OPERATING AND SERVICE MANUAL

MODEL 606A

SERIALS PREFIXED: 038-

HIGH FREQUENCY SIGNAL GENERATOR

00170-2

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Table 1-1. Specifications

OUTPUT ACCURACY:
Within ±1 db into 50-ohm resistive load

FREQUENCY RESPONSE:
Within ±1 db into 50 ohms resistive load over entire frequency range at any output level setting

OUTPUT IMPEDANCE:
50 ohms, swr less than 1.1 on 0.3 volt range; on 1-volt and 3-volt ranges, less than 1.1 to 20 mc and less than 1.2 to 65 mc. BNC output connector mates with UG-88A/B/C/D.

SPURIOUS HARMONIC OUTPUT:
Less than 3%

LEAKAGE:
Negligible; permits receiver sensitivity measurements down to at least 0.1 microvolt

AMPLITUDE MODULATION:
Continuous adjustable from 0 to 100%. Indicated by a panel meter. Modulation level is constant within ±1/2 db regardless of carrier frequency and output level changes.

INTERNAL MODULATION:
0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%

MODULATION BANDWIDTH:
DC to 20 kc maximum, depends on carrier frequency, f_c, and percent modulation as shown in the following table:

Max. Mod. Frequency:

30% Mod.	70% Mod.	Squarewave Mod.
$0.06 f_c$	$0.02 f_c$	$0.003 f_c$ (3 kc max.)

EXTERNAL MODULATION:
0 to 100% sinusoidal modulation dc to 20 kc, 4.5 volts peak produces 100% modulation at modulating frequencies from dc to 20 kc. Input impedance is approximately 600 ohms. May also be modulated by square waves and other complex signals.

ENVELOPE DISTORTION:
On the 1-volt and lower ranges; less than 1% at 30% modulation using internal 400 or 1000 cps source, less than 3% from 0 to 70% modulation.

MODULATION METER ACCURACY:
Within ±5% of full scale from 0 to 90%

INCIDENTAL FM:
On the 1-volt and lower ranges and 30% modulation: 0.0025% or 100 cps, whichever is greater

SPURIOUS FM:
Less than 0.0001% or ±20 cps whichever is greater

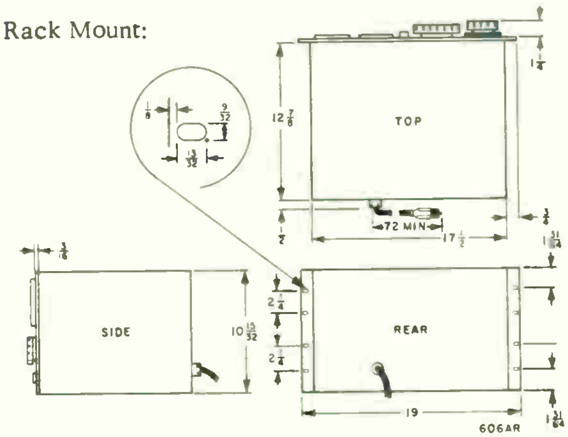
SPURIOUS AM:
Hum and noise sidebands are 70 db below carrier down to thermal level of 50-ohm output system

FREQUENCY DRIFT:
On the 1-volt and lower range; less than 0.005% or 5 cps whichever is greater, for a 10-minute period after warmup or restabilization at frequency of use.

POWER:
115 or 230 volts ±10%, 50 to 1000 cps, 135 watts

DIMENSIONS:
Cabinet Mount: 20-3/4 in. wide, 12-1/2 in. high, 14-3/4 in. deep.

Rack Mount:



WEIGHT:
Cabinet Mount: Net 46 lbs, shipping 57 lbs
Rack Mount: Net 43 lbs, shipping 58 lbs

ACCESSORIES AVAILABLE:
606A-34A Output Termination. Three positions; 50 ohms, for use into high impedance; 5 ohms (10:1 voltage division); IRE Standard Dummy Antenna (driven from 10:1 divider).

AC-16K Cables.

608A-95A Fuseholder, type N connectors. Protects output attenuator.

SECTION I
GENERAL INFORMATION

1-1. GENERAL DESCRIPTION.

1-2. The Hewlett-Packard Model 606A is a general-purpose signal generator with a frequency range of 50 kc to 65 mc. The instrument has a direct reading frequency dial calibrated to an accuracy of 1%. Output is held constant within ± 1 db and is continuously adjustable from .01 microvolt to 3 volts into a 50 ohm resistive load. An internal crystal calibrator provides check points at 100 kc and 1 mc intervals with an error of less than 0.01%. A front-panel meter accurately indicates the percent amplitude modulation for frequencies within the modulation bandwidth of the signal generator.

1-3. The Model 606A has a highly refined amplitude modulation system which allows modulation up to 90% with low distortion and incidental fm. This feature makes possible precision distortion checks of receivers from antenna to output. The instrument can be internally modulated at 400 or 1000 cps. It can be externally modulated from dc to 20 kc or more, depending on rf frequency in use. Complex waveforms, square waves, and dc voltages may be used to modulate the Model 606A for testing and evaluating filters, networks, amplifiers, and receivers.

1-4. DIFFERENCES BETWEEN INSTRUMENTS.

1-5. The Model 606A carries a five-digit serial number with a three-digit prefix (000-00000). The prefix changes only when a change is made in the instrument. The prefix, then, is an identifier, and it appears on the title page of this manual to indicate to which instrument this manual directly applies. A supplement may be included with this manual to indicate the necessary changes to be made in the manual to make it apply directly to instruments which carry a different serial number prefix.

1-6. UNPACKING AND INSPECTION.

1-7. Unpack and inspect the Model 606A as soon as possible after receipt. Save all packing materials until inspection is complete. These materials may be required for reshipment should you discover any damage.

1-8. Inspect the instrument first for signs of physical damage such as scratched or abraded panel, broken knobs, etc. If possible, energize the instrument and check it electrically. Operation check is described in paragraph 4-56. If there is any indication of damage, file a claim with the carrier. Refer to the warranty page in this manual.

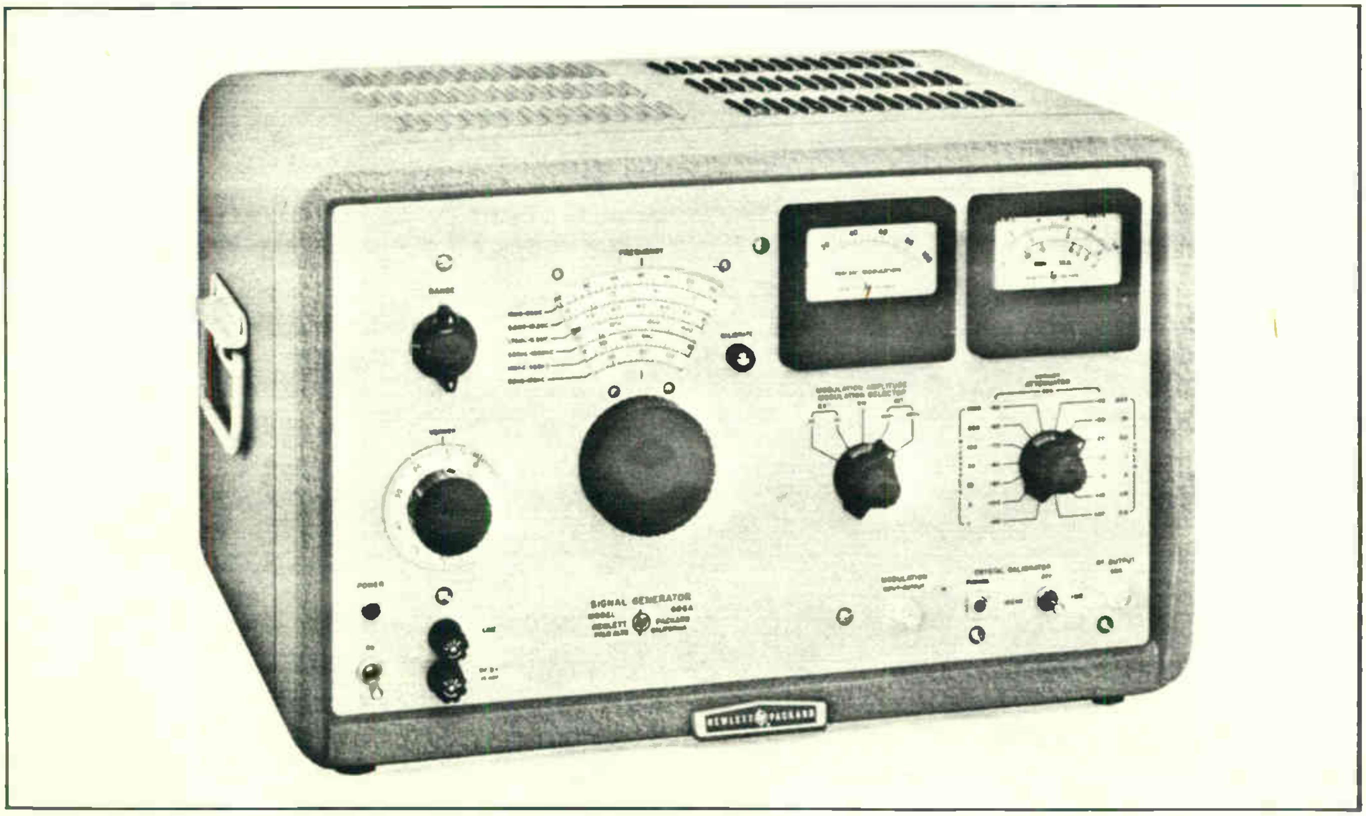


Figure 1-1. Model 606A High Frequency Signal Generator

1-9. POWER REQUIREMENTS.

1-10. The Model 606A requires a power source of 115 or 230 volts ±10%, single phase, 50 to 1000 cps, which can deliver approximately 135 watts. The instrument is normally shipped from the factory wired for use with a 115-volt power source. To convert it for use from a 230-volt power source, change the dual 115-volt primary windings of the power transformer from a parallel combination to a series combination. See figure 4-10. At the time of the change, replace the 2-ampere slow-blow line fuse with a 1-ampere slow-blow fuse.

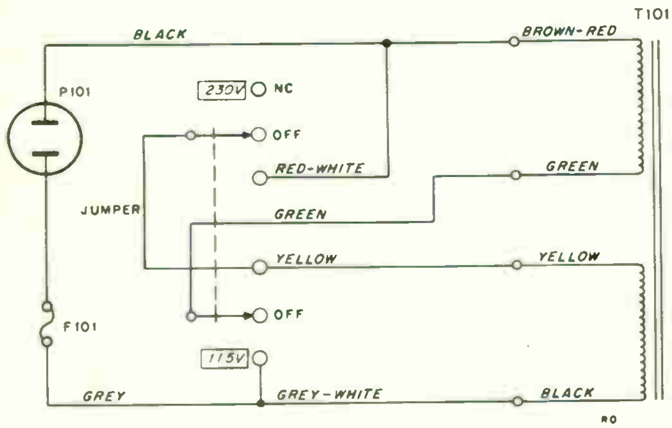


Figure 1-2. 115 or 230 volt Power Switch

1-11. POWER SWITCH FOR HPSA INSTRUMENTS.

1-12. Model 606A purchased through Hewlett-Packard S. A. have a special three-position power switch. The switch automatically connects the power transformer for 115-volt or 230-volt operation when set to the appropriate position. The on positions are marked "115V" and "230V"; the middle position is the off position. A mechanical guard limits the switch action to one voltage position and the off position.

1-13. To convert the instrument from 115-volt operation to 230-volt operation, or vice versa, loosen the nut holding the mechanical guard, swing the guard 180°, and retighten the nut.

CAUTION

Be sure to set the switch guard properly. The power supplies may be damaged if the power switch is set to the wrong position.

1-14. INSTALLATION INSTRUCTIONS.

1-15. The Model 606A should not be operated in an ambient temperature greater than +50°C. Do not install the rack-mount model near other equipment discharging hot air around the Model 606A.

1-16. POWER CABLE.

1-17. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset round pin on the power cable connector is the ground pin.

1-18. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter, and connect the green pigtail on the adapter to ground.

1-19. ACCESSORIES AVAILABLE.

1-20. ⓗ 606A-34A OUTPUT TERMINATION. The 606A-34A provides the following:

a) 50 ohm termination reduces the source impedance to 25 ohms.

b) 20 db attenuator (10:1 voltage divider) which reduces the source impedance to 5 ohms.

c) Simulates IRE standard dummy antenna (10:1 voltage division) for precision measurements on receivers.

1-21. ⓗ 608A-95A FUSED ATTENUATOR PROTECTOR. Prevents the Model 606A output attenuator from burning out when working with transceiver type equipment. If the transmitter is accidentally keyed the 608A-95A prevents power from being applied to the RF OUTPUT jack of the Model 606A. (Requires two BNC to type "N" adapters UG-201A/U and UG-349A/U. Not furnished.)

SECTION II
OPERATING INSTRUCTIONS

2-1. OUTPUT TERMINATION.

2-2. The Model 606A output level is calibrated only when terminated with a 50-ohm resistive load. For use into any other load the ℏ 606A-34A output termination is recommended (see paragraph 1-20).

2-3. A coaxial cable of 50 ohms nominal impedance with BNC male connectors is suitable for use with the Model 606A. Single braid shield types are suitable for use from maximum output to approximately -80 dbm (30 microvolts). Double braid or solid types are recommended for use over the entire attenuation range. A good general purpose cable is 3 feet of RG-55U (double braid shield) with UG-88C/U BNC connectors on each end. See figure 2-3, External Output Termination, for information concerning output cable termination.

2-4. The output jack on the ℏ 606A-34A has been provided as a BNC connector for maximum shielding. Clip-lead connection may be provided easily by inserting a UG-290U connector with soldered-on clip leads into the output jack of the Output Termination. Keep the length of the clip leads as short as possible.

2-5. SETTING THE CURSOR.

2-6. Set the cursor (movable index) with the CALIBRATE knob so that it is aligned with the line under the engraving reading FREQUENCY before setting the frequency. The FREQUENCY dial is calibrated only after this operation is performed.

2-7. OUTPUT ATTENUATOR.

CAUTION

Damage to output attenuator may be incurred if: 1) Output is shorted in the 3-volt range, 2) External voltage is applied to the attenuator output.

2-8. The output attenuator contains resistors which can be burned out by careless usage. If the output is shorted out in the 3-volt range or if voltage is fed into the attenuator accidently, these resistors may be burned out or heated up so that they are no longer calibrated. This may occur while measuring the sensitivity of the receiver in a mobile transmitter-receiver installation when the transmit button is pushed accidently. An attenuator fuse is available as an accessory when it is desired to use this generator under conditions where the attenuator may be burned out (see paragraph 1-21). The resistors in the attenuator are NOT field replaceable. Do not open the attenuator to check these resistors as placement of the resistors is critical. The attenuator may be removed from the instrument and returned separately to the factory for repair.

2-9. USE OF THE 3-VOLT RANGE.

2-10. The unusually high output range of 3 volts is useful for driving rf bridges or other equipment requiring a calibrated high-level high-frequency voltage. This useful range is obtained at the expense of operating the power amplifier stage near the overload point. You will obtain best life from these tubes by not leaving the generator on the 3 VOLT range any longer than necessary to make your measurement. Never leave it on this range while warming up or during standby operation.

2-11. EXTERNAL MODULATION.

2-12. Take care when using external modulation with direct coupling. The dc level of the signal will affect the average rf level. If only the ac component of the modulating signal is desired, switch the MODULALATION SELECTOR to EXT. AC. Do not apply more than 10 volts dc or ac to the MODULATION jack. Overloading will shorten life of the MODULATION AMPLITUDE control.

2-13. EXTERNAL SYNCHRONIZATION SIGNAL.

2-14. When the Model 606A is modulated internally a signal is available at the MODULATION INPUT-OUTPUT jack for synchronization purposes. This signal is fed from the same oscillator which modulates the carrier. It is of approximately 1-volt amplitude from a high impedance source. Since the signal comes from a high impedance source use it only as a voltage source and do not attempt to draw current.

2-15. B+ FUSE.

2-16. The regulated B+ voltage is fused on the front panel. If excessive modulation is accidentally applied to the instrument the tuned circuits may flash over from excessive peak rf voltage. This will blow the B+ fuse. The instrument will have no output and the output level meter will be pinned to the left of zero. If this happens, the fuse must be replaced to restore operation.

2-17. MODULATION DATA.

2-18. Figure 2-1 shows the modulation limits for various types of modulation over the operating frequency range.

