current for the meter. A new tube may change the biasing current and affect the accuracy of the instrument. Readjust as described above.

Voltage Regulator Adjustment --

Adjust R57 (see Fig. 8) so that the voltage between pin 3 of V7 and the chassis is 250 volts.

Crystal Rectifier Selection --

Crystals CR1, 2, 3, 4, and 5 should be selected to have a back resistance of not less than 50,000 ohms measured at 65°C. on an ohmmeter with an internal battery of 3 volts and series resistance of 100,000 ohms. Inasmuch as resistance in the reverse direction is almost proportional to voltage at low voltages, any ordinary ohmmeter can be used if the resistance reading obtained is used to calculate the back current. In this case, the back current should not exceed .02 Ma. If ordinary unselected crystals are installed, they may result in error in the readings because of a large decrease in back resistance at high temperatures.

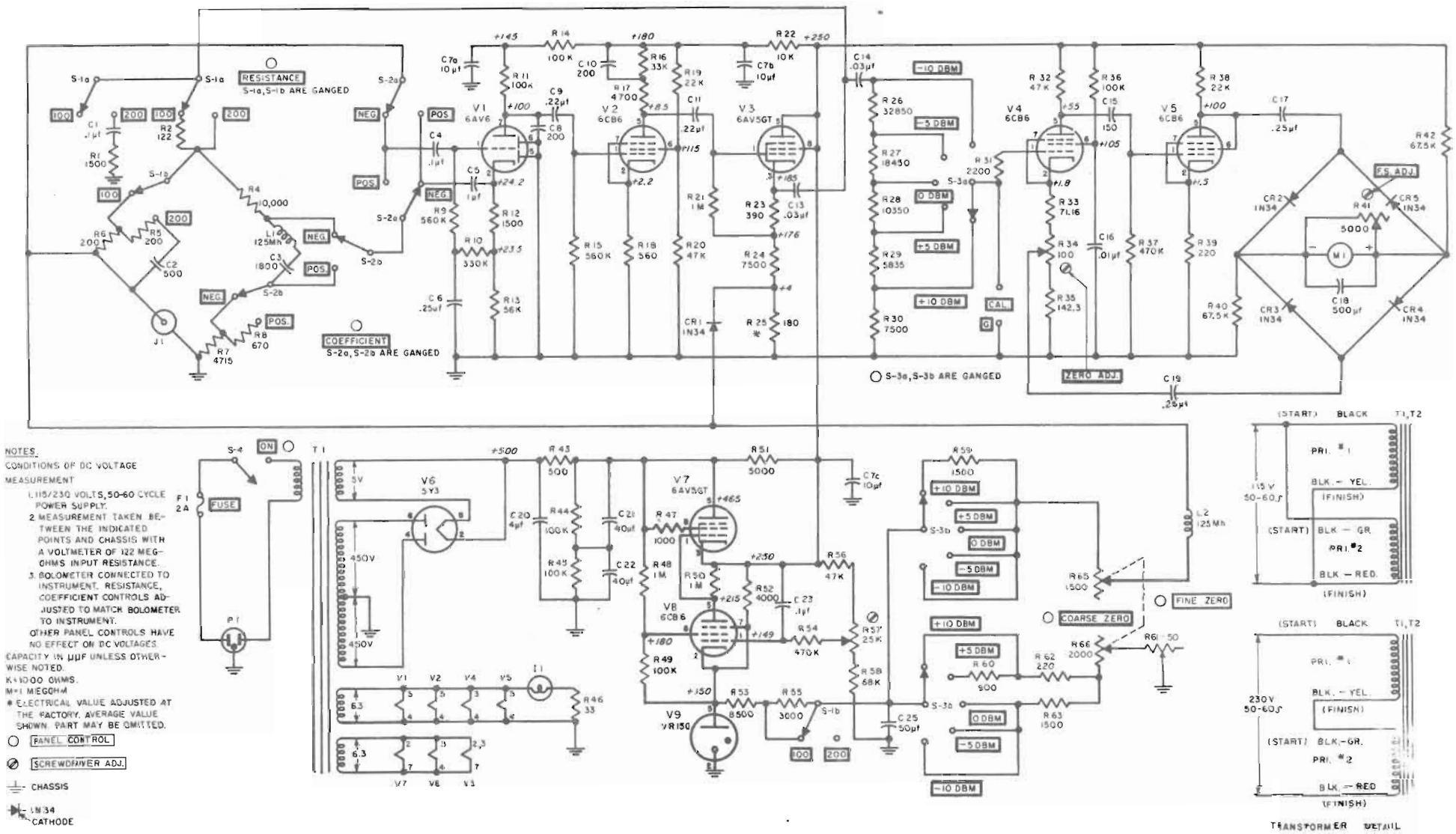
Power Transformer Connections --

This instrument is shipped from the factory with the power transformer primaries connected in parallel for 115 volt operation. If the instrument is to be operated on 230 volts, connect the two power transformer primaries in series as shown in the "Transformer Detail" on the schematic diagram.

Trouble Shooting --

The following is a listing of possible symptoms, causes, and remedies.

Symptoms	Causes	Remedies
Instrument inoperative (Indicator lamp won't light)	Blown fuse	Clear short circuit and replace fuse
Instrument inoperative (Indicator lamp lights)	Defective tube Check V6 first	Replace tube (See "Tube Replacement" in Maintenance Section)
	Short circuit in DC power circuit capacitor	Replace capacitor



NOTES.

CONDITIONS OF DC VOLTAGE MEASUREMENT

1. 115/230 VOLTS, 50-60 CYCLE POWER SUPPLY.
2. MEASUREMENT TAKEN BETWEEN THE INDICATED POINTS AND CHASSIS WITH A VOLTMETER OF 122 MEGOHMS INPUT RESISTANCE.
3. BOLOMETER CONNECTED TO INSTRUMENT. RESISTANCE, COEFFICIENT CONTROLS ADJUSTED TO MATCH BOLOMETER TO INSTRUMENT.

