MODEL RA-250

250 WATT

AM TRANSMITTER

RAYTHEON MFG. CO.

Commercial Products Division

WALTHAM 54, MASS.

1B-402

Printed in U. S. A.

Table of Contents

GENERAL DESCRIPTION

PAGE

General 1
Electrical Characteristics 1
Mechanical Construction 1
Antenna Meter 1

DETAILED DESCRIPTION

General 2
R.F. Channel 2
A.F. Channel 4
Power Supply Circuit 5

INSTALLATION

Unpacking 6
Assembly 6
Basic Connections 6
Monitoring Connections 6
Initial Adjustments 6

OPERATION

To Start the Transmitter 10
To Stop the Transmitter 10

MAINTENANCE

List of Tables

Vacuum Tube Complement 4
Capacitors and Tank Coils Required for Various Frequencies . . 5
Table of Meters 7
Table of Controls 11
Tube Voltages and Currents 12
Recommended List of Spare Parts to be Kept on Hand . . . 12
Replacement Parts List 13

List of Illustrations

FIGURE	TITLE	PAGE
1	Raytheon AM Transmitter RA-250: Front View	0
2	R.F. Exciter: Top Rear View	2
3	R.F. Exciter: Underside	2
4	Front View, Showing Meters and Controls	3
5	Rear View, Showing Driver and Final Amplifier	3
6	Rear View, Right Side	4
7	Top Rear View of Transmitter, Showing Upper Components	4
8	Rear View of Control Panel Hinged Down, Showing Components	6
9	A.F. Amplifier Chassis: Top View	6
10	A.F. Amplifier Chassis: Underside	6
11	A.F. Amplifier Power Supply: Underside	6
12	Rear View, Left Side	6
13	A.F. Amplifier Power Supply: Top View	7
14	Modulator Bias Supply Chassis: Underside	7
15	Modulator Bias Supply Chassis: Top View	7
16	Top Rear View of Transmitter, Showing Lower Components	10
17	Left Rear View of Meter Panel	10
18	Mounting and Wiring Layout for Lower Components (Outline Drawing)	17
19	Physical Layout, 4-Door Cabinet	18
20	Physical Layout, 3-Door Cabinet	19
21	Arrangement of Conduit Holes (Outline Drawing)	20
22	Schematic Diagram	21

High Voltage Warning

The RA-250 has been carefully designed to protect personnel from possible injury from high voltages. Positive interlocks which do not rely on spring action to break the circuit are used, and circuits capable of storing high voltages are equipped with adequate drainage. Nevertheless, it is recommended that the Filament Stop Switch always be opened as an added protection when inspecting or servicing the equipment.

Every effort having been made to eliminate danger to personnel, Raytheon accepts no responsibility for any injury or loss of life suffered in connection with this equipment.

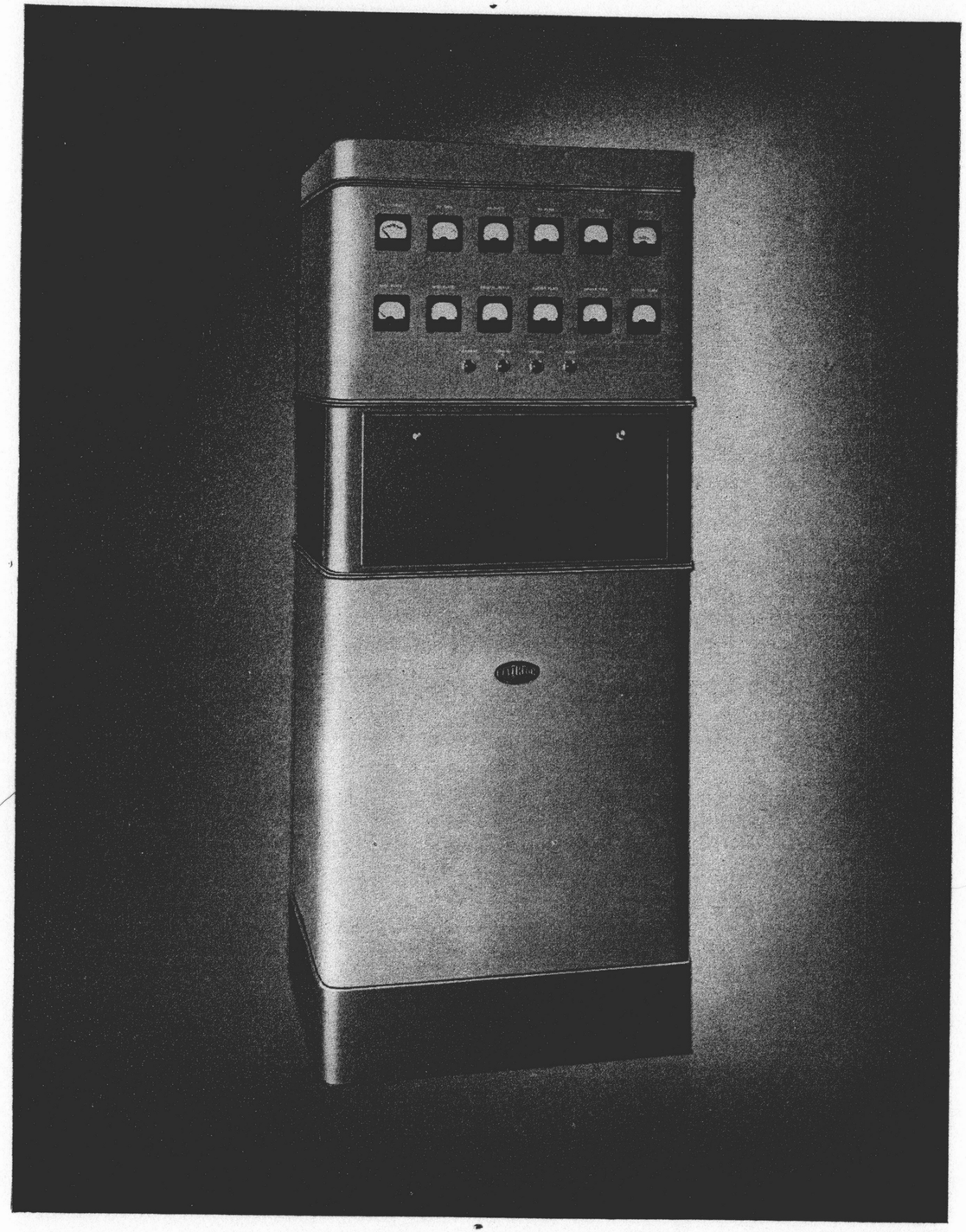


Figure 1. Raytheon AM Transmitter RA-250: Front View.

GENERAL DESCRIPTION

GENERAL

The Raytheon AM Radio Transmitter, Model RA-250, is designed to operate from a 3-wire line supplying 208–230 volts 50–60 cycles, single phase. It will supply a power output of 250 watts to a 50–250-ohm transmission line in the frequency range of 540–1600 kc.

The total weight of the Transmitter installed is 1200 lbs. The Transmitter case is 32⅝″ wide, 29″ deep, and 80″ high.

Electrical design of the RA-250 Transmitter has been co-ordinated with the mechanical design so as to give long, economical, trouble-free operation.

Inherently lower distortion level is ensured by the use of triode-type tubes in both the modulator and the amplifier. Due to the use of triodes, feedback failure will not be serious. The inclusion of the feedback circuit improves the quality of the signal, but failure will not hamper satisfactory operation.

The performance of the Transmitter is guaranteed to comply with all F.C.C. regulations. The db variation and maximum noise level tolerances are considerably under the maximum F.C.C. limits.

ELECTRICAL CHARACTERISTICS

Type of emission:	Telephone
Modulation	
Type:	AM high level
Capability:	100%
Carrier output:	250 watts
Frequency range:	540–1600 kc.
Power supply:	208–230 volts, 3-wire, 50–60 cycles, single phase
Power consumption:	1700 watts
Radio-frequency stability:	±10 cycles
Audio input for 100% modulation (500–600-ohm source):	0 db (1 milliwatt ref. level)
Average program level:	–5 db (1 milliwatt ref. level)
Audio-frequency distortion (50–7500 cycles):	2.0% or less with 95% mod.; 1.8% or less with 85% mod.
Noise level:	60 db below 100% mod.
Audio-frequency response:	±1 db, 30–10,000 cycles

MECHANICAL CONSTRUCTION

The Transmitter is housed in one cabinet. The main access doors are at the rear, and are provided with interlock switches to remove the high plate voltage when the doors are opened. Side doors, secured by four half-turn screw fasteners, provide access to the wiring, control panel, and meter panel. Whenever possible, chassis construction is used in order to separate the various circuits of the Transmitter to facilitate servicing.

No forced air ventilation is used; therefore there is no fan noise—a valuable feature for stations where the Transmitter is located in the studio; and no excessive dust is introduced into the Transmitter to cause arcing and eventual breakdown. Cool fresh air enters the vents at the bottom of the rear doors, and circulates upward by convection, cooling the tubes. The heated air leaves the Transmitter through vents in the top. Vertical chassis construction makes this free circulation possible.

This Transmitter uses only two tuned stages: the r.f. driver amplifier and the power amplifier. These stages are tuned by a low-speed motor which is equipped with a clutch. The clutch allows the control to stop turning when the tuning button is released. Even an inexperienced operator can achieve accurate tuning, and do it quickly and easily with a little practice.

ANTENNA METER

No antenna current meter is supplied with the equipment unless requested. However, space has been provided on the front panel for this meter. A Vacuum-Tube R.F. Current Meter RCM-10 will be supplied upon request for use as the antenna meter.

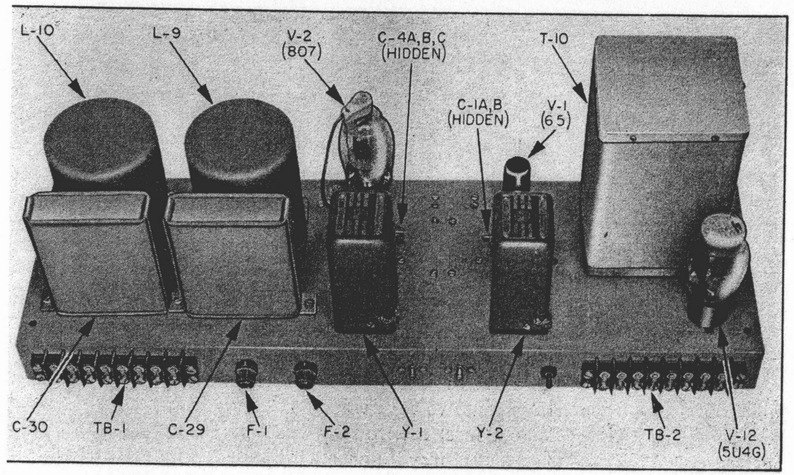


Figure 2. R.F. Exciter: Top Rear View.

(C-49 and C-64 are located between Y-1 and Y-2; S-1 to the right of Y-2.)

DETAILED DESCRIPTION

GENERAL

The Raytheon Transmitter RA-250 consists of an r.f. channel, an audio channel, input power control circuits, and the necessary d.c. power supplies. (See Fig. 22 for schematic diagram.)

R.F. CHANNEL

The r.f. channel consists of a 6J5 crystal oscillator, an 807 buffer amplifier, an 813 r.f. driver amplifier, and two 810 tubes operating in push-pull as a power amplifier.

The crystal oscillator and buffer amplifier, together with their power supply, comprise one long chassis located near the bottom of the cabinet. This is called the r.f. exciter chassis (see Figs. 2 and 3).

The crystal oscillator has provision for two crystals (Y-1 and Y-2), which are enclosed in ovens to maintain them at constant temperature (see Fig. 2). The ovens are kept within $\pm 1^{\circ}$ C. at 60° C. The oven heaters are energized from 110 volts 60 cycles; they are always operative, subject to thermostatic control, regardless of whether or not the Transmitter is turned on. Indicator lights I-1 and I-2 glow when the heaters are actually energized. The crystal in use is selected by relay K-3, located on the same chassis (Fig. 3), and operated by the CRYSTAL Switch (front panel Fig. 4). The coil of K-3 is protected by fuse F-2 (see Fig. 2). Two small variable condensers C-64 and C-49 (Figs. 2 and 3) are located beneath their respective crystal holders. (Holder No. 1 is to the left, and holder No. 2 is to the right, as viewed from the rear). These condensers are connected between each crystal and ground to permit zero-beating the crystal frequency with the frequency monitor. Meter M-1 indicates the plate current of the crystal oscillator (see Fig. 4).

