RCA Boston — ~~Dave~~ Allen
158 "A" St   Wilbur Kelley
Needham   1-617-444-7200

TYPE 5-DX
BROADCAST TRANSMITTER

MI-7232

Manufactured by

RCA Manufacturing Company, Inc.

Camden, N. J., U. S. A.

"A SERVICE OF THE RADIO CORPORATION OF AMERICA"

IB-30034

751 = STYLE 683969-B Type AB1-3
250A

TYPE 5-DX

BROADCAST TRANSMITTER

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INSTRUCTIONS

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RCA Manufacturing Company, Inc.

Camden, N. J., U. S. A.

"An RCA SERVICE"

Printed in U. S. A.

IB-30034

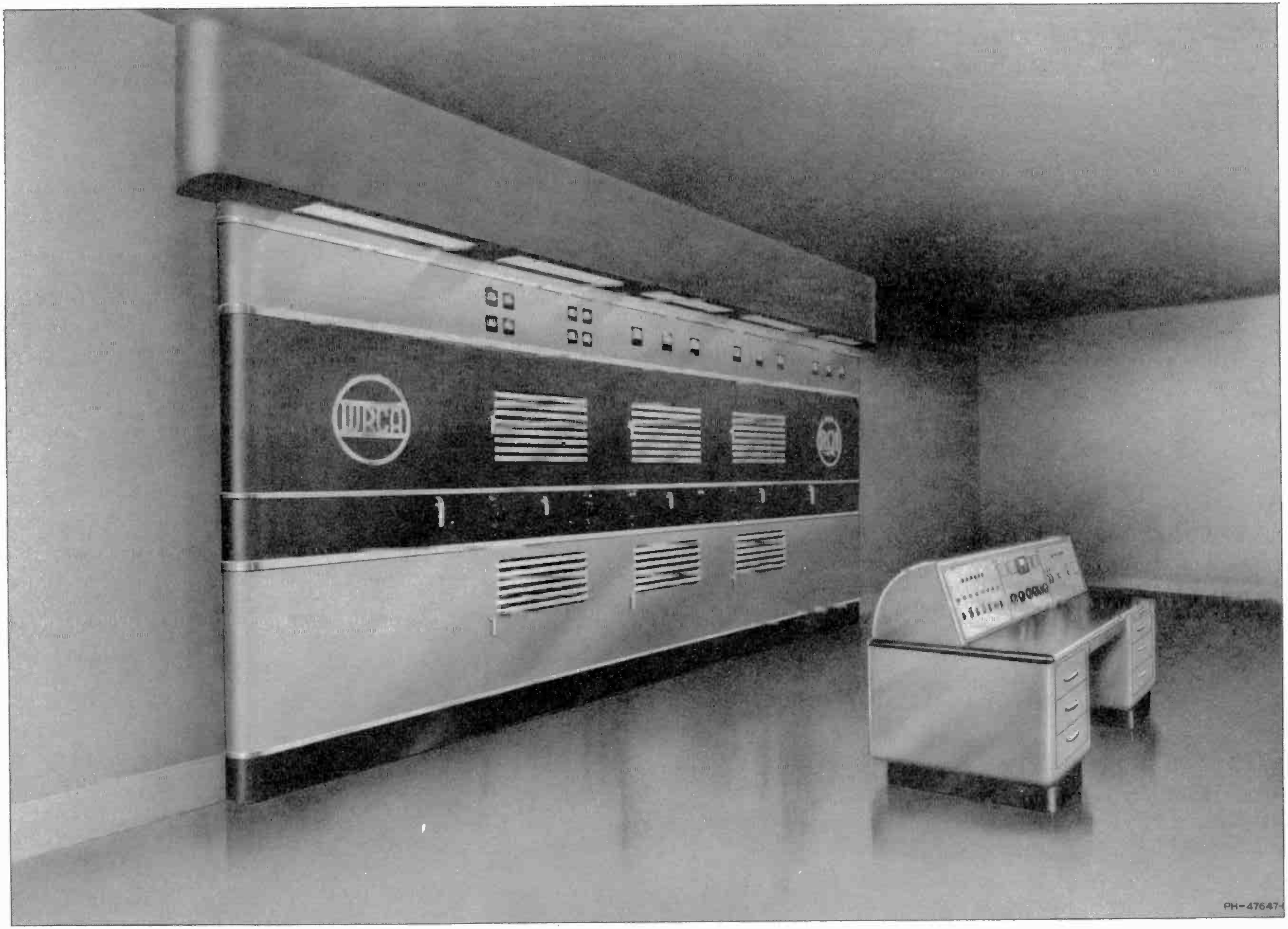


Figure 1—Type 5-DX Broadcast Transmitter (Typical Installation)

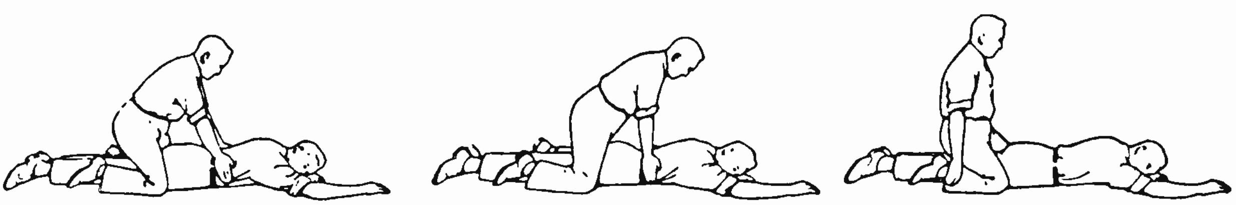
WARNING

THE VOLTAGES EMPLOYED IN THIS TRANSMITTER 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

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SPECIFICATIONS

ELECTRICAL RATING:

Frequency Range	550 to 1600 kilocycles
Power Output	1000/5000 watts

Power Supply Requirements .... 230 volts, 60 cycles, 3-phase capable of supplying normal loads up to 16 kw at 90% power factor and peak loads up to 25 kw at 95% power factor with an instantaneous regulation not exceeding 3% and a slow-time drift of not more than 5%. A separate 115-volt, 60-cycle, single-phase supply is required for the crystal heaters which consume approximately 30 watts.

TUBE COMPLEMENT:

Exciter (Type 250-F)	
Crystal Oscillators	2 RCA-802
Buffer Amplifier	1 RCA-802
Intermediate Power Amplifier	1 RCA-805
Power Amplifier	2 RCA-805
Oscillator Rectifier	1 RCA-5Z3
Low-Voltage Rectifier	2 RCA-866-A
High-Voltage Rectifier	4 RCA-866-A
Power Amplifier	
Final R-F Amplifier	1 RCA-892-R
First A-F Amplifier	2 RCA-1603
Second A-F Amplifier	2 RCA-807
Modulator Driver	4 RCA-845
Modulator-Rectifier	
Modulator	2 RCA-891-R
Modulator Bias Rectifier	2 RCA-866-A
Main Rectifier	6 RCA-872-A
Antenna Tuning Unit (Type 205-A)	
Monitoring Rectifier	1 RCA-83-v

MECHANICAL LIMITS:

Dimensions, Front Panel	207 inches long x 84⅛ inches high
Weight, total	10,138 pounds

EQUIPMENT: The Type 5-DX Transmitter (MI-7232) consists of the following items:

Quantity	Item	MI
1	Exciter Unit	7241
2	Crystal Holders (with crystals)	7467
1	Power Amplifier Unit	7202A
6	Capacitors, PA Plate Tuning and Output Coupling (selected according to frequency requirements)	
1	Modulator-Rectifier Unit	7203A
1	Power Control Panel	7205
1	Antenna Tuning Unit	7444A
1	Antenna Ammeter	7116
1	Supervisory Console	11616
1	Filter Rack	7204
1	Amplifier and Modulator Components Kit	7206
1	Mouldings, Trims, etc.	7240
1	Miscellaneous Hardware Kit	7474
1	Enamel Kit	7499
2	Sets RCA Tubes (see "Tube Complement")	7161

OPTIONAL EQUIPMENT: Required when 5/1-kw operation is contemplated:

Quantity	Item	MI
1	Audio Relay Panel	4309

DESCRIPTION

GENERAL DESCRIPTION. This transmitter will provide reliable, high-fidelity operation at any frequency between 550 and 1600 kilocycles with negligible distortion and low carrier noise. It is easily installed, requiring only the connection of external wiring and minor alterations of the exciter unit (see "Installation"). Such alterations are necessary since the exciter for this equipment is a standard Type 250-F designed for independent operation as a 250-watt transmitter.

An important feature of this equipment is the provision for dual-power operation at either 5000 or 1000 watts. This provision is accomplished by simple switching devices which permit power changes to be made without program interruption. Rated power will be delivered into a 50- to 300-ohm transmission line or into any type antenna normally used with broadcast transmitters. A standard Type 205-A Antenna Tuning Unit is employed.

The operating frequency of the transmitter will be maintained constant at the assigned value within ± 10 cycles. Such stability is achieved by means of the crystal-controlled oscillator (Type UL-4292) which has been developed particularly for broadcast applications. Two of these oscillator units are incorporated to insure continuity of operation, a selector switch being provided on the exciter control panel. The crystals proper are "V"-cut, this type having a low temperature coefficient, and are mounted in compensated, temperature-controlled holders (Type TMV-129-B) arranged for plugging into the oscillator units. A vernier capacitor, adjustable externally from the front of the transmitter, is provided in each oscillator unit for setting the crystal frequency to the exact value.

Four main units are utilized in this transmitter: (1) Exciter, (2) Power Amplifier, (3) Modulator-Rectifier, and (4) Power Control Panel. These units are normally arranged in this order from left to right as shown in Figure 1 which illustrates a typical installation.

The frames of the first three units are divided vertically into two sections. For the exciter, these sections are referred to herein as the r-f and a-f chassis at the right and left respectively, viewing the front. The crystal oscillators and all r-f amplifiers except the final stage are mounted in the r-f chassis of the exciter. In the a-f chassis of this unit are the associated rectifiers, most of the audio-frequency equipment not being required in this application. These (a-f) components may be left idle or removed at the discretion of the installation engineer.

In the power amplifier unit are the final r-f amplifier and the first three a-f stages, which latter are herein referred to collectively as the "Low-Power Audio Amplifier." The modulator-rectifier unit contains the modulator stage and the modulator bias and main rectifiers. A small spot air blast from the main blowers serves to cool the main rectifier tubes at the front of the unit.

Panel markings clearly denote the functions of all meters, tubes, and controls except for minor deviations due to use of the Type 250-F as an exciter. In this connection, it should be observed that the large knob marked "R. F. OUTPUT" on the exciter controls the excitation to the final r-f amplifier instead of the final output, which is adjusted by the "TANK TUNING" knob on the power amplifier. Similarly, the output circuit is resonated by the knob marked "ANTENNA TUNING" on the power amplifier instead of by the small "ANT." knob on the exciter, the latter control being left idle. Antenna current, however, is still measured at the meter position marked "ANT. CURRENT" in the exciter, although another meter is supplied with the equipment for substitution at installation.

Duplicate controls for starting and stopping the transmitter, and a volume indicator, together with complete audio switching facilities are contained in the supervisory console. Complete details of this equipment will be given in the separate supplement (IB-30034a) describing the console.

CIRCUIT DESCRIPTION. The complete electrical circuit of this transmitter is shown in the overall schematic diagram Figure 13. Each circuit component is identified by means of a schematic symbol number for convenient reference. These numbers are repeated on the various diagrams, photographs, and parts list so that any item may be located readily to facilitate circuit analysis and servicing. Further simplification is obtained through the use of different type symbols for the exciter than for the other units. Thus, the exciter parts are assigned two- or three-digit numerical symbols whereas the parts in the power amplifier and subsequent frames are identified by symbols which include a representative letter, such as "C" for capacitors, "R" for resistors, etc. Each of the latter type symbols also bears a prefix numeral indicating the frame or assembly in which the part is located, as follows:

Prefix Numeral	Unit Frame or Assembly
1	Power Amplifier
2	Modulator-Rectifier
3	Low-Power Audio Amplifier
4	Filter-Rack
5	High-Voltage Transformer
6	Modulation Transformer & Reactor
7	Power Control Panel
8	Antenna Tuning Unit
9	Supervisory Console

All terminals are represented by means of letters as well as numerals, the letters corresponding to terminal board designations as shown in the wiring diagrams and photographs.

POWER AND CONTROL CIRCUITS. The general arrangement of the power distribution circuits throughout the transmitter is clearly shown in Figure 14. A simplified diagram of the control circuits employed is shown in Figure 15. Reference should be made to these diagrams while reading the following discussion.

The main line switch (7S1) controls the power supply to the complete equipment except for the separate 115-volt source to the crystal heaters. Power is fed to the exciter through the "OVERLOAD" switch (301) located beneath the crystal oscillators in that unit. A tapped auto-transformer (302) and selector switch (303) marked "LINE VOLTAGE" reduce the supply voltage for the exciter to 115 volts. The power amplifier and modulator-rectifier are operated directly from the 230-volt line through the various switches on the power control panel.

In the exciter unit, the operation of either overload relay (333 or 345) will remove a short circuit from the holding coil of relay 7S27, placing it in series with plate contactor 323. Since the impedance of contactor 323 is much less than that of relay 7S27, the latter (7S27) will pick up and the former (323) will drop out, removing plate voltage from the exciter and the entire transmitter. Operation of relay 7S27 will cause the notching relay (7S18) to function if the transmitter is set for automatic operation.

Relay 7S8 operates when normal rectified current from the monitoring rectifier is flowing and any interruption of current through loss of carrier power at the antenna will cause this relay to drop out, closing the back contacts. This action, in turn, causes potential to be applied to the coil of relay 7S24, operation of which removes all plate power from the transmitter and causes the notching relay (7S18) to function as with any overload. Relay 7S24 is set to operate with a delay of approximately 0.2 second in order that all relays may function and apply power when the transmitter is started. Resistor 7R7 serves to reduce the coil current after operation so that heating is minimized. The "hold-in" current required is much less than the "pick-up" current.

For automatic operation, switch 2S10 is set in the "AUTOMATIC" position, and the notching relay (7S18) will function once for each operation of any one of the overload relays (333, 345, 7S22, 7S23, 7S24, 7S25, 7S26). The first operation will close one set of contacts, completing the circuit to the "OVERLOAD" indicator (2A10) on the modulator-rectifier and 9A10 on the supervisory console. After the first and second overloads, the transmitter is restarted immediately, since the "START" switch (1S9) is bypassed through switch 2S10. Should a third overload occur, a second set of contacts on relay 7S18 will open, breaking the circuit to the exciter plate contactor (323). This, in turn, removes all plate potential from the transmitter. The transmitter may be placed on the air by throwing switch 2S10 or 9S9 to the "RESET" position momentarily. If the 2S10 is left in this position, the first overload will remove all plate potential and operation is resumed manually by depressing the "START" switch (1S9). Should relay 7S18 operate three times in rapid succession, it is advisable to determine and clear the fault before attempting to apply power. In case of a single operation, the relay may be reset at any time without interrupting operation.

A change may be made from 5-kw to 1-kw operation or the reverse without program interruption, provided switch 2S10 is set in the "AUTOMATIC" position. If it be set for manual operation ("RESET" position), it will be necessary to depress the "START" switch (1S9) after the power-change relay (4S2) has functioned. The power change is controlled by switch 9S7 on the power-control panel. Indicators 9A7 and 9A8 show the position of switch 957 "HIGH" or "LOW" power.

The power-change relay (4S2) is of the momentary type and its coils are energized only during actual operation. Since it is impossible to switch the high potential d.c., it is necessary to remove plate power during the instant of operation of this relay. The sequence of operation is as follows: Operation of switch 9S7 opens the holding coil circuit of the main rectifier primary contactor (7S17), removing plate potential from the power-change relay (4S2). A back contact on contactor 7S17 energizes either the trip or operate coil of relay 4S2, depending on the position of the latter at the time of operation. Operation of relay 4S2 reduces or increases the plate voltage on the final r-f amplifier and at the same time operates an interlock switch, reclosing the holding coil circuit of contactor 7S17 and returning the carrier to the air. The sequence of these operations is so rapid that there is no evident interruption of the program.

The coils of relay 4S2 receive power only through the set of back contacts on contactor 7S17. Hence, the latter must be open before relay 4S2 will operate. It is obvious, therefore, that all functions are electrically interlocked to a degree of absolute safety.

RADIO-FREQUENCY CIRCUITS. All of the radio-frequency circuits except the final power amplifier stage are contained in the exciter unit. The final (modulated) r-f amplifier is located in the power amplifier unit.

As shown by the schematic diagram, the first tube in the radio-frequency system is an RCA-802 operated as a crystal-controlled oscillator. The crystal is connected between the control and screen grids and is shunted by a small vernier capacitor (03) which permits adjustment of carrier frequency to the exact assigned value. This capacitor is adjustable externally through the grille bars at the front, using a bakelite rod cut similar to a screwdriver. Four choke coils (011) are employed in the plate circuit of this stage, each covering a portion of the total frequency range (550 to 1600 kc) as follows:

Coil No.	Band Coverage (KC)
4	550— 700
3	700—1150
2	1150—1400
1	1400—1600

At installation, it is only necessary to make the proper coil connection and adjust the circuit to zero beat, as indicated by a frequency monitor, by means of the vernier capacitor (03). The crystal is adjusted to the prescribed frequency in a similar oscillator circuit prior to shipment. Plate and screen voltages for this stage are applied only to the oscillator unit for which the selector switch (120) on the control panel is set and are obtained from the oscillator rectifier (see "Rectifier Circuits"). Both crystals, however, are maintained at the proper operating temperature, being heated simultaneously from the separate 115-volt supply.

Following the crystal oscillator is the buffer amplifier which also employs an RCA-802 tube. The tank circuit of this stage (129, 132) will tune over the frequency range without changing coils and is arranged to furnish grid exciting and neutralizing voltages to the succeeding (IPA) stage. Plate and screen voltages are obtained from the low-voltage rectifier (see "Rectifier Circuits").

The intermediate power amplifier (IPA) stage embodies an RCA-805 tube and furnishes a balanced output voltage for excitation of the two tubes used in the following (PA) stage. In order to tune over the frequency range, it is necessary to change taps on the tank coil (145) only once. Additional taps are provided on the latter coil for excitation of a frequency monitor. Plate voltage is supplied by the high-voltage rectifier (see "Rectifier Circuits").

The power amplifier stage of the exciter utilizes two RCA-805 tubes in a balanced push-pull circuit and is cross-neutralized by capacitor 159. Panel controlled inductive coupling is provided between the plate tank coil (165) and the grid tank circuit of the final (modulated) amplifier. As in the case of the IPA stage, plate voltage is obtained from the high-voltage rectifier.

An RCA-892-R tube operated Class C is used in the final r-f amplifier stage. Capacitors 1C24 and 1C25 across the grid tank coil (1L1) afford a direct low-impedance path to ground for the suppression of spurious frequencies. The tuning capacitors (1C1, 1C2) may be used singly, in series, or in parallel as required for the assigned frequency of the transmitter. Neutralization of this stage is effected by capacitor 1C7, a fixed value being used since the adjustment is not critical.

The plate tank circuit of the modulated amplifier consists of four fixed capacitors (1C8, 1C9, 1C11, 1C12) in a series-parallel arrangement, the main tuning coil (1L6), and the panel-controlled variable inductor (1L7) identified as "TANK TUNING." This circuit is roughly tuned by adjustment of the taps on coil 1L6 and finally adjusted by variation of inductor 1L7. Ground return of the tank circuit is made through the output coupling capacitors (1C10, 1C13) which are selected at installation to provide the best impedance matching for any desired loading condition between 50 and 300 ohms. Plate voltage for the final amplifier is procured from the main rectifier located in the modulator-rectifier unit (see "Rectifier Circuits").

Another panel-controlled variable inductor (1L8) marked "ANTENNA TUNING" is connected in series with the output line and affords fine adjustment of carrier output and loading. Resonance conditions of the output circuit are such that when the tank is tuned on the proper side of resonance, as indicated by maximum output, an appreciable range of power-output control is possible by means of inductor 1L7. Under these conditions, resonance is broad and tuning for power control will have no effect upon the modulation characteristics.

The r-f output is fed to the Type 205-A antenna tuning unit through a six-wire transmission line. Separate instructions (IB-30033-1), inserted at the rear of this book, describe the tuning unit. The line is terminated in a full "T" impedance-matching section comprising items 8L1, 8L2, 8C1, 8C2, to which is inductively coupled a pick-up coil (8L3) for supplying energy to a monitoring rectifier. Direct current from this rectifier is fed back to the transmitter for operation of an antenna current indicator (1M5) installed in the exciter. Since the rectified current is directly proportional to the current flowing in the antenna circuit, this meter when properly calibrated to agree with the antenna ammeter (8M1) will provide a true indication of the transmitter output. The audio envelope of the rectified carrier also is fed back to the station to operate a monitoring amplifier.

AUDIO-FREQUENCY CIRCUITS. All of the audio-frequency stages except the final (modulator) stage are located in the power amplifier unit. The modulator stage is contained in the modulator-rectifier.

The audio input at approximately zero level is delivered to the input transformer (3T1) feeding the first audio amplifier which uses two RCA-1603 tubes in push-pull arrangement. Since the secondaries of the input transformer are connected in series with the feedback voltage dividers (2R36, 2R37) between the modulator plates and ground, the first audio grids are excited by a voltage which is the vector sum of the input and feedback voltages. The feedback loop comprises all circuits between the secondary of the input transformer and the primary of the modulation transformer (6T1). Plate and screen voltages for the first audio tubes are supplied by the low-voltage rectifier in the exciter.

Two RCA-807 tubes in push-pull are employed for the second audio amplifier which is resistance coupled to the first stage. This stage receives plate and screen potentials from the high-voltage rectifier in the exciter.

The third audio or modulator driver stage likewise is resistance coupled to the second and utilizes four RCA-845 tubes in a parallel push-pull circuit. As in the case of the second stage, the driver tubes obtain plate power from the high-voltage rectifier of the exciter. The output of this third stage is coupled to the modulators through the driver transformer (2T13) located in the modulator-rectifier unit.

Modulation of the final r-f amplifier is performed by the final a-f or modulator stage which embodies two RCA-891-R tubes in push-pull. Plate and bias voltages for these tubes are furnished by the main and bias rectifiers (see "Rectifier Circuits").

The circuit elements throughout the audio system are designed to reduce phase shift to such a degree that the feedback loop is inherently stable. Adjacent-channel interference is minimized through the use of a rapidly-dropping response characteristic beyond the 10-kc band of audio frequencies.

RECTIFIER CIRCUITS. Five rectifier circuits are employed in this transmitter. The oscillator rectifier and the low- and high-voltage rectifiers are embodied in the exciter while the main and bias rectifiers are contained in the modulator-rectifier. All circuits are of the full-wave type except that the main rectifier functions simultaneously as both full- and half-wave during 1-kw operation. The associated filter components are generously designed to insure low ripple content.

The oscillator rectifier utilizes an RCA-5Z3 tube and furnishes plate and screen voltages to the operative crystal oscillator. Two RCA-866-A tubes are employed in the low-voltage rectifier which supplies plate and screen voltages to the buffer and first audio amplifiers. The high-voltage rectifier uses four RCA-866-A tubes to provide plate voltages for the exciter IPA and PA stages, plate and screen voltages for the second audio amplifier, and plate voltage for the modulator driver. Both of the latter rectifiers have a regulation of less than five per cent.

Bias for the modulator tubes is obtained from the bias rectifier which utilizes two RCA-866-A tubes. The main rectifier comprises six RCA-872-A tubes in a three-phase, full-wave circuit to furnish plate power for the final r-f amplifier and modulator stages. High voltage, a-c power is delivered to this (main) rectifier from the separate plate transformer (5T1) which is connected delta primary, wye secondary. Filtering of the rectified output is accomplished by the elements located in the filter rack.

At the instant of power application, resistors 4R5 and 4R6 are connected in series with the filter capacitors. As a result, the starting surge through the rectifier tubes is greatly reduced. After a short interval permitting the condensers to charge gradually through these resistors, relay 4S3 closes, shorting out the starting resistors. The timing section of relay 7S17 controls the starting delay.

During 1-kw operation, the rectifier tubes function simultaneously in three-phase, full-wave and three-phase, half-wave circuits. The latter provides a supply of one-half voltage for the final r-f amplifier, while the modulators continue to operate at full voltage. The half-wave section operates through a separate filter consisting of items 4C4, 4C5, and 4X1.

One other rectifier circuit not mentioned above is contained in the antenna tuning unit. Reference should be made to the booklet included at the rear for information pertaining to this item.

INSTALLATION

ASSEMBLY DETAILS. A thorough study of the installation drawings (DL-500174) will enable the engineer to plan any installation to fit the requirements of building design. These prints will supply the necessary data to plan the conduit systems and feeder-line installation and to prepare a bill of material. Ordering information for the various insulators, cable, potheads and other accessories is included in the data.

The drawings indicate a floor channel connecting the various units for power and control circuit installation. The construction of the transmitter, however, is such that the wiring may be installed above the surface of the floor and beneath the elevated base plates of the units. This, of course, will require raised enclosures on the floor between the units to protect the wiring and designed to meet all electrical-code requirements. If desired, wiring may be enclosed in the base channels beneath the bottom moldings.

When making a layout plan, reference should be made to the local electrical code so that all requirements may be met in the installation.

Conduit and wire sizes are clearly shown on the "Wire Chart," Figure 24, and the "Typical

Installation" diagram T-611495. An average installation will require approximately 1300 feet of #14 V.C.C., 600-volt, lead-sheathed wire and 250 feet of #10 V.C.C., 600-volt, lead-sheathed wire. The larger power circuits and overhead bus connections may be accurately determined from a layout sketch of the actual installation.

A recommended 4-wire transmission line and lead-in system are illustrated in diagrams W-303537 and P-708324. If the antenna tuning unit is to be mounted in an enclosure, the latter should be well ventilated.

The access door at the extreme left of the transmitter assembly is interlocked. The interlock switch must be wired into the circuit at terminals #CP98 and #CP100 on the power panel. Any other interlock external to the equipment itself which may be desirable should be connected in series with the CP98-100 circuit. The most convenient method for running this circuit will be determined by the physical details of the installation.

A few of the parts are removed from the transmitter and packed separately to insure safer transportation. Each part is labeled and reference to the circuit diagrams and photographs will enable their correct replacement. The two antenna coupling coils (167, 168) of the exciter unit need not be installed.

A careful check of the blowers should be made. The rotors should function smoothly and the oil cups should be filled with a good grade of SAE-20, or equivalent, lubricant. The air-interlock dampers must operate freely. The air tubes to the main rectifiers should be checked to make certain that the air ducts are not obstructed; although the volume of air circulation required is small, it is very essential for correct operation.