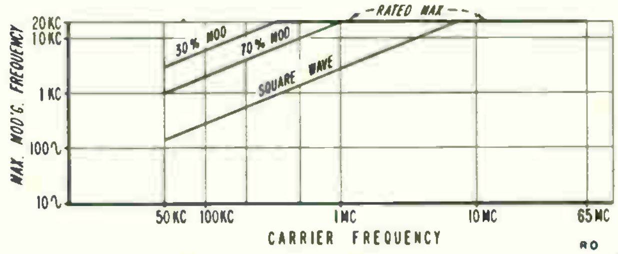
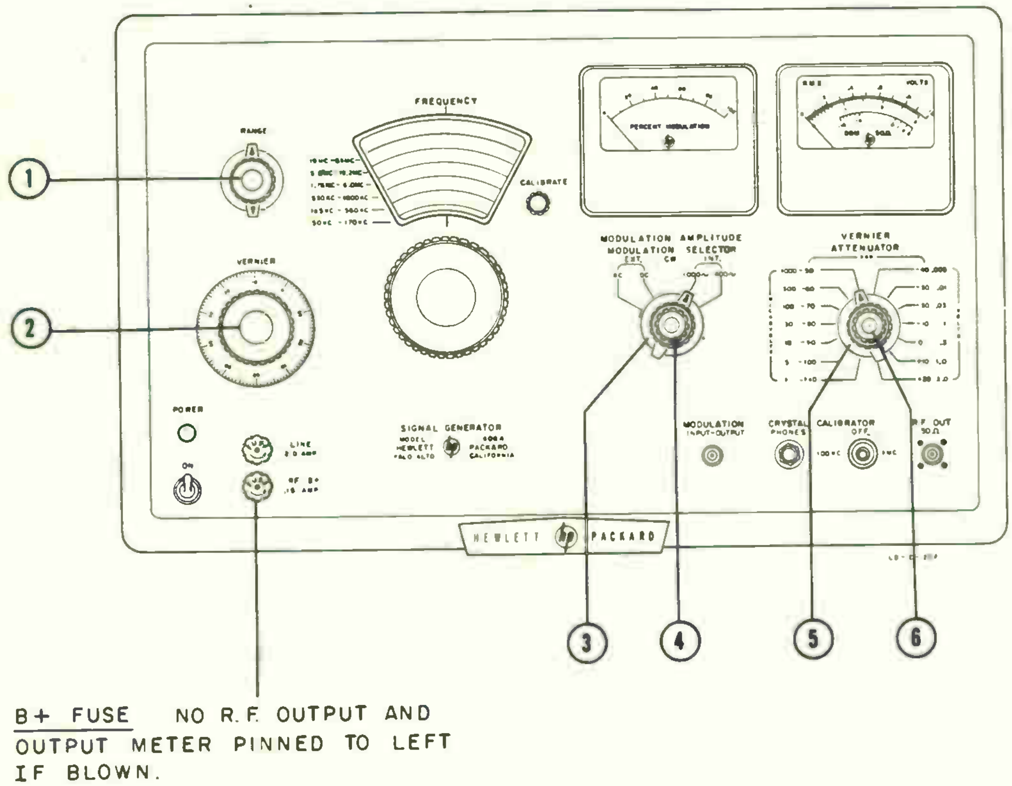
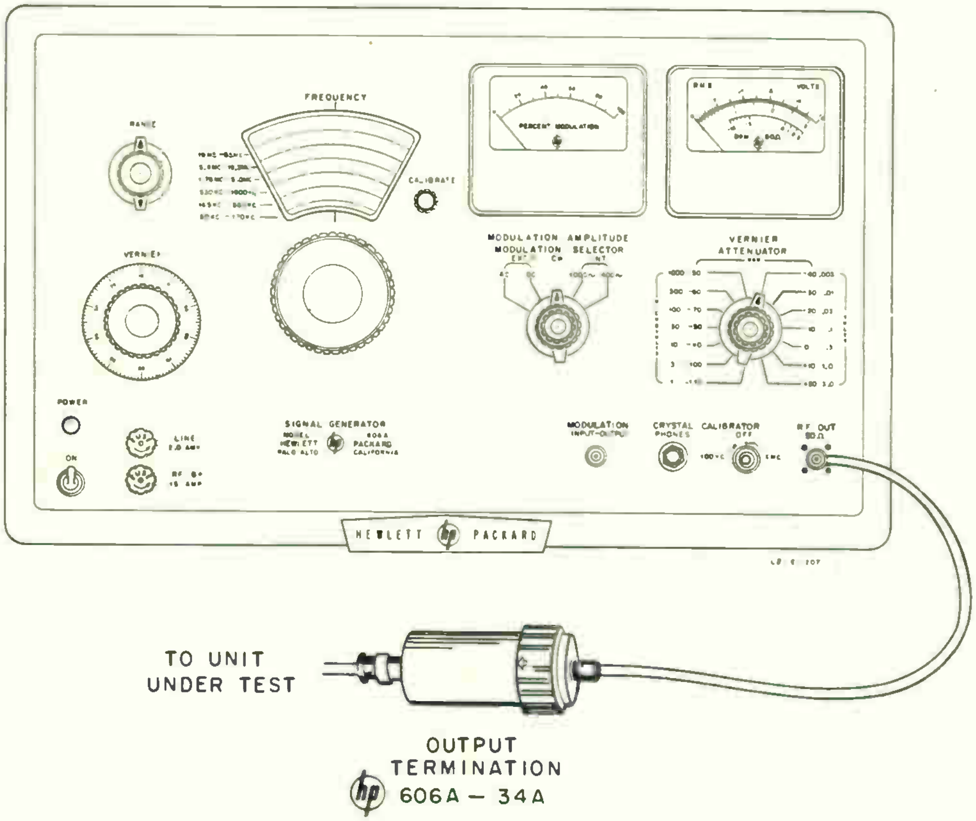


Figure 2-1. Modulating vs Carrier Frequency



1. Rotate RANGE switch to select desired band.
2. Rotate FREQUENCY control to desired frequency. Read frequency on scale indicated by pointer.
3. Rotate MODULATION SELECTOR to INT (either 400 cps or 1000 cps modulation is available).
4. Set modulation level as read on PERCENT MODULATION meter with MODULATION AMPLITUDE control.
5. Rotate ATTENUATOR to select output voltage level desired.
6. Rotate ATTENUATOR VERNIER to desired output level. Read range of output meter on ATTENUATOR switch and value on meter.

Figure 2-2. General Operation



The attenuator on the Model 606A Signal Generator is calibrated only when used with a load of 50 ohms. For high impedance loads or receiver inputs the output termination (hp 606A-34A) is recommended. This output termination is designed for use at the end of a 50 ohm shielded cable, and to operate into a high impedance (500 ohms or greater) load.

The 606A-34A has three positions as the rear shell is rotated clockwise as follows:

a. DUMMY ANTENNA. Output impedance varies as per IRE Standard Dummy Antenna* at an output level 20 db below the input level (10:1 voltage division ratio).

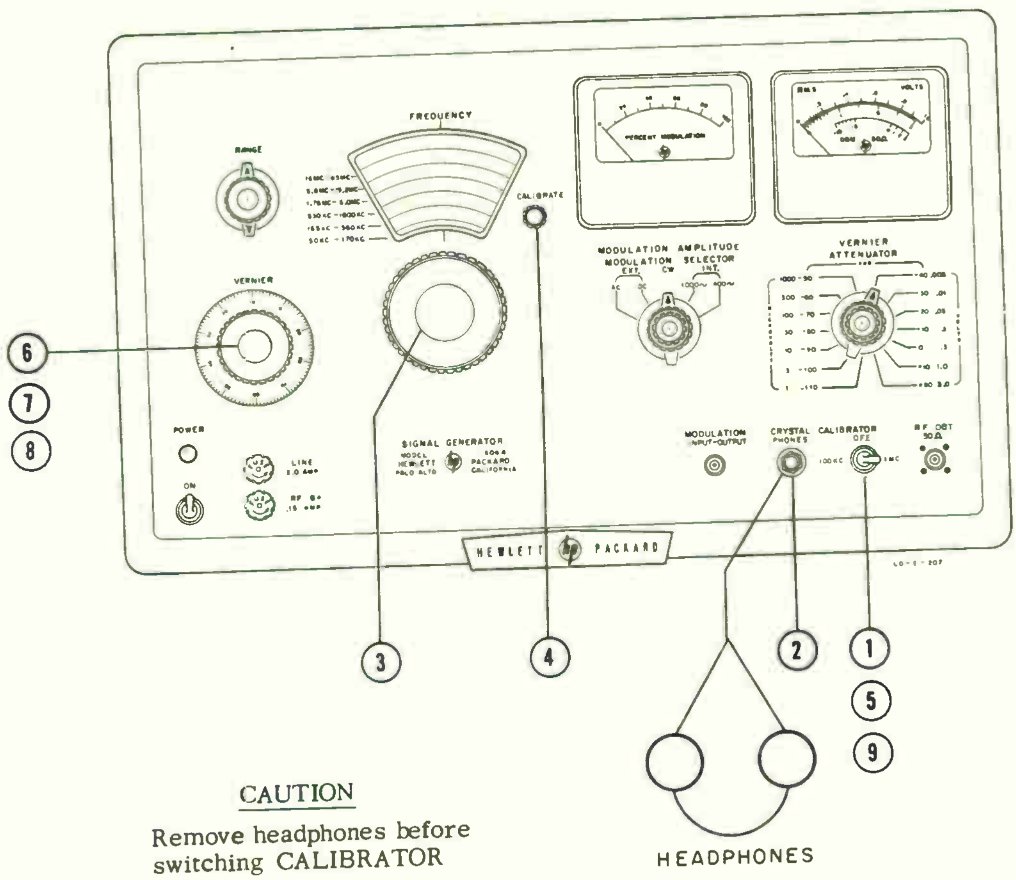
b. ZERO DB ATTENUATION. 25 ohms output impedance (1:1 voltage ratio).

c. TWENTY DB ATTENUATION. 5 ohms output impedance (10:1 voltage division).

Note: Maximum permissible input power to probe is 180 milliwatts (3 volts across 50 ohms).

* See "Standards on Radio Receivers", Institute of Radio Engineers, 1938; and Terman, "Radio Engineers Handbook", any edition -- section entitled "Measurements on Radio Receivers".

Figure 2-3. External Output Termination

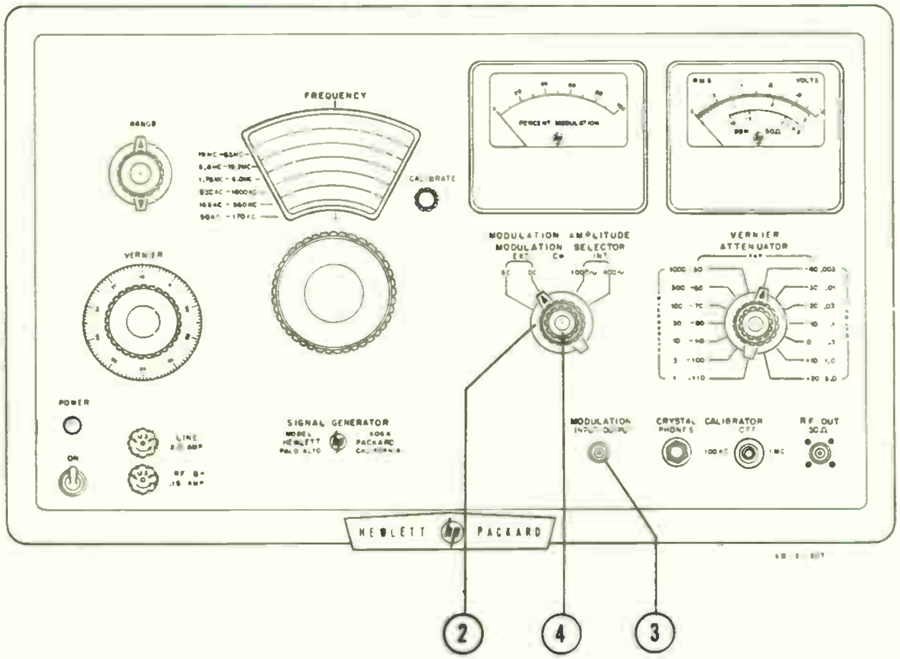


CAUTION

Remove headphones before switching CALIBRATOR

1. Switch CRYSTAL CALIBRATOR to 1 MC.
2. Plug a set of high impedance headphones into PHONES jack.
3. Zero-beat nearest even megacycle division to desired frequency.
4. Set the cursor exactly on the megacycle mark.
5. Switch CRYSTAL CALIBRATOR switch to 100 KC (lower frequencies only).
6. Turn VERNIER dial toward desired frequency while counting 100 kc beats. This procedure will set the frequency within 100 kc. If the frequency is desired with greater accuracy follow the remaining steps:
7. Determine number of scale divisions on VERNIER dial between zero-beat of the two 100 kc beats on either side of the desired frequency.
8. Set VERNIER dial to proportional number of divisions from nearest 100 kc beat to the desired frequency.
9. Turn CRYSTAL CALIBRATOR to OFF. If left on it will modulate output signal.

Figure 2-4. Calibration



1. Perform procedure for CW operation (figure 2-2)
2. Set MODULATION SELECTOR to EXT (AC or DC coupling).
3. Connect modulating signal (3 volts or more adjustable) to MODULATION terminal.
4. Turn MODULATION AMPLITUDE fully clockwise.
5. Increase signal from external generator until a reading of 100% is obtained on the PERCENT MODULATION meter.
6. Reduce the percent modulation to the desired level with the MODULATION AMPLITUDE control.

The limits of modulation frequency depend upon the maximum tolerable envelope distortion. For three percent envelope distortion the limits in terms of the carrier frequency, f_c, are:

	30% Mod.	70% Mod.	Square-Wave Mod.
$f_{mod.\ max}$ =	$.06\ f_c$	$.02\ f_c$	$.003\ f_c$
absolute $f_{mod.\ max}$ =	20 kc	20 kc	3 kc

Applying these formulas, typical bandwidths are:

Carrier Freq. Frequency	Modulation Frequency 30% Mod.	70% Mod.	Square Wave
50 kc	3 kc	1 kc	150 cps
200 kc	12 kc	4 kc	600 cps
500 kc	20 kc	10 kc	1500 cps
1 mc and above	20 kc	20 kc	3 kc

NOTE: On the 3 VOLT output range and between 19 - 65 mc in frequency, modulation beyond 30% is not recommended.

Figure 2-5. External Modulation

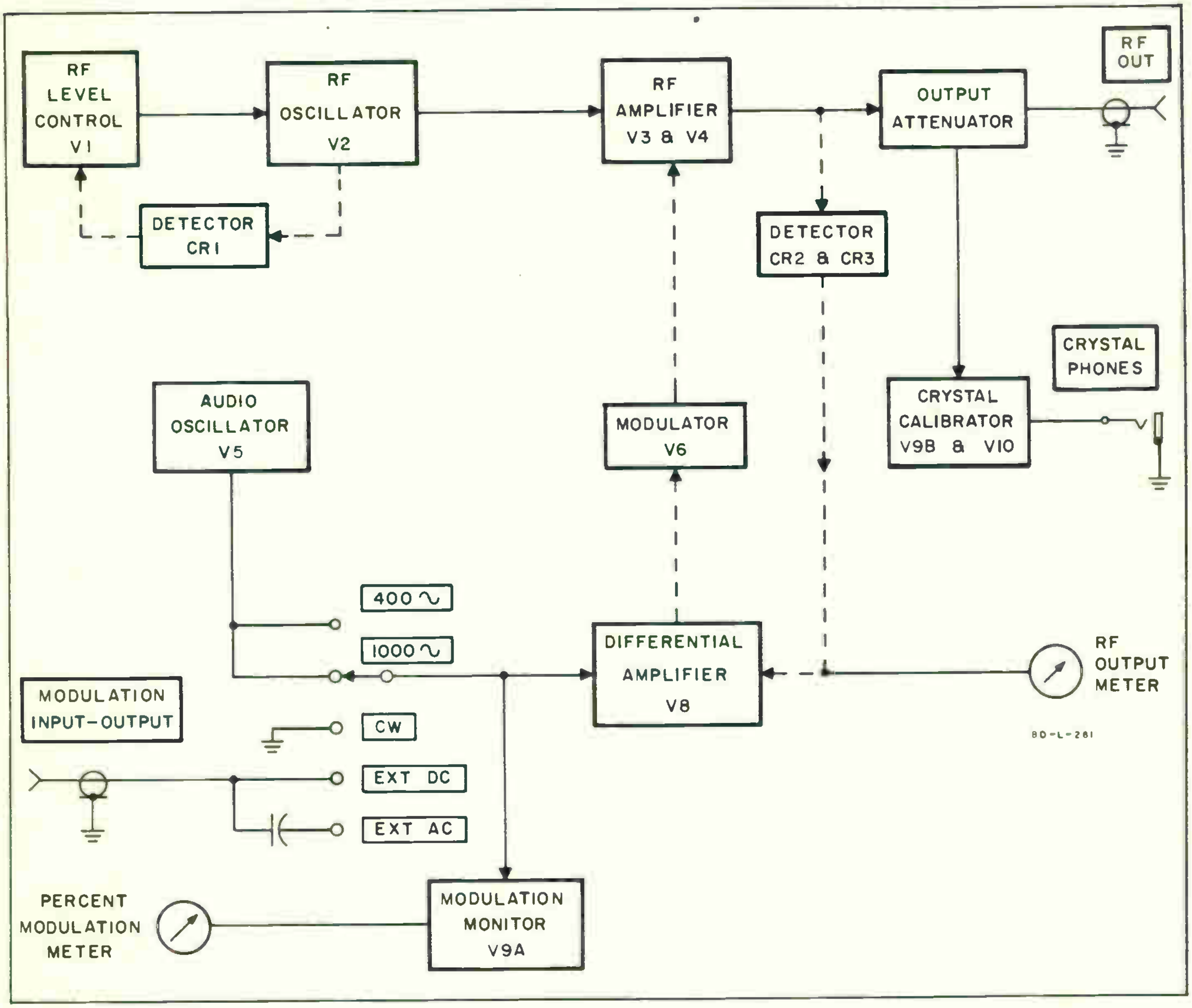


Figure 3-1. Model 606A Block Diagram

SECTION III
THEORY OF OPERATION

3-1. OVERALL OPERATION.

3-2. Refer to the block diagram figure 3-1. The level of the rf oscillator is stabilized by a feedback circuit from the rf oscillator to the oscillator level control tube. In a similar way the rf output and modulation levels are held constant by a feedback loop from the rf output through the differential amplifier to the modulator. The rest of the block diagram represents standard circuitry for signal generators.

3-3. CIRCUIT DESCRIPTION.

3-4. RF OSCILLATOR AND LEVEL CONTROL. The rf oscillator is a tuned-plate push-pull oscillator. The pentode section of V1 acts as a variable cathode resistor for V2 to control the oscillator level. The control grid of this pentode receives a rectified portion of the oscillator signal. This voltage decreases the current through V1 when the oscillator level rises and vice versa. Since this current is also the cathode current of the rf oscillator, the level of oscillation will be held constant. The triode section of V1 is a cathode follower which provides bias voltage for the grids of the oscillator and amplifier.

3-5. RF AMPLIFIER. The rf oscillator signal is fed to the control grids of the push-pull rf amplifier stage, V3 and V4. The screen grids are connected directly to +300 volts. The amplifier cathode current is controlled by V6, which acts as a variable cathode resistor. See the next paragraph for an explanation.

3-6. MODULATOR. Triode V6 is inserted in the cathode circuit of the rf amplifier to obtain cathode modulation. The internal resistance of the triode changes according to the applied modulation signal at the control grid. Thus cathode current of the rf amplifier is varied which, in turn, amplitude modulates the rf level.

