TM 11-804

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

RADIO TRANSMITTERS T-208/U and T-417/GR

DEPARTMENT OF THE ARMY • DECEMBER 1954

WARNING

HIGH VOLTAGE

is used in the operation
of this equipment

DEATH ON CONTACT

may result if operating personnel fail
to observe safety precautions

Be careful not to contact high-voltage connections or 115-volt input connections when working on or near this equipment. When working inside the equipment, after the power has been turned off, always short-circuit the high-voltage capacitors.

GPO 829–928–1

TECHNICAL MANUAL
No. 11–804

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *20 December 1954*

RADIO TRANSMITTERS T–208/U AND T–417/GR

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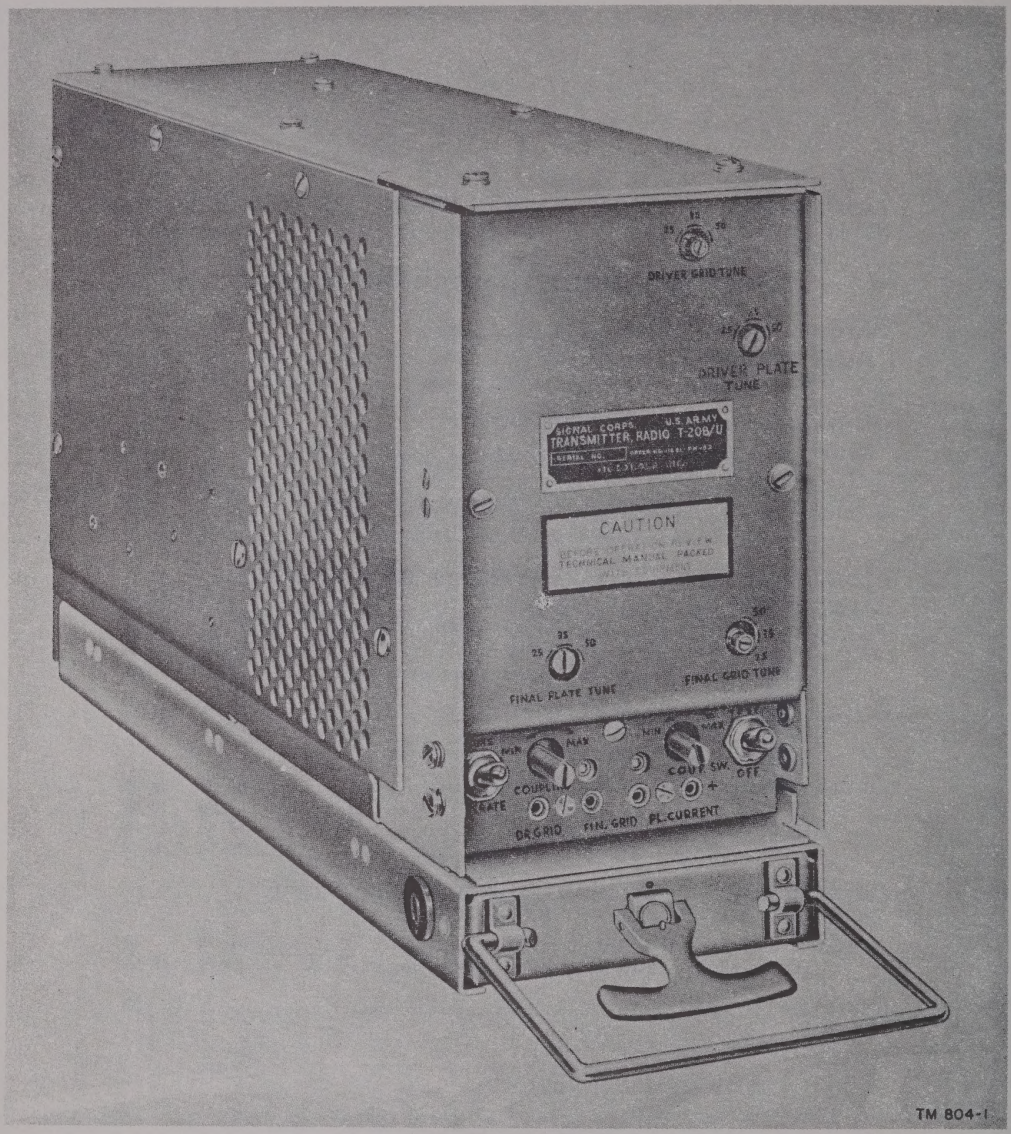


Figure 1. Radio Transmitter T–208/U.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains information for tuning, maintenance, and repair of Radio Transmitters T–208/U and T–417/GR. Official nomenclature followed by (*) is used to indicate all models of the equipment covered in this manual. Thus, Radio Set AN/VRC–6(*) represents Radio Set AN/VRC–6, AN/VRC–6X, or AN/VRC–6Y; Electrical Equipment Cabinet CY–938(*)/VRC represents Electrical Equipment Cabinets CY–938/VRC or CY–938A/VRC; Electrical Equipment Cabinet CY–1221(*)/G represents Electrical Equipment Cabinets CY–1221/G or CY–1221A/G.

b. The two transmitters are discussed simultaneously. Specific differences are shown only when and where appropriate. The word *transmitter* as used throughout this manual applies to either transmitter. A list of nomenclature assignments for some components normally used with the transmitters is given below. A common usage name is indicated after each component.

Nomenclature	Common name
Radio Transmitter T–208/U	Transmitter.
Radio Transmitter T–417/GR	Transmitter.
Electrical Equipment Cabinets CY–938/VRC or CY–938A/VRC.	Cabinet.
Electrical Equipment Cabinets CY–1221/G or CY–1221A/G.	Cabinet.
Radio Set Control C–847/U	Control.
Radio Set Control C–845/U	Control.
Radio Set AN/VRC–6	Radio set.
Radio Set AN/VRC–6X	Radio set.
Radio Set AN/VRC–6Y	Radio set.
Radio Set AN/FRC–15	Radio set.
Radio Set AN/TRC–22	Radio set.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and in performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army), and Navy Shipping Guide, Article 1850–4.

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment—Radio Communication, Direction Finding, Carrier, Radar, will be prepared in accordance with instructions on the back of the form.

d. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Radio Transmitter T–208/U (fig. 1) is a frequency-modulated (fm) radio transmitter designed for mobile use. It has a power output of 25 watts. Radio Transmitter T–417/GR is an fm transmitter operated from a fixed station; it has a power output of 45 watts. Both transmitters are intended for use in system application to provide point-to-point two-way communication or radio relay service by retransmission. These transmitters cover a frequency range of 25 to 50 megacycles (mc). Provision is made for operation on either of two preset crystal-controlled frequencies.

b. Neither transmitter is self-contained but must be used in conjunction with the other units of a system. Radio Transmitter T–208/U is used with Radio Set AN/VRC–6(*). Radio Transmitter 417/GR is used with Radio Sets AN/FRC–15 and AN/TRC–22. When used with Radio Set AN/TRC–22, Radio Transmitter T–417/GR is used as an exciter for Radio Frequency Amplifier AM–495/GR which provides a power output of 250 watts.

4. System Application

(fig. 2)

a. Radio Transmitter T–208/U as Part of Radio Set AN/VRC–6(*).

(1) This application provides simplex, single-channel, two-way voice communication. While the operator at one station is transmitting, his receiver is inoperative and the other station cannot break in. Pressing the push-to-talk switch on the handset operates the transmitter; releasing the switch makes the receiver operative. Only one antenna is used in simplex operation.

(2) The use of separate antennas for the transmitter and the receiver permits radio-relay operation. Signals picked up by the radio receiver at one frequency modulate the transmitter, which then will retransmit the signal on another frequency.

(3) The transmitter is housed in Electrical Equipment Cabinet CY–938(*)/VRC with a transmitter power supply and the complete Radio Receiver R–257/U. Either Dynamotor-Power Supply 93/G, DY–98/G, or DY–100/U is used as the transmitter power supply. These power supplies are intended for mobile operation, and receive their input power from a 12-, 24-, or 6-volt battery. Radio Set Control C–847/U is used to control both the receiver and the transmitter. Push-to-talk operation is provided by Handset H–33D/PT. The power output of this system is 25 watts.

b. Radio Transmitter T–417/GR as Part of Radio Set AN/FRC–15.

(1) This application provides single-channel simplex voice communication, with either local or remote control. Radio-relay operation by retransmission is possible by providing a separate antenna for the radio receiver. The system is designed for fixed station operation.

(2) The use of an additional antenna provides duplex communication between two points. This arrangement uses two operating frequencies. It normally provides one voice channel in each direction. Communication can take place in both directions simultaneously, enabling the operators to talk to each other as in normal conversation. A remote control unit is provided for remote operation.

(3) The transmitter is housed in Electrical Equipment Cabinet CY–1221(*)/G with a transmitter power supply, one complete Radio Receiver R–257/U, and a local control unit. A remote control unit is connected externally. Push-to-talk operation is provided by the handset. The power output of the system is 45 watts.

