OPERATING INSTRUCTIONS

for

TYPE 1170-A FREQUENCY-MODULATION MONITOR

FORM 666-A

GENERAL RADIO COMPANY

CAMBRIDGE 39 MASSACHUSETTS

NEW YORK CHICAGO LOS ANGELES

U. S. A.

6605 North Ave Oak Park
VI - 8-9400

OPERATING INSTRUCTIONS

for

Ser. No. 164

TYPE 1170-A
AND
TYPE 1170-AT
FREQUENCY-MODULATION MONITORS

FORM 666-B

GENERAL RADIO COMPANY

6605 W. North Ave, Oak Park, Illinois

CAMBRIDGE 39 MASSACHUSETTS

VI-8-9400

NEW YORK CHICAGO LOS ANGELES

U. S. A.

FM MOD MON 1070 A-

1- Disconnect Relay assembly an plug in Jones plug with jumper in place.

2- Apply 90% sine wave to xmtr.

3- Remove jumper and re-connect relay assembly ~~then adjust~~ - with dial on pos 9 then adjust "Zero Set" on monitor to 90%.

4- Reset relay and adjust R2 on relay assembly untill meter reads 90% –

FM Freq mon connection same way

TABLE OF CONTENTS

Errata Sheet

for

Rec. 9-20-48

Operating Instructions for Type 1170-A

Frequency-Modulation Monitor

Form 666-B

Specifications

Vacuum Tubes: 3 type 6AG5 are supplied when 1170-P2 is used.

Operating Instructions

Section 1.6, KILOCYCLES DEVIATION: Change GR Type MEDS-27 to read GR Type MEDS-27-2.

Section 2.3, second paragraph: Change second and third sentences to read: A 0 - 10 ma d-c meter may be plugged into this jack, using a standard telephone plug, to check the oscillator current. This should be approximately 2 ma (3 ma non-oscillating).

Figure 11, page 14: Change V-104 to read V-204.

Wiring Diagram for Type 1170-A Discriminator Assembly

R-181 = 50 kΩ ±10%

R-181 is used only with 6-0-6 kc auto scale.

Wiring Diagram for Power Supply Section

Omit C-313

Change R-320 to 1.25Ω ± 5%

SPECIFICATIONS

Transmitter Frequency Range: 30 to 162 Mc with Type 1170-P1 R-F Tuning Unit; 160 to 220 Mc with Type 1170-P2 R-F Tuning Unit.

R-F Input Impedance: High impedance, with Type 774 Coaxial Connector. A capacitance attenuator is provided for adjusting the input level. The monitor can be used with standard R M A transmitter monitoring output.

Input Sensitivity: 1 volt r-f, or better.

Input Level Indicators: A meter for indicating r-f input level is provided at the rear of the chassis. Signal pilot lamp and center-frequency-meter pilot glow when input level is adequate, and are extinguished when level drops below the usable minimum.

Intermediate Frequency: 150 kc.

Discriminator: Pulse-counter type, linear to better than 0.1% over a range of ±100 kc (133% modulation).

Center Frequency:

Indication: Meter is calibrated in 100-cycle divisions from −3000 to +3000 cycles per second An alternative scale range calibrated in 200-cycle divisions from −6000 to +6000 cycles per second is available for high frequency transmitters. No zero set is necessary for each reading and no second crystal is provided.

Accuracy: Crystal frequency, when monitor is received, is within ±10 parts per million of specified channel frequency. Center-frequency reading is adjustable over ±3000-cycle rang to bring monitor into agreement with frequency-measuring service. Center-frequency indication then is accurate to ±200 cycles.

Stability: ±4 parts per million, or better, over-all, for long periods.

Percentage Modulation:

Indication: Meter is calibrated from 0 to 133%. Additional db scale is provided. Switch selects positive or negative peaks, or full-wave (peak-to-peak) indication. 100% modulation corresponds to 75 kc deviation for f-m bands. Internal adjustment of meter circuit changes calibration to read 100% at 25 kc deviation, for television audio monitoring. Meter ballistics meet FCC requirements.

Accuracy: ±5% modulation.

Overmodulation Indicator: Lamp flashes when predetermined modulation level, as set on a dial, is exceeded. Range of dial is 0 to 120% modulation.

Output Circuits:

1. Distortion and Noise Measurements: Terminals are provided for connecting a Type 1932 Distortion and Noise Meter, and a gain control is provided.

Residual Distortion: Less than 0.2% at 100-kc swing (133% modulation).

Response: 50 to 30,000 cycles per second ±½ db. Standard 75 microsecond de-emphasis circuit is included.

Maximum Output: 1.5 volts into 100,000 ohms.

Residual Noise Level: −75 db or better referred to 75 kc deviation; −65 db or better for 25 kc deviation.

Sensitivity: Full output can be obtained down to 8% of 75 kc deviation. Sensitivity varies with modulation frequency in accordance with standard de-emphasis characteristic.

2. Audio Monitoring Output:

Impedance: 600 ohms, unbalanced.

Output: Zero dbm at 75 kc deviation, 100% modulation.

Response: 50 to 15,000 cycles per second ±¼ db.

Crystal Oscillator: General Radio high-stability circuit. Crystal is temperature-controlled at (60 ±0.15)° C. Temperature coefficient of crystal is 2 parts per million or less per degree C. Crystal oscillator output level can be read on panel meter by pressing a push-button switch. A jack is mounted at the rear of the chassis for connecting a milliammeter to check crystal oscillator plate current.

Remote Indicators: Circuits and terminals are provided for connecting the following indicators externally:

Center-frequency indicator
Percentage-modulation meter
Over-modulation lamp
600-ohm unbalanced aural monitor

Vacuum Tubes: The following tubes are used and are supplied with the monitor:

1—6AK6 V1-	2—6C4 V102-V106
2—6AG7 V2-V109	1—815 V108
1—6AB7 V3	2—0D3/VR150 V110-V303
2—6SN7-GT V4-V203	1—6J6 V111
1—6BE6 V5	1—991 V113
x 2—6AG5 V6-V101	1—6SK7 V114
2—2050 V201-V301	1—6AS7-G V301
2—6SJ7 V202-V302	1—0C3/VR105 V305
6—6AL5 V107-V112-V115 V204-V116-V302	2—3-4 V304-V306
4—6SL7-GT V103-V104-V105-V205	

Accessories Supplied: All tubes, coaxial connector for r-f input, power line connection cord.

Power Supply: 105 to 125 volts, 50 to 60 cycles. Power-transformer-primary connections can be changed to permit operation on 210 to 250 volts. Rated power input 300 watts.

Mounting: 19-inch relay-rack panel with dust cover.

Panel Finish: Standard General Radio black crackle lacquer. Certain standard grays and other finishes that can be processed in quantity can be furnished at an extra charge of $20.00.

Dimensions: Panel, 19 x 26¼ inches, depth behind panel, 13¼ inches, over-all.

Net Weight: 88 pounds.

x 3 when 1170-P2 is used.

Manufactured and sold under United States Letters Patent:

1,967,185. 2,012,497.

2,012,291. 2,069,934.

2,362,503.

United States Letters Patent owned or controlled by American Telephone and Telegraph Company.

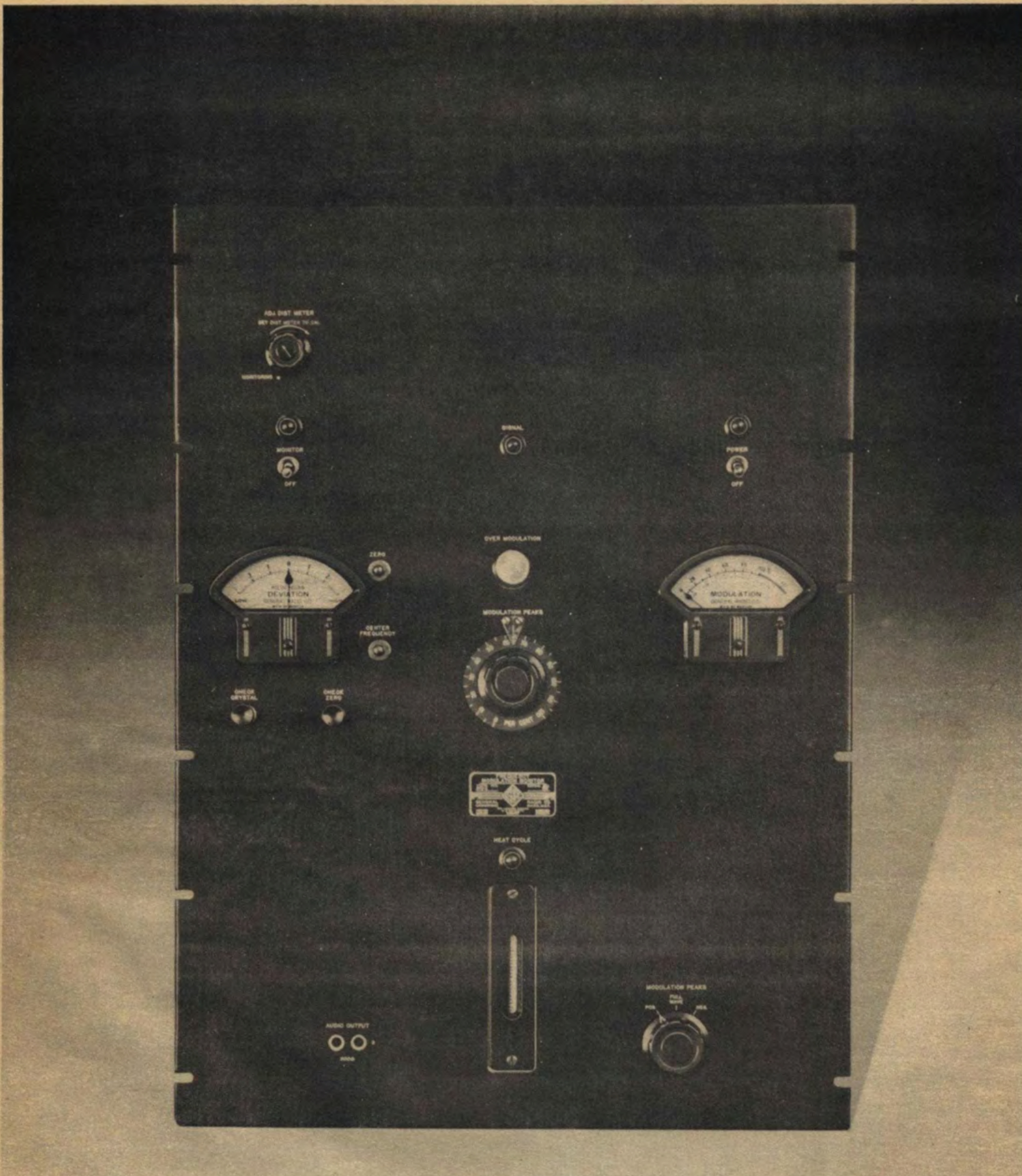


Figure 1

Panel View of the Type 1170-A Frequency-Modulation Monitor

OPERATING INSTRUCTIONS

for

TYPE 1170-A

FREQUENCY - MODULATION MONITOR

The General Radio Type 1170-A Frequency-Modulation Monitor has been designed for use with standard frequency-modulation broadcast transmitters, to enable them to comply with Section 3.252 and 3.253 of the Standards of Good Engineering Practice Concerning F-M Broadcast Stations, as required by the Federal Communications Commission. The monitor meets the specifications as stated in Paragraphs 14 and 15 of these standards.

The monitor can also be used in conjunction with the General Radio Type 1932-A Distortion and Noise Meter, for transmitter-type tests as required by Paragraph 13, "Requirements for Type Approval."

The Type 1170-AT model is used for monitoring the sound transmitters of television stations. The operating procedure is the same for both models, and any differences are noted in the instructions.

Before installing the monitor, read SECTION 1, INSTALLATION, and SECTION 2, OPERATION. A general review of the basic operating principles is contained in SECTION 3, CIRCUIT DESCRIPTION. SECTION 4, CIRCUIT DETAILS AND ADJUSTMENTS, is a complete discussion of the various circuits and their methods of adjustment and calibration.

SECTION 1.0

INSTALLATION

1.1 MOUNTING

The Type 1170-A F-M Monitor will fit a standard 19-inch relay rack and has a maximum depth-behind-panel of 13-3/8 inches, including connecting plugs, to permit installation in standard sizes of cabinet racks. The panel height is 26-1/4 inches.

Do not mount the monitor in relay racks above power rectifiers, or other equipment generating large amounts of heat. The General Radio Company will assume no responsibility for improper operation of the monitor due to excessive heating, if the installation is made so that the temperature of the air surrounding the instrument is more than 115° F.

In those cases where a Type 1932-A Distortion and Noise Meter is to be used, this should be placed directly below the Type 1170-A F-M Monitor or in an adjacent relay rack. Serious overheating of both instruments may result if the Type 1932-A is placed above the Type 1170-A F-M Monitor.

In all installations, the Type 1170-A F-M Monitor should be located at or near the top of the relay rack and have a minimum of six inches of panel-space clearance to any objects placed above it.

1.2 QUARTZ PLATE

The quartz plate is shipped in place within the temperature-controlled heater box and is ready for operation when received. The position of the quartz plate can be examined by removing the wooden cover on the rear of the heater box and opening the inner aluminum case by removing the two slotted thumb screws.

1.3 THERMOMETER, THERMOSTAT, AND TUBES

The thermometer is packed separately in the rear compartment of the instrument. This should be unpacked carefully and inserted in the hole behind the window on the front panel.

The thermostat is mounted in the wall of the inner aluminum crystal housing and is held in place by means of an internal spring clamp. Connections are made to two adjacent terminals.

All tubes and the thermostat are shipped in place and it is only necessary to make certain that they are still properly seated in their sockets.

1.4 COUPLING TO TRANSMITTER

The R-F INPUT terminal is located near the lower left corner on the rear of the instrument and will fit the GR Type 774-M Cable Jack, which is supplied. The main body of the R-F INPUT terminal is arranged to rotate and thus control the input level. Maximum and minimum positions are indicated by engraved markings.

Belden #8238 RG-11/U 75-Ω

The input circuit consists of a capacitive voltage divider, and requires an input level of approximately one volt.

Standard RMA monitoring output circuits may be used. Because of the low voltage requirements of the monitor, it is recommended that an external fixed attenuator, with a loss of about 10 db, be used between the transmitter monitoring output and the R-F INPUT terminals. This attenuator can also be used to terminate the transmitter monitoring output circuit (in its nominal impedance of 50 ohms) whenever this is considered desirable.

1.5 POWER SUPPLY

A power cord is supplied with the instrument for connecting it to the a-c power source. Either 105- to 125-, or 210- to 250-volt, 50- or 60-cycle power may be used. The line voltage for which the instrument has been connected is indicated on a plate located near the power input plug.

If the alternate voltage supply is to be used, the connections to TWO transformers must be changed, and the power supply nameplate removed and reversed so that it will agree with the changed line voltage.

The Wiring Diagram shows the terminal connections for both power transformers and their connection data for either 115 or 230 volt sources. Fuses should be changed in accordance with Figure 2 and are accessible from the rear of the instrument without the necessity of removing dust covers, etc.

Fuse	115-volt SUPPLY	230-volt SUPPLY
HEAT (F303)	~~3~~ 1 Amp.	1 1/2 Amp.
HEAT (F304)	~~3~~ 1 Amp.	1 1/2 Amp.
MONITOR (F301)	~~1~~ 3 Amp.	1/2 Amp.
MONITOR (F302)	~~1~~ 3 Amp.	1/2 Amp.

Figure 2. Fuse ratings.

1.6 EXTERNAL METERS

Provision has been made to connect remote indicating meters to the monitor. The upper Jones plug, located in the upper left corner on the rear of the instrument, is used to make the necessary connections. The connections should be made as shown in Figure 3.

Additional meters, of the type used on the instrument panel, are available from the factory. Other type meters can be used where desired, provided the general electrical characteristics are equivalent to those of the panel meter.

General meter characteristics are as follows:

KILOCYCLES DEVIATION - GR Type MEDS-27-2

Sensitivity	-	100 - 0 - 100 μa, dc
Resistance	-	450 ohms $\pm$20%
Calibration	-	Linear

MODULATION - GR Type MEDS-28

Sensitivity	-	0 - 600 μa, dc
Resistance	-	700 ohms $\pm$20%
Calibration	-	Special
Ballistics	-	High-speed movement, approx. 0.15 seconds

The General Radio Company cannot assume responsibility for calibration errors resulting from the use of external meters unless these units are supplied by the General Radio Company or fulfill the minimum requirements given above.

CAUTION: Whenever remote meters are not used, the dummy plug provided with the monitor must be inserted in the Jones socket before either panel meter will operate.

1.7 EXTERNAL "OVER MODULATION" LAMP

A small Jones plug is located in the upper right-hand corner of the monitor which can be used to connect to a remote over-modulation warning lamp. Any standard 115-volt, 3- or 6-watt lamp may be used as a remote indicator. One side of this circuit is grounded.

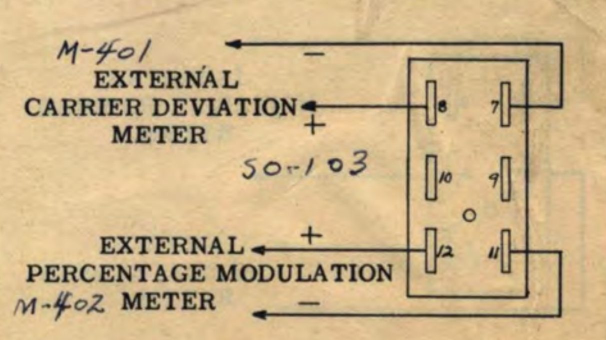


Figure 3. External Meter Connections.

1.8 EXTERNAL AUDIO CONNECTIONS

A program monitoring output is provided for connection to an unbalanced 600-ohm line. This may be used for local aural monitoring purposes, and is available on the front panel via standard W. E. plugs, marked AUDIO OUTPUT.

The lower Jones Plug, located near the upper left corner on the rear of the instrument, provides for permanent connection to the audio output circuits.

The 600-ohm aural monitoring output is connected to terminals #7 and #12 (Grounded) of this plug.