OTHER PANEL CONTROLS HAVE NO EFFECT ON DC VOLTAGES.

CAPACITY IN μμF UNLESS OTHERWISE NOTED.

K = 1000 OHMS.

M = 1 MEGOHM

* ELECTRICAL VALUE ADJUSTED AT THE FACTORY. AVERAGE VALUE SHOWN. PART MAY BE OMITTED.

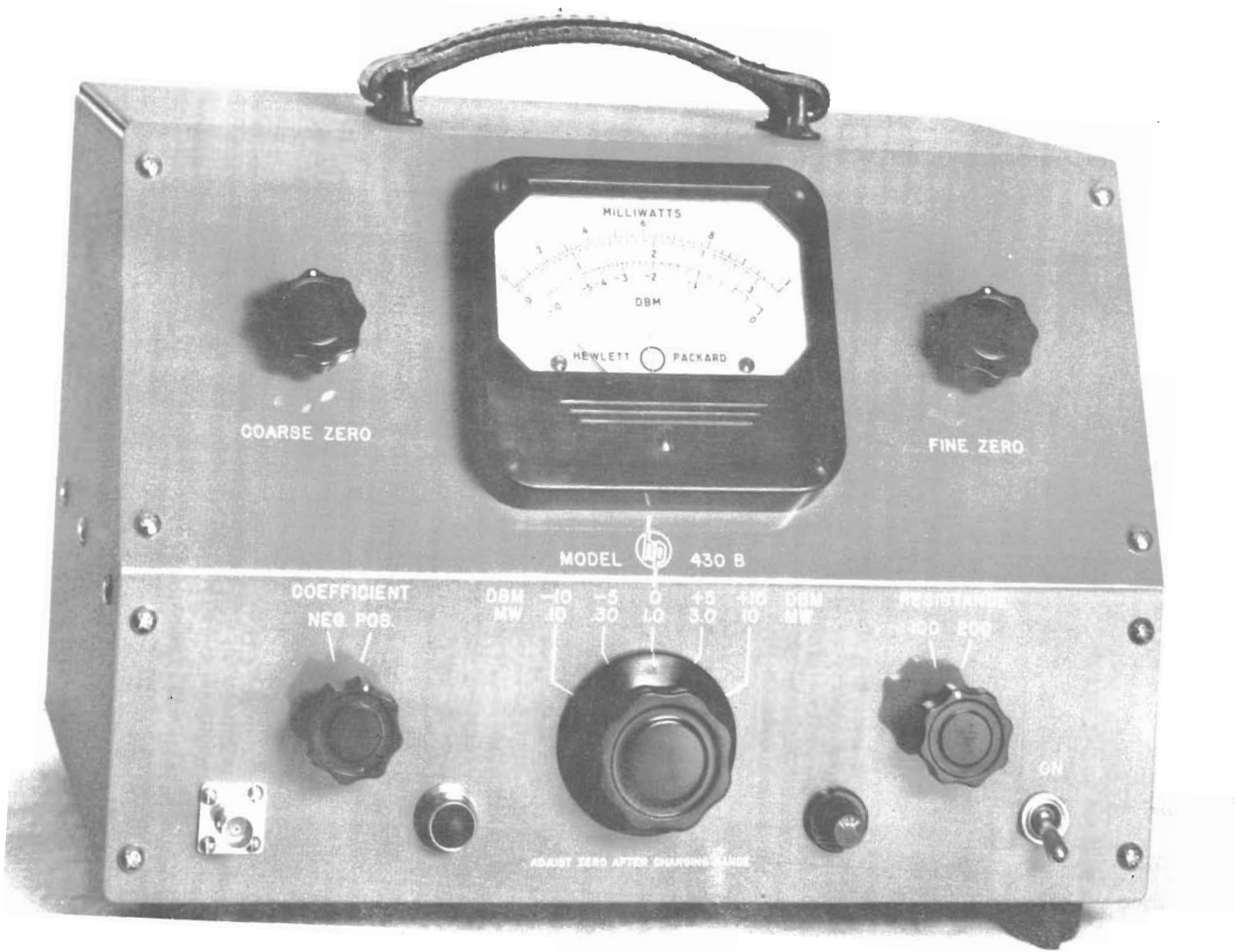
○ PANEL CONTROL

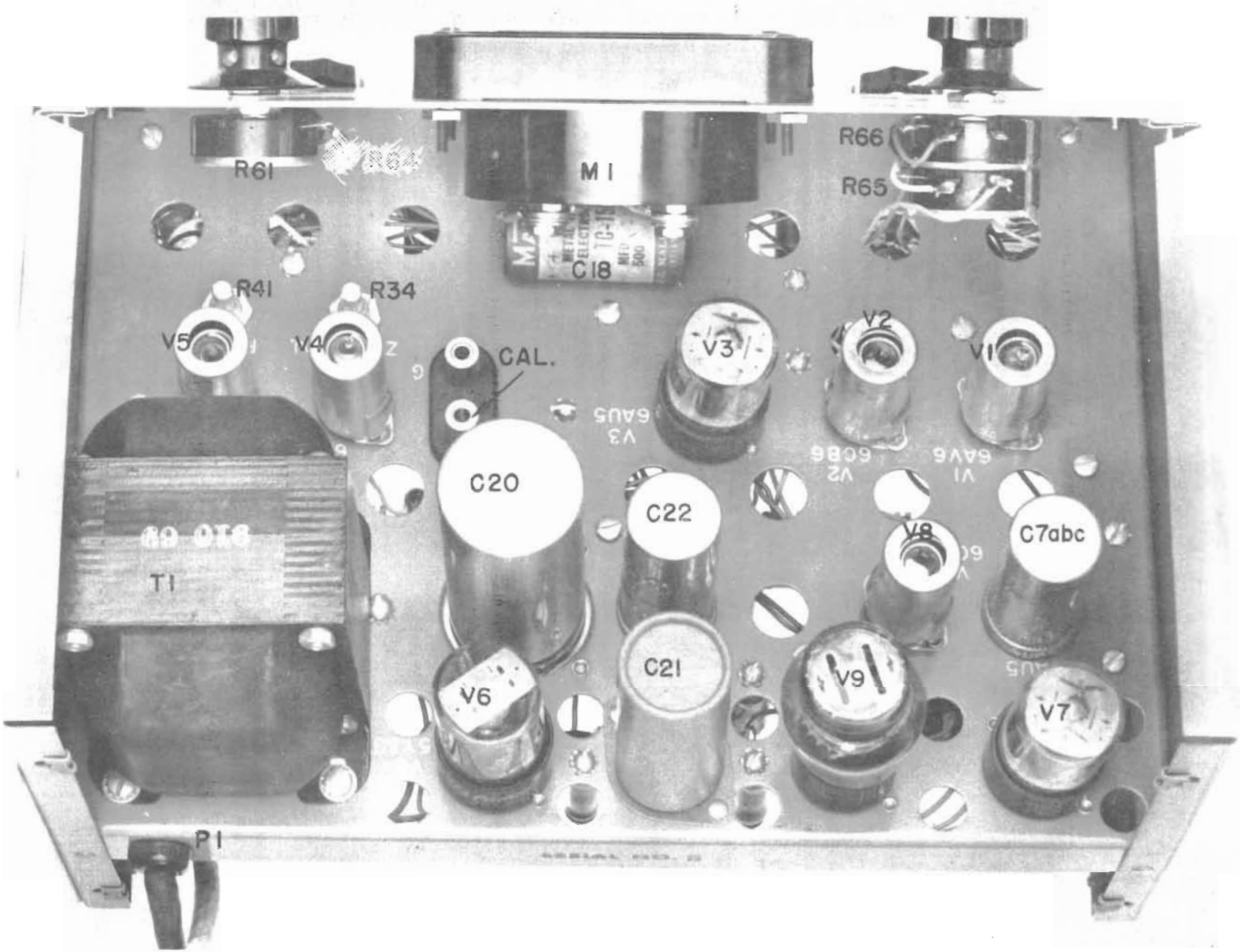
⊘ SCREWDRIVER ADJ.

⏚ CHASSIS

