BTF-3B

BROADCAST TRANSMITTER

FREQUENCY MODULATED

3000 WATTS

88 TO 108 MEGACYCLES

RCA

Instruction Book

WARNING

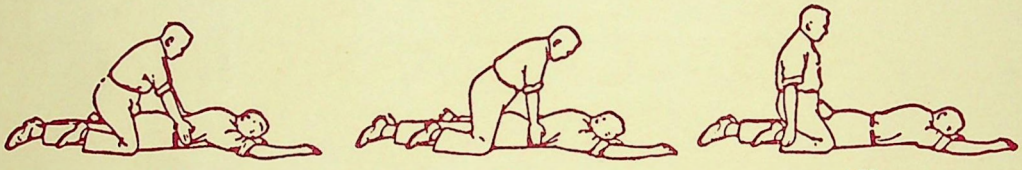
THE VOLTAGES EMPLOYED IN THIS EQUIPMENT ARE SUFFICIENTLY HIGH TO ENDANGER HUMAN LIFE AND EVERY REASONABLE PRECAUTION HAS BEEN OBSERVED IN DESIGN TO SAFEGUARD THE OPERATING PERSONNEL. AN IMPORTANT PART OF THE PROTECTIVE SYSTEM IS THE SERIES OF DOOR INTERLOCK SWITCHES AND ANY TAMPERING WITH THESE SWITCHES SHOULD BE PROHIBITED. THE POWER SHOULD BE REMOVED COMPLETELY BEFORE CHANGING TUBES OR MAKING INTERNAL ADJUSTMENTS.

FIRST AID IN CASE OF ELECTRIC SHOCK

1. PROTECT YOURSELF with dry insulating material.

2. BREAK THE CIRCUIT by opening the power switch or by pulling the victim free of the live conductor.

   DON'T TOUCH VICTIM WITH YOUR BARE HANDS until the circuit is broken.



(A) (B) (C)

3. LAY PATIENT ON STOMACH, one arm extended, the other arm bent at elbow. Turn face outward resting on hand or forearm.

4. REMOVE FALSE TEETH, TOBACCO OR GUM from patient's mouth.

5. KNEEL STRADDLING PATIENT'S THIGHS. See (A).

6. PLACE PALMS OF YOUR HANDS ON PATIENT'S BACK with little fingers just touching the lowest ribs.

7. WITH ARMS STRAIGHT, SWING FORWARD gradually bringing the weight of your body to bear upon the patient. See (B).

8. SWING BACKWARD IMMEDIATELY to relieve the pressure. See (C).

9. AFTER TWO SECONDS, SWING FORWARD AGAIN. Repeat twelve to fifteen times per minute.

10. WHILE ARTIFICIAL RESPIRATION IS CONTINUED, HAVE SOMEONE ELSE:
    (a) Loosen patient's clothing.
    (b) Send for doctor.
    (c) Keep patient warm.

11. IF PATIENT STOPS BREATHING, CONTINUE ARTIFICIAL RESPIRATION. Four hours or more may be required.

12. DO NOT GIVE LIQUIDS UNTIL PATIENT IS CONSCIOUS.

BTF-3B

FREQUENCY MODULATED BROADCAST TRANSMITTER

INSTRUCTIONS

Manufactured by
RADIO CORPORATION OF AMERICA
ENGINEERING PRODUCTS DEPARTMENT
Camden, New Jersey, U. S. A.

Printed in U. S. A.

IB-30133-1

NOTICE

DEFECTIVE TUBES

To obtain replacement and/or credit for defective tubes, proceed as follows:

1. Request return authorization from

   Radio Corporation of America
   Tube Adjustment Department
   Harrison, New Jersey

   state the type and quantity of tubes to be returned for examination.

2. When authorization is received, return the tube(s) as directed.

   DO NOT RETURN ANY TUBES UNTIL AUTHORIZATION HAS BEEN RECEIVED.

   The authorization will include information as to how and where the tube(s) should be returned, together with a data sheet which must accompany the return.

3. Replacement tube(s) will not be shipped unless a specific order is placed with

   Radio Corporation of America
   Tube Department
   Harrison, New Jersey

4. Customer will be billed for all tubes ordered. Credit for defective tubes will be made on customer's account.

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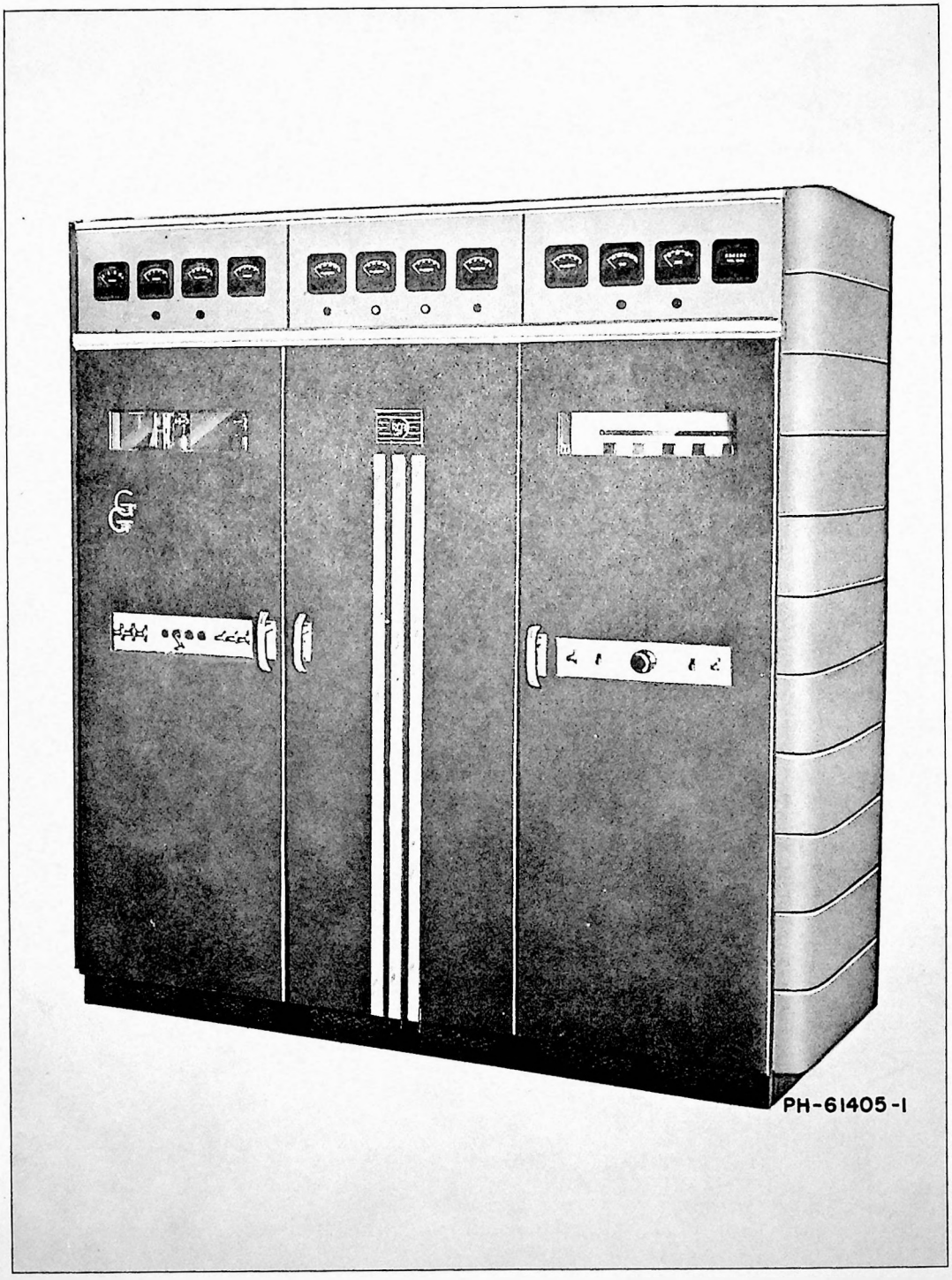


Figure 1—BTF-3B F-M Transmitter

LIST OF ILLUSTRATIONS

TECHNICAL SUMMARY

ELECTRICAL CHARACTERISTICS

Type emission	Frequency Modulated
Frequency range	88 to 108 megacycles
Power output (into transmission line)	1000 to 3000 watts
Output impedance	51.5 ohms (standing wave ratio 1.75 to 1 or less)
Carrier frequency stability, deviation less than	1000 cycles
Modulation capability	±100 kilocycles
Method of modulation	Reactance-tubes
Audio input impedance	600/150 ohms
100 per cent modulation level*	+10 ±2 dbm
Audio frequency response†	
30 to 15,000 cycles (1000 cycle reference)	flat within ±1 db
Audio frequency distortion‡	
30 to 15,000 cycles	not more than 1.0 per cent
(including all harmonics up to 30 kilocycles per second at 75 kc swing)	
FM noise level (reference ±75 kc swing‡)	not more than 65 db
AM noise level (reference 100 per cent amplitude modulation‡)	not more than 50 db
Power line requirements—transmitter	
Line voltage	230/208 volts
Phase	3
Frequency	50 or 60 cycles
Line regulation (maximum)	5 per cent
Power consumption (approximate)	7700 watts
Power factor (approximate)	90 per cent
Power line requirements—crystal heaters	
Line voltage	100 to 130 volts A.C. or D.C.
Power consumption	28 watts

*Level at input of 600 ohm pre-emphasis network.
Insertion loss of this network is approximately 24 db.

†Audio frequency response is referred to a standard 75 micro-second curve when measured using pre-emphasis.

‡Distortion and noise are measured following a standard 75 micro-second de-emphasis network.

TUBE COMPLEMENT

Circuit Symbol	Function	Quantity and Type
	EXCITER	
V101, V102	Modulators	(2) RCA 6V6
V103	Modulated Oscillator	(1) RCA 6V6
V104	1st Buffer—Multiplier	(1) RCA 6V6
V105	2nd Buffer—Multiplier	(1) RCA 2E26
V106	Amplifier	(1) RCA 2E26
V107	1st Frequency Divider	(1) RCA 6AC7
V108	2nd Frequency Divider	(1) RCA 6AC7
V109	3rd Frequency Divider	(1) RCA 6AC7
V110	4th Frequency Divider	(1) RCA 6AC7
V111, V112, V113, V114	Motor Control Tubes	(4) RCA 1614
V115	Crystal Frequency Divider	(1) RCA 6AC7
V116	Crystal Oscillator	(1) RCA 6SH7
V119	Cathode Ray Indicator	(1) RCA 2BP1
	EXCITER POWER SUPPLY	
V201, V207	Low Voltage Rectifiers	(2) RCA 5U4G
V202	High Voltage Rectifier	(1) RCA 5U4G
V204	Voltage Regulator	(1) RCA OC3/VR105
V203, V205	Voltage Regulators	(2) RCA OD3/VR150
	TRANSMITTER UNIT	
V301	Doubler	(1) RCA 4-125A/4D21
V302, V303	1st R-F Amplifier	(2) RCA 4-125A/4D21
V305	Intermediate Power Amplifier	(1) RCA 7C24
V306	Power Amplifier	(1) RCA 7C24
V304	Low Voltage Rectifier	(1) RCA 5U4G
V501, V502, V503, V504, V505, V506	High Voltage Rectifiers	(6) RCA 8008
	TRANSMISSION LINE MONITOR	
V901	R-F Rectifier	(1) RCA 6AL5
V902	Thyratron	(1) RCA 2D21

MECHANICAL SPECIFICATIONS

Dimensions (inches, overall)		
Length	**Height**	**Depth**
81 3/16	84	31 1/16

Weight (approx. lbs.)	Crated	Uncrated
Complete Equipment	4500	2900
Heaviest Unit	810	543

VENTILATION REQUIREMENTS

(Based on 10° C. rise above 45° C.)

Air required for cooling ..... *1700 cfm

Maximum Velocity (Through 1.7 square foot unobstructed opening) ..... 1000 ft/min

Maximum ambient temperature ..... 45° C.

Heat dissipation (approximate) ..... 4700 watts
276 BTU/min

*This figure is based on exhausting the air from the transmitter into the room, and then exhausting the air from the room at another point. In practice, the size of the exhaust fan may be reduced if the transmitter exhaust is fed through a duct or otherwise directed to the room exhaust fan.

EQUIPMENT

The BTF-3B FM transmitter, for 60-cycle operation, is identified by MI-28913 and includes the following equipment:

Quantity	Description	Reference
1	Low Power R-F and IPA and PA unit	MI-28103
1	Exciter Unit	MI-28104-1
1	Power and Control Unit	MI-28105
1	Harmonic Filter	MI-28151
1	Transmission Line Monitor	MI-28155-3
1	Pre-emphasis Network	MI-4926-A
1	Base	MI-28123-3
1	Meter Panel (L. H.)	MI-28133-4
1	Meter Panel (Center)	MI-28133-5
1	Meter Panel (R. H.)	MI-28133-6
1	Set of Doors (Front and Rear)	MI-28126
1	Set of Shields (R. H. and L. H. Ends and Center)	MI-28118
1	Set of Strips (Filler and Trim)	MI-28136
1	Wiring Material Kit	MI-28146
1	Installation Material Kit	MI-28168
1	Finish Touch-up Kit	MI-28153
1	Tool Kit	MI-28288
1	Gas End Seal	MI-19112-5
*2	Blowers	MI-28195-1
2	Instruction Books	IB-30133-1
2	TMV-129G Crystal Unit	MI-19450-A
2	Set of Tubes	MI-28158
1	Nameplate	MI-28180-1
**	Installation Plans	IB-30214

*For altitudes in excess of 5000 feet and/or for operation at 50 cycles, specify MI-28195-2 instead of MI-28195-1.

**One set of drawings is shipped prior to the delivery of the equipment.

NOTE: A conversion kit, MI-28177, is required for 50-cycle operation.

DESCRIPTION

INTRODUCTION

The type BTF-3B Frequency Modulated Broadcast Transmitter is capable of a power output of between 1000 and 3000 watts at any frequency between the limits of 88 and 108 megacycles. The transmitter includes an RCA standard MI-7016 Exciter, followed by a doubler stage and three power amplifier stages.

CONSTRUCTION

The circuit and mechanical layout of the transmitter are arranged to permit maximum accessibility. Vertical chassis type of construction has been followed with surface mounting of components and exposed wiring for easy and speedy circuit tracing and servicing. Transmitter inter-unit wiring is supplied as part of the equipment; only external connections need be considered when making the installation.

The entire transmitter is housed in three fabricated steel frames which are bolted to a base frame. Each compartment is equipped with both front and rear doors. The rear doors and the front doors of the two outside cabinets are provided with windows for observation of the transmitter while in operation. End shields and meter panels complete the cabinet-type enclosure. A filtered air supply for each cabinet is supplied through the air inlet openings and removable filters provided in the base frame. Exhaust fans in the top of the center and right-hand cabinets expel the warm air. For ease in installation, the equipment is shipped partially disassembled. To facilitate handling in confined spaces the dimensions of the largest unit when uncrated are 25 x 28 x 80 inches.

The important meters and indicator lights are grouped together at the top of the transmitter for quick observation of the electrical performance of the several circuits. Control and tuning switches necessary for the normal operation of the transmitter are situated on the control strips conveniently located at hand height above the floor.

Safety of the operating personnel has been given special consideration. All access doors to compartments containing high voltages are equipped with door interlock switches. When these doors are opened all rectifiers are immediately de-energized. In addition, each compartment is equipped with a mechanically operated grounding bar automatically released when the door is opened.

CIRCUITS

A. General—Frequency modulation is accomplished by push-pull reactance tubes connected across the frequency-determining circuit of the modulated oscillator. The automatic frequency control circuit is completely independent of the modulator circuit. Center-frequency stability is maintained by comparing a sub-harmonic of the modulated signal with a frequency developed by a temperature-controlled precision-ground quartz crystal oscillator. Any difference between the mean frequency of the modulated signal and that of the reference frequency actuates a frequency control motor, with a compensating capacitor mounted on its shaft, which is connected across the tuned circuit of the modulated oscillator. This capacitor is driven by the two-phase frequency control motor, the position of which is determined by the information supplied by a beat frequency between the above two signals. Two quartz crystal units are normally furnished for the reference frequency oscillator. The standby crystal is automatically maintained at operating temperature and may be connected into the oscillator circuit by the operation of a switch.

Simplified single-ended amplifiers operating Class "C" and comprising a minimum of variable elements form the r-f section of the BTF-3B. High stability grounded-grid circuits are employed for the last two stages. Variable output provided by front panel control adjusts the power output, into the antenna transmission line.

A transmission line monitor acts as a watchman over the antenna and transmission line system. An unwarranted change in the standing wave ratio such as might result from an arc in the transmission line or a fault in the antenna itself, actuates this monitor which shuts down the transmitter.

All power circuits are protected by magnetically-tripped circuit-breaker type switches. These circuit breakers automatically open under overloaded conditions and thus isolate the fault from the a-c bus. An interlocking control circuit prevents the application of plate power until the rectifier filaments have reached operating temperature. The principal d-c circuits and the high voltage rectifier transformer primaries are protected by instantaneous overload relays. Only two fuses are used in the entire transmitter. They are located in the crystal heater circuits on the FM exciter chassis.

To facilitate locating various electrical components,

the circuits have been divided into several sections identified by a series of schematic symbol numbers as listed below.

100 series	Exciter r-f unit
200 series	Exciter power supply
300 series	R-F circuits
500 series	Control and power circuits
900 series	Line monitor

Suffix letters are used to designate the various terminal boards throughout the transmitter. The following tabulation designates the section in which a particular terminal board is located.

"A"	Exciter r-f unit
"B"	Exciter power supply
"C"	1st r-f amplifier and doubler
"D"	Power amplifier cabinet
"E"	Exciter cabinet
"F"	Power and control cabinet
"K"	Line monitor

B. Exciter — The schematic diagram of the exciter is shown in Figure 17. The exciter consists of a radio frequency unit and a regulated power supply. The exciter operates at frequencies between the limits of 44 and 54 megacycles. The radio frequency unit consists of three sections: the modulator, the automatic frequency control, and the cathode ray circuit. The regulated power supply consists of three separate supply sources: (1) a regulated d-c filament supply for the reactance tubes, modulated oscillator, and first frequency multiplier; (2) a 600-volt d-c supply for the cathode ray tube; and (3) a d-c supply providing 400, 250, 150 and 105 volts for the plate and screen circuits of the other tubes. The 150- and 105-volt supplies are regulated.

The audio signal is introduced into the r-f unit through the audio input transformer, T101. After passing through T101, the signal is applied to transformer, T114, and from there to the control grids of the reactance tubes, V101 and V102. The modulated oscillator is of the Hartley type and employs a permeability tuned tank coil, T115. Modulation is obtained through the use of reactance tubes. The grids of these tubes are connected in a push-pull circuit. R-F voltage is supplied to the grids from the tank of the modulated oscillator through a link coupling to the reactance tube grid tank. This tank is tuned by capacitors, C105 and C104. The push-pull grid tank circuit provides each reactance tube grid with an r-f voltage that is 90 degrees out of phase with that which appears on its plate and 180 degrees out of phase with the voltage on the opposite reactance tube grid. One reactance tube produces a plate current leading its plate voltage by 90 degrees, thus functioning as a capacitive reactance across the modulated oscillator. The other reactance tube produces a plate current lagging its plate voltage by 90 degrees thus acting as an inductive reactance across the tank of the modulator oscillator.

The amount of the reactive plate current from the tubes is directly proportional to the amplitude of the audio frequency signal applied to the grids of the reactance tubes. A frequency shift of the modulated oscillator at an audio rate is thus obtained. Following the modulated oscillator are two frequency multipliers and an amplifier. The first multiplier utilizes a permeability tuned tank coil and a capacity divider, C120, C174 to excite the second multiplier. The second multiplier tank is tuned by capacitor, C173 and excites the amplifier through a capacity divider, C125, C172. The amplifier tank is tuned by capacitor, C171 and the output is inductively coupled to the transmitter doubler stage through a 51.5-ohm coaxial transmission line. Each of the multipliers and the amplifier utilize grid and cathode bias. Enough cathode bias is applied to protect the tubes in case of excitation failure. The automatic frequency control is composed of a crystal controlled reference frequency source, a frequency source from the modulated oscillator section, and a frequency control system. The reference frequency is supplied by a crystal oscillator. This oscillator has two temperature controlled crystals either of which may be switched into the circuit by means of switch, S103. Exact frequency adjustment is made with trimmer capacitors, C160 and C162. The output of the crystal oscillator is used to excite the frequency divider. The frequency divider is a "locked-in oscillator," that divides the crystal frequency by five. Its output is inductively coupled to a phase-shifting network, C150-L105 and C151-L104 which divides the reference circuit output into two voltages, 90 degrees out of phase with each other. These voltages appear across R132 and R133 and are used to furnish quadrature voltages to the primary windings of the frequency correcting mechanism input transformers, T102 and T103. The frequency derived from the modulated oscillator is supplied to the grids of the control tube for the frequency correcting mechanism through a system of four permeability tuned, "locked-in oscillator," frequency dividing stages. The first divider is synchronized with the modulated oscillator through capacitors, C131 and C132. Its tank coil, T108, is tuned to one-third the frequency of the modulated oscillator. The voltage obtained from this circuit is used to excite the second divider which is synchronized through capacitor, C134. The second divider tank coils, T109, are tuned to one-fourth the output frequency of the first divider. The voltage obtained from this circuit is used to synchronize the third divider through capacitor, C138. The third divider tank coils, T110, are tuned to one-fourth

the output frequency of the second divider. The voltage obtained is used to synchronize the fourth frequency divider through capacitor, C142. The fourth divider tank coils are tuned to one-fifth the output frequency of the third divider. The frequency derived here represents that of the output of the modulated oscillator divided by 240. Output from the fourth divider is fed through C147 and R149 to the secondary center taps of the motor tube input transformers, T102 and T103.

The frequency correcting mechanism consists of two pairs of balanced motor control tubes (V111, V112 and V113, V114) in which the output of the fourth frequency divider (V110) is compared to the output of the crystal divider (V115). The quadrature voltage derived from the crystal divider introduces push-pull voltages to the grids of each pair of balanced modulator tubes with a 90-degree phase shift between modulators. The fourth frequency divider introduces push-push in-phase voltages to the grids of both pairs of balanced modulators. Any difference in frequency between the output of the synchronized variable frequency dividers and the output of the crystal divider results in a rotation of the magnetic field in the two-phase control motor (B101) connected to the output of the balanced modulators. This causes the motor shaft to rotate (usually a small fraction of a degree) in one direction if the frequency of the modulated oscillator is high and in the opposite direction if the frequency is low as required to re-establish correct frequency. A split stator capacitor (C115) is attached directly to the motor shaft and is connected electrically across the tank coil (T115) of the modulated oscillator. The modulated oscillator frequency is maintained at a fixed ratio to the crystal oscillator as required for a zero beat output from the balanced modulator tubes.

A cathode ray tube (V119) is provided for use in aligning and servicing the modulated oscillator, frequency multipliers, amplifier, crystal oscillator, crystal frequency divider, and the first, second, third, and fourth frequency dividers. A table has been provided to aid in determining which circuits are represented by different positions on the nine-position switch.

Position	Circuits Observed
1	Output of Crystal Oscillator and Crystal Frequency Divider.
2	Output of Crystal Frequency Divider and Fourth Modulated Frequency Divider.
3	Output of Third and Fourth Modulated Frequency Dividers.
4	Output of Second and Third Modulated Frequency Dividers.
5	Output of First and Second Modulated Frequency Dividers.
6	Output of Modulated Oscillator and First Modulated Frequency Divider.
7	Output of First Frequency Multiplier and Modulated Oscillator.
8	Output of First and Second Frequency Multipliers.
9	Output of First Frequency Multiplier and Amplifier.

The cathode ray tube may also be used to check tube conditions while they are under actual operating conditions.

An alarm bell (E301), located in the transmitter section, is actuated by the rotation of the control motor shaft against the arm of switch (S106). This warns the operator when the frequency control has reached the end of its range and indicates some adjustment is required.

A test circuit is provided to aid in checking modulation and alignment of the reactance tube modulators. A d-c bias voltage is applied to the circuit by means of a three-position switch (S107). When the switch is set at either of the two outside positions, a d-c test voltage is applied to the grid of one reactance tube or the other. The center position is the neutral or operating position. With the test voltage applied to the reactance tube modulators it is possible to check both the operation of the modulators and the performance of the frequency control circuit. Application of this test voltage also aids in the initial tuning of the grid tank circuit of the reactance tubes.

C. 1st R-F Amplifier — The schematic diagram of the transmitter is shown in Figure 16. The output of the exciter is coupled to a doubler in the 1st R-F Amplifier section through a 51.5-ohm flexible coaxial cable. A small trimmer capacitor (C302) provides adjustable matching between the transmission line and the grid circuit. A single RCA 4-125A/4D21 tube is used as the doubler and the output of this tube is tuned to the carrier frequency. It drives two RCA 4-125A/4D21 1st R-F amplifier tubes that operate in parallel.

Three-element "pi" networks are utilized to tune the 1st R-F Amplifier and doubler. The plate and grid capacity of the tubes is used as part of the networks. The networks are tuned by means of three variable coils,

L301, L303, and L308. Such an arrangement minimizes the capacitance in the tuned circuits. The high LC ratio that is present provides a maximum band-pass and tends to minimize distortion and losses. These coils are operated from the front panel by means of flexible shafts.

The 1st R-F Amplifier is neutralized by series-tuning the screen grid lead inductances with the dual-section capacitor, C315.

The loading circuit utilizes a "T" network and is adjusted with capacitor, C317 or with coil, L306. For most applications, C317 may be left at one setting and the loading adjustments made entirely with L306 which is operated from the front panel.

D. Intermediate Power Amplifier — The output of the 1st R-F Amplifier is fed to the intermediate power amplifier through a seven-eights inch transmission line (L312) and a coupling loop (L313). The input circuit of the intermediate power amplifier employs a three-quarter wave open wire unbalanced line (L314) and is tuned by capacitor, C338. This capacitor is driven by a motor which is operated by a front panel control. Filament power is supplied through the twin conductors inside the cathode line.

The grid of the IPA tube is grounded through capacitor C339 thus producing a "grounded grid" amplifier. The tube is mounted inside the inner conductor of tank coil, L315. This inner conductor provides an air duct for cooling the tube. The high voltage supply is connected to the bottom end of this conductor. The plate shorting bar capacitor is made of an annular silver-plated disc of high dielectric material. This capacitor has silver-plated phosphor-bronze fingers on the inner and outer periphery which make a sliding contact with the inner and outer conductor. The fingers are insulated from each other by the dielectric. The capacitor forms a short circuit to the r-f tank current and an open circuit to the d-c plate voltage. The capacitor is driven by the two motor-operated racks controlled by a lever switch on the front control panel. The position of shorting bar capacitor is continuously adjustable to change the effective length of the transmission line circuit.

The output coupling circuit consists of loop, L317 and capacitor, C363. A voltage is induced in the loop due to the current flowing through the inner conductor. A capacitive reactance introduced by C363 is made equal in value to the inductive reactance of the loop thus making the net reactance zero. This becomes necessary at high frequencies due to the large loop inductance present. Capacitor, C363 is adjusted to a fixed setting for a given frequency. A large coupling range is possible with the motor-driven loop which is controlled from the front panel.

E. Power Amplifier — The Power Amplifier is identical, in circuit construction, to the IPA with the exception of the coupling circuits. The IPA is coupled to the PA cathode by means of capacitor, C363, and inductors, L317 and L318.

The PA is coupled to the transmission line assembly by means of capacitor, C364, and inductor, L322. Power from the PA is transmitted to the antenna system through a 51.5-ohm coaxial transmission line assembly. Two pick-up loops are inserted in this assembly. One, in conjunction with a thermocouple meter is used to adjust the output. The other loop is used as a source of r-f voltage for test and measuring equipment.

F. Control Circuit—The control circuit of the transmitter is shown in the right-hand section of the schematic diagram (Figure 16) and includes the following features:

1. Except for the blowers and the exciter, the transmitter may be turned on and off by means of two toggle switches, the filament switch (S512) and the plate switch (S513) located on the front panel. The exciter and the blowers are controlled by breakers inside the front door of the left-hand cabinet.