A second audio output circuit, intended mainly for connection directly to a Type 1932-A Distortion and Noise Meter, is connected to terminals #9 and #12 (Ground). The output cable supplied with the instrument should be used to make the connection between the Type 1170-A F-M Monitor and the Type 1932-A Distortion and Noise Meter. This is a special low-capacitance shielded cable and forms a part of the circuit capacitance. Use of substitute cables is, therefore, not recommended. This output circuit is designed to work into an impedance of approximately 100,000 ohms.

SECTION 2.0

OPERATION

2.1 TEMPERATURE CONTROL

Throw the POWER switch ON and the MONITOR switch to OFF. The red HEAT CYCLE bull's-eye should light immediately, as well as the red one at the upper right of the panel.

To test the operation of the heat-control circuit, short-circuit the thermostat terminals temporarily. The relay should open and the red HEAT CYCLE lamp go out. A fusible link is provided which melts and opens the heater circuit if the temperature becomes excessively high due to relay or thermostat failure.

The heat will remain on for about half an hour before the thermostat begins to operate. After about an hour, the thermostat will cycle so that the heat is on (indicator lamp lighted) about 50 seconds and heat off (indicator lamp out) about 160 seconds at ordinary room temperatures (70° to 80° F). A period of about four hours is required before the inner temperature reaches its final value. When proper operating temperature has been reached, the thermometer should read 60.0 ± 0.3°C.

2.2 RANGE OF OPERATION

Either of two types of r-f mixer assemblies is supplied with the R-F Section of the monitor. The Type 1170-P1 unit covers the range between 30 - 162 megacycles; and the Type 1170-P2 unit covers the range between 160 and 220 megacycles.

Only one unit is supplied with each monitor and has been selected to provide operation at the frequency requested and is completely tuned and adjusted when received. Changes in these adjustments are not normally required and should not be attempted without referring to SECTION 4.

The monitor can be set up for operation anywhere within the specified range by following the procedure outlined in SECTION 4, CIRCUIT DETAILS AND ADJUSTMENTS.

2.3 CRYSTAL OSCILLATOR AND HARMONIC MULTIPLIER

Having allowed the crystal to reach normal operating temperature, turn the MONITOR switch ON and allow a few minutes for the tubes to stabilize. A time-delay relay will connect the plate supply within a period of 15 - 60 seconds. Depress the CHECK CRYSTAL button on the panel. A deflection of the meter to, or above, the red line will indicate that the crystal is oscillating with sufficient amplitude to drive the first multiplier stage.

A rear jack, labeled OSC. CURRENT, is provided on the lower rear left corner of the instrument. A 0 - ~~25~~ ma d-c meter may be plugged into this jack, using a standard telephone plug, to check the oscillator current. This should be approximately ~~6~~ ma (8ma non-oscillating).

2.4 INPUT SIGNAL LEVEL

The small meter, located on the lower left corner of the rear of the instrument, will provide a visual indication of the transmitter input signal level to the monitor. When an r-f signal is connected to the R-F INPUT terminal, this meter will show a deflection, provided the monitoring crystal is oscillating at the correct frequency and the harmonic multipliers are properly adjusted. These adjustments have been set at the factory for operation at the specified transmitter frequency, and will not normally require alteration.

The deflection obtained on the rear meter may be varied over a considerable range by rotation between the limits of MAX and MIN of the hexagonal nut that forms the main body of the R-F INPUT jack. The meter deflection should be set to approximately 100 (10 x 10) by means of this adjustment. A friction clamping screw maintains sufficient pressure upon the adjustment device to permit forced movement but will guard against accidental turning. The clamping screw is accessible through a hole located in the left-side internal shield plate.

When the R-F INPUT level has been set correctly, the SIGNAL pilot lamp on the panel and also the illumination lamps of the FREQUENCY DEVIATION meter, will glow with normal brilliance. These serve the purpose of continuously indicating normal operation of the monitor. Failure of either the R-F INPUT from the transmitter or the monitoring crystal oscillator will cause these SIGNAL lamps to become very dim.

2.5 METER READINGS

2.51 Center-Frequency Deviation: The monitoring crystal oscillator should be permitted to operate for a period of about four hours following the initial installation in order that it reach final temperature and frequency stability before the indications of the meter can be considered normal.

Assuming that the monitor is fully stabilized, as noted above, the meter will indicate directly the deviation from the assigned transmitter frequency, if this is within the range of ±3000* cycles. Should the frequency deviation exceed this value, the meter will deflect off scale, provided that the frequency is within 120 kc of the assigned value. If the transmitter is more than 120 kc off frequency, the meter may give false indications. It is important, therefore, to determine the exact transmitter frequency, as precisely as possible, before using the deviation meter.

Before reading the KILOCYCLES DEVIATION meter, the "electrical" zero setting of the circuit should be checked. Depress the CHECK ZERO push button near the lower right corner of the meter and hold it in. If the pointer fails to return to exact zero, remove the snap button located next to the upper right corner of the meter, and set the screwdriver adjustment until exact zero is obtained. The movement of the meter will be sluggish under these conditions; hence, it is best to make changes in the ZERO adjustment in small increments and allow sufficient time for the meter to reach its final setting. It is important that the transmitter be on when this check is made.

An adjustment for bringing the readings of the FREQUENCY DEVIATION meter into agreement with the results of an independent frequency check of the transmitter is provided on the front panel. The control located under the snap-button marked CENTER FREQUENCY, adjacent to the lower right corner of the meter, is used for this purpose. This adjustment has a useful range of ±3000* cycles, which provides a wider range than any long-term drifts in frequency will normally require.

CAUTION: It is recommended that these adjustments be left undisturbed for a period of at least twenty-four hours after the initial installation, in order to permit the instrument to become thoroughly stabilized.

2.52 Modulation: The MODULATION meter will deflect up scale when modulation is applied to the transmitter. A MODULATION PEAKS switch, located in the lower right corner of the panel permits the meter response to be set for positive, negative, or full-wave modulation peaks.

It is important that the control marked ADJ. DIST. METER be set at the Monitoring position at all times, except when distortion or noise measurements are being made. (See 2.7)

2.6 OVER MODULATION INDICATOR

An OVER MODULATION warning lamp, located near the center of the front panel, will flash whenever the modulation peaks exceed the setting on the MODULATION PEAKS dial. This dial may be set for any modulation level between the limits of 10 and 120 per cent.

2.7 DISTORTION AND NOISE MEASUREMENTS

2.71 Noise Measurements: The Type 1932-A Distortion and Noise Meter should be set to the CAL position, with its panel CAL control set at maximum, or full clockwise position, and the INPUT - 100 kΩ switch depressed.

Before proceeding with the tests it is advisable to check the over-all system for minimum residual noise level. First check that the residual noise level in the Type 1932-A Distortion and Noise Meter is approximately -80 db, or less. This can be done by simply removing one end of the connecting cable. Refer to Paragraph 4.4 PRECAUTIONS on Page 5 of the Type 1932-A Instruction Book.

With the connecting cable in position and the ADJ. DIST. METER control, on the panel of the Type 1170-A F-M Monitor, set at the Monitoring position, a slight increase in noise level in the order of 2 db may be noted. This may be minimized by securely grounding both instruments, reversing power plugs, etc. In all cases, the residual indicated noise level should not exceed -75 db.

To measure the transmitter noise level, apply a 400 cycle - 100% Modulation signal to the transmitter. By means of the ADJ. DIST. METER control, set the Type 1932-A Distortion and Noise Meter to the CAL. setting. Remove the modulation signal from the transmitter and operate the Type 1932-A in the usual manner for noise measurements. Refer to Paragraph 2.2 Noise Level Measurements, on Page 2, of the Type 1932-A Instruction Book. Noise measurements include a range of frequencies from 30 to 30,000 cycles, and the standard 75 microsecond de-emphasis frequency-weighting characteristic is included.

2.72 Distortion Measurements: Calibration of the Type 1932-A when used as a distortion meter is similar to the process just outlined for the noise measurement, except that measurements can be made at any fundamental frequency between 50 and 15,000 cycles and at modulation levels between 10 and 140 per cent. At the higher modulating frequencies, the available audio output signal from the monitor is reduced in accordance

* ±6000 cycles for television channels 7 to 13.

with the standard 75 microsecond de-emphasis weighting characteristic. This limits the percentage of modulation at which measurements can be made, at the higher modulating frequencies. The overall range of operation is shown in Figure 13.

2.8 STAND BY OPERATION

When the transmitter is not operating, the monitor cyrstal oven should be left on to enable a quick return to service conditions. By throwing the MONITOR switch to OFF, all circuits except those required to maintain the temperature control of the crystal oven, will be shut off.

A return to normal operation, from the stand-by condition, merely requires throwing the MONITOR switch to ON, and allowing sufficient time for the tubes to warm up. Within a matter of minutes, all circuits will be sufficiently stabilized to operate normally, with the possible exception of the KILOCYCLES DEVIATION meter. This latter circuit may require approximately 15 minutes to approach final stability, which condition should be fully reached within an hour.

For short periods of broadcast interruption, lasting a few hours or less, it is advisable to permit the monitor to operate continuously.

A period of about four hours is required for the monitor to become stabilized from a condition of complete shut-down including the crystal oscillator temperature control system.

SECTION 3.0
CIRCUIT DESCRIPTION
AND
PRINCIPLES OF OPERATION

A functional block diagram of the Type 1170-A Frequency-Modulation Monitor is shown in Figure 4. The standard of frequency against which the transmitter is monitored is a crystal oscillator whose frequency, when multiplied up to the region of the transmitter, differs from the assigned channel by exactly 150 kilocycles. The beat-frequency produced in the mixer, between the transmitter and a harmonic of the crystal

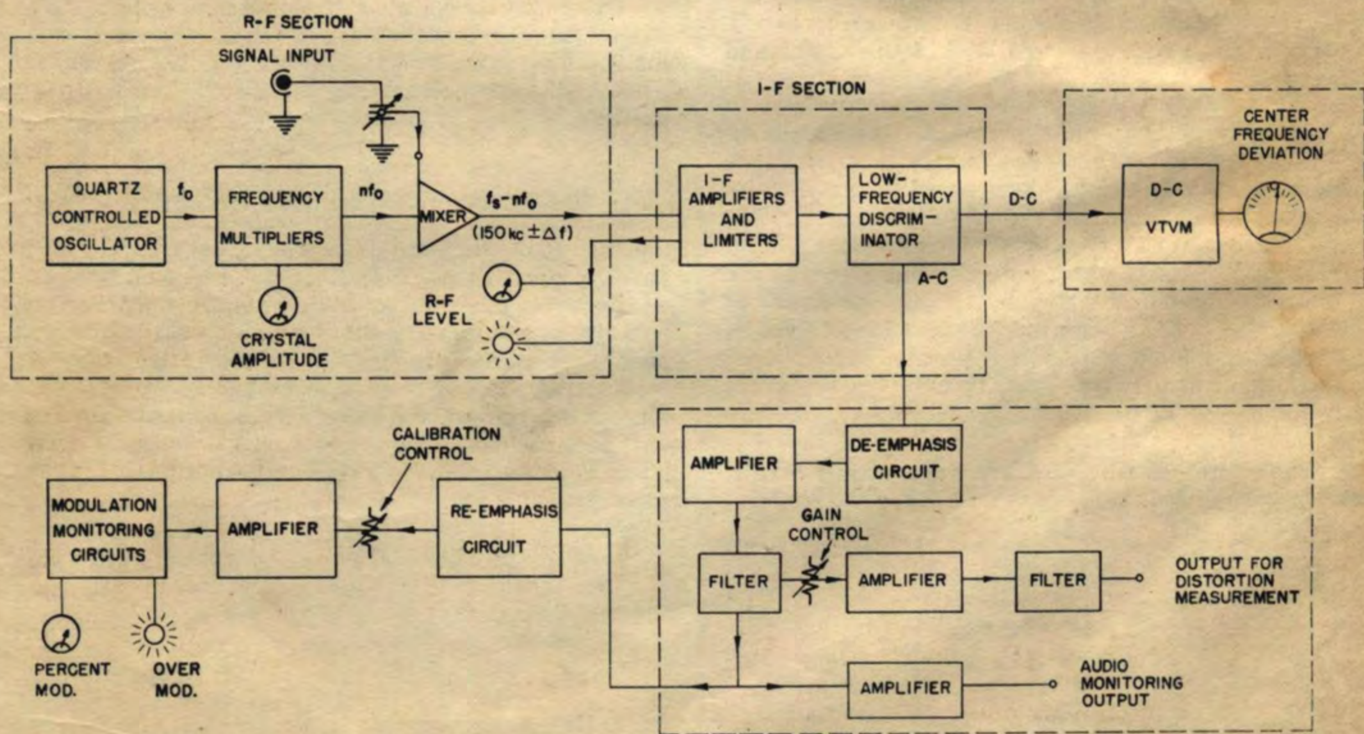


Figure 4. Functional Block Diagram of the Type 1170-A Frequency-Modulation Monitor.

oscillator, is fed to a series of amplifiers and clippers to produce a square wave. A "pulse counter" type of discriminator is operated by the square wave to produce an output voltage which is proportional to the instantaneous fundamental frequency of the square wave. Under conditions of 100 per cent modulation, the fundamental frequency of the square wave will swing ±75† kilocycles about the 150 kilocycle center point, or average frequency. The average, or d-c component, of the discriminator output signal is used to operate a vacuum-tube voltmeter which indicates the deviation of the transmitter average-center-frequency from the assigned channel.

The a-c components of the discriminator output signal include the original modulation and other higher order functions present as a result of the pulse-type waveform, etc. By means of a low-pass filter, the unwanted higher order components are eliminated.

The audio circuits are coupled to the output of the discriminator by means of a standard 75 microsecond de-emphasis circuit (which also assists in the filtering process) and a 30-kilocycle low-pass filter.

One audio amplifier operates as a low-impedance output stage to provide a local monitoring output at 600 ohms impedance for direct connection to telephone lines, etc.

A second audio amplifier is provided with a gain control and additional output filter to minimize noise and spurious signals. This circuit has been designed for very low residual noise and distortion levels and is intended for use with the Type 1932-A Distortion and Noise Meter.

A third audio system consists of a pre-emphasis circuit which restores the frequency response to a uniform characteristic for the purpose of operating the modulation meter circuits. A pre-amplifier is used to operate two semi-peak diodes, and a d-c amplifier. The gain of the pre-amplifier may be changed so that the monitor may be calibrated to read 100% modulation at any value between the limits of 25 and 75 kilocycles. This permits the monitor to be calibrated for services employing modulation levels other than the f-m broadcast standard of ± 75 kc for 100% modulation.

The semi-peak diodes are arranged to permit the selection of positive, negative, or full-wave modulation response characteristics by means of a panel switch. The modulation meter is operated by a vacuum-tube voltmeter having the required dynamic-response characteristics for modulation monitors as specified by the FCC. On transient signals, this results in the meter response having a fast upswing and slow return.

An "Over-Modulation" warning lamp is provided, which will flash whenever the transient modulation peaks exceed a predetermined level as set on the MODULATION PEAKS potentiometer dial. The audio-modulation signal is applied to the grid of an amplifier tube together with a variable portion of a d-c bias voltage, as determined by the dial setting. The total potentiometer d-c voltage is made equal to the peak value of the audio signal, at 120% modulation level, which is the full range of the dial calibration. In addition, a fixed negative bias is applied in series with the grid to maintain the tube just at the cut-off point. Thus, whenever the modulation peaks exceed the dial setting, a pulse is developed in the plate circuit of the amplifier tube. This pulse is used to trigger a thyratron tube which causes the indicator lamp connected to its anode circuit to glow.

This circuit will respond to transient modulation peaks which are too short to cause the modulation meter to deflect to its final value. For this reason, coincidence of the meter readings and the lamp flashes may not occur on all types of program material. The two will agree closely on steady-state or sine-wave modulation. The lamp operates on positive modulation peaks. This is not significant except when asymmetrical modulation is encountered. In these instances, the agreement between the flashing lamp and the meter deflections will be closest when the meter switch is set to the positive-peak position.

In general, the monitoring applications of the modulation meter and the over-modulation lamp will be identical to the well-established practices used for many years in standard a-m broadcasting. There is, however, no longer any reason to favor monitoring either one polarity of the modulation, such as exists in the a-m case*. Operators will find that the use of the full-wave modulation position (i.e. positive and negative simultaneously) an advantage since it eliminates the need for switching back and forth in order to determine the maximum modulation swing on asymmetrical program material.

†25 kc for Type 1170-AT.

*J. L. Hathaway: "Effect of Microphone Polarity on Percentage Modulation", ELECTRONICS, p. 28, October 1939.

SECTION 4.0
CIRCUIT DETAILS AND ADJUSTMENTS

4.1 R-F SECTION (See Figure 5)

4.11 Crystal Oscillator: The temperature coefficient of the frequency monitoring crystal is less than 2 parts per million. The quartz plate is mounted in a dust-proof pre-set air-gap-type holder, which imposes a minimum of restraint upon the vibration of the quartz. This assembly is plugged into a terminal plate, and is enclosed in an aluminum casting whose temperature is controlled at 60°C.

The oscillator circuit* is of a type developed in the General Radio laboratories for use in standard frequency oscillators. No inductance elements are employed in the frequency-determining system. Since the crystal operates very near its true resonant frequency, a high degree of stability is obtained.

Condensers C-22 and C-23 have been set at the factory for optimum conditions with the particular crystal supplied. In general, these two condensers will be set equally, and the amount of the circuit capacitance will be determined by the particular crystal frequency. Maximum stability will be obtained with these condensers set for the maximum capacitance consistent with adequate output level. These adjustments are accessible through two holes located underneath the r-f section on the lower left side of the instrument.

The crystal oscillator plate current should be about 2 ma, as read on a meter connected to J-1 on the rear of the instrument. The indicated plate current will rise, with crystal not oscillating, to about 3 ma. The maximum crystal voltage is limited by the fixed bias applied to the two crystal rectifiers.

*U. S. Patent No. 2,012,497

The CHECK CRYSTAL switch located on the panel connects the panel meter into the grid circuit of the second multiplier stage V-2 (6AG7). By measuring the grid current at this point, the output of the crystal is indirectly determined.

4.12 Crystal Frequency: The operating crystal frequency will generally be within the range of 1300-2250 kilocycles. Excellent stability can be obtained with crystals operating at these relatively low frequencies.

The final selection of the exact frequency to be employed in each case is rigorously determined by several factors including:

1. 150-kilocycle offset frequency from the assigned channel frequency.