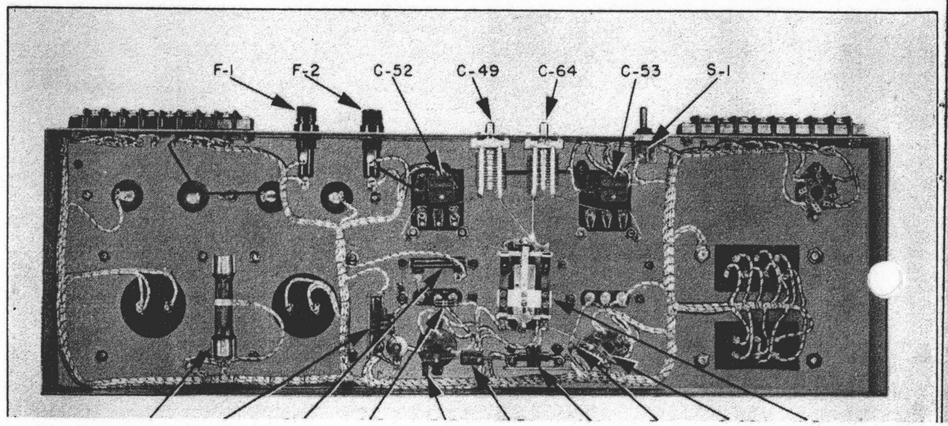


Figure 3.
R.F. Exciter: Underside.

The buffer stage is metered by M-2 (see Fig. 4). A small pickup coil is coupled to the output of the buffer and is brought out to terminals 5 (ground) and 6 on terminal board TB-1 to provide r.f. for a frequency monitor.

The r.f. exciter chassis contains no tuning controls. The oscillator plate coil L-1 (Fig. 3) was designed to permit oscillation over the frequency range. The value of L-2 in the buffer stage was selected to give broad-band response (see Fig. 3). Capacitor C-69 is generally required for operation below 1000 kc., and is added at the factory if necessary.

The power supply for the crystal oscillator and buffer can be turned off by toggle switch S-1, located on the rear of the chassis (see Fig. 2). The oscillator-buffer power supply is protected by fuse F-1, located to the right of TB-1 (see Fig. 2). The full output voltage is applied to the 807; reduced voltage, adjusted by means of a tap on bleeder resistor R-7, is applied to the crystal oscillator (see Fig. 3).

Figure 4. Front View, Showing Meters and Controls. →

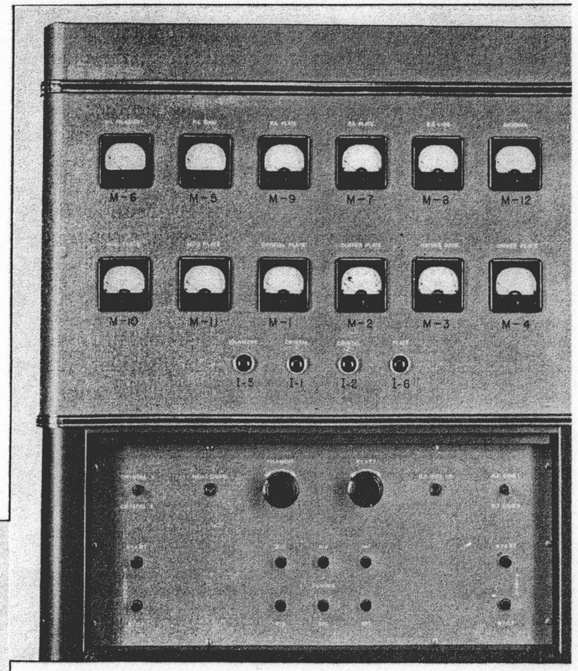
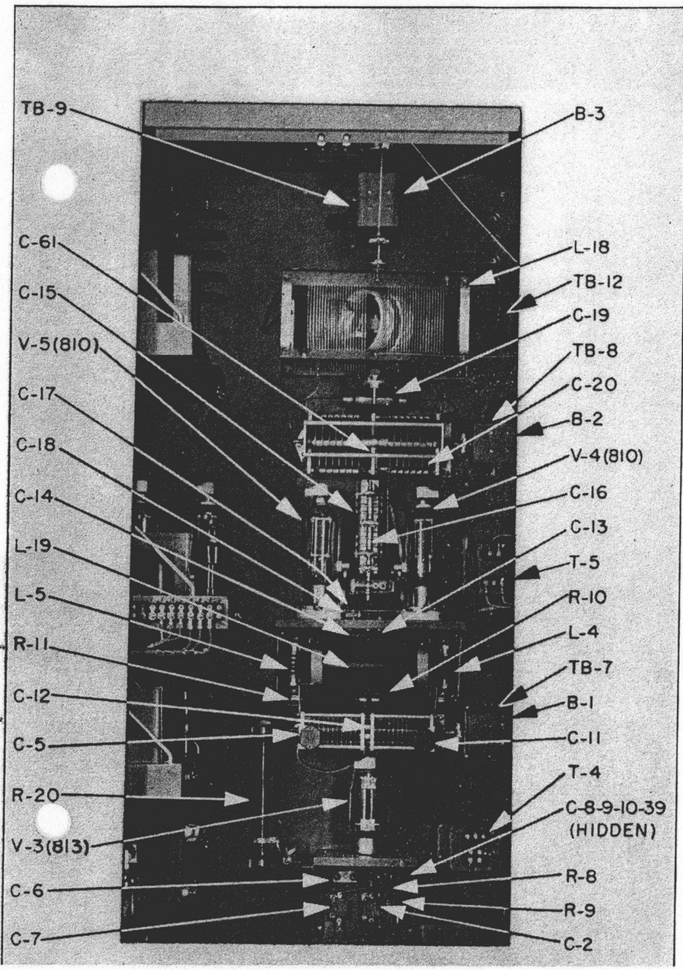


Figure 5. Rear View, Showing Driver and Final Amplifier. ↓



The 813 r.f. driver is located directly above the r.f. exciter chassis. The grid and plate currents are indicated by meters M-3 and M-4 respectively (see Fig. 4). The plate and screen voltages are applied to the 813 from the high-voltage power supply. A tap is provided on bleeder resistor R-20 (on the high-voltage supply) to adjust the screen voltage (see Fig. 5). The drive to the power amplifier can be adjusted by varying the screen voltage on the 813 driver stage.

The power amplifier stage (two 810's in push-pull) is located directly above the 813 r.f. driver, and the grid and plate currents of this stage are indicated by meters M-5 and M-7 respectively (see Fig. 4). The filament and plate voltages are measured by meters M-6 and M-9 respectively (see Fig. 4). The mounting brackets of L-18 are so arranged that they

serve as two single-turn coils (see Fig. 7). One coil is used to supply output from the Transmitter to the modulation monitor; the other coil is connected to R.F. PICKUP jack (front panel) for neutralizing the final amplifier (see Fig. 4). Audible monitoring is accomplished by a tap on the final cathode resistor R-12 brought out through a condenser to terminals 1 and 2 on terminal board TB-10 (see Fig. 6). When neutralizing, the high voltage supplied to the power amplifier and modulator is disconnected by means of relay K-11, located on the right side of the Transmitter, near the 813 transformer. Switch S-16, which operates relay K-11, is located inside the Transmitter, just above the relay (see Fig. 6). The high voltage applied to the power amplifier can be varied by means of the PLATE Control (R-19), located on the front panel (see Figs. 4 and 8).

Meter M-8 measures transmission-line current and is connected in series with the output coil feeding the transmission line (see Fig. 4). Meter M-12 indicates current at the antenna.

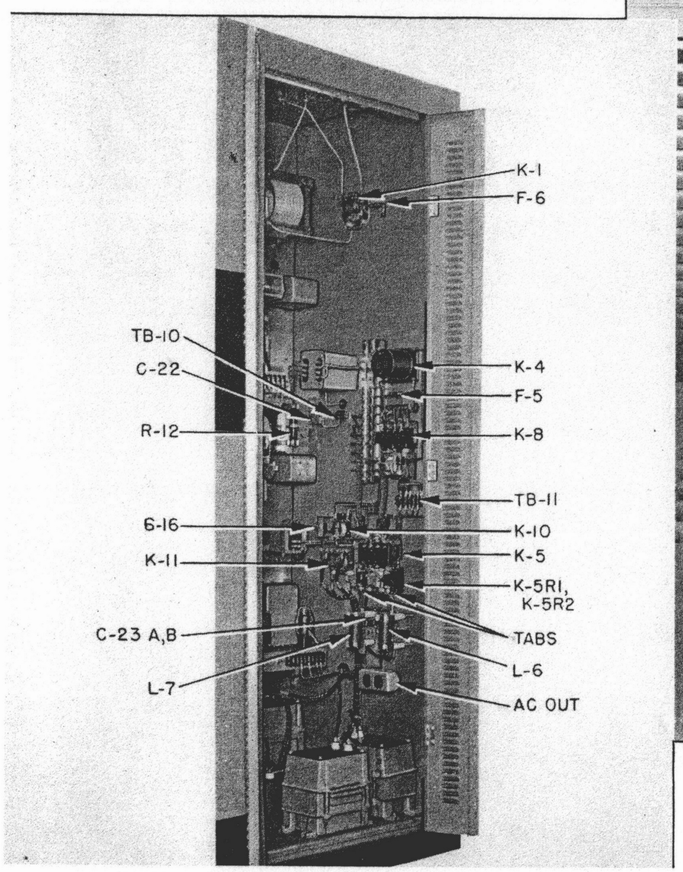
Refer to the table, *Capacities and Tank Coils Required for Various Frequencies*, at the end of this section, for these special components.

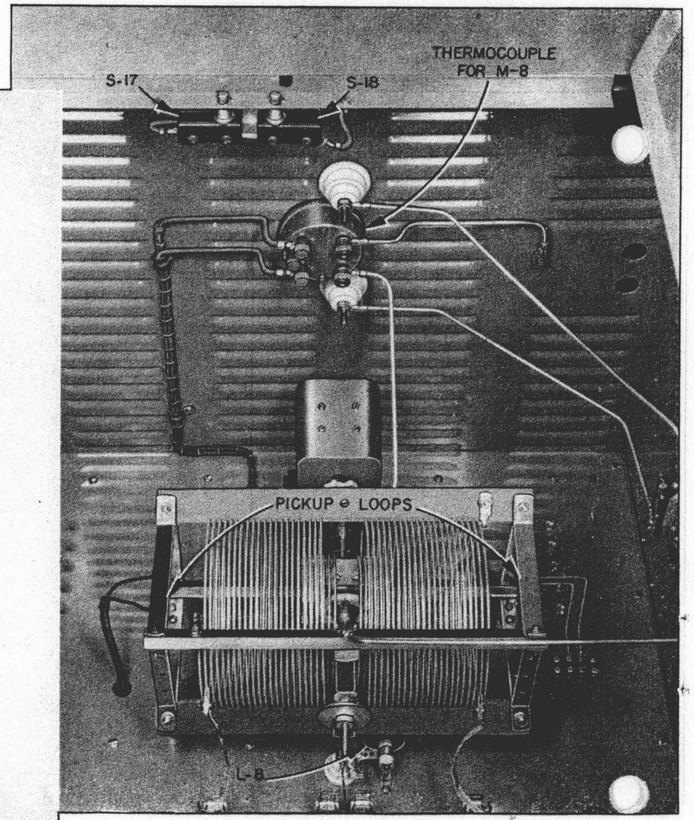
VACUUM TUBE COMPLEMENT	
Quantity	Tube Type
3	6J5
1	807
1	813
4	810
4	6B4G
3	5U4G
2	872A

A.F. CHANNEL

The audio channel consists of a pair of push-pull 6J5's resistance-coupled to four 6B4G's in push-pull parallel, which serve as driver for the 810 modulators (see Figs. 9, 10 and 12).

↓ Figure 6. Rear View, Right Side.





↑ Figure 7. Top Rear View of Transmitter, Showing Upper Components.

The audio amplifier is one chassis, mounted on the left side of the Transmitter. The bias supply for the 810 modulator is located beneath this chassis (see Figs. 12, 14, and 15). The power supply for the 6J5's and 6B4's is located above the audio chassis (see Figs. 11, 12, and 13).

The input circuit is transformer-coupled to the 6J5 grids, the primary of this transformer being designed to be connected to a 500–600-ohm balanced line. Bias voltage for the 6B4G tubes is obtained from resistor R-16, located on the power supply chassis (see Fig. 11). Adjustable bias for each 810 of the modulator is furnished by the bias supply through the use of two variable resistors, R-18 and R-23, on the bias supply chassis (see Figs. 14 and 15). Plate current for each 810 tube is measured by meters M-10 and M-11 (see Fig. 4).

CAUTION

The interlocks on the rear door remove only the high voltage. The operation of the oscillator buffer power supply, the audio amplifier power supply, and the bias supply are subject only to the FILAMENT START Button.

POWER SUPPLY CIRCUIT

The 230-volt 60-cycle line is fed through an r.f. filter to a filament contactor. The contactor is protected by thermal overload relays (K-5R1, K-5S1, K-5R2, and K-5S2), which will reset manually or automatically, depending on the position of small tabs located on either side of the reset button (see Fig. 6).

