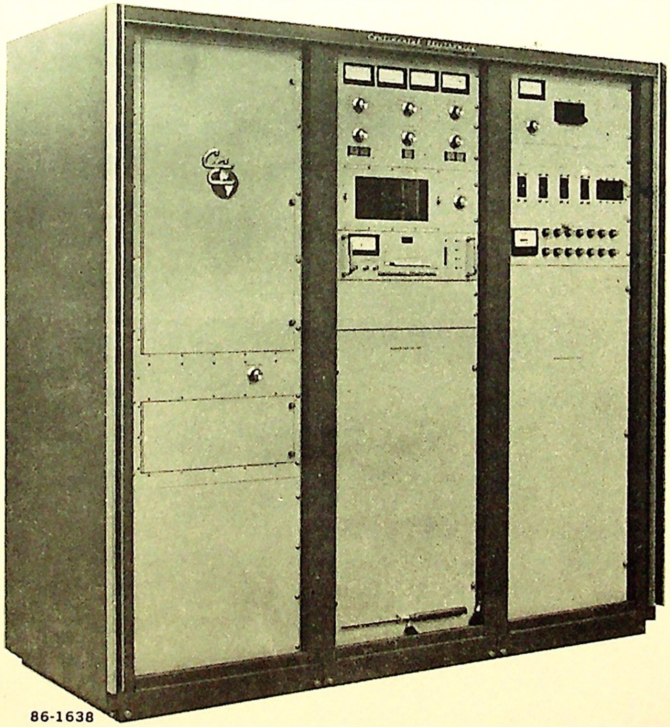
TYPE 816R-5

FM BROADCAST TRANSMITTER

WITH SOLID STATE EXCITER 802A

INSTRUCTION MANUAL



86-1638

Continental Electronics

a Division of Varian Associates, Inc.

P.O. BOX 270879 DALLAS, TEXAS 75227 (214) 381-7161

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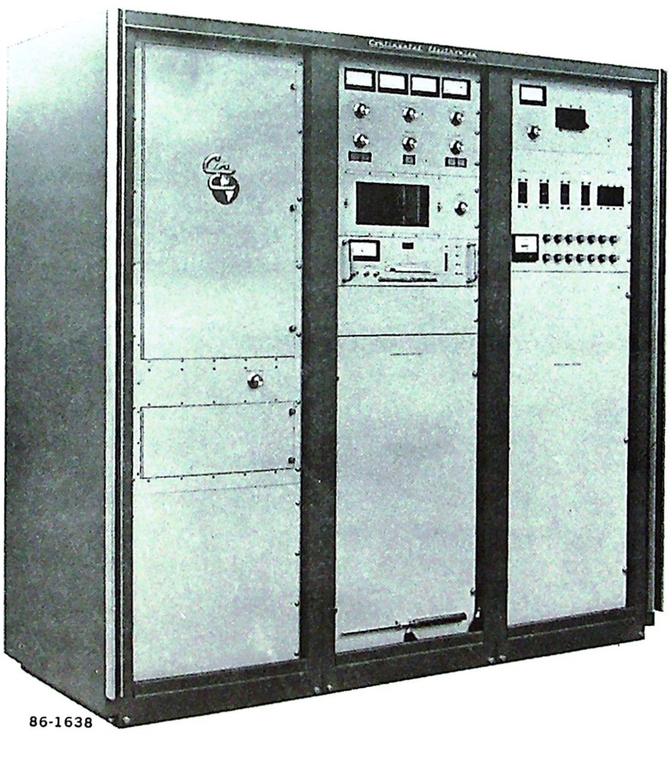

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LIST OF EFFECTIVE CHANGES

CHANGE NO.	DATE	EFFECTIVITY
1	8 APRIL 1987	ALL TRANSMITTERS

TABLE OF CONTENTS

Paragraph	Title	Page
	SECTION 1 - GENERAL	
1-1.	Introduction	1-1
1-2.	Functional Description	1-1
1-3.	Physical Description	1-1
1-4.	Technical Characteristics	1-3
1-4.1	Technical	1-3
1-4.2	Electrical	1-3
	SECTION 2 - INSTALLATION	
2-1.	Pre-Installation Information	2-1
2-1.1	Transmitter Cooling	2-2
2-2.	Unpacking and Inspecting	2-7
2-2.1	Domestic Shipments	2-7
2-2.2	Foreign Shipments	2-7
2-3.	Assembly	2-7
2-4.	Set Up and Operation	2-18
2-4.1	Initial Turn-On Procedure	2-18
2-4.2	Remote Operation	2-25
2-4.3	2nd Power Level (Low Power) Adjustment	2-25
2-4.4	Automatic Recycle Resetting	2-25
2-5.	Shutdown Procedures	2-26
2-5.1	Normal Turnoff (At Transmitter Site)	2-26
2-5.2	Emergency Turnoff	2-26
	SECTION 3 - OPERATION	
3-1.	General	3-1
3-2.	Controls and Indicators	3-1
3-3.	Initial Turn-On Procedure	3-13
3-4.	Remote Operation	3-24
3-5.	2nd Power Level (Low Power) Adjustment	3-24
3-6.	Automatic Recycle Resetting	3-24
3-7.	Normal Turnoff (At Transmitter Site)	3-24
3-8.	Emergency Turnoff	3-25

TABLE OF CONTENTS - Continued

Paragraph	Title	Page
	SECTION 4 - THEORY OF OPERATION	
4-1.	General	4-1
4-2.	Block Diagram Discussion	4-1
4-3.	RF Circuits	4-1
4-3.1	Exciter	4-1
4-3.2	RF Driver	4-1
4-3.3	RF Power Amplifier	4-4
4-3.4	Low Pass Filter, A13	4-8
4-3.5	Directional Coupler, DC1	4-8
4-4.	Power Supplies and Power Control Circuits	4-8
4-4.1	General	4-8
4-4.2	28 Volt DC Power Supply, P/O A10	4-8
4-4.3	PA Bias Power Supply, P/O A10	4-8
4-4.4	PA Plate Power Supply	4-9
4-4.5	Power Control Unit, A9	4-9
4-4.6	Power Control Regulator, A8	4-9
4-4.7	PA Screen Power Supply	4-10
4-4.8	Driver Power Supply, P/O A10	4-10
4-4.9	Filament Voltage Regulator, A5	4-10
4-4.10	Filament Voltage Distribution	4-13
4-5.	Primary Power Distribution Control & Overload Circuits	4-14
4-5.1	Primary Power Distribution	4-14
4-5.2	Transmitter Turn-On	4-17
4-5.3	Exciter Power Control Override	4-17
4-5.4	Fwd/Refl Calibrate and Auto Power Control Unit, A3	4-19
4-5.5	Overload Protection	4-20
4-5.6	Overland and Recycle Board, A7	4-21
4-5.7	Power Failure Recycle Board, A19A1	4-22
4-5.8	Latching Relay and Status Indicator Board, A12	4-22
4-5.9	Blower Off Delay	4-23
4-5.10	Power Control Relays, P/O A9	4-23
4-5.11	Remote Relays, P/O A9	4-23
4-5.12	Remote Connections	4-23
	SECTION 5 - MAINTENANCE	
5-1.	Routine Maintenance	5-1
5-2.	Cleaning	5-1
5-2.1	General Cleaning Procedures	5-1
5-2.2	Air Filter	5-1
5-2.3	Tube Cleaning	5-2
5-3.	Inspection	5-2
5-4.	Lubrication	5-2

TABLE OF CONTENTS - Continued

Paragraph	Title	Page
	SECTION 5 - MAINTENANCE - Continued	
5-5.	Parts Replacement	5-2
5-5.1	9019/CV130 PA Tube	5-2
5-5.2	4CX250B Driver Tube (Refer to Figure 5-1)	5-3
5-5.3	Control Panel Indicator Lamps	5-4
5-5.4	Fuse Replacement	5-4
5-6.	Troubleshooting	5-4
5-6.1	Access Panel Interlock Switch	5-4
5-6.2	Test Equipment	5-4
5-7.	Adjustments	5-6
5-7.1	Switch Adjustments	5-6
5-7.1.1	Air Interlock Switch, S1	5-6
5-7.1.2	Tuning Motor Limit Switches, S11, S12, S13 and S14	5-6
5-7.2	Filament Voltage Adjustment	5-7
5-7.3	Driver Filament Voltage Adjustment	5-8
5-7.4	DC Overload Adjustment	5-8
5-7.5	PA Grid Current & Driver Screen Current Meter Calibration	5-10
5-7.6	High Voltage Power Supply Static Check (No Drive)	5-10
5-7.7	A3, FWD/REFL Cal & Power Control Card Alignment Procedure	5-11
5-7.8	Phase Monitor Adjustment	5-13
5-7.9	Blower Off Delay Adjustment	5-14
5-8.	Changing Power	5-14
5-9.	Changing Frequency	5-14
5-9.1	Shorting Plane, Driver Loading Slider, Driver Tuning Slider, Driver Grid Slider, PA Neutralization Preliminary Adjustment, PA Cathode Return Capacitors, PA Bias, PA Efficiency Capacitor, Driver Bias, Driver Neutralization	5-16
5-9.2	Driver Grid Tuning	5-21
5-9.3	PA Tuning	5-22
5-9.4	PA Neutralization	5-25
5-9.5	Driver Neutralization	5-25
	SECTION 6 - PARTS LISTS	
6-1.	General	6-1
6-2.	Ref Des	6-1
6-3.	Description	6-1
6-4.	Continental Electronics Part Number	6-1
6-5.	Illustrations	6-1
6-6.	List of Equipment	6-3

LIST OF ILLUSTRATIONS

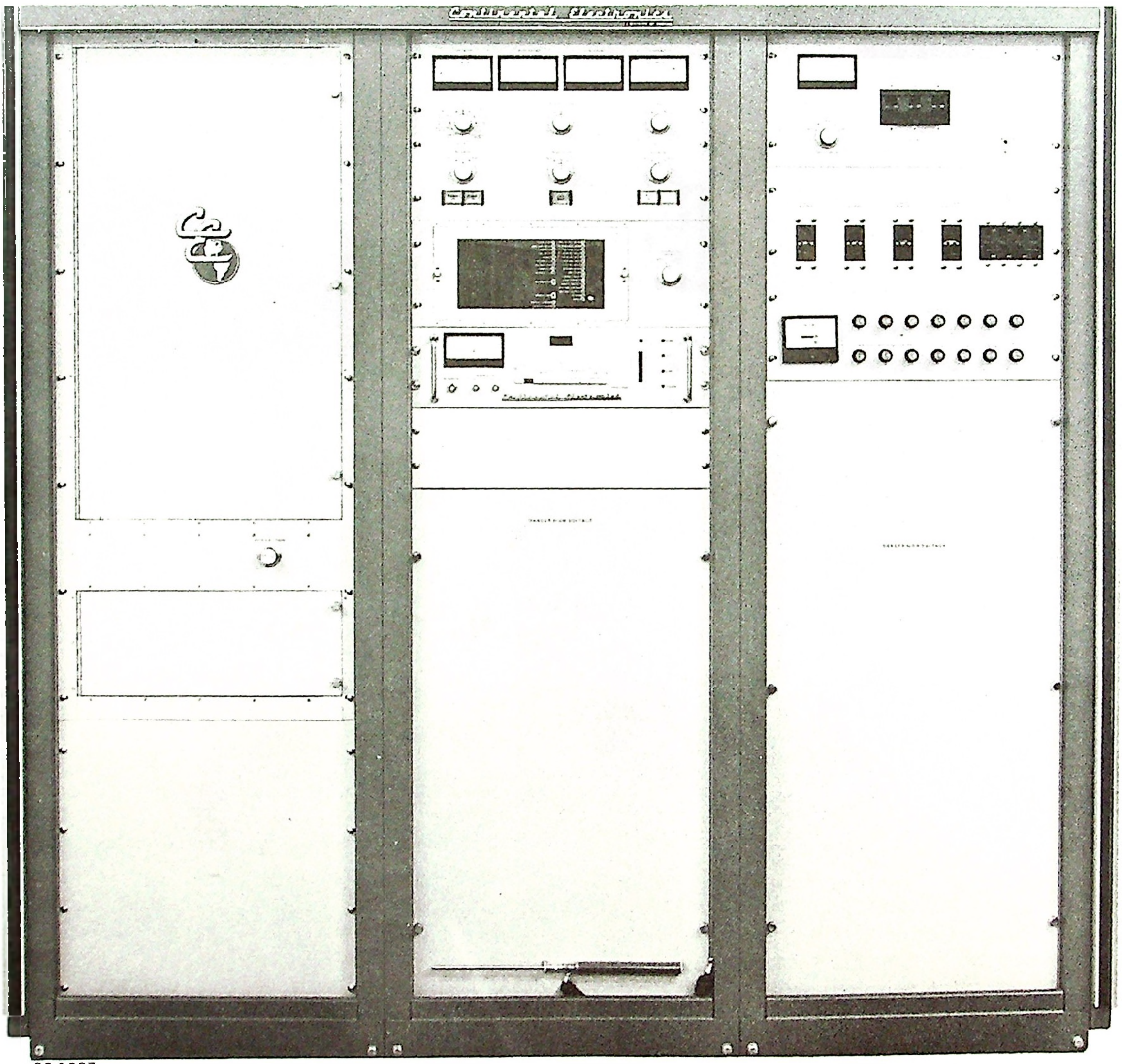
Figure	Title	Page
1-1.	FM Transmitter, 816R-5	1-0
1-2.	Plate Transformer Housing, Unit 2	1-2
2-1.	FM Transmitter Outline & Installation Drawing	2-3/2-4
2-2.	Interconnecting Xmtr & Plate Xfmr Assembly	2-9
2-3.	Plate Xfmr Primary Interconnect Inside Xmtr	2-11
2-4.	Plate Xfmr & Component Identification Primary Interconnect	2-12
2-5.	Remote Plate Current Sample Circuit	2-14
2-6.	Remote Control Connections to Terminal Board, A17TB4	2-15
2-7.	PA Tuning and Loading	2-17
2-8.	Power to VSWR Conversion Graph	2-24
3-1.	FM Transmitter, 816R-5, Controls & Indicators	3-2
3-2.	AC Power Control Panel	3-8
3-3.	Power Circuit Breaker Panel	3-9
3-4.	PA Control Panel	3-10
3-5.	Card Rack, Door Open	3-11
3-6.	Card Rack, Door Closed	3-12
3-7.	PA Tuning and Loading	3-16
3-8.	Amplifier Efficiency vs. Frequency & Power	3-19
3-9.	Power to VSWR Conversion Graph	3-23
4-1.	FM Transmitter, 816R-5, Block Diagram	4-2
4-2.	Driver DC Bias - Same for Each Tube Simplified	4-3
4-3.	PA DC Bias Circuitry Simplified	4-5
4-4.	Plate Cavity	4-6
4-5.	FM Xmtr, 816R-5, Schematic Diagram, Output Network	4-7
4-6.	Power Control Circuits, Simplified Diagram	4-11/4-12
4-7.	Filament Voltage Distribution	4-15
4-8.	Primary Power Distribution	4-16
4-9.	Power ON-OFF Control Circuits	4-18
4-10.	Latching Relays Simplified, A12	4-24
4-11.	Power Control Relays, Simplified Schematic, P/O A9	4-25
4-12.	Remote Control Connections to Terminal Board A17TB4	4-26
5-1.	Driver Tube Replacement	5-3
5-2.	Power Amplifier Socket, A21	5-15
5-3.	PA Plate Tuning Cavity Slider Approximate Adjustment	5-17
5-4.	Graph for Approximate Setting of Driver Loading, Driver Tuning and Driver Grid Slider	5-18
5-5.	PA Neutralizing Adjustment	5-19
5-6.	PA Socket, Cathode Return Capacitors	5-20
5-7.	Adjustment of Cathode Return Capacitor	5-20

LIST OF ILLUSTRATIONS - Continued

Figure	Title	Page
6-1.	816R-5 FM Transmitter (Sheet 1 of 2)	6-4
6-1.	816R-5 FM Transmitter (Sheet 2 of 2)	6-5
6-2.	Control Panel, A1 (Sheet 1 of 2)	6-9
6-2.	Control Panel, A1 (Sheet 2 of 2)	6-10
6-3.	Driver Bias Supply, A2	6-13
6-4.	Fwd/Refl Cal & Power Control Board, A3	6-15
6-5.	VSWR Foldback & Two Level Auto Power Control, A3A1	6-18
6-6.	Filament Regulator	6-20
6-7.	Circuit Breaker Panel, A6	6-23
6-8.	Overload & Recycle Board, A7	6-25
6-9.	Power Control Regulator, A8	6-29
6-10.	This Page Left Blank	6-31
6-10.1	Gate Drive Card, A9AR1A1-A3	6-33 *
6-11.	Power Supplies, A10	6-35
6-12.	RF Driver Assembly, A11 (Sheet 1 of 2)	6-37
6-12.	RF Driver Assembly, A11 (Sheet 2 of 2)	6-38
6-13.	Latching Relay and Status Board,A12	6-41
6-14.	RF Output Low-Pass Filter, A13	6-43
6-15.	Power Supply Filter, A14 (Sheet 1 of 2)	6-45
6-15.	Power Supply Filter, A14 (Sheet 2 of 2)	6-46
6-16.	Metering Multiplier Board, A15	6-49
6-17.	Bleeder Resistor Panel, A17	6-51
6-18.	Power Amplifier Cavity, A18	6-54
6-19.	Component Panel, A19	6-59
6-20.	Power Failure Recycle Board, A19A1	6-62
6-21.	Variable Transformer Drive Assembly, A19A2	6-64
6-22.	Card Cage Assembly, A20	6-66
6-23.	Power Amplifier Socket, A21 (Sheet 1 of 2)	6-69
6-23.	Power Amplifier Socket, A21 (Sheet 2 of 2)	6-71
6-24.	Overload & Meter Calibrate Panel, A22	6-72
6-25.	AC Metering Panel, A25	6-74
6-26.	Not Used	
6-27.	Resistor Board Assembly, A25A1	6-76
6-28.	Plate Transformer Housing, Unit 2	6-78

LIST OF TABLES

Table	Title	Page
2-1.	FM Transmitter, Nominal Heat Balance	2-5/2-6
2-2.	Transformer Connection Schedule	2-17
3-1.	Left Cabinet	3-3
3-2.	Center Cabinet	3-4
3-3.	Right Cabinet	3-7
3-4.	Operating Parameters vs. Frequency	5-34
3-5.	Operating Parameters vs. Power Levels	5-35
5-1.	Required Test Equipment	5-5



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NS1-1

Figure 1-1. FM Transmitter, 816R-5

SECTION 1 - GENERAL INFORMATION

WARNING

DISCONNECT PRIMARY POWER BEFORE SERVICING THIS TRANSMITTER. SHORT ALL CAPACITORS AND POWER SUPPLIES WITH GROUNDING STICK. VOLTAGES IN THIS TRANSMITTER ARE DEADLY TO HUMAN LIFE.

1-1. INTRODUCTION

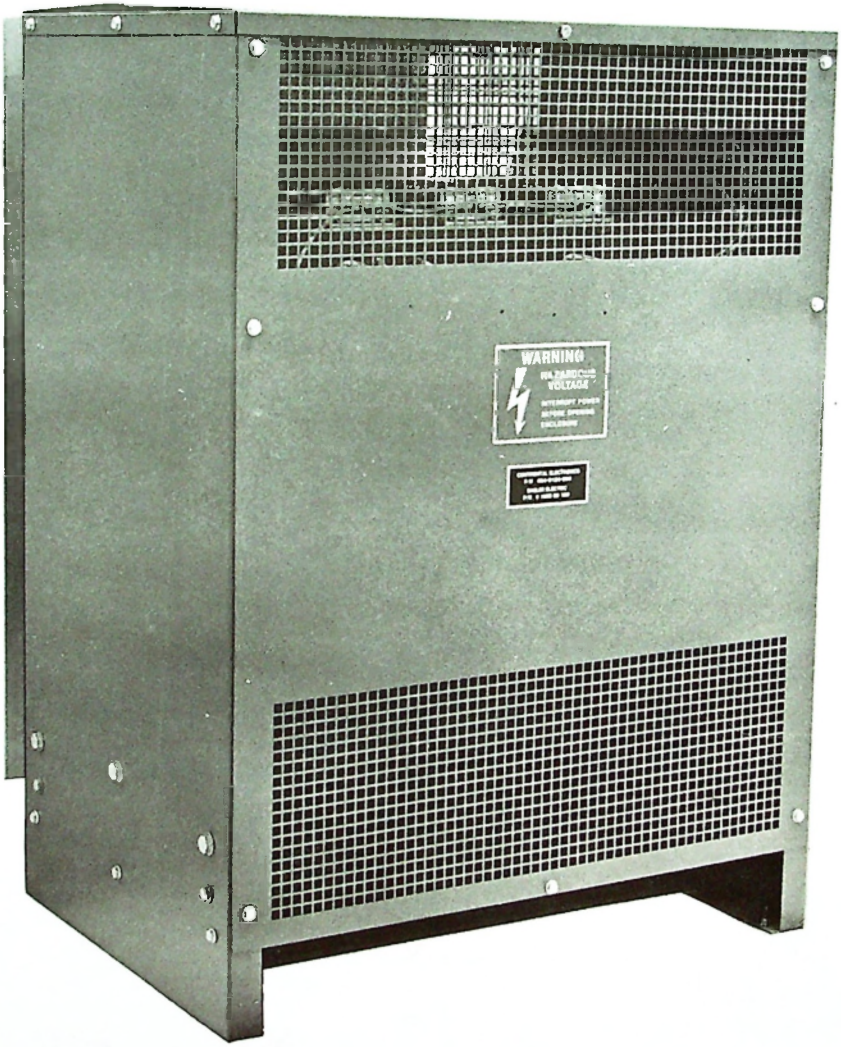
The 816R-5 transmitter operates in the FM broadcast range (88-108MHz) with an RF output power of 35kW. Reduced power is available by tap changes of the plate and screen transformer to meet customer requirements. The FM Transmitter, 816R-5 provides monaural programming or other optional programming as customer requires. When the exciter is inputted with optional stereo generator and SCA generator, the transmitter provides continuous monaural, stereophonic, and SCA (subsidiary communication authorization) frequency-modulated programs.

1-2. FUNCTIONAL DESCRIPTION

The transmitter consists of an exciter, a driver, and power amplifier. The output of the exciter is applied to the driver. The driver stage consists of two 4CX250B tubes operated class C. The input to the driver is amplified to approximately 500 watts and applied to the power amplifier that contains one 9019/YC130 tube operated class C. The input to the power amplifier is amplified and applied to a 50-ohm unbalanced load. Power control circuits monitor the RF output power level. When a change in output power is detected, these circuits change the plate voltage to compensate. Other control circuits within the transmitter monitor reflected power, forward power, operating voltage, air pressure and exhaust air temperature within the power amplifier section. They protect the transmitter by removing power when excessive currents, VSWR, loss of air pressure, or excessive air exhaust temperature occur.

1-3. PHYSICAL DESCRIPTION

The transmitter, Unit 1, is housed in a basic unistrut cabinet that contains all transmitter components, except for plate transformer and rectifier. Refer to Figure 1-1. The transmitter contains three sections. The section on the left in Figure 1-1 contains the power amplifier and driver circuits. The center section houses the control panel, exciter, and control circuits. The section on the right contains the power supplies, the circuit breakers, and fuse panel. Unit 2 is the Plate Transformer Assembly. It contains the plate transformer and rectifier. See Figure 1-2.



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NS1-2

Figure 1-2. Plate Transformer Housing, Unit 2

1-4. TECHNICAL CHARACTERISTICS

1-4.1 MECHANICAL

Weight
Transmitter, Unit 1 1657 lbs

Plate Transformer Assembly, Unit 2 901 lbs

Size - Transmitter *
Height: 69" (175 cm)
(Not Including Directional Coupler)
Width: 72" (183 cm) *
Depth: 28" (71 cm) *

Size - Plate Transformer
Height: 46" (116.8 cm) *
Width: 35" (88.9 cm) *
Depth: 24" (60.9 cm) *

Ventilation Depth: (2 sources)
Squirrel cage type blower mounted under the cavity
Axial fan that provides positive air pressure within the entire cabinet.

Ambient Temperature Range:
-20°C to +50°C (-4°F to +122°F) operating

Relative Humidity Range:
0 to 95% relative humidity

Altitude:
Up to 7500 feet (2285m) at 40°C (104°F)
Up to 10000 feet at 40°C (104°F)
With Optional High altitude blower)

Shock and Vibration:
Normal handling and transportation

Finish:
Front Panel: Tan
Cabinet: Brown

1-4.2 ELECTRICAL

Frequency Range:
88 to 108 MHz

Output Power:
15,000 watts to 35,000 watts

Output Impedance:
50 ohms, VSWR 2:1 Maximum

Standing Wave Ratio: *
Not to exceed 2:1 (Refer to Figure 3-9)

Power Source:
200 to 250 volts, 60 Hz, 3 phase
Available voltage taps on transformer:
200, 210, 220, 230, 240, and 250
50 Hz operation available on special order

Power Line Variations:
±5% overall power line variations; in addition, the phase angle and voltage unbalance shall be within 5% of the average of all three phases.

Harmonic and Spurious Radiation:
Any emission appearing on a frequency removed from the Carrier by between 120 kHz and 240 kHz inclusive is attenuated at least 25 dB below the level of the unmodulated carrier.

Any emission appearing on a frequency removed from the carrier by more than 240 kHz and up to and including 600 kHz is attenuated at least 35 dB below the level of the unmodulated carrier.

Any emission appearing on a frequency removed from the carrier by more than 600 kHz is attenuated at least 80 dB below the level of the unmodulated carrier.

Modulation Characteristics:
Wideband direct FM

Input Power Requirements:
at 35 kW output: 54 kW at 0.93 Power Factor

Excitation Source:
Continental 802A exciter capable of accepting an input signal of from 20 Hz to 100 kHz.

Output Impedance:
50 Ohms, unbalanced

Carrier Frequency Stability:
Frequency will not vary more than ±250 Hz for an ambient temperature range of 0-55°C.

Modulation Input:
Monaural: 600 Ohms, balanced, +10 dBm ±2 dB, for ±75 kHz deviation
Composite: 5,000 Ohms, balanced or unbalanced, 1.25 vrms, for ±75 kHz deviation
SCA (2 ea.) 50,000 Ohms, balanced or unbalanced, 1.25 vrms, for ±7.5 kHz deviation

Audio Frequency Response (Monaural operation):
±0.5 dB; flat, 25, 50, 75 microsecond pre-emphasis, 20 Hz to 15 kHz.

Audio Frequency Distortion:
Monaural: Not more than 0.10%, 20 Hz to 15 kHz (Measured with spectrum analyzer)

FM Noise Level:
75 dB below 100% modulation (±75 kHz)

AM Noise Level:
55 dB below equivalent 100% AM modulation

SECTION 2 - INSTALLATION

2-1. PRE-INSTALLATION INFORMATION

The transmitter requires three phase 200 to 250 volts, 50 or 60 Hz, AC primary power of either Wye or Closed Delta configuration. Line to line balance must be within five percent both for voltage and phase.

Figure 2-1 shows the location of the input power terminals and the openings in the top and floor of the transmitter that can be used to bring the power cables into the transmitter. You may choose to bring the power cables through a two inch knockout in the top of the cabinet or through a two inch round opening in the floor of the transmitter. The size of the power wiring is determined by local electrical code and good engineering practice. In no case should the wiring be smaller than number 3/0 AWG wire where the wire length is up to 100 feet. The wall breaker or fuses should be 200 ampere capacity. The transmitter will require no more than 175 amperes depending on line voltage and transmitter power output. The transmitter has a 200 ampere primary power disconnect breaker.

The plate transformer and its associated rectifier are housed in a separate enclosure that can be located up to 20 feet from the transmitter via 8 wires. Six of these wires supply the plate transformer primary and two return high voltage DC from the rectifiers to the transmitter. The six primary wires and the two high voltage wires are to be enclosed separately in their own conduits. Holes are provided in the tops of both the transmitter and transformer enclosure for this purpose. See Figure 2-1.

The RF output termination is a 3-1/8" eia flange.

Refer to Figure 2-1 for location of air ports, wire ports, and cabinet dimensions. Transmitter should be located to allow access to front and rear. Plate transformer assembly should be located to allow access to the primary side of the transformer for tap changing and servicing.

AC line transient suppressors are suggested for the primary lines. For recommendation of installation, call Broadcast Products Field Service.

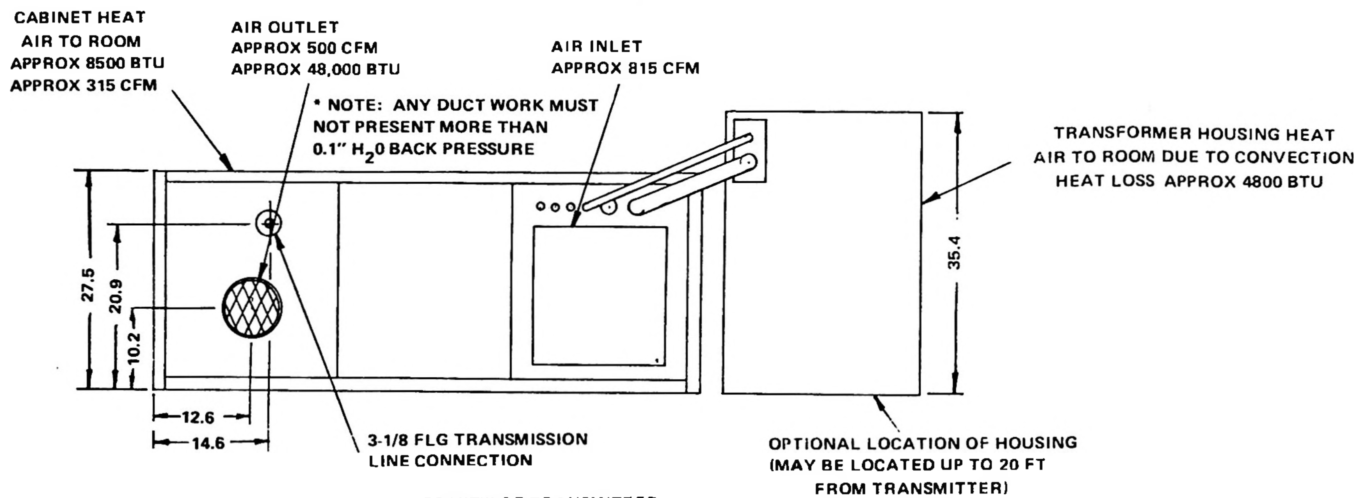
2-1.1 TRANSMITTER COOLING

Adequate cooling of the transmitter is imperative to reduce downtime, to extend component reliability, and to provide longer tube life. An adequate supply of cool clean uncontaminated ambient air (temperature must not exceed +50°C [122°F]) is required. See Table 2-1 for nominal heat balance readings. Consult a qualified air-conditioning engineer for recommendations on ducting and cooling requirements. When designing the cooling system, observe the following rules:

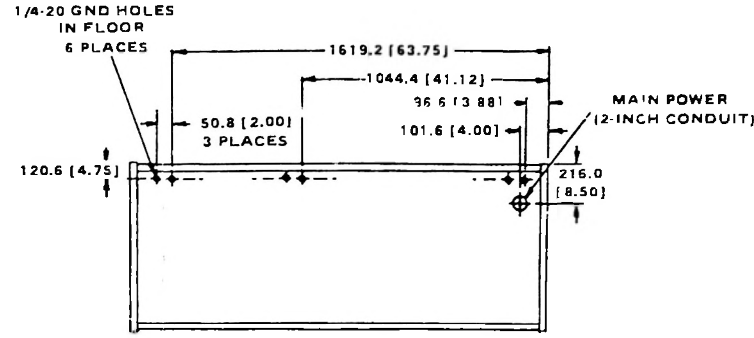
1. If the exhaust air is ducted away from the transmitter, the duct work must not create any back pressure that is greater than 0.1 inches of water at the transmitter exhaust output.

2. If intake air is ducted in from the roof, raise the intake sufficiently high above the surface to prevent intake of air warmed by the heated roof.

3. If both intake and exhaust ducts are used, locate the duct openings in the same wall of the building to equalize wind pressure effects. However, do not allow the exhaust to recirculate into the intake causing heat buildup.



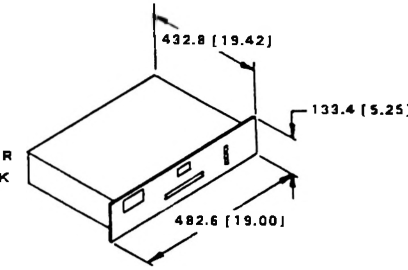
TOP VIEW OF TRANSMITTER

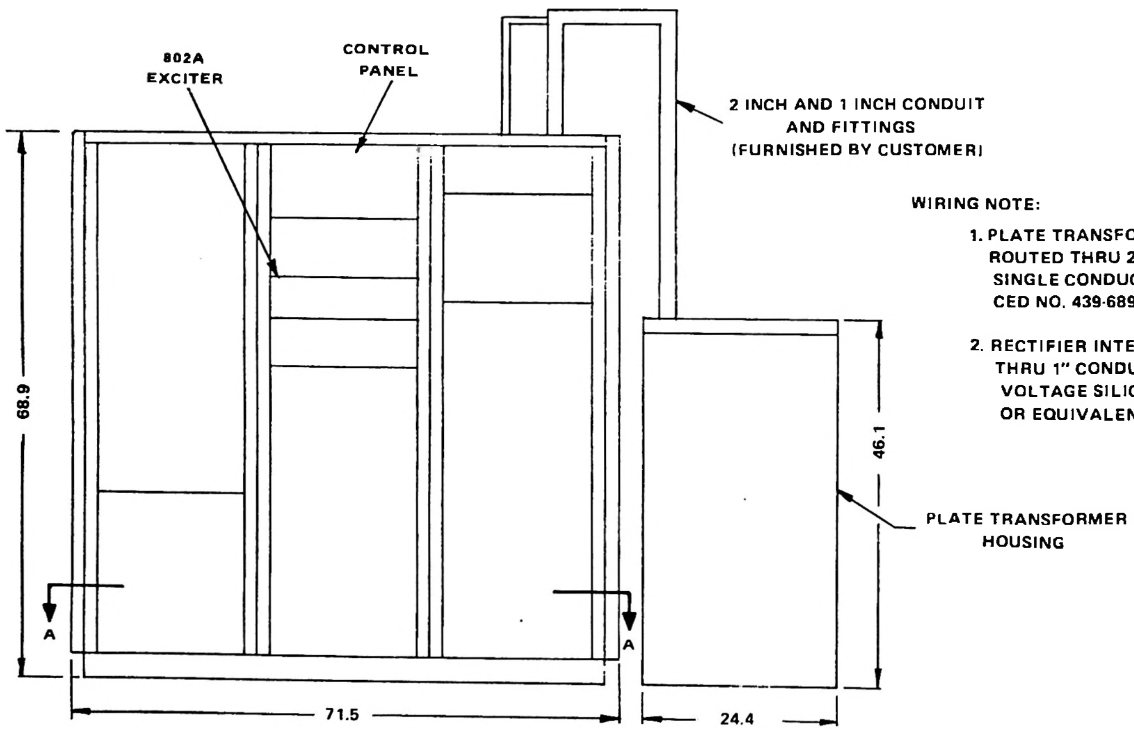


SECTION A-A

802A EXCITER

NORMALLY INSTALLED IN TRANSMITTER
MAY BE INSTALLED IN EQUIPMENT RACK
OR CONSOLE.



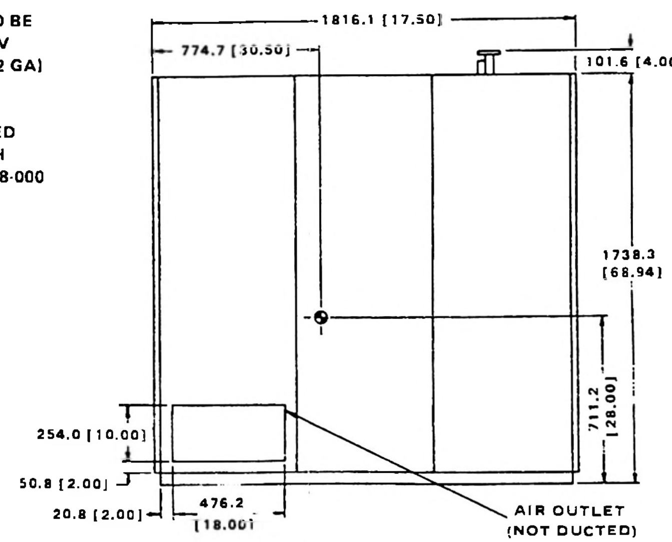


FRONT VIEW OF TRANSMITTER

WIRING NOTE:

1. PLATE TRANSFORMER INTERCONNECT WIRINGTO BE ROUTED THRU 2" CONDUIT. WIRE SIZE TO BE 600V SINGLE CONDUCTOR INSULATED COPPER WIRE (2 GA) CED NO. 439-6890-000 OR EQUIVALENT.