2. Centrifugal switches in the PA and IPA anode blowers normally prevent the application of filament or plate power until the blowers have reached operating speed.

NOTE: Make certain that the blowers are operating before energizing the filaments. Also check to see that blowers are rotating in the correct direction (sending air toward the top of the transmitter).

3. A time-delay relay (K503) prevents application of plate voltage until the filaments have reached operating temperature.

4. A time-delay by-pass relay (K506) is employed which, for power failures of short duration (up to three seconds), allows the transmitter to return to normal operation immediately instead of waiting for the re-cycling of the time-delay relay.

5. Switch, S514 provides for either automatic or manual overload protection. When automatic operation is employed, the plate voltage will be automatically returned after being turned off momentarily. If the overload persists for the third time the plate voltage will remain off. This is accomplished by means of the ratchet relay, K508.

6. Two overload indicator lamps (I301, I302) and targets on the overload relays aid in isolating a faulty circuit.

7. A power reduction switch located in the primary circuit of the main rectifier provides reduced plate voltage for tune up and emergency operation.

G. Harmonic Filter—A harmonic filter is supplied for use in series with the transmitter output, and may be inserted at any convenient place in the output transmission line. An equivalent schematic diagram of this unit is shown in Figure 2. Electrically, the filter functions as a low-pass filter presenting essentially no attenuation at the fundamental frequency, but attenuating the harmonic frequencies in the output tank circuit. Physically the input and output circuits of the harmonic filter consist of 1/8 wave shorted transmission line sections. At the second harmonic frequency these sections are 1/4 wave long, and thus present a high series-impedance to the second harmonic frequency. Only one adjustment is required to cover the FM broadcast band. This adjustment depends on the frequency, and is determined from the curve shown in Figure 5. This adjustment should provide for a minimum standing wave ratio (SWR). If after adjustment has been made the SWR is high, the filter should be adjusted for minimum SWR.

H. Transmission Line Monitor (MI-28155-3) — This unit removes plate power from the transmitter in the event of an unwarranted increase in the transmission line standing wave ratio.

1. Construction — The equipment is mounted in a metal cabinet 6 1/8 inches wide, 6 3/4 inches deep, and 11 1/2 inches high. The front and back covers of the cabinet are removable. A 6 1/8-inch length of 51.5-ohm coaxial transmission line extends from side to side through the upper part of the cabinet. This line has an outside diameter of 1 5/8 inches and becomes part of the transmission line to the antenna when the unit is installed. A small bracket, mounted along a cutout in the transmission line section, serves as a mounting for the control components. The power supply transformer and a control relay are mounted on a small chassis located in the lower part of the cabinet. A hole for 3/4-inch conduit (through which interconnecting wires to the transmitter may be run) is provided through the bottom of the cabinet.

2. Circuit Description—Refer to the upper right corner of the transmitter schematic diagram, Figure 16. The plate of one diode section of the RCA 6AL5 tube (V901) is coupled to the center conductor of the transmission line by the network consisting of C901, L901, and R901. The voltages coupled through L901 and C901 are approximately opposite in phase and equal in value when the network is properly adjusted. For a transmission line which has a standing wave ratio of one-to-one these voltages essentially cancel each other. Under these conditions, a minimum of rectified positive voltage is applied to the grid of the RCA-2D21 thyratron tube (V902). Any increase in the standing wave ratio will unbalance the coupling through L901 and C901, thus causing an increase in the r-f voltage at the diode rectifier plate. Increased current flow through this tube will increase the amount of positive voltage at the grid of V902, which will ignite, causing relay K901 to operate, thus removing high voltage from the transmitter.

Voltage obtained from a winding of the power supply transformer (T901) and adjusted by means of the SENSITIVITY control (R905) is applied to the second diode plate of V901. Rectified output voltage from this section of the tube is applied to the cathode and shield grid of V902 where it serves to control the triggering level of the tube. Filament voltages for both tubes (V901, V902) and plate voltage for the thyratron (V902) are obtained from separate windings of the transformer, T901. The coil of the control relay (K901) is in the plate circuit of the thyratron (V902), and is connected in series with resistor R904.

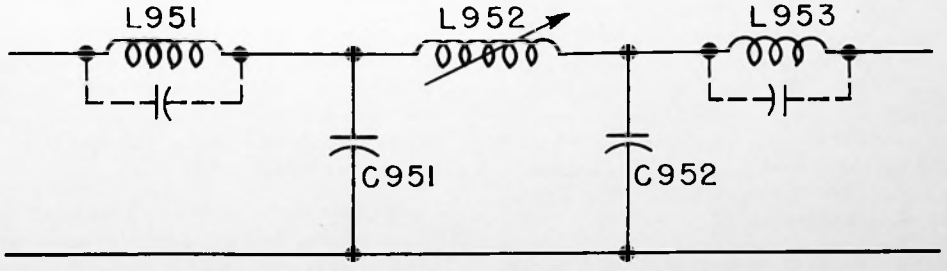


Figure 2—Harmonic Filter, Equivalent Schematic Diagram

INSTALLATION

GENERAL

Immediately upon receipt, the equipment should be carefully inspected to make certain that no damage has been incurred during shipment. Any damage or shortage should be immediately referred to the transportation company and suitable reports completed so that lost or damaged material will be recovered or paid for.

Instructions for installing this equipment are provided on the installation drawings. In addition to the drawings included in this book, the Floor Plan (T-619944), the Cabinet Outline (T-618692), the Assembly (T-619487), and the Transmission Line Monitor and Harmonic Filter Installation Plan (T-619999) drawings should be referred to. Reproductions of these drawings are normally supplied prior to the delivery of the equipment and are also supplied with the installation material.

Before proceeding with any adjustments, the frequency control motor on the exciter must have the necessary damping fluid added. The level of the fluid should be approximately 3/8 inch below the bottom of the RCA monogram.

PRELIMINARY ADJUSTMENTS

After the equipment has been assembled, wired, and the tubes installed, the control and power circuits should be checked as follows:

1. Check to see that the IPA and PA grid grounding capacitor fingers make firm contact with the IPA and PA tube grid rings and that each of the four fastening clamps are tight. Throw all six breaker switches (S501, S503, S504, S502, S505, S506) OFF. These breakers are located inside the control and power supply cabinet. Throw the PLATE and FILAMENT switches (S512 and S513 located on front panel of the previously mentioned cabinet) OFF. Set the AUTOMATIC-MANUAL switch in the MANUAL position.

2. Apply 115 volts to the crystal heaters. If the crystals are in place the two white indicator lamps in the center cabinet will come on. They will remain on until the crystal units have reached operating temperature and then automatically go off and on as the thermostats inside the units control the temperature.

3. Close any external line switches and apply voltage to the transmitter by closing the line breaker (S501).

4. Close the control breaker (S503). All blowers and fans should start. Relays, K512 and K513 should close as soon as the blowers have reached operating speed. Make certain blowers are rotating in proper direction.

5. Adjust the filament voltages.

a. Measure the average line voltage under normal conditions and adjust the taps on the transformer primaries as tabulated in the chart provided. (See page 15.)

NOTE: The transmitter is shipped with the taps set for operation from a line voltage of 230 volts.

b. Close the filament breaker (S504) and the filament switch (S512) and measure the filament voltage on one of the 4-125A/4D21, 1st R-F tubes. The green indicator lamp (I504) should go on at this time. Adjust the filament rheostat, R503 until the voltage measured agrees with that tabulated in the filament voltage chart which follows. Note and record the reading of voltmeter, M504. The approximate reading is given in the transformer tap chart which follows.

c. Measure the filament voltage on the remaining transmitter tubes. These voltages should agree with the values shown in the table tabulating the filament voltages. The filaments of the 7C24 (PA and IPA) can be further adjusted by rheostats, R315 and R316 respectively, by changing the taps on L325, and by changing the links to the PA filament phasing capacitors. The filament voltages on the 7C24 tubes should be rechecked when a new tube is installed.

6. Close the exciter breaker (S502). The exciter plate and filament circuits should be energized after the breaker is closed. The center cabinet rear door is interlocked and will remove the plate voltage when opened. Adjust the exciter as explained in the tuning section which follows.

NOTE: After the transmitter has been tuned and fully loaded, recheck the reading on M504 and if necessary re-adjust R503 until M504 indicates the same value obtained in step b. No further adjustment of the filament voltage should be necessary as long as the line voltage does not vary more than ±5 per cent. For slow variations in line voltage, it is desirable to reset R503 from time to time.

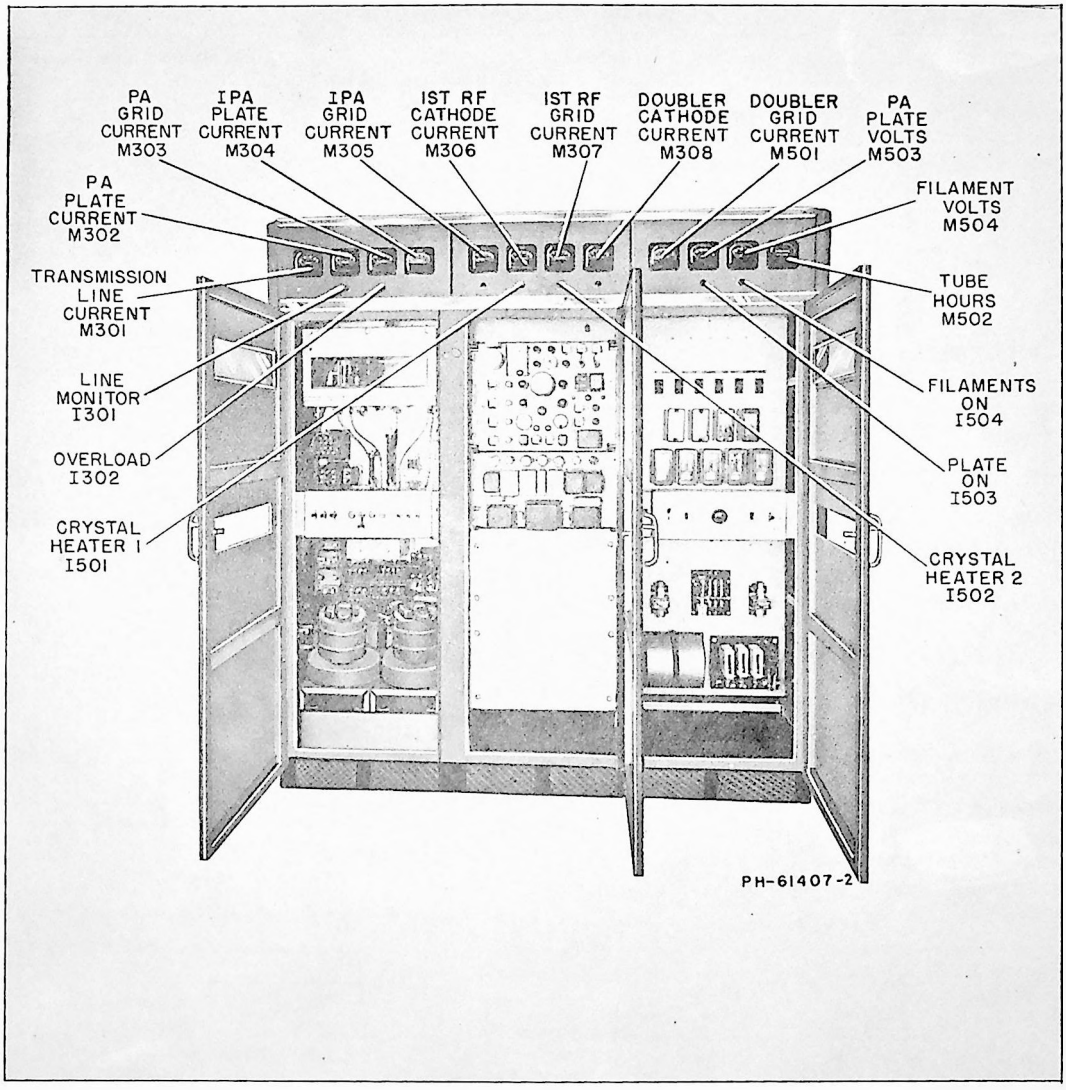


Figure 3—BTF-3B F-M Transmitter (Front View, Doors Open)

FILAMENT VOLTAGE CHART

Symbol	Tube	Pin Numbers	Voltage
V301	4-125A—Doubler	1-5	5.0
V302	4-125A—1st R-F Amplifier	1-5	5.0
V303	4-125A—1st R-F Amplifier	1-5	5.0
V304	5U4G—L-V Rectifier	2-8	5.0
V305	7C24—Intermediate Power Amplifier	Two outside straps	12.6
V306	7C24—Power Amplifier	Two outside straps	12.6
V501, V502, V503, V504, V505, V506	8008—H-V Rectifier	2-3	5.0

PRE-EMPHASIS NETWORK (MI-4926-A)

The pre-emphasis network MI-4926-A is supplied as a separate item so that it may be inserted in the audio input circuit either before or after the line amplifier, depending on the requirements of the particular installation.

HARMONIC FILTER (MI-28151)

The plan (drawing T-619999) for the installation and adjustment of the harmonic filter is not included in this instruction book. However, a reproduction of the chart for setting the adjustable shorting bar is given in Figure 4. This adjustment should be made at time of installation before plate power is applied to the transmitter.

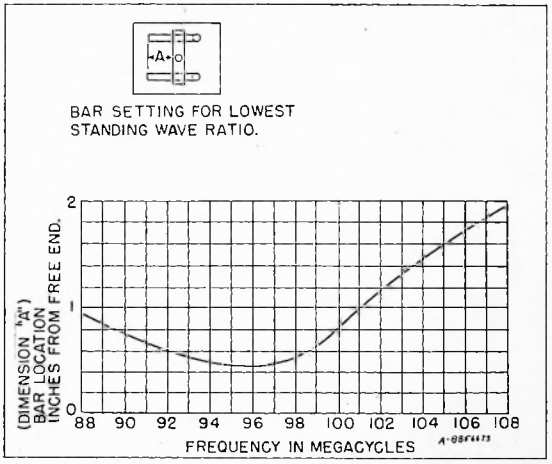
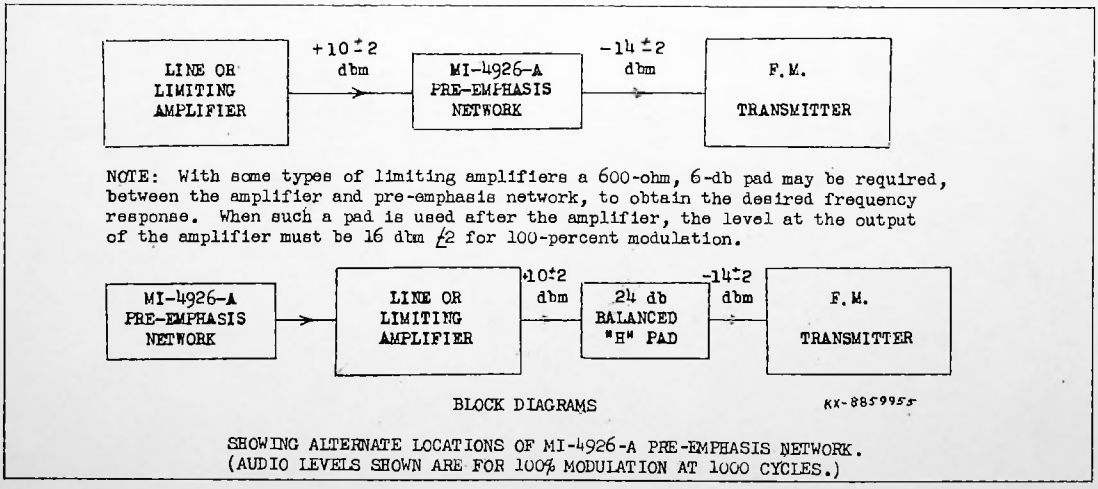


Figure 4—Harmonic Filter, Adjustment Chart



SHOWING ALTERNATE LOCATIONS OF MI-4926-A PRE-EMPHASIS NETWORK.
(AUDIO LEVELS SHOWN ARE FOR 100% MODULATION AT 1000 CYCLES.)

Figure 5—Location of Pre-emphasis Network

Although the exact location of the harmonic filter is not normally critical, a certain critical location of the harmonic filter may combine with critical settings of the output coupling control, and cause the transmission line to resonate at a second-harmonic frequency. This very unlikely condition would be noticed when first loading the transmitter, and would show up as a sharp dip in plate current accompanied by a sharp rise in transmission line current (meter reading off-scale). To overcome such a situation, move the harmonic filter to a new location approximately 15 inches in either direction along the line. This recommended distance is roughly 1/4 wavelength at the second-harmonic frequency.

ADJUSTMENT OF TRANSFORMER PRIMARY TAPS

The following chart is to be used for making the correct connections to the transformer taps to obtain the required voltages.

Transformer Symbol	Circuit	Transformer Taps					
		230 Volt Line			208 Volt Line		
		+5%	Normal	−5%	+5%	Normal	−5%
T104	R-F Filament (exciter)	1-4	1-4	1-4	1-3	1-3	1-3
T201	Rectifier Plates (exciter)	0-230	0-230	0-230	0-210	0-210	0-210
T202	Rectifier Filament (exciter)	1-4	1-4	1-4	1-3	1-3	1-3
T301	R-F and L-V Rectifier Filament	1-4	1-4	1-3	1-3	1-3	1-2
T302	L-V Rectifier Plates	1-5	2-5	3-5	1-4	2-4	3-4
T303	IPA Filament Transformer	1-4	1-4	1-3	1-3	1-3	1-2
L325	IPA Filament Reactor	1-3	1-3	1-3	1-3	1-3	1-2
T304	PA Filament Transformer	1-4	1-4	1-3	1-3	1-3	1-2
C356 to C358 and C370 to C373	PA Filament Capacitors*	35 mfd	35 mfd	45 mfd	45 mfd	45 mfd	55 mfd
T501, T502, T503, T504, T505, T506	Rectifier Filament	0-220	0-220	0-205	0-205	0-205	0-190
T507	H-V Rectifier Plate	1-5	2-5	3-5	1-4	2-4	3-4
T508	Control	1-5	2-5	3-5	1-4	2-4	3-4
M504	Fil. Line Voltmeter (see b under previous step 5)	220	220	205	205	205	190

*Refer to connection diagram Figure 6.

FILAMENT PHASING CAPACITORS

It is important that the connections made to the filament phasing capacitors be made correctly. The following diagram, Figure 6, is provided to aid in making the correct connections.

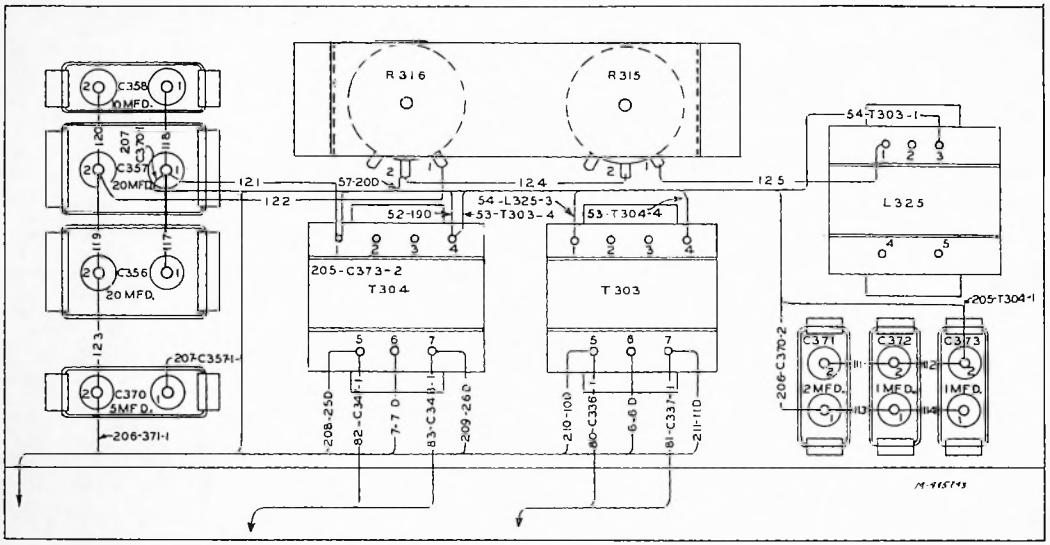


Figure 6—Filament Phasing Capacitor Connection Diagram

NOTES

TUNING

EXCITER

A. Preliminary Adjustments — Operate LINE SWITCH (S501) and EXCITER SWITCH (S502) to the ON positions. The plate and filament circuits of the exciter will be energized provided the rear door of the center cabinet is closed. This door controls an interlock switch which is connected in the exciter plate voltage circuit.

The cathode-ray tube should be adjusted before proceeding with the tuning procedure by turning the filament switch (S102) to the ON position and then adjusting the intensity control (R142) and focus control (R144) for a sharp definition of the figure on the cathode ray tube.

Tuning patterns are illustrated following the various tuning steps. These patterns are to be used to facilitate tuning but the operator should not expect to observe identical patterns on the cathode ray tube. The illustrated patterns will provide a quick reference as to the number of peaks that should appear on the tube. The figures observed on the tube will differ in amplitude or shape, in some cases, with those illustrated. The number of peaks should be identical. Two methods of tuning are described, either method will result in accurate tuning of the exciter circuits.

WHEN AN ACCURATELY CALIBRATED C-W RECEIVER (4.5 TO 6 MC) IS AVAILABLE, PROCEED AS FOLLOWS:

1. Release the spring on the motor locking knob by lifting it up with one finger. Turn the motor shaft until the center line on the damping wheel lines up with the marker line on the wheel cover.

2. Check the position of MODULATOR TEST switch (S107) by operating the switch through its three positions. It should then be turned to the center or OPERATE position.

3. Divide the carrier frequency in megacycles by 18 and set the receiver to the resulting frequency. Place the receiver near the exciter and turn it on.

4. Go to the rear of the exciter and adjust the iron core of the modulated oscillator Tank (T115) until a "zero beat" is heard in the receiver.

5. Turn the nine-position SELECTOR SWITCH to position seven. Adjust T105 (1st multiplier) for a multiplication rate of three. Tune for maximum amplitude of signal.

NOTE: If patterns appear to be exceedingly "fuzzy" refer to the "Maintenance" section for probable cause and remedy.

6. Turn SELECTOR SWITCH to position eight and adjust T106 (2nd multiplier) for a multiplication rate of three. Tune for maximum amplitude of the signal.

7. Turn SELECTOR SWITCH to position nine and adjust T107 (amplifier) for a multiplication rate of three. Tune for maximum amplitude of the signal.

8. Turn SELECTOR SWITCH to position six and tune T108 (1st divider) until a division rate of three is observed on the cathode ray tube.

9. Turn SELECTOR SWITCH to position five and tune T109 (2nd divider) until a division rate of four is observed on the cathode ray tube.

10. Turn SELECTOR SWITCH to position four and tune T110 (3rd divider) until a division rate of four is observed on the cathode ray tube.

11. Turn SELECTOR SWITCH to position three and tune T111 (4th divider) until a division rate of five is observed on the cathode ray tube.

12. Turn SELECTOR SWITCH to position one and rotate the adjusting screw on T112 (crystal oscillator) clockwise until the crystal oscillator ceases to oscillate as indicated by the following pattern.

Now rotate the adjusting screw on T112 counterclockwise until oscillation is resumed, indicated as follows:

13. With the SELECTOR SWITCH remaining on position one, tune T113 (crystal divider) until a division rate of five is noted on the cathode ray tube.

14. Check the patterns obtained when the SELECTOR SWITCH is successively placed in positions nine, eight, seven, six, five, four, three, and one. Make certain that the figures on the cathode ray tube correspond with those illustrated.

IMPORTANT: If the patterns are found to be incorrect, do not attempt to adjust any one stage. Start at the beginning and repeat each step as outlined.

15. Unlock the tuning motor by pulling the knob out and turn the SELECTOR SWITCH to position two. An oval-shaped pattern should now appear on the cathode ray tube.

If this pattern is not present, adjust the front control of T115 until it appears and until the center radial line on the tuning motor disc is vertical. For large adjustments use the rear control of T115 and for fine adjustments use the front control.

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

17. Tuning of the reactance tube circuit is accomplished by turning the MODULATOR TEST SWITCH (S107) to either one of two test positions and tuning capacitor, C105 for maximum deflection of the center line on the motor damping wheel. Proper operation is also indicated by tuning C105 for a maximum reading of the modulator tube currents as indicated on M101. The deflection should be measured from the reference line on the damping unit cover. Turn the test switch back to the center or "OPERATE" position. It may be necessary to retune the oscillator as outlined in step 15 after each adjustment of C105.

Later, after the transmitter 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
Beat Frequency Oscillator

The following steps should be taken after the complete transmitter has been tuned.

1. Set the audio levels at the desired modulation percentages and adjust the reactance tube grid tuning capacitor, C105 for minimum distortion. Adjust the input levels after each tuning operation to prevent false readings.

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

3. The R-F output stages should now be tuned for minimum distortion by adjusting controls on T105, T106, and T107.

B. Final Adjustment — Adjust the output carrier frequency to that assigned to the station by tuning 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 carried out only after the transmitter has been put into operation and the 115 volt crystal heater voltage has been on for one hour in order to stabilize the temperature of the crystal holder. Recheck alignment for any change that may have occurred while making this last adjustment.

WHEN A C-W RECEIVER IS NOT AVAILABLE, PROCEED AS FOLLOWS:

1. Execute steps one and two of the tuning procedure, given on page 17.

2. Determine whether the carrier frequency to be used is in the upper or lower half of the band.

3. If the carrier frequency to be used is in the lower half of the band, turn the control on T105 all the way in. If the frequency to be used is in the upper half of the band, turn the control on T105 all the way out.

4. Turn the SELECTOR SWITCH to position seven. Go to the rear of the exciter and adjust the control on T115 to the position at which a pattern with a multiplication rate of three appears on the cathode ray tube. Performing this step requires the assistance of another person due to the fact that one person cannot make the adjustment and see the cathode ray tube at the same time. Tune for maximum amplitude of the signal. (See pattern shown for step 5 of previous tuning procedure.)

5. Execute steps six through thirteen inclusive of the tuning procedure given on page 17.

6. 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 fre-

quency of the modulated oscillator and its frequency dividers was too high to synchronize with the frequency standard.

7. 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.

8. Repeat steps five through thirteen of the previous tuning procedure to compensate for the new frequency that has been set up on the modulated oscillator.

9. Continue the above 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.

10. Release the stop on the motor damping disc. 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. Complete tuning by making balance and distortion adjustments as previously described.

For optimum operating conditions, make use of the Frequency Modulation Monitor and the distortion measuring equipment previously mentioned.

DOUBLER AND AMPLIFIER CIRCUITS

After the exciter has been properly tuned and the filament voltages adjusted, the doubler and amplifier circuits of the transmitter should be tuned as follows:

1. Check the 1st R-F plate tank coil (L307). The 2½-turn coil should be used when operating below 104 megacycles and the 1½-turn coil should be used when operating above 104 megacycles.

NOTE 1: The low frequency coil is shipped in place and the high frequency coil is shipped with the installation material (MI-28168 Item 1).

NOTE 2: The SENSITIVITY control (R905) on the Transmission Line Monitor should be turned to its maximum counterclockwise position before plate voltage is turned on. This control (R905) is set after the transmitter initial adjustments have been completed.

2. Set the delta-wye switch (S507) in the low voltage (down) position.

3. Disconnect the IPA and PA plate voltage supply leads from the bottom of their respective resonant tanks (L315, L320) and ground the IPA and PA plates at capacitors, C340 and C351 (refer to Figure 18).

4. Adjust the DOUBLER DRIVE control (L301) for a maximum reading on the DOUBLER GRID CURRENT meter, M501 (located on the front of the exciter). If a reading of at least 10 milliamperes is not obtained with this adjustment, rotate capacitor, C302 (located in the right-hand corner of the doubler compartment) a small amount at a time (readjusting L301 after each turn) until this value is reached.

