Ordinarily, it will not be necessary to change the adjustment of any of the video peaking coils in either the modulator or constant-resistance network. Also, changing tubes will not affect the frequency response sufficiently to warrant re-alignment of the peaking coils.

## MONITORING RACK ADJUSTMENTS

The monitoring rack units are equipped with individual power switches and these should be placed in the OFF position before proceeding with the following adjustments. Insofar as possible each unit should be checked individually in accordance with the instruction book accompanying the unit. It should be noted that the Console switch is in series with the rack unit power switches and the Console switch must be ON before any adjustments can be made. Only the frequency monitors are on a separate power circuit.

Both racks contain individual incoming power switches. The rear door of the Visual Monitor Rack also operates an interlock circuit which will remove dangerous potentials when the door is opened.

*Visual Monitor Rack* - Insert the dual connector plugs into the eight jacks at the left of the visual jack panel.

Operate the switch at the bottom of the visual Monitor Rack, and the Console switch to the ON positions. The indicator lamps adjacent to both switches should light.

Operate the Power switch on the 580-C Regulated Power Supply to the On position. This switch also controls the filament circuits of the TA-5 Stabilizing Amplifier.

Operate the Power switch on the WP-33 Power Supply to the ON position.

Adjust the controls of the Stabilizing Amplifier in accordance with the instruction book supplied with the amplifier.

Operate the power switch of the MI-8262 power supply to the ON position.

Adjust the WM-12 Visual Monitor Converter and WM-13 Visual Modulation Converter as described in the respective instruction books. The WM-12 output is observed on the kinescope and the WM-13A output on the CRO.

The AM carrier deviation meter supplied for use with the frequency monitor unit mounts in the upper part of the rack. This meter has two scales, one on each side of the meter scale.

As shipped the 3-0-3 KC scale is in position for use on channels 2-6. If operation is to be on channels 7-13 the front cover of the meter case must be removed and the meter scale reversed so that it reads 6-0-6 KC.

Operate the power switches of the WF-49B A-M Frequency Meter and WF-50A Frequency Monitor to the ON positions. Adjust these units as described in their instruction books.

*Aural Monitor Rack* - Operate the power switch at the bottom of the Aural Monitor Rack to the ON position.

Operate the power switch on the BA-4 Monitor Amplifier to the ON position. Adjust this amplifier later as described under TUNING, "Incoming Line Adjustments, Console."

Operate the power switch of the 86-A1 Limiting Amplifier to the ON position. Make the necessary adjustments to this unit when the console incoming line adjustments are made under the subsequent TUNING heading.

Operate the power switch of the F-M Frequency and Modulation Monitor to the ON position and adjust according to directions in the instruction book for that unit.

Place the power switch of the F-M Monitor in the ON position and adjust this unit in accordance with the accompanying instruction book. The duplicate meter at the top of the aural rack has two scales, one on each side of the meter scale. As shipped, the 3-0-3 KC scale is in position for use on channels 2 to 6. If channels 7 to 13 are to be used, the meter front cover must be removed and the meter scale reversed so that it reads 6-0-6 KC.

# TUNING

## VISUAL SECTION TUNING

*General* - The tuning procedure for the visual transmitter section involves adjusting the r-f circuits and then obtaining the required modulator output. Since additional r-f stages are required for the higher channels, the tuning procedure for these channels differs slightly. All tuning variations are, therefore, itemized separately where necessary: No differentiation is made for operations common to all channels.

The r-f channels in a television transmitter require a different tuning technique from that used on a-m or f-m equipment. In a picture transmitter the change in plate current usually associated with resonance is lacking. Instead the transmitter output must be "broadbanded" so as to achieve a broad, reasonably flat response curve. This "broadbanding" is accomplished by adjusting the three r-f controls which affect the bandwidth - p-a plate, output coupling, and output tuning controls.

*Visual PA Broadbanding Theory* - Two broadbanding methods may be used at the discretion of the operator. Both methods yield an output circuit passband characteristic displaced slightly on the nigh-frequency side of the carrier, thus permitting an appreciably narrower bandwidth than full double-sideband response. One procedure is a "rapid" method

which gives an approximation of the correct characteristic, without the necessity of using test equipment. The second method utilizes auxiliary equipment and is the recommended method where accurate tuning is desired.

The first, or rapid tuning method utilizes a "tune-up" crystal in the oscillator stage and adjustment of the intermediate r-f stages by conventional meter readings. The carrier frequency thus obtained is approximately 1.6 mc. higher than the assigned carrier frequency, and, hence, falls in the center of the channel passband. The final stage is then tuned symmetrically around this frequency by means of meter readings, the screen grid current and the output reflectometer readings being the most useful. Output coupling is increased until the plate current dip vanishes.

When this preliminary tune-up is complete, the "operate" crystal is switched into use and the r-f amplifier chain, (except the output circuits of the final stage) is retuned to the assigned carrier frequency. Thus, the band-pass of the output stage is properly set as to width and position in the spectrum. The carrier remains at 100% response, but with a resultant characteristic which is between a double sideband and a vestigial sideband characteristic. The PA is not required to have flat response in the region below the carrier which is later suppressed in the sideband filter. Improved PA plate efficiency is thus obtained, with no observable degradation due to phase characteristic.

For accurate broadbanding, or tuning, the procedure utilizes a video sweep generator such as the RCA type WA-21A and an oscilloscope with reasonably good vertical linearity. It is usually desirable to make the initial PA tune-up at installation, using a dummy load, so that any temporary troubles existing in the antenna or transmission line will not lead to errors when broadbanding.

Actual broadbanding normally may be divided into the following three steps:

1. Resonating the unloaded plate tank circuit,
2. PA loading,
3. Adjustment of broadband characteristic.

These three steps are described briefly to familiarize the operator with the problems involved, before actual tuning is attempted.

With the visual PA unloaded, output coil loosely coupled, and on low voltage and r-f drive, the plate tank circuit can be resonated by the usual dip in plate current or rise in screen current. The output tuning can also be resonated by tuning for maximum reflectometer reading. Here the similarity between tuning a television visual transmitter and an a-m transmitter ends.

During loading the PA output coupling should be increased while simultaneously increasing the excitation. Care must be taken to keep the screen current within ratings. Approximate loading is obtained when no significant dip in plate current or rise in screen current can be observed when tuning through the unloaded resonance point. With normal plate and screen voltages on the PA a rough check of power output can be made with the dummy load. Since the reflectometer indicates average current it can be calibrated to read power.

With a video sweep generator feeding the transmitter and the power amplifier on normal plate and screen voltages the final broadband characteristic can be obtained.

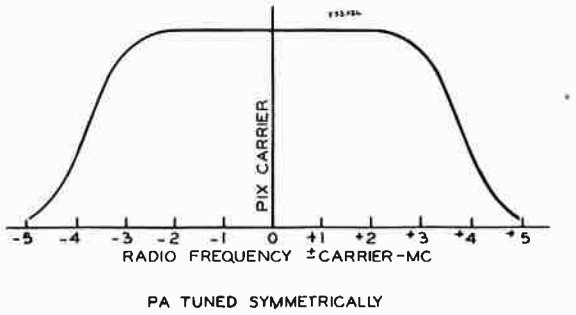



Figure 36 - Broadbanding Theory - PA Tuned Symmetrically (738586-sub 0)

The transmitter tuning and output loading previously discussed should have produced approximately the r-f output response shown in Figure 36, picture carrier being in the center of the band. To obtain the required r-f bandwidth in conjunction with the sideband filter the pass-band must be effectively shifted until the response of Figure 37 is obtained.

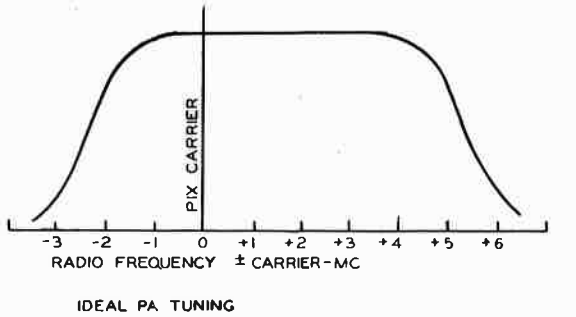



Figure 37 - Broadbanding Theory - Ideal PA Tuning

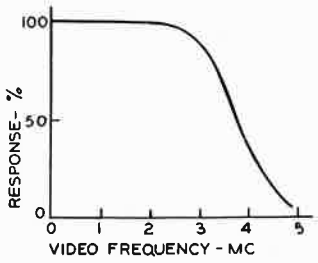



Figure 38 - Broadbanding Theory - Demodulated Response of Figure 36

These two r-f response curves cannot be observed but a detected curve can be seen. The detected outputs of Figures 36 and 37 are shown in Figures 38 and 39 respectively. The response curves result from addition of the corresponding upper and lower sideband amplitudes in the r-f envelope curve. The r-f response out of the sideband filter is shown in Figure 40. Final detected sweep at the output of the sideband filter should be similar to Figure 41.

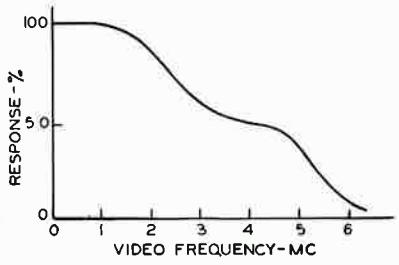



Figure 39 - Broadbanding Theory - Demodulated Response of Figure 37

The final adjustments to obtain the response of Figure 41 must be made while observing the detected video sweep output. Roughly the three PA controls have the following effects on the response curve:

*PA Plate*

Tuning the PA plate control will tilt the frequency response curve of Figure 41 so that either the high or low-frequency end of the curve may be peaked. See Figures 42 and 43.

In tuning, the high-frequency side should be favored (shorting bar closest to tube) to accomplish the shift indicated by Figures 36 and 38.

*Output Tuning*

Operating the output tuning control will have much the same effect as the PA plate control in that it will also tilt the frequency response curve, Figure 41, to peak either the high- or low-frequency end of the curve.

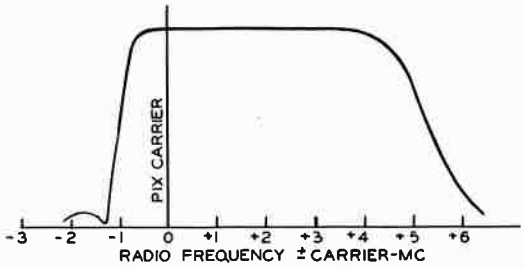



Figure 40 - Broadbanding Theory - Frequency Response Output of Sideband Filter

*Output Coupling*

Manipulation of the output coupling control will change the power output and bandwidth. Over the useful tuning range the power output-bandwidth product is approximately constant. If the power output is low and the bandwidth too broad the coupling should be reduced slightly and the plate and output tuning controls readjusted for the flattest frequency response and the highest reflectometer reading. If the bandwidth is too narrow, the coupling must be increased slightly and plate and output tuning readjusted.

The modulator frequency response begins to cut off just beyond 5 mc as shown on curve "A," Figure 44. This, of course, will mask

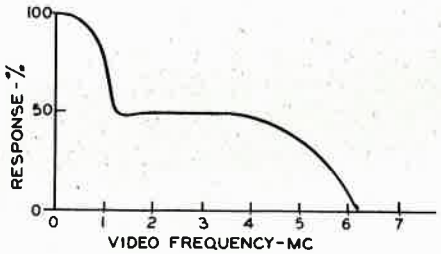
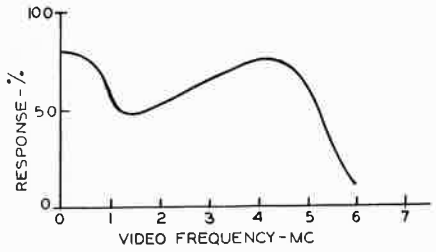


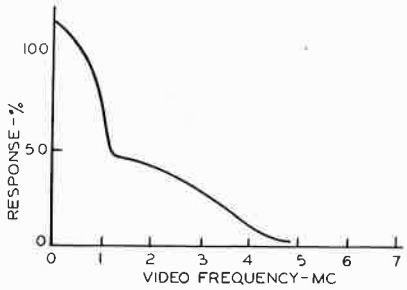

Figure 41 - Broadbanding Theory - Demodulated Output of Sideband Filter




PA MISSTUNED - HIGH FREQUENCY PEAKED

Figure 42 - Broadbanding Theory - PA Mis-Tuned, High Frequency Peaked

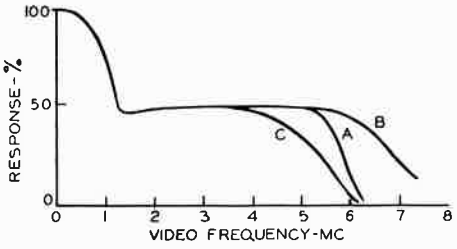
any r-f bandwidth beyond 5 mc which would appear as curve "B," Figure 44. If the high frequency cut-off region on the modulator frequency response curve appears the same as on the r-f output frequency response curve the r-f bandwidth is too wide. The desired overall response is shown on curve "C," Figure 44.




PA MISSTUNED - LOW FREQUENCY PEAKED

Figure 43 - Broadbanding Theory - PA Mis-Tuned, Low Frequency Peaked

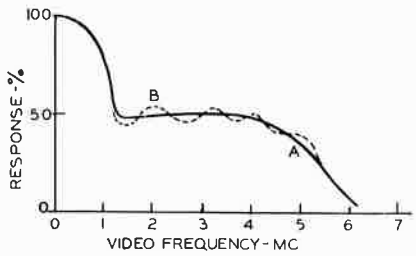
When observing broadband response with the antenna connected, it is to be expected that the antenna reflections will appear as irregularities in Curve "B", Figure 45. Spacing




CURVE A, MODULATOR CUTOFF, CURVE B, PA TOO BROADBAND. CURVE C, NORMAL RF CUTOFF

Figure 44 - Broadbanding Theory - Modulator and PA Response

of the reflections will depend on transmission line length, and the amplitude will depend on the magnitude of mismatch at antenna end of line. This will cause no material degradation of the picture so long as the antenna measurements show the reflections to be within tolerance.




CURVE A, SIDEBAND FILTER TERMINATED BY DUMMY LOAD. CURVE B, SIDEBAND FILTER TERMINATED BY ANTENNA SYSTEM

Figure 45 - Broadbanding Theory - Output Response

When changing tubes, the only factor affecting broadbanding is slight manufacturing variation in tube output capacitance. Hence, of the three broadbanding controls, only the plate tuning should normally have to be shifted. Some tubes require no change. This effect on the picture is minor and the results are not drastic if no change in tuning is made. Emergency changes can be made, therefore, without serious consequences.

It is good practice, however, when time is available, to operate each spare 8D21 tube in the visual PA and then, with the video sweep through the transmitter, to make exact tune-up and log dial settings.

Most tubes may require retuning of the grid circuit, but this does not affect broadbanding and the adjustment required is simply peaking for maximum PA plate current.

*Tuning Controls, Visual* - Function of most controls in the visual section follow conventional practice and require no explanation. However, since the visual modulator introduces special operating features, the significance of the modulator panel controls is covered in the following discussion.

*Picture Gain Control* - The picture gain control is a potentiometer (R922) connected to vary the value of the composite video signal on the grid of the first video amplifier stage, and hence to control the gain of the entire video system. It is motor driven through a friction clutch such that the potentiometer may either be manually controlled at the transmitter or remotely controlled from the console. Fixed resistors R929 and R930 in shunt across R922 serve

to properly terminate the 75-ohm video coaxial cable feeding the transmitter. Associated with this circuit is a variable resistor, R921, which functions as a fine adjustment (± 10 ohms) on the terminating resistance, and is particularly useful when the input cable exceeds 50 feet in length.

*Black Level Control* – This control is a potentiometer (R908) in the grid circuit of the modulator stage, connected so as to vary the reference voltage of clamp tube X815. This in effect varies the bias on the modulator stage. The clamp circuit will always cause the pedestal of a composite signal to occur at whatever point on the modulator characteristic is dictated by the setting of this reference voltage. Hence, the function of the Black Level control is to set the modulator bias to the correct value for proper clamping of the pedestal level. Figure 60 shows typical operating parameters of the modulator and PA stages.

It is to be further noted that this control will simultaneously vary the bias on the PA stage, since the anodes of the modulator stage are direct-coupled to the PA grids. This control is one of the most important operating controls in the transmitter.

*Synchronizing Amplitude Control* – The Sync Ampl control, R904, is a bias adjustment on the grid of the synchronizing pulse stretcher tube X812. By means of this bias variation, the amount of plate current excursion in the synchronizing region, and hence synchronizing voltage, contributed by the "stretcher" tube, may be controlled. The function of this control is, therefore, to pre-emphasize the synchronizing pulse amplitude to the desired amount. The maximum degree of stretching available in this control is such as to increase the synchronizing pulse percentage in a given composite signal from 25% to approximately 30%. This amount of stretching will in general be approximately that required to compensate for the curvature of the modulator and PA tube characteristics. It should be noted that additional synchronizing pulse pre-emphasis (Available in the TA-5 series Stabilizing Amplifier) is required depending on depth of modulation. This will be covered when final tuning adjustments are made.

*Amplifier Coupling Switch* – For normal program operation, the Amplifier Coupling switch (S801) should be operated in the DC position. During the transmission of a typical television composite signal, the clamp circuit will then operate to restore the d-c component of the picture signal at the modulator grids.

When using a video sweep, square wave, sine wave generator, or other test signals which do not contain standard synchronizing pulses, it is necessary to disable the clamp circuits. For such test signals, therefore, the Amplifier Coupling switch should be operated to the AC position. This renders the clamp circuit inoperative, and returns the modulator grid bias, and simultaneously, PA grid bias, to approximately mid-characteristic operation (provided the Black Level control adjustment was correctly set at pedestal level for a normal composite picture signal). For correct mid-characteristic modulator and PA settings, see Figure 60. The time constant of the modulator grid coupling circuit is short; therefore, frequencies below approximately 10 kc will be attenuated when the Amplifier Coupling switch is in the AC position. A video sweep generator or a 100 kc square wave test signal may be used without difficulty.

*Plate Meter Switch* – The visual Amplifier Plate Current meter, M805, is provided with a Plate Current switch, S803, which connects the meter to read the plate current of the first or second video stage, as indicated on the switch nameplate.

*Bucking Bias Control* – Bucking Bias Control R946, provides means for adjusting the d-c output voltage of the PA bucking bias power supply by virtue of its control on the reference bias voltage of d-c amplifier tube X826. Maximum change available in this output voltage is limited to the range over which the supply will remain in proper regulation. This range is approximately ±5% for any given transformer tap connection on T803.

This control is located on the inside lower left-hand panel in cabinet 8. During the preliminary adjustments this control was set tentatively for an output voltage of 1025 volts. The final setting is important to the proper operation of the transmitter, and is discussed when the final tuning adjustments are made.

*Reflectometer Switch* – The Reflectometer switch, S802, although not directly associated with the visual modulator, is situated on the visual modulator panel. In the aural section, the switch (S110) is located on the right-hand panel inside cabinet 1. This switch transfers the Reflectometer meters M801 (M104) on the transmitter, and M1101 (M1102) on the console, to the "Incident" diode head or to the "Reflected" diode head, as desired. From the meter readings so obtained the operator may maintain a check on the correctness of the transmission line termination.

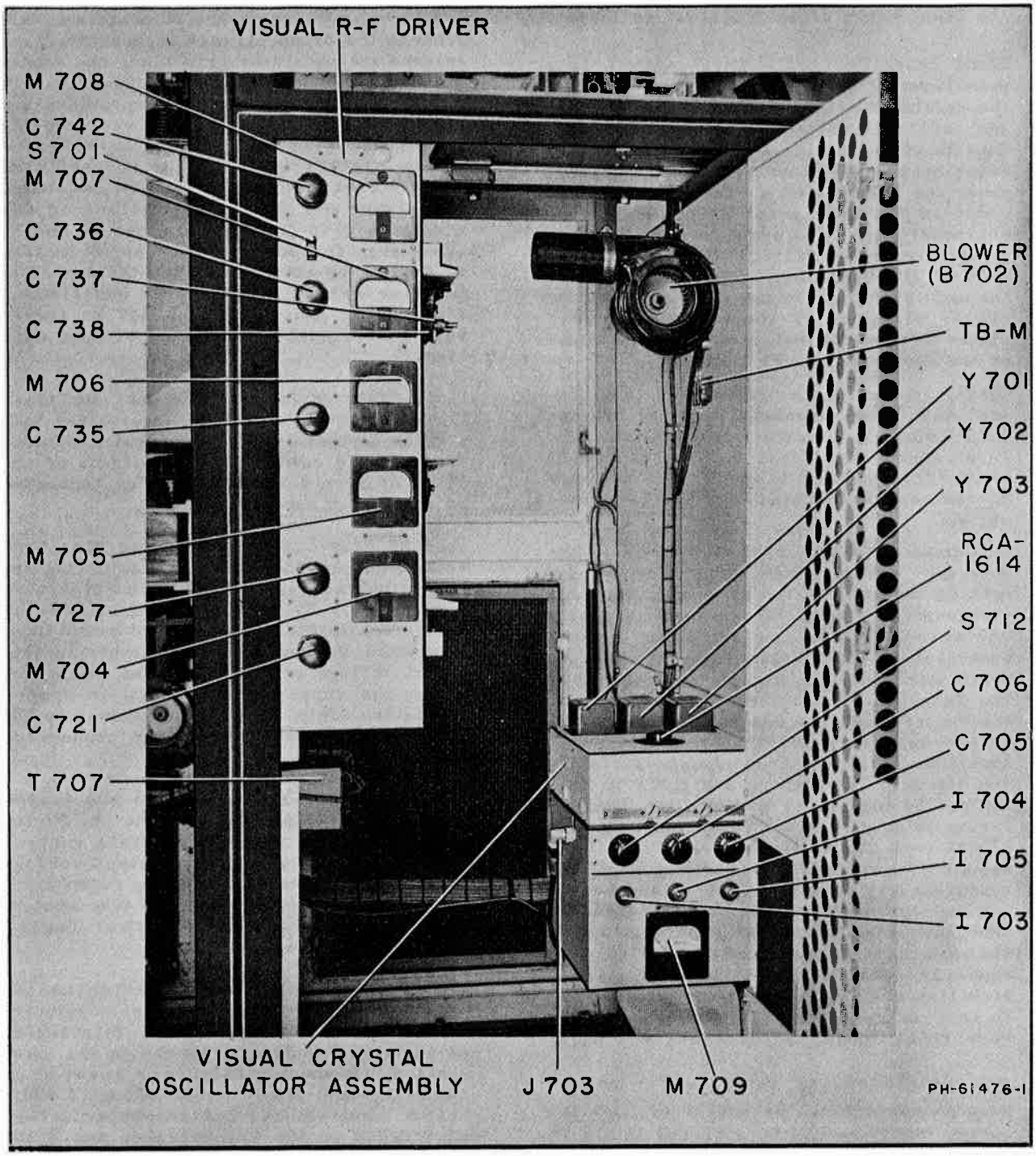



Figure 46 – Oscillator and R-F Driver, Channels 2 to 6 - Visual (Frame 7, Front View)

*R-F Tuning, Visual - Channels 2 to 13 -* The following tabulation lists the tuning operations necessary for adjusting the visual r-f section. Tables 9 and 10 list the operating frequencies and the coil setting for channels 2 to 6 and 7 to 13, respectively.

*WARNING: The voltages encountered in this equipment are dangerous, and a shock may prove fatal. Observe safety regulations. Use grounding sticks to remove charges retained by capacitors.*

TABLE 9

VISUAL SECTION

OPERATING FREQUENCIES AND COIL DATA
CHANNELS 2 TO 6

| TUNING DATA | CHANNEL | | | | |
|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 |
| CHANNEL FREQUENCY LIMITS (MC)..... | 54-60 | 60-66 | 66-72 | 76-82 | 82-88 |
| Visual Carrier (MC)..... | 55.25 | 61.25 | 67.25 | 77.25 | 83.25 |
| Visual Crystal (MC)..... | 4.60416 | 5.10416 | 5.60416 | 6.4375 | 6.9375 |
| Visual Tune-Up Crystal (MC)..... | 4.73958 | 5.23958 | 5.73958 | 6.57291 | 7.07291 |
| Visual Tune-Up Frequency (MC)..... | 56.875 | 62.875 | 68.875 | 78.875 | 84.875 |
| VISUAL CRYSTAL OSCILLATOR (1614).. | | | | | |
| Cathode Coil.....L702..... | 11T | 11T | 7T | 7T | 7T |
| Plate Coil.....L703..... | 11T | 11T | 7T | 7T | 7T |
| Output Coil.....L704..... | 1T | 1T | 1T | 1T | 1T |
| Output Frequency (MC)..... | 9.2084 | 10.2084 | 11.2084 | 12.875 | 13.875 |
| DOUBLER (4E27)-1st R.F. STAGE | | | | | |
| Input Coil.....L720..... | 1T | 1T | 1T | 1T | 1T |
| Grid Coil.....L721 C721 | 7T | 7T | 7T | 7T | 7T |
| Plate Coil.....L722 C722 | 6T | 6T | 6T | 6T | 6T |
| Output Frequency (MC)..... | 18.4166 | 20.416 | 22.416 | 25.75 | 27.75 |
| TRIPLER (4E27)-2nd R.F. STAGE | | | | | |
| Plate Coil.....L724 C735 | 2T | 2T | 2T | 2T | 2T |
| Output Frequency (MC)..... | 55.25 | 61.25 | 67.25 | 77.25 | 83.25 |
| AMPLIFIER (2, 4-125A/4D21)-3rd R.F. STAGE. | | | | | |
| Grid Coil.....L725 C736 | 4T | 4T | 4T | 2T | 2T |
| Plate shorting bar adjustment (inches from top).....L728 C742 | No Bar | No Bar | 4 | 4 | 4 |
| Output Frequency (MC)..... | 55.25 | 61.25 | 67.25 | 77.25 | 83.25 |
| POWER AMPLIFIER (8D21) | | | | | |
| Grid.....C744 | | | | | |
| Spacing between Grid Lines (inches)..... | 1 1/2 | 1 1/2 | 1/2 | 1/4 | 1/4 |
| Grid shorting bar adjustment (inches from top, approx.)..... | No Bar | 2 | 3 | 4 | 5 |
| Output Frequency (MC)..... | 55.25 | 61.25 | 67.25 | 77.25 | 83.25 |

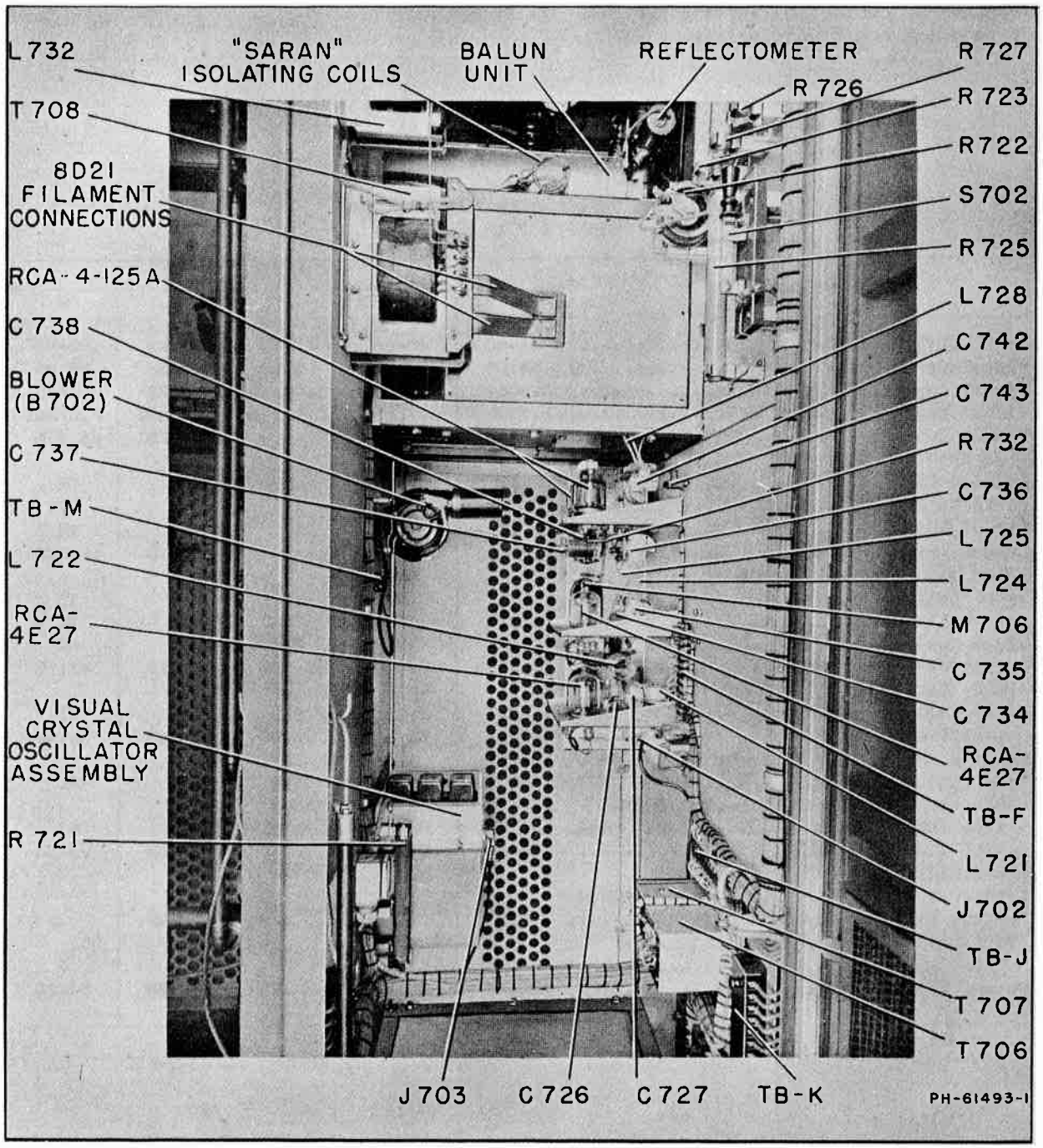



Figure 47 - Oscillator and R-F Driver, Channels 2 to 6 - Visual (Frame 7, Rear View)