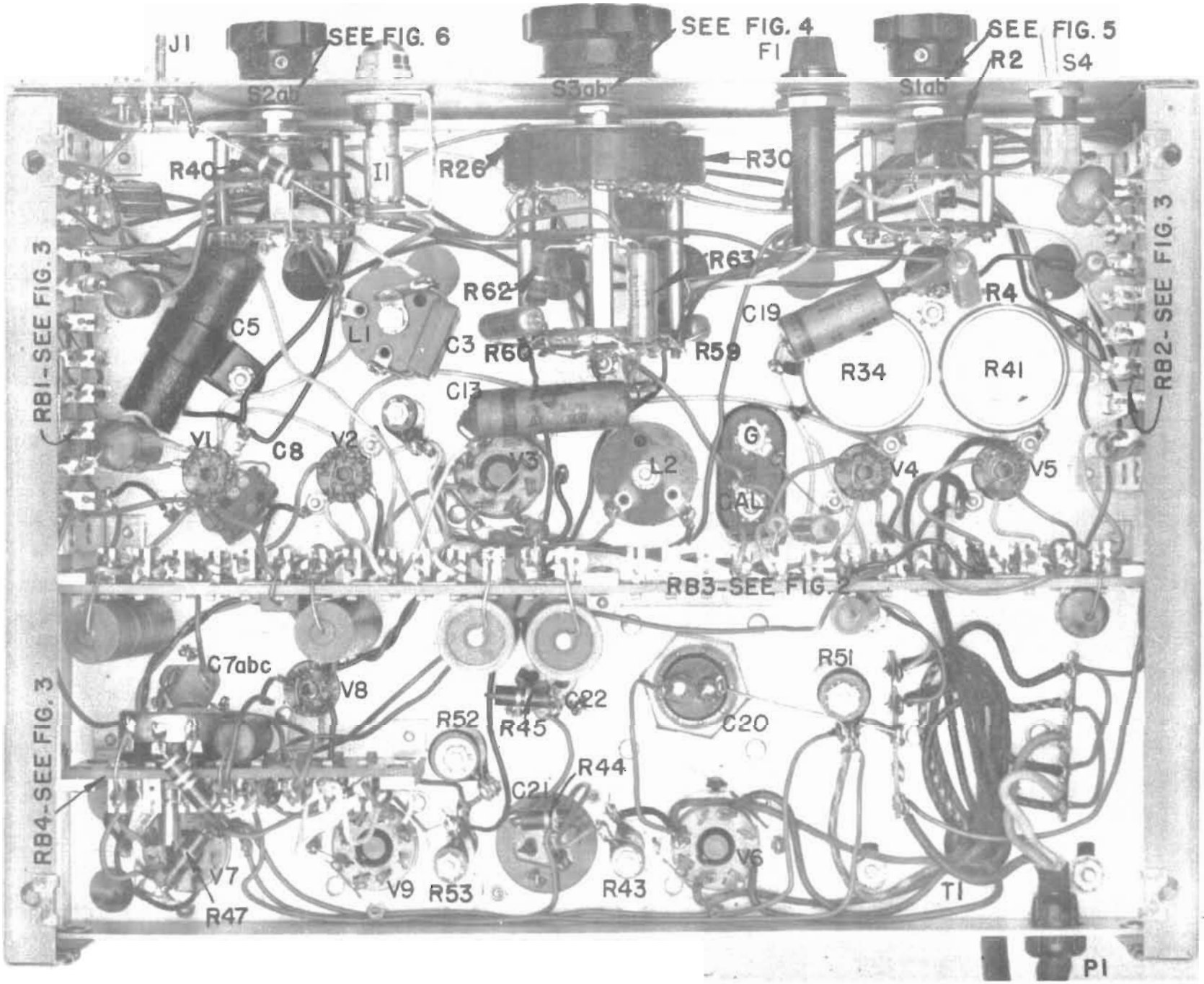
1N34 CATHODE

SCHEMATIC DIAGRAM OF MODEL 430B
SERIAL 461 & ABOVE


MILLIWATTS
DBM
HEWLETT PACKARD
COARSE ZERO
FINE ZERO
MODEL 430 B
COEFFICIENT
NEG. POS.
DBM MW
-10 .10
-5 .30
0 1.0
+5 3.0
+10 10
DBM MW
RESISTANCE
100 200
ON
ADJUST ZERO AFTER CHANGING RANGE



Model 430B Top View. Cover Removed.