2. Crystal harmonic utilized.

3. Avoidance of spurious responses.

The first consideration stems from the fact that the instrument operates on a 150-kilocycle intermediate frequency which is obtained by heterodyning the oscillator harmonic with the transmitter carrier.

The second point is mainly determined by the transmitter operating frequency and is also influenced in some cases by Item 3 above. The harmonic of the crystal employed may range from the 32nd to the 128th for standard FM and TV operation.

The third consideration mentioned above is due to cross modulation products which may be generated within the monitor itself. This will not be important,

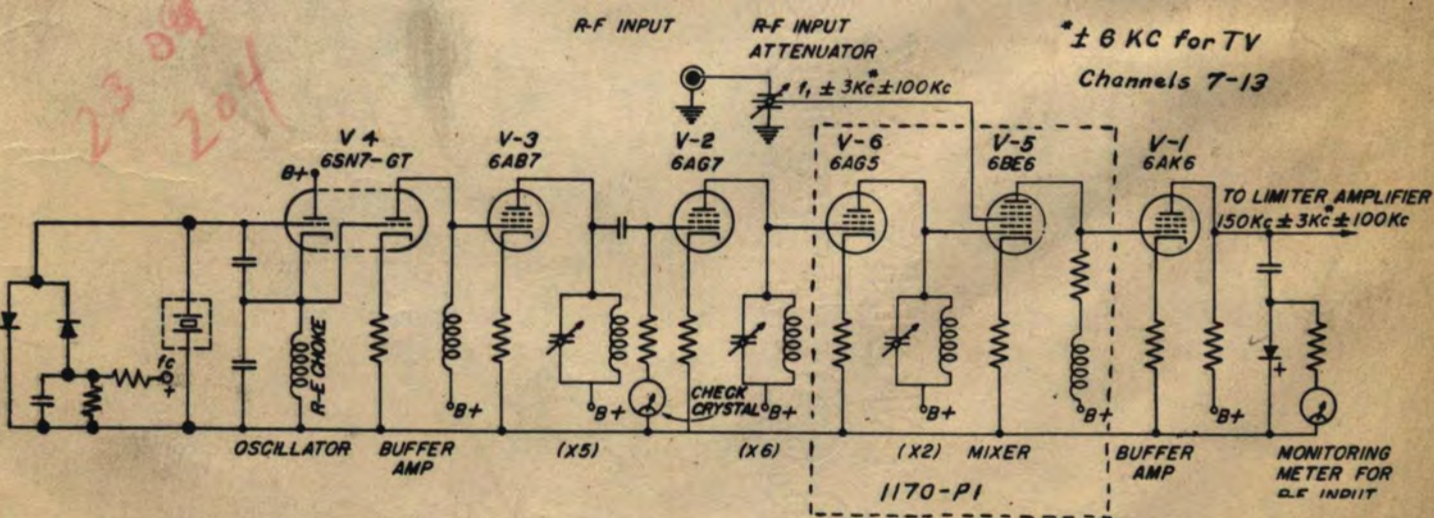


Figure 5. Elementary Circuit Diagram of R-F Section With Type 1170-P1 Mixer Assembly. Type 1170-P2 Mixer Assembly uses one additional tube.

unless the monitor is to be used in conjunction with a distortion and noise meter. Harmonics of the intermediate frequency (150 kc) may cause spurious responses to exist in the detector audio-output circuit by heterodyning with the fundamental of the monitoring crystal frequency. While other cross-modulation products may exist, they will be too small to cause any interference. If these extraneous beats are produced within the "pass-band" of the audio output system (i.e., less than 30 kc) they will have the effect of raising the apparent noise level of the transmitter as indicated by a distortion and noise meter. By judicious selection of the crystal fundamental frequency, it is possible to have any spurious responses, due to this cause, occur above the audio pass-band and thus have no effect upon the noise measurements.

Table I (see end of book) contains complete data for the standard FM and TV channels and the arrangements have been selected on a basis of the three conditions just mentioned.

4.13 Tuning R-F Circuits

4.131 Minor Adjustments: When the multiplier stages require slight adjustments, such as shifting transmitter frequency to adjacent channels, etc., the procedure is quite simple and can be made by using the transmitter as a test source. It will be necessary to remove the monitor from the relay rack to make the required adjustments.

The multiplier tuning capacitance adjustments are accessible upon removing the left side cover. The inner shield plate on the r-f section should not be removed, since it does have a slight influence upon the tuning adjustments. It is preferable to use an insulated screw driver to make the tuning adjustments to avoid "hand-capacitance" effects, etc.

Proceed by turning C-13 through a small angle and set at the position which results in a maximum deflection of the R-F INPUT meter on the rear of the instrument. Then proceed to set C-7 and C-30, in this order, for maximum meter deflection. The R-F INPUT attenuator may be used to keep the deflection of the meter on scale, as each tuning adjustment is made.

Be sure to allow sufficient time for the new monitor crystal to warm up to final temperature before attempting these adjustments.

4.132 Major Adjustments: When the monitor is to be set up for a markedly different transmitter frequency than that for which it was originally adjusted, the following procedure will enable the changes to be made with speed and accuracy. A test oscillator, capable of providing an output of one volt at the channel frequency, can be substituted for the transmitter, if desired. A wavemeter, covering the ranges shown in Table I, for the particular transmitter frequency desired, will be necessary, and, in addition, a standard model oscilloscope.

TUNING ADJUSTMENTS OF CRYSTAL HARMONIC MULTIPLIERS

Transmitter Frequency in Mc	30 to 50	50 to 88	88 to 160	160 to 220
R-F Tuning Unit	1170-P1	1170-P1	1170-P1	1170-P2
Fourth Multiplier	None	None	None	$L_{604}C_{608}$ $L_{605}C_{611}$ L_{605} = 1170-825 (160-220 Mc) L_{604} = 1170-826
Third Multiplier	L_8C_{30} L_8 = 1170-206 (22-50 Mc)	L_8C_{30} L_8 = 1170-86 (42-88 Mc)	L_8C_{30} L_8 = 1170-803 (61-163 Mc)	$L_{602}C_{604}$ L_{602} = 1170-824 (80-110 Mc)
Second Multiplier	L_2C_7 L_2 = 1170-205 (15-25 Mc)	L_2C_7 L_2 = 1170-206 (25-44 Mc)	L_2C_7 L_2 = 1170-86 (40.4-80.8 Mc)	L_2C_7 L_2 = 1170-86 (40-55 Mc)
First Multiplier	L_3C_{13} ——	L_3C_{13} ——	L_3C_{13} ——	L_3C_{13} L_3 = 1170-27 (*5.4-10 Mc 6.3-11.8 Mc) *with 2COU-3-P2 iron core in coil

Connect the oscilloscope to Pin #1 of the 6AL5 tube socket (V-112 located just below the 815 tube in the above Discriminator Section) by removing the tube and inserting a wire into the socket in place of the tube pin. Remove the inner shield from the R-F Section. Refer to Table I and note the operating frequencies for each multiplier.

First make certain that the new crystal is warmed up and oscillating normally. Using the wavemeter, adjust C-13 for the correct harmonic of the crystal frequency. When this has been done, depressing the CHECK CRYSTAL switch on the panel will show a deflection to, or above, the red line on the panel meter.

Connect the R-F INPUT to the transmitter monitoring line, or the local test oscillator set at the transmitter frequency. Increase the scope gain until a deflection is observed on its screen. Should the input r-f happen to be set exactly on the desired frequency of the transmitter, the scope frequency will be 150 kc. However, it is not important that this be done precisely and the frequency observed may vary between 50 and 250 kc.

Adjust C-7 and then C-30 in that order for a maximum deflection on the oscilloscope, gradually decreasing the amplifier gain to keep the pattern within the range of the oscilloscope. Usually, it will be found that only one position for each of these capacitance adjustments will result in maximum oscilloscope deflection. When this condition has been met, the R-F INPUT meter on the rear of the instrument will be reading up scale, and it may be necessary to adjust the R-F INPUT attenuator to keep the meter deflection on scale. Remove the cylindrical shields from the tuning inductances, L-2 and L-8, and using the wavemeter, check the frequencies to be in accordance with Table I. The power in these circuits will not be sufficient to give a direct indication on most absorption-type wavemeters. However, a reaction on the oscilloscope will be noted as the wavemeter is tuned through resonance and held near the inductance. Removal of the coil shields, etc., will slightly de-tune the multipliers; hence, when it has been determined that the frequency settings have been correctly made, the final adjustment should be made with all shields in place.

4.14 V-H-F Range Extension: The monitor has two different mixer assemblies which form a part of the R-F Section. These have overlapping ranges, and the appropriate assembly as required by the operating frequency will be supplied.

These units are mounted upon a removable plate which contains the final multiplier and mixer stages and also an additional I-F amplifier in the higher frequency unit. While it is possible to interchange these units in the field, this practice is not recommended.

4.2 DISCRIMINATOR SECTION (See Figures 6-10)

4.21 I-F Limiter Amplifiers: The output of the previous R-F Section is passed on to the input full-wave diode clipper tube V-112 (6AL5), is then amplified by V-114 (6SK7), and again clipped by the full-wave diode clipper V-115 (6AL5). Each of the two diodes has a fixed bias applied to alternate plates and cathodes. (See 4.45). This fixes the cut-off point of the diodes and assists in reducing the effect of tube characteristics upon the waveform and amplitude of the square wave.

The resultant square wave is further amplified and limited by V-109 (6AG7) and finally by V-108 (815). At this point, the square wave has a high degree of amplitude stability and maintains essentially constant waveform over the entire frequency swing from 50 to 250 kc (i.e., 133% modulation).

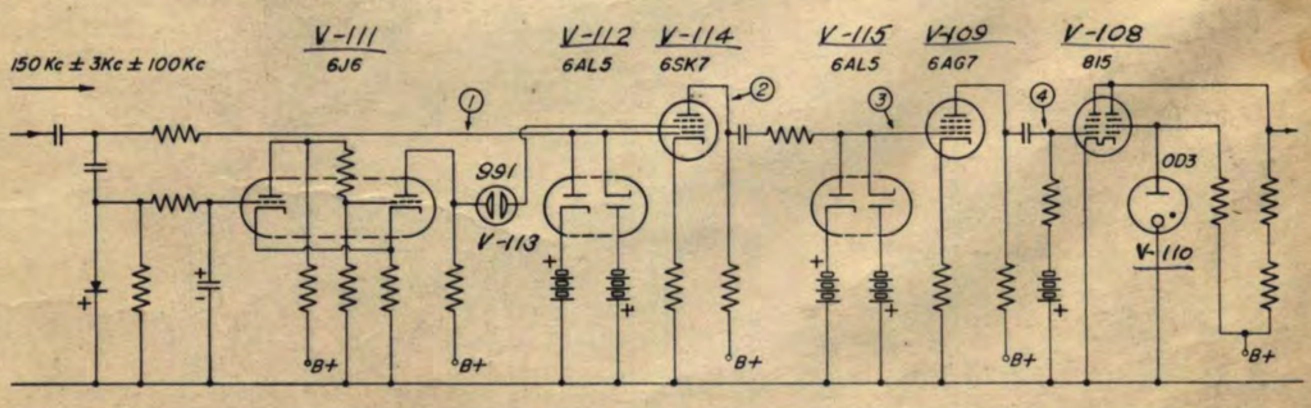


Figure 6. Elementary Schematic Diagram of I-F Limiter Amplifier

4.22 Signal Monitoring Circuits: (See Figure 7) With square-wave circuits, it is possible to obtain an output signal with a relatively low amplitude of input signal, such as might be obtained with one or more of the clippers and limiters operating below saturation. This would then result in an erratic behavior of an indicating device which is normally intended to operate from a constant-amplitude square wave. To avoid this effect, a control is introduced which reduces the gain of the i-f amplifier until sufficient signal amplitude is present to maintain the miminum required for proper operation. It is also advantageous to have a monitoring circuit to indicate continuously the minimum signal level. Both of these functions are obtained from a single control circuit.

Part of the incoming signal from the previous r-f section is passed to a crystal diode rectifier (D-103). Since the signal level at this point is proportional to the R-F INPUT level, the rectified output of the crystal diode is an indirect measure of the R-F INPUT level. The microammeter which responds to this crystal diode current is the small meter placed on the rear of the instrument under the caption ADJ. R. F. INPUT TO 100.

The d-c voltage developed by the crystal diode (D-103) is filtered and applied to the grid of one section of an unbalanced "flip-flop" tube V-111 (6J6). This tube controls the gain of the i-f amplifier tube V-114 (6SK7) by cutting off its screen-grid potential and simultaneously controls the action of the SIGNAL thyratron by cutting off the source of positive grid potential normally applied to its control grid. A relay in the thyratron anode circuit controls the plate and screen supply for the i-f amplifier tubes V-108 and V-109, also the signal pilot, and meter lamps in M-401.

With no signal present and the diode potential at zero, the right side of the twin-triode tube V-111 (6J6) is conducting, by virtue of its positive grid potential. This is developed by the resistances R-167 and R-166. Due to the cathode current flowing in R-165, a voltage is developed across this resistance which is sufficient to bias the left side of the twin triode beyond cutoff. The plate current of the right-hand triode causes a potential drop through R-172, which is in series with the plate supply. The voltage appearing across the neon glow lamp V-113 (991) is not sufficient to cause conduction; hence, no current can flow through it. This results in an essentially open circuit in series with the screen-grid supply of the amplifier V-114 (6SK7).

When a carrier signal is applied to the R-F input jack, a d-c potential is developed across capacitor C-137 by the rectifying action of the crystal diode D-103, proportional to the level of the input signal. The polarity of this potential is such as to decrease the net negative bias applied to the left triode section of V-111, and as a result this section begins to conduct, causing a voltage drop across R-173, and consequently a decrease in the positive bias applied to the right triode. Because of the common cathode resistor R-165 this action is cumulative, so that at a critical level of input signal the right triode is biased beyond cut-off.

When this happens, the voltage drop across R-172 momentarily disappears, thus applying sufficient potential from the plate supply to cause V-113 (991) to become conducting. A positive potential is now applied to the screen grid of V-114 (6SK7) and this amplifier tube functions with normal gain. Simultaneously, a positive voltage is applied to the grid of the SIGNAL thyratron-control tube via R-171 and R-335. The relay REL-302

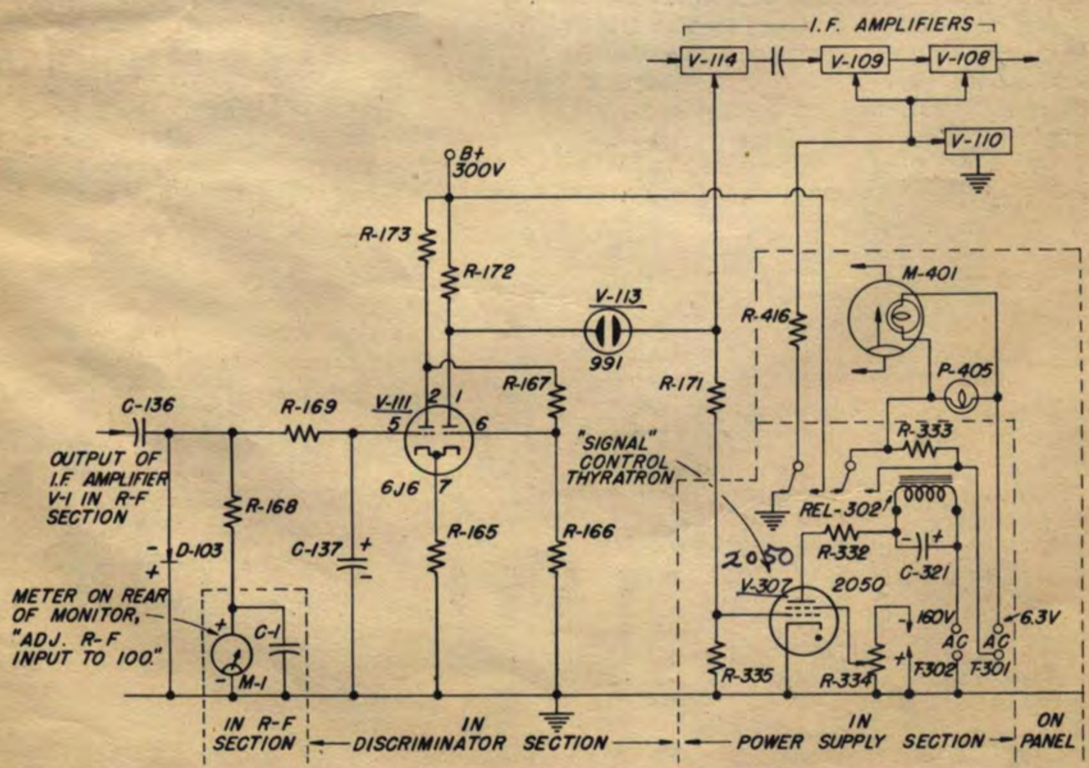


Figure 7. Signal Monitoring Circuits

then lights the SIGNAL pilot and meter lamps, and connects the plate and screen supply to V-108 and V-109. R-333 permits the SIGNAL lamps to glow very dimly in the absence of signal voltage for the purpose of indicating circuit continuity.

4.23 Discriminator Circuit Operation: The discriminator circuit used in the monitor is a pulse-counter type. It consists essentially of a series capacitance and shunt resistance, as shown in the elementary schematic diagram of Figure 8. The RC time constant is quite small compared to a half cycle of the square wave. When a square wave is applied to such a circuit, the capacitance will be charged to the peak value of the square on alternate half cycles.

By the addition of two diodes, the capacitance may be made to charge through one and discharge through the other, and thus result in unidirectional voltage pulses appearing across the resistance at the rate of one per cycle of the square wave. A bias is applied in series with the diodes to eliminate the residual diode current which would otherwise flow through the resistances.

4.24 Discriminator Circuit Details: The basic discriminator circuit includes the duo-diode tube V-107 (6AL5), the series capacitor C-120, and the shunt impedance element R-140 and L-102. The capacitor is adjusted at the factory for output level and maximum linearity of the discriminator characteristic. It is intended for use in adjusting for manufacturing tolerances only and should never be changed in any way.

A bias voltage is developed across the resistance R-141 for the purpose of limiting the initial diode current produced by the tube V-107 (6AL5). This minimizes the effects of the tube characteristics upon the calibration. The voltage is derived from the regulated plate supply and is filtered by the R-C combination of R-143 and C-121.