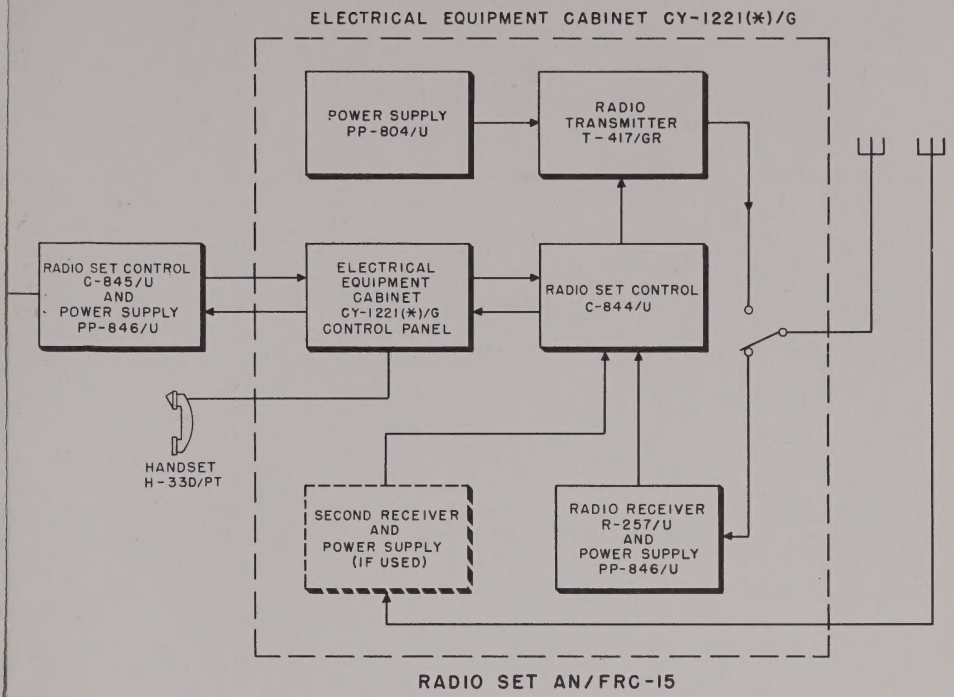
c. Radio Transmitter T–417/GR as Part of Radio Set AN/TRC–22.

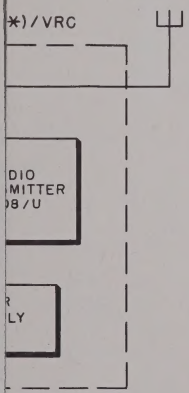
(1) This application is for fixed station operation and provides both simplex and duplex single-channel voice communication with either local or remote control. Radio-relay (facilities) by retransmission are also available.

(2) The transmitter is housed in Electrical Equipment Cabinet CY–1221(*)/G with a transmitter power supply, one complete Radio Receiver R–257/U, and a local control unit. A remote control unit is connected externally. With this system, a radio-frequency (rf) power amplifier (pa.) and its power supply are included to increase the overall power output of the system to 250 watts.

5. Technical Characteristics

Frequency range	25 to 50 mc.
Transmitter type	Crystal-controlled fm.
Distance range	Line of sight.
Type of modulation	Fm, as derived from phase modulation.
Frequency deviation	15 kc deviation for 100 percent modulation at 1,000 cycles.
Type of transmission	Voice.
Number of tubes	13.


ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G
POWER SUPPLY PP-804/U
RADIO TRANSMITTER T-417/GR
RADIO SET CONTROL C-845/U AND POWER SUPPLY PP-846/U
ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G CONTROL PANEL
RADIO SET CONTROL C-844/U
HANDSET H-33D/PT
SECOND RECEIVER AND POWER SUPPLY (IF USED)
RADIO RECEIVER R-257/U AND POWER SUPPLY PP-846/U
RADIO SET AN/FRC-15



ponents.

b. Neither transmitter is self-contained but must be used in conjunction with the other units of a system. Radio Transmitter T–208/U is used with Radio Set AN/VRC–6(*). Radio Transmitter 417/GR is used with Radio Sets AN/FRC–15 and AN/TRC–22. When used with Radio Set AN/TRC–22, Radio Transmitter T–417/GR is used as an exciter for Radio Frequency Amplifier AM–495/GR which provides a power output of 250 watts.

4. System Application

(fig. 2)

a. Radio Transmitter T–208/U as Part of Radio Set AN/VRC–6(*).

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(2) The use of separate antennas for the transmitter and the receiver permits radio-relay operation. Signals picked up by the radio receiver at one frequency modulate the transmitter, which then will retransmit the signal on another frequency.

(3) The transmitter is housed in Electrical Equipment Cabinet CY–938(*)/VRC with a transmitter power supply and the complete Radio Receiver R–257/U. Either Dynamotor-Power Supply 93/G, DY–98/G, or DY–100/U is used as the transmitter power supply. These power supplies are intended for mobile operation, and receive their input power from a 12-, 24-, or 6-volt battery. Radio Set Control C–847/U is used to control both the receiver and the transmitter. Push-to-talk operation is provided by Handset H–33D/PT. The power output of this system is 25 watts.

b. Radio Transmitter T–417/GR as Part of Radio Set AN/FRC–15.

(1) This application provides single-channel simplex voice communication, with either local or remote control. Radio-relay operation by retransmission is possible by providing a separate antenna for the radio receiver. The system is designed for fixed station operation.

(2) The use of an additional antenna provides duplex communication between two points. This arrangement uses two operating frequencies. It normally provides one voice channel in each direction. Communication can take place in both directions simultaneously, enabling the operators to talk to each other as in normal conversation. A remote control unit is provided for remote operation.

(3) The transmitter is housed in Electrical Equipment Cabinet CY–1221(*)/G with a transmitter power supply, one complete Radio Receiver R–257/U, and a local control unit. A remote control unit is connected externally. Push-to-talk operation is provided by the handset. The power output of the system is 45 watts.

c. Radio Transmitter T–417/GR as Part of Radio Set AN/TRC–22.

(1) This application is for fixed station operation and provides both simplex and duplex single-channel voice communication with either local or remote control. Radio-relay (facilities) by retransmission are also available.

(2) The transmitter is housed in Electrical Equipment Cabinet CY–1221(*)/G with a transmitter power supply, one complete Radio Receiver R–257/U, and a local control unit. A remote control unit is connected externally. With this system, a radio-frequency (rf) power amplifier (pa.) and its power supply are included to increase the overall power output of the system to 250 watts.

5. Technical Characteristics

Frequency range	25 to 50 mc.
Transmitter type	Crystal-controlled fm.
Distance range	Line of sight.
Type of modulation	Fm, as derived from phase modulation.
Frequency deviation	15 kc deviation for 100 percent modulation at 1,000 cycles.
Type of transmission	Voice.
Number of tubes	13.