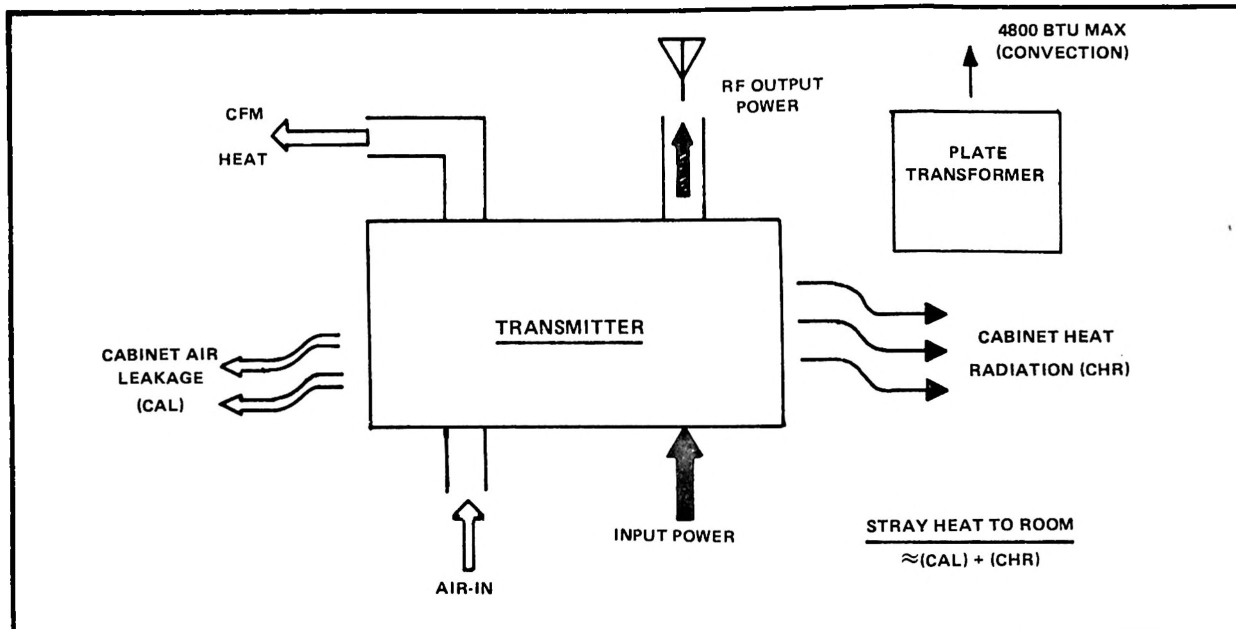
2. RECTIFIER INTERCONNECT WIRING TO BE ROUTED THRU 1" CONDUIT. WIRE TYPE TO BE 14 GA. HIGH VOLTAGE SILICON LEAD WIRE, CED NO. 423-0238-000 OR EQUIVALENT.

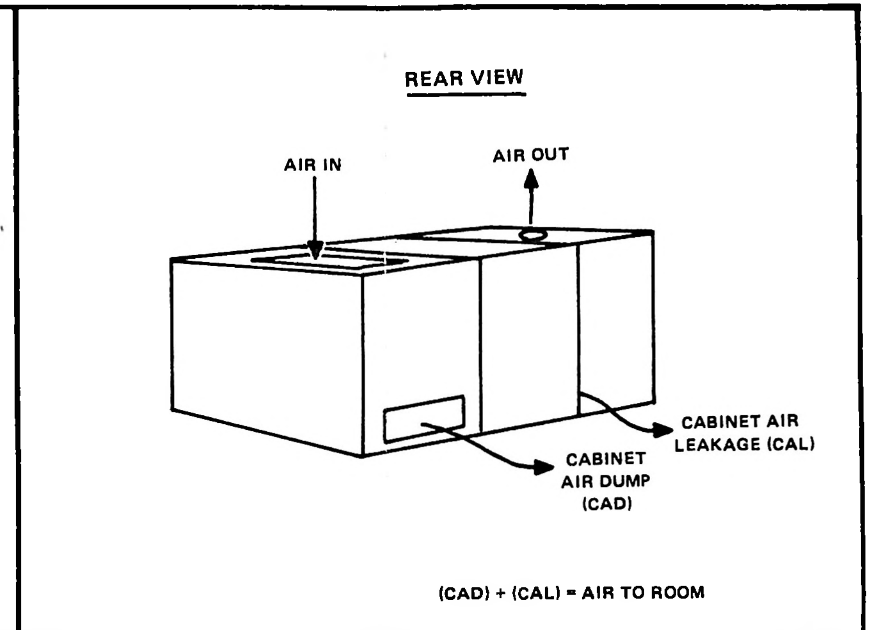


REAR VIEW OF TRANSMITTER

DWG. NO. 159421

Figure 2-1. FM Transmitter Outline and Installation Drawing





TRANSMITTER TYPE	RATED POWER OUTPUT	OPERATING POWER OUT	INPUT POWER kW	INPUT KVA	AIR IN CFM		AMBIENT TEMP MAXIMUM	AMBIENT TEMP OPTIMUM	AIR OUT CFM	AIR-OUT HEAT KW	AIR-OUT HEAT BTU	AIR OUT TEMP °F.	AIR OUT TEMP °C	AIR TEMP RISE °F.	AIR TEMP RISE °C	STRAY AIR TO ROOM CFM	STRAY HEAT TO ROOM kW	STRAY HEAT TO ROOM BTU	BLOWER CFM CAP	BLOWER CFM USE	FAN CFM CAP	FAN CFM USE	AIR-IN SUPPLY PRESSURE (MIN)	AIR-OUT BACK PRESSURE (MAX)
816R-5	35 kW	35 kW	54.7	58.3	815		+50 °C.	+22.2	500	15.8	53925	171.7	77.6	131.7	56.4	315	3.9	13310	750	500	1000	815	+0.1" H_2O	+0.1" H_2O
		30 kW	47.6	50.7	815		+50 °C.	+22.2	500	14.1	48123	157.6	69.8	117.7	47.6	315	3.5	11945	750	500	1000	815	+0.1" H_2O	+0.1" H_2O
		25 kW	39.4	41.8	815		+50 °C.	+22.2	500	11.6	39591	142.0	61.1	102.0	38.9	315	2.8	9556	750	500	1000	815	+0.1" H_2O	+0.1" H_2O
		20 kW	33.2	35.4	815		+50 °C.	+22.2	500	10.1	34471	136.9	58.3	97.0	36.1	315	3.1	10580	750	500	1000	815	+0.1" H_2O	+0.1" H_2O
		15 kW	26.1	29.2	815		+50 °C.	+22.2	500	8.6	20352	125.1	51.7	85.1	29.6	315	2.5	8532	750	500	1000	815	+0.1" H_2O	+0.1 H_2O

TABLE 2-1 816R-5 NOMINAL POWER AND HEAT BALANCE CHART

Table 2-1. FM Transmitter, Nominal Heat Balance

2-2. UNPACKING AND INSPECTING

2-2.1 DOMESTIC SHIPMENTS

a. The uncrated transmitter cabinet and Power Supply Cabinet are shipped on a shipping skid. The transmitter is not attached to the skid. Inspect for loose screws and fasteners. Ensure that all controls operate freely. Examine the cabinet for dents or scratches. Ensure that cable and wiring connections are tight and situated clear of each other, the chassis, and transformer and all choke windings.

b. If any received item is freight damaged, the customer should accept the equipment, note the damage on the shipping documents and immediately file a freight claim. All boxes and packing material should be retained for the freight inspector. Refusal to accept delivery of damaged equipment removes the evidence and makes freight damage reimbursement complicated or impossible.

2-2.2 FOREIGN SHIPMENTS

a. The transmitter is shipped in a skid type crate with unpacking instructions stenciled on the side. Heavy iron components are crated separately, bolted down to a 2-inch solid base. Uncrate the transmitter carefully to avoid damage. Inspect for loose screws and fasteners. Ensure that all controls operate freely. Examine the cabinet for dents or scratches. Ensure that cable and wiring connections are tight and situated clear of each other and the chassis.

b. File any damage claims properly with the transportation company. Retain all packing material if a claim is filed.

2-3. ASSEMBLY

1. Plan the placement of the transmitter and its external wiring carefully before beginning installation. (Refer to Figure 2-1 and paragraph 2-4). Six knockout holes are located on the top of the transmitter section that contains the power supplies. The holes accommodate cabling for 3-phase input voltage, 3 phase supply to plate transformer, DC from plate rectifiers, and the remote control wiring. A 2-inch conduit entry is also provided in the floor of the power supply section. (See Figure 2-1.)

2. Wire the Plate Transformer Assembly to the Transmitter (Refer to Figures 2-2, 2-3, and 2-4.)

   a. High Voltage DC Wiring
      2 wires - type Le-9 installed in 1" conduit with each end of both wires lugged.

      (1) Transmitter end termination
         (a) Two high voltage cone insulators are located at the upper left side of right-most section.
         (b) Each insulator has a marking next to it for identification, either "-HV" or "+HV".

      (2) Transformer end termination
         (a) Two connecting terminals of the rectifier nearest the transformer primary terminal blocks.
         (b) Each end of the rectifiers is bolted to an insulating support. On the side of these end supports there is a marking for identification, either "-HV" or "+HV".

   b. In the case of all terminations mentioned here, remove only the cap nut and one lock washer before installing the lugged end of each wire on its respective terminal. After connecting the wires as follows, replace hardware and tighten.

Transmitter Terminal	Transformer Terminal
+HV	+HV
-HV	-HV

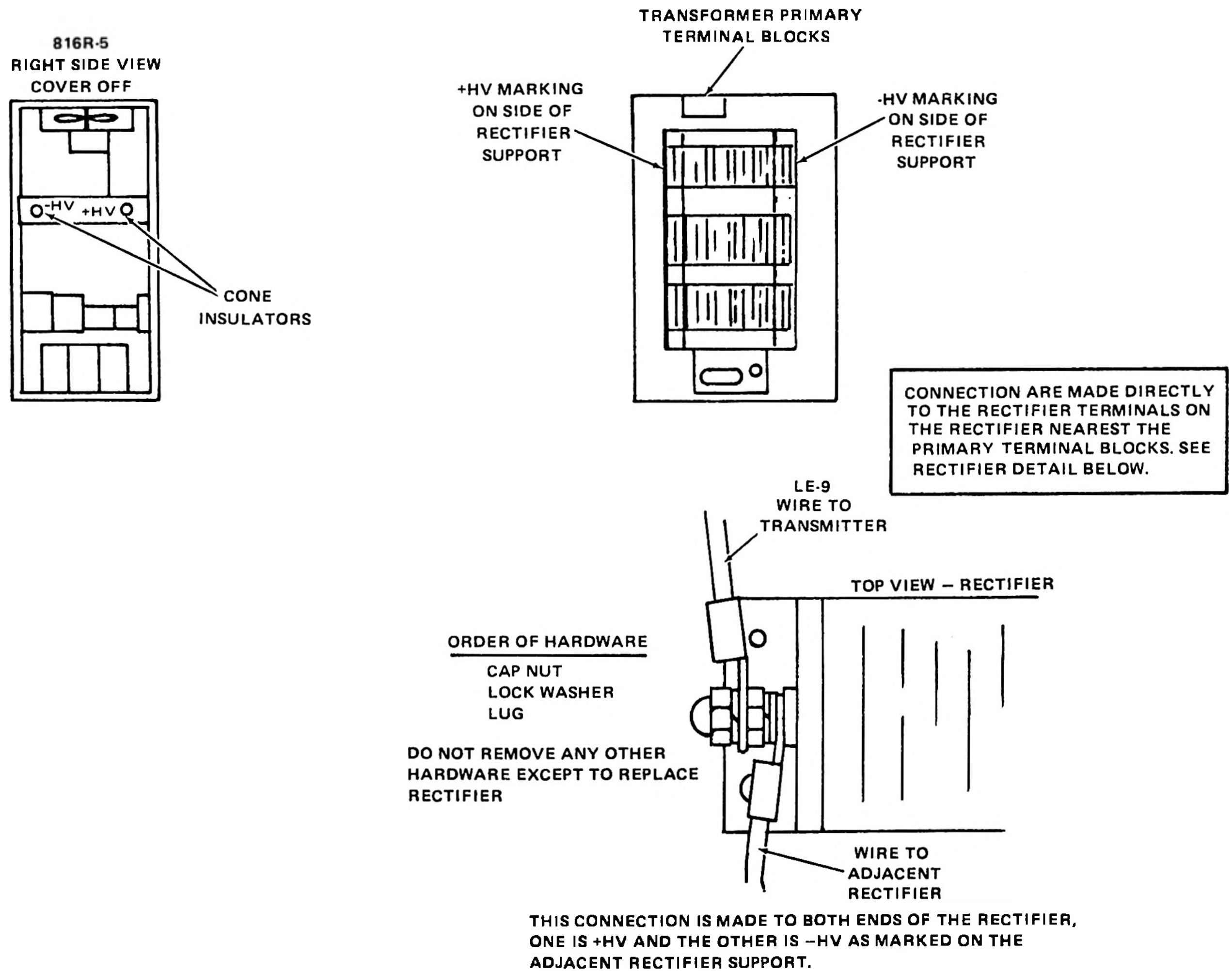


Figure 2-2. Interconnecting Transmitter and Plate Transformer Assembly

3. Transformer Primary Wiring

a. Six 2-gauge wires installed in 2" conduit

(1) Transmitter and Transformer end termination
(a) Two 3-terminal terminal blocks are located at the lower right hand side of the right-most section.
(b) A white label strip is found in the middle of each terminal block. Each strip is marked to identify all terminals. The terminals are labelled A, B, C, D, E, and F.

(2) Connect wires as follows:

Transmitter Terminal	Transformer Terminal
A	A
B	B
C	C
D	D
E	E
F	F

4. Connect transmitter and transformer enclosure to the station ground system using 2 inch copper strap. Holes are provided on the floor of the transmitter and transformer enclosure for this purpose.

5. Connect Input Power Wiring from customer supplied fuse or circuit breaker panel, 200 Amp rating. Route 3 phase 3/0 AWG cable and connect to transmitter terminal board A17TB3 in * accordance with Schematic 159433. Do not turn on power at this time.

6. Mounting 802A Exciter

(a) If the 802A exciter was not factory installed, mount it in the area provided in the transmitter center section. Connect an RF cable from exciter output to the driver input. Attach the MUTE voltage lead from A4TB1-6 to A19E6 (right side panel of transmitter). The yellow wire that is tied to the RF cable is used for this purpose. Connect the 117-volt AC * power cable from the exciter to connector J3 (Figure 6-1.) Refer to the 802A exciter instruction book for installation of audio input cables.

(b) If the 802A Exciter is to be mounted separate from the transmitter, extend the power cable from J3 at the rear of the center cabinet. The exciter mute voltage from A19E6 must also be connected to the 802A Exciter TB1-6. The RF Output from J2 will be connected to A11J1, the RF input connector on the Driver assembly using 50 ohm cable such as RG-223.

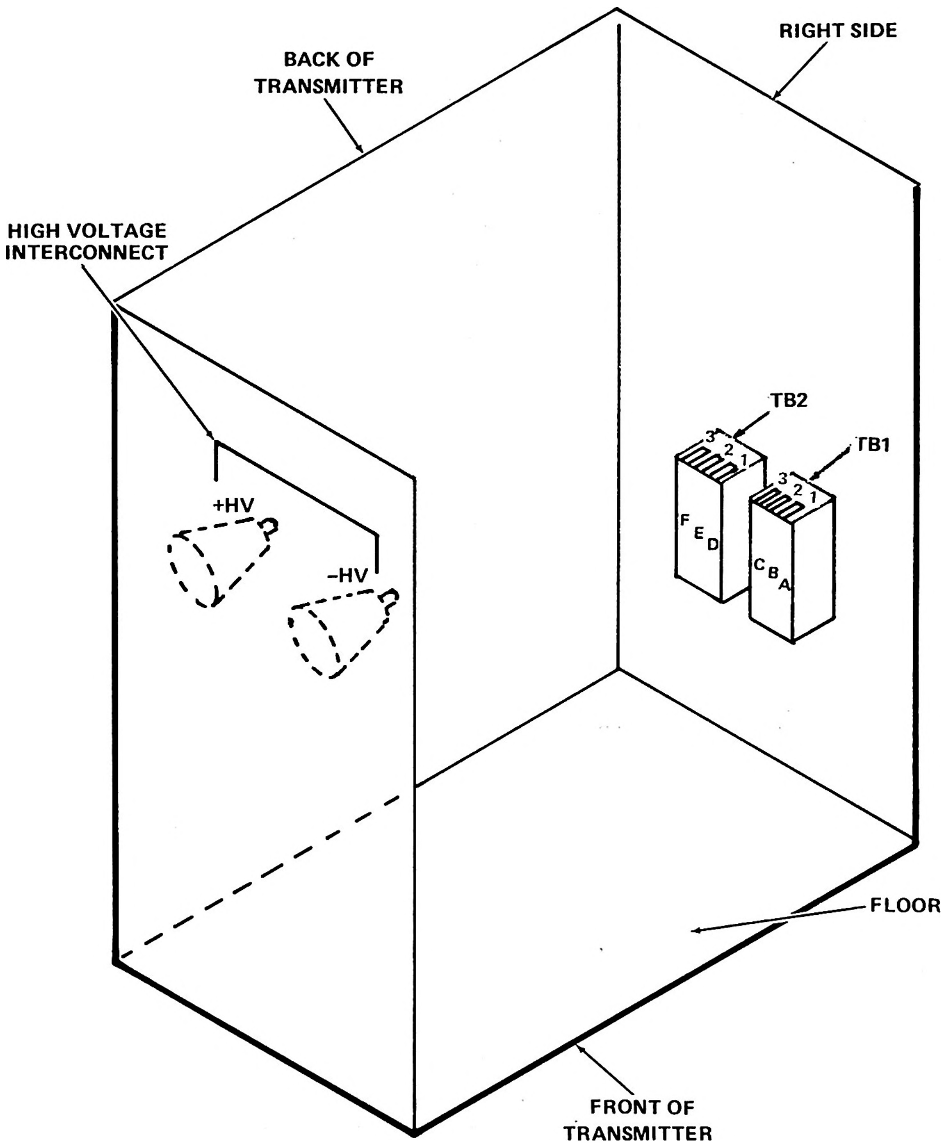


Figure 2-3. Plate Transformer Primary Interconnect Inside Transmitter

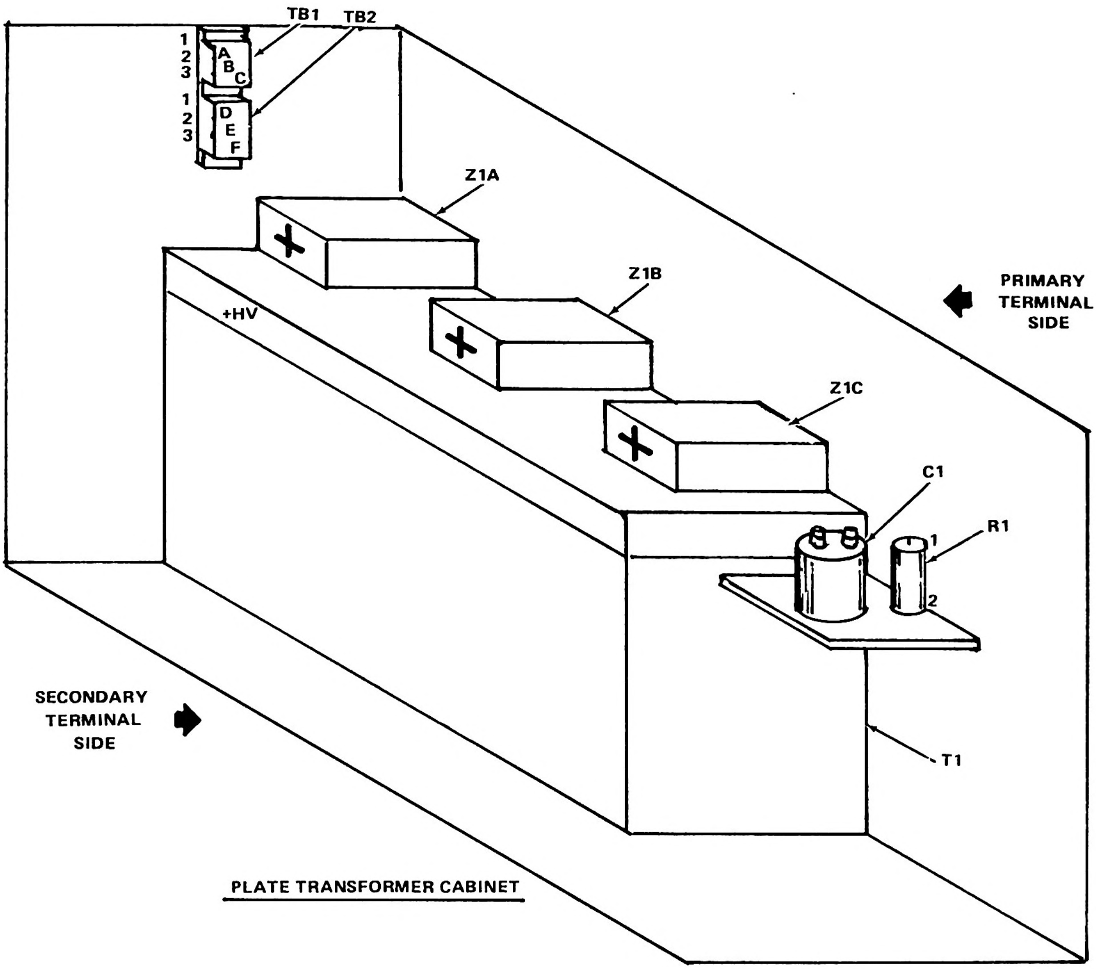
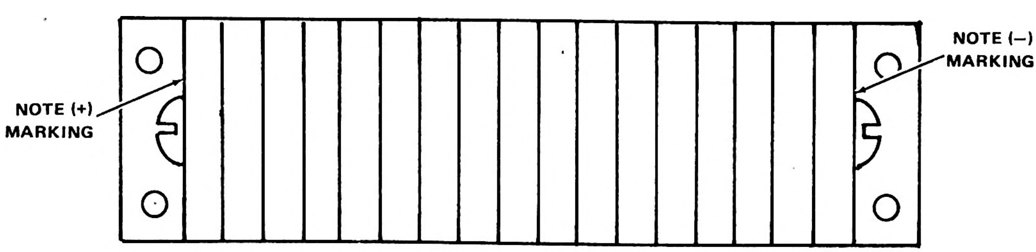


PLATE TRANSFORMER CABINET



Z1, A,B,C TOP VIEW

Figure 2-4. Plate Transformer and Component Identification Primary Interconnect

6. Transformers T1 and T2, filters L1 and L2, and filter capacitor C3 may have been removed to facilitate shipping. Install these components if they were shipped separately.

7. If output tube 9019/YC130 was removed for shipping, install it using the procedure outlined in Paragraph 5-5.1

8. If remote control is used, run the external wiring from the remote unit into the transmitter and connect it to TB4 as shown on Figure 2-5 and on Figure 2-6.

NOTE

The positive plate current sample, TB4-30, must be connected to the ground side of the remote metering circuits if one side of the remote metering is grounded. The negative plate current sample, TB4-29, will then be connected to the remote metering input. The open circuit voltage at TB4-29, 30 will be approximately 9.5VDC when plate current is 4.0 amperes. An external voltage divider may be required to obtain a sample that is within allowable limits for the remote control. Refer to Figure 2-5. *

10. Connect the customer supplied 50 ohm transmission line to the RF output connector mounted on top of the transmitter cabinet.

CAUTION

DAMAGE MAY RESULT FROM AN IMPROPER IMPEDANCE MATCH BETWEEN THE TRANSMITTER AND THE TRANSMISSION LINE. ENSURE THAT THE TRANSMISSION LINE AND ANTENNA PRESENT A 50 OHM IMPEDANCE AND A VSWR NOT GREATER THAN 2:1 TO THE TRANSMITTER AT THE OPERATING FREQUENCY.

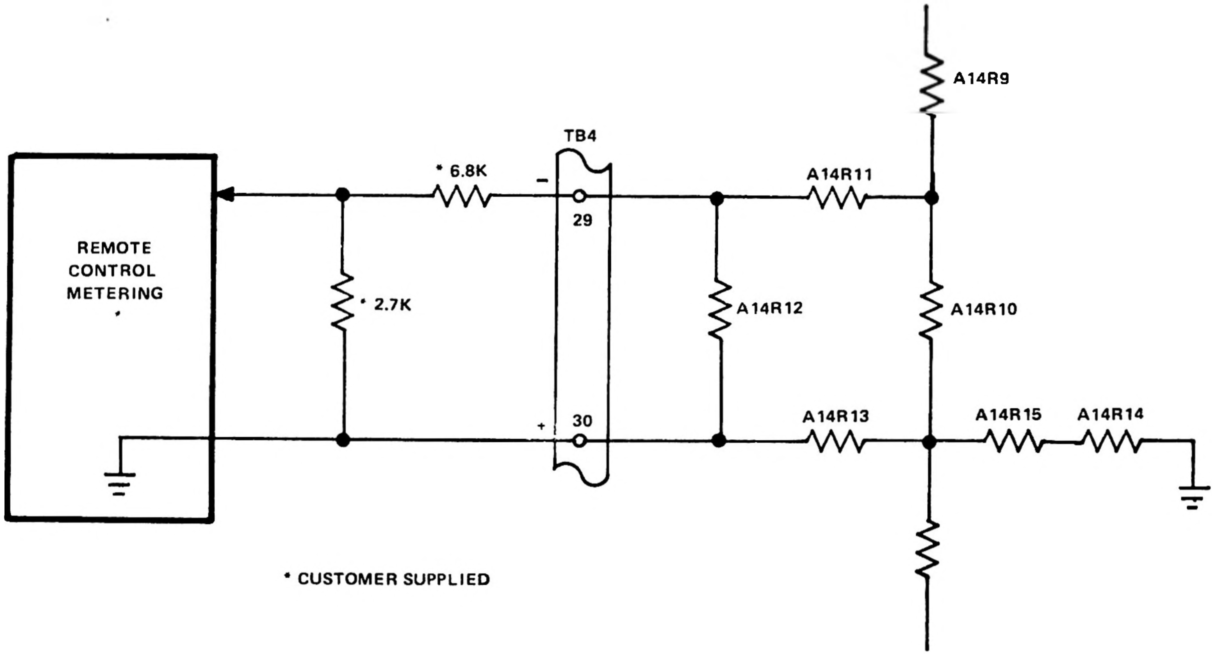
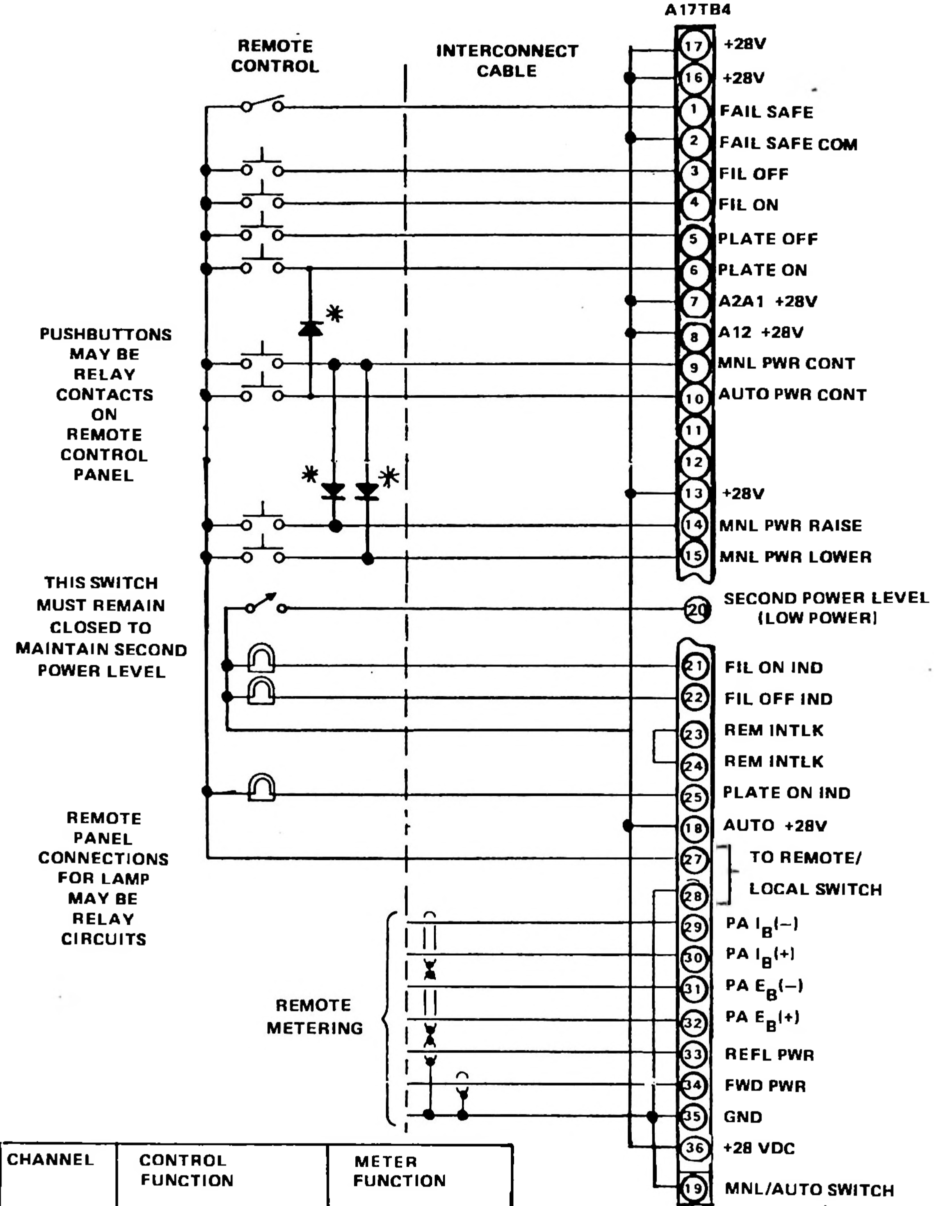


Figure 2-5. Remote Plate Current Sample Circuit



CHANNEL	CONTROL FUNCTION	METER FUNCTION
1	FIL OFF/ON	–
2	PLATE OFF/ON	PLATE VOLTS
3	MANUAL/AUTO	PLATE CURRENT
4	PWR RAISE/LOWER	FWD PWR
5		REFL PWR

TYPICAL REMOTE CONTROL CHANNEL ASSIGNMENT

*NOTE: AS SHOWN, THE STEERING DIODES (NOT SUPPLIED) ENSURE THAT THE TRANSMITTER IS PLACED IN THE AUTOMATIC POWER CONTROL MODE WHEN THE PLATE ON CONTROL IS ENERGIZED AND ALSO THAT THE TRANSMITTER IS PLACED IN MANUAL POWER WHEN EITHER THE MANUAL POWER RAISE OR MANUAL LOWER CONTROL IS ENERGIZED. ALL DIODES ARE 1N4007 OR EQUIVALENT (CE NO. 353-6442-070).

Figure 2-6. Remote Control Connections to Terminal Board, A17TB4

NOTE

For 60 Hz operation only, the transformer primary taps must not be set to a tap that is more than two taps lower than the highest line voltage expected. For example, if line voltage is 245 volts, the screen transformer primary taps can be set to the 230,240 or 250 volt taps. If line voltage is 240 volts, the screen transformer could be set to the 220 volt taps if necessary to increase transmitter power.

Transformer taps cannot be set to a lower tap than the highest expected line voltage where 50 Hz primary power source is used.

11. Set Transformer Taps

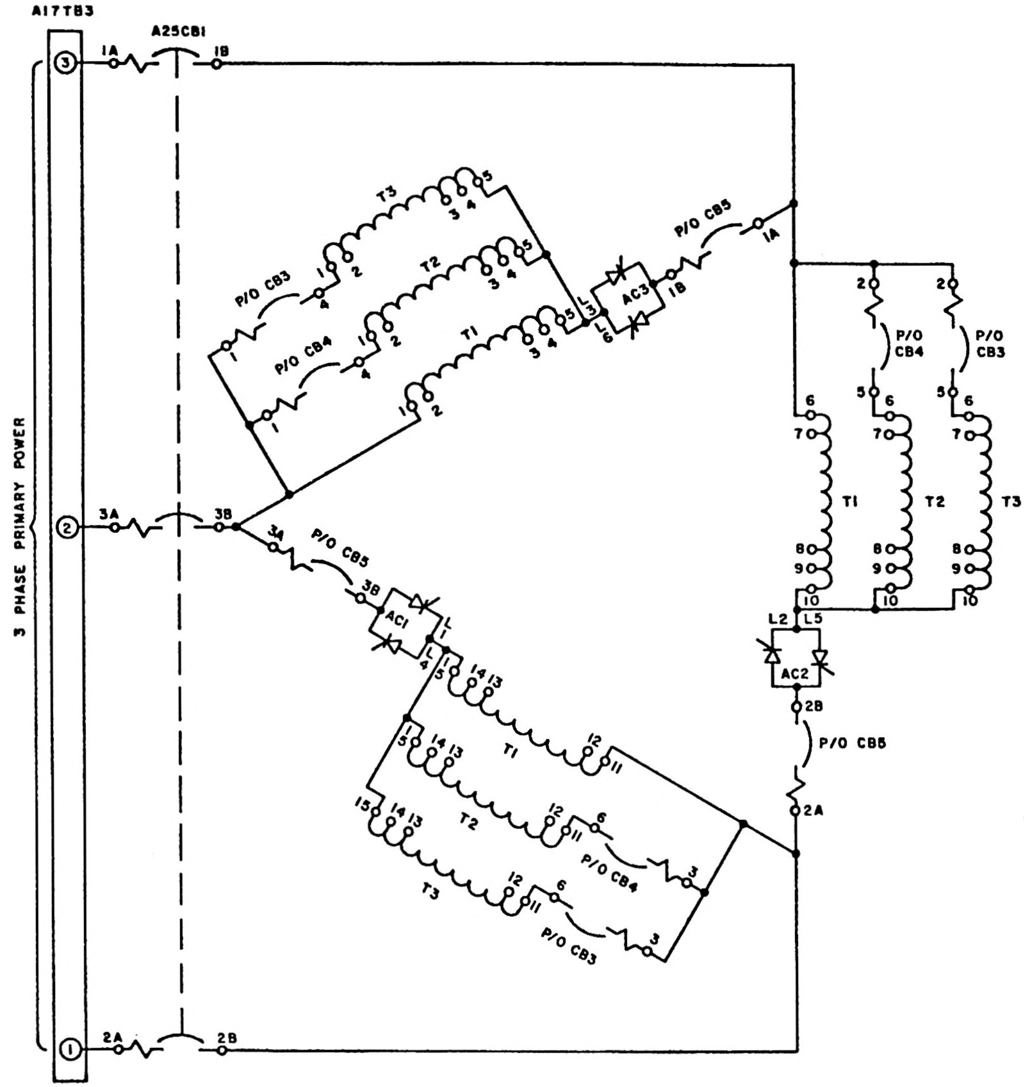
The Transmitter is shipped with all transformers on the highest voltage taps unless specific instructions are given regarding line voltage. This is done to prevent damage where line voltage may be higher than transformers are tapped and power is applied without changing taps.

The broad range of allowable voltage sources (200 to 250 volts is made possible by the availability of different tap connections of power transformers T1, T2, T3, and T4 and power supply transformers A10T1 and A10T2. Table 2-2 shows the details of the proper primary line connections for various line voltages.

Two connections are made at transformer T4. One connection is made at Terminal No. 1 regardless of the source voltage. The second wire is connected to correspond with the power source voltage and is connected as indicated in Table 2-2.

Six connections are made on power supply transformer A10T2. Three of these connections (at Terminals 1,4 and 7) are made regardless of the source voltage. The other three connections are made to correspond with the power source voltage. These wires are connected according to instructions supplied in Table 2-2.

Two connections are made at power supply transformer A10T1. One connection is made at Terminal No. 1 regardless of the source voltage. The second wire is connected to correspond with the power source voltage and is connected according to instructions supplied in Table 2-2.



LINE VOLTAGE	T1,T2,T3 TERMINALS	T4 TERM. CONN.	A10T2 TERM. CONN.	A10T1 TERM CONN.
200V	2-3,7-8,12-13	1 & 2	1&2,4&5,7&8	1 & 2
210V	2-4,7-9,12-14	1 & 3		1 & 2
220V	2-5,7-10,12-15	1 & 4		1 & 2
230V	1-3,6-8,11-13	1 & 5	1&3,4&6,7&9	1 & 3
240V	1-4,6-9,11-14	1 & 6		1 & 3
250V	1-5,6-10,11-15	1 & 7		1 & 3

T1 PLATE TRANSFORMER
T2 SCREEN TRANSFORMER
T3 DRIVER TRANSFORMER
T4 EXCITER/CONTROLS TRANSFORMER
A10T2 28 VOLT SUPPLY
A10T1 PA BIAS SUPPLY

Table 2-2. Transformer Connection Schedule

TABLE 2-3. SCREEN VOLTAGE TRANSFORMER TAP SCHEDULE

SECONDARY TAPS	PRI TAPS	LINE VOLTAGE 200	210	220	230	240	250
100% WYE							
	200	800	840	880			
	210	762	800	838	876		
	220	727	764	800	836	873	
	230	696	730	765	800	835	870
	240	667	700	733	767	800	833
	250	640	672	704	736	768	800
85% WYE							
	200	680	714	748			
	210	648	680	712	745		
	220	618	649	680	711	742	
	230	591	621	650	680	710	739
	240	567	595	623	652	680	708
	250	544	571	598	625	653	680
70% WYE							
	200	560	588	616			
	210	533	560	587	613		
	220	509	535	560	585	611	
	230	487	511	536	560	584	609
	240	467	490	513	537	560	583
	250	448	470	493	515	538	560
100% DELTA							
	200	462	485	508			
	210	440	462	484	506		
	220	420	441	462	483	504	
	230	402	422	442	462	482	502
	240	385	404	424	443	462	481
	250	370	388	407	425	444	462

DC SCREEN VOLTAGE

SECTION 3 - OPERATION

3-1. GENERAL

The transmitter can be operated from the control panel or by Remote Control. Once the transmitter has been installed and properly tuned, it is only necessary to monitor meter indications and to make minor tuning and loading adjustments (Figure 3-1). Instructions for the 802A exciter are found in the Exciter Instruction Manual.

