The RCA 50D was insta[illegible] in 1938
J.W.

Received - November - 1940

HIGH-POWER

BROADCAST TRANSMITTER

Type 50-D

Manufactured by

RCA Manufacturing Company, Inc.

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

"A SERVICE OF THE RADIO CORPORATION OF AMERICA"

IB-30020

KNX changed to 1070 KC

at 3 AM E.S.T.

March 29, 1941

The equipment for a 50KW final amplifier was received at the KNX transmitter in San Fernando Valley August 29, 1932. On Oct. 20, 1932 power was increased to 25KW

12/18/59 - Distance center of tower to exposed deadman (North) 357 ft.

Distance center of tower to curb 186th Street = 775 ft.

Plot plan shows tower 780' S of N line
500' N of S "
780' E of W "

KNX ANTENNA

Original Tower Destroyed In 1965

Height - 500 feet.

Type - Uniform triangular section, insulated, guyed, vertical.

Maximum Thrust On Base Insulator - 90,000 pounds.

Base Insulator - Porcelain, working capacity 225,000 pounds.

Tower Base - Reinforced concrete - 7 ft. 6 in. deep.

Guy Anchorages - 10 cu.yds. of reinforced concrete each 10 feet deep.

Wind Loading - Tower is designed to resist 120 miles per hour wind.

Earthquake Loading - Tower is designed for earthquake loading of .2 times weight.

Design Tension 10,700-lbs.

Upper Guy Wires - 7/8 in. dia. extra high strength, 19 wire, galvanized.

Ditto 7,300-lbs.

Lower Guy Wires - 3/4 in. dia. extra high strength, 19 wire, galvanized.

Construction - 20 foot sections shop welded, field bolted together with high tensile machine bolts.

Ground Screen - IDECO patented, 55 foot diameter.

Ground Radials - 240 bare copper wires, No. 8 gauge, 500 feet long each, installed at 6 inch depth, galvanized steel grounding stake at outer end of every fifth radial.

Lighting Circuit Insulation - Two air core transformers, 2-3 kw. capacity each.

Beacon Flasher - Mercury tube tilting switch, cam operated by synchronous motor.

Lighting Control - Electric eye installed on roof of tuning house, operated by light intensity in Northerly sky.

DESIGNED, MANUFACTURED, AND COMPLETELY INSTALLED
BY
INTERNATIONAL DERRICK AND EQUIPMENT COMPANY OF CALIFORNIA
TORRANCE, CALIFORNIA
division of

INTERNATIONAL-STACEY CORPORATION
COLUMBUS, OHIO

Mc Keon

TYPE 50-D

BROADCAST TRANSMITTER

MI-7351

INSTRUCTIONS

Manufactured by
RCA Manufacturing Company, Inc.
Camden, N. J., U. S. A.
"AN RCA SERVICE"

Printed in U.S.A.

IB-30020

Figure 1—Type 50-D Broadcast Transmitter, Front View

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

ILLUSTRATIONS

LOOSE-LEAF BULLETINS

Subject	Number
G. E. Transil Oil, 10-C	GEA-1180A
G. E. Types PAA, PAC, PAV, PBA, PBC and PCV Plunger Relays, Instructions	GEH-954A
G. E. Types PAA, PAC, PAV, PBA, PBC and PCV Plunger Relays, Renewal Parts Bulletin	GEF-2337A
G. E. Types CR-2820-1731A and -1731B Time Delay Relays, Instructions	GEH-1016A
G. E. Type CR-2820-1099 A-C Motor-Operated Definite-Time Relay, Instructions	GEH-985C
G. E. Types CR-9503-206A, -207B to G incl., -208D, -209A and C, -210A, -211A and E, -212A, -213A, -214A and -215A Solenoids, Renewal Parts Bulletin	GEF-1555B
G. E. Type AB-2 Air Circuit Breaker, Instructions	GEI-6534B
G. E. Dry Type Instrument Transformers, Instructions	GEH-230K
G. E. Polyphase Squirrel-Cage Induction Motors	GEH-790D
G. E. Polyphase Squirrel-Cage Induction Motors	GES-1476A
Westinghouse Type SG Auxiliary Relays, Catalog Section	41-350
Westinghouse Types KU-11 and KU-12 Definite Time Relays, Instructions	2091-B
Westinghouse Type L-41 Electrical Interlock, Instructions	2406
Westinghouse Type DN Linestarter, Size No. 1, Parts Data	11-110
Westinghouse Type DN Linestarter, Size Nos. 3 and 4, Parts Data	11-130
Westinghouse Type M Edgewound Resistors, Instructions	1733-B
Westinghouse Type WL Field Rheostat, Instructions	2299A
American Transformer Co. Types TH, RH and LC Transtats, Instructions	S-36963

SAFETY

SAFETY

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.

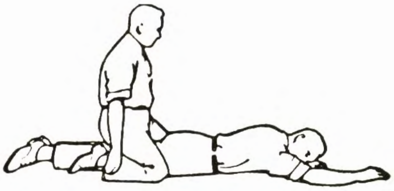
FIRST AID IN CASE OF ELECTRIC SHOCK

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.

SPECIFICATIONS

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

Frequency	Any specified allocation between 550 and 1600 kilocycles
Power Output (into antenna)	50,000 watts
Power Input:	
Unmodulated carrier	140 kilowatts
Average program modulation	142 kilowatts
Peak (100%) modulation	175 kilowatts
Envelope Distortion	3% (r-m-s) from 50 to 7500* cycles at 90% modulation
Residual Modulation (spurious carrier noise and hum)	60 db below 100% modulation
Radio-Frequency Harmonic Field Intensity (max.)	70 db below fundamental at 1 mile
Audio-Frequency Input Level (approximate)	1 mw in 600 ohms
Audio-Frequency Response	Uniform within 1 db from 30 to 10,000 cycles

* 2nd harmonic

(Measured with an RCA Type 69-A Distortion and Noise Meter) — for Residual Modulation

(Using a-f input voltage corresponding to 60% modulation at 1000 cycles) — for Audio-Frequency Response

Power Supply Requirements . . . . 2300 volts, 60 50 cycles, 3-phase with 5% maximum regulation and variation. The equipment can be adapted for 50-cycle operation by minor modifications.

TUBE COMPLEMENT

Unit	Function	Type
Exciter (250 W)	Oscillators	2 RCA-802
	Buffer Ampl.	1 RCA-802
	1st I.P.A.	1 RCA-805
	2nd I.P.A.	2 RCA-805
	1200-Volt Rectifier	2 RCA-~~872-A~~ 8008
	400-Volt Rectifier	2 RCA-866-A ✓
	Osc. Plate Rectifier	1 RCA-5Z3
Modulated Amplifier (5 KW)	1st A-F Amplifier	2 RCA-1603
	2nd A-F Amplifier	2 RCA-807
	Modulator Driver (3rd A-F Ampl.)	2 RCA-845
	Modulated Amplifier (3rd I.P.A.)	1 RCA-892-R
Modulator-Rectifier	Modulator	2 RCA-891-R
	10-KV Rectifier ⑦	6 ~~RCA-872-A~~ 673
	Bias Rectifier	2 RCA-866-A
Power Amplifier (50 KW)	Power Amplifier 2. Federal.	~~2 RCA-898~~ 862A
	Bias Rectifiers	✓ 4 RCA-~~872-A~~ 8008
	Feedback Rectifier	4 RCA-836
Antenna Monitor Rectifier		4 RCA-836
Main Power Rectifier	CBS Hytron ⑦	6 RCA-857-B

EQUIPMENT

			MI
1		Transmitter Enclosure (Optional, as specified by customer):	
		Straight-Line Type	7367
		"U" Type	7371
1		Driver Section, comprising:	
		Exciter Unit, Type 250-F	7431
	2	Crystal Holders (with crystals)	7467
	1	Modulated-Amplifier Unit	7372
	1	Modulator-Rectifier Unit	
	1	Filter Rack	
	1	Power Control Panel	
	1	Plate Transformer	
	1	Booster Transformer	
	1	Modulation Reactor	
1		Power Amplifier Section	7362
1		Control and Distribution System	7364
1		Supervisory Console	7366-A
1		Main Power Rectifier Equipment, comprising:	
	1	Rectifier Tube Rack	7363
	1	Filter Capacitor Assembly, including eight 2-mfd, 18-kva capacitors	
	1	Filter Reactor (air-cooled)	
	3	Plate Transformers (Outdoor Type)	
1		Antenna Tuning Unit and Monitor Rectifier	7369
3		Distribution Transformers (25-kva, single-phase, outdoor type)	7368
1		Oil Circuit Breaker	7370
1		Water Cooling System, comprising:	
	1	Water Cooler (indoor type)	7365
	1	Set of Louvres and Controls	
	2	Centrifugal Pumps, Distilled-Water	
	1	Copper Reservoir, 300-Gallon, Distilled-Water	
2		Sets RCA Tubes (see "Tube Complement")	
1		Miscellaneous Hardware Kit	7474
2		Instruction Books, IB-30020	

DESCRIPTION

DESCRIPTION

The Type 50-D transmitter is available in either of two distinct styles known as the "straight line" and "U" types. In either case. the transmitter proper is the same, the only difference being in the front enclosure which is supplied separately (see "Equipment" under Part II). This enclosure provides a unified front appearance and is furnished in the two optional styles so that the various units may be arranged in the most advantageous layout for each station.

Each type enclosure is attractively styled to present a refined architectural appearance, both in line and color. Final finishes are applied at the time of installation. Indicating instruments are mounted upon the enclosure together with all devices and controls essential to routine operation. Most of the controls, however, are concealed by access doors which serve to protect them from inadvertent manipulation while they are not actually in use.

DESIGN

The transmitter proper consists of three main sections referred to herein as the driver, the power amplifier, and the power control and distribution sections. These are described in detail under subsequent Parts VIII, IX, and XII, respectively, of this instruction book. Other units furnished with this equipment for independent installation are described in Parts X, XI, XIII, and XIV.

In the driver section, the units from left to right, viewing the front, are the exciter, modulated amplifier, modulator-rectifier, and power control panel. The exciter is a standard RCA Type 250-F (250-watt) transmitter while the remaining units are very similar to those of the RCA 5-D (5-kw) transmitter. The amplifier is plate modulated.

Exceptional frequency stability is attained through the use of the new Type UL-4292 crystal-controlled oscillator, two of which are contained in the exciter to insure continuity of operation. The Type UL-4292 oscillator is a completely-shielded unit developed particularly for broadcast applications and will maintain the operating frequency constant within ± 10 cycles. The crystals proper are "V" cut since this type affords a low temperature coefficient and each is sealed inside a combination holder and oven, equipped with a vacuum thermostat. These holders are simply plugged into the respective oscillator units and the output frequency is adjustable by means of the screwdriver control at the front.

The 50-kw power amplifier uses two RCA-898 (100-kw) tubes in a Class B-C circuit, so-called because one side of the amplifier operates essentially Class C to give the normal carrier output power of 50,000 watts, while the other side of the circuit is brought into action on positive modulation peaks, operating Class B. One RCA-898 tube is used for each side of this circuit, both cooperating to produce the 200 kw required for positive 100% modulation peaks. Separate heavy-duty bias rectifiers supply bias to each tube and the tube filaments operate with three-phase excitation, which is very advantageous for high-fidelity performance.

The *peak* tube is located on the left and the *carrier* tube on the right. The center door provides entrance to an area-way between the components of each side of the amplifier which arrangement is convenient for making adjustments and servicing. There are no tuning controls on the front of this amplifier, all adjustments being made internally with suitable instruments and permanently maintained. The plate-tank circuits use new RCA air capacitors. These units are practically indestructable, require no servicing, and permit a compact and electrically efficient circuit arrangement.

Control of power output to comply with F.C.C. requirements is achieved by varying the power amplifier bias-voltage controls. Variation of excitation also is possible for control of power output if desired. The bias voltages are varied by means of Transtat, continuously-variable autotransformers. The r-f output is delivered to a 235-ohm, four-wire, open-type transmission line after passing through a harmonic filter. This filter can be adjusted for either the "T" or "Pi" connection as required for the needs of each particular installation.

A switch is provided in the power amplifier unit for emergency operation at 5-kw from the driver section. The changeover makes the application of high voltages in the power amplifier impossible and safely permits fault correction or tube change. Since the RCA-898 tube has six filament strands, the failure of one strand generally will not require immediate attention and the defective tube may be changed at the end of the broadcast day. The failure of a filament strand in the *peak* tube increases the carrier shift a few percent at high percentages of modulation. If the strand failure occurs in the *carrier* tube, the carrier power is reduced a few percent.

The main power rectifier is a new design unit with mountings for seven RCA-857B hot-cathode, mercury-vapor rectifier tubes, six of which are actively in circuit and the other in a warm-up position ready for instant entry into service. These tubes are maintained at proper mercury-vapor pressure by a blast of cool air directed against the base of each tube. The circuit is a 3-phase, full-wave, delta-series arrangement and the tubes are operated well within their ratings in all respects. The spare tube can be switched quickly to any part of the circuit without shifting the tube physically.

Although the main power rectifier utilizes the familiar RCA-857B tubes, noteworthy improvements have been made in the associated filter circuits. These circuits are equipped with a device which suppresses transients in the filter while starting or interrupting operation, thus tending to prolong the life of the rectifier tubes. Individual fused horn gaps are employed, one across each unit of the rectifier filter. The gaps are of a new type with the horns held in position by the fuse wire against spring tension. In the event of failure, the arc is taken by the horns and rapidly extinguished as the fuse melts and the spring pulls the gap apart. The faulty unit is then not only isolated from the filter but is short-circuited and completely discharged and so can be handled in perfect safety at any later time.

The plate transformers are specifically designed and tested for rectifier service. Each of the three single-phase units is rated at 50 kva, and is suitable for either indoor or outdoor locations. Secondary-tap switches are included.

The rectifier filter reactor is air cooled and therefore requires practically no maintenance. Protective gaps are provided across the terminals to ground. Pyranol-filled capacitor units are used to provide the utmost realiability obtainable, and extremely economical space requirements. The fused horn gaps and the surge suppressor have been mentioned. The capacitor rack is to be mounted on a suitable base, and may be located inside the building wherever convenient.

All control elements, with the exception of overload relays for the individual tubes, are centralized in a single automatic control panel for the main power amplifier, while those for the modulated amplifier are separately arranged in a similar manner. The distribution circuits are fed at 220 volts from a special panel located beside the main automatic control panel.

The control circuits are a transmitter feature of unusual merit from a maintenance standpoint. "Fail-safe" operation is employed, in that a failure of power will cause all circuits to return to the initial starting position, ready for complete recycling. It is impossible for abnormal sequences to be introduced by any event. Three-shot overload and lock-out protection is provided. Each power tube in the modulated amplifier, modulator and power amplifier is individually metered and protected with indicators which permit accurate accounting of the performance of each tube. Hour counters are provided for keeping a record of operating hours and tube life. Water-temperature and air-temperature protective devices are employed for protection of apparatus in extreme circumstances.

Status lights are provided to indicate the status of the major circuits, and are mounted on the automatic control panel. All relays and contactors are behind a panel door where they are readily accessible for observation and servicing.

Since three single-phase distribution transformers are employed, the 220-volt load could be carried by an open-delta arrangement of two of them in the rare event of a failure of one. As with the rectifier plate transformers, the only maintenance required is a semi-annual filtering of the oil.

Water cooling is used only in the final power amplifier. The driver section (5-kw) power tubes are air-cooled—a new development which greatly simplifies the design, as well as the maintenance of the equipment.

The cooling system is entirely porcelain and copper, insuring the lowest possible operating cost for distilled water. The porcelain insulating coils used with each RCA-898 tube are internally glazed. Normal pressure in the system is 60 pounds maximum, and a flow of 20 gallons of water per minute is delivered to each tube. If the transmitter is disposed on a single floor, the water tank and pumps should be located in a submerged area to permit automatic draining of the set after shut-down or when changing RCA-898 tubes. If a two-floor layout is desired, the cooling apparatus would be located on the lower floor. The radiator is arranged for a system of ducts which permits proper conditioning of the outside air with the warmed exhaust air leaving the unit so that, in cold weather, there is no danger of freezing and no need for using anti-freeze solutions.

Antenna tuning apparatus is supplied for matching the impedences of the antenna and transmission line. Although the actual network employed will depend upon the type of antenna, suitable apparatus is supplied to accommodate any particular case. Air-dielectric capacitors are used. A monitor from which the remote antenna ammeter is actuated also is included.

The outgoing waves from the antenna are monitored in the antenna circuit by means of a linear rectifier located in the antenna tuning house. This is a high-fidelity unit designed for the utmost linearity of amplitude and frequency response. The coupling to the antenna circuit is adjusted permanently, and the rectified d-c component connected back to an instrument at the station to indicate antenna current remotely, after suitable calibration. The audio output from the envelope of the carrier is connected to the monitoring system.

SAFETY

Extreme caution has been taken to insure positive safety, both of personnel and equipment. It is virtually impossible for one to come in contact with dangerous voltages. Interlock switches are provided on all doors giving access to apparatus, which remove all voltages except the 220-volt, a-c supply. In addition, mechanically-actuated, high-voltage grounding switches short-circuit the main power circuits to ground. Heavy-duty bleeder resistors are provided for the bias rectifiers. The fused horn gaps for the main filter capacitors are a new safety feature. Panels and operating adjustors are deadfront. The 220-volt distribution panel also is deadfront. The design conforms to the best outstanding engineering practices in the field, including the F.C.C. rules for good engineering practice, N.E.M.A. and A.I.E.E.

No inflammable materials are used in the construction of the transmitter unless treated for flameproof qualities. All r-f and high-voltage insulation is either porcelain, Isolantite or Mycalex.

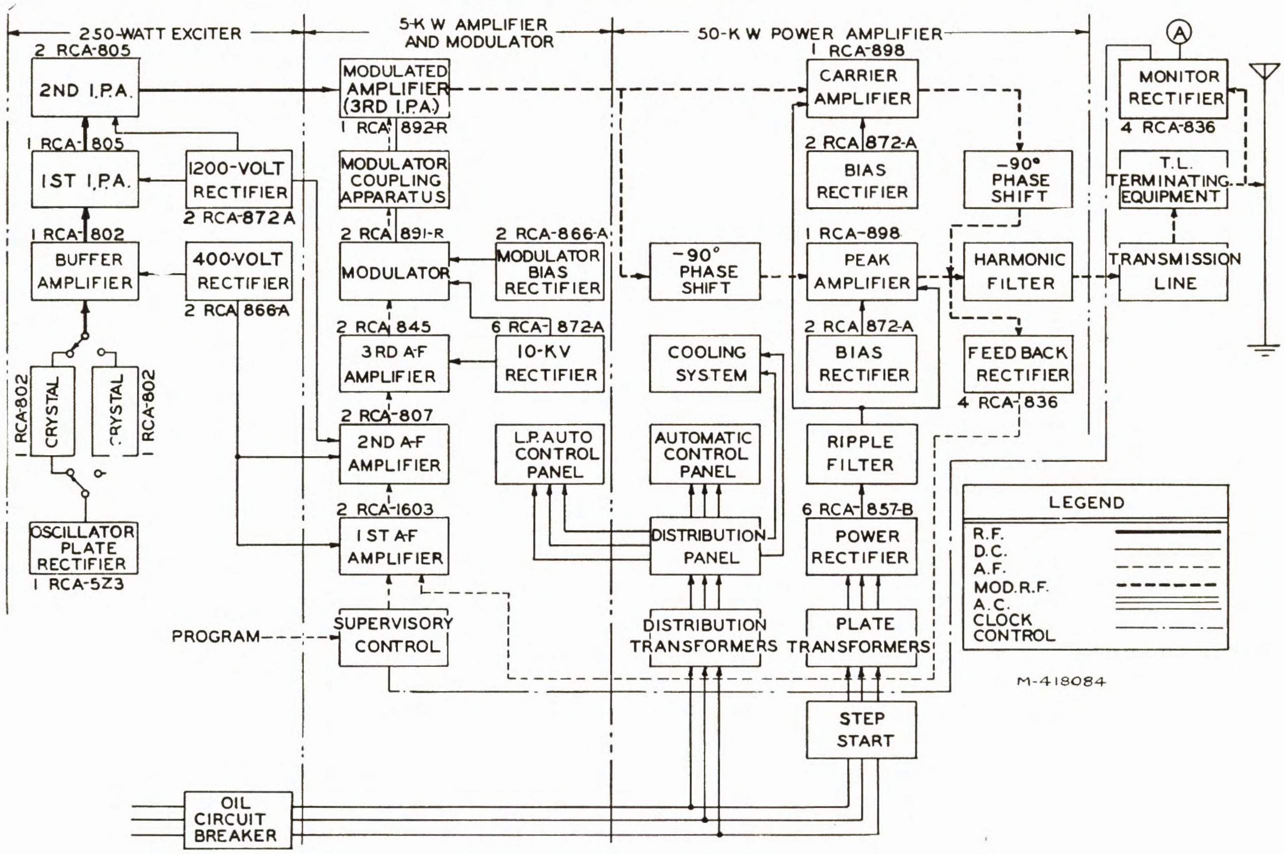


Figure 2—Block Diagram, Transmitter Circuits

F. C. C. CONSTRUCTION PERMIT AND LICENSE DATA

F. C. C. CONSTRUCTION PERMIT AND LICENSE DATA

for

Type 50-D Transmitter

Temp. Coefficient less than 1.5 cycles per megacycle per degree centigrade.

Question 17:

(a) **Make:** RCA Mfg. Co., Inc. TYPE No. 50-D

(b) **Oscillator: Type of Circuit** "V" Cut Quartz Crystal

Number, Manufacturer's Name and Type of Tubes

1 RCA-802

(c) **List Buffer and Intermediate Power Stages by Type of Tubes in Each Stage**

Buffer Amplifier 1—RCA-802
1st Int. Amp. 1—RCA-805
2nd Int. Amp. 2—RCA-805
3rd Int. Amp. 1—RCA-892-R

(d) **Last Radio Stage: Number, Manufacturer's Name and Type of Tubes**

2—RCA-~~898~~ (high efficiency linear amplifier circuit) (862)

Normal Night Operation for Power Requested: Plate Current Per Tube

Carrier tube 4 amperes
Peak tube 0.6 ampere (both for unmodulated carrier condition)

Plate Voltage: 18,000

(e) **Modulator or Last Audio Stage: Number, Manufacturer's Name and Type of Tube and How Operated**

2—RCA-891-R operated Class A

Normal Plate Current per Tube 0.35 ampere

Plate Voltage 10,000

(f) **What Radio Stage is Modulated?**

3rd intermediate (penultimate) amplifier is plate modulated.

(g) **What System of Modulation is Employed?** Low Level

(h) **If Low-Level Modulation is Employed, Give for Modulated Stage:**

Number and Type of Tubes

1—RCA-892-R

Plate Current per Tube 0.5 ampere

Plate Voltage 8500

(i) **The Transmitter is Designed for What Maximum Percentage of Satisfactory Modulation?**

100%

(j)

(k)

(l) **Specify Manufacturer's Name, Type, Number and Full Scale Reading of the Following Meters:**

(1) In Last Radio Stage:

Plate Voltmeter—Westinghouse Type HX 0-25 KV
Plate Ammeter—Westinghouse Type HX 0-10 amperes

(2) Antenna Ammeter—Westinghouse Type HX 0-35 amperes

(m) **Describe the Plate Power Supply for Last Stage**

Rating: Current 8 amperes
Voltage 18,000

(n) **Maximum Carrier Output of Transmitter for Satisfactory Operation Is**

50,000 watts

(o) **Maximum Rated Carrier Power of Transmitter As Determined By Orders of Federal Communication Commission Is**

50,000 watts

Question 18: **Description of Automatic Frequency Control Equipment**

(a) **Make**—RCA Mfg. Co., Inc. **Type No.** UL-4292

(c) **By Whom Will Unit Be Calibrated?** RCA Manufacturing Company, Inc.

(e) **State Number of Frequency Control Oscillators Which Will Be Maintained Constantly at Correct Operating Temperature and Frequency in Heat-Controlled Chambers:** Two

(f) **Is Provision Made for Instantaneous Connection of Spare Frequency Control Units:** Yes, switch provided.

(g) **Manufacturer's Name and Type of Automatic Temperature Control:** RCA TMV-129-B

(h) **State Within What Limit Automatic Temperature Control Will Hold the Temperature:** 0.25 degree C.

(i) **State Temperature Coefficient of the Frequency Control Units:** Less than 1.5 cycles/mc/degree C.

(j) **Is Temperature Coefficient Positive or Negative?** May be either positive or negative

(k) **State Manufacturer's Name and Rated Accuracy of Thermostat:**
Edison bi-metallic 1°C.
Thermometer not used

(l) **The Circuit Diagram of the Automatic Temperature Control System Is on File with the Commission**

(m) **Drawing of the Automatic Temperature Control Chamber is on File with the Commission**

Question 19:

Schematic circuit diagram dwg. WX-230294 is attached.

Question: State make & type of frequency monitor giving F.C.C. approval number.

Answer:-

	Fcc Approval No
RCA type 311 A	1462
RCA type 311AB	1462
G.R. type 475C	1461

RECOMMENDED TEST EQUIPMENT

RECOMMENDED TEST EQUIPMENT

The following equipment is required in testing the Type 50-D Transmitter. Such items should be included as part of the regular station equipment to facilitate the routine measurements necessary to maintain optimum performance. Most of this equipment is procurable from either the RCA Manufacturing Co., Inc., Camden, N. J., or the General Radio Co., Cambridge, Mass. Other items, listed in the "Miscellaneous" group, are common instruments which can be obtained locally.

Item	Designation	Item	Designation
RCA			
Beat-Frequency Oscillator	Type 68-A	Test Oscillator	Stock 150
	or Type 68-B	Cathode-Ray Oscillograph	Stock 155
Distortion and Noise Meter	Type 69-A	Universal A-C Bridge	Stock 9600
GENERAL RADIO			
Vacuum-Tube Voltmeter	Type 726-A	500-Mmfd Condenser	Type 505-E
Radio-Frequency Bridge	Type 516-C	1000-Mmfd Condenser	Type 505-F
1111-Ohm Decade Boxes (2)	Type 602-K	100-Ohm Resistor	Type 500-D
100-Mmfd Condenser	Type 505-A	200-Ohm Resistor	Type 500-E
200-Mmfd Condenser	Type 505-B	500-Ohm Resistor	Type 500-F
MISCELLANEOUS			
500-Volt Portable Megger		Volt-Ohmmeter	

NORMAL INSTRUMENT READINGS

NORMAL INSTRUMENT READINGS

DRIVER SECTION

EXCITER UNIT:

Panel	Line Voltage (304)	115 volts a.c.
	Osc. Plate Voltage (315)	320 to 340 volts d.c.
	Osc. Plate Current (316)	15 to 30 ma d.c.
	2nd IPA Plate Voltage (182)	1.44 to 1.47 kilovolts d.c.
	2nd IPA Plate Current (155)	310 to 350 ma d.c.
	Mod. Plate, left (231)	Not used
	Mod. Plate, right (231)	Not used
	R-F Output	Not used
Sub-panel	1st Audio Plate, left	Not used
	1st Audio Plate, right	Not used
	2nd Audio Plate, left	Not used
	2nd Audio Plate, right	Not used
	Buffer Plate Current (127)	50 to 60 ma d.c.
	1st IPA Grid Current (138)	35 to 45 ma d.c.
	1st IPA Plate Current (139)	75 to 100 ma d.c.
	2nd IPA Grid Current (140)	100 to 120 ma d.c.

MODULATED AMPLIFIER UNIT:

Panel	Modulated Amplifier Grid Current (1M1)	215 to 230 ma d.c.
	Modulated Amplifier Plate Current (1M2)	0.48 to 0.52 amperes d.c.
	R-F Tank Current (1M3)	7 to 9 amperes r.f.
Sub-panel	1st Audio Plate Current (3M1)	4 to 6 ma d.c.
	2nd Audio Plate Current (3M2)	115 to 125 ma d.c.
	3rd Audio or Modulator Driver Plate Current (3M3)	90 to 100 ma d.c.

MODULATOR-RECTIFIER UNIT:

Panel	Modulator # 1 Plate Current (2M1)	0.33 to 0.38 amperes d.c.
	Modulator # 2 Plate Current (2M2)	0.33 to 0.38 amperes d.c.
	Plate Voltage (2M3)	9.9 to 10.1 kilovolts d.c.

POWER CONTROL PANEL:

Line Voltage (7M1)	(1)	Phase A	220 to 230	volts a.c. (4 positions)
	(2)	Phase B	220 to 230	
	(3)	Phase C	220 to 230	
	(4)	10-kv Rect. Fil. Tr. Pri.	210	
Filament Voltage (7M2)	(1)	Mod. # 1	14.5 to 15.5	volts a.c. (3 positions)
	(2)	Mod. # 2	14.5 to 15.5	
	(3)	Mod.-Ampl.	15.5	
Tube Life (7M3)				hours

POWER AMPLIFIER SECTION

Peak Tube Grid Current (M11)			Approx. 0 amperes d.c.
Carrier Tube Grid Current (M17)			Approx. 0 amperes d.c.
Bias Voltage (M20)	(1)	Peak Tube	1125 to 1200 volts d.c. (2 positions)
	(2)	Carrier Tube	235 to 260
Peak Tube Plate Current (M12)			0.4 to 0.7 amperes d.c.
Carrier Tube Plate Current (M18)			3.8 to 4.0 amperes d.c.

Total Plate Current (M13)		4 to 4.6	amperes d.c.
Plate Voltage (M19)		18	kilovolts d.c.
Filament Voltage (M14)	(1)	30	volts a.c. (6 positions)
	(2)	30	
	(3)	30	
	(4)	30	
	(5)	30	
	(6)	30	

POWER CONTROL AND DISTRIBUTION SECTION

Line Voltage (207)	(1)	2300	volts a.c. (3 positions)
	(2)	2300	
	(3)	2300	
Bus Voltage (211)	(1)	220 to 230	volts a.c. (3 positions)
	(2)	220 to 230	
	(3)	220 to 230	
Remote Antenna Current (M27)			amperes r.f.

ROUTINE MAINTENANCE SCHEDULE

ROUTINE MAINTENANCE SCHEDULE

Daily

1. General inspection after shut-down. Inspect pumps and surge suppressor relay.
2. Check all alarms and status lights.
3. Count filament strands in RCA-898 tubes.
4. Inspect antenna transmission-line terminating equipment.
5. Hourly inspection of cooling apparatus; level in distilled-water tank, operation of automatic louvre controls, temperatures of cooling water and anode temperatures of air-cooled RCA-891-R and RCA-892-R tubes.

Weekly

1. Check and log water resistance.
2. Clean internal parts of transmitter; insulators, bushings, etc.
3. Inspect all auxiliary relays. Clean and adjust as required.
4. Inspect contactor fingers. Dress smaller contacts with crocus cloth, larger ones with mill file, as required. Keep pole faces clean and rust-free to avoid excessive hum. Check operation manually, tightening any loose screws. Replace broken arc-chutes and magnetic blow-outs.
5. Test operation of notching and synchronous timing relays. Clean and lubricate as required.
6. Service all high-speed overload relays.
7. Test air-flow interlocks in driver units; water interlocks in power amplifier; all door interlocks.
8. Examine contacts on grounding switches and check operation.
9. Pinch jaws of 5/50 KW transfer switch together and check operation. Service relay E-1.
10. Check contacts in all Ohmspun resistor banks, cleaning with crocus cloth and pinching springs together as required.
11. Check resistance of surge suppressors and all Globar composition resistors.
12. Test feed-back and monitor rectifier tubes.
13. Clean antenna tuning apparatus.
14. Test calibration of remote antenna ammeter against direct antenna ammeter.
15. Change water pumps.
16. Record emission checks of low-power audio tubes.
17. Record response characteristics with and without feed-back.

Monthly

1. Clean RCA-872-A and RCA-866-A tube prongs and sockets.
2. Clean blower blades in driver units and main rectifier; check cooler fan blades.
3. Check grease and oil in all rotating machines.
4. Inspect hose reels and fittings.
5. Check lubrication of clocks and hour counters.
6. Clean console attenuator contacts.
7. Check air filters in driver units and water cooler.
8. Replace distilled water losses.
9. Record instantaneous arc-drop characteristics of RCA-857-B and RCA-872-A rectifier tubes.
10. Service voltage regulator auxiliaries (if used).

Quarterly

1. General detailed close inspection of every unit in transmitter, with whatever tests of parts seem advisable.
2. Test all spare power tubes in circuit and clean up any gassy tubes.
3. Replace electrolytic targets in hose reels. Remove low-potential hose-reel fittings and remove any deposits from reels.
4. Check plate contactors, delta-wye switch, and main OCB. Renew fingers as required. Change oil when black or sludged.

Semi-Annually

1. Service cooling unit. Remove corrosion from metallic surfaces and treat with corrosion-resisting compound. Wire brush fan blades if badly pitted or corroded.
2. Test transformer oil and filter if necessary.
3. Clean transmission-line insulators and check all grounding or bonding joints for corrosion or electrolysis.

DRIVER SECTION OF TRANSMITTER
(5 KW)

REFERENCE DRAWINGS

T-606624

MX-242016

PX-271719

TX-260868

DRIVER SECTION OF TRANSMITTER (5 KW)

CIRCUITS

The complete electrical circuit of this driver section is shown in the overall schematic diagram, Figure 50. 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 modulated 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	Modulated Amplifier
2	Modulator-Rectifier
3	Low-Power Audio Amplifier
4	Filter-Rack
5	High-Voltage Transformer
6	Modulation Reactor
7	Power Control Panel

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 driver section is clearly shown by the simplified diagram of the control circuits included on the overall schematic diagram. Reference should be made to this control-circuit diagram while reading the following discussion.

The main line switch (7S1) controls the power supply to the complete section 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 driver section. Operation of relay 7S27 will cause the notching relay (7S18) to function if the driver section is set for automatic operation.

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. After the first and second overloads, the driver section 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 driver section. The driver section may be placed on the air by throwing switch 2S10 to the "RESET" position momentarily. If the latter switch 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.

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 7S30 opens the holding coil circuit of the 10-kv 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 modulated amplifier and at the same time operate 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 (modulated) amplifier stage are contained in the exciter unit. The modulated 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 1,600 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 (1st IPA) stage. Plate and screen voltages are obtained from the 400-volt rectifier (see "Rectifier Circuits").

The first intermediate power amplifier (1st IPA) stage uses an RCA-805 tube and furnishes a balanced output voltage for excitation of the two tubes used in the following (2nd IPA) 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 1200-volt rectifier (see "Rectifier Circuits").

The second IPA 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 modulated ampliger. As in the case of the first IPA stage, plate voltage is obtained from the 1200-volt rectifier.

An RCA-892-R tube operated Class C is used in the modulated amplifier (3rd IPA) 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 two fixed capacitors (1C12) in series arrangement, the main tuning coil (1L6), and the panel-controlled variable inductor (1L7). This circuit is roughly tuned by adjustment of the taps on coil 1L6 and finally adjusted by variation of inductor 1L7, which varies the reactance of the capacitive branch of the tank circuit. Grid drive voltage for the final amplifier is taken from a tap on the tank inductor 1L6. Variable inductor 1L8 is in series with the grid to the final amplifier and permits panel control of the loading on the modulated amplifier. Plate voltage for the modulated amplifier is procured from the 10-kv rectifier stage located in the modulator-rectifier unit (see "Rectifier Circuits").

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 a level of less than one milliwatt (input level required varies with amount of feedback employed) is delivered to the input transformer (3T1) feeding the first audio amplifier which uses two RCA-1603 tubes in parallel arrangement. Since the secondary of the input transformer is connected in series with the feedback voltage potentiometer 3R15, the first audio grids are excited by a voltage which is the vector sum of the input and feedback voltages. Plate and screen voltages for the first audio tubes are supplied by the 400-volt rectifier in the exciter.

Two RCA-807 tubes in parallel are employed for the second audio amplifier which is resistance coupled to the first stage. This stage receives plate and screen potentials from the 1200-volt rectifier in the exciter.

The third audio or modulator driver stage likewise is resistance coupled to the second and utilizes two RCA-845 tubes in a parallel circuit. These obtain plate power from the 10-kv rectifier in the modulated-rectifier unit. The output of this third stage is coupled to the modulator driver transformer (2T13) also located in the modulator-rectifier unit.

Low-level modulation of the transmitter is performed by the final a-f or modulator stage which embodies two RCA-891-R tubes in parallel. Plate and bias voltages for these tubes are furnished by the 10-kv and bias rectifiers (see "Rectifier Circuits").

The circuit elements throughout this audio system are designed to reduce phase shift to such a degree that the feedback loop is inherently stable.

RECTIFIER CIRCUITS

Five rectifier circuits are employed in this driver section. The oscillator rectifier and the 400- and 1200-volt rectifiers are embodied in the exciter while the 10-kv and bias rectifiers are contained in the modulator-rectifier. All circuits are of the full-wave type and 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 400-volt rectifier which supplies plate and screen voltages to the buffer and first audio amplifiers. The 1200-volt rectifier uses two RCA-872-A tubes to provide plate voltages for the first and second IPA stages, and plate and screen voltages for the second audio amplifier. 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 10-kv rectifier comprises six RCA-872-A tubes in a three-phase, full-wave circuit to furnish plate power for the modulated amplifier and modulator stages and plate voltage for the third audio amplifier. High voltage, a-c power is delivered to this (10-kv) 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.

Normally, the modulators receive the full output voltage of the rectifiers. The modulated amplifier receives power through the plate dropping resistors, 4R11 to 22, inclusive.

There are two complete filter systems arranged so that the 10-kv rectifier functions simultaneously as a full-wave rectifier and as a half-wave rectifier. For test purposes half-voltage may be applied to the modulator and modulated amplifier, by operating the power-change relay, 4S2. This relay is controlled by switch 7S30 on the driver power control panel.

Under either condition of operation, the RCA-845 audio drivers are fed from the half-wave section through the dropping resistors 4R7, 4R8 and 4R9. To provide voltage regulation, a thyrite unit is connected from the low-potential end of resistor 4R7 to ground.

Series reactances in the form of retard chokes (7X1, 7X2, 7X3) are incorporated in the power-feed circuit of the 10-kv rectifier to limit surge currents during short-circuit faults such as gas flashes and rectifier backfires. This is a new feature in transmitters for broadcast service which prevents undesirable breaker operation during transient faults which should normally be cleared by operation of the high-speed overload relays.

INSTALLATION

ASSEMBLY DETAILS

All circuit elements removed for shipment are tagged and identified for replacement. Reference to the marked photographs of the various driver units will simplify this assembly work.

Complete information for interconnecting the units is given on wire chart TX-260860. This drawing covers all necessary specifications for conductors employed in the installation. An average installation will require approximately 1300 feet of #14, 600-volt lead-sheathed wire and 250 feet of #12. The larger power circuits and overhead bus connections may be accurately determined from a layout sketch of the actual installation.

Dimensional outlines of the equipment for installation purposes are shown on drawings T-611522 and WX-230283.

A few of the parts are removed from the exciter unit and packed separately to insure safer transportation. Each part is labeled and reference to the circuit diagrams and photographs will enable their correct placement. The two antenna coupling coils (167, 168) of the exciter unit need not be installed. All red wooden blocks and associated steel support bolts should be removed.

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 22kv 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, #A15 and #A16, and #B10 and #B11.
2. Connect jumpers between terminals #A13 and #A16 and terminals #A14 and #A17.

3. Remove connection from upper right-hand terminal of item 350 (facing rear) which is the 250-F power change switch but not used. Tape the lead end.
4. Open the holding-coil circuits of relays 180 and 233 to prevent their operation if desired since these relays are not required.
5. Check the connection of terminal #CP82 to terminal #EX1 on relay 323—the lower left-hand operating coil terminal.
6. Check the auto-transformer (302) and make certain that the outer (230-volt) terminals are connected to terminals #A27 and #A28.
7. Check the 1200-volt rectifier plate transformer (326) and make certain that the secondary connections are attached to the terminals marked #1.
8. Check the 400-volt rectifier plate transformer (338) and make certain that the secondary connections are attached to the terminals marked "1290".
9. Short-circuit resistor 343 by connecting the strap across the clip terminals of that unit.
10. 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 50).
11. Connect the rotor of the PA tank coil (165) to terminals #1W1 and #1W2 in the modulated amplifier, using ⅛-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.

In the modulated 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 an 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.

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
4X1	Fitter Reactor	3/16 inch (0.187″)
4X2	Filter Reactor	¼ inch (0.250″) max.
6X1	Modulation 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 gap on the modulation reactor so that it will flash at approximately 10 db. above 100% modulation level.

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 throw-out values:

Item	Relay	Setting (amperes)
333	1200-volt Rectifier	1.7
345	400-volt Rectifier	0.8
7S22	Modulated Amplifier	0.8
7S23	Modulator	1.0
7S25 7S26	10-kv Rectifier (Pri.)	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 are 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, 10-kv 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, 10-kv 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, Modulated 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, 10-kv 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 filament and plate voltages to the 10-kv rectifier. 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 of one second will cause a delay in application of plate voltage of approximately one second. This eliminates the need of the full delay where only a short interruption has occurred.

7. Item 7S21, Blower "Keep-Alive" Relay: This relay 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) or this circuit will fail to operate. Adjust for four to seven minutes.

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. 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.

STARTING SEQUENCE

To start the driver section, 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

Under all conditions of operation, main station start switch C101 must be closed, energizing the low-power control relay (C102).

One set of contacts on relay C102 are in series with the exciter filament start switch (305).

All door interlocks must be closed unless the main power change switch is set for 5-kw operation. Under this condition, the doors of the power amplifier section may be opened. Interlock relay E-1 shorts out these interlocks during 5-kw operation.

Switch 2S10 must be in the "RESET" position. All manually-operated breakers in the exciter unit (301, 307, 324) and all in the power control panel must be closed. All door interlocks must be closed.

Close the exciter and modulated amplifier filament switches (305, 1S10). The latter switch normally would be left in the "ON" position so that all filaments will be energized upon closing switch 305. Closure of switch 305 starts the exciter time-delay relay (309) and all blower motors, while closure of switch 1S10 starts the amplifier time-delay relays (7S19, 7S20). For a "cold" start, it is advisable to wait several minutes before applying any plate potentials. It is also preferable to start with "LOW POWER" operation.

After proper delay, the "READY" pilot light (1A6) will indicate that the minimum delay time has elapsed. The exciter plate switch (322) may now be closed, applying plate power to all exciter stages and all low-power audio stages. Power is then applied to modulated amplifier and modulator by depressing the "MAIN RECTIFIER"—ON" switch (1S9) momentarily. Closure of switch 322 energizes the exciter plate contactor (323) which upon closing, completes the circuit to the driver section main plate contactor (7S17) up to the start switch (1S9). However, if switch 2S10 is set for "AUTOMATIC" operation, contactor 7S17 would operate immediately upon closing switch 322.

The high-power interlock relay (C127) operates through a set of normally-open contact fingers on contactor 7S17. Energizing of the latter contactor therefore operates relay C127.

To shut down the driver section, simply open the exciter filament switch (305) or the main station switch (C101). 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" pilot light (1A4) is extinguished, indicating that the blowers have stopped.

Power may be reduced in the driver, or the reverse, merely by shifting the power-change switch (7S30) to the proper position. Unless switch 2S10 is set at "AUTOMATIC," it will be necessary to operate switch 1S9 again to energize the 10-kv rectifier after a power change. The same operation is necessary should any overload relay function. In the case of automatic operation, should the overloads operate three times, the notching relay (7S18) must be reset by momentarily placing switch 2S10 in the "RESET" position.

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 operation of the exciter filament switch (305) only, assuming that all interlock switches, filament switch 1S10, exciter pjlate switch 322 and main station start switch C101 are closed. Closure of switch 305 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.