It is well to have the oil used in the plate transformer (5T1) checked for moisture at the time of installation. A sample drawn from the transformer should be tested at 25 kv in a cup-type tester.

INTERNAL CONNECTIONS. As noted heretofore, the exciter furnished with this equipment is in itself a complete 250-watt transmitter. In order to use this unit as an exciter, a limited number of circuit changes will be necessary as follows:

1. Remove the jumpers between terminals #A11 and #A12, #A13 and #A14, and #A15 and #A16.
2. Connect jumpers between terminals #A13 and #A16 and terminals #A14 and #A17.
3. Open the holding-coil circuits of relays 180 and 233 to prevent their operation if desired since these relays are not required.
4. Check the connection of terminal #CP82 to terminal #EX1 on relay 323—the lower left-hand operating coil terminal.
5. Check the auto-transformer (302) and make certain that the outer (230-volt) terminals are connected to terminals #A27 and #A28.
6. Check the high-voltage rectifier plate transformer (326) and make certain that the secondary connections are attached to the terminals marked #1.
7. Check the low-voltage rectifier plate transformer (338) and make certain that the secondary connections are attached to the terminals marked "1290".
8. Short-circuit resistor 343 by connecting the strap across the clip terminals of that unit.
9. Connect the screen supply lead for the buffer amplifier and the plate and screen supply lead for the first audio amplifier to the taps on resistor 344 in the arrangement shown on the schematic diagram, Figure 13. The proper taps may be determined readily by checking the voltages against the tabulation entitled "Typical Meter Readings" during preliminary testing.
10. Connect the rotor of the PA tank coil (165) to terminals #1W1 and #1W2 in the power amplifier, using 1/8-inch tinned copper bus wire. Remove any existing connections to this rotor. The stand-off insulators just above the variable tank capacitor (164) may be used to support these leads.
11. Install and connect the new antenna-current indicator (1M5) in place of the existing meter (169) at the position marked "ANT. CURRENT". The scale of this meter is selected at installation according to the antenna resistance and its calibration is explained under "Tuning". Tape the leads removed from meter 169 and connect the formerly unused pair at this position (from terminals #A9 and #A10) to meter 1M5.
12. Disconnect the lead between CP57 and 7S30 at 7S30. The two free ends of the interrupted lead should be connected and taped.

In the power amplifier unit, connect a jumper between terminals #C17 and #D13. It is recommended that the tank thermocouple (1M4) be removed from the circuit during preliminary tuning and reconnected after stable operation is assured. Under normal conditions, the latter precaution would be unnecessary but it is well justified since the thermocouple might easily be damaged by any excessive current incurred through unexpected severe self-oscillation or parasitics.

Before applying power to any circuit, check all wiring to the power and control circuits and the internal wiring inserted during installation. The power circuit feeding the transmitter should be fused at 200 amperes.

SPHERE GAP ADJUSTMENTS. The sphere gaps mounted upon the various units should be polished and carefully checked for spacing as follows:

Item	Unit	Gap Spacing
4X2	Main Filter Reactor	¼ inch (0.250") max.
6T1	Mod. Transformer	3/32 inch (0.094") max., each
6X1	Mod. Reactor	⅛ inch (0.125") to 3/16 inch (0.187")

The above spacings are to a small degree approximate. It is advisable to adjust the gaps on the modulation transformer and reactor so that they will flash respectively at approximately 15 db and 10 db above 100% modulation level. The reactor gap preferably should flash over before the transformer gap since an arc at this point will clear itself more readily.

Excessively large gaps should be avoided since the extra spacing removes protection that is absolutely essential in cases of modulation surges. Such surges are of common occurrence with telephone-line transmission.

The series resistor (6R3) used with the modulation reactor sphere gap should be checked for continuity. THIS IS IMPORTANT.

RELAY ADJUSTMENTS. The stroke of the plungers in the overload relays should be adjusted for the following throwout values:

Item	Relay	Setting (amperes)
333	Exciter H-V Rectifier	1.7
345	Exciter L-V Rectifier	0.8
7S22	Power Amplifier	0.8
7S23	Modulator	1.0
7S25 / 7S26	Main Rectifier Primary	110-150

The various time-delay relays and other relays with delay functions should be adjusted as follows:

1. Item 309, Exciter Time-Delay Relay: This relay prevents the application of plate voltage to the exciter rectifiers until a definite time after the rectifier filaments ar energized. Before adjustment, the dashpot must be filled with the oil provided. The delay time should then be adjusted so that the contacts close approximately 30 seconds after power is applied to the operating coil. Such variation may be accomplished either by regulating the stroke of the plunger or by turning the disc in the bottom of the plunger cup to alter the effective number and size of holes in the cup.

2. Item 4S1, Main Rectifier Filter Capacitor Grounding Relay: This relay is an important safety feature, operating upon the opening of any protective interlock circuit to ground the high-potential filter capacitors. It should be checked frequently for 1.0 to 1.5-second operation and serviced at regular periods. REMEMBER THIS. Failure of this relay to operate and remove the ground on the filter capacitors will prevent the main plate contactor (7S17) from operating to apply plate potential.

3. Item 4S2, Power-Change Relay: This relay is equipped with a small screw and lock-nut device (lower right-hand set of interlock contacts) by means of which the closing time should be adjusted so that the armature will latch in place before the operating coil is de-energized. Any tendency of this unit to "pump" may be remedied by such adjustment.

4. Item 7S17, Main Rectifier Contactor: The delay section of this contactor withholds the closing of the starting relay (4S3) until the filter capacitors have charged at a low rate, minimizing current surges through the rectifier tubes. Adjust the delay section of this unit, which is mounted directly above the main power contacts, for an interval of 1.5 to 3.0 seconds.

5. Item 7S19, Power Amplifier and Modulator Filament Time-Delay Relay: This relay prevents the immediate application of full filament voltage until the filament temperature rises to a safe value, thereby eliminating current surges which may cause filament rupture. Set the delay time for 12 to 15 seconds on the up stroke and adjust the valves for delay on both the up and down strokes. An instruction pamphlet (GEH-954A) published by the manufacturer of this unit is included at the rear of this book.

6. Item 7S20, Main Rectifier Time-Delay Relay: This relay is of the same type as Item 7S19, but should be adjusted for a delay interval of 15 to 20 seconds. It operates only after relay 7S19 has closed, the sum of the two delays being the time interval between application of the main rectifier filament and plate voltages. The operation of these relays, using delay on both strokes, is such as to give an inverse time function. For example, after closing, any power failure will cause a delay proportionate to the time of power failure, within limits. A power failure lasting one second will cause a delay of approximately one second in the application of plate voltage. This eliminates the need of the full delay where only a short interruption has occurred.

7. Item 7S21, Blower "Keep-Alive" Relay: This relay should be adjusted for a delay of 4 to 7 minutes and functions to maintain operating potential on the blower motors after the transmitter is turned off to insure gradual cooling of the large tubes. The transmitter must not be turned off at the main line breaker (7S1) until after this relay has functioned or this circuit will fail to operate.

8. Items 7S22 and 7S23, Overload Relays: Adjust these relays for zero delay on the up stroke and the minimum delay obtainable (approximately 0.2 second) on the down stroke. This delay is recommended to assure operation of the notching relay (7S18) and to eliminate the possibility of failure of an arc to be extinguished because of instantaneous reclosure.

9. Item 7S24 "Carrier-Off" Relay: Adjust this relay for the minimum delay obtainable on both strokes. Should this unit operate and cause the notching relay (7S18) to function before it is possible to get the carrier on, increase the timing just sufficiently to give satisfactory operation.

10. Items 7S25 and 7S26, Overload Relays: These relays are similar to Items 7S22 and 7S23 and should be adjusted for equivalent operation.

Note.—The contact bar in relays 7S19 and 7S20 have a red bakelite center section, while the contact bar in relays 7S22, 7S23, 7S24, 7S25 and 7S26 is black. The black bar has a continuous piece of metal passing through the bakelite. The red bar contains two pieces of metal, one at each end and insulated from each other. The two types of bars are not interchangeable.

OPERATION

STARTING SEQUENCE

To start the transmitter, all main doors must be shut since they are electrically interlocked. Close the manually-operated breakers, both in the exciter (301, 307, 324) and on the power control panel (7S1, 7S2, 7S3, 7S4, 7S5, 7S6, 7S7, 7S10, 7S28, 7S29).

MANUAL OPERATION. For manual operation, switch 2S10 must be thrown to the "RESET" position. Close the exciter and power amplifier filament switches (305, 9S5 and 1S10), the latter normally being left "ON" so that all filaments may be energized by switch 305 or 9S5. Closure of this switch (305) starts the exciter time-delay relay (309) and all blower motors while closure of switch 1S10 starts time-delay relays 7S19 and 7S20. For a "cold" start, it is advisable to wait several minutes before applying plate voltage and to set the power change switch (9S7) for "LOW POWER" operation.

After proper delay, the "READY" indicator (1A6) will indicate that the minimum delay time has elapsed. The exciter plate switch (322) now may be closed, applying plate power to all exciter stages and all low-power audio stages. Power is then applied to the final r-f amplifier and modulator stages by depressing the "MAIN RECTIFIER" "ON" switch (1S9) momentarily. Closure of switch 322 (9S8 must be closed) energizes the exciter plate contactor (323) which upon closing completes the circuit through the main rectifier contactor (7S17) up to the start switch (1S9). If switch 2S10, however, is set for "AUTOMATIC" operation, contactor 7S17 would operate immediately upon closing switch 322.

Power may be changed from 5 kw to 1 kw, or the reverse, merely by shifting the power change switch (9S7) to the proper position. Unless switch 2S10 is set at "AUTOMATIC," it will be necessary to operate the start switch (1S9) (or 9S6) to re-energize the main rectifier after a power change. The same operation is necessary should any overload relay function. If a series of power changes is desirable during test, it is very important that the starting relay (4S3) be allowed to close each time before switch 9S7 is reversed.

AUTOMATIC OPERATION. After the transmitter has been warmed up, it is advisable to change switch 2S10 to the "AUTOMATIC" position so that an overload or power failure will cause a minimum interruption of service. Under this condition, the transmitter may be started (or stopped) by the operation of the exciter filament switch (305) or (9S5) only, assuming that all interlock switches, the filament switches (1S10) and (9S5) and the exciter plate switches (322) and (9S8) are closed. Closure of switches 305 or 9S5 will start the relay sequence exactly as described under "MANUAL OPERATION," except that all delays and relay functions are automatic.

An interruption caused by overload permits instantaneous resumption of operation unless the overload occurs three times in rapid succession or if the notching relay (7S18) has not been reset after a previous operation. Relay 7S18 may be reset by momentarily placing switch 2S10 in the "RESET" position or operating 9S9.

To shut down the transmitter, simply open the exciter filament switch (305) or (9S5). To prepare for restarting, switch 322 also should be opened and switch 2S10 placed in the "RESET" position. To insure proper cooling, the main line breaker (7S1) should not be opened until the "AIR FLOW" indicator (1A4) is extinguished, indicating that the blowers have stopped.

Failure of control circuits to function may readily be corrected by observing operation of the starting sequence to the point of failure. A study of the control circuit diagram and the characteristics of the failure should make it possible to remedy any abnormal operation.

TUNING

Open the "PLATE" overload switch (324) in the exciter and the main rectifier plate switch (7S29) on the power control panel, thus removing all high voltage from the equipment. Detach the plate caps from all tubes in the exciter, then close the "LINE" switch (301) and adjust the associated "LINE VOLTAGE" control (303) until the "LINE VOLTS" meter (304) reads 115 volts. Finally, close the "FILAMENT" overload switch (307) and the "FILAMENT ON-OFF" switch (305) and measure all filament voltages, which should be within 2% of their rated values. Before proceeding, allow an interval of approximately 30 minutes to elapse as this will materially increase the life of the mercury-vapor rectifier tubes.

NOTE—This "warm-up" period of 30 minutes need be observed only with new tubes and is required in order to dislodge mercury deposited upon the cathode during handling and shipping. After the tubes have been in operation, a 30-second interval is ample.

EXCITER. Check the crystal oscillators to make certain that the proper plate coil (011) for the required frequency is used in each as specified in the tabulation given under "Circuits." To select the latter inductance, the shield of the unit must be removed by withdrawing the two small screws and taking off the output terminal nuts. A terminal strip containing four numbered terminals corresponding to those listed in the tabulation will be found inside.

Replace the plate caps on the RCA-802 tubes in the crystal oscillator units and close the "PLATE" overload and "ON-OFF" switches (324, 322, and 9S8). Check the oscillator plate voltage as indicated by the "OSC. PLATE VOLTS" meter (315); the correct value is 330 ± 10 volts. The oscillator plate current should be within the limits specified in the tabulation entitled "Typical Meter Readings." Measurements should be made in both positions of the "OSCILLATOR" selector switch (120) to ascertain whether both crystals are functioning properly.

Check the operation of the door interlock switches (351) by opening and closing the doors, then open the "PLATE ON-OFF" switch (322) and replace the plate caps on the buffer (RCA-802) and two low-voltage rectifier (RCA-866-A) tubes. Upon reclosing switch 322, plate and screen voltages will be applied to the buffer tube.

Resonate the buffer stage by rotating the variable tank capacitor (129) from maximum capacitance toward "minimum" for a "dip" in plate current as registered on meter 127. Also, check the screen-grid voltage using a high-resistance voltmeter of at least 1000 ohms per volt. The screen potential should be limited to 230 volts by adjusting the tap connection on resistor 344 to the 1250- or 1450-ohm point. This resistor also controls the plate and screen voltages applied to the first audio amplifier (RCA-1603) tubes and the associated tap may be adjusted at this time to provide a plate potential of 190-200 volts when measured to ground.

Adjust the taps on the IPA tank coil (145) as follows:

	550-850 kc	**850-1150 kc**	**1150-1600 kc**
"IPA" capacitor (144) taps	P1–P1	P1–P1	P2–P2
"PA" grid taps (from frame out)	G2–G2	G1–G2	G2–G2
Center tap	C2	C1	C2

NOTE—It may be found necessary to connect jumpers from P1 to P2 at both ends of the coil in order to resonate this circuit at 1600 kc. Taps C1 and C3 which are slightly off center are used to balance the grid currents through the PA tubes; these taps are not to be employed except where the unbalance is 10% or greater.

Replace the plate caps on the IPA (RCA-805) and four high-voltage rectifier (RCA-866-A) tubes and resonate the IPA tank circuit by rotating the variable capacitor (144) from maximum capacitance toward "minimum" until a "dip" in plate current is observed on meter 139. The plate voltage should be set at approximately 800 volts by adjusting the tap connection on resistor 336.

Neutralize the IPA stage by setting the neutralizing capacitor (141) for a minimum or for zero PA grid current. At the higher broadcast frequencies, better neutralization may be obtained by selecting taps C1 or C3 and G1 instead of taps C2 and G2 as normally used. The proper voltage for a frequency monitor may be obtained from either tap T1 or tap T2 on this coil through connection to terminal #A8.

Replace the plate caps on the two PA (RCA-805) tubes and adjust the rotor in the plate tank coil (165) for minimum coupling to the final r-f amplifier grid tank coil (1L1). This condition will be obtained with the axes of the rotor and plate tank coils at right angles to each other.

The PA plate tank circuit embodies a variable capacitor (164), two 200-mmfd fixed capacitors (163) and two 150-mmfd fixed capacitors (162). These capacitors may be connected in different arrangements and the effective number of turns per section on each side of the center of the tank coil (165) may be varied to resonate this circuit at the desired frequency. Suggested settings for the tank circuit elements are given in the following tabulation:

Frequency (kc)	Tank Coil (165) Active Turns/Section from Center	Fixed Tank Capacitance	
		Mmfd (each side)	Capacitors (each side)
550– 650	24–22	750	162, 163, 183
650– 750	22–20	700	163, 183, 184
750– 800	20–18	650	162, 183, 184
800– 850	18–16	600	163, 183
850– 900	16–14	550	162, 183
900– 950	14–12	500	183, 184
950–1000	12–10	450	162, 163, 184
1000–1100	10– 8	400	183
1100–1200	8– 7	350	162, 163
1200–1300	7– 6	300	163, 184
1300–1400	6– 5	250	162, 184
1400–1500	5– 4	200	163
1500–1600	4	150	162

The tank-coil settings tabulated above are only approximate and slight deviations are permissible. Throw the "HIGH-LOW" power switch (350) to the "LOW" position to avoid excessive plate current during these preliminary adjustments. After making each trial setting, apply plate voltage and resonate the plate tank circuit by rotating the variable capacitor (164) from maximum capacitance toward "minimum" until an adjustment is obtained where a plate current "dip" is indicated upon meter 155.

Neutralize the PA stage by connecting a 0-115 milliampere thermo-galvanometer or low-reading r-f milliammeter in the tank circuit. With this meter inserted and plate voltage removed, tune the variable tank capacitor (164) for a maximum deflection, then adjust the neutralizing capacitor (159) until a minimum reading is obtained.

Upon completing the PA tuning adjustments, the plate voltage should be adjusted to approximately 1375 volts with the "HIGH-LOW" power switch (350) in the "HIGH" position. Such adjustments may be accomplished by shifting the tap connections on resistors 346 and 334, the latter unit affording fine variation.

The plate current of the exciter PA stage will be somewhat excessive until plate voltage is applied to the final r-f amplifier. Before applying this potential, however, individual plate currents of the RCA-805 tubes should be checked for balance. This check may be made readily by removing the center-tap connections from the secondaries of the filament transformer (318) and reconnecting them by jumpers to the two center-taps of transformer 320 which feed through the "MOD. PLATE" meters (231) to ground. The latter will then indicate the individual totals of the grid and plate currents and the regular plate current meter (155) for the power amplifier will indicate reverse grid current. The currents should balance within 5% of the mean and in no case should exceed 210 ma per tube, exclusive of grid current. Total grid current will be read on meter 140.

All of the exciter neutralization adjustments should be checked after the entire transmitter is operating by removing the crystal and making certain that the respective grid and tank currents drop to zero. Especially is this true of the output stage. Neutralization also should be checked with a cathode-ray oscilloscope after modulation has been applied.

POWER AMPLIFIER. The exciter and main rectifier breakers (324, 7S29) should be left open and switches 4S4 and 4S5 on the filter rack should be thrown to the "GROUND" position while adjusting the final r-f amplifier to avoid any possibility of power application.

Connect the feed line from the exciter (terminals #1W1 and #1W2) to taps on the final amplifier grid-tank coil (1L1) located symmetrically on each side of center. The adjustment should vary from four turns off center at 1600 kc to six turns off center at 550 kc. Such settings are not critical, the principle effect of this adjustment being to control the matching and consequent efficiency of energy transfer.

Grid-Tank Circuit. The grid-tank coil (1L1) should be adjusted with respect to the operating frequency, maintaining an equal number of effective turns on each side of center. At 550 kc, approximately 24 turns will be required on each side while intermediate values down to 8 turns at 1600 kc will be employed. The unused turns should be left open (disconnected from the coil terminals) at frequencies between 550 and 850 kc but should be short circuited at frequencies between 850 and 1600 kc.

Connect the flexible lead from capacitor 1C3 to the tap at the exact center of coil 1L1 and adjust the grid tank capacitance as shown by the following tabulation. Capacitors 1C24 and 1C25 should be used at all frequencies.

Frequency Range (kc)	Capacitor Connection
550-850	1C1 (0.0004 mfd) and 1C2 (0.0003 mfd) in parallel
850-1350	1C1 (0.0004 mfd)
1350-1600	1C2 (0.0003 mfd)

Plate-Tank and Output Circuits. The plate-tank coil (1L6) should be adjusted with respect to the operating frequency, preferably maintaining the active turns at the bottom to insure maximum pickup to coils 1L9 and 1L10. Approximate settings for this tank coil throughout the overall frequency range are shown in the following tabulation:

Frequency Range (kc)	Effective Turns
550-650	44-37
650-850	37-32
850-1050	32-25
1050-1350	25-20
1350-1600	20-14

For frequencies below 800 kc, the unused turns on coil 1L6 should be left open, removing the upper flexible lead and the jumper to coil 1L7. These unused turns should be short-circuited at frequencies above 800 kc. The connections of all bus and flexible leads in the tank circuit should be carefully checked with the schematic and wiring diagrams.

Connect the plate-tank circuit capacitors (1C8, 1C9, 1C11, 1C12) and the output coupling capacitors (1C10, 1C13), selecting values with respect to frequency as shown in the following tabulations. The four plate-tank capacitors are connected in series-parallel and the two output coupling capacitors in parallel as shown in the schematic diagram. Fixed capacitors of the Faradon Case 111 Type are used throughout.

After making the foregoing preliminary adjustments, check the neutralization of the modulated amplifier stage. It is advisable for this purpose to remove the tank-current meter thermocouple (1M4) and insert in its place a 0-500 ma r-f meter. Energizing the exciter only, this meter should indicate not more than approximately 200 ma with the antenna load connected. If the current is excessive, the taps on the grid-tank coil (1L1) should be carefully balanced since the symmetry of voltages at this point determines the accuracy of neutralization. Any test meter employed must be removed before plate voltage is applied.

Antenna Tuning Unit. Care should be taken not to apply power to the transmission line until the antenna tuning unit has been properly adjusted. Any misadjustment will cause standing waves to occur on the line. These standing waves may develop a sufficiently high voltage to produce an arc between the conductors which may damage the line. This is particularly true of the concentric-tube type of line where the conductors are not widely spaced.

Complete instructions for adjustment of the Type 205-A antenna tuning unit employed with this equipment are given in the booklet (IB-30033-1) inserted at the rear of this text.

Final R-F Adjustments. Final adjustments of the plate-tank and output coupling circuits in the power amplifier unit obviously require the application of plate voltage to the modulated amplifier stage. Before applying power, however, the overload relays (7S22, 7S23) should be checked for normal operation. These relays may be checked by passing rated current (using 10 volts d.c.) in turn through the respective operating coils. For relay 7S22, connect the positive side to the center tap of resistor 1R3; for relay 7S23, connect the positive side to the junction of the secondaries of transformers 2T1 and 2T2. The negative side of the d-c voltage in each case should be returned to ground. This potential will cause overload current to flow and will indicate proper functioning of these relays.

Assuming that the overload relays operate satisfactorily, all protective grounds should be removed from the power amplifier. Switches 4S4 and 4S5 in the filter rack also should be cleared from ground. The latter (4S5), however, should be thrown only to the neutral position so that no power will be applied to the modulator stage. Finally, close the main rectifier switch (7S29).

CAUTION—THE POWER-CHANGE SWITCH (9S7) SHOULD BE IN THE "LOW POWER" POSITION FOR THE FIRST APPLICATION OF POWER.

The plate-tank circuit now should be resonated by changing the number of effective turns on the plate-tank coil (1L6) in small steps until a "dip" in plate current is observed on meter 1M2 as variable inductor 1L7 is rotated through the central portion of its range. Upon obtaining this condition, however, it will be found that the power output will continue to increase as this inductor is turned beyond the minimum current setting in a direction which decreases the tank inductance (clockwise). This occurs because the tank inductance setting for minimum plate current is not the same as for unity power factor in the tube load circuit.

Such a condition will be found in any tank circuit similar to the one used in this transmitter where the kva to kw ratio of the tank current is less than approximately 10. For higher ratios, the two inductance settings become practically iden-

PLATE-TANK CIRCUIT

Frequency Range (kc)	Total Capacitance (mmfd)	Tank Capacitors							
		1C8		1C9		1C11		1C12	
		mmfd	UC-	mmfd	UC-	mmfd	UC-	mmfd	UC-
550–650	300	300	3113	300	3113	300	3113	300	3113
650–750	266	200	3119	400	3107	200	3119	400	3107
750–850	200	200	3119	200	3119	200	3119	200	3119
850–1050	150	150	3125	150	3125	150	3125	150	3125
1050–1350	120	150	3125	100	3131	150	3125	100	3131
1350–1600	100	100	3131	100	3131	100	3131	100	3131

OUTPUT-COUPLING CIRCUIT

Frequency Range (kc)	Total Capacitance (mmfd)		Coupling Capacitors							
			240-ohm Line				70-ohm Line			
			1C10		1C13		1C10		1C13	
	240-ohm Line	70-ohm Line	mmfd	UC-	mmfd	UC-	mmfd	UC-	mmfd	UC-
550–650	2000	3000	1000	3075	1000	3075	1000	3075	2000	3222-A
650–750	1800	2800	1000	3075	800	3083	800	3083	2000	3222-A
750–850	1500	2500	1000	3075	500	3099	500	3099	2000	3222-A
850–1050	1300	2300	800	3083	500	3099	300	3113	2000	3222-A
1050–1350	1200	2100	800	3083	400	3107	100	3131	2000	3222-A
1350–1600	1000	1600	800	3083	200	3119	100	3131	1500	3067

tical but increase in separation as the ratio is decreased below that value. The separation in this case is not great and represents but a few revolutions of the control for variable inductor 1L7.

From the foregoing, it will be evident that the output and efficiency will increase as inductor 1L7 is rotated beyond the "dip" position to the unity power factor condition. Upon passing the latter point, the output will continue to increase but the efficiency will start to decrease.

A solution of the mathematics of this tank circuit shows that for tuning in the region of unity power factor, very small variations (one or two revolutions) of inductor 1L7 will produce large changes of the load into which the tube looks. Consequently, it is possible to obtain a considerable variation in power output without appreciably affecting the efficiency, tuning, or modulation characteristics. This tank control, therefore, provides an excellent means of compensating for reasonably wide deviations in output circuit loading and plate supply voltage.

After the plate-tank circuit adjustments have been made and if there is no indication whatever of abnormal operation, the power-change switch (9S7) should be thrown to the "HIGH POWER" position. Observe the value of plate current at the minimum or "dip" position as registered upon meter 1M2. If this current is not in agreement with the value given in the tabulation of "Typical Meter Readings," it may be assumed that the modulated amplifier is loaded incorrectly and that the output coupling circuit requires further adjustment.

The output coupling circuit is another important factor governing the power output and efficiency of the transmitter. In this circuit, the coupling capacitors (1C10, 1C13) are furnished to satisfy a specified line (or load) impedance. Since the reactance of these units controls the loading of the transmitter, it must be calculated for each installation. If the loading is found to be insufficient, as indicated by low plate current, this reactance must be increased (capacitance decreased) to increase the tube load. Obviously, the converse also is true. Small discrepancies in loading may be corrected by shifting taps on the line-terminating inductor (8L1) in the antenna tuning unit.

