AIR-GROUND RADIO
PRIVATE SYSTEMS
ECHO-FOX UHF RADIO SYSTEM
BASE TRANSMITTER GE-MASTR PROGRESS LINE
ALIGNMENT

This section outlines the procedures for adjusting and testing the Echo-Fox UHF transmitter-exciter, power amplifier, and associated power amplifier power supply. Methods are provided for aligning the units, adjusting deviation and frequency, replacing the vacuum tubes, and adjusting for low-power operation.

This section is reissued to reflect the deletion of wideband service.

Equipment Test Lists are affected.

Before applying power to the transmitter, either upon initial installation or immediately before maintenance, inspect the transmitter for proper installation of electron tubes and interconnecting wiring (including coaxial cables and connectors). Ensure that there is no loose hardware. Care must be exercised at all times when testing and making adjustments on the power amplifier and associated power supply. **The vacuum tube circuit employed in the power amplifier operates at a plate potenial of approximately 2000 volts. Observe safety precautions described in Section 010-110-001.**

The transmitter employed in this radio system is operated with primary power applied on a continuous 24-hour per day basis. A release ***must*** be obtained from the operational control office before work may be performed which would interrupt or impair communications service.

A record of meter indications ***must*** be maintained of all adjustments, parts replacements, tube replacements, repair work, and wiring or apparatus modifications.

In applying the information contained in this section, it is necessary that maintenance personnel understand the equipment, especially the power amplifier and the associated power supply, and are familiar with the test apparatus required in testing the transmitter.

CHART **PAGE**

APPARATUS:

The following test apparatus is required for performing the tests in this section. Before any test equipment is used, ensure that each item is properly calibrated in accordance with the manufacturer's specifications. Test equipment may be substituted if it meets the specifications of the item listed.

1—FM Deviation Meter, Oscilloscope type

1—Transmission Measuring Set J94021A (21A TMS)

1—Test Cable Set, Amphenol C133-216

1—1P2A Test Cord

1—2P13A Test Cord

3—Dummy Plugs

1—Frequency Counter, accurate to 1 part in 10 million

Additional apparatus required if a major alignment is to be performed:

1—Grid Dip Meter

1—Thru-Line Power Meter

CHART 1

FREQUENCY ADJUSTMENT

The transmitter master oscillator is on when primary power is applied. In this test it is not necessary to key the transmitter until the final adjustment. The transmitter frequency should never be checked or adjusted while the transmitter is modulated. During final adjustment, if the counter indicates that the transmitter frequency is changing rapidly, there may be spurious signals emitted from the exciter or power amplifier.

STEP	PROCEDURE
1	Verify that permission has been obtained from the control office to remove the station from service. Remove the station from service and proceed with the steps that follow.
2	Place dummy plugs in the following LINE jacks: Transmit audio and TC1.
3	Disconnect the RF line from the exciter output jack.
4	Release the exciter locking device and swing the exciter away from the power supply. Remove the rear cover.
5	Reconnect the RF line to the exciter output jack through the extender cable.

CHART 1 (Cont)

STEP	PROCEDURE
6	Locate L2 on the wideband modulator board (Fig. 1) and set the top slug flush with the top of the coil form. Set the botton slug flush with the bottom of the coil form.
7	Connect the test cord with the pickup loop to the frequency counter and place the pickup loop within the radiation field of the oscillator.
8	Make a coarse tuning by turning the bottom slug of L2 into the coil form until the frequency counter indicates between 100 Hz and 200 Hz above the crystal frequency.
9	Make a fine tuning adjustment by turning the top slug of L2 down from the top of the coil form until the frequency counter indicates the crystal frequency.
10	Replace the cover on the exciter.
11	Connect the frequency counter to the RF COUNTER jack on the power amplifier.
12	Disconnect the antenna from the diplexer and connect the diplexer output to the dummy load.
13	Key the transmitter. Plug a 1P2A cord into the TC1 EQPT jack ***first*** and then into the −48 volt jack.
14	Insert the tuning tool through the hole in the cover of the exciter and adjust the top slug of L2 until the frequency counter indicates the station frequency. ***Note:*** If the frequency adjustment is unsuccessful or if the frequency is unstable, return the exciter to the factory for depot maintenance in accordance with Section 406-116-800. If maintenance is to be performed at the station, check the filament supply voltage and VR2, RT1, and RT2 on the wideband modulator board (A101).
15	Return the station to service (or continue to other charts as applicable).

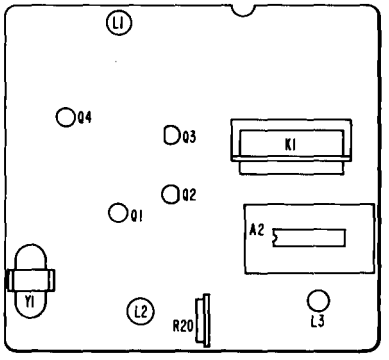

Fig. 1—Wideband Modulator Board

CHART 2

EXCITER ALIGNMENT

During the exciter alignment procedure, maintain the exciter connection to the power amplifier. The power amplifier plate circuit breaker is turned off and the diplexer output is removed from the antenna and connected to the dummy load. The output from the exciter drives the power amplifier. The power amplifier grid circuit is the load for the exciter output. It is necessary to check the power amplifier grid drive before proceeding with the remainder of the alignment procedure.

STEP	PROCEDURE
1	Key the transmitter and observe the TRANSMITTER meter (with external probe in the green GRID jack and the TRANSMITTER switch in position K). Refer to Table A. ***Requirement:*** 2 volts minimum.
2	If the requirement of Step 1 is not met, adjust the PA GRID on the power amplifier and the OUTPUT TUNING -1 and -2 on the exciter for maximum meter indication.
3	On the station power supply, ensure that the ON-OFF switch S501 is in the OFF position.
4	Insert dummy plugs in the following jacks: TC1 and transmit audio.
5	Remove the cover plate from the exciter. Exercise care in removing the cover to avoid breaking the meter plug wires. Place meter switching circuit plug P1001 into centralized metering jack J102.
6	Disconnect the antenna from the diplexer output and connect the diplexer output to the dummy load.
7	If only a touchup alignment is to be performed, proceed to Step 12 and continue the procedure with the coil slugs in the existing positions. If a large change in frequency is required, or a seriously misaligned transmitter is evident, make the following preliminary control adjustments. Refer to Fig. 2 and 3 for location of the controls.
8	Set the tuning slugs of exciter coils L2, T1, T2, T3, T4, T5, and T6 to the bottom of each coil form.
9	Set the tuning slugs of MULT-3 GRID Z101 to the top of the coil form.
10	Adjust AMPL PLATE capacitor C145 counterclockwise until the stub is even with the top of the protective shield.
11	Adjust tuning capacitors C121 and C122 and OUTPUT TUNING -1 and -2 capacitors fully counterclockwise.
12	Adjust OUTPUT CONTROL potentiometer R124 fully counterclockwise.

TABLE A
METER SWITCHING PANEL
ECHO-FOX BASE STATION
TRANSMITTER-RECEIVER

POSITION TRANSMITTER SWITCH		TRANSMITTER FUNCTION	TRANSMITTER METER RANGE F.S.
	(J102)		
A	10	MULT 1	1V
B	2	MULT 2	1V
C	3	AMPL 3	1V
D	4	MULT 3	1V
E	5	AMPL/MULT 4	1V
F	6	PA GRID	1V
G	1	PA PLT CURRENT	1V
H	11	PWR OUT	1V
I	12	20 V	30V
J	9	PA PLT VOLTAGE	1,000V
K		EXTERNAL PROBE	3V
L/VM		RCVR 2ND IF	1V

POSITION RECEIVER SWITCH		RECEIVER FUNCTION	RECEIVER METER RANGE F.S.
	(J442)		
A	10	DISC	* 1V
B	2	2nd IF	* 1V
C	3	1st LIM	* 1V
D	4	MULT 1	* 1V
E	5	MULT 2	* 1V
G	1	AUDIO PA	* 1V
J	13	10 VOLTS	15V

* Meter range may be increased to 3V by switch S1003.