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 PROCEDURE

Open the "PLATE" overload switch (324) in the exciter and the 10-kv 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 anode 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). Check the oscillator plate voltage and current as indicated respectively by meters 315 and 316. The readings obtained should be within the limits specified in Part VI; i. e., 320 to 340 volts and 15 to 30 ma. Measurements should be made at 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 400-volt 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 capacity 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 first IPA plate-tank coil (145) as follows:

	550-850 kc	**850-1150 kc**	**1150-1600 kc**
Taps from 1st IPA tank capacitor (144)	P1–P1	P1–P1	P2–P2
Plate supply tap	C2	C1	C2
Taps to 2nd IPA grids (from frame out)	G2–G2	G1–G2	G2–G2

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 2nd IPA tubes; these taps are not to be employed except where the unbalance is 10% or greater.

Replace the plate caps on the first-IPA (RCA-805) and two 1200-volt rectifier (RCA-866-A) tubes and reasonate the first-IPA tank circuit by rotating the associated variable capacitor (144) from maximum capacity 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 first-IPA stage by setting the neutralizing capacitor (141) for a minimum, or for zero tank current with no plate voltage. 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 second-IPA (RCA-805) tubes and adjust the rotor in the associated plate-tank coil (165) for minimum coupling to the modulated 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 second-IPA 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)	**Active Turns/Section from Center**	**Fixed Tank Capacitance (each side)**	
		Mmfd	**Capacitors**
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. After making each trial setting, apply plate voltage and resonate the plate tank circuit by rotating the variable capacitor (164) from maximum capacity toward "minimum" until an adjustment is obtained where a plate current "dip" is indicated upon meter 155.

Neutralize the second-IPA stage by connecting a 0-115 millampere thermo-galvanometer or a 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.

The plate current of the second-IPA stage will be somewhat excessive until plate voltage is applied to the modulated 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 second-IPA stage will indicate reverse grid current. The currents should balance within 5% of the mean and in no case should exceed 210 ma plate current per tube.

All of the exciter neutralization adjustments should be checked after the entire driver section 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 oscillograph after modulation has been applied.

MODULATED AMPLIFIER

The exciter and 10-kv 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 modulated amplifier to avoid any possibility of power application.

Connect the feed line from the exciter (terminals #1W1 and #1W2) to taps on the modulated 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 required for the operating frequency involved. Capacitors 1C24 and 1C25 should be used at all frequencies, while capacitors 1C1 (0.0004 mfd) and 1C2 (0.0003 mfd) should be connected as shown in the following tabulation:

Frequency Range (kc)	Capacitors Required	Capacitor Connection
550- 650	1C1 and 1C2	Parallel
650- 850	1C1	Single
850-1350	1C2	Single
1350-1600	1C1 and 1C2	Single

Plate-Tank Circuits. The plate tank coil (1L6) should be adjusted with respect to the operating frequency, maintaining the effective turns at the bottom of the coil. Approximate settings for this coil throughout the overall frequency range are as follows:

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. 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.

The leads from the variable tank tuning inductor (1L7) connect across three or four turns of the tank coil (1L6), and the excitation lead for the main power amplifier is connected midway between the connections of inductor 1L7. The clamps are placed a few turns above the low-potential end of coil 1L6 so that about one-quarter of the active coil turns will be between the clamps and ground potential.

Connect the plate-tank circuit capacitors (1C11, 1C12) in series, selecting values with respect to frequency as shown in the following tabulation. 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 0.5-ampere 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.

Frequency Range (kc)	Tank Capacitance (mmfd)	Tank Capacitors			
		1C11		1C12	
		Mmfd	UC-	Mmfd	UC-
550-650	150	.0003	3113	.0003	3113
650-750	133	.0002	3119	.0004	3107
750-850	100	.0002	3119	.0002	3119
850-1050	75	.00015	3125	.00015	3125
1050-1350	60	.0001	3131	.00015	3125
1350-1600	50	.0001	3131	.0001	3131

Final R-F Adjustments. Final adjustments of the plate-tank circuit in the power amplifier unit obviously requires 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 10-kv rectifier switch (7S29).

CAUTION—THE POWER-CHANGE SWITCH (7S30) SHOULD BE IN THE "LOW POWER" POSITION FOR THE FIRST APPLICATION OF POWER.

The plate-tank circuit now may be resonated by changing the number of effective turns on the plate-tank coil (1L6). Such variation should be made 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.

After the plate-tank circuit adjustments have been made and if there is no indication whatever of abnormal operation, the power-change switch (7S30) should be thrown to the "HIGH POWER" position. Observe the value of plate current at the minimum or "dip" position as registered upon 1M2.

Upon obtaining a condition of normal plate current in the modulated amplifier, adjust the modulator driver series plate resistors (4R7, 4R8, 4R9) until the normal plate current of ma is attained.

Throw switch 7S30 once again to the "LOW POWER" position and 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 driver section 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 (7S30) to "HIGH POWER" and repeat this test.

In conclusion, it should be observed that the power output and efficiency 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.

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.

MODULATOR-RECTIFIER

Modulator Bias. Adjust the total static plate current of the modulator tubes to a value of approximately 350 ma by means of the variable resistor 2R9. Movement of the slider toward the front panel will increase the static plate currents.

CORRECTIVE MEASURES

DISTORTION CONTROL

Careful observance of the following details of operation will insure satisfactory control of distortion:

1. Filament Voltages: The filament voltages of the modulators and modulated 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 determined by distortion. It is very important that the filaments be operated at a voltage slightly above the minimum value which results in increased distortion.

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 modulated amplifier filament. Adjust the modulators by means of rheostats 7R11 and 7R12, starting with a potential of 13 volts for new tubes. The modulated 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 flattening of the positive peaks of modulation with a consequent increase of distortion.

Adjust the master rheostat (7R13) for a normal potential of 210 volts on the 10-kv 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 voltage of these transformers should be 5 volts and, if otherwise, the primary taps and rheostat, 7R13 should be shifted as required.

2. Grid Excitation: Variation of grid excitation will afford a fine control of distortion.

3. A-F Plate Voltages: All audio tubes must be operated at proper plate voltage for minimum distortion.

4. Modulated 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. 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 driver section. All of these are associated with the modulated amplifier and modulated stages, as follows:

1. Grid Excitation: The grid excitation to the modulated amplifier must be maintained above the minimum limit (190 ma).

2. Filament Balancing: Balancing of the respective filament circuits is accomplished by adjustment of resistors 1R3, 2R1 and 2R2. Initially, these resistors 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 of the modulated-amplifier tube is obtained by adjustment of rheostat 7R10, 7R10A, 7R10B. Similarly, phase balancing of the two modulator tubes is accomplished by adjustment of rheostats 7R11, 7R11A, 7R11B and 7R12, 7R12A, 7R12B.

In each case, a minimum value of resistance should be used, measuring voltages at the tube contacts 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.

IX

POWER AMPLIFIER SECTION
OF TRANSMITTER
(50 KW)

REFERENCE DRAWINGS
WX-230294
WX-230260

POWER AMPLIFIER SECTION OF TRANSMITTER (50 KW)

HIGH-EFFICIENCY LINEAR AMPLIFIER

BASIC PRINCIPLES

Reduced to the simplest terms, the High-Efficiency Linear Amplifier consists of two tubes driven out of phase and delivering their outputs in phase to a common load. The amplifier circuit thus is divided into two parallel branches known as the *peak* and *carrier* sides respectively. Under carrier conditions, the *carrier* tube is operated in a nearly saturated condition while the *peak* tube is biased almost to cut-off. The *carrier* tube therefore supplies most of the carrier power of 50 kilowatts, only a very small amount being furnished by the *peak* tube. During modulation, the *peak* tube contributes virtually all of the positive modulation, while the *carrier* tube takes care of only the downward modulation. The dynamic loading of the two tubes changes with modulation in a manner described later within this section, so that for carrier conditions the output is 50 kw, and the peak instantaneous power during peaks of modulation is the required 200 kw.

COUPLING NETWORKS

Phasing of the grid and plate voltages is accomplished by means of quarter-wave networks between the two tubes. The plate-coupling network is utilized as an impedance-inverting device, operating in the following manner: At carrier conditions, the load as viewed from the *carrier* tube is approximately 2800 ohms, and the *carrier* tube is delivering 50 kw to the load. The *peak* tube is delivering only a small amount of power as it is biased to draw very little plate current at that point. As excitation is increased, the *peak* tube begins to deliver power due to the flow of plate current and the net effective load as viewed from the *carrier* tube through the impedance-inverting network, begins to decrease. The *carrier* tube therefore delivers more power into the load since it maintains essentially constant voltage across a decreasing load resistance, reaching a limit at a net output of 100 kw. The *peak* tube is now increasing its power delivery since its plate current increases with excitation until it reaches saturation at a net output of 100 kw. At this instant (maximum point of excitation cycle), each tube is delivering 100 kw into a common load of approximately 1400 ohms, and if the voltages across the load are in phase, the net total output will be 200 kw, satisfying the requirement of four times the carrier power for 100 percent amplitude modulation.

By using a quarter-wave network to accomplish the impedance inversion necessary for the proper operation of the amplifier, an unavoidable phase shift is introduced, causing the output voltage of the *carrier* tube to lag that of the *peak* tube by 90 degrees. To compensate for this action, it is necessary to introduce an equal lag in the excitation voltage to the *peak* tube and so another quarter-wave network is employed at that point. The impedance inverting properties of the circuit are used to advantage, permitting the use of a single grid-loading resistor physically connected in parallel with the grid of the *peak* tube. The ohmic value of this resistor is low enough to give the correct degree of regulation compensation for the *peak* grid, and is also lower than the reactance value of the network elements, so that the resistance reflected to the grid of the *carrier* tube is higher and is the correct value for regulation control in the grid circuit of the latter.

The quarter-wave networks employed in this transmitter are of the "Pi" type, in which the reactances are equal. Designating the shunt elements as X_1 and X_3, and the series element as X_2, the following conditions will obtain when a load resistance (R) is connected in parallel with X_3: (1) As R is increased, approaching infinity as a limit, X_2 and X_3 constitute a series resonant circuit whose net effect is a short-circuit across the system as viewed from the "send" end across X_1; (2) As R is decreased, approaching zero as a limit, X_3 is short-circuited and X_1 and X_2 constitute a parallel resonant circuit whose net effect is an infinite impedance or open circuit. Therefore, reducing the value of the load resistance raises the net impedance at the "send" end of the line, and vice versa.

PHASE RELATIONS

The block diagram of Figure 3 divides the amplifier circuit into its constituent elements. The voltages at each point in the circuit are indicated symbolically. The excitation voltage, E_x, appears directly on the grid of the *carrier* tube, but passes through a 90-degree phase retarding circuit in the *peak* branch, where it becomes voltage E_2 at the grid of the *peak* tube. The *carrier* excitation voltage E_x is amplified and the a-c component of the plate voltage becomes the carrier output voltage E_1, the phase of which is inverted with respect to E_x. Voltage E_1 passes through the impedance inverting network and receives a 90-degree phase shift at the terminals of

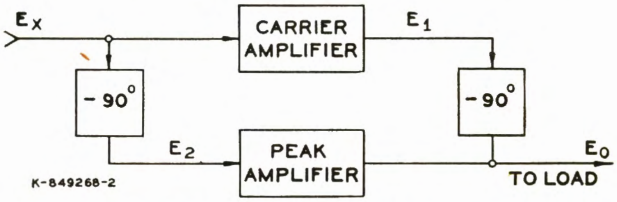


Figure 3—Block Diagram, Power Amplifier System

the load. In the *peak* branch of the circuit, the grid voltage E_2 is inverted in passing through the *peak* tube, and the a-c component of the plate voltage appears across the terminals of the load in phase with the output voltage of the *carrier* tube. These phase relations are shown vectorially in Figure 4.

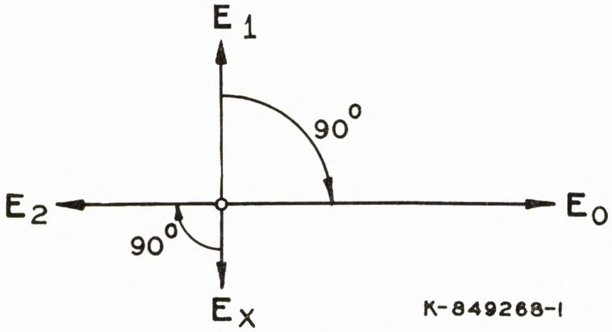


Figure 4—Phase Relations in Power Amplifier

Figure 5 shows the fundamental operating characteristics of the two branches of the amplifier during a complete cycle of full modulation. The plate voltage for the *carrier* tube rises linearly from "O" to "A" at which point saturation occurs. From this point on, an increase in exciting voltage produces very little increase in plate voltage. Plate current for the *carrier* tube rises linearly from "O" to "B". From "O" to "A", the action is strictly Class B linear amplification into a constant load while from "A" to "B", the plate current increases because there is a progressive reduction in its plate impedance due to the influence of the positive delivery of power by the *peak* tube on upward modulation, as seen through the impedance-inverting circuit. In the *peak* amplifier, the plate voltage rises linearly from "O" to "B" where saturation occurs. While this branch is biased so that it delivers very little positive power for exciting voltages below carrier amplitude "A", a voltage exists in its plate circuit nevertheless during this quiescent stage by virtue of its coupling to the *carrier* amplifier output circuit through the im-

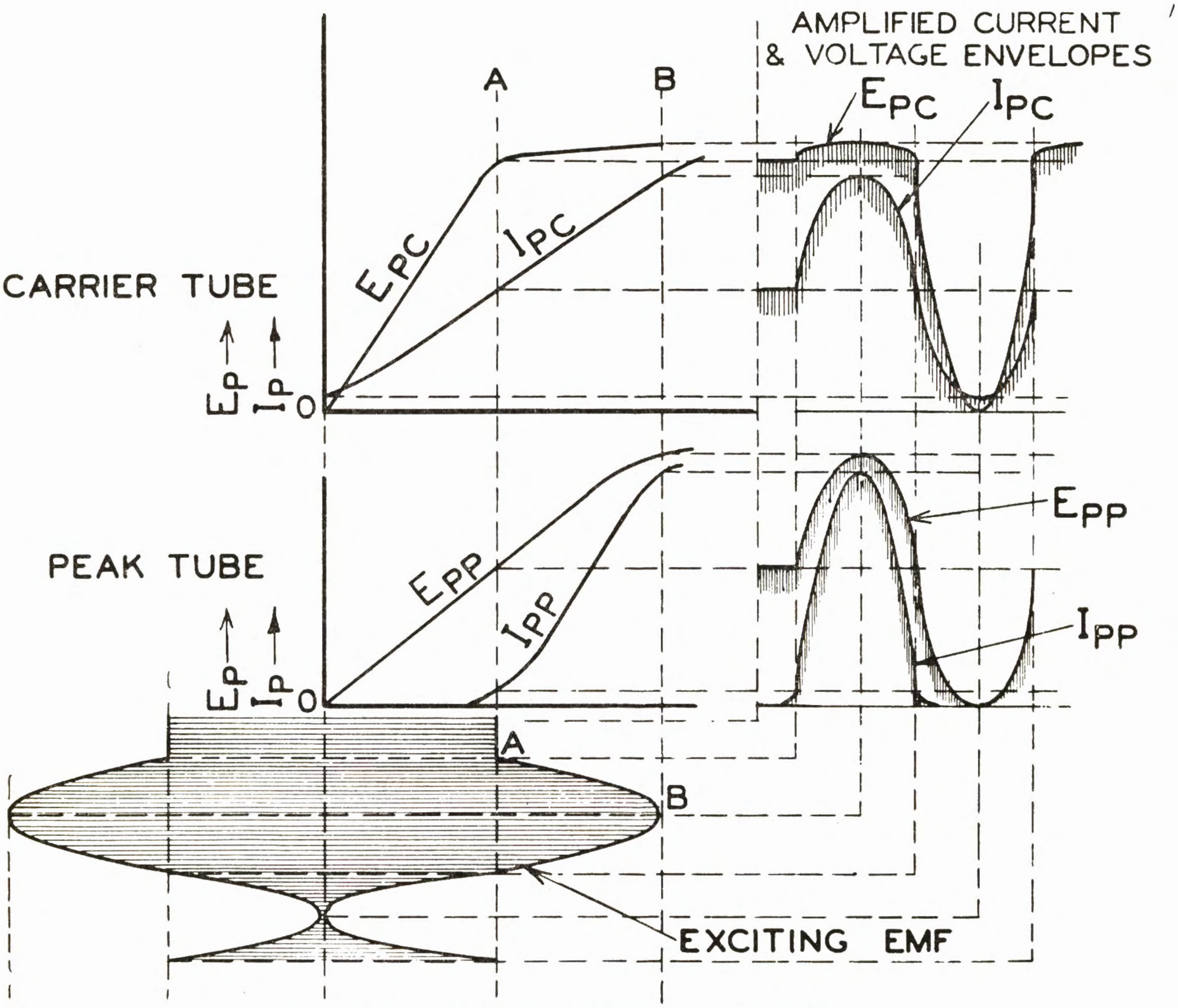


Figure 5—Amplifier Operating Characteristics

pedance-inverting network. Thus, a linear variation in the plate voltage for the *carrier* tube between "O" and "A" produces a corresponding linear voltage variation between "O" and "A" in the *peak* amplifier plate circuit which is in parallel with the load. Due to the conditions of bias with respect to the exciting voltage for the *peak* amplifier, plate current begins to flow in appreciable amounts when the exciting voltage assumes amplitudes higher than that of the unmodulated carrier. From "A" to "B" the plate current rises in an essentially linear manner to the limit at "B". At the crest of the modulation cycle ("B"), both the *carrier* and *peak* amplifiers are delivering equal outputs in phase to the load.

TUNING PROCEDURE

Preliminary tuning of the power-amplifier circuits is accomplished by making a few simple bridge measurements, followed by neutralizing adjustments using a vacuum-tube voltmeter as an indicating instrument. Final tuning adjustments are then made to obtain correct phasing as indicated on a cathode-ray oscillograph connected to the grid and plate circuits through external jacks. A detailed step-by-step tuning procedure is outlined in the following paragraphs:

TERMINATION OF ANTENNA TRANSMISSION LINE

Using an impedance bridge, measure the characteristic impedance (R_0) of the transmission line with everything exactly as it will be in operation. Measure the impedance at the input to the line with a non-inductive decade box across the far end of the line adjusted until the input impedance is a pure resistance equal to the terminating resistance. This determines the value of R_0.

Measure the reactance and resistance of the antenna at the operating frequency, calculate the circuit values required to match the antenna impedance to R_0, and adjust the line-terminating equipment elements to these values by measurement. All apparatus should be connected exactly as it will be used in operation, including the tower lighting circuits.

Measure the impedance at the points where the transmission line will be connected and make small corrective adjustments until the observed impedance looking into the terminating equipment (with antenna connected and r-f meter short-circuited) is equal to R_0.

Connect the transmission line to the terminating equipment and again measure the input impedance at the "send" end of the transmission line. Make whatever corrective adjustments are required to obtain an impedance of R_0.

It is assumed that an anti-fading antenna will be used with a 50-kw transmitter. A radiator of this type usually will have a complex impedance consisting of resistance and capacitive reactance. The constants of the matching circuit for terminating the transmission line may be either computed algebraically or determined by the ensuing vector method.

There are two possible conditions to be encountered using a 190-degree antenna, as follows:

(a) Where the antenna resistance R_A is greater than R_0.

(b) Where the antenna resistance R_A is less than R_0.

NOTE—Condition (b) is the one most likely to occur in the geld. Consult the curve of Figure 6 for impedance matching information.

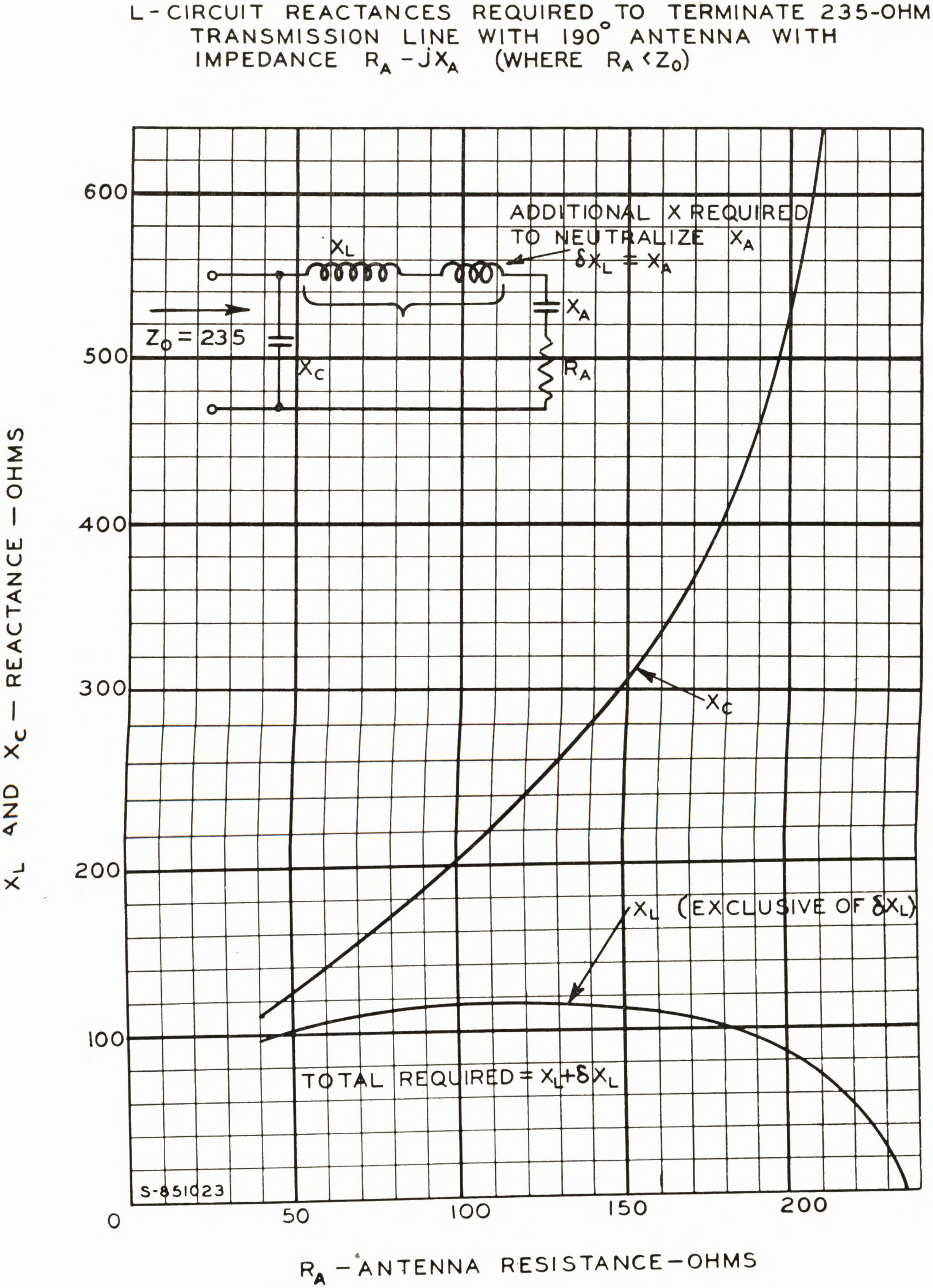


Figure 6—Antenna Matching Characteristics

(a) For the condition where R_A is greater than R_0, the circuit is that of Figure 7 with L and C to be determined.

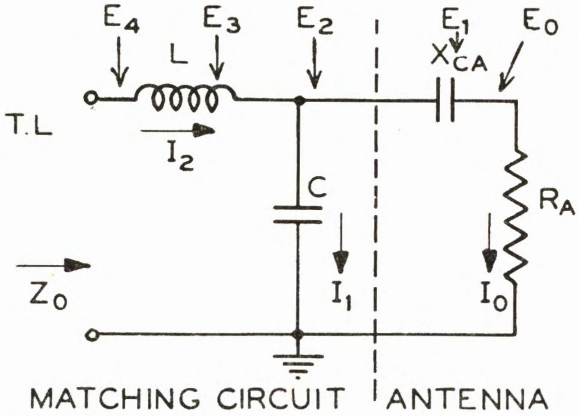


Figure 7—Antenna Circuit Connections
Where $R_A > R_0$

Draw E and I vectors to convenient scales so that

$$R_A = \frac{E_0}{I_0} \text{ and } X_A = \frac{E_1}{I_0}$$

I_1 leads E_2 by 90°
E_3 leads I_2 by 90°

Try various lengths of I_1 until $\frac{E_4}{I_2} = R_0$ (in-phase)

as shown in Figure 8.

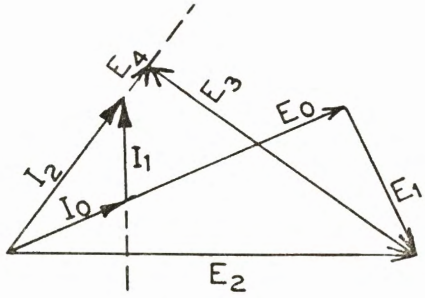


Figure 8—Antenna Circuit Vectors
Where $R_A > R_0$

Then $X_C = \frac{E_2}{I_1}$

and $X_L = \frac{E_3}{I_2}$

as determined by the length of the vectors.

(b) For the condition where R_A is less than R_0, the circuit is that of Figure 9 with L and C to be determined.

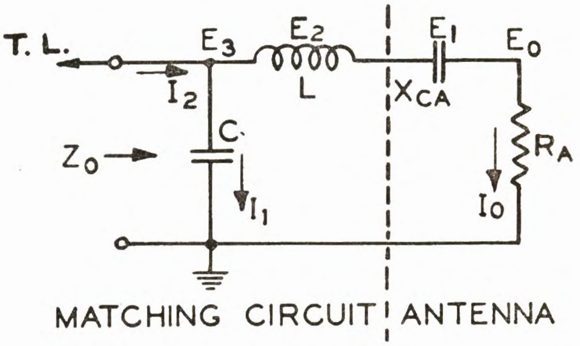


Figure 9—Antenna Circuit Connections
Where $R_A < R_0$

Proceed as in (a). Since E_2 is 180 degrees out of phase with and must be greater than E_1, X_L must be greater than X_A.

$$R_A = \frac{E_0}{I_0} \text{ and } X_A = \frac{E_1}{I_0}$$

I_1 leads E_3 by 90°

Try various lengths of E_2 until $\frac{E_3}{I_2} = R_0$ (in phase)

as shown in Figure 10.

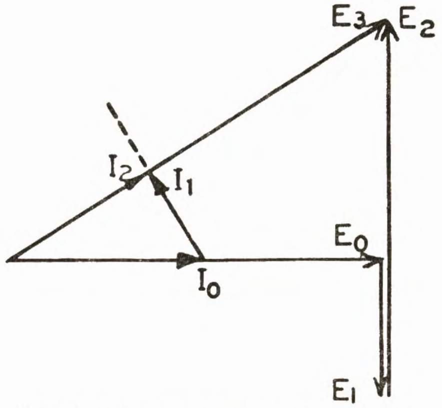


Figure 10—Antenna Circuit Vectors
Where $R_A < R_0$

Then $X_C = \frac{E_3}{I_1}$

and $X_L = \frac{E_2}{I_0}$

as determined by the vector lengths.

SELECTION OF HARMONIC FILTER

Selection of a low-pass single- end ladder type filter is used for harmonic suppression and is connected between the transmission line and the transmitter output. Each installation requires an individual design of filter, based entirely upon the observed impedance of the line input at various harmonics of the carrier frequency. Harmonic impedance measurements determine where one or two stages are required and whether "T" or "Pi" configuration is to be used. Most cases will be satisfied by one of the two circuits of Figure 11, the constants to be determined for each station.

As nearly as possible, the input impedance to the harmonic filter when terminated by the correctly adjusted transmission line should be equal to R_0.

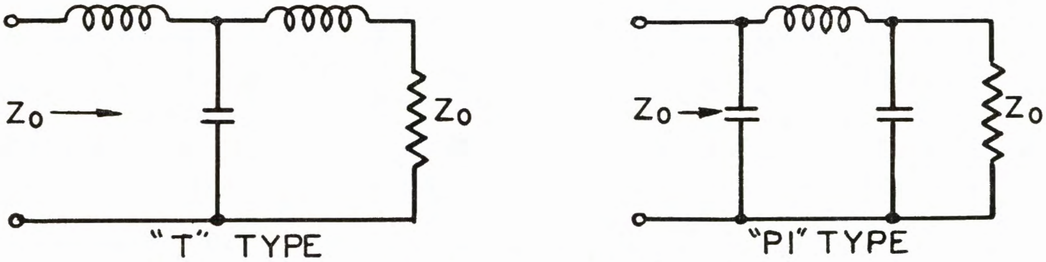


Figure 11—Harmonic Filter Circuits

ADJUSTMENT OF TANK CIRCUITS

The actual components required in the grid- and plate-tank circuits in each side of the power amplifier depend upon the frequency at which the transmitter is to be operated. Selection of the proper units is made prior to shipment as indicated in the tabulation entitled "Frequency Determining Parts."

Grid Circuits—The following instructions are based on the assumption that the values of all fixed capacitors have been specified and that the inductance of the *peak* grid series inductor (L1) has been calculated but that the inductances required in the grid-tank inductors (L2, L12) are unknown.

FREQUENCY DETERMINING PARTS

Item	Quantity		Frequency Range in KC									
			550—650		650—800		800—1050		1050—1200		1200—1600	
Capacitors		Connection	MFD	UC	MFD	UC	MFD	UC	MFD	UC	MFD	UC
C-1	2	Series	0.01	2551A	0.008	3106	0.006	3025	0.005	2663A	0.004	2360A
C-7	2	Parallel	0.0008	3083	0.0006	3091	0.0005	3099	0.0004	3107	0.0003	3113A
C-9	1	—	0.01	3008A	0.01	3008A	0.01	3008A	—	—	—	—
	2	Series	—	—	—	—	—	—	0.01	2551A	0.01	2551A
C-14	2	Parallel	0.0007	3261	—	—	—	—	—	—	—	—
	2	Spares	0.0007	3261	—	—	—	—	—	—	—	—
	1	—	—	—	0.0011	*13x 1.5	0.0009	*13x 2	0.00072	*11x2	0.0006	*9x2
C-22	1	—	0.001	3255	0.0008	3321	0.0007	3261	0.0006	3259	0.0005	3270
C-25	1	—	Same as	for C-22								
C-30	2	Parallel	Same as	for C-1								
C-32	1	—	0.004	3042	0.003	3050	0.003	3050	0.002	3222A	0.0015	3067
C-34	Same as	for C-9	—	—	—	—	—	—	—	—	—	—
C-39	1	—	0.00062	*9x2	0.00044	*7x2	0.0003	*5x2	0.0003	*5x2	0.00023	*4x2

* Number of plates x spacing in inches (Capacitor Assem. TX-260857).

FREQUENCY DETERMINING PARTS—Continued

Inductors		Micro-henries	550–650	650–800	800–1050	1050–1200	1200–1600
L-1	1	120	T-602442-501	T-602442-501	T-602442-501	—	—
	1	60	—	—	—	T-602442-504	T-602442-504
L-2	Same as	for L-1					
L-3	1	1200	MX-242059-501	—	—	—	—
	1	815	—	TX-261815-502	—	—	—
	1	500	—	—	TX-261815-501	—	—
	1	350	—	—	—	MX-241588-501	—
	1	180	—	—	—	—	PX-272608-501
L-4	2	30	TX-260855-501	TX-260855-501	TX-260855-501	TX-260855-501	—
	2	9.6	—	—	—	—	TX-260885-501
L-5	1	155	PX-271309-502	PX-271309-502	PX-271309-502	—	—
	1	60	—	—	—	PX-271309-504	PX-271309-504
L-6	Same as	for L-5					
L-11	Same as	for L-4					
L-12	1	60	T-602442-504	T-602442-504	T-602442-504	T-602442-504	T-602442-504
L-13	Same as	for L-4					
L-14	2	110	TX-261816-501	TX-261816-501	TX-261816-501	—	—
	2	68	—	—	—	TX-260865-501	—
	2	30	—	—	—	—	TX-260855-501
L-15	1	450	PX-271309-503	PX-271309-503	—	—	—
	1	350	—	—	PX-271309-501	PX-271309-501	—
	1	155	—	—	—	—	PX-271309-502
L-18	5	Clip	MX-241538-501	MX-241538-501	MX-241538-501	MX-241538-501	—
	5	Clip	—	—	—	—	MX-241538-503
L-19	4	Clip	MX-241538-504	MX-241538-504	MX-241538-504	—	—
	4	Clip	—	—	—	MX-241538-502	—
	4	Clip	—	—	—	—	MX-241538-501

NOTE: Calculation of the correct inductance for coil L1 is based on the desired grid-loading resistance values for the peak and carrier tubes. Approximately 275 ohms for the peak side and 300 ohms for the carrier side are the selected values for minimum grid regulation. The required reactance of L1 is, therefore, the geometric mean of these loading values, or 287 ohms. These constants are somewhat arbitrary, and may be varied within reasonable limits to obtain the correct grid-drive ratio.

With the values specified above, the power delivered by the driver will be approximately 3.33 kw, based on a potential of approximately 1000 volts (r.m.s) across the network input impedance of 300 ohms. Since the driver is approximately 80 per cent efficient and its plate voltage is 8.5 kv, the driver plate current would be 0.49 ampere. It is desirable to keep the network impedance as low as 300 ohms so that the driver will be sufficiently loaded when switching to the 235-ohm output transmission line for emergency 5-kw operation. Correct grid excitation for the *carrier* tube is obtained by tapping down on the associated grid-tank inductor (L12).

Before proceeding with the tuning of the *peak* grid-tank circuit, the bus connection between the *carrier* input-blocking capacitor (C30) and the *carrier* grid-tank capacitor (C32) should be grounded to the frame as directly as possible and the bias tap should be disconnected from the *peak* grid-tank inductor (L2). The r-f bridge should be connected between the *high* side of the *peak* grid-tank capacitor (C7) and ground, and adjusted for the shunt method of determining resistance and reactance. The variable tap on inductor L2 should then be adjusted until the bridge indicates zero reactance.

To complete the preliminary tuning of the *peak* grid-tank circuit, the bias tap on inductor L2 is set at the voltage null; that is, at the point where that tap does not affect either the resistance or the reactance indication of the bridge whether it is connected or disconnected. This point will be found fairly broad due to the shunt resistance but should be determined as accurately as possible by estimating the center of the null section.

To tune the *carrier* grid-tank circuit, the bus connection between inductors L1 and L2 should be grounded to the frame as directly as possible, and the 5/50-kw transfer switch set at mid-position so that the bus connecting the *peak* and *carrier* grid circuits is disconnected from the modulated amplifier. On the *carrier* grid-tank inductor (L12), the bias tap should be removed and the variable tap normally connected to the associated tube grid should be temporarily tied in parallel with the tap connected to *carrier* grid-tank capacitor (C32). The r-f bridge should be connected directly across the latter capacitor (C32) which is varied until the bridge indicates zero reactance. The *carrier* tube grid tap should then be set at approximately two-thirds the number of turns between the tuning tap and the end connected to the grid-bypass capacitor (C34), and the tuning tap adjusted until the bridge again indicates resonance with the variable grid-tank capacitor (C33) set approximately at mid-position. In the same manner as described for the *peak* tube, the bias tap should be set at the voltage node on inductor L12 and the ground removed from the bus between inductors L1 and L2. The *carrier* grid-tank variable capacitor (C33) finally should be readjusted slightly until the bridge indicates resonance.

Plate Circuits. In the following discussion, it is assumed that the antenna, transmission line and harmonic filter have been properly tuned, that the input impedance of the filter is 200 + j0 (±10%) as measured from the tank side of the antenna-coupling capacitor (C21), and that the neutralizing inductors have been adjusted for best neutralizing. (If an original tuneup is being made, the neutralizing taps should be set each at the approximate center of the adjustment range).

Before attempting to tune the plate circuit, the plate impedance-inverting inductance (L15) should be adjusted to + j1400 ohms as indicated by the r-f bridge. This adjustment should be made with the bridge leads connected directly across the inductor, the unused end turns of the latter being shorted out.

To tune the *peak* plate-tank circuit, the *high* side of the *carrier* plate-tank capacitor (C39) should be grounded as directly as possible to the ground side of the *carrier* plate-bypass capacitors (C42), and the r-f bridge should be connected between the *high* side of the *peak* plate-tank capacitor (C14) and the ground side of the *peak* plate-bypass capacitors (C20). With the transmission-line tap set at the center of the *peak* plate-tank inductor (L4), the ground and plate taps should be adjusted for resonance and the effective resistance calculated. The percentage of turns included between the line tap and ground should be varied until the correct resistance is obtained, readjusting the taps for zero reactance each time before computing the effective resistance. When finally adjusted, the *peak* tank should measure 500 + j0 ohms.

To tune the *carrier* plate-tank circuit, the *high* side of the *peak* plate-tank capacitor (C14) should be grounded as directly as possible to the ground side of the *peak* plate-bypass capacitor (C20), and the r-f bridge should be connected from the *high* side of the *carrier* plate-tank capacitor (C39) to the ground side of the *carrier* plate-bypass capacitor (C42). The *carrier* plate-tank inductor (L14) then should be adjusted for zero reactance by varying the taps and adjusting the coupling.

Final Tuning Adjustments. After the preliminary adjustments outlined under "Grid Circuits" and "Plate Circuits" have been made, the neutralizing adjustments should be checked by means of the vacuum-tube voltmeter. In making neutralizing checks, the tube voltmeter should be connected between the *high* side of the plate-tank capacitor and ground (frame), and the neutralizing tap varied for minimum voltage across the tank with full grid excitation but no plate voltage on the power-amplifier tubes. When neutralizing the *peak* tube, the *carrier* plate-tank should be grounded, but when neutralizing the *carrier* tube, the *peak* side should not be grounded. The RCA-898 filaments must be deenergized so as to prevent erratic deflection of the voltmeter due to harmonics caused by rectification in the grid circuits.

NOTE: If an original tune-up is being made, it will be necessary to repeat all of the foregoing adjustments of the grid and plate circuits and then to re-check the neutralizing adjustments before proceeding to the final tuning.

To make final tuning adjustments, connect the cathode-ray oscillograph between grid and plate of the *carrier* tube (through front panel jacks), apply "delta" voltage and bias the *peak* tube to cut-off using maximum bias. Adjust the *carrier* plate-tank inductor (L14) until a straight line (closed figure) is observed on the oscillograph screen.

Transfer the oscillograph to the *peak* grid and plate jacks and adjust the *peak* bias for normal plate current. Then adjust the *peak* grid variable capacitor (C2) until a straight-line pattern is obtained.

A final check should be made on phase relation between grid and plate voltages of the *carrier* tube. The oscillograph should show a straight line if the tuning is correct. The grid-to-grid pattern should now be a true ellipse, the major axes of which should exactly coincide with the straight-line pattern obtained by viewing a single grid. The plate-to-plate pattern also should be a true ellipse.

If the grid-to-grid ellipse shows an abnormal amount of harmonics (as indicated by multiple waves in the pattern), the grid excitation tap may be too low on the *carrier* grid-tank inductor (L12). The amplifier is likely to become unstable under these conditions, or to produce abnormally high audio distortion components. Readjustment of the grid tap to eliminate this condition may require a lowering of the resistance value of the *peak* grid-loading resistor (R1 and R11) to re-establish the correct grid-drive ratio between the *peak* and *carrier* tubes. The tabulation of normal instrument readings listed within Part VI of these instructions will be found useful as a guide in obtaining correct drive and efficiency for optimum conditions.

OPERATION

In regular service, operation of this transmitter is extremely simple. The control circuits afford full automatic as well as manual operation and are compeltely interlocked to insure protection of the equipment and personnel. Automatic operation, however, should not be attempted during the initial start and the "LOCKOUT-AUTOMATIC" Switch (C-144) should be placed in the "LOCKOUT" position.

INITIAL OPERATION

Before applying power to the transmitter for the first time, the following checks should be made:

Contactors. Inspect all contactors, making sure that the contact fingers and bars operate freely and seat properly. This is especially important in the case of oil-filled contactors and circuit breakers. See that the pole faces are clean and seating properly, and that all auxiliary contacts operate in their proper sequence.

Power Feed. Make certain that all high-voltage conductors have sufficient clearance from ground and that all safety switches are operating correctly. It is also very important that all electrical interlocks and door switches shall be operative.

Control System. Check the control sequence of the entire transmitter with the plate voltage held off. Check the settings of all overload and protective relays and operate them manually to assure correct contact sequence. For recommended current settings of the overload relays and time settings for the timing relays, see the "Maintenance and Service" section (Part XV) of these instructions.

Water Flow. Check the water-flow and flow-meter interlocks and examine all water connections in the system.

Air Flow. See that all air-cooling jets are operating properly and test the air interlocks.

Tube Contacts. Make certain that all electrical connections to the tubes are tight and properly made. Filament connections must be carefully checked to assure operation without excessive heating.

Filament Voltages

After application of filament power, check all filament voltages. During the warm-up or "forming" period, individual filament voltages on all mercury-vapor rectifiers should be checked with an accurately calibrated voltmeter and tap adjustments made where necessary to obtain the rated filament voltage within ±5%. New rectifier tubes should be given an initial forming period of not less than 30 minutes prior to the application of plate potential.

Low-Power Start

For the initial application of plate voltage, the "delta-wye" switch (201 and 202) on the high-power distribution panel should be set in the "wye" position, and the driver power-change switch (7S30) should be set in the "LOW POWER" position. After applying "wye" voltage to the power amplifier, the bias voltages should be adjusted by means of the Transtat regulators. The transmitter should be allowed a 30-minute warm-up period at low power, and all meters and instruments checked at this time.

High-Power Run

After the initial warm-up at low power, both the driver and the power amplifier may be operated at full voltage and the driver should then be adjusted to deliver the correct excitation to the power amplifier.

If the RCA-898 tubes show evidence of gas when full voltage is applied, de-gassing may be accomplished by reverting to "wye" voltage and applying tone modulation in gradually increasing percentages. When the tube is stable at "wye" voltage with full modulation, "delta" operation may be resumed and the modulation again increased gradually until the tube runs without flashing on continuous 100% tone.

If the RCA-891-R modulators show traces of gas, they may be cleaned up by being operated in the modulated-amplifier socket for a time, starting on low power and continuing until they become stable at high power.

PHANTOM ANTENNA

The water-cooled phantom antenna located at the rear of the power amplifier has a resistance of approximately 232 ohms (same value as surge impedance of the standard four-wire grounded transmission line), and is capable of dissipating over 75 kw when 20 gallons of water per minute flow through it.

The large knife switch (S4) at the rear permits shifting the r-f output either to the transmission line or to the phantom antenna. Valves are provided so that the water flow through the phantom antenna may be stopped.

CAUTION: POWER SHOULD NEVER BE APPLIED TO THE PHANTOM ANTENNA UNLESS WATER IS FLOWING. WITHOUT WATER, THE RESISTORS WILL BURN OUT ON LESS THAN TWO KILOWATTS.

OPERATIONAL TESTS

General checks before attempting to measure performance characteristics should include tests for stability and modulation capabilities, and a heat run with program modulation for several hours. After the heat run, all component parts should be inspected carefully, and if any part shows evidence of abnormal heating, accurate measurements of temperature rise should be made. It is recommended that transformer, reactor and motor temperatures shall be measured by the resistance-variation method. Other equipment may require the use of thermometers or thermocouple instruments.

CAUTION: NEVER USE A MERCURY THERMOMETER IN A RADIO-FREQUENCY FIELD!

Stability tests should be made before any attempt at applying feed-back. A simple test for stability consists of operating the transmitter at full power in the carrier condition, and starting and stopping the crystal oscillator. Upon stopping the oscillator, all grid currents should fall to zero.

With full modulation using a 400-cycle tone, the envelope viewed on a cathode-ray oscillograph connected to the *peak* plate jack should be free from transients. Tone keying with 6 db over-modulation should not cause an overload tripping or a flashover anywhere in the equipment.