3-2. CONTROLS AND INDICATORS

Refer to the following tables for a general description of the operating controls found on the front panels of the transmitter cabinets: Table 3-1, left cabinet; Table 3-2, center cabinet; Table 3-3, right cabinet.

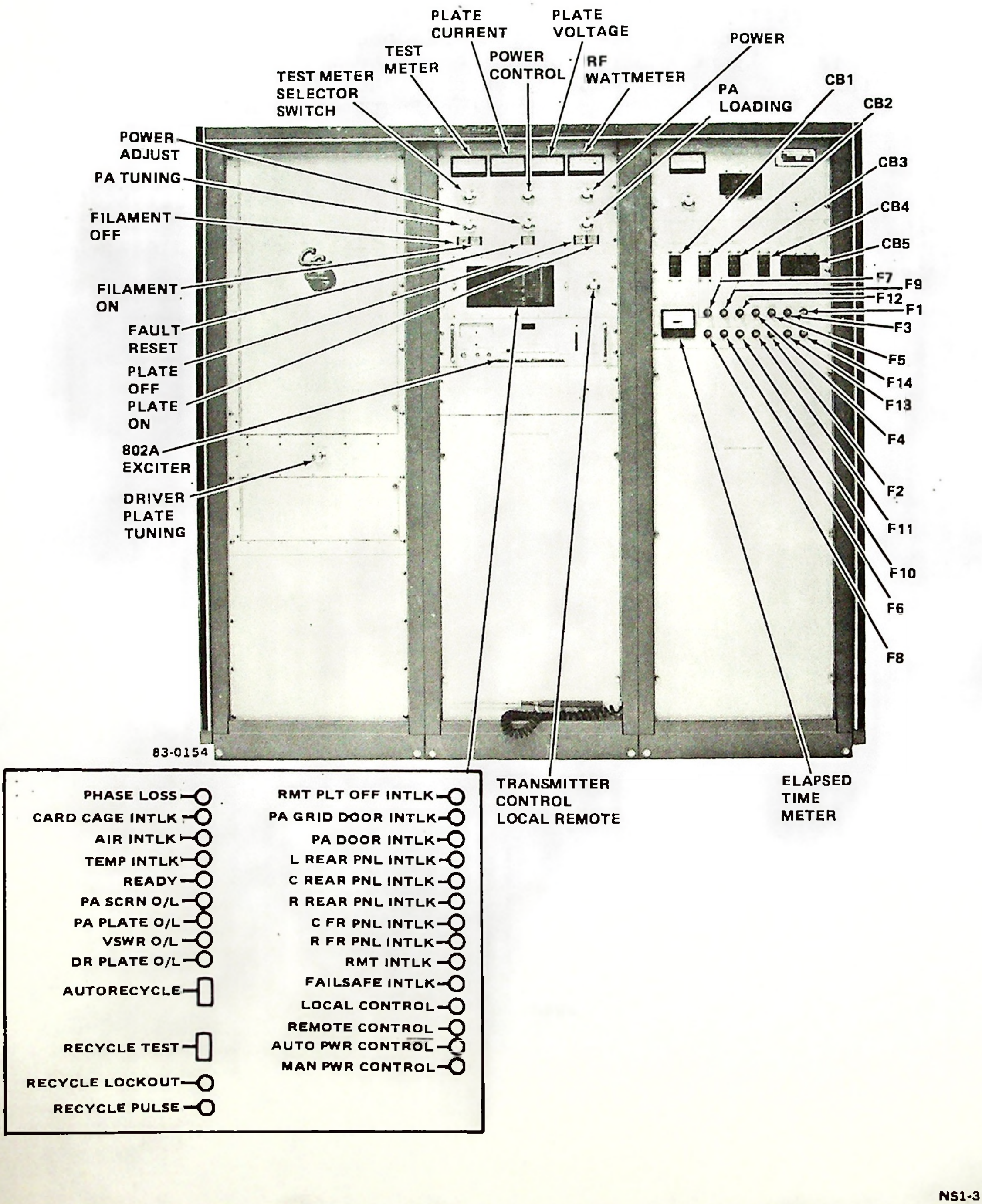


Figure 3-1. FM Transmitter, 816R-5, Controls & Indicators

TABLE 3-1. LEFT CABINET

REF DES	CONTROLS AND INDICATORS	FUNCTION
C37	DRIVER PLATE TUNING	A variable capacitor that adjusts driver tuning

TABLE 3-2. CENTER CABINET

REF DES	CONTROLS AND INDICATORS	FUNCTION
A1M1	TEST METER	Displays 11 internal operational voltage or current readings.
A1S1	TEST METER SELECTOR	Rotary switch that readings to display on the test meter. The value below each switch position is the full scale reading for that position.
A1M2	PLATE CURRENT	Displays power amplifier plate current.
A1M3	PLATE VOLTAGE	Displays power amplifier plate voltage.
A1M4	RF WATTMETER	Displays transmitter forward and reflected power.
A1S2	POWER FORWARD/ REFLECTED	2-position switch that selects forward or reflected power for display on the RF WATTMETER
A1S5	POWER CONTROL AUTOMATIC/MANUAL	Spring loaded momentary switch that selects automatic or manual power control.
A1S6	POWER ADJUST LOWER/RAISE	Spring-loaded momentary switch that lowers or raises power when POWER CONTROL Switch S5 is in MANUAL.
A1S3	PA TUNING RAISE/LOWER	Spring-loaded momentary switch that positions tuning capacitor C50.
A1S4	PA LOADING RAISE/LOWER	Spring-loaded momentary switch that positions loading capacitor C51.
A1S7	PLATE OFF	Push-button momentary indicator switch that removes all operating voltage from the transmitter.
A1S8	PLATE ON	Push-button momentary indicator switch that applies operating voltage to the transmitter.
A1S9	FILAMENT OFF	Push-button momentary indicator switch that removes filament voltage from the transmitter.

TABLE 3-2. CENTER CABINET - Continued

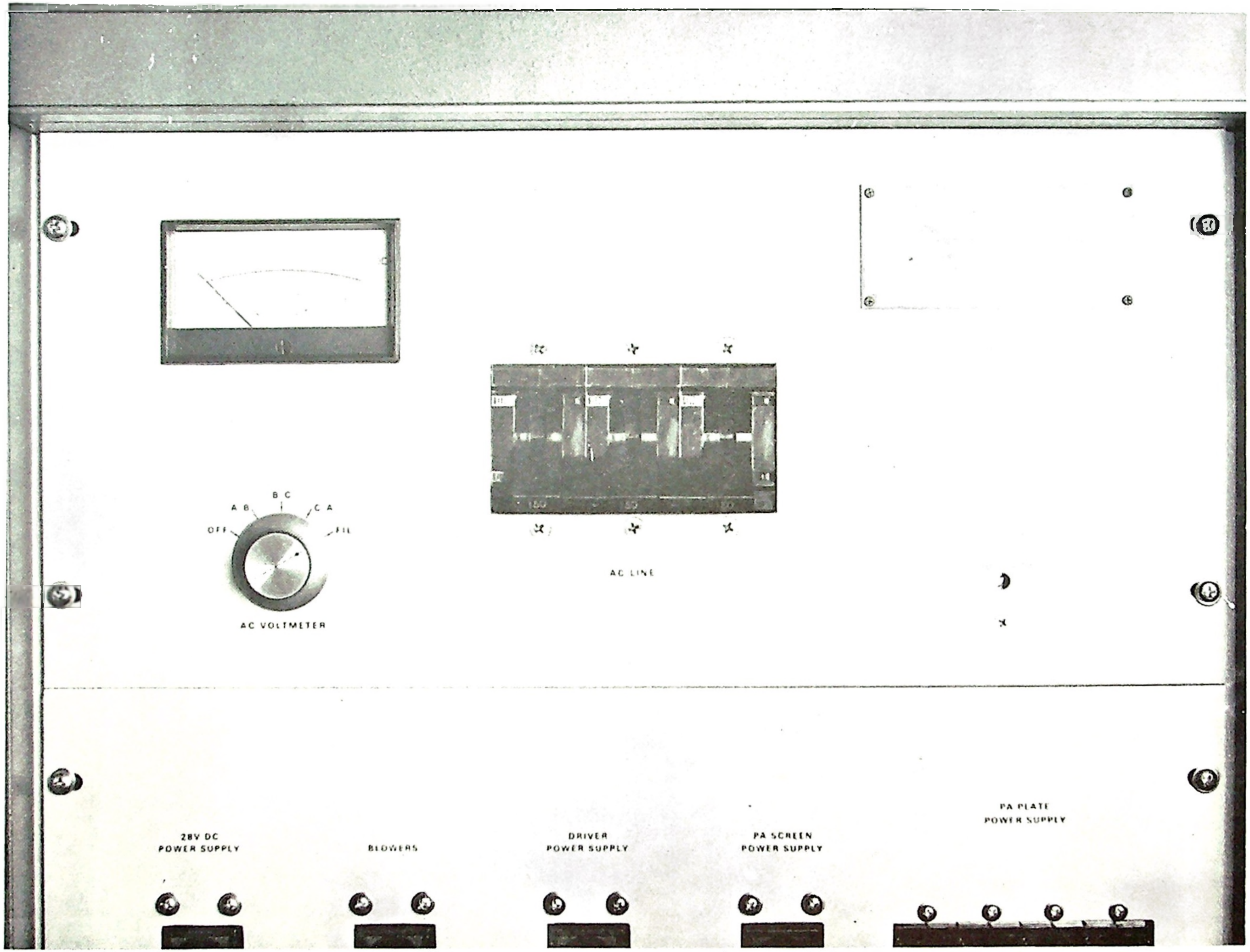
REF DES	CONTROLS AND INDICATORS	FUNCTION
A1S10	FILAMENT ON	Push-button momentary indicator switch that applies filament voltage to the transmitter.
A1S11	FAULT RESET	Push-button momentary switch that resets the fault indicators.
A20S10	TRANSMITTER CONTROL LOCAL/REMOTE	2-position switch that selects local or remote operation.
A7CR14	PHASE LOSS	Phase Loss/Phase Sequence/Phase Unbalance Indicator.
A7CR15	CARD CAGE INTLK	CARD CAGE interlock indicator.
A7CR16	AIR INTLK	PA Cooling Indicator
A7CR17	TEMP INTLK	Exhaust Air Temp indicator
A7CR18	READY	Filament Time Delay Indicator
A7CR6	PA SCREEN O/L	PA Screen Fault Indicator
A7CR7	PA PLATE O/L	PA Plate Fault Indicator
A7CR8	VSWR O/L	VSWR Fault Indicator
A7CR9	DVR PLATE O/L	Driver Plate Fault indicator
A7S2	AUTO RECYCLE	Automatic Recycle ON/OFF Switch
A7S1	RECYCLE TEST	Automatic Recycle Circuit Test Switch
A7CR3	RECYCLE LOCKOUT	Recycle Circuit Lockout Indicator
A7CR5	RECYCLE PULSE	Recycle Circuit Pulse Indicator
A12CR5	RMT PLT OFF INTLK	Remote Plate Off Relay Indicator
A12CR6	PA GRID DOOR INTLK	PA Grid Door Interlock
A12CR7	PA DOOR INTLK	PA Door Interlock Indicator
A12CR8	L REAR PANEL INTLK	Left Rear Panel Interlock Indicator

TABLE 3-2. CENTER CABINET - Continued

REF DES	CONTROLS AND INDICATORS	FUNCTION
A12CR9	C REAR PNL INTLK	Center Rear Panel Interlock Indicator
A12CR10	R REAR PNL INTLK	Right Rear Panel Interlock Indicator
A12CR11	C FR PNL INTLK	Center Front Panel Interlock Indicator
A12CR12	R FR PNL INTLK	Right Front Panel Interlock Indicator
A12CR13	RMT INTLK	Remote Interlock Indicator
A12CR14	FAILSAFE INTLK	Remote Fail Safe Relay Interlock Indicator
A12CR15	LOCAL CONTROL	A1S10 Local Control Position Indicator
A12CR16	REMOTE CONTROL	A1S10 Remote Control Position Indicator
A12CR17	AUTO PWR CONTROL	A1S5 Automatic Power Control Position Indicator
A12CR18	MAN PWR CONTROL	A1S5 Manual Power Control Position Indicator

TABLE 3-3. RIGHT CABINET

REF DES	CONTROLS AND INDICATORS	FUNCTION
A6CB1	28 VDC POWER SUPPLY	1 ampere magnetic circuit breaker that protects the 28-V DC power supply.
A6CB2	BLOWERS	15-ampere magnetic circuit breaker that protects blower and fan.
A6CB3	DRIVER POWER SUPPLY	4.5-ampere magnetic circuit breaker That protects the driver power supply.
A6CB4	PA SCREEN POWER SUPPLY	15-ampere magnetic circuit breaker that protects the PA screen power supply.
A6CB5	PA PLATE POWER SUPPLY	110-ampere magnetic circuit breaker
A6F7/F9 F12	FAN	2-ampere fuse.
A6F6/F8 F10	CONTROLLER	1-ampere fuse.
A6F4/F5	PA BIAS POWER SUPPLY	0.25-ampere fuse.
A6F1/F3	FILAMENTS	10-ampere fuse.
A6F2/F11	EXCITER	3-ampere fuse.
A6F13/F14	DRIVER FILAMENT	2-ampere fuse.



NS1-4

86-1216

Figure 3-2. AC Power Control Panel

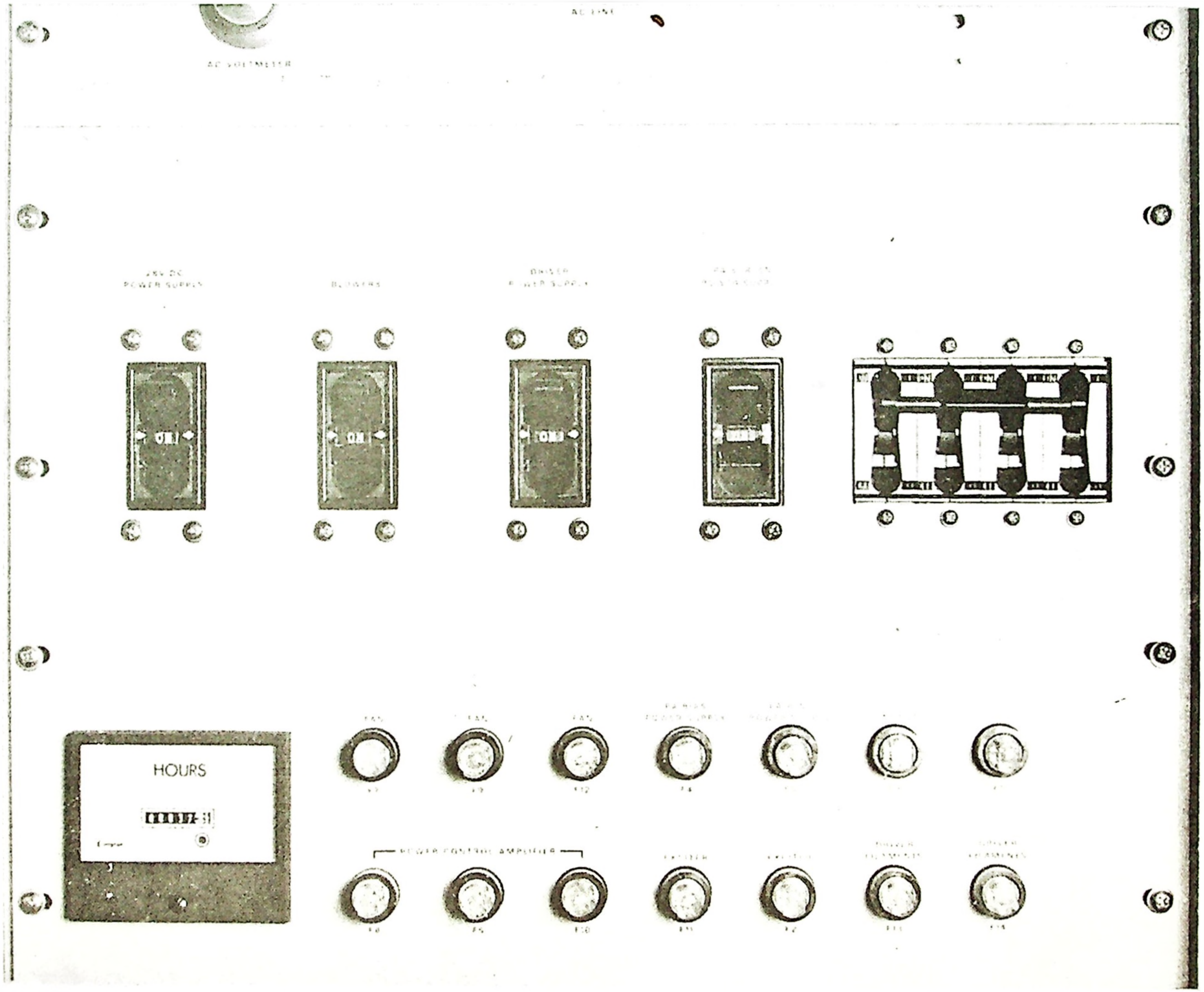


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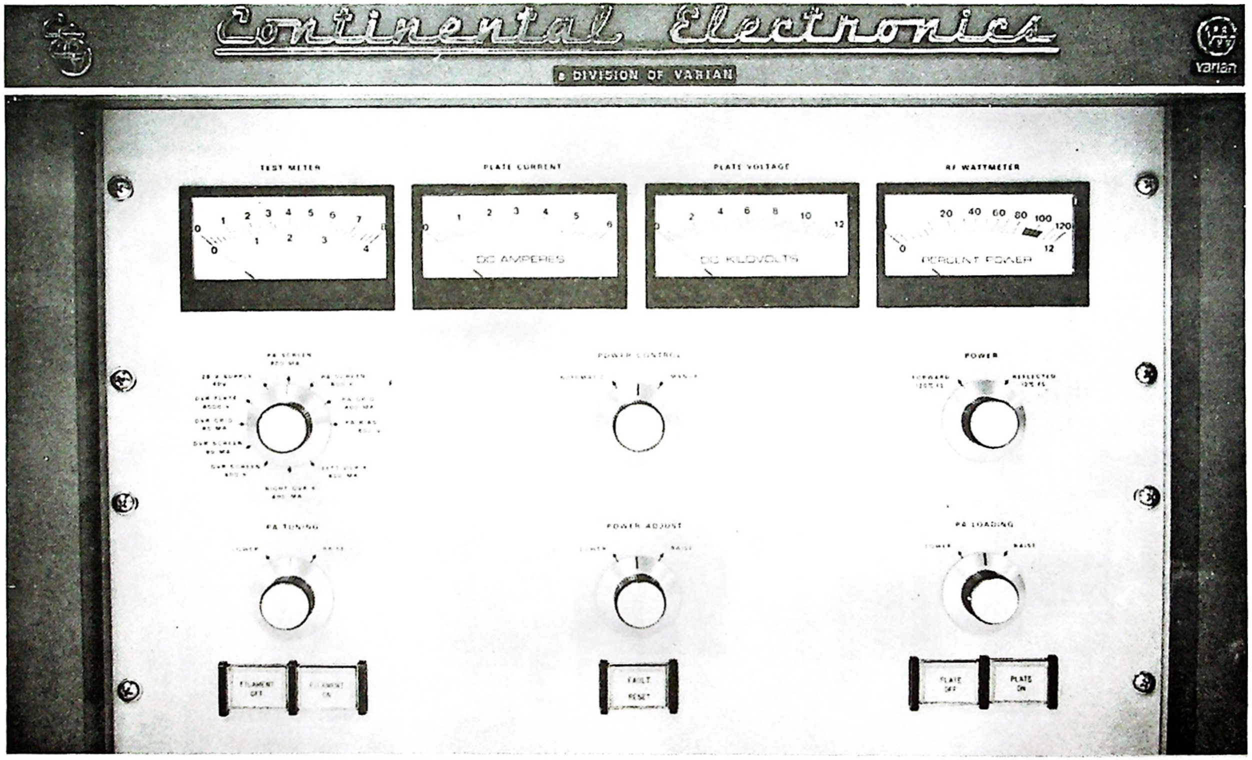
Figure 3-3. Power Circuit Breaker Panel



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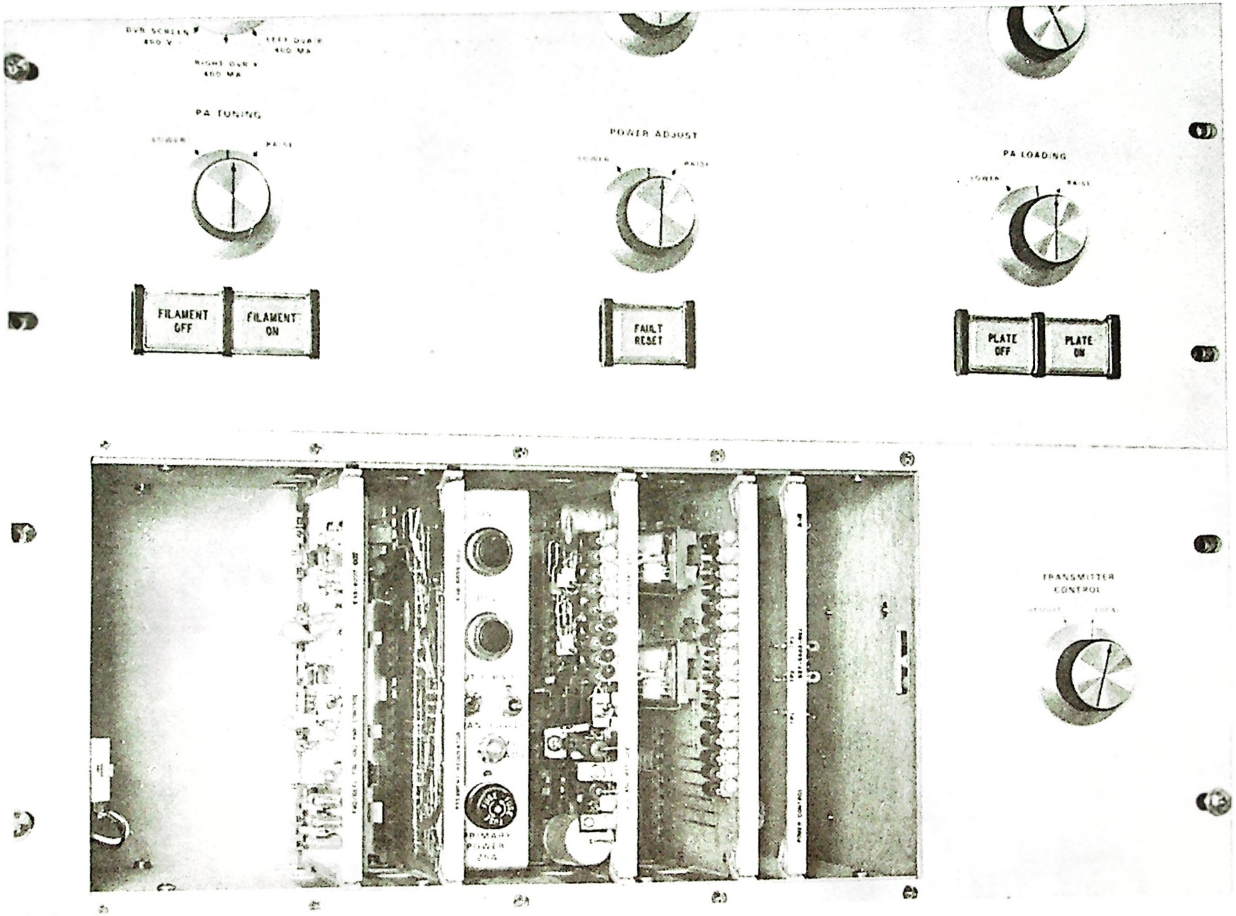
NSI-6

Figure 3-4. PA Control Panel



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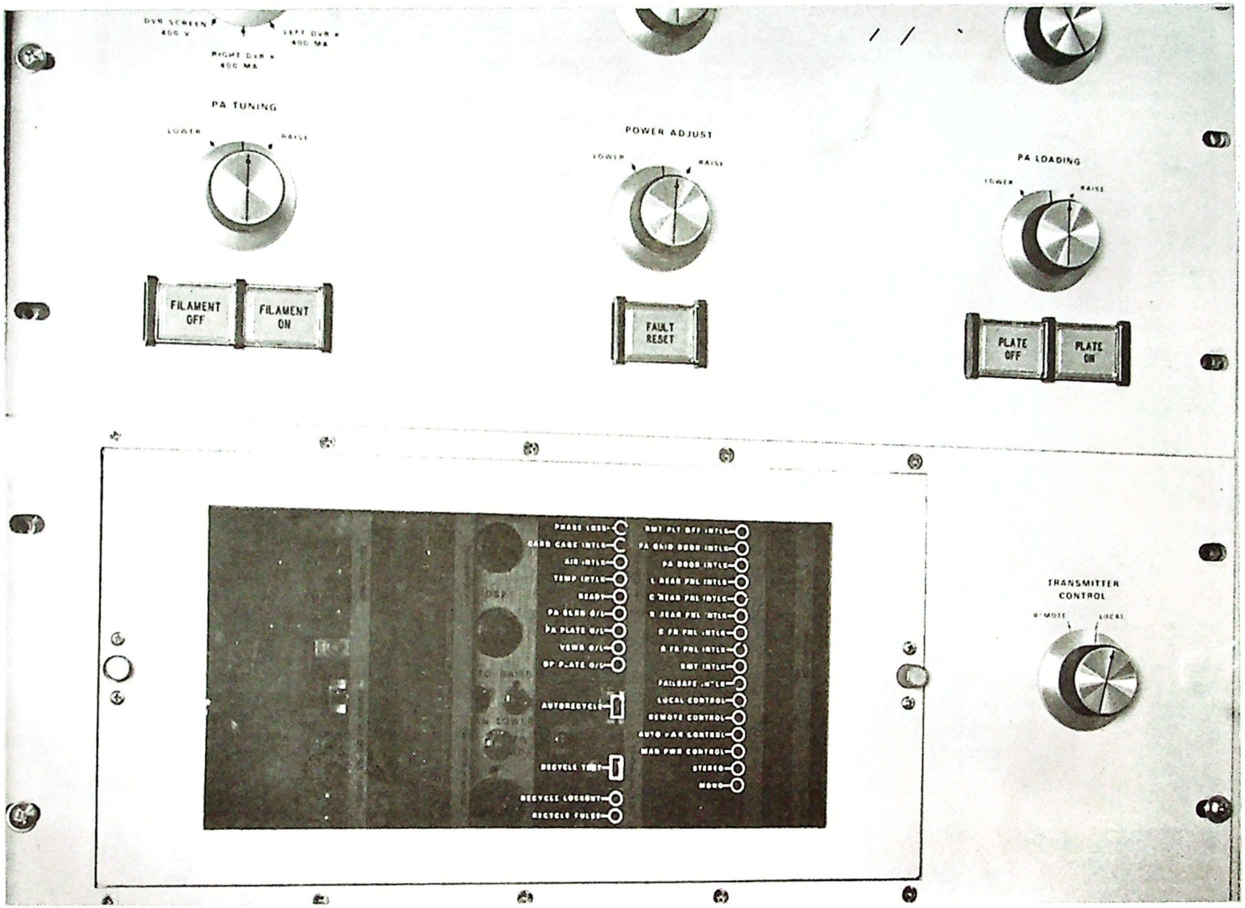
NSI-7

Figure 3-5. Card Racks, Door Open



86-1215

Figure 3-6. Card Rack, Door Closed

NS1-8

3-3. INITIAL TURN-ON PROCEDURE

WARNING

DISCONNECT PRIMARY POWER BEFORE SERVICING THIS TRANSMITTER. SHORT ALL CAPACITORS AND POWER SUPPLIES WITH GROUNDING STICK. VOLTAGES IN THIS TRANSMITTER ARE DEADLY TO HUMAN LIFE.

1. Ensure that the transmitter has been properly assembled and connected according to instructions provided in Paragraphs 2-1 through 2-3.

2. Open access panel to the control circuit cards. Check the circuit cards for proper installation.

3. Replace access panel and ensure that all doors and panels are properly closed.

4. Ensure that all transmitter circuit breakers are OFF.

5. Apply primary power to transmitter.

6. Set the 28 VDC POWER SUPPLY and BLOWER circuit breaker to ON. Check the phase loss/phase rotation indicator on A7, top LED (see Figure 6-1). If this indicator is not on, remove primary power and the right front bay access panel. Locate K5 (the phase loss/phase rotation monitor) and turn its control to minimum (full counterclockwise). Replace the access panel and restore primary power. If the phase loss/ phase rotation indicator is still not on, remove primary power and interchange any two primary input leads at A17TB3 (figure 6-17). Restore primary power and check indicator.

7. Adjust the Phase Monitor phase loss threshold.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR IF EXTREME CARE IS NOT EXERCISED WHEN PERFORMING THE FOLLOWING PROCEDURES.

a. Remove primary power and the right front bay access panel.

b. Block the interlock grounding switch open.

Note

* The phase loss/phase rotation monitor will shut the transmitter off when phase loss or incorrect sequence is detected. A phase loss will be detected if the line voltage drops below the threshold voltage level which is set by turning the control on K5. The threshold voltage range is 190-270V and it must be set below your lowest expected line voltage. To accomplish this, the line voltage should be at the lowest expected level when performing the following adjustment.

c. Restore primary power.

d. Increase the phase loss threshold voltage by turning the control on K5 clockwise until the LED on K5 goes out. Turn the control counterclockwise slightly past the point where the LED comes back on.

e. Remove primary power.

f. Remove block from interlock/grounding switch.

g. Replace access panel.

WARNING

DEADLY VOLTAGES ARE EXPOSED WHEN SIDE COVER IS REMOVED. USE EXTREME CAUTION TO PREVENT OPERATION INJURY.

8. Loosen the two retaining bolts at the bottom of the left cabinet side panel. Grip the panel securely and lift it from place.

9. Apply primary power and press filament on button.

10. Remove primary power and observe direction of rotation of the PA cavity blower and the cabinet fan as they come to a stop. Cabinet fan rotation may be observed by lifting the foam filter from the top right side of the cabinet. PA cavity blower rotation should be counterclockwise when viewed from the left side. Cabinet fan rotation should be counterclockwise when viewed from the top. Replace cabinet side panel.

CAUTION

DO NOT PERFORM THE REMAINDER OF THIS PROCEDURE IF THE TRANSMITTER IS NOT CONNECTED TO AN ANTENNA WITH A 50-OHM IMPEDANCE OR A DUMMY LOAD CAPABLE OF DISSIPATING AT LEAST THE RATED RF OUTPUT OF THE TRANSMITTER.

11. Set all circuit breakers to ON and apply primary power. Press filament on button.

12. Set the test meter selector switch to 28V SUPPLY (40V SCALE). The test meter will indicate 28 +/-2.0 volts DC.

13. Set the AC Meter Panel selector switch to FIL. The test meter should indicate 7.5 +/-0.1 volts. Adjust Filament Voltage if it is not correct, using procedures in Paragraph 5-7.2 and 5-7.3. These adjustments are required to be made at customer's normal line voltage.

14. Ascertain that the exciter POWER Switch is ON. The power indicator on the exciter should light when the transmitter filament on switch is depressed. The primary switch is on the back of the exciter. Remove primary power before removing access panel.

NOTE

The transmitter is adjusted and pretuned at the factory for specific customer power output and frequency requirements. In normal applications, the fine-tuning and adjustment procedures provided in steps 14 through 25 are adequate to ensure proper transmitter operation. However, if the transmitter to be operated at a frequency or power output is different from the frequency or power output designated in the factory test data supplied with the transmitter, perform the complete RF tuning and power adjustment procedures listed in Paragraphs 5-8 and 5-9.

15. Set the POWER CONTROL switch to MANUAL.

16. Set the RF POWER switch to FORWARD.

17. Set the TRANSMITTER CONTROL switch to LOCAL.

18. Press the PLATE switch. The PLATE ON switch lamp will light.

19. Adjust DRIVER PLATE TUNE for maximum PA GRID current.

20. Slightly adjust the PA LOADING and PA TUNING controls until maximum power output is displayed on the RF WATTMETER.

21. After 5 minutes of operation, repeat steps 19, 20 and 21 until PA grid current stabilizes.

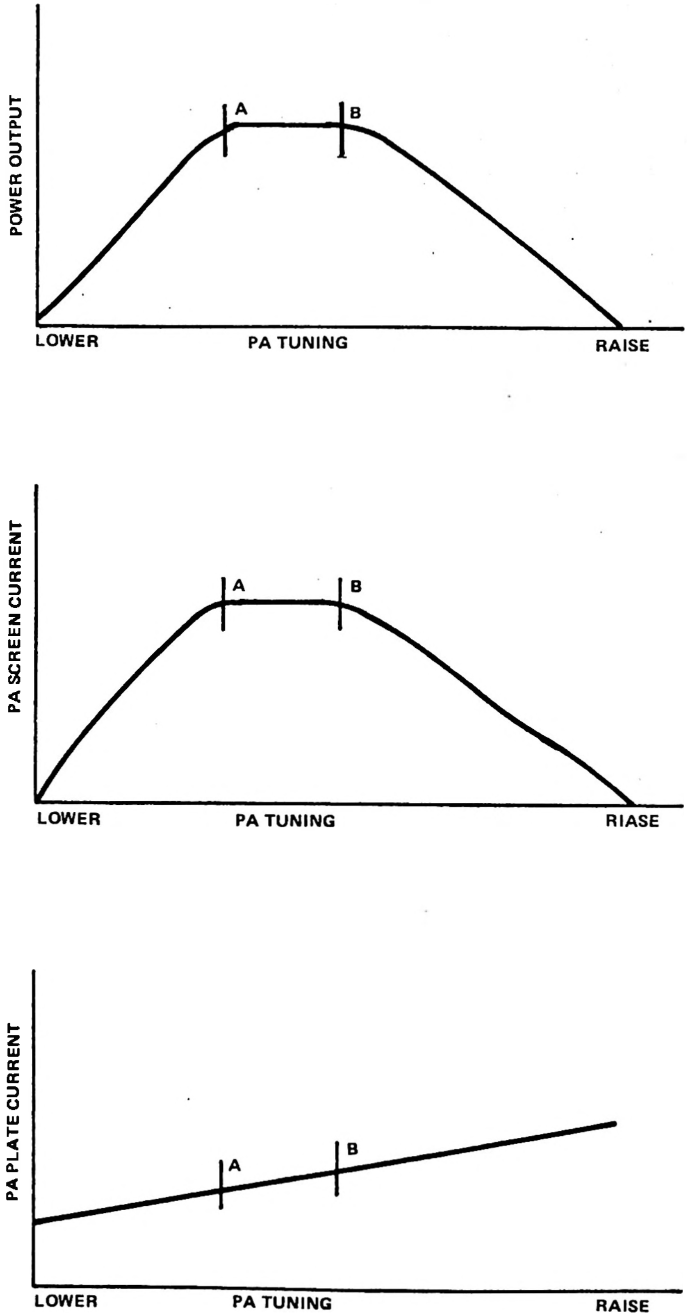


Figure 3-7. PA Tuning and Loading

Note

In this transmitter, operating parameters will become stable within 10-15 minutes. All fine tuning and recording of operating parameters should be performed only after the transmitter has stabilized. *

22. RAISE or LOWER the POWER ADJUST control until the RF WATTMETER displays the station's authorized power level. If specified, the RF WATTMETER was calibrated to indicate 100% at this power.

23. Compare meter readings with those listed in the the factory test data located at the back of this manual. If additional tuning or transformer tap adjustment is required, refer to the adjustment procedures listed in Section 5.

24. Set POWER CONTROL switch to AUTOMATIC. On the transmitter Power Control Adjust Module, A3 (see Figure 6-1), adjust A3R7 for 100% output power if necessary.

NOTE

Do not perform this procedure unless PA is neutralized. See paragraph 5-9.4.