Note: Test probe P1003 is used to measure the high voltage power amplifier control grid E/I and screen grid E/I.

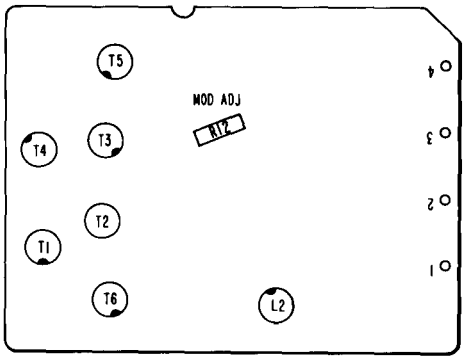

Fig. 2—Exciter Board A113-A120

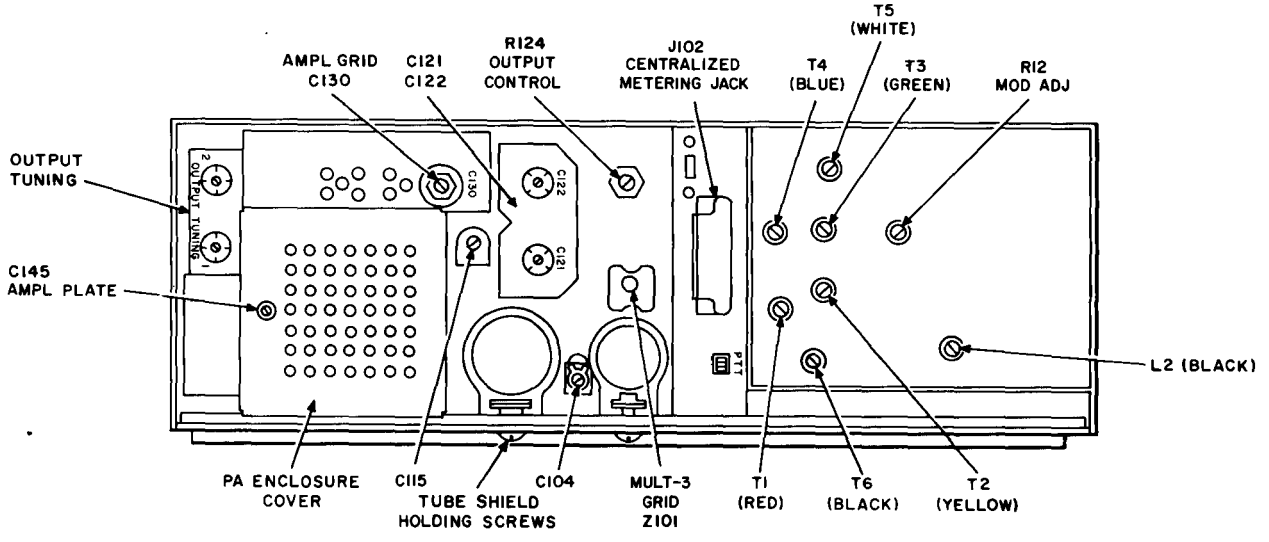

Fig. 3—Front View of Exciter—Cover Removed

CHART 2 (Cont)	
STEP	**PROCEDURE**
13	Place the power amplifier PLATE circuit breaker in the OFF position.
14	Place the proper crystal in socket XY1.
15	On the station power supply, set the ON-OFF switch to ON.
	Note: All adjustments must be made with the transmitter keyed. To key the transmitter, plug a 1P2A cord into the TC1 EQPT jack ***first,*** then into the −48 volt jack. This keying procedure eliminates blowing fuses.

CHART 2 (Cont)

STEP	PROCEDURE
16	Set the TRANSMITTER switch on the meter switching panel to A (MULT 1).
17	Alternately adjust coils T6 and L2 for a maximum meter indication. Refer to Fig. 1 for location of components.
	Requirement: The meter indicates approximately 0.55 volt (0.4 volt minimum).
18	If the requirement is not met, set the slug in L2 to a different position and readjust T6.
19	Maintain the switch position and adjust T1 (red) for a dip in the meter indication.
20	On the meter switching panel, set the TRANSMITTER switch to B (MULT 2).
21	Adjust T2 (yellow) and then T1 (red) for maximum meter indication.
22	Adjust T3 (green) for minimum meter indication.
	Requirement: The meter indicates approximately 0.65 volt (0.5 volt minimum).
23	On the meter switching panel, set the TRANSMITTER switch to C (AMPL 3).
24	Adjust T4 (blue) and then T3 (green) for maximum meter indication. Then adjust T5 (white) for minimum meter indication.
	Note: The dip of T5 and the peak of T3 may be very broad.
	Requirement: The meter indicates approximately 0.6 volt (0.5 volt minimum).
25	Set the TRANSMITTER switch on the meter switching panel to D (MULT 3).
26	Adjust MULT 3 GRID coil Z101 for a maximum meter indication.
	Requirement: The meter indicates approximately 0.6 volt (0.5 volt minimum).
27	Set the TRANSMITTER switch on the meter switching panel to C (AMPL 3).
28	Readjust coil T4 (blue) for a maximum meter indication.
29	Set the TRANSMITTER switch on the meter switching panel to D (MULT 3).
30	Readjust MULT 3 GRID coil Z101 for a maximum indication on the meter.
31	Set the TRANSMITTER switch on the meter switching panel to E (AMPL/MULT 4).
32	Adjust intermediate power amplifier (IPA) grid capacitor C104 for a maximum indication on the meter. Then adjust capacitor C115 for a maximum meter indication. Readjust both C104 and C115 until no further increase in meter indication is observed.

CHART 2 (Cont)	
STEP	**PROCEDURE**
33	Maintain the meter switch in position E and adjust capacitor C121 clockwise until a sudden drop in meter indication is observed. Adjust capacitor C122 clockwise until the meter indication rises to a peak.
34	On the meter switching panel, set the TRANSMITTER switch to F (PA GRID).
35	Adjust AMPL GRID capacitor C130 for a maximum indication on the meter. Then readjust, in the order given, capacitors C115, C121, C122, and C130, repeating until no further increase in meter indication is observed. ***Requirement:*** The meter indicates no less than 0.2 volt.
36	On the meter switching panel, set the TRANSMITTER switch to G (PA PLATE CURRENT).
37	Adjust AMPL PLATE capacitor C145 for dip in meter indication. ***Note:*** When tuning the final amplifier plate circuit and the output circuit, the objective is to find the point where a dip in the plate current and a peak of the output are simultaneous. Failure to meet this objective is often due to improper neutralization of the final amplifier.
38	On the meter switching panel, set the TRANSMITTER switch to K (external probe) and insert the external probe in the power amplifier GRID jack.
39	Alternately adjust OUTPUT TUNING -1 and -2 capacitors (C1 and C3) for a maximum meter indication (maximum grid drive). ***Note:*** When the optimum electrical position of OUTPUT TUNING -1 and -2 is found, both capacitors should be near the physical center of the range and each near the same point.
40	On the meter switching panel, set the TRANSMITTER switch to G (PA PLATE CURRENT).
41	Adjust OUTPUT CONTROL potentiometer R124 clockwise until the meter indicates 0.6 volt.
42	If there are indications that the final stage is not properly neutralized, the final amplifier tube V103 may be changed for corrective action.
43	If the touchup alignment is unsuccessful, the unit should be returned to the factory for repair according to Section 406-116-800.