5. With the aid of the connection diagram (Figure 23), locate terminal 23C (located under the doubler compartment) and remove the screen voltage lead (number 90) from this terminal. The color of the wire to be removed is white with a red tracer.

6. Check to see that the following breakers are closed.

(a) LINE (S501)
(b) CONTROL (S503)
(c) EXCITER (S502)
(d) FILAMENT (S504)

Throw filament switch, S512, (located on the control panel) to the ON position and allow the filaments to reach operating temperature.

NOTE: New rectifier tubes should be given an initial seasoning period of not less than 30 minutes during which time filament power should be applied but not the plate power. It is not necessary to repeat this initial warm-up unless the tubes have been replaced or otherwise disturbed. Normally the 70 to 80 second delay provided by the time-delay relay, K503, is sufficient. However, for ambient temperatures below 10° C (50° F) it is recommended that the filament be allowed to warm up for at least five minutes each time before applying plate power.

Make sure that the coupling loop (L324) is turned at right angles to the inner conductor of the transmission line. This loop is in the transmission line assembly near the upper right-hand side of the PA cabinet as viewed from the rear.

Adjust the 1st R-F neutralizing capacitor (C315) to approximately one-half maximum capacity.

7. Close all interlocked doors. Close the low voltage and high voltage plate breakers (S505, S506) and throw the plate switch (S513) ON. If the plate time-delay relay has closed, the red indicator lamp (I503) should come on and the plate voltmeter (M503) should read approximately 2000 volts.

8. Tune the 1st R-F DRIVE control (L303) for a maximum reading on the 1st R-F GRID CURRENT meter (M307).

9. Turn the 1st R-F LOADING control (L306) to its maximum clockwise position (minimum loading). Adjust capacitor, C317 (located in upper left-hand corner of 1st R-F unit) to 90 per cent of its maximum capacity.

10. Observe the 1st R-F GRID CURRENT meter and rotate the 1st R-F PLATE control (L308) until the meter registers a dip indicating plate resonance (this should occur when the tuning coil slider is on the lower half of the tuning range; the dial reading between 3 and 7). In some cases, it may be necessary to press together or spread open the turns of L307 to properly resonate the plate circuit. To neutralize this equipment, tune the neutralizing capacitor, C315 (screwdriver adjustment located under center of 1st R-F compartment) for maximum grid current indication. This must be done in small steps since when the front door is opened to permit adjustment of C315 the plate voltage will be removed through action of the interlock switch. Repeat steps 8 and 10 until a minimum effect on the grid current is observed while tuning the plate circuit through resonance.

11. Throw the PLATE switch OFF and connect the screen voltage lead (removed in step 5) to terminal 23C.

12. Throw the PLATE switch ON and rapidly rotate the 1st R-F PLATE TUNING control to the position at which a dip in the 1st R-F CATHODE CURRENT meter (M306) is obtained.

NOTE: If the 1st R-F GRID CURRENT meter reads less than 17 milliamperes, R328 should be removed.

13. Increase loading by rotating the 1st R-F LOADING control approximately four turns counterclockwise, retune the 1st R-F plate circuit (see step 12), and tune the IPA cathode circuit (the IPA and PA tuning controls are motor driven and are energized by means of key switches operated from the front panel) and resonance as indicated by the maximum indication on the IPA GRID CURRENT meter (M305).

NOTE: If the transmitter is to be operated between the frequencies of 100 to 108 megacycles it will be necessary to lower the stationary plates of capacitors, C338 and C349 approximately two inches in order to resonate the cathode circuits.

14. Rotate the 1st R-F LOADING control in small steps (after each adjustment retune the 1st R-F plate circuit and the IPA cathode circuit) until a maximum IPA grid current is obtained. This value will approximate 50 milliamperes but will vary over wide ranges depending on the tuned position of the IPA plate tank.

15. Adjust the IPA and PA LOADING controls for minimum output coupling. This is accomplished by holding the key switches down until the coupling loops (L317 and L322) are at the greatest distance from their center conductors.

16. Adjust the IPA PLATE TUNING control for resonance (indicated by a minimum reading on the PLATE CURRENT meter, M304).

NOTE: When tuning the transmitter for the first time, hold the key switch down until the limit switch (S313) opens, then hold the key up until resonance is indicated.

17. Throw the PLATE switch OFF. Remove the ground connection to the IPA tube plate (refer to step 3) and reconnect the IPA high voltage lead. Throw the PLATE switch ON. Readjust the IPA PLATE TUNING control for resonance.

NOTE: Leave the PA grounded.

18. Retune the 1st R-F plate and loading circuits and the IPA cathode circuit for a maximum indication on the IPA GRID CURRENT meter (M305).

19. Tune the PA cathode circuit for resonance as indicated by a maximum reading on the PA GRID CURRENT meter (M303). If necessary, retune the IPA plate circuit.

20. Throw the PLATE switch OFF when making the next capacitor adjustment and then ON again after the adjustment has been made.

Capacitor C363 (located in the output coupling loop of the IPA tank) should be set as near maximum capacity (center rod down) as possible and still allow required loading (see step 21). To adjust capacitor C363 start with the maximum setting. If sufficient loading is not obtained when the position of the loop is set at two-thirds maximum coupling the loop capacitor (C363) should be opened one-half inch at a time until the required loading is obtained. Use the setscrew provided to hold the sliding section in place.

CAUTION: Under no circumstances should the capacitor be opened more than FOUR inches.

21. Increase the IPA LOADING (keeping the IPA plate and PA cathode circuits tuned to resonance) until a value of approximately 0.3 ampere is read on the IPA PLATE CURRENT meter (M304).

22. Adjust the PA PLATE TUNING control for resonance (indicated by a minimum reading on the PA PLATE CURRENT meter, M302).

23. Throw the PLATE switch OFF. Remove the ground connection to the PA tube plate (refer to step 3) and reconnect the high voltage lead. Readjust the PA PLATE TUNING control for resonance.

24. Repeat step 21.

25. Throw the PLATE switch OFF when making the next capacitor adjustment and then ON again after the adjustment has been made.

Capacitor C364 (located in the output coupling loop of the PA tank) should be set as near maximum capacity (center rod down) as possible and still allow required loading (see step 26). To adjust capacitor C364 start with the maximum setting. If sufficient loading is not obtained when the position of the loop is set at two-thirds maximum coupling the loop capacitor (C364) should be opened one-half inch at a time until the required loading is obtained. Use the setscrew provided to hold the sliding section in place.

CAUTION: Under no circumstances should the capacitor be opened more than FOUR inches.

26. Adjust the PA OUTPUT LOADING control for a reading of approximately 0.6 ampere on the PA PLATE CURRENT meter (M302). Operate the transmitter under the above conditions for a 15 minute period to "season" the tubes.

NOTE: Under certain conditions and with some critical settings of the output coupling control, the output circuit may become resonant at the second harmonic. This will be indicated by a sharp dip in plate current accompanied by a sharp rise in the TRANSMISSION LINE CURRENT meter reading. If this condition should occur (and it is unlikely that it will) the harmonic filter should be moved along the transmission line to a new position. It may be moved in either direction thus shortening or lengthening the line between the transmitter tank and the harmonic filter. Optimum results will be obtained if the filter is moved 15 inches (¼ wavelength); however, if space prohibits a movement this great a smaller distance may be used and the resonant condition will still be eliminated.

27. Throw the PLATE switch OFF and set the delta-wye switch in the high voltage (up) position. Throw the PLATE switch ON and retune all circuits for resonance and readjust the coupling circuits as required until the meters indicate the values shown in the right-hand column of the chart which follows on the next page.

After the transmitter is completely tuned and loaded, it may be desirable to tune out the inductance of the coupling loop. This is done in order to obtain maximum coupling and to minimize the detuning effect of changing the loading. Tuning is accomplished by throwing OFF the PLATE switch, moving the sliding capacitor in or out approximately one-half inch, throwing ON the PLATE switch, retuning the 2nd R-F plate circuit, and noting whether the loading increased or decreased. Continue to adjust the sliding capacitor in this manner until maximum loading is attained. The capacitor should not be set out more than four inches.

The equipment is now loaded for operation at an output of approximately 3000 watts.

An efficiency versus output curve (Figure 24) is provided to aid in making calculations for operating at lower output. To determine the plate input for any specified power output, divide the desired output power by the efficiency factor (obtained from curve). This value should be equal to the product of plate voltage and plate current.

Transmission Line Meter Coupling Adjustment—After the transmitter has been tuned for the desired power output, adjust the coupling loop (L324) until the TRANSMISSION LINE CURRENT meter (M301) reads 100 per cent. This is accomplished by performing the following steps:

1. Throw the PLATE switch to the OFF position.

2. Loosen the lock nut on the coupling loop (L324). This loop is in the transmission line assembly near the upper right-hand side of the PA cabinet as viewed from the rear.

3. Turn the loop slightly in either direction then throw the PLATE switch to the ON position and check M301 for a reading of 100 per cent. Repeat as outlined until a 100 per cent reading is obtained then tighten the lock nut.

NOTE: This adjustment will enable the operator to keep the output constant despite line voltage variations.

The BTC-1A Control Console may be equipped with an extension T/L Monitor Meter if desired. Refer to the Parts List at the rear of this book for ordering information.

Adjustment of Transmission Line Monitor—After the transmitter has been tuned and is in operating condition, the relay (K901) in the Transmission Line Monitor should be adjusted. Additional information on the Transmission Line Monitor is given in the instruction manual (IB-30174) packed with that equipment, and in the Maintenance section of this book.

1. The SENSITIVITY control (R905) should be in maximum counterclockwise position. With the transmitter on, slowly advance R905 clockwise until the control relay (K901) closes, and thereby shuts off the transmitter high voltage.

2. Now turn R905 back slightly, counterclockwise, until K901 remains open under normal operating conditions and during switching surges when plate voltage is applied.

TYPICAL METER READINGS

Symbol	Circuit	1000 Watts	3000 Watts
M502	Tube Hours	Total Fil. Time	Total Fil. Time
M504	Filament Volts	220/205/190‡	220/205/190‡
M503	PA Plate Volts	3600 volts	3500 volts
M501	Doubler Grid Current	5 ma	5 ma
M308	Doubler Cathode Current	60-70 ma	60-70 ma
M307	1st R-F Grid Current	17-23 ma	17-23 ma
M306	1st R-F Cathode Current	210-230 ma	210-230 ma
M305	IPA Grid Current	120-150 ma	120-150 ma
M304	IPA Plate Current	0.35 amp	0.40 amp
M303	PA Grid Current**	See Figure 24	See Figure 24
M302	PA Plate Current	0.37 amp	0.88 amp
M301	Transmission Line Current	100%*	100%*
M101	Modulator Current	11 ma	11 ma

‡Refer to section on Adjustment of Transformer Taps.
*After adjustment.
**Grid current indicated in Figure 24 must be maintained for a given power output.

NOTES

OPERATION

In normal operation, all switches except the PLATE (S513), FILAMENT switch (S512), and LINE breaker (S501) will always be left in the ON position.

To Start the Transmitter:

1. Throw the LINE breaker (S501) ON. Check to see that the other five breakers located in the power and control cabinet are closed.

2. Throw the FILAMENT switch (S512) ON.

3. Set the AUTOMATIC-MANUAL switch in AUTOMATIC position. (When in this position, the tuning controls are rendered inoperative to prevent accidental detuning.)

4. Check to see that the exciter is locked in (step 15 of exciter tuning procedure).

5. Throw the PLATE switch (S513) ON. High voltage will be applied to the plates if the filaments have been on for approximately one minute.

6. Adjust the PA loading control for a 100 per cent reading on the TRANSMISSION LINE CURRENT meter (M301). Check the power input to the last stage. See last paragraph of Step 27 in tuning procedure.

NOTE: Normally the transmission line current will remain constant for any given power output but it may vary if the transmission line impedance changes for any reason. If the power input, as determined from the efficiency curve, is incorrect when the TRANSMISSION LINE CURRENT meter indicates 100 per cent the loading should be readjusted until the correct power input is obtained. The transmission line current may be readjusted for 100 per cent indication on its respective meter at any convenient time (see step 25 under "Tuning Doubler and Amplifier Circuits").

7. Adjust the filament rheostat (R503) for proper filament voltage (see b under step 5 of INSTALLATION). The equipment is now ready for operation.

NOTE: If any appreciable change in line voltage occurs, an adjustment of filament voltage and PA loading will be necessary.

To Stop the Transmitter:

1. Throw the PLATE switch (S513) OFF.
2. Throw the FILAMENT switch (S512) OFF.

To Shut the Transmitter Down Completely:

Open the LINE breaker (S501).

NOTE: The crystal heaters should be left on continuously unless it is necessary to shut down the equipment for several days.

MAINTENANCE

GENERAL

It is important that the equipment described in this book be kept free from dust. With ordinary care, little servicing will be required to maintain this equipment. However, to avoid interruption of service, a regular schedule of inspection should be established.

TUBES

IMPORTANT: The air filters used in conjunction with blowers B303 and B305 must be kept clean at all times in order to insure maximum life of the 7C24 tubes. Any discoloring of the 7C24 tube radiators should be investigated immediately. If the color changes from silver to a dirty brown or black, prolonged excessive tube operating temperatures should be suspected. If this be the case check for insufficient air being delivered to the tubes or improper tuning of the stage where the trouble occurs.

A periodic check should be made of all tubes. Weak tubes should be replaced at once. In general the efficiency of each tube may be checked by substituting a new one of the same type. Spare tubes of each type should be kept on hand at all times. Spare mercury rectifier tubes should be "seasoned" and then stored in an upright position ready for immediate use. Take care to avoid tipping or splashing of mercury on the tube elements after seasoning. If mercury is splashed upon the elements, it will be necessary to "re-season" the tubes before they are used.

NOTE: To "season" the mercury tubes, they should be run a minimum of 30 minutes with only the filament voltage applied.

EMERGENCY OPERATION

Little trouble will be experienced in the operation of transmitter but provision has been made for maintain-

ing frequency control should the automatic frequency control fail due to tube or component failure during the period that a program is being transmitted.

The operator will be warned of the loss in control either by the closing of the alarm switch, actuated by the rotor of the control motor, or by a reaction in the carrier frequency monitor due to detuning.

Tube failure may be found in some cases by switching the cathode ray tube to various stages until a lack of amplitude in the horizontal or vertical position indicates a defective stage.

Until such repairs or replacements as are necessary can be made, the output carrier frequency can be controlled manually in the following manner.

1. Engage the motor damping disc with the tuning knob on the front end of the motor as previously described.

2. Turn the motor shaft until it is lined up with the guide lines on the motor damping unit as in the normal operating position.

3. Adjustment of the vernier iron core in the front of T115 will usually be sufficient to bring the output frequency to its assigned value. The carrier frequency monitor will indicate when the frequency has reached its correct value.

4. In some cases, a failure of the automatic frequency control may not involve failure of any of the frequency divider stages. In this case, the assigned carrier frequency may be maintained by following the preceding steps and keeping a circle pattern on the screen of the cathode ray tube when the selector switch is on position number two.

Transmission Line Monitor Adjustment — If the adjustment of factory-adjusted capacitor C901 should ever be required in the field, proceed as follows:

1. Make certain that the transmission line standing wave ratio is as near to a one-to-one ratio as is possible.

2. Temporarily remove the interconnecting lead at Terminal 3K. This prevents the removal of high voltage from the transmitter while the monitor is being adjusted.

3. Connect an electronic voltmeter to jack J901. (Use the 0-10 volt d-c range on the RCA VoltOhymst.) With power applied to the transmitter, adjust capacitor C901 until a minimum voltage reading is obtained on the test voltmeter.

4. Disconnect voltmeter from J901, and replace lead to terminal 3K.

5. Check setting of R905 (SENSITIVITY control), the alignment of which is given in the Installation and Adjustment section of this book.

TYPICAL TUBE SOCKET VOLTAGES (EXCITER)

All measurements are to be made with at least a 1000 ohms-per-volt voltmeter except as indicated. The voltages are measured to ground.

Tube	Symbol	Plate Voltage	Screen Voltage	Bias	
				Cathode	Fixed
Reactance Tubes	V101, V102	150	150	14	..
Modulated Oscillator	V103	150	50	..	..
1st Frequency Divider	V107	70	70	..	..
2nd Frequency Divider	V108	80	80	..	..
3rd Frequency Divider	V109	95	95	..	..
4th Frequency Divider	V110	90	90	..	..
Xtal Frequency Divider	V115	55	55	..	..
Crystal Oscillator	V116	105	105	..	..
1st Frequency Multiplier	V104	250	142	10	..
2nd Frequency Multiplier	V105	250	167	25	..
Power Amplifier	V106	400	182	35	..
Motor Control Tubes	V111, V112, V113, V114	220	250	..	—55*

NOTE: The plate voltages tabulated above are measured under dynamic conditions. The static plate voltage may range from 195 to 250 volts depending on the phasing of the a-c feed voltages to the grids of the motor control tubes.

Tabulated at the right are typical voltages as measured on the exciter power supply terminal board with the exciter connected:

Terminal	Voltage
2	600
3	400
4	250
5	150
6	150
7	105
*8	—55
9	25

*Must be measured with a 20,000 ohms-per-volt voltmeter.

TRANSMITTER VOLTAGES

Symbol	Function	Tube Type	Plate Voltage	Screen Voltage	Bias			Filament Voltage a. c.
					Cathode	Fixed Grid	Grid Leak*	
V301	Doubler	RCA-4-125A/4D21	2400	250†	104	—	100	5.0
V302, V303	1st r-f amplifier	RCA-4-125A/4D21	2800	320	88	—	200	5.0
V304	Low-voltage rectifier	RCA-5U4G	—	—	—	—	—	5.0
V305	IPA	RCA-7C24	3500	—	0	—	337	12.6
V306	PA	RCA-7C24	3500	—	0	—	580	12.6
V501	High-voltage rectifier	RCA-8008	—	—	—	—	—	5.0
V502	High-voltage rectifier	RCA-8008	—	—	—	—	—	5.0
V503	High-voltage rectifier	RCA-8008	—	—	—	—	—	5.0
V504	High-voltage rectifier	RCA-8008	—	—	—	—	—	5.0
V505	High-voltage rectifier	RCA-8008	—	—	—	—	—	5.0
V506	High-voltage rectifier	RCA-8008	—	—	—	—	—	5.0

*Grid Leak voltages vary considerably, depending upon frequency, power output, and other variables.
†Doubler screen voltages vary considerably depending upon frequency and drive.

CONTROL SEQUENCE CHECKS

Tabulated in the following material, as an aid in trouble-shooting, are charts on control-circuit sequence of events.

STARTING CONTROL SEQUENCE

CONDITIONS: Breakers S502, S503, S504, S505, S506, and S507 are closed. All door interlocks closed.

Action	Comments
LINE BREAKER (S501) closed	
Fans (B501 and B502) on	
Blowers (B302 and B304) on	
Blower (B303) on	
Air interlock (K512) closes	Air interlocks close after blowers reach operating speed.
Blower (B305) on	
Air interlock (K513) closes	
FILAMENT switch (S512) ON	Circuit completed only if K512 and K513 are closed.
Filament relay (K504) closes	
Filament energized	
Filament indicator lamp (I504) glows	
Plate time-delay relay (K503) is energized	Closes after 60-80 second time delay.
PLATE switch (S513) ON	Circuit completed only after K503 closes and only if door interlocks are closed.
Plate time delay bypass relay (K506) closes	
Plate contactor (K505) closes	
Plate indicator light (I503) glows	
Plate circuits energized	

OVERLOAD CONTROL CIRCUIT SEQUENCE

CONDITIONS: Transmitter is in operation, S514 is in AUTOMATIC position.

Action	Comments
First momentary overload occurs (an overload relay, K501, K502, K510, K511, or K901 closes momentarily).	
Relay K508 closes; moves to second step position.	Only if overload is in transmission line—initiated through K901
Relay K507 closes and latches self in	
Line monitor overload lamp (I301) glows	
Overload indicator lamp (I302) glows	
Relay K509 closes and latches self in	See Note 1
Plate contactor, K505 releases	
Plate circuits de-energized	
Plate ON lamp (I503) OFF	
Overload auxiliary relay, K509 releases	See Note 2
Plate contactor, K505 closes	See Note 3
Plate circuits re-energized	
Plate ON lamp (I503) glows	See Note 4
Second momentary overload occurs	See Note 5
Third momentary overload occurs	See Note 6

CONTROL SEQUENCE TO RESET OVERLOAD SEQUENCE

Action
Depress OVERLOAD RESET switch (S509) or turn OFF and then ON either the PLATE ON (S513) or the FILAMENT ON (S512) switches.
Relay, K508 is reset to first notch.
Overload indicator lamps are extinguished.
Plate contactor K505 closes.
Plate circuits re-energized.
PLATE ON indicator lamp glows.

NOTE 1 K509 is a high speed relay which immediately latches in a circuit across K508 insuring positive action of the mechanically slower step relay K508.

NOTE 2 Small contact opens more slowly than main contacts giving a fraction of a second time delay allowing more positive action of relay K508.

NOTE 3 If AUTOMATIC-MANUAL switch, S514 were set on MANUAL the transmitter plate circuits would remain de-energized after the first overload until K508 is reset by switch S509, S512, or S513.

NOTE 4 Overload indicators remain ON, until overload reset switch S509 is depressed or S512 or S513 opened.

NOTE 5 Action detailed under first momentary overload repeats with notching relay K508 latched to third position.

NOTE 6 Action detailed under first momentary overload repeats with K508 latched into fourth position except that the plate circuits remain de-energized until K508 is reset.

RECOMMENDED CLEANING PROCEDURE

Item	Method of Cleaning
Insulators	Use cloth dampened with carbon tetrachloride.
Contacts (relay, switch, tube)	Polish with crocus cloth and then wipe off with cloth dampened with carbon tetrachloride.
Air Filter	Remove the filter panel from its mounting and tap it several times on a hard surface to remove the heavy accumulation. Wash the filter panel in a pan of hot soapy water, with a stream of hot water, or preferably with a jet of live steam. Set the panel on its open end to drain and dry thoroughly. The panel may be recharged by immersing it in the recommended adhesive and then draining it in a warm place. Air-Maze Filterkote and Filterkote "W" are recommended adhesives and may be obtained from the Air-Maze Corporation, Cleveland, Ohio. Any low cost, odorless oil (SAE 30) may be used if desired.
Internal parts of transmitter	Use dry compressed air. As an alternative use a bellows.

ROUTINE MAINTENANCE SCHEDULE

Daily

1. Check filament line voltages every half hour.

2. General inspection after shutdown.

3. Inspect antenna transmission line terminating equipment if there have been heavy static discharges or lightning during the day.

4. If there have been any overloads during the day examine the components concerned and repair as necessary.

Weekly

1. Inspect and clean all relays.

2. Clean internal parts of transmitter, insulators.

3. General performance checkup (noise, distortion and frequency characteristics).

4. Inspect all blowers.

5. Test all door interlocks.

6. Test operation of overload relays.

Monthly

1. Clean RCA 7C24 tube contacts.

2. Lubricate doubler and 1st R-F blower motors with a good grade motor oil.

3. Clean all socket contacts.

4. Service all relay contacts.

5. Check air filter and clean if necessary.

6. Remove the grid bypass capacitor assemblies (C341, C352) and the 7C24 tubes and clean the plate tank capacitor assemblies. Use a long-handled duster or an air gun.

Quarterly

1. Test all spare power tubes in circuit.

2. Operate all spare mercury vapor tubes for 30 minutes (filament only).

3. General detailed close inspection of every unit in transmitter with whatever tests of parts seem advisable.

4. Clean air filter, blower impellers and canvas boots.

5. Service all contactors.

Semi-Annually

1. Clean transmission line insulators. Inspect all relay contacts and make replacements where required. Clean pole faces on contactors.

2. Test spare tubes.

3. Tighten all connections in transmitter.

Annually

1. Disassemble doubler and 1st RF blowers (B302 and B304); clean bearings, reassemble and lubricate.

2. Refer to Figure 26 and lubricate IPA and PA blower motors as directed.

3. Disassemble cabinet fans (B501, B502); clean bearings and pack with the same type grease used in IPA and PA blower motors.

4. Lubricate tuning motors with a light machine oil.

SERVICING PLATE TANK CAPACITORS

1. It is necessary to remove the capacitor assembly (C341, C352, C409, or C419) as the case may be from inside the tank. Proceed as follows:

a. First remove the grid bypass capacitor assembly (C339, C350, C407, or C417) from the top of the tank; then remove the 7C24 tube.

b. Temporarily disconnect the connections to the output coupling loop, and remove the loop assembly.

c. Hold the plate tuning switch in the "up" position, until the plate tuning motor disengages the drive gear from the two racks inside the tank.

NOTE: Line breaker (S602), control breaker (S603), and tuning motor switch (S507) must all be on.

d. Remove the plate tank capacitor assembly through the top of the tank.

2. To re-assemble the plate tanks, proceed as follows:

a. Carefully insert the plate capacitor assembly so as not to damage any of the contact fingers.

b. Apply pressure lightly to the top of the capacitor assembly to align the two racks with their drive gear, then press down plate tuning switch until the teeth of the racks engage in their drive gears.

CAUTION: The two racks must be simultaneously and smoothly engaged by their drive gear. Failure to observe this precaution may result in jamming (stalling) the drive motor, and/or stripping the speed reduction gears.

c. Run the racks down a little, until their alignment can be checked just as they extend beyond the bottom edge of the tank base casting.

ADDITIONAL SERVICE INFORMATION

The following service notes have been compiled from field data and represent possible troubles and their remedy. Additional information may be supplied from time to time. Although much of this information may never apply to your transmitter, its availability should help obtain maximum operating efficiency and reliability from your BTF-3B transmitter.

1. MODIFICATION KITS

a. Modification kits which may apply to BTF-3B transmitters are listed below. In most cases, the modifications were made before the transmitter was shipped. However, each installation should be checked for modification kits still applying. If all kits have not been received they will be shipped to the customer (at no charge) upon notification of the absence of the kit.

Kit 102—**Screen Bypass Capacitor for 4-125A Amplifier.** This kit provides ceramic capacitors rated at 10,000 volts to replace the Model "T" capacitors, C314 and C323.

Kit 103—**Plate Blocking Capacitor for 4-125A Amplifier.** This kit provides a larger 15,000 volt ceramic capacitor to replace the 10,000 volt ceramic capacitor, C318.

Kit 105—**Spacers for 7C24 Tubes.** This kit is designed to raise the 7C24 tubes slightly and thus increase grid contact pressure. It should only be installed where necessary. The correct distance between the top of the tank center conductor and the top of the ring on which the tube rests is 2-7/16 inches.

Kits 106 and 113—**Bolts for Tanks.** This kit supplies the necessary hardware to connect the two tanks (PA and IPA) together at the top and bottom. Installation usually reduces stray r.f. in the cabinet and wiring.

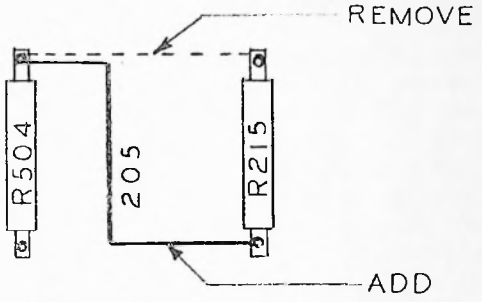
Kit 109—**Relay Marker Strips.** This kit supplies etched marker strips for the relays and breakers in the power and control unit.

Kit 110—**Tuning Motor Switch.** This kit provides a new "automatic manual" switch which in the "automatic" position opens the tuning motor circuit thus minimizing the possibility of accidental detuning of the amplifier tank circuits.

Kit 111—**Contactor Shock Mounts.** This kit provides shock mounts for the plate contactor mounted on the power and control panel.

Kit 112—**Replacement Capacitor for C308.** This kit provides a larger type 15,000 ceramic capacitor to replace the 10,000 volt capacitor C308.

Kit 114—**Wiring Change, R504.** This change reduces the plate voltage on the 4-125A/4D21 tubes. The change may be identified by the following sketch.