Tuning of the output coupling circuit to a condition of correct match with the transmission line is accomplished by the series variable inductor (1L8). Since small percentages of mismatch have no effect upon the transmission characteristics, this inductor also may be used to control the loading. This element, however, is much more effective with low load impedances than when high-impedance lines are employed. It has little effect on lines having characteristic impedances greater than 200 ohms and may be removed from the circuit in such cases if desired. The chief value of this inductor is to provide the vernier correction necessary to obtain an exact match to low-impedance lines since that condition cannot be secured with commercially-available steps in capacitance.

A simple check to insure proper line matching may be made by inserting an ammeter in series with each end of the transmission line. The currents indicated by the two meters should both lie within 20% of the value of I_L as derived by the formula:

$$I_L = \sqrt{\frac{W}{Z_0}} \qquad (1)$$

where: I_L = transmission line current (amperes)
W = antenna power (watts)
Z_0 = characteristic impedance of line (ohms)

The antenna power (W) may be calculated from the equation:

$$W = I_a^2 R_a \qquad (2)$$

where: W = antenna power (watts)
I_a = antenna current (amperes)
R_a = antenna resistance (ohms) meas- at the same point as I_a

Upon obtaining a condition of normal plate current in the modulated amplifier at high power, throw switch 9S7 once more to the "LOW POWER" position. Now adjust the series plate resistors (4R7, 4R8, 4R9) until normal plate current for this (low power) condition is attained.

If the r-f pickup coils (1L9, 1L10) do not provide sufficient radio-frequency energy for the test equipment, the number of turns on these coils should be reduced one turn at a time until the coil itself matches the impedance of the transmission line to the test equipment. Resistors 1R1 and 1R2 may be adjusted so that the output level at the test equipment will not vary with a change in power level of the transmitter. Tuned circuits *never* should be attached to the lines from coils 1L9 and 1L10.

Re-install the tank thermocouple (1M4) so that the tank current may be observed on meter 1M3. Remove one of the crystals so that the oscillator may be stopped with the transmitter energized. Upon throwing the "OSCILLATOR" selector switch (120) to the idle position, all grid and tank currents should return to zero. If there is no indication of spurious oscillation, throw the power-change switch (9S7) to "HIGH POWER" and repeat this test.

After all adjustments have been completed satisfactorily, the antenna current indicator (1M5) installed in the exciter should be calibrated against the antenna ammeter (8M1) in the antenna tuning unit. This check should be made at high power, setting the antenna current indicator shunt (7R8) at a position where the readings of both meters are identical. A reading should finally be taken at low power. Recheck this calibration at least once each week.

In conclusion, it should be observed that the power output and efficiency of the transmitter are controlled by many variables. Of these, the most important are filament emission, grid excitation, plate-tank tuning, and adjustment of the output coupling circuit. The two latter items have been discussed fully within this section and require no further clarification.

Filament emission of the RCA-892-R tube is a limiting factor on the output of the modulated amplifier stage. If the filament voltage is abnormally low, the tube will be incapable of full output because of decreased emission. Similarly, the grid excitation must have sufficient amplitude or optimum efficiency and output will not be realized. The grid current should be within the limits specified in the tabulation of "Typical Meter Readings" to insure proper operation.

MODULATION

CIRCUIT ADJUSTMENTS. The modulator stage should be tested initially at one-half normal plate voltage to insure proper phasing of the feedback circuit. To obtain this voltage, switches 4S4 and 4S5 on the filter rack should be maintained in the same respective positions as described for tuning the final r-f amplifier—switch 4S4 closed and switch 4S5 in the neutral setting. At terminal #6W2, remove the lead from terminal #4W5 and connect a jumper from the latter to terminal #4W1. Also, remove the connections to terminals #E21 and #F21 temporarily.

With the power-change switch (9S7) in the "LOW POWER" position, apply power to the modulator-rectifier unit. If everything is satisfactory, replace the connections to terminals #E21 and #F21 and re-apply the power. Observe the modulator plate currents which should remain at zero if the feedback circuit is properly phased. If these currents rise above zero, reverse the connections at terminals #C3 and #C4. The temporary connections on the filter rack may now be removed and full power applied to the entire transmitter.

Adjust the static plate currents of the modulator tubes to a value of approximately 20 ma by means of the variable resistor 2R9. Movement of the slider toward the front of the transmitter will increase the static plate currents.

AUDIO RELAY PANEL. The MI-4309 Audio Relay Panel is a separate assembly which is supplied (on special order) when regular two power (5/1 kw) operation is contemplated. The panel is intended for relay rack mounting. The schematic diagram is shown as a part of the over-all schematic, Figure 13.

To adjust this unit, the following procedure should be observed:

a. Place the "HIGH-LOW" power switch (9S7) in the "HIGH" power position and adjust the line amplifier to provide the proper a-f input for five-kilowatts output.

b. Adjust the "MONITOR" control to provide the desired signal level to the monitor amplifier.

c. Operate the "HIGH-LOW" power switch (9S7) to the "LOW" power position and adjust the "INPUT" control to provide the correct a-f input for one-kilowat output.

When the above-mentioned adjustments have been completed, operation of the "HIGH-LOW" power switch (9S7) will automatically provide the correct a-f input to the transmitter for either **high** or **low** power output and will at the same time maintain the input to the monitor amplifier at a constant level.

CORRECTIVE MEASURES

DISTORTION CONTROL. Careful observance of the following details of operation will insure a satisfactory distortion characteristic:

1. Filament Voltages: The filament voltages of the modulators and final r-f amplifier should be checked frequently and adjusted as necessary. Since increased tube life may be secured by operating at a minimum filament voltage, which must be gradually increased as the tube ages, the minimum value employed is a determining factor on distortion. It is very important that the filaments be operated at a voltage slightly above the minimum value which results in increased distortion.

Further, if the filament voltage is too low (less than approximately 17.5 volts) there may be a tendency for the modulators to motorboat when 100 per cent. tone is applied.

Filament voltages are indicated by meter 7M2 which is controlled by switch 7S7. This meter is connected across the modulator filaments in turn when switch 7S7 is thrown to positions 1 and 2. In position 3, the meter is connected across the final r-f amplifier filament. Adjust the modulators by means of rheostats 7R11 and 7R12, starting with a potential of 18 volts for new tubes. The final amplifier filament voltage likewise is controlled by rheostat 7R10 which should be set for a starting minimum not less than approximately 14.7 volts. Below the proper minimum value, there will be a flattening of the positive peaks of modulation with a consequent increase of distortion.

Before adjusting the individual filament controls (7R10, 7R11, 7R12), it will be necessary to adjust the master rheostat (7R13) for a normal potential of 210 volts on the main rectifier filament transformers (2T7 to 2T12, inclusive). This voltage will be indicated by meter 7M1 upon throwing switch 7S10 to position 4. Under this condition, the secondary of each transformer should furnish 5 volts, which is the proper value of filament potential. If any other value of filament voltage is measured, the primary taps and rheostat 7R13 should be shifted as required.

2. A-F Plate Voltages: All audio tubes must be operated at proper plate voltage for minimum distortion. The values given under "Typical Meter Readings" should be satisfactory although small variations may be necessary to obtain an optimum adjustment.

3. Final R-F Amplifier Grid Excitation: The limits of grid excitation for the modulated amplifier are given in the tabulation of "Typical Meter Readings." Variation of this excitation will afford a fine control of distortion.

4. Final R-F Amplifier Grid Leak: Adjustment of the flexible lead from the grid leak bypass capacitor (1C20) to an optimum position on the bank of grid-leak resistors (1R5 to 1R9, inclusive) can be made only under actual test. The position chosen will determine a balance between low- and high-frequency distortion. In most cases, minimum distortion at both ends of the spectrum will result with approximately two-thirds of the resistance bank included within the bypass circuit. The final position selected may include up to the last tap on resistor 1R9 but never the entire resistor.

5. Final R-F Amplifier Grid Tank Kv-A: In some cases, distortion may be reduced by using a higher value of capacitance in the modulated amplifier grid-tank circuit than that specified in the tabulation included in the foregoing section entitled "Tuning" (see "Power Amplifier, Grid-Tank Circuit"). For example, an improvement may result by substituting capacitor 1C1 for capacitor 1C2, or by using both in parallel.

6. Neutralization: All of the radio-frequency stages must be accurately neutralized and stable in operation if minimum distortion is to be realized. The proper method of neutralizing the respective circuits has been described under "Tuning."

HUM CONTROL. There are three major factors which control the hum level in this transmitter. All of these are associated with the final r-f amplifier stage, as follows:

1. Grid Excitation: The final amplifier excitation must be maintained above the minimum limit (190 ma) specified in the tabulation of "Typical Meter Readings."

2. Filament Balancing: Balancing of the filament circuit is accomplished by adjustment of resistor 1R3. Initially, this resistor should be set as near as possible to the physical center. A final adjustment should be made during test for minimum hum level. If an analyzer is used for this purpose, care should be taken to secure an optimum balance of the 60- and 120-cycle components.

3. Phase Balancing: Proper balance and phase relation of the two filament sections is obtained by adjustment of resistors 7R10, 7R10A and 7R10B. A minimum value of resistance should be used, measuring voltages at the tube proper after each readjustment. The sections will be balanced and 90 degrees apart vectorially when the potential across the two outer legs (small terminals) is 15.5 volts and when the potential from each of these legs to the center is 11 volts. It may be found advisable to alter the phase shift slightly from the normal (90-degree) relation to secure maximum field cancellation for minimum hum.

SUPERVISORY CONSOLE

The supervisory control desk has been designed to permit the utmost in flexibility and convenience of transmitter control. The complete audio switching facilities make it practicable as an emergency program source.

The "FILAMENT ON" switch (9S5) is connected in series with the "FILAMENT ON" switch (305) of the exciter. Both switches must be closed in order to operate the equipment. The transmitter may then be started or stopped at the console by means of switch 9S5. "FILAMENT ON" pilot (9A5) will indicate whether the power is turned on or not.

If the transmitter is not set for automatic operation the main rectifier must be started from the power amplifier panel of the transmitter by depressing the "PLATE ON" switch (9S5), which is of the momentary contact type.

Operation of the "POWER" change switch (9S7) has been described elsewhere. Pilots (9A7) "LOW" and (9A8) "HIGH" indicate the condition of the power change circuits.

The "PLATE" switch (9S8) operates in series with the exciter "PLATE ON" switch (322). Both switches must be closed for operation. Opening (9S8) will remove all plate voltages from both the exciter and power amplifier.

The "OVERLOAD" switch (9S9) is of the momentary contact type. Momentary depression will reset the notching relay (7S18) after it has operated. Operation of (7S18) will illuminate the "OVERLOAD" pilot (9A10). Switch (9S9) should be operated after each overload; otherwise after three overloads (7S18) will lock out and the program will be interrupted.

The audio power switch (9S1) controls the 115-volt a-c supply to the speech rack, making it possible to control the line amplifier and other equipment from the console as desired. Pilot (9A1) operates in conjunction with (9S1).

A "TOWER LIGHTS" switch (9S4) has been incorporated for convenience in controlling the tower lights. If a multi-element antenna array is used it may be desirable to use 9S4 to control a small contactor rather than run the full power for all the towers through the control desk. The installation drawings do not show a conduit from floor channels to the tower for the tower lighting circuit. Conditions vary so widely that it is preferable to locate this run after all station layout plans are available. A convenient point of entrance would be near the conduit run to the monitoring rectifier or any place along channel C-1. (See installation drawings.)

Metering facilities include an "ANTENNA CURRENT" indicator (9M1), which operates in the rectifier carrier circuit in series with the antenna current indicator (1M5) on the Exciter. The "MODULATION" meter (9M2) is designed to operate as an extension meter from the station modulation monitor.

A more detailed description of the supervisory console and its audio-circuit facilities will be found in the supplement (IB-30034a) which is furnished separately.

TYPICAL METER READINGS

	Meter	1 kw	5 kw
Exciter line (volts)	304	115	115
Oscillator E_p (volts)	315	320-340	320-340
Oscillator I_p (ma)	316	15-30	15-30
Buffer Ampl. E_p (volts)		450-480	450-480
Buffer Ampl. I_p (ma)	127	45-55	45-55
Buffer Ampl. E_{sg} (volts)		200-230	200-230
IPA E_p (volts)		700-900	700-900
IPA I_p (ma)	139	75-110	75-110
IPA I_g (ma)	138	30-40	30-40
Exc. PA E_p (volts)	182	1300-1450	1300-1450
Exc. PA I_p (ma total)	155	300-350	350-400
Exc. PA I_g (ma total)	140	100-120	100-120
Final R-F Ampl. E_p—Zero modulation (volts)	2M3	4100	8500
Final R-F Ampl. I_p (ma)	1M2	305*	735*
Final R-F Ampl. I_g (ma)	1M1	190-230	190-230
Final R-F Ampl. I_{tank}—Zero modulation (amperes)	1M3	3.0-4.0	6.0-7.5
Final R-F Ampl. E_f (volts nominal, 2-phase)	7M2 (pos. 3)	15.5	15.5
1st A-F Ampl. E_p (volts measured to ground)		190-200	190-200
1st A-F Ampl. I_p (ma total)	3M1	5-7	5-7
1st A-F Ampl. E_{sg} (volts)		130	130
1st A-F Ampl. E_k (volts cathode to ground)		30	30
2nd A-F Ampl. E_p (volts measured to ground)		300-320	300-320
2nd A-F Ampl. I_p (ma total)	3M2	124-132	124-132
2nd A-F Ampl. E_{sg} (volts)		300-320	300-320
2nd A-F Ampl. E_k (volts cathode to ground)		65	65
Mod. Driver E_p (volts measured to ground)		1450	1450
Mod. Driver I_p (ma total)	3M3	174-192	174-192
Mod. #1 & #2 E_p (volts)		8500	8500
Mod. #1 I_p—Zero modulation (ma)	2M1	10-30	10-30
Mod. #2 I_p—Zero modulation (ma)	2M2	10-30	10-30
Mod. #1 I_p—100% modulation (ma)	2M1	280-320	470-530
Mod. #2 I_p—100% modulation (ma)	2M2	280-320	470-530
Mod. #1 E_f (volts nominal, single-phase)	7M2 (pos. 1)	22	22
Mod. #2 E_f (volts nominal, single-phase)	7M2 (pos. 2)	22	22
Main line (volts, phase a)	7M1 (pos. 1)	230	230
Main line (volts, phase b)	7M1 (pos. 2)	230	230
Main line (volts, phase c)	7M1 (pos. 3)	230	230
Main rect. fil. trans. E_{pri}	7M1 (pos. 4)	210	210

* Indirect Power Measurement only.

MAINTENANCE

In order to avoid program interruptions through failures in the transmitter, a regular schedule of inspection should be maintained.

It is important that the transmitter be kept clean and that all connections be checked periodically for tightness.

The air circulating through the two main units is filtered but it will be necessary to replace the filter units at regular intervals in order that the air supply will not be decreased. In most installations, replacements should not be required more frequently than every three months. These filters carry the trade-name "Dustop" (15 x 20 x 2, bulletin No. 200) and are manufactured by the Owens-Illinois Glass Company, Industrial Materials Division, Newark, Ohio. Ordinarily, they may be secured locally.

The blower motors should be oiled at regular intervals and checked at least once every month. The impeller blades should be cleaned thoroughly at such times.

All relay contacts require servicing and should be included in the routine inspection schedule. This applies also to all coil connections and to the blades and jaws of all switches.

A regular check should be made of all tubes in the transmitter. Tubes should be replaced upon any indication of a decrease in filament emission. Spare rectifier tubes should be given a minimum of 30 minutes heat run before being placed on the shelf. The tubes should be kept in an upright position and care taken to avoid splashing the mercury onto the cathode. If a tube has been shaken or tipped, it should be reheated before being placed in service. A regular inspection of tube prongs and socket contacts is necessary if failure is to be avoided. The handle assembly on the RCA-891-R and RCA-892-R may be moved to any desired position relative to the grid and filament leads of the tube by loosening the three screws on the chrome-plated clamp band.

Each tube should be inspected and tested immediately upon receipt to make certain that it has suffered no damage in shipment. The filament connectors on the air-cooled tubes should be tightened regularly so that heating may not occur at this point with possible damage to the seals. Before installing a tube, note whether any foreign material has fallen into the stem opening and lodged between the filament leads. The filament leads operate at a fairly high temperature so that any foreign material may become charred and cause a puncture of the insulation. Use of the tube hour-meter (7M3) makes it a simple matter to keep an accurate record of tube life.

The spacings of the sphere gaps on the main filter reactor, modulation transformer and modulation reactor should be checked periodically for conformance to the recommended settings given under "Installation." All spheres should be cleaned and polished as often as necessary. Should it become necesary to operate without the modulation reactor (6X1), the direct current for the modulated amplifier may run directly through the secondary of the modulation transformer (6T1). The only effect will be a slight increase in distortion.

ROUTINE MAINTENANCE SCHEDULE

Daily

1. General Inspection after shut-down.
2. Hourly check of power tube filament voltages.
3. Inspect antenna transmission line terminating equipment if there has been heavy static discharges or lightning during the day.
4. If there has been any overloads during the day. Examine all safety gaps for burning. Clean and reset if necessary.

Weekly

1. Inspect interior of low power audio unit.
2. Inspect all auxiliary relays.
3. Clean internal parts of transmitter, insulators.
4. General performance checkup (noise, distortion and frequent characteristic).
5. Inspect blowers.
6. Test air-flow interlocks.
7. Test all door interlocks.
8. Examine contacts on grounding switches (filter rack).
9. Check antenna monitor rectifier tubes.
10. Test operation of notching relay.
11. Clean antenna tuning apparatus.
12. Check all sphere and needle gaps.
13. Test calibration of remote antenna ammeter against direct antenna ammeter.

Monthly

1. Clean RCA-872-A tube contacts.
2. Check oil in blowers.
3. Clean all socket contacts.

4. Clean console attenuator contacts.
5. Service high speed relay contacts (PAC and PCV relays).
6. Check air filters.
7. Test all spare power tubes in circuit and clean up gassy tubes if any.
8. Operate all spare mercury vapor tubes for 30 minutes—filament only.

Quarterly

1. General detailed close inspection of every unit in transmitter, with whatever tests of parts seem advisable.
2. Service all contactors.

Semi-Annually

1. Replace air filters.
2. Test transformer oil and filter if necessary.
3. Clean transmission line insulators. Inspect all control contacts and make replacements where required. Clean pole faces on contactors.
4. Test spare tubes and clean up gas if necessary.
5. Tighten all connections in transmitter.

PARTS LIST

Replacement parts should be ordered from the Transmitter Section, Service Division, RCA Manufacturing Company, Inc., Camden, New Jersey, U. S. A. In order to expedite service, the information found in this parts list should be given in its entirety. If there is any question of detail, give a full description of each part required and specify the type number of the transmitter.

In cases where parts can be secured more easily locally or through the manufacturer than through the RCA Service Division, stock numbers have not been shown but the manufacturer's type and/or style numbers are indicated. Such replacement parts should be ordered directly from the manufacturer giving complete nameplate details and the style numbers shown in this data.

Where frequency determining parts are involved, the term "see chart in text" has been employed instead of a stock number as the ratings of such parts vary with each installation. Necessary data will be found on the nameplate.

A complete set of spare parts, stamped with the circuit item number and stocked at the station so that these parts may be readily identified, will prove a great asset when emergency service becomes necessary.

EXCITER (MI-7241)

Item No.	Description	Stock No.
	RADIO-FREQUENCY EQUIPMENT	
01	Resistor, 180,000 ohms, 1 w	12356
02	Socket, Crystal Holder	16889
03	Capacitor, Variable Frequency Control	16890
04	Tube Socket, Osc., 7-contact	16593
05	Capacitor, 15 mmfd, 5000 v	F-152
06	Resistor, 10,000 ohms, 1 w	13097
07	Resistor, 5600 ohms, 2 w	8097
08-010	Capacitor, 0.02 mfd, 700 v	F-20004
011	Coil Assembly, Osc. Plate	16891
012	Choke, Osc. Plate	16892
013	Capacitor, 200 mfd, 5000 v	F-203
014	Resistor, 9000 ohms, 10 w	16893
015, 016	Resistor, 20,500 ohms, 20 w	16894
017	Resistor, 4400 ohms, 10 w	16895
018	Capacitor, Same as 08	
019	Resistor, 220 ohms, 1 w	30496
020	Capacitor, Same as 08	
021	Crystal Holder, Type TMV-129-B, Dwg. P-708820-501	
022	Capacitor, 0.0025 mfd, 5000 v	F-2504
023-118	Omitted	
119	Lamp, Heater Indicator	16391
119A	Lens, Green, Westinghouse Style 822266	43112
119B	Socket Assembly, Westinghouse Style 822322	43111
120	Switch, Crystal Selector	17022
121	Choke, Buffer Grid, Same as 012	
122	Capacitor, Same as 08	
123	Resistor, 22,000 ohms, 2 w	13669
124	Capacitor, Same as 08	
125	Resistor, 270 ohms, 2 w	13219
126	Capacitor, 0.02 mfd, 700 v	BF-20004
127	Milliammeter, 0-100 ma d.c.	17023
128	Tube Socket, Buffer, Same as 04	
129	Capacitor, Variable, Buffer Tank	17024
130	Capacitor, Same as 08	
131	Choke, Buffer Plate	16917
132	Coil, Buffer Tank	17025
133	Capacitor, 0.001 mfd, 5000 v	F-1004
134	Choke, IPA Grid, Same as 012	
135	Capacitor, Same as 08	
136	Resistor, 2500 ohms	17026
137	Capacitor, Same as 126	
138	Milliammeter, Same as 127	
139, 140	Milliammeter, 0-200 ma	17027
141	Capacitor, Variable, IPA Neutralizing	17028
142	Tube Socket, IPA, 4-contact	MI-7437A
143	Capacitor, Same as 08	
144	Capacitor, Variable, IPA Tank	17029
145	Coil, IPA Tank	17030
146	Capacitor, 0.01 mfd	UC-3004
147	Capacitor, Same as 08	
148	Choke, IPA Plate, Same as 131	
149	Capacitor, 0.0001 mfd	UC-3126A
150	Capacitor, 0.01 mfd, 2000 v (test)	F-10004
151	Resistor, 3500 ohms	17031
152	Resistor, 325 ohms (tapped at 25 ohms)	17032
153	Capacitor, 50 mfd	16449
154	Transformer, Audio Monitor, XT-2083-A	17033
155	Milliammeter, 0-500 ma d.c.	17034
156	Capacitor, Same as 126	
157	Capacitor, 0.001 mfd	UC-3070
158	Choke, PA Grid, Same as 012	
159	Capacitor, Variable, PA Neutralizing	17035
160	Tube Socket, PA, Same as 142	
161	Capacitor, Same as 150	
162	Capacitor, PA Tank, 150 mmfd	UC-3121
163	Capacitor, PA Tank, 200 mmfd, 5000 v	UC-3115
164	Capacitor, Variable, PA Tank	17036
165	Coil Assembly, PA Tank and Coupling	17037
166	Choke, PA Plate, Same as 131	
167-180	Not required	
181	Capacitor, Same as 126	

Item No.	Description	Stock No.
182	Voltmeter, 0-2 kv, 1000 ohms/volt	17044
183	Capacitor, 400 mmfd	UC-3103
184	Capacitor, 100 mmfd, 15,000 v	UC-3127A
185-199	Omitted	
	AUDIO-FREQUENCY EQUIPMENT	
200, 201	Omitted	
202-223	Not required	
224	Capacitor, 5 mfd, 1500 v	16234
225-229	Not required	
230	Reactor, Filter, XT-2282	16928
231-241	Not required	
242-299	Omitted	
	POWER EQUIPMENT	
300	Omitted	
301	Switch, Main Overload, 2-pole, 35 a	17724
302	Auto-Transformer, XT-1212	15537
303	Tap Switch, Line Voltage	17063
	Blades and Block	43593
	Resistance Ribbon	43594
	Phospher Bronze Jumper	43595
304	Voltmeter, 0-150 v a.c.	17064
305	Switch, Filament, SPST	17241
306	Contactor, Filament, 3-pole, 25 a	17066
	Contacts only	17532
307	Switch, Filament Overload, 2-pole, 10 a	17067
308	Lamp, Filament Indicator, Same as 119	
308A	Lens, Ivory, Westinghouse Style 822267	44290
308B	Socket Assembly, Same as 119B	
309	Relay, Time-Delay, Adjustable from 15 to 30 seconds	17068
310	Switch, DPST	17069
311	Transformer, Plate, XT-2315	17070
312	Tube Socket, Osc. Rect., 4-contact	16906
313	Reactor, XT-536A	17071
314	Capacitor, 5 mfd, 600 v	17047
315	Voltmeter, 0-500 v d.c., 1000 ohms/volt	17073
316	Milliammeter, 0-50 ma	17074
317	Capacitor, Same as 126	
318	Transformer, Filament, XT-2284	17075
319	Transformer, Filament, XT-2465	17076
320	Not required	
321	Transformer, Filament, XT-2280	16920
322	Switch, Plate, Same as 305	
323	Contactor, Plate, Same as 306	
324	Switch, Plate Overload, 2-pole, 30 a	
325	Lamp, Plate Indicator, Same as 119	17062
325A	Lens, Red, Westinghouse Style 822265	16839
325B	Socket Assembly, Same as 119B	
326	Transformer, Plate, XT-2266	16922
327	Tube Socket, H-V Rect., 4-contact	MI-7438A
328	Resistor, 50 ohms (tapped at 25 ohms)	17081
329	Reactor, Filter, XT-2023A	16924
330	Capacitor, 2 mfd, 1500 v	16179
331	Reactor, XT-1785-24	17083
332	Capacitor, 10 mfd, 1500 v	16672
333	Relay, Overload, Coil to operate at 0.75 to 1.55 a d.c.	17084
334	Resistor, 250 ohms (tapped at 100, 130, 160, 190 and 220 ohms)	17085
335	Resistor, 650 ohms (tapped at 250, 350, 450 and 550 ohms)	17086
336	Resistor, 4100 ohms (tapped at 400, 600, 800, 1000, 1200, 2600, 2900, 3200, 3500 and 3800 ohms)	17087
337	Resistor, 75,000 ohms, carbon type	17088
338	Transformer, Plate, XT-2285	17089
339	Tube Socket, L-V Rect., Same as 327	
340	Reactor, Filter, RT-471	17090
341	Capacitor, Filter, 10 mfd, 1000 v	16180
342	Potentiometer, 160 ohms, 30 w	17091
343	Resistor, 840 ohms (tapped at 800, 760, 700, 660, 620, 580, 540, 500 and 460 ohms)	17092
344	Resistor, 2860 ohms (tapped at 70, 250, 300, 1250 and 1450 ohms)	17093
345	Relay, Overload, Coil to operate at 0.5 to 1.1 a d.c.	17094
346	Resistor, 1800 ohms (tapped at 1600, 1400, 1200, 1000, 900, 800, 700, 600 and 500 ohms)	17095
347	Resistor, 130 ohms	17096
348	Capacitor, 0.01 mfd	UC-3202
349	Relay, Power Change, DPST, 115 v, 60 cy.	17043
350	Switch, DPDT	17098
351	Switch, Door Interlock	23552
352	Capacitor, 20 mfd, 330 v a.c.	17285
353, 354	Omitted	
355	Fuse, Cartridge type, 1 a	17102
355A	Fuse Block	17103