TABLE 10

VISUAL SECTION

OPERATING FREQUENCIES AND COIL DATA
CHANNELS 7 TO 13

| TUNING DATA | CHANNEL | | | | | | |
|---|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| CHANNEL FREQUENCY LIMITS (MC) | 174-180 | 180-186 | 186-192 | 192-198 | 198-204 | 204-210 | 210-216 |
| Visual Carrier (MC) | 175.25 | 181.25 | 187.25 | 193.25 | 199.25 | 205.25 | 211.25 |
| Visual Crystal (MC) | 4.86805 | 5.03472 | 5.20138 | 5.36805 | 5.53472 | 5.701388 | 5.868055 |
| Visual Tune-Up Frequency (MC) | 176.875 | 182.875 | 188.875 | 194.875 | 200.875 | 206.875 | 212.875 |
| Visual Tune-Up Crystal (MC) | 4.91319 | 5.07986 | 5.24652 | 5.44097 | 5.57986 | 5.74652 | 5.913194 |
| VISUAL CRYSTAL OSCILLATOR (1614) | | | | | | | |
| Cathode Coil.....L702 | 11T | 11T | 7T | 7T | 7T | 7T | 7T |
| Plate Coil.....L703 | 11T | 11T | 7T | 7T | 7T | 7T | 7T |
| Output Coil.....L704 | 1T | 1T | 1T | 1T | 1T | 1T | 1T |
| Output Frequency (MC) | 9.736 | 10.069 | 10.402 | 10.736 | 11.069 | 11.402 | 11.736 |
| DOUBLER (4E27)-1st R.F. STAGE | | | | | | | |
| Input Coil.....L720 | 1T | 1T | 1T | 1T | 1T | 1T | 1T |
| Grid Coil.....C721...L721 | 7T | 7T | 7T | 7T | 7T | 7T | 7T |
| Plate Coil.....C722...L722 | 6T | 6T | 6T | 6T | 6T | 6T | 6T |
| Output Frequency (MC) | 19.472 | 20.1388 | 20.8056 | 21.4724 | 22.1388 | 22.8045 | 23.4724 |
| FIRST TRIPLER (4E27)-2nd R.F. STAGE | | | | | | | |
| Plate Coil.....C735...L724 | 2T | 2T | 2T | 2T | 2T | 2T | 2T |
| Output Frequency (MC) | 58.417 | 60.416 | 62.416 | 64.417 | 66.416 | 68.416 | 70.417 |
| FIRST IPA (2, 4-125A/4D21)-3rd R.F. STAGE | | | | | | | |
| Grid Coil.....C736...L725 | 4T | 4T | 4T | 4T | 4T | 2T | 2T |
| Plate Shorting Bar (inches from closed end to center of shorting bar) | No Bar | No Bar | No Bar | No Bar | No Bar | No Bar | No Bar |
| Output Frequency (MC) | 58.417 | 60.416 | 62.416 | 64.417 | 66.416 | 68.416 | 70.417 |
| SECOND TRIPLER (2, 4-125A/4D21)-4th R.F. STAGE | | | | | | | |
| Plate Shorting Bar (inches from closed end to center of shorting bar) | No Bar | No Bar | 3/4 | 1 1/4 | 1 1/4 | 1 1/2 | 1 1/2 |
| Output Frequency (MC) | 175.25 | 181.25 | 187.25 | 193.25 | 199.25 | 205.25 | 211.25 |
| SECOND IPA (2-4X500A) - 5th RF STAGE | | | | | | | |
| Grid Shorting Bar (inches from closed end to center of shorting bar) | 1 1/2 | 1 1/2 | 1 3/4 | 2 | 2 1/4 | 2 1/2 | 2 3/4 |
| Plate Shorting Bar (inches from closed end to center of shorting bar) | 4 1/4 | 4 1/4 | 4 3/4 | 5 1/4 | 5 1/4 | 5 3/4 | 5 3/4 |
| Output Frequency (MC) | 175.25 | 181.25 | 187.25 | 193.25 | 199.25 | 205.25 | 211.25 |
| POWER AMPLIFIER (8D21) | | | | | | | |
| Output Frequency (MC) | 175.25 | 181.25 | 187.25 | 193.25 | 199.25 | 205.25 | 211.25 |

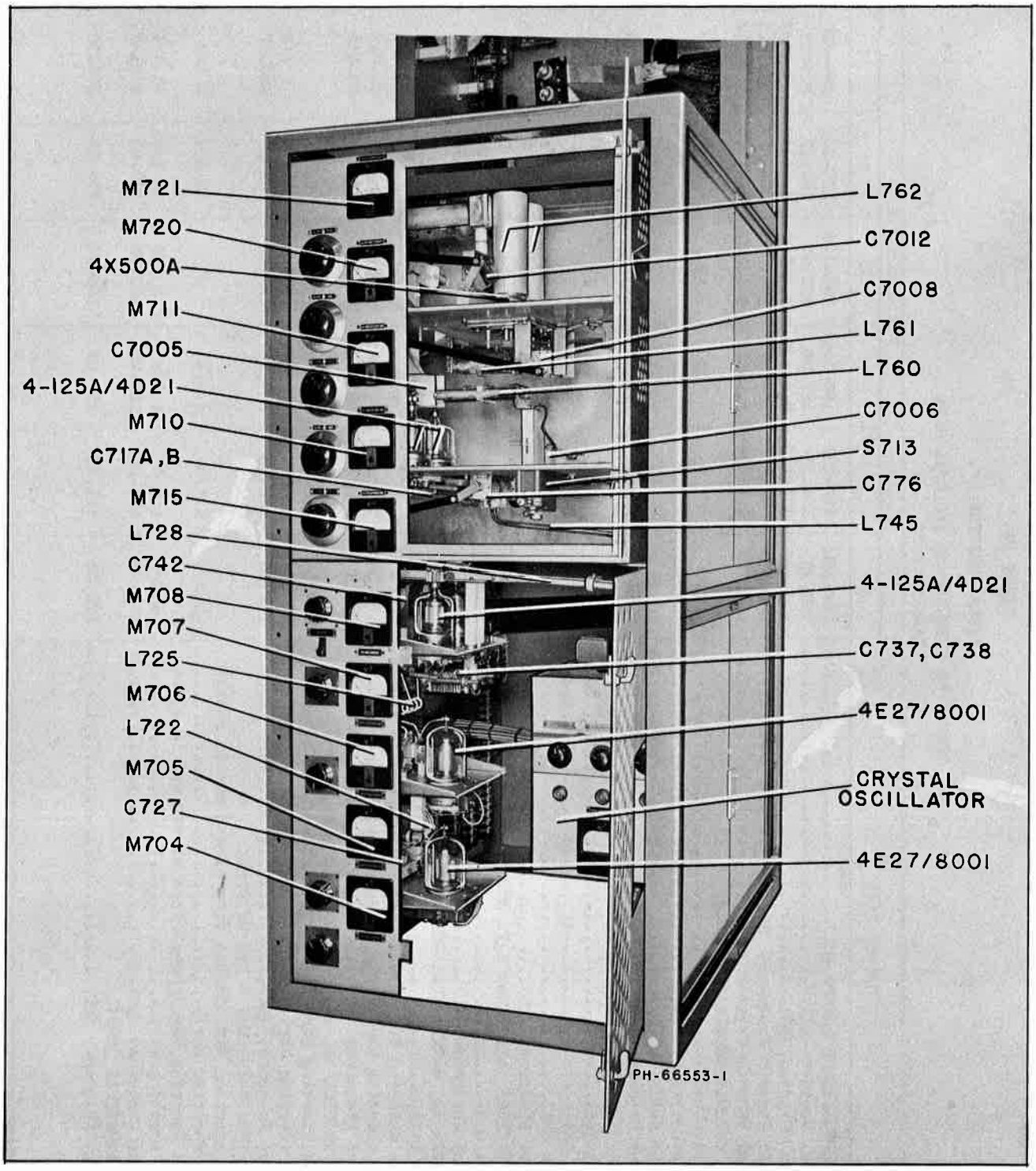



Figure 48 - Oscillator and R-F Driver, Channels 7 to 13 - Visual (Frame 7, Front View)

# TUNING - VISUAL R-F
# CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| *PRELIMINARY ADJUSTMENTS* | |
| Attach the plate caps to the driver rectifier tubes (X601, X602, X603). | |
| | Disconnect the bus lead to terminal on C7015 and C7016 and disconnect wire from TB-W9, on rear of the high-frequency driver assembly. Remove resistor R773 from the resistor panel. Remove lead from C718 and wire from terminal E702. Opening of these circuits will remove the plate and screen voltages from the 1st IPA, 2nd tripler, and 2nd IPA stages. |
| Operate the Picture Driver, K405, circuit breaker to the ON position. | |
| Make certain that the picture PA circuit breaker, K406, is in the OFF position. This circuit breaker must remain in the OFF position during tuning of the R-F driver chain. | |
| Rotate the Excitation control, R722, to the extreme counterclockwise position. | |
| Open the Tune-up switch (S702). This switch is in the rear of cabinet seven. | |
| Operate the Picture Plate switch (S701) to the ON position. If all interlocks are closed:<br>Plate voltage will be applied to crystal oscillator and driver stages.<br>Driver Plate Voltage meter M603 will indicate 1500 volts.<br>Meters in the low-frequency driver stages should indicate zero, since all stages are detuned.<br>The "OSC CATH CUR" meter, M709 should indicate 30 milliamperes or less.<br>Excessive plate current in any of the driver stages may indicate the absence of grid bias, or the presence of an oscillation. | |
| An external voltmeter having an internal resistance of at least 1000 ohms-per-volt should be used to make the following measurements:<br>Driver bias voltage, as measured at terminal 10 of terminal board TB-F (cabinet seven) should be approximately 90 volts.<br>Screen-grid voltage of the first r-f stage should be approximately 150 volts, as measured at the screen-grid terminal of the tube.<br>Screen-grid voltage as measured at the terminal of the second r-f stage should be approximately 300 volts.<br>Screen-grid voltage for the r-f driver stages may be adjusted, if necessary, by changing connections on resistor R726 to the appropriate taps. | |
| *OSCILLATOR TUNING* | |
| Rotate Crystal switch, S712 to the tune-up crystal position. | |
| Slowly rotate oscillator plate capacitor C706 until a slight dip, a few milliamperes is indicated by Osc Cath Cur meter M709. The dip in cathode current (as indicated by a meter) will not be as great as the dip in plate current. | |

*(Continued)*

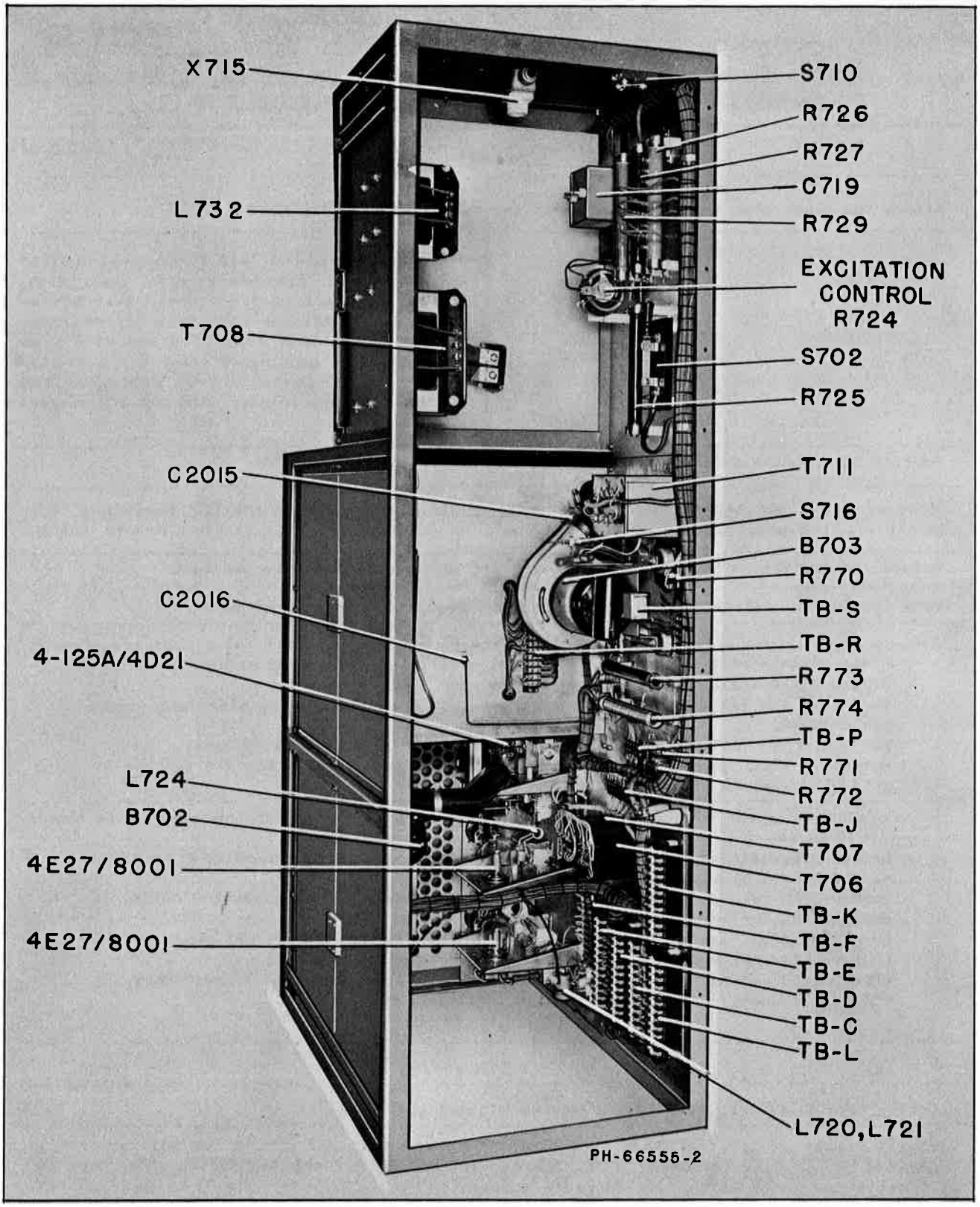



Figure 49 - Oscillator and R-F Driver, Channels 7 to 13 - Visual (Frame 7, Rear View)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| Failure of the crystal oscillator to oscillate may be traced to the following causes:<br>Crystal not in circuit, or improperly seated.<br>Fractured crystal. This may be checked by operating Crystal switch S712 to a spare crystal position.<br>Defective oscillator tube.<br>Lack of filament or plate voltages.<br>Incorrect coils in circuit. See Tables 9 or 10. | |
| *DOUBLER TUNING (1st R-F Stage)* | |
| Slowly rotate doubler grid tuning capacitor C721 until resonance is obtained, as indicated by an increase of a few tenths of milliampere of grid current on Doubler Grid Cur meter M704. A larger and sharper indication will be noted on the Doubler Cath Cur meter, M705. | |
| Failure to obtain an indication of grid circuit resonance may be due to:<br>The r-f link, P702 and P703, may not be connected between the crystal oscillator and the doubler stages.<br>Grid inductance L721 may not be in place. | |
| As soon as indication is obtained on Doubler Cath Cur meter M705, rotate the doubler plate tuning capacitor, C727, to the point where cathode current is a minimum. | |
| *TRIPLER TUNING (2nd R-F Stage)* | *FIRST TRIPLER TUNING (2nd R-F Stage)* |
| Simultaneous with resonance of the doubler plate circuit, current will flow in the grid and cathode circuits of the tripler as indicated by the Tripler Grid Cur and Tripler Cath Cur meters, M706 and M707 respectively. | Simultaneous with obtaining resonance of the doubler plate circuit, current will flow in the grid and cathode circuits of the tripler as indicated by the Tripler Grid Cur and Tripler Cath Cur meters, M706 and M707, respectively. |
| Rotate tripler plate capacitor C735 until a minimum of cathode current is indicated by Tripler Cath Cur meter M707. | Excitation of this stage should be adjusted so that the grid bias, resulting from fixed and grid leak bias, does not exceed 500 volts. Excitation may be controlled by varying the screen-grid voltage of the doubler stage as follows:<br>Move the doubler screen-grid voltage lead to the tap on R726 which will give a grid current reading not exceeding three milliamperes, as indicated by Tripler Grid Cur meter M706. Normally, the first tap from the ground end of R726 will provide sufficient doubler screen grid voltage for proper excitation of the first tripler grid. Bias voltage may be measured by connecting an external voltmeter across capacitor C762. |
| *FREQUENCY CHECK* | |
| Before proceeding, the operating frequencies of the crystal oscillator and first two multiplier stages should be checked with an absorption type wavemeter. The output frequency of each of these stages is shown in Table 9.<br>In order to position the wavemeter close to the multiplier stages, it is necessary to open the perforated metal door and to temporarily operate the door interlock switch while measuring the frequency. EXTREME CAUTION SHOULD BE OBSERVED WHEN PLACING THE WAVEMETER IN THE VICINITY OF THE PLATE CIRCUITS. Usually it is only necessary to place the wavemeter within five inches of these circuits. | Rotate tripler plate capacitor C735 until a minimum of cathode current is indicated by Tripler Cath Cur meter, M707. |

*(Continued)*

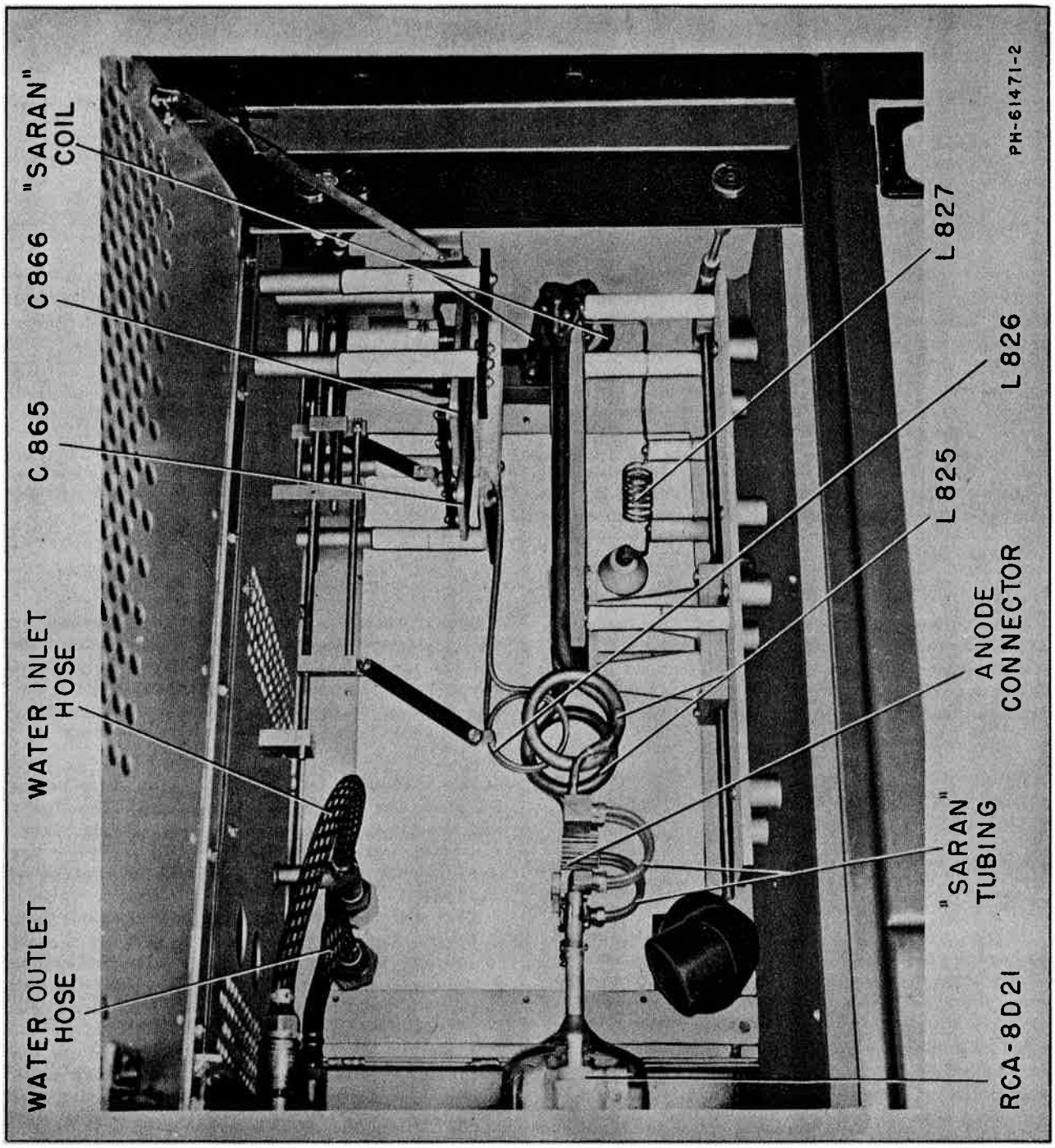



Figure 50 - Power Amplifier, Channels 2 to 13 - Visual (Top Frames 7, 8 - Front View)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

### CHANNELS 2 TO 6

If any stage is operating on an incorrect harmonic, the number of turns of the plate coil (Table 9) should be checked, or the tuning capacitor should be rotated until the correct harmonic is obtained. A stage may resonate on two harmonic frequencies; however, these harmonic frequencies will be at widely different dial settings.

After the proper harmonic has been obtained the dial setting should be noted to expedite future retuning of the stage to the proper harmonic.

*IPA (Driver) TUNING (3rd R-F Stage)*

Rotate the driver grid tuning capacitor until resonance is indicated by a maximum grid current reading on IPA Grid Current meter M708. Tripler plate tunnng, C735, and driver grid tuning, C736, capacitors should be readjusted for maximum driver grid current.

The tripler cathode current, M707, will increase as the driver grid circuit is resonated.

The anode circuit of the driver stage includes capacitor C742, and inductance L728. The inductance is a "hairpin loop" and is provided with a movable shorting bar for adjusting the inductance of the loop to the correct value. For preliminary adjustments, make an approximate setting of the shorting bar, as specified in Table 6, after first operating the Picture Plate switch S701 to the OFF position.

Operate Picture Plate switch S701 to the ON position.

Rotate Excitation control R722 slowly in a clockwise direction until the Driver Plate Current meter, M602, indicates approximately 0.15 ampere.

Rotate the plate tuning capacitor, C742, until resonance is indicated by a dip on Driver Plate Current meter M602.

### CHANNELS 7 TO 13

*FIRST IPA TUNING (3RD R-F STAGE)*

Remove fixed bypass capacitors C755, C756, C757, and C758 from the screen grid circuit of this stage. These capacitors are not used for channels 7 to 13.

Rotate the first IPA grid tuning capacitor, C736, to the position at which maximum current is indicated on the 1st IPA Grid Cur meter, M708.

Resonate the plate circuit by means of capacitor C742. A neon lamp mounted on an insulated rod and held near the anode circuit may be used to determine resonance. A more sensitive device can be made by using a small pickup loop, crystal rectifier, and a low-range milliammeter mounted on the end of an insulated rod.

*NEUTRALIZING FIRST IPA*

The use of tetrodes in the driver stage normally eliminates the necessity of neutralizing since the screen-grids isolate the input and output circuits. At high frequencies, however, the inductance of the screen-grid lead becomes appreciable, and prevents the screen-grid from being adequately bypassed to ground. Tuning capacitors C737 and C738 series-resonate the screen-grid lead inductance to effectively neutralize the stage.

To perform this neutralization, rotate the two neutralizing capacitors, C737 and C738, keeping them approximately equal in capacity until a position is found where little, if any, dip occurs in the grid current as plate circuit capacitor C742 is rotated through resonance. This represents a neutralized condition. Proper neutralization is also a condition of minimum energy in the plate circuit as indicated by one of the preceding pickup methods.

Operate the picture plate switch to the OFF position.

Reconnect the lead to C718 and lead to E702. This applies plate and screen voltage to the first IPA.

Operate the Picture Plate switch to the ON position.

Check resonance of the grid and plate circuits of the first IPA.