25. PA TUNING AND LOADING (FOR BEST EFFICIENCY). There is not likely to be a plate current dip within the normal range of tuning control. There are, however, three indicators to be observed for proper PA TUNE. Power Output and PA Screen current will be maximum. PA Plate current will be changing as the tuning is changed. Plate current will increase when the tuning control is held in the raise position and will decrease when tuning control is placed in the lower position. When the shorting plane is positioned correctly, the PA Screen current and Power Output will go through a peak. Make certain that Screen Current and Power Output actually go through a peak and that power reduces if the tuning control is held in one position or the other past the point of maximum PA Screen Current and Power Output. Refer to Figure 3-7 for an indication of what to expect as the tuning control is run through its total mechanical range from one limit to the other. Notice that Power Output is the same at point B and point A but that Plate Current is greater at point B. The proper tuning point is at point A which results in maximum output and also the least amount of plate current (not plate current dip). The Loading control is adjusted for maximum RF Output. *

You will notice that PA screen current will decrease when loading is increased and PA screen current will increase when loading is decreased. Screen Current will be between about 150 ma and 550 ma. The screen current is dependent upon loading, Power Output requirements, plate and screen voltage, and individual tube peculiarities. When the PA tube is replaced, screen voltage may have to be changed in order to obtain the desired Power Output.

26. MAXIMUM POWER OUTPUT ADJUSTMENT.

NOTE

This procedure is intended to maintain authorized station maximum power output with line voltage variations.

a. Set the POWER ADJUST control to RAISE until maximum power output is displayed on the RF WATTMETER.

b. If the maximum power output is not more than 5% above the authorized station maximum output, skip to step h. If the maximum power output is more than 5% of the authorized station maximum output, proceed to step c.

c. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

d. Turn off primary power to the transmitter.

e. Refer to Tables 2-2 and 3-3, and change wires to the screen transformer terminals to decrease screen voltage.

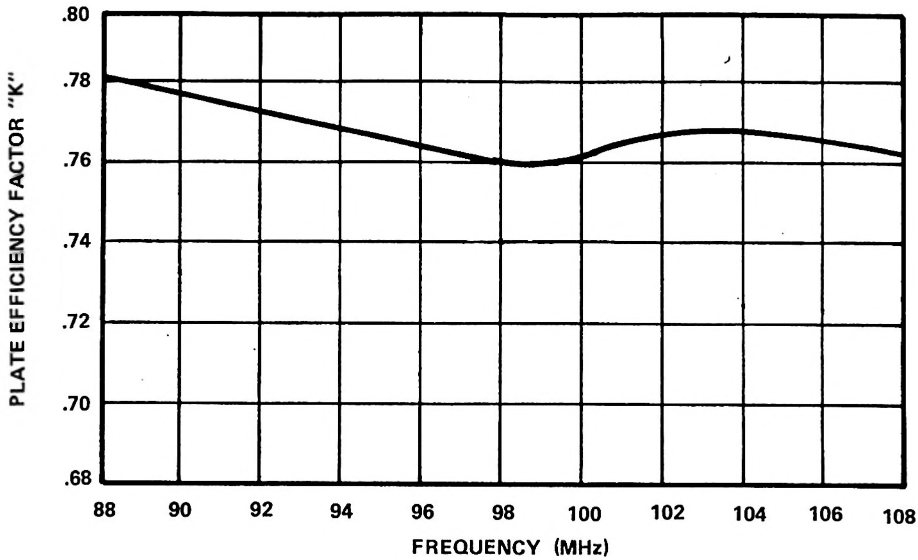
f. Reapply primary power and press the FILAMENT ON and PLATE ON switches on control panel A1.

g. Repeat steps c. through f. until the maximum transmitter output is approximately 5% above the authorized station maximum output.

h. Compare the PLATE VOLTAGE reading with the plate voltage listed in Table 3-4 for the authorized station maximum power output. (Linear interpolation of tabulated values may be necessary.) If the compared voltages differ by more than 10%, proceed to step i. If the compared voltages differ by less than 10%, skip to step n.

i. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

j. Turn off primary power to the transmitter.



POWER OUTPUT = I_P E_P "F"

WHERE I_P = PA PLATE CURRENT IN AMPS
E_P = PA PLATE VOLTAGE IN VOLTS
"K" = EFFICIENCY FACTOR FROM CHART

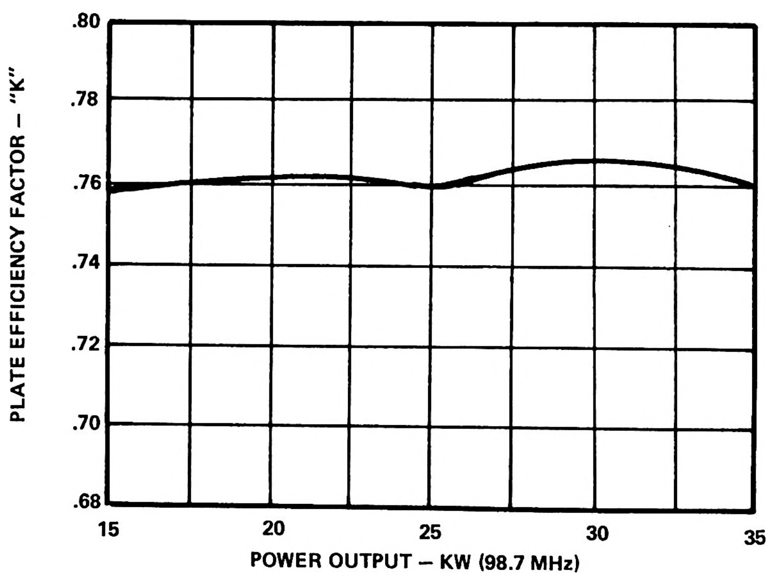


Figure 3-8. Amplifier Efficiency vs. Frequency and Power

k. Refer to Table 2-2. If the transmitter plate voltage exceeds the tabulated voltage, change wires on transformer T1 to the terminals listed for the next higher line voltage. If the tabulated voltage exceeds the transmitter plate voltage, change wires on transformer T1 to the terminals listed for the next lower line voltage.

l. Repeat steps h. through k. until the transmitter and the tabulated plate voltages differ by less than 10%.

m. Repeat step a.

n. Adjust the POWER ADJUST control until the RF WATTMETER displays the authorized station maximum power output.

27. ANTENNA SYSTEM VSWR CHECK. The RF WATTMETER and the graph in Figure 3-9 can be used for this purpose if other means are not available. Typically, VSWR is less than 1.1:1 and it must not exceed 2:1.

TABLE 3-4. OPERATING PARAMETERS VS. POWER LEVELS

816R-5 OPERATING PARAMETERS	RF OPERATING POWER - kW				
	15	20	25	30	35
Plate Voltage (kV)	8.93	9.68	9.80	9.76	9.80
Plate Current (Amps)	2.20	2.66	3.37	4.09	4.75
Screen Voltage (V)	465	538	618	715	770
Screen Current (mA)	260	300	400	485	495
Grid Bias Voltage (V)	-613	-656	-670	-682	-620
Grid Current (mA)	118	125	127	131	116
Forward Power (%)	48	62	74	90	100
Reflected Power (%)	<0.2	<0.2	<0.2	<0.2	<0.2
Filament Voltage (VRMS)	7.75	7.50	7.55	7.70	7.75
PA Inlet Air Temp (°C)	25.9	25.8	26.1	25.9	26.8
PA Exhaust Air Temp (°C)	55.4	61.9	65.0	73.5	82.2
AC Line Phase A-B (VRMS)	212	212	209	209	209
AC Line Phase B-C (VRMS)	214	214	211	211	213
AC Line Phase C-A (VRMS)	215	216	213	213	215
DRIVER					
Plate Voltage (kV)	1.55	1.67	1.90	2.00	1.99
Cathode Current, Left (mA)	180	182	208	212	217
Cathode Current, Right (mA)	180	182	209	212	217
Screen Voltage (V)	285	288	292	294	294
Screen Current (mA)	30.0	29.8	29.5	31.0	29.5
Grid Current (mA)	8.0	8.0	9.0	9.0	9.0
CALORIMETER					
Water Flow (GPM)	9.9	9.9	9.9	9.9	10.0
Water Inlet Temp (°C)	34.4	34.6	31.9	31.2	36.0
Water Outlet Temp (°C)	40.1	42.1	41.5	42.9	49.4
RF Power Output (kW)	14.9	19.6	25.1	30.6	35.4
AC POWER ANALYZER					
Phase A-B (VRMS)	209	209	207	207	208
Phase B-C (VRMS)	212	212	209	209	210
Phase C-A (VRMS)	212	212	209	209	212
Line A (A RMS)	80.0	97.5	116.5	140.5	160.0
Line B (A RMS)	75.3	93.0	110.5	135.5	155.5
Line C (A RMS)	84.5	100.5	120.8	145.5	165.5
AC Input Power (kW)	26.1	33.2	39.4	47.6	54.7
AC Input (kVA)	29.2	35.4	41.8	50.7	58.3
AC Power Factor	0.89	0.94	0.94	0.94	0.94
PA Efficiency Factor "F" (%)	75.8	76.1	76.0	76.6	76.0

TABLE 3-5. OPERATING PARAMETERS VS. FREQUENCY

816R-5 OPERATING PARAMETERS	FREQUENCY - MHz				
	88.1	93.1	98.7	103.1	107.9
Plate Voltage (kV)	9.68	9.66	9.80	9.68	9.72
Plate Current (Amps)	4.76	4.80	4.75	4.75	4.74
Screen Voltage (V)	760	765	770	735	710
Screen Current (mA)	465	475	495	455	445
Grid Bias Voltage (V)	-571	-586	-620	-596	-539
Grid Current (mA)	109	113	116	112	103
Forward Power (%)	100	100	100	100	100
Reflected Power (%)	<0.2	<0.2	<0.2	<0.2	<0.2
Filament Voltage (VRMS)	7.80	7.80	7.75	7.75	7.65
PA Inlet Air Temp (°C)	27.6	23.4	26.8	24.0	26.5
PA Exhaust Air Temp (°C)	80.4	77.4	82.2	80.9	86.7
AC Line Phase A-B (VRMS)	212	213	209	211	208
AC Line Phase B-C (VRMS)	214	214	213	213	210
AC Line Phase C-A (VRMS)	217	216	215	214	213
DRIVER					
Plate Voltage (kV)	2.00	1.97	1.99	1.97	2.00
Cathode Current, Left (mA)	170	188	216	220	222
Cathode Current, Right (mA)	170	188	216	218	220
Screen Voltage (V)	295	298	294	292	295
Screen Current (mA)	23.0	20.0	20.5	27.0	30.0
Grid Current (mA)	6.5	6.5	9.0	8.5	7.5
CALORIMETER					
Water Flow (GPM)	9.75	9.65	10.0	9.70	9.85
Water Inlet Temp (°C)	35.7	31.4	36.0	33.7	32.8
Water Outlet Temp (°C)	49.7	45.4	49.4	47.5	46.3
RF Power Output (kW)	36.0	35.7	35.4	35.3	35.1
AC POWER ANALYZER					
Phase A-B (VRMS)	210	211	208	209	206
Phase B-C (VRMS)	213	213	210	211	208
Phase C-A (VRMS)	213	212	212	211	208
Line A (A RMS)	157.5	158.5	160.0	156.5	158.5
Line B (A RMS)	153.8	154.5	155.5	153.5	153.5
Line C (A RMS)	164.0	164.5	165.5	162.7	162.0
AC Input Power (kW)	53.4	53.5	54.7	53.5	54.0
AC Input (kVA)	58.2	58.4	50.3	57.4	56.7
AC Power Factor	0.92	0.92	0.94	0.93	0.95
PA Efficiency Factor "F" (%)	78.1	77.0	76.0	76.8	76.2

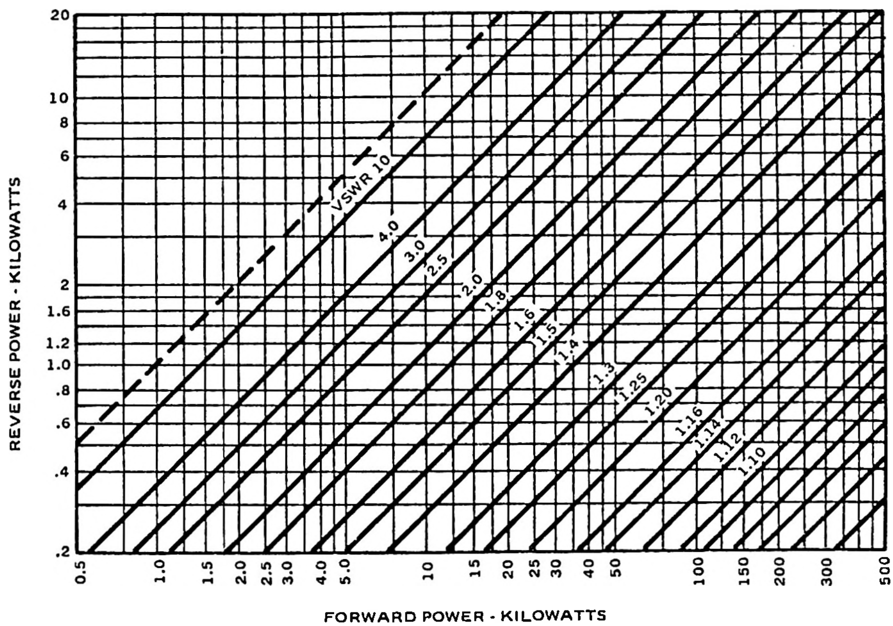


Figure 3-9. Power to VSWR Conversion Graph

3-4. REMOTE OPERATION

To initiate remote operation, set the TRANSMITTER CONTROL switch to REMOTE. When operating with the control panel, this switch must be in the LOCAL position.

3-5. 2nd POWER LEVEL (LOW POWER) ADJUSTMENT

1. Perform this step only if you will be using a second power level.

2. Switch transmitter to AUTO POWER CONTROL mode.

3. Apply 28 VDC to A17TB4, Terminal 20 (Remote Control), to activate relay A3K1.

4. Adjust R41 on A3 (Power Control Card) for the desired power level.

3-6. AUTOMATIC RECYCLE RESETTING

Automatic transmitter shutdown occurs when PA Screen, PA Plate, Driver, or VSWR is overloaded. An overload indicator A7CR6 through A7CR9 illuminates on overload and recycle board A7. If the overload was of short duration, the automatic recycling circuits restart the transmitter. The indicator lamp remains on until the transmitter operator presses the FAULT RESET switch on the main control panel. The fault Indicator lamp cannot be RESET from Remote Control location. Perform maintenance procedures if the automatic recycling circuits fail to restart the transmitter.

The fault recycling circuits may be disabled for tuning maintenance by switching the AUTO RECYCLE switch A7S2 to OFF.

3-7. NORMAL TURNOFF (AT TRANSMITTER SITE)

1. Press the PLATE OFF push-button and allow a few seconds for the voltage to decrease.

2. Press the FILAMENT OFF push-button.

3. Allow time (less than 3 minutes) for the blower off delay circuit to turn blower off.

4. Set AC LINE circuit breaker A25CB1 OFF.

5. Open the primary disconnect switch. (Customer supplied wall disconnect switch.)

3-8. EMERGENCY TURNOFF

In the event of an emergency, remove power in any of the following ways:

1. Turn AC LINE circuit breaker A25CB1 OFF.
2. Press the FILAMENT OFF push-button.
3. Turn 28 VDC POWER SUPPLY circuit breaker, CB1 OFF.
4. Open the Primary Disconnect switch.

SECTION 4 - THEORY OF OPERATION

4-1. GENERAL

The FM Transmitter, 816R-5, operates in the 88 to 108 MHz range at a maximum rated RF output OF 35 KW. A CE 802A solid-state FM wideband exciter provides excitation. The transmitter is equipped with circuits that maintain constant power output and that protect the transmitter from overload conditions. A control panel provides complete transmitter metering and tuning controls. Refer to the overall schematic diagrams for detailed circuit information.

4-2. BLOCK DIAGRAM DISCUSSION

Referring to Figure 4-1, an input signal (monaural, stereo, or SCA) modulates the exciter. The output of the exciter is applied to the driver stage, the output of which is applied to the power amplifier. The power amplifier output is applied via a low-pass filter and directional coupler to a 50-ohm antenna.

A DC sample of the forward power from the directional coupler (DC1) is monitored by the auto power control circuit. If a change in output power is detected, a signal is sent to the power control unit that increases or decreases the plate and screen power supply input voltage to compensate. A sample of the reflected power is also monitored by the power control circuits. If an excessive amount of reflected power is detected, the control circuits removes all plate voltages from the transmitter. The 28-volt power supply provides power for the control circuits.

4-3. RF CIRCUITS

4-3.1 EXCITER

Refer to the 802A instruction manual, principles of operation.

4-3.2 RF DRIVER

The exciter output is applied to the driver stage that consists of two 4CX250B tetrodes in parallel (A11V1 an A11V2). The stage operates class C with adjustable cathode bias provided by R40 and R44 and grid leak bias by R42 and R50. The adjustable cathode bias is used to balance the cathode currents between the two driver tubes and to provide some further control over driver power output. The driver grid swamping resistor, R57, provides wide bandwidth and minimizes plate-to-grid feedback.

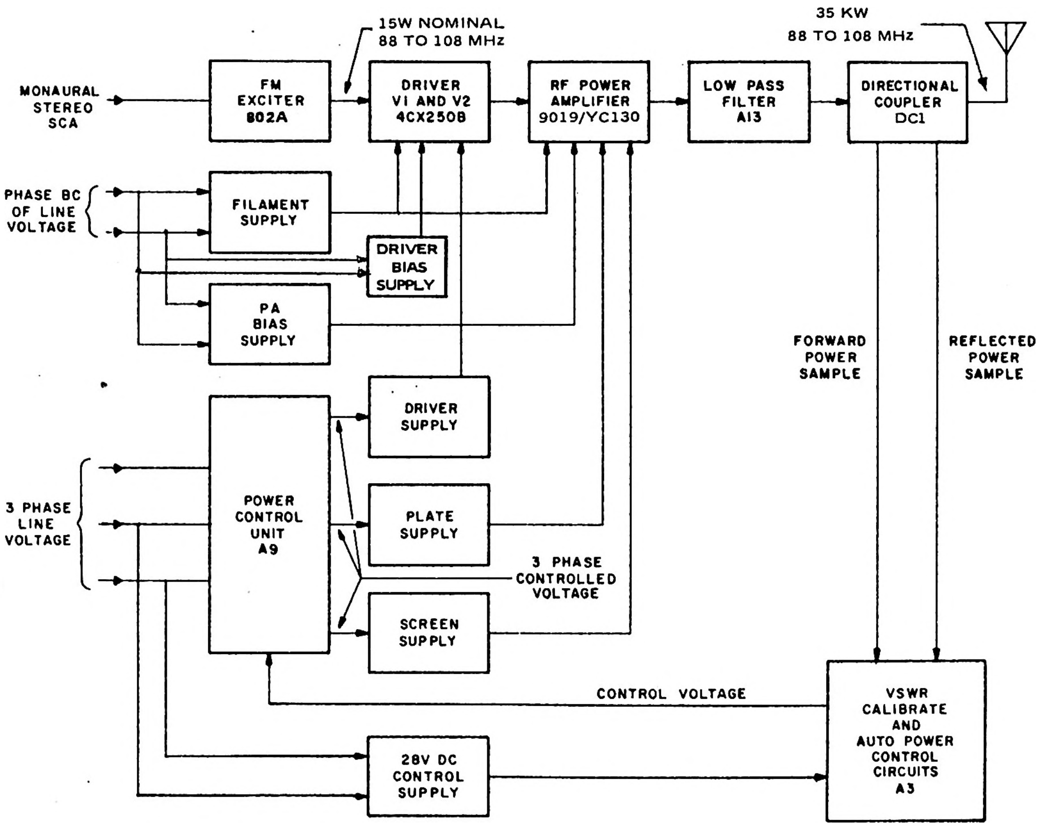


Figure 4-1. FM Transmitter, 816R-5 Block Diagram

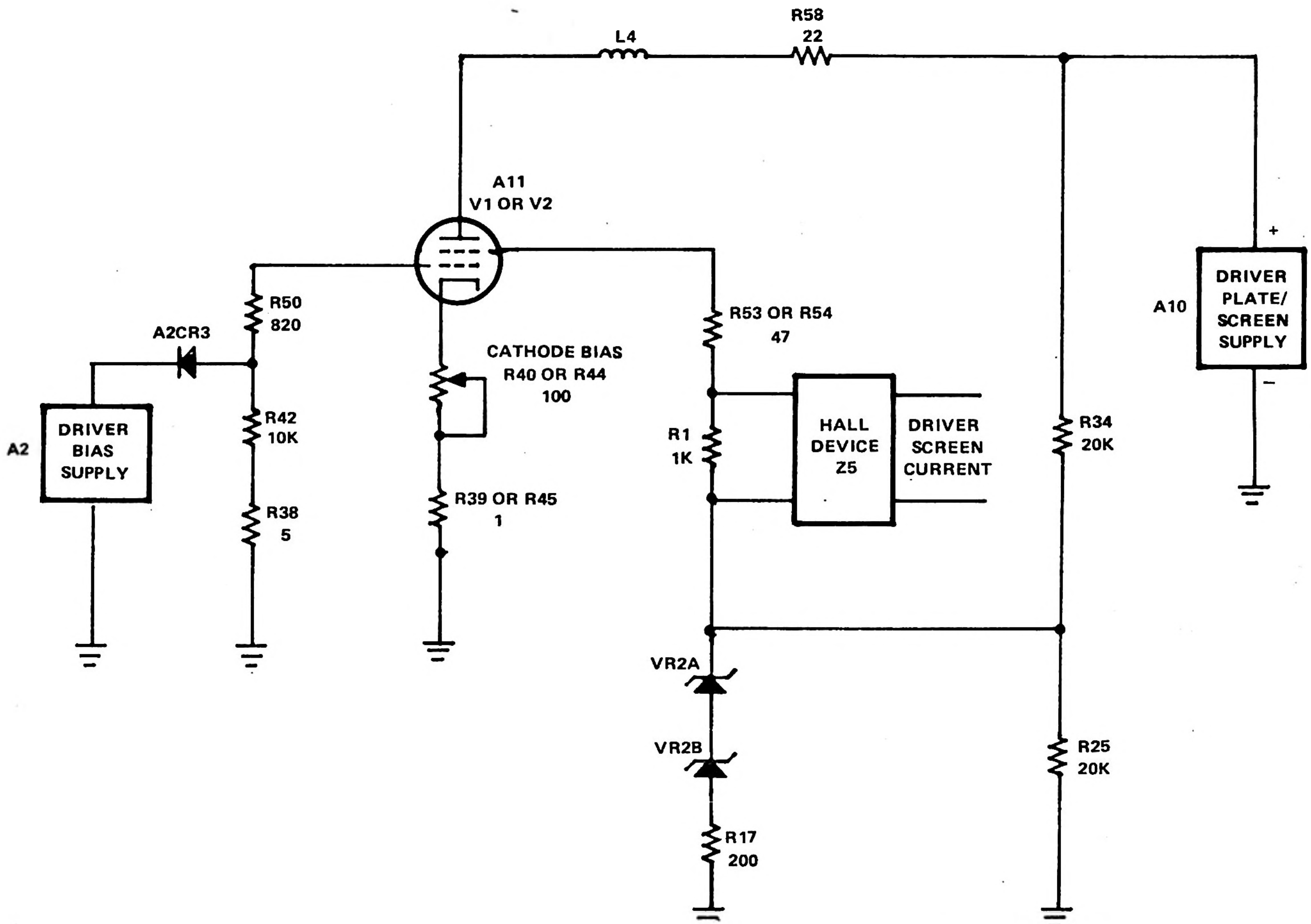


Figure 4-2. Driver DC Bias - Same for Each Tube Simplified

816R-5

The input circuit is a tuned transmission line with resistance loading. Neutralization Capacitor CN is a short piece of wire with a paddle on the end physically placed near the anodes of V1 and V2. The location of the paddle provides sufficient capacitance to neutralize the stage. A sample of the screen current flows through a transformer winding inside Hall effect probe A22Z5 (Figure 4-2) for screen current monitoring. Using the principle of the Hall effect, the stationary magnetic field around the transformer produces a current through the control panel meter connected to A22Z5. A control current that is adjusted to calibrate the control panel meter is also supplied to A22Z5 through resistor A22R73 (Driver Screen Metering Calibration).

4-3.3 RF POWER AMPLIFIER

The driver output is coupled through C57A and C57B capacitors to the grid of the power amplifier tube V3. A tuned circuit composed of A21L7 and A18C37 provides impedance matching. Loading of the driver amplifier is accomplished by adjusting A21L7 (tuning) and A21L8 (loading). Inductor A21L8 is used to cancel a portion of the input capacity of V3. Inductor A18L14 and the distributed capacity of A18R75 couple A18R75 to the cavity, forming a suppressor that dampens the higher order cavity resonances that can occur near the third harmonic of the output frequency. Cathode tuning (or peaking) capacitor A21C39 improves the bypass action at the operating frequency. Resistors A21R76 and A21R77 broaden the frequency response and minimize synchronous amplitude modulation products. Inductors A11L4 and A21L5 are the driver plate and the PA grid chokes.

The power amplifier is a plate-tuned 9019/YC130 tube that is operated Class C. The tube screen is grounded and the cathode is placed 750 volts (nominal) below ground to provide screen bias (see Figure 4-3). A fixed bias from the PA bias power supply is applied to the control grid through A22TB8-19, A22R37, and A22TB8-20. When an input signal is present, grid current flows and develops grid leak bias across A18R35, A18R36 and A18R80. The increased negative potential on the grid causes the diode in the PA bias supply to reverse bias, preventing grid current flow through the supply. Hall effect probe A22Z4 monitors the amount of grid current for control panel metering.

The power amplifier plate circuit is coarse tuned from 88 to 108 MHz by resonating an adjustable coaxial resonator. (See Figure 4-4). The resonator is the area between the tube shelf and the sliding shorting plane. Two motor-driven capacitors permit more precise tuning (A18C51) and loading (A18C50). RAISE/LOWER switches S3 (PA TUNING) and S4 (PA LOADING) on control panel A1, control capacitor drive motors.

The DC blocking capacitor A18C45 is located between the top of PA tube and input to air chimney. Figure 4-5 shows the electrical equivalence of the plate tuning circuit.

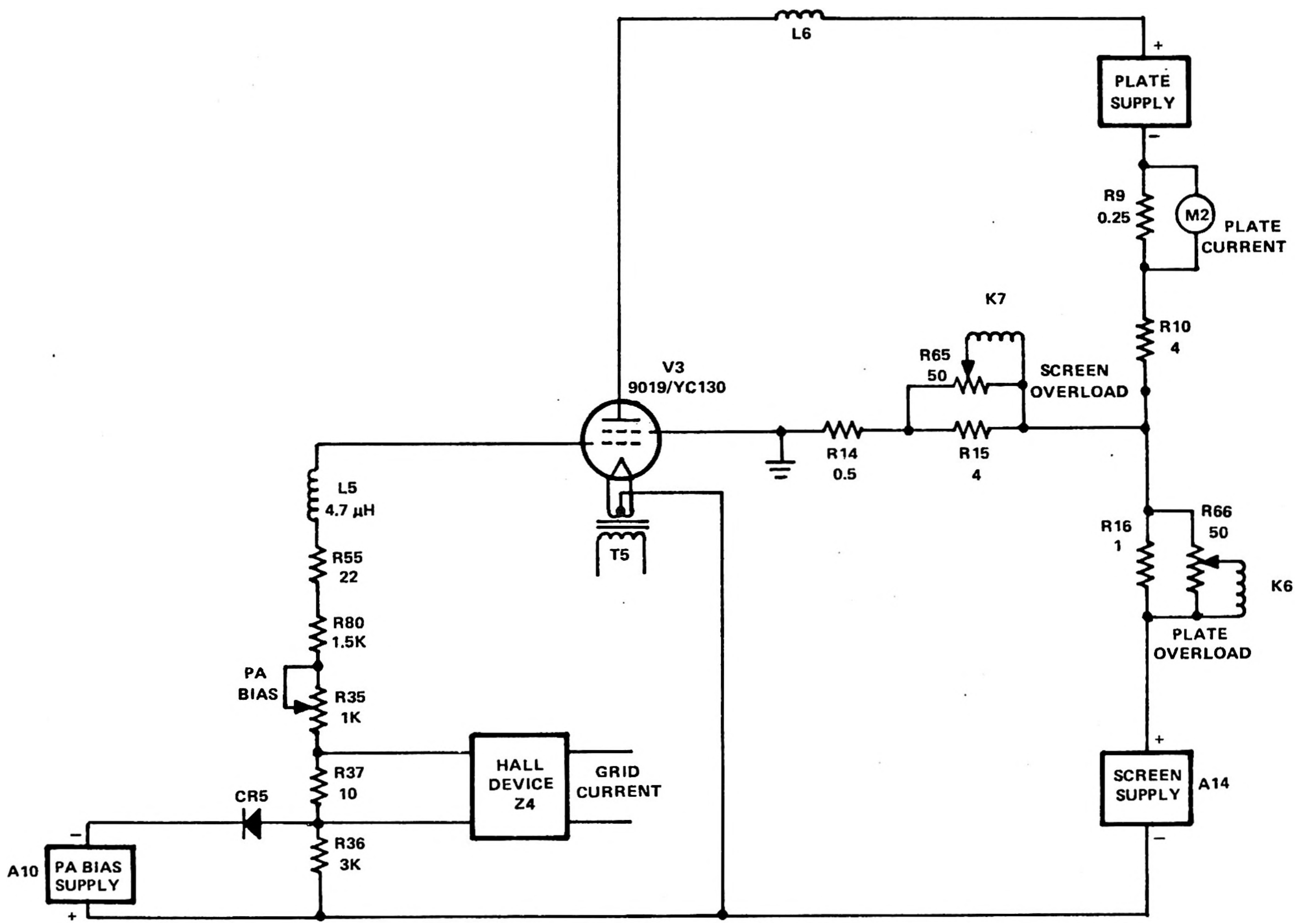
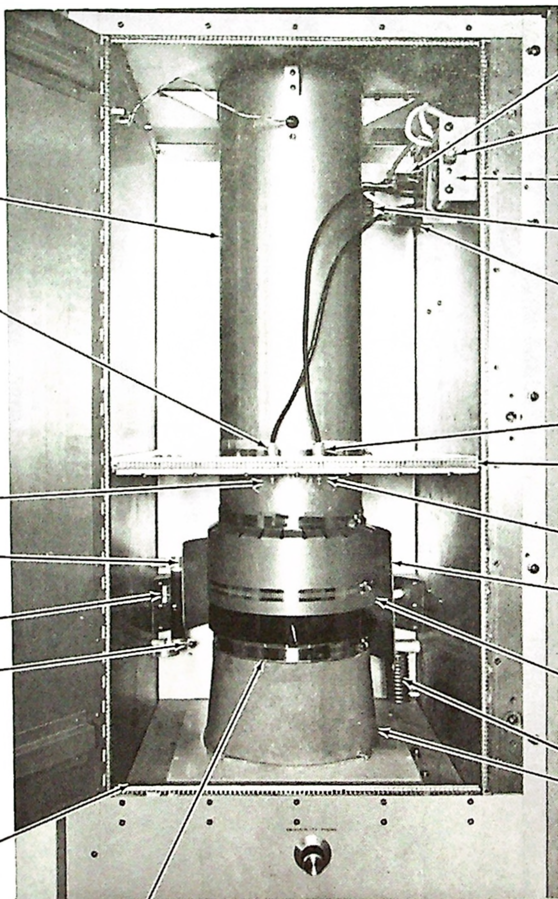


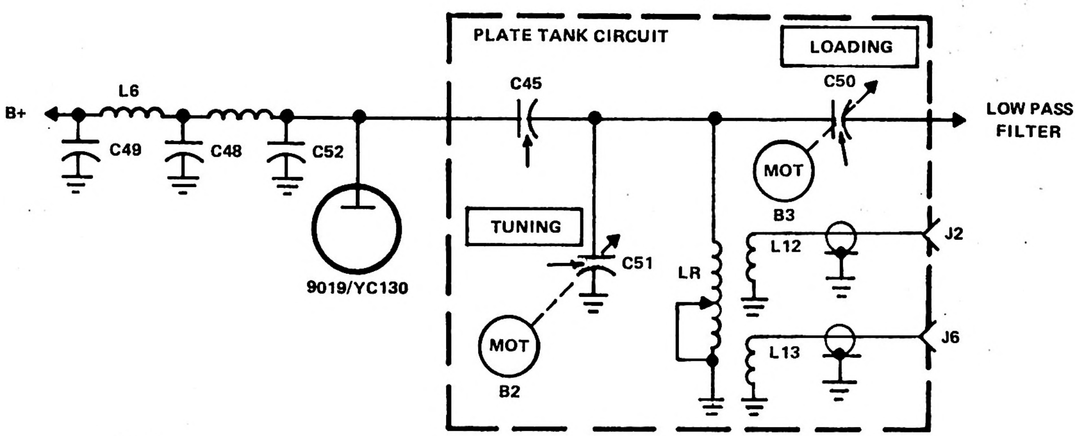
Figure 4-3. PA DC.Bias Circuitry Simplified



88-1071

NS1-9

Figure 4-4. Plate Cavity, A18



NOTE:

C45 IS THE CAPACITANCE BETWEEN TUBE ANODE AND THE CAVITY CENTER CONDUCTOR
C50 IS THE CAPACITANCE BETWEEN MOVABLE PLATE 1 AND THE TUBE ANODE
C51 IS THE CAPACITANCE BETWEEN MOVABLE PLATE 2 AND THE TUBE ANODE
LR IS THE LUMPED CONSTANT EQUIVALENT OF THE SHORTENED 1/4 WAVE RESONATOR

Figure 4-5. FM Transmitter, 816R-5, Schematic Diagram, Output Network

4-3.4 LOW-PASS FILTER A13

Low Pass filter A13, (See Figure 6-1, 6-14) consists of two coaxial filters in tandem. The first filter has a cutoff of 130 MHz, while the second has a cutoff of 300 MHz.

4-3.5 DIRECTIONAL COUPLER DC1

The Directional Coupler provides a DC voltage to both Forward and Reflected circuit of A3 and the output is then routed and can be displayed on Forward/Reflected Meter (M4). Also, a sample of Forward power is routed from A3 to A9 gating cards to control SCR's for PA Plate HV supply.

4-4. POWER SUPPLIES AND POWER CONTROL CIRCUITS

4-4.1 GENERAL

There are six separate power supplies in the transmitter. Three of the six, the plate, screen and PA bias power supplies, provide voltage to the power amplifier. The three remaining, the driver plate/screen supply and driver bias supply, furnish voltage to the driver stage. The 28-volt DC power supply provides power to the control circuits.

4-4.2 28-VOLT DC POWER SUPPLY, P/O A10

The 28-volt DC supply receives its 3-phase 60-Hz input from the unregulated line voltage. The input is applied through circuit breaker A6CB1 and stepdown transformer T2 to 3-phase bridge rectifier assembly CR6. The 28-volt DC output of the bridge is filtered by the RC circuits and applied to the control circuits.

4-4.3 PA BIAS POWER SUPPLY, P/O A10

The PA bias power supply provides the power amplifier with fixed grid bias that holds the tube near cutoff when no signal is present on the grid. Single-phase primary power is applied through contactor A19K1 and step-up transformer T1 to a bridge rectifier network. An L-section filter is formed by L1 and C2.

The power supply output is applied to the grid of the power amplifier through CR5. CR5 blocks grid current flow through the supply when the grid leak bias exceeds the fixed bias. A sample of the bias voltage is applied through R3 to front panel meter A1M1 for monitoring.

4-4.4 PA PLATE POWER SUPPLY

The PA plate power supply provides plate voltage to the power amplifier. Primary components of the supply are transformer T1, 3-phase bridge rectifier assembly Z1, filter choke L1, and filter capacitor C3. T1 and Z1 are located in the Plate Transformer assembly external to the transmitter. A meter multiplier board, A15, samples plate voltage and allows constant monitoring. Input power to T1 is controlled by SCR (silicon-controlled rectifier) power control unit A9. This unit connected as a closed loop regulator, maintains constant power output to offset conditions of varying line voltage.

4-4.5 POWER CONTROL UNIT A9

Power control unit A9 regulates the 3-phase AC power input to the PA plate, the PA screen and the driver plate/screen transformer. Unit A9 consists of two major component assemblies - SCR assembly A9Z1 and firing control unit A9AR1. SCR assembly A9Z1 has three SCR pairs; one pair in series with each primary winding of the 3-phase power transformers. Each pair is connected within the delta circuit of the transformer primaries. SCR firing control unit A9AR1 consists of three control cards. Each control card controls the firing (turn-on) point of one SCR pair.

A common DC control signal from power control regulator A8 is fed simultaneously to each control card. This control signal governs the firing of the SCR pairs that regulate the input power applied to the power supplies. Relay A9AR1K1 de-energizes on PLATE OFF, disabling the three SCR gate driving cards. (See Figure 4-6).

4-4.6 POWER CONTROL REGULATOR A8

Power control regulator A8 provides the necessary control signals to operate power SCR control unit A9. A8 supplies a soft-start PA plate supply turn-on signal, a negative voltage for manual power control, and amplifier mixer functions for automatic power control.

When the PLATE ON switch is pressed, +28 volts is supplied to XA8-27. The +28 volts activates transistor A8Q1 to turn on relay K12. Relay A19K12 supplies 3-phase AC control power to A9AR1. An RC time delay circuit formed by A8R2 and A8C1 maintains K12 closed for a short interval after the PLATE OFF switch is pressed. Transistors A8Q2, Q3, and Q4, also energized by the +28 volts, provide the DC turn-on signal to unit A9AR1. On power control regulator A8, R8, R9, and C2 modify this signal to soft-start the high voltage PA plate power supply. Zener regulator A8VR2 provides a -10 volt voltage to MANUAL power adjust resistor A20R43.