Additional stabilization is provided through the use of a series constant-current ballast-tube of the Amperite 3-4 type, V-304.

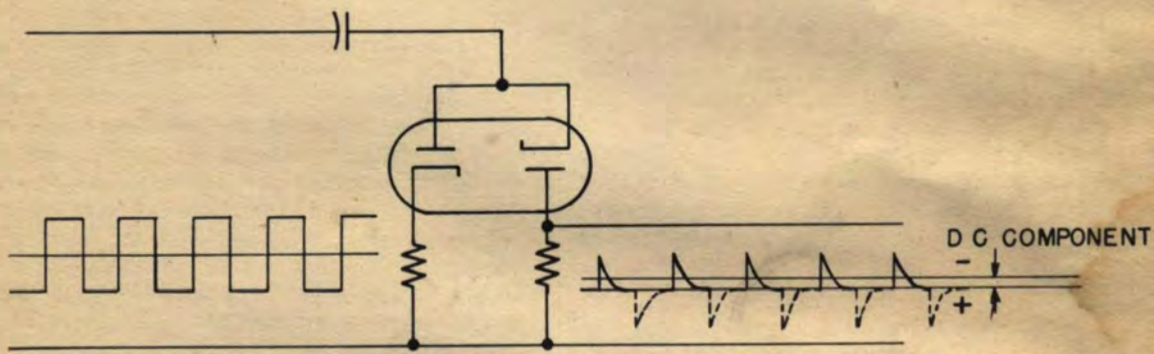


Figure 8. Schematic Diagram Showing Discriminator Circuit Operation

4.25 Operation of Center Frequency Indicator: An elementary diagram of the center-frequency indicator circuit is shown in Figure 9.

With the transmitter unmodulated and operating on its assigned channel frequency the output of the discriminator will consist of a series of identical, uniformly spaced, unidirectional pulses, occurring at a rate of 150 kc. By integrating these pulses, a d-c voltage is developed which is used to operate a balanced d-c vacuum-tube voltmeter.

When frequency modulation is applied to the transmitter the above conditions are changed. With the transmitter operating on its assigned channel frequency, the average recurrence rate of the discriminator output pulses is still 150 kc, but the instantaneous rate depends upon the instantaneous transmitter frequency as determined by the modulation wave.

If the frequency of the transmitter departs from its assigned channel frequency, the frequency of the square wave changes in the same manner. Since the number of pulses generated by the discriminator per unit time has changed, the d-c voltage developed will also change in magnitude and thus cause a shift in the vacuum-tube voltmeter. This is the basis of operation of the KILOCYCLES DEVIATION or center-frequency meter.

Changes in both amplitude and frequency of the square wave will affect the discriminator output voltage. Since it is desired to have the discriminator respond only to frequency, the square wave amplitude must be precisely regulated. This is achieved for the most part in the i-f limiter-amplifier circuits, but it is impractical to attempt to reduce the amplitude changes to the degree required for operation of the center frequency indicator. Accordingly, compensation circuits are included in the center-frequency indicator which reduce the effects of minor amplitude changes to a negligible value.

The discriminator d-c output voltage is applied to one side of a balanced d-c vacuum tube voltmeter, as shown in Figure 9. A peak-response diode is used as an amplitude compensation device and develops a d-c voltage which is applied to the opposite side of the balanced d-c vacuum-tube voltmeter.

The center-frequency indicator is a zero-center device. To adjust the d-c vacuum-tube voltmeter to zero, a positive voltage is obtained from the regulated plate supply. This voltage is set to give a zero reading on the meter, when the i-f is exactly 150 kc. Since this control determines the calibration of the meter with respect to the i-f, it is also used to adjust for frequency drifts in the crystal oscillator, and is available on the panel under a snap-button captioned CENTER FREQUENCY.

It is important to note that the final i-f limiter amplifier V-108 (815) is operated between the limits of plate-current cutoff, and plate current saturation. The resultant square wave is thus limited in positive amplitude by the regulated plate supply, and in negative amplitude by the voltage drop across the tube. Compensation for minor changes in the positive amplitude of the square wave are thus obtainable directly from the plate supply. This is accomplished automatically by the center frequency adjustment circuit. Compensation for minor changes in the negative square wave amplitude is effected by means of the half-wave diode. The other half of the duo-diode tube V-116 (6AL5) is used to balance out the contact potential of the diode as well as changes in the emission current of the limiter tube V-108 (815) with heater supply voltage.

4.26 Circuit Details of Center-Frequency Indicator: The square-wave amplifier output is fed to the discriminator diodes V-107 and the amplitude compensation diode circuit, V-116. The resultant d-c voltages are applied to opposite grids of the two balanced vacuum-tube voltmeter tubes V-104 and V-105 (6SL7-GT).

By slight adjustment of a compensating d-c voltage derived from the plate supply, the center-frequency position of the KILOCYCLES DEVIATION meter can be shifted over a limited range. Under the original calibrating conditions, the total amount of compensating d-c voltage is made equal to the d-c voltage output of the discriminator when the fundamental frequency of the square wave is 150 kc*, to result in a zero center reading of the meter. There are two adjustments which control this d-c compensating voltage. The first, which is located behind the monitor nameplate on the front panel, is identified by the engraving CENTER FREQ. and is only used for initial factory adjustment. A second control is accessible beneath a snap-button on the panel, adjacent to the lower right corner of the KILOCYCLES DEVIATION meter and is engraved CENTER FREQUENCY. This control is intended for use in adjusting the monitor to agree with the results obtained from independent transmitter frequency measuring services. This calibration adjustment should not be disturbed unless an accurate frequency check indicates that the monitor readings are in error. The useful range of adjustment is ±3 kilocycles#. Should the required correction exceed this limit, the monitor crystal will probably be found off frequency. The potentiometers R-156 and R-160 are factory adjusted and should not be disturbed.

R-181 is inserted to change the meter scale range to 6-0-6 kc, which is normally supplied for high frequency transmitters.

The balanced d-c vacuum-tube voltmeter, which is used to operate the KILOCYCLES DEVIATION meter, is a zero-center device and will deflect to full scale in either direction (±3000 cycles) when a nominal potential of ±0.30† volt is applied. The effects of power-supply voltage variations have been reduced to a minimum through the use of a balanced circuit, regulated plate voltage supply, and regulation of the tube heater current. The latter is achieved through the use of a series connection, employing a constant-current ballast tube of the Amperite 3-4 type, V-306.

±6 kc for television channels 7 to 13.

* If the crystal oscillator has drifted slightly, necessitating a change in the setting of the CENTER FREQUENCY adjustment, the intermediate frequency will no longer be 150 kc for a zero meter reading. It will differ from 150 kc by an amount equal to the shift in the control.

† ±0.60 volts for the ±6 kc range.

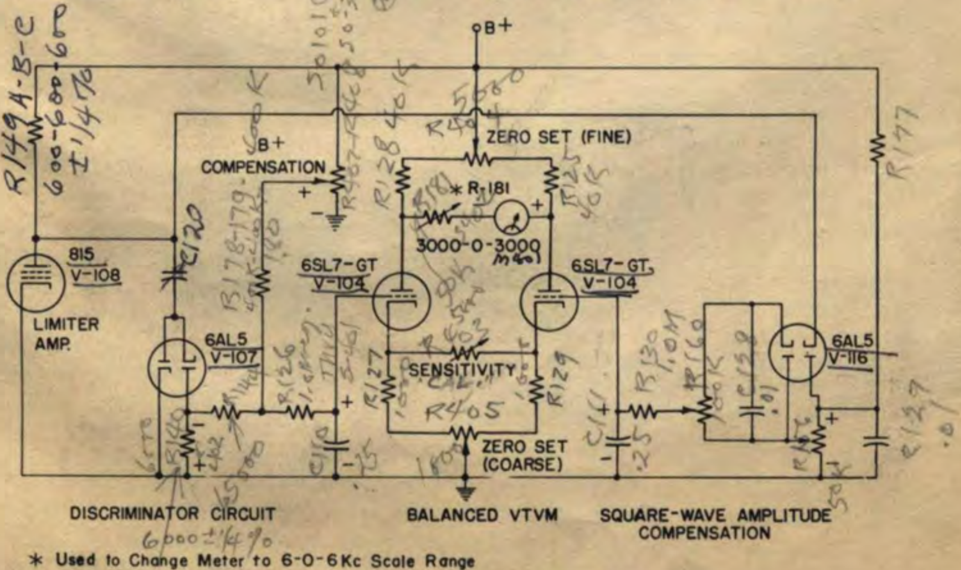


Figure 9. Elementary Schematic Diagram of Center-Frequency Indicator

An independent check of the electrical zero* of the KILOCYCLES DEVIATION meter is provided on the instrument panel. When the panel CHECK ZERO switch is depressed, the signal is removed from the balanced d-c vacuum-tube voltmeter. The meter should slowly return to zero in this case. In the event that a zero drift is found, the zero adjustment (R-404) (located to the right of the meter and under a snap-button) can be changed. Do not make this check unless the monitor is operating with a signal from the transmitter.

The initial calibration of this vacuum-tube voltmeter circuit has been made by means of the two concealed adjustments located under the panel nameplate. These are engraved CAL (R-403) and ZERO (R-405) and are factory adjusted and should not be disturbed.

There are two cylindrical shields placed over the two vacuum-tube voltmeter tubes V-104 and V-105 (6SL7-GT) for the purpose of removing electrostatic charges which may build up on the glass envelopes of the tubes and cause erratic behavior of the indicating meter. A spring clip grounds each shield.

4.27 Discriminator Audio-Output System Operation: An elementary schematic is shown in Figure 10. The pulse rate in the discriminator output varies linearly with the original modulation wave applied to the transmitter. Due to the unidirectional pulse-type waveform, the discriminator output contains a d-c component and also a-c components which are a result of the modulation wave, the pulse fundamental frequency, and many high-frequency harmonics. The d-c component is eliminated by a series capacitor, and the unwanted higher frequencies, by a low-pass audio filter. The remaining components are essentially those of the original transmitter-modulation frequency.

To minimize the reactive load placed across the discriminator output, the de-emphasis network is introduced as the coupling link between the discriminator and the associated audio circuits. An additional advantage is also realized in that this network is essentially a low-pass filter and thus assists in attenuating the unwanted high frequency components present in the pulse wave. Added filtering follows, and the resultant audio signal is passed on to three independent circuits. One of these provides a 600-ohm output for local aural monitoring; a second is used as a pre-amplifier for distortion and noise measurements; and a third includes a pre-emphasis network to restore the over-all response to a flat frequency characteristic, for operation of the modulation meter section of the instrument.

4.28 Circuit Details of Discriminator Audio-Output System: The de-emphasis network consists of the series resistance R-145, and the shunt capacitance C-116. The latter is adjustable, and is intended for manufacturing use only to calibrate the frequency-response characteristic.

*It is important to note that this is the actual zero setting of the balanced d-c vacuum-tube voltmeter alone, and is entirely independent of the center frequency adjustment. Errors in setting of this zero adjustment are addition to the readings of center frequency, however, hence this checking system is provided.

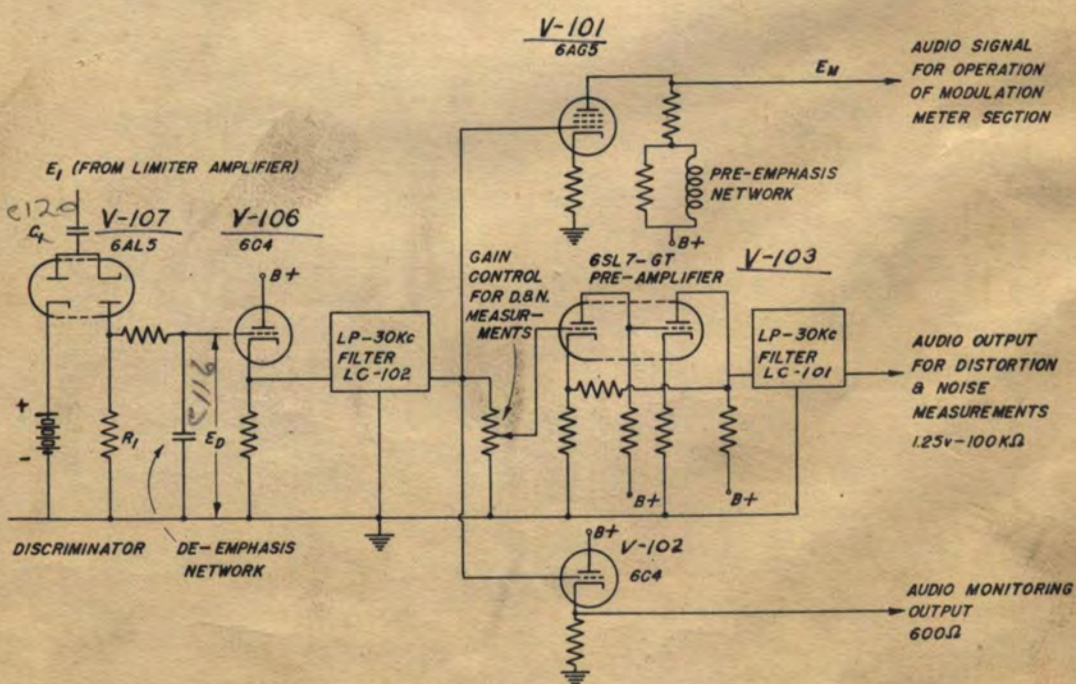


Figure 10. Discriminator Audio-Output System

A cathode follower tube, V-106 (6C4), is employed to couple this high-impedance circuit into a 30-kc low-pass filter, LC-102. At this point in the circuit, the signal is essentially a replica of the original modulation wave.

V-102 (6C4) provides an audio output signal at a 600-ohm level and is intended for local aural monitoring.

The audio signal is connected to a potentiometer (R-116) located on the panel and engraved ADJ. DIST. METER (SET DIST. METER TO CAL.). This controls the audio input level to the pre-amplifier which is used to operate the external Type 1932-A Distortion and Noise Meter. In order to minimize the residual distortion within this amplifier, it is operated at essentially a constant level by means of the potentiometer. There is a possibility of overloading the amplifier at high modulation levels (i. e., maximum audio signal) if this control is turned full on. For this reason, the OFF position is engraved MONITORING and the control should be left in this position at all times, except when in use. When distortion or noise-level measurements are made, the fixed sensitivity of the external Type 1932-A Distortion and Noise Meter will automatically determine the correct setting of this control. If a distortion and noise meter of a different type is used, its sensitivity must be such that it will operate with an input signal not greater than 1.25 volts. Its gain control should be left full ON, and the calibration effected via the potentiometer control (R-116) on the monitor panel.

In order to provide for noise measurements approaching a limit of 80 db below 100% modulation, additional filtering is added in this circuit and consists of a second 30-kc low-pass filter, LC-101. Both of the low-pass filters have adjustments which are intended only for manufacturing use and should not be altered in any way.

4.3 MODULATION METER SECTION (See Figure 11)

4.31 Pre-Amplifier (See Figure 11): The audio signal is applied to the modulation meter section through the shielded cable lead which is plugged into the receptacle PL-202, located on the inside surface of the shelf just above the crystal oven.

A pre-amplifier V-203 (6SN7-GT) has an adjustable gain control (R-220) which can be used to change the over-all calibration of the modulation meter and the MODULATION PEAKS dial. The instrument is normally calibrated for 100% modulation equal to a modulation swing of $\pm$ 75 kc, for all standard FM broadcast transmitters in the 88 - 108 Mc band.

Television aural FM transmitters employ a calibration level of 100% modulation equal to a modulation swing of $\pm$25 kc. The adjustment R-220 is intended for changing the pre-amplifier gain to set this calibration. The control is continuously variable so that it is possible, therefore, to set the monitor to 100% modulation level for any value of modulation swing between the

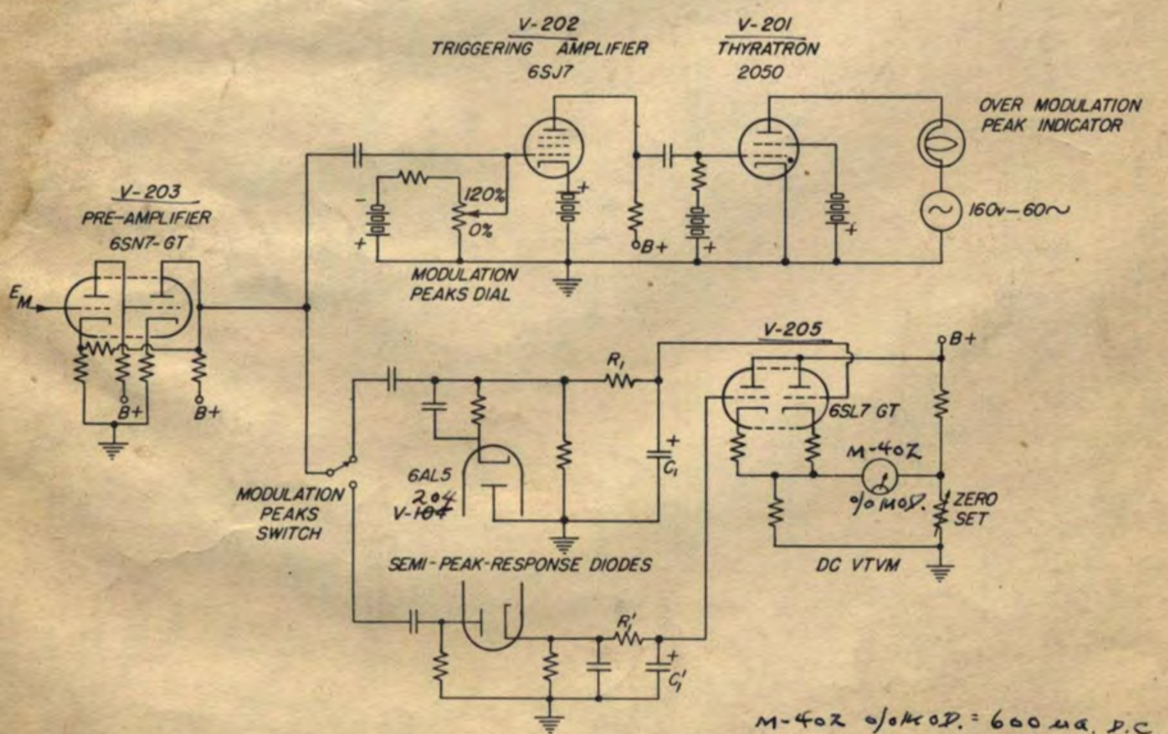


Figure 11. Elementary Schematic Diagram of Modulation Metering Section

limits of ±25 to ±75 kc. The arrangement of this control makes it possible to shift the entire audio circuit calibration by means of one adjustment.