Filament contactor K-5, located on the lower right-hand side of the Transmitter, is operated by means of push buttons on the front panel (see Fig. 4).

When the contactor is closed, the main bus is supplied with 230 volts 60 cycles through the FILAMENT Control (variable resistor R-21 on the front panel, see Fig. 4).

Plate contactor K-8, located above the filament contactor, can be operated by the PLATE START Button on the front panel after the filament contactor is closed (see Figs. 4 and 6). Plate contactor K-8 will not close, however, until the following has occurred:

(a) The Transmitter doors are closed, operating interlock switches S-17 and S-18 (see Fig. 7).

CAPACITORS AND TANK COILS REQUIRED FOR VARIOUS FREQUENCIES

SYMBOL and DESCRIPTION	NUMBER REQUIRED	FREQUENCY (Kc.)	CAPACITY (Mmfd.) or IND. (μh)		RAYTHEON STORES NO.
Capacitors					
C-5 and C-11 Type 9F, 3000 v dc wkg	2	540—570	500	±10%	—
		570—630	400		—
		630—720	300		35RA-20
		720—850	200		35RA-21
		850—1000	300		35RA-20
		1000—1200	200		35RA-21
		1200—1350	100		35RA-17
		1350—1600	50		35RA-13
C-19 Vacuum type 7.5 kv.	3	540—720	300		35RA-50L32
	2	720—850	200		35RA-50L32
	2	850—1200	200		35RA-50L32
	1	1200—1400	100		35RA-50L32
		1400—1600	0		—
Tank Coils					
L-19	1	540—850	300		92RA-4B402
		850—1600	200		92RA-4U68
L-18 Type 2426N3 with 2124VN3CC rotor	1	540—850	240		92RA-2 P2
		850—1600	135		92RA-2 P1

(b) The synchronous timer K-4 (above the plate contactor) has operated (see Fig. 6).

(c) The bias power supply is operating at the proper voltage to close relay K-10, located above relay K-11 on the right side of the Transmitter (see Fig. 6).

If a momentary overload (such as a high-voltage breakdown or severe overmodulation) occurs, relay K-9 (located on the left side of the cabinet above the high-voltage plate transformer) will open the coil circuit of plate contactor K-8. The overload point is set by changing the tap on R-22 (Fig. 12); this tap was adjusted at the factory as follows: Sufficient audio signal of 1000 c.p.s. was fed into the input of the audio amplifier to modulate the transmitter 100%. Then the audio input signal was increased 6 db and R-22 adjusted so that relay K-9 would operate.

INSTALLATION

UNPACKING

The Raytheon Transmitter RA-250 is shipped in four packing cases. Each case should be opened carefully by using a nail puller.

The large transformers and chokes were removed from the Transmitter before shipment for the sake of convenience in handling.

ASSEMBLY

Install the transformers and chokes in the bottom of the cabinet, as shown in Figs. 16 and 18. Connect the associated wiring (which is labeled) as shown in the drawing.

BASIC CONNECTIONS

(*See Fig. 19 for arrangement of conduit holes.*)

(a) To provide operating power for the Transmitter, bring a 3-wire line supplying 230 volts 50–60 cycles, single phase, through the hole in the bottom or on the rear right-hand side of the cabinet. Connect the 230-volt line to the line choke terminals 1 and 3, and connect a ground to the strap located between these terminals.

(b) Bring a balanced audio line through the hole on the bottom or rear left-hand side of the cabinet. Connect this line to terminals 1 and 3 and the shield to terminal 2 on terminal board TB-3, located on the audio amplifier chassis.

(c) Connect an r.f. frequency monitor through a 70-ohm line to terminals 5 (ground) and 6 on terminal board TB-1, located on the r.f. exciter chassis.

(d) Connect a 50–250-ohm transmission line directly to the output posts on the Transmitter. The Raytheon Antenna Tuning Unit RT-1000 is available for matching antennas of widely diverse characteristics to either concentric or open-wire transmission lines.

MONITORING CONNECTIONS

Terminal board TB-12 provides connections for modulation monitoring through a 50-ohm line.

For audible monitoring purposes, terminals 1 and 2 (ground) are provided on terminal board TB-10. Monitoring lines from both the tank coil and TB-10 terminals may be run through the hole in the bottom or rear right-hand side of the cabinet.

INITIAL ADJUSTMENTS

(*See Table of Controls.*)

(a) Before applying power to the Transmitter, check the line voltage with a voltmeter. It should be about 230 volts for normal operation.

(b) Press the FILAMENT START Button.

(c) Advance the FILAMENT Control until the P.A. FILAMENT Meter reads 10 volts.

NOTE

If the FILAMENT Control is not about at mid-scale when the P.A. FILAMENT Meter reads 10 volts, the line voltage is either too low or too high, and taps on all the primaries of the transformers must be changed to compensate for this. This control will normally give a ±10% adjustment in the line voltage for everything except the high-voltage plate transformer and crystal ovens. The ovens start when the line voltage is supplied to the Transmitter proper.

(d) Check the balance of the 6B4G plate currents at the two closed-circuit jacks located on the rear of the audio amplifier chassis. The normal reading should be about 75–90 ma. for each pair of tubes. (Each reading should be within 4 ma.)

(e) Advance the PLATE Control to about one-half maximum.

(f) Note the reading of the DRIVER GRID Meter; it should be about 7 ma. Open the rear doors of the cabinet and turn off (down) switch S-16, located inside the Transmitter on the right side. (S-16 controls relay K-11 which removes the plate voltage from the power amplifier and modulator—see Fig. 6.)

(g) Press the PLATE START Button.

CAUTION

Allow the filaments of the 872A's to be preheated at least 30 minutes before applying the plate voltage. This procedure is only necessary each time a new 872A is installed.

(h) Neutralize the Transmitter as follows:

(1) Press the 813 TUNING Button to check for maximum reading on the P.A. GRID Meter or for minimum reading on the DRIVER PLATE Meter.

(2) Adjust the NEUT. COND. Control (screwdriver adjustment on the front panel) for minimum r.f. as indicated by a *low-impedance indicating device* plugged into the R.F. PICKUP jack on the front panel (see Fig. 4). The indicator may be a 1.5-volt 60-ma. pilot light or an r.f. milliammeter. During this adjustment, press the 810 TUNING Button to check for maximum r.f. indication on the external indicator.

(i) Make sure that the P.A. GRID Meter reads 120 ma. If not, adjust the tap on bleeder resistor R-20 until this grid current is obtained.

(j) Connect either the antenna or a dummy load (such as a 300-watt light bulb) to the two insulators on top of the cabinet, and turn on (up) switch S-16 inside the cabinet.

(k) Press the PLATE START Button. Adjust the 810 TUNING Button for minimum reading on the P.A. PLATE Meter. Adjust the PLATE Control until the P.A. PLATE Meter (KV) reads 1350 volts. Press the ANT. TUNING Button until the P.A. PLATE Meter (MA) reads 266 ma. Recheck the resonance of the power amplifier.

NOTE

It should only be necessary to advance the PLATE Control to about mid-scale to give 1350 volts. If not, the line voltage is not 230 volts, and it will be necessary to change the tap on the primary of the plate transformer to either 210 or 220 volts. The PLATE Control should normally take care of a ±10% variation in the line voltage for the plate transformer.

(l) Adjust the screwdriver controls located on the side of the modulator bias supply (Figs. 14 and 15), until both of the MOD. PLATE Meters read 40 ma.

(m) Set the crystals to zero-beat with the frequency monitor, by means of the adjustments (C-49 and C-64) located on the rear of the r.f. exciter (see Figs. 2 and 3).

(n) As a final check, press the 813 TUNING Button to check the DRIVER PLATE Meter for minimum reading; and press the 810 TUNING Button to check the P.A. PLATE Meter (MA) for minimum reading.

(o) Connect the feed-line to the two insulators on top of the case if not already done as outlined in step (j) above. Adjust the PLATE Control until the R.F. LINE and ANTENNA Meters read correctly for the type of line and antenna used.

NOTE

If a Vacuum Tube R.F. Current Meter RCM-10 is used as the ANTENNA Meter (Fig. 4), the fine adjustment potentiometer for this meter is R-2 (see Fig. 17).

TABLE OF METERS

NAME	SYMBOL	FUNCTION
CRYSTAL PLATE	M-1	Crystal plate current
BUFFER PLATE	M-2	Buffer plate current
DRIVER GRID	M-3	Driver grid current
DRIVER PLATE	M-4	Driver plate current
P.A. GRID	M-5	P.A. grid current
P.A. FILAMENT	M-6	P.A. filament volts
P.A. PLATE (MA)	M-7	P.A. plate current
R.F. LINE	M-8	R.F. line current
P.A. PLATE (KV)	M-9	P.A. plate volts
MOD. PLATE (left)	M-10	Modulator plate current
MOD. PLATE (right)	M-11	Modulator plate current
ANTENNA	M-12	Antenna current

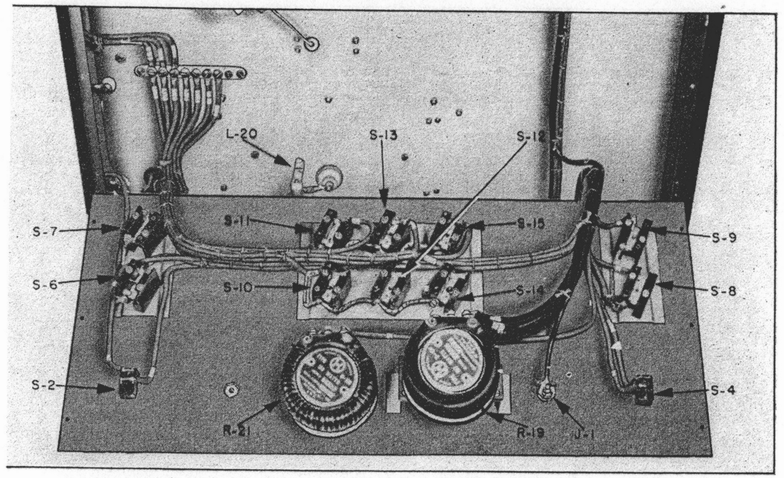


Figure 8. Rear View of Control Panel Hinged Down, Showing Components.

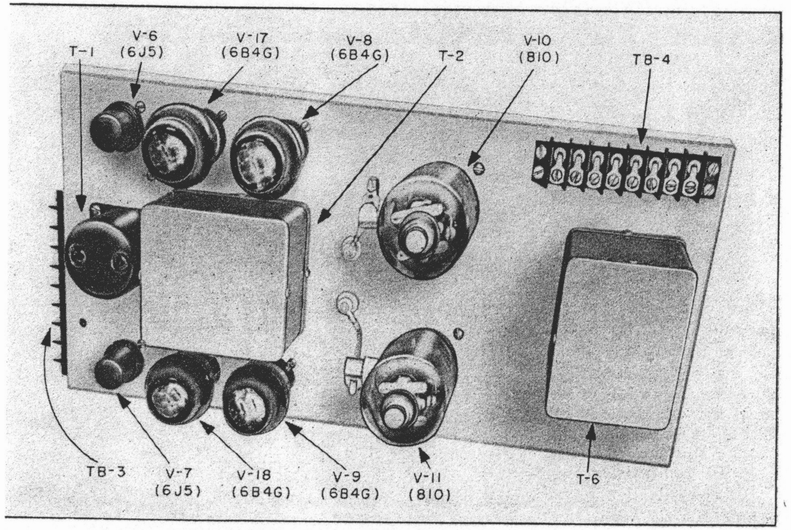


Figure 9. A.F. Amplifier Chassis: Top View.

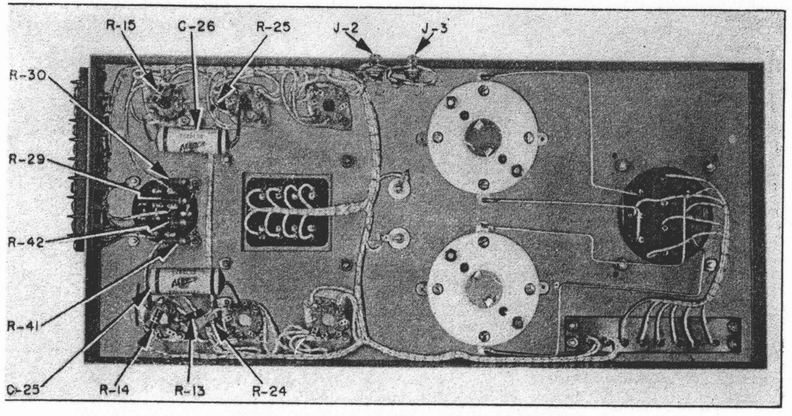


Figure 10. A.F. Amplifier Chassis: Underside.