Transistors A8Q5 and A8Q4 amplify the automatic control signal from A3 and apply the signal to A9AR1TB2-1 when the MANUAL/AUTOMATIC switch is in AUTOMATIC. A8C5 and A8R5 phase compensate the power control servo loop.

4-4.7 PA SCREEN POWER SUPPLY

The 3-phase regulated voltage from the power control unit is applied through transformer T2 to a silicon 3-phase full-wave bridge assembly, Z2, in the PA screen power supply. The output of Z2 is filtered and applied to the cathode circuit of the power amplifier at the secondary center tap of filament transformer A18T5. The PA screen power supply also provides -28 volts, obtained from the junction of resistors A17R4 and A17R18, for manual power control.

4-4.8 DRIVER POWER SUPPLY, P/O A10

The driver power supply provides plate and screen voltages for the driver stage. The 3-phase AC power for the primary of T3 is supplied by power control A9. The output of T3 is applied to a silicon 3-phase full-wave bridge assembly, Z1. The output of the rectifier bridge is filtered and applied to the driver plate circuit. The driver screen voltage, developed at the junction of A17R34 and A17R25 is applied through a metering resistor A22R1 to the driver screen circuit. Gaseous protector A17E2B shorts excessive transient voltages to ground. Driver plate and screen metering samples are obtained from A14R32 and A17R3 respectively.

4-4.9 FILAMENT VOLTAGE REGULATOR A5

When the Filament Regulator is in automatic mode, the filament voltage regulator detects and compensates for sustained fluctuations in the input AC voltage. The fluctuations are detected by a balanced bridge circuit, which in conjunction with a motor control circuit, adjusts the setting of variable transformer A19A2T1. The output voltage of the variable transformer (A19A2T1) is then applied to the primary of the Driver (A11T6) and PA (A18T5) Filament Transformer.

The variable transformer output is also applied to the primary of detector circuit transformer A20T8. Secondary (1) of this transformer is applied to a resistive bridge circuit consisting of lamps A5DS1, A5DS2, A5R1 and A5R2 and filament voltage adjust potentiometer A5R3. While observing PA filament meter, A5R3 can be adjusted for the required filament voltage.

When the input primary AC voltage increases, the voltage dropped across the bridge circuit increases, which causes more current to flow through the components located in the legs of the bridge circuit. The increased current flow causes the filament resistance of A5DS1 and A5DS2 to increase. The increased resistance of the filaments unbalances the bridge circuit and applies an AC signal, in phase with the AC voltage dropped across the bridge circuit, to the junction of A5C1 and A5R17. From A5C1 and A5R17, the AC signal is coupled to the base of transistor A5Q1. Transistor A5Q1 amplifies and phase shifts the AC signal 180 degrees. From A5Q1, the inverted AC signal is routed through capacitor A5C3 to the gate circuits of controlled rectifiers A5Q2 and A5Q3.

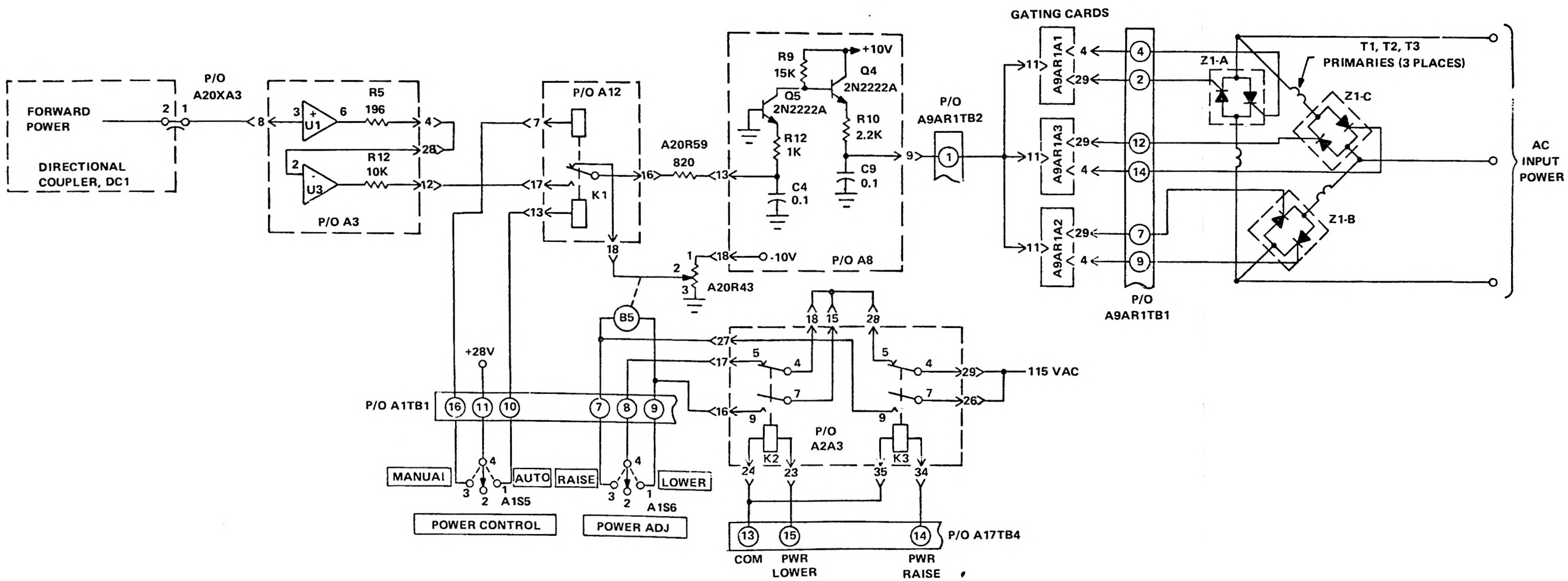


Figure 4-6. Power Control Circuits, Simplified Diagram

Another sample of the input AC voltage is applied from secondary (2) of A20T8 through diodes A5CR1 and A5CR2 to RAISE relay A5K1 and LOWER relay A5K2, respectively. Because of A5CR1 and A5CR2, only positive half cycles of the AC voltage are applied to A5K1 and A5K2. As the input AC voltage increases, positive half cycles are connected through A5K2 to the cathode of A5Q3. The in-phase AC signal present at the gate of A5Q3 allows A5Q3 to conduct, energizing A5K2. Capacitor A5C6 discharges during negative half cycles keeping A5K1 energized. The AC signal present at the gate of A5Q2 is out of phase with the half cycles connected through A5K1 to the cathode of A5Q2, preventing A5Q2 from conducting. This action prevents A5K1 from energizing.

Operation of the detector circuit under low input AC voltage conditions is similar to the operation during high voltage conditions, with the following exceptions. The sample AC voltage dropped across the resistive bridge circuit is 180 degrees out of phase with the AC signal at the junction of A5C1 and A5R17. The out-of-phase AC signal prevents A5Q3 from conducting, but allows A5Q2 to conduct. This action energizes A5K1, but not A5K2.

If A5DS1 or A5DS2 burns out, a large AC signal will appear at the base of A5Q1. As a result, the drive motor would run to either end stop, trying to compensate for an erroneous indication of a very high or low AC filament voltage. To prevent this type of malfunction, a protective circuit is connected to the output of A5Q1. When a large AC signal is applied to the base of A5Q1, the same AC signal is applied to the protective circuit which consists of voltage divider A5R17 and A5R16 and controlled rectifier A5Q4. From the junction of A5R17 and A5R16, the AC signal is connected to the gate of A5Q4 causing it to conduct. When A5Q4 conducts, the output of A5Q1 is shunted to ground preventing A5K1 from energizing. This action prevents the drive motor from operating.

The motor control circuits which operate to lower or raise the AC filament voltage are similar; therefore, only the raise control circuit is discussed in detail. Under low AC filament conditions, raise relay A5K1 energizes, connecting +28 volts DC through contacts 8 and 9 to a time delay circuit, consisting of resistor A5R19 capacitors A5C8 and A5C9. Relay A5K1 must remain energized for 1.5 seconds before the time delay circuit allows A5K3 to energize. The time delay assures that only sustained fluctuations of the AC filament voltage will allow the drive motor to operate. After 1.5 seconds, A5K3 energizes, applying 115 VAC through contacts 11 and 12 and limit switches A9A2S1 to Variac drive motor A19A2B1.

The Variac drive motor operates, driving the rotor on variable transformer A19A2T1 until the input AC voltage is raised to a value to provide filament voltage determined by A5.

4-4.10 FILAMENT VOLTAGE DISTRIBUTION

The filament voltage distribution is shown in Figure 4-7. Filament voltage regulator A5 maintains a constant RMS voltage on the filaments as discussed in paragraph 4-4.9.

4-5. PRIMARY POWER DISTRIBUTION CONTROL AND OVERLOAD CIRCUITS

4-5.1 PRIMARY POWER DISTRIBUTION

The 60 Hz, 3-phase primary power is distributed to the various circuits of the transmitter via circuit breakers and fuses mounted on circuit breaker panel A6, Figure 4-8. PA PLATE POWER SUPPLY circuit breaker A6CB5 is connected inside the delta of plate transformer T1. It also serves to interrupt primary power to the PA screen transformer T2 and driver plate transformer T3 through additional associated circuit breakers, A6CB4, PA SCREEN SUPPLY, and A6CB3, DRIVER POWER SUPPLY.

AC line voltage metering is provided by AC meter panel A25. In addition to the three phase-to-phase voltages, a fourth position of A25S1 is used to monitor PA filament voltage.

BLOWERS circuit breaker, A6CB2, controls application of primary power to cavity blower B1 through filament-on relay A19K2 and FAN fuses A6F7, F9, and F12. Relay A19K2 is energized when the filaments switch (S10) is turned on.

Application of primary power to the filament circuits, the exciter, the PA bias power supply, and the PA tuning and loading motors is relay controlled. Filament-on relay A19K1 and blower on relay A19K2 control application of power to the regulated filament circuit through autotransformer A19A2T1. Relay A19K1 also controls application of power to 802A exciter A4, to PA bias power supply, P/O A10, and to the PA tuning and loading motors (B2 and B3 respectively). Power to the exciter and the motors is through isolation transformer T4. Time totalizing meter A6M1 is placed across the load side of filament on relay A19K1.

The filament, exciter, and PA bias supply input power circuits are protected by associated fuses. These circuits receive power from the blowers circuit breaker, A6CB2.

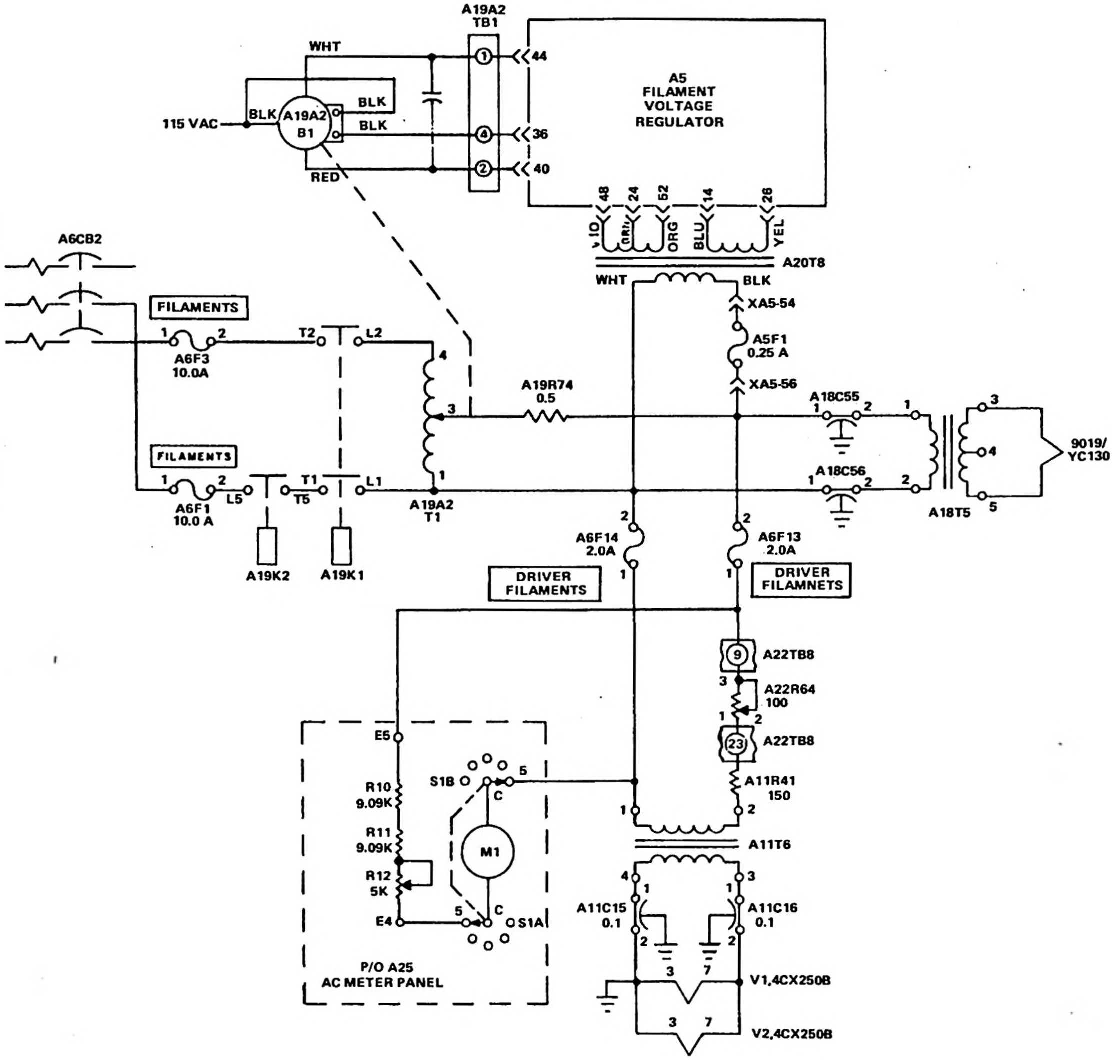


Figure 4-7. Filament Voltage Distribution

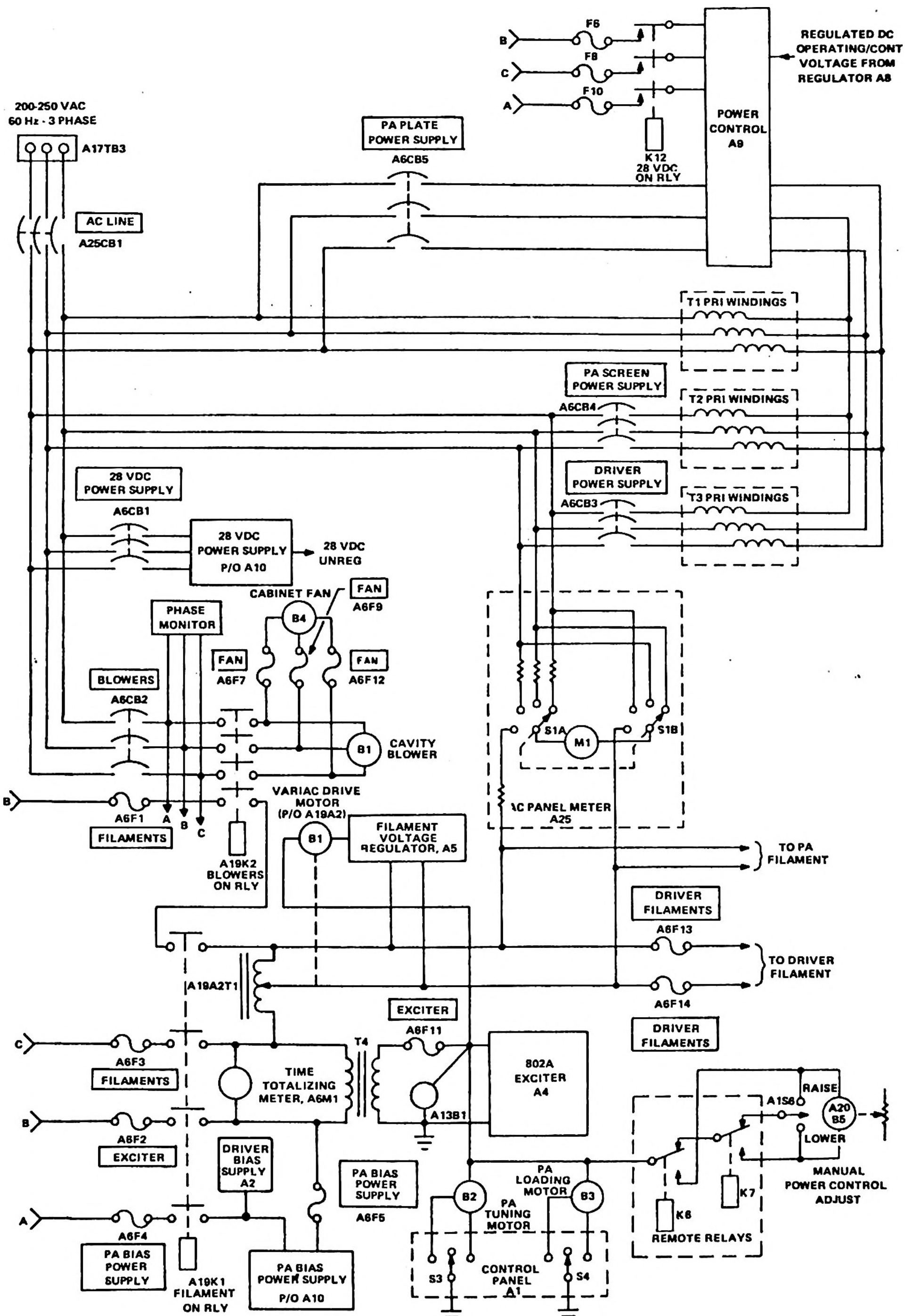


Figure 4-8. Primary Power Distribution

4-5.2 TRANSMITTER TURN-ON

The transmitter is energized by pressing FILAMENT ON switch A1S10 in the A1 control panel, Figure 4-9. Relay A19K2 is energized and power is applied to the blower motors. After sufficient air pressure is created in the power amplifier cabinet, air switch A18S1 is closed and relay A19K1 is energized.

After the 30-second delay, relay A19K4 is energized. The PLATE ON switch is pressed and relay A19K3 is energized and +28 Volts is supplied to the base of transistor A8Q3. This turns on control amplifier A9AR1, which applies input voltage to the plate, screen, and driver power supplies.

The transmitter may also be energized by pressing the PLATE ON switch which latches A19K3 and energizes A19K2 through contacts 8 and 5. By pressing a single switch (PLATE ON) will enable the transmitter to go through the above sequence of Blower Filament, Time Delay and Plate On.

4-5.3 EXCITER POWER CONTROL OVERRIDE

An output override voltage is supplied to the 802A exciter when the plate voltage is turned off. This mutes the output of the exciter while the PA plate voltage is turned off (Figure 4-9). The voltage is applied from the 28-volt power supply through contacts 3 and 9 of relay A19K4 to the 802A exciter power supply regulator.

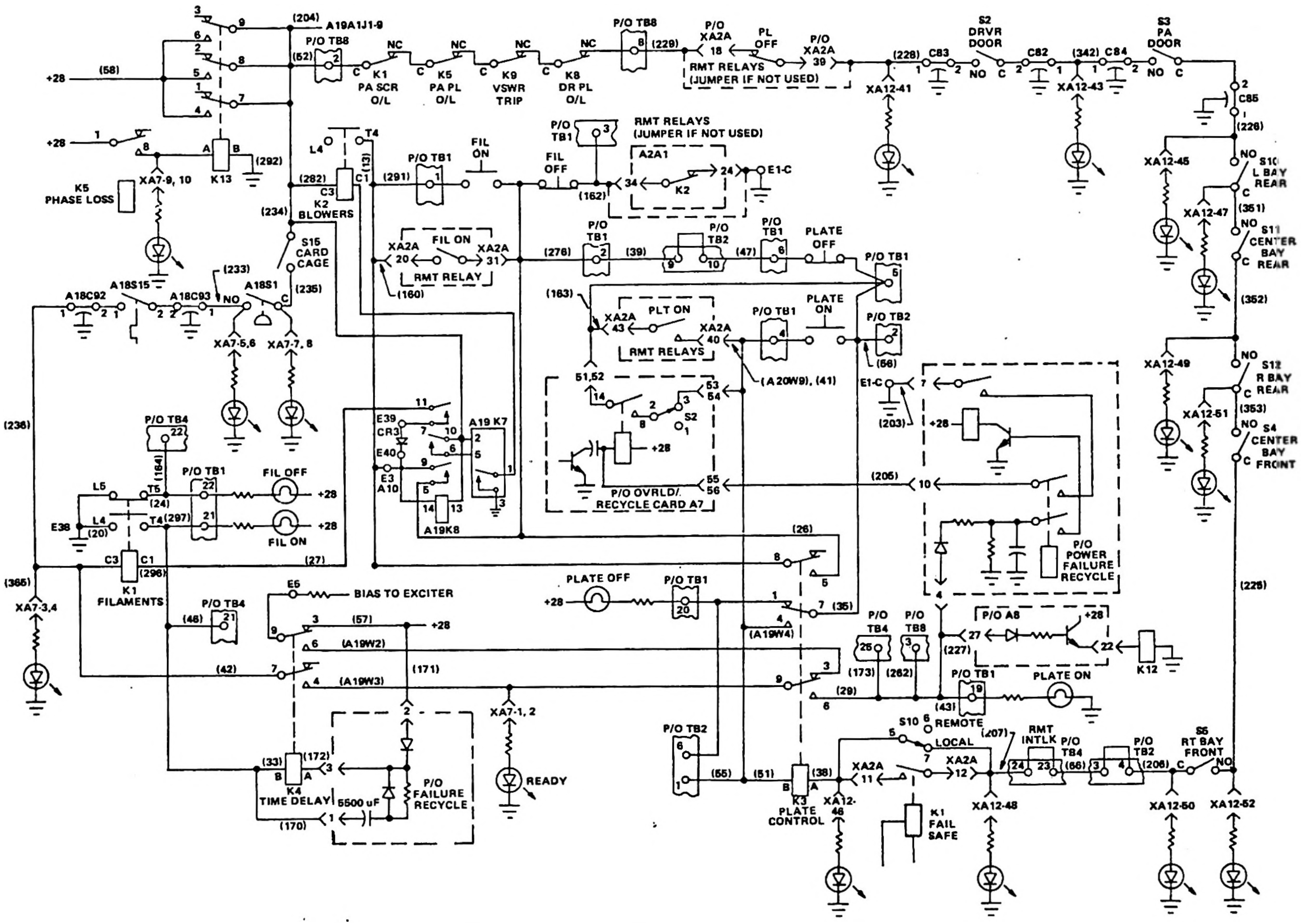


Figure 4-9. Power ON-OFF Control Circuits

4-5.4 FWD/REFL CALIBRATE AND AUTO POWER CONTROL UNIT, A3

FUNCTION:

The A3, FWD/REFL CALIBRATE AND AUTO POWER CONTROL card performs these functions:

1. The Forward Power Signal from the Directional Coupler is buffered and amplified to provide a panel power meter reading of 100% at the customer's specified TPO (Transmitter Power Output); full scale is 120% in the Forward Power Position.

2. The Forward Power Signal from the Directional Coupler is compared against either of two internal, adjustable voltages for Automatic Power Control. Two discrete levels of power control are remotely selectable and maintain the desired power to within 1%.

3. The Reflected Power Signal from the Directional Coupler is buffered and amplified to provide a full scale reading of 12% of the customer's specified TPO on the panel power meter in the Reflected Power Position.

4. The Reflected Power Signal from the Directional Coupler is compared against an internal limit to smoothly fold the Forward Power Level back when a slowly rising VSWR level is detected. Forward Power is reduced to keep the Reflected Power at 5-6% of the customer's specified TPO.

5. The Reflected Power Signal from the Directional Coupler is compared to a second internal limit that can remove power from the transmitter and light the VSWR tally LED when a rapidly rising VSWR level greater than 10% of the customer's specified TPO is detected.

THEORY OF OPERATION:

The Forward Power Signal from the Directional Coupler, DC1, is amplified and buffered by U1. Resistor R25 is an offset null adjusted for zero output at TP1 when no input signal is present. Resistor R14 is adjusted to provide a 100% Forward Power Indication of the panel power adjusted to provide a 100% Forward Power Indication of the panel power meter, A1M4, at the customer's specified TPO. The output of U1 is also presented on A17TB4, Terminal 34, through a 2.2K Ohm isolation resistor, R13, to provide remote metering of Forward Power. The positive output of U1 is coupled through CR6 and compared at the inverting input of U3 against the negative voltage from either R17 (Normal Power) or R41 (Second Power) in the Automatic Mode. The output of U3 is used to raise or lower the transmitter plate voltage, as necessary, to maintain the selected power level. The input to U3 is switched from R17 to R41 by relay A3K1 which is activated by applying +28 VDC to the A3K1 coil through A17TB4, Terminal 20. Normally, R17 sets the normal operating TPO reference while R41 is adjusted for some lower value, perhaps necessary during emergency operation with a generator unable to supply the full power load.

The Reflected Power Signal from the Directional Coupler, DC1, is amplified and buffered by U2. Resistor R26 is an offset null adjusted, for zero output at TP2 when no input signal is present. Resistor R24 is adjusted to cause a 10% reflected power indication on the panel power meter, A1M4, when the Reflected power reaches 10% of the customer's specified TPO. Resistor R27 is adjusted to simulate that 10% reflected power level when the Test Switch, S2, is depressed. This allows testing of the VSWR Protection and Metering Circuits. The output of U2 is fed through resistor R20 to the gate of the VSWR Overload SCR, A7Q8, when the VSWR Protect Switch, S1, is in the ON position. Resistor R20 is adjusted to fire SCR A7Q8 when the Reflected Power reaches 10% of the customer's specified TPO. When A7Q8 fires, VSWR Overload Relay, A22K9, activates, removes power from the transmitter and illuminates the VSWR Overload LED. The output of U2 is also presented on A17TB4, Terminal 33, through a 2.2 Ohm resistor, R23, to provide remote metering of Reflected Power.

U6 and U7 form the VSWR Foldback Circuit. A sample of the buffered Reflected Power Signal from U2 is fed to U6 through Resistor R32. Resistor R33 is the offset null adjustment for U6 and is adjusted to give zero output at Pin 6 of U6 when no input signal is present. The output of U6 is coupled through CR4 to the Automatic Power Comparator, U3. Resistor R32 sets the gain so that the output voltage of U6 will exceed that of U1 - causing the power to be reduced - when the Reflected Power exceeds 5-6% of the normal TPO. The VSWR Foldback Circuit is defeated by the circuitry of the Ten Second Timer, U7. The Timer is triggered by sampling the anode voltage of VSWR Overload SCR, A7Q8. The response time of the VSWR Foldback Circuit is relatively slow. A sudden significant increase in VSWR - as in an arc - would cause the VSWR Overload SCR to fire. Power to the transmitter is removed, the VSWR Overload LED is illuminated and the VSWR Foldback Circuit is disabled for ten seconds. The VSWR Foldback Circuit is disabled to allow the VSWR Overload Circuit to sample the VSWR at full power thereby preventing operation into a dangerously deficient load.

4-5.5 OVERLOAD PROTECTION

Relays A22K6, A22K7, and A22K9 are adjusted to energize and remove power from the transmitter when an overload occurs in the plate, screen, or driver supply or when the VSWR exceeds a preset level. Screen current through A14R15 produces a voltage that is applied to relay A22K7 through A22R65. Plate current through A14R16 produces a voltage that is applied to relay A22K6 through A22R66. Driver current through A17R33 produces a voltage that is applied to relay A22K8 through A22R60. When SCR A7Q8 is gated on, a ground is applied and A22K9 is energized. Each relay is adjusted to trip at a factory preset current level. The relay contacts are in series with plate control relay A19K3. If an overload occurs, the corresponding relay trips and de-energizes A19K3, removing plate power from the transmitter.

4-5.6 OVERLOAD AND RECYCLE BOARD A7

Overload and recycle board A7 contains circuits that provide overload indication and memory, automatic power on recycling, and filament control circuit interlock status.

When an overload occurs in the PA plate PA screen, VSWR, or driver plate, a 28-volt pulse is supplied to the appropriate SCR (Q4 through Q7). The SCR latches and lights its associated LED indicator (CR6 through CR9) to indicate which overload has occurred. All indicators that have been lighted by an overload function remain lighted until FAULT RESET switch A1S11 on the main control panel is pressed. Plate voltage is removed by overload relays A22K6, A22K7, A22K8 or A22K9. The 28-volt pulse that triggers the SCR is simultaneously routed to the recycle circuit via diode CR10, CR11, CR12 or CR13 to be used to automatically restart the transmitter.

The automatic recycle circuit provides a timed, automatic restart pulse up to four times in a 30-second period. The supplied card is connected so only two restart pulses will occur in a 30-second period; but may be reconnected to allow four restart pulses in a 30-second period. Conversion from the 2-pulse to the 4-pulse production may be accomplished by removing the jumper between terminals A and B on the card and replacing it between A and C.

The auto recycle begins when the 28-volt pulse is applied to the base of transistor Q1 causing it to conduct. The output of Q1 is fed to timers U1 and U4. Timer U1 provides a 0.5-second delay, then triggers timer U2 which generates a 0.5-second output pulse. This pulse is fed through gate U3A to inverter Q3 which causes Q9 to conduct and charge capacitor C16. The charging current of 16 momentarily energizes K1 which closes the PLATE ON circuit through S2. The charging current of C16 also flows through RECYCLE PULSE indicator CR5 giving an indication of the recycle circuit operation.

Gate U3D conducts the output pulse from timer U1 to counter U5. Counter U5 counts the number of recycle pulses and provides a logic 1 output at terminal C when four pulses have been received. Depending on which terminal has been strapped to terminal A, two or four recycle attempts in a 30-second period will close gates U3A, U3B, U3C and U3D preventing any further attempts by the card to restart the transmitter. RECYCLE LOCKOUT indicator CR3 will light to indicate this condition. When the 30-second period of time U4 has elapsed, a pulse is generated, inverted by Q2, and applied to U5 to reset it to zero. This clears the memory and allows another sequence to begin. If the maximum count of two or four pulses has not been received in the 30-second period, the timer will also reset the counter automatically.

AUTO-RECYCLE switch S2 may be used to disable the auto recycle card when desired. This is usually done during tune-up or maintenance procedures. RECYCLE TEST switch S1 may be used to test the automatic recycle circuit during maintenance procedures by simulating an overload pulse at the input to the recycle circuit.

Filament control circuit interlock status indicators provide a visual indication of the condition of the filament protection circuit. The PHASE LOSS indicator CR14 is lighted when phase monitor A19K5 provides a 28-volt signal indicating all three primary power phases are present, balanced, not too low and of the proper sequence. CARD CAGE INTLK indicator CR15 is lighted when the card cage cover is in place. AIR INTLK indicator CR16 is lighted when sufficient cooling air to the PA tube is flowing. TEMP INTLK indicator CR17 is lighted when the PA tube exhaust air temperature is below 240 degrees F +/-10 degrees F. The switch will reclose at 200 degrees F temperature operating range of the PA tube. The READY indicator is lighted when the 30-second filament warm-up time has expired and the transmitter is ready for the application of plate voltage. These indicators are in series and in sequence from top to bottom as they are connected in the circuit. Therefore, an interlock must be satisfied before its status indicator will light or any indicator that follows it will light.

4-5.7 POWER FAILURE RECYCLE BOARD A19A1

In the event of momentary loss of primary power, the power failure recycle circuit will restore the transmitter to operational status. Capacitor C3 maintains current flow through time delay relay A19K4 keeping the time delay circuit active for short term power outages and a separate circuit provides a momentary ground at pin 10 when power is restored. The momentary ground is applied to A7C16 and the charging current of A7C16 pulls relay A7K4 in and initiates the power on command.

4-5.8 LATCHING RELAY AND STATUS INDICATOR BOARD A12

The latching relays permit local or remote selection of manual or automatic power control.

The latching relay is connected to the remote control panel through A17TB4 (Figure 4-10). A +28-volt signal applied buy local control switch A1S5 or through remote control interface terminal board A17TB4 will latch relay K1 in one of two stable states. AUTO PWR CONTROL indicator CR17 indicates automatic power control is selected and MAN PWR CONTROL indicator CR18 indicates manual power control is selected.

Visual indication of TRANSMITTER CONTROL REMOTE/LOCAL switch A20S10 is given by status indicators CR15 and CR16. CR15 lights when local control is selected and CR16 lights when remote control is selected.

Plate control circuit interlock status indicators are provided on the A12 board. RMT PLT OFF INTLK indicator CR5 is lighted when optional remote relay A2A1K4 is de-energized. (If optional remote relays are not used, this relay will be jumpered and CR5 will always be lighted.) PA GRID DOOR INTLK indicator CR6 is lighted when the PA grid compartment door is closed. PA DOOR INTLK indicator CR7 is lighted when the PA plate compartment door is closed. L REAR PNL INTLK indicator CR8, C REAR PNL

INTLK indicator CR9, R REAR PNL INTLK indicator CR10, C FR PNL INTLK indicator CR11 and R FR PNL INTLK indicator CR12 are panel interlock status indicators that are lighted when the respective panels are in place. Panel designations refer to the three bays of the transmitter cabinet (left, center and right) as viewed from the front of the transmitter. RMT INTLK indicator CR13 is lighted when continuity exists between remote control interface terminal board terminals 23 and 24.

FAILSAFE INTLK indicator CR14 is lighted when remote relay A2A1K1 is energized. (If optional remote relays are not used, LOCAL/REMOTE switch A20S10 will bypass this interlock in the LOCAL position.) Indicators CR5 through CR14 are in series and in sequence from top to bottom as they are connected in the circuit. Therefore, an interlock must be satisfied before its status indicator will light or any that follow it will light.

4-5.9 BLOWER OFF DELAY

A blower off delay circuit maintains power to the cooling blower after the transmitter is turned off for a set time delay of up to 3 minutes to allow the transmitter to cool down for component protection. Relays A19K7 and A19K8 are part of this circuit.

4-5.10 POWER CONTROL RELAYS P/O A9

Unit provides remote manual power lower and raise control (Figure 4-11). When power is decreased at the remote control panel, relay A9K6 is energized closed contacts 7 and 9 provide 115 VAC to motor A20B5 which adjusts the resistance of A20R43 to decrease the transmitter power output. When the power is increased at the remote control panel, relay A9K7 is energized and closed contacts 7 and 9 provide 115 VAC to motor A20B5 which adjusts the resistance of A20R43 to increase the transmitter power output.

4-5.11 REMOTE RELAYS P/O A9

Remote relays Unit A9 parallels the front panel control operations. All relays, except A2K1 and A3K1, and switches are momentary in operation. Failsafe relay A2K1 is energized only when +28-volts is present in the control circuit. If +28-volts is lost, the relay de-energizes and removes plate power from the transmitter. Second power level (low power) relay A3K1 must also be energized continuously (28V) to maintain this function.

4-5.12 REMOTE CONNECTIONS

Typical remote interconnections to remote control terminal board TB4 are given in Figure 4-12.