Kit 115—**Replacement Crystal Oscillator Trimmer Capacitors.** This kit provides 25 mmf capacitors (7 plate) to replace the 10 mmf capacitors (3 plate). This substantially increases the amount of crystal oscillator frequency adjustment.

Kit 117—**Output Coupling Loops.** This kit provides new output coupling loops L317, L322. The old loops can be identified by a white teflon bushing between the center and outer rods at the top of the loop capacitor. The new loops have an air space around the top of the center rod.

Kit 119—**Mycalex Arms for Output Coupling Loops.** This kit provides Mycalex drive arms for the output coupling loops to replace the arms made of dielectine (red).

2. HIGH STANDING WAVE RATIO

A high standing wave ratio on the transmission line may appear in any of the following ways:

(a) Arcing in output coupling loop capacitors.

(b) Excessive heating in transmission line and harmonic filter. Hot spots on line will occur every 60 inches or so.

(c) Excessive distortion.

(d) Excessive movement of transmission line current and plate current meters with modulation.

(e) Erratic loading of the PA stage. Depending on the phase of the impedance loading into the transmission line, this may show up in any one of the following three ways:

(1) Inability to load the PA fully even at maximum coupling of the loading loop.

(2) Inability to unload the PA to proper value except at minimum coupling of loading loop.

(3) Rapid de-tuning of the PA plate circuit as loading is increased or decreased.

It is recommended that wherever possible, a device for monitoring the standing wave ratio on the transmission line be secured as a regular part of the station test equipment. Several such devices are commercially available. Information on these will be forwarded upon request.

Where no other equipment is available, the transmission line monitor may be used as a rough indication of standing wave ratio by performing the following operations:

(a) Set TUNE-OPERATE switch (S507), located on the power and control panel, in low voltage position.

(b) Turn on carrier and measure D-C voltage at the jack (J901), located in transmission line monitor, using a high resistance voltmeter such as an RCA VoltOhmyst. Call this voltage V_r.

(c) Turn off carrier. Remove the monitor from the line and remount it in the reverse direction, i.e., with arrow on tube block marked "antenna" pointing in the direction of the line to the transmitter.

(d) Remove leads from terminal 3K and 5K in the transmission line monitor. Turn on carrier and again measure voltage at J901. Call this voltage V_i.

(e) Calculate the approximate standing wave ratio as follows:

$$SWR = \frac{V_i + V_r}{V_i - V_r}$$

The standing wave ratio on the transmission line should not exceed 1.75 to 1. If it has been determined to be higher than this value, it is recommended that the antenna be checked. A few of the important points to check on an RCA Pylon antenna are as follows:

(a) Check position of shorting bars across slots. Refer to the charts in the antenna instruction books.

(b) Check all grounding clamps and bonding straps. If one of these has broken, loosened, or is missing, a high standing wave ratio may result.

(c) If the standing wave ratio is very high, look for a missing or loose center conductor connector anywhere in the line or antenna.

(d) Check the insulated cover over the slot. This should not be painted.

(e) Check for water in the transmission line. This will not normally occur if the line gas pressure can be properly maintained.

3. EXCESSIVE GRID CURRENT

In order to prevent damage to the 7C24 tubes, it is extremely important that all the grid currents be kept as low as possible, or, in the case of the PA stage, as near the specified value as possible. Particular care should be taken when it becomes necessary to unload a stage because the grid current tends to increase as the loading is decreased. It is therefore recommended that any loading or unloading be done in small steps and the effect on the grid current carefully watched. The efficiency curve, showing the proper value of grid current for any power output is included in this book. (See Figure 24.)

4. DE-TUNING WITH LOADING

If the circuits are properly adjusted, it should be possible to make the necessary loading and unloading adjustment for normal operating conditions with little or no effect on the tuning of the plate circuits. If the PA plate circuit de-tunes rapidly as loading is adjusted, it is possible that the standing wave ratio on the line is high. (See Section 1 of these notes.) Improvement can sometimes be obtained by adjusting loop capacitor C374. (Do not open more than 4 inches.)

5. OVERHEATING OF L308

To reduce heating of first RF plate tuning coil, check the following:

(a) Make sure the plate voltage is not excessive. Check for wiring change covered by Kit 114. The voltage on the plates of the 1st RF amplifier tubes should not exceed 2800 volts.

(b) L308 should be operated with the slider on the lower half of the coil. It may be necessary to spread L307 slightly to enable the circuit to resonate under these conditions.

(c) Check neutralization by setting S507 in the low voltage position and removing the drive from the doubler stage. This can be done by disconnecting plug P102 at the exciter output. All grid currents should drop to zero. If necessary, touch up the adjustment of C315.

(d) Make sure coil bearings are not loose. If necessary, tighten the top bearing screw.

(e) Slider should make good contact. It may be necessary to remove the slider and spring it slightly.

6. UNSTABLE FREQUENCY CONTROL (without modulation)

Although the frequency stability of the transmitter is guaranteed to be within plus or minus 1000 cycles, it has been our experience that, once the heaters have warmed up and the circuits properly tuned, the frequency variation to be expected from a normal transmitter is approximately plus or minus 100 cycles. If the frequency is constantly changing 1000 cycles or so, it is suggested that the following checks be made:

(a) Set the selector switch in position #1 and turn the carrier on and off. If there is any change in the vertical amplitude of the pattern, it is an indication that RF is getting into the crystal oscillator grid circuits and causing a frequency shift. (Fuzzing or widening of the line is not normally an indication of frequency shift.)

It has been our experience that L112, in series with the crystals, is sufficient filtering for almost all installations; however, should it be necessary to provide additional filtering, see Section 8 of these notes.

(b) Set the selector switch in position #2 and note whether or not the ellipse remains fixed in one position. If it rotates slowly, (one cycle every four or five seconds) it is an indication that the motor is not pulling in completely to zero beat, and a frequency shift of the order mentioned above will result. If this occurs, check the arm of the alarm switch, S106. It should not drag on the tuning motor shaft bakelite bushing over the operating range of the motor armature. This can be easily adjusted by loosening the switch mounting screws and moving the switch slightly. In some cases, shifting the fine tuning control of T115 will move the armature to a position where the torque will be greater. If the above suggestions do not stop the pattern from rotating, it probably indicates a defective motor, and it is suggested that your local sales representative be contacted for a replacement.

7. UNSTABLE FREQUENCY CONTROL (with modulation)

If the frequency is stable without modulation but jumps or shifts excessively when modulation is applied, make the following checks:

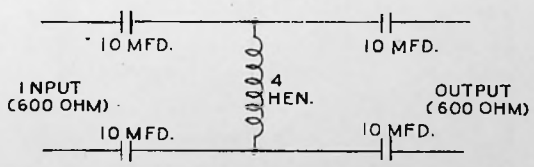
(a) Check the level of the damping fluid in the exciter frequency control motor. This should be approximately 3/8" below the bottom of the RCA monogram.

(b) Temporarily lock the frequency control motor, (retune T115 for correct frequency if necessary). If the monitor meter still shifts with modulation, this probably indicates that the shift is in the monitor itself and is caused by unsymmetrical audio signal often present in a normal program.

(c) If the frequency shift occurs only when the frequency control is functioning and the signal on all receivers is broad and distorted, a very low frequency component (below 30 cycles) in the input signal may be the cause. Look for a 1 to 10 cycle "motor-boating" in one of the amplifiers or in studio transmitter link equipment.

(d) If the erratic frequency shift occurs only when the limiter is functioning, the frequency instability may actually be caused by low frequency "plops" of the limiter action. These can usually be corrected by making the proper adjustment in the limiter circuit. This effect should not occur in the RCA 86A1 limiting amplifiers if the 6K7 tubes are properly balanced. If difficulty is encountered, try a new set of matched tubes, MI-11250. If this does not correct the trouble, contact our local sales representative or the Broadcast Audio Section in Camden for circuit modifications which will permit balancing of nearly any 6K7 tube.

Another way to eliminate these sub-audio components is to insert a high-pass filter (cuts off below 30 cycles) in the line between limiter and the transmitter input. This will effectively reduce any sub-audio components present. The diagram which follows shows such a filter for a 600 ohm line. The disadvantage of this filter is that the capacities required are of rather large value and may not be readily available. It may be possible that an equivalent filter can be added to one of the high impedance circuits of the limiting amplifier, in which case, the capacitors required will be correspondingly smaller.



8. RF IN EXCITER OSCILLOSCOPE

Occasionally, RF from the PA will get into the exciter oscilloscope circuit causing a slight "fuzzing" of the trace. This usually does no harm to the functioning of the transmitter other than making it difficult to adjust the exciter with the carrier on. This RF usually enters through the wiring and will almost always be eliminated by adding Ohmite type ZO chokes (available in most radio parts stores) in series with one or more of the following leads (refer to the Exciter Cabinet Connection diagram, Figure 20).

Lead 12 at terminal 12B
Lead 13 at terminal 13B
Lead 18 at terminal 15B
Lead 19 at terminal 16B
Lead 20 at terminal 17B
Lead 21 at terminal 18B

In addition the following sometimes help eliminate stray RF.

(a) Bolt the two tanks together at top and bottom (see Kits 106 and 113).

(b) Ground the output transmission line to the frame, particularly near where it leaves the cabinet.

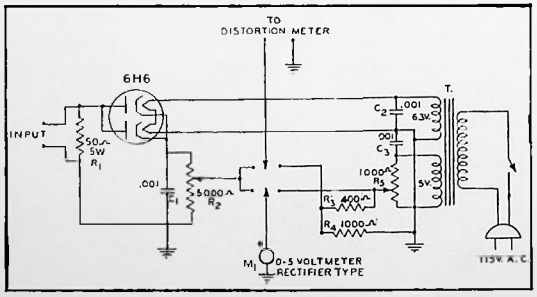
(Use 1 inch copper strap with leads as short as possible.)

(c) Remove the paint from under the bolts which mount the PA rear door to the frame and under the bolts which mount the left-hand end shield.

(d) Shorten strap between the PA tank output coupling loop and the transmission line. (On some of the earlier transmitters this strap was much longer than necessary.)

9. METHOD OF MEASURING A-M NOISE

A diode detector suitable for making the A-M hum and noise measurements which are required for FCC licensing, can be readily constructed from a few parts, all of which are available from any radio supply house. A description of such a detector follows:



BASIC PRINCIPLES

The schematic diagram shown is included in order to aid in the explanation of the basic principles.

In an A-M transmitter, it is conventional to measure noise level with respect to the amplitude of the modulating signal at 100% modulation. In an F-M transmitter, however, the noise is measured with respect to the amplitude of the carrier itself. This is accomplished by providing a source of low frequency A.C. with the same amplitude as the carrier and then comparing it with the noise voltage.

The signal is fed into the diode detector. Across the potentiometer will be developed a D-C voltage equal to the peak voltage of the carrier. Super-imposed on this D.C. will be the noise voltage, which is A.C. The D-C voltage is measured by the rectifier type A-C voltmeter which is connected in such a manner that it will read the D-C output of the diode.

On the opposite side of the equipment is a transformer which provides a source of low value 60 cycle A.C. This voltage may be controlled in amplitude by a potentiometer, R5.

It will be observed from the schematic that for any value of A.C. which is applied to the meter only 0.707 of that value is delivered to the output. This is explained by the fact that the D-C signal voltage is equal to the peak value of the carrier, and it is desired to generate an A.C. of exactly the same amplitude but of a low audio frequency. Since the comparing device is the rectifier type meter which reads effective values of A.C., the meter will give the same reading for both D-C signal voltage and A-C voltage only when the A.C. is 1.414 times the D.C. However, for the output, a peak A.C. which is exactly equal to the D-C voltage is desired. We get this simply by tapping off 0.707 of the A-C voltage on a voltage dividing resistor.

The noise voltage is then compared with the amplitude of the A-C voltage on the distortion meter.

OPERATION

(a) Introduce R-F signal from transmitter to input connector. Connect output to distortion meter.

(b) With switch in "Signal" position, increase signal voltage until meter reads in the neighborhood of 3.5 to 4 volts.

(c) Throw switch to "A-C" position, and increase A.C. until meter reads same value as in "Signal" position. Set up distortion meter to read zero db, at this level.

(d) Throw switch to "Signal" position, and read noise level on distortion meter.

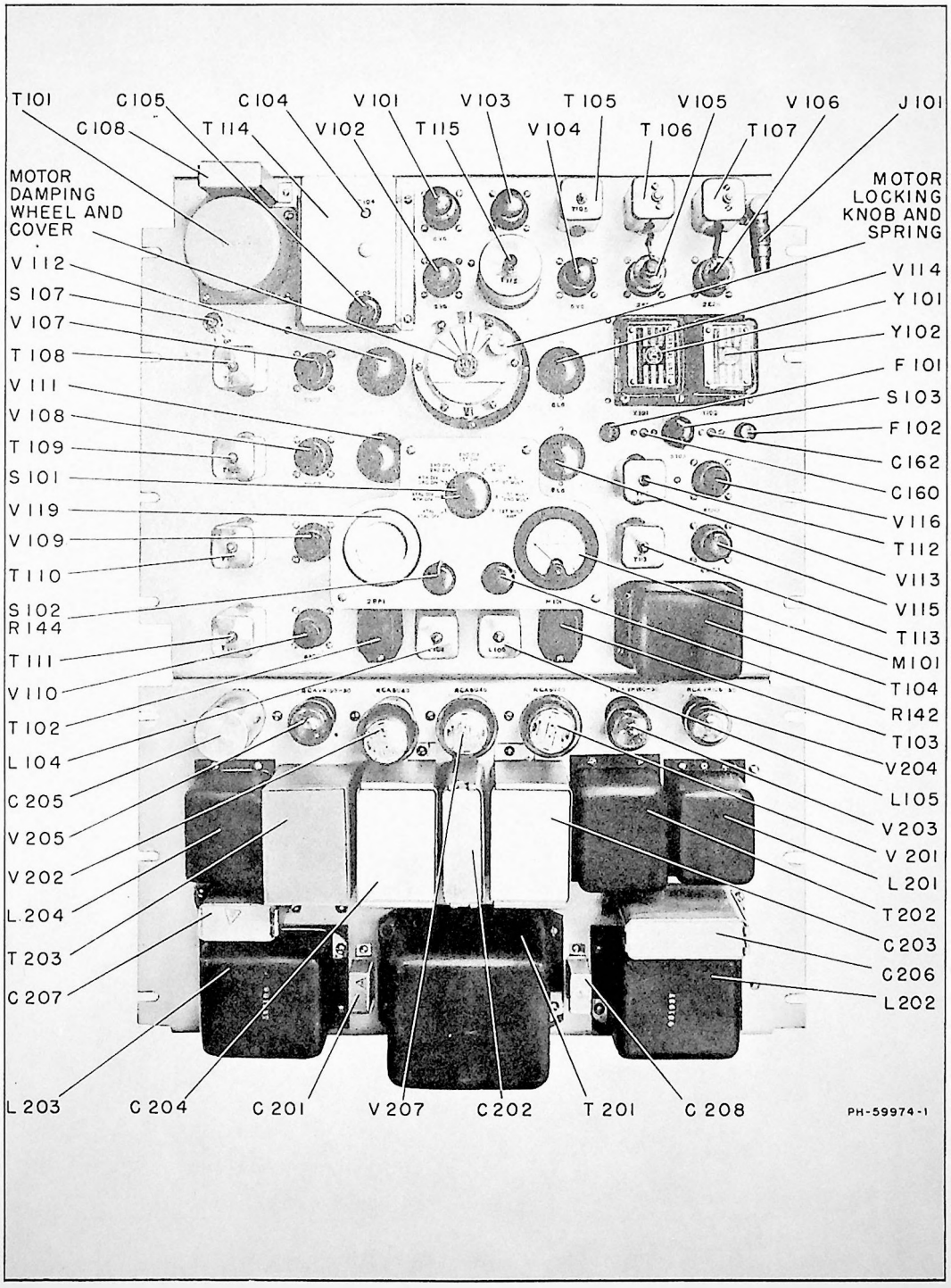


Figure 7—F-M Exciter and Power Supply Chassis (Front View)

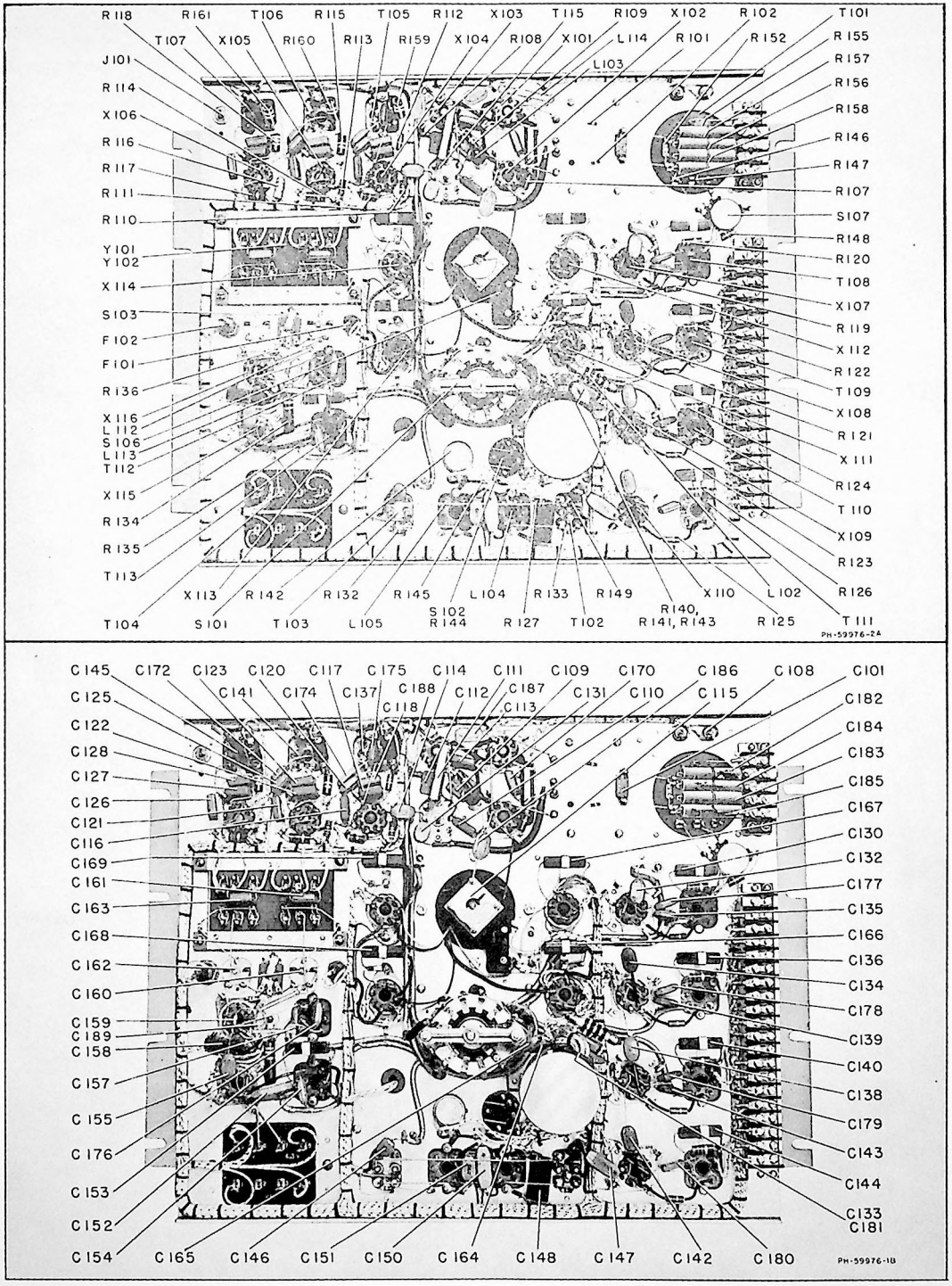


Figure 8—F-M Exciter Chassis (Rear View)

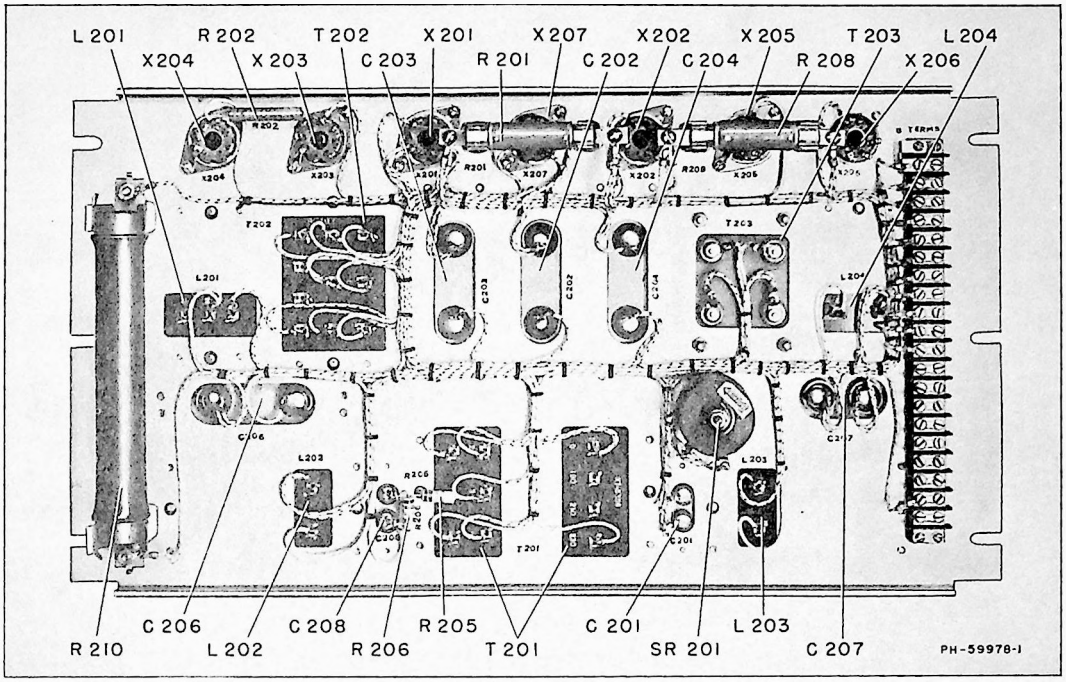


Figure 9—F-M Exciter Power Supply Chassis (Rear View)

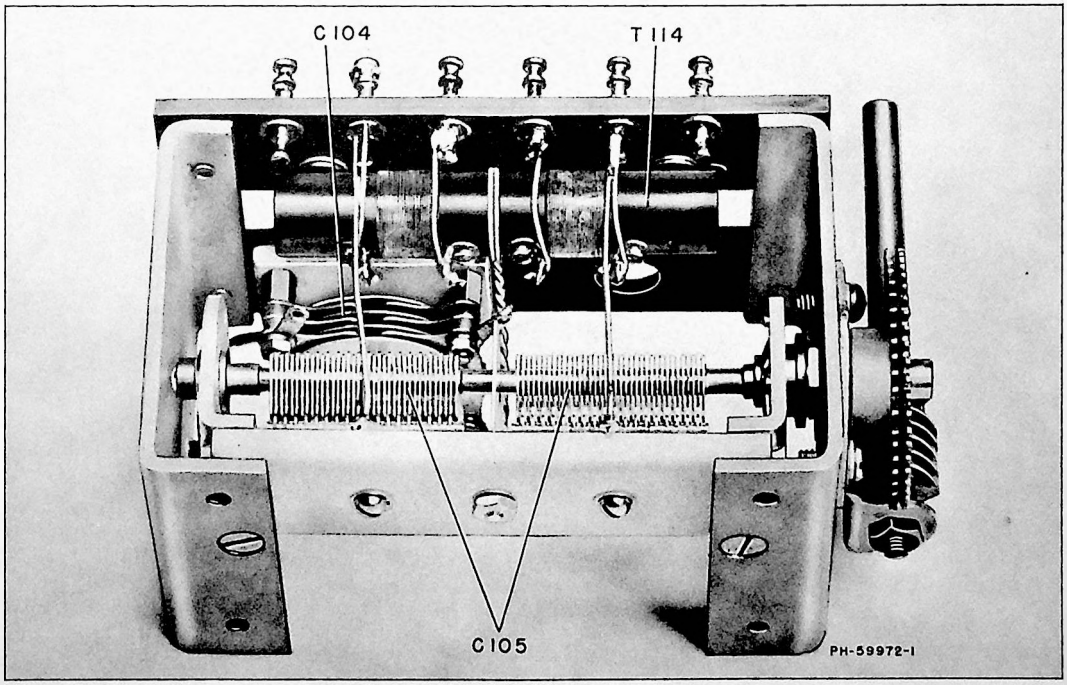


Figure 10—Reactance Tube Grid Tuning Assembly

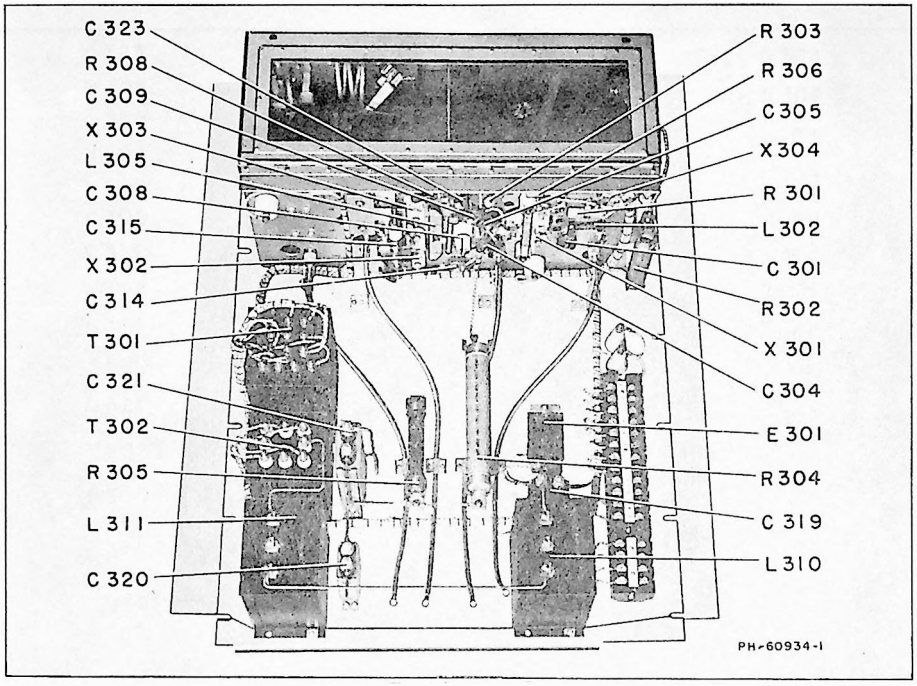


Figure 11—1st R-F Amplifier Chassis (Front View, Cover Removed)

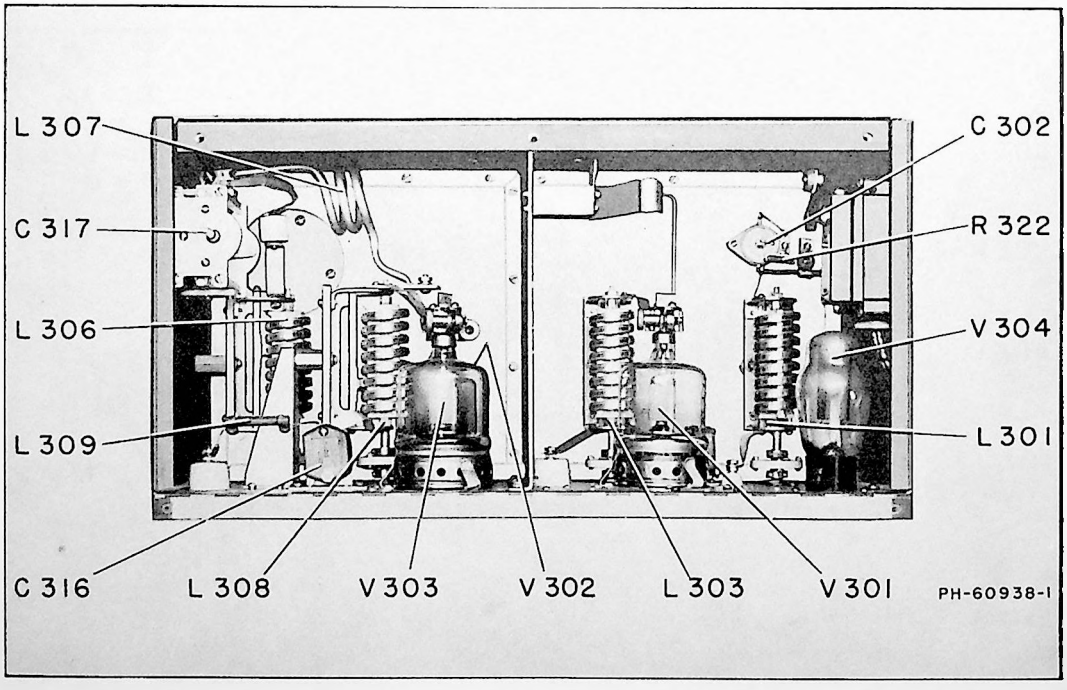


Figure 12—1st R-F Amplifier Chassis (Top Section)