POWER AMPLIFIER (MI-7202A)

Item No.	Description	Stock No.	Item No.	Description	Stock No.
1A1	Blower, Counterclockwise, up-blast discharge, American Blower Co., Size No. 1½, Dwg. H-39890. Motor only	17228	1L3	Choke, R F	17229
	Boot, Blower, Canvas	18217	1L4	Coil, Parasitic Suppressor.	17230
1A2	Safety Gap, Grid		1L5	Omitted	
1A3-1A6	Lamp, Same as 119, 119A Socket Assembly West. Style 822321		1L6	Inductor, Plate Tank	17231
1C1	Capacitor, 400 mmfd	UC-3105	1L7, 1L8	Inductor, Variable	17232
1C2	Capacitor, 300 mmfd	UC-3111	1L9, 1L10	Coil, R-F Pickup	19337
1C3	Capacitor, 0.02 mfd	UC-2996	1M1	Milliammeter, 0-500 ma d.c., calibrated for mounting on steel plate	17233
1C4, 1C5	Capacitor, dual unit, 0.05/0.05 mfd	UC-3145	1M2	Ammeter, 0-1.5 a	17234
1C6	Capacitor, 300 mmfd	UC-3113A	1M3	Ammeter, 0-10 a r.f.	17235
1C7	Capacitor, 28 mmfd	UC-3220	1M4	Thermocouple, furnished with 1M3	
1C8, 1C9	Capacitor, Tuning (see chart in text)		1M5	Indicator, Antenna Current	17441
1C10	Capacitor, Antenna Coupling (see chart in text)		1R1, 1R2	Resistor, 800 ohms	17995
1C11, 1C12	Capacitor, Same as 1C8 (see chart in text)		1R3	Resistor, 50 ohms	17238
1C13	Capacitor, Same as 1C10 (see chart in text)		1R4	Omitted	
1C14-1C18	Omitted		1R5-1R9	Resistor, 700 ohms	17240
1C19	Capacitor, 200 mmfd	UC-3118	1S1	Relay, Power Change, for r-f pickup coils; Leach Type 1357 with Mycalex base; DPDT, 220 v, 60 cy.	
1C20	Capacitor, 10 mfd	16195	1S2	Switch, Air Interlock, mercury type	17219
1C21-1C23	Capacitor, Same as 150		1S3-1S6	Switch, Door Interlock	23552
1C24, 1C25	Capacitor, 200 mmfd	UC-3117	157, 158	Omitted	
1L1	Inductor, Grid Tank	17038	1S9	Switch, Rectifier Start	17221
1L2	Omitted		1S10	Switch, Filament "ON"	17241
			1T1, 1T2	Transformer, Filament, XT-2145	16402
			1V1	Tube Socket, PA	17239

MODULATOR-RECTIFIER (MI-7203A)

Item No.	Description	Stock No.	Item No.	Description	Stock No.
2A1	Same as 1A1		2R11	Resistor, 16,000 ohms	17216
2A2	Blower, Clockwise, otherwise same as 1A1		2R12	Resistor, 100 ohms	17217
	Boot, Blower, Canvas	18217	2R13	Omitted	
2A3-2A8	Indicator, Arc Back	17207	2R14	Resistor, Same as 2R12	
2A9-2A12	Lamp, Same as 325, 325A Socket Assembly West. Style 822321		*2R16-2R35	Resistor, 2.2 megohms	18006
2C1, 2C2	Capacitor, 2 mfd, 2500 v d.c.	19216	*2R36, 2R37	Resistor, 56,000 ohms	17440
2C3, 2C4	Capacitor, 0.01 mfd	BF-10004	2S1, 2S2	Switch, Same as 1S2	
2C5	Capacitor, Same as 332		2S3-2S6	Switch, Same as 1S3	
2C6	Omitted		2S9	Relay, Westinghouse Type SG-837275	
2C7	Capacitor, 4 mfd	17150	2S10	Switch, Manual-Automatic	17220
2C8	Capacitor, Same as 2C3		2S11	Switch, Rectifier "OFF," Same as 1S9	
2C9, 2C10	Capacitor, 0.002 mfd	F-2003	2T1-2T4	Transformer, Modulator Filament, XT-2145	16402
*2C11-2C30	Capacitor, 0.004 mfd	F-4003	2T5	Transformer, Bias Rectifier Plate, XT-2496	17222
*2C31	Capacitor, 0.1 mfd	UC-3263	2T6	Transformer, Bias Rectifier Filament, XT-2504	17223
2C32	Omitted		2T7-2T12	Transformer, Main Rectifier Filament, XT-1511-A	17224
*2C33	Capacitor, Same as 2C31		2T13	Transformer, Interstage, XT-2605	17225
2M1, 8M2	Ammeter, 0-2 a	17210	2V1, 2V2	Tube Socket, Modulator, Same as 1V1	
2M3	Voltmeter, 0-12 kv, complete with multiplier (4R10)	17211	2V3, 2V4	Tube Socket, Bias Rect., UR-542	MI-7438A
2R1-2R4	Omitted		2V5-2V10	Tube Socket, Main Rect., UT-541-A	MI-7437A
2R5, 2R6	Resistor, 100 ohms	17212	2X1	Reactor, XT-25-A	17227
2R7	Resistor, 6400 ohms	17213			
2R8	Resistor, 560 ohms	17214			
2R9	Resistor, 5000 ohms	17215			
2R10	Resistor, Same as 2R8				

* Included in feedback voltage divider assembly. Stock No. 17258.

LOW-POWER AUDIO AMPLIFIER (MI-7202A)

Item No.	Description	Stock No.	Item No.	Description	Stock No.
3C1, 3C2	Capacitor, Same as 013		3R12	Resistor, 4700 ohms	11768
3C3, 3C4	Capacitor, 1 mfd	11897	3R13	Resistor, 1000 ohms	17249
3C5	Capacitor, 8 mfd	17243	3R14, 3R15	Resistor, 390,000 ohms	28743
3C6	Capacitor, 0.008 mfd	F-80003	3R16, 3R17	Resistor, 500 ohms	3383
3C7	Capacitor, Same as 3C5		3R18	Resistor, 100,000 ohms	3058
3C8	Capacitor, Same as 3C6		3R19	Resistor, 500 ohms	17251
3C9, 3C10	Capacitor, 0.05 mfd	AF-50003	3R20	Resistor, 8500 ohms	17442
3C11	Omitted		3R21	Resistor, 6400 ohms	17443
3C12	Capacitor, Same as 3C3		3R22, 3R23	Resistor, 5000 ohms	17252
3C13-3C16	Capacitor, Same as 3C5		3R24, 3R25	Resistor, 47,000 ohms	11766
3C17, 3C18	Capacitor, 0.0015 mfd	F-1503	3R26-3R29	Resistor, 68 ohms	17253
3C19, 3C20	Capacitor, Same as 3C9		3R30, 3R31	Resistor, 2500 ohms	17254
3M1	Milliammeter, 0-25 ma d.c.	17244	3R32, 3R33	Resistor, 2200 ohms	17255
3M2	Milliammeter, 0-200 ma d.c.	17245	3R34, 3R35	Resistor, 47,000 ohms	13481
3M3	Milliammeter, 0-300 ma d.c.	17246	3T1	Transformer, Input, XT-2615	17256
3R1, 3R2	Resistor, 24,000 ohms	17247	3T2	Transformer, Filament, XT-2602	17257
3R3, 3R4	Resistor, 100 ohms	34765	3V1, 3V2	Tube Socket, 1st A-F 6-contact	8012
3R5	Resistor, 4700 ohms	17248	3V3, 3V4	Tube Socket, 2nd A-F, 5-contact	17051
3R6	Resistor, 47,000 ohms	17445	3V5-3V8	Tube Socket, Driver, Same as 2V5	
3R7	Resistor, 22,000 ohms	17446			
3R8, 3R9	Resistor, 10,000 ohms	8043			
3R10, 3R11	Resistor, 1 megohm	2546			

FILTER RACK (MI-7204)

Item No.	Description	Stock No.	Item No.	Description	Stock No.
4C1-4C3	Capacitor, 3 mfd	17200	4S3	Switch, Resistor Shorting, Monitor Controller Co., Type SP-708; 220-v, 60-cy. operation, DPST	
4C4, 4C5	Capacitor, 4 mfd	17201		Coil only	17534
4R1, 4R2	Resistor, 50 ohms	17202		Contacts only	17540
4R3, 4R4	Omitted		4S4, 4S5	Switch, Disconnect, Trumbull No. 9048, Cat. No. 15 (less handle), 60 a	
4R5, 4R6	Resistor, 10,000 ohms	17203	4S6, 4S7	Jaw, Grounding, for switches 4S4 and 4S5, resp.	
4R7-4R9	Resistor, 500 ohms	17204	4X1	Reactor, Filter, XT-2228	17206
4R10	Voltmeter Multiplier, 12.0 kv (furnished with meter 2M3)		4X2	Reactor, Filter, XT-1512	16407
4S1	Switch, Automatic Capacitor Grounding	16689			
4S2	Relay, Power Change, Monitor Controller Co. (Baltimore, Md.), Type SP-836, 20,000-volt trip-locked, high - tension switch, 220 v, 60 cy. operation, SPDT				
	Contacts only	17533			

H-V TRANSFORMER (MI-7206-1)

Item No.	Description	Stock No.	Item No.	Description	Stock No.
5T1	Transformer, Main Rect. Plate	MI-7206-5			

MODULATION TRANSFORMER (MI-7206-5) AND REACTOR (MI-7206-6)

Item No.	Description	Stock No.	Item No.	Description	Stock No.
6C1	Capacitor, 3 mfd	17259	6T1	Transformer, Modulation, XT-2354	17262
6C2, 6C3	Capacitor, 0.002 mfd	UC-2366	6X1	Reactor, Modulation, XT-2402	17263
6R1, 6R2	Resistor, 10,000 ohms	17203			
6R3	Resistor, 9000 ohms	17261	6X2	Reactor, XT-2664	17264

POWER CONTROL PANEL (MI-7205)

Item No.	Description	Stock No.
7A1	Lamp, A-C Line "ON," Same as 2A9	
7A2	Lamp, Control Circuit "ON," Same as 2A9 ...	
7A3	Lamp, Rectifier A-C Line "ON," Same as 1A3 ..	
7A4	Lamp, "HIGH POWER," Same as 2A9	
7A5	Lamp, "LOW POWER," Same as 1A3	
7F1-7F4	Fuse, Instrument, 6 a, renewable	
7F5, 7F6	Fuse, External Signal Light Circuit, 30 a, renewable	
7M1	Voltmeter, 0-300 v. 60 cy.	17197
7M2	Voltmeter, 0-30 v, 60 cy..	17198
7M3	Meter, Tube Hour, 220 v, 60 cy.	17199
7R1-7R6	Omitted	
7R7	Resistor, Relay 7S8 Coil Shunting, 500 ohms	
7R8	Resistor, 3 ohms	17998
7R9	Omitted	
7R10, 7R10A, 7R10B	Rheostat, 12.5 ohms, 500 w	18218
7R11, 7R12	Rheostat, 8 ohms, 500 w, Ohmite Model "R," Stock No. 0856, Dwg. A-1817	
7R13	Rheostat, 2.5 ohms, Westinghouse Type WL, 13" plate, Style 874750	
7R13B	Rheostat, 25 ohms, Westinghouse Type WL, 13" plate, Style 874756	
7R14, 7R14A, 7R14B	Resistor, 3.6 ohms, Westinghouse Type M, Style 833778	
7R15, 7R15A, 7R15B	Resistor, 10 ohms	17196
7R16	Resistor, 3.84 ohms	17517
7R17	Resistor, 14.3 ohms	17518
7S1	Circuit Breaker, Main Line, Westinghouse Style 545349	
7S2	Circuit Breaker, Control Circuit, Westinghouse Style 545333	
7S3	Switch, Main Filament, Westinghouse Style 545345	
7S4, 7S5	Circuit Breaker, Same as 7S2	
7S6	Switch, PA & Modulator Tube Filament, Westinghouse Style 545346..	
7S7	Switch, Voltmeter, Westinghouse Type W, Style 519115	
7S8	Relay, Westinghouse Type SG, panel mtg., similar to Style 1008541 except with 3660-ohm coil (Style 837269)	
7S10	Switch, Voltmeter, Same as 7S7	
7S11, 7S12	Omitted	
7S13	Contactor, Westinghouse, comprising:	
	Type DN-120, Style 968145	
	Type DN-140, Style 968147	
	Contacts only	17538
	Coil only	18219
7S14	Contactor, Westinghouse Type DN-140, Style 968147	
7S15	Contactor, Same as 7S13	
7S16, 7S16A	Contactor, Same as 7S14	
7S17	Contactor, Main Rectifier. Westinghouse Type DN-330, con. WBO, Style 897455	
	Main contacts only ...	17539
	Coil only	18221
	Interlock, Westinghouse Type L41 "Make," Style 897837	
	Interlock, Westinghouse Type L41 "Break," Style 897842	
	Interlock Adapter, Westinghouse Style 884640 ..	
	Relay, Time Delay, Westinghouse Type KU-11, Style 844212	
7S18	Relay, Notching	15774
7S19, 7S20	Relay, G.E. Type PCV-12B2	
7S21	Relay, G.E. Type CR2820-1099, Form AJ, 230 v, 60 cy., 1-17 minutes	
7S22	Relay, G.E. Type PAC-12A21	
7S23	Relay, G.E. Type PAC-12A1	
	Coil only	18220
7S24	Relay, G.E. Type PAA-12A19	
7S25, 7S26	Relay, G.E. Type PAC-12A18	
	Coil only	18222
7S27	Relay, Westinghouse Type SG, panel mtg., 110 v, 60 cy., Style 1008539...	
7S28	Circuit Breaker, Westinghouse Type AB, Style 545337	
7S29	Circuit Breaker, Same as 7S1	
7S30	Switch, Power Change, tumbler type, Bryant Cat. 3981, Back Connected, 250 v, 5 a, SPDT	
7T1, 7T2	Transformer, Current, Westinghouse Type KO, Style 651913	

RELAY PANEL (MI-4309)

Item No.	Description	Stock No.
	Relay Panel, Black	MI-4309A
	Relay Panel, Grey	MI-4309B
	Pad, 500/500-ohm ladder .	43698
	Knob, Ladder Pad	17269
	Pad, Input, 4-db fixed H..	44140
	Pad, Monitor, 24-db fixed H	18762
	Relay, Monitor Input	43699

