OPERATING AND SERVICING MANUAL

MODEL 618B
SHF SIGNAL GENERATOR

SERIALS PREFIXED: 951 -

275 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U. S. A.

618B004/11-59

SPECIFICATIONS

Frequency Range:	3,800 to 7,600 mc covered in a single band. Repeller voltage automatically tracked and proper mode automatically selected.
Calibration:	Direct reading. Frequency calibration accuracy better than ±1%.
Frequency Stability:	Frequency variation less than 0.006% per degree centigrade change in ambient temperature: line voltage change of ±10% causes less than .02% frequency change.
Output Range:	1 milliwatt or 0.223 volt to 0.1 microvolt (0 dbm to -127 dbm) into 50 ohms. Directly calibrated in microvolts and db. Coaxial Type N connector.
Output Accuracy:	Within ±2 db from - 7 dbm to -127 dbm, at the end of 6 ft. output cable, terminated in 50-ohm load.
Internal Impedance:	50 ohms nominal. (VSWR less than 2)
Modulation:	Internal or external pulse, fm and square wave.
Internal Pulse Modulation:	Repetition rate variable from 40 to 4000 pps, pulse width variable 1/2 to 10 microseconds.
Sync Out Signals:	1) Simultaneous with rf pulse - positive. 2) In advance of rf pulse - positive, variable 3 to 300 microseconds. (Better than 1 microsecond rise time and 25 to 100 volts amplitude into 100 ohms load.)
External Synchronization:	1) Sine wave: 40 to 4000 cps, amplitude 5 to 50 volts rms. 2) Pulse signals: Zero to 4000 pps and 5 to 50 volts amplitude, both positive and negative, pulse width 0.5 to 5 microseconds, rise time 0.1 to 1 microsecond.
Internal Square Wave Modulation:	Variable 40 to 4000 cps, controlled by "pulse rate" control.
Internal Frequency Modulation:	Saw-tooth sweep rate adjustable 40 to 4000 cps. Frequency deviation up to ±3 mc.
External Pulse Modulation:	Pulse requirements: amplitude from 15 to 70 volts positive or negative, width 0.5 to 2500 microseconds.
External Frequency Modulation:	Provides capacitive coupling to repeller of klystron. Maximum deviation approximately ±5 mc.
Power Source:	115/230 volts ±10%, 50 to 60 cps, 250 watts.
Size:	Cabinet Mount: 17-1/2 in. wide, 14 in. high, 19-1/2 in. deep. Rack Mount: 19 in. wide, 14 in. high, 17 in. deep behind panel.
Weight:	Cabinet Mount: Net 95 lbs., shipping 118 lbs. Rack Mount: Net 96 lbs., shipping 119 lbs.
Accessories Supplied:	AC-16Q Cable Assembly, 6 feet of specially treated RG9A/U 50 ohms coaxial cable terminated at each end with UG-21B/U Type N male connectors. Each cable is tested and selected for minimum swr at frequencies above 4000 mc.

CONTENTS

RAYTHEON

KLYSTRON TUBE WARRANTY

FOR TUBES SUPPLIED BY HEWLETT-PACKARD

Raytheon klystron tubes are guaranteed by the manufacturer only to the original purchaser, the Hewlett-Packard Company. For this reason, all warranty claims for premature failure of this tube, if purchased from or supplied by the Hewlett-Packard Company, must be made to Hewlett-Packard and not Raytheon. All credit allowed by Raytheon will be passed on to the customer by Hewlett-Packard.

This klystron tube is guaranteed against defects in manufacture only, for a period of 500 hours filament operation or one year from date of purchase, whichever occurs first. Allowance will be proportional to the percent guaranteed life (filament hours) remaining.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow the shipping instructions carefully to insure safe arrival of the tube. If a tube arrives broken, delay will be caused in determining who is liable -- the transportation company or the shipper. Many tubes will be subjected to a laboratory examination to determine the cause of failure before credit can be allowed. Proper examination is either difficult or impossible when the tube is damaged.

SHIPPING INSTRUCTIONS

1) Fill out the Warranty Claim on the reverse side of this sheet.

2) Carefully wrap the tube in at least 1/4 inch thick cotton batting, or other soft padding material.

3) Wrap the padded tube with the Warranty Claim in heavy kraft paper.

4) Pack in a rigid container which is at least 4 inches larger than the padded tube on all sides. Surround the tube with packed excelsior or similar shock absorbing material.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Mark the box FRAGILE and ship prepaid, preferably via Air Freight or Railway Express. Ship to Hewlett-Packard.

RAYTHEON KLYSTRON WARRANTY CLAIM

Please Answer All Questions Fully

FROM: DATE__________

NAME: ________________________________

COMPANY: ________________________________

ADDRESS: ________________________________

____

Person to contact for further information:

NAME: ________________________________

TITLE: ________________________________

COMPANY: ________________________________

ADDRESS: ________________________________

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1) Klystron Type No.________________ Serial No.__________________

2) hp instrument in which tube was used, Model______, Serial No.__________

3) Date tube purchased______________

4) Tube purchased from____

5) Tube was original__________or replacement______________

6) Total number of hours in operation________

7) COMPLAINT (Please describe nature of trouble)____________________

____

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8) OPERATING CONDITIONS (Please describe conditions prior to and at time of failure)

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SIGNATURE____________________

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SECTION I
GENERAL DESCRIPTION

1-1 INTRODUCTION

The Model 618B SHF Signal Generator is designed to generate voltages in the frequency range from 3800 to 7600 megacycles with one milliwatt power output available across the band. The output frequency is indicated on a direct reading dial, and the attenuator controlling output level is calibrated in microvolts and decibels.

The types of rf output are as follows:

UNMODULATED (CW).

INTERNAL PULSE MODULATION -

Repetition rate variable from 40 to 4000 pulses/sec. Pulse length variable from .5 to 10 microseconds as measured between points that are 50% of the maximum amplitude of the initial rise. The combined rise and decay time does not exceed .5 microseconds.

EXTERNAL PULSE MODULATION -

External pulse modulation requires pulses having the following characteristics:

Amplitude	15 to 70 volts
Width	.5 to 2500 microseconds
Separation	1 to 2500 microseconds
Polarity	positive or negative
Rise Time	.1 to 1 microsecond
Decay Time	.1 to 1 microsecond

INTERNAL FREQUENCY MODULATION -

The saw-tooth sweep rate is variable from 40 to 4000 cycles/sec. The frequency deviation is variable from 0 to ±3 megacycles.

EXTERNAL FREQUENCY MODULATION -

With sine-wave input, frequency deviation up to 10 megacycles can be obtained depending on the frequency of the radio frequency oscillator.

INTERNAL SQUARE-WAVE MODULATION -

Variable from 40 to 4000 cycles/sec.

EXTERNAL SQUARE-WAVE MODULATION -

Externally generated square wave of at least 15 volts amplitude and a frequency of 40 to 20,000 cycles/sec.

SYNC OUT SIGNALS -

1) Delayed Sync Out. A positive pulse simultaneous with the front of the radio frequency pulse. Pulse amplitude at least 25 volts and rise time shorter than one microsecond. The output circuit is designed to work into a load of 1000 ohms or more shunted by not more than 50 $\mu\mu$f capacity.

2) Undelayed. Has the same characteristics as the number 1 sync out signal except that the pulse precedes the front of the radio frequency pulse by 3 to 300 microseconds.

Both the pulse and frequency modulated radio frequency output may be synchronized with the following externally generated signals.

a. Sine waves of 40 to 4000 cycles/sec. and 5 to 50 volts (rms) amplitude.

b. Pulses of 40 to 4000 cycles/sec., a peak amplitude of 5 to 50 volts, a rise time of .1 to 1 microsecond, and a width of .5 to 5 microseconds.

1-2 DAMAGE IN TRANSIT

This instrument should be thoroughly inspected when it is received. If any damage is evident, refer to the "Claim for Damage in Shipment" paragraph on the Warranty page.

1-3 ATTENUATOR CALIBRATED FOR OUTPUT CABLE

The accuracy of the output system and the calibration of the attenuator in the Model 618B is determined at the end of the output cable supplied with the instrument.

CAUTION

Do not connect rf or dc power in any magnitude to the output terminals of this instrument. As little as 1/5 watt can either severely damage or burn out the attenuator probe.

Extreme care should be exercised when working with transceiver types of equipment to insure that the transmitter section is not operating while the Model 618B is connected to the antenna.

Erratic instrument performance at the output terminals, or even no power output is frequently an indication that the instrument has been subjected to the abuse described above. This condition may be confirmed by measuring either the dc resistance of the attenuator or the vswr looking into the panel connector.

DC resistance = approximately 85 ohms,

VSWR (at panel connector) = 2.0 or better.

If investigation shows an attenuator burnout, the probe assembly must be replaced.

1-4 POWER TRANSFORMER CONVERSION

Should it be desired to operate the Model 618B from a 230 volt source, proceed as follows:

1) Remove the following transformer terminal jumpers: T301, 1A to 3A and 2A to 4A; T302, 1 to 3 and 2 to 4.

2) Install the following jumpers: T301, 2A to 3A; T302, 2 to 3.

3) Change the line fuse F301 to a 1.6 ampere, slow-blow fuse.

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

1-5 KLYSTRON TUBE WARRANTY

Two copies of the klystron warranty sheet have been included in this manual. When replacing a klystron tube which has failed prior to the expiration of the guarantee, fill out a warranty sheet and return it with the tube to the company from which the tube was obtained. A new sheet will be furnished with each replacement tube purchased from the Hewlett-Packard Company.

SECTION II
OPERATING INSTRUCTIONS

2-1 OPERATING PRECAUTION

This equipment employs high circuit voltages (1500 volts). Although bleeder circuits are used to prevent capacitors from retaining charges after the power has been disconnected, always discharge and ground circuits before touching them when working inside the cabinet.

2-2 CONTROLS AND TERMINALS

A. ON This toggle switch controls all power to the instrument.

B. POWER When this red light is on, it indicates that power is being supplied to the instrument.

C. SIGNAL FREQUENCY

This control is used to adjust the operating frequency of the SHF oscillator to the desired output frequency. The frequency is read on the MEGA-CYCLES dial above the control. A 360° vernier scale graduated from 0 to 100 is provided on the control itself so that accurate resetting to specific frequency can be made.

D. ZERO SET

This control is used to set the needle of the POWER SET meter to the zero position when the MOD. SELECTOR switch is in the OFF position and the power switch is in the ON position.

E. POWER SET

This control is used to set the needle of the POWER SET meter to 0 db (red line at center of scale) prior to adjusting the attenuation. It also operates the fiducial over the OUTPUT ATTEN. (attenuator) dial to establish the reference level for reading the attenuator dial.

F. OUTPUT ATTEN.

This control determines the attenuation of the radio frequency output of the signal generator. It also operates the OUTPUT ATTN dial so that the reading of this dial under the index indicates the output level of the signal generator in voltage and in decibels below one milliwatt.

G. FM AMPLITUDE

This control adjusts the deviation (frequency swing) of the output frequency from 0 to ±3 mega-cycles from the center (CW) frequency when frequency modulation is employed.

H. MOD. SELECTOR

This switch is located in the upper left corner of the front panel of the signal generator. It has the following positions:

1) EXT. FM - When in this position, the signal generator circuits are switched so that an external sine- or saw - tooth voltage may be applied to the EXT. MOD. input connector to provide externally modulated output.

2) INT. FM - When in this position, the signal generator circuits are switched so that saw-tooth type frequency-modulated pulses are provided. When the SYNC SELECTOR switch is in the X1 or X10 position, these pulses are initiated by the internal pulse generating circuits of the signal generator.

3) CW - When in this position, the output of the signal generator is continuous wave.

4) OFF - When in the OFF position, the rf oscillator tube is biased off so that the signal generator will provide no output. This position is provided to permit the POWER SET meter to be zero set before each test by adjustment of the ZERO SET control. However, filament and plate

voltages remain applied to all tubes so that the signal generator may be instantly operative when this switch is moved to one of its other positions.

5) INT - When in this position, pulse repetition frequency is indicated by the position of the PULSE RATE control when the SYNC SELECTOR switch is in the X1 position. When the SYNC SELECTOR switch is in the X10 position, the pulse rate will be 10 times the rate indicated by the calibrations of the PULSE RATE control.

6) EXT. (+) - When in this position, the signal generator may be modulated by positive external pulses or square waves applied to the EXT. MOD. connector on the front panel.

7) EXT. (-) - When in this position, the signal generator may be modulated by negative external pulses or square waves applied to the EXT. MOD. connector on the front panel.

8) SQ. WAVE - When in the SQ. WAVE position, the output signal generator will be square waves of radio frequency voltage. The repetition rate of these pulses will be determined by the adjustment of the PULSE RATE control and the SYNC SELECTOR switch in the X1 or X10 position and will be between 40 to 4000 pulses per second. The "on" time will be approximately equal to the "off" time.

I. PULSE WIDTH

The adjustment of this calibrated control determines the width of the main output pulse when the MOD. SELECTOR switch is in the INT. position and the SYNC switch is in the EXT. +, EXT. -, ∿ , X1 or X10 positions. The width between is approximately 0.5 (MIN) and 10 microseconds, depending on the position of the control.

J. PULSE DELAY

This control determines the time delay between the start of the synchronizing pulse and the start of the radio freuency output pulse delivered by the signal generator. The control permits insertion of delays from 3 to 300 microseconds following the synchronizing pulse. This same delay period will also be present between the pulse appearing on the SYNC OUT connector and the DELAYED SYNC OUT connector on the control panel.

K. PULSE RATE

The setting of this control determines the pulse repetition frequency of the internal pulse generating circuits when the MOD. SELECTOR switch is in the INT, INT. FM or SQ. WAVE position and the SYNC SELECTOR switch is in either the X1 or the X10 position. When the SYNC SELECTOR switch is in the X1 position, the pulse repetition rate is as read on the calibrated dial of the control. When the SYNC SELECTOR switch is in the X10 position, the reading of the pulse rate control must be multiplied by 10 to indicate pulse repetition rate.

L. SYNC SELECTOR

This switch determines the type of synchronization that is to be employed by the signal generator. It has the following positions:

1) ∿ - When the switch is in this position, and the MOD. SELECTOR switch is in the INT. position, the signal generator may be synchronized by external sine-wave voltages with an amplitude between 5 and 50 volts rms, applied to the SYNC IN connector on the front panel.

2) EXT.(-) - When the switch is in this position, and the MOD. SELECTOR is in the INT. position, the signal generator must be synchronized by external negative voltage pulses of an amplitude between 5 and 50 volts applied to the SYNC IN connector on the front panel.

3) EXT.(+) - When the switch is in this position, and the MOD. SELECTOR switch is in the INT. position, the signal generator must be synchronized by external positive voltage pulses with an amplitude of between 5 and 50 volts applied to the SYNC IN connector on the front panel.

4) X1 - When the SYNC SEL. switch is in this position, and the MOD. SELECTOR switch is in the INT. position, the internal pulse generator is free-running. The repetition rate is as read directly on the PULSE RATE control.

5) X10 - When the SYNC SELECTOR switch is in this position, and the MOD. SELECTOR switch is in the INT. position, the repetition rate of the synchronizing pulses is as read on the dial of the PULSE RATE control multiplied by 10.

2-3 OPERATING INSTRUCTIONS, GENERAL

Operating this instrument can be divided into two parts: adjusting the rf section, and adjusting the modulator section. In general, it is desirable first to adjust the rf section, since this adjustment establishes the reference levels for the output power-monitoring system. The following procedures assume that the instrument has been energized and allowed to reach a stable operating temperature for a period of at least five minutes. If the ambient temperature is below 50°F (10°C), a longer warm-up period is desirable.

2-4 ADJUSTING THE RF SECTION TO OBTAIN CW OUTPUT

1) Tune the signal generator to the desired frequency with the SIGNAL FREQUENCY control.

2) Set MOD. SELECTOR switch to OFF position and adjust ZERO SET control so that POWER SET meter needle is exactly over the ZERO SET index line on the meter.

3) Place MOD. SELECTOR switch to the CW position.

4) Adjust POWER SET meter to zero dbm position by means of the POWER SET control.

5) Adjust the OUTPUT ATTEN. control to the desired value of attenuation as indicated by the OUTPUT ATTEN. dial under the index.

6) The above adjustments determine the frequency of the rf output of the signal generator and the output power level in decibels below one milliwatt (0.228 volt) when working into the rated load of 52 ohms.

NOTE

For a given setting of the OUTPUT ATTENUATOR dial, the indicated peak voltage of rf output, under conditions other than cw, will be within ±1 decibel of that for cw operation.

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2-5 MODULATED OUTPUT

The signal generator, for the purpose of the following adjustments, is assumed to be adjusted as described in paragraph 2-4. The following subparagraphs outline control adjustments and cable connections to obtain various types of modulated output.

A. SQUARE-WAVE OUTPUT

1) Set MOD. SELECTOR switch to SQ. WAVE position.

2) Set SYNC SELECTOR switch to the X1 or X10 position and set PULSE RATE control as necessary to obtain desired repetition rate.

3) Connect the rf cable between RF OUTPUT connector on the signal generator and equipment being tested.

4) A sync pulse is available at the SYNC OUT connector for each cycle of the square wave.

B. INTERNAL PULSE MODULATION

1) Set MOD. SELECTOR switch to INT position.

2) Set SYNC SELECTOR switch to X1 or X10 and set PULSE RATE control as necessary to obtain desired pulse repetition rate.

3) Set PULSE WIDTH control to a position between 0.5 (MIN.) and 10 microseconds as desired.

4) Set PULSE DELAY control to obtain desired delay.

5) Set FM AMPLITUDE control to OFF position.

6) Connect rf cable between RF OUTPUT connector and load.

7) Connect video cable between the SYNC OUT and/or DELAYED SYNC OUT connectors and external equipment as required by the application.

C. INTERNAL FREQUENCY MODULATION (Saw-tooth)

1) Set MOD. SELECTOR switch to INT. FM position.

2) Set the SYNC SELECTOR switch to X1 or X10 position and set PULSE RATE control so that desired repetition frequency will be obtained.

3) Set FM AMPLITUDE control to OFF position; then slowly advance the control to a position between OFF and maximum to establish the desired degree of fm about the center frequency. Because of the characteristics of the klystron, unstable operation will occur when the control has been

advanced so that the fm deviation is greater than the stable portion of the mode. Deviations of ±3 megacycles or more can be obtained.

4) Connect rf cable between RF OUTPUT connector on signal generator and load.

5) If desired, connect video cable between SYNC OUT connector and external equipment.

D. EXTERNAL PULSE MODULATION

1) Set MOD. SELECTOR switch to the EXT.+ or EXT.- position, as required by the polarity of the external modulating pulse available.

2) Connect external modulation pulse to the EXT. MOD. connector on the front panel. External pulse should have an amplitude of at least 15 volts peak.

3) No output pulses other than the rf output are available under this condition.

E. EXTERNAL FREQUENCY MODULATION

1) Set the MOD. SELECTOR switch to EXT. FM position.

2) Connect external modulation voltage to the EXT. MOD. connector on the front panel. A source voltage of 20-30 volts rms is desirable.

3) Set FM AMPLITUDE control to OFF position; then slowly advance the control to a position between OFF and maximum to establish the desired degree of FM about the center frequency. Because of the characteristics of the klystron, unstable operation will occur when the control has been advanced so that the fm deviation is greater than the stable portion of the mode. Deviations of ±3 megacycles or more can be obtained.

4) No output other than rf output is available under these conditions.

SECTION III
CIRCUIT DESCRIPTION

3-1 GENERAL

As seen in the block diagram, the Model 618B Signal Generator consists of the following basic sections:

SYNCHRONIZING CIRCUITS -
To establish the repetition rate of the modulation pulse applied to the rf oscillator.

MODULATOR -
To develop a positive pulse to be applied to the klystron modulator grid.

RF OSCILLATOR -
Which receives the positive modulation pulse and generates the rf output pulse.

OUTPUT ATTENUATOR -
A coupling system that adjusts the rf output to the desired power level.

POWER MONITOR -
To monitor the power level existing in the rf oscillator and to provide a reference from which to calibrate the output power level.

POWER SUPPLY -
Which develops the operating voltages employed by the electronic components of the generator.

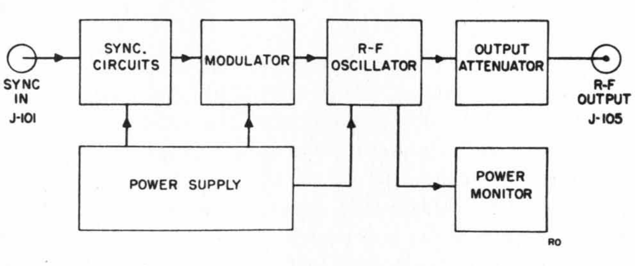

Figure 3-1. Circuit Block Diagram

3-2 SYNCHRONIZING CIRCUITS

These circuits accept the external synchronizing voltage applied at J101 the SYNC IN connector, and transform it into a negative pulse employed to trigger the pulse rate multivibrator V103. The circuit elements are shown in Figure 3-2. V101A is 1/2 of a type 12AT7 dual triode. The grid is returned to B+(ground). This places the grid at zero bias and the tube is drawing current through plate load resistor R103. The tube responds to both positive and negative signals.

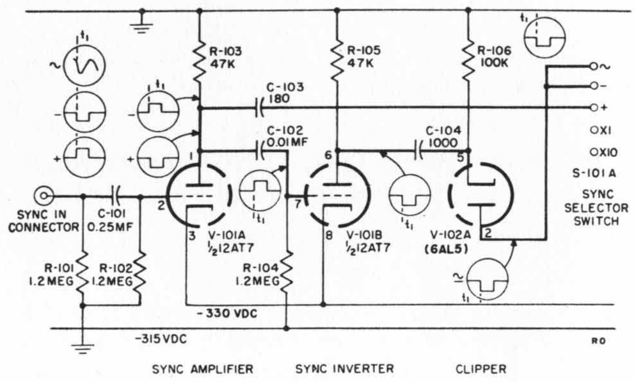

Figure 3-2. Basic Sync Input Circuits

The negative-going portion of a sine wave synchronizing voltage, or a negative sync pulse, causes the tube to cut off, developing a positive pulse in its plate circuit. This is applied to the grid of V101B. V101B is cut off with a bias of -15 volts; and the positive voltage causes it to draw current through load resistor R105, developing a negative pulse with a steep leading edge.

This negative pulse is applied to the ∿ and (-) contacts of the SYNC SELECTOR switch S101A through the series diode clipper V102A. V102A acts to apply only negative pulses to following circuits.

When a positive external sync pulse is applied to the grid of V101A, a negative pulse is developed in its plate circuit and applied to the (+) contact of S101A by capacitor C103.

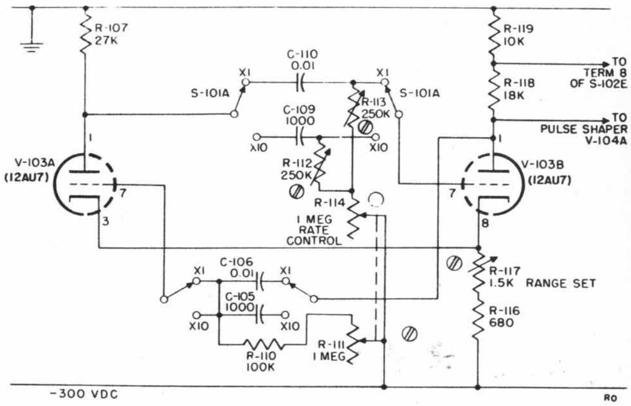

Figure 3-4. Basic Pulse Rate Multivibrator

A. PULSE RATE MULTIVIBRATOR

(SYNC CONDITION) - When external sine wave sync signals are employed, the sync multivibrator is switched to the operating condition shown in Figure 3-3. This circuit is standard one-shot multivibrator with V103A drawing current as its grid is returned to its cathode while V103B is cut off, its grid being returned to the -360 vdc line.

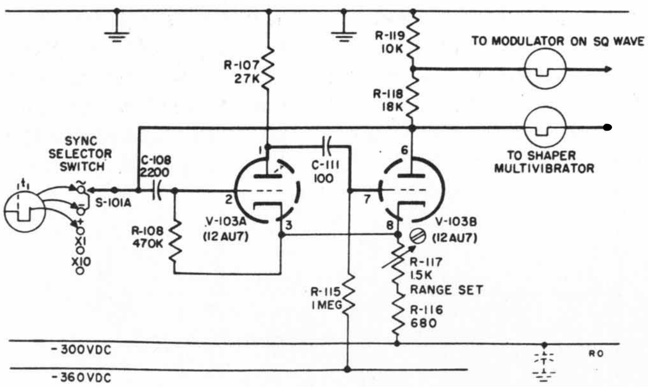

Figure 3-3. Basic Pulse Rate Multivibrator, External Sine Wave Sync Condition

The negative pulse from the sync input circuits causes the multivibrator to switch at t_1 developing a negative pulse in the plate circuit of V103B. The width of the pulse is determined by the length of time necessary to discharge capacitors C111 through R115.

B. PULSE RATE MULTIVIBRATOR

(FREE-RUNNING CONDITION) - In the INT. FM, INT. (pulse), and SQ. WAVE positions of the modulation selector switch S102, the pulse rate multivibrator is converted to a free-running multivibrator (Figure 3-4). Under this condition the sync input circuits are disconnected from the rate multivibrator.

The time constants of the multivibrator are balanced so that the circuit generates a wave that is essentially square with approximately a 50% duty cycle; however, this may vary depending upon the repetition rate. This arrangement is used so that internal square wave as well as internal pulse modulation of the rf oscillator can be obtained. The arrangement also provides for equally-spaced pulses to trigger the saw-tooth generator when internal saw-tooth fm modulation is desired.