CHART 3

DEVIATION ADJUSTMENT

During the deviation adjustment, the transmitter shall remain connected in the normal configuration except that the diplexer output is disconnected from the antenna and connected to the dummy load.

STEP	PROCEDURE
1	On the FM deviation meter, set the POWER switch to the STANDBY position.
2	On the 21A TMS, place the ON-OFF switch to ON.
3	Allow the test sets to stabilize for at least 15 minutes.
4	On the FM deviation meter, set the POWER switch to ON.
5	Set the MARKER switch to OPERATE.
6	Set the MULTIPLIER switch to X1 NORMAL.
7	Turn the BAND switch to the appropriate frequency.
8	Adjust the TUNING dial to the approximate frequency to be received.
9	Couple the FM deviation meter to the transmitter. ***Note:*** The deviation meter may be connected to the transmitter at the variable attenuator on the output of the power amplifier. If the transmitter is not equipped with the attenuator, a coaxial test cable with a coupling loop may be slipped over the exciter coaxial cable or placed near the exciter output circuit.
10	Disconnect the RF cable from the exciter and swing the unit out for access. Remove the rear cover and locate R20 [a yellow plastic wheel with a knurled edge (Fig. 1)]. To eliminate any possible interaction between wideband and narrowband components, it is necessary to adjust R20 (formerly wideband deviation adjustment) to maximum resistance (turned down position). Replace cover and swing the unit back in place. Reconnect the RF cable to the exciter.
11	Insert dummy plugs in the following LINE jacks in the auxiliary bay jack field: TC1 and transmit audio.
12	Remove the front cover from the exciter being careful not to break the meter plug wires. Locate MOD ADJ resistor R12, which is a blue plastic wheel with a knurled edge, Fig. 2.
13	Key the transmitter. Plug the 1P2A test cord into the TC1 EQPT jack ***first,*** then into the −48 volt jack.

CHART 3 (Cont)	
STEP	**PROCEDURE**
14	Observe the indication on the input level meter located on the front panel of the deviation meter. Vary the TUNING control until a maximum meter deflection is observed.
15	Readjust the TUNING control until the trace line on the CRT is exactly on the center line of the graticule.
16	Momentarily place the MARKER switch in the + and − positions and adjust the CALIBRATION and TUNING controls so that the marker frequency trace line on the CRT graticule is in the positions shown in Fig. 4A. ***Note:*** It may be necessary to vary the rear V CENTER control to obtain a fine center trace on the CRT.

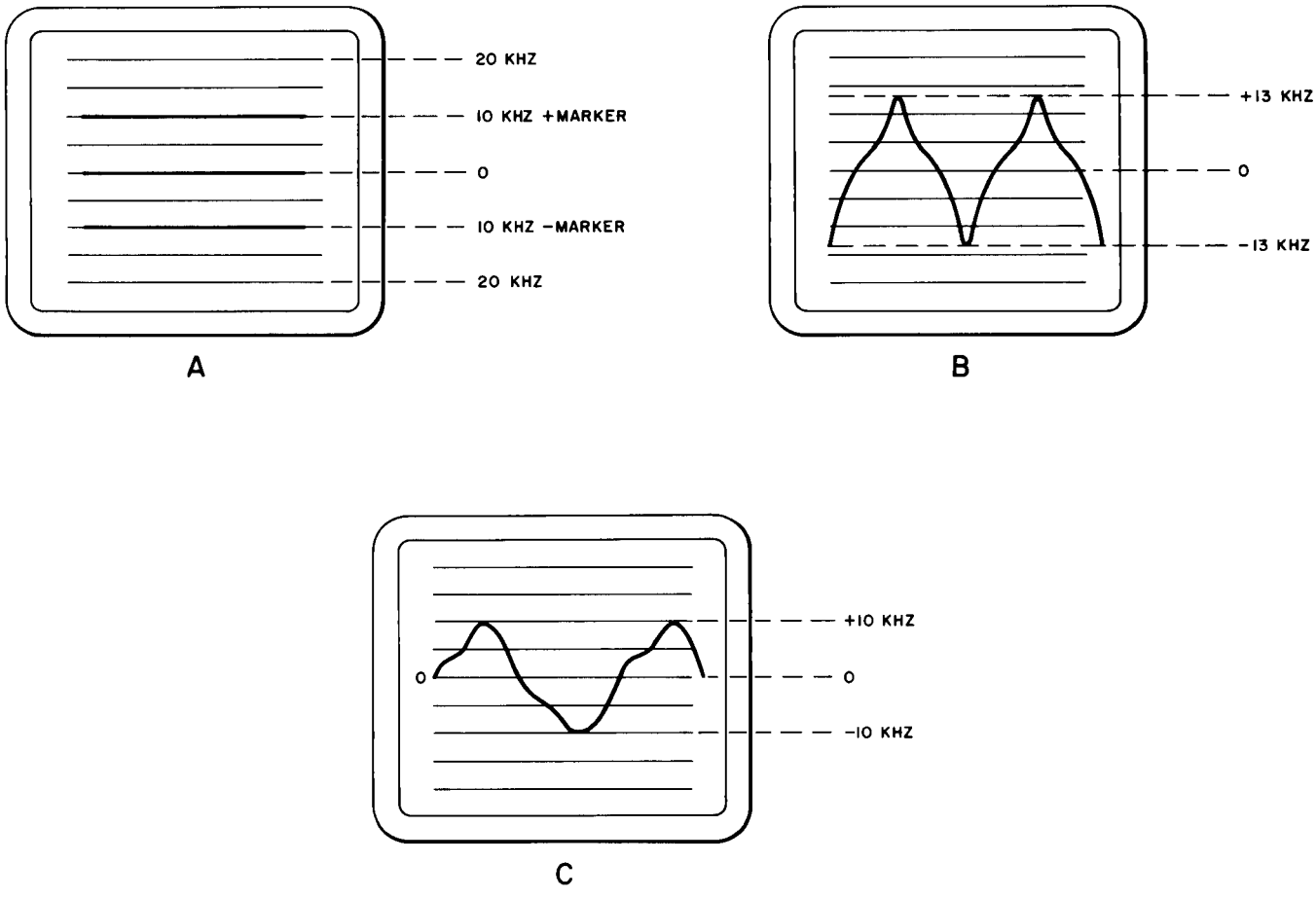

Fig. 4—FM Deviation Meter Calibration Points

CHART 3 (Cont)

STEP	PROCEDURE
17	Observe that the wideband lamp in the auxiliary jack field is not lighted.
18	On the 21A TMS, set the frequency and output controls to provide a +6 dBm, 1000-Hz signal at the OSC OUT 600Ω jacks.
19	Connect a 2P13A from the OSC out 600Ω jacks on the 21A TMS to the transmit EQPT jacks in the jack field.
20	On the voice-frequency control panel, adjust AUDIO LEVEL potentiometer R501 fully clockwise.
21	Key the transmitter as in Step 12.
22	On the transmitter chassis, adjust MOD ADJ potentiometer R12 until the vertical trace on the CRT indicates ±13 kHz deviation as shown in Fig. 4B.
23	Vary the SWEEP FREQUENCY control clockwise until 3 or 4 cycles are shown on the CRT. ***Note:*** The presentation apppears as a series of positive- and negative-going sharp peaks, indicating the signal is undergoing heavy limiting.
24	On the 21A TMS, adjust the output controls for a −6 dBm signal at the oscillator output jacks.
25	On the voice-frequency control panel, adjust AUDIO LEVEL potentiometer R501 for a presentation of ±10 kHz deviation on the CRT, shown in Fig. 4C. The presentation appears as a series of positive- and negative-going, slightly sharpened peaks, indicating the signal is undergoing only light limiting or the beginning of limiting. Potentiometer R501 remains at this adjustment point.
26	Unkey the transmitter. Remove the 1P2A test cord from the −48 volt jack ***first,*** then from the TC1 EQPT jack.
27	Remove all plugs and test cords and return the station to service.

