INTRODUCTION

The General Electric 50-KW AM Broadcast Transmitter (Fig. 1), Models 4BT50A1, 2, and 3, is an air-cooled transmitter designed to provide the broadcaster with modern equipment that will deliver high quality performance at low operating cost. The Transmitter will easily supply 53 kilowatts of amplitude-modulated carrier in the frequency range of 535 to 1620 kilocycles.

Three models are supplied: Model 4BT50A1 for a three-phase power input of 480 volts, Model 4BT50A2 for a power input of 2400 volts, and Model 4BT50A3 for a power input of 4160 volts.

It is the purpose of this instruction book to provide detailed information about the circuits employed and the adjustment and maintenance procedures to be followed. Adherence to these instructions will insure optimum performance as well as long and satisfactory service from the Transmitter.

TECHNICAL SUMMARY

Electrical

Type of Emission:	A3.
Frequency:	535 to 1620 kilocycles.
Frequency Stability:	± 5 cycles.
Power Output (at Transmitter output terminal):	53 KW.
Type of Modulation:	High level.
Audio Input:	10 dbm, ± 2 dbm for 100% modulation.
Audio Input Impedance:	600 ohms.
Audio Response:	± 1.5 db, 50 to 10,000 cycles.
Audio Distortion:	Less than 3%, 50 to 7500 cycles.
Noise Level:	More than 60 db below 100% modulation.
Carrier Shift:	Less than 2.5%, 0 to 100% modulation with 0 regulation of supply voltage.
Output:	Unbalanced.
Output Impedance:	50 to 230 ohms.
Power Requirements:	480, 2400, or 4160 volts, 60 cps, 3-phase.

Percentage Modulation	50 KW RF Carrier Power	53 KW RF Carrier Power
0%	94 KW at 0.9 PF	98 KW at 0.9 PF
30%	108 KW at 0.91 PF	113 KW at 0.91 PF
100%	145 KW at 0.93 PF	153 KW at 0.93 PF

Tube Complement

Quantity	Type	Symbol	Function
1	6146	AV1	Crystal oscillator
1	6146	BV1	Buffer amplifier
1	6156	CV1	First intermediate power amplifier
1	6623	DV1	Second intermediate power amplifier
2	6427	EV1, EV2	Power amplifier
2	6136	KV1, KV2,	First audio amplifier
2	6156	MV1, MV2	Second audio amplifier
4	304TL	NV1, NV2 NV3, NV4	Third audio amplifier
2	6427	PV1, PV2	Modulator

Mechnical

DIMENSIONS

	Height	Width	Depth	Shipping Weight
Rectifier and Control Cubicle	84"	54"	54"	2148 lb
Exciter and Modulator Cubicle	84"	54"	54"	1744 lb
RF Amplifier Cubicle	84"	54"	54"	1570 lb

MOUNTING

Refer to Figs. 2 through 7.

OPERATING CONDITIONS

Ambient Temperature: 0 to 120 F (-18 to +49 C approximately)

Maximum Altitude: 5000 feet for standard equipment (larger blower required for higher altitudes)

SAFETY PROVISIONS

All doors are provided with both electrical interlocks and safety grounding switches to protect personnel from high voltage. Control circuits provide overload protection and proper sequencing to prevent damage to the equipment.

FCC Filing Data

When applying for a Federal Communications Commission license, the following information will be helpful in filling out Section II-A of FCC Form 302.

Transmitter make:	General Electric
Type number:	BT-50-A
Rated power:	50 KW
Operation of last radio-frequency amplifier stage:	Class C

Manufacturer's recommended operating efficiency for last radio-frequency stage:	76%
Is inverse feedback utilized:	Yes
To what value of feedback power is the Transmitter adjusted?	12 db

EQUIPMENT

Equipment Furnished

The General Electric AM Broadcast Transmitter discussed in this instruction book is identified by Model Number 4BT50A1, 4BT50A2, or 4BT50A3. Each of these models consists of the basic items listed below, their differences lying in the external equipment supplied for 480-, 2400-, and 4160-volt operation. The specific external equipment supplied for each model is tabulated under External Equipment Breakdown.

Item	Quanity	Designation
Rectifier and Control Cubicle	1	ML-589E231-G2
Exciter and Modulator Cubicle	1	ML-589E232-G2
RF Amplifier Cubicle	1	ML-589E233-G2
External Equipment		
4BT50A1	1	PLA-7162232-G1
4BT50A2	1	PLA-7162232-G2
4BT50A3	1	PLA-7162232-G3
Electronic Tubes	1 set	PLA-7163820
Intercubicle Connections	1	ML-101A6794-G1
External Connections		
4BT50A1	1	MLA-7164515-G1
4BT50A2	1	MLA-7164515-G2
4BT50A3	1	MLA-7164515-G3
Antenna Meter*	1	B-603B290
RF Current Transformer*	1	555C711
Crystals*		M-7466947
Reflectometer**	1	ML-444D442-G2
Instruction Book	2	EBI-2169

*Determined by customer requisition.

**Quantity determined by customer requisition; one supplied, others required are extra (usually one per tower).

External Equipment Breakdown

COMMON TO ALL MODELS

Item	Quanity	Designation
Modulation Reactor (RL1)	1	B-603B283-P1
Modulation Transformer (RT1)	1	B-603B282-P1
Filter Reactor (WL1)	1	B-7491984-P1
Thyrite Arrestor (WE1, WE2, WE3, RE1, RE2, RE3, RE4)	7	Cat. No. 9LA21BX8
Blower (ZB1)	1	C-7776861-P2
Vacuum Switch Box	1	ML-444D142-G1
208-Volt Supply Switch (ZS13)	1	Cat. No. TC90423SNSDJ6
208-Volt Supply Fuse (ZF4, ZF5, ZF6; spares included)	6	Cat. No. GF6A100
Blower-Supply Circuit Breaker (ZS14)	1	7777407-G1

MODEL 4BT50A1

Item	Quanity	Designation
Plate Transformer (WT1, WT2, WT3)	3	Cat. No. 5508AD2550
Current-Limiting Reactor (ZL1, Outline 516B729)	1	Cat. No. 92H37
Delta-Wye Switch (WS1A, B, C)	1	Cat. No. TC35364
Plate Disconnect Switch (WS2A, B, C)	1	Cat. No. TC90364SDJ6
Distribution Disconnect Switch (ZS12A, B, C)	1	Cat. No. TC90362SDJ6
Distribution Transformer (ZT1, ZT2, ZT3)	3	Model No. 9T21Y12
Fuse for Plate Supply (WF1, WF2, WF3; spares included)	6	Cat. No. GF6B200
Fuse for Distribution Supply (ZF1, ZF2, ZF3; spares included)	6	Cat. No. GF6B60

MODEL 4BT50A2

Item	Quanity	Designation
Plate Transformer (WT1, WT2, WT3)	3	Cat. No. 5525AD1550
Current-Limiting Reactor (ZL1)	1	B-7491983-P1
Delta-Wye Switch (WS1A, B, C)	3	Cat. No. 175L625G37
Plate Disconnect Switch (WS2A, B, C)	1	Cat. No. 175L630G213
Plate Fuse Holder (WXF1, WXF2, WXF3)	1	Cat. No. 175L661G1
Distribution Disconnect Switch (ZS12A, B, C)	3	Cat. No. 175L615G1

Item	Quanity	Designation
Distribution Transformer (ZT1, ZT2, ZT3)	3	Cat. No. 2701AC6510
Fuse for Plate Supply (WF1, WF2, WF3; spares included)	6	Cat. No. 6193403G13
Fuse for Distribution Supply (ZF1, ZF2, ZF3; spares included)	6	Cat. No. 6193403G8
Fuse Tong and Switch Hook	1	Cat. No. 6106644G2
Fuse Tong and Switch Hook	1	Cat. No. 6106644G10

MODEL 4BT50A3

Item	Quanity	Designation
Plate Transformer (WT1, WT2, WT3)	3	B-594B667-P1
Current-Limiting Reactor (ZL1)	1	B-7492285-P1
Delta-Wye Switch (WS1A, B, C)	3	Cat. No. 175L626G36
Plate Disconnect Switch (WS2A, B, C)	1	Cat. No. 175L632G210
Plate Fuse Holder (WXF1, WXF2, WXF3)	1	Cat. No. 175L661G7
Distribution Disconnect Switch (ZS12A, B, C)	3	Cat. No. 175L615G9
Distribution Transformer (ZT1, ZT2, ZT3)	3	Cat. No. 3601AC6510
Fuse for Plate Supply (WF1, WF2, WF3; spares included)	6	Cat No. 6193406G11
Fuse for Distribution Supply (ZF1, ZF2, ZF3; spares included)	6	Cat. No. 6193404G7
Fuse Tong and Switch Hook	1	Cat. No. 6106644G2
Fuse Tong and Switch Hook	1	Cat. No. 6106644G10

Accessories

The following accessories are supplied with the Transmitter:

Item	Quanity	Designation
Air Filters	4	ML-102A4632-P1
Felt, 826A952-P1 x 30' long	1	
Rubber Strip, 832A336-P1 x 10" long	2	
Paint Touch-up Kit	1	K-7134491-G2
Screw, ¼-20 x 3/4 long	16	N-81P21012C13
Lockwasher, ¼ ID	16	N-414P25C13
Nut, ¼-20	16	N-210P21C13
Washer, ¼	32	N-402P41C13
Glyptal (tube)	1	No. 1276

DESCRIPTION

Construction

The General Electric 50-KW AM Broadcast Transmitter consists of the Transmitter proper and the external components listed under EQUIPMENT.

The Transmitter is housed in three cubicles (Rectifier and Control, Exciter and Modulator, and RF Amplifier) which are designed to be joined together in a straight line. A recessed kick cove is provided along the front of each cubicle to prevent scuffing of the finish. The frequently used controls and supervisory lights are located on the panels to the side of the front door of each cubicle. The necessary indicating meters are mounted on the doors. The control breakers are located within the Rectifier and Control cubicle at the front. The front and rear doors provide access to components and subassemblies for adjustment and servicing. The rear doors of all three cubicles and the front doors of the Exciter and Modulator and RF Amplifier cubicles are provided with interlocks and safety grounding switches.

Rectifier and Control Cubicle

Refer to Figs. 8 through 18.

All the bias and plate supplies use germanium rectifiers in a three-phase, full-wave circuit and are located in the Rectifier and Control cubicle. The 500-volt supply provides 500 volts for the oscillator and buffer stages, 300 volts for the plates and screens of the first audio amplifier, d-c voltage for the screens of the second audio amplifier, and voltage for the screen grid of the first IPA. The 1500-volt supply provides plate voltage for the first IPA and the third audio amplifier. The 3500-volt supply provides the plate voltage for the second IPA and the second audio amplifier. The Modulator bias supply provides bias voltage for the first IPA tube, the third audio amplifier, and the Modulator. The PA bias supply provides protective bias for the PA tubes when there is no RF drive to the final stage. The 9000-volt supply provides plate voltage for the Modulator and PA stages.

Power and control circuit breakers as well as overload relays are mounted on the relay chassis located on the inner front panel of the Rectifier and Control cubicle. Refer to the discussion under Control System.

Exciter and Modulator Cubicle

Refer to Figs. 19 through 29.

The Exciter and Modulator cubicle houses the following RF and audio circuits.

The crystal oscillator and buffer amplifier are housed in a separate shielded compartment. The oscillator stage utilizes a Type 6146 tube in an electron-coupled Colpitts circuit and two low temperature-coefficient crystals in individual Thermocells*, either of which may be switched into the circuit. The plate of the Type 6146 tube has a resistive load and is capacity-coupled to the grid of the buffer stage.

The buffer stage consists of a Type 6146 tube providing (1) isolation of the oscillator stage for high-frequency stability, (2) drive for the first IPA stage, and (3) a convenient point at which the carrier may be interrupted. The plate load of the Type 6146 tube is a conventional parallel-resonant circuit consisting of fixed capacitors and a slug-tuned coil. Drive to the first IPA stage is adjusted by a variable resistor which controls the screen voltage of the buffer amplifier tube.

The first IPA uses a high-gain tetrode (Type 6156), operating Class C. Fixed bias on the grid, obtained from the Modulator bias supply, assures complete elimination of the carrier when the carrier trip circuit operates.

*Registered U.S. Patent Office.

The second IPA uses a neutralized triode (Type 6623), operating Class C. It provides drive for the PA stage.

The first audio amplifier uses two Type 6136 pentodes connected to form a Schmidt circuit having a large resistance common to both cathodes. The amplified audio signal is resistance-capacity coupled to the grids of the next stage.

The second audio amplifier uses two Type 6156 tetrodes in a resistance-capacity coupled amplifier. It amplifies the audio signal to the voltage level required to drive the Modulator tubes.

The third audio amplifier uses four Type 304TL triodes connected as a parallel push-pull cathode follower circuit. It transforms the high-impedance signal appearing at the plates of the preceding stage into a low-impedance signal to drive the grids of the Modulator tubes operating in Class B.

Feedback around the audio stages makes it easy to maintain low distortion. Adjustments are neither critical nor subject to small variations in tubes or other operating parameters. Feedback is applied to the Transmitter by means of two audio feedback circuits. The "primary" feedback, operating at the higher audio frequencies, is obtained from the modulation transformer primary, while the "secondary" feedback is obtained from the cathode of the PA (that is, virtually across the secondary of the Modulation transformer) and operates at the lower audio frequencies. This feedback at low audio frequencies keeps hum well below 60 db and reduces distortion.

The Modulator stage uses two Type 6427 triodes operating in Class B push-pull. The grids are coupled directly to the cathodes of the preceding stage. Grid bias for the Modulator tubes is obtained from a voltage divider across the -780 volt supply. The divider is so arranged that the adjustment of the third amplifier bias and the Modulator bias are independent of each other.

RF Amplifier Cubicle

Refer to Figs. 30 through 44.

The RF Amplifier cubicle houses the power amplifier stage, which employs two Type 6427 triodes in parallel, operating as a Class C amplifier. The output circuit consists of three sections: (1) an impedance transformer to transform any resistive impedance in the range of 50 to 230 ohms up to a resistance of 250 ohms; (2) a double-section pi filter operating at an impedance level of 250 ohms (one leg of the filter consists of a series-resonant trap tuned to the second harmonic of the carrier frequency); and (3) a pi tank circuit which transforms the filter impedance of 250 ohms up to 535 ohms required by the PA tubes. The loaded Q of this tank circuit varies from a value of 6 at the low-frequency end of the band to 12 at the high-frequency end.

Control System

The several functions of the control system include those of conveniently starting and stopping the Transmitter, properly maintaining the starting and stopping sequence, protecting the equipment from self-destruction, and protecting station personnel from accidental contact with the high-voltage circuits. The rear access doors of all three cubicles and the front doors of the Modulator and RF Amplifier cubicles are equipped with interlocks that remove the primary power from the rectifier transformers when the doors are open. These doors actuate switches that mechanically ground the high-voltage a-c and d-c buses. Quick-acting d-c overload relays and magnetically-operated a-c switches protect the equipment against electrical overload. If there is a plate circuit overload, two plate reclosures can occur before lockout; provision has been made for automatic reset if no more than two overloads occur in any 30-second period. The Transmitter will also recycle for power-line failures of less than two seconds. When operated by the Reflectometer, the lightning trip-circuit will trip the carrier at the buffer stage for a fraction of a second. It will also insure that the audio input will be shorted out before RF excitation is cut and that RF excitation is restored to normal before audio drive is resumed.

Power control to the individual power supplies can be exercised from the control chassis on the inner front panel of the Rectifier and Control cubicle.

For a detailed discussion of the control system, refer to the THEORY AND CIRCUIT ANALYSIS section.

Cooling System

Forced air is used for tube and cubicle cooling. The blower is located externally to the Transmitter. Air is drawn through filters in the roof of the Rectifier and Control cubicle, passes through the Modulator and RF Amplifier cubicles via openings in the side walls, and through the final tubes into the air duct and is exhaused by the blower. Some of the air bypasses the final tubes and cools the low-level audio and RF stages.

AC Power Supply Circuits

The Transmitter requires a three-phase power source of either 480, 2400, or 4160 volts at a frequency of 60 cycles per second. The input voltage specified affects the following components: the current-limiting reactor, plate disconnect switch, delta-wye switch, plate transformers, distribution transformers, and the distribution disconnect switch. These components differ in rating for the different input voltages, but are in all cases similar in their functions.

The incoming power line is terminated at the common junction of the distribution disconnect switches. Back-up protection for the plate circuit is provided by current-limiting fuses.

Vacuum switches perform the normal function of switching on the primary voltage to the plate transformers while also serving as very fast-acting circuit breakers. Tripping action is initiated by overcurrent relays in the secondary of the plate transformers. The current-limiting reactors restrict fault currents to approximately ten times normal operating current.

The distribution circuit is protected by current-limiting fuses, and the primary voltage is then stepped down by three transformers to a 208-volt, four-wire supply.

Drawings and Symbols

Drawing are titled, numbered, and listed in the front of this book.

Circuit components are indentified by two letters followed by a number. The first letter identifies the circuit in which the component is to be found. The circuits so identified include the following:

Letter	Circuit
A	Oscillator
B	Buffer
C	1st IPA
D	2nd IPA
E	PA
F	Harmonic filter

Letter	Circuit
G	-450 volt bias supply
H	Secondary feedback-circuit filter
J	Reflectometer
K	1st audio amplifier
M	2nd audio amplifier
N	3rd audio amplifier
P	Modulator
R	Modulator external equipment
S	500-volt supply
T	1500-volt supply
U	3500-volt supply
V	9000-volt supply
W	9000-volt external equipment
X	-780 volt bias supply
Y	Control circuit
Z	Distribution circuit

The second letter of the component symbol indicates the type of component: C for capacitor, R for resistor, K for relay, V for tube, and so on. The numerical suffix indicates the number of the component in the circuit. The symbol number AV1, for example, identifies tube 1 in the crystal oscillator circuit.

All parts are listed alphabetically by symbol numbers in the Parts List, which includes a description and drawing number for each.

Terminal board numbers are followed by a dash, and then the particular terminal number is given. (The component designation TB, it should be noted, is omitted on the elementary diagram to conserve space.)

All controls on the Transmitter are labeled with their names. All components in the Transmitter, wherever possible, are stamped with their symbols numbers and are similarly identified on drawings.

INSTALLATION

Unpacking

Inspect each package as it is received for possible shipping damage. Claims for damaged equipment must be filed against the carrier within ten days of delivery or the carrier will not accept the claim. When the equipment is delivered to the carrier by the General Electric Company, it becomes the property of the customer.

Check the equipment received against the packing list. The packing cases of all units are stenciled with a number. If there is a shipping error or if, because of damage, replacement equipment must be ordered, notify the General Electric Company representative.

The packing list designates the various boxes by number and the contents by name, symbol number, and drawing or model number to facilitate positive location and identification of all components.

All tubes and crystals are separately packed and identified on the packing list by type and symbol number to facilitate their correct location in the Transmitter. All loose items, such as contactor arms, are securely tied. Remove the fastenings and inspect such items for possible shipping damage. Any component which required the removal of screws, nuts, and any other hardware for disassembly has these either fastened to the component or to the mounting area in order to facilitate reassembly.

It is recommended that the Transmitter cubicles be permanently located before re-installing any of the components removed to facilitate shipping. The procedures for reassembly are covered in detail under Assembly of Components Removed for Shipment, below.

Handle crystals and electronic tubes with care.

If the Transmitter site has not been completed by the time the equipment is received, leave the units packed and place the boxes in a safe, dry place. This will prevent dust and dirt raised by sweeping, plastering, or drilling from settling into electrical components and causing serious maintenance problems later.

Location

Typical station layouts are shown in Figs. 45 and 46.

Locate the Transmitter in a well-ventilated room. Provide wiring ducts or conduit suitable for wiring between the Transmitter, transmitter racks, and the three-phase incoming power. It is not necessary, however, to lay the wiring before the equipment is in place.

Some of the factors to consider in planning a station are the following: (1) provision for incoming power supply lines, (2) good grounding connection, (3) proper transmission-line supports, (4) exits to the antenna, (5) adequate illumination, (6) sufficient space for the proper mounting of external equipment, and (7) sufficient space in front and at the rear of the Transmitter cubicles to permit opening and closing of the cabinet doors (the clearances required in the station layout are shown in Figs. 45 and 46).

Before locating the cubicles in their final positions, apply the adhesive-backed felt stripping supplied around and on the outside of the side-wall openings of the cubicles where they will join together to form an air stop. After this has been done the cubicles can be set in their positions, shimmed if necessary to level them, and then bolted together with the hardware provided.

Assembly of Components Removed for Shipment

The cubicles have been fairly extensively dismantled for shipment. It is important that all of the components that have been removed be re-installed and wired correctly before attempting to operate the Transmitter. The parts removed from the cubicles have been tagged with their symbol numbers. The hardware required for mounting them has been enclosed in a bag attached either to the component removed or to the mounting area. Wherever practicable, the cubicle has also been marked with the symbol number of the component removed to show its proper location. Photographs (Figs. 8 through 44) and Connection Diagrams (Figs. 47 through 56) are included in this book to show the location of parts. It should be noted that shipping fixtures used to provide firm support for elements left in the cubicles for shipment are tagged to indicate this. Remove and discard the shipping fixtures.

Refer to the Interconnection Diagram and Elementary Diagram, Figs. 57 and 58, to make certain that proper electrical connections have been made both for the components replaced in the cubicle and for the power components located externally to the cubicles.

RECTIFIER AND CONTROL CUBICLE

1. Transformers ZT4, ZT5, and ZT6

The filament transformers, ZT4 and ZT5, for the PA tubes as well as voltage-stabilizing transformer ZT6 are removed from the Rectifier and Control cubicle for shipment and are packed in boxes 2 through 4 (refer to the packing list). Their location in the cubicle is shown in Figs. 9 through 11 and Fig. 47. The hardware required to mount them is enclosed in a bag attached either to the transformer or to the cubicle supporting members designed to accomin the WYE position, close the disconnect switch, WS2. To check for resonance of the tank circuit, the PA PLATE TUNING capacitor, EC20, should be turned until a dip is indicated on the TOTAL PA PLATE current meter, EM5. The capacitor should then be turned slightly on the minimum capacity side (higher number on the tuning position indicator) of the dip. With a reading of 5 amperes on EM5, the output should be approximately 10 KW.

After the satisfactory completion of these adjustments, the Transmitter is ready for full-power operation.

FULL POWER TESTING

With the Transmitter turned off, switch off, switch the DELTA-WYE switch to the DELTA position. Switch on the Transmitter as before. Adjust the PA PLATE TUNING capacitor, EC20, for a reading of 8 amperes on the TOTAL PA PLATE current meter, EM5. For the setting of EC20 which will give maximum efficiency, refer to page 23 under PA Tank Circuit.

Adjust the MODULATOR BIAS and MODULATOR BALANCE controls for a reading of 200 ma on both the LEFT MODULATOR CATHODE meter, PM1, and the RIGHT MODULATOR CATHODE meter, PM2. Adjust the LEFT and RIGHT 3RD AMP BIAS controls for a reading of 100 ma on both the LEFT and RIGHT 3RD AMP ANODE meters, NM1 and NM2, respectively.

Audio may now be applied to the Transmitter. Feed a 1000-cycle tone to the input and increase the amplitude until 100% modulation is obtained. Meter readings should then be checked. The audio and RF stages are now ready for normal service.

Typical Meter Readings

Meter Marking	Meter	Selector Switch Position	Reading No Modulation	Reading 100% Modulation (1000 cps)
9000 V SUPPLY	VM1		9.0 kv	8.8 kv
3500 V SUPPLY	UM1		3.65 kv	3.6 kv
1500 V SUPPLY	TM1		1.55 kv	1.5 kv
500 V & BIAS SUPPLIES	SM1	500 V	0.5 kv	0.49 kv
		PA BIAS	0.46 kv	0.47 kv
		MOD BIAS	0.7 kv	0.68 kv
FILAMENT ELAPSED TIME	YM1		-	-
FILAMENTS	EM2	LEFT MOD	7.6 v	7.6 v
		RIGHT MOD	7.6 v	7.6 v
		LEFT PA	7.9 v	7.9 v
		RIGHT PA	7.9 v	7.9 v
AUDIO AMPLIFIERS	LM1	LEFT 1ST	6.4 ma	6.0 ma
		RIGHT 1ST	6.2 ma	6.0 ma
		LEFT 2ND	100 ma	100 ma
		RIGHT 2ND	100 ma	100 ma
LEFT 3RD AMP ANODE	NM1		100 ma	250 ma
RIGHT 3RD AMP ANODE	NM2		100 ma	250 ma
LEFT MODULATOR CATHODE	PM1		0.2 amp	3.5 amp
RIGHT MODULATOR CATHODE	PM2		0.2 amp	3.5 amp
RF EXCITER	DM1	OSC CATHODE	16 ma	15 ma
		BUFFER CATHODE	22 ma	21 ma
		1ST IPA GRID	12 ma	12 ma
		1ST IPA CATHODE	160 ma	160 ma
		2ND IPA GRID	210 ma	210 ma
2ND IPA PLATE	DM2		1.15 amp	1.10 amp

Meter Marking	Meter	Selector Switch Position	Reading No Modulation	Reading 100% Modulation (1000 cps)
PA GRID	EM1		0.9 amp	0.9 amp
LEFT PA CATHODE	EM3		4.55 amp	4.45 amp
RIGHT PA CATHODE	EM4		4.55 amp	4.45 amp
TOTAL PA PLATE	EM5		8.0 amp	7.8 amp
ANTENNA	FM1		-	-

Additional Control Circuit Checks

NOTE

The delay periods of the control relays have been set at the factory and do not normally require resetting. Should the relays get out of adjustment, the following are the instructions for resetting. The adjustments may be made with or without plate power being applied.

PLATE TIME-DELAY RELAY, YK6

The Transmitter should be operating for at least 10 minutes in order to stabilize the temperature of the relay. Operate the TRANSMITTER STOP-START switch to the STOP position and after three seconds return the switch to the START position. This effectively simulates a power failure of three seconds. If the 500-volt and bias supplies come on immediately, increase the value of YR1 by a clockwise motion of the screwdriver adjustment until a time delay of less than half a second occurs between the turning of the transmitter switch to the START position and the operation of the power supplies.

PLATE TIME-DELAY RELAY, YK15

Time-delay relay YK15 should be set for a delay of one second. This is the time elapsed between turning the PLATE SUPPLIES switch to the ON position and the actual presence of the voltage. The time delay is increased by turning the screw at the top of the relay clockwise.

CAPACITORS CHARGED TIME-DELAY RELAY, YK25

Relay YK25 controls the time between the application of the 9000-volt supply and the closing of the contactor which shorts the surge suppressor resistors. The delay may be noted by the time between the lighting of the 9000 V supervisory light and the CAPACITORS CHARGED supervisory light. A screw on top of the relay regulates this time. The delay should be between 1/3 and ½ second.

RESET TIME-DELAY RELAY, YK12

Relay YK12 controls the time between the occurrence of an overload and the resetting of stepping relay YK11. To note the timing of this relay, manually press the stepping relay armature of YK11 while the Transmitter is operating normally, thereby simulating an overload. Note the time delay between the overload simulation and the operation of the reset coil. The timing of this relay may be adjusted by a screw on top of the relay. The normal operating time is 30 seconds.

OVERLOAD RESET DELAY RELAY, YK14

This relay keeps the reset coils of the overload relays energized to make sure that all have been properly reset. The duration of operation of this relay may be timed by operating one of the overload relays manually (removing the cover and lifting the armature with an insulated screwdriver). When this is done, a buzzing sound will be heard, indicating that the reset coils of the overload relays are operating. The duration of this buzz is the duration of the delay of YK14. The screw on top of the relay adjusts the length of the delay. Check for normal delay time of half a second.

Tuning Instructions

The following is a description of the procedure for changing from one frequency to another, i.e., completely retuning the Transmitter. Plug in a pair of crystals of the desired output frequency.

Referring to TUNING DATA in the MAINTENANCE section, page 35, make the appropriate changes to the following components: BL2, CL4, DL4, DL5, EL1, EL7, EL9, FL1 and FL3, FL2 and FL4.

See that circuit breakers ZS3 through ZS11 are in the ON position.

Turn selector switch YS3 to the 500 V only position.

Move the TRANSMITTER STOP-START switch to the START position.

OSCILLATOR

The 500-volt supply comes on with the bias and filament voltages. Check that the oscillator plate current is approximately 16 ma by means of the RF EXCITER meter, DM1, and its associated switch, DS1.

BUFFER

With the RF EXCITER meter reading 1ST IPA GRID current, adjust the slug-tuned buffer tank coil, BL2, for a maximum reading. Adjust drive control BR10 for a reading of 20 ma. (The drive control should be re-checked later, when the Transmitter is operating normally, and readjusted, if necessary, for a reading of 12 ma, 1st IPA grid current.)

The frequency of the oscillator should now be checked on the station frequency monitor. The frequency of both controls should be adjusted by means of the frequency trimming capacitors, AC4 and AC5, for the left and right crystals respectively to within a few cycles of the desired frequency.

1ST IPA

The screen voltage to the 1ST IPA tube, CV1, has been set at the factory by adjusting the tap on resistor SR5 and should not need to be changed. The normal screen voltage is approximately 300 volts.

In order to tune the 1st IPA, make the following adjustments.

Move the supplies switch, YS3, to the 9000 V OFF position.

Change over the TUNE/OPERATE switches, DS2 and CS1 (located on the inner panel of the Modulator cubicle), to the TUNE position.

Disconnect the 3500 V B+ lead from the top end of the 2nd IPA plate choke, DL3. Disconnect the strap from the 2nd IPA blocking capacitor, DC6, to the tank coil, DL5. (The object of the last operation is to isolate the, as yet, untuned 2nd IPA neutralizing circuit from the 1st IPA tank circuit.)

Turn 1st IPA tank capacitor CC8 for maximum capacity (counterclockwise).

Switch on the plate supplies. Turn the RF EXCITER meter switch to read 2ND IPA GRID current. Turn 1st IPA tank capacitor CC8 clockwise until a maximum meter reading is obtained.

The 1ST IPA CATHODE current meter should now read approximately 100 ma, and the 2ND IPA GRID current meter, 30 ma.

The loading of this 1st IPA stage has been predetermined by following the tuning charts. If it is desired for any reason to change the loading, it may be increased by moving the tap towards the left and vice versa. Care should be taken not to increase the coupling too much as low efficiency will result. The loading cannot, however, be checked until the 2nd IPA stage is operating normally.

2ND IPA

Switch the plate supplies off.

Reconnect the strap from capacitor DC6 to tank coil DL5.

Turn the coupling coil in DL5 for minimum coupling, i.e., with the axis of the two coils at right angles.

Turn tank capacitor DC7 to maximum capacity.

Switch on the plate supplies.

Move the TUNE/OPERATE switch, CS1, in the 1st IPA stage to the operate position.

Turn the tank capacitor, DC7, out until a pronounced dip in the 2nd IPA GRID current occurs due to lack of neutralizing. A turn by turn change of the neutralizing capacitor, DC5, will minimize this dip. When the minimum has been reached, the stage is approximately neutralized.

Switch off the plate supplies.

Reconnect the 3500 V B+ lead to the plate choke, DL3.

Switch on the plate supplies.

Tune the second IPA tank capacitor through resonance and note the reading of the counter of the 2ND IPA PLATE TUNING capacitor when the plate current reaches minimum and again when the grid current reaches the maximum. If these two readings do not coincide, slightly turn the neutralizing capacitor, DC5, until they do. When this is achieved, the stage is perfectly neutralized.

Care should be taken to use as much inductance (DL4) and as little capacity (DC5) as possible since this gives the broadest bandwidth to the neutralizing circuit.

With the 2nd IPA tank circuit at resonance and with minimum coupling to the PA, tune the PA GRID capacitor for a maximum reading on the PA GRID CURRENT meter (starting from zero reading on the counter, indicating maximum capacity). This completes the tuning of the PA grid current and the control should not subsequently be moved.

Increase the coupling to the PA by moving the coupling coil of DL5 by small amounts, at the same time retuning the 2ND IPA PLATE TUNING for minimum 2ND IPA PLATE CURRENT until a minimum reading of 0.6 ampere plate current is reached.

Move the 2nd IPA TUNE/OPERATE switch (DS2) to the OPERATE position and readjust the loading and tuning approximately 1.2 amperes. Proper PA grid current is obtained with approximately 1.1 amperes of 2ND IPA PLATE CURRENT. (Later, when the PA plate voltage is switched on, the PA grid current will drop to approximately 0.9 ampere.)

If necessary, readjust the loading of the 1ST IPA stage to give a final reading of 160 to 200 ma as read on the 1ST IPA CATHODE current meter and 210 to 250 ma on the 2ND IPA GRID current meter.

PA

Switch off the plate supplies.

Reduce the loading of the PA by temporarily short-circuiting the loading capacitor (EC21) by connecting a strap from the bowl insulator to ground. (The reason for doing this is to obtain a sharp resonance point which makes neutralizing easier.)

Keep the selector switch, YS3, in the 9000 V OFF position. Switch on the plate supplies. Vary the PA PLATE TUNING until a sharp reaction is noted in the reading of the PA GRID current meter. Adjust the taps on EL7 and EL8 until reaction is at a minimum; the PA is now approximately neutralized.

Switch off the plate supplies.

Take off the short across EC21.

The Transmitter is now tuned except for the PA tank circuit. Begin further tuning from the transmission line terminal. Tune the Harmonic Filter first, followed by the PA tank circuit.

HARMONIC FILTER

With the transmission line connected to the output terminal of the Transmitter, proceed to tune the Harmonic Filter as follows:

1. Break the connection joining FL3 to FL2. With an impedance bridge connected across FC2, adjust FC2 for zero reactance. The resistance should be 250 ohms. If necessary, alter FL4, readjusting FC2 for zero reactance at each step until a value of 250 ohms is obtained. Disconnect the bridge.

2. Break the connection joining EL9 to EC21. With a suitable signal generator, apply a voltage at the second harmonic frequency across EC21. Adjust FC1 for minimum second harmonic voltage across the series combination of FL2 and FC1 as observed with a sensitive receiver connected at this point. Disconnect the signal generator and receiver. Reconnect FL3 to FL1 and FL2.

3. Connect the impedance bridge across EC21 and adjust FC2 for 350 ohms resistance and EC21 for zero reactance. Disconnect the impedance bridge and replace the connection joining EL9 to FL1 and EC21.

4. Break the connection joining EL8 and EC18 to EC19 and EL9. With the impedance bridge connected across EC19, adjust EC20 and EC21 for approximately 550 ohms resistance and not more than 250 ohms reactance. Disconnect the impedance bridge, and reconnect EL8 and EC18 to EC19, EC20, and EL9.

The harmonic filter is now correctly tuned and the tank circuit is approximately tuned.

PA TANK CIRCUIT

To finalize the PA tuning proceed as follows: Move the DELTA-WYE switch to the WYE or low-voltage position.

Turn the selector switch, YS3, to the OPERATE position. Switch on the plate supplies.

Tune the PA PLATE TUNING capacitor, EC20, to resonance as indicated by a dip in the PA PLATE current meter. The reading should be 4.3 to 4.5 amperes. If the reading is too low, increase the loading by moving the PA PLATE LOADING switch to the INCREASE position for a few seconds. Retune the PA PLATE TUNING to resonance and check the current. Repeat this procedure until the correct current is obtained. If, however, the plate current is too high, DECREASE the loading.

Check the neutralizing by noting the reading on the PA PLATE TUNING counter when the PA PLATE CURRENT is at a minimum and again when the PA GRID CURRENT is at a maximum. The minimum and maximum should occur at the same counter reading. If it does not, change the tap on EL8 a few turns at a time until coincidence is obtained.

Before switching to high power it is advisable at this point to make a check of the system. An estimate should be made of the efficiency of the PA. The power output can be measured by means of the antenna current meter, and the efficiency calculated as follows:

$$\text{PA Efficiency} = \frac{I_a^2 R}{E I} \times 100\%$$

Where I_a is antenna current
R is resistance of antenna
E is PA plate voltage
I is PA plate current

The efficiency must be between 65 and 75 percent.
Switch off the plate supplies.
Turn the DELTA-WYE switch to the DELTA or high-voltage position.
Switch on the plate supplies.
Proceed as follows and obtain optimum efficiency from the PA.

Reduce the PA loading in small steps, and at each step adjust the PA tuning to the point on the low capacity side of resonance (that is, clockwise or to the higher numerical reading of the counter) which gives 8.0 amperes of PA plate current. Record the RF line current at each step. The RF current will initially increase and then decrease. Choose settings of EC20 and EC21 that give the maximum RF line current, that is, maximum power output. This is the point of highest efficiency because the power input is held constant during the tuning procedure.

An over-all plate efficiency of at least 72 percent should be obtained when operating into a dummy load. If the power input has to be increased for operating into a directional antenna, the plate efficiency may decrease to approximately 70 percent.

Routine Operation

STARTING PROCEDURE

1. Move the TRANSMITTER STOP-START switch to the START position.
2. Move the PLATE SUPPLES switch momentarily to the ON position. The Transmitter will switch on and be in full operation in about 20 seconds.

STOPPING PROCEDURE

1. Move the PLATE SUPPLIES switch momentarily to the OFF position.
2. Move the TRANSMITTERS STOP-START switch to the STOP position.

All supplies will be switched off except the blower which will continue to run for five minutes.

The crystal heating supply is independent of the Transmitter control circuit and must remain connected.

THEORY AND CIRCUIT ANALYSIS

RF Circuits

CRYSTAL OSCILLATOR

The crystal oscillator and buffer amplifier are housed in a separate shielded compartment in the Exciter and Modulator cubicle. The oscillator stage uses one Type 6146 tube (AV1) in an electron-coupled Colpitts circuit. Two low temperature-coefficient crystals in individual Thermocells (AY1 and AY2) are provided, either of which may be switched into the circuit by the solenoid operated switch, AS1. This switch may be operated remotely, or locally by the CRYSTAL CHANGE push button, AS2. Supply voltage for the crystal heaters is normally obtained from the station lighting supply (115 volts, 50/60 cps) and is usually left on continuously to maintain the crystals in a ready condition. The amber supervisory lights, AI1 and AI2, indicate which crystal is in operation. The white supervisory lights, AI3 and AI4, in series with the heating elements of their associated Thermocell, show the normal heating cycle of the Thermocells by flashing on and off. When Thermocell AY1 is in use, trimmer capacitor AC4 provides a few cycles of frequency adjustment. Similarly, capacitor AC5 is the trimmer when AY2 is is use. The plate of tube AV1 has a resistive load and RF is coupled through capacitor AC9 to the grid of the buffer stage. The cathode current of the oscillator tube is measured by the RF EXCITER meter, DM1, when the RF EXCITER selector switch, DS1, is switched to the OSCillator CATHODE x 50 position.

BUFFER AMPLIFIER

The buffer stage uses one Type 6146 tube (BV1) and serves three functions:

1. Provides isolation of the oscillator stage for high frequency stability.
2. Drives the 1st IPA stage.
3. Provides a means by which the carrier may be interrupted.

The plate load of BV1 is a conventional paralled-resonant circuit, consisting of fixed capacitors BC6 and BC7 and a slug-tuned coil, BL2. A few turns are coupled with this coil to supply a signal to the frequency monitor. Drive to the 1st IPA stage is adjusted by a variable resistor BR10 which varies the screen voltage of tube BV1. Cathode current is measured by the RF EXCITER meter, DM1, when switched to the BUFFER CATHODE x 50 position. Resistor BR8 is normally shorted out by carrier trip relay YK29. When this relay operates, the contacts open and BR8 is placed in series with BR9, BR7, and BR12 across the 500-volt, B+ supply. In this condition there is cathode bias of about 100 volts across BR8 which cuts off the tube completely, thus interrupting the carrier.

FIRST INTERMEDIATE POWER AMPLIFIER

The 1st IPA uses a high-gain tetrode tube, Type 6156 (CV1), operating in Class C with fixed bias on the grid. This fixed bias, which is obtained from the Modulator bias supply through resistor CR2, assures complete elimination of the carrier when the carrier trip-relay operates. Grid current is measured by the RF EXCITER meter, DM1, when switched to the 1ST IPA GRID x 20 position. Cathode current is measured by the same meter when switched to the 1ST IPA CATHODE x 500 position. The TUNE/OPERATE switch, CS1, shorts out resistor CR7 when it is in the OPERATE position. For tuning purposes CS1 is opened so that sufficient cathode bias is introduced to limit the plate dissipation of tube CV1 until tuning is completed. Screen voltage is obtained from the 500-volt supply through a tapped resistor, SR5. The normal operating voltage is 300 volts, but this value may vary, since screen current is very sensitive to plate tuning. The plate load is a conventional shunt-fed parallel-resonant circuit. Tuning is accomplished by variable capacitor CC8, the control of which is labeled 1ST IPA PLATE TUNING. Plate voltage is obtained from the 1500-volt supply through the choke, CL3. Coupling to the next stage is achieved by means of a preset tap on coil CL4.

SECOND INTERMEDIATE POWER AMPLIFIER

The 2nd IPA stage uses a neutralized triode tube, Type 6623 (DV1), operating in Class C and provides drive for the PA stage. Bias for DV1 is supplied by resistors in the cathode circuit plus a small amount of additional bias obtained by means of the grid leak resistor, DR4. Grid current is measured by the RF EXCITER meter, DM1, when switched to the 2ND IPA GRID x 500 position. Cathode current is measured by a separate 2ND IPA PLATE meter, DM2. The plate circuit is a conventional shunt-fed parallel-resonant circuit consisting of capacitor DC7 and coil DL5. Plate voltage is obtained from the 3500-volt supply through a winding of transformer PT1. This enables the drive to the PA stage to be modulated approximately 10% by partially plate-modulating the 2nd IPA stage. This aids in reducing distortion by improving the linearity of the PA stage. Plate tuning of the 2nd IPA is achieved by variable capacitor DC7, the control of which is labeled 2ND IPA PLATE TUNING. Feedback from the plate to the grid circuit is neutralized by adjustment of coil DL4 and the small trimmer capacitor, DC5, so that parallel resonance is obtained. When neutralizing, it is desirable to keep the capacity of DC5 at a minimum while aiming for as high a value of inductance as possible with DL4. In this way, the neutralizing circuit assumes broader band characteristics and is, therefore, more stable in operation. The TUNE/OPERATE switch, DS2, shorts out resistors DR7 and DR8 in the OPERATE position. For tuning purposes DS2 is opened so that sufficient cathode bias is developed across DR7 and DR8 to limit the plate dissipation of tube DV1 while tuning. Coupling to the PA stage is by means of a coaxial cable connecting the center winding of the variometer coil, DL5, to a tap on the PA grid coil, EL1.

POWER AMPLIFIER

The Power Amplifier stage uses two Machlett Type ML-6427 triodes (EV1 and EV2) in parallel operating as a Class C amplifier. The grid circuit is tuned by coil EL1 and variable capacitor EC1, the control of which is labeled PA GRID TUNING. Drive to the grid of EV1 is applied through blocking capacitor EC3. Similarly, the grid of EV2 is fed through EC2. Grid-leak bias is used, EL2 and EL3 being the feed chokes, with RF bypassing achieved by EC10, EC12, EC11, and EC13. Cathode currents are individually monitored by meters EM3 (LEFT PA CATHODE) and EM4 (RIGHT PA CATHODE), and equalization is achieved by PA BALANCE potentiometer ER9. Grid current is measured by PA GRID meter EM1, and total plate current is measured by TOTAL PA PLATE meter EM5. The tube filaments are bypassed to RF by capacitors EC6, EC7, EC8, and EC9. Overload relays YK18 and YK19 will operate if cathode currents are too high. EL7 and EL8 provide coil neutralization of the PA stage, coarse adjustment being made by EL7 and fine adjustment by EL8. The plate supply voltage is fed through RF choke EL6 which is decoupled by EC4 and EC5. Blocking capacitors EC17 and EC18 couple the modulated RF output to the output circuit, which consists of the following three sections:

1. An impedance transformer, consisting of FL4 and FC2, to transform any resistive antenna impedance in the range of 50 to 230 ohms up to a resistive impedance of 250 ohms as seen at FC2.

2. A double-section pi filter, operating at an impedance level of 250 ohms and consisting of variable capacitors EC21 (PA LOADING), FC1, and FC2, together with coils FL1, FL2, and FL3. FL2 and FC1 constitute a series-resonant trap tuned to the second harmonic of the carrier frequency.

3. A pi tank circuit, consisting of EC19, EC20 (PA PLATE TUNING), coil EL9, and EC21 which transforms the filter impedance of 250 ohms up to 535 ohms required by the PA tubes. The loaded Q of this tank circuit varies from a value of 6 at the low-frequency end of the band to 12 at the high-frequency end.

Audio Circuits

The purpose of the audio circuits is to amplify the incoming audio signal from a level of 10 ± 2 dbm at 600 ohms impedance to a level sufficient to modulate the Power Amplifier. The following description will cover the 1st audio amplifier (tubes KV1 and KV2), 2nd audio amplifier (tubes MV1 and MV2), 3rd audio amplifier (tubes NV1, NV2, NV3, and NV4), the modulator (tubes PV1 and PV2), and the feedback circuit.

FIRST AUDIO AMPLIFIER

The audio input terminals are numbers 18 and 20 on terminal board KTB3, located in the bottom left-hand corner of the Exciter and Modulator cubicle. The signal is fed through an 8-db isolating pad consisting of KR1, KR2, KR3, KR4, and KR5 to the input transformer, KT1. Networks between KT1 and the grid of tube KV1 form part of the feedback circuit, which will be described later. The first audio amplifier tubes, KV1 and KV2, are Type 6136 pentodes connected to form a "Schmidt" circuit having a large resistance common to both cathodes. The single-ended input to the grid of KV1 results in a balanced push-pull signal at the plates. A hum-bucking voltage derived from the filament transformer, KT2, is applied to the grid of KV2. The amplified audio signal is resistance-capacity coupled to the grids of the next stage. The network consisting of KR25, KR26, KC13, and KC14 across the output of the first stage controls the phase shift at the higher audio frequencies, providing a smooth drop in the response and singing-free operation of the feedback circuit. Inductors KL1 and KL2 provide a slight lift in the response in the region of 10 kc to compensate for falling off in the response in succeeding stages. The plate current of tubes KV1 and KV2 is measured across resistors KR27 and KR28 by means of the AUDIO AMPLIFIER meter, LM1, when the AUDIO AMPLIFIER selector switch, LS1, is in the LEFT 1ST x 20 or RIGHT 1ST x 20 position. The plate voltage of 300 volts is obtained from the 500-volt supply through dropping resistor SR1.

SECOND AUDIO AMPLIFIER

The second audio amplifier, using two Type 6156 tetrode tubes (MV1 and MV2) in a resistance-capacity-coupled circuit, amplifies the audio signal to the voltage level required to drive the Modulator tubes. Cathode bias is adjusted by variable resistors MR3 and MR4, so that the plate current of each tube can be set at 100 ma. Controls for MR3 and MR4 are labeled LEFT 2ND AMP BIAS and RIGHT 2ND AMP BIAS. The cathode currents are measured across shunt resistors MR11 and MR12 by the AUDIO AMPLIFIER meter, LM1, when switched to the LEFT 2ND x 20 or RIGHT 2ND x 20 position. The cathode bypass capacitor, MC1, prevents the application of cathode feedback. Screen voltage is obtained from the 500-volt supply through tapped resistor SR4. Plate voltage is obtained from the 3500-volt supply and is metered by the 3500 V SUPPLY meter, UM1.

THIRD AUDIO AMPLIFIER

This stage uses four Type 304TL triode tubes (NV1, NV2, NV3, and NV4) connected as a parallel push-pull cathode follower circuit. Its purpose is to transform the high-impedance signal appearing at the plates of the preceding stage into a low-impedance signal to drive the grids of the Modulator tubes operating in Class B. Grid bias for tubes NV1 and NV2 is obtained from the LEFT 3RD AMP BIAS potentiometer, PR2. Similarly, bias for tubes NV3 and NV4 is fed from the RIGHT 3RD AMP BIAS potentiometer, PR3. Transformer PT1 has two primary windings, one in the cathode circuit of tubes NV1 and NV2 and the other in the cathode circuit of NV3 and NV4. PR44 and PR45 are damping resistors connected across these windings. This transformer is used to provide partial modulation of the plate supply to the 2nd IPA tube, DV1, as mentioned earlier. The cathodes of tubes NV1 and NV2 are connected directly to the grid of the modulator tube, PV1. Similarly, the cathodes of NV3 and NV4 are connected directly to the grid of PV2. Plate voltage is obtained from the 1500-volt supply. The total plate current of NV1 and NV2 is measured by the LEFT 3RD AMP ANODE meter, NM1, while the RIGHT 3RD AMP ANODE meter, NM2, measures the total plate current of NV3 and NV4. These meters are also used to measure the grid current of the modulator tubes in the following manner. With no AF input signal, the currents through NM1 and NM2 are adjusted to 100 ma each. With maximum AF signal input providing 100% modulation, these plate currents increase to 250 ma each. The difference of 150 ma is the grid current of each modulator tube.

MODULATOR

This stage utilizes two Machlett Type ML-6427 triodes (PV1 and PV2) operating in Class B push-pull. The grids are connected directly to the cathodes of the previous stage. Grid bias for PV1 and PV2 is obtained from the voltage divider across the -780 volt supply. This divider is so arranged that interference between the 3rd audio amplifier bias adjustment and the modulator stage bias adjustment is at a minimum. The total plate current of the modulator is adjusted by the MODULATOR BIAS control, PR9, while individual plate currents are balanced by the MODULATOR BALANCE controls, PR1 and PR28, and measured by LEFT MODULATOR CATHODE meter PM1 and RIGHT MODULATOR CATHODE meter PM2. Between the cathodes of the mdoulator tubes and ground, current flows through the following circuits: meters PM1 and PM2, transformer ZT8, overload relays YK20 and YK21, and telemetering resistors PR42 and PR43 (used when the Transmitter is remotely controlled). Across the overload relays and transformer ZT8 are two resistors, PR40 and PR41. These resistors damp out any AF resonance which might develop across the overload relay and transformer at high audio frequencies. The transformer (ZT8) prevents the passage of low-frequency audio signals through the overload relays, thus ensuring that the operation of YK20 and YK21 is independent of audio frequencies. These overload relays are set to operate at 4.5 amperes, which provides protection of the modulator tubes from overdissipation yet allows for occasional heavy bursts of modulation. Capacitors PC1, PC2, PC3, and PC4 bypass the tube filaments, which are heated in phase. The plate supply voltage is fed to the plates from the 9000-volt supply through the center tap of the modulation transformer, RT1. The transformer windings are protected by thyrite arrestors RE2, RE3, and RE4, consisting essentially of a spark gap in series with a thyrite resistor. Resistors PR32 through PR39 and capacitors PC9 through PC12 are connected across the primary of the modulation transformer to damp out resonances above 20 kc, thus preventing any possibility of "singing" in the feedback network. The secondary of RT1, in series with the blocking capacitors, RC1 through RC4, is connected between the d-c high-voltage supply to the PA tubes and ground. The plate voltage to the PA tubes is fed through the modulation reactor, RL1, which is protected by the thyrite arrestor, RE1. Meter VM1, located on the front of the Rectifier and Control cubicle, measures the d-c plate voltage to the PA stage.

FEEDBACK CIRCUIT

Feedback is applied to the Transmitter by means of two circuits. The "primary" feedback, operating at the higher audio frequencies, is obtained from the modulation transformer primary, while the "secondary" feedback is obtained from the cathode of the PA and operates at the lower audio frequencies.

1. The Primary Circuit

Because of the very tight coupling between the two halves of the modulation-transformer primary winding, feedback need be taken from one half of the primary only. A voltage divider network, consisting of resistors PR10, PR17, and PR26 and capacitors PC5, PC6, PC14, and PC15, is connected between the plate of tube PV1 and ground. The voltage developed across PR26 and PC15 is injected into the grid circuit of tube KV1 through a step circuit consisting of KC1, KC2, and KR8, applying 10 db feedback. The step circuit reduces the amount of feedback below 1000 cps.

2. The Secondary Circuit

In order to obtain a sample of the audio voltage modulating the PA, the PA cathode current goes to ground via two resistors, HR1 and HR2, in parallel. This voltage is fed back to the audio input via two high-frequency, step attenuating circuits to provide negative feedback at low audio frequencies. Resistors KR14, KR15, and KR16 and capacitor KC5 form one step circuit, and KR12, KR13, KC3, and KC4 form the other. At 250 cycles the feedback is 10 db.

A filter circuit consisting of coils HL1 and HL2 and capacitors HC1 through HC6 is inserted between resistors HR1 and HR2 and prevents RF appearing at the low-level audio amplifier stages.

Resistor KR17 and capacitor KC9 at the grid of KV1 reduce the amplifier gain at very low frequencies and provide a smooth change of phase so that complete stability is ensured.

AC and DC Power Supply Circuits

AC SUPPLY CIRCUITS

The Transmitter requires a three-phase source of power at either 480, 2400, or 4160 volts, and a frequency of 60 cps. The supply specified affects the following components:

Current-limiting reactor ZL1
Disconnect fuses WF1, WF2, and WF3 and switch WS2
Delta-wye switch WS1
Plate supply transformers WT1, WT2, and WT3
Distribution transformers ZT1, ZT2, and ZT3
Distribution fuses ZF1, ZF2, and ZF3 and switch ZS12

These components, mounted externally to the Transmitter, differ in rating for the different voltages, but their functions are, in all cases, the same.

The incoming power line goes to both the plate disconnect switch, WS2, and the distribution disconnect switch, ZS12.

The plate circuit is protected by current-limiting fuses WF1, WF2, and WF3 and current-limiting reactor WL1. The special function of the latter is to limit the short-circuit current drawn by the Transmitter, in the event of a severe fault, to a value well within the maximum rating of the components.

WK1, WK2, and WK3 are vacuum switches which perform the normal function of switching on the primary voltage to the plate transformers.

The distribution circuit is protected by current-limiting fuses ZF1, ZF2, and ZF3. The primary voltage is then stepped down by means of transformers ZT1, ZT2, and ZT3 to a 208-volt, four-wire supply which is run into the Transmitter to terminal board ZTB5. The supply is distributed from ZTB5 to the control circuit through breaker ZS3, to the blower through ZS4, to the filament supply through ZS5, to the 1500- and 3500-volt supplies through ZS6, to the 500-volt supply through ZS7, to the Modulator bias supply through ZS9, and to the PA bias supply through ZS10.

Power for the tube filaments is applied by the filament contactor, YK4. A single-phase supply is regulated by a stabilizing transformer, ZT6, and supplies power to the Modulator tubes. From the same transformer, through circuit breaker ZS11, all low-power tube filament transformers are energized. In addition, the three-phase supply from contactor YK4 is taken to a Scott-connected auto-transformer, ZT7. The two outputs from ZT7 are fed to two stabilizing transformers, ZT4 and ZT5, which supply the filaments of the PA tubes, EV1 and EV2, respectively, with the filament voltages 90 degrees out of phase. Transformers ZT4, ZT5, and ZT6 not only provide a very stable source of voltage but also serve as current-limiting devices when switching on the power to the filaments of the output tubes.

A 115-volt a-c supply is run into the Transmitter to heat the thermostatically controlled crystal ovens. This supply is preferably obtained from the same source as the building lighting. The reason for this is that the main supply to the Transmitter may be disconnected for servicing the Transmitter without interrupting the heating of the crystals.

Two indicating fuses, AF1 and AF2, are provided in the Transmitter for the protection of the 115-volt supply.

DC SUPPLY CIRCUITS

All bias and plate supplies are provided by three-phase, full-wave germanium rectifier circuits.

1. The 500-Volt Supply

The supply voltage to rectifier SCR1 is obtained via circuit breaker ZS7, relay YK8, and plate transformer ST1. Resistor SR6 across the filter reactor, SL1, eliminates any voltage transients produced by the reactor. The d-c voltage is measured by the 500 V & BIAS SUPPLIES meter, SM1, when the slector switch, SS1, is in the 500 V position. The oscillator and buffer stages require 500 volts, and 300 volts are supplied via dropping resistor SR1 to the plates and screens of the 1st audio amplifier. The screens of the 2nd audio amplifier are fed from tapped resistor SR4, while the screen grid of the 1st IPA is fed from tapped resistor SR5.

2. The 1500-Volt Supply

This circuit provides plate voltage for the 1st IPA and the 3rd audio amplifier. The large filter capacitors, TC1, TC2, and TC3, provide the low-impedance source needed by the latter stage. Overcurrent protection is provided by overload relay YK16. The voltage is measured by the 1500 V SUPPLY meter, TM1.

3. The 3500-Volt Supply

Plate voltage for the 2nd IPA and 2nd audio amplifier is supplied from this circuit. Twelve germanium rectifier stacks provide the required d-c voltage, which is measured by the 3500 V SUPPLY meter, UM1. Circuit protection is provided by the overload relay, YK17, in the ground lead and also by the circuit breaker, ZS6. The primary current of the 1500-volt supply is also carried by this circuit breaker, but since this current drain is small compared to that drawn by the 3500-volt supply, the effect of the 1500-volt supply is negligible. The germanium rectifiers, UCR1 through UCR12, are provided with forced-air-cooling to provide an extra safety factor for these rectifiers. Operator protection is provided by safety grounding switches YS13, YS14, and YS17. These are connected to those doors which, on being opened, would give access to either 1500 or 3500 volts. Should a door be opened, an immediate short circuit is connected across the power supply, irrespective of the functioning of the control circuit.

4. The Modulator Bias Supply

This supply provides bias voltage for the 1st IPA tube, the 3rd audio amplifier, and the Modulator. The output voltage is adjusted by the MODULATOR BIAS control, PR29, and is measured by the 500 V & BIAS SUPPLIES meter, SM1, when selector switch SS1 is switched to the MOD BIAS position. Potentiometers PR1 and PR28 are ganged and form the MODULATOR BALANCE control. PR2 (LEFT 3RD AMP BIAS) and PR3 (RIGHT 3RD AMP BIAS) adjust the 3rd audio amplifier. The supply is protected by circuit breaker ZS9 in the primary of transformer XT1.

5. The PA Bias Supply

The purpose of this circuit is to provide protective bias for the PA tubes when there is no RF drive to the final stage. With normal operation, self-bias is obtained for the final RF stage from resistors ER1 through ER6. When the carrier trip circuit cuts the drive to the PA, the PA tubes will be provided with a bias of about 400 volts, which will hold the PA plate current within the maximum dissipation rating of the tube plates. With normal drive to the PA stage, this power supply plays no part in Transmitter operation and for this reason it is not necessary to filter the rectified output. The d-c output voltage is measured by the 500 VOLT & BIAS SUPPLIES meter, SM1, when selector switch SS1 is switched to the BIAS position.