A square-wave voltage of full amplitude is taken from the plate across R118 and R119 for the pulse shaper while one of approximately one-third the amplitude is taken across R119 for application to the modulator when the MOD. SELECTOR switch is in the SQ. WAVE position. This output to the modulator is employed only when square-wave modulation is desired.

3-3 MODULATOR SECTION

The modulator section is shown in block diagram form in Figure 3-5. The function of the circuits in this section is to establish a modulating pulse (for pulse operation) or a saw-tooth voltage (for frequency modulation) and to apply it to the rf oscillator to secure the desired type of rf output.

Various portions of these circuits are not employed in certain types of operation such as when external pulse or frequency modulation voltages are provided. However, the block diagram shows the condition where all of the circuits are employed (delayed pulse output with external synchronization) and the description will cover this type of operation. Other types of operation will be described in later paragraphs.

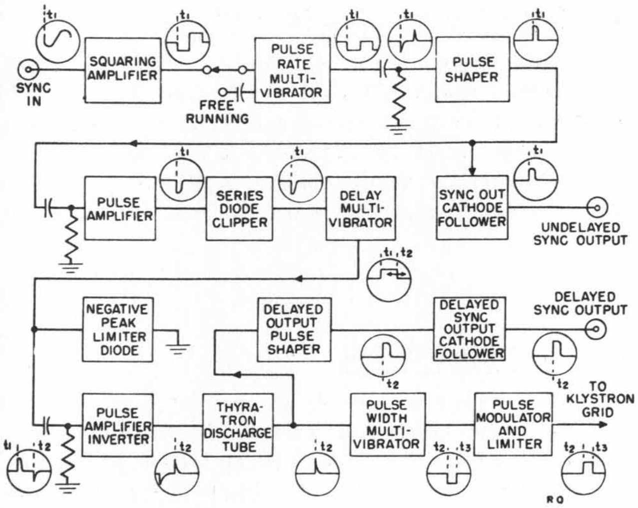

Figure 3-5. Block Diagram of Modulator Circuits

A. PULSE SHAPER

The pulse shaper (Figure 3-6) is a one-shot multivibrator with a two-microsecond time constant. It consists of V104A and V104B, two halves of type 5814 dual triode. In the steady-state condition, V104A is drawing current as its grid is returned to the cathode by resistor R121. V104B is cut off as its grid is returned to -300 vdc, thus placing a bias on the grid developed by the flow of current through V104A and cathode resistor R120.

When this multivibrator is triggered by the negative going leading edge of the wave generated by the pulse multivibrator, a positive voltage pulse appears at the plate of V104A. The pulse width is narrow, essentially two microseconds.

The positive output pulse is applied to the sync amplifier tube V105A shown in Figure 3-7 and to sync out cathode follower V105B shown in Fig. 3-6.

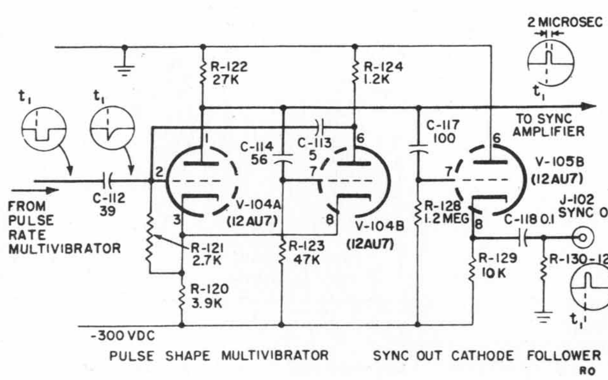

Figure 3-6. Pulse Shaping Multivibrator and Sync Out Cathode Follower

B. SYNC OUT CATHODE FOLLOWER

This stage provides the undelayed sync output signal for synchronizing external equipment. It is a standard cathode follower comprised of V105B, one-half of a type 5814 dual triode tube. The output is taken across R129, the cathode resistor, and is capacitively coupled to the SYNC OUT connector J102 by C118. Resistor R130 is returned from the center conductor of the connector to ground so that the line is terminated in reference to ground instead of the 300 vdc potential existing at the base of the cathode resistor.

The output of the cathode follower is a positive pulse greater than 25 volts when applied to a load having a resistance of from 1000 to 100,000 ohms and a shunt capacitance of 500 $\mu\mu$f. At no load, the pulse will have an amplitude of up to 55 volts.

C. PULSE AMPLIFIER

The pulse amplifier is comprised of V105A, one-half of a type 5814 tube as shown in Figure 3-7, and its associated components. It amplifies and inverts the two-microsecond pulse provided by the pulse shaper and provides negative pulse at t_1 in its plate circuit. It also provides a positive-going pulse in its cathode circuit from C115 that is employed to trigger the saw-tooth generator when internal frequency modulation is employed. C115 acts as a cathode bypass capacitor when internal pulse modulation is employed.

D. SERIES DIODE BASE LIMITER

The negative pulse from the plate of the pulse amplifier is applied to the cathode of the diode limiter V106A shown in Figure 3-7. This limiter is so connected that only the negative components with an amplitude greater than the bias on the diode will pass on to the cathode of the delay multivibrator. This prevents triggering the multivibrator by any positive or low amplitude negative transients that may appear on the output of V105A in addition to the desired trigger pulse.

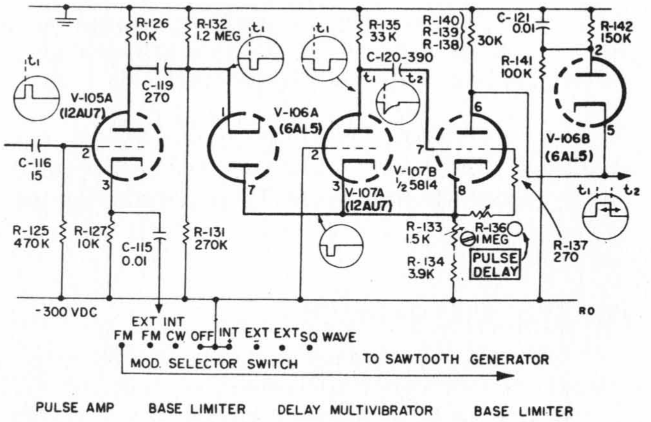

Figure 3-7. Pulse Amplifier and Delay Multivibrator

The multivibrator starts its cycle when a negative pulse drives the cathode of V107A in a negative direction. This is equivalent to placing a positive signal on the grid, and the tube draws current. A negative wave front appears at the plate of V107A and through capacitor C120, drives the grid of V107B in a negative direction, cutting off this half of the stage. The length of time the circuit will require before returning to its resting condition will be determined by the time constant of C120, R136 and R137. R136 is the calibrated PULSE DELAY panel control that adjusts the delay from 3 to 300 microseconds, while R133 is a chassis adjustment used to set the maximum delay to 300 microseconds.

V106B serves as a negative base limiter which eliminates low amplitude negative pulses that may otherwise follow the trailing edge of the main pulse from V107B.

E. DELAY MULTIVIBRATOR

This circuit (Figure 3-7) provides an adjustable time delay in applying the modulation of the rf oscillator. It consists of the two sections of V107, a type 5814 dual triode connected as a one-shot multivibrator with a time constant adjustable from 3 to 300 microseconds by R136, the calibrated PULSE DELAY panel control.

In the steady-state condition V107A is cut off while V107B is drawing current through its plate load resistors R138, R139 and R140 in parallel with R142 and the diode V106B.

F. PULSE AMPLIFIER INVERTER

This stage shown in Figure 3-8 is comprised of V109A, one-half of a type 5814 dual triode. The positive pulse from the pulse delay multivibrator is differentiated by capacitor C122 and resistor R187 to form a sharp positive spike at t_2. These are amplified and inverted in the plate circuit of V109A.

G. BLOCKING DIODE

The output of V109A is applied to the grid of the thyratron discharge tube V110 through blocking diode V108B. The purpose of V108B is to pass the positive output spike at t_2 and to block the negative spike at t_1. At short delays this insures positive triggering of the thyratron V110.

H. THYRATRON DISCHARGE TUBE

This stage consists of the type 2D21 thyratron tube V110 shown in Figure 3-8. Its grid is returned to approximately -315 volts while the cathode is returned to -300 volts, cutting off the tube. Capacitor C127 is charged to approximately 110 volts positive to the cathode, a point established by the values of R148 and R149 and diode V108A. This device of limiting the voltage on C127 is necessary due to wide variation in the pulse repetition frequency of the unit and the fact that the capacitor will charge exponentially with time.

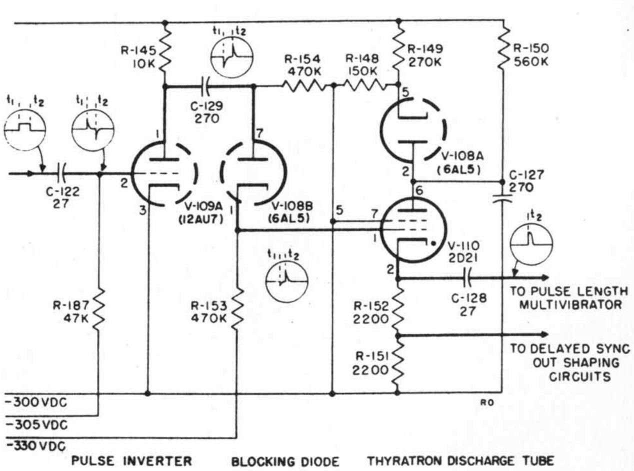

Figure 3-8. Thyratron Discharge Circuits

This would result in the capacitor charging to a higher potential at the low repetition frequencies than at the higher frequencies. The diode circuit limits the charge to a value that can be reached at the highest repetition frequencies, and prevents it from going higher regardless of the charging time available.

When the positive pulse of voltage from V109A reaches the grid, the gas in the tube ionizes and C127 discharges through the tube, and cathode resistors R157 and R152 in series. This causes a positive pulse to appear across the cathode resistors.

When C127 is nearly discharged and the plate voltage is at a very low value the gas in the tube deionizes and the tube returns to the resting condition. By this time the pulse on the grid has decayed and the grid bias is again -315 volts.

C127 is rapidly recharged to its resting voltage of approximately 110 volts and is maintained at this value through the action of the diode circuit explained above.

The spike occurring in the cathode circuits at t_2 is applied to the pulse length multivibrator and to the delayed sync pulse output circuits.

I. <u>DELAYED OUTPUT PULSE SHAPER AND CATHODE FOLLOWER</u> - Figure 3-9, the delayed output shaper, is a multivibrator comprised of the two triode sections of the type 5814 tube V115. One half the type 5814 dual triode tube, V109B, is connected as a cathode follower. The positive spike developed in the cathode circuit of the thyratron discharge tube is applied to grid of V115A through capacitor C138 at time t_2.

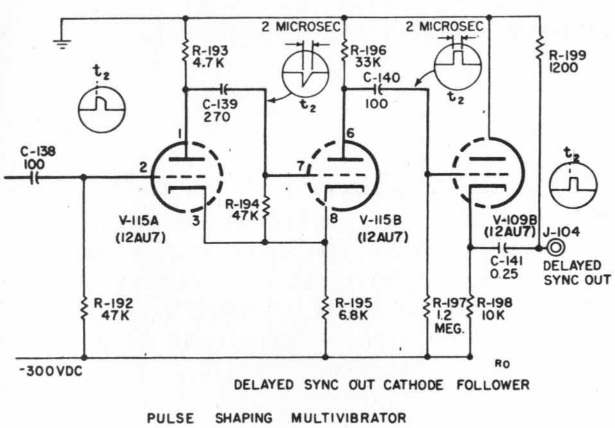

Figure 3-9. Pulse Shaping Multivibrator and Delayed Sync Out Cathode Follower

The section of the multivibrator formed by V115A is cut off, its negative bias being established by current of V115B flowing through cathode resistor R195.

The section comprised of V115B is drawing current in the resting condition as its grid is returned to the cathode through R194. The positive leading edge of the pulse from V110 causes the multivibrator to switch, cutting off current through V115B and causing the voltage at its plate to rise.

The time constant of the circuit is approximately two microseconds. At the end of this time capacitor C139 is discharged through R194 and R195 to a point where V115B again draws current and completes the cycle. The output at the plate of V115B is a positive pulse of two microseconds duration. This is coupled to V109B, the cathode follower.

V109B is a conventional cathode follower employed as an impedance transformer, receiving the pulse from the high impedance plate of the multivibrator and delivering it to the relatively low impedance across the DELAYED SYNC OUT panel connector J104 for synchronizing external equipment at t_2.

J. <u>PULSE LENGTH MULTIVIBRATOR</u>

The pulse length multivibrator shown in Figure 3-10 is a one-shot multivibrator employing a type 5814 tube V111. The circuit employs capacitive cathode to cathode coupling to secure the necessary interstage action. This avoids any feedback connection to the plate of V111A, reducing stray capacitance that would tend to slow down the voltage rise and fall. Peaking inductance L101 is also employed in the plate circuit from which the output is taken to further steepen the wave front.

The section comprised of V111A is cut off since a negative bias of 30 volts is placed on its grid. This places the V111A side of C130 at a potential of -300 volts. The second section is drawing saturation current because its grid is tied to the positive supply point (ground) through R162. As a result, the other side of C130 is at a relatively higher potential due to the drop across R158.

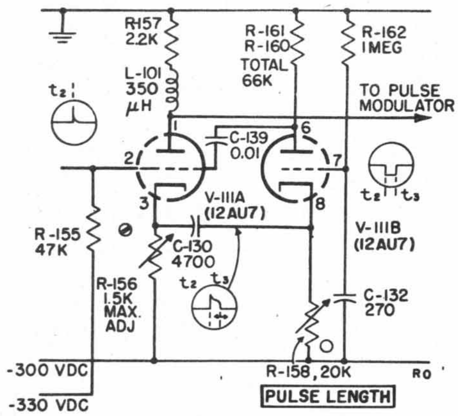

Figure 3-10. Pulse Length Multivibrator

When the positive pulse at t_2 is applied to the grid of V111A, it immediately draws current, causing the V111A side of C130 to rise to the potential set up by the current flowing through R156. R156 is adjustable, and the amount of this rise is determined by the resistance. R156 acts as a maximum delay time adjustment for the circuit.

The voltage rise across R156 is applied to the cathode of V111B causing it to become more positive with respect to grid 7. This cuts off the tube rapidly since the grid is maintained at essentially the cathode potential due to the time constant of R162 and C132.

Capacitor C130 is now charged in a positive direction and commences to discharge. The time constant of this discharge to the point where V111B will again draw current, determines the duration of the negative output pulse. The width is adjusted by R158 which is the calibrated PULSE WIDTH panel control. This control can be adjusted to provide pulses of from 0.5 to 10 microseconds duration.

The output of the pulse length multivibrator is a negative pulse starting at t_2 and ending at t_3. This negative pulse is applied to the pulse modulator tube V113.

K. KLYSTRON MODULATOR

The klystron modulator circuits shown in Figure 3-11 consist of V113, type 5763 pentode amplifier, and V112A, one-half of a type 12AT7 dual triode connected as a diode positive peak clipper. V112B, the other half of the type 12AT7 dual triode, diode-connected, provides a fixed operating bias for the accelerated grid of the klystron rf oscillator tube V114.

The negative pulse from the pulse width multivibrator is coupled to the control grid of V113 by C133 and C134 in parallel. Bias for the grid is adjusted by potentiometer R338 in the power supply, so that the flow of current in the modulator is sufficient to cut off the klystron.

The adjustment of R341 determines the maximum positive voltage applied to the grid of the klystron when the modulation pulse is present.

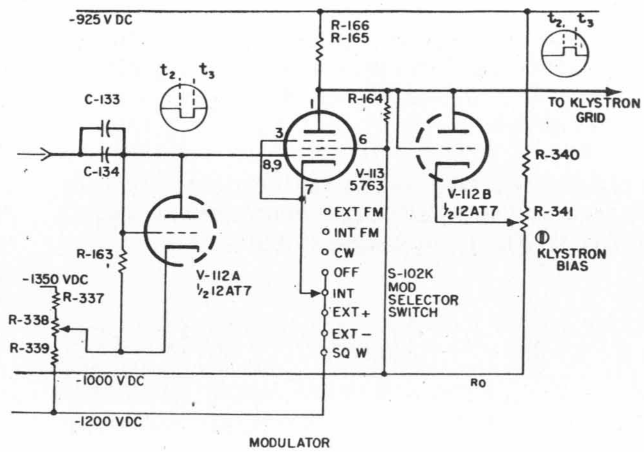

Figure 3-11. Klystron Modulator Circuit

L. INTERNAL FREQUENCY MODULATION

When the MOD. SELECTOR switch S102 is in the INT. FM position, the thyratron discharge tube is switched to comprise a conventional relaxation oscillator as shown in Figure 3-12. This oscillator develops a saw-tooth voltage wave that is applied to the rf oscillator repeller.

C124, C125 and C126 with resistors R146 and R147 determine the time constant of the saw-tooth output for the X1 range while C126, R146 and R147 perform the same function for the X10 range. R147 is ganged with R111 and R114 and adjusted by the calibrated PULSE RATE panel control so that the

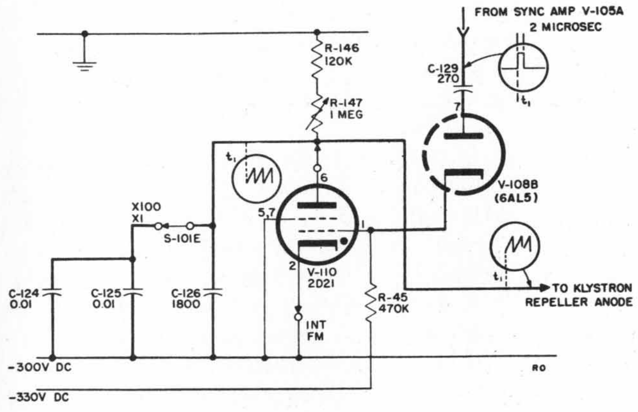

Figure 3-12. Internal Frequency Modulating Circuit

fm sweep rate and the internal pulse repetition rate may be controlled by the same knob.

The relaxation oscillator is triggered by a positive pulse from the cathode of the pulse shaper and when activated, delivers a rising saw-tooth voltage to the repeller, sweeping the frequency and providing a saw-tooth frequency modulation.

3-4 RF OSCILLATOR

A. REFLEX KLYSTRON

The rf oscillator is a reflex klystron V114 operating with a parallel-plane resonator. The resonant section is coupled to the resonator grids of the klystron as shown in Figure 3-13, and in the equivalent circuit, Figure 3-14.

It may be seen how oscillation occurs when it is assumed that a small amplitude rf voltage exists across the resonator grids which has its origin as thermal agitation noise. The electron stream directed through the resonator grids from the cathode will be velocity modulated by this small rf voltage. The stream will cease to be uniform in nature, and may be thought of as having some of its electrons accelerated and some retarded. The resultant stream in the drift space past the resonator grids will possess bunches of electrons, and is therefore said to be velocity modulated.

As this bunched stream, or velocity modulated stream moves toward the negative repeller, it is turned about and shot back through the resonator grids. Since the stream is bunched, it produces an rf voltage across the grids.

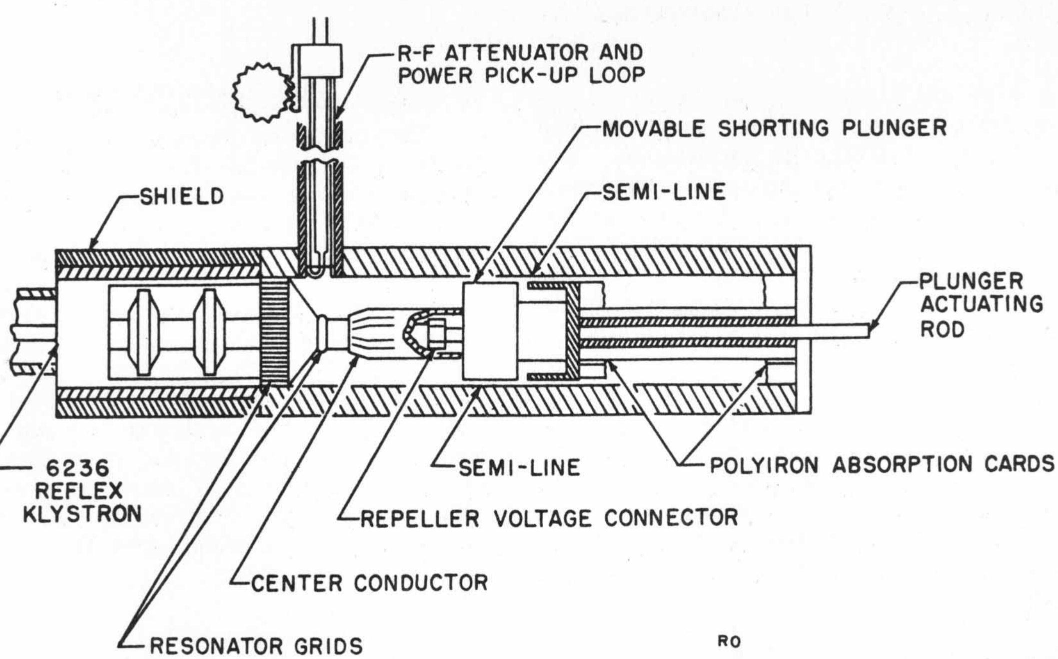

Figure 3-13. Cross Section of RF Oscillator

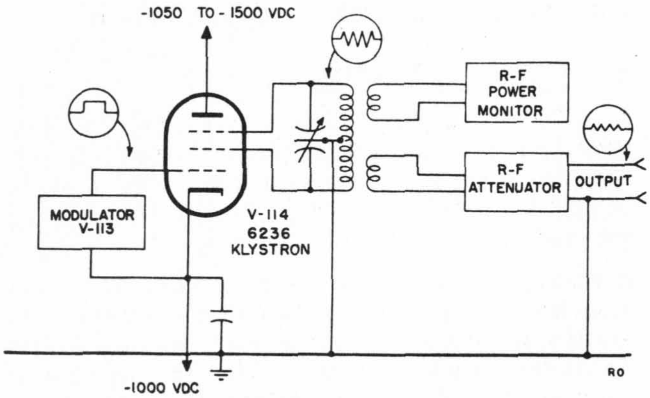

Figure 3-14. Equivalent Circuit of RF Oscillator

If the transit time has been right, this new rf voltage will be in phase with the very small thermal rf voltage initially across the grids. As a result it will strengthen the bunching effect on the following stream. Upon reflection, the following stream will again strengthen the resonator grid voltage. This process, however, does not continue indefinitely.

A point is ultimately reached where the fundamental component of the bunching current decreases in magnitude. It may be inferred, therefore, that a point exists where there is just sufficient reflected energy to satisfy the requirements for oscillation.

Assuming that stable oscillation exists in the system described above, suppose that a sudden change in repeller voltage is introduced. The transit time of the electron stream, as it enters and departs the repeller field, would be changed. The current bunching effect would change also, and a new rf voltage would be produced across the resonator grids. The velocity modulation would give way to a new value with the circuit oscillating at a new frequency.

The situation described above, is only valid for relatively small variations in repeller voltage. Excessive variations will alter the relationship between the resonator voltage and the transit time of the electron stream, producing dead spots of no oscillation or conditions of oscillation on undesired modes.

The term mode in this sense is used to describe two different, but interrelated, characteristics. One mode is the characteristic of the cavity or line section resonator which is resonant at a series of frequencies when the effective electrical length of the line is 1/4 wavelength, 3/4 wavelengths, 5/4 wavelengths . . . . These effective electrical lengths are termed resonator modes.

Another mode is the repeller mode which describes the roundtrip transit time of the electron stream as expressed in the cycles of rf voltage across the resonator grids. It has been found that oscillations most easily occur when the transit time equals 3/4, 1-3/4, 2-3/4, 3-3/4, 4-3/4 . . . rf cycles. It is to be remembered that these repeller modes are distinguished by different transit times rather than by different resonant frequencies, and that they are functions of repeller voltage. Generally, the value of the repeller voltage increases for a given mode as the mean klystron frequency is tuned upward.

When a specific repeller mode is desired throughout a given band of frequencies, the repeller voltage is adjusted against the plunger travel (of a tunable resonator, for example) to hold the transit time constant. Since the repeller mode is a function of transit time, it also remains constant.

A third use of the term mode, is oscillation mode, which is defined in terms of the repeller mode and the cavity mode. For example, an oscillation mode might be 3/4 wavelength cavity and 3-3/4 repeller.

B. PARALLEL-PLANE RESONATOR

The resonator employed in the Model 618B is known as a parallel-plane resonant line. In its physical shape it resembles a rectangular box type cavity with a circular center element and a rectangular plunger to vary the cavity depth.

Actually, the line is a direct development from a circular coaxial line as shown in Figure 3-15. Part A of Figure 3-15 shows such a line, and the field configurations that exist when it is excited electrically. The resonant frequency of such a line with one end shorted is determined by its electrical length in a direction parallel to the center conductor. The other dimensions of the line play a very small part in determining the oscillating frequency.

The evolution of the parallel-plane line from the coaxial line may be described by reference to Figure 3-15, parts A and B. Assume the outer conductor were cut at the points "X" and the two semi-lines thus created were flattened out as shown by the horizontal dotted lines. The voltage and current configurations would then take the form shown in part B. To carry this example through in complete detail, the cross-section of the center conductor would take a slightly elliptical form of perfect configurations. However, for practical purposes, this is not necessary, and a circular center conductor is used.