PERFORMANCE

The initial adjustment of excitation and efficiency is described earlier in this section. In order to obtain minimum distortion, it is essential that the correct grid drive ratio shall be established in the power amplifier and that the plate-circuit efficiency of the power amplifier shall be maintained between 60 and 61 percent. Optimum values of plate current and voltage will be very nearly as shown in Part IV of these instructions, based on 60 percent efficiency and 50kw delivered to the antenna (by direct power measurement). Bias voltages will depend somewhat on individual tubes, but generally will be approximately -250 volts for the *carrier* tube and -1200 volts for the *peak* tube.

PHASE RELATIONS

In order to satisfy the requirements outlined in the preceding paragraph, it is essential that correct phase relations shall exist in the power amplifier. This means precisely 90-degree phase displacement as measured from grid-to-grid and plate-to-plate, and 180-degree phase opposition between plate and grid voltages of each tube individually. Final tuning adjustments, using the oscillograph as a phase-indicating instrument, should be made as previously outlined in these instructions.

FEED-BACK OPERATION

Distortion without feed-back may vary considerably with individual installations but in general, will be between eight and twelve percent and fairly constant throughout the range of modulation frequencies. Measurement of the response characteristics with and without feed-back provides a very satisfactory means of determining the amount of feed-back at various frequencies of modulation. In order to maintain the audio-frequency amplifier equipment within the feed-back loop at the optimum performance level, the following routine of measurement is recommended:

Amount of Feed-Back. To be certain of duplicating results, the amount of feed-back should always be measured at the frequency of maximum feed-back, which is, of course, also the frequency of maximum gain. The measurement of audio feedback then involves two measurements, both of which are significant in determining whether any change has occurred in the audio circuits and in indicating the remedy.

1. To determine the frequency of maximum gain, disconnect the feed-back lead at the low-pass filter choke (L1) and modulate the transmitter with continuous tone of about 500 cycles. Adjust the gain until the percentage of modulation is about 50 and vary the modulation frequency to a value where the greatest percentage of modulation occurs. Percentage modulation may be checked by the modulation monitor, the distortion and noise meter, or the cathode-ray oscillograph.

2. To measure the amount of feed-back, set the audio-frequency oscillator at the frequency of maximum gain as determined above, and with the feedback lead still disconnected from the audio amplifier, increase the gain until the transmitter is modulated about 75 percent.

Assuming use of the Type 69-A Distortion and Noise Meter, set the selector switch at 100% on the "PERCENT DISTORTION" scale and adjust the "AMPLITUDE" controls until full-scale deflection of the meter is obtained. For this test, no voltage should be fed from the audio oscillator to the distortion and noise meter. Now reconnect the feed-back lead to the audio amplifier, apply the same level of audio input at the same frequency, and rotate the selector switch of the Type 69-A instrument until an "on-scale" reading is obtained. The amount of feed-back may then be calculated, remembering that moving the selector switch from the 100% tap to the 30% tap represents an increase in gain of 10.4 db, to the 10% tap an increase of 20 db, to the 3% tap an increase of 30.4 db, and to the 1% tap a gain of 40 db. Thus if upon applying feed-back, it is necessary to move the selector switch to the 1% tap and the output meter then indicates a level of -3 db, the net feed-back is 43 db.

The amount of feed-back can be measured in much the same way if an accurately calibrated input gain control is available. Then it is only necessary to modulate the transmitter to an arbitrary level (preferably not greater than 75% to avoid distorting the measurement by amplitude compression which may be quite severe at high percentages of modulation when no feed-back is used), then to disconnect the feed-back lead and decrease the gain until the same percentage of modulation is obtained. The difference between the two gain settings will be the amount of feed-back.

In making these measurements, care should be taken that the antenna power does not vary appreciably, since a change in the antenna power is a change in overall gain and consequently a change in the amount of feed-back.

It is recommended that such measurements shall be made at weekly intervals and that a permanent record shall be kept to enable comparison from week to week. Any shift in the frequency of maximum gain may be taken as an indication that there has been a change in one of the frequency-determining elements contained in the shunt circuits of the RCA-1603 or -807 stages. These elements should be replaced one by one until the source of the deviation is found.

Any marked change in the amount of feed-back measured should be followed by a check on the RCA-836 rectifier tubes and the resistors in the rectifier circuit, as well as capacitors C17, C18 and C19 in the r-f voltage divider supplying voltage to the feed-back rectifier. The tubes in the audio system also should be checked. It is advisable to have a complete set of spare tubes for the audio amplifier which have been operated together, so that their performance is known, and which can be substituted for those normally used.

Audio Amplifier Frequency Characteristic. As a check on the feed-back at the high- and low-frequency ends of the range, and on the elements of the audio-frequency amplifier which control the gain vs. frequency characteristic, an overall frequency characteristic should be run at weekly intervals with the feed-back lead to the audio amplifier disconnected. The frequency range should extend from 30 to 17,000 cycles. To avoid errors due to compression, it is recommended that the percentage of modulation shall be held at some value such as 60 or 75%, and the characteristic taken in terms of variation of input level necessary to maintain that percentage of modulation.

Any change in the gain at high frequencies is indicative of a change in the special circuits shunting the grids of the RCA-807 tubes.

Audio Amplifier Tube Voltages. As a part of the weekly measurement routine, the voltages on all the elements of the audio-frequency amplifier tubes should be measured. Any change should be checked by substituting a calibrated tube for the one under examination. It should be noted that the bias voltage on each of the RCA-845 tubes may be measured from either filament connection to ground. A tabulation of typical voltages will be found under "Maintenance and Service" (Part XV).

CAUTION: GREAT CARE SHOULD BE EXERCISED IN MAKING THESE MEASUREMENTS SINCE VOLTAGES DANGEROUS TO LIFE ARE INVOLVED.

FEED-BACK COMPENSATION

With the use of a large amount of overall feed-back, certain precautions must be taken to insure correct performance. If the feed-back is excessive, oscillations will be generated at or above certain discreet percentages of modulation. Spurious high- or low-frequency oscillations may develop as the result of r-f pickup in the audio circuits or erratic distribution of ground currents. If signals from other local high-power stations are of such a frequency as to fall within the side-bandband range of the transmitter, they will modulate the carrier and produce cross-modulation products. In certain cases, it may be necessary to install special "acceptor-rejector" circuits in the transmitter output circuit to prevent such spurious signals from reaching the feed-back rectifier.

The maintenance of a high degree of feed-back compensation is desirable for three principal reasons: (1) To provide stable and permanent carrier noise reduction to a degree not possible by any other means; (2) To reduce audio-frequency distortion to an absolute minimum throughout the audio spectrum; and (3) To reduce the undesirable effects of "sum and difference" distortion products falling outside the useful audio range. This latter condition requires that envelope distortion at the higher audio frequencies shall be kept as low as possible and, for this reason, this transmitter has been designed to hold the distortion well below the recognized limits throughout the entire useful audio range.

OPERATION ON LOW-POWER (5 KW)

A single switch in the harmonic filter compartment of the power amplifier section permits changing the output power from 50 kw to 5 kw. The latter power is useful for maintaining service when it becomes necessary to change tubes in the power amplifier or main rectifier.

In the 50-kw output condition:

1. The output of the modulated amplifier is fed to the input of the power amplifier.
2. The output of the power amplifier is fed to the input to the harmonic filter.
3. The correct capacitor potentiometer is in circuit to deliver proper e.m.f. to the feedback rectifier.

In the 5-kw output condition:

1. The output of the modulated amplifier is connected directly to the input to the harmonic filter.
2. The input to the power amplifier is isolated.
3. The correct capacitor potentiometer is placed in circuit to properly energize the feedback rectifier.
4. The power amplifier door interlocks are short-circuited, permitting access to that section of the transmitter while operating at low power.
5. The main power rectifier plate circuit is de-energized.

6. The power amplifier and main power rectifier filaments can be de-energized.
7. The water cooling system can be stopped.
8. The only r-f energy in the power amplifier section is in the shielded harmonic-filter compartment. There is also approximately 400 volts in the monitor rectifier.

MAINTENANCE

TROUBLE CORRECTION

Water Temperature. The temperature of the cooling water should be kept below 135° F. Abnormal water temperature is likely to cause the release of small quantities of gas within the tubes resulting in gas snaps during the program.

Gassy Tubes. Daily de-gassing runs of 20 minutes just prior to the program, using "wye" voltage with 50 to 100% tone modulation, will minimize the "offs-ons" due to gas snaps.

Leaky Gaskets in P. A. Tube Jackets. If difficulty is experienced in obtaining tight gasket seals in the RCA-898 jackets, the pressure rollers in the compression head should be inspected. If the rollers are in good working order, a Vellumoid gasket may be substituted for the lead-rubber gasket normally supplied with the tube. The Vellumoid gasket should be cut to the same dimensions and have the same initial thickness as an unused lead-rubber gasket.

Carrier Shift. A sudden increase in carrier shift is generally an indication of failure of an RCA-898 filament strand. Carrier shift therefore should be observed and logged following any overload in the power amplifier. At the close of each operating day, the filament strands should be counted while they are cooling. Similarly, they should be counted during the first filament starting step when first starting the plant for the daily schedule. Failure of a single strand usually does not result in a permanent grid-to-filament short-circuit, and operation ordinarily can be resumed after an automatic reclosure. If necessary under such conditions, the balance of the program day may be maintained at full power. It is imperative, however, that the tube shall be removed from service at the end of the program day, since electron focusing may weaken the anode if longer runs are attempted, resulting in an anode "suck-in" with the possibility of damage to the jacket.

Distortion. A gradual increase in distortion might be caused by loss of emission in one of the RCA-836 tubes in the feed-back rectifier. Such a condition also may be the result of an increase in the amount of overall feedback (see foregoing instructions for measurement of the "Amount of Feed-Back" under "Performance").

Modulation. Abnormal variation of the audio plate currents during modulation, especially a *downward* deflection of the modulator plate currents, indicates saturation of the modulator. Check the pyranol capacitors by-passing the 5-kw plate-voltage dropping resistors, since shorting of one of these units or arcing between dropping resistors places abnormal voltage on the RCA-892-R, upseting the impedance of the modulated amplifier.

Rectifiers. A method of measuring instantaneous arc drop in mercury-vapor rectifiers is described in Part XI. The RCA-857-B tubes have sufficient cooling air for operation at normal ambient temperatures, but should not be subjected to sudden drafts of cold air or permitted to operate in ambient temperatures in excess of 125°F without provisions being made for increasing the volume of cooling air. Filament voltage must be kept within 5% of rating, and the filament stud wing-nuts must be kept tight. RCA-872-A rectifiers require weekly inspection of their filament pins and socket contacts. Monthly cleaning of pins and contacts is suggested as the best insurance against frequent backfires in these tubes.

Reduced-Power Operation. When repeated faults occurs in the power amplifier, it may be advisable to try "wye" voltage before shifting to 5-kw operation. This form of operation may minimize outage time and provides a useful signal of 20-kw. Should it become necessary to shift to emergency 5-kw operation, the transfer normally can be made and the program restored in approximately six seconds. Regular inspection of the 5/50-kw transfer switch and the auxiliary relay (E1) should be made a part of the weekly maintenance schedule, and it is suggested that weekly tests be made to check the operation at 5 kw. With the transmitter on 5-kw emergency status, the rectified antenna current may not be sufficient to operate the "Carrier off" sensitive relay (E13), in which case the soaking resistor for this relay will cause the remote antenna ammeter (M27) to read low. By pushing the relay firmly closed with an insulated stick, normal antenna current will be indicated.

EMERGENCY MEASURES

Although most emergency measures must of necessity be left to the discretion of the operator, a few suggestions that may be of some assistance and will not jeopardize equipment are listed below. In the event of:

a. Failure of Main Rectifier Step-Start Resistors: Open the 2300-volt air-disconnect switch or the main OCB to remove 2300 volts from the distribution panel. Short-circuit *all* phases of the plate step-start resistors to avoid phase unbalance. Reclose AD or OCB and recycle the transmitter in the usual manner after screwing the plungers on the primary a-c overload relays down to the 15-ampere calibration mark. Tripping of a primary overload relay may occur if the plate contactor closes at the peak of the voltage wave, but a successful start will occur in two or three trials unless a permanent fault exists.

WARNING: THE MOST FREQUENT CAUSE OF STARTING RESISTOR FAILURE IS REPEATED ATTEMPTS AT STARTING WITH A FORGOTTEN GROUND STICK ON SOME PART OF THE P. A. CIRCUIT. ALWAYS CHECK THIS POSSIBILITY BEFORE ATTEMPTING EMERGENCY STARTS AS OUTLINED ABOVE.

b. Repeated Gas Flashes in PA Tubes or Arcs in PA or Antenna Equipment: Try operation on "wye" voltage with an appropriate reduction in the audio level.

c. Loss of Feed-back: Reduce the audio level and continue operation. It may be necessary to turn the feed-back potentiometer (3R15) to zero or to disconnect the feed-back lead altogether.

d. Failure of any Parallel Tube in the Audio Chain: If a short-circuit does not occur in the faulty tube, operation may be continued with reduced audio input.

e. Failure of Monitor Rectifier: This may cause tripping of the "Carrier Off" sensitive relay (E13). If inspection of the monitor rectifier shows no evidence of fire hazard, operation may be resumed by blocking up relay E13.

After any serious fault, always check the phase voltage on all three phases as indicated by the 210-volt "BUS" voltmeter. If one phase is out, shut down the entire plant immediately and check for an open cut-out or other thermal device in the system ahead of the main OCB. An open phase will cause "single phasing" of the polyphase pump and cooler motors and result in rapid over-heating of these units.

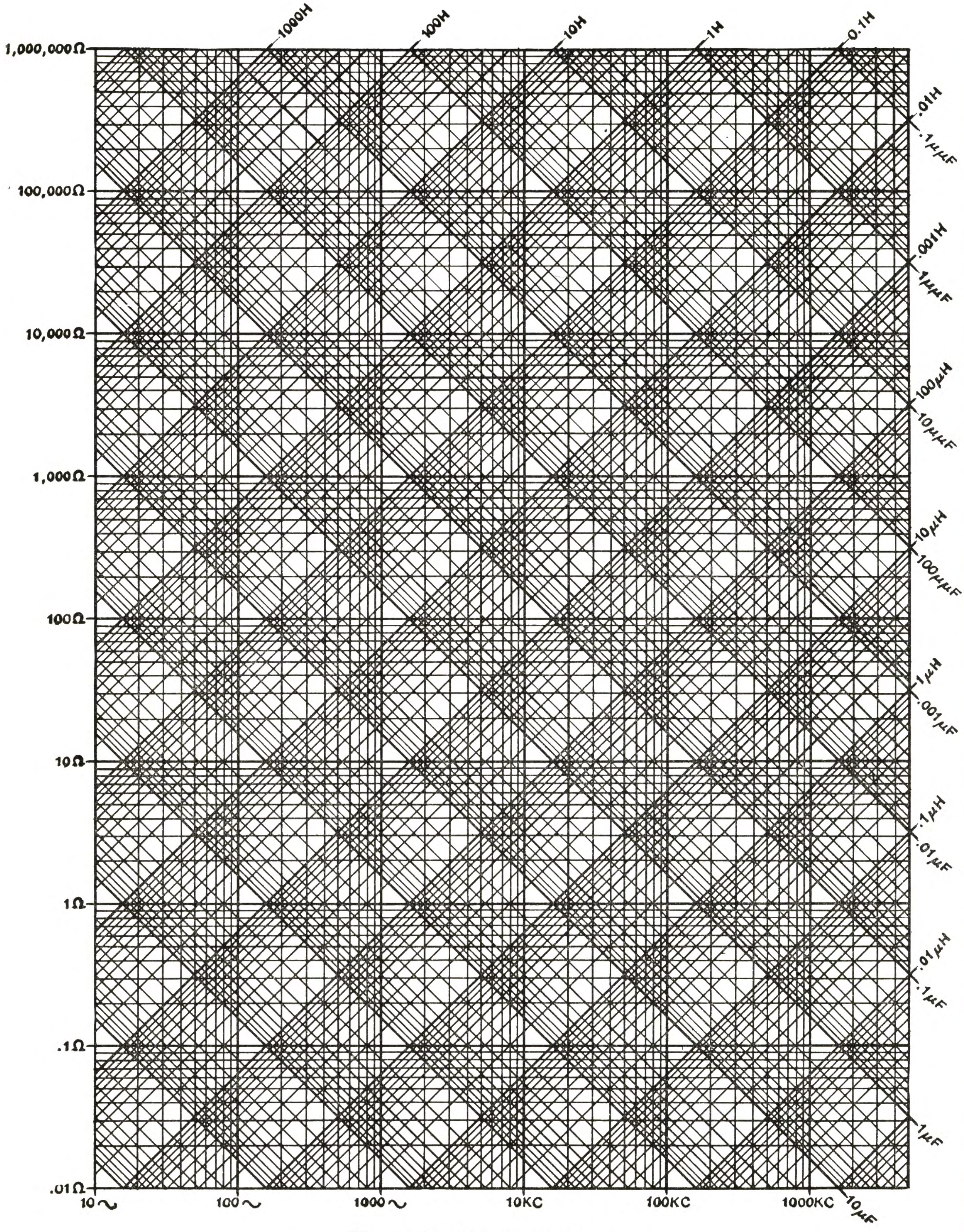


Figure 12—Reactance Chart

ANTENNA TUNING AND ASSOCIATED EQUIPMENT

REFERENCE DRAWINGS

WX-230294
P-717256
MX-242025

X

ANTENNA TUNING AND ASSOCIATED EQUIPMENT

The antenna transmission line terminating apparatus consists of the following units:

a. Antenna Tuning Unit comprising a parallel plate air capacitor and a pair of coupled inductances for impedance matching, an antenna ammeter and a static drain coil.

b. Monitor Rectifier Unit.

ANTENNA TUNING UNIT

The theory of transmission line termination adjustment is included under instructions for the adjustment of the power amplifier. The desired match is obtained by using the proper values of L and C. Inductance is adjustable by means of coil clips, and, when both coil sections are used, by adjustment of mutual inductance between them by sliding coupling.

The capacitor is variable in steps by removal or addition of plates. This means of variation, by itself, does not permit the fineness of adjustment often required for exact termination adjustments. Therefore, to obtain the equivalent of a continuously variable capacitor, the capacitive reactance is made slightly higher than required, and a small amount of adjustable inductance included in series to neutralize the excess reactance. Thus, variation is obtained by variation of an inserted series inductance. This inductance is obtained by using a small end portion of the antenna inductance. The circuit is shown in the overall schematic diagram.

The required L and C values, calculated from previous instructions, are set up by means of the impedance bridge, and, with antenna, drain coil and all other circuits connected, the impedance at the points where the transmission line will attach is measured.

If the impedance measured is not precisely equal to that of the line Z_0, small corrective adjustments are made until a value equal to Z_0 is obtained.

MONITOR RECTIFIER UNIT

Reference to the overall schematic diagram (Figure 50) shows that three RCA-836 tubes are used in parallel for the monitoring system and associated circuits. The potentiometer (302) is used to set the output at the desired level. The audio component is fed through transformer 305 to terminals #7 and #8, the terminal impedance being 500 ohms. The d-c return for this section is through resistors 301 and 302 to terminal #9 (shorting bar 312 being removed during installation). Terminal #9 is connected to the coil of relay E-13, thence to the remote antenna ammeter (M-27) and back to terminal #1 on the monitor rectifier unit. Terminal #1 is grounded at the antenna and no other grounds should be used in this circuit. Drawing MX-242025 shows the fundamental circuits and connections of the monitor rectifier, the supervisory console, and the remote antenna ammeter.

The fourth RCA-836 (311) is connected through capacitor 316 to the r-f input terminal (Isolantite bushing). Capacitor 316 is chosen so that proper voltage is obtained on tube 311 for operation of relay 307. The d-c return of this portion of the circuit is through resistors 301A and 314. Relay 307 is connected across all or a portion of resistor 314, depending on the voltage supplied and the relay adjustment. When antenna voltage is applied, the rectified current through resistor 314 operates relay 307, opening one contact and closing another. These contacts control the operation of the "Time of Outage" and "Duration of Outage" clocks, and of the "Carrier On" lamp on the supervisory console.

OPERATION AND ADJUSTMENT

R-f potential to operate the monitor rectifier is obtained by tapping the input on the antenna static drain coil (L2) a few turns above ground to a point where the carrier-off auxiliary relay (E13) holds in when the final amplifier is operating with wye voltage. This current is usually in the order of 70 to 80 ma. Resistor R24 which shunts the remote antenna ammeter (M27) is then adjusted until the meter reads exactly the same as the antenna ammeter (M1). The tap on resistor 314 is adjusted so that the potential across relay coil 307 does not exceed 25 volts with full antenna power. The voltage, however, should be sufficient to cause the relay to operate on the power from the plate start step of the high-power plate contactor. The potentiometer 302 should be adjusted for the desired monitor output level. After these adjustments, the remote antenna ammeter reading should be rechecked against the thermocouple type meter.

OPERATION OF THE ANTENNA AND TRANSMISSION-LINE PROTECTIVE SYSTEM

The drain choke should be adjusted so that it is equivalent to a quarter-wave line at the operating frequency, thus presenting a very high impedance to normal r-f voltages but very little impedance to static charges built up at a relatively low rate.

The horn gap is adjusted so that it just flashes over on modulation peaks of 100%. This spacing is then doubled.

In case of a direct hit on the antenna by lightning, the small coil (L_1) has sufficient impedance to retard the steep front of the current wave which might otherwise flow through the transmission line and causes the horn gap at the base of the antenna to flash over more rapidly than it would otherwise, discharging most of the energy to ground. The horn gap is designed to rupture the arc quickly. If the fault is of such a nature that antenna voltage has been removed or reduced, but has not necessarily caused an overload circuit at the transmitter to function, relay E-13 drops out and its back contacts close, energizing the "Carrier Off" relay (E-14). The latter relay functions similarly to a regular overload relay, although it is actually operated by an under-voltage at the antenna, thus preventing a sustained arc due to r-f power supplied to the antenna circuits.

In case of a direct hit or other surge on the transmission line, the coil L_2 has sufficient impedance to retard the current which might otherwise flow into the transmitter tank circuits, causing the horn gap between the transmission line and the transmitter to flash over, discharging most of the energy to ground. Other functions of the protective circuits depend upon whether the fault causes an overload current in the P.A. or an under-voltage at the antenna, the net result being the same.

Operation of the control circuits in case of faults of this kind is discussed in detail in the article entitled "Control Sequence" under "Power Control and Distribution Section of Transmitter."

MISCELLANEOUS INFORMATION

Antenna tuning unit capacitor (30″ x 30″ plates spaced 2 inches)

No. of Plates	Capacitance (mmfd)
2	160
3	283
4	405
5	530
6	650
7	780
8	900

Power amplifier oscillograph potentiometer capacitor (4¼-inch discs)

Spacing (inches)	Capacitance (mmfd)
0.500	12.5
0.750	10.0
1.000	8.0
1.500	6.5
2.000	6.0

Maximum capacitance of variable capacitors in grid circuits . . .	268 mmfd
Average characteristic impedance of transmission line composed of 4 – 0.150″ wires at corners of 15-inch square with 1 pair of diagonal wires grounded . . .	235 ohms

POWER RECTIFIER AND ASSOCIATED EQUIPMENT

POWER RECTIFIER AND ASSOCIATED EQUIPMENT

CIRCUIT

The main power supply consists of six RCA-857-B hot-cathode, mercury-vapor tubes connected in a three-phase, full-wave circuit having the characteristics of the well-known six-phase connection. A seventh tube, acting as a pre-heated spare, is furnished as an integral part of the rectifier assembly. Instantaneous anode current is maintained essentially constant by the filter reactor, which, in conjunction with the filter capacitor bank, smooths the output ripple to a value equivalent to approximately −70 decibels below 100% modulation. The plate transformer bank consists of three single-phase, 50-kva units connected delta-delta for normal operation and wye-delta for low-voltage operation. For the delta-delta connection, the rectifier is rated at 18 kv and 150-kw, while the wye-delta connection permits test operation at approximately 57% rated voltage and capacity. Mechanically-interlocked oil circuit breakers on the distribution panel provide rapid switching from delta to wye primary and the reverse. The interlock is so arranged that both breakers cannot be closed simultaneously, and in the event of a changeover, the closed breaker must be tripped before switching can take place.

OPERATION

Before high voltage is applied to new rectifier tubes they must be operated at rated filament voltage for at least 30 minutes in order to completely vaporize any metallic mercury that may have become condensed on the elements or on the upper portions of the envelope. In routine handling of the tubes, they should always be kept in an upright position to avoid contamination of the elements. Filament voltage should be checked on each tube with an accurately calibrated voltmeter to assure proper emission. The rated filament voltage of 5 volts r-m-s must be maintained within ±5%. Loss of emission due to sub-normal filament voltage results in excessive backfiring and cathode disintegration and a serious shortening of tube life, while abnormal voltage on the filament produces excessive emission with consequent shortening of life by evaporation of the cathode material.

With the exception of infrequent random backfiring due to changes in the arc-plasma, virtually all reverse conduction faults are caused by either excessive current demands at low vapor pressure or too great a vapor pressure for the inverse voltage existing across the tube. Vapor pressure within the tube is directly proportionate to the bulb temperature at its coldest point; hence, cooling air volume and temperature play an important part in correct tube operation. The cooling air blown on the base of the RCA-857-B rectifiers is sufficient for satisfactory operation of these tubes at full rated voltage under ambient temperatures not exceeding 125°F. In the event of cold starting under conditions of extremely low ambient temperatures, the blower motor may be held off for the first few minutes of operation until the load has raised the temperature within the tubes. The blower motor control is through an individual circuit breaker on the distribution panel. Adequate protection against excessive tube current has been provided for in the equipment. Starting transients due to filter charging current are limited to a value well within the current rating of the tubes by means of a suppressor resistor in the filter circuit which is shorted out approximately 2 seconds after the plate-run contactor has closed. Step-starting in the plate transformer primary further reduces the transformer switching transient on the system.

Short-circuit faults, such as amplifier flashovers or rectifier back-firing, are cleared by high-speed overload relays which trip the start breaker in the very short time of from 5 to 6 cycles. High-voltage arcs in the radio transmitter are immediately suppressed on opening of the plate contactor by reinsertion of the surge-suppressor resistor.

SPARING

Should one of the six active tubes become defective, the spare tube may be switched into service with a minimum of delay. Sparing switches are provided at each of the active tube positions. The upper contacts of these switches are connected to the active tubes while the lower contacts are connected to the "spare" bus. By simply moving the switch bar from the upper to the lower position, the defective tube is disconnected and the spare connected in its place. Only one of the switch bars may be placed in the spare position since only one has a clearance hole to pass an interlock stud mounted in the spare position.

In general, failure of a rectifier tube usually may be predicted by diagnosis of its arc-drop record or by oscillographic examination of its voltage characteristic. A simple test for arc-drop may be made by applying any d-c voltage greater than 30 volts across the tube through an adjustable limiting resistor. With positive voltage connected to the anode and negative to the cathode, a d-c voltmeter across the tube will read the arc-drop directly. All such measurements should be made at a standard tube current of approximately 5 amperes, or, if practicable, at the full tube rating of 25 amperes.

A more exact determination of the condition of a tube can be made by inspection of its firing characteristic using a cathode-ray oscillograph. A faulty tube will fire later and later in the first (conduction) half-cycle, and display a greater reverse-voltage transient. This oscillographic test also may be made in a low-voltage test set-up provided the tube is loaded correctly. The oscillograph should be connected directly across the tube and will indicate the voltage characteristic when an a-c voltage of 60 to 120 volts (r. m. s.) is applied between anode and cathode. A suitable resistance must be in series with the voltage source in order to limit the current through the tube during the conduction half-cycle. For a standard test potential of 115 volts, a 50-ohm resistor capable of dissipating 200 watts continuously will limit the current to approximately two amperes (based on average tube drop of ten volts).

Both the oscillograph and the applied voltage should be connected between anode and filament center-tap terminals of the rectifier tube circuit, with the anode disconnected from the main rectifier circuits. It is suggested that all measurements be made with a standard applied voltage rather than at constant current.

The oscillograph must be used without amplifiers and with the sweep self-synchronized with the source. The pattern will then be a reproduction of the full voltage wave across the tube, one-half being sinusoidal during the non-conducting half-cycle and the other half a trace of the instantaneous voltage drop during conduction. At the start of the conduction period, a steep wave-front transient will indicate the peak instantaneous arc drop, which is the criterion of rectifier performance.

Excessive arc drop causes back-firing during operation, and with a little experience in making these observations, *eventual failure of a tube can be predicted before excessive backfiring develops.* Peak arc-drop voltages generally will range between 12 volts for a perfect tube to 60 volts for one subject to frequent backfiring. Monthly records of arc-drop measurements will provide accurate tube data at roughly 500-hour intervals. When peak arc-drop values in the region of 30 to 40 volts are indicated, more frequent tests may be desirable. Because the oscillographic tests reveal peak arc-drop voltages and give an accurate picture of the firing characteristic, this method of testing rectifier tubes is recommended as being much more valuable than the d-c method of measurement previously described. If the 115-volt source is a grounded neutral system, it will be necessary to use a 1:1-ratio isolation transformer to prevent distortion due to ground capacitance. Such a transformer should have a rating of not less than 300 volt-amperes. A standard time interval of two minutes should be allowed for thorough heating of the tube before applying anode voltage during these tests. A d-c ammeter in series with the tube will indicate the average current during the conduction period.

Higher peak arc-drop voltages generally will be accompanied by lower average-current readings, within certain limits, providing all measurements are made at a standard voltage. This is due to a reduction in the area under the wave as a defective tube fires later and later in the conduction half-cycle. Conduction current data should be recorded simultaneously with the peak arc-drop readings. This test is applicable to the RCA-872-A rectifiers as well as to the RCA-857-B tubes.

So-called "arc-back indicators" are not included in this equipment since they serve no useful purpose other than indicating that a reverse-current fault has occurred somewhere in the rectifier. Any severe overload in tubes of this size usually causes cathode sputtering in one or more tubes, followed immediately by a back-fire. Hence, an arc-back in one tube can, and usually does, cause sputtering and consequent back-fire in the phase-companion tube. In the case of multiple arc-backs short-circuiting the system, filter oscillation is likely to cause back-fires in other tubes not previously involved.

Cathode material floating on the surface of the mercury pool is one indication that a tube has been back-firing. Unless an examination shows the suspected tube to have an abnormally sudden increase in arc-drop or a poor firing characteristic, it should not be retired unless observations under operating conditions indicate it is back-firing frequently. Such obscure faults as spurious cathode spots on the envelope, concentrated "streamers" or the release of occluded foreign gases may exist during high-voltage operation and cannot be detected by the low-voltage tests.

FILTER RACK

The smoothing filter consists of a 16-mfd bank made up of eight Pyranol capacitor units of 2 mfd each and a 1.5 -henry reactor rated at 8 amperes d.c. and insulated for 18 kv. The reactor is sufficiently large to maintain constant current in the rectifier tubes, while the capacitor bank is designed for minimum a-c regulation under conditions of syllabic modulation. Each of the 2-mfd capacitor units is provided with a spring-loaded safety grounding device and a fused horn gap. In the event of a failure of any unit, fault current clears the fuse and the following high-voltage arc is ruptured by the horn-gap action. At the same time, the movable arcing horn is actuated by the compression spring and moves a shorting contact to meet the ground bus terminal. As soon as the arc is extinguished, automatic reclosure takes place as in any other fault tripping and service is restored. The faulty capacitor has been removed from service and its terminals short-circuited to ground to prevent the accumulation of any potential.

The surge resistor and its shorting relay are mounted on one end of the capacitor rack, while a rugged current-limiting resistor connected in series with the high-voltage output of the filter is mounted on the other end of the rack.

Plate transformers are of the oil-filled outdoor type, with 4-point ratio adjusters brought out through their covers in a weatherproof fitting. D-c output voltage of the rectifier may be raised 5% or 10% or lowered 5% from normal by means of the 4 tap positions (based on normal line voltage of 2300 at full load). The rated reactance of these transformers is 5.2%, which is the equivalent of 2.6% regulation for the rectifier connection employed.

POWER CONTROL AND DISTRIBUTION SECTION OF TRANSMITTER

XII

POWER CONTROL AND DISTRIBUTION SECTION OF TRANSMITTER

ADJUSTMENT OF CONTROL APPARATUS

Although high-speed tripping is employed in the overload protection circuits of the control system and a comprehensive time-interlocking sequence is involved, the relays and associated control devices are of comparatively rugged construction and do not require any highly-developed servicing technique for installation or maintenance.

This section deals primarily with maintenance considerations, since the operating sequence is covered subsequently under the heading "Control Sequence."

Actual mechanical adjustment of each individual control and distribution item is covered in detail in a series of instruction pamphlets incorporated in the Appendix, while another group of pamphlets gives all essential ordering information for spare or renewal parts.

General instructions also are included for the testing of oil used in all oil-filled apparatus. (See Bulletin GEA-1180A in Appendix.)

IMPORTANT

Before placing any oil-filled transformers or switch-gear in service, make sure that clean oil of the proper grade is in the tank and filled to the level indicated.

The correct oils for this equipment are as follows:

Transformers: G. E. Transil Oil 10-C
Breakers and Contactors: G. E. Transil Oil 6-C
Dashpots on OCB Trips: G. E. Transil Oil #21

Adjustment of Timing Elements:

- Main OCB Dashpots: ½-second trip.
- Pump hold timing relay (C-106): 7-minute opening after energization. This keeps main circulator pump in operation for the time specified after shutdown.
- Filament TD relay (C-112), step 1: 30-second closing.
- Filament TD relay (C-114), step 2: 15-second closing.
- Plate TD relay (C-119): 2-minute closing.
- Reclose TD relay (C-142): Minimum reset time, approximately ¾ second.
- Plate start ratchet (C-153): 2-second closing.
- Plate run ratchet (C-156): 2-second closing.
- Auto reset relay (C-146): 5-second closing.
- Power failure hold-on relay (C-157): 1-second opening.

Note that none of these timing adjustments is critical, and may be set within ±10% without any hazard.

The Agastat timing relay (C-146) is of a new improved design and should require very little attention beyond periodic inspection of its contacts.

Notching relay C-139 has a very important function in the automatic reclosure sequence, and should therefore be periodically checked for correct operation of its cams. The service schedule outlined elsewhere in these instructions should take care of all relay servicing requirements.

The definite-time, motor-driven, synchronous timers (C-112, C-114, C-119) are of a new improved design having a rubber pinion in the timing gear-train clutch which entirely eliminates the possibility of gear jamming as experienced on older models.

In servicing filament contactors C-111, C-113 and C-115, see that the normally-closed interlock finger of contactor C-115 is properly overlapped. When correctly adjusted, the overlap interval permits contactor C-115 sealing in before contactors C-111, C-113 and timers C-112, C-114 are de-energized. Reclose relay C-142 has a ratcheted time-delay reclosing arrangement whereby the time of outage during automatic reclosure may be controlled. By changing the position of the ratchet gear, this time delay may be increased to approximately four seconds. The purpose of the time interval before reclosure is to ensure complete functioning of notching relay C-139 and of alarm relay C-147, and to permit positive interruption of any power arc that may exist during fault conditions. Normally, this relay is adjusted for its minimum delay of approximately ¾ second. Bias relay C-122 is adjusted for correct pick-up and drop-out voltages by series resistor C-125 located on the rear of the control panel. All auxiliary relays are of rugged construction and require very little servicing beyond routine inspection of contacts.

To prevent contact opening or "bouncing," which might be occasioned by high-voltage contactor operation, the spring tension and contact clearances of these auxiliary relays should be maintained as initially adjusted. All high-speed relays are mounted on the front of the enclosure where their targets are easily seen by the operator. The high-voltage contacts of the surge relay mounted on the filter capacitor rack should be inspected daily and dressed with a mill-type file whenever any pitting or burning is evidenced, since these contacts sometimes are called upon to break extremely high surge currents under certain fault conditions.

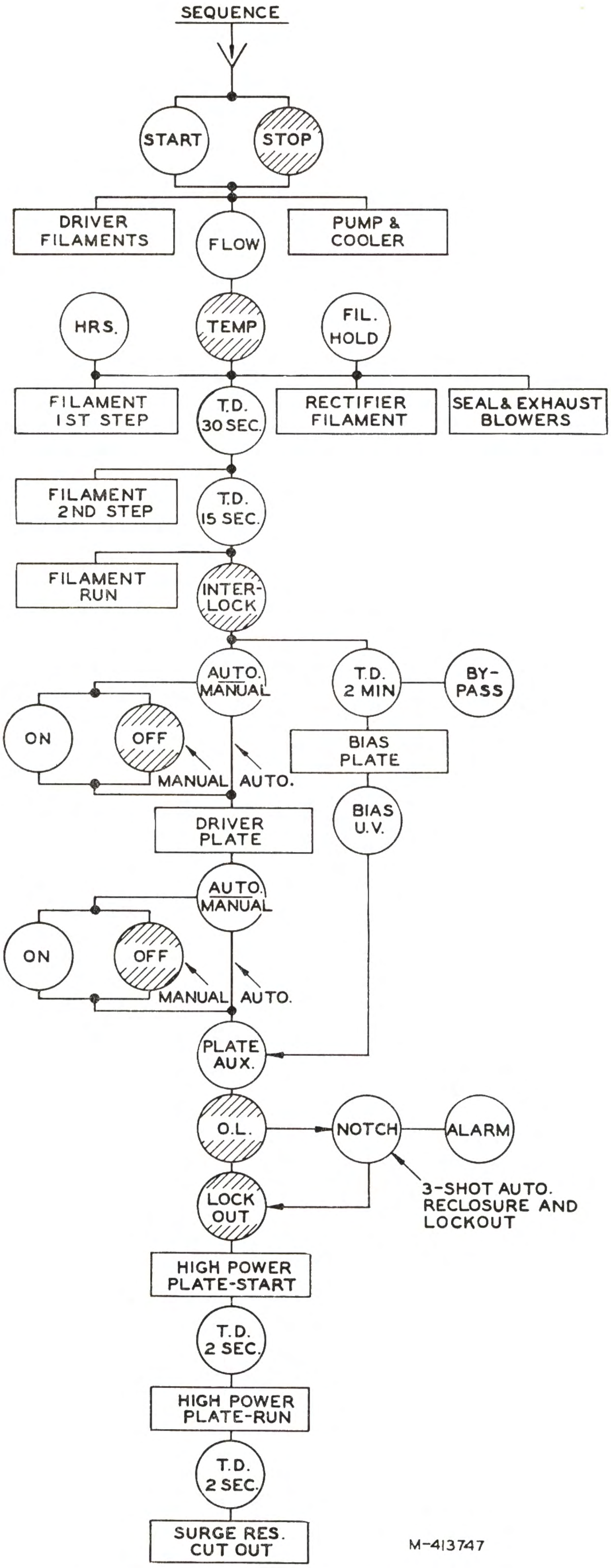


Figure 13—Control Sequence Diagram

OPERATING NOTES

The RCA-857-B rectifier tubes are of the filamentary type requiring the relatively short filament heating time of one to two minutes under operating conditions. It is recommended that a two-minute plate time-delay setting be adhered to as a minimum for long tube life, and that a warm-up period of 15 minutes be allowed for initial daily starting, followed by five minutes "carrier on" with wye voltage before applying delta voltage.

The alarm bell is arranged so that it is energized during the filament starting sequence, being de-energized after the final filament contactor seals in. This serves as a warning to anyone who may be within the enclosure. "Lockout" operation may be used if desired. With the "LOCKOUT-AUTOMATIC" switch (C-144) in the "LOCKOUT" position, any overload trips the main plate contactor and seals in the lockout relay (C-143) and the reclose relay (C-142). Automatic operation is resumed by putting the switch in the "AUTOMATIC" position. When automatic status obtains, individual overloads trip the main contactor, which recloses after the ¾-second time delay of relay C-142. If no subsequent fault occurs within five seconds, the automatic reset relay (C-146) returns the notching relay to its original status. Three recurrent faults or three consecutive trippings due to a sustained fault, all occurring within the five-second time cycle of the automatic reset relay (C-146), will result in two automatic reclosures and eventual lockout on the third shot. After a lockout of this nature, resetting is accomplished by momentary closure of the manual reset switch (C-145).

After any overload or carrier failure fault, the alarm bell (C-150) and the alarm indicator light (C-148) are energized, being manually reset by the alarm reset switch (C-149). Any failure of carrier, arc-over of antenna lightning-protection gaps or inadvertent operation of starting sequence switches in the driver section also will cause the alarm to sound, though it will not sound on normal station shutdown when the station "START-STOP" switch is placed in the "STOP" position. A description of the lightning protection and carrier failure relay system will be found elsewhere in these instructions.

In the event of a momentary power failure tripping the entire station, the plate time delay on recycling of the transmitter may be by-passed manually by operating the TD by-pass switch (C-121). A power-failure hold-on relay (C-157) having a one-second time delay on its drop-out stroke is incorporated in the control system in such a way that the power amplifier filament starting sequence and plate time-delay relay are bypassed immediately provided the system voltage recovers within one second after a severe dip or complete failure.

POWER SYSTEM

The main power supply to the station is a three-phase, three-wire, 2300-volt system of a frequency as specified by customer (50 or 60 cycles). Power feed is connected directly to the main oil-circuit breaker (OCB) furnished with the equipment, from the air disconnects in incoming line to the station. Should any circuit breakers be included in the system ahead of main OCB they must be furnished with time-delay dashpots to provide a minimum of ½-second delay on overcurrent tripping. This is necessary in order that automatic reclosure may function on momentary short-circuit faults without tripping the main station breaker. The main OCB furnished with the transmitter has an interrupting rating of 15,000 kva, which is more than adequate to meet any local or national underwriters' requirements. The current and potential transformers incorporated in the equipment are sufficiently accurate for metering purposes, providing their volt-ampere rating is not exceeded by the burden imposed.

Three-phase, 220-volt power is obtained from a delta-connected distribution bank, connected to the distribution bus through a main bus air breaker on the distribution panel. Branch circuit breakers are provided for the driver and all auxiliary equipment. Where single-phase loads are taken off the three-phase bus, the individual loads are properly distributed so that the total distribution load is essentially balanced.

Selective breaker operation is obtained by the use of correct inverse-time current ratings of the individual breakers, so that momentary faults in the driver which normally are taken care of by its own automatic reclosure system, do not trip the distribution breakers. Instantaneous magnetic trips are provided in the 220-volt bus breaker to clear any faults not relieved by the automatic reclosure system in the driver section.

CONTROL SEQUENCE

In reading the following discussion of the control sequence, reference should be made to the simplified diagram of the control circuits included with the overall schematic diagram. Also see Figure 13.

Start Sequence:

(a) Closure of toggle switch C-101 energizes the run relay (C-102). One normally-open finger of relay C-102 closes the start circuit of the driver, while another normally-open finger energizes the pump auxiliary relay (C-106) and closes one side of filament auxiliary relay (C-108) after the filament interlock relay (C-130) has closed.

(b) The normally-open finger of the pump relay (C-106) energizes the pump, the cooler starters and the blower contactor (C-107).

(c) As soon as the flow interlocks are closed by normal water flow, the filament auxiliary relay (C-108) is energized. One normally-open finger energizes the Hour Counter (C-109) and the filament status light (C-110). Another normally-open finger energizes step 1 filament start contactor (C-111). An auxiliary normally-open finger of contactor C-111 starts definite TD relay C-112. After 15 seconds, relay C-112 closes, energizing alarm relay (C-147), alarm (C-150), and step 2 contactor (C-113) whose normally-open auxiliary finger starts definite TD relay C-114. After 15 seconds, relay C-114 closes, energizing the filament run contactor (C-115) and filament seal relay (C-116). As run contactor C-115 closes, its normally-closed auxiliary finger de-energizes step 1 and step 2 contactors (C-111, C-113), timing relays (C-112, C-114) and alarm relay (C-147), all of which drop out. The run contactor (C-115), however, is maintained by the filament seal-in relay (C-116), which has sealed in.