3-7. RF FEEDBACK AND LEVEL CONTROL CIRCUIT. The modulated rf output signal is sampled at the secondary winding of the rf output transformer and rectified by crystal diodes CR2 and CR3. The time constant of the rc filter is determined by the position of the frequency RANGE selector. This time constant is selected to bypass the rf component but not the modulation or dc level. The demodulated rf signal is then fed to the control grid, pin 7, of the differential amplifier.

3-8. This demodulated signal is dc-coupled and thus has a dc component equal to the cw level of the output plus an ac component corresponding to the modulation. The demodulated rf signal also passes through an rf filter R36, C37, C38, and L6 which minimizes leakage. At the output of this filter a dc current is obtained which is proportional to the cw rf level. This current is then fed to the rf output meter.

3-9. A two-position attenuator, which controls the amount of feedback, is inserted between the crystal detectors and the differential amplifier. In the 1 VOLT and lower output positions the feedback is obtained through the divider R25 and R36. Only in the 3 VOLT position is R36 (in feedback loop) shunted by R26. This raises the current through the rf amplifier by 10 db. This switching is done automatically by relay K1 whenever the ATTENUATOR selector is switched to the 3 VOLT position.

3-10. RF ATTENUATOR. The rf output signal is tapped off the secondary winding of the output rf transformer and fed to the input of the output attenuator. This attenuator provides a maximum attenuation of 120 db in 10 db ranges. The output level may be varied between ranges by changing the input to the attenuator with the ATTENUATOR VERNIER control. Input is monitored by the rf level meter. The 3 VOLT rf output is obtained by reducing the demodulator rf feedback.

3-11. CRYSTAL CALIBRATOR. A small signal, coupled from the attenuator, is fed to the control grid (pin 2) of a mixer amplifier (triode section of V10). The output of the crystal oscillator (pentode section of V10) is also fed to this grid. The mixed signal from V10 is fed into an output triode amplifier, V9B. The beat-frequency output of V9B is brought out to the front panel CRYSTAL CALIBRATOR PHONE output jack.

3-12. The crystal oscillator is the pentode section of V10 operating as an electron-coupled oscillator. Positive feedback to the control grid is obtained from the screen grid through the crystals. Two crystals provide oscillation at either 1 mc or 100 kc, as selected by the CRYSTAL CALIBRATOR switch. The plate of the oscillator provides the signal necessary to drive the mixer grid of the triode section.

3-13. AUDIO OSCILLATOR. The audio oscillator is a modified Wien bridge oscillator with amplitude stabilization. The feedback signal is taken from the secondary winding of the output transformer. Two oscillator frequencies (400 and 1000 cps) can be selected by switching different resistors in the Wien bridge. The level of oscillation is set by the Modulation Oscillator Adjustment (R51) which controls the feedback to lamp RT1. Increased feedback causes the lamp to heat up, increasing its resistance. The increased resistance causes more degeneration in the cathode of V5, limiting the gain.

3-14. In the INT. position the modulating voltage is available at the front panel MODULATION INPUT-OUTPUT jack. This voltage is supplied for synchronization purposes. It has a source impedance of 82K ohms.

3-15. PERCENT MODULATION METER CIRCUIT. The modulating signal goes to pin 2 of V9A, a cathode-follower. This tube feeds shunt diode CR5 which rectifies the signal. A dc voltage corresponding to the modulation is fed to the PERCENTAGE MODULATION meter. Clamp diode CR4 prevents the cathode of V9 from going negative to protect capacitor C56, whose voltage rating is 25 volts. This point would otherwise go toward -200 volts if V9 was removed or was weak.

3-16. The modulating signal also goes to pin 2 of V8. The signal level to V8 can be controlled by the ATTENUATOR VERNIER. When the signal level is varied the output modulation is varied, as explained in the following paragraph. This circuit is also used to reduce the voltage on the rf amplifier during switching. As soon as the RANGE switch is rotated out of the detent position, S7 disconnects the +300 volt power supply, hence grid voltage of V8 drops to ground potential. The B+ is not reconnected until after the turret has made contact in its new position. This action keeps the amplifier tubes from drawing excessive screen current when the turret is disengaged from the plate circuit. When the +300 volt dc supply is disconnected R64 is substituted as a load to keep the power supplies in regulation.

3-17. DIFFERENTIAL AMPLIFIER. The external modulation signal fed into the MODULATION jack is combined with the dc reference level in the same manner as the internal modulation. Either of these signals is applied to a resistive network consisting of R57, R62 and R68 and is added to the dc reference voltage. The combined voltages appear at the ATTENUATOR VERNIER (R63). This control varies the dc, which controls the carrier, and the modulation signal at the same rate. Thus the percentage of modulation remains constant regardless of carrier level.

3-18. The dc (carrier level) and ac (modulation) signals are fed through an rf filter to pin 2, grid of the triode section of V8, as a reference signal to be compared to a signal from the output which is fed to the pentode grid (pin 7). This triode plus the pentode section of the same tube form a differential amplifier. The ac level of both of these signals is proportional to the modulation. The modulating signal is the reference voltage and the actual modulation of the output is compared to this reference. The dc level of the output (proportional to the rf) is compared to a reference dc level that is proportional to the desired rf level, as set by the ATTENUATOR VERNIER control.

3-19. Since the cathodes of V8 are connected together, the reference signal applied to the triode section will also appear on the cathode of the pentode section. This signal will be compared to the signal from the output which is applied to the grid. Any deviation from a fixed voltage difference between these two signals results in an output signal which has a polarity such as to reduce this difference. Thus the original conditions are restored. For example, if the rf level drops, the voltage on pin 7 of V8 will become more negative. This will reduce the amount of current flowing through this tube so the plate will become more positive. The grid voltage of V6 is proportional to the plate voltage of V8. As this grid voltage becomes more positive the current through V6 will increase. But this current is also the cathode current for the rf amplifier, so the output will increase until the original conditions are restored. By this action the output is stabilized and is constant to better than ±1 db over the entire frequency range. The rf level can be changed by varying the ATTENUATOR VERNIER (R63) which will change the reference bias. In a similar way the modulation is held constant. Since the crystal detector circuit has a time constant fast enough to follow the modulation envelope, the output modulation is compared to the modulating frequency and distortion is minimized.

3-20. BIAS SUPPLY. One half of V7 is used as a constant voltage source to furnish the plate potential needed for the triode section of the differential amplifier. The other half of V7 supplies the screen potential for the pentode section of the differential amplifier. The screen potential is adjusted for rf amplifier cut-off when both grids of the differential amplifier are at ground potential. This establishes the zero point of the ATTENUATOR VERNIER control.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section contains instructions for adjusting and servicing the Model 606A Signal Generator. In addition it contains a performance check suitable for incoming or quality-control inspection. The performance check does not require cabinet removal or internal adjustments.

4-3. CABINET REMOVAL.

a. Disconnect the power cord from the receptacle.

b. Remove the four screws on the rear cover of the cabinet and remove the rear cover.

c. Unplug the inner chassis power cord from the rf filter box mounted in the cover.

d. Tip the unit up on its back.

e. Loosen the two screws on the bottom of the cabinet which clamp the cabinet to the front panel. (Do not remove any screws from the front panel.)

f. Lift the cabinet off the instrument.

CAUTION

When the cabinet is removed, dangerous voltages are exposed. Take adequate safety precautions.

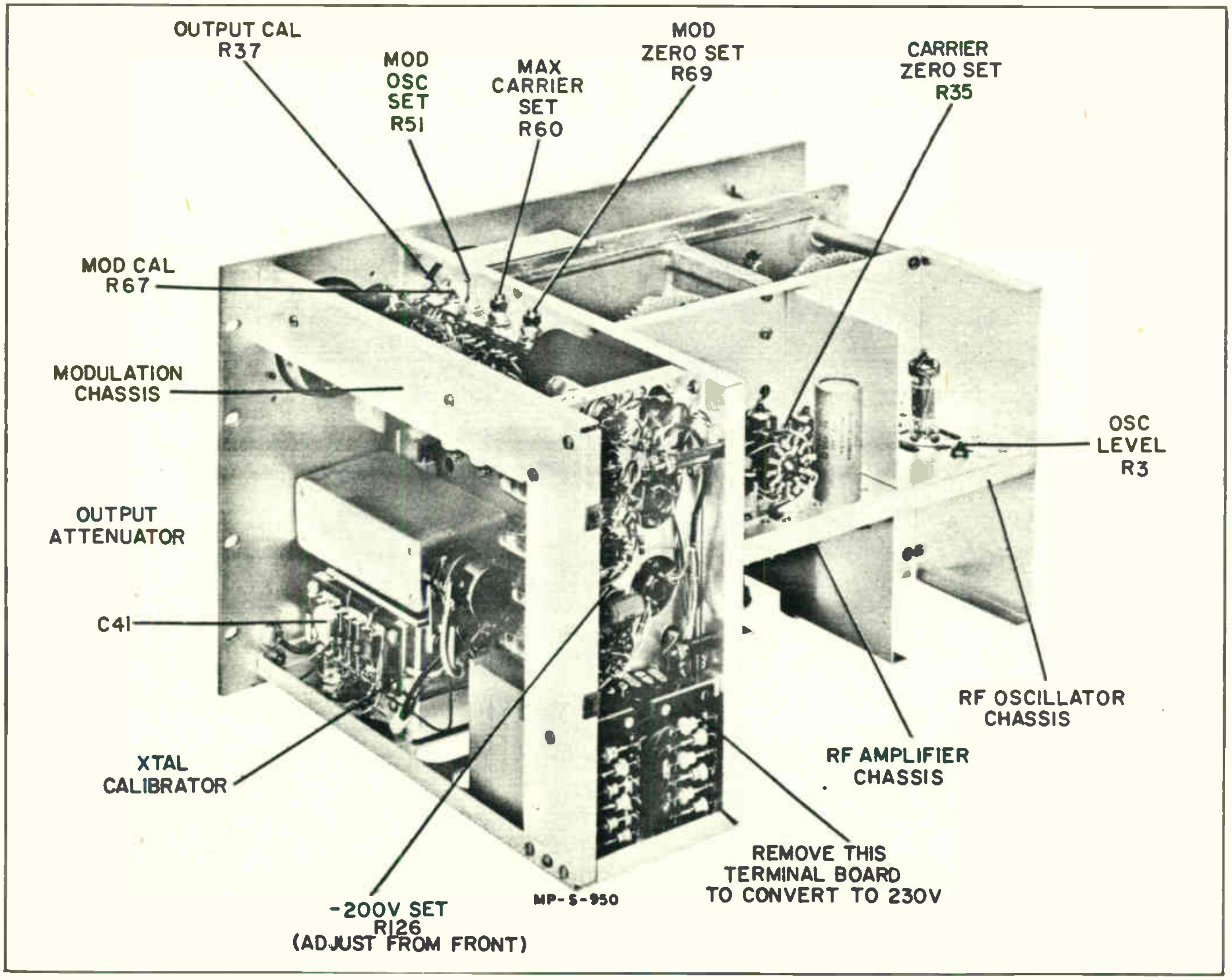


Figure 4-1. Location Diagram Model 606A

4-4. RF SHIELD REMOVAL.

a. Remove all screws holding the rf shield (use allen wrench clipped to top of shield to remove cap screws).

b. Remove the rf shield by pulling to rear.

4-5. TEST EQUIPMENT REQUIRED.

4-6. The following equipment is required to test the Model 606A:

a. VTVM accurate to ±3% with a high frequency probe, such as the ⓗ Model 410B Vacuum Tube Voltmeter.

b. AC voltmeter accurate to ±2%, such as the ⓗ Model 400D/H/L Vacuum Tube Voltmeter.

c. Clip-on dc milliammeter, such as the ⓗ Model 428A/B Clip-On DC Milliammeter or a conventional 300 ma milliammeter.

d. Electronic counter, such as ⓗ Models 524B/C/D Electronic Counters with Model 525A Converter.

e. Oscilloscope, such as ⓗ Model 150A, 160B, or 170A.

f. Variable transformer continuously adjustable over the range 100 to 130 volts, equipped with a monitor voltmeter accurate within 1 volt.

g. Square-wave generator, such as the ⓗ Model 211A Square Wave Generator.

4-7. TUBE REPLACEMENT.

4-8. In many cases instrument malfunction can be corrected by replacing a weak or defective tube. Before changing the setting of any internal adjustment check the tubes. Adjustments made in an attempt to restore operation when the cause is a defective tube will often complicate the repair problem.

4-9. Check tubes by substitution rather than using a "tube checker". The results obtained from the "tube checker" can be misleading. Before removing a tube, mark it so that if the tube is good it can be returned to the same socket. Replace only those tubes proved to be weak or defective.

4-10. Any tube with corresponding standard EIA characteristics can be used as replacement. Where variations in tube characteristics will affect circuit performance an adjustment is provided. Table 4-1 lists the tests to make and the adjustments that may be necessary if such tubes are replaced.

Table 4-1. Tube Replacement

Circuit Ref.	Tube Type	Function	Tests and/or Adjustments	Par. Ref.
V1	6AW8	Oscillator Level Control	Set Maximum Oscillator Current	4-45
V2	12AT7	RF Oscillator	Set Maximum Oscillator Current	4-45
V3, 4	6CL6	RF Amplifier	Carrier Zero Set Maximum Carrier Set RF Output Meter	4-46 4-47 4-49
V5	12AT7	Audio Oscillator	Audio Oscillator Mod. Zero Set Modulation Meter	4-42 4-47 4-48
V6	12B4	Modulator	Maximum Carrier Set Mod. Zero Set RF Output Meter Modulation Meter	4-47 4-47 4-49 4-48
V7	12AT7	Cathode Follower	Carrier Zero Set Maximum Carrier Set Mod. Zero Set RF Output Meter Modulation Meter	4-46 4-47 4-47 4-49 4-48
V8	6AW8	Differential Amplifier	Same as V7	
V9	12AT7	Modulation Monitor and Beat Frequency Output	Mod. Zero Set Modulation Meter Crystal Calibrator	4-47 4-48 4-43
V10	6AW8	Crystal Oscillator and Mixer	Crystal Oscillator	4-43
V101, 2, 3, 4, 5 V106 V107 V108 V109	12B4A 6AW8 12B4A 6AW8 5651	Regulators Amplifier Regulator Amplifier Voltage Reference	Power Supplies	4-36

4-11. FRONT PANEL OPERATION CHECK.

4-12. The following in-cabinet procedures are simple checks to be performed first whenever difficulty is encountered in operation of the signal generator. These checks will isolate the trouble to either the signal generator or associated equipment and if the trouble is in the signal generator will isolate it to a particular section.

4-13. PRELIMINARY CHECK.

4-14. Always perform these check before attempting to isolate the trouble within the instrument.

a. Turn unit on with no load and allow to warm up five minutes or more.

b. If output meter is off scale in the negative direction, check for blown B+ fuse.

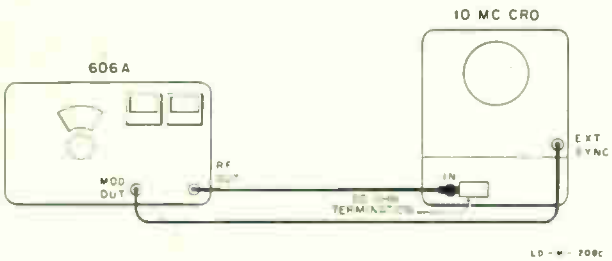


Figure 4-2. Modulation Meter Calibration

4-15. MODULATION METER CALIBRATION.

a. Connect the unit to a 10 mc oscilloscope as shown in figure 4-2.

b. Set RANGE switch to 530-1800 kc band.

c. Set FREQUENCY control to 1000 kc.

d. Set MODULATION SELECTOR to CW.

e. Set ATTENUATOR to 1 VOLT.

f. Adjust vertical sensitivity of oscilloscope to get 4 cm of deflection.

g. Set MODULATION SELECTOR switch to 1000 ∿.

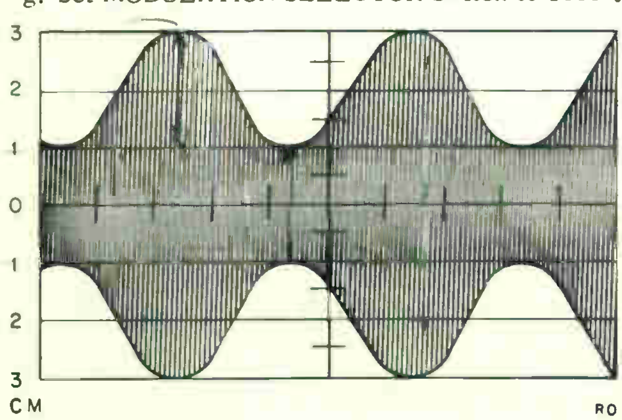


Figure 4-3. Waveform for 50% Modulation

h. Adjust MODULATION SELECTOR control until maximum deflection is exactly 6 cm high (see figure 4-3). Modulation meter should be reading between 45 and 55%.

i. Check modulation meter calibration from 0 to 90%. It should be accurate within ± 5% of full scale.

4-16. FREQUENCY CALIBRATION.

4-17. The easiest way to check frequency calibration is with a counter, such as the ⓗⓟ Model 524B/C/D with a 525B plug-in converter. If a counter is not available proceed as follows:

a. Allow both a receiver capable of receiving WWV and the Model 606A to warm up for fifteen minutes.

b. Tune in WWV on 5, 10, or 15 mc, whichever gives best reception.

c. Lightly couple a single wire from the RF OUT jack of the Model 606A to the antenna as shown in figure 4-4.

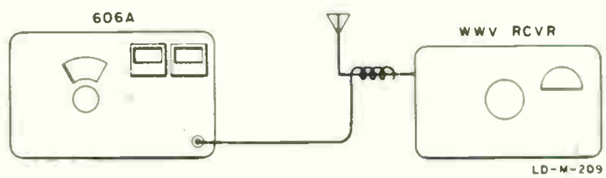


Figure 4-4. Frequency Calibration

d. Tune the RANGE and FREQUENCY controls of the Model 606A to the frequency of the incoming WWV signal. The MODULATION SELECTOR switch should be on CW (no modulation).

e. Adjust the output level to be about the same as WWV (use S meter on receiver if it has one). Too much signal will block the receiver and obscure the beat-note.

f. Zero-beat the frequency of the Model 606A to the WWV signal during a time that WWV has no modulation. Do not disturb the FREQUENCY dial after this adjustment. Set CALIBRATE adjustment to align window.

g. Listen to 1 MC CALIBRATOR with headphones. If beat-note is a low audio tone, less than 1 kc, crystal calibrator is within specifications.

h. Repeat step g using 100 KC CALIBRATOR.

i. With the CALIBRATOR on 1 MC check all megacycle marks on the dial on all bands. Beat-note should be within 1% of the dial reading.