CHART 4

POWER AMPLIFIER ALIGNMENT

If the alignment to be performed pertains only to the power amplifier, proceed with all the succeeding steps . If the alignment of the power amplifier is to immediately follow the alignment of the exciter, proceed to Step 5.

CHART 4 (Cont)

The grid and plate cavities of the power amplifier are LC tank circuits which are tuned to present maximum impedance at the station frequency. The filter cavity provides buffer action to the plate circuit and is an impedance matching transformer between the amplifier and the load (antenna). The filter cavity is a double-tuned LC tank circuit with variable coupling.

The impedances involved in tuning the power amplifier are reactive. This means that the exciter output tuning and power amplifier grid tuning must be adjusted concurrently to effect optimum performance since the coaxial interconnect cable is a coaxial transformer. The power amplifier filter control is adjusted to effect impedance matching between the power amplifier plate and the diplexer or load.

STEP	PROCEDURE
1	Insert dummy plugs in the following LINE jacks on the auxiliary bay jack field: TC1 and transmit audio.
2	On the station power supply, set ON-OFF switch S501 to the OFF position.
3	On the power amplifier power supply, set PA PLATE switch S451 and CONTROL switch S452 to OFF. Adjust the SCREEN control fully counterclockwise.
4	Disconnect the antenna from the diplexer output and connect the diplexer output to the dummy load. ***Note:*** Never key the transmitter unless it is connected to a load.
5	Remove the cover plate from the exciter so that all controls are accessible. Exercise care when removing the cover so that the meter plug wires do not break. Connect plug P1001 to jack J102.
6	On the station power supply, set ON-OFF switch S501 to ON. On the power amplifier power supply, set the CONTROL switch to ON. ***Note:*** Allow both the exciter and power amplifier to stabilize for at least 15 minutes.
7	Ensure that PA PLATE switch S451 remains in the OFF position.
8	On initial adjustment, pull out the PA COUPLING control to the maximum limit. Turn the control clockwise until the key engages the coupling window. Push the control in until the knob is approximately three-fourths of an inch from the panel. Carefully turn the control counterclockwise to disengage from the coupling window. Push the disengaged control shaft to the fully inserted position. ***Note:*** The coupling will affect the power output and power output stability. It will usually be necessary to tighten the coupling a small amount beyond critical coupling to establish a stable power output over a wide temperature range. Push in to tighten coupling; pull out to increase coupling.

CHART 4 (Cont)	
STEP	**PROCEDURE**
9	Connect the red probe from the meter switching panel to the green GRID jack on the power amplifier power supply. Set the TRANSMITTER switch to EXTERNAL. Set the EXT switch to the – position.
10	Key the transmitter. Connect the 1P2A test cord to the TC1 EQPT jack ***first,*** then to the –48 volt jack.
11	Adjust the PA GRID capacitor on the power amplifier and OUTPUT TUNING capacitors –1 and –2 on the exciter for maximum PA GRID current indication on the TRANSMITTER meter on the meter panel. Adjust the PA GRID capacitor first, OUTPUT TUNING –2 capacitor second, and OUTPUT TUNING –1 last. Repeat this sequence of adjustment until no further increase in grid current is obtained. ***Requirement:*** The meter indicates between 2.0 and 2.6 volts (20 to 26 mA). ***Note:*** Full scale reading on the transmitter will be 3.0 volts.
12	Locate the SWR switch on the dummy load panel and place it in the DUP (diplexer) position.
13	On the Station Guardian, place the R.F. POWER switch to the forward or incident position.
14	On the power amplifier power supply, set the PLATE switch to ON. ***Note:*** The transmitter is equipped with an overload circuit (K454). Low grid drive and/or high plate current (375 mA) de-energizes K454 and shuts off the power amplifier, opening the plate supply and grounding the screen grid.
15	Adjust the PA PLATE control for a dip in plate current as indicated on the PA PLATE current meter.
16	Adjust the PA FILTER control for a peak power indication on the Station Guardian meter.
17	Adjust the power amplifier SCREEN control for a plate current indication of 150 mA maximum.
18	Repeat Steps 15 and 16, then repeat Step 11.
19	On the Station Guardian, set the R.F. POWER switch in the back or reflected position. ***Requirement:*** The back (reflected) power is less than 10 percent of the forward (incident) power.
20	Return the R.F. POWER switch to the forward or incident position.
21	Increase the power amplifier plate current in 50 mA steps with the power amplifier SCREEN control, repeating Steps 15 and 16 after each increase, until the plate current is 250 mA.

CHART 4 (Cont)

STEP	PROCEDURE
	Requirement: The output power indicated on the Station Guardian is 200 watts or greater.
	Note: Power out requirement may be met before Ip reaches 250 mA.
22	If the requirement in Step 21 is not met, increase the PA COUPLING a ***small*** amount (pull the shaft outward). Repeat Step 21 until the transmitter output power meets the requirement.
23	Note and record the power amplifier plate current, plate voltage, control grid voltage, screen grid voltage, power output, and back power.
	Note: Screen grid voltage is indicated on the transmitter meter with the red external probe placed in the blue screen grid jack on the power amplifier power supply and with EXT switch in + position.
24	Unkey the transmitter. Remove the 1P2A test cord from the −48 volt jack ***only.***
25	Observe that the power amplifier plate current falls to zero. If not, and assuming that the exciter is in good working order and the final stage is not oscillating, the power amplifier is oscillating and the neutralization adjustment (Step 30) must be performed.
26	Wait ten minutes after unkeying the transmitter and key the transmitter again.
27	Observe the power amplifier plate current, plate voltage, control grid voltage, screen grid voltage, power out, and back power.
	Requirement: Indications are within 10 percent of those recorded in Step 23.
28	Operate the transmitter for ten minutes and observe the indications listed in Step 27.
	Requirement: The meter indications are stable and equal to those recorded in Step 23.
29	If there is a large change in plate current, output power, grid voltage, and back power, tighten the PA COUPLING and retune.
	If there is a large change in plate current, output power, and back power, check that the grid voltage is proper. Check the RF cables, then bypass the diplexer by connecting the power amplifier output to the dummy load through the DUP directional coupler.
	If all indications are unstable, check the power amplifier power supply voltages; and check the exciter alignment with the exciter output connected to the dummy load.
	If the power amplifier requires repair beyond local maintenance facilities, place the station in low power transmitter operation as described in Chart 6 and return the power amplifier to the factory for depot maintenance in accordance with Section 406-116-800.