Model 430B Bottom View. Bottom Plate Removed.

430B 1/11/62 SERIAL 210 TO

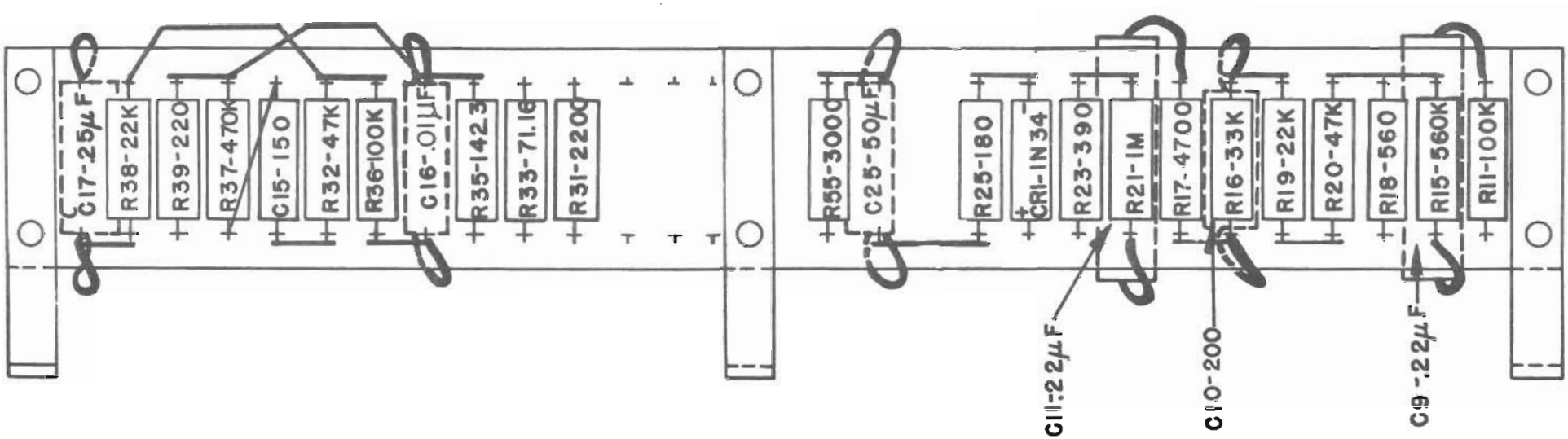
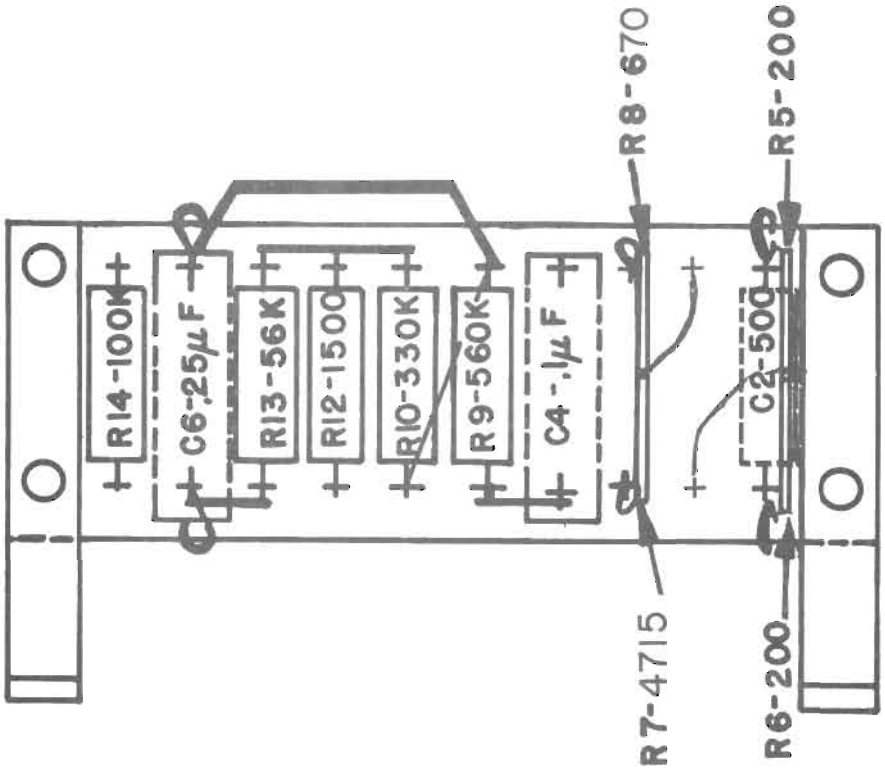
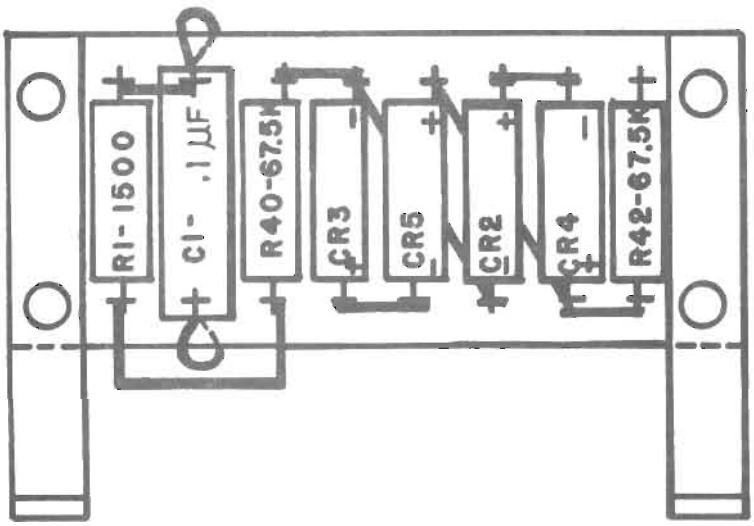


