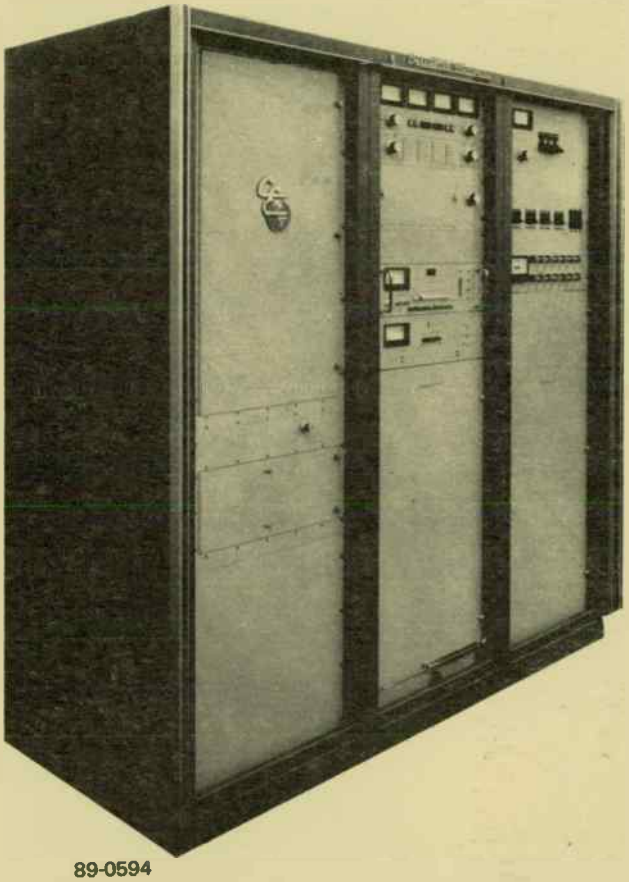
OPERATIONS AND MAINTENANCE
for
TYPE 816R-3B
FM BROADCAST TRANSMITTER
WITH SOLID-STATE EXCITER 802A



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P.O. BOX 270879 DALLAS, TEXAS 75227 (214) 381-7161
FAX NUMBER (214) 381-4949 TELEX ADDRESS: 73-398

ISSUED 11/89

SERIAL NUMBERS 0817 AND ABOVE

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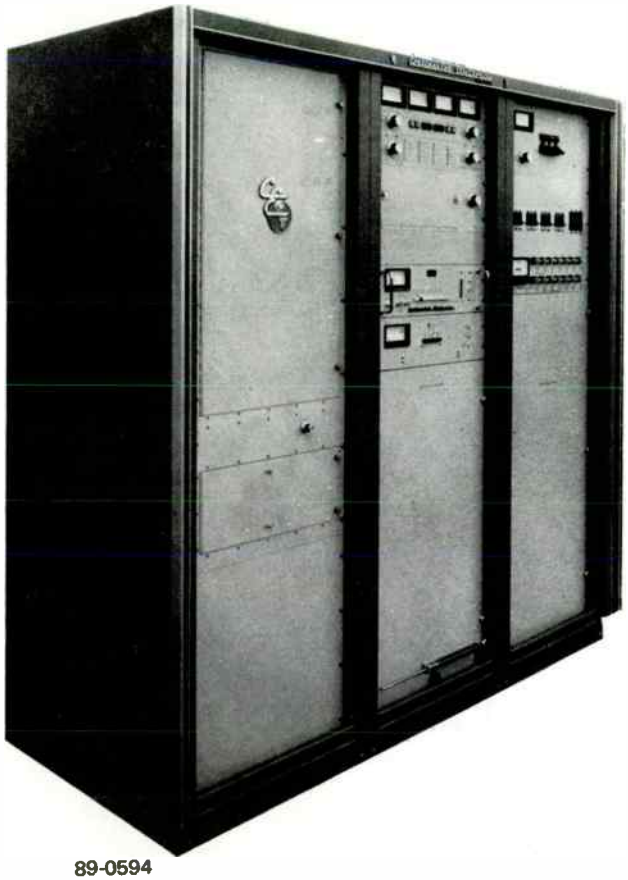

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SECTION 1 - GENERAL DESCRIPTION

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-3B transmitter operates in the FM broadcast range (88-108MHz) with an RF output power of 25kW. Reduced power is available by tap changes of the plate and screen transformer to meet customer requirements. The transmitter provides monaural programming or other optional programming as customer requires. When the exciter receives input from the 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 solid-state driver, and a power amplifier. The output of the exciter is applied to the driver. The driver consists of cascaded solid-state amplifiers (a 150-watt unit driving a 700-watt module). The input to the driver is amplified to approximately 500 watts and applied to the power amplifier that contains one 4CX15000A 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 is housed in a basic uni-strut cabinet that contains all transmitter components. Refer to Figure 1-1. The transmitter contains three sections. The section on the left in Figure 1-1 contains the power amplifier. The center section houses the control panel, exciter, driver circuits, and control circuits. The section on the right contains the power supplies, the circuit breakers, and fuse panel.

TABLE 1-1. TECHNICAL CHARACTERISTICS

MECHANICAL	
Weight	1962 lbs (890 kg)
Size - Transmitter	Height: 69 in (175 cm) (Not Including Directional Cplr) Width: 72 in (183 cm) Depth: 28 in (71 cm)
Ventilation:	Squirrel cage type blower mounted under the cavity. Axial fan that provides positive air pressure within the entire cabinet
Ambient Temperature Range:	-4°F to +122°F operating (-20°C to +50°C)
Relative Humidity Range:	0 to 95% relative humidity
Altitude:	Up to 7500 ft (2285m) at 104°F (+40°C) Up to 10000 ft (3046m) at 104°F (+40°C) with optional high altitude blower
Shock and Vibration:	Normal handling & transportation
Finish:	Front Panel: Tan Cabinet: Brown
ELECTRICAL	
Frequency Range:	88 to 108 MHz
Output Power:	10,000 watts to 25,000 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 & 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 25 kW output)	40 kW at 0.9 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 +32°F to +131°F (0 to +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 ±75kHz deviation SCA: (2 ea) 15,000 Ohms, balanced or unbalanced, 1.25 Vrms, for ±7.5 kHz deviation
Audio Frequency Response	Monaural: ±0.5 dB; flat, 25, 50, 75 microsecond pre-emphasis, 20 Hz to 15 kHz.
Audio Frequency Distortion:	Monaural: Not more than 0.08%, 20 Hz to 15 kHz (Measured with spectrum analyzer)
FM Noise Level:	75 dB below 100% modulation (±75kHz)
AM Noise Level:	Asynchronous: 55 dB below equivalent 100% AM modulation Synchronous: 50 dB below equivalent 100% AM modulation

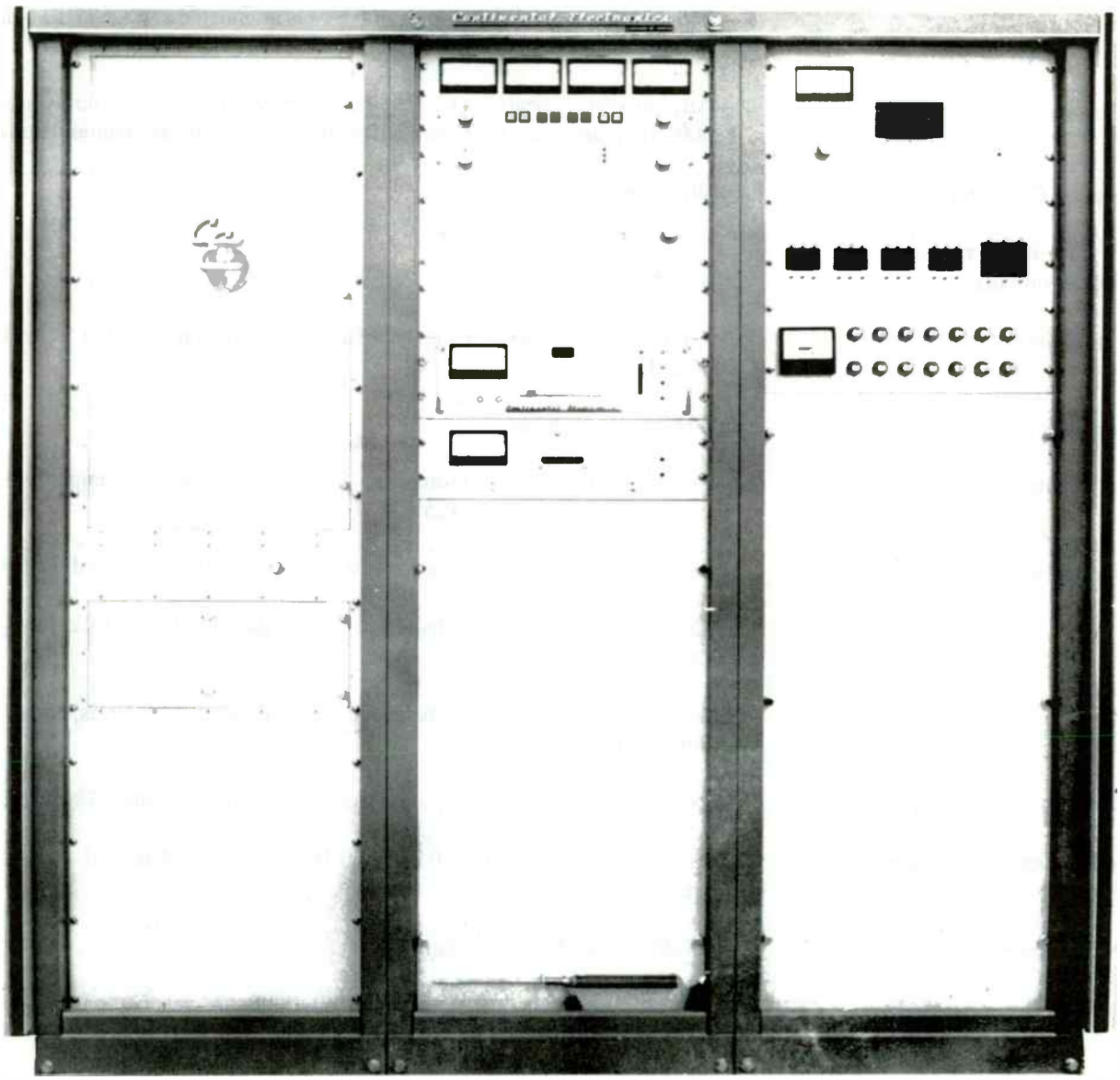

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Figure 1-1. 816R-3B FM Transmitter

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. Power cables may be brought through either a two-inch (5 cm) 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 #1/0 AWG wire where the wire length is up to 100 feet (31 m). The wall breaker or fuses should be 150 ampere capacity. The transmitter has a 105 ampere primary power disconnect breaker.

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. The transmitter should be located to allow access to front and rear.

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

2-1.1 TRANSMITTER COOLING

Adequate cooling of the transmitter is imperative to reduce downtime, to improve component reliability, and prolong tube life. An adequate supply of cool clean uncontaminated ambient air (temperature must not exceed 122°F (+50°C)) 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 (24.9 pascal) 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.

2-2. UNPACKING AND INSPECTING

2-2.1 DOMESTIC SHIPMENTS

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 all controls operate freely. Examine the cabinet for dents or scratches. Ensure cable and wiring connections are tight and situated clear of each other, the chassis, the transformer, and all choke windings.

If any 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

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 (5 cm) 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 cable and wiring connections are tight, and situated clear of each other and the chassis.

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

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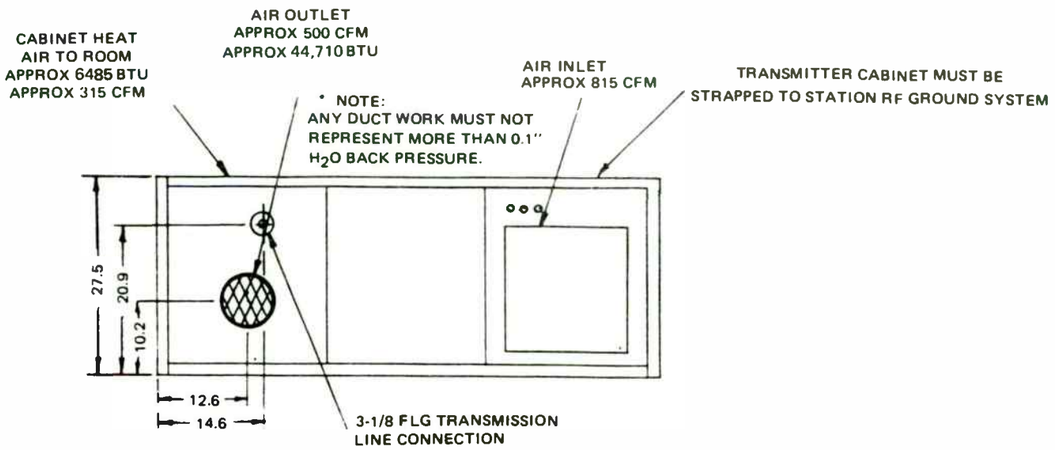
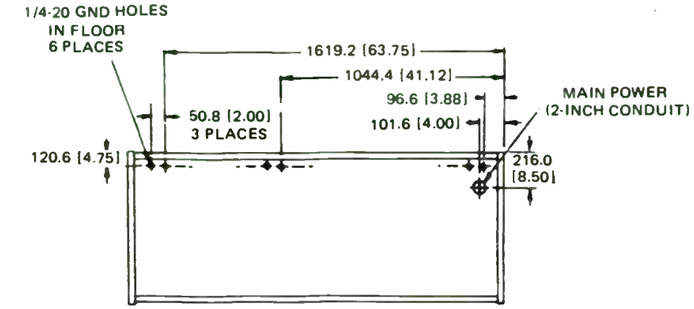
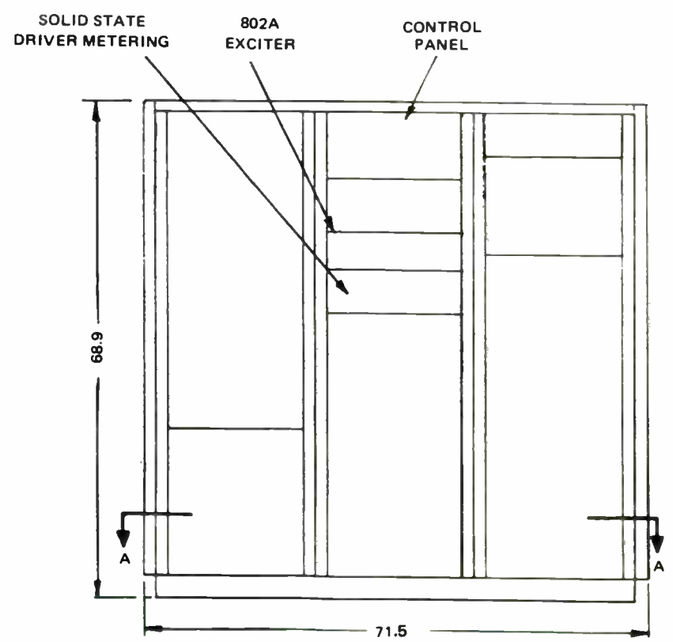


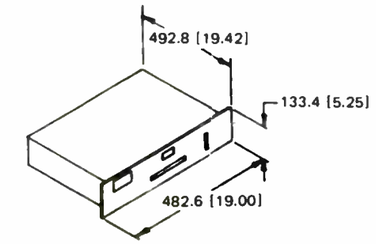
TOP VIEW OF TRANSMITTER



SECTION A – A

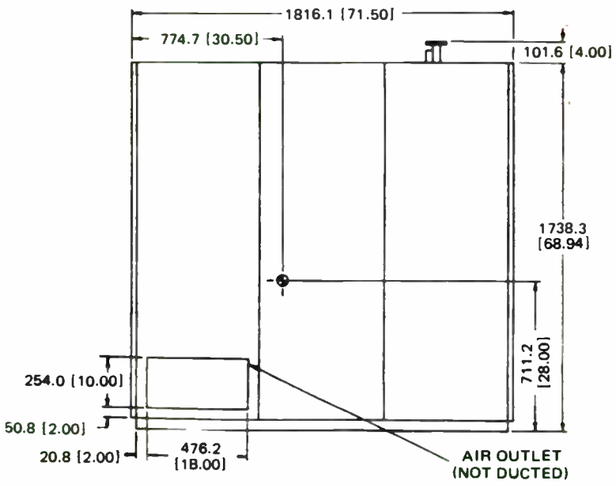


FRONT VIEW OF TRANSMITTER



802A EXCITER

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



REAR VIEW OF TRANSMITTER

REF. DWG. 159421

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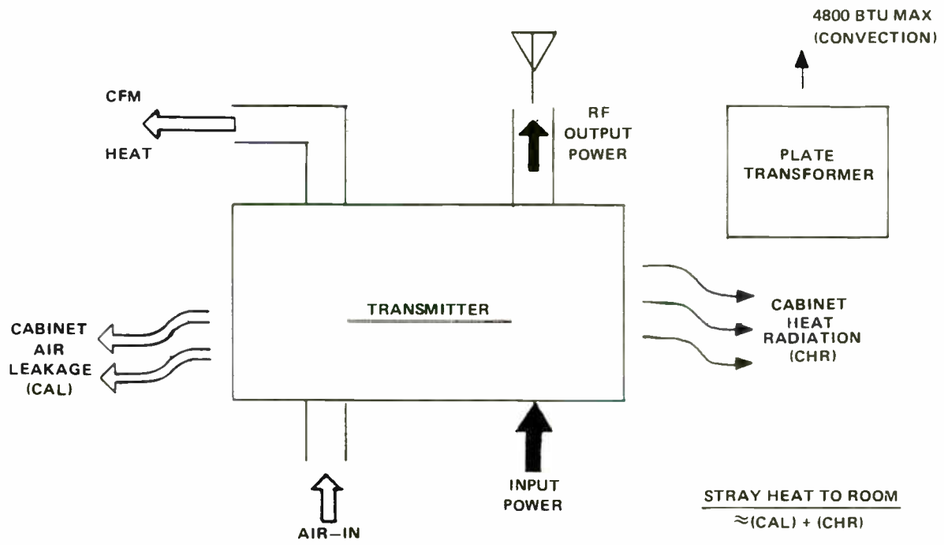
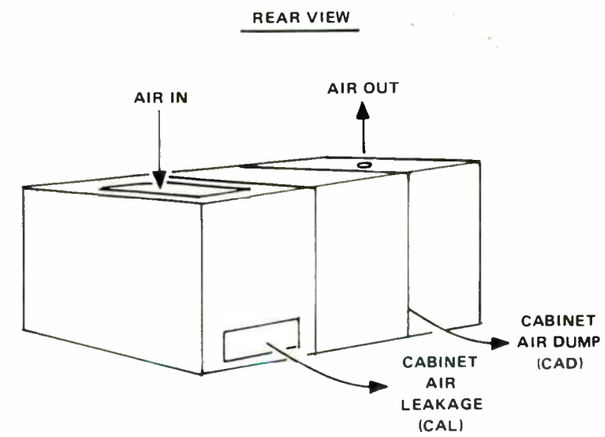
Figure 2-1. FM Transmitter Outline and Installation Drawing





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 / BTU	AIR–OUT TEMP °F / °C	AIR TEMP RISE °F / °C	STRAY AIR TO ROOM CFM	STRAY HEAT TO ROOM KW / BTU	BLOWER CFM CAP / USE	FAN CFM CAP / USE	AIR–IN SUPPLY PRESSURE (MIN)	AIR–OUT BACK PRESSURE (MAX)
816R-3B	25 KW	25KW	40	44.4	815		+45°C	+22.2°C	500	13.1 / 44710	149 / 65.3	77 / 43.1	315	1.9 / 6485	750 / 535	1000 / 850	+0.1" H_2O	+0.1" H_2O
		20 KW	33	36.7	815		+45°C	+22.2°C	500	11.4 / 38908	139 / 59.7	67 / 37.5	315	1.6 / 5461	750 / 535	1000 / 850	+0.1" H_2O	+0.1" H_2O
		15 KW	27.5	30.6	815		+45°C	+22.2°C	500	10.9 / 37202	137 / 58.1	65 / 35.9	315	1.6 / 5461	750 / 535	1000 / 850	+0.1" H_2O	+0.1" H_2O
		10 KW	22	24.4	815		+45°C	+22.2°C	500	10.2 / 34813	132 / 55.8	60 / 33.6	315	1.8 / 6143	750 / 535	1000 / 850	+0.1" H_2O	+0.1" H_2O

Figure 2-2. FM Transmitter Nominal Heat Balance

2-3. ASSEMBLY

1. Plan the placement of the transmitter and its external wiring carefully before beginning installation. Refer to figure 2-1. 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 and the remote control wiring. A 2-inch (5 cm) conduit entry is also provided in the floor of the power supply section.

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

3. Connect the input power wiring from the customer supplied fuse or circuit breaker panel with a 200 Amp rating. Using a #1/0 AWG cable, (Use local Electrical Code for wire size using a 200 Amp wall fuse) connect 3-phase power to transmitter terminal board A17TB3 in accordance with Schematic Diagram No. 159433. Connect the power AC GND to the GND terminal adjacent to A17TB3. Do not turn on power at this time.

4. 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 the exciter output through the 3dB attenuator to the driver input (A26AR1-P7). Attach the MUTE voltage leads from A4TB1-6 to A19E6 (right side panel of transmitter) and from A26TB2-6 to A4TB1-6. The yellow wire tied to the RF cable is used for this purpose. Connect the 117-volt ac power cable from the exciter to connector J3. Refer to 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 and A26TB2-6 must also be connected to the 802A Exciter TB1-6. The RF output from J2 will be connected to A26AR1-J1, the RF input connector on the driver assembly using 50 ohm cable such as RG-223.

5. 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.

6. If output tube 4CX15000A was removed for shipping, install it using the procedure outlined in paragraph 5-5.1

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 7.2Vdc when plate current is 3.0 Amperes. An external voltage divider may be required to obtain a sample that is within allowable limits for the remote control. Refer to figure 2-2.

7. 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 2-3 and on figure 2-4.

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.

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

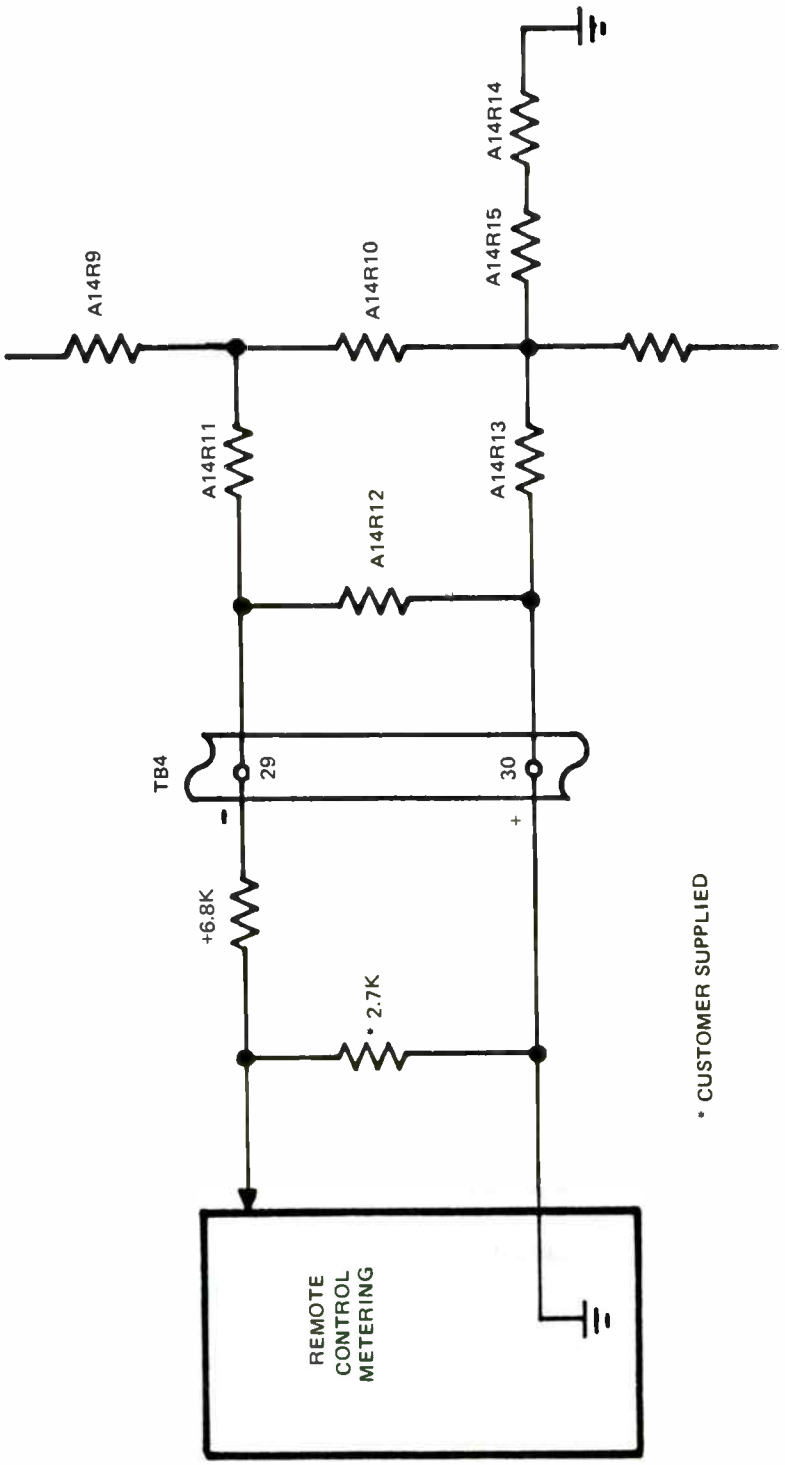
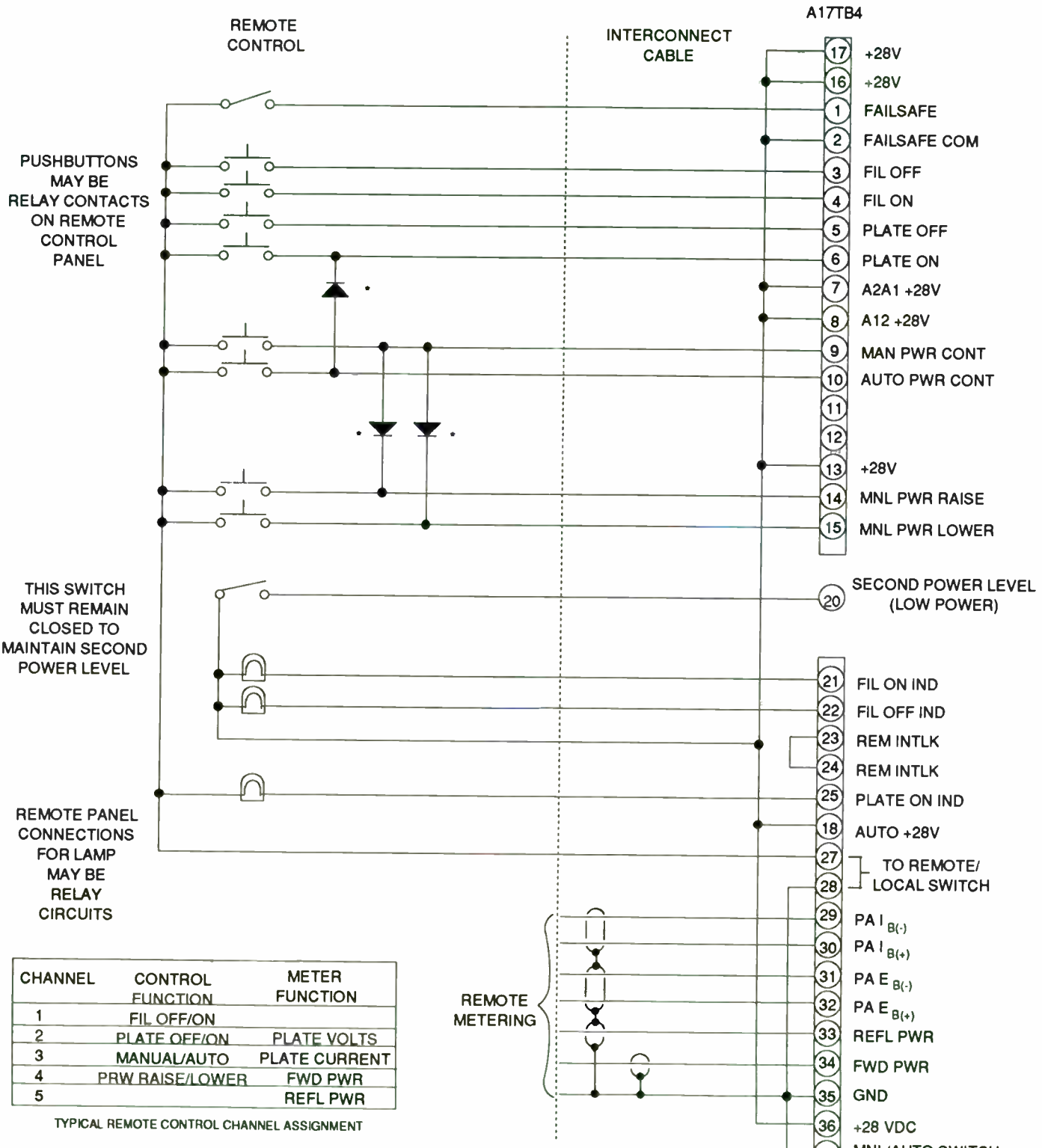


Figure 2-3. Remote Plate Current Sample Circuit



CHANNEL	CONTROL FUNCTION	METER FUNCTION
1	FIL OFF/ON	
2	PLATE OFF/ON	PLATE VOLTS
3	MANUAL/AUTO	PLATE CURRENT
4	PRW 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 TAT 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 (CED NO. 353-6442-070

Figure 2-4. Remote Control Connections to Terminal Board A17TB4

CAUTION

For 60 Hz operation only, the transformer primary taps must not be set 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 shall not be set to a lower tap than the highest expected line voltage where 50 Hz primary power source is used. Failure to comply may result in damage to equipment.