CHART 4 (Cont)

STEP	PROCEDURE
	Neutralization Procedure
30	Ensure that the transmitter is unkeyed and the TC1 LINE jack is blocked.
	Caution: Failure to have the PLATE switch in the OFF position when neutralizing the power amplifier may result in damage to the equipment.
31	On the station power supply, set ON-OFF switch S501 to OFF.
32	Remove the power amplifier input cable from the RF output jack on the transmitter-exciter. Remove the power amplifier output cable from the output jack (cabinet bulkhead connector).
33	Connect the coaxial test cable from the output jack of the power amplifier to the output jack of the transmitter-exciter.
	Note: This cable is used temporarily for neutralization purposes only.
34	On the station power supply, set ON-OFF switch S501 to ON. Allow 15 minutes for stabilization.
35	Turn the power amplifier neutralizing control fully counterclockwise. Use an insulated tuning tool.
36	Connect the red external probe to the green control grid jack located on the power amplifier power supply. Place the meter switch in position K (external).
37	Key the transmitter and adjust the PA PLATE, PA FILTER, and PA GRID controls for a maximum meter indication. Alternately adjust each of these controls until no further increase in meter deflection is observed.
38	Insert an alignment tool in the PA neutralizing well (Fig. 5).

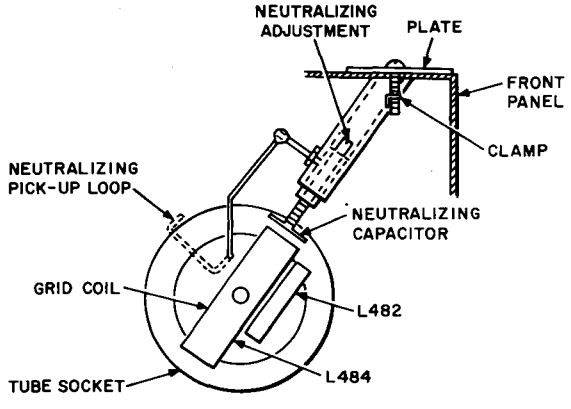

Fig. 5—Neutralizing System (Through Front Panel)

CHART 4 (Cont)

STEP	PROCEDURE
	Caution: Exercise care when inserting tool. Note that tool is inserted at an angle. The head of the adjustment control might break if too much pressure is exerted.
39	Rotate the control in a clockwise direction until a null (minimum indication) is observed on the meter. ***Requirement:*** The TRANSMITTER panel meter indicates between 4 and 7 mA (0.4 and 0.7 volt). ***Note 1:*** The null indication represents complete neutralization. No further adjustment is required. ***Note 2:*** If a null indication of less than 10 mA (1 volt) cannot be obtained, it is possible that the power amplifier tube is improperly seated in the tube socket. Reposition the tube using the tube replacement part of this section. After repositioning the tube, repeat the neutralization procedure. ***Note 3:*** It may be necessary to adjust (slightly) the PA COUPLING control to facilitate neutralization.
40	Unkey the transmitter.
41	On the station power supply, set ON-OFF switch S501 to OFF.
42	Remove the coaxial test cable from the power amplifier output jack and the transmitter-exciter output jack.
43	Restore the coaxial cable, normal connection, to the power amplifier output jack.
44	Restore the power amplifier input cable to the transmitter-exciter jack.
45	After neutralization, the power amplifier must be realigned. Repeat Steps 1 through 25.

CHART 5

RESTORING TO OPERATIONAL STATUS

STEP	PROCEDURE
	Note: After the alignment procedures have been completed for the exciter and power amplifier, restore the transmitter to operational status.
1	On the power amplifier power supply, set the PLATE switch to OFF.

CHART 5 (Cont)

STEP	PROCEDURE
2	Return the cover plates to the exciter and secure.
3	Connect all RF cables in normal condition, including the antenna.
4	On the power amplifier power supply, set the PLATE switch to ON.
5	Key the transmitter by connecting the 1P2A test cord to the TC1 EQPT jack ***first.***
6	Refer to Section 406-116-501, Charts 1, 2, and 3, and check and record the frequency, deviation, power, and VSWR. Record the maintenance data on the maintenance log, Fig. 6.
7	Unkey the transmitter, remove the 1P2A test cord from the −48 volt jack ***first.***
8	Remove all test cords, test equipment, and dummy plugs. Place the SWR switch on the dummy load in the ANT position.
9	Place the Station Guardian R.F. POWER switch in the forward or incident position.
10	Close cabinet doors and secure all latches.
11	Return the station to service via the control office.

CHART 6

LOW-POWER TRANSMITTER OPERATION CHANGEOVER AND ADJUSTMENT

If trouble develops in the Echo-Fox power amplifier, the transmitter-exciter unit can be used as a low-power (60-watt) transmitter. The control office must be informed of the change in mode of operation. During the following procedures, the transmitter is connected to the dummy load while adjustments are made. In addition, station power supply fuse F502 must be inserted in its holder to obtain full power output from the low-power transmitter.

STEP	PROCEDURE
1	Notify the control office that the station is being changed to emergency (low-power) operation.
2	Set the ON-OFF switch S501 on the station power supply and the PA PLATE switch on the power amplifier power supply to OFF.
3	Insert station power supply fuse F502.

Date_____

Technician_____

Station_____

MAINTENANCE LOG

ECHO-FOX BASE STATION TRANSMITTER

FUNCTION		INITIAL	FINAL
GENERAL			
RF FREQUENCY	MHz		
DEVIATION	±kHz		
PWR DUP	Watts		
ANT	Watts		
VSWR DUP	Ratio		
ANT	Ratio		
EXCITER	**TYPICAL READINGS**		
A MULT 1	.7V/.4 min		
B MULT 2	.65V/.5 min		
C AMPL 3	.65V/.5 min		
D MULT 3	.65V/.5 min		
E AMPL/MULT 4	.7V/.5 min		
F PA GRID	.5V/.2 min		
G PA PLT 1	.6V		
H REL. PWR OUT			
I 20 VOLTS	—20V		
J PA PLT E	275V min		
POWER AMPLIFIER			
K PA CONT. GRID	2V min		
K PA-SCRN. GRID			
PA PLT. I	250 mA max		
PA PLT. E	2000V		

Remarks:
Reason for maintenance, trouble, or routine description of trouble and remedy

Fig. 6 — Sample Maintenance Log

CHART 6 (Cont)

STEP	PROCEDURE
4	Disconnect the power amplifier from the transmitter-exciter. Disconnect the power amplifier output cable from the RF COUNTER jack. Use a test cable to connect the exciter output to the RF COUNTER jack. Route this cable as far as possible from the receiver input cable.
5	Disconnect the antenna from the diplexer output and connect the diplexer output to the dummy load.
6	Remove the cover plate from the exciter and connect meter switching plug P1001 to the centralized metering jack J102.
7	Place a dummy plug in the TC1 LINE jack.
8	Adjust the exciter OUTPUT CONTROL R124 fully counterclockwise.
9	Set the TRANSMITTER switch on the meter switching panel to F (PA GRID).
10	Set the station power supply ON-OFF switch S501 to ON.
11	On the dummy load, set the SWR switch to the DUP position.
12	Key the transmitter.
13	Adjust AMPL GRID capacitor C130 for a peak indication on the PA GRID meter.
14	Set the TRANSMITTER switch on the meter switching panel to G (PA PLATE CURRENT).
15	Adjust AMPL PLATE (C145) for a dip in plate current.
16	Alternately adjust OUTPUT TUNING −1 and −2 (C1 and C3) for a peak indication on the Station Guardian power meter. ***Note:*** The R.F. POWER switch must be in the forward position.
17	Adjust the exciter OUTPUT CONTROL R124 until the TRANSMITTER meter indicates 0.6 volt.
18	Repeat Steps 15, 16, and 17 until the optimum condition is reached.
19	Calibrate the Station Guardian. Place the R.F. POWER switch in the CALIBRATE position and adjust STANDING WAVE RATIO CALIBRATE control for a meter indication of 100 (on the bottom scale).
20	Place the R.F. POWER switch in the SWR position. ***Requirement:*** Forward power 60 watts minimum SWR 1.05 maximum

CHART 6 (Cont)

STEP	PROCEDURE
21	Unkey the transmitter.
22	Replace the cover on the exciter. Close the cabinet and secure all latches. Disconnect the diplexer output from the dummy load and connect the diplexer output to the antenna.
23	Key the transmitter.
24	On the dummy load, set the SWR switch to the ANT position. ***Requirement:*** The Station Guardian meter indicates 45 watts minimum and SWR 1.5 maximum. ***Note:*** In order to pass the RF loopback test, it will be necessary to ***remove*** 5 dB of attenuation from the loopback circuit arrangement using the oscillator-converter variable attenuator (R1).
25	Unkey the transmitter.
26	Remove all test cords and dummy plugs.
27	Notify the control station.