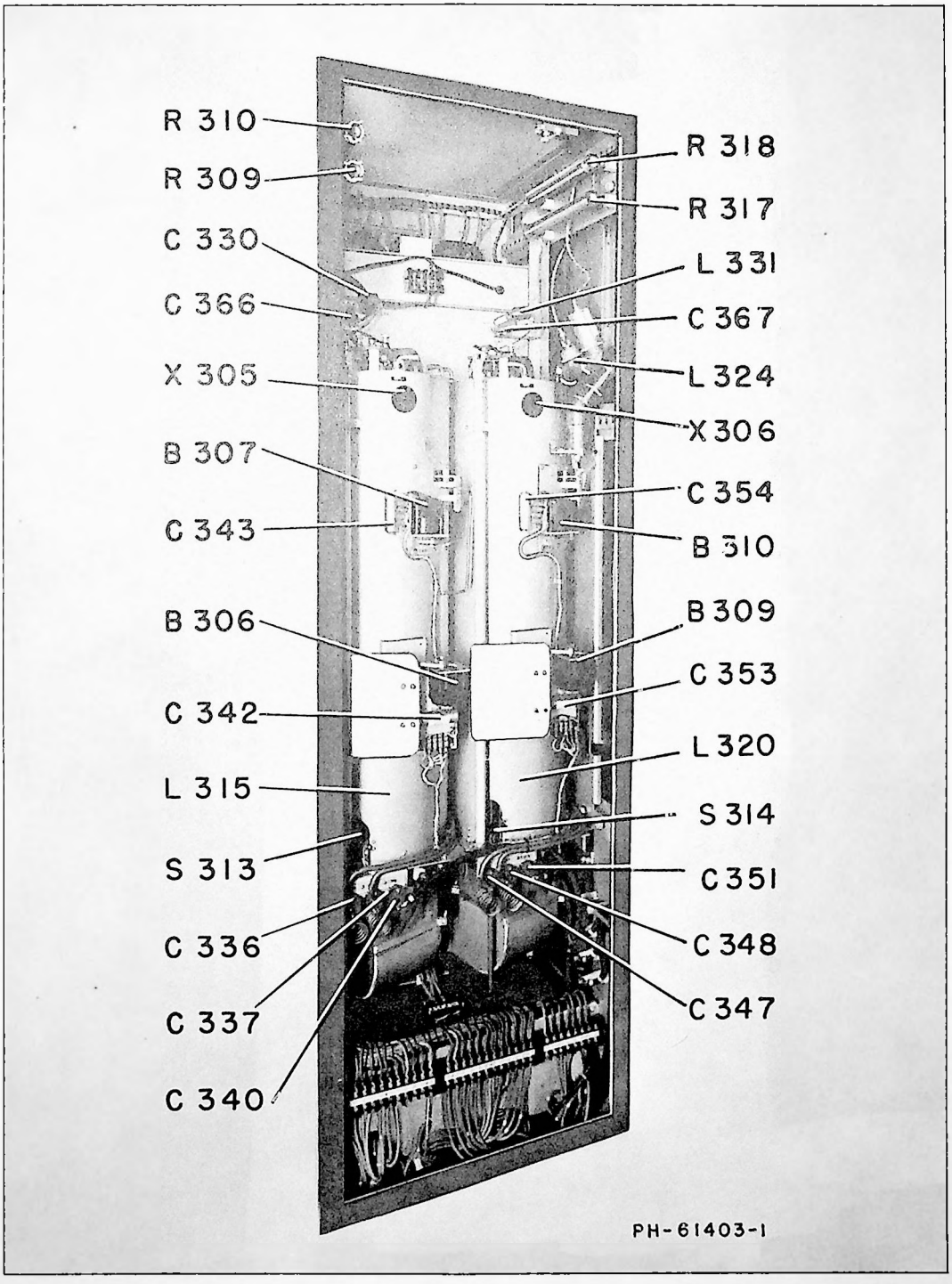


Figure 13—PA Compartment (Rear View)

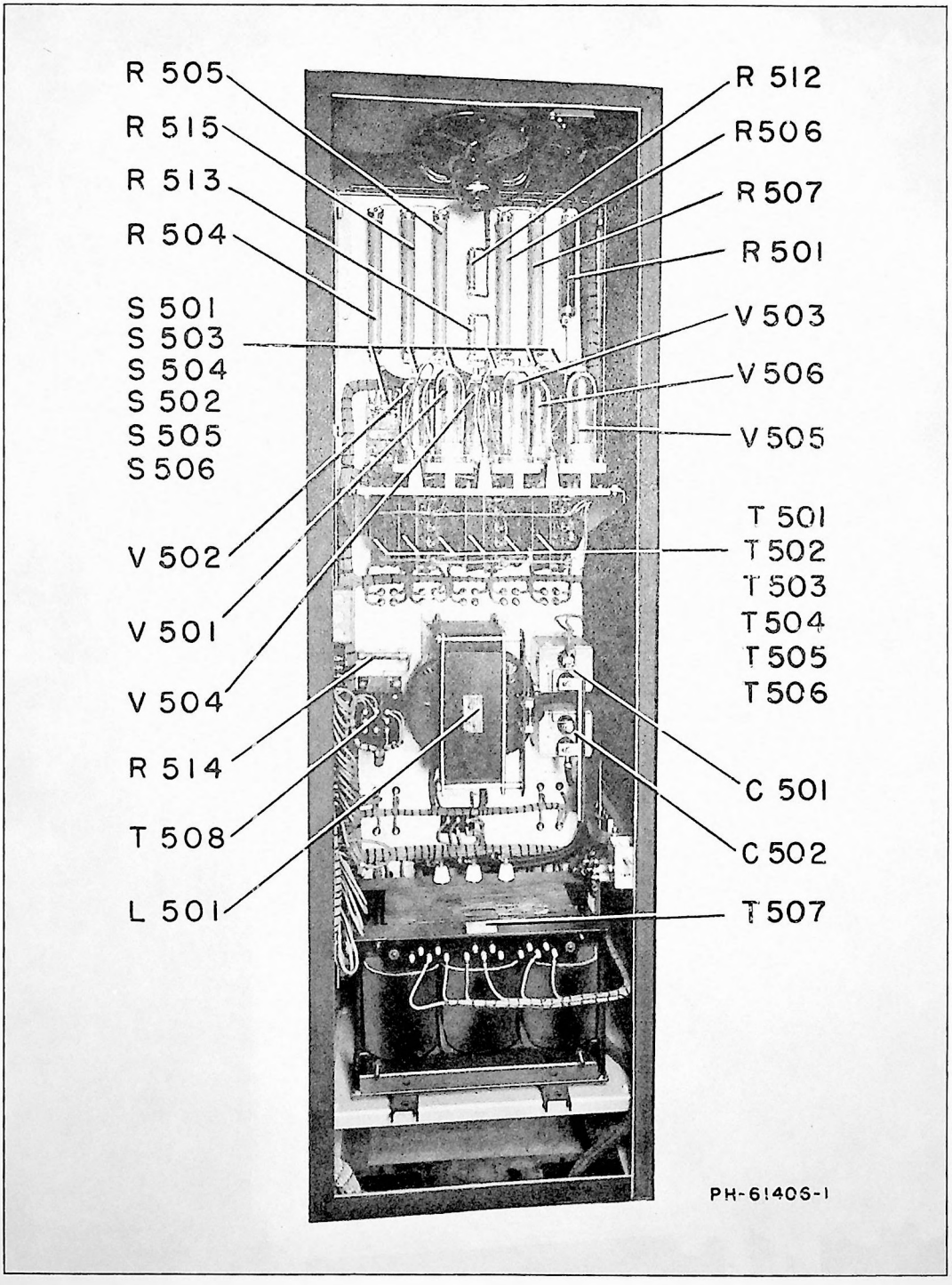


Figure 14—Power and Control Compartment (Rear View)

PARTS LIST

When ordering replacement parts, please give RCA Stock Number. Symbol Number, Description, and Drawing Number will be helpful in further identifying the desired part and should be given when no Stock Number is shown in the following list.

The part which will be supplied against an order for a replacement item may not be an exact duplicate of the original part, however, it will be a satisfactory replacement, differing only in minor mechanical or electrical characteristics. Such differences will in no way impair the operation of the equipment.

Symbol Numbers with suffix letters may not be shown on the schematic and are used for relating the parts to the main item of which they are components.

FM Exciter Unit — MI-7016

Symbol	Description	Dwg. No.	Stock No.
B101	Motor, frequency control	P-727856-131	67562
C101	Capacitor, reactance tube grid, mica, 220 mmfd., 500 V.	M-438057-1	51708
C104	Capacitor, reactance tube grid tuning, variable, 5-25 mmfd.	M-438449-2	51709
C105	Capacitor, reactance tube grid tuning, variable, 6-140 mmfd.	K-882321-1	45362
C108	Capacitor, reactance tube cathode bypass, 5.2 mfd., 50 V. D.C.	K-8890673-1	51711
C109	Capacitor, reactance tube screen bypass, mica, 10,000 mmfd., 300 V.	P-727866-171	92036
C110	Capacitor, osc. plate bypass. Same as C109		
C111	Capacitor, osc. plate, ceramic, 80 mmfd.	K-870647-7	44703
C112	Capacitor, osc. grid blocking, mica, 820 mmfd., 500 V.	P-727866-145	47048
C113	Capacitor, osc. screen bypass. Same as C109		
C114	Capacitor, buffer-1st multiplier coupling, mica, 270 mmfd., 500 V.	P-727856-133	65401
C115	Capacitor, osc. plate tuning, variable, 2-12 mmfd.	M-443175-2	51714
C116	Capacitor, 1st multiplier cathode bypass. Same as C109		
C117	Capacitor, 1st multiplier screen bypass. Same as C109		
C118	Capacitor, 1st multiplier plate bypass. Same as C109		
C120	Capacitor, 1st multiplier-2nd multiplier coupling, mica, 27 mmfd., 500 V.	P-727856-109	68757
C121	Capacitor, 2nd multiplier cathode bypass. Same as C109		
C122	Capacitor, 2nd multiplier screen bypass. Same as C109		
C123	Capacitor, 2nd multiplier plate bypass. Same as C109		
C125	Capacitor, 2nd multiplier-amplifier coupling, mica, 18 mmfd., 500 V.	P-727856-105	51058
C126	Capacitor, amplifier cathode bypass. Same as C109		
C127	Capacitor, amplifier screen bypass. Same as C109		
C128	Capacitor, amplifier plate bypass. Same as C109		
C130	Capacitor, 1st divider plate bypass, 0.1 mfd., 400 V.	K-896980-2	51710
C131	Capacitor, osc.-cathode ray coupling, mica, 33 mmfd., 500 V.	P-727856-111	53302
C132	Capacitor, 1st divider sync. coupling, mica, 22 mmfd., 500 V.	P-727856-107	39612
C133	Capacitor, cathode ray plate bypass. Same as C109		
C134	Capacitor, 2nd divider sync. coupling, mica, 7 mmfd., 500 V.	P-728608-173	53635
C135	Capacitor, 1st divider-cathode ray coupling. Same as C132		
C136	Capacitor, 2nd divider plate bypass. Same as C130		
C137	Capacitor, 1st multiplier-cathode ray coupling, mica, 5 mmfd., 500 V.	P-727856-1	68736
C138	Capacitor, 3rd divider sync. coupling, mica, 10 mmfd., 500 V.	P-727856-102	72615
C139	Capacitor, 2nd divider cathode ray coupling. Same as C134		
C140	Capacitor, 3rd divider plate bypass. Same as C130		
C141	Capacitor, 2nd multiplier-cathode ray coupling, 2.2 mmfd., 500 V.	K-99327-14	71502
C142	Capacitor, 4th divider sync. coupling. Same as C134		
C143	Capacitor, 3rd divider-cathode ray coupling, mica, 6 mmfd., 500 V.	P-728608-172	53636
C144	Capacitor, 4th divider plate bypass. Same as C130		
C145	Capacitor, amplifier-cathode ray coupling. Same as C141		
C146	Capacitor, 4th divider-cathode ray coupling, mica, 82 mmfd., 500 V.	P-727856-121	39626
C147	Capacitor, motor tube coupling, mica, 2200 mmfd., 500 V.	P-727866-155	47047
C148	Capacitor, motor tube grid bypass, 0.1 mfd., 400 V.	P-727895-168	51710
C150	Capacitor, crystal divider, 90° network. Same as C147		
C151	Capacitor, crystal divider, 90° network, mica, 390 mmfd., 500 V.	P-727856-137	68542
C152	Capacitor, crystal divider, plate tuning, mica, 2700 mmfd., 500 V.	P-727866-157	65400
C153	Capacitor, crystal divider plate bypass. Same as C130		
C154	Capacitor, crystal divider-cathode ray coupling, mica, 39 mmfd., 500 V.	P-727856-113	39618
C155	Capacitor, crystal osc.-crystal divider coupling. Same as C137		
C157	Capacitor, crystal osc.-cathode ray coupling. Same as C134		
C158	Capacitor, crystal osc. plate bypass. Same as C148		
C159	Capacitor, crystal osc. feedback, ceramic, 2 mmfd.	K-99179-1	51724
C160	Capacitor, crystal osc. grid, variable, 25 mmfd.	K-844546-10	43369
C161	Capacitor, crystal heater bypass. Same as C109		
C162	Capacitor, crystal osc. grid. Same as C160		
C163	Capacitor, crystal heater bypass. Same as C109		
C164	Capacitor, cathode ray coupling, mica, 56 mmfd., 500 V.	P-727856-117	50399
C165	Capacitor, cathode ray coupling. Same as C164		
C166	Capacitor, motor tube plate bypass. Same as C130		

FM Exciter Unit — MI-7016 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
C167	Capacitor, motor tube plate bypass. Same as C130		
C168	Capacitor, motor tube plate bypass. Same as C130		
C169	Capacitor, motor tube plate bypass. Same as C130		
C170	Capacitor, reactance tube cathode bypass. Same as C109		
C171	Capacitor, amplifier plate tuning, variable. (Part of T107)	M-253132-11	66414
C172	Capacitor, 2nd multiplier-amplifier coupling. Same as C125		
C173	Capacitor, 2nd multiplier plate tuning, variable. (Part of T106)	M-253132-12	63210
C174	Capacitor, 1st multiplier-2nd multiplier coupling. Same as C120		
C175	Capacitor, 1st multiplier plate tuning. Same as C134		
C176	Capacitor, crystal osc. plate tuning. Same as C131		
C177	Capacitor, 1st divider plate tuning, mica, 47 mmfd., 500 V.	P-727856-115	68737
C178	Capacitor, 2nd divider plate tuning. Same as C177		
C179	Capacitor, 3rd divider plate tuning, mica, 100 mmfd., 500 V.	P-727856-123	68077
C180	Capacitor, 4th divider plate tuning, mica, 470 mmfd., 500 V.	P-727856-139	39644
C181	Capacitor, cathode ray filament bypass. Same as C109		
C182	Capacitor, audio input filter, paper, 0.25 mfd., 100 V.	P-72086-49	70618
C183	Capacitor, audio input filter. Same as C182		
C184	Capacitor, audio input filter. Same as C182		
C185	Capacitor, audio input filter. Same as C182		
C186	Capacitor, osc. plate. Same as C138		
C187	Capacitor, reactance tube heater bypass. Same as C109		
C188	Capacitor, osc. heater bypass. Same as C109		
C189	Capacitor, crystal osc. heater bypass. Same as C109		
F101	Fuse, crystal heater, 1 Amp.	K-55544-14	14133
F102	Fuse, crystal heater. Same as F101		
J101	Receptacle, amplifier output	P-255223-1	51800
L102	Choke, cathode ray plate	K-834206-501	16612
L103	Choke, reactance tube plate	K-862943-1	44679
L104	Choke, crystal divider, 90° network	P-728446-8	51726
L105	Choke, crystal divider, 90° network	P-728446-7	51727
L107	Choke, amplifier plate. Same as L102. (SUPERSEDED BY R161)		
L108	Choke, 1st multiplier plate. Same as L102. (SUPERSEDED BY R159)		
L109	Choke, 2nd multiplier plate. Same as L102. (SUPERSEDED BY R160)		
L110	Choke, 2nd multiplier plate parasitic. (Part of T106)		
L111	Choke, amplifier plate parasitic. Same as L110. (Part of T107)		
L112	Choke, crystal osc. filter	K-899833-1	52072
L113	Choke, crystal osc. plate. Same as L112		
L114	Choke, reactance tube screen. Same as L112		
M101	Meter, reactance tube cathode, 0-30 Ma. D.C.	K-897918-1	51728
P101	Connector, amplifier output	K-252868-1	65956
P102	Adapter, amplifier output	K-893648-1	
P103	Right Angle Adapter, amplifier output	P-255223-10	
R101	Resistor, reactance tube grid damping, 4700 ohms, ½ W.	P-727834-70	
R102	Resistor, grid damping. Same as R101		
R107	Resistor, reactance tube cathode bias, 1500 ohms, 1 W.	P-727836-64	
R108	Resistor, osc. grid leak, 18,000 ohms, 1 W.	P-727836-77	
R109	Resistor, osc. screen, 100,000 ohms, 1 W.	P-727836-86	
R110	Resistor, 1st multiplier grid leak, 47,000 ohms, 1 W.	P-727836-82	
R111	Resistor, 1st multiplier cathode bias, 470 ohms, 1 W.	P-727836-58	
R112	Resistor, 1st multiplier screen, 56,000 ohms, 1 W.	P-727836-83	
R113	Resistor, 2nd multiplier grid leak, 27,000 ohms, 1 W.	P-727836-79	
R114	Resistor, 2nd multiplier cathode bias, 470 ohms, 2 W.	P-727838-58	
R115	Resistor, 2nd multiplier screen, 15,000 ohms, 2 W.	P-727838-76	
R116	Resistor, 3rd multiplier grid leak, 22,000 ohms, 1 W.	P-727836-78	
R117	Resistor, 3rd multiplier cathode bias, 820 ohms, 2 W.	P-727838-61	
R118	Resistor, 3rd multiplier screen dropping, 68,000 ohms, 2 W.	P-727838-84	
R119	Resistor, 1st divider parasitic suppressor, 1000 ohms, ½ W.	P-727834-62	
R120	Resistor, 1st divider plate, 8200 ohms, 2 W.	P-727838-73	
R121	Resistor, 2nd divider parasitic suppressor. Same as R119		
R122	Resistor, 2nd divider plate. Same as R120		
R123	Resistor, 3rd divider parasitic suppressor, 2200 ohms, ½ W.	P-727834-66	
R124	Resistor, 3rd divider plate. Same as R120		
R125	Resistor, 4th divider parasitic suppressor. Same as R123		
R126	Resistor, 4th divider plate. Same as R120		
R127	Resistor, motor tubes bias, 100,000 ohms, ½ W.	P-727834-25	
R132	Resistor, 90° phasing network termination, 3900 ohms, ½ W.	P-727834-173	
R133	Resistor, 90° phasing network termination. Same as R132		
R134	Resistor, crystal divider plate, 27,000 ohms, 2 W.	P-727838-79	
R135	Resistor, crystal divider parasitic suppressor. Same as R123		
R136	Resistor, crystal osc. gridleak, 390,000 ohms, ½ W.	P-727834-221	
R137	Resistor, crystal oven heater. (Part of TMV129G)		
R138	Resistor, crystal oven heater. Same as R137. (Part of TMV129G)		
R140	Resistor, cathode ray plate, 470,000 ohms, ½ W.	P-727834-29	

FM Exciter Unit — MI-7016 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
R141	Resistor, cathode ray plate. Same as R140		
R142	Potentiometer cathode ray intensity control	M-430116-23	52837
R143	Resistor, cathode ray focus divider, 270,000 ohms, ½ W.	P-727834-91	
R144	Potentiometer, cathode ray focus control, 250,000 ohms. (Includes S102)	K-872939-1	51730
R145	Resistor, cathode ray focus divider, 39,000 ohms, ½ W.	P-727834-81	
R146	Resistor, reactance tube test, 2200 ohms, ½ W.	P-727834-167	
R147	Resistor, reactance tube test. Same as R146		
R148	Resistor, reactance tube test, 180,000 ohms, 1 W.	P-727836-89	
R149	Resistor, 4th divider motor tube coupling. Same as R112		
R150	Resistor, 47 ohms. (Part of T106)	K-82283-127	
R151	Resistor, 47 ohms. Same as R150 (Part of T107)		
R152	Resistor, reactance tube input loading, 27,000 ohms, ½ W.	P-727834-79	
R153	Resistor, audio input filter, 560 ohms, ½ W.	P-727834-153	
R154	Resistor, audio input filter. Same as R153		
R155	Resistor, audio input filter, 56 ohms, 1 W.	P-727836-129	
R156	Resistor, audio input filter. Same as R155		
R157	Resistor, audio input filter. Same as R155		
R158	Resistor, audio input filter. Same as R155		
R159	Resistor, 1st multiplier plate, 220 ohms, 2 W.	K-99126-54	
R160	Resistor, 2nd multiplier plate. Same as R159		
R161	Resistor, amplifier plate, 180 ohms, 2 W.	K-99126-53	
S101	Switch, cathode ray selector	M-442529-1	51731
S102	Switch, cathode ray ON-OFF filament. (Part of R144)		
S103	Switch, crystal selector, S.P.D.T.	M-442389-2	52980
S104	Switch, crystal oven thermostat. (Part of TMV129G)		
S105	Switch, crystal oven thermostat. Same as S104. (Part of TMV129G)		
S106	Switch, off frequency alarm	K-872223-2	51733
S107	Switch, reactance tube test	K-8890163-1	55890
T101	Transformer, audio input	M-902022-1	52685
T102	Transformer, motor tube input	M-442511-1	51734
T103	Transformer, motor tube input. Same as T102		
T104	Transformer, filament	M-441295-1	51735
T105	Transformer, 1st multiplier plate	P-728452-4	51736
T106	Transformer, 2nd multiplier plate	M-430871-2	51737
T107	Transformer, amplifier plate	M-430871-1	53634
T108	Transformer, 1st divider	P-728446-1	51738
T109	Transformer, 2nd divider	P-728446-2	51739
T110	Transformer, 3rd divider	P-728446-3	51740
T111	Transformer, 4th divider	P-728446-4	51741
T112	Transformer, crystal osc. plate	P-728446-6	51742
T113	Transformer, crystal divider plate	P-728446-5	51743
T114	Transformer, reactance tube grid phasing	K-897903-501	51744
T115	Transformer, osc. plate	P-727590-501	51745
X101	Socket, reactance tube	M-422515-501	67849
X102	Socket, reactance tube. Same as X101		
X103	Socket, osc. tube. Same as X101		
X104	Socket, 1st multiplier tube	M-422515-502	67849
X105	Socket, 2nd multiplier tube. Same as X104		
X105A	Tube Cap, 2nd multiplier plate, for X105	K-845240-5	
X106	Socket, amplifier tube. Same as X104		
X106A	Tube Cap, amplifier plate, for X106. Same as X105A		
X107	Socket, 1st divider. Same as X101		
X108	Socket, 2nd divider. Same as X101		
X109	Socket, 3rd divider. Same as X101		
X110	Socket, 4th divider. Same as X101		
X111	Socket, motor tube. Same as X104		
X112	Socket, motor tube. Same as X104		
X113	Socket, motor tube. Same as X104		
X114	Socket, motor tube. Same as X104		
X115	Socket, crystal divider. Same as X104		
X116	Socket, crystal osc. Same as X104		
X117	Fuse Holder, crystal heater	K-99088-2	48894
X118	Fuse Holder, crystal heater. Same as X117		
X119	Socket, cathode ray tube	K-8857265-501	51746
X120	Socket, crystal holder	M-433740-501	51747
X121	Socket, crystal holder. Same as X120		
Y101	Crystal Unit—TMV129G		
	Thermostat for TMV129G Crystal Unit		15983
Y102	Crystal. Same as Y101		

Power Supply — MI-7017

Symbol	Description	Dwg. No.	Stock No.
C201	Capacitor, H.V. filter tuning, oil, 1.0 mfd., 500 V. D.C.	K-845824-104	18379
C202	Capacitor, H.V. filter, oil, 10 mfd., 330 V. A.C.	M-418477-223	18984
C203	Capacitor, H.V. filter, oil, 20 mfd., 330 V. A.C.	M-418477-226	51694
C204	Capacitor, H.V. filter. Same as C203		
C205	Capacitor, filament filter, plug-in electrolytic, 1000 mfd., 25 V.	K-86060-7	45920
C206	Capacitor, H.V. filter. Same as C202		
C207	Capacitor, filter, oil, 4 mfd., 330 V. A.C.	M-418477-164	51695
C208A	Capacitor, bias filter, oil, 0.5/0.5 mfd., 300 V. D.C.	P-721478-2	51696
C208B	Capacitor, bias filter. (Part of C208A)		
L201	Reactor, H.V. input filter	M-441297-1	51697
L202	Reactor, H.V. filter	M-442507-1	51698
L203	Reactor, H.V. filter. Same as L202		
L204	Reactor, filament filter	M-442508-1	51699
R201	Resistor, H.V. divider, 2000 ohms, 20 W.	P-722460-444	51700
R202	Resistor, H.V. divider, 2200 ohms, 2 W.	P-727838-167	34769
R205	Resistor, voltage divider, bias filter, 56,000 ohms, 1 W.	P-722333-83	
R206	Resistor, voltage divider. Same as R205		
R208	Resistor, H.V. divider. Same as R201		
R210	Resistor, H.V. divider, 630 ohms, 90 W.	P-722457-439	53387
T201	Transformer, H.V. rectifier plate	M-442504-1	51702
T202	Transformer, H.V. rectifier filaments	M-441292-1	51703
T203	Transformer, filament rectifier (60 cycles)	M-442538-1	51704
T203A	Transformer, filament rectifier (50 cycles)	M-442538-2	
X201	Socket, H.V. rectifier tube	M-442539-501	51705
X202	Socket, H.V. rectifier tube. Same as X201		
X203	Socket, H.V. ballast tube. Same as X201		
X204	Socket, H.V. ballast tube. Same as X201		
X205	Socket, H.V. ballast tube. Same as X201		
X206	Socket, capacitor plug-in, for C205	K-181516-2	45368
X207	Socket, H.V. rectifier tube. Same as X201		
SR201	Roctifier, selenium, filament supply	M-433719-2	51706