*(Continued)*

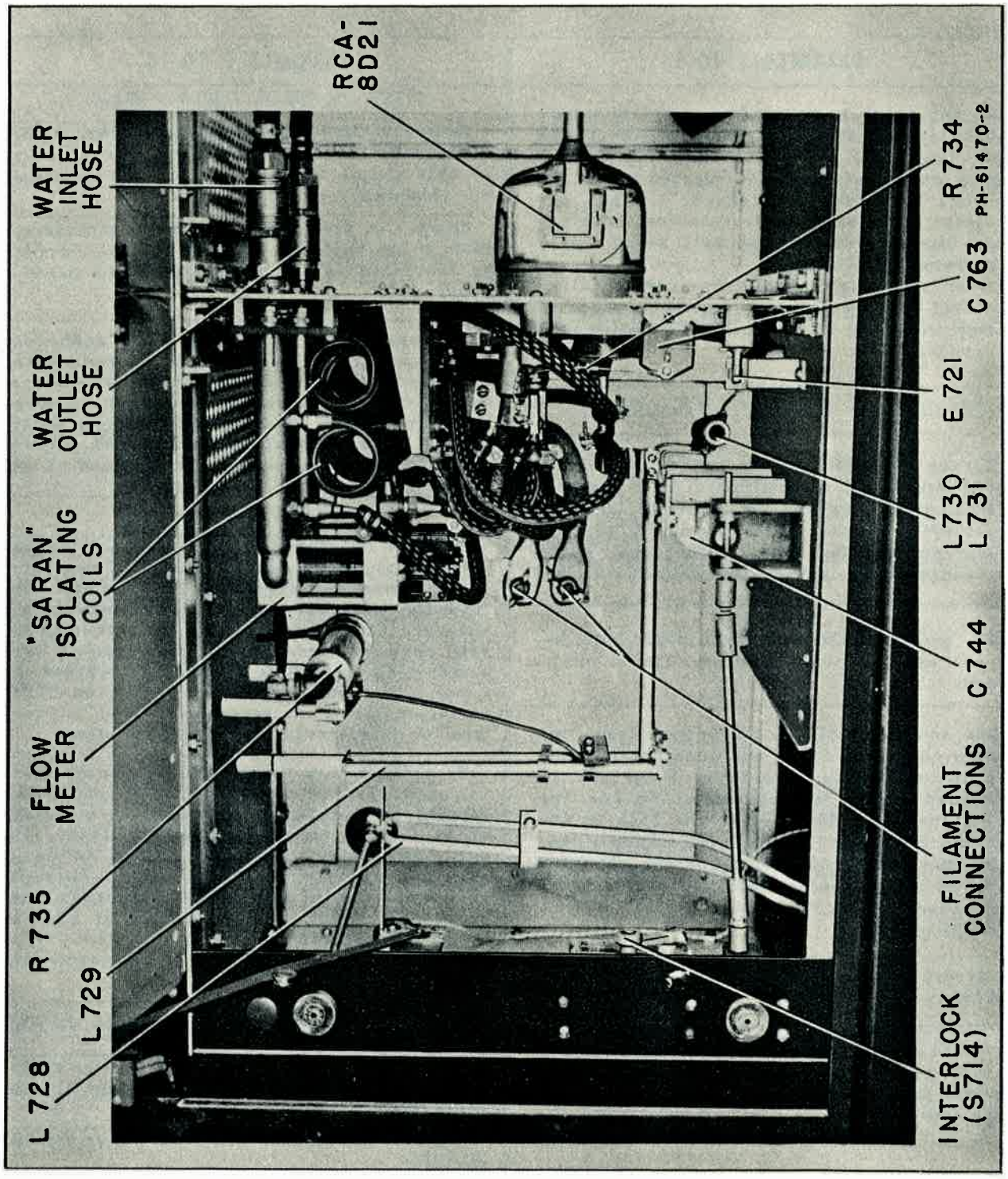



Figure 51 - Power Amplifier, Channels 2 to 13 - Visual (Top Frames 7, 8 - Rear View)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| *NEUTRALIZING IPA (Driver)*<br><br>The use of tetrodes in the driver stage normally eliminates the necessity of neutralizing since the screen-grids isolate the input and output circuits. At high frequencies, however, the inductance of the screen-grid lead becomes appreciable, and prevents the screen-grid from being adequately bypassed to ground. For channels two and three, good stability will be obtained with the screen-grids bypassed to ground by capacitors C755, C756, C757, and C758. For channels four, five and six, provision is made to series resonate the screen-grid leads of the two type 4-125A/4D21 tubes by variable capacitors C737 and C738. Capacitors C755, C756, C757, and C758 must be removed (or disconnected) when the transmitter is to be used on channels four, five, or six. Variable capacitors C737 and C738 may remain in the circuit when operating on channels two or three. | The screen voltage for the first IPA may be adjusted by moving the tap on R726. It should be set for approximately 130 volts. |
| | *SECOND TRIPLER TUNING (4th R-F Stage)* |
| | Rotate the 2nd tripler grid circuit tuning capacitor (C776) to the position at which maximum current is indicated on the 2nd tripler grid current meter M710. The 2nd tripler grid tuning and 1st IPA plate tuning controls are somewhat interlocking so should be adjusted together to obtain the true maximum 2nd tripler grid current. |
| Rotate the Excitation control to the extreme counterclockwise position. This operation will remove the screen-grid voltage from the driver stage. | Operate the Picture Plate switch to the OFF position. |
| | *NEUTRALIZING SECOND TRIPLER* |
| Operate the Picture Plate switch to the OFF position. | Two separate adjustments of neutralizing are provided on the 4-125A/4D21, 2nd tripler stage, one being a vernier on the other. The two screen terminals on each 4-125A/4D21 are connected by a large strap. The spacing between the two straps and a large grounded plate is varied to obtain approximate neutralizing. The final neutralizing adjustment is accomplished with the 2nd Tripler Neut. control, C779. The tripler is neutralized for the output frequency. |
| Remove the plate voltage from the type 4-125A/4D21 tubes by removing the wire connected to capacitor C743. This capacitor is accessible through the rear door of cabinet seven and will be found near the upper edge of the driver assembly. | Adjust the grounded plate so that the spacing between it and the screen-grid straps is approximately 3/32 inch. |
| | Operate the Picture Plate switch to the ON position. |
| Operate the Picture Plate switch to the ON position. | A pickup device tuned to the output (tripled frequency) is necessary to determine the neutralization. This may consist of a tuned circuit feeding a crystal rectifier and microammeter. |
| A sensitive r-f galvanometer is required to neutralize the plate circuits of the type 4-125A/4D21 tubes. A 0-100 milliampere r-f galvanometer with a single-turn loop approximately three inches in diameter connected across the meter should be used for this purpose. | Rotate the 2nd Tripler Neut. control C779 until minimum indication is obtained in the plate circuit pickup device. Both grid and plate circuits must be kept in resonance at their respective frequencies during neutralizing. Minimum indication on the plate circuit pickup device represents proper neutralization. |
| | When neutralized, 2nd Tripler Neut. control C779 should indicate between 0 and 15 on the dial for proper vernier action. To obtain |

*(Continued)*

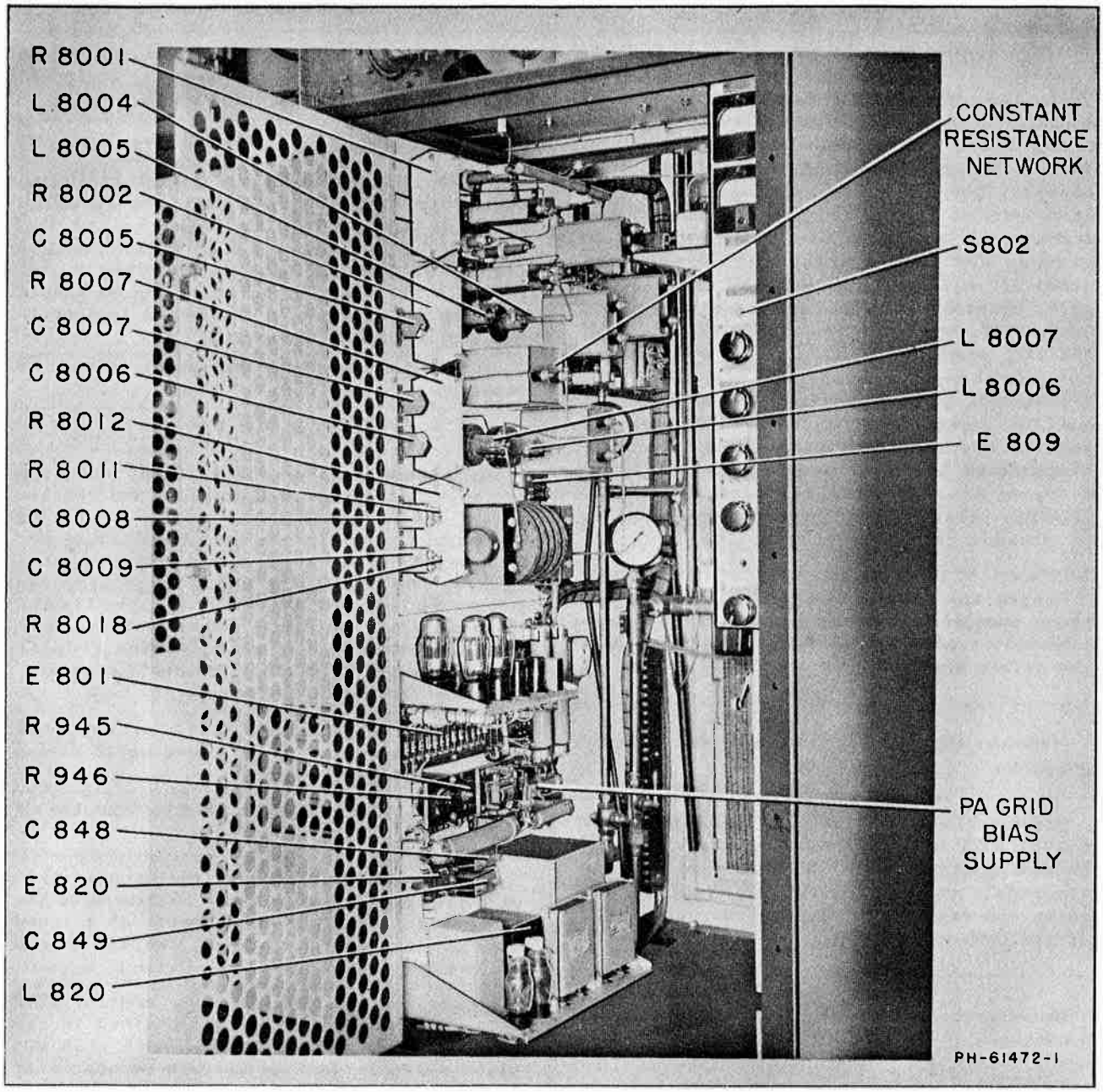



Figure 52 – Modulator, Visual (Frame 8, Front View - Left)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| CAUTION: To perform the following adjustments, it will be necessary to close the power amplifier and r-f driver door interlock switches. *Extreme caution should be observed when placing the galvanometer near the plate circuits. Note that the grid line of the power amplifier will have bias voltage on it, and therefore, should not be touched when power is applied to the transmitter.*<br>The grid circuit of the power amplifier should not be at resonance when neutralizing the driver stage. If the transmitter has been operated previously, the grid circuit of the power amplifier should be completely detuned. It is also desirable to loosen the coupling between the driver plate and the power-amplifier grid circuits. | this condition, readjustment of the spacing between the grounded plate and screen-grid straps may be necessary. |
| Adjust screen-grid capacitors C737 and C738, until a null is obtained on the galvanometer. | Operate the Picture Plate switch to the OFF position. |
| Remove the galvanometer after a definite null has been obtained. | Reconnect the bus leads to terminals on C7015 and C7016 and the wire to terminal board TB-W9. Replace resistor R773 on the resistor panel. |
| Operate the Picture Plate switch to the OFF position. | Close tune-up switch S702. |
| Reconnect the plate lead to capacitor, C743. | Operate the Picture Plate switch to the ON position. |
| Operate the Picture Plate switch to the ON position. | Check resonance of the plate circuit, indicated by a slight dip in cathode current M711. Resonance is also indicated by maximum brilliance of a small neon bulb mounted on an insulated rod and held near the plate circuit. |
| Advance the Excitation control until a reading of 0.15 ampere is obtained on the Driver Plate Cur meter (M602). | The plate line of this stage is supplied with an adjustable shorting bar. This bar should be adjusted so that plate tuning capacitor C7005 has sufficient tuning range and there is sufficient coupling to the 2nd IPA grid circuit. See table 10. |
| Check the plate circuit for resonance. If the stage is properly neutralized the grid current will be at maximum when the plate | The screen voltage of the 2nd tripler may be adjusted by moving the tap on R726. It should be set for approximately 200 volts. |
| | For channels 7 through 10, the strap connecting the 4-125A/4D21 plate cap to capacitor C7005 should be secured under the screw holding C7005 to the insulator. For channels 11 through 13 fasten this strap under the screw holding the plate line to the capacitor. |
| | *FREQUENCY CHECK* |
| | Before proceeding, the operating frequencies of the crystal oscillator and multiplier stages should be checked with an absorption type wavemeter. Output frequency of each stage is shown in Table 10.<br>CAUTION: In order to place the wavemeter close to the multiplier stages it is necessary to open the perforated metal door and to temporarily operate the door interlock switch while measuring the frequency. *Extreme caution should be observed when placing the wavemeter in the vicinity of the plate circuits.* Usually it is only necessary to place the wavemeter within five inches of these circuits. |

*(Continued)*

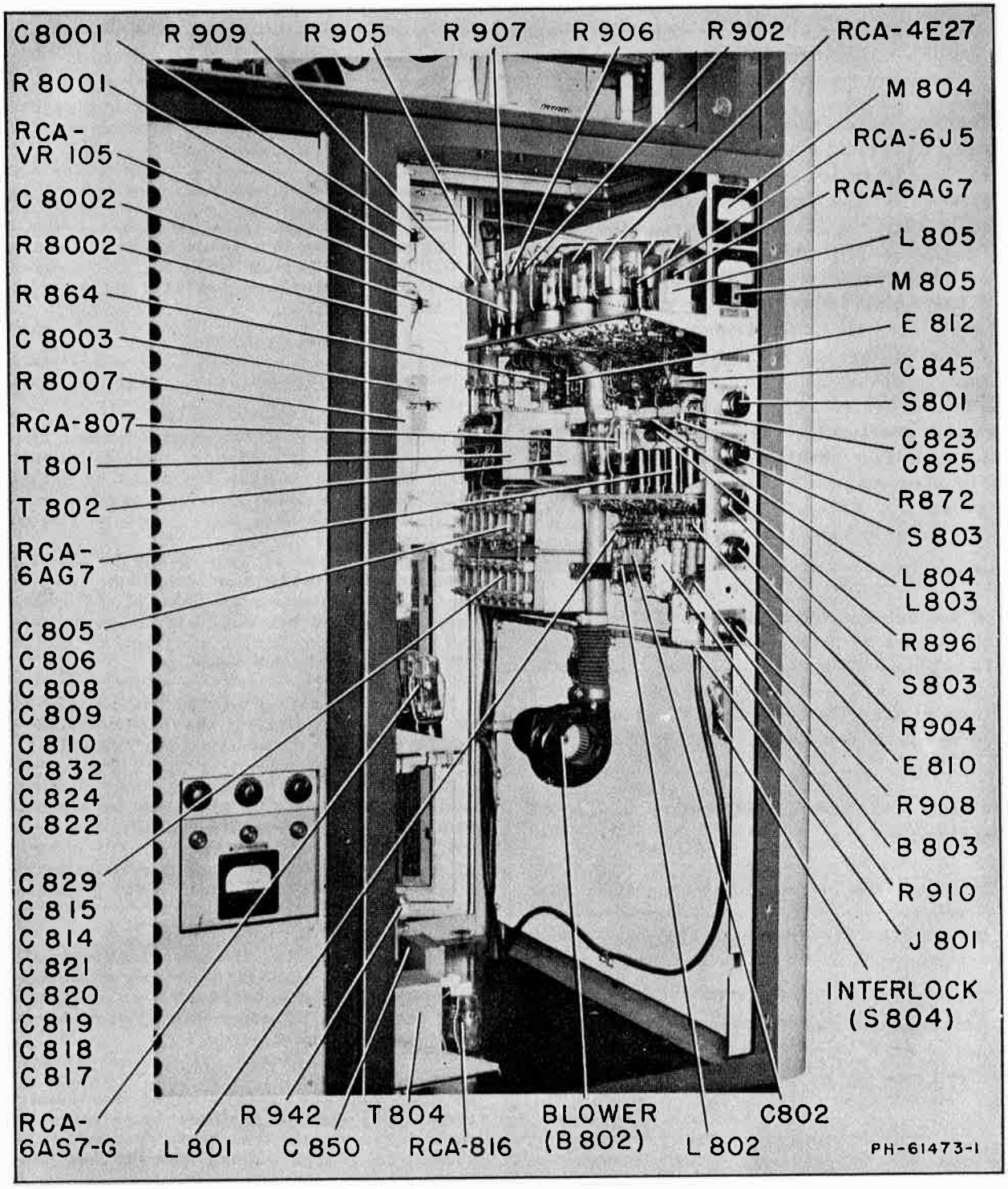



Figure 53 – Modulator, Visual (Frame 8, Front View - Right)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

### CHANNELS 2 TO 6

circuit is resonated (cathode current at a minimum). Sharp dips or rises which occur when the plate circuit is tuned through resonance indicate the stage is not correctly neutralized, or that parasitic oscillations exist.

The shorting bar on the driver plate line, L728, may now be adjusted so that capacitor C742 is meshed approximately 50 per cent when the circuit is at resonance.

### CHANNELS 7 TO 13

If any stage is operating on an incorrect harmonic, the number of turns of the plate coil (see Table 10) should be checked, or the tuning capacitor rotated until the correct harmonic is obtained. A stage may resonate on two harmonic frequencies; however, these harmonic frequencies will be at widely different dial settings.

After the proper harmonic has been obtained the dial setting should be noted to expedite future retuning of the stage to the proper harmonic.

*SECOND IPA TUNING (5th R-F Stage)*

Rotate driver grid circuit tuning capacitor C7008 until resonance is indicated by maximum grid current M720. The grid line of this stage is supplied with an adjustable shorting bar. Moving the shorting bar to shorten the line reduces the coupling between the 2nd tripler plate and the 2nd IPA grid. See Table 10 for approximate shorting bar settings.

Resonate the plate circuit by means of capacitor C7012. Maximum screen current as read on driver screen current meter M721 may be used to indicate resonance. Maximum screen current should coincide, approximately, with minimum driver plate current as read on M602.

The driver anode circuit is supplied with an adjustable shorting bar. For best vernier action, this shorting bar should be adjusted so that resonance occurs with the plate tuning capacitor approximately 30° from maximum capacity. See Table 10.

Excitation control R724 adjusts the screen voltage of the 2nd IPA. Control R724 is part of a voltage divider across the 1500-volt supply. Its maximum and minimum voltage may be increased or decreased by changing taps on R729 and R774. The tap on R729 should normally be adjusted so that 1000 ohms resistance remains in the circuit and on R774 so that all 5000 ohms are in the circuit.

With type 4X500A tubes that draw a considerably higher screen-grid current than the typical meter readings show it may be necessary to raise the resistance of R729 and decrease the resistance of R774 to obtain sufficient screen-grid voltage. In no case should the screen-grid voltage exceed 500 volts.

Table 15 under *Maintenance* gives the typical meter readings for the visual section.

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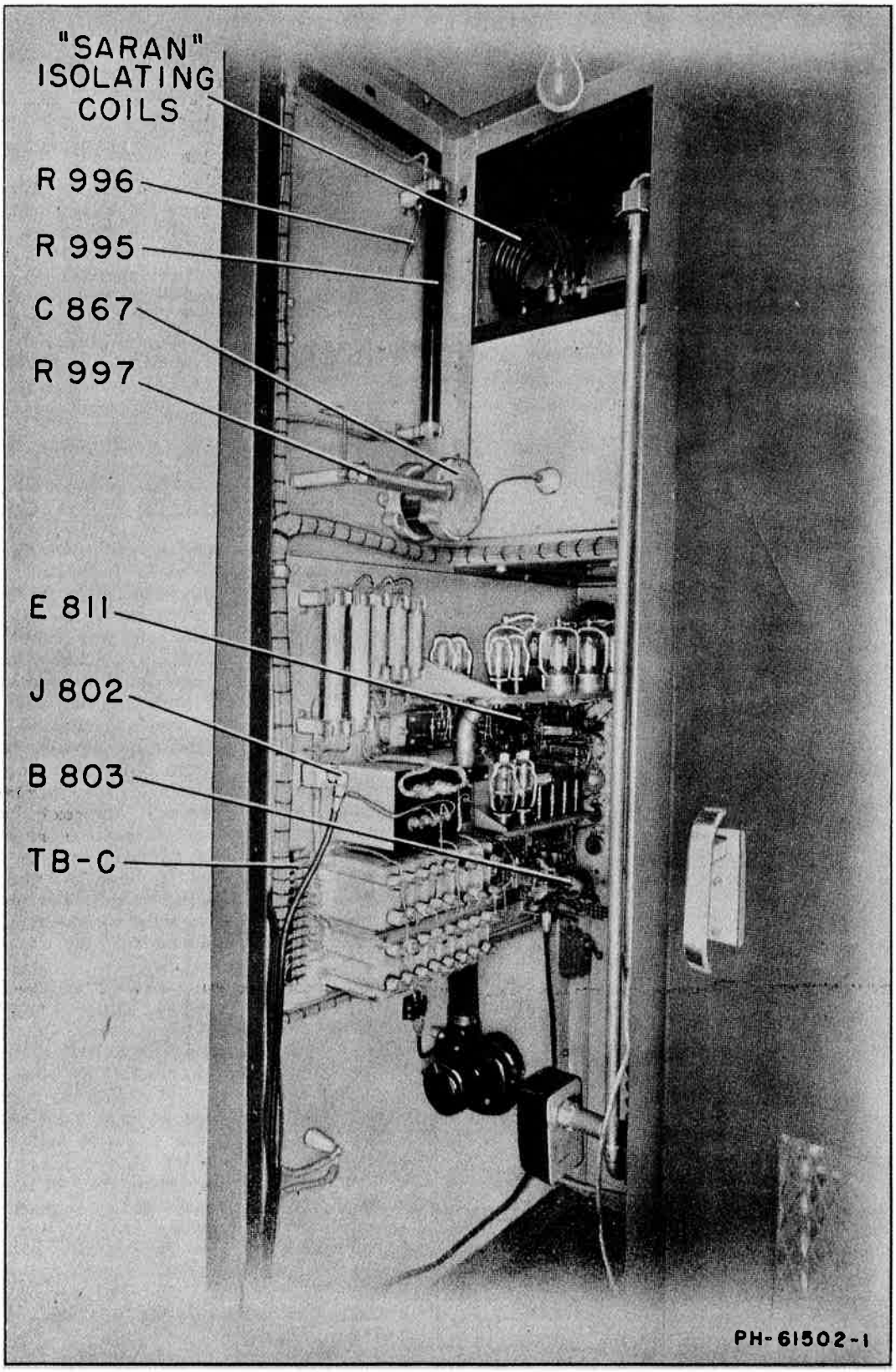


Figure 54 - Modulator, Visual (Frame 8, Rear View - Left)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| *POWER AMPLIFIER TUNING* | |
| The grid circuit of the power-amplifier stage consists of two sections of transmission line. The horizontal portion is arranged so that the spacing between the two conductors may be varied so as to change the surge impedance. The vertical portion has fixed spacing between conductors but employs a shorting bar to adjust the inductance. A disk-type tuning capacitor is connected across the grid end of the line for vernier tuning adjustments. Spacing of the horizontal line and the position of the shorting bar on the vertical line must be adjusted so that sufficient portion of the vertical part of the line is available to permit coupling the driver tank circuit to the power-amplifier grid circuit. Space must also be available for connecting the grid resistor to the vertical line at a point just below the shorting bar. | The grid circuit of the power-amplifier stage consists of a section of transmission line (L729) tuned by the variable capacitor, C744. An adjustable coupling loop at one end of the line is used to couple the second intermediate power-amplifier (driver) plate circuit to the power-amplifier grid circuit. A damping resistor is capacitively coupled to the grid line by means of two adjustable "L" shaped straps, one connected to each end of the resistor. Coupling between the power-amplifier grid line and the damping resistor is varied by adjusting the positions of the straps so as to change the spacing between the ends of the straps and the grid line. |
| Adjust the grid line shorting bar for the assigned frequency, as shown in Table 9. | Adjust the spacing between the two padding capacitor plates so that resonance occurs with the PA grid tuning capacitor disks, C744, spaced at least ½ inch apart for best vernier performance. |
| With the driver stages operating, and with relatively loose coupling between the driver and the power-amplifier grid line, rotate PA Grid tuning capacitor C744 until resonance is obtained. | With excitation on the power-amplifier grid, rotate the PA Grid tuning capacitor (C744) until resonance is obtained. |

Resonance may be determined by:

(a) A neon bulb mounted on a wire and placed near the grids of the power-amplifier tube.

(b) An indication of control-grid and screen-grid current on the Ampl Grid current (M701) and Ampl Screen Current (M703) meters, respectively. This method is practical only when there are no plate and screen-grid voltages on the power amplifier (K406 in OFF position) and the Black Level control is adjusted to the point where the power-amplifier grid bias is approximately 400 volts. The control-grid and screen-grid current meters, M701 and M703, respectively, will then indicate when excitation is applied to the power amplifier.

(c) After the transmitter has been in operation, grid circuit resonance may be determined by tuning for power-amplifier plate current maximum.

| | |
|---|---|
| Adjust the PA Grid tuning capacitor C744 to mid-tuning range. | |
| Adjust the grid-line shorting bar to obtain resonance of the grid line. | |
| The water cooled grid load resistor, R735, should be connected to the grid line at a point just below the shorting bar. During preliminary tune-up it will be desirable to decrease the loading to insure that sufficient excitation voltage is available at the tube. This is accomplished by moving the resistor further away from the 8D21 tube (closer to shorting bar). | |

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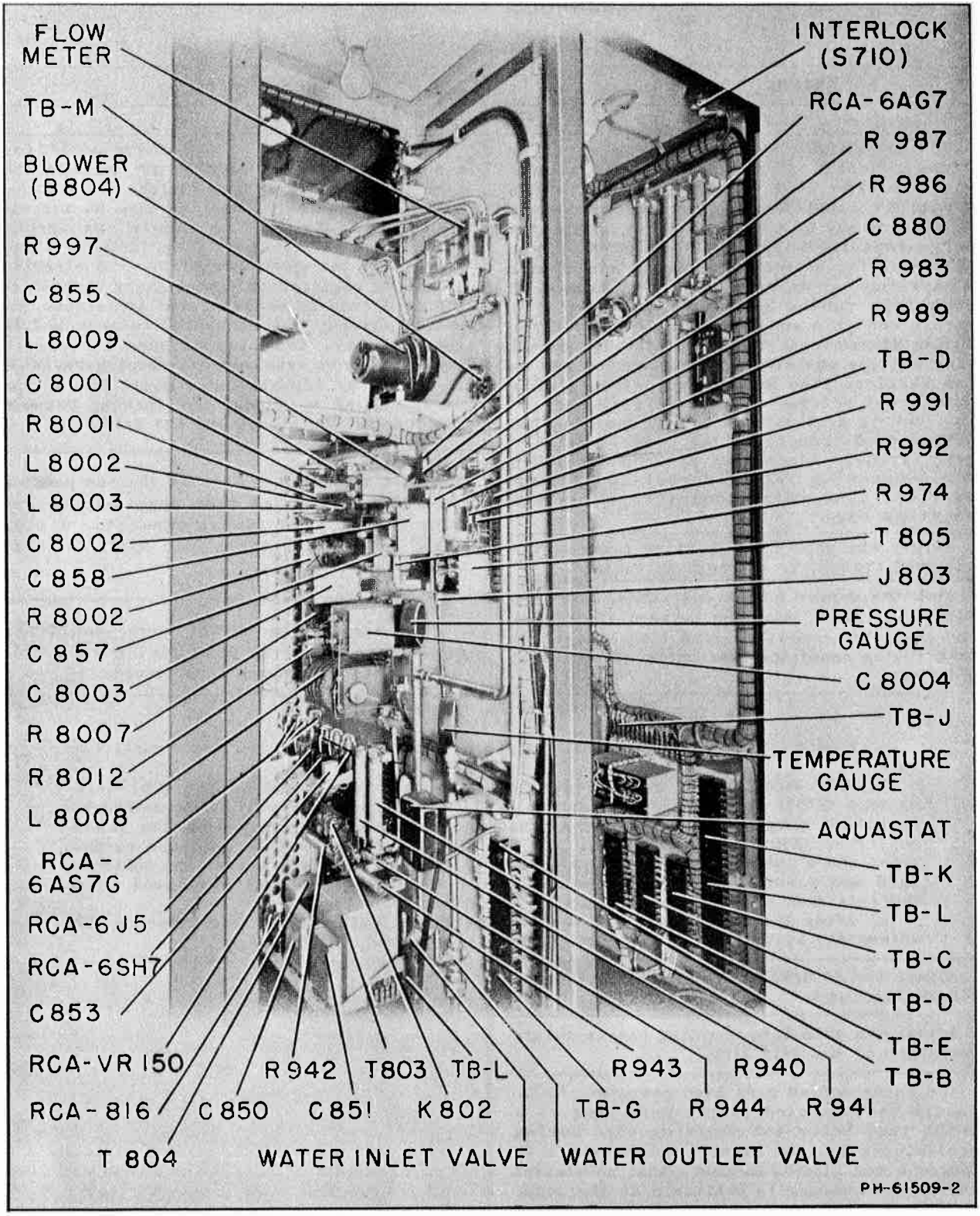



Figure 55 – Modulator, Visual (Frame 8, Rear View - Right)

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|

The final setting of the coupling to the damping resistor should be such as to absorb 100 to 150 watts of power from the driver. Since the absorbed power is not directly measurable, other means should be used to indicate proper coupling. It will be found that the driver plate current will be quite low when the damping resistor is completely uncoupled from the PA grid circuit. As coupling is increased, driver plate current will increase because of (a) the heavier plate loading and (b) the fact that the Excitation Control must be advanced to maintain correct drive on the PA, as explained in the following notes. The proper degree of coupling is obtained when these adjustments lead to a driver plate current which is equal to or under some conditions slightly greater than the values given for Typical Meter Readings in Table 15. It is important to operate with the damping resistor adjusted in this manner to avoid excessive hum and microphonic modulation of the carrier accruing from the extremely high power gain capabilities of the 8D21.

At this point reference should be made to the preceding discussion on broadbanding. The broadbanding procedure must be fully understood before attempting the adjustments which follow.

Prior to applying plate voltage to the power-amplifier stage the following adjustments must be made:

Adjust the PA Filament control to the correct 8D21 filament voltage.

Operate the Delta/Wye switch, S601, so that it is set in Wye position, switch handle pointing toward front of cabinet.

By means of R549, reduce the power-amplifier screen-grid voltage to a minimum. The normal operating voltage for the power-amplifier screen-grid is 800 volts. During tuning, however, reduced voltage should be used to protect the type 8D21 tube. The power-amplifier screen-grid voltage should be decreased by means of R549 to a value not lower than 650 volts. If it is necessary to operate at reduced voltage for extended periods, the screen-grid voltage should be adjusted as described previously under "Screen Grid Power Supply, Visual PA."

Rotate the Excitation (R722) and Picture Gain (R922) controls to the extreme counterclockwise position.

Rotate the PA Output Coupling control to obtain minimum coupling to the load.

Terminate the output of the transmitter in a dummy load.

Operate Picture Modulator circuit breaker K407 to the ON position.

Adjust Black Level control R908 until power amplifier grid bias, as indicated by Ampl Grid Voltage meter M702, is 400 volts.

Operate Picture Driver circuit breaker K405 to the ON position, then rotate the Excitation control in a clockwise direction until a reading of 0.2 ampere is indicated by the Ampl Plate Current meter, M802.