9. Set Transformer Taps

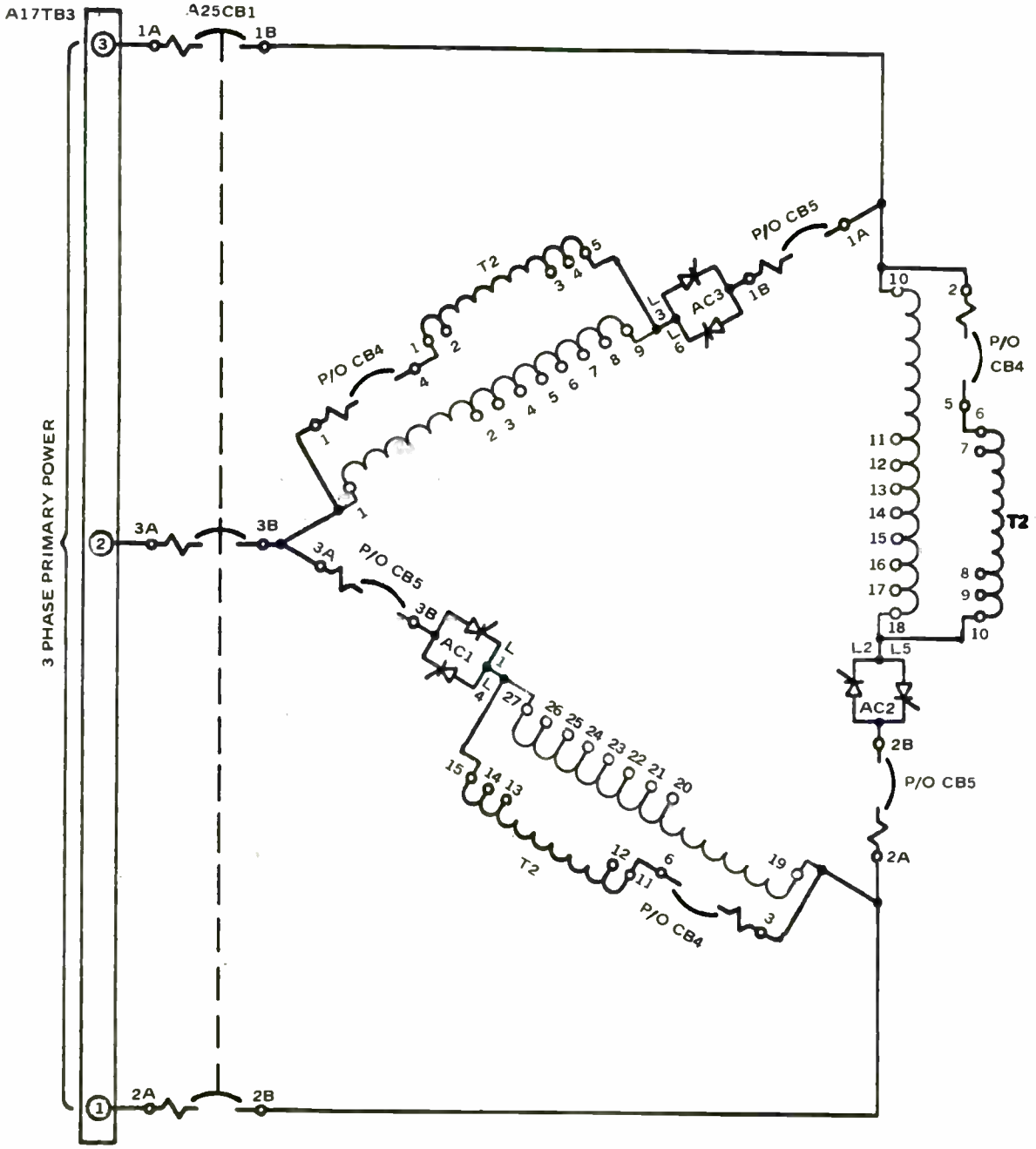
The Transmitter is shipped with all transformers on the highest voltage taps unless specific instructions are given regarding line voltage. This is done to prevent damage where line voltage may be higher than transformers are tapped and power is applied without changing taps.

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, T4, and A28T1 and power supply transformers A10T1 and A10T2. Figures 2-5, 2-6, and Table 2-4 show 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 Figure 2-5.

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 Figure 2-5.

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 to the power source voltage and is connected according to instructions supplied in Figure 2-5.



LINE VOLTAGE	T1 TERMINALS	T2 TERMINALS	T4 TERM.CONN.	A10T2 TERM.CONN.	A10T1 TERM.CONN.
200V	1-4, 10-13, 19-22	2-3, 7-8, 12-13	1 & 2	1&2, 4&5, 7&8	1 & 2
210V	1-5, 10-14, 19-23	2-4, 7-9, 12-14	1 & 3	↓	1 & 2
220V	1-6, 10-15, 19-24	2-5, 7-10, 12-15	1 & 4	↓	1 & 2
230V	1-7, 10-16, 19-25	1-3, 6-8, 11-13	1 & 5	1&3, 4&6. 7&9	1 & 3
240V	1-8, 10-17, 19-20	1-4, 6-9, 11-14	1 & 6	↓	1 & 3
250V	1-9, 10-18, 19-27	1-5, 6-10, 11-15	1 & 7	↓	1 & 3

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

Figure 2-5. Transformer Connection Schedule

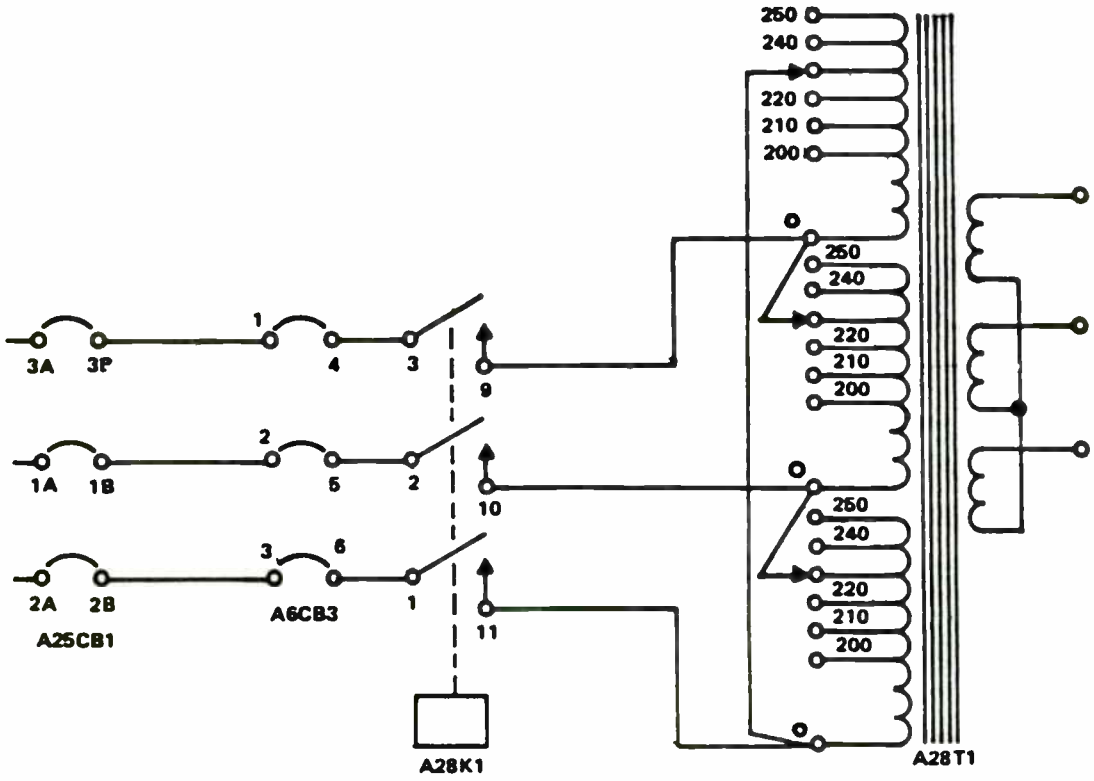


Figure 2-6. Driver Transformer Connection

TABLE 2-1. 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

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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. Instructions for the 802A exciter are found in the Exciter Instruction Manual.

3-2. CONTROLS AND INDICATORS

Refer to the following figures and tables for a general description of the operating controls found on the front panels of the transmitter. Figure 3-1 shows the location of the control and indicator panels. Figures 3-2 through 3-6 show details of each panel. Tables 3-1 through 3-5 supplement Figures 3-2 through 3-6.

3-2.1 The PA GRID TUNING control is part of Power Amplifier Cavity A18. The control shaft extends through a hole in a structural panel. The control knob and its accompanying stenciled panel nomenclature is shown in Figure 3-1. This control allows adjustment of PA grid circuit resonance for maximum bias and frequency stablility.

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 .

1. Ensure transmitter has been assembled and connected according to instructions in paragraphs 2-1 thru 2-3.

2. Remove access panel of Card Cage Assembly for access to the control circuit cards. Check the circuit cards for proper installation.

3. Install Card Cage access panel and ensure all doors and panels are properly closed or installed.

4. Ensure all transmitter circuit breakers on CB panel A6 are OFF.

5. Connect primary power to transmitter and set AC LINE circuit breaker on AC Metering Panel to ON.

6. Set the 28 VDC POWER SUPPLY and BLOWERS circuit breakers to ON. Check the PHASE LOSS indicator on PA Control Panel (see Figure 3-4). If this indicator is not on, set AC LINE circuit breaker on AC Metering Panel to OFF. Remove the right front bay access panel. Locate A19K5 (the phase loss/phase rotation monitor) and turn its control to minimum (full counterclockwise). Install the access panel and restore primary power. If the PHASE LOSS indicator is still not on, shut off primary power and disconnect power from power input lines. Interchange any two primary input leads at A17TB3 (figure 6-15). Restore primary power and check indicator.

7. Adjust the Phase Monitor A19K5 phase loss threshold.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED. DEATH ON CONTACT MAY OCCUR. BE CAREFUL WHEN PERFORMING THE FOLLOWING PROCEDURES.

a. Set AC LINE circuit breaker on AC Metering Panel to OFF and remove the right front bay access panel.

b. Block the interlock grounding switch in the open position.

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 A19K5 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.

Continued on Page 3-17.

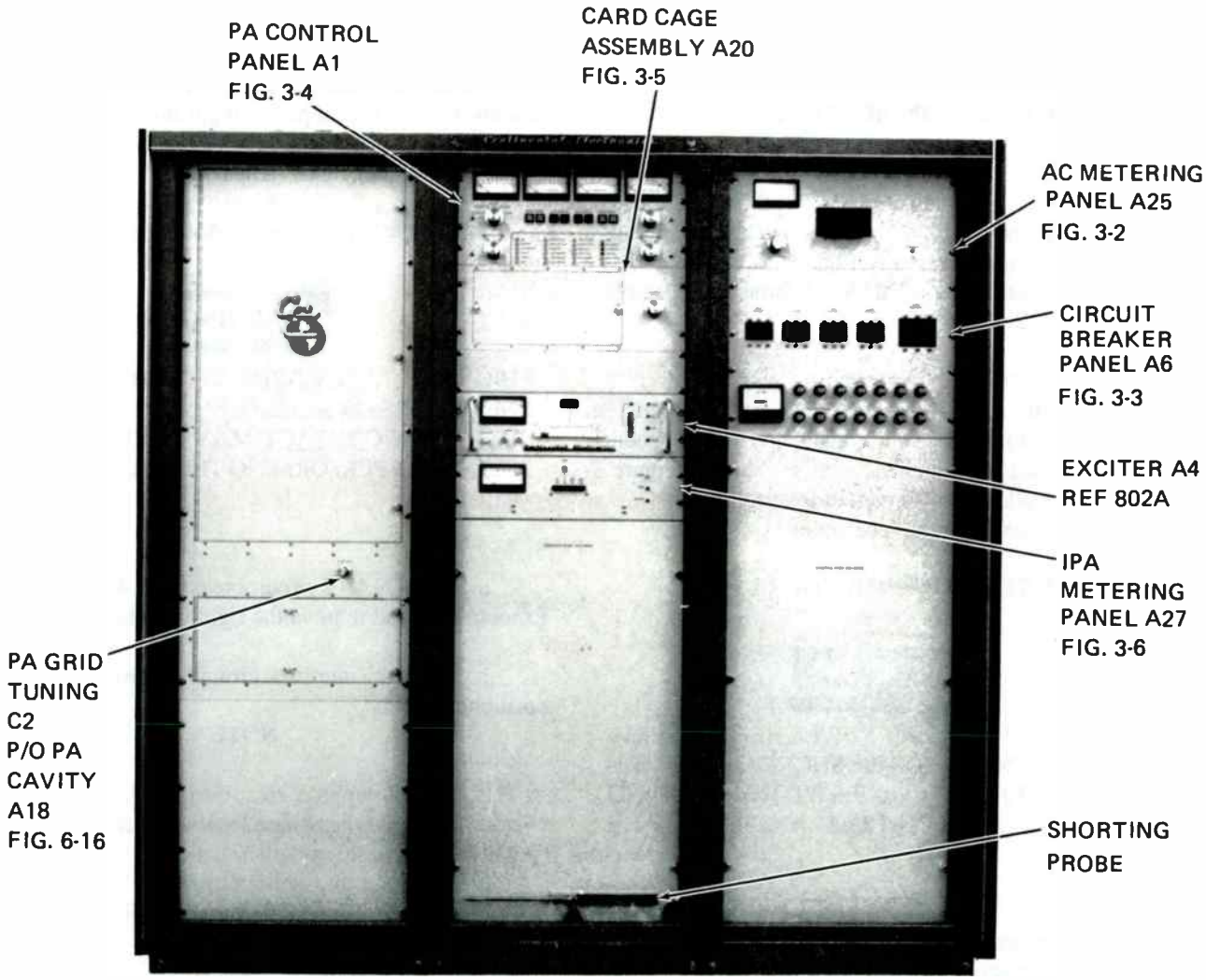

Figure 3-1. Transmitter Control Panels

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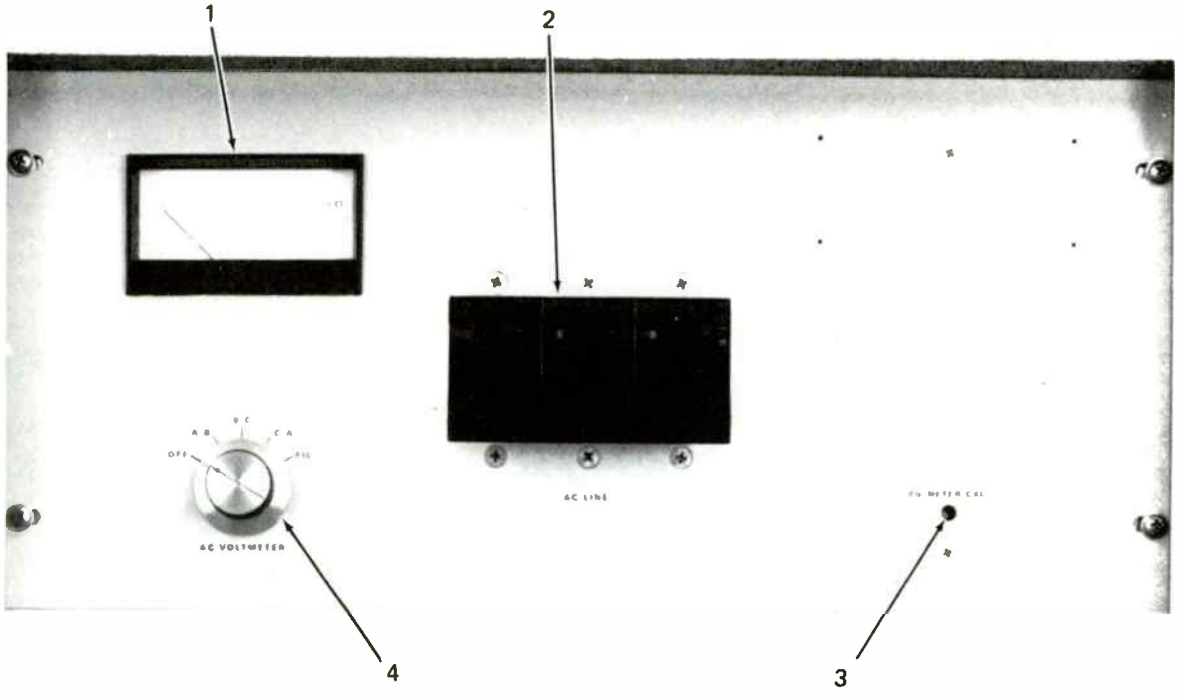

Figure 3-2. AC Metering Panel, A25, Controls and Indicators

RQ-3-002

Table 3-1. AC Metering Panel A25 Controls and Indicators

Index No.	Control or Indicator	Function
1	AC VOLTS meter A25M1	Displays voltage selected by AC VOLTMETER switch.
2	AC LINE circuit breaker A25CB1	ON/OFF control for input ac puwer to the transmitter.
3	FIL METER CAL control A25A1R12	Allows calibration of AC VOLTS meter in comparison to a voltage standard measurement.
4	AC VOLTMETER switch A25S1	Selects power phase voltage or power amplifier filament voltage to be indicated on AC VOLTS meter.

Table 3-2. Circuit Breaker Panel A6 Controls and Indicators

Index No.	**Control or Indicator**	**Function**
1	28 VDC POWER SUPPLY circuit breaker A6CB1	ON/OFF control for 28V dc power supply.
2	BLOWER circuit breaker A6CB2	ON/OFF control for ac power to trasmitter cooling air blowers.
3	DRIVER POWER SUPPLY circuit breaker A6CB3	ON/OFF control for driver (IPA) power supply.
4	PA SCREEEN POWER SUPPLY circuit breaker A6CB4	ON/OFF control for power amplifier screen power supply.
5	PA PLATE POWER SUPPLY circuit breaker A6CB5	ON/OFF control for power amplifier plate power supply.
6	FILAMENTS fuse A6F1	Power amplifier filament circuit protector.
7	FILAMENT METER fuse A6F4	Power amplifier filament current metering circuit protector.
8	FILAMENTS fuse A6F3	Power amplifier filament circuit protector.
9	FILAMENT METER fuse A6F13	Power amplifier filament current metering circuit protector.
10	PA BIAS POWER SUPPLY fuse A6F13	Power amplifier grid bias power supply circuit protector.

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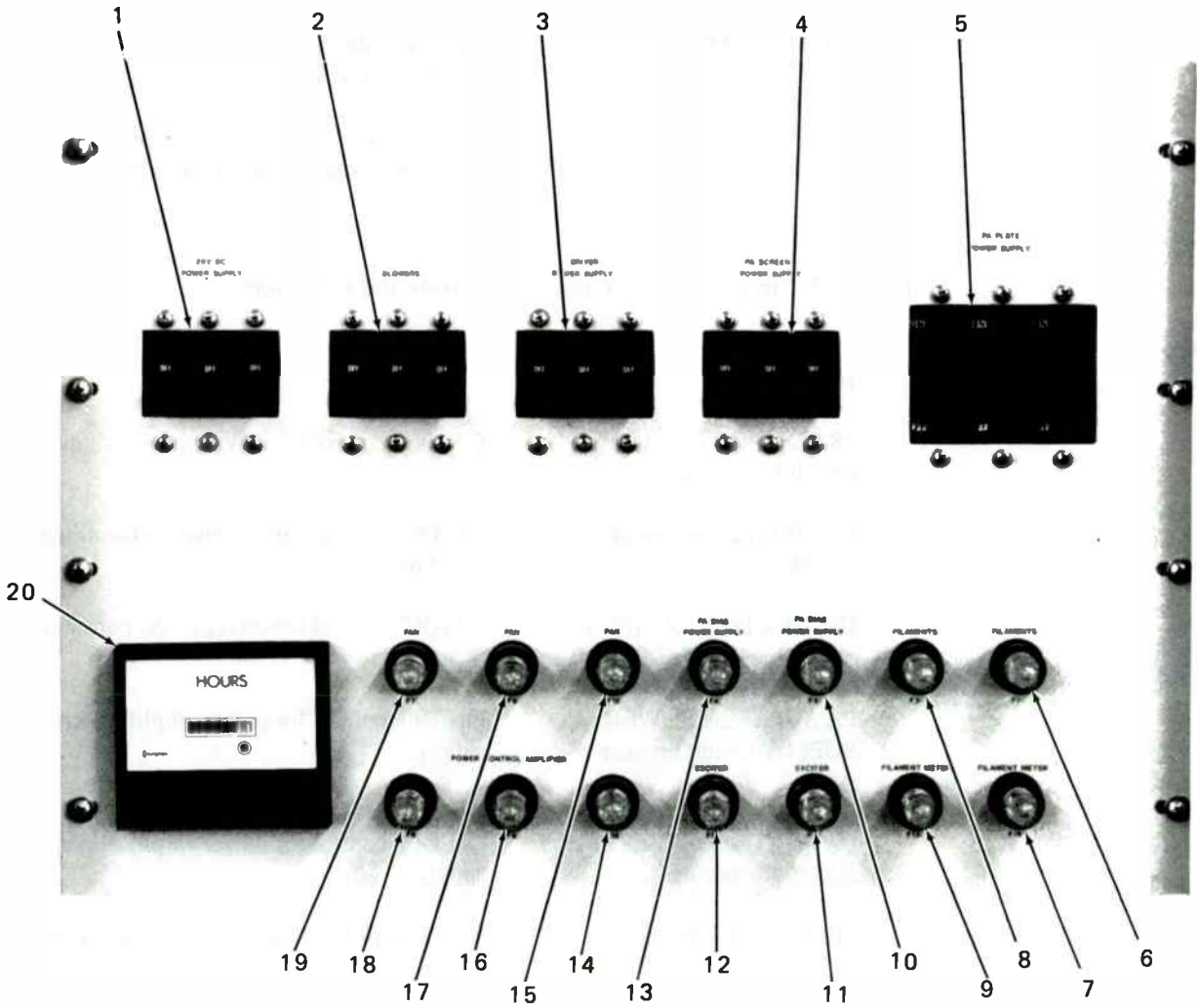


Figure 3-3. Circuit Breaker Panel, A6, Controls and Indicators

RQ-3-003

Table 3-2. Circuit Breaker Panel A6 Controls and Indicators - cont.

Index No.	Control or Indicator	Function
11	EXCITER fuse A6F2	Exciter power circuit protector.
12	EXCITER fuse A6F11	Exciter power circuit protector.
13	PA BIAS POWER SUPPLY fuse A6F4	Power amplifier grid bias power supply circuit protector.
14	POWER CONTROL AMPLIFIER fuse A6F10	Controller relay A19K12 actuator circuit protector.
15	FAN fuse A6F12	Blower fan power circuit protector.
16	POWER CONTROL AMPLIFIER fuse A6F6	Controller relay A19K12 actuator circuit protector.
17	FAN fuse A6F9	Blower fan power circuit protector.
18	POWER CONTROL AMPLIFIER fuse A6F8	Controller relay A19K12 actuator circuit protector.
19	FAN fuse A6F7	Blower fan power circuit protector.
20	HOURS meter	Transmitter operation elapsed time recorder.