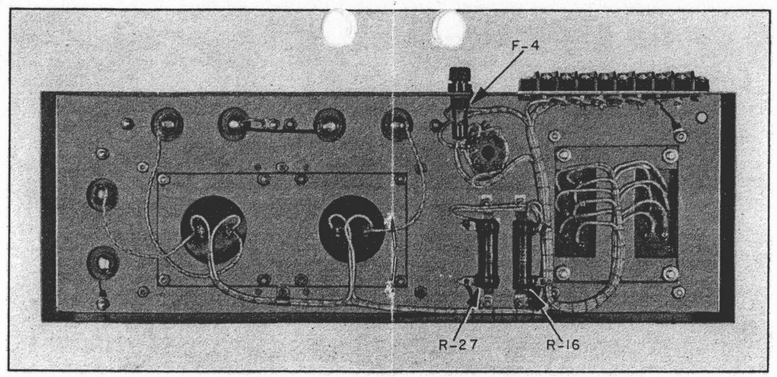


Figure 11. A.F. Amplifier Power Supply: Underside.

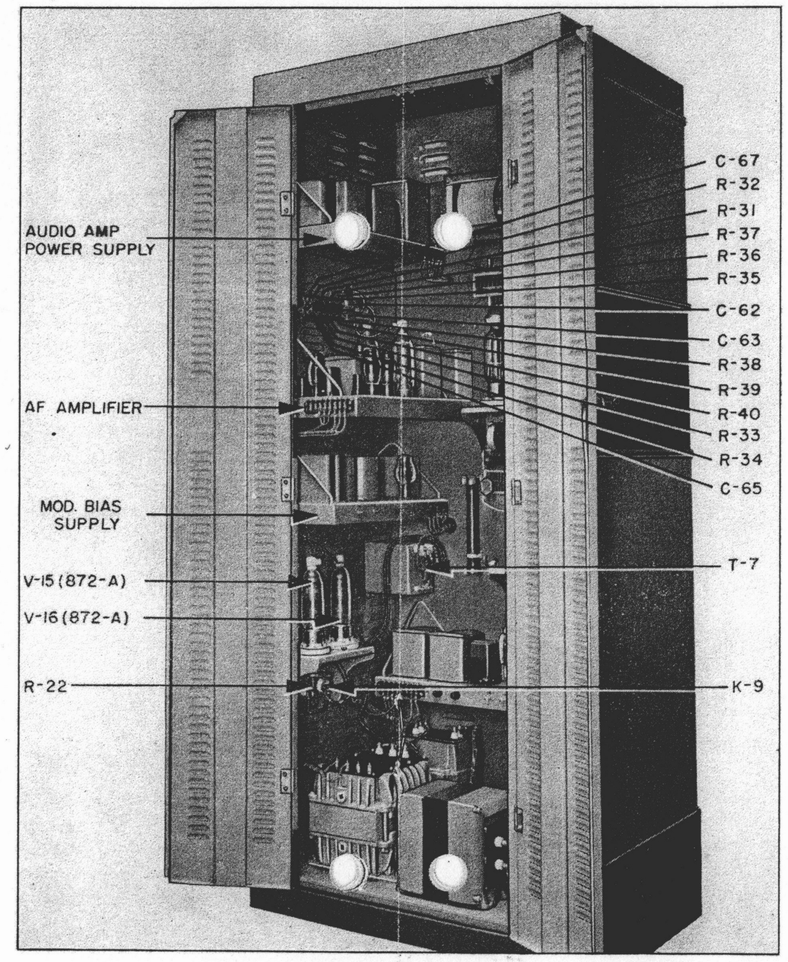


Figure 12. Rear View, Left Side.

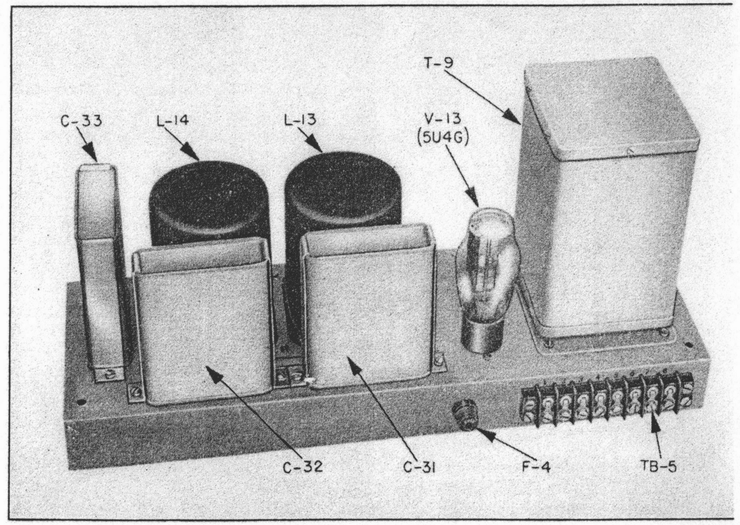


Figure 13. A.F. Amplifier Power Supply: Top View.

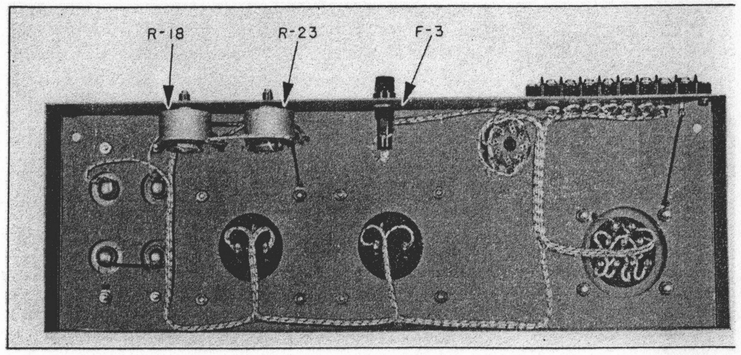


Figure 14. Modulator Bias Supply Chassis: Underside.

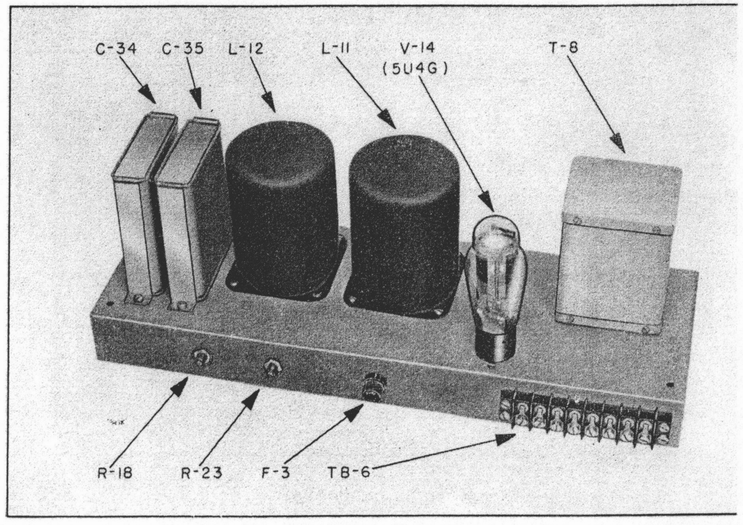


Figure 15. Modulator Bias Supply Chassis: Top View.

OPERATION

TO START THE TRANSMITTER

Press the black FILAMENT START Button on the front panel. The following meter readings should now be noted:

P.A. FILAMENT . . . 10 volts
CRYSTAL PLATE . . . 6–9 ma.
BUFFER PLATE . . . 40–50 ma.
DRIVER GRID . . . . 4–8 ma.

After 30 seconds have elapsed, press the black PLATE START Button. The following additional meter readings should be noted:

P.A. GRID . . . . . 120 ma.

P.A. PLATE (KV) . . 1350 volts
P.A. PLATE (MA) . . 266 ma.
R.F. LINE (depends upon type of line)

DRIVER PLATE . . . 90–110 ma.
MOD. PLATE—left, M-10 (V-11) . . . . . 40 ma.
MOD. PLATE — right, M-11 (V-10) . . . .40 ma.
ANTENNA (depends upon type of antenna)

The Transmitter is now ready to operate, and audio modulation may be applied.

TO STOP THE TRANSMITTER

Press the red PLATE STOP Button, then after a few seconds press the red FILAMENT STOP Button. This shuts everything off except the crystal heaters and their indicating lights.

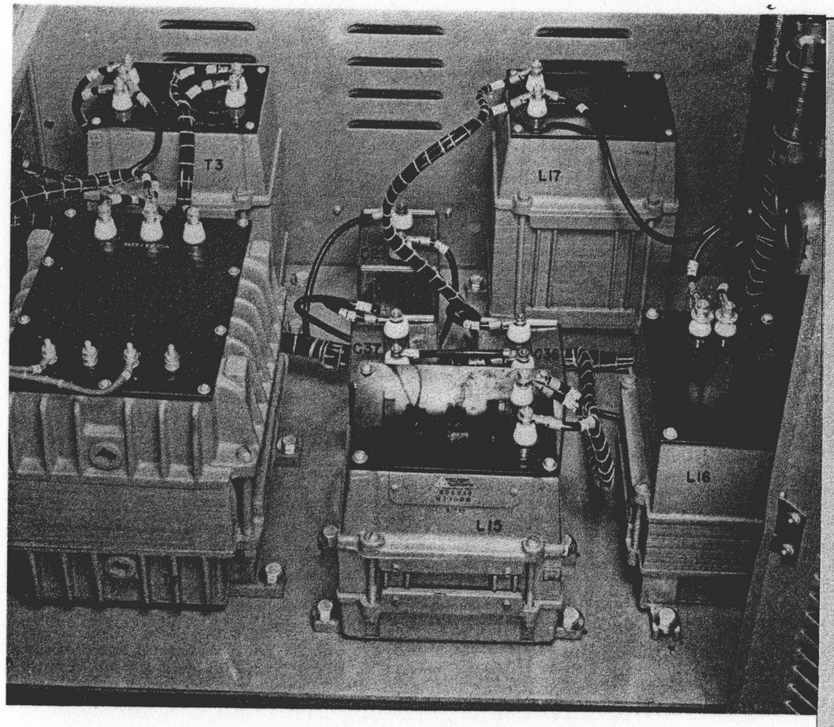


Figure 16. Top Rear View of Transmitter, Showing Lower Components.

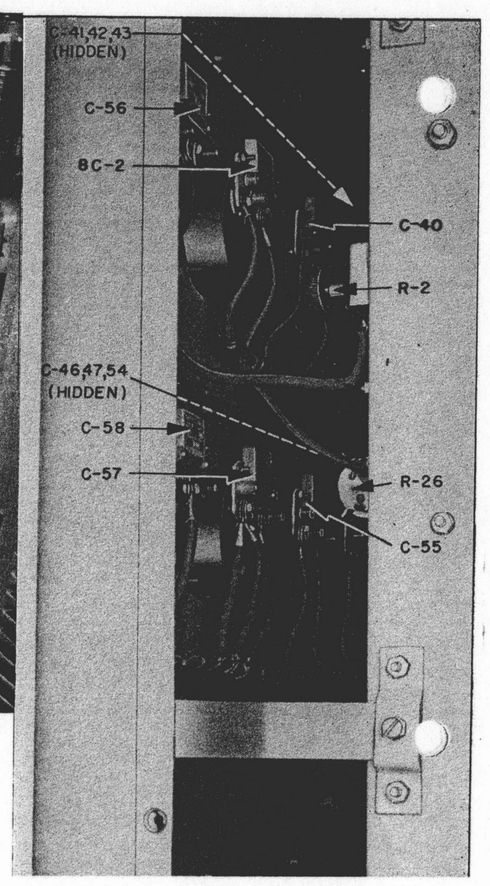


Figure 17.
Left Rear View of Meter Panel. ➤➤➤

TABLE OF CONTROLS
(See Fig. 4)

NAME	SYMBOL	FUNCTION
CRYSTAL 1 CRYSTAL 2	S-2	Selects crystals.
R.F. LINE 1 R.F. LINE 2	S-4	Selects output line.
NEUT. COND. (Screwdriver control)	C-15 and C-16	Neutralizes 810's.
FILAMENT START STOP	 S-6 S-7	 Controls all filaments, bias power supply, speech amplifier power supply, osc. buffer supply, tuning motors, and relays K-1, K-3, and K-11.
PLATE START STOP	 S-8 S-9	 Controls high voltage on driver plate, P.A, plates, and modulator plates.
FILAMENT Control	R-21	Adjusts filament voltage, low-voltage power supplies, and relays K-1, K-3, and K-11.
PLATE Control	R-19	Adjusts plate voltage on buffer and final stages, and modulator.
813 TUNING Buttons	S-10 and S-11	Tunes driver stage.
810 TUNING Buttons	S-12 and S-13	Tunes power amplifier stage.
ANT. TUNING Buttons	S-14 and S-15	Controls antenna coupling.