*(Continued)*

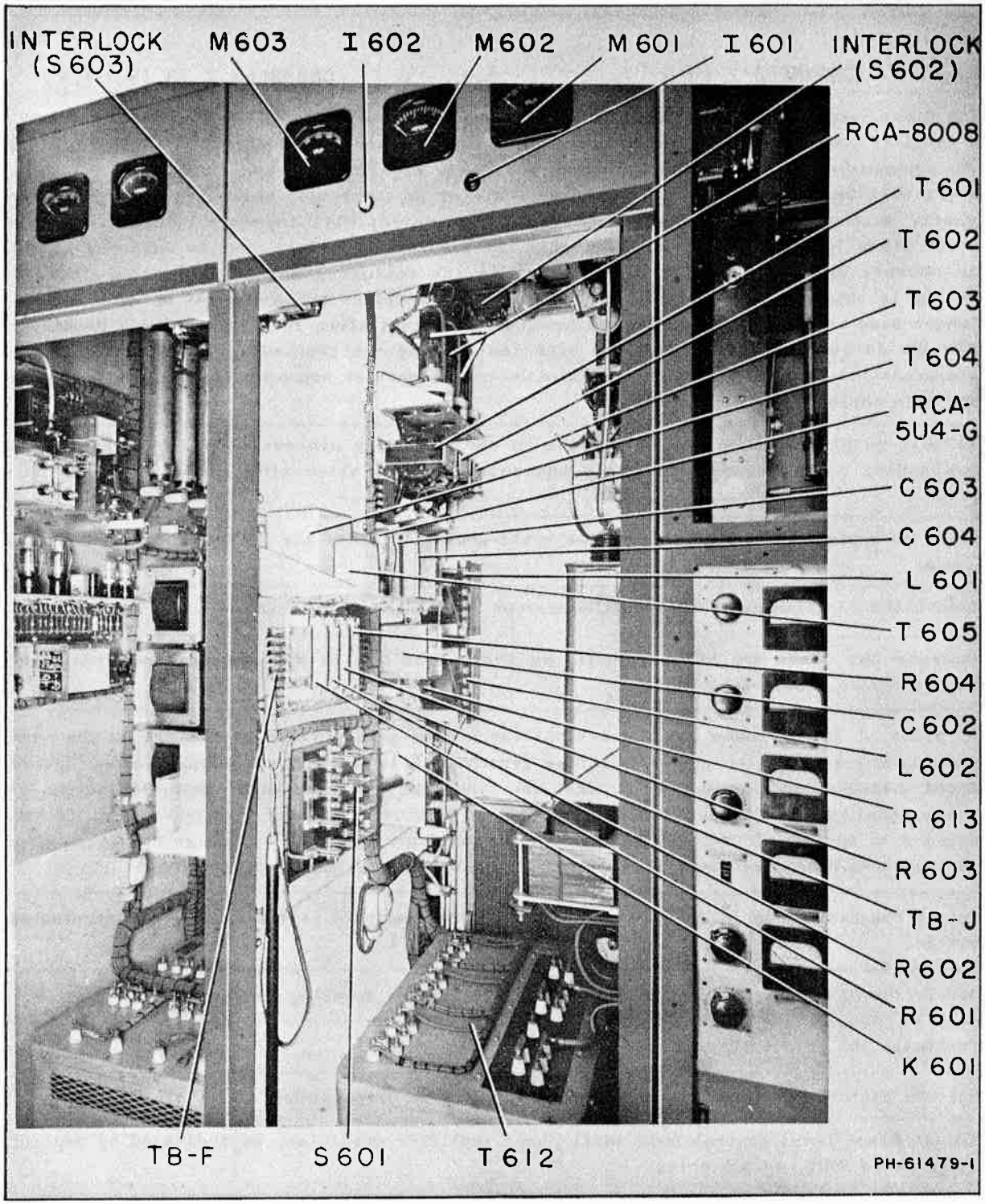



Figure 56 – Rectifier Unit, Visual (Frame 6, Front View - Left)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|

Rotate the PA Plate tuning control with one hand and the Excitation control with the other. Maximum screen-grid current may be used as an indication of resonance as it is considerably more sensitive than plate current.

*CAUTION: Do not permit the screen-grid current to exceed + 50 milliamperes during the tuning procedure. In the event a higher screen-grid current is indicated, reduce the R-F excitation (Excitation control) until a reading of + 50 milliamperes is obtained without regard to plate current.*

After resonance of the plate circuit has been obtained, adjust the Excitation control to the point at which a maximum of + 50 milliamperes of screen-grid current is indicated by the Ampl Screen Current meter, M703.

Rotate the PA Output tuning control, capacitors, C865 and C866 until the screen-grid current decreases to a minimum. If the screen-grid currents drop to + 10 milliamperes before resonance is obtained, increase the r-f excitation (Excitation control) until the current is again a maximum of + 50 milliamperes. Continue tuning the output circuit until resonance is obtained.

Recheck the PA Plate control for resonance.

Increase the coupling between output coupling coil L826 and plate coil L825. This may be accomplished by means of the PA Output Coupling control.

As the coupling is increased the screen-grid current should decrease. Rotation of the Excitation control will raise the screen-grid current so that resonance of the plate and output circuits may be rechecked.

As the loading of the power amplifier is further increased, a point will be reached where it will become increasingly difficult to obtain positive screen-grid current even though the Excitation control is at maximum clockwise rotation. This indicates a loaded condition, although probably not sufficient.

*CAUTION: Never operate the power amplifier at high plate voltage and/or full excitation unless the plate circuit is properly loaded. Be positive the dummy load is connected and that the output coupling and tuning are adjusted so that at least approximately correct broadband response is obtained before applying normal voltages and excitation.*

In order to avoid serious tube damage DO NOT operate with currents in excess of the following:

| | |
|---|---|
| Modulator Plate Current.....1.4 amperes | Modulator Plate Current.....1.4 amperes |
| Driver Cathode Current.....450 milliamperes | Driver Cathode Current.....800 milliamperes |
| Power-Amplifier Grid Current.....25 milliamperes | Power-Amplifier Grid Current.....25 milliamperes |
| Power-Amplifier Screen Current.....75 milliamperes | Power-Amplifier Screen Current.....75 milliamperes |
| Power-Amplifier Plate Current.....1.7 amperes | Power-Amplifier Plate Current.....1.7 amperes |

*(Continued)*

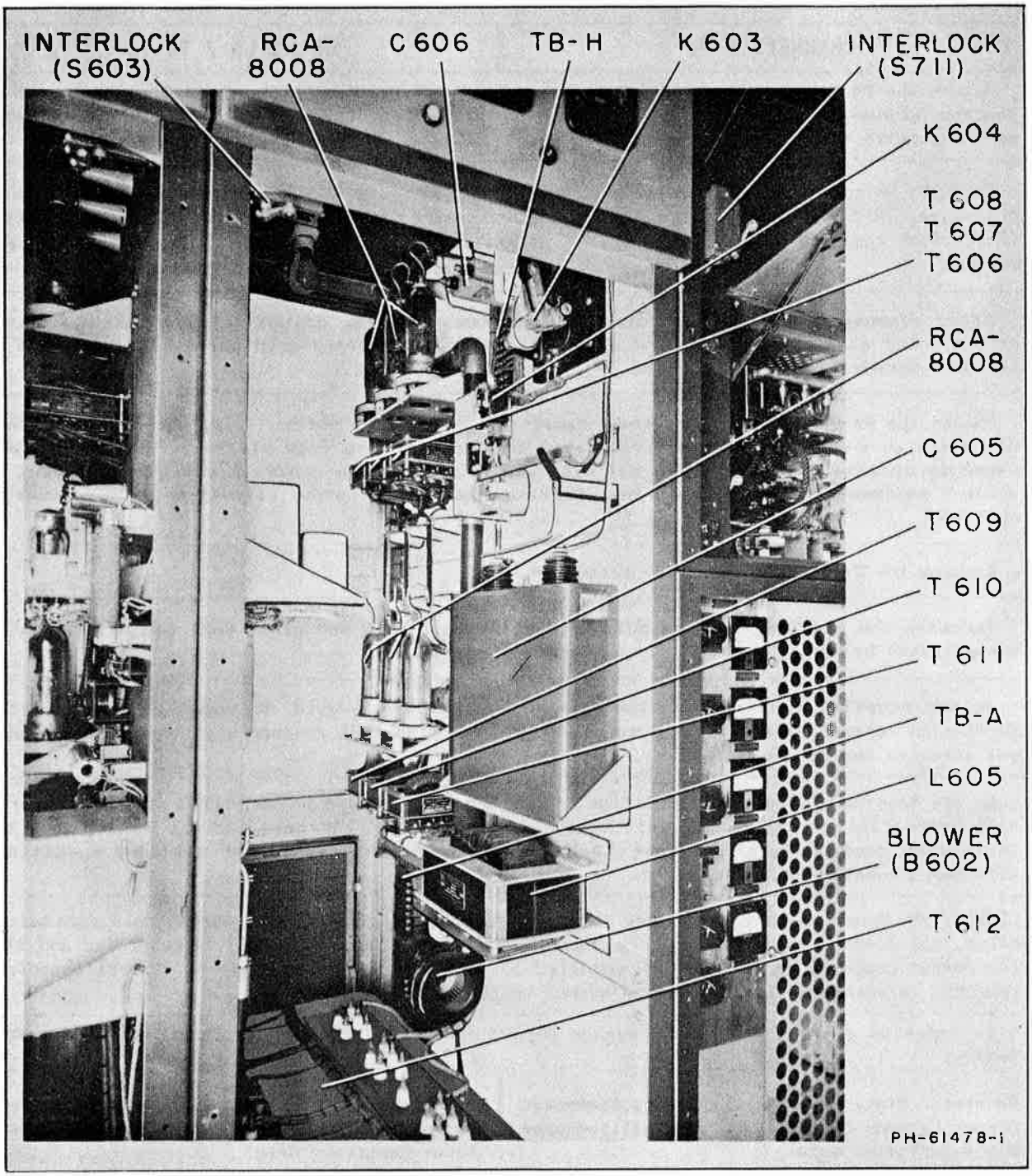



Figure 57 – Rectifier Unit, Visual (Frame 6, Front View - Right)

# TUNING - VISUAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|

Operate Delta/Wye switch S601 to the Delta position, handle of switch pointing towards rear of cabinet. This will apply full plate voltage, 5000 volts, to the power-amplifier stage.

Adjust the power-amplifier screen-grid power supply by means of R549 (as described previously under "Preliminary Adjustments" until 800 volts is obtained.

Rotate the Black Level control to the point at which a plate current of approximately 0.5 ampere is indicated by the Ampl Plate Current meter.

*If screen-grid current exceeds + 50 milliamperes at any time, increase bias (Black Level control) without regard to a PA plate current at black level modulation. Do not exceed maximum plate current on modulator at white level bias. The proper bias for black and white levels is shown on Figure 60.*

Check the PA tuning control for resonance. The plate dip, and accompanying screen-grid current rise, at resonance will be broader or less pronounced than they were before the output circuit was tuned and coupled to the plate circuit. In some instances it may be necessary to reduce the grid-bias (Black Level control) considerably to produce an indication of screen-grid current on the Ampl Screen Current meter.

Recheck the power-amplifier grid circuit and the r-f driver chain for resonance.

The proper degree of loading for the power amplifier may be roughly determined by adjusting the Black Level control to 400 volts (as indicated by the Ampl Grid Voltage meter) and tuning the PA Plate tuning control. Wide variations of this control should not cause any appreciable change in plate current.

Increase the power-amplifier bias (Black Level control) to 820 volts and adjust the Excitation control so as to produce a power-amplifier plate current of 0.10 ampere. This procedure sets up the proper r-f grid excitation to the PA and as in any grid modulation system, this value of excitation is extremely important. It should, therefore, be adjusted and maintained with accuracy in order to avoid degraded performance in regard to such items as power output, depth of modulation, white saturation, and linearity.

The excitation control should not be adjusted to greater than 75 per cent of its rotation to obtain the desired excitation. The setting of the excitation control is a function of the output of the low level r-f stages and this output, in turn, is controlled by the respective screen voltages, adjustable by taps on R726.

*(Continued)*

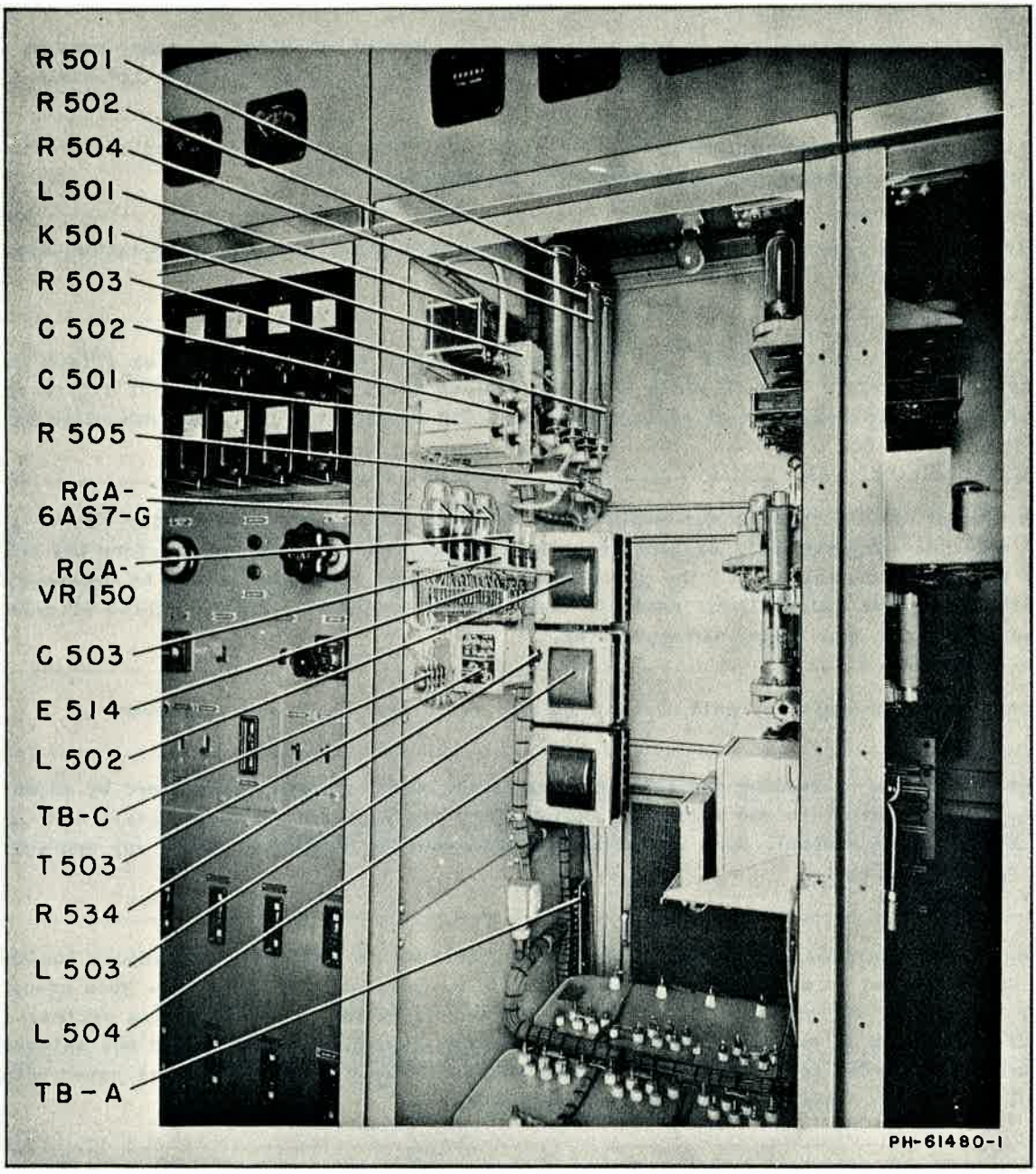



Figure 58 - Modulator Rectifier, Visual (Frame 5, Front View - Left)

# TUNING - VISUAL R-F *(Continued)*

## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| Recheck the r-f driver chain for resonance, and for maximum current at the power-amplifier grid for a given bias. | |
| At this point the r-f portion of the visual section will be sufficiently broadband to permit tuning completion. To check the broadband characteristic of the power amplifier proceed as follows: | |
| Remove the video input cable from the modulator input jack, J801, and connect the output of a video sweep generator, such as the RCA type WA-21A, to this jack. | |
| Set switch, S801, to the AC position. Place the transmitter in operation and adjust the Black Level control for mid-characteristic operation, grid bias of power amplifier approximately 510 volts, as shown on Figure 60. | |
| Set the Test switch on the WM-12/WM-13 power supply to the Test position. This places the "sweep diode" portion of the WM-13 unit in proper operating status. The output cable will now carry a signal which is the envelope of the demodulated sweep output. Note that no high-frequency sweep components are present. This output can normally be obtained on the Monitoring Equipment visual jack panel. Connect an oscilloscope with good low-frequency response to this output to obtain the sweep presentation. This presentation may also be obtained on the Console CRO if the WM-13 unit is patched through the Monitoring Equipment jack panel by pushing the CRO Transm Out button on the Console. This presentation will be less satisfactory because the 30-cycle sweep limits the available horizontal spread on the oscilloscope face. | |
| Operate Reflectometer switch S802 to the Incident position. | |
| Slowly advance the Picture Gain control R922 to the point at which an increase of a few divisions is indicated by the Reflectometer meter. Care should be taken not to over-modulate the transmitter. It is advisable to utilize as much of the vertical gain of the oscilloscope and as low a percentage of modulation as possible, consistent with low hum level.<br>Adjust the horizontal sweep and phasing controls (on the CRO) until the response characteristic appears on the oscilloscope. This presentation may appear inverted, depending upon the number of stages in the oscilloscope and the phasing of the horizontal sweep frequency. After experience with measurements of this type, it will not be difficult to correct or interpret the CRO patterns. | |
| Minor adjustments of the PA Plate and PA Output tuning controls will enable the operator to substantially duplicate the response curve of Figure 59. | |

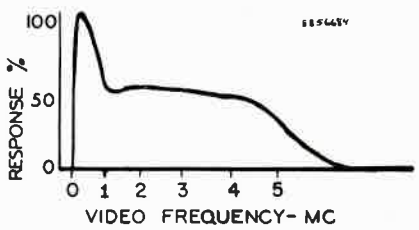



Figure 59 - Demodulated Response of Visual PA Output into Dummy Load (8856684-sub 0)

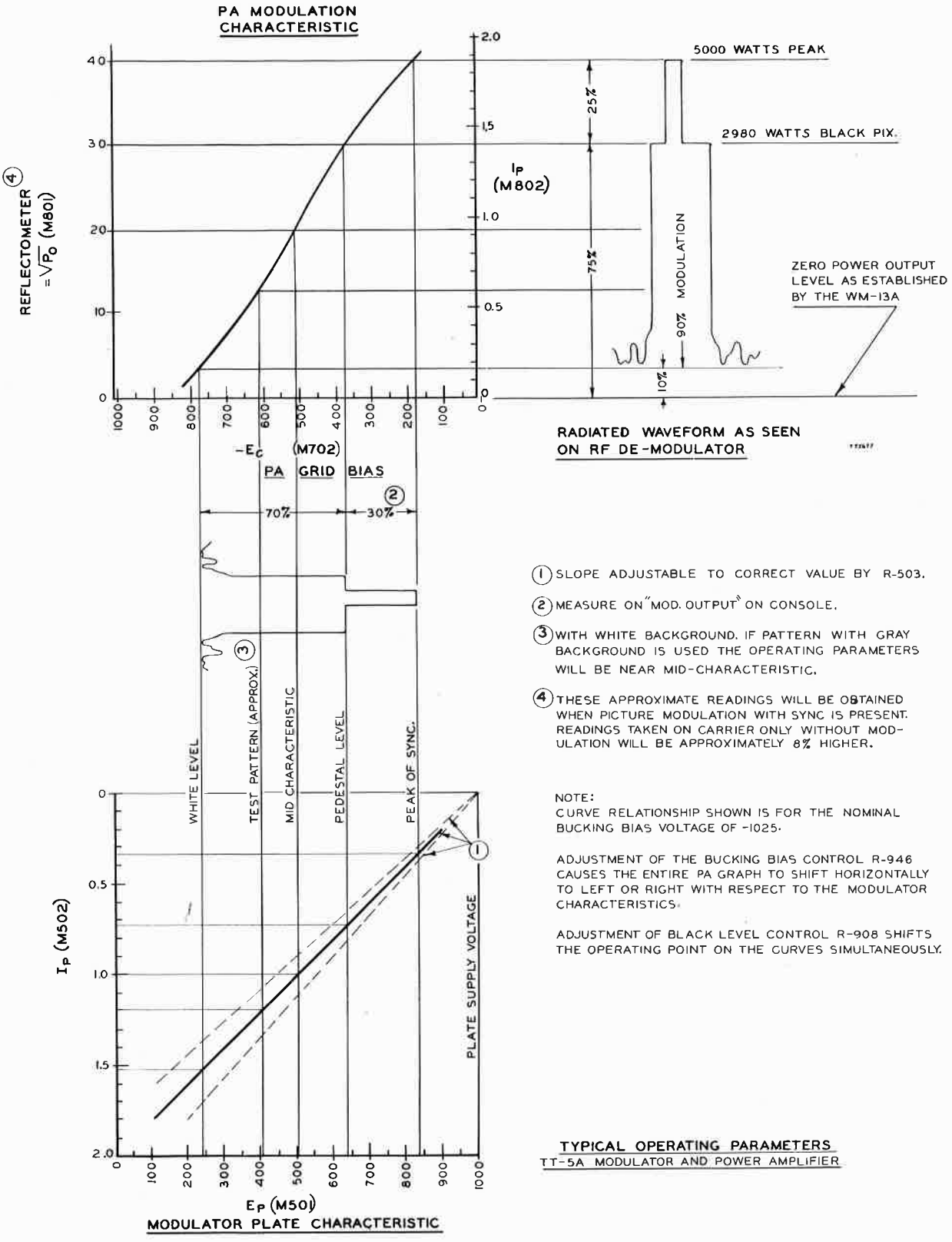



Figure 60 - Typical Operating Parameters, Visual (735677-sub 0)

*Reflectometer Adjustments, Visual* - Each reflectometer has been tuned at the factory for the assigned operating frequency. The locating device which positions the detent should not be touched as the proper rotational setting requires considerable equipment and elaborate tests to properly locate the detent. However, it is desirable to check the tuned circuit of each reflectometer, and to adjust the sensitivity controls. In the following procedure, adjustments to the visual transmitter reflectometers will be described. Similar adjustments must be made to the reflectometers in the aural portion of the transmitter, and these instructions will also serve for the aural adjustments. Symbol numbers in parenthesis pertain to the aural portion of the transmitter.

Either the reflection co-efficient or the standing wave ratio may be simply computed from the reflectometer readings. For example, if the "Incident" reading is 40 and the "Reflected" is 2, the reflection co-efficient is 2 over 40, or 0.05. The standing wave ratio is

$$SWR = \frac{40 - 2}{40 + 2} = 0.9$$

To check the reflectometers, operate the Picture Plate (Sound Plate) switch to the OFF position.

The reflectometer heads are arranged to be rotated, and two detents are provided 180 degrees apart. Make certain the reflectometer head in the forward part of the cabinet is firmly located by the detent.

Rotate the reflectometer head facing the rear of the cabinet 180 degrees from the original position. Both units will now be set to read the forward, or incident wave.

Remove the RCA type 502A tubes from their sockets, or bias them to cut-off by rotating the control R988 (R188), to the extreme clockwise position.

Feed a composite picture signal into the transmitter and place the transmitter in operation as previously described.

Operate the Picture Plate (Sound Plate) switch to the ON and OFF positions several times to make certain the output remains constant as indicated on the Reflectometer meter.

Rotate the tuning adjustment screw in each reflectometer. These tuning adjustments vary the inductance of L740 and L742 (L240, L242). The tuning adjustment screw projects alongside the type 6AL5 tube and should be set for maximum indication on the Reflectometer meter. Since the reflectometers are located behind interlocked doors, it will not be possible to make a continuous adjustment. The screw should be rotated one-half turn at a time; operating the Picture Plate (Sound Plate) switch to the OFF and ON positions between adjustments. A graph should be plotted of reflectometer meter readings against screw rotation, so that the screw can be returned to the position which gave the maximum Reflectometer meter indication.

The two reflectometer diode heads must be adjusted for equal sensitivity on the incident wave while the transmitter is in operation. To make this adjustment, operate the Reflectometer switch, S802 (S110), to the Reflected position.

Adjust the reflectometer sensitivity controls R986 and R987 (R186, R187) until the two positions of the switch, S802 (S110) (Reflected and Incident) give the same indication on the Reflectometer meter. The sensitivity controls are in the rear of cabinet eight for the picture section and cabinet one for the sound section.

It is also necessary to adjust the sensitivity of the reflectometer overload relay control circuit.

Replace the type 502A tubes previously removed and bias the circuit to cut-off by rotating control R988 (R188) to the extreme clockwise position. Control R988 (R188) is adjacent to R987 (R187) as shown on Figure 55 and (68).

Increase the PA bias control (Black Level control) until the Reflectometer meter indicates approximately 20 scale divisions (10 divisions on aural section by reduction of Excitation control setting).

Alternately operate the Picture Plate (Sound Plate) switch to the ON and OFF positions. Each time the switch is placed in the OFF position reduce the setting of relay sensitivity control R988 (R188) slightly until the relay operates when the switch is operated to ON.

Place the Picture Plate (Sound Plate) switch in the OFF position.

Rotate the rear reflectometer head 180 degrees -- its original position.

When rotating the reflectometer head to the original position make certain that it is firmly located by the detent. A few degrees displacement from the proper position will result in appreciable error in Reflectometer meter reading.

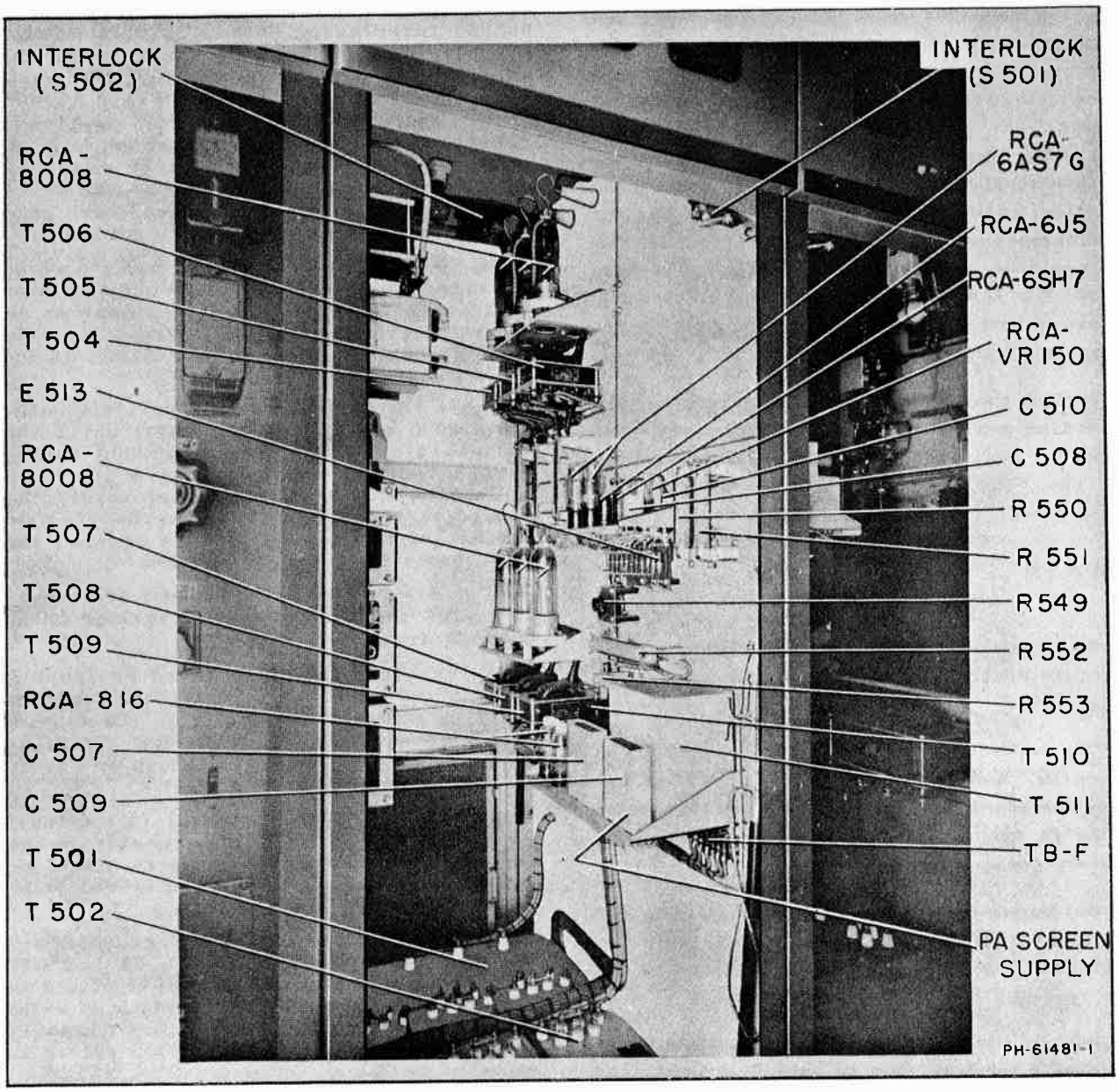



Figure 61 - Modulator Rectifier, Visual (Frame 5, Front View - Right)