R-F Unit — MI-28103

B302	Blower, doubler cooling	P-735523-1	53423
B303	Blower, I.P.A. plate cooling, 1725 RPM. (See Note #1)	P-727596-8	
B303A	Motor, for B303, 1725 RPM	P-727596-10	55060
B303B	Blower, I.P.A. plate cooling, 3450 RPM. (See Note #1)	P-727596-7	
B303C	Motor, for B303B, 3450 RPM	P-727596-9	55061
B304	Blower, 1st R.F. cooling. Same as B302		
B305	Blower, P.A. plate cooling. Same as B303. (See Note #1)		
B305A	Motor, for B305. Same as B303A		
B305B	Blower, P.A. plate cooling. Same as B303B. (See Note #1)		
B305C	Motor, for B305B. Same as B303C		
B306	Motor, I.P.A. cathode tuning	K-863681-9	52643
B307	Motor, I.P.A.-P.A. coupling. Same as B306		
B308	Motor, I.P.A. plate tuning	K-899202-1	52026
B309	Motor, P.A. cathode tuning. Same as B306		
B310	Motor, P.A. loading. Same as B306		
B311	Motor, P.A. plate tuning. Same as B308		
C301	Capacitor, doubler grid coupling, mica, 10,000 mmfd., 500 V.	P-32170-520	8024
C302	Capacitor, doubler grid loading, variable, ceramic, 10-100 mmfd.	K-258851-3	54937
C303	Capacitor, doubler screen bypass, ceramic, 51 mmfd., 10,000 V.	K-984023-1	51893
C304	Capacitor, doubler filament bypass. Same as C301		
C305	Capacitor, doubler filament bypass. Same as C301		
C306	Capacitor, doubler screen bypass. Same as C303		
C307	Capacitor, doubler plate bypass, mica, 1000 mmfd., 3750 V.	K-899841-1	52071
C308	Capacitor, 1st R.F. grid coupling, ceramic, 50 mmfd., 15,000 V.	K-8881806-4	54609
C309	Capacitor, 1st R.F. grid bypass. Same as C301		
C310	Capacitor, 1st R.F. filament bypass. Same as C301		
C311	Capacitor, 1st R.F. filament bypass. Same as C301		
C312	Capacitor, 1st R.F. filament bypass. Same as C301		
C313	Capacitor, 1st R.F. filament bypass. Same as C301		
C314	Capacitor, 1st R.F. screen bypass. Same as C303		
C315	Capacitor, 1st R.F. neutralizing, variable	K-899835-1	51894
C316	Capacitor, 1st R.F. plate bypass. Same as C307		
C317	Capacitor Assembly, 1st R.F. output loading	M-445061-501	
C317A	Capacitor, variable, 35 mmfd., for C317	M-443197-2	51892
C318	Capacitor, 1st R.F. plate blocking. Same as C308		
C319	Capacitor, L.V. rectifier filter, oil, 2 mfd., 600 V.	M-418141-2	17660
C320	Capacitor, L.V. rectifier filter. Same as C319		
C321	Capacitor, L.V. roctifier filter, oil, 4 mfd., 1000 V.	M-418141-13	19217

R-F Unit — MI-28103 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
C322	Capacitor, doubler grid loading, ceramic, 100 mmfd., 500 V.	P-722418-422	53419
C323	Capacitor, 1st R.F. screen bypass. Same as C303		
C330	Capacitor Assembly, transmission line meter bypass. (Incl. mounting brackets)	K-36655-501	
C330A	Capacitor, mica, 10,000 mmfd., 1200 V., for C330	P-32203-592	610003
C331	Capacitor Assembly, P.A. plate meter bypass. Same as C330		
C331A	Capacitor. Same as C330A, for C331		
C332	Capacitor Assembly, P.A., grid meter bypass. Same as C330		
C332A	Capacitor. Same as C330A, for C332		
C333	Capacitor Assembly, I.P.A. cathode meter bypass. Same as C330		
C333A	Capacitor. Same as C330A, for C333		
C334	Capacitor, I.P.A. filament bypass, mica, 1000 mmfd., 2500 V. (Part of C339 Assembly)	P-32211-620	52123
C335	Capacitor, I.P.A. filament bypass. Same as C334. (Part of C339 Assembly)		
C336	Capacitor, I.P.A. filament bypass. Same as C334		
C337	Capacitor, I.P.A. filament bypass. Same as C334		
C338	Capacitor Assembly, I.P.A. cathode tank tuning, variable		
C338A	Plate, fixed, for C338	K-899207-501	
C338B	Plate, movable, for C338	K-897953-1	
C338C	Spring (movable plate), for C338	K-892177-1	
C339	Capacitor Assembly, I.P.A. grid bypass	P-728483-501	
C339A	Capacitor Disc, for C339. (2 required)	K-898952-1	52118
C339B	Terminal Thumb Screw, for C339 (4 required)	K-872949-1	55264
C339C	Terminal Board, for C339	K-897945-1	
C339D	Contact, spring, for C339	443117-1	52127
C339E	Insulator, bushing for C339	8859612-1	52126
C340	Capacitor, I.P.A. plate bypass, mica, 1000 mmfd., 5000 V.	K-99371-1	52648
C341	Capacitor Assembly, I.P.A. plate tuning	P-735551-501	
C341A	Capacitor Disc, for C341	P-728415-1	52117
C341B	Contact Assembly, (small diameter), for C341	M-443140-501	52121
C341C	Contact Assembly, (large diameter), for C341	M-443136-501	52122
C341D	Disc, aluminum plate (inner), for C341	447080-1	55028
C341E	Disc, aluminum plate (outer), for C341	447079-1	55027
C342	Capacitor, I.P.A. cathode tuning motor, 1 mfd.	K-863691-1	44896
C343	Capacitor, I.P.A.-P.A. coupling tuning motor. Same as C342		
C344	Capacitor, I.P.A. plate tuning motor. Same as C342		
C345	Capacitor, P.A. filament bypass. Same as C334. (Part of C350 Assembly)		
C346	Capacitor, P.A. filament bypass. Same as C334. (Part of C350 Assembly)		
C347	Capacitor, P.A. filament bypass. Same as C334		
C348	Capacitor, P.A. filament bypass. Same as C334		
C349	Capacitor Assembly, P.A. cathode tank tuning, variable. Same as C338. (See C338 for parts)		
C350	Capacitor Assembly, P.A. grid bypass. Same as C339. (See C339 for parts)		
C351	Capacitor, P.A. plate bypass. Same as C340		
C352	Capacitor Assembly, P.A. plate tuning. Same as C341. (See C341 for parts)		
C353	Capacitor, P.A. cathode tuning motor. Same as C342		
C354	Capacitor, P.A. loading motor. Same as C342		
C355	Capacitor, P.A. plate tuning motor. Same as C342		
C356	Capacitor, P.A. filament phasing, oil, 20 mfd., 330 V. A.C.	M-418321-78	43441
C357	Capacitor, P.A. filament phasing. Same as C356		
C358	Capacitor, P.A. filament phasing, oil, 10 mfd., 330 V. A.C.	M-418321-75	52190
C359	Capacitor Assembly, I.P.A. grid meter bypass. Same as C330		
C359A	Capacitor, for C359. Same as C330A		
C360	Capacitor Assembly, 1st R.F. cathode meter bypass. Same as C330		
C360A	Capacitor, for C360. Same as C330A		
C361	Capacitor Assembly, 1st R.F. grid meter bypass. Same as C330		
C361A	Capacitor, for C361. Same as C330A		
C362	Capacitor Assembly, double cathode meter bypass. Same as C330		
C362A	Capacitor, for C362. Same as C330A		
C363	Capacitor, I.P.A. output coupling. (See L317)		
C364	Capacitor, per cent meter filter. Same as C322		
C365	Capacitor, per cent meter filter. Same as C322		
C366	Capacitor, I.P.A. grid bypass. Same as C307		
C367	Capacitor, P.A. grid bypass. Same as C307		
C368	Capacitor, indicator lamp carrier off bypass, mica, 1000 mmfd., 500 V.	P-727865-47	39652
C369	Capacitor, indicator lamp overload bypass. Same as C368		
C370	Capacitor, P.A. filament phasing, oil, 5 mfd., 330 V. A.C.	M-418321-69	54240
C371	Capacitor, P.A. filament phasing, oil, 2 mfd., 330 V. A.C.	M-418321-65	54241
C372	Capacitor, P.A. filament phasing, oil, 1 mfd., 330 V. A.C.	M-418321-64	54242
C373	Capacitor, P.A. filament phasing. Same as C372		
C374	Capacitor, P.A. output coupling. (See L322)		
C378	Capacitor, I.P.A. filament bypass. Same as C334. (Part of L314)		
C379	Capacitor, I.P.A. filament bypass. Same as C334. (Part of L314)		
C380	Capacitor, P.A. filament bypass. Same as C334. (Part of L319)		
C381	Capacitor, P.A. filament bypass. Same as C334. (Part of L319)		
E301	Bell, off frequency alarm	K-899839-1	

R-F Unit — MI-28103 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
I301	Indicator Lamp Assembly, carrier off, yellow	M-440312-4	
I301A	Lamp only, for I301	M-440312-36	16154
I301B	Color Cap, for I301	M-440312-33	44137
I301C	Receptacle, lamp, for I301	M-440312-46	44997
I302	Indicator Lamp Assembly, overload, yellow. Same as I301. (See I301 for parts)		
I302A	Lamp only, for I302. Same as I301A		
I302B	Color Cap, for I302. Same as I301B		
I302C	Receptacle, lamp for I302. Same as I301C		
J301	Jack, monitor	P-255223-1	61647
L301	Coil, doubler drive tuning, variable	M-442550-501	51891
L301A	Contact, slide	897905-1	55013
L301B	Spring, slide contact	897909-501	55014
L302	Coil, doubler grid choke. Same as L102		
L303	Coil, 1st R.F. drive tuning. Same as L301		
L304	Coil, doubler plate choke. Same as L112		
L305	Coil, 1st R.F. grid choke. Same as L112		
L306	Coil, 1st R.F. loading. Same as L301		
L307A	Coil, 1st R.F. plate tank (88-104 Mc.)	M-445059-1	53420
L307B	Coil, 1st R.F. plate tank (104-108 Mc.)	M-445060-1	53421
L308	Coil, 1st R.F. plate tuning. Same as L301		
L309	Coil, 1st R.F. plate choke. Same as L112		
L310	Reactor, L.V. rectifier filter	M-443196-1	52074
L311	Reactor, L.V. rectifier filter. Same as L310		
L312	Inductor, transmission line 1st R.F.-I.P.A. coupling	P-735841-501	
L313	Inductor, 1st R.F.-I.P.A. coupling	K-885577I-1	
L314	Inductor, I.P.A. transmission line cathode tank assembly. (See Note #2)	M-450205-501	
	SUPERSEDED BY	M-450286-501	55672
L315	Inductor, I.P.A. transmission line plate tank		
L315A	Insulator, glass bonded mica, for L315	M-442578-1	52119
L315B	Insulator, D-C connection (inside) for L315	M-426764-61 }	52027
L315C	Insulator, D-C connection (outside) for L315. (Mates with L315B)	M-426764-11 }	
L315D	Insulator, filament line, for L315. (2 required)	M-426765-11	92010
L316	Coil, I.P.A. plate choke	K-899274-501	
L317	Inductor, I.P.A. output coupling assembly	P-735517-501	55354
L317A	Tube (outer), for L317	M-446241-502	55361
L317B	Guide, steatite, for L317	K-8885234-2	55350
L317C	Tube (inner), for L317	K-8884067-501	55351
L317D	Bushing and Link, for L317	K-8880606-502	55352
L317E	Stand-off Insulator, for L317	K-802914-1	55353
L317F	Insulating Control Arm, for L317	K-8880601-1	55011
L317G	Assembly of Parts, L317A through L317E	735517-502	55354
L318	Inductor, I.P.A.-P.A. coupling. Same as L313		
L319	Inductor, P.A. transmission line cathode tank assembly. Same as L314. (See Note #2)	M-450205-501	
	SUPERSEDED BY	M-450286-501	55672
L320	Inductor, P.A. transmission line plate tank. Same as L315. (See L315 for parts)		
L320A	Insulator, glass bonded mica. Same as L315A		
L320B	Insulator, D-C connection (inside). Same as L315B }		
L320C	Insulator, D-C connection (outside). Same as L315C } Mates with L320B		
L320D	Insulator, filament line. Same as L315D. (2 required)		
L321	Coil, P.A. plate choke. Same as L316		
L322	Inductor, P.A. loading assembly. Same as L317. (See L317 for parts)		
L322A	Tube (outer). Same as L317A		
L322B	Guide, steatite. Same as L317B		
L322C	Tube (inner). Same as L317C		
L322D	Bushing and Link. Same as L317D		
L322E	Stand-off Insulator. Same as L317E		
L322F	Insulating Control Arm. Same as L317F		
L322G	Assembly. Same as L317G		
L323	Inductor, P.A. transmission line output assembly	T-619947-502	
L324	Coil, transmission line meter coupling. (Part of L323)	K-8855249-501	
L325	Reactor, I.P.A. filament phasing	M-443402-1	52191
L327	Coil, monitor pick-up. (Part of L323)	K-8855243-2	
L328	Coil, R-F choke. Same as L112. (Part of L323)		
L329	Coil, R-F choke. Same as L112. (Part of L323)		
L330	Inductor, I.P.A. grid choke.	K-899838-502	
L331	Inductor, P.A. grid choke. Same as L330		
L332	Inductor, I.P.A. filament choke	K-8858223-1	
L333	Inductor, I.P.A. filament choke	K-8858223-2	
L334	Inductor, P.A. filament choke. Same as L332		
L335	Inductor, P.A. filament choke. Same as L333		
M301	Meter, transmission line current, 0-125%. (See Notes #4 and #6)	M-438447-64	56194
M302	Meter, P.A. plate current, 0-1.5 Amp. D.C. (See Note #4)	M-438447-13	52060
M303	Meter, P.A. grid current, 0-500 Ma. D.C. (See Note #4)	M-438447-23	52057
M304	Meter, I.P.A. cathode current, 0-1 Amp. D.C. (See Note #4)	M-438447-30	52063

R-F Unit — MI-28103 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
M305	Meter, I.P.A. grid current. Same as M303. (See Note #4)		
M306	Meter, 1st R.F. cathode current. Same as M303. (See Note #4)		
M307	Meter, 1st R.F. grid current, 0-50 Ma. D.C. (See Note #4)	M-438447-11	52062
M308	Meter, doubler cathode current, 0-150 Ma. D.C. (See Note #4)	M-438447-4	52061
R301	Resistor, doubler grid leak bias, 20,000 ohms, 10 W.	K-899837-1	52075
R302	Resistor, doubler cathode bias, 1600 ohms, 45 W.	K-99029-33	52076
R303	Resistor, 1st R.F. grid leak bias, 10,000 ohms	K-899837-4	52077
R304	Resistor, 1st R.F. cathode bias, tapped, 400 ohms, 95 W.	K-890146-1	19674
R305	Resistor, screen supply bleeder, 16,000 ohms, 45 W.	K-99029-43	47803
R306	Resistor, doubler screen. Same as R301		
R307	Resistor, 1st R.F. screen, 100 ohms, 2 W.	P-722357-50	
R308	Resistor, 1st R.F. screen. Same as R307		
R309	Resistor, I.P.A. grid leak, 1250 ohms, 150 W.	K-99035-32	19333
R310	Resistor, I.P.A. grid leak. Same as R309		
R313	Resistor, 6300 ohms, for 1301	M-440312-41	44570
R314	Resistor, for 1302. Same as R313		
R315	Rheostat, I.P.A. filament, 7.5 ohms, 100 W.	M-433464-5	54239
R316	Rheostat, P.A. filament. Same as R315		
R317	Resistor, P.A. grid leak, 1600 ohms, 200 W.	K-99037-33	45983
R318	Resistor, P.A. grid leak. Same as R317		
R328	Resistor, doubler screen bleeder. (See Note #5)	K-99126-83	
S301	Switch, door interlock (L.P.R.F.) (See Note #3)	M-439530-1	51047
S302	Switch, door interlock, front. Same as S301. (See Note #3)		
S303	Switch, door interlock, rear. Same as S301. (See Note #3)		
S304	Switch, I.P.A. cathode tuning	M-427520-3	51984
S305	Switch, I.P.A.-P.A. coupling. Same as S304		
S306	Switch, I.P.A. plate tuning. Same as S304		
S307	Switch, P.A. cathode tuning. Same as S304		
S308	Switch, P.A. loading. Same as S304		
S309	Switch, P.A. plate tuning. Same as S304		
S310	Switch Assembly, H.V. grounding (rear)		
S310A	Contact Spring, for S310	K-8857281-1	
S310B	Spring, opening, for S310	K-898988-1	53083
S310C	Insulator, for S310	M-426762-8	51782
S310D	Contact, fixed, for S310	K-8855732-1	
S311	Switch, I.P.A. blower motor interlock. (Part of B303 or B303B)	P-727596-15	
S312	Switch, P.A. blower motor interlock. Same as S311. (Part of B305 or B305B)		
S313	Switch, I.P.A. plate tuning limit	K-872223-1	54923
S314	Switch, P.A. plate tuning limit. Same as S313		
S315	Switch Assembly, H.V. grounding (front). Same as S310. (See S310 for parts)		
T301	Transformer, R.F. and L.V. rectifier filaments	M-443198-1	52080
T302	Transformer, L.V. rectifier plates	M-443400-1	52081
T303	Transformer, I.P.A. filament	M-443401-1	52189
T304	Transformer, P.A. filament. Same as T303		
TC301	Thermocouple, transmission line meter. (Part of L323)	M-426727-2	56195
X301	Socket, doubler tube	K-895296-1	51772
X301A	Tube Cap, less strap, for X301	K-896460-502	55916
X301B	Strap, for X301A	8855281-1	55917
X302	Socket, 1st R.F. tube. Same as X301. (See X301 for parts)		
X303	Socket, 1st R.F. tube. Same as X301. (See X301 for parts)		
X304	Socket, L.V. rectifier tube	K-843314-6	9924
X305	Socket, I.P.A. tube		
X306	Socket, P.A. tube. Same as X305		

Control Unit — MI-28105

B501	Fan, cabinet cooling (power supply)	M-415726-4	52642
B502	Fan, cabinet cooling (exciter). Same as B501		
C501	Capacitor, H.V. rectifier filter, 2 mfd., 4000 V.	M-418141-47	17957
C502	Capacitor, H.V. rectifier filter. Same as C501		
C503	Capacitor Assembly, doubler grid meter bypass. Same as C330		
C503A	Capacitor, for C503. Same as C330A		
C504	Capacitor, indicator lamp bypass. Same as C368		
C505	Capacitor, indicator lamp bypass. Same as C368		
C506	Capacitor, indicator lamp bypass. Same as C368		
C507	Capacitor, indicator lamp bypass. Same as C368		
I501	Indicator Lamp Assembly, crystal heater, white	M-440312-11	
I501A	Lamp Only, for I501. Same as I301A		
I501B	Color Cap, for I501	M-440312-34	44135
I501C	Receptacle, lamp, for I501. Same as I301C		
I502	Indicator Lamp Assembly, crystal heator, white. Same as I501. (See I501 for parts)		
I503	Indicator Lamp Assembly, plate volts on, red	M-440312-2	

Control Unit — MI-28105 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
I503A	Lamp Only, for I503. Same as I301A		
I503B	Color Cap, for I503	M-440312-31	19897
I503C	Receptacle, lamp. Same as I301C		
I504	Indicator Lamp Assembly, filaments on, green	M-440312-3	
I504A	Lamp Only, for I504. Same as I301A		
I504B	Color Cap, for I504	M-440312-32	44136
I504C	Receptacle, lamp, for I504. Same as I301C		
K501	Relay, A-C overload, 20-80 Amps.	M-429580-7	44540
K501A	Operating Coil, for K501	M-429580-32	
K501B	Contacts, stationary, for K501. (2 required)	M-429580-40	
K501C	Contacts, movable, for K501. (2 required)	M-429580-41	
K502	Relay, A-C overload. Same as K501. (See K501 for parts)		
K503	Relay, plate time-delay	M-429587-16	52044
K503A	Operating Coil, for K503	M-429587-33	
K504	Relay, filaments	M-433748-1	52046
K504A	Operating Coil, for K504	M-433748-21	54556
K504B	Moving contact and lead L.H., for K504	M-433748-31	44942
K504C	Moving contact and lead R.H., for K504	M-433748-32	44942
K504D	Stationary make contact, for K504. (2 required)	M-433748-33	44942
K504E	Stationary break contact, for K504 (2 required)	M-433748-34	44942
K505	Contactor, plate	M-430866-1	52644
K505A	Operating Coil, for K505	M-430866-2	57184
K505B	Set of main contacts, for K505	M-430866-3	
K505C	Set of auxiliary contacts, for K505	M-430866-4	
K506	Relay, plate time-delay bypass	M-429587-12	52045
K506A	Operating Coil, for K506. Same as K503		
K507	Relay, carrier off. Same as K504. (See K504 for parts)		
K508	Relay, recycling	M-445100-1	52047
K509	Relay, overload auxiliary. Same as K504. (See K504 for parts)		
K510	Relay, I.P.A. overload	M-429580-6	52043
K510A	Operating Coil, for K510	M-429580-30	
K510B	Contacts, stationary, for K510. Same as K501B	M-429580-40	
K510C	Contact, movable, for K510. Same as K501C	M-429580-41	
K511	Relay, P.A. overload. Same as K510. (See K510 for parts)		
K512	Relay, I.P.A. air interlock. Same as K504. (See K504 for parts)		
K513	Relay, P.A. air interlock. Same as K504. (See K504 for parts)		
L501	Reactor, H.V. rectifier filter	M-900027-501	16407
M501	Meter, doubler grid current, 0-25 Ma. D.C. (See Note #4)	M-438447-10	52058
M502	Meter, tube hours, 0-99999 hours. (See Note #4)	M-438447-8	52065
M503	Meter, plate voltmeter, 0-5000 V. D.C. (See Note #4)	M-438447-2	52059
M504	Meter, filament volts, 0-350 V. A.C. (See Note #4)	M-438447-1	52029
R501	Resistor, multiplier, for M503	K-878811-7	52030
R502	Resistor, shunt for M503, 100,000 ohms, 2 W.	P-722352-86	
R503	Rheostat, filament volts, 5 ohms, 225 W.	M-433747-2	51988
R504	Resistor, doubler plate voltage drop, 12,500 ohms, 200 W. (See Note #7)	K-99037-42	
R505	Resistor, 1st R.F. plate voltage drop, 6300 ohms, 200 W. (See Note #7)	K-99037-39	
R506	Resistor, I.P.A.-P.A. plate, 200 ohms, 200 W.	K-99037-24	45914
R507	Resistor, I.P.A.-P.A. plate. Same as R506		
R508	Resistor, for I501, 2800 ohms	M-440312-40	16155
R509	Resistor, for I502. Same as R508		
R510	Resistor, for I503. Same as R313		
R511	Resistor, for I504. Same as R313		
R512	Resistor, I.P.A. overload relay shunt, 10 ohms, 20 W.	K-99027-11	19658
R513	Resistor, P.A. overload relay shunt. Same as R512		
R514	Resistor, isolation transformer ground, 100,000 ohms, 8 W.	K-890144-18	52049
R515	Resistor, 1st R.F. plate voltage drop. Same as R505		
S501	Switch, line breaker, 45 Amp.	K-897954-5	52050
S502	Switch, exciter breaker, 7 Amp.	K-894304-3	51979
S503	Switch, control breaker, 15 Amp.	K-894304-1	51983
S504	Switch, filament breaker. Same as S503		
S505	Switch, L.V. rectifier breaker, 2 Amp.	K-894304-5	52051
S506	Switch, H.V. rectifier breaker. Same as S501		
S507	Switch, tune-operate	M-443148-1	52053
S508	Switch Assembly, H.V. grounding		
S508A	Contact Spring, for S508	K-894585-1	
S508B	Spring, opening, for S508. Same as S310B		
S508C	Insulator, for S508. Same as S310C		
S508D	Contact, fixed, for S508	K-894584-1	
S509	Switch, overload reset. Same as S304		
S510	Switch, door interlock (rear exciter). (See Note #3)	M-439530-4	51047
S511	Switch, door interlock (rear power). Same as S510. (See Note #3)		
S512	Switch, filaments	K-8855265-1	52647
S513	Switch, plate. Same as S512		
S514	Switch, automatic-manual and tuning control cutout	M-427520-6	52042

Control Unit — MI-28105 *(continued)*

Symbol	Description	Dwg. No.	Stock No.
S514A	Switch, automatic-manual. (Part of S514)		
S514B	Switch, tuning control cutout. (Part of S514)		
S515	Switch, door interlock (exciter plate). Same as S510. (See Note #3)		
T501	Transformer, H.V. rectifier filament	M-901845-2	52040
T502	Transformer, H.V. rectifier filament. Same as T501		
T503	Transformer, H.V. rectifier filament. Same as T501		
T504	Transformer, H.V. rectifier filament. Same as T501		
T505	Transformer, H.V. rectifier filament. Same as T501		
T506	Transformer, H.V. rectifier filament. Same as T501		
T507	Transformer, H.V. rectifier plates	M-443152-1	52054
T508	Transformer, isolation	M-443405-1	52055
X501	Socket, H.V. rectifier tube	M-429151-1	44755
X502	Socket, H.V. rectifier tube. Same as X501		
X503	Socket, H.V. rectifier tube. Same as X501		
X504	Socket, H.V. rectifier tube. Same as X501		
X505	Socket, H.V. rectifier tube. Same as X501		
X506	Socket, H.V. rectifier tube. Same as X501		
X507	Socket, convenience outlet	K-890041-4	51049
X508	Socket, convenience outlet, exciter. Same as X507		

Transmission Line Monitor — MI-28155-3

C901	Capacitor. (Part of L901)		
C902	Capacitor, fixed, ceramic, 100 mmfd., 500 V.	P-722418-422	53419
C903	Capacitor, fixed, paper-oil, 0.5 mfd., 600 V.	K-894670-7	42195
C904	Capacitor, fixed, electrolytic, 12 mfd., 150 V.	M-441677-8	52335
J901	Jack, pin type	K-845964-1	33891
K901	Relay, three conduit, 2 N.O., 1 N.C. contacts, 5000-ohm coil, 6 Ma.	K-863484-2	54518
L901	Inductor, loop	K-899880-3	
R901	Resistor, fixed, 56 ohms, 2 W.	K-99126-129	55272
R902	Resistor, fixed, 100,000 ohms, ½ W. (See Note #1)	P-727834-86	3252
R903	Resistor. Same as R902		
R904	Resistor, fixed, 2200 ohms, 2 W.	P-727838-66	34769
R905	Resistor, variable, 1000 ohms, 2 W.	M-430116-33	54519
R906	Resistor, fixed, 47,000 ohms, ½ W. (See Note #1)	K-82283-94	
T901	Transformer, power supply	M-254771-1	54520
X901	Socket, tube	K-99146-1	52460
X902	Socket, tube. Same as X901		

Harmonic Filter — MI-28151

C951	Capacitor, shunt filter		
C952	Capacitor, shunt filter		
L951	Inductor, input line assembly	P-728436-501	
L951A	Insulator, co-axial	K-895227-1	
L952	Inductor, adjustable		
L952A	Tube, input	K-899215-1	
L952B	Tube, output	K-899215-2	
L952C	Shorting Bar, front	K-899209-2	
L952D	Shorting Bar, rear	K-899209-1	
L952E	Thumb Screw	K-99017-16	
L953	Inductor, output line assembly	P-728436-502	
L953A	Insulator, co-axial. Same as L951A		

BTF-3B Transmitter — Miscellaneous Parts for MI-7016, MI-7107, MI-28103, MI-28104, MI-28105, MI-28151, and MI-28155-3

Description	Dwg. No.	Stock No.
Air Filter. (3 required)	P-727518-2	55705
Air Filter Frame. (3 required)	P-727518-3	55706
Boot, for L.P.R.F. blowers	K-8857239-1	54938
Boot, blower to tank	P-727437-1	52068
Boot, inlet to blower	K-899229-1	
Bottle of damping fluid	M-427943-501	56904
Cable, for Exciter to Exciter power supply	M-443174-501	52688
Clamp, for C903	M-95437-12	91577
Crank, for L.P.R.F. tuning	K-887449-501	
Flexible Shaft, for L301	K-8857299-1	52113
Flexible Shaft, for L303	K-8857299-2	52114
Flexible Shaft, for L308	K-8857299-3	54770
Flexible Shaft, for L306	K-8857299-4	54823
Governor, 1725 RPM, for B303, etc.	P-727596-14	
Governor, 3450 RPM, for B303B, etc.	P-727596-13	
Insulator, cylindrical pillar, 3/8" dia. x 1/2" lg.	M-426765-2	92075
Insulator, cylindrical pillar, 3/8" dia. x 1 1/2" lg., for E301	M-426765-16	
Insulator, cylindrical pillar, 1/2" dia. x 3/4" lg.	M-426766-5	52681
Insulator, cylindrical pillar, 3/4" dia. x 1" lg.	M-426767-2	51086
Insulator, cylindrical pillar, 1/2" dia. x 1" lg.	M-426766-8	92011
Insulator, cylindrical pillar, 1/2" dia. x 1 1/2" lg.	M-426766-14	52128
Insulator, cylindrical pillar, 3/4" dia. x 1 1/2" lg.	M-426767-8	51087
Insulator, cylindrical pillar, 3/4" dia. x 2" lg., for L330, etc.	M-426767-11	50777
Insulator, cylindrical pillar, 1" dia. x 1 1/2" lg.	M-426768-5	
Insulator, conical pillar, 1/2" dia. /1" dia. x 1 1/2" lg.	M-426762-5	51781
Insulator, conical, 1 1/8" dia. base x 2" lg.	M-426762-8	51782
Insulator, sq. pillar, 3/4" x 3/4" x 1 1/4" lg., for R201, etc.	M-426773-5	92430
Insulator, feedthru bushing, 5/8" dia. x 5/8" lg., for C301, etc.	M-426764-5	52111
Insulator, feedthru bushing, 5/8" dia. x 3/8" lg., for C301, etc.	M-426764-55	51517
Insulated Coupling, for L301, etc.	K-869499-1	
Insulator, for cathode line ends	K-898999-1	52125
Insulator, for ends of PA feed line	K-8855768-1	53084
Knob, for S101	P-712336-505	17268
Knob, for S107, R142, S103, C105 and S102	P-712336-507	30075
R.F. Connector, male, single contact	K-252868-1	65956
Resistor Clip, for R302, etc.	K-838400-2	42736
Resistor Clip, for R201, etc.	K-838400-4	52690
Resistor Clip, for R304, etc.	K-7862770-1	52717
Shield, for tube V901	K-99147-1	53016
Shield, for tube V902	K-99147-2	54521
Tool, trimmer adjusting	K-86183-507	
Wrench, indicating lamp	K-885977-1	90040

Note #1:—1725 RPM Blowers for BTF-1C-BTF-3B and BTF-10B (2nd R.F.) transmitters for 60 cycles and below 5000 ft. altitude—otherwise 3450 RPM Blowers required.

