HEWLETT-PACKARD COMPANY

430C

MICROWAVE POWER METER

430C

OPERATING AND SERVICE MANUAL

MODEL 430C
MICROWAVE POWER METER

SERIALS PREFIXED: 252-

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Table 1-1. Specifications

Power Range:
5 ranges. Full-scale reading of 0.1, 0.3, 1, 3, and 10 milliwatts. Also calibrated in dbm to give continuous indication from -20 dbm to +10 dbm (0 dbm = 1 mw).

External Bolometer:
Frequency range depends on bolometer mount. Bolometers can operate at resistance of 100 or 200 ohms and can have positive or negative temperature coefficients. Any dc bias current up to 16 ma is available for biasing positive or negative temperature coefficient bolometers. DC bias current is continuously adjustable and is independent of bolometer resistance and power level range.

Accuracy:
Within 5% of full scale value.

Power Supply:
115 or 230 volts ±10%, 50 to 1000 cycles, approximately 90 watts.

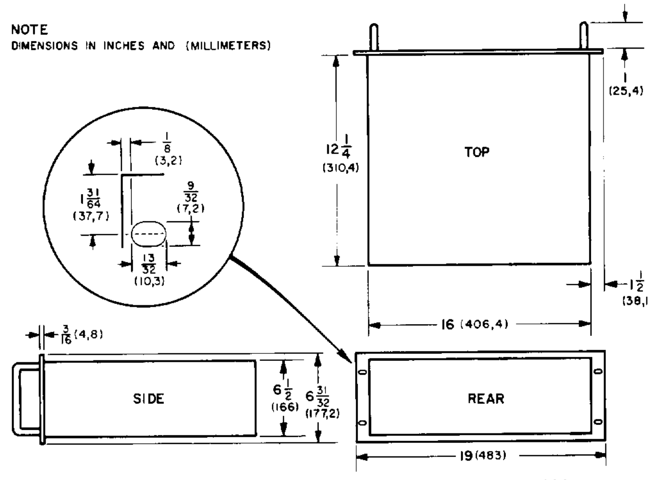
Accessories Available:
AC-16D Cable Assembly, consisting of 44 in. RG-58/U cable terminated on one end with a UG-88/U BNC connector.

AC-16K Cable Assembly, BNC to BNC, 48 in. long.

Coaxial Bolometer Mounts:
Model 476A 10 to 1000 mc
Model 477B 10 mc to 10 gc

Accessories Available (Cont'd)
Waveguide Bolometer Mounts:
Model 485A, S-band
Model 485B, G through X-band
Model 487B, G through R-band

Dimensions:
Cabinet Mount: 7-3/8 in. wide, 11-1/2 in. high, 14 in. deep.
Rack Mount:



Weight:
Cabinet Mount: Net 14 lb, shipping 19 lb
Rack Mount: Net 18 lb, shipping 30 lb

SECTION I
GENERAL INFORMATION

1-1. GENERAL DESCRIPTION.

1-2. The Model 430C Microwave Power Meter is designed to give instantaneous power measurements directly either in milliwatts or decibels. It may be used at any frequency range for which bolometer mounts exist, and will measure either continuous or pulsed power with instrument fuses, barretters, or thermistors of 100 ohm and 200 ohm values.

1-3. Power may be read directly in milliwatts from .01 to 10 mw, or in dbm from -20 to +10 dbm. Power exceeding 10 mw may be measured by adding attenuators such as ⓗⓟ 370, 380, 382 series or directional couplers such as ⓗⓟ 750 and ⓗⓟ 752 to the microwave system.

1-4. A d-c bias control provides complete control over the d-c bias current up to 16 ma to the bridge for balancing external bolometers. This feature allows the use of many commercially available low power bolometer mounts.

1-5. The flexible zero-set feature, the closely regulated power supply, and performance stability permit measurement of low power levels under wide ambient temperature variations.

1-6. DAMAGE IN TRANSIT.

1-7. After unpacking the instrument, should any shipping damage be discovered, follow the procedure outlined in the "Claim for Damage in Shipment" section on the last page of this book.

1-8. POWER TRANSFORMER CONVERSION.

1-9. Should it be desired to convert the Model 430C to 230 volt operation, proceed as follows:

a. Remove the bare wire jumper on the power transformer, underside of chassis, which connects terminal 1 to terminal 8; remove bare wire jumper between terminal 2 and terminal 9.

b. Insert a new jumper on the transformer which connects terminal 8 to terminal 2.

c. Change the line fuse to 0.5 ampere slow-blow type.

1-10. As shown in the schematic diagram this alteration changes the primary windings of the power transformer from a parallel arrangement to a series arrangement.

1-11. POWER CABLE.

1-12. The three conductor power cable supplied with this instrument is terminated in a polarized three prong male connector recommended by the National Electrical Manufacturers' Association. The third contact is an offset round pin added to a standard two-blade connector which grounds the instrument chassis when used with an appropriate receptacle. To use this connector in a standard two-contact receptacle, an adapter should be used to connect the NEMA connector to the two contact system. When the adapter is used, the third contact is terminated in a short lead from the adapter which can then be connected to the grounded receptacle mounting box in order to ground the instrument chassis.

COAXIAL SYSTEM

	10MC – 50MC	50MC – 100MC	100MC – 500MC	500MC – 1GC	1GC – 5GC	5GC – 10GC
BOLOMETER MOUNT	←476A	476A	476A	476A→		
THERMISTOR MOUNT	←477B	477B	477B	477B	477B	477B→
TO EXTEND THE POWER RANGE, FOLLOWING EQUIPMENT MAY BE USED:						
ATTENUATORS	←355A/B	355A/B	355A/B→	←393A→	←394A→	

WAVEGUIDE SYSTEM

	2.6GC – 3.95GC	3.95GC – 5.85GC	5.85GC – 8.2GC	8.2GC – 12.4GC	12.4GC – 18GC	18GC – 26.5GC	26.5GC – 40GC
BARRETTER MOUNTS	←S485→	←G485→	←J485→ ←H485	←X485→ H485→			
THERMISTOR MOUNTS	←S487→	←G487→	←J487→ ←H487	←X487→ H487→	←P487→	←K487→	←R487→
TO EXTEND THE POWER RANGE, FOLLOWING EQUIPMENT MAY BE USED:							
WAVEGUIDE ATTENUATORS	←S382→	←G382→ ←C382	←J382→ C382→ ←H382	←X382→ H382→ ←M382	←P382→ M382→	←K382→	←R382→
DIRECTIONAL COUPLERS	←S752→	←G752→	←J752→ ←H752	←X752→ H752→ ←M752	←P752→ M752→	←K752→	←R752→

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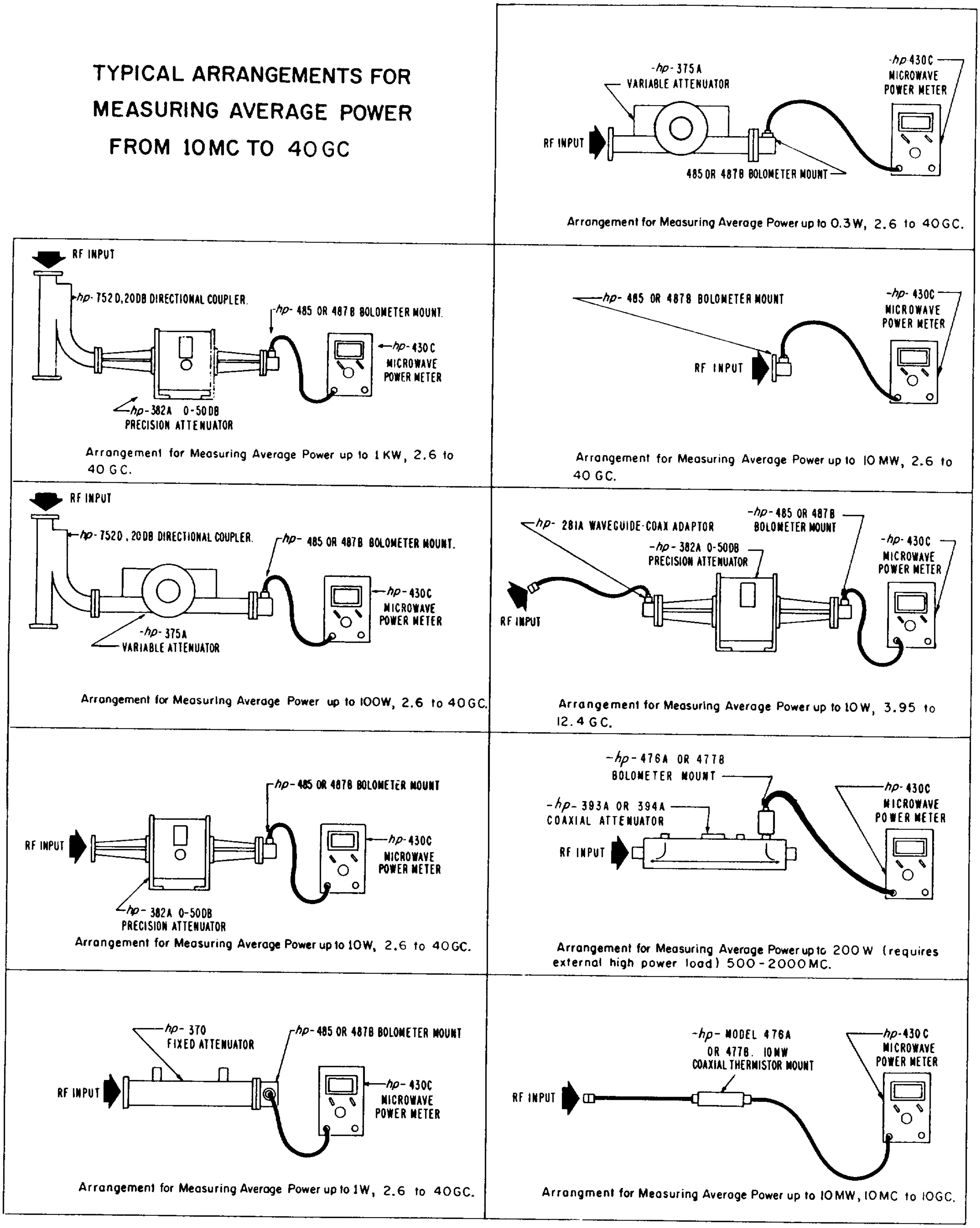
Table 1-1. Accessory Equipment for Use with the ℎ𝑝 Model 430C



Arrangement for Measuring Average Power up to 0.3W, 2.6 to 40GC.

Arrangement for Measuring Average Power up to 1 KW, 2.6 to 40 GC.

Arrangement for Measuring Average Power up to 10 MW, 2.6 to 40 GC.

Arrangement for Measuring Average Power up to 100W, 2.6 to 40GC.

Arrangement for Measuring Average Power up to 10W, 3.95 to 12.4 GC.

Arrangement for Measuring Average Power up to 10W, 2.6 to 40GC.

Arrangement for Measuring Average Power up to 200 W (requires external high power load) 500-2000MC.

Arrangement for Measuring Average Power up to 1W, 2.6 to 40GC.

Arrangment for Measuring Average Power up to 10MW, 10MC to 10GC.

Figure 1-1. Typical Arrangements for Measuring Average Power from 10 mc to 40 gc

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SECTION II
OPERATING INSTRUCTIONS

2-1. INSTRUMENT BEHAVIOR WHEN TURNED ON WITH NO BOLOMETER CONNECTED.

	Bias Current Off		Bias Current On
POS Coef:	Pins up-scale	POS Coef:	Pins up-scale
NEG Coef:	Needle vibrates against left hand pin	NEG Coef:	Pins down-scale

Some instruments may behave differently in that the meter may vibrate in an erratic manner. THESE ACTIONS ARE NORMAL AND WILL STOP AS SOON AS A BOLOMETER IS PROPERLY CONNECTED TO THE INSTRUMENT. Connecting the bolometer completes the fourth arm of a bridge circuit which is a part of the oscillator balancing circuit.