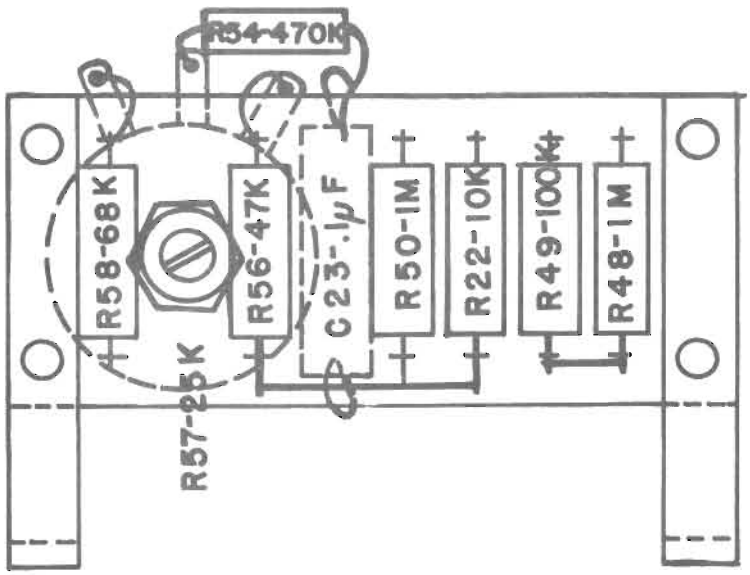
FIG. 2 MODEL 430B RESISTOR BOARD DETAIL



RB1



RB2



RB3

Fig. 3. Model 430B Resistor Boar

430B 12/10/51 Serial 111 To 160

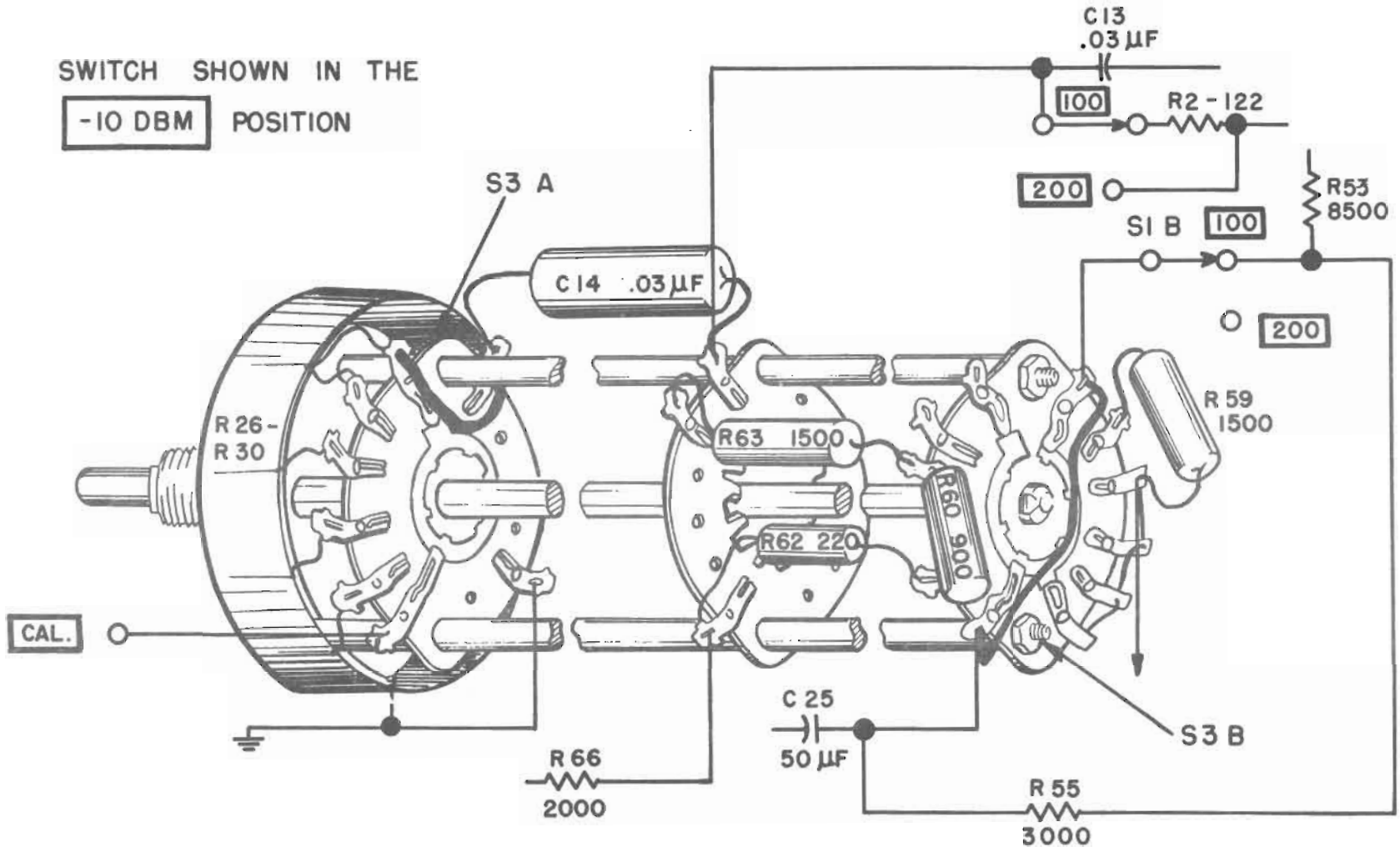


Fig. 4. Model 430B. Range Switch Detail (S3ab)