6. The 9000-Volt Supply

This circuit provides plate voltage for the Power Amplifier and Modulator. The delta-wye switch, WS1, is in the primary of the three plate transformers, WT1, WT2, and WT3. The purpose of this switch is to connect the supply to the plate transformers either in wye or delta. For tuning operations, the wye connection provides approximately 58% of the full plate voltage. The transformers are protected against transients and surges by thyrite arrestors WE1, WE2, and WE3. Between the transformer secondary windings and the rectifiers two of the lines pass through current transformers (VT1 and VT2), which in turn operate two overload relays (YK22 and YK23) should an overload occur. These fast-acting relays in turn operate vacuum contactors WK1, WK2, and WK3. The rectifier section consists of 42 diodes series-connected in each leg of the three-phase, full-wave circuit. Across each individual diode is a capacitor, the purpose of which is to equalize the distribution of any transient voltages that might appear across the rectifiers. The filter reactor, WL1, is protected against the generation of voltage surges across it by resistors VR8 through VR15. Filter capacitors VC1, VC2, VC3, VC4, VC257, and VC258 are not connected to ground immediately upon starting but through two resistors, VR1 and VR2, in order to limit the charging current through the rectifiers when first switching on. After half a second VR1 and VR2 are shorted out by vacuum switch VK1. The safety grounding switches, YS13, YS14, YS15, YS16, and YK20 are fitted on the doors of the appropriate cubicles. Should the doors be opened, the appropriate switch immediately short-circuits any live plate supply circuits.

Control Circuits

SEQUENCE

Power to the control circuit is fed through ZS3, contacts 1-5 of YK26 and 1-5 of YK27. Supervisory light YI1 indicates that the control circuit bus has been energized. If either of the two phases controlling YK26 and YK27 fails, the power to the control circuit will be shut off.

The Transmitter is started by closing the lever-key switch, YS1. This operates YK1, energizing YK3, which in turn controls blower ZB1 if ZS4 is closed. Contacts 2-6 of YK1 energize contactor YK4 when air-flow switch YS2 closes. At the same time, YI2 is energized, indicating that the air flow switch is closed. YK4 energizes all filaments as well as the filament interlock relay, YK5.

Contacts 1-5 of YK5 energize the filaments supervisory light, YI3, and the FILAMENT ELAPSED TIME meter, YM1. At the same time, the filament time-delay relay, YK6, is energized and after 10 seconds its contacts 5-7 close, energizing YK7, which locks in through its contacts 1-5. An auxilary contact on YK7 inserts YR1 in series with the heater of YK6, so that in the event of power failure the filament time-delay relay will provide a delay proportional to the length of time the power is off. The heater of YK6 will, however, not be so hot that there will be no time delay after a power failure of more than 3 seconds duration. YI4 indicates that all of the door interlocks are closed, and YK7 is operated as described above, its contacts 2-6 energizing supervisory light YI5 and the coil of YK8, the 500-volt supply contactor. This supply will come on, provided that ZS7 is closed.

For the purposes of this part of the discussion, it will be assumed that YS3 is in the OPERATE-RECYCLE position. Under these conditions switch contacts 21 and 25 of YS3 are connected, 31 and 35 are connected, 41 and 45 are connected, and 51 and 55 are connected. YK9 is energized through YS3-21-25. This energizes the bias supplies through ZS9 and ZS10. BIAS supervisory light YI6 is energized indicating that the bias is on. If YK10 has previously been set in the latch position, power will flow through contacts YK10-7-6, YK11-3-4, and contacts 2-6 of YK14 energizing YK15. YK15 is a time-delay relay and when its cycle is completed, power flows through its contacts 5-1 to energize YK13 through contacts 5-7 of YK17 and YK16, the 3500-volt and 1500-volt supply overload relays.

YK13 energizes the 3500-volt supply, provided that ZS6 is closed. It also energizes supervisory light YI8 through its contacts 7-8 which indicates that the 3500-volt supply is on. Power flows through YS3-51-55 to YCR1 through surge-limiting resistors YR4 and YR5. YCR1 energizes contactors WK1, WK2, and WK3 for the 9000-volt supply through contacts 3-2 of YK10 and contacts 5-7 of overload relays YK18, YK19, YK20, YK21, YK22, and YK23.

When contactors WK1, WK2, and WK3 have operated the circuit through their auxiliary contacts 4-5, they energize supervisory lights YI11, YI12, YI13, YI14, and YI19. These contacts also energize the coil of YK25. YK25 is a time-delay relay that allows the filter capacitors to become fully charged through resistors VR1 and VR2 before operating high-voltage contactor VK1. YK25 also delays the application of voltage to the 1500-volt supply through YK28. Through its auxilary contacts 5-4, VK1 energizes supervisory light YI10.

It should be noted that when the Transmitter is operating, all of the supervisory lights that appear in a row on the Exciter and Modulator cubicle door (YI1 and YI10) are illuminated.

When the plate contactors, WK1, WK2, and WK3, are de-energized, their contacts 2-3 energize supervisory lights YI15, YI16, YI17, and YI18.

When control circuit breaker ZS4 is closed, power is immediately available to operate the crystal stepping switch, AS1. This is a rotary solenoid-type switch that is energized by pushing AS2, which transfers the oscillator circuit from one crystal to the other. Supervisory lights AI1 and AI2 indicate which crystal is being used.

PLATE-ON SWITCH

When ZS3 is closed, power is available at YS4, YS5, YS6, and YS7 to operate the plate power relay, YK10. This relay may be electrically latched or tripped by any of the above four switches. Note that YK10 is a latching type relay and will, therefore, not be affected by power failures.

BLOWER TIME-DELAY CIRCUIT

In order that the tubes may be properly cooled off on shutdown, time-delay relay YK2 is provided. On starting the Transmitter, YS1 is closed, energizing YK1. In addition to energizing the blower contactor YK3, YK1 interrupts circuit breaker YK2 through contacts YK1-3-10. On turning off the Transmitter by opening switch YS1, YK1 drops out, but YK3 is held in by its contacts 7-8 and by YK2-3-5. The timing coil of YK2 is now energized through YK1-3-10. After it has timed out, its contacts 5-3 will open, releasing blower contactor YK3. When YK3 drops out, its contacts 7-8 will open, deenergizing the coil of YK2, which then resets.

TUNING MOTOR

When YS1 is closed, energizing YK1, it also provides power for operating tuning motor

EB1 on the output loading capacitor, EC21. This is controlled by the RAISE-LOWER switch, ES1.

SEQUENCE SELECTOR SWITCH YS3

During tune-up or trouble-shooting it is convenient to interrupt the control operation sequence at various points. This is done by sequence selector switch YS3. This switch has four positions, as follows:

1. 500 V(olts) ONLY

When YS3 is in this position, contacts 11-12 are closed, and the front door interlock for the Exciter and Modulator cubicle is shorted out. At the same time, contacts 21, 31, 41 and 51 are all open, and no voltage can be applied to any but the 500-volt supply.

2. 9000 V(olts) OFF

When YS3 is in this position, contact 11 is open-circuited, contact 21 is connected through 23 to energize YK9 and subsequent parts of the control circuit, so that the bias supplies, the 1500-volt, and the 3500-volt supplies may be energized. Contacts 31-33 complete the circuit from the "on" side of switches YS4, YS5, YS6, and YS7, so that in the event of an overload relay being tripped, it may be electrically reset by the operation of one of these switches. YS3-41 is still open-circuited, and YS3-51 connects to YS3-53 to energize YK25. When YK25 times out, it energizes YK28 and supplies the 1500-volt supply with power after the starting surge for the 3500-volt supply has been dissipated. Under this condition no power is supplied to rectifier YCR1, and high-voltage supply contactors WK1, WK2, and WK3 will not be operated.

3. OPERATE

When in this position, YS3 contacts 11 and 41 are open-circuited. YS3-21-24 are connected, YS3-31-34 are connected, and YS3-51-54 are connected. In the event of an overload, the overload relays must be electrically reset by the operation of YS4, YS5, YS6, YS7 as described above. YS3-5-54 energizes rectifier YCR1, and the control circuit will operate normally with the 9000-volt supply coming on after YK13 has closed. YK25 will not start to time out until high-voltage contactors WK1, WK2, and WK3 have all been energized. When it times out, the 1500-volt supply contactor, YK28, will operate, and resistor-shorting contactor VK1 will also be operated.

The following describes the overload reset circuit, a non-recycling operation with YS3 in position 3. When an overload relay is tripped, YS3 contacts 5-7 will open and contacts 1-3 will close. The open contacts will interrupt the circuit to the corresponding contactor or contactors, that is, YK13 or WK1, WK2, and WK3. Contacts 1-3 will complete the circuit to the coil of YK14. This will cause YK15 to drop out, since it will no longer receive energy through contacts 2-6 of YK14. YK14 contacts 3-5 will close, connecting the electrical reset coils of all overload relays through terminals 31 and 45 of YS3. With YS3 in position 3, contacts 31-34 are connected and from there the circuit is connected to the "on" side of switches YS4, YS5, YS6, and YS7. Nothing will happen until one of these switches is operated. When it is operated, it will reset the relay or relays, YK14 will be de-energized, and the circuit will be restored to normal operating condition.

4. OPERATE RECYCLE

When YS3 is in this position, contact 11 is open-circuited, and contacts 21-25, 31-35, 41-45, and 51-55 will be connected. Under these conditions the operation of the control circuit will be that described above, except that now YK11 will operate to reset the overload relays after an overload. It will automatically reset if there are not more than two overloads occurring in a 30-second period. On the third such overload YK11 contacts 3-4 will open and will stay open until reset by the operation of the plate supply switches.

The operation is as follows: The overload relay will operate closing its contacts 1-3, operating YK14. The overload reset coils will be connected through YK14-3-5 to YS3-31 and -45. YS3-31 is connected to YS3-35, which in turn connects to the step coil of YK11. YS3-45 connects through YS3-41 to YK15, and when YK15 releases (by the operation of YK14), contacts 3-5 close, and power is automatically applied to the overload reset coils and the step coil of YK11. This resets the overload relay, de-energizes YK14, and in turn re-operates YK15, restoring the main part of the control circuit to normal. YK11, however, has now stepped, so that its contacts 5-6 are closed and start the timing relay, YK12. Should another overload occur within 30 seconds, or if the first one is still present, the above process will be repeated. Should a third overload occur before YK12 has timed out, contacts 3-4 and 5-6 of YK11 will open and the overload relays will not be automatically reset. Relay YK11 will remain in the locked-out position until one of the transmitter-start switches, YS4, YS5, YS6, or YS7, is operated. This will reset YK11 through its reset coil; the overload reset coils will be operated and the circuit restored to normal. If YK12 times out without recurrence or repeated overloads, its contact 3-5 will close at the end of 30 seconds and operate the reset coil of YK11 so that it will again be able to accept two overloads in a 30-second period. The resetting of YK11 will open its contacts 5-6, allowing the time-delay relay, YK12, to reset also.

LIGHTNING TRIP-CIRCUIT

Power for the operation of relays YK29 and KK1 in the lightning trip-circuit is made available when YK1 closes with the operation of the TRANSMITTER START switch, YS1. Capacitor YC2 is normally charged to the peak voltage of the control circuit supply. Relays YK29 and KK1 may be operated by the test push button, YS18, or by a reflectometer or other device which is required only to ground terminal YS2-4. Relay KK1 effectively grounds the audio input to the Transmitter through a one-microfarad capacitor, and at the same time, energizes the coil of YK29. YK29 opens a normally closed contact across BR8, thereby greatly increasing the bias on BV1 and reducing the excitation to the 1st IPA. On removal of the ground from Y2-4, YK29 will release immediately, and KK1 will be delayed because of the capacitor across its coil. The rectifier in series with the coil of KK1 prevents the capacitor from being discharged through YK29. This circuit ensures that the audio input is shorted out before the RF excitation is reduced and that the RF excitation is restored to normal before the audio drive is resumed.

REFLECTOMETER, PL-7444D442-G2

Introduction

The General Electric Reflectometer, PL-444D442-G2, has been designed for use with the 50-KW AM Broadcast Transmitter, Type BT-50-A. When properly installed, the Reflectometer will cause momentary shutdown of the Transmitter whenever the transmission-line VSWR exceeds a ratio of 2.1 to 1. This ratio is a very sensitive indication of any component failure or lightning arc at the tower or antenna-tuning unit.

Installation

Refer to Figs. 59 and 60.

Electrically, the Reflectometer must be in the transmission line between the Transmitter and the antenna. With an omnidirectional antenna, the Reflectometer is usually between the Transmitter and the transmission line. With a directional antenna, as many Reflectometers are needed as there are towers. One reflectometer should be located between the tuning and phasing unit and each of the transmission lines to the individual towers.

The control function of the Reflectometer is exercised by a set of contacts, normally open, brought out to the terminal strip, JTB1, located on the front panel of the Reflectometer. Connect one terminal to the Transmitter ground and the other to ZTB3-20, which is located in the control portion of the Rectifier cubicle of the BT-50-A Transmitter. This connection is indicated in Fig. 58 in the lower right-hand corner. These connections may be made by means of any suitable conductors, No. 22 AWG or larger.

Physically, the Reflectometer may be mounted at any convenient location and in any position at the Transmitter site, provided that the electrical requirements indicated above are fulfilled and that reasonable access to the Reflectometer controls is maintained. Provision has been made for wall-mounting the unit by means of four keyhole slots in the cover of the Reflectometer (see Fig. 59).

Setting-Up Procedure

Before setting-up as outlined below, it is necessary to remove the connections between JTB1 and the Transmitter.

The Reflectometer is designed to operate properly with the control of the coupling coil, JL1B, set to maximum for an RF line current of 15 amperes, which corresponds to the current in a 230-ohm line. When used with a 50-ohm line, rotate the coupling coil approximately 60 degrees from its maximum position to allow for the higher current. Now proceed as follows:

1. Turn the VOLTAGE LEVEL potentiometer, JR1, fully counterclockwise, that is, to zero voltage level.

2. Turn the SENSITIVITY potentiometer, JR3, fully clockwise, that is, to minimum sensitivity.

NOTE

> To prevent damage to the diodes in the detector, it is necessary to limit the detector current at certain stages of the setting-up procedure. The SENSITIVITY control, JR3, is provided for this purpose. A relay coil d-c voltage of 20 volts corresponds to the maximum allowable detector current.

3. Attach a 20,000-ohms-per-volt meter across the relay coil test points (JTB2).

4. With the shorting bar removed (Fig. 59), turn the Transmitter on and apply unmodulated RF to the Reflectometer.

5. Adjust JC2 for resonance as indicated by a maximum reading on the test meter. This maximum is usually about 6 volts.

6. Shut down the Transmitter. Place the shorting bar across the input of the Reflectometer. Turn on the Transmitter. Adjust the VOLTAGE LEVEL potentiometer to give a reading of approximately 15 volts on the test meter when the SENSITIVITY potentiometer is at its fully counterclockwise limit.

7. Shut down the Transmitter. Remove the shorting bar. Turn on the Transmitter. Touch up the VOLTAGE LEVEL potentiometer and the settings of JC2 alternately by increments to obtain an absolute minimum reading on the test meter. Any minimum below 0.5 volt d-c is acceptable.

8. Make sure that the balance obtained is with a voltage level of approximately 25 volts RF across JR1 as follows. With the shorting bar in place and the Transmitter on, the test meter should read between 10 and 15 volts d-c for this setting of the controls.
9. Remove the shorting bar and replace the connections from the Transmitter to JTB2.

NOTE

If the Reflectometer is to be used at a frequency below 700 kc, it may be necessary to add an additional fixed capacitor across JC2 to provide sufficient capacitance to permit resonance with the inductance of JL1B. A suitable 0.0001-ufd, 2500-volt d-c w capacitor is included with each Reflectometer for this purpose (JC2A). This capacitor will be found mounted on the chassis support bracket adjacent to JC2. Also note that neither side of JC2 is at chassis ground potential, so that it will not suffice to connect this additional capacitor with one side to ground. It must be connected between the rotor and stator sections of JC2.

Theory of Operation

Refer to Fig. 61.

The Reflectometer has been designed to cause momentary Transmitter shutdown whenever the transmission-line VSWR exceeds a ratio of 2.1 to 1.

Capacitor JC1 and parallel resistors JR1 and JR4 constitute a voltage divider across the Transmitter output. Because of the large impedance of JC1 compared with JR1 and JR4 in parallel, the current through these resistors, and therefore the voltage developed across them, leads the RF line voltage by almost 90 degrees and is proportional to it.

Similarly, the voltage induced across JL1B lags the line current by 90 degrees and, therefore, with JC2 adjusted for resonance, the voltage across JR3 lags the line current by 90 degrees and is proportional to it.

Since the voltage applied to the detector is the vector sum of the voltage across JR3 plus the voltage across JR1, it is possible to balance these two voltages by adjustment of JR1 and the coupling control, so that the voltage applied to the detector is a minimum for normal line conditions. Any subsequent variation in the relative phase or magnitude of either the line current or the line voltage will lead to a resultant voltage at the detector. This, in turn, will energize the control relay and close the normally open contacts, which will momentarily remove the audio and RF drive to the Transmitter.

Maintenance

Little or no maintenance should be necessary during the lifetime of any installation of the Reflectometer. If desired, an occasional check for proper operation may be simply performed as follows. With the Transmitter on and the test meter connected across the relay coil test points as explained under Setting-Up Procedure, rotate JL1B either way from its normal operating position and observe the test meter indication. A movement of JL1B should cause an increase in the d-c voltage across the relay coil, and at approximately 2 volts the relay contacts should close. Following the test, readjust JL1B until the original minimum is restored.

To check for proper operation of the detector circuit, disconnect the detector input at JC2-1 and, by means of an RF signal generator, apply a voltage of about 6 volts rms to the

PARTS LIST

Symbol	Description	G-E Drawing
	BLOWER AND MOTOR	
EB1	Gear motor: 115 v, 60 cycles a-c, 1 phase, 5.7 rpm, 75 in oz. torque. Bodine Electric Co. Cat. #B8192E-300C.	A-101A6127-P1
ZB1	American Blower #15AH CW, Industrial Series 106, ARRT.9L, ball bearings. G-E Tri-Clad #55 general purpose open a-c motor: Type K, frame 254 U, 7.5 hp, 1750 rpm, 3 phase, 60 cycles, 220/440 v. Drive: Allis Chalmers Cat. #2BM66-5.0/6.4-6.2 Vbelt drive on 24"-0 centers, bore fan sheave 1-11/16" with 3/8 x 3/16 keyway, bore motor sheave 1-3/8. Replacement belts, matched sets of two. Allis Chalmers Cat. #BM66.	C-7776861-P2
	CAPACITORS	
AC1 and AC2	Mica, Class B: 10,000 mmfd ± 10%, 300 v d-c w. EIA Type RCM35B103K.	P-3R139-P17
AC3	Silver mica; 15 mmfd ± 5%, 500 v d-c w.	P-3R122-P134
AC4 and AC5	Air trimmer; variable, 4.4 to 50 mmfd. Hammarlund Type APC-50.	P-3R47-P2
AC6	Mica, Class B: 10,000 mmfd ± 10%, 300 v d-c w. EIA Type RCM35B103K.	P-3R139-P17
AC7	Mica, Class C; 330 mmfd ± 5%, 500 v d-c w. EIA Type RCM20C331J.	P-3R141-P139
AC8	Mica: 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
AC9	Mica: 1000 mmfd ± 10%, 2500 v d-c w. EIA Type RCM45B102K.	P-3R31-P9
AC10 thru AC12	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65

CAPACITORS (CONTINUED)

Symbol	Description	G-E Drawing
BC1	Mica, Class B; 10,000 mmfd ± 10%, 300 v d-c w. EIA Type RCM35B103K.	P-3R139-P17
BC2	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
BC3 thru BC5	Mica, 1000 mmfd ± 10%, 2500 v d-c w. EIA Type RCM45B102K.	P-3R31-P9
BC6 and BC7	Mica, 320 mmfd ± 5%, 2500 v d-c w. EIA Type RCM45B221J.	P-3R31-P25
BC8	*Pyranol; 10 mfd ± 10%, 600 v d-c w. G-E Cat. #23F876.	P-3R88-P19
CC1 thru CC3	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
CC4 and CC5	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
CC6	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
CC7	Ceramic; 150 mmfd ± 20%, 6 kv d-c w. Telegraphic Condenser Co. Type KO3555/TS.	B-594B831-P16
CC8	Variable, 10 to 400 mmfd, 7.5 kv peak. Jennings Radio Type UCS.	B-603B298-P9
DC1	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
DC2 and DC3	Mica; 22,000 mmfd ± 5%, 1200 v d-c w. EIA Type RCM60B223J	P-3R32-P97
DC4	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
DC5	Variable, 15 to 75 mmfd, 20 kv peak. Jennings Radio Type AT.	A-101A6731-P4

*Registered U.S. Patent Office

CAPACITORS (CONTINUED)

Symbol	Description	G-E Drawing
DC6	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
DC7	Variable condenser; 50 to 2300 mmfd, voltage rating 7 5 kv. Jennings Cat. #UCSXF.	B-603B303-P4
DC8	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
EC1	Variable condenser; 50 to 2300 mmfd, voltage rating 7.5 kv. Jennings Cat. #UCSXF.	B-603B303-P4
EC2 and EC3	Ceramic; 4000 mmfd ± 10%, 3 kv a-c working. Stemag Type 65136.	B-603B302-P7
EC4 and EC5	Ceramic; 2000 mmfd ± 20%, 15 kv d-c working, 60 amp max RF current. Telegraph Condenser Co. Type HLC2120.	B-594B829-P1
EC6 thru EC9	Mica; 0.06 mfd ± 5%, 2000 v peak working voltage.	M-2R49-P21
EC10 and EC11	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM55B103K.	P-3R32-P17
EC12 and EC13	Pyranol; 8.0 mfd ± 10%, 2000 v d-c w. G-E Cat. #23F385.	P-7769201-P3
EC17 and EC18	Ceramic; 4000 mmfd ± 20%, 15 kv d-c working, 70 amp max RF current Telegraph Condenser Co Type HLC4150.	B-594B829-P4
EC19	Vacuum; fixed, 1000 mmfd ± 5%, 35,000 v peak test. Jennings Type MLC.	A-7142212-P2
EC20	Vacuum; variable, 60 to 1000 mmfd, voltage rating 35 kv Jennings Cat. #VMMHC.	B-594B806-P11
EC21	Vacuum; variable, 100 to 5000 mmfd, voltage rating 15 kv Jennings Cat. #VMMC.	B-594B806-P10
FC1	Vacuum; variable, 100 to 2000 mmfd, voltage rating 15 kv. Jennings Cat. #VMM.	B-594B806-P3

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
FC2	Vacuum; variable, 100 to 5000 mmfd, voltage rating 15 kv. Jennings Cat. #VMMC.	B-594B806-P10
GC1	Pyranol; 1.0 mfd ± 10%, 1000 v d-c w. G-E Cat. #22F397.	P-3R115-P11
HC1	Paper, hermetically sealed; 0.047 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P47302S4.	B-151B855-P11
HC2	Paper, hermetically sealed; 0.15 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P15402S4.	B-151B855-P14
HC3	Paper, hermetically sealed; 0.033 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P33302S4.	B-151B855-P10
HC4	Paper, hermetically sealed; 0.022 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22302S4.	B-151B855-P9
HC5 and HC6	Paper, hermetically sealed; 0.4 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22402S4.	B-151B855-P15
KC1 and KC2	Paper, hermetically sealed; 0.01 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10302S4.	B-151B855-P7
KC3	Paper, hermetically sealed; 0.022 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22302S4.	B-151B855-P9
KC4	Paper, molded plastic; 0.033 mfd ± 20%, 400 v d-c w. Sprague Cat. #109P33304.	B-7491096-P30
KC5 thru KC7	Paper, hermetically sealed; 0.1 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10402S4.	B-151B855-P13
KC8	Pyranol; 1.0 mfd ± 10%, 1000 v d-c w. G-E Cat #22F397.	C-3R143-P11
KC9	Paper, hermetically sealed; 0.0022 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22202S4.	B-151B855-P3
KC10 thru KC12	Pyranol; 1.0 mfd ± 10%, 1000 v d-c w. G-E Cat. #22F397.	C-3R143-P11

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
KC13 and KC14	Paper, molded plastic; 0.0033 mfd ± 20%, 600 v d-c w. Sprague Cat. #109P33206.	B-7491096-P44
KC15	Paper, hermetically sealed; 0.1 mfd ± 20%. 200 v d-c w. Sprague Cat. #91P10402S4.	B-151B855-P13
KC16	Paper, hermetically sealed; 0.01 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10302S4.	B-151B855-P7
KC17	Paper, hermetically sealed; 4.0 mfd ± 20%, 200 v d-c w. Sprague Cat. #118P40502S4.	B-777B115-P2
KC18	Paper, hermetically sealed; 1.0 mfd ± 20%, 200 v d-c w. Sprague Cat. #118P10502S4.	B-777B115-P1
KC19	Paper, hermetically sealed; 0.1 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10402S4.	B-151B855-P13
MC1 and MC2	Pyranol, 10 mfd ± 10%, 600 v d-c w. G-E Cat. #23F876.	P-3R88-P19
MC3 and MC4	Pyranol, 0.5 mfd ± 10%, 4000 v d-c w. G-E Cat. #23F409.	P-3R87-P12
PC1 thru PC4	Mica; 0.06 mfd ± 5%, 2000 v peak working voltage.	M-2R49-P21
PC5 and PC6	Disk type; 160 mmfd ± 10%, 10 kv a-c working. C.G.E.C. Type 40553.	B-594B835-P10
PC9 thru PC12	Teflon; 0.01 mfd ± 5%, 20,000 v d-c w. Plastic Capacitors Inc., Cat. #OF200-103.	B-359B864-P31
PC15	Paper, molded plastic; 0.068 mfd ± 20%, 400 v d-c w. Sprague Cat. #109P68304.	B-7491096-P32
RC1 thru RC4	Pyranol; 1.25 mfd ± 10%, 20,000 v d-c w. G-E Cat. #14F442.	P-7770298-P11

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
SC1	Pyranol; 6.0 mfd ± 10%, 600 v d-c w. G-E Cat. #23F352.	P-3R88-P14
SC2	Pyranol; 40 mfd ± 10%, 600 v d-c w, 330 v a-c w. G-E Cat. #23F880.	P-7769244-P18
TC1 thru TC3	Pyranol: 10 mfd ± 10%, 2000 v d-c w. G-E Cat. #23F386.	P-3R87-P4
UC1 and UC2	Pyranol, 6.0 mfd ± 10%. 4000 v d-c w. G-E Cat. #23F413.	P-7769201-P13
VC1 thru VC4	Pyranol; 3.3 mfd ± 10%, 12,500 v d-c w. G-E Cat. #14F431.	P-7770283-P30
VC257 and VC258	Pyranol; 3.3 mfd ± 10%, 12.500 v d-c w. G-E Cat. #14F431.	P-7770283-P30
XC1	Pyranol; 10 mfd ± 10%, 1000 v d-c w. G-E Cat. #23F364.	P-3R88-P9
YC2 and YC3	Pyranol; 1.0 mfd ± 10%, 600 v d-c w. G-E Cat. #22F418.	C-3R143-P35
	RECTIFIERS	
ACR1	Germanium rectifier. G-E Cat. #4JA211BB1AC1.	
GCR1	Germanium rectifier. G-E Cat. #4JA211CF2AC1.	
KCR1	Germanium diode. G-E Type 1N92.	
SCR1	Germanium rectifier. G-E Cat. #4JA211CF2AC1.	
TCR1 thru TCR6	Germanium rectifier. G-E Cat. #4JA211CX250.	

RECTIFIERS (CONTINUED)

Symbol	Description	G-E Drawing
UCR1 thru UCR12	Germanium rectifier. G-E Cat. #4JA211CX250.	
VCR1 thru VCR42	Rectifier assemblies Include: Germanium rectifier. Capacitor, paper 0.01 mfd ± 10%, 600 v d-c w. Sprague Cat. #91P10396S4, with terminals added.	B-7492254-G1 C-7776930-P1 B-603B642-P47
XCR1 thru XCR3	Germanium rectifiers G-E Cat #4JA211CD3AC1.	
YCR1	Germanium rectifier. G-E Cat. #4JA211CB1AC2.	
YCR2	Germanium rectifier. G-E Cat. #4JA211BH2AC1.	

*THYRITE ARRESTORS

Symbol	Description	G-E Drawing
RE1 thru RE4	G-E Cat. #9LA21BX8.	
WE1 thru WE3	G-E Cat. #9LA21BX8.	

FUSES

Symbol	Description	G-E Drawing
AF1 and AF2	Slow blow; rated 1 amp at 250 v. Bussman Cat. #MDL-1.	B-7487942-P5
WF1 thru WF3	Fuses for plate supply G-E Cat. #GF6B200. Group 1 only.	
WF1 thru WF3	Fuses for plate supply. G-E Cat. #6193403G13. Group 2 only.	

*Registered U.S. Patent Office.

FUSES (CONTINUED)

Symbol	Description	G-E Drawing
WF1 thru WF3	Fuses for plate supply. G-E Cat. #6193406G11. Group 3 only.	
ZF1 thru ZF3	Fuses for distribution supply. G-E Cat. #GF6B60. Group 1 only.	
ZF1 thru ZF3	Fuses for distribution supply. G-E Cat. #6193403G8. Group 2 only.	
ZF1 thru ZF3	Fuses for distribution supply. G-E Cat. #6193404G7. Group 3 only.	

INDICATING LAMPS

Symbol	Description	G-E Drawing
AI1 and AI2	Miniature bayonet base. G-E Cat. #1813.	A-101A5514-P5
AI3 and AI4	Miniature bayonet base. G-E Cat. #47.	A-101A5514-P2
YI1 thru YI18	Glow lamps. G-E Cat. #NE-51.	A-101A5514-P12

RELAYS

Symbol	Description	G-E Drawing
KK1	Relay, dpdt, coil resistance 10,000 ohms, pull in 5.0 ma. standard 8 pin octal. Potter and Brumfield Type KCP series, Cat. #KCP11.	A-102A5064-P1
VK1	Vacuum switch, 50 amp rms, solenoid voltage 115 v a-c. Jennings Radio Mfg. Corp. Model EO2P, switch Type RC5.	C-555C224-P1
WK1 thru WK3	Vacuum switches: 5000 v rms continuous in 50° C ambient, 200 amp rms, 2000 v rms make and break, solenoid voltage 115 v d-c; pull-in current 0.7 amp, holding current 0.1 amp. Jennings Model #EO4P115DC.	B-603B607-P1

Symbol	Description	G-E Drawing
	RELAYS (CONTINUED)	
YK1	Relay, hermetically sealed; 120 v, 50/60 cycles; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC. (Enclosure #44100).	C-555C230-P1
YK2	Time delay relay; 115 v, 60 cycles, 5 min ± 15 sectime delay, spdt.	P-7772761-P10
YK3 and YK4	Contactors, a-c magnetic; 3 NO. main poles; 1 NO. interlock; 110 v, 60 cycles. G-E Type CR2810-D11AB1B2.	P-8569617-P1
YK5	Relay, hermetically sealed; 120 v, 50/60 cycles; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC. (Enclosure #44100).	C-555C230-P1
YK6	Time delay relay, operating time 10 sec ± 3 sec spst NO. contacts rated 3 amp at 115 v. Amperite Cat. #115NO10.	A-825A596-P1
YK7 thru YK9	Relays, hermetically sealed; 120 v, 50/60 cycles; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC. (Enclosure #44100).	C-555C230-P1
YK10	Relay, 2 coil latching type; hermetically sealed; 2 form C contacts rated 10 amp, 115 v resistive; latch and release coil operating voltage 120 v, 50/60 cycles a-c. Potter & Brumfield Latching Relay Series LK, Type H.	A-101A6590-P1
YK11	Sequence relay, elec reset, both coils rated 115 v ± 10%, 60 cycles (momentary duty), one OCCO, one CCCO, and one NO. aux contact which closes only when operating coil is energized. Struthers Dunn Type 99AXA115.	M-7474991-P3
YK12	Time delay relay: spdt db contacts rated 5 amp at 230 v, 110/120 v coil voltage, 1 sec delay. American Gas Accumulator Co. Type NE-11.	B-603B529-P2
YK13	Contactor, a-c magnetic; 3 NO. main poles; 1 NO. interlock; 110 v, 60 cycles. G-E Type CR2810-D11AB1B2.	P-8569617-P1

Symbol	Description	G-E Drawing
	RELAYS (CONTINUED)	
YK14	Time delay relay: 60 cycles, dpdt sb contacts rated 5 amp at 120 v; 110/120 v coil voltage. American Gas Accumulator Co., Type NE-24.	M-8569170-P9
YK15	Time delay relay: dpdt sb contacts rated 2.5 amp at 230 v, 110/120 v coil voltage, 2 sec delay. American Gas Accumulator Co., Type NE-16.	B-603B529-P1
YK16 and YK17	Overload relays: coil operates at 2 amp continuous rating; 1.0 to 3.0 amp calibration range; 0.76 ohms d-c resistance ; 2 NO. and 2 NC contacts; reset coil rated 115 v, 60 cycles. G-E Cat. #12PBC13B23.	C-7776348-P16
YK18 thru YK23	Overload relays: coil operates at 5 amp continuous rating; 2.5 to 7.5 amp calibration range; 0.132 ohms d-c resistance; 2 NO. and 2 NC contacts; reset coil rated 115 v, 60 cycles. G-E Cat. #12PBC13B24.	C-7776348-P17
YK25	Time delay relay: spdt db contacts rated 5 amp at 230 v, 110/120 v coil voltage. American Gas Accumulator Co., Type NE-11.	B-603B529-P2
YK26 thru YK28	Relays, hermetically sealed; 120 v, 50/60 cycles ; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC (Enclosure #44100).	C-555C230-P1
YK29	Relay: dpdt,coil resistance 10,000 ohms, pull-in 5.0 ma, standard 8 pin octal. Potter and Brumfield Type KCP series, Cat. #KCP11.	A-102A5064-P1
	INDUCTORS	
AL1	RF choke coil: inductance 2.5 mh ± 5%, d-c resistance 50 ohms nominal.	K-7107898-P2
BL1	RF choke coil; inductance 2.5 mh ± 5%, d-c resistance 50 ohms nominal.	K-7107898-P2
BL2	Driver tank coil.	C-315C267-P1
CL1	RF choke coil; inductance 2.5 mh ± 5%, d-c resistance 50 ohms nominal.	K-7107898-P2
CL2	Parasitic suppressor.	M-7476387-P1

Symbol	Description	G-E Drawing
	INDUCTORS (CONTINUED)	
CL3	RF choke; 7.0 mh ± 10%, 7.2 ohms resistance, 750 ma current JW Miller Co. Cat. #2881.	A-521A991-P1
CL4	Coil assembly. Inductance 300 uh.	ML-555C123-G1
CL5	Parasitic suppressor. Ohmite Cat. #P-300.	M-7476387-P1
DL1	RF choke; 7.0 mh ± 10%, 7.2 ohms resistance, 750 ma current. JW Miller Co. Cat. #2881.	A-521A991-P1
DL2	Parasitic suppressor. Ohmite Cat. #P-300.	M-7476387-P1
DL3	Grid choke coil assembly.	ML-7478900-G1
DL4	Neutralizing coil assembly.	ML-555C228-G1
DL5	Variometer coil; outer coil inductance 63 uh, inner coil inductance 22.5 uh, mutual inductance 12.5 uh max. EF Johnson Cat. #204-901-3, Type 4258N6+2126VM41C.	D-438D461-P1
DL6	Parasitic suppressor assembly.	ML-7478192-G1
EL1	PA grid coil; inductance 50 uh. EF Johnson Cat. #200-303.	C-555C125-P1
EL2 and EL3	Grid choke coil assemblies.	ML-7478900-G1
EL4 and EL5	Parasitic suppressor assemblies.	ML-7478192-G1
EL6	Plate choke coil assembly.	ML-7768793-G2
EL7	Neutralizing coil assembly.	ML-7664532-G2
EL8	Neutralizing coil assembly.	ML-7768797-G2
EL9	Tank coil. EF Johnson Part #236-150.	C-503C658-P1
EL10	Monitor coil assembly.	ML-603B552-G1
FL1	Filter coil; inductance 50 uh. EF Johnson Part #202-512-2.	C-503C659-P1

Symbol	Description	G-E Drawing
	INDUCTORS (CONTINUED)	
FL2	Filter coil; inductance 22 uh. EF Johnson Cat. #200-307-1.	C-503C657-P1
FL3	Filter coil; inductance 50 uh. EF Johnson Part #202-512-2.	C-503C659-P1
FL4	Filter coil; inductance 40 uh. EF Johnson Cat. #202-501-2.	C-503C660-P1
HL1	Coil assembly. Inductance 1.0 uh ± 10%.	A-102A4552-G1
HL2	Coil assembly. Inductance 55 uh ± 10%.	A-102A4552-G2
KL1 and KL2	Choke coils; inductance 85 mh ± 5%, resistance 328 ohms ± 15%. F W Sickles Cat. #SC-106A.	K-1R15-P10
PL1 and PL2	Parasitic suppressor assemblies.	ML-777B307-G1
RL1	Modulation reactor. Electric Eng. Works Cat. #E9908.	B-603B283-P1
SL1	Reactor; inductance 2.0 h min at 0.6 amp; d-c resistance 9.0 ohms. Hammond Cat. #41849.	B-594B796-P1
TL1	Reactor; inductance 1.0 h at 1.2 amp; d-c resistance 11 ohms. Hammond Cat. #41875.	B-594B805-P1
UL1	Reactor; inductance 1.0 h min at 1.5 amp; d-c resistance 10 ohms. Hammond Cat. #41874.	B-594B804-P1
WL1	Filter reactor; inductance 1.0 h at 8.0 amp, d-c resistance 3.5 ohms, d-c operating voltage 9000 v; oil filled sealed tank.	B-7491984-P1
XL1	Reactor; inductance 2.0 h min at 0.6 amp; d-c resistance 9.0 ohms. Hammond Cat. #41849.	B-594B796-P1
ZL1	Current limiting reactor. G-E Cat. #92H37. Group 1 only.	
ZL1	Current limiting reactor. Group 2 only.	B-7491983-P1
ZL1	Current limiting reactor. Group 3 only.	B-7492285-P1

Symbol	Description	G-E Drawing
	METERS	
DM1	Milliammeter: rated 1.0 ma d-c. G-E Type DO-71.	P-3R127-P20
DM2	Ammeter: rated 1.5 amp d-c. G-E Type DO-71.	P-3R125-P2
EM1	Ammeter: rated 1.5 amp d-c. G-E Type DO-71.	P-3R125-P2
EM2	Voltmeter: rated 10 v a-c. G-E Type AO-72.	P-3R136-P6
EM3 and EM4	Ammeters: rated 8.0 amp d-c. G-E Type DO-71.	P-3R125-P6
EM5	Ammeter: rated 15 amp d-c. G-E Type DO-71.	P-3R125-P8
FM1	Antenna indicator. Part number selected to agree with customer's requirements as specified on requisition. Part 1. Full scale deflection marked for 50 amp. Part 2. Full scale deflection marked for 40 amp. Part 3. Full scale deflection marked for 30 amp. Part 4. Full scale deflection marked for 25 amp. Part 5. Full scale deflection marked for 20 amp. Part 6. Full scale deflection marked for 15 amp. G-E Type DO-71.	B-603B290
LM1	Milliammeter: rated 1.0 ma d-c. G-E Type DO-71.	P-3R127-P20
NM1 and NM2	Milliammeters: rated 500 ma d-c.	B-603B285-P1
PM1 and PM2	Ammeters: rated 5.0 amp d-c. G-E Type DO-71.	P-3R125-P5
SM1	Kilovoltmeter: rated 1.0 kv d-c. G-E Type DO-71.	P-3R123-P20
TM1	Kilovoltmeter: rated 2.0 kv d-c. G-E Type DO-71.	P-3R123-P22
UM1	Kilovoltmeter: rated 5.0 kv d-c. G-E Type DO-71.	P-3R123-P26
VM1	Kilovoltmeter: rated 10 kv d-c. G-E Type DO-71.	P-3R123-P28
YM1	Elapsed time meter: 99,999 hours; 115 v, 60 cycles.	P-3R142-P1

Symbol	Description	G-E Drawing
	RESISTORS (Composition, unless otherwise specified)	
AR1 and AR2	15 ohms ± 5%, 2 w.	C-3R79-P150J
AR3	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
AR4	1500 ohms ± 5%, 2 w.	C-3R79-P152J
AR5 thru AR7	10,000 ohms ± 5%, 2 w.	C-3R79-P103J
AR8	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
AR9	43 ohms ± 5%, 2 w.	C-3R79-P430J
AR10	Wirewound; 1500 ohms ± 10%, 25 w.	C-594B877-P23
BR1	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
BR2	1000 ohms ± 5%, 2 w.	C-3R79-P102J
BR3 and BR4	2200 ohms ± 5%, 2 w.	C-3R79-P222J
BR5	43 ohms ± 5%, 2 w.	C-3R79-P430J
BR6	Wirewound; 25,000 ohms ± 10%, 50 w.	B-594B849-P34
BR7	Wirewound; 1500 ohms ± 10%, 25 w.	B-594B877-P23
BR8	20,000 ohms ± 5%, 2 w.	C-3R79-P203J
BR9	33,000 ohms ± 5%, 2 w.	C-3R79-P333J
BR10	Rheostat, wirewound; 10,000 ohms ± 10%, linear taper. Ohmite Model J, Cat. #0332.	M-2R34-P25
BR11 and BR12	33,000 ohms ± 5%, 2 w.	C-3R79-P333J
BR13	100 ohms ± 5%, 2 w.	C-3R79-P101J

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED) (Composition, unless otherwise specified)	
CR1	Wirewound; 2000 ohms ± 5%, 50 w. Ward Leonard Cat. #50F2000.	M-2R17-P164
CR2	Wirewound; 5000 ohms ± 10%, 160 w.	B-594B824-P25
CR3	Wirewound; 4.0 ohms ± 5%, 10 w.	B-594B791-P5
CR5	110 ohms ± 5%, 2 w.	C-3R79-P111J
CR7	Wirewound; 750 ohms ± 10%, 25 w.	B-594B877-P18
DR2	2000 ohms ± 5%, 2 w.	C-3R79-P202J
DR4	Wirewound; 500 ohms ± 10%, 100 w.	B-594B823-P14
DR5	Wirewound; 4.0 ohms ± 5%, 10 w.	B-594B791-P5
DR7 and DR8	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
DR9 thru DR11	Wirewound; 50 ohms ± 5%, 200 w.	B-594B825-P8
DR13	Wirewound; 50 ohms ± 5%, 160 w.	A-101A5555-P106
DR14	Wirewound; 50 ohms ± 5%, 160 w.	A-101A5555-P106
ER1 thru ER6	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
ER9	Rheostat; 750 ohms ± 20%, 500 w. Ohmite Model R; Type #0867.	B-603B351-P1
ER10 and ER11	Wirewound; 3.0 ohms ± 10%, 100 w.	B-594B823-P3
GR1	Precision multiplier; 1.0 megohm ± 0.5%, at 25 C, 1000 v. Jan Type MFC105.	M-7470483-P3
GR2	10,000 ohms ± 5%, 2 w.	C-3R79-P103J
GR3 thru GR8	Wirewound; 100 ohms ± 5%, 200 w.	B-594B825-P10

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
HR1 and HR2	Wirewound; 2.0 ohms ± 10%, 100 w.	B-594B823-P2
HR3 and HR4	4700 ohms ± 10%, 2 w.	C-3R79-P472K
KR1 thru KR4	100 ohms ± 5%, 1 w.	C-3R78-P101J
KR5	680 ohms ± 5%, 1 w.	C-3R78-P681J
KR6	10,000 ohms ± 5%, 1 w.	C-3R78-P103J
KR7	0.22 megohm ± 5%, 1 w.	C-3R78-P224J
KR8	68,000 ohms ± 5%, 1 w.	C-3R78-P683J
KR9 thru KR11	22,000 ohms ± 5%, 1 w.	C-3R78-P223J
KR12	22 ohms ± 5%, 1 w.	C-3R78-P220J
KR13	220 ohms ± 5%, 1 w.	C-3R78-P221J
KR14 thru KR16	330 ohms ± 5%, 1 w.	C-3R78-P331J
KR17	3.0 megohm ± 5%, 1 w.	C-3R78-P305J
KR18 and KR19	0.47 megohm ± 5%, 1 w.	C-3R78-P474J
KR20	4700 ohms ± 5%, 2 w.	C-3R79-P472J
KR21	100 ohms ± 5%, 2 w.	C-3R79-P101J
KR22	22,000 ohms ± 5%, 2 w.	C-3R79-P223J
KR23 and KR24	6800 ohms ± 5%, 1 w.	C-3R78-P682J

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
KR25 and KR26	680 ohms ± 5%, 1 w.	C-3R78-P681J
KR27 and KR28	110 ohms ± 5%, 2 w.	C-3R79-P111J
KR29	Potentiometer, wirewound; 2000 ohms ± 10%, 2 w, linear taper. IRC Cat. #W-2000.	M-8569017-P62
KR30	0.10 megohm ± 5%, 1 w.	C-3R78-P104J
KR31	10,000 ohms ± 5%, 1 w.	C-3R78-P103J
KR32	22,000 ohms ± 5%, 1 w.	C-3R78-P223J
LR13	2000 ohms ± 5%, 2 w.	C-3R79-P202J
MR1 and MR2	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
MR3 and MR4	Rheostat, wirewound; 500 ohms ± 10%, 25 w, linear taper. Ohmite Model "H", Cat. #0156.	M-2R33-P17
MR5 thru MR8	Wirewound: 10,000 ohms ± 10%, 160 w.	B-594B824-P27
MR11 and MR12	10 ohms ± 5%, 2 w.	C-3R79-P100J
MR13 and MR14	100 ohms ± 5%, 2 w.	C-3R79-P101J
MR15 and MR16	100 ohms ± 10%, 2 w.	C-3R79-P101K

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED) (Composition, unless otherwise specified)	
NR1 thru NR4	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
NR9 thru NR12	47 ohms ± 5%, 2 w.	C-3R79-P470J
PR1	Potentiometer, wirewound; 400 ohms ± 10%, 100 w, linear taper. Ohmite Model "K", Cat. #0454.	M-7477518-P15
PR2 and PR3	Rheostat, wirewound; 300 ohms ± 10%, 75 w, linear taper. Ohmite Model "G", Cat. #1113.	M-2R35-P14
PR4 thru PR8	Wirewound; 500 ohms ± 10%, 100 w.	B-594B823-P14
PR9	Rheostat, wirewound; 350 ohms ± 10%, 150 w, linear taper. Ohmite Model "L", Cat. #0540.	M-2R37-P17
PR10 thru PR17	Carbon coated; 1.0 megohm ± 5%. Corning Glass Co. #N30.	A-102A4555-P1
PR26	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
PR28	Potentiometer, wirewound; 750 ohms ± 10%, 100 w, linear taper. Ohmite Model "K", Cat. #0456.	M-7477518-P17
PR29	Rheostat, wirewound; 200 ohms ± 10%, 150 w, linear taper. Ohmite Model "L", Cat. #0538.	M-2R37-P15
PR32 thru PR39	Wirewound; 250 ohms ± 5%, 200 w.	B-594B825-P12
PR40 and PR41	Wirewound; 3.0 ohms ± 10%, 100 w.	B-594B823-P3
PR42	Wirewound; 1.0 ohms ± 5%, 110 w. Ward Leonard Cat. #110F1.0.	M-2R19-P131

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED) (Composition, unless otherwise specified)	
PR44 and PR45	Wirewound; 3500 ohms ± 10%, 100 w.	B-594B823-P22
SR1	Wirewound; 5000 ohms ± 10%, 100 w.	B-594B823-P25
SR2	Precision multiplier; 1.0 megohm ± 0.5% at 25 C, 1000 v. Jan Type MFC 105.	M-7470483-P3
SR3	10,000 ohms ± 5%, 2 w.	C-3R79-P103J
SR4	Wirewound; 10,000 ohms, 150 w, taps divide resistor into ten equal resistances. Ohmite Stock #1606.	B-603B280-P5
SR5	Wirewound; 5000 ohms, 150 w, taps divide resistor into ten equal resistances. Ohmite Stock #1605.	B-603B280-P4
SR6	2200 ohms ± 5%, 2 w	C-3R79-P222J
SR7	Wirewound; 5000 ohms ± 10%, 100 w.	B-594B823-P25
TR2	Wirewound; 5000 ohms ± 5%, 10 w.	B-594B791-P47
TR3	Precision multiplier; 2.0 megohm ± 0.5% at 25 C, 2000 v. Jan Type MFB205.	M-7470483-P6
TR5	Wirewound; 10 ohms ± 5%, 25 w. Ward Leonard Cat. #25F10.	M-2R14-P61
UR1	Precision multiplier; 5.0 megohm ± 0.5% at 25 C, 5000 v. Jan Type MFA505.	M-7470483-P12
UR2	Wirewound; 5000 ohms ± 5%, 10 w.	B-594B791-P47
UR3	Wirewound; 10 ohms ± 5%, 25 w Ward Leonard Cat. #25F10.	M-2R14-P61
VR1 and VR2	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
VR3 and VR4	Precision multiplier; 5.0 megohm ± 0.5% at 25 C, 5000 v. Jan Type MFA505.	M-7470483-P12

Symbol	Description	G-E Drawing

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
VR5	0.33 megohm ± 10%, 2 w.	C-3R79-P334K
VR6	5600 ohms ± 10%, 2 w.	C-3R79-P562K
VR7	Wirewound; 10,000 ohms ± 5%, 200 w.	B-594B825-P25
VR8 thru VR15	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
XR1	2200 ohms ± 5%, 2 w.	C-3R79-P222J
XR2	Precision multiplier; 1.0 megohm ± 0.5% at 25 C, 1000 v. Jan Type MFC105.	M-7470483-P3
XR3	10,000 ohms ± 10%, 2 w.	C-3R79-P103K
YR1	Potentiometer, composition; 5000 ohms ± 20%, 2.25 w, linear taper. Allen Bradley Type J.	M-2R73-P52
YR2	470 ohms ± 5%, 2 w.	C-3R79-P471J
YR4 and YR5	Wirewound; 5.0 ohms ± 10%, 25 w.	B-594B877-P5
YR6	3300 ohms ± 10%, 2 w.	C-3R79-P332K

SWITCHES

Symbol	Description	G-E Drawing
AS1	Stepping switch; 110 v d-c, 12 positions, 2 wafers, 4 pole, 2 throw operation. G.H. Leland Inc. Type BD5SR35.	B-603B294-P1
AS2	Push-button type; momentary contact, red button, sp NO. snap acting, 10 amp at 115 v a-c, 1 amp at 115 v d-c. Grayhill Cat. #2201.	M-7481654-P3
CS1	Toggle type; dpst, contacts rated 12 amp at 125 v a-c. Arrow Hart and Hegeman Cat. #82143.	A-7109677-P1
DS1	Rotary style; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2

Symbol	Description	G-E Drawing
	SWITCHES (CONTINUED)	
DS2	Toggle type; dpst. contacts rated 12 amp at 125 v a-c. Arrow Hart and Hegeman Cat. #82143.	A-7109677-P1
ES1	Lever key switch; 1 form F contact, 3 positions. D.P. Mossman Series 4103.	C-7777140-P2
ES2	Rotary type; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2
ES3 and ES4	Sensitive, snap acting, pressure actuated, spdt, 9 to 13 oz. operating force. Microswitch Cat. #BZ-2R.	M-7489189-P1
LS1	Rotary style: 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2
SS1	Rotary style; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2
WS1A thru WS1C	Delta Wye switches. G-E Cat. #TC35364. Group 1 only.	
WS1A thru WS1C	Delta Wye switches. G-E Cat. #175L625G37. Group 2 only.	
WS1A thru WS1C	Delta Wye switches. G-E Cat. #175L626G36. Group 3 only.	
WS2A thru WS2C	Plate disconnect switches. G-E Cat. #TC90364SDJ6. Group 1 only.	
WS2A thru WS2C	Plate disconnect switches. G-E Cat. #175L630G213. Group 2 only.	
WS2A thru WS2C	Plate disconnect switches. G-E Cat. #175L632G210. Group 3 only.	
YS1	Lever key switch; 1 form A contact, 2 positions. D.P. Mossman Series 4102.	C-7777140-P1
YS2	Airflow switch; spdt. Rotron Type 1000.	B-7487948-P1

Symbol	Description	G-E Drawing
	SWITCHES (CONTINUED)	
YS3	Rotary type; 5 sections, rated 5 amp, 115 v a-c. Esco Electric Corp Type AF.	B-603B281-P5
YS4 thru YS7	Lever key switches; 1 form F contact, 3 positions. D.P. Mossman Series 4103.	C-7777140-P12
YS8 thru YS12	Interlock switch assemblies.	ML-7460330-G4
YS13 and YS14	Safety grounding switch assemblies.	ML-503C612-G2
YS15	Safety grounding switch assembly.	ML-503C612-G3
YS16	Safety grounding switch assembly.	ML-503C612-G2
YS17	Safety grounding switch assembly.	ML-503C612-G1
YS18	Push-button type; momentary contact, red button, sp NO. snap acting, 10 amp at 115 v a-c. Grayhill Cat. #2201.	M-7481654-P3
YS19	Interlock switch assembly.	ML-7460330-G4
YS20	Safety grounding switch assembly.	ML-503C612-G2
ZS3	Circuit breaker; 3 pole, rated 10 amp, time overload curve 1. Heinemann Cat. #3363S-10.	P-7768830-P2
ZS4 and ZS5	Circuit breakers; 3 pole, rated 35 amp, time overload curve 1. Heinemann Cat. #3363S-35.	P-7768830-P6
ZS6	Circuit breaker; 3 pole, rated 25 amp, time overload curve 3. Heinemann Cat. #3363S-25.	P-7768830-P19
ZS7	Circuit breaker: 3 pole, rated 3 amp, time overload curve 3. Heinemann Cat. #3363S-3.	P-7768830-P33
ZS8	Circuit breaker; 3 pole, rated 5 amp, time overload curve 3. Heinemann Cat. #3363S-5.	P-7768830-P15

Symbol	Description	G-E Drawing
	SWITCHES (CONTINUED)	
ZS9 and ZS10	Circuit breakers; 3 pole, rated 3 amp, time overload curve 3. Heinemann Cat. #3363S-3.	P-7768830-P33
ZS11	Circuit breaker; 2 pole, rated 8 amp, time overload curve 2. Heinemann Cat. #2263S-8.	P-7768829-P37
ZS12A thru ZS12C	Distribution disconnect switches. G-E Cat. #TC90362SDJ6. Group 1 only.	
ZS12A thru ZS12C	Distribution disconnect switches. G-E Cat. #175L615G1. Group 2 only.	
ZS12A thru ZS12C	Distribution disconnect switches. G-E Cat. #175L615G9. Group 3 only.	
	TRANSFORMERS	
AT1	Filament, single phase. Pri: 208 v, 50/60 cycles; sec #1: 6.3 v ± 2%, 1.25 amp; sec #2: 6.3 v ± 2%, 1.25 amp.	B-603B556-P1
AT2	Filament, single phase. Pri: 115 v, 50/60 cycles; sec: 11 v, 0.9 amp.	B-152B982-P1
CT1	Filament, single phase. Pri: 208 v, 60/60 cycles; sec: 5 v CT, 14.5 amp.	B-594B678-P1
DT1	Filament, single phase. Pri: 193-218 v, 50/60 cycles; sec: 6 v CT, 60 amp.	B-594B679-P1
ET1 and ET2	Filament, single phase. Pri: 193/218 v, 50/60 cycles; sec: 8 v CT, 200 amp.	B-594B680-P1
GT1	Power transformer. Pri: delta connected, 208 v, 3 phase, 50/60 cycles; sec: delta connected, 3 phase, to supply 400 v d-c at 1 amp via germanium rectifiers.	B-603B562-P1

Symbol	Description	G-E Drawing
	TRANSFORMERS (CONTINUED)	
KT1	Audio transformer. Frequency response: ± ½ db, 50-20,000 cps; distortion at 30 cps: less than 0.5% at +10 dbm; self resonance: above 35 kc; input impedance: 150 and 600 ohms; output impedance: two windings each 20,000 ohms.	B-594B786-P1
KT2	Filament, single phase. Pri: 208 v, 50/60 cycles; sec: 6.3 v CT, 1.2 amp.	B-594B665-P1
MT1 and MT2	Filament, single phase. Pri: 208 v, 50/60 cycles; sec: 5 v CT, 14.5 amp.	B-594B678-P1
NT1 thru NT4	Filament, single phase. Pri: 208 v, 50/60 cycles; sec: 5 v, 25 amp.	B-603B559-P1
PT1	Audio (cathode) transformer. Hammond Cat. #41847.	B-603B553-P1
PT2 and PT3	Filament, single phase. Pri: 193/218 v, 50/60 cycles; sec: 8 v CT, 200 amp.	B-594B680-P1
RT1	Modulation transformer. Electro Eng. Works Cat. #E9907.	B-603B282-P1
ST1	3 phase plate transformer. Pri: 208 v, 50/60 cycles, delta connected; sec: 370 v. Hammond Cat. #41876.	B-594B797-P1
TT1	3 phase plate transformer. Pri: 208 v, 50/60 cycles, delta connected; sec: 1120 v delta connected. Hammond Cat. #41851.	B-594B803-P1
UT1	Power transformer. Pri: 208 v, 3 phase, 50/60 cycles, delta connected; sec: 2620, 2820, or 3010 v, delta connected.	B-603B561-P1
VT1 and VT2	Current transformers. Ratio: 15:5; imp level: 75,000 v, 25/60 cycles. G-E Cat. #640 x 27, Type JKM-4, Model AAD11.	A-101A6586-P1

Symbol	Description	G-E Drawing
	TRANSFORMERS (CONTINUED)	
WT1 thru WT3	Plate transformers. G-E Cat. #5508AD2550. Group 1 only.	
WT1 thru WT3	Plate transformers. G-E Cat. #5525AD1550. Group 2 only.	
WT1 thru WT3	Plate transformers. Group 3 only.	B-594B667-P1
XT1	3 phase plate transformer. Pri: 208 v, 50/60 cycles; sec: 580 v.	B-594B799-P1
ZT1 thru ZT3	Distribution transformers. G-E Model #9T21Y12. Group 1 only.	
ZT1 thru ZT3	Distribution transformers. G-E Cat. #2701AC6510. Group 2 only.	
ZT1 thru ZT3	Distribution transformers. G-E Cat. #3601AC6510. Group 3 only.	
ZT4 and ZT5	Voltage stabilizing. Input: 170-235 v, 60 cycles; output: 208 v. G-E Model #9T91Y30.	B-603B560-P1
ZT6	Voltage stabilizing. Input: 170-235 v, 60 cycles; output: 208 v. G-E Model 9T91Y31.	B-603B560-P2
ZT7	G-E Cat. #21Y7264.	
ZT8	Audio bucking transformer.	B-777B100-P1

Symbol	Description	G-E Drawing
	***THYRITE RESISTORS**	
VTY1 and VTY2	G-E Cat. #9238208-G1.	A-101A6587-P1
YTY1	Similar to G-E Cat. #9RV3A11 except with 3 disks, G-E Cat. #3900353-G1.	B-7491992-P1
	FUSE HOLDERS	
AXF1 and AXF2	Indicating type, clear color. Bussman Cat. #HKL.	A-7141874-P1
	INDICATING LAMP SOCKETS	
AXI1 and AXI2	Miniature bayonet, red. Dialight Cat. #53410-991.	A-101A5509-P1
AXI3 and AXI4	Miniature bayonet, green. Dialight Cat. #53410-992.	A-101A5509-P2
YXI1 thru YXI14	Red transparent jewel. Drake Cat. #101N.	A-7140623-P1
YXI15 thru YXI17	Amber transparent jewel. Drake Cat. #101N.	A-7140623-P5
YXI18	Red transparent jewel. Drake Cat. #101N.	A-7140623-P1
	RELAY SOCKETS	
KXK1	Octal, mica filled. Jan Type TS101P01.	B-7408127-P1
YXK6	Octal, mica filled. Jan Type TS101P01.	B-7408127-P1
YXK29	Octal, mica filled. Jan Type TS101P01.	B-7408127-P1

*Registered U.S. Patent Office.