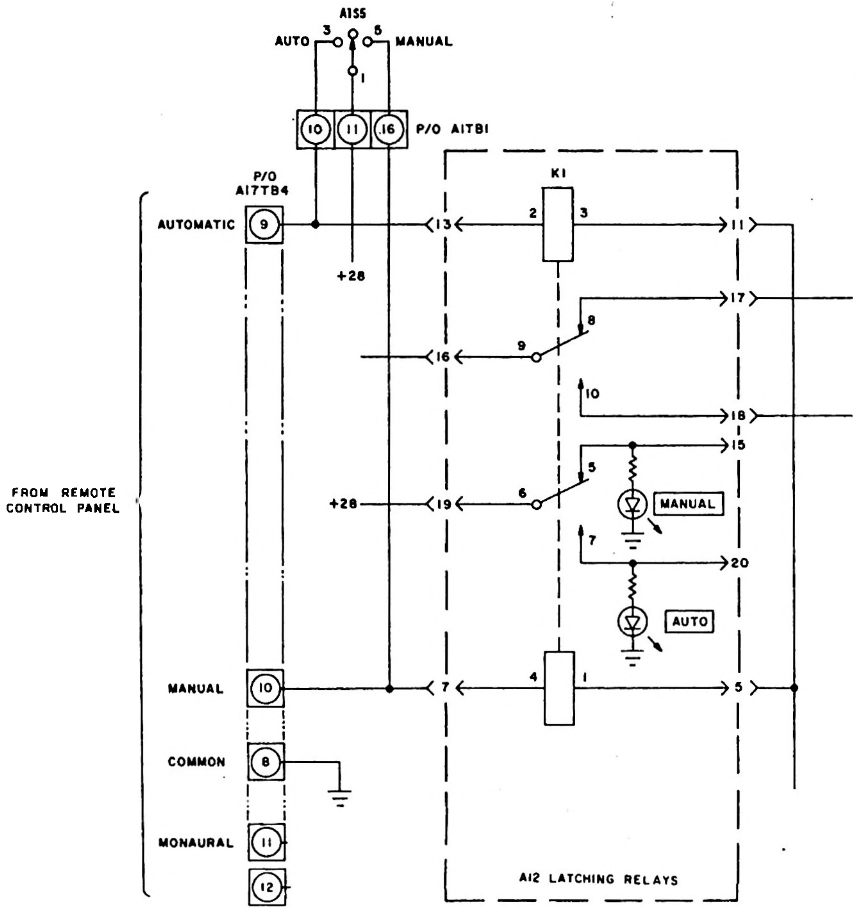


Figure 4-10. Latching Relays A12, Simplified

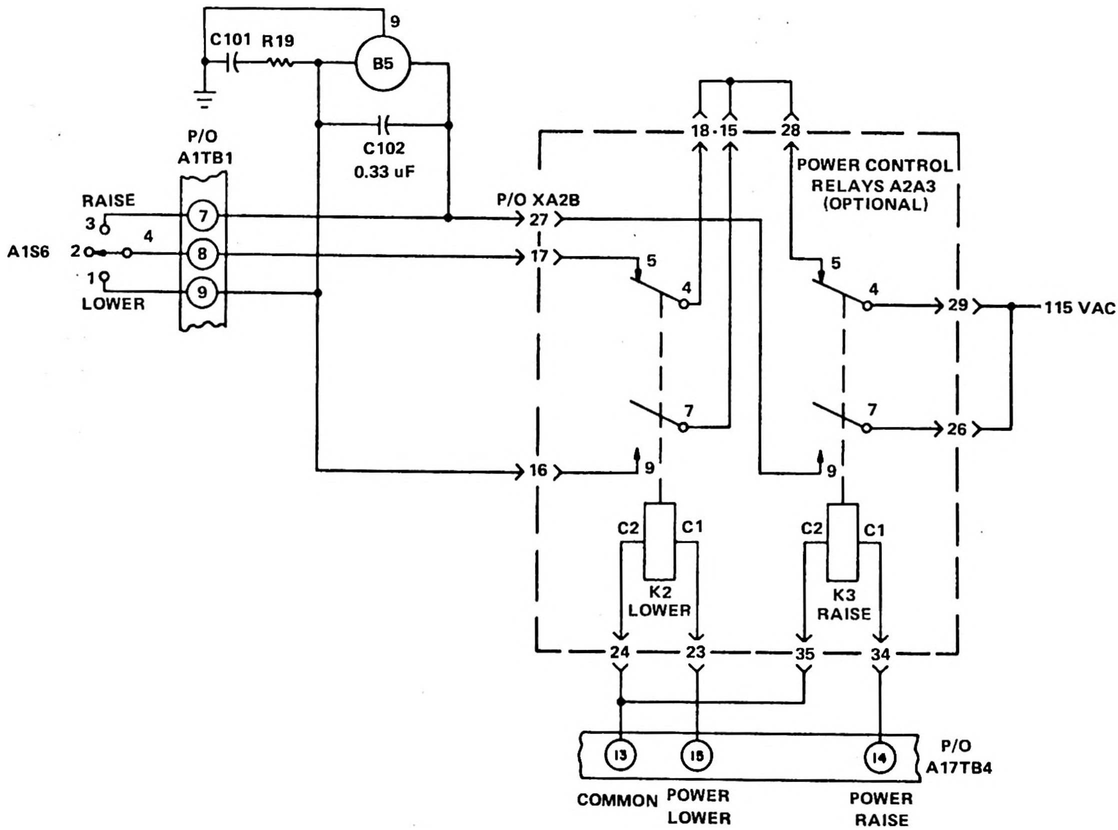
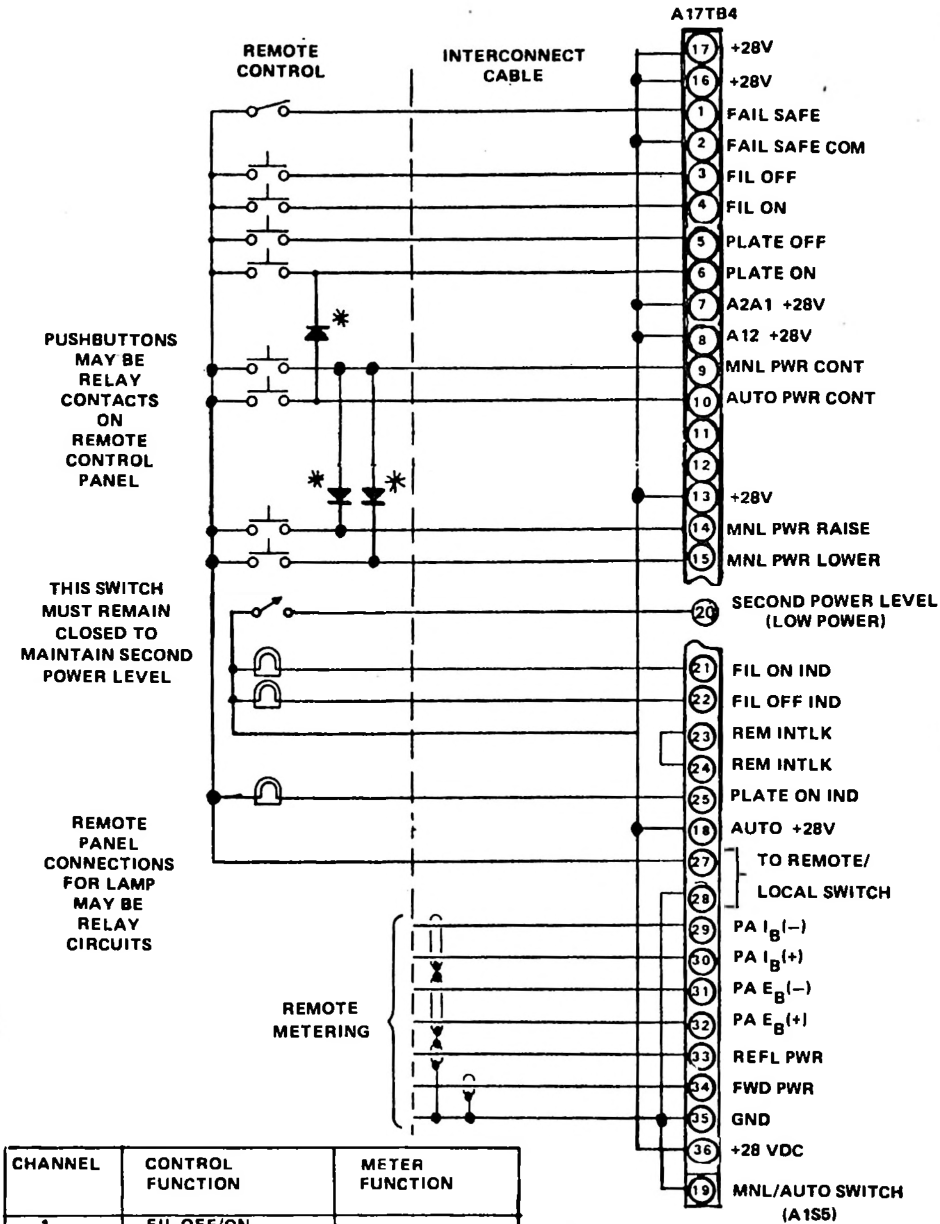


Figure 4-11. Power Control Relays P/O A9 Simplified Schematic



CHANNEL	CONTROL FUNCTION	METER FUNCTION
1	FIL OFF/ON	–
2	PLATE OFF/ON	PLATE VOLTS
3	MANUAL/AUTO	PLATE CURRENT
4	PWR RAISE/LOWER	FWD PWR
5		REFL PWR

TYPICAL REMOTE CONTROL CHANNEL ASSIGNMENT

*NOTE: AS SHOWN, THE STEERING DIODES (NOT SUPPLIED) ENSURE THAT THE TRANSMITTER IS PLACED IN THE AUTOMATIC POWER CONTROL MODE WHEN THE PLATE ON CONTROL IS ENERGIZED AND ALSO THAT THE TRANSMITTER IS PLACED IN MANUAL POWER WHEN EITHER THE MANUAL POWER RAISE OR MANUAL LOWER CONTROL IS ENERGIZED. ALL DIODES ARE 1N4007 OR EQUIVALENT (CE NO. 353-6442-070).

Figure 4-12. Remote Control Connections to Terminal Board A17TB4

SECTION 5 - MAINTENANCE

5-1. ROUTINE MAINTENANCE

The transmitter is carefully inspected and adjusted at the factory to reduce maintenance to a minimum. To ensure peak performance, adhere to a regular schedule of periodic checks and maintenance procedures. Refer to the parts list, section 6, for component location in the transmitter.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR IF YOU FAIL TO OBSERVE SAFETY PRECAUTIONS. WHEN WORKING INSIDE THE EQUIPMENT, BE SURE THAT ALL CIRCUIT BREAKERS ARE OFF AND THAT PRIMARY POWER IS DISABLED AT THE WALL DISCONNECT OR CIRCUIT BREAKER UNLESS OTHERWISE DIRECTED. ALWAYS SHORT ALL HIGH VOLTAGE TERMINALS TO GROUND WITH THE GROUNDING STICK PROVIDED.

5-2. CLEANING

Clean the transmitter when dust accumulation occurs anywhere inside the equipment. A solvent of trichlorethylene may be used as a cleaning material.

5-2.1 GENERAL CLEANING PROCEDURES

1. Remove dust from chassis, panels, and components with a soft-bristled brush.

2. Remove foreign matter from flat surfaces and accessible areas with a lintless cloth moistened with solvent. Dry with a clean, dry, lintless cloth.

3. Wash switch and relay contacts with relay contact cleaner and less accessible areas with solvent lightly applied with a small soft-bristled brush.

5-2.2 AIR FILTER

The air filter should be cleaned whenever a perceptible quantity of dust and dirt accumulates on the filter element. Remove and clean the filter as follows:

1. Remove the cross-wire brace that holds the filter in place.

2. Remove the filter.

3. Use a vacuum cleaner to remove heavy dust accumulation from the filter.

4. Blow a stream of air through the filter in a direction opposite to normal air flow.

5. Wash the filter in a solution of hot water and detergent.

6. Replace the filter when dry.

5-2.3 TUBE CLEANING

The power amplifier and driver tubes should be cleaned when a visible quantity of dust accumulates on the cooling fins of the tubes. Carefully remove the tubes from their sockets and clean each with a dry, oil free jet of air.

5-3. INSPECTION

Inspect the transmitter at least once a week. Check all metal parts for corrosion and general deterioration. Examine wiring and components for signs of overheating. Ensure that all controls are operating smoothly. Inspect all connections and tighten any nuts, screws, or bolts found loose. Examine the blower and cabinet fans for normal operation.

5-4. LUBRICATION

The tuning and loading motor and the manual power increase/decrease motor are sealed and do not require lubrication. The cabinet inlet fan motor (B4) and the PA cavity blower motor (B1) should be lubricated with SAE 10 oil as required.

5-5. PARTS REPLACEMENT

5-5.1 9019/YC130 PA TUBE

1. Remove air shields (tube chimney) between the PA blocker and the cabinet base. Loosen the two bands on PA blocking capacitor and slide it down over the PA tube.

2. Remove the anode lead.

3. Carefully lift the tube and PA blocking capacitor out of its socket, taking care to prevent bending or breaking the socket's finger contacts. They are fragile!

4. Reverse the procedure to replace the tube.

5-5.2 4CX250B DRIVER TUBE (Refer to Figure 5-1)

1. Open PA Grid Compartment door.

2. Loosen clamp around tube and remove clamp.

3. Pull tube out of socket.

4. Note that the tube is keyed to go into the socket only one way. Care must be taken when replacing the tube to align the key of the tube with the tube socket before pushing the tube back into the socket.

5. Reinstall clamp and tighten, being careful to avoid making clamp so tight as to deform the anode cooling fins. Also be certain that the clamp captures the Plate DC Blocking Capacitor bracket.

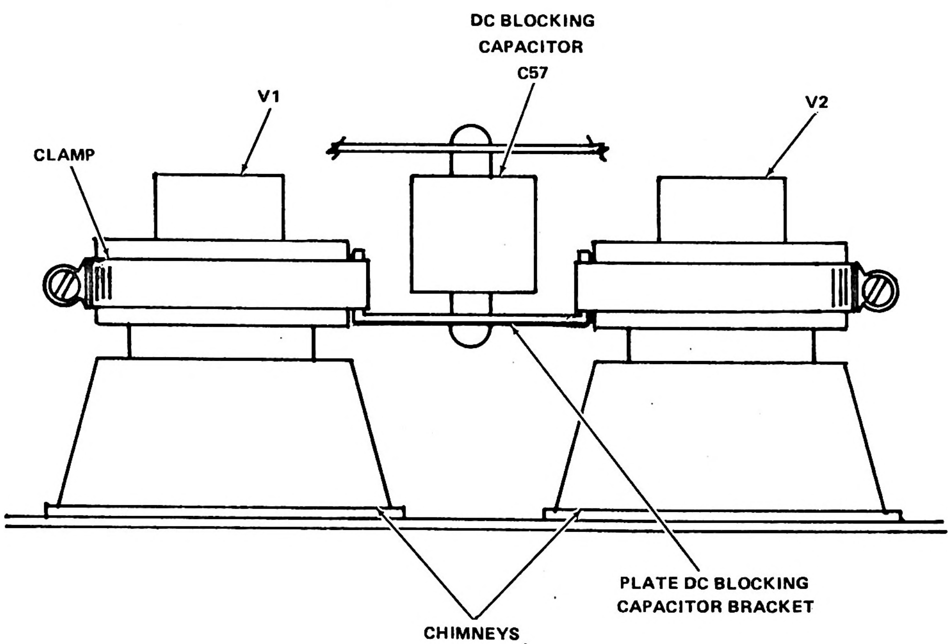


FIGURE 5-1. DRIVER TUBE REPLACEMENT

5-5.3 CONTROL PANEL INDICATOR LAMPS

1. Pull the switch out and rotate it 90 degrees ccw; the lamp assembly should pop out.

2. Remove the defective lamp by pressing down on the bulb.

3. Reinsert new bulb and replace the assembly.

5-5.4 FUSE REPLACEMENT

Turn AC line breaker off before removing or installing fuses.

5-6. TROUBLESHOOTING

If the transmitter fails to operate properly, check each circuit in the order that it is made operative. Use the simplified schematics in section 4 and the overall schematic in section 7 when needed. Normal control panel meter readings are provided in Tables 5-4 and 5-5. Efficiency graphs are provided in Figure 5-10.

5-6.1 ACCESS PANEL INTERLOCK SWITCH

The access panel interlock switches must be blocked open to perform certain adjustment procedures. To block the panel switch to open, push in on the plunger and insert two insulated blocks between the switch contactors. Remove the insulated blocks before replacing the panel.

5-6.2 TEST EQUIPMENT

Table 5-1 lists the test equipment necessary to maintain the transmitter.

TABLE 5-1. REQUIRED TEST EQUIPMENT

NAME	DESCRIPTION	MANUFACTURER AND MODEL
Volt-ohm-milliammeter	Test Meter	Triplett 630-N
AC Voltmeter	0 to 10 volts, 1% tol	Weston 433 (true RMS)
Power Supply	0 to 28 volts DC, 6 amps	
RF Wattmeter	5kW and 40kW elements,	Bird 460 50 to 125 MHz
Thruline Wattmeter	0-50 Watt element	Bird 43
DC Voltmeter	0 to 10 kV, 1% tol	
DC Ammeter	0 to 5 amperes, 1% tol	

5-7. ADJUSTMENTS

All transmitters are factory adjusted and pretuned to specific customer requirements. No adjustments are required by the customer unless a broken part is replaced, a specific assembly does not display meter readings within allowable tolerances, or the transmitter is operated at a frequency or power output different, from the frequency or power output specified in the production test data supplied with the transmitter.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR IF YOU ARE NOT EXTREMELY CAREFUL WHEN YOU PERFORM THE FOLLOWING PROCEDURES.

NOTE

The 28-volt power supply is on when both the 28V supply breaker and AC line breaker are on.

Unless otherwise indicated, the POWER CONTROL switch is set to MANUAL, the POWER switch is set to FORWARD, the AUTO RECYCLE switch is set to OFF, and all circuit breakers are set to ON during adjustment procedures.

5-7.1 SWITCH ADJUSTMENTS

5-7.1.1 AIR INTERLOCK SWITCH S1

1. Press the PLATE OFF and FILAMENT ON switches on control panel A1.

2. Remove the rear panel behind the plate cavity.

3. Adjust the tension bolt on switch S1 so that the green filament light goes out when the PA grid compartment door is opened approximately 1 inch.

5-7.1.2 TUNING MOTOR LIMIT SWITCHES S11, S12, S13, AND S14

1. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

2. Remove the rear panel behind the plate cavity, or the side panel next to the cavity.

3. Loosen the mounting screws on the limit switch.

4. Position the limit switches so that the peg mounted to the rack gear causes the switch to trip before the peg runs into either end-stop. The tuning and loading paddles must never be closer than 5/8 inch from the blocking capacitor.

5-7.2 FILAMENT VOLTAGE ADJUSTMENT

1. Press the PLATE OFF and FILAMENT OFF switches on the control panel A1.

2. Open the PA grid compartment and connect a 0- to 10-volt true RMS AC 1 percent meter to the PA filament rings on the tube socket.

3. Run the meter leads out the corner of the compartment and close the PA compartment door.

4. Remove the cover from the control circuits card cage and pull the plunger on the card cage interlock all the way out.

   Turn main circuit breaker A25CB1 off.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. THE SHAFT OF VARIABLE TRANSFORMER A19T7 HAS HAZARDOUS VOLTAGE TO GROUND WHEN FILAMENT CONTACTOR IS ENERGIZED. DEATH ON CONTACT MAY OCCUR IF YOU ARE NOT EXTREMELY CAREFUL WHEN YOU PERFORM THE FOLLOWING PROCEDURES.

5. Loosen motor coupling set screws on variable transformer A19T7 (Right side panel) end of coupling.

   Turn Main Circuit Breaker on.

6. With A5S1 (Filament Regulator Card) in MANUAL position, run variable transformer drive motor until limit switch actuator arm is against the Upper (CW) limit switch.

7. Press FILAMENT ON switch on control panel A1.

8. Adjust variable transformer A19A2T1 with an insulated rod for an indication of 7.8 volts AC. Note the filament meter reading - if filament meter does not agree with calibration meter, then adjust A20A1R1 (Filament Meter Calibration) until it does. Remove primary power and move the wire on terminal 4 of A19A2T1 to terminal 2 if you cannot get 7.8 vac by the above adjustment.

9. Press FILAMENT OFF switch on control panel A1. Turn OFF Main circuit Breaker (A25CB1).

10. Tighten set screws on variable transformer end of motor coupling.

11. Turn Main Breaker (A25CB1) back on. Press FILAMENT ON switch on control panel A1.

12. Place A5S1 (Filament Regulator Card) in AUTOMATIC position.

13. Adjust A5R3 for an indication of 7.5 volts AC.

14. The useful life of the PA Tube can be doubled by using the filament voltage management program described in EIMAC Application Bulletin AB-18. A reprint of this bulletin titled "Extending Transmitter Tube Life" is included in this manual under the Tube Data Sheet tab.

5-7.3 DRIVER FILAMENT VOLTAGE ADJUSTMENT

NOTE

This procedure should be performed only after procedure in 5-7.2 has been completed.

1. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

2. Remove the front panel beneath the grid compartment door and the lower front panel of the center bay.

3. Connect an AC voltmeter across terminals 3 and 4 of driver filament transformer A11T6.

4. Press FILAMENT ON switch and adjust DVR FIL VOLTS ADJUST control A11R64 to produce an indication of 6.0 +/-0.1 volts on the AC voltmeter when PA Filament is at 7.5 volts AC.

5-7.4 DC OVERLOAD ADJUSTMENT

1. Press the PLATE OFF and FILAMENT OFF switches on control panel A1. Turn DRIVER POWER SUPPLY, PA SCREEN POWER SUPPLY and PA PLATE POWER SUPPLY circuit breakers OFF.

2. Remove the front panel beneath the PA grid compartment door.

DRIVER OVERLOAD ADJUSTMENT

3. Connect a milliammeter from the positive terminal of an adjustable 28V DC power supply to TB8-6 on the transmitter.

4. Connect the negative terminal of the DC power supply to the transmitter chassis.

5. Raise the power supply current to 600mA and note to see if overload occurs.

6. If overload does not trip then adjust DVR OVLD ADJ A11R60 to trip relay A22K8 at this current. (The DR PLATE O/L fault indicator on the overload/recycle board lights when the relay trips.) If overload trip occurs at less than 600 mA, adjust A11R60 until overload trip occurs at 600 mA.

7. Disconnect the milliameter and remove the jumper from the DC power supply to the chassis.

PA PLATE OVERLOAD ADJUSTMENT

8. Connect an ammeter from the positive terminal of an adjustable 28-volt DC power supply to A14R15-1.

9. Connect the negative terminal of the DC power supply to A14R16-1.

10. Raise the DC power supply current to 5.6 amperes.

11. If overload does not occur, then adjust PA PLATE OVLD ADJ A22R66 to trip relay A22K6 at this current. (The PA PLATE O/L fault indicator on the overload/recycle board lights when the relay trips.) If overload trip occurs at less than 5.6A, adjust A22R66 to raise trip point to 5.6A.

12. Disconnect the ammeter and remove the jumper from the DC power supply to A14R16-1.

PA SCREEN OVERLOAD ADJUSTMENT

13. Connect a milliammeter from the positive terminal of an adjustable 28-volt power supply to TB8-5.

14. Connect the negative terminal of the DC power supply to TB8-4.

15. Raise the power supply current to 600mA.

16. If overload does not occur, then adjust PA SCREEN OVLD ADJ A22R65 to trip relay A22K7 at this current. (The PA SCRN O/L fault indicator on A7 lights when the relay trips.) If overload trip occurs at less than 600 mA, adjust A22R65 to raise trip point to 600 mA.

17. Disconnect the milliameter and remove the jumper from the DC power supply to TB8-4.

18. Press the FAULT RESET switch on control panel A1.

5-7.5 PA GRID CURRENT AND DRIVER SCREEN CURRENT METER CALIBRATION

1. Press PLATE OFF and FILAMENT OFF switches on control panel A1. Turn DRIVER POWER SUPPLY, PA SCREEN POWER SUPPLY and PA PLATE POWER SUPPLY circuit breakers OFF.
2. Remove the front panel beneath the PA grid compartment door.
3. Connect the negative terminal of an adjustable 28-volt DC power supply to A22E78 and the positive terminal to A22E77.
4. Adjust the DC power supply current to 400 mA.
5. Set the TEST METER selector switch to PA GRID 400 mA.
6. Adjust PA GRID MTRG CAL CONTROL A22R72 FOR A 400 mA READING ON the test meter.
7. Remove the DC power supply test leads.
8. Attach the positive terminal of the DC power supply to A22E76 and the negative terminal to A22E75 and adjust the DC Power Supply current to 80 milli-amps.
9. Set the TEST METER selector switch to DVR SCREEN 80 MA.
10. Adjust the DVR SCREEN MTRG CAL control A22R73 from an 80-mA driver screen current reading on the TEST METER.
11. Remove the DC power supply test leads.

5-7.6 HIGH VOLTAGE POWER SUPPLY STATIC CHECK (NO DRIVE)

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR IF YOU ARE NOT EXTREMELY CAREFUL WHEN YOU PERFORM THE FOLLOWING PROCEDURES.

1. Remove the lower front panel below the exciter and block open the interlock switch.
2. Press the MUTE button on the exciter.
3. Press the FILAMENT ON and PLATE ON switches on control panel A1.
4. Raise or lower the POWER ADJUST control until approximately 9800 volts is indicated on the PLATE VOLTAGE meter.
5. Set TEST METER select switch to PA SCREEN 800 V. Observe that approximately 750 volts is indicated on the TEST METER.

6. Set TEST METER select switch to DVR SCREEN 400 V. Observe that 280 +/- 10 volts is indicated on the TEST METER.

7. Set TEST METER select switch to DVR PLATE 4000 V. Observe that 1800 to 2000 volts is indicated on the TEST METER.

8. Set the TEST METER selector switch to the LEFT DVR K 400 MA position. Test meter should indicate less than 100 mA.

9. Set the TEST METER selector switch to the RIGHT DVR K 400 mA position. Test meter should indicate less than 100 mA.

10. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

11. Replace all panels and close all compartment doors.

5-7.7 A3 FWD/REFL CAL AND POWER CONTROL CARD ALIGNMENT PROCEDURE

NOTE

Routine maintenance is not required and will be necessary only if major part damage has occurred. Adequate test equipment is required for proper, accurate alignment.

A. Offset Nulls

1. Place the A3 card on the extender board. Turn on only the transmitter filaments and allow the components to temperature stabilize for at least fifteen minutes.

2. Use a high impedance DC Voltmeter to measure the voltage at TP1. Adjust Resistor R25, FWD OFF, set for zero voltage at TP1.

3. Use a high impedance DC Voltmeter to measure the voltage at TP2. Adjust Resistor R26, REFL OFFSET, for zero voltage at TP2.

4. Use a high impedance DC Voltmeter to measure the voltage at pin 6 of U7, most easily accessible at either end of Resistor R37. Adjust R33, OFFSET ADJUST, for zero voltage at pin 6 of U7.

B. Forward Power Calibration

1. Adjust the transmitter to normal power output using the manual power control. An indirect power calculation may be used if an external power meter is not available.

2. Adjust R14, FWD CAL, to indicate 100% on the output power meter, A1M4. DO NOT ADJUST THIS CONTROL AGAIN. Increase the power control to maximum output power. Refer to the test data for proper Plate Screen and Driver Transformer Taps if the maximum power output exceeds 105%. The maximum power should not exceed 105% unless unusual circumstances exist.

3. Switch to AUTO Power Control and adjust R7, PWR CNTRL ADJ for 100% power in the AUTO mode.

4. Apply +28 VDC to A17TB4, Terminal 20, to activate Relay A3K1.

5. Adjust R41, LP ADJUST, to the desired second power level.

C. Reflected Power and VSWR Protection Calibration

1. Remove transmitter primary supply. Remove the Thyrector Protection Assembly, VR1, from across the High Voltage Filter Reactor, L1, to prevent damage to the Thyrectors. Restore transmitter primary supply.

2. Use the Manual Power Control to reduce the power output to 10% of the desired operating TPO.

3. Turn the VSWR PROT switch, S1, OFF and reverse the direction of the top element in the Directional Coupler, DC1.

NOTE

Reflected Power (VSWR) trip point is factory adjusted to 10% of rated transmitter power or 10% of TPO if factory is advised of TPO. This level may not be desired and must be set by station engineer to safe level.

4. Adjust R24, REFL CAL, to indicate 10% Reflected Power. Full scale is 12% when Reflected Power is selected. DO NOT ADJUST THIS CONTROL AGAIN.

5. With plates OFF, depress TEST switch, S2, and adjust R27, REFL ADJ, for desired reflected (VSWR) level indication on panel power meter, A1M4. Full scale is 12%. Nuisance trips may occur if trip level is set less than 5%.

6. Turn VSWR PROT switch, S1, ON and adjust R20, VSWR PROT CAL,until a VSWR Overload occurs.

7. Remove all voltage, return the top element and VSWR PROT switch to normal. Reconnect the High Voltage Filter Reactor Thyrector Assembly, VR1, and return the transmitter to normal operation.

D. VSWR Foldback Adjustment

1. Turn VSWR PROT switch, S1, OFF and switch to AUTO Power Control.

2. Remove the low power element from the top, Reflected Power Position of the Directional Coupler, DC1.

3. Remove the high power element form the bottom, Forward Power Position of the Directional Coupler, DC1, and install it in the Reflected Power Position with the element arrow pointing toward the load.

NOTE

Foldback level should be set to fully CCW position unless ice conditions are likely.

4. Turn on the plate voltage and, in AUTO Power Mode, adjust R32, VSWR FOLDBACK LEVEL, to desired Reflected Power Level. Foldback level must be approximately half VSWR trip level or less.

5. Remove plate voltage, return the high power and low power Directional Coupler Elements to their proper sockets and direction. Return the VSWR PROT switch, S1, to ON and resume normal transmitter operation.

5-7.8 PHASE MONITOR ADJUSTMENT

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR IF EXTREME CARE IS NOT USED IN PERFORMING THE FOLLOWING PROCEDURES.

1. Remove primary power and the right front bay access panel.

2. Block the interlock grounding switch open.

Note

The phase loss/phase rotation monitor will shut the transmitter off when phase loss or incorrect sequence is detected. A phase loss will be detected if the line voltage drops below the threshold voltage level which is set by turning the control on K5. The threshold voltage range is 190-270V and it must be set below your lowest expected line voltage. To accomplish this, the line voltage should be at the lowest expected level when performing the following adjustment. *

3. Restore primary power.

4. Increase the phase loss threshold voltage by turning the control on K5 clockwise until the LED on K5 goes out. Turn the control counterclockwise slightly past the point where the LED comes back on.

5. Remove primary power.

6. Remove block from interlock/grounding switch.

7. Replace access panel.

5-7.9 BLOWER OFF DELAY ADJUSTMENT

1. Shut off main AC line breaker, A25CB1.

2. Remove the right front by access panel.

3. Set control on A19K6 (near Phase Monitor Module A19K5) for a minimum of 1 minute. It can be set for up to 3 minutes of turn-off delay.

4. Replace access panel.

5-8. CHANGING POWER

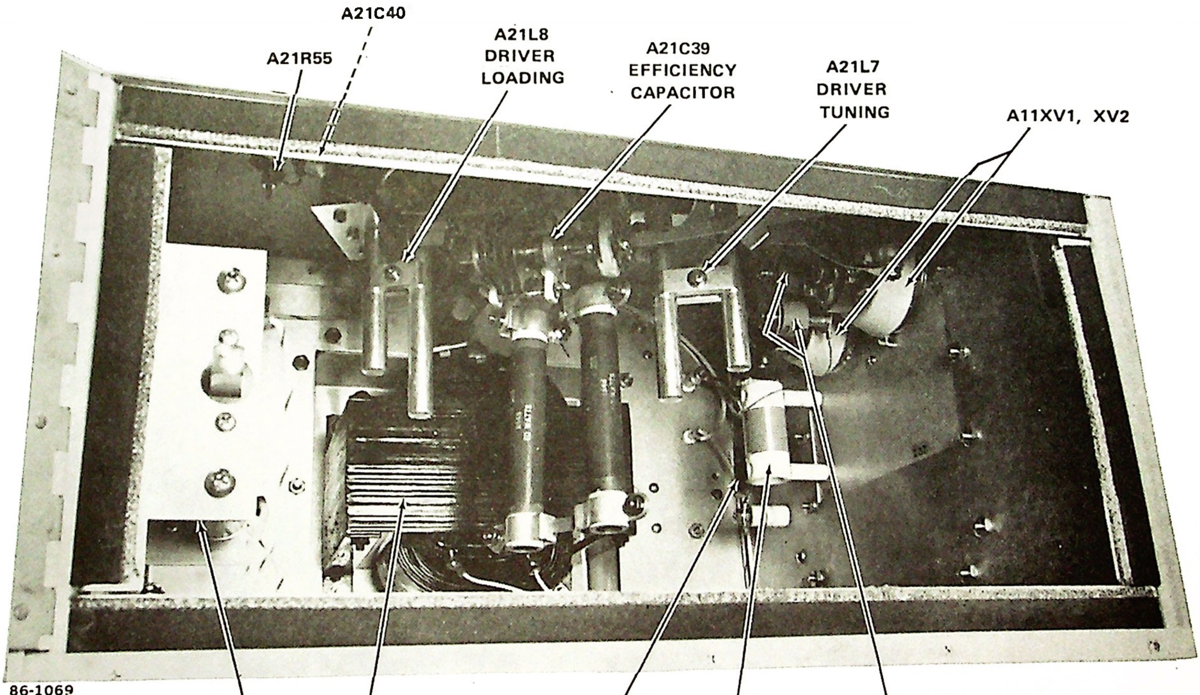
The power output is changed by changing taps on the Screen Transformer T2. PA Plate voltage is maintained high (9.5 to 9.8 kV) to keep efficiency high. (When operating the transmitter at 35 kW, the plate voltage is also maintained high to permit operation at a plate current of 4.8 A or less.) Using the data supplied at the end of this section as a guide, Table 5-2, and Screen Voltage Transformer Tap Schedule (Table 5-3), adjust the screen voltage to obtain the desired output power. To complete the power change, refer to paragraphs 5-7.7, 5-9.3, 5-9.4, 5-9.5, 5-9.6, and 5-9.7.

5-9. CHANGING FREQUENCY

NOTE

If power <u>and</u> frequency is to be changed, refer to Power Change, Paragraph 5-8, and change transformer taps as directed, then return to this paragraph to complete the frequency change procedure.

Major RF tuning is required only when components in the RF circuit are replaced or when the operating frequency is changed. Refer to the initial turn-on procedures (Paragraph 2-4.1 for minor tuning instructions.



NS1-30

Figure 5-2. Power Amplifier Socket, A21

The following paragraphs provide procedures for major RF tuning of the transmitter. If the operating frequency is the same as the frequency specified in the production test data supplied with the transmitter, perform the procedures in paragraphs 5-9.3 through 5-9.6. If the operating frequency is different from the frequency specified in the production test data supplied with the transmitter, perform the procedures in paragraphs 5-9.1 through 5-9.8.

NOTE

The data presented in the graphs (Figures 5-3, 5-4 and 5-5) is approximate and is intended only to get the transmitter tuning "in the ballpark".

5-9.1 SHORTING PLANE, DRIVER LOADING SLIDER, DRIVER TUNING SLIDER, DRIVER GRID SLIDER, PA NEUTRALIZATION, PA CATHODE RETURN CAPACITORS, PA BIAS, PA EFFICIENCY CAPACITOR, DRIVER BIAS, DRIVER NEUTRALIZATION PRELIMINARY ADJUSTMENT

NOTE

These adjustments are not necessary if the related components have not been replaced and the operating frequency is the same as the frequency specified in the production test data supplied with the transmitter.

1. SHORTING PLANE

   a. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

   b. Open the plate cavity and grid compartment doors.

   c. Adjust the plate cavity shorting plane (Figure 4-4) to the desired frequency in accordance with the graph in Figure 5-4.

2. DRIVER LOADING AND TUNING SLIDER Adjust driver loading slider, A21L8, and driver tuning slider, A21L7, (see Figure 5-2) to the desired frequency in accordance with the graph in Figure 5-4.

3. PA NEUTRALIZATION Adjust the PA neutralization bar to the desired frequency in accordance with the graph in Fig. 5-5.

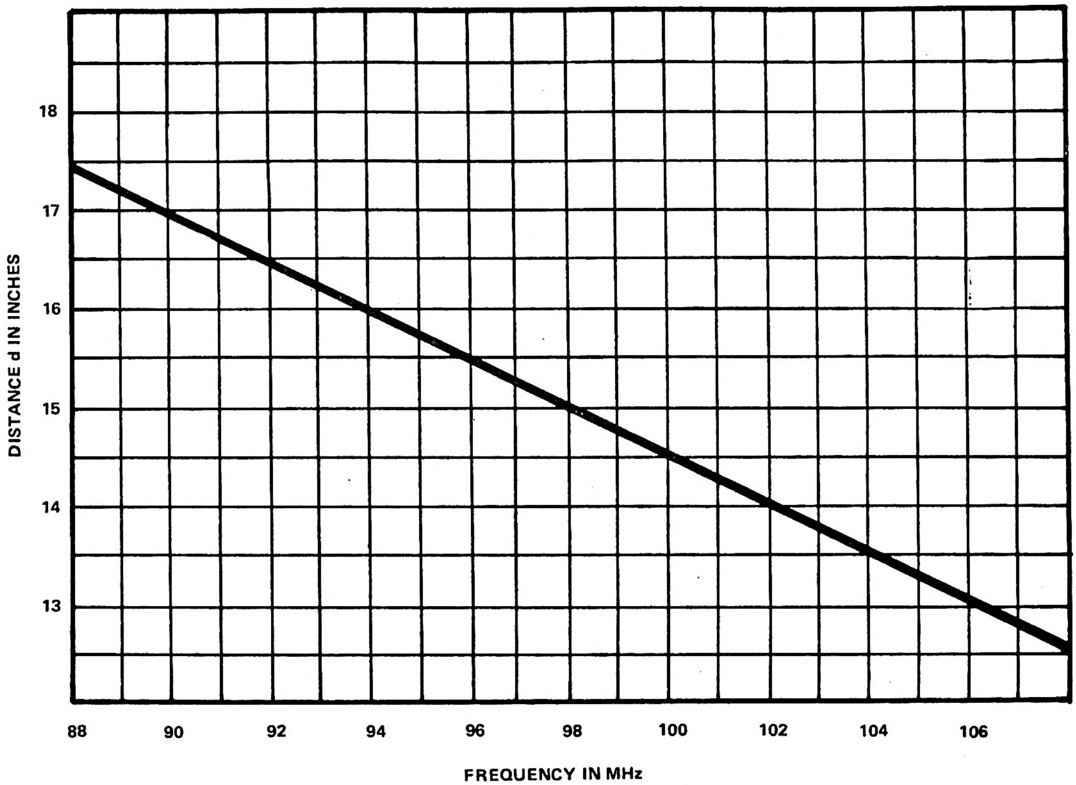
4. DRIVER GRID SLIDER Adjust driver grid slider A11L9 (see Figure 6-12) as follows:

   a. Remove the largest panel located beneath the exciter.

   b. Discharge all large capacitors.

   c. Remove the driver box access panel.

   d. Adjust driver grid slider, A11L9, to the desired frequency in accordance with the graph in Figure 5-4.