Note #2:—M-450205-501 and M-450286-501 are interchangeable. For replacements order M-450286-501. Order by Stock No. 55672.

Note #3:—The Stock Number given covers one interlock switch that can be adjusted for any location in the transmitter.

Note #4:—Stock and drawing numbers shown are for Westinghouse meters only. When ordering replacements, order by stock number and state whether your transmitter has Westinghouse or Weston meters.

Note #5:—If the 1st R.F. grid current is less than 18 Ma., R328 is not used.

Note #6:—Where two transmission line current meters (M301) are operated in series, order stock number 56412 for both meters, and state whether your transmitter has Westinghouse or Weston meters.

Note #7:—R504 was 1000 ohms and R505 was 5000 ohms (K-99037-41 and K-99037-38). Transmitters with these values order latest parts for replacements as shown.

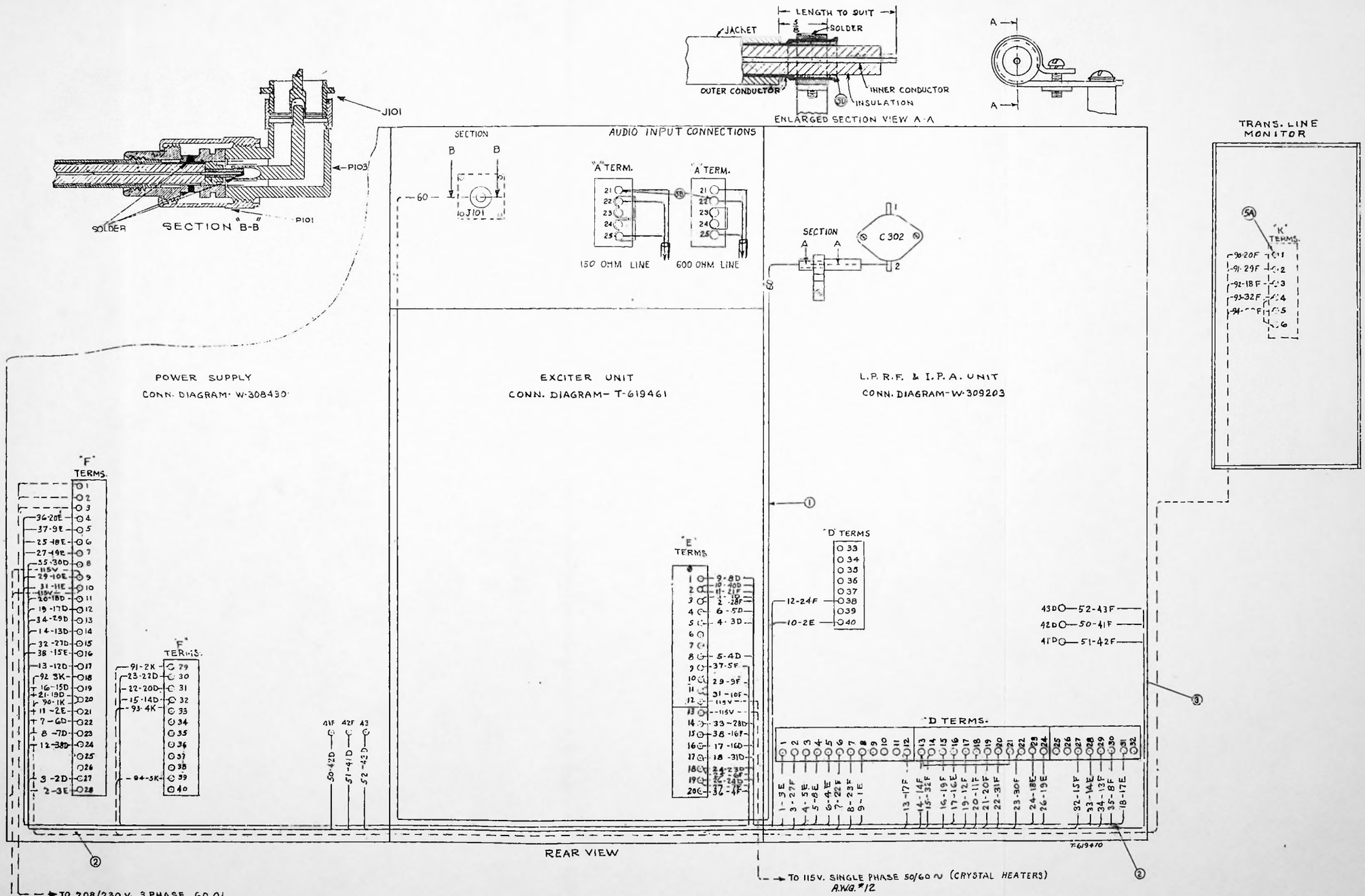
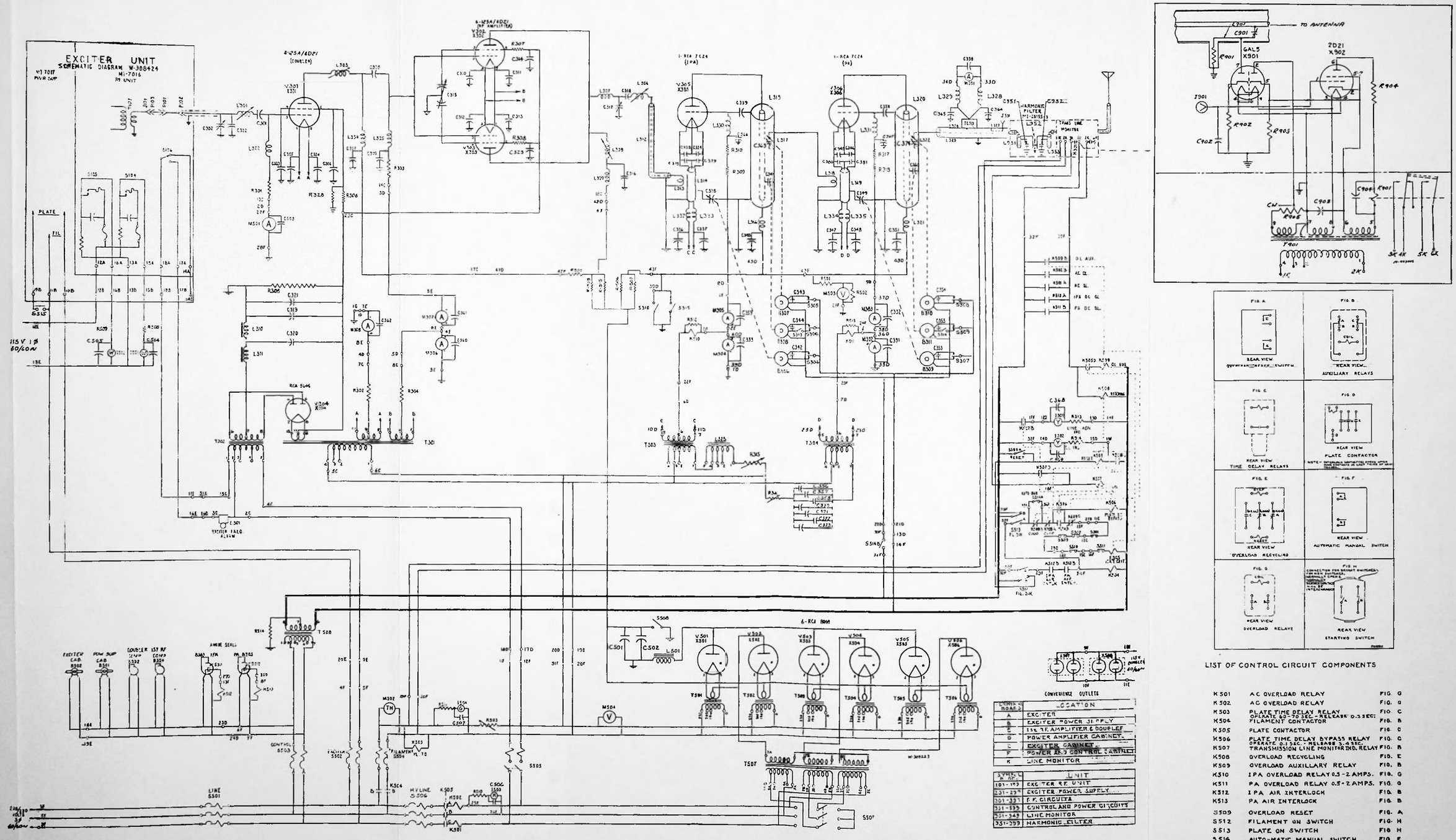


Figure 15—Interconnection Diagram



SYMBOL NO.	LOCATION
A	EXCITER
B	EXCITER POWER SUPPLY
C	1st I.F. AMPLIFIER & DOUBLER
D	POWER AMPLIFIER CABINET
E	EXCITER CABINET
F	POWER AMP. CONTROL CABINET
K	LINE MONITOR

SYMBOL NO.	UNIT
101-199	EXCITER RF UNIT
201-299	EXCITER POWER SUPPLY
301-399	I.F. CIRCUITS
501-599	CONTROL AND POWER CIRCUITS
601-649	LINE MONITOR
701-799	HARMONIC FILTER

FIG. A — REAR VIEW — OVERLOAD SWITCH

FIG. B — REAR VIEW — AUXILIARY RELAYS

FIG. C — REAR VIEW — TIME DELAY RELAYS

FIG. D — REAR VIEW — PLATE CONTACTOR

FIG. E — REAR VIEW — OVERLOAD RECYCLING

FIG. F — REAR VIEW — AUTOMATIC MANUAL SWITCH

FIG. G — REAR VIEW — OVERLOAD RELAYS

FIG. H — REAR VIEW — STARTING SWITCH

LIST OF CONTROL CIRCUIT COMPONENTS

K 501	AC OVERLOAD RELAY	FIG. G
K 502	AC OVERLOAD RELAY	FIG. G
K 503	PLATE TIME DELAY RELAY OPERATE 60-70 SEC - RELEASE 0.3 SEC;	FIG. C
K504	FILAMENT CONTACTOR	FIG. B
K 505	PLATE CONTACTOR	FIG. D
K 506	PLATE TIME DELAY BYPASS RELAY OPERATE 0.1 SEC - RELEASE 2-4 SEC.	FIG. C
K 507	TRANSMISSION LINE MONITOR IND. RELAY	FIG. B
K 508	OVERLOAD RECYCLING	FIG. E
K 509	OVERLOAD AUXILLARY RELAY	FIG. B
K 510	I PA OVERLOAD RELAY 0.5 - 2 AMPS.	FIG. G
K 511	PA OVERLOAD RELAY 0.5 - 2 AMPS.	FIG. G
K 512	I PA AIR INTERLOCK	FIG. B
K 513	PA AIR INTERLOCK	FIG. B
S 509	OVERLOAD RESET	FIG. A
S 512	FILAMENT ON SWITCH	FIG. H
S 513	PLATE ON SWITCH	FIG. H
S 514	AUTO-MATIC MANUAL SWITCH	FIG. F

Figure 16—Overall Schematic Diagram

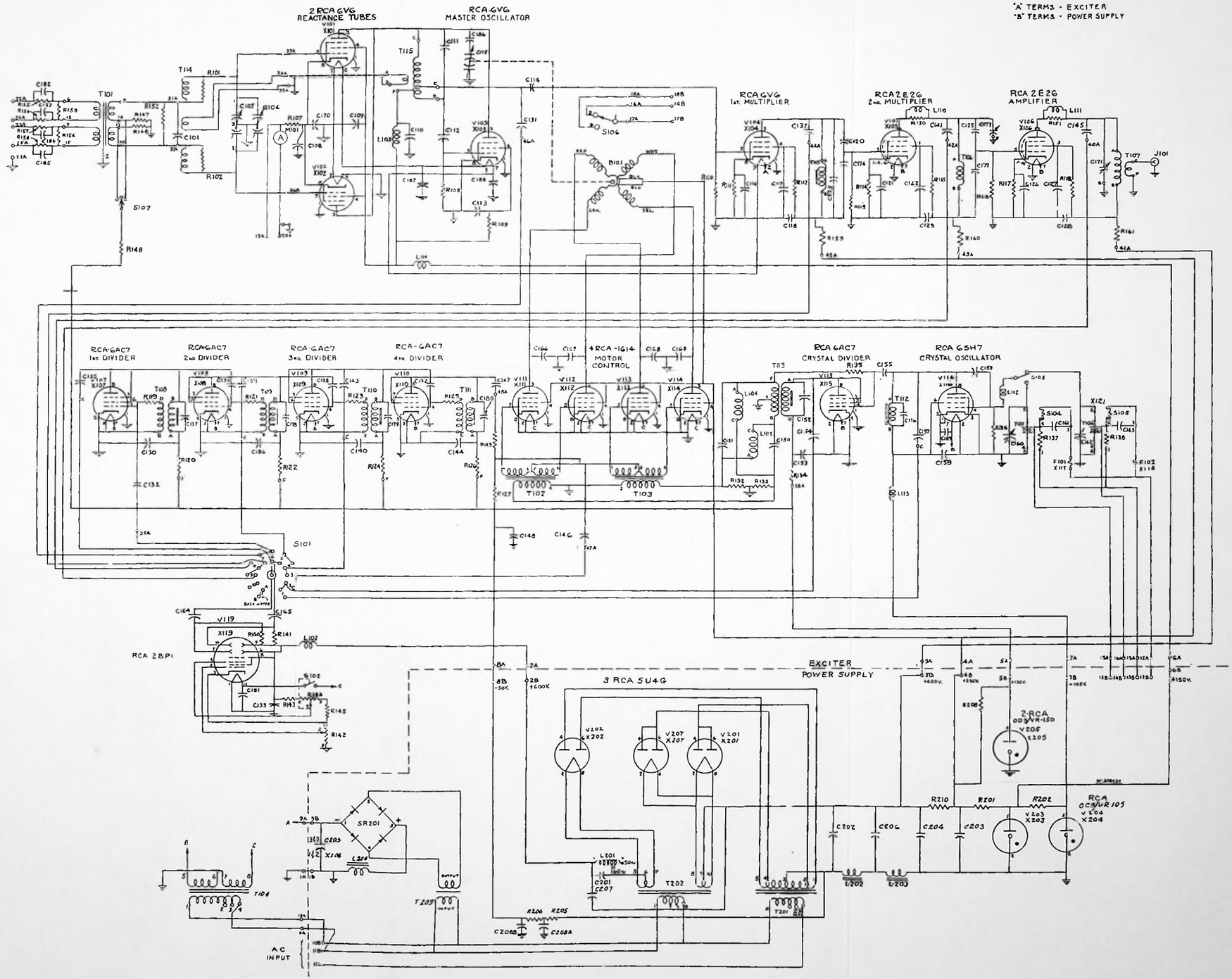


Figure 17—Exciter Schematic Diagram

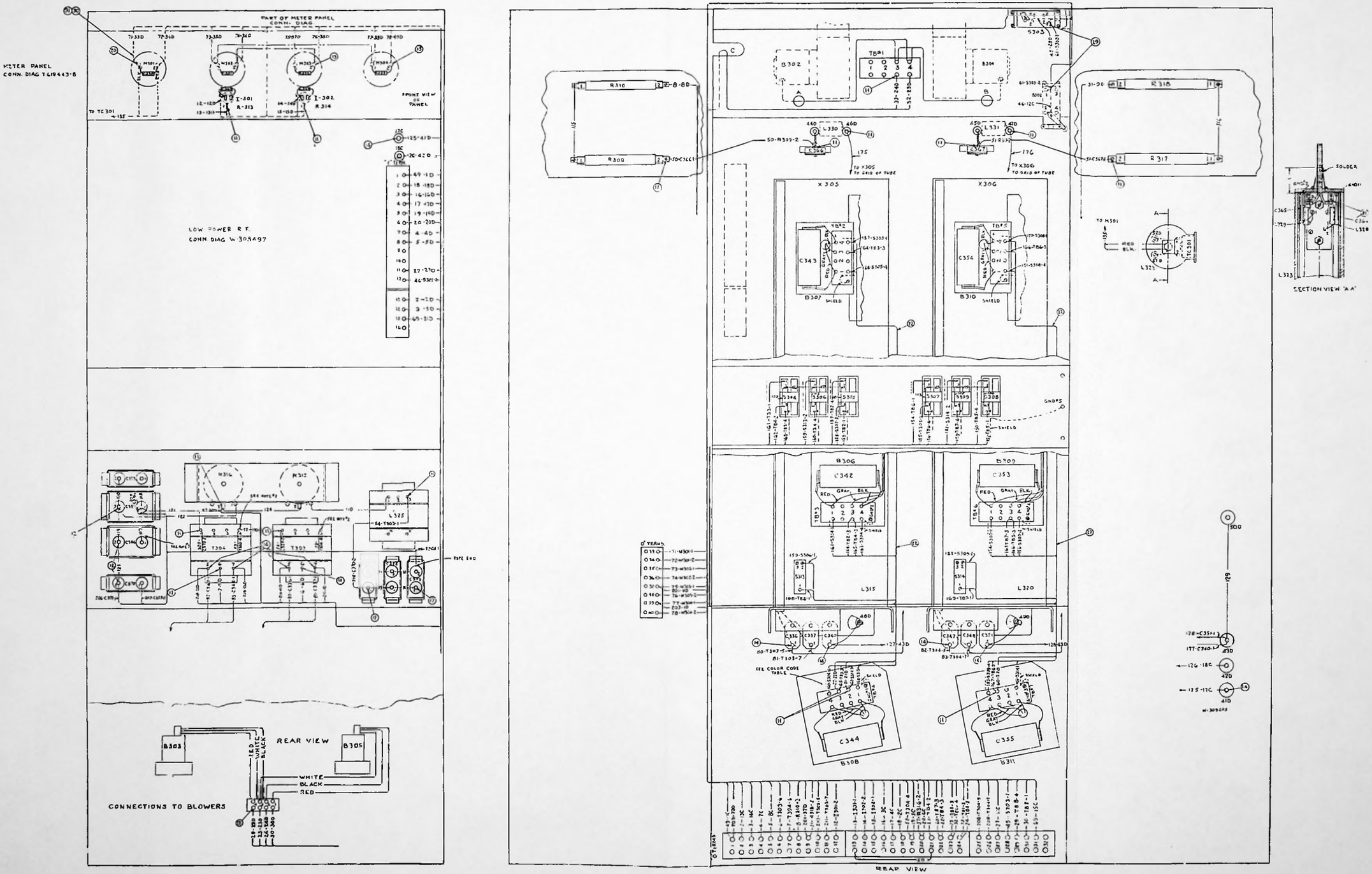


Figure 18—Transmitter Unit Connection Diagram

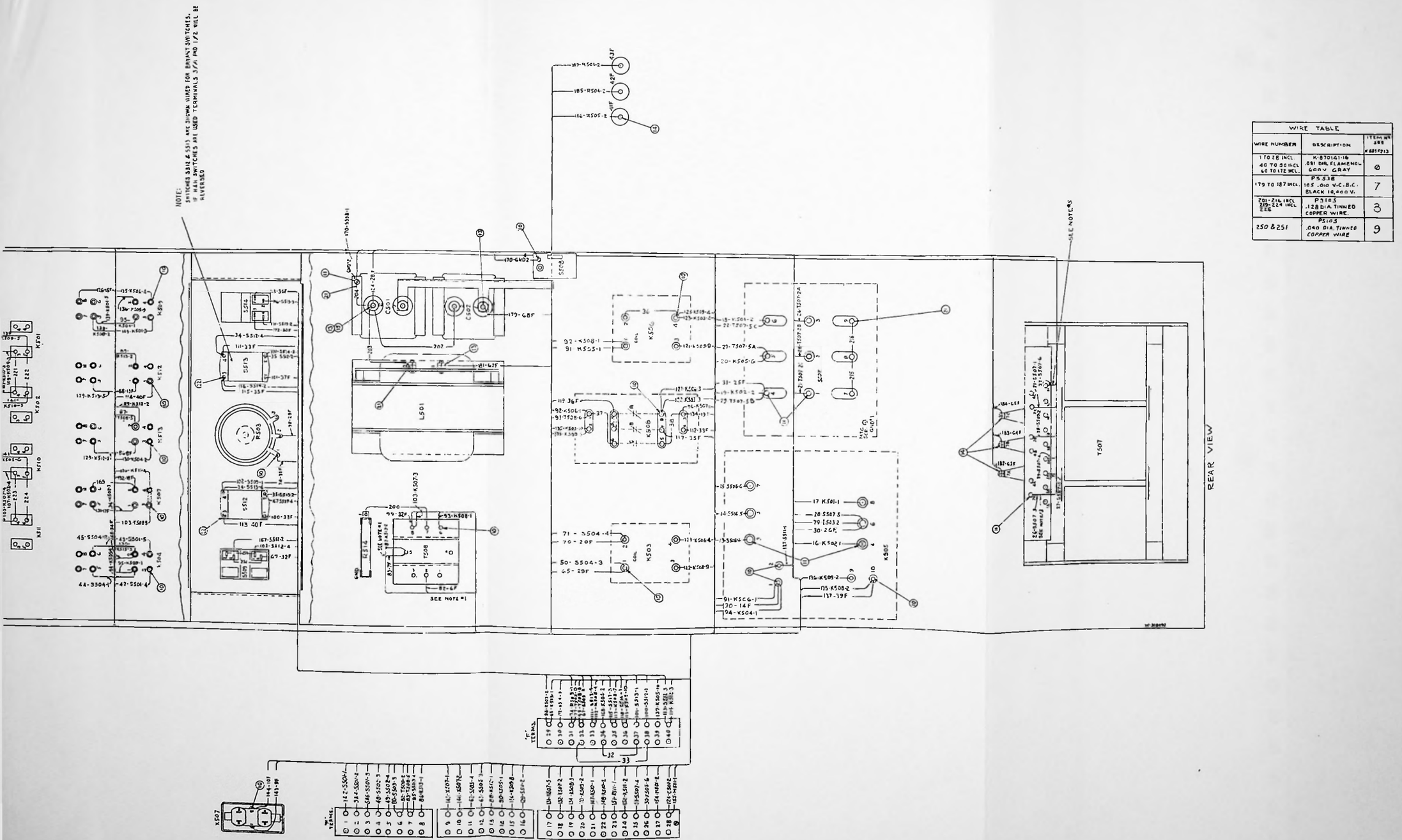
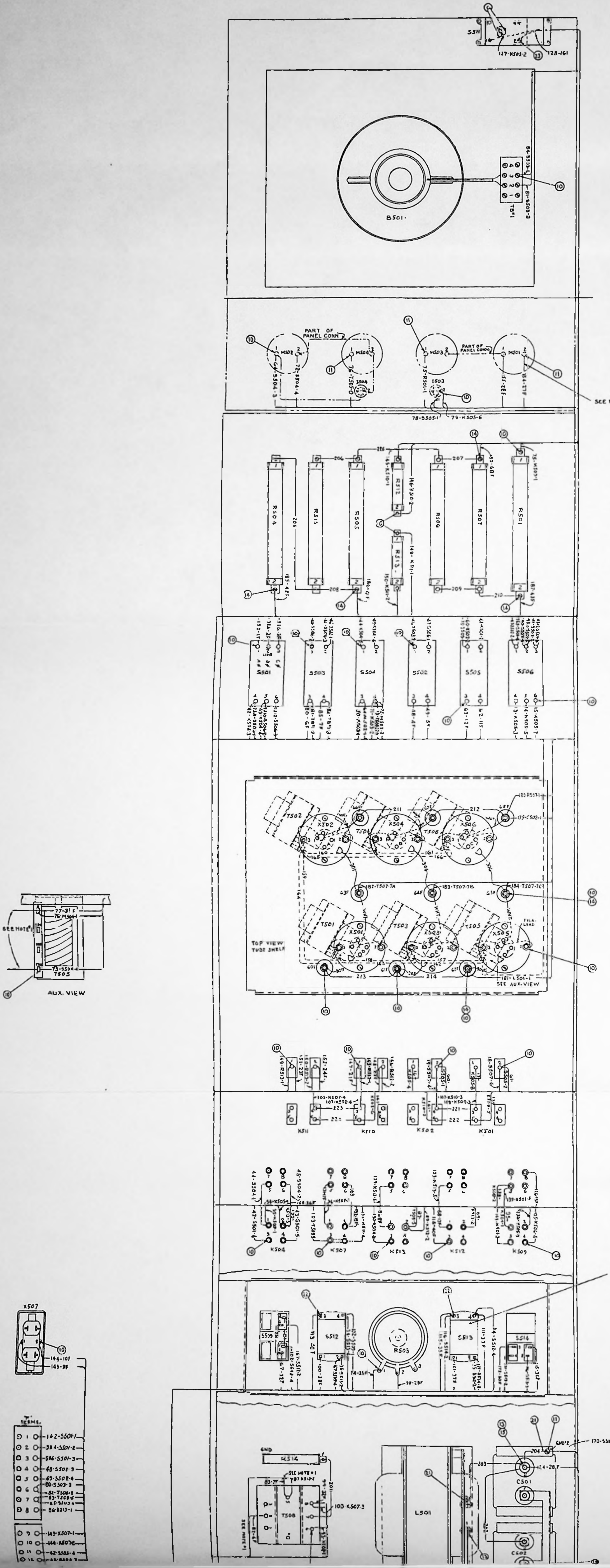
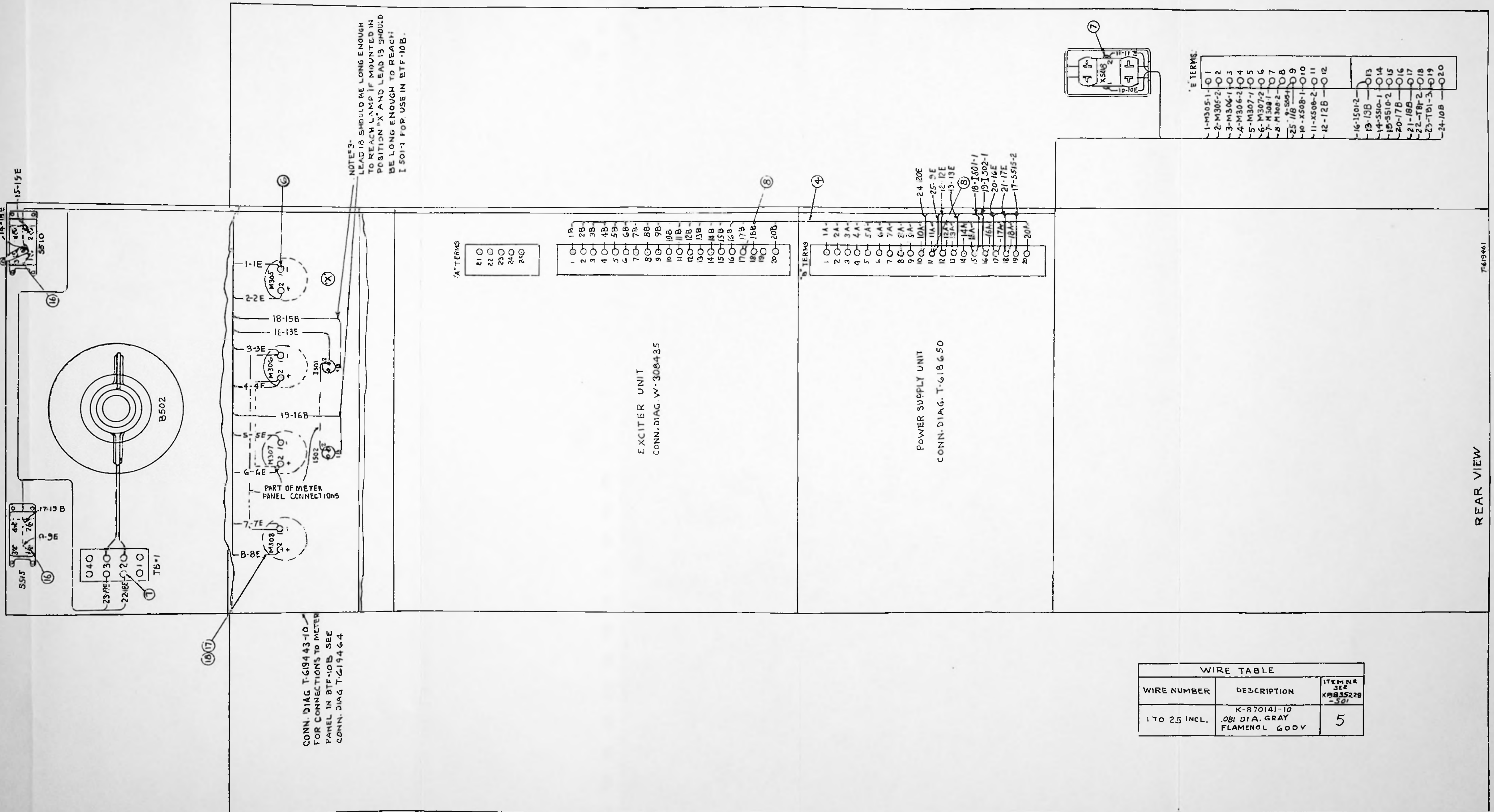