Symbol	Description	G-E Drawing
	TUBE SOCKETS	
AXV1	Mica filled phenolic, octal. Cinch Type 9886.	K-7103053-P1
BXV1	Mica filled phenolic, octal. Cinch Type 9886.	K-7103053-P1
CXV1	5 pin giant. EF Johnson Cat. #122-275-200.	A-102A5142-P1
DXV1	Machlett Cat. #21186.	B-603B524-P1
KXV1 and KXV2	Turret type, 7 pin miniature, bottom mount saddle type, 4 ground lugs.	B-7484399-P3
MXV1 and MXV2	5 pin giant. EF Johnson Cat. #122-275-200.	A-102A5142-P1
NXV1 thru NXV4	4 pin. EF Johnson Cat. #123-213-1.	A-102A4551-P1
	CRYSTAL SOCKETS	
AXY1 and AXY2	Mica filled phenolic, octal. Cinch Type 9886.	K-7103053-P1
	CRYSTALS	
AY1 and AY2	Part number selected to agree with customer's requirements as specified on requisition.	B-7466947

Part Number	Crystal and Carrier Frequency in KC
1	540.000
2	550.000
3	560.000
4	570.000
5	580.000
6	590.000
7	600.000
8	610.000
9	620.000
10	630.000

Symbol	Description	G-E Drawing

CRYSTALS (CONTINUED)

Part Number	Crystal and Carrier Frequency in KC
11	640.000
12	650.000
13	660.000
14	670.000
15	680.000
16	690.000
17	700.000
18	710.000
19	720.000
20	730.000
21	740.000
22	750.000
23	760.000
24	770.000
25	780.000
26	790.000
27	800.000
28	810.000
29	820.000
30	830.000
31	840.000
32	850.000
33	860.000
34	870.000
35	880.000
36	890.000
37	900.000
38	910.000
39	920.000
40	930.000
41	940.000
42	950.000
43	960.000
44	970.000
45	980.000
46	990.000
47	1000.000
48	1010.000
49	1020.000
50	1030.000

Symbol	Description	G-E Drawing

CRYSTALS (CONTINUED)

Part Number	Crystal and Carrier Frequency in KC
51	1040 000
52	1050.000
53	1060.000
54	1070.000
55	1080.000
56	1090.000
57	1100.000
58	1110.000
59	1120.000
60	1130.000
61	1140.000
62	1150.000
63	1160.000
64	1170.000
65	1180.000
66	1190.000
67	1200.000
68	1210.000
69	1220.000
70	1230.000
71	1240.000
72	1250.000
73	1260.000
74	1270.000
75	1280.000
76	1290.000
77	1300.000
78	1310.000
79	1320.000
80	1330.000
81	1340.000
82	1350.000
83	1360.000
84	1370.000
85	1380.000
86	1390.000
87	1400.000
88	1410.000
89	1420.000
90	1430.000

Symbol	Description	G-E Drawing

CRYSTALS (CONTINUED)

Part Number	Crystal and Carrier Frequency in KC
91	1440.000
92	1450.000
93	1460.000
94	1470.000
95	1480.000
96	1490.000
97	1500.000
98	1510.000
99	1520.000
100	1530.000
101	1540.000
102	1550.000
103	1560.000
104	1570.000
105	1580.000
106	1590.000
107	1600.000

CONNECTORS

Symbol	Description	G-E Drawing
	Small filament connector. Machlett Cat. #F17487.	A-101A6732-P1
	Large filament connector. Machlett Cat. #F17488.	A-101A6732-P2
	Grid connector. Machlett Cat. #F17489.	A-101A6732-P3

REFLECTOMETER ASSEMBLY ML-444D442-G2

CAPACITORS

Symbol	Description	G-E Drawing
JC1	10 mmfd, 15 kv peak, 20 amp RMS. Jennings Radio Type JCS-2.	A-102A5083-P1
JC2	Variable, air; 13 to 341 mmfd, 2400 v peak. Hammond Cat. #8135 modified for shaft length 1.12".	A-122A5120-P2
JC2A	Mica; 1000 mmfd ± 10%, 2500 v d-c w. EIA Type RCM45B102K.	P-3R31-P9

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
JC3	Ceramic Hi-K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
JC4 and JC5	Ceramic Hi-K disk, 0.02 mfd +100% -0%, 500 v d-c w.	C-7774750-P15
JC6	Silver mica, dipped phenolic insulation; 150 mmfd ± 10%, 500 v d-c w. Electromotive Type DM15.	B-7489162-P131
	RECTIFIERS	
JCR1 thru JCR4	Germanium diodes. Type 1N39A.	
	RELAY	
JK1	2 v, 6.3 ma d-c. Struthers-Dunn Type 112XAX.	A-102A5082-P1
	INDUCTORS	
JL1A	Coil assembly.	B-777B105-P1
JL1B	Coil assembly.	A-102A5080-G1
JL2 and JL3	RF chokes; inductance 1.0 mh, 125 ma d-c, 6 ohms d-c resistance. Hammond Mfg Co. Type 1500.	A-122A5152-P1
	RESISTORS	
JR1	Rheostat, wirewound; 1000 ohms ± 10%, 25 w. Ohmite Model "H", Cat. #O158.	M-2R33-P42
JR2	Wirewound, 500 ohms ± 10%, 25 w.	B-594B877-P17
JR3	Rheostat, wirewound; 2500 ohms ± 10%, 25 w. Ohmite Model "H", Cat. #O160.	M-2R33-P44
JR4	Wirewound, 800 ohms ± 10%, 25 w.	B-594B877-P19

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED)	
JR5	Composition, 1500 ohms ± 5%, 2 w.	C-3R79-P152J
	TERMINAL BOARDS	
JTB1 and JTB2	2 terminals. Cinch Electronics Components Type 1720.	A-102A5148-P1
JTB3 and JTB4	5 terminals, center terminal grounded.	C-7775500-P11

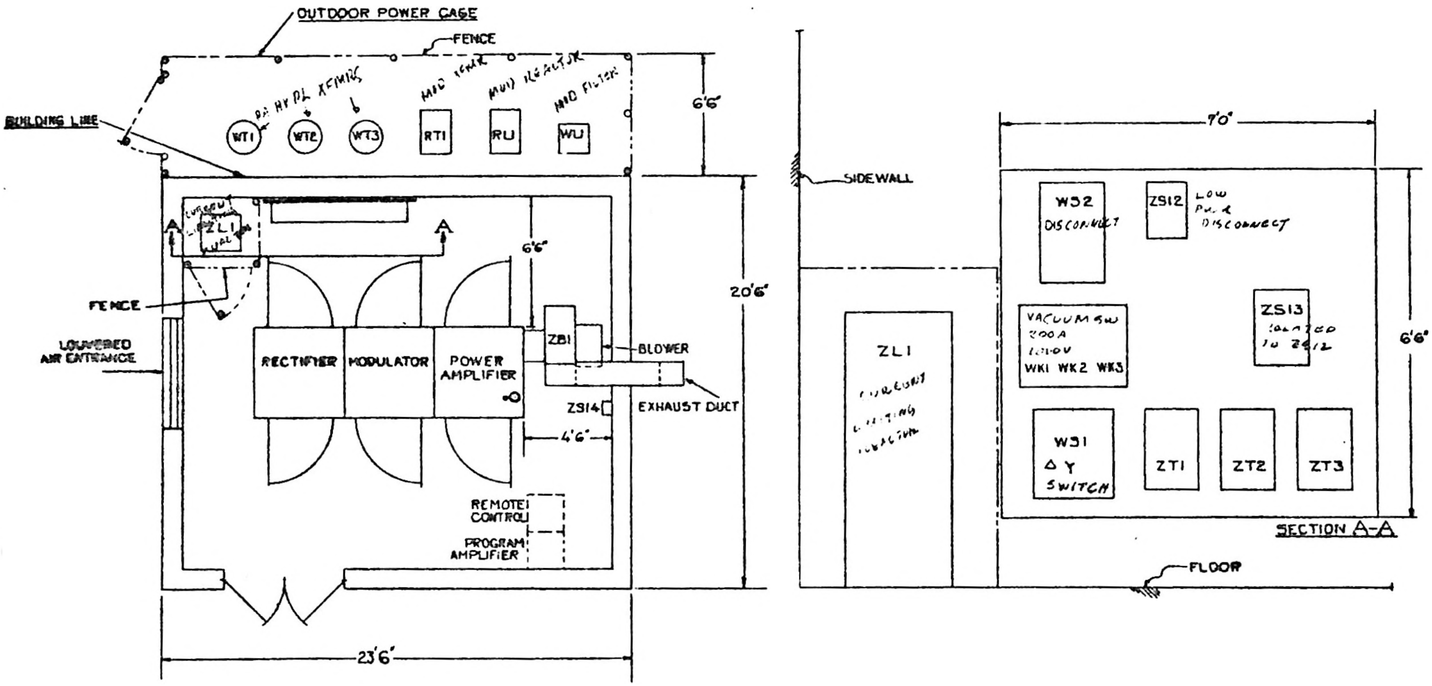

Fig. 45 Typical Station Layout for 480-Volt Operation (D-7669896, Sheet 1)

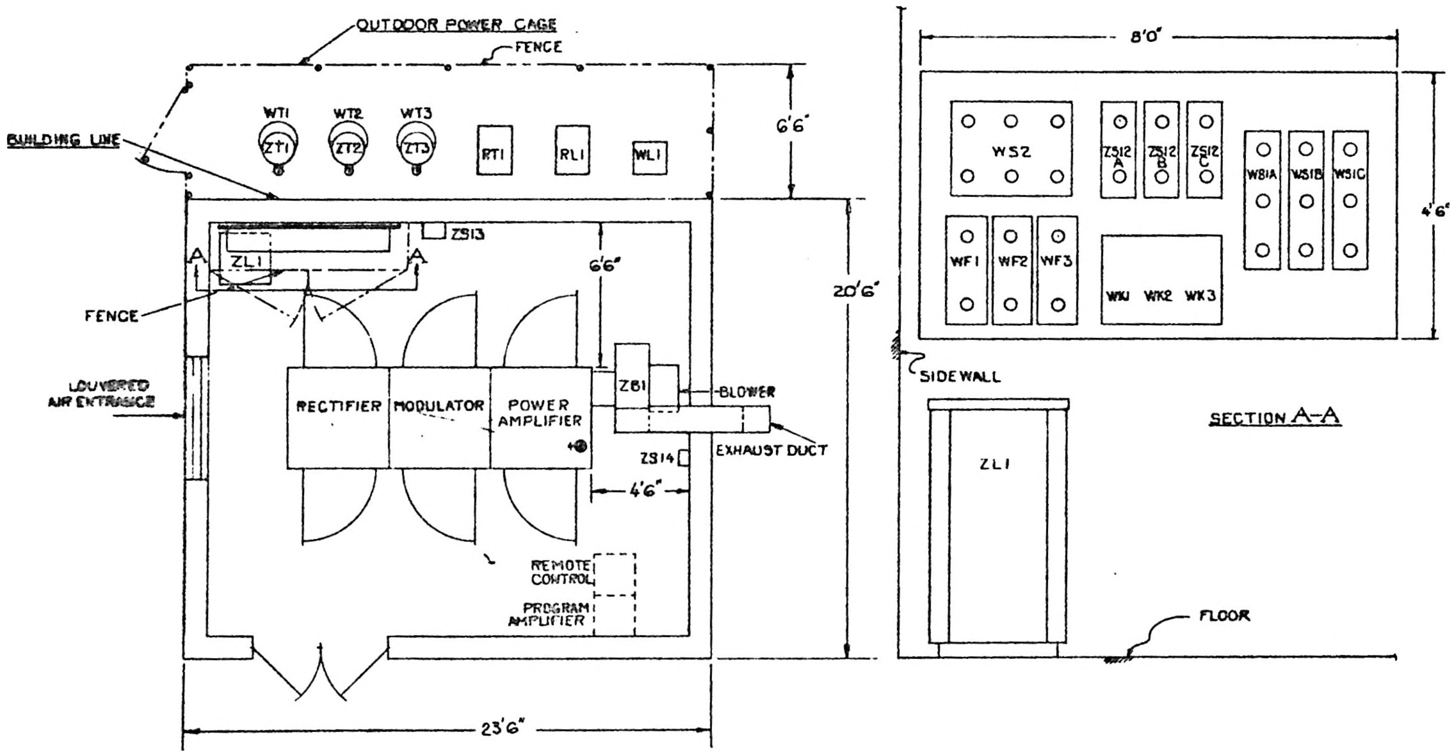

Fig. 46 Typical Station Layout for 2400/4160-Volt Operation (D-7669896, Sheet 2)

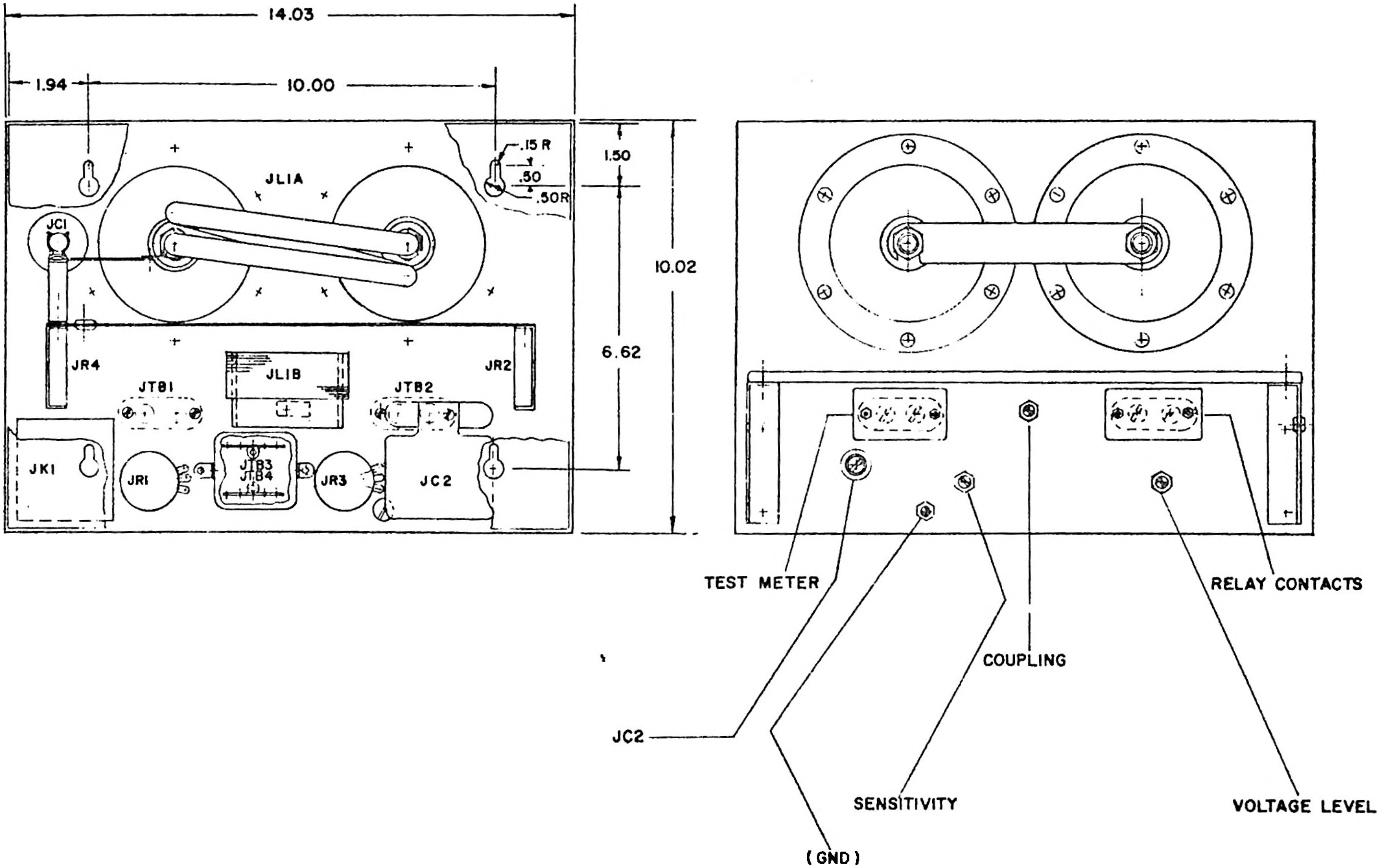

Fig. 59 Outline: Top and Bottom Views, Reflectometer, PL-444D442-G2 (C-7777467, Sheet 1)

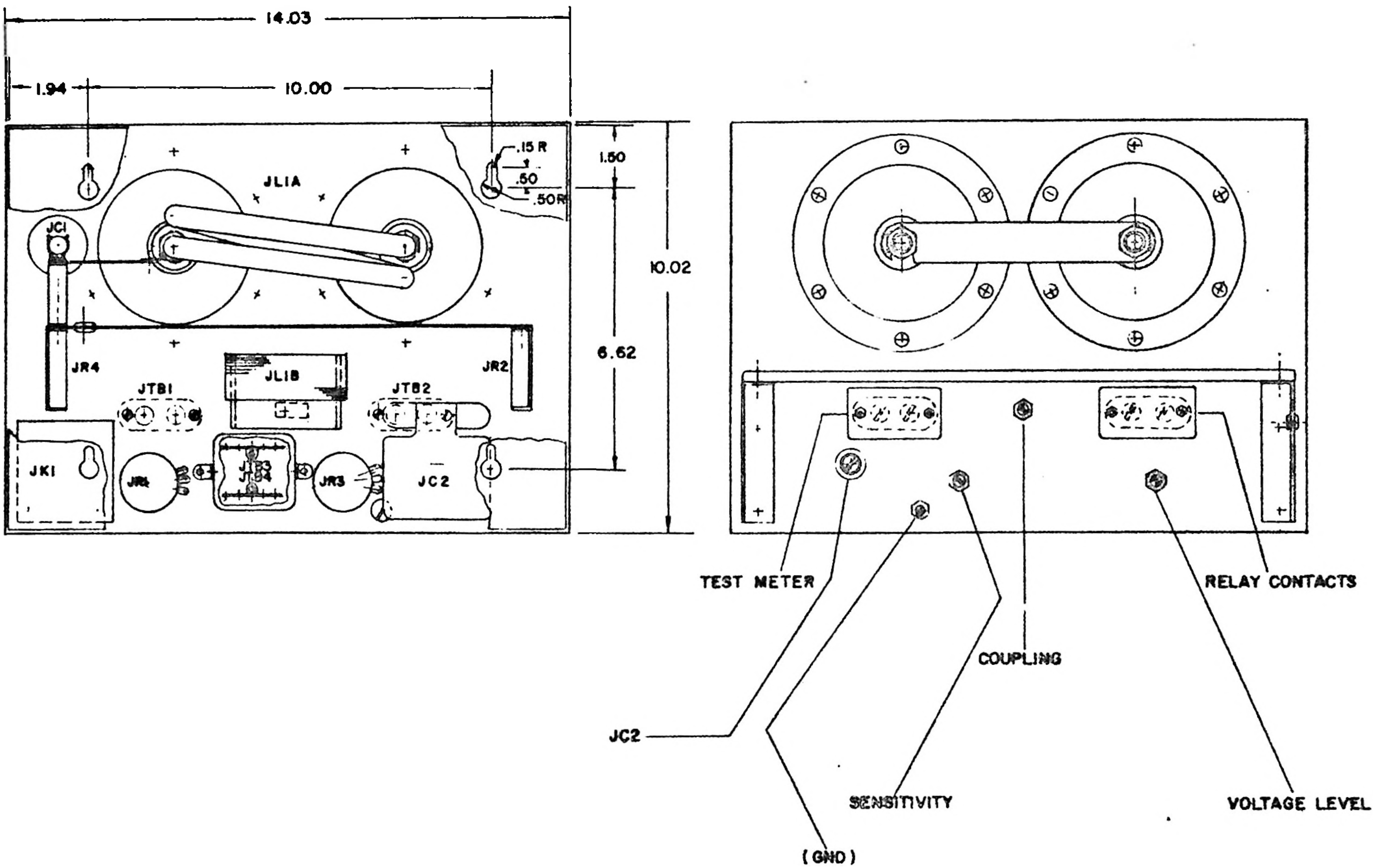

Fig. 59 Outline: Top and Bottom Views, Reflectometer, PL-444D442-G2 (C-7777467, Sheet 1)

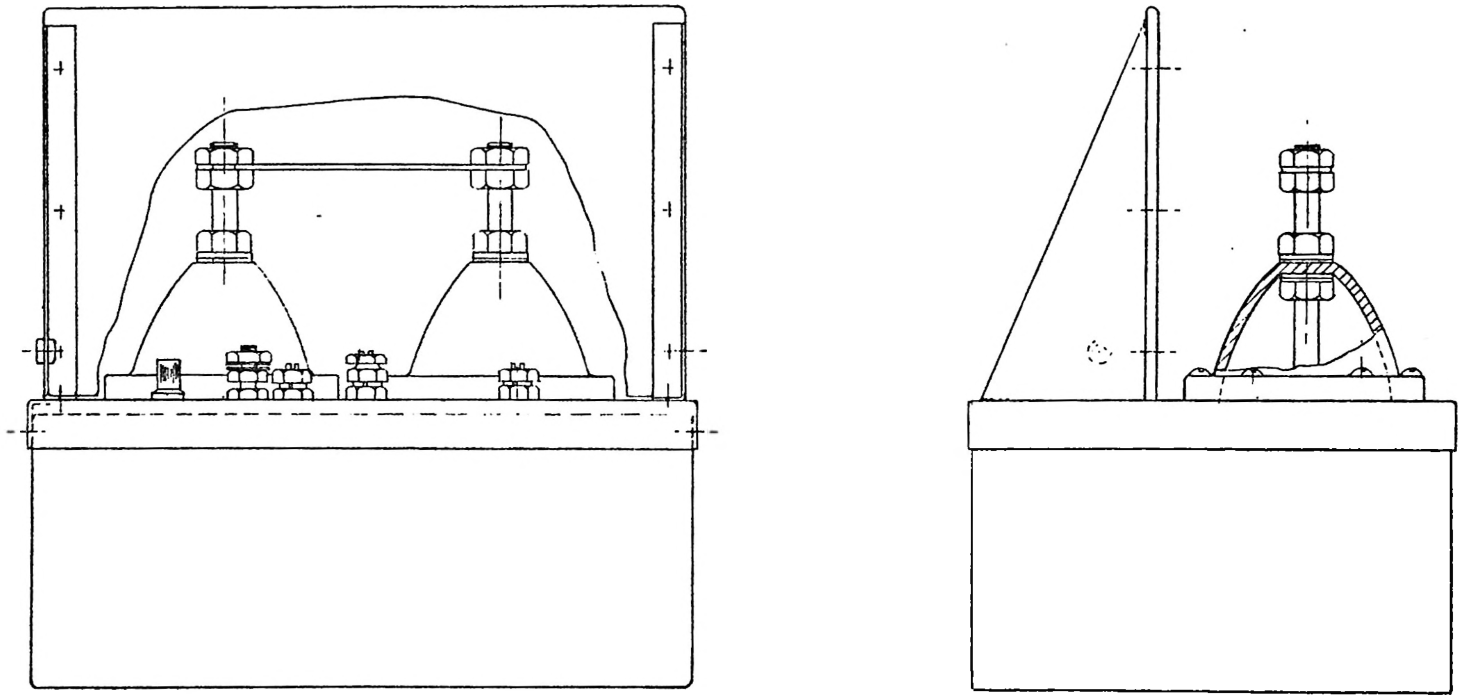

Fig. 60 Outline: Side and End Views, Reflectometer, PL-444D442-G2 (C-7777467, Sheet 2)

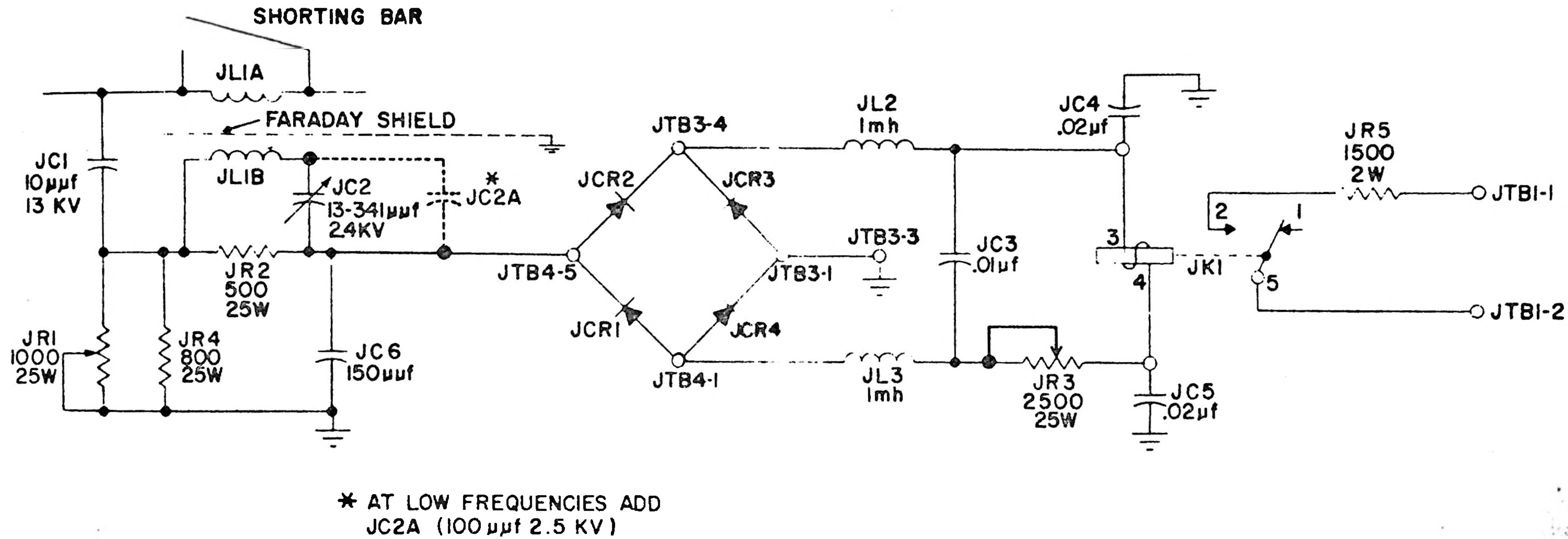

Fig. 61 Elementary Diagram, Reflectometer, PL-444D442-G2 (B-7492737)

Fig. 61
Reflectometer
Elementary

INTRODUCTION

The General Electric 50-KW AM Broadcast Transmitter (Fig. 1), Models 4BT50A1, 2, and 3, is an air-cooled transmitter designed to provide the broadcaster with modern equipment that will deliver high quality performance at low operating cost. The Transmitter will easily supply 53 kilowatts of amplitude-modulated carrier in the frequency range of 535 to 1620 kilocycles.

Three models are supplied: Model 4BT50A1 for a three-phase power input of 480 volts, Model 4BT50A2 for a power input of 2400 volts, and Model 4BT50A3 for a power input of 4160 volts.

It is the purpose of this instruction book to provide detailed information about the circuits employed and the adjustment and maintenance procedures to be followed. Adherence to these instructions will insure optimum performance as well as long and satisfactory service from the Transmitter.

TECHNICAL SUMMARY

Electrical

Type of Emission:	A3.
Frequency:	535 to 1620 kilocycles.
Frequency Stability:	± 5 cycles.
Power Output (at Transmitter output terminal):	53 KW.
Type of Modulation:	High level.
Audio Input:	10 dbm, ± 2 dbm for 100% modulation.
Audio Input Impedance:	600 ohms.
Audio Response:	± 1.5 db, 50 to 10,000 cycles.
Audio Distortion:	Less than 3%, 50 to 7500 cycles.
Noise Level:	More than 60 db below 100% modulation.
Carrier Shift:	Less than 2.5%, 0 to 100% modulation with 0 regulation of supply voltage.
Output:	Unbalanced.
Output Impedance:	50 to 230 ohms.
Power Requirements:	480, 2400, or 4160 volts, 60 cps, 3-phase.

Percentage Modulation	50 KW RF Carrier Power	53 KW RF Carrier Power
0%	94 KW at 0.9 PF	98 KW at 0.9 PF
30%	108 KW at 0.91 PF	113 KW at 0.91 PF
100%	145 KW at 0.93 PF	153 KW at 0.93 PF

Tube Complement

Quantity	Type	Symbol	Function
1	6146	AV1	Crystal oscillator
1	6146	BV1	Buffer amplifier
1	6156	CV1	First intermediate power amplifier
1	6623	DV1	Second intermediate power amplifier
2	6427	EV1, EV2	Power amplifier
2	6136	KV1, KV2,	First audio amplifier
2	6156	MV1, MV2	Second audio amplifier
4	304TL	NV1, NV2 NV3, NV4	Third audio amplifier
2	6427	PV1, PV2	Modulator

Mechnical

DIMENSIONS

	Height	Width	Depth	Shipping Weight
Rectifier and Control Cubicle	84"	54"	54"	2148 lb
Exciter and Modulator Cubicle	84"	54"	54"	1744 lb
RF Amplifier Cubicle	84"	54"	54"	1570 lb

MOUNTING

Refer to Figs. 2 through 7.

OPERATING CONDITIONS

Ambient Temperature: 0 to 120 F (-18 to +49 C approximately)

Maximum Altitude: 5000 feet for standard equipment (larger blower required for higher altitudes)

SAFETY PROVISIONS

All doors are provided with both electrical interlocks and safety grounding switches to protect personnel from high voltage. Control circuits provide overload protection and proper sequencing to prevent damage to the equipment.

FCC Filing Data

When applying for a Federal Communications Commission license, the following information will be helpful in filling out Section II-A of FCC Form 302.

Transmitter make: General Electric

Type number: BT-50-A

Rated power: 50 KW

Operation of last radio-frequency amplifier stage: Class C

Manufacturer's recommended operating efficiency for last radio-frequency stage:	76%
Is inverse feedback utilized:	Yes
To what value of feedback power is the Transmitter adjusted?	12 db

EQUIPMENT

Equipment Furnished

The General Electric AM Broadcast Transmitter discussed in this instruction book is identified by Model Number 4BT50A1, 4BT50A2, or 4BT50A3. Each of these models consists of the basic items listed below, their differences lying in the external equipment supplied for 480-, 2400-, and 4160-volt operation. The specific external equipment supplied for each model is tabulated under External Equipment Breakdown.

Item	Quanity	Designation
Rectifier and Control Cubicle	1	ML-589E231-G2
Exciter and Modulator Cubicle	1	ML-589E232-G2
RF Amplifier Cubicle	1	ML-589E233-G2
External Equipment		
4BT50A1	1	PLA-7162232-G1
4BT50A2	1	PLA-7162232-G2
4BT50A3	1	PLA-7162232-G3
Electronic Tubes	1 set	PLA-7163820
Intercubicle Connections	1	ML-101A6794-G1
External Connections		
4BT50A1	1	MLA-7164515-G1
4BT50A2	1	MLA-7164515-G2
4BT50A3	1	MLA-7164515-G3
Antenna Meter*	1	B-603B290
RF Current Transformer*	1	555C711
Crystals*		M-7466947
Reflectometer**	1	ML-444D442-G2
Instruction Book	2	EBI-2169

*Determined by customer requisition.

**Quantity determined by customer requisition; one supplied, others required are extra (usually one per tower).

External Equipment Breakdown

COMMON TO ALL MODELS

Item	Quanity	Designation
Modulation Reactor (RL1)	1	B-603B283-P1
Modulation Transformer (RT1)	1	B-603B282-P1
Filter Reactor (WL1)	1	B-7491984-P1
Thyrite Arrestor (WE1, WE2, WE3, RE1, RE2, RE3, RE4)	7	Cat. No. 9LA21BX8
Blower (ZB1)	1	C-7776861-P2
Vacuum Switch Box	1	ML-444D142-G1
208-Volt Supply Switch (ZS13)	1	Cat. No. TC90423SNSDJ6
208-Volt Supply Fuse (ZF4, ZF5, ZF6; spares included)	6	Cat. No. GF6A100
Blower-Supply Circuit Breaker (ZS14)	1	7777407-G1

MODEL 4BT50A1

Item	Quanity	Designation
Plate Transformer (WT1, WT2, WT3)	3	Cat. No. 5508AD2550
Current-Limiting Reactor (ZL1, Outline 516B729)	1	Cat. No. 92H37
Delta-Wye Switch (WS1A, B, C)	1	Cat. No. TC35364
Plate Disconnect Switch (WS2A, B, C)	1	Cat. No. TC90364SDJ6
Distribution Disconnect Switch (ZS12A, B, C)	1	Cat. No. TC90362SDJ6
Distribution Transformer (ZT1, ZT2, ZT3)	3	Model No. 9T21Y12
Fuse for Plate Supply (WF1, WF2, WF3; spares included)	6	Cat. No. GF6B200
Fuse for Distribution Supply (ZF1, ZF2, ZF3; spares included)	6	Cat. No. GF6B60

MODEL 4BT50A2

Item	Quanity	Designation
Plate Transformer (WT1, WT2, WT3)	3	Cat. No. 5525AD1550
Current-Limiting Reactor (ZL1)	1	B-7491983-P1
Delta-Wye Switch (WS1A, B, C)	3	Cat. No. 175L625G37
Plate Disconnect Switch (WS2A, B, C)	1	Cat. No. 175L630G213
Plate Fuse Holder (WXF1, WXF2, WXF3)	1	Cat. No. 175L661G1
Distribution Disconnect Switch (ZS12A, B, C)	3	Cat. No. 175L615G1

Item	Quanity	Designation
Distribution Transformer (ZT1, ZT2, ZT3)	3	Cat. No. 2701AC6510
Fuse for Plate Supply (WF1, WF2, WF3; spares included)	6	Cat. No. 6193403G13
Fuse for Distribution Supply (ZF1, ZF2, ZF3; spares included)	6	Cat. No. 6193403G8
Fuse Tong and Switch Hook	1	Cat. No. 6106644G2
Fuse Tong and Switch Hook	1	Cat. No. 6106644G10

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Plate Transformer (WT1, WT2, WT3)	3	B-594B667-P1
Current-Limiting Reactor (ZL1)	1	B-7492285-P1
Delta-Wye Switch (WS1A, B, C)	3	Cat. No. 175L626G36
Plate Disconnect Switch (WS2A, B, C)	1	Cat. No. 175L632G210
Plate Fuse Holder (WXF1, WXF2, WXF3)	1	Cat. No. 175L661G7
Distribution Disconnect Switch (ZS12A, B, C)	3	Cat. No. 175L615G9
Distribution Transformer (ZT1, ZT2, ZT3)	3	Cat. No. 3601AC6510
Fuse for Plate Supply (WF1, WF2, WF3; spares included)	6	Cat No. 6193406G11
Fuse for Distribution Supply (ZF1, ZF2, ZF3; spares included)	6	Cat. No. 6193404G7
Fuse Tong and Switch Hook	1	Cat. No. 6106644G2
Fuse Tong and Switch Hook	1	Cat. No. 6106644G10

Accessories

The following accessories are supplied with the Transmitter:

Item	Quanity	Designation
Air Filters	4	ML-102A4632-P1
Felt, 826A952-P1 x 30' long	1	
Rubber Strip, 832A336-P1 x 10" long	2	
Paint Touch-up Kit	1	K-7134491-G2
Screw, ¼-20 x 3/4 long	16	N-81P21012C13
Lockwasher, ¼ ID	16	N-414P25C13
Nut, ¼-20	16	N-210P21C13
Washer, ¼	32	N-402P41C13
Glyptal (tube)	1	No. 1276

DESCRIPTION

Construction

The General Electric 50-KW AM Broadcast Transmitter consists of the Transmitter proper and the external components listed under EQUIPMENT.

The Transmitter is housed in three cubicles (Rectifier and Control, Exciter and Modulator, and RF Amplifier) which are designed to be joined together in a straight line. A recessed kick cove is provided along the front of each cubicle to prevent scuffing of the finish. The frequently used controls and supervisory lights are located on the panels to the side of the front door of each cubicle. The necessary indicating meters are mounted on the doors. The control breakers are located within the Rectifier and Control cubicle at the front. The front and rear doors provide access to components and subassemblies for adjustment and servicing. The rear doors of all three cubicles and the front doors of the Exciter and Modulator and RF Amplifier cubicles are provided with interlocks and safety grounding switches.

Rectifier and Control Cubicle

Refer to Figs. 8 through 18.

All the bias and plate supplies use germanium rectifiers in a three-phase, full-wave circuit and are located in the Rectifier and Control cubicle. The 500-volt supply provides 500 volts for the oscillator and buffer stages, 300 volts for the plates and screens of the first audio amplifier, d-c voltage for the screens of the second audio amplifier, and voltage for the screen grid of the first IPA. The 1500-volt supply provides plate voltage for the first IPA and the third audio amplifier. The 3500-volt supply provides the plate voltage for the second IPA and the second audio amplifier. The Modulator bias supply provides bias voltage for the first IPA tube, the third audio amplifier, and the Modulator. The PA bias supply provides protective bias for the PA tubes when there is no RF drive to the final stage. The 9000-volt supply provides plate voltage for the Modulator and PA stages.

Power and control circuit breakers as well as overload relays are mounted on the relay chassis located on the inner front panel of the Rectifier and Control cubicle. Refer to the discussion under Control System.

Exciter and Modulator Cubicle

Refer to Figs. 19 through 29.

The Exciter and Modulator cubicle houses the following RF and audio circuits.

The crystal oscillator and buffer amplifier are housed in a separate shielded compartment. The oscillator stage utilizes a Type 6146 tube in an electron-coupled Colpitts circuit and two low temperature-coefficient crystals in individual Thermocells*, either of which may be switched into the circuit. The plate of the Type 6146 tube has a resistive load and is capacity-coupled to the grid of the buffer stage.

The buffer stage consists of a Type 6146 tube providing (1) isolation of the oscillator stage for high-frequency stability, (2) drive for the first IPA stage, and (3) a convenient point at which the carrier may be interrupted. The plate load of the Type 6146 tube is a conventional parallel-resonant circuit consisting of fixed capacitors and a slug-tuned coil. Drive to the first IPA stage is adjusted by a variable resistor which controls the screen voltage of the buffer amplifier tube.

The first IPA uses a high-gain tetrode (Type 6156), operating Class C. Fixed bias on the grid, obtained from the Modulator bias supply, assures complete elimination of the carrier when the carrier trip circuit operates.

*Registered U.S. Patent Office.

The second IPA uses a neutralized triode (Type 6623), operating Class C. It provides drive for the PA stage.

The first audio amplifier uses two Type 6136 pentodes connected to form a Schmidt circuit having a large resistance common to both cathodes. The amplified audio signal is resistance-capacity coupled to the grids of the next stage.

The second audio amplifier uses two Type 6156 tetrodes in a resistance-capacity coupled amplifier. It amplifies the audio signal to the voltage level required to drive the Modulator tubes.

The third audio amplifier uses four Type 304TL triodes connected as a parallel push-pull cathode follower circuit. It transforms the high-impedance signal appearing at the plates of the preceding stage into a low-impedance signal to drive the grids of the Modulator tubes operating in Class B.

Feedback around the audio stages makes it easy to maintain low distortion. Adjustments are neither critical nor subject to small variations in tubes or other operating parameters. Feedback is applied to the Transmitter by means of two audio feedback circuits. The "primary" feedback, operating at the higher audio frequencies, is obtained from the modulation transformer primary, while the "secondary" feedback is obtained from the cathode of the PA (that is, virtually across the secondary of the Modulation transformer) and operates at the lower audio frequencies. This feedback at low audio frequencies keeps hum well below 60 db and reduces distortion.

The Modulator stage uses two Type 6427 triodes operating in Class B push-pull. The grids are coupled directly to the cathodes of the preceding stage. Grid bias for the Modulator tubes is obtained from a voltage divider across the -780 volt supply. The divider is so arranged that the adjustment of the third amplifier bias and the Modulator bias are independent of each other.

RF Amplifier Cubicle

Refer to Figs. 30 through 44.

The RF Amplifier cubicle houses the power amplifier stage, which employs two Type 6427 triodes in parallel, operating as a Class C amplifier. The output circuit consists of three sections: (1) an impedance transformer to transform any resistive impedance in the range of 50 to 230 ohms up to a resistance of 250 ohms; (2) a double-section pi filter operating at an impedance level of 250 ohms (one leg of the filter consists of a series-resonant trap tuned to the second harmonic of the carrier frequency); and (3) a pi tank circuit which transforms the filter impedance of 250 ohms up to 535 ohms required by the PA tubes. The loaded Q of this tank circuit varies from a value of 6 at the low-frequency end of the band to 12 at the high-frequency end.

Control System

The several functions of the control system include those of conveniently starting and stopping the Transmitter, properly maintaining the starting and stopping sequence, protecting the equipment from self-destruction, and protecting station personnel from accidental contact with the high-voltage circuits. The rear access doors of all three cubicles and the front doors of the Modulator and RF Amplifier cubicles are equipped with interlocks that remove the primary power from the rectifier transformers when the doors are open. These doors actuate switches that mechanically ground the high-voltage a-c and d-c buses. Quick-acting d-c overload relays and magnetically-operated a-c switches protect the equipment against electrical overload. If there is a plate circuit overload, two plate reclosures can occur before lockout; provision has been made for automatic reset if no more than two overloads occur in any 30-second period. The Transmitter will also recycle for power-line failures of less than two seconds. When operated by the Reflectometer, the lightning trip-circuit will trip the carrier at the buffer stage for a fraction of a second. It will also insure that the audio input will be shorted out before RF excitation is cut and that RF excitation is restored to normal before audio drive is resumed.

Power control to the individual power supplies can be exercised from the control chassis on the inner front panel of the Rectifier and Control cubicle.

For a detailed discussion of the control system, refer to the THEORY AND CIRCUIT ANALYSIS section.

Cooling System

Forced air is used for tube and cubicle cooling. The blower is located externally to the Transmitter. Air is drawn through filters in the roof of the Rectifier and Control cubicle, passes through the Modulator and RF Amplifier cubicles via openings in the side walls, and through the final tubes into the air duct and is exhaused by the blower. Some of the air bypasses the final tubes and cools the low-level audio and RF stages.

AC Power Supply Circuits

The Transmitter requires a three-phase power source of either 480, 2400, or 4160 volts at a frequency of 60 cycles per second. The input voltage specified affects the following components: the current-limiting reactor, plate disconnect switch, delta-wye switch, plate transformers, distribution transformers, and the distribution disconnect switch. These components differ in rating for the different input voltages, but are in all cases similar in their functions.

The incoming power line is terminated at the common junction of the distribution disconnect switches. Back-up protection for the plate circuit is provided by current-limiting fuses.

Vacuum switches perform the normal function of switching on the primary voltage to the plate transformers while also serving as very fast-acting circuit breakers. Tripping action is initiated by overcurrent relays in the secondary of the plate transformers. The current-limiting reactors restrict fault currents to approximately ten times normal operating current.

The distribution circuit is protected by current-limiting fuses, and the primary voltage is then stepped down by three transformers to a 208-volt, four-wire supply.

Drawings and Symbols

Drawing are titled, numbered, and listed in the front of this book.

Circuit components are indentified by two letters followed by a number. The first letter identifies the circuit in which the component is to be found. The circuits so identified include the following:

Letter	Circuit
A	Oscillator
B	Buffer
C	1st IPA
D	2nd IPA
E	PA
F	Harmonic filter

Letter	Circuit
G	-450 volt bias supply
H	Secondary feedback-circuit filter
J	Reflectometer
K	1st audio amplifier
M	2nd audio amplifier
N	3rd audio amplifier
P	Modulator
R	Modulator external equipment
S	500-volt supply
T	1500-volt supply
U	3500-volt supply
V	9000-volt supply
W	9000-volt external equipment
X	-780 volt bias supply
Y	Control circuit
Z	Distribution circuit

The second letter of the component symbol indicates the type of component: C for capacitor, R for resistor, K for relay, V for tube, and so on. The numerical suffix indicates the number of the component in the circuit. The symbol number AV1, for example, identifies tube 1 in the crystal oscillator circuit.

All parts are listed alphabetically by symbol numbers in the Parts List, which includes a description and drawing number for each.

Terminal board numbers are followed by a dash, and then the particular terminal number is given. (The component designation TB, it should be noted, is omitted on the elementary diagram to conserve space.)

All controls on the Transmitter are labeled with their names. All components in the Transmitter, wherever possible, are stamped with their symbols numbers and are similarly identified on drawings.

INSTALLATION

Unpacking

Inspect each package as it is received for possible shipping damage. Claims for damaged equipment must be filed against the carrier within ten days of delivery or the carrier will not accept the claim. When the equipment is delivered to the carrier by the General Electric Company, it becomes the property of the customer.

Check the equipment received against the packing list. The packing cases of all units are stenciled with a number. If there is a shipping error or if, because of damage, replacement equipment must be ordered, notify the General Electric Company representative.

The packing list designates the various boxes by number and the contents by name, symbol number, and drawing or model number to facilitate positive location and identification of all components.

All tubes and crystals are separately packed and identified on the packing list by type and symbol number to facilitate their correct location in the Transmitter. All loose items, such as contactor arms, are securely tied. Remove the fastenings and inspect such items for possible shipping damage. Any component which required the removal of screws, nuts, and any other hardware for disassembly has these either fastened to the component or to the mounting area in order to facilitate reassembly.

It is recommended that the Transmitter cubicles be permanently located before re-installing any of the components removed to facilitate shipping. The procedures for reassembly are covered in detail under Assembly of Components Removed for Shipment, below.

Handle crystals and electronic tubes with care.

If the Transmitter site has not been completed by the time the equipment is received, leave the units packed and place the boxes in a safe, dry place. This will prevent dust and dirt raised by sweeping, plastering, or drilling from settling into electrical components and causing serious maintenance problems later.

Location

Typical station layouts are shown in Figs. 45 and 46.

Locate the Transmitter in a well-ventilated room. Provide wiring ducts or conduit suitable for wiring between the Transmitter, transmitter racks, and the three-phase incoming power. It is not necessary, however, to lay the wiring before the equipment is in place.

Some of the factors to consider in planning a station are the following: (1) provision for incoming power supply lines, (2) good grounding connection, (3) proper transmission-line supports, (4) exits to the antenna, (5) adequate illumination, (6) sufficient space for the proper mounting of external equipment, and (7) sufficient space in front and at the rear of the Transmitter cubicles to permit opening and closing of the cabinet doors (the clearances required in the station layout are shown in Figs. 45 and 46).

Before locating the cubicles in their final positions, apply the adhesive-backed felt stripping supplied around and on the outside of the side-wall openings of the cubicles where they will join together to form an air stop. After this has been done the cubicles can be set in their positions, shimmed if necessary to level them, and then bolted together with the hardware provided.

Assembly of Components Removed for Shipment

The cubicles have been fairly extensively dismantled for shipment. It is important that all of the components that have been removed be re-installed and wired correctly before attempting to operate the Transmitter. The parts removed from the cubicles have been tagged with their symbol numbers. The hardware required for mounting them has been enclosed in a bag attached either to the component removed or to the mounting area. Wherever practicable, the cubicle has also been marked with the symbol number of the component removed to show its proper location. Photographs (Figs. 8 through 44) and Connection Diagrams (Figs. 47 through 56) are included in this book to show the location of parts. It should be noted that shipping fixtures used to provide firm support for elements left in the cubicles for shipment are tagged to indicate this. Remove and discard the shipping fixtures.

Refer to the Interconnection Diagram and Elementary Diagram, Figs. 57 and 58, to make certain that proper electrical connections have been made both for the components replaced in the cubicle and for the power components located externally to the cubicles.

RECTIFIER AND CONTROL CUBICLE

1. Transformers ZT4, ZT5, and ZT6

The filament transformers, ZT4 and ZT5, for the PA tubes as well as voltage-stabilizing transformer ZT6 are removed from the Rectifier and Control cubicle for shipment and are packed in boxes 2 through 4 (refer to the packing list). Their location in the cubicle is shown in Figs. 9 through 11 and Fig. 47. The hardware required to mount them is enclosed in a bag attached either to the transformer or to the cubicle supporting members designed to accomin the WYE position, close the disconnect switch, WS2. To check for resonance of the tank circuit, the PA PLATE TUNING capacitor, EC20, should be turned until a dip is indicated on the TOTAL PA PLATE current meter, EM5. The capacitor should then be turned slightly on the minimum capacity side (higher number on the tuning position indicator) of the dip. With a reading of 5 amperes on EM5, the output should be approximately 10 KW.

After the satisfactory completion of these adjustments, the Transmitter is ready for full-power operation.

FULL POWER TESTING

With the Transmitter turned off, switch off, switch the DELTA-WYE switch to the DELTA position. Switch on the Transmitter as before. Adjust the PA PLATE TUNING capacitor, EC20, for a reading of 8 amperes on the TOTAL PA PLATE current meter, EM5. For the setting of EC20 which will give maximum efficiency, refer to page 23 under PA Tank Circuit.

Adjust the MODULATOR BIAS and MODULATOR BALANCE controls for a reading of 200 ma on both the LEFT MODULATOR CATHODE meter, PM1, and the RIGHT MODULATOR CATHODE meter, PM2. Adjust the LEFT and RIGHT 3RD AMP BIAS controls for a reading of 100 ma on both the LEFT and RIGHT 3RD AMP ANODE meters, NM1 and NM2, respectively.

Audio may now be applied to the Transmitter. Feed a 1000-cycle tone to the input and increase the amplitude until 100% modulation is obtained. Meter readings should then be checked. The audio and RF stages are now ready for normal service.

Typical Meter Readings

Meter Marking	Meter	Selector Switch Position	Reading No Modulation	Reading 100% Modulation (1000 cps)
9000 V SUPPLY	VM1		9.0 kv	8.8 kv
3500 V SUPPLY	UM1		3.65 kv	3.6 kv
1500 V SUPPLY	TM1		1.55 kv	1.5 kv
500 V & BIAS SUPPLIES	SM1	500 V	0.5 kv	0.49 kv
		PA BIAS	0.46 kv	0.47 kv
		MOD BIAS	0.7 kv	0.68 kv
FILAMENT ELAPSED TIME	YM1		-	-
FILAMENTS	EM2	LEFT MOD	7.6 v	7.6 v
		RIGHT MOD	7.6 v	7.6 v
		LEFT PA	7.9 v	7.9 v
		RIGHT PA	7.9 v	7.9 v
AUDIO AMPLIFIERS	LM1	LEFT 1ST	6.4 ma	6.0 ma
		RIGHT 1ST	6.2 ma	6.0 ma
		LEFT 2ND	100 ma	100 ma
		RIGHT 2ND	100 ma	100 ma
LEFT 3RD AMP ANODE	NM1		100 ma	250 ma
RIGHT 3RD AMP ANODE	NM2		100 ma	250 ma
LEFT MODULATOR CATHODE	PM1		0.2 amp	3.5 amp
RIGHT MODULATOR CATHODE	PM2		0.2 amp	3.5 amp
RF EXCITER	DM1	OSC CATHODE	16 ma	15 ma
		BUFFER CATHODE	22 ma	21 ma
		1ST IPA GRID	12 ma	12 ma
		1ST IPA CATHODE	160 ma	160 ma
		2ND IPA GRID	210 ma	210 ma
2ND IPA PLATE	DM2		1.15 amp	1.10 amp

Meter Marking	Meter	Selector Switch Position	Reading No Modulation	Reading 100% Modulation (1000 cps)
PA GRID	EM1		0.9 amp	0.9 amp
LEFT PA CATHODE	EM3		4.55 amp	4.45 amp
RIGHT PA CATHODE	EM4		4.55 amp	4.45 amp
TOTAL PA PLATE	EM5		8.0 amp	7.8 amp
ANTENNA	FM1		-	-

Additional Control Circuit Checks

NOTE

The delay periods of the control relays have been set at the factory and do not normally require resetting. Should the relays get out of adjustment, the following are the instructions for resetting. The adjustments may be made with or without plate power being applied.

PLATE TIME-DELAY RELAY, YK6

The Transmitter should be operating for at least 10 minutes in order to stabilize the temperature of the relay. Operate the TRANSMITTER STOP-START switch to the STOP position and after three seconds return the switch to the START position. This effectively simulates a power failure of three seconds. If the 500-volt and bias supplies come on immediately, increase the value of YR1 by a clockwise motion of the screwdriver adjustment until a time delay of less than half a second occurs between the turning of the transmitter switch to the START position and the operation of the power supplies.

PLATE TIME-DELAY RELAY, YK15

Time-delay relay YK15 should be set for a delay of one second. This is the time elapsed between turning the PLATE SUPPLIES switch to the ON position and the actual presence of the voltage. The time delay is increased by turning the screw at the top of the relay clockwise.

CAPACITORS CHARGED TIME-DELAY RELAY, YK25

Relay YK25 controls the time between the application of the 9000-volt supply and the closing of the contactor which shorts the surge suppressor resistors. The delay may be noted by the time between the lighting of the 9000 V supervisory light and the CAPACITORS CHARGED supervisory light. A screw on top of the relay regulates this time. The delay should be between 1/3 and ½ second.

RESET TIME-DELAY RELAY, YK12

Relay YK12 controls the time between the occurrence of an overload and the resetting of stepping relay YK11. To note the timing of this relay, manually press the stepping relay armature of YK11 while the Transmitter is operating normally, thereby simulating an overload. Note the time delay between the overload simulation and the operation of the reset coil. The timing of this relay may be adjusted by a screw on top of the relay. The normal operating time is 30 seconds.

OVERLOAD RESET DELAY RELAY, YK14

This relay keeps the reset coils of the overload relays energized to make sure that all have been properly reset. The duration of operation of this relay may be timed by operating one of the overload relays manually (removing the cover and lifting the armature with an insulated screwdriver). When this is done, a buzzing sound will be heard, indicating that the reset coils of the overload relays are operating. The duration of this buzz is the duration of the delay of YK14. The screw on top of the relay adjusts the length of the delay. Check for normal delay time of half a second.

Tuning Instructions

The following is a description of the procedure for changing from one frequency to another, i.e., completely retuning the Transmitter. Plug in a pair of crystals of the desired output frequency.

Referring to TUNING DATA in the MAINTENANCE section, page 35, make the appropriate changes to the following components: BL2, CL4, DL4, DL5, EL1, EL7, EL9, FL1 and FL3, FL2 and FL4.

See that circuit breakers ZS3 through ZS11 are in the ON position.

Turn selector switch YS3 to the 500 V only position.

Move the TRANSMITTER STOP-START switch to the START position.

OSCILLATOR

The 500-volt supply comes on with the bias and filament voltages. Check that the oscillator plate current is approximately 16 ma by means of the RF EXCITER meter, DM1, and its associated switch, DS1.

BUFFER

With the RF EXCITER meter reading 1ST IPA GRID current, adjust the slug-tuned buffer tank coil, BL2, for a maximum reading. Adjust drive control BR10 for a reading of 20 ma. (The drive control should be re-checked later, when the Transmitter is operating normally, and readjusted, if necessary, for a reading of 12 ma, 1st IPA grid current.)

The frequency of the oscillator should now be checked on the station frequency monitor. The frequency of both controls should be adjusted by means of the frequency trimming capacitors, AC4 and AC5, for the left and right crystals respectively to within a few cycles of the desired frequency.

1ST IPA

The screen voltage to the 1ST IPA tube, CV1, has been set at the factory by adjusting the tap on resistor SR5 and should not need to be changed. The normal screen voltage is approximately 300 volts.

In order to tune the 1st IPA, make the following adjustments.

Move the supplies switch, YS3, to the 9000 V OFF position.

Change over the TUNE/OPERATE switches, DS2 and CS1 (located on the inner panel of the Modulator cubicle), to the TUNE position.

Disconnect the 3500 V B+ lead from the top end of the 2nd IPA plate choke, DL3. Disconnect the strap from the 2nd IPA blocking capacitor, DC6, to the tank coil, DL5. (The object of the last operation is to isolate the, as yet, untuned 2nd IPA neutralizing circuit from the 1st IPA tank circuit.)

Turn 1st IPA tank capacitor CC8 for maximum capacity (counterclockwise).

Switch on the plate supplies. Turn the RF EXCITER meter switch to read 2ND IPA GRID current. Turn 1st IPA tank capacitor CC8 clockwise until a maximum meter reading is obtained.

The 1ST IPA CATHODE current meter should now read approximately 100 ma, and the 2ND IPA GRID current meter, 30 ma.

The loading of this 1st IPA stage has been predetermined by following the tuning charts. If it is desired for any reason to change the loading, it may be increased by moving the tap towards the left and vice versa. Care should be taken not to increase the coupling too much as low efficiency will result. The loading cannot, however, be checked until the 2nd IPA stage is operating normally.

2ND IPA

Switch the plate supplies off.

Reconnect the strap from capacitor DC6 to tank coil DL5.

Turn the coupling coil in DL5 for minimum coupling, i.e., with the axis of the two coils at right angles.

Turn tank capacitor DC7 to maximum capacity.

Switch on the plate supplies.

Move the TUNE/OPERATE switch, CS1, in the 1st IPA stage to the operate position.

Turn the tank capacitor, DC7, out until a pronounced dip in the 2nd IPA GRID current occurs due to lack of neutralizing. A turn by turn change of the neutralizing capacitor, DC5, will minimize this dip. When the minimum has been reached, the stage is approximately neutralized.

Switch off the plate supplies.

Reconnect the 3500 V B+ lead to the plate choke, DL3.

Switch on the plate supplies.

Tune the second IPA tank capacitor through resonance and note the reading of the counter of the 2ND IPA PLATE TUNING capacitor when the plate current reaches minimum and again when the grid current reaches the maximum. If these two readings do not coincide, slightly turn the neutralizing capacitor, DC5, until they do. When this is achieved, the stage is perfectly neutralized.

Care should be taken to use as much inductance (DL4) and as little capacity (DC5) as possible since this gives the broadest bandwidth to the neutralizing circuit.

With the 2nd IPA tank circuit at resonance and with minimum coupling to the PA, tune the PA GRID capacitor for a maximum reading on the PA GRID CURRENT meter (starting from zero reading on the counter, indicating maximum capacity). This completes the tuning of the PA grid current and the control should not subsequently be moved.