4-18. OUTPUT LEVEL FREQUENCY RESPONSE.

a. Connect ac probe of ⓗⓟ Model 410B High Frequency VTVM to output termination as shown in figure 4-5. Solder tip of Model 410B ac probe to center conductor of UG-290/U connector. Clip ground lead

of probe to skirt of connector. Insert connector into OUTPUT connector of Output Termination.

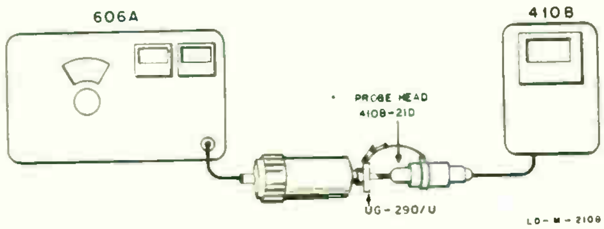


Figure 4-5. Output Level Frequency Response

b. Set the output to 0.9 volt on the 530-1800 kc band and run the FREQUENCY dial and RANGE switch throughout all bands. The voltage should not vary more than ±11% (1 db) at any output level setting.

4-19. TROUBLESHOOTING.

4-20. In general, internal controls have only a limited range and are designed to compensate for minor variations in tubes and/or circuit components. If a major section or the complete instrument is inoperative adjustment of internal controls will seldom, if ever, restore operation. To avoid complications and reduce "down time" locate and correct the cause of a dead instrument before you make internal adjustments. Refer to paragraph 4-7 before making internal adjustments.

4-21. When a section shows up faulty, refer to the appropriate section of table 4-2 and perform the recommended tests. If the trouble is in the output termination or attenuator you may return them separately to the factory for repair. They are not field repairable.

4-22. A good starting point when repairing a dead instrument is with the power supply. Check line cord, both fuses, and the power supply output voltages. BE SURE TO CHECK THE B+ FUSE IN ADDITION TO THE MAIN FUSE, ESPECIALLY IF THE OUTPUT METER IS PINNED TO THE LEFT. If you find a dead power supply tube, tube replacement will normally restore instrument operation without any internal adjustments. However, check the output voltages of each supply to see if the output is within limits. If the output is within the limits given in the power supply section do not attempt to refine the adjustments.

4-23. IF THE INSTRUMENT IS INOPERATIVE, FIRST TRY BLOWING OUT THE PLATES OF THE TUNING CAPACITOR WITH A LOW VELOCITY AIR STREAM SUCH AS THAT FROM A VACUUM CLEANER. Blow out these plates every time you remove the instrument from the cabinet for maintenance.

4-24. TROUBLESHOOTING CHART, TABLE 4-2. Since the operation of many sections in this generator is dependent upon the proper operation of other sections, troubleshooting in this instrument must be done in proper sequence. After determining in which section the trouble lies, refer to the appropriate section of this chart and perform the tests indicated. Also, if the trouble cannot be found by any other means, go through table 4-2 from the beginning. Once the trouble has been found and fixed do not continue with the tests in this table.

4-25. If output is obtained, troubleshoot the particular section giving difficulty by referring to the appropriate part of table 4-2.

4-26. If no output is obtained, the trouble may be anywhere in the feedback loop. Refer to table 4-3, Troubleshooting the Feedback Loop, for instructions.

Table 4-2. Troubleshooting Chart

Measure	Normal Indication	Possible Cause of Malfunction
A. -200 VDC SUPPLY		
PREPARATION: Disable +300 vdc supply by disconnecting R101 (5 ohm 5 watt wirewound resistor found just above rectifier terminal boards at rear of instrument). Temporarily connect a 1 megohm 1 watt resistor between pins 2 and 9 of V107. Measure the voltage to ground at the following points:		
1. C108 filter cap.	-200 vdc ±5%	Open or shorted C105 C108 open or shorted, also disconnect load and remeasure
2. Transform.sec.(blue)	143 volts rms ±10%	Open or shorted secondary
3. C105 unregulated dc	+195 vdc ±10% (one side)	V107 (12B4) defective. Check heater (6.3 vrms)
4. V109 pins 1, 5 (plate)	-110 vdc (nominal) ±20%	V109 (5651) defective. Check for orange glow.
5. V108 pins 1, 6 (cathode)	-112 vdc (nominal) ±20%	V108 or associated components defective; check heater (6.3 volt rms).

Table 4-2. Troubleshooting Chart (Cont'd)

Measure	Normal Indication	Possible Cause of Malfunction
B. +300 VDC SUPPLY		
PREPARATION: The -200 vdc supply is assumed to be operating (remove 1 megohm resistor and reconnect +300 volt supply if these temporary changes were made to troubleshoot -200 vdc supply). Adjust line to 115 volts rms.		
1. C104 filter cap	+300 vdc ± 5%	Also measure with RANGE switch between ranges; this will isolate a defective tuning capacitor in RF OSC. or AMP.
2. Transf.sec.(red) R101	+175 volts rms ± 10%	Open or shorted turns in transformer
3. C101 and C102	250 vdc across each	C101, 102, and 104 or CR101, 102, 103 and 104 open or shorted.
4. V101 pin 9 (plate)	+500 vdc	C101, 102 or CR101, 102, 103 and 104 open or shorted. Check V101, 102, 103, 104, 105 and 106.
5. V106		
pin 9 (plate)	+270 vdc	V106, R102, 103 and 104
pin 8 (screen)	+ 38 vdc	V106, CR103, R110, R111 and -200 volts
pin 6 (cathode)	+ 3.6 vdc	V106, R113 and -200 volt supply
C. RF OSCILLATOR		
PREPARATION: This procedure assumes the power supply is operating correctly. Use a clip-lead to short across R30 (caution -200 volts) to disable RF Amplifier temporarily while measuring the following voltages: (Measure voltage to ground.)		
1. V2 pin 9 (tie point)	+26 vdc ± 10%	Check voltage at rf filter Check voltage at junction of CR110 and 112
pin 5 to 9	6.3 vdc ± 10%	Open heater-check for visible glow
2. V1 pin 5	+26 vdc ± 10%	Same as step 1, V2 pin 9
pin 4 to 5	6.3 vdc	Same as step 1, V2 pin 5 to 9
pin 3	+295 vdc (nominal)	Check B+ fuse, detent micro-switch S7, rf filter (C8, 10ABC, 11, 16, 32 and 33 for shorts, L4 for open circuit). Turn range switch between ranges-should be no change
pin 2	+99 vdc	Check R1, 2, 3 and C1
pin 1	+100 vdc	Check R19, V1 or rf lead to 6CL6's
3. V2 pin 1 & 6 (plates)	+295 vdc (nominal)	Check R9, and C4, 5 and 7 for shorts
pin 2 & 7 (grids)	+100 vdc	Check V1 and associated components
pin 3 & 8 (cathode)	+110 vdc	Check V1, 2, CR1 or associated components
pin 2 & 7 (grids)	6 volt rms (nom.) to 19 mc 3 to 5 rms to 65 mc (meas. with ⓗ 410B-AC Probe).	Check V2, CR1, C4, 5, 7, T2 (tank coil) and grid line to 6CL6's.
4. R9 (turn off and measure resistance)	100 ohms ± 10%	Check C4, 5 or V1 or V2 for shorts
D. RF AMPLIFIER		
PREPARATION: This procedure assumes the power supply and oscillator are operating. (Disconnect short across R30, if installed in step C.) Measure voltage at:		
1. C111	+27 vdc ± 10%	C109, C110, C111, R132, V1 to 4, and V6 to 8
2. V3, 4, 7 & 8 (acr.htrs)	6.3 vdc ± 10%	Same as above
V6	12.6 vdc ± 10%	Same as above

Table 4-2. Troubleshooting Chart (Cont'd)

Measure	Normal Indication	Possible Cause of Malfunction
	D. RF AMPLIFIER (CONT'D)	
3. R15 at tank term.	+295 vdc ±10%	R15 open, C10C, 11 shorted
4. V8 (6AW8) pin 2	0 to 3.5 vdc as R63 is rotated	R31, 53, 57, 60, 61, 62, 64, 65 and 68
pin 6	+4.1 vdc (nominal)	C29, R32, 33, 34, 35, V7, 8
pin 9	+76 vdc (nominal)	R20, 22, 23, 29, 30, V8
pin 3	+150 vdc (nominal)	R28, 29, R33, 34, 35, V7
pin 8	+54 vdc (nominal)	Same as pin 3
pin 7	0 to +3.4 vdc as R63 is rotated	C23, 24, 25, CR2, 3, R17, 24, 25, 26, 36, V8
5. V6 (12B4) pin 2, 7	-10 to -25 vdc as R63 is rotated	C19, R20, 22, 23, 29, 30, V7 or 8
pin 9	+110 vdc (nominal)	R10, 38, V3, 4, 6
6. V3 and 4 (6CL6's)		
pin 6	+295 vdc (nominal)	Shorted C12,14,15, open T3 or contacts on turret
pin 3, 8	+295 vdc (nominal)	Check C10, 11, 14, 15, 16, R10, 15
pin 2, 9	+100 vdc (nominal). If this voltage is incorrect the rf oscillator is not functioning properly	R11, 12 triode section of V1
pin 1	+112 vdc (nominal)	R13, 14, check voltage on pin 9 V6
7. CR2, anode	6 volt rms (nominal) with 1 VOLT output level. Varies 0 to 6 volt rms as ATTENUATOR VERNIER is turned	Check V3 and 4 plate voltage and output voltage as given in table 4-4

Symptom	Possible Cause
8. Fuse F1, (0.15 amp) burns out	Defective C8, 10ABC, 32, 33, 53 and L1, 4 Foreign material across tuning capacitors: C4, 5, 7, 14, 15 and 18 Defective microswitch S7 Feedback system defective
9. Sharp drop (hole) in power output level, or a sharp increase (peak) in oscillator or amplifier current as frequency dial is tuned	Check shorting fingers in turret. This prevents next lower band coil from resonating and absorbing power
10. R15 (100 ohms) burns out	Shorted tuned capacitor C14, 15 or 18 Open or shorted CR2, 3 Shorted C23, 24, 25 or S3 If this condition affects one band only, check the turret contact and coil for that one band. Also check switch S3 (on rf deck) for shorts This condition persists on all bands see table 4-3

E. AUDIO OSCILLATOR

Most troubles can be found easily by measuring the voltages in the circuit as follows:
Set MODULATION SELECTOR to INT. 1000 ∿
MODULATION AMPLITUDE to 100%

V5 (12AT7)	pin 1	3.7 volts rms	+180 vdc (approximate voltages)
	pin 2	6.6 volts rms	0 vdc
	pin 3	6.2 volts rms	+2.6 vdc
	pin 6	80 volts rms	+292 vdc
	pin 7	3.8 volts rms	0 vdc
	pin 8	1.88 volts rms	+4.8 vdc
T1 leads	green	20 volts rms	0 vdc (approximate voltages)
	yellow	3 volts rms	0 vdc
	blue	80 volts rms	+292 vdc

Table 4-2. Troubleshooting Chart (Cont'd)

F. MODULATION MONITOR

Most troubles can be found easily by measuring the voltages in the circuit as follows:
Set MODULATION SELECTOR to INT. 1000 ∿
MODULATION AMPLITUDE to 100%

V9A (1/2 12AT7)		
pin 2	2.8 volts rms	0 vdc (approximate voltages)
pin 3	2.8 volts rms	+3.9 vdc

Diode CR4 (1N90) prevents a high negative voltage developing at the cathode of V9A during warmup. Such a high voltage of reversed polarity would damage electrolytic capacitor C56. The high negative voltage could also be developed if the heater of V9 burned out or if the instrument were turned on with V9 removed.

Diode CR5 (1N90) is the detector for the modulation meter.

Both diodes can be measured only out of the circuit. Forward resistance should be approximately 500 ohms. Back resistance should be greater than 100K ohms.

G. CRYSTAL CALIBRATOR

Most troubles can be found easily by measuring the voltages in the circuit as follows:
Set CRYSTAL CALIBRATOR to either 100 KC or 1 MC as indicated.

	100 KC		1 MC		
V10 (6AW8A)	DC	AC	DC	AC	
pin 1	0 vdc	0 volt rms	0 vdc	0 volt rms	
pin 2	-58 vdc	41 volts rms	-34 vdc	23 volts rms	
pin 3	+71 vdc	0.44 volt rms	+196 vdc	0.1 volt rms	all
pin 6	0 vdc	0 volt rms	0 vdc	0 volt rms	voltages
pin 7	-82 vdc	60 volts rms	-35 vdc	23 volts rms	approximate
pin 8	+108 vdc	31 volts rms	+122 vdc	7.5 volts rms	
pin 9	+240 vdc	41 volts rms	+222 vdc	22 volts rms	

Table 4-3. Troubleshooting the Feedback Loop

SYMPTOM. No output on all ranges, or R15 (100 ohms) burns out on all ranges.

PREPARATION. This procedure assumes that:

a) The -200 volt and +300 volt supplies are functioning properly.

b) All heater voltages in the rf chassis measure the correct value.

c) All tubes have been checked.

d) The oscillator is working properly on all bands and gives approximate voltages and currents as listed in table 4-4.

e) The tuning capacitor or its leads are not short circuited.

PROCEDURE. Unless otherwise noted all measurements are made at 115 volts rms, 60 cycle line, with the Model 606A on CW.

Proceed from step to step. Rectify any troubles before proceeding to the next step.

Measurements are made with an ⓗⓟ Model 410B VTVM and Model 428A Clip-On Milliammeter, or other milliammeter.

E = dc voltages; e = ac voltages; I = current.

Procedure	Observe or Measure
1. Disable the feedback by connecting pin 2. V6 (12B4) to -200 volts by shorting R30 (220K).	This bias should cutoff V6 and provide no current for V3 or V4. There should be no current through R15. Check with ⓗⓟ Model 428A.

Table 4-3. Troubleshooting the Feedback Loop (Cont'd)

Procedure	Observe or Measure			
2. Connect a series combination of 5K, 5W, fixed and a 2K, 2W variable resistor from pin 9 of V6 (12B4) to ground. Terminate output with 50 ohm load. Adjust 2K pot. to obtain 1 volt at 1 mc.	V6 (12B4)	pin 1 to ground	I_k is approx.	19 ma
	R10 (33K)		I_k is approx.	5.6 ma
	R38 (33K)	bands 1 to 5	I_k is approx.	5.6 ma
		band 6	" "	0 ma
	V3 or V4 (6CL6)	pin 6 to ground	e is approx.	7.8 vrms
		pin 1 to ground	" "	2.0 vrms
		pin 1 to 2	E is approx.	-14 vdc
		pin 6 to ground	" "	+295 vdc
		pin 8 to ground	" "	+295 vdc
		pin 7 to ground	" "	+110 vdc
	Drop across R13 or 14 (39 ohms)		E is approx.	0.15 vdc
	CR2 (anode)		e is approx.	5.7 vrms
	CR3 (cathode)		E is approx.	7.1 vdc
	V8 (6AW8)	pin 7 to ground	E is approx.	3.1 vdc
		pin 7 to ground	e "	0 vrms
	R18 (50 ohms)	input voltage	is approx.	2 vrms
		output voltage	"	1 vrms
3. Repeat for bands 1, 2, 4, 5 and 6	Check with data on table 4-4. Data for CR2, CR3 and V8 for this test are same as listed in item 2			
4. Adjust the 2K variable resistor until 3.1 vdc appears on pin 7 of V8 (6AW8A). Set R63 (ATTENUATOR VERNIER) fully counterclockwise (zero ohms).	V8 (6AW8)	pins 1 and 6	E is approx.	+3.9 vdc
		pin 2	" "	0 vdc
		pin 3	" "	+143 vdc
		pin 4	" "	+19.5 vdc
		pin 5	" "	+13 vdc
		pin 7	" "	+3.1 vdc
		pin 8	" "	+54 vdc
		pin 9	" "	+10 vdc
	V7 (12AT7)	pins 1 and 6	E is approx.	+295 vdc
		pin 2	" "	+50 vdc
		pin 3	" "	+54 vdc
		pins 4 and 5	" "	+19.5 vdc
		pin 7	" "	+135 vdc
		pin 8	" "	+143 vdc
		pin 9	" "	+13 vdc
5. Turn R63 (ATTENUATOR VERNIER) fully clockwise (5K).	V8 (6AW8)	pins 1 and 6	E is approx.	+4.5 vdc
		pin 2	" "	+3.3 vdc
		pin 3	" "	+138 vdc
		pin 6	" "	+4.5 vdc
		pin 7	no voltage change as R63 is rotated	
		pin 8	E is approx.	+54 vdc
		pin 9	" "	+42 vdc
6. Disconnect jumper from pin 2 V6 to -200 volts. Remove 5K and 2K resistor.	The unit should be working properly.			
7. Realign the rf oscillator and amplifier sections if any tubes or components have been replaced or altered.	See section on Max. Carrier Set, Mod. Zero Set, Carrier Zero Set, Percentage Mod. and Carrier Output Meters.			