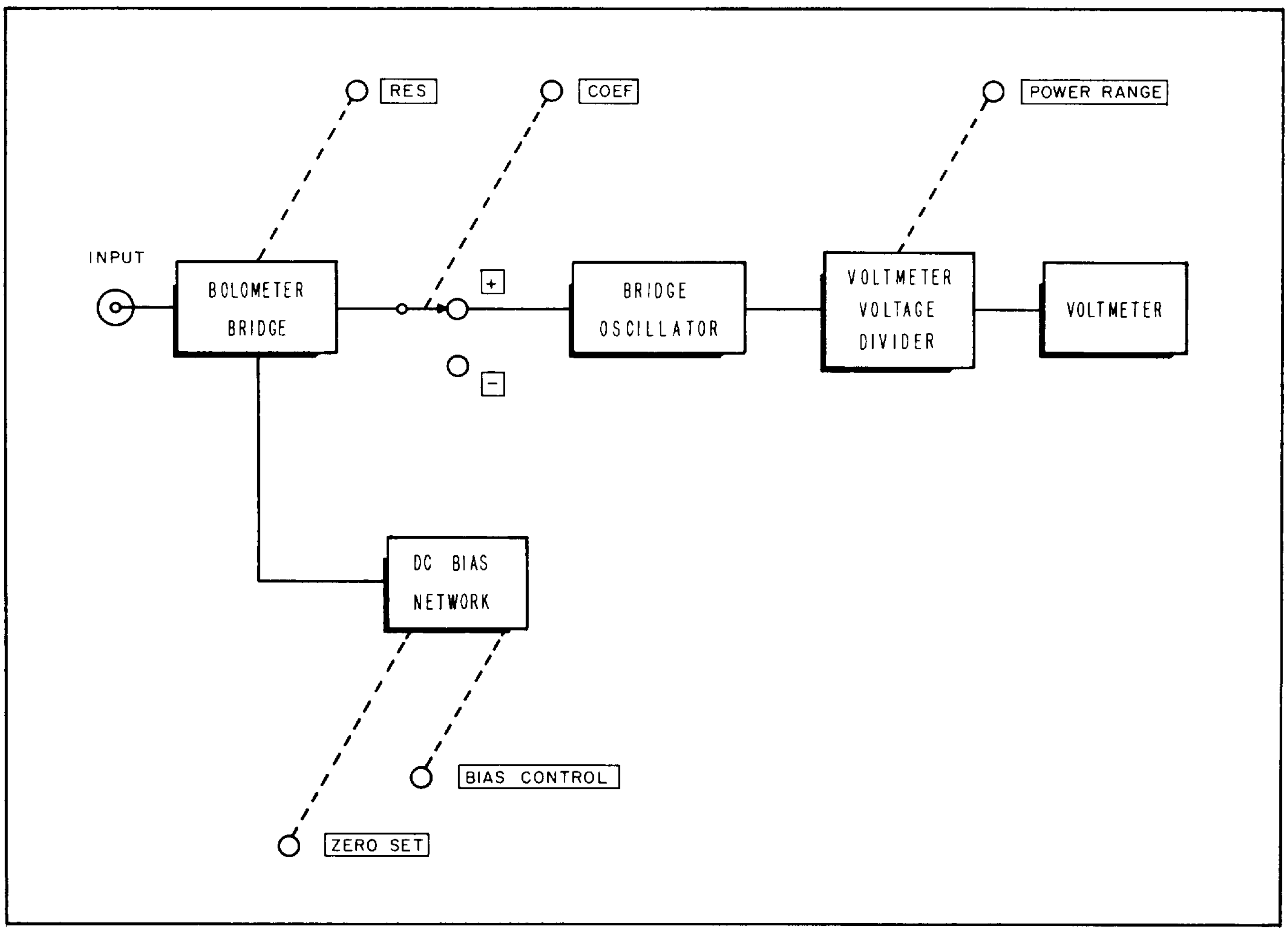

Figure 2-1. Block Diagram Showing Operating Controls

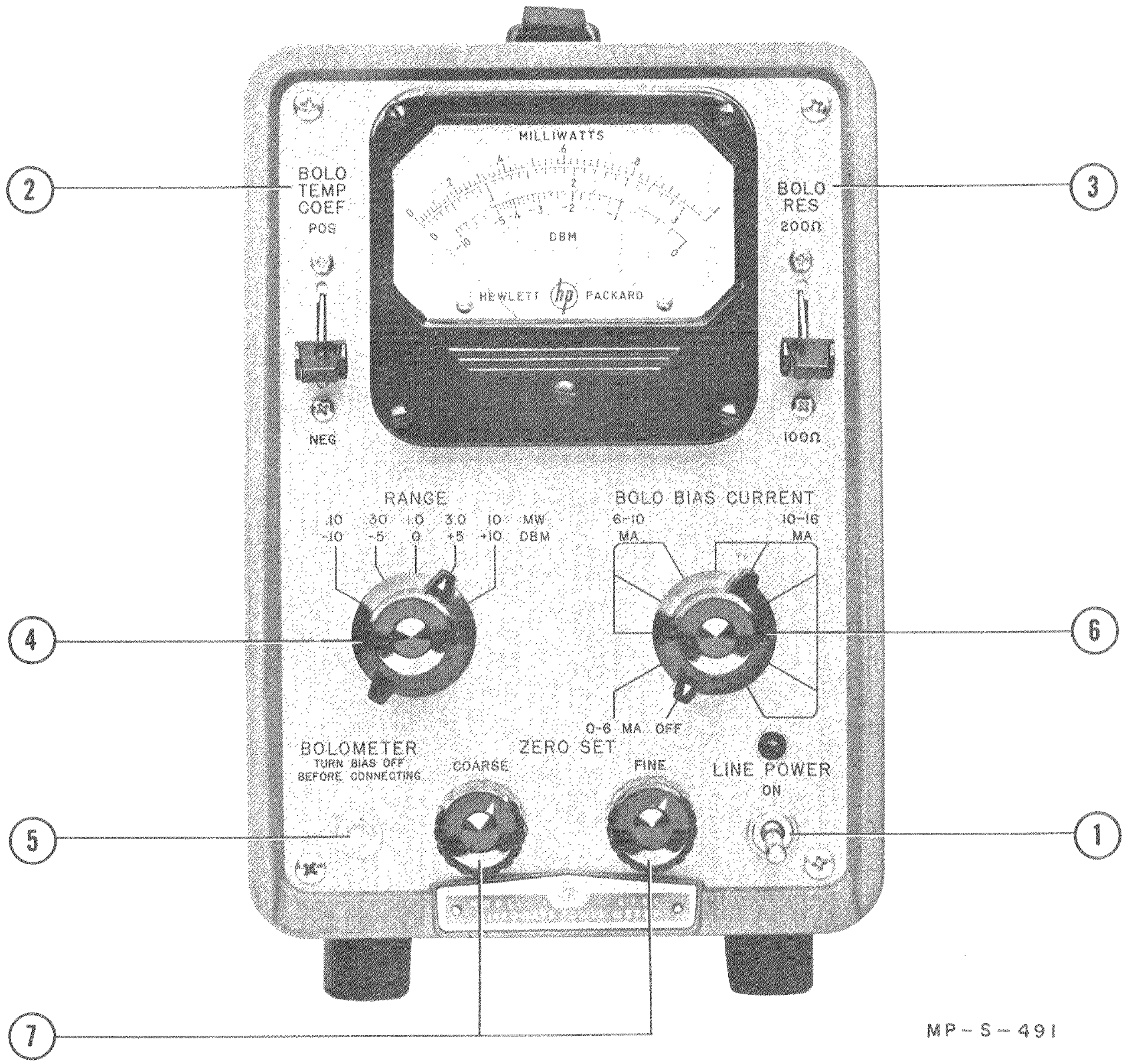

Figure 2-2. Operating Panel

2-2. OPERATING INSTRUCTIONS.

(1) LINE POWER
Turn on power to all circuits in instrument.

(2) BOLO TEMP COEF
Set temperature coefficient according to bolometer type: positive for barretter (fuse), negative for thermistor.

(3) BOLO RES
Set to operating resistance of bolometer: either 100 ohms or 200 ohms.

(4) RANGE
Select the proper power range for the power to be measured.

(5) BOLOMETER
Turn BIAS CURRENT switch to OFF. Rotate ZERO SET controls full counterclockwise. Connect the bolometer to BNC jack with suitable cable. Bolometer damage is likely if above conditions are not met before connection is made or broken. Do not apply rf power to bolometer at this time.

(6) BOLO BIAS CURRENT
After the bolometer is connected, and ac power has been on 2 minutes (min.), select the current range which will allow the ZERO SET controls to bring the meter to zero. Use the lowest current setting possible. Do not advance switch beyond the setting which supplies the maximum safe current for the bolometer in use. Refer to chart in the text or to the manufacturers instructions for the maximum safe current. See paragraph 2-5. WARNING: THE SWITCHING TRANSIENT RESULTING WHEN THE BIAS CURRENT SWITCH IS TURNED TO "OFF" OR FROM "OFF" TO "0-6 MA" MAY BURN OUT LOW CURRENT BOLOMETERS UNLESS THE COARSE ZERO SET CONTROL IS FIRST ROTATED FULL CCW (minimum bias current).

(7) ZERO SET
With no r-f power applied to bolometer, set meter electrical zero with Coarse and Fine adjustment of d-c bias selected by the BIAS CURRENT range switch. Return Coarse control to full CCW position each time before advancing the d-c BIAS CURRENT range switch to the next higher position. See para. 2-8. Apply rf power for measurement.

FUSE
Located at the rear of the instrument. Use only slow-blow type fuse as listed in the Table of Replaceable Parts.

2-3. BIAS CURRENT RANGE SWITCH MAXIMUM SETTINGS.

2-4. The following table lists the maximum current ratings of common bolometers which may be used with the ⓗⓟ 430C Power Meter. Note that barretter type detectors are especially sensitive to burn-out. Normal operation is quite close to the critical current, thus extreme care should be used when changing BIAS CURRENT range switch settings to not accidently go one step too far and exceed the critical value, even for an instant.

0-6 MA
This range of bias should not be exceeded when using low level bolometer elements such as the PRD Models 610A, 614, 617 and 631C because the maximum safe current that can be passed through these bolometers is 6 ma which corresponds to the maximum current available in the 0-6 range.

6-10 MA
The currents on this range of bias should not be exceeded when using bolometers like the Sperry Type 821 barretter, a 1/100 instrument fuse, the Narda Type N821B, and the Narda Type N610B barretters because the maximum safe current for these bolometers is 10.5 ma which corresponds to the maximum current available in the 6-10 range.

10-16 MA
This range of bias currents should be used only for thermistor elements or bolometer mounts such as the Hewlett-Packard 476A and 477B which have maximum safe current ratings over 16 ma.

2-5. BOLOMETER MOUNTS, GENERAL.

2-6. Before successful operation of the Microwave Power Meter, a bolometer mount of proper characteristics must be selected.[1] The two general types of bolometers, barretters and thermistors, are resistive devices which are capable of dissipating rf power and using the thermal energy absorbed to change resistance. The barretter is constructed usually of wire or film and has a positive coefficient of temperature typical of metals. Some consist of encapsulated platinum wire while others are platinum or resistive coatings on glass or mica. The thermistor has a negative coefficient of temperature and is constructed generally of a small amount of semiconducting material suspended by two fine wires. They, also, may be obtained in capsulated form.

2-7. Both of these elements are used as sensitive bolometers in conjunction with suitably designed bridges, and enjoy widespread use without a well defined preference.[2]

[1] Montgomery, C.G. Technique of Microwave Measurements, Ch 3, McGraw-Hill, New York, 1947.

[2] Terman, F.E., Pettit, J.M. Electronic Measurements, Ch 2, Sect. 2-2, McGraw-Hill, New York, 1952.

Table 2-1. Bolometer Characteristics

Make & Model	Temp. Coeff.	Max. Pwr. MW	Max. Current MA	Cold Res. Ohms	Oper. Res. Ohms	Oper. Pwr. MW	Oper. Current MA	Sens. Ohms per MW	Time Const. Micro-sec.	3 db Freq. cps	Remarks
Narda N610B-100	Pos				100	7.7	8.75				Like 1N23
Sperry 821*	Pos	32	10.5	110	200	15.3	8.75	4.5	350	450	} Fully interchangeable
Narda N821B*	Pos	32	10.5	110	200	15.3	8.75	4.5	350	450	} Fully interchangeable
Narda N610B	Pos	32	10.5	110	200	15.3	8.75	4.5	350	450	Like 1N23
PRD 610A	Pos	7.5	6	160	200	4	4.5	10	100	1600	Like 1N23
PRD 614	Pos	7.5	6	160	200	4	4.5	10	100	1600	Like 1N26 crystal
PRD 617	Pos	7.5	6	160	200	4	4.5	10	100	1600	Wire element on mica sheet
PRD 631C	Pos			160	200	4	4.5	10			Two 100 ohm wires on mica
Buss MJB 1/100*	Pos	60	14	140	200	15.3	8.75	3			Large variations
W.E. Co. D166382 D170575											D166382, 32A3 in glass bead, interchangeable
Victory 32A3 32A5*	Neg	100	130	2000	100 200	14 9	12 6.7	13 36	10^6		D170575, 32A5 uncapsuled, interchangeable

* used in ℎ𝑝 equipment

Note: All values in this table are approximate. Individual units will vary considerably.

2-8. In terms of ohm change for a given amount of power, the thermistor is more sensitive than the barretter, and may be thought of as being more flexible over a wide power range. In addition, the thermistor possesses much better overload and burn-out characteristics than the barretter.

2-9. While the operating resistance of the barretter is limited to a smaller range than that of the thermistor, it responds more quickly because of its smaller time constant, and is therefore more able to follow a modulation envelope (see paragraph 2-11b). For this reason, it is sometimes used as a detector as well as a bolometer.

2-10. Both barretters and thermistors are used, however, to measure the average value of modulated power. Since a wide range of d-c bias is provided in the Model 430C to adjust for individual bolometer variation, a bolometer may be considered suitable for use provided the meter can be zero set.

2-11. Table 2-1 is a table of a few commonly available bolometers suitable for use with the Model 430C.

2-12. BARRETTERS.

2-13. The Model 430C is designed to operate with positive temperature coefficient bolometers such as the Sperry Type 821 Barretter, a 1/100 ampere instrument fuse; the Polytechnic Research and Development Company, 1 mw Bolometers (Models 610A, 614, 617, 631C) or the Hewlett-Packard Model 476A Bolometer Mount.

2-14. R24 is connected in a protective circuit across the bridge to limit the surge voltage at the BNC jack in case a bolometer mount 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 even when the BIAS CURRENT is in its lowest range. This change may eventually reach a sufficient magnitude to prevent zero setting the meter on a desired range. To eliminate this possibility, place the BIAS CURRENT in the OFF position when connecting and disconnecting any bolometer mount when the instrument is turned on. The external criterion for judging the operating characteristics of a barretter is whether or not the meter can be zero set.

2-15. THERMISTORS.