Increase the coupling to the PA by moving the coupling coil of DL5 by small amounts, at the same time retuning the 2ND IPA PLATE TUNING for minimum 2ND IPA PLATE CURRENT until a minimum reading of 0.6 ampere plate current is reached.

Move the 2nd IPA TUNE/OPERATE switch (DS2) to the OPERATE position and readjust the loading and tuning approximately 1.2 amperes. Proper PA grid current is obtained with approximately 1.1 amperes of 2ND IPA PLATE CURRENT. (Later, when the PA plate voltage is switched on, the PA grid current will drop to approximately 0.9 ampere.)

If necessary, readjust the loading of the 1ST IPA stage to give a final reading of 160 to 200 ma as read on the 1ST IPA CATHODE current meter and 210 to 250 ma on the 2ND IPA GRID current meter.

PA

Switch off the plate supplies.

Reduce the loading of the PA by temporarily short-circuiting the loading capacitor (EC21) by connecting a strap from the bowl insulator to ground. (The reason for doing this is to obtain a sharp resonance point which makes neutralizing easier.)

Keep the selector switch, YS3, in the 9000 V OFF position. Switch on the plate supplies. Vary the PA PLATE TUNING until a sharp reaction is noted in the reading of the PA GRID current meter. Adjust the taps on EL7 and EL8 until reaction is at a minimum; the PA is now approximately neutralized.

Switch off the plate supplies.

Take off the short across EC21.

The Transmitter is now tuned except for the PA tank circuit. Begin further tuning from the transmission line terminal. Tune the Harmonic Filter first, followed by the PA tank circuit.

HARMONIC FILTER

With the transmission line connected to the output terminal of the Transmitter, proceed to tune the Harmonic Filter as follows:

1. Break the connection joining FL3 to FL2. With an impedance bridge connected across FC2, adjust FC2 for zero reactance. The resistance should be 250 ohms. If necessary, alter FL4, readjusting FC2 for zero reactance at each step until a value of 250 ohms is obtained. Disconnect the bridge.

2. Break the connection joining EL9 to EC21. With a suitable signal generator, apply a voltage at the second harmonic frequency across EC21. Adjust FC1 for minimum second harmonic voltage across the series combination of FL2 and FC1 as observed with a sensitive receiver connected at this point. Disconnect the signal generator and receiver. Reconnect FL3 to FL1 and FL2.

3. Connect the impedance bridge across EC21 and adjust FC2 for 350 ohms resistance and EC21 for zero reactance. Disconnect the impedance bridge and replace the connection joining EL9 to FL1 and EC21.

4. Break the connection joining EL8 and EC18 to EC19 and EL9. With the impedance bridge connected across EC19, adjust EC20 and EC21 for approximately 550 ohms resistance and not more than 250 ohms reactance. Disconnect the impedance bridge, and reconnect EL8 and EC18 to EC19, EC20, and EL9.

The harmonic filter is now correctly tuned and the tank circuit is approximately tuned.

PA TANK CIRCUIT

To finalize the PA tuning proceed as follows: Move the DELTA-WYE switch to the WYE or low-voltage position.

Turn the selector switch, YS3, to the OPERATE position. Switch on the plate supplies.

Tune the PA PLATE TUNING capacitor, EC20, to resonance as indicated by a dip in the PA PLATE current meter. The reading should be 4.3 to 4.5 amperes. If the reading is too low, increase the loading by moving the PA PLATE LOADING switch to the INCREASE position for a few seconds. Retune the PA PLATE TUNING to resonance and check the current. Repeat this procedure until the correct current is obtained. If, however, the plate current is too high, DECREASE the loading.

Check the neutralizing by noting the reading on the PA PLATE TUNING counter when the PA PLATE CURRENT is at a minimum and again when the PA GRID CURRENT is at a maximum. The minimum and maximum should occur at the same counter reading. If it does not, change the tap on EL8 a few turns at a time until coincidence is obtained.

Before switching to high power it is advisable at this point to make a check of the system. An estimate should be made of the efficiency of the PA. The power output can be measured by means of the antenna current meter, and the efficiency calculated as follows:

$$\text{PA Efficiency} = \frac{I_a^2 R}{EI} \times 100\%$$

Where I_a is antenna current
R is resistance of antenna
E is PA plate voltage
I is PA plate current

The efficiency must be between 65 and 75 percent.
Switch off the plate supplies.
Turn the DELTA-WYE switch to the DELTA or high-voltage position.
Switch on the plate supplies.
Proceed as follows and obtain optimum efficiency from the PA.

Reduce the PA loading in small steps, and at each step adjust the PA tuning to the point on the low capacity side of resonance (that is, clockwise or to the higher numerical reading of the counter) which gives 8.0 amperes of PA plate current. Record the RF line current at each step. The RF current will initially increase and then decrease. Choose settings of EC20 and EC21 that give the maximum RF line current, that is, maximum power output. This is the point of highest efficiency because the power input is held constant during the tuning procedure.

An over-all plate efficiency of at least 72 percent should be obtained when operating into a dummy load. If the power input has to be increased for operating into a directional antenna, the plate efficiency may decrease to approximately 70 percent.

Routine Operation

STARTING PROCEDURE

1. Move the TRANSMITTER STOP-START switch to the START position.
2. Move the PLATE SUPPLES switch momentarily to the ON position. The Transmitter will switch on and be in full operation in about 20 seconds.

STOPPING PROCEDURE

1. Move the PLATE SUPPLIES switch momentarily to the OFF position.
2. Move the TRANSMITTERS STOP-START switch to the STOP position.

All supplies will be switched off except the blower which will continue to run for five minutes.

The crystal heating supply is independent of the Transmitter control circuit and must remain connected.

THEORY AND CIRCUIT ANALYSIS

RF Circuits

CRYSTAL OSCILLATOR

The crystal oscillator and buffer amplifier are housed in a separate shielded compartment in the Exciter and Modulator cubicle. The oscillator stage uses one Type 6146 tube (AV1) in an electron-coupled Colpitts circuit. Two low temperature-coefficient crystals in individual Thermocells (AY1 and AY2) are provided, either of which may be switched into the circuit by the solenoid operated switch, AS1. This switch may be operated remotely, or locally by the CRYSTAL CHANGE push button, AS2. Supply voltage for the crystal heaters is normally obtained from the station lighting supply (115 volts, 50/60 cps) and is usually left on continuously to maintain the crystals in a ready condition. The amber supervisory lights, AI1 and AI2, indicate which crystal is in operation. The white supervisory lights, AI3 and AI4, in series with the heating elements of their associated Thermocell, show the normal heating cycle of the Thermocells by flashing on and off. When Thermocell AY1 is in use, trimmer capacitor AC4 provides a few cycles of frequency adjustment. Similarly, capacitor AC5 is the trimmer when AY2 is is use. The plate of tube AV1 has a resistive load and RF is coupled through capacitor AC9 to the grid of the buffer stage. The cathode current of the oscillator tube is measured by the RF EXCITER meter, DM1, when the RF EXCITER selector switch, DS1, is switched to the OSCillator CATHODE x 50 position.

BUFFER AMPLIFIER

The buffer stage uses one Type 6146 tube (BV1) and serves three functions:

1. Provides isolation of the oscillator stage for high frequency stability.
2. Drives the 1st IPA stage.
3. Provides a means by which the carrier may be interrupted.

The plate load of BV1 is a conventional paralled-resonant circuit, consisting of fixed capacitors BC6 and BC7 and a slug-tuned coil, BL2. A few turns are coupled with this coil to supply a signal to the frequency monitor. Drive to the 1st IPA stage is adjusted by a variable resistor BR10 which varies the screen voltage of tube BV1. Cathode current is measured by the RF EXCITER meter, DM1, when switched to the BUFFER CATHODE x 50 position. Resistor BR8 is normally shorted out by carrier trip relay YK29. When this relay operates, the contacts open and BR8 is placed in series with BR9, BR7, and BR12 across the 500-volt, B+ supply. In this condition there is cathode bias of about 100 volts across BR8 which cuts off the tube completely, thus interrupting the carrier.

FIRST INTERMEDIATE POWER AMPLIFIER

The 1st IPA uses a high-gain tetrode tube, Type 6156 (CV1), operating in Class C with fixed bias on the grid. This fixed bias, which is obtained from the Modulator bias supply through resistor CR2, assures complete elimination of the carrier when the carrier trip-relay operates. Grid current is measured by the RF EXCITER meter, DM1, when switched to the 1ST IPA GRID x 20 position. Cathode current is measured by the same meter when switched to the 1ST IPA CATHODE x 500 position. The TUNE/OPERATE switch, CS1, shorts out resistor CR7 when it is in the OPERATE position. For tuning purposes CS1 is opened so that sufficient cathode bias is introduced to limit the plate dissipation of tube CV1 until tuning is completed. Screen voltage is obtained from the 500-volt supply through a tapped resistor, SR5. The normal operating voltage is 300 volts, but this value may vary, since screen current is very sensitive to plate tuning. The plate load is a conventional shunt-fed parallel-resonant circuit. Tuning is accomplished by variable capacitor CC8, the control of which is labeled 1ST IPA PLATE TUNING. Plate voltage is obtained from the 1500-volt supply through the choke, CL3. Coupling to the next stage is achieved by means of a preset tap on coil CL4.

SECOND INTERMEDIATE POWER AMPLIFIER

The 2nd IPA stage uses a neutralized triode tube, Type 6623 (DV1), operating in Class C and provides drive for the PA stage. Bias for DV1 is supplied by resistors in the cathode circuit plus a small amount of additional bias obtained by means of the grid leak resistor, DR4. Grid current is measured by the RF EXCITER meter, DM1, when switched to the 2ND IPA GRID x 500 position. Cathode current is measured by a separate 2ND IPA PLATE meter, DM2. The plate circuit is a conventional shunt-fed parallel-resonant circuit consisting of capacitor DC7 and coil DL5. Plate voltage is obtained from the 3500-volt supply through a winding of transformer PT1. This enables the drive to the PA stage to be modulated approximately 10% by partially plate-modulating the 2nd IPA stage. This aids in reducing distortion by improving the linearity of the PA stage. Plate tuning of the 2nd IPA is achieved by variable capacitor DC7, the control of which is labeled 2ND IPA PLATE TUNING. Feedback from the plate to the grid circuit is neutralized by adjustment of coil DL4 and the small trimmer capacitor, DC5, so that parallel resonance is obtained. When neutralizing, it is desirable to keep the capacity of DC5 at a minimum while aiming for as high a value of inductance as possible with DL4. In this way, the neutralizing circuit assumes broader band characteristics and is, therefore, more stable in operation. The TUNE/OPERATE switch, DS2, shorts out resistors DR7 and DR8 in the OPERATE position. For tuning purposes DS2 is opened so that sufficient cathode bias is developed across DR7 and DR8 to limit the plate dissipation of tube DV1 while tuning. Coupling to the PA stage is by means of a coaxial cable connecting the center winding of the variometer coil, DL5, to a tap on the PA grid coil, EL1.

POWER AMPLIFIER

The Power Amplifier stage uses two Machlett Type ML-6427 triodes (EV1 and EV2) in parallel operating as a Class C amplifier. The grid circuit is tuned by coil EL1 and variable capacitor EC1, the control of which is labeled PA GRID TUNING. Drive to the grid of EV1 is applied through blocking capacitor EC3. Similarly, the grid of EV2 is fed through EC2. Grid-leak bias is used, EL2 and EL3 being the feed chokes, with RF bypassing achieved by EC10, EC12, EC11, and EC13. Cathode currents are individually monitored by meters EM3 (LEFT PA CATHODE) and EM4 (RIGHT PA CATHODE), and equalization is achieved by PA BALANCE potentiometer ER9. Grid current is measured by PA GRID meter EM1, and total plate current is measured by TOTAL PA PLATE meter EM5. The tube filaments are bypassed to RF by capacitors EC6, EC7, EC8, and EC9. Overload relays YK18 and YK19 will operate if cathode currents are too high. EL7 and EL8 provide coil neutralization of the PA stage, coarse adjustment being made by EL7 and fine adjustment by EL8. The plate supply voltage is fed through RF choke EL6 which is decoupled by EC4 and EC5. Blocking capacitors EC17 and EC18 couple the modulated RF output to the output circuit, which consists of the following three sections:

1. An impedance transformer, consisting of FL4 and FC2, to transform any resistive antenna impedance in the range of 50 to 230 ohms up to a resistive impedance of 250 ohms as seen at FC2.

2. A double-section pi filter, operating at an impedance level of 250 ohms and consisting of variable capacitors EC21 (PA LOADING), FC1, and FC2, together with coils FL1, FL2, and FL3. FL2 and FC1 constitute a series-resonant trap tuned to the second harmonic of the carrier frequency.

3. A pi tank circuit, consisting of EC19, EC20 (PA PLATE TUNING), coil EL9, and EC21 which transforms the filter impedance of 250 ohms up to 535 ohms required by the PA tubes. The loaded Q of this tank circuit varies from a value of 6 at the low-frequency end of the band to 12 at the high-frequency end.

Audio Circuits

The purpose of the audio circuits is to amplify the incoming audio signal from a level of 10 ± 2 dbm at 600 ohms impedance to a level sufficient to modulate the Power Amplifier. The following description will cover the 1st audio amplifier (tubes KV1 and KV2), 2nd audio amplifier (tubes MV1 and MV2), 3rd audio amplifier (tubes NV1, NV2, NV3, and NV4), the modulator (tubes PV1 and PV2), and the feedback circuit.

FIRST AUDIO AMPLIFIER

The audio input terminals are numbers 18 and 20 on terminal board KTB3, located in the bottom left-hand corner of the Exciter and Modulator cubicle. The signal is fed through an 8-db isolating pad consisting of KR1, KR2, KR3, KR4, and KR5 to the input transformer, KT1. Networks between KT1 and the grid of tube KV1 form part of the feedback circuit, which will be described later. The first audio amplifier tubes, KV1 and KV2, are Type 6136 pentodes connected to form a "Schmidt" circuit having a large resistance common to both cathodes. The single-ended input to the grid of KV1 results in a balanced push-pull signal at the plates. A hum-bucking voltage derived from the filament transformer, KT2, is applied to the grid of KV2. The amplified audio signal is resistance-capacity coupled to the grids of the next stage. The network consisting of KR25, KR26, KC13, and KC14 across the output of the first stage controls the phase shift at the higher audio frequencies, providing a smooth drop in the response and singing-free operation of the feedback circuit. Inductors KL1 and KL2 provide a slight lift in the response in the region of 10 kc to compensate for falling off in the response in succeeding stages. The plate current of tubes KV1 and KV2 is measured across resistors KR27 and KR28 by means of the AUDIO AMPLIFIER meter, LM1, when the AUDIO AMPLIFIER selector switch, LS1, is in the LEFT 1ST x 20 or RIGHT 1ST x 20 position. The plate voltage of 300 volts is obtained from the 500-volt supply through dropping resistor SR1.

SECOND AUDIO AMPLIFIER

The second audio amplifier, using two Type 6156 tetrode tubes (MV1 and MV2) in a resistance-capacity-coupled circuit, amplifies the audio signal to the voltage level required to drive the Modulator tubes. Cathode bias is adjusted by variable resistors MR3 and MR4, so that the plate current of each tube can be set at 100 ma. Controls for MR3 and MR4 are labeled LEFT 2ND AMP BIAS and RIGHT 2ND AMP BIAS. The cathode currents are measured across shunt resistors MR11 and MR12 by the AUDIO AMPLIFIER meter, LM1, when switched to the LEFT 2ND x 20 or RIGHT 2ND x 20 position. The cathode bypass capacitor, MC1, prevents the application of cathode feedback. Screen voltage is obtained from the 500-volt supply through tapped resistor SR4. Plate voltage is obtained from the 3500-volt supply and is metered by the 3500 V SUPPLY meter, UM1.

THIRD AUDIO AMPLIFIER

This stage uses four Type 304TL triode tubes (NV1, NV2, NV3, and NV4) connected as a parallel push-pull cathode follower circuit. Its purpose is to transform the high-impedance signal appearing at the plates of the preceding stage into a low-impedance signal to drive the grids of the Modulator tubes operating in Class B. Grid bias for tubes NV1 and NV2 is obtained from the LEFT 3RD AMP BIAS potentiometer, PR2. Similarly, bias for tubes NV3 and NV4 is fed from the RIGHT 3RD AMP BIAS potentiometer, PR3. Transformer PT1 has two primary windings, one in the cathode circuit of tubes NV1 and NV2 and the other in the cathode circuit of NV3 and NV4. PR44 and PR45 are damping resistors connected across these windings. This transformer is used to provide partial modulation of the plate supply to the 2nd IPA tube, DV1, as mentioned earlier. The cathodes of tubes NV1 and NV2 are connected directly to the grid of the modulator tube, PV1. Similarly, the cathodes of NV3 and NV4 are connected directly to the grid of PV2. Plate voltage is obtained from the 1500-volt supply. The total plate current of NV1 and NV2 is measured by the LEFT 3RD AMP ANODE meter, NM1, while the RIGHT 3RD AMP ANODE meter, NM2, measures the total plate current of NV3 and NV4. These meters are also used to measure the grid current of the modulator tubes in the following manner. With no AF input signal, the currents through NM1 and NM2 are adjusted to 100 ma each. With maximum AF signal input providing 100% modulation, these plate currents increase to 250 ma each. The difference of 150 ma is the grid current of each modulator tube.

MODULATOR

This stage utilizes two Machlett Type ML-6427 triodes (PV1 and PV2) operating in Class B push-pull. The grids are connected directly to the cathodes of the previous stage. Grid bias for PV1 and PV2 is obtained from the voltage divider across the -780 volt supply. This divider is so arranged that interference between the 3rd audio amplifier bias adjustment and the modulator stage bias adjustment is at a minimum. The total plate current of the modulator is adjusted by the MODULATOR BIAS control, PR9, while individual plate currents are balanced by the MODULATOR BALANCE controls, PR1 and PR28, and measured by LEFT MODULATOR CATHODE meter PM1 and RIGHT MODULATOR CATHODE meter PM2. Between the cathodes of the mdoulator tubes and ground, current flows through the following circuits: meters PM1 and PM2, transformer ZT8, overload relays YK20 and YK21, and telemetering resistors PR42 and PR43 (used when the Transmitter is remotely controlled). Across the overload relays and transformer ZT8 are two resistors, PR40 and PR41. These resistors damp out any AF resonance which might develop across the overload relay and transformer at high audio frequencies. The transformer (ZT8) prevents the passage of low-frequency audio signals through the overload relays, thus ensuring that the operation of YK20 and YK21 is independent of audio frequencies. These overload relays are set to operate at 4.5 amperes, which provides protection of the modulator tubes from overdissipation yet allows for occasional heavy bursts of modulation. Capacitors PC1, PC2, PC3, and PC4 bypass the tube filaments, which are heated in phase. The plate supply voltage is fed to the plates from the 9000-volt supply through the center tap of the modulation transformer, RT1. The transformer windings are protected by thyrite arrestors RE2, RE3, and RE4, consisting essentially of a spark gap in series with a thyrite resistor. Resistors PR32 through PR39 and capacitors PC9 through PC12 are connected across the primary of the modulation transformer to damp out resonances above 20 kc, thus preventing any possibility of "singing" in the feedback network. The secondary of RT1, in series with the blocking capacitors, RC1 through RC4, is connected between the d-c high-voltage supply to the PA tubes and ground. The plate voltage to the PA tubes is fed through the modulation reactor, RL1, which is protected by the thyrite arrestor, RE1. Meter VM1, located on the front of the Rectifier and Control cubicle, measures the d-c plate voltage to the PA stage.

FEEDBACK CIRCUIT

Feedback is applied to the Transmitter by means of two circuits. The "primary" feedback, operating at the higher audio frequencies, is obtained from the modulation transformer primary, while the "secondary" feedback is obtained from the cathode of the PA and operates at the lower audio frequencies.

1. The Primary Circuit

Because of the very tight coupling between the two halves of the modulation-transformer primary winding, feedback need be taken from one half of the primary only. A voltage divider network, consisting of resistors PR10, PR17, and PR26 and capacitors PC5, PC6, PC14, and PC15, is connected between the plate of tube PV1 and ground. The voltage developed across PR26 and PC15 is injected into the grid circuit of tube KV1 through a step circuit consisting of KC1, KC2, and KR8, applying 10 db feedback. The step circuit reduces the amount of feedback below 1000 cps.

2. The Secondary Circuit

In order to obtain a sample of the audio voltage modulating the PA, the PA cathode current goes to ground via two resistors, HR1 and HR2, in parallel. This voltage is fed back to the audio input via two high-frequency, step attenuating circuits to provide negative feedback at low audio frequencies. Resistors KR14, KR15, and KR16 and capacitor KC5 form one step circuit, and KR12, KR13, KC3, and KC4 form the other. At 250 cycles the feedback is 10 db.

A filter circuit consisting of coils HL1 and HL2 and capacitors HC1 through HC6 is inserted between resistors HR1 and HR2 and prevents RF appearing at the low-level audio amplifier stages.

Resistor KR17 and capacitor KC9 at the grid of KV1 reduce the amplifier gain at very low frequencies and provide a smooth change of phase so that complete stability is ensured.

AC and DC Power Supply Circuits

AC SUPPLY CIRCUITS

The Transmitter requires a three-phase source of power at either 480, 2400, or 4160 volts, and a frequency of 60 cps. The supply specified affects the following components:

Current-limiting reactor ZL1
Disconnect fuses WF1, WF2, and WF3 and switch WS2
Delta-wye switch WS1
Plate supply transformers WT1, WT2, and WT3
Distribution transformers ZT1, ZT2, and ZT3
Distribution fuses ZF1, ZF2, and ZF3 and switch ZS12

These components, mounted externally to the Transmitter, differ in rating for the different voltages, but their functions are, in all cases, the same.

The incoming power line goes to both the plate disconnect switch, WS2, and the distribution disconnect switch, ZS12.

The plate circuit is protected by current-limiting fuses WF1, WF2, and WF3 and current-limiting reactor WL1. The special function of the latter is to limit the short-circuit current drawn by the Transmitter, in the event of a severe fault, to a value well within the maximum rating of the components.

WK1, WK2, and WK3 are vacuum switches which perform the normal function of switching on the primary voltage to the plate transformers.

The distribution circuit is protected by current-limiting fuses ZF1, ZF2, and ZF3. The primary voltage is then stepped down by means of transformers ZT1, ZT2, and ZT3 to a 208-volt, four-wire supply which is run into the Transmitter to terminal board ZTB5. The supply is distributed from ZTB5 to the control circuit through breaker ZS3, to the blower through ZS4, to the filament supply through ZS5, to the 1500- and 3500-volt supplies through ZS6, to the 500-volt supply through ZS7, to the Modulator bias supply through ZS9, and to the PA bias supply through ZS10.

Power for the tube filaments is applied by the filament contactor, YK4. A single-phase supply is regulated by a stabilizing transformer, ZT6, and supplies power to the Modulator tubes. From the same transformer, through circuit breaker ZS11, all low-power tube filament transformers are energized. In addition, the three-phase supply from contactor YK4 is taken to a Scott-connected auto-transformer, ZT7. The two outputs from ZT7 are fed to two stabilizing transformers, ZT4 and ZT5, which supply the filaments of the PA tubes, EV1 and EV2, respectively, with the filament voltages 90 degrees out of phase. Transformers ZT4, ZT5, and ZT6 not only provide a very stable source of voltage but also serve as current-limiting devices when switching on the power to the filaments of the output tubes.

A 115-volt a-c supply is run into the Transmitter to heat the thermostatically controlled crystal ovens. This supply is preferably obtained from the same source as the building lighting. The reason for this is that the main supply to the Transmitter may be disconnected for servicing the Transmitter without interrupting the heating of the crystals.

Two indicating fuses, AF1 and AF2, are provided in the Transmitter for the protection of the 115-volt supply.

DC SUPPLY CIRCUITS

All bias and plate supplies are provided by three-phase, full-wave germanium rectifier circuits.

1. The 500-Volt Supply

The supply voltage to rectifier SCR1 is obtained via circuit breaker ZS7, relay YK8, and plate transformer ST1. Resistor SR6 across the filter reactor, SL1, eliminates any voltage transients produced by the reactor. The d-c voltage is measured by the 500 V & BIAS SUPPLIES meter, SM1, when the slector switch, SS1, is in the 500 V position. The oscillator and buffer stages require 500 volts, and 300 volts are supplied via dropping resistor SR1 to the plates and screens of the 1st audio amplifier. The screens of the 2nd audio amplifier are fed from tapped resistor SR4, while the screen grid of the 1st IPA is fed from tapped resistor SR5.

2. The 1500-Volt Supply

This circuit provides plate voltage for the 1st IPA and the 3rd audio amplifier. The large filter capacitors, TC1, TC2, and TC3, provide the low-impedance source needed by the latter stage. Overcurrent protection is provided by overload relay YK16. The voltage is measured by the 1500 V SUPPLY meter, TM1.

3. The 3500-Volt Supply

Plate voltage for the 2nd IPA and 2nd audio amplifier is supplied from this circuit. Twelve germanium rectifier stacks provide the required d-c voltage, which is measured by the 3500 V SUPPLY meter, UM1. Circuit protection is provided by the overload relay, YK17, in the ground lead and also by the circuit breaker, ZS6. The primary current of the 1500-volt supply is also carried by this circuit breaker, but since this current drain is small compared to that drawn by the 3500-volt supply, the effect of the 1500-volt supply is negligible. The germanium rectifiers, UCR1 through UCR12, are provided with forced-air-cooling to provide an extra safety factor for these rectifiers. Operator protection is provided by safety grounding switches YS13, YS14, and YS17. These are connected to those doors which, on being opened, would give access to either 1500 or 3500 volts. Should a door be opened, an immediate short circuit is connected across the power supply, irrespective of the functioning of the control circuit.

4. The Modulator Bias Supply

This supply provides bias voltage for the 1st IPA tube, the 3rd audio amplifier, and the Modulator. The output voltage is adjusted by the MODULATOR BIAS control, PR29, and is measured by the 500 V & BIAS SUPPLIES meter, SM1, when selector switch SS1 is switched to the MOD BIAS position. Potentiometers PR1 and PR28 are ganged and form the MODULATOR BALANCE control. PR2 (LEFT 3RD AMP BIAS) and PR3 (RIGHT 3RD AMP BIAS) adjust the 3rd audio amplifier. The supply is protected by circuit breaker ZS9 in the primary of transformer XT1.

5. The PA Bias Supply

The purpose of this circuit is to provide protective bias for the PA tubes when there is no RF drive to the final stage. With normal operation, self-bias is obtained for the final RF stage from resistors ER1 through ER6. When the carrier trip circuit cuts the drive to the PA, the PA tubes will be provided with a bias of about 400 volts, which will hold the PA plate current within the maximum dissipation rating of the tube plates. With normal drive to the PA stage, this power supply plays no part in Transmitter operation and for this reason it is not necessary to filter the rectified output. The d-c output voltage is measured by the 500 VOLT & BIAS SUPPLIES meter, SM1, when selector switch SS1 is switched to the BIAS position.

6. The 9000-Volt Supply

This circuit provides plate voltage for the Power Amplifier and Modulator. The delta-wye switch, WS1, is in the primary of the three plate transformers, WT1, WT2, and WT3. The purpose of this switch is to connect the supply to the plate transformers either in wye or delta. For tuning operations, the wye connection provides approximately 58% of the full plate voltage. The transformers are protected against transients and surges by thyrite arrestors WE1, WE2, and WE3. Between the transformer secondary windings and the rectifiers two of the lines pass through current transformers (VT1 and VT2), which in turn operate two overload relays (YK22 and YK23) should an overload occur. These fast-acting relays in turn operate vacuum contactors WK1, WK2, and WK3. The rectifier section consists of 42 diodes series-connected in each leg of the three-phase, full-wave circuit. Across each individual diode is a capacitor, the purpose of which is to equalize the distribution of any transient voltages that might appear across the rectifiers. The filter reactor, WL1, is protected against the generation of voltage surges across it by resistors VR8 through VR15. Filter capacitors VC1, VC2, VC3, VC4, VC257, and VC258 are not connected to ground immediately upon starting but through two resistors, VR1 and VR2, in order to limit the charging current through the rectifiers when first switching on. After half a second VR1 and VR2 are shorted out by vacuum switch VK1. The safety grounding switches, YS13, YS14, YS15, YS16, and YK20 are fitted on the doors of the appropriate cubicles. Should the doors be opened, the appropriate switch immediately short-circuits any live plate supply circuits.

Control Circuits

SEQUENCE

Power to the control circuit is fed through ZS3, contacts 1-5 of YK26 and 1-5 of YK27. Supervisory light YI1 indicates that the control circuit bus has been energized. If either of the two phases controlling YK26 and YK27 fails, the power to the control circuit will be shut off.

The Transmitter is started by closing the lever-key switch, YS1. This operates YK1, energizing YK3, which in turn controls blower ZB1 if ZS4 is closed. Contacts 2-6 of YK1 energize contactor YK4 when air-flow switch YS2 closes. At the same time, YI2 is energized, indicating that the air flow switch is closed. YK4 energizes all filaments as well as the filament interlock relay, YK5.

Contacts 1-5 of YK5 energize the filaments supervisory light, YI3, and the FILAMENT ELAPSED TIME meter, YM1. At the same time, the filament time-delay relay, YK6, is energized and after 10 seconds its contacts 5-7 close, energizing YK7, which locks in through its contacts 1-5. An auxilary contact on YK7 inserts YR1 in series with the heater of YK6, so that in the event of power failure the filament time-delay relay will provide a delay proportional to the length of time the power is off. The heater of YK6 will, however, not be so hot that there will be no time delay after a power failure of more than 3 seconds duration. YI4 indicates that all of the door interlocks are closed, and YK7 is operated as described above, its contacts 2-6 energizing supervisory light YI5 and the coil of YK8, the 500-volt supply contactor. This supply will come on, provided that ZS7 is closed.

For the purposes of this part of the discussion, it will be assumed that YS3 is in the OPERATE-RECYCLE position. Under these conditions switch contacts 21 and 25 of YS3 are connected, 31 and 35 are connected, 41 and 45 are connected, and 51 and 55 are connected. YK9 is energized through YS3-21-25. This energizes the bias supplies through ZS9 and ZS10. BIAS supervisory light YI6 is energized indicating that the bias is on. If YK10 has previously been set in the latch position, power will flow through contacts YK10-7-6, YK11-3-4, and contacts 2-6 of YK14 energizing YK15. YK15 is a time-delay relay and when its cycle is completed, power flows through its contacts 5-1 to energize YK13 through contacts 5-7 of YK17 and YK16, the 3500-volt and 1500-volt supply overload relays.

YK13 energizes the 3500-volt supply, provided that ZS6 is closed. It also energizes supervisory light YI8 through its contacts 7-8 which indicates that the 3500-volt supply is on. Power flows through YS3-51-55 to YCR1 through surge-limiting resistors YR4 and YR5. YCR1 energizes contactors WK1, WK2, and WK3 for the 9000-volt supply through contacts 3-2 of YK10 and contacts 5-7 of overload relays YK18, YK19, YK20, YK21, YK22, and YK23.

When contactors WK1, WK2, and WK3 have operated the circuit through their auxiliary contacts 4-5, they energize supervisory lights YI11, YI12, YI13, YI14, and YI19. These contacts also energize the coil of YK25. YK25 is a time-delay relay that allows the filter capacitors to become fully charged through resistors VR1 and VR2 before operating high-voltage contactor VK1. YK25 also delays the application of voltage to the 1500-volt supply through YK28. Through its auxilary contacts 5-4, VK1 energizes supervisory light YI10.

It should be noted that when the Transmitter is operating, all of the supervisory lights that appear in a row on the Exciter and Modulator cubicle door (YI1 and YI10) are illuminated.

When the plate contactors, WK1, WK2, and WK3, are de-energized, their contacts 2-3 energize supervisory lights YI15, YI16, YI17, and YI18.

When control circuit breaker ZS4 is closed, power is immediately available to operate the crystal stepping switch, AS1. This is a rotary solenoid-type switch that is energized by pushing AS2, which transfers the oscillator circuit from one crystal to the other. Supervisory lights AI1 and AI2 indicate which crystal is being used.

PLATE-ON SWITCH

When ZS3 is closed, power is available at YS4, YS5, YS6, and YS7 to operate the plate power relay, YK10. This relay may be electrically latched or tripped by any of the above four switches. Note that YK10 is a latching type relay and will, therefore, not be affected by power failures.

BLOWER TIME-DELAY CIRCUIT

In order that the tubes may be properly cooled off on shutdown, time-delay relay YK2 is provided. On starting the Transmitter, YS1 is closed, energizing YK1. In addition to energizing the blower contactor YK3, YK1 interrupts circuit breaker YK2 through contacts YK1-3-10. On turning off the Transmitter by opening switch YS1, YK1 drops out, but YK3 is held in by its contacts 7-8 and by YK2-3-5. The timing coil of YK2 is now energized through YK1-3-10. After it has timed out, its contacts 5-3 will open, releasing blower contactor YK3. When YK3 drops out, its contacts 7-8 will open, deenergizing the coil of YK2, which then resets.

TUNING MOTOR

When YS1 is closed, energizing YK1, it also provides power for operating tuning motor

EB1 on the output loading capacitor, EC21. This is controlled by the RAISE-LOWER switch, ES1.

SEQUENCE SELECTOR SWITCH YS3

During tune-up or trouble-shooting it is convenient to interrupt the control operation sequence at various points. This is done by sequence selector switch YS3. This switch has four positions, as follows:

1. 500 V(olts) ONLY

When YS3 is in this position, contacts 11-12 are closed, and the front door interlock for the Exciter and Modulator cubicle is shorted out. At the same time, contacts 21, 31, 41 and 51 are all open, and no voltage can be applied to any but the 500-volt supply.

2. 9000 V(olts) OFF

When YS3 is in this position, contact 11 is open-circuited, contact 21 is connected through 23 to energize YK9 and subsequent parts of the control circuit, so that the bias supplies, the 1500-volt, and the 3500-volt supplies may be energized. Contacts 31-33 complete the circuit from the "on" side of switches YS4, YS5, YS6, and YS7, so that in the event of an overload relay being tripped, it may be electrically reset by the operation of one of these switches. YS3-41 is still open-circuited, and YS3-51 connects to YS3-53 to energize YK25. When YK25 times out, it energizes YK28 and supplies the 1500-volt supply with power after the starting surge for the 3500-volt supply has been dissipated. Under this condition no power is supplied to rectifier YCR1, and high-voltage supply contactors WK1, WK2, and WK3 will not be operated.

3. OPERATE

When in this position, YS3 contacts 11 and 41 are open-circuited. YS3-21-24 are connected, YS3-31-34 are connected, and YS3-51-54 are connected. In the event of an overload, the overload relays must be electrically reset by the operation of YS4, YS5, YS6, YS7 as described above. YS3-5-54 energizes rectifier YCR1, and the control circuit will operate normally with the 9000-volt supply coming on after YK13 has closed. YK25 will not start to time out until high-voltage contactors WK1, WK2, and WK3 have all been energized. When it times out, the 1500-volt supply contactor, YK28, will operate, and resistor-shorting contactor VK1 will also be operated.

The following describes the overload reset circuit, a non-recycling operation with YS3 in position 3. When an overload relay is tripped, YS3 contacts 5-7 will open and contacts 1-3 will close. The open contacts will interrupt the circuit to the corresponding contactor or contactors, that is, YK13 or WK1, WK2, and WK3. Contacts 1-3 will complete the circuit to the coil of YK14. This will cause YK15 to drop out, since it will no longer receive energy through contacts 2-6 of YK14. YK14 contacts 3-5 will close, connecting the electrical reset coils of all overload relays through terminals 31 and 45 of YS3. With YS3 in position 3, contacts 31-34 are connected and from there the circuit is connected to the "on" side of switches YS4, YS5, YS6, and YS7. Nothing will happen until one of these switches is operated. When it is operated, it will reset the relay or relays, YK14 will be de-energized, and the circuit will be restored to normal operating condition.

4. OPERATE RECYCLE

When YS3 is in this position, contact 11 is open-circuited, and contacts 21-25, 31-35, 41-45, and 51-55 will be connected. Under these conditions the operation of the control circuit will be that described above, except that now YK11 will operate to reset the overload relays after an overload. It will automatically reset if there are not more than two overloads occurring in a 30-second period. On the third such overload YK11 contacts 3-4 will open and will stay open until reset by the operation of the plate supply switches.

The operation is as follows: The overload relay will operate closing its contacts 1-3, operating YK14. The overload reset coils will be connected through YK14-3-5 to YS3-31 and -45. YS3-31 is connected to YS3-35, which in turn connects to the step coil of YK11. YS3-45 connects through YS3-41 to YK15, and when YK15 releases (by the operation of YK14), contacts 3-5 close, and power is automatically applied to the overload reset coils and the step coil of YK11. This resets the overload relay, de-energizes YK14, and in turn re-operates YK15, restoring the main part of the control circuit to normal. YK11, however, has now stepped, so that its contacts 5-6 are closed and start the timing relay, YK12. Should another overload occur within 30 seconds, or if the first one is still present, the above process will be repeated. Should a third overload occur before YK12 has timed out, contacts 3-4 and 5-6 of YK11 will open and the overload relays will not be automatically reset. Relay YK11 will remain in the locked-out position until one of the transmitter-start switches, YS4, YS5, YS6, or YS7, is operated. This will reset YK11 through its reset coil; the overload reset coils will be operated and the circuit restored to normal. If YK12 times out without recurrence or repeated overloads, its contact 3-5 will close at the end of 30 seconds and operate the reset coil of YK11 so that it will again be able to accept two overloads in a 30-second period. The resetting of YK11 will open its contacts 5-6, allowing the time-delay relay, YK12, to reset also.

LIGHTNING TRIP-CIRCUIT

Power for the operation of relays YK29 and KK1 in the lightning trip-circuit is made available when YK1 closes with the operation of the TRANSMITTER START switch, YS1. Capacitor YC2 is normally charged to the peak voltage of the control circuit supply. Relays YK29 and KK1 may be operated by the test push button, YS18, or by a reflectometer or other device which is required only to ground terminal YS2-4. Relay KK1 effectively grounds the audio input to the Transmitter through a one-microfarad capacitor, and at the same time, energizes the coil of YK29. YK29 opens a normally closed contact across BR8, thereby greatly increasing the bias on BV1 and reducing the excitation to the 1st IPA. On removal of the ground from Y2-4, YK29 will release immediately, and KK1 will be delayed because of the capacitor across its coil. The rectifier in series with the coil of KK1 prevents the capacitor from being discharged through YK29. This circuit ensures that the audio input is shorted out before the RF excitation is reduced and that the RF excitation is restored to normal before the audio drive is resumed.

REFLECTOMETER, PL-444D442-G2

Introduction

The General Electric Reflectometer, PL-444D442-G2, has been designed for use with the 50-KW AM Broadcast Transmitter, Type BT-50-A. When properly installed, the Reflectometer will cause momentary shutdown of the Transmitter whenever the transmission-line VSWR exceeds a ratio of 2.1 to 1. This ratio is a very sensitive indication of any component failure or lightning arc at the tower or antenna-tuning unit.

Installation

Refer to Figs. 59 and 60.

Electrically, the Reflectometer must be in the transmission line between the Transmitter and the antenna. With an omnidirectional antenna, the Reflectometer is usually between the Transmitter and the transmission line. With a directional antenna, as many Reflectometers are needed as there are towers. One reflectometer should be located between the tuning and phasing unit and each of the transmission lines to the individual towers.

The control function of the Reflectometer is exercised by a set of contacts, normally open, brought out to the terminal strip, JTB1, located on the front panel of the Reflectometer. Connect one terminal to the Transmitter ground and the other to ZTB3-20, which is located in the control portion of the Rectifier cubicle of the BT-50-A Transmitter. This connection is indicated in Fig. 58 in the lower right-hand corner. These connections may be made by means of any suitable conductors, No. 22 AWG or larger.

Physically, the Reflectometer may be mounted at any convenient location and in any position at the Transmitter site, provided that the electrical requirements indicated above are fulfilled and that reasonable access to the Reflectometer controls is maintained. Provision has been made for wall-mounting the unit by means of four keyhole slots in the cover of the Reflectometer (see Fig. 59).

Setting-Up Procedure

Before setting-up as outlined below, it is necessary to remove the connections between JTB1 and the Transmitter.

The Reflectometer is designed to operate properly with the control of the coupling coil, JL1B, set to maximum for an RF line current of 15 amperes, which corresponds to the current in a 230-ohm line. When used with a 50-ohm line, rotate the coupling coil approximately 60 degrees from its maximum position to allow for the higher current. Now proceed as follows:

1. Turn the VOLTAGE LEVEL potentiometer, JR1, fully counterclockwise, that is, to zero voltage level.
2. Turn the SENSITIVITY potentiometer, JR3, fully clockwise, that is, to minimum sensitivity.

NOTE

To prevent damage to the diodes in the detector, it is necessary to limit the detector current at certain stages of the setting-up procedure. The SENSITIVITY control, JR3, is provided for this purpose. A relay coil d-c voltage of 20 volts corresponds to the maximum allowable detector current.

3. Attach a 20,000-ohms-per-volt meter across the relay coil test points (JTB2).
4. With the shorting bar removed (Fig. 59), turn the Transmitter on and apply unmodulated RF to the Reflectometer.
5. Adjust JC2 for resonance as indicated by a maximum reading on the test meter. This maximum is usually about 6 volts.
6. Shut down the Transmitter. Place the shorting bar across the input of the Reflectometer. Turn on the Transmitter. Adjust the VOLTAGE LEVEL potentiometer to give a reading of approximately 15 volts on the test meter when the SENSITIVITY potentiometer is at its fully counterclockwise limit.
7. Shut down the Transmitter. Remove the shorting bar. Turn on the Transmitter. Touch up the VOLTAGE LEVEL potentiometer and the settings of JC2 alternately by increments to obtain an absolute minimum reading on the test meter. Any minimum below 0.5 volt d-c is acceptable.

8. Make sure that the balance obtained is with a voltage level of approximately 25 volts RF across JR1 as follows. With the shorting bar in place and the Transmitter on, the test meter should read between 10 and 15 volts d-c for this setting of the controls.

9. Remove the shorting bar and replace the connections from the Transmitter to JTB2.

NOTE

If the Reflectometer is to be used at a frequency below 700 kc, it may be necessary to add an additional fixed capacitor across JC2 to provide sufficient capacitance to permit resonance with the inductance of JL1B. A suitable 0.0001-ufd, 2500-volt d-c w capacitor is included with each Reflectometer for this purpose (JC2A). This capacitor will be found mounted on the chassis support bracket adjacent to JC2. Also note that neither side of JC2 is at chassis ground potential, so that it will not suffice to connect this additional capacitor with one side to ground. It must be connected between the rotor and stator sections of JC2.

Theory of Operation

Refer to Fig. 61.

The Reflectometer has been designed to cause momentary Transmitter shutdown whenever the transmission-line VSWR exceeds a ratio of 2.1 to 1.

Capacitor JC1 and parallel resistors JR1 and JR4 constitute a voltage divider across the Transmitter output. Because of the large impedance of JC1 compared with JR1 and JR4 in parallel, the current through these resistors, and therefore the voltage developed across them, leads the RF line voltage by almost 90 degrees and is proportional to it.

Similarly, the voltage induced across JL1B lags the line current by 90 degrees and, therefore, with JC2 adjusted for resonance, the voltage across JR3 lags the line current by 90 degrees and is proportional to it.

Since the voltage applied to the detector is the vector sum of the voltage across JR3 plus the voltage across JR1, it is possible to balance these two voltages by adjustment of JR1 and the coupling control, so that the voltage applied to the detector is a minimum for normal line conditions. Any subsequent variation in the relative phase or magnitude of either the line current or the line voltage will lead to a resultant voltage at the detector. This, in turn, will energize the control relay and close the normally open contacts, which will momentarily remove the audio and RF drive to the Transmitter.

Maintenance

Little or no maintenance should be necessary during the lifetime of any installation of the Reflectometer. If desired, an occasional check for proper operation may be simply performed as follows. With the Transmitter on and the test meter connected across the relay coil test points as explained under Setting-Up Procedure, rotate JL1B either way from its normal operating position and observe the test meter indication. A movement of JL1B should cause an increase in the d-c voltage across the relay coil, and at approximately 2 volts the relay contacts should close. Following the test, readjust JL1B until the original minimum is restored.

To check for proper operation of the detector circuit, disconnect the detector input at JC2-1 and, by means of an RF signal generator, apply a voltage of about 6 volts rms to the

PARTS LIST

Symbol	Description	G-E Drawing
	BLOWER AND MOTOR	
EB1	Gear motor: 115 v, 60 cycles a-c, 1 phase, 5.7 rpm, 75 in oz. torque. Bodine Electric Co. Cat. #B8192E-300C.	A-101A6127-P1
ZB1	American Blower #15AH CW, Industrial Series 106, ARRT.9L, ball bearings. G-E Tri-Clad #55 general purpose open a-c motor: Type K, frame 254 U, 7.5 hp, 1750 rpm, 3 phase, 60 cycles, 220/440 v. Drive: Allis Chalmers Cat. #2BM66-5.0/6.4-6.2 Vbelt drive on 24"-0 centers, bore fan sheave 1-11/16" with 3/8 x 3/16 keyway, bore motor sheave 1-3/8. Replacement belts, matched sets of two, Allis Chalmers Cat. #BM66.	C-7776861-P2
	CAPACITORS	
AC1 and AC2	Mica, Class B: 10,000 mmfd ± 10%, 300 v d-c w. EIA Type RCM35B103K.	P-3R139-P17
AC3	Silver mica; 15 mmfd ± 5%, 500 v d-c w.	P-3R122-P134
AC4 and AC5	Air trimmer; variable, 4.4 to 50 mmfd. Hammarlund Type APC-50.	P-3R47-P2
AC6	Mica, Class B: 10,000 mmfd ± 10%, 300 v d-c w. EIA Type RCM35B103K.	P-3R139-P17
AC7	Mica, Class C; 330 mmfd ± 5%, 500 v d-c w. EIA Type RCM20C331J.	P-3R141-P139
AC8	Mica: 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
AC9	Mica: 1000 mmfd ± 10%, 2500 v d-c w. EIA Type RCM45B102K.	P-3R31-P9
AC10 thru AC12	Mica: 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
BC1	Mica, Class B; 10,000 mmfd ± 10%, 300 v d-c w. EIA Type RCM35B103K.	P-3R139-P17
BC2	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
BC3 thru BC5	Mica; 1000 mmfd ± 10%, 2500 v d-c w. EIA Type RCM45B102K.	P-3R31-P9
BC6 and BC7	Mica; 320 mmfd ± 5%, 2500 v d-c w. EIA Type RCM45B221J.	P-3R31-P25
BC8	*Pyranol; 10 mfd ± 10%, 600 v d-c w. G-E Cat. #23F876.	P-3R88-P19
CC1 thru CC3	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
CC4 and CC5	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
CC6	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
CC7	Ceramic; 150 mmfd ± 20%, 6 kv d-c w. Telegraphic Condenser Co. Type KO3555/TS.	B-594B831-P16
CC8	Variable. 10 to 400 mmfd, 7.5 kv peak. Jennings Radio Type UCS.	B-603B298-P9
DC1	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM50B103K.	P-3R31-P65
DC2 and DC3	Mica; 22,000 mmfd ± 5%, 1200 v d-c w. EIA Type RCM60B223J.	P-3R32-P97
DC4	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
DC5	Variable, 15 to 75 mmfd, 20 kv peak. Jennings Radio Type AT.	A-101A6731-P4

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Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
DC6	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
DC7	Variable condenser; 50 to 2300 mmfd, voltage rating 7.5 kv. Jennings Cat. #UCSXF.	B-603B303-P4
DC8	Ceramic; 1200 mmfd ± 20%, 10 kv d-c w. Telegraphic Condenser Co. Type KO3551/TS.	B-594B831-P39
EC1	Variable condenser; 50 to 2300 mmfd, voltage rating 7.5 kv. Jennings Cat. #UCSXF.	B-603B303-P4
EC2 and EC3	Ceramic; 4000 mmfd ± 10%, 3 kv a-c working. Stemag Type 65136.	B-603B302-P7
EC4 and EC5	Ceramic; 2000 mmfd ± 20%, 15 kv d-c working, 60 amp max RF current. Telegraph Condenser Co. Type HLC2120.	B-594B829-P1
EC6 thru EC9	Mica; 0.06 mfd ± 5%, 2000 v peak working voltage.	M-2R49-P21
EC10 and EC11	Mica; 10,000 mmfd ± 10%, 1200 v d-c w. EIA Type RCM55B103K.	P-3R32-P17
EC12 and EC13	Pyranol; 8.0 mfd ± 10%, 2000 v d-c w. G-E Cat. #23F385.	P-7769201-P3
EC17 and EC18	Ceramic; 4000 mmfd ± 20%, 15 kv d-c working, 70 amp max RF current Telegraph Condenser Co Type HLC4150.	B-594B829-P4
EC19	Vacuum; fixed,1000 mmfd ± 5%, 35,000 v peak test. Jennings Type MLC.	A-7142212-P2
EC20	Vacuum; variable, 60 to 1000 mmfd, voltage rating 35 kv. Jennings Cat. #VMMHC.	B-594B806-P11
EC21	Vacuum; variable, 100 to 5000 mmfd, voltage rating 15 kv Jennings Cat. #VMMC.	B-594B806-P10
FC1	Vacuum; variable, 100 to 2000 mmfd, voltage rating 15 kv. Jennings Cat. #VMM.	B-594B806-P3

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
FC2	Vacuum; variable, 100 to 5000 mmfd, voltage rating 15 kv. Jennings Cat. #VMMC.	B-594B806-P10
GC1	Pyranol; 1.0 mfd ± 10%, 1000 v d-c w. G-E Cat. #22F397.	P-3R115-P11
HC1	Paper, hermetically sealed; 0.047 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P47302S4.	B-151B855-P11
HC2	Paper, hermetically sealed; 0.15 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P15402S4.	B-151B855-P14
HC3	Paper, hermetically sealed; 0.033 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P33302S4.	B-151B855-P10
HC4	Paper, hermetically sealed; 0.022 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22302S4.	B-151B855-P9
HC5 and HC6	Paper, hermetically sealed; 0.4 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22402S4.	B-151B855-P15
KC1 and KC2	Paper, hermetically sealed; 0.01 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10302S4.	B-151B855-P7
KC3	Paper, hermetically sealed; 0.022 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22302S4.	B-151B855-P9
KC4	Paper, molded plastic; 0.033 mfd ± 20%, 400 v d-c w. Sprague Cat. #109P33304.	B-7491096-P30
KC5 thru KC7	Paper, hermetically sealed; 0.1 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10402S4.	B-151B855-P13
KC8	Pyranol; 1.0 mfd ± 10%, 1000 v d-c w. G-E Cat. #22F397.	C-3R143-P11
KC9	Paper, hermetically sealed; 0.0022 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P22202S4.	B-151B855-P3
KC10 thru KC12	Pyranol; 1.0 mfd ± 10%, 1000 v d-c w. G-E Cat. #22F397.	C-3R143-P11

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
KC13 and KC14	Paper, molded plastic; 0.0033 mfd ± 20%, 600 v d-c w. Sprague Cat. #109P33206.	B-7491096-P44
KC15	Paper, hermetically sealed; 0.1 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10402S4.	B-151B855-P13
KC16	Paper, hermetically sealed; 0.01 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10302S4.	B-151B855-P7
KC17	Paper, hermetically sealed; 4.0 mfd ± 20%, 200 v d-c w. Sprague Cat. #118P40502S4.	B-777B115-P2
KC18	Paper, hermetically sealed; 1.0 mfd ± 20%, 200 v d-c w. Sprague Cat. #118P10502S4.	B-777B115-P1
KC19	Paper, hermetically sealed; 0.1 mfd ± 20%, 200 v d-c w. Sprague Cat. #91P10402S4.	B-151B855-P13
MC1 and MC2	Pyranol, 10 mfd ± 10%, 600 v d-c w. G-E Cat. #23F876.	P-3R88-P19
MC3 and MC4	Pyranol, 0.5 mfd ± 10%, 4000 v d-c w. G-E Cat. #23F409.	P-3R87-P12
PC1 thru PC4	Mica; 0.06 mfd ± 5%, 2000 v peak working voltage.	M-2R49-P21
PC5 and PC6	Disk type; 160 mmfd ± 10%, 10 kv a-c working. C.G.E.C. Type 40553.	B-594B835-P10
PC9 thru PC12	Teflon; 0.01 mfd ± 5%, 20,000 v d-c w. Plastic Capacitors Inc., Cat. #OF200-103.	B-359B864-P31
PC15	Paper, molded plastic; 0.068 mfd ± 20%, 400 v d-c w. Sprague Cat. #109P68304.	B-7491096-P32
RC1 thru RC4	Pyranol; 1.25 mfd ± 10%, 20,000 v d-c w. G-E Cat. #14F442.	P-7770298-P11

CAPACITORS (CONTINUED)

Symbol	Description	G-E Drawing
SC1	Pyranol; 6.0 mfd ± 10%. 600 v d-c w. G-E Cat. #23F352.	P-3R88-P14
SC2	Pyranol; 40 mfd ± 10%. 600 v d-c w. 330 v a-c w. G-E Cat. #23F880.	P-7769244-P18
TC1 thru TC3	Pyranol; 10 mfd ± 10%. 2000 v d-c w. G-E Cat. #23F386.	P-3R87-P4
UC1 and UC2	Pyranol, 6.0 mfd ± 10%. 4000 v d-c w. G-E Cat. #23F413.	P-7769201-P13
VC1 thru VC4	Pyranol; 3.3 mfd ± 10%. 12,500 v d-c w. G-E Cat. #14F431.	P-7770283-P30
VC257 and VC258	Pyranol; 3.3 mfd ± 10%. 12,500 v d-c w. G-E Cat. #14F431.	P-7770283-P30
XC1	Pyranol; 10 mfd ± 10%. 1000 v d-c w. G-E Cat. #23F364.	P-3R88-P9
YC2 and YC3	Pyranol; 1.0 mfd ± 10%. 600 v d-c w. G-E Cat. #22F418.	C-3R143-P35

RECTIFIERS

Symbol	Description	G-E Drawing
ACR1	Germanium rectifier. G-E Cat. #4JA211BB1AC1.	
GCR1	Germanium rectifier. G-E Cat. #4JA211CF2AC1.	
KCR1	Germanium diode. G-E Type 1N92.	
SCR1	Germanium rectifier. G-E Cat. #4JA211CF2AC1.	
TCR1 thru TCR6	Germanium rectifier. G-E Cat. #4JA211CX250.	