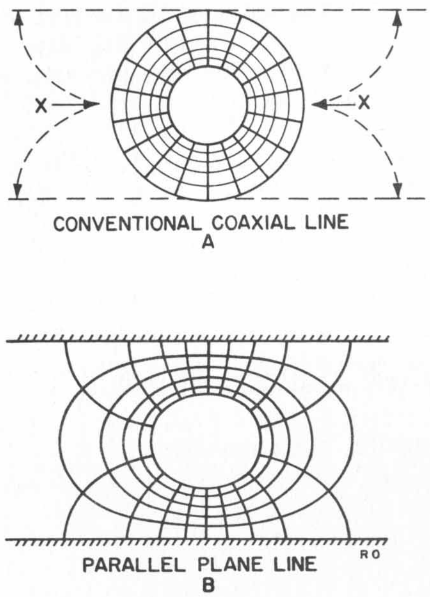

Figure 3-15. Field Configurations of Coaxial and Parallel Plane Lines

The line, as shown in Figure 3-15, part B is not enclosed on the short sides, and it is possible to operate it in this manner. However, sides are provided to prevent stray rf leakage currents.

The parallel plane line depends, for its resonant frequency, upon its electrical length and consequently may be tuned by simple mechanical means and can be directly calibrated.

This type of cavity provides a resonator in which simple and straight-forward methods can be employed to provide broad band suppression of the various parasitic resonances that occur when other physical dimensions approach the frequency-determining electrical dimensions.

Figure 3-16 shows a cut-away view of the resonant line and the other components of the parallel-plane oscillator. V114 reflex klystron is mounted so that one of the resonator grids is coupled to the two simi-lines while the other is coupled to the circular center conductor. The repeller voltage is applied through an insulated filter in the center conductor while the other potentials required to operate the tube are applied through the tube base pins.

C. PLUNGER RESONANCE

The plunger employed in the parallel-plane resonator is of the non-contacting type and a small air gap exists between the periphery of the plunger and the surfaces of the semi-planes and sidewalls, as shown in Figure 3-16.

This gap has a physical length of approximately 17 centimeters, and an electrical length such that it has a two-cycle and a four-cycle resonant frequency occurring near or in the frequency range of the oscillator. As shown in Figure 3-16, these frequencies correspond to one-half and one-quarter of the electrical length of the periphery of the plunger.

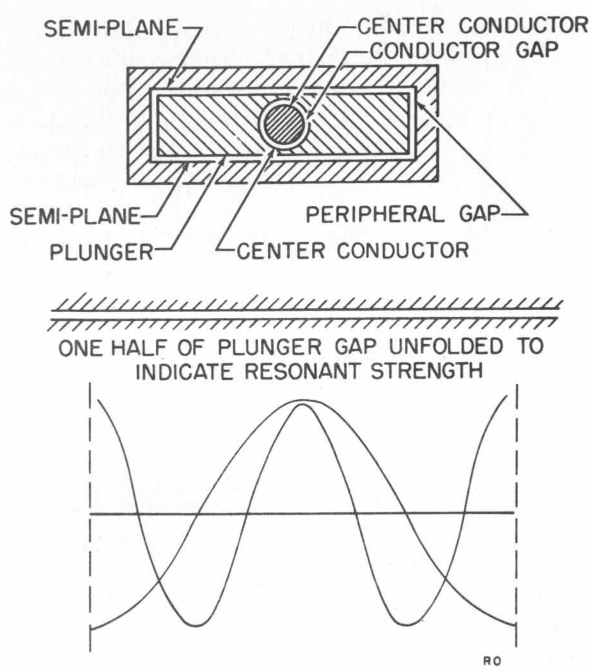

Figure 3-16. Plunger Resonances in Uncompensated Parallel-Plane Line Resonator

A similar gap exists between the center conductor and the plunger. However, the length of this gap is such that no resonances occur in the frequency range of the oscillator.

Compensation is applied to control resonance of the line formed by the peripheral plunger gap in the resonator.

D. RF POWER MONITOR AND ATTENUATOR

Two pickup loops are located in the resonator to collect rf power. The first is the output attenuator loop which couples the power to be supplied by the generator to the load through an output connector on the panel. The position of this loop is adjustable so that the output power level may be varied as desired. The second is the power monitoring loop which monitors the power level in the oscillating circuit and establishes a reference point to calibrate the output power.

Power is coupled to the load from the rf oscillator by a coupling loop located at a suitable point in the resonant line. This loop slides in a circular waveguide section (Figure 3-13). The cross-section of the waveguide is very small in relation to the frequencies of operation, and normal propagation down the waveguide will not take place.

However, some limited propagation does take place, and the power level decreases exponentially as the distance from the resonant line increases. Thus it is possible, by moving a pickup loop linearly in the waveguide to secure an output that varies in decibels in proportion to the linear travel.

This type of attenuator is known as an attenuator of the cut-off type and its characteristics are employed so that the pick-up probe and indicating dial can be moved by a simple gear train and the dial may be calibrated directly in decibels.

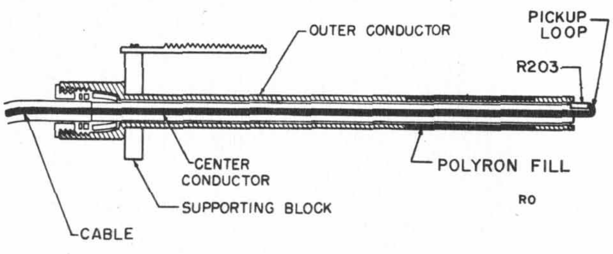

Figure 3-17. Cross-Section View of Attenuator Probe

A cross-section of the attenuator and rf pick-up loop is shown in Figure 3-17. The rf pick-up loop is terminated by a special resistor, R203, which is made by coating platinum on a glass bead. This resistor is used to match the attenuator to the output cable. The dc resistance of R203 is approximately 60 ohms.

The polyiron section on the outside of the probe is designed to absorb power that may leak past the probe in the space between the outer conductor and the waveguide walls.

The power monitor rf probe, shown in Figure 3-18, is constructed similarly to the attenuator probe.

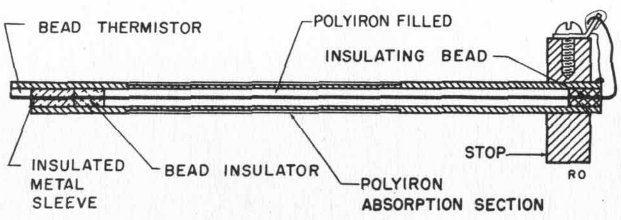

Figure 3-18. Cross-Section View of Power Monitor Probe

The power generated by the klystron varies with frequency. Therefore, a power monitor circuit is included to indicate the level of the field at the attenuator input.

The power in the resonator is monitored by the thermistor bridge circuit shown in Figure 3-19. The bead thermistor R202 which is one arm of the bridge, is located in the piston type probe. The probe couples a small amount of the power from the resonator and the resistance of the bead thermistor varies from the heat developed.

The bridge, essentially a Wheatstone bridge circuit, is balanced for dc conditions. When rf power from the resonator is applied to the thermistor, the bridge becomes unbalanced. The balance indicating device is M101, a 200 microampere meter, connected across the bridge to indicate circuit balance. R201, is a disc-type thermistor connected in parallel with the meter and it acts as a sensitivity regulator to counteract the tendency of the bridge to decrease in sensitivity as the temperature applied to the bridge increases.

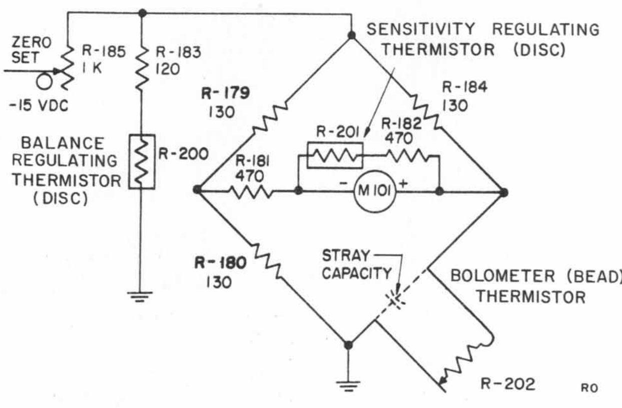

Figure 3-19. Schematic of Power Level Monitor Circuit

A second disc thermistor, R200 is shunted across the bridge in series with limiting resistor R183. This acts as a balance regulating device to compensate for unbalance due to resistance changes in R202 caused by variations in ambient temperature. An ambient temperature increase will cause the resistance of R202 to decrease causing more current to flow through its leg of the bridge, increasing the meter reading by unbalancing the bridge. R200 will also decrease in resistance, causing a drop in the total voltage across the bridge and a decrease in current flow through its various legs, thereby decreasing the meter reading.

Since the static resistance of R202 is determined by both the ambient temperature and the static bridge current flowing through it, the decrease in bridge current caused by the actions of R200 will act to decrease the temperature of R202 and tend to restore the static balance of the bridge. The two disc thermistors are mounted directly on the resonator so that they are immediately sensitive to temperature changes.

RF power in the coupling loop is isolated from the bridge since sufficient stray capacity exists in the probe and line to effectively bypass it to ground. This is indicated by the dotted capacity shown in Figure 3-19.

The power monitor probe is moved within its waveguide in a manner similar to the power attenuator pickup probe. Its position is controlled by the POWER SET control on the front panel and is indicated by the position of the transparent index scale over the calibrated OUTPUT ATTEN. (attenuator) dial.

The power level existing at the location of the probes in the resonator varies as the signal generator is tuned over its frequency range. To compensate for this, the position of the power monitor probe is moved so that it picks up the amount of power necessary to balance the bridge. This establishes the basic reference level for 1 milliwatt and positions the transparent index scale over the attenuator dial. The attenuator control is then adjusted with reference to this index scale to provide the desired attenuation below 1 milliwatt as read on the calibrated dial.

The OUTPUT ATTENUATOR control moves the output attenuator probe mechanically and also moves the calibrated dial. Thus when any calibration point on the dial is under the index line, the position of the output probe in its waveguide is proportional to that of the power indicating probe (which has been set to the proper reference level) and the power output may be read directly on the dial.

Movement of the output probe in its waveguide will cause attenuation as described in an earlier section. The power indicating dial is calibrated in decibels below one milliwatt when coupled to a 52-ohm load.

E. REPELLER VOLTAGE CONTROL

The operating characteristics of a reflex klystron are such that an optimum value of repeller voltage exists for each operating frequency. This voltage is the value that will cause the bunched electrons to return to the resonator grids at the proper time. Figure 3-20 shows the repeller voltage characteristics for the type 6236 klystron over the range employed in the signal generator.

The repeller voltage characteristic shown in Figure 3-20 provides for operation in the 2-3/4 repeller mode. The required voltage for optimum operation is essentially linear with frequency for the frequency range above 4400 mc. In the frequency range from 3800 to 4400 mc the required voltage is not a linear function of frequency but is slightly curved as shown.

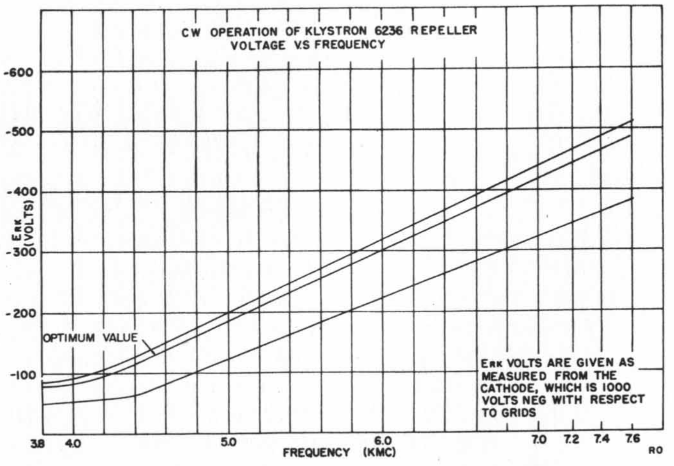

Figure 3-20. Plot of Repeller Voltage VS. Frequency

Figure 3-21 shows the circuit that provides negative voltage to the repeller. R174 is a 100,000 ohm wirewound potentiometer that is mechanically ganged with the mechanism that tunes the resonant line, providing a proper voltage to the repeller electrode as the frequency is changed.

The values of the resistor R170 and R175 are adjustable to establish the voltage applied across the tracking potentiometer R174.

The values of resistors R173 and R178 are adjustable to provide the required curvature in the repeller voltage characteristic below 4400 mc.

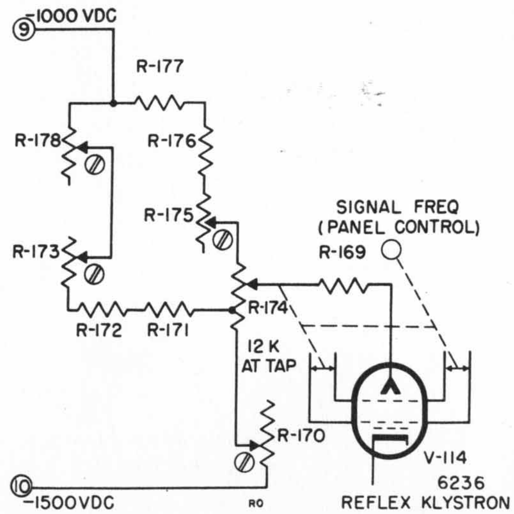

Figure 3-21. Schematic of Klystron Repeller Voltage Tracking Circuits

SECTION IV
MAINTENANCE

NOTE

Constant ventilation is required for cooling the klystron when the instrument is in operation. Inadequate ventilation resulting either from an ineffective blower motor or from a clogged air filter can reduce klystron life.

Inspect the air filter and the blower motor regularly. If the instrument is operated continuously or in dusty areas, the filter should be inspected at least once a month and replaced if necessary. The condition of the blower motor should be checked more frequently for overheating, excessive bearing noise, and other signs of reduced speed or inadequate air handling capacity. A poor blower motor should be replaced.

4-1 INTRODUCTION

This section contains instructions for maintaining, trouble shooting, replacing tubes, and internal adjusting of the Model 618B SHF Signal Generator. A special systematic trouble shooting procedure tests the complete signal generator in a manner that localizes most troubles which may occur. A chart includes instructions for tube replacement and subsequent adjustments. It is keyed with applicable paragraphs in the test to facilitate testing. The following information can be found in this section.

4-2 CABINET REMOVAL

To remove the 618B from its cabinet, proceed as follows:

DANGER - 1000 to 1500 volt potentials from very low impedance sources are used throughout the circuits of the signal generator. Be very careful when handling the generator with the cabinet removed.

1) Place instrument panel down on a low surface so that it rests on the guard rail handles.

2) Loosen the four captive screws in the rear of the cabinet and lift cabinet off the chassis.

4-3 BLOWER SYSTEM

Inspect the air filter regularly. If the instrument is operated continuously or in dusty areas, clean the air filter twice a month. Clean air is required for cooling the klystron oscillator inside the cavity, and a clogged filter can shorten the life of the klystron by restricting the air flow. The air filter supplied is a permanent, washable type. You can remove it by simply sliding it from the bracket on the rear of the cabinet. When you clean the filter wash it with soap and water. After rinsing and drying, coat it with a fine spray of light machine oil.

4-4 VISUAL INSPECTION

Always precede electrical trouble shooting with a visual check. Look for signs of damage, burned-out components, etc. Be alert for signs of misuse, looseness of parts, overheating, or any other sign that suggests a source of possible future trouble.

A cold tube found simply by touch may save considerable time and effort in restoring the signal generator to operation. A knowledge of the locations of the tubes and sections of the signal generator will assist trouble shooting. Photographs locate the various sections and call out important adjustments, while Figure 4-2 locates the tubes in the instrument.

4-5 TEST EQUIPMENT REQUIRED

The maintenance procedures described in the paragraphs following in this section attempt to isolate as many difficulties as possible employing the front panel indications and an accurate multimeter (20,000 ohms per volt or better). More complex procedures, however, demand more equipment. For signal tracing and pulse measurements, a high-speed synchroscope is required. To observe the rf output pulse waveshape of the klystron oscillator, an SHF crystal detector, such as the ⓗⓟModel 420A, is required ahead of the oscilloscope. Calibrating the power output required a power meter and bolometer mount, such as the ⓗⓟ Models 430C and 477B, respectively.

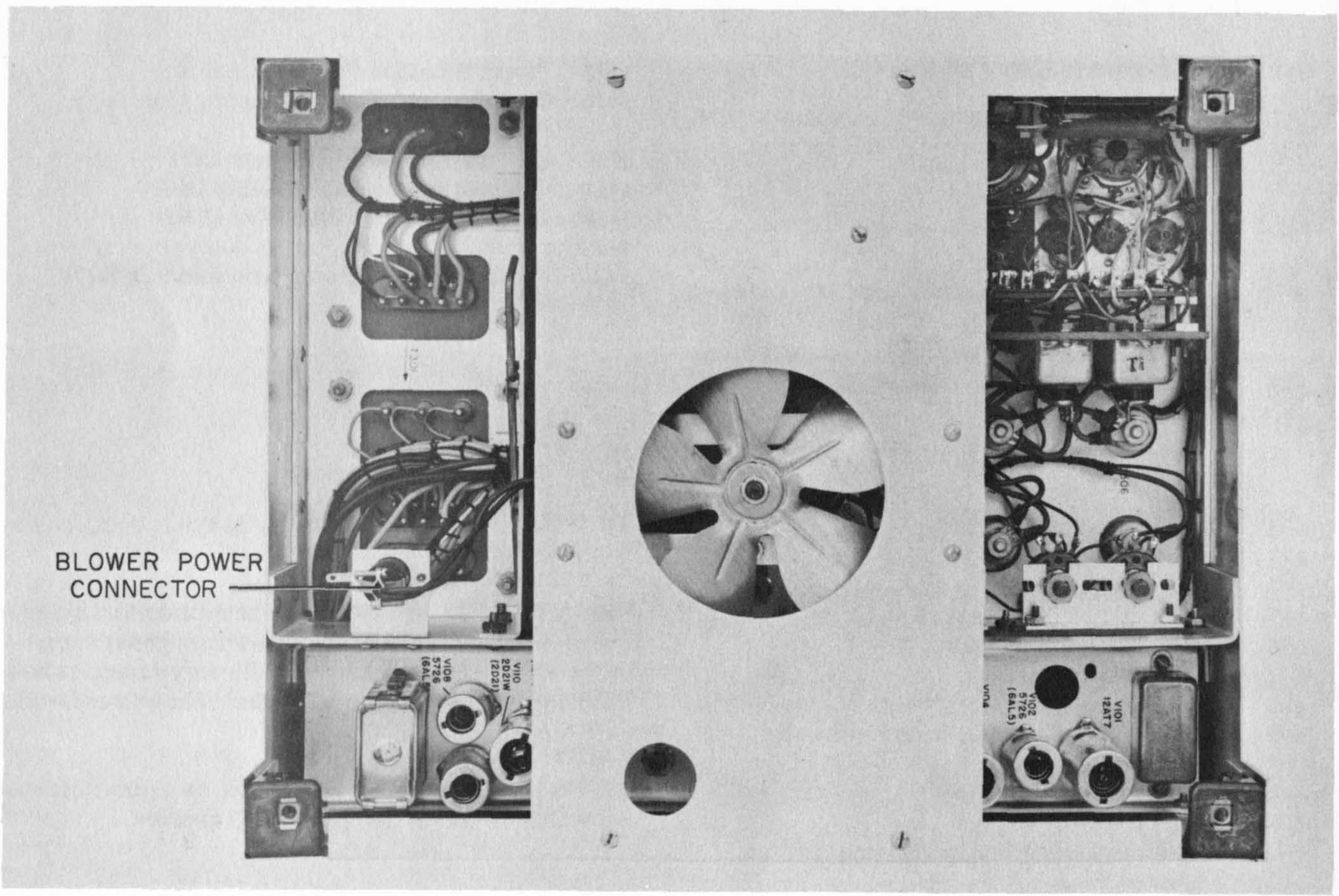

Figure 4-1. Rear View showing Blower Connector

TABLE 4-1. TEST EQUIPMENT REQUIRED

Name	Characteristics	Application
Multimeter	DC-AC-OHMS 20,000 ohms/volt	General testing & trouble shoot.
Oscilloscope	.05 volt sensitivity, 1μ sec sweep, 10 mc frequency response, and trigger input feature.	Waveform and klystron pulse observation.
Crystal Detector (hp420A)	- - -	RF Output pulse observation.
Power Meter (hp430C) and Bolometer Mount (hp477B)	- - -	RF power output measurement.
Wavemeter (hpJ530A or H530A)	Indicate 7.65 kmc.	Frequency dial calibration.
Microwave Frequency Standard	.05% accuracy as PRESTO 100.	Frequency calibration.
Coaxial T Mixer	- - -	Frequency calibration.
VHF Detector (hp 417A or equiv.)	- - -	Frequency dial calibration.

4-6 TUBE REPLACEMENT CHART

The tubes used in the 618B Signal Generator are listed in the following Table 4-2. Many of the tubes may be replaced without further adjustment; those which require adjustment when replaced are accompanied by a reference to the pertinent step in a trouble shooting chart. It is recommended that tubes be checked by substituting a new tube of the same type; if no improvement in performance is noted, return the original tube to the socket.

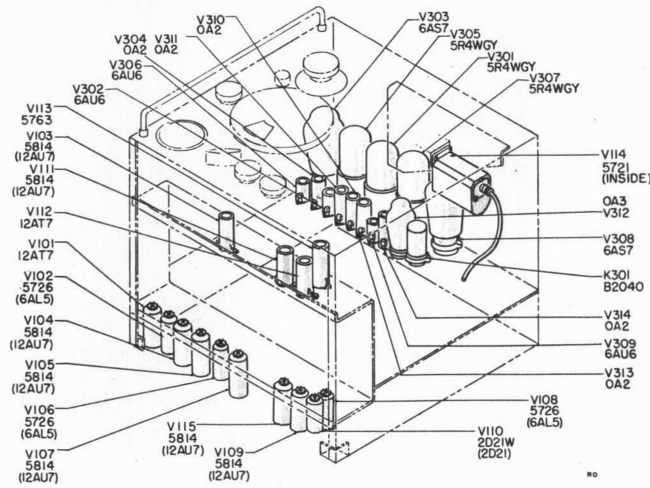

Figure 4-2. Tube Location Diagram

TABLE 4-2. TUBE COMPLEMENT, SIGNAL GENERATOR 618B

Tube	Type	Function	Adjustments Required
V101	12AT7	Sync Amplifier and Inverter	None
V102	5726 (6AL5)	Clipper (1/2 tube not used)	None
V103	5814 (12AU7)	Rate Multivibrator	Para. 4-17 - Table 4-6
V104	5814 (12AU7)	Pulse Shaping Multivibrator	None
V105	5814 (12AU7)	Pulse Amplifier and Sync Out Cathode Follower	None
V106	5726 (6AL5)	Base Limiter for Delay Multivibrator	None

TABLE 4-2. TUBE COMPLEMENT, SIGNAL GENERATOR 618B (CONT'D.)