41-2-1

16391

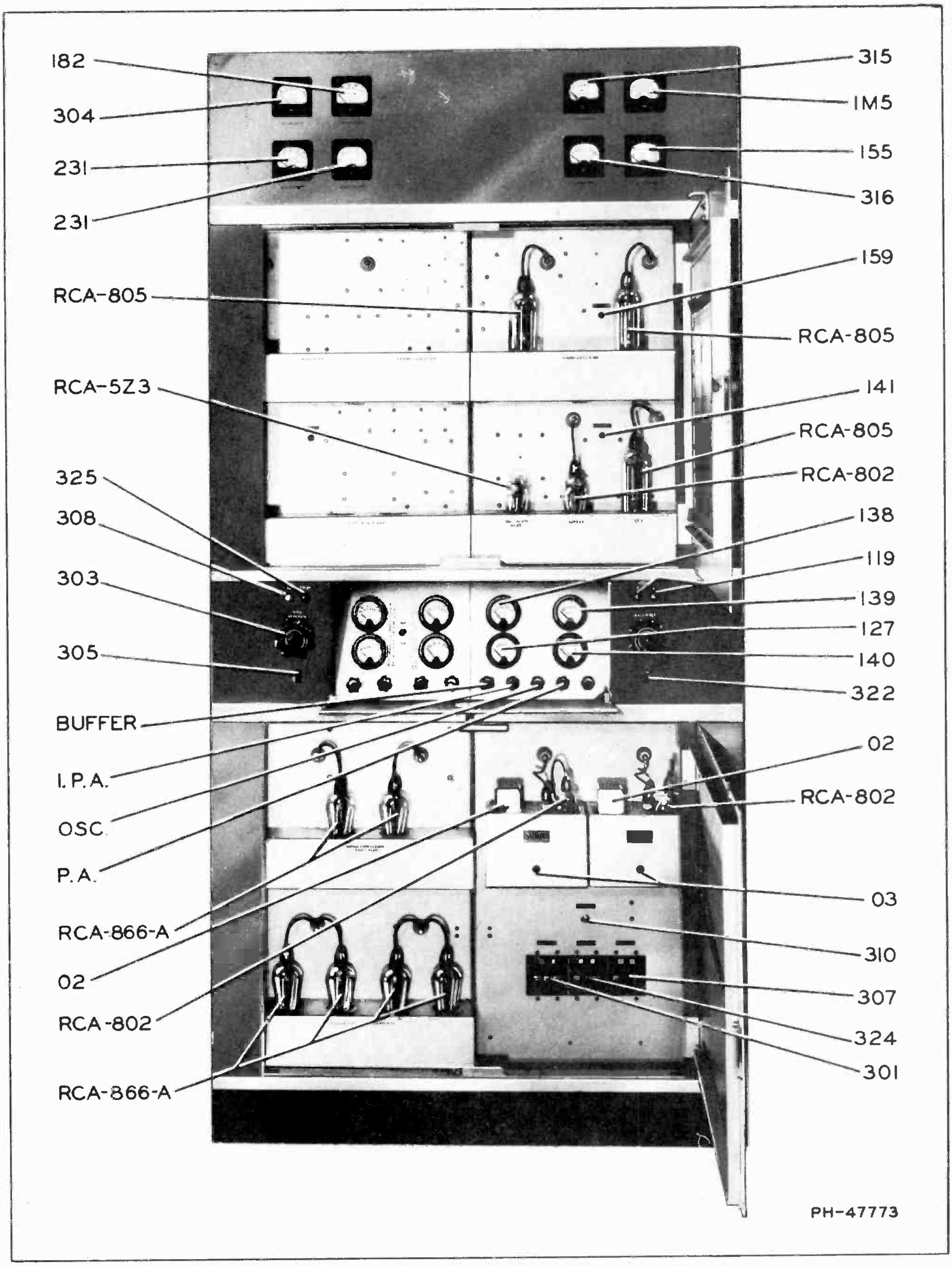


Figure 2—Type 250-F Exciter, front view, doors open

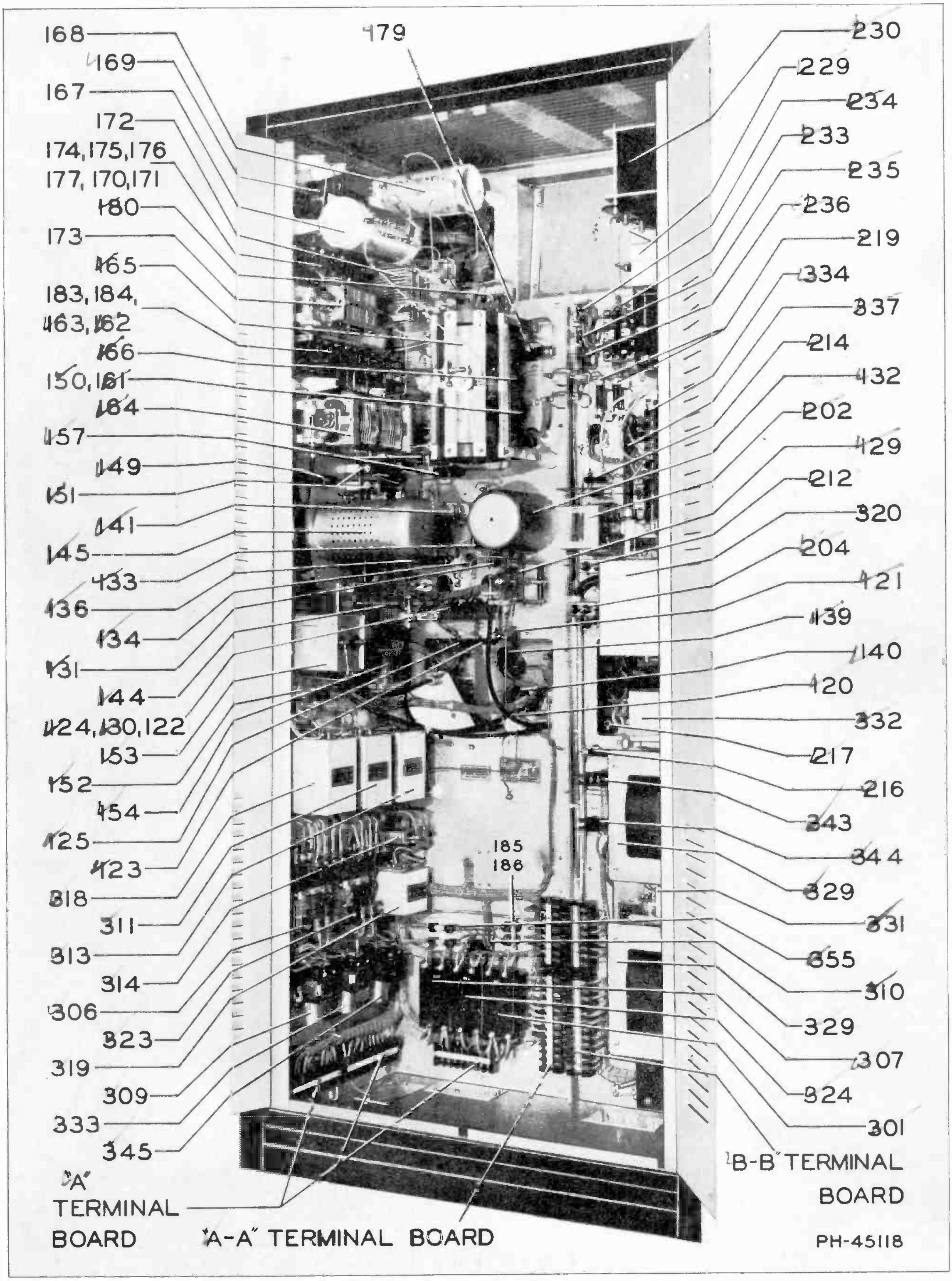


Figure 3—Type 250-F Exciter, rear view showing r-f chassis

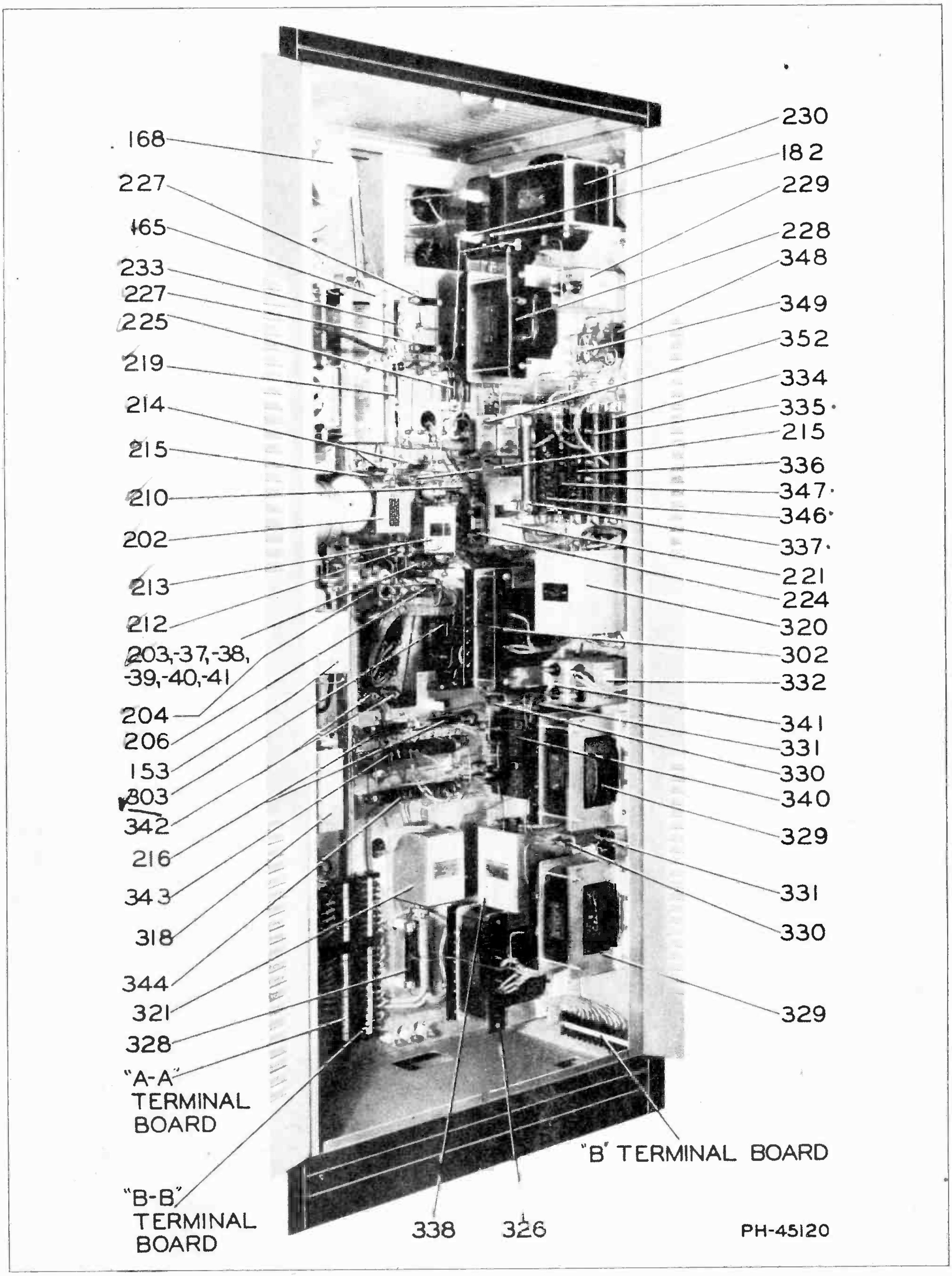


Figure 4—Type 250-F Exciter, rear view showing a-f chassis

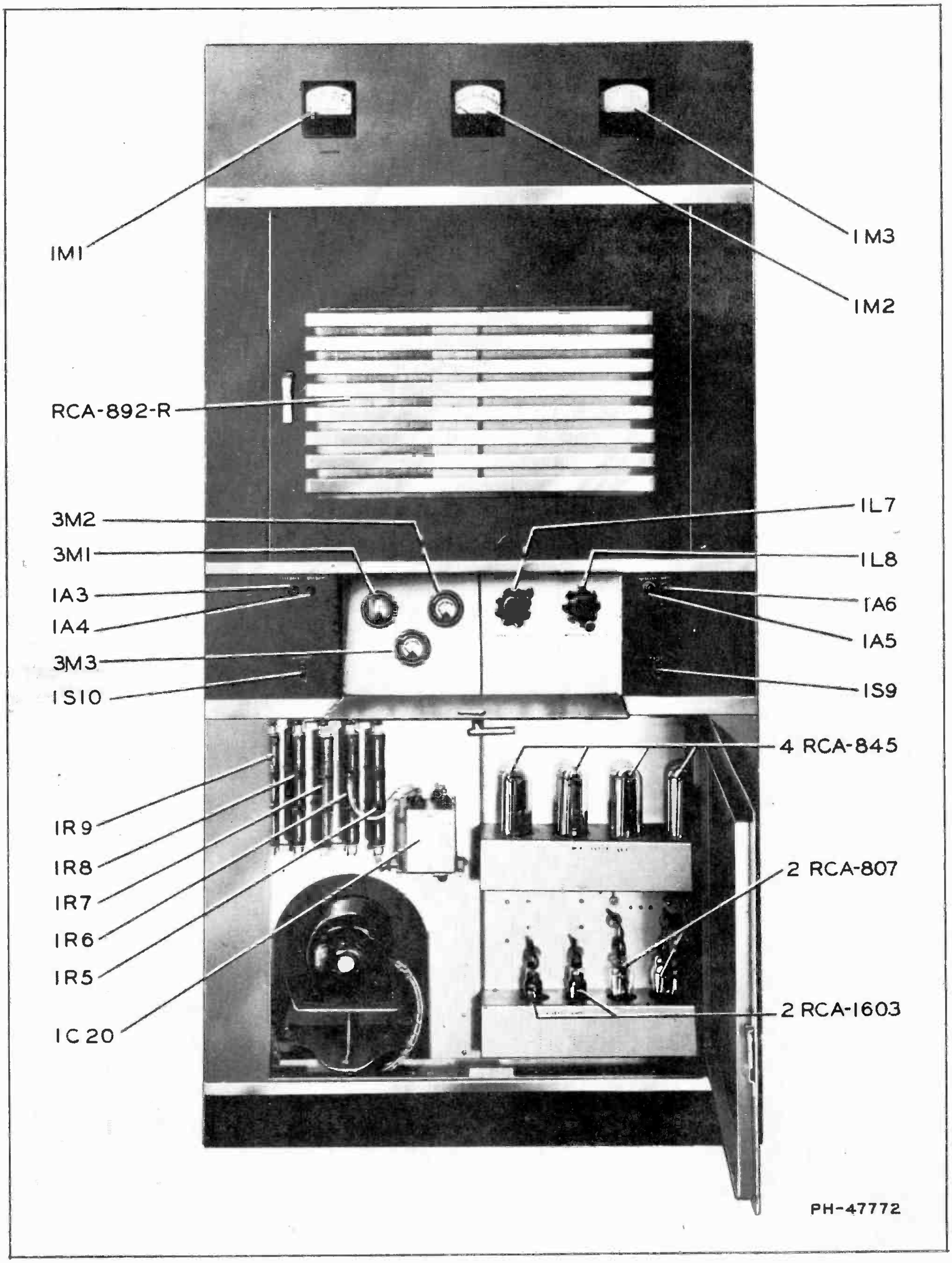


Figure 5—Power Amplifier, front view, doors open

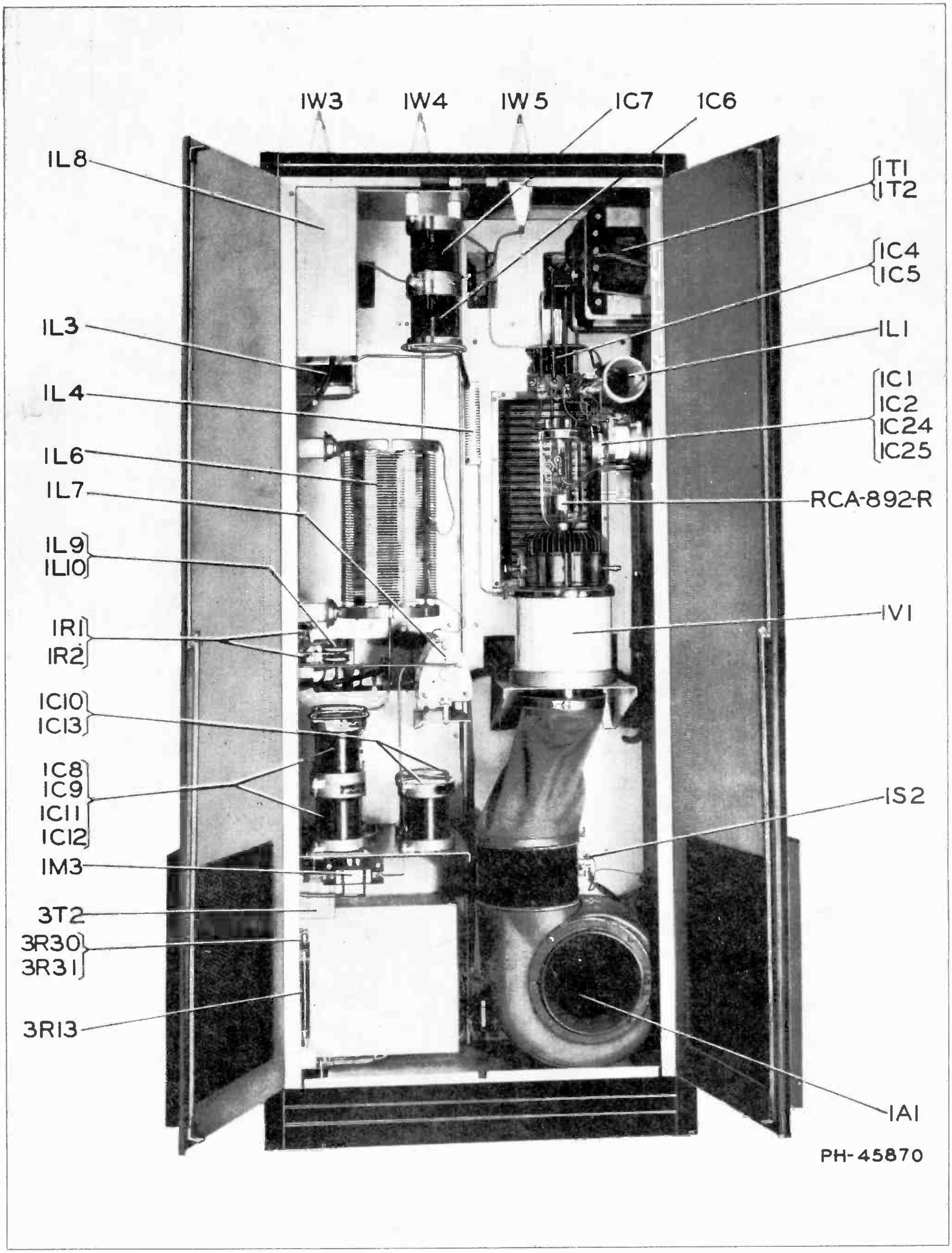


Figure 6—Power Amplifier, rear view, doors open

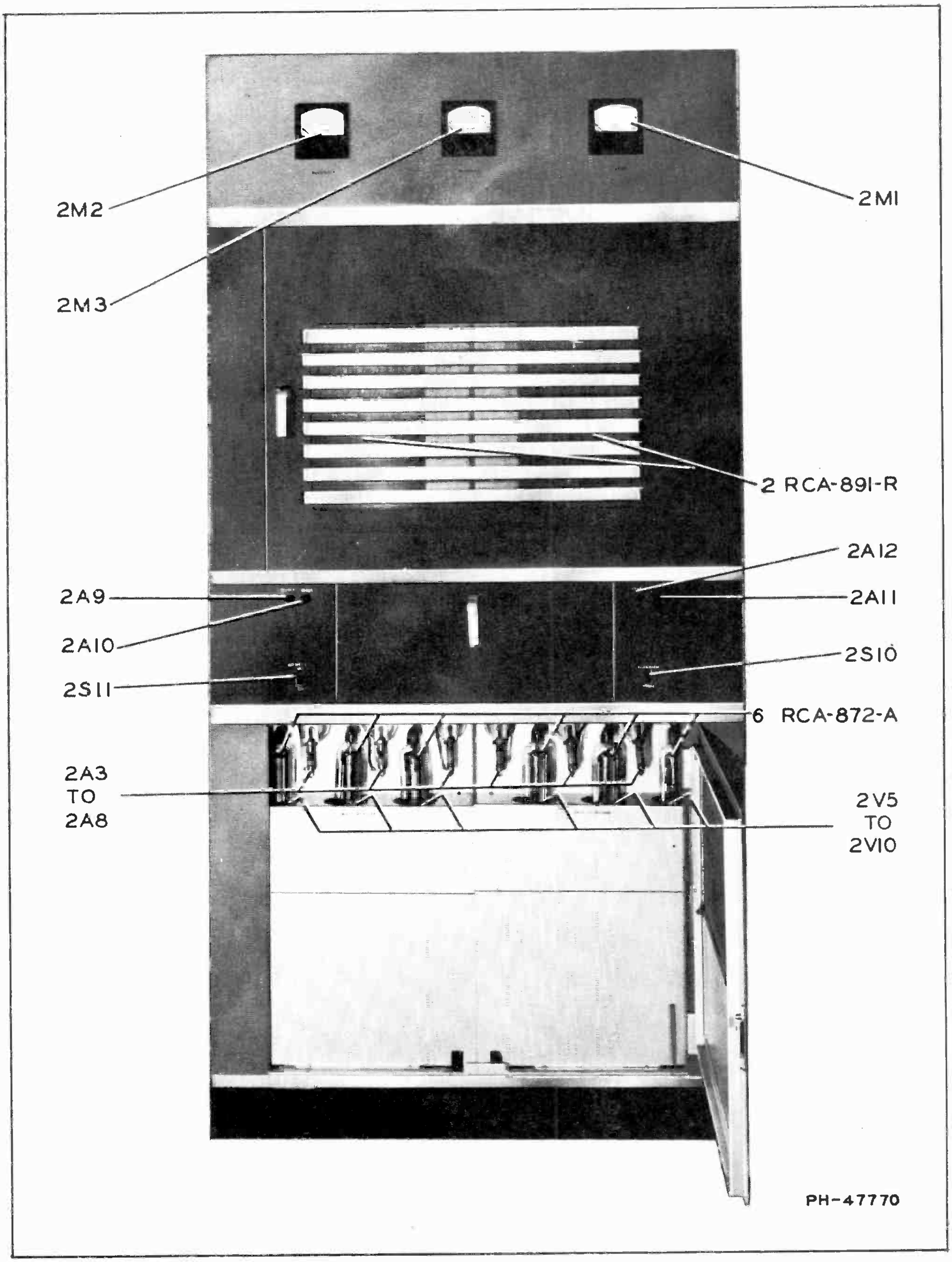


Figure 7—Modulator-Rectifier, front view, door open

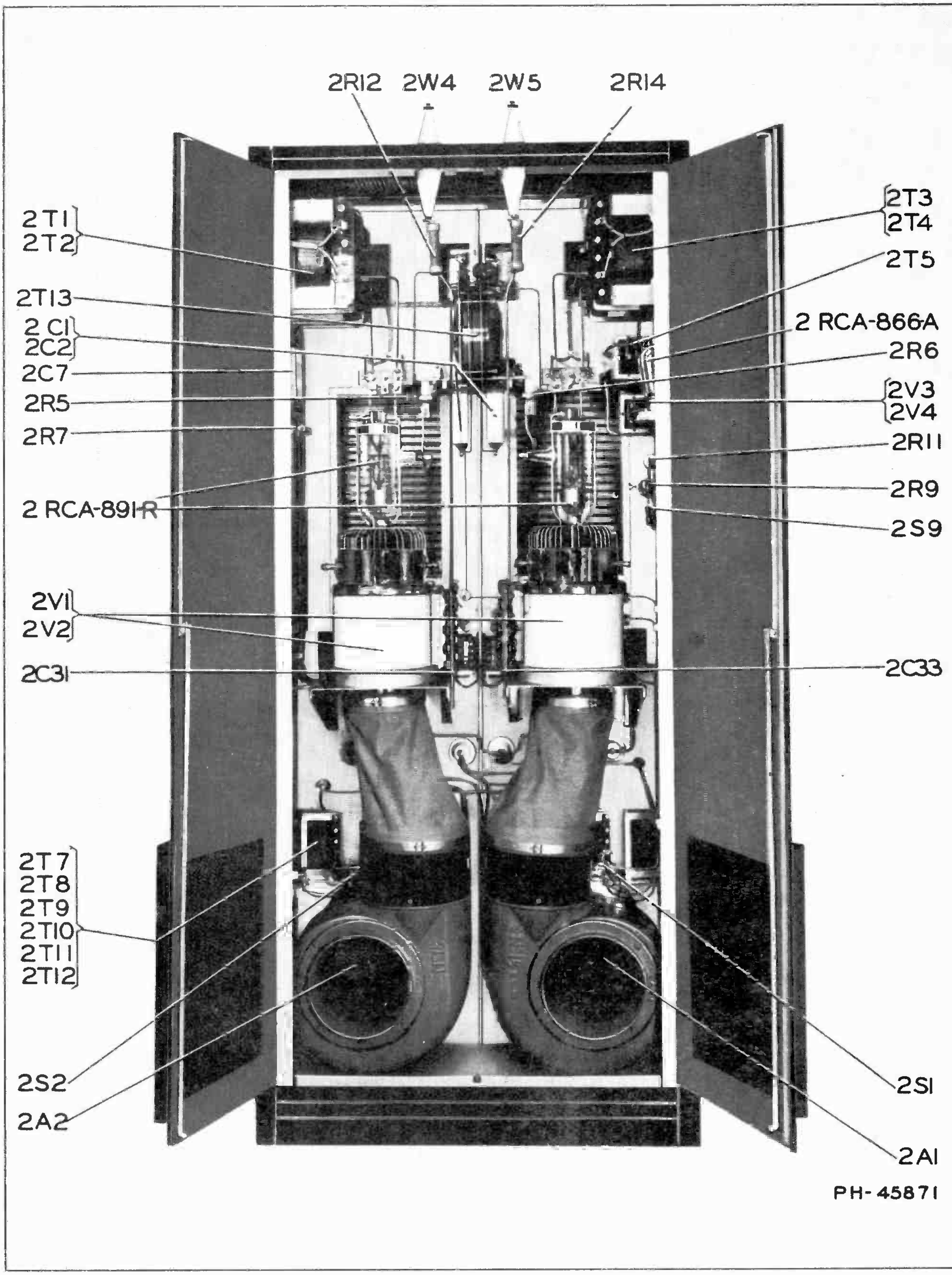


Figure 8—Modulator-Rectifier, rear view, doors open

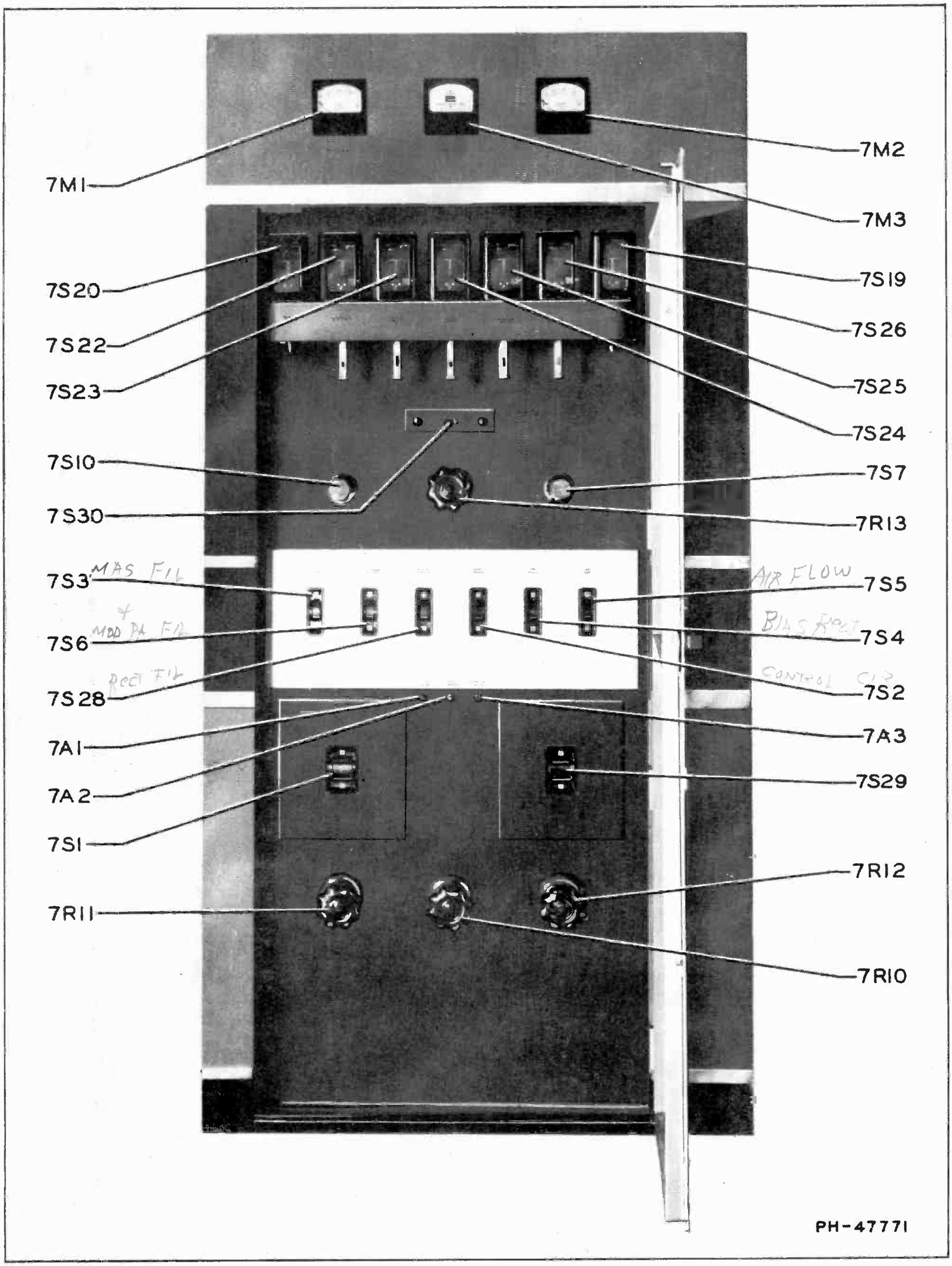


Figure 9—Power Control Panel, front view

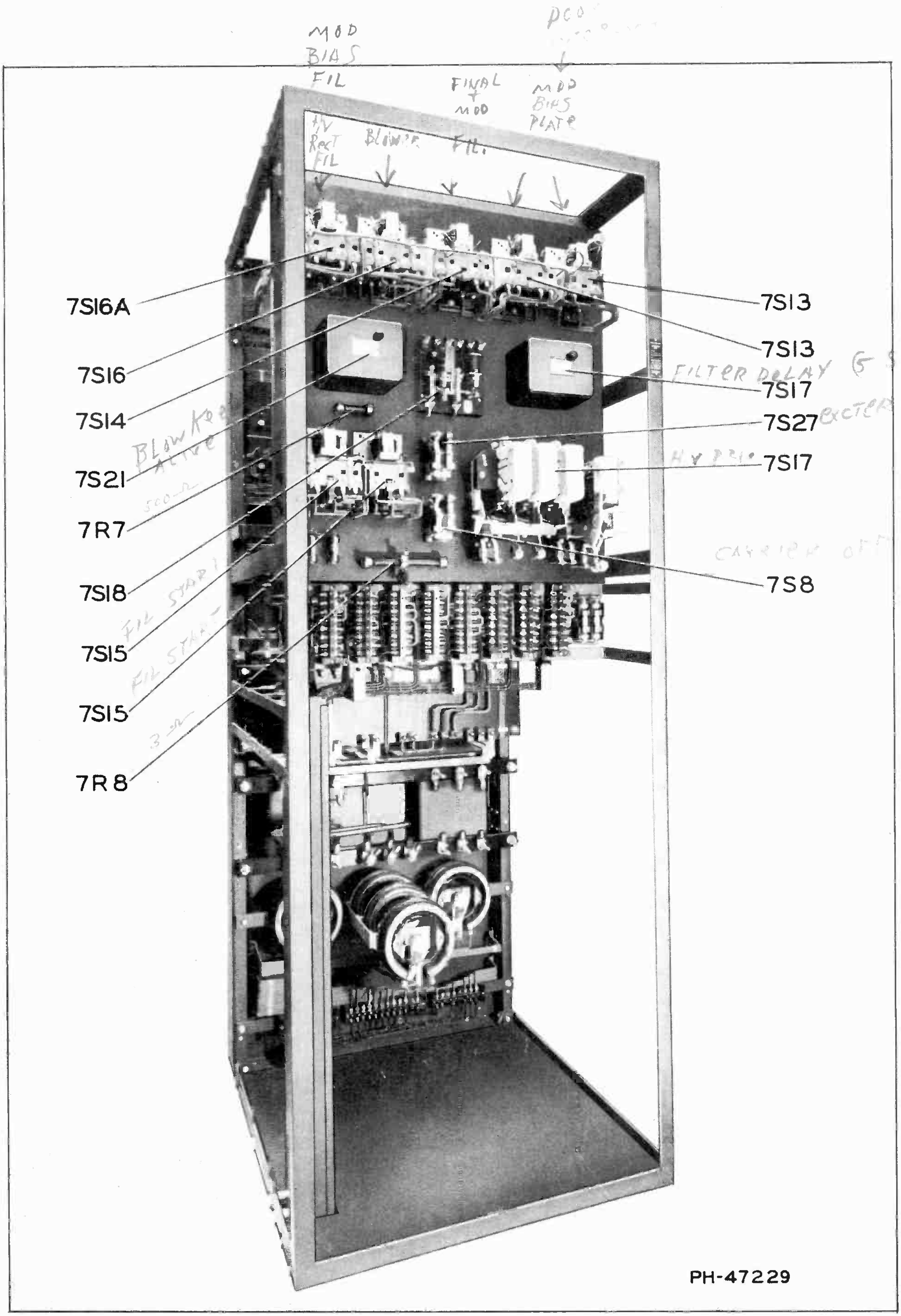


Figure 10—Power Control Panel, rear view

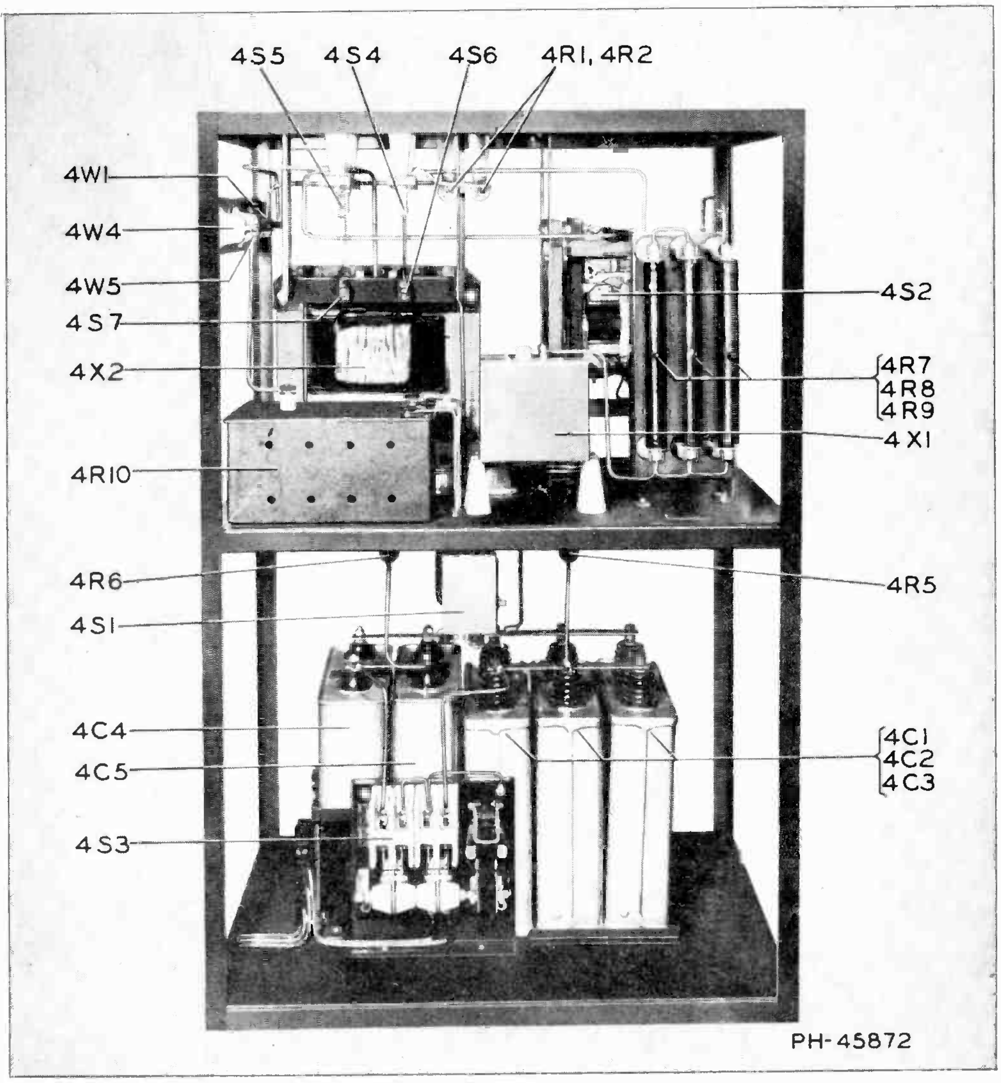


Figure 11—Filter Rack

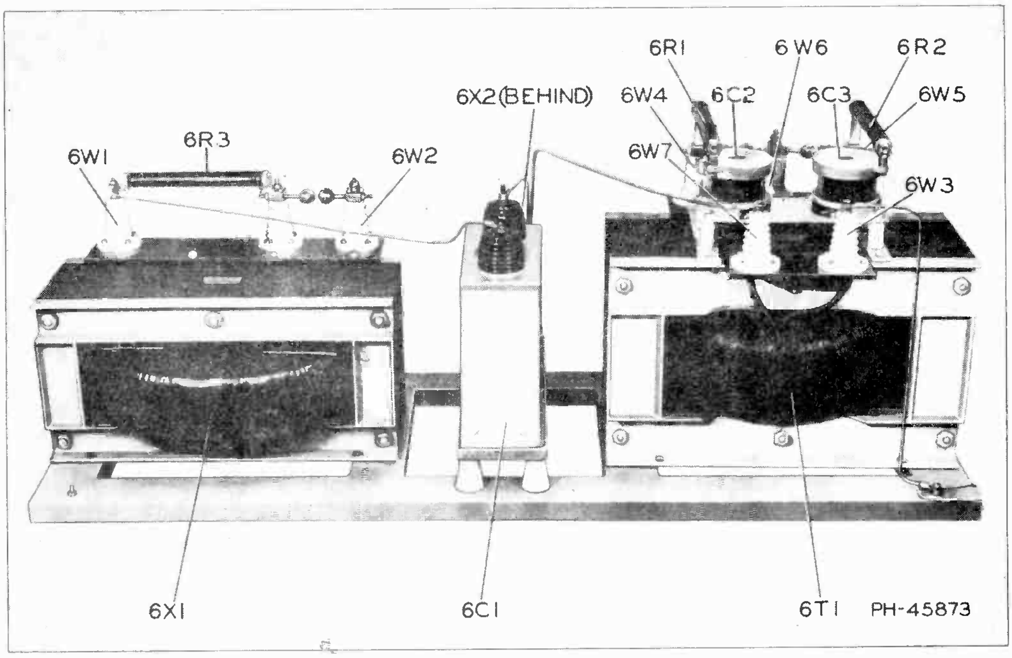


Figure 12—Modulation Transformer and Reactor Assembly

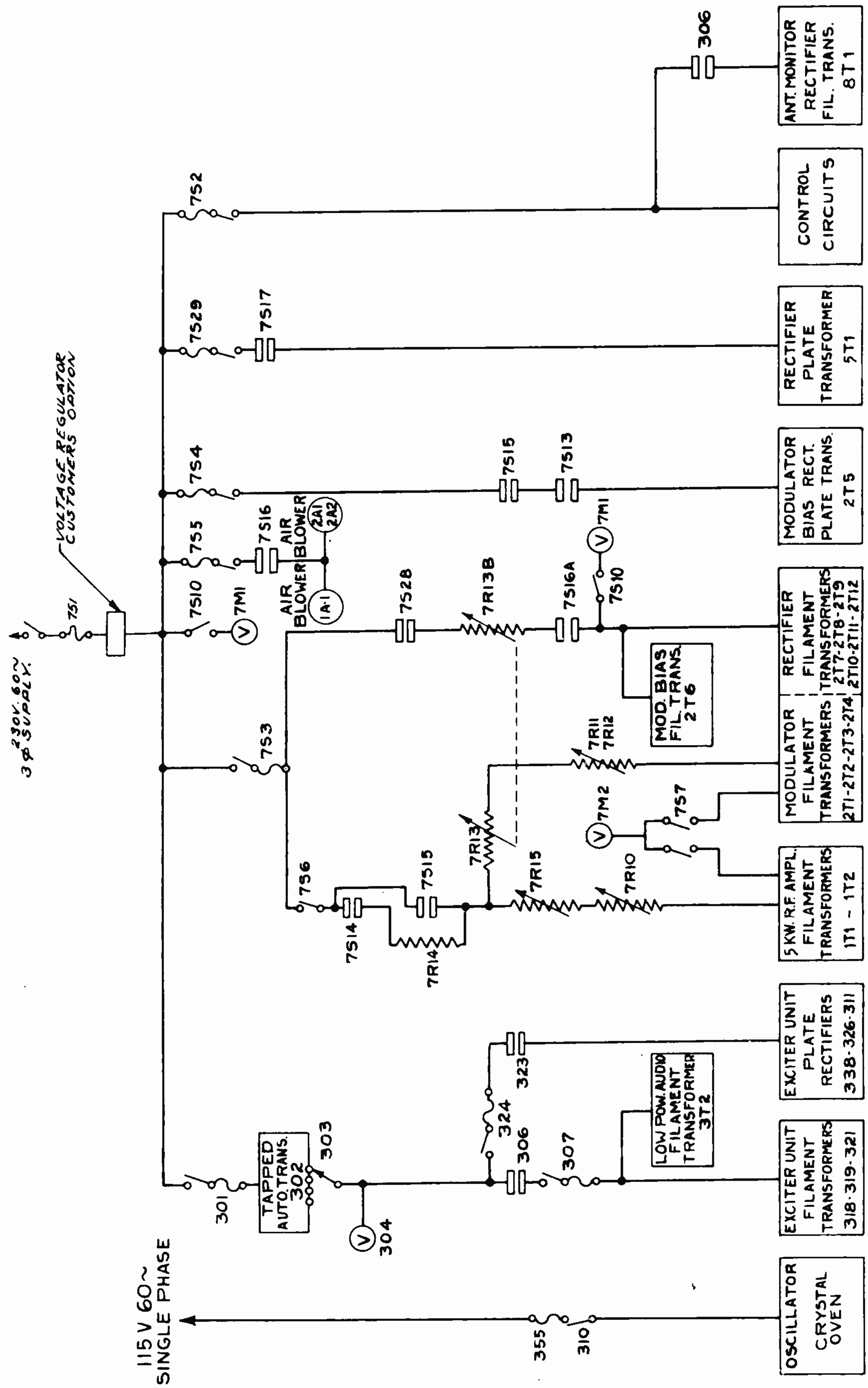


Figure 14—Transmitter Power Circuits (Simplified Diagram M-418188)

EXCITER	
301	MAIN OVERLOAD SWITCH
302	AUTO TRANSFORMER
305	FILAMENT SWITCH
306	FILAMENT CONTACTOR
307	FILAMENT OVERLOAD SWITCH
308	FILAMENT "ON" PILOT
309	TIME DELAY RELAY
322	PLATE SWITCH
323	PLATE CONTACTOR
333	OVERLOAD RELAY (1500 VOLT RECTIFIER)
345	OVERLOAD RELAY (LOW VOLTAGE RECTIFIER)
349	POWER CHANGE RELAY
350	EXCITER POWER CHANGE SWITCH
351	DOOR INTERLOCKS
354	METER LAMPS

POWER AMPLIFIER	
1A3	INTERLOCK CLOSED PILOT
1A4	AIRFLOW PILOT
1A5	FILAMENTS "ON" PILOT
1A6	MAIN RECT. READY PILOT
1A13, 1A14	METER LIGHTS
152	AIR INTERLOCK
153 TO 158	DOOR INTERLOCKS
159	MAIN RECT. "ON" SWITCH
1510	FILAMENT "ON" SWITCH
151	PWR. CHANGE RELAY FOR MONITOR CCT