4.32 Modulation Meter Circuits: A duo-diode tube V-204 (6AL5) is arranged in a semi-peak response circuit so that either diode alone, or both in parallel, may be operated. The panel selector switch MODULATION PEAKS (S-201) connects these diodes so that positive, negative, or full-wave response will be indicated by the MODULATION meter.

The d-c voltage developed by the diodes is applied to a d-c vacuum-tube voltmeter through R-C coupling networks. These networks, in conjunction with a high-speed meter produce the required response characteristics for FM modulation monitors as specified by the FCC*. The over-all characteristic results in a rapid rise of the modulation indicating meter in response to a modulation peak, followed by a slow return toward zero.

The d-c vacuum-tube voltmeter consists of two paralleled triodes, each of which is controlled by its separate diode. When full-wave operation is used, both triodes are operating simultaneously; hence, the sensitivity of the indicating meter is halved by a shunt resistance (R-203) CAL-FULL WAVE. A calibration control is provided for setting the meter sensitivity (R-233) CAL-POS. NEG.; and the electrical zero setting is made by means of (R-205) ZERO-SET. These three adjustments are accessible from the rear of the instrument, on the lower right corner. An internal adjustment R-231 is a balance control and is used to equalize the positive and negative readings on sine-wave modulation. This is intended for manufacturing use only and will not normally require re-setting. Adjustments C-201, C-206, C-207 are frequency-characteristic compensation capacitors and should not be disturbed.

4.33 Over-Modulation Lamp Circuits: The pre-amplifier audio output signal is coupled to the grid of V-202 (6SJ7). A fixed bias is introduced in the grid circuit which is sufficient to maintain the tube at plate current cut-off, in the absence of an audio signal on its grid. Whenever an audio signal appears on the grid, this bias is exceeded and, provided the MODULATION PEAKS dial is set at zero, a pulse of plate current is developed by the amplifier tube. This fixed bias is adjusted by means of R-214 so that the lamp remains extinguished in the absence of modulation, with the MODULATION PEAKS dial set at zero.

The MODULATION PEAKS dial (R-401) controls an additional negative bias in the grid circuit of V-202. The range of the control is equivalent to 0 to 120% modulation; hence, the audio-signal peak amplitude at 120% modulation level is adjusted (via R-216) to be equal to the total d-c potential across the potentiometer R-401. Thus, whenever the peak value of the modulation signal exceeds the grid bias as set by the MODULATION PEAKS dial, the amplifier tube V-202 develops a plate current pulse.

The bias voltages for operation of this circuit are obtained from the voltage-regulated bias rectifier system within the power-supply section.

The plate voltage pulse developed by V-202 is used to trigger a thyratron tube V-201. The OVER MODULATION lamp (P-406) is connected in the anode circuit of the thyratron and hence will flash whenever the thyratron conducts. Fixed negative potentials are applied to both grids of the thyratron tube, whose anode circuit is operated from a winding on the main power transformer T-301. Because of this condition, the thyratron becomes non-conducting during each negative half-cycle of the power-line frequency. This characteristic may result in a "beat" indication of the OVER MODULATION lamp whenever steady sine-wave modulation is employed on the transmitter. With normal program modulation, this effect is not noticeable.

4.4 POWER SUPPLY SECTION

The power supply for the monitor is located on the upper right shelf assembly. Two power transformers are used; one to supply the requirements of stand-by operation which includes the crystal-oven heaters, etc., and a second to provide for the majority of the monitor tube circuits. Each is separately fused.

4.41 Adjustments: There are only three adjustments provided. These are set at the factory and will not normally require adjustment after the monitor is placed in service. The voltage of the main regulated plate supply has been set to 300 volts by means of R-317; and the power-supply ripple voltage set for a minimum via R-315. The third adjustment controls the negative bias applied to the screen grid of a thyratron tube, which in turn controls the SIGNAL and KILOCYCLES DEVIATION meter pilot lamps. This bias voltage is sufficient to maintain the tube at cut-off until it is triggered by a positive voltage applied to its control grid. Unless a markedly different thyratron tube is placed in the V-307 position (adjacent to R-334) this control will not require resetting. To check its setting, it is merely necessary to remove the 6BE6 mixer tube (R-F Section) and note that the SIGNAL pilot goes out, or becomes very dim.

4.42 Plate Voltage Supply: The plate voltage supply employs selenium rectifiers (RX-304, 305, etc.) connected in a full-wave voltage doubler circuit. An unregulated source of d-c voltage is derived from the rectifier output and employs an R-C ripply filter. The main portion of the rectifier output is passed through an L-C ripple filter and a series-type electronic regulator which maintains a close control of the voltage level.

4.43 Regulated Tube-Heater Supply for Vacuum-Tube Voltmeter: The tubes used in the vacuum-tube voltmeter circuit for the KILOCYCLES DEVIATION meter are supplied from a constant current a-c source, and have their heater circuits connected in series (V-104 and V-105). A series ballast tube, V-306, is used as the control device. This tube is located toward the rear of the power-supply shelf assembly and is nearest to the MONITOR fuses.

* FCC Standards of Good Engineering Practice.

A similar regulator tube, V-304, is used to control the heater of the diode rectifier (V-107) employed in the discriminator circuit. This tube is located toward the rear of the power supply shelf and is immediately below the main rectifier unit.

By employing this regulation on the vacuum-tube voltmeter tube heater, a high degree of stability is achieved and the effects of line-voltage variation do not interfere with the normal operation of the circuits used to indicate the transmitter center frequency (i.e., KILOCYCLES DEVIATION meter).

If either of these ballast tubes should fail, an emergency substitution of a fixed resistor may be made, in order to restore the monitor to operating condition until a replacement can be obtained. The resistance should consist of a 2 watt, 3.3 ohm +10% resistor and be connected between terminals #2 and #7 of the tube socket. It must be noted, however, that substitution of either a fixed resistor or of another 3-4 tube for V-306 may change the calibration of the KILOCYCLES DEVIATION meter by 500 cycles in the worst case.

4.44 D-C Tube Heater Supply: Two separate rectifier supplies, employing full-wave bridge-connected selenium rectifiers, are used to provide a source of d-c for the heaters of low-level audio amplifier tubes and also for the discriminator drive tube. Owing to the extremely low values of hum level required for operation of these circuits, their heaters are operated from well filtered d-c sources.

The first rectifier system (RX-301) is used to supply heater power to the audio amplifier (V-103) and also the cathode follower stage which is used as an impedance coupling device at the input to the low-pass filter (LC-102). Owing to the necessity of limiting heater-cathode potentials to their rated value, this supply is operated above ground potential.

A second rectifier (RX-302) is used to supply heater power to the discriminator input tube, V-108 (815). The negative side of this supply is grounded.

4.45 Bias Supply: A diode rectifier tube V-308 (6AL5) is used to supply bias voltages at five different levels. This system is controlled by use of an 0C3/VR105 voltage regulator tube (V-305). Biasing potentials are developed across a voltage divider (R-322 to R-326 inc.) and are used to supply the following circuits: (1) positive and negative bias potentials for the diode clipper tubes V-112 and V-115; (2) negative bias potentials for the control and screen grids of the thyratron tube V-201 which controls the OVER MODULATION warning lamp; and, (3) a negative bias potential which is applied to the grid of V-202, the thyratron triggering amplifier, through the MODULATION PEAKS potentiometer.

A second negative bias voltage, applied to the control grids of the discriminator driver tube V-108 (815), is obtained from the selenium rectifier system RX-303. This rectifier is operated from the auxiliary power transformer and also connects to other circuits.

4.46 Auxiliary Transformer Supply: When the monitor is operated under stand-by conditions, the small power transformer T-302 is used to supply the power for the crystal oven heaters. This heat circuit is controlled by a d-c relay, which derives its source of power from the selenium rectifier system RX-303. A d-c relay control system is employed to avoid the chatter and uncertain contact difficulties that are apt to result from the use of sensitive a-c operated relays. The mercury-column thermostat (S-405-51) is arranged so that it will short-circuit the relay energizing coil, when the temperature reaches a critical point. Opening of the relay disconnects the heater circuit. The panel HEAT CYCLE pilot lamp is in series with a part of the heater circuit and thus indicates normal functioning of the system.

4.47 "Signal" Thyratron Control: The SIGNAL pilot and meter lamps are controlled by the anode-circuit relay REL-302 of the thyratron tube V-307 (2050). With an a-c potential supplied from the main power transformer heater winding connected in the relay circuit, the SIGNAL pilot (and meter illumination lamps of the center-frequency indicating meter) will glow whenever the relay is actuated by the thyratron. To keep the thyratron from conducting under conditions of zero control grid potential, a negative d-c voltage is applied to the screen grid via R-334. This voltage is derived from the same rectifier source, RX-303, used to supply the relay, REL-301.

TABLE I

CRYSTAL FREQUENCIES
AND
R-F TUNING ADJUSTMENTS
FOR STANDARD FM BROADCAST BAND--88-108 Mc

CRYSTAL FREQUENCY IN KILOCYCLES	FIRST MULTIPLIER		SECOND MULTIPLIER		THIRD MULTIPLIER		TOTAL MULT.	TRANSMITTER CHANNEL	
	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Freq. Mc	Number
1570.536	x4	6.282	x7	43.97	x2	87.95	x56	88.1	1
1574.107	"	6.296	"	44.07	"	88.15	"	88.3	2
1577.679	"	6.311	"	44.18	"	88.35	"	88.5	3
1581.250	"	6.325	"	44.28	"	88.55	"	88.7	4
1584.821	"	6.339	"	44.37	"	88.75	"	88.9	5
1588.393	"	6.354	"	44.48	"	88.95	"	89.1	6
1591.964	"	6.368	"	44.58	"	89.15	"	89.3	7
1595.536	"	6.382	"	44.67	"	89.35	"	89.5	8
1599.107	"	6.396	"	44.77	"	89.55	"	89.7	9
1402.344	"	5.609	x8	44.87	"	89.75	x64	89.9	10
1405.469	"	5.622	"	44.97	"	89.95	"	90.1	11
1408.594	"	5.634	"	45.07	"	90.15	"	90.3	12
1411.719	"	5.647	"	45.18	"	90.35	"	90.5	13
1414.844	"	5.659	"	45.27	"	90.55	"	90.7	14
1417.969	"	5.672	"	45.37	"	90.75	"	90.9	15
1421.094	"	5.684	"	45.47	"	90.95	"	91.1	16
1424.219	"	5.697	"	45.58	"	91.15	"	91.3	17
1427.344	"	5.709	"	45.67	"	91.35	"	91.5	18
1430.469	"	5.722	"	45.78	"	91.55	"	91.7	19
1433.594	"	5.734	"	45.87	"	91.75	"	91.9	20
1436.719	"	5.747	"	45.98	"	91.95	"	92.1	21
1439.844	"	5.759	"	46.07	"	92.15	"	92.3	22
1442.969	"	5.772	"	46.17	"	92.35	"	92.5	23
1446.094	"	5.784	"	46.27	"	92.55	"	92.7	24
1545.833	x5	7.729	x6	46.37	"	92.75	x60	92.9	25
1549.167	"	7.746	"	46.48	"	92.95	"	93.1	26
1552.500	"	7.763	"	46.58	"	93.15	"	93.3	27
1555.833	"	7.779	"	46.67	"	93.35	"	93.5	28
1559.167	"	7.796	"	46.78	"	93.55	"	93.7	29
1562.500	"	7.813	"	46.88	"	93.75	"	93.9	30
1565.833	"	7.829	"	46.97	"	93.95	"	94.1	31
1569.167	"	7.846	"	47.08	"	94.15	"	94.3	32
1572.500	"	7.863	"	47.18	"	94.35	"	94.5	33
1575.833	"	7.879	"	47.27	"	94.55	"	94.7	34
1579.167	"	7.896	"	47.37	"	94.75	"	94.9	35
1582.500	"	7.913	"	47.48	"	94.95	"	95.1	36
1585.833	"	7.929	"	47.57	"	95.15	"	95.3	37
1589.167	"	7.946	"	47.68	"	95.35	"	95.5	38
1592.500	"	7.963	"	47.78	"	95.55	"	95.7	39
1709.821	x4	6.839	x7	47.87	"	95.75	x56	95.9	40
1713.393	"	6.854	"	47.98	"	95.95	"	96.1	41
1716.964	"	6.869	"	48.08	"	96.15	"	96.3	42
1720.536	"	6.882	"	48.17	"	96.35	"	96.5	43
1724.107	"	6.896	"	48.27	"	96.55	"	96.7	44
1727.679	"	6.911	"	48.37	"	96.75	"	96.9	45

CRYSTAL FREQUENCY IN KILOCYCLES	FIRST MULTIPLIER		SECOND MULTIPLIER		THIRD MULTIPLIER		TOTAL MULT.	TRANSMITTER CHANNEL	
	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Freq. Mc	Number
1731.250	x4	6.925	x7	48.47	x2	96.95	x56	97.1	46
1734.821	"	6.939	"	48.57	"	97.15	"	97.3	47
1738.393	"	6.954	"	48.68	"	97.35	"	97.5	48
1741.964	"	6.968	"	48.78	"	97.55	"	97.7	49
1745.536	"	6.982	"	48.87	"	97.75	"	97.9	50
1749.107	"	6.996	"	48.97	"	97.95	"	98.1	51
1752.679	"	7.011	"	49.08	"	98.15	"	98.3	52
1756.250	"	7.025	"	49.18	"	98.35	"	98.5	53
1759.821	"	7.039	"	49.27	"	98.55	"	98.7	54
1542.969	"	6.172	x8	49.38	"	98.75	x64	98.9	55
1546.094	"	6.184	"	49.47	"	98.95	"	99.1	56
1549.219	"	6.197	"	49.58	"	99.15	"	99.3	57
1552.344	"	6.209	"	49.67	"	99.35	"	99.5	58
1555.469	"	6.222	"	49.78	"	99.55	"	99.7	59
1558.594	"	6.234	"	49.87	"	99.75	"	99.9	60
1561.719	"	6.247	"	49.98	"	99.95	"	100.1	61
1564.844	"	6.259	"	50.07	"	100.15	"	100.3	62
1567.969	"	6.272	"	50.18	"	100.35	"	100.5	63
1571.094	"	6.284	"	50.27	"	100.55	"	100.7	64
1574.219	"	6.297	"	50.38	"	100.75	"	100.9	65
1577.344	"	6.309	"	50.47	"	100.95	"	101.1	66
1580.469	"	6.322	"	50.58	"	101.15	"	101.3	67
1583.594	"	6.334	"	50.67	"	101.35	"	101.5	68
1586.719	"	6.347	"	50.78	"	101.55	"	101.7	69
1589.844	"	6.359	"	50.87	"	101.75	"	101.9	70
1592.969	"	6.372	"	50.98	"	101.95	"	102.1	71
1596.094	"	6.384	"	51.07	"	102.15	"	102.3	72
1599.219	"	6.397	"	51.18	"	102.35	"	102.5	73
1602.344	"	6.409	"	51.27	"	102.55	"	102.7	74
1605.469	"	6.422	"	51.38	"	102.75	"	102.9	75
1608.594	"	6.434	"	51.47	"	102.95	"	103.1	76
1841.964	"	7.368	x7	51.58	"	103.15	x56	103.3	77
1845.536	"	7.382	"	51.67	"	103.35	"	103.5	78
1849.107	"	7.396	"	51.77	"	103.55	"	103.7	79
1852.679	"	7.411	"	51.88	"	103.75	"	103.9	80
1856.250	"	7.425	"	51.98	"	103.95	"	104.1	81
1859.821	"	7.439	"	52.07	"	104.15	"	104.3	82
1863.393	"	7.454	"	52.18	"	104.35	"	104.5	83
1866.964	"	7.468	"	52.28	"	104.55	"	104.7	84
1870.536	"	7.482	"	52.37	"	104.75	"	104.9	85
1874.107	"	7.496	"	52.47	"	104.95	"	105.1	86
1877.678	"	7.511	"	52.58	"	105.15	"	105.3	87
1881.250	"	7.525	"	52.68	"	105.35	"	105.5	88
1884.821	"	7.539	"	52.77	"	105.55	"	105.7	89
1888.393	"	7.554	"	52.88	"	105.75	"	105.9	90
1891.964	"	7.568	"	52.98	"	105.95	"	106.1	91
1895.536	"	7.582	"	53.07	"	106.15	"	106.3	92
1899.107	"	7.596	"	53.17	"	106.35	"	106.5	93
1902.679	"	7.611	"	53.28	"	106.55	"	106.7	94

CRYSTAL FREQUENCY IN KILOCYCLES	FIRST MULTIPLIER		SECOND MULTIPLIER		THIRD MULTIPLIER		TOTAL MULT.	TRANSMITTER CHANNEL	
	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Freq. Mc	Number
1906.250	x4	7.625	x7	53.38	x2	106.75	x56	106.9	95
1909.821	"	7.639	"	53.47	"	106.95	"	107.1	96
2143.000	x5	10.715	x5	53.58	"	107.15	x50	107.3	97
2147.000	"	10.735	"	53.68	"	107.35	"	107.5	98
2151.000	"	10.755	"	53.78	"	107.55	"	107.7	99
2155.000	"	10.775	"	53.88	"	107.75	"	107.9	100