2-16. The Model 430C is designed to operate with negative temperature coefficient bolometer such as the Hewlett-Packard Model 477B Thermistor Mount, or the Western Electric D166382 thermistor.

2-17. Many individual thermistors will not function (i.e. permit zero setting) at 200 ohms on the 10 mw range because they consume too little power. This limitation does not apply to dual thermistor arrangements, such as the Hewlett-Packard Model 477B.

2-18. OPERATION, GENERAL.

CAUTION

With low-level bolometers, always turn ZERO SET control (coarse) full counterclockwise BEFORE turning the BIAS CURRENT switch either on or off. This procedure avoids putting a switching transient through the bolometer.

2-19. Thus in normal operation with low-level bolometers, make sure the coarse ZERO SET control is fully counterclockwise before the BIAS CURRENT is moved from OFF to the 0-6 MA position.

2-20. When making measurements on the 0.1 mw range, allow one hour for the temperature to stabilize after turning the instrument on if it is desired to realize the full accuracy of the Model 430C.

2-21. It should be remembered that the bolometer element is a temperature sensitive device, and inconsistent results will be obtained where a cold mount is attached to a warm object. Always allow the mount ambient temperature to reach that of the equipment under measurement. To further reduce temperature variation effects it is good practice to make the measurement as soon after the meter has been zero set as possible.

2-22. OPERATING PROCEDURE.

a. Place the BOLO TEMP COEF. and BOLO RES. switches at the appropriate settings for the bolometer in use. (200 NEG for the 477B Coaxial Thermistor Mount.)

b. Place the BOLO BIAS CURRENT switch in the OFF position. ZERO SET controls (coarse and fine) fully counterclockwise.

CAUTION

Turn the BOLO BIAS CURRENT switch OFF when connecting a bolometer. The voltage developed during open circuit across the input jack is sufficient to burn out a barretter - even when the BOLO BIAS CURRENT is set to a safe current for the bolometer in use.

c. Set the RANGE switch for the range of power under measurement.

d. Connect bolometer mount to BOLOMETER BNC connector. Do not apply RF power to bolometer.

e. Check meter mechanical zero. (Normally adjustment is only required at time of maintenance or calibration, see paragraph 4-8.) If mechanical adjustment is necessary, proceed as follows:

(1) Mechanical Zero Adjustment - Turn LINE POWER ON and allow instrument to come up to operating temperature. Then turn off instrument power for two minutes.

(2) Rotate the meter mechanical zero adjusting screw (located below the window on the meter) clockwise until the meter pointer is traveling

downscale toward zero and stop at zero on the upperscale (MILLIWATT scale). If you go post zero with the downscale pointer movement, continue clockwise rotation of the screw until the pointer is again traveling downscale and stop exactly on zero.

f. Turn LINE POWER ON and allow at least ten minutes to reach operating temperature.

g. Place the BOLO BIAS CURRENT in the 0-6MA position.

h. Rotate the ZERO SET controls clockwise. If the pointer goes off scale at the high end or moves to a position on scale, zero set the meter for a zero MILLIWATTS scale indication using the ZERO SET control. Measurements can now be made using either the MILLIWATT or DBM scales. Thus, with the RANGE switch set to 1.0 MW, a full scale meter reading indicates either a 1.0 milliwatt or a 0 dbm power level. To verify this MILLIWATT and DBM scale relationship, note that using the same range, a reading of 0.5 MW also indicates -3 dbm. Proceed with step j.

i. If the pointer rests off scale at the low end, return the ZERO SET controls to full CCW. Increase BOLO BIAS CURRENT switch one step at a time and attempt to zero meter. Always return the ZERO SET controls to full CCW (minimum bias) before advancing the BOLO BIAS CURRENT switch to the next higher position. Do not go beyond the setting which corresponds to the maximum current for the bolometer in use.

j. Apply RF power to bolometer. Adjust tuning device on bolometer mount (if any) for maximum meter deflection.

k. Shut off RF power from source and re-zero set instruments as in step h.

m. Apply RF power for measurement.

2-23. MODULATED POWER MEASUREMENT.

2-24. Experimental data shows that under most conditions of modulated power measurement the readings of the Model 430C are accurate irrespective of modulation type or bolometer type. It also shows, however, that under certain conditions of low frequency modulation, sine-wave or square-wave, errors can occur. At certain repetition rates of pulse modulation also, errors sometimes occur. All of these errors are the exception rather than the rule when reading modulated power and they will be discussed as envelope tracking errors and beat frequency errors.

2-25. SINE WAVE AND SQUARE WAVE MODULATION.

a. ENVELOPE TRACKING ERROR. At low modulation frequencies the bolometer attempts to follow the modulation envelope. There fore the bridge oscillator attempts to follow the envelope by adjusting its power output to accommodate the changes in resistance of the bolometer. The modulation frequency becomes impressed upon the oscillator frequency, and the average responding meter will indicate the average of the troughs and peaks of the modulation envelope. The quick response of the barretter resulting from its small time constant makes it particularly susceptible to this action. The power indicated on the meter no longer corresponds to the power being measured because the meter responds to average voltages rather than rms voltages. Since the average value is lower than the rms value, the meter reading will be high. The amount of the error depends upon the modulation frequency and upon the Q of the bridge oscillator circuit. The Q of the oscillator in the 430C has been made high to limit this effect and to lower the critical modulation frequencies at which it occurs.

b. THE CRITICAL FREQUENCY. The effect of envelope tracking error is that as the modulation frequency is reduced, the meter indication is steady until a critical modulation frequency is reached. At this point the meter indication starts to increase. As the modulation frequency is further lowered, the meter indication continues to increase to a maximum possible error of approximately 1 db high. This condition is the same for both sine wave and square wave modulation.

The maximum error occurs when a barretter is used on the 10 mw range of the instrument at frequencies below 200-300 cps. When using other ranges or a thermistor, the critical frequency is below 100 cps.

Above these critical frequencies the readings are accurate for either sine wave or square wave modulation, being one-half the peak power for square waves and in the proper proportion to the CW level for the percentage of modulation used in the case of sine waves.

2-26. PULSE MODULATION.

2-27. Power measurement of pulse modulated signals is accurate since it varies in a linear manner with both repetition rate and pulse width. The maximum pulse width employed in experiment was 10 microseconds but it is assumed that as the pulse width is increased a region will be approached where square wave behavior exists. In this square wave region, the critical frequency effects described in paragraph 2-10b may arise.

a. BEAT FREQUENCY ERRORS. When measuring pulse modulated power avoid repetition rates which are sub-multiples of 10.8 KC, the frequency of the bridge oscillator. On sub-multiple frequencies a beating effect occurs in the bridge circuit which is reflected in the meter indications. This effect is particularly active when using a barretter on the 0.1 mw range where, if the prr is right, violent beating occurs followed by the meter's falling to a low value as the bridge oscillator locks-in. Any slight variation in the prr will remove this difficulty, since the tuning is so sharp it is a simple matter to set the prr between successive sub-multiple frequencies down to about 200 pps.

This effect is noticeable when employing thermistors, but the beats are small with no oscillator lock-in, and readings are not affected.

SECTION III
THEORY OF OPERATION

3-1. CIRCUIT DESCRIPTION.

3-2. Power Meter design is predicated on the assumption that the bolometer element is not a frequency sensitive device, and that equivalent amounts of dc or rf power will produce the same resistance in the element. The bolometer element forms one leg of a self balancing bridge balanced for the operating resistance of the element, usually 100 or 200 ohms. The power meter contains such a bridge, a 10.8 KC oscillator, a dc bias circuit, and a meter circuit. See figure 3-1.

3-3. Initially, the bolometer element is connected to the instrument bridge circuit but is not placed in an rf field. The bolometer bridge is balanced when the element changes from its cold resistance to its operating resistance. The change takes place as the element absorbs power from the oscillator and dc power from the bias circuit.

3-4. As seen in the simplified schematic diagram in figure 3-1 when the bridge is unbalanced, transmission occurs through the bridge allowing the system to oscillate with the consequent oscillator power being absorbed by the bolometer element. This element continues to absorb power and to heat itself until it balances the bridge at a predetermined operating resistance. The oscillator power stabilizes as the balanced bridge resists further transmission.

3-5. The voltmeter is zero set and the bolometer element is placed in an rf field. The element absorbs the external rf, heats, and changes its resistance which unbalances the bridge (in a direction opposite to that of the cold resistance condition of unbalance). This action causes the output from the oscillator to decrease to accommodate the external rf power through the bolometer element. The voltmeter circuit measures the amount of this power decrease from the oscillator and displays the measurement calibrated as a power increase added by the external rf field.

3-6. BOLOMETER BRIDGE.

3-7. The bolometer bridge is a resonant bridge one leg of which is adjustable to either 400 ohms or 200 ohms to establish a 3:1 voltage relationship when using a 200 ohm or 100 ohm bolometer element respectively. As seen in figure 3-2 and 3-3 the circled values 1, 3, 1±3/A represent the balance voltage relationships around the bridge, and the boxed values show resistance ratios. If the bridge is out of balance, it will permit either an increase or decrease in transmission through it from the oscillator; and thus, an increase or decrease in the current through the bolometer element. The successful balance of the bridge is determined by the resistance value of the element. When it reaches its operating resistance, as determined by the RESISTANCE switch setting, the

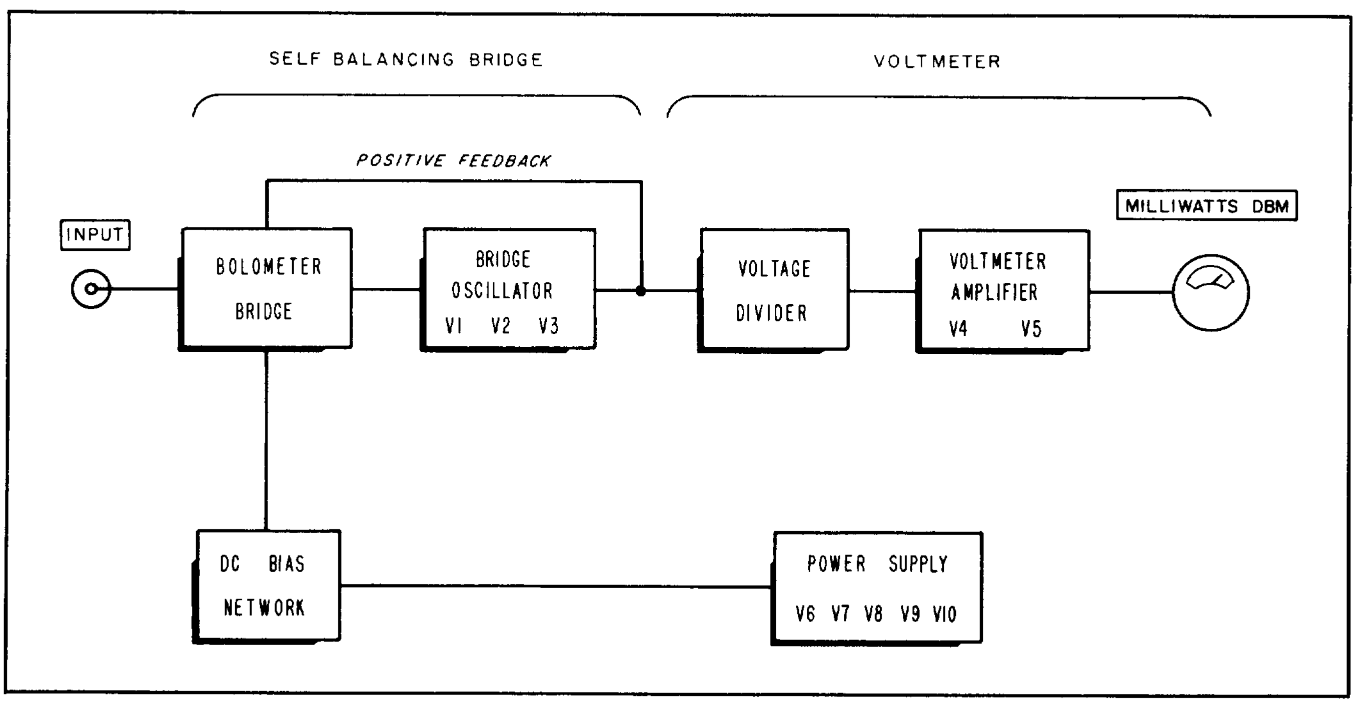

Figure 3-1. Circuit Block Diagram

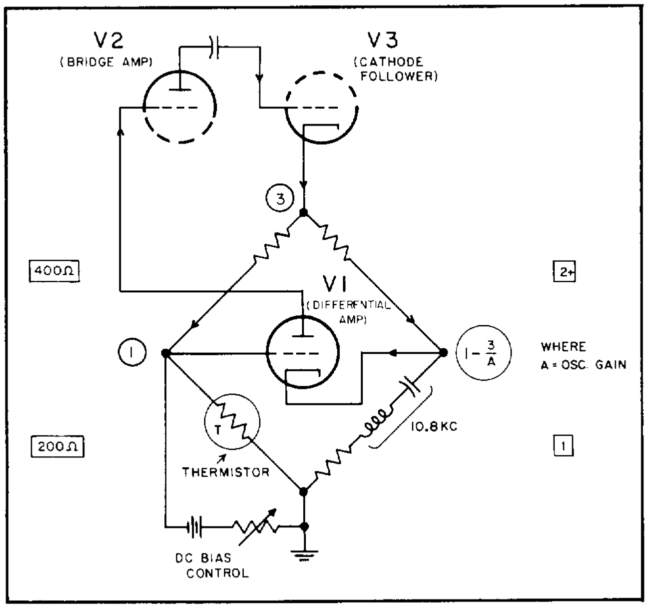

Figure 3-2. Simplified Schematic Showing 200 Ω Thermistor Bridge

bridge balances and the oscillator is forced to adjust its power output accordingly. The operation of the oscillator is controlled by the bridge as seen in the following paragraph.