Symbol	Description	G-E Drawing
	RECTIFIERS (CONTINUED)	
UCR1 thru UCR12	Germanium rectifier. G-E Cat #4JA211CX250.	
VCR1 thru VCR42	Rectifier assemblies Include: Germanium rectifier. Capacitor paper 0.01 mfd ± 10%. 600 v d-c w. Sprague Cat. #91P10396S4 with terminals added.	B-7492264-G1 C-7776930-P1 B-603B642-P47
XCR1 thru XCR3	Germanium rectifiers G-E Cat #4JA211CD3AC1.	
YCR1	Germanium rectifier. G-E Cat. #4JA211CB1AC2.	
YCR2	Germanium rectifier. G-E Cat. #4JA211BH2AC1.	
	***THYRITE ARRESTORS**	
RE1 thru RE4	G-E Cat #9LA21BX8	
WE1 thru WE3	G-E Cat. #9LA21BX8.	
	FUSES	
AF1 and AF2	Slow blow; rated 1 amp at 250 v. Bussman Cat. #MDL-1.	B-7487942-P5
WF1 thru WF3	Fuses for plate supply G-E Cat #GF6B200. Group 1 only	
WF1 thru WF3	Fuses for plate supply. G-E Cat #6193403G13. Group 2 only	

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Symbol	Description	G-E Drawing
	FUSES (CONTINUED)	
WF1 thru WF3	Fuses for plate supply. G-E Cat. #6193406G11. Group 3 only.	
ZF1 thru ZF3	Fuses for distribution supply. G-E Cat. #GF6B60. Group 1 only.	
ZF1 thru ZF3	Fuses for distribution supply. G-E Cat. #6193403G8. Group 2 only.	
ZF1 thru ZF3	Fuses for distribution supply. G-E Cat. #6193404G7. Group 3 only.	
	INDICATING LAMPS	
AI1 and AI2	Miniature bayonet base. G-E Cat. #1813.	A-101A5514-P5
[illegible] and AI4	Miniature bayonet base. G-E Cat. #47.	A-101A5514-P2
YI1 thru YI18	Glow lamps. G-E Cat. #NE-51.	A-101A5514-P12
	RELAYS	
KK1	Relay, dpdt, coil resistance 10,000 ohms, pull in 5.0 ma. standard 8 pin octal. Potter and Brumfield Type KCP series, Cat. #KCP11.	A-102A5064-P1
VK1	Vacuum switch, 50 amp rms, solenoid voltage 115 v a-c. Jennings Radio Mfg. Corp. Model EO2P, switch Type RC5.	C-555C224-P1
WK1 thru WK3	Vacuum switches: 5000 v rms continuous in 50° C ambient, 200 amp rms, 2000 v rms make and break, solenoid voltage 115 v d-c; pull-in current 0.7 amp, holding current 0.1 amp. Jennings Model #EO4P115DC.	B-603B607-P1

Symbol	Description	G-E Drawing
	RELAYS (CONTINUED)	
YK1	Relay, hermetically sealed; 120 v, 50/60 cycles; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC. (Enclosure #44100).	C-555C230-P1
YK2	Time delay relay; 115 v, 60 cycles, 5 min ± 15 sectime delay, spdt.	P-7772761-P10
YK3 and YK4	Contactors, a-c magnetic; 3 NO. main poles; 1 NO. interlock; 110 v, 60 cycles. G-E Type CR2810-D11AB1B2.	P-8569617-P1
YK5	Relay, hermetically sealed; 120 v, 50/60 cycles; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC. (Enclosure #44100).	C-555C230-P1
YK6	Time delay relay, operating time 10 sec ± 3 sec spst NO. contacts rated 3 amp at 115 v. Amperite Cat. #115NO10.	A-825A596-P1
YK7 thru YK9	Relays, hermetically sealed; 120 v, 50/60 cycles; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC. (Enclosure #44100).	C-555C230-P1
YK10	Relay, 2 coil latching type; hermetically sealed; 2 form C contacts rated 10 amp, 115 v resistive; latch and release coil operating voltage 120 v, 50/60 cycles a-c. Potter & Brumfield Latching Relay Series LK, Type H.	A-101A6590-P1
YK11	Sequence relay, elec reset, both coils rated 115 v ± 10%, 60 cycles (momentary duty), one OCCO, one CCCO, and one NO. aux contact which closes only when operating coil is energized. Struthers Dunn Type 99AXA115.	M-7474991-P3
YK12	Time delay relay: spdt db contacts rated 5 amp at 230 v, 110/120 v coil voltage, 1 sec delay. American Gas Accumulator Co. Type NE-11.	B-603B529-P2
YK13	Contactor, a-c magnetic; 3 NO. main poles; 1 NO. interlock; 110 v, 60 cycles. G-E Type CR2810-D11AB1B2.	P-8569617-P1

Symbol	Description	G-E Drawing
	RELAYS (CONTINUED)	
YK14	Time delay relay: 60 cycles, dpdt sb contacts rated 5 amp at 120 v; 110/120 v coil voltage. American Gas Accumulator Co., Type NE-24.	M-8569170-P9
YK15	Time delay relay: dpdt sb contacts rated 2.5 amp at 230 v, 110/120 v coil voltage, 2 sec delay. American Gas Accumulator Co., Type NE-16.	B-603B529-P1
YK16 and YK17	Overload relays: coil operates at 2 amp continuous rating: 1.0 to 3.0 amp calibration range; 0.76 ohms d-c resistance ; 2 NO. and 2 NC contacts; reset coil rated 115 v, 60 cycles. G-E Cat. #12PBC13B23.	C-7776348-P16
YK18 thru YK23	Overload relays: coil operates at 5 amp continuous rating; 2.5 to 7.5 amp calibration range; 0.132 ohms d-c resistance; 2 NO. and 2 NC contacts; reset coil rated 115 v, 60 cycles. G-E Cat. #12PBC13B24.	C-7776348-P17
YK25	Time delay relay: spdt db contacts rated 5 amp at 230 v, 110/120 v coil voltage. American Gas Accumulator Co., Type NE-11.	B-603B529-P2
YK26 thru YK28	Relays, hermetically sealed; 120 v, 50/60 cycles ; 3 pdt contacts rated 25 amp at 125 v non-inductive. Phillips Control Corp. #33AC (Enclosure #44100).	C-555C230-P1
YK29	Relay: dpdt,coil resistance 10,000 ohms, pull-in 5.0 ma, standard 8 pin octal. Potter and Brumfield Type KCP series, Cat. #KCP11.	A-102A5064-P1
	INDUCTORS	
AL1	RF choke coil: inductance 2.5 mh ± 5%, d-c resistance 50 ohms nominal.	K-7107898-P2
BL1	RF choke coil; inductance 2.5 mh ± 5%, d-c resistance 50 ohms nominal.	K-7107898-P2
BL2	Driver tank coil.	C-315C267-P1
CL1	RF choke coil; inductance 2.5 mh ± 5%, d-c resistance 50 ohms nominal.	K-7107898-P2
CL2	Parasitic suppressor.	M-7476387-P1

Symbol	Description	G-E Drawing
	INDUCTORS (CONTINUED)	
CL3	RF choke; 7.0 mh ± 10%, 7.2 ohms resistance, 750 ma current JW Miller Co. Cat. #2881.	A-521A991-P1
CL4	Coil assembly. Inductance 300 uh.	ML-555C123-G1
CL5	Parasitic suppressor. Ohmite Cat. #P-300.	M-7476387-P1
DL1	RF choke; 7.0 mh ± 10%, 7.2 ohms resistance, 750 ma current. JW Miller Co. Cat. #2881.	A-521A991-P1
DL2	Parasitic suppressor. Ohmite Cat. #P-300.	M-7476387-P1
DL3	Grid choke coil assembly.	ML-7478900-G1
DL4	Neutralizing coil assembly.	ML-555C228-G1
DL5	Variometer coil; outer coil inductance 63 uh, inner coil inductance 22.5 uh, mutual inductance 12.5 uh max. EF Johnson Cat. #204-901-3, Type 4258N6+2126VM41C.	D-438D461-P1
DL6	Parasitic suppressor assembly.	ML-7478192-G1
EL1	PA grid coil; inductance 50 uh. EF Johnson Cat. #200-303.	C-555C125-P1
EL2 and EL3	Grid choke coil assemblies.	ML-7478900-G1
EL4 and EL5	Parasitic suppressor assemblies.	ML-7478192-G1
EL6	Plate choke coil assembly.	ML-7768793-G2
EL7	Neutralizing coil assembly.	ML-7664532-G2
EL8	Neutralizing coil assembly.	ML-7768797-G2
EL9	Tank coil. EF Johnson Part #236-150.	C-503C658-P1
EL10	Monitor coil assembly.	ML-603B552-G1
FL1	Filter coil; inductance 50 uh. EF Johnson Part #202-512-2.	C-503C659-P1

INDUCTORS (CONTINUED)

Symbol	Description	G-E Drawing
FL2	Filter coil; inductance 22 uh. EF Johnson Cat. #200-307-1.	C-503C657-P1
FL3	Filter coil; inductance 50 uh. EF Johnson Part #202-512-2.	C-503C659-P1
FL4	Filter coil; inductance 40 uh. EF Johnson Cat. #202-501-2.	C-503C660-P1
HL1	Coil assembly. Inductance 1.0 uh ± 10%.	A-102A4552-G1
HL2	Coil assembly. Inductance 55 uh ± 10%.	A-102A4552-G2
KL1 and KL2	Choke coils; inductance 85 mh ± 5%, resistance 328 ohms ± 15%. F W Sickles Cat. #SC-106A.	K-1R15-P10
PL1 and PL2	Parasitic suppressor assemblies.	ML-777B307-G1
RL1	Modulation reactor. Electric Eng. Works Cat. #E9908.	B-603B283-P1
SL1	Reactor; inductance 2.0 h min at 0.6 amp; d-c resistance 9.0 ohms. Hammond Cat. #41849.	B-594B796-P1
TL1	Reactor; inductance 1.0 h at 1.2 amp; d-c resistance 11 ohms. Hammond Cat. #41875.	B-594B805-P1
UL1	Reactor; inductance 1.0 h min at 1.5 amp; d-c resistance 10 ohms. Hammond Cat. #41874.	B-594B804-P1
WL1	Filter reactor; inductance 1.0 h at 8.0 amp, d-c resistance 3.5 ohms, d-c operating voltage 9000 v; oil filled sealed tank.	B-7491984-P1
XL1	Reactor; inductance 2.0 h min at 0.6 amp; d-c resistance 9.0 ohms. Hammond Cat. #41849.	B-594B796-P1
ZL1	Current limiting reactor. G-E Cat. #92H37. Group 1 only.	
ZL1	Current limiting reactor. Group 2 only.	B-7491983-P1
ZL1	Current limiting reactor. Group 3 only.	B-7492285-P1

Symbol	Description	G-E Drawing
	METERS	
DM1	Milliammeter: rated 1.0 ma d-c. G-E Type DO-71.	P-3R127-P20
DM2	Ammeter: rated 1.5 amp d-c. G-E Type DO-71.	P-3R125-P2
EM1	Ammeter: rated 1.5 amp d-c. G-E Type DO-71.	P-3R125-P2
EM2	Voltmeter: rated 10 v a-c. G-E Type AO-72.	P-3R136-P6
EM3 and EM4	Ammeters: rated 8.0 amp d-c. G-E Type DO-71.	P-3R125-P6
EM5	Ammeter: rated 15 amp d-c. G-E Type DO-71.	P-3R125-P8
FM1	Antenna indicator. Part number selected to agree with customer's requirements as specified on requisition. Part 1. Full scale deflection marked for 50 amp. Part 2. Full scale deflection marked for 40 amp. Part 3. Full scale deflection marked for 30 amp. Part 4. Full scale deflection marked for 25 amp. Part 5. Full scale deflection marked for 20 amp. Part 6. Full scale deflection marked for 15 amp. G-E Type DO-71.	B-603B290
LM1	Milliammeter: rated 1.0 ma d-c. G-E Type DO-71.	P-3R127-P20
NM1 and NM2	Milliammeters: rated 500 ma d-c.	B-603B285-P1
PM1 and PM2	Ammeters: rated 5.0 amp d-c. G-E Type DO-71.	P-3R125-P5
SM1	Kilovoltmeter: rated 1.0 kv d-c. G-E Type DO-71.	P-3R123-P20
TM1	Kilovoltmeter: rated 2.0 kv d-c. G-E Type DO-71.	P-3R123-P22
UM1	Kilovoltmeter: rated 5.0 kv d-c. G-E Type DO-71.	P-3R123-P26
VM1	Kilovoltmeter: rated 10 kv d-c. G-E Type DO-71.	P-3R123-P28
YM1	Elapsed time meter: 99,999 hours; 115 v, 60 cycles.	P-3R142-P1

Symbol	Description	G-E Drawing
	RESISTORS (Composition, unless otherwise specified)	
AR1 and AR2	15 ohms ± 5%, 2 w.	C-3R79-P150J
AR3	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
AR4	1500 ohms ± 5%, 2 w.	C-3R79-P152J
AR5 thru AR7	10,000 ohms ± 5%, 2 w.	C-3R79-P103J
AR8	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
AR9	43 ohms ± 5%, 2 w.	C-3R79-P430J
AR10	Wirewound; 1500 ohms ± 10%, 25 w.	C-594B877-P23
BR1	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
BR2	1000 ohms ± 5%, 2 w.	C-3R79-P102J
BR3 and BR4	2200 ohms ± 5%, 2 w.	C-3R79-P222J
BR5	43 ohms ± 5%, 2 w.	C-3R79-P430J
BR6	Wirewound; 25,000 ohms ± 10%, 50 w.	B-594B849-P34
BR7	Wirewound; 1500 ohms ± 10%, 25 w.	B-594B877-P23
BR8	20,000 ohms ± 5%, 2 w.	C-3R79-P203J
BR9	33,000 ohms ± 5%, 2 w.	C-3R79-P333J
BR10	Rheostat, wirewound; 10,000 ohms ± 10%, linear taper. Ohmite Model J, Cat. #0332.	M-2R34-P25
BR11 and BR12	33,000 ohms ± 5%, 2 w.	C-3R79-P333J
BR13	100 ohms ± 5%, 2 w.	C-3R79-P101J

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED) (Composition, unless otherwise specified)	
CR1	Wirewound; 2000 ohms ± 5%, 50 w. Ward Leonard Cat. #50F2000.	M-2R17-P164
CR2	Wirewound; 5000 ohms ± 10%, 160 w.	B-594B824-P25
CR3	Wirewound; 4.0 ohms ± 5%, 10 w.	B-594B791-P5
CR5	110 ohms ± 5%, 2 w.	C-3R79-P111J
CR7	Wirewound; 750 ohms ± 10%, 25 w.	B-594B877-P18
DR2	2000 ohms ± 5%, 2 w.	C-3R79-P202J
DR4	Wirewound; 500 ohms ± 10%, 100 w.	B-594B823-P14
DR5	Wirewound; 4.0 ohms ± 5%, 10 w.	B-594B791-P5
DR7 and DR8	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
DR9 thru DR11	Wirewound; 50 ohms ± 5%, 200 w.	B-594B825-P8
DR13	Wirewound; 50 ohms ± 5%, 160 w.	A-101A5555-P106
DR14	Wirewound; 50 ohms ± 5%, 160 w.	A-101A5555-P106
ER1 thru ER6	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
ER9	Rheostat; 750 ohms ± 20%, 500 w. Ohmite Model R; Type #0867.	B-603B351-P1
ER10 and ER11	Wirewound; 3.0 ohms ± 10%, 100 w.	B-594B823-P3
GR1	Precision multiplier; 1.0 megohm ± 0.5%, at 25 C, 1000 v. Jan Type MFC105.	M-7470483-P3
GR2	10,000 ohms ± 5%, 2 w.	C-3R79-P103J
GR3 thru GR8	Wirewound; 100 ohms ± 5%, 200 w.	B-594B825-P10

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
HR1 and HR2	Wirewound; 2.0 ohms ± 10%, 100 w.	B-594B823-P2
HR3 and HR4	4700 ohms ± 10%, 2 w.	C-3R79-P472K
KR1 thru KR4	100 ohms ± 5%, 1 w.	C-3R78-P101J
KR5	680 ohms ± 5%, 1 w.	C-3R78-P681J
KR6	10,000 ohms ± 5%, 1 w.	C-3R78-P103J
KR7	0.22 megohm ± 5%, 1 w.	C-3R78-P224J
KR8	68,000 ohms ± 5%, 1 w.	C-3R78-P683J
KR9 thru KR11	22,000 ohms ± 5%, 1 w.	C-3R78-P223J
KR12	22 ohms ± 5%, 1 w.	C-3R78-P220J
KR13	220 ohms ± 5%, 1 w.	C-3R78-P221J
KR14 thru KR16	330 ohms ± 5%, 1 w.	C-3R78-P331J
KR17	3.0 megohm ± 5%, 1 w.	C-3R78-P305J
KR18 and KR19	0.47 megohm ± 5%, 1 w.	C-3R78-P474J
KR20	4700 ohms ± 5%, 2 w.	C-3R79-P472J
KR21	100 ohms ± 5%, 2 w.	C-3R79-P101J
KR22	22,000 ohms ± 5%, 2 w.	C-3R79-P223J
KR23 and KR24	6800 ohms ± 5%, 1 w.	C-3R78-P682J

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
KR25 and KR26	680 ohms ± 5%, 1 w.	C-3R78-P681J
KR27 and KR28	110 ohms ± 5%, 2 w.	C-3R79-P111J
KR29	Potentiometer, wirewound; 2000 ohms ± 10%, 2 w, linear taper. IRC Cat. #W-2000.	M-8569017-P62
KR30	0.10 megohm ± 5%, 1 w.	C-3R78-P104J
KR31	10,000 ohms ± 5%, 1 w.	C-3R78-P103J
KR32	22,000 ohms ± 5%, 1 w.	C-3R78-P223J
LR13	2000 ohms ± 5%, 2 w.	C-3R79-P202J
MR1 and MR2	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
MR3 and MR4	Rheostat, wirewound; 500 ohms ± 10%, 25 w, linear taper. Ohmite Model "H", Cat. #0156.	M-2R33-P17
MR5 thru MR8	Wirewound; 10,000 ohms ± 10%, 160 w.	B-594B824-P27
MR11 and MR12	10 ohms ± 5%, 2 w.	C-3R79-P100J
MR13 and MR14	100 ohms ± 5%, 2 w.	C-3R79-P101J
MR15 and MR16	100 ohms ± 10%, 2 w.	C-3R79-P101K

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
NR1 thru NR4	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
NR9 thru NR12	47 ohms ± 5%, 2 w.	C-3R79-P470J
PR1	Potentiometer, wirewound; 400 ohms ± 10%, 100 w, linear taper. Ohmite Model "K", Cat. #0454.	M-7477518-P15
PR2 and PR3	Rheostat, wirewound; 300 ohms ± 10%, 75 w, linear taper. Ohmite Model "G", Cat. #1113.	M-2R35-P14
PR4 thru PR8	Wirewound; 500 ohms ± 10%, 100 w.	B-594B823-P14
PR9	Rheostat, wirewound; 350 ohms ± 10%, 150 w, linear taper. Ohmite Model "L", Cat. #0540.	M-2R37-P17
PR10 thru PR17	Carbon coated; 1.0 megohm ± 5%. Corning Glass Co. #N30.	A-102A4555-P1
PR26	0.10 megohm ± 5%, 2 w.	C-3R79-P104J
PR28	Potentiometer, wirewound; 750 ohms ± 10%, 100 w, linear taper. Ohmite Model "K", Cat. #0456.	M-7477518-P17
PR29	Rheostat, wirewound; 200 ohms ± 10%, 150 w, linear taper. Ohmite Model "L", Cat. #0538.	M-2R37-P15
PR32 thru PR39	Wirewound; 250 ohms ± 5%, 200 w.	B-594B825-P12
PR40 and PR41	Wirewound; 3.0 ohms ± 10%, 100 w.	B-594B823-P3
PR42	Wirewound; 1.0 ohms ± 5%, 110 w. Ward Leonard Cat. #110F1.0.	M-2R19-P131

RESISTORS (CONTINUED)
(Composition, unless otherwise specified)

Symbol	Description	G-E Drawing
PR44 and PR45	Wirewound; 3500 ohms ± 10%, 100 w.	B-594B823-P22
SR1	Wirewound; 5000 ohms ± 10%, 100 w.	B-594B823-P25
SR2	Precision multiplier; 1.0 megohm ± 0.5% at 25 C, 1000 v. Jan Type MFC 105.	M-7470483-P3
SR3	10,000 ohms ± 5%, 2 w.	C-3R79-P103J
SR4	Wirewound; 10,000 ohms, 150 w, taps divide resistor into ten equal resistances. Ohmite Stock #1606.	B-603B280-P5
SR5	Wirewound; 5000 ohms, 150 w, taps divide resistor into ten equal resistances. Ohmite Stock #1605.	B-603B280-P4
SR6	2200 ohms ± 5%, 2 w	C-3R79-P222J
SR7	Wirewound; 5000 ohms ± 10%, 100 w.	B-594B823-P25
TR2	Wirewound; 5000 ohms ± 5%, 10 w.	B-594B791-P47
TR3	Precision multiplier; 2.0 megohm ± 0.5% at 25 C, 2000 v. Jan Type MFB205.	M-7470483-P6
TR5	Wirewound; 10 ohms ± 5%, 25 w. Ward Leonard Cat. #25F10.	M-2R14-P61
UR1	Precision multiplier; 5.0 megohm ± 0.5% at 25 C, 5000 v. Jan Type MFA505.	M-7470483-P12
UR2	Wirewound; 5000 ohms ± 5%. 10 w.	B-594B791-P47
UR3	Wirewound; 10 ohms ± 5%, 25 w. Ward Leonard Cat. #25F10.	M-2R14-P61
VR1 and VR2	Wirewound; 500 ohms ± 5%. 200 w.	B-594B825-P13
VR3 and VR4	Precision multiplier; 5.0 megohm ± 0.5% at 25 C, 5000 v. Jan Type MFA505.	M-7470483-P12

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED) (Composition, unless otherwise specified)	
VR5	0.33 megohm ± 10%, 2 w.	C-3R79-P334K
VR6	5600 ohms ± 10%, 2 w.	C-3R79-P562K
VR7	Wirewound; 10,000 ohms ± 5%, 200 w.	B-594B825-P25
VR8 thru VR15	Wirewound; 500 ohms ± 5%, 200 w.	B-594B825-P13
XR1	2200 ohms ± 5%, 2 w.	C-3R79-P222J
XR2	Precision multiplier; 1.0 megohm ± 0.5% at 25 C, 1000 v. Jan Type MFC105.	M-7470483-P3
XR3	10,000 ohms ± 10%, 2 w.	C-3R79-P103K
YR1	Potentiometer, composition; 5000 ohms ± 20%, 2.25 w, linear taper. Allen Bradley Type J.	M-2R73-P52
YR2	470 ohms ± 5%, 2 w.	C-3R79-P471J
YR4 and YR5	Wirewound; 5.0 ohms ± 10%, 25 w.	B-594B877-P5
YR6	3300 ohms ± 10%, 2 w.	C-3R79-P332K
	SWITCHES	
AS1	Stepping switch; 110 v d-c, 12 positions, 2 wafers, 4 pole, 2 throw operation. G.H. Leland Inc. Type BD5SR35.	B-603B294-P1
AS2	Push-button type; momentary contact, red button, sp NO. snap acting, 10 amp at 115 v a-c, 1 amp at 115 v d-c. Grayhill Cat. #2201.	M-7481654-P3
CS1	Toggle type; dpst, contacts rated 12 amp at 125 v a-c. Arrow Hart and Hegeman Cat. #82143.	A-7109677-P1
DS1	Rotary style; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2

Symbol	Description	G-E Drawing
	SWITCHES (CONTINUED)	
DS2	Toggle type; dpst, contacts rated 12 amp at 125 v a-c. Arrow Hart and Hegeman Cat. #82143.	A-7109677-P1
ES1	Lever key switch; 1 form F contact, 3 positions. D.P. Mossman Series 4103.	C-7777140-P2
ES2	Rotary type; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2
ES3 and ES4	Sensitive, snap acting, pressure actuated, spdt, 9 to 13 oz. operating force. Microswitch Cat. #BZ-2R.	M-7489189-P1
LS1	Rotary style; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2
SS1	Rotary style; 2 sections, rated 5 amp, 115 v a-c. Esco Electric Switch Corp Type AF.	B-603B281-P2
WS1A thru WS1C	Delta Wye switches. G-E Cat. #TC35364. Group 1 only.	
WS1A thru WS1C	Delta Wye switches. G-E Cat. #175L625G37. Group 2 only.	
WS1A thru WS1C	Delta Wye switches. G-E Cat. #175L626G36. Group 3 only.	
WS2A thru WS2C	Plate disconnect switches. G-E Cat. #TC90364SDJ6. Group 1 only.	
WS2A thru WS2C	Plate disconnect switches. G-E Cat. #175L630G213. Group 2 only.	
WS2A thru WS2C	Plate disconnect switches. G-E Cat. #175L632G210. Group 3 only.	
YS1	Lever key switch; 1 form A contact, 2 positions. D.P. Mossman Series 4102.	C-7777140-P1
YS2	Airflow switch; spdt. Rotron Type 1000.	B-7487948-P1

Symbol	Description	G-E Drawing
	SWITCHES (CONTINUED)	
YS3	Rotary type; 5 sections, rated 5 amp, 115 v a-c. Esco Electric Corp Type AF.	B-603B281-P5
YS4 thru YS7	Lever key switches; 1 form F contact, 3 positions. D.P. Mossman Series 4103.	C-7777140-P12
YS8 thru YS12	Interlock switch assemblies.	ML-7460330-G4
YS13 and YS14	Safety grounding switch assemblies.	ML-503C612-G2
YS15	Safety grounding switch assembly.	ML-503C612-G3
YS16	Safety grounding switch assembly.	ML-503C612-G2
YS17	Safety grounding switch assembly.	ML-503C612-G1
YS18	Push-button type; momentary contact, red button, sp NO. snap acting, 10 amp at 115 v a-c. Grayhill Cat. #2201.	M-7481654-P3
YS19	Interlock switch assembly.	ML-7460330-G4
YS20	Safety grounding switch assembly.	ML-503C612-G2
ZS3	Circuit breaker; 3 pole, rated 10 amp, time overload curve 1. Heinemann Cat. #3363S-10.	P-7768830-P2
ZS4 and ZS5	Circuit breakers; 3 pole, rated 35 amp, time overload curve 1. Heinemann Cat. #3363S-35.	P-7768830-P6
ZS6	Circuit breaker; 3 pole, rated 25 amp, time overload curve 3. Heinemann Cat. #3363S-25.	P-7768830-P19
ZS7	Circuit breaker; 3 pole, rated 3 amp, time overload curve 3. Heinemann Cat. #3363S-3.	P-7768830-P33
ZS8	Circuit breaker; 3 pole, rated 5 amp, time overload curve 3. Heinemann Cat. #3363S-5.	P-7768830-P15

Symbol	Description	G-E Drawing
	SWITCHES (CONTINUED)	
ZS9 and ZS10	Circuit breakers; 3 pole, rated 3 amp, time overload curve 3. Heinemann Cat. #3363S-3.	P-7768830-P33
ZS11	Circuit breaker; 2 pole, rated 8 amp, time overload curve 2. Heinemann Cat. #2263S-8.	P-7768829-P37
ZS12A thru ZS12C	Distribution disconnect switches. G-E Cat. #TC90362SDJ6. Group 1 only.	
ZS12A thru ZS12C	Distribution disconnect switches. G-E Cat. #175L615G1. Group 2 only.	
ZS12A thru ZS12C	Distribution disconnect switches. G-E Cat. #175L615G9. Group 3 only.	
	TRANSFORMERS	
AT1	Filament, single phase. Pri: 208 v, 50/60 cycles; sec #1: 6.3 v ± 2%, 1.25 amp; sec #2: 6.3 v ± 2%, 1.25 amp.	B-603B556-P1
AT2	Filament, single phase. Pri: 115 v, 50/60 cycles; sec: 11 v, 0.9 amp.	B-152B982-P1
CT1	Filament, single phase. Pri: 208 v, 60/60 cycles; sec: 5 v CT, 14.5 amp.	B-594B678-P1
DT1	Filament, single phase. Pri: 193-218 v. 50/60 cycles; sec: 6 v CT, 60 amp.	B-594B679-P1
ET1 and ET2	Filament, single phase. Pri: 193/218 v, 50/60 cycles; sec: 8 v CT, 200 amp.	B-594B680-P1
GT1	Power transformer. Pri: delta connected, 208 v, 3 phase, 50/60 cycles; sec: delta connected, 3 phase, to supply 400 v d-c at 1 amp via germanium rectifiers.	B-603B562-P1

TRANSFORMERS (CONTINUED)

Symbol	Description	G-E Drawing
KT1	Audio transformer. Frequency response: ± ½ db, 50-20,000 cps; distortion at 30 cps: less than 0.5% at +10 dbm; self resonance: above 35 kc; input impedance: 150 and 600 ohms; output impedance: two windings each 20,000 ohms.	B-594B786-P1
KT2	Filament, single phase. Pri: 208 v, 50/60 cycles; sec: 6.3 v CT, 1.2 amp.	B-594B665-P1
MT1 and MT2	Filament, single phase. Pri: 208 v, 50/60 cycles; sec: 5 v CT, 14.5 amp.	B-594B678-P1
NT1 thru NT4	Filament, single phase. Pri: 208 v, 50/60 cycles; sec: 5 v, 25 amp.	B-603B559-P1
PT1	Audio (cathode) transformer. Hammond Cat. #41847.	B-603B553-P1
PT2 and PT3	Filament, single phase. Pri: 193/218 v, 50/60 cycles; sec: 8 v CT, 200 amp.	B-594B680-P1
RT1	Modulation transformer. Electro Eng. Works Cat. #E9907.	B-603B282-P1
ST1	3 phase plate transformer. Pri: 208 v, 50/60 cycles, delta connected; sec: 370 v. Hammond Cat. #41876.	B-594B797-P1
TT1	3 phase plate transformer. Pri: 208 v, 50/60 cycles, delta connected; sec: 1120 v delta connected. Hammond Cat. #41851.	B-594B803-P1
UT1	Power transformer. Pri: 208 v, 3 phase, 50/60 cycles, delta connected; sec: 2620, 2820, or 3010 v, delta connected.	B-603B561-P1
VT1 and VT2	Current transformers. Ratio: 15:5; imp level: 75,000 v, 25/60 cycles. G-E Cat. #640 x 27, Type JKM-4, Model AAD11.	A-101A6586-P1

Symbol	Description	G-E Drawing
	TRANSFORMERS (CONTINUED)	
WT1 thru WT3	Plate transformers. G-E Cat. #5508AD2550. Group 1 only.	
WT1 thru WT3	Plate transformers. G-E Cat. #5525AD1550. Group 2 only.	
WT1 thru WT3	Plate transformers. Group 3 only.	B-594B667-P1
XT1	3 phase plate transformer. Pri: 208 v, 50/60 cycles; sec: 580 v.	B-594B799-P1
ZT1 thru ZT3	Distribution transformers. G-E Model #9T21Y12. Group 1 only.	
ZT1 thru ZT3	Distribution transformers. G-E Cat. #2701AC6510. Group 2 only.	
ZT1 thru ZT3	Distribution transformers. G-E Cat. #3601AC6510. Group 3 only.	
ZT4 and ZT5	Voltage stabilizing. Input: 170-235 v, 60 cycles; output: 208 v. G-E Model #9T91Y30.	B-603B560-P1
ZT6	Voltage stabilizing. Input: 170-235 v, 60 cycles; output: 208 v. G-E Model 9T91Y31.	B-603B560-P2
ZT7	G-E Cat. #21Y7264.	
ZT8	Audio bucking transformer.	B-777B100-P1

Symbol	Description	G-E Drawing
	***THYRITE RESISTORS**	
VTY1 and VTY2	G-E Cat. #9238208-G1.	A-101A6587-P1
YTY1	Similar to G-E Cat. #9RV3A11 except with 3 disks, G-E Cat. #3900353-G1.	B-7491992-P1
	FUSE HOLDERS	
AXF1 and AXF2	Indicating type, clear color. Bussman Cat. #HKL.	A-7141874-P1
	INDICATING LAMP SOCKETS	
AXI1 and AXI2	Miniature bayonet, red. Dialight Cat. #53410-991.	A-101A5509-P1
AXI3 and AXI4	Miniature bayonet, green. Dialight Cat. #53410-992.	A-101A5509-P2
YXI1 thru YXI14	Red transparent jewel. Drake Cat. #101N.	A-7140623-P1
YXI15 thru YXI17	Amber transparent jewel. Drake Cat. #101N.	A-7140623-P5
YXI18	Red transparent jewel. Drake Cat. #101N.	A-7140623-P1
	RELAY SOCKETS	
KXK1	Octal, mica filled. Jan Type TS101P01.	B-7408127-P1
YXK6	Octal, mica filled. Jan Type TS101P01.	B-7408127-P1
YXK29	Octal, mica filled. Jan Type TS101P01.	B-7408127-P1

*Registered U.S. Patent Office.

Symbol	Description	G-E Drawing
	TUBE SOCKETS	
AXV1	Mica filled phenolic, octal. Cinch Type 9886.	K-7103053-P1
BXV1	Mica filled phenolic, octal. Cinch Type 9886.	K-7103053-P1
CXV1	5 pin giant. EF Johnson Cat. #122-275-200.	A-102A5142-P1
DXV1	Machlett Cat. #21186.	B-603B524-P1
KXV1 and KXV2	Turret type, 7 pin miniature, bottom mount saddle type, 4 ground lugs.	B-7484399-P3
MXV1 and MXV2	5 pin giant. EF Johnson Cat. #122-275-200.	A-102A5142-P1
NXV1 thru NXV4	4 pin. EF Johnson Cat. #123-213-1.	A-102A4551-P1
	CRYSTAL SOCKETS	
AXY1 and AXY2	Mica filled phenolic, octal. Cinch Type 9886.	K-7103053-P1
	CRYSTALS	
AY1 and AY2	Part number selected to agree with customer's requirements as specified on requisition.	B-7466947

Part Number	Crystal and Carrier Frequency in KC
1	540.000
2	550.000
3	560.000
4	570.000
5	580.000
6	590.000
7	600.000
8	610.000
9	620.000
10	630.000

Symbol	Description	G-E Drawing

CRYSTALS (CONTINUED)

Part Number	Crystal and Carrier Frequency in KC
11	640.000
12	650.000
13	660.000
14	670.000
15	680.000
16	690.000
17	700.000
18	710.000
19	720.000
20	730.000
21	740.000
22	750.000
23	760.000
24	770.000
25	780.000
26	790.000
27	800.000
28	810.000
29	820.000
30	830.000
31	840.000
32	850.000
33	860.000
34	870.000
35	880.000
36	890.000
37	900.000
38	910.000
39	920.000
40	930.000
41	940.000
42	950.000
43	960.000
44	970.000
45	980.000
46	990.000
47	1000.000
48	1010.000
49	1020.000
50	1030.000

Symbol	Description	G-E Drawing

CRYSTALS (CONTINUED)

Part Number	Crystal and Carrier Frequency in KC
51	1040.000
52	1050.000
53	1060.000
54	1070.000
55	1080.000
56	1090.000
57	1100.000
58	1110.000
59	1120.000
60	1130.000
61	1140.000
62	1150.000
63	1160.000
64	1170.000
65	1180.000
66	1190.000
67	1200.000
68	1210.000
69	1220.000
70	1230.000
71	1240.000
72	1250.000
73	1260.000
74	1270.000
75	1280.000
76	1290.000
77	1300.000
78	1310.000
79	1320.000
80	1330.000
81	1340.000
82	1350.000
83	1360.000
84	1370.000
85	1380.000
86	1390.000
87	1400.000
88	1410.000
89	1420.000
90	1430.000

Symbol	Description	G-E Drawing

CRYSTALS (CONTINUED)

Part Number	Crystal and Carrier Frequency in KC
91	1440.000
92	1450.000
93	1460.000
94	1470.000
95	1480.000
96	1490.000
97	1500.000
98	1510.000
99	1520.000
100	1530.000
101	1540.000
102	1550.000
103	1560.000
104	1570.000
105	1580.000
106	1590.000
107	1600.000

CONNECTORS

Symbol	Description	G-E Drawing
	Small filament connector. Machlett Cat. #F17487.	A-101A6732-P1
	Large filament connector. Machlett Cat. #F17488.	A-101A6732-P2
	Grid connector. Machlett Cat. #F17489.	A-101A6732-P3

REFLECTOMETER ASSEMBLY
ML-444D442-G2

CAPACITORS

Symbol	Description	G-E Drawing
JC1	10 mmfd, 15 kv peak, 20 amp RMS. Jennings Radio Type JCS-2.	A-102A5083-P1
JC2	Variable, air; 13 to 341 mmfd, 2400 v peak. Hammond Cat. #8135 modified for shaft length 1.12".	A-122A5120-P2
JC2A	Mica; 1000 mmfd ± 10%, 2500 v d-c w. EIA Type RCM45B102K.	P-3R31-P9

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
JC3	Ceramic Hi-K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
JC4 and JC5	Ceramic Hi-K disk, 0.02 mfd +100% -0%, 500 v d-c w.	C-7774750-P15
JC6	Silver mica, dipped phenolic insulation; 150 mmfd ± 10%, 500 v d-c w. Electromotive Type DM15.	B-7489162-P131
	RECTIFIERS	
JCR1 thru JCR4	Germanium diodes. Type 1N39A.	
	RELAY	
JK1	2 v, 6.3 ma d-c. Struthers-Dunn Type 112XAX.	A-102A5082-P1
	INDUCTORS	
JL1A	Coil assembly.	B-777B105-P1
JL1B	Coil assembly.	A-102A5080-G1
JL2 and JL3	RF chokes; inductance 1.0 mh, 125 ma d-c, 6 ohms d-c resistance. Hammond Mfg Co. Type 1500.	A-122A5152-P1
	RESISTORS	
JR1	Rheostat, wirewound; 1000 ohms ± 10%, 25 w. Ohmite Model "H", Cat. #O158.	M-2R33-P42
JR2	Wirewound, 500 ohms ± 10%, 25 w.	B-594B877-P17
JR3	Rheostat, wirewound; 2500 ohms ± 10%, 25 w. Ohmite Model "H", Cat. #O160.	M-2R33-P44
JR4	Wirewound, 800 ohms ± 10%, 25 w.	B-594B877-P19

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED)	
JR5	Composition, 1500 ohms ± 5%, 2 w.	C-3R79-P152J
	TERMINAL BOARDS	
JTB1 and JTB2	2 terminals. Cinch Electronics Components Type 1720.	A-102A5148-P1
JTB3 and JTB4	5 terminals, center terminal grounded.	C-7775500-P11

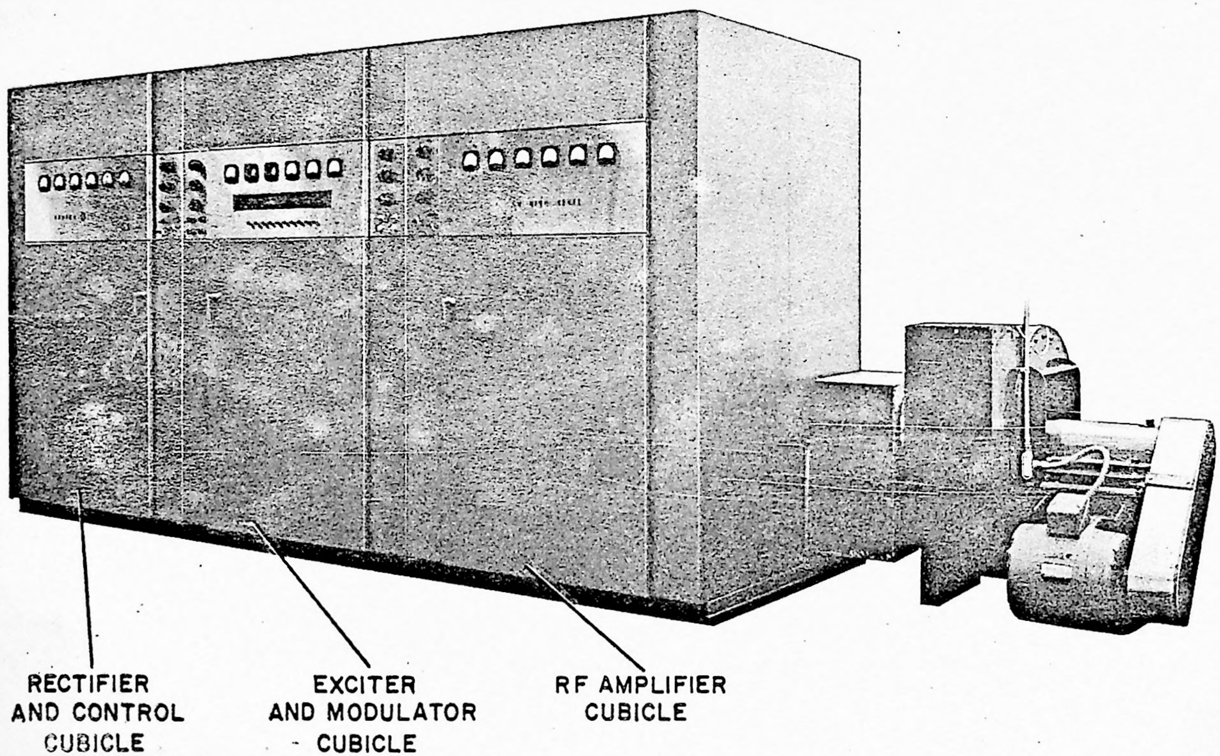


Fig. 1 Front View of 50-KW AM Broadcast Transmitter, Type BT-50-A (8-962)

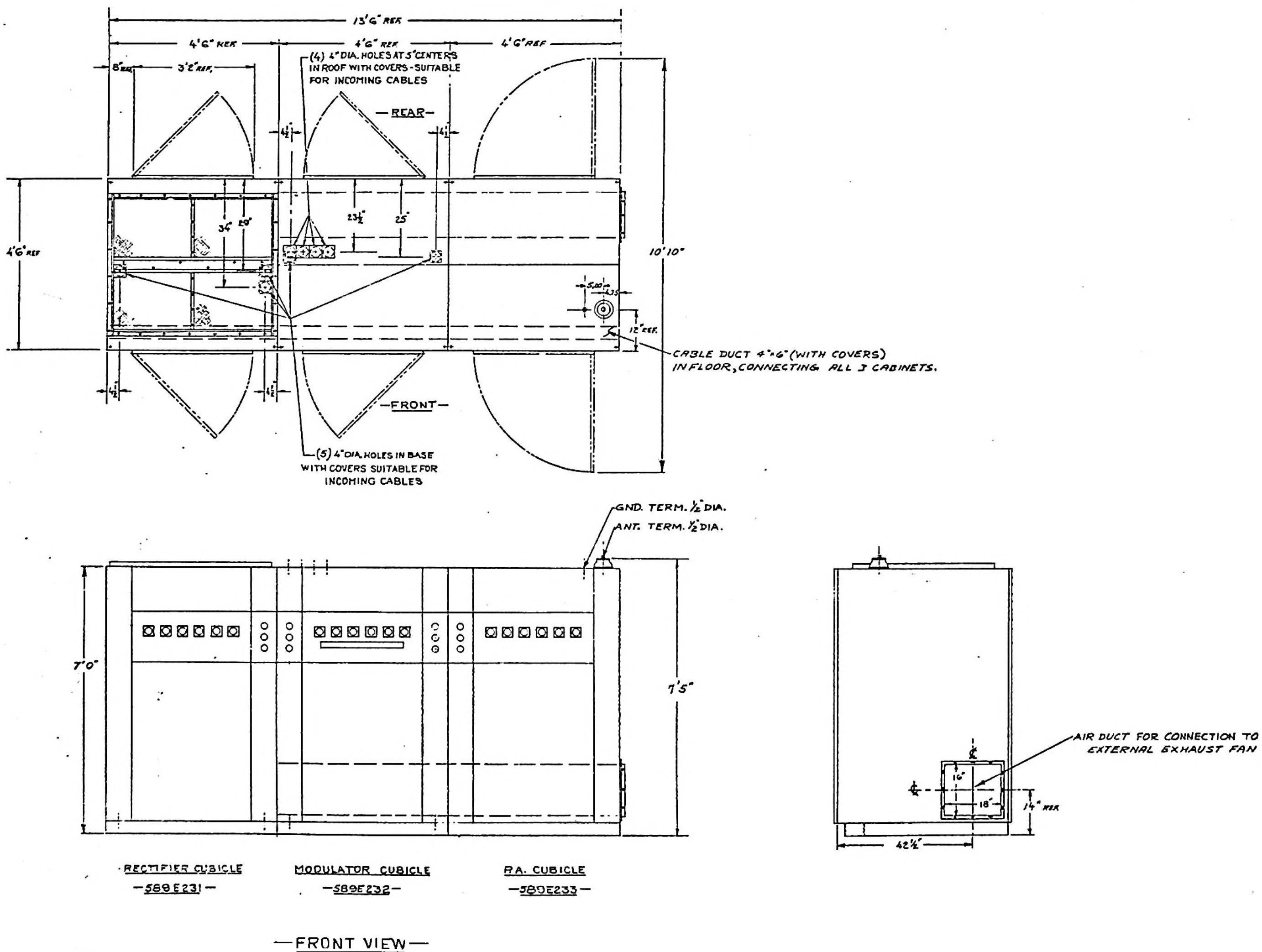


Fig. 2 Outline: Transmitter Cubicles with Physical Data (D-7669883, Sheet 1)

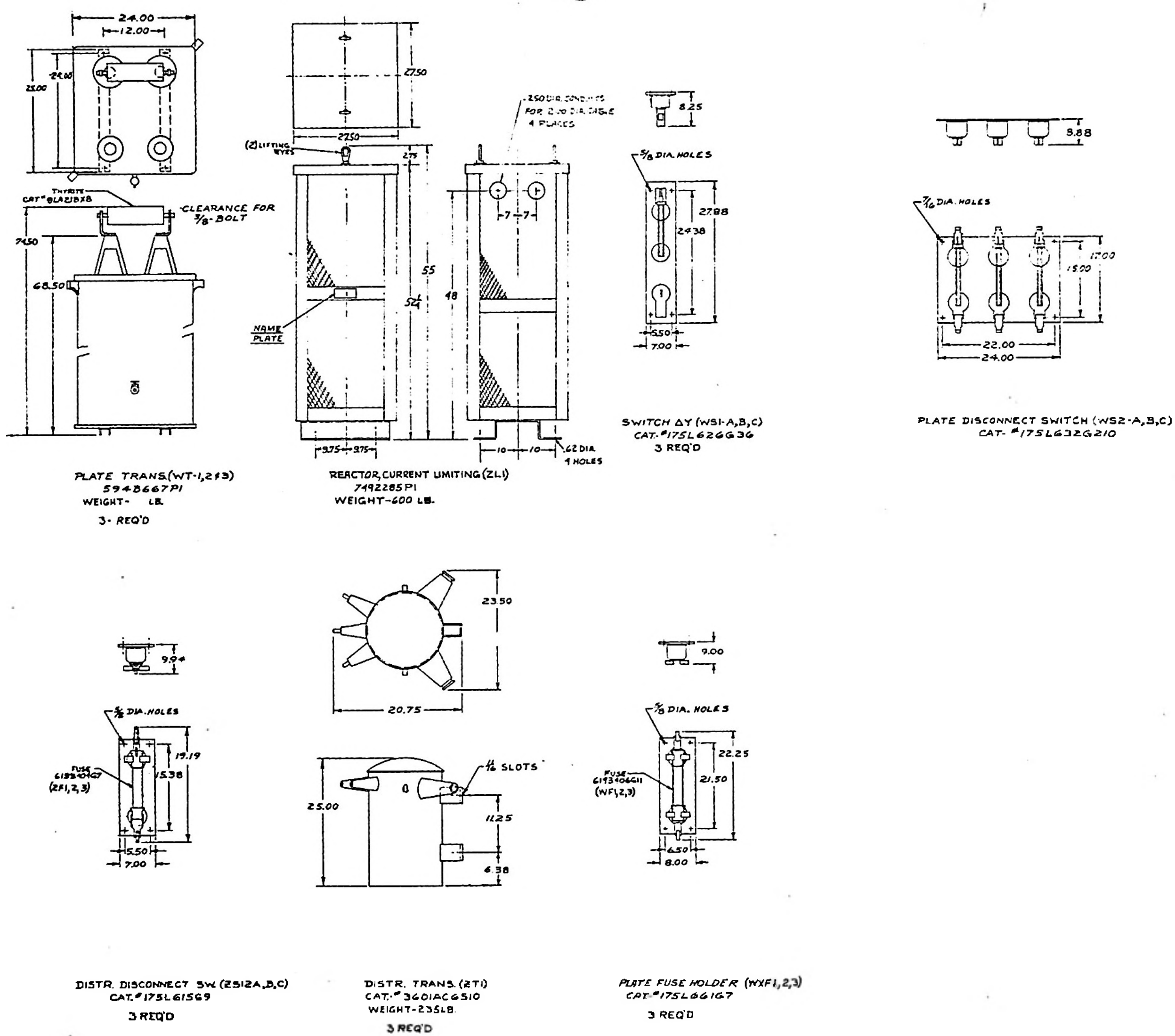


Fig. 7 Outline: External Components for Operation with 4160-Volt Input (D-7669883, Sheet 6)

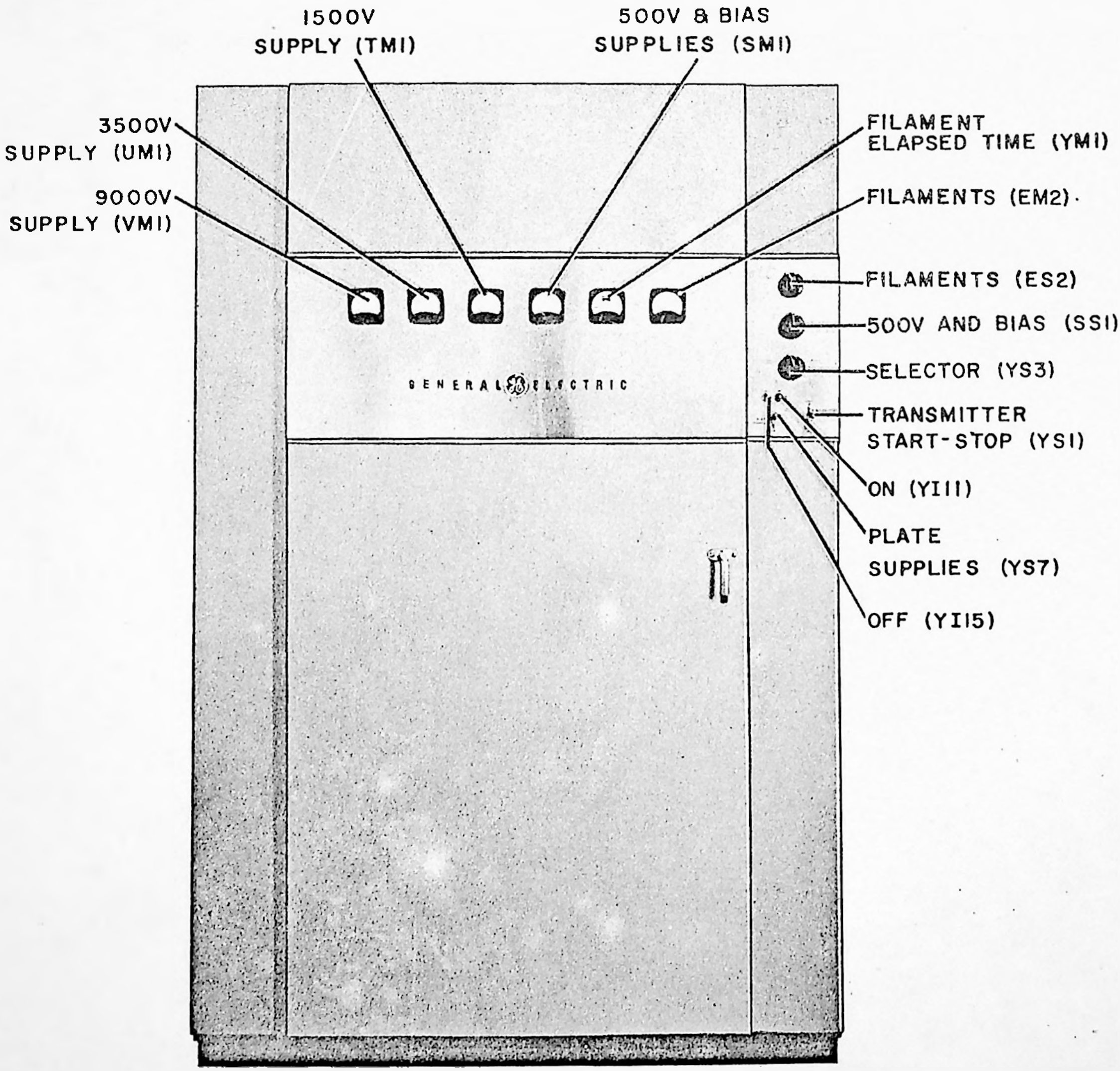


Fig. 8 Front View of Rectifier and Control Cubicle with Door Closed (7-6732)

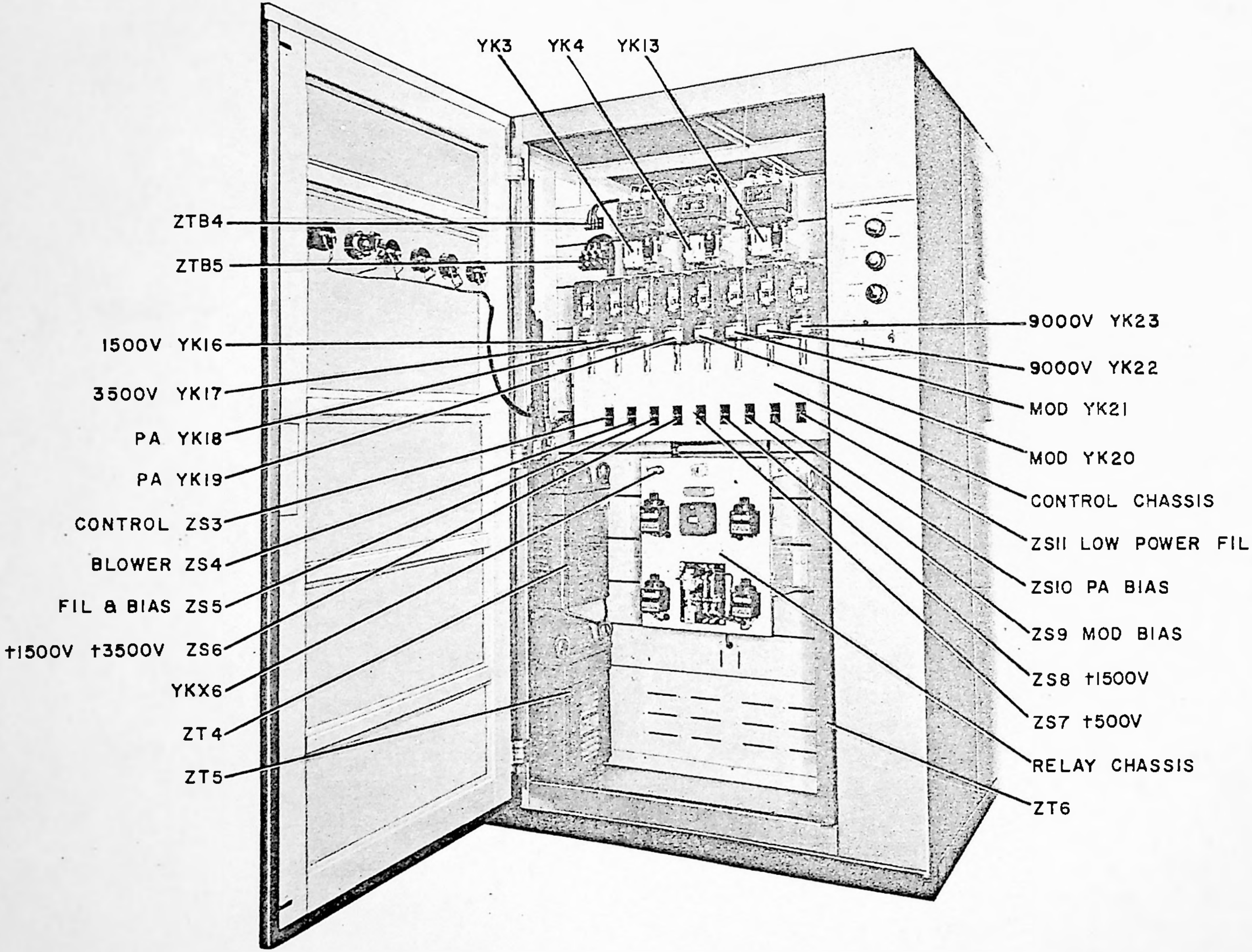


Fig. 9 Front View of Rectifier and Control Cubicle with Door Open (7-6730)

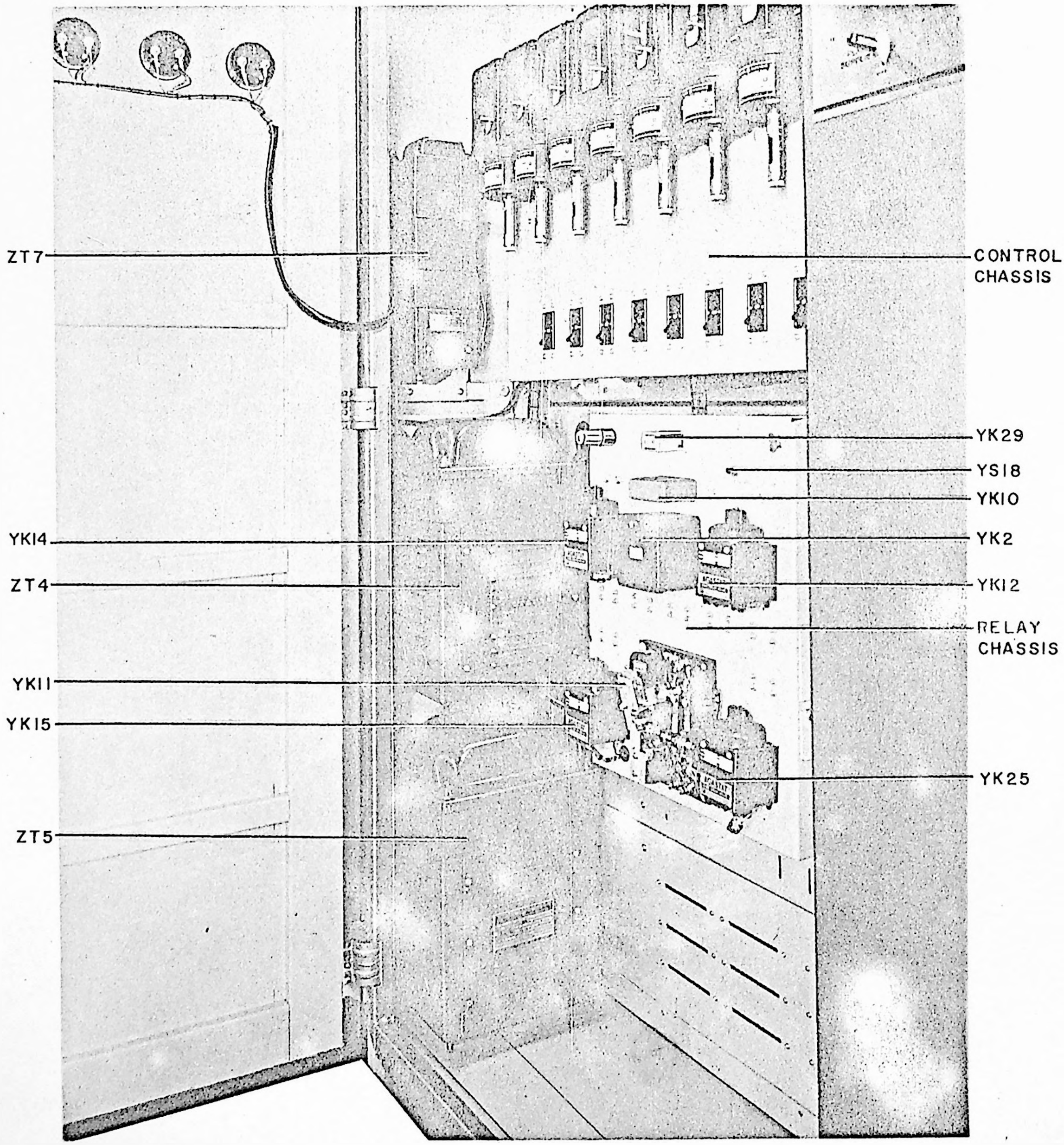


Fig. 10 Front Interior and Left Wall View of Rectifier and Control Cubicle (7-6731)

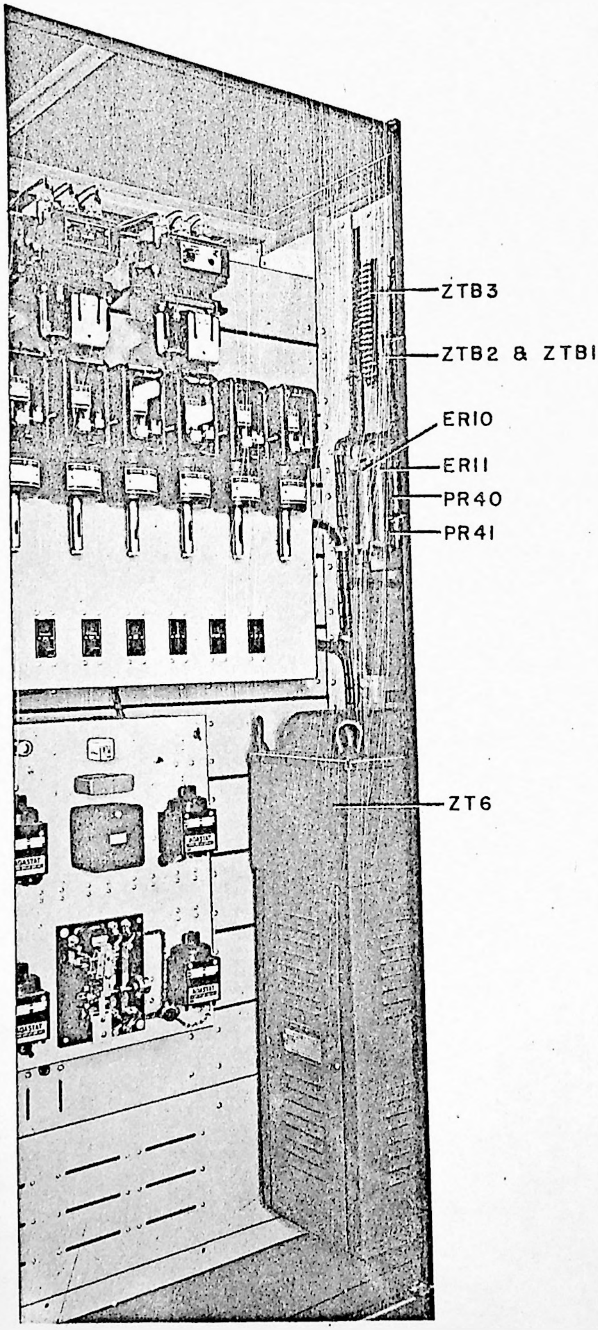


Fig. 11 Front Interior and Right Wall View of Rectifier and Control Cubicle (7-6729)