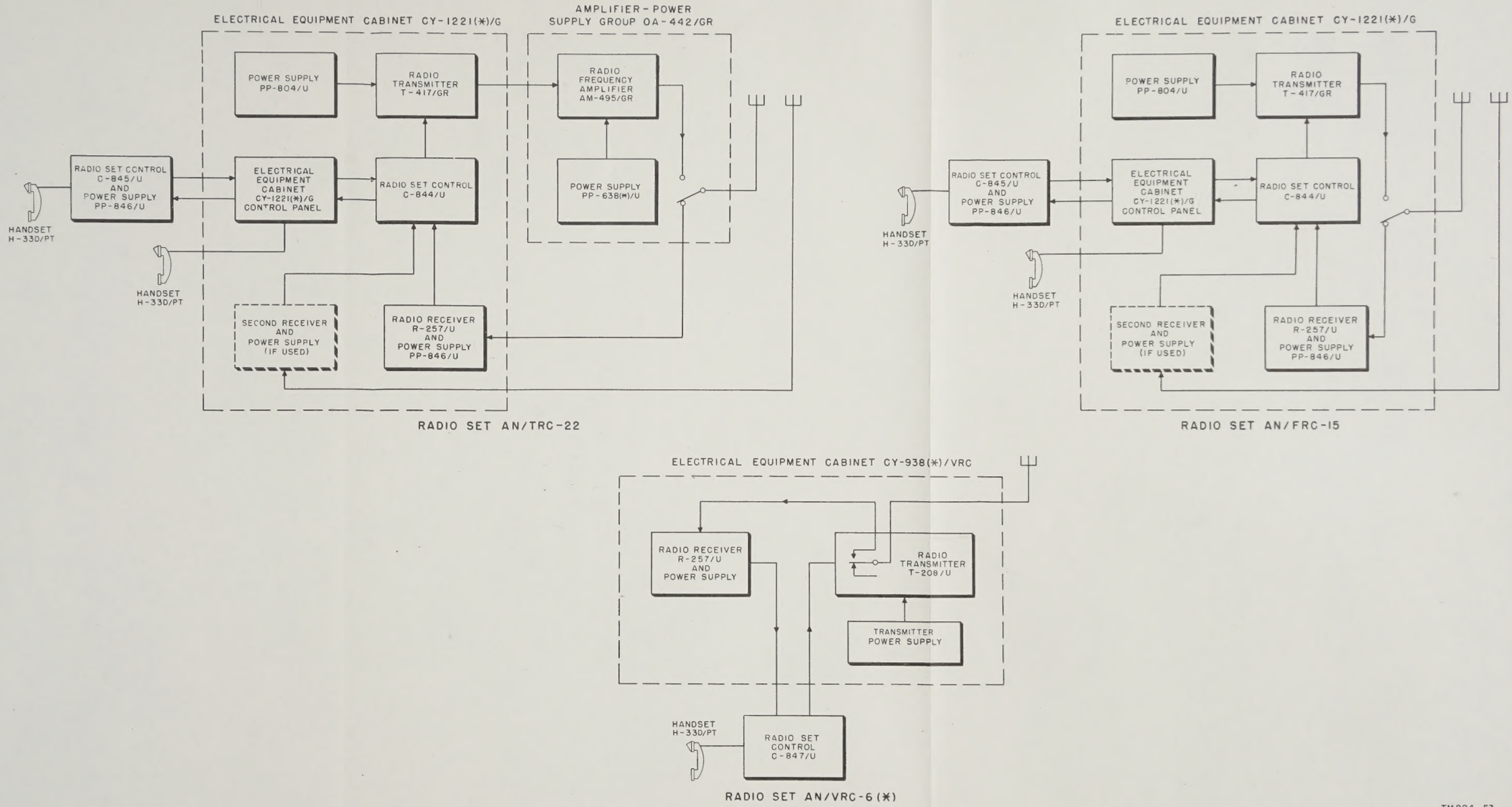
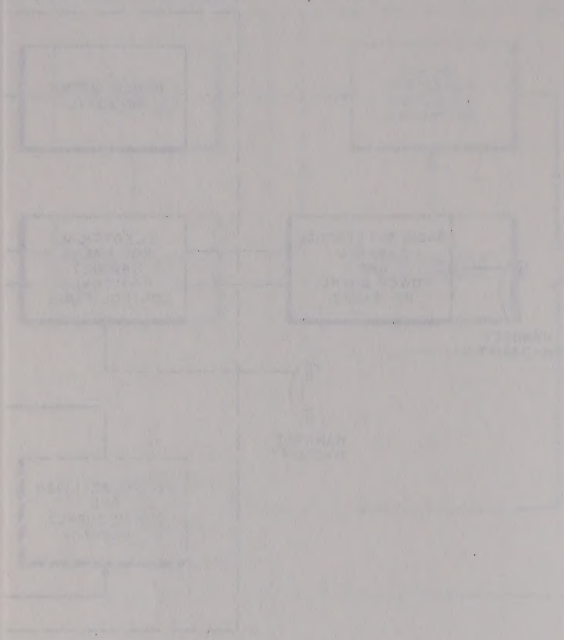


Figure 2. Radio Sets AN/VRC-6, AN/FRC-15, and AN/TRC-22, major components.



Crystals:	
Type	Quartz Crystal Unit CR–27/U, calibrated for 32-$\mu\mu$f circuit.
Frequency range	1562.5 to 3125 kc.
Multiplication in transmitter	16 times on all frequencies.
Dual frequency operation	Maximum of 250 kc between operating frequencies.
Output impedance	50 ohms into coaxial cable.
Audio input:	
Carbon microphone	100 mv for 100 percent modulation at 1,000 cycles.
600-ohm line input	200 mv for 100 percent modulation at 1,000 cycles.
Spurious emission	Attenuated at least 70 db below carrier.
Antenna	¼ wavelength vertical.
Weight, unmounted	8½ lb.
Power supply (T–208/U)	Dynamotor-Power Supply DY–93/G, DY–98/G, or DY–100/U.
Power output (T–208/U)	25 watts.
Power supply (T–417/GR)	External ac operated Power Supply PP–804/U.
Power output (T–417/GR)	45 watts.

6. Packaging Data

The transmitters are mounted in either Electrical Equipment Cabinet CY–938(*)/VRC or CY–1221(*)/G, depending on the system application (par. 4). When packaged for export shipment, the cabinet is placed in a moisture-vaporproof container and then is packed in a wooden export crate. The wooden crate varies in size, depending on the system.

7. Description of Transmitters

a. Radio Transmitters T–208/U and T–417/GR are crystal-controlled fm transmitters, capable of operation in the 25- to 50-mc frequency range. Dual frequency operation permits a choice of either of two preset operating frequencies.

b. The phase-shift method is used to obtain the desired frequency deviation. This permits direct crystal control of the carrier frequency. The circuit is designed for a maximum frequency deviation of 18 kilocycles (kc). At 12-kc deviation, the distortion is less than 10 percent.

c. The transmitters are designed as plug-in units to function as a component of a system. As such, they are mounted in waterproof cabinets with other system components. All conections to the transmitters are made through a single connector mounted in the cabinet. The transmitters are dependent on other system components for power and control.

d. The front panels of the transmitters provide controls for tuning, and test point jacks to provide a means of connecting a meter for visual indication during the tuning procedure. Overall dimensions of the transmitters are 8½ inches high, 4½ inches wide, and 14½ inches deep.

8. Spare Parts

Spare parts are supplied with each system for all normally expendable items such as tubes, fuses, pilot lamps, and vibrators. Consult the system manual for a list of running spares supplied with each radio set.

9. Additional Equipment Required

Since both transmitters are dependent on other system components for power and control, it will be necessary to provide the components listed below for normal operation.

a. Radio Set AN/VRC—6(*).
- Radio Receiver R–257/U with
  - Power Supply PP–867/U (Radio Set AN/VRC–6) (24 volts) or
  - Power Supply PP–868/U (Radio Set AN/VRC–6X) (12 volts) or
  - Power Supply PP–869/U (Radio Set AN/VRC—6Y) (6 volts)
- Radio Transmitter T–208/U with
  - Dynamotor-Power Supply DY–98/G (Radio Set AN/VRC—6) (24 volts) or
  - Dynamotor-Power Supply DY–93/G (Radio Set AN/VRC–6X) (12 volts) or
  - Dynamotor-Power Supply DY–100/U (Radio Set AN/VRC–6Y) (6 volts)
- Radio Set Control C–847/U
- Handset H–33D/PT
- Electrical Equipment Cabinet CY–938(*)/VRC

b. Radio Set AN/FRC–15.
- Radio Receiver R–257/U
- Power Supply PP–846/U (two required)
- Radio Set Control C–845/U
- Radio Transmitter T–417/GR
- Power Supply PP–804/U

Handset H–33D/PT
Electrical Equipment Cabinet CY–1221(*)/G
Radio set Control C–844/U

c. Radio Set AN/TRC–22. All components required for Radio Set AN/FRC–15 and in addition the following:

Radio Frequency Amplifier AM–495/GR
Power Supply PP–638(*)/U

Note. The combination of the AM–495/GR and the PP–638/U is known as Amplifier-Power Supply Group OA–441/GR.

10. Differences in Models

Radio Transmitters T–208/U and T–417/GR are exactly the same externally. Internally, they are also the same, except for the following:

Radio Transmitter T–208/U uses tube type 2E24 for the driver-doubler stage and Radio Transmitter T–417/GR uses tube type 2E26 for this stage.

Radio Transmitter T–208/U uses 2E24 type tubes for the power amplifier stages, and Radio Transmitter T–417/GR uses 6146 type tubes for these stages.

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

11. Siting

Siting instructions are discussed in the radio set system manual. Read the siting instructions thoroughly before attempting to place the equipment.

12. Uncrating, Unpacking, and Checking New Equipment

a. Remove all the packing material from the cabinet that contains the transmitter.

b. Release the latches that hold the front cover on the cabinet and remove the cover.

c. Release the transmitter from the cabinet by turning the hold-in lock counterclockwise (fig. 29). This action will start to move the transmitter out of the cabinet and should be continued until further movement of the transmitter stops. The transmitter then may be pulled out of the cabinet, using the handle located on the front panel.

d. Inspect the pins on the plug located behind the transmitter (fig. 4), to be certain that none have been bent or damaged in shipment.

e. Remove the right and left side dust covers from the transmitter to check for damaged tubes, resistors, broken leads, bent parts, etc. See that all tubes are seated firmly in their proper sockets (fig. 3).

f. Check all fuses for value and condition (par. 20).