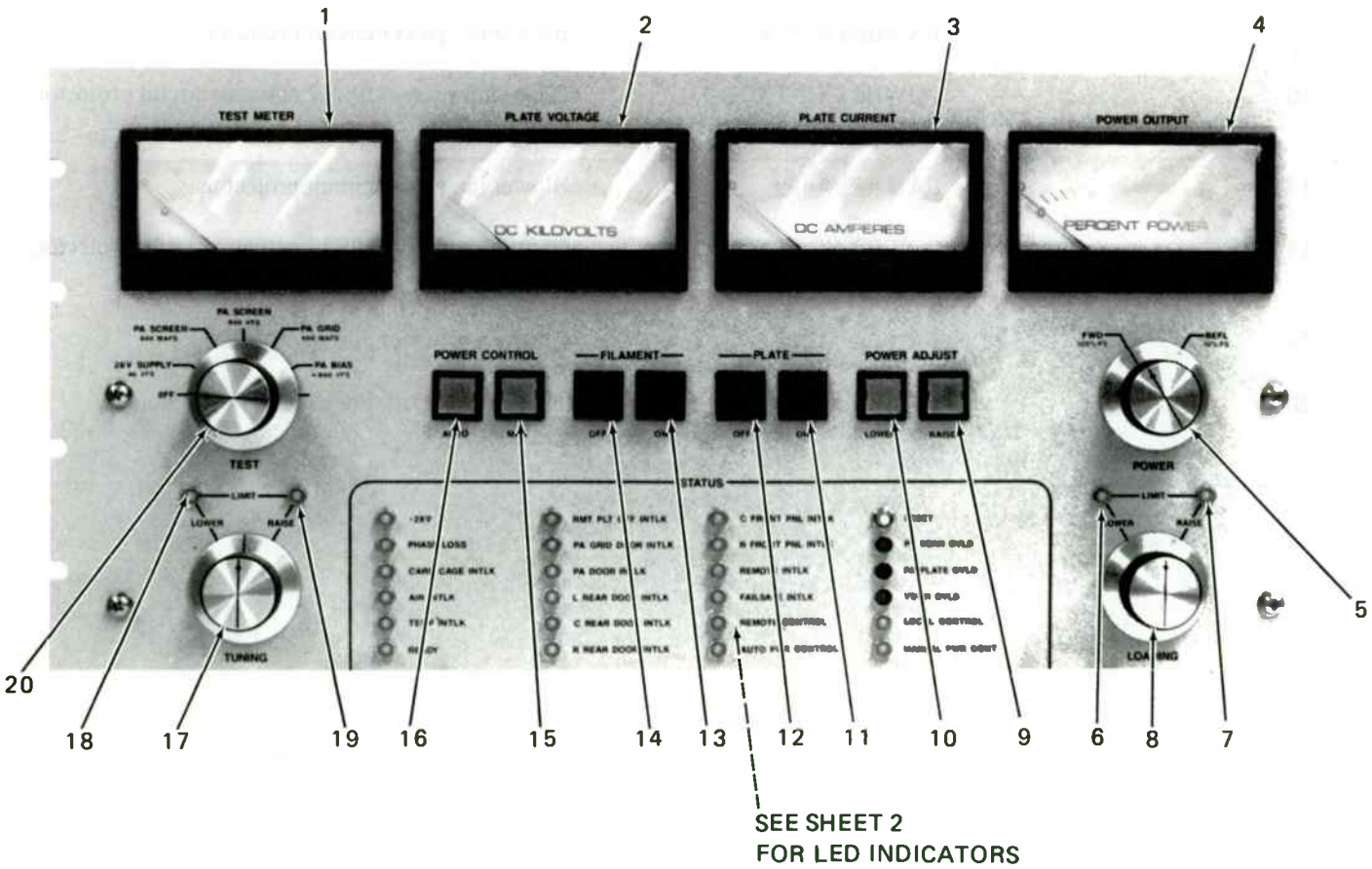


Figure 3-4. PA Control Panel, A1, Controls and Indicators (Sheet 1 of 2)

RQ-3-004

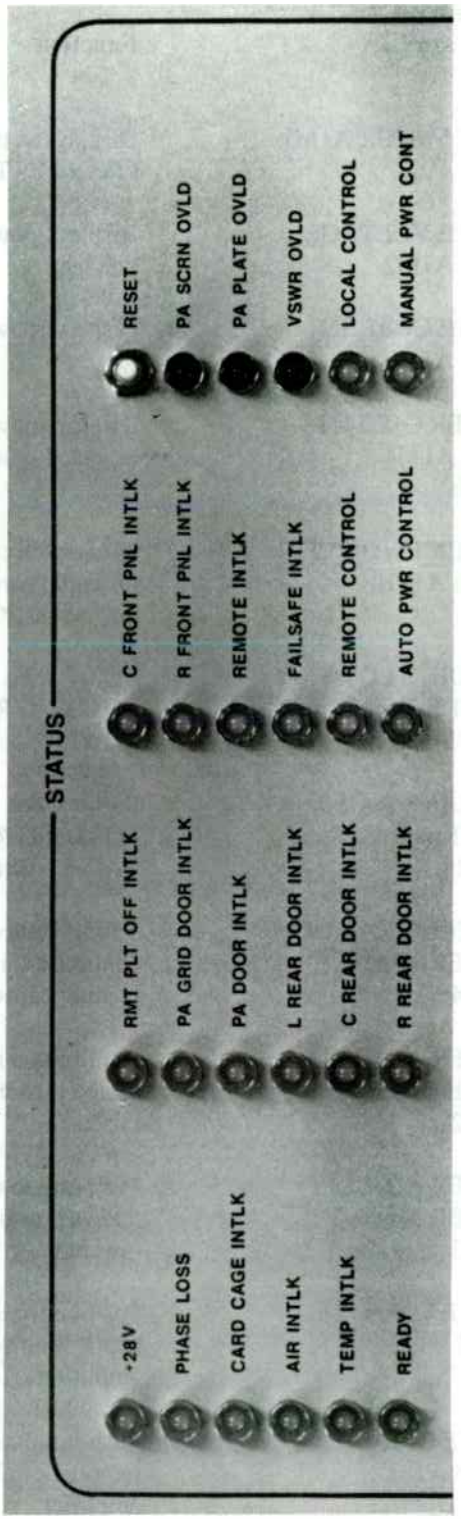


Figure 3-4. PA Control Panel, A1, Controls and Indicators (Sheet 2 of 2)

Table 3-3. PA Control Panel A1 Controls and Indicators

Index No.	Control or Indicator	Function
1	TEST METER A1M1	Displays voltages and currents selected by TEST switch.
2	PLATE VOLTAGE meter A1M2	Displays power amplifier plate voltage.
3	PLATE CURRENT meter A1M3	Displays power amplifier plate current.
4	POWER OUTPUT meter A1M4 switch.	Displays power amplifier forward or reflected power as selected by POWER
5	POWER FWD-REFL switch A1S10	Allows selection of power amplifier forward power or reflected power for display on POWER OUTPUT meter.
6	LOADING LOWER LIMIT indicator A1CR7	Lights when lower limit is reached and LOADING RAISE-LOWER switch is held in LOWER position.
7	LOADING RAISE LIMIT indicator A1CR8	Lights when upper limit is reached and LOADING RAISE-LOWER switch is held in RAISE position.
8	LOADING RAISE-LOWER switch A1S14	Spring-loaded momentary switch that controls adjustment of variable loading capacitor C50.
9	POWER ADJUST RAISE switch A1S12	Push-button momentary switch that allows power amplifier output to be raised.
10	POWER ADJUST LOWER switch A1S13	Push-button momentary switch that allows power amplifier output to be lowered.
11	PLATE ON switch A1S4	Push-button switch-indicator for application of plate voltage to power amplifier.
12	PLATE OFF switch A1S3	Push-button switch-indicator for removal of plate voltage from power amplifier.

- continued -

Table 3-3. PA Control Panel A1 Controls and Indicators - cont.

Index No.	Control or Indicator	Function
13	FILAMENT ON switch A1S2	Push-button switch-indicator for application of filament voltage to power amplifier.
14	FILAMENT OFF switch A1S1	Push-button switch-indicator for removal of filament voltage from power amplifier.
15	POWER CONTROL MAN switch A1S5	Push-button switch-indictor that allows selection of manual power amplifier output control.
16	POWER CONTROL AUTO switch A1S6	Push-button switch-indicator that allows selection of automatic power amplifier output control.
17	TUNING RAISE-LOWER switch A1S13	Spring-loaded momentary switch that controls adjustment of variable tuning capacitor C51.
18	TUNING LOWER LIMIT indicator A1CR5	Lights when lower limit is reached and TUNING RAISE-LOWER switch is held in LOWER position.
19	TUNING UPPER LIMIT indicator A1CR6	Lights when upper limit is reached and TUNING RAISE-LOWER switch is held in RAISE position.
20	TEST switch A1S9	Allows selection of voltages and currents to be displayed on TEST METER. Value listed below each selection on Figure 3-4 is full scale value.
(See figure 3-4, sheet 2 for close-up of STATUS section of panel)	RESET switch A1S11	Push-button momentary switch that resets fault indicators.
STATUS Indicators:		
	+28V, A1CR9	Lights when 28V dc power is available.
	PHASE LOSS, A1CR10	Lights when phase loss, phase sequence, or phase balance fault occurs.

- continued -

Table 3-3. PA Control Panel A1 Controls and Indicators - cont.

Index No.	Control or Indicator	Function
	CARD CAGE INTLK, A1CR11	Lights when interlock circuit is normal.
	AIR INTLK, A1CR12	Lights when there is adequate air pressure.
	TEMP INTLK, A1CR13	Goes out when exhaust temperature is too hot.
	READY, A1CR14	Lights to indicate completion of PA filament warmup time delay.
	RMT PLT OFF INTLK, A1CR20	Remote plate off relay indicator.
	PA GRID DOOR INTLK A1CR21	PA grid door interlock indicator.
	PA DOOR INTLK, A1CR22	PA door interlock indicator.
	L REAR DOOR INTLK, A1CR23	Left rear door interlock indicator.
	C REAR DOOR INTLK, A1CR24	Center rear door interlock indicator.
	R REAR DOOR INTLK, A1CR25	Right rear door interlock indicator.
	C FRONT PNL INTLK, A1CR26	Center front panel interlock indicator.
	R FRONT PNL INTLK, A1CR27	Right front panel interlock indicator
	REMOTE INTLK, A1CR28	Remote interlock indicator.
	FAILSAFE INTLK, A1CR29	Remote failsafe relay interlock indicator.
	REMOTE CONTROL, A1CR19	A1S10 remote control position indicator.

- continued -

Table 3-3. PA Control Panel A1 Controls and Indicators - cont.

Index No.	Control or Indicator	Function
	AUTO PWR CONTROL, A1CR31	A1S6 automatic power control position indicator.
	PA SCRN OVLD, A1CR17	PA screen fault indicator.
	PA PLATE OVLD, A1CR16	PA plate fault indicator.
	VSWR OVLD, A1CR18	VSWR fault indicator.
	LOCAL CONTROL, A1CR15	A1S10 local control position indicator.
	MANUAL PWR CONTROL A1CR30	A1S5 Manual power control position indicator.

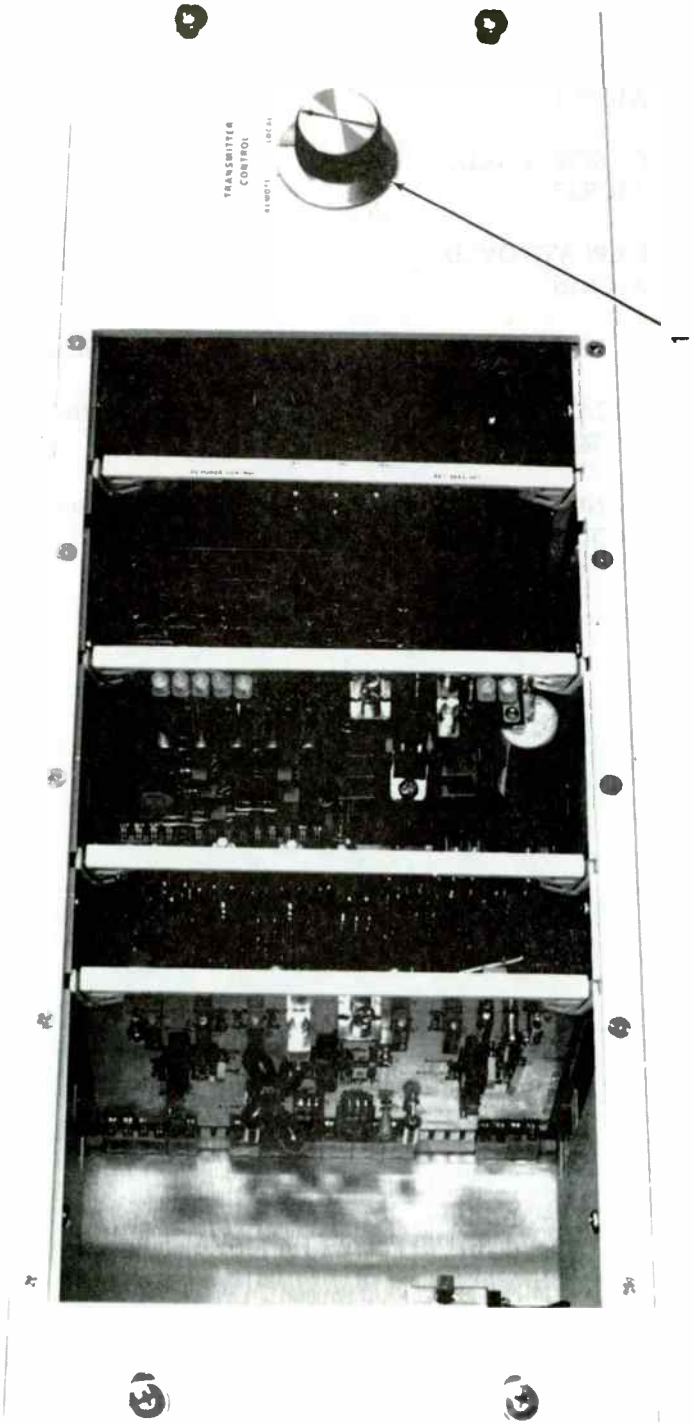


Figure 3-5. Card Cage Assembly, A20, Controls and Indicators

RQ-3-006

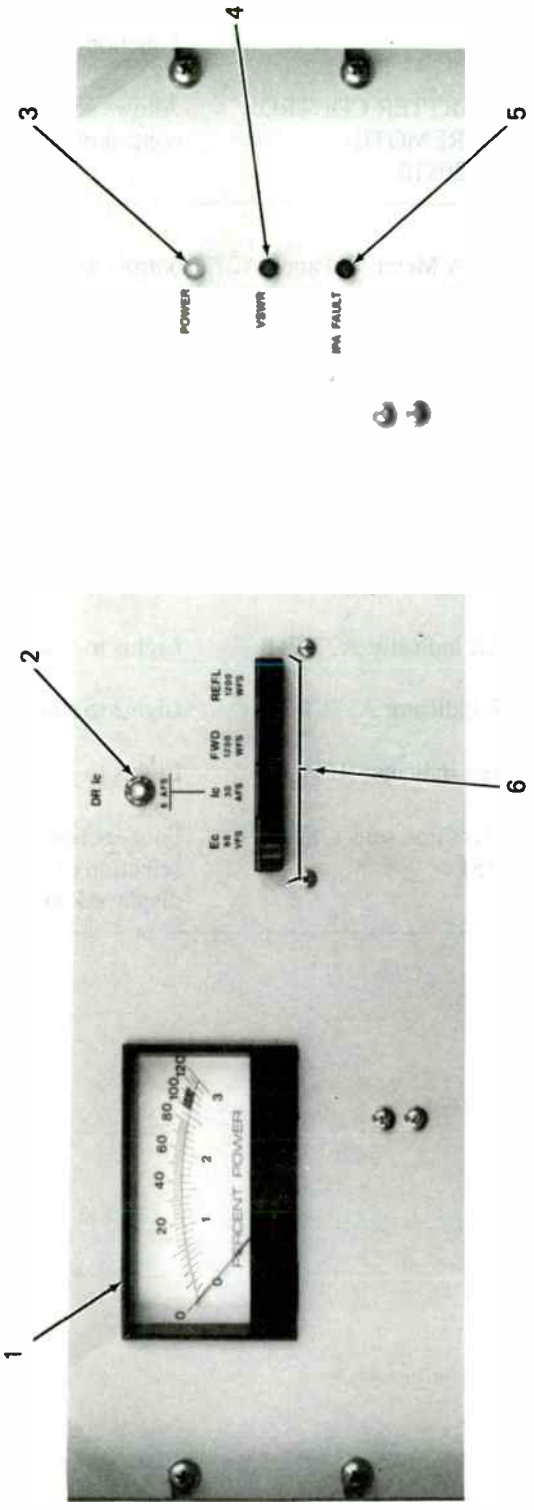


Figure 3-6. IPA Metering Panel, A27, Controls and Indicators

Table 3-4. Card Cage Assembly, A20, Controls and Indicators

Index No.	Control or Indicator	Function
1	TRANSMITTER CONTROL LOCAL-REMOTE switch A20S10	Allows selection of local or remote control of power amplifier operations.

Table 3-5. IPA Metering Panel, A27, Controls and Indicators

Index No.	Control or Indicator	Function
1	Multiple display meter A27M1	Displays voltage, current, or power selected at panel's selector switch.
2	DR Ic Switch A27S1	Push-button switch allows selection of driver current for measurement when Ic 30 AFS is selected on panel's selector switch.
3	POWER indicator A27CR1	Lights to show that IPA is on.
4	VSWR indicator A27CR2	Lights to show high load on IPA.
5	IPA fault indicator A27CR3	Lights to indicate fault in IPA.
6	Meter function selector switch A27A1S1	Four-section, push-button switch allows selection of voltage, current, or power to be displayed on panel's meter.

f. Remove block from interlock grounding switch.

g. Install access panel.

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS ARE OPENED OR ACCESS PANELS ARE REMOVED. DEATH ON CONTACT MAY OCCUR. BE CAREFUL WHEN PERFORMING THE FOLLOWING PROCEDURES.

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

9. Apply primary power and press FILAMENT ON switch on PA Power Control Panel.

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. Install 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 switch.

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

13. Set the AC Metering Panel selector switch to FIL. The test meter should indicate 6.0 +/-0.1 volts. Adjust filament voltage if it is not correct. Use procedure in Paragraph 5-7.2. These adjustments are required to be made at customer's normal line voltage.

NOTE

Refer to 802A Exciter Instruction Manual for exciter details

14. Verify POWER indicator on exciter front panel is lit. If not, proceed as follows:

a. Set AC LINE circuit breaker on AC Metering Panel to off.

b. Remove rear panel of center cabinet.

c. Set exciter POWER switch, at rear of cabinet, to on.

d. Install rear panel of center cabinet.

e. Set AC LINE circuit breaker on AC Metering Panel to ON. Verify POWER indicator on exciter front panel lights.

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 thru 25 are adequate to ensure proper transmitter operation. However, if the transmitter is to be operated at a frequency or power output 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 for manual operation.

16. Set the 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 PA GRID TUNING and the COUPLING control for minimum IPA reflected power.

20. Slightly adjust the PA LOADING and PA TUNING controls until maximum power output is displayed on the POWER OUTPUT meter.

21. As the transmitter warms up, the IPA reflected power will rise. Retune the PA GRID TUNING as needed to keep the reflected power below 75 watts (final value is less than 20 watts). Once the IPA reflected power appears stabilized, repeat steps 19 & 20. The final setting should be established after the transmitter has been on for at least 30 minutes. Do not retune the grid after the final setting has been established.

NOTE

In this transmitter, operating parameters will become stable within 15-20 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 POWER OUTPUT meter displays the station's authorized power level. If specified, the meter 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 paragraph 5-7.

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 the power amplifier is neutralized. See paragraph 5-9.3.

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 will be maximum and screen current will be nearly so. PA plate current will change as the tuning is changed. Plate current will increase when the tuning control is held in the lower position. When the shorting plane is positioned correctly, the PA screen current and power output will go through a peak. Ensure screen current and power output peak, and 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 3-8 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 A and point B, 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. PA screen current decreases when loading is raised and increases when loading is lowered. Normally, screen current is between 300 - 600 mA. The screen current is dependent upon loading, power output requirements, plate and screen voltage, and individual tube characteristics. 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 POWER OUTPUT METER.

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% above the authorized station maximum output, proceed to setp c.

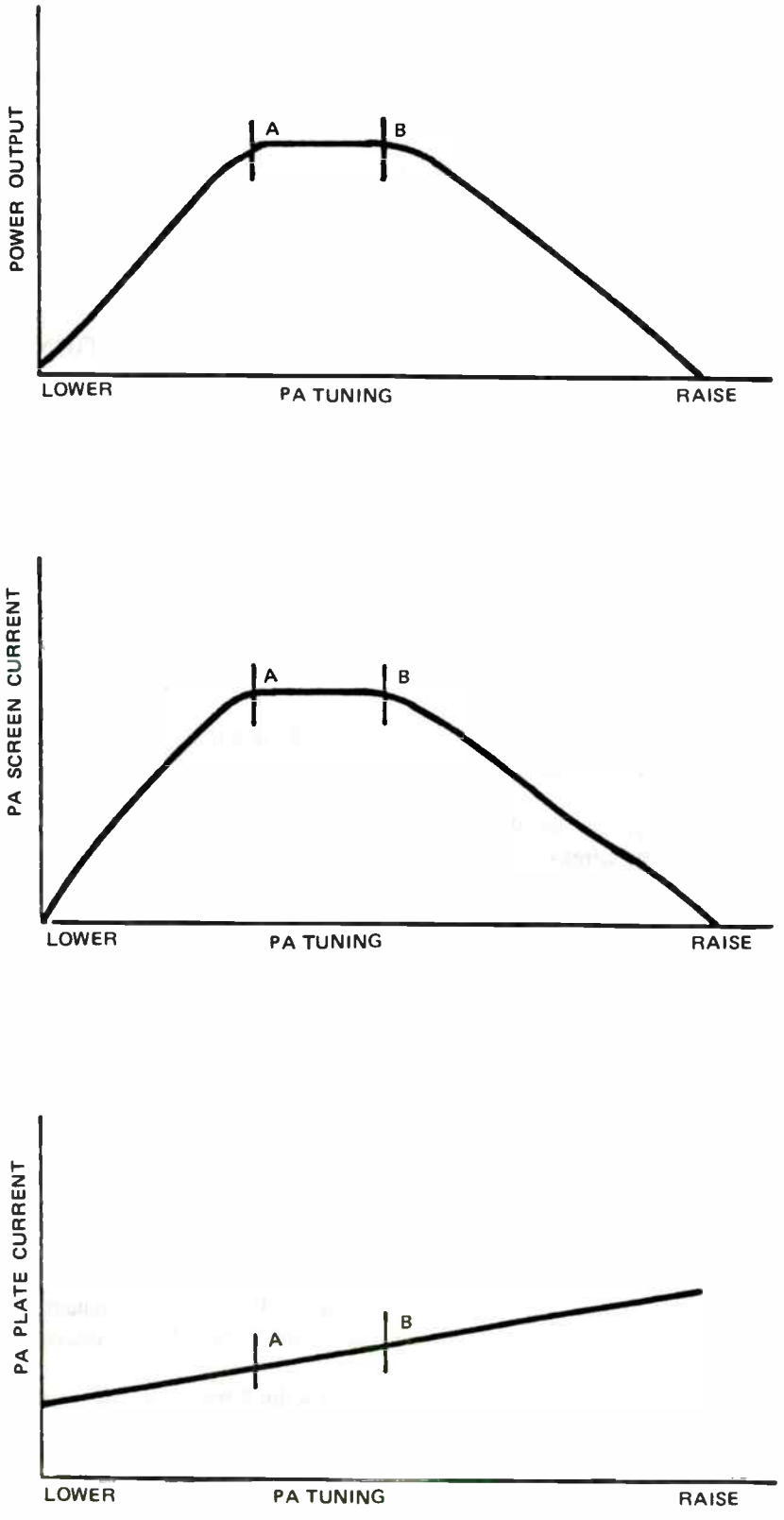


Figure 3-7. PA Tuning and Loading

RQ-3-008

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

d. Turn off primary power to the transmitter.

e. Refer to Figure 2-5 and Table 2-1, 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 thru 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 Tables 3-6 and 3-7 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.

k. Refer to Figure 2-5. 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 thru 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 POWER OUTPUT meter displays the authorized station maximum power output.

NOTE

Use curves and equations in Figure 3-8 for indirect power output determination.

27. ANTENNA SYSTEM VSWR CHECK. The POWER OUTPUT meter 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.

3-4. REMOTE OPERATION

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

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

NOTE

Perform this step only if using a second power level.

1. Switch transmitter to AUTO POWER CONTROL mode.

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

3. 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, or VSWR is overloaded. An overload indicator, A1CR16 thru A1CR18, 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.

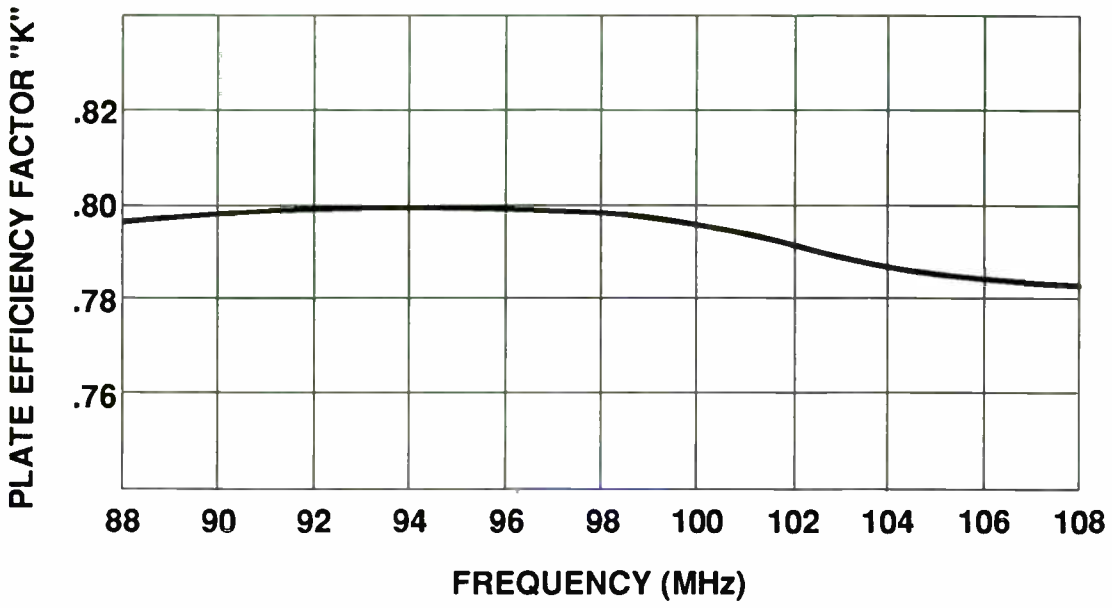
The fault recycling circuits may be disabled for tuning maintenance by switching the AUTO RECYCLE switch A7S2 to OFF.