Tube	Type	Function	Adjustments Required
V107	5814 (12AU7)	Delay Multivibrator	Par. 4-18 - Table 4-6
V108	5726 (6AL5)	Blocking Diode	None
V109	5814 (12AU7)	Pulse Amplifier Inverter and Delayed Sync Out Cathode Follower	None
V110	2D21	Thyratron Discharge Tube	None
V111	5814 (12AU7)	Pulse Width Multivibrator	Par. 4-19 - Table 4-6
V112	12AT7	Clipper and Klystron Bias Regulator	Steps 7 & 8 - Table 4-4
V113	5763	Modulator	Steps 7 & 8 - Table 4-4
V114	6236	Radio Frequency Oscillator	Par. 4-10, 4-11 & 4-12
V115	5814 (12AU7)	Delayed Sync Out Multivibrator	None
V301	5R4GY	Full Wave Rectifier	None
V302	6AU6	Regulator Amplifier	Step 1 - Table 4-4
V303	6AS7	Series Regulator	Steps 1 & 2 - Table 4-4
V304	OA2	Voltage Regulator	Step 1 - Table 4-4
V305	5R4GY	Full Wave Rectifier	None
V306	6AU6	Regulator Amplifier	Step 2 - Table 4-4
V307	5R4GY	Full Wave Rectifier	None
V308	6AS7	Series Regulator	Step 4 - Table 4-4
V309	6AU6	Regulator Amplifier	Step 4 - Table 4-4
V310	OA2	Voltage Regulator	Step 4 - Table 4-4
V311	OA2	Voltage Regulator	Step 4 - Table 4-4
V312	OA3	Voltage Regulator	Steps 4 & 5 - Table 4-4
V313	OA2	Voltage Regulator	Step 6 - Table 4-4
V314	OA2	Voltage Regulator	Step 6 - Table 4-4

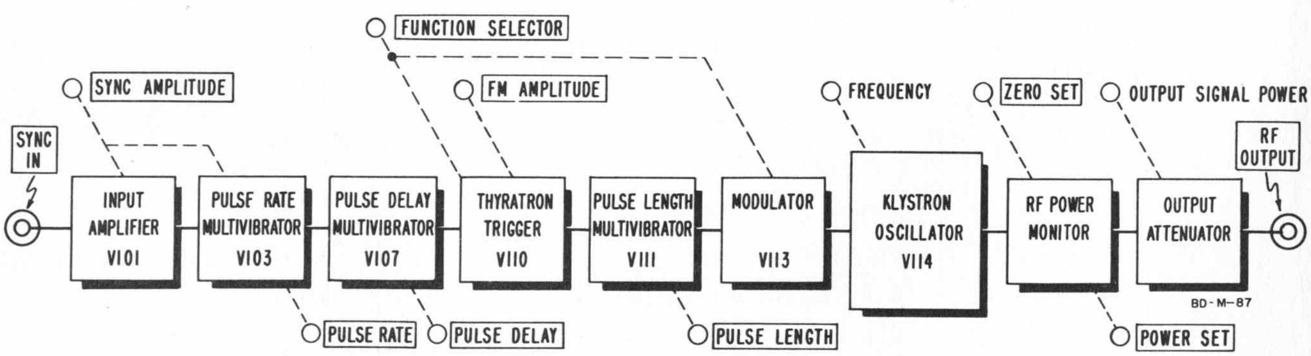

Figure 4-3. Block Diagram showing Major Circuits and Operating Controls

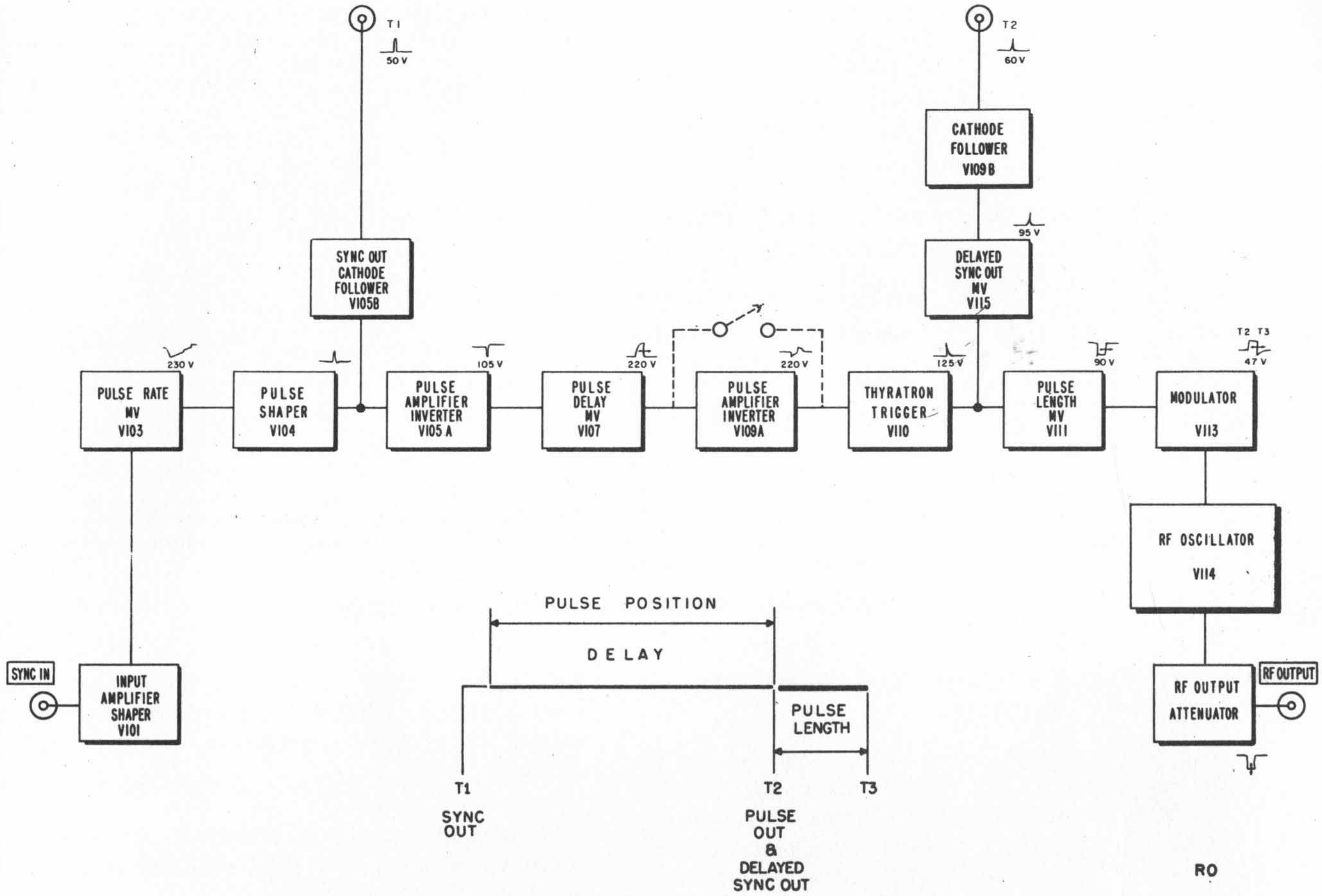

Figure 4-4. Block Diagram showing Important Waveforms

4-7 TROUBLE LOCALIZATION

The Model 618B SHF Signal Generator is a precision instrument conservatively designed for long component life, and it is expected that tube replacement and adjustments will repair a majority of troubles that may develop. Isolation of a circuit failure is best accomplished by considering the basic sections of the instrument as shown in the block diagrams Figures 4-3 and 4-4. Figure 4-3 shows the sections of the signal generator which are operated by the front panel controls. Figure 4-4 shows the important waveforms which may be expected at various points in the circuit.

The trouble shooting charts, Tables 4-4, 4-5, and 4-6 describe symptoms of improper performances with possible causes and remedies. The maintenance steps in the chart should be performed in the order given. For simplification, only the tubes are referred to in the chart, but it should be remembered that components associated with the referenced tubes are also failure possibilities. First, the power supply is checked, next the rf power monitor, the rf oscillator, and last the pulser section. For all testing of the 618B Signal Generator, the use of a variable transformer to adjust the line voltage between 103 and 127 volts is recommended. An instrument in good electrical condition should operate satisfactorily over this voltage range. An instrument having marginal operation (from weak tubes, etc.) can be quickly detected by reducing the line voltage to 105 volts. At this point, the various weaknesses are amplified and become easier to trace.

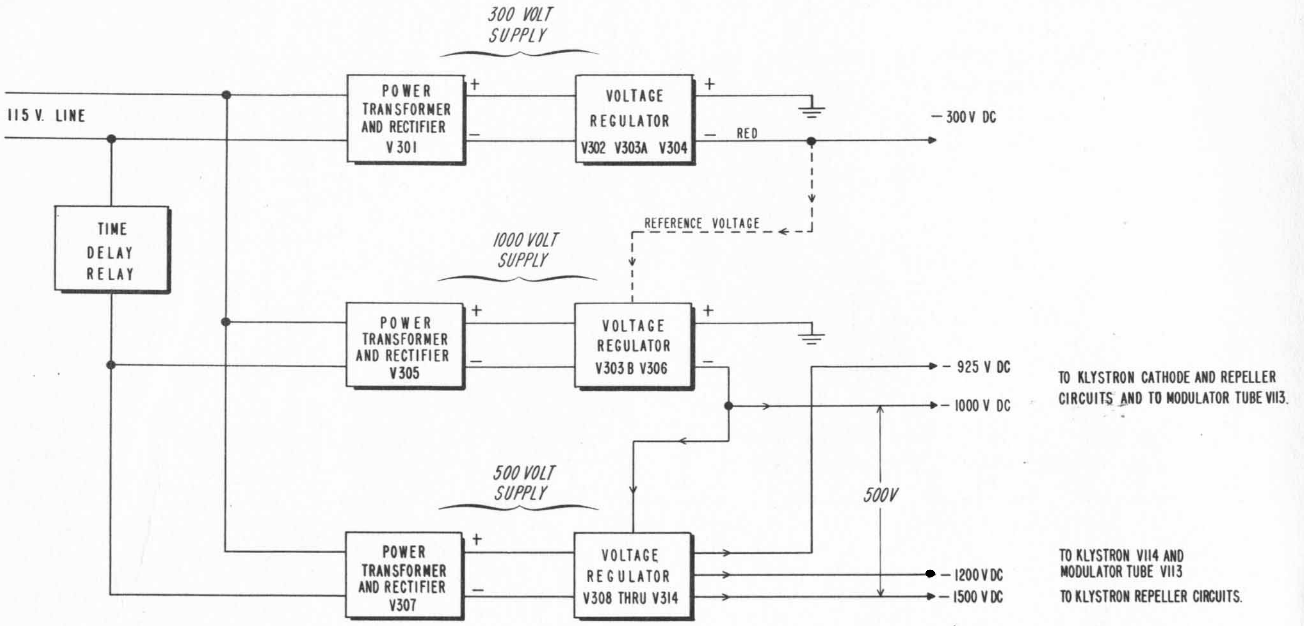

Figure 4-5. Block Diagram of Power Supply

4-8 TROUBLE SHOOTING THE POWER SUPPLY SECTION

Correct operation of the power supply is vital to proper operation of the signal generator. Noise or variation in the regulated voltages causes other circuits to operate in a random or erratic manner. It is advisable to make resistance and voltage checks on the power supply whenever the 618B is suspected of marginal operation and prior to any service work. This will eliminate such factors as low voltages or poor regulation as causes of unsatisfactory performance.

The power supply section of the 618B contains three regulated power supplies as shown in Figure 4-5. The 300 volt and the 1000 volt supplies both have their positive terminals grounded to the chassis which means that their output voltages are negative with respect to the chassis. The 500 volts supply is connected to the output of the 1000 volt supply so that the output voltages from the 500 volt supply are algebraically added to the 1000 volt supply.

The 300 volt supply is independent of the other two supplies and delivers -300 volts for operation of the modulator section of the 618B. The -300 dc regulated voltage is used as a reference voltage for the regulator in the 1000 volt supply. Any changes in the 300 volt supply output will be reflected in the 1000 volt supply.

The 500 volt supply has output voltages of + 75, -200, and -500 with respect to a common point within the supply. This common point is connected to the -1000 volt output from the 1000 volt supply to provide voltages of -975, -1200, and -1500 dc volts.

When the instrument is turned on, a thermal time delay relay turns the 1000 and 500 volt supplies on after a 30 second delay.

To check the power supply, measure the voltages and resistances at the rear of the instrument with the cabinet removed (see Figure 4-6, Power Supply Section). Table 4-3 lists the proper voltage and resistance values that may be read at the points called out in Figure 4-6. Make all measurements with a 20,000 ohm/volt multimeter.

TABLE 4-3. POWER SUPPLY TEST MEASUREMENTS

Power Supply Voltage	Current OFF	(MA) CW	Resistance
-300 v to gnd	83	83	10,000 Ω to gnd
-1000 v to gnd	4.8	25	200,000 Ω to gnd
-1200 v to gnd (-200 v to -1000 v supply)	5.7	33	28,000 Ω to 1000 volt bus
-1500 v to gnd (-500 v to -1000 v supply)	35	58	135,000 Ω to -1000 volt bus

Adjust the voltage applied to the instrument between 104 and 126 volts while measuring the output voltage of the regulated supply in question. The regulated voltages may vary ± 1% with a line voltage change from 104 to 126 volts. Hum level should be less than 30 millivolts with the same line voltage variation.

For these measurements, the MOD. SELECTOR should be in the OFF position unless otherwise specified.

TABLE 4-4. POWER SUPPLY TROUBLE SHOOTING AND TUBE REPLACEMENT PROCEDURE

Check and Symptom	Possible Cause	Remedy
1. Check the -300-volt supply. Measure voltage between instrument chassis and the top terminal of C303 (small red lead).		
Small deviation:	Out of adjustment.	Adjust R307 to obtain 300 volts; check all regulated voltages. Figure 4-6.
Low voltage:	Defective rectifier V301 or regulator V303.	Replace V301 and/or V303. Adjust R307 as above.
	Excessive loading.	Check resistance of and current through load. (See list above).
High voltage:	Defective control tube V302.	Replace V302. Adj. R307 as above.
Erratic, unstable voltage:	Defective reference tube V304.	Replace V304. Adj. R307 as above.
2. Check the -1000-volt supply. Measure voltage between instrument chassis and the top terminal of C308 (large red lead).		
Small deviation:	Out of adjustment.	Adjust R320; check all regulated voltages. Figure 4-6.
No voltage:	Defective relay K301.	Replace K301; check time delay.
	Burned out resistor R316.	Replace R316 and locate reason for burnout.
Low voltage:	Defective rectifier V305 or regulator V303.	Replace V305 and/or V303. Adjust R320 as above.
High voltage:	Defective control tube V306.	Replace V306. Adj. R320 as above.
3. Check -360-volt pulser bias. Measure the voltage between the center arm of potentiometer R329 and chassis.		
Incorrect voltage:	Out of adjustment.	Adjust R329 to obtain -360 volts. Figure 4-6.
	Excessive loading	Check pulser for short.

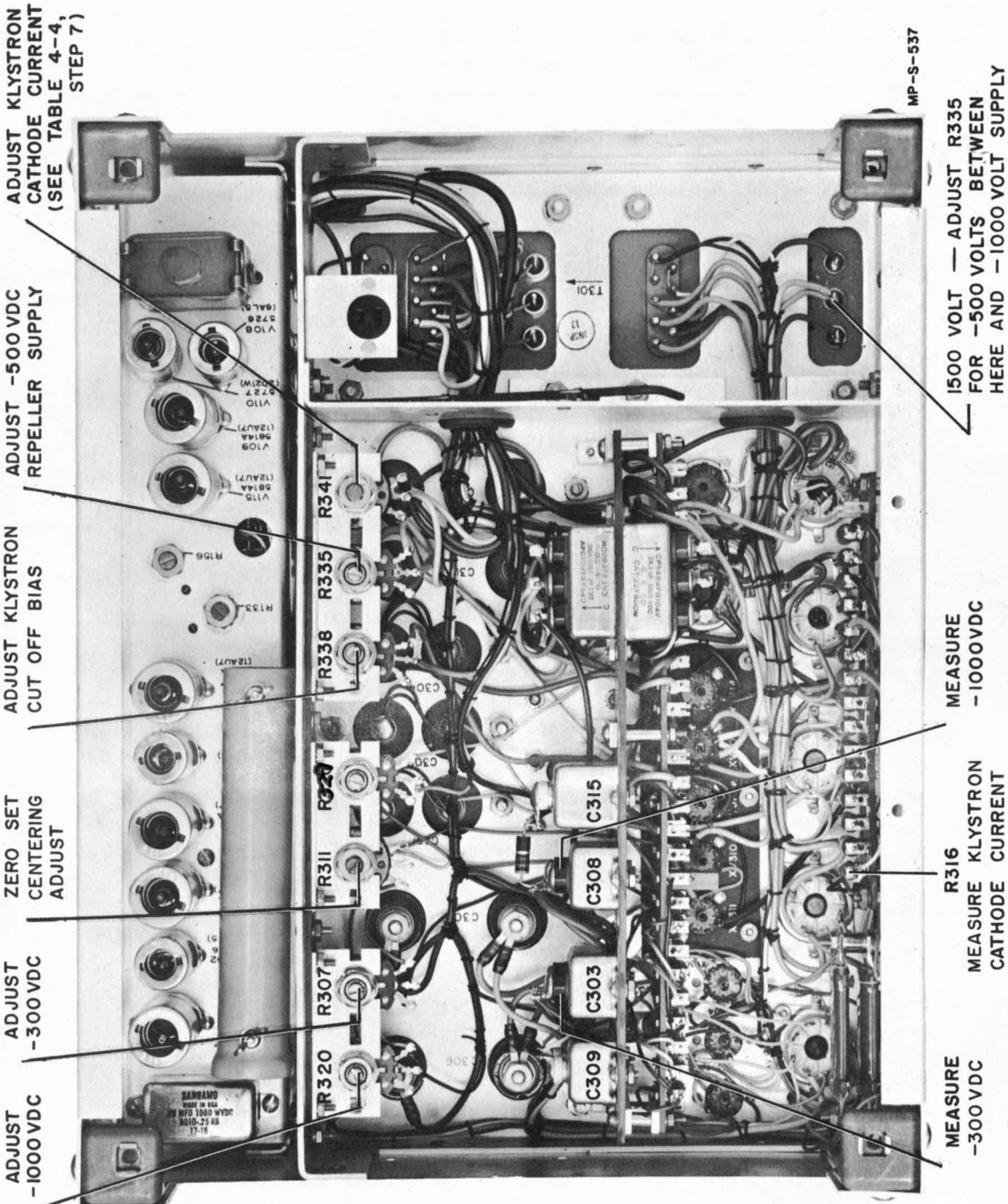

Figure 4-6A. Rear View Showing Power Supply Section

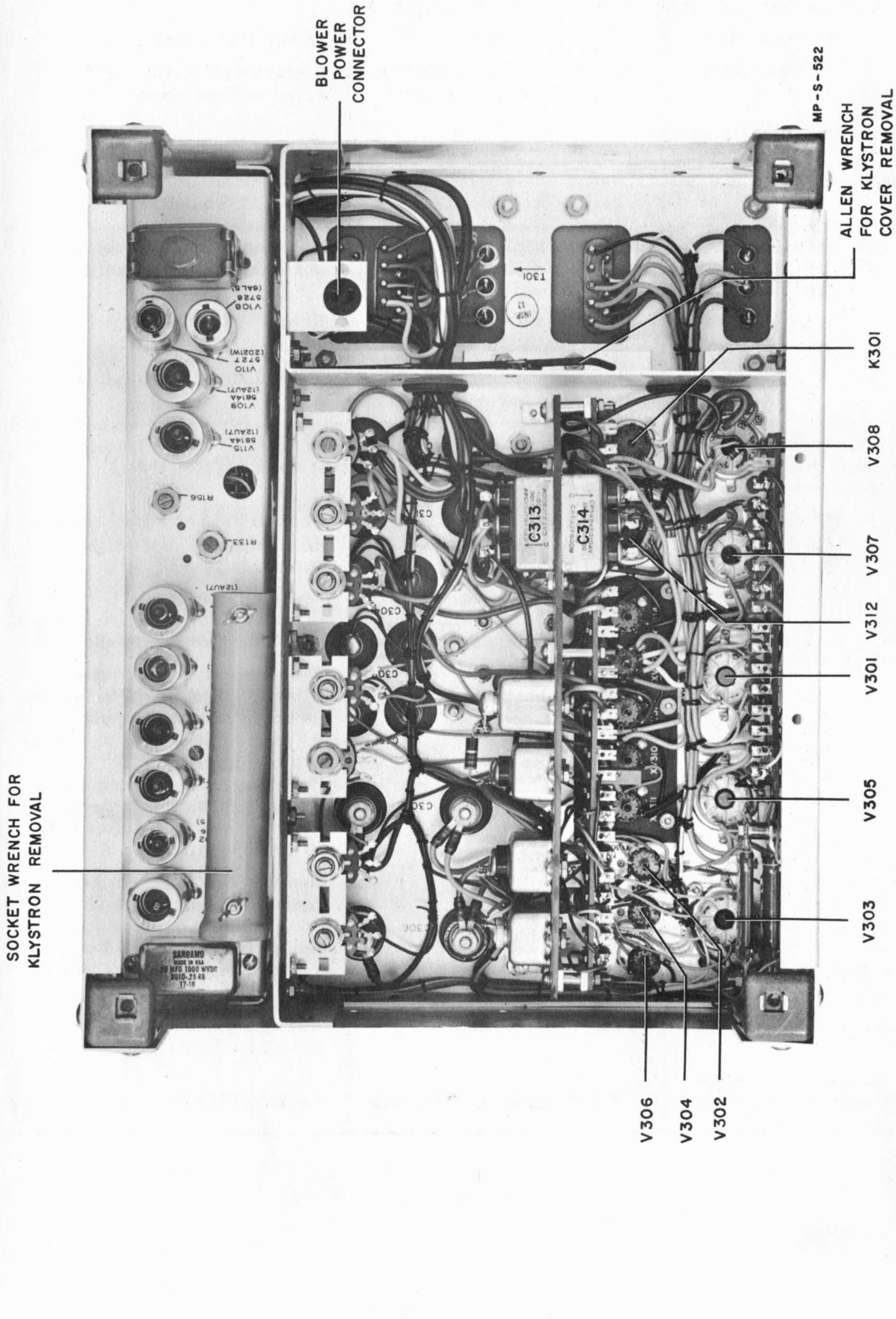

Figure 4-6B. Rear View Showing Power Supply Section

TABLE 4-4. POWER SUPPLY TROUBLE SHOOTING AND TUBE REPLACEMENT PROCEDURE (CONT'D.)

Check and Symptom	Possible Cause	Remedy
4. Check the -500 volt klystron repeller supply. See Figure 4-6.		
Small deviation:	Out of adjustment.	Adjust R335 to obtain -500 volts.
Low voltage:	Defective rectifier V307 or regulator V308 or shorted capacitor C314.	Replace V307 and/or V308; adjust R335 as above.
High voltage:	Defective control tube V309.	Replace V309. Adj. R335 as above.
Erratic, unstable voltage:	Defective reference tubes V310, V311 and V312.	Replace V310, V311, V312; adjust R333 as above.
5. Check regulator V312 with the MOD. SELECTOR in OFF and CW positions. Measure voltage between the center and top terminals of C308 (large red and brown leads). Voltage should remain stable at 75 volts.		
Unstable or incorrect voltage:	Defective V312.	Replace V312. No adjustment required.
	Incorrect setting of klystron off-bias adjustment R338.	Reset R338 as described in step 8.
6. Check regulators V313 and V314 with the MOD. SELECTOR in the OFF and ON positions. Measure voltage between center and top terminals of C314 (large black and pink leads). Voltage should remain at 300 volts.		
Unstable or incorrect voltage:	Defective V313 or V314. Incorrect setting of klystron off-bias adjustment.	Replace V313 or V314; readjust R338, klystron off-bias as described in step 8.
	Excessive loading.	Check for shorts.
7. Check the klystron cathode current. Measure the dc voltage across R316 (see Figure 4-6) with the MOD. SELECTOR in the CW position.		
Voltage too high or too low:	Out of adjustment.	Tune generator to a frequency above the point where the microswitch is actuated (approx. 5.0 to 5.5 kmc). Adjust R341 to obtain approx. 2.3 volts. Tune generator to a frequency below the point where the microswitch is actuated. Adjust R355 to obtain approx. 1.4 volts.
Cannot increase this voltage by adjustments of R341 and R355:	Weak klystron V114	Replace V114, as described in para. 4-10, 4-11 and 4-12.
8. Check the klystron off-bias. Connect the dc voltmeter between the top terminal of C308 and the junction of R164 and R165. Fig. 4-13. Voltmeter should read from -22 to -25 volts with the MOD. SELECTOR in the OFF position.		
Voltage too low or too high:	Out of adjustment.	Adjust R338 to obtain -22 volts or slightly more if required to cut off the klystron.
Cannot increase this voltage by adjustment of R338:	Weak modulator V113, V112.	Replace V113 and readjust R338.

4-9 CHECKING AND TROUBLE SHOOTING THE RF GENERATOR SECTION

Satisfactory voltages obtained in the power supply trouble shooting chart assure that with the exception of the klystron repeller voltages, the proper operating voltages are applied to all portions of the signal generator. The 618B can generate a cw output signal with a minimum of circuits operating. The output meter monitors the klystron itself directly and if known to be operating properly may be used to check operation of the klystron oscillator. The chart continues below and lists steps to determine if the rf power monitor and rf generator are operating; and, if not, where the trouble lies.

TABLE 4-5. RF GENERATOR TROUBLE SHOOTING CHART

Check and Symptom	Possible Cause	Remedy
1. Note output meter indications with MOD. SELECTOR at OFF.		
Meter inoperative; no zero set:	No supply voltage. Fuse F303 blown.	Measure supply voltage at R185; should be approx. -3 volts from ground. Replace F303 and determine cause for burnout.
	Open meter M101.	Disconnect meter and check continuity. Caution: 200 μamp movement.
Meter pins upscale or downscale:	Shorted or open component on one or other side of bridge to cause unbalance.	Disconnect one side of meter. Measure supply voltage at R185; should be approx. -3 volts from ground. Then measure the voltage between each side of the bridge to determine side at fault. The voltage at both midpoints on each side of the bridge should be 1/2 the voltage applied to the bridge from ZERO SET potentiometer R185.
Meter erratic under all conditions:	Unstable thermistor R202.	Replace power monitor assembly and recalibrate the attenuator as described in para. 4-14.
Meter indicates rf power output with the MOD. SELECTOR in the OFF position:	Defective modulator tube V113.	Replace V113 and reset klystron operating bias as described in step 7, Table 4-4.
2. Reading the front panel output meter, check cw operation of klystron over the full frequency range:	Unstable klystron operation, particularly at high frequency end of range due to poor klystron seating in cavity or improper repeller supply voltage settings, insufficient beam current or weak klystron.	Check setting of repeller voltage as described in para. 4-12. If voltages cannot be improved, check seating. Remove tube and clean up seat. Using care not to scratch glass, clean klystron grid rings. Reseat as in para. 4-11. Check beam current as in step 7, Table 4-4.
Poor pulse output, cw output satisfactory:	R170, R173, R175, and R352 out of adjustment.	See para. 4-12.