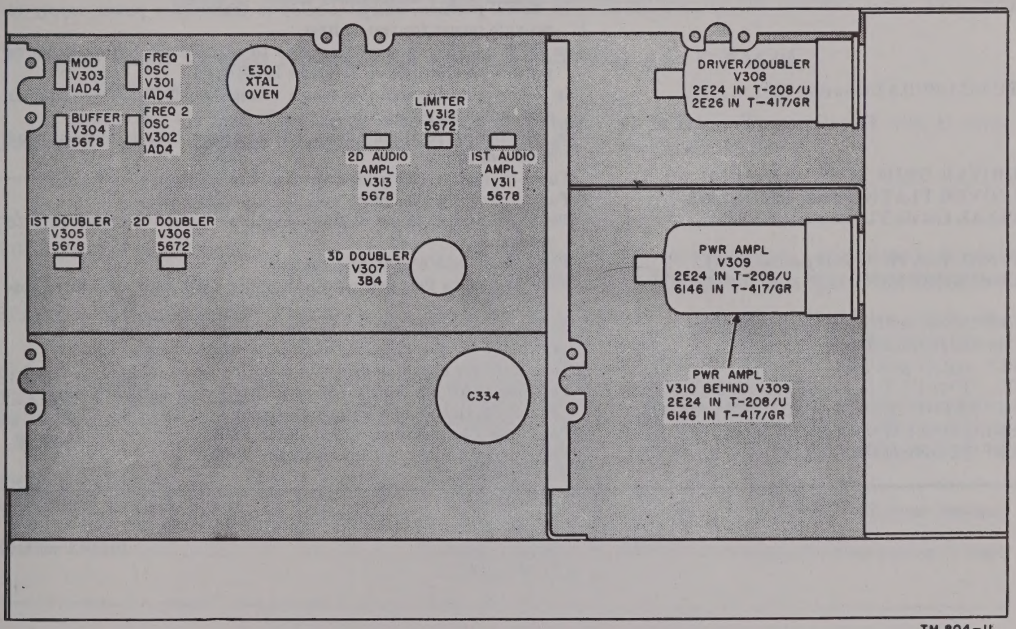


Figure 3. Transmitter tube locations.

13. Installation of Transmitter

a. After checking the transmitter, reassemble the dust covers and slide the transmitter on the guide rails in the cabinet.

b. Push back firmly without forcing or bumping the transmitter against the back of the cabinet.

c. Turn the hold-in lock clockwise until the transmitter is seated securely in place. This action will engage plug P301 on the back of Radio Transmitter T–208/U to jack J801 of Cabinet CY–938 (*)/VRC. In Radio Transmitter T–417/GR, plug P301 makes contact with jack J1904 of Electrical Equipment Cabinet CY–1221(*)/G.

14. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 12 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in wiring of the equipment. If any changes have been made, note the changes in this instruction book, preferably on the schematic diagrams. If no tags are found, make the operational test described in paragraph 41*e* to ascertain that the equipment is functioning properly.

c. Perform the installation procedure outlined in paragraph 13.

Section II. CONTROLS AND INSTRUMENTS

15. Controls and Their Uses

Haphazard operation or improper setting of the controls can cause damage to the transmitter. For this reason, it is important to know the function of every control. Adjustment of all controls is discussed in paragraphs 18 and 19.

16. Controls on Radio Transmitters T–208/U and T–417/GR

(figs 4, 11, and 13)

Control	Function
TEST-OFF switch S301	In TEST position, energizes relay in transmitter power supply to provide power for transmitter.
	In OFF position, power is applied to transmitter by operation of push-to-talk switch on Handset H–33D/PT.
TUNE-OPERATE switch S302	In TUNE position, reduces screen voltage applied to driver/doubler and power-amplifier tubes.
	In OPERATE position, allows normal screen voltage to be applied to above tubes.
DRIVER GRID TUNE control C337	Tunes driver/doubler grid tank circuit to resonance.
DRIVER PLATE TUNE control C343	Tunes driver/doubler plate tank circuit to resonance.
FINAL GRID TUNE control C345	Tunes grid tank circuit of power-amplifier tubes V309 and V310 to resonance.
FINAL PLATE TUNE control C354	Tunes final tank circuit to resonance.
COUPLING MIN-MAX control C355	Varies coupling between power-amplifier plate tank and filter network.
COUP. SW. MIN-MAX control S303	Acts as loading adjustment in conjunction with C355.
DR. GRID jack J304	Test point for checking grid voltage of driver/doubler stage.
FIN. GRID jack J305	Test point for checking grid voltage of power-amplifier.
PL. CURRENT jacks J306 and J307	Test points for checking plate current of power-amplifier stage.
DEVIATION LEVEL control R354 (fig. 11)	Controls deviation of transmitted signal.
FREQ 1 control C304 (fig. 13)	Fine tuning adjustment for oscillator V301.
FREQ 2 control C303 (fig. 13)	Fine tuning adjustment for oscillator V302.

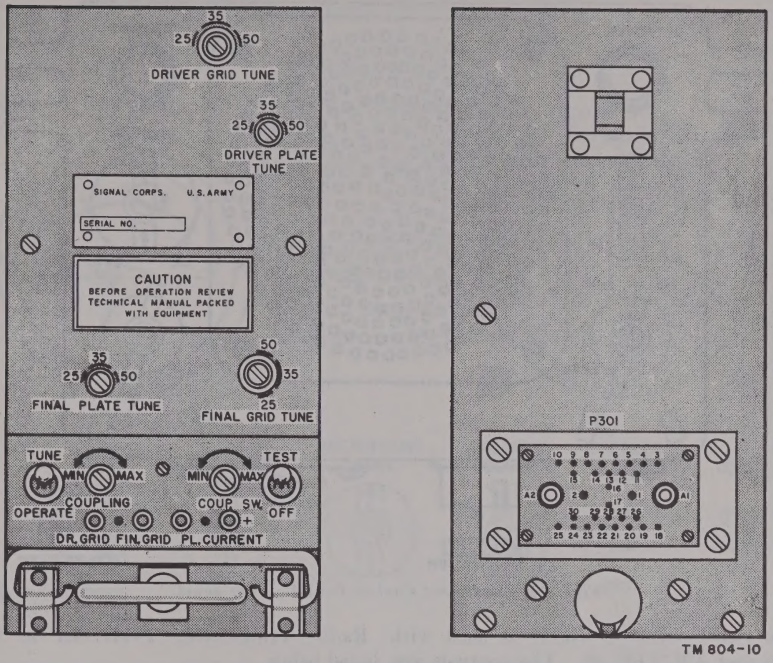


Figure 4. Radio Transmitter T–208/U or T–417/GR, controls and test points.

17. Front Panel Controls on Radio Set Controls C–847/U and C–845/U

(figs. 5 and 6)

a. Radio Set Control C–847/U is necessary for the operation of Radio Transmitter T–208/U with Radio SET AN/VRC–6(*). Controls and their functions are listed below.

Control	Function
VOLUME-OFF switch S1501	Turns on power to radio set and controls volume level to handset and speaker through attenuator pad. Four volume levels are available.
SPKR ON-OFF switch S1502	Connects speaker in ON position. In OFF position, disconnects speaker and replaces it with loading resistor. Switch is spring loaded and must be held in OFF position.
POWER indicator I 1501	Indicates that power is applied to receiver.
TRANSMIT indicator I 1502	Indicates that transmitter is in operation and receiver is disabled.
SQUELCH ON-OFF control R1509 and switch S1504.	Disables receiver squelch circuit with the SQUELCH control in OFF position. In other positions control sets *threshold* of squelch operation.
FREQ 1–2 switch S1503	Selects either of two preset transmitter frequencies.
HANDSET connector J1501	Located on bottom of control unit; provides connections between handset and radio set.
Speaker LS1501	Enables operator to hear incoming signals without having to hold handset to his ear.

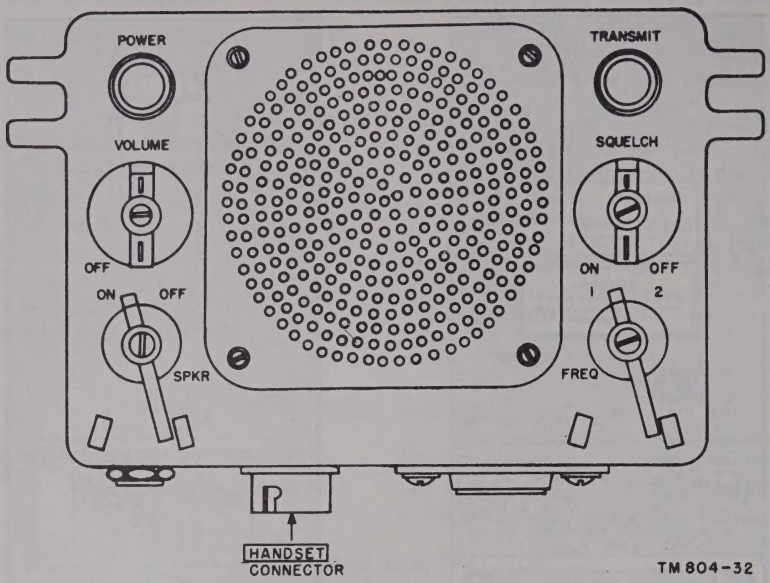


Figure 5. Radio Set Control C–847U, front panel.

b. Radio Set Control C–845/U is used with Radio Transmitter T–417/GR in Radio Sets AN/FRC–15 and AN/TRC–22. The controls are listed below.