MAINTENANCE

Once the transmitter is properly installed, it will provide reliable trouble-free operation for a long time. Nevertheless, a regular preventive maintenance schedule should be established and rigidly followed.

It is important to keep the equipment clean and free from dust and foreign matter, particularly the variable condensers, insulators, and tube prongs and contacts.

All mechanical connections such as bolts, nuts, and screws should be kept tight. However, they should not be overtightened by using an improper tool and excessive or suddenly applied pressure.

All tubes should be checked regularly and any tube showing low emission should be replaced. The spare 872A tubes should be kept stored in an upright position, and the mercury should not be splashed on the tube elements. If these tubes have been shaken or tipped, so as to splash the mercury, they should be preheated before being placed in service.

The gear train and tuning motors should be greased every two years.

During the routine maintenance periods, defects can be detected by inspection, touch, and measurement. Every part of the equipment should be closely scrutinized for any visible defect, for visual inspection will detect the presence of dirt, corrosion, mechanical injury, wear, discoloration, and chipped, cracked, or broken parts. The sense of touch will detect abnormal rise in temperature and chipped, cracked, broken, or loose parts. Electrical measurements will locate any deviation from operating tolerances.

BALL GAP SETTING

Adjust the spacing of the ball gap associated with modulation choke L17 to 0.062 inch.

TUBE VOLTAGES AND CURRENTS

NOTE: Voltages are read with respect to ground, using a 20,000 ohms-per-volt meter. It is not advisable to attempt voltage and current measurements where values have been omitted in this table.

TUBE SYMBOL	TUBE TYPE	FUNCTION	VOLTAGE				CURRENT (Ma.)	
			Scr. Grid	Plate	Grid	Cath.	Grid	Plate
R.F. EXCITER								
V-1	6J5	Crystal osc.		150*				7—9
V-2	807	Buffer	225	305			0	40—50
AUDIO AMPLIFIER								
V-6	6J5	Amplifier		134		+4.5		
V-7	6J5	Amplifier		134		+4.5		
V-8, V-9	6B4G	Amplifier		375		+65		75—90†
V-17, V-18	6B4G	Amplifier		375		+65		75—90†
V-10	810	Modulator			-35			40
V-11	810	Modulator			-35			40
DRIVER AND POWER AMPLIFIER								
V-3	813	R.F. driver	260	1350			4—7	90—110
V-4, V-5	810	Final amplifier		1350			120	266†

*This voltage is set for class A operation of the 807, just below the point where the 807 draws grid current.
†For two tubes.

RECOMMENDED LIST OF SPARE PARTS TO BE KEPT ON HAND

Qty.	Description	Supplier	Part. No.
2	Capacitor: 0.01 mfd ±10% 600 V DCW mica type H	Sangamo	50-L-17 A35-15222
2	Capacitor: 0.01 mfd ±10% 1200 V DCW type 4 #4-21010	Cornell-Dubilier	50-L-78 A35-15369
1	Capacitor: vacuum type 7.5 kv. (cap. determined by trans. freq.) GE #GL-1L33 100 mmf usual value	Raytheon or General Electric	50-L-32 A35-15289
2	Capacitor: 0.001 mfd ±10% 3000 V DCW mica type 9F	Cornell-Dubilier	50-L-65 A35-15370
1	Capacitor: 8 mfd 600 V DCW, oil, type TJL 6080	Cornell-Dubilier	50-L-23 A35-15265
1	Capacitor: 4 mfd 2500 V DCW, oil, type 2509-MS mtg.	Aerovox	50-V-7 C35-15371
2	Capacitor: 0.005 mfd ±10% 600 V mica, type 4	Cornell-Dubilier	50-L-39 A35-15264
2	Capacitor: 50 or 100 mmf, mica (depends on frequency of trans.), type 9F	Cornell-Dubilier	
2	Capacitor: 100 mmf ±10% 3000 V DCW, mica, type 9F	Cornell-Dubilier	50-L-18 A35-15368
1	Choke: 350 mh., 200 ma. with pickup coil	S.W. Ind.	65-L-20 A92-15345
1	Choke: 5.5 mh., 500 ma., type #278	Insuline	65-L-21 A92-15344
1 (8M-8)	Meter, Line: 0–2.5 amps. RF scale #425 rect. bakelite case supplied with ext. thermocouple having 60" lead	Weston	Note: If thermocouple type meter is used
1	Meter, Antenna (remote reading) (Same type of meter as used in the equipment)	Weston	Note: If thermocouple type meter is used
4	Resistor: 22,000 ohms ±10% 1 W. insl. carbon type GB	A. Bradley	237-L-225 80-15561
1	Resistor: 15,000 ohms ±10% 18 W wire wound, adjustable ferrule ends, type 2 1/16 A20-9 with K band	H. Hindle	237-L-771 A80-15466P2
2	Thermal overload A. H. & H. Resistor #42018	A. H. & H.	231-L-787 A80-15559
1	Resistor: 300 ohms ±10% 18 W wire wound, ferrule ends, type 2 1/16 A20-9	H. Hindle	237-L-784 A80-15557
1	Resistor: 4,000 ohms ±10% 45 W wire wound, ferrule ends, type 5 1/8 120-13	H. Hindle	237-U-778 B80-15558
1	Resistor: 390 ohms ±10% 20 W wire wound, type 2R	Lectrohm	237-L-785 A80-15556
1	Potentiometer: 350 ohms ±10% 25 W wire wound, type M, style 2955-3 TC	H. Hindle	244-L-13 A40-15087
1	Resistor: 40,000 ohms ±10% 160 W wire wound, adj. with ferrule ends, type 9 5/8 V20-18 with 341 band	H. Hindle	237-L-772 A80-15555
1	Resistor: 10 ohms ±10% 18 W wire wound, adj., type 2 1/16 A20-9 with K band	H. Hindle	237-L-782 A80-15466P1
2	Resistor: 470,000 ohms ±10% 1 W type GB	A. Bradley	237-L-241 80-15480
10	Fuse: 1.5 amps., type 3AG	Jefferson	112-L-6 A26-15070
10	Fuse: 1/2 amp., type 3AG #1046	Jefferson	112-L-4 A26-15090
5	Fuse: 1 amp., type 3AG	Jefferson	112-L-5 A26-15063
12	Pilot lamp: 110V 6 W., clear, type 56	General Electric or Mazda	177-L-6 A77-15008
1	Crystal: RCA, type TMV-129B	Bliley or RCA	55-U-1 B122-15004
1	Motor: 1 RPM 115 V 60 cy., reversible type	Electro-Eng.	188-L-1 A115-15039
3	Tube: 6J5, metal	Raytheon	
1	Tube: 807	Raytheon	
1	Tube: 813	RCA	
4	Tube: 6B4G	Raytheon	
4	Tube: 810	RCA	
3	Tube: 5U4G	Raytheon	
2	Tube: 872A	Raytheon	
2	Insulator: Feed-thru, type #44	Johnson	145-L-1 A22-15099
1	Insulator: Feed-thru, type #51	Johnson	28-L-3 A22-15101
2	Cone: Alsimag "196," #500	Johnson	145-L-9 A22-15094
1	Cone: Alsimag "196," #502	Johnson	145-L-4 A22-15118

Footnote: The second part number attached to each item on this list is the new Raytheon part number.

REPLACEMENT PARTS LIST

SYMBOL NUMBER	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
	CAPACITORS		
C-1AB	Capacitor: 3x0.1 mfd ±10% oil filled V DCW #A84-51BA	Fast	50-L-25
C-2	Capacitor: 0.01 mfd ±10% 600 V DCW mica type H	Sangamo	50-L-17
C-3	Capacitor: 5 mmf ±20% 500V DCW type 5R5V5	Cornell-Dubilier	50-L-62
C-4ABC	Same as C-1AB		
C-5	Capacitor: 50 or 100 mmf mica (depends on frequency of trans.) type 9F	Cornell-Dubilier	
C-6	Capacitor: 1mfd ±10% 600 V type NDO	Cornell-Dubilier	50-L-16
C-7	Capacitor: 0.0005 mfd ±10% 500 V DCW mica Cornell-Dubilier type 4 or Sangamo type H	Cornell-Dubilier or Sangamo	50-L-51
C-8, 9, 10	Same as C-2		
C-11	Same as C-5		
C-12	Capacitor: 100 mmf dual air type 4500 V #100 ED45	Johnson	50-L-56
C-13, 14	Capacitor: 100 mmf ±10% mica 3000 V DCW type 9F	Cornell-Dubilier	50-L-18
C-15, 16	Capacitor: 12 mmf air 0.25" spacing 12G70	Johnson	50-L-76
C-17, 18	Same as C-2		
C-19	Capacitor: vacuum type 7.5 kv (cap. determined by trans. freq.) GE #GL-1L33 100 mmf usual value	Raytheon or General Elec.	50-L-32
C-20	Capacitor: 100 mmf dual air #DD70	Johnson	50-V-6
C-22	Same as C-2		
C-23AB	Capacitor: 2x0.1 mfd ±10% 600 V DCW type DYR	Cornell-Dubilier	50-L-55
C-25, 26	Capacitor: 0.25 mfd ±10% 600 V DCW type DT 6P25	Cornell-Dubilier	50-L-54
C-27	Capacitor: 4 mfd 2500 V DCW oil, type 2509-MS mtg.	Aerovox	50-V-7
C-29, 30, 31, 32, 33, 34, 35	Capacitor: 8 mfd 600 V DCW oil, type TJL 6080	Cornell-Dubilier	50-L-23
C-36, 37	Same as C-27		
C-39	Same as C-2		
C-40, 41, 42, 43, 46, 47	Capacitor: 0.005 mfd ±10% 600 V mica, type 4	Cornell-Dubilier	50-L-39
C-49	Capacitor: 3–30 mfd air 0.050 spacing special type J	Johnson	50-L-31
C-51	Capacitor: 0.001 mfd ±10% 3000 V DCW mica, type 9F	Cornell-Dubilier	50-L-65
C-52, 53	Capacitor: 0.0025 mfd ±10% 600 V DCW mica, type 1R	Cornell-Dubilier	50-L-64
C-54, 55, 56, 57, 58	Same as C-40		
C-60	Same as C-2		
C-61	Same as C-51		
C-62, 63	Capacitor: 0.01 mfd ±10% 1200 V DCW type 4 #4-21010	Cornell-Dubilier	50-L-78
C-64	Same as C-49		
C-65, 67	Capacitor: 500 mmf ±20% 500 V DCW mica #5W5T5	Cornell-Dubilier	
C-69	Capacitor: 4 mmf 500 V	Erie	If required
8C-2	Same as C-40		
	RESISTORS		
R-1	Resistor: 47,000 ohms ±10% 1/2 W. insl. carbon type EB	A. Bradley	237-L-156
R-2	Potentiometer: 20 ohms WW type T	Mallory	244-L-14
R-3	Resistor: 100,000 ohms ±10% 1/2 W. insl. carbon type EB	A. Bradley	237-L-160
R-4	Resistor: 350 ohms ±10% 10 W. WW type A-119	H. Hindle	237-L-774
R-5	Resistor: 22,000 ohms ±10% 1 W. insl. carbon type GB	A. Bradley	237-L-225
R-7	Resistor: 15,000 ohms ±10% 18 W. WW adjustable ferrule ends type (2 15/16 A-20-9) with K band	H. Hindle	237-L-771