MODULATOR-RECTIFIER	
2A9	MAIN RECT "ON" PILOT
2A10	OVERLOAD PILOT
2A11	BIAS "ON" PILOT
2A12	CARRIER "OFF" PILOT
2A15, 2A16	METER LIGHTS
251	AIR INTERLOCK
252	AIR INTERLOCK
253 TO 258	DOOR INTERLOCKS
259	BIAS INTERLOCK RELAY
2510	MANUAL AUTOMATIC SWITCH
2511	MAIN RECT. "OFF" SWITCH

FILTER RACK	
451	CONDENSER GROUNDING SWITCH
452	POWER CHANGE RELAY
453	STARTING RELAY

POWER CONTROL PANEL	
7A2	CONTROL CIRCUIT "ON"
7A4	"HIGH POWER" PILOT
7A5	"LOW POWER" PILOT
752	CONTROL BUS BREAKER
758	CARRIER "OFF" RELAY
7513	DOOR INTERLOCK CONTACTOR
7514	FILAMENT STARTING CONTACTOR #1
7515	FILAMENT STARTING CONTACTOR #2
7516	BLOWER MOTOR CONTACTOR
7516A	RECTIFIER FILAMENT CONTACTOR
7517	MAIN RECT. PRIMARY CONTACTOR
7518	OVERLOAD NOTCHING RELAY
7519	FILAMENT STARTING DELAY RELAY
7520	MAIN RECT. TIME DELAY RELAY
7521	BLOWER KEEPALIVE RELAY
7522	POWER AMP. OVERLOAD RELAY
7523	MODULATOR OVERLOAD RELAY

POWER CONTROL PANEL (CONT'D)	
7524	"CARRIER OFF" AUXILIARY RELAY
7525, 7526	RECT. PRI. A.C. OVERLOAD RELAYS
7527	EXCITER OVERLOAD NOTCHING RELAYS
7530	POWER CHANGE SWITCH
CONSOLE	
9A5	"FILAMENT ON" PILOT
9A6	"PLATE ON" PILOT
9A7	"LOW POWER" PILOT
9A8	"HIGH POWER" PILOT
9A10	"OVERLOAD" PILOT
955	"FILAMENT ON" SWITCH
957	"POWER CHANGE" SWITCH
958	"PLATE ON" SWITCH
959	"RESET" SWITCH

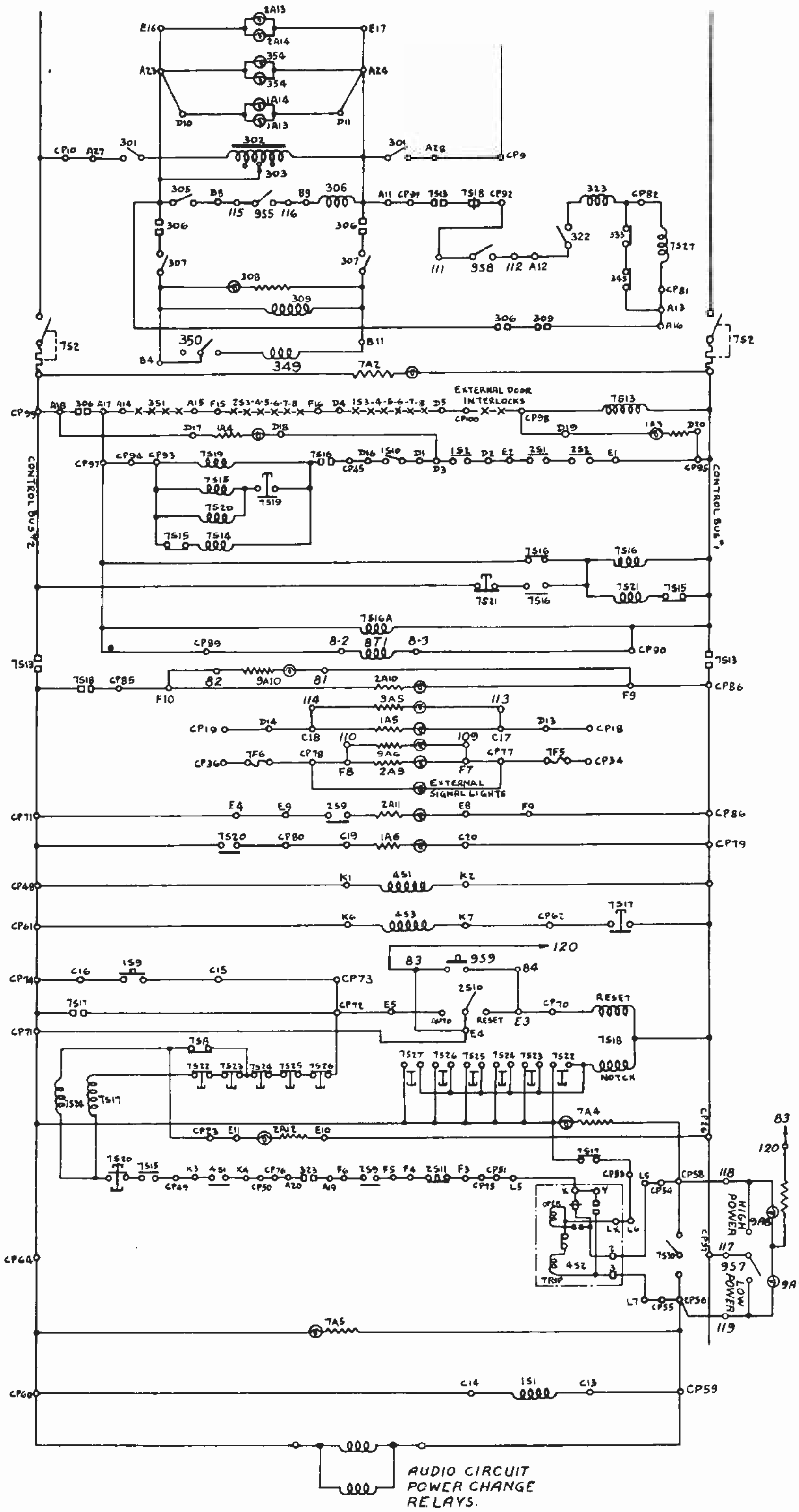


Figure 15—Transmitter Control Circuits (Simplified Diagram P-714684)

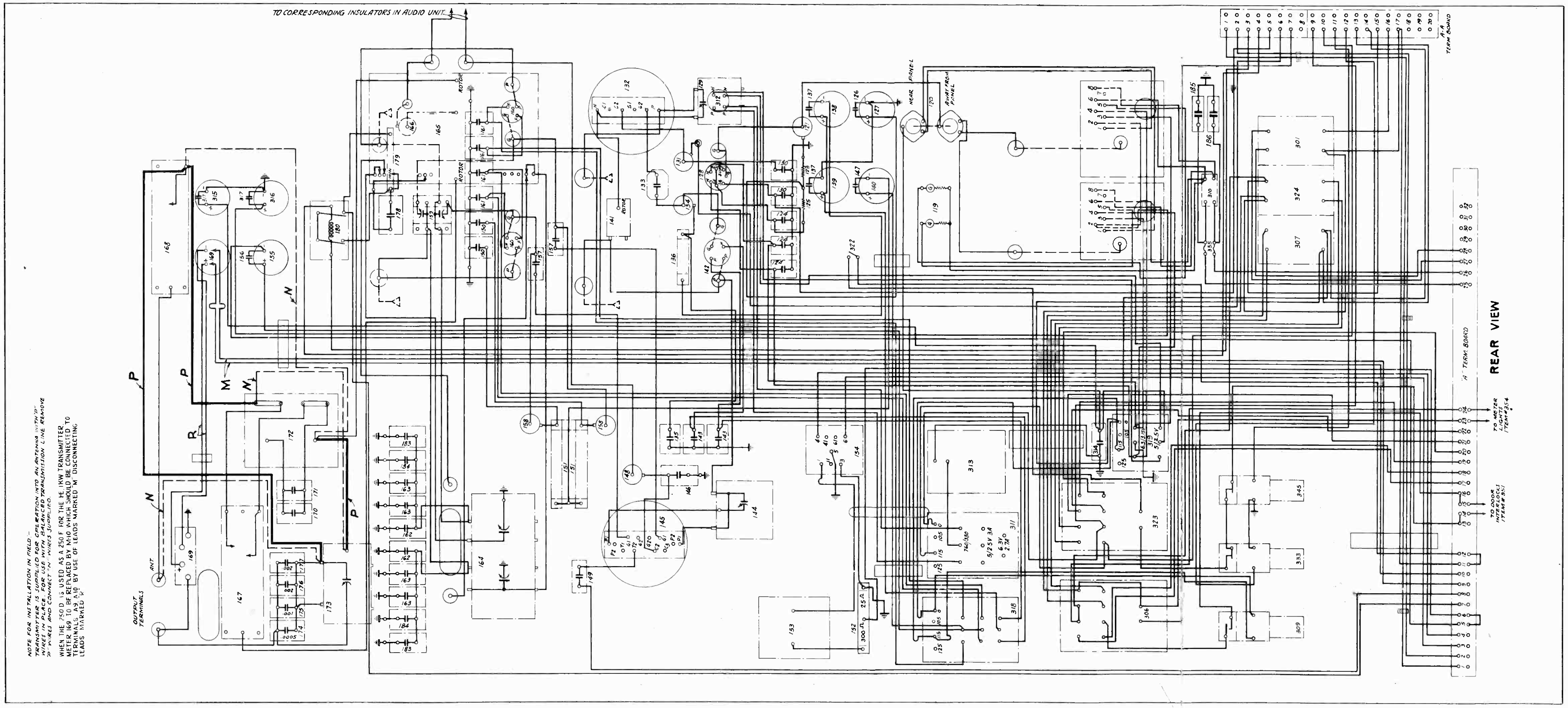


Figure 16—Type 250-F Exciter (R-F Connections T-611458)

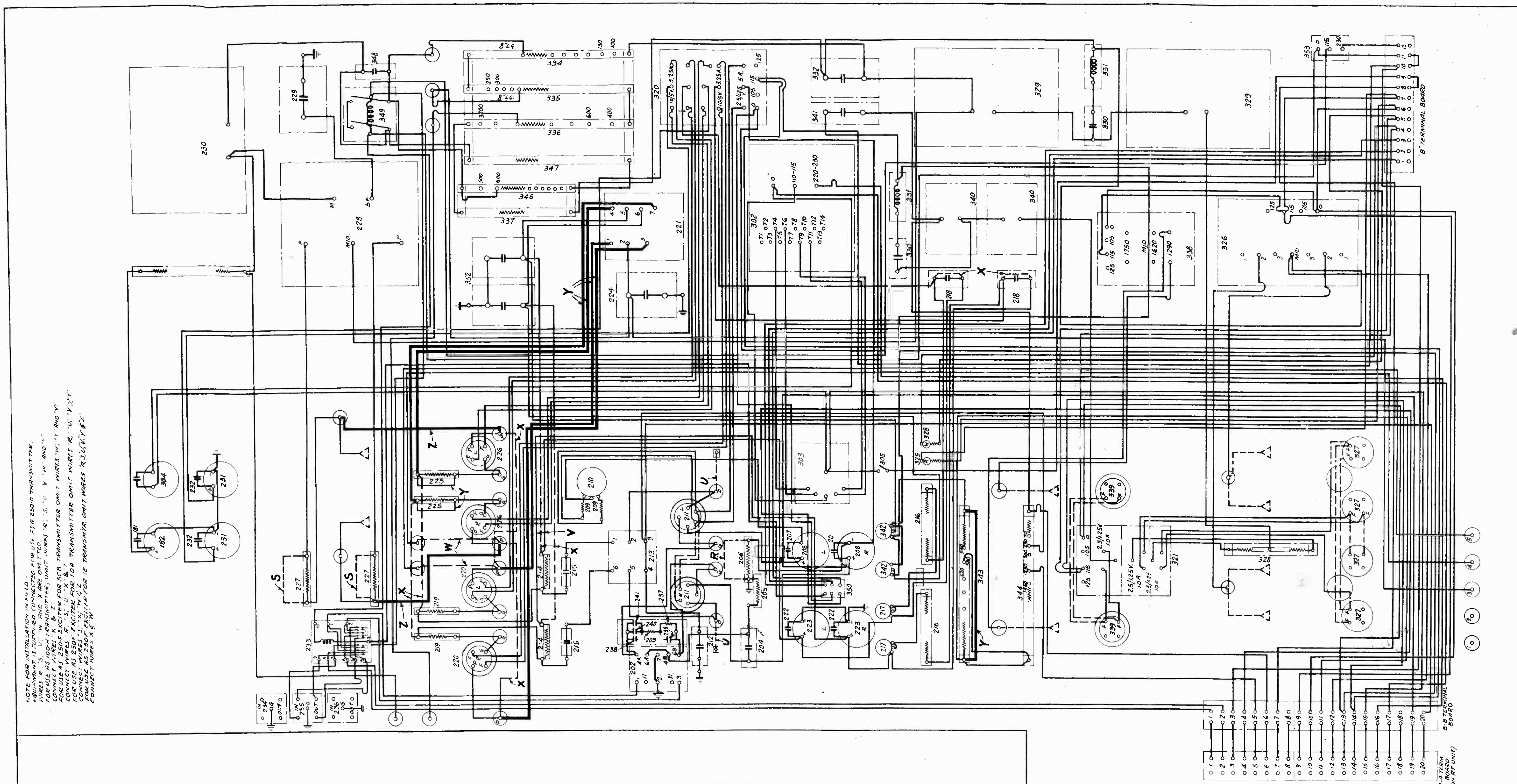


Figure 17—Type 250-F Exciter
(A-F Connections T-611442)

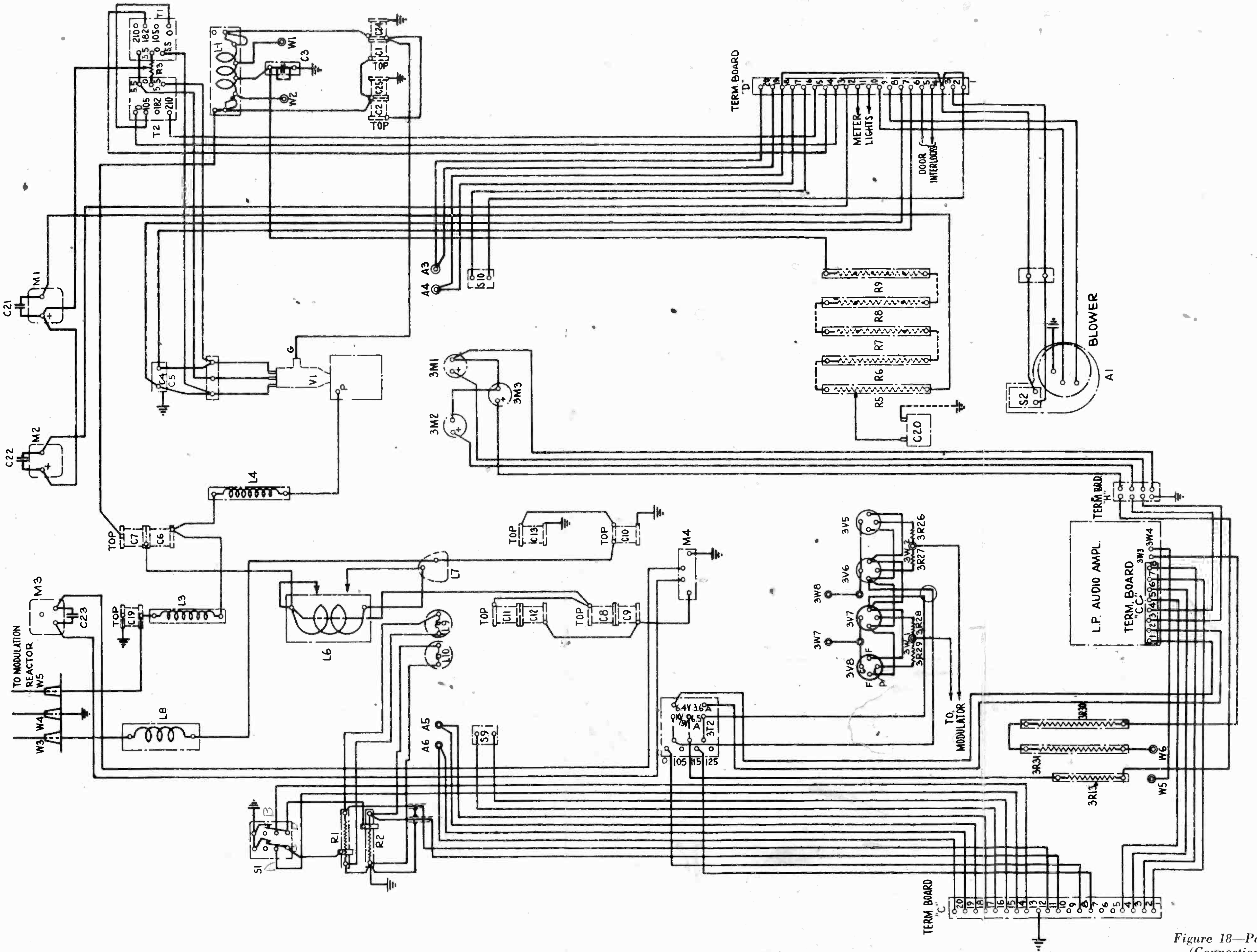


Figure 18—Power Amplifier
(Connections T-611432)

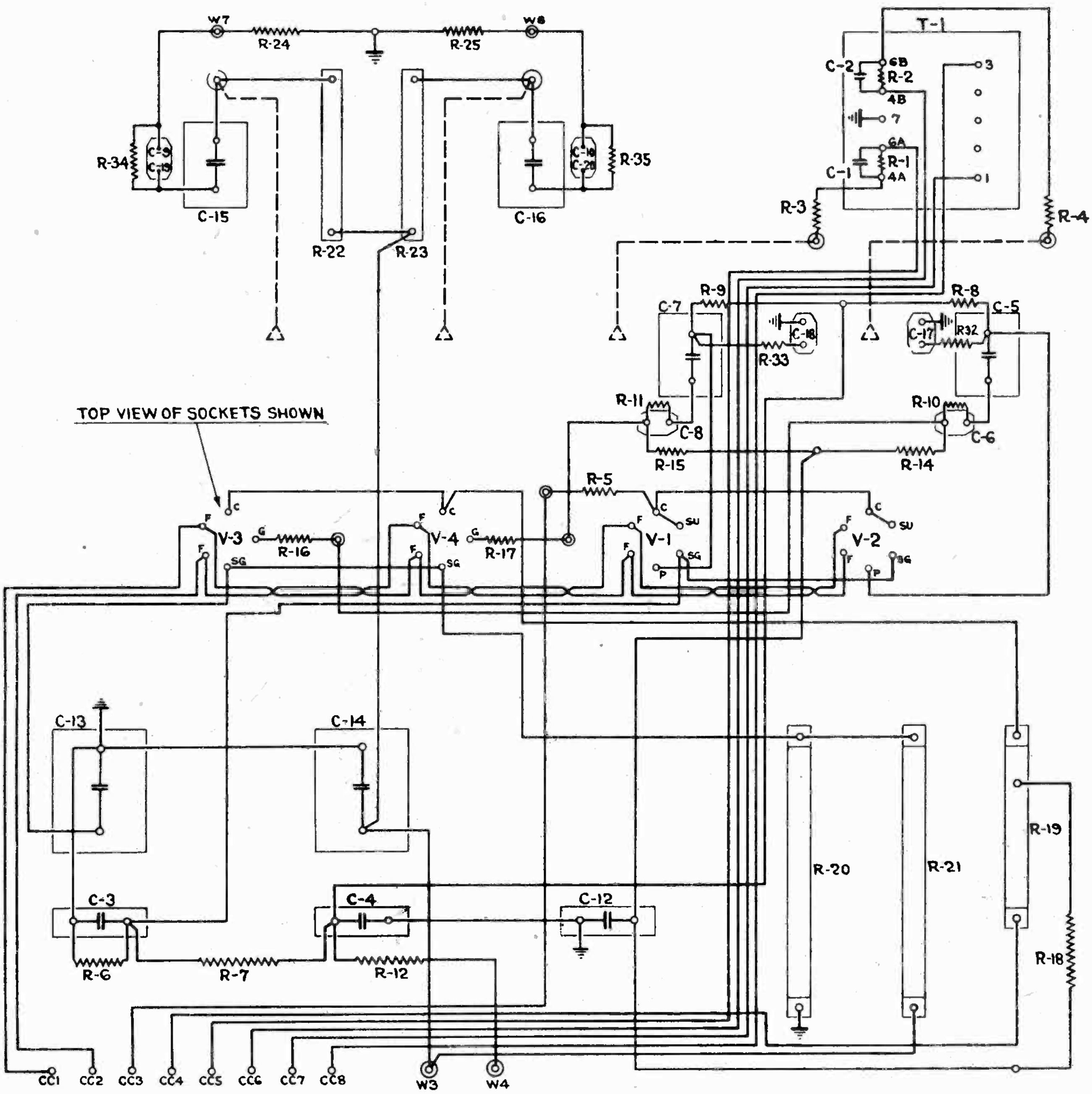


Figure 19—Low-Power Audio Amplifier (Connections P-717081)