Table 4-4. Typical Voltage(1). Oscillator and Amplifier Current Output
1 Volt into 50 Ohms, CW

FREQ. (6)	I_o (2)	e_{go} V2 pin 2, 7	e_{po} V2 pin 1 or 6	e_{ko} @C4/C5	I_a (3)	e_{ga} V3 or 4 pin 2	e_{pa} V3 or 4 pin 6	e_{ka} @C14/C15	e_{out} term. (5)	e_{fb} term. (4)	I_k 12B4 V6 pin 1
94 KC	1.3 ma	7.1 v	92 v	209 v	5.7 ma	7.1 v	9.3 v	58 v	2.0 v	5.5 v	19 ma
310 KC	2.8	7.0	70	150	4.9	7.1	9.8	31	2.0	5.3	19
1 MC	4.8	5.9	130	130	6.4	5.9	7.8	19	2.0	5.7	19
3.33 MC	5.3	6.7	93	93	7.6	6.8	19	19	2.0	5.5	26
10.9 MC	4.6	6.9	55	55	4.0	6.85	15.5	15.5	2.0	5.5	17
36.3 MC	14.0	6.6	24.5	25	9.4	5.3	6.8	6.8	2.0	5.5	26

Notes:
(1) Measured by DC VTVM, such as ℎ𝓅 Model 410B
(2) Measured by ℎ𝓅 Model 428A Clip-On Milliammeter at red-green wire loop between B+ and R9 (beneath rf oscillator stator turret contacts).
(3) Measured by ℎ𝓅 Model 428A Clip-On Milliammeter at red-green wire loop between B+ and R15 (beneath rf amplifier stator turret contacts).
(4) Feedback voltage terminal (4) next to diode detector CR2.
(5) Output voltage terminal (5) next to generator terminating resistor, R18.
(6) Leave dial set at 1 MC, rotate range switch only to desired band.

Explanation of symbols:
e = voltage
I = current
g = grid
o = oscillator
k = cathode
a = amplifier
f = filament
p = plate

4-27. TURN-ON PROCEDURE AFTER REPAIR.

4-28. Be sure to check for shorts in tuning capacitors C4 and C5, C14 and C15 with an ohmmeter after repair and before turning on the instrument. Solder splashes may occur which short these capacitors when repairing other parts of the instrument. If the instrument is turned on with these capacitors shorted, resistors R9 or R15 may be damaged.

4-29. MECHANICAL ADJUSTMENT OF METER ZERO.

4-30. When meter is properly zero-set, pointer rests over the zero calibration mark on the meter scale when instrument is: 1) at normal operating temperature, 2) in its normal operating position, and 3) turned off. Zero-set as follows to obtain best accuracy and mechanical stability:

a. Allow the instrument to operate for at least 20 minutes; this allows meter movement to reach normal operating temperature.

b. Turn instrument off and allow 30 seconds for all capacitors to discharge.

c. Rotate mechanical zero-adjustment screw clockwise until meter pointer is to left of zero and moving upscale toward zero.

d. Continue to rotate adjustment screw clockwise; stop when pointer is right on zero. If pointer overshoots zero, repeat steps c and d.

e. When pointer is exactly on zero, rotate adjustment screw approximately 15 degrees counterclockwise. This is enough to free adjustment screw from the meter suspension. If pointer moves during this step you must repeat steps c through e.

4-31. GENERAL TEST AND ALIGNMENT.

4-32. Usually the instrument will not need complete test and adjustment. This is particularly true when repair has been accomplished without changing any internal adjustments. BEFORE MAKING ANY INTERNAL ADJUSTMENTS, SEE PARAGRAPH 4-7. If unnecessary adjustments are eliminated you will often save time by being able to finish a repair without completing the entire test and adjustment procedure.

4-33. The procedures are listed in a recommended sequence for a complete test and adjustment operation. Test instrument recommendations are given in paragraph 4-5. The test frequencies and voltages are based upon the use of these recommended instruments. If other equipment is substituted, you may have to alter the procedures accordingly. When other equipment or methods are used, it is important to select components and techniques which have equal or greater accuracy. Any instrument can be adjusted for optimum performance at a particular frequency or voltage, or the most commonly used range.

4-34. The specifications for the Model 606A are given in the front of this manual. The test procedures contain extra checks to help you analyze the instrument. These extra checks and the data they include are not to be considered as specifications.

4-35. A ten to fifteen minute warmup at normal line voltage (nominally 115 or 230 volts) and power supply output voltage measurements are always recommended before making any other tests or adjustments. Refer to paragraph 4-36 before making any power supply adjustments.

4-36. POWER SUPPLIES.

4-37. The power supplies in this instrument are extremely stable and will require infrequent adjustment. The output voltages may be measured at regular intervals or as a first troubleshooting step but unnecessary adjustment should be avoided. A defective tube or component may overload the power supply and lead you to believe that the power supply is not functioning properly.

4-38. As long as the power supply regulator is functioning properly, you need not know the absolute values of the power supply output voltages. However, when power supply adjustment is necessary, you should use a voltmeter with a known calibration accuracy.

4-39. Regulation of the power supply can be checked by varying the power line voltage between 103 and 127 volts. The output voltage will vary only slightly, if at all, from the value measured with a 115 volt line. Loss of power supply regulation is most easily detected, as a sudden large increase in power supply ripple as the line voltage is raised and lowered ± 10% from 115 volts.

4-40. When the power supply output voltages are within limits with the line voltage at 115 volts, adjustment is not necessary. Do NOT adjust in attempt to refine the existing control settings.

4-41. To test the power supplies proceed as follows:

a. Measure power supply outputs. They should be within the limits shown in table 4-5.

b. If the voltage is outside the limits in the table adjust R126 (-200 volt set) for -200 volts. This control is in the center of the power supply deck with access only from the front side of the chassis.

c. You may wish to check the regulation of each power supply as the line voltage is varied between 103 and 127 volts. All regulated voltages should remain within ±1% over this range of line voltage.

d. Measure the ripple voltage on the various supplies. They should approximate the values indicated in table 4-5 with the power line voltage set at 115 or 230 volts.

Table 4-5. Regulated Power Supply Tolerances

Nominal Voltage	Nominal Ripple at 115/230 vrms Input	Output Voltage Range
-200 (violet wire)	10 mv	200 ± 8 volts
+300 (red wire)	10 mv	300 ± 12 volts
+27 (brown-orange wire)	---	unregulated

4-42. AUDIO OSCILLATOR.

a. Set RANGE 540 KC-1800KC
MODULATION SELECTOR . . . . . INT 400 ∿

b. Turn POWER switch to ON.

c. Connect an ℎ𝑝 Model 400D AC VTVM to output tap on audio transformer (yellow lead on signal tie point behind rf output meter). Connect ground lead of voltmeter to ground.

d. Set Mod.Osc.Adj (R51) potentiometer for 3.2 volts. This control is the middle one in the row of five potentiometers on top of the modulation deck.

4-43. CRYSTAL CALIBRATOR.

a. Set CRYSTAL CALIBRATOR to 100 KC.

b. Connect an electronic counter to pin 2 of the crystal oscillator tube (V10).

c. Adjust trimmer (C41) for exactly 100.000 KC. This trimmer is the ceramic capacitor on the right side (as viewed from the front) of the instrument under the modulation deck.

d. Set CRYSTAL CALIBRATOR to 1 MC and read counter. Reading should be between 999.900 and 1000.100 KC.

e. Set CRYSTAL CALIBRATOR to 100 KC and read counter. Reading should be between 99.990 and 100.010 KC.

f. Set trimmer C41 to best compromise between the above limits.

g. Turn CRYSTAL CALIBRATOR to OFF.

4-44. TUNE OSCILLATOR AND AMPLIFIER.

Note

This procedure should be performed only if there is a definite indication that the oscillator is off frequency. It should NOT be done on a routine basis.

a. Set CALIBRATE cursor to align with FREQUENCY centerline
ATTENUATOR . . . . .3 VOLT
MODULATION SELECTOR . . . . CW
FREQUENCY dial . . . . low end of one of the bands (except highest frequency)

b. Connect RF OUT terminal to an electronic counter, such as the ℎ𝑝 Model 524B/C/D with a Model 525A Converter.

c. If the frequency as read on the low end of the dial is off more than 1%, adjust the slug in the oscillator coil to correct. This slug can be reached by removing the cabinet and the shield (see paragraphs 4-3 and 4-4). Clockwise rotation of the slug will decrease the frequency.

d. Shift the frequency to the high end of the band. If the frequency as read on the FREQUENCY dial is off more than 1% adjust the trimmer capacitor across the oscillator coil to correct. Always use a plastic screwdriver when making this adjustment.

e. Repeat steps c and d until no further adjustment is necessary.

f. Repeat steps b through e on the other bands. On the highest frequency band adjust the slug with a plastic allen wrench (#18). If any adjustment is necessary check maximum oscillator current as in paragraph 4-45.

g. Connect the probe of an oscilloscope to the cathode of CR3. This point can be found on the pink-white wire between the amplifier stator turret terminal block and the tie-point for the 33K resistor R25.

h. Set the MODULATION SELECTOR to EXT.DC.

i. Connect a square-wave generator, such as the ⓗⓟ Model 211A set to 1 KC to the MODULATION INPUT-OUTPUT connector. Feed in sufficient square-wave signal so that the carrier is cut off for at least part of the cycle.

j. Tune throughout all bands and check the pattern on the oscilloscope for ringing or squegging. Reduce the frequency of the external modulation to 300 cps on the lowest frequency band to keep from overmodulating. If ringing is found tune the amplifier.

k. Measure the rf amplifier plate current with ⓗⓟ Model 428A/B Clip-On Milliammeter clipped over the red-green lead going to the 100 ohm resistor R15 on the turret stator contact terminal block (beneath rf amplifier chassis). If a Model 428A/B is not available, unsolder the red-green lead on the B+ side and insert a conventional 300 ma dc milliammeter. Bypass the point between the 100 ohm resistor and the meter with a 0.1 μf capacitor.

m. Tune inner slug in the amplifier coil from the top for a plate current dip at the low end of one band.

n. Tune trimmer capacitor for a plate current dip at the high end of the same band. This adjustment is made through a hole in the chassis between V3 and V4 underneath the amplifier turret shaft. Use a plastic screwdriver for this adjustment. In addition, if this tool has a metal tip, slide a tiny piece of tubing over the metal tip to prevent the trimmer shorting to ground when making this adjustment.

p. Recheck ringing as in step j.

q. Repeat steps j through p on all bands.

4-45. SET MAXIMUM OSCILLATOR CURRENT.

a. Set MODULATION SELECTOR . . . . . . CW
RANGE . . . . 19 MC-65 MC

b. Measure rf oscillator plate current with ⓗⓟ Model 428A/B Clip-On Milliammeter clipped over red-green lead going to the 100 ohm resistor R9 on turret stator contact terminal block (beneath oscillator chassis). If a Model 428A/B is not available, unsolder the red-green lead on the B+ side and insert a conventional 300 ma dc milliammeter. Bypass the point between 100 ohm resistor and meter with a 0.1 μf capacitor.

c. Tune FREQUENCY dial throughout the 19 MC - 65 MC band while noting the current.

d. Adjust Osc. Level control (R3) on the oscillator chassis for a maximum current of 25 ma at the frequency of maximum current. If this adjustment is made, check the following:

(1) Paragraph 4-46, Carrier Zero Set

(2) Paragraph 4-47, Maximum Carrier Set and Modulation Zero Set

(3) Paragraph 4-48, Set Percentage Modulation Meter.

4-46. CARRIER ZERO SET.

a. Set RANGE . . . . 50 KC - 170 KC
ATTENUATOR . . . . 1 VOLT
ATTENUATION VERNIER . . . . . . fully ccw
Carrier Output Zero (R35) . . . . . . fully ccw
MOD. SELECTOR . . . . . EXT DC with no input
MODULATION VERNIER . . . . fully ccw

b. Connect oscilloscope to output of the Output Termination.

c. Zero-set the carrier output meter with the instrument off as explained in paragraph 4-29.

d. Turn on and allow 5 minutes warmup.

e. Slowly turn Carrier Zero Set control (R35) on the rf amplifier chassis clockwise until there is some output on the oscilloscope. Then adjust carrier zero set until the indication on the oscilloscope, set to the most sensitive range, just collapses. Set the sweep on the oscilloscope for a free-running condition so that the indication will not disappear for lack of synchronizing signal.

f. Check for zero output across the band on each range. Bands 5.8 MC-19.2 MC and 19.2 MC-65 MC typically have a minimum output of 0.03 volt rms. If this adjustment is made, check the following:

(1) Paragraph 4-47, Maximum Carrier Set and Modulation Zero Set

(2) Paragraph 4-48, Set Percentage Modulation Meter.

4-47. MAXIMUM CARRIER SET AND MODULATION ZERO SET.

a. Set ATTENUATOR VERNIER pot . . fully cw
MODULATION SELECTOR . . . . . . EXT AC

b. Connect Model 410B ac probe to end of output termination. Solder tip of 410B ac probe to center conductor of a UG-290/U connector. Clip ground end of probe to skirt of connector. Insert connector into OUTPUT connector of output termination.

c. Set RANGE switch to band 1 (see box on schematic for band frequency ranges) and turn FREQUENCY dial over the band at moderate speed, noting the minimum output voltage read on the Model 410B.

d. Repeat step c on bands 2,3,4,5; and repeat on band 6 but turn much more slowly.

e. Set Model 606A to the range and frequency having lowest output voltage. Set MODULATION SELECTOR switch to CW, adjust Max. Carrier Set (R60) for 1.05 volt rf output on Model 410B. This control is fourth from the front in the row of five potentiometers on the top of the modulation deck.

f. Switch MODULATION SELECTOR from CW to EXT AC while noting output change on the Model 410B. There should be no change in voltage shown on the Model 410B. If necessary adjust Mod. Zero Set (R69, rearmost control in row of five controls on modulation chassis) until there is no change of output when the MODULATION SELECTOR is switched. Turn the MODULATION AMPLITUDE control. The output should not change. If necessary, adjust R69.

g. Recheck step e and f and adjust, if necessary. The two controls R69 and R60 interact with each other. Recheck the other adjustment any time one control is adjusted.

4-48. SET PERCENT MODULATION METER.

a. Set FREQUENCY. . . . . 1 MC
MODULATION SELECTOR. . . . . INT 1000 ∿
ATTENUATOR . . . . 1 VOLT range
VERNIER . . . . 1 volt
Meter mechanical zero . . . . par. 4-29
MODULATION AMPLITUDE meter. . . 50% on

b. Connect the RF OUT output, properly terminated, to the vertical input terminals of an oscilloscope such as an ⓗ Model 150A. If a lower frequency oscilloscope is used it may be necessary to set the Model 606A to a lower frequency.

c. Synchronize pattern internally so that several modulation cycles are visible on the screen.

d. Set the MODULATION SELECTOR to CW.

e. Adjust the sensitivity control on the oscilloscope until the pattern is exactly 4 centimeters high. Do not use the 3 VOLTS range on the Model 606A.

f. Switch the MODULATION SELECTOR to INT 1000 ∿ .

g. Set PERCENTAGE MODULATION meter to 50% with the MODULATION AMPLITUDE control. The pattern on the screen should now be 6 centimeters high at the peaks and 2 centimeters high at the troughs (see figure 4-3). If pattern is not exactly three times as high at the peaks as at the troughs, adjust the MODULATION AMPLITUDE control until it is. The Model 606A is now modulating exactly 50%.

h. Adjust Mod. Cal. (R67) control until PERCENTAGE MODULATION meter reads 50%. This control is second from the front in the row of five controls on the modulation chassis.

i. Set ATTENUATOR VERNIER to 0.2 VOLTS.

j. Repeat steps d to g. If the reading on the PERCENTAGE MODULATION meter is not 50 ± 5% adjust MODULATION AMPLITUDE until it is. Now adjust Carrier Zero Set (R35) slightly until the pattern on the oscilloscope is as in step g. Recheck MAXIMUM CARRIER SET paragraph 4-47 resetting R60 if necessary.

4-49. RF OUTPUT METER CALIBRATION.

a. Check the output meter zero adjustment (see paragraph 4-29).

b. Connect ac probe of Model 410B High Frequency VTVM (1 volt range) to the end of the output termination using a UG-290/U connector. Solder tip of 410B ac probe to center conductor of connector (see figure 4-5). Insert connector into OUTPUT connector of output termination.

c. Set ATTENUATOR VERNIER so that the Model 606A output meter reads 0.9 volt rms.

d. Rotate the FREQUENCY dial and RANGE switch through all frequencies, keeping the reading on the Model 606A output meter at 0.9 volt. Record the lowest and highest readings on the Model 410B.

e. Determine the average of the two readings recorded in step d.

f. Set the FREQUENCY dial and RANGE switch to a frequency that will give this average reading on the Model 410B.

g. Set attenuator vernier so that the Model 410B reads 0.9 volt.

h. Set the output meter to read 0.9 volts by adjusting Output Cal. control (R37).

4-50. ATTENUATOR REPAIR.

4-51. The ⓗ 606A-34B output attenuator is a precision device. It is held to rigid electrical and mechanical specifications during manufacture. Testing of the attenuator is extremely involved; it requires special equipment and techniques which are not normally available. It is recommended that the attenuator be returned to the factory for necessary repair.

4-52. ADJUST FEEDBACK RELAY.

4-53. Set ATTENUATOR to 3 VOLTS. Feedback relay K1 should operate, increasing the output to 3 volts. If the relay does not operate, complete the following procedure:

a. Clip an hp Model 428A/B Clip-On Milliammeter probe over the lead going to the coil of relay, K1. If a Model 428A/B is not available, unsolder the lead and insert a conventional 10 ma dc milliammeter.

b. Set ATTENUATOR to 3 VOLTS range. The current through the relay should be a nominal 5.5 ma. If the current is not approximately this value, check the +300 volts supply and C26, C27, R27, R28 and R46. If this current does not operate the relay, fix or replace the relay. If the relay operates but the output does not increase to 3 volts, check R25, R26 and the entire feedback loop.

4-54. DRIVE CABLE ASSEMBLY REPLACEMENT.