(d) Simultaneously with the energization of the filament run contactor (C-115), the main plate definite TD relay (C-119) is energized.

(e) After the 2-minute time cycle of TD relay C-119 has elapsed, its normally-open contact closes and energizes the interlock auxiliary relay (C-131), and the interlock status light (C-132), provided that all door interlocks are closed and that the LP interlock relay (C-127) is closed. (Relay C-127 is energized when the LP plate contactor closes.)

(f) With the closing of interlock relay C-131, the bias plate contactor (C-135) is energized, and the HP plate auxiliary relay (C-136) is ready for energization, provided the oncoming bias voltage has operated the bias undervoltage relay (C-122) and the bias status light (C-126).

(g) Closure of the normally-open momentary contact "plate on" switch (C-137) energizes the plate auxiliary relay (C-136), which seals in and energizes the plate start contactor (C-155) and the plate status lights (C-151, C-152). A ratchet time-delay finger on the start contactor (C-155) closes after a 2-second time delay, energizing the plate run contactor (C-156) which short circuits the plate starting grids, applying full voltage to the rectifier. After one or two seconds, the ratchet TD finger on run contactor C-156 closes, energizing the surge relay which short circuits the transient suppressor in the capacitor leg of the filter.

Shut-down Sequence:

(a) Opening the start switch (C-101) de-energizes the control relay (C-102) which drops out.

(b) Opening of the contacts of the control relay (C-102) opens the start circuit of the LP exciter, de-energizes filament auxiliary relay (C-108) and the pump auxiliary relay (C-106). All lights and HP relays drop out, except the TD release contact of the pump auxiliary relay.

(c) After 7½ minutes the TD finger of the pump relay (C-106) opens, shutting down the pump and cooling system. Complete shut-down.

AUTOMATIC RECLOSURE

With lockout switch C-144 open (in "AUTO" position), the following sequence obtains in the event of an overload fault (a.c. or d.c.):

Instantaneous opening of the normally-closed contacts of any OL relay energizes the reclose relay (C-142), which opens its normally-closed contact instantaneously. This contact hesitates before reclosing after de-energization of reclose relay (C-142), thus preventing high-speed pumping of plate contactor C-155 in the event of failure of notching relay C-139. Simultaneously with the energization of reclose relay C-142 on the upstroke of OL relay, another pair of normally-open contacts on OL relay energizes the notching relay (C-139). The notching relay advances its CCCO contact from C to C and its OCCO contact from O to C. The CCCO contact thus remains closed, permitting reclosure of the plate start contactor (C-155) as soon as hesitating contact of the reclose relay (C-142) resumes its normally-closed status. Simultaneously with the energization of notching relay C-139, the alarm auxiliary relay (C-147) and the overload indicator light (C-148) are energized. The alarm relay (C-147) seals in, maintaining the overload light and energizing the alarm bell (C-150). Manual operation of the alarm reset switch (C-149) releases the alarm auxiliary relay and light, de-energizing the alarm bell.

If the fault has cleared during the initial COC operation of plate contactor C-155, notching relay C-139 remains in its first advanced position until the 5-second time cycle of the automatic reset relay (C-146) has elapsed. Closing of the TD finger of the reset relay (C-146) energizes the reset coil of notching relay C-139, restoring CCCO and OCCO contacts to normal or home position. As OCCO contact resumes O status, the automatic reset relay (C-146) is de-energized and drops out. Status is now normal, ready for subsequent trippings.

SUSTAINED OR RAPIDLY RECURRENT OVERLOADS

If an overload fault persists after a tripping and reclosure, another tripping will immediately follow and the notching relay (C-139) will advance one step with each tripping. If three trippings occur within the time cycle of the automatic reset relay (C-146)—say 5 seconds—then, on the third tripping, the CCCO contact of relay C-139 will reach an open position, locking out the plate contactor (C-155). At the same time, the OCCO contact will reach an open position, de-energizing the reset relay (C-146) which then drops out without having completed its cycle. The plate contactor and automatic reclosure are now locked out. Operation of the hand reset switch (C-145) energizes the reset coil of notching relay C-139, sending both contacts back to normal. The plate contactor will reclose, and the automatic reclosure sequence will repeat unless the fault has been cleared.

LOCK-OUT OPERATION

With the lock-out switch (C-144) in the "LOCK-OUT" position, opening of the normally-closed contacts of an OL relay trips the plate contactor (C-155) as before, but closure of the normally-open contacts also energizes the lock-out relay (C-143) which now seals in, its normally-closed contact preventing reclosure of plate contactor C-155 on the down-stroke of the OL relay after the fault is cleared. The reclose relay (C-142) also is held in the energized position by the seal-in contact of the lock-out relay (C-143), assuring lock-out status in the event of failure of the normally-closed contacts of the lock-out relay to open. The alarm relay operates as before, being reset by the alarm reset switch (C-149). To restore the circuit to service with lock-out operation, the "PLATE-OFF" switch (C-138) is first operated, the lock-out switch is thrown first to the "AUTO" position then back to "LOCK-OUT," and the plate contactor is manually restored by the "PLATE ON" switch (C-137). To restore the circuit to service with "AUTOMATIC" operation, the lock-out switch (C-144) is simply thrown to the "AUTO" position without manual operation of the plate switches.

FAULTS OTHER THAN OVERLOADS

(a) Bias undervoltage—Drops the bias UV relay (C-122) and the plate contactor (C-155). The bias light and all subsequent lights go out. All circuits are restored with resumption of normal bias voltage.

(b) Open door or LP failure—Opening of any door interlock or tripping of LP plate contactor drops bias plate, bias UV and plate contactor C-155. Bias and plate status lights go out. All circuits are restored with correction of fault.

(c) Water flow failure—The filament auxiliary relay (C-108) is de-energized by opening of flow meter contacts, dropping the entire HP chain. On resumption of normal flow, the circuits resume start sequence, HP plate being held off until manually reclosed.

(d) Abnormal water temperature—High contacts in thermometer close, energizing temperature auxiliary relay (C-105), which opens its normally-closed contact, de-energizing filament auxiliary relay (C-108) and tripping the entire HP chain. Circuits resume start sequence on drop in temperature.

(e) Power-feed fault—Undervoltage fault on main station feeder drops the entire station. Starting sequence is resumed after restoration of feeder voltage. In the event of a momentary failure, the main HP plate time delay may be by-passed by the TD by-pass switch (C-121) at discretion of operator, depending on the duration of outage. The by-pass relay (C-120) will not operate, however, until auxiliary contact of the filament seal relay (C-116) has closed, thus ensuring that plate voltage will not be applied until the filament run contactor has sealed in. After an operation of the TD by-pass relay (C-120), it is sealed in through the normally-closed contact of the plate TD relay (C-119) and hence remains energized until TD relay C-119 has completed its time cycle and restored normal plate control. When TD relay C-119 completes its cycle, its normally-closed contact opens, de-energizing the by-pass relay (C-120).

PHASE-TO-GROUND FAULT OR SHORT CIRCUIT IN CONTROL SYSTEM

Clears control circuit breaker in distribution panel, dropping the entire transmitter.

CIRCUIT TEST AND WARM-UP

By means of the "PLATE OFF" switch (C-138), the plate contactor (C-155) may be held off for any length of time for purposes of circuit check or forming of new rectifier tubes.

Delta-wye switching is provided in the rectifier plate transformer primary so that 57% rated voltage may be obtained during circuit adjustments or for low-power operation.

FAIL-SAFE OPERATION

All controls are arranged for fail-safe operation. Failure of any relay or contactor solenoid releases that unit, de-energizing all subsequent controls.

In the event of a failure in the automatic reclosure and lock-out circuits, non-automatic lock-out operation can be maintained by setting the plunger tubes on the individual overload relays for lock-out tripping, using the reset plunger on individual relays for manual reclosure after the overload tripping.

SUPERVISORY CONSOLE

XIII

SUPERVISORY CONSOLE

The Type 50-D Console was designed for use as a supervisory unit rather than for remote control. The controls essential to proper supervision are available at the console panel and will be discussed briefly herein. The exciter plate "ON" and "OFF" buttons and the high power plate "ON" and "OFF" buttons provide convenient control of the main plate power circuits. The "ON" buttons are black and the "OFF" buttons are red, this arrangement being consistent with other "START" and "STOP" buttons used in the transmitter.

An indicator lamp with a red color cap (High-Voltage) tells the status of high-voltage plate auxiliary relay (C-136).

An indicator lamp with a red color cap (Carrier On) lights when antenna power is on, since it is controlled by relay 307 in the antenna monitor rectifier.

A rectifier-type level indicator with a range of –8 to +32 db (zero level = 6 mw) is used to read audio input to the transmitter. Another extension-type level indicator with scale calibrated in "percent modulation" may be used for measuring positive and negative peaks of modulation. This meter should be connected in series with the auxiliary audio envelope rectifier in a modulation monitor.

A volume control with a range of 20 decibels in steps of one decibel is mounted conveniently in the center of the panel just above the desk for ease of operation. This control is connected so that the input to the transmitter audio system appears to be 500 ohms at all times.

At zero setting, the attenuation is infinite and the audio input to the attenuator is short-circuited. Throwing the transfer switch to the neutral position terminates both lines with 500 ohms, leaves the input to the volume control short-circuited, but the transmitter audio input still sees 500 ohms, approximately.

Three clocks, marked "TIME OF OUTAGE," "STATION TIME," and "DURATION OF OUTAGE," make it unnecessary for the operator to note the time of a failure or the duration of a failure until it is convenient to do so.

The "TIME OF OUTAGE" clock is connected through contacts on relay E-1 which is controlled by relay 307 in the antenna monitor rectifier and by the "CLOCK START" button. If antenna power fails, relay E-1 is de-energized and opens a pair of contacts stopping the clock. This clock has a red second hand with very little inertia, and stops in approximately ½ second, thus accurately indicating the time that antenna power failed. At the same time, the back contacts on relay 307 close, starting the right-hand clock ("DURATION OF OUTAGE"). This clock has a red second hand and a black minute hand and runs until antenna power is restored, thus indicating in minutes and seconds, the length of time the station was off the air.

The "STATION TIME" clock is so connected that it runs continuously from a 115-volt a-c source. Should the power source fail, the clock continues to run for six hours, being operated mechanically by a spring.

The "TIME OF OUTAGE" clock is reset by manually adjusting the minute hand and starting the second hand at the correct time by pressing the "CLOCK START" button.

The "DURATION OF OUTAGE" clock is restored to its normal position by pressing the "CLOCK RESET" button until the second hand is at the zero position and resetting the minute hand manually.

These clocks also can be reset from the rear. Neither clock can be restored to normal until the carrier power comes on.

The front panel is hinged and can be opened easily, providing quick accessibility to component parts and terminal boards. Operation of the clocks is not affected by leaving the panel in a horizontal position for a short while.

Space is provided on either side of the panel for buzzers, telegraph sounders, loudspeakers, or other signal instruments. A number of spare terminals are provided for use as desired.

Ample space for controls for auxiliary apparatus, short-wave equipment, etc., is purposely provided on the panel.

The line-selector switch (key type) for the two program lines is connected so that the line not used for program is connected for other uses, such as service telephones between station and studio.

A second key switch (S-2) on the right is provided as a monitor transfer switch, intended to switch the monitor speaker to either the incoming audio line or the amplifier for the antenna monitor rectifier. With suitable associated apparatus on the station speech-input rack to balance the speaker levels for the two positions, a direct comparison is available between the transmitter input and output.

A concentric jack (J-1) is available on the console panel to plug in a cathode-ray oscillograph. This jack should be connected to a pick-up from the transmitter output, using a shielded concentric conductor.

COOLING SYSTEM

COOLING SYSTEM

A surface-type water cooler is employed in the Type 50-D transmitter. The efficiency of this equipment is such that the distilled-water temperature at the outlet of the transmitter will not exceed 135°F. with an ambient (dry-bulb) temperature of 105°F. at the intake of the cooler. Such performance is based on a distilled-water flow of 20 gallons per minute per tube and an air flow of 8,000 cubic feet per minute. The above distilled-water temperature also will be maintained when operating the transmitter into the water-cooled phantom antenna as long as the entering air temperature does not exceed 70°F. (dry bulb) at 100% modulation.

Two sturdy main circulator pumps of the direct-coupled centrifugal type are furnished, one as a spare. A switching arrangement is provided so that the spare may be cut in to pick up the load and the preferred pump shut down for repairs without tripping the station. It is desirable that preferred service be alternated weekly so as to insure correct operation on demand and to keep the pumps clean internally.

AUTOMATIC LOUVRE CONTROL

(Optional)

For indoor installations, a system of air ducts carries cooling air to the surface-cooler equipment and hot air away from it. A bypass connects the intake and discharge ducts, and a group of thermostatically-controlled louvres regulates the temperature of the cooling air by controlling the degree of by-passing.

A low-limit temperature controller, which has its sensitive element immersed in the cooling air duct at the entrance to the surface cooler, controls a pair of modulating motors in such a way as to cause them to close louvres in the intake and discharge ducts and to open louvres in the by-pass duct when the intake air temperature falls below a safe value. A high-limit temperature controller having its sensitive element immersed in the hot-water line entering the surface cooler also controls the louvre-modulating motors so that they open the intake and discharge louvres and close the by-pass louvres when the hot distilled water returning from the power amplifier exceeds a definite temperature.

The entire system operates on the "proportioning" principle, so that the louvres always assume a position in proportion to the demands of the controllers. The limits between which control is maintained have been chosen for optimum cooler efficiency. The mean control range may be altered to suit extreme climatic conditions by adjustment of the range indices on the controllers.

"Fail-safe" operation is assured by spring-loading the louvre motor linkages so that the louvres assume their fully-closed position when control power is removed.

OPERATION AND MAINTENANCE

BEARING LUBRICATION

The essential functions which a ball-bearing lubricant should perform are:

1. Protect the surfaces of balls and races from rust or corrosion.
2. Assist in the exclusion of dirt and water by forming a supplementary seal.
3. Prevent friction between the balls and the container.

These requirements positively preclude the use of all lubricants containing acid, alkali or sulphur, which instead of protecting would inevitably pit or etch, and thus seriously injure the highly polished surfaces of balls and races. Therefore, vegetable and animal oils which are apt to gum up, become rancid and develop acid, are not suitable for ball-bearing lubrication, and should never be employed for this purpose. Moreover, lubricants containing graphite are decidedly unqualified for ball-bearing use. The reason for this is that graphite is a solid substance which tends to accumulate in the races and obstruct the free rolling action of the balls. This tendency increases and eventually becomes a menace as the oil in which the graphite is suspended is gradually lost through volatilization. The same can be said of talc and pumice.

THE IDEAL LUBRICANT FOR A BALL-BEARING IS A PURE, NEUTRAL, MINERAL OIL OR GREASE.

It is recommended that a grease, a little stiffer than vaseline (No. 2 or No. 3 as graded by the Automobile Grease Manufacturers) be used. Housings may be completely filled using a hand-operated grease gun. The small amount of grease that may work out at first can be wiped off easily.

The frequency of subsequent removal depends considerably on local operating conditions. Normally, it will be satisfactory to grease the ball-bearings every three to six months. DO NOT GREASE BEARINGS EXCESSIVELY.

DRIVES

The cooler is provided with a standard V-belt for the fan drive. Normal operation of the unit will in time cause this belt to stretch. The motor is mounted on a base that permits raising the motor and tightening the belt. The belt is too loose when excessive slippage is noted or when the fans are not turning over at the speed (r.p.m.) noted on the unit nameplate. The speed should be checked with a speed-counter or tachometer.

The belt is too tight or the pulleys are not properly aligned if a high, mouse-like squeak is heard. If the belt is too tight or if the pulleys are not properly lined up, the belt will wear excessively and its life will be much shorter than normal expectancy.

AIR FILTER

The air-filter section of this cooler is built up of seven filter pads of the spun-glass type which provide maximum air cleaning efficiency. These pads are manufactured by the Owens-Illinois Glass Co. of Newark, Ohio, under the tradename of "Dustop" (16″ x 25″ x 2″). They are easily removed and should be replaced when filled with dirt, such renewals being required approximately every two to six months depending on the local air contamination. Excessive outlet water temperature is generally an indication that the filters are dirty, the air delivery of the unit being reduced because of increased air resistance. NEVER OPERATE THE COOLER WITHOUT THESE FILTER PADS IN PLACE.

NOTE: If a maintenance record of external static pressure is kept, an increase in static pressure head between inlet and outlet may indicate either that the filters are fouled or that dust is accumulating on the coil. If the static pressure head is normal but the dissipation rating starts dropping off, it is an indication that the coil needs cleaning.

COIL

Approximately once every six months, the coil of the unit should be inspected and any foreign deposit (if present) should be cleaned off. Usually a stiff wire brush will be satisfactory for this purpose, or compressed air from a suitable nozzle may be used if preferred.

FAN

Approximately once every six months, or at the same time that the coil is examined, the fan should be inspected and cleaned if necessary. This usually can be most easily accomplished by means of a stiff wire brush.

Fan Motors. The fan motor is manufactured by the General Electric Company and is provided with ball bearings. Care of these bearings is in general as described above. For specific information on the care of the bearings as well as on general maintenance, see General Electric Instructions GEH-790-C and GES-1476.

Replacement motors may be obtained directly from the General Electric Company. All other parts may be obtained through the Trane Company, LaCrosse, Wisconsin. When ordering repair parts, be sure to specify the complete name plate data on the cooler.

Fan Speed. The fan speeds required to give the delivery of 8,000 CFM depends on the external static pressure as shown in the following table:

External Static Pressure	Fan Speed (R.P.M.)
0	630
1/8″	665
1/4″	700

For additional information refer to the parts list.

PUMPS

The pump motors are manufactured by the Master Electric Company and are of the ball-bearing type. The correct lubricant for these bearings, as recommended by the manufacturer, is New York and New Jersey #A29 Special. Since the duty cycle of the pump motors is quite severe in broadcast service, it is recommended that the grease be checked at least once a month in accordance with the Routine Maintenance Schedule listed in Section VII. At least once every three months, a slight excess of grease should be forced into the bearings to make sure that the entire bearing is packed full of grease. The excess grease forced out of the bearing can be wiped off after a short period of operation. For information on gland packing, refer to Maintenance and Service, Section XV.

MAINTENANCE AND SERVICE

XV

MAINTENANCE AND SERVICE

For daily, weekly, monthly, quarterly and semi-annual maintenance schedules, see Part VII of this instruction book. The following general notes concern specific items and include tabulated data where necessary.

TIME-DELAY RELAYS

Adjustments of the various time-delay relays throughout the transmitter described in Sections VIII and XII are given in the following table:

Item	Relay	Timing (seconds)
309	Exciter	30
4S1	Filter Capacitor Grounding	1.0-1.5
4S2	Power Change	Overlap
7S17	10-KV Rectifier Contactor	1.5-3.0
7S19	Filament Delay	15-15
7S20	10-KV Rectifier Plate	15-20
7S21	Blower "Keep-Alive"	4-7 minutes
7S22 7S23	DC Overloads	Minimum (approx. 0.2)
7S24 7S25	10-KV Rectifier Primary	Minimum (approx. 0.2)
227	Main OCB	0.5
C-106-B	Pump "Hold-On"	7.0 minutes
C-112	Filament Step 1	15.0
C-114	Filament Step 2	15.0
C-119	Plate	2.0 minutes
C-142	Reclose (minimum)	0.7-1.2
C-153	Plate Start Rachet	0.7-1.5
C-156	Plate Run Rachet	0.7-1.5
C-146	Auto Reset	4.0-9.0
C-157	Power Failure Seal	0.9-1.1

OVERLOAD RELAYS

When correctly adjusted as outlined in Sections VIII and XII, the various overload relays employed in this transmitter will trip at the respective values of current shown in the following table:

Item	Relay	Setting (amperes)
333	Exciter 1200-volt Rectifier	1.7
345	Exciter 400-volt Rectifier	0.8
7S22	Modulated Amplifier	0.8
7S23	Modulator	1.0
7S25 7S26	10-KV Rectifier Primary	110-150
E11	Peak Amplifier Plate	6.0
E12	Carrier Amplifier Plate	6.0
C-140	Main Rectifier Primary	12.0
C-141	Main Rectifier Primary	12.0
227	Main OCB	5.0

SPHERE GAPS

The correct settings of the protective sphere gaps in the driver section are given under Section VIII. For the complete transmitter, the gap spacings are as follows:

Item	Unit	Spacing (inches)
4X1	Filter Reactor	0.187
4X2	Filter Reactor	0.250
6X1	Modulation Reactor	0.125-0.187
243	Main Filter Reactor	0.187-0.250

NOTE: TRANSMISSION LINE AND TERMINAL EQUIPMENT HORN GAPS AND ANTENNA BASE GAPS SHOULD BE ADJUSTED FIRST SO THAT THEY JUST FLASH OVER AT 100% MODULATION, THEN FINALLY TO TWICE THE CRITICAL SPACING.

OILS AND LUBRICANTS

Insulating and damping oils required in the different types of equipment are as follows:

Transformers	GE Transil Oil No. 10-C
Breakers and Contactors,	GE Transil Oil No. 10-C or No. 6-C
Dashpots on OCB Trips	GE Oil No. 21
Dashpots in Square D Overloads,	Square D Dashpot Oil

For information on lubricants, consult Part XIV (Cooling System), and the nameplate or manufacturer's instructions for specific units.

LOW-POWER AUDIO AMPLIFIER

Typical voltages and currents in the low-power audio amplifier are as shown in the following table:

Stage (RCA-)	Voltage to Ground				Plate Current (ma)*
	Plate	Screen	Cathode	Grid	
-1603	145-155	103-110	3		4-6
-807	300-320	230-240	11-13		110-130
-845	1700-1750			-250	90-110

* *Values indicated are for two tubes in parallel.*

WATER RESISTANCE

Since the maintenance of 60 percent efficiency plays an important part in obtaining low distortion, it is advisable to check the r-f resistance of the water hose reel at frequent intervals. Such measurements may be performed most easily with the r-f bridge, as follows:

1. Disconnect the plate, grid and neutralizing leads.

2. Adjust the bridge for parallel measurement at a clear frequency in the vicinity of the carrier frequency.

3. Add the 100-ohm standard to the bridge "standard" arm and 300 ohms to the "unknown" arm.

4. Balance for zero with 140 to 150 mmfd across the "unknown" to simulate the 150-mmfd anode-to-ground stray capacitance.

5. Remove the 140-150 mmfd calibrating capacitance and take the "unknown" reading.

6. The effective resistance is then $R_1R_2/(R_1-R_2)$.

The reel resistance should be measured both for full and empty conditions. A record of weekly observations will indicate gradual loss of water resistivity or fouling of the inner walls of the reels. New distilled water should measure approximately 90,000 to 100,000 ohms. Fouled reels may be cleaned by flushing them with a five-percent solution of nitric acid, rinsing thoroughly with clean water.

Meter taps are provided as an integral part of the reels, and a 0-3 or 0-5 ma d-c instrument may be connected either permanently or temporarily between the tap and ground. Average readings for clean water are 0.4 to 0.5 ma, and for foul water 1.9 and 2.1 ma, corresponding roughly to 90,000 and 50,000 ohms (r.f.) respectively. Normally the d-c leakage current will increase fairly rapidly to approximately 1.0 ma within a few days, then very slowly to 2.0 ma as the r-f resistance approaches 50,000 ohms. With reasonably good water, renewal should not be necessary at intervals of less than three months.

If examination of the hose-reel electrolysis targets shows a considerable evaporation of the material, new targets should be installed and the bottom fitting of the hose reel examined for excessive metallic deposit. Such deposits should be scraped away lest they result in abnormal constriction of the discharge orifice. Replacement targets may be made of No. 8 copper wire if necessary.

BLOWERS AND AIR FILTERS

All blowers, fans and air filters should be serviced in accordance with the schedules listed in Part VII.

The exhaust fans in the power-amplifier grid compartments should be oiled regularly and the associated impeller set screws should be checked for tightness.

The air-cooling blowers and the fan section of the water cooler have a high-efficiency type of impeller that must be kept clean to maintain rated delivery. Oily dust is likely to accumulate on the blades and should be wiped off regularly as these deposits change the effective section of the blades. If caking or pitting becomes noticeable, the fan blades of the water cooler should be thoroughly cleaned with a light wire brush and repainted with a good grade of quick-drying synthetic resin enamel such as GE "Glyptal" or duPont "Flint-flex."

All air filters are of the spun-glass "throw-away" type, manufactured by Owens-Illinois under the trade name of "Dustop." Filters in the driver section are 15″ x 20″ x 22″, while those in the water cooler are 16″ x 25″ x 2″.

RESISTORS

Vitreous enamel resistors having cracks in the enamel should be replaced. Globar composition resistors are likely to show a progressive increase of resistance when overheated or subjected to severe overloads or shock. Ohmspun resistors generally fail at the point where the connection lead is soldered to the resistor grid, a brown spot usually appearing at this point before actual failure occurs. If such spots are observed, the unit should be replaced.

TUBES

To make certain that spare tubes are suitable for immediate use on demand, all tubes should be tested on arrival and every six months thereafter. Large power tubes should be tested in the transmitter. It is preferable also to test the RCA-898 tubes in the *carrier* position since gas clean-up there is more rapid than in the *peak* side.

Occasionally a large power tube will develop a small amount of gas which can be cleaned up by operating the tube at reduced plate potential for a while, raising it to normal full value as the gas cleans up. The recommended procedure for breaking in a new RCA-898 is as follows:

With the tube in the *carrier* position, apply "wye" voltage without modulation. After a few minutes, apply tone modulation and gradually increase the percentage modulation to full value. If no gas flashes occur after ten minutes of full tone, remove the modulation and switch to "delta" voltage. Again increase the modulation gradually to full value and allow the tube to run at full power for at least ten minutes. If gas flashes develop during any stage of this process, immediately revert to the no-modulation condition and repeat the conditioning with longer periods of tone after each increase of modulation.

Tubes that flash occasionally with "wye" voltage and no modulation may clean up at slightly lower voltages obtainable by means of the plate transformer taps. In extreme cases, it may be necessary to run a temporary lead to the neutral point of the 10-kv rectifier in order to obtain a seasoning voltage of 5-kv. A tube that flashes continuously at low voltage is probably leaking air through a porous seal.

If handled with reasonable care, there should be no objection to testing spare tubes in the transmitter at least every six months. It is advisable to operate spare tubes a day or so on program before returning them to storage.

An RCA-891-R modulator tube that develops a small amount of gas may usually be cleaned up by operating it in the modulated amplifier socket for a while.

Aging tubes that are showing signs of subnormal emission should have their filament voltage raised as required, within the ratings specified by the manufacturer. The RCA-836 tubes used in the feedback and monitor rectifiers should be replaced every 2000 hours unless there is definite evidence that this is unnecessary.

Procedure for Changing RCA-898 Tubes in Power Amplifier. Each RCA-898 tube is mounted in a tilting support to facilitate removal and safe handling. Study the recommended procedure for changing tubes, as outlined below, so that a tube change can be made quickly and smoothly. Rapidity of change, and least time off the air, depends upon the operator knowing in advance the precise routine procedure.

To Remove a Tube:

1. Upon failure of an RCA-898 during program, immediately shift to operation on 5 kw.
2. Shut off PA filaments and cooling system at the distribution panel.
3. Detach grid and filament connectors and filament air hose, leaving the glass envelope free of all attachments.
4. Release the anode clamp by turning the roller top until the rollers are free of the anode flange.
5. If the tube is not free in the jacket after the rollers are clear of the anode flange (test carefully by hand to see), break the gasket adhesion between the flange and the jacket by means of the ejector at the bottom of the jacket. Back off the ejector as soon as the tube is free.
6. When the tube is free, tilt the jacket to a 45-degree position by means of the tilting handwheel and remove the tube from the jacket.

To Insert a Tube:

1. Put the new anode gasket in place.
2. Insert a new tube in the jacket in the 45-degree position.
3. Return the jacket and tube to the upright position by means of the tilting device handwheel.
4. Seat the tube firmly on the gasket.
5. Turn the roller clamp until the anode flange is securely clamped.
6. Attach the anode air hose to the jacket hood.
7. Attach the filament and grid connections and the filament air hose.
8. Start the water cooling system and check for watertight anode gasket seal.
9. Start the filaments by closing the circuit switch at the distribution panel.
10. After normal starting cycle of filaments, the set is ready to return to 50-kw operation.
11. Press the time delay by-pass button if desired to apply PA plate power before the two minute timing cycle is over.

GENERAL CLEANING

Insulators and bushings should be kept clean at all times. Those parts subject to stress in high-voltage, d-c fields rapidly accumulate dust particles and may rupture if sufficient accumulation develops to cause corona. In trouble-shooting cases where flashovers cannot be readily located, check for internal arcs in the glazed ceramic bushings.

High-voltage capacitor plates should be kept clean and free of arc etchings, both for the sake of appearance and to prevent the development of corona leading to flashover.

Horns and sphere gaps should be burnished after heavy arcing has occurred, and their clearance checked. If surge-absorbing resistors are part of the gap, check their resistance regularly.

Tube envelopes must be kept clean to avoid possible puncture resulting from bombardment or corona. Tissue paper and alcohol is the most effective combination for cleaning glassware.

Plate-tank inductances should be cleaned with a dry rag or, if necessary, with very fine sandpaper. Never use liquid polish or steel wool to burnish these units. Clamp type connectors must be kept tight at all times to avoid excessive heating.

INSTRUMENTS

Do not attempt repairs on any instrument requiring disassembly of the unit.

SWITCHGEAR

Relay servicing is comparatively simple, but must necessarily be carefully performed. The delicate contact fingers in high-speed relays should be checked carefully after each cleaning operation. Make sure that good wiping occurs on contact "make," and that the back contacts do not follow the bar too far as it moves to the opposite position. Plunger type relays must be perfectly free in their tubes, and should trip their contacts with a definite "snap" as the toggle is tripped. Contacts should be cleaned with a clean piece of cloth moistened with carbon tetrachloride, then wiped off with a dry piece of bond paper. In extreme cases, the contact surface may be burnished with crocus cloth. Always wipe the contacts with dry paper after any cleaning operation, and operate the relay manually several times to assure correct alignment.

Large contactors of the air-break type may require dressing with a mill-type file when contacts are severely pitted. Adjustments are provided for maintaining correct contact alignment and "wipe." Keep the pole faces clean and see that they seat securely. Check the operation manually, tightening any loose screws. Replace broken arc-chutes and magnetic blowouts. "Overlapped" fingers should be checked frequently to see that their sequence is correct with respect to other contacts.

Oil-immersed contactors should be checked manually to make sure they operate freely and seat properly. When the tank is dropped for examination of the oil, check all contact fingers and renew any members that are badly burned. Examine the bushings for cracks and oil leaks.

Oil circuit breakers having V-type fingers should be checked for alignment whenever the tank is removed for oil inspection.

Bushings on potential transformers must be kept clean. CAUTION: NEVER LEAVE THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER OPEN. If it becomes neecssary to remove an over-current relay actuated by a current transformer, short circuit the current-transformer secondary winding until the unit has been replaced and permanently connected in the circuit. The induced voltage in an open current-transformer secondary may endanger personnel and will almost certainly break down the insulation on the low-voltage secondary wiring.

Motor starters of the "across the line" type are provided with thermal trip devices. In locations where abnormal ambient temperatures are encountered, or where vibration is severe, it may be advisable to install heaters of the next larger size. These can be obtained locally by catalog number selected from the manufacturer's data posted inside the cover. Make sure no overload exists on the branch circuit before installing heaters of greater capacity.

The distilled-water centrifugal pumps should be alternated in service to prevent undue corrosion. Packing for the glands of these units may be obtained locally. The recommended packing is ¼ x ¼ "Palmetto" brand, manufactured by the Greentweed Company, New York. Do not bring up the gland too tight or overheating will result. A certain amount of water leakage is necessary for correct lubrication of the packing, and the gland should be tightened only as much as necessary to prevent abnormal leakage. Approximately six drops per minute will be found about right.

Should there be any fusible cut-outs in the 2300-volt service to the station, they should be of the high-reactance type and of adequate capacity to withstand momentary short circuits of 30 cycles duration without clearing. If any oil circuit breakers are in the system ahead of the main OCB, the tripping device must be equipped with oil dash pots to provide a ½-second delay in tripping on short-circuit faults.

PHANTOM ANTENNA

The resistor assembly used in the phantom antenna is composed of three pairs of Ohmspun plates in series, each pair being a 115-ohm plate in parallel with a 230-ohm plate. When servicing these resistors or inserting new elements, special care must be exercised to keep the resistors approximately ⅜-inch or more from the envelope. In asembling replacement groups, always form the plates so that the 115-ohm units have the smaller radius of curvature.

PERFORMANCE TESTS

Periodic performance tests will do much to familiarize the staff with the intimate details and condition of the transmitter. A high standard of performance is easy to maintain if this is done. Specific directions are contained in previous sections of this book.

In using the bridge for parallel resonance measurements, it is essential that stray effects shall be minimized. Where long leads are required, such as in tuning the power amplifier, it is recommended that the leads shall be twisted together permanently. While adjusting the bridge for balance, the ground lead should be connected to ground at the point to be used during measurement, and the "hot" lead temporarily placed very near the point to which it is to be connected, so that when the measurement is made, the "hot" lead may be connected to the "unknown" with the least possible disturbance of the leads.

When measuring distortion, be sure that correct power relations obtain. That is, adjust the PA input power to 83.0 kw and the antenna power to 50 kw, giving an efficiency of 60.24 percent. It is essential that the PA efficiency shall be adjusted to a value between 60 and 61% with rated 50-kw output for conditions of minimum distortion. The input power should be adjusted by varying the *peak* bias so as not to affect the output too greatly. Similarly, the antenna power should be adjusted by varying the *carrier* bias, so as not to affect the input power too greatly.

A list of test equipment recommended for testing and servicing the Type 50-D transmitter is given in Part V. These instruments are adequate for all normal tests.

It is suggested that each station keep a "Maintenance" log in the form of a bound or looseleaf notebook in which all test records such as bridge settings, tuning records, computations and general maintenance notes can be kept for reference.

PARTS LIST

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.

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. See "Recommended Spare Parts."

In instances where parts can more easily be secured locally or through the manufacturer than through a centralized 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 in these data.

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

DRIVER SECTION (5 KW)

Item No.	Description	Stock No.
	EXCITER	
	Radio-Frequency Equipment	
01	Resistor, 180,000 ohms, 1 w.	12356
02	Socket, Crystal Holder	16889
03	Capacitor, Frequency Control, 20 mmfd (max.)	16890
04	Tube Socket, Osc., 7-contact	16593
05	Capacitor, 150 mmfd, 5000 v.	F-152
06	Resistor, 10,000 ohms, 1 w.	13488
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, 0.0002 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	
119B	Socket Assembly, Westinghouse Style 822322	
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, 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-3126-A
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, PA Neutralizing	17035
160	Tube Socket, PA, same as 142	
161	Capacitor, same as 150	
162	Capacitor, 0.00015 mfd	UC-3121
163	Capacitor, 200 mmfd, 5000 v.	UC-3115
164	Capacitor, Variable, PA Tank, 180 mmfd 1 section (max.)	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	
182	Voltmeter, 0-2 kv, 1000 ohms per volt	17044
183	Capacitor, 0.0004 mfd	UC-3103

Item No.	Description	Stock No.
184	Capacitor, 0.100 mmfd, 15,000 v.	UC-3127-A
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, Modulator, 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
304	Voltmeter, 0-150 v. a.c.	17064
305	Switch, Filament, SPST	17078
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	
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-536-A	17071
314	Capacitor, 5 mfd, 600 v.	17047
315	Voltmeter, 0-500 v. d.c., 1000 ohms per 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.	17062
325	Lamp, Plate Indicator, same as 119	
325A	Lens, Red, Westinghouse Style 822265	
325B	Socket Assembly, same as 119B	
326	Transformer, Plate, XT-2266	16922
327	Tube Socket, 1200-v. Rectifier	17080
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, 400-v. Rectifier	17080
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, 1300 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	Omitted	
354	Lamp, Meter Illuminating, 115 v, 15 w, int. screw base	4206
355	Fuse, Cartridge type, 1 a.	17102
355A	Fuse Block	17103
	MODULATED AMPLIFIER	
1A1	Blower, Counterclockwise, up-blast discharge, American Blower Co., size #1½, Dwg. H-39890	
	Motor only	17228
1A2	Safety Gap, Grid	
1A3–1A6	Lamp, same as 119, 119A, Socket Assem. West. Style 822321	
1C1	Capacitor, 0.0004 mfd	UC-3105
1C2	Capacitor, 0.0003 mfd	UC-3111
1C3	Capacitor, 0.02 mfd	UC-2996
1C4, 1C5	Capacitor, dual unit, 0.05/0.05 mfd	UC-3145
1C6	Capacitor, 0.0003 mfd, 30 kv.	UC-3113-A
1C7	Capacitor, 28 mmfd	UC-3220
1C8, 1C9	Capacitor, Tuning (see chart in text)	
1C10	Omitted	
1C11, 1C12	Capacitor Tuning (see chart in text)	
1C13–1C18	Omitted	
1C19	Capacitor, 0.0002 mfd	UC-3118
1C20	Capacitor, 10 mfd, 2000 v d.c.	16195
1C21–1C23	Capacitor, 0.01 mfd	F-10004
1C24, 1C25	Capacitor 0.0002 mfd	UC-3117
1L1	Inductor, Grid Tank	17038
1L2	Omitted	
1L3	Choke, R-F Plate	17229
1L4	Coil, Plate Parasitic Suppressor	17230
1L5	Omitted	
1L6	Inductor, Plate Tank	17231
1L7, 1L8	Inductor, Variable	17232

Item No.	Description	Stock No.
1L9, 1L10	Coil, R-F Pickup, Dwg. M-415745-3	
1M1	Milliammeter, 0-500 ma d.c.	18034
1M2	Ammeter, 0-1.5 a. d.c.	18035
1M3	Ammeter, 0-8 a. r.f. complete with Thermocouple 1M4	18036
1M4	Thermocouple, furnished with meter 1M3	
1R1, 1R2	Resistor, 800 ohms	17995
1R3	Resistor, 50 ohms	17238
1R4	Omitted	
1R5–1R9	Resistor, 700 ohms (tapped at 1/3 and 2/3 points)	17240
1S1	Relay, Power Change, for r-f pickup coils; Leach Type 1357 with Mycalex base; DPDT, 220 v, 60 cy.	
1S2	Switch, Air Flow Interlock, mercury type	17219
1S3–1S8	Switch, Door Interlock	23552
1S9	Switch, Rectifier Start, 3-point tumbler	17221
1S10	Switch, Filament "ON"	17241
1T1, 1T2	Transformer, Filament, XT-2145	16402
1V1	Tube Socket, 3rd IPA	17239
	MODULATOR-RECTIFIER	
2A1, 2A2	Blower, same as 1A1 except clockwise rotation	
	Motor only	17228
2A3–2A8	Indicator, Arc Back	17207
2A9-2A12	Lamp, same as 325, 325A, Socket Assem. West. Style 822321	
2C1, 2C2	Capacitor, 2 mfd, 2500 v. d.c.	17208
2C3, 2C4	Capacitor, 0.01 mfd	BF-10004
2C5	Capacitor, same as 332	
2C6	Omitted	
2C7	Capacitor, 4 mfd, 1500 v.	17150
2C8	Capacitor, same as 2C3	
2M1, 2M2	Ammeter, 0-2 a. d.c.	18040
2M3	Voltmeter, 0-12 kv d.c.	18041
2R1, 2R2	Resistor, Filament Center Tap, 50 ohms	17238
2R3, 2R4	Omitted	
2R5, 2R6	Resistor, 100 ohms	17212
2R7	Resistor, 6400 ohms	17213
2R8	Omitted	
2R9	Resistor, 5000 ohms, adjustable	17215
2R10	Omitted	
2R11	Resistor, 16,000 ohms	17216
2R12	Omitted	
2R13	Resistor, 100 ohms	17217
2R14	Resistor, same as 2R12	
2S1, 2S2	Switch, same as 1S2	
2S3, 2S4	Switch, same as 1S3	
2S5–2S8	Omitted	
2S9	Relay, Bias Interlock, Westinghouse Type SG-1008540	
2S10	Switch, Manual-Automatic, SPDT	17220
2S11	Switch, Rectifier "OFF," same as 1S9	
2T1–2T4	Transformer, Modulator Filament, XT-2145	16402
2T5	Transformer, Bias Rectifier Plate, XT-2496	17222
2T6	Transformer, Bias Rectifier Filament, XT-2504	17223
2T7–2T12	Transformer, 10-kv Rectified Filament, XT-1511-A	17224
2T13	Transformer, Modulator Driver, XT-2726	18042

Item No.	Description	Stock No.
2V1, 2V2	Tube Socket, Modulator, same as 1V1	
2V3, 2V4	Tube Socket, Bias Rect., UR-542	MI-7438-A
2V5–2V10	Tube Socket, 10-kv Rect., UT-541-A	MI-7437A
2X1	Reactor, Bias Rectifier Filter, XT-25-A	17227
	LOW-POWER AUDIO AMPLIFIER	
3C1	Capacitor, same as 013	
3C2	Capacitor, 8 mfd	17243
3C3	Capacitor, 1 mfd	17242
3C4	Capacitor, 0.005 mfd	NF-5003
3C5, 3C6	Capacitor, same as 3C2	
3C7–3C12	Omitted	
3C13, 3C14	Capacitor, same as 3C3	
3C15	Capacitor, same as 3C2	
3C16	Capacitor, 1 mfd, 1000 v.	18023
3C17, 3C18	Omitted	
3C19, 3C20	Capacitor, same as 3C3.	
3C21	Capacitor, 0.02 mfd	NF-20003
3M1	Milliammeter, 0-25 ma d.c.	17244
3M2	Milliammeter, 0-200 ma d.c	17245
3M3	Milliammeter, 0-300 ma d.c.	17246
3R1	Resistor, 56,000 ohms, 1 w.	17440
3R2	Resistor, 100,000 ohms, 2 w.	11371
3R3, 3R4	Resistor, 100 ohms, ¼ w.	14439
3R5	Resistor, 220 ohms, 2 w.	13218
3R6	Resistor, 10,000 ohms, 10 w.	18021
3R7, 3R8	Resistor, 15,000 ohms, 10 w.	18022
3R9, 3R10	Resistor, 100 ohms, ½ w.	30540
3R11	Resistor, 15,000 ohms, 2 w.	35351
3R12, 3R13	Resistor, 5000 ohms	18025
3R14	Resistor, 220,000 ohms, 2 w.	18024
3R15	Potentiometer, Feed- -back control, 100 ohms	18026
3R16, 3R17	Resistor, same as 3R3	
3R18, 3R19	Resistor, 200 ohms, 10 w.	18027
3R20	Resistor, 30,000 ohms	18028
3R21	Resistor, 25,000 ohms	18029
3R22, 3R23	Resistor, 6,000 ohms	18030
3R24	Omitted	
3R25	Resistor, 22,000 ohms, 2 w.	13669
3R26	Omitted	
3R27, 3R28	Resistor, 68 ohms, 2 w.	17253
3R29	Omitted	
3R30, 3R31	Resistor, 2500 ohms	17254
3R32, 3R33	Omitted	
3R34, 3R35	Resistor, 100 ohms, 2 w.	14162
3R36	Resistor, same as 3R2	
3S1	Relay, Audio Short, same as 1S1	
3T1	Transformer, Input, XT-2692	18031
3T2	Transformer, Filament, XT-2602	17257
3V1, 3V2	Tube Socket, 1st A-F, 6-contact	8012
3V3, 3V4	Tube Socket, 2nd A-F, 5-contact	17051
3V5, 3V6	Tube Socket, Driver, same as 2V5	
3X1	Reactor, Feed-back, XT-2820	18032
3X2	Reactor, Air-Core, 5 mh.	18033
3X3	Reactor, 2.5 mh, National Co. Type R-100	
	FILTER RACK	
4C1–4C3	Capacitor, 3 mfd, 10,000 v.	17200
4C4, 4C5	Capacitor, 4 mfd, 5000 v.	17201
4C6	Capacitor, 0.16 mfd, 5,000 v.	18043
4C7	Omitted	
4C8, 4C9	Capacitor, 4 mfd, 7.5 kv.	19846
4R1–4R4	Omitted	
4R5, 4R6	Resistor, 10,000 ohms	17203
4R7–4R9	Resistor, 11,000 ohms	18045