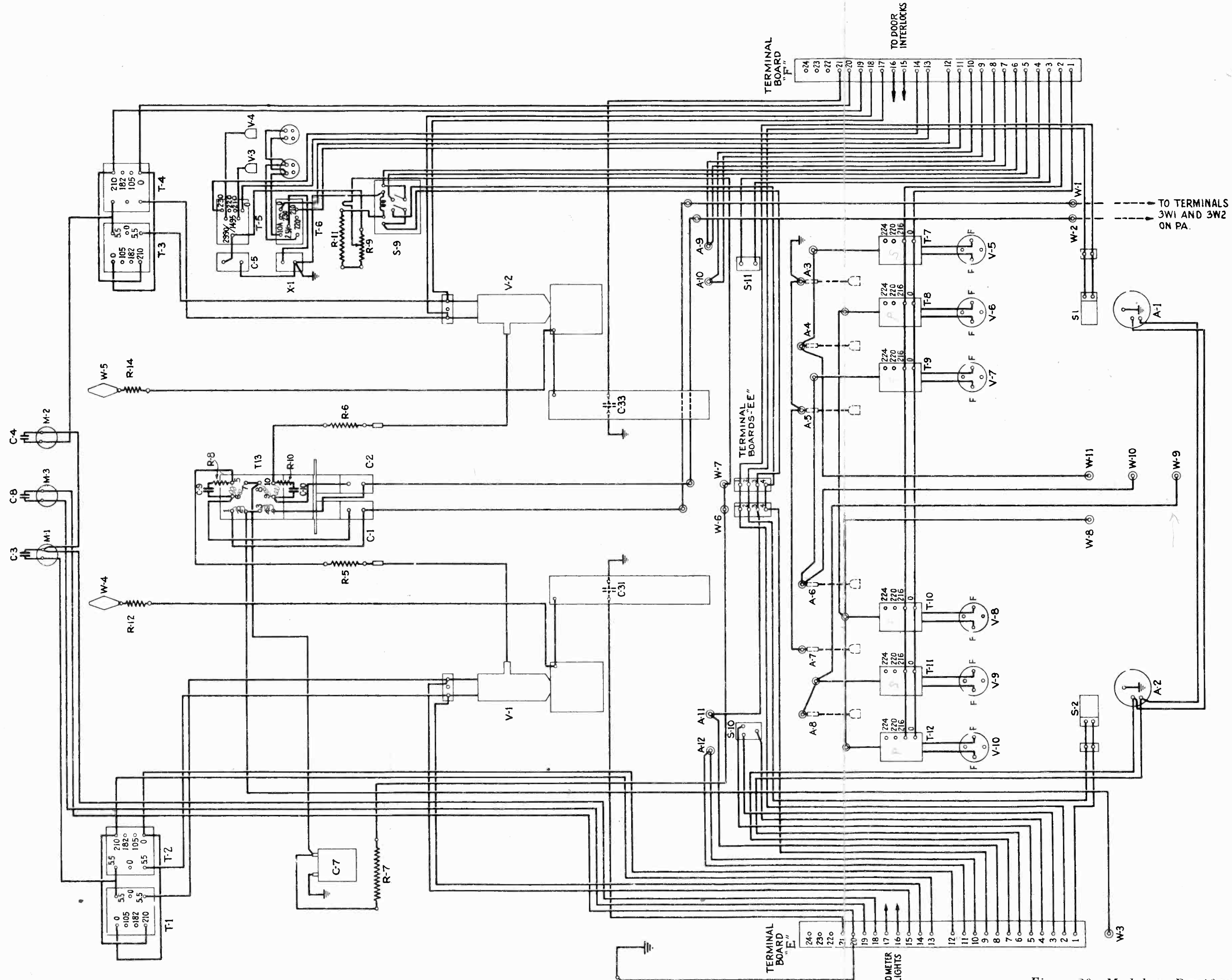
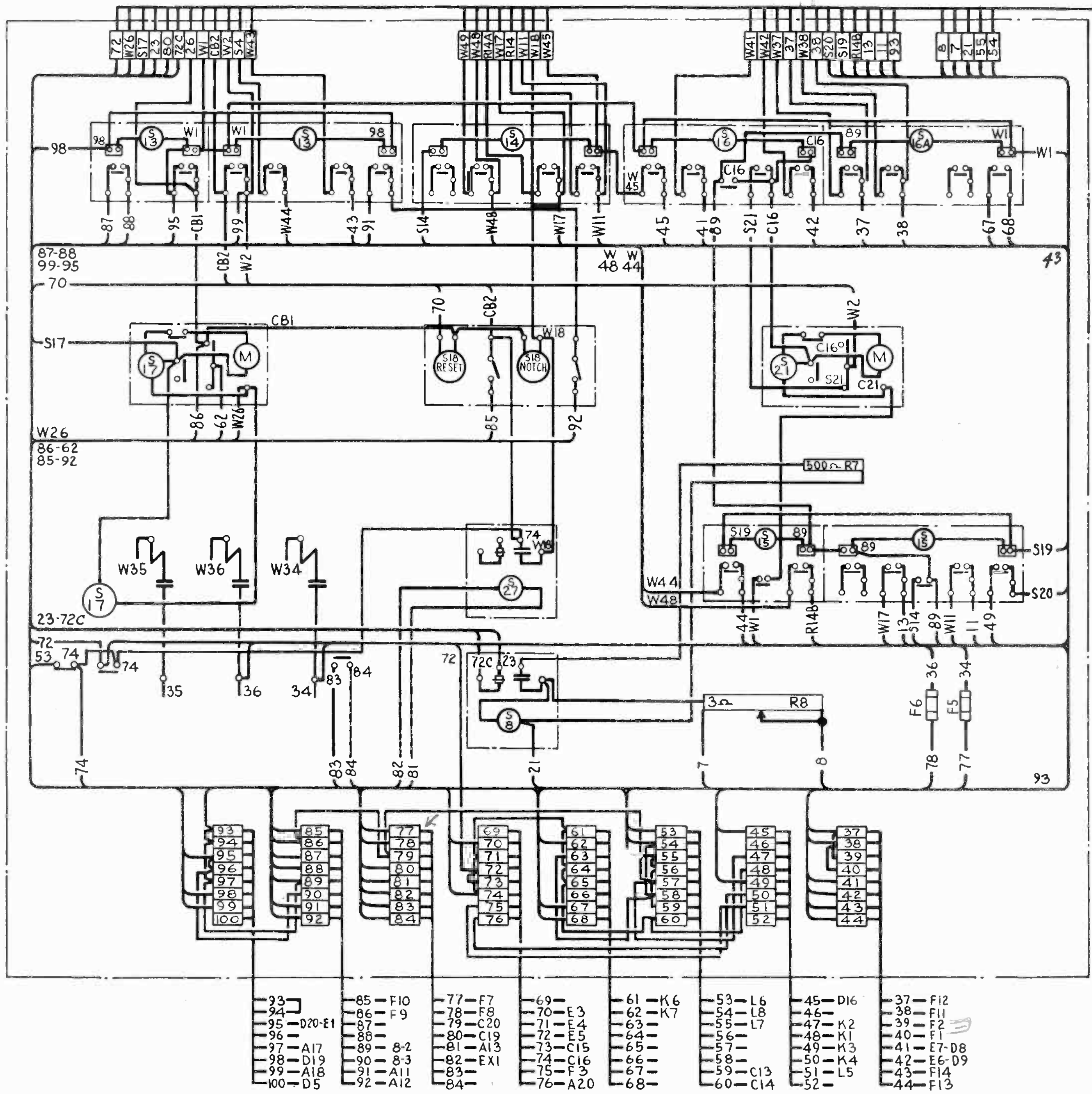
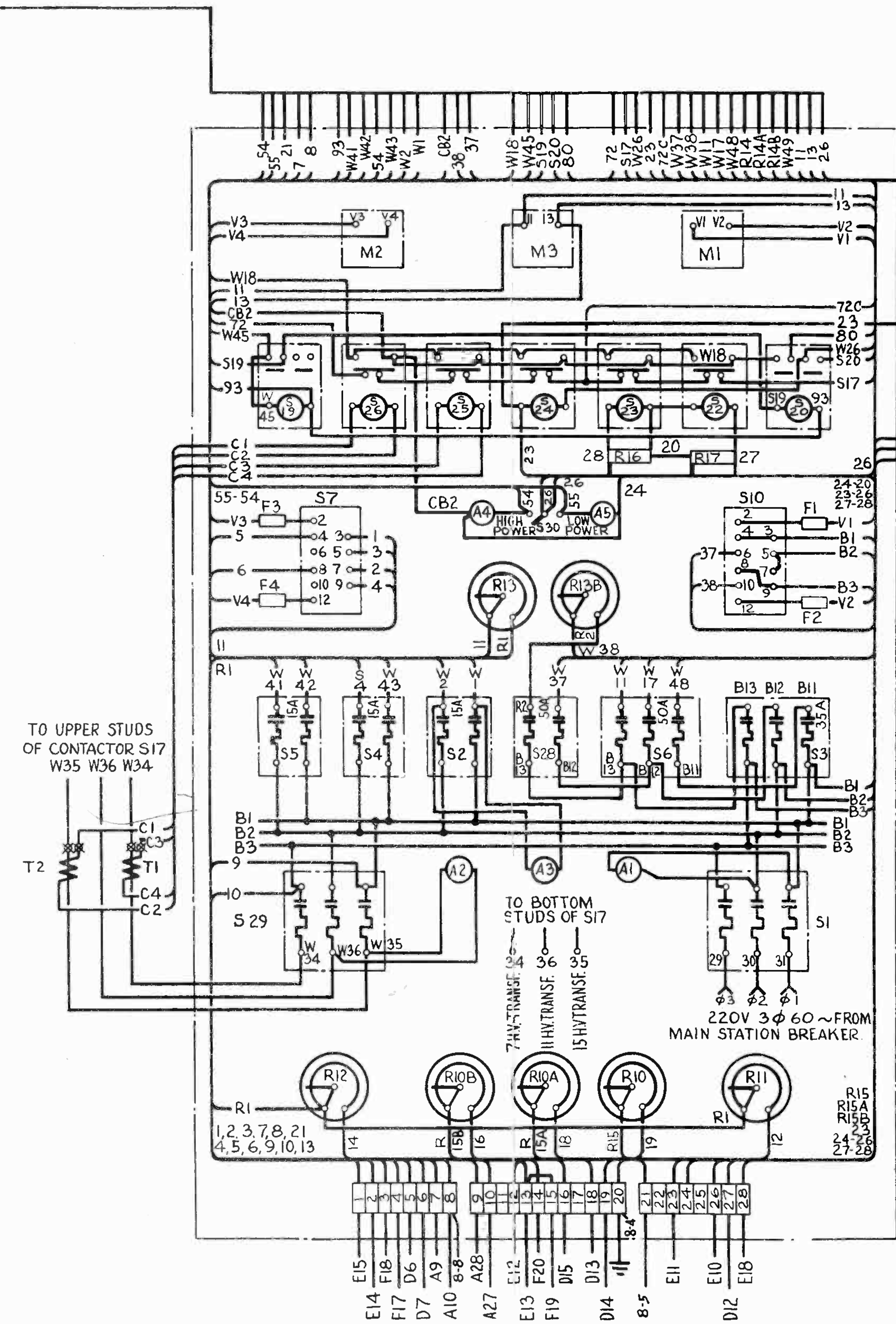


Figure 20—Modulator-Rectifier (Connections T-611431)



REAR VIEW CONNECTION DIAGRAM OF CONTROL PANEL



REAR VIEW CONNECTION DIAGRAM ST. PANEL

VOLTMETER SW. S7 & S10		
POS	INTERNAL CON.	
OFF		
1	2 TO 3	12 TO 7
2	2 TO 5	12 TO 9
OFF		
3	2 TO 4	12 TO 8
4	2 TO 6	12 TO 10

Figure 21—Power Control Panel (Connections T-611418)

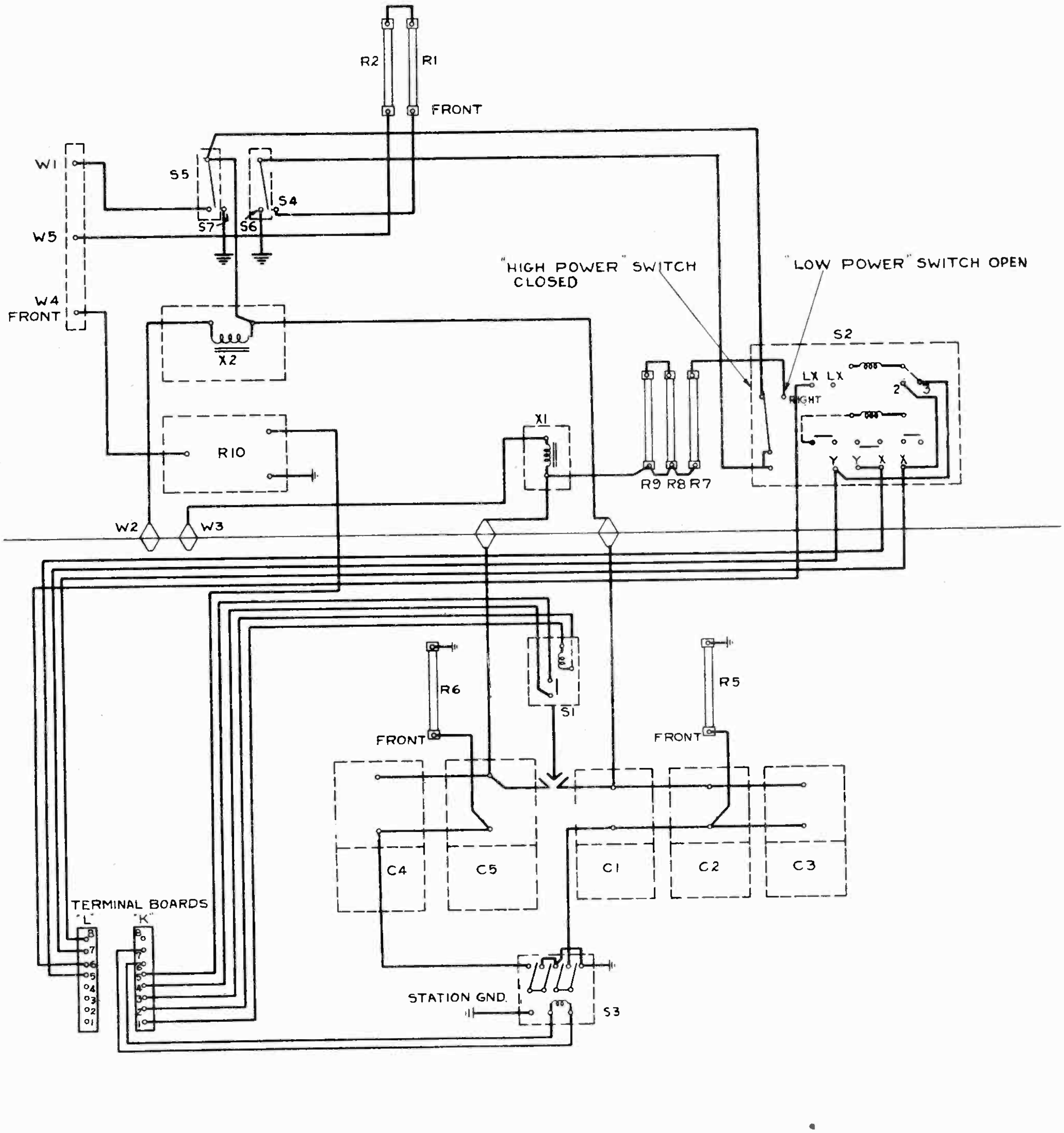


Figure 22—Filter Rack (Connections P-717802)

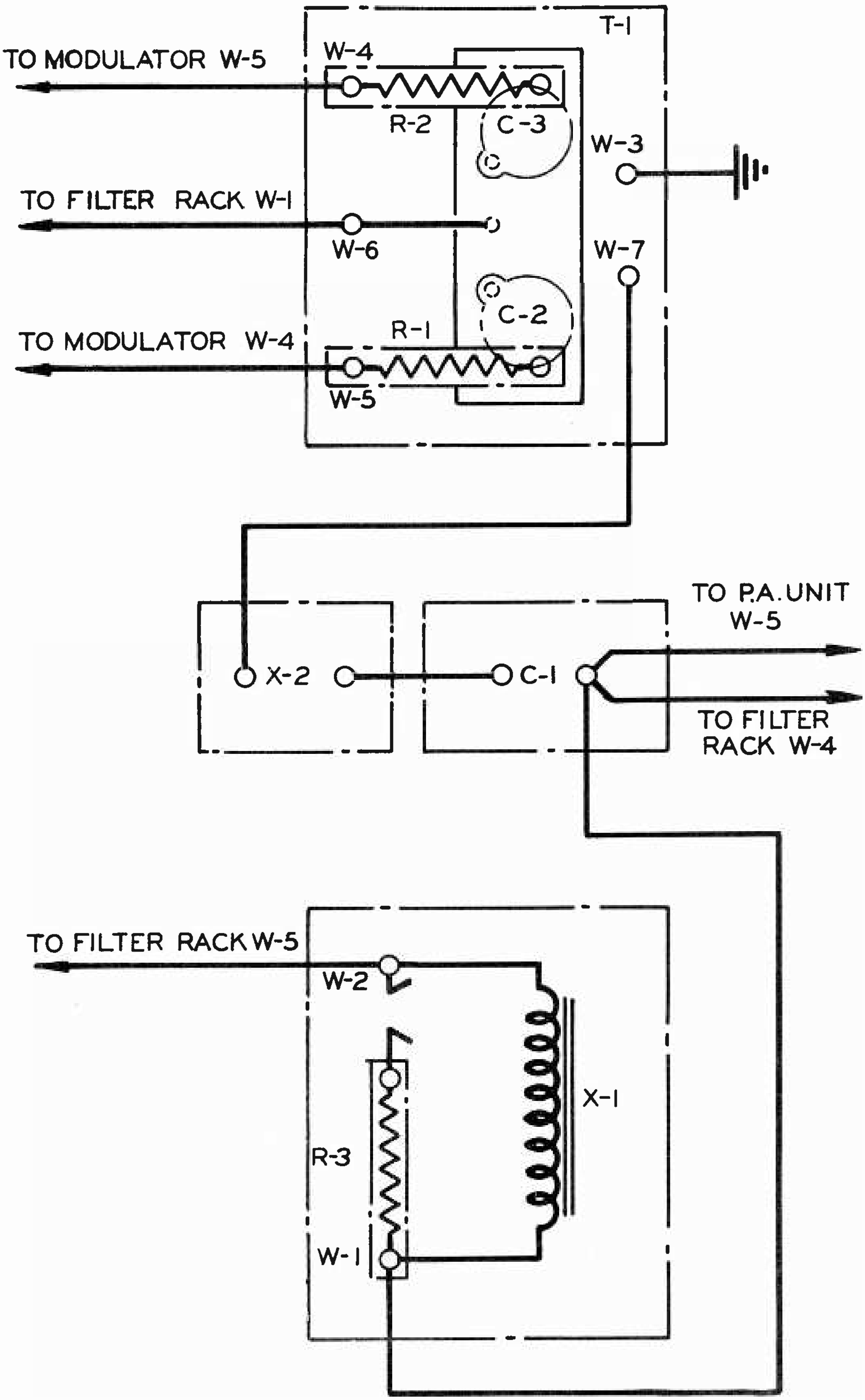


Figure 23—Modulation Transformer and Reactor (Connections K-843051)

Figure 23—Overall Schematic Diagram (TT-611870, Sub. 9)

ANTENNA TUNING UNIT

TYPE 205-A

(MI-7444A)

INSTRUCTIONS

Manufactured by

RCA Manufacturing Company, Inc.

Camden, N. J., U. S. A.

Printed in U. S. A.

IB-30033-1

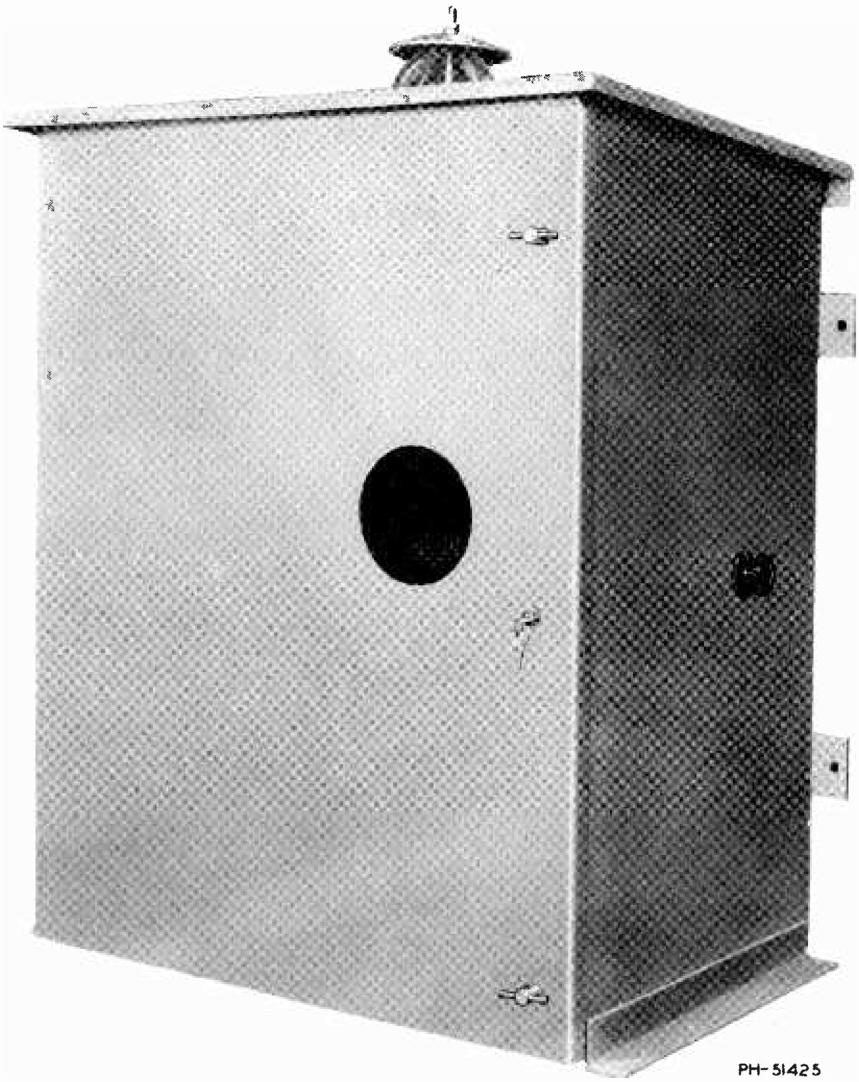


Figure 1—Type 205 Antenna Tuning Unit (Exterior View)

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ILLUSTRATIONS

TECHNICAL SUMMARY

ELECTRICAL CHARACTERISTICS:

Operating Limits:

Carrier Frequency	550 kc to 1700 kc
Transmitting Power (maximum)	10 kw

Antenna Resistance:

Output 5 kw or less	10 ohms to 1100 ohms
Output 10 kw or less	20 ohms to 1100 ohms
Line Impedance	50 ohms to 350 ohms
Antenna Reactance	+j500 to —j500 ohms

Can be extended in a positive direction by the addition of a series capacitor; and in a negative direction if operating from a line of lower impedance than the antenna resistance.

Monitoring Rectifier:

Output Impedance	to operate into 20,000-ohm bridging load

Output Level (including bridging loss):

At 5-kw output	9 db below zero vu
At 1-kw output	15 db below zero vu
Rectified Current	75 ma d.c. maximum into a maximum of 1000 ohms
Frequency Characteristic	substantially flat to 10,000 cycles
Power Supply	250 volts, 60 cycles

TUBE COMPLEMENT:

Rectifier	1 RCA-83-v

MECHANICAL SPECIFICATIONS:

Dimensions:

Height	44 inches
Width	34 inches
Depth	23 inches
Weight (net)	330 pounds

DESCRIPTION

PURPOSE. The Type 205-A Antenna Tuning Unit serves the double purpose of matching antennas of widely divergent characteristics to either concentric or open-wire transmission lines and of suppressing carrier harmonics on transmitters up to ten kilowatts (kw) output.

CONSTRUCTION. All parts of this equipment are enclosed in a weatherproof metal housing equipped at the front with a door affording ready access to the interior. This door is provided with a lock. The antenna ammeter may be read through a circular window in the door and is protected from lightning surges by a short-circuiting switch, which is operated by means of a knob extending through the side of the housing. A monitoring rectifier unit (MI-7488) is contained within the housing to furnish, if desired, audio-frequency voltage for program monitoring and rectified carrier current for remote antenna current indication.

CIRCUIT. The circuit of this antenna tuning unit essentially consists of a single T-section low-pass filter which reduces the number of elements to a minimum. Referring to the schematic diagram, Figure 5, there will be observed two series inductors (L1, L2) which are employed to adjust independently the respective terminating impedances of the transmission line and the antenna circuit. The capacitive shunt leg, which is common to the two branches, is fixed at a value determined by the operating frequency of the station.