Control	Function
LINE LEVEL meter M2601	Indicates outgoing audio signal levels across 600-ohm line. Scale indicates from −10 to +6db. Red line marks −2-db reading to facilitate setting audio level to correct voltage.
POWER pilot lamp I 2602	Indicates that power is being supplied to control.
TRANSMIT pilot lamp I 2601	Lights when push-to-talk handset switch is closed. INTERCOM. switch must be in either FREQ. 1 REC. 1 or FREQ. 2 REC. 1 and 2 position.
HANDSET jack J2601	Handset H-33D/PT connecting jack.
INTERCOM.-FREQ. 1 REC. 1-FREQ. 2 REC. 1 and 2 switch S2602.	Switch has three positions: *Position* — *Function* FREQ. 1 REC. 1 — Places transmitter on frequency No. 1 and connects receiver 1. INTERCOM. — Permits intercommunication. FREQ. 2 REC. 1 and 2. — Transmitter is placed on the No. 2 operating frequency and both receivers are energized.
MICROPHONE LEVEL control R2633	Adjusts handset microphone level to audio line to maintain proper modulation at the transmitter.
SPEAKER VOLUME-OFF control S2603B and switch S2603A.	One section controls power to control power supply, and other varies speaker and handset volume level in steps. There are four steps of control.
SPEAKER ON-OFF switch S2604	Allows operator to mute speaker by placing switch in OFF position. Switch is springloaded and will return to ON position when-released.
TONE switch S2601	When TONE switch is depressed, tone signal of 1,000 cps is sent through amplifier. It can be used to attract attention or to test control for proper operation and set audio level to the transmitter.
Speaker LS2601	Provided for monitoring purposes.

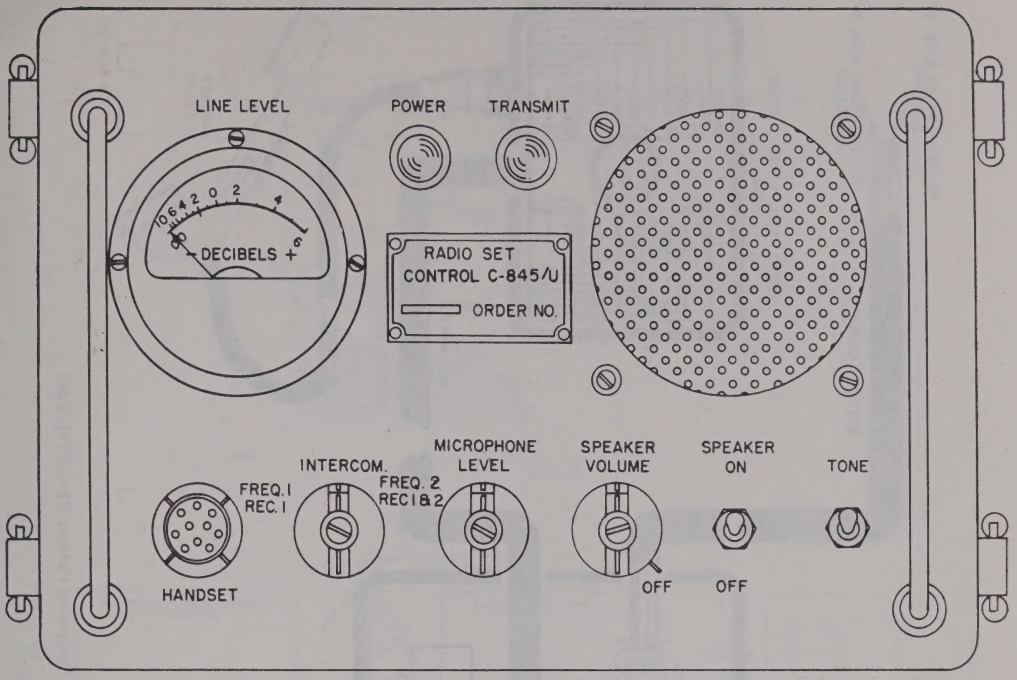


Figure 6. Radio Set Control C–845/U, front panel.

Section III. PRELIMINARY ADJUSTMENTS AND TUNING

18. Preliminary Adjustment of Radio Transmitters T–208/U and T–417/GR

Note. The following procedures for adjusting and tuning the transmitter should be performed by second (or higher) echelon maintenance personnel. Before attempting to tune the transmitter, it will be necessary to perform the following steps:

a. Connect the equipments as indicated in figure 7 or 8.

b. Release the transmitter from the cabinet by turning the hold-in lock counterclockwise. The transmitter then may be pulled out by using the handle located on the front panel.

c. Remove the right and left side dust covers from the transmitter and check to see that all tubes are in place.

d. Connect the patch cord (fig. 8) from the transmitter jack in the cabinet to the plug at the rear of the transmitter (fig. 4). The patch cord is not supplied with the equipment but must be requisitioned through supply channels.

e. Determine the correct crystal frequency. Crystal Units CR–27/U are used. The two preset operating frequencies of the transmitter may not differ by more than 250 kc and must fall in the operating range of the same final tank coil. After selecting two operating frequencies that meet this requirement, choose the correct crystal frequency by means of the following formula:

$$\text{Crystal frequency} = \frac{\text{operating frequency}}{16}.$$

Example:

F_1 = desired operating frequency = 30 mc

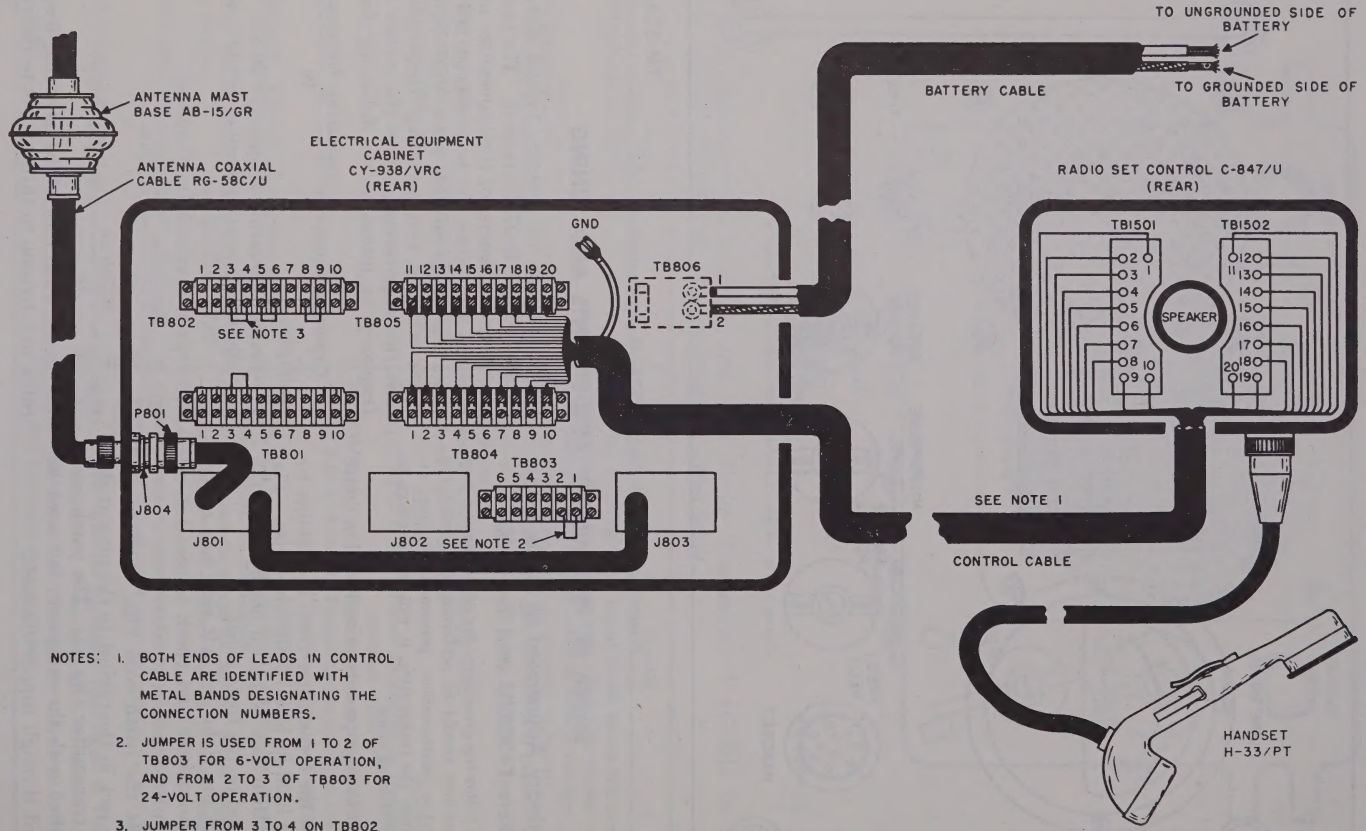
F_2 = alternate operating frequency = 30 ± .25 mc = 29.75 or 30.25 mc

F_c = crystal fundamental frequency

$$F_c = \frac{F_1}{16} = \frac{30{,}000 \text{ kc}}{16} = 1{,}875.000 \text{ kc}$$

$$F_c = \frac{F_2}{16} = \frac{29{,}750 \text{ kc}}{16} = 1{,}859.375 \text{ kc}.$$

To maintain accuracy of the operating frequency, carry out division to three places to the right of



NOTES:
1. BOTH ENDS OF LEADS IN CONTROL CABLE ARE IDENTIFIED WITH METAL BANDS DESIGNATING THE CONNECTION NUMBERS.
2. JUMPER IS USED FROM 1 TO 2 OF TB803 FOR 6-VOLT OPERATION, AND FROM 2 TO 3 OF TB803 FOR 24-VOLT OPERATION.
3. JUMPER FROM 3 TO 4 ON TB802 IS USED FOR 12-VOLT OPERATION.