TABLE 3-6. NOMINAL OPERATING PARAMETERS VS. POWER LEVELS
(99.7 MHz)

816R-3B OPERATING PARAMETERS	RF OPERATING POWER - kW				
	10	15	20	22.5	25.0
Plate Voltage (kV)	7.82	8.40	8.50	8.53	8.48
Plate Current (Amps)	1.60	2.20	2.92	3.30	3.73
Screen Voltage (V)	375	500	610	675	710
Screen Current (mA)	190	298	400	450	510
Grid Bias Voltage (V)	-608	-607	-587	-585	-566
Grid Current (mA)	106	107	100	107	118
Forward Power (%)	40	60	80	90	100
Reflected Power (%)	<0.2	<0.2	<0.2	<0.2	<0.2
Filament Voltage (VRMS)	6.0	6.0	6.0	6.0	6.0
DRIVER					
IPA Voltage (Volts)	45	45	44	44	44
IPA Current (Amps)	22.0	21.5	19.5	21.5	18.5
DR Current (Amps)	2.84	2.78	2.3	2.6	2.2
FWD Power (watts)	550	530	480	520	4.40
RFL Power (watts)	<10	<10	<10	<10	<10
PA Efficiency Factor F (%)	79.9	81.2	80.6	79.9	79.0
AC POWER ANALYZER					
Phase A-B (VRMS)	210	207	206	205	205
Phase B-C (VRMS)	204	203	202	202	200
Phase C-A (VRMS)	208	206	205	206	204

TABLE 3-7. NOMINAL OPERATING PARAMETERS VS. FREQUENCY

816R-3B Operating Parameters Frequency (mHz)	88.1	92.1	96.1	99.7	104.1	107.9
Plate Voltage (kV)	8.48	8.41	8.40	8.48	8.40	8.41
Plate Current (Amps)	3.70	3.70	3.72	3.73	3.85	3.79
Screen Voltage (V)	710	740	730	710	700	700
Screen Current (mA)	450	482	510	510	450	490
Grid Bias Voltage (V	-515	-556	-574	-566	-488	-535
Grid Current (mA)	110	115	115	118	95	103
Forward Power (%)	100	100	100	100	100	100
Reflected Power (%)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Filament Voltage (VRMS)	6.3	6.3	6.3	6.3	6.3	6.3
Power Output (KW)	25.0	25.0	25.0	25.0	25.0	25.0
DRIVER						
IPA Voltage (V)	43.0	44.0	43.0	44.0	44.0	44.0
IPA Current (A)	21.0	21.0	21.0	18.5	22.0	22.0
DR Current (A)	2.70	2.90	2.70	2.20	3.00	1.70
FWD Power (W)	555	550	530	440	600	s600
RFL Power (W)	<10	<10	<20	<10	<15	<20
PA Efficiency Factor "F" (%)	79.7	80.0	80.0	79.0	78.8	78.4



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

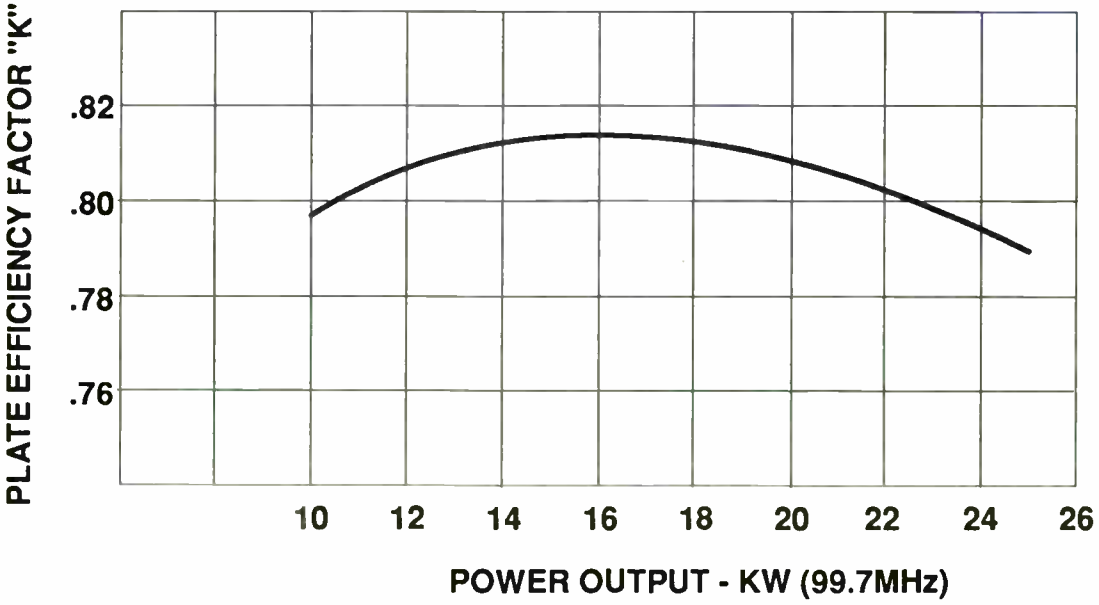


Figure 3-8. Amplifier Efficiency vs. Frequency and Power

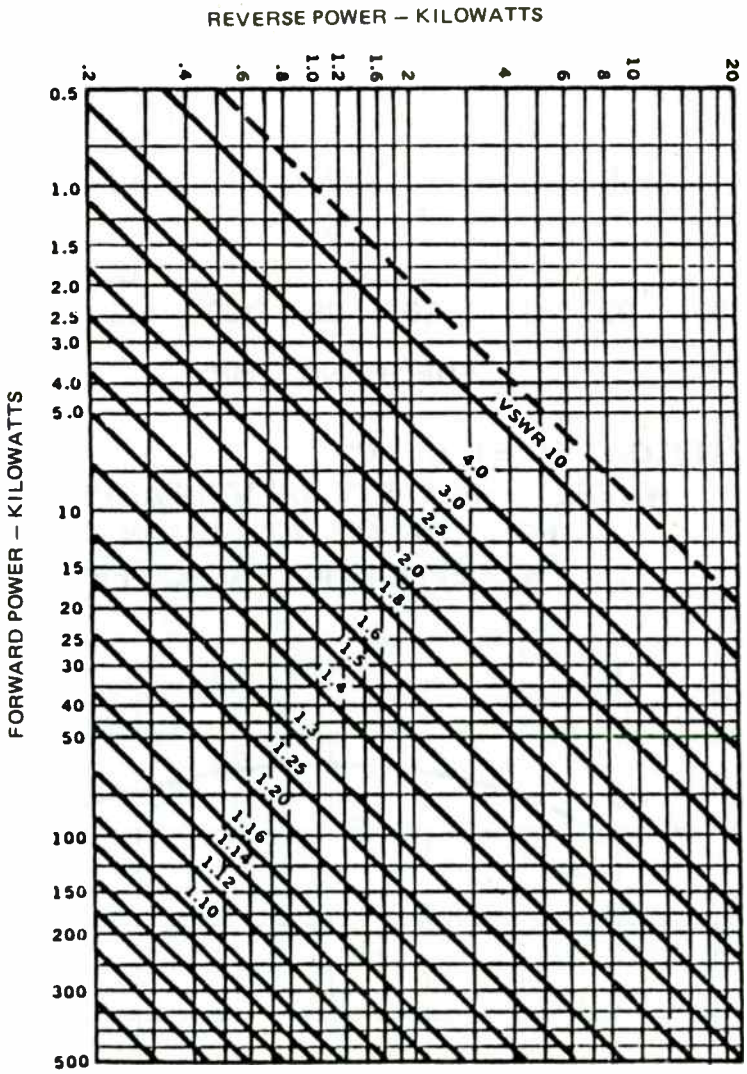


Figure 3-9. Power to VSWR Conversion Graph

RQ-3-010

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 (3 minutes or less) 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-mounted, 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 CB1 circuit breaker OFF.

4. Open the Primary Disconnect switch.

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SECTION 4 - THEORY OF OPERATION

4-1. GENERAL

The FM Transmitter, 816R-3B, operates in the 88 to 108 MHz range at a maximum rated RF output of 25 kW. A CE 802A solid- state FM wideband exciter provides excitation. The transmitter is equipped with circuits that maintain constant power output and 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 composite, or SCA is supplied to the exciter. The exciter's RF output drives a three stage power amplifier. The first stage, the driver, raises the exciter power to approximately 40 to 50 Watts. The following stage, the IPA (intermediate power amplifier), raises the driver output to a level of 500 Watts. The last stage, the RF power amplifier, raises the IPA output to the transmitter's rated power output. The power amplifier is followed by a low pass filter and a directional coupler which is connected to the station's antenna system. 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 remove all plate voltage 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 SOLID-STATE DRIVER

4-3.2.1 DRIVER (A26AR1)

The exciter RF output is applied to the driver amplifier module through a 3dB pad. The pad is used to assure a good load to the exciter under all operating conditions. The amplifier features two MOSFET devices in a broadband, push- pull configuration which is rated for 150 Watts of output. The driver receives its power from a 45-Volt dc supply which is also used to supply the IPA and its metering circuitry. A resistor, in series with the supply, limits the driver's maximum output power. The driver is thermally protected by a temperature sensitive switch mounted to the driver heat sink. The amplifier's supply current is monitored by the meter on the IPA Metering Panel as it passes through the meter and its shunt resistor A26R3. The output of the driver is fed to the IPA module.

4-3.2.2 IPA (A26AR2)

The IPA is a modular amplifier (schematic diagram Figure 4-3) mounted on top of the IPA shelf. The amplifier has the following features.

1. Broadband. Solid state (MOSFET) design, rated to 700 Watts.

2. Redundancy. The amplifier module contains two separate amplifiers and a 90-degree combiner. Should one of the amplifiers fail, the other would continue to produce power.

3. Internal protection. If supply voltage, RF drive power, or heat sink temperature exceed preset limits, the protection circuit will shut the module off until the above parameters return to normal.

The IPA receives its dc power from a 45-Volt supply which also serves the driver and the IPA metering board. the IPA is followed by a directional coupler. The coupler drives the IPA RF power meter and provides a reflected power signal which is used to protect the IPA from high load VSWR. This is done by reducing the exciter power output when a high VSWR is detected, thus reducing the stress on the IPA, while keeping the transmitter on the air. The VSWR lamp on the IPA metering panel will light when this condition occurs. The RF output of the directional coupler is connected to the RF power amplifier cavity.

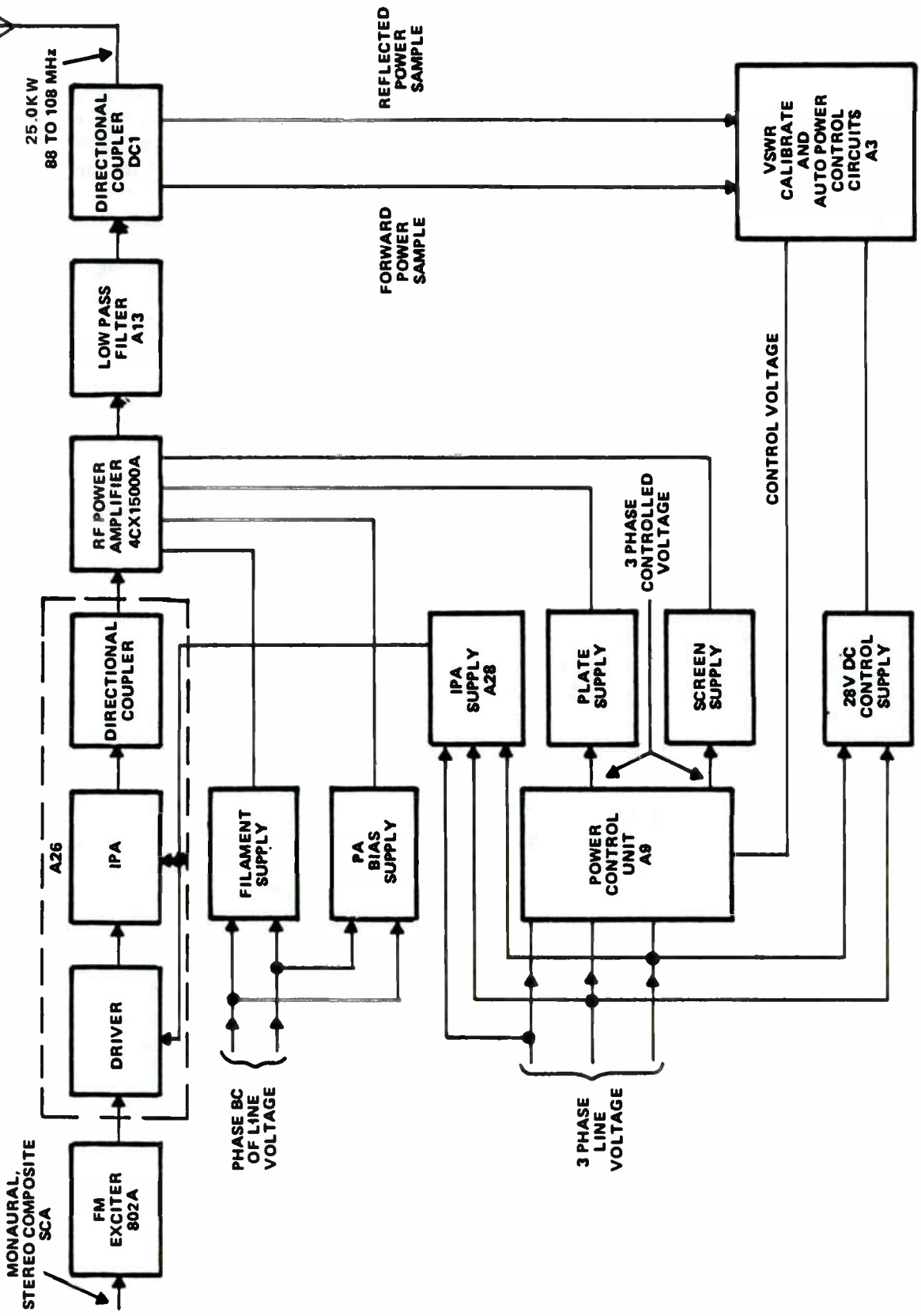

Figure 4-1. FM Transmitter 816R-3B, Block Diagram

RQ-4-001

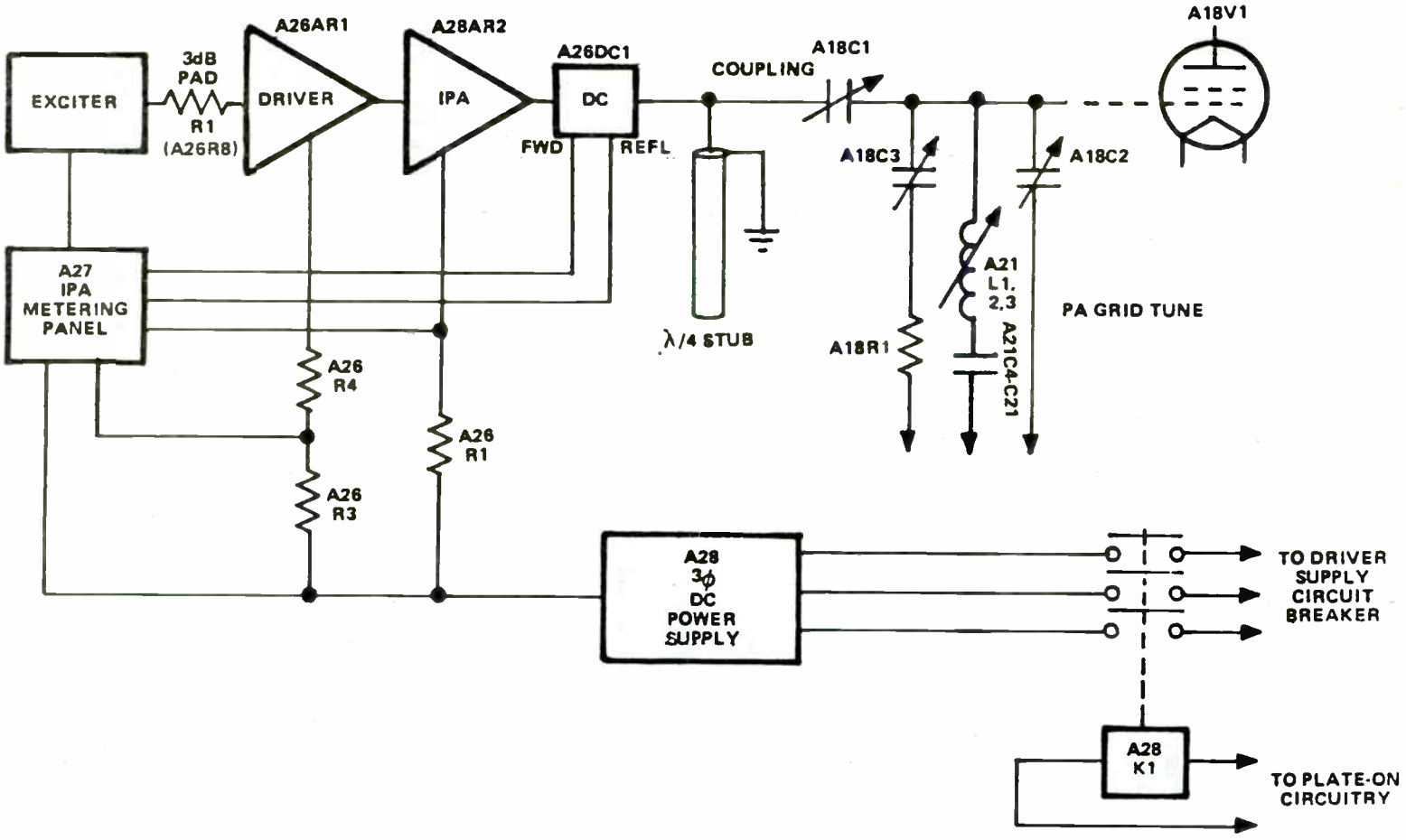

Figure 4-2. Basic RF Chain

4-3.2.3 IPA METERING PANEL (A27)

Refer to Figures 4-4 and 4-5 IPA metering schematic diagrams for the following discussion. The IPA metering panel permits measurement of driver current, IPA supply voltage, current, forward RF power, and reflected RF power. Additionally, the panel has three LEDs which indicate power on, high VSWR, and IPA module fault. The module fault lamp lights when the module's internal protection circuitry shuts the module off. The metering panel printed circuit board contains all meter calibration pots, a voltage regulator (U1), an op amp/comparator (U2), and the metered parameter select switch (S1). The op amp amplifies the reflected power signal (U2-5) from the IPA directional coupler. This amplified signal (U2-7) is used to reduce (foldback) the exciter power output under high IPA load VSWR conditions. This signal is also compared to a reference voltage using the comparator of U2. When the reflected power signal (U2-3) exceeds the reference voltage (U2-2), U2-1 goes high, causing the VSWR LED to light. The metering circuitry is powered from the 45-Volt IPA supply through R1 and U1 on the card. U1 is a 12-Volt regulator.

4-3.3 RF POWER AMPLIFIER (A21)

The RF power amplifier is driven by the IPA through a matching network consisting of the COUPLING control (C1), the PA GRID TUNE control (C2), and L1,2,3(See Figure 4-2). Capacitor C3 and resistor R1 de-Q the power amplifier grid circuit and provide a more uniform impedance to the IPA under varying drive conditions. Inductor A18L14 and the distributed capacity of resistor 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 & A21R77 broaden the frequency response and minimize synchronous amplitude modulation products. Inductor A21L5 is the power amplifier grid bias feed choke.

The power amplifier is a plate tuned 4CX15000A 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, as shown in Figure 4-6. A fixed bias from the power amplifier bias power supply is applied to the control grid through terminal board A22TB8-19, resistor A22R37, and terminal board A22TB8-20. When an input signal is present, grid current flows and develops grid leak bias across resistors A18R35, A18R36 & A18R80. The increased negative potential on the grid causes the diode in the power amplifier 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 adjustable coaxial resonators, Figure 4-7. The resonators are in the area between the tube shelf and the sliding shorting plane. Two motor-driven capacitors permit more precise tuning (capacitor A18C51) and loading (capacitor 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 power amplifier tube and input to the air chimney. Figure 4-8 shows the electrical equivalence of the plate tuning circuit.

4-3.4 LOW-PASS FILTER A13

Low Pass filter A13 (Figures 6-1 & 6-12) consists of two coaxial filters in tandem. The first filter has a cutoff frequency of 130 MHz, while the second has a cutoff frequency of 300 MHz.

4-3.5 DIRECTIONAL COUPLER DC1

The directional coupler provides a proportional dc voltage to both the forward and reflected circuits of A3. The output of each is then routed to, and can be displayed on, the Forward/ Reflected Meter (M4). Also, a sample of forward power is routed from A3 to the A9 power control gating cards that control SCR's for the power amplifier plate HV supply.

4-4. POWER SUPPLIES AND POWER CONTROL CIRCUITS

4-4.1 GENERAL

There are five separate power supplies in the transmitter. Three of the five, the plate, screen and power amplifier bias power supplies provide voltages to the power amplifier. The IPA supply, furnishes voltage to the IPA stage. The 28-Volt dc power supply provides power to the control circuits.

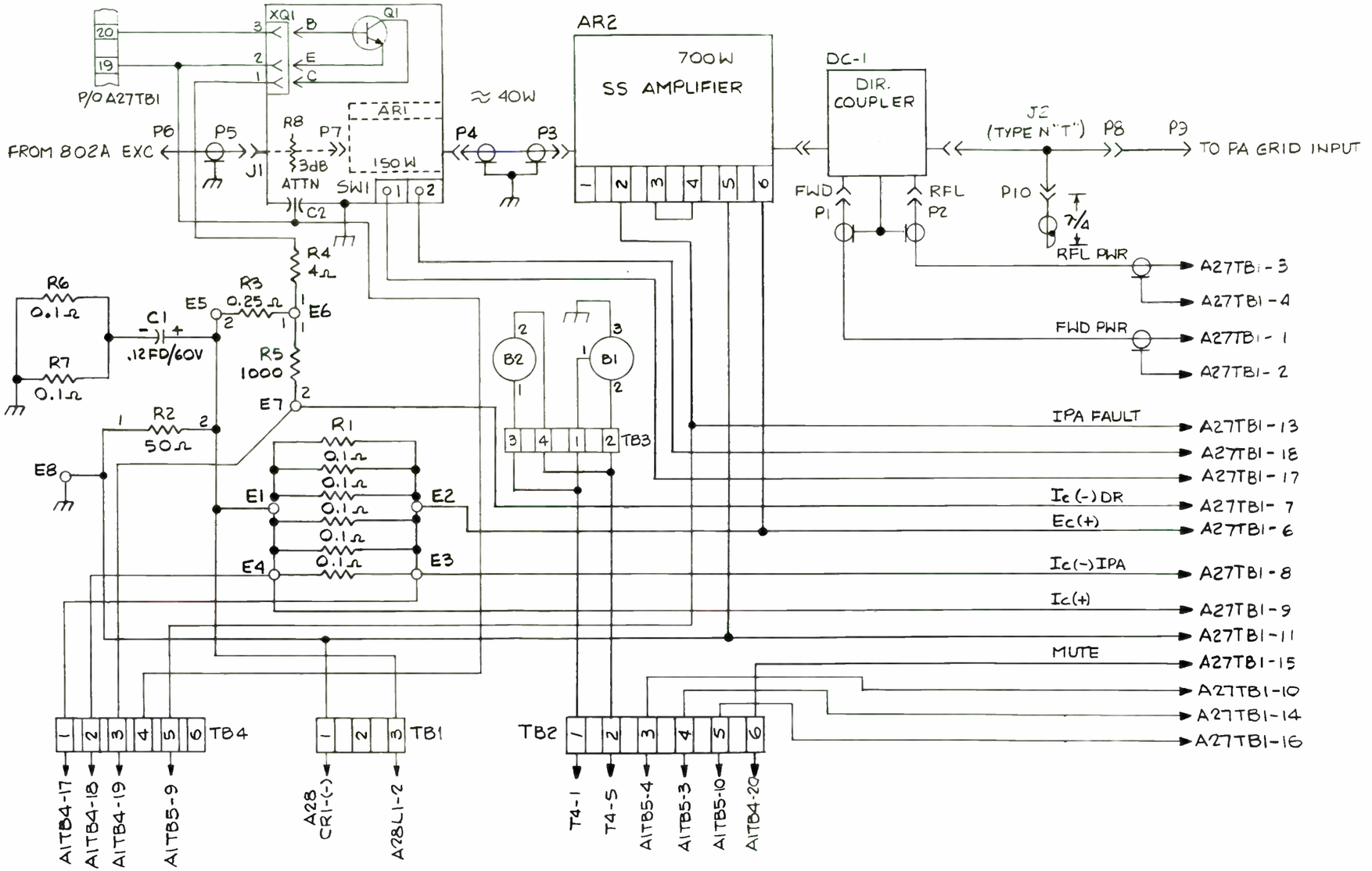

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Figure 4-3. IPA Shelf, Schematic Diagram