4-55. Replacement of the drive cable assembly (hp stock number 606A-18) requires only the removal of the old drive cable assembly and winding the replacement drive cable onto the idler shaft, tuner pulley, and drive pulley. An adjustment of the drive cable assembly is made to obtain proper rotation of the frequency dial and tuner plates. No special tools are required. Following is the installation procedure:

a. Disconnect power. Remove cabinet and rf generator shield.

b. Turn instrument upside-down and remove the aluminum shielding plate between the rf oscillator and rf amplifier.

c. Refer to figure 4-6. Loosen the two setscrews in the spring load nut and the one setscrew in the end of the drive pulley.

d. Remove old drive cable assembly.

e. Push end of replacement drive cable nearest drive collar over tuner pulley. Press the drive collar into the notch in tuner pulley.

f. Wrap the short end of drive cable around the tuner pulley as shown in figure 4-6. Attach end of

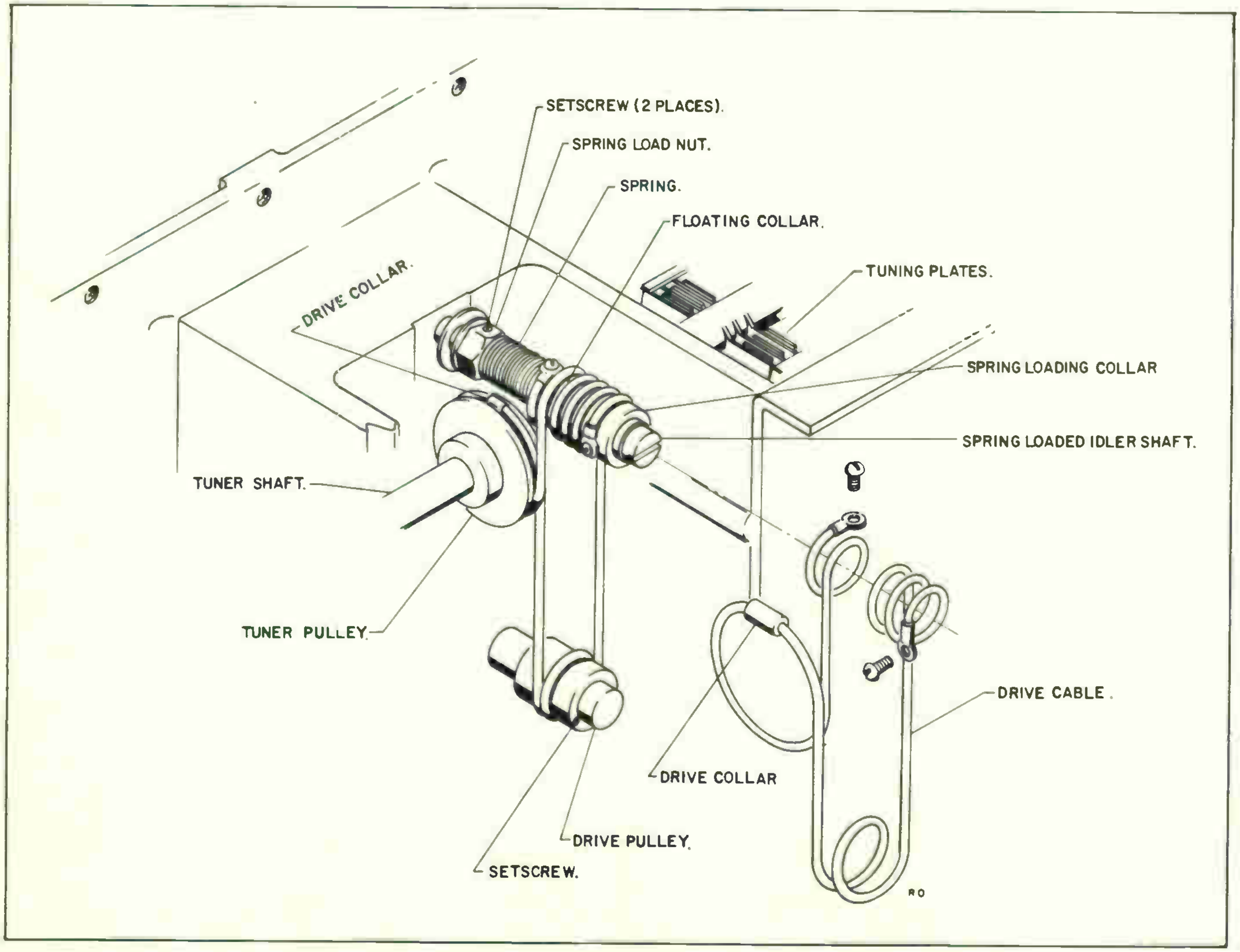


Figure 4-6. Installation of Drive Cable Assembly

cable to the floating collar on the spring loaded idler shaft with 4-40 x 1/4 inch round-head machine screw.

g. Wind two full turns of the drive cable onto the floating collar. Be sure the spring load nut is positioned so that one of the setscrews is accessible. Place a 9/16 inch open-end wrench over the spring load nut to prevent its turning.

h. Wrap one and a half turns of the drive cable around the drive pulley as shown in figure 4-6.

i. Rotate the spring-loaded idler shaft so that the number 4-40 screw hole in the spring-loading collar is accessible.

j. Attach the long end of drive cable to the spring loading collar using the 4-40 x 1/4 round-head machine screw.

k. Place a screwdriver in the slot at end of the spring-loaded idler shaft and rotate shaft counterclockwise to remove slack in drive cable. Continue to hold spring-load nut with end wrench.

m. Tighten one setscrew in the spring-load nut and remove end wrench.

n. Turn frequency dial to approximately mid-range and seat cable in the slot on the drive pulley.

p. Holding spring-load nut with 9/16 inch open-end wrench, loosen the previously tightened setscrew in spring-load nut and turn spring-loaded idler shaft counterclockwise to a torque of approximately 7 inch-pounds. Retighten setscrew and remove wrench.

q. Hold frequency dial against its low frequency stop. Slip the drive cable on the drive pulley by turning the spring-loaded idler shaft with screwdriver. Turn the idler shaft until both tuning capacitors are fully meshed.

r. Tighten the 4-40 allen setscrew in drive pulley.

s. Rotate frequency dial through its range and observe position of drive cable.

t. Check dial calibration as outlined in para. 4-16.

u. Replace aluminum shielding plate between the rf oscillator and rf amplifier.

v. Turn instrument right-side up. Replace rf generator shield and cabinet. This completes the procedure.

4-56. PERFORMANCE CHECK.

4-57. The following procedures check performance and verify proper operation of the Model 606A.

4-58. FREQUENCY CALIBRATION.

a. Set line voltage to 115 volts.

b. Perform operations listed in paragraph 4-17.

c. Repeat this procedure with line voltage set at 102.5 volts and 127.5 volts.

4-59. OUTPUT.

a. With line voltage set at 115 volts perform operations indicated in paragraph 4-18.

b. Rotate output meter RANGE switch through each position, adjusting output control at each setting. Output should be adjustable from zero to full scale in each position of the range switch.

c. Repeat steps a and b with line voltage set at 102.5 volts and 127.5 volts.

d. To check output impedance switch VTVM to 3 volt range.

e. Adjust Model 606A output to read 1 volt on VTVM at 20 mc.

f. Remove the 50 ohm load. Output voltage should rise to 2 volts ±0.1 volt.

g. Set Model 606A FREQUENCY dial to 65 mc and reconnect the 50 ohm load.

h. Reset output to 1 volt as indicated by VTVM.

i. Remove 50 ohm load. Output should rise to 2 volts ±0.2 volt.

4-60. MODULATION.

a. Perform procedure outlined in paragraph 4-15 with line voltage set at 115 volts.

b. Rotate FREQUENCY dial through all ranges; observe envelope pattern for distortion and squegging.

c. Repeat steps a and b with line voltage set at 102.5 volts and 127.5 volts.

d. Reset line voltage to 115 volts.

e. To check external modulation set MODULATION SELECTOR to EXT.AC.

f. Turn MODULATION AMPLITUDE control fully clockwise.

g. Set FREQUENCY control to 15 mc.

h. Connect an audio oscillator (20 cps to 20 kc) to MODULATION input jack of Model 606A and SYNC input of oscilloscope.

i. Adjust the audio oscillator to produce a signal of 4.5 volts peak. PERCENT MODULATION meter of Model 606A should indicate at least 100%.

j. Repeat steps e to i with line voltage set at 102.5 volts and 127.5 volts.

4-61. FREQUENCY DRIFT.

a. Allow Model 606A to warm up for at least one hour.

b. Set FREQUENCY control to 1 mc.

c. Monitor output of Model 606A with a counter for 10 minutes. Frequency drift should be less than 50 cycles over the 10 minute period.

SCHEMATIC DIAGRAM NOTES

1. Heavy solid line shows main signal path; heavy dashed line shows control, secondary signal, or feedback path.
2. Heavy box indicates front-panel engraving.
3. Arrows on potentiometers indicate clockwise rotation as viewed from the round shaft end; counterclockwise from the rectangular shaft end.
4. Resistance values in ohms, inductance in microhenry, and capacitance in picofarads unless otherwise specified.
5. Rotary switch schematic are electrical representations; for exact switching details refer to the switch assembly drawings.
6. Relays shown in condition prevailing during normal instrument operation.
7. ǂ indicates a selected part. See table of replaceable parts (section V).
8. Interconnecting parts and assemblies are shown on cable diagram.
9. * indicates factory adjustment. Part may be omitted.

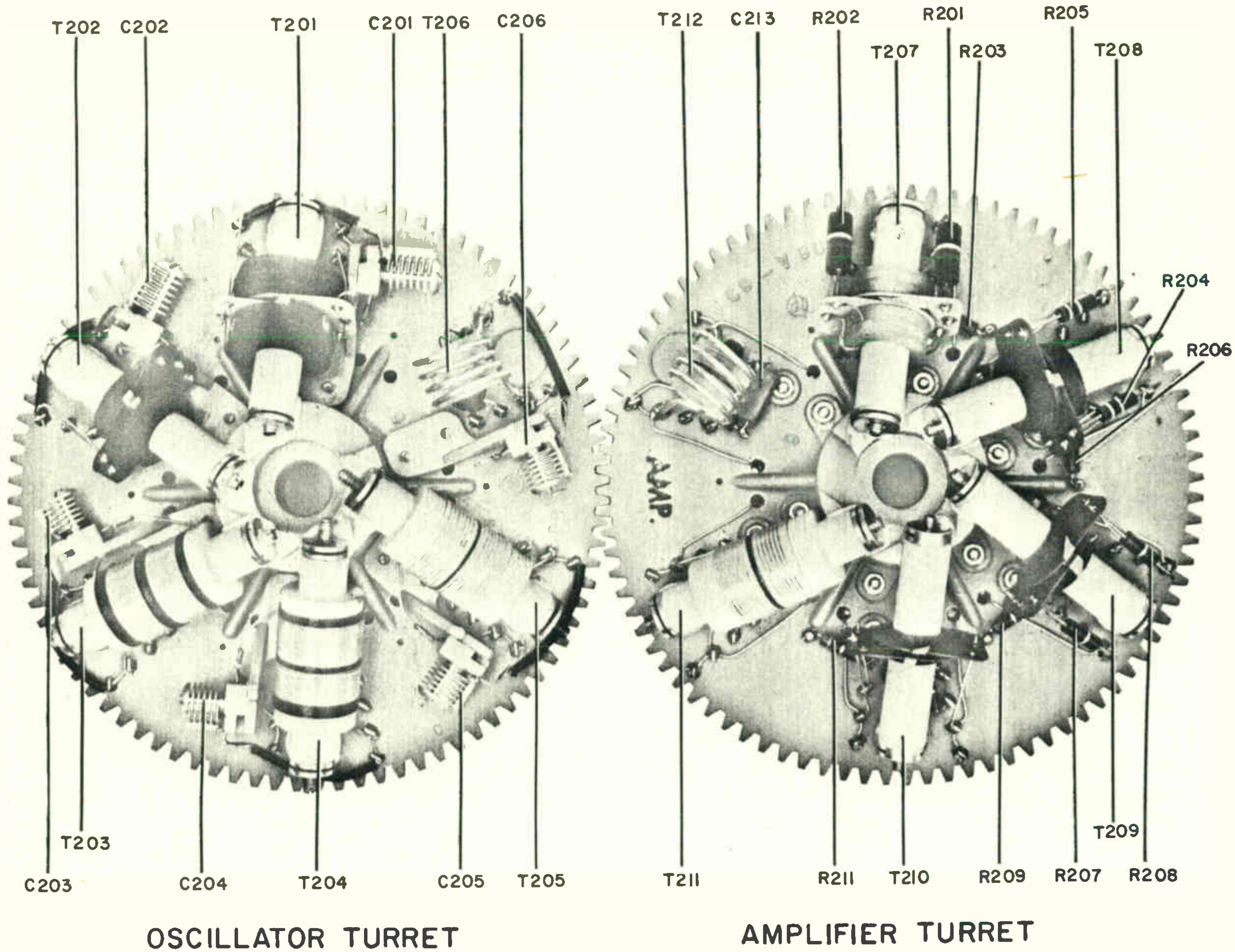
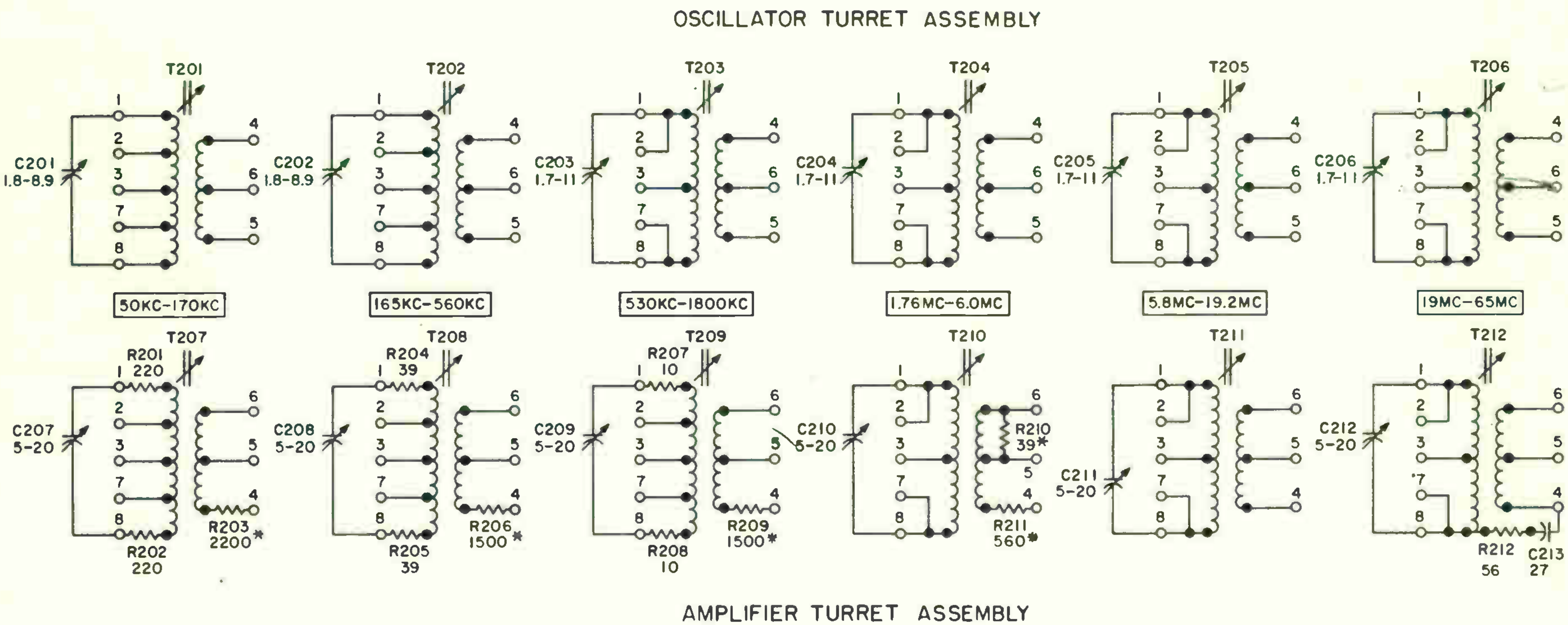
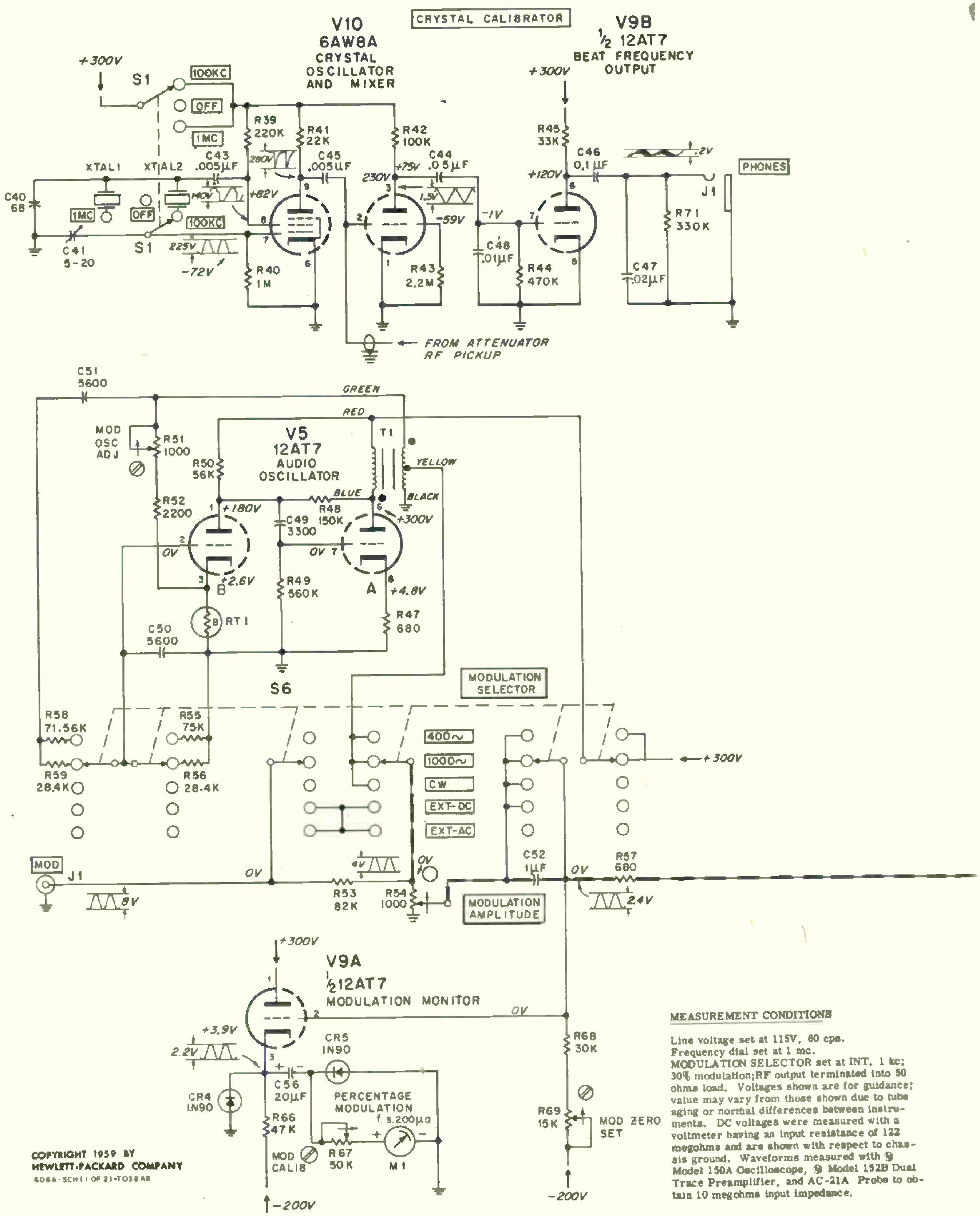


Figure 4-7. Oscillator and Amplifier Turrets viewed from Front Panel



606A-OAT-T036A

Figure 4-8. Oscillator and Amplifier Turrets Schematic



MEASUREMENT CONDITIONS

Line voltage set at 115V, 60 cps. Frequency dial set at 1 mc. MODULATION SELECTOR set at INT. 1 kc; 30% modulation; RF output terminated into 50 ohms load. Voltages shown are for guidance; value may vary from those shown due to tube aging or normal differences between instruments. DC voltages were measured with a voltmeter having an input resistance of 122 megohms and are shown with respect to chassis ground. Waveforms measured with ℏ Model 150A Oscilloscope, ℏ Model 152B Dual Trace Preamplifier, and AC-21A Probe to obtain 10 megohms input impedance.