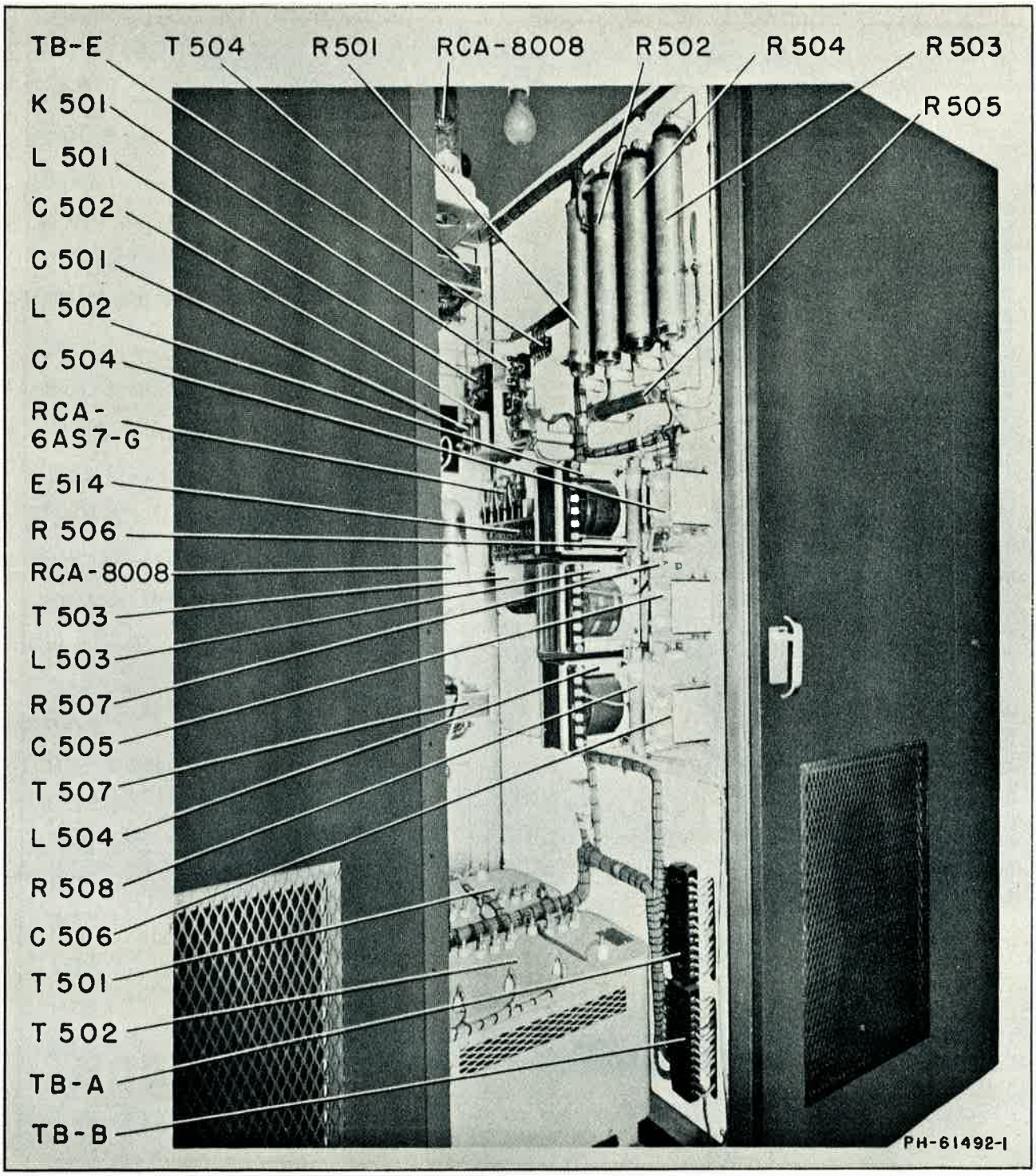



Figure 62 – Modulator Rectifier, Visual (Frame 5, Rear View - Left)

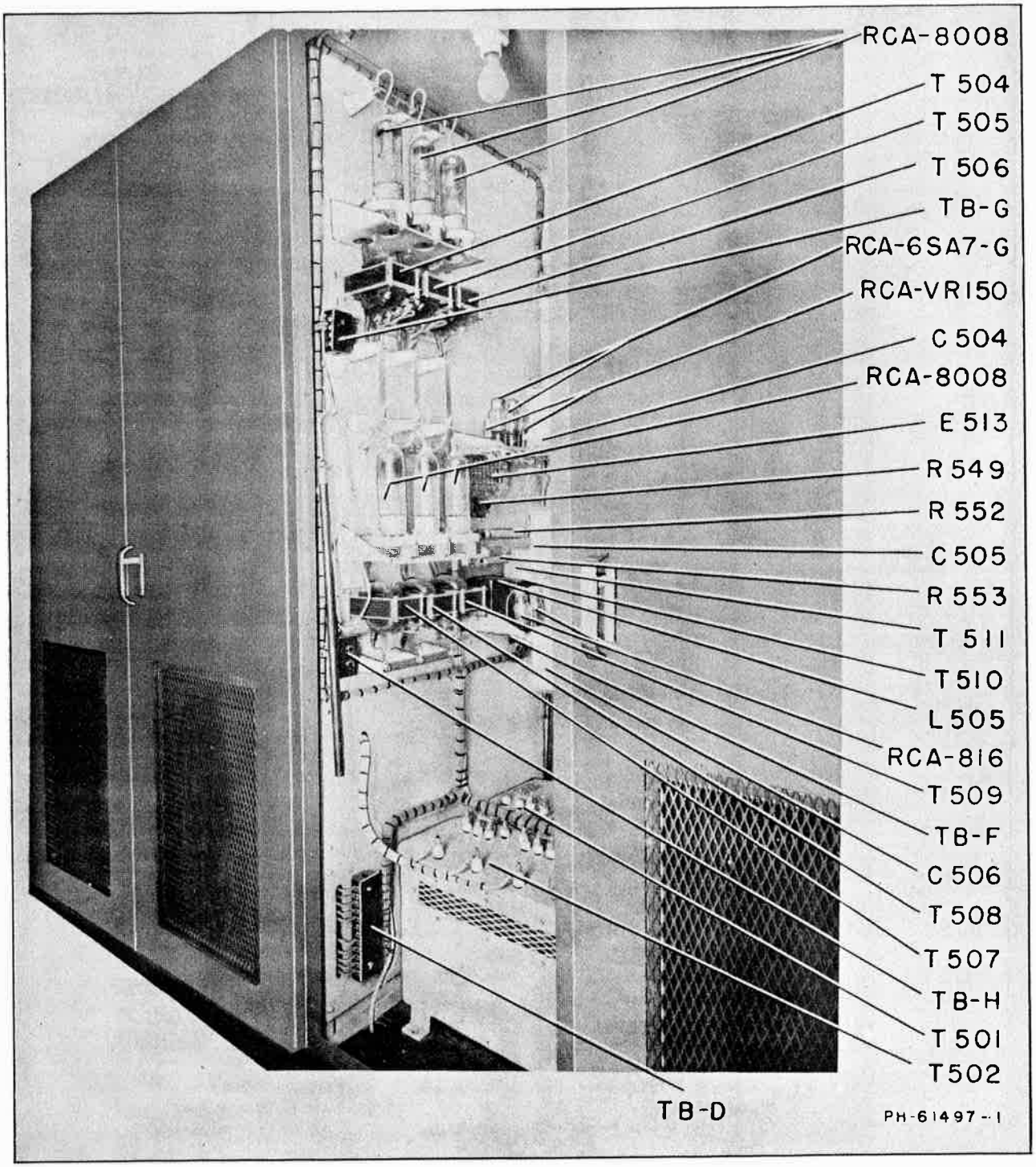



Figure 63 – Modulator Rectifier, Visual (Frame 5, Rear View - Right)

## AURAL SECTION TUNING

*General* - It is not necessary for the visual section of the transmitter to be energized while tuning the aural section. To de-energize the picture section of the transmitter set the Picture Filament switch, S405, and the Picture Plate switch, S701 to the OFF position. All other switches and circuit breakers should be left in the ON positions, as explained previously under visual transmitter tuning.

Two methods of tuning the exciter are given: the first method utilizing an accurately-calibrated c-w receiver; the second procedure when a receiver is unavailable. Since the method using a receiver is by far the simplest, it is recommended that a suitable unit covering the 4 to 6 mc. range be utilized.

*F-M Exciter Tuning, Recommended Method (Using C-W Receiver)*-Operate Sound Filaments switch S419 to the ON position. This will energize the F-M exciter unit.

*CAUTION: Opening rear door of cabinet one will not remove the voltages present in the F-M exciter. Do not close the Sound PA (K409), or the Sound Driver (K408) circuit breakers. These breakers must remain in the OFF position during tuning of the F-M exciter.*

The exciter cathode ray tube should be adjusted before tuning by setting intensity control R142 and Focus control R144 for sharp spot definition.

Oscillograms which are included in this tuning procedure are to be used to facilitate tuning but the operator should not expect to observe identical patterns on the CRO. The illustrated patterns were copied from an operating exciter and provide a quick reference as to the number of peaks that should appear on the tube. However, the patterns observed on the tube will in some cases differ a great deal from those illustrated, but the indicated division or multiplication rates should be the same.

TABLE 11

AURAL SECTION

OPERATING FREQUENCIES AND COIL DATA
CHANNELS 2 TO 6

| TUNING DATA | CHANNEL | | | | |
|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 |
| CHANNEL FREQUENCY LIMITS (MC)..... | 54-60 | 60-66 | 66-72 | 76-82 | 82-88 |
| Aural Carrier (Mc)..... | 59.75 | 65.75 | 71.75 | 81.75 | 87.75 |
| Aural Crystal (Kc)..... | 103.72 | 114.149 | 124.565 | 106.445 | 114.257 |
| FM EXCITER | | | | | |
| Oscillator Frequency (Mc) ..... | 4.979 | 5.479 | 5.979 | 5.109 | 5.484 |
| First Doubler (Mc) ..... | 9.958 | 10.958 | 11.958 | 10.219 | 10.969 |
| Second Doubler (Mc) ..... | 19.917 | 21.917 | 23.917 | 20.438 | 21.938 |
| Output Frequency (Mc) ..... | 19.917 | 21.917 | 23.917 | 20.438 | 21.938 |
| AMPLIFIER/DOUBLER (4E27) - 1ST R.F. STAGE | | | | | |
| Input Coil.....L220 | | | | | |
| Grid Coil.....L221 C221 | 3T | 3T | 3T | 3T | 3T |
| Plate Coil.....L222 C227 | 6T | 6T | 6T | 3T | 3T |
| Output Frequency (Mc) ..... | 19.917 | 21.917 | 23.917 | 40.876 | 43.876 |
| DOUBLER/TRIPLER (4E27) - 2ND R.F. STAGE | | | | | |
| Plate Coil..... L224 C235 | 2T | 2T | 2T | 2T | 2T |
| Output Frequency (Mc) ..... | 59.75 | 65.75 | 71.75 | 81.75 | 87.75 |
| DRIVER (2, 4-125A/4D21) - 3RD R.F. STAGE | | | | | |
| Grid Coil.....L225 C236 | 4T | 4T | 2T | 2T | 2T |
| Shorting bar adjustments (inches c to c)... | No Bar | No Bar | 10 | 10 | 10 |
| Output Frequency (Mc) ..... | 59.75 | 65.75 | 71.75 | 81.75 | 87.75 |
| POWER AMPLIFIER (8D21) | | | | | |
| Grid.....C244 | | | | | |
| Spacing between lines (inches c to c)..... | 3/4 | 5/8 | 5/8 | 5/8 | 5/8 |
| Shorting bar adjustment (inches from shorted end) ..... | No Bar | No Bar | 3 1/2 | 6 3/4 | 9 |
| Spacing between capacitor plates (inches) . | 5/32 | 5/32 | 1/4 | 3/16 | 1/8 |
| Output Frequency (Mc)..... | 59.75 | 65.75 | 71.75 | 81.75 | 87.75 |

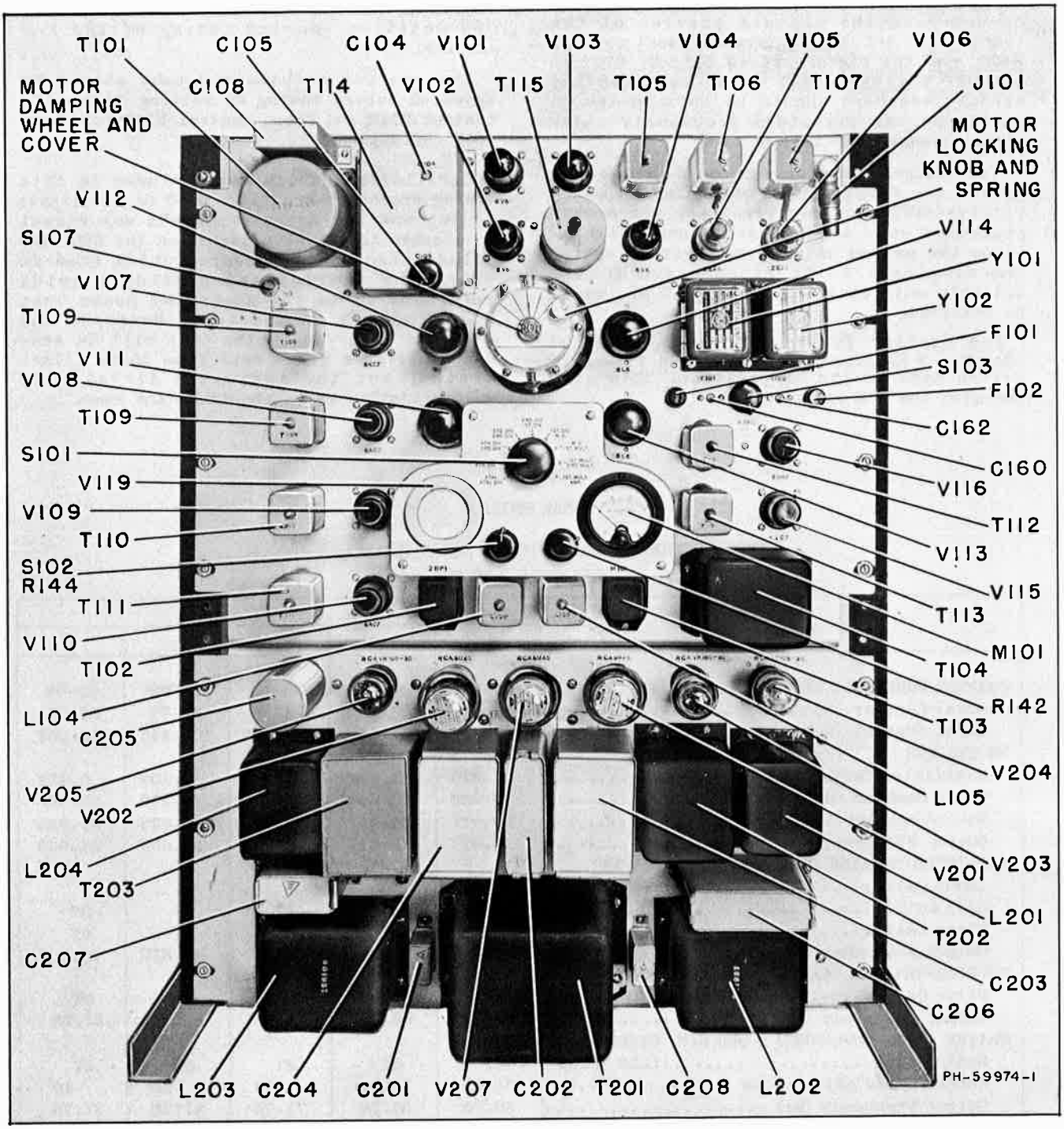



Figure 64 – Exciter and Exciter Power Supply, Aural (Frame 1, Front View)

Table 12

AURAL SECTION

OPERATING FREQUENCIES AND COIL DATA
CHANNELS 7 TO 13

| TUNING DATA | CHANNEL | | | | | | |
|---|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| CHANNEL FREQUENCY LIMITS (MC) | 174-180 | 180-186 | 186-192 | 192-198 | 198-204 | 204-210 | 210-216 |
| Aural Carrier (MC) | 179.75 | 185.75 | 191.75 | 197.75 | 203.75 | 209.75 | 215.75 |
| Aural Crystal (KC) | 104.022 | 107.494 | 110.966 | 114.438 | 117.910 | 121.383 | 124.855 |
| FM EXCITER | | | | | | | |
| Oscillator Frequency (MC) | 4.993 | 5.150 | 5.326 | 5.493 | 5.659 | 5.826 | 5.993 |
| First Doubler | 9.986 | 10.319 | 10.653 | 10.986 | 11.319 | 11.653 | 11.986 |
| Second Doubler | 19.972 | 20.639 | 21.306 | 21.972 | 22.639 | 23.306 | 23.972 |
| Output Frequency (MC) | 19.972 | 20.639 | 21.306 | 21.972 | 22.639 | 23.306 | 23.972 |
| AMPLIFIER (4E27) - 1ST R.F. STAGE | | | | | | | |
| Input Coil L220 | | | | | | | |
| Grid Coil C221 L221 | 3T | 3T | 3T | 3T | 3T | 3T | 3T |
| Plate Coil C222 L222 | 6T | 6T | 6T | 6T | 6T | 6T | 6T |
| Output Frequency (MC) | 19.972 | 20.639 | 21.306 | 21.972 | 22.639 | 23.306 | 23.972 |
| FIRST TRIPLER (4E27) - 2ND R.F. STAGE | | | | | | | |
| Plate Coil C235 L224 | 2T | 2T | 2T | 2T | 2T | 2T | 2T |
| Output Frequency (MC) | 59.916 | 61.917 | 63.918 | 65.916 | 67.917 | 69.918 | 71.916 |
| FIRST IPA (2, 4D21/4-125A) - 3RD R.F. STAGE | | | | | | | |
| Grid Coil C236 L225 | 4T | 4T | 4T | 4T | 4T | 4T | 2T |
| Plate Shorting Bar (inches from closed end to center of shorting bar) | NO BAR | NO BAR | NO BAR | NO BAR | NO BAR | NO BAR | NO BAR |
| Output Frequency (MC) | 59.916 | 61.917 | 63.918 | 65.916 | 67.917 | 69.918 | 71.916 |
| SECOND TRIPLER (2, 4D21/4-125A) - 4TH R.F. STAGE | | | | | | | |
| Plate Shorting Bar (inches from closed end to center of shorting bar) | NO BAR | 1/2 | 1 | 1 | 1-1/2 | 1-3/4 | 1-3/4 |
| Output Frequency (MC) | 179.75 | 185.75 | 191.75 | 197.75 | 203.75 | 209.75 | 215.75 |
| SECOND IPA (2-4X500A) - 5TH R.F. STAGE | | | | | | | |
| Grid Shorting Bar (inches from closed end to center of shorting bar) | 1-1/2 | 1-3/4 | 2 | 2-1/4 | 2-1/2 | 2-3/4 | 2-7/8 |
| Plate Shorting Bar (inches from closed end to center of shorting bar) | 4-1/2 | 4-1/2 | 5 | 5-1/2 | 5-1/2 | 6 | 6 |
| Output Frequency (MC) | 179.75 | 185.75 | 191.75 | 197.75 | 203.75 | 209.75 | 215.75 |
| POWER AMPLIFIER (8D21) | | | | | | | |
| Output Frequency (MC) | 179.75 | 185.75 | 191.75 | 197.75 | 203.75 | 209.75 | 215.75 |

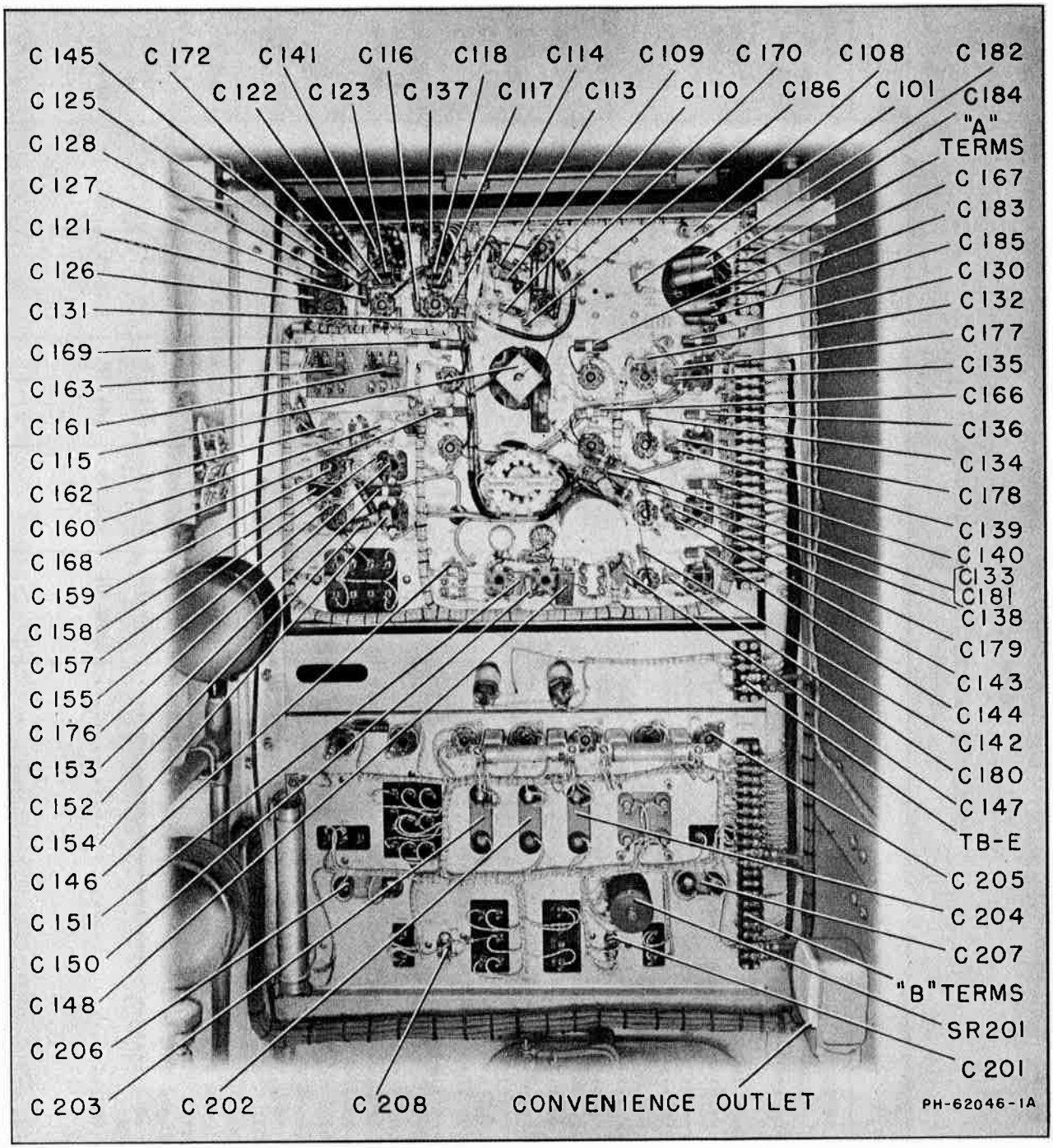



Figure 65 – Exciter and Exciter Power Supply, Aural (Frame I, Rear View)

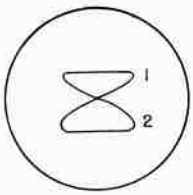
1. Release the spring on the motor locking knob by raising it with one finger. Rotate the motor shaft until the center line on the damping wheel is aligned with the marker line on the wheel cover.

2. Set Modulater Test switch S107 in the OPERATE position.

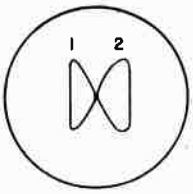
3. Place the receiver near the exciter, and accurately tune the receiver to the desired oscillator frequency. The proper frequencies for channels 2 to 6 are included on Table 11, and those for channels 7 to 13 on Table 12.

4. (At the rear of the exciter unit) adjust the iron core of the modulator oscillator tank, T115, until "zero beat" is obtained (as monitored by the receiver).

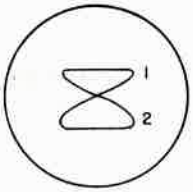
5. Rotate the Selector switch to position 7. Adjust T105 for a multiplication rate of two. Tune for maximum amplitude of the following pattern.



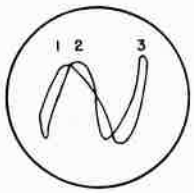

6. Rotate the Selector switch to position 8 and adjust T106 for a multiplication rate of two. Tune for maximum amplitude of the following oscillogram:



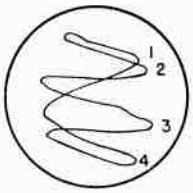

7. Rotate the Selector switch to position 9 and adjust T107 for a multiplication rate of two. Tune for maximum amplitude of the following pattern:



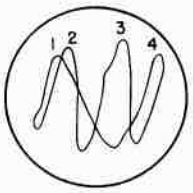

8. Rotate the Selector switch to position 6 and tune T108 until a division rate of three is observed on the CRO as shown on the following oscillogram:



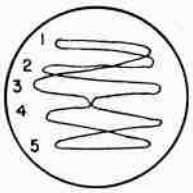

9. Rotate the Selector switch to position 5 and tune T109 until a division rate of four is observed on the CRO, as illustrated by the following pattern:



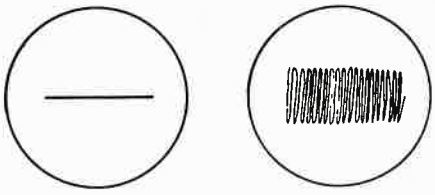

10. Rotate the Selector switch to position 4 and tune R110 until a division rate of four is observed on the CRO and the following pattern is observed:




11. Rotate the Selector switch to position 3 and tune T111 until a division rate of five and the following patterns are observed on the CRO:




12. Rotate the Selector switch to position 1 and turn T112 clockwise until the crystal oscillator ceases to oscillate. Rotate T112 counterclockwise until oscillation is resumed. The adjustment of T112 is complete at this point. Oscillograms before and after oscillation are represented by the following two patterns:



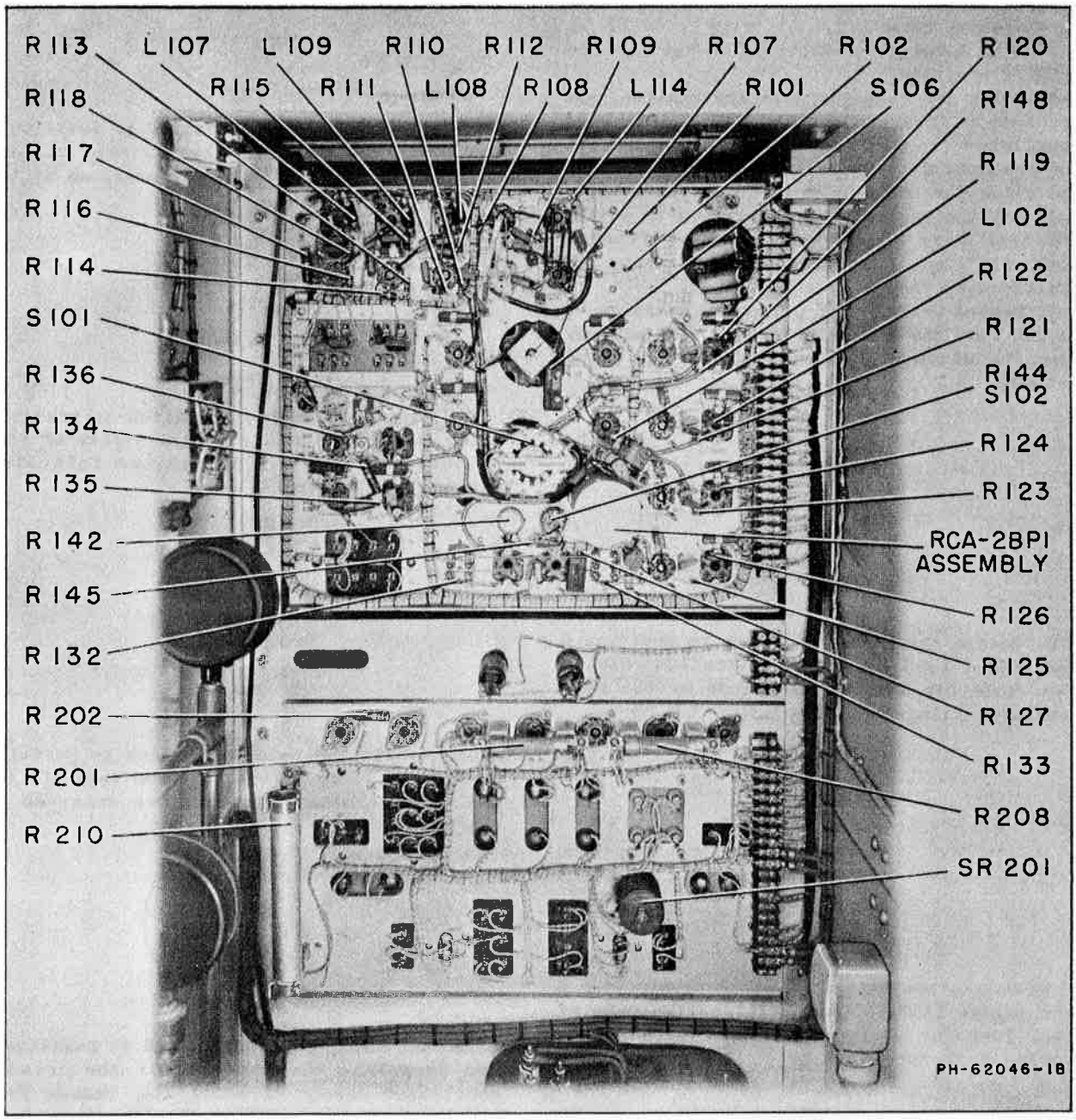
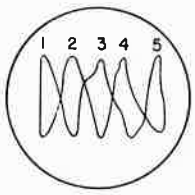


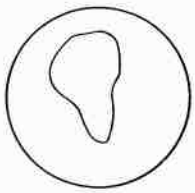

Figure 66 – Exciter and Exciter Power Supply, Aural (Frame I, Rear View)

13. With the Selector switch remaining on position 1, tune T113 until a division rate of five is noted on the CRO, as shown on the following oscillogram:




14. Check positions 9, 8, 7, 6, 5, 4, and 1 of the Selector switch. Make certain that the peaks in the CRO patterns are similar in division number and direction to those shown in the accompanying illustrations. If the patterns are found to be incorrect, do not attempt to readjust any one stage, start at the beginning and repeat each step as outlined.