CHART 7

TUBE REPLACEMENT (EXCITER)

Warning: Before replacing any of the vacuum tubes contained in the transmitter, remove all power from the unit so that the transmitter cannot be keyed. Set ON-OFF switch S501 on the station power supply to OFF and discharge the filter capacitors in the transmitter as described in Section 010-110-001.

STEP	PROCEDURE
1	Remove the cover plate from the exciter. Exercise care when removing the cover plate so that meter plug wires are not broken.
	Removal and Replacement of the Third Multiplier and Intermediate Power Amplifier Tubes.
2	To remove the third multiplier and the IPA tubes (V101 and V102), loosen the two holding screws (Fig. 3) holding the tube shield and heat sink to the chassis.

CHART 7 (Cont)

STEP	PROCEDURE
3	Remove the tube shields and then carefully work the tube or tubes from the socket or sockets.
4	To replace the tubes, carefully align the base prongs of the replacement tubes with the correct holes in the tube socket and insert the tube to the full length of travel. Replace the tube shield and heat sink, and secure with the two holding screws.
	Removal and Replacement of Exciter Power Amplifier (PA) Tube
5	Verify that all power is removed from the exciter.
6	Remove the top cover from the amplifier enclosure (Fig. 3). Allow the exciter to cool as necessary.
7	Remove the three plate-line screws (Fig. 7), starting with the two screws nearest the tube socket. Lift off the top section of the plate line.
8	Carefully work the tube out of the socket.
	Caution: Extreme care should be taken during exciter tube replacement to avoid damaging the screen ring contacts.
9	Replace the tube by hand, making certain that the tube is fully seated in the socket. Verify that all screen ring contacts are touching the tube base.
	Note: If necessary, with the tube removed, use a screwdriver to bend the screen ring contacts out toward the center of the tube socket so that ***all*** contacts touch the base of the tube.
10	Replace the plate lines, tightening the screw nearest the heat sink first. Then replace the top cover of the amplifier enclosure.
11	Realign the exciter before restoring the unit to service.

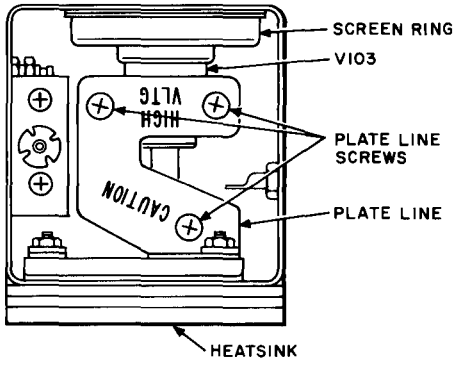

Fig. 7—Power Amplifier Plate Box With Cover Removed

CHART 8

TUBE REPLACEMENT (POWER AMPLIFIER)

It is necessary to remove both the exciter and the power amplifier from service before replacing the power amplifier tube. Permission must be obtained from the control office before removing the station from service. Exercise care when removing and replacing the tube in the power amplifier. The tube and socket contacts are easily damaged.

Warning: Before removing the tube in the power amplifier, remove all power from the exciter and the power amplifier by opening the main power switch on the rear of the auxiliary equipment cabinet so that the unit cannot be keyed. Before removing the high-voltage lead from the power amplifier, discharge the filter capacitors with an insulated grounding stick as described in Section 010-110-001. Do not rely on the interlock device on the cabinet rear door to discharge the 2000-volt power supply.

STEP	PROCEDURE
	Removal of Power Amplifier Tube
1	Remove the high-voltage lead from connector PO-2, located at the rear of the power amplifier.
2	Loosen the screws that hold the rear cover plate to the power amplifier assembly. Remove the rear cover plate.
3	Insert the prongs of the tube extractor between the cooling fins of the power amplifier tube. Rotate the tube 30 degrees counterclockwise; then carefully pull the tube straight out from the socket.
	Caution: Care should be taken during removal of the tube to avoid damage to the tube and socket contacts.
	Replacement of Power Tube
4	Insert the prongs of the tube extractor between the cooling fins of the power amplifier tube. Carefully insert the tube into the socket so that the tube contacts clear the socket contacts.
5	Push the tube all the way into the socket and carefully rotate the tube 30 degrees clockwise.
	Caution: Do not exert excessive pressure while inserting the tube into the socket; too much pressure can damage the contacts of the tube and/or socket.
6	Check filament continuity to make certain that the tube is properly seated by disconnecting PA plug P481 from high-voltage power supply jack J451 and verifying that there is very low resistance between pin 2 of P481 and ground.

CHART 8 (Cont)	
STEP	**PROCEDURE**
7	Replace the rear cover plate of the power amplifier and tighten the screws that hold the cover in place.
8	Restore the high-voltage lead to connector P0-2, located at the rear of the power amplifier.
9	Realign the power amplifier before restoring the station to service.
	Note: Fig. 8, 9, 10, and 11 are included for troubleshooting purposes.