Figure 4-9. Signal Generator (Sheet 1 of 2)

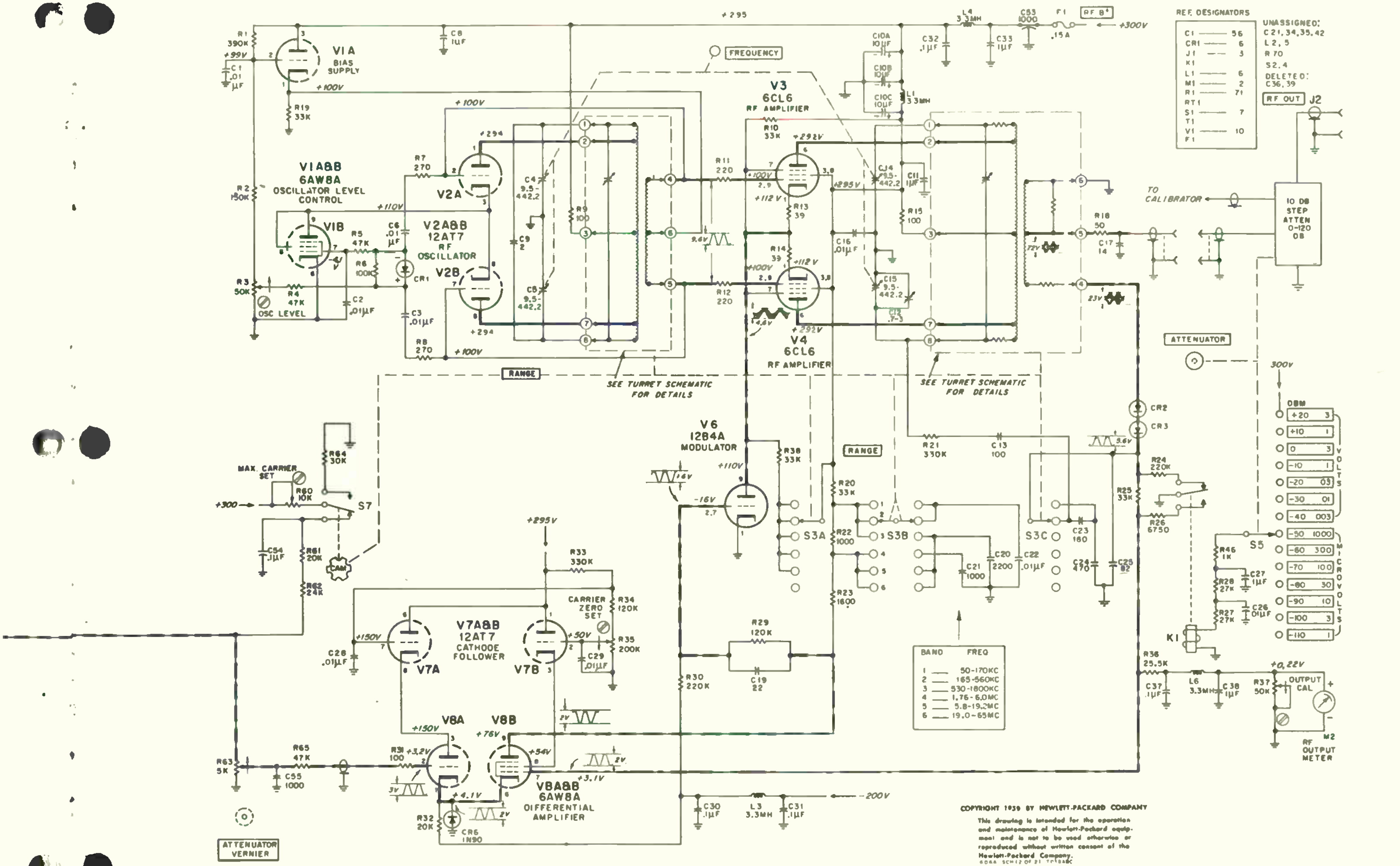


Figure 4-9. Signal Generator (Sheet 2 of 2)

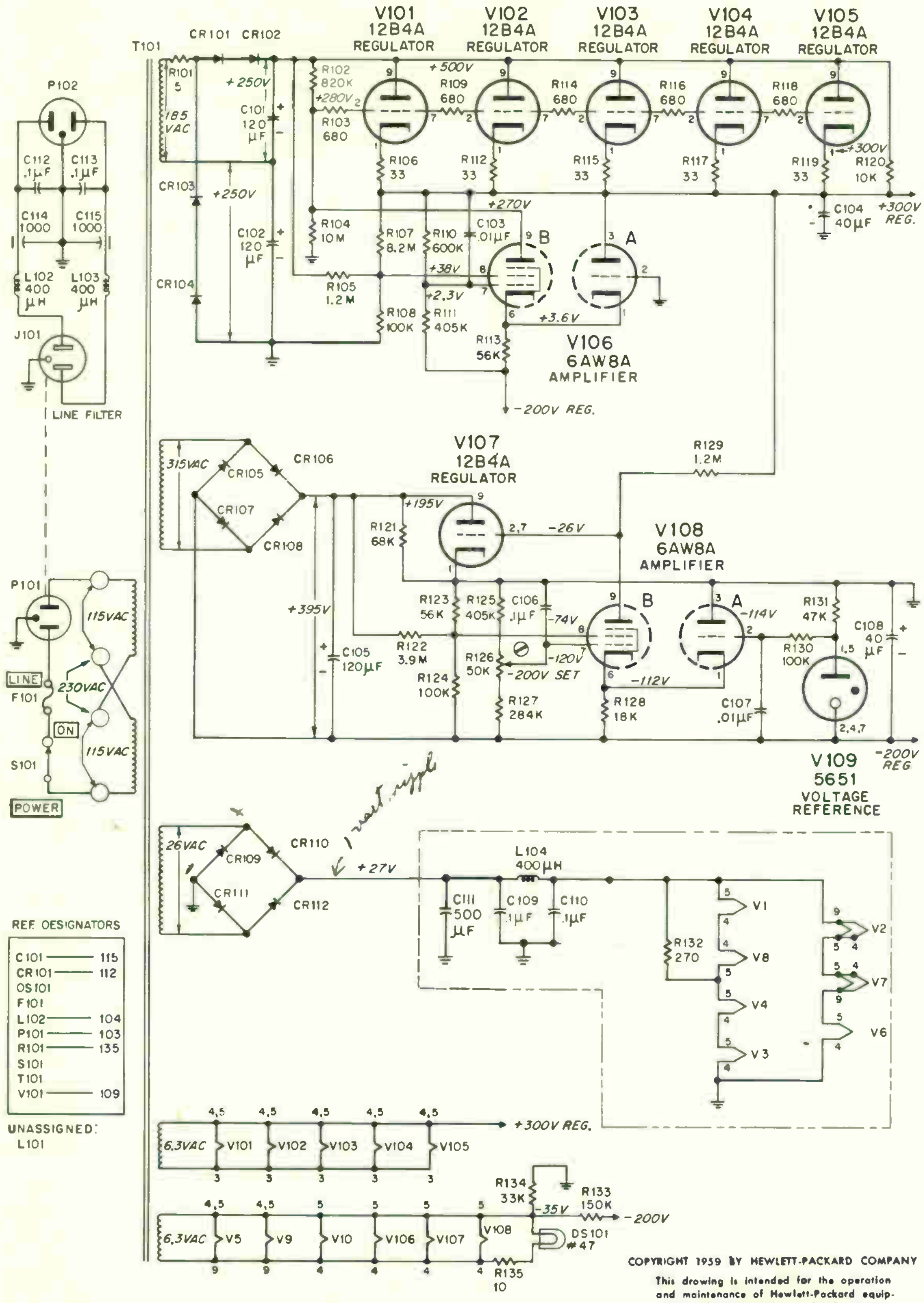


Figure 4-10. Power Supply

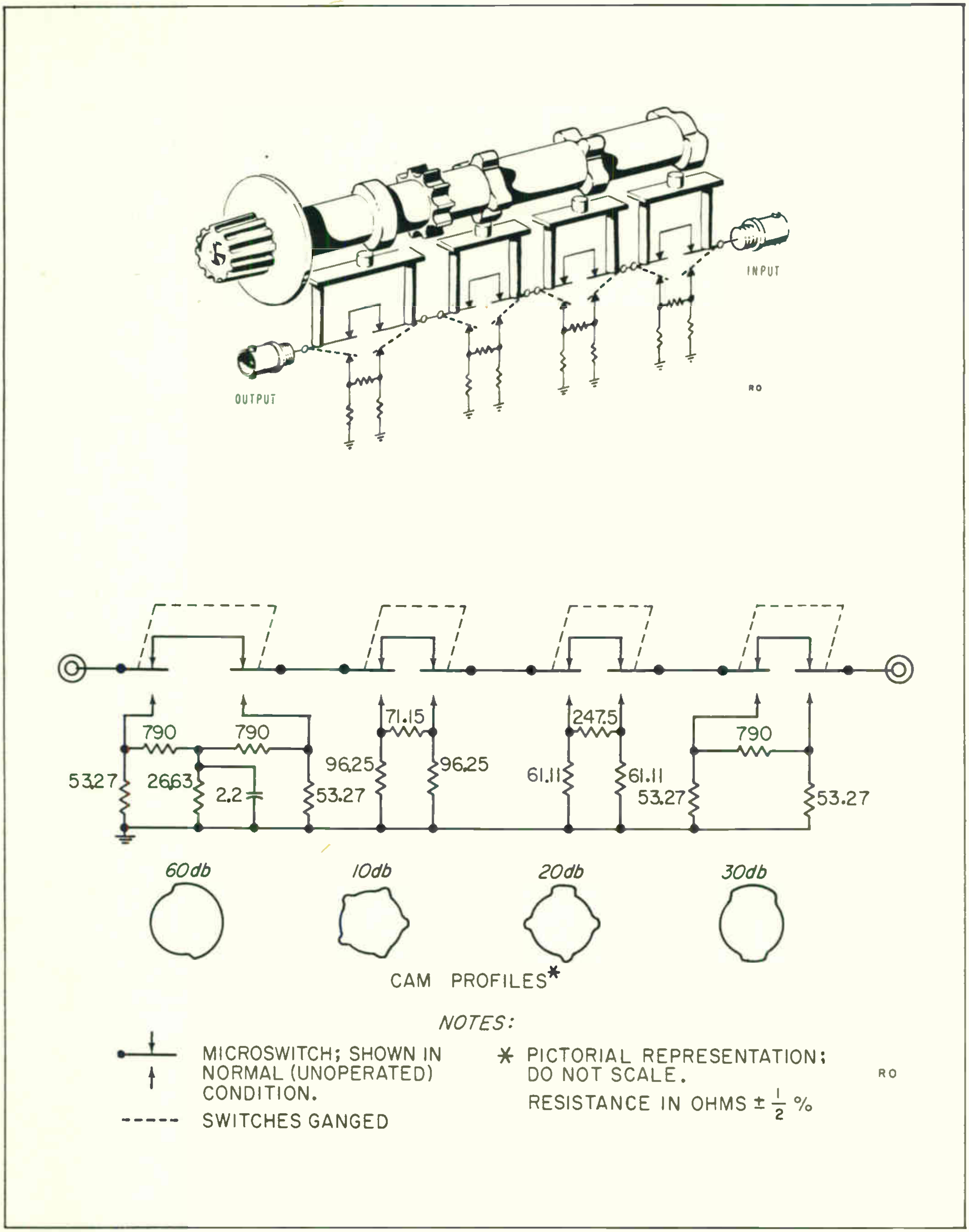


Figure 4-11. Model 606A Output Attenuator

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION.

5-2. This section contains information for ordering replacement parts for the Model 606A, High Frequency Signal Generator.

5-3. Table 5-1 lists replaceable parts in alphanumerical order of their reference designators. Detailed information on a part used more than once in the instrument is listed opposite the first reference designator applying to the part. Other reference designators applying to the same part refer to the initial designator. Miscellaneous parts are included at the end of the list. Detailed information includes the following:

a. Reference designator.

b. Full description of the part.

c. Manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

d. Hewlett-Packard stock number.

e. Total quantity used in the instrument (TQ col).

f. Recommended spare quantity for complete maintenance during one year of isolated service (RS col).

5-4. ORDERING INFORMATION.

5-5. To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales office or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S. A.
Rue du Vieux Billard No. 1
Geneva, Switzerland

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 table 5-1, give a complete description of the part and include its function and location.

Table 5-1. Replaceable Parts

Ckt Ref.	Description	Mfr	hp Stock No.	TQ	RS		
A1	Assembly, attenuator	28480	606A-34B	1	1		
A2	Assembly, oscillator turret, includes: C201 thru C206 T201 thru T206	28480	606A-42B	1	0		
A3	Assembly, amplifier turret, includes: C207 thru C213 R201 thru R212 T207 thru T212	28480	606A-42A	1	0		
C1 thru 3	Capacitor: fixed, ceramic, 10,000 pf ± 20%, 1000 vdcw	71590	0150-0012	10	3		
C4, 5	Capacitor: variable, air, 2 sections, 9.5 to 443.2 pf	76854	0121-0027	2	1		
C6	Same as C1						
C7	Not assigned						
C8	Capacitor: fixed, mylar, 0.1 μf ± 20%, 600 vdcw	09134	0170-0022	14	3		
C9	Capacitor: fixed, ceramic, 2 pf ± 1 pf, 500 vdcw	72982	0150-0025	1	1		

Table 5-1. Replaceable Parts (Con'd)

Ckt Ref.	Description	Mfr *	ⓗⓟ Stock No.	TQ*	RS*		
C10A,B,C	Capacitor: fixed, electrolytic, 3 sections, 10 μf/ section -10%/+50%, 450 vdcw	37942	0180-0016	1	1		
C11	Same as C8						
C12	Capacitor: variable, polystyrene, 0.7 to 3.0 pf	72982	0132-0003	1	1		
C13	Capacitor: fixed, mica, 100 pf ± 5%, 500 vdcw	76433	0140-0041	1	1		
C14, 15	Capacitor: variable, air, 2 sections 9.5 to 443.2 pf	76854	0121-0026	2	1		
C16	Same as C1						
C17	Capacitor: fixed, ceramic, 14 pf ± 3%, 500 vdcw	72982	0150-0056	1	1		
C18	Not assigned						
C19	Capacitor: fixed, mica, 22 pf ± 5%, 500 vdcw	00853	0140-0034	1	1		
C20	Capacitor: fixed, mica, 2200 pf ± 10%, 500 vdcw	00853	0140-0024	1	1		
C21	Capacitor: fixed, mica, 1000 pf ± 5%, 500 vdcw	00656	0140-0079	1	1		
C22	Capacitor: fixed, mica, 10,000 pf ± 10%, 300 vdcw	00853	0140-0008	1	1		
C23	Capacitor: fixed, mica, 180 pf ± 10%, 500 vdcw	00853	0140-0023	1	1		
C24	Capacitor: fixed, mica, 470 pf ± 10%, 500 vdcw	00853	0140-0027	1	1		
C25	Capacitor: fixed, mica, 82 pf ± 5%, 300 vdcw	72136	0140-0146	1	1		
C26	Same as C1						
C27	Same as C8						
C28, 29	Same as C1						
C30 thru C33	Same as C8						
C34 thru C36	Not assigned						
C37, 38	Same as C8						
C39	Not assigned						

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	hp Stock No.	TQ*	RS*		
C40	Capacitor: fixed, mica, 68 pf ± 5%, 500 vdcw	00853	0140-0082	1	1		
C41	Capacitor: variable, ceramic, 5 to 20 pf, 500 vdcw	72982	0130-0006	7	2		
C42	Not assigned						
C43	Capacitor: fixed, ceramic, 0.005 µf, 500 vdcw	96095	0150-0014	2	1		
C44	Capacitor: fixed, ceramic, 0.05 µf ± 20%, 400 vdcw	05729	0150-0052	1	1		
C45	Same as C43						
C46	Same as C8						
C47	Capacitor: fixed, ceramic, 20,000 pf +80% -20%, 600 vdcw	91418	0150-0024	1	1		
C48	Same as C1						
C49	Capacitor: fixed, paper, 0.0033 µf ± 10%, 600 vdcw	56289	0160-0008	1	1		
C50, 51	Capacitor: fixed, mica, 5600 pf ± 1%, 500 vdcw	00656	0140-0071	2	1		
C52	Capacitor: fixed, mylar, 1 µf ± 5%, 200 vdcw	84411	0170-0018	1	1		
C53	Capacitor: fixed, ceramic, 1000 pf ± 25%, 500 vdcw	96095	0150-0005	1	1		
C54	Same as C8						
C55	Capacitor: fixed, mica, 1000 pf ± 10%, 500 vdcw	76433	0140-0003	1	1		
C56	Capacitor: fixed, electrolytic, 20 µf, 25 vdcw	56289	0180-0045	1	1		
C57 thru C100	Not assigned						
C101, 102	Capacitor: fixed, electrolytic, 2 sections 120 x 40 µf, 450 vdcw	56289	0180-0030	3	1		
C103	Same as C16						
C104	Component not separately replaceable; part of C101						
C105	Same as C101						
C106	Same as C8						
C107	Same as C1						