CRYSTAL FREQUENCIES
AND
R-F TUNING ADJUSTMENTS
FOR TELEVISION AURAL TRANSMITTER CHANNELS 1-13

CRYSTAL FREQUENCY IN KILOCYCLES	FIRST MULTIPLIER		SECOND MULTIPLIER		THIRD MULTIPLIER		FOURTH MULTIPLIER		TOTAL MULT.	TRANSMITTER CHANNEL	
	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Approx. Tuning in Mc	Ratio	Freq. Mc	Number
1550.000	x4	6.20	x4	24.8	x2	49.6			x32	49.75	1
1862.500	"	7.45	"	29.8	"	59.6			"	59.75	2
2050.000	"	8.20	"	32.8	"	65.6			"	65.75	3
1432.000	x5	7.16	x5	35.8	"	71.6			x50	71.75	4
2040.000	x4	8.16	"	40.8	"	81.6			x40	81.75	5
1752.000	x5	8.76	"	43.8	"	87.6			x50	87.75	6
1603.571	x4	6.41	x7	44.9	"	89.8	x2	179.6	x112	179.75	7
1546.667	x5	7.73	x6	46.4	"	92.8	"	185.6	x120	185.75	8
1596.667	"	7.98	"	47.9	"	95.8	"	191.6	"	191.75	9
1543.750	x4	6.18	x8	49.4	"	98.8	"	197.6	x128	197.75	10
1590.625	"	6.36	"	50.9	"	101.8	"	203.6	"	203.75	11
1871.429	"	7.49	x7	52.4	"	104.8	"	209.6	x112	209.75	12
~~2156.000~~	~~x5~~	~~10.78~~	~~x5~~	53.9	"	107.8	"	215.6	~~x100~~	215.75	13
3368.750	x2	6.74	x8						x 64		

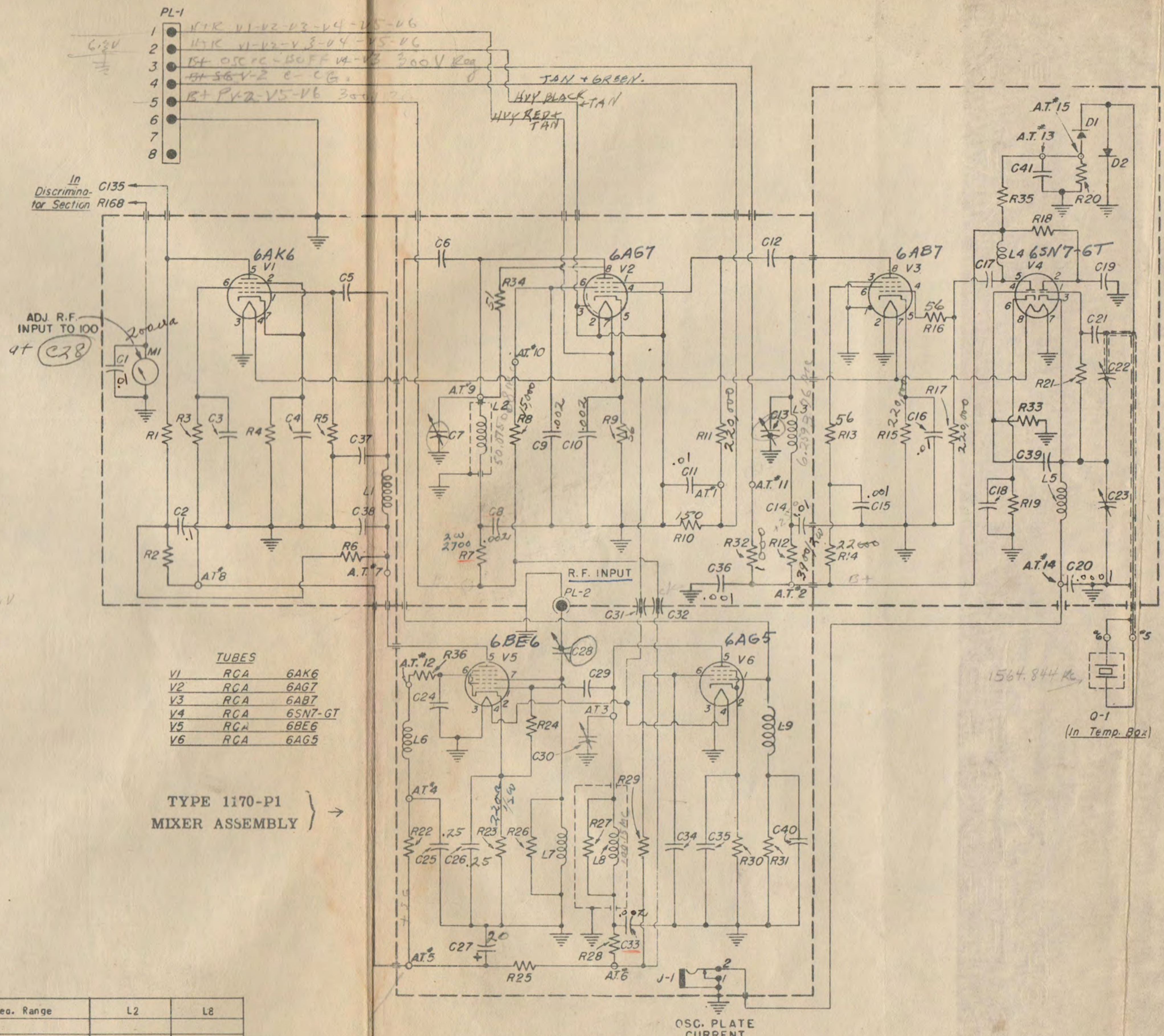
R-35=	100 K Ohms	±10%%		REC-31BF	
R-36=	56 Ohms	±10%		REC-21BF	

RESISTORS				TYPE
R-1 =	10 K Ohms	± 2%	GR	REPO-1036
R-2 =	1000 Ohms	±10%	IRC	BTS
R-3 =	47 K Ohms	±10%	IRC	BTA
R-4 =	560 Ohms	±10%	IRC	BTS
R-5 =	220 K Ohms	±10%	IRC	BTS
R-6 =	10 K Ohms	±10%	IRC	BTA
R-7 =	2700 Ohms	±10%	IRC	BT-2
R-8 =	15 K Ohms	±10%	IRC	BTA
R-9 =	56 Ohms	±10%	IRC	BW-1/2
R-10=	150 Ohms	±10%	IRC	BW-1/2
R-11=	220 K Ohms	±10%	IRC	BTS
R-12=	3900 Ohms	±10%	IRC	BT-2
R-13=	56 Ohms	±10%	ERIE	504-B
R-14=	22 K Ohms	±10%	IRC	BTS
R-15=	220 Ohms	±10%	IRC	BW-1/2
R-16=	56 Ohms	±10%	ERIE	504-B
R-17=	220 K Ohms	±10%	IRC	BTS
R-18=	47 K Ohms	±10%		REC-31BF
R-19=	3300 Ohms	±10%	IRC	BTS
R-20=	12 K Ohms	±10%		REC-21BF
R-21=	2.7 Megohms	±10%	IRC	BTS
R-22=	33 K Ohms	±10%	IRC	BT-2
R-23=	220 Ohms	±10%	IRC	BW-1/2
R-24=	22 K Ohms	±10%	IRC	BTS
R-25=	1 K Ohms	±10%	IRC	BTA
R-26=	22 K Ohms	±10%	IRC	BTS
R-27=	10 K Ohms	±10%	IRC	BTA
R-28=	3900 Ohms	±10%	IRC	BT-2
R-29=	100 K Ohms	±10%	IRC	BTS
R-30=	220 Ohms	±10%	IRC	BW-1/2
R-31=	56 K Ohms	±10%	IRC	BTS
R-32=	1 K Ohms	±10%	IRC	BTA (100)
R-33=	150 K Ohms	±10%	IRC	BTS
R-34=	51 Ohms	± 5%	Erie	504-B

CONDENSERS				TYPE
C-1 =	0.01 µf	±10%	AERO	1467
C-2 =	0.1 µf	±10%	GR	COLB-2
C-3 =	0.1 µf	±10%	GR	COLB-2
C-4 =	0.1 µf	±10%	GR	COLB-2
C-5 =	0.002 µf	±10%	AERO	1467
C-6 =	50.0 µµf	± 1%	ERIE	NPO
C-7 =	100 µµf		GR	COA-4-2
C-8 =	0.002 µf	±10%	GR	ZCOU-20
C-9 =	0.002 µf	±10%	GR	COU-27
C-10=	0.002 µf	±10%	GR	COU-27
C-11=	0.01 µf	±10%	AERO	1441-L
C-12=	0.001 µf	±10%	AERO	1467 500 DC WV
C-13=	100 µµf		GR	COA-4
C-14=	0.01 µf	±10%	AERO	1445
C-15=	0.001 µf	±10%	AERO	1468
C-16=	0.01 µf	±10%	MICAMOLD	337-10 (600 w.v.)
C-17=	0.00005µf	±10%	AERO	1468
C-18=	0.01 µf	±10%	MICAMOLD	337-10 (600 w.v.)
C-19=	0.001 µf	±10%	AERO	1468
C-20=	100 µµf	±10%	GR	COU-8
C-21=	250 µµf	±10%	AERO	1468
C-22=	320 µµf		GR	COA-6
C-23=	320 µµf		GR	COA-6
C-24=	200 µµf	±10%	GR	COU-24
C-25=	0.25 µf	±10%	GR	COLB-16
C-26=	0.25 µf	±10%	GR	COLB-16
C-27=	20 µf	450 w.v.	GR	COE-5
C-28=			GR	Built in
C-29=	5 µµf	±10%	AERO	1468
C-30=	100 µµf		GR	COA-4
C-31=	200 µµf	±10%	GR	COU-8
C-32=	200 µµf	±10%	GR	COU-8
C-33=	0.002 µf	±10%	GR	ZCOU-20
C-34=	0.001 µf	±10%	GR	COU-24
C-35=	0.002 µf	±10%	GR	COU-27
C-36=	0.001 µf	±10%	AERO	1468
C-37=	50 µµf	±10%		COM-20B
C-28=	10 µµf	±10%		COM-20B
C-39=	200 µµf	±10%		COM-20B
C-40 =	1 µf			COL-5
C-41=	.001 µf	±10%		COM-20B

L-1 =	Inductor	4 mh	GR	ZCHA-35
L-2 =	Inductor		See Table	
L-3 =	Inductor		GR	1170-27
L-4 =	Inductor		GR	CHA-597A
L-5 =	Inductor	2.5 mh	GR	CHA-597
L-6 =	Inductor	45 µh	GR	ZCHA-9
L-7 =	Inductor	45 µh	GR	ZCHA-9
L-8 =	Inductor		See Table	
L-9 =	Inductor	45 µh	GR	ZCHA-9
M-1 =	Meter	200 µamp	GR	MED-24
J-1 =	Jack			CDSJ-1326
PL-1 =	Plug			CDMP-1275-8
PL-2 =	Plug			274-321
D-1 =	Detector	Sylvania IN34		(GR)2DEC-6
D-2 =	Detector	Sylvania IN34		(GR)2DEC-6

Freq. Range	L2	L8
30-50 Megacycles	1170-205	1170-206
50-88 Megacycles	1170-206	1170-86
88-160 Megacycles	1170-86	1170-803

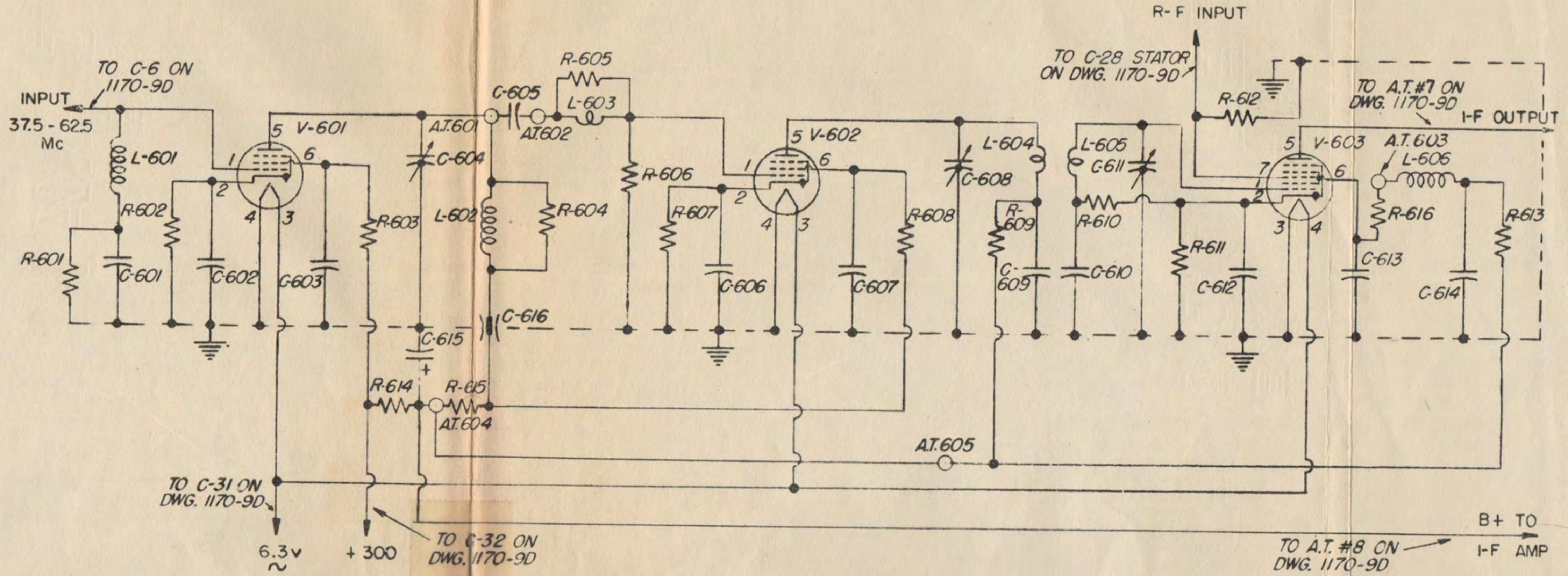


TUBES		
V1	RCA	6AK6
V2	RCA	6AG7
V3	RCA	6AB7
V4	RCA	6SN7-GT
V5	RCA	6BE6
V6	RCA	6AG5

WIRING DIAGRAM OF R-F SECTION WITH TYPE 1170-P1 MIXER ASSEMBLY

RESISTORS

R-601 =	51 K	Ohms	± .5%	REC-21BF
R-602 =	220	Ohms	±10%	REC-21BF
R-603 =	100 K	Ohms	±10%	REC-21BF
R-604 =	10 K	Ohms	±10%	REC-31BF
R-605 =	56	Ohms	±10%	REC-21BF
R-606 =	56 K	Ohms	±10%	REC-21BF
R-607 =	220	Ohms	±10%	REC-21BF
R-608 =	100 K	Ohms	±10%	REC-21BF
R-609 =	3300	Ohms	±10%	REC-21BF
R-610 =	22 K	Ohms	±10%	REC-21BF
R-611 =	220	Ohms	±10%	REC-21BF
R-612 =	22 K	Ohms	±10%	REC-21BF
R-613 =	33 K	Ohms	±10%	REC-41BF
R-614 =	1 K	Ohm	±10%	REC-31BF
R-615 =	3300	Ohms	±10%	REC-31BF
R-616 =	56	Ohms	±10%	REC-21BF

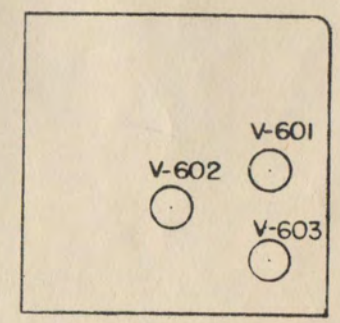


CONDENSERS

C-601 =	1 µf		±10%	COL-5
C-602 =	.001 µf		±10%	COU-24
C-603 =	.001 µf		±10%	COU-24
C-604 =	7-100 µµf			COA-4
C-605 =	100 µµf		±10%	COM-20B
C-606 =	500 µµf		±10%	COU-24
C-607 =	500 µµf		±10%	COU-24
C-608 =	7-45 µµf			COT-12
C-609 =	500 µµf		±10%	COU-24
C-610 =	500 µµf		±10%	COU-24
C-611 =	7-45 µµf			COT-12
C-612 =	.25 µf		±10%	COLB-16
C-613 =	200 µµf		±10%	COU-24
C-614 =	.25 µf		±10%	COLB-16 (In same can with C-612)
C-615 =	20 µf	450 w.v.		CDE-5
C-616 =	.002 µf		±10%	ZCOU-20

TUBES

V-601 = 6AG5
V-602 = 6AG5
V-603 = 6BE6



INDUCTORS

L-601 =	45 µh	ZCHA-9
L-602 =		1170-824
L-603 =	#20 Straight wire (Approx. 1")	
L-604 =		1170-826
L-605 =		1170-825
L-606 =	45 µh	ZCHA-9

WIRING DIAGRAM FOR 1170-P2 160-220 Mc R.F. TUNING UNIT

RESISTORS

R-101 =	270	Ω	± 10%
R-102 =	1	MΩ	± 10%
R-103 =	270	Ω	± 5%
R-104 =	2200	Ω	± 5%
R-105 =	68	KΩ	± 10%
R-106 =	30	KΩ	± 1%
R-107 =	2500	Ω	± 5%
R-108 =	1	KΩ	
R-109 =	5600	Ω	± 10%
R-110 =	270	Ω	± 10%
R-111 =	1	MΩ	± 10%
R-112 =	820	Ω	± 5%
R-113 =	4700	Ω	± 5%
R-114 =	750	Ω	± 2%
R-115 =	1200	Ω	± 2%
R-116 =	100	KΩ	
R-117 =	620	Ω	± 5%
R-118 =	7500	MΩ	± 5%
R-119 =	100	KΩ	± 10%
R-120 =	620	Ω	± 5%
R-121 =	1	KΩ	± 10%
R-122 =	22	KΩ	± 10%
R-123 =	14,600	KΩ	± 1%
R-124 =	2	KΩ	± 1%
R-125 =	40	KΩ	±0.1%
R-126 =	1	MΩ	± 5%
R-127 =	1	KΩ	±0.1%
R-128 =	40	KΩ	±0.1%
R-129 =	1	KΩ	±0.1%
R-130 =	1	MΩ	± 5%
R-131 =	270	Ω	± 10%
R-132 =	270	Ω	± 10%
R-133 =	270	Ω	± 10%
R-134 =	270	Ω	± 10%
R-135 =	1	MΩ	± 10%
R-136 =	200	KΩ	± 5%
R-137 =	100	KΩ	± 5%
R-138 =	220	Ω	± 10%
R-139 =	22	KΩ	± 10%
R-140 =	6	KΩ	±1/4%
R-141 =	470	Ω	± 5%
R-142 =	22	KΩ	± 10%
R-143 =	22	KΩ	± 10%
R-144 =	65	KΩ	± 1%
R-145 =	1	MΩ	± 2%
R-146 =	3300	Ω	± 10%
R-147 =	3300	Ω	± 10%
R-148 =	47	KΩ	± 10%
R-149A=	600	Ω	±1/4%
R-149B=	600	Ω	±1/4%
R-149C=	600	Ω	±1/4%
R-150 =	250	Ω	±1/4%
R-151 =	1800	Ω	± 5%
R-152 =	20	KΩ	
R-153 =	47	KΩ	± 10%
R-154 =	3300	Ω	± 10%
R-155 =	22	KΩ	± 10%
R-156 =	50	KΩ	± 5%
R-157 =	40	KΩ	± 1%
R-158 =	1	MΩ	± 10%
R-159 =	47	KΩ	± 10%
R-160 =	100	KΩ	± 10%
R-161 =	1	MΩ	± 1%
R-162 =	430	Ω	± 5%
R-163 =	680	Ω	± 10%
R-164 =	39	KΩ	± 1%
R-165 =	5600	Ω	± 10%
R-166 =	33	KΩ	± 10%
R-167 =	240	KΩ	± 5%
R-168 =	200	KΩ	± 5%
R-169 =	1	MΩ	± 10%
R-170 =	15	KΩ	± 10%
R-171 =	1.2	MΩ	± 10%
R-172 =	82	KΩ	± 10%
R-173 =	82	KΩ	± 10%
R-174 =	470	Ω	± 10%
R-175 =	27	KΩ	± 10%
R-176 =	15	KΩ	± 10%
R-177 =	3	MΩ	± 1%
R-178 =	400	KΩ	± 1%
R-179 =	400	KΩ	± 1%
R-180 =	400	KΩ	± 1%
*R-181 =	50	KΩ	± 10%