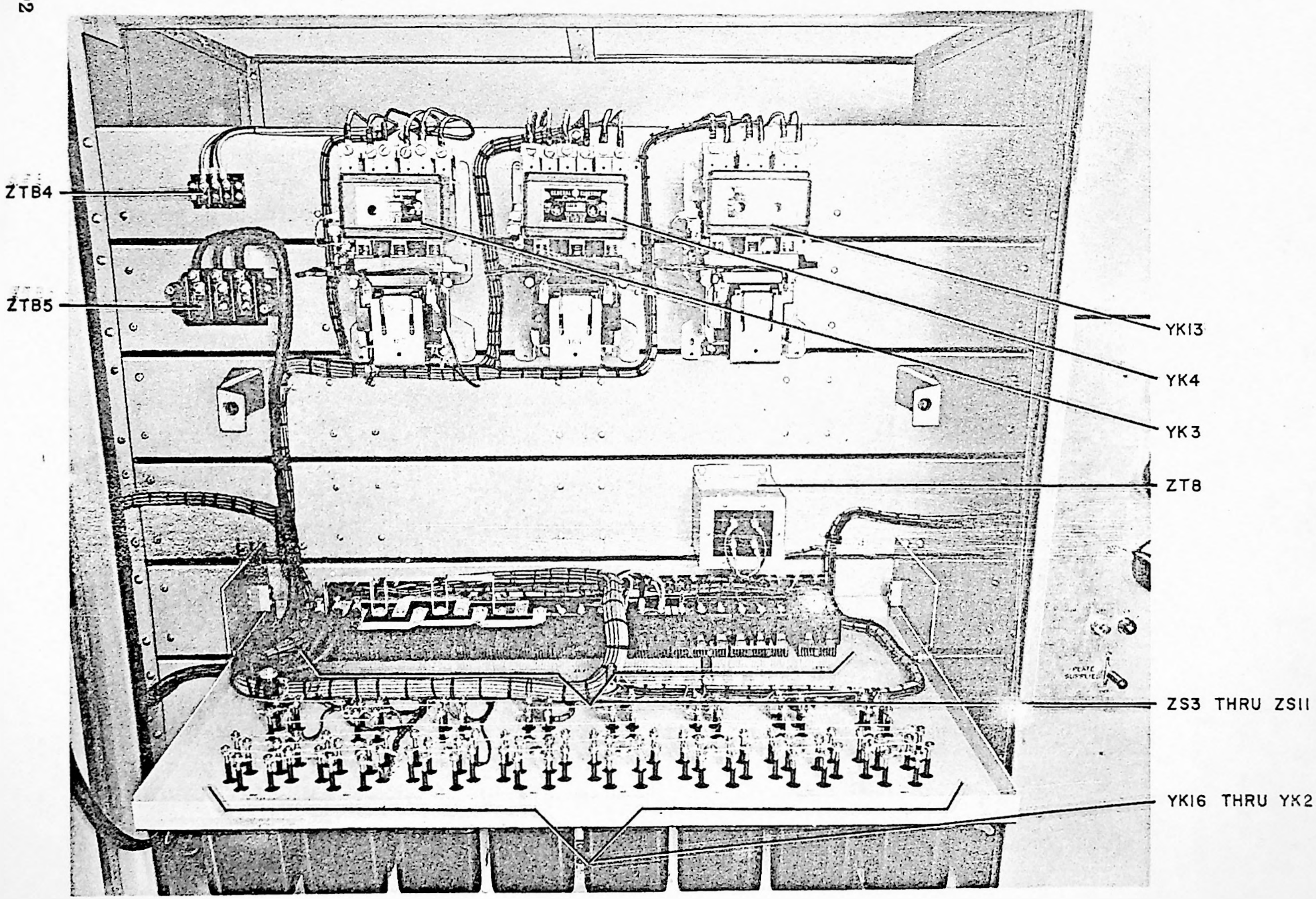


Fig. 12 Rectifier and Control Cubicle Control Chassis (8-2267)

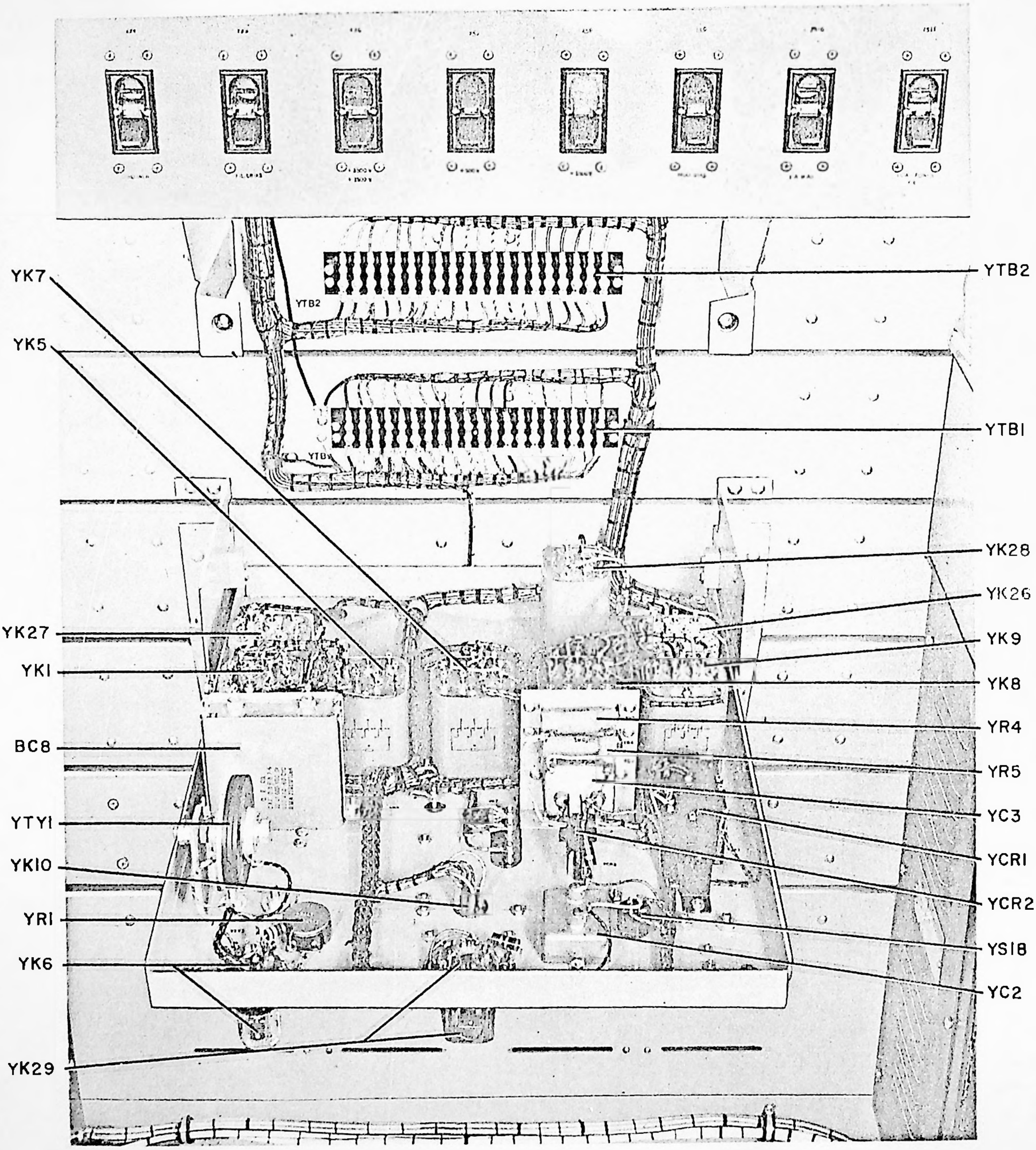


Fig. 13 Rectifier and Control Cubicle Relay Chassis (8-2270)

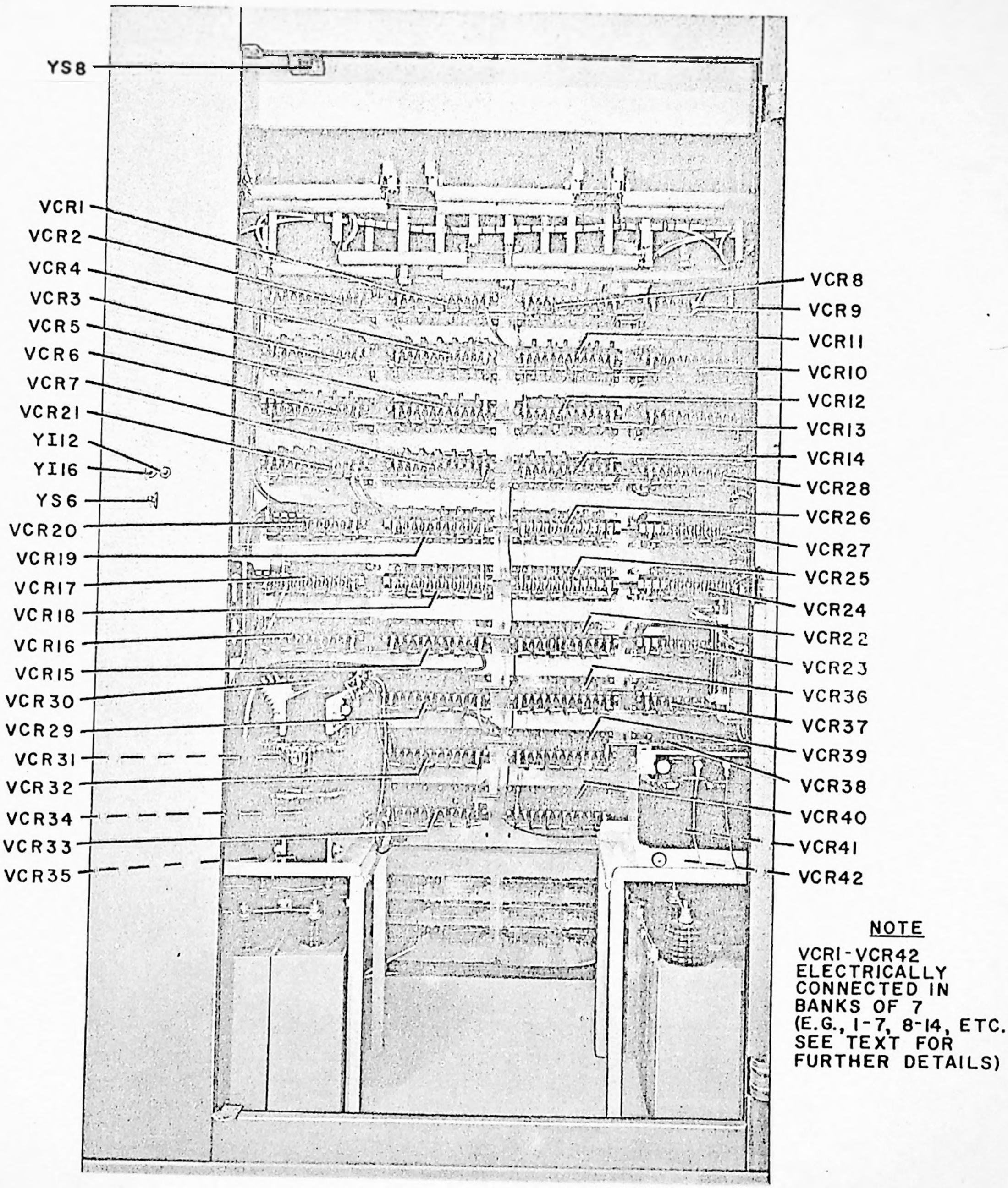


Fig. 14 Rear View of Rectifier and Control Cubicle (7-6936)

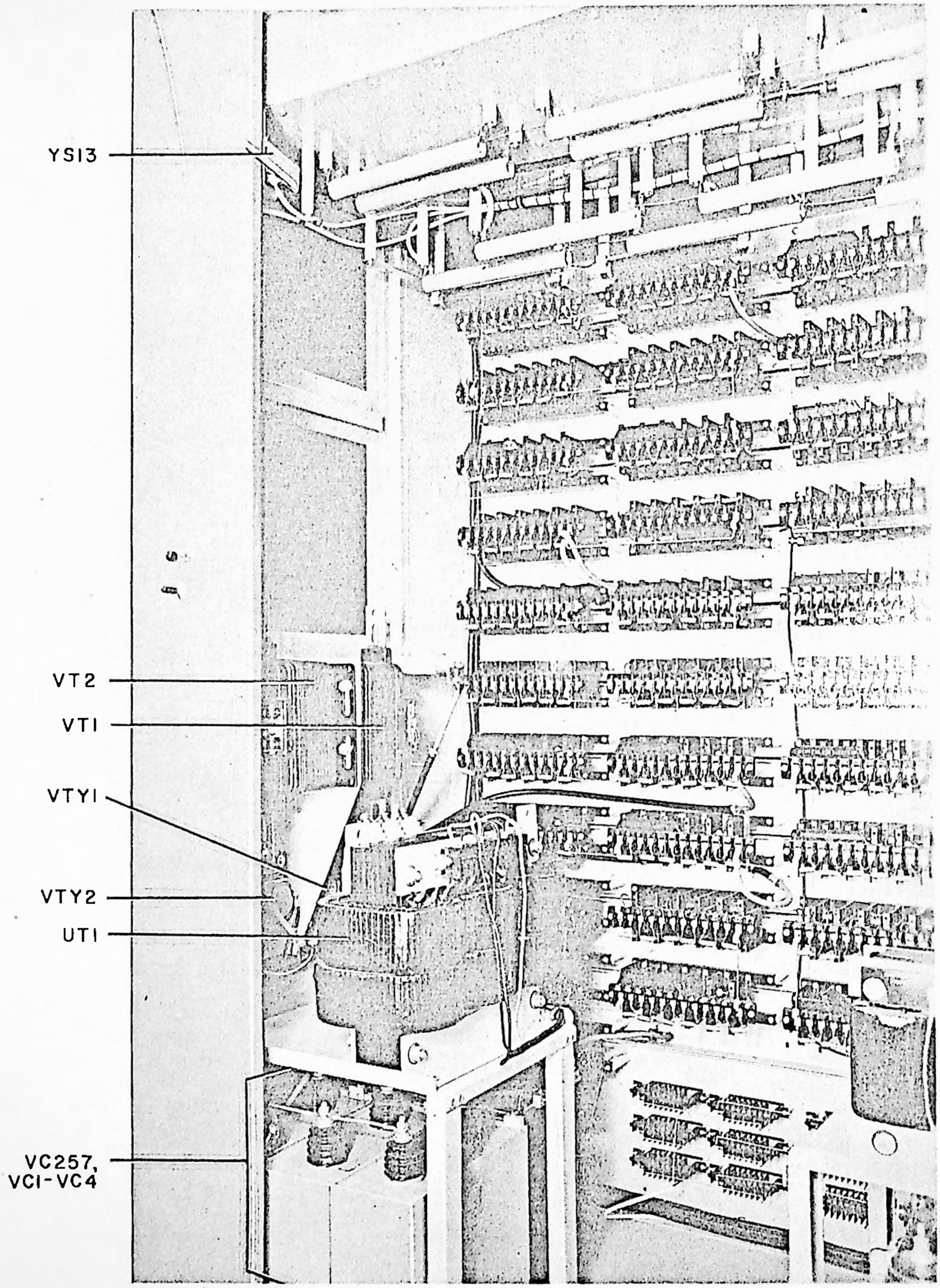


Fig. 15 Rear and Left Wall View of Rectifier and Control Cubicle (7-6927)

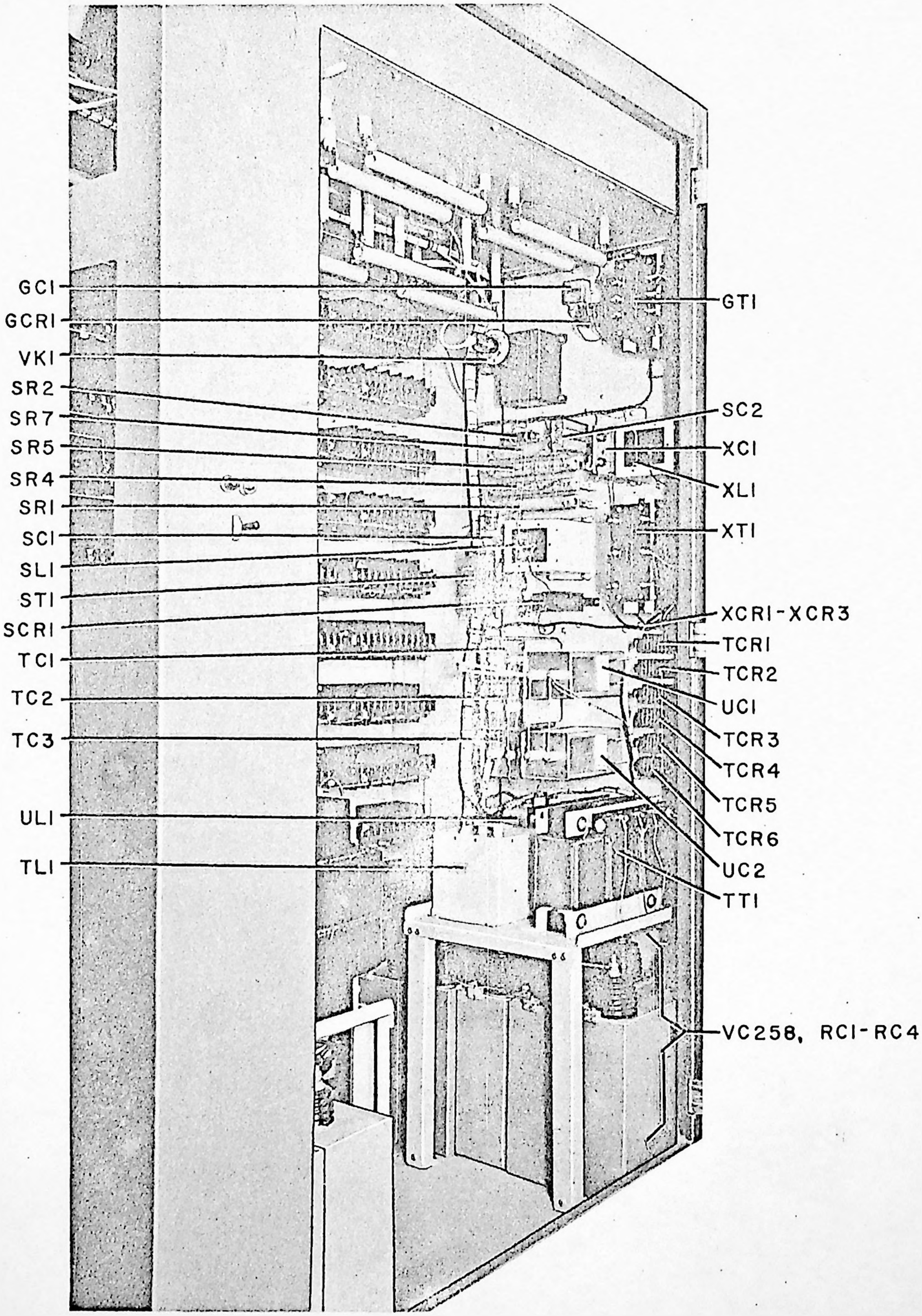


Fig. 16 Rear and Right Wall View of Rectifier and Control Cubicle (7-6937)

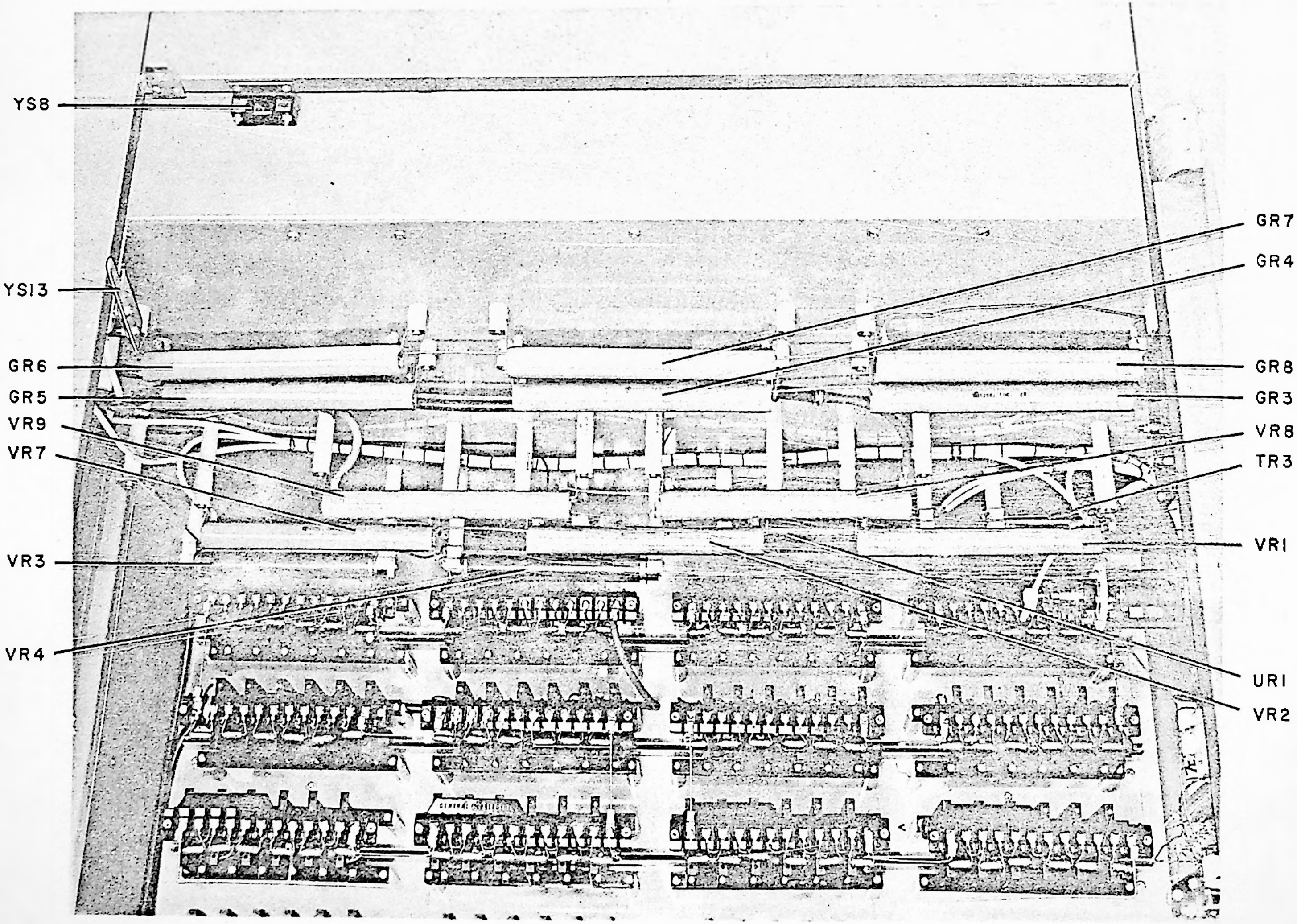


Fig. 17 Rear and Ceiling View of Rectifier and Control Cubicle (7-6910)

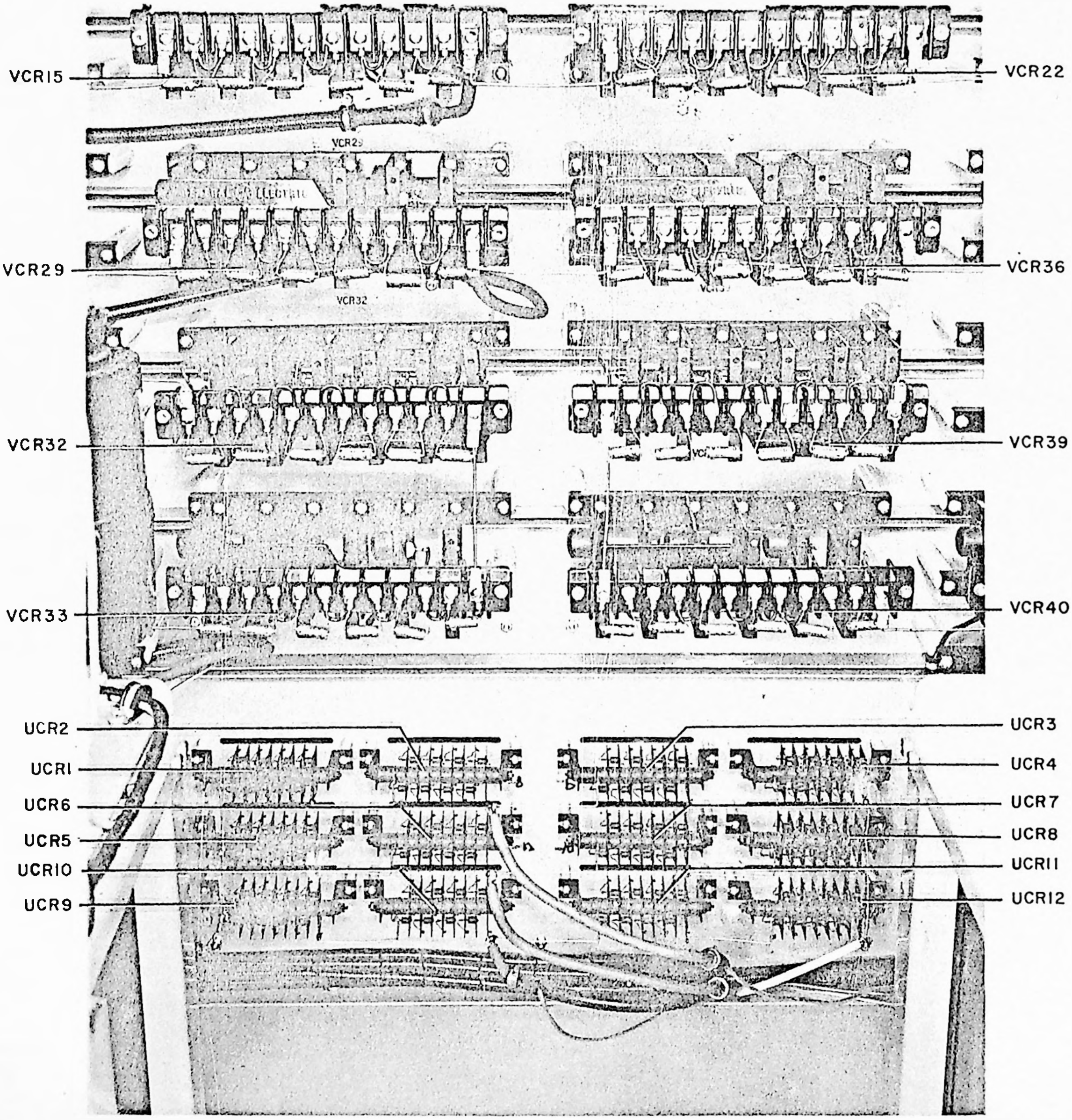


Fig. 18 Rear and Bottom View of Rectifier and Control Cubicle (8-960)

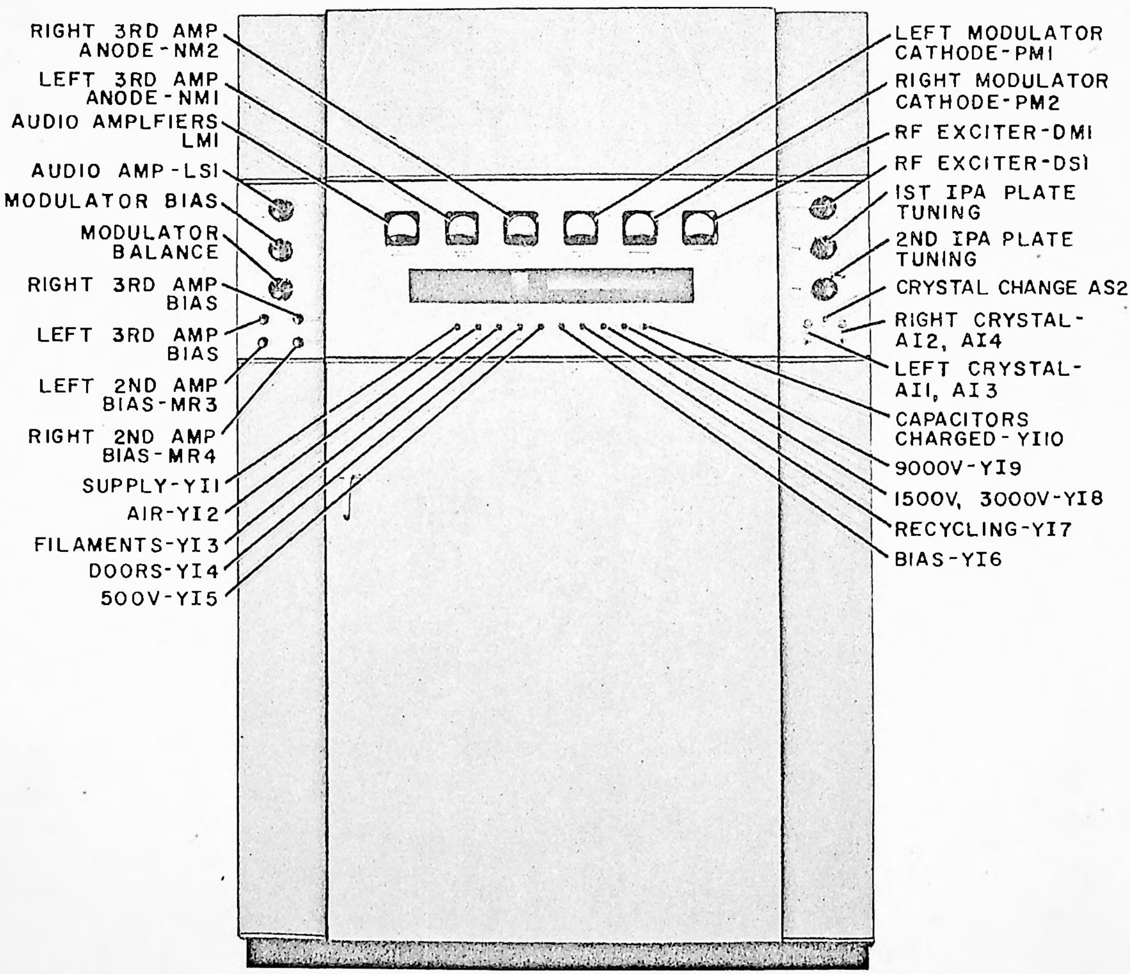


Fig. 19 Front View of Exciter and Modulator Cubicle with Door Closed (7-6914)

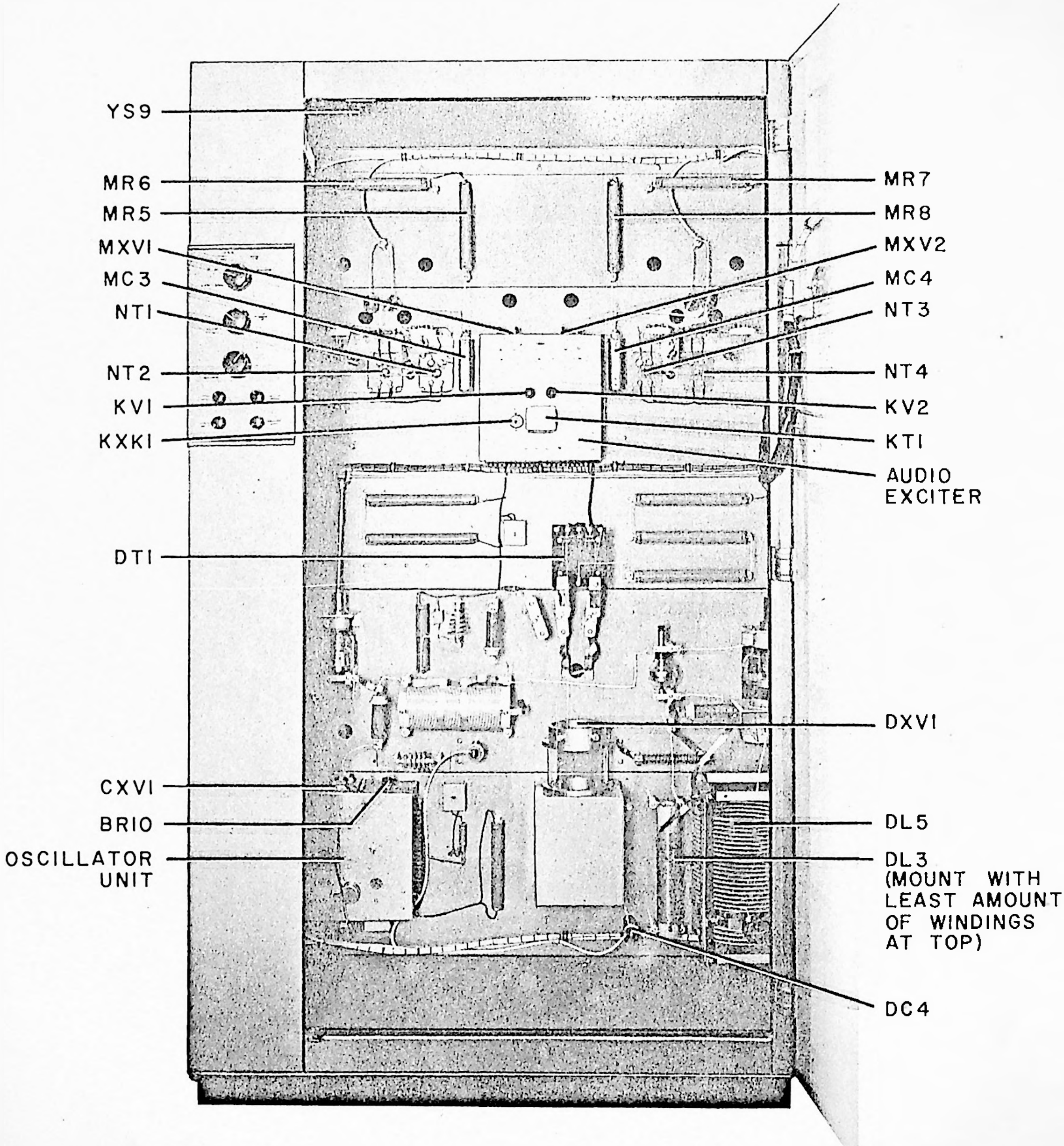


Fig. 20 Front View of Exciter and Modulator Cubicle with Door Open (7-6932)

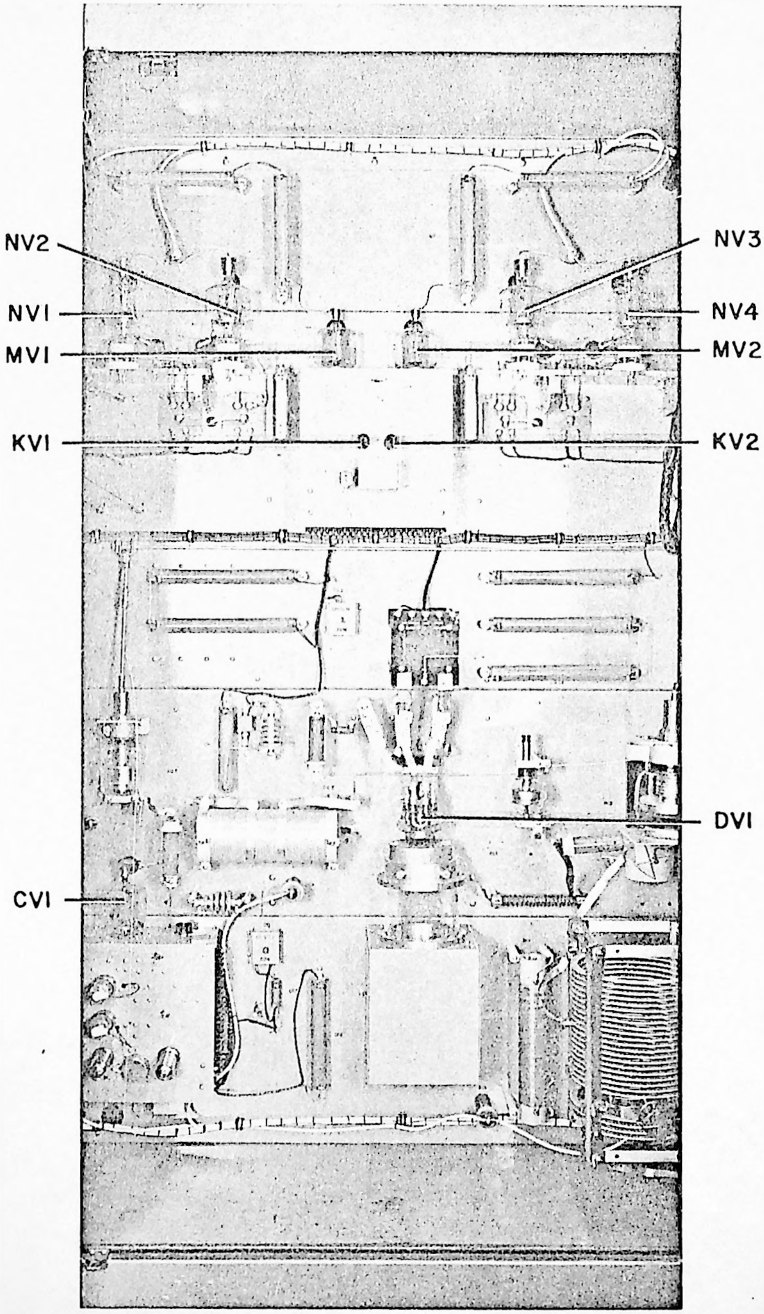


Fig. 21 Front View of Exciter and Modulator Cubicle Showing Tubes Installed (8-957)

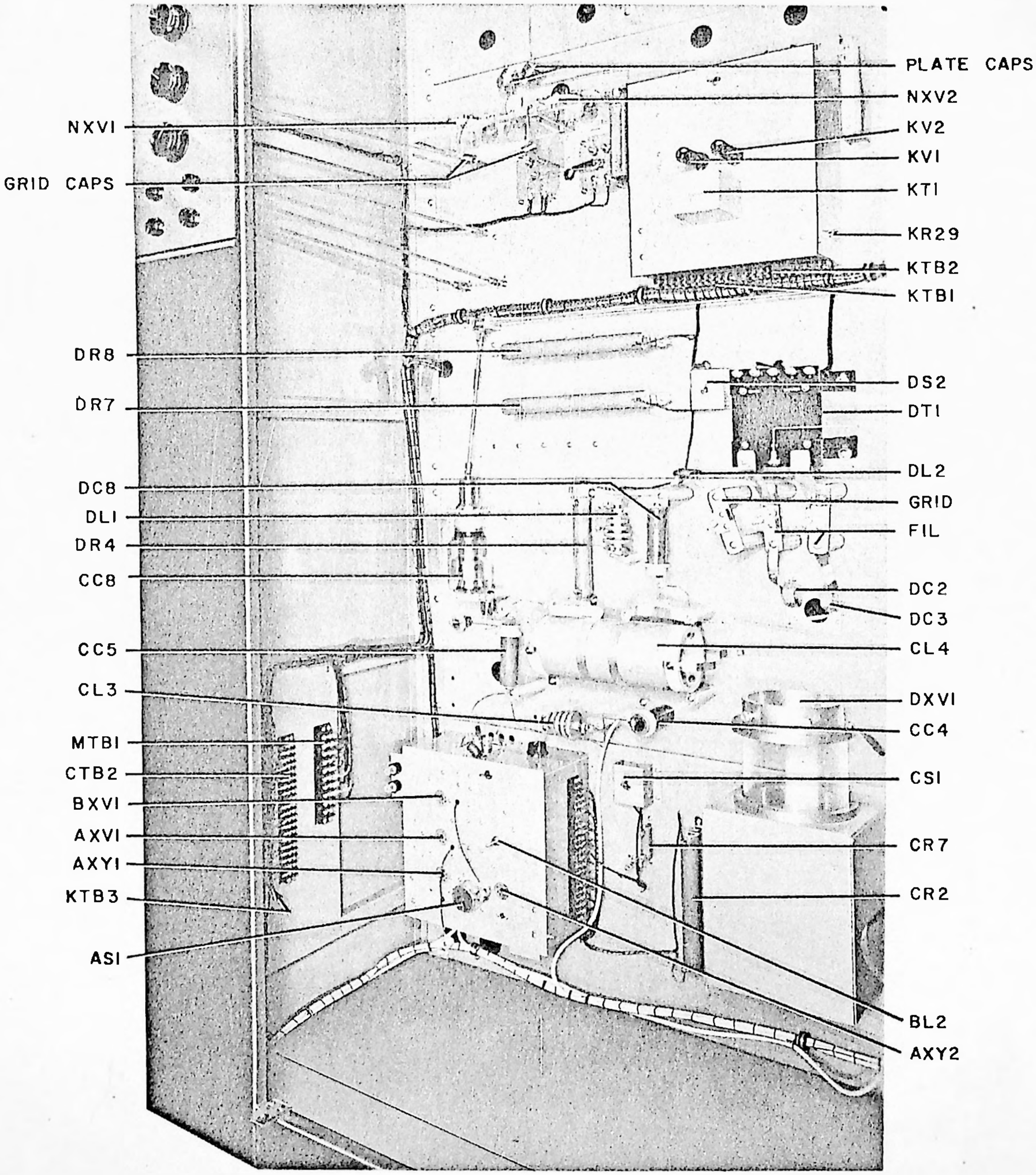


Fig. 22 Front Interior and Left Wall View of Exciter and Modulator Cubicle (7-6916)

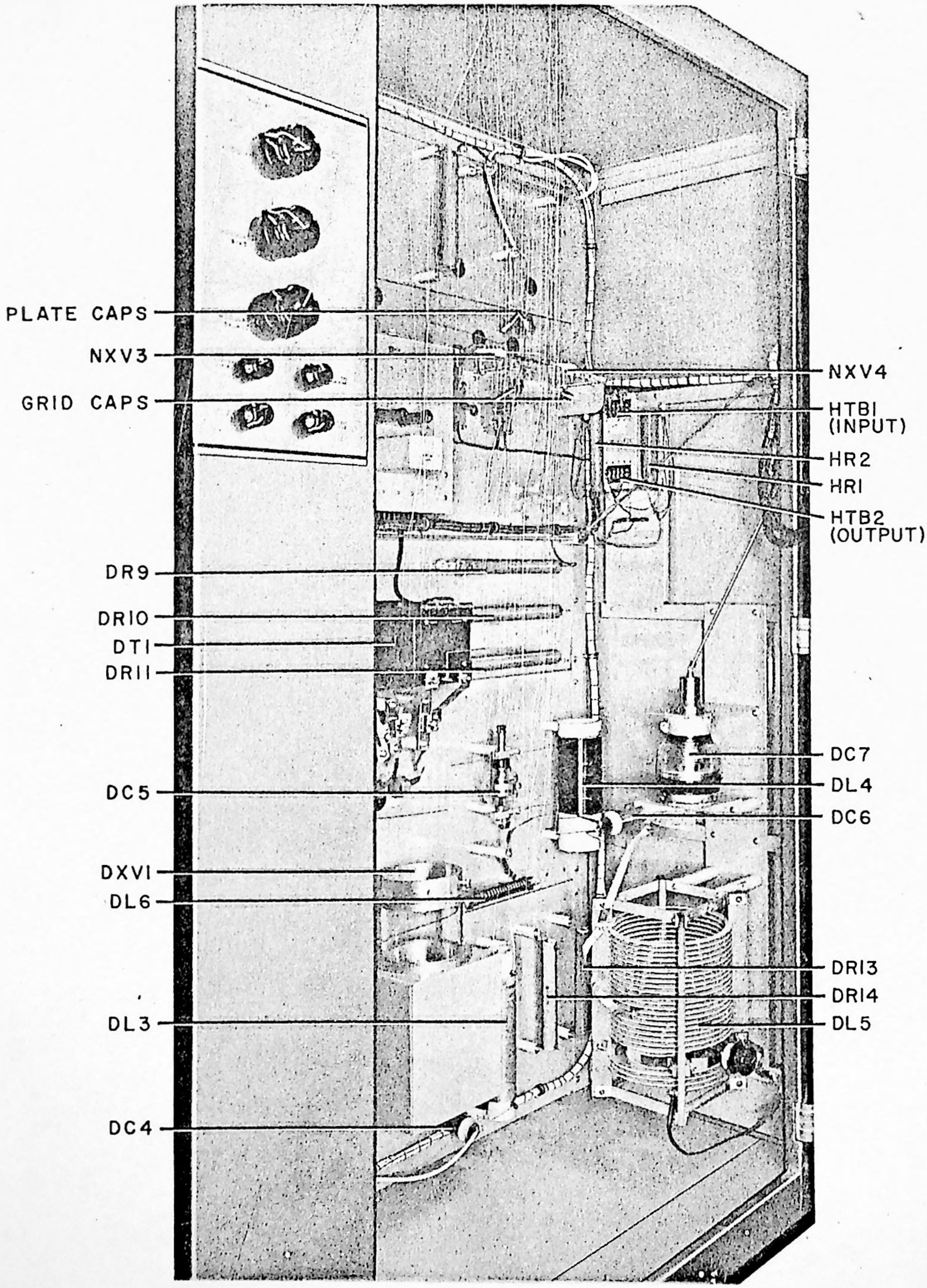


Fig. 23 Front Interior and Right Wall View of Exciter and Modulator Cubicle (7-6933)

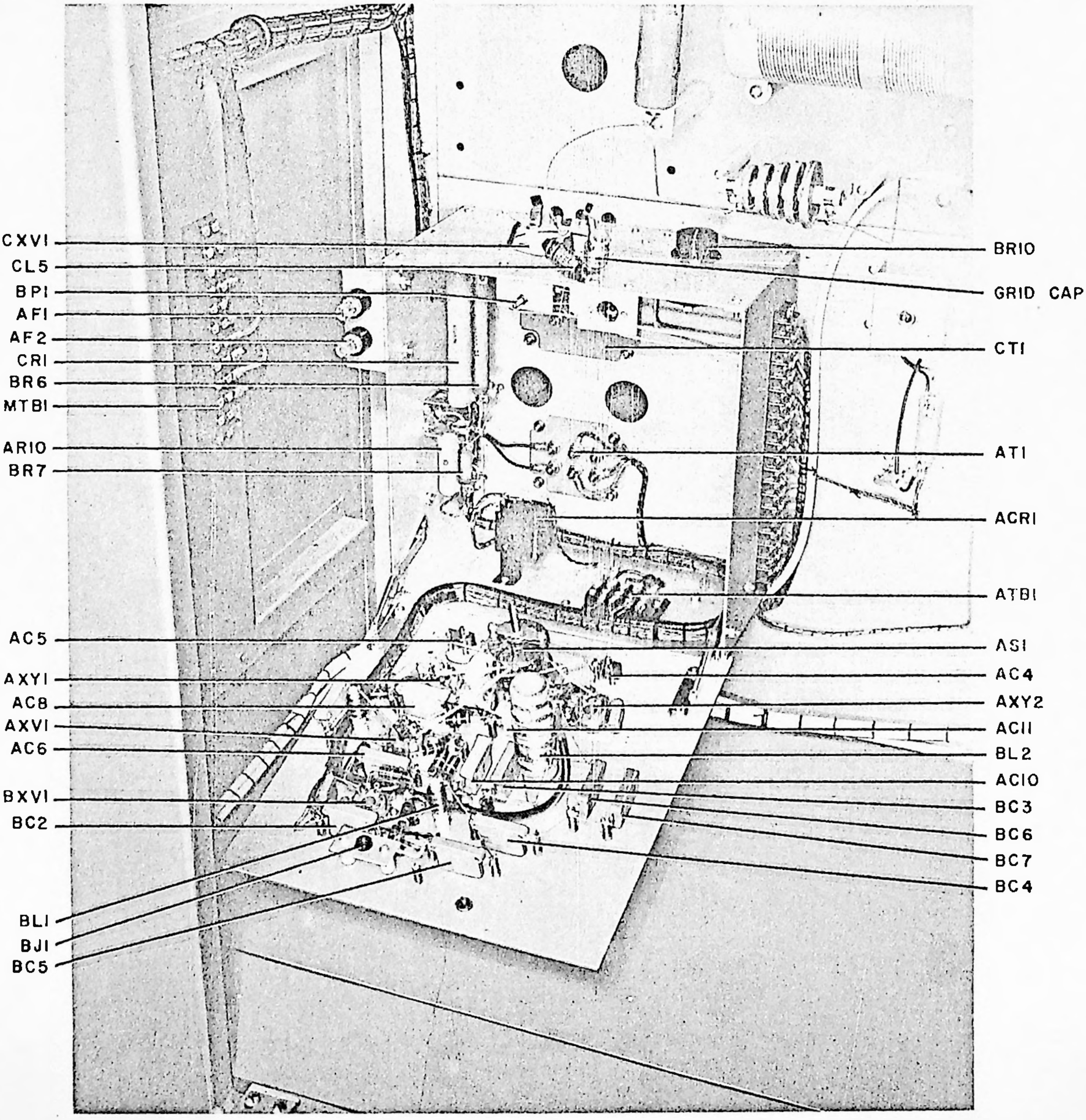


Fig. 24 Oscillator Unit with Front Panel Lowered (7-6917)

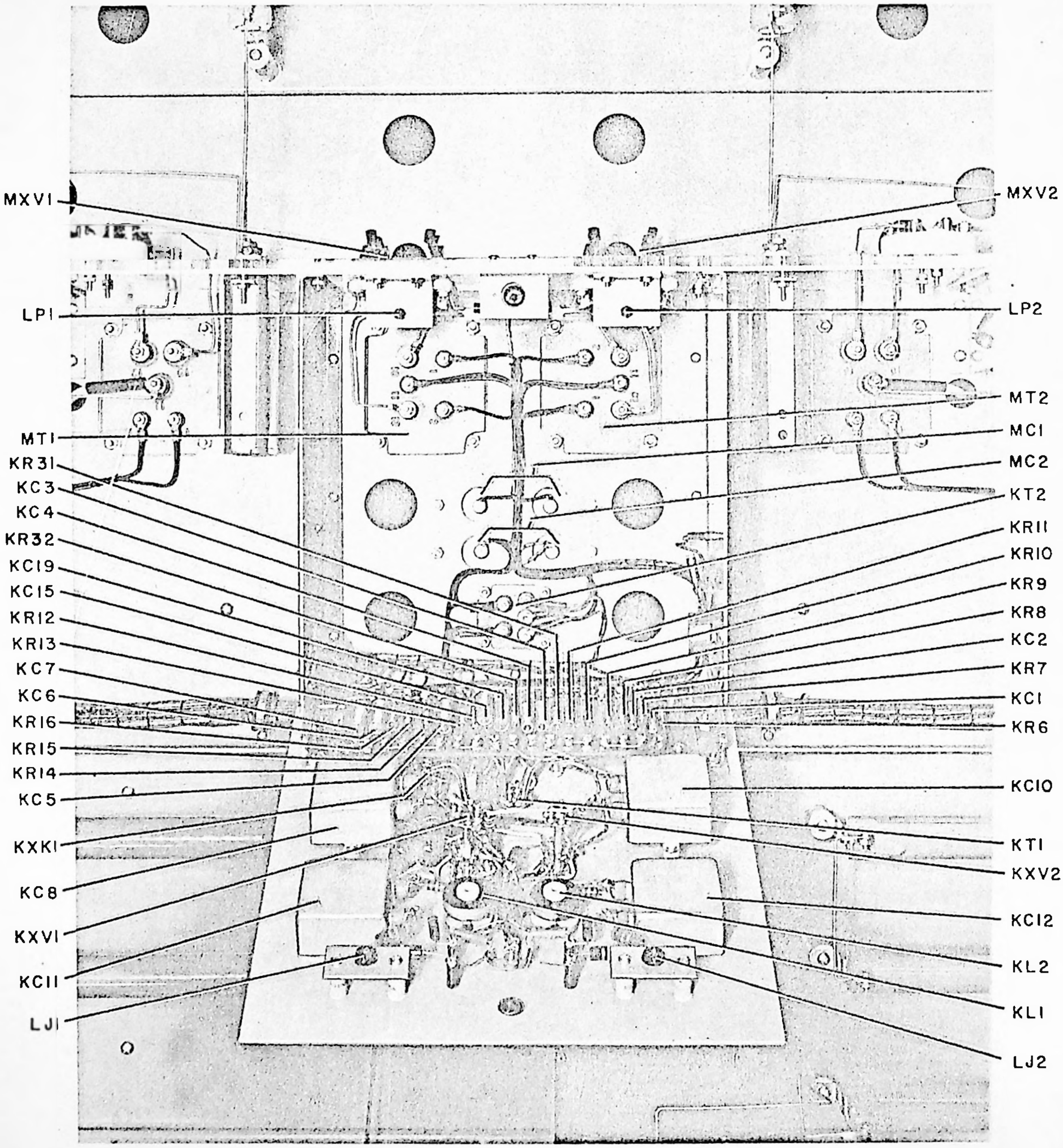


Fig. 25 Audio Exciter Unit with Front Panel Lowered (7-6907)

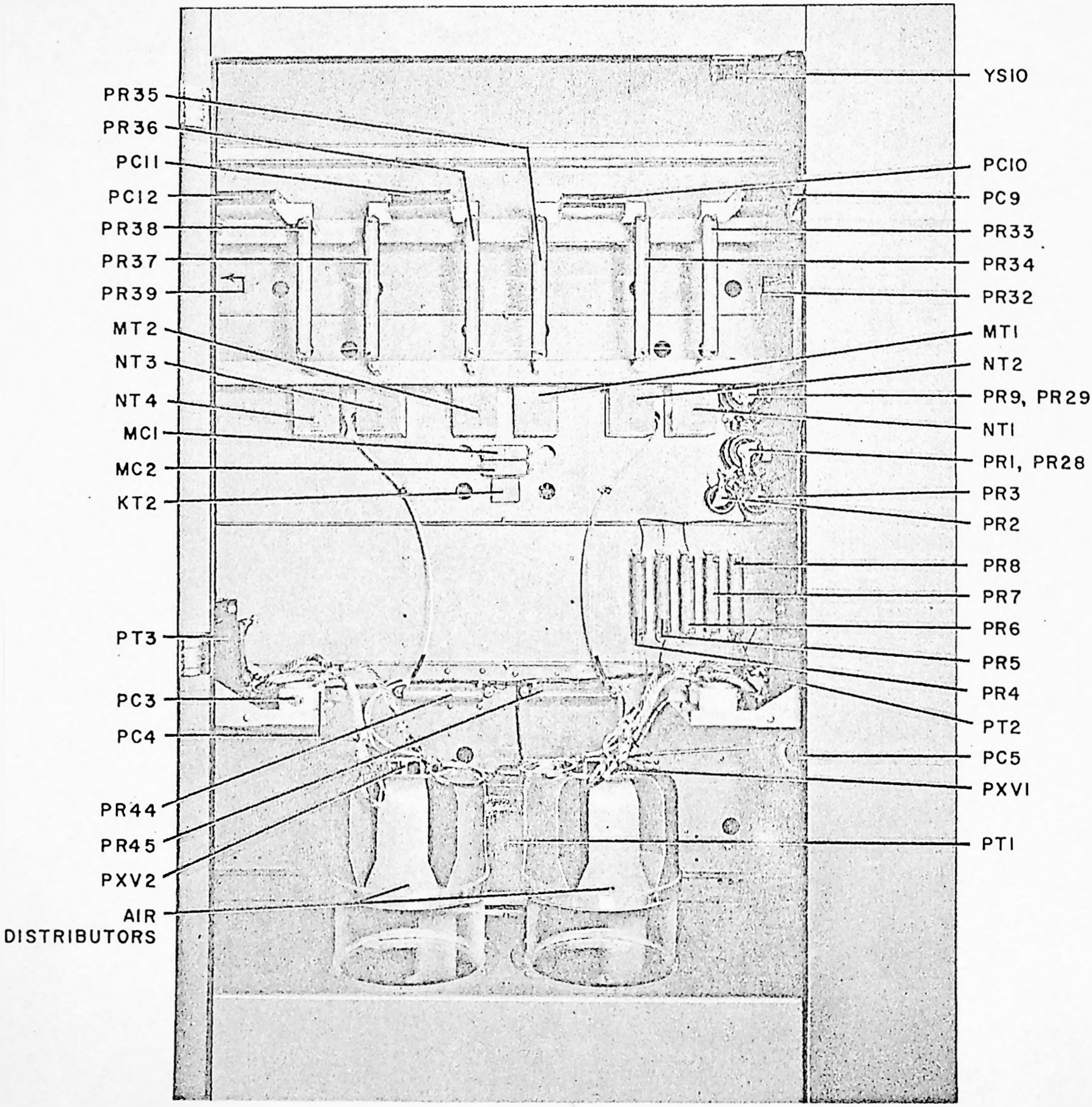


Fig. 26 Rear View of Exciter and Modulator Cubicle (7-6930)