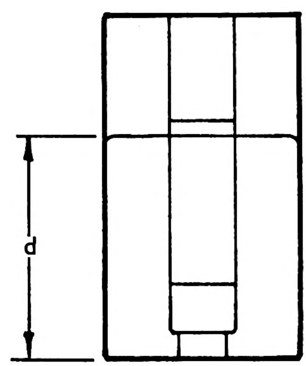


Figure 5-3. PA Plate Tuning Cavity Slider Approximate Adjustment

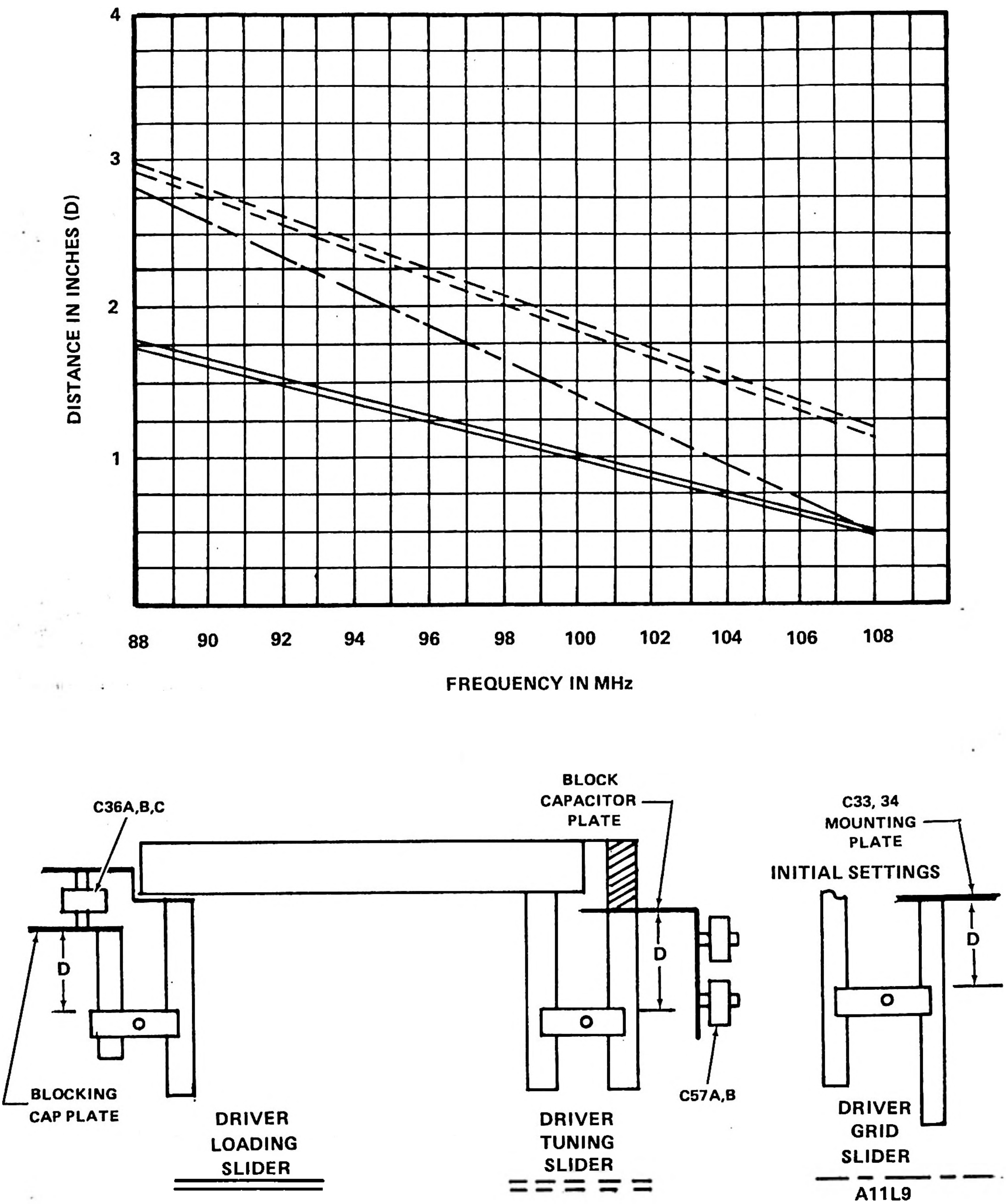


Figure 5-4. Graph for Approximate Setting of Driver Loading, Driver Tuning, and Driver Grid Slider

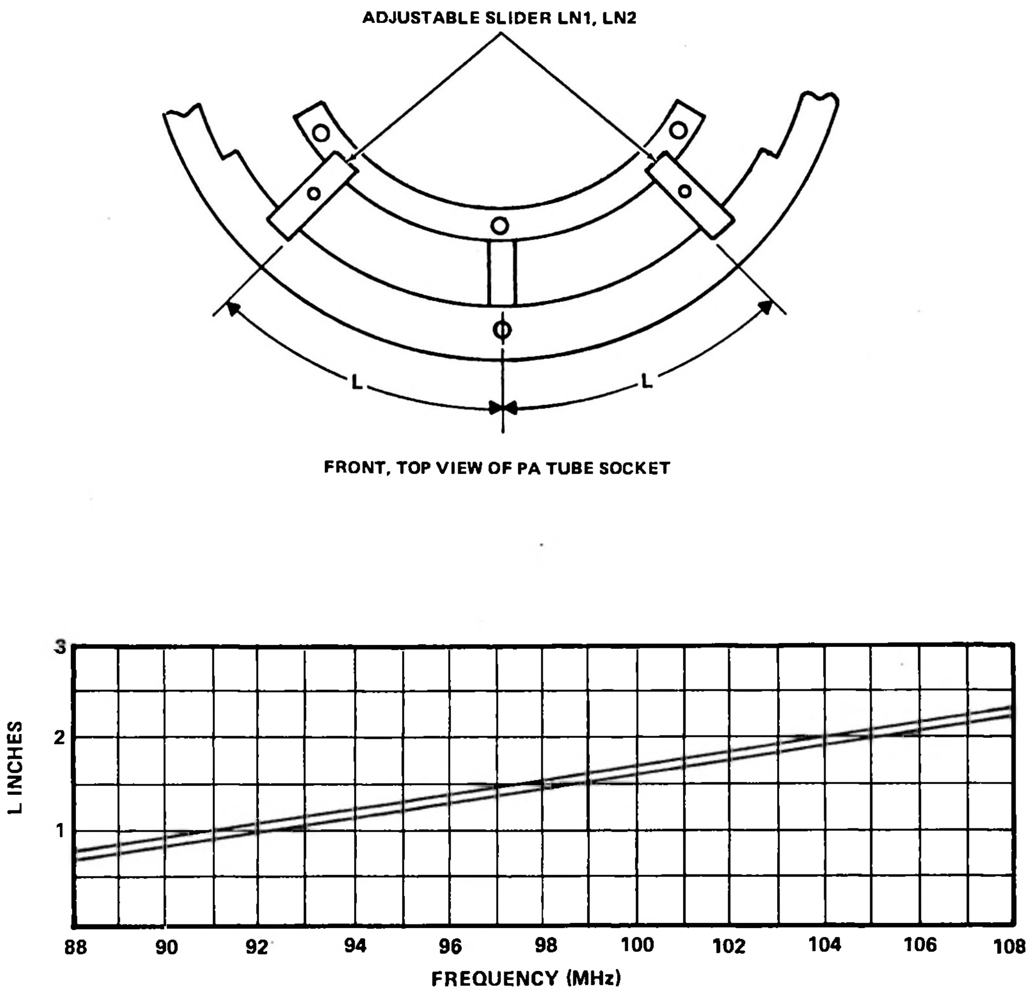


Figure 5-5. PA Neutralizing Adjustment

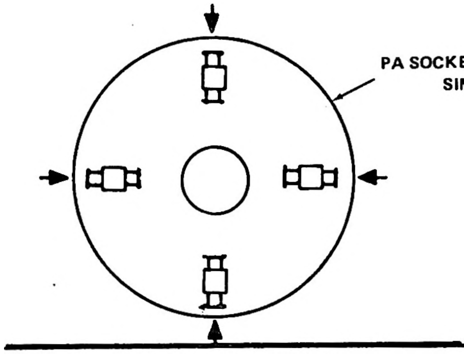


Figure 5-6. PA Socket, Cathode Return Capacitors

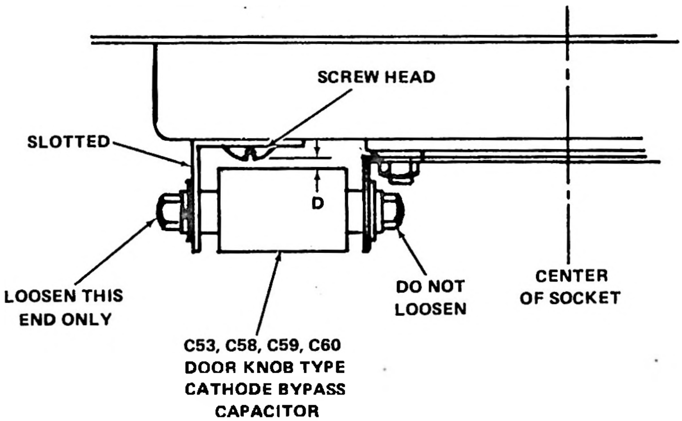


Figure 5-7. Adjustment of Cathode Return Capacitor

Distance between screw heads (pointed out) and capacitor body is called "d". See Above diagram. Move capacitor body up or down (loosened end only) until "d" is correct. It is important to set all capacitors the same. A small mirror or "feeler gauge" makes this adjustment easier.

FREQUENCY (MHz)	d (inches
88 - 94.9	3/32
95.1 - 101.7	1/16
101.9 - 108	0

5. PA CATHODE RETURN CAPACITORS Loosen only the screws indicated by an arrow on C53, C58, C59 and C60. (100 pf door knob capacitors). Do not loosen screws near the center of the socket. Set all four capacitors the same way. A small mirror or "feeler gauge" is helpful. Refer to Figures 5-6 and 5-7.

6. PA BIAS ADJ resistor A18R35 (behind PA cavity) should be set to the middle of its range.

7. EFFICIENCY CAPACITOR A21C39 Air variable mounted to bottom of PA socket and adjustable via a small black knob located between driver box and front of transmitter, see Figure 5-1, should be set to minimum capacitance, plates fully unmeshed.

8. DRIVER BIAS PRE-SET Set L DVR BIAS ADJ A11R40 and R DVR BIAS ADJ A11R44 to maximum clockwise position. (These controls are found on the Driver box.)

9. DRIVER NEUTRALIZATION PRE-SET Set driver neutralization paddle (in PA Grid compartment) so that it is half way between the PA chassis and the Plate to which C57a and C57b are attached. A small mirror is helpful.

5-9.2 DRIVER GRID TUNING

NOTE

This procedure is not necessary if the related components have not been replaced and the operating frequency is the same as the frequency specified in the production test data supplied with the transmitter.

1. Perform the preliminary adjustments in paragraph 5-9.1 before proceeding.

2. Tune the 802A exciter to the desired operating frequency. Refer to the 802A exciter instruction book. Press the PLATE OFF and FILAMENT OFF switches, located on the Control Panel, A1. Remove the largest panel located beneath the exciter and discharge all large capacitors.

3. Block the interlock grounding switch open.

4. Set DRIVER, PA SCREEN, and PA PLATE POWER SUPPLY circuit breakers A6CB3, A6CB4, and A6CB5 to OFF.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR IF EXTREME CARE IS NOT USED IN PERFORMING THE FOLLOWING PROCEDURES.

5. Press the FILAMENT ON and PLATE ON switches.

6. Adjust exciter POWER OUTPUT control until 15-watt forward power is indicated on exciter forward meter. Switch FWD/REFL switch of 802A exciter to read REFL POWER.

Note

It may not be possible to get 15W out of the exciter at this point as the reflected power may be high, thus causing the exciter to limit its power output. Subsequent tuning will correct this problem.

7. Adjust TUNE and COUPLE capacitors A11C33 and A11C34 on the driver box for minimum reflected power. Should be "0" or near "0".

8. Check that the TUNE capacitor is approximately one-half mesh when adjusted for minimum reflected power.

9. If the tune control is not approximately midrange, remove power from the transmitter, adjust A11L9, and repeat steps 5 through 8.

10. Adjust exciter power output for a driver grid current of 8-10 mA. Exciter power output is typically 15W. Repeat steps 7, 8, 9 and 10.

11. Turn transmitter OFF and replace all panels and close all compartment doors.

5-9.3 PA TUNING

1. Press PLATE OFF and FILAMENT OFF switches on control panel A1.

2. If possible, connect the transmitter to an RF wattmeter/ dummy load combination or a calorimeter capable of measuring and dissipating 35 kilowatts at 50 to 125 MHz. If these devices are unavailable, refer to the RF WATTMETER on the control panel for power output measurement.

CAUTION

DO NOT PERFORM THE REMAINDER OF THIS PROCEDURE IF THE TRANSMITTER IS NOT CONNECTED TO AN ANTENNA WITH A 50-OHM IMPEDANCE OR A DUMMY LOAD CAPABLE OF DISSIPATING AT LEAST 35 KILOWATTS.

3. Turn the DRIVER PLATE TUNING control fully counterclockwise. Then turn the control seven turns clockwise (Full CCW is maximum capacity. The full range of the capacitor is covered in 20 turns.)

4. Open the plate cavity access door and observe PA tuning and loading capacitors A18C51 and A18C50. (See Figure 4-4.) Adjust the PA TUNING and PA LOADING controls on the control panel until the two capacitors are positioned approximately midrange. Close the plate cavity door.

NOTE

An easier way to determine position of A18C51 and C50 is to look at the capacitor motor drive units. Each has a limit switch actuator bar that travels with the capacitor plate. When it is in the middle of its range so are the capacitors. Left side an center rear covers must be removed.

5. Set PA SCREEN circuit breaker to OFF. Ascertain that the exciter POWER switch and all other breakers are ON.

CAUTION

DO NOT EXCEED THE FOLLOWING MAXIMUM RATINGS:

LEFT DRIVER CATHODE CURRENT:	250 mA
RIGHT DRIVER CATHODE CURRENT:	250 mA
PA SCREEN CURRENT:	600 mA
PA PLATE CURRENT:	5.0 AMPERES

6. Place power control in MANUAL mode

7. Press the FILAMENT ON and PLATE ON switches on control panel A1.

CAUTION

PROLONGED OPERATION WITH THE PLATE IMPROPERLY TUNED MAY DAMAGE THE POWER AMPLIFIER.

8. Adjust the DRIVER PLATE TUNING for maximum PA Grid Current.

9. Adjust the PA TUNING and PA LOADING controls for a maximum output power indication.

10. Repeat steps 8 and 9 until maximum output power is obtained. If the PA TUNING control encounters an end-stop while in the LOWER position, lower the shorting plane and retune. If an end-stop is encountered in the RAISE position, raise the shorting plane and retune.

NOTE

Because of the relatively high output capacity of the 9019/YC130 tube and the resulting low cavity inductance, no plate current dip will be noted at higher power levels. Tuning and loading should be adjusted in steps for maximum output power.

CAUTION

MAXIMUM PA TUBE PLATE DISSIPATION IS 18KW. PROLONGED OPERATION WITH THE PLATE IMPROPERLY TUNED MAY DAMAGE THE POWER AMPLIFIER. PLATE DISSIPATION MAY BE CALCULATED AS FOLLOWS:

PLATE DISSIPATION (WATTS) = DC PLATE CURRENT (AMPERES) X DC PLATE VOLTAGE (VOLTS)-RF POWER OUTPUT (WATTS).

11. Turn PLATE off then turn SCREEN breaker on. After PA PLATE voltage has been dropped to less than 1 kV, turn PLATE ON.

    a. Tune DRIVER PLATE for maximum PA GRID current.

    b. Tune PA LOADING for maximum output power.

    c. Tune PA TUNING for maximum output power.

    d. Repeat a, b, c until no further increase in output power occurs.

    e. Check to be sure tube parameters are not being exceeded.

    f. Raise plate voltage (manual power control) and repeat a,b,c,d,e.

    g. Repeat a,b,c,d,e and f until desired power output is obtained.

12. Check for PA neutralization. Refer to paragraph 5-9.4.

13. Check Driver neutralization. Refer to paragraph 5-9.5.

NOTE

Compare the transmitter operating parameters with those in Tables 5-4 and 5-5. Some fine tuning of the previously pre-set adjustments may be needed to bring operating parameters into agreement with those found in the data. If efficiency needs improvement, adjustment of the efficiency capacitor (A21C39) and/or the PA cathode return capacitors may be needed. It is important that all capacitors be set the same. In general, the distance "d" must be reduced when going up in frequency; otherwise "d" is increased. Change "d" in 1/16" increments and record efficiency and "d" for each trial. Repeat step 12 for each trial as well.

14. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

15. Determine if plate tuning capacitor A18C50 is approximately halfway between its limits.

16. If plate tuning capacitor A18C50 is not approximately half way between its limits, adjust the PA plate cavity shorting plane (paragraph 5-9.1) and repeat steps 3 through 16 of this paragraph.

5-9.4 PA NEUTRALIZATION

1. Check the transmitter for proper neutralization by tuning the transmitter for a PA screen current peak and observing that maximum output power occurs at the same time. If neutralization is correct, do not perform the remainder of this procedure.

2. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

3. Open the PA cavity door. Short all high voltage terminals with grounding stick.

4. Remove front half of tube air guide to gain access to screen sliders.

5. Refer to Figure 5-5 and adjust the screen sliders LN1 and LN2. The sliders should not require an adjustment greater than +/-1/4 inch from the initial setting. (A setting on the plus side is preferred.)

6. Replace the tube air guide.

7. Close the cavity door and apply power to the transmitter.

8. Check for proper neutralization again. If incorrect, repeat steps 2 through 7.

NOTE

Always be sure that PA Neutralization is correct before checking Driver Neutralization.

5-9.5 DRIVER NEUTRALIZATION

1. Check for proper driver neutralization by adjusting the DRIVER PLATE tuning of the transmitter and noting that the DVR SCREEN current peak is coincident (or nearly so) with the peak of PA GRID current, and a dip of DVR K current. If neutralization is correct, do not perform the remainder of this procedure.

2. Press the PLATE OFF and FILAMENT OFF switches on control panel A1.

3. Open the tube socket access door directly beneath the DRIVER PLATE TUNING control.

4. Slightly adjust the paddle CN, attached to capacitor A11C35. There should be a minimum clearance of 1/4" between paddle and Driver Anode Plate.

5. Close the access door and recheck the driver neutralization.

6. Repeat steps 2 through 5 until proper neutralization is obtained.

7. If Driver neutralization cannot be obtained, return driver neutralization paddle to preset position (5-9.1) and fine tune the PA neutralization (5-9.4) using step 1 of 5-9.5 as the indicator of correct neutralization.

6-1. GENERAL

This section contains a list of all repairable/replaceable electrical, and critical mechanical parts for the 816R-5 FM Transmitter.

6-2. REF DES

This column contains the electrical reference designators of all parts that have been assigned on schematics or wiring diagrams, and/or index numbers for all parts for which reference designators have not been assigned. When a reference designator, within a series of reference designators, has not been assigned a part number, the unassigned referenced designator will be reflected as "NOT USED" in the DESCRIPTION column.

6-3. DESCRIPTION

This column contains the identifying noun or item name followed by a brief description. The description for electrical/electronic parts includes the application ratings and tolerances. For consecutively listed identical parts within an assembly, "SAME AS ---" is reflected in the description of subsequent listings, referencing to the first listing within the assembly.

6-4. CONTINENTAL ELECTRONICS PART NUMBER

The CED Specification or part number, for each item in the parts list, is reflected in this column.

6-5. ILLUSTRATIONS

All parts listed in the REF DES column are located on corresponding illustrations. The illustration usually precedes the parts list. When a replaceable electrical item is hidden from view by structural parts of wiring, a dotted leader line is used to show the locations of the item on the illustration.

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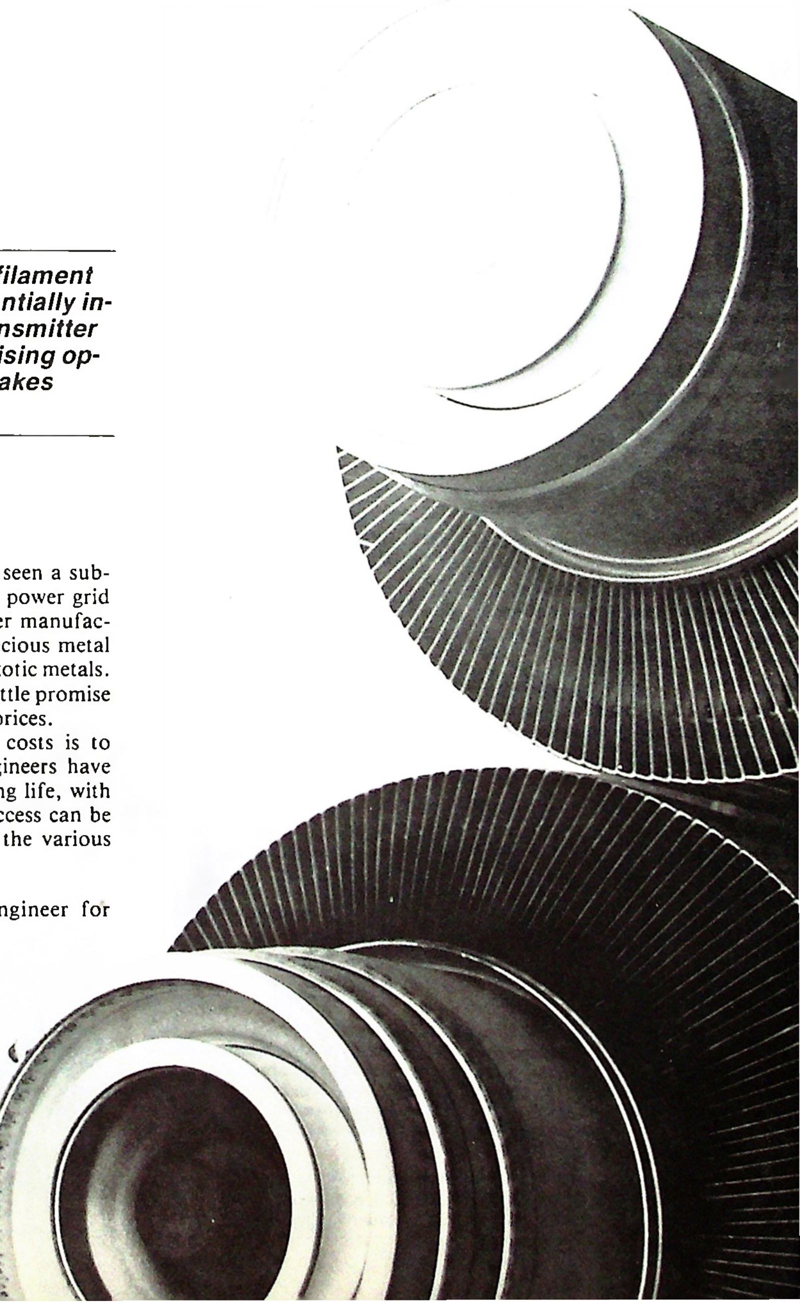
EXTENDING TRANSMITTER TUBE LIFE



By Robert Artigo

A carefully followed program of filament voltage management can substantially increase the life expectancy of transmitter power grid tubes. With today's rising operating costs, such a program makes good financial sense.

IN RECENT YEARS station managers have seen a substantial increase in replacement costs for power grid tubes. The blame can be placed on higher manufacturing costs due to inflation, volatile precious metal prices, and an uncertain supply of some exotic metals. The current outlook for the future holds little promise for a reversal in this trend toward higher prices.

One way to offset higher operating costs is to prolong tube life. For years station engineers have used various tricks to get longer operating life, with greater and lesser degrees of success. Success can be maximized, however, by understanding the various

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factors that affect tube life and implementing a program of filament voltage management.

A number of factors can aid maximum tube life in your transmitter. For example, are the maximum ratings given on the tube manufacturer's data sheet being exceeded? Data sheets are available upon request from most companies. Most tube manufacturers have an application engineering department to assist in evaluating tube performance for a given application. Make use of these services!

Headroom

Is the final power tube of the transmitter capable of delivering power in excess of the desired operating level? Or is the demand for performance so great that minimum output power levels can only be met at rated nominal filament voltage?

Figure 1 can be used as a basic guide to determine if a given transmitter and tube combination has a good probability of giving extended life service. Extended life service is defined as useful operating life beyond that normally achieved by operating at rated nominal filament voltage. The amperes/watt ratio is obtained by dividing average plate current by the product of filament voltage and filament current. If the amperes/watt ratio falls in the "good" to "excellent" range, excess emission is sufficient to permit filament voltage derating. At a lower filament voltage, the filament temperature is lowered, thus extending life. A typical FM transmitter on the market today may have an amperes/watt filament ratio of 0.002 to 0.003. This equipment would be considered an excellent choice to achieve extended tube life. On the other hand, if the amperes/watt ratio falls in the "poor" range, it is unlikely that filament derating is possible due to limited emission. Note that this guideline should be used for thoriated tungsten emitters only, and does not apply to oxide cathode-type tubes.

Instrumentation

Are all tube elements metered in the transmitter? Elements should be metered for both voltage and current, and meters should be redlined to define operation within safe limits. More modern transmitters may incorporate a microprocessor-controlled circuit to monitor all pertinent parameters.

In addition, the following controls are necessary if an effective filament voltage management program is to be undertaken: power output metering for an FM transmitter or a distortion level meter for AM equipment; *accurate* filament voltage metering (an iron-vane instrument is preferred over the more common average responding RMS calibrated type; the filament voltage measurement must be made at the tube socket terminals); filament voltage control, capable of being adjusted to 0.1 V secondary voltage change; and a filament current meter—desirable but optional.

A means must be provided to hold filament voltage constant. If the filament voltage is permitted to vary in accordance with primary line voltage fluctuation, the effect on tube life can be devastating. An acceptable solution is the use of a ferroresonant transformer or line regulator. This accessory is offered by some transmitter manufacturers as an option and should be seriously considered if a tube life extension program is planned.

Transmitter housekeeping

Once the transmitter has been place in operation, tube life is in the hands of the chief engineer. The first action to prolong tube life falls into the category of routine maintenance. Most transmitter manufac-

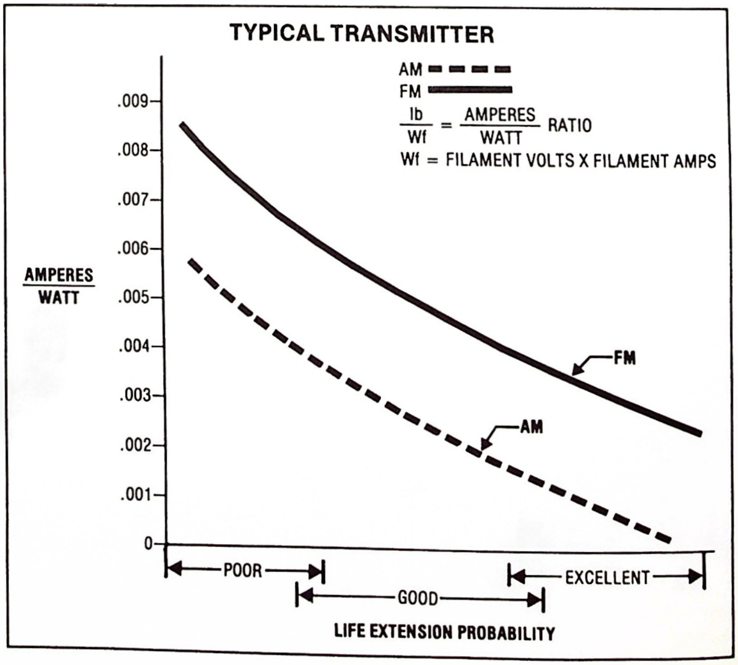


***Fig. 1.** Probability of extended life service can be determined from this graph. Divide the average p.a. plate current in amperes by the product of filament voltage and current. The resulting amperes/watt ratio (Y-axis) is projected horizontally to the appropriate curve. The vertical projection to the X-axis indicate the life extension probability.*

Extending Transmitter Tube Life

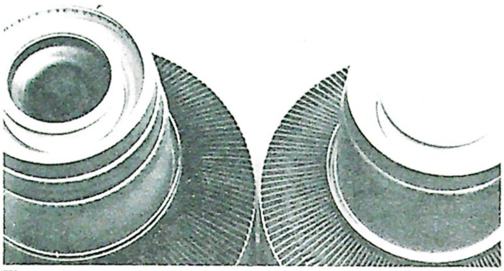


Figure 2

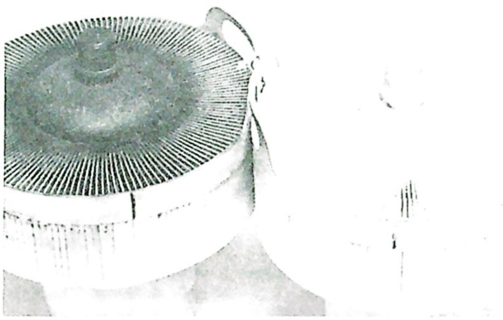


Figure 3

Figure 4

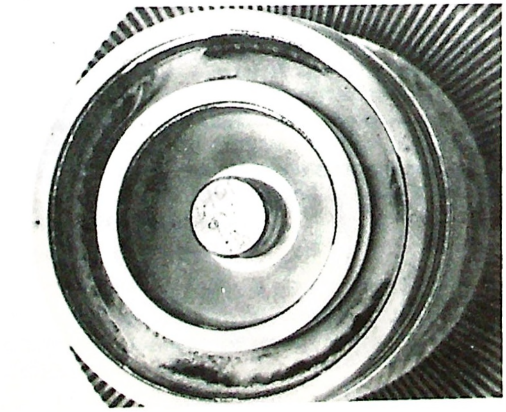


Figure 5

turers have a routine maintenance schedule established in the equipment manual. This procedure must be followed carefully if operating costs are to be held to a minimum. During routine maintenance it is very important to look for tube and socket discoloration, either of which can indicate overheating.

Look for discoloration around the top of the cooler near the anode core and at the bottom of the tube stem where the filament contacts are made. Review Figures 2 and 3 for examples of a tube operating with inadequate cooling. It is possible for discoloration to appear in the areas mentioned if the transmitter has to operate in a dirty environment. If this is the case, the tube should be removed and cleaned with a mild detergent. After cleaning, the tube should be rinsed thoroughly to remove any detergent residue and blown dry with compressed air. If the discoloration remains, this is an indication that the tube has operated at too high a temperature. Check inlet and outlet air ducting and filters for possible air restriction. It may also be necessary to verify that the air blower is large enough to do the job in the present environment and that it is operating at rated capacity.

With the tube removed, the socket should be blown or wiped clean and carefully inspected. Any discoloration in the socket finger stock caused by overheating could contribute to early tube failure. A finger stock that loses its temper through prolonged operation at high temperature will no longer make contact to the tube elements (Figure 4). A well-maintained socket will score the tube contacts when the tube is inserted. If all fingers are not making contact, more currect flows through fewer contacting fingers, causing additional overheating and possible burnout (Figure 5).

Filament voltage management

The useful operating life of a thoriated tungsten emitter can vary widely with filament voltage. Figure 6 describes the relative life expectancy with various filament voltage levels. Obviously, a well-managed filament voltage program will result in longer life expectancy. Improper management, on the other hand, can be very costly.

For a better understanding of this sensitive aging mechanism, the filament itself must be understood. Most filaments in high-power, gridded tubes are a mixture of tungsten and thoria with a chemical com-

Fig. 2. Improper cooling means short tube life (left). Discoloration of metal around inner filament stem and anode fins indicates poor cooling or improper operation of tube. Properly cooled and operated tube (right) shows no discoloration after many hours of use. In both cases, good socketing is indicated by scoring on circular connector rings.

Fig. 3. Dirty and discolored cooler of amplifier tube at left indicates combination of discoloration due to heating and lack of cleaning. Tube has operated too hot and dust has collected in anode louvres.

Fig. 4. Minute scoring in base contact rings indicates that socket finger stock has made good, low-resistance contact to tube elements. Well-maintained socket will score the tube contacts when tube is inserted. If all fingers do not make contact, more current will flow through fewer contact fingers, causing additional overheating and burning, as shown in Fig. 5.

Fig. 5. High resistance socket contacts has caused severe burning of contact area in the base. Overheated base caused early demise of tube.

position of W + THO_2. A filament made of this wire is not a suitable electron emitter for extended life applications until it is processed. Once the filament is formed into the desired shape and mounted, it is heated to approximately 2100°C in the presence of a hydrocarbon. The resulting thermochemical reaction forms di-tungsten carbide on the filament's surface. Life is proportional to the degree of carburization. If the filament is overcarburized, however, it will be brittle and easily broken during handling and transporting. Therefore, only approximately 25% of the cross-sectional area of the wire is converted to di-tungsten carbide. Di-tungsten carbide has a higher resistance than tungsten; thus, the reaction can be carefully monitored by observing the reduction in filament current as the carburizing process proceeds.

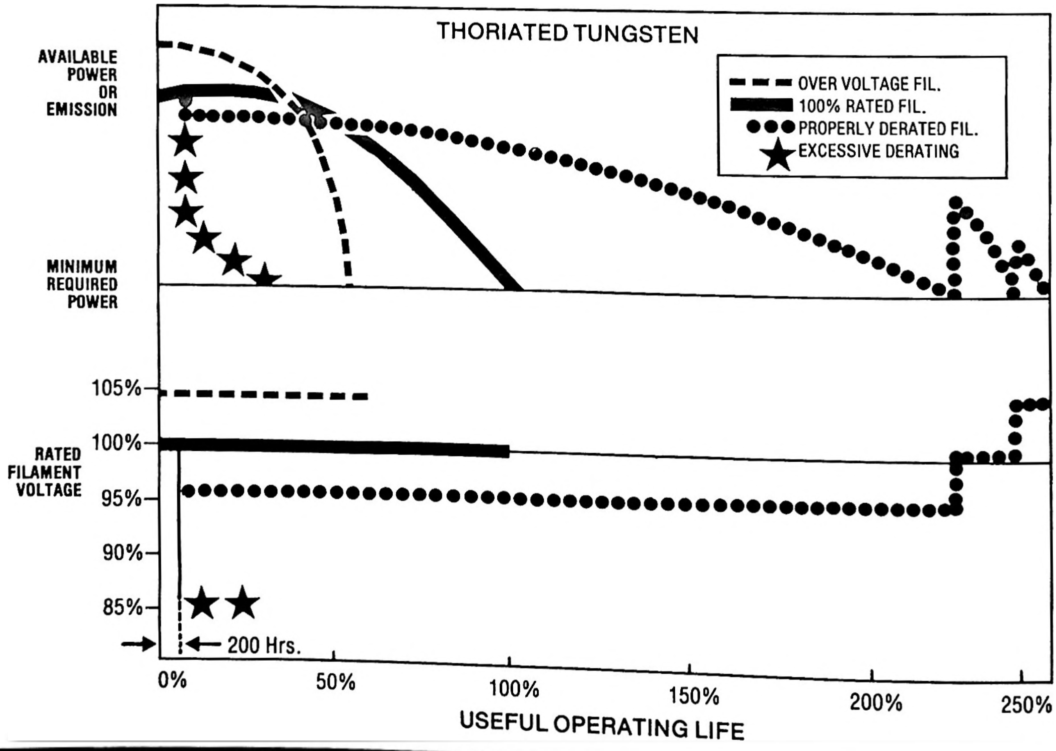
As the tube is used the filament slowly decarburizes. At some point in life, all of the di-tungsten carbide layer is depleted and the reduction of thoria to free thorium stops. The filament is now decarburized and is no longer an effective electron emitter.

The key to extending the life of a thoriated tungsten filament emitter is to control operating temperature. Emitter temperature is a function of the total RMS power applied to the filament. Thus, filament voltage control is temperature control. Temperature varies directly with voltage. As the emitter temperature rises the de-carburizing process is accelerated and tube life shortened. Figure 6 shows that useful tube life can vary significantly with only a 5% change in filament voltage. *If the filament voltage cannot be regulated to within ±3%, the filament should always be operated at the rated nominal voltage.* The danger of operating on the "cold" temperature side is that the emitter may be "poisoned." A cold filament acts as a getter; that is, it attracts contaminants. When a contaminant becomes attached to the surface of the emitter, that area is rendered inactive and loss of emission results. Operation of the filament at slightly below rated nominal voltage, however, can extend tube life if done properly.

FILAMENT VOLTAGE MANAGEMENT (Figure 6)

Filament voltage management allows extended tube life when accompanied by a continuing housekeeping program. When filament voltage is too high (dashes), power tube looses emission rapidly and normal operating life is not achieved. When filament is operated at rated voltage (black curve) normal tube life is achieved in a majority of cases. With a filament voltage management program (bullets), extended tube life may be achieved. When the minimum required output power level is finally reached (right-hand portion of curve), the filament voltage may be raised to rated value, or above, to achieve additional useful operating life. If filament is run "cool" (stars), extremely short life will result. Note that filament voltage management program does not take effect until about 200 hours of operating time have passed.