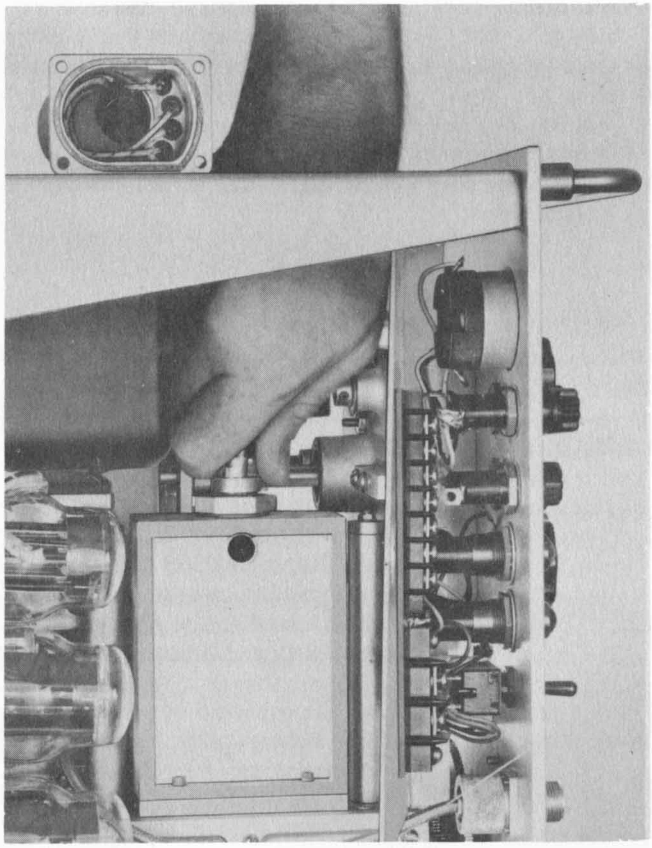

Figure 4-7. Instrument in Position for Klystron Removal

4-10 KLYSTRON REMOVAL V114

To remove the klystron oscillator tube V114 from the resonant cavity, remove the instrument from the cabinet as described in paragraph 4-2. Place the instrument in the position shown in Figure 4-7 for ease in reaching the tube.

1) Remove the socket housing cap, screws and lock washers (items 1 and 2 shown in Figure 4-8) with the large key wrench located in the Fahnstock storage clip on the rear chassis. Pull the housing (item 3, Figure 4-8) away until the tube socket is exposed.

2) Pull straight back on the socket until it is free of the tube base. DO NOT apply lateral pressure when removing socket.

3) Unscrew and remove sleeve (4) which covers klystron body.

CAUTION: Do not at any time apply side motion to the klystron; to do so will break the tube.

4) Turn klystron (6) clockwise, and at the same time pull straight back from the cavity. Do not attempt to rock the klystron.

5) Remove clamping ring (5).

6) Unscrew retaining nut (7) at cavity entrance using socket wrench supplied with the instrument. Remove the seating ring (9) and the spring (8) below retaining nut. Do not use this spring or washer again except as a necessity. New springs and washers are supplied with replacement klystrons ordered from Hewlett-Packard Co.

7) If the cavity ventilating pipe connector (11) protrudes into the cavity, remove the connector nut (9) and disengage pipe (10). Loosen set nut (12) and back out adapter (11) until it is flush with the inside face of the cavity bottom plate.

NOTE: See Klystron Tube Warranty Claim in this manual.

4-11 KLYSTRON REPLACEMENT

Prior to installing a new klystron V114, practice reinstalling the old one. The proper force and twist required to push the klystron past the spring may then be learned by practice. The procedure for installing the new klystron is as follows:

1) Install new "waffle" seating ring (9) and then new spring (8) in cavity entrance. Ends of spring should meet to form a complete circle.

2) Thread the retaining nut (7) into cavity until it is seated very lightly against the spring. Press spring into place under the nut so that it forms a circle. Tighten the nut slightly to hold the spring in position.

CAUTION

When inserting the tube, always keep it straight in line with the cavity. DO NOT work it from side to side.

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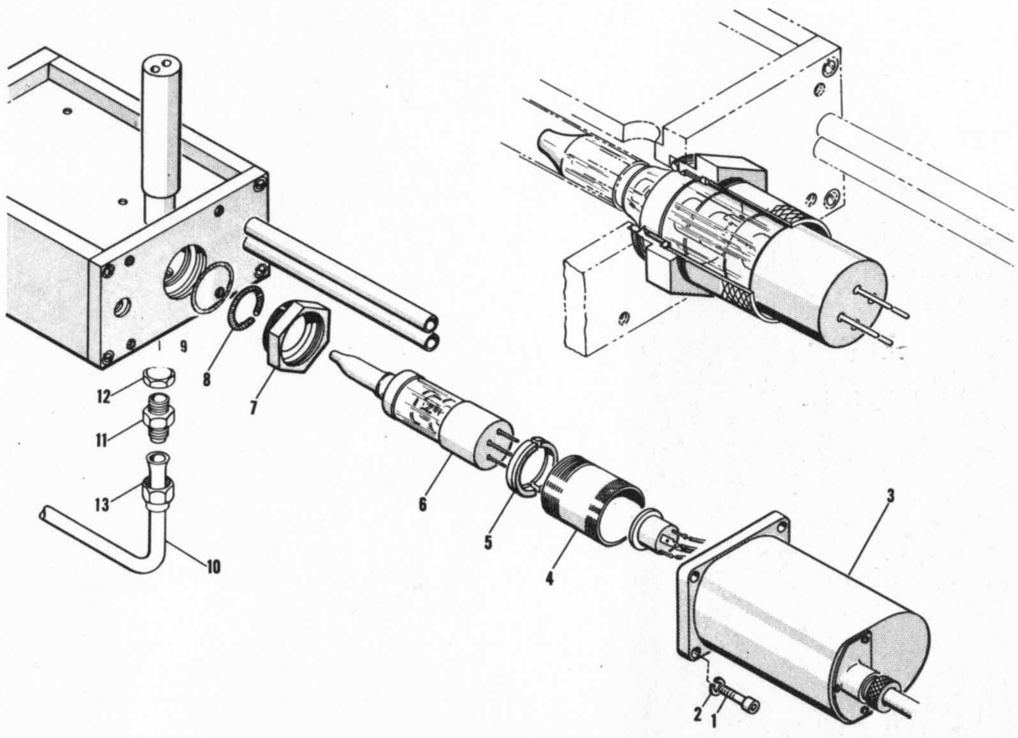


Figure 4-8. Exploded View of Klystron Mounting Parts

3) Insert the klystron tube (6) into the cavity until it engages the spring (8). Firmly press the tube straight into the cavity at the same time giving it a clockwise twist. The twist will cause the spring to expand and pass the tube allowing it to seat firmly in the cavity.

4) Tighten the retaining nut moderately with socket wrench supplied.

5) Insert the clamping rings (5) making certain that they encircle the grid ring of the klystron which may be seen just inside the retaining nut. When the rings are in position three or four threads of the nut (7) should be visible between the clamping rings and the outside face of the nut.

6) Thread the cover sleeve (4) into the retaining nut so that it seats against the clamping rings, causing the clamping ring to grip the grid ring of the klystron. Tighten the sleeve firmly by hand.

7) Install the tube socket and housing (3), pressing the socket straight into position.

8) Position socket housing. Attach cap screws (1), and tighten with large key wrench supplied.

4-12 ADJUSTMENTS FOLLOWING REPLACEMENT OF KLYSTRON V114

Following replacement of V114, it is important that certain adjustments be made as soon as the signal generator is turned on. The following procedure is recommended. Step references are steps included in trouble shooting chart.

1) With the signal generator removed from the cabinet and with MOD. SELECTOR on OFF, turn on signal generator.

2) Check the voltage of the -1000 volt supply as in step 2, Table 4-4.

3) Check the voltage of the -585 volt supply as in step 4, Table 4-4.

4) With the MOD. SELECTOR set to CW, adjust the klystron cathode current (25 ma maximum) as in step 7, Table 4-4.

5) With the MOD. SELECTOR set to OFF, adjust the klystron cutoff bias as in step 8, Table 4-4.

A new klystron tube should now operate at least

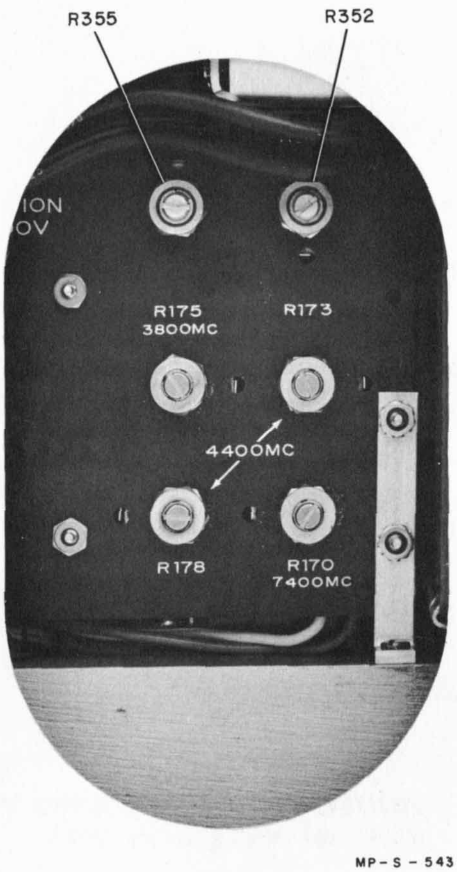


Figure 4-9. Right Side View showing Reflector Tracking Potentiometer

partially over the frequency range with original repeller voltage settings and for the most part, will require only 1/8 turn to bring the repeller voltage to optimum.

6) With a trigger input oscilloscope and an SHF detector connect instrument as shown in Figure 4-10.

7) Set MOD. SELECTOR to INT. (SYNC SELECTOR to X10). Tune FREQUENCY control to 7600 MC.

8) Adjust R170, shown in Figure 4-9, for optimum pulse shape.

9) At this point it is advisable to check the dial calibration at the high end stop. This check avoids possible retracking adjustments when the dial calibration is adjusted later. To conduct the check, tune frequency control to high end stop and place wavemeter in circuit as shown in Figure 4-10. Wavemeter should indicate 7650 MC. When the wavemeter is tuned to the actual frequency of the generator a slight decrease in the peak level of the pulse appears on the scale. If this frequency is more than 25 mc away from 7650 mc perform step 4 in paragraph 4-13.

10) Remove wavemeter and reconnect output cable as shown in Figure 4-10. Tune the frequency control toward 5000 MC adjusting R170 for best pulse shape between 7600 and 5000 mc.

11) Tune the frequency control between 5000 MC and 4200 MC, adjust R173 and/or R178 for optimum pulse shape.

12) Continue tracking the dial downward toward 3800 MC, adjusting R175 for optimum pulse.

13) Tune the FREQUENCY control back toward 7600 MC observing the pulse shape on the oscilloscope. Readjust the appropriate reflector tracking potentiometer as shown in Figure 4-9 for optimum pulse shape.

14) If pulse misfiring or jitter occurs at any point in the band which cannot be corrected by adjustment of the reflector tracking potentiometers, adjust R352 for frequencies above the micro-switch operation and R355 for frequencies below the micro switch.

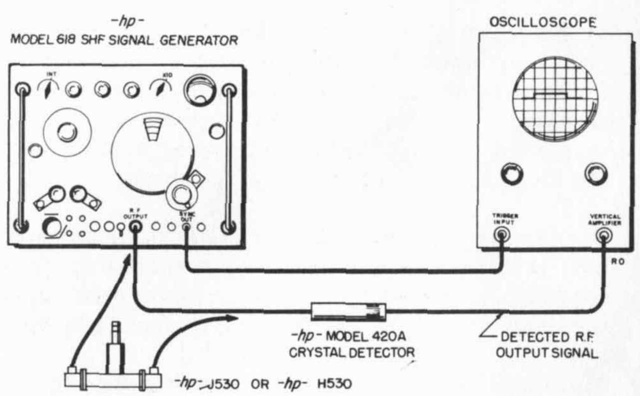


Figure 4-10. Test Setup for Observing Pulse Output

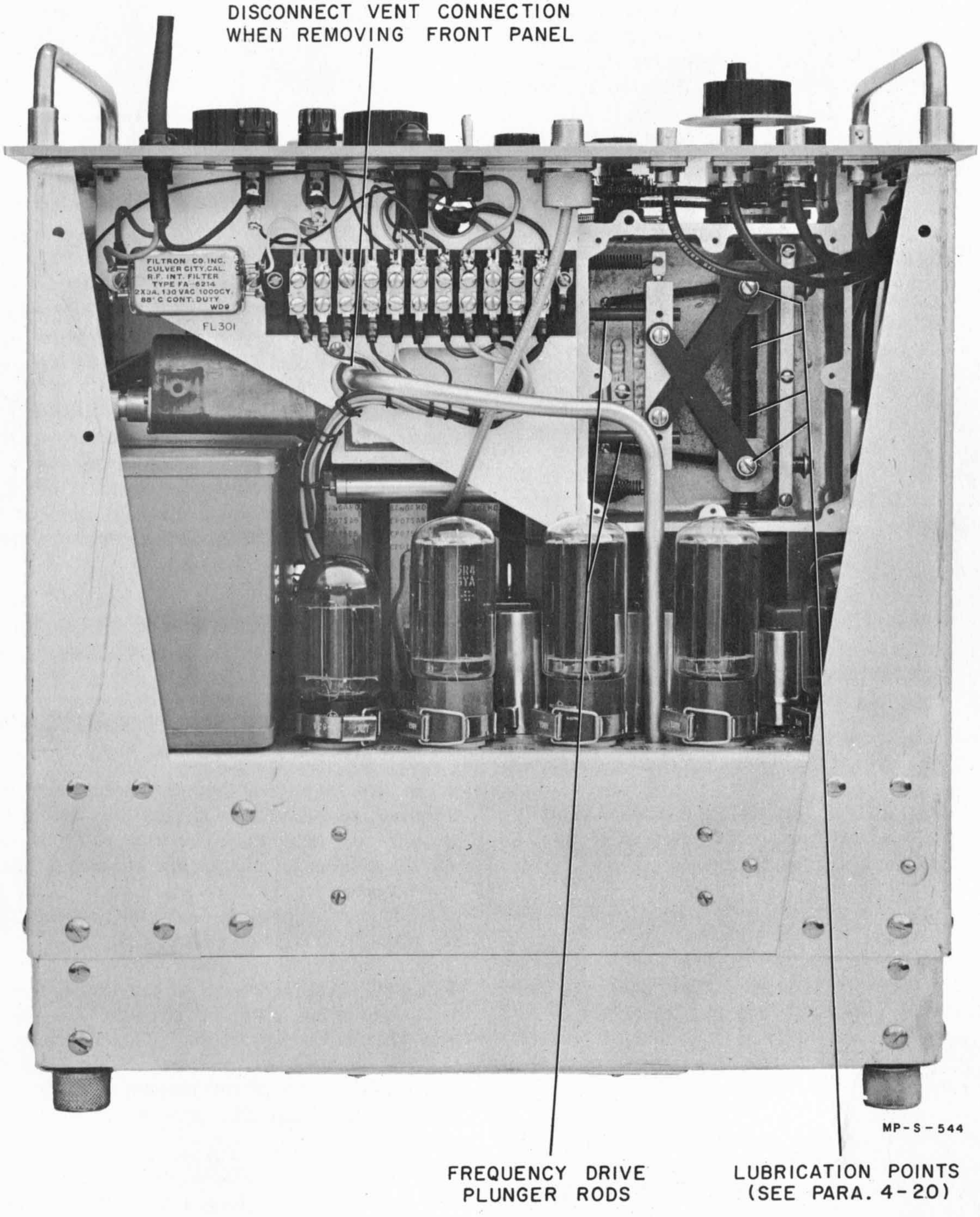


Figure 4-11. Bottom View Showing Plunger Drive

15) If satisfactory tracking adjustments still cannot be made, refer to step 2, Table 4-5. Proper adjustment of pulsing operation assures proper performance in CW and SQ. WAVE.

16) Set the MOD. SELECTOR to SQ. WAVE and observe the waveshape across the band. The waveshape may be improved by repeating the adjustment of R352 and R355 as outlined in step 14 above.

17) Check frequency dial calibration as described in paragraph 4-13.

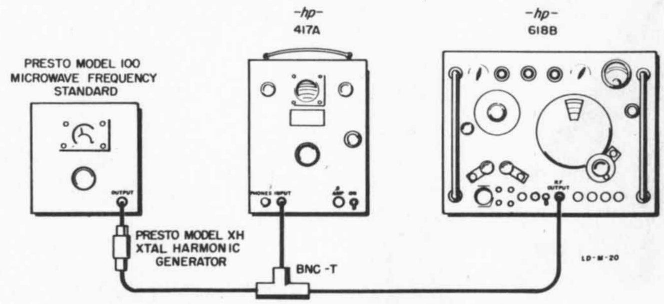


Figure 4-12. Test Setup for Frequency Calibration

4-13 CALIBRATING THE FREQUENCY DIAL

Replacing the klystron will usually reduce the accuracy of the megacycles dial by several percent from its rated accuracy of 1%. If accuracy of frequency dial calibration is important, the following procedure can be used to restore accuracy. This procedure requires a wavemeter covering the frequency range or a frequency standard setup. In general when a new klystron oscillator tube is installed it will be necessary to slip the frequency dial slightly to bring into calibration. In some cases, it may also be necessary to reset the plunger depth at the high frequency end of the band to re-establish the correct high frequency limit. There are no trimmers or other adjustment of that sort; all adjustments for frequency recalibration must be done mechanically.

To recalibrate the frequency dial following a change in klystron oscillator tube, proceed as follows:

1) Set MOD. SELECTOR switch to CW. The equipment should be allowed a warm-up of at least 20 minutes before checking calibration.

2) Tune signal generator to 7650 on MEGACYCLES dial.

3) Measure output frequency with wavemeter. If reading of MEGACYCLES dial is in error by more than approximately 100 megacycles, it will be necessary to remove plate that covers frequency drive assembly.

4) With MEGACYCLES dial still set at 7650, loosen set screws holding resonator plunger rods in drive bar, shown in Figure 4-11. Then manually move plunger rods in approximately 1/32 inch steps until output frequency is approximately 7650 megacycles as indicated by wavemeter. Tighten set screws in drive bar in this position.

5) Tune MEGACYCLES dial to 7500. Measure output frequency with wavemeter. If output frequency does not agree with dial within 1%, adjust the frequency dial slightly by slipping it on its shaft.

6) Check calibration of MEGACYCLES dial through range of generator, using a microwave standard and suitable detector. (Test setup shown in Figure 4-12.) If accuracy at lower frequencies is outside 1% tolerance, the dial can be slipped slightly on its shaft to obtain desired accuracy at lower frequencies.

7) It may not be possible to achieve 1% overall accuracy with some replacement klystrons. In this case try another klystron and repeat procedure.

4-14 REPLACING AND RECALIBRATING THE ATTENUATOR

It is not expected that the attenuator dial will require recalibration unless the attenuator assembly is replaced. The attenuator is not ordinarily subject to change or breakage. Small improvements in accuracy may be made by slipping the attenuator dial on the front panel slightly on its shaft to bring into calibration.

Following replacement of the probe, the attenuator assembly must be adjusted for the correct and safe operating depth. The following discussion is divided into two parts. The first concerns the replacement of the attenuator probe, and the second concerns the attenuator dial alignment.

CAUTION

There are high voltages on V112 and V113 tube shields. Turn off the instrument completely when replacing the attenuator and power monitor probe assemblies.

- - - - - - - - -

PART 1 - REPLACING ATTENUATOR PROBE

Power from the resonator is coupled to the RF OUTPUT jack at the front panel through an assembly consisting of the panel jack, a length of RG-55/U cable, and the attenuator probe. The attenuator probe is terminated by a special resistor, R203, which is made by coating platinum on a glass bead. This resistor should normally last for the life of the equipment even if subject to shock and vibration.

Should the resistor become broken or otherwise defective however, the complete attenuator assembly must be replaced. The stock number for this assembly is listed in the Table of Replaceable Parts (Section V).

If the glass bead becomes broken, the following two symptoms will usually be present:

- No rf output will be obtained, or will be obtained with erratic frequency response.
- The dc resistance between the center pin of the RF OUTPUT connector and ground will be very large.

Replace a defective attenuator assembly as follows:

1) Remove the four screws holding the RF OUTPUT connector to the front panel.

2) Release attenuator cable from under cable clamp.

3) Remove mounting screw which holds the rack to the aluminum block on the attenuator probe.

4) Lift mounting block and probe from the circular waveguide housing.

5) Use care in handling attenuator probes. The glass bead resistor can be broken by twisting the cable. Mounting block comes affixed to new probe.

6) Insert new probe into the waveguide only as far as is necessary to match up the block mounting holds. Insert mounting screw and tighten.

7) Carefully thread cable under cable clamp and around casting to front panel. Avoid twisting cable more than one-quarter turn.

8) Remount RF OUTPUT connector. Tighten cable clamp.

9) After the assembly is replaced, an error of a few decibels may exist in the calibration of the attenuator dial.

PART 2 - ATTENUATOR DIAL ALIGNMENT

1) The following equipment will be required for this operation:

a. An ⓗⓟ Model 477B Thermistor Mount or equivalent. The ⓗⓟ Model G485B Detector Mount and G281A Waveguide to Coax Adapter plus the ⓗⓟ Model J485B Detector Mount and J281A Waveguide to Coax Adapter can also be used.

b. An ⓗⓟ Model 430C Microwave Power Meter.

2) Connect rf power meter such as ⓗⓟ Model 430C to output end of output cable by means of a thermistor mount such as ⓗⓟ Model 477B. The ⓗⓟ Model G485B Detector Mount and G281A Waveguide to Coax Adapter can be used from 3800 to 5850 mc. The ⓗⓟ Model J485B Detector Mount and J281A Waveguide to Coax Adapter can be used from 5850 to 7600 mc.

3) Turn signal generator on and allow a 20 minute warm up period with modulation selector switch in CW position.

4) Turn modulation selector switch to OFF position, adjust zero set controls in generator and power meter to zero, and return modulation selector switch to CW position. To prevent drift due to temperature change make these adjustments as quickly as possible.

5) Tune signal generator to 3800 MC and adjust power set control for zero dbm indication on power set meter in generator.

6) Adjust detector mount for maximum reading on power meter with generator output attenuator set to 7 (-7 dbm). Record frequency and external power meter reading. If the 477B Thermistor mount is used, no adjustment of the detector mount will be required.

7) Repeat step 6 every 200 mc across entire frequency range. Change detector mount and adaptor as explained in step 2 at 5850 mc.

8) Plot a dbm-frequency curve from readings obtained in step 7. Resulting response curve will consist of a series of peaks and troughs having an amplitude of ±1.25 db or less. Draw a straight line (parallel to frequency axis) through response curve in such a way that variations are averaged about the line.

9) Select a frequency where response curve crosses average line drawn in step 8 and set generator to this frequency.

10) Repeat step 4.

11) Adjust detector mount for maximum reading on power meter (no adjustment required for 477B Thermistor Mount). Set generator output attenuator for -7 dbm reading on power meter and lock attenuator. If attenuator dial does not now read 7 (-7 dbm), remove plate covering hub of dial, loosen set screws holding dial to shaft and slip dial to read -7 dbm. Tighten set screws and replace plate over hub of dial.

12) Repeat step 10 and first part of step 11 without changing generator frequency. The readings obtained on external power meter and from output attenuator should be the same. If they are not, repeat steps 10 and 11 until they are the same.

4-15 POWER MONITOR PROBE ASSEMBLY

The power level within the resonator is sampled by an assembly consisting of the power monitoring probe, an open-head type thermistor at its tip, and the probe mounting block and terminals. The assembly will normally last the life of the equipment. However, in the event that replacement becomes necessary, the following procedure should be employed:

1) Remove attenuator probe as explained in ATTENUATOR ASSEMBLY.

2) Disconnect the fine black and white leads that are soldered to the terminals on the power monitoring probe mounting block.

3) Remove screw holding mounting block to end of rack gear.

4) Withdraw probe from circular waveguide housing. Mounting block comes affixed to new probe.

5) Insert new probe only as far as is necessary to line up mounting holes. It is important that the replacement probe not be inserted too far into the waveguide housing.

6) Install mounting screw and tighten.

7) Solder black lead to terminal which is connected to shell of probe.

8) Solder white wire to terminal which is connected to the center conductor of the probe.

9) Install attenuator as instructed in ATTENUATOR ASSEMBLY.

Upon installation of a new power monitoring probe the calibration of the attenuator dial will usually be inaccurate, necessitating recalibration of this dial in accordance with paragraph 4-14.

4-16 CHECKING AND TROUBLE SHOOTING THE PULSER SECTION

Trouble shooting the pulser section of the signal generator requires a high speed synchroscope to measure waveforms. By referring to the block diagram in Figure 4-4 and measuring the waveforms at front panel jacks and at various points in the circuit a fault can quickly be localized to a small portion of the pulser circuits.

Briefly, the operation of the pulser section is as follows:

1) When the MOD. SELECTOR is in the INT. position, V103 is a free running multivibrator that generates an approximate square wave, the frequency of which is controlled by the front panel PULSE RATE control. The output is differentiated and applied to pulse shaper V104.

2) The shaped pulse from V104 is applied to both the front panel SYNC OUT jack and to the pulse delay circuit.

3) The pulse delay multivibrator V107 is a one shot multivibrator producing one output pulse for each input pulse. The length of the output pulse is controlled by the front panel PULSE DELAY control.

4) The adjustable trailing edge from the pulse delay multivibrator is applied through amplifier-inverter V107 to thyratron pulse shaper V110 which provides a strong, fast output pulse to the delayed sync out and pulse width circuits.

5) When the MOD. SELECTOR is in the INT. FM position, thyratron V110 serves as a relaxation oscillator supplying a saw-tooth wave to the repeller circuits of the klystron.

6) The delayed sync out circuit utilizes a one shot multivibrator to provide a strong, fast pulse of a particular shape to the DELAYED SYNC OUT jack on the front panel.

7) The pulse width circuit utilizes a one shot multivibrator producing one output pulse for each input pulse. The width of the output pulse is controlled by the front panel PULSE WIDTH control.

8) The entire negative portion of the adjustable width output pulse from pulse width multivibrator V101 is applied to modulator tube V113.

9) The modulator tube which is normally in a conducting condition to hold the klystron cutoff is cut off by the negative pulse from pulse length multivibrator allowing the klystron to conduct for the length of the pulse.