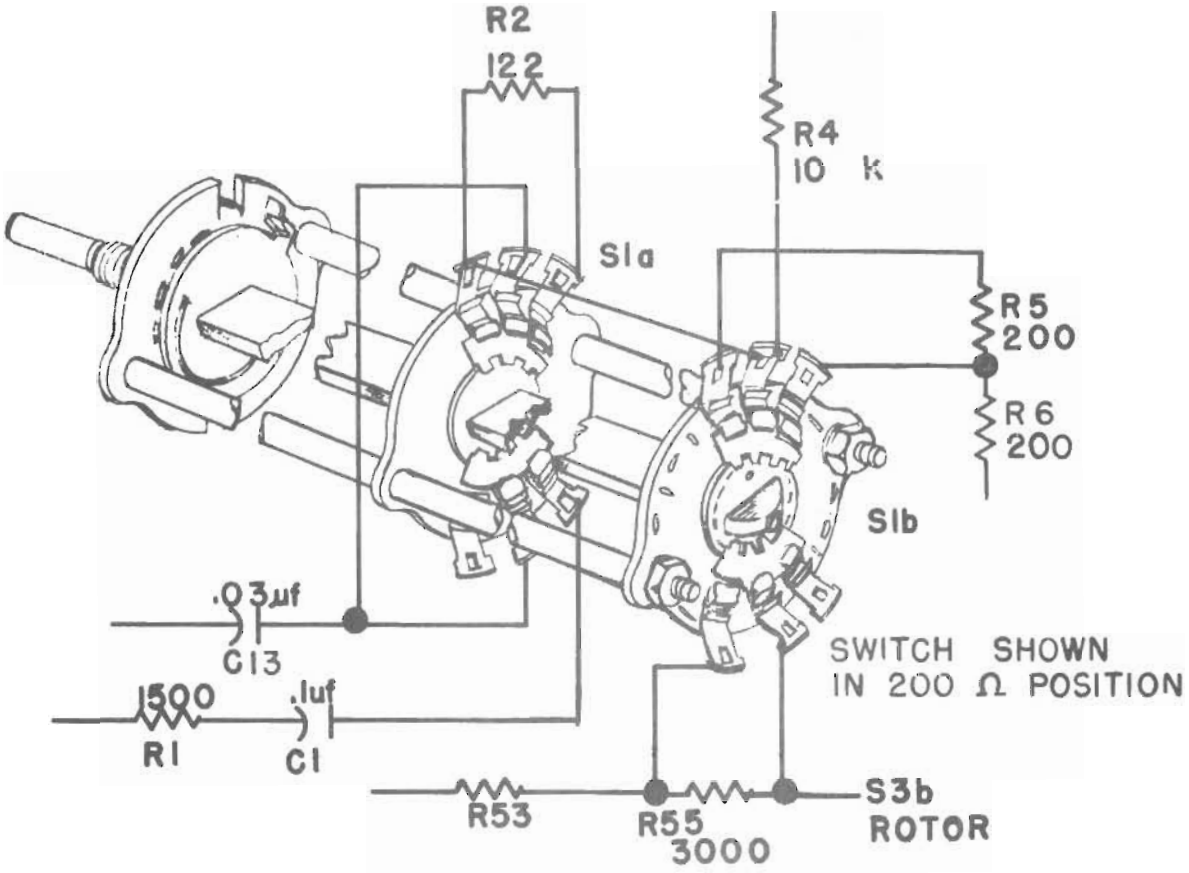


Fig. 5. Model 430B Resistance Switch Detail

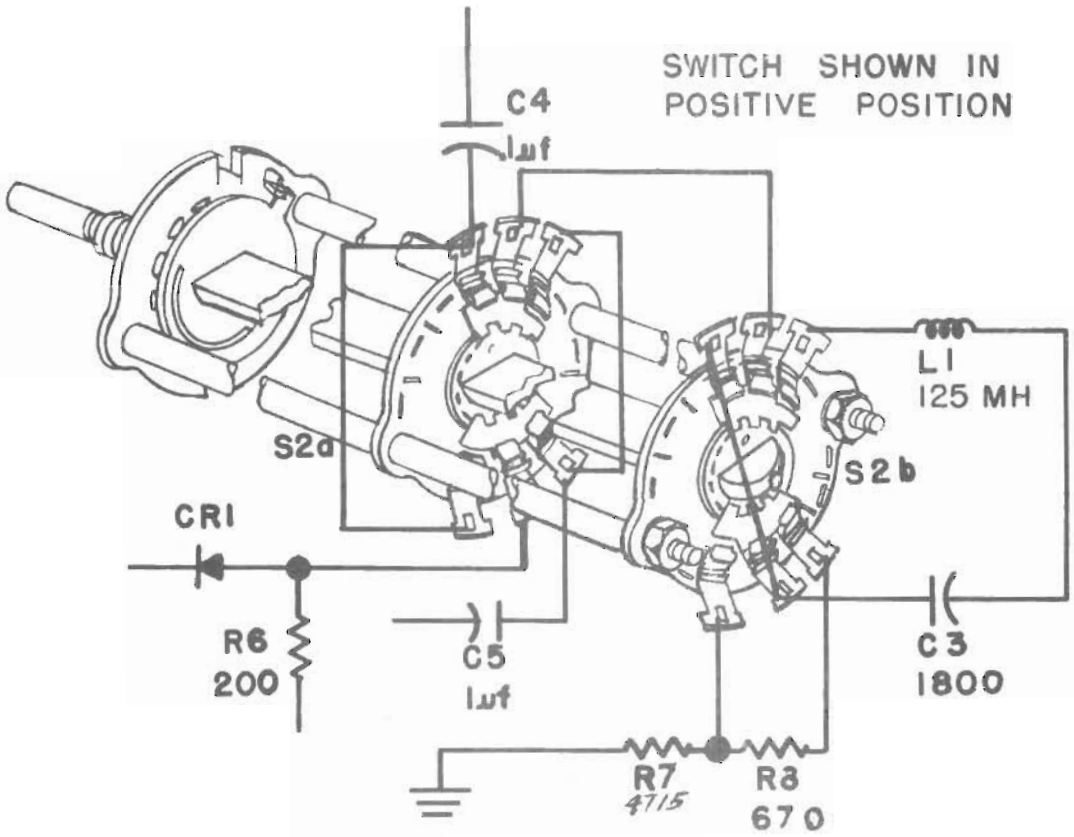


Fig. 6. Model 430B Coefficient Switch Detail

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
C1	Capacitor: fixed, paper, .1 μf, ±20%, 400 vdcw	16-35	CC #68P10404
C2	Capacitor: fixed, mica, 500 μμf, ±10%, 500 vdcw	14-500	V Type OXM
C3	Capacitor: fixed, silver mica, 1800 μμf, ±5%, 500 vdcw	15-19	V Type PW
C4	Capacitor: fixed, paper, .1 μf, ±20%, 400 vdcw	16-35	CC #68P10404
C5	Capacitor: fixed, paper, 1 μf, ±20%, 400 vdcw	16-44	A Type P482
C6	Capacitor: fixed, paper, .25 μf, 200 vdcw	16-36	CC #68P
C7 abc	Capacitor: fixed, electrolytic, 10, 10, 10 μf, 450 vdcw	18-31	X FPT-389
C8	Capacitor: fixed, mica, 200 μμf, ±10%, 500 vdcw	14-200	V Type OXM
C9	Capacitor: fixed, paper, .22 μf, ±20%, 400 vdcw	16-48	A P488
C10	Capacitor: fixed, mica, 200 μμf, ±10%, 500 vdcw	14-200	V Type OXM
C11	Capacitor: fixed, paper, .22 μf, ±20%, 400 vdcw	16-48	A P488
C12	This circuit reference not assigned		
C13	Capacitor: fixed, paper, .03 μf, +30%, -10%, 600 vdcw	16-13	A Type 684
C14	Capacitor: fixed, paper, .03 μf, +30%, -10%, 600 vdcw	16-13	A Type 684
C15	Capacitor: fixed, mica, 150 μμf, ±10%, 500 vdcw	14-150	V Type OXM
C16	Capacitor: fixed, paper, .01 μf, ±10%, 600 vdcw	16-11	A Type P688

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

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
C17	Capacitor: fixed, paper, .25 µf, 200 vdcw	16-36	CC #68P
C18	Capacitor: fixed, electrolytic, 500 µf, 15 vdcw	18-5	X TC 1505
C19	Capacitor: fixed, paper, .25 µf, 200 vdcw	16-36	CC #68P
C20	Capacitor: fixed, oil filled paper, 4 µf, ±10%, 600 vdcw	17-10	P
C21	Capacitor: fixed, electrolytic, 40 µf, 450 vdcw	18-40	X FPS-146
C22	Capacitor: fixed, electrolytic, 40 µf, 450 vdcw	18-40	X FPS-146