Item No.	Description	Stock No.
4R10	Voltmeter Multiplier, 12.0 kv, for use with meter 2M3. Shallcross Mfg. Co.	
4R11–4R22	Resistor, 300 ohms	18046
4R23	Omitted	
4R24	Resistor, 5000 ohms	18047
4S1	Switch, Automatic, Capacitor Grounding	16689
4S2	Relay, Power change, Monitor Controller Co. (Baltimore, Md.) Type SP-836 20,000-v. trip-locked, high-tension switch, 220-v, 60-cy. operation, SPDT:	
	Contacts only	17533
4S3	Switch, Resistor Shorting, Monitor Controller Co. Type SP-708; 220-v, 60 cy. operation, DPST:	
	Coil only	17534
	Contacts only	17540
4S4, 4S5	Switch, Disconnect, Trumbull #9048, Cat. #15, 60 a, (less handle)	
4S6, 4S7	Jaw, Grounding for Switches 4S4 and 4S5 respectively	
4X1	Reactor, Filter, XT-2228	17206
4X2	Reactor, Filter, XT-1512	16407
4X3	Reactor, Modulation, XT-2983	18048
	H-V TRANSFORMERS	
5T1	Transformer, 10 kv. Rect. Plate	MI-7372-5
5T2	Transformer, Booster	MI-7372-10
	POWER CONTROL PANEL	
7A1	Pilot Lamp, A-C Line "ON," same as 2A9	
7A2	Pilot Lamp, Control Circuit "ON," same as 2A9	
7A3	Pilot Lamp, Rectifier A-C Line "ON," same as 1A3	
7A4	Pilot Lamp, "HIGH POWER," same as 2A9	
7A5	Pilot 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	Tube Hour Meter, 220 v, 60 cy.	17199
7R1–7R6	Omitted	
7R7	Resistor, Relay 7S8 Coil Shunting, 500 ohms	
7R8	Resistor, 3 ohms	17998
7R9	Omitted	
7R10–7R12	Rheostat, 3 sections, each 12.5 ohms, 500 w.	18218
7R13B	Rheostat, 25 ohms, Westinghouse Type WL, 13″ plate, style 874756	
7R14	Resistor, 3 sections, each 3.6 ohms Westinghouse Type M, style 833778	
7R15	Resistor, 3 sections, each 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, P. A. & 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 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, Blower "Keep Alive"	19841
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	
7X1–7X3	Choke, Retard, PX-271784-501	

POWER AMPLIFIER SECTION (50 KW)

Item No.	Description	Stock No.
A-1	Fan, Exhaust	17840
A-2	Water-Jacket, Peak, UT-1289-A	MI-7436-A
	Roller Assembly	18601
A-3	Hose Reel, Porcelain	17826
	Gasket	19278
A-4	Blower, Seal Air	17841
A-5	Connector, Filament, MX-241595-501	
A-6	Connector, Filament, MX-241595-502	
A-7	Connector, Filament, MX-241595-503	
A-8	Bus, Filament, MX-242022-4	
A-9	Bus, Filament, MX-242022-1	
A-10	Bus, Filament, MX-242023-2	
A-11	Feedback Rectifier, comprising:	
	(a) Transformer, filament	17846
	(b) Tube socket	16906
	(c) Resistor Assembly, 55220 ohms total, consisting of twelve ¼-ampere resistors in series. Resistor unit only	18130
A-12	Fan, Exhaust, same as A-1	
A-13	Water-Jacket, Carrier, same as A-2	
A-14	Hose Reel, Porcelain	17826
A-15	Blower, Seal Air, same as A-4 except for counterclockwise, down blast discharge	
A-16	Connector, Filament, same as A-5	
A-17	Connector, Filament, same as A-6	
A-18	Connector, Filament, same as A-7	
A-19	Bus, Filament, MX-242022-3	
A-20	Bus, Filament, MX-242023-1	
A-21	Bus, Filament, MX-242022-2	
A-22–A-25	Fuse Block Assembly, Fan block only	17103
	Fuse, cartridge type, 10 amperes, 250 v.	21924
A-26	Outlet, Twin Convenience, for 110 v., 60 cy., Crouse-Hinds FS-1 condulet ½″ with twin outlet plate	
A-27	Lamp, "PLATE ON," 25 w., 220 v., Mazda, red	
A-28	Outlet, Service Light, single receptacle, Crouse-Hinds CC-227-GX with ½″ condulet fitting	
C-1	Capacitor, Input Blocking (see chart in text)	
C-2	Capacitor, Variable, 238 mmfd (max.), 8.7 kv.	19838
C-3–C-5	Omitted	
C-6	Capacitor, Peak Grid Oscilloscope Coupling, consists of two assemblies per MX-241511-501	
C-7	Capacitor, Peak Grid Tank (see chart in text)	
C-8	Omitted	
C-9	Capacitor, Peak Grid By-pass (see chart in text)	
C-10–C-12	Capacitor, 0.1 mfd, 2 kv.	UC-2988
C-13	Capacitor, 0.01 mfd, 10 kv.	UC-3188
C-14	Capacitor, Peak Plate Tank (see chart in text)	
C-15	Capacitor, Peak Plate Potentiometer, 3000 mmfd, 7 kv.	UC-3048
C-16	Capacitor, Peak Plate Potentiometer, 50 mmfd, 10 kv.	UC-3167
C-17	Capacitor, Feedback Coupling, 500 mmfd, 20 kv.	UC-2344
C-18	Capacitor, LP Feedback, 250 mmfd, 20 kv.	UC-2461-A
C-19	Capacitor, HP Feedback, 175 mmfd, 30 kv.	UC-3136
C-20	Capacitor, Plate By-pass, 0.01 mfd, 20 kv.	UC-3305
C-21	Capacitor, Antenna Blocking 0.5 mfd, 20 kv.	17547
C-22	Capacitor, Harmonic Filter (see chart in text)	
C-23, C-24	Capacitor, 10 mfd, 1500 v.	18108
C-25	Capacitor, same as C-22	
C-26–C-29	Omitted	
C-30	Capacitor, Carrier Grid Blocking (see chart in text)	
C-31	Capacitor, Carrier Grid Oscilloscope, same as C-5	
C-32	Capacitor, Carrier Grid Tank (see chart in text)	
C-33	Capacitor, Carrier Grid Tank, same as C-2	
C-34	Capacitor, Carrier Grid By-pass, same as C-9	
C-35–C-37	Capacitor, same as C-10	
C-38	Capacitor, same as C-13	
C-39	Capacitor, Carrier Plate Tank (see chart in text)	
C-40	Capacitor, Carrier Plate Potentiometer, 6000 mmfd, 5 kv.	UC-3023
C-41	Capacitor, Carrier Plate Potentiometer, same as C-16	
C-42	Capacitor, same as C-20	
C-43, C-44	Capacitor, Carrier Bias Filter, 10 mfd, 1000 v.	18118
C-45	Omitted	
C-46–C-53	Capacitor, Meter By-pass	BF-10004
E-1	Relay, Auxiliary Power Change	18113
E-2–E-10	Omitted	
E-11	Relay, Peak Plate Overload, coil rated 4 a. d.c. continuous, plunger calibrated 4-6-9-12 a. Instantaneous type self-resetting, with target, 2 N.O. circuits, 2 N.C. circuits, G.E. Co. Type PAC-13-B	
	Coil only	19845
E-12	Relay, Carrier Plate Overload, same as E-11	
E-13	Relay, Sensitive, Antenna Protective	18119
E-14	Relay, Tripping, Antenna Protective, 2 N.O. circuits, 2 N.C. circuits, instantaneous self-resetting, with indicating target and reset plunger, coil for 230 v., 60 cy., one minute service, G.E. Co. Type PAA-13-B	
	Coil only	19844
J-1–J-10	Omitted.	
J-11	Jack and Plug, Western Electric Co., Jack D-157789, Plug D-157790	
J-12	Omitted	

Item No.	Description	Stock No.
J-13	Jack and Plug, Peak Plate, Oscillograph, same as J-11	
J-14	Jack and Plug, Carrier Grid, Oscillograph, same as J-11	
J-15	Jack and Plug, Carrier Plate, Oscillograph, same as J-11	
L-1	Inductance, Peak Grid Series (see chart in text)	
L-2	Inductance, Peak Grid Tank (see chart in text)	
L-3	Inductance, Neutralizing (see chart in text)	
L-4	Inductance, Peak Plate Tank (see chart in text)	
L-5, L-6	Inductance, Harmonic Filter (see chart in text)	
L-7	Choke, Peak Grid Parasitic (see chart in text)	
L-8–L-10	Omitted	
L-11	Inductance, Monitor Pickup, same as L-3	
L-12	Inductance, Carrier Grid Tank (see chart in text)	
L-13	Inductance, Neutralizing, same as L-3	
L-14	Inductance, Carrier Plate Tank (see chart in text)	
L-15	Inductance, Carrier Plate Series (see chart in text)	
L-16	Omitted	
L-17	Clamp, Harmonic Filter Grid (⅛ inch)	18140
L-18	Clamp, Peak Plate Coil (⅝ inch) (¾ inch)	 18141 19836
L-19	Clamp, Carrier Plate Coil (⅜ inch) (½ inch) (⅝ inch)	 19387 18142 18141
M-1	Indicator, Water Flow, 0-30 GPM, Right-Hand Flow Diaphragm only	18115 19155
M-2–M-5	Omitted	
M-6	Indicator, Water Flow, 0-30 GPM, Left-Hand Flow Diaphragm only	18117 19155
M-7–M-10	Omitted	
M-11	Ammeter, Peak Grid, 1-0-1 a d.c., zero center, Westinghouse Type HX, 40 scale divisions, special target per ED sk. 139861	
M-12	Ammeter, Peak Plate, 0-10 a, d.c.	18121
M-13	Ammeter, FCC, Total Plate, same as M-12	
M-14	Voltmeter, Filament, 0-50 v. a.c., Westinghouse Type HA, 50 scale divisions with special pointer per ED sk. 139861	
M-15, M-16	Thermometer, Dial, 5 inch dial, class II instrument, flush type, #5187 aluminum case, black finish, black dial, white characters, scale 50-180° F, 2″ brass bulb #2314, union rigid, with 1″ SPT bushing and 10 feet flexible tubing, back connected case, electric contact attachment, high contacts only, Foxboro Instrument Co. Type C	
M-17	Ammeter, Carrier Grid, same as M-11	
M-18	Ammeter, Carrier Plate, same as M-12	
M-19	Voltmeter, FCC, Plate, 0-25 kv d.c., 50 scale divisions, complete with external multiplier	18800
M-20	Voltmeter, Bias, 0-150 ma d.c. milliammeter with scale marked as voltmeter 0-1500 v. d.c., Westinghouse Type HX. External resistor not furnished, 60 scale divisions. Special target per ED sk. 139861	
M-21–M-26	Omitted	
M-27	Ammeter, FCC, Remote Antenna, 0-50 ma d.c.	18122
R-1	Resistor Assembly, Peak Grid Load, 550 ohms, total, consisting of sixteen 2.5-ampere resistors in series. Resistor unit only	18116
R-2	Resistor, Peak Bias R-F Filter, 20 ohms, non-inductive	19843
R-3	Resistor, Peak Grid Series, same as R-2	
R-4	Resistor, Protective, 2500 ohms, 180 w.	17838
R-5	Resistor Assembly, Peak Bias Bleeder, 2760 ohms total, consisting of twenty-four ¼-ampere resistors in series - parallel. Resistor unit only	18130
R-6	Resistor, Peak Bias Voltmeter, 5000 ohms ±1%, 180 w.	17836
R-7	Phantom Antenna, 235 ohms, water cooled, rated 75 kw, TX-260888-501, consists of three 1-ampere resistors and three ½-ampere resistors Set of three 1-ampere resistors Set of three ½-ampere resistors	 18144 18143
R-8–R10	Omitted	
R-11	Resistor Assembly, Peak Grid Load, same as R-1	
R-12	Resistor, Carrier Bias R-F Filter, same as R-2	
R-13	Resistor, Carrier Grid Series, same as R-2	
R-14	Resistor, 35 ohms	17837
R-15	Resistor, Carrier Bias Voltmeter, same as R-6	
R-16–R-20	Omitted	
R-21, R-22	Resistor, Relay Shunt, 2.35 ohms ±10%, 80 w.	18123
R-23	Resistor, Relay Shunt, Ohmite "Brown Devil," 500 ohms, 10 w.	26935
R-24	Resistor, Remote Ammeter Shunt, adjustable, 3 ohms, 10 w.	19842
S-1	Switch, Input Transfer, PX-271337-501	
S-2	Switch, Output Transfer, PX-271337-502	
S-3	Switch, Feedback Transfer, PX-271337-503	

Item No.	Description	Stock No.	Item No.	Description	Stock No.
S-4	Switch, Phantom Antenna Transfer, SPDT, PX-271737-501		S-22–S-25	Switch, Door Interlock, same as S-12.	
S-5	Omitted		S-26	Outlet Box, Service Light, Crouse-Hinds ½" FS-1 condulet with switch plate for tumbler snap switch	
S-6	Switch, High Voltage Grounding, PX-271736-501.		T-1	Transformer, Filament, 7.5 kva, 3-phase	17545
S-7–S-10	Omitted		T-2	Transformer, Bias Plate, 1-phase, XT-2738	17831
S-11	Switch, Filament Voltmeter, 6-position, escutcheon plate to be furnished with pistol grip and white pointer, General Electric Co., Type SB-1		T-3	Transformer, Bias Rect. Filament, XT-2572	17833
S-12–S-15	Switch, Door Interlock	18110	T-4	Voltage Control, Peak Bias, 5.2 kva	17834
S-16	Switch, Bias Voltmeter, for measuring 2 voltages with one instrument, Escutcheon plate furnished with pistol grip and white pointer, G. E. Type SB-1.		T-5–T-10	Omitted	
S-17	Switch, L.P. "PLATE ON"	18111	T-11	Transformer, Filament, same as T-1	
S-18	Switch, L.P. "PLATE OFF"	18112	T-12	Transformer, Bias Plate XT-2648	17832
S-19	Switch, H.P. "PLATE ON," same as S-17		T-13	Transformer, Bias, Rect. Filament, XT-2572	17833
S-20	Switch, H.P. "PLATE OFF," same as S-18		T-14	Voltage Control, Carrier Bias, 1.15 kva	17835
S-21	Switch, Service Light, single circuit toggle snap, Bryant 3952 modified to fit Crouse-Hinds ½" FS1 condulet with tumbler switch plate.		V-1, V-2	Tube Socket, K-842105-1	
			V-3–V-5	Omitted	
			V-6, V-7	Tube Socket, same as V-1	
			X-1, X-2	Reactor, 2 h, XT-2641	18109
			X-3–X-5	Omitted	
			X-6, X-7	Reactor, same as X-1	

ANTENNA TUNING AND ASSOCIATED EQUIPMENT

	ANTENNA TUNING UNIT		302	Potentiometer, 500 ohms, 300 w.	18131
C-1	Capacitor — Part of KX-283783-501		303	Capacitor, 0.003 mfd	UC-3048
L-1	Coil, Tank, TX-260855-501		304	Omitted	
L-2	Coil, Choke, PX-271396		305	Transformer, XT-2446	18132
M-1	Ammeter, Antenna, 0-35 a. r.f.	18125	306	Transformer, XT-2442	17846
M-2	Thermocouple for use with M-1, W.E.M. Co.		307	Relay	17845
S-1	Switch, Knife, Type A, SPST, 100a, 250 v, d.c., 500 v. a.c., Trumbull Elec. Co. Cat. #3764		308–311	Tube Socket, 4-contact	16906
	MONITOR RECTIFIER UNIT		312	Connection Link Assembly, 713644-12&-37	
301	Resistance Unit, 460 ohms	18130	313	Capacitor, 4 mfd, 600 v.	15763
301-A	Resistance Unit, 230 ohms	17549	314	Resistor, 125 ohms (tapped at 75 and 100 ohms)	18128
			315	Capacitor, 0.004 mfd	UC-3038
			316	Capacitor, 0.004 mfd	UC-3040
			317	Capacitor, 0.0002 mfd	UC-3117

POWER RECTIFIER AND ASSOCIATED EQUIPMENT

A-1	Blower, American Blower Co., Size 1, Cat. #8126. Motor only	17825	T-1–T-7	Transformer, Filament	17844
A-2	Terminal Board, 12 Terminals, G. E. Type 16EB-1A3				

POWER CONTROL AND DISTRIBUTION SECTION

	POWER CONTROL PANEL		C-107	Relay, Blower Motor Auxiliary. Same as 102	
C-101	Switch, Station Start-Stop. Tumbler snap switch, DPST, Textolite handle		C-108	Relay, Filament Auxiliary. Same as C-102	
C-102	Relay, Low-Power Control	18133	C-109	Hour Counter, 0-10,000 hours. Flush mounting. Motor for 220 v. 60 cycles. Weston Electrical Instrument Co., Model 734	
C-103, 104	Omitted				
C-105	Relay, Temperature Auxiliary. Same as C-102 except N.C.				
C-106A	Relay Pump and Blower Seal, same as C-102				
C-106B	Relay, Pump and Blower Hold-On, motor-driven definite-time type, adjustable from 2 to 15 minutes	19841			

Item No.	Description	Stock No.
C-110	Indicator, Filament Status, Lamp only	18135
C-111	Contactor, Filament Start, Coil only	18136
C-112	Relay, Filament Time Delay, Step 1. Motor driven definite time relay. One N.O. and one N.C. contact, with time adjustable from 2 to 40 seconds. G. E. CR-2820-1099 or equivalent. Motor for 220 v. 60 cycles.	
C-113	Contactor, Filament Start, Step 2. Same as C-111	
C-114	Relay, Filament Time Delay, Step 2. Same as C-112	
C-115	Contactor, Filament Run. 3 main poles rated 75 a. 220 v. 60 cycles. One N.C. auxiliary contact overlapped so that it does not open until after main poles are closed. Coil for 220 v. 60 cycles, continuous duty	
C-116	Relay, Filament Seal-in Auxiliary. Same as C-102	
C-117	Resistor, Filament Starting, Step 1. One unit in each line. Each unit 2.0 ohms, rated 40 a. for one minute	
C-118	Resistor, Filament Starting, Step 2. One unit in each line. Each unit 0.6 ohm, rated 40 a. for one minute	
C-119	Relay, H.P. Plate Time Delay. Same as C-106B	
C-120	Relay, Time Delay By-pass. Same as C-102	
C-121	Switch, Time Delay By-pass. Momentary contact, 1 N.C., 1 N.O. Red button. Hart & Hegeman cat. #27901-U	
C-122	Relay, Bias Undervoltage. Same as C-102 except with coil for 125 v. d.c. continuous	
C-123	Resistor, Peak Filament Dropping. One unit in each line	19835
C-124	Resistor, Carrier Filament Dropping, same as C-123	
C-125	Resistor, Bias Relay. 10,000 ohms, 50 watts. Ward-Leonard "Adjustohm," cat. #507-139	
C-126	Light, Bias Status. 220 v., green color cap, GE #6005406G7 or equivalent	
C-127	Relay, Exciter Plate Auxiliary. Same as C-102	
C-128	Switch, Exciter Plate "ON." Same as C-121 except with black button	
C-129	Switch, Exciter Plate "OFF." Same as C-121	
C-130	Relay, Auxiliary. Same as C-102	
C-131	Relay, Interlock Auxiliary. Same as C-102	
C-132	Light, Interlock Status. Same as C-126	
C-133, 134	Omitted	
C-135	Contactor, Bias Plate. 4 N.O. contacts rated 15 a. 220 v., coil for 220 v. 60 cycles, continuous duty, G.E. size "0" contactor	
C-136	Relay, H.P. Plate Auxiliary. Same as C-102	
C-137	Switch, H.P. Plate "ON." Same as C-128	
C-138	Switch, H.P. Plate "OFF." Same as C-121	
C-139	Relay, Notching. Two cam-operated contact fingers, one pair of contacts having a sequence of CCCO, and one pair having a simultaneous sequence of OCCO. Ratchet to advance on power stroke. Cam shaft spring-loaded, with pawl stop. Electrical reset coil to lift pawl, returning cam shaft to home position by spring action. Operating coil and reset coil for 220 v., 60 cycles, intermittent duty. Struthers-Dunn ratchet relay #CX-1276-B, contact sequence as specified	
C-140, 141	Relay, AC Overload. 2 N.O., 2 N.C. circuits. Self-resetting, with indicator target. Instantaneous type. 5 a. coil, plunger calibrated 5-8-12-15 a. GE type PAC-13-B	
C-142	Relay, Automatic Reclose. One N.C. circuit, 1 N.O. circuit, instantaneous opening, time delay reclosing. Coil for 220 volts, 60 cycles. GE type CR-2820-1731	
C-143	Relay, Lock-out. One N.O. circuit, one N.C. circuit, otherwise same as C-102	
C-144	Switch, "LOCK-OUT/AUTOMATIC." Same as C-101	
C-145	Switch, hand reset. Same as C-121	
C-146	Relay, Automatic Reset Auxiliary. 2 N.O. contacts rated 5 a. 220 v., 60 cycles. Instantaneous opening, 5 sec. time delay closing. Coil for 220 v. 60 cycles. American Gas Accumulator Co. "Agastat" NA-11	
C-147	Relay, Overload Alarm. Same as C-102	
C-148	Light, Overload Status. Same as C-126 except with yellow color cap	
C-149	Switch, Alarm Reset. Same as C-121	
C-150	Bell, Alarm. 220 volts, 60 cycles, 6" gong	
C-151, 152	Light, H.P. Plate Status. Same as C-126 except with red color cap	
C-153, 154	Omitted	
C-155	Contactor, H.P. Plate "START"	
	Coil only	18137
	Contacts only	18138

Item No.	Description	Stock No.
C-156	Contactor, H.P. Plate "RUN." Same as C-155	
C-157	Relay, Filament Hold-On, 1 second inverse time, 2NO and 2NC circuits, GE Type PCV-14-B2	
	Coil only	19839
	Timing Head only	19840
	DISTRIBUTION PANEL	
201	Switch, Delta. Oil circuit breaker, 3-pole 50 a. 2300 v., with operating handle through dead front panel. GE type FK-33 or equivalent	
202	Switch, Wye. Same as 201. This item incorporated in 201, making a three-pole, double-throw switch	
203	Omitted	
204, 205	Transformer, Potential. 2300-volt primary, 20 to 1 ratio. Complete with fuses. GE type E-21 or equivalent	
206	Switch, Line Voltmeter Transformer. Pistol grip, 2 poles, 4 positions. GE type SB-1 or equivalent, with escutcheon plate and white pointer	
207	Voltmeter, Line. 0-300 v. movement with scale marked 0-3000 v, a-c Flush mounting type HA instrument, Westinghouse style 931781, except equipped with special pointer	
208	Circuit Breaker, Bus. GE type AB-2, 3-pole, trip free air breaker, rated 225 a, 220 v, 60 cy. with three inverse time thermal trips and three magnetic trips to operate from 8 to 10 times rated current. Breaker manually operated through dead front panel	
209	Fuse Block, Voltmeter. 3-pole line block, complete with cartridge fuses	
210	Switch, Bus Voltmeter Selector. Same as 206	
211	Voltmeter, Bus. Same as 207 except scale marked 0-300 v. a-c	
212	Breaker, Exciter Feeder. 3-pole, 150 a. rating, 225 a. frame size. Thermal trips only. Magnetic trips not to be furnished	
213	Breaker, Filament Feeder. 3-pole, 100-a. rating, 100 a. frame size. Thermal trips only. Magnetic trips not to be furnished. GE type AF-1	
214	Breaker, Pump Feeder. 3-pole, 50-a. rating, 50-a. frame size. Thermal trips only. GE type AF-1	
215	Breaker, Bias Feeder, 2-pole, 25-a. rating, 50-a. frame size. Thermal trips only. Magnetic trips not to be furnished. GE type AF-1	
216	Breaker, Blower Feeder. 2-pole, 25-a. rating, 50-a. frame size. Thermal trips only. GE type AF-1	
217	Breaker, Control Feeder. Same as 216	
218, 219	Breaker, Spare Feeder. Same as 216	
220	Breaker Emergency Feeder. Same as 216	
221	Omitted	
222, 223	Transformer, Current. 2300-volt service, 50:5 ratio. To withstand momentary short-circuit current of 775 amperes. GE type WF-12 or equivalent	
224	Resistor, Plate Starting, 6 ohms	18139
	MISCELLANEOUS ITEMS	
225	Transformer, Main Rectifier Plate, 50 kva, 1-phase, oil filled, for outdoor service. Primary 2300/4000 v. wye, 50/60 cy.; secondary "no load" AIEE voltage 13297/13997/14697/15397 v., ratio adjuster handle brought through cover; standard NEMA auxiliaries, less suspension hooks. G.E. Co.	
226	Transformer, Distribution, 25 kva, 1-phase, oil filled for outdoor service. Primary 2300/4000 v. wye, 50/60 cy.; secondary 115/230 v., standard NEMA auxiliaries, less suspension hooks, Type RS tank, American Transformer Co.	
227	Circuit Breaker, Main, Oil, 3-pole manual, 200 a, 5 kv, interrupting capacity 15,000 kva. Time delay trips 0.5 sec., with two tripping transformers for 2300 v. service, 50:5 ratio to withstand momentary short circuit of 775 a. Breaker mounted on 76″ steel panel, with Type HA-2 operating lever through panel. G. E. Co. Breaker Type FK-33	
228	Pumps, Circulating, Monobloc Type 1½ DG-1. All bronze horizontal volute, single stage, close-coupled, centrifugal, with bronze casing, suction head, impeller and impeller locknut, steel shaft, bronze gland, close-coupled to 5-HP, 3600-RPM, 220-v, 60-	

Item No.	Description	Stock No.
	cy., 3-phase, "Master Electric," splash-proof, squirrel-cage, induction motor; to deliver 50 gal. per min. against 150 ft. total dynamic head, complete with companion flanges. Worthington Pump and Machinery Corp.	
229	Surface Cooler, Trane Co., Air delivery 8000 CFM. Motor 3 HP	
230, 231	Omitted	
232	Breaker, Temperature Controller Feeder, 2-pole, 10-a. Furnished and installed by customer	
233	Switch, Circulating Pump Control, DPST toggle snap switch, Hart and Hegeman or equivalent. Furnished and installed by customer	
234, 235	Pump Starter	18127
236	Cooler Starter, same as 234	
237, 238	Omitted	
239	Capacitor, Main Filter, 2 mfd, 18 kv, d.c. 2 porcelain bushings, G. E. Co. Cat. #18F5	
240	Solenoid, coil only	17551
241	Resistor, Surge Suppressor, 10,000 ohms	18129
242	Resistor, Current Limiting, 42 ohms, total, consisting of two 21-ohm units in series. G. E. Co. Assemblies per G. E. Dwg. P-7702535 G501	
243	Reactor, Main Filter, 1.5 henry at 8 a, d.c. continuous duty, insulated for 18-kv service, American Transformer Co., per Amertran outline drawing S-34335	

SUPERVISORY CONSOLE

Item No.	Description	Stock No.
A-1	Clock, Time of Outage, indoor round flush Telechron clock, Model FOS7655 with movement B3G2; bezel case, 4–¾″ OD, hinged at top and finished in ebony black lacquer; standard silver clock dial with Arabic numerals and dots and "TIME OF OUTAGE" printed in black; black hour and minute hands, red sweep second hand; movement for 115 v, 60 cy. Outline and mounting dimensions shown on Warren Telechron Co. Dwg. 2-CA-1477	
A-2	Clock, Station Time, indoor round flush Telechron clock with mechanical carry-over; Model FOS-7655 with AUX movement; bezel case 4–¾″ OD, hinged at top and finished in ebony black lacquer; standard silver clock dial with Arabic numerals and dots printed in black; black hour and minute hands; movement for 100/125 v, 60 cy. Outline and mounting dimensions shown on Warren Telechron Co. Dwg. 2-CA-1477	
A-3	Clock, Duration of Outage, indoor round flush Telechron clock, Model FOS-7655 with movement B3-G2; bezel case 4–¾″ OD, hinged at top and finished in ebony black lacquer; special silver dial with Arabic numerals 0-5-10 etc. up to 55 and dots and "DURATION OF OUTAGE" printed in black; black minute hand, red sweep second hand; movement for 115 v, 60 cy. Outline and mounting dimensions shown on Warren Telechron Co. Dwg. 2-CA-1477	
A-4	Light, Carrier On, indicator light and resistor assembly for 125 v. G.E. Cat. #6005443 G10 with red color cap, with spacer for 3/16″ panel	
A-5	Light, Plate On, indicator light and resistor assembly for 220 v. G.E. Cat. #6005443 G7 with red color cap, with spacer for 3/16″ panel	
A-6	Convenience Outlet, part of M-415450-501	
E-1	Relay	18124
J-1	Jack and Plug Combination, coaxial, Western Elec. Co. Jack D-157789, Plug D-157790	
M-1	Indicator, Power Level Meter and Range Switch Assembly, KX-283812-1	
M-2	Meter, Modulation, Extension, M-412226-1	
R-1	Attenuator, 500-ohm pad, M-406541-4	
S-1	Switch, Program Transfer, 2-way lever key, 4-pole DT, position 1 locking with 2 C spring combinations, position 2 locking with 2 C spring combinations. Automatic Elec. Co. Cat. #A-33 without escutcheon plate	
S-2	Switch, Monitor Transfer, same as S-1	
S-3	Switch, Clock Start, K-838503-1	
S-4	Switch, Clock Reset, same as S-3	
S-5	Switch, Exciter Plate On, same as S-3.	
S-6	Switch, Exciter Plate Off, K-838503-2	
S-7	Switch, Amplifier Plate On, same as S-3	
S-8	Switch, Amplifier Plate Off, same as S-6	

RECOMMENDED SPARE PARTS

RECOMMENDED SPARE PARTS

DRIVER SECTION

Item	Q'ty	Description	Stock No.
		EXCITER	
136	1	Resistor, IPA Grid	17026
151	2	Resistor, PA Grid	17031
158	2	Choke, PA Grid	16892
166	1	Choke, Buffer Plate	16917
308	10	Lamp, Filament Indicator	16391
323	1 set	Contactor, Plate, Contacts only	17532
326	1	Transformer, Plate	16922
330	1	Capacitor, H-V Rect. Filter	16179
332 (or 2C5)	1	Capacitor, H-V Rect. Filter	16672
333	1	Relay, Overload	17084
334	1	Resistor, Voltage Divider	17085
335	1	Resistor, Voltage Divider	17086
336	1	Resistor, Voltage Divider	17087
337	1	Resistor, Voltage Divider	17088
343	1	Resistor, Voltage Divider	17092
344	1	Resistor, Voltage Divider	17093
355	6	Fuse, Crystal Heater	17102
		MODULATED AMPLIFIER	
1A1	1	Blower, Motor only	17228
1C1	1	Capacitor, Grid Tank	UC-3105
1C6	1	Capacitor, Plate Blocking	UC-3113-A
1C7	1	Capacitor, Neutralizing	UC-3220
1C11	1	Capacitor, Plate Tank (see chart in text)	
1C19	1	Capacitor, Plate Bypass	UC-3118
1C24	1	Capacitor, Grid Tank	UC-3117
1M2	1	Ammeter, Plate Current	18035
1R3	2	Resistor, Filament Center Tap	17238
1R5	4	Resistor, Grid Leak	17240
1S2	2	Switch, Airflow Interlock	17219
1S9	1	Switch, Rectifier Start	17221
		MODULATOR-RECTIFIER	
2C1	1	Capacitor, Modulator Grid Blocking	17208
2R5	2	Resistor, Modulator Grid	17212
2R9	1	Resistor, Bias Adjusting	17215
2R11	1	Resistor, Grid Bias Bleeder	17216
2R12	2	Resistor, Modulator Plate	17217
2S10	1	Switch, Manual-Automatic	17220
2T1	2	Transformer, Modulator Filament	16402
2T7	2	Transformer, Main Rectifier Filament	17224
2T13	1	Transformer, Modulator Driver	18042
		LOW-POWER AUDIO AMPLIFIER	
3C2	1	Capacitor, Feedback Input	17243
3C3	2	Capacitor, Screen Bypass	17242
3C4	2	Capacitor, Compensating	NF-5003
3C5	2	Capacitor, Coupling	F-203
3C16	1	Capacitor, Plate By-pass	18023
3R1	1	Resistor, Input Shunt	17440
3R2	2	Resistor, Feedback Shunt	11371
3R3	2	Resistor, Grid Series	14439
3R5	1	Resistor, Cathode Grounding	13218
3R6	1	Resistor, Screen Bleeder	18021
3R8	2	Resistor, Plate Loading	18022
3R9	2	Resistor, Plate Series	30540
3R11	1	Resistor, Compensating	35351
3R12	1	Resistor, Cathode	18025
3R14	1	Resistor, Grid Loading	18024
3R15	1	Potentiometer, Feedback	18026
3R18	1	Resistor, Cathode	18027
3R20	1	Resistor, Screen Bleeder	18028
3R21	1	Resistor, Screen Divider	18029
3R22	2	Resistor, Plate Coupling	18030
3R24	1	Resistor, Grid Loading	13669
3R27	1	Resistor, Plate Series	17253
3R30	1	Resistor, Plate Dropping	17254
3R34	1	Resistor, Plate Series	14162
3T1	1	Transformer, Input	18031
3T2	1	Transformer, Filament	17257
3X1	1	Reactor, Feedback	18032
3X2	1	Reactor, Compensating, 5 mh.	18033
3X3	1	Reactor, Compensating, 2.5 mh., National Co. Type R-100	
		FILTER RACK	
4C6	1	Capacitor, Filter	18043
4C8	1	Capacitor, Bypass	19846
4R5	3	Resistor, Starting	17203
4R11	8	Resistor, Modulator Plate Dropping	18046
4R24	1	Resistor, Arc Limiting	18047
4S3	1 set	Switch, Filter Resistor Shorting:	
		Coil only	17534
		Contact only	17540
*4X3	1	Reactor, Modulation	18048
		POWER CONTROL PANEL	
7R10 7R10A 7R10B	1	Rheostat, Filament	18218
7R16	1	Resistor, Modulator Overload Relay Shunt	17517
7R17	1	Resistor, Modulated Amplifier Overload Relay Shunt	17518
7S13		Contactor, Interlock Circuit	
	2 sets	Contacts only	17538
	1	Coil only	18219
7S17		Contactor, Main Rectifier	
	1 set	Main Contacts only	17539
	1	Coil only	18221
7S23	1	Relay, Modulator Overload, Coil only	18220
7S25 7S26	1	Relay, A-C Overload, Coil only	18222
	4 sets	G.E. Type PAC Relays, Contacts only	17535
	2	G.E. Type PAC Relays, Black Contact Bar only	17536
	2	G.E. Type PCV Relays, Red Contact Bar Only	17537

*Optional

POWER AMPLIFIER SECTION

Item	Q'ty	Description	Stock No.
A-1, A-12	1	Fan, Exhaust	17840
A-2	1	Water-Jacket, Peak (optional) Roller assembly only	18601
A-3	1	Hose Reel, Porcelain	17826
A-4	1	Blower, Seal Air	17841
C-1		Capacitor, Input Blocking (see chart in text)	
C-7	1	Capacitor Peak Grid Tank (see chart in text)	
C-9, C-34	2	Capacitor, Grid By-pass (see chart in text)	
C-10–C-12 C-35–C-37	2	Capacitor, Filament By-pass	UC-2988
C-13, C-38	2	Capacitor, Neutralizing Blocking	UC-3188
C-17	1	Capacitor, Feedback Coupling	UC-2344
C-18	1	Capacitor, L-P Feedback	UC-2461-A
C-19	1	Capacitor, HP Feedback	UC-3136
C-20, C-42	2	Capacitor, Plate By-pass	UC-3305
C-21	1	Capacitor, Antenna Blocking	17547
C-24	2	Capacitor, Peak Bias Filter	18108
C-32	1	Capacitor, Carrier Grid Tank (see chart in text)	
C-43, C-44	2	Capacitor, Carrier Bias Filter	18118
C-46	2	Capacitor, Meter By-pass	BF-10004
E-1	1	Relay, Auxiliary Power Change	18113
E-11		Relay- D-C Overload:	
	1	Coil	19845
	4 sets	Contacts	17535
	2	Contact Bar (red)	17537
E-13	1	Relay, Antenna Protective Sensitive	18119
E-14		Relay Antenna Protective Tripping:	
	1	Coil	19844
L-3	1	Inductance, Neutralizing (see chart in text)	
M-1	1	Indicator, Water Flow	18115
M-6	1	Indicator, Water Flow	18117
M-13	1	Ammeter, FCC, Total Plate	18121
M-27	1	Ammeter, FCC, Remote Antenna	18122
R-1		Resistor Assembly, Peak Grid Load:	
	6	Resistor unit	18116
R-2	4	Resistor, Peak Bias R-F Filter	19843
R-4	1	Resistor, Protective	17838
R-5		Resistor Assembly, Peak Bias Bleeder:	
	6	Resistor unit	18130
R-6, R-15	2	Resistor, Bias Voltmeter	17836
R-14	2	Resistor, Stabilizing Load	17837
R-21, R-22	2	Resistor, Relay Shunt	18123
R-24	1	Resistor, Ammeter Shunt	19842
S-12–S-15 S-22–S-25	2	Switch, Door Interlock	18110
S-17, S-19	1	Switch, "PLATE ON"	18111
S-18, S-20	1	Switch, "PLATE OFF"	18112
T-1, T-11	1	Transformer, Filament	17545
T-2	1	Transformer, Bias Plate	17831
T-3	1	Transformer, Bias Rectifier Filament	17833
T-4	1	Voltage Control, Peak Bias	17834
T-12	1	Transformer, Bias Plate	17832
X-1, X-2, X-6, X-7	1	Reactor, Bias Filter	18109
		MECHANICAL PARTS	
	10 ft.	Hose, Rubber	19832
	1	Hose Adaptor (¾-inch S. P. S. x ¾-inch hose)	16682
	1	Hose Adaptor (1-inch S. P. S. x ⅝-inch copper)	19834
	50 ft.	Cable, Flexible Coaxial	MI-96
	12	Gasket, Rubber Lead	17879
	1 set	Resistor Plates, Phantom Antenna ½ amp.)	18143
	1 set	Resistor Plates, Phantom Antenna (1 amp.)	18144

ANTENNA TUNING AND ASSOCIATED EQUIPMENT

		ANTENNA TUNING UNIT	
M-1, M-2	1	Ammeter, Antenna, and Thermocouple	18125
		MONITOR RECTIFIER UNIT	
301	6	Resistance Unit, Diode Rect. Load	18130
303	1	Capacitor, Blocking	UC-3048
305	1	Transformer, A-F	18132
306	1	Transformer, Filament	17846
307	1	Relay, Carrier On	17845
314	1	Potentiometer, Relay Control	18128
315	2	Capacitor, R-F By-pass	UC-3038
316	2	Capacitor, D-C Blocking	UC-3040

POWER RECTIFIER AND ASSOCIATED EQUIPMENT

A-1	1	Blower, Motor only	17825
T-1–T-7	1	Transformer, Filament	17844

POWER CONTROL AND DISTRIBUTION SECTION

Item	Qt'y	Description	Stock No.	Item	Qt'y	Description	Stock No.
		POWER CONTROL PANEL				**DISTRIBUTION PANEL**	
C-102	2	Relay, Low-Power Control	18133	224	3	Resistor, Plate Starting	18139
C-106B	1	Relay, Pump and Blower	19841			**MISCELLANEOUS**	
C-110	24	Indicator, Filament Status, Lamp only	18135	234	1	Pump Starter	18127
C-111	2	Contactor, Filament Start, Coil only	18136	240	1	Solenoid, Coil only	17551
C-155	2	Contactor, H-P Plate "START," Coil only	18137	241	2	Resistor, Surge Suppressor	18129
C-156	2 sets	Contactor, H-P Plate "RUN," Contacts only	18138			**SUPERVISORY CONSOLE**	
C-157		Relay, Filament Hold-On:					
	1	Coil	19839				
	1	Timing Head	19840	E-1	1	Relay, Aux. Seal	18124