Signal energy for operation of the monitoring rectifier is obtained from a tuned pickup coil (L3) which is coupled to the antenna loading inductor (L2). This energy is rectified in a full-wave circuit using an RCA-83-v tube and the output is balanced to ground for excitation of a monitoring amplifier. Terminals also are provided for connection to a remote antenna ammeter and interlock relay located in the transmitter house. A 220-volt, 60-cycle power supply is required for energizing the rectifier filament transformer (T1).

INSTALLATION

MOUNTING. The unit is designed for mounting on a wooden platform or a steel angle cradle by means of the side flanges at the bottom of the housing. Rear mounting strips also are provided to permit mounting the unit on two upright posts. Dimensions are given in the outline drawing, Figure 6.

Care should be taken at installation to select a position where the antenna lead will be as short as possible. It is also important to insure adequate grounding by connecting the housing to the ground system through a heavy conductor or a copper bus.

R-F CONNECTIONS. The antenna lead-in post is located on the top of the unit, and provision is made for mounting a similar post (MI-19413 bowl insulator) on the left-hand side of the housing in case an open-wire line is used. Concentric line when employed should be brought in through a hole in the bottom of the cabinet and connection made to the upper terminal of coil L1. In cases where a remote antenna ammeter is not used, terminals No. 5 and No. 8 should be connected together by means of a jumper.

REMOTE METERING AND AUDIO MONITORING. An a-c supply of 220 volts, 60 cycles will be required to operate the rectifying equipment for remote metering. The associated filament transformer is tapped for operation at 190, 210, 230 or 250 volts and should be adjusted to the tap nearest the existing line voltage. Terminals No. 2 and No. 3 are used for connection of the power supply.

STATIC DRAIN. No provision for static drain is made in this unit. If no conductive path to ground exists elsewhere, a static drain should be mounted across the antenna horn gap, or at some other suitable place.

TOWER LIGHTING. No complication as to tower lighting is introduced as the shunt arm is open circuit to power frequencies.

TUNING

CAUTION—Remove the transmitter plate voltage prior to each adjustment of the antenna and transmission-line circuits. Full power should not be applied to the line before proper adjustments have been completed. Dangerous voltages may occur through improper termination and result in damage to the line and equipment.

GENERAL CONSIDERATIONS. Although the network used in this unit serves the two functions of impedance matching and antenna tuning concurrently, it is desirable to consider them separately.

For antenna tuning, the coil L2 can be used to series-resonate the reactive component of a capacitive antenna; or, if the antenna is inductive, the reactive component can be thought of as being absorbed into the antenna tuning coil. In either case, only the resistive portion of the antenna impedance is left, and the impedance matching function can be regarded as taking place between purely resistive impedances, inasmuch as the characteristic impedance of most lines is resistive.

Under these conditions, the values of reactance employed are determined by the values of the impedances to be matched, with the phase shift through the network as a parameter. Since the circuit is a section of a low-pass filter, the phase shift may be anywhere between zero and 180 degrees, making possible a wide range of reactance values. However, it is not advisable to work too close to the 180 degree (or cut-off) point of the section, or with such low values of phase shift that the second harmonic will not be sufficiently attenuated; hence a value near 90 degrees will usually be found most suitable. These statements will become clearer upon examination of the equations relating to the reactances of the arms of the net work and the antenna and line impedances. Referring to Figure 2, which shows a simplified circuit diagram, the reactances are:

$$X_1 = \frac{-\sqrt{R_1 R_2}\left[1 - \sqrt{\frac{R_1}{R_2}} \cos \beta\right]}{\sin \beta}$$

$$X_2 = \frac{-\sqrt{R_1 R_2}\left[1 - \sqrt{\frac{R_2}{R_1}} \cos \beta\right]}{\sin \beta}$$

$$X_3 = +\frac{\sqrt{R_1 R_2}}{\sin \beta} \qquad (1)$$

where: R_1 = Line impedance

R_2 = Antenna resistance

β = Phase shift through net work

It will be appreciated that choice of β near zero or 180 degrees leads to large values of reactance in all arms since sin β approaches zero for these values. On the other hand, if we take $B = -90$ degrees, these equations simplify to:

$$X_1 = +\sqrt{R_1 R_2} \qquad (2)$$

$$X_2 = +\sqrt{R_1 R_2}$$

$$X_3 = -\sqrt{R_1 R_2}$$

If this leads to inconvenient sizes of X_1, X_2, or X_3, a new value of β can be chosen to yield better values for the desired reactance.

TUNING PROCEDURE WITH R-F BRIDGE. The use of a radio-frequency bridge is recommended to insure accurate tuning adjustment and the application of this instrument will be assumed during the ensuing treatment of the tuning procedure. In cases where a bridge is not available, measurements can be made by a substitution method, also to be described.

To determine the values of inductance and capacitance to be used for proper line matching and antenna tuning, it is essential to know the impedance of the antenna at the operating frequency. For purposes of comparison, the resistances and reactances for various heights of insulated towers of the guyed-mast and self-supporting types are shown in Table I.

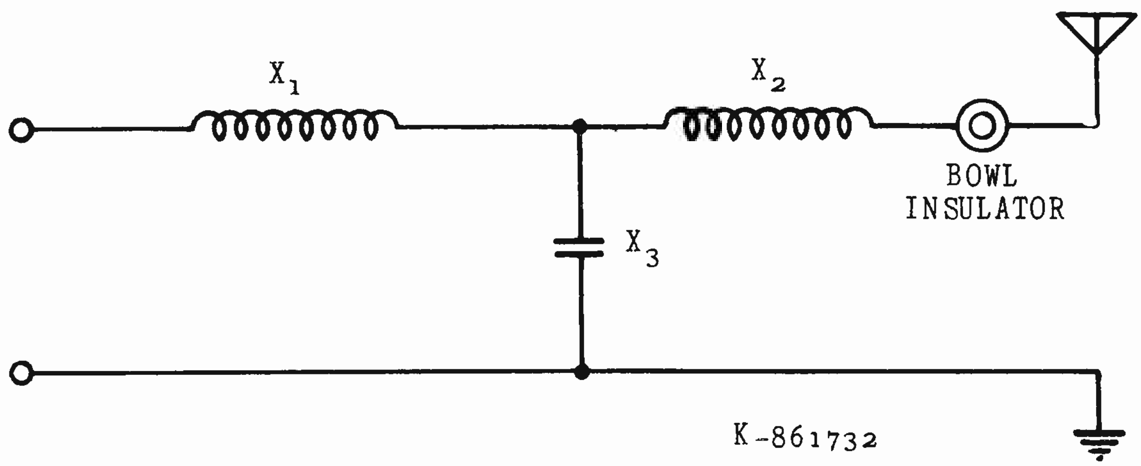

Figure 2—Simplified Circuit Diagram (K-861732)

TABLE I

Antenna Height* in Electrical Degrees	Self- Supporting Type		Guyed-Mast Type	
G	R_a	jX_a	R_a	jX_a
50	7	—j 100	8	—j 220
60	9	—j 70	13	—j 170
70	14	—j 25	19	—j 75
80	20	+j 11	28	—j 28
90	40	+j 35	36	+j 0
100	60	+j 80	80	+j 140
110	90	+j 90	140	+j 320
120	175	+j 80	220	+j 500
130	190	+j 15	370	+j 600
140	165	—j 70	660	+j 480
150	130	—j 85	1100	+j 0
160	82	—j 55	550	—j 250
170	60	—j 25	280	—j 450
180	40	—j 5	180	—j 500
190	28	+j 25	120	—j 430
200	23	+j 50	80	—j 400

* Height in electrical degrees = Height in feet X frequency in kilocycles X 1.016 X 10^{-6} X 360.

Substitution of the resistance components of line and antenna impedances in the equations (1) gives the values of X_1, X_2 and X_3 necessary for the impedance matching function. Examination of the reactive components indicates the reactance necessary for tuning. For example, suppose we have a 60-ohm line and a 120-degree antenna with 175 ohms of resistance and +j80 ohms of reactance. Substitution of the values 60 and 175 ohms in equations (2) gives the value of 102.5 ohms for X_1, X_2 and X_3.

To tune out the antenna reactance in this case, it is only necessary to assume that this reactance is a part of the required value of X_2. Subtracting the 80 ohms of antenna reactance from 102.5 ohms leaves 22.5 ohms to be obtained in the coil L2. When the other arms of the network have been adjusted to the proper value of the 102.5 ohms, there will exist a condition of impedance match between the line and the antenna resistance and the antenna reactance has been removed as a cause of loss.

In making these adjustments, the line should be disconnected and the impedance bridge connected across the input terminals to determine when the desired value of 60 ohms has been obtained. When measurements show that the input impedance of the tuner with the antenna connected is 60 ohms resistive, the line may be reconnected for a final check before turning on full power.

Calculations of the current in the capacitive branch are made to insure that the rating of the capacitor is not exceeded. Proper capacitors are supplied on the basis of information received with the order.

To enable intelligent estimates to be made of the inductances obtained by tapping down on coils L1 and L2, it should be mentioned that their maximum inductance is 120 microhenries.

TUNING PROCEDURE WITHOUT R-F BRIDGE. If no impedance bridge is available, a simple substitution method may be used to determine when a proper adjusment has been obtained. To do this, it is necessary to arrange to switch the line from the tuner to a resistance equal to the line impedance, noting the change in line current accompanying the switching. When no change occurs, the tuner is in proper adjustment. Because it is not desirable to apply full power to the test resistor, which will usually have a rating of a relatively few watts, connection should be made to a low power stage in the transmitter during this adjustment. To make the adjustments simple, a coupling circuit and a series tuning capacitor can be used, as shown in Figure 3.

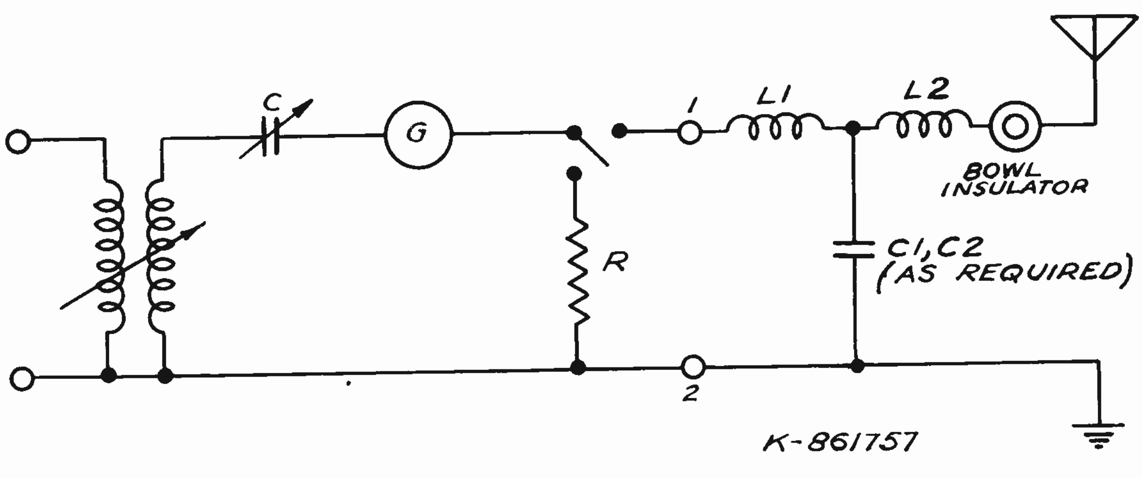

Figure 3—Coupling Circuit and Tuning Unit Network (K-861757)

With the switch in the resistor position, capacitor C can be tuned for a maximum current reading in meter G. Then, on switching to the tuner input, the direction in which capacitor C must be turned to increase the current again to a maximum indicates the sign of the reactance in the antenna circuit. If the capacitance must be increased, the load is capacitively reactive; if the capacitance must be decreased, the load is inductively reactive; if no change is necessary, the load is resistive. Similarly, if the current reading at resonance is greater than before, the load resistance is less than Z_0, if that reading is less than before, the load resistance is greater than Z_0; if there is no change the load resistance is equal to Z_0.

CAUTION—Remove unused jumpers.

This method may be used to determine unknown resistances simply by using a calibrated test resistor; likewise, unknown reactance values may be determined by using a calibrated condenser at C.

FINAL CHECK. Upon completing the tuning procedure as outlined in the preceding paragraphs, the adjustments should be checked before full power is applied to the line and antenna. The recommended method of check is described in the following paragraph.

With the measuring equipment disconnected from the tuning unit, attach the transmission line and insert a low-range thermal milliammeter in the ungrounded side at each end of the line. Apply sufficient power to provide a readable deflection on each meter and note the current values. These values should agree within 15 per cent when the tuning adjustment has been correctly performed. Under such conditions, full power may be applied to the line after removing the milliammeters.

Upon application of full power, the current through each of the tuning capacitors (C1, C2) should be measured under conditions of full modulation. The maximum permissible current values for these capacitors at three nominal frequencies are shown on the nameplates. At intervening frequencies, the maximum values will be approximately proportional to those listed. If such currents are found to be excessive, the capacitors should be rearranged in the circuit.

REMOTE METERING EQUIPMENT. The antenna tuning unit embodies the necessary equipment to enable the installation of a remote meter for measuring antenna current and also furnishes audio-frequency energy for operation of a monitoring amplifier. The method of remote antenna-current indication as outlined herein has been approved by the Federal Communications Commission.

The remote meter should require 25 to 50 ma direct current for full-scale deflection and should have a scale corresponding to that of the antenna ammeter (M1). It should be equipped with a shunt adjusted so that the deflections of both meters are identical. In most cases, a 5-ohm variable shunt will be satisfactory for this purpose.

As shown by the schematic diagram (Figure 5), terminals No. 5 and No. 8 are used for connection to the remote meter and transmitter interlock relay. Sufficient output for proper deflection of the remote meter may be obtained by adjusting the coupling between the antenna loading inductor (L2) and the monitoring pick-up coil (L3) and by tuning the latter to the carrier frequency. A wide tuning range is afforded by the six taps on the pick-up coil and by the use of two capacitors (C4, C5) which may be employed singly, in series, or in parallel. Jumpers are provided to facilitate inter-connection of these capacitors.

Maximum output will be secured as the pick-up coil is tuned to resonance. It is not advisable, however, to approach reasonance too closely since the increasing selectivity of this circuit will seriously impair the audio-frequency response characteristic. At resonance, the response at 10,000 cycles will be down approximately 4 db. Under no conditions should the current through the series resistors (R1, R4) be allowed to exceed 75 ma d.c.

When an audio monitor is to be used, an output level of approximately +17 vu is available from this source, the circuit of which is balanced to ground and may be used to feed a 500-ohm load. The load in this case must be capable of handling 25 ma of direct current. It is desirable, therefore, to feed a 20,000-ohm or greater bridging load. If the monitoring amplifier has only a 500-ohm input, a 20,000-ohm carbon resistor may be inserted in series with the 500-ohm transformer. Under this condition, the direct-current flow is negligible and the output level from the rectifier is reduced to —1 vu at 5-kw operation and to —7 vu at 1-kw operation.

MAINTENANCE

The antenna ammeter shorting switch (S1) should be kept closed except when readings are being taken.

All connections, especially the coil connector clips, should be inspected regularly to insure tightness and thus avoid undue heating at such points. Screens and ventilation openings should be unobstructed to permit free circulation of air.

PARTS LIST

Symbol	Description	Stock No.	Symbol	Description	Stock No.
C1	Capacitor—Faradon, Case 111 (a frequency-determined part)		R1	Resistor—6400 ohms, 90 watts	17899
C2	Capacitor—Faradon, Case 111 (a frequency-determined part)		R2	Resistor—10,000 ohms, 90 watts	17900
C4	Capacitor — 0.0003 mfd, Faradon	UC-3109	R3	Resistor—250 ohms, 10 watts	17901
C5	Capacitor — 0.0002 mfd, Faradon	UC-3115	R4	Resistor—125 ohms, 10 watts	17902
C6	Capacitor — 0.001 mfd, molded	12635	R5	Resistor—Same as R3	
L1, 2	Coil—Antenna loading	MI-7487A	S1	Switch—Ammeter, short-circuiting, S.P.S.T., 30 amperes, 250 volts	
L3	Coil—Monitor pick-up	17898	T1	Transformer—Filament	17897
M1	Ammeter—R-F Weston Model 425 (a frequency-determined part)		V1	Socket—Tube, 4-contact	16906
				Insulator—Lead-in, bowl type	MI-19413
				Knob—Switch shaft	43346

40-30-10

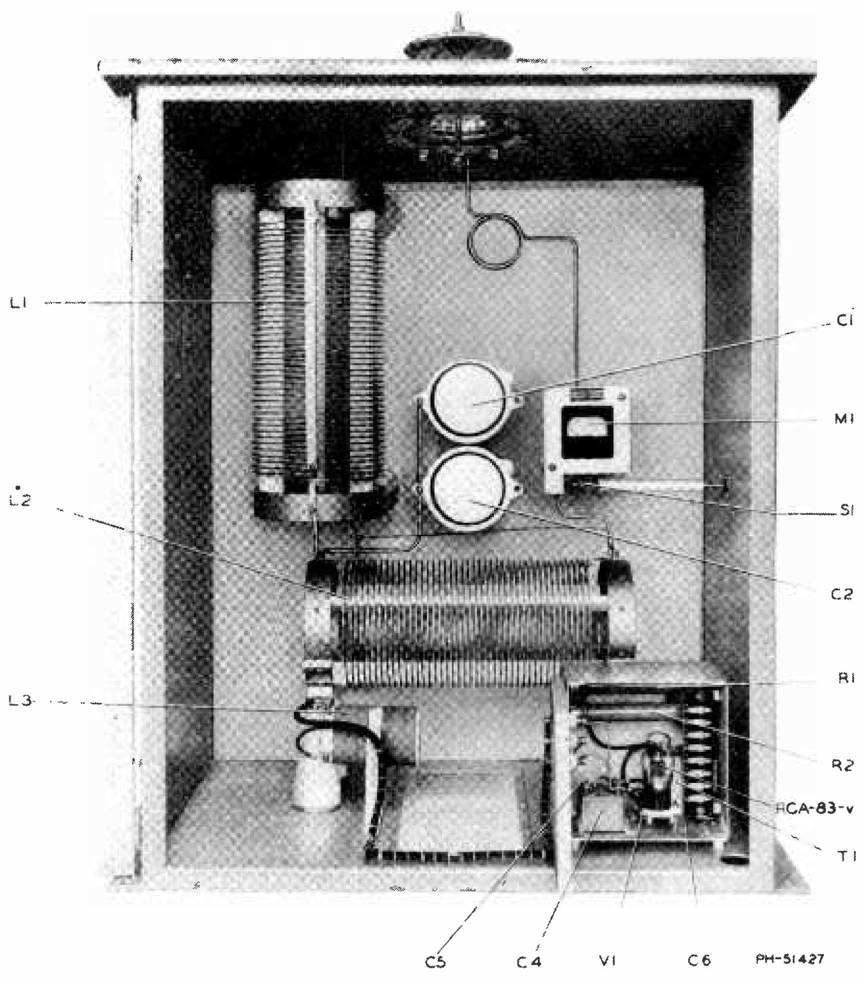

Figure 4—Antenna Tuning Unit (Interior View)

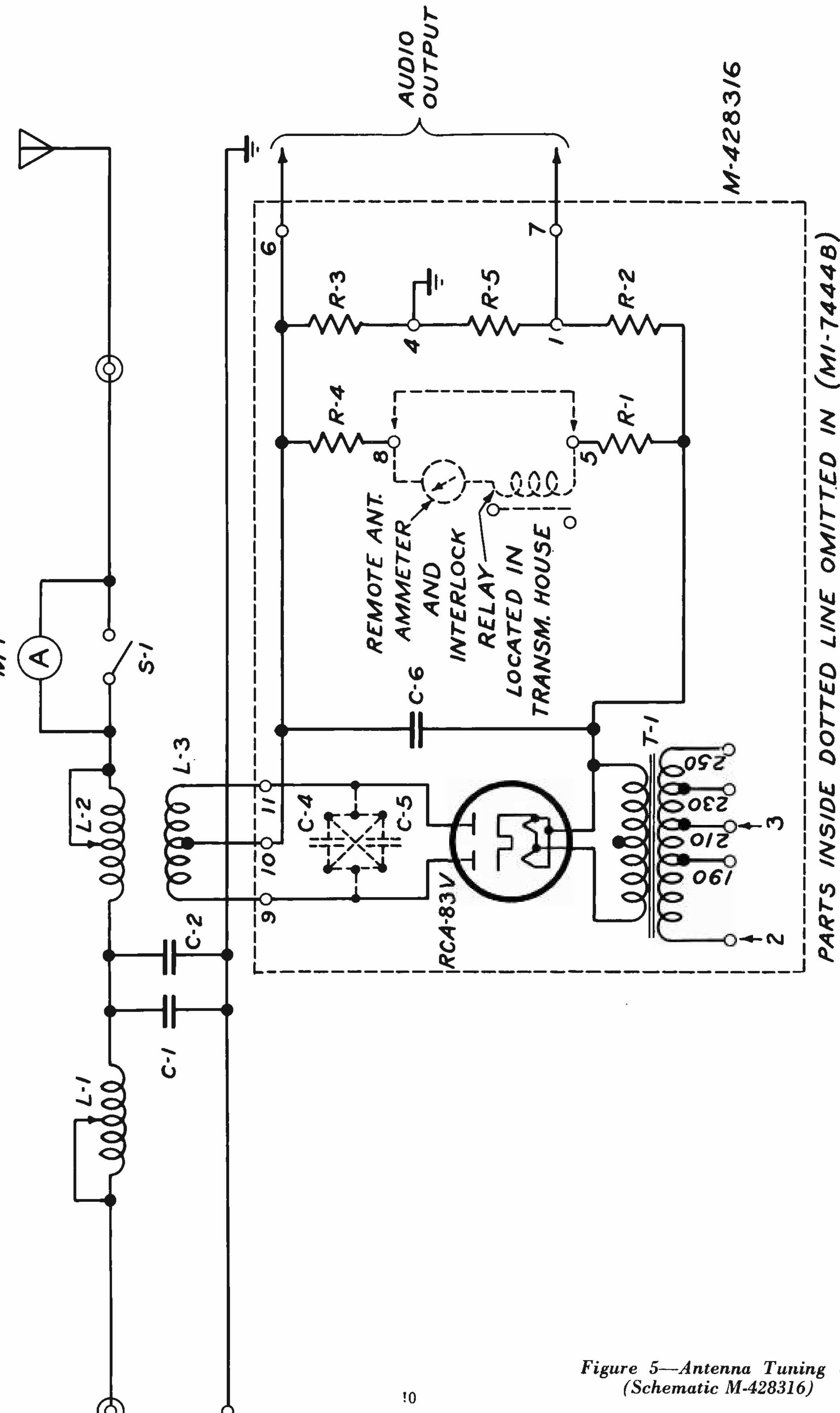

Figure 5—Antenna Tuning Unit (Schematic M-428316)

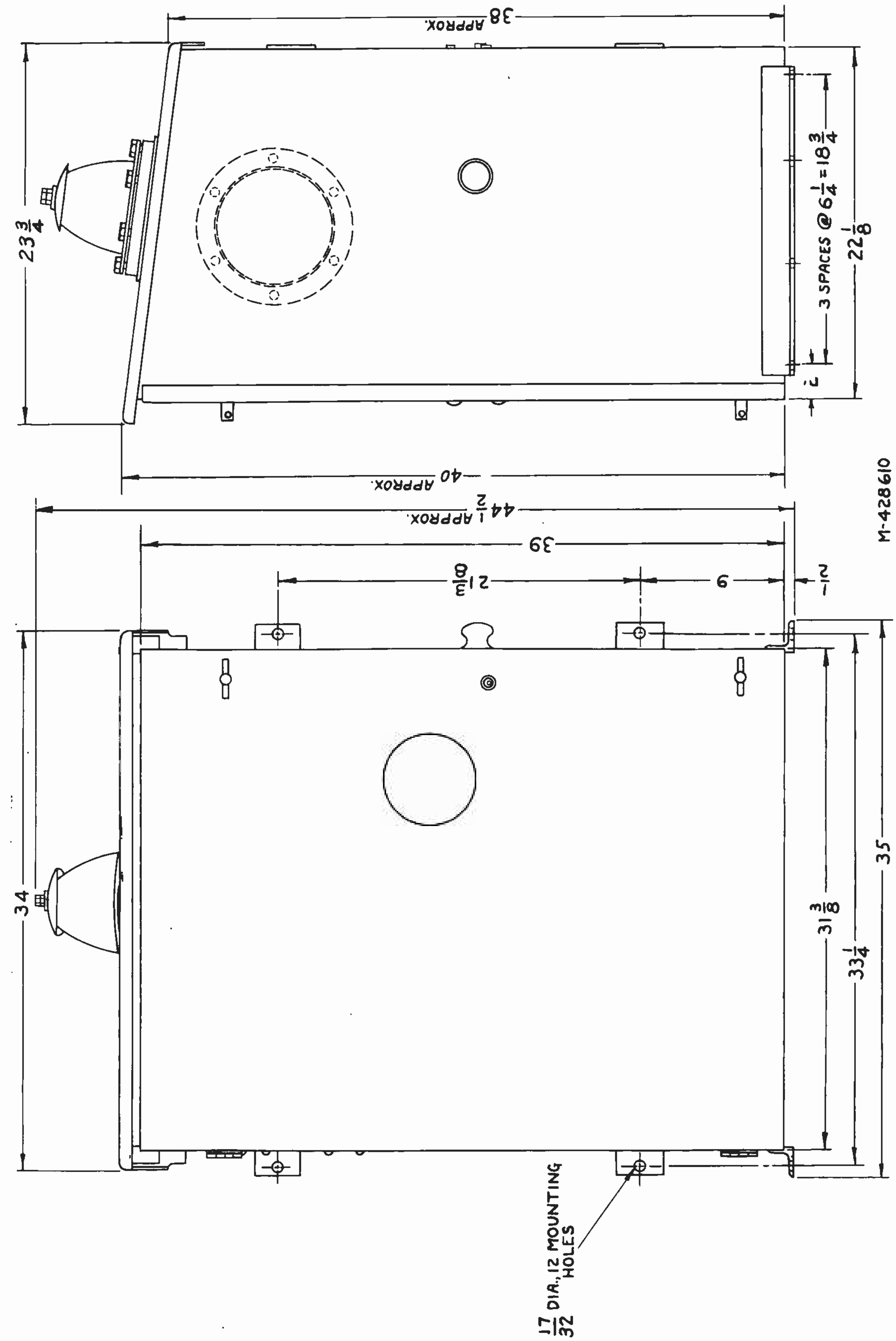

Figure 6—Antenna Tuning Unit
(Outline M-428610)