10) Clamp V111 protects the signal voltage applied to the klystron control grid from going positive farther than -975 volts.

11) In general, coupling between circuits is done through clipping and/or clamping diodes. The diodes provide effective decoupling between circuits, eliminating unwanted portions (overshoot, extraneous pulses, and the unwanted polarity) of trigger pulses to prevent interaction between multivibrators. If interaction is present, it will most often be seen as erratic or double pulsing and is caused by extra-triggering of a multivibrator by some portion of a pulse from another multivibrator, or by a multivibrator that is free-running.

To trouble shoot the pulser section of the 618B Signal Generator, make the following tests in the order given. This order checks small circuit portions at a time at the front panel without going into the pulser circuitry.

TABLE 4-6. PULSER TROUBLE SHOOTING CHART

Check and Symptom	Possible Cause	Remedy
1. Check square wave operation. This check tests the pulse rate mv V103. (Square wave is approximately 3 db down from CW on output meter).		
Incorrect square wave frequency:	Out of adjustment or defective V103.	Adjust pulse rate as described in para. 4-17.
No square waves:	Defective V103.	Replace V103 and adjust rate as above.
2. Check internal FM operation. This check tests thyratron V110 and diode V108.		
No mode pattern obtainable:	Defective V110, V108B.	Replace without further adjustment.
3. Measure pulse at SYNC OUT jack. This check tests pulse shaper V104 and cathode follower V105B.		
Poor pulse shape or no pulse:	Defective V104 or V105B.	Replace V104 or V105B without further adjustment.

TABLE 4-6. PULSER TROUBLE SHOOTING CHART (CONT'D.)

Check and Symptom	Possible Cause	Remedy
4. Check pulse at DELAYED SYNC OUT jack. This check tests delayed sync out V115, pulse delay V107, amplifiers V105B and V109A and coupling diode V106.		
Poor DELAYED SYNC output pulse shape:	Defective V115 or V109B.	Replace V105 or V109 without further adjustment.
Inadequate delay time:	Out of adjustment or defective V107.	Adjust pulse delay as described in para. 4-18.
No output pulse:	Defective V106, V107, V109, or V115.	Replace V106, V107, V109 or V115, make adjustments as required.
5. Check rf output pulse. This check tests the remaining pulser circuit pulse length multivibrator V111.		
Inadequate pulse length:	Out of adjustment or defective V111.	Adjust pulse length as described in para. 4-19.
6. Apply external signal to SYNC IN jack.		
No rf output pulse:	Defective V101, V102.	

4-17 CALIBRATING THE PULSE RATE DIAL

Replacing V103 may lessen the accuracy of the PULSE RATE dial, but will not otherwise affect the performance of the signal generator. It should be noted, however, that the calibration of this dial is only approximate.

To calibrate the PULSE RATE dial, proceed as follows:

1) Connect SYNC OUT connector to the SYNC input of an oscilloscope.

2) Connect DELAYED SYNC OUT connector to the oscilloscope vertical amplifier input.

3) Connect the output of a calibrated audio oscillator to the oscilloscope vertical amplifier input through a 10,000 ohm isolating resistor.

4) Set the MOD. SELECTOR switch to INT. and the pulse rate to 4000 pps (SYNC SELECTOR switch to X10 and PULSE RATE control to 400).

5) Adjust the amplitude controls on the oscilloscope to obtain a convenient scope presentation.

6) Set the oscillator to 4000 cps.

7) Adjust the sweep rate of the oscilloscope so that several cycles of sine wave occupy the full width of the screen.

8) Adjust R112, Figure 4-13, so that the generated pulse rate is 4000 pps. When the repetition rate of the pulses is 4000 pps, each pulse will be superimposed upon each cycle of the sine wave. Adjust R112 until the pattern is stationary and all slope is removed (top of pulses in a straight, horizontal line).

9) Set the SYNC SELECTOR to X1 with the other controls remaining unchanged. Set oscillator to 400 cps.

10) Adjust R113 so that the generated pulse rate is 400 pps.

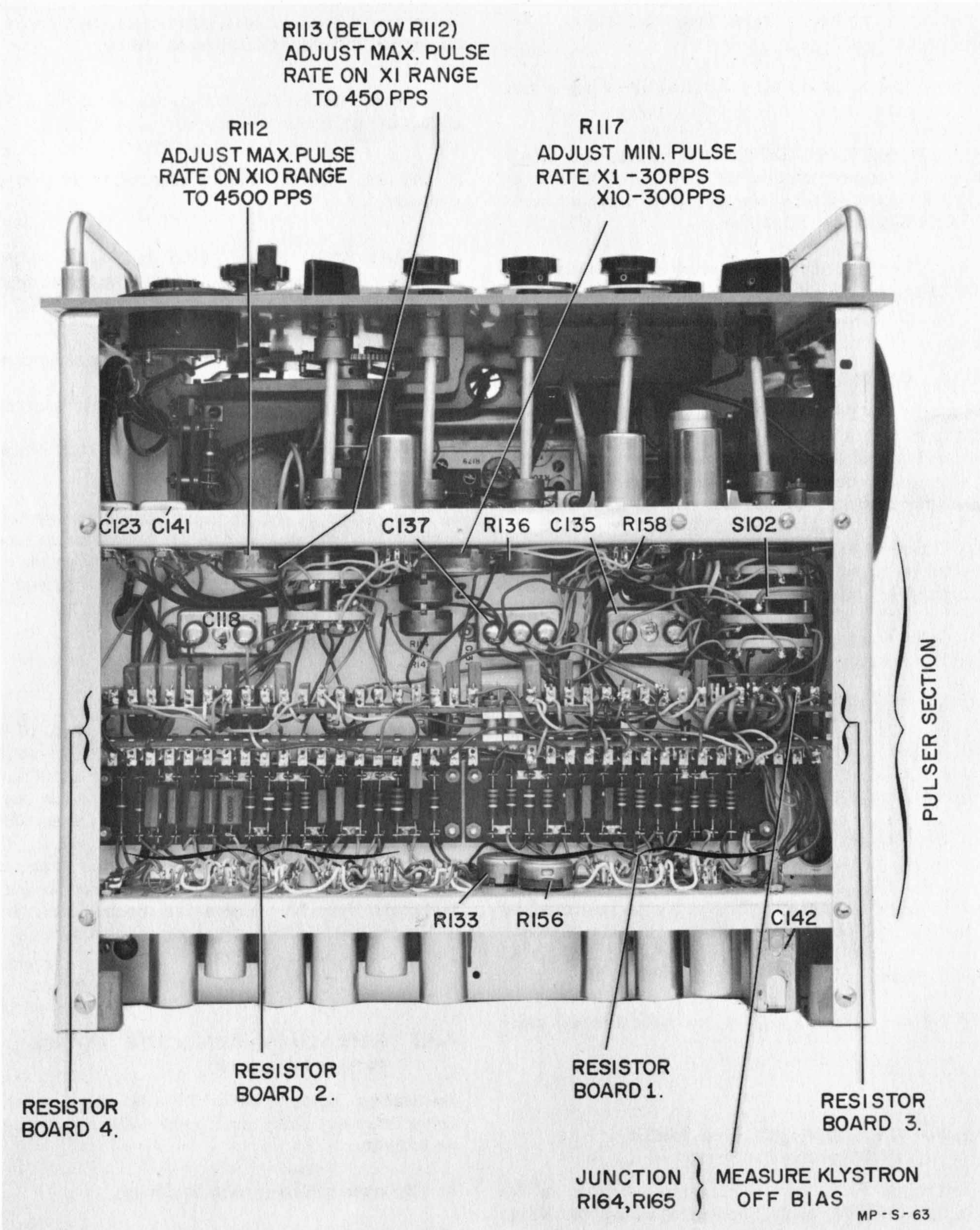


Figure 4-13. Top View Showing Pulser Section

11) Set the PULSE RATE control to 40 pps, with the other controls remaining unchanged. Set oscillator to 40 cps.

12) Adjust R117 so that the generated pulse rate is 40 pps.

13) Set the SYNC SELECTOR to X10 and check the calibration of the PULSE RATE dial in vicinity of 40. R117 can be readjusted to improve calibration accuracy if desired.

14) Refine the above adjustments as desired or for best overall accuracy.

4-18 CALIBRATING THE PULSE DELAY DIAL

Replacing V107 may lessen the accuracy of the PULSE DELAY dial. After replacing V107, the following procedure can be used to adjust the delay calibration; however, the calibration of the PULSE DELAY dial is intended only to be approximate.

1) Connect the DELAYED SYNC OUT terminal to the vertical input of an oscilloscope having an accurately calibrated sweep.

2) Synchronize the oscilloscope from the SYNC OUT connector.

3) Set PULSE DELAY control to 300 microseconds.

4) Adjust R133, Figure 4-6B or Figure 4-13, to give a delay of 300 microseconds as measured on the calibrated oscilloscope screen.

5) Set PULSE DELAY control to 3 microseconds as read on oscilloscope screen. If necessary, slip the PULSE DELAY dial on its shaft to make calibration accurate. The delay is indicated by the interval between the start of the oscilloscope trace and the leading edge of the DELAYED SYNC OUT pulse.

6) Repeat steps 3 and 4 for best overall calibration.

4-19 CALIBRATING THE PULSE WIDTH DIAL

Replacing V111 may lessen the accuracy of the PULSE WIDTH dial. After replacing the V111, the following procedure can be used to calibrate the PULSE WIDTH dial:

1) Connect the RF OUTPUT through a crystal detector to the vertical input of an oscilloscope having an accurately calibrated sweep.

2) Connect the SYNC OUT connector to the SYNC connector on the oscilloscope.

3) Set the PULSE WIDTH control to 10 microseconds.

4) Adjust R156, Figure 4-6B and 4-13, so that the width of the generated pulse is 10 microseconds as measured on the oscilloscope.

5) Set the PULSE WIDTH control to 1 microsecond.

6) If necessary, slip dial to read 1 microsecond.

7) Repeat steps 3, 4, 5 and 6 for best overall calibration accuracy.

8) The width of the rf pulse will vary approximately 1/4 microsecond as the generator is tuned through its rf range. The above adjustments can be made for best accuracy at any desired rf frequency.

4-20 LUBRICATION

It is not expected that the mechanical parts of the signal generator will require lubrication within the first year of operation. Moving parts such as the attenuator and power monitor rack gears are lubricated at the factory with Lubriplate 105V, Fiske Brothers Refining Co., Newark, N. J. The frequency drive gears behind the front panel are lubricated with a mixture of Shell Tonna Oil G and Molykote Type M. The drive mechanism shown in Figure 4-11 is lubricated with Shell Tonna Oil G. Do not lubricate cavity plunger rods.

4-21 REPLACING REFLECTOR POTENTIOMETER R174

To replace potentiometer R174 on the frequency drive casting, refer to Figure 4-14 and proceed as follows:

1) Disconnect blower tube at cavity.

2) Remove the four flat head screws on each side of the front panel that hold the panel assembly to

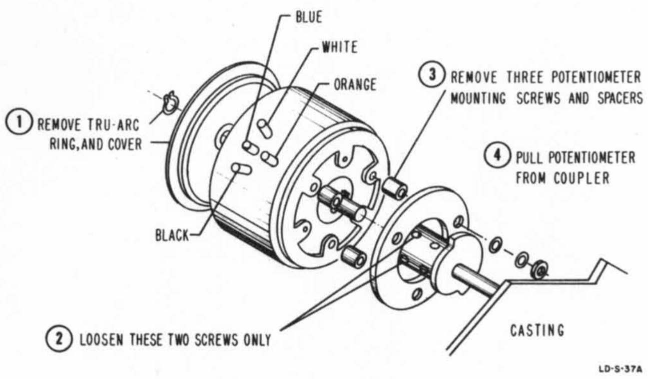


Figure 4-14. Detail showing Reflector Potentiometer Removal

the side gussets. Pull panel assembly away from the chassis to give access to the reflector potentiometer.

3) Remove leads from terminals on potentiometer.

4) Remove Tru-Arc ring and potentiometer rear cover.

5) Loosen only the two set screws holding potentiometer shaft in the coupler. Do not loosen screws holding coupler to the front panel shaft.

6) Remove the three screws holding the potentiometer to the mounting ring and withdraw potentiometer. Do not loosen screws holding mounting ring to casting.

7) Remove rear cover and place shaft of new potentiometer in the coupler. Do not tighten the set screws.

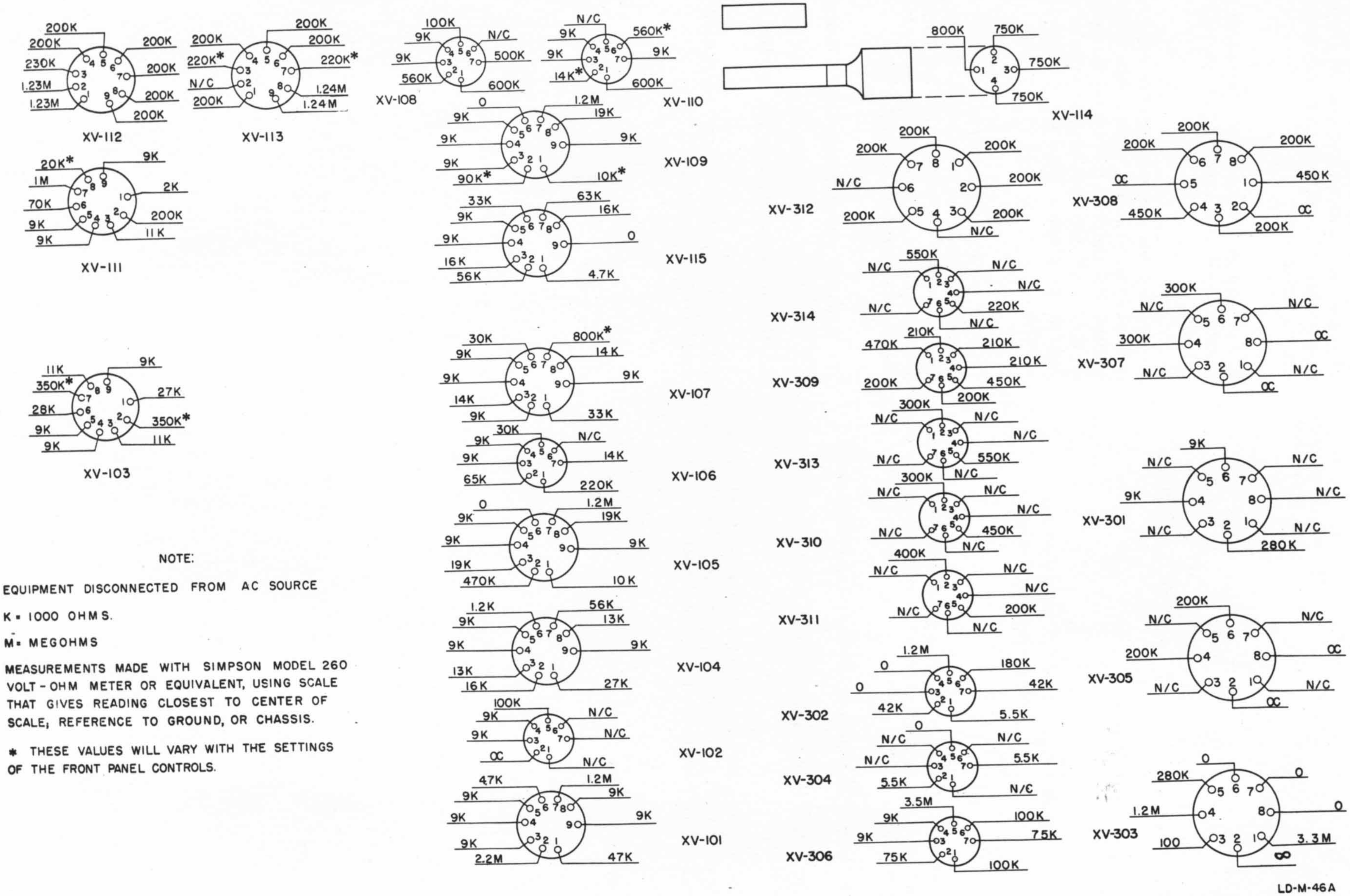
8) Position the new potentiometer with the terminals near the top and replace the three mounting screws and spacers. Position the potentiometer so that shaft does not bind in coupler during any portion of coupler rotation. Tighten mounting screws.

9) With an ohmmeter connected between the blue and white leads on the potentiometer, turn the frequency dial control to the high frequency stop. The resistance measured across these terminals should be between 50 and 100 ohms.

10) Replace rear potentiometer cover and reconnect leads.

11) Tighten set screws in the coupler.

12) Reset repeller voltage adjustments as described in paragraph 4-12.



NOTE:

EQUIPMENT DISCONNECTED FROM AC SOURCE

K = 1000 OHMS.

M = MEGOHMS

MEASUREMENTS MADE WITH SIMPSON MODEL 260 VOLT-OHM METER OR EQUIVALENT, USING SCALE THAT GIVES READING CLOSEST TO CENTER OF SCALE; REFERENCE TO GROUND, OR CHASSIS.

* THESE VALUES WILL VARY WITH THE SETTINGS OF THE FRONT PANEL CONTROLS.

Figure 4-15. Tube Socket Resistance Measurements

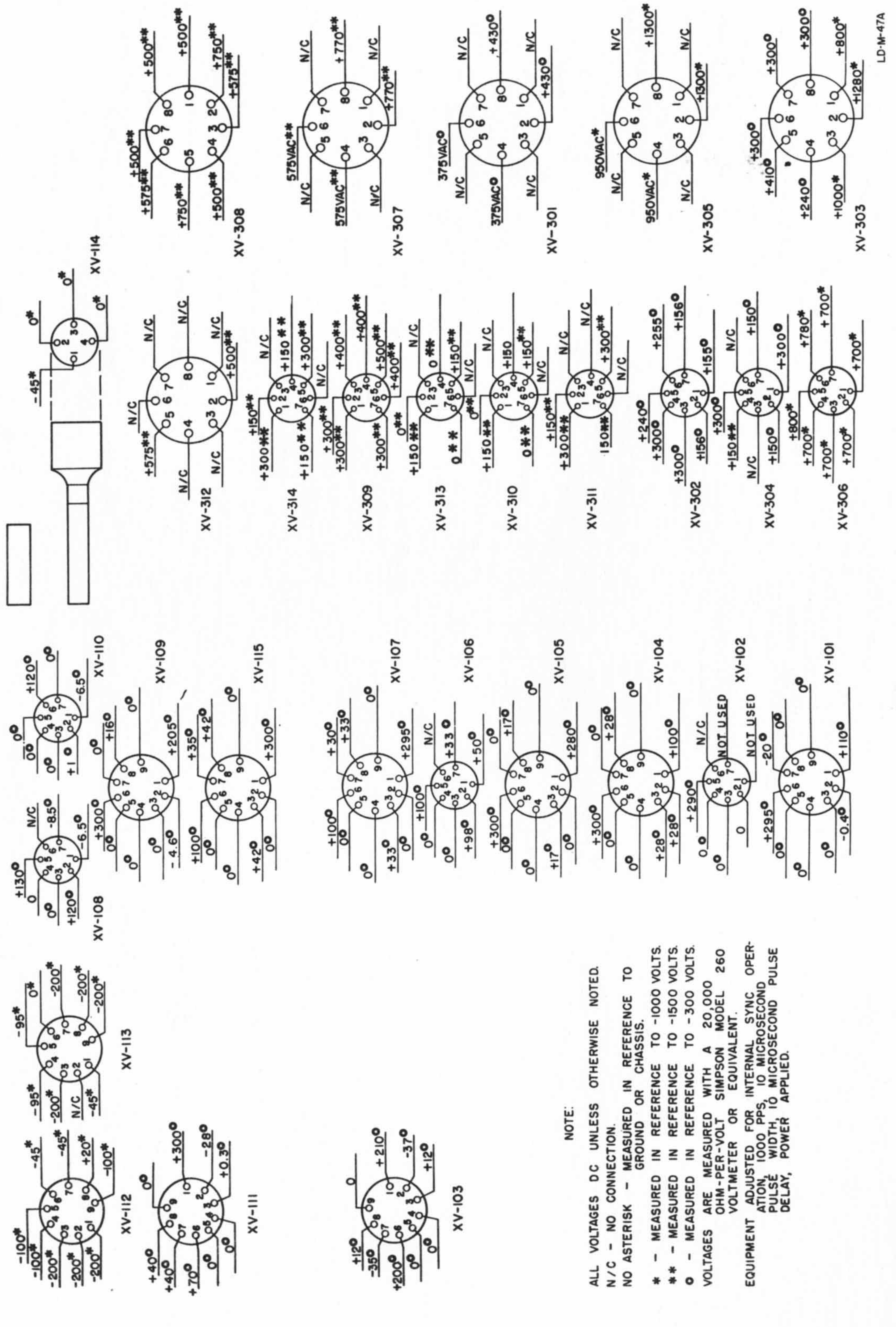


Figure 4-16. Tube Socket Voltage Measurements

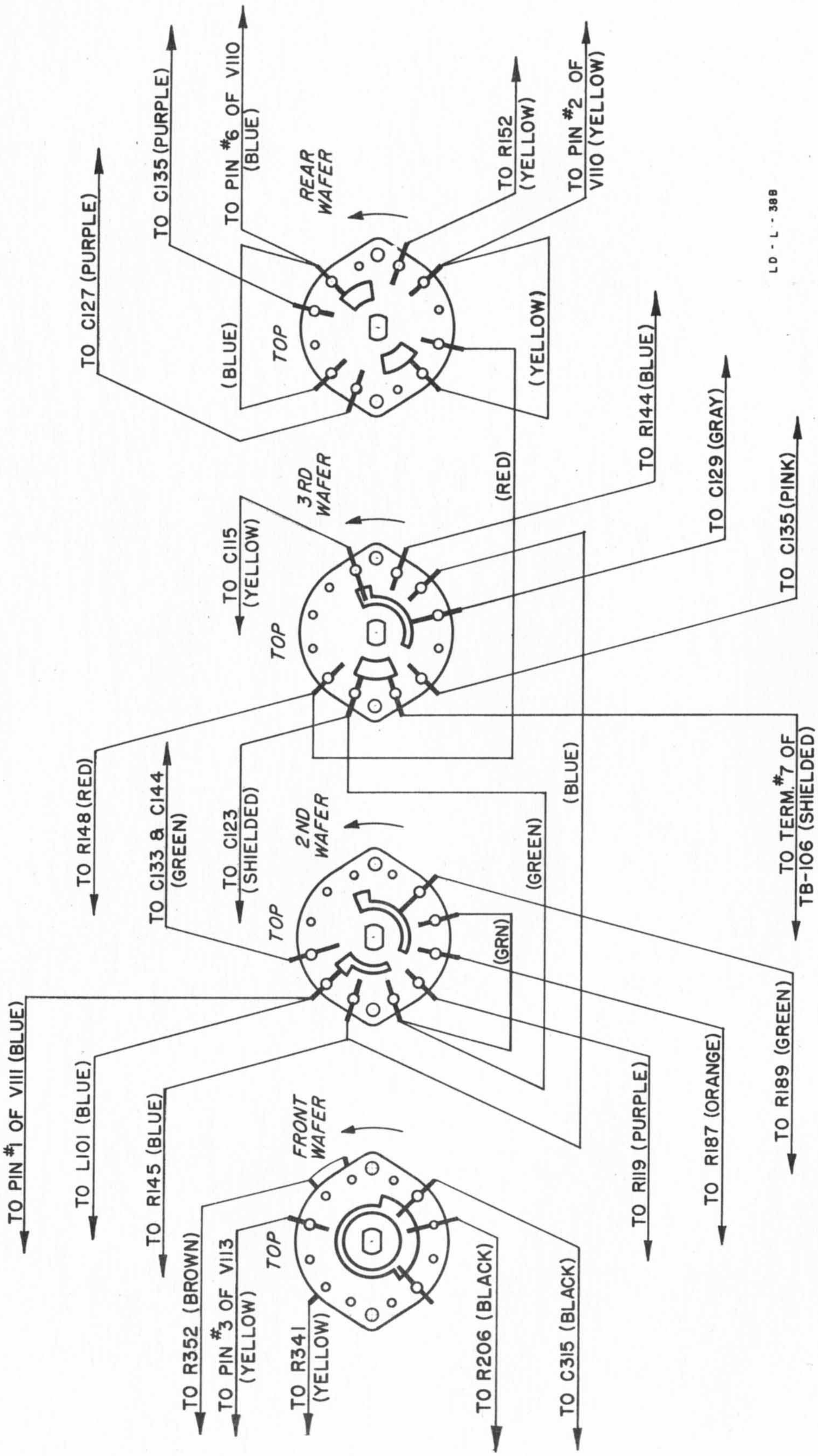


Figure 4-17. MOD SELECTOR Switch S102 Wiring Detail
Rear View all Sections EXT FM Position