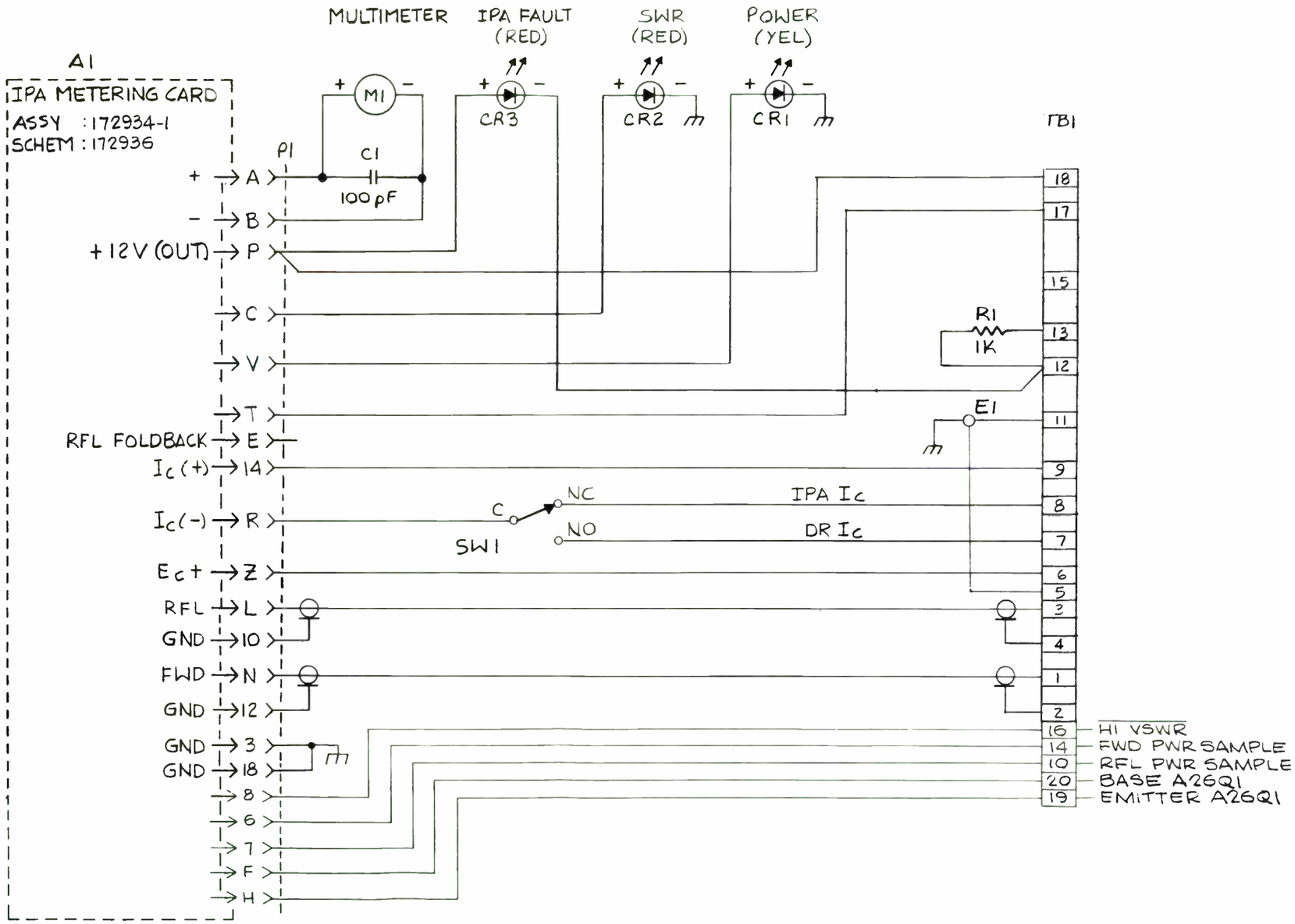

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Figure 4-4. IPA Metering Panel

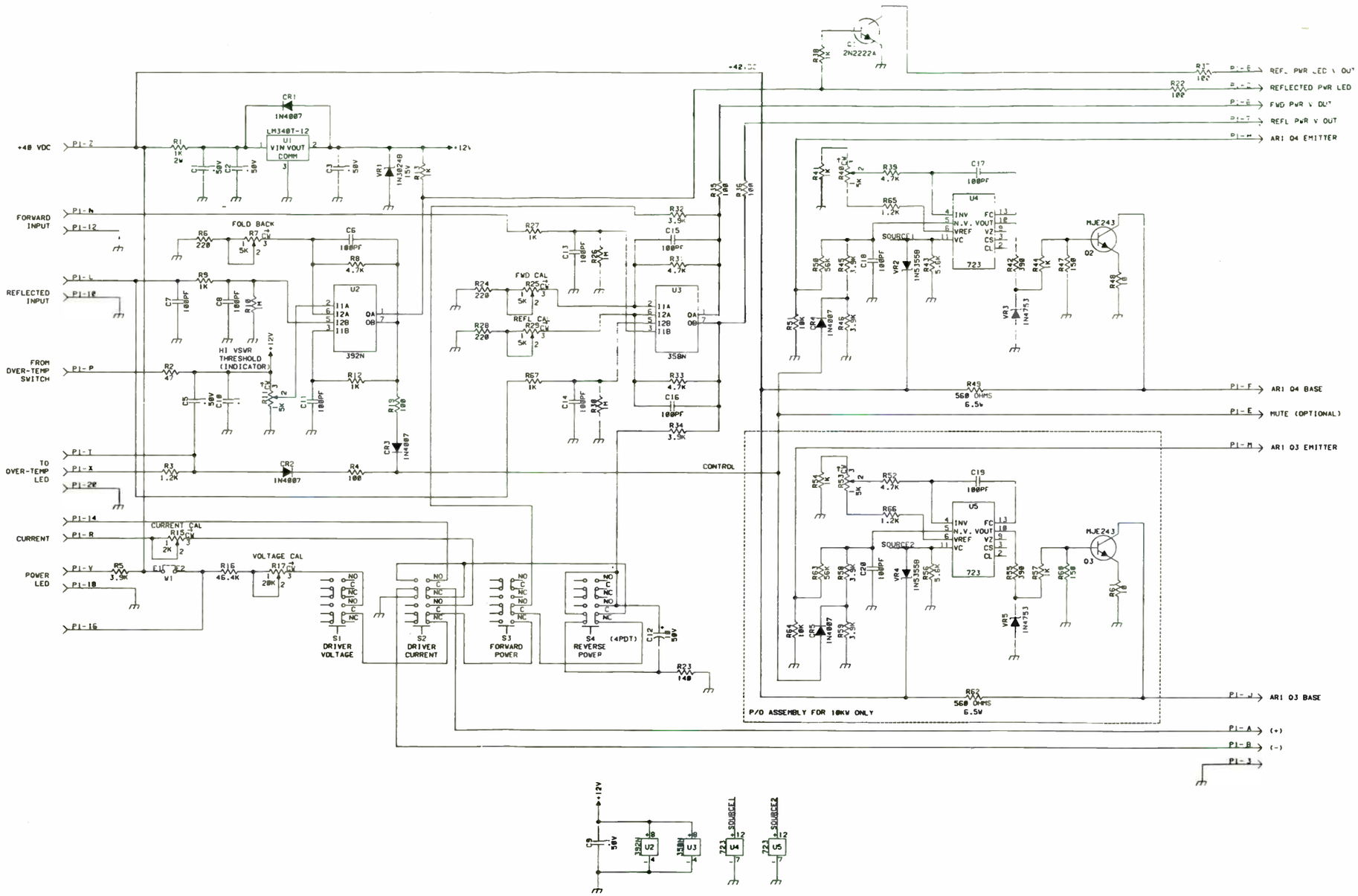

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Figure 4-5. IPA Metering Card

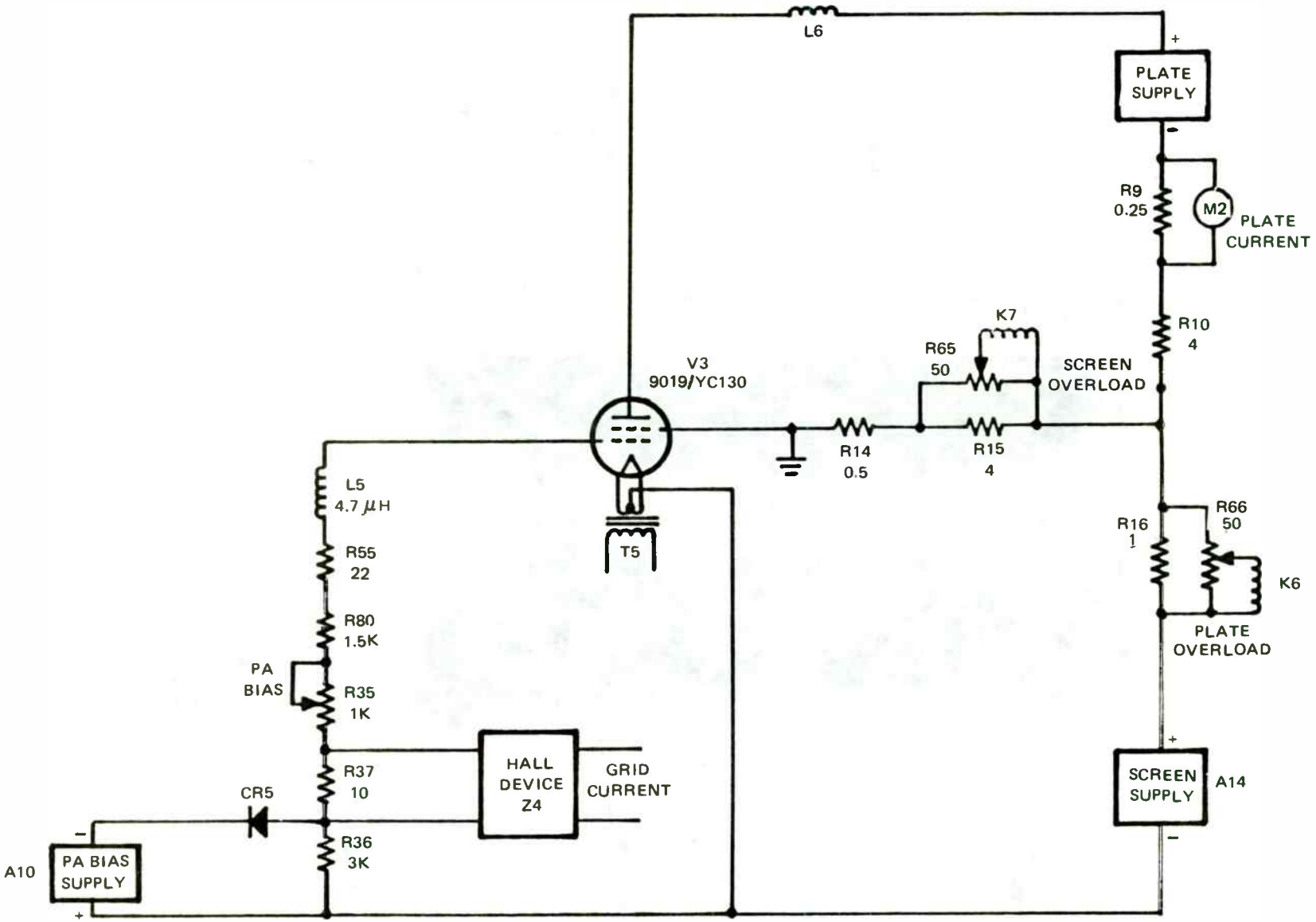


Figure 4-6. Power Amplifier DC Bias Circuitry Simplified Schematic

RQ-4-006

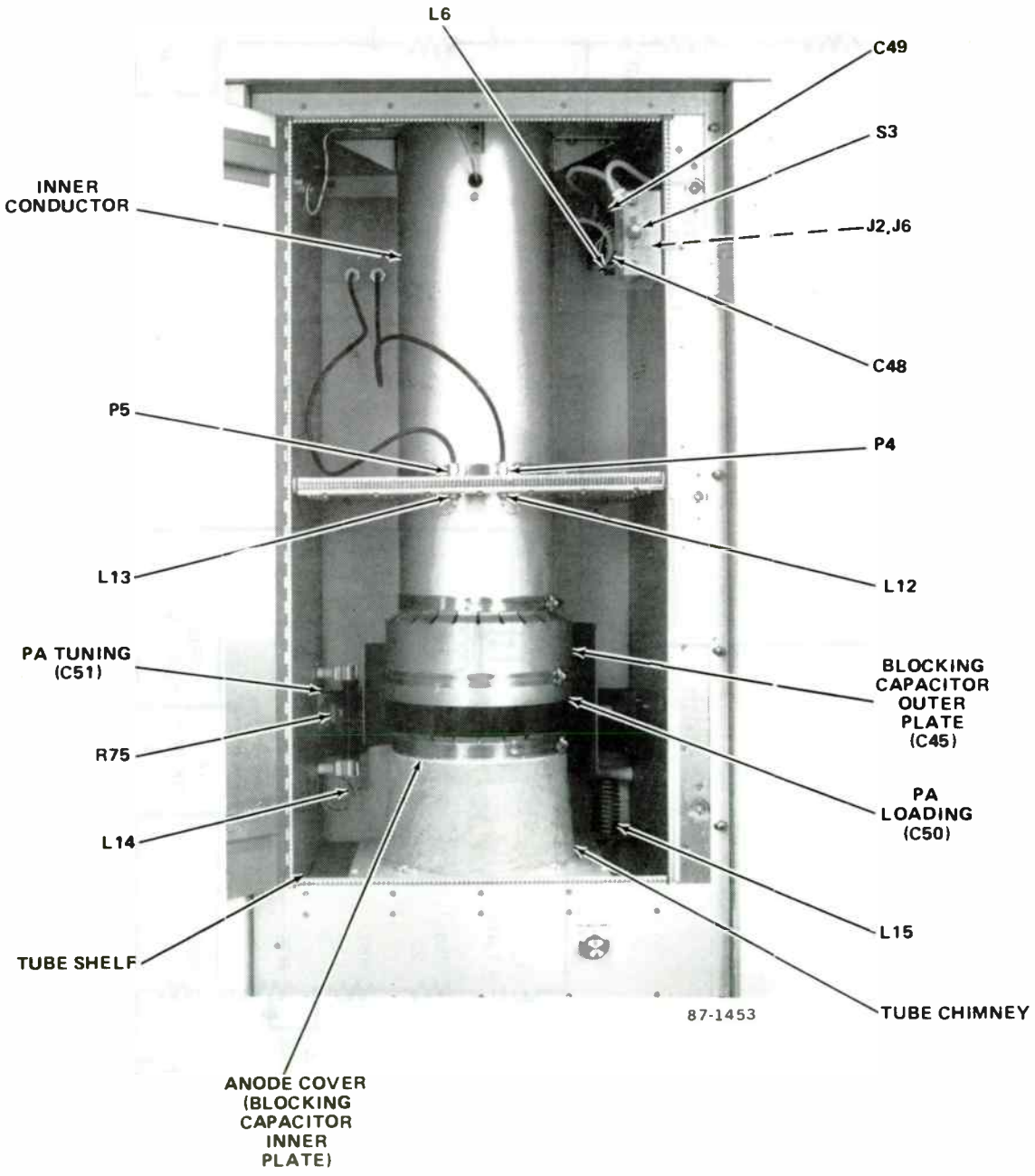


Figure 4-7. Plate Cavity, A18

RQ-4-007

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 RC circuits and applied to the control circuits.

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

The power amplifier 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 inductor L1 and capacitor C2.

The power supply output is applied to the grid of the power amplifier through diode CR5. Diode 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 resistor R3 to front panel meter A1M1 for monitoring.

4-4.4 PA PLATE POWER SUPPLY

The power amplifier 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. A meter multiplier board, A15, samples plate voltage and allows constant monitoring. Input power to transformer 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 power amplifier plate and the power amplifier 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. Upon receipt of a PLATE OFF control signal, relay A9AR1K1 de-energizes disabling the three SCR gate driving cards shown in Figure 4-9.

4-4.6 POWER CONTROL REGULATOR A8

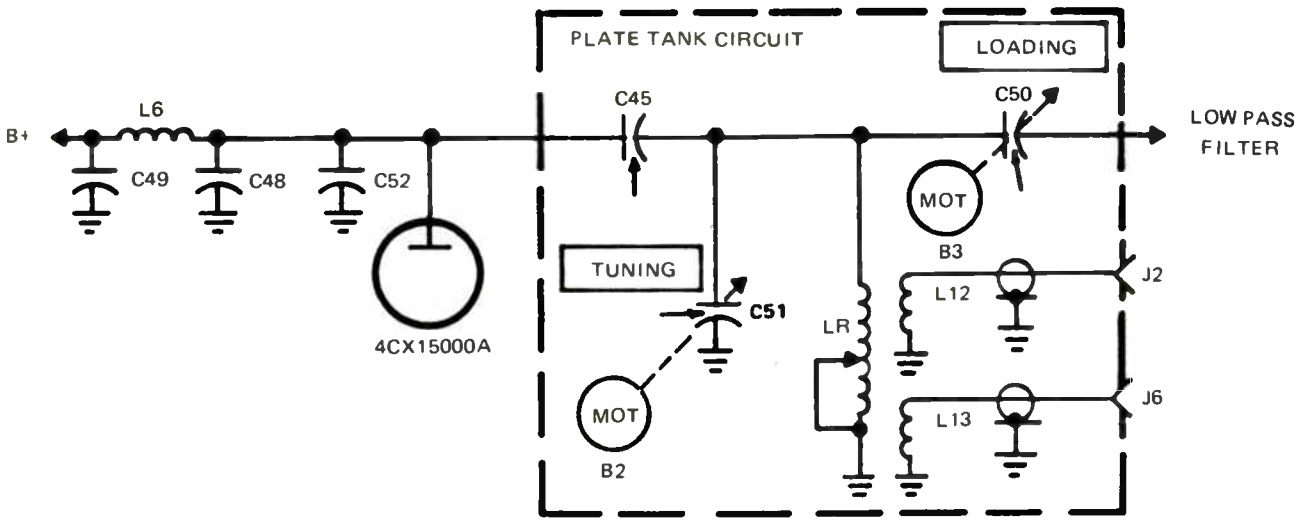
Power control regulator A8 provides the necessary control signals to operate power SCR control unit A9. A8 supplies a soft-start power amplifier plate supply turn-on signal, a negative voltage for manual power control, and amplifier mixer functions for automatic power control.

When the PLATE ON switch is pressed, +28 Volts dc is supplied to XA8-27. The +28 Volts activates transistor A8Q1 to turn on relay A19K12. Relay K12 in turn supplies 3-phase ac control power to resistor A9AR1. An RC time delay circuit formed by resistor A8R2 and capacitor 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, resistors R8 and R9, and capacitor C2 modify this signal to soft-start the high voltage power amplifier plate power supply. Zener regulator A8VR2 provides -10 Volts dc to MANUAL power adjust resistor A20R43.

When the MANUAL/AUTOMATIC switch is in AUTOMATIC position, transistors A8Q5 and A8Q4 amplify the automatic control signal from unit A3 and apply the signal to terminal board A9AR1TB2-1. Capacitor A8C5 and resistor 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 silicon 3-phase full-wave bridge rectifier assembly Z2 in the power amplifier 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.



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 4-8. FM Transmitter 816R-2B Output Network

4-4.8 IPA POWER SUPPLY, A28

The IPA power supply is a 3-phase full-wave type using a single section choke input filter. It nominally delivers 45 Volts at 25 Amps to its load which consists of the driver, IPA, and the metering panel. The supply's primary power is switched through relay A26K1 which is operated by the PLATE ON circuitry. The supply is protected through circuit breaker A6CB3.

4-4.9 FILAMENT VOLTAGE REGULATOR, A5

(See Schem. Diag. 159703 at the end of this Section)

When the Filament Regulator Card is in the automatic mode, the filament voltage regulator detects and compensates for sustained fluctuations in the input ac voltage. The fluctuations are detected by a true RMS detection circuit which in conjunction with associated circuitry, including motor control circuits, adjusts the setting of variable transformer A19A2T1. The output voltage of the variable transformer is then applied to the primary of power amplifier filament transformer A18T5. The variable transformer voltage is also applied to the primary of detector circuit transformer A20T8.

Voltage for the power supply circuits on the filament regulator board is derived from sampling transformer A20T8 via contacts 52 and 48 on the card edge connector. This ac voltage is rectified by diodes CR1-CR4 and applied to voltage dropping resistor R33. Capacitors C25 and C26 provide filtering, and zener diode CR5 provides a voltage drop to approximately 18 Volts. Three-terminal 15-Volt regulator U9 supplies voltage to the 15-Volt circuits with additional regulation provided by capacitors C27 and C28. Voltage dropping resistor R34 feeds three-terminal 5-Volt regulator U10 while capacitors C29 and C30 provide additional voltage regulation. LED DS5 indicates voltage present on the 5-Volt line which implies that the 15-Volt circuits are powered also. Negative supply voltage is provided via diodes CR1 and CR2 via resistor R3 and capacitor C24 to card edge connection 42 for distribution to other circuit cards in the transmitter. Fuse F1 is in series with the primary of transformer A20T8, and is located on the filament voltage regulator board.

A sample of the voltage feeding the power amplifier tube filament transformer is applied via transformer A20T8 through card edge connector 26. This ac signal is applied to RF filtering components inductor L1 and capacitor C14. L1 is a 4.7 uH inductor whose parallel resonance falls in the FM broadcast band providing a high impedance path for frequency modulated RF signals. Capacitor C14 is a 100 pF capacitor whose series resonance falls in the FM broadcast band providing a low impedance shunt path for frequency modulated RF signals. These filtering components are used in several locations in the filament regulator card, and provide the same filtering functions as described here.

The filament voltage sample signal is then applied to the RMS-to-dc converter circuit via voltage divider resistors R1 and R2, and through capacitor C15. This RMS-to-dc converter circuit is based around U7, an Analog Devices AD536A true RMS-to-dc Converter integrated circuit. The AD536A directly computes the true RMS of any complex input waveform containing ac components. It has crest factor compensation which allows very accurate measurements up to 300 kHz. The crest factor of a waveform is the ratio of the peak signal swing to the RMS value. Components C17, R17, R18, C18, R19, and C20 provide time constant and filtering functions for the AD536A.

Test point 3 (TP3) provides easy access to the dc voltage representation of the filament RMS voltage. During normal operation of the filament voltage regulator, resistor R2 is adjusted so the output of the RMS-to-dc converter circuit is 5.00 Volts dc when the filament voltage has been preset to the nominal value by the operator. The output voltage is then fed to window comparator composed of U8 (LM339) and related devices. The voltage references for the window comparator are provided by U11 (LH0070-OH), a very high precision 10-Volt regulator, and voltage divider components R20, R21, R22, and R23. In normal operation, resistor R20 is adjusted to provide 5.00 Volts at test point 2 (TP2). The corrected reference voltages are then applied to their respective comparators. Pin 5 of U8 has 5.05 Volts applied, and pin 10 of U8 has 4.95 Volts applied. These voltages will be correct if resistor R20 has been properly adjusted for 5.00 Volts on test point 2 (TP2). The 50 mV voltage drops are provided by voltage divider resistors R21 and R22. This 100 mV total window provides a total $\pm$ 1% window for the voltage comparator, and hence for the voltage regulator circuitry.

If the voltage from the RMS-to-dc converter circuit is within the 4.95 - 5.05-Volt window, the outputs of the comparators will both be high and the output of AND gate (7408) U4C will go high illuminating green LED DS4 indicating proper filament voltage is present. If the voltage from the RMS-to-dc converter is not within the 4.95 - 5.05-Volt window, the circuit will then operate to make the necessary corrections if switch S2 is in the AUTO position.

Assuming that switch S2 is in the AUTO position, if the filament voltage rises above +1% of the nominal value setting, the following actions are taken. The output of the 5.05-Volt comparator will go low at pin 2 of U8 causing the output of U4 to go low and DS4, the LOCK LED, will extinguish. U8 (7400) pin 11 will go high bringing pin 13, the input of U1 (7400), high. When either of the comparators goes low, indicting a correction is necessary, U2B, U2D, and U2C (7400) in combination act as an OR gate forcing pin 10 of U1 high which in turn triggers 555 timer U6. When U6 is timing, the output pin 3 goes high illuminating yellow LED DS1. At the same time, U1 output pin 3 goes low which takes the input pin 1 of U4A low. This output is fed through switch S1A to inputs U1 pin 9, U1 pin 12 and U2 pin 1 bringing them all low. Hence, while the 555 timer is in its timing state, the outputs of U1C, U1D, and U2A are all high, inhibiting the actuation of relays K1, K2, and K3 respectively. Once the 555 timer U6 has timed out, the inputs of U1C, U1D, and U2A fed from switch S1A are brought high. At this point if the filament voltage is still above the +1% nominal value, both inputs of U1 will be high providing an actuation of relay K1 and the clutch assembly on the filament voltage adjust variac motor. Simultaneously, both inputs of U1D will go high forcing the output (pin 11) to go low. The LOWER LED (DS2) will be illuminated and relay K2 will be activated which in turn actuates the lower winding in the motor driving the filament voltage control variac. Once the variac brings the filament voltage back inside the range of nominal operation, the comparator output of U8 (pin 2) will go high, and the above logic actions are reversed removing power from the filament voltage regulator variac motor.

The raise function operates just as the lower function described above, but instead activates the raise circuits. It may be noted that if future adjustments by the operator are required in the automatic mode, resistor A5R2 may be used as a simple filament voltage adjustment control.

The timing period of 555 timer U6 is provided to guard from constantly correcting momentary excursions in the filament voltage This timing period is adjustable from nearly no delay to approximately 12 seconds via resistor R7.

If automatic operation of the filament voltage regulator circuit is not desired, switch S1 can be put in the MAN (manual) position. This effectively takes the regulator out of the circuit, but the green LED lock indicator will still show if the filament voltage is within nominal range.

While in the manual mode, momentary switches S2 and S3 can be used to manually activate the clutch and raise or lower circuits respectively. Other than the timer not being active in this mode, these switches simulate the output of the comparators per the operators command, thus manually raising or lowering the filament voltage. This provides a convenient way to determine if most of the digital logic and the solid state relays are functioning properly should a problem occur.

U3A and U3B are provided to insure that the raise and lower functions are not activated simultaneously by circuit failure or accidentally by the operator using the manual control. While in the manual mode, the operator may depress both the raise and lower switches simultaneously and the only action to take place is the timing of U6 as noticed by the illumination of yellow LED DS1. This allows the operator a convenient way to set the time delay of U6 without affecting the other circuits.

Solid state relays K1, K2 and K3 provide a return for the ac voltages already on the windings of the clutch, and the lower and raise circuits of the variac drive motor. Relays K2 and K3 also have the return path for the ac voltages routed through microswitches S1 and S2 on the variac assembly. This provides a secondary measure against operating the filament voltage regulator outside of the prescribed range provided by the mechanical stops on the variac drive motor.