PHOTOGRAPHS
AND
SCHEMATIC DIAGRAM

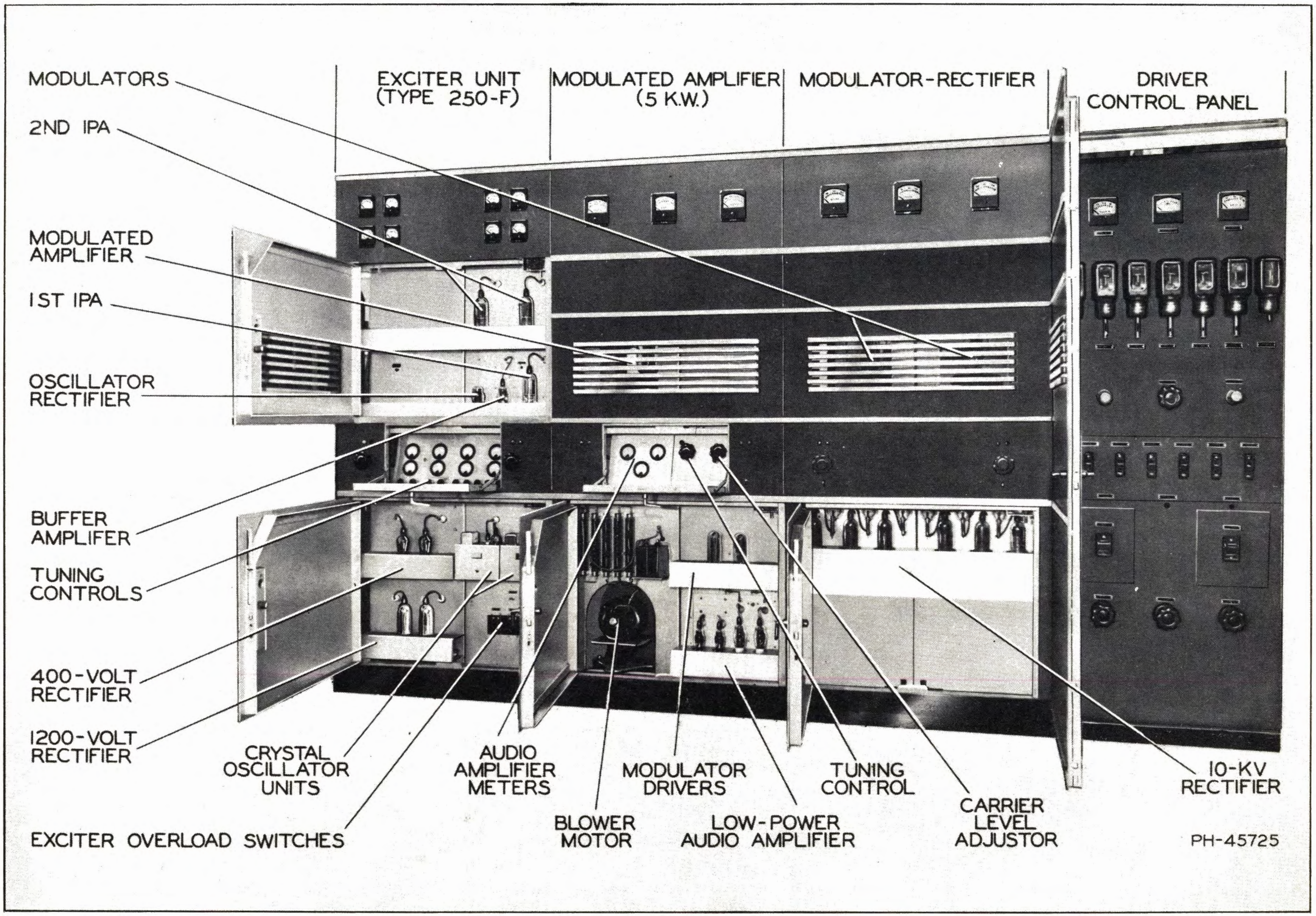


Figure 14—Driver Section of Transmitter, Front View, Doors Open

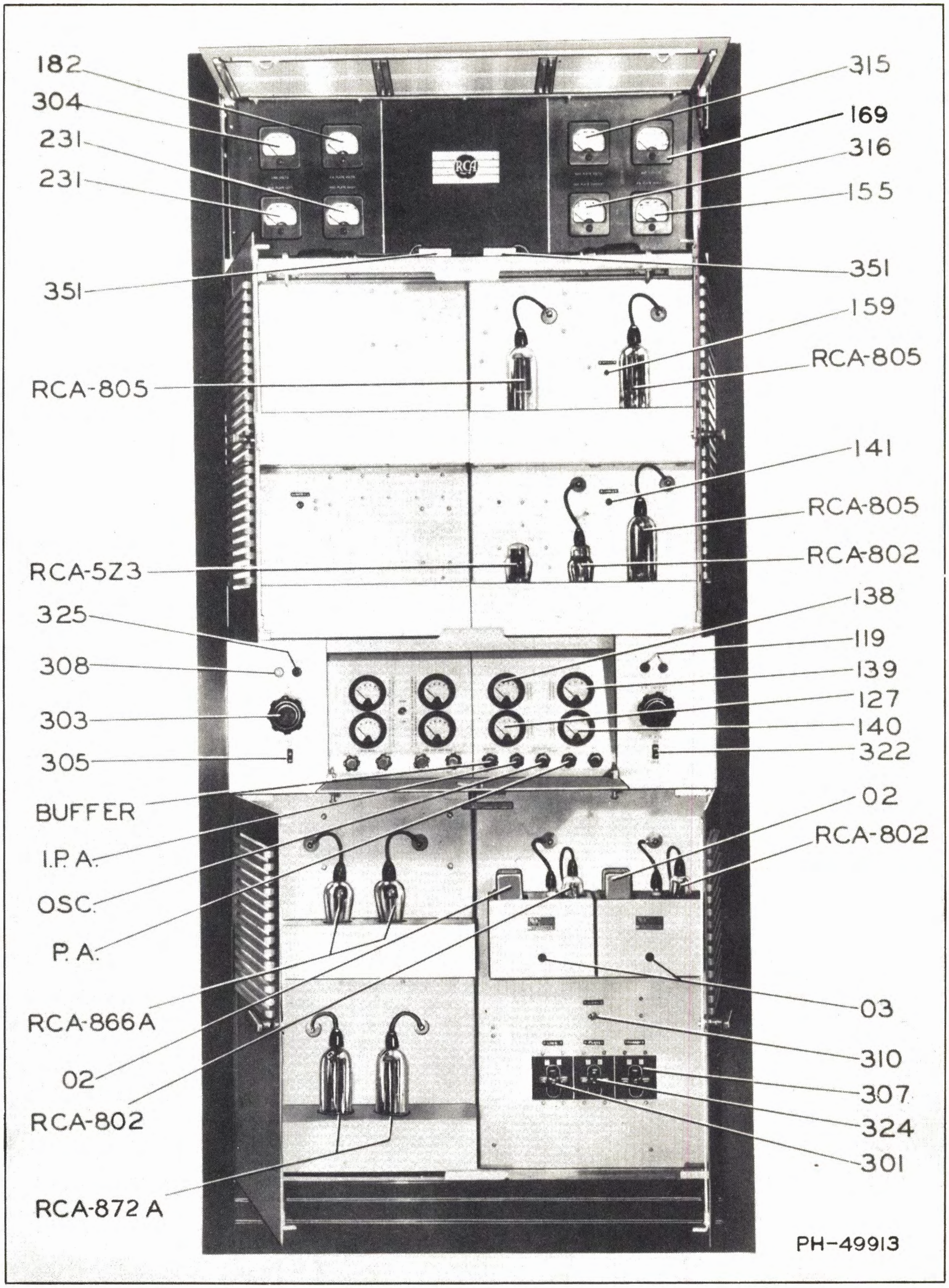


Figure 15—Type 250-F Exciter Unit, Front View, Doors Open

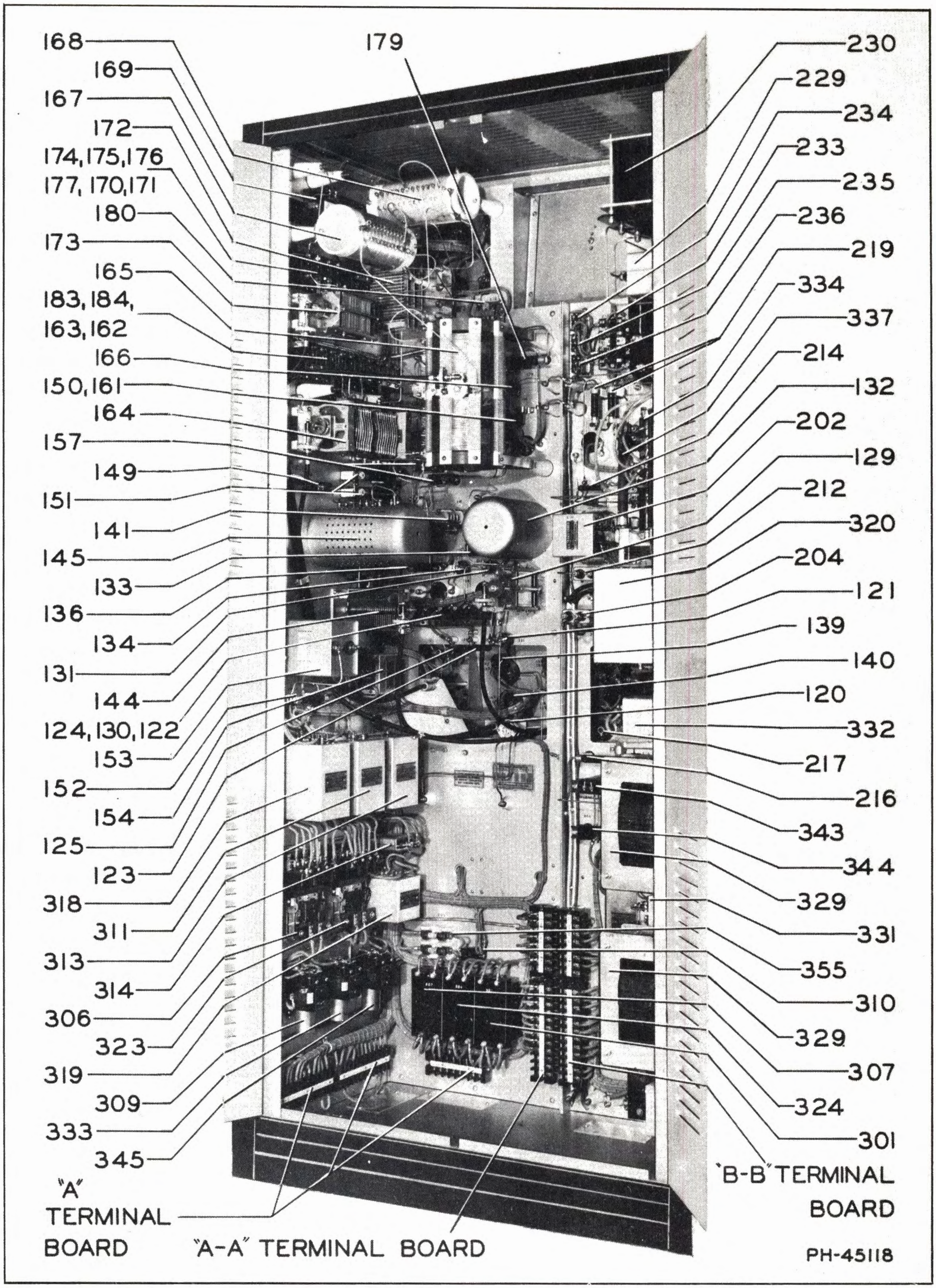


Figure 16—Type 250-F Exciter Unit, Rear View Showing R-F Chassis

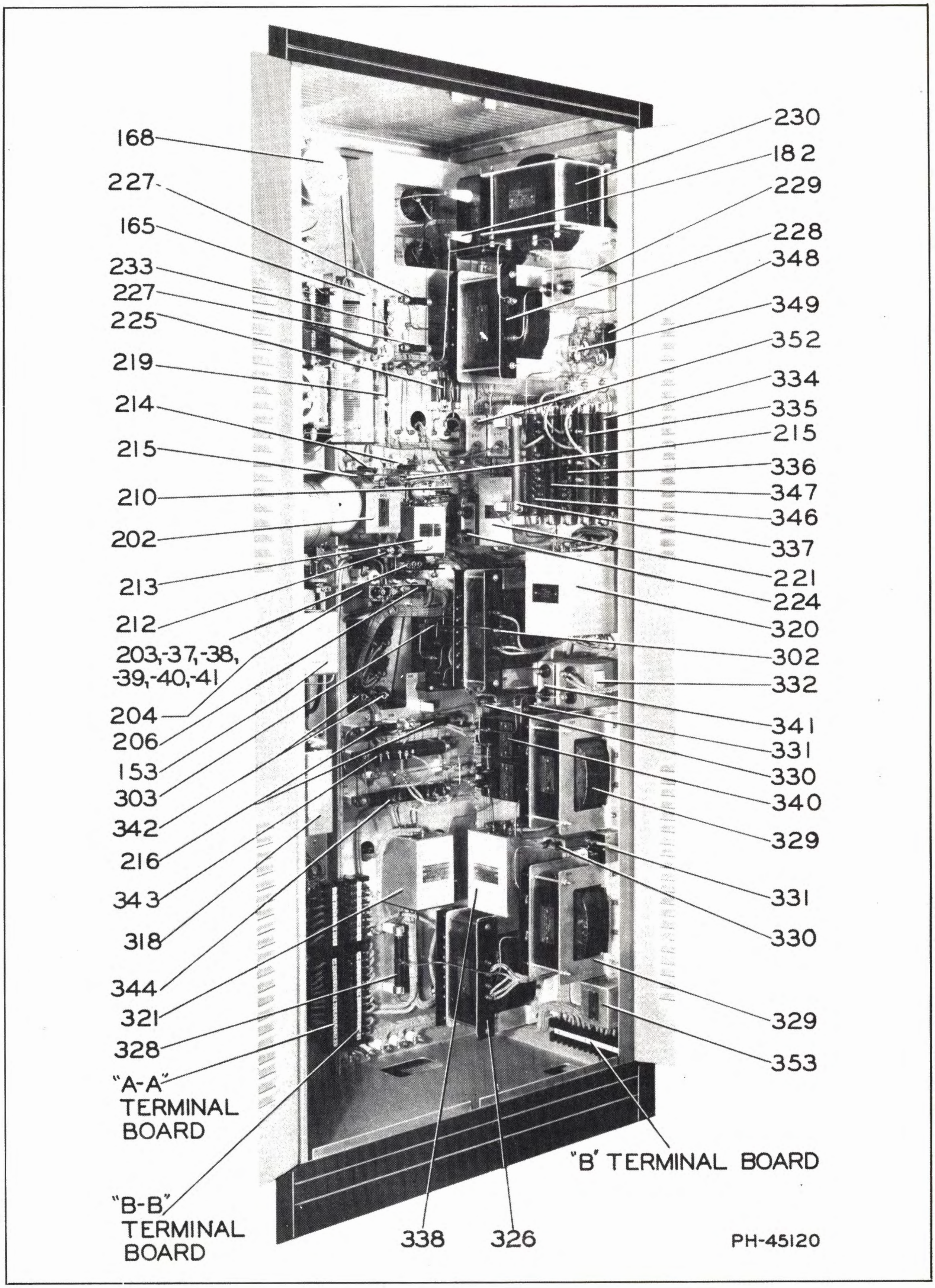


Figure 17—Type 250-F Exciter Unit, Rear View Showing A-F Chassis

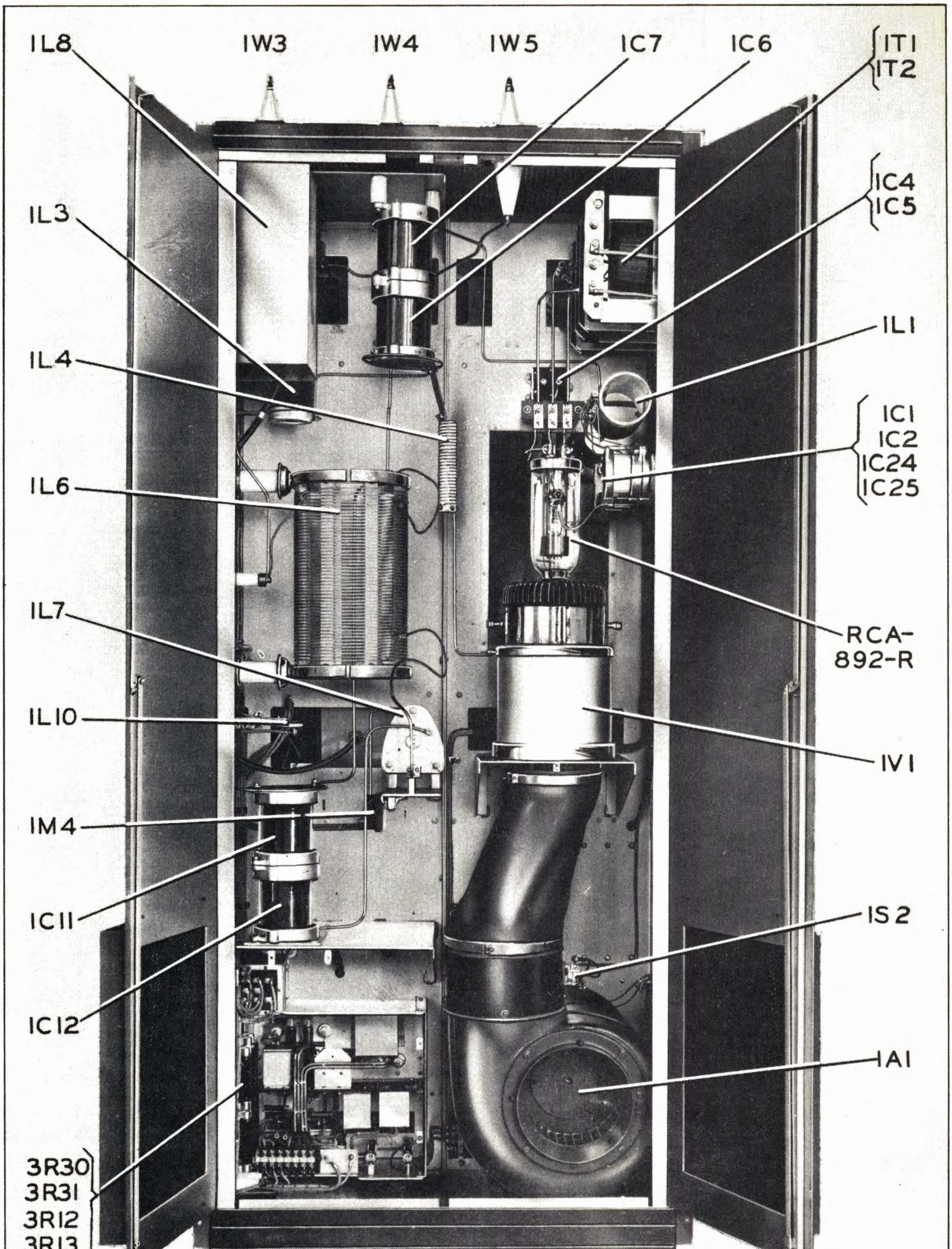


Figure 18—Modulated Amplifier, Rear View

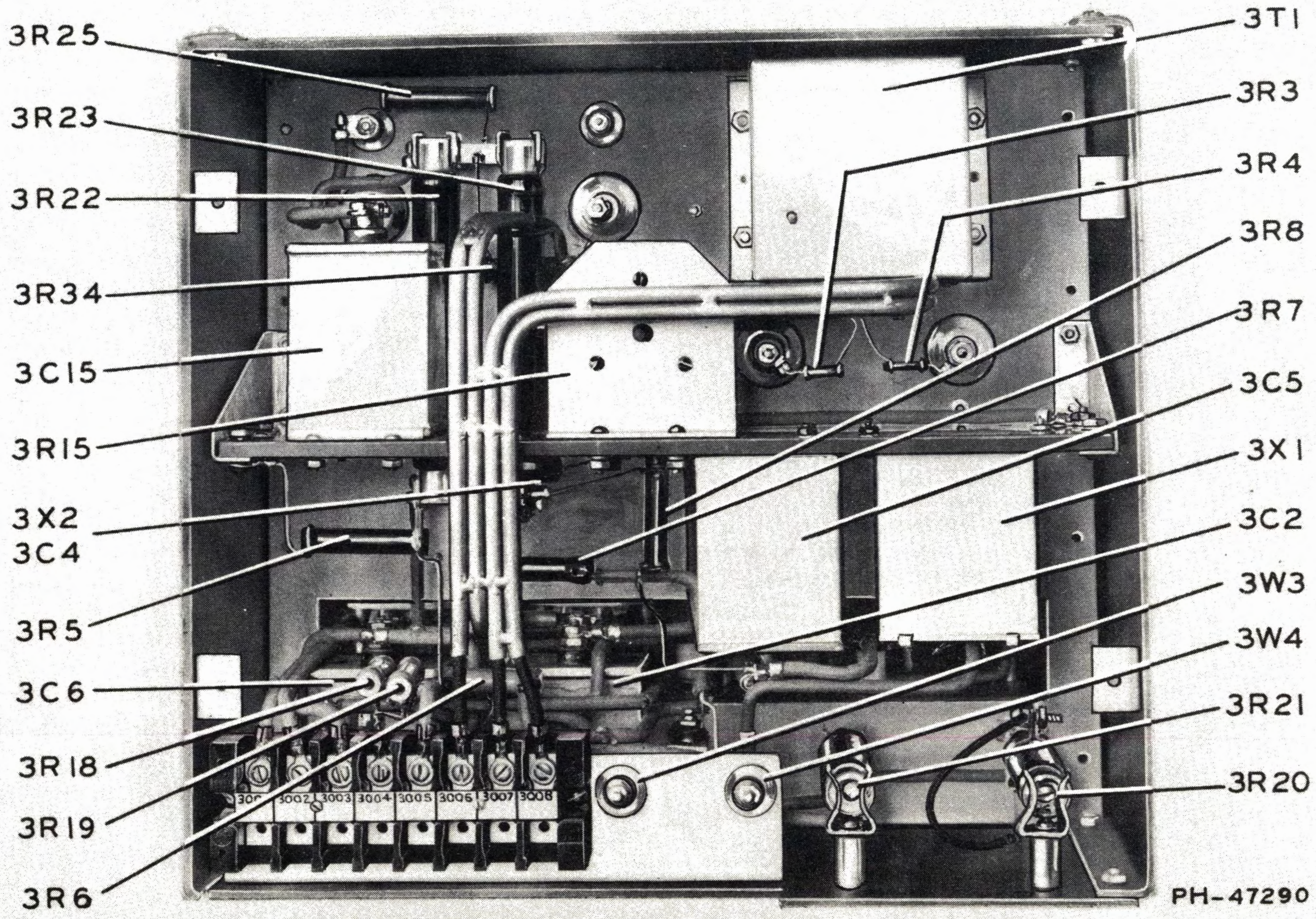


Figure 19—Low-Power Audio Amplifier, Rear Interior View

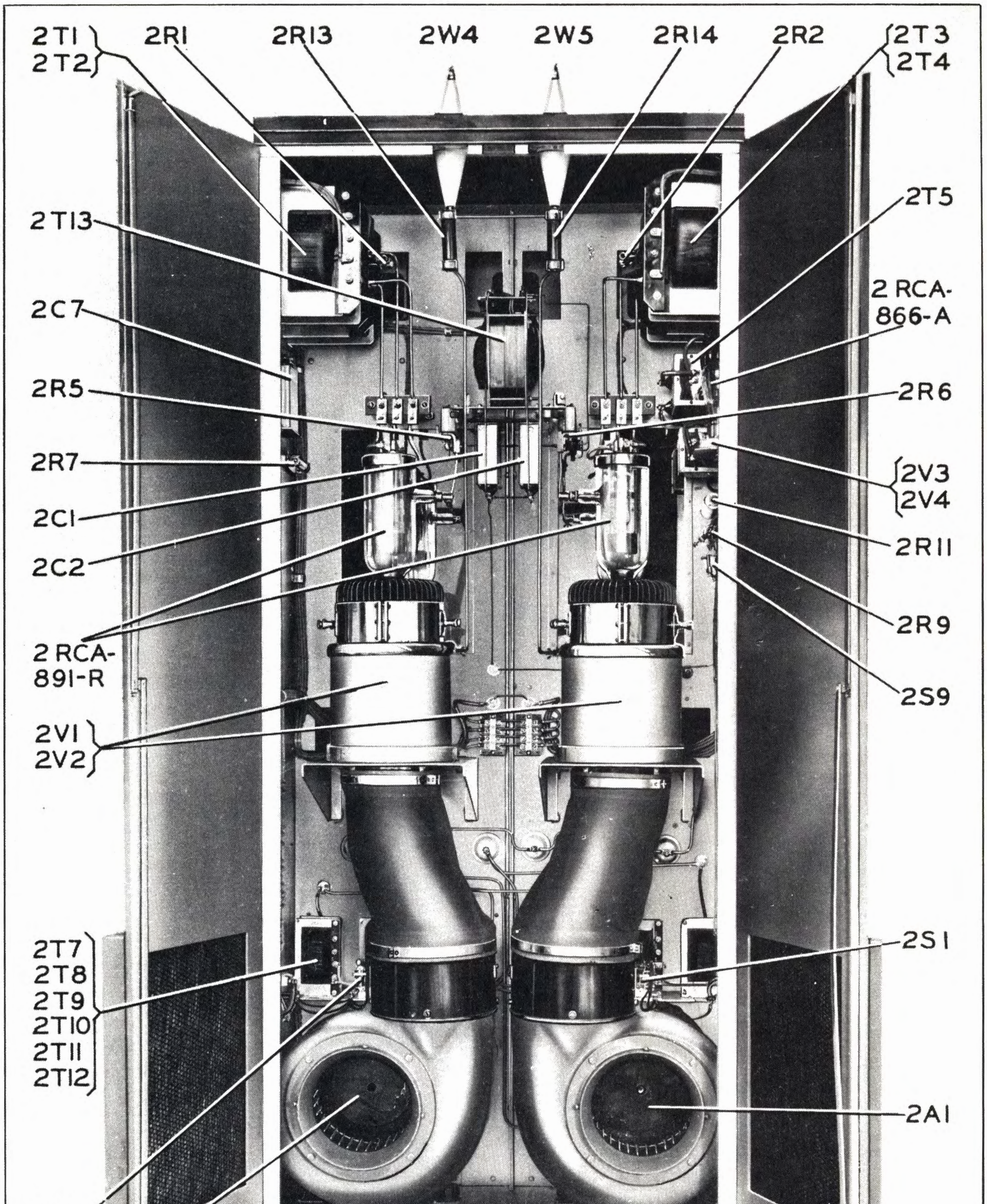


Figure 20—Modulator-Rectifier Unit, Rear View

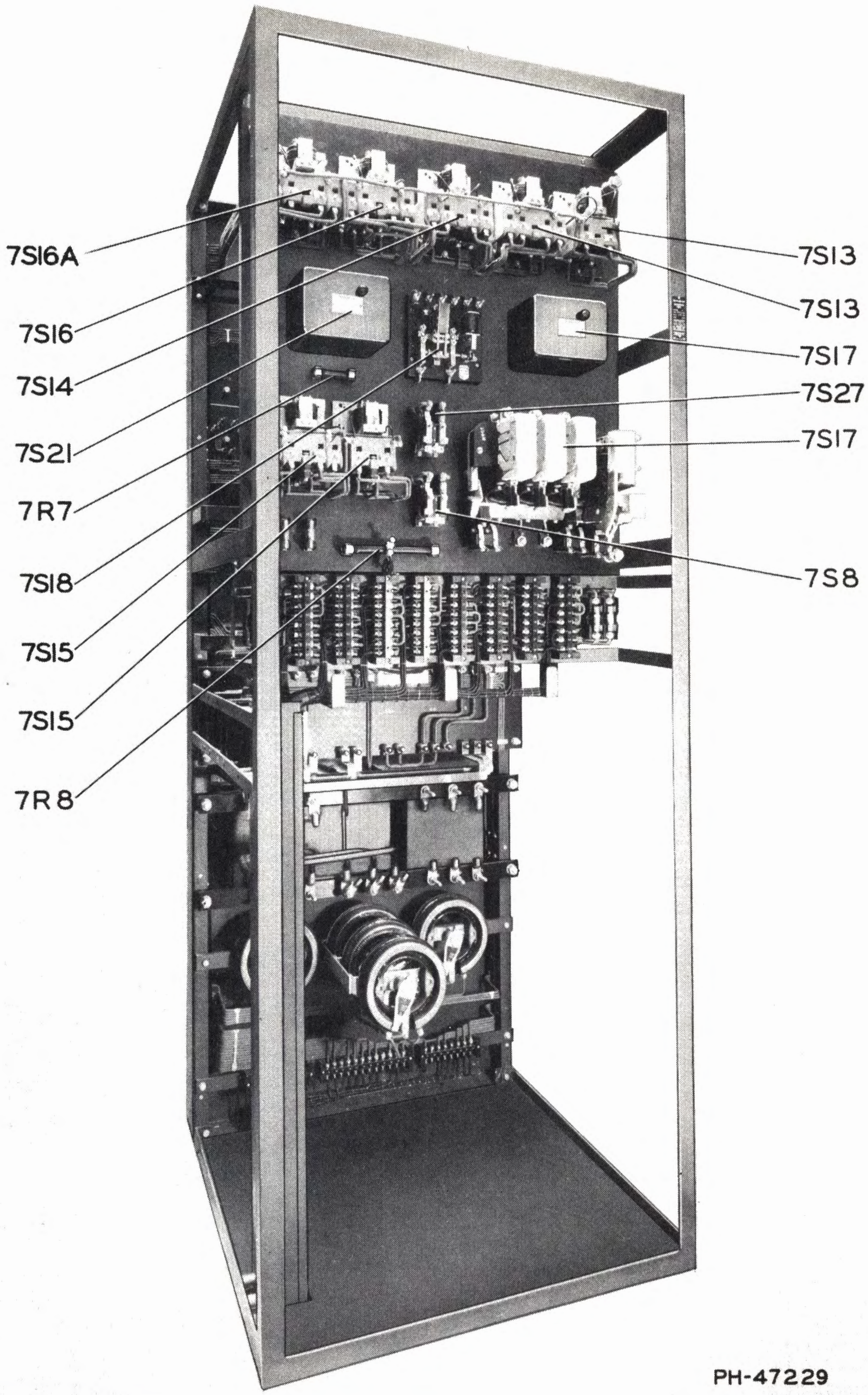


Figure 21—Driver Section Control Panel, Rear View

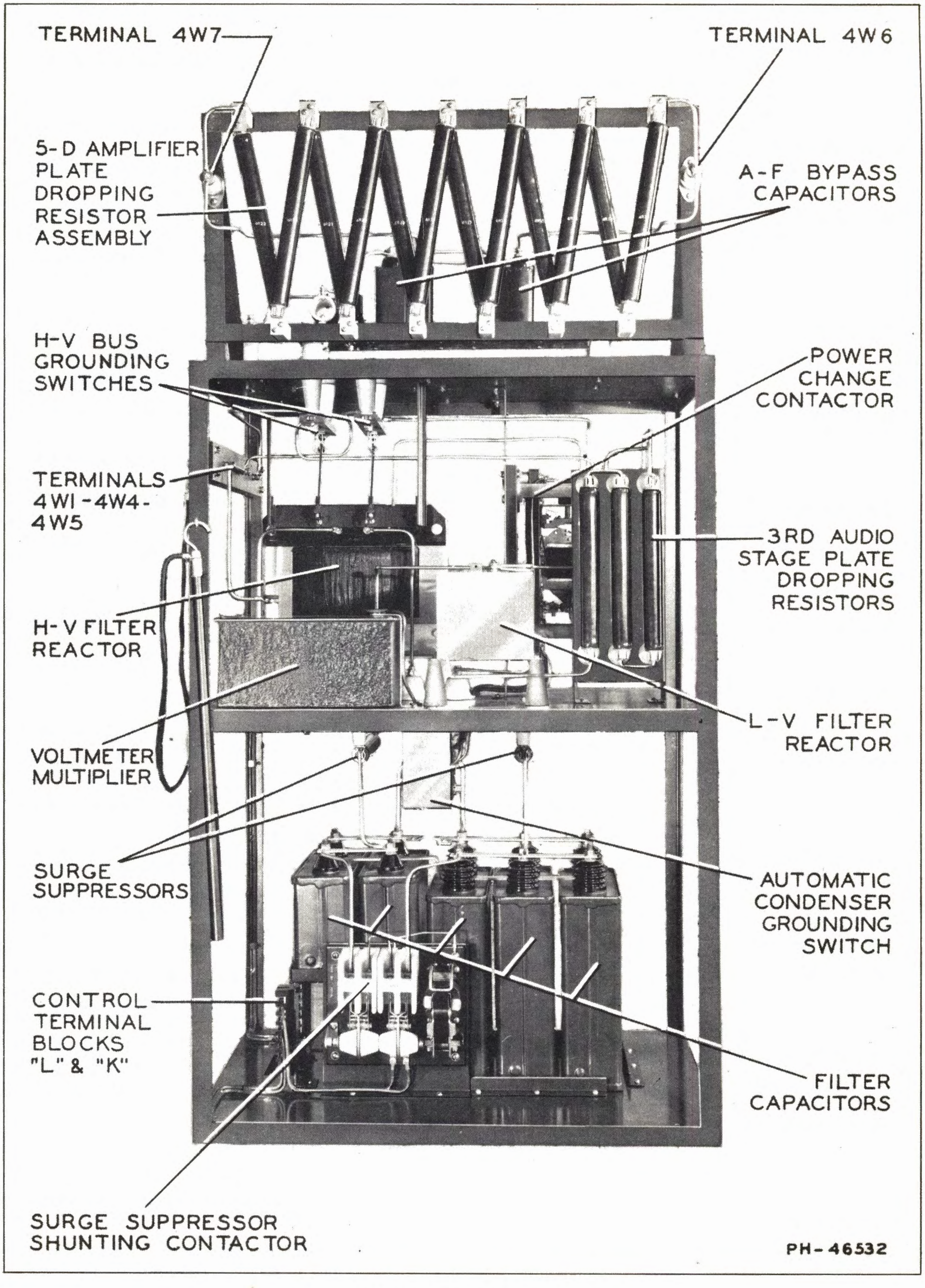


Figure 22—Driver Section Filter Rack

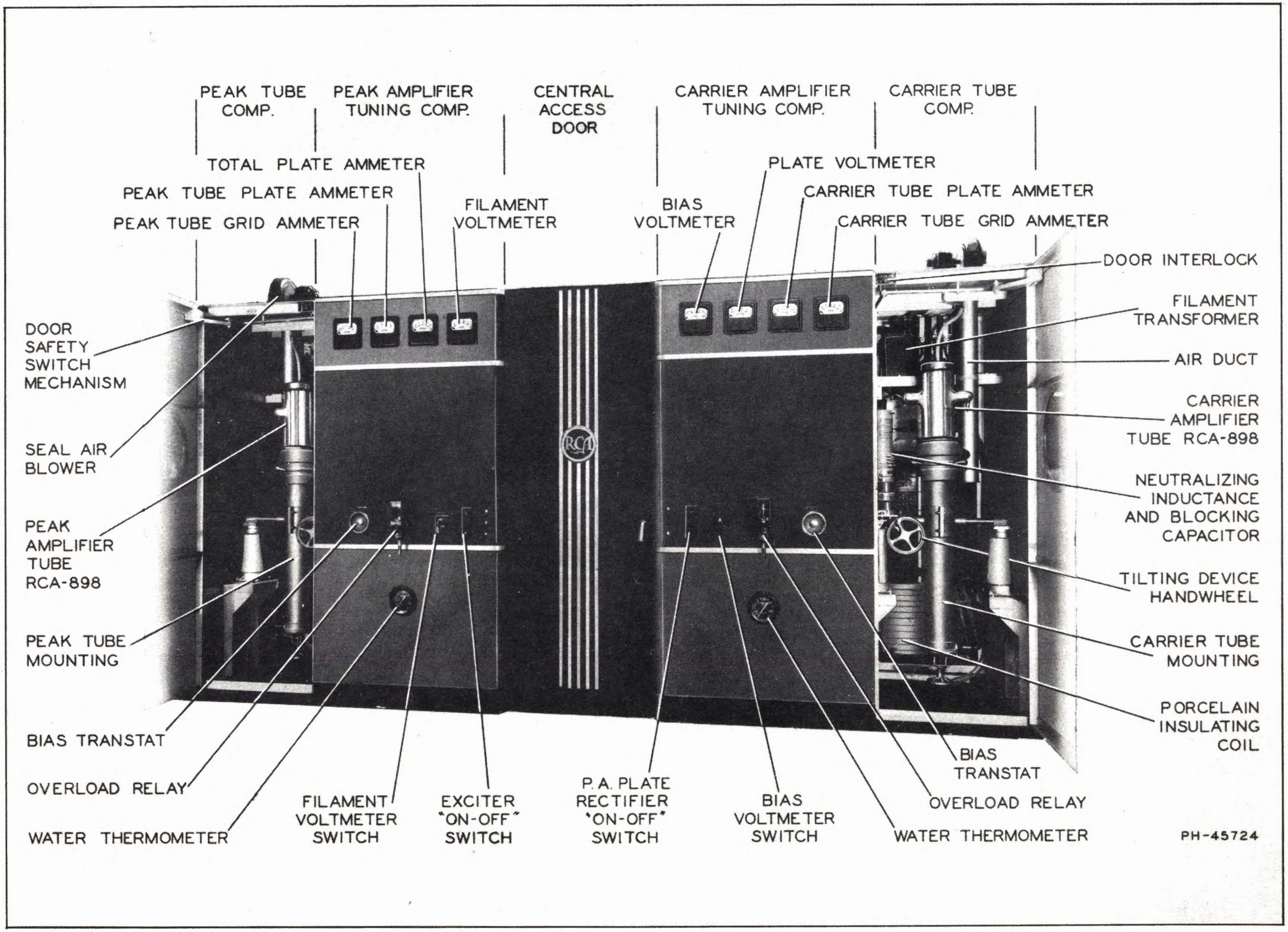


Figure 23—Power Amplifier Section of Transmitter, Front View, Doors Open

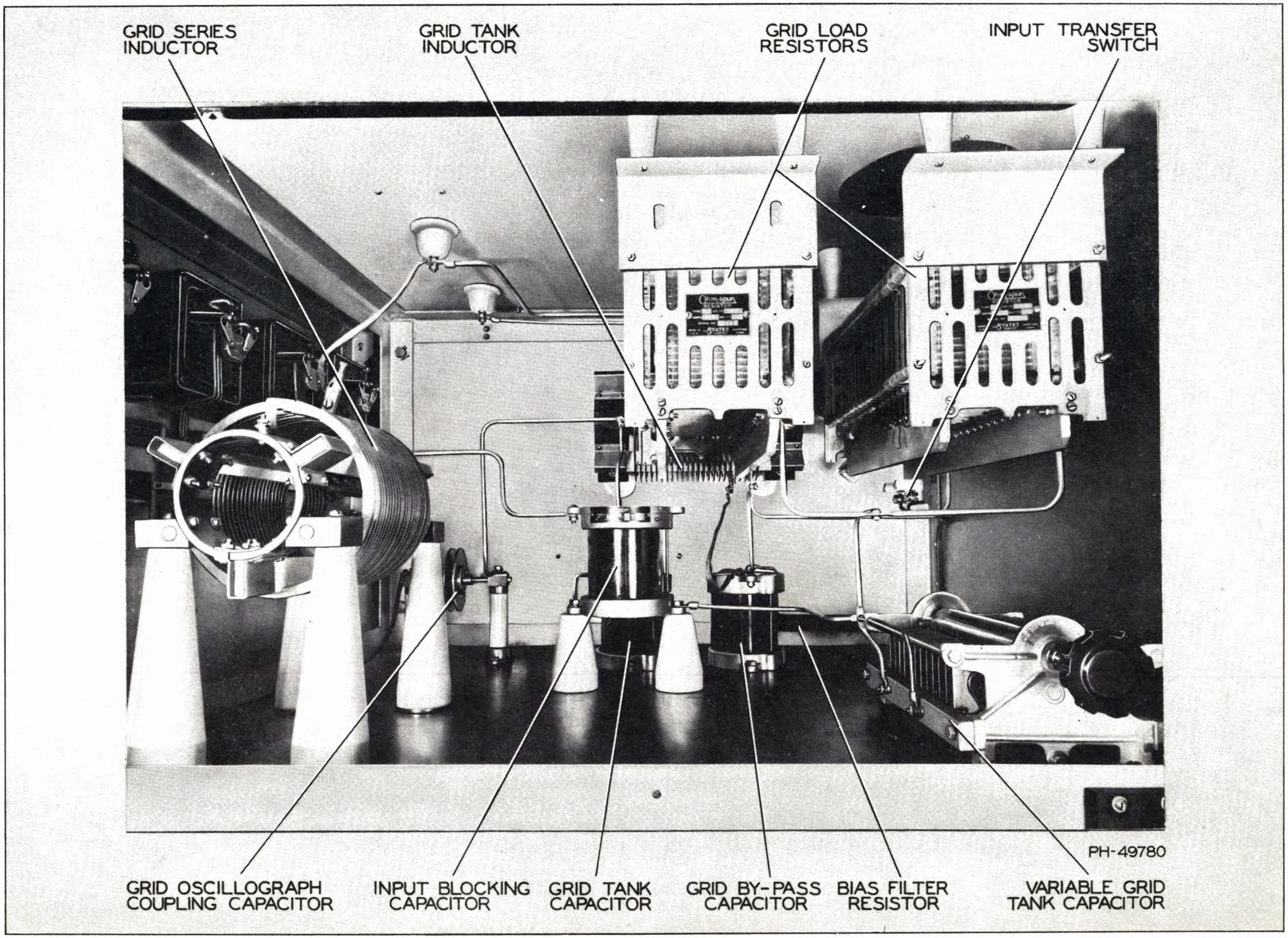


Figure 24—P. A. Peak Grid Tuning Compartment

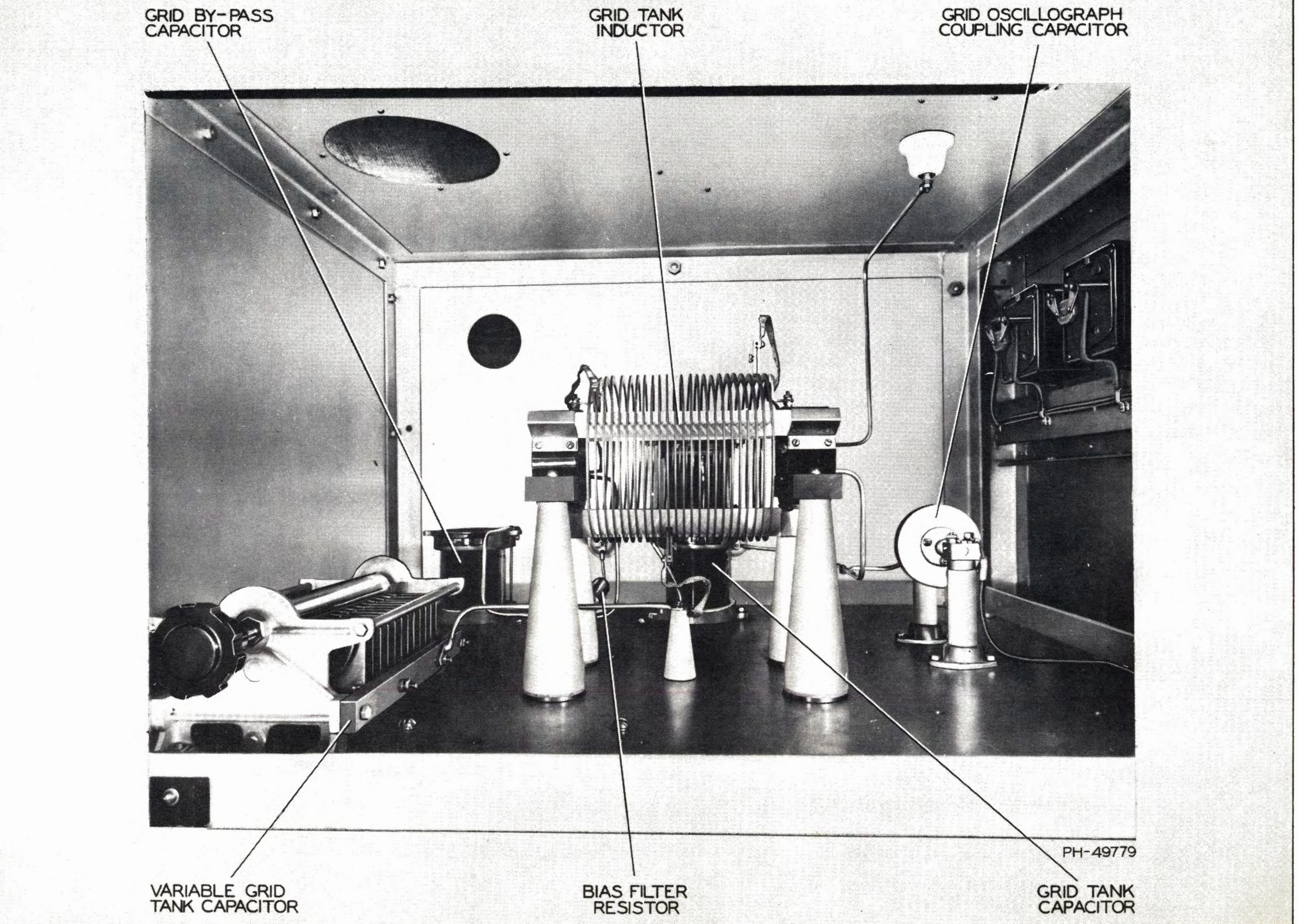


Figure 25—P. A. Carrier Grid Tuning Compartment

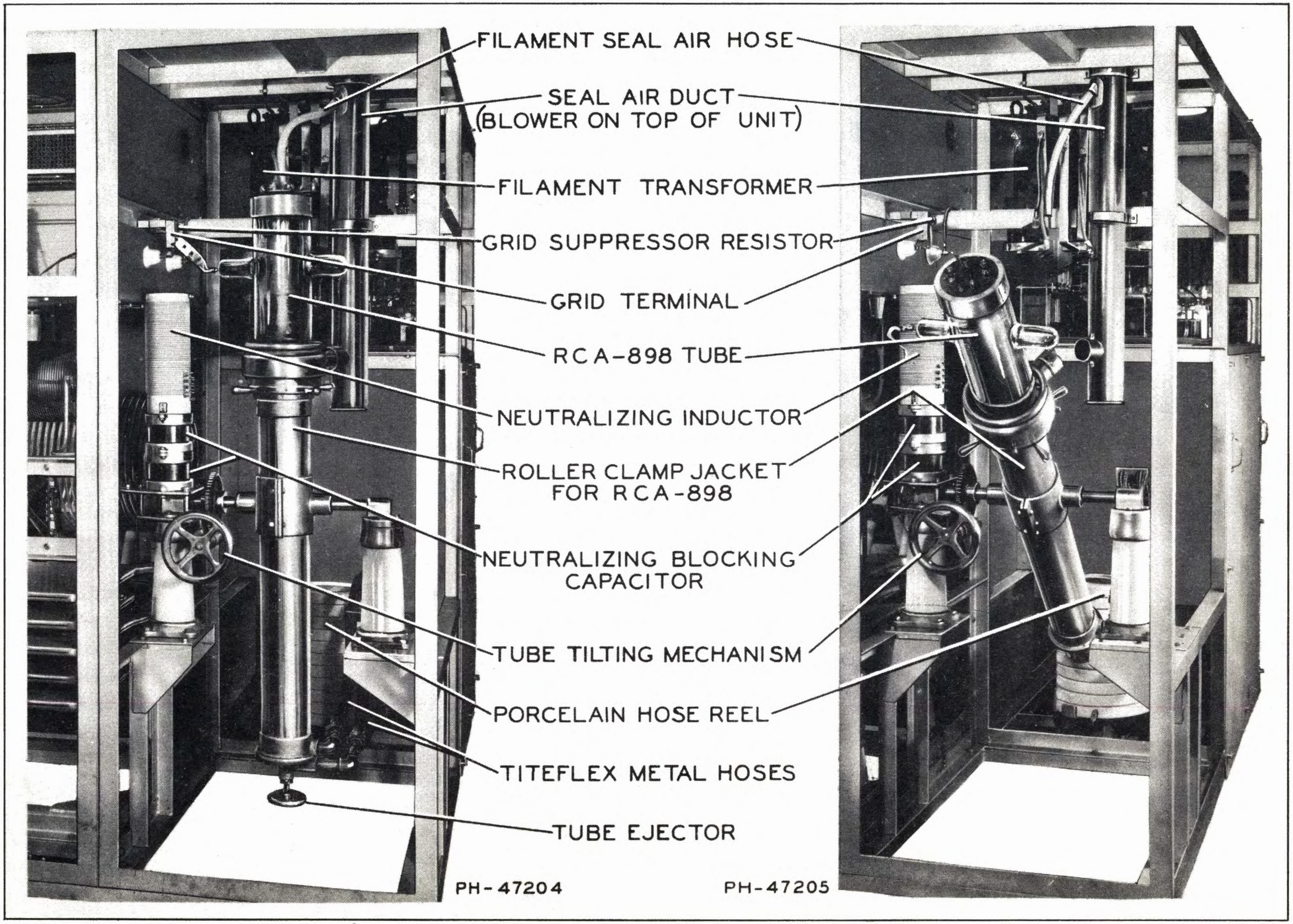