CAPACITORS

C-101 =	0.01	μf	±10%
C-102 =	0.5	μf	±10%
C-103 =	20	μf	450 w.v.
C-104 =	0.01	μf	±10%
C-105 =	40	μf	150 w.v.
C-106 =	0.07	μf	±10%
C-107 =	1	μf	±10%
C-108 =	0.05	μf	±10%
C-109 =	4	μf	450 w.v.
C-110 =	0.25	μf	±10%
C-111 =	0.25	μf	±10%
C-112 =	40	μf	450 w.v.
C-113 =	40	μf	450 w.v.
C-114 =	40	μf	450 w.v.
C-115 =	40	μf	450 w.v.
C-116 =	4-50	μμf	
C-117 =			
C-118 =	0.01	μf	±10%
C-119 =	16	μf	150 w.v.
C-120 =	5-75	μμf	
C-121 =	20	μf	450 w.v.
C-122 =	100	μf	25 w.v.
C-123 =	0.5	μf	±10%
C-124 =	40	μf	450 w.v.
C-125 =	0.5	μf	±10%
C-126 =			
C-127 =	0.01	μf	±10%
C-128 =	0.01	μf	±10%
C-129 =	20	μf	450 w.v.
C-130 =			
C-131 =	0.5	μf	±10%
C-132 =			
C-133 =	20	μf	450 w.v.
C-134 =	20	μf	450 w.v.
C-135 =	0.005	μf	±10%
C-136 =	0.001	μf	±10%
C-137 =	0.01	μf	±10%
C-138 =	200	μf	6 w.v.
C-139 =	200	μf	6 w.v.
C-140 =	200	μf	6 w.v.
C-141 =	0.1	μf	±10%
C-142 =	20	μf	450 w.v.
C-143 =	0.005	μf	±10%
C-144 =	500	μμf	±10%
C-145 =	500	μμf	±10%

MISCELLANEOUS		TYPE
SO-103 =	Socket	1170-39
SO-104 =	Socket	CDMS-464-6
J-101 =	Jack	774-M
LC-101 =	Filter	1170-305
LC-102 =	Filter	1170-306
Pl-101 =	Plug	CDMP-10-33
Pl-102 =	Plug	CDMP-1275-4
Pl-103 =	Plug	CDMP-9-6
Pl-104 =	Plug	CDMP-9-6

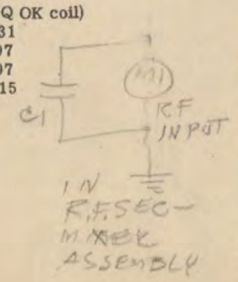
TUBES

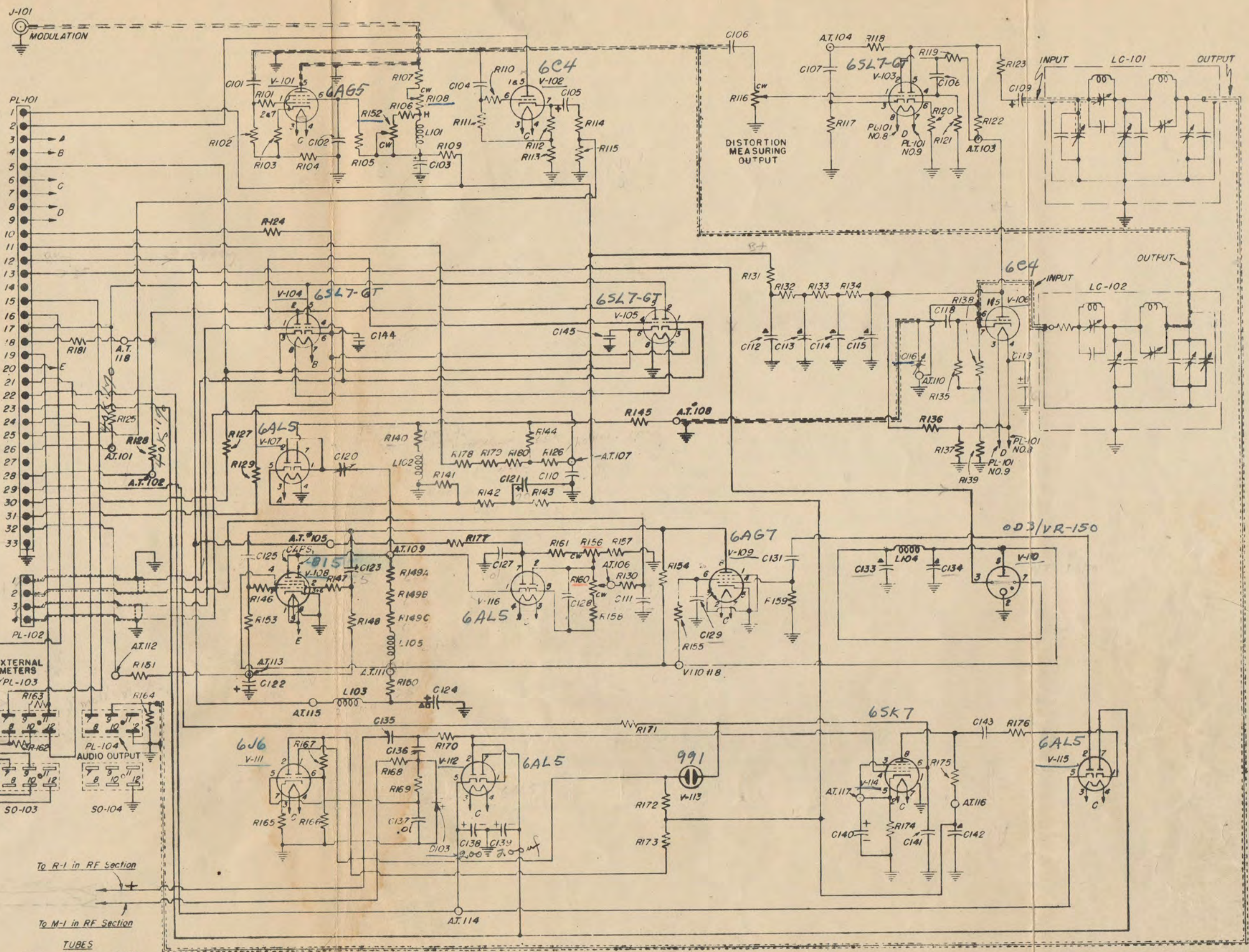
V-101	RCA	6AG5
V-102	RCA	6C4
V-103	RCA	6SL7-GT
V-104	RCA	6SL7-GT
V-105	RCA	6SL7-GT
V-106	RCA	6C4
V-107	RCA	6AL5
V-108	RCA	815
V-109	RCA	6AG7
V-110	RCA	0D3/VR-150
V-111	RCA	6J6
V-112	RCA	6AL5
V-113	RCA	991
V-114	RCA	6SK7
V-115	RCA	6AL5
V-116	RCA	6AL5

INDUCTORS				TYPE
L-101 =	250	mh	± 5%	119-A (Q OK coil)
L-102 =	1040	μh	±1/2%	ZCHA-31
L-103 =	2.5	mh	±0.5	CHA-597
L-104 =	2.5	mh		CHA-597
L-105 =	147	μh	± 1%	ZCHA-15

CRYSTAL DETECTOR	TYPE
D-103 = Sylvania	IN34

* used only with 6-0-6 kc auto scale.





TUBES		
V101	RCA	6AG5
V102	RCA	6C4
V103	RCA	6SL7-GT
V104	RCA	6SL7-GT
V105	RCA	6SL7-GT
V106	RCA	6C4
V107	RCA	6AL5
V108	RCA	815
V109	RCA	6AG7
V110	RCA	0D3/VR-150
V111	RCA	6J6
V112	RCA	6AL5
V113	RCA	991
V114	RCA	6SK7
V115	RCA	6AL5
V116	RCA	6AL5

WIRING DIAGRAM OF 1170A DISCRIMINATOR ASSEMBLY

RESISTORS					TYPE
R-201 =	390	Ohms	±10%	IRC	BW-1/2
R-202 =	1800	Ohms	±10%	IRC	BW-1
R-203 =	5	K Ohms		GR	POSW-862
R-204 =	270	K Ohms	±10%	IRC	BTS
R-205 =	5	K Ohms		GR	POSW-862
R-206 =	200	K Ohms	± 5%	IRC	BTS
R-207 =	220	K Ohms	±10%	IRC	BTS
R-208 =	1.8	Megohms	±10%	IRC	BTS
R-209 =	10	Megohms	±10%	IRC	BTA
R-210 =	100	K Ohms	±10%	IRC	BT2
R-211 =	270	K Ohms	±10%	IRC	BTS
R-212 =	3.9	K Ohms	±10%	IRC	BTS
R-213 =	22	K Ohms	±10%	IRC	BTS
R-214 =	30	K Ohms		GR	POSC-860
R-215 =	100	K Ohms	±10%	IRC	BTS
R-216 =	100	K Ohms	±10%	GR	POSC-860
R-217 =	200	K Ohms	± 1%	IRC	WW-4
R-218 =	1	Megohm	±10%	IRC	BTS
R-219 =	3	K Ohms	± 5%	IRC	BW-1
R-220 =	20	K Ohms		GR	301-408
R-221 =	3	K Ohms	± 5%	IRC	BW-1
R-222 =	1	Megohm	±10%	IRC	BTS
R-223 =	100	k Ohms	±10%	IRC	BTS
R-224 =	12	Megohms	±10%	IRC	BTS
R-225 =	200	K Ohms	± 5%	IRC	BTS
R-226 =	200	K Ohms	± 5%	IRC	BTS
R-227 =	3	Megohms	± 5%	IRC	BTS
R-228 =	12	Megohms	±10%	IRC	BTS
R-229 =	3	Megohms	± 5%	IRC	BTS
R-230 =	25	K Ohms	± 1%	IRC	WW-3
R-231 =	5	K Ohms		GR	POSW-862
R-232 =	25	K Ohms	± 1%	IRC	WW-3
R-233 =	10	K Ohms		GR	POSW-862
R-234 =	10	K Ohms	± 1%	IRC	WW-3

CONDENSERS				TYPE
C-201 =	5-50 μμf			COT-12
C-202 =	1.0 μf	±10%	GR	COL-5
C-203 =	0.00015 μf	±10%	AERO	1468
C-204 =	0.025 μf	±10%	AERO	1445
C-205 =	0.001 μf	±10%	AERO	1445
C-206 =	10-110 μμf			COT-21
C-207 =	10-110 μμf			COT-21
C-208 =				
C-209 =	0.001 μf	±10%	AERO	1445
C-210 =	0.025 μf	±10%	AERO	1445
C-211 =	0.1 μf	±10%	SOLAR	MPW *
C-212 =	1.0 μf	±10%	GR	COL-5
C-213 =	0.025 μf	±10%	AERO	1445
C-214 =	.008 μf	±10%	AERO	1467
C-215 =	0.025 μf	±10%	AERO	1445
C-216 =	1.0 μf	±10%	GR	COL-5
C-217 =	0.003 μf	±10%	AERO	1467
C-218 =	0.003 μf	±10%	AERO	1467

* 400 w.v.

MISCELLANEOUS

S-201 =	Switch	SWRW-20
PL-201=	Plug	CDMP-1275-12
PL-202=	Plug	774-G

WIRING DIAGRAM OF 1170A MODULATION METER SECTION

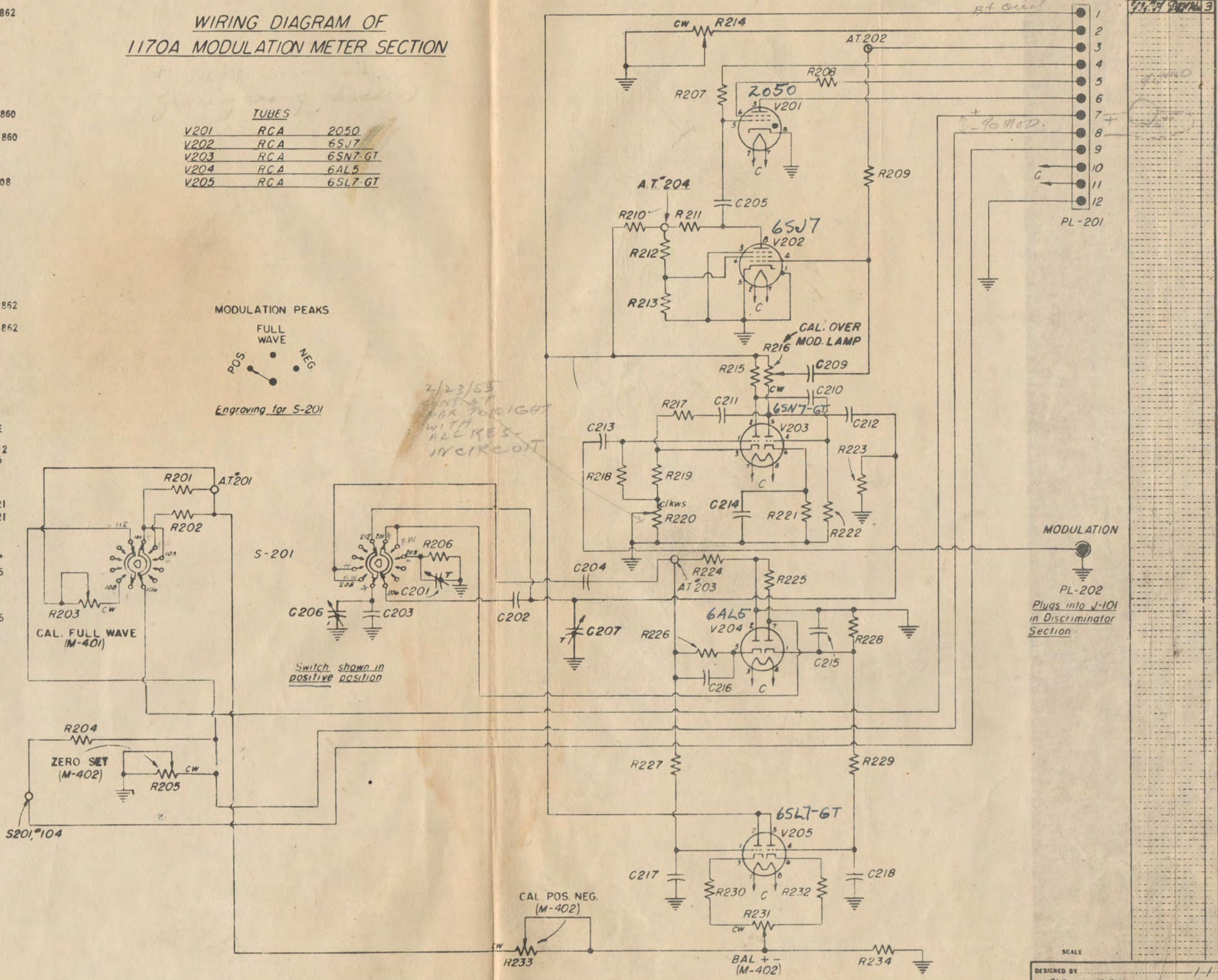
TUBES

V201	RCA	2050
V202	RCA	6SJ7
V203	RCA	6SN7-GT
V204	RCA	6AL5
V205	RCA	6SL7-GT

MODULATION PEAKS

FULL WAVE
POS
NEG

Engraving for S-201



STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED		ALL PIECES MUST BE CLEAN AND FREE OF BURRS. SEE SPEC. MPS-2. THREADS TO BE CLASS 2 UNLESS OTHERWISE SPECIFIED. SPECIFIED LENGTH APPLIES TO PERFECT THREADS. THERE SHALL NOT BE MORE THAN 3 IMPERFECT THREADS BEYOND THE SPECIFIED LENGTH.	FIRST USED ON / LINEAR DIMENSIONS IN INCHES / THIRD ANGLE PROJECTION	DWG. NO. 1170-11D ISS /3 — 1170 F.M. MONITOR
DIMENSIONS TO BEND OR TO SHEARED EDGES ±.015; ALL OTHER LINEAR DIMENSIONS FRACTIONS ±.010, DECIMALS ±.005; TOLERANCES NOT TO BE CUMULATIVE	ANGLES IN DEGREES: FORMED ANGLES ± 1/2°, MACHINED ANGLES ± .010° MEASURED ON THE ARC; FINISH TURNING CONCENTRIC TO .003 INDICATOR READING			

SCALE

DESIGNED BY
DR. BLB
APP'V ENG. WPB

GENERAL RADIO CO.
CAMBRIDGE, MASS. U.S.A.