3-8. BRIDGE OSCILLATOR.

3-9. The oscillator circuit is composed of V1, V2, and V3 as a simple feedback oscillator.

3-10. Assume for purposes of illustration that we are using a 200 ohm thermistor mount to measure power on the 10 mw range. Also assume that 28 mw are required to drive the thermistor mount from its high cold resistance down to 200 ohms operating resistance. As soon as the mount is connected, the oscillator sees an unbalanced bridge and supplies nearly maximum output to the thermistor. As the thermistor heats its resistance drops and the bridge approaches a balance. However, the meter is calibrated to zero set on the 10 mw range when the oscillator is supplying 12 mw only. (It must be remembered that the meter samples the oscillator power and not directly any rf which is externally supplied to the thermistor. The oscillator in effect backs-off when external rf is supplied so the meter is a reverse reading or upscale device as regards its calibration.) On the 10 mw range the meter zero sets at 12 mw and reads full scale when the oscillator supplies approximately 2 mw. At this point in the example the oscillator is supplying much more than 12 mw because the bridge is far out of balance. To force the oscillator to supply only 12 mw and thus zero the meter, we supply dc bias current to the thermistor. If we adjust the BIAS CONTROL and the ZERO SET controls to furnish exactly 16 mw to the thermistor, the oscillator backs-off to 12 mw. The bridge is balanced and the meter reads zero. Should we connect the thermistor to an external rf source, suppose 10 mw, the 16 mw of dc which we are supplying to the element remains constant, but the oscillator sees an unbalanced bridge in the form of a decreased grid load on V1 (see figure 3-2). Its output decreases until its grid load is again 200 ohms. To accomplish this it must decrease the exact amount of the external field which is 10 mw. It now supplies 2 mw instead of 12 mw and the meter reads full scale or 10 mw.

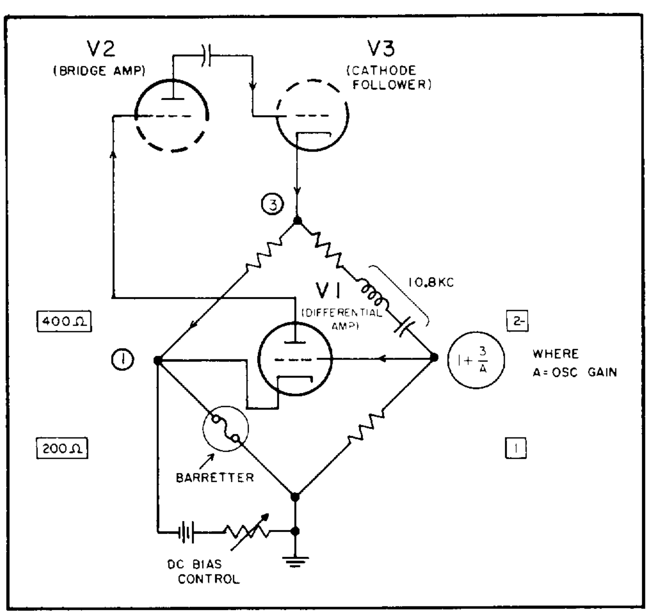

Figure 3-3. Simplified Schematic Showing 200 Ω Barretter Bridge

3-11. The action in the above example is similar in case of a barretter, but as seen in figure 3-3 the bridge is rearranged to accommodate the positive temperature coefficient of the barretter.

3-12. POWER SUPPLY.

3-13. The power supply for the Model 430C consists of a full wave rectifier section followed by a differential amplifier as a regulator.

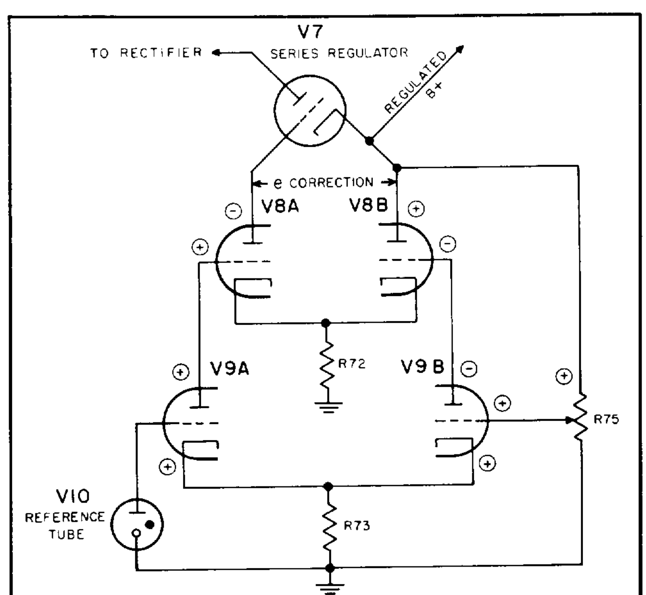

Figure 3-4. Simplified Schematic Showing Voltage Regulator Action

3-14. The regulator section is shown in a simplified schematic diagram in figure 3-4 and operates as follows:

3-15. The significant characteristic of a differential amplifier is that it does not transmit in-phase signals applied across the grids of the first stage, in this case V9. In-phase signals such as tube effects and heater to cathode emission effects are degenerated in the large cathode resistors R73 and R72.

3-16. Out of phase signals, however, are amplified and receive normal amplification for a cascaded triode arrangement finally appearing across the plates of the output stage V8.

3-17. As a regulator circuit, the grid of V9A is held constant by the reference tube V19 so that an unbalance will occur across the grids when a change in the B+ takes place. For example (see figure 3-4), if the regulated B+ tends to increase, an increase is developed across R75 and an increase on the grid of V9B occurs. This results in a drop on the grid of V8B and an increase on the plate of V8B.

3-18. Considering the other half-sections of these tubes, V9A and V8A assume the same conditions as above. When the grid of V9B is increased, its cathode followed as did the cathode of V9A. Since the grid of V9A is held constant by the reference tube, the plate of V9A also increases which increases the voltage on the grid of V8A. This action appears as a decrease on the plate of V8A. Looking at figure 3-4, it is seen that the decreasing signal is applied to the grid of the series regulator V7 while the increasing signal from V8B is applied to the cathode of V7. This polarity of signals across the plates of V8 applied across the grid and cathode of V7 increases the effective plate resistance of V7 and thus drops the voltage across it bringing the B+ back to the desired value. When a decrease starts in the regulated B+ the action described above occurs in reverse polarity tending to decrease the plate resistance of the series regulator.

SECTION IV
MAINTENANCE

4-1. GENERAL.

Note

If the BIAS CURRENT and ZERO SET controls do not operate in the normal manner always substitute another bolometer that is known to be in operating condition before checking the instrument. With NO bolometer connected the meter will normally pin to the right on POS. COEF. and to the left on NEG. COEF. and may also oscillate.

The procedures that follow are listed in a sequence that is most easily followed when the entire procedure is to be completed. In many cases only one or two parts of the procedure will be required, and they may be done without completing all the other steps.

A twenty or thirty minute warm-up and check of the power supply output voltages is always recommended before making any other tests or adjustment.

The specifications for this instrument are given in the front of this manual. The following procedure contains information to help you service the instrument but this additional information cannot be considered as a part of the specifications.

Table 4-1. Tube Replacement Chart

Circuit Ref.	Type	Function	Adjustments Required
V1	6AV6	Oscillator Differential Amplifier	
V2	6CB6	Oscillator Amplifier	None
V3	6AU5GT	Oscillator Cathode Follower	
V4	6CB6	Voltmeter Amplifier	Voltmeter Calibration Sect. 4-9
V5	6CB6		
V6	5Y3	Rectifier	Power Supply Sect. 4-6
V7	6AU5GT	Power Supply Series Regulator	
V8	12AX7	Power Supply Control Amplifier	
V9	12AX7		
V10	5651	Power Supply Reference Tube	

4-2. EQUIPMENT REQUIRED.

4-3. The following equipment is required to complete the test procedure:

a. A variable transformer with an accurate ac voltmeter to vary the instrument line voltage between 103 and 127 volts.

b. Dc vacuum tube voltmeter for measurements up to 275 volts.

c. An ac vacuum tube voltmeter with an accuracy of ±1/2% at 10 kc. The meter should also have a maximum sensitivity of at least 3 millivolts full scale. An hp Model 400H or 400L freshly calibrated using 100 or 400 cps source with a reference of at least 0.25% accuracy, is suitable. The meter should be checked at 0.2, 0.5, 1, and 3 volts.

d. A frequency meter, counter, or oscilloscope with calibrated sweeps for measuring the 10 kc oscillator frequency.

e. Bolometer elements as required for the various steps.

f. Dc milliammeter indicating 20 ma full scale and having a resistance of 200 ohms.

4-4. RAPID PERFORMANCE TEST.

4-5. The following tests may be performed with the instrument in its cabinet. This test is an indication of accurate power measurements on all ranges of the Model 430C.

a. Set the BIAS CURRENT to OFF, RES. to 200 ohms, and connect a 200 ohm bolometer to the input connector.

b. Connect an accurate (at least ±1% at 10 kc) ac VTVM in parallel with the bolometer.

c. Set the power meter on the Model 430C to zero on the 10 mw range using the BIAS CURRENT and ZERO SET controls. The voltage indicated on the ac VTVM must fall within the range indicated in table 4-2.

d. Set the power meter on the Model 430C to 10 mw using the BIAS CURRENT and ZERO SET controls. This voltage must be within the limits indicated in the FULL SCALE column for the zero voltage noted in step c.

Table 4-2. Voltmeter Accuracy Limits

10 MW Range		1 MW Range		0.1 MW Range	
Voltage at Zero	Full Scale Voltage Limits	Voltage at Zero	Full Scale Voltage Limits	Voltage at Zero	Full Scale Voltage Limits
1.50	0.387 - 0.592	0.474	0.122 - 0.187	0.150	0.0387 - 0.0592
1.52	0.459 - 0.641	0.481	0.145 - 0.203	0.152	0.0459 - 0.0641
1.54	0.521 - 0.687	0.487	0.165 - 0.217	0.154	0.0521 - 0.0687
1.55	0.550 - 0.709	0.490	0.174 - 0.224	0.155	0.0550 - 0.0709
1.56	0.578 - 0.730	0.493	0.183 - 0.231	0.156	0.0578 - 0.0730
1.58	0.630 - 0.772	0.500	0.199 - 0.244	0.158	0.0630 - 0.0772
1.60	0.678 - 0.813	0.506	0.214 - 0.257	0.160	0.0678 - 0.0813

e. Repeat steps c and d for the remaining ranges listed in table 4-2.

f. Disconnect the bolometer and ac VTVM.

4-6. POWER SUPPLY.

a. Connect the instrument to the variable power line transformer.

b. Set the COEF. switch to POS. Do not make any connection to the BOLOMETER jack.

c. Set the regulated power supply voltage at 250 volts ±3 volts with R75.

d. This voltage should not vary more than ±1% as the line voltage is varied between 103 and 127 volts. Allow the instrument to stabilize for one minute after a change in line voltage before measuring the regulated voltage.

e. Ripple voltage on the regulated power supply should be less than 3 millivolt with the power line voltage set at any voltage between 103 and 127 volts. Wait at least one minute after changing the line voltage before measuring the ripple voltage.

4-7. DC BIAS CURRENT.

a. Set the COEF. switch to POS. and the RES. switch to 200.

b. Set the BIAS CURRENT to OFF and both ZERO SET controls at minimum (max CCW).

c. Remove V1.

d. Connect a milliammeter to the BOLOMETER jack. The meter should have an internal resistance of 200 ohms.

e. Check the current range as the ZERO SET controls are varied in each step of the BIAS CURRENT switch. There should be an overlap between adjacent ranges.

f. Maximum BIAS CURRENT should be between 16 and 18 ma. The regulated power supply may be set between 247 and 253 volts as required to obtain this current range. Current on the lowest range should vary between 0 and 5.5 to 6.5 ma. If these conditions cannot be met, adjust the value of R29A.

g. Disconnect the milliammeter and replace V1.

4-8. METER MECHANICAL ZERO.

a. Allow the instrument to come up to operating temperature and then turn off the power for two minutes.

b. Rotate the meter mechanical zero adjusting screw (located below the window on the meter) clockwise until the meter pointer is traveling downscale toward zero and stop at zero. If you go too far, continue clockwise rotation of the screw until the pointer is again traveling downscale and stop exactly on zero.

4-9. BOLOMETER BRIDGE RESISTANCE RATIO AND VOLTMETER CALIBRATION.

4-10. Two different calibration procedures follow. Procedure A is used to calibrate the instrument for general purpose use with all types of bolometers with nominal resistance values of 200 and 100 ohms. Procedure B is suggested for use when the instrument is used consistently with one type of bolometer and provides improved calibration accuracy.

4-11. Either procedure involves two basic adjustments. One is the adjustment of the bolometer operating resistance to the correct value as determined by the bridge resistance ratio. The other is the adjustment of the voltmeter end points for the correct bolometer voltage.