15. Rotate the Selector switch to position 2. The following oval-shaped pattern should now appear on the CRO.



If this pattern is not present, adjust the front control of T115 until the pattern appears and until the center line on the motor disk is vertical. In some instances, the front control of T115 may have negligible effect. In such cases the rear control should be used as a coarse adjustment and the front control as a fine adjustment.

16. With the Selector switch remaining in position two, individually set the adjusting screw on T108, T109, T110, T111, and T113 at the midpoint of the range through which "the screw" can be rotated without losing the oval pattern. Count the number of turns made between the two positions and set the control centrally.

17. Operate the Modulator Test switch, S107. from its operate position to either of the two test positions. Tuning of the reactance tube circuit is accomplished by adjusting capacitor C105 for maximum deflection on M101. It may be necessary to retune the oscillator as outlined in step 15 after each adjustment of C105. After completing the adjustments turn the Modulator Test switch back to the Operate position.

This completes the recommended exciter-tuning method.

*F-M Exciter Tuning, Optional Method (For Use Only When C-W Receiver Is Unavailable)-*

1. Repeat steps 1 and 2 of the foregoing procedure.

2. If the oscillator frequency to be used is lower than 5.5 mc, turn the control of T105 all the way in. If the frequency to be used is higher than 5.5 mc, turn the control of T105 all the way out.

3. Rotate the Selector switch to position 7. Adjust the control on T115 (at the rear of the exciter unit) until a pattern with a multiplication rate of two appears on the CRO. Performing this step requires the assistance of another person since one person cannot make the adjustment, and see the cathode ray tube at the same time. Tune for maximum amplitude of the pattern.

4. Repeat steps "6" through "13" of the preceding tuning procedure.

5. Turn the Selector switch to position two and adjust T113 to the position at which an oval-shaped pattern is observed on the cathode ray tube. (See pattern for step 15 of previous tuning procedure.) While adjusting for this pattern, note whether the core had to be turned into the coil or out of it to reach the desired position. If the core had to be turned in, then the synchronized frequency of the modulated oscillator and its frequency dividers was too low to synchronize with the frequency standard. If the core had to be turned out of the coil, then the synchronized frequency of the modulated oscillator and its frequency dividers was too high to synchronize with the frequency standard.

6. If the modulated oscillator frequency was too high, go to the rear of the exciter and rotate the control of T115 one full turn in a clockwise direction. If the modulated oscillator frequency was too low, rotate the control one full turn in a counterclockwise direction.

7. Repeat steps five through thirteen of the previous tuning procedure to adjust for the new frequency set up on the modulated oscillator.

8. Continue this cycle of tuning steps until a frequency division rate of five is seen on the cathode ray tube when the Selector switch is turned to position one.

9. Now turn the Selector switch to position two. A circle or oval-shaped pattern should be observed. Execute step 16 of the preceding tuning procedure.

This exciter-tuning procedure has now been completed.

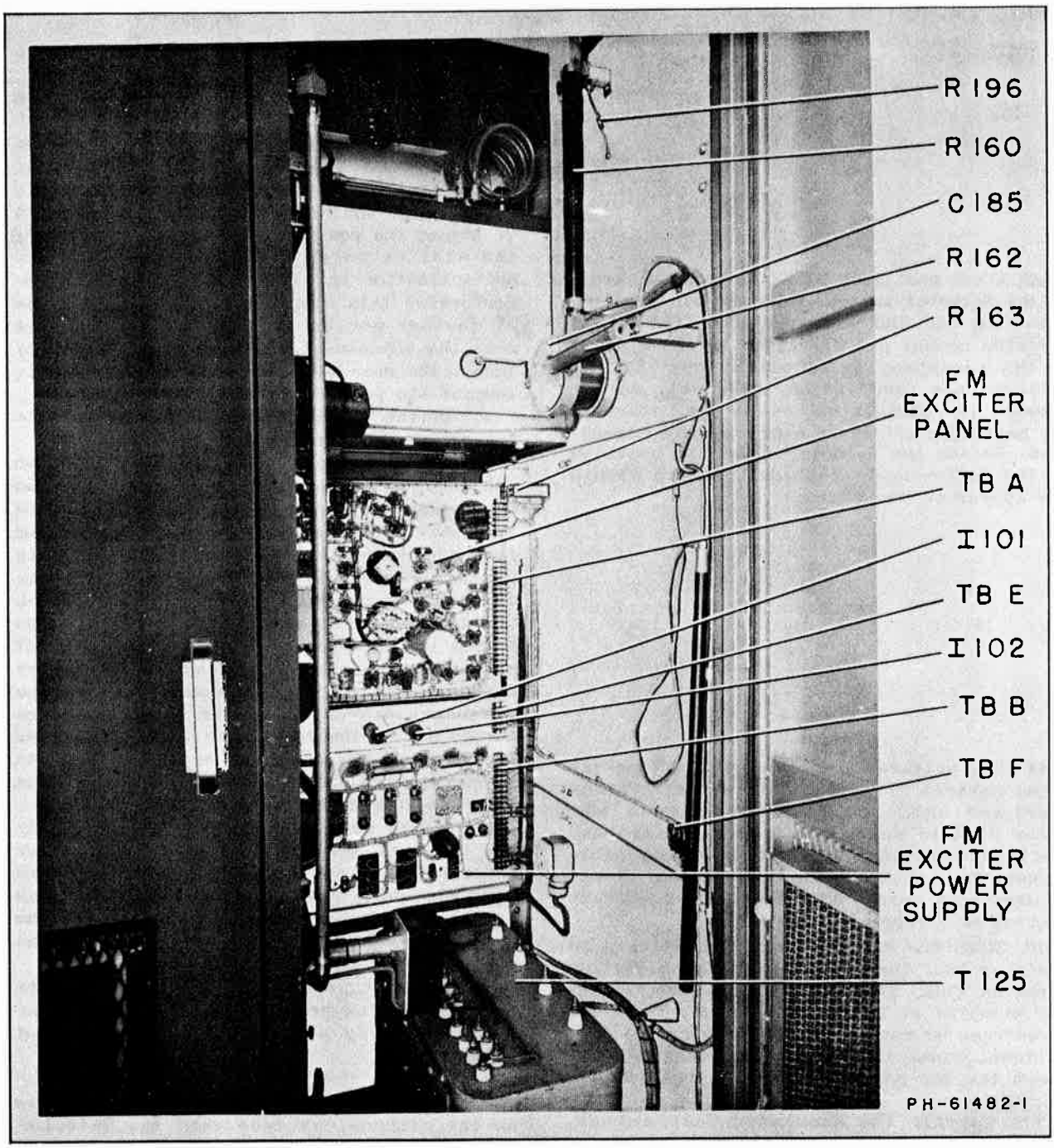



Figure 67 – Exciter and Exciter Power Supply, Aural (Frame I, Rear View - Right)

*R-F TUNING, AURAL - Channels 2 to 13* - After the exciter has been tuned the r-f stages should be adjusted as described in the following tabulation.

## TUNING - AURAL R-F
## (Stages following exciter)
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| *PRELIMINARY ADJUSTMENTS* | |
| Attach the plate caps to the aural driver and aural PA rectifier tubes (X301, X302, X303, and X306 to X311). | |
| | Disconnect the bus lead to terminal on C2015 and C2016 and disconnect wire from terminal board TB-W-9, on rear of the high-frequency driver assembly. Remove resistor R273 from the resistor panel. Remove lead from C218 and wire from terminal E202. Opening of these circuits will remove plate and screen voltages from the 1st IPA, 2nd Tripler, and 2nd IPA. |
| *AMPLIFIER/DOUBLER TUNING (1st R-F Stage)* | *AMPLIFIER TUNING (1st R-F Stage)* |
| Open Tune-up switch S202 in the rear of cabinet two. | |
| Rotate the Excitation control, R222, to the extreme counterclockwise position. | |
| Operate Sound Driver circuit breaker K408 to the ON position. | |
| Operate Sound Plate switch S201 to the ON position. | |
| Rotate grid tuning capacitor C221 and the output of the F-M Exciter unit T107, to the position at which maximum grid current is indicated by Amplifier/Doubler Grid Cur meter M204. Due to the interlocking effect between these two circuits, it will be necessary to slowly rotate one control and simultaneously rock the other through resonance to obtain maximum grid drive.<br>Failure to obtain an indication of circuit resonance may be due to the following:<br>(a) The r-f link between the F-M Exciter and the amplifier/doubler stage may not be connected.<br>(b) Grid inductance, L221, may not be in place. | |
| As soon as an indication is obtained on the Amplifier/Doubler Cath Cur meter M205, rotate plate tuning capacitor C227 to the point where the cathode current is a minimum, and the following stage grid current, as indicated by the Doubler/Tripler Grid Cur meter, M206, is a maximum. | |
| *DOUBLER/TRIPLER TUNING (2nd R-F Stage)* | *FIRST TRIPLER TUNING (2nd R-F Stage)* |
| Rotate the doubler-tripler plate tuning capacitor, C235, until a minimum of current is indicated by Doubler/Tripler Cath Cur meter M207. | |

*(Continued)*

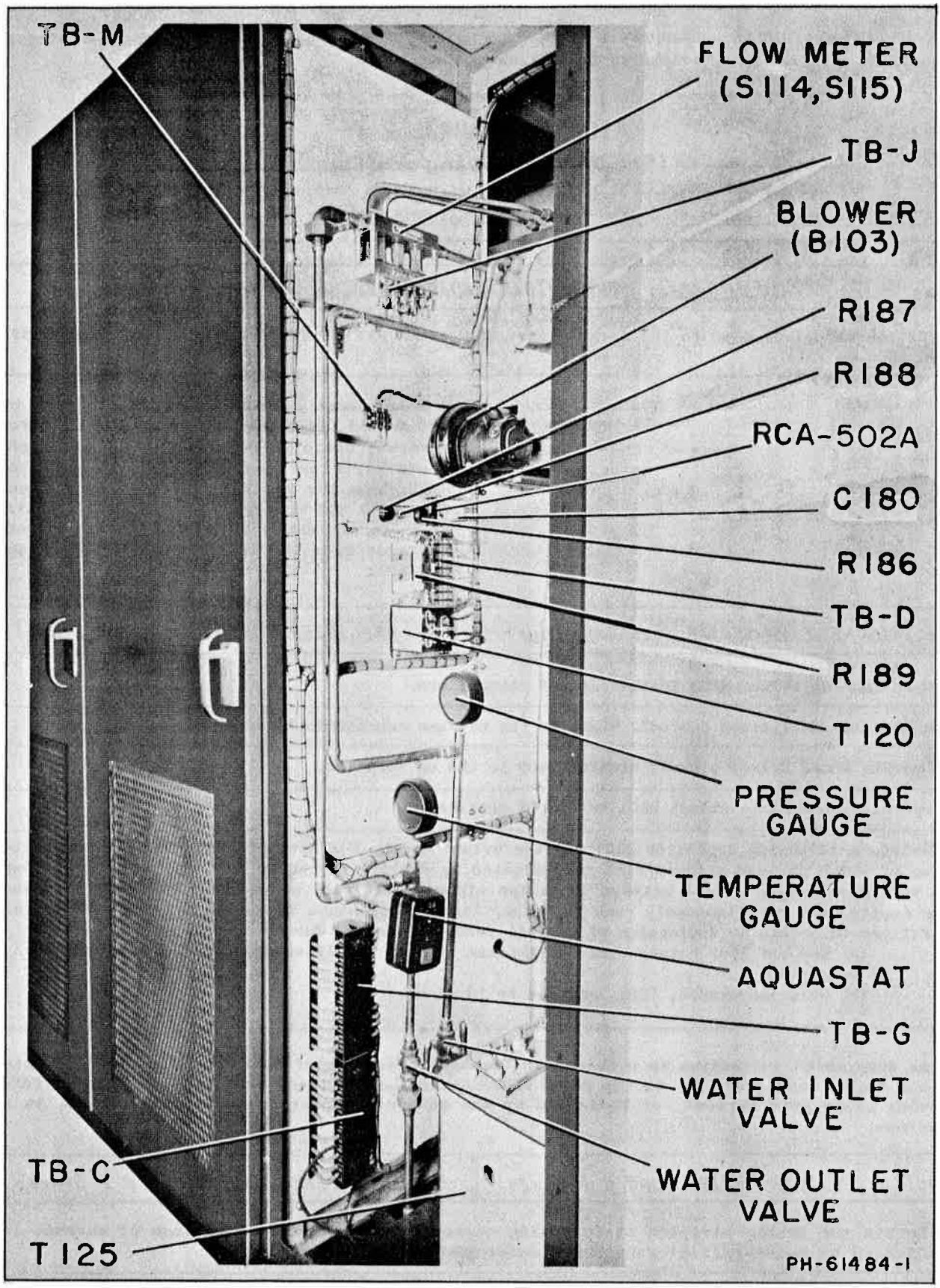



Figure 68 – Exciter and Exciter Power Supply, Aural (Frame I, Rear View - Left)

# TUNING - AURAL R-F *(Continued)*
# CHANNELS 2 TO 13

## CHANNELS 2 TO 6

### *FREQUENCY CHECK*

Before proceeding, the operating frequencies of the F-M exciter and first two stages should be determined with an absorption type wavemeter. The output frequency of each of these stages is shown in Table 11.

In order to bring the wavemeter close to the multiplier stages, it is necessary to open the perforated metal door and to temporarily operate the door interlock switch while measuring frequency. Extreme caution should be observed when placing the wavemeter in the vicinity of the plate circuits. Usually, it is necessary only to place the wavemeter within five inches of these circuits to obtain a satisfactory indication.

If any stage is operating on an incorrect harmonic, the number of turns of the plate coil (see Table 11) should be checked, or the tuning capacitor should be rotated until the correct harmonic is obtained. On some channels a stage may resonate on two harmonic frequencies, but these harmonic frequencies will be at widely different dial settings.

After the proper harmonic has been obtained the dial setting should be recorded so that the stage may be retuned to the proper harmonic in the future.

### *DRIVER TUNING (3rd R-F Stage)*

Resonate the grid circuit of the driver by rotating capacitor C236. Resonance will be indicated by maximum grid current reading on the Driver Grid Cur meter M208. Interaction between the doubler/tripler plate and driver grid circuits may require checking of the doubler/tripler tank circuit when tuning the driver grid circuit. The doubler/tripler plate tuning C235 and the driver grid tuning C236 capacitors should be readjusted for maximum driver grid current.

The anode circuit of the driver stage includes capacitor C242 and inductance L228. The inductance is a "hairpin loop" and is provided with a movable shorting bar for adjusting the inductance of the loop to the correct value. For the purpose of preliminary adjustment make the approximate setting of the shorting bar as shown in Table 11.

## CHANNELS 7 TO 13

### *FIRST IPA TUNING (3rd R-F Stage)*

Remove fixed bypass capacitors C255, C256, C257, and C258 from the screen grid-circuit of this stage. These capacitors are not required for Channels 7 to 13.

Rotate first IPA grid tuning capacitor C236 to the position at which maximum current is indicated on the 1st IPA Grid Cur meter, M208.

Resonate the plate circuit by means of capacitor C242. A neon lamp mounted on an insulated rod and held near the anode may be used to determine resonance. A more sensitive device to indicate plate circuit resonance can be made by using a small pickup loop, crystal rectifier, and a low-range milliammeter mounted on the end of an insulated rod.

### *NEUTRALIZING FIRST IPA*

Tuning capacitors C237 and C238 series resonate the screen-grid lead inductance to effectively neutralize the stage.

To achieve neutralization, rotate the two neutralizing capacitors, C237 and C238, keeping them approximately equal in capacity until a position is found where little, if any, dip occurs in the grid current as plate circuit capacitor C242 is moved through resonance. This represents a neutralized condition. Proper neutralization is also a condition of minimum energy in the plate circuit as indicated by one of the pickup methods.

Operate the Sound Plate switch to the OFF position.

Reconnect the lead to C218 and the lead to E202. This applies plate and screen voltage to the first IPA.

Operate the Sound Plate switch to the ON position.

Check resonance of the grid and plate circuits of the first IPA. The screen-grid voltage for the first IPA may be adjusted by moving the tap on R226. It should be set for approximately 70 volts.

*(Continued)*

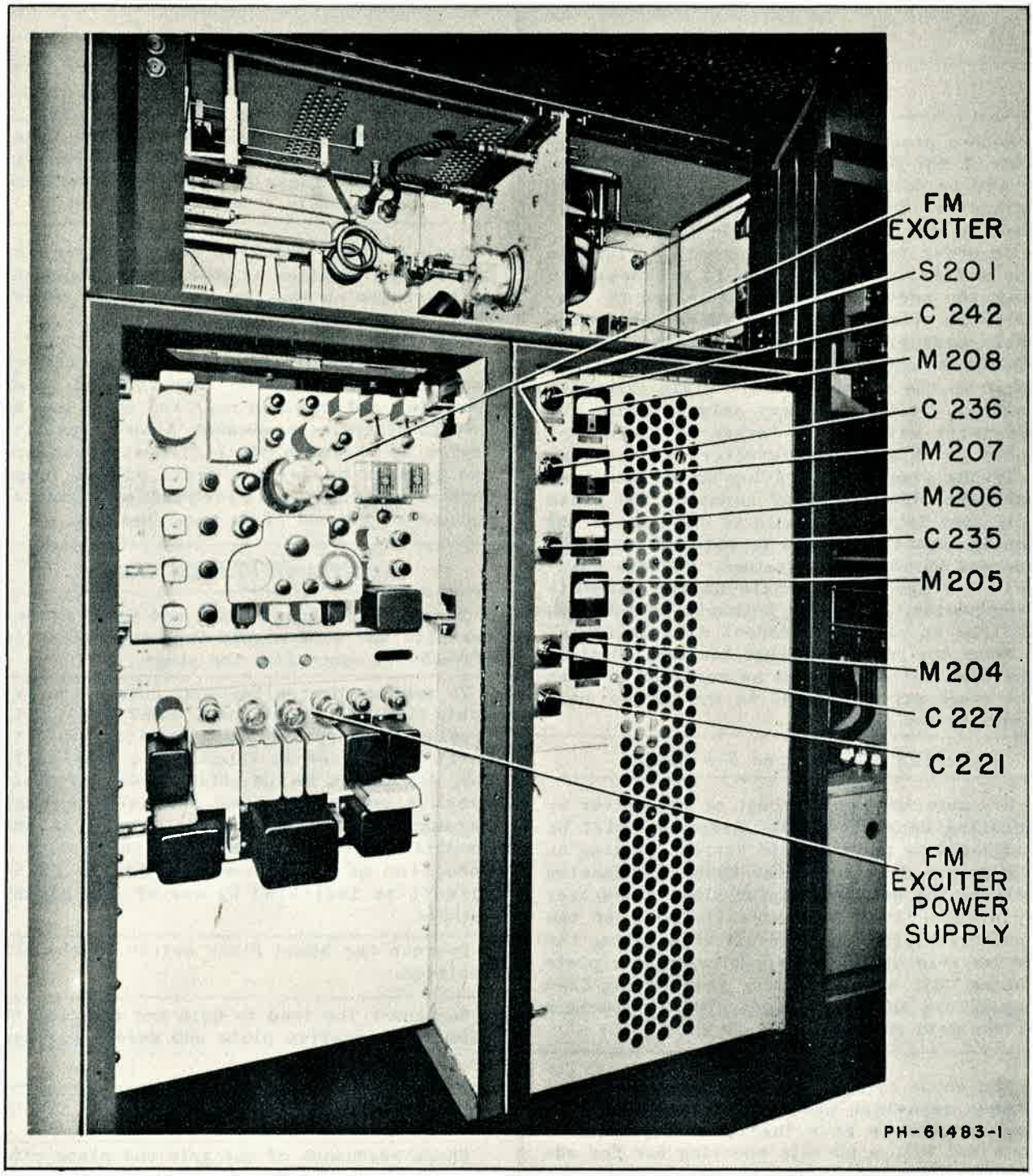



Figure 69 - R-F Driver, Channels 2 to 6 - Aural (Frames 1, 2 - Front View)

# TUNING - AURAL R-F *(Continued)*
# CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| | *SECOND TRIPLER TUNING (4th R-F Stage)* |
| Resonate the plate circuit of the driver stage by means of capacitor C242. Resonance is indicated by a minimum of current on Driver Plate Cur meter M302. | Rotate the 2nd tripler grid circuit tuning capacitor C276, to the position at which maximum current is indicated on 2nd Tripler grid current meter M210. The 2nd tripler grid tuning and the 1st IPA plate tuning controls are interrelated so it will be necessary to slowly rotate one control while rocking the other through resonance to obtain maximum grid drive. |
| *NEUTRALIZING DRIVER* | Operate the Sound Plate switch to the OFF position. |
| The use of tetrodes in the driver stage normally eliminates the necessity of neutralizing since the screen grids isolate the input and output circuits. At high frequencies, however, the inductance of the screen-grid lead becomes appreciable, and prevents the screen-grid from being adequately bypassed to ground. For channels two and three good stability will be obtained with the screen-grids bypassed to ground by capacitors C255, C256, C257, and C258. For channels four, five, and six, provision is made to series-resonate the screen-grid leads of the two type 4-125A/4D21 tubes by variable capacitors, C237 and C238. Capacitors, C255, C256, C257, and C258, must be removed (or disconnected) when the transmitter is to be used on channels five or six. Variable capacitors, C237 and C238, may remain in the circuit when operating on channels two, three, or four. | *NEUTRALIZING SECOND TRIPLER* |
| | Two separate adjustments of neutralizing are provided on the 4-125A/4D21, 2nd tripler stage, one being a vernier on the other. The two screen terminals on each 4-125A/4D21 are connected by a large strap. The spacing between the two straps and a large grounded plate is varied to obtain approximate neutralizing. The final adjustment of neutralizing is accomplished with the 2nd tripler neut control (C279). The tripler is neutralized for the output frequency. |
| | Adjust the grounded plate so that the spacing between it and the screen-grid straps is approximately 3/32 inch. |
| | Operate the Sound Plate switch to the ON position. |
| NOTE: The grid circuit of the power-amplifier should not be at resonance when making the following adjustments. If the transmitter has been operated previously the grid circuit of the power-amplifier should be completely detuned. It is also desirable to loosen the coupling between the driver plate and the power-amplifier grid circuits. | A pickup device tuned to the output (tripled frequency) is necessary to determine the neutralization. This may consist of a tuned circuit feeding a crystal rectifier and a microammeter. |
| | Rotate the 2nd Tripler Neut. control (C279) until minimum indication is obtained in the plate circuit pickup device. |
| | Both grid and plate circuits must be kept in resonance at their respective frequencies during neutralization. |
| Rotate the Excitation control to the extreme counterclockwise position. This operation will remove the screen-grid voltage from the driver stage. | When neutralized, the 2nd Tripler Neut control C279 should indicate between 0 and 15 on the dial for proper vernier action. To obtain this condition, readjustment of the spacing between the grounded plate and the screen-grid straps may be necessary. |
| Operate the Sound Plate switch to the OFF position. | Operate the Sound Plate switch to the OFF position. |

*(Continued)*

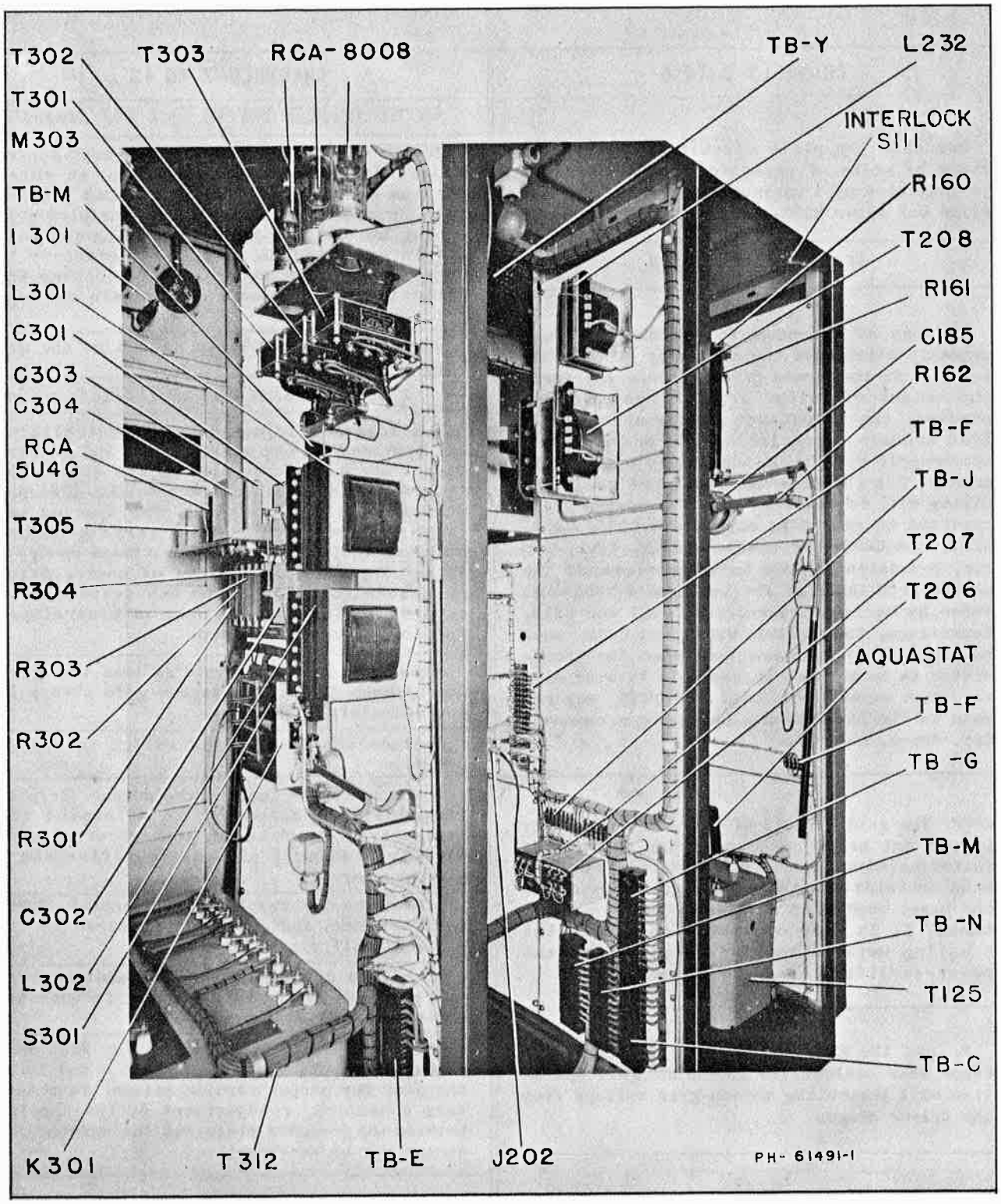



Figure 70 - R-F Driver, Channels 2 to 6 and Rectifier Unit - Aural (Frames 1, 2, 3 - Rear View)

# TUNING - AURAL R-F *(Continued)*
# CHANNELS 2 TO 13

## CHANNELS 2 TO 6

Remove the plate voltage from the RCA type 4-125A/4D21 tubes by removing the wire connected to capacitor C243. This capacitor is accessible through the rear door of frame two and will be found near the upper edge of the driver assembly.

Operate the Sound Plate switch to the ON position.

A sensitive r-f galvanometer is required to neutralize the plate circuits of the type 4-125A/4D21 tubes. A 0-100 milliampere r-f galvanometer with a single turn loop approximately three inches in diameter connected across the meter should be used for this purpose.

To perform the following adjustments, it will be necessary to close the power-amplifier and r-f driver door interlock switches. *EXTREME CAUTION SHOULD BE OBSERVED WHEN PLACING THE GALVANOMETER NEAR THE PLATE CIRCUITS. NOTE THAT THE GRID LINE OF THE POWER AMPLIFIER WILL HAVE BIAS VOLTAGE ON IT AND THEREFORE SHOULD NOT BE TOUCHED WHEN POWER IS APPLIED TO THE TRANSMITTER.*

Adjust the screen-grid capacitors, C237 and C238, until a null is obtained on the galvanometer. These capacitors should be adjusted so they are each meshed an equal amount.

Remove the galvanometer after a definite null has been obtained.

Operate the Sound Plate switch to the OFF position.

Reconnect the plate lead from the tubes to capacitor C243.

## CHANNELS 7 TO 13

Reconnect the bus leads to terminals on C2015 and C2016 and the wire to terminal board TB-W9, and replace resistor R-273 on the resistor panel.

Close tune-up switch S202.

Operate the Sound Plate switch to the ON position.