C23	Capacitor: fixed, paper, .1 µf, ±20%, 400 vdcw	16-35	CC #68P10404
C24	This circuit reference not assigned		
C25	Capacitor: fixed, electrolytic, 50 µf, +200%, -10%, 50 vdcw	18-50	A PRS-EP
R1	Resistor: fixed, composition, 1,500 ohms, ±10%, 1W	24-1500	B GB 1521
R2	Resistor: fixed, wirewound, 122 ohms Also included in stock #430B-19A	430B-26A	HP
R3	Resistor: Electrical value adjusted at the factory		
R4	Resistor: fixed, wirewound, 10,000 ±25 ohms	430B-26D	HP
R5, R6	Resistor: fixed, wirewound, 200, 200 ohms	430B-26B	HP
R7, R8	Resistor: fixed, wirewound, 4715 ± 15 ohms, 670 ± 2 ohms	430B-26C	HP
R9	Resistor: fixed, composition, 560,000 ohms, ±10%, 1W	24-560K	B GB 5641

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

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R10	Resistor: fixed, composition, 330,000 ohms, ±10%, 1W	24-330K	B GB 3341
R11	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
R12	Resistor: fixed, composition, 1,500 ohms, ±10%, 1W	24-1500	B GB 1521
R13	Resistor: fixed, composition, 56,000 ohms, ±10%, 1W	24-56K	B GB 5631
R14	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
R15	Resistor: fixed, composition, 560,000 ohms, ±10%, 1W	24-560K	B GB 5641
R16	Resistor: fixed, composition, 33,000 ohms, ±10%, 1W	24-33K	B GB 3331
R17	Resistor: fixed, composition, 4700 ohms, ±10%, 1W	24-4700	B GB 4721
R18	Resistor: fixed, composition, 560 ohms, -10%, 1W	24-560	B GB 5611
R19	Resistor: fixed, composition, 22,000 ohms, ±10%, 1W	24-22K	B GB 2231
R20	Resistor: fixed, composition, 47,000 ohms, ± 10%, 1W	24-47K	B GB 4731
R21	Resistor: fixed, composition, 1 megohm, ± 10%, 1W	24-1M	B GB 1051
R22	Resistor: fixed, composition, 10,000 ohms, ±10%, 1W	24-10K	B GB 1031
R23	Resistor: fixed, composition, 390 ohms, ±10%, 1W	24-390	B GB 3911
R24	Resistor: fixed, wirewound, 7500 ohms, ±10%, 10W	26-9	S Type 1-3/4E