4-12. The bridge resistance adjustment (R8) establishes bridge balancing resistance for four conditions: 1) Thermistor, 200 ohms, negative coefficient. 2) Thermistor, 100 ohms, negative coefficient. 3) Fuse or barretter, 200 ohms, positive coefficient. 4) Fuse or barretter, 100 ohms, positive coefficient. A compromise adjustment of R8 may be necessary to meet all four of these conditions when the instrument is used with several types of bolometers. However, when the instrument is used primarily with one type of bolometer this compromise will not be necessary.

4-13. Two highly accurate test instruments are required. One is a very accurate, high impedance, ac rms vtvm, preferably freshly calibrated at 10 kilocycles. An ⓗⓟ Model 400H Vacuum Tube Voltmeter, calibrated at 400 cps with an ⓗⓟ Model 738AR Voltmeter Calibrator, is sufficiently accurate. The other requirement is for a Decade Resistance Box, capable of adjustment to 100 or 200 ohms with a resolution of at least 0.1 ohm and accurate at 10 kilocycles to within 0.1% or better. A General Radio type 1432-T is quite satisfactory.

4-14. PROCEDURE A.

(1) Turn instrument on and allow at least two hours for the instrument to warm up.

(2) Connect the decade resistance box across the BOLOMETER connector on the Power Meter.

(3) Set BOLO RES to 200 Ω, RANGE to 1.0 MW, and BOLO BIAS CURRENT to OFF.

(4) Set BOLO TEMP COEF to POS. Adjust the resistance box until the oscillator is observed to go into and out of oscillation. A down-scale meter indication shows oscillation while off-scale, to the right, shows no oscillation. In the "positive" position, oscillation indicates too low a resistance.

(5) Adjust the resistance box until the meter either stays on-scale at one setting or swings between extremes at two successive 0.1 ohm steps and leave the resistance box at the highest setting. This adjustment is sensitive to slight non-linearities in the circuit and there may be a slight delay in the meter swing.

(6) Record the resistance box setting.

(7) Switch BOLO TEMP COEF to NEG and repeat step 4. In the "negative" position, oscillation indicates too high a resistance.

(8) Repeat step 5 except leave the resistance box at the lowest setting and record the resistance box setting.

(9) The resistance values obtained in steps 6 and 8 will normally be within approximately 1% of the nominal value of 200 ohms and an equal distance on each side of 200 ohms. If necessary control R8 in the bridge circuit can be adjusted to minimize the spread between the two resistance values. If the setting of R8 is changed, repeat steps 4 through 9 until the desired results are obtained.

(10) Switch BOLO RES to 100 Ω and repeat steps 4 through 9 except use a value of 100 ohms in step 9. If the setting of R8 is changed, repeat steps 3 through 10 until the desired compromise is obtained.

(11) Connect a 200 ohm bolometer and the test ac vtvm in parallel across the BOLOMETER input connector in place of the decade resistance box. A 100 ohm bolometer can also be used. Use normal operating procedures and adjust the instrument controls as appropriate for the bolometer used.

(12) Adjust the ZERO SET controls to obtain an indication of 0.490 volts on the test voltmeter. Adjust for 0.346 volts if a 100 ohm bolometer is used.

(13) Adjust ZERO ADJ control (R58) to obtain an indication of zero on the meter in the Power Meter.

(14) Adjust the ZERO SET controls to obtain an indication of 0.200 volts on the test voltmeter. Adjust for 0.141 volts if a 100 ohm bolometer is used.

(15) Adjust FULL SCALE ADJ control (R63) to obtain a full-scale indication on the Power Meter.

(16) Repeat steps 12 through 15 as a final check since there is a slight interaction between R58 and R63.

4-15. PROCEDURE B. This procedure is intended for use when the Power Meter is consistently used with one type of bolometer. When calibrated for a particular type of bolometer, the Power Meter indication will be more directly related to the displaced audio power in the bolometer and there will be a corresponding improvement in measurement accuracy. This alternate procedure calibrates out any errors in the bridge components or in the resistor in series with the bridge in the 100 Ω position.

(1) Turn instrument on and allow at least two hours for the instrument to warm up.

(2) Connect the decade resistance box across the BOLOMETER connector on the Power Meter.

(3) Set the BOLO TEMP COEF, BOLO RES, RANGE BOLO BIAS CURRENT, and ZERO SET controls at the settings normally required for the bolometer to be used.

(4) Adjust the resistance box until the oscillator is observed to go into and out of oscillation. A down-scale meter indication shows oscillation while off-scale, to the right, shows no oscillation. Oscillation indicates too low a resistance for a positive temperature coefficient and too high a resistance for a negative coefficient.

(5) Adjust the resistance box until the meter either stays on-scale at one setting or swings between extremes at two successive 0.1 ohm steps and leave the resistance box at the setting that provides an off-scale indication to the right. This adjustment is sensitive to slight non-linearities in the circuit and there may be a slight delay in the meter swing.

(6) The setting of the resistance box is the operating resistance a bolometer will have when

connected to the Power Meter. If necessary, control R8 in the bridge circuit can be adjusted to bring the operating resistance within about 1% of the nominal value of 200 or 100 ohms. Exact adjustment to 200 or 100 ohms is not essential. If the setting of R8 is changed, repeat steps 4 and 5.

(7) Record the final operating resistance determined in the last step.

(8) Replace the resistance box with a bolometer of the type for which the instrument is being calibrated. Connect the test voltmeter in parallel with the bolometer. Follow standard operating procedures to prevent damaging the bolometer.

(9) On all ranges, the correct value of power delivered to the bolometer by the oscillator is 1.2 times the full-scale reading at zero and 0.2 times the full-scale reading at full-scale. Full-scale on all ranges is the "1" on the 0-1 scale. Therefore, the "3" ranges are actually 3.162 at full-scale.

(10) For any desired RANGE switch position, calculate the voltages necessary for 1.2 (zero) and 0.2 (full-scale) times the full-scale power reading, using the actual operating resistance recorded in step 7. For example, if the operating resistance is 200.4 ohms and calibration is done on the 3 MW RANGE, the calculated voltages will be:

$$E_o = \sqrt{P_o R} = \sqrt{(1.2 \times 3.162 \times 10^{-3}) \times (200.4)} = 0.872 \text{ volts}$$

$$E_{fs} = \sqrt{P_{fs} R} = \sqrt{(0.2 \times 3.162 \times 10^{-3}) \times (200.4)} = 0.356 \text{ volts}$$

E_o = bolometer voltage (10 KC) for zero indication.

E_{fs} = bolometer voltage (10 KC) full-scale indication.

P_o = 10 KC power (watts) input to bolometer for zero.

P_{fs} = 10 KC power (watts) input to bolometer for full-scale.

R = measured bolometer operating resistance in ohms.

(11) Set the ZERO SET controls to give E_o at the bolometer as indicated by the test ac voltmeter. Adjust the ZERO ADJ control (R58) to make the Power Meter indicate zero.

(12) Set the ZERO SET controls to give E_{fs} at the bolometer. Adjust the FULL-SCALE ADJ control (R63) to make the Power Meter indicate full-scale.

(13) Repeat steps 11 and 12 as a final check since there is a slight interaction between R58 and R63.

(14) Calibration of the power meter is now complete. The two steps that follow are included for those who wish to check accuracy on other positions of the RANGE switch and/or meter tracking.

(15) If the Power Meter is used on ranges other than that on which it is calibrated, a slight but ordinarily negligible error may be introduced by the RANGE switch attenuator. This possible error may be evaluated by measuring the 10 KC bolometer voltages at zero and full-scale and then calculating the power difference. The power difference should be within ±5% of the RANGE switch setting.

(16) To check tracking on any RANGE, measure the 10 KC voltages at zero and the desired meter scale indication and calculate the power difference. The power difference should be within ±5% of the RANGE switch setting.

4-16. VOLTMETER STABILITY WITH LINE VOLTAGE CHANGE.

a. Set the power line voltage to 103 volts.

b. With the BIAS CURRENT OFF and POWER RANGE on 1.0 MW connect a bolometer to the instrument.

c. Connect an ac VTVM to the CAL terminals on the chassis.

d. Adjust the BIAS CURRENT and ZERO SET controls so the ac VTVM indicates 0.300 volts. Note the indication on the Model 430C meter, this is a reference that will determine the instrument stability in a later step.

e. Increase the power line voltage to 127 volts and allow one minute for the instrument to stabilize.

f. Adjust the ZERO SET controls so the external ac VTVM again indicates 0.300 volts.

g. The indication on the Model 430C meter should be within 2% of full scale of the reference indication noted in step d. Excess drift is usually caused by V4 or V5.

h. Disconnect the ac VTVM.

4-17. POWER SUPPLY STABILITY WITH LINE VOLTAGE CHANGE.

4-18. The following check may require several hours to perform and may be omitted unless excessive zero drift is experienced.

a. Set the power line voltage to 115 volts.

b. Set the POWER RANGE switch to the .10 MW range.

c. Set the BIAS CURRENT switch to OFF and connect a thermistor mount such as the ⓗⓟ Model 477B to the BOLOMETER input. Insulate the thermistor mount in a heavy cloth to protect it against temperature changes.

d. Zero set the instrument with the BIAS CURRENT and ZERO SET controls and allow the instruments to operate until the zero indication will remain stable for periods of 30 seconds. This may take several hours, depending on initial thermistor and room temperature.

e. Adjust the ZERO SET controls for a meter indication of 0.07 milliwatts.

f. Reduce the line voltage to 103 volts and the meter indication should not change more than 3 major scale divisions, that is between .03 and .1 milliwatt.

g. If the meter drift exceeds this amount it is probably due to insufficient power supply regulation. Try replacing V7, V8, or V9 and repeat steps e and f.

4-19. CHECK OSCILLATOR FREQUENCY.

a. Set the BIAS CURRENT to OFF and connect a bolometer to the instrument.

b. Set the POWER RANGE switch to 1.0 MW.

c. Adjust the BIAS CURRENT and ZERO SET controls to zero the Model 430C power meter.

d. Measure the oscillator frequency, available at the CAL terminals on the chassis, it should be between 9.8 and 11.8 kilocycles.

4-20. BOLOMETER BRIDGE RESISTANCE RATIO.

4-21. This is a further check on the calibration accuracy of the instrument and is included although it is doubtful that any adjustment will be necessary.

4-22. The bridge resistance adjustment (R8) establishes bridge balancing resistance for three conditions.

(1) Thermistor, 200 ohms, negative coefficient.

(2) Thermistor, 100 ohms, negative coefficient.

(3) Fuse or Barretter, 200 ohms, positive coefficient.

The ac VTVM used for this procedure must have a minimum accuracy of ±1/2% at 10 kc.

a. Set the BIAS CURRENT to OFF, the RESistance switch to 200 OHMS, and the COEFficient switch to NEGative. Connect a 200 ohm thermistor to the BOLOMETER jack.

b. Set the POWER RANGE to 1 MW and measure the ac voltage between chassis and the purple lead located on the resistor board at the top of the instrument. This point is indicated in figure 4-1 and is shown as the 3 volt test point on the schematic. Set the BIAS CURRENT and ZERO SET controls to obtain a voltage of 3.00 volts at this point.

c. Shift the ac VTVM to the adjacent green lead on the same resistor board. This point is the 1 volt test point indicated on the schematic and in figure 4-1. The ac VTVM should indicate between 1.01 and 0.99 volts, if it does not further check is necessary. If the voltage does not fall within these limits continue.

d. Adjust the BIAS CURRENT and ZERO SET controls to obtain an indication of 3.00 volts at the 3 volt test point located in step b.

e. Shift the voltmeter to the 1 volt test point and note the error from 1.00 volts. Adjust R8 to double the error, for example if the voltmeter indication is .96, adjust R8 for an indication of .92.

f. Adjust the ZERO SET controls for an indication of 1.00 volts at the 1 volt test point.

g. Shift the voltmeter back to the 3 volt test point and note the voltage. If it is not 3.00 volts adjust the ZERO SET controls for 3.00 volts and repeat steps e, f, and g until no error is evident in these two voltages.

h. Repeat this procedure starting with step a. but substitute in turn a 100 ohm thermistor or a 200 ohm barretter until all three possibilities are checked. If an error in excess of 1% exists with any of these bolometers connected to the input, compromise the setting or R8 to divide the error equally between the three.