Check resonance of the plate circuit. Plate circuit resonance is indicated by a slight dip in cathode current (M211). Resonance is also indicated by maximum brilliance of a small neon bulb mounted on an insulated rod and held near the plate circuit.

The plate line of this stage is supplied with an adjustable shorting bar. This bar should be adjusted so the plate tuning capacitor C7005, has sufficient tuning range and there is sufficient coupling to the 2nd IPA grid circuit. See Table 12.

The screen voltage of the 2nd tripler may be adjusted by moving the tap on R226. The tap should be set for approximately 150 volts.

For channels 7 through 10, the strap connecting the 4-125A/4D21 plate cap to capacitor C2005 should be secured under the screw holding C2005 to the insulator. For channels 11 through 13, fasten this strap under the screw holding the plate line to the capacitor.

### *FREQUENCY CHECK*

Before proceeding, the operating frequencies of the F-M exciter and multiplier stages should be determined with an absorption type wavemeter. The output frequency of each stage is shown on Table 12.

*CAUTION:* In order to place the wavemeter close to the multiplier stages, it is necessary to open the perforated metal door and to temporarily operate the door interlock switch while measuring frequency. EXTREME CAUTION SHOULD BE OBSERVED WHEN PLACING THE WAVEMETER IN THE VICINITY OF THE PLATE CIRCUITS. Usually, it is necessary only to place the wavemeter within five inches of these circuits to obtain a satisfactory indication.

If any stage is operating on an incorrect harmonic, the number of turns of the plate coil should be checked, or the tuning capacitor should be rotated until the correct harmonic is obtained. On some channels a stage may resonate on two harmonic frequencies, but these harmonic frequencies will be at widely different dial settings.

*(Continued)*

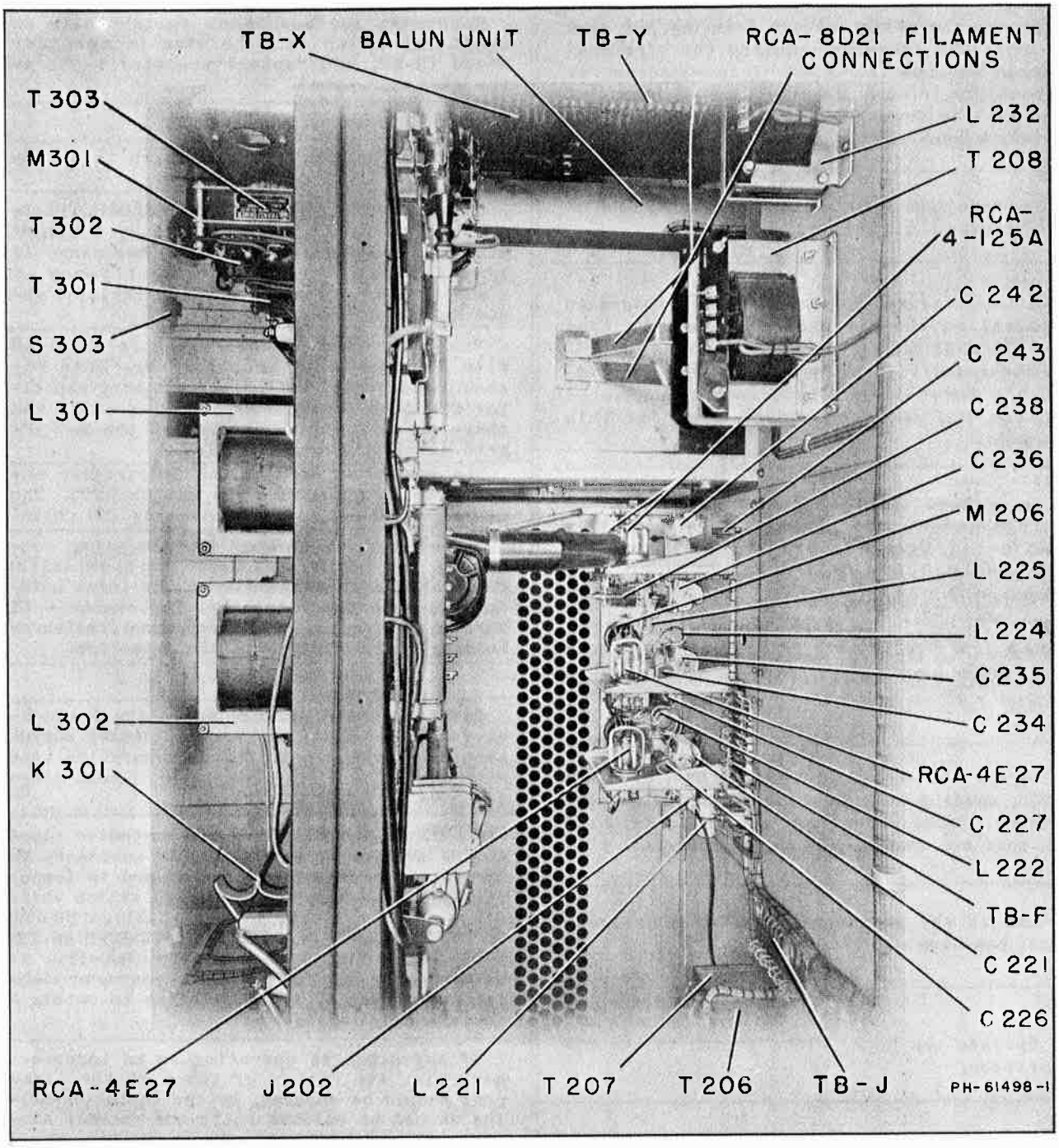



Figure 71 – R-F Driver, Channels 2 to 6 and Rectifier Unit - Aural (Frames 1, 2, 3 - Rear View)

# TUNING - AURAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| Operate the Sound Plate switch to the ON position. | After the proper harmonic has been obtained the dial setting should be recorded, to enable the operator to retune the stage to the proper harmonic in the future. |
| Advance the Excitation control until a reading of 0.15 ampere is obtained on the Driver Plate Cur meter. | *SECOND IPA TUNING (5th R-F Stage)* |
| Check the plate circuit for resonance. If the stage is properly neutralized the grid current will become a maximum when the plate circuit is resonated (cathode current at a minimum). Sharp dips, or rises in the grid current which occur when the plate circuit is tuned through resonance indicates instability and incorrect neutralization. | Rotate the driver grid circuit tuning capacitor C2008 until resonance is indicated by maximum grid current (M220). The grid line of this stage is supplied with an adjustable shorting bar. Moving the shorting bar to shorten the line reduces the coupling between the 2nd tripler plate and the 2nd IPA grid. See Table 12 for approximate shorting bar settings. |
| | Resonate the plate circuit by means of capacitor C2012. Maximum screen-grid current as read on the driver screen current meter M221 may be used to indicate resonance. Maximum screen grid current should coincide, approximately, with minimum driver plate current as read on M202. |
| | The driver anode circuit is supplied with an adjustable shorting bar. This shorting bar should be adjusted so that resonance occurs with the plate tuning capacitor approximately $30^{0}$ from the maximum capacity for best vernier action. See Table 12. |
| | The excitation control, R224, adjusts the screen voltage of the 2nd IPA. Control R224 is part of a voltage divider across the 1500-volt supply in which maximum and minimum voltage may be increased or decreased by changing taps on R229 and R274. The tap on R229 should normally be adjusted so that 1000-ohms resistance remains in the circuit, and R274 so that all 5000 ohms are in the circuit. With type 4X500A tubes that draw a considerably higher screen-grid current than indicated by the typical meter readings, it may be necessary to raise the resistance of R229 and decrease the resistance of R274 to obtain sufficient screen-grid voltage. In no case should the screen-grid voltage exceed 500 volts. |

*(Continued)*

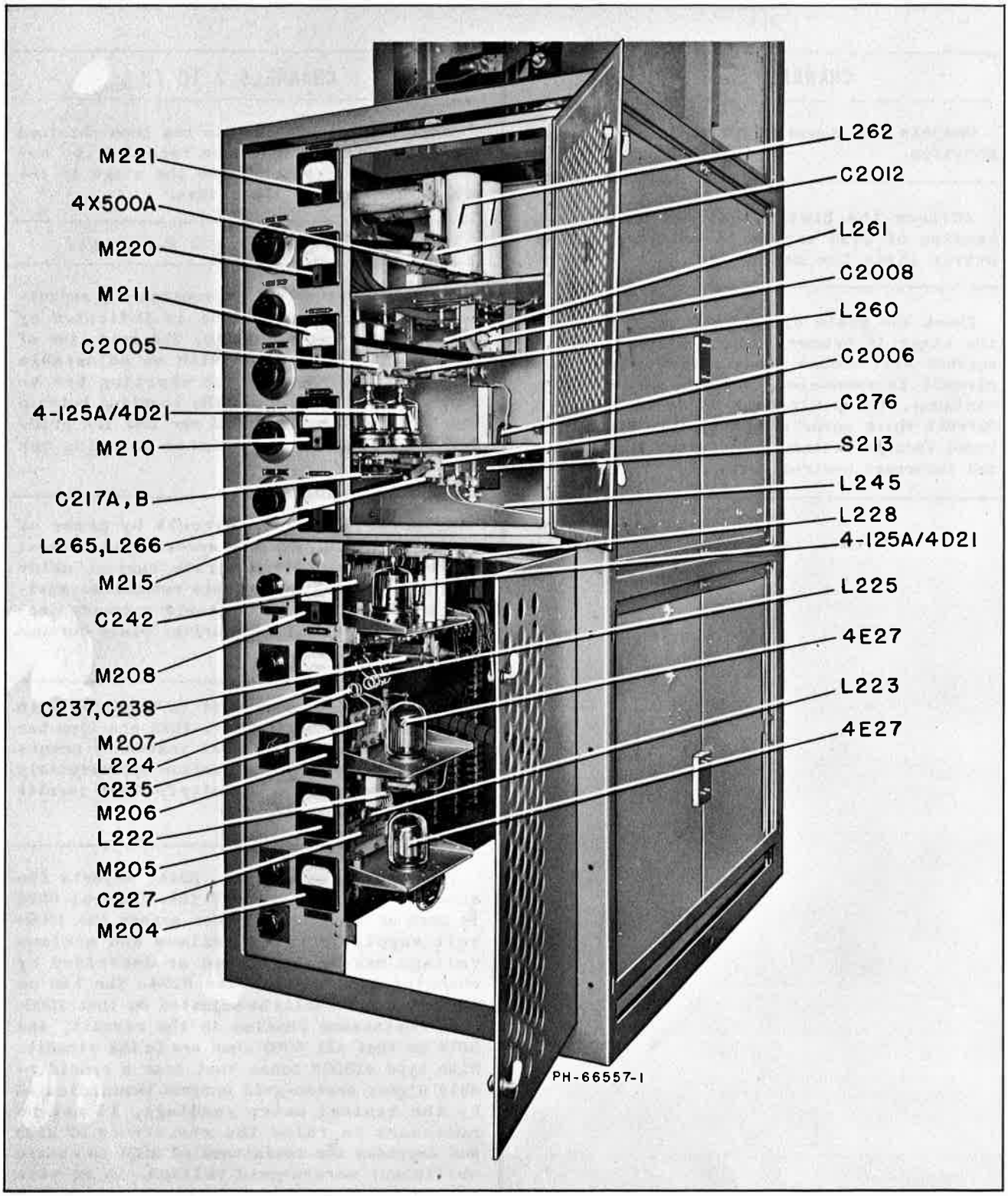



Figure 72 - R-F Driver, Channels 7 to 13 - Aural (Frame 2, Front View)

# TUNING - AURAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| *POWER AMPLIFIER TUNING* | |
| The grid circuit of the power-amplifier stage consists of a section of transmission line (L229) arranged so that spacing between the two conductors may be varied to change the surge impedance. A shorting bar is employed to adjust the inductance. Disk type tuning capacitor C244 is connected across the grid end of the line for vernier tuning adjustments. | The grid circuit of the power amplifier stage includes a section of transmission line (L229) tuned by variable capacitor C244. An adjustable coupling loop at one end of the line is used to couple the second intermediate-power-amplifier (driver) plate circuit to the power-amplifier grid circuit. |
| Approximate adjustments to the PA grid line shorting bar should be made (for the assigned transmitter frequency) as shown in Table 11. | Adjust the spacing between the two padding capacitor plates so that resonance occurs with the PA Grid tuning disks spaced at least 1/2 inch apart, for best vernier performance. |

With excitation on the PA Grid, rotate PA Grid tuning capacitor C244 until resonance is obtained. It may be helpful to use a neon lamp placed temporarily near the grid line when making this adjustment.

Slowly advance Excitation control R224 until a reading of not over 10 milliamperes is indicated by Amplifier Grid Current meter M201.

Readjust the driver plate and PA grid tuning capacitors for maximum PA grid current, using a "rocking" technique.

Adjust the PA Filament control, R402, to the correct 8D21 filament voltage. See Typical Meter Readings, Table 15.

Adjust the PA Output Coupling control for very loose coupling to the load.

Rotate the Excitation control to the extreme counterclockwise position.

Operate the Delta/Wye PA plate voltage switch (S301) to the "Low" position.

Reduce the screen grid voltage by connecting the screen lead to the fifth tap from the ground end of resistor R220.

Terminate the output of the transmitter in a dummy load.

Operate the Sound PA contactor (K409) to the ON position.

Resonate the anode circuit by adjustment of the PA Plate Tuning control. Maximum screen grid current may be observed as a resonance indication. Do not permit the screen grid current (as indicated by the Ampl Screen Current Meter) to rise above 75 milliamperes while tuning the plate circuit. It may be necessary to reduce excitation to the grid by detuning one of the low level r-f controls as resonance is approached in the plate circuit.

Set the Reflectometer meter, M104 on "Incident", and adjust the PA Output Tuning and PA Plate Tuning controls for maximum deflection. If necessary, increase the PA coupling slightly to obtain a useful reading on the Reflectometer meter. The coupling should remain loose so as not to disturb the power amplifier plate circuit resonance when the PA Output Tuning control is checked.

(Continued)

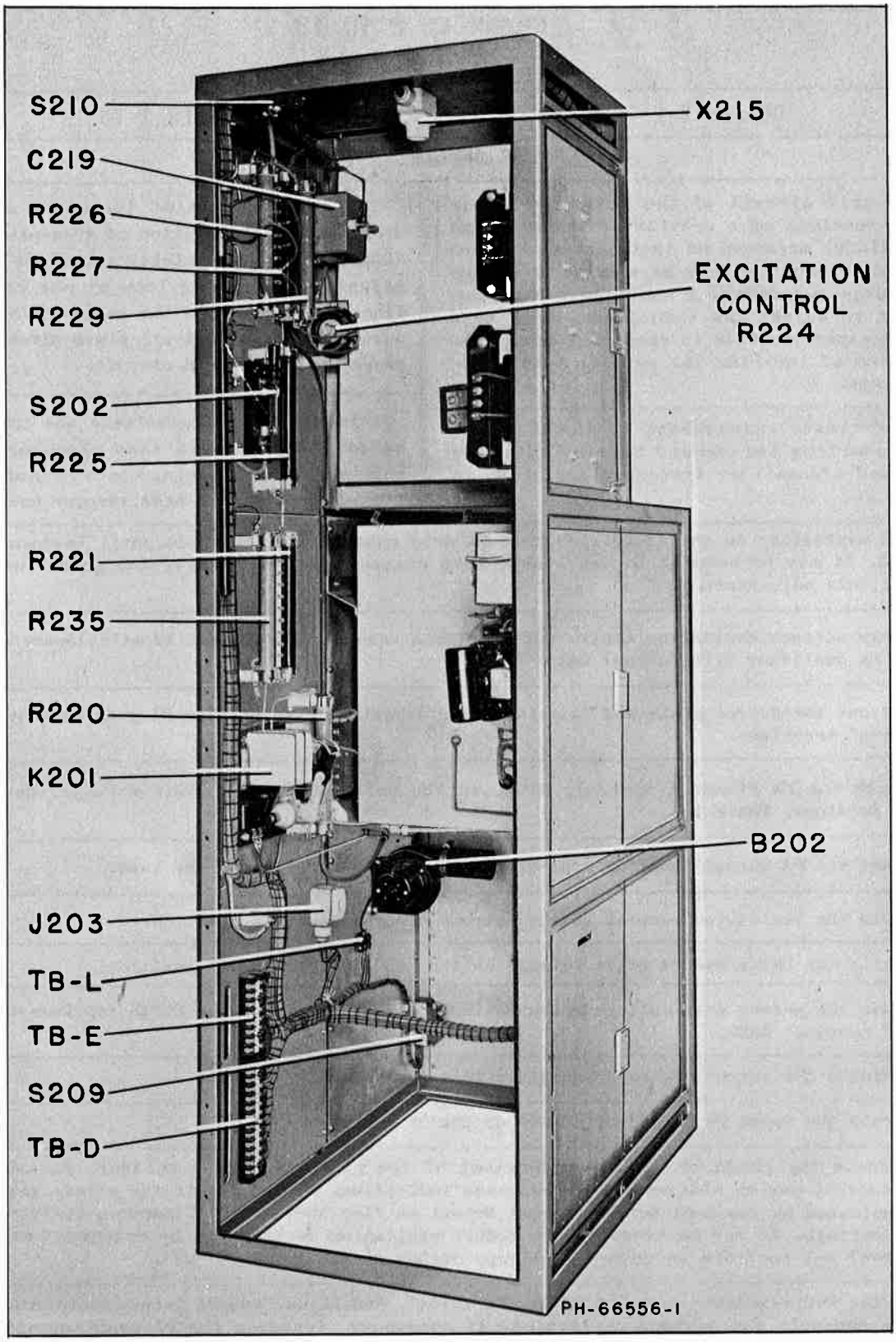



Figure 73 - R-F Driver, Channels 7 to 13 - Aural (Frame 2, Rear View - Left)

# TUNING - AURAL R-F *(Continued)*
## CHANNELS 2 TO 13

| CHANNELS 2 TO 6 | CHANNELS 7 TO 13 |
|---|---|
| Check the driver and power amplifier circuits for resonance. Each circuit should be carefully resonated for a maximum indication of the Reflectometer meter. *Caution: The Power Amplifier Screen grid current should never exceed 75 milliamperes and the control grid current should not exceed 20 milliamperes. In the event higher currents are indicated, rotate the excitation control until the indicated reduction is obtained.* | |
| Slowly increase the antenna coupling and increase the grid drive until a maximum reflectometer reading is obtained. It is important to note that the objective is to reach "optimum" coupling, as contrasted to the visual PA loading adjustments, in which the broadband requirements make it necessary to achieve a judicious amount of over-coupling. Therefore, a point will be found, as the aural PA Output Coupling is being increased, where the reflectometer reading will begin to decrease after having passed the peak. The correct operating print is slightly on the tighter-coupled side of the actual output peak. | |
| Operate the Sound Plate switch to the OFF position. | |
| Set the Delta/Wye PA plate voltage switch to the High position. | |
| Restore the screen grid voltage connection on resistor R220 to the original tap. | |
| Operate the Sound Plate switch to the ON position. | |
| IN ORDER TO AVOID THE POSSIBILITY OF SERIOUS TUBE DAMAGE DO NOT OPERATE WITH CURRENT IN EXCESS OF THE FOLLOWING VALUES (SEE "TYPICAL METER READINGS," TABLE 15, FOR NORMAL VALUES): | |
| Driver Cathode Current.....450 milliamperes<br>PA Grid Current..... 20 milliamperes<br>PA Screen Current..... 75 milliamperes<br>PA Plate Current.....1.4 amperes | Driver Cathode Current.....800 milliamperes<br>PA Grid Current..... 20 milliamperes<br>PA Screen Current..... 75 milliamperes<br>PA Plate Current.....1.4 amperes |
| Check the PA screen grid voltage. The Ampl Screen Voltage meter should indicate approximately 700 volts. Move the connection on resistor R220 toward the grounded end if the voltage is high, or toward the ungrounded end if the voltage is low. | |
| Check the PA Output Coupling adjustment over a narrow range as described previously. *Under no circumstances should the PA output coupling control and/or the PA output tuning control be adjusted so as to substantially unload the PA, while high plate and screen voltages are being applied.* | |
| Recheck the tuning adjustments of the exciter and driver stages, carefully operating each circuit. It is necessary to drive the aural PA tube to saturation in order to reduce A-M noise and hum modulation. The lowest plate voltage and the greatest grid drive should be used to satisfy the output requirements without exceeding a control grid current of 20 milliamperes and a screen grid current of 75 milliamperes. | |

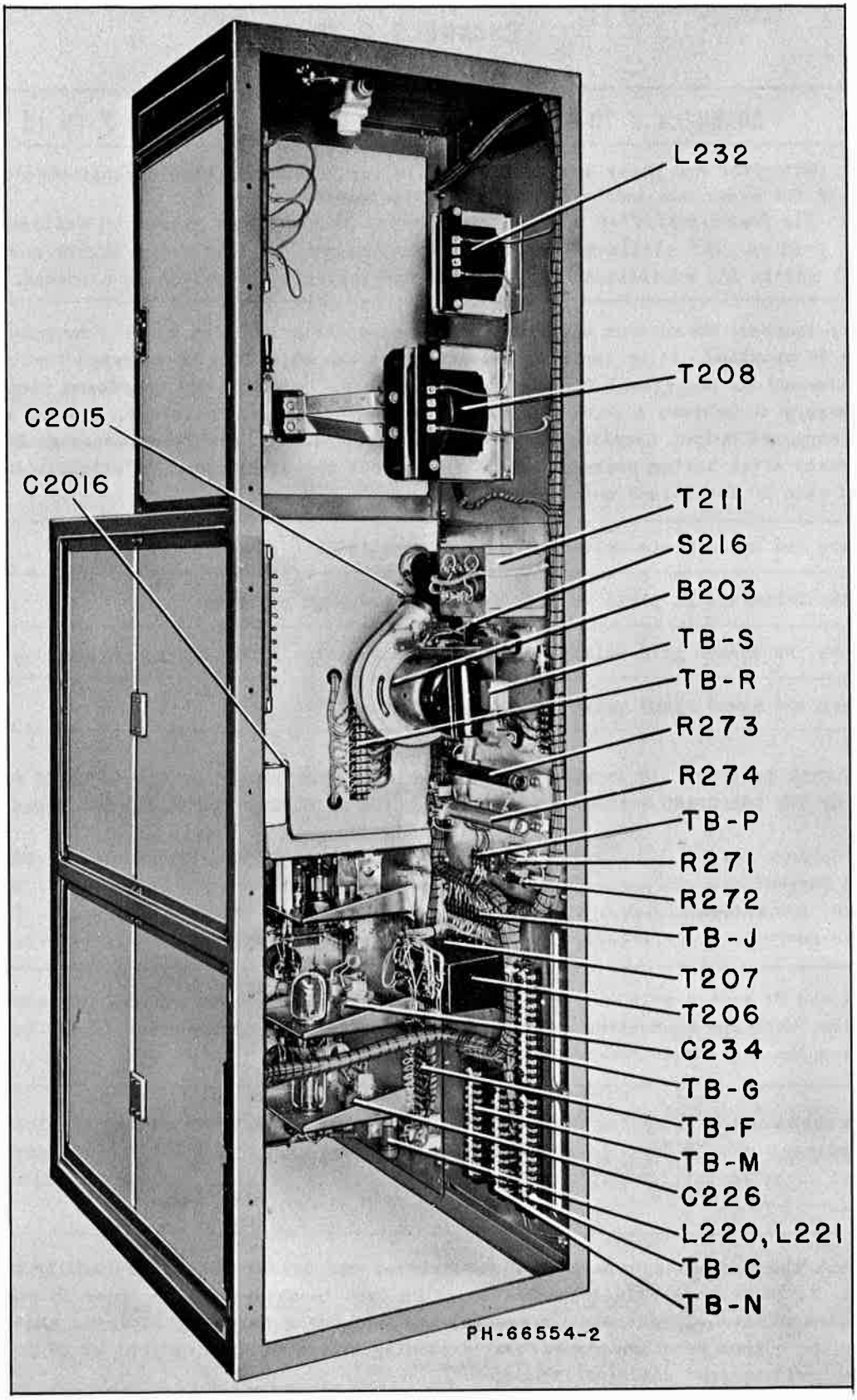



Figure 74 - R-F Driver, Channels 7 to 13 - Aural (Frame 2, Rear View - Right)

After the aural section has been tuned, peak performance may be obtained by the use of distortion measuring equipment in conjunction with a modulation monitor. The recommended equipment is listed below.

Distortion and Noise Meter
Attenuator
Audio Oscillator

The following steps should be taken:
Set the audio levels at the desired modulation percentages and adjust reactance tube grid tuning capacitor C105 for minimum distortion. Adjust the input levels after each tuning operation to prevent false readings.

Modulate the exciter with a frequency of 15,000 cycles and adjust balancing capacitor C104 for minimum distortion.

The r-f output stages should now be tuned for minimum distortion by adjusting controls C104, C105, T105, T106, and T107.

Adjust the F-M Exciter output carrier frequency, Table 11, by manipulation of the crystal trimmer capacitors, C160 and C162, located on crystals, Y101 and Y102. Make this adjustment with the use of a standard carrier frequency monitor.

This step should be accomplished only after the transmitter has been in operation and the 115-volt crystal heater voltage has been on for at least one hour to stabilize the temperature of the crystal holder. Recheck alignment for any change that may have occurred while making this adjustment.

If all stages have been carefully resonated, the distortion should not exceed one per cent.

Check the power output into the Dummy Load.

*Reflectometer Adjustments, Aural* - Adjust the aural reflectometers as outlined under the preceding heading "Reflectometer Adjustments, Visual."

## INCOMING LINE ADJUSTMENTS, CONSOLE

*Console Visual Level*—To adjust the visual levels, first set the gain of the stabilizing amplifier so that the composite signal output is the normal value of two volts, ± 25 per cent, with 30 per cent synchronizing pulse. Use a suitably calibrated oscilloscope or the CRO in the master monitor to make the voltage measurements. Next, depress the Trans.-Input buttons on switches S1103 and S1104 and, using the same calibrated oscilloscope or the CRO in the master monitor, adjust potentiometer R1130 so that the voltage between the contact arm and ground is approximately 1.25 volts. This value is chosen because it is below the minimum standard level of two volts, -25%, yet is high enough to operate the monitor properly.

Adjust the picture monitor Contrast and Brightness controls so that the proper picture appears on the kinescope.

Set the CRO gain and calibrating voltage controls for a trace of suitable size on the CRO screen. With this 1.25-volt signal the CRO tube may now be used as a level indicator for the adjustment of potentiometers R1127, R1128, and R1129, which should be set to apply the same value voltage to the picture monitor input when the monitor sources are delivering their normal outputs.

To adjust R1127, interchange the inputs to the master monitor. This will connect the Type WM-12 modulation monitor, through R1127, to the CRO input of the master monitor and permit viewing the relative amplitude of the picture signal. Inasmuch as the transmitter is not ordinarily modulated to zero power for full white output, the relative amount of synchronizing component in the de-modulated r-f output will be greater than in the input signal before modulation. Therefore, when adjusting R1127, the synchronizing portion of the signal should be disregarded and the picture component alone should be set to the same amplitude as the picture portion of the output of the stabilizing amplifier. The kinescope brightness may require readjustment when changing monitor inputs. After this adjustment has been made, the master monitor inputs should be re-connected in accordance with the console schematic diagram, Figure 81.

Once the preceding adjustments have been properly made, any change in the level of a monitoring line will be reflected as a proportionate change in the vertical deflection on the CRO tube.