DWG. NO. 1170-11D ISS /3

RESISTORS

R-301 =	1	KΩ	±10%
R-302 =	1	KΩ	±10%
R-303 =	2.2	MΩ	±10%
R-304 =	2.2	MΩ	±10%
R-305 =	2.2	MΩ	±10%
R-306 =	2.2	MΩ	±10%
R-307 =	10	Ω	± 5%
R-308 =	47	Ω	±10%
R-309 =	47	Ω	±10%
R-310 =	1	MΩ	±10%
R-311 =	10	KΩ	±10%
R-312 =	270	KΩ	±10%
R-313 =	22	KΩ	±10%
R-314 =	100	KΩ	±10%
R-315 =	5	KΩ	
R-316 =	100	KΩ	±10%
R-317 =	50	KΩ	
R-318 =	100	KΩ	±10%
R-319 =	560	Ω	±10%
R-320 =	1.25	Ω	± 5%
R-321 =	41	Ω	±10%
R-322 =	240	Ω	± 5%
R-323 =	240	Ω	± 5%
R-324 =	82	Ω	± 5%
R-325 =	680	Ω	± 5%
R-326 =	15,700	Ω	± 1%
R-327 =	560	Ω	± 5%
R-328 =	1	KΩ	±10%
R-329 =	560	Ω	±10%
R-330 =	560	Ω	±10%
R-331 =	560	Ω	±10%
R-332 =	1	KΩ	± 5%
R-333 =	10	Ω	± 5%
R-334 =	1	KΩ	
R-335 =	270	KΩ	±10%
R-336 =	300	Ω	± 5%
R-337 =	1	KΩ	±10%
R-338 =	1	KΩ	±10%
R-339 =	27	Ω	±10%
* R-340 =	2.2	Ω	±10%
** R-341 =			
R-342 =	1	KΩ	+10%

CAPACITORS

C-301 =	40	µf	450 w.v.
C-302 =	40	µf	450 w.v.
C-303 =	80	µf	450 w.v.
C-304 =	80	µf	450 w.v.
C-305 =	40	µf	450 w.v.
C-306 =	40	µf	450 w.v.
C-307 =	2000	µf	12 w.v.
C-308 =	2000	µf	12 w.v.
C-309 =	0.5	µf	
C-310 =	0.5	µf	
C-311 =	0.01	µf	±10%
C-312 =	0.01	µf	±10%
C-313 =	2000	µf	12 w.v.
C-314 =	2000	µf	12 w.v.
C-315 =	200	µf	6 w.v.
C-316 =	200	µf	6 w.v.
C-317 =	20	µf	450 w.v.
C-318 =	20	µf	450 w.v.
C-319 =	20	µf	450 w.v.
C-320 =	20	µf	450 w.v.
C-321 =	40	µf	150 w.v.
C-322 =	100	µf	25 w.v.
C-323 =	100	µf	25 w.v.
C-324 =	0.1	µf	
C-325 =	0.15	µf	600 w.v.

TUBES

V-301	RCA	6AS7-G
V-302	RCA	6SJ7
V-303	RCA	0D3/VR-150
V-304	AMPERITE	3-4
V-305	RCA	0C3/VR-105
V-306	AMPERITE	3-4
V-307	RCA	2050
V-308	RCA	6AL5

MISCELLANEOUS

T-301 =	Power Transformer	565-410
T-302 =	Power Transformer	485-421
L-301 =	Choke	485-453
PL-301 =	Plug	CDMP-10-33
PL-303 =	Input Plug	CDPP-562A
SO-302 =	Socket	CDMS-1262-4
SO-303 =	Socket	CDMS-1262-2
REL-301 =	Relay	3RE-2
REL-302 =	Relay	3RE-3
S-301 =	Time Delay Relay	3RE-1
RX-301 =	Rectifier	2RE-1400-8
RX-302 =	Rectifier	2RE-1400-9
RX-303 =	Rectifier	2RE-1400-6
RX-304 to RX-311 incl. =	Rectifiers	2RE-2

F-301 = Fuse 3 amp. Bussmann 8AG
F-302 = Fuse 3 amp. Bussmann 8AG
F-303 = Fuse 1 amp. Bussmann 8AG
F-304 = Fuse 1 amp. Bussmann 8AG
} For 115v. input

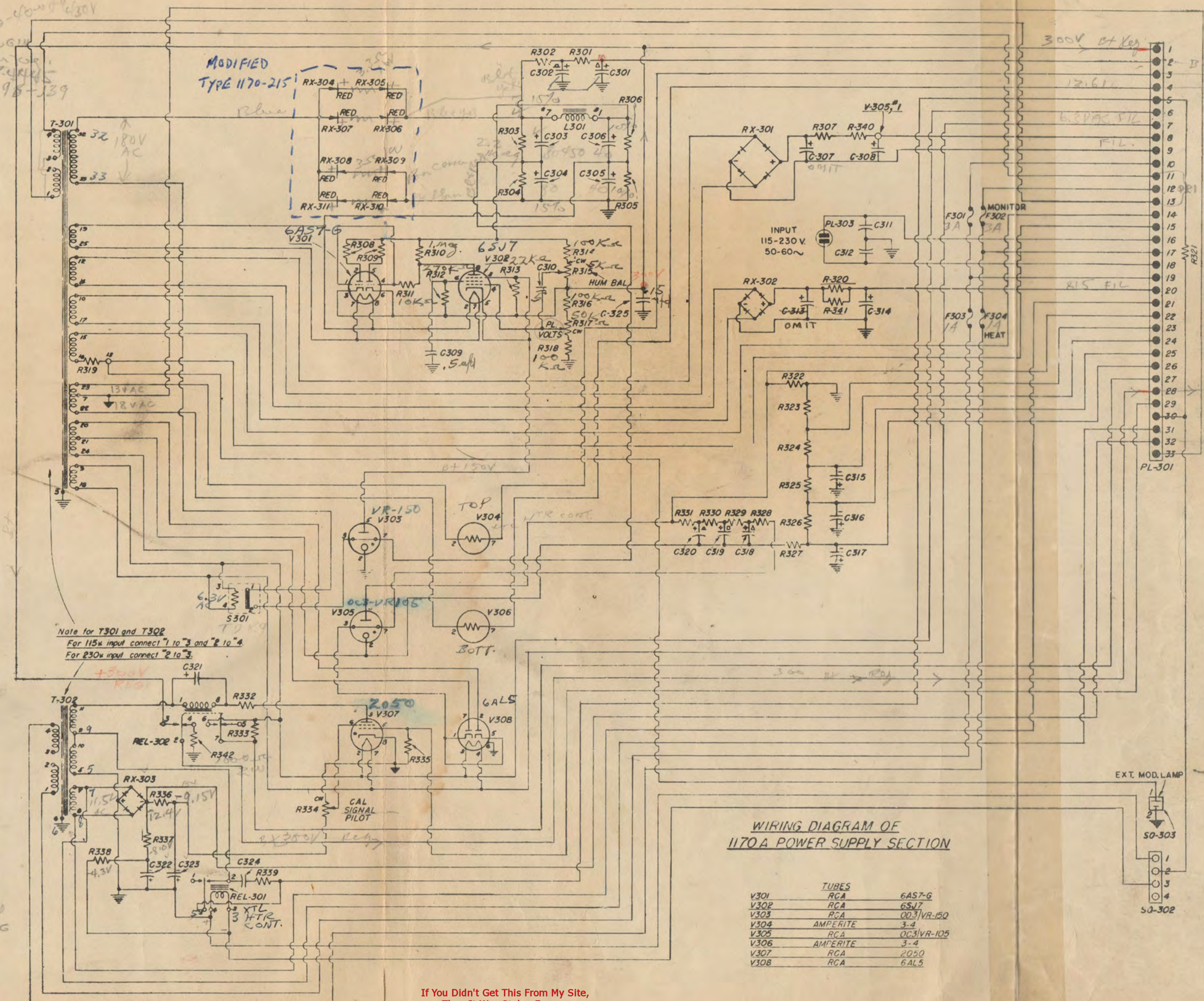
F-301 = Fuse 1-1/2 amp. Bussmann 8AG
F-302 = Fuse 1-1/2 amp. Bussmann 8AG
F-303 = Fuse 1/2 amp. Bussmann 8AG
F-304 = Fuse 1/2 amp. Bussmann 8AG
} For 230v. input

or

F-301 = Fuse 3.2 amp. Slow Blow 3AG
F-302 = Fuse 3.2 amp. Slow Blow 3AG
F-303 = Fuse 0.4 amp. Slow Blow 3AG
F-304 = Fuse 0.4 amp. Slow Blow 3AG
} For 115v. input

F-301 = Fuse 1.6 amp. Slow Blow 3AG
F-302 = Fuse 1.6 amp. Slow Blow 3AG
F-303 = Fuse 0.2 amp. Slow Blow 3AG
F-304 = Fuse 0.2 amp. Slow Blow 3AG
} For 230v. input

* Lab. to change value if necessary
**Lab. to determine value and add if necessary



WIRING DIAGRAM OF
1170A POWER SUPPLY SECTION

TUBES		
V301	RCA	6AS7-G
V302	RCA	6SJ7
V303	RCA	OD3/VR-150
V304	AMPERITE	3-4
V305	RCA	OC3/VR-105
V306	AMPERITE	3-4
V307	RCA	2050
V308	RCA	6AL5

RESISTORS

R-401 = 100 K Ω +10% −0%
R-402 = 250 K Ω ± 1%
R-403 = 5 K Ω ±10%
R-404 = 5 K Ω ±10%
R-405 = 1 K Ω ±10%
R-406 = 35 K Ω ± 1%
R-407 = 100 K Ω ±10%
R-408 = 50 K Ω ±10%
R-409 = 35 K Ω ± 1%
R-410 = 15 Ω ±10%
R-411 = 15 Ω ±10%
R-412 = 15 Ω ±10%
R-413 = 4.1 Ω ±10%
R-414 = 4.1 Ω ±10%
R-415 = 15 Ω ±10%
R-416 = 1800 Ω ±10%
R-417 = 200 K Ω ± 1%
R-418 = 820 Ω ± 5%
R-419 = 1 M Ω ± 5%
R-420 = 1 M Ω ± 5%

SWITCHES TYPE

S-401 = D.P.D.T. SWP-1314
S-402 = D.P.D.T. SWP-1314
S-403 = D.P.S.T. SWT-333
S-404 = D.P.S.T. SWT-333
S-405 = 60° C TH-503

PILOT LAMPS TYPE

P-401 = 6.3 v. 2LAP-939
P-402 = 6.3 v. 2LAP-939
P-403 = 6.3 v. 2LAP-939
P-404 = 6.3 v. 2LAP-939
P-405 = 6.3 v. 2LAP-939
P-406 = 120 v. 2LAP-430
P-407 = 6.3 v. 2LAP-939F (2 Req. in M401)
P-408 = 6.3 v. 2LAP-939F (2 Req. in M402)

SOCKETS TYPE

SO-1 = CDMS-1262-8
SO-101 = CDMS-1262-33
SO-102 = CDMS-1262-4
SO-201 = CDMS-1262-12
SO-301 = CDMS-1262-33

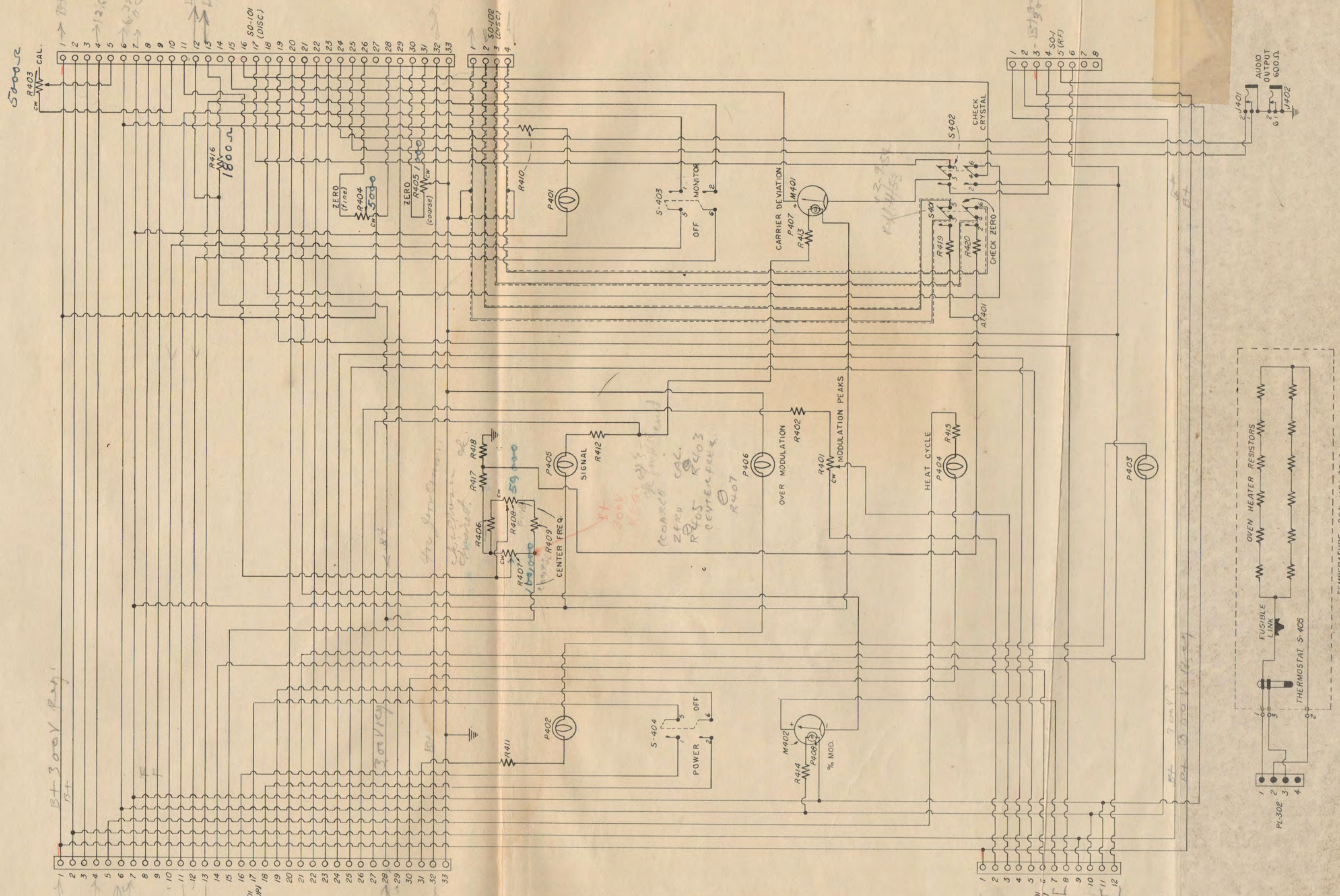
MISCELLANEOUS

J-401 = Jack CDSJ-818
J-402 = Jack CDSJ-818

M-401 = Meter 200 μa. MEDS-27
M-402 = Meter 600 μa. MEDS-28

PL-302 = Plug CDMP-1275-4

405 ZERO 403 CAL.
CENTER FREQ. 407
FRONT OF PANEL VIEW.



WIRING DIAGRAM OF 1170A PANEL ASSEMBLY

GENERAL RADIO COMPANY
service department

SELENIUM RECTIFIER ASSEMBLY REPLACEMENT IN THE TYPE 1170-B or BT F-M MONITOR

Replacement of
The Type 1170-327 or 1170-337 Plate Supply Selenium Rectifier Assembly
With The Type 1170-215 Rectifier Assembly Kit

As originally designed, the plate supply voltage for these instruments was derived from eight Type 5Q1 Seletron Selenium Rectifiers, RX-304 to 311 inclusive, our Assembly Type 1170-327. This assembly was later replaced by a single improved type rectifier RX-304, our Assembly Type 1170-337.

The manufacture of our Type 1170-337 Rectifier has now been discontinued by the manufacturer. Another replacement rectifier having identical electrical characteristics and the same mounting base as the former single unit is available. This assembly kit carries our Type 1170-215.

When wiring this replacement rectifier into the circuit, shorten and reservice the single blue lead as necessary. Connections should be made as indicated on the diagram below.

Parts List Type 1170-215 Rectifier Assembly Kit

Part Number	Description
REPO-22	3 Ω, ±10%, 10 watts
1170-42-2	Rectifier
WAI-111B	Washer
WAM-138	Washer
SCR-6/32 x 2¼	Screw
WALS-6	Lock Washer

Assembly Procedure

1. Remove old rectifier stack from mounting board. Do not remove board from instrument.

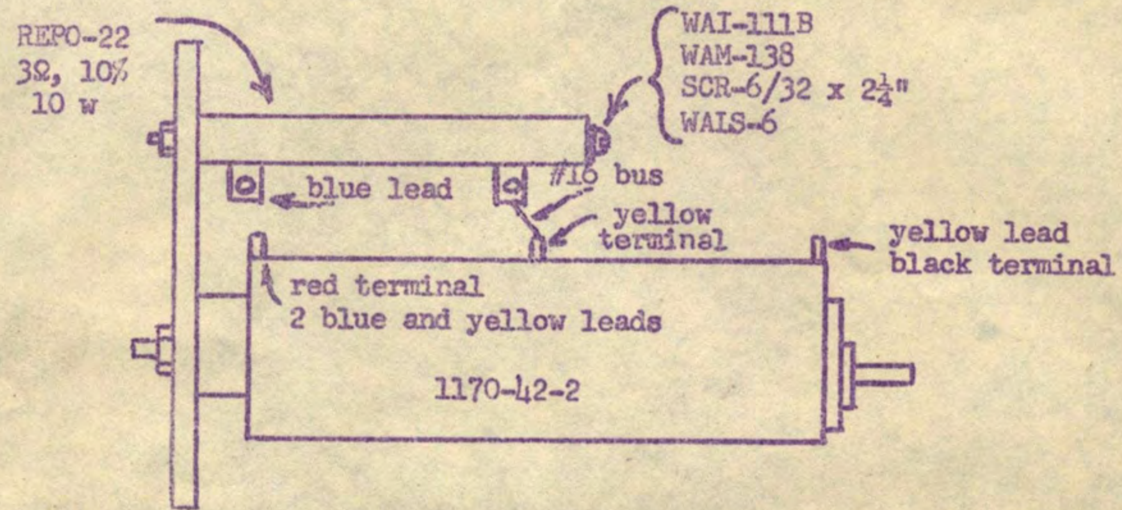
2. Enlarge mounting hole for new rectifier with #11 drill.

3. Assemble and wire as shown on diagram.

Installed on 12-4-61

R.J.G.

Diagram of
Type 1170-215 Rectifier Kit Assembled and Wired



Price of Kit $13.70

Service Department
May 1959