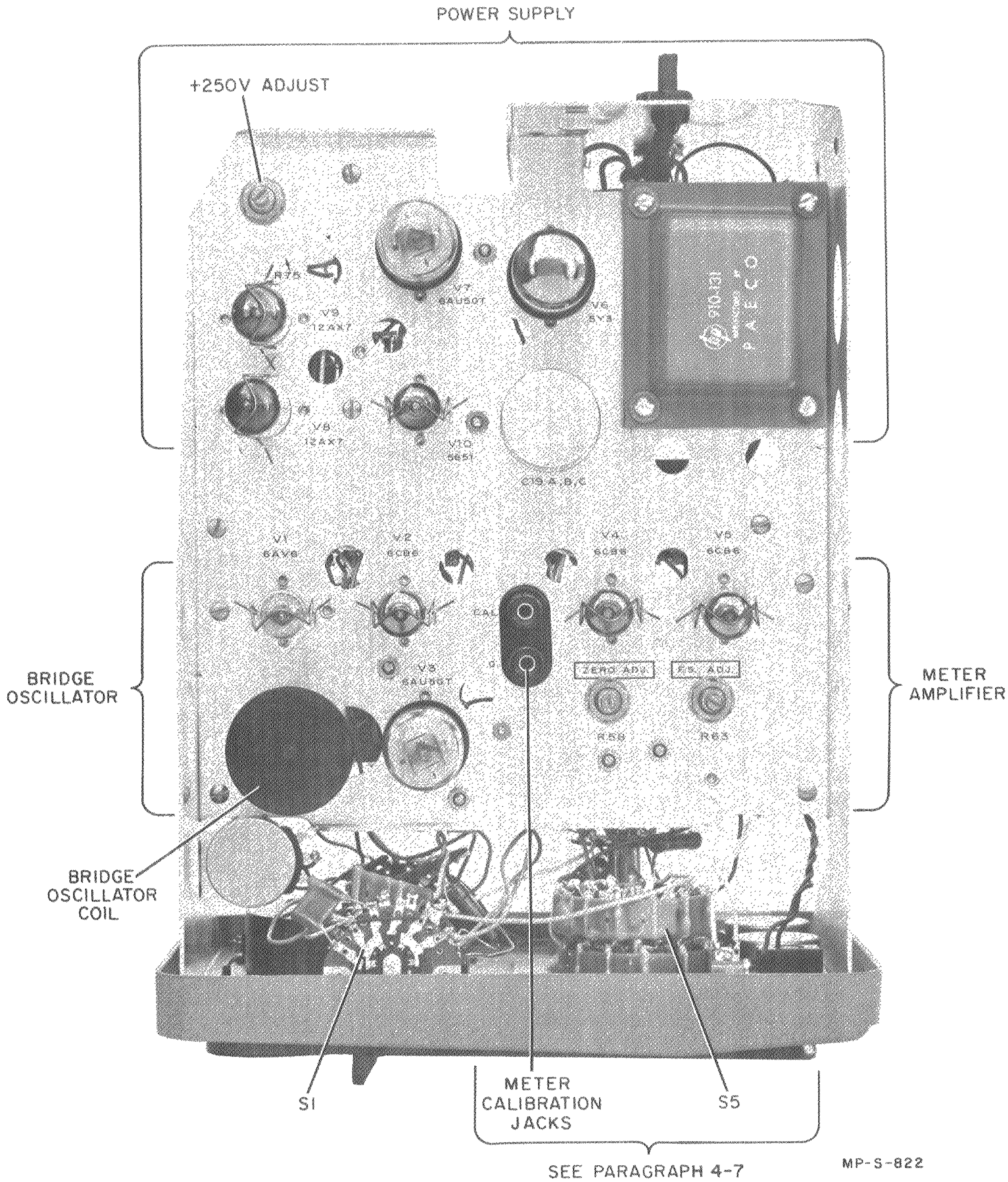

Figure 4-1. Right Side View Cover Removed

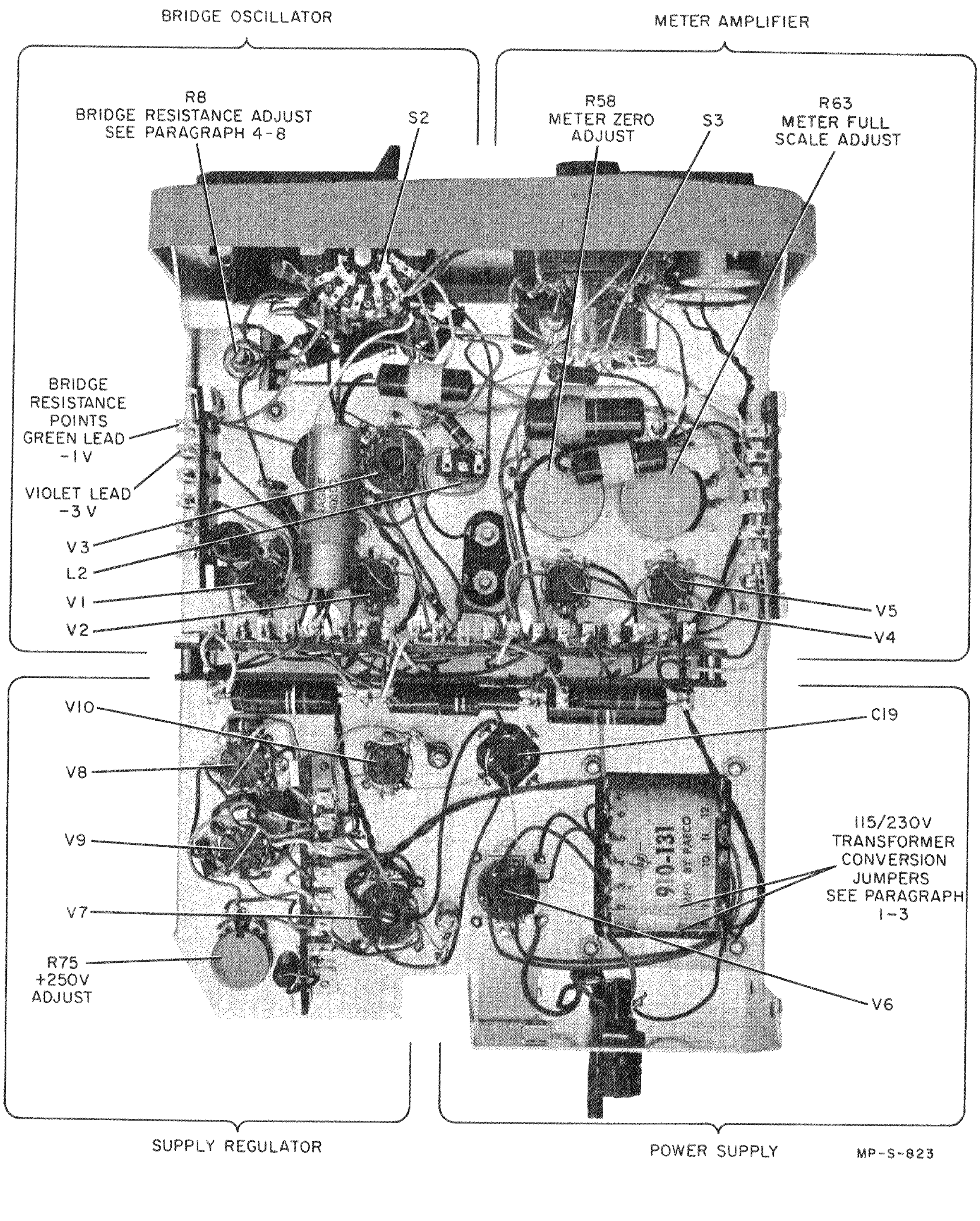

Figure 4-2. Left Side View Cover Removed

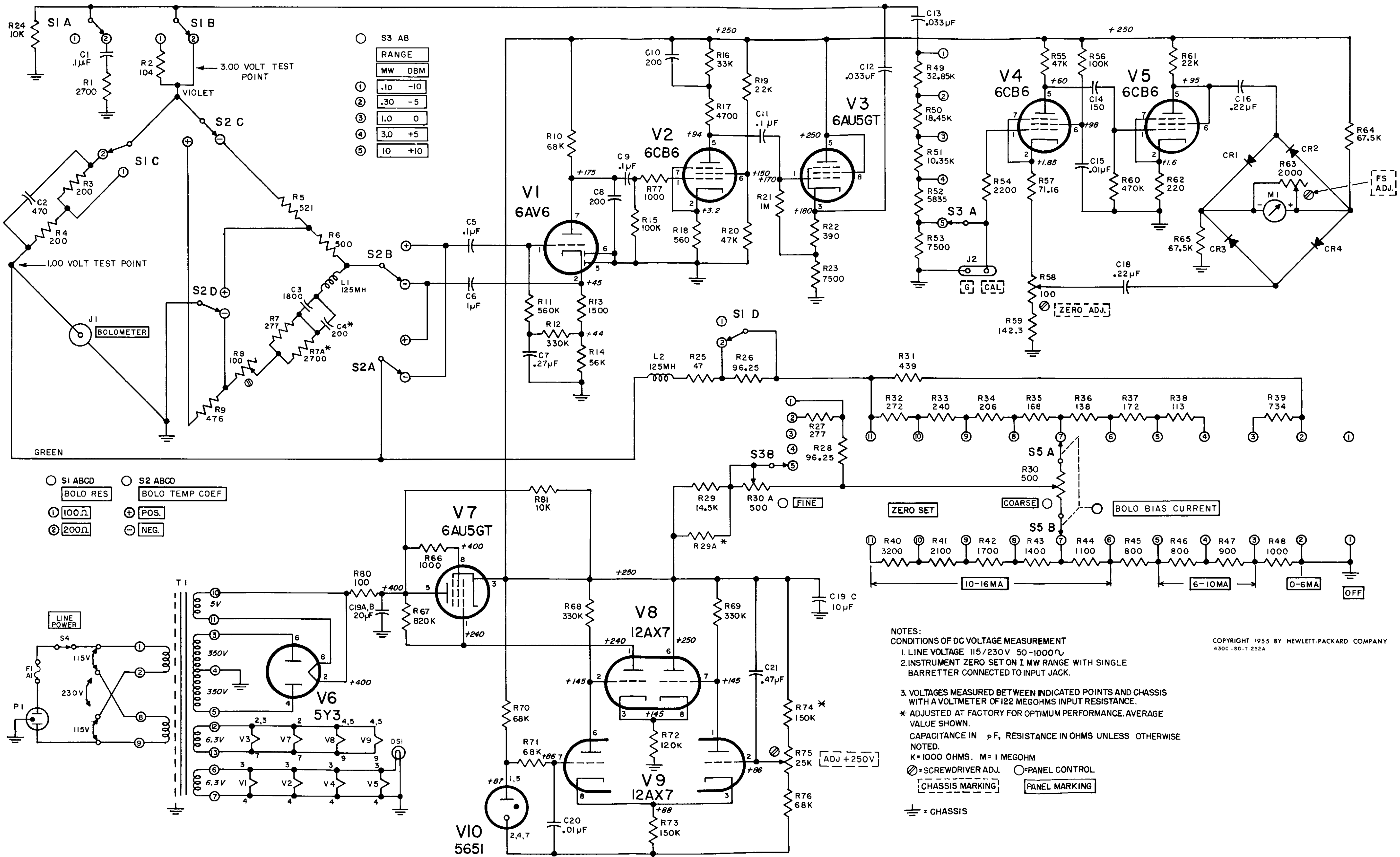

Figure 4-3. Microwave Power Meter

SECTION V
REPLACEABLE PARTS

5-1 INTRODUCTION.

5-2. This section contains information for ordering replacement parts. Table 5-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗⓟ stock number of each part, together with any applicable notes. Table 5-2 lists parts in alpha-numerical order of their ⓗⓟ stock numbers and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in the instrument (TQ column).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

5-3. Miscellaneous parts not indexed in table 5-1 are listed at the end of the table.

5-4. ORDERING INFORMATION.

5-5. To order a replacement part, address order or inquiry to your nearest Hewlett-Packard field office (see maps at the rear of this manual).

5-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

5-7. To order a part not listed in tables 5-1 and 5-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	Y	= crystal
DL	= delay line	L	= inductor	S	= switch	Z	= network
DS	= device signaling (lamp)	M	= meter	T	= transformer		
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

A	= amperes
A.F.C	= automatic frequency control
AMP	= amplifier
B.F.O.	= beat frequency oscillator
BE CU	= beryllium copper
BH	= binder head
BP	= bandpass
BRS	= brass
BWO	= backward wave oscillator
CER	= ceramic
CMO	= cabinet mount only
COEF	= coefficient
COM	= common
COMP	= composition
CONN	= connector
CP	= cadmium plate
CRT	= cathode-ray tube
DEPC	= deposited carbon
EIA	= Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗⓟ stock numbers.
ELECT	= electrolytic
ENCAP	= encapsulated
F	= farads
FH	= flat head
FIL H	= fillister head
FXD	= fixed
GE	= germanium
GL	= glass
GRD	= ground(ed)
H	= henries
HEX	= hexagonal
HG	= mercury
HR	= hour(s)
IMPG	= impregnated
INCD	= incandescent
INS	= insulation(ed)
K	= kilo = 1000
LIN	= linear taper
LK	= lock
LOG	= logarithmic taper
LPF	= low pass filter
M	= milli = 10^{-3}
MEG	= meg = 10^{6}
METFLM	= metal film
MFR	= manufacturer
MINAT	= miniature
MOM	= momentary
MTG	= mounting
MY	= mylar
NC	= normally closed
NE	= neon
NI PL	= nickel plate
NO	= normally open
NPO	= negative positive zero (zero temperature coefficient)
NSR	= not separately replaceable
OBD	= order by description
OH	= oven head
OX	= oxide
P	= peak
PC	= printed circuit board
PF	= picofarads = 10^{-12} farads
PH BRZ	= phosphor bronze
PIV	= peak inverse voltage
POLY	= polystyrene
POR	= porcelain
POS	= position(s)
POT	= potentiometer
PP	= peak-to-peak
PT	= point
RECT	= rectifier
RF	= radio frequency
RH	= round head
RMO	= rack mount only
RMS	= root-mean-square
ROT	= rotary
S-B	= slow-blow
SE	= selenium
SECT	= section(s)
SEMICON	= semiconductor
SI	= silicon
SIL	= silver
SL	= slide
SPL	= special
SST	= stainless steel
TA	= tantalum
TD	= time delay
TI	= titanium
TOG	= toggle
TOL	= tolerance
TRIM	= trimmer
TWT	= traveling wave tube
U	= micro = 10^{-6}
VAC	= vacuum
VAR	= variable
W	= watts
W/	= with
W/O	= without
WW	= wirewound