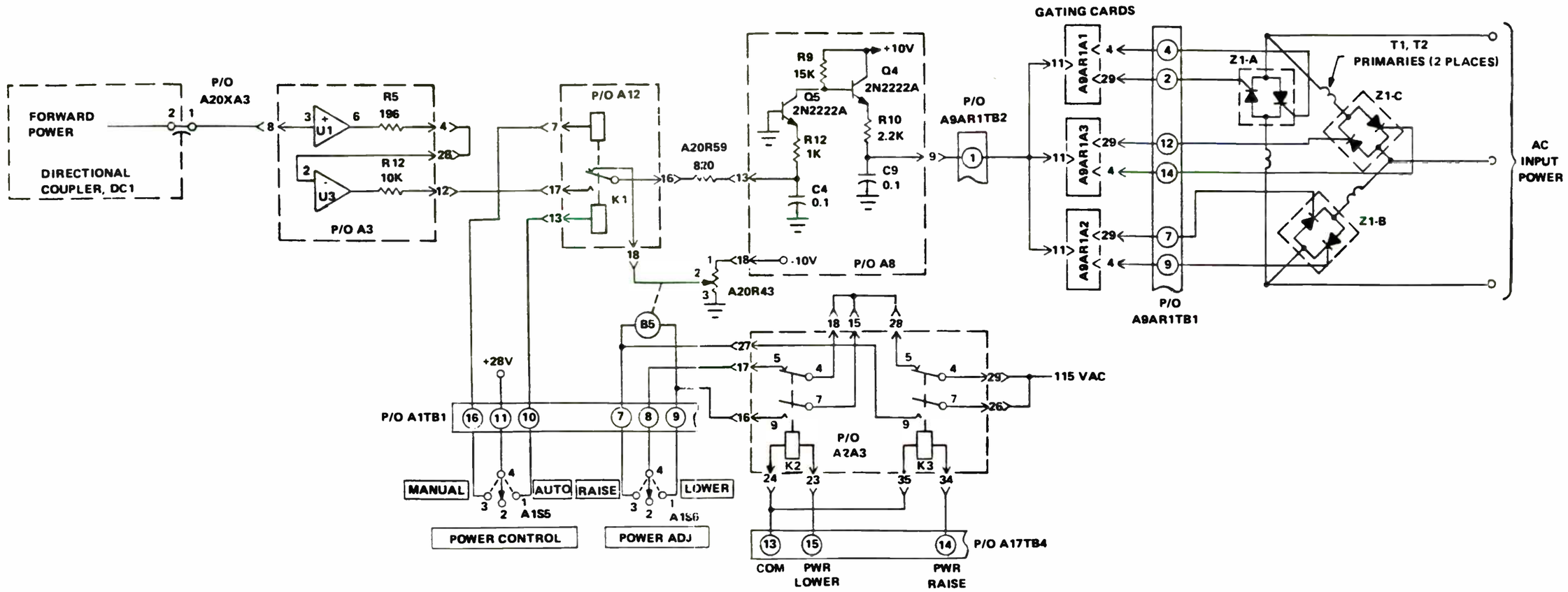


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Figure 4-9. Power Control Circuits, Simplified Diagram

4-4.10 FILAMENT VOLTAGE DISTRIBUTION

The filament voltage distribution is shown in Figure 4-10. 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 4-11. 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 through associated circuit breaker, A6CB4. Circuit breaker A6CB3 controls power to driver power supply (IPA) transformer A28T1. Ac line voltage metering is provided by ac meter panel A25. In addition to the three phase-to-phase voltages, a fourth position of switch A25S1 is used to monitor the power amplifier 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 power amplifier bias power supply, and the power amplifier 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 power amplifier bias power supply, P/O A10, and to the power amplifier 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 power amplifier bias supply input power circuits are protected by associated fuses. These circuits receive power from the blowers circuit breaker, A6CB2.

4-5.2 TRANSMITTER TURN-ON

The transmitter is energized by pressing FILAMENT ON switch A1S2 on the A1 control panel, Figure 4-12. Relay A19K2 is energized and 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 energizing relay A19K3 which applies +28 Volts to the base of transistor A8Q3. This turns on control amplifier A9AR1, which applies input voltage to the plate and power supplies.

The transmitter may also be energized by pressing the PLATE ON switch which latches relay A19K3, and energizes relay A19K2 through contacts 8 and 5. Pressing this single switch (PLATE ON) enables 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 power amplifier plate voltage is turned OFF (Figure 4-12). 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.

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

4-5.4.1 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 meter indication 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%.

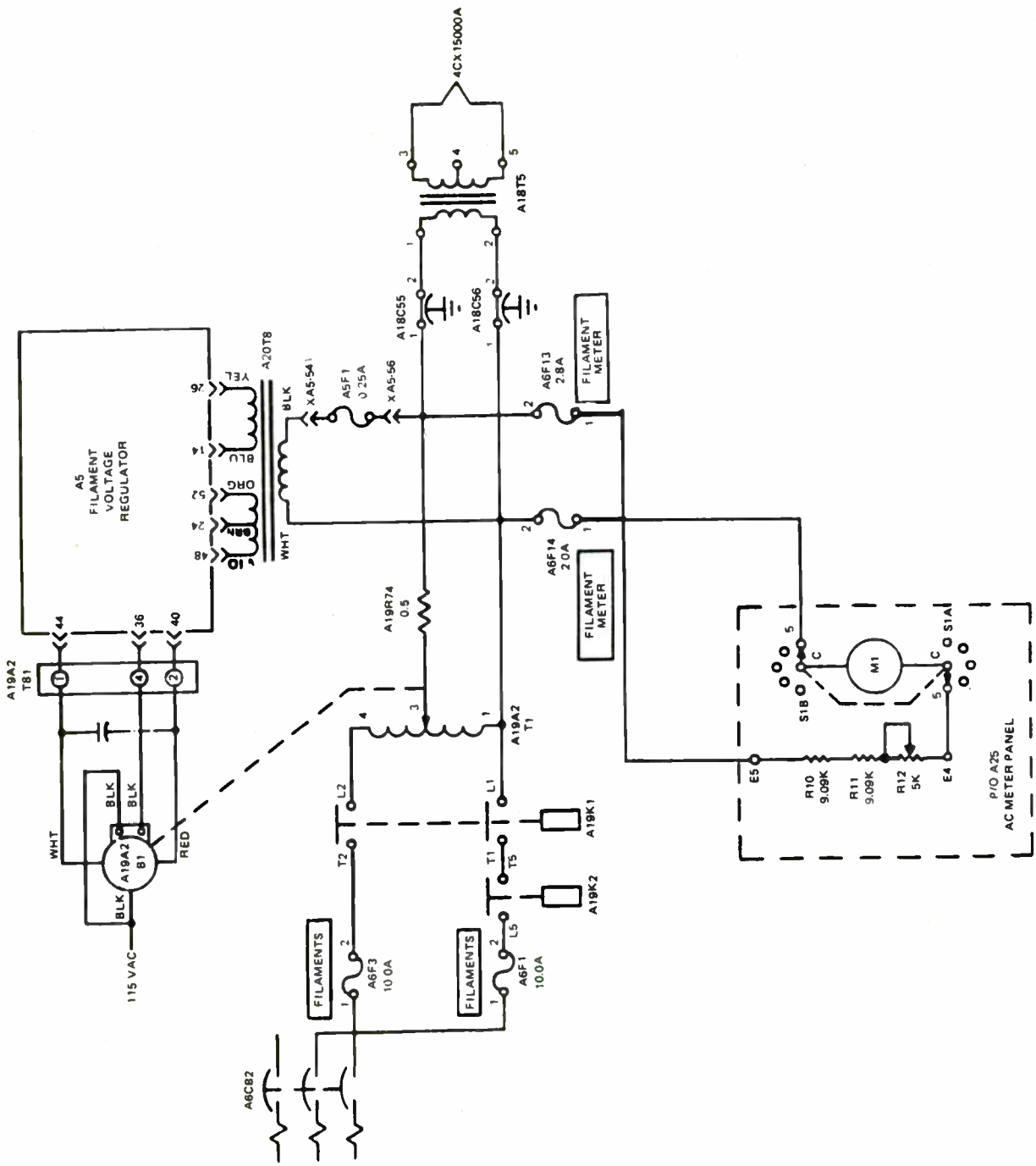


Figure 4-10. Filament Voltage Distribution

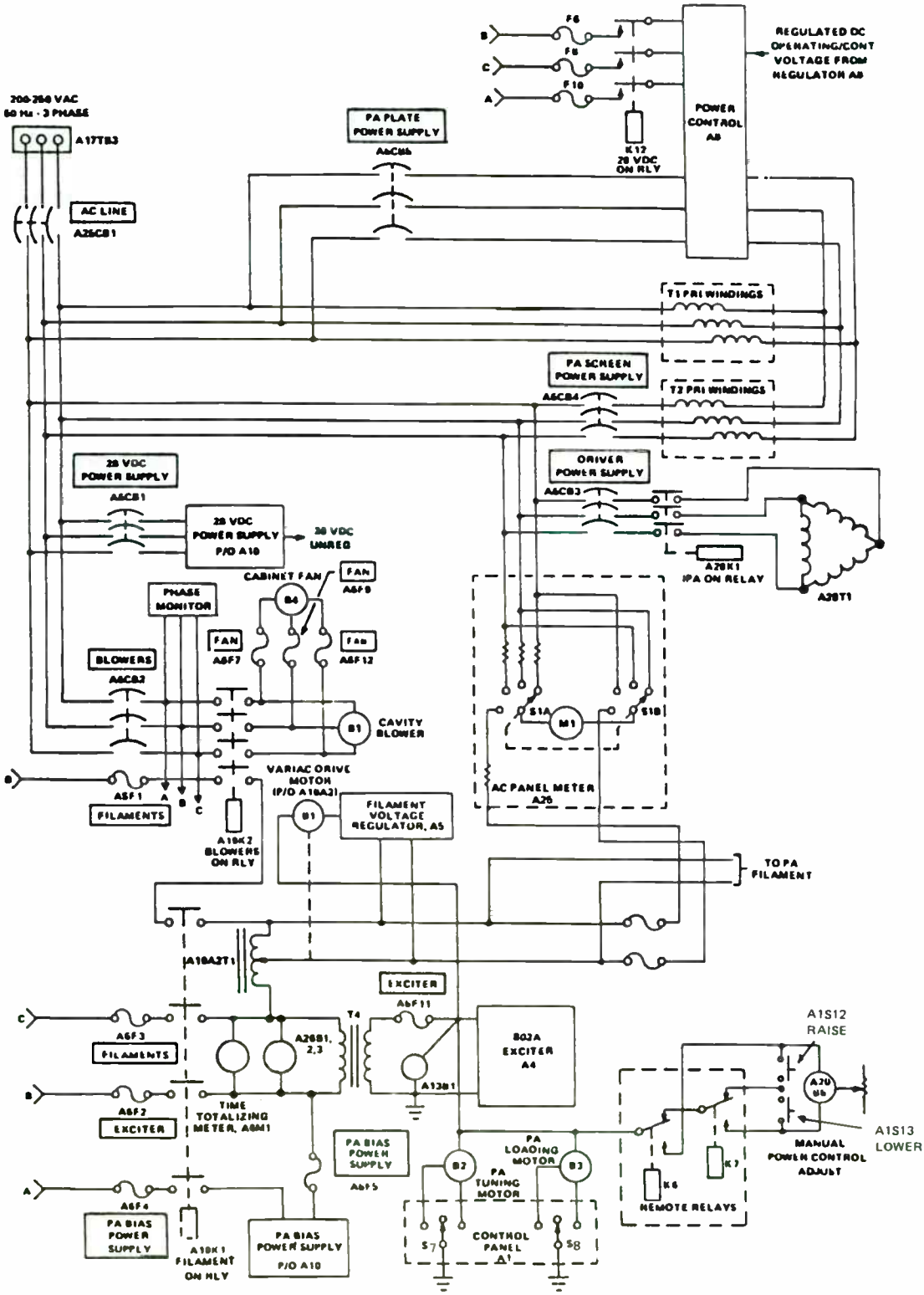


Figure 4-11. AC Power Distribution

RQ-4-011

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 reflected power level greater than 10% of the customer's specified TPO is detected.

4-5.4.2 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 on the panel power meter (A1M4) at the customer's specified TPO. The output of U1 is also present on terminal board 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 diode CR6 and compared at the inverting input of U3 against the negative voltage from either resistor R17 (Normal Power) or resistor 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 resistor R17 to resistor R41 by relay A3K1 which is activated by applying +28 Vdc to relay A3K1 coil through terminal board A17TB4, terminal 20. Normally, resistor R17 sets the normal operating TPO reference while resistor 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 directional coupler DC1 is amplified and buffered by U2. Resistor R26 is an offset null adjustment 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 SCR A7Q8 fires, VSWR overload relay A22K9 activates, removing power from the transmitter and illuminating the VSWR OVERLOAD LED. The output of U2 is also present on terminal board A17TB4, Terminal 33, through 2.2K 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 diode 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 or screen supply or when the VSWR exceeds a preset level. Screen current through resistor A14R15 produces a voltage that is applied to relay A22K7 through resistor A22R65. Plate current through resistor A14R16 produces a voltage that is applied to relay A22K6 through resistor A22R66. When SCR A7Q8 is gated on, a ground is applied and relay 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 relay 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 or VSWR circuits, a 28-Volt dc 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, or A22K9. The 28-Volt pulse that triggers the SCR is simultaneously routed to the recycle circuit via diode CR10, CR11 or CR12 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 capacitor C16 momentarily energizes relay K1 which closes the PLATE ON circuit through switch S2. The charging current of capacitor C16 also flows through RECYCLE PULSE indicator LED 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 LOCK-OUT indicator LED CR3 will light to indicate this condition. When the 30-second period of time U4 has elapsed, a pulse is generated, inverted by transistor 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 circuit. The PHASE LOSS indicator LED CR10 is lighted when phase monitor relay 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 LED CR11 is lighted when the card cage cover is in place. AIR INTLK indicator LED CR12 is lighted when sufficient cooling air to the power amplifier tube is flowing. TEMP INTLK indicator LED CR13 is lighted when the power amplifier tube exhaust air temperature is at or above 240 degrees F $\pm$10 degrees F. The switch will reclose when the exhaust air returns to 200 $\pm$ 10 degrees F temperature operating range of the power amplifier 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 capacitor A7C16 and the charging current of capacitor A7C16 pulls relay A7K4 in and initiates the power ON command.

4-5.8 AUTO-MANUAL POWER CONTROL LATCHING RELAY AND TRANSMITTER STATUS INDICATORS

The latching relay permits local or remote selection of manual or automatic power control.

The latching relay is connected to the remote control panel through terminal board A17TB4, Figure 4-13. A +28-volt signal applied by local control switch A1S5 or through remote control interface terminal board A17TB4 will latch relay A9K8 in one of two stable states. AUTO PWR CONTROL indicator LED A1CR31 indicates automatic power control is selected and MAN PWR CONTROL indicator LED A1CR30 indicates manual power control is selected.

Visual indication of TRANSMITTER CONTROL REMOTE/LOCAL switch A20S10 is given by status indicator LEDs A1CR19 and A1CR15. Indicator LED CR15 lights when local control is selected and indicator LED CR16 lights when remote control is selected.

Plate control circuit interlock status indicators are provided on the Control Panel, A1. RMT PLT OFF INTLK indicator LED A1CR20 is lighted when remote relay A2A9K5 is de-energized. PA GRID DOOR INTLK A1CR21 LED CR6 is lighted when the PA grid compartment door is closed. PA DOOR INTLK indicator LED A1CR22 is lighted when the power amplifier plate compartment door is closed. L REAR DOOR INTLK indicator LED A1CR23, C REAR DOOR INTLK indicator LED A1CR24, R REAR DOOR INTLK indicator LED A1CR25, C FR PNL INTLK indicator LED A1CR26 and R FR PNL INTLK indicator LED A1CR27 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. REMOTE INTLK indicator LED A1CR28 is lighted when continuity exists between remote control interface terminal board terminals 23 and 24.

FAILSAFE INTLK indicator LED A1CR29 is lighted when remote relay A2A1K1 is energized. Indicator LEDs A1CR20 through A1CR29 are in series and in sequence as they are connected in the circuit. Therefore, an interlock must be satisfied before its status indicator LED 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 A9 provides remote manual power lower and raise control . When power is decreased at the remote control panel, relay A9K6 is energized, Figure 4-14. Closed contacts 7 and 9 provide 115 Vac to motor A20B5 which adjusts the resistance of resistor 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 resistor A20R43 to increase the transmitter power output.

4-5.11 REMOTE RELAYS P/O A9

Remote relays in Unit A9 parallel the front panel control operations. All relays, except A9K4 and A3K1, and switches are momentary in operation. Failsafe relay A9K4 is energized only when +28 Volts dc is present in the control circuit. If the +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 4-15.