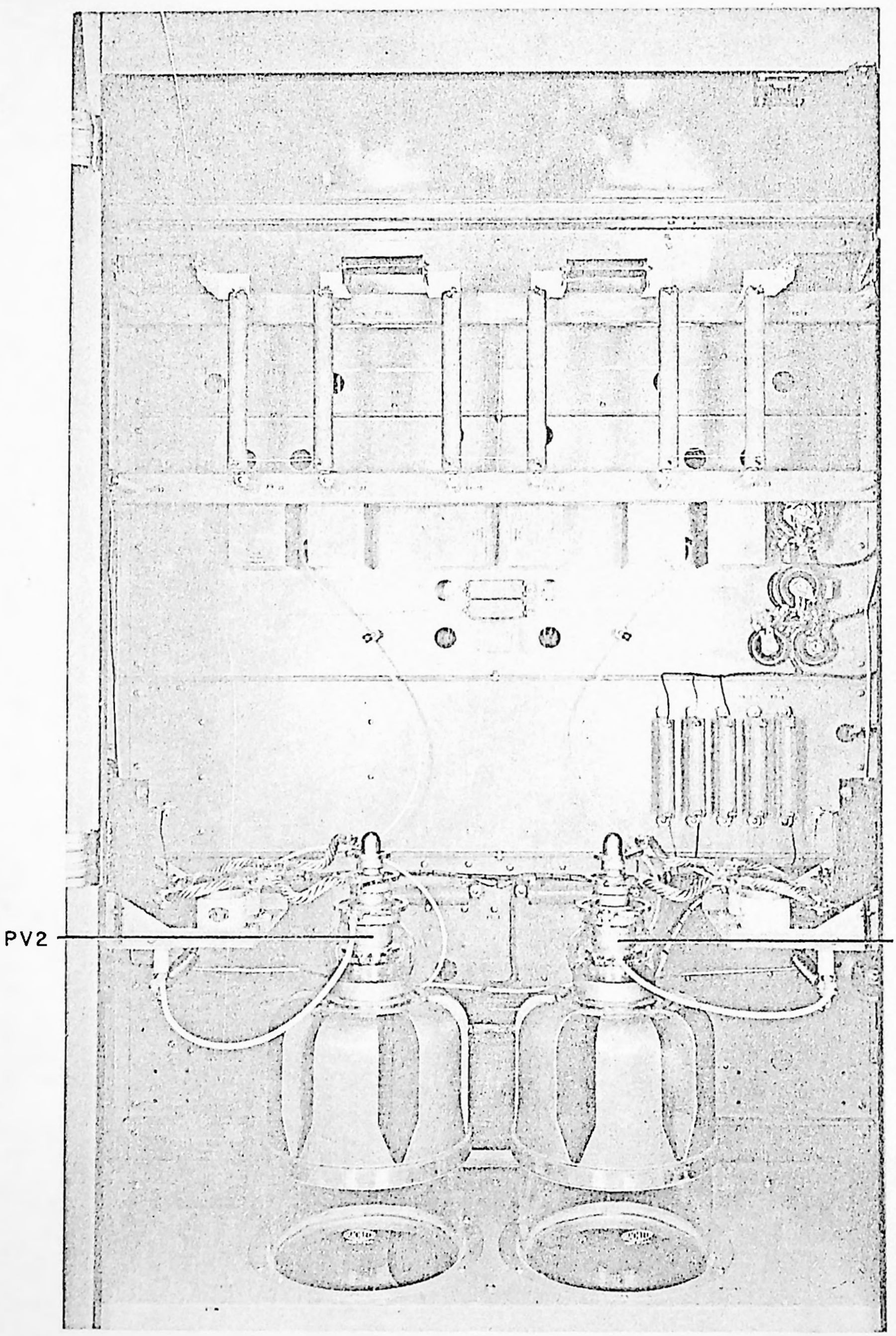


Fig. 27 Rear View of Exciter and Modulator Cubicle Showing Tubes Installed (8-959)

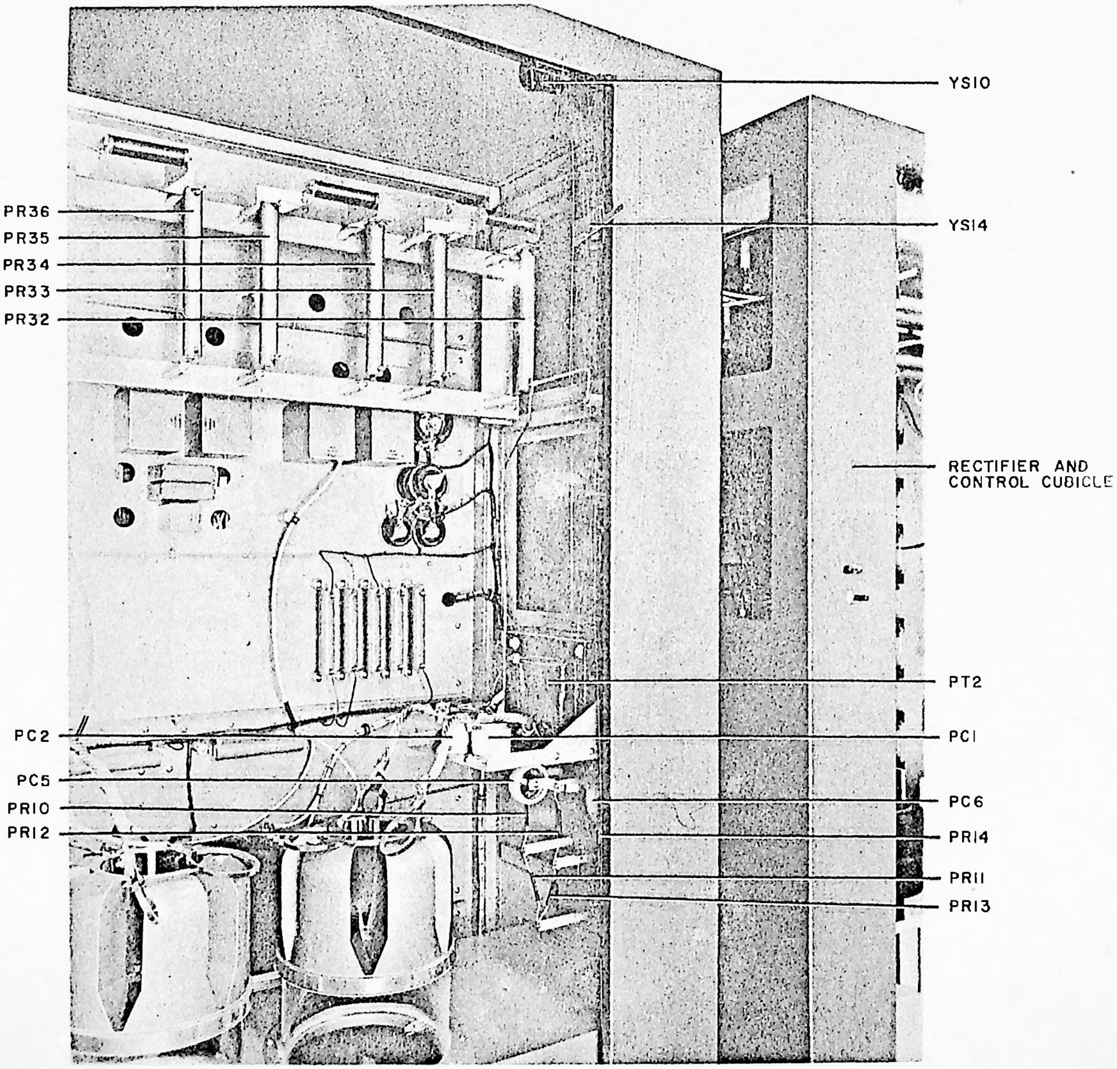


Fig. 28 Rear and Right Wall View of Exciter and Modulator Cubicle (7-6929)

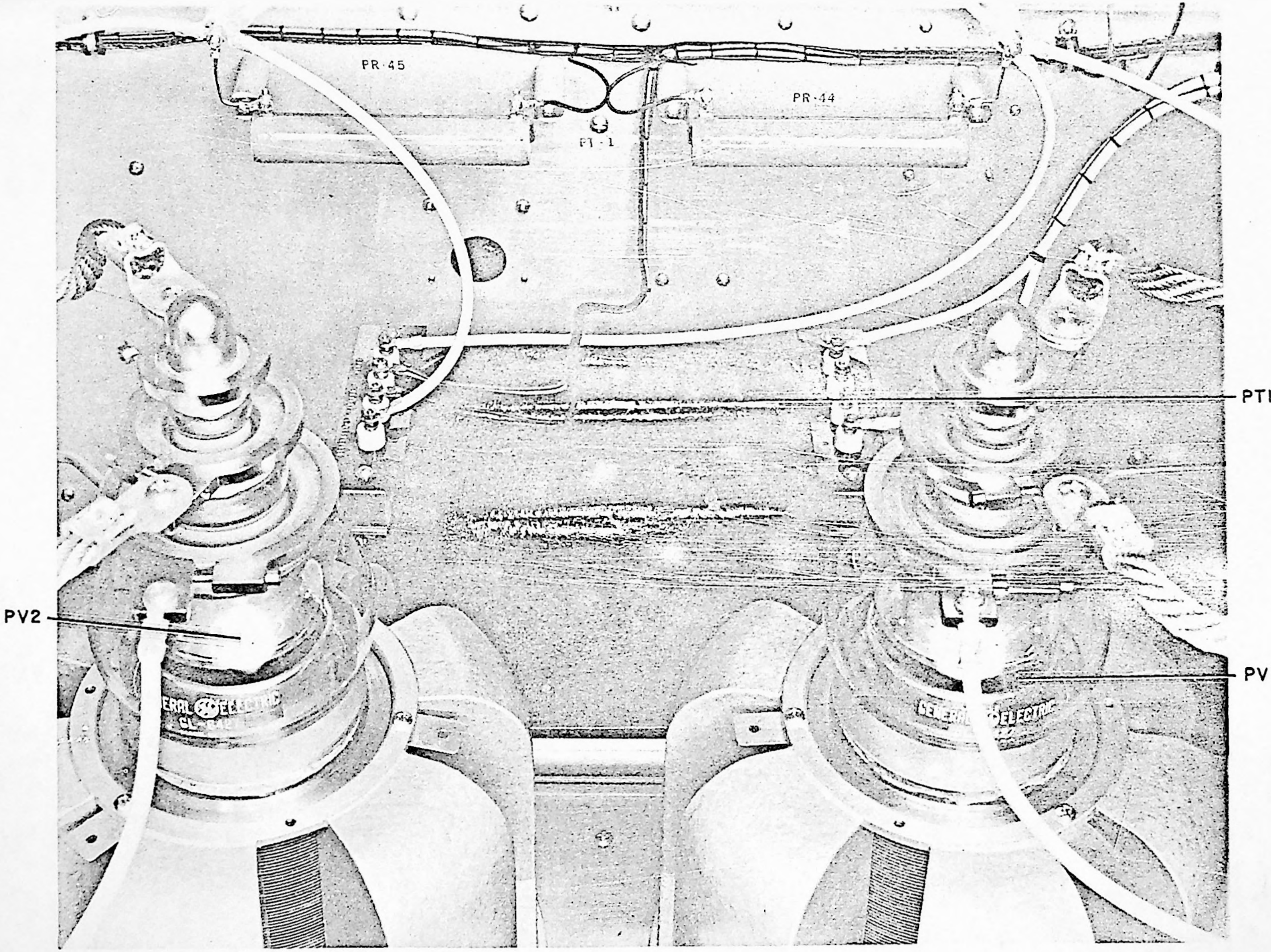


Fig. 29 Close-up View of Transformer PT1 in Exciter and Modulator Cubicle (8-961)

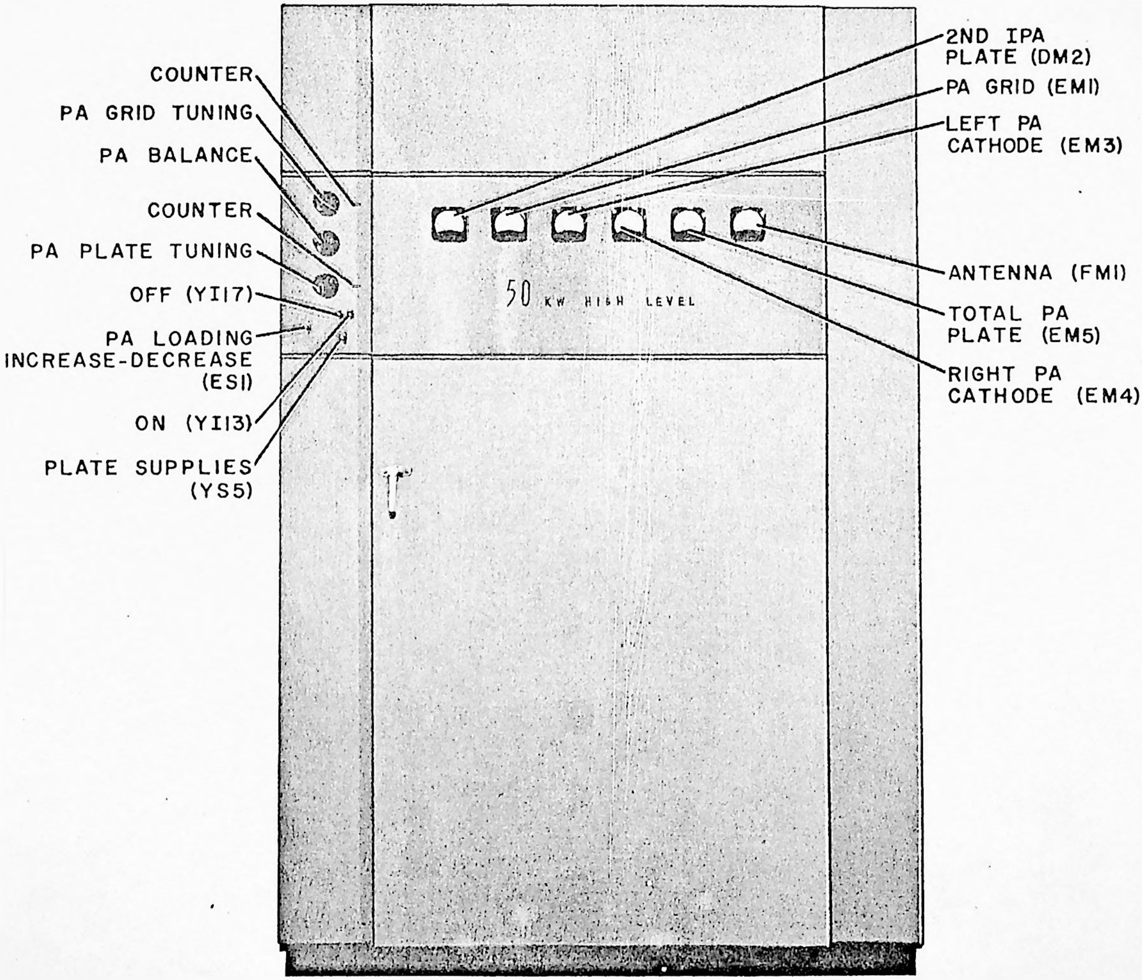


Fig. 30 Front View of RF Amplifier Cubicle with Door Closed (7-6728)

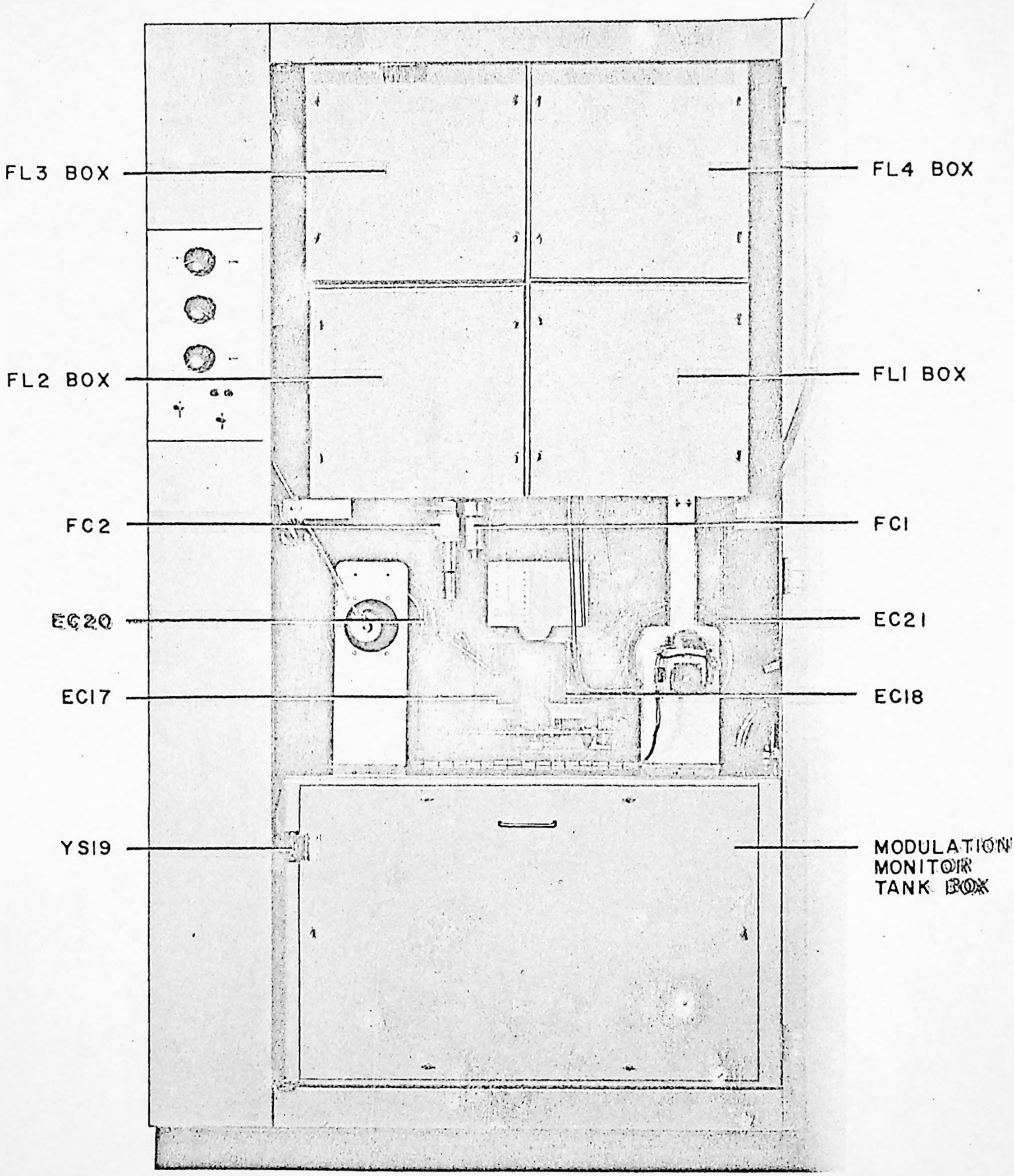


Fig. 31 Front View of RF Amplifier Cubicle with Door Open (7-6918)

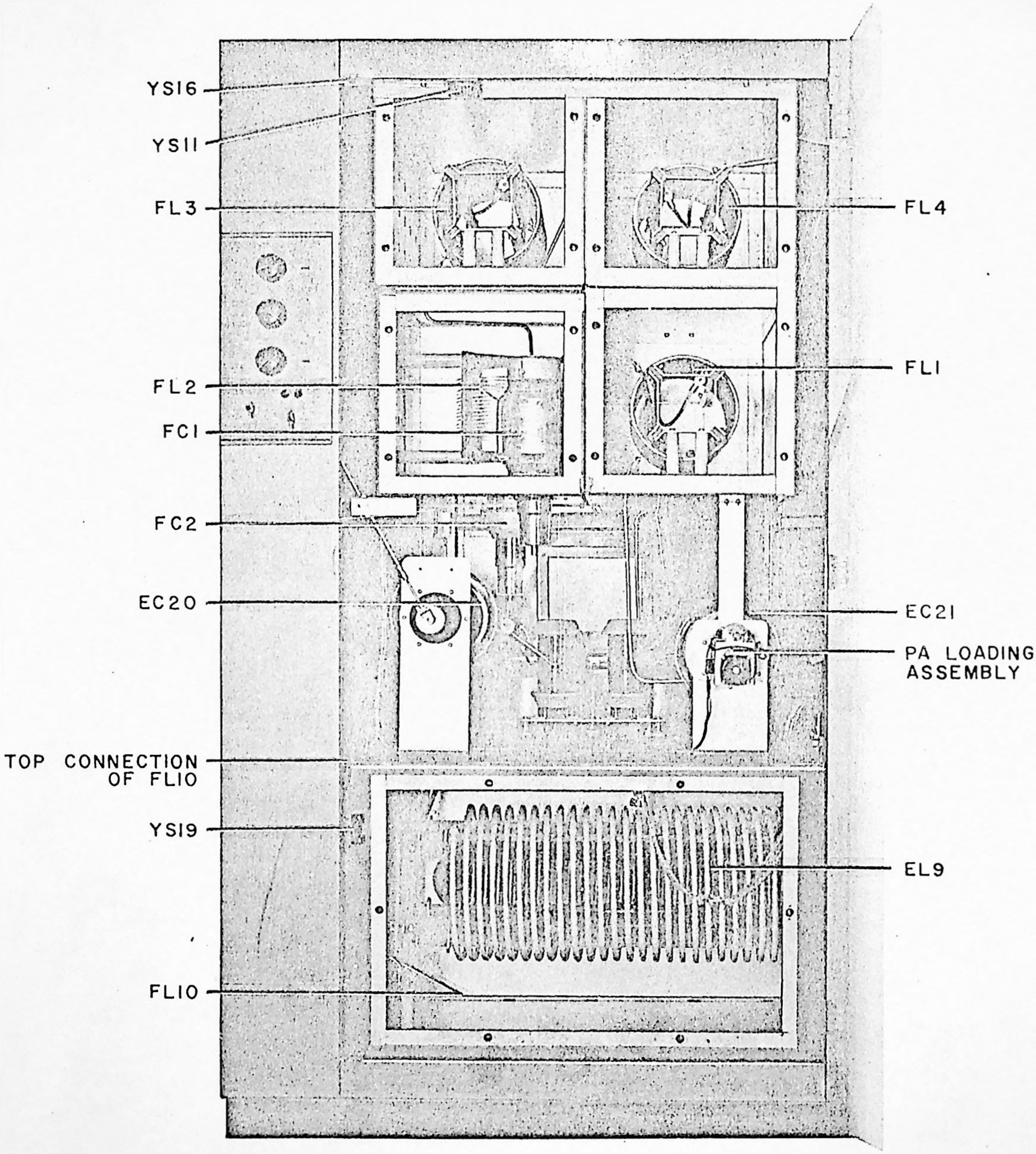


Fig. 32 Front Interior View of RF Amplifier Cubicle with Covers Removed (7-6906)

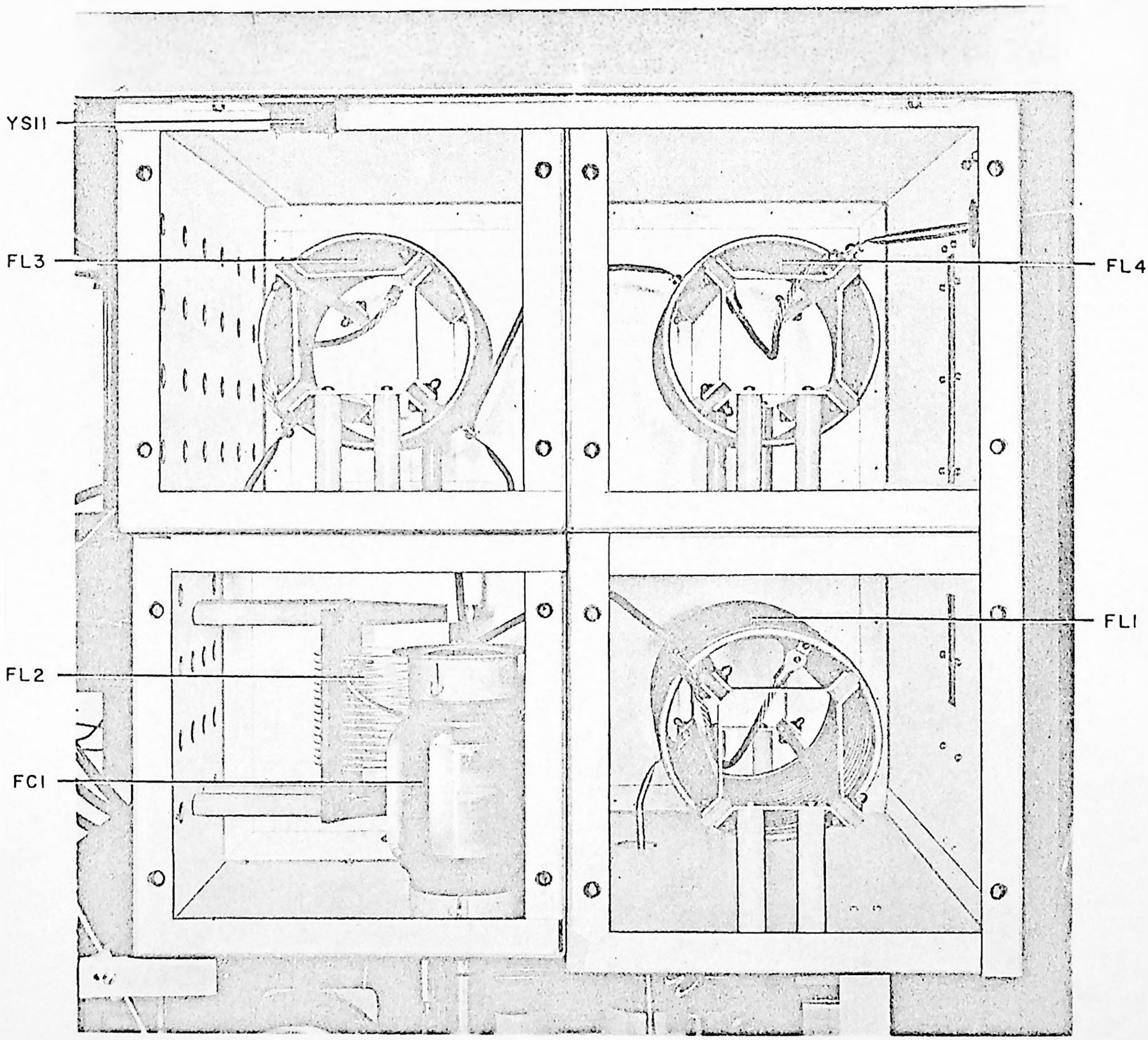


Fig. 33 View of Filter Boxes with Covers Removed (7-6908)

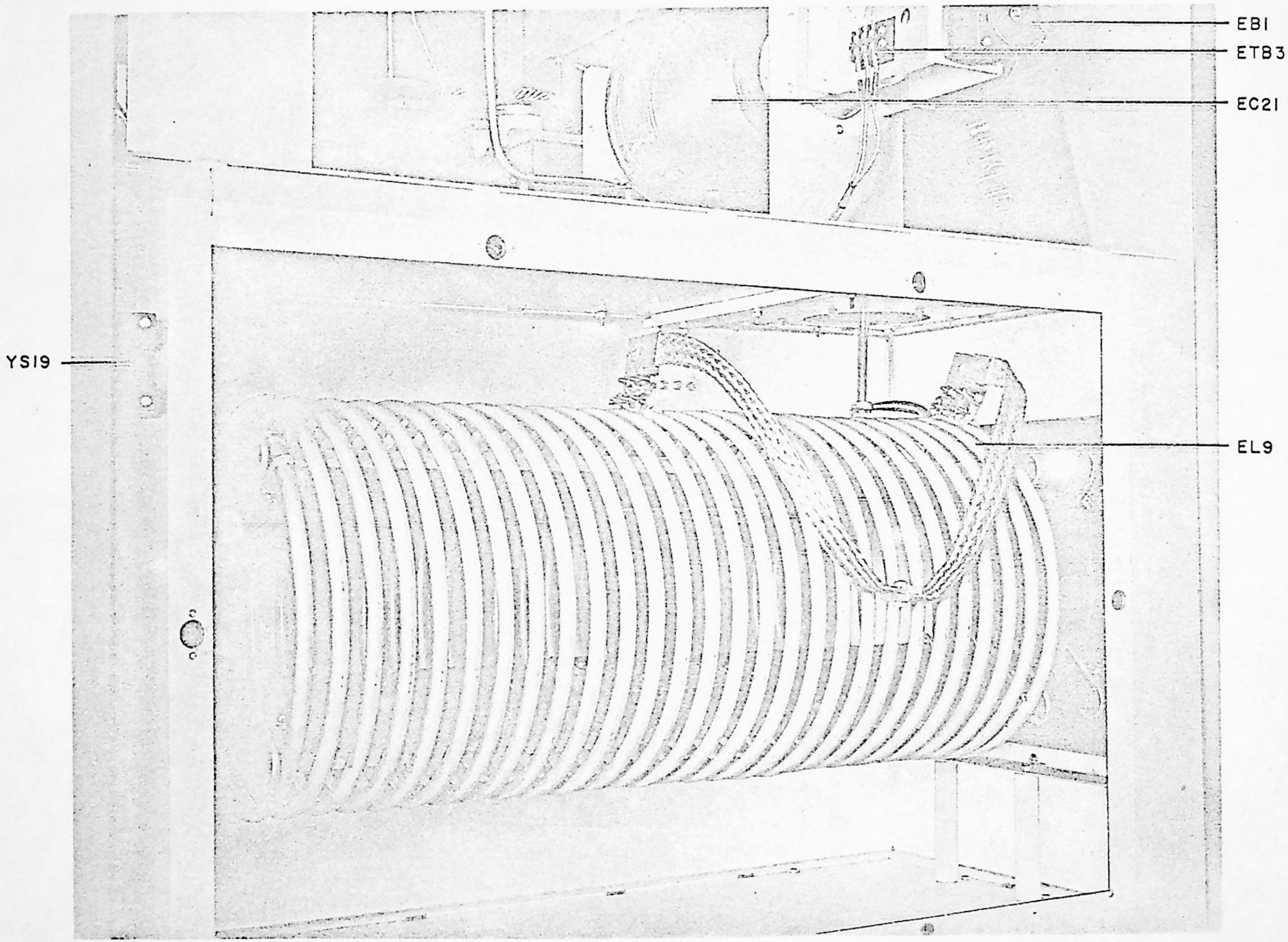


Fig. 34 Tuning Coil Tank with Cover Removed Showing Coil EL9 (7-6909)

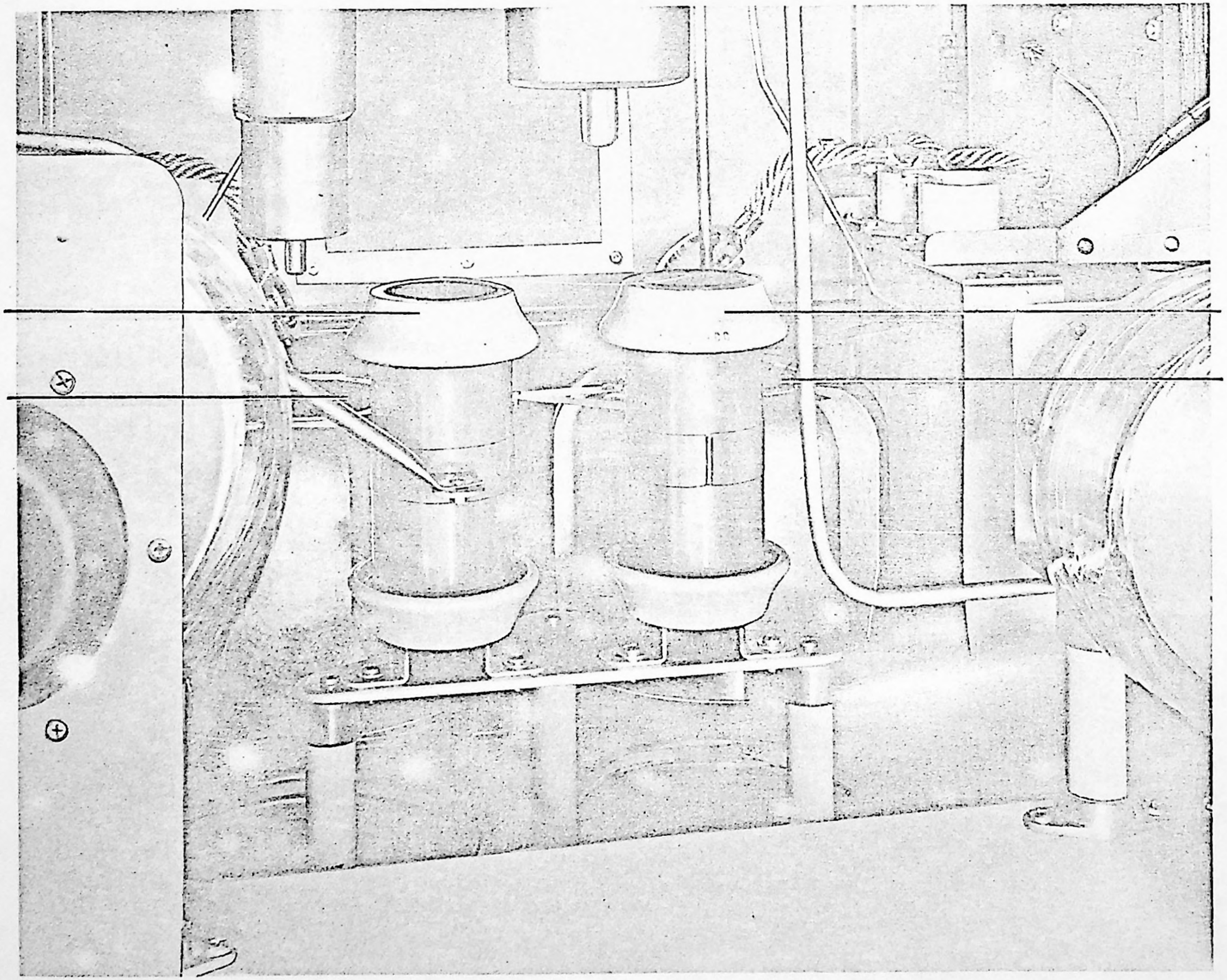


Fig. 35 Front Close-up of Center Interior of RF Amplifier Cubicle Showing EC17 and EC18 (7-6921)

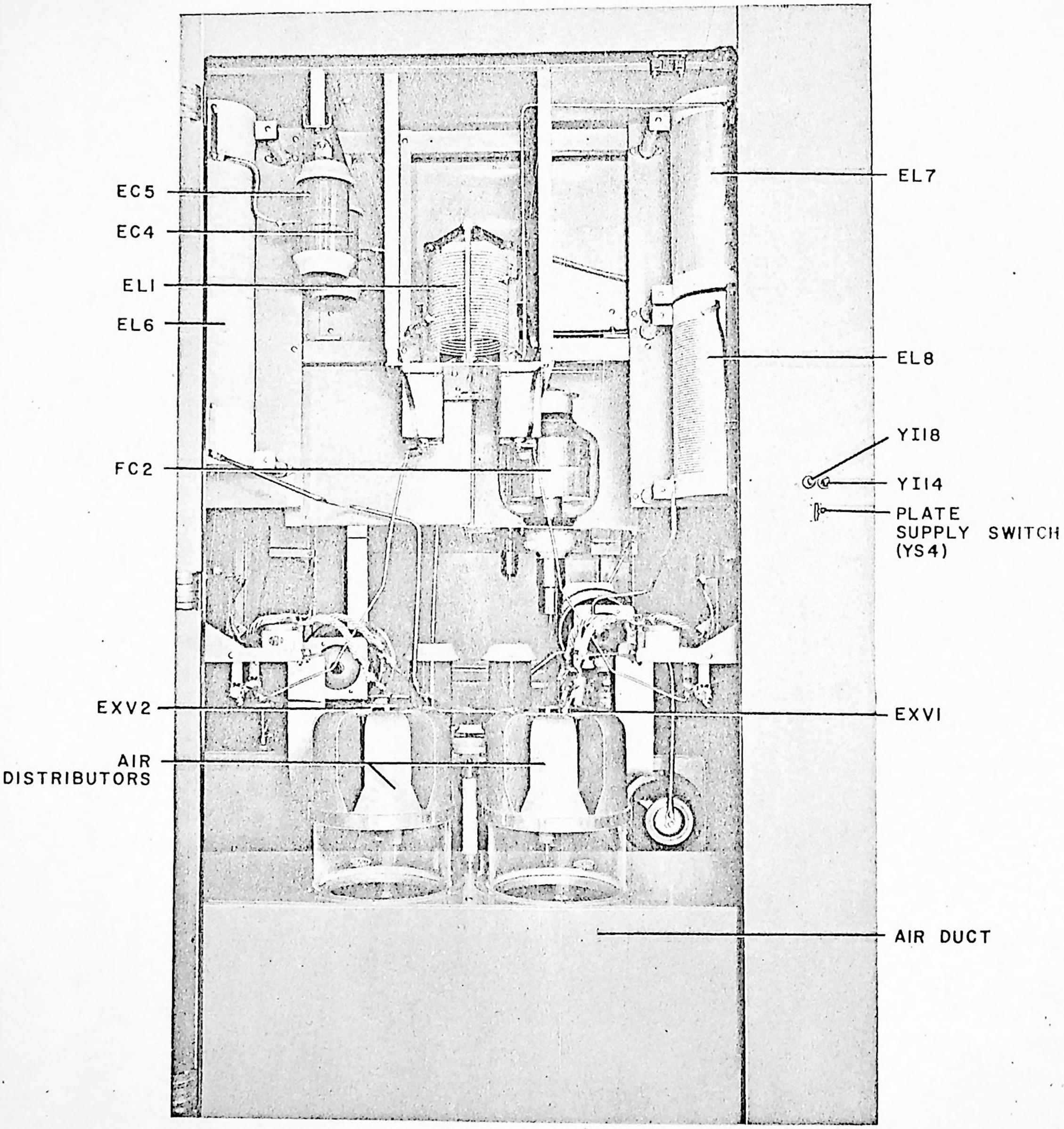


Fig. 36 Rear View of RF Amplifier Cubicle (7-6924)

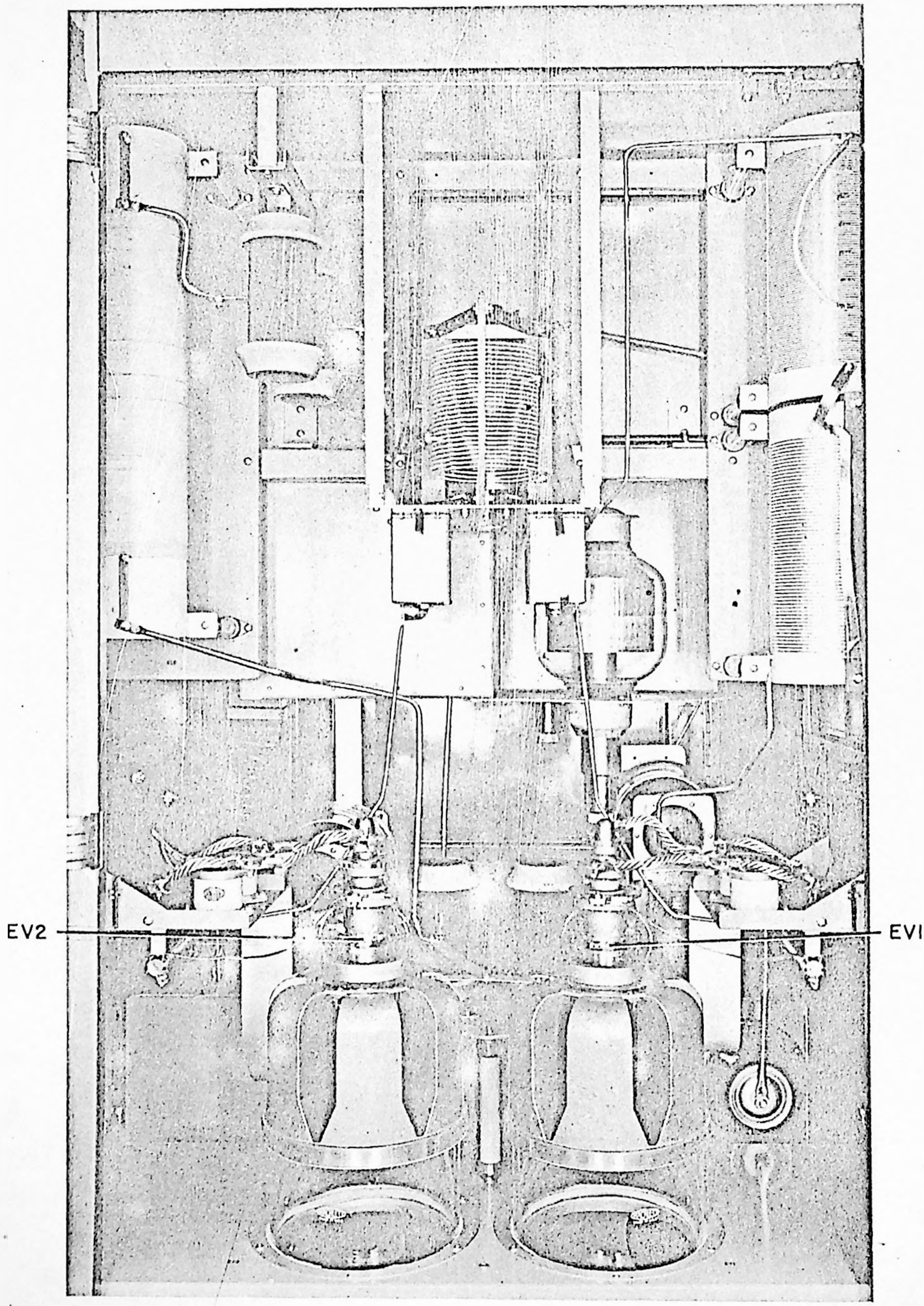


Fig. 37 Rear View of RF Amplifier Cubicle Showing Tubes Installed (8-958)

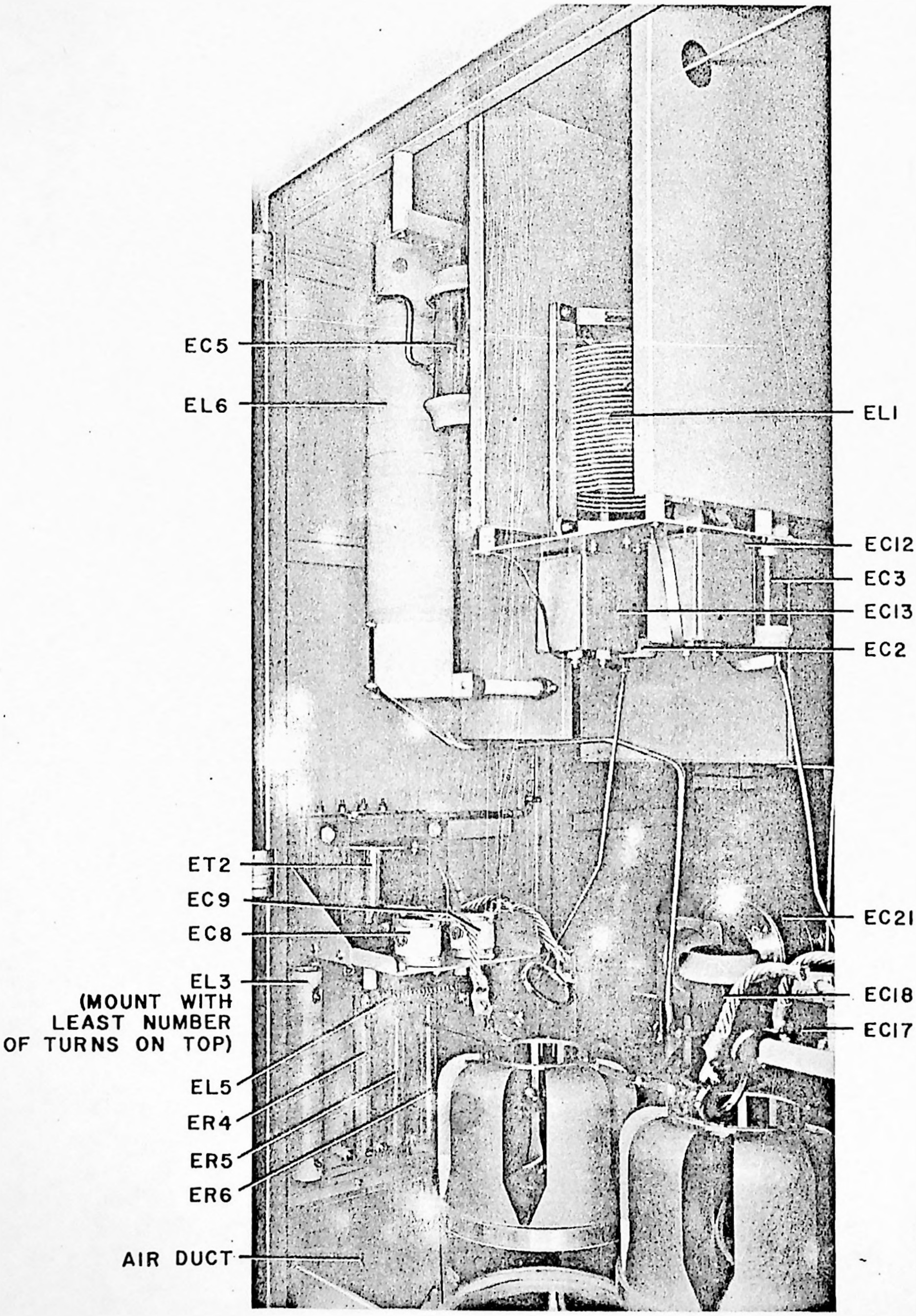


Fig. 38 Rear and Left Wall View of RF Amplifier Cubicle (7-6919)

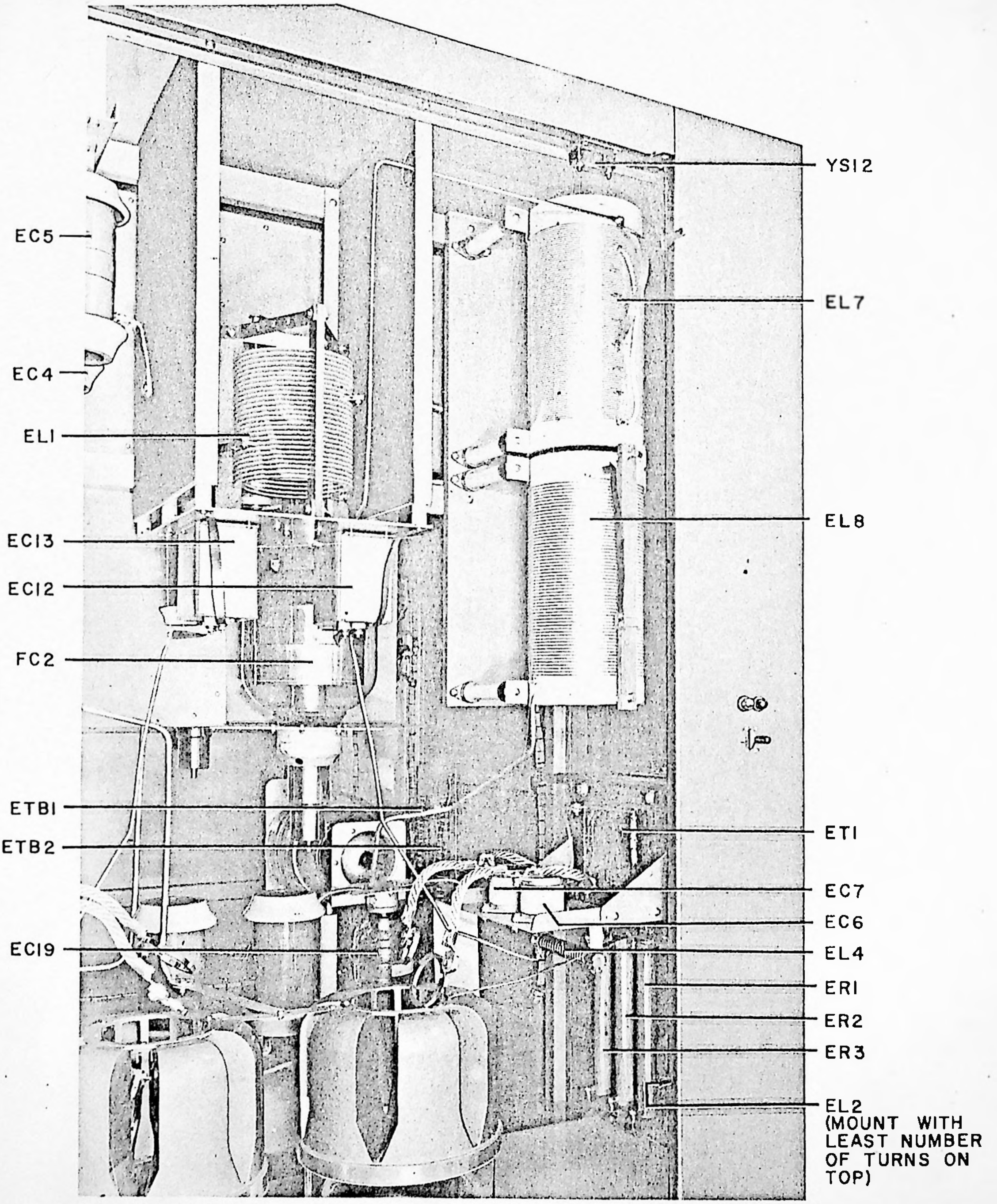


Fig. 39 Rear and Right Wall View of RF Amplifier Cubicle (7-6923)

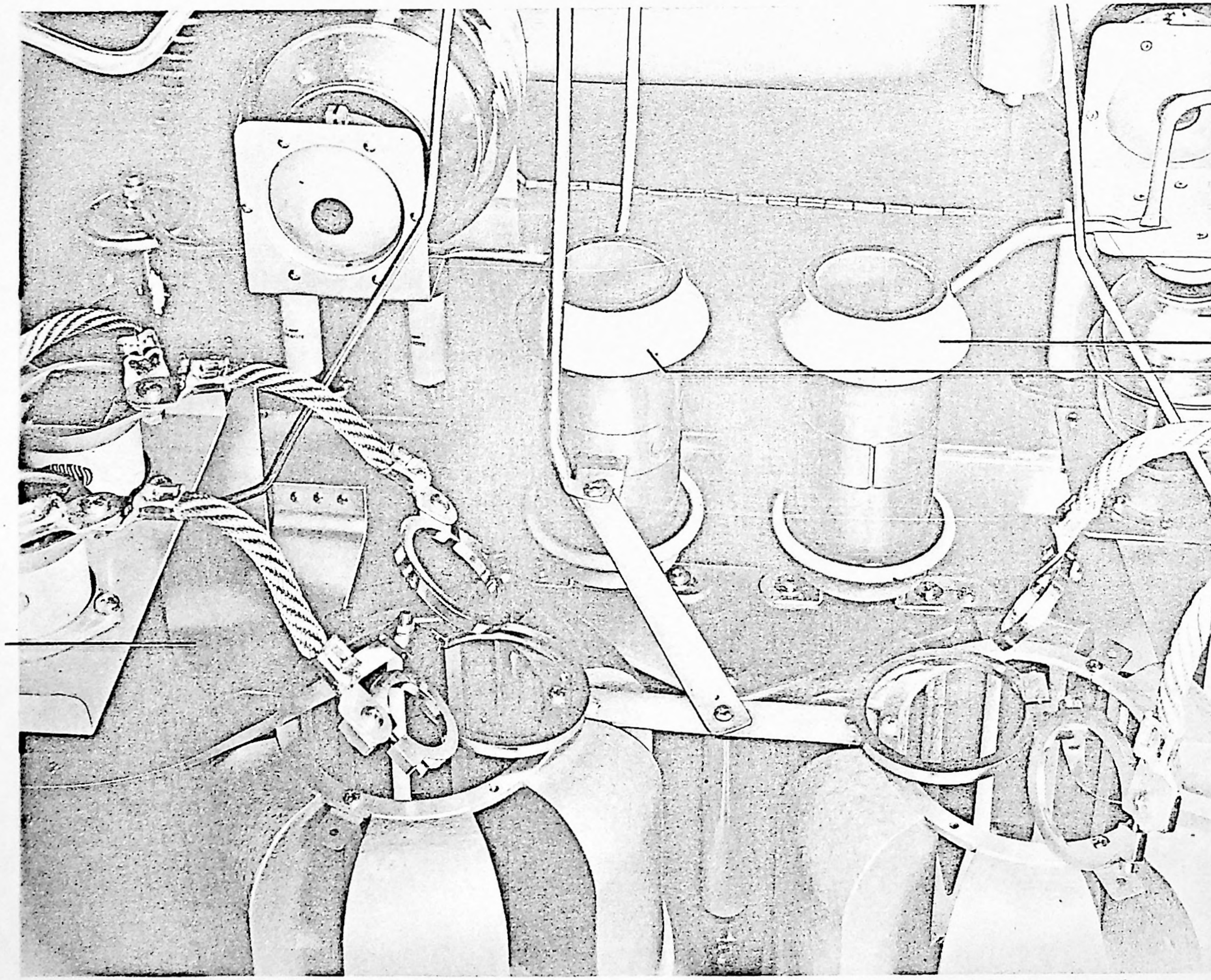


Fig. 40 Rear Close-up of Center Section of RF Amplifier Cubicle (7-6928)

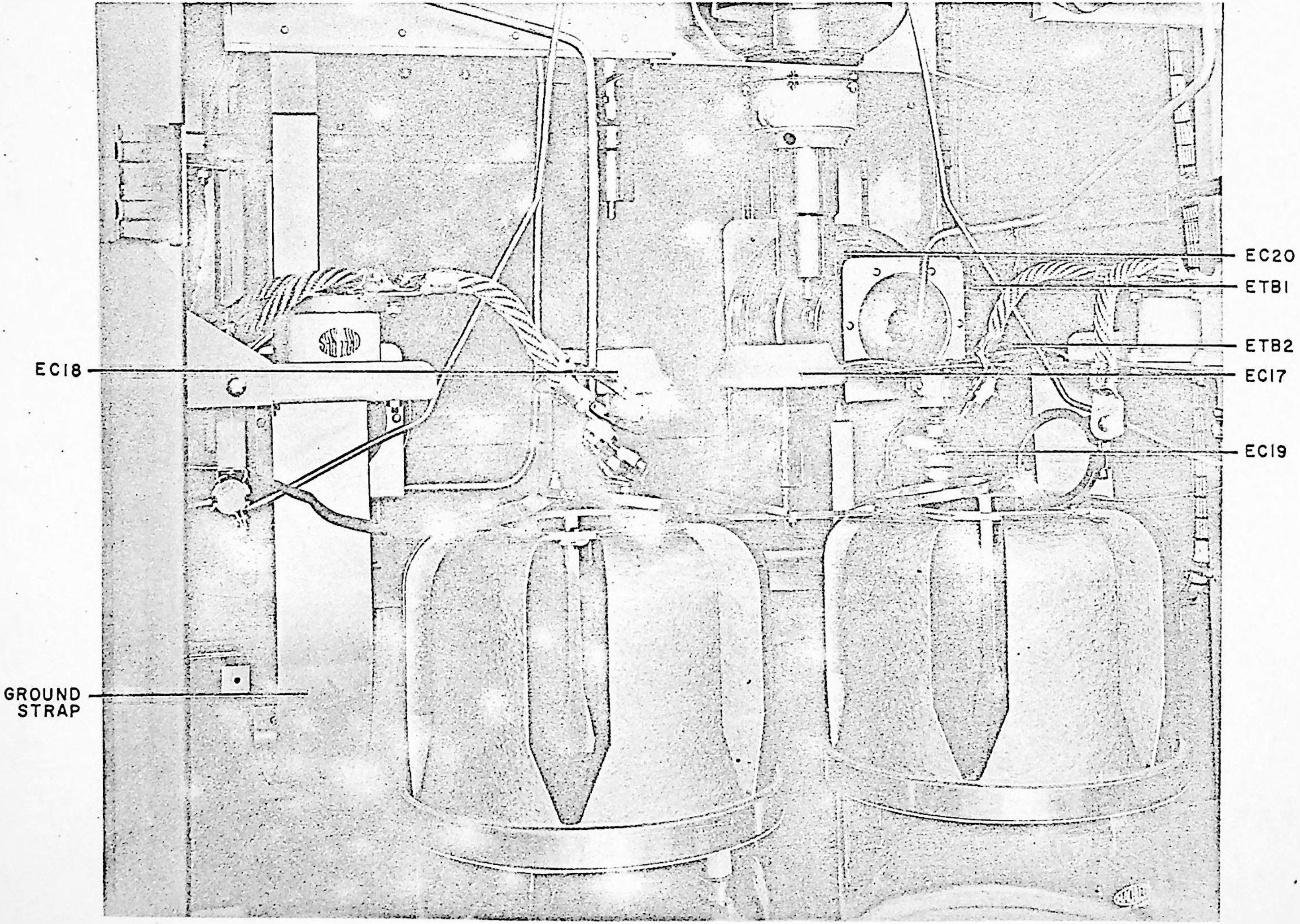


Fig. 41 Additional View of Center Section of RF Amplifier Cubicle (7-6905).