SYMBOL NUMBER	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
R-8	Resistor: 30,000 ohms ±10% 10 W. WW #A131	H. Hindle	237-L-783
R-9	Resistor: 300 ohms ±10% 18 W. WW ferrule ends type 2 5/16 A20-9	H. Hindle	237-L-784
R-10, 11	Resistor: 4,000 ohms ±10% 45 W. WW ferrule ends type (5 1/8 120-13)	H. Hindle	237-U-778
R-12	Resistor: 250 ohms ±10% 38 W. WW adj. type (4 7/16 120-13) with K band	H. Hindle	237-L-773
R-13	Resistor: 820 ohms ±10% 1 W. insl. carbon type GB	A. Bradley	237-L-208
R-14, 15	Resistor: 100,000 ohms ±10% 1 W. insl. carbon type GB	A. Bradley	237-L-233
R-16	Resistor: 390 ohms ±10% 20 W. WW type 2R	Lectrohm	237-L-785
R-18	Potentiometer: 350 ohms ±10% 25 W. WW type M style 2955-3 TC	H. Hindle	244-L-13
R-19	Potentiometer: 500 ohms ±10% 150 W. WW type D-150	H. Hindle	246-LA-1
R-20	Resistor: 40,000 ohms ±10% 160 W. WW adj. with ferrule ends type (9 5/8 V20-18) with 341 band	H. Hindle	237-L-772
R-21	Rheostat: 7.5 ohms ±10% 150 W. WW type D-150	H. Hindle	246-LB-1
R-22	Resistor: 10 ohms ±10% 18 W. WW adj. type (2 15/16 A-20-9) with K band	H. Hindle	237-L-782
R-23	Same as R-18		
R-24, 25	Same as R-3		
R-26	Resistor: (Meter resistor as supplied by mfr.)	Weston or G.E.	237-U-775
R-27	Resistor: 50,000 ohms ±10% 20 W. WW type 2R with brackets	Lectrohm	237-L-786
R-29, 30, 31, 32, 33, 34	Same as R-5		
R-35, 36, 37, 38, 39, 40	Resistor: 470,000 ohms ±10% 1 W. type GB	A. Bradley	237-L-241
R-41, 42	Same as R-5		
	RELAYS & CIRCUIT BREAKERS		
K-1	Relay: Antenna (normally open) 110 V 60 cycles #1527 (furnished with 1/8" bakelite board)	Leach	235-L-3
K-3	Relay: Crystal (normally open) 110 V 60 cycles #1177 CBF	Leach	235-L-2
K-4	Relay: Time delay 30 sec. TD-2. Front connection 115 V 60 cycles	Cramer	235-V-12
K-5	Circuit Breaker: #28518-UA	A. H. & H.	235-V-9
K-5R1, 2	Thermal Overload Resistor: #42018	A. H. & H.	237-L-787
K-8	Circuit Breaker: #28586U	A. H. & H.	235-U-8
K-9	Relay: Overload type #1252 3 V 6 ohms (normally closed) with 1/8" bakelite board	Leach	235-L-10
K-10	Relay: Bias type #1251 35 V DC normally open	Leach	235-L-6
K-11	Same as K-1		
	COILS & CHOKES		
L-1	Choke: 350 mh 200 ma	S.W. Ind.	65-L-19
L-2	Same as L-1 but with pickup coil	S.W. Ind.	65-L-20
L-4, 5	Choke: 5.5 mh 500 ma type #278	Insuline	65-L-21
L-6, 7	Line Choke: 16.5 mh single section 20 amp ferrule mtg. type PW-3	Lectrohm	65-L-28
L-8	Same as L-4		
L-9, 10, 11, 12, 13, 14	Choke: 10 hy 200 ma 94201 RC-125 case	U.T.C.	65-L-5
L-15	Choke: (Swinging) 16-5 hy 750 ma U11026	Raytheon	92RA-65L24
L-16	Choke: 10-hy 450 ma U11062	Raytheon	92RA-65L23
L-17	Choke: 80 hy 260 ma #U11022	Raytheon	65-L-25

SYMBOL NUMBER	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
L-18	Tank Coil: 135 mh type 2436N3 with 2124VN3CC rotor. (In special cases 240 mh will be used)	Johnson	48-U-2
L-19	Tank Coil: 200 mh (fab). In special cases 300 mh will be used	Raytheon	4-U-68
L-20	Same as L-4		
	SWITCHES		
S-1, 2, 4	Switch: SPST toggle #8381K7 bat handle type 3 amp 250 V black oxidized finish	Cutler-Hammer	263-L-16
S-6, 10, 11, 12, 13, 14, 15	Switch: Push button B-1	A. H. & H.	263-L-18
S-7	Switch: Push button B-3	A. H. & H.	263-L-19
S-8	Same as S-6		
S-9	Same as S-7		
S-10, 11, 12, 13, 14, 15	Same as S-6		
S-16	Same as S-1		
S-17, 18	Switch: Interlock (normally open) #YZ-RQ1 type Z	Micro Switch	263-L-15
	METERS		
M-1	Meter: 0-15 ma DC #301 rectangular bakelite case, calib. for use on 16 ga. steel panel	Weston	187-V-10
M-2	Meter: 0-100 ma DC #301 rectangular bakelite case, calib. for use on 16 ga. steel	Weston	187-V-8
M-3	Meter: 0-10 ma DC #301 rectangular bakelite case, calib. for use on 16 ga. steel	Weston	187-V-11
M-4, 10, 11	Meter: 0-250 ma DC #301 rectangular bakelite case, calib. for use on 16 ga. steel	Weston	187-V-12
M-5	Meter: 0-150 ma DC #301 rectangular case, calib. for use on 16 ga. steel	Weston	187-V-6
M-6	Meter: 0-15 V 60 cycles #476 rectangular bakelite case, calib. for use on 16 ga. steel	Weston	187-V-5
M-7	Meter: 0-500 ma DC #301 rectangular bakelite case, calib. for use on 16 ga. steel	Weston	187-V-7
8M-8	Meter, Line: Either one of the two types of meters listed below may be furnished: Type 1: 0-2.5 A. type 301-01 movement rect. bakelite case supplied with Raytheon Vacuum Tube Current Meter Assembly RCM-10 Type 2: 0-2.5 A. RF Scale #425 rect. bakelite case supplied with ext. thermocouple having 60" lead	Weston	
M-9	Meter: 0-2 kv DC #301 rectangular bakelite case calib. for use on 16 ga. steel with ext. resis.	Weston	187-V-9
8M-12 (optional at extra cost)	Meter, Remote Reading Ant: Type 301, 1 ma movement, rect. case. Scale 0-25 or 0-5 A. per customer's requirement. (Used with Vacuum Tube Current Meter RCM-10)	Weston	
	TRANSFORMERS		
T-1	Transformer: Audio line to grid	U.T.C.	291-L-52
T-2	Transformer: M-11021 Audio Driver	Raytheon	291-L-73
T-3	Transformer: U-10917 Modulation	Raytheon	291-L-74
T-4	Transformer: Filament M-10587	Raytheon	291-L-68
T-5	Transformer: Filament U-10933	Raytheon	291-L-7
T-6	Transformer: Filament U-11025	Raytheon	291-L-69
T-7	Transformer: Filament U-10931	Raytheon	291-L-4
T-8	Transformer: Low Voltage U-11024	Raytheon	291-L-71
T-9, 10	Transformer: Low Voltage U-10590	Raytheon	291-L-70
T-11	Transformer: High Voltage U-10581A	Raytheon	291-L-72

SYMBOL NUMBER	DESCRIPTION	SUPPLIER	RAYTHEON PART NO.
	TUBES, LAMPS, & FUSES		
V-1	Tube: 6J5 metal	Raytheon	
V-2	Tube: 807	Raytheon	
V-3	Tube: 813	RCA	
V-4, 5	Tube: 810	RCA	
V-6, 7	Same as V-1		
V-8, 9	Tube: 6B4G	Raytheon	
V-10, 11	Same as V-4		
V-12, 13, 14	Tube: 5U4G	Raytheon	
V-15, 16	Tube: 872A	Raytheon	
V-17, 18	Same as V-8		
F-14	Fuse: 1.5 amp type 3AG	Jefferson	112-L-6
F-2, 3	Fuse: ½ amp type 3AG #1046	Jefferson	112-L-4
F-5	Fuse: 1 amp type 3AG	Jefferson	112-L-5
F-6	Same as F-2		
I-1, 2, 5, 6	Pilot Lamp: 110 V 6 W clear type 56	General Electric or Mazda	117-L-6
	MISCELLANEOUS		
Y-1, 2	Crystal: RCA type TMV-129B	Bliley or RCA	55-U-1
B-1, 2, 3	Motor: 1 RPM 115 V 60 cy. reversible type	Electro-Eng.	188-L-1
	Fuse Holder: #HMC	Bussmann	112-L-1
	Fuse Holder for 3AG fuses #1101	H. B. Jones	112-L-3
	Pilot Lamp Holder: #1201 plain jewel, red, green, 2 amber, screw jewel	Gothard	177-L-3, 4, 5
	Socket: Octal with 1 1/2" mtg. centers #9859 mica filled	Cinch	256-L-10
	Socket: 5-prong type #77M1-P5T mica filled	Amphenol	256-L-7
	Socket: For 813 tube #237	Johnson	256-L-4
	Socket: For 810 tube #211	Johnson	265-L-1
	Socket: For RCA TMV-129B Crystal	RCA	256-L-8
TB-1 through 6	Terminal Board: #8-142-YM	Jones	290-L-18
TB-7, 8, 9	Terminal Board: #3-141-YMS	Jones	290-L-7
TB-10, 12	Terminal Board: #2-141-MS	Jones	290-L-52
TB-11	Terminal Board: #8-142-MS	Jones	290-L-53
	Fuse Clip: #3425	Econ. Fuse	47-L-12
	Fuse Clip: #3426	Econ. Fuse	47-L-13
	Fuse Clip: #5651	Econ. Fuse	47-L-14
	Flexible Coupling: #250	Johnson	59-L-1
	Geared Drive: Millen #1000	Millen	90-L-1
	Insulator: Feed through type #44	Johnson	145-L-1
	Insulator: Feed through type #51	Johnson	28-L-3
	Cone: Alsimag "196," #504	Johnson	145-L-5
	Cone: Alsimag "196," #500	Johnson	145-L-9
	Cone: Alsimag "196," #502	Johnson	145-L-4
J-1, 2, 3	Jack: #2A closed circuit IMP type with 1 flat and 1 swaged insl. washer for 7/16" hole	Utah	155-L-2
	Insulator: Round pillar type, 1 1/2" hole, 10-32 screw, porcelain Knobs		145-L-17
	Plate Cap: Type #12	John-Mack	166-V-2
	Plate Cap: Ceramic #36001	National	
	Plate Cap: Ceramic #36002	Millen	41-L-3
	Handy Box: Approx. size 4"x2"x2"	Millen	41-L-2
	Handy Box Metal Cover: Duplex receptacle type		18-L-2
	Duplex Receptacle		52-L-30
	#52 Lead-in bushing	Johnson	
	Insulator-spacer: #600	Johnson	267-L-1
	Miter Gear: #G463	Boston Gear	120-U-1

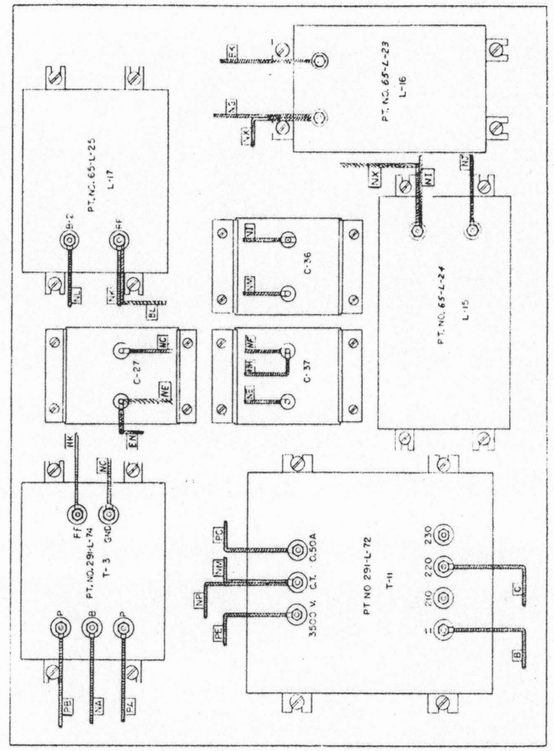


Figure 18. Mounting and Wiring Layout for Lower Components (Outline Drawing) (D2-15487).