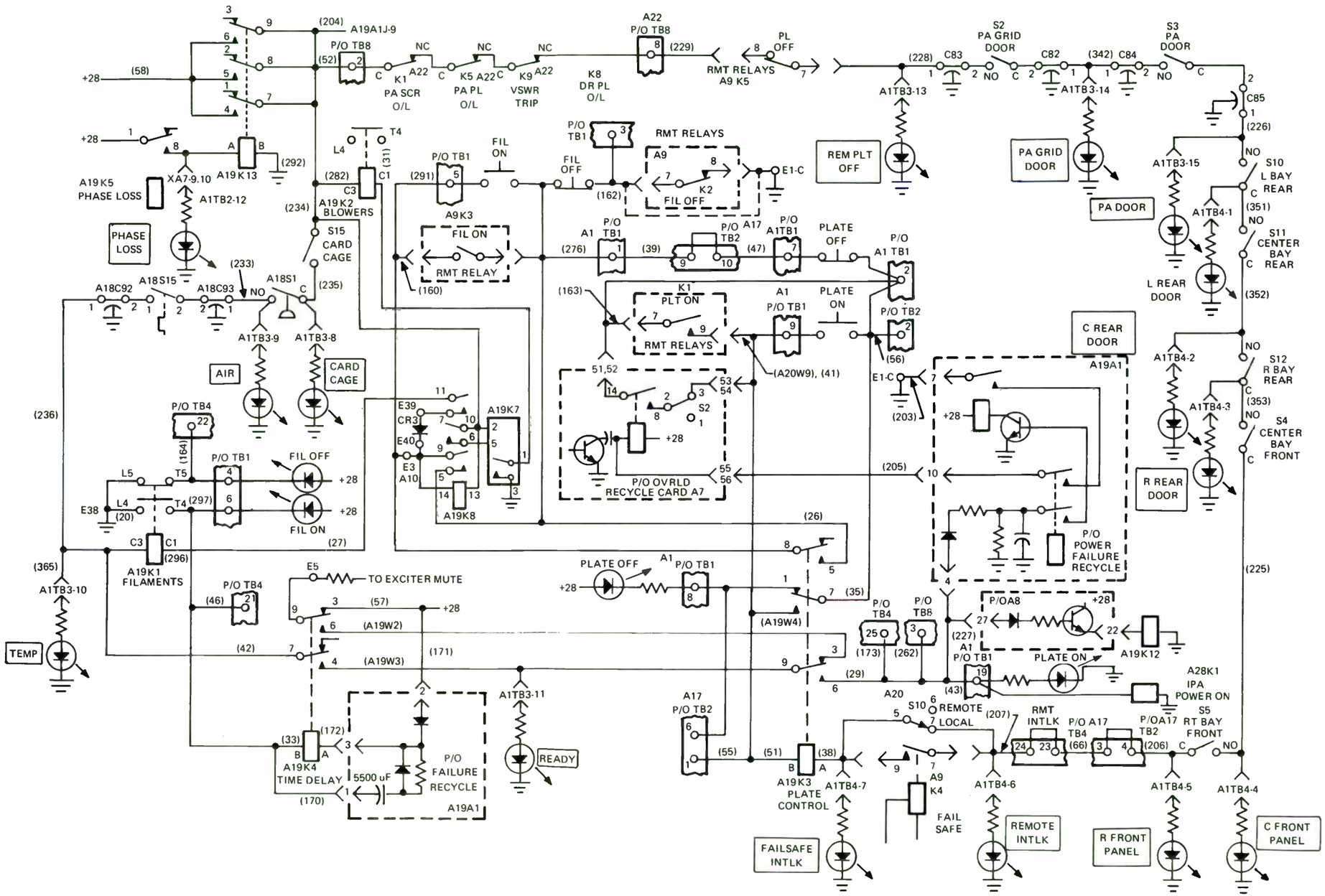


Figure 4-12. Interlock and Control Circuits

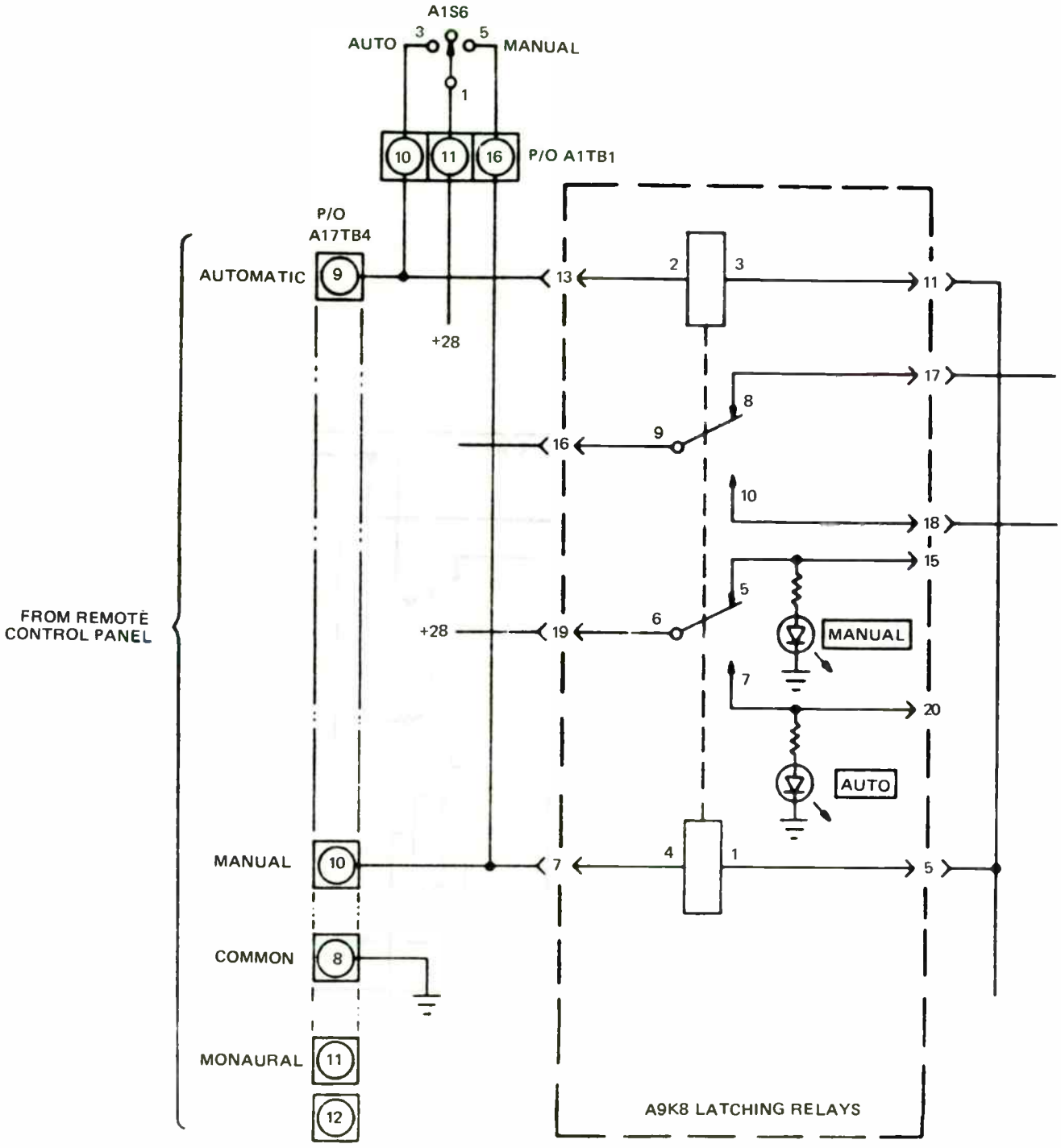


Figure 4-13. Latching Relays Simplified Schematic

RQ-4-013

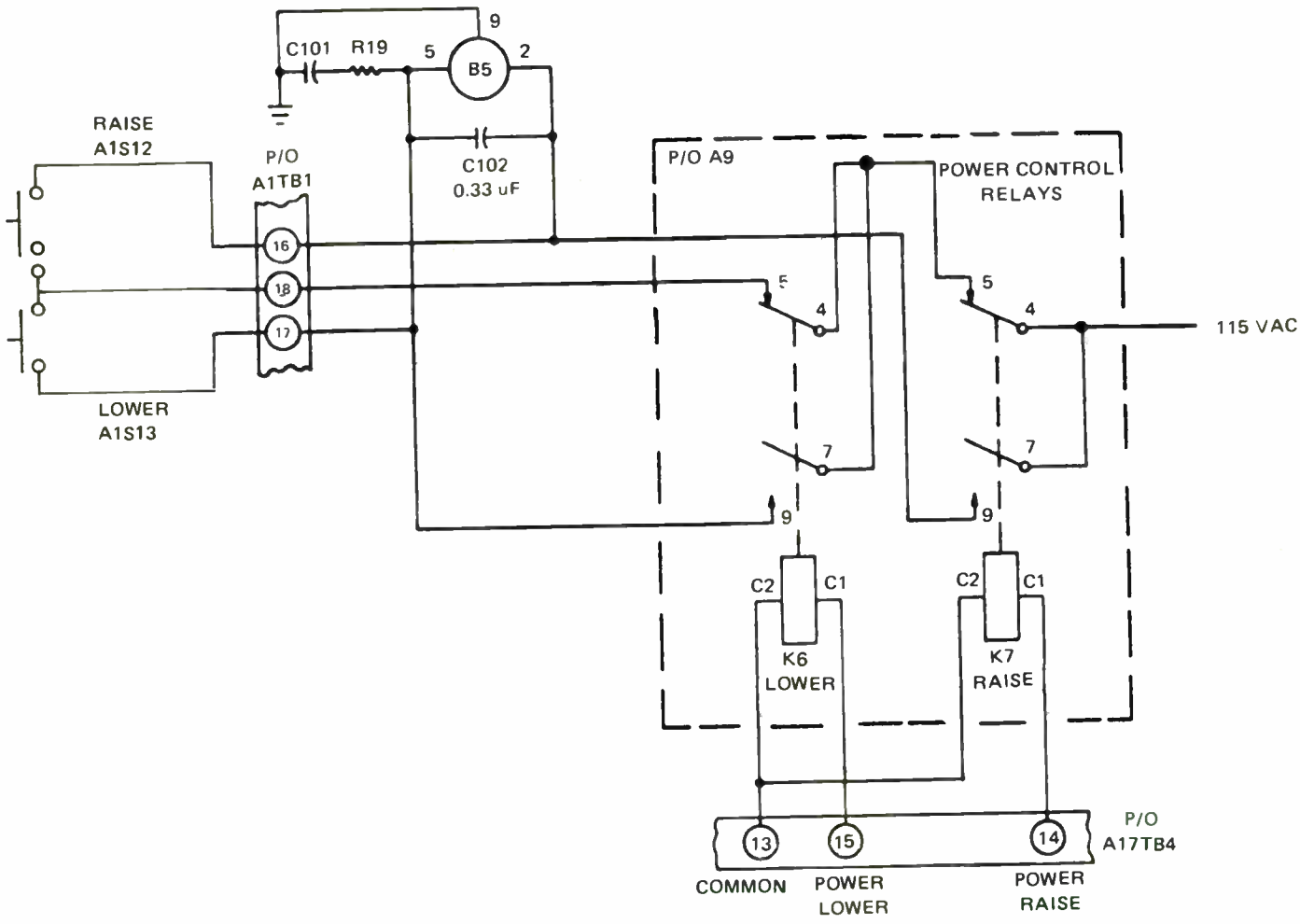
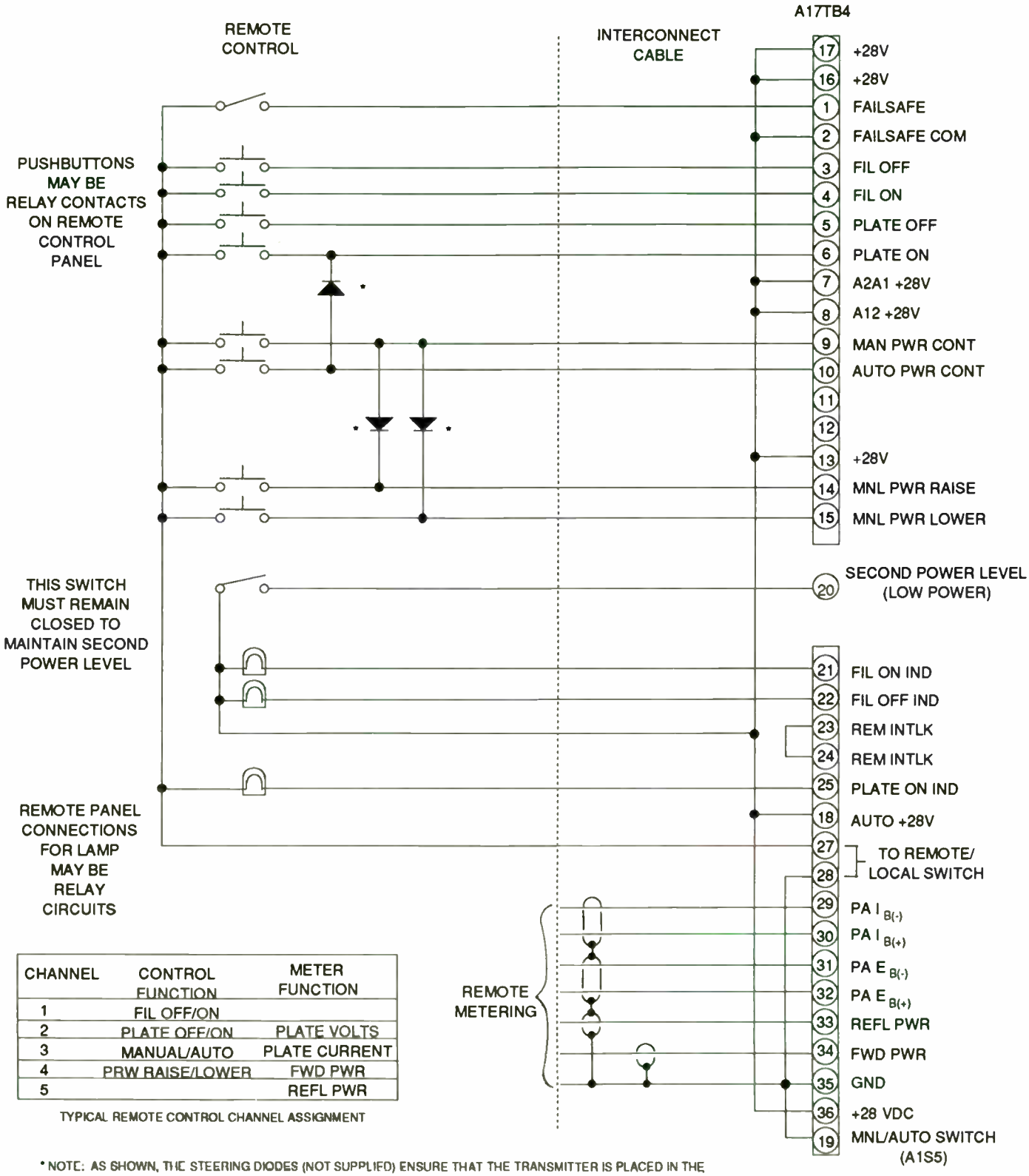


Figure 4-14. Power Control Relays P/O A9, Simplified Schematic

RQ-4-014



CHANNEL	CONTROL FUNCTION	METER FUNCTION
1	FIL OFF/ON	
2	PLATE OFF/ON	PLATE VOLTS
3	MANUAL/AUTO	PLATE CURRENT
4	PRW 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 TAT 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 (CED NO. 353-6442-070

Figure 4-15. Remote Control Connections to Terminal Board A17TB4

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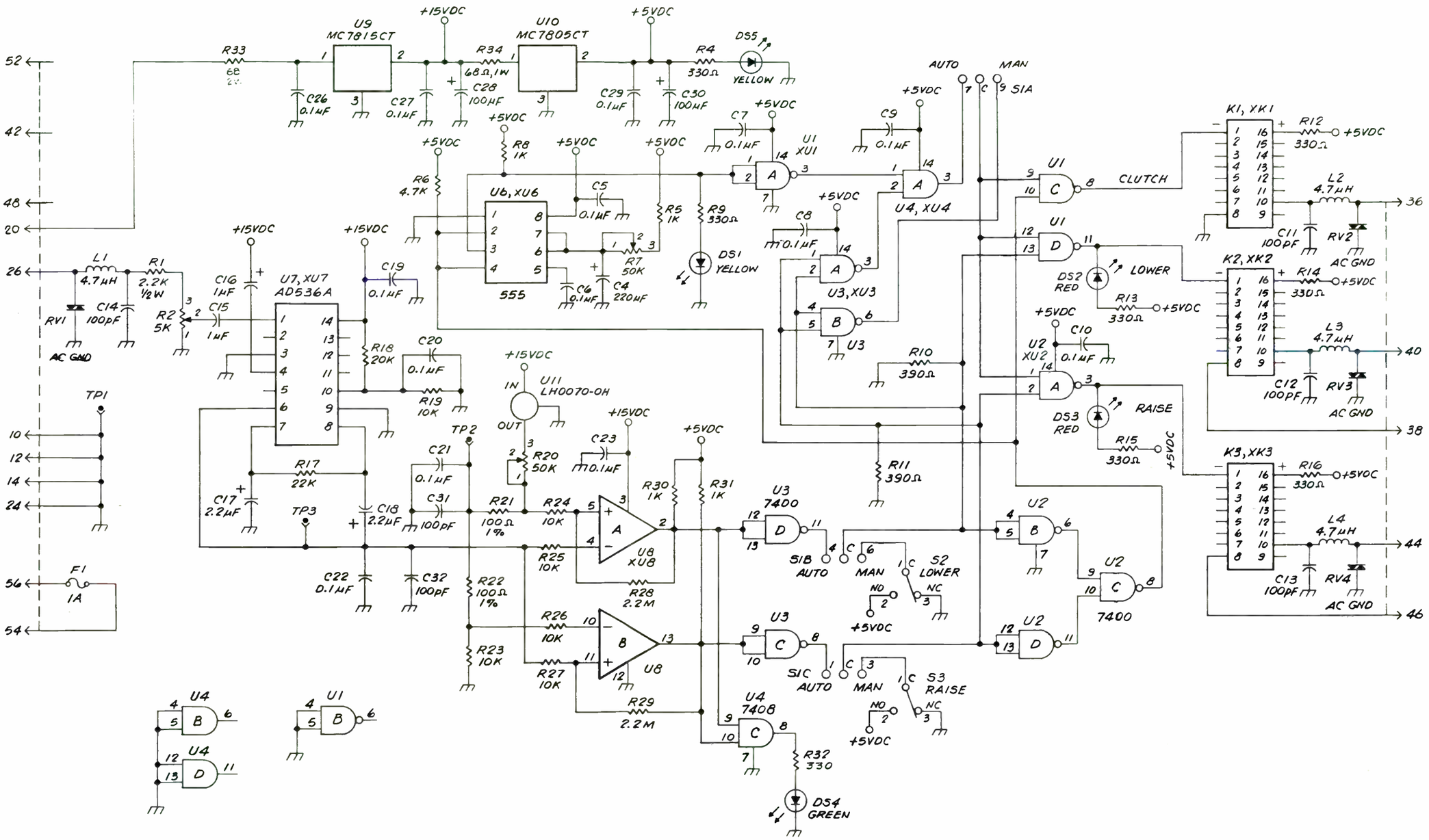


RQ-4-016

Figure 4-16. Filament Regulator Schematic Diagram

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. FAILURE TO COMPLY MAY RESULT IN DEATH ON CONTRACT. 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. Reinstall the filter when dry.

5-2.3 TUBE CLEANING

The power amplifier tube should be cleaned when a visible quantity of dust accumulates on the cooling fins of the tube. Carefully remove the tube from the socket and clean 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) bearings should be lubricated with SAE 10 oil as necessary.

5-5. PARTS REPLACEMENT

The following paragraphs present general descriptions for the removal and replacement of certain component parts.

5-5.1 9019/YC130 PA TUBE

1. Remove air guides (tube chimney) between the PA blocker and the cabinet base. Loosen the two bands (top and bottom only, never loosen the center band) on PA blocking capacitor and slide it down over the PA tube.

2. Remove the anode lead.

CAUTION

Be careful to not bend or break the socket's finger contacts. They are fragile!

3. Carefully lift the tube, and PA blocking capacitor, out of its socket.

4. Reverse the procedure to install the replacement.

5-5.2 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 and the overall schematic in section 4 when needed. Normal control panel meter readings are provided in Tables 3-6 and 3-7. Efficiency graphs are provided in Figure 3-8.

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 reinstalling 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 (true RMS)	Weston 433
Power Supply	0 to 28 volts DC, 6 amps	
RF Wattmeter	2.5kW and 25kW elements, 50 to 125 MHz	Bird Thruline (or equivalent)
Thruline Wattmeter	0-1kW element, 0-100 W	Bird 43 (or equivalent)
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. BE EXTREMELY CAREFUL WHEN PERFORMING 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 switch 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 power amplifier grid compartment and connect a 0 - 10 volt true RMS ac one percent meter to the power amplifier filament rings on the tube socket.

3. Run the meter leads out the corner of the compartment and close the power amplifier 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 OR REMOVED. 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 A19A2T1 (Right side panel) end of coupling, and turn the main circuit breaker ON.

6. With A5S1 (Filament Regulator Card) in MANUAL position,depress SW3 and 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 6.4 volts ac. Note the filament meter reading. If filament meter does not agree with calibration meter, adjust A20A1R1 (Filament Meter Calibration) until it does.

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. Place switch A5S1 (Filament Regulator Card) in MANUAL position.

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

13. Use the RAISE or LOWER switches on the filament regulator card to adjust the filament voltage to the desired voltage (6.0 VAC rms is the recommended operating voltage), as indicated on the true rms voltmeter.

14. Check the comparator window voltage on the filament regulator card. It should be preset to 5.00 volts. If it is not, adjust resistor R20 observing the voltage on BLUE test point 2 (TP2) and adjust for 5.00 volts. Once this voltage is set, it should not need be reset unless a component change is made.

15. Adjust resistor R2 for 5.00 volts by observing the voltage on RED test point 3 (TP3). At this point the green LOCK LED DS4 should illuminate.

16. To adjust the timer, while still in the MANUAL position of switch S1, push both RAISE and LOWER switches (SW3 and SW2) simultaneously and notice how long the timer yellow indicator LED DS1 stays illuminated before it extinguishes. Normally this delay is set at the factory for 5 seconds. This prevents momentary changes in the power line voltage from constantly effecting a correction. To increase time delay adjust resistor R7 CCW, to decrease time delay adjust resistor R7 CW. Repeating the above will verify your action. The range of the time delay is approximately 0 - 12 seconds.

17. Once the above adjustments are made, activate the automatic mode of filament voltage regulation by placing switch S1 in the AUTO position. RAISE and LOWER switches S3 and S2 only operate in the MAN (manual) mode of operation.

18. The life of the PA tube can be greatly enhanced by correctly adjusting the filament voltage required to produce the emission needed for your rated output power. To obtain the optimum tube life you should adopt the following procedure.

19. First stabilize a new tube's emission by operating it at rated filament voltage for 48 hours. Refer to the tube data sheet for the rated filament voltage.

20. Place the transmitter output power control in the Manual position. Also place the filament voltage regulator in the Manual position.

21. Raise the transmitter output power to 105% of normal rated power.

22. Carefully lower the filament voltage in .2 volt steps, pausing about 30 seconds after each decrement, until you see a significant (greater than 2%) change in output power or plate current. This is the filament emission knee. Now raise the filament voltage .2 volts above this voltage. This is the correct filament voltage for your output power.

23. It may be necessary to adjust the lower limit of the filament - voltage varible transformer to find the knee and/ or operate at the correct filament vvoltage.

CAUTION

REMOVE ALL POWER FROM THE TRANSFORMER BEFORE WORKING ON THE VARIBLE TRANSFORMER LIMIT SWITCHES.

24. After the correct voltage for your operating power has been established, repeat steps 13 thru 17 and reset the "desired voltage" to the correct level.

25. Check for a change in the filament voltage knee one week later. Keep the operating voltage .2 volts above the emission knee. Repeate this check monthly throughout the life of the tube.

26. After the filament voltage has been set, return the transmitter output power control (ensure filament voltage regulator is also in "AUTO") to the AUTO position.

5-7.3 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.

PA PLATE OVERLOAD ADJUSTMENT

3. Connect an ammeter from the positive terminal of an adjustable 28-volt dc power supply to resistor A14R15-l.

4. Connect the negative terminal of the dc power supply to resistor A14R16-l.

5. Raise the dc power supply current to 4.8 amperes.

6. If overload does not occur, then adjust PA PLATE OVLD ADJ resistor 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 4.8A, adjust resistor A22R66 to raise trip point to 4.8A.

7. Disconnect the ammeter and remove the jumper from the dc power supply to resistor A14R16-l.

PA SCREEN OVERLOAD ADJUSTMENT

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

9. Connect the negative terminal of the dc power supply to terminal board TB8-4.

10. Raise the power supply current to 800 mA.

11. If overload does not occur, then adjust PA SCREEN OVLD ADJ resistor A22R65 to trip relay A22K7 at this current. (The PA SCRN O/L fault indicator LED on A7 lights when the relay trips.) If overload trip occurs at less than 800 mA, adjust resistor A22R65 to raise trip point to 800 mA.

12. Disconnect the milliammeter and remove the jumper from the dc power supply to terminal board TB8-4.

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

5-7.4 PA GRID CURRENT

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 resistor A22R72 for a 400 mA reading on the test meter.

7. Remove the dc power supply test leads.

5-7.5 HIGH VOLTAGE POWER SUPPLY STATIC CHECK (NO DRIVE)

WARNING

HIGH VOLTAGES ARE EXPOSED WHEN CABINET DOORS OR ACCESS PANELS ARE OPENED OR REMOVED. 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 8000 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. Press the PLATE OFF and FILAMENT OFF switches on control panel A1 and Mute on the exciter.

7. Replace all panels and close all compartment doors.

5-7.6 IPA METERING BOARD CALIBRATION

1. General Information

Necessary equipment for this calibration includes: Bird Thruline wattmeter with 500-watt and 100-watt elements, ammeter with 0-to-30 ampere dc rating and inductive sensor, digital voltmeter, Bird 500-watt dummy load, mobile workbench with electrically non-conductive top and at least 36 inches high, 50-ohm coaxial cable with Type N cable connector and adapters: male-to-male and female-to-female.

WARNING

MAKE SURE TRANSMITTER POWER IS OFF OR DISCONNECTED WHEN CONNECTING AND DISCONNECTING TEST EQUIPMENT AND OTHER TEST COMPONENTS. HIGH VOLTAGES AND HIGH POWER RF SIGNALS MAY CAUSE INJURY OR DEATH IF CONTACTED.

2. Setup Procedures

a. Refer to FM Broadcast Exciter 802A Instruction Manual and adjust exciter power output to 15 watts.

b. Set PA SCREEN and PA PLATE POWER SUPPLY circuit breakers on Circuit Breaker Panel (Figure 3-3) to OFF.

c. Set AC LINE circuit breaker on AC Metering Panel (Figure 3-2) to OFF.

d. Remove lower front access panel of center cabinet. Block interlock switch for the panel so that it is bypassed.

e. Position mobile workbench at center front of transmitter (directly below IPA Metering Panel).

f. Remove four retaining screws and pull IPA Metering Panel and attached cables out from front of cabinet. Rest panel on top of mobile workbench.

g. Set IPA Metering Assembly controls (Figure 6-28) as follows:

R7 (FOLDBACK THRESHOLD)	Fully CCW
R11 (THRESHOLD INDICATOR)	Fully CW
R15 (COLLECTOR CURRENT CAL)	Fully CCW
R17 (COLLECTOR VOLTAGE CAL)	Fully CCW
R25 (FORWARD POWER CAL)	Fully CCW
R29 (REFLECTED POWER CAL)	Fully CCW
R40 (REG. VOLTAGE CONTROL)	Fully CW

h. Disconnect coaxial cable from output of IPA Driver at connector J2.

NOTE

In the following step, the DC coupler (A26DC1) is to remain in place at the IPA Driver output.

i. Connect input of Thruline wattmeter with 500-watt element to IPA connector J2. Use appropriate coaxial adapter(s) and 50-ohm cable. Connect input of Bird 500-watt dummy load to output of wattmeter with appropriate adapter(s) and cable.

3. Calibration Procedures

a. Set AC LINE circuit breaker on AC Metering Panel Figure 3-2) to ON.

b. Set BLOWERS circuit breaker, and 28 VDC and DRIVER POWER SUPPLY circuit breakers, on Circuit Breaker Panel (Figure 3-3) to ON.

c. Press POWER CONTROL MAN and FILAMENT ON switch-indicators on PA Control Panel (Figure 3-4).

d. After time delay when READY indicator on PA Control Panel illuminates, set PA SCREEN and PA PLATE POWER SUPPLY circuit breakers on Circuit Breaker Panel to ON.

e. Press PLATE ON switch-indicator on PA Control Panel.

WARNING

CONTACT WITH EXPOSED ELECTRICAL TERMINALS OR CONDUCTORS OF THE TRANSMITTER CAN RESULT IN SERIOUS INJURY OR DEATH.

f. Use digital voltmeter to measure voltage at junction of A27A1R3, A27A1R4 and A27A1R5 on IPA Metering Assembly (Figure 6-28). Record measurement.

g. Press Ec 60 VFS switch on IPA Metering Panel (Figure 3-6).

h. Adjust A27A1R17 on IPA Metering Assembly (Figure 6-28) so that voltage shown on meter of IPA Metering Panel (Figure 3-6) matches that measured in step f, above.

i. Slowly adjust A27A1R40 CCW so that power output of IPA as shown on Thruline wattmeter is 500 watts.

j. Press FWD 1200 WFS switch on IPA Metering Panel (Figure 3-6).

k. Adjust A27A1R25 on IPA Metering Assembly (Figure 6-28) so that power output shown on meter of IPA Metering Panel (Figure 3-6) is 500 watts (forward power scale on meter is 0-to-1200 watts).

WARNING

CONTACT WITH DANGEROUS VOLTAGES AND RF SIGNALS IN THE TRANSMITTER CAN CAUSE SERIOUS INJURY OR DEATH. BE CAREFUL WHEN MAKING THE FOLLOWING MEASUREMENT.

l. Press Ic 30 AFS switch on IPA Metering Panel (Figure 3-6).

m. Position inductive sensor of 0-to-30 ampere ammeter around the wire attached to terminal A26TB1-3. Record this measurement.

n. Adjust A27A1R15 on IPA Metering Assembly (Figure 6-28) so that current measurement shown on meter of IPA Metering Panel (Figure 3-6) matches that recorded in step m, above.

o. Adjust A27A1R40 CW until a measurement of 100 watts in shown on Thruline wattmeter.

p. Press PLATE OFF switch-indicator on PA Control Panel (Figure 3-4). Press FILAMENT OFF switch-indicator.

q. Set PA PLATE, PA SCREEN, DRIVER, and 28 VDC POWER SUPPLY circuit breakers on Circuit Breaker Panel (Figure 3-3) to OFF.

r. Disconnect cable and adapter(s) from IPA Driver connector J2.

s. Disconnect Directional Coupler A26DC1 from IPA Driver. Reverse coupler and use appropriate adapter(s) to reinstall it in the reverse mode.

t. Reconnect Thruline wattmeter cable and adapter(s) to IPA Driver connector J2.

u. Perform steps b through e, above, to repower the transmitter.

v. Verify that output of IPA Driver is still 100 watts as established in step o, above.

w. Press REFL 1200 WFS switch on IPA Metering Panel (Figure 3-6).

x. Adjust A27A1R29 on IPA Metering Assembly (Figure 6-28) until a measurement of 100 watts is shown on meter of IPA Metering Panel (Figure 3-6).

y. Press FWD 1200 WFS switch on IPA Metering Panel.

z. Adjust A27A1R7 on IPA Metering Assembly (Figure 6-28) CW until forward power shown on meter of IPA Metering Panel (Figure 3-6) is 60 watts.

aa. Adjust A27A1R11 on IPA Metering Assembly (Figure 6-28) CCW until the VSWR light on the IPA Metering Panel (Figure 3-6) just comes on.

ab. Perform steps p through u, above.

ac. Adjust A27A1R40 on IPA Metering Assembly (Figure 6-28) until Thruline wattmeter indicates 500 watts.

ad. Perform steps p and q, above.

ae. Disconnect Thruline wattmeter and dummy load from output of IPA Driver.

af. Reconnect coaxial cable so that grid input circuit of power amplifier is connected to output of driver at connector J2. Be sure directional coupler A26DC1 is still in configuration established in step ab, above. (Directional coupler is to be in its normal forward configuration.)

ag. Perform steps b through e, above.

ah. Verify that output of IPA Driver as shown on meter of IPA Metering Panel (Figure 3-6) is 500 +/-50 watts. Slight adjustments may be made to A27A1R40 on the IPA Metering Assembly (Figure 6-28) if necessary.

ai. Perform steps p and q above. Then set AC LINE Circuit Breaker on AC Metering Panel (Figure 3-2) to OFF.

WARNING

RESIDUAL ELECTRICAL CHARGES ON CAPACITORS IN TRANSMITTER CAN BE INJURIOUS OR FATAL. BE CAREFUL WHEN PERFORMING THE FOLLOWING STEPS.

aj. Install IPA Metering Panel (Figure 3-6) into transmitter. Attach with four screws.

ak. Unblock interlock switch for access panel of lower compartment of transmitter center cabinet. Install access panel.

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

NOTE

Routine maintenance is not required and maintnenance 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 test point TP1. Adjust resistor R25, FWD OFFSET, set for zero voltage at test point TP1.

3. Use a high impedance dc voltmeter to measure the voltage at test point TP2. Adjust resistor R26, REFL OFFSET, for zero voltage at test point 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 resistor 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 resistor 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 resistor R7, PWR CNTRL ADJ for 100% power in the AUTO mode.

4. Apply +28 Vdc to terminal board A17TB4, terminal 20, to activate relay A3K1.

5. Adjust resistor 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 the desired safe level.

4. Adjust resistor 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 resistor R27, REFL ADJ, for desired reflected (VSWR) level indication on panel power meter, A1M4. Full scale is 12%. Nuisance trips may occur if the trip level is set for less than 5%.

6. Turn VSWR PROT switch, S1, ON and adjust resistor 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

NOTE

The Foldback Circuit is not enabled when the treansmitter is shipped from our factory . There is the possibility of additional damage to a previously damaged antenna system where the Foldback circuit is in use. The Foldback level should be sey to the fully CCW position unless antenna icing conditions are likely.

1. Turn VSWR PROT switch, S1, OFF switch to AUTO power control, and set the FWD/REFL Switch to the REFL position.

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

3. Remove the high power element from 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.

4. Turn the plate voltage ON, and in AUTO Power Mode, adjust A3R32, VSWR FOLDBACK LEVEL, to the desired Foldback Level. Read the reflected power on the 12% scale. (Disregard the fact that the forward element is not calibrated for the reflected power meter. This test only requires a voltage that is controlled by the powert controller and represents some amount of reflected power). 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 ands 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. 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 relay K5. The threshold voltage range is 190-270V. Set control to 190V, (full counterclockwise).

3. Replace access panel.

5-7.9 BLOWER OFF DELAY ADJUSTMENT

1. Shut off the main ac line circuit breaker, A25CB1.

2. Remove the right front bay access panel.

3. Set the control on relay 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 the access panel.

5-8. CHANGING POWER

The power output is changed by changing taps on the screen transformer T2. The PA plate voltage is maintained high (8.3 to 8.5 kV) to keep efficiency high. Use the following data supplied in Section 3.0 as a guide: Tables 2-1, 3-4 and 3-5, and figure 2-8. Adjust the screen voltage to obtain the desired output power. To complete the power change, refer to paragraphs 5-7.7, 5-9.3, and 3.3, step 25.

5-9. CHANGING FREQUENCY

NOTE

If power and frequency are 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 3-3 steps 19 thru 24) for minor tuning instructions.

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 5-9.2, steps 1 thru 10. 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 thru 5-9.3.