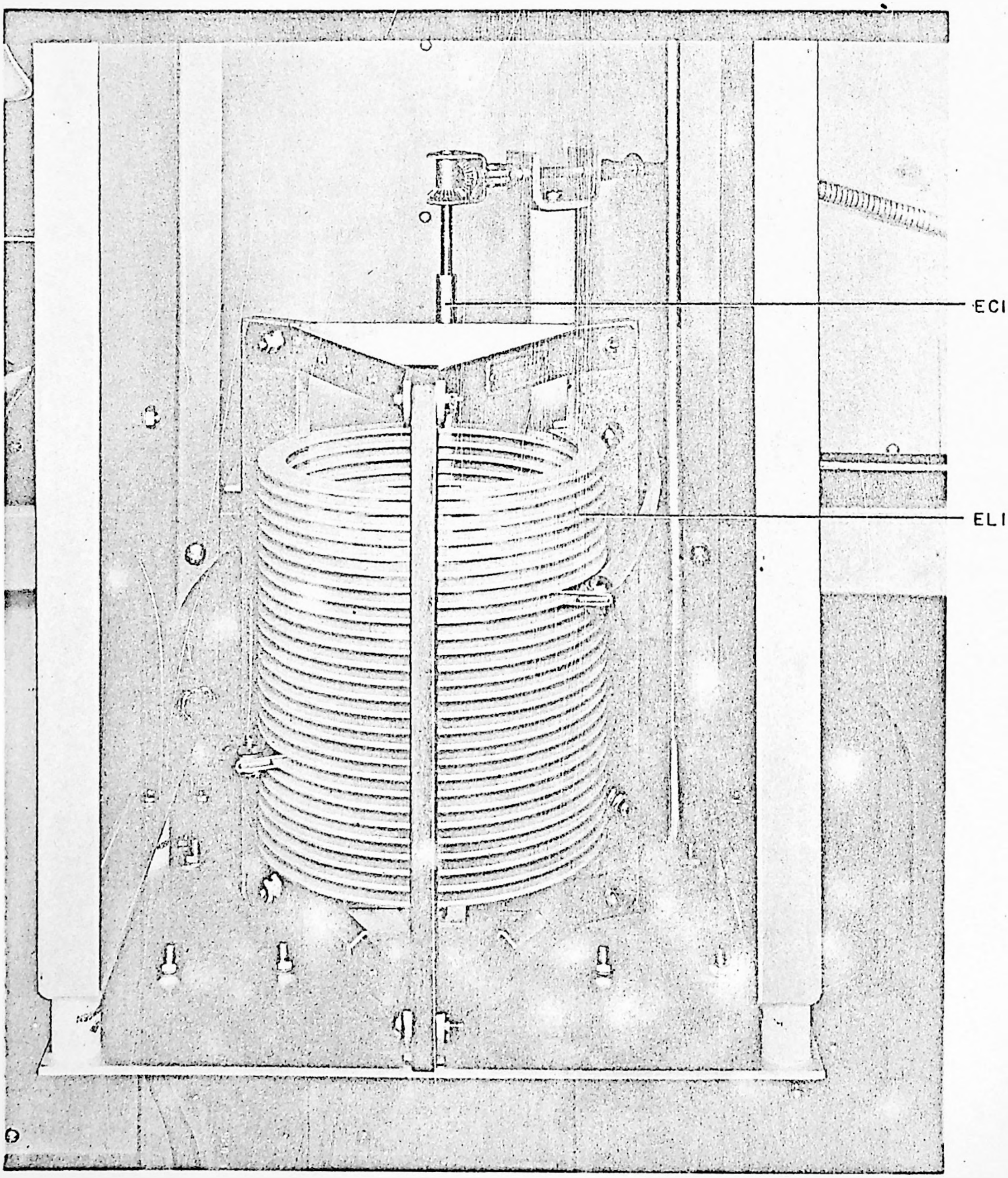


Fig. 42 Close-up of Coil EL1 (7-6931)

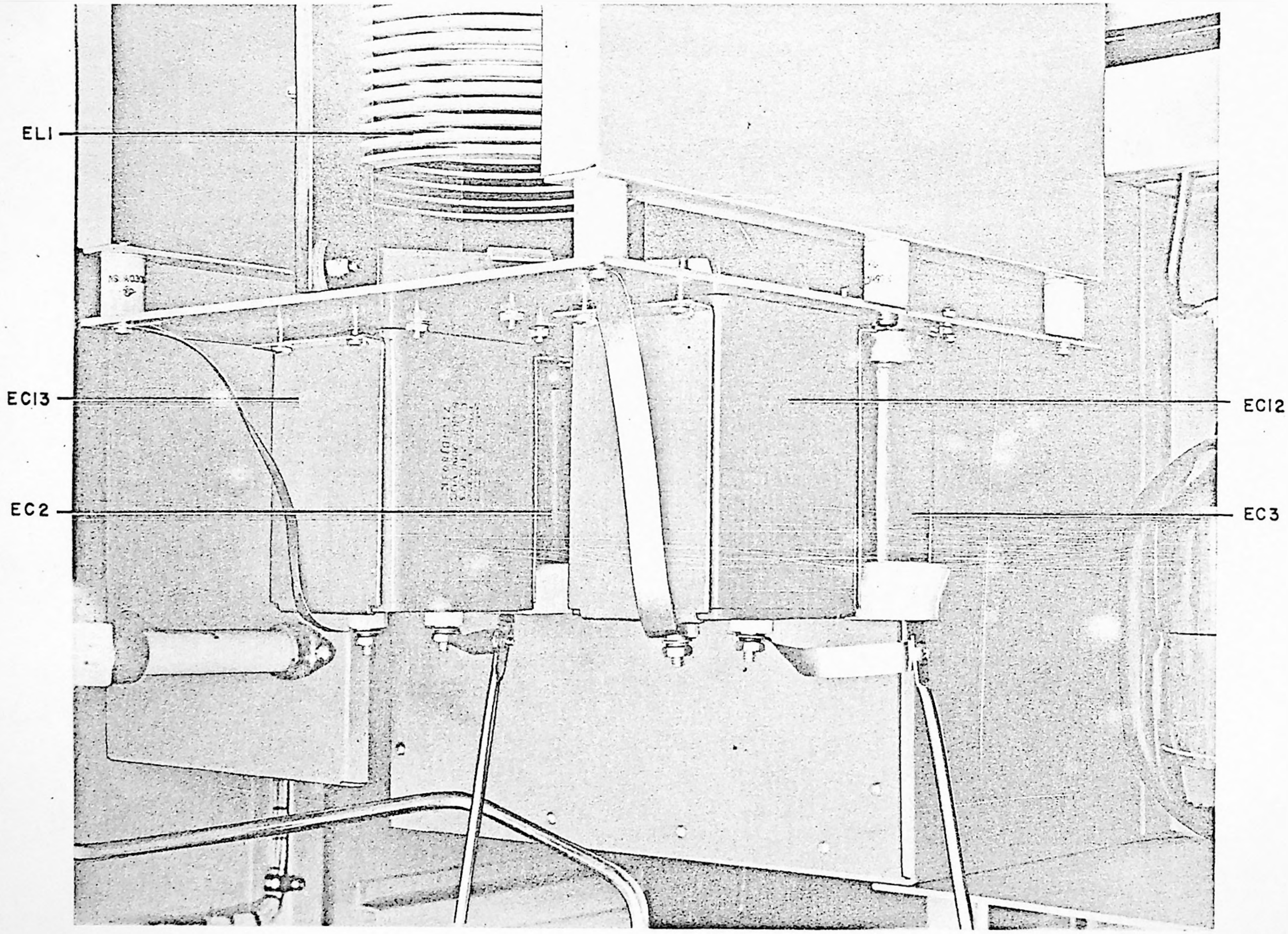


Fig. 43 Close-up Showing EC2, EC3, EC12, and EC13 (7-6934)

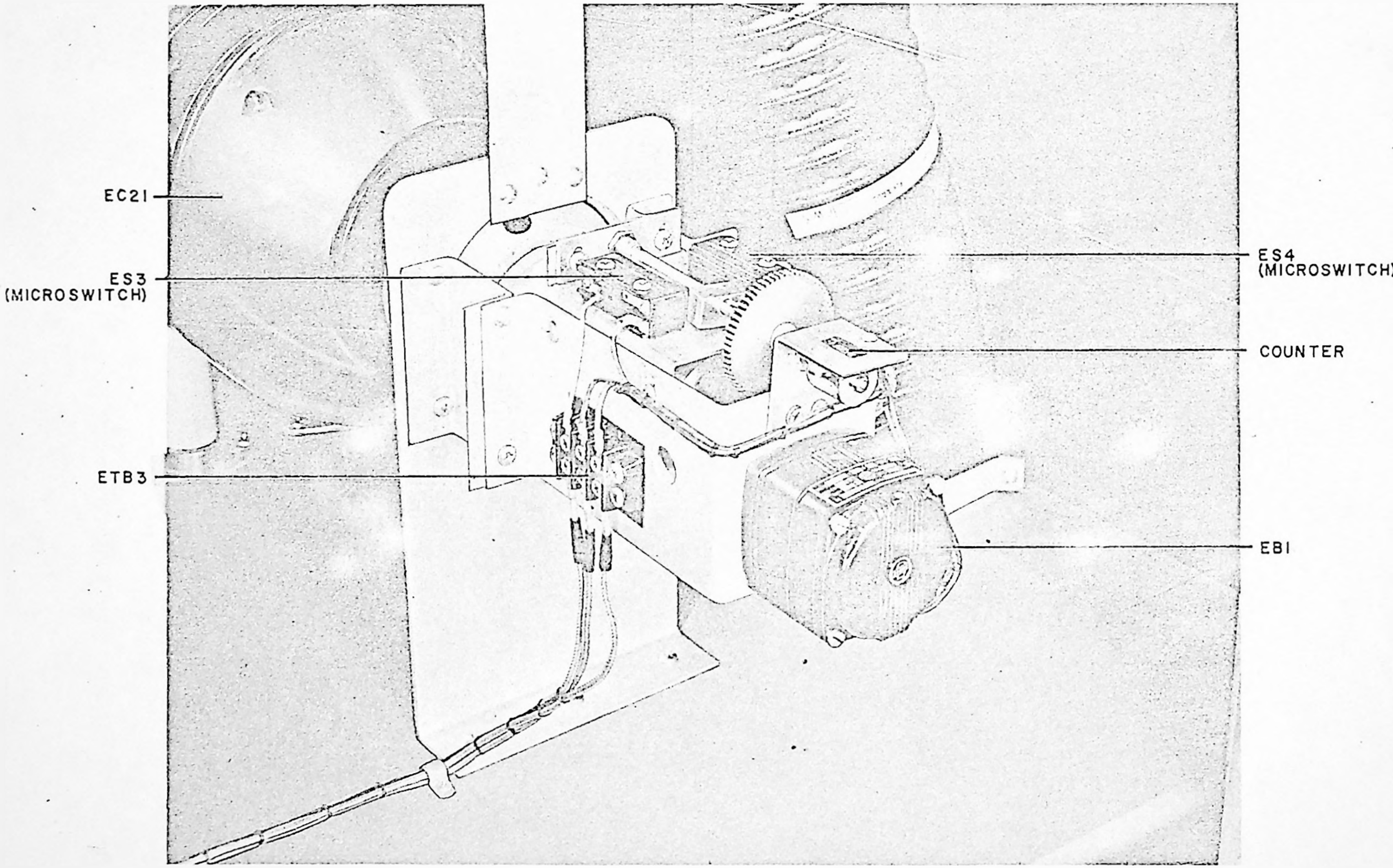


Fig. 44 View of PA Loading Assembly (7-6925)

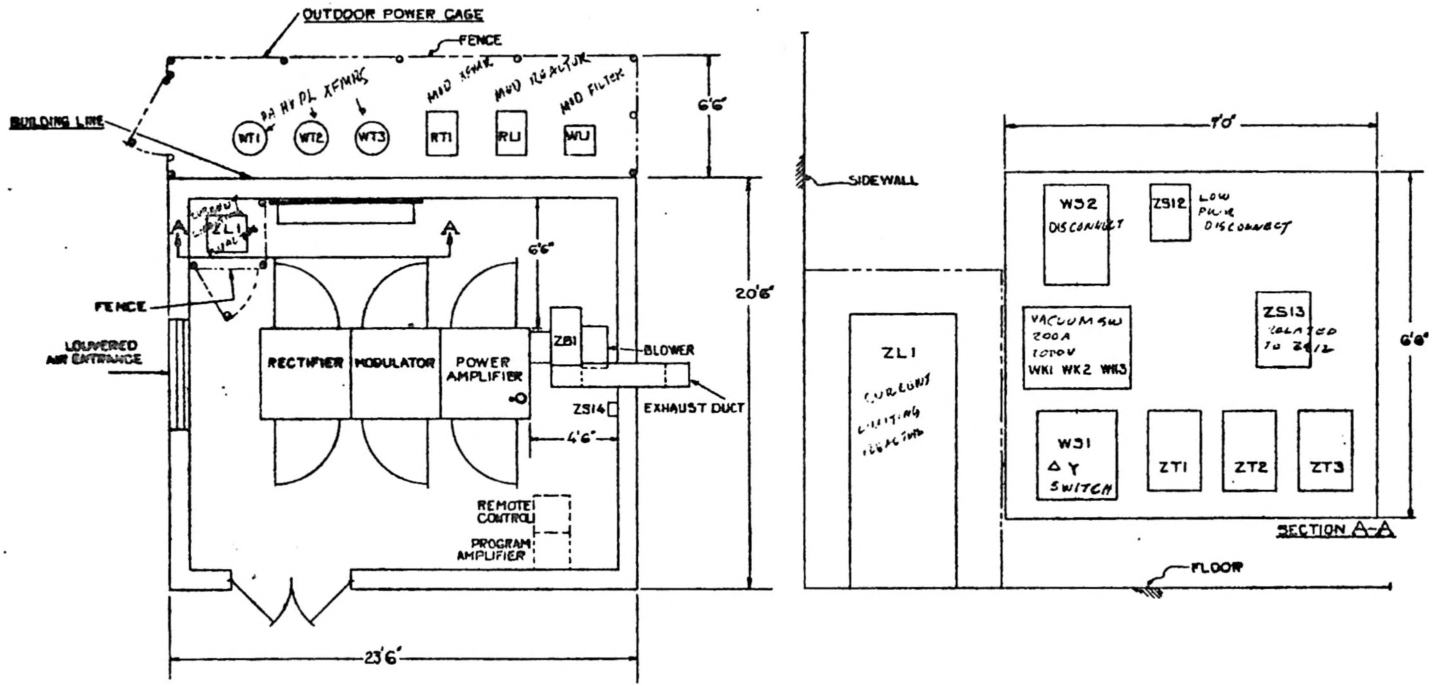


Fig. 45 Typical Station Layout for 480-Volt Operation (D-7669896, Sheet 1)

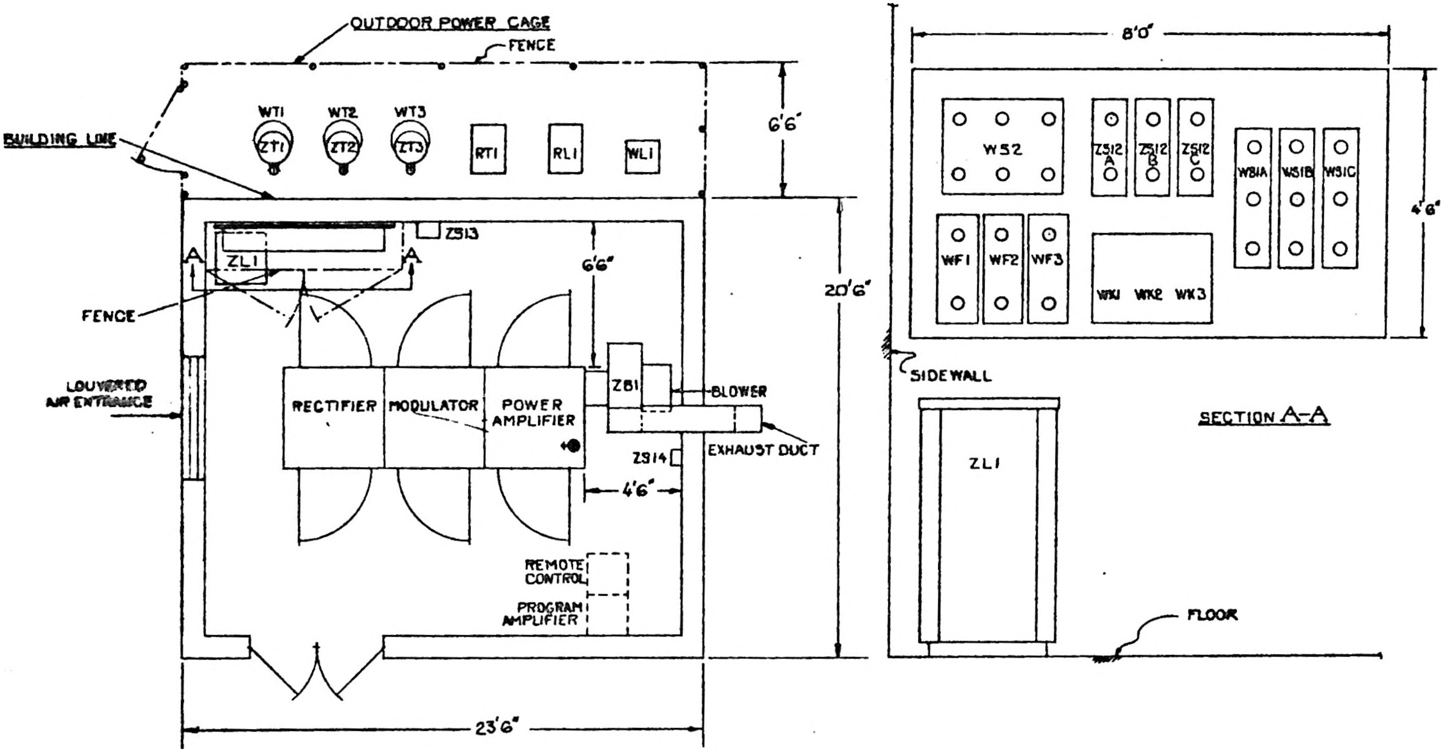


Fig. 46 Typical Station Layout for 2400/4160-Volt Operation (D-7669896, Sheet 2)

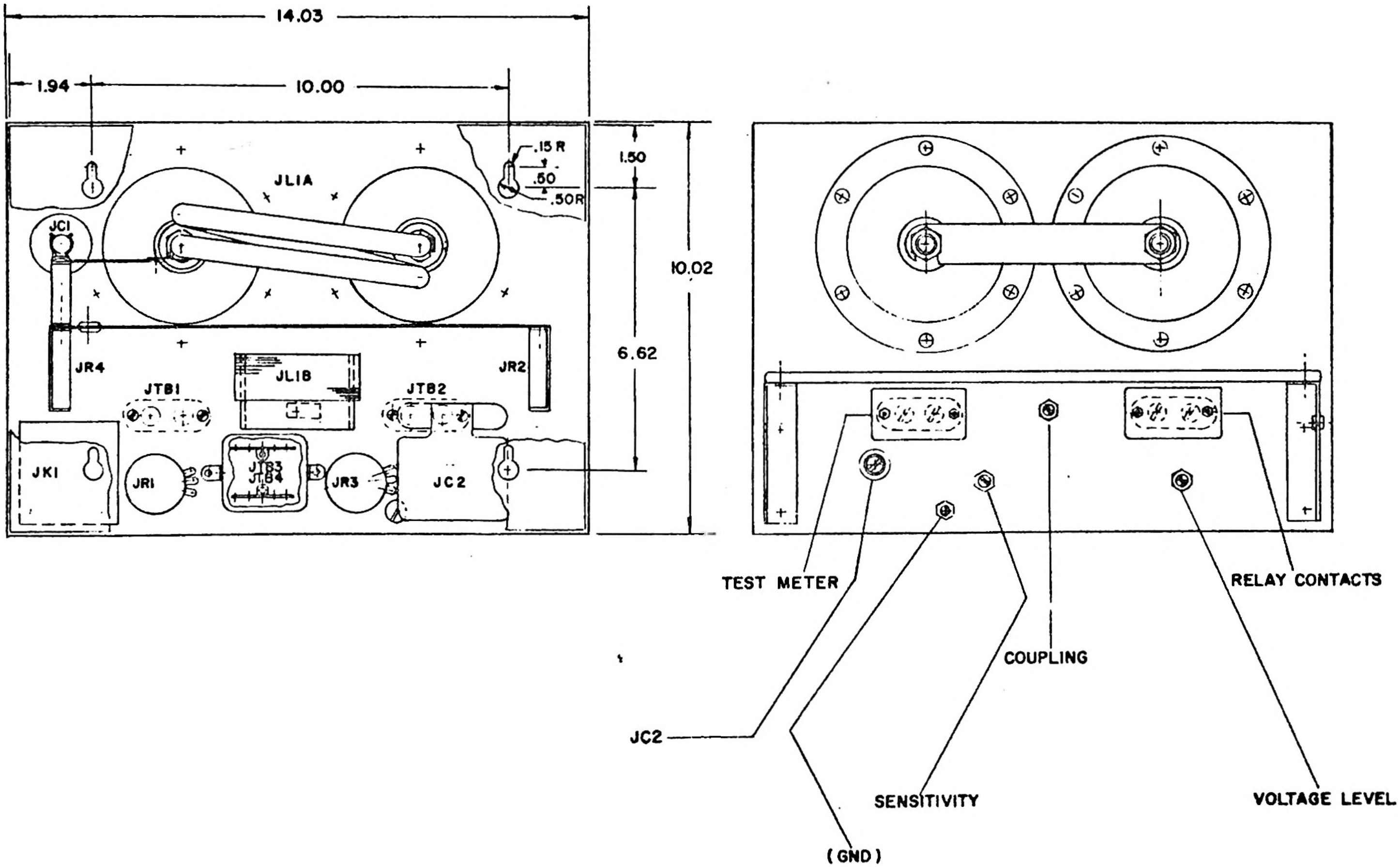


Fig. 59 Outline: Top and Bottom Views, Reflectometer, PL-444D442-G2 (C-7777467, Sheet 1)

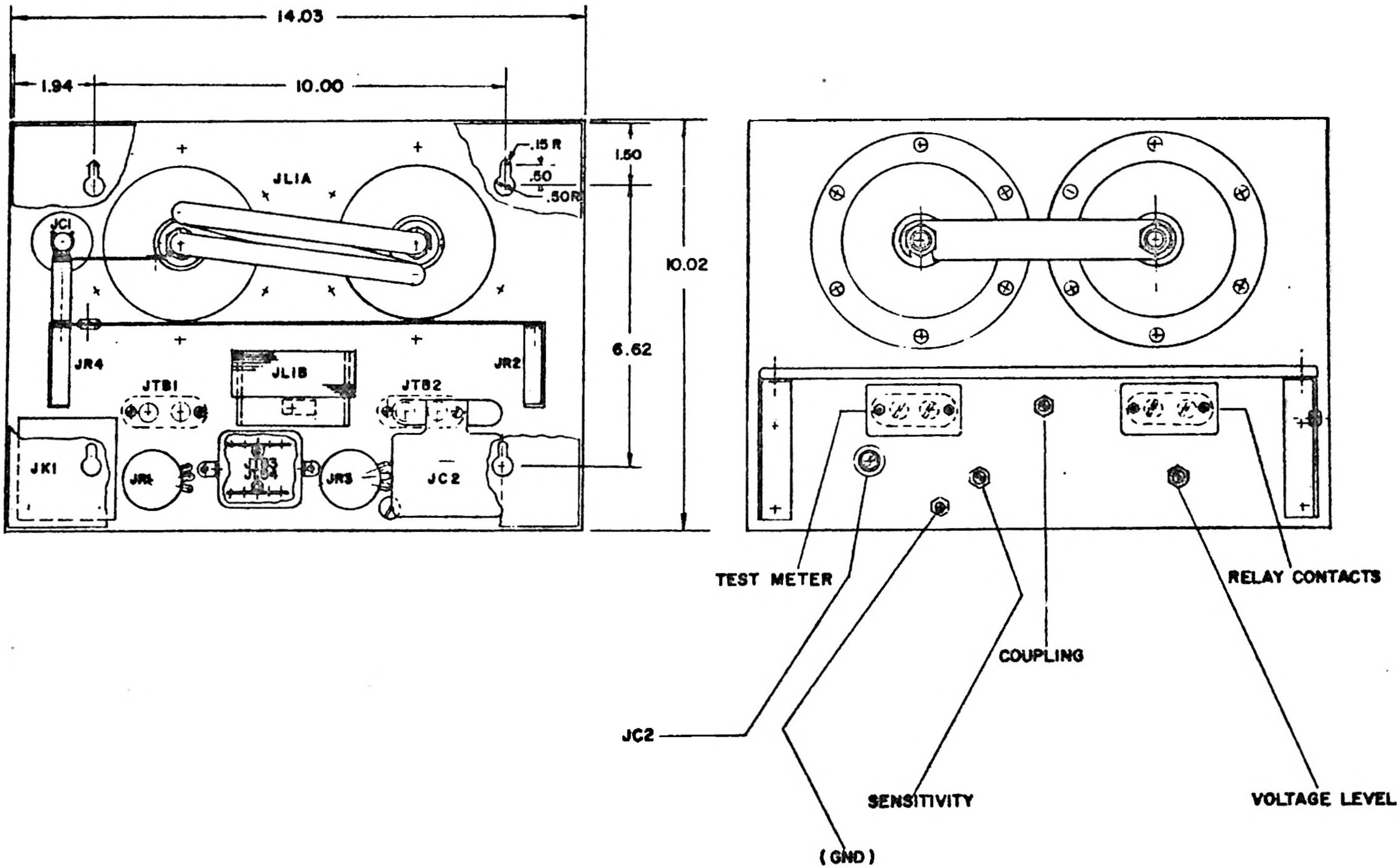


Fig. 59 Outline: Top and Bottom Views, Reflectometer, PL-444D442-G2 (C-7777467, Sheet 1)

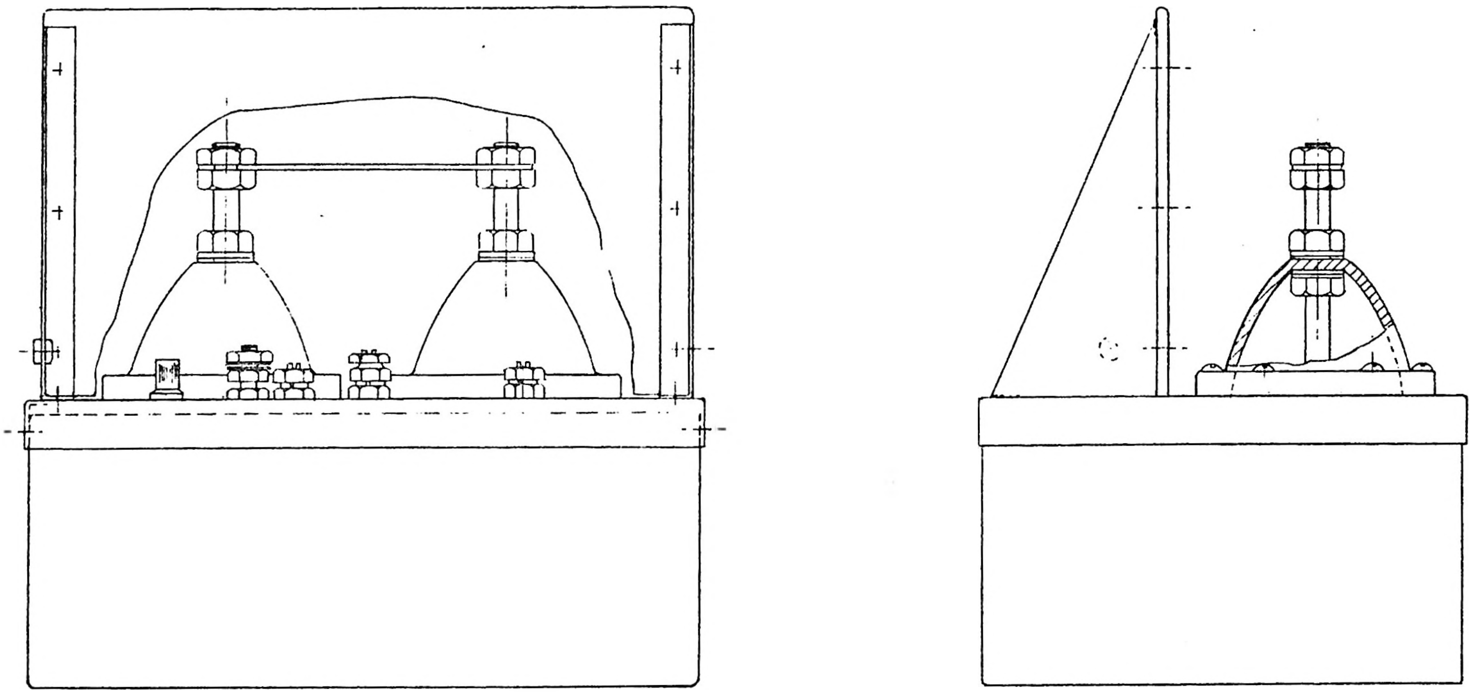


Fig. 60 Outline: Side and End Views, Reflectometer, PL-444D442-G2 (C-7777467, Sheet 2)

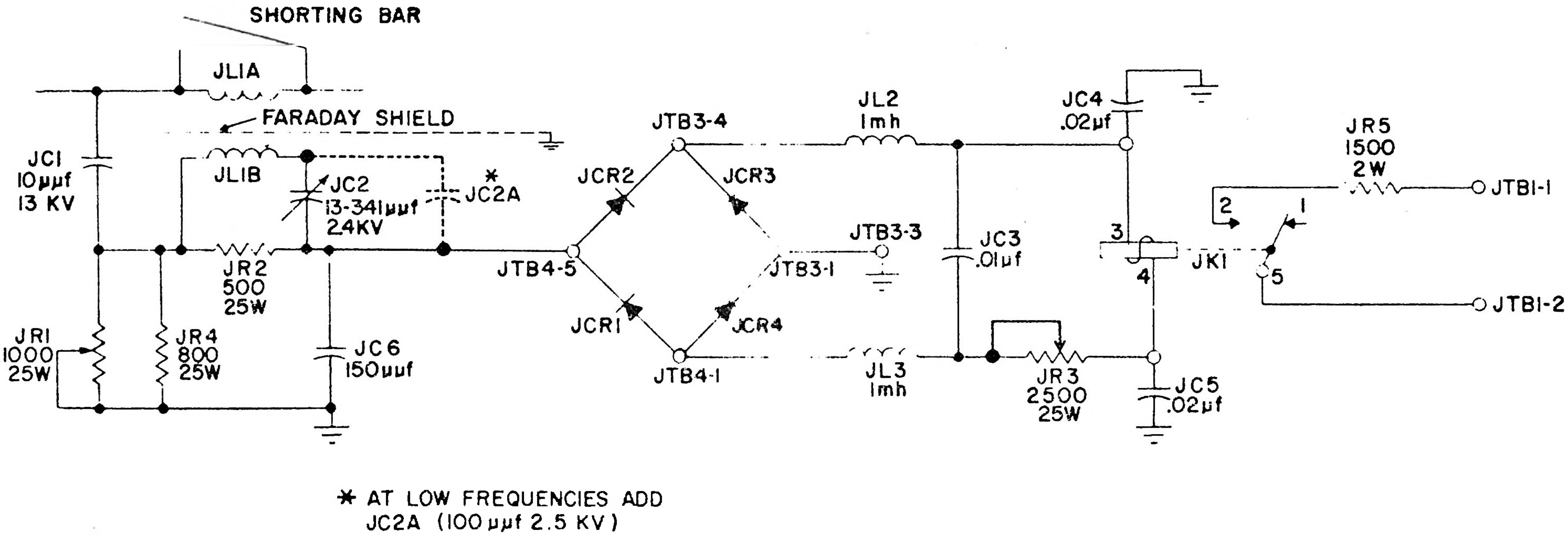
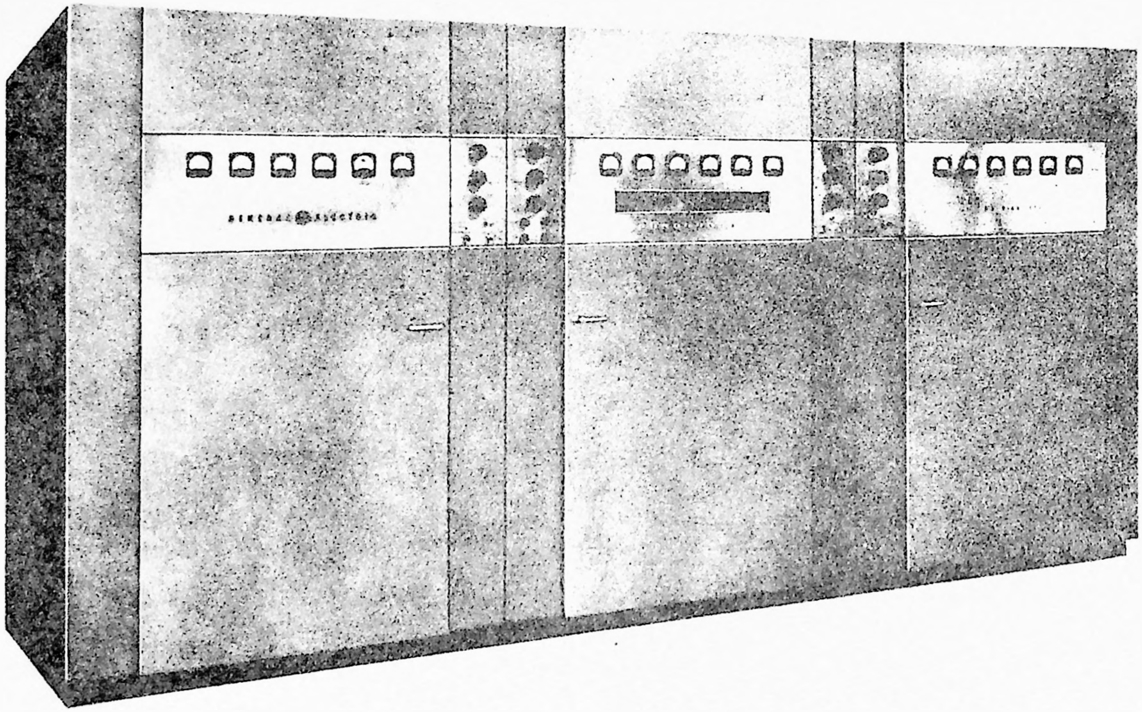


Fig. 61 Elementary Diagram, Reflectometer, PL-444D442-G2 (B-7492737)

Fig. 61
Reflectometer
Elementary

50 KW AM Transmitter, Type BT-50-A



APPLICATION

Type BT-50-A 50 KW AM Transmitter supplies 53.0 kilowatts of amplitude modulated RF carrier in the frequency range from 535 to 1620 kilocycles.

INTERCHANGEABILITY

Can be used with studio broadcast equipment whose output signal complies with RETMA standard.

COMPLIANCE

Complies with all applicable FCC and RETMA specifications.

FEATURES

1—Low installation cost.

- *a. Small size* (13½ ft. x 4½ ft.) can be housed in small building.
- *b. Lightweight tubes do not require dollies or hoists*—access aisles can be limited to 42".
- *c. No under-floor ducts*—intercubicle wiring ducts built into cabinetry.
- *d. External blower* can be located remotely for accessibility and layout flexibility.
- *e. Can be operated in unheated building*—ambient temperature range is 0° to 120° F.
- *f. Multiple radiator antenna and single radiator omnidirectional antenna* installations facilitated by multiple RF output impedance (50 to 230 ohms).

2—Low operating cost.

- *a. Small tube complement*—only 16 in complete transmitter. Since there are only six types, spare tube inventory can be small.
- *b. Low-cost, long-life tubes.*
- *c. Standard power input*—2400 or 480 volts, three phase. (Equipment for operation at other voltages and frequencies available if required.)
- *d. Low power consumption*—108 KW at 0.91 power factor for average (30%) modulation.

3—Dependable operation and low maintenance expense.

- *a. Germanium rectifiers supply all direct current.*
- *b. Long rectifier life assured*—operating characteristics of germanium do not change with age.
- *c. Germanium rectifiers eliminate destructive voltage surges* caused by arc starvation in mercury vapor tubes.
- *d. Can be used at low temperatures* simplifying remote operation when approved.
- *e. Extreme simplicity in RF circuits*—conventional proven circuits familiar to all operators are used throughout the transmitter.
- *f. Class B audio modulation with Class C RF stage.*
- *g. Only 3 Class C amplifier stages* produce 53 KW output at terminals.
- *h. Easily-tuned.* Front-of-cubicle meters easily read; no tuning procedures that require oscilloscopes or special equipment.

i. The 6427 final RF and audio tubes weigh only 20 pounds each and can easily be lifted into or out of their sockets without tube hoists or other auxiliary equipment.

j. Quick, complete access full length cubicle doors front and back.

k. Low distortion feed-back circuits make it easy to maintain low distortion; (measured less than 2%, 50 7500 cycles).

l. Protection against momentary surges recloser with automatic reset re-applies power in case of momentary outages (sometimes caused by lightning).

m. Power is automatically re-applied following short duration (2 second) power outages.

n. Extra care has been given to the selection and placement of components so that long uninterrupted operation will be obtained with a minimum of care.

4—The plate modulated Class C amplifier used will operate satisfactorily into directional antennas where the load impedance often varies 2 to 1 at sideband frequencies.

5—To restrict harmonic radiation, harmonic filters are built in and RF circuits are completely shielded.

6—Complete safety protection to operating personnel and equipment has been provided.

7—Can be supplied with Pyranol filled transformers and reactors.

DESCRIPTION

Type BT-50-A 50 KW AM Transmitter consists of three cubicles each 7 ft. high, 4½ ft. wide and 4½ ft. deep.

The Modulator is driven by four 304TL triodes operated as cathode followers. By using two 304TL's in parallel on each side of the push-pull circuit an extremely low impedance driver is obtained for the modulator tubes and these tubes are operated with very low dissipation.

A Class A audio amplifier employing a pair of 6156 tetrodes provides ample voltage for the cathode follower stage.

Feedback around the audio stages makes it easy to maintain low distortion. Adjustments are not critical nor subject to small variations in tubes or other operating parameters. Ten DB of rectified RF feedback at low audio frequencies keeps hum well below 60 db and reduces distortion.

Plate power for the final RF and audio stages is applied with high-speed contactors which have demonstrated their ability to operate many years without service. These contactors are backed up by current limiting protectors which prevent damage to transformers and contactors should a fault develop in primary power circuits. A step-down distribution transformer provides 208 and 120 volt power for low level circuits.

Final radio frequency is generated by a crystal controlled oscillator and amplified by only 3 Class C amplifier stages to produce a carrier signal of 53 kilowatts. This power, and more if needed to provide for unusual losses in directional antenna phasing networks, and transmission lines, is available at the transmitter output terminals. The RF output circuit is a conventional pi-network type of circuit with the load capacitively coupled to the tank circuit to minimize harmonics.

A built-in completely shielded low-pass harmonic filter further reduces harmonic output to levels far below present specifications and adequate to meet anticipated revised FCC specifications.

Germanium rectifiers, which do not deteriorate with age, are used for all DC voltage supplies. As mentioned previously, use of germanium rectifiers will completely eliminate destructive voltage surges which may develop in plate transformers with arc starvation in gas rectifier tubes. Not only will the Broadcaster save money on tubes, but he can operate this transmitter in an unheated building and save the expense of installing a heating system.

MECHANICAL SPECIFICATIONS

Units: Type number consists of three cubicles and associated external equipment.

Dimensions and Mounting:

	Height	Width	Depth	Weight
Rectifier and Control Cubicle	84"	54"	54"	2200 lbs. (approx)
Exciter & Modulator Cubicle	84"	54"	54"	2200 lbs. (approx)
RF Amplifier Cubicle	84"	54"	54"	2200 lbs. (approx)

Mounting: See diagram of Typical Station Layout for dimensions of external equipment and for mounting requirements.

Operating Conditions:

Ambient Temperature 0 120° F.

Maximum altitude 5000 ft. for standard equipment, easily modified for higher altitudes.

Maximum Relative Humidity 95%.

Safety Provisions: All doors are provided with electrical interlocks and safety grounding switcher to protect personnel from high voltage. Control circuits provide overload protection and proper sequencing to prevent damage to the equipment.

ELECTRICAL SPECIFICATIONS

Performance:

Frequency: As specified between 535 and 1620 kc.

Frequency Stability: ±5 cycles.

Power Output (at Transmitter Output Terminal): 53 KW.

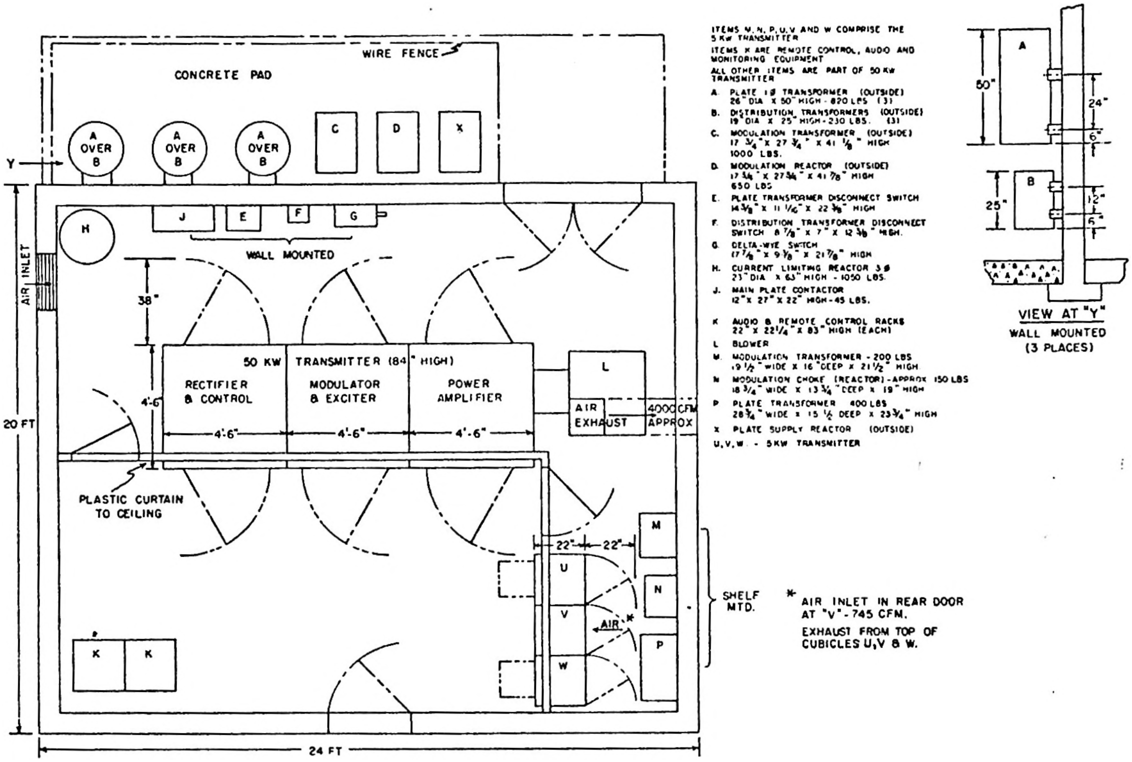
Type of Emission: A3.

Type of Modulation: High Level.

Power Requirements:

Percentage Modulation	50 KW RF Carrier Power	53 KW RF Carrier Power
0%	94 KW @ 0.9 P.F.	98 KW @ 0.9 P.F.
30%	108 KW @ 0.91 P.F.	113 KW @ 0.91 P.F.
100%	145 KW @ 0.93 P.F.	153 KW @ 0.93 P.F.

2400 or 480, 60 cycles 3 phase (If required, equipment can be furnished for operation at other power line voltages and frequencies.)



Typical Station Layout
50 KW AM Broadcast Transmitter with 5 KW Standby and Conelrad Transmitter

Audio Input: +10 dbm, ±2 dbm for 100% modulation.

Audio Input Impedance: 600/150 ohms.

Audio Response: ±1.5 db 30–10,000 cycles.

Audio Distortion: Less than 3% 50–7500 cycles.

Noise Level: More than 60 db below 100% modulation.

Carrier Shift: Less than 2½%—0 to 100% modulation with 0 regulation of supply voltage.

Output: Unbalanced.

Output Impedance: 50 to 230 ohms.

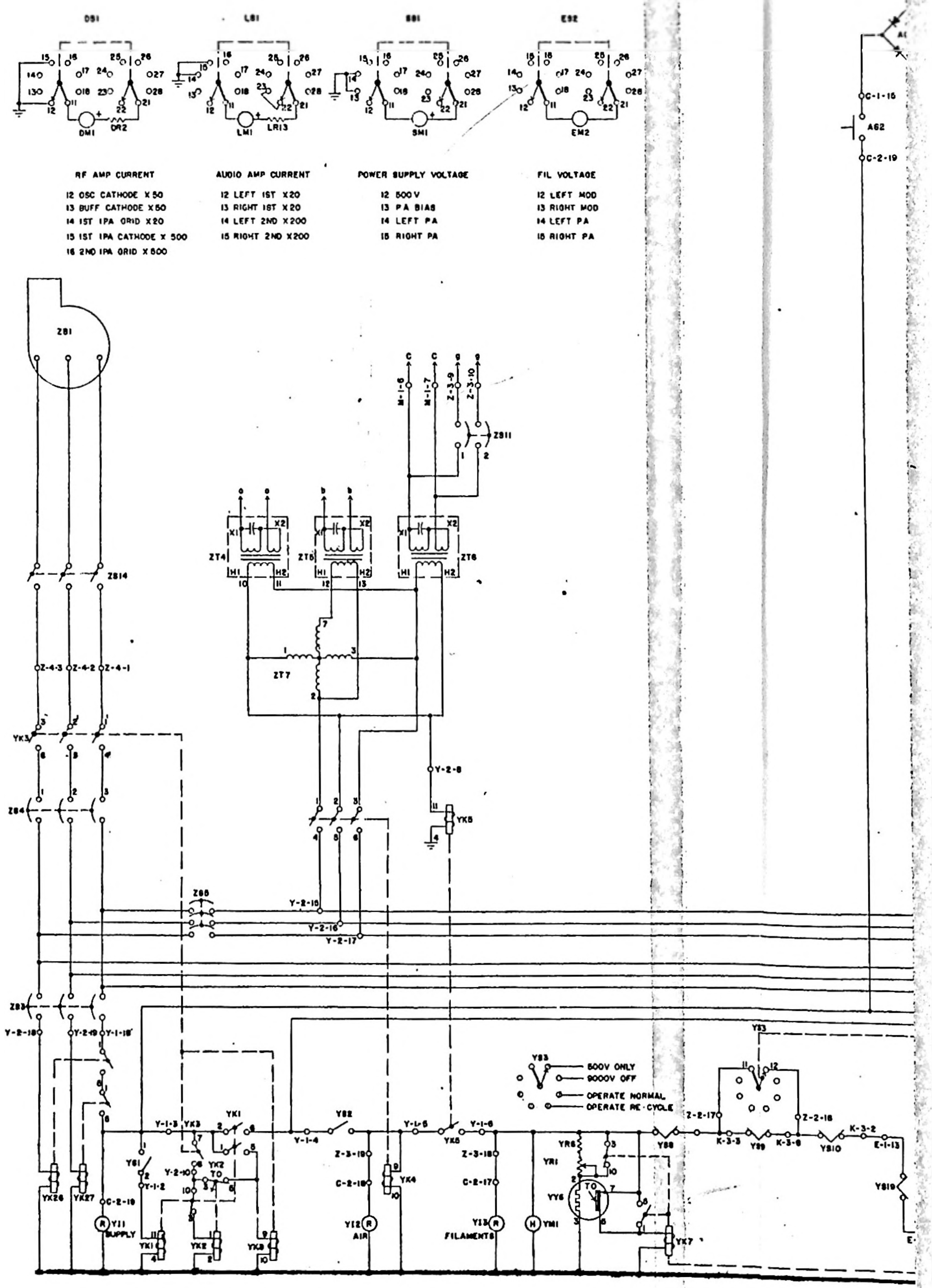
TUBE COMPLEMENT

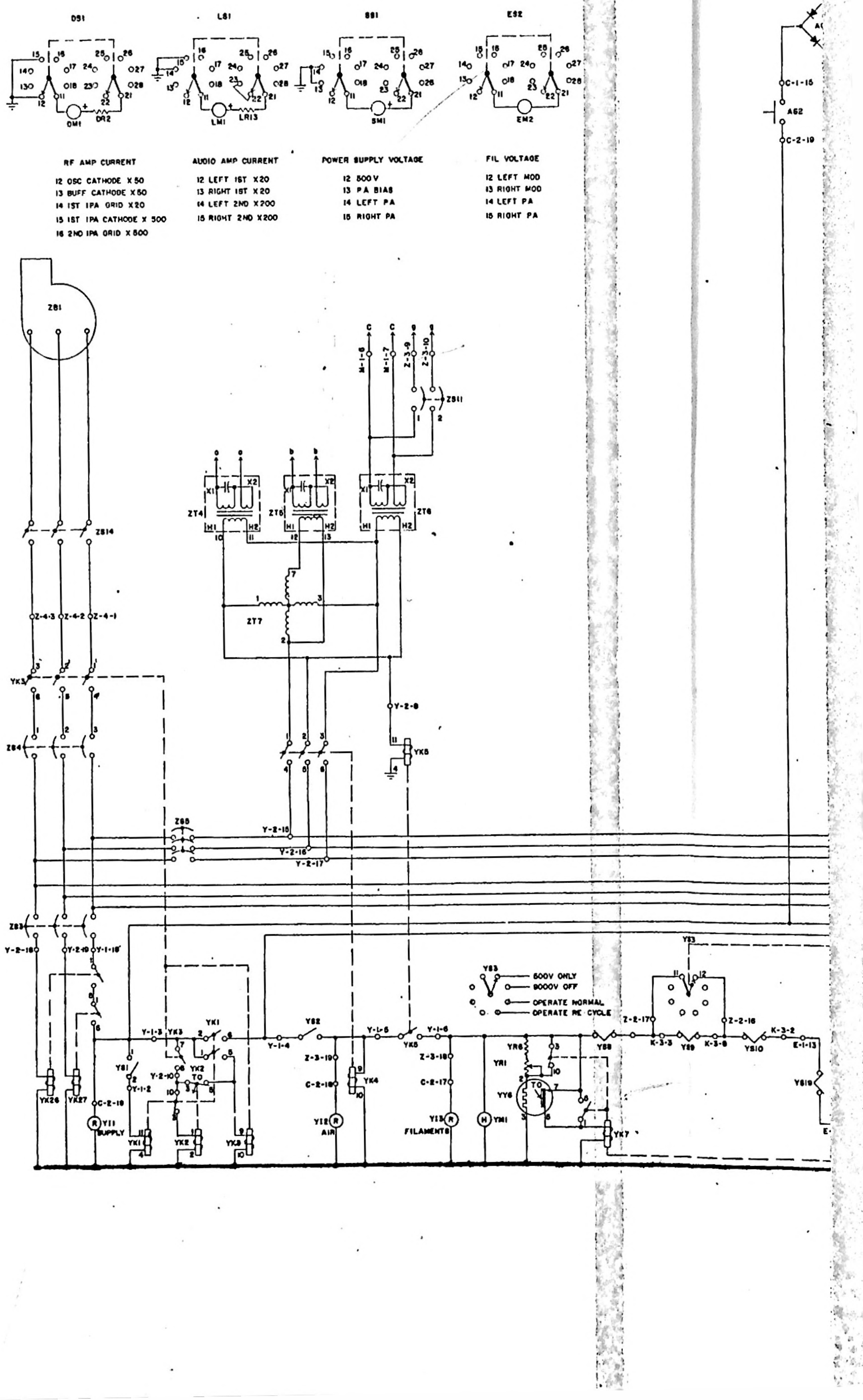
1—6146 Crystal Oscillator
1—6146 Buffer Amplifier
1—6156 1st Intermed. Power Amplifier
1—6623 2nd Intermed. Power Amplifier
2—ML-6427 Power Amplifier
2—6136 First Audio
2—6156 Second Audio
4—304TL Third Audio
2—ML-6427 Modulator

ORDERING INFORMATION

When ordering please specify: Type BT-50-A 50 KW AM Transmitter. This standard transmitter consists of:

1—Rectifier & Control Cubicle
1—Exciter & Modulator Cubicle
1—RF Amplifier Cubicle
1—Blower
3—Plate Transformers
1—Current Limiting Reactor, 3 phase
1—Plate Contactor Assembly
1—Delta Wye Switch
1—Fused Disconnect Switch (200 amps)
1—Filter Reactor
1—Modulation Transformer
1—Modulation Reactor
3—Distribution Transformers
1—Fused Disconnect Switch (60 amp)


DM1
LM1
SM1
EM2
RF AMP CURRENT
12 OSC CATHODE X50
13 BUFF CATHODE X50
14 1ST IPA GRID X20
15 1ST IPA CATHODE X 500
16 2ND IPA GRID X 500
AUDIO AMP CURRENT
12 LEFT 1ST X20
13 RIGHT 1ST X20
14 LEFT 2ND X200
15 RIGHT 2ND X200
POWER SUPPLY VOLTAGE
12 500V
13 PA BIAS
14 LEFT PA
15 RIGHT PA
FIL VOLTAGE
12 LEFT MOD
13 RIGHT MOD
14 LEFT PA
15 RIGHT PA
500V ONLY
5000V OFF
OPERATE NORMAL
OPERATE RE-CYCLE
SUPPLY
AIR
FILAMENTS



DS1
LS1
SS1
ES2
RF AMP CURRENT
12 OSC CATHODE X 50
13 BUFF CATHODE X 50
14 1ST IPA GRID X 20
15 1ST IPA CATHODE X 500
16 2ND IPA GRID X 500
AUDIO AMP CURRENT
12 LEFT 1ST X 20
13 RIGHT 1ST X 20
14 LEFT 2ND X 200
15 RIGHT 2ND X 200
POWER SUPPLY VOLTAGE
12 500 V
13 P A BIAS
14 LEFT PA
15 RIGHT PA
FIL VOLTAGE
12 LEFT MOD
13 RIGHT MOD
14 LEFT PA
15 RIGHT PA
ZB1
ZS14
ZT4
ZT5
ZT6
ZT7
ZS11
YK3
ZS4
YK5
ZS5
ZS3
YS3
500V ONLY
5000V OFF
OPERATE NORMAL
OPERATE RE CYCLE
YK26
YK27
YK1
YK2
YK9
YK4
YK7
YS1
YS2
YS8
YS9
YS10
YS19
YI1 SUPPLY
YI2 AIR
YI3 FILAMENTS
YM1
YR6
YR1
YY6
A62

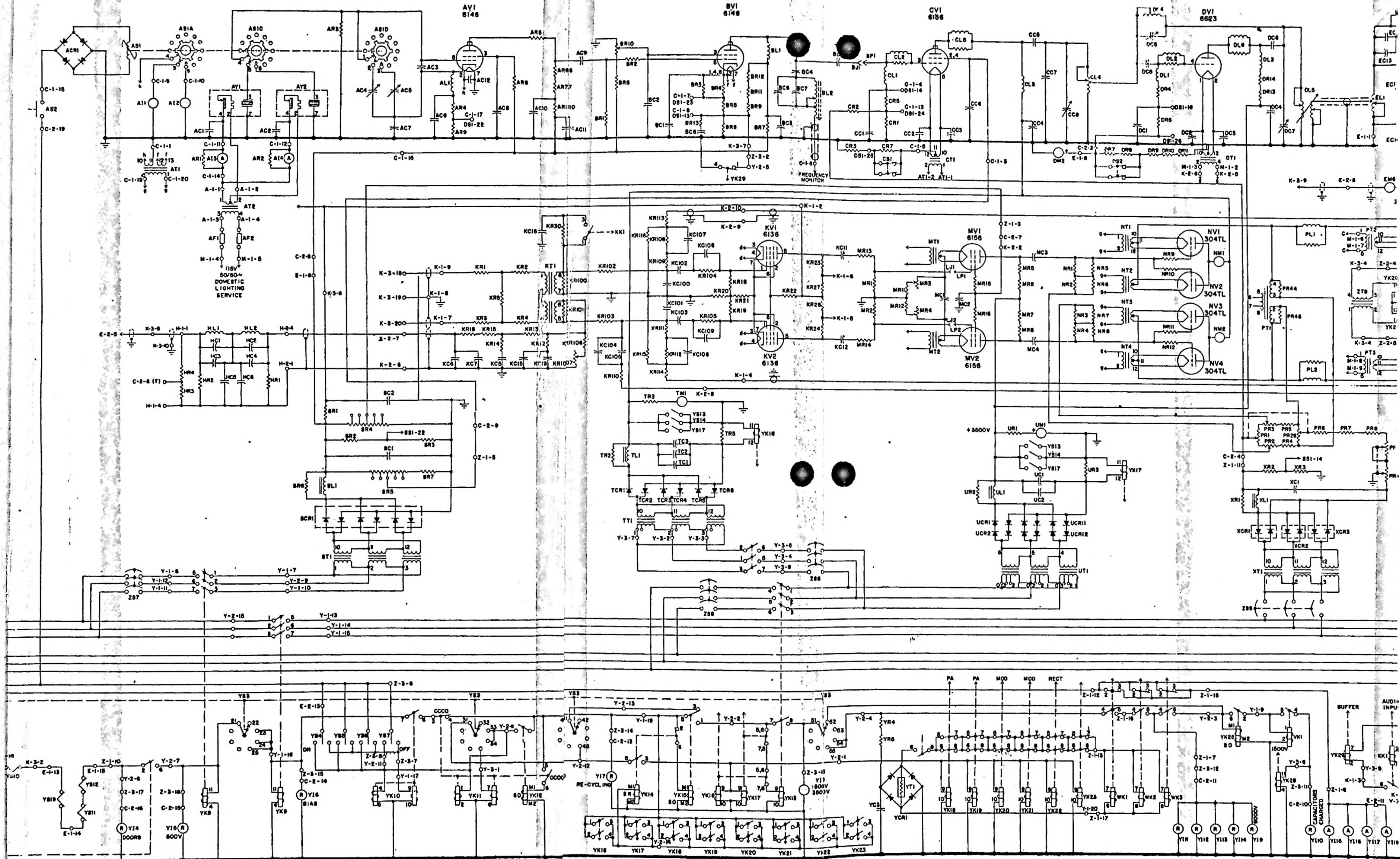
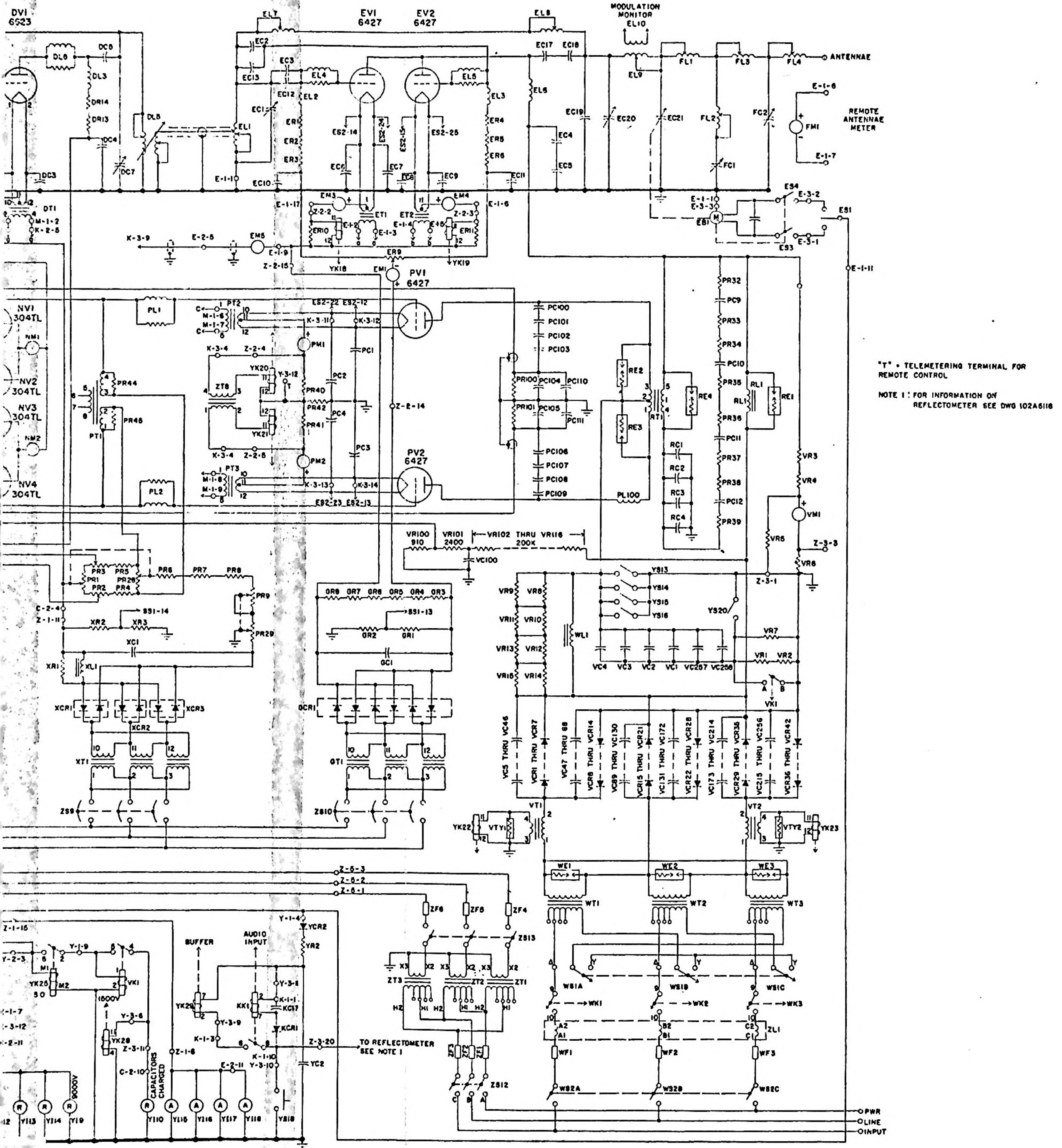


Fig. 58 Elementary Diagram, Type BT-50-A Transmitter (EE-7354334, Rev. 1)



SEE REVISED DRAWING
IN ENCLOSURE ENVELOPE

Fig. 58
Elementary