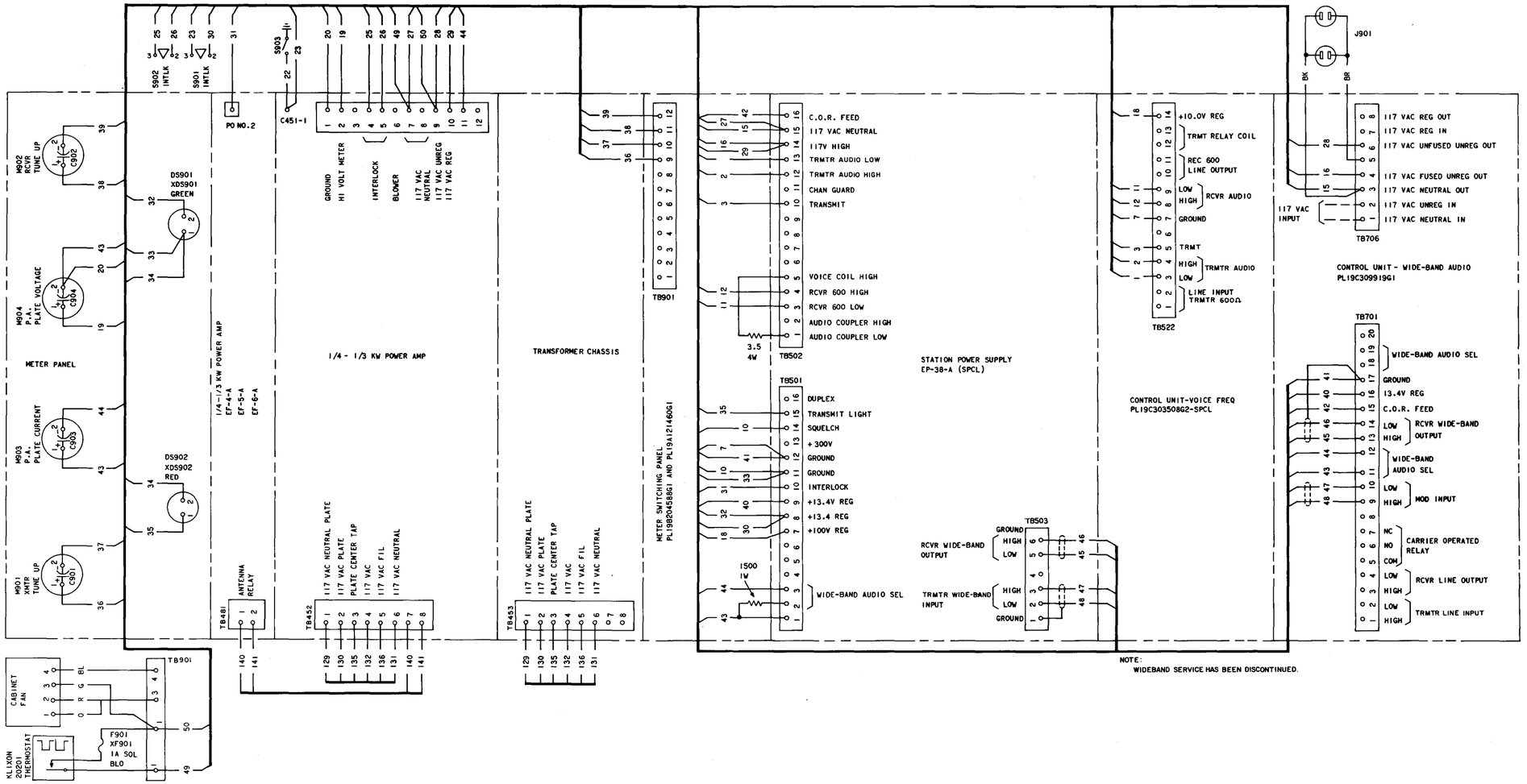

Fig. 8—Interconnection Diagram

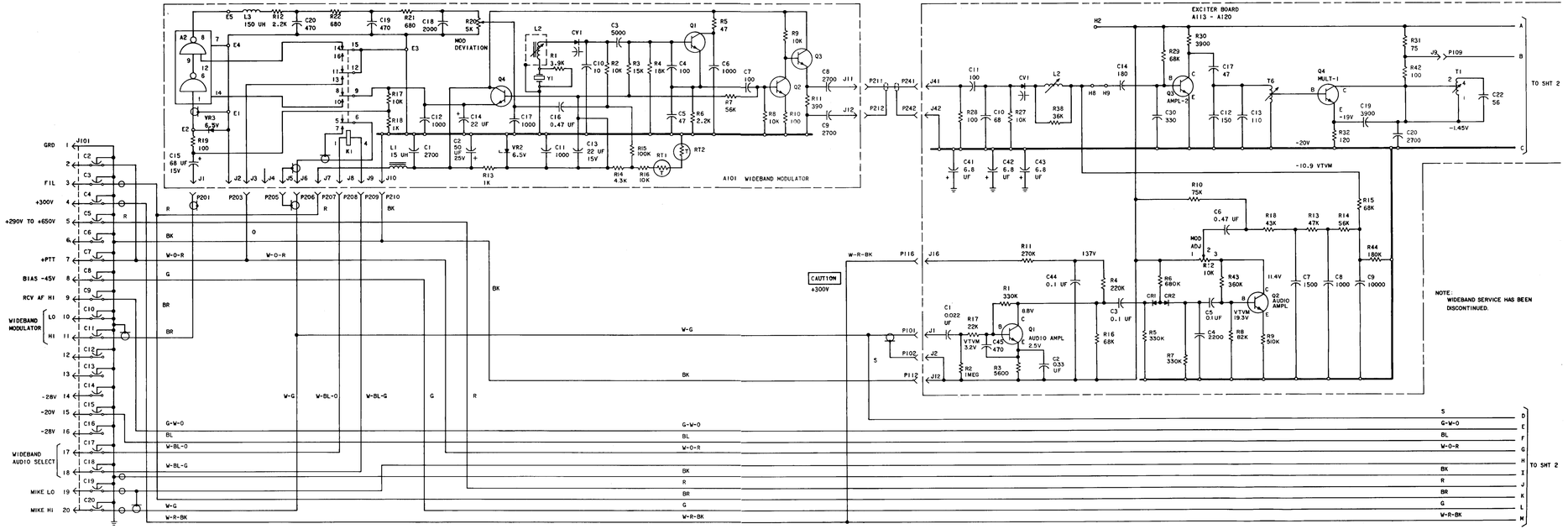

Fig. 9—Transmitter Exciter—Schematic Diagram (Sheet 1 of 2)

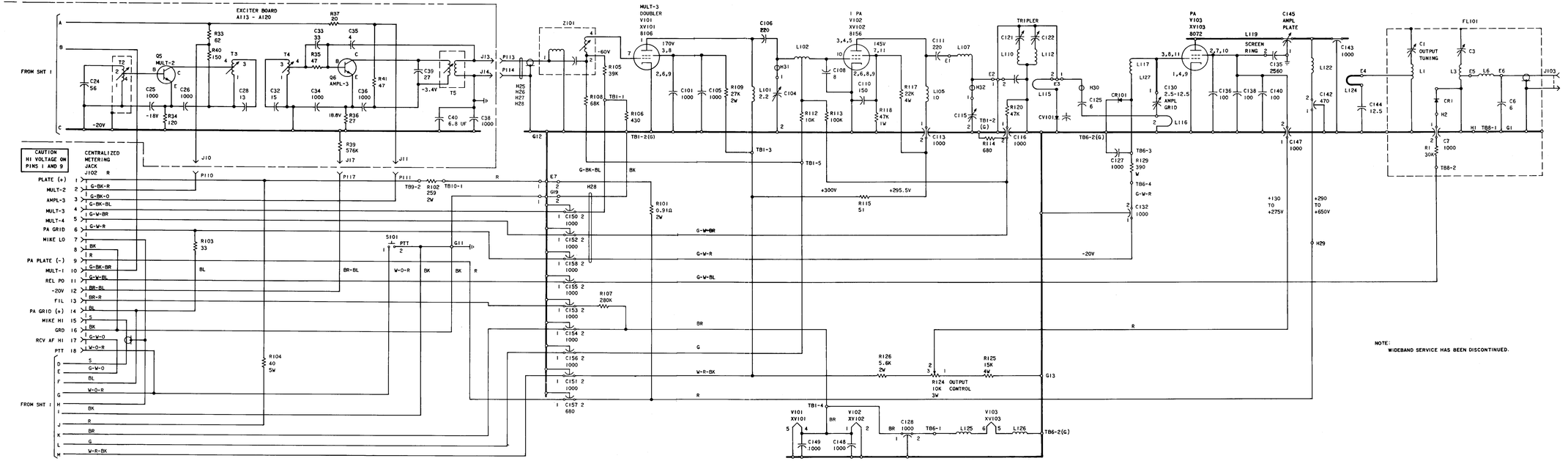

Fig. 9—Transmitter Exciter—Schematic Diagram (Sheet 2 of 2)