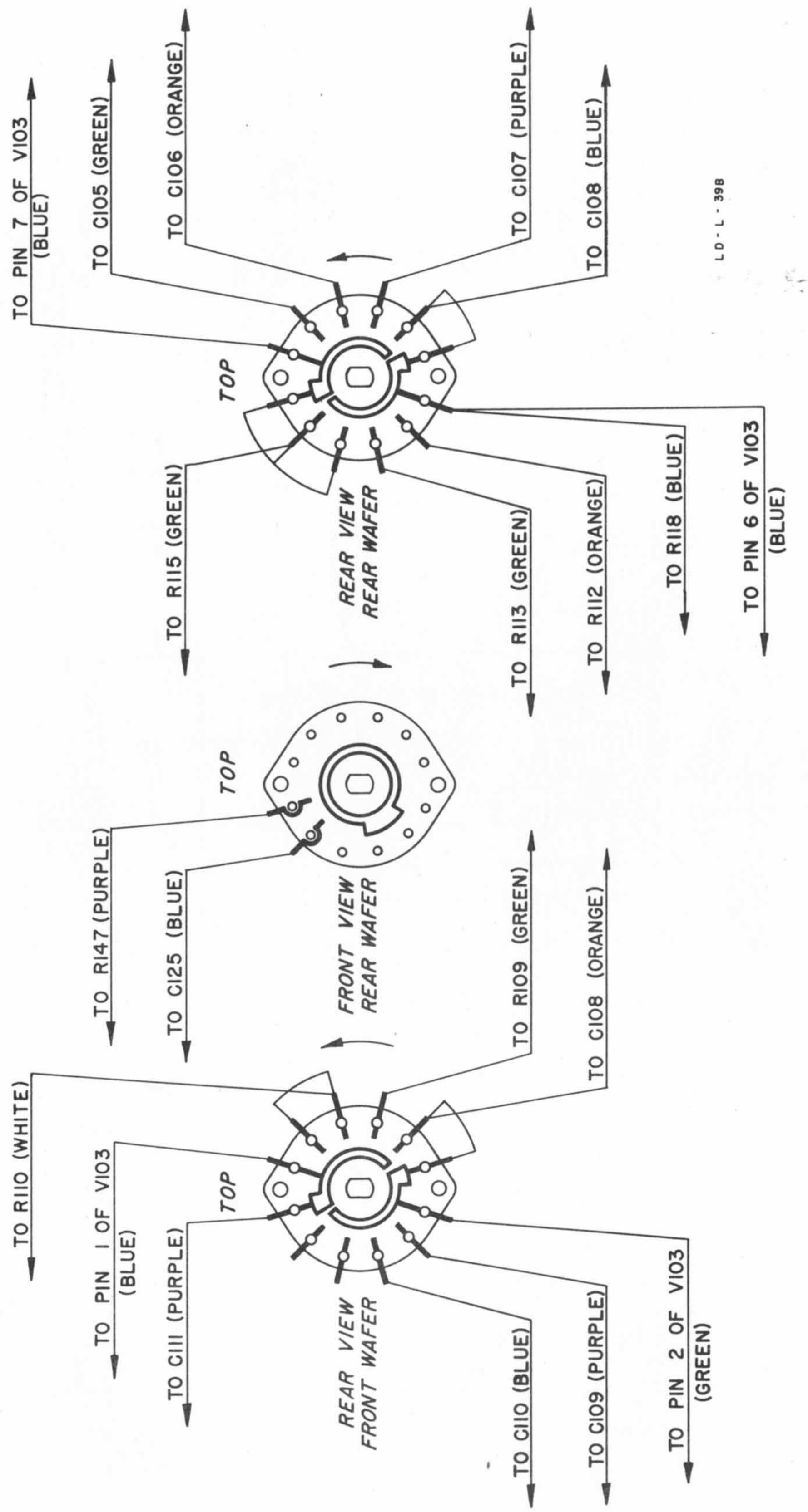


Figure 4-18. SYNC SELECTOR Switch S101 Wiring Detail. Phase Position

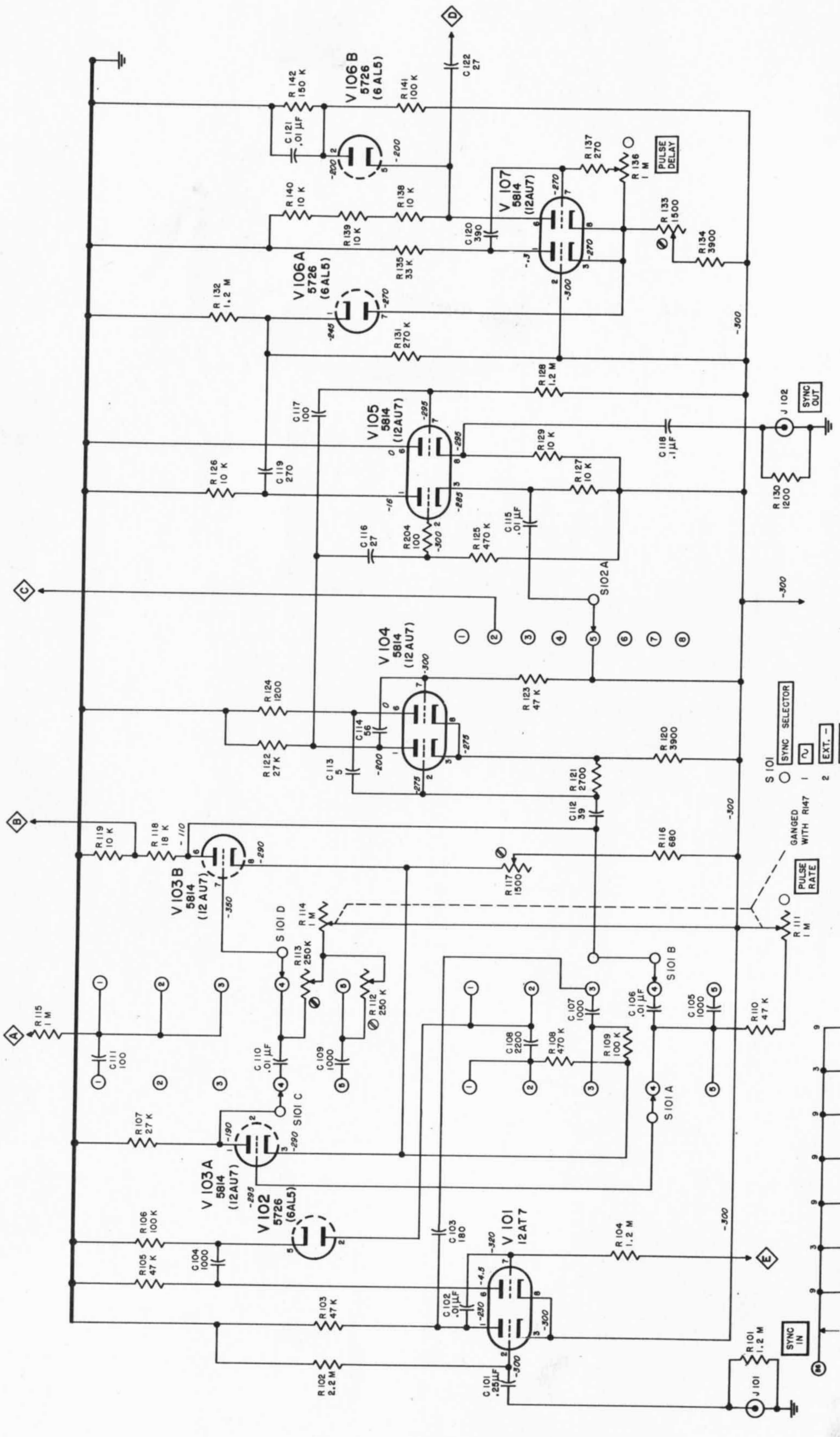


Figure 4-19. Modulator Section Part I

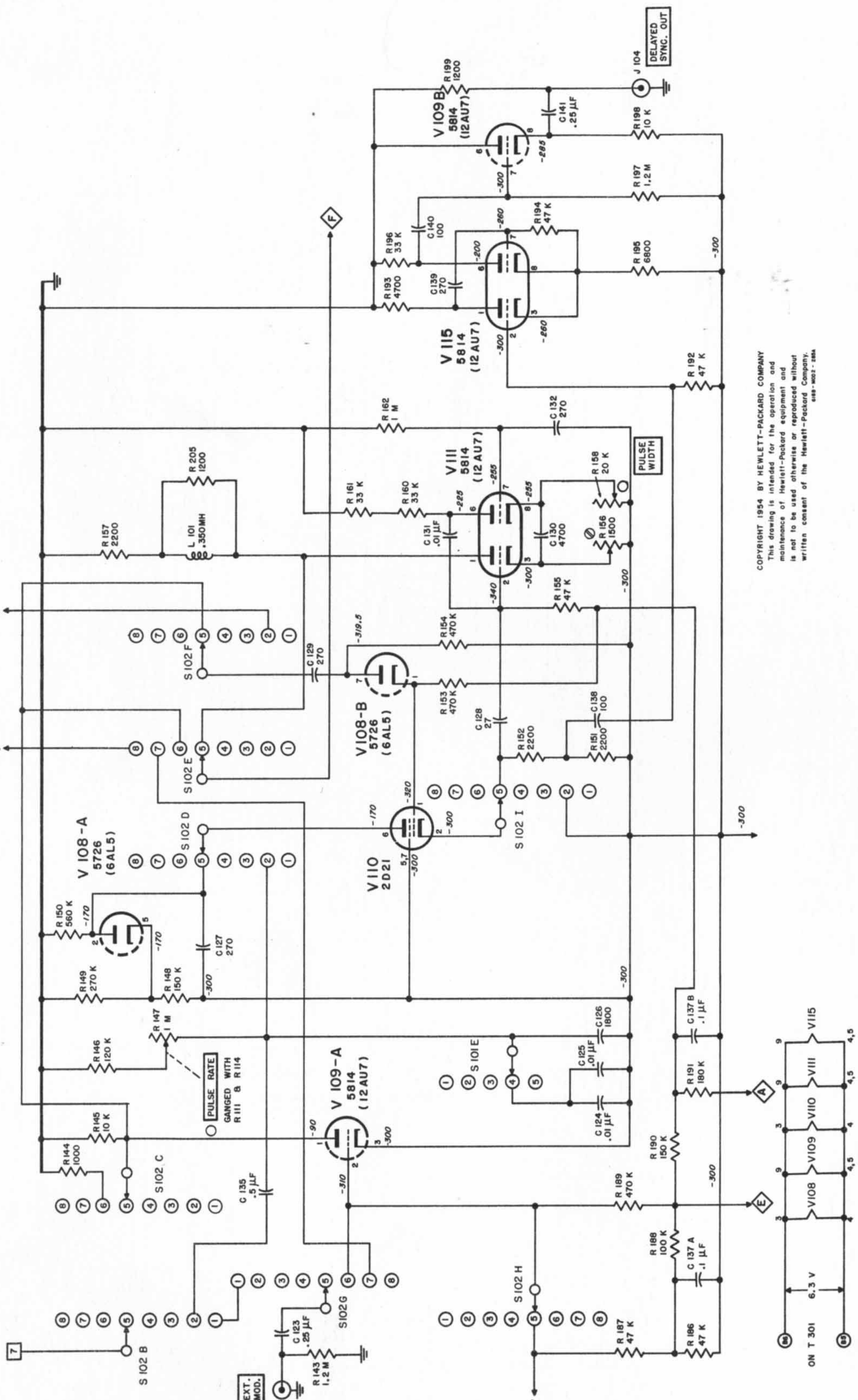


Figure 4-20. Modulator Section Part II

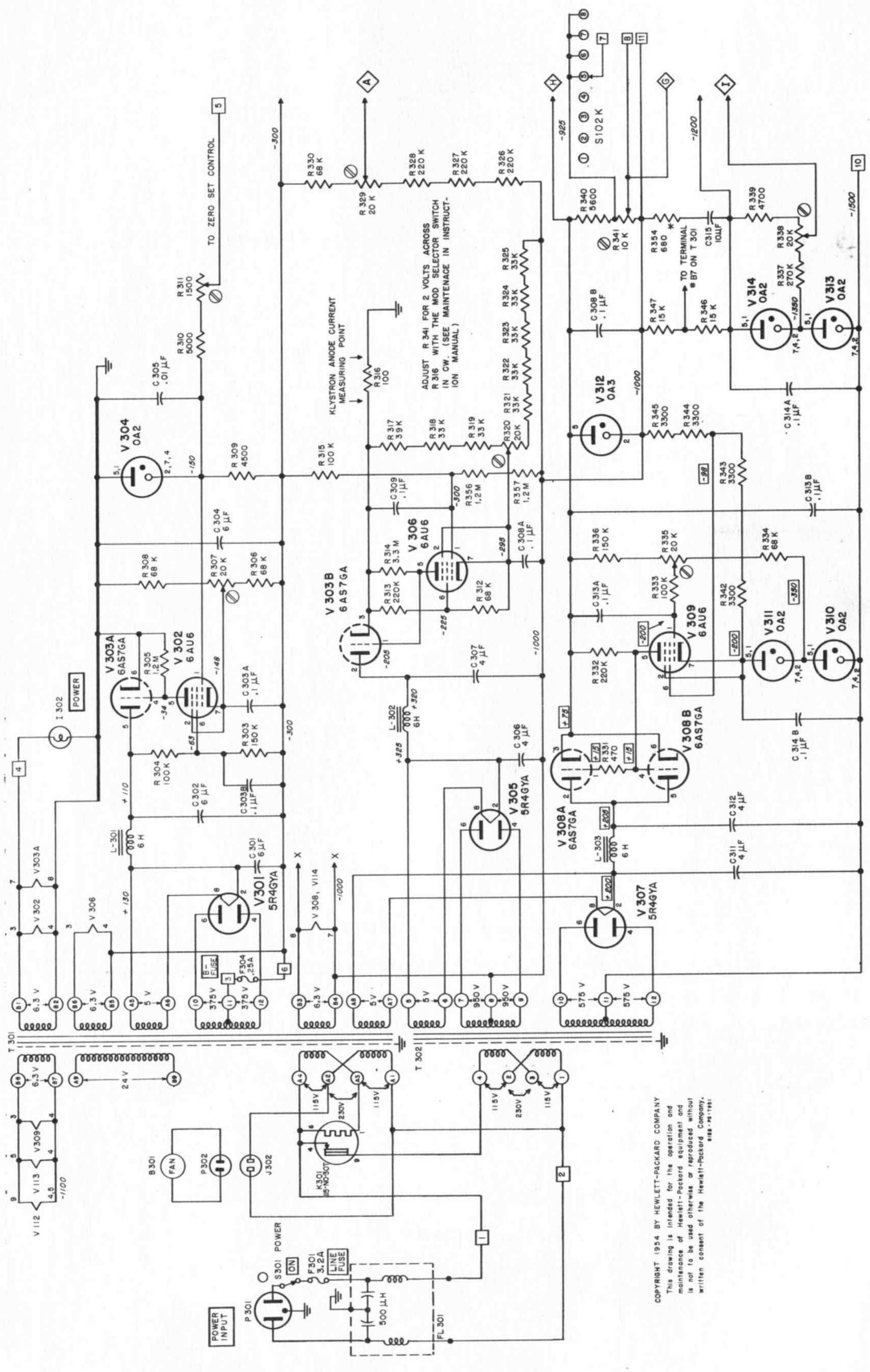
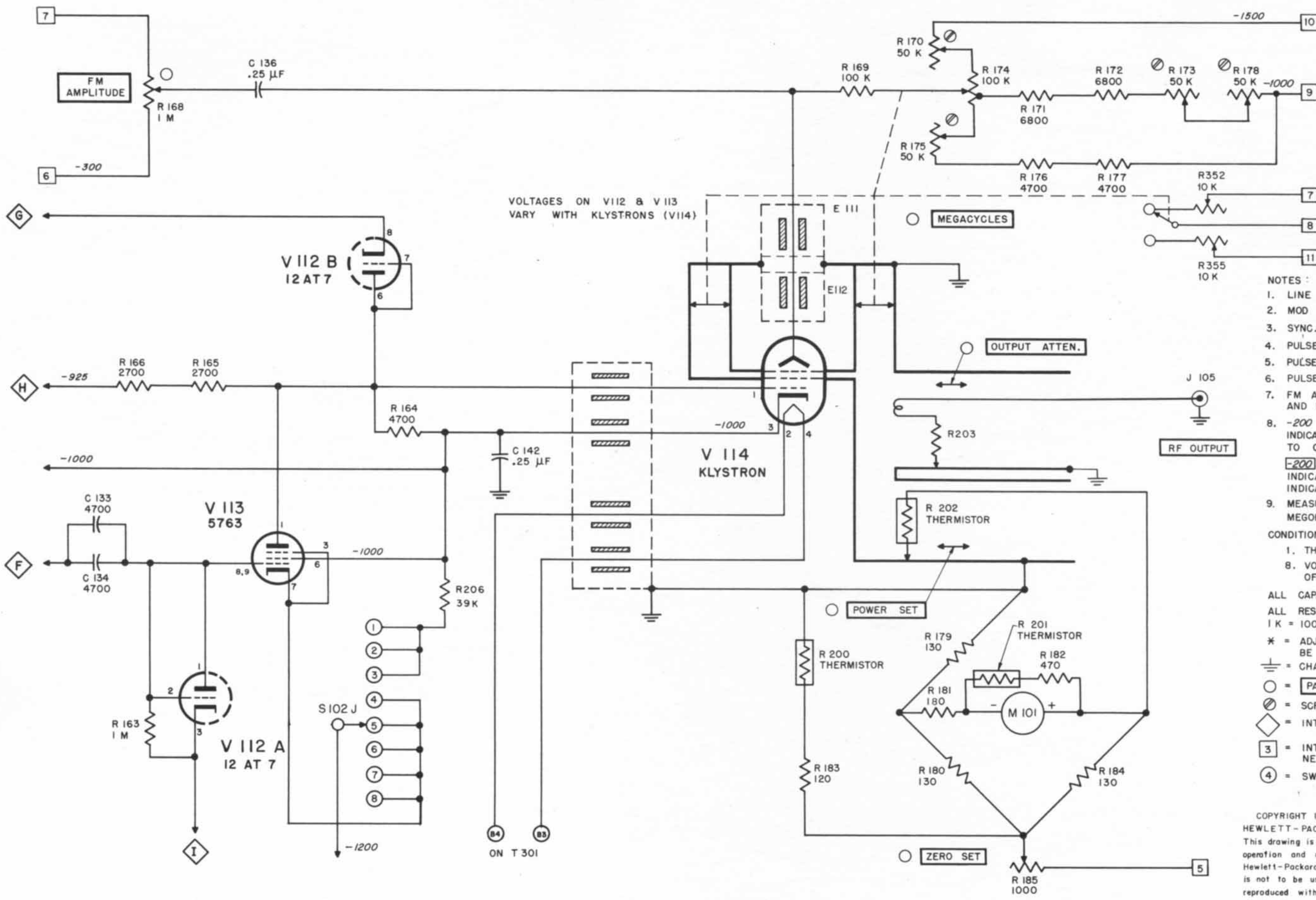


Figure 4-21. Power Supply



S 102 POSITION	PANEL DESIGNATION
1	EXT. FM
2	INT. FM
3	C W
4	OFF
5	INT.
6	EXT. +
7	EXT. -
8	SQ. WAVE

NOTES:

1. LINE VOLTAGE AT 115/230V, 50/4000~.
2. MOD SELECTOR SWITCH ON INT.
3. SYNC. SELECTOR ON X1
4. PULSE WIDTH ON 10
5. PULSE DELAY ON 10
6. PULSE RATE ON 100
7. FM AMPLITUDE, OUTPUT ATTEN., POWER SET, ZERO SET, AND FREQUENCY ARE NOT CRITICAL.
8. *-200* VOLTAGES INDICATED IN THIS MANNER ARE MEASURED BETWEEN INDICATED POINTS AND CHASSIS. POLARITY INDICATED WITH RESPECT TO CHASSIS.
   [-200] VOLTAGES INDICATED IN THIS MANNER ARE MEASURED BETWEEN INDICATED POINTS AND THE -1000 VOLT SUPPLY. POLARITY INDICATED WITH RESPECT TO -1000 VOLT SUPPLY.
9. MEASUREMENTS MADE WITH A VACUUM TUBE VOLTMETER WITH 122 MEGOHMS INPUT RESISTANCE. (HP MODEL 410B)

CONDITIONS OF AC VOLTAGE MEASUREMENT:

1. THRU 7. SAME AS DC CONDITIONS.
8. VOLTAGES MEASURED BETWEEN INDICATED POINTS WITH A METER OF 1000 OHMS/VOLT OR GREATER SENSITIVITY.

ALL CAPACITANCE VALUES IN μμF UNLESS OTHERWISE NOTED.

ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE NOTED, 1 K = 1000 OHMS, 1 M = 1 MEGOHM.

* = ADJUSTED AT FACTORY, AVERAGE VALUE SHOWN, PART MAY BE OMITTED.

⏚ = CHASSIS

○ = [PANEL CONTROL]

⊘ = SCREWDRIVER ADJUSTMENT

◇ = INTERCONNECTION BETWEEN SECTIONS OF SCHEMATIC DIAGRAM.

[3] = INTERCONNECTIONS LOCATED ON TERMINAL BOARD BEHIND PANEL NEAR PILOT LIGHT.

④ = SWITCH POSITIONS OR TRANSFORMER TERMINALS.

618B-XS-T951B

Figure 4-22. Klystron Section

RAYTHEON
KLYSTRON TUBE WARRANTY
FOR TUBES SUPPLIED BY HEWLETT-PACKARD

Raytheon klystron tubes are guaranteed by the manufacturer only to the original purchaser, the Hewlett-Packard Company. For this reason, all warranty claims for premature failure of this tube, if purchased from or supplied by the Hewlett-Packard Company, must be made to Hewlett-Packard and not Raytheon. All credit allowed by Raytheon will be passed on to the customer by Hewlett-Packard.

This klystron tube is guaranteed against defects in manufacture only, for a period of 500 hours filament operation or one year from date of purchase, whichever occurs first. Allowance will be proportional to the percent guaranteed life (filament hours) remaining.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow the shipping instructions carefully to insure safe arrival of the tube. If a tube arrives broken, delay will be caused in determining who is liable -- the transportation company or the shipper. Many tubes will be subjected to a laboratory examination to determine the cause of failure before credit can be allowed. Proper examination is either difficult or impossible when the tube is damaged.

SHIPPING INSTRUCTIONS

1) Fill out the Warranty Claim on the reverse side of this sheet.

2) Carefully wrap the tube in at least 1/4 inch thick cotton batting, or other soft padding material.

3) Wrap the padded tube with the Warranty Claim in heavy kraft paper.

4) Pack in a rigid container which is at least 4 inches larger than the padded tube on all sides. Surround the tube with packed excelsior or similar shock absorbing material.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Mark the box FRAGILE and ship prepaid, preferably via Air Freight or Railway Express. Ship to Hewlett-Packard.

HEWLETT-PACKARD CO. 275 PAGE MILL ROAD, PALO ALTO, CALIF. U.S.A.

RAYTHEON KLYSTRON WARRANTY CLAIM

Please Answer All Questions Fully

FROM: DATE__________

NAME: ______________________________

COMPANY: ______________________________

ADDRESS: ______________________________

____

Person to contact for further information:

NAME: ______________________________

TITLE: ______________________________

COMPANY: ______________________________

ADDRESS: ______________________________

____

1) Klystron Type No.__________________ Serial No.____________________

2) hp instrument in which tube was used, Model______, Serial No.______________

3) Date tube purchased__________________

4) Tube purchased from____

5) Tube was original______________or replacement____________________

6) Total number of hours in operation__________

7) COMPLAINT (Please describe nature of trouble)________________________

____

____

8) OPERATING CONDITIONS (Please describe conditions prior to and at time of failure)

____

____

SIGNATURE________________________

____

SECTION V
TABLE OF REPLACEABLE PARTS

NOTE

Readily available standard-components have been used in this instrument, whenever possible. However, special components may be obtained from your local Hewlett-Packard representative or from the factory.

When ordering parts always include:

1. hp Stock Number.
2. Complete description of part including circuit reference.
3. Model number and serial number of instrument.
4. If part is not listed give complete description, function, and location of part.