If voltage management program is not undertaken, tube should be run at rated filament voltage.



Extending Transmitter Tube Life

Of great importance to long tube life is the temperature of the elements and the ceramic-to-metal seals. Element temperature can be held within proper limits by observing the maximum dissipation ratings listed in the data sheet. Seal temperature should be limited to 200°C at the lower anode seal under worst-case conditions. As element temperature rises beyond 200°C, the release of contaminants locked in the materials used in tube manufacturing increases rapidly. These contaminants cause a rapid depletion of the di-tungsten carbide layer of the filament.

When a new power tube is installed in a transmitter, it must be operated at rated nominal filament voltage for the first 200 hours. This procedure is very important for two reasons. First, operation at normal temperature allows the getter to be more effective during the early period of tube life when contaminants are more prevalent. This break-in period conditions the tube for operation at lower filament voltage to obtain longer filament life. Secondly, during the first 200 hours of operation filament emission increases. It is necessary for the life extension program to start at the peak emission point.

A chart recorder or other device should be used to monitor variations in primary line voltage for several days of transmitter operation. The history of line voltage variations during on-air time must be reviewed prior to derating filament voltage. Plan to establish the derated voltage during the time period of historically low line voltage, as this is the worst-case condition. If line variation is greater that ±3%, filament voltage must be regulated.

Record output power (FM) or distortion level (AM) with the tube operating at rated nominal filament voltage. Next, reduce filament voltage in increments of 0.1 V and record power or distortion levels at each increment. Allow one minute between each increment for the filament emission to stabilize.

When a noticeable change occurs in output power or the distortion level changes, the derating procedure must stop. Obviously, operation at this point is unwise since there is no margin for a drop in line voltage. It is safer to raise the voltage 0.2 V above the critical voltage at which changes are observed to occur. If this new filament voltage setting is more than 5% below the nominal rated level, filament voltage must be raised to the 95% level. Operation below this point is unpredictable and life expectancy is uncertain. Finally, recheck power output or distortion to see if they are acceptable at the chosen filament voltage level. Recheck again after 24 hours to determine if emission is stable and that the desired performance is maintained. If performance is not repeatable, the derating procedure must be repeated.

Continuing the program

The filament voltage should be held at the properly derated level as long as minimum power or maximum distortion requirements are met. Filament voltage can be raised to reestablish minimum requirements as necessary. This procedure will yield results similar to those shown in the illustration, to achieve as much as 10% to 15% additional life extension. When it becomes necessary to increase filament voltage, it is a good time to order a new tube. Filament voltage can be increased as long as the increase results in maintaining minimum level requirements.

When an increase fails to result in meeting a level requirement, filament emission must be considered inadequate and the tube should be replaced. Don't discard it or sell it for scrap! Put it on the shelf and save it. It will serve as a good emergency spare and may come in very handy some day. Also, in AM transmitters, a low-emission RF amplifier tube can be shifted to modulator use where the peak filament emission requirement is not as severe.

Start planning for longer tube life now! Review the following steps you can take:

- Investigate the manufacturer's ratings on the power tubes in your present equipment, or the transmitter you plan to buy.
- Check that your transmitter has sufficient headroom. Is there a margin of safety in tube operation?
- Look for important instrumentation in the next transmitter you buy. Are all tube elements monitored for voltage and current in the transmitter?
- Whether your transmitter is new or old, start a filament life extension program.

Remember that each time you replace a power tube, the recommended derating procedure must be rerun. Voltage levels required with one tube do not apply to a replacement tube.

When purchasing a tube, insist on a new tube that carries the full, original manufacturer's warranty. Only tubes manufactured by the company of origin have to perform to published data. This is the important reason that transmitter manufacturers buy new, warranted tubes from the original manufacturer. **BM/E**

Thanks to William Barkley, William Orr, William Sain, and Bob Tornoe, all of Varian EIMAC, for their help and suggestions in preparing this paper.

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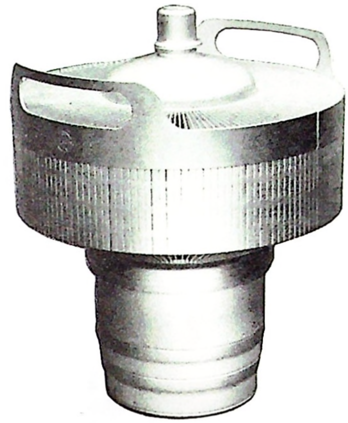
ADVANCE PRODUCT ANNOUNCEMENT

9019
YC130
VHF
RADIAL BEAM
POWER
TETRODE



The EIMAC 9019/YC130 is a ceramic/metal VHF power tetrode. It is rated for full power input to 110 MHz and is recommended for use as a Class C power amplifier or plate modulated amplifier.

Air-system sockets and matching air chimneys are available from EIMAC. A connector clip is available for making the dc connection to the anode.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh

Voltage	7.5 ± 0.37 V
Current, at 7.5 volts	160 A
Amplification Factor (average), Grid to Screen	4.5
Direct Interelectrode Capacitance (cathode grounded)[2]	
Cin	160 pF
Cout	26.5 pF
Cgp	1.5 pF
Direct Interelectrode Capacitance (grids grounded)[2]	
Cin	67 pF
Cout	27.5 pF
Cpk	0.2 pF
Maximum Frequency for Full Ratings (CW)	110 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:

Length	9.375 In; 23.81 cm
Diameter	7.580 In; 19.25 cm
Net Weight	12.8 Lb; 5.8 kg
Operating Position	Axis Vertical, Base Up or Down
Maximum Operating Temperature, Ceramic/Metal Seals or Envelope	250°C
Cooling	Forced Air
Base	Special Concentric
Recommended Air-System Socket: For LF or HF Service	EIMAC SK-300A
For VHF Service	EIMAC SK-360
Recommended Air-System Chimney: For Either the SK-300A or SK-360 Socket	EIMAC SK-316
Recommended Screen Grid Bypass Capacitor Kit for the SK-360 Socket	EIMAC SK-355
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY POWER AMPLIFIER
Class C FM
(Key-down conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000 VOLTS
DC SCREEN VOLTAGE	2000 VOLTS
DC GRID VOLTAGE	-750 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	18 KILOWATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

TYPICAL OPERATION (Frequencies to 110 MHz)

DC Plate Voltage	7.5	10.0	kVdc
DC Screen Voltage	750	750	Vdc
DC Grid Voltage	-510	-550	Vdc
DC Plate Current	4.65	4.55	Adc
DC Screen Current *	0.59	0.54	Adc
DC Grid Current *	0.30	0.27	Adc
Peak rf Grid Voltage *	730	790	v
Calculated Driving Power	220	220	W
Plate Dissipation	8.1	9.0	kW
Plate Output Power	26.7	36.5	kW

* Approximate value; will vary with circuit and tube

395035(Effective March 1986)
VA4889

Printed in U.S.A.

PLATE MODULATED RF POWER AMPLIFIER
Grid Driven
Class C Telephony - Carrier Conditions

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE . . .	8000 VOLTS
DC SCREEN VOLTAGE . .	2000 VOLTS
DC GRID VOLTAGE . . .	-750 VOLTS
DC PLATE CURRENT . . .	4.0 AMPERES
PLATE DISSIPATION # .	12 KILOWATTS
SCREEN DISSIPATION ##	450 WATTS
GRID DISSIPATION ## .	200 WATTS

Corresponds to 18 kW at 100% sine-wave modulation.

TYPICAL OPERATION

DC Plate Voltage	6.0	8.0	kVdc
DC Screen Voltage	750	750	Vdc
Peak AF Screen Voltage (100% Mod)	740	710	v
DC Grid Bias Voltage	-600	-640	Vdc
DC Plate Current	3.75	3.65	Adc
DC Screen Current *	0.45	0.43	Adc
DC Grid Current *	0.18	0.18	Adc
Peak rf Grid Voltage *	800	840	v
Grid Driving Power (calculated) *	150	150	W
Plate Dissipation *	5.1	5.8	kW
Plate Output Power *	17.4	23.5	kW

* Approximate value.
Average, with or without modulation.

AUDIO FREQUENCY AMPLIFIER OR MODULATOR
Grid Driven, Class AB1, Sinusoidal Wave

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE . . .	10.0 KILOVOLTS
DC SCREEN VOLTAGE . .	2000 VOLTS
DC PLATE CURRENT . . .	6.0 AMPERES
PLATE DISSIPATION . .	18.0 KILOWATTS
SCREEN DISSIPATION . .	450 WATTS
GRID DISSIPATION . . .	200 WATTS

* Approximate value. # Per tube.
Adjust for specified zero-signal plate current.

TYPICAL OPERATION (two tubes)

DC Plate Voltage	7.5	10.0	kVdc
DC Screen Voltage	1500	1500	Vdc
DC Grid Voltage ##	-350	-370	Vdc
Zero-Signal Plate Current	1.0	1.0	Adc
Maximum Signal Plate Current	8.8	8.5	Adc
Maximum Signal Screen Current * . .	0.34	0.30	Adc
Peak AF Grid Voltage * #	330	340	v
Driving Power *	0	0	W
Load Resistance Plate-to-Plate . . .	1730	2520	Ohms
Maximum Signal Plate Dissipation * #	12.2	14.0	kW
Plate Output Power *	41.6	57.0	kW

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	148	168	A
Interelectrode Capacitance (grounded filament connection) [1]			
Cin	154	167	pF
Cout	24	29	pF
Cgp	---	2.0	pF

1 Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The tube must be mounted vertically, base up or down at the designer's convenience, and should be protected from vibration and shock.

STORAGE - If a tube is to be stored as a spare it should be kept in its original shipping carton, with the original packing material, to minimize the possibility of handling damage.

Before storage a new tube should be operated in the equipment for 100 to 200 hours to establish it has not been damaged and operates properly (See FILAMENT OPERATION for recommendations on initial value of filament voltage during this operation period). If the tube is still in storage 6 months later it again should be operated in the equipment for 100 to 200 hours to make sure there has been no degradation. If operation is satisfactory the tube can again be stored with great assurance of being a known-good spare.

SOCKETING - An air-system socket should be used in all applications to assure cooling of the tube base seals. The EIMAC SK-300A is recommended for audio or LF/HF rf operation; the SK-360 is recommended for VHF operation. The SK-360 incorporates low-inductance filament bypassing in the form of three 5000 pF copper-clad Kapton®capacitors. A screen grid bypass capacitor kit (the SK-355) is also available for the SK-360 socket, and includes eight 1000 pF 5000 DCWV capacitors (EIMAC P/N 050706), 16 mounting clips (EIMAC P/N 242859), and an assembly drawing (EIMAC P/N 243135) which shows how the parts are attached to the socket.

COOLING - The tube requires forced-air cooling in all applications. An air-system socket is recommended, with a matching air chimney. Normally the tube socket is mounted in a pressurized compartment so the cooling air passes through the socket and is then guided to the anode cooling fins by an air chimney. A chimney is available from EIMAC, the SK-316, for use with the SK-300A socket at frequencies below 30 MHz and with the SK-360 at VHF. If all cooling air is not passed around the base of the tube and through the socket, then arrangements must be made to assure adequate cooling of the tube base and the socket contacts themselves.

In this regard it should be noted the contact fingers used in the four contact collet assemblies (inner and outer filament, control grid and screen grid) are made of beryllium copper. If operated above 150°C for any appreciable length of time this material will lose its temper (or springy characteristic) and then will no longer make good contact to the base rings of the tube. This can lead to arcing which, in an extreme case, can burn through the metal of the tube base ring and the tube's vacuum integrity is then destroyed.

Thus adequate movement of cooling air around the base of the tube accomplishes a double purpose in keeping the tube base <u>and</u> the socket contact fingers at a safe operating temperature.

Though the maximum temperature rating for seals and the anode core is 250°C, it is considered good engineering practice to allow some safety factor and the table shown is for sea level with cooling air at 50°C and maximum tube anode temperature of 225 °C. Such a safety factor makes some allowance for variables such as dirty air filters, dirty tube anode cooling fins which will effect cooling efficiency, duct losses, etc. The figures shown are for the tube in an air-system socket with an air chimney in place, with air passing in a base-to-anode direction. Pressure drop values shown are approximate and are for the tube/socket/chimney combination.

Plate Diss. (Watts)	Air Flow (cfm)	Press.Drop Inches Water
7,500	230	0.7
12,500	490	2.7
15,000	645	4.6
18,000	970	8.2

At altitudes significantly above sea level flow rate must be increased for equivalent cooling. At 5000 feet both the flow rate and the pressure drop should be increased by a factor of 1.20, while at 10,000 feet both flow rate and pressure drop must be increased by 1.46.

Anode and base cooling should be applied before or simultaneously with filament voltage turnon and should normally continue for a brief period after shutdown to allow the tube to cool down properly.

IMPACT AND VIBRATION - The 9019/YC130 has a thoriated tungsten mesh filament and is intended for regular commercial service. Any tube with a thoriated tungsten filament should be protected from undue shock and vibration and if not installed in equipment should always be stored in its protective packing material in its shipping container.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. <u>It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously</u>.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

FILAMENT OPERATION - With a new tube, or one which has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter material mounted within the filament structure to absorb any residual gas molecules which have accumulated during storage. Once normal operation has been established a minimum filament warmup time of four to five seconds is normally sufficient.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours.

Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

EIMAC Application Bulletin #18 titled "EXTENDING TRANSMITTER TUBE LIFE" contains valuable information and is available on request.

GRID OPERATION - Maximum control grid dissipation is 200 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between control grid and cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 450 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

PLATE DISSIPATION - The rated maximum plate dissipation of the tube is 18 kilowatts, which may be safely sustained with adequate air cooling. When the tube is used as a plate-modulated rf amplifier the dissipation under carrier conditions should be limited to 12 kilowatts.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and cooling air interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if protection is adequate.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail and is available from EIMAC on request.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the appliction. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

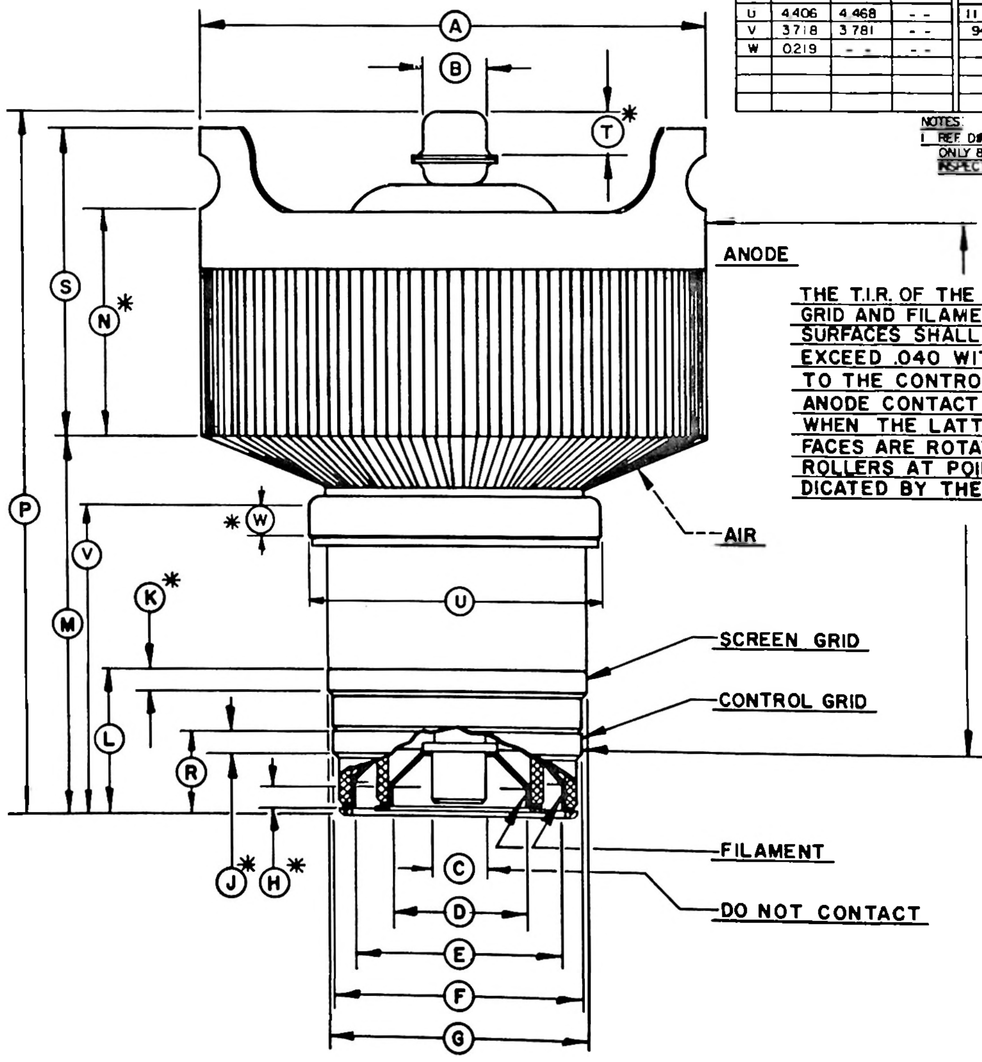
d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF	MIN.	MAX.	REF
A	7460	7 580	- -	18948	192.53	- -
B	0855	0 895	- -	21.72	22.73	- -
C	0720	0 760	- -	18 29	1930	- -
D	1.896	1.936	- -	46 63	49 17	- -
E	3 133	3.173	- -	79 58	8059	- -
F	3.792	3.832	- -	96 32	97.33	- -
G	3980	4.020	- -	101.09	102.11	- -
H	0.188	- -	- -	4.78	- -	- -
J	0 188	- -	- -	4 78	- -	- -
K	0 188	- -	- -	4.78	- -	- -
L	1.764	1 826	- -	44 81	4638	- -
M	4659	4 783	- -	118.34	121.49	- -
N	2412	2.788	- -	61 26	70 82	- -
P	9000	9 375	- -	228.60	238.13	- -
R	0986	1050	- -	25 04	26.67	- -
S	3560	3684	- -	90.42	93.57	- -
T	0375	- -	- -	9.53	- -	- -
U	4406	4 468	- -	111.91	113.49	- -
V	3718	3 781	- -	94.44	9604	- -
W	0.219	- -	- -	5.56	- -	- -

NOTES:
1 REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



THE T.I.R. OF THE SCREEN GRID AND FILAMENT CONTACT SURFACES SHALL NOT EXCEED .040 WITH RESPECT TO THE CONTROL GRID AND ANODE CONTACT SURFACE WHEN THE LATTER SURFACES ARE ROTATED ON ROLLERS AT POINTS INDICATED BY THE ARROWS

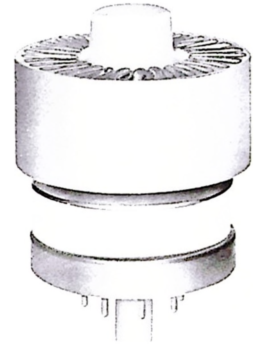
* CONTACT SURFACE

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

7203 / 4CX250B / 8621 / 4CX250FG

RADIAL-BEAM POWER TETRODE

The 7203/4CX250B and 8621/4CX250FG are ceramic/metal forced-air cooled, external-anode radial-beam tetrodes with a maximum plate dissipation rating of 250 watts and a maximum input-power rating of 500 watts. The 7203/4CX250B is designed to operate with a heater voltage of 6.0 volts, while the 8621/4CX250FG is designed for operation at a heater voltage of 26.5 volts. Otherwise, the two tube types have identical characteristics.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage (4CX250B)	6.0 ± 0.3 V
Current, at 6.0 volts	2.6 A
Cathode-Heater Potential, maximum	±150 V
Heater: Voltage (4CX250FG)	26.5 ± 1.3 V
Current, at 26.5 volts	0.54 A
Cathode-Heater Potential, maximum	±150 V
Amplification Factor (Average):	
Grid to Screen	5
Direct Interelectrode Capacitances (Grounded cathode)[2]	
Input	15.7 pF
Output	4.5 pF
Feedback	0.04 pF
Direct Interelectrode Capacitances (grounded grid and screen)[2]	
Input	13 pF
Output	4.5 pF
Feedback	0.01 pF
Frequency of Maximum Rating:	
CW	500 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.46 in; 62.5 mm
Diameter	1.64 in; 41.7 mm
Net Weight	4 oz; 113 gm
Operating Position	Any

Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Base	Special 9-pin JEDEC-B8-236
Recommended Socket	EIMAC SK-600 Series
Recommended Chimney	EIMAC SK-600 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN (SSB)

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	250	250	250	mAdc
Two-Tone Plate Current	190	190	190	mAdc
Single-Tone Screen Current [2]	10	8	5	mAdc
Two-Tone Screen Current [2]	2	-1	-2	mAdc
Single-Tone Grid Current [2]	0	0	0	mAdc
Peak rf Grid Voltage [2]	50	50	50	v
Plate Output Power	120	215	300	W
Resonant Load Impedance	2000	3000	4000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Carrier Plate Current	150	150	150	mAdc
Carrier Screen Current	-3	-4	-4	mAdc
Peak rf Grid Voltage [2]	25	25	25	v
Plate Output Power	30	50	65	W

1. Adjust to specified zero-signal dc plate current

2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)					500 MHz [2]	
Plate Voltage	500	1000	1500	2000	2000	Vdc
Screen Voltage	250	250	250	250	300	Vdc
Grid Voltage	-90	-90	-90	-90	-90	Vdc
Plate Current	250	250	250	250	250	mAdc
Screen Current [1]	45	38	21	19	10	mAdc [2]
Grid Current [1]	35	31	28	26	10	mAdc [2]
Peak rf Grid Voltage [1]	114	114	112	112	---	v
Measured Driving Power [1]	4.0	3.5	3.2	2.9	---	W
Plate Input Power	125	250	375	500	500	W
Plate Output Power	70	190	280	390	290	W [2]
Heater Voltage (4CX250B)	6.0	6.0	6.0	6.0	5.5	V
Heater Voltage (4CX250FG)	26.5	26.5	26.5	26.5	24.3	V

1. Approximate value.
2. Measured values for a typical cavity amplifier circuit.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1500	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION[1]	165	WATTS
SCREEN DISSIPATION[2]	12	WATTS
GRID DISSIPATION[2]	2	WATTS

1. Corresponds to 250 watts at 100% sine-wave modulation.

2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 175 MHz)

Plate Voltage	500	1000	1500	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-100	-100	-100	Vdc
Plate Current	200	200	200	mAdc
Screen Current	31	22	20	mAdc
Grid Current	15	14	14	mAdc
Peak rf Grid Voltage	118	117	117	v
Calculated Driving Power	1.8	1.7	1.7	W
Plate Input Power	100	200	300	W
Plate Output Power	60	145	235	W

3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate value.
2. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1/3]	-55	-55	-55	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max Signal Plate Current	500	500	500	mAdc
Max Signal Screen Current[1]	20	16	10	mAdc
Max Signal Grid Current[1]	0	0	0	mAdc
Peak af Grid Voltage[2]	50	50	50	v
Peak Driving Power	0	0	0	W
Plate Input Power	500	750	1000	W
Plate Output Power	240	430	600	W
Load Resistance (plate to plate)	3500	6200	9500	Ω

3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Nom.	Max.	
Heater: 4CX250B Current at 6.0 volts	2.3	---	2.9	A
Heater: 4CX250FG Current at 26.5 volts	0.45	---	0.62	A
Cathode Warmup Time	30	60	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)				
Input	14.2	---	17.2	pF
Output	4.0	---	5.0	pF†
Feedback	---	---	0.06	pF
Interelectrode Capacitances[1] (grounded grid and screen)				
Input	---	13.0	---	pF
Output	4.0	---	5.0	pF†
Feedback	---	0.01	---	pF

†Cout values shown are for 4CX250B; for 4CX250FG, values are . . . 4.0 --- 5.3 pF

APPLICATION

MECHANICAL

MOUNTING - The 4CX250B and 4CX250FG may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen capacitors and may be obtained with either grounded or ungrounded cathode terminals.

COOLING - Sufficient forced-air cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain anode core temperatures at 200°C with an inlet air temperature of 50°C are tabulated below. These requirements apply when a socket of the EIMAC SK-600 series and an EIMAC SK-606 chimney are used with air flow in the base to anode direction.

	SEA LEVEL		10,000 FEET	
Plate Dissipation (watts)	Air Flow (CFM)	Pressure Drop (In. of water)	Air Flow (CFM)	Pressure Drop (In. of water)
200	5.0	0.52	7.3	0.76
250	6.4	0.82	9.3	1 20

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

At 500 MHz or below, base cooling air requirements are satisfied automatically when the tube is operated in an EIMAC Air-System Socket and the recommended air flow rates are used. Experience has shown that if reliable long life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

VIBRATION - These tubes are capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tubes will function well in automobile and truck mobile installations and similar environments. However, when shock and vibration more severe than this are expected, it is suggested that the EIMAC 4CX300A or 4CX250R be employed.

ELECTRICAL

HEATER - The rated heater voltage for the 4CX250B and 4CX250FG is 6.0 volts and 26.5 volts, respectively, and the voltage should be maintained as closely as practicable. Short-time changes of ± 10% will not damage the tube, but variations in performance must be expected. The heater voltage must be maintained within ± 5% to minimize these variations and to obtain maximum tube life.

At frequencies above approximately 300 MHz transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon frequency, plate current, and driving power. When the tube is driven to maximum input as a class-C amplifier, the heater voltage should be reduced according to the table below;

Frequency MHz	4CX250B	4CX250FG
300 and lower	6.00 volts	26.5 volts
301 to 400	5.75 volts	25.3 volts
401 to 500	5.50 volts	24.3 volts

CATHODE OPERATION - The oxide coated unipotential cathode must be protected against excessively high emission currents. The maximum rated dc input current is 200 mA for plate-modulated operation and 250 mA for all other types of operation except pulse.

The cathode is internally connected to the four even-numbered base pins and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts regardless of polarity.

GRID OPERATION - The maximum rated dc grid bias voltage is -250 volts and the maximum grid dissipation rating is 2.0 watts. In ordinary audio and radio-frequency amplifiers the grid dissipation usually will not approach the maximum rating. At operating frequencies above the 100 MHz region, driving-power requirements for amplifiers increase noticeably. At 500 MHz as much as 20 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory 500 MHz operation of the tube in a stable amplifier is indicated by grid-current values below approximately 15 mA.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 100,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes, or an electron tube *shunt* regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube *series* regulator can be used only when an a equate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation for plate-modulated rf amplifiers using the 4CX250B or 4CX250FG.

PLATE OPERATION - The maximum rated plate dissipation power is 250 watts. In plate-modulated applications the carrier plate dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that one tube fails.

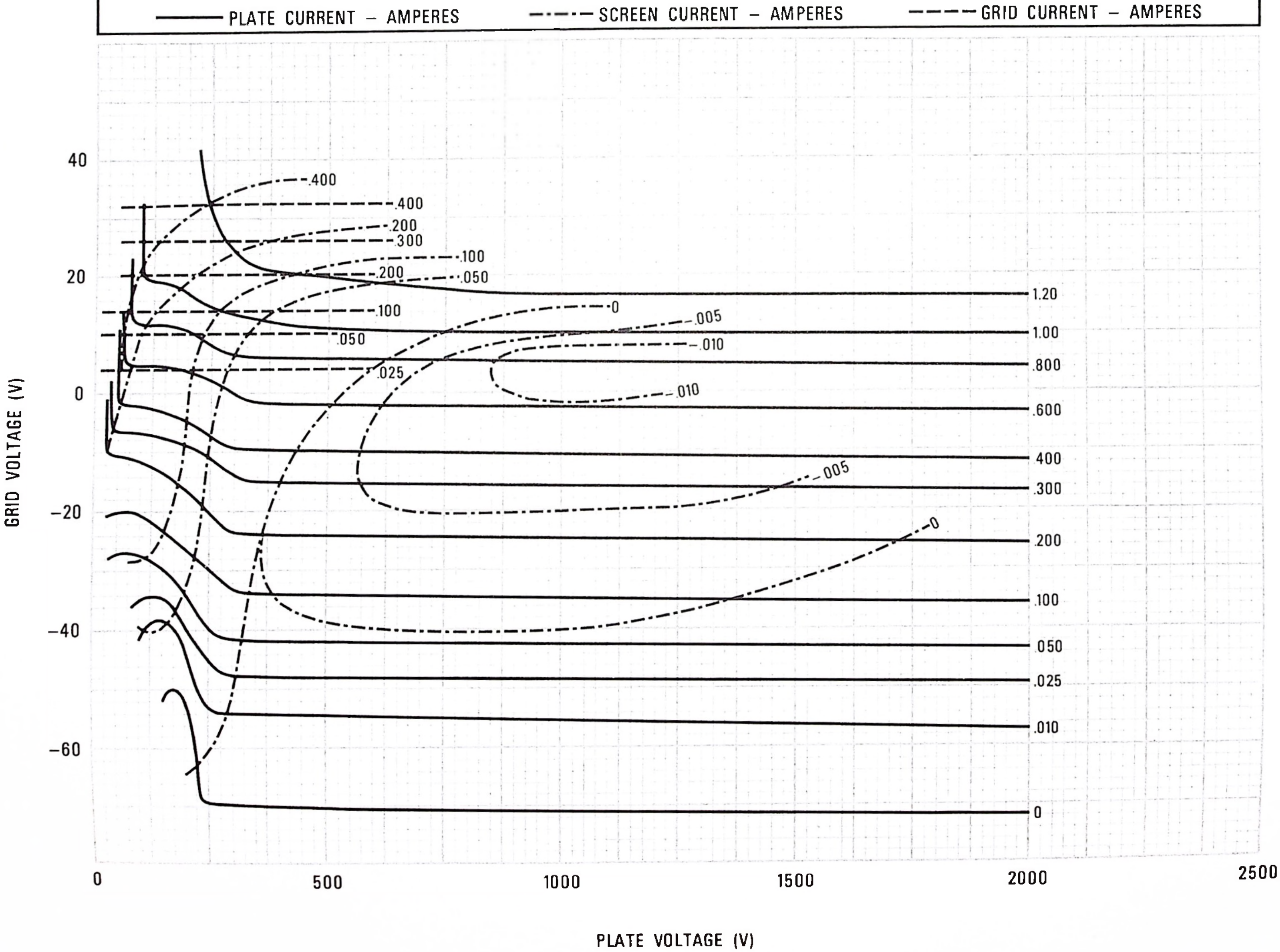
VHF OPERATION-The 4CX250B and 4CX250FG are suitable for use in the VHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

HIGH VOLTAGE - The 7203/4CX250B and 8621/4CX250FG operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SPECIAL APPLICATIONS-If it is desired to operate these tubes under conditions widely different from those given here, write to Application Engineering Dept., EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

TYPICAL CONSTANT CURRENT CHARACTERISTICS

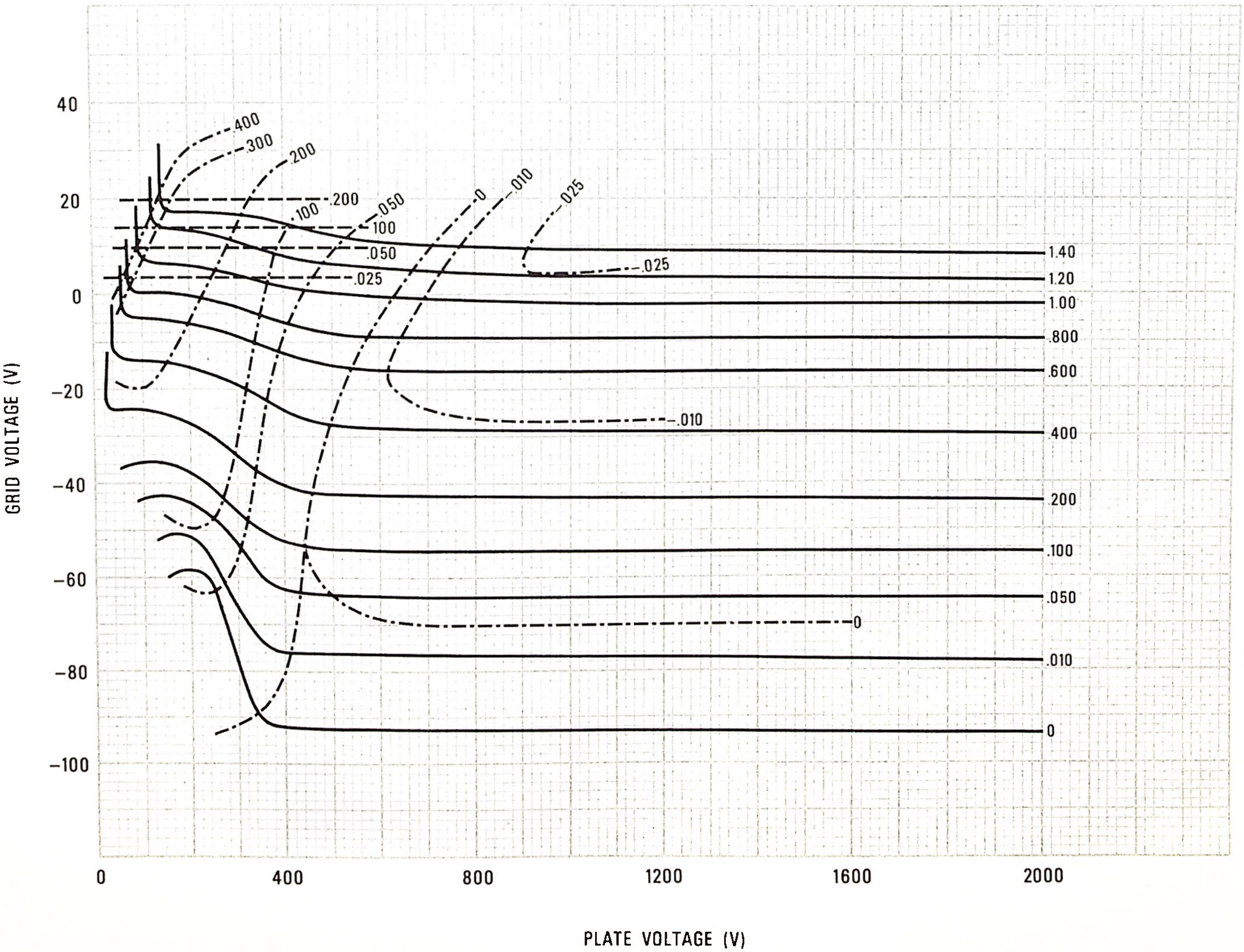
SCREEN VOLTAGE = 250V



TYPICAL CONSTANT CURRENT CHARACTERISTICS

SCREEN VOLTAGE = 350V

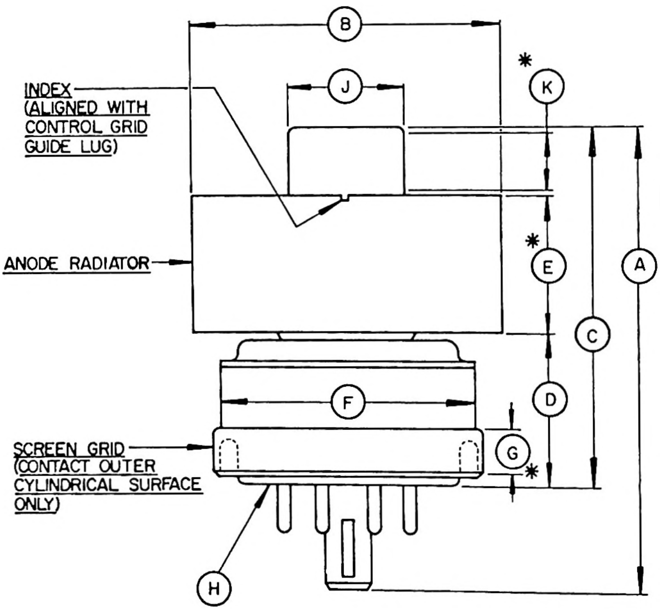
——— PLATE CURRENT – AMPERES —·—·— SCREEN CURRENT – AMPERES ———— GRID CURRENT – AMPERES



DIMENSIONAL DATA				
DIM	INCHES		MILLIMETERS	
	MIN.	MAX	MIN.	MAX.
A	2.342	2.464	59.03	62.59
B	1.610	1.640	40.89	41.66
C	1.810	1.910	45.97	48.51
D	0.750	0.810	19.05	20.57
E	0.710	0.790	18.03	20.07
F	--	1.406	--	35.71
G	0.187	--	4.75	--
H	BASE· B8-236 (JEDEC DESIGNATION)			
J	0.559	0.573	14.20	14.55
K	0.240	--	6.10	--

PIN DESIGNATION

PIN NO. 1 SCREEN GRID
PIN NO. 2 CATHODE
PIN NO. 3 HEATER
PIN NO. 4 CATHODE
PIN NO. 5 I.C. DO NOT USE FOR EXTERNAL CONNECTION.
PIN NO. 6 CATHODE
PIN NO. 7 HEATER
PIN NO. 8 CATHODE
CENTER PIN-CONTROL GRID



NOTES:
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2. (✱) CONTACT SURFACES.