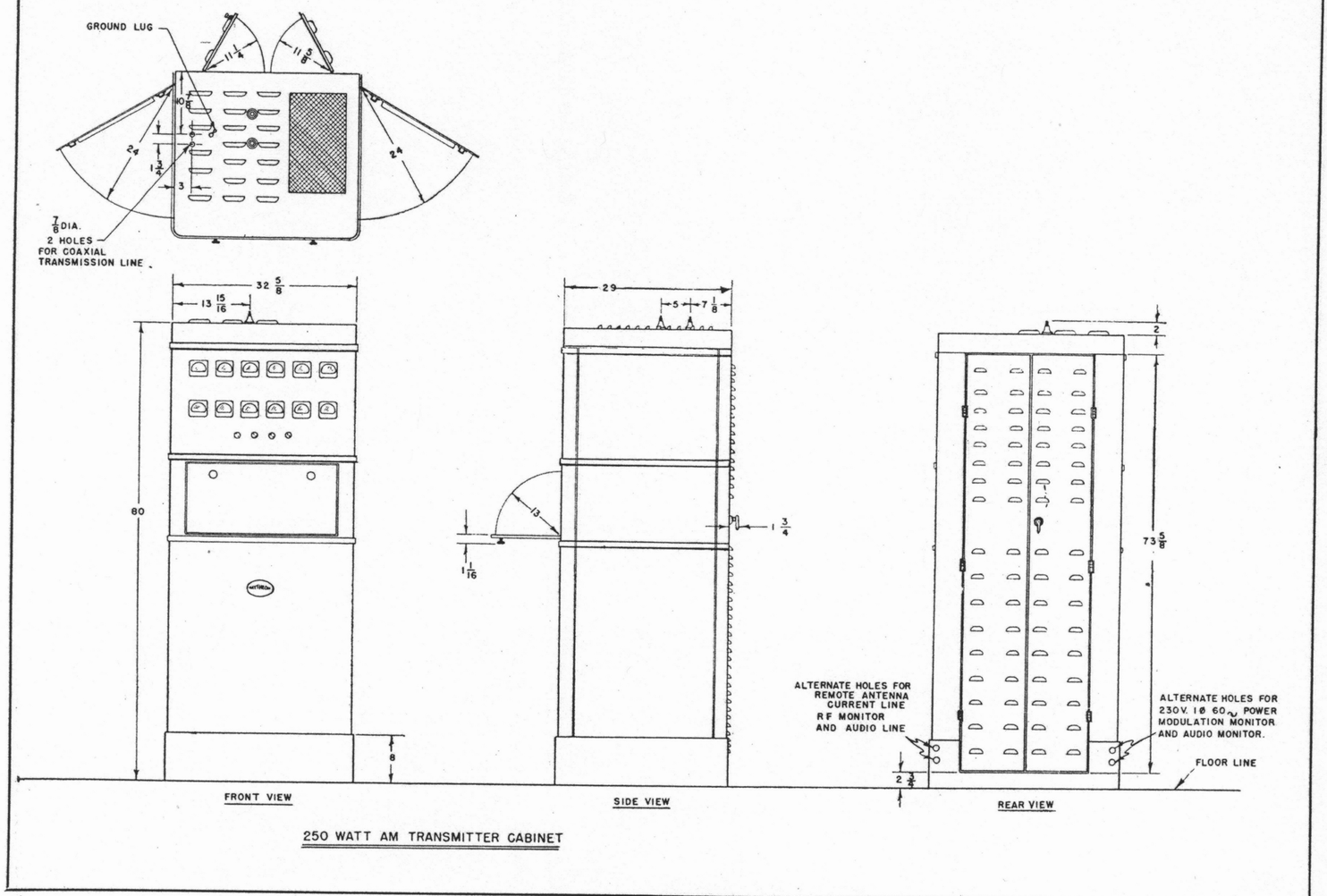


Figure 19. Physical Layout, 4-Door Cabinet (C20-15136).

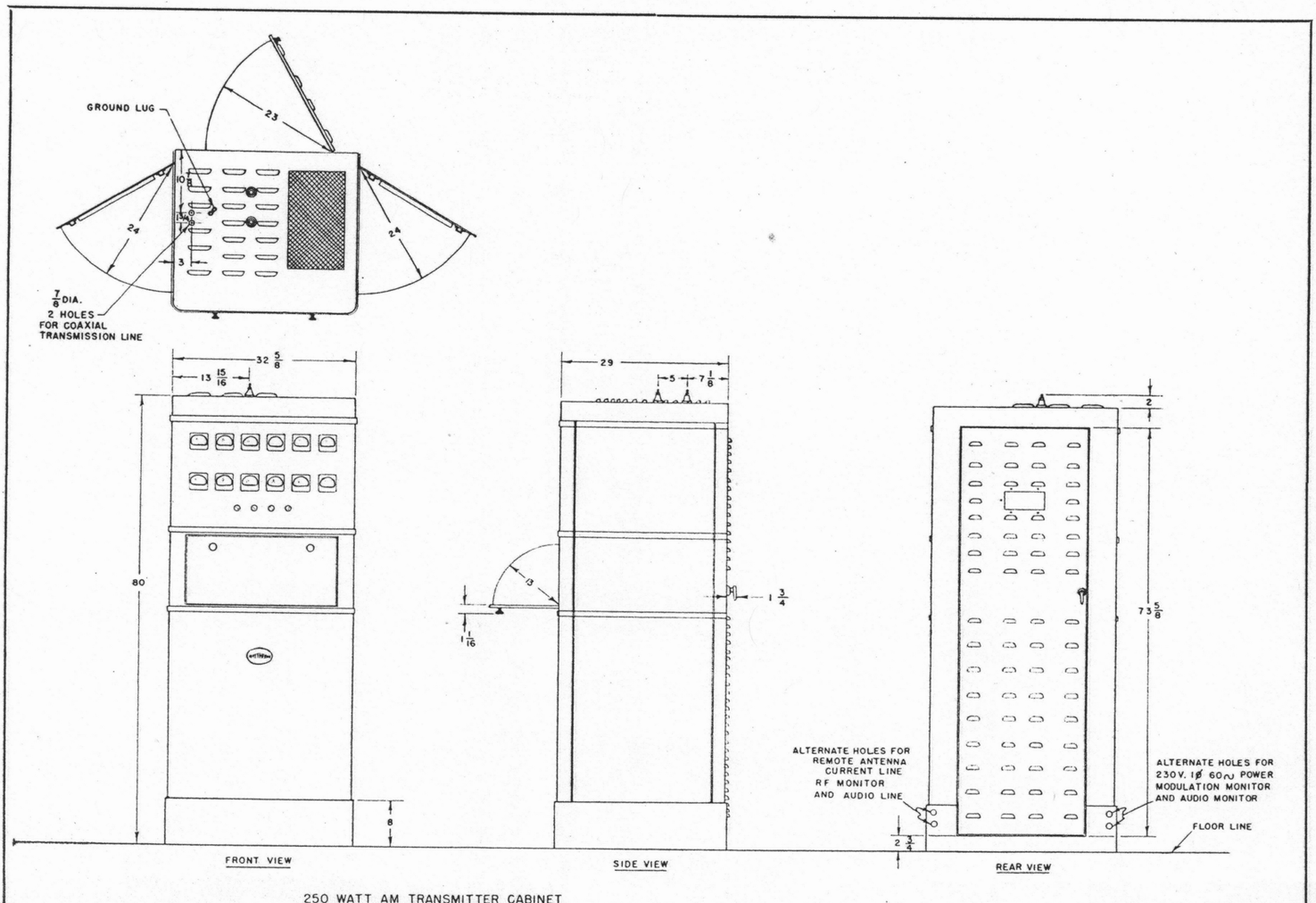


Figure 20. Physical Layout, 3-Door Cabinet (C20-15133).

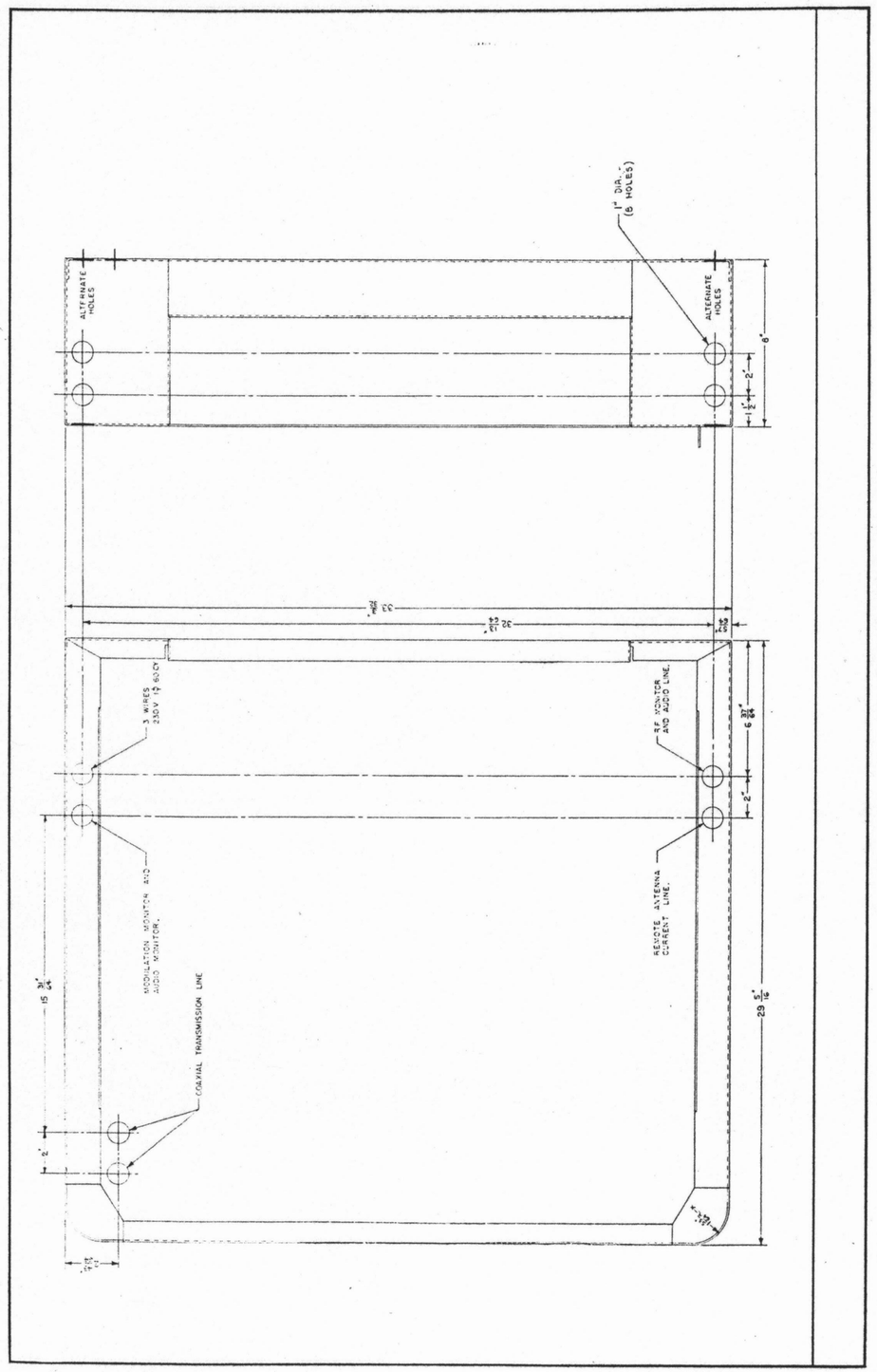


Figure 21. Arrangement of Conduit Holes (Outline Drawing).

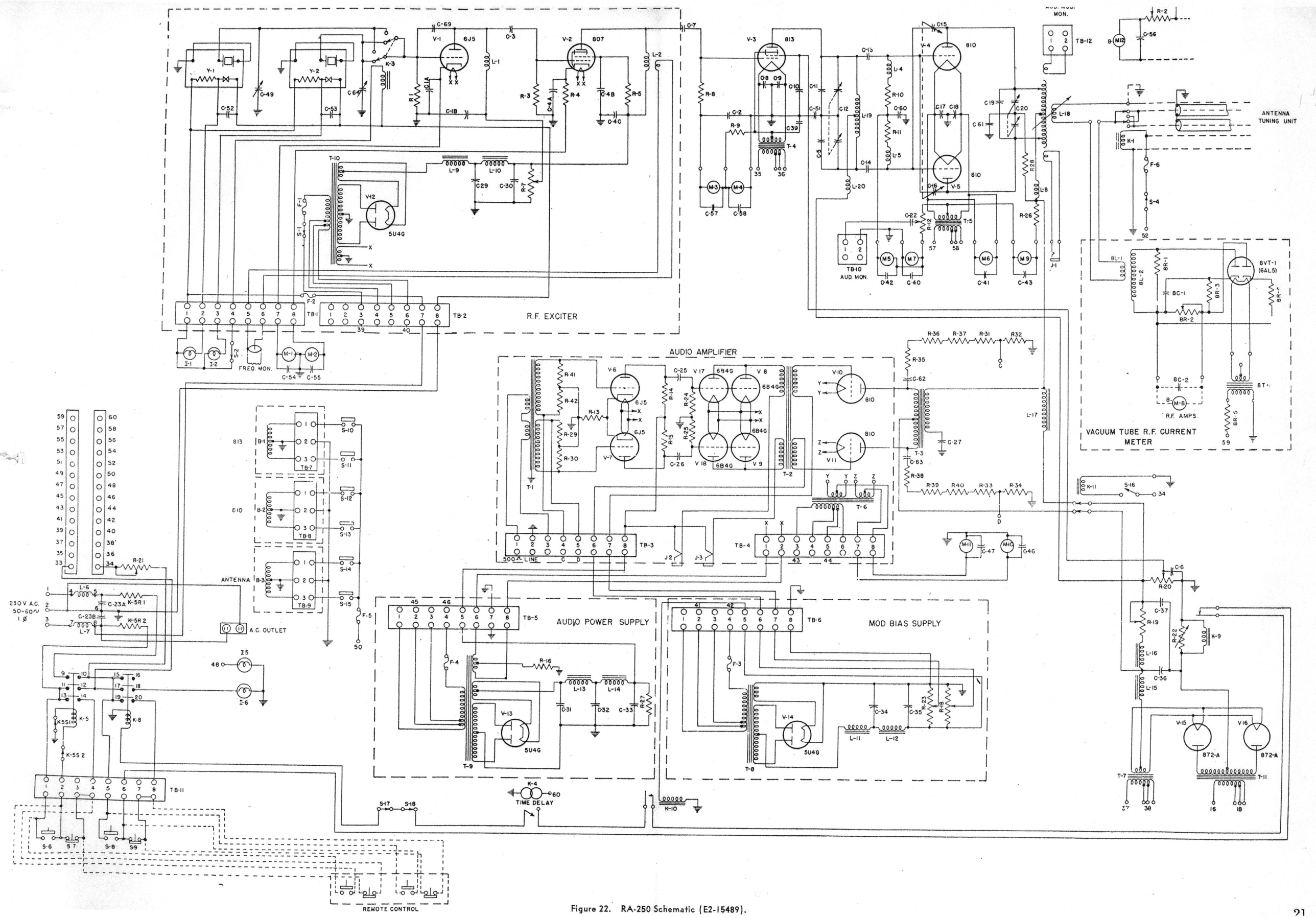


Figure 22. RA-250 Schematic (E2-15489).