If there are any corrections for the Table of Replaceable Parts they will be listed on an Instruction Manual Change sheet at the front of this manual.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		hp STOCK NO.	#			
B301	Motor, A, C	Gen. Ind. Co.	314-28	1			
	Blade, fan	BD*	314-44	1			
	Filter, air: expanded aluminum	Research Prod.	314-21	1			
C101	Capacitor: fixed, paper dielectric .25 μf, ±10%, 1000 vdcw	J*	17-16	3			
C102	Capacitor: fixed, mica, .01 μf ±10%, 300 vdcw	V*	14-23	5			
C103	Capacitor: fixed, mica, 180 μμf ±10%, 500 vdcw	Z*	14-51	1			
C104, 105	Capacitor: fixed, silver mica, 1000 μμf ±5%, 500 vdcw	V*	14-45	4			
C106	Capacitor: fixed, mica, .01 μf ±5%, 300 vdcw	Z*	14-24	2			
C107	Same as C104						
C108	Capacitor: fixed, mica, 2200 μμf ±10%, 500 vdcw	Z*	14-52	1			
C109	Same as C104						
C110	Same as C106						
C111	Capacitor: fixed, mica, 100 μμf ±10%, 500 vdcw	V*	14-100	4			
C112	Capacitor: fixed, mica, 39 μμf ±10%, 500 vdcw	V*	14-48	1			
C113	Capacitor: fixed, mica, 5 μμf ±20%, 500 vdcw	V*	14-5	1			
C114	Capacitor: fixed, mica, 56 μμf ±10%, 500 vdcw	V*	14-41	1			
C115	Capacitor: fixed, mica, .01 μf ±10%, 300 vdcw	V*	14-23	2			
C116	Capacitor: fixed, mica, 27 μμf ±10%, 500 vdcw	V*	14-17	1			
C117	Same as C111						
C118	Capacitor: fixed, paper dielectric, 100,000 μμf ±10%, 1000 vdcw	Z*	17-32	2			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
# Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		hp STOCK NO.	#			
C119	Capacitor: fixed, mica, 270 $\mu\mu$f ±10%, 500 vdcw	V*	14-42	5			
C120	Capacitor: fixed, mica, 390 $\mu\mu$f ±5%, 500 vdcw	Z*	14-43	1			
C121	Same as C102						
C122	Capacitor: fixed, mica, 27 $\mu\mu$f ±10%, 500 vdcw	V*	14-17	2			
C123	Same as C101						
C124, 125	Same as C102						
C126	Capacitor: fixed, mica, 1800 $\mu\mu$f ±10%, 500 vdcw	V*	14-47	1			
C127	Same as C119						
C128	Same as C122						
C129	Same as C119						
C130	Capacitor: fixed, mica, 4700 $\mu\mu$f ±10%, 500 vdcw	V*	14-44	1			
C131	Same as C115						
C132	Same as C119						
C133, 134	Capacitor: fixed, mica, 4700 $\mu\mu$f ±10%, 2500 vdcw	Z*	14-46	2			
C135	Capacitor: fixed, paper dielectric 500,000 $\mu\mu$f ±10%, 600 vdcw	Z*	17-29	1			
C136	Capacitor: fixed, paper dielectric, .25 μf ±10%, 1500 vdcw	Z*	17-30	2			
C137	Capacitor: fixed, paper dielectric, 2 sections, 100,000 $\mu\mu$f/sect. +20%, -10%, 1000 vdcw	Z*	17-31	5			
C138	Same as C111						
C139	Same as C119						
C140	Same as C111						
C141	Same as C101						

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	#			
C142	Same as C136						
C143 thru C300	These circuit references not assigned						
C301, 302	Capacitor: fixed, paper dielectric, 6 μf ±10%, 600 vdcw	Z*	17-11	3			
C303	Same as C137						
C304	Same as C301						
C305	Same as C102						
C306, 307	Capacitor: fixed, paper dielectric, 4 μf ±10%, 2000 vdcw	Z*	17-27	2			
C308	Same as C137						
C309	Same as C118						
C310	This circuit reference not assigned						
C311, 312	Capacitor: fixed, paper dielectric, 4 μf ±10%, 1500 vdcw	Z*	17-28	2			
C313, 314	Same as C137						
C315	Capacitor: fixed, electrolytic, 10 μf, 300 vdcw	Z*	18-16	1			
DS302	Lamp, incandescent: 6-8V, .15 amp, #47	N*	211-47	1			
E111	Filter, R.F., cylindrical, 4" long (mounts in castings)	HP*	618B-27	1			
E112	Repeller Filter Assembly: including repeller contact	HP*	618B-36AK	1			
F301	Fuse, cartridge: 3.2 amp, 115V	E*	211-45	1			
or	Fuse, cartridge: 1.6 amp, 230V	E*	211-15				
F302, 303	These circuit references not assigned						
F304	Fuse, cartridge: .25 amp	E*	211-55	1			
FL301	Filter, line	Filtron	911-37	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
# Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	#			
J101	Connector: SYNC IN		125-UG-291/U	4			
J102	Connector: SYNC OUT						
J103	Connector: EXT. MOD.						
J104	Connector: DELAYED SYNC OUT	LL*					
J105	Connector: R.F. OUTPUT (part of Attenuator Assembly)						
K301	Relay, vacuum sealed: miniature 9 pin base	C*	49-20	1			
L101	Reactor R.F wound on 1200 ohms resistor, .350 μh	HP*	618B-60A	1			
L102 thru L300	These circuit references not assigned						
L301	Reactor, choke filter, 6h, 90 ma	Paeco	911-33	2			
L302	Reactor, choke filter, 6h, 30 ma	Paeco	911-34	1			
L303	Same as L301						
M1	Meter	BF*	112-53	1			
P301	Cable, power: with male plug	Elec. Cords	812-56	1			
P302	Connector, male	H*	125-22	1			
R101	Resistor: fixed, composition, 1.2 megohms ±10%, 1 W	B*	24-1.2M	7			
R102	Resistor: fixed, composition, 2.2 megohms ±10%, 1 W	B*	24-2.2M	1			
R103	Resistor: fixed, composition, 47,000 ohms ±10%, 1 W	B*	24-47K	9			
R104	Same as R101						
R105	Same as R103						
R106	Resistor: fixed, composition, 100,000 ohms ±10%, 1 W	B*	24-100K	7			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	#			
R107	Resistor: fixed, composition, 27,000 ohms ±10%, 2 W B*	25-27K	2			
R108	Resistor: fixed, composition, 470,000 ohms ±10%, 1 W B*	24-470K	6			
R109	Same as R106					
R110	Same as R103					
R111	Resistor: variable, composition, linear taper, 1 megohm, ±10%, ganged to R114 and R147 B*	210-78	3			
R112, 113	Resistor: variable, composition, 150,000 ohms ±10%, B*	210-37	2			
R114	Same as R111					
R115	Resistor: fixed, composition, 1 megohm ±10%, 1 W B*	24-1M	3			
R116	Resistor: fixed, composition, 680 ohms ±10%, 1 W B*	24-680	2			
R117	Resistor: variable, composition, linear taper, 1500 ohms ±10% B*	210-33	4			
R118	Resistor: fixed, composition, 18,000 ohms ±10%, 2 W B*	25-18K	1			
R119	Resistor: fixed, composition, 10,000 ohms ±10%, 2 W B*	25-10K	5			
R120	Resistor: fixed, composition, 3900 ohms ±10%, 1 W B*	24-3900	2			
R121	Resistor: fixed, composition, 2700 ohms ±10%, 1 W B*	24-2700	1			
R122	Same as R107					
R123	Same as R103					
R124	Resistor: fixed, composition, 1200 ohms ±10%, 1 W B*	24-1200	3			
R125	Same as R108					
R126, 127	Resistor: fixed, composition, 10,000 ohms ±10%, 1 W B*	24-10K	4			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	#			
R128	Same as R101						
R129	Same as R126						
R130	Same as R124						
R131	Same as R108						
R132	Same as R101						
R133	Same as R117						
R134	Same as R120						
R135	Resistor: fixed, composition, 33,000 ohms ±10%, 2 W	B*	25-33K	12			
R136	Resistor: variable, composition, 1 megohm ±20%	B*	210-66	2			
R137	Resistor: fixed, composition, 270 ohms ±10%, 1 W	B*	24-270	1			
R138 thru R140	Same as R119						
R141	Same as R106						
R142	Resistor: fixed, composition, 150,000 ohms ±10%, 1 W	B*	24-150K	3			
R143	Same as R101						
R144	Resistor: fixed, composition, 1000 ohms ±10%, 1 W	B*	24-1000	1			
R145	Same as R119						
R146	Resistor: fixed, composition, 120,000 ohms ±10%, 1 W	B*	24-120K	1			
R147	Same as R111						
R148	Same as R142						
R149	Resistor: fixed, composition, 270,000 ohms ±10%, 1 W	B*	24-270K	2			
R150	Resistor: fixed, composition, 560,000 ohms ±10%, 1 W	B*	24-560K	1			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	#			
R151, 152	Resistor: fixed, composition, 2200 ohms ±10%, 1 W B*	24-2200	3			
R153, 154	Same as R108					
R155	Same as R103					
R156	Same as R117					
R157	Same as R151					
R158	Resistor: variable, composition, 20,000 ohms ±10%, 2.25 W B*	210-70	1			
R159	This circuit reference not assigned					
R160, 161	Same as R135					
R162, 163	Same as R115					
R164	Resistor: fixed, composition, 4700 ohms ±10%, 1 W B*	24-4700	2			
R165, 166	Resistor: fixed, composition, 2700 ohms ±10%, 2 W B*	25-2700	2			
R167	This circuit reference not assigned					
R168	Same as R136					
R169	Same as R106					
R170	Resistor: variable, composition, 50,000 ohms ±10% B*	210-36	4			
R171, 172	Resistor: fixed, composition, 6800 ohms ±10%, 2 W	25-6800	2			
R173	Same as R170					
R174	Resistor: variable, 100,000 ohms ±10%, 8 W Paeco	210-175	1			
R175	Same as R170					
R176, 177	Resistor: fixed, composition, 4700 ohms ±10%, 2 W B*	25-4700	2			
R178	Same as R170					

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	ⓗⓟ STOCK NO.	#			
R179, 180	Resistor: fixed, wirewound, 130 ohms ±0.5%, .25 W SS*	26-13	3			
R181	Resistor: fixed, composition, 180 ohms ±10%, 1 W B*	24-180	1			
R182	Resistor: fixed, composition, 470 ohms ±10%, 1 W B*	24-470	1			
R183	Resistor: fixed, composition, 120 ohms ±10%, 1 W B*	24-120	1			
R184	Same as R179					
R185	Resistor: variable, composition, linear taper 1000 ohms ±10%, 2 W B*	210-32	1			
R186, 187	Same as R103					
R188	Same as R106					
R189	Same as R108					
R190	Same as R142					
R191	Resistor: fixed, composition, 180,000 ohms ±10%, 1 W B*	24-180K	1			
R192	Same as R103					
R193	Same as R164					
R194	Same as R103					
R195	Resistor: fixed, composition, 6800 ohms ±10%, 1 W B*	24-6800	1			
R196	Same as R135					
R197	Same as R101					
R198	Same as R126					
R199	Same as R124					
R200	Thermistor: 725 ohms ±5%, disc type CE*	211-52	1			
R201	Thermistor: disc type, (meter shunt) CE*	211-22	1			
R202	Thermistor: bead type, (bolometer) CE*	211-40	1			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
#. Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	#			
R203	Resistor: fixed, platinized glass bead, part of attenuator, not separately replaceable						
R204	Resistor: fixed, composition, 100 ohms ±10%, 1/2 W	B*	23-100	1			
R205	See L101						
R206	Resistor: fixed, composition, 39,000 ohms ±10%, 2 W	B*	25-39K	1			
R207 thru R302	These circuit references not assigned						
R303	Resistor: fixed, composition, 150,000 ohms ±10%, 2 W	B*	25-150K	1			
R304	Resistor: fixed, composition, 100,000 ohms ±10%, 2 W	B*	25-100K	1			
R305	Same as R101						
R306	Resistor: fixed, composition, 68,000 ohms ±5%, 1 W	B*	24-68K-5	2			
R307	Resistor: variable, composition, linear taper 20,000 ohms ±20%	BO*	210-213	5			
R308	Same as R306						
R309	Resistor: fixed, wirewound, 4500 ohms ±5%, 40 W	I*	27-30	1			
R310	Resistor: fixed, wirewound, 5000 ohms ±5%, 12.5 W	I*	27-19	1			
R311	Same as R117						
R312	Resistor: fixed, composition, 68,000 ohms ±10%, 1 W	B*	24-68K	1			
R313	Resistor: fixed, composition, 220,000 ohms ±10%, 1 W	B*	24-220K	2			
R314	Resistor: fixed, composition, 3.3 megohms ±10%, 1 W	B*	24-3.3M	1			
R315	Same as R106						
R316	Resistor: fixed, composition, 100 ohms ±5%, 1 W	B*	24-100-5	1			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗ STOCK NO.	#			
R317 thru R319	Same as R135						
R320	Same as R307						
R321 thru R325	Same as R135						
R326 thru R328	Resistor: fixed, composition, 220,000 ohms ±10%, 2 W	B*	25-220K	3			
R329	Same as R307						
R330	Same as R306						
R331	Resistor: fixed, composition, 470 ohms ±10%, 1/2 W	B*	23-470	1			
R332	Same as R313						
R333	Same as R106						
R334	Resistor: fixed, composition, 68,000 ohms ±5%, 2 W	B*	25-68K-5	1			
R335	Same as R307						
R336	Resistor: fixed, composition, 150,000 ohms ±5%, 2 W	B*	25-150K-5	1			
R337	Same as R149						
R338	Same as R307						
R339	Resistor: fixed, composition, 4700 ohms ±10%, 1 W	B*	24-4700	1			
R340	Resistor: fixed, composition, 5600 ohms ±10%, 2 W	B*	25-5600	1			
R341	Resistor: variable, composition, linear taper 10,000 ohms ±10%	B*	210-35	1			
R342 thru R345	Resistor: fixed, composition, 3300 ohms ±10%, 2 W	B*	25-3300	4			
R346, 347	Resistor: fixed, composition, 15,000 ohms ±10%, 2 W	B*	25-15K	2			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	#			
R348 thru R351	These circuit references not assigned						
R352	Resistor: variable, composition, linear taper 10,000 ohms ±20%, 1/2 W	B*	210-208	2			
R353	This circuit reference not assigned						
R354	Same as R116 Electrical value adjusted at factory						
R355, 356	Resistor: fixed, composition, 1.2 megohms ±10%, 1/2 W	B*	23-1.2M	2			
R357	Same as R352						
S101	Sync Selector Switch, (complete)	HP*	618B-19B	1			
	Sync Selector Switch: rotary, 5 position (less components)	D*	310-106	1			
S102	Mod Selector Switch (complete)	HP*	618B-19A	1			
	Switch, rotary: 8 position (less components)	D*	310-107	1			
S103	Switch, micro, SPDT	AQ*	310-47	1			
S104 thru S300	These circuit references not assigned						
S301	Switch, toggle: DPDT	D*	310-54	1			
T301	Transformer, power	Paeco	910-116	1			
T302	Transformer, power	Paeco	910-115	1			
V101	Tube, electron: 12AT7	ZZ*	212-12AT7	2			
V102	Tube, electron: 6AL5	ZZ*	212-6AL5	3			
V103 thru V105	Tube, electron: 12AU7	ZZ*	212-12AU7	7			
V106	Same as V102						
V107	Same as V103						
V108	Same as V102						

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		hp STOCK NO.	#			
V109	Same as V103						
V110	Tube, electron: 2D21	ZZ*	212-2D21	1			
V111	Same as V103						
V112	Same as V101						
V113	Tube, electron: 5763	ZZ*	212-5763	1			
V114	Tube, klystron: 6236	CA*	212-6236	1			
V115	Same as V103						
V116 thru V300	These circuit references not assigned						
V301	Tube, electron: 5R4GYA	ZZ*	212-5R4GYA	1			
V302	Tube, electron: 6AU6	ZZ*	212-6AU6	3			
V303	Tube, electron: 6AS7GA	ZZ*	212-6AS7GA	2			
V304	Tube, electron: OA2	ZZ*	212-OA2	5			
V305	Same as V301						
V306	Same as V302						
V307	Same as V301						
V308	Same as V303						
V309	Same as V302						
V310, 311	Same as V304						
V312	Tube, electron: OA3	ZZ*	212-OA3	1			
V313, 314	Same as V304						
	MISCELLANEOUS						
	Attenuator Assembly: plunger, pad output type N panel jack and cable. When ordering indicate model and serial number.	HP*	618B-34	1			
	Bolometer Assembly: thermistor, body and stop	HP*	618B-28	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
# Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ⓗⓟ STOCK NO.	#			
	Cable, power: connectors both ends	HP*	618B-16H	1			
	Center Conductor Assembly: with grid contact fingers	HP*	618B-36Z	1			
	Cavity Assembly	HP*	618B-95A	1			
	Crank, handle	HP*	G-74AE	1			
	Dial, frequency	HP*	618B-40A	1			
	Dial Assembly: pulse rate (includes knob)	HP*	618B-40G	1			
	Dial Assembly: pulse delay (includes knob)	HP*	618B-40F	1			
	Dial Assembly: pulse width (includes knob)	HP*	618B-40H	1			
	Dial Assembly: frequency vernier (includes knob)	HP*	618B-40J	1			
	Fuseholder	T*	140-16	2			
	Filter, air: glass fiber	Western Fiber Gls.	314-20	1			
	Filter, blower motor: 300 μh, 0.1 μf	CC*	911-36	1			
	Klystron seating ring	HP*	618B-88A	1			
	Knob: FM AMPLITUDE, ZERO SET	HP*	G-74F	2			
	Knob: OUTPUT ATTENUATOR, POWER SET	HP*	G-74R	2			
	Knob: MOD SELECTOR, SYNC SELECTOR	HP*	G-74N	2			
	Light, indicator	II*	145-3	1			
	Mounting nut: for klystron cavity, threaded inside and outside, hexagonal, 1-1/8"	HP*	618B-3C	1			
	Nipple for ventilating tube	HP*	618B-36AN	1			
	Plunger Assembly	HP*	618B-36U	1			

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
 # Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	(hp) STOCK NO.	#			
	Resistor: variable, wirewound, 100,000 ohms, repeller tracking Paeco	210-80	1			
	Rectifier, selenium BV*	212-76	1			
	Rubber air seal for blower Cole Mfr.	432-14	1			
	Ring: for klystron tube mounting, threaded inside and outside, 1" outside dia. HP*	618B-3D	1			
	Socket, tube: for klystron, 4 pin	120-17	1			
	Spring, for klystron tube mounting, 2-1/2" long, .096" outside diameter HP*	618B-3F	1			
	Socket Assembly: consists of housing, filters and klystron socket HP*	618B-52	1			
	Tube contact ring set: consists of two half sections, .096" overall diameter, .792" inside diameter HP*	618B-95B	1			
	Ventilating tube: klystron HP*	618B-36AM	1			
	Window, dial, attenuator HP*	G-99C	1			
	Window, frequency dial HP*	618B-40D	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
# Total quantity used in the instrument.

LIST OF CODE LETTERS USED IN TABLE OF REPLACEABLE PARTS TO DESIGNATE THE MANUFACTURERS

CODE LETTER	MANUFACTURER	ADDRESS
A	Aerovox Corp.	New Bedford, Mass.
B	Allen-Bradley Co.	Milwaukee 4, Wis.
C	Amperite Co.	New York, N. Y.
D	Arrow, Hart & Hegeman	Hartford, Conn.
E	Bussman Manufacturing Co.	St. Louis, Mo.
F	Carborundum Co.	Niagara Falls, N. Y.
G	Centralab	Milwaukee 1, Wis.
H	Cinch-Jones Mfg. Co.	Chicago 24, Ill.
HP	Hewlett-Packard Co.	Palo Alto, Calif.
I	Clarostat Mfg. Co.	Dover, N. H.
J	Cornell Dubilier Elec. Co.	South Plainfield, N. J.
K	Hi-Q Division of Aerovox	Olean, N. Y.
L	Erie Resistor Corp.	Erie 6, Pa.
M	Fed. Telephone & Radio Corp.	Clifton, N. J.
N	General Electric Co.	Schenectady 5, N. Y.
O	General Electric Supply Corp.	San Francisco, Calif.
P	Girard-Hopkins	Oakland, Calif.
Q	Industrial Products Co.	Danbury, Conn.
R	International Resistance Co.	Philadelphia 8, Pa.
S	Lectrohm Inc.	Chicago 20, Ill.
T	Littlefuse Inc.	Des Plaines, Ill.
U	Maguire Industries Inc.	Greenwich, Conn.
V	Micamold Radio Corp.	Brooklyn 37, N. Y.
W	Oak Manufacturing Co.	Chicago 10, Ill.
X	P. R. Mallory Co., Inc.	Indianapolis, Ind.
Y	Radio Corp. of America	Harrison, N. J.
Z	Sangamo Electric Co.	Marion, Ill.
AA	Sarkes Tarzian	Bloomington, Ind.
BB	Signal Indicator Co.	Brooklyn 37, N. Y.
CC	Sprague Electric Co.	North Adams, Mass.
DD	Stackpole Carbon Co.	St. Marys, Pa.
EE	Sylvania Electric Products Co.	Warren, Pa.
FF	Western Electric Co.	New York 5, N. Y.
GG	Wilkor Products, Inc.	Cleveland, Ohio
HH	Amphenol	Chicago 50, Ill.
II	Dial Light Co. of America	Brooklyn 37, N. Y.
JJ	Leecraft Manufacturing Co.	New York, N. Y.
KK	Switchcraft, Inc.	Chicago 22, Ill.
LL	Gremar Manufacturing Co.	Wakefield, Mass.
MM	Carad Corp.	Redwood City, Calif.
NN	Electra Manufacturing Co.	Kansas City, Mo.
OO	Acro Manufacturing Co.	Columbus 16, Ohio
PP	Alliance Manufacturing Co.	Alliance, Ohio
QQ	Arco Electronics, Inc.	New York 13, N. Y.
RR	Astron Corp.	East Newark, N. J.
SS	Axel Brothers Inc.	Long Island City, N. Y.
TT	Belden Manufacturing Co.	Chicago 44, Ill.
UU	Bird Electronics Corp.	Cleveland 14, Ohio
VV	Barber Colman Co.	Rockford, Ill.
WW	Bud Radio Inc.	Cleveland 3, Ohio
XX	Allen D. Cardwell Mfg. Co.	Plainville, Conn.
YY	Cinema Engineering Co.	Burbank, Calif.
ZZ	Any brand tube meeting RETMA standards.	
AB	Corning Glass Works	Corning, N. Y.
AC	Dale Products, Inc.	Columbus, Neb.
AD	The Drake Mfg. Co.	Chicago 22, Ill.
AE	Elco Corp.	Philadelphia 24, Pa.
AF	Hugh H. Eby Co.	Philadelphia 44, Pa.
AG	Thomas A. Edison, Inc.	West Orange, N. J.
AH	Fansteel Metallurgical Corp.	North Chicago, Ill.
AI	General Ceramics & Steatite Corp.	Keasbey, N. J.
AJ	The Gudeman Co.	Sunnyvale, Calif.
AK	Hammerlund Mfg. Co., Inc.	New York 1, N. Y.
AL	Industrial Condenser Corp.	Chicago 18, Ill.
AM	Insuline Corp. of America	Manchester, N. H.
AN	Jennings Radio Mfg. Corp.	San Jose, Calif.
AO	E. F. Johnson Co.	Waseca, Minn.
AP	Lenz Electric Mfg. Co.	Chicago 47, Ill.
AQ	Micro-Switch	Freeport, Ill.
AR	Mechanical Industries Prod. Co.	Akron 8, Ohio
AS	Model Eng. & Mfg., Inc.	Huntington, Ind.
AT	The Muter Co.	Chicago 5, Ill.
AU	Ohmite Mfg. Co.	Skokie, Ill.
AV	Resistance Products Co.	Harrisburg, Pa.
AW	Radio Condenser Co.	Camden 3, N. J.
AX	Shallcross Manufacturing Co.	Collingdale, Pa.
AY	Solar Manufacturing Co.	Los Angeles 58, Calif.
AZ	Sealectro Corp.	New Rochelle, N. Y.
BA	Spencer Thermostat	Attleboro, Mass.
BC	Stevens Manufacturing Co.	Mansfield, Ohio
BD	Torrington Manufacturing Co.	Van Nuys, Calif.
BE	Vector Electronic Co.	Los Angeles 65, Calif.
BF	Weston Electrical Inst. Corp.	Newark 5, N. J.
BG	Advance Electric & Relay Co.	Burbank, Calif.
BH	E. I. DuPont	San Francisco, Calif.
BI	Electronics Tube Corp.	Philadelphia 18, Pa.
BJ	Aircraft Radio Corp.	Boonton, N. J.
BK	Allied Control Co., Inc.	New York 21, N. Y.
BL	Augat Brothers, Inc.	Attleboro, Mass.
BM	Carter Radio Division	Chicago, Ill.
BN	CBS Hytron Radio & Electric	Danvers, Mass.
BO	Chicago Telephone Supply	Elkhart, Ind.
BP	Henry L. Crowley Co., Inc.	West Orange, N. J.
BQ	Curtiss-Wright Corp.	Carlstadt, N. J.
BR	Allen B. DuMont Labs	Clifton, N. J.
BS	Excel Transformer Co.	Oakland, Calif.
BT	General Radio Co.	Cambridge 39, Mass.
BU	Hughes Aircraft Co.	Culver City, Calif.
BV	International Rectifier Corp.	El Segundo, Calif.
BW	James Knights Co.	Sandwich, Ill.
BX	Mueller Electric Co.	Cleveland, Ohio
BY	Precision Thermometer & Inst. Co.	Philadelphia 30, Pa.
BZ	Radio Essentials Inc.	Mt. Vernon, N. Y.
CA	Raytheon Manufacturing Co.	Newton, Mass.
CB	Tung-Sol Lamp Works, Inc.	Newark 4, N. J.
CD	Varian Associates	Palo Alto, Calif.
CE	Victory Engineering Corp.	Union, N. J.
CF	Weckesser Co.	Chicago 30, Ill.
CG	Wilco Corporation	Indianapolis, Ind.
CH	Winchester Electronics, Inc.	Santa Monica, Calif.
CI	Malco Tool & Die	Los Angeles 42, Calif.
CJ	Oxford Electric Corp.	Chicago 15, Ill.
CK	Camloc-Fastener Corp.	Paramus, N. J.
CL	George K. Garrett	Philadelphia 34, Pa.
CM	Union Switch & Signal	Swissvale, Pa.
CN	Radio Receptor	New York 11, N. Y.
CO	Automatic & Precision Mfg. Co.	Yonkers, N. Y.
CP	Bassick Co.	Bridgeport 2, Conn.
CQ	Birnbach Radio Co.	New York 13, N. Y.
CR	Fischer Specialties	Cincinnati 6, Ohio
CS	Telefunken (c/o MVM, Inc.)	New York, N. Y.
CT	Potter-Brumfield Co.	Princeton, Ind.
CU	Cannon Electric Co.	Los Angeles, Calif.
CV	Dynac, Inc.	Palo Alto, Calif.
CW	Good-All Electric Mfg. Co.	Ogallala, Nebr.

CLAIM FOR DAMAGE IN SHIPMENT

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

WARRANTY

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

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

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

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

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

DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

275 PAGE MILL ROAD PALO ALTO. CALIF. U.S.A.

CABLE "HEWPACK"

0501

MANUAL CHANGES

MODEL 618B

SHF SIGNAL GENERATOR

Manual printed: 11-59
For Serials Prefixed: 951-

ADDENDUM:

R317: Add "Optimum value selected at factory. Average value shown."

1/6/60