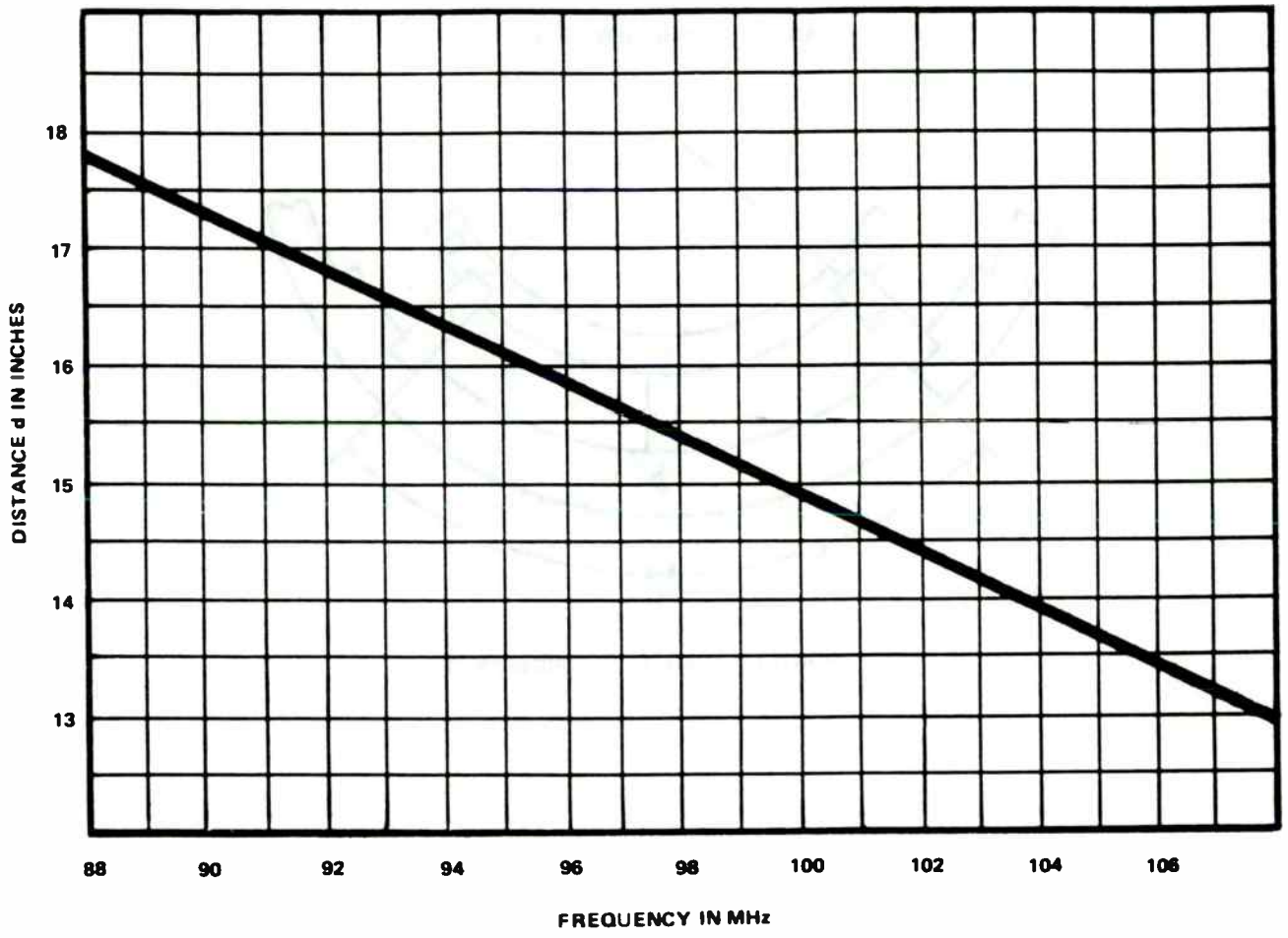
NOTE

The data presented in the graphs (Figures 5-1, 5-2 and 5-3) is approximate and is intended only to get the transmitter tuning close.

5-9.1 FREQUENCY CHANGE ADJUSTMENTS

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.



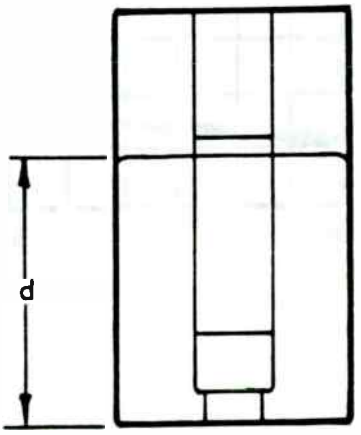
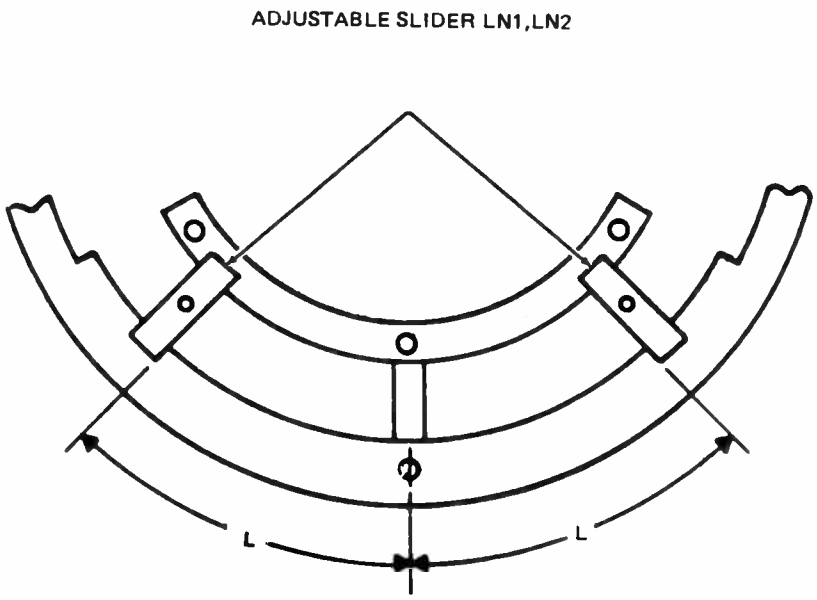


Figure 5-1. PA Plate Tuning Cavity Slider Approximate Adjustment

RQ-5-001



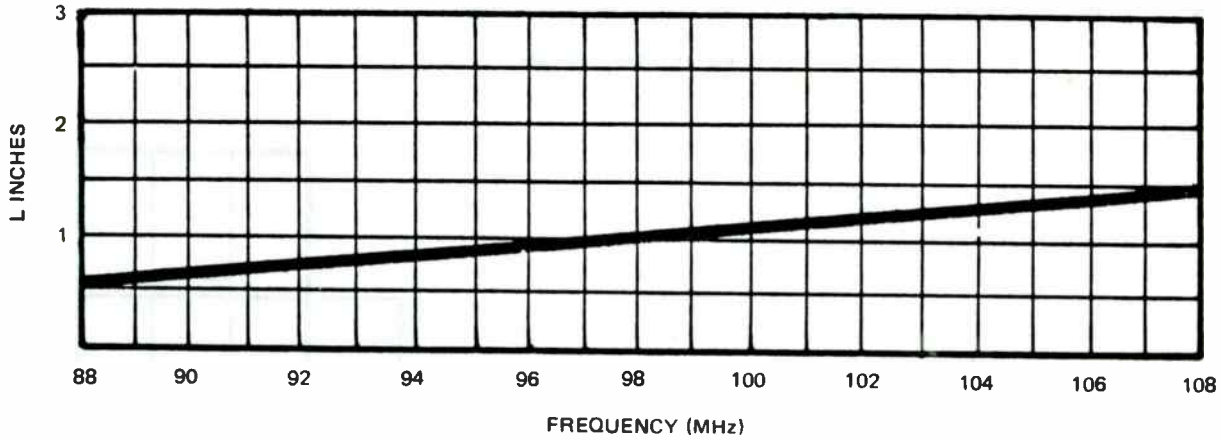
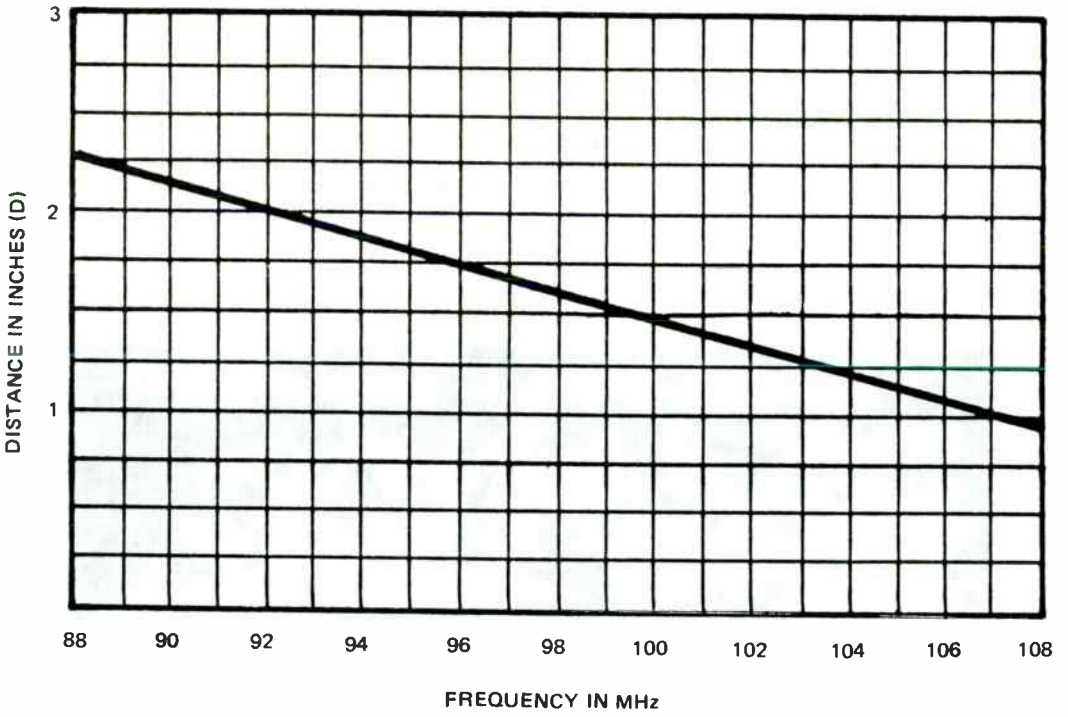


Figure 5-2. PA Neutralizing Adjustment

RQ-5-002



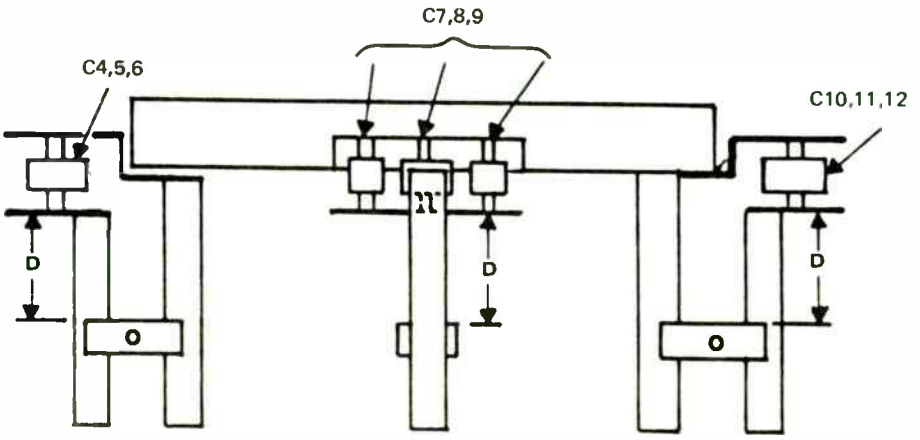


Figure 5-3. Graph for Approximate Setting of PA Grid Tuning Inductors

RQ-5-003

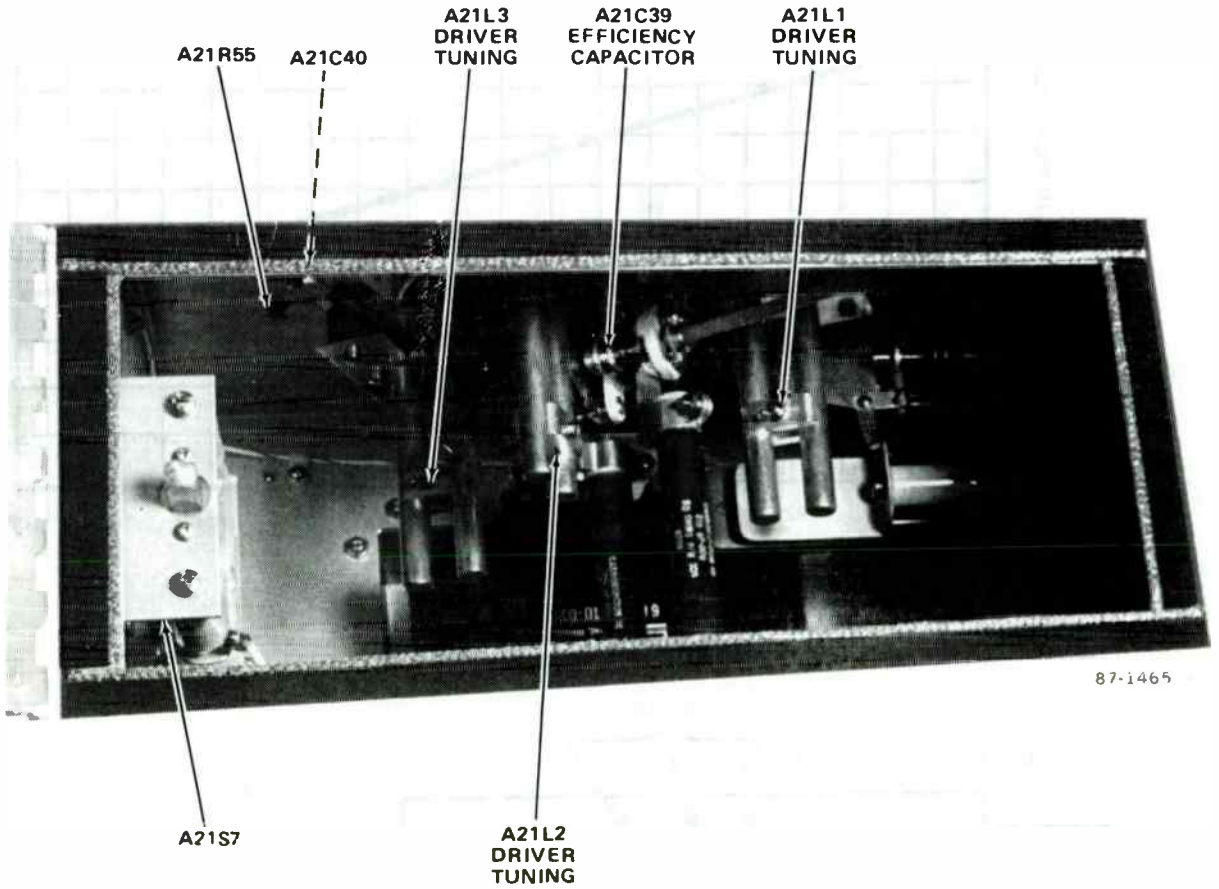


Figure 5-4. Power Amplifier Socket, A21

RQ-5-004

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 4-7) to the desired frequency in accordance with the graph in Figure 5-1.

2. PA NEUTRALIZATION

Adjust the PA neutralization bars to the desired frequency in accordance with the graph in Figure 5-2.

3. PA GRID TUNING SLIDER

a. Open the PA grid compartment door.

b. Adjust the PA grid tuning sliders (Figures 5-3 and 5-4, L1,2,3) in accordance with the graph shown in Figure 5-3 for the desired frequency.

4. PA GRID SWAMPING CAPACITOR

a. Swamping capacitor C3 consists of two aluminum plates separated by some distance. The position of the plate nearest the front of the transmitter is adjustable, thus making it possible to set the distance between the two plates. Referring to Figure 5-5, loosen the screw on the adjustable plate and position it to obtain the plate to plate spacing indicated in figure 5-5 for the desired operating frequency. The spacing may be checked using a feeler gauge or a similar device inserted between the plates.

b. Tighten the screw on the adjustable plate.

5. CATHODE RETURN CAPACITOR ADJUSTMENT

Cathode capacitor slot position definition: There are seven capacitor positions defined for each side of the four cathode return capacitors. The seven positions are chosen to be easily identified by eye. The positions are described below and in Figures 5-6, 5-7, 5-8 & 5-9.

Initially set the capacitor to the nearest whole position indicated above. The final position of the capacitor may be fine adjusted for improved efficiency after the transmitter is operating.

6. EFFICIENCY CAPACITOR

Preset the efficiency capacitor C39 for MINIMUM capacitance. The capacitor plate should be completely unmeshed.

7. COUPLING CAPACITOR

Preset the coupling capacitor (C1) for minimum capacitance. The capacitor plate should be completely unmeshed. Close the grid compartment door.

8. PA BIAS

Preset the bias resistor (R35), located behind the power amplifier cavity, to the middle of its range.

9. IPA TO PA CABLE LENGTH

The length of the coaxial cable between the IPA directional coupler (A26DC1) and the PA cavity input connector (J1) should be cut to the length (Figure 5-10) for the desired operating frequency. The cable must be type RG-14B/U. It can be obtained from CE by ordering part number 425-1132-000.

10. IPA OUTPUT QUARTER-WAVE STUB

The length of the coaxial /4 stub on the output of the IPA directional coupler A26DC1 should be cut to length as shown in figure 5-10. The cable must be type RG-142B/U.

5-9.2 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 25 kW at 88 to 108 MHz. If these devices are unavailable, refer to the RF WATTMETER on the control panel for power output measurement.

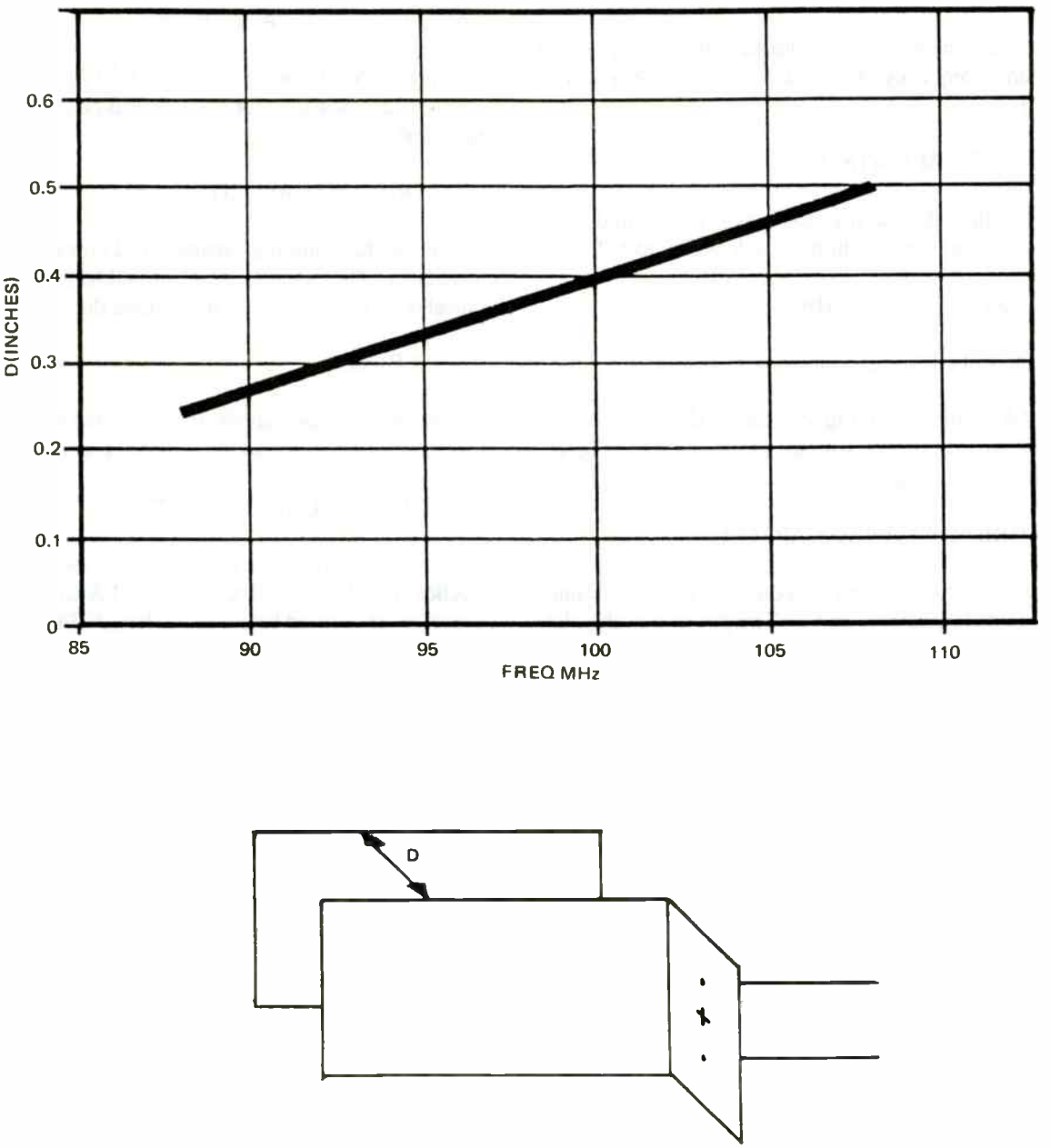


Figure 5-5. PA Grid Swamping Capacitor

RQ-5-005

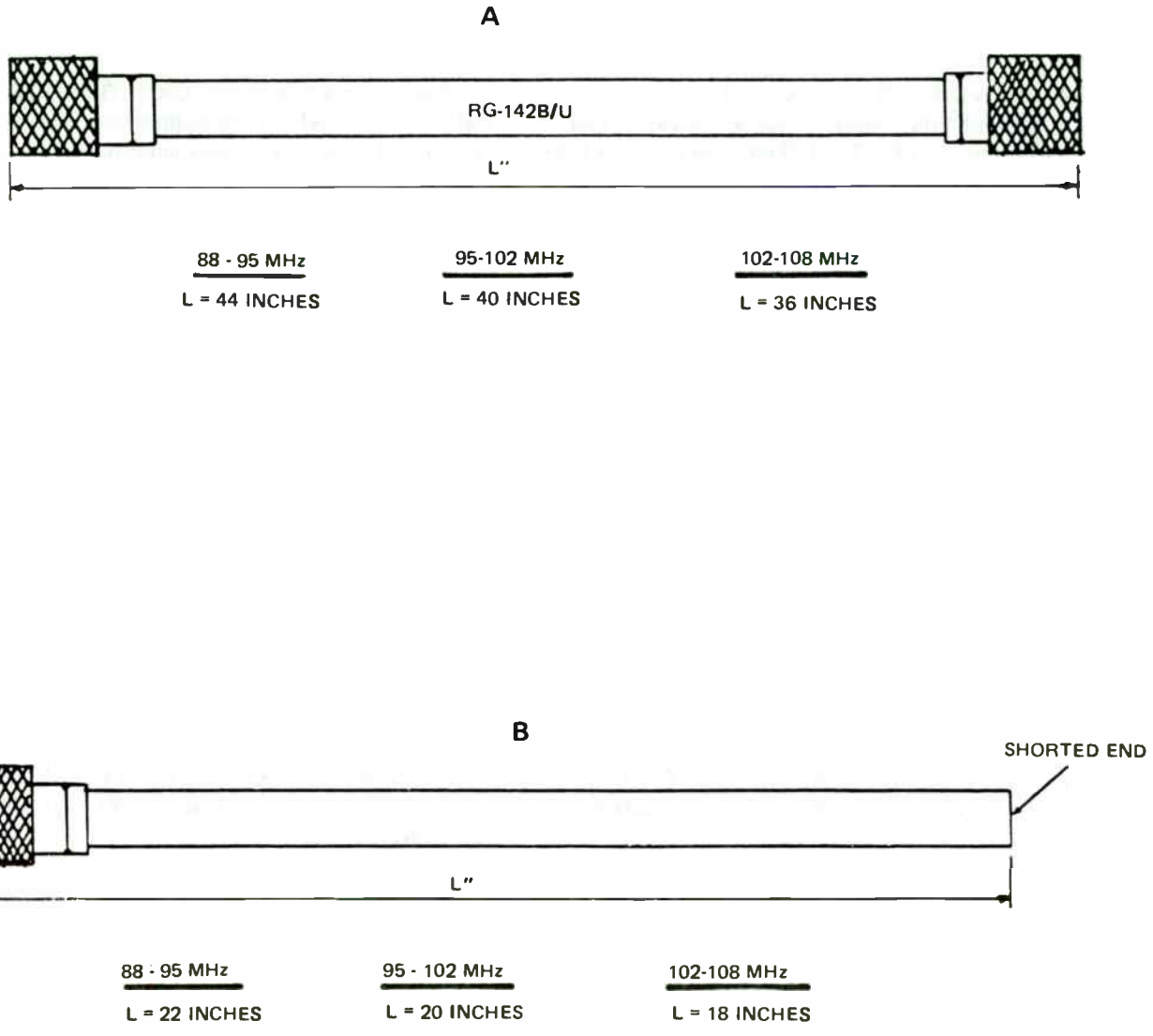


Figure 5-6. Cable and Stub Lengths

RQ-5-010

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 PA GRID TUNING control fully counter-clockwise. Then turn the control ten 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 4-7.) 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 capacitors 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 and 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:

PA SCREEN CURRENT:	600 mA
PA PLATE CURRENT:	4.0 A

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. Alternately adjust the PA GRID TUNING (A18C2) and COUPLING (A18C1) capacitors for minimum reflected IPA reflected power. The power amplifier grid current should be at least 80 mA.

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.

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).

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.

11. Check for power amplifier neutralization. Refer to paragraph 5-9.3.

NOTE

Compare the transmitter operating parameters with those in Tables 3-4 and 3-5. 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) may be needed.

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

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

14. If plate tuning capacitor A18C50 is not approximately half way between its limits, adjust the PA plate cavity shorting plane (paragraph 5-9.1, step 1) and repeat steps 3 through 14 of this paragraph.

5-9.3 PA NEUTRALIZATION

A. NEUTRALIZING PROCEDURE

NOTE

Check the transmitter for proper neutralization. If neutralization is correct, do not perform this procedure.

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

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

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

4. Refer to Figure 5-2 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.)

5. Install the tube air guide.

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

7. Check for proper neutralization again. If incorrect, repeat steps 2 through 6.

The power amplifier of the transmitter can be found in one of three possible states of neutralization (neut). These are:

a. REGENERATIVE (Positive Feedback)

b. PERFECTLY NEUTRALIZED (No Feedback)

c. DEGENERATIVE (Negative Feedback)

The state of neutralization can be identified by observing the control grid current while raising the plate tuning.

IF GRID CURRENT:	STATE OF NEUT:
Rises	Regenerative
Doesn't change	Perfect
Drops	Degenerative

Experience has shown that it is best to adjust the neutralization slightly beyond the point of perfect neutralization into the region of degeneration. Moving the neutralization bars out slightly (1/16" - 1/8") from the point of perfect neutralization will place the PA into the degenerative region.

B. ALTERNATIVE NEUTRALIZING PROCEDURE

It is time consuming, however, to locate the perfect neutralization point. The following is an alternative approach.

1. Pre-set neut per tuning chart.

2. Get the power amplifier running and determine the present state of neut.

3. If the neutralization is regenerative or perfect, then move the neutralization bars out slightly (1/16" - 1/8") and go back to step 2. If the neutalization is degenerative then proceed with tuning.

4. Repeat steps 8, 9 and 10 of paragraph 5-9.2.

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