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	Stock No.	TQ*	RS*		
C108	Component not separately replaceable; part of C105						
C109, 110	Same as C8						
C111	Capacitor: fixed, electrolytic, 500 μf, 75 vdcw	56289	0180-0047	1	1		
C112, 113	Capacitor: fixed, paper, 0.1 μf ± 10%, 600 vdcw	56289	0160-0001	2	1		
C114, 115	Capacitor: fixed, ceramic, 1000 pf ± 20%, 500 vdcw	72982	0150-0019	2	1		
C116 thru C200	Not assigned						
C201, 202	Capacitor: variable, air, 1.8 to 8.9 pf. Includes mounting bracket	28480	606A-95C	2	1		
C203 thru C206	Capacitor: variable, air, 1.7 to 11 pf. Includes mounting bracket	28480	606A-95B	4	1		
C207 thru C212	Same as C41						
C213	Capacitor: fixed, mica, 27 pf ± 5%, 500 vdcw	76433	0140-0042	1	1		
CR1 thru CR3	Diode, germanium	73293	1910-0011	3	3		
CR4 thru CR6	Diode, germanium: 1N90	73293	1910-0004	3	3		
CR7 thru CR100	Not assigned						
CR101 thru CR108	Diode, silicon: SD 500, 400 P. I. V., 500 ma	81483	1901-0007	8	8		
CR109 thru 112	Diode, silicon: SD 91A, 100 P. I. V., 500 ma	81483	1901-0008	4	4		
DS1 thru DS100	Not assigned						
DS101	Lamp, incandescent: 6 to 8 volt, 0.15 amp	24455	2140-0009	1	1		
F1	Fuse, cartridge, slow blow: 0.15 amp	71400	2110-0017	1	10		
F2 thru F100	Not assigned						
F101	Fuse, cartridge, slow blow: 2 amp (115 volt operation)	71400	2110-0006	1	10		
	Fuse, cartridge, slow blow: 1 amp (230 volt operation)	71400	2110-0007				

* See introduction to this section

Table 5-1 Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	hp Stock No.	TQ*	RS*		
J1	Jack, telephone	82389	1251-0071	1	1		
J2	Component not separately replaceable; part of A1 assembly						
J3	Connector: female, BNC	91737	1250-0001	1	1		
J4 thru J100	Not assigned						
J101	Connector, power: 2 female contacts	75382	1251-0095	1	1		
K1	Relay, armature: SPDT, 5000 ohms	77342	0490-0018	1	1		
L1	Coil: RF, 3.3 mh	09250	9140-0052	4	1		
L2	Not assigned						
L3, 4	Same as L1						
L5	Coil: 400 mh ± 5%	09250	9140-0051	4	1		
L6	Same as L1						
L7 thru L101	Not assigned						
L102 thru L104	Same as L5						
M1	Meter: MODULATION	77221	1120-0075	1	1		
M2	Meter, output	77221	1120-0074	1	1		
P1 thru P100	Not assigned						
P101	Power, cord: with NEMA plug, 24 in. long	70903	8120-0045	1	1		
P102	Power, cord: with NEMA plug, 7 ft, 6 in. long	70903	8120-0015	1	1		
R1	Resistor: fixed, composition, 390,000 ohms ± 10%, 1 watt	01121	0690-3941	1	1		
R2	Resistor: fixed, composition, 150,000 ohms ± 10%, 1 watt	01121	0690-1541	1	1		
R3	Resistor: variable, composition, linear taper, 50,000 ohms ± 20%, 1/4 watt	11237	2100-0141	4	1		
R4, 5	Resistor: fixed, composition, 47,000 ohms ± 10%, 1/2 watt	01121	0687-4731	4	1		
R6	Resistor: fixed, composition, 100,000 ohms ± 10%, 1/2 watt	01121	0687-1041	5	2		

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	hp Stock No.	TQ*	RS*		
R7, 8	Resistor: fixed, composition, 270 ohms ± 10%, 1/2 watt	01121	0687-2711	2	1		
R9	Resistor: fixed, composition, 100 ohms ± 10%, 1/2 watt	01121	0687-1011	3	1		
R10	Resistor: fixed, composition, 33,000 ohms ± 10%, 2 watts	01121	0693-3331	4	1		
R11, 12	Resistor: fixed, composition, 220 ohms ± 10%, 1/2 watt	01121	0687-2211	2	1		
R13, 14	Resistor: fixed, composition, 39 ohms ± 10%, 1/2 watt	01121	0687-3901	5	2		
R15	Same as R9						
R16, 17	Not assigned						
R18	Resistor: fixed, deposited carbon, 50 ohms ± 1%, 1/2 watt	19701	0727-0023	1	1		
R19	Resistor: fixed, composition, 33,000 ohms ± 10%, 1 watt	01121	0690-3331	1	1		
R20	Same as R10						
R21	Resistor: fixed, composition, 330,000 ohms ± 10%, 1/2 watt	01121	0687-3341	2	1		
R22	Resistor: fixed, composition, 1000 ohms ± 5%, 1/2 watt	01121	0686-1025	1	1		
R23	Resistor: fixed, composition, 1600 ohms ± 5%, 1/2 watt	01121	0686-1625	1	1		
R24	Resistor: fixed, composition, 220,000 ohms ± 10%, 1/2 watt	01121	0687-2241	2	1		
R25	Resistor: fixed, deposited carbon, 33,000 ohms ± 1%, 1 watt	19701	0730-0048	1	1		
R26	Resistor: fixed, deposited carbon, 6750 ohms ± 1%, 1/2 watt	19701	0727-0144	1	1		
R27, 28	Resistor: fixed, composition, 27,000 ohms ± 10%, 2 watts	01121	0693-2731	2	1		
R29	Resistor: fixed, composition, 120,000 ohms ± 10%, 1 watt	01121	0690-1241	2	1		
R30	Resistor: fixed, composition, 220,000 ohms ± 10%, 1 watt	01121	0690-2241	1	1		
R31	Same as R9						
R32	Resistor: fixed, wirewound, 20,000 ohms ± 10%, 10 watts	35434	0816-0018	1	1		

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	℔ Stock No.	TQ*	RS*		
R33	Resistor: fixed, composition, 330,000 ohms ± 10%, 1 watt	01121	0690-3341	1	1		
R34	Same as R29						
R35	Resistor: variable, composition, 200,000 ohms ± 10%	11237	2100-0016	1	1		
R36	Resistor: fixed, deposited carbon, 25,500 ohms ± 1%, 1/2 watt	19701	0727-0180	1	1		
R37	Same as R3						
R38	Same as R10						
R39	Same as R24						
R40	Resistor: fixed, composition, 1 megohm ± 10%, 1/2 watt	01121	0687-1051	1	1		
R41	Resistor: fixed, composition, 22,000 ohms ± 10%, 1/2 watt	01121	0687-2231	1	1		
R42	Same as R6						
R43	Resistor: fixed, composition, 2.2 megohms ± 10%, 1/2 watt	01121	0687-2251	1	1		
R44	Resistor: fixed, composition, 470,000 ohms ± 10%, 1/2 watt	01121	0687-4741	1	1		
R45	Same as R10						
R46	Resistor: fixed, composition, 1,000 ohms ± 10%, 1/2 watt	01121	0687-1021	1	1		
R47	Resistor: fixed, composition, 680 ohms ± 10%, 1/2 watt	01121	0687-6811	6	2		
R48	Resistor: fixed, composition, 150,000 ohms ± 10%, 1/2 watt	01121	0687-1541	2	1		
R49	Resistor: fixed, composition, 560,000 ohms ± 10%, 1/2 watt	01121	0687-5641	1	1		
R50	Resistor: fixed, composition, 56,000 ohms ± 10%, 1 watt	01121	0690-5631	1	1		
R51	Resistor: variable, composition, linear taper, 1000 ohms	71590	2100-0036	1	1		
R52	Resistor: fixed, composition, 22,000 ohms ± 10%, 1/2 watt	01121	0687-2221	2	1		
R53	Resistor: fixed, composition, 82,000 ohms ± 10%, 1/2 watt	01121	0687-8231	1	1		
R54	Part of S6, component not separately replaceable						

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	hp Stock No.	TQ*	RS*		
R55	Resistor: fixed, deposited carbon, 75,000 ohms ± 1%, 1 watt	19701	0730-0058	1	1		
R56	Resistor: fixed, deposited carbon, 28,400 ohms ± 1%, 1/2 watt	19701	0727-0184	2	1		
R57	Resistor: fixed, deposited carbon, 680 ohms ± 1%, 1/2 watt	19701	0727-0085	1	1		
R58	Resistor: fixed, deposited carbon, 71,560 ohms ± 1%, 1/2 watt	19701	0727-0201	1	1		
R59	Same as R56						
R60	Resistor: variable, wirewound, 10,000 ohms ± 20%, 2 watts	11237	2100-0053	2	1		
R61	Resistor: fixed, metal film, 20,000 ohms ± 10%, 4 watts	07115	0771-0004	1	1		
R62	Resistor: fixed, metal film, 24,000 ohms ± 10%, 4 watts	07115	0771-0005	1	1		
R63	Resistor: variable, wirewound, linear taper, 5000 ohms ± 10%, 2 watts	11237	2100-0225	1	1		
R64	Resistor: fixed, wirewound, 30,000 ohms ± 5%, 10 watts	35434	0815-0001	1	1		
R65	Same as R4						
R66	Resistor: fixed, composition, 47,000 ohms ± 10%, 2 watts	01121	0693-4731	1	1		
R67	Same as R3						
R68	Resistor: fixed, metal film, 30,000 ohms ± 10%, 4 watts	07115	0771-0007	1	1		
R69	Same as R60						
R70	Not assigned						
R71	Same as R21						
R72 thru R100	Not assigned						
R101	Resistor: fixed, wirewound, 5 ohms ± 10%, 5 watts	94310	0813-0017	1	1		
R102	Resistor: fixed, composition, 820,000 ohms ± 10%, 1/2 watt	01121	0687-8241	1	1		
R103	Same as R47						
R104	Resistor: fixed, composition, 10 megohms ± 10%, 1/2 watt	01121	0687-1061	1	1		

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	ⓗⓟ Stock No.	TQ*	RS*		
R105	Resistor: fixed, composition, 1.2 megohms ± 10%, 1/2 watt	01121	0687-1251	1	1		
R106	Resistor: fixed, composition, 33 ohms ± 10%, 1/2 watt	01121	0687-3301	5	2		
R107	Resistor: fixed, composition, 8.2 megohms ± 10%, 1/2 watt	01121	0687-8251	1	1		
R108	Same as R6						
R109	Same as R47						
R110	Resistor: fixed, deposited carbon, 600,000 ohms ± 1%, 1/2 watt	19701	0727-0246	1	1		
R111	Resistor: fixed, deposited carbon, 405,000 ohms ± 1%, 1/2 watt	19701	0727-0240	2	1		
R112	Same as R106						
R113	Resistor: fixed, composition, 56,000 ohms ± 10%, 2 watts	01121	0693-5631	1	1		
R114	Same as R47						
R115	Same as R106						
R116	Same as R47						
R117	Same as R106						
R118	Same as R47						
R119	Same as R106						
R120	Resistor: fixed, wirewound, 10,000 ohms ± 10%, 10 watts	35434	0816-0008	1	1		
R121	Resistor: fixed, composition, 68,000 ohms ± 10%, 1/2 watt	01121	0687-6831	1	1		
R122	Resistor: fixed, composition, 3.9 megohms ± 10%, 1/2 watt	01121	0687-3951	1	1		
R123	Resistor: fixed, composition, 56,000 ohms ± 10%, 1/2 watt	01121	0687-5631	1	1		
R124	Same as R6						
R125	Same as R111						
R126	Same as R3						
R127	Resistor: fixed, deposited carbon, 284,000 ohms ± 1%, 1/2 watt	19701	0727-0230	1	1		
R128	Resistor: fixed, composition, 18,000 ohms ± 10%, 1 watt	01121	0690-1831	1	1		

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	ⓗⓟ Stock No.	TQ*	RS*		
R129	Resistor: fixed, composition, 1.2 megohms ± 10%, 1 watt	01121	0690-1251	1	1		
R130	Same as R6						
R131	Same as R4						
R132	Resistor: fixed, composition, 270 ohms ± 10%, 1 watt	01121	0690-2711	1	1		
R133	Same as R48						
R134	Resistor: fixed, composition, 33,000 ohms ± 10%, 1/2 watt	01121	0687-3331	1	1		
R135	Resistor: fixed, composition, 10 ohms ± 10%, 1 watt	01121	0690-1001	1	1		
R136 thru R200	Not assigned						
R201, 202	Resistor: fixed, composition, 220 ohms ± 10%, 1 watt	01121	0690-2211	2	1		
R203	Same as R52						
R204, 205	Same as R13						
R206	Resistor: fixed, composition, 1,500 ohms ± 10%, 1/2 watt	01121	0687-1521	2	1		
R207, 208	Resistor: fixed, composition, 10 ohms ± 10%, 1/2 watt	01121	0687-1001	2	1		
R209	Same as R206						
R210	Same as R13. Optimum value selected at factory, average value shown						
R211	Resistor: fixed, composition, 560 ohms ± 10%, 1/2 watt. Optimum value selected at factory, average value shown	01121	0687-5611	1	1		
R212	Resistor: fixed, composition, 56 ohms ± 10%, 1/2 watt	01121	0687-5601	1	1		
RT1	Lamp, incandescent: 250 volts, 10 watts	24455	2140-0007	1	1		
S1	Switch, toggle: DPDT	04009	3101-0012	1	1		
S2	Not assigned						
S3	Switch, rotary: 2 section, 6 position	76854	3100-0197	1	1		
S4	Not assigned						

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	hp Stock No.	TQ*	RS*		
S5	Switch, wafer	76854	3100-0189	1	1		
S6	Switch, rotary: 1 section, 5 position	76854	3100-0190	1	1		
S7	Switch, sensitive: SPDT	91929	3102-0010	1	1		
S8 thru S100	Not assigned						
S101	Switch, toggle: SPST	04009	3101-0030	1	1		
T1	Transformer, audio	98734	9120-0036	1	1		
T2 thru T100	Not assigned						
T101	Transformer, power	98734	9100-0101	1	1		
T102 thru T200	Not assigned						
T201	Transformer, oscillator: 50 to 170 kc	28480	606A-60A	1	1		
T202	Transformer, oscillator: 165 to 560 kc	28480	606C-60C	1	1		
T203	Transformer, oscillator: 530 to 1800 kc	28480	606A-60E	1	1		
T204	Transformer, oscillator: 1.76 to 6.0 mc	28480	606A-60G	1	1		
T205	Transformer, oscillator: 5.8 to 19.2 mc	28480	606A-60J	1	1		
T206	Transformer, oscillator: 19 to 65 mc, consists of: Primary coil	28480	606A-60L	2	1		
	Secondary coil	28480	606A-60M	1	1		
T207	Transformer, amplifier: 50 to 170 kc	28480	606A-60B	1	1		
T208	Transformer, amplifier: 165 to 560 kc	28480	606A-60D	1	1		
T209	Transformer, amplifier: 530 to 1800 kc	28480	606A-60F	1	1		
T210	Transformer, amplifier: 1.76 to 60 mc	28480	606A-60H	1	1		
T211	Transformer, amplifier: 5.8 to 19.2 mc	28480	606A-60K	1	1		
T212	Transformer, amplifier: 19 to 65 mc, consists of: Primary coil (same as T206)						
	Secondary coil	28480	606A-60N	1	1		
V1	Tube, electron: 6AW8	80131	1933-0002	5	5		
V2	Tube, electron: 12AT7	80131	1932-0027	4	4		
V3, 4	Tube, electron: 6CL6	80131	1923-0030	2	2		
V5	Same as V2						
V6	Tube, electron: 12B4A	80131	1921-0010	7	7		

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

Ckt Ref.	Description	Mfr *	℗ Stock No.	TQ*	RS*		
V7	Same as V2						
V8	Same as V1						
V9	Same as V2						
V10	Same as V1						
V11 thru V100	Not assigned						
V101 thru V105	Same as V6						
V106	Same as V1						
V107	Same as V6						
V108	Same as V1						
V109	Tube, electron: 5651	86684	1940-0001	1	1		
XTAL 1	Crystal unit, quartz: 1000 kc	0000Y	0410-0013	1	1		
XTAL 2	Crystal unit, quartz: 100 kc	0000Y	0410-0014	1	1		
	MISCELLANEOUS						
	Assembly, line filter	28480	606A-27A	1	1		
	Assembly, frequency drive cable	28480	606A-18	1	1		
	Assembly, turret contact	28480	606A-95A	2	1		
	Detent spring leaf	28480	608D-59C	2	1		
	Fuseholder: extractor post type	75915	1400-0084	2	1		
	Gear frequency, vernier pinion	28480	606A-14E	2	1		
	Jewel, pilot light: POWER	72765	1450-0020	1	1		
	Knob, bar with skirt: RANGE	28480	G-74P	1	1		
	Knob, concentric: MODULATION SELECTOR and ATTENUATOR	28480	G-74Q	2	1		
	Knob: FREQUENCY	28480	G-74BB	1	1		
	Knob: CALIBRATE	28480	G-74BZ	1	1		
	Knob: ATTENUATOR and MODULATION AMPLITUDE	28480	G-74AV	2	1		
	Slug, polyiron: for T212	28480	9170-0024	1	1		
	Spring, ground on line filter	28480	606A-91A	1	1		

* See introduction to this section