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

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R25	Resistor: fixed, composition, 180 ohms, ±10%, 1W Electrical value adjusted at factory	24-180	B GB 1811
R26	Resistor: fixed, wirewound, 32,850 ohms	Resistors R26, R27, R28, R29, R30 are part of Stock #430B -19W.	
R27	Resistor: fixed, wirewound, 18,450 ohms		
R28	Resistor: fixed, wirewound, 10,350 ohms		
R29	Resistor: fixed, wirewound, 5835 ohms		
R30	Resistor: fixed, wirewound, 7500 ohms		
R31	Resistor: fixed, composition, 2200 ohms, ±10%, 1W	24-2200	B GB 2221
R32	Resistor: fixed, composition, 47,000 ohms, ±10%, 2W	25-47K	B HB 4731
R33	Resistor: fixed, composition, 71.16 ohms, ±1%, 1/2W	33-71.16	GG Type CP 1/2
R34	Resistor: variable, wirewound, 100 ohms, linear taper	210-4	G #21-010-354
R35	Resistor: fixed, composition, 142.3 ohms, ±1%, 1W	31-142.3	GG Type CP 1
R36	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
R37	Resistor: fixed, composition, 470,000 ohms, ±10%, 1W	24-470K	B GB 4741
R38	Resistor: fixed, composition, 22,000 ohms, ±10%, 2W	25-22K	B HB 2231
R39	Resistor: fixed, composition, 220 ohms, ±10%, 1W	24-220	B GB 2211
R40	Resistor: fixed, composition, 67,500 ohms, ±1%, 1W	31-67.5K	GG Type CP 1

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

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R41	Resistor: variable, wirewound, 5000 ohms, linear taper	210-7	G #21-010-357
R42	Resistor: fixed, composition, 67,500 ohms, ±1%, 1W	31-67.5K	GG Type CP 1
R43	Resistor: fixed, composition, 500 ohms, ±10%, 10W	26-5	S Type 1-3/4E
R44	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
R45	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
R46	Resistor: fixed, composition, 33 ohms, ±10%, 1W	24-33	B GB 3301
R47	Resistor: fixed, composition, 1000 ohms, ±10%, 1W	24-1000	B GB 1021
R48	Resistor: fixed, composition, 1 megohm, ±10%, 1W	24-1M	B GB 1051
R49	Resistor: fixed, composition, 100,000 ohms, ±10%, 1W	24-100K	B GB 1041
R50	Resistor: fixed, composition, 1 megohm, ±10%, 1W	24-1M	B GB 1051
R51	Resistor: fixed, wirewound, 500 ohms, ±10%, 20W	27-3	S Type 2R
R52	Resistor: fixed, wirewound, 4000 ohms, ±5%, 20W	27-7	S Type 2R
R53	Resistor: fixed, wirewound, 8500 ohms, ±10%, 10W	26-29	S Type 1-3/4E
R54	Resistor: fixed, wirewound, 470,000 ohms, ±10%, 1W	24-470K	B GB 4741
R55	Resistor: fixed, composition, 3000 ohms, 5%, 1W	26-3000	R Type BW

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

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R56	Resistor: fixed, composition, 47,000 ohms, ±10%, 1W	24-47K	B GB 4731
R57	Resistor: variable, composition, 25,000 ohms, linear taper	210-11	G BA1-010-1990
R58	Resistor: fixed, composition, 68,000 ohms, ±10%, 1W	24-68K	B GB 6831
R59	Resistor: fixed, composition, 1500 ohms, ±1 %, 1W	31-1500	GG Type CP 1
R60	Resistor: fixed, composition, 900 ohms, ±1%, 1W	31-900K	GG Type CP 1
R61	Resistor: variable, wirewound, 50 ohms, linear taper	210-2	G #21-010-067
R62	Resistor: fixed, composition, 220 ohms, ±10%, 1W	24-220	B GB 2211
R63	Resistor: fixed, composition, 1500 ohms, ±1%, 1W	31-1500	GG Type CP 1
R64	This circuit reference not assigned		
R65, R66	Resistor: variable, wirewound, 2 sections, front 2000 ohms, rear 1500 ohms, linear taper	210-76	HP
CR1	Crystal Rectifier:	G-11G	HP
CR2, CR5	Crystal Rectifier:	G-11B	HP
	Binding Post:	312-3	HP
J1	Connector:	38-99	Q, #4500
F1	Fuse: 2A, 3AG type	211-2	
	Fuseholder:	312-8	T, #342001
	Indicator Lamp Assembly:	312-10	BB, #807BS
	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
I1	Lamp:	211-47	O, Mazda #47
M1	Meter:	112-24	HP
P1	Power Cable:	812-56	HP
L1	RF Choke: 125 mh.	48-10	Meissner,
L2	RF Choke: 125 mh.	48-10	#19-6848
S1 ab, R2	Resistance Switch Assembly:	430B-19A	HP
S2 ab	Coefficient Switch Assembly:	430B-19B	HP
S3 ab, R59, R60, R62, R63, R26-R30	Range Switch Assembly:	430B-19W	HP
S4	Toggle Switch:	310-11	D, 20994-NU
T1	Power Transformer:	910-69	HP
V1	Tube: 6AV6	212-6AV6	ZZ
V2	Tube: 6CB6	212-6CB6	ZZ
V3	Tube: 6AV5GT	212-6AV5GT	ZZ
V4	Tube: 6CB6	212-6CB6	ZZ
V5	Tube: 6CB6	212-6CB6	ZZ
V6	Tube: 5Y3GT	212-5Y3GT	ZZ
V7	Tube: 6AV5GT	212-6AV5GT	ZZ
V8	Tube: 6CB6	212-6CB6	ZZ
V9	Tube: VR150	212-VR150	ZZ

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

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 instructions or shipping data.

2. On receipt of shipping instructions, 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

HEWLETT-PACKARD COMPANY
Laboratory Instruments for Speed and Accuracy
395 PAGE MILL ROAD PALO ALTO, CALIF.