Figure 7. Connections for Electrical Equipment Cabinet CY-938(*)/VRC.

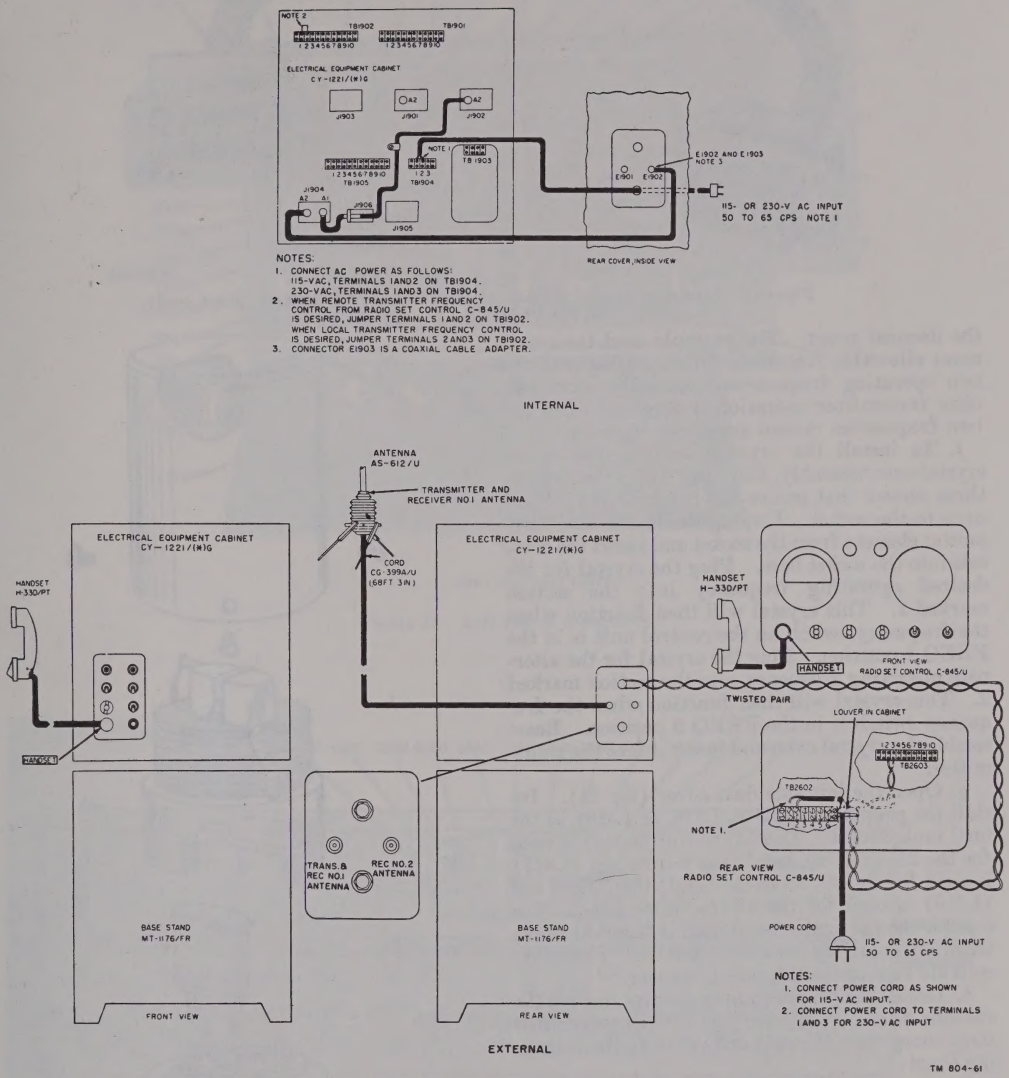


Figure 8. Connections for Electrical Equipment Cabinet CY-1221(*)/G.

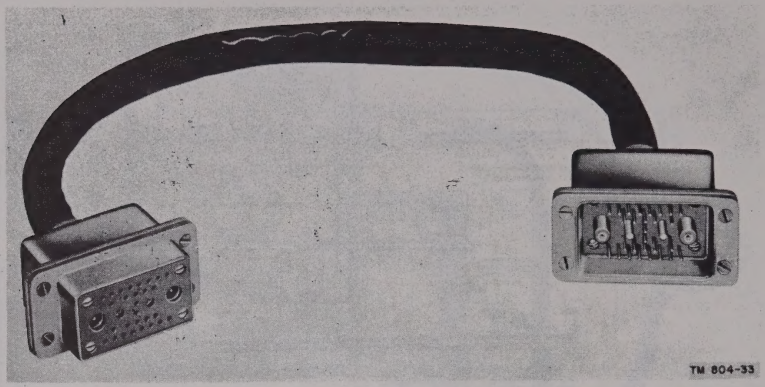


Figure 9. Electrical Special Purpose Cable Assembly CX–2371/U (patch cord).

the decimal point. The example used the maximum allowable frequency difference between the two operating frequencies. Actually, more efficient transmitter operation is obtained when the two frequencies chosen are closer together.

f. To install the crystals, unplug the entire crystal oven assembly, E301 (fig. 10). Remove the three screws that secure the cover of the crystal oven to the socket. Unplug the heater and thermostat element from the socket and insert the crystals into the socket base. Plug the crystal for the desired operating frequency into the section marked 1. This crystal will then function when the frequency switch on the control unit is in the FREQ 1 position. Plug the crystal for the alternate operating frequency into the section marked 2. This crystal will then function when the frequency switch is in the FREQ 2 position. Reassemble the crystal oven and insert it into the transmitter.

g. Open the left side dust cover (fig. 11). Install the proper coil (L316, L317, or L319) in the final tank circuit. The 9-turn coil (L319) is used for the 25- to 32-mc band; the 6-turn coil (L317) is used for the 32- to 40-mc band; the 5-turn coil (L316) is used for the 40- to 50-mc band. The coil for the particular band used is fastened to the terminal board by two 6–32 screws. The other coils are kept on the left side dust cover.

h. Install the proper jumper connections for the antenna filter. Solder the jumpers to the terminal strip connecters (fig. 12) according to the following chart:

Freq (mc)	Antenna filter connections		
	Strap		
25 to 32	2 to 3	4 to 6	9 to 8
	2 to 1	4 to 5	9 to 10
32 to 40	2 to 3	4 to 6	9 to 8
40 to 50	2 to 1	4 to 5	9 to 10

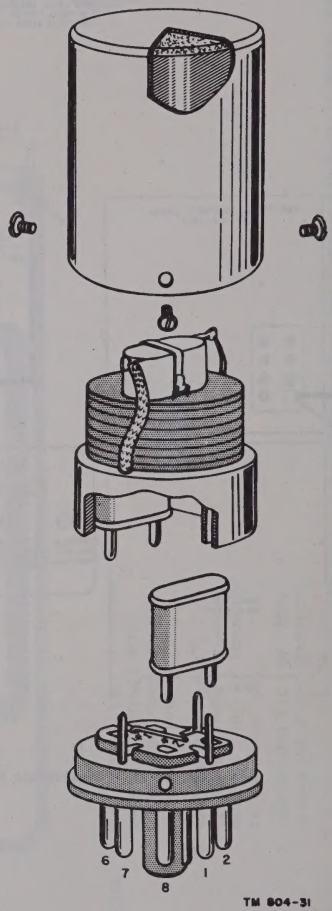


Figure 10. Transmitter crystal oven, exploded view.