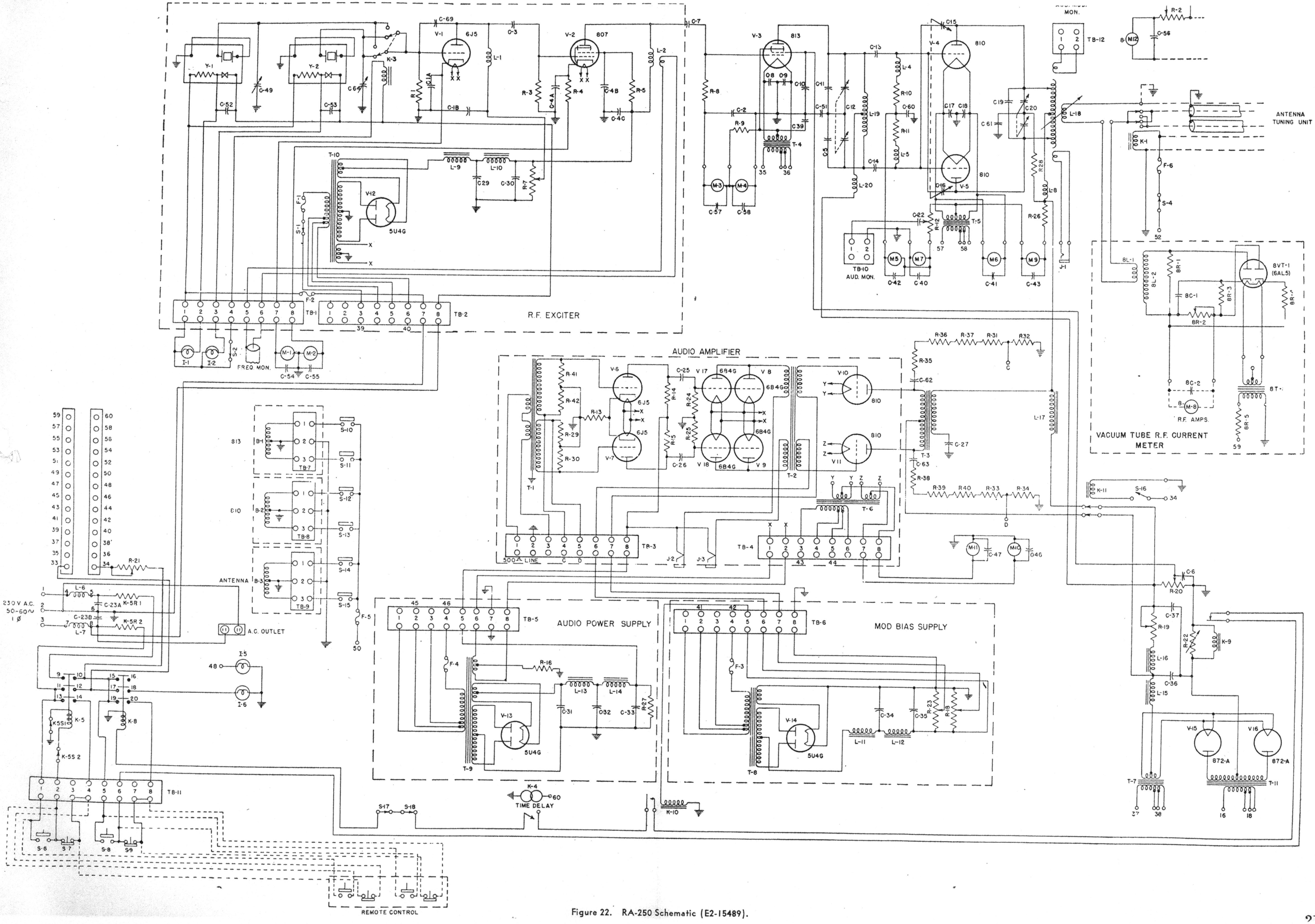


Figure 22. RA-250 Schematic (E2-15489).

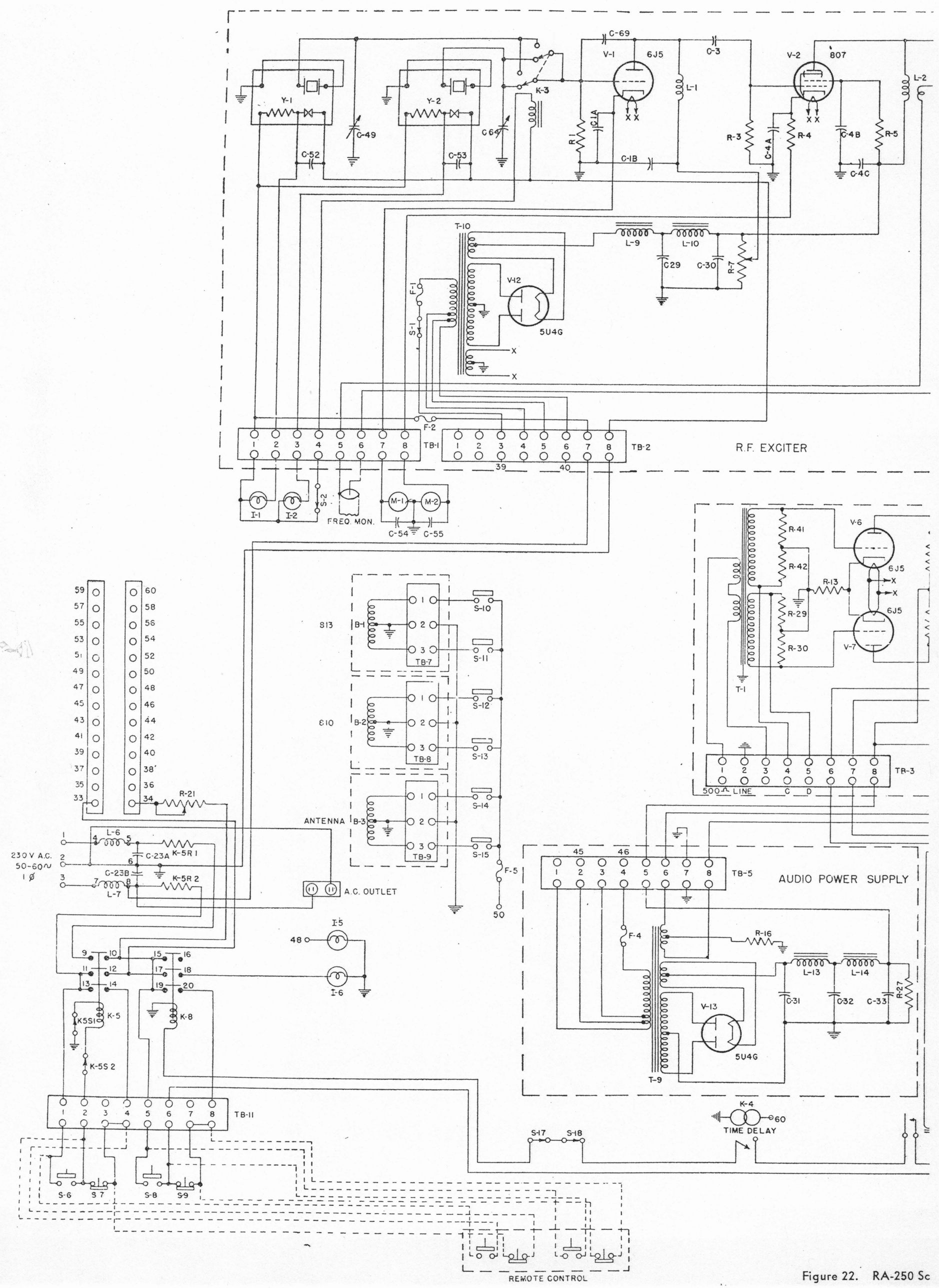
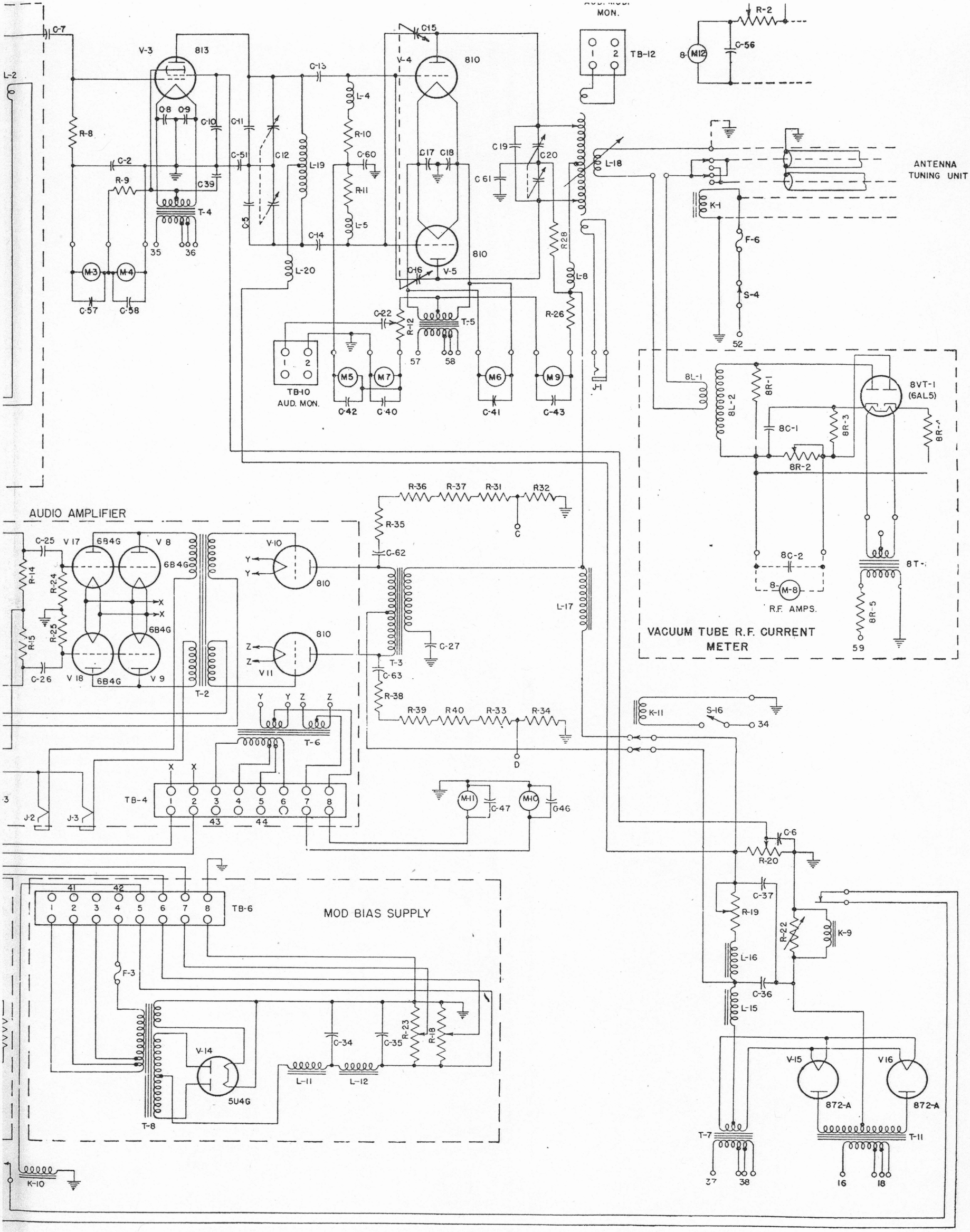


Figure 22. RA-250 Sc



0 Schematic (E2-15489).