*Console Aural Level*--Before making any adjustments in the level of the aural inputs to the console, set VU Attenuator, R1140, to the OFF position. This will prevent any damage to the VU Meter due to excessively high line levels. Similarly, whenever VU meter switch S1101 is operated, the VU Attenuator should be set at OFF before switching. It may then be rotated counterclockwise to bring the meter registration within the desired limits. If this is not done, damage to the VU Meter may result. Since the VU Meter is designed to withstand considerable momentary overload this precaution will not be necessary after the system has been adjusted. In general, the aural monitor level adjustments are intended to preserve a uniform output level on the sound monitor speaker without the necessity of making any

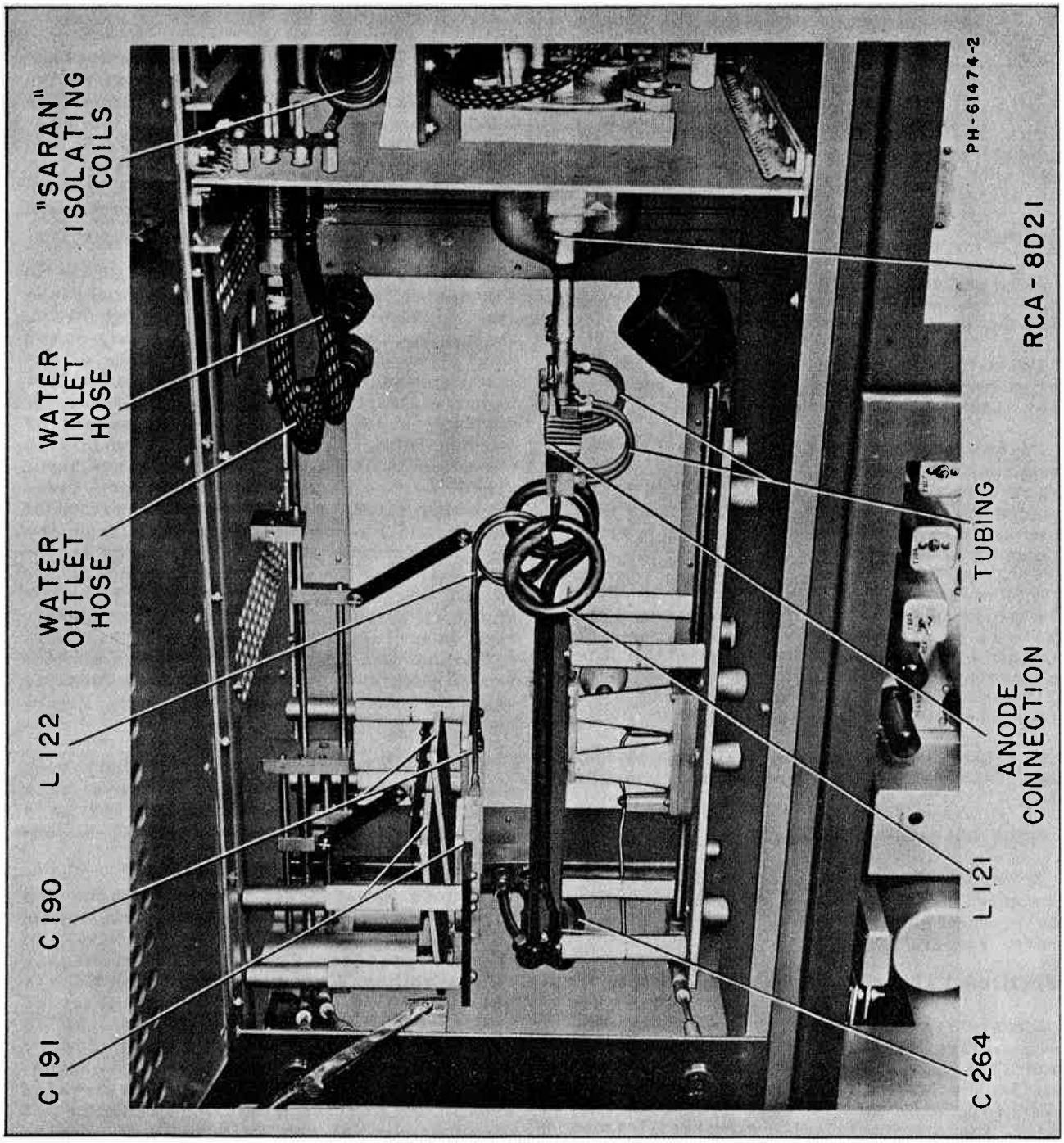



Figure 75 – Power Amplifier, Channels 2 to 13 - Aural (Top Frames 1, 2 - Front View)

adjustments when lines are switched. Accordingly, the adjustment procedure outlined is intended to serve only as a guide and may be varied to suit individual installations.

Depress the Line 1 or Line 2 button of switch S1102 and apply a fixed-frequency tone such as a 400-cycle sine wave at normal level on the appropriate line.

Set the Gain Control in the sound monitor amplifier at minimum, and the console SOUND MONITOR GAIN control at maximum.

Rotate potentiometer R1123 (or R1124) clockwise to approximately three-quarters of maximum.

Now advance the Gain Control in the sound monitor amplifier to obtain the desired maximum sound level on the monitor speaker.

Adjust the Type 86-A Limiting Amplifier to obtain the desired sound level at the input to the transmitter as described in the following discussion entitled, "Audio Levels in the Sound System." This material treats the theoretical aspects of pre-emphasis for use as a guide when adjusting the audio levels. After setting R1123, adjust the other bridging potentiometers in the same manner to obtain the same sound level from the monitor amplifier when the respective line levels are normal.

The pre-emphasis network precedes the type 86-A Limiting Amplifier. The gain of the amplifier and the loss of the network are such that a 400-cycle sine wave signal of any level between -2 dbm and + 38 dbm can produce 3db of limiting in the amplifier when it is properly adjusted for the input level. The pre-emphasis network is rated for an input level not exceeding + 30 dbm. A level much higher than + 20 dbm is not recommended in the television system, to obtain minimum crosstalk between circuits.

For 100%, 400 cycle sine wave transmitter modulation the input line level may be between -2 dbm and + 20 dbm. A level of + 10 dbm is recommended. Output of the type 86-A Limiting Amplifier can then be adjusted for any level between + 10 dbm and + 30 dbm. If the sound Gain Control on the Console is set at 10 (mid position), its loss will be 11 dbm and the output of the Limiting Amplifier should be + 21, ± 2 dbm for a transmitter input level of + 10, ± 2 dbm.

The foregoing describes the levels for sine wave operation at 400 cycles or less. If the frequency of the input signal is increased without changing the level, the pre-emphasis network characteristic will cause an increase in input to the Limiting Amplifier, but the amplifier output will increase very little. Such action prevents serious over-modulation of the transmitter. Since the limiting action of the amplifier is a function of voltage, and the modulation of the transmitter is also a function of voltage, even though the Limiting Amplifier is adjusted with sine wave operation its operation for complex waves will be correct when the complex wave peaks are the same magnitude as the sine wave peaks. However, because of the characteristics of the VU meter used for measuring the input line level, the input gain control of the amplifier should be reduced 8 to 10 db when complex waves are being transmitted at the same indicated line level as when sine wave adjustments were made. This is advisable because the peaks of average complex program signals exceed the reading of the VU meter (a short time averaging indicator) by approximately 8 to 10 db.

The preceding adjustments are recommended for initial operation. Effects of the controls on the transmitter system, with different types of program material, may indicate that slightly different adjustments are required. In all cases, the system should be operated so that the action of the Limiting Amplifier is not observed by the listener. In general, this can be accomplished by operation such that the Gain Reduction meter on the amplifier indicates a maximum of 3 db gain reduction on peaks. Careful study of the instructions for the Limiting Amplifier is recommended.

Excessive gain reduction will cause objectionable "holes" in the accompaniment background noise or of a program and, will upset the dynamic variations of music particularly, because of pre-emphasis, when the musical tones have large components of relatively high frequency. Note that, because the limiting action is a function only of input signal voltage to the Limiting Amplifier the frequency response is not affected by limiting, but as described in the limiting amplifier instructions the return to normal gain after severe limiting can cause objectionable performance. To obtain the best results, the system must be carefully adjusted and operated as adjusted. Care must be taken to maintain the proper signal level on the sound program line so that the system operates as desired.

## OUTPUT MEASUREMENTS AND ADJUSTMENTS

*Hum-Bucking Adjustments, Visual* – Potentiometer R864 across the filaments of the modulator tubes may be adjusted to give minimum hum out of the visual section. To accomplish this, observe the blanking level of a normal picture signal on the console CRO connected to the output of the WM-13 waveform monitor. Make certain the WM-13 monitor is operating at a normal output level so that no hum will be introduced from this source. Adjust potentiometer R864 for minimum hum as observed on the CRO. After the control is adjusted in this manner, it may become necessary to correct this setting from time to time, as for example when the power-amplifier filament voltage is altered or when the power-amplifier tube is replaced.

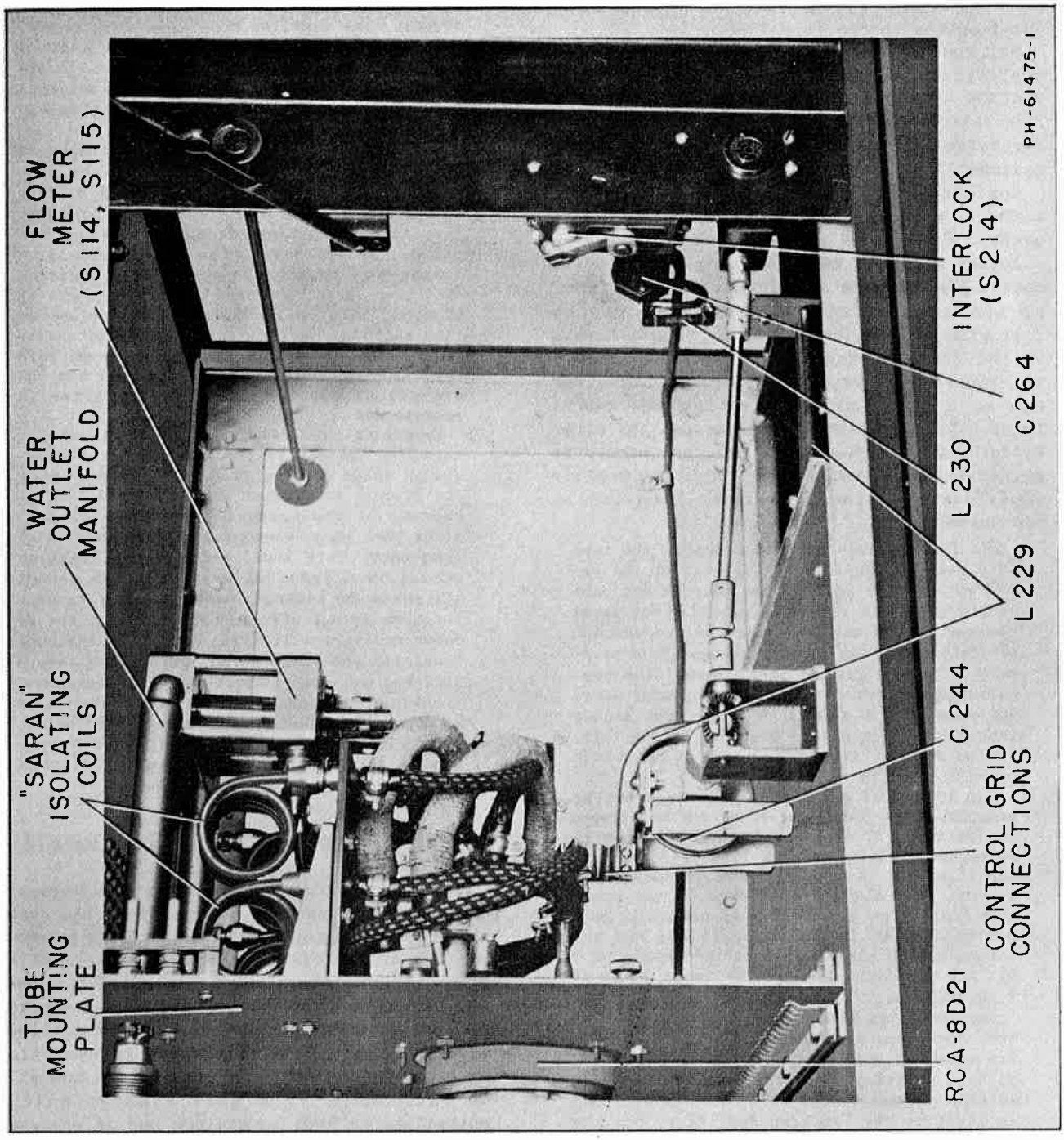



Figure 76 - Power Amplifier, Channels 2 to 13 - Aural (Top Frames 1, 2 - Rear View)

*Modulator Resistance Adjustment, Visual* – After visual r-f tuning has been completed it may be desirable to check and alter the modulator d-c resistance slightly to compensate for changes that may have occurred in other parts of the visual transmitter section. Reference should be made to the previous instructions under PRELIMINARY ADJUSTMENTS, "Modulator Adjustments, Visual."

Energize the visual section, and feed an all-white composite signal into the transmitter.

Observe the Black Level output of the transmitter by means of the console CRO connected across the output of the WM-13 waveform monitor.

Change the modulator input signal from an all-white picture to an all-black picture.

The distance between the reference axis, zero carrier, and the black level as observed on the CRO should not shift. If the distance between the Black Level and the reference axis decreases, the resistance of R503 should be increased.

*Power Output Measurements, Visual* – As specified in "FCC Standards of Good Engineering Practice," the output power of the picture section must be measured when transmitting a black picture. As an aid when making adjustments, reference should be made to Figure 60, "Typical Operating Parameters, Visual." The dummy load must be connected to the output of the sideband filter during measurements.

If, during the following adjustments, it becomes necessary to change the 1025-volt PA bucking bias supply setting by more than five per cent, the transformer primary tap on TB-L should be checked and relocated if necessary. Directions for making this change were given previously under "Preliminary "Adjustments."

Apply power at normal operating voltages to the visual section of the transmitter and, with the PA stage properly broadbanded adjust the excitation as specified in the final steps of tuning the power amplifier.

Patch a composite picture signal containing reference whites into the transmitter. Adjust the level on the line feeding the transmitter to 2 volts peak-to-peak, of which approximately 30% is synchronizing pulse. This synchronizing ratio may be easily achieved by proper set-up of the TA-5 Stabilizing Amplifier.

Set up the Synchronizing Pulse Generator and associated equipment for a black picture (synchronizing pulses only). Advance the Picture Gain Control to a tentative setting of approximately 3.5. This procedure will place the approximate normal value of synchronizing voltage into the visual modulator system.

Set the Sync Ampl control to approximately 6 on the dial. This setting will utilize approximately the maximum amount of stretching available.

Adjust the Black Level control until a modulator plate current of 0.71 ampere is indicated by the Modulator Plate Current meter. The modulator plate voltage will read approximately 645 volts, providing the adjustments previously described under "Modulator Adjustments, Visual" have been made correctly. This procedure locates the pedestal level on the correct point on the Modulator characteristic. During the subsequent adjustments do not change this setting.

The next step is to properly locate pedestal level on the Power Amplifier characteristic. The "Bucking Bias Control" R946 provides the means for properly making this adjustment. Referring to the PA Modulation Characteristic of Figure 60, it will be noted that the proper bias for pedestal level is -380 volts. Note that the total bucking bias voltage is always equal to the arithmetic sum of the modulator plate voltage as read on M501 and the PA grid bias as read on M702. If the PA Bucking Bias supply has been adjusted properly for an output of 1025 volts as described under "Preliminary Adjustments," the PA Grid Bias meter should now read 380 volts when the Black Level control is set as previously described. Make any small adjustments of R946 necessary to achieve the 380-volt reading.

Note by reference to Figure 60 that the PA plate current at this point should be in the order of 1.41 amperes. A check on the r-f excitation, as described under power amplifier tuning should be made if this current is not obtained. In this connection, also note that the excitation set-up figure of 820 volts bias at 0.1 amp. plate current may be read on the PA graph of Figure 60.

Observe the rectified transmitter output as produced by the WM-13 unit, or by a simple diode with chopper ahead of the sideband filter, on the console CRO. Accurately re-adjust the Picture Gain control until the synchronizing pulse is 25% of the total deflection between synchronizing peak and the zero axis established by the chopper.

Measure the output power in the dummy load. (See Dummy Load Instruction Book.) This measurement gives average power of a black picture and comprises the steady-state pedestal level power and a small amount (about 4%) contributed by the synchronizing pulses. Calculate the peak power by multiplying this average power by the factor 1.68. This factor takes into account the power ratio between pedestal level and synchronizing peak, and holds only for a value of 25% synchronizing pulse.

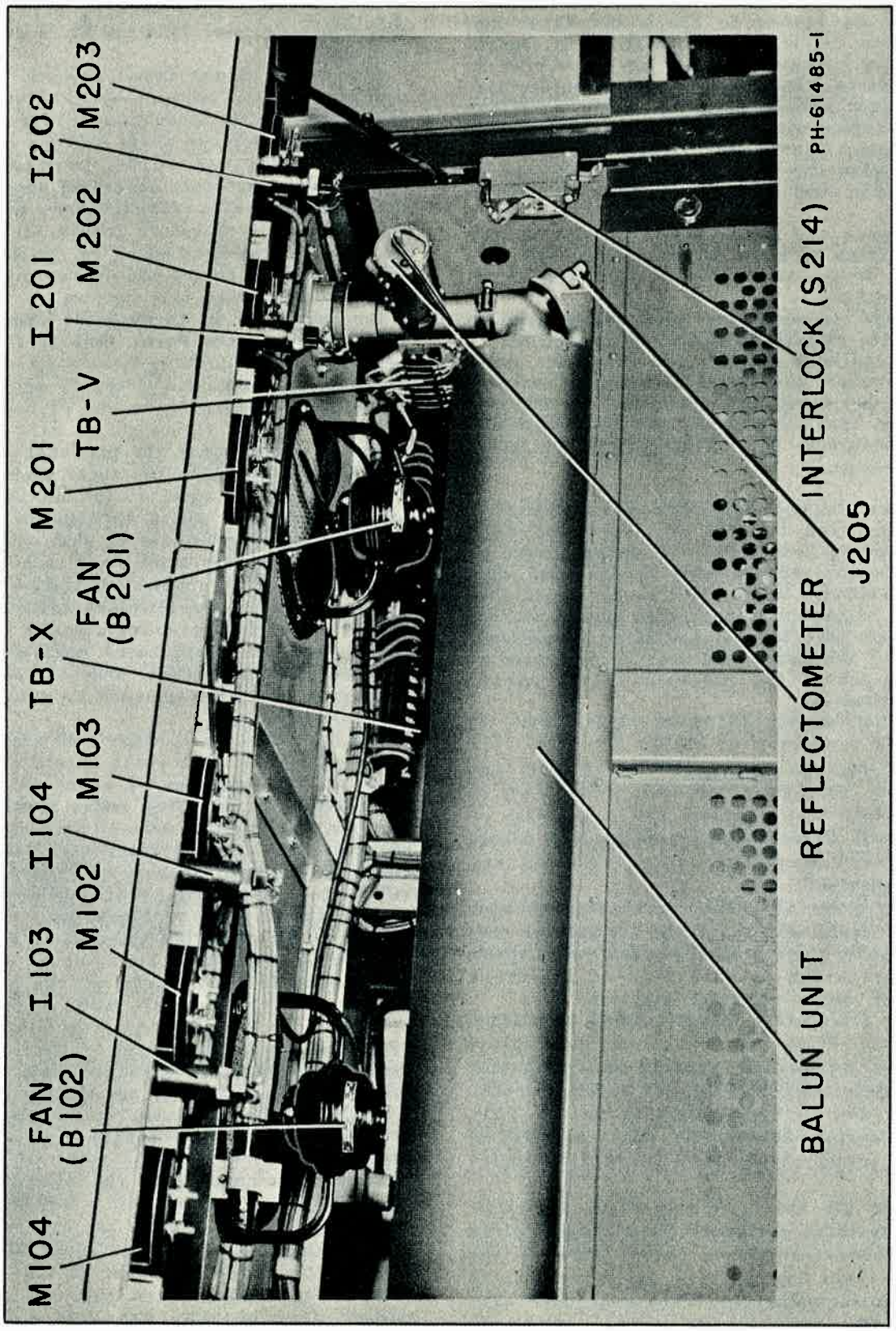



Figure 77 - Power Amplifier Output, Channels 2 to 13 - Aural (Frames 1, 2 - Meter Panels Raised)

If the power output is satisfactory, 5000 watts maximum, log the reflectometer reading for future reference. The foregoing procedure, constitutes power calibration of the reflectometer, required by the FCC, and will hold true for a long period of time. Since the reflectometer is a current indicating device, power varies as the square of the readings. The correct power at any reading may be calculated from the following relationship:

$$P_o = P_c \left(\frac{A_o}{A_c}\right)^2$$

where $P_o$ is the unknown power at reading $A_o$, and $P_c$ and $A_c$ are the calibrated power and reading respectively. Note that this calibration holds only for composite picture signal modulation. If it is desired to use the reflectometer to read unmodulated carrier power, a new calibration using the dummy load should be made. The formula given may also be used for this type of calibration.

If the calculated power output is too low, lower the PA bias by readjusting the bucking bias control, accurately readjust the Picture Gain control for 25% synchronizing pulse on the demodulated output, and repeat the power measurement. Increase the PA bias if the output is too high. Check the PA broadbanding if necessary.

When the measurements have been satisfactorily concluded, read and log all meter readings. Include dial settings if desired. Note that the setting of the Bucking Bias control R946 may now be locked in position and should not be regarded as an operating control. Slight readjustment might be necessary if the 8D21 tube is replaced, but even this is unlikely. It is very important to recognize the individual and overlapping functions of this control and the Black Level control. The Bucking Bias control permanently ties together the modulator characteristic and the PA characteristic in such relationship as to properly accommodate the picture signal with a minimum of non-linearity in either the white or black region. The Black Level control, the *operating* adjustment, is the means of shifting the operating point simultaneously on both modulator and PA characteristics to the proper composite set of operating conditions. This may be to either pedestal level for the television signal or mid-characteristic for test signal usage.

*Overall Adjustments, Visual* – In carrying out the foregoing power output measurement, a large percentage of the adjustments which will be used in future program operation will have been completed. However, these final steps should be taken in actually putting a picture signal on the air:

(a) Remove the dummy load and connect the antenna.

(b) Arrange to feed approximately 2 volts of composite picture signal to the transmitter, such as a test pattern or a station announce slide. It is preferable to use picture material which has considerable white area in order to establish proper depth of modulation. The composite input signal should always consist of 30% synchronizing pulses for reasons indicated in Figure 60.

(c) With the transmitter set up for pedestal level conditions as previously described, adjust the Picture Gain control (small readjustments of the Black Level control are also permissible) until the following conditions are obtained:

(a) The reflectometer reading is the same as previously recorded.

(b) The output signal of the transmitter contains a synchronizing pulse of 25% as measured to the zero axis.

(c) Depth of modulation as indicated by the WM-13 is 90%, maximum.

Note that as the Picture Gain control is advanced the reflectometer will deflect upward, since it is responsive to synchronizing peaks, substantially, but that the PA plate current will deflect downard to a value which is proportional to the average brightness of the picture. Equivalent changes occur in the Modulator current and Voltage Meter readings. During normal programming containing variations and changing of picture content, the reflectometer reading will remain constant, but the PA Plate current and grid bias, and the modulator meter readings will be constantly changing in accordance with average picture brightness.

The equipment is now ready for programming. The TT-5A transmitter is capable of radiating an excellent picture. However, consistent high-quality picture transmission will depend to a large extent on thorough understanding of operating principles, accurate and diligent observance of correct operating procedures, establishment of a regular equipment check schedule, and intelligent servicing of the equipment.

*Monitoring Diode Adjustments, Visual*— Checking the quality of the composite picture signal to the sideband filter requires that both visual and aural transmitter sections be operated into the antenna. The monitoring diode pick-up may then necessitate probe relocation to achieve the final sound null location.

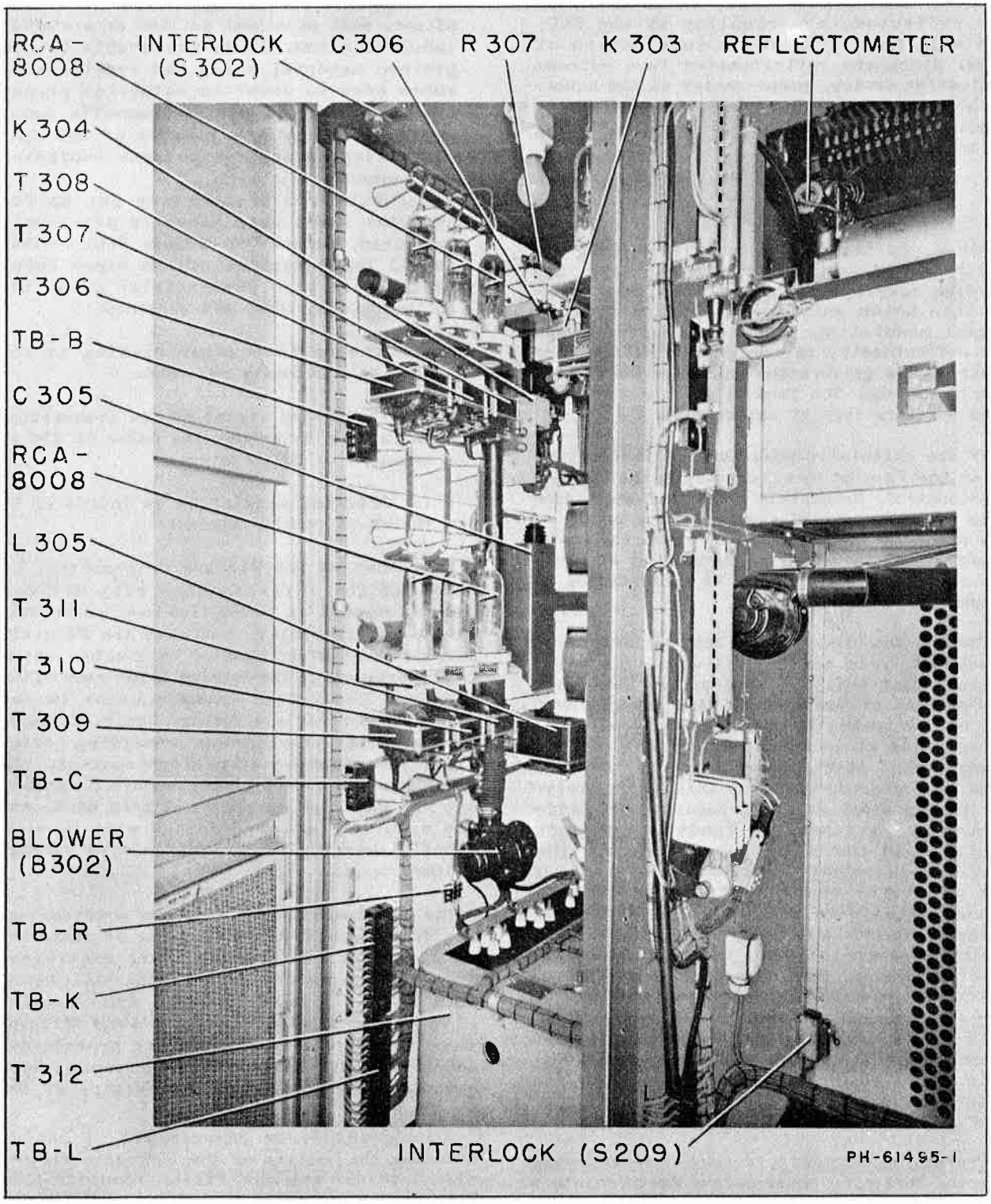



Figure 78 - Rectifier Unit, Aural (Frame 3, Rear View)

To check the diode pick-up, energize the aural and visual sections, using a 400-cycle sound input and a composite picture input not exceeding two volts peak-to-peak.

Adjust the probe for a peak-to-peak visual signal of approximately 1.75 volts. If there is objectionable sound interference in the picture, as indicated by a fine herringbone cross-hatch pattern on the kinescope, and a thickening of all horizontal traces on the CRO, de-energize the transmitter and drill a second hole for the probe. This hole should be located nine inches from the first hole for channels 2 to 6, and three inches away for channels 7 to 13.

Again energize the transmitter and check the interference. Drill additional holes as required, using the relative amount of pick-up in the various holes as a guide in arriving at the sound null location. Do not, under any circumstances, permit the diode probe to touch the transmission line inner conductor during operation.

# OPERATION

## ROUTINE PROCEDURE

After completion of all preliminary adjustments and tuning and when ready to initiate regular broadcasts, it is desirable to follow a routine procedure for putting the transmitter on the air.

The TT-5A transmitter control circuit design incorporates automatic starting wherein, if all other controls are left in the ON position, operation of the Transmitter ON switches will place the transmitter on the air with full modulation. In this starting procedure the proper sequence for air, water, filaments, screen, and plate power is automatically controlled.

It has been found that nearly all operators prefer a more cautious start, with greater, manually-controlled, delay between the various steps. This procedure is desirable particularly in high channel transmitters where the following daily warm-up and shut-down schedules are recommended.

### DAILY WARM-UP SCHEDULE

At the beginning of each operating day, make sure that the water- and air-cooling systems are functioning properly before applying any voltages to the 8D21. Then apply the regular operating voltage to the filament (see filament operating voltage) for ten minutes with no voltages on the other electrodes. After this period, apply the regular operating plate voltage, grid No. 2 voltage, and excitation. Adjust the grid No. 1 bias or excitation to give a plate current of about 500 milliamperes. Operate at this value for about ten minutes, after which the tube is ready for the day's operation.

### DAILY SHUT-DOWN SCHEDULE

At the close of each operating day, remove all d-c voltages and excitation from the 8D21 tube. Then reduce the a-c filament voltage to a value as low as the filament control will permit, and operate the filament at this value for five minutes. Filament power may then be turned off, but continue the water cooling for an additional 30 seconds. Air cooling may be stopped with removal of the d-c voltages and excitation. If, however, the air-cooling system is interlocked with the water-cooling system, continue both the water and air cooling for 30 seconds.

On the visual side, it is assumed that the Black Level control remains at the pedestal level setting used in the previous day's operation. Therefore, as an important check on the proper amplitude of excitation, the Ampl Plate Current should be observed and the reading should be approximately 1.4 amperes. To make an additional check on the excitation, rotate the Black Level control until a bias of 820 volts is indicated on the Ampl Grid Voltage meter and adjust the Excitation control, if required, for a reading of 0.1 ampl plate current. Return the Black Level control to its correct pedestal level setting.

The visual transmitter is now ready for modulation with a composite picture signal. At schedule time, advance the Picture Gain control at either the console or the transmitter until the reflectometer reads the logged value. Advance the Sound Gain control. Station programming may now proceed.

The Tower Lights switch on the console provides control of this circuit.