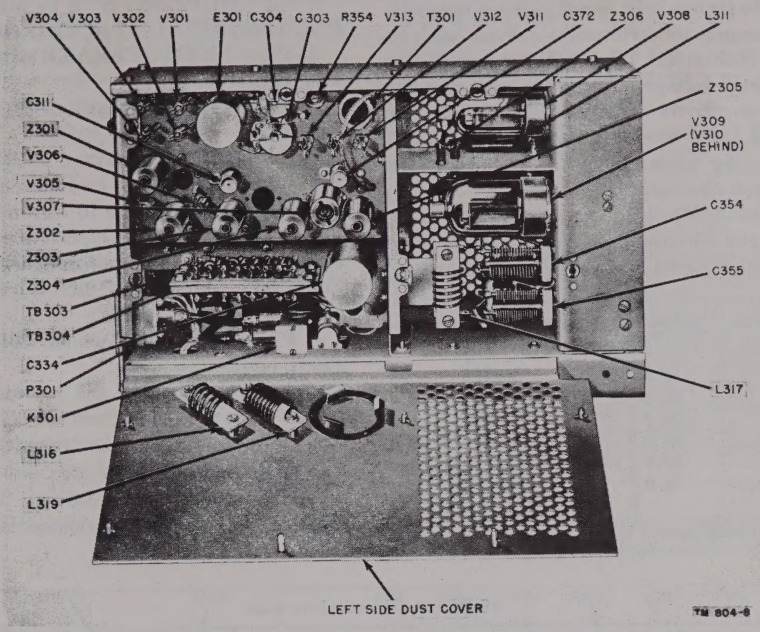


Figure 11. Left side of transmitter.

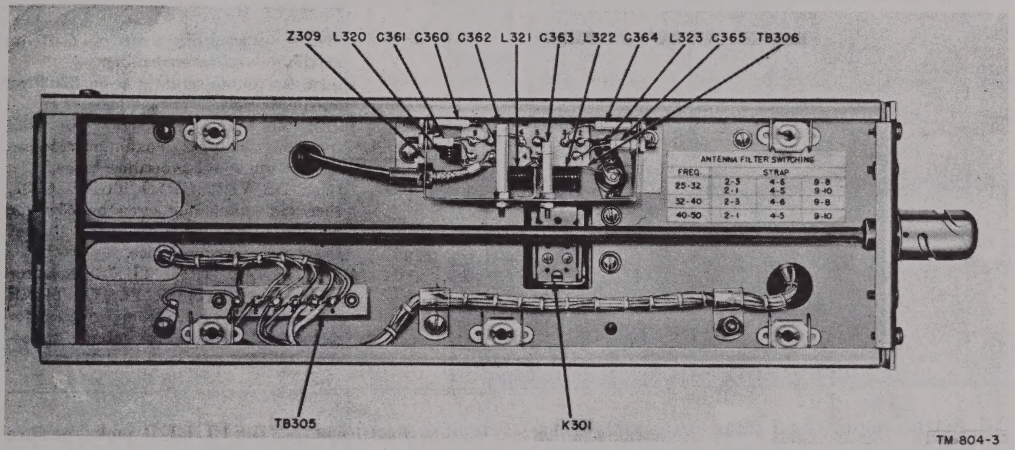


Figure 12. Bottom view of transmitter.

19. Tuning Radio Transmitters T–208/U or T–417/GR

To tune the transmitter, two meters are required. One is a vacuum tube voltmeter (vtvm) such as Electronic Multimeter TS–505/U (or equal) for measuring grid voltage. The other is a voltmeter that has a sensitivity of at least 1,000 ohms per volt, such as Multimeter TS–297/U or TS–352/U for determining plate current. Refer to figure 13 for test and alinement points.

a. Set tuning adjusting screws of Z301, Z302, Z303, Z304, and Z305 to the approximate operating frequency as indicated by the following chart:

Core position in 16ths of an inch [1]	Final output in mc	Core position in 16ths of an inch [1]	Final output in mc
2	25. 0	8	37. 5
3	26. 5	9	40. 0
4	28. 0	10	45. 0
5	30. 0	11	48. 0
6	32. 5	12	50. 0
7	35. 0		

[1] Core position is measured from the top of the tension unit to the top of the slug screw.

b. Set the tuning controls on the front panel to the approximate frequency.

c. Set COUP. SW. S303 to MIN and COUPLING capacitor C355 to MIN coupling.

d. Place TUNE-OPERATE switch S302 in the TUNE position.

e. Place TEST-OFF switch S301 in the OFF position.

f. For Radio Transmitter T–208/U, turn the VOLUME-OFF switch on Radio Set Control C–847/U (fig. 5) clockwise to turn on power. For Radio Transmitter T–417/GR place the MAIN POWER switch on the control panel of Electrical Equipment Cabinet CY–1221(*)/G in the ON position.

g. Place TEST–OFF switch S301 (fig. 13) in TEST position.

h. After the steps in the preceeding subparagraphs have been made, use the following charts and the vtvm to tune the transmitter properly. The maximum reading should be within 20 percent of the listed normal reading. If it cannot be obtained refer to the troubleshooting section of this manual.

Tuning the multiplier and driver stages

Test point	Normal reading (volts)						Adjustment
	T–208/U			T–417/GR			
	25–33 mc	33–41 mc	41–50 mc	25–33 mc	33–41 mc	41–50 mc	
J301	−23	−22	−18	−20	−19	−17	Adjust the tuning screw slug on Z301 for maximum voltmeter reading.
J302	−25	−25	−24	−23	−23	−23	Adjust the tuning screw slug on Z302 for maximum voltmeter reading.
J303	−18	−20	−24	−18	−21	−24	Adjust the tuning slug screw on Z303, then on Z304 for maximum reading. Repeat the above procedure twice.
DR GRID (J304)	−42	−60	−71	−37	−55	−59	Adjust DRIVER GRID TUNE C337, then the tuning slug screw on Z305 for maximum voltmeter reading. Repeat the above procedure twice.
FIN GRID (J305)	−61	−72	−68	−53	−66	−64	Adjust FINAL GRID TUNE capacitor C345, then DRIVER PLATE TUNE capacitor C343 for maximum voltmeter deflection. Repeat the above procedure twice.

i. For tuning the final stage, use a 1,000-ohms-per-volt (or higher) voltmeter, with leads inserted in J306 and J307.

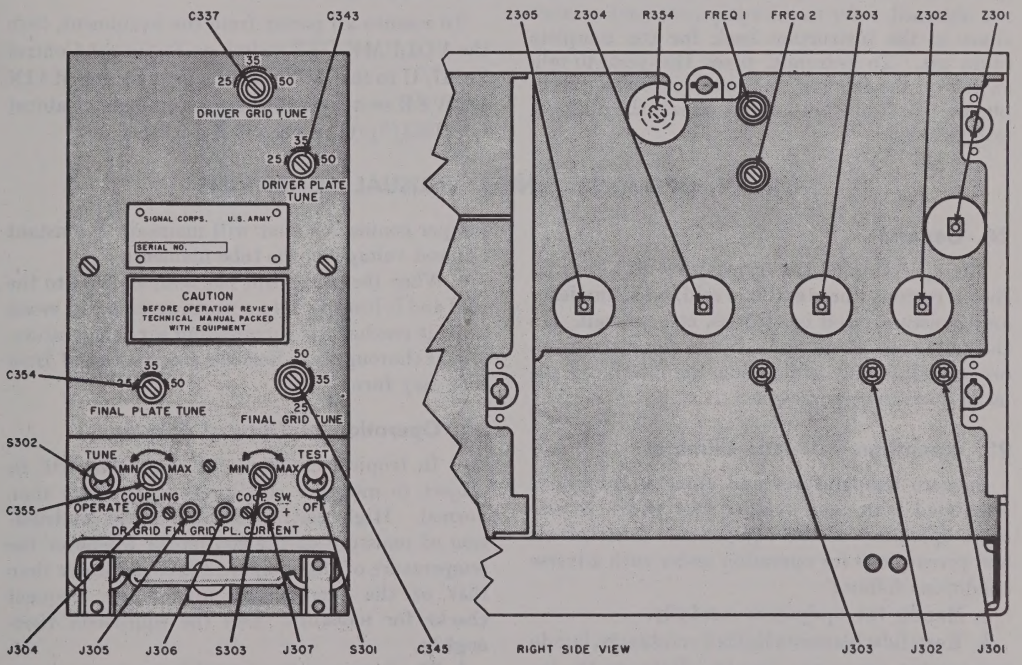
Caution: If a voltmeter with a metal case is used to measure across the PL CUR jacks, be sure to insulate the case from the equipment chassis (ground). Both jacks are at a high positive potential. Do not touch the voltmeter while making measurements.

Tuning the final stage

Voltmeter selector switch	Test point		Normal reading (volts)		Adjustment
	From—	To—	T-208/U	T-417/GR	
0–5 volts dc	PL. CURRENT (J306).	PL. CURRENT + (J307).	1. 5	2	Adjust C354 for minimum voltmeter reading. With S303 at MIN, adjust COUPLING capacitor C355 until maximum reading is obtained. Place TUNE-OPERATE switch in OPERATE position. Readjust C354 for minimum reading and again C355 for maximum reading. If it cannot be obtained, or if reading is too low, turn S303 to a position one above MIN and repeat above procedure. Continue turning S303 towards MAX until proper reading is obtained. Last adjustment always is capacitor C354 for minimum.

j. Turn the TEST-OFF switch to the OFF position.

k. Disconnect the meters, reassemble the dust covers, and install the transmitter in the cabinet.