Figure 19—Power and Control Panel Connection Diagram

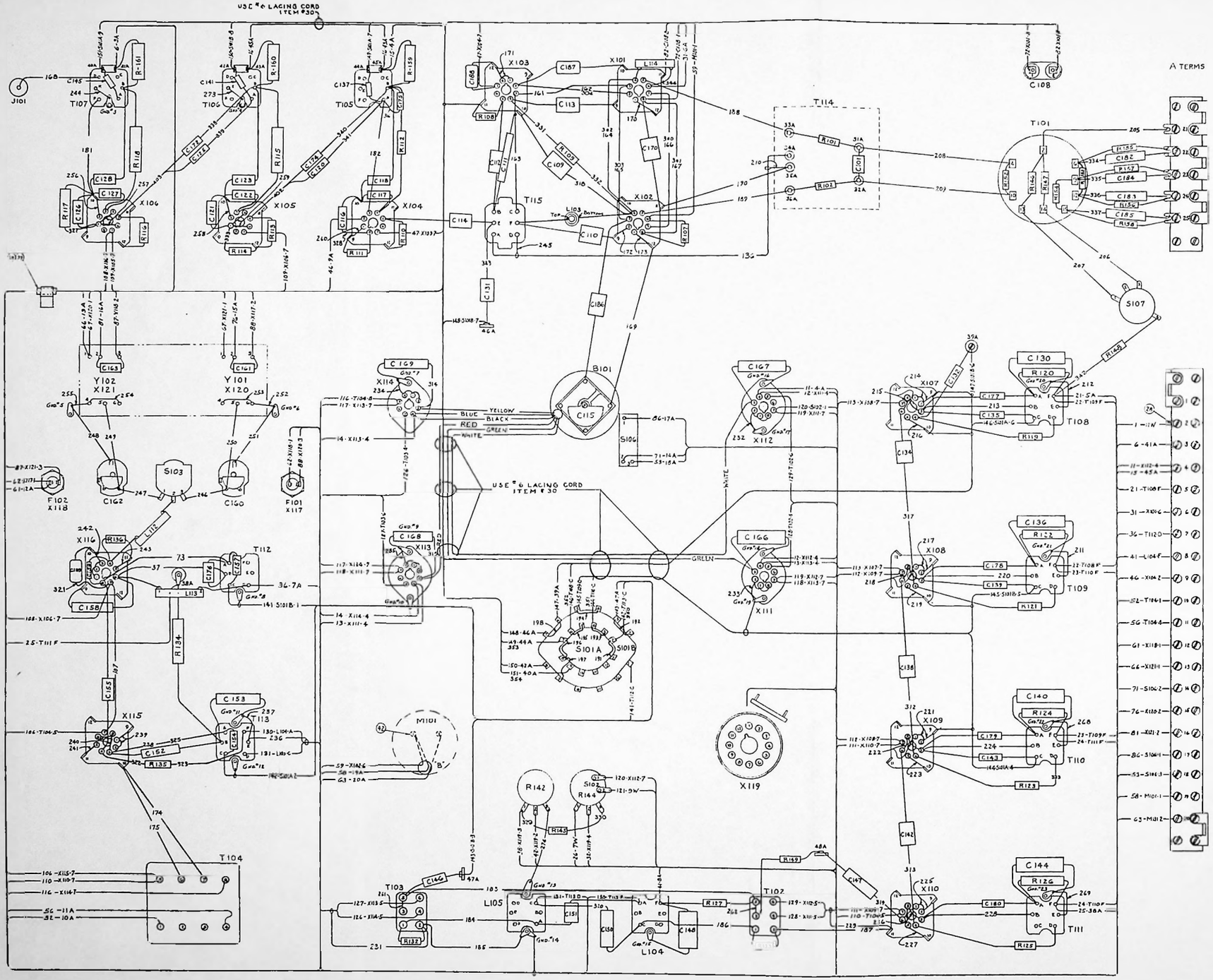


NOTE:
SWITCHES S512 & S513 ARE SHOWN WIRED FOR BRYANT SWITCHES.
IF H&H SWITCHES ARE USED TERMINALS 3/4 AND 1/2 WILL BE REVERSED



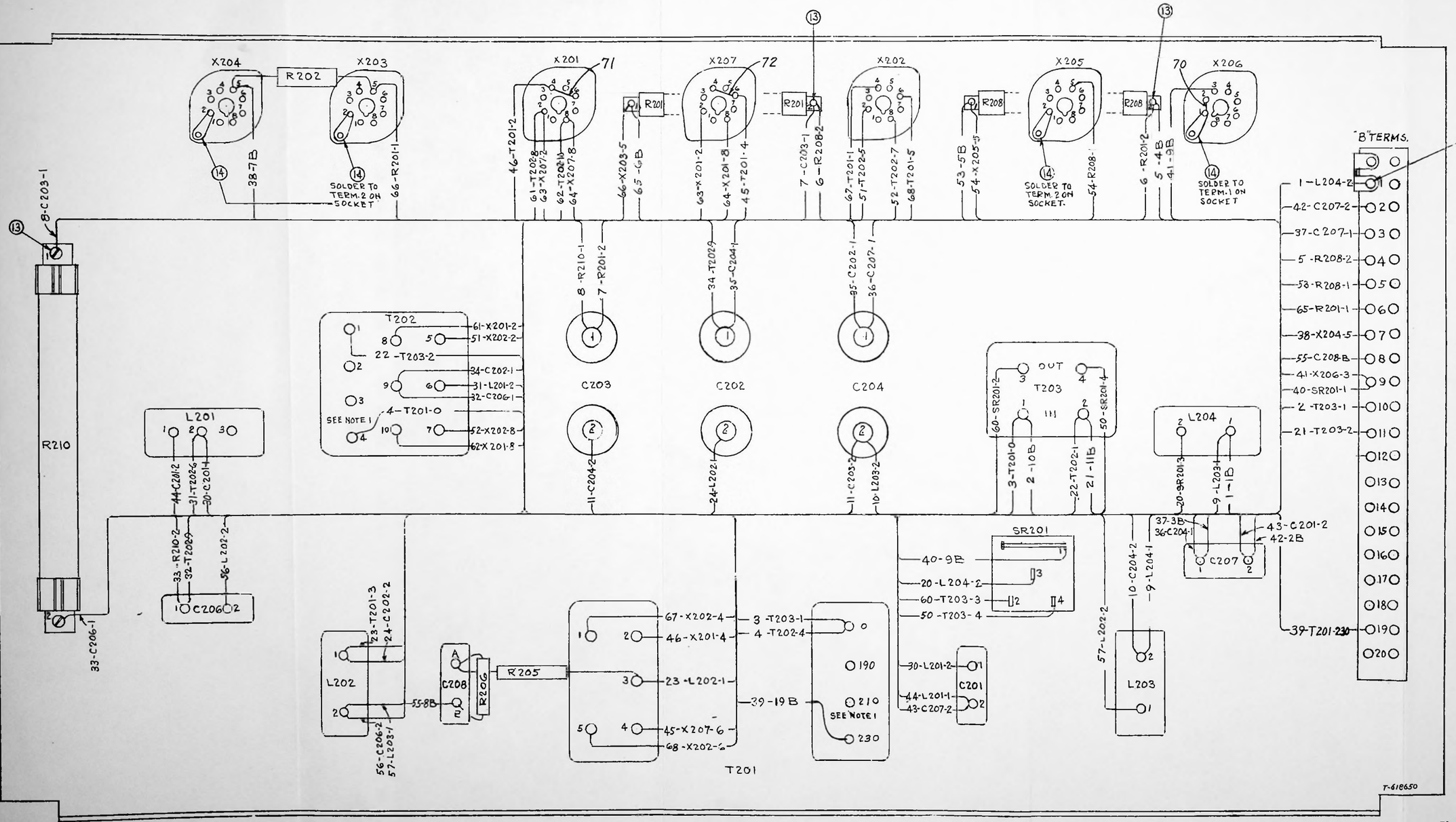
WIRE TABLE		
WIRE NUMBER	DESCRIPTION	ITEM NR SEE K-898552 28-501
1 TO 25 INCL.	K-870141-10 .081 DIA. GRAY FLAMENOL 600V	5

Figure 20—Exciter Cabinet Connection Diagram



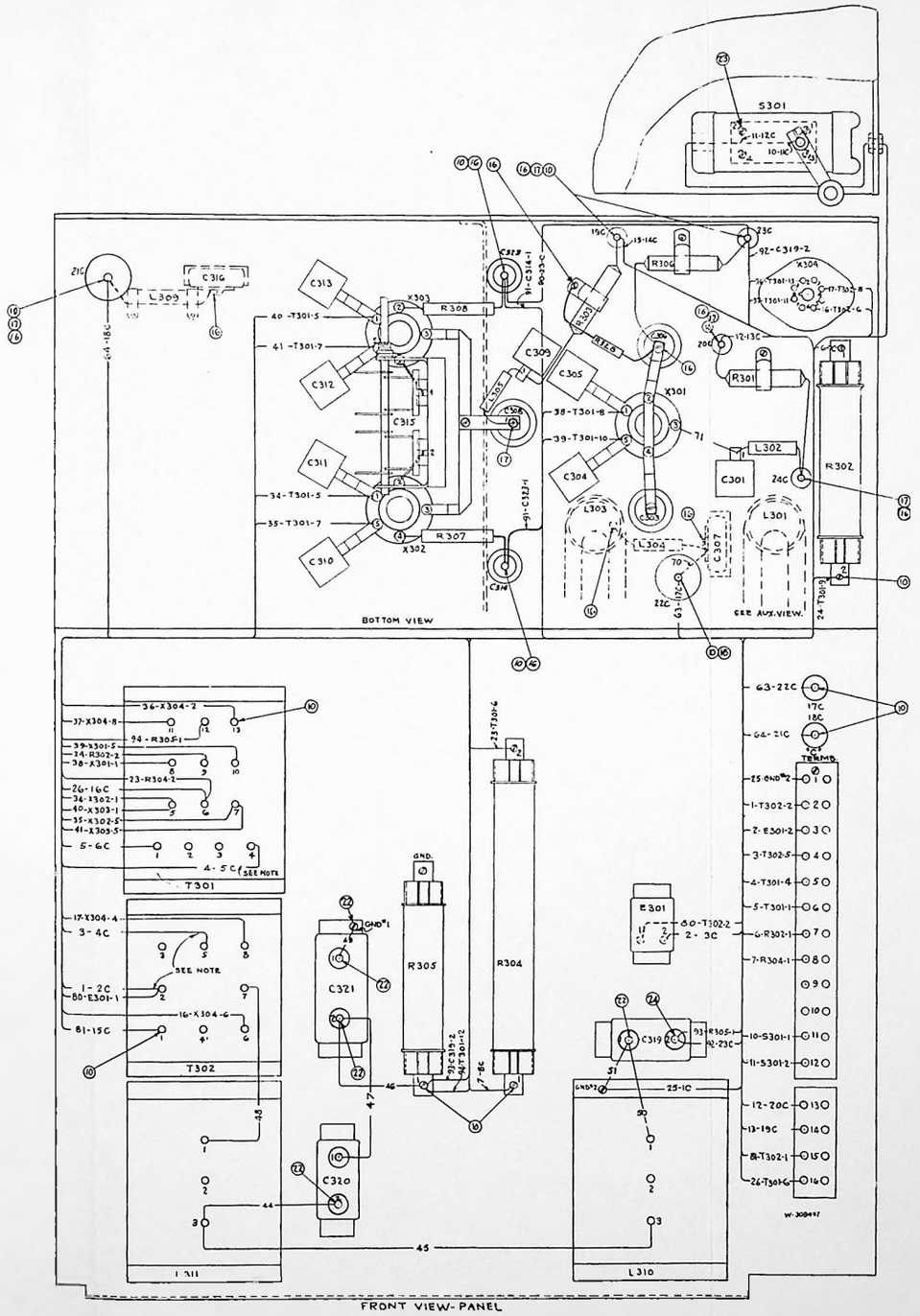
WIRE TABLE		
PART No.	DESCRIPTION	WIRE NO.
9		1 - 2
8		6 - 7
10		11 - 16
12		21 - 26
11		31 - 32
13		36 - 38
14		41 - 42
15		46 - 48
16		51 - 53
17		56 - 59
18		61 - 63
19		66 - 67
20		71 - 73
21		76
22		81 - 82
23		86 - 88
6		116 - 123
7		105 - 113
24	2 COND. SHIELDED	126 - 131
25	1 COND. SHIELDED	141 - 153
26	.0808 DIA BUS	161 - 173
37	.0641 DIA BUS	181 - 190
27	.0641 DIA BUS	205 - 214
35	RG 59/U COAXIAL CABLE	136
32		312 - 323
33		327 - 344
34		350 - 354
41		400 - 403
40	.032 DIA BUS	300 - 301
43	.0508 DIA BUS	191 - 198

Figure 21—Exciter Connection Diagram



WIRE TABLE		
WIRE NUMBER	DESCRIPTION	ITEM Nº
1 TO 11 INCL.	PS663-32 19/.0092 WHT. BLK. TR. 1000 V.	4
20 TO 24 INCL.	PS663-32 19/.0092 WHT. BRN TR. 1000 V.	5
30 TO 39 INCL.	PS663-32 19/.0092 WHT. RED TR. 1000 V.	6
40 TO 46 INCL.	PS663-32 19/.0092 WHT. BLU. TR.	7
50 TO 57 INCL.	PS663-32 19/.0092 WHT. YEL. TR 1000 V.	8
60 TO 68 INCL.	PS663-32 19/.0092 WHT. GRN. TR 1000 V.	9
70 TO 72	PS105 .064 DIA. TINNED COPPER WIRE	10

Figure 22—Exciter Power Supply Connection Diagram



WIRE TABLE		
WIRE NUMBERS	DESCRIPTION	ITEM NO. XM58262
0 TO 7 INCL. 10 TO 13 INCL. 15 TO 17 INCL.	PSGG3-33 19/0117 WHT. BLK. TR. 1000V	6
34 TO 41 INCL	PSGG3-11 41/010 WHT. BLK. TR. 1000V	7
44 TO 51 INCL	PS 103 .128 DIA. TINNED COPPER WIRE	8
	PSGG3 1/4 O.D. x .035" W. ELECTRO TINNED COPPER TUBING-SOFT	9
70 TO 73 INCL	PS 103 .040 DIA. TINNED COPPER WIRE	15
80 & 81	PSGG3-33 19/0117 WHT. 1000V.	18
90	PSGG3-33 19/0117 WHT. RED TR. 1000 V.	19
G3 & G4	PSGG3-22 19/0.032 WHT. RED TR. 2000 V.	20

Figure 23—Low Power R-F Connection Diagram

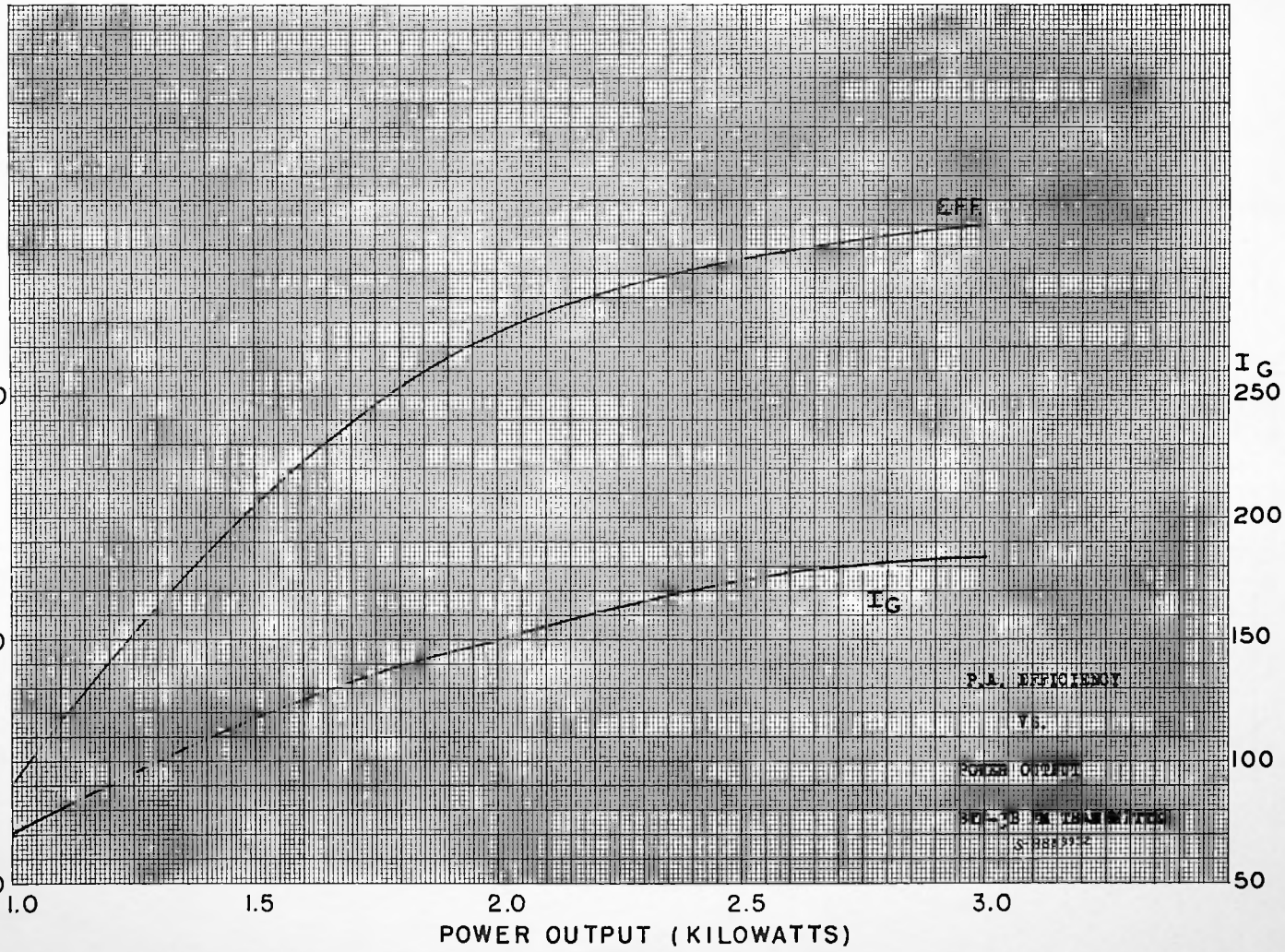
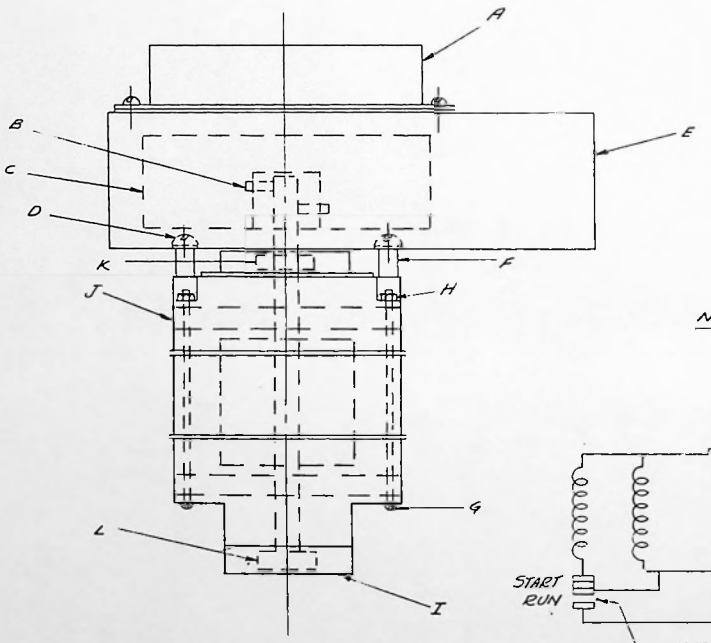


Figure 24—Average Efficiency Curve

MI-7015 FM Exciter Crystal Frequencies (Broadcast-88 to 108 mc)					
Channel No.	Carrier Freq. (mc)	Crystal Freq. (kc)	Channel No.	Carrier Freq. (mc)	Crystal Freq. (kc)
1	88.1	101.9676	51	98.1	113.5417
2	88.3	102.1991	52	98.3	113.7731
3	88.5	102.4306	53	98.5	114.0046
4	88.7	102.6620	54	98.7	114.2361
5	88.9	102.8935	55	98.9	114.4676
6	89.1	103.1250	56	99.1	114.6991
7	89.3	103.3565	57	99.3	114.9306
8	89.5	103.5880	58	99.5	115.1620
9	89.7	103.8194	59	99.7	115.3935
10	89.9	104.0509	60	99.9	115.6250
11	90.1	104.2824	61	100.1	115.8565
12	90.3	104.5139	62	100.3	116.0880
13	90.5	104.7454	63	100.5	116.3194
14	90.7	104.9769	64	100.7	116.5509
15	90.9	105.2083	65	100.9	116.7824
16	91.1	105.4398	66	101.1	117.0139
17	91.3	105.6713	67	101.3	117.2454
18	91.5	105.9028	68	101.5	117.4769
19	91.7	106.1343	69	101.7	117.7083
20	91.9	106.3657	70	101.9	117.9398
21	92.1	106.5972	71	102.1	118.1713
22	92.3	106.8287	72	102.3	118.4028
23	92.5	107.0602	73	102.5	118.6343
24	92.7	107.2917	74	102.7	118.8657
25	92.9	107.5231	75	102.9	119.0972
26	93.1	107.7546	76	103.1	119.3287
27	93.3	107.9861	77	103.3	119.5602
28	93.5	108.2176	78	103.5	119.7917
29	93.7	108.4491	79	103.7	120.0231
30	93.9	108.6806	80	103.9	120.2546
31	94.1	108.9120	81	104.1	120.4861
32	94.3	109.1435	82	104.3	120.7176
33	94.5	109.3750	83	104.5	120.9491
34	94.7	109.6065	84	104.7	121.1806
35	94.9	109.8380	85	104.9	121.4120
36	95.1	110.0694	86	105.1	121.6435
37	95.3	110.3009	87	105.3	121.8750
38	95.5	110.5324	88	105.5	122.1065
39	95.7	110.7639	89	105.7	122.3380
40	95.9	110.9954	90	105.9	122.5694
41	96.1	111.2269	91	106.1	122.8009
42	96.3	111.4583	92	106.3	123.0324
43	96.5	111.6898	93	106.5	123.2639
44	96.7	111.9213	94	106.7	123.4954
45	96.9	112.1528	95	106.9	123.7268
46	97.1	112.3843	96	107.1	123.9583
47	97.3	112.6157	97	107.3	124.1898
48	97.5	112.8472	98	107.5	124.4213
49	97.7	113.0787	99	107.7	124.6528
50	97.9	113.3102	100	107.9	124.8843

M-443137

Figure 25—Crystal Frequency Chart



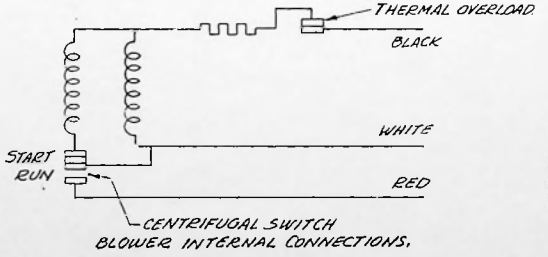
LUBRICATION INSTRUCTIONS.

*1. REMOVE BLOWER FROM TRANSMITTER.
*2. REMOVE FLANGE (A).
*3. REMOVE TWO SET SCREWS (B).
*4. REMOVE WHEEL (C) IF WHEEL IS ON TIGHT IT MAY BE NECESSARY TO HOLD BLOWER UP BY WHEEL (C) AND TAP ARMATURE SHAFT WITH A SHORT METAL ROD.
*5. REMOVE 4 SCREWS (D) & BLOWER HOUSING (E) & SPACES (F).
*6. REMOVE 4 SCREWS (G) & NUTS (H).
*7. REMOVE END BELLS (I) & (J).
*8. APPLY GREASE TO BEARING (L) & (K) FILL SPACE IN BEARING CHAMBER IN THE END SHIELD CASTING ADJACENT TO BALL BEARING SHIELD WITH GREASE. (SEE NOTE *1.)
*9. REASSEMBLE AS SHOWN

NOTE *1.

USE STANDARD OIL CO. TYPE ANDOK "B" GREASE. MASTERS LUBRICO M-G GREASE OR ANY HIGH GRADE BALL BEARING GREASE HAVING A SODIUM OR LITHIUM BASE.

M-950926



BLOWER INTERNAL CONNECTIONS.

1

Figure 26—Lubrication Chart

NOTES and SKETCHES

Manufactured by
RADIO CORPORATION OF AMERICA
Engineering Products Department
CAMDEN, NEW JERSEY, U. S. A.