Figure 26—P. A. Carrier Tube Compartment Showing Tilting Mechanism

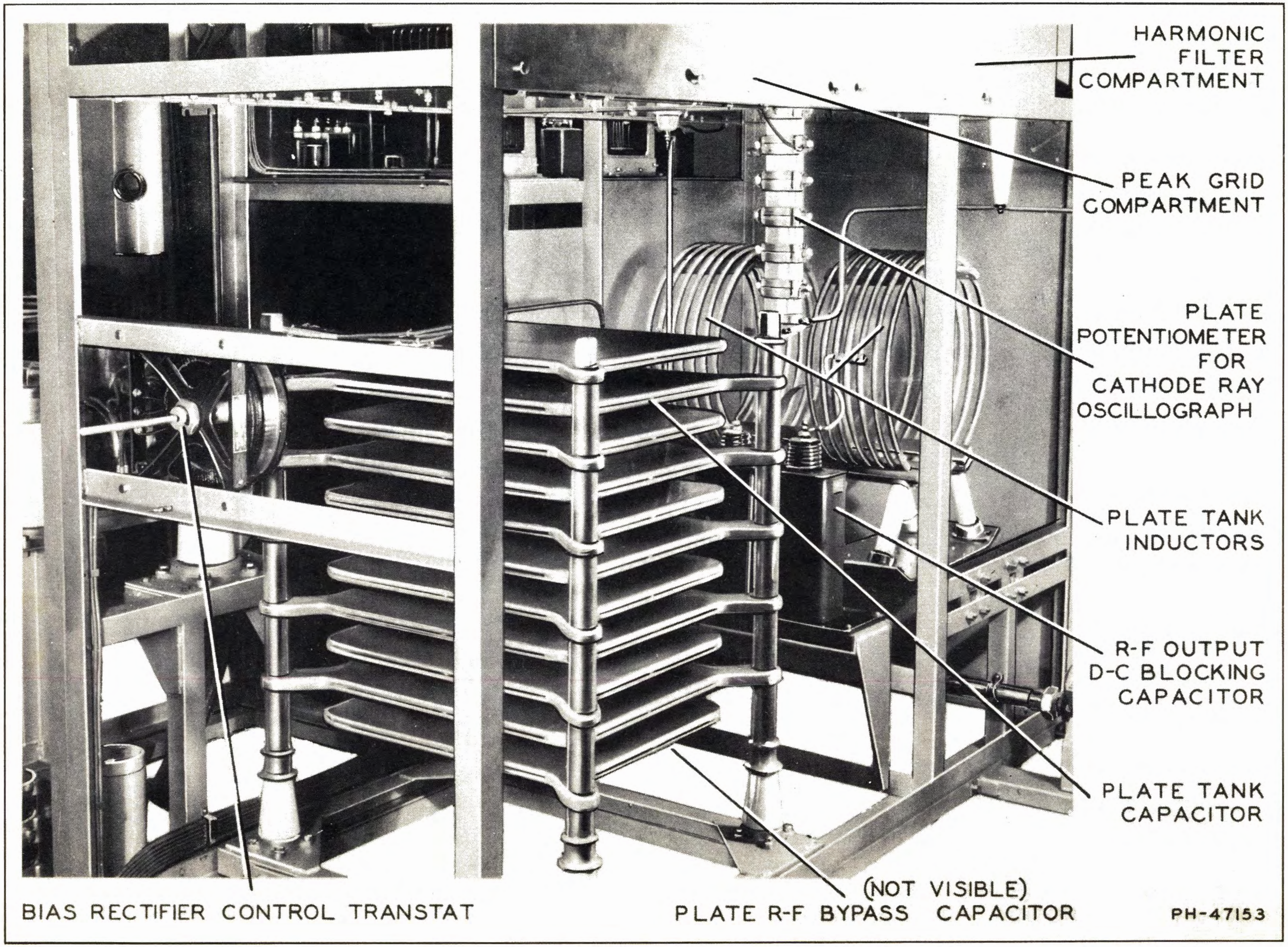


Figure 27—P. A. Peak Plate Tank Compartment

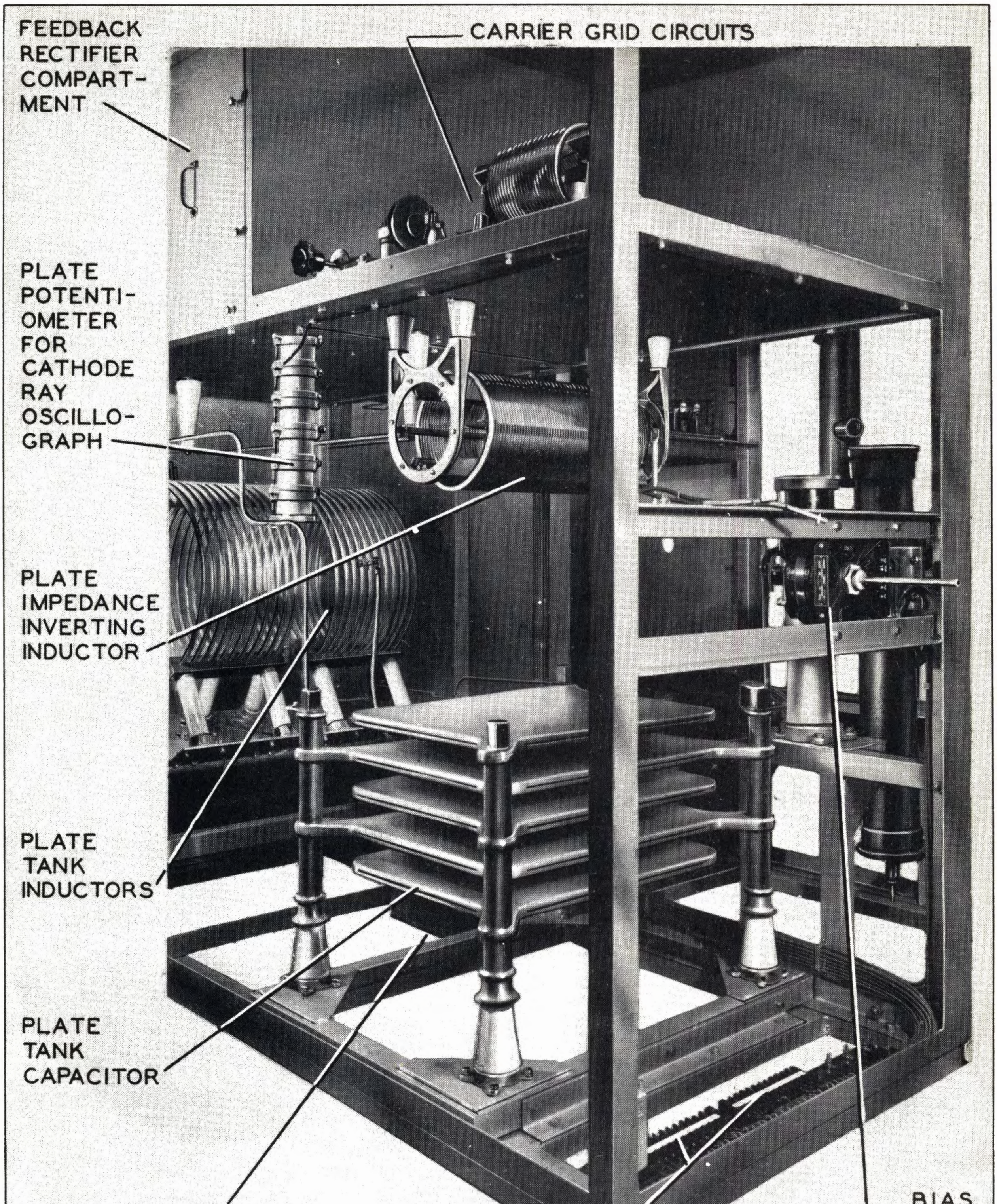


Figure 28--P. A. Carrier Plate Tank Compartment

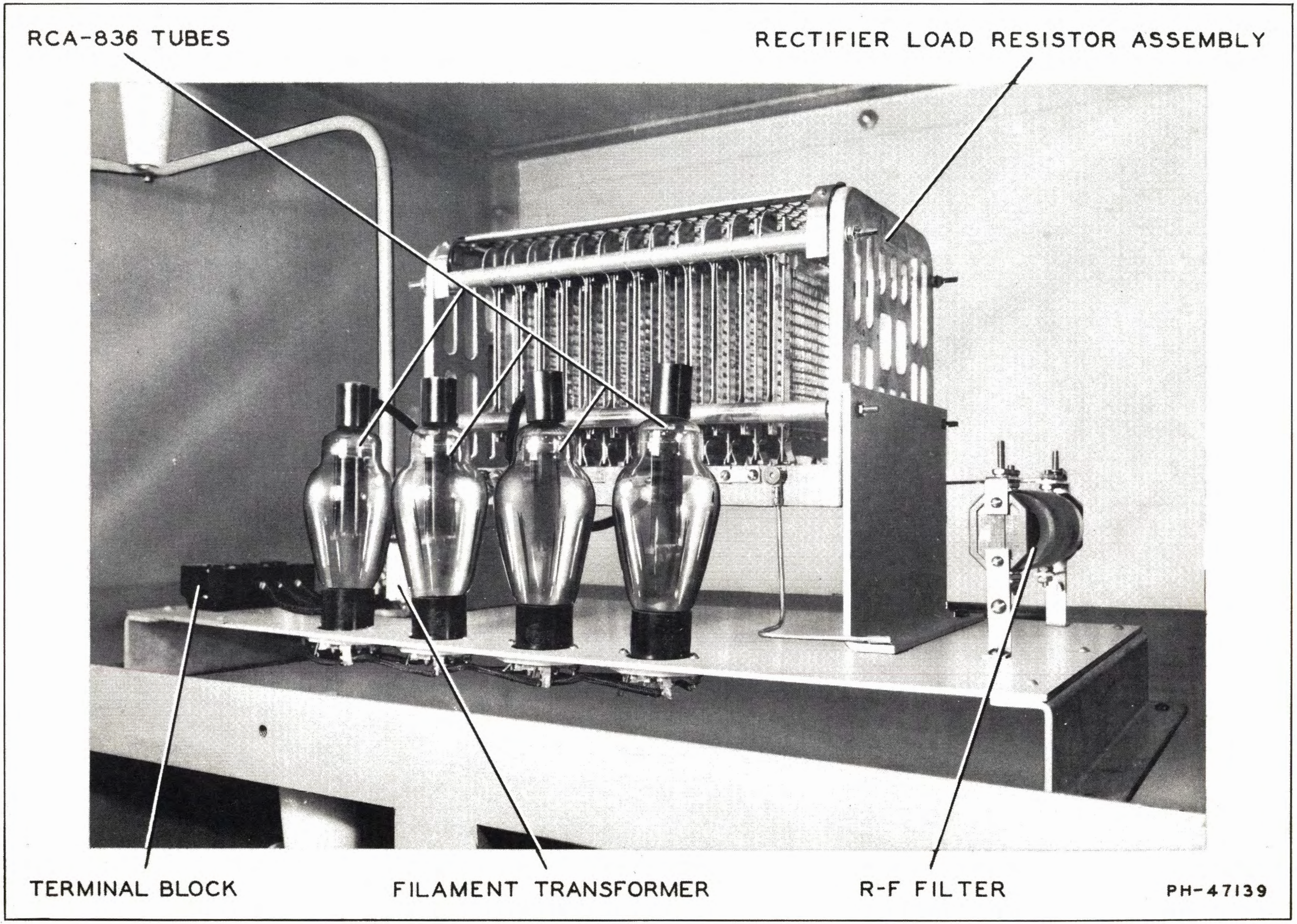


Figure 29—P. A. Feedback Rectifier Compartment

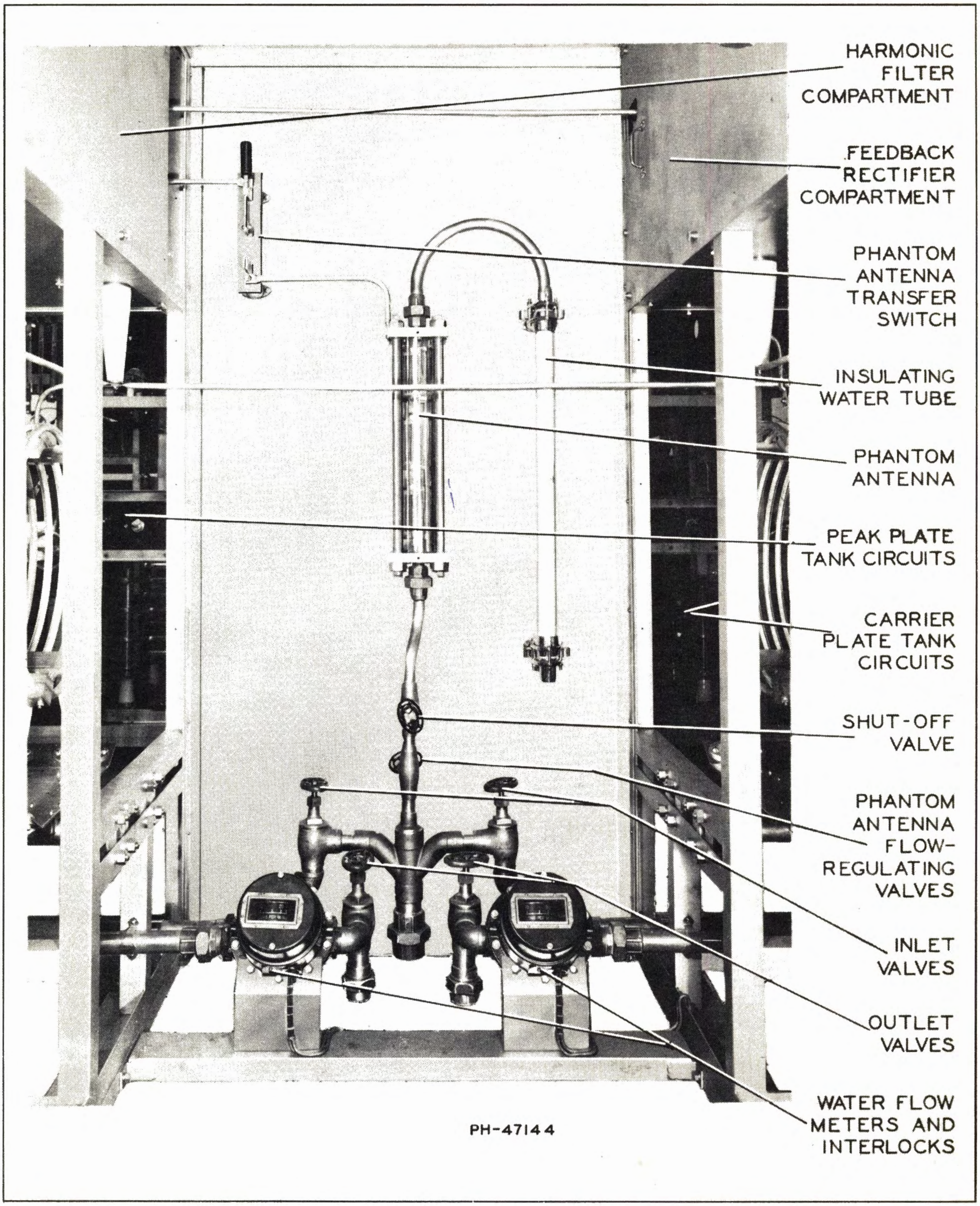


Figure 30--P. A. Water Piping Assembly and Phantom Antenna

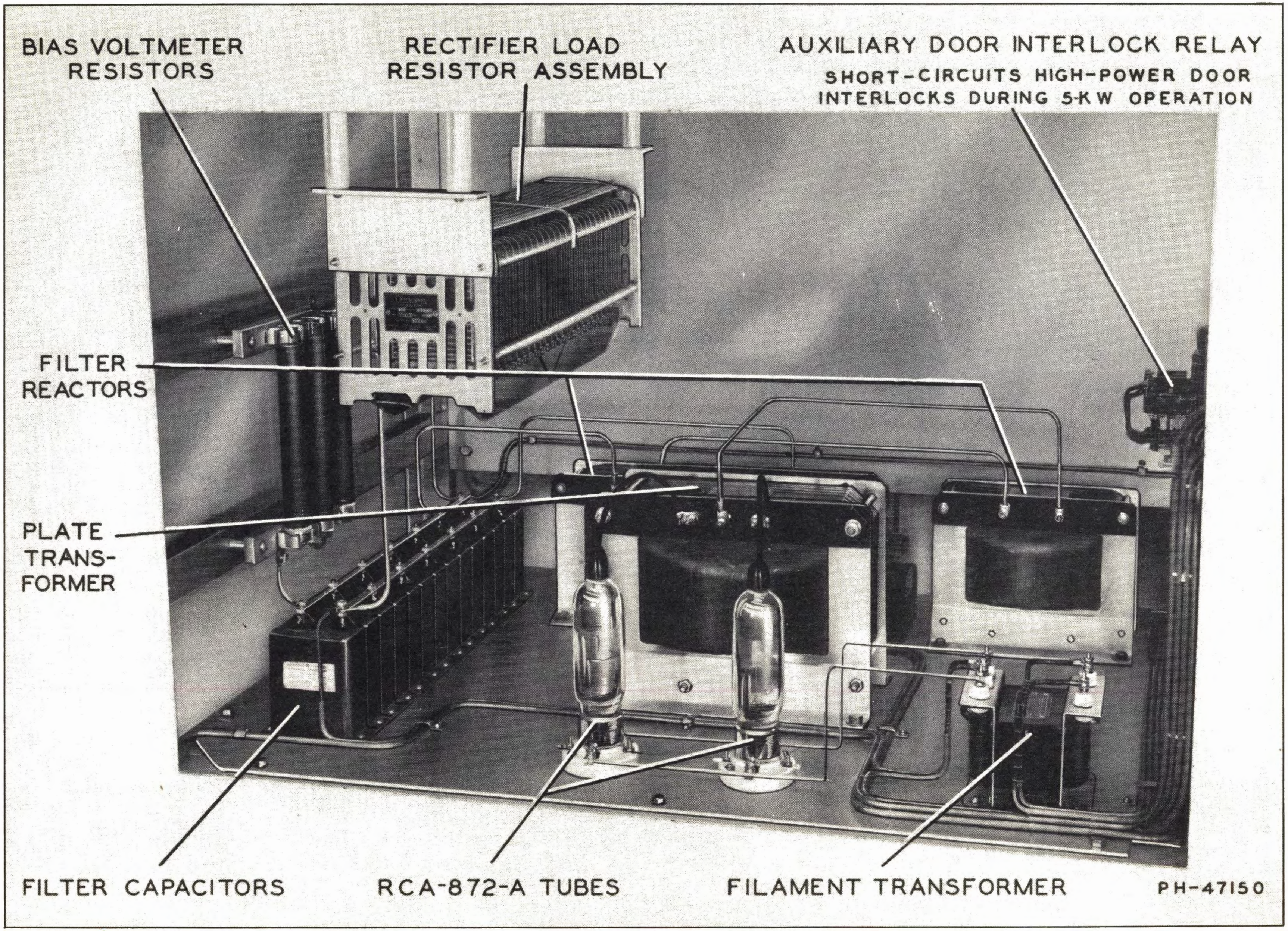


Figure 31—P. A. Peak Bias Rectifier Compartment

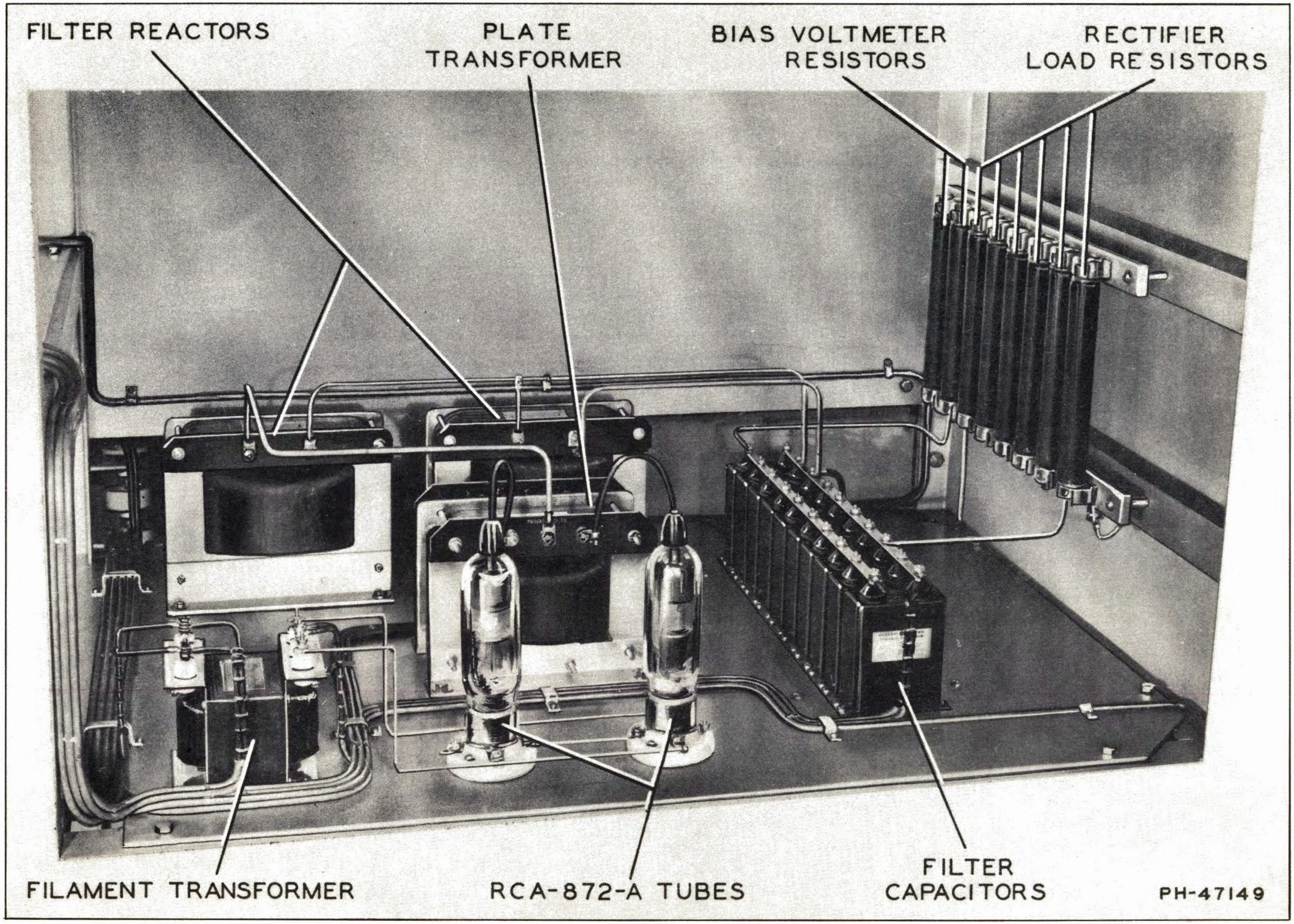


Figure 32—P. A. Carrier Bias Rectifier Compartment

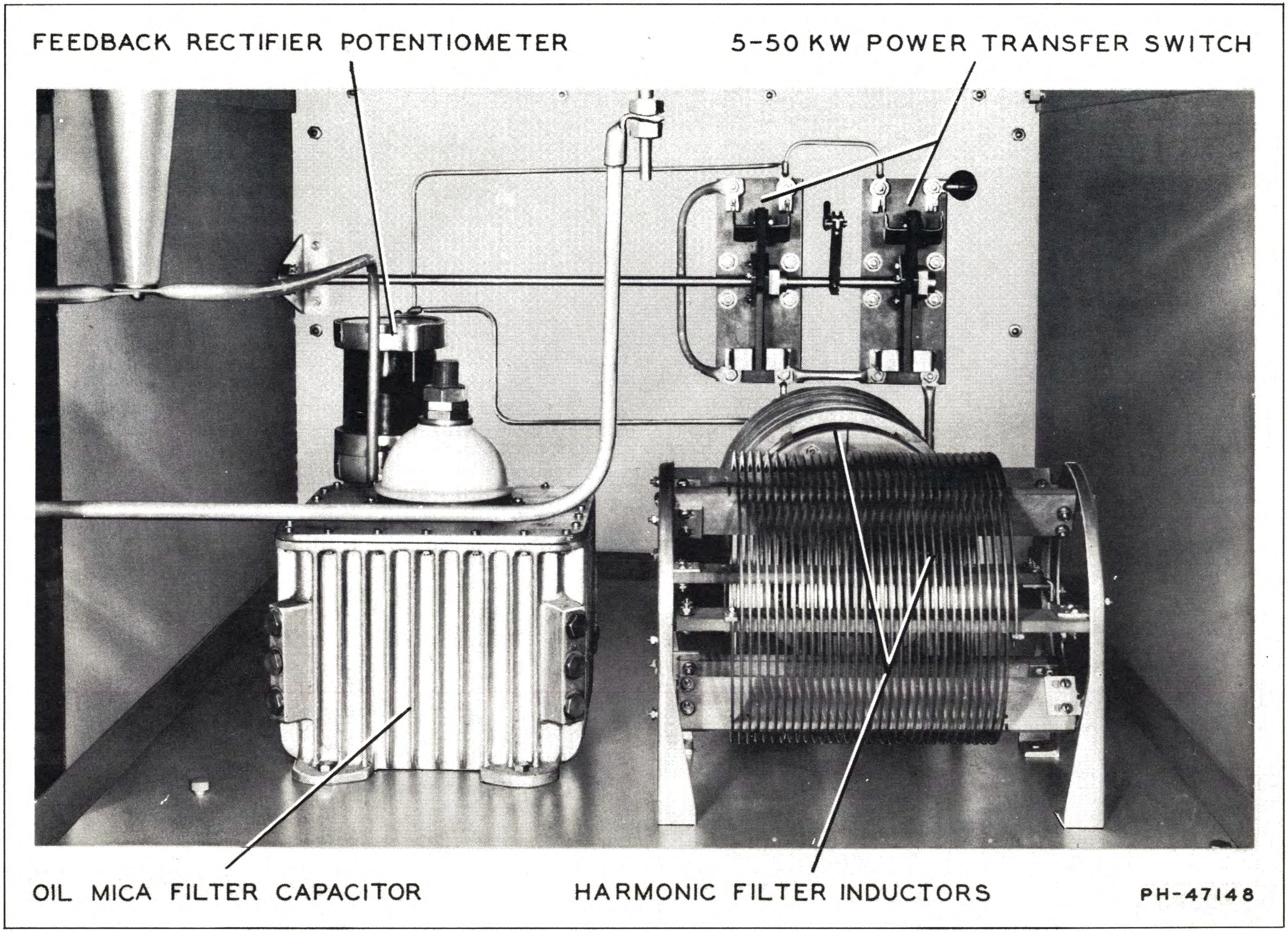


Figure 33—P. A. Harmonic Filter Compartment, Rear View

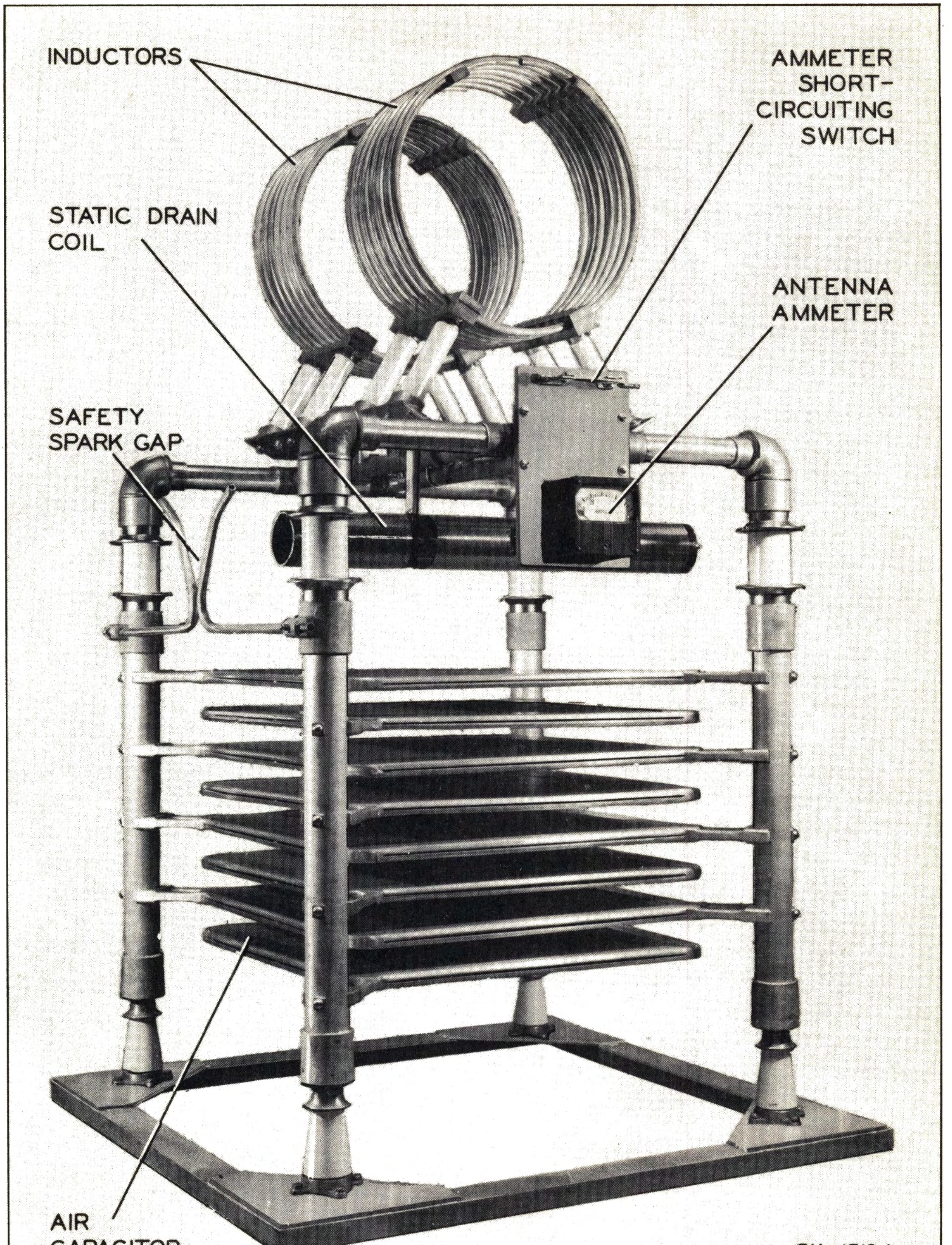


Figure 34—Antenna Tuning Unit

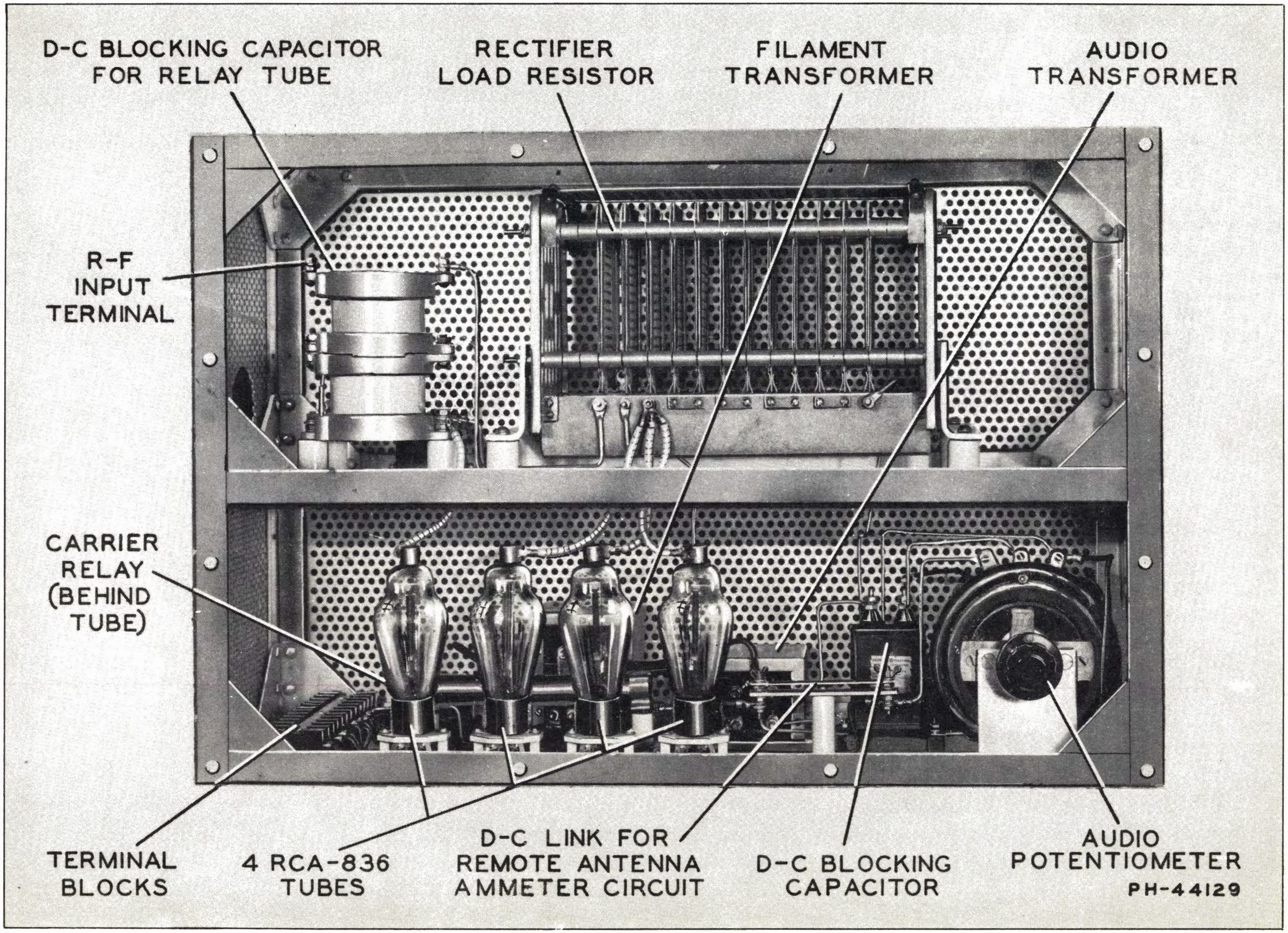


Figure 35—Antenna Monitor Rectifier

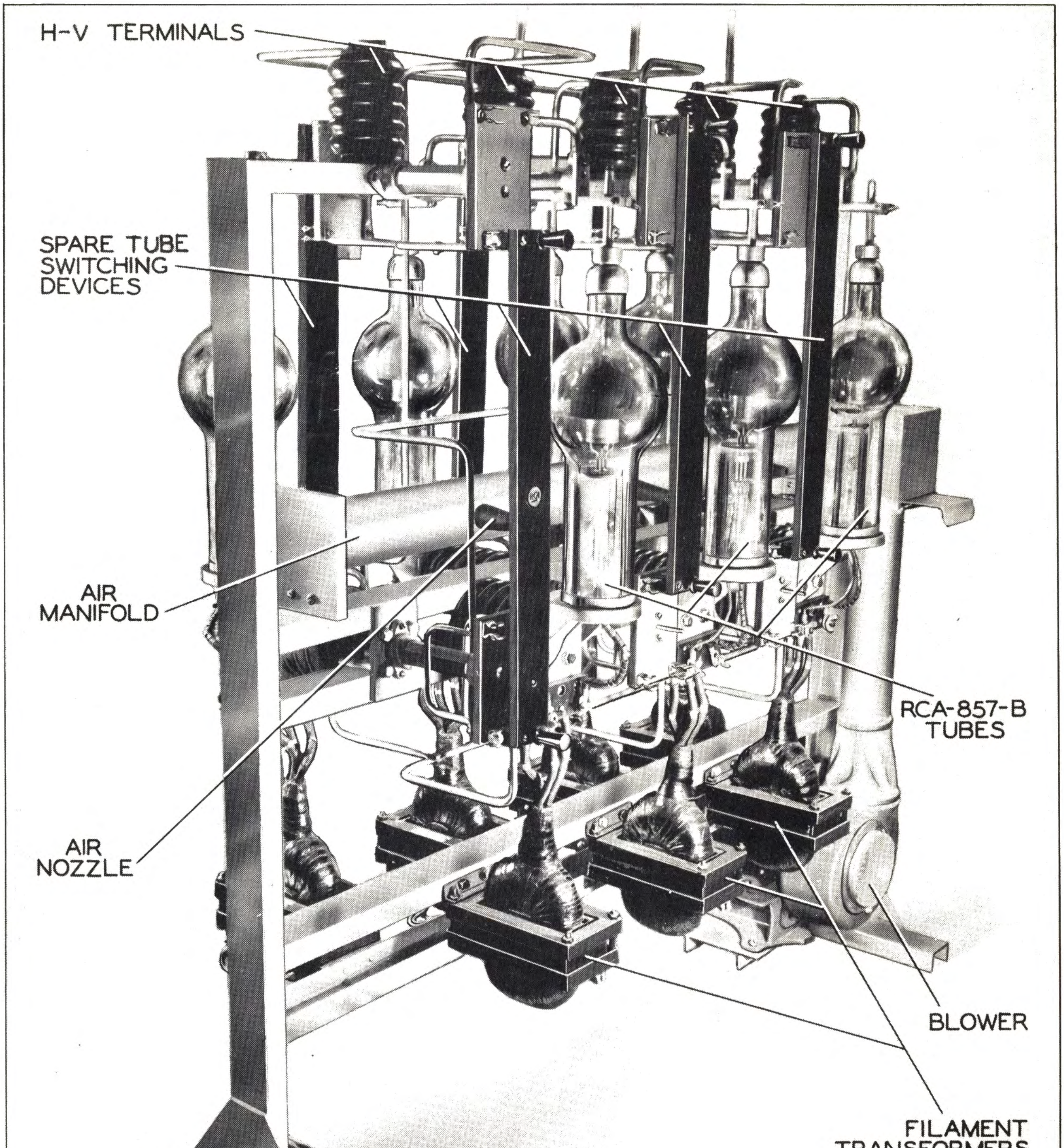


Figure 36—Main Power Rectifier

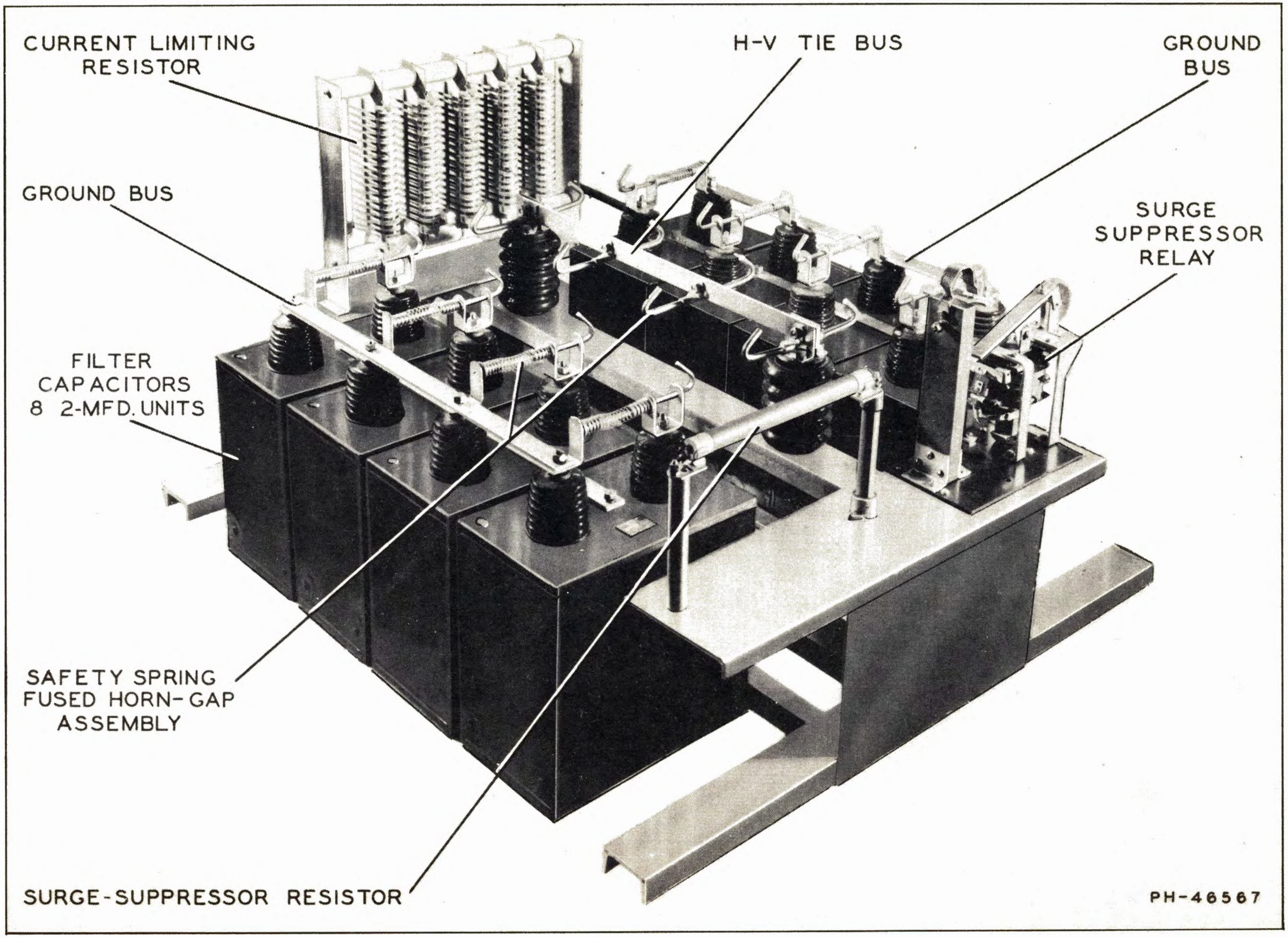


Figure 37—Main Power Rectifier Filter Rack

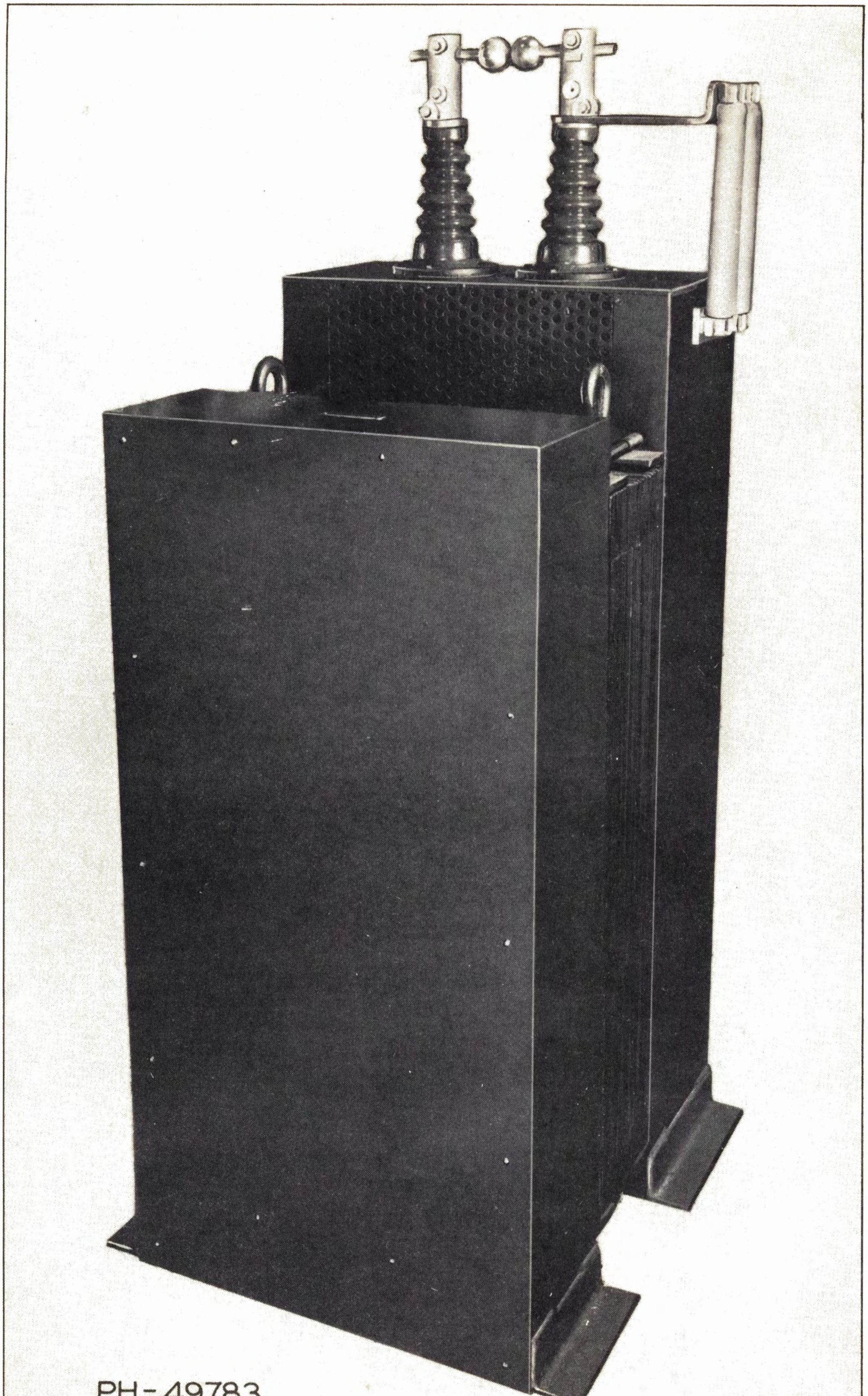


Figure 38—Main Power Rectifier Filter Reactor

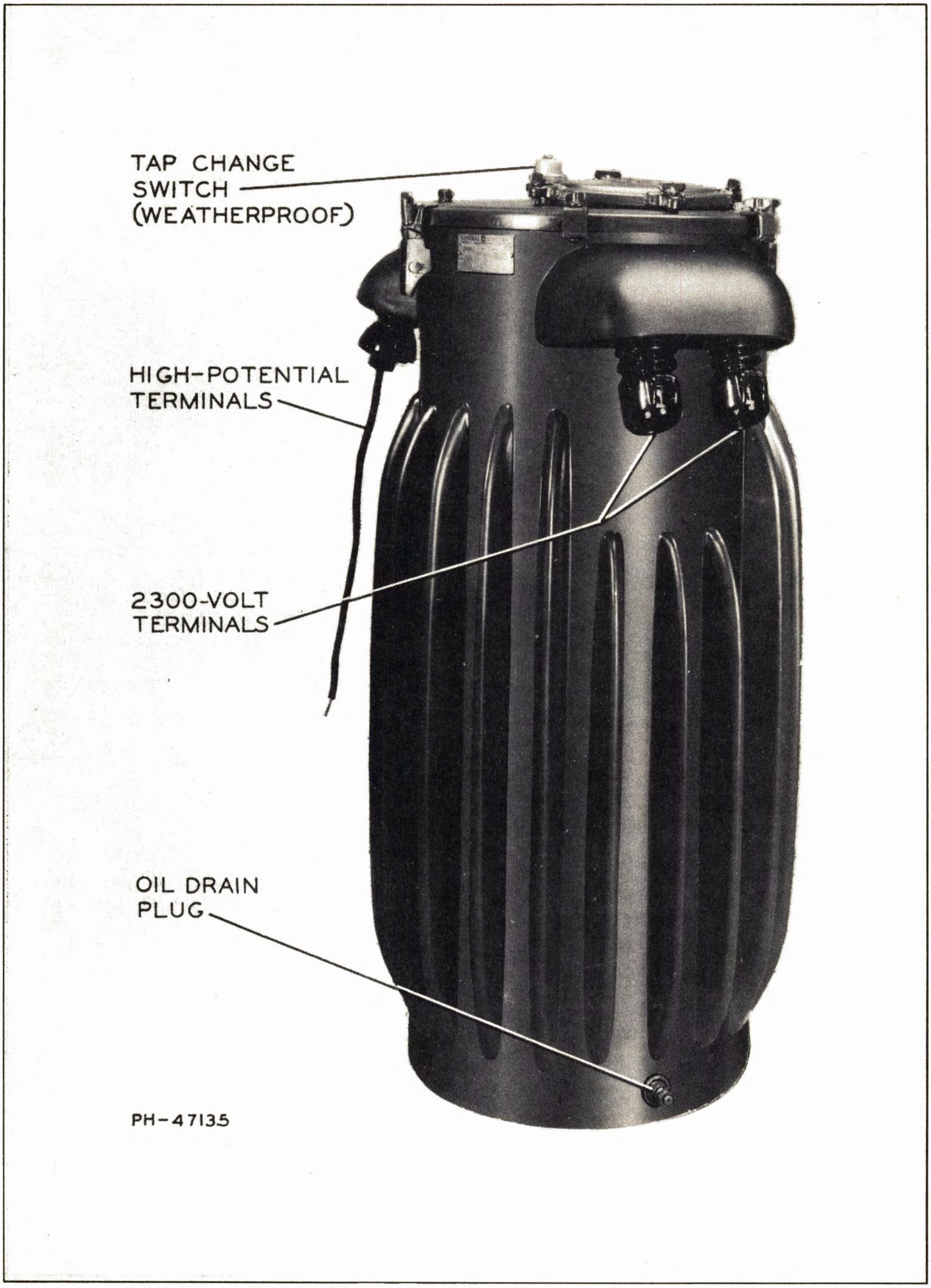


Figure 39—Main Power Rectifier Plate Transformer

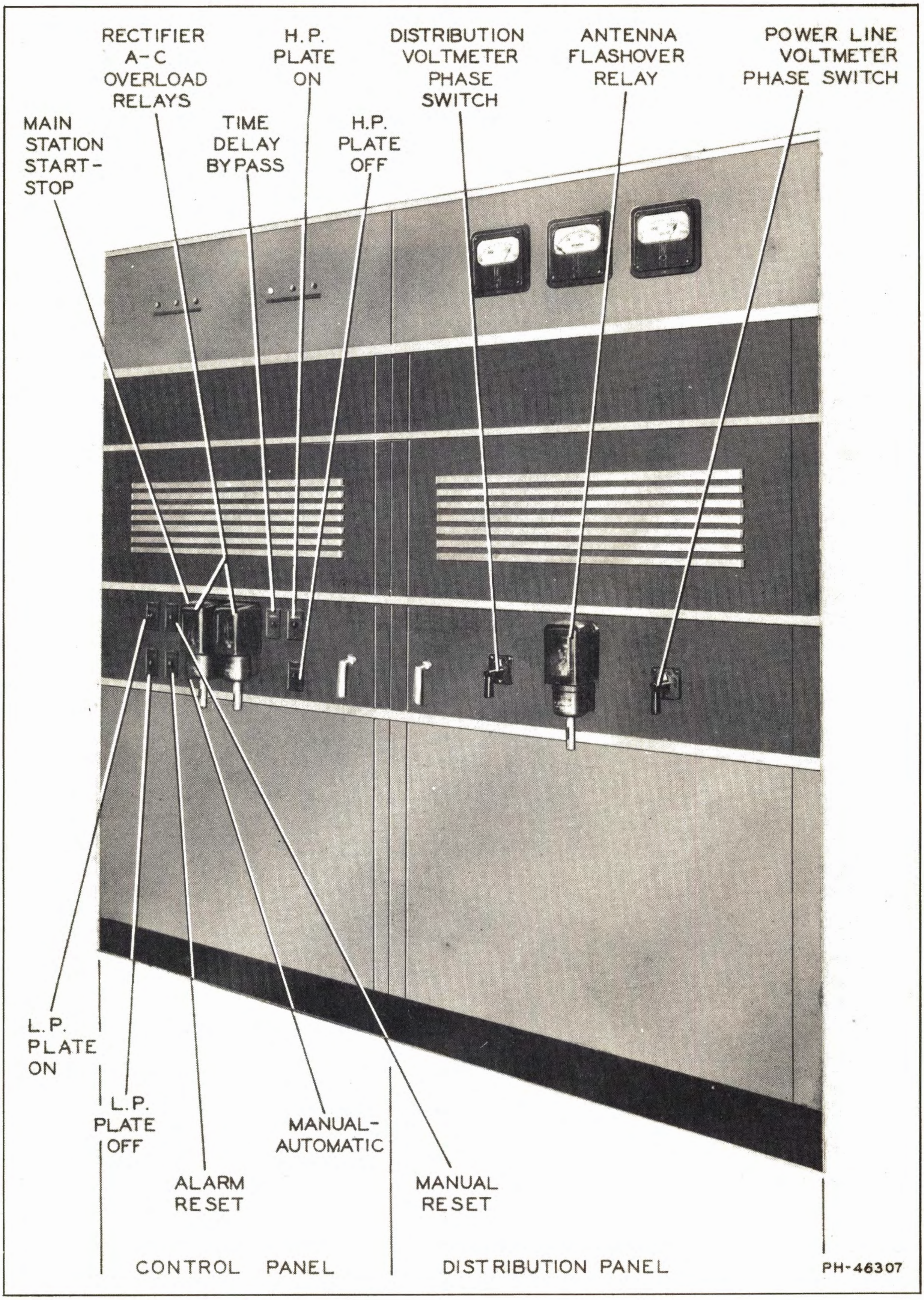