01194-8

Table 5-1. Reference Designation Index

Circuit Reference	ⓗ Stock No.	Description	Note
C1	0160-0013	C:FXD PAPER 0.1 UF 10% 400VDCW	
C2	0140-0027	C:FXD MICA 470 PF 10% 500VDCW	
C3	0140-0063	C:FXD MICA 1800 PF 5% 500VDCW FACTORY SELECTED COMP;TYPICAL VALUE GIVEN	
C4	0140-0090	C:FXD MICA 200 PF 5% 500VDCW FACTORY SELECTED COMP;TYPICAL VALUE GIVEN	
C5	0160-0013	C:FXD PAPER 0.1 UF 10% 400VDCW	
C6	0160-0016	C:FXD PAPER 1 UF 20% 400VDCW	
C7	0160-0039	C:FXD PAPER 0.27 UF 10% 200VDCW	
C8	0140-0056	C:FXD MICA 200 PF 10% 500VDCW	
C9	0160-0013	C:FXD PAPER 0.1 UF 10% 400VDCW	
C10	0140-0056	C:FXD MICA 200 PF 10% 500VDCW	
C11	0160-0013	C:FXD PAPER 0.1 UF 10% 400VDCW	
C12	0160-0004	C:FXD PAPER 0.33 UF 10% 600VDCW	
C13	0160-0004	C:FXD PAPER 0.33 UF 10% 600VDCW	
C14	0140-0055	C:FXD MICA 150 PF 10% 500VDCW	
C15	0160-0019	C:FXD PAPER 0.01 UF 5% 600VDCW	
C16	0160-0018	C:FXD PAPER 0.22 UF 10% 400VDCW	
C17		NOT ASSIGNED	
C18	0160-0018	C:FXD PAPER 0.22 UF 10% 400VDCW	
C19A,B,C	0180-0017	C:FXD ELECT 3 X 10 UF 450VDCW	
C20	0160-0002	C:FXD PAPER 0.01 UF 10% 600VDCW	
C21	0160-0015	C:FXD PAPER 0.47 UF 10% 200VDCW	
CR1,2,3,4	1910-0016	SEMICON DEVICE:DIODE GE	
DS1	2140-0012	LAMP,INCANDESCENT:2 PIN MINIATURE #12	
F1	2110-0007 2110-0008	FUSE,CARTRIDGE:1 AMP(FOR 115 VOLT OPERATION) FUSE,CARTRIDGE:1/2 AMP(FOR 230 VOLT OPERATION)	
J1	1250-0083 1250-0001	CONNECTOR:BNC (CABINET MODEL) (RACK MOUNT)	
L1	430B-60A	COIL:RF 125 MH	
L2	9140-0006	CHOKE:RF	
M1	1120-0016	METER	
P1	8120-0050	CABLE:POWER	
R1	0690-2721	R:FXD COMP 2700 OHM 10% 1W	
R2	430B-26E	R:FXD WW 104 OHM	
R3	430B-26B	R:FXD WW 200 OHM	
R4	430B-26B	R:FXD WW 200 OHM	
R5	430C-26E	R:FXD WW 521 OHM	
R6	430C-26F	R:FXD WW 500 OHM	
R7	0730-0008	R:FXD DEPC 277 OHM 1% 1W	
R7A	0730-0008	R:FXD DEPC 277 OHM 1% 1W FACTORY SELECTED COMP;TYPICAL VALUE GIVEN	
R8	2100-0003	R:VAR WW 100 OHM 10% LIN 2W	
R9	430B-26G	R:FXD WW 476 OHM	
R10	0690-6831	R:FXD COMP 68K OHM 10% 1W	
R11	0690-5641	R:FXD COMP 560K OHM 10% 1W	
R12	0690-3341	R:FXD COMP 330K OHM 10% 1W	
R13	0690-1521	R:FXD COMP 1500 OHM 10% 1W	

See introduction to this section

Table 5-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗ Stock No.	Description	Note
R14	0690-5631	R:FXD COMP 56K OHM 10% 1W	
R15	0690-1041	R:FXD COMP 100K OHM 10% 1W	
R16	0690-3331	R:FXD COMP 33K OHM 10% 1W	
R17	0690-4721	R:FXD COMP 4700 OHM 10% 1W	
R18	0690-5611	R:FXD COMP 560 OHM 10% 1W	
R19	0690-2231	R:FXD COMP 22K OHM 10% 1W	
R20	0690-4731	R:FXD COMP 47K OHM 10% 1W	
R21	0690-1051	R:FXD COMP 1 MEGOHM 10% 1W	
R22	0690-3911	R:FXD COMP 390 OHM 10% 1W	
R23	0816-0007	R:FXD WW 7500 OHM 10% 10W	
R24	0690-1031	R:FXD COMP 10K OHM 10% 1W	
R25	0690-4701	R:FXD COMP 47 OHM 10% 1W	
R26	0730-0005	R:FXD DEPC 96.25 OHM 1% 1W	
R27	0730-0008	R:FXD DEPC 277 OHM 1% 1W	
R28	0730-0005	R:FXD DEPC 96.25 OHM 1% 1W	
R29	0814-0002	R:FXD WW 14.5K OHM 1% 10W	
R29A	0690-1541	R:FXD COMP 150K OHM 10% 1W FACTORY SELECTED COMP;TYPICAL VALUE GIVEN	
R30	2100-0054	R:VAR WW 500 OHM 10% LIN 2W	
R30A	2100-0054	R:VAR WW 500 OHM 10% LIN 2W	
R31 THRU R48		NOT SEPARATELY REPLACEABLE, PART OF ZERO SET SWITCH ASSEMBLY (S5)	
R49 THRU R53		NOT SEPARATELY REPLACEABLE, PART OF RANGE SWITCH ASSEMBLY (S3)	
R54	0690-2221	R:FXD COMP 2200 OHM 10% 1W	
R55	0693-4731	R:FXD COMP 47K OHM 10% 2W	
R56	0690-1041	R:FXD COMP 100K OHM 10% 1W	
R57	0727-0036	R:FXD DEPC 71.16 OHM 1% 1/2W	
R58	2100-0003	R:VAR WW 100 OHM 10% LIN 2W	
R59	0730-0006	R:FXD DEPC 142.3 OHM 1% 1W	
R60	0690-4741	R:FXD COMP 470K OHM 10% 1W	
R61	0693-2231	R:FXD COMP 22K OHM 10% 2W	
R62	0690-2211	R:FXD COMP 220 OHM 10% 1W	
R63	2100-0005	R:VAR WW 2000 OHM 10% LIN 2W	
R64	0727-0199	R:FXD DEPC 67.5K OHM 1% 1/2W	
R65	0727-0199	R:FXD DEPC 67.5K OHM 1% 1/2W	
R66	0690-1021	R:FXD COMP 1000 OHM 10% 1W	
R67	0690-8241	R:FXD COMP 820K OHM 10% 1W	
R68	0690-3341	R:FXD COMP 330K OHM 10% 1W	
R69	0690-3341	R:FXD COMP 330K OHM 10% 1W	
R70	0690-6831	R:FXD COMP 68K OHM 10% 1W	
R71	0687-6831	R:FXD COMP 68K OHM 10% 1/2W	
R72	0690-1241	R:FXD COMP 120K OHM 10% 1W	
R73	0690-1541	R:FXD COMP 150K OHM 10% 1W	
R74	0690-1541	R:FXD COMP 150K OHM 10% 1W FACTORY SELECTED COMP;TYPICAL VALUE GIVEN	
R75	2100-0009	R:VAR COMP 25K OHM 20% LIN 1/3W	
R76	0690-6831	R:FXD COMP 68K OHM 10% 1W	
R77	0687-1021	R:FXD COMP 1000 OHM 10% 1/2W	

See introduction to this section

Table 5-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗ Stock No.	Description	Note
R78 AND R79		NOT ASSIGNED	
R80	0693-1011	R:FXD COMP 100 OHM 10% 2W	
R81	0816-0008	R:FXD WW 10K OHM 5% 10W	
S1A,B,C,D	430C-19B	RESISTANCE SWITCH ASSEMBLY, INCLUDES C2,R2,R3,R4,R24,R26	
S2A,B,C,D	430C-19A	COEFFICIENT SWITCH ASSEMBLY,INCLUDES R5,R6,R9	
S3A,B,C	430C-19W	RANGE SWITCH ASSEMBLY,INCLUDES C13,R27,R28,R49,R53	
S4	3101-0001	SWITCH:TOGGLE,SPST	
S5A,B	430C-19C	ZERO SET SWITCH ASSEMBLY,INCLUDES R31,R39,R40,R48	
T1	9100-0063	TRANSFORMER:POWER	
V1	1939-0001	ELECTRON TUBE:6AV6	
V2	1923-0028	ELECTRON TUBE:6CB6A	
V3	1923-0020	ELECTRON TUBE:6AU5GT	
V4	1923-0028	ELECTRON TUBE:6CB6A	
V5	1923-0028	ELECTRON TUBE:6CB6A	
V6	1930-0010	ELECTRON TUBE:5Y3GT	
V7	1923-0020	ELECTRON TUBE:6AU5GT	
V8	1932-0030	ELECTRON TUBE:12AX7	
V9	1932-0030	ELECTRON TUBE:12AX7	
V10	1940-0001	ELECTRON TUBE:5651	
		MISCELLANEOUS	
	5060-0632	BINDING POST ASSEMBLY:BLACK	
	5060-0633	BINDING POST ASSEMBLY:RED	
	1400-0084	FUSEHOLDER:EXTRACT POST TYPE	
	0340-0086	INSULATOR,BINDING POST:DOUBLE	
	0370-0046	KNOB:COEF., RES.	
	0370-0029	KNOB:ZERO SET,COURSE,FINE	
	0370-0035	KNOB:POWER RANGE,BIAS CURRENT	
	1450-0022	LAMPHOLDER	
	1450-0020	JEWEL,FOR LAMPHOLDER	

See introduction to this section

Table 5-2. Replaceable Parts

ⓗ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0140-0027	C:FXD MICA 470 PF 10% 500VDCW	00853	TYPE K K1347 B10	1	1
0140-0055	C:FXD MICA 150 PF 10% 500VDCW	04062	RCM15E 151K	1	1
0140-0056	C:FXD MICA 200 PF 10% 500VDCW	04062	RCM20E 201K	2	1
0140-0063	C:FXD MICA 1800 PF 5% 500VDCW	00853	RCM30E 182J	1	1
0140-0090	C:FXD MICA 200 PF 5% 500VDCW	00853	RCM15E 201J	1	1
0160-0002	C:FXD PAPER 0.01 UF 10% 600VDCW	56289	160P10396	1	1
0160-0004	C:FXD PAPER 0.33 UF 10% 600VDCW	56289	160P33396	2	1
0160-0013	C:FXD PAPER 0.1 UF 10% 400VDCW	56289	160P10494	4	1
0160-0015	C:FXD PAPER 0.47 UF 10% 200VDCW	56289	TYPE 109P 47492	1	1
0160-0016	C:FXD PAPER 1 UF 20% 400VDCW	00656	TYPE P82Z K18	1	1
0160-0018	C:FXD PAPER 0.22 UF 10% 400VDCW	56289	160P22494	2	1
0160-0019	C:FXD PAPER 0.01 UF 5% 600VDCW	56289	160P10356	1	1
0160-0039	C:FXD PAPER 0.27 UF 10% 200VDCW	56289	160P27492	1	1
0180-0017	C:FXD ELECT 3 X 10 UF 450VDCW	56289	D32631	1	1
0340-0086	INSULATOR,BINDING POST:DOUBLE	28480	0340-0086	2	0
0370-0029	KNOB:ZERO SET,COURSE,FINE	28480	0370-0029	2	0
0370-0035	KNOB:POWER RANGE,BIAS CURRENT	28480	0370-0035	2	0
0370-0046	KNOB:COEF., RES.	28480	0370-0046	2	0
430B-26B	R:FXD WW 200 OHM	28480	430B-26B	1	1
430B-26E	R:FXD WW 521 OHM	28480	430B-26E	1	1
430B-26G	R:FXD WW 476 OHM	28480	430B-26G	1	1
430B-60A	COIL,RF:125 MH	28480	430B-60A	1	1
430C-19A	COEFFICIENT SWITCH ASSEMBLY	28480	430C-19A	1	1
430C-19B	RESISTANCE SWITCH ASSEMBLY	28480	430C-19B	1	1
430C-19C	ZERO SET SWITCH ASSEMBLY	28480	430C-19C	1	1
430C-19W	RANGE SWITCH ASSEMBLY	28480	430C-19W	1	1
430C-26E	R:FXD WW 521 OHM	28480	430C-26E	1	1
430C-26F	R:FXD WW 500 OHM	28480	430C-26F	1	1
0687-1021	R:FXD COMP 1000 OHM 10% 1/2W	01121	EB 1021	1	1
0687-6831	R:FXD COMP 68K OHM 10% 1/2W	01121	EB 6831	1	1
0690-1021	R:FXD COMP 1000 OHM 10% 1W	01121	GB 1021	1	1
0690-1031	R:FXD COMP 10K OHM 10% 1W	01121	GB 1031	1	1
0690-1041	R:FXD COMP 100K OHM 10% 1W	01121	GB 1041	2	1
0690-1051	R:FXD COMP 1 MEGOHM 10% 1W	01121	GB 1051	1	1
0690-1241	R:FXD COMP 120K OHM 10% 1W	01121	GB 1241	1	1
0690-1521	R:FXD COMP 1500 OHM 10% 1W	01121	GB 1521	1	1
0690-1541	R:FXD COMP 150K OHM 10% 1W	01121	GB 1541	3	1
0690-2211	R:FXD COMP 220 OHM 10% 1W	01121	GB 2211	1	1
0690-2221	R:FXD COMP 2200 OHM 10% 1W	01121	GB 2221	1	1
0690-2231	R:FXD COMP 22K OHM 10% 1W	01121	GB 2231	1	1
0690-2721	R:FXD COMP 2700 OHM 10% 1W	01121	GB 2721	1	1
0690-3331	R:FXD COMP 33K OHM 10% 1W	01121	GB 3331	1	1
0690-3341	R:FXD COMP 330K OHM 10% 1W	01121	GB 3341	3	1
0690-3911	R:FXD COMP 390 OHM 10% 1W	01121	GB 3911	1	1
0690-4701	R:FXD COMP 47 OHM 10% 1W	01121	GB 4701	1	1
0690-4721	R:FXD COMP 4700 OHM 10% 1W	01121	GB 4721	1	1
0690-4731	R:FXD COMP 47K OHM 10% 1W	01121	GB 4731	1	1
0690-4741	R:FXD COMP 470K OHM 10% 1W	01121	GB 4741	1	1
0690-5611	R:FXD COMP 560 OHM 10% 1W	01121	GB 5611	1	1
0690-5631	R:FXD COMP 56K OHM 10% 1W	01121	GB 5631	1	1
0690-5641	R:FXD COMP 560K OHM 10% 1W	01121	GB 5641	1	1
0690-6831	R:FXD COMP 68K OHM 10% 1W	01121	GB 6831	2	1