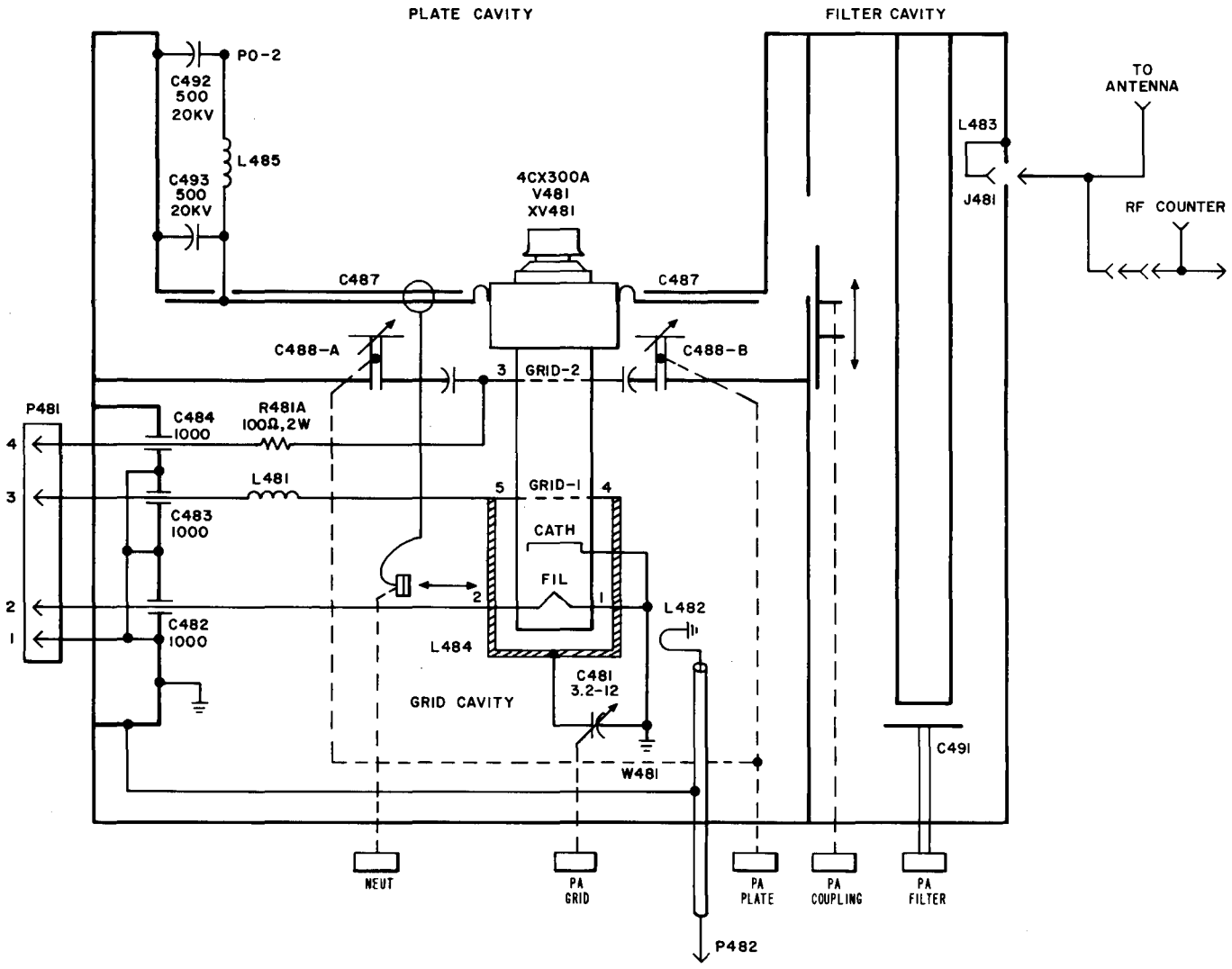

Fig. 10—Power Amplifier—Schematic Diagram

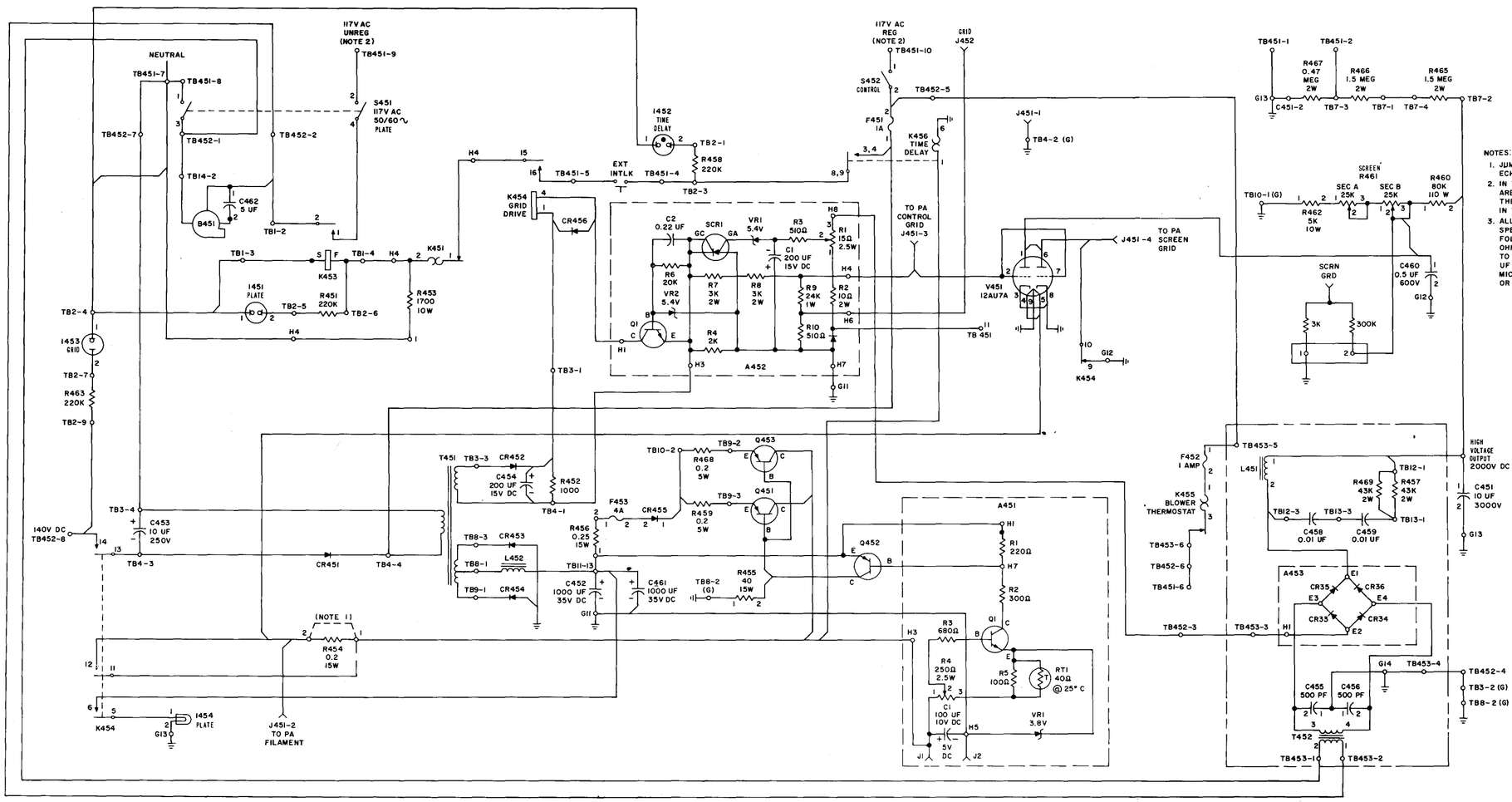

Fig. 11—Power Amplifier Power Supply—Schematic Diagram