Figure 40—Power Control and Distribution Section of Transmitter, Front View, Doors Closed

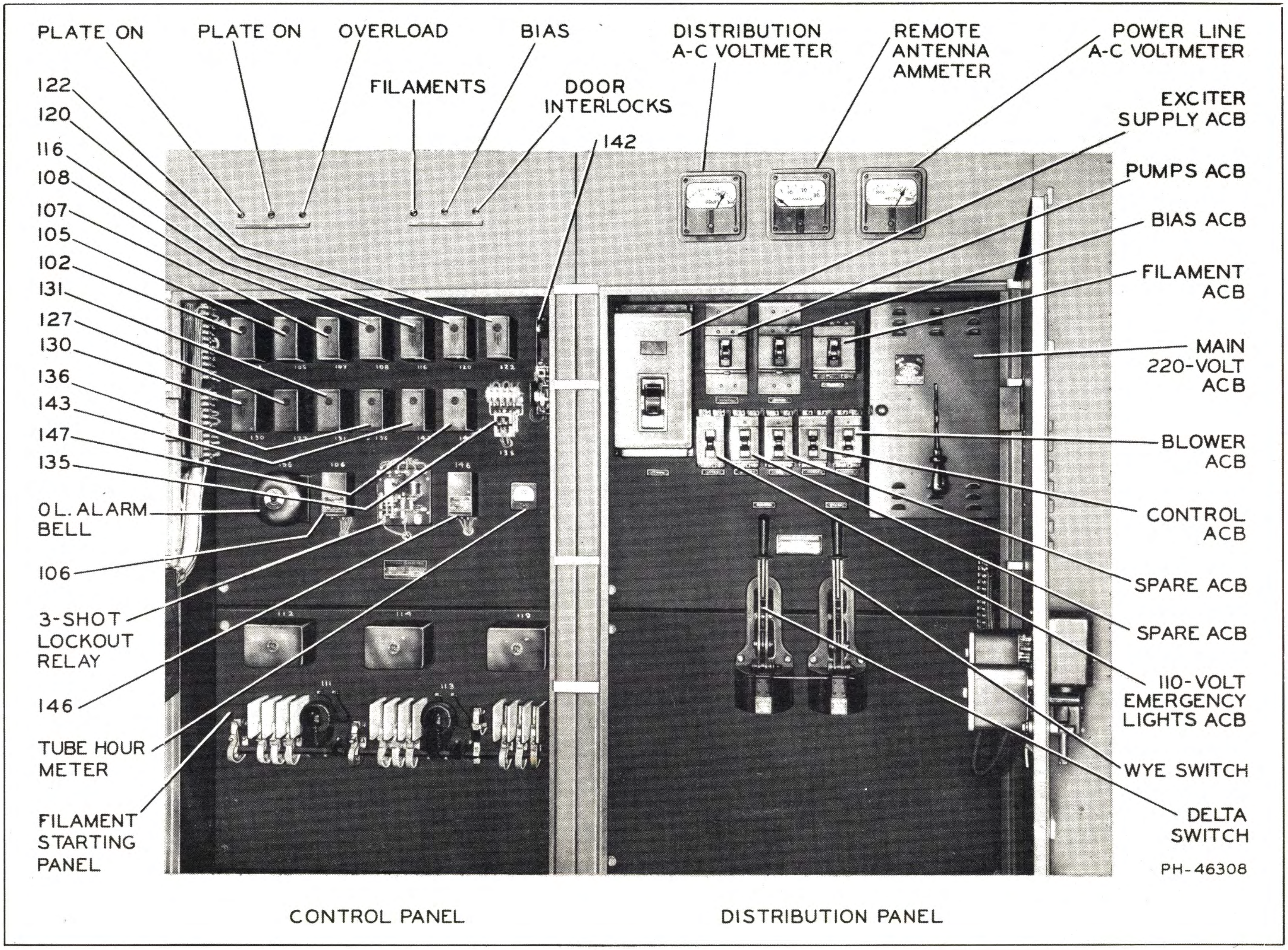


Figure 41—Power Control and Distribution Panels, Front View, Doors Open

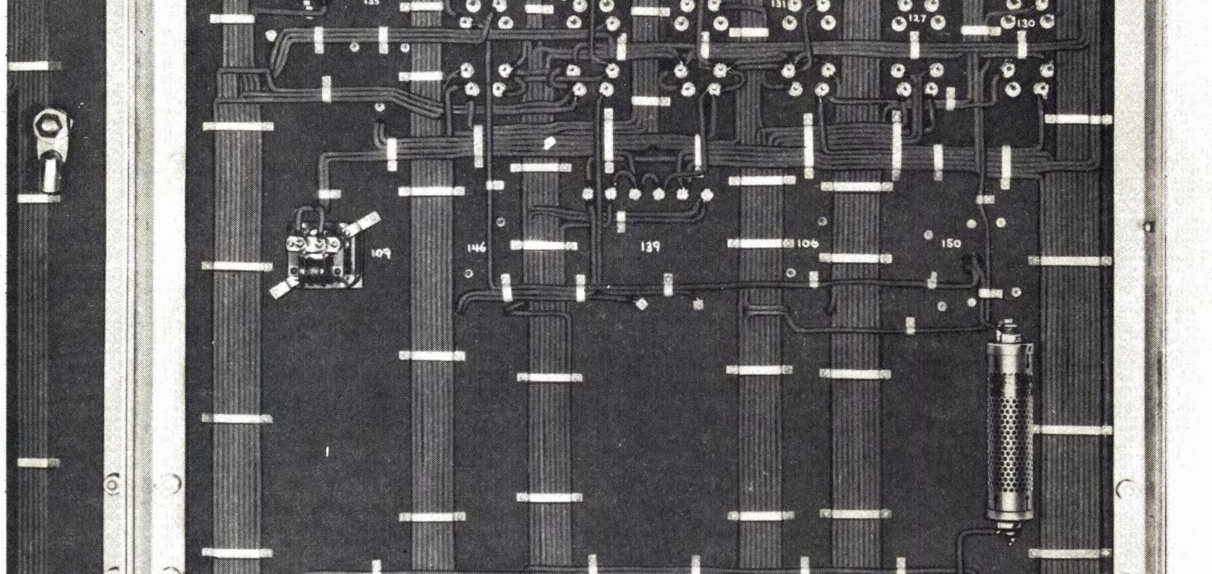


Figure 42—Main Power Control Panel, Rear View

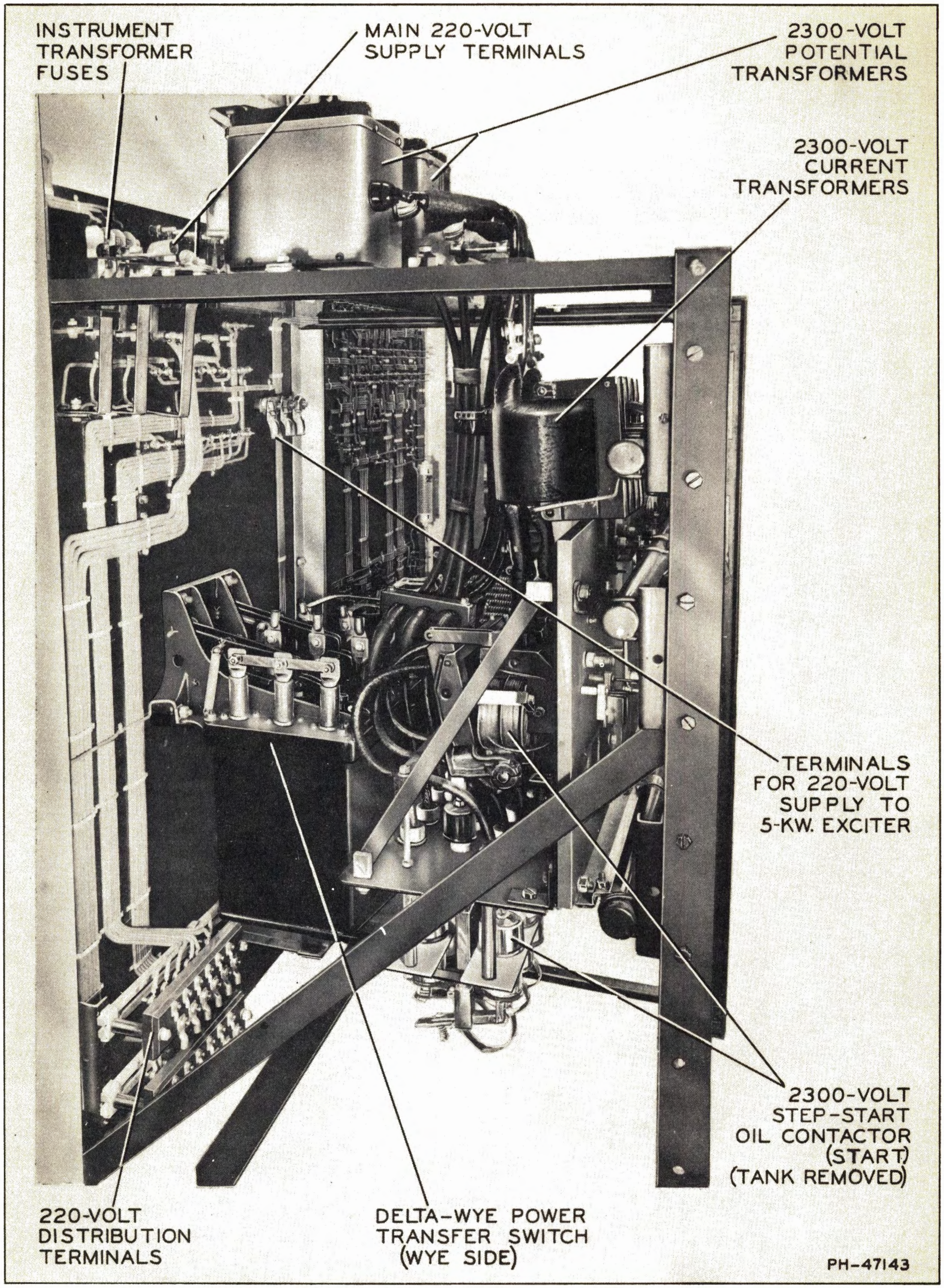


Figure 43—Distribution Panel, Rear View

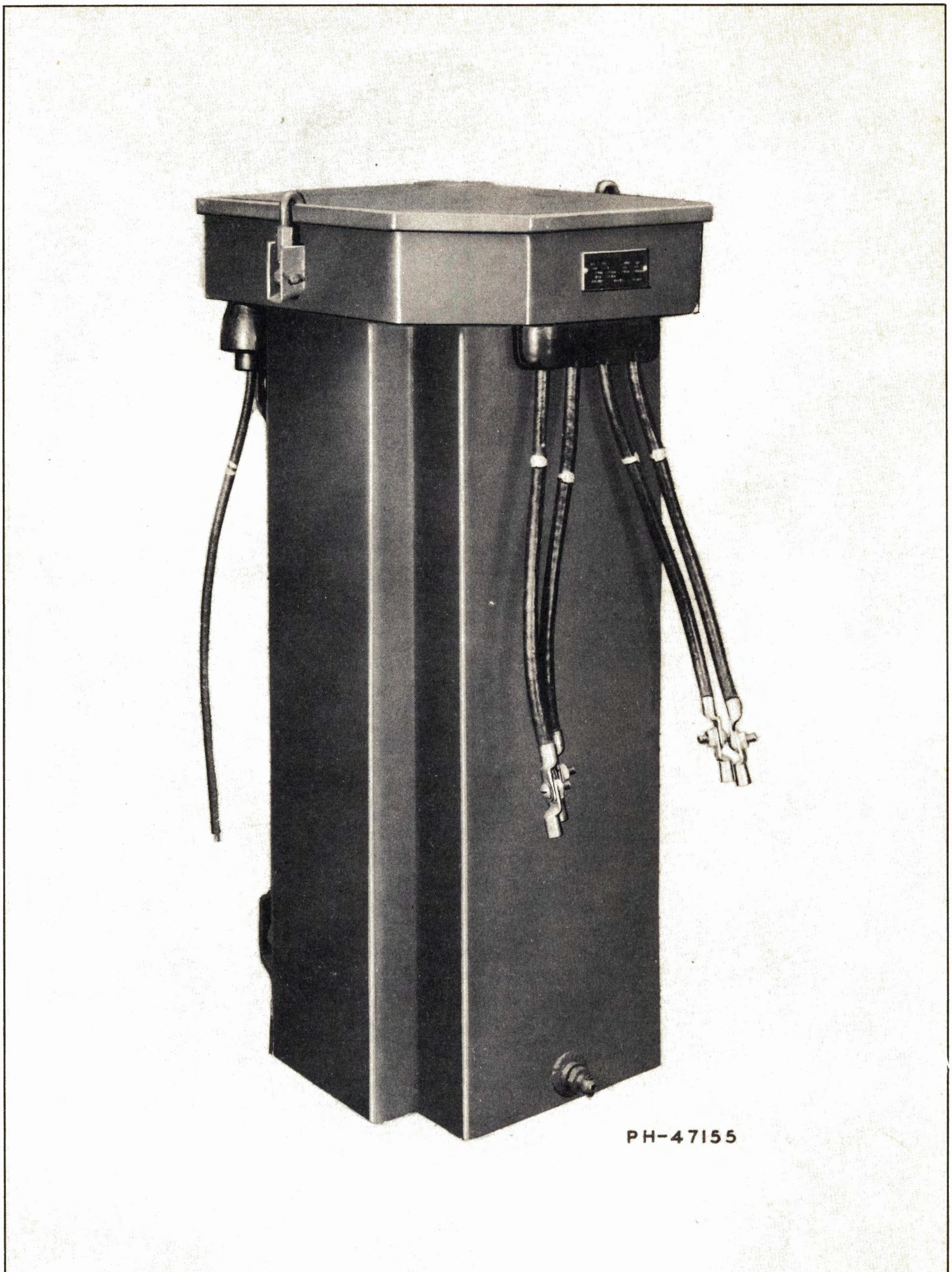
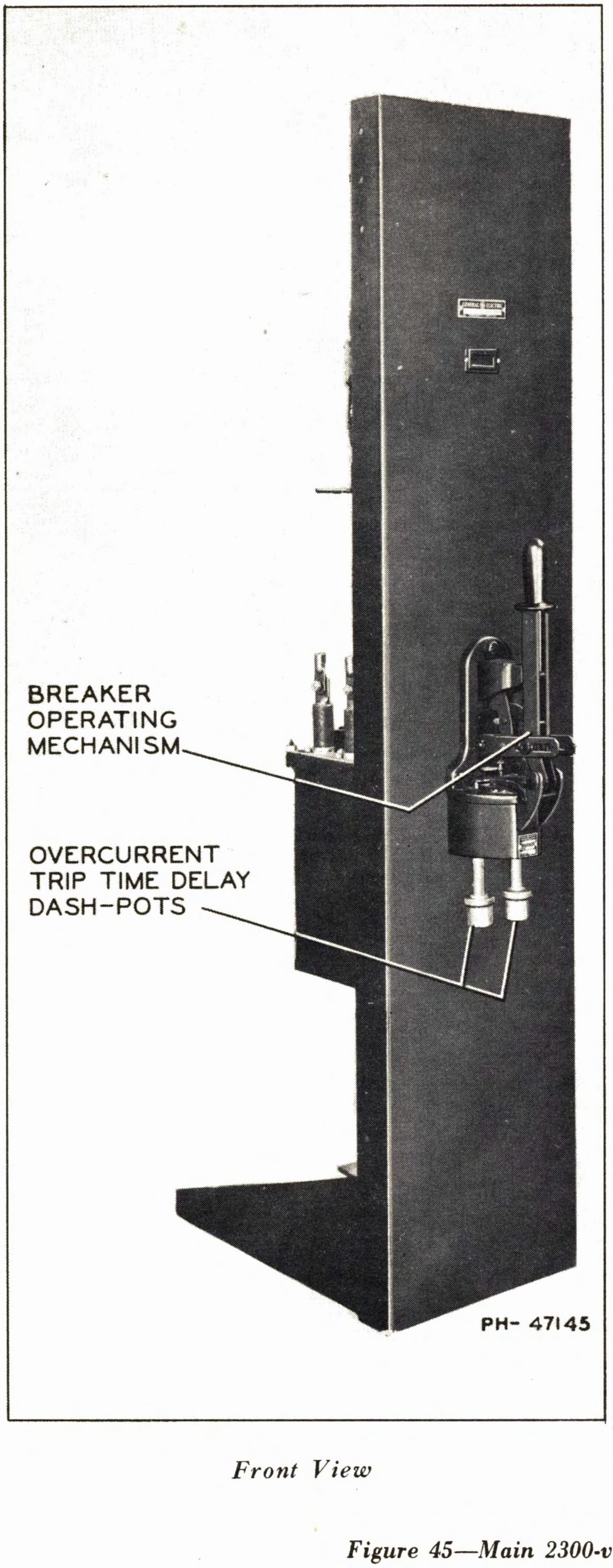
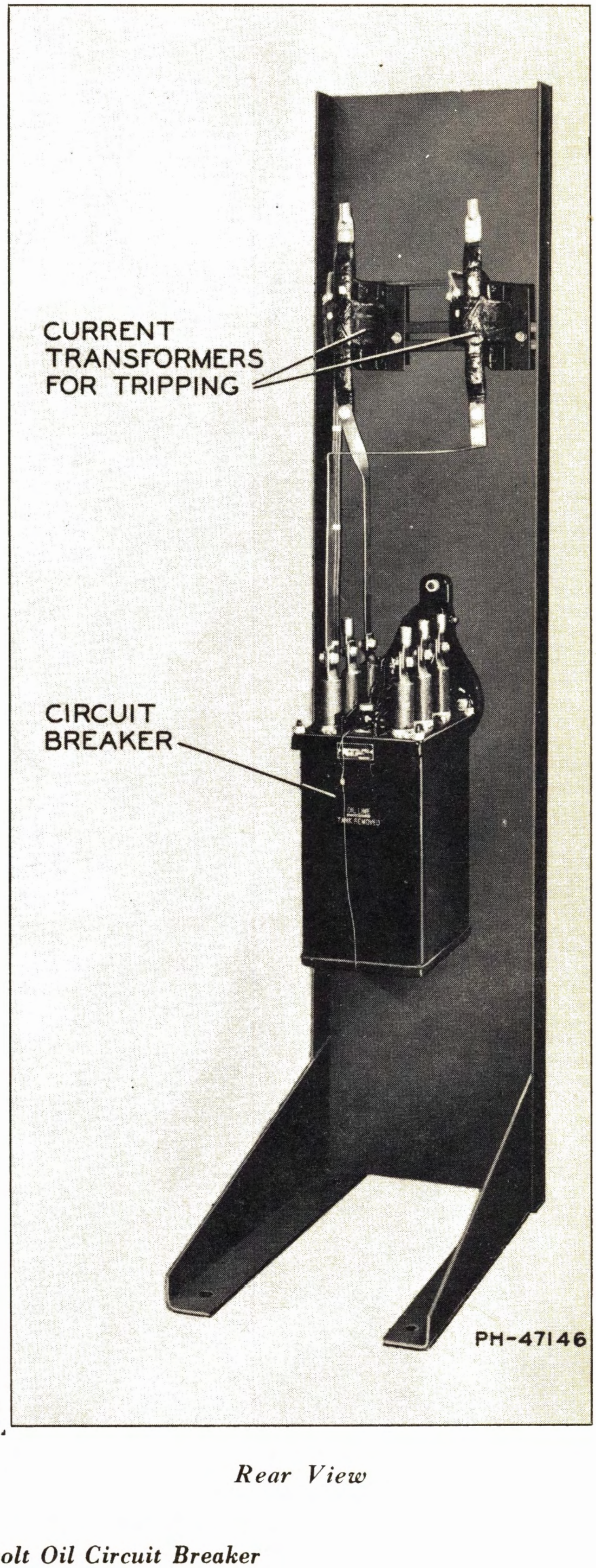


Figure 44—Distribution Transformer



Front View



Rear View

Figure 45—Main 2300-volt Oil Circuit Breaker

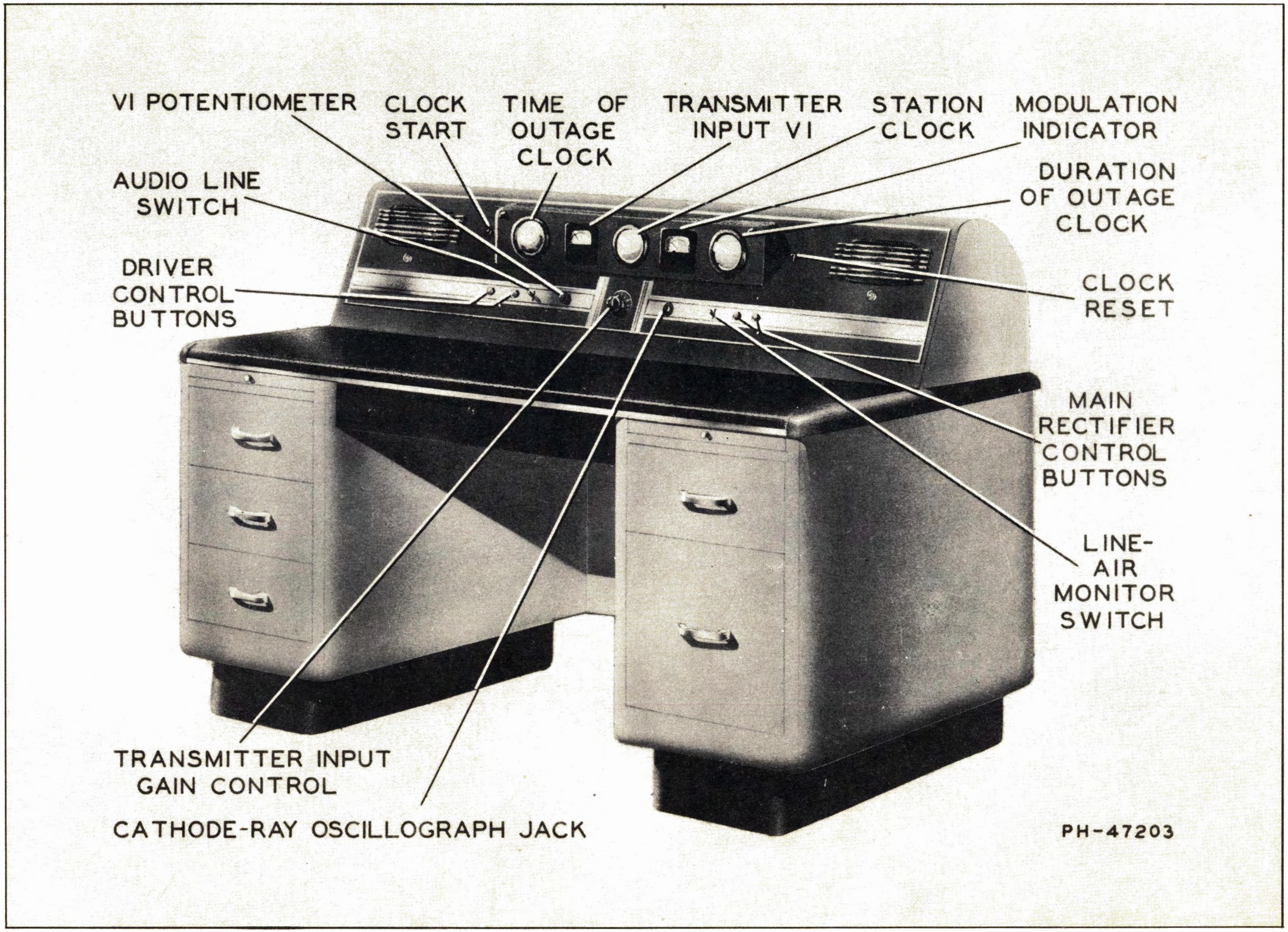


Figure 46—Supervisory Console and Desk

Figure 47—Water Cooler, Front View

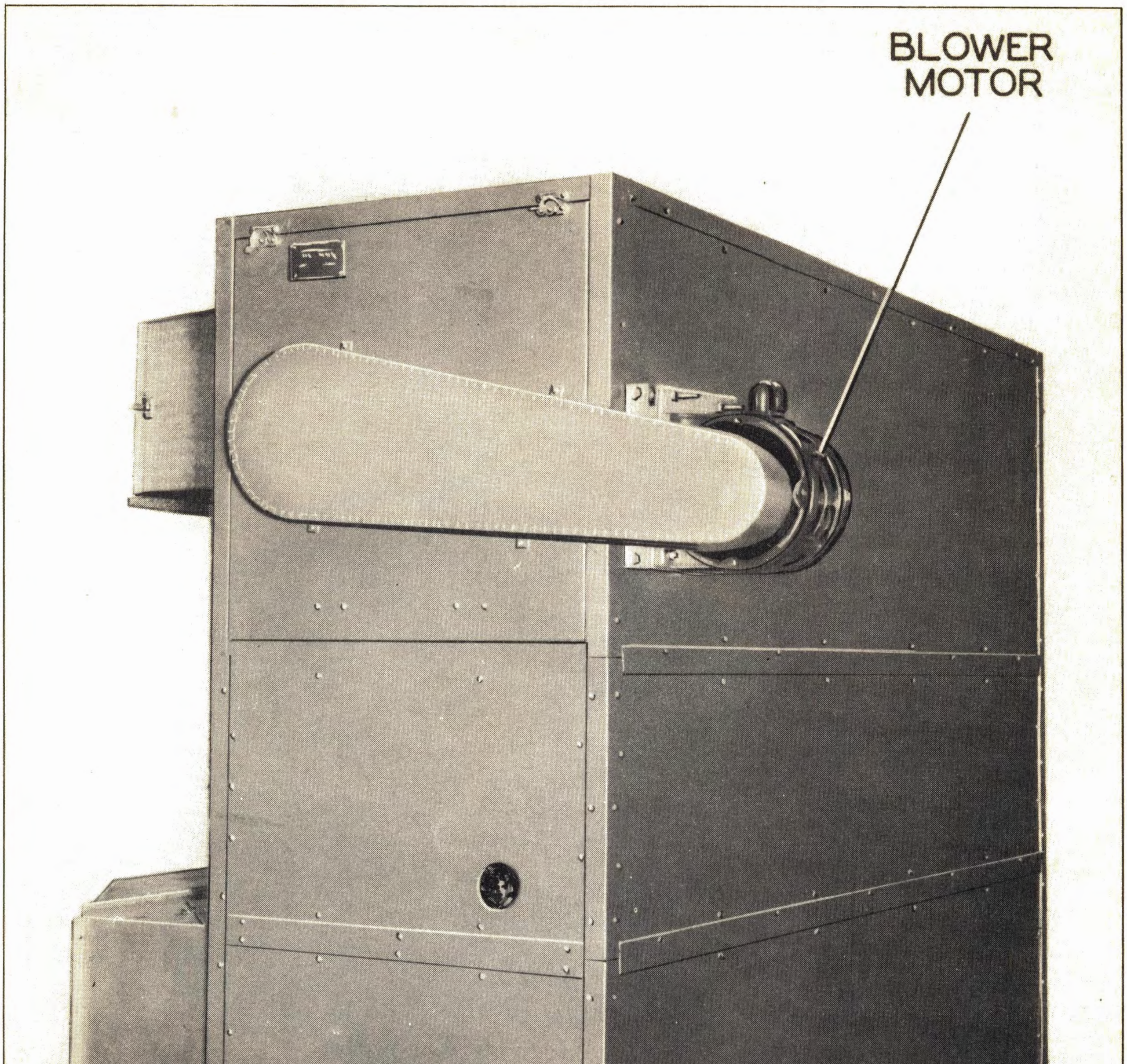


Figure 48—Water Cooler, Rear View

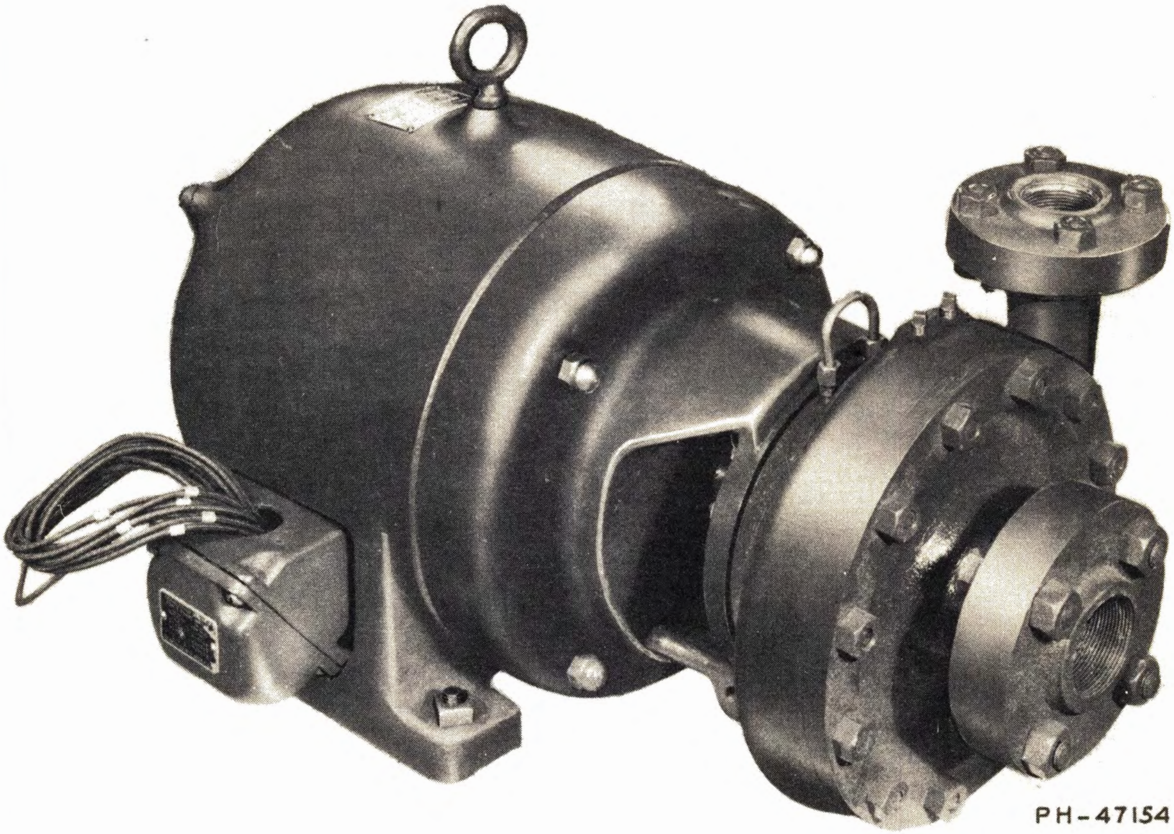


Figure 49—Distilled-Water Pump

TERMINAL PREFIXES	
A, B, BB	250 WATT EXCITER
C, D,	5 KW. POWER AMPLIFIER
C, CC, Y	LOW POWER AUDIO
E, F	MODULATOR RECTIFIER
K, L	LOW POWER FILTER RACK
CP	5 KW. CONTROL PANEL

TERMINAL SUFFIXES	
A	CONSOLE
C	HIGH POWER CONTROL
D	HIGH POWER DISTRIBUTION
E	ENCLOSURE
F	FEED BACK RECTIFIER
M	MONITOR RECTIFIER
P	50 KW. POWER AMPLIFIER
R	HIGH POWER RECTIFIER

Figure 50—Schematic Diagram, Overall, WX-230294