See introduction to this section

Table 5-2. Replaceable Parts (Cont'd)

ⓗⓟ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0690-8241	R:FXD COMP 820K OHM 10% 1W	01121	GB 8241	1	1
0693-1011	R:FXD COMP 100 OHM 10% 2W	01121	HB 1011	1	1
0693-2231	R:FXD COMP 22K OHM 10% 2W	01121	HB 2231	1	1
0693-4731	R:FXD COMP 47K OHM 10% 2W	01121	HB 4731	1	1
0727-0036	R:FXD DEPC 71.16 OHM 1% 1/2W	19701	DC1/2C	1	1
0727-0199	R:FXD DEPC 67.5K OHM 1% 1/2W	19701	CF1/2	2	1
0730-0005	R:FXD DEPC 96.25 OHM 1% 1W	19701	DC1	2	1
0730-0006	R:FXD DEPC 142.3 OHM 1% 1W	19701	DC1	1	1
0730-0008	R:FXD DEPC 277 OHM 1% 1W	19701	DC1	2	1
0814-0002	R:FXD WW 14.5K OHM 1% 10W	91637	TYPE RS-10	1	1
0816-0007	R:FXD WW 7500 OHM 10% 10W	35434	C10	1	1
0816-0008	R:FXD WW 10K OHM 5% 10W	35434	C10	1	1
1120-0016	METER	28480	1120-0016	1	1
1250-0001	CONNECTOR:BNC(RACK MODEL)	91737	5126		
1250-0083	CONNECTOR:BNC(CABINET MODEL)	91737	UG 1094/U MODIF.	1	1
1400-0084	FUSEHOLDER:EXTRACT POST TYPE	75915	342014	1	1
1450-0020	JEWEL,FOR LAMPHOLDER	72765	#14L-15 LESS NUT	1	0
1450-0022	LAMPHOLDER	72765	2020-AEA	1	0
1910-0016	SEMICON DEVICE:DIODE GE	93332	D2361	4	4
1923-0020	ELECTRON TUBE:6AU5GT	86684	6AU5GT	2	2
1923-0028	ELECTRON TUBE:6CB6A	86684	6CB6A	3	3
1930-0010	ELECTRON TUBE:5Y3GT	86684	5Y3GT	1	1
1932-0030	ELECTRON TUBE:12AX7	86684	12AX7	2	2
1939-0001	ELECTRON TUBE:6AV6	93332	6AV6	1	1
1940-0001	ELECTRON TUBE:5651	86684	5651	1	1
2100-0003	R:VAR WW 100 OHM 10% LIN 2W	28480	2100-0003	2	1
2100-0005	R:VAR WW 2000 OHM 10% LIN 2W	28480	2100-0005	1	1
2100-0009	R:VAR COMP 25K OHM 20% LIN 1/3W	28480	2100-0009	1	1
2100-0054	R:VAR WW 500 OHM 10% LIN 2W	28480	2100-0054	2	1
2110-0007	FUSE,CARTRIDGE:1 AMP(115 V OPERATION)	75915	313001	1	10
2110-0008	FUSE,CARTRIDGE:1/2 AMP(230 V OPERATION)	71400	MDL 1/2		
2140-0012	LAMP,INCANDESCENT:2 PIN #12	24455	GE #12	1	1
3101-0001	SWITCH:TOGGLE,SPST	04009	3101-0001	1	1
5060-0632	BINDING POST ASSEMBLY:BLACK	28480	5060-0632	1	1
5060-0633	BINDING POST ASSEMBLY:RED	28480	5060-0633	1	1
8120-0050	CABLE:POWER	70903	KH4096	1	1
9100-0063	TRANSFORMER:POWER	28480	4070	1	1
9140-0006	CHOKE,RF	28480	9140-0006	1	1

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U.S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermolloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc,	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostran Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoell Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81349	Military Specification	....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.

Revised: Nov. 14, 1963
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H4-1 Dated March 1963
H4-2 Dated March 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

Code No.	Manufacturer	Address
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronis, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

Code No.	Manufacturer	Address
C0000	JFD Electronics Corp.	Van Nuys, Calif.
G0000	Tranex Company	Mountain View, Calif.
I0000	Western Devices, Inc.	Inglewood, Calif.
J0000	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000O	U.S.A. Common	Any supplier of U.S.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000AD	Curtis Instrument Inc.	Mt. Kisco, N.Y.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

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Revised: Nov. 14, 1963

From: F.S.C. Handbook Supplements
H4-1 Dated March 1963
H4-2 Dated March 1962

MANUAL CHANGES

GMBH

MODEL 430C

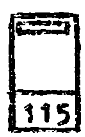
MICROWAVE POWER METER
Manual Printed: 4-61
Manual Serial Prefixed: 005-

For Serials Prefixed G-204 place the following changes:

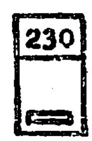
Change Section I, Paragraph 1-3 to read:

A switch located on the instrument rear converts the Model 430C for use from either a 115-volt or 230-volt power source . The switch changes the connection of the dual 115-volt primary windings of the power transformer from a parallel combination to a series combination or vice versa. Switch positionsare marked 115 and 230.

115V OPERATION



230V OPERATION



To convert the instrument from 115-volt operation to 230-volt operation, or vice versa, insert a screwdriver blade into the switch slot and slide the slot until the marking indicates the line voltage. At the time of the change, replace the line fuse. A 1.0 ampere slow-blow fuse should be used for 115-volt operation; a 0.5 ampere slow-blow fuse should be used for 230-volt operation.

C A U T I O N

Be sure the 115/230V switch is set at the proper position before applying power to the instrument. Incorrect setting of the switch can result in damage to the instrument.

For instruments supplied with German "Siemens Meter" and "Schuko" power cord place the changes listed below:

Table 5-1 Replaceable Parts (Sheet 3 of 7):
M 1: Change to Meter-Siemens & Halske -hp- Stock No. No. 1120-0138
P 1: Change to Power cord Desco-Werke -hp- Stock No. 8120-0100
Section I, Page 4, Paragraph 1-4, Change to read:

The power cord supplied with this instrument is terminated in a standard German "Schuko" connector.

32 - 1163 - 10000

MANUAL CHANGES

GMBH

MODEL 430 C (Cont.)

ERRATA: Under Step F, Paragraph 4-5, Change to read: "Maximum BIAS CURRENT should be between 16 and 18 ma ".

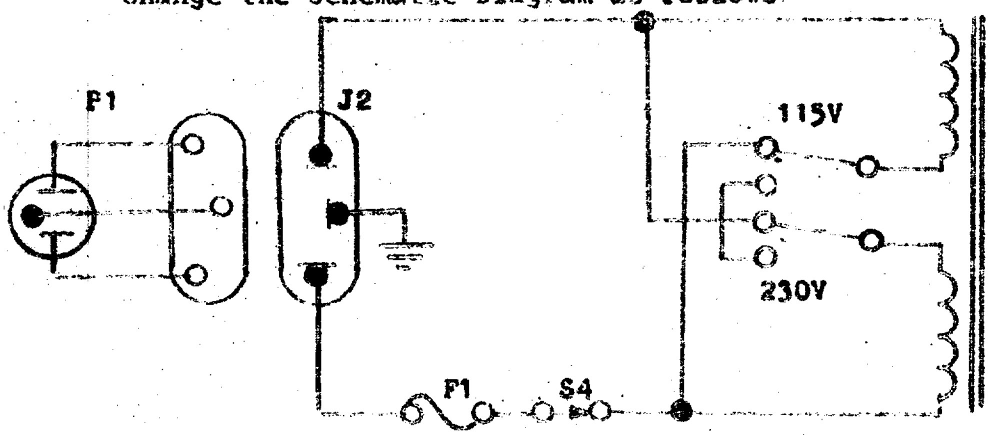
Under R8 in figure 4-1, change to read: "Bridge Resistance Adjust, see paragraph 4-11".

In step d, paragraph 4-7, change to read: "The meter on the Model 430C should now indicate exactly zero; if not, adjust R58, Zero Adj Control".

Section V (Page 6 of 7 Table of Replaceable Parts

ADD: S6 switch- slide DPDT -hp- Stock No. 3101-0033
J2 connector- power -hp- Stock No. 1251-0148

Figure 4-3
Change the Schematic Diagram as follows:



For instruments supplied with "NEMA" Power Cable place the changes listed below:

DELETE: P1 Cable- Power -hp- Stock No. 8120-0050
ADD: P1 Cable- Power -hp- Stock No. 8120-0078
R81 Change -hp- Stock No. to 0816-0008

MANUAL CHANGES

GMBH

MODEL 430C

MICROWAVE POWER METER

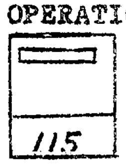
Manual Printed 1-64
Manual Serial Prefixed: 252 -

For Serials Prefixed G-204 place the following changes:

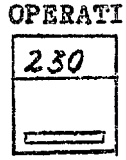
Change Section I, Paragraph 1-8 to read:

A switch located on the instrument rear converts the Model 430C for use from either a 115-volt or 230-volt power source. The switch changes the connection of the dual 115-volt primary windings of the power transformer from a parallel combination to a series combination or vice versa. Switch positions are marked 115 and 230.

115V OPERATION



230V OPERATION



To convert the instrument from 115-volt operation to 230-volt operation, or vice versa, insert a screwdriver blade into the switch slot and slide the slot until the marking indicates the line voltage. At the time of the change, replace the line fuse.
A 1.0 ampere slow-blow fuse should be used for 115-volt operation
a 0.5 ampere slow-blow fuse should be used for 230-volt operation.

C A U T I O N

Be sure the 115/230V switch is set at the proper position before applying power to the instrument. Incorrect setting of the switch can result in damage to the instrument.

For instruments supplied with German "Siemens Meter" and "Schuko" power cord place the changes listed below:
Table 5-1 Replaceable Parts (Sheet 3 of 7):
M1 Change to Meter Siemens & Halske -hp- Stock No. 1120-0138
P1 Change to Power cord Desco Werke -hp- Stock No. 8120-0100
Section I; Paragraph 1-11, Change to read:
The power cord supplied with this instrument is terminated in a standard German "Schuko" connector.

Section V:
Add: S6: Switch- slide DPDT -hp- Stock No. 3101-0033
J2: Connector- power -hp- Stock No. 1251-0148

32 - 0364 - 10000

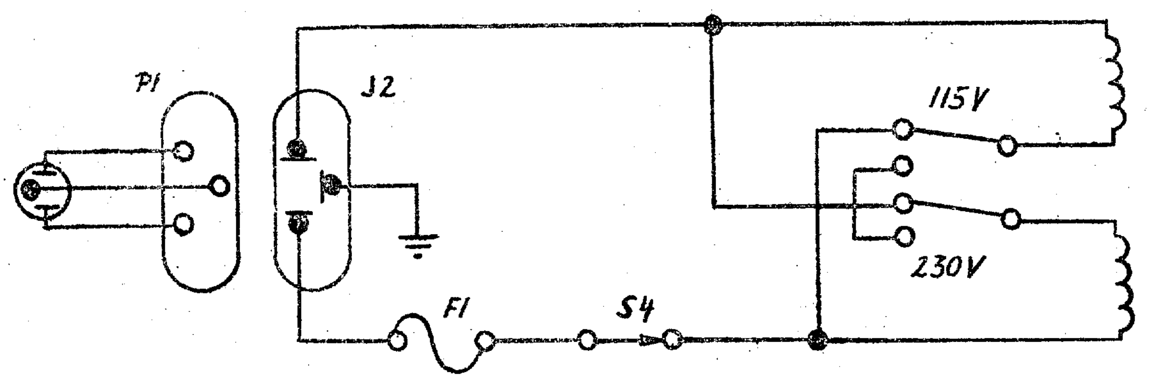
MANUAL CHANGES

GMBH

Model 430 C
(Cont.)

Figure 4-3

Change the schematic Diagram as follows



For instruments supplied with "NEMA" Power Cable
place the changes listed below:

DELETE: P1 Cable Power -hp- Stock No. 8120-0050
Add: P1 Cable- Power -hp- Stock No. 8120-0078

32 - 0884 - 10000