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Figure 13. Test points and alinement locations.

Section IV. OPERATION UNDER USUAL CONDITIONS

20. Preliminary Starting Procedure

Before attempting to operate the equipment, check all cable connections and fuses. Failure to do so will result in improper equipment performance or equipment damage. Refer to figure 7 or 8 for the proper cable connections and to the following chart for fuse values:

Fuse	Value	Location
F801	50 amperes	CY–938(*)/VRC.
F1201, F3101, or F1302	15 amperes, 10 amperes, or 6 amperes, respectively.	DY–100/U, DY-93/G, or DY–98/G, respectively.
F3001	2 amperes	PP–84€/U.
F601	3 amperes (115 volts)	PP–804/U.
F601	1.5 amperes (230 volts)	PP–804/U.

21. Operating Procedure

For Radio Transmitter T–208/U, turn the VOLUME-OFF switch on Radio Set Control C–847/U to a VOLUME position. For Radio Transmitter T–417/GR, place the MAIN POWER switch on Electrical Equipment Cabinet CY–1221(*)/G to the ON position. The POWER light will light and a signal or noise will be heard from the handset or speaker. If these results are not obtained, refer to the equipment performance chart in the instruction book for the complete radio set. To transmit, press the push-to-talk switch on the handset and speak into the microphone. To stop transmitting, release the push-to-talk switch.

22. Frequency Changing

To change to the alternate frequency, turn the frequency selector switch on the control (fig. 5 or 6) to the alternate position. This may be done at any time and does not require retuning the transmitter.

23. Stopping Procedure

To remove all power from the equipment, turn the VOLUME-OFF switch on Radio Set Control C–847/U to the OFF position or place the MAIN POWER switch on Electrical Equipment Cabinet CY–1221(*)/G in the OFF position.

Section V. OPERATION UNDER UNUSUAL CONDITIONS

24. General

The operation of the transmitter may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In the following paragraphs, instructions are given on procedure for minimizing the effects of unusual operating conditions.

25. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather will affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep tube filaments lighted constantly, but do not overtax the power supply. Refer to the instruction book on the power supply in use for a jumper connection that will maintain a constant reduced voltage on the tube filaments.

c. When the equipment has been exposed to the cold and is brought into a warm area, it will sweat until it reaches the surrounding air temperature. Dry it thoroughly. Remove any coating of frost that may form.

26. Operation in Tropical Climates

a. In tropical climates, the equipment will be subject to moisture conditions more acute than normal. High relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than that of the surrounding air. Make frequent checks for moisture. Dry the equipment thoroughly.

b. The fungiproofing on all items must remain unbroken.

27. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand, or dust and dirt, that may enter the moving parts of the transmitter controls. Make frequent preventive maintenance checks.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

28. Tools and Materials

Tools and materials adequate for organizational repair and maintenance of Radio Transmitters T–208/U and T–417/GR, discussed in paragraphs 34 and 35, are contained in Tool Equipment TE–41.

29. Special Tools and Materials

a. An alinement tool suitable for hf (high-frequency) adjustments is necessary for tuning the tank circuits of the transmitter. Emergency alinement tools should contain as little metal as possible. The alinement tool is attached to Electrical Equipment Cabinet CY–1221(*)/G and on the transmitter power supply in cabinet CY–938(*)/VRC.

b. A 20-conductor patch cord, Electrical Special Purpose Cable Assembly CX–2371/U (fig. 9), is required to supply power to the transmitter when it is removed from the radio set cabinet. Removal from the cabinet is necessary during the tuning procedure and for repair purposes.

c. Five Allen wrenches are attached to the right side dust cover with spring binding posts. They are used for the variable capacitor shaft coupling screws.

Section II. PREVENTIVE MAINTENANCE SERVICES

30. General

The following three sections outline the specific duties and responsibilities of organizational maintenance personnel (operators and repairmen). The two phases of organizational maintenance are the prevention of break-down in the equipment and the repair of any trouble that arises. Preventive measures include periodic cleaning and weatherproofing and visual inspection of the components. The general preventive maintenance techniques (par. 32) are those that can be performed with a minimum of equipment and effort. More extensive troubleshooting and repair procedures are given in chapter 5.

31. Definition of Preventive Maintenance

The best maintenance work is preventive in nature; potential failures are spotted and corrected before they have a chance to develop. This is accomplished by a definite sequence of operations performed on the equipment, and by the systematic recording and studying of all performance, test, and servicing data. Preventive maintenance differs from troubleshooting and repair in that the former prevents break-downs and subsequent repairs, and the latter locates and corrects existing defects. It is important that repairmen and operators perform all preventive maintenance operations completely.

32. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent Dry Cleaning (SD); then wipe the parts with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a cloth.

> ***Caution:*** Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: RADIO TRANSMITTERS T-208/U AND T-417/GR

EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	COND.	NO.	ITEM	COND.
(1)	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 12		(19)	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS: INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 35c	
(2)	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 11		(20)	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION. PAR. 35	
(3)	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 12		(21)	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 35d	
(4)	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 12		(22)	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS. PAR. 35e	
(5)	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 12		(23)	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 35f	
(6)	CHECK FOR NORMAL OPERATION. PAR. 41		(24)	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 35g	
(7)	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 32		(25)	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 35g	
(8)	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 32		(26)	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 35h	
(9)	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 32		(27)	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR. 35h	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.	
(12)	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 32		30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.		(31)	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 35i	
(14)	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 32		(32)	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 35i	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.		33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.		35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.		36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
			(37)	MOISTURE AND FUNGIPROOF. PAR. 34 AND 35	
(38)	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 35k				

DA FORM 1 MAY 51 11-239 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE. 16-46492-1

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Figure 14. DA Form 11-239.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch (psi) to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

33. Use of Preventive Maintenance Form (fig. 14)

a. The decision as to which items on DA Form 11–239 are applicable to this equipment is a decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative and, in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of the form appear on the reverse side of the form.

b. Circled items in figure 14 are partially or totally applicable to the transmitting equipment. References in the ITEM block refer to paragraphs in the text which contain additional maintenance information.

34. Performing Exterior Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. Check for completeness of equipment: spare parts, technical manual, and accessories.

b. Remove dirt and moisture from all jacks and controls on the front panel. Inspect plug P301 on the back of the transmitter (fig. 4).

c. Check for normal operation. If abnormal results occur at any point in the operating procedure, refer to the equipment performance checklist (par. 41).

d. Clean and tighten the transmitter cabinet (fig. 1).

e. Inspect metal surfaces for corrosion and moisture (par. 37).

f. Inspect patch cord for cuts, breaks, fraying, deterioration, kinks, and strain (fig. 9).

g. Inspect all switches and jacks on front panel for looseness (fig. 4).

h. If deficiencies noted are not corrected during inspection, indicate on DA Form 11–239 the action taken to initiate correction.

35. Performing Interior Preventive Maintenance

Caution: Disconnect all power before performing the following operations. Upon completion of these operations, reconnect power and check for satisfactory operation (par. 41).

a. Inspect seating of plug-in capacitor C334 and the crystal oven unit (figs. 10 and 11). Check tightness of coaxial connecters at the antenna relay.

b. Inspect the FINAL PLATE TUNE (C354) control shaft (figs. 4 and 11) for binding, excessive looseness, damaged thread, and misalinement. Do the same for COUPLING control C355 (figs. 4 and 11).

c. Inspect electron tubes for loose envelopes, loose cap connecters, cracked sockets, and insufficient socket spring tension; remove dust and dirt carefully; check emission of receiver-type tubes (fig. 3).

d. Inspect all fixed capacitors for leaks, bulges, and discoloration (figs. 11 and 12).

e. Inspect the antenna relay in the transmitter for loose mounting, corroded contacts, misalinement of contacts, and insufficient spring tension (fig. 11).

f. Inspect the variable capacitors for dirt, moisture, misalinement of plates, and loose mountings (figs. 11 and 28).

g. Inspect resistors and insulators for cracks, chips, blisters, discoloration, and moisture (fig. 11).

h. Clean and tighten switches, antenna relay mount, and interior components (fig. 11).

i. Clean and tighten connections and mounting of the power-amplifier tank coil. Check the mounting of transformer T301 and potentiometer R354 (fig. 11).

j. Check moistureproofing and fungiproofing (par. 37).

k. If deficiencies noted are not corrected during inspection, indicate on DA Form 11–239 the action taken to initiate correction.

Section III. LUBRICATION AND WEATHERPROOFING

36. Lubrication

Radio Transmitters T–208/U and T–417/GR require no lubrication.

37. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials. Some of the problems encountered are—

(1) Resistors, capacitors, coils, chokes, transformer windings, etc., fail because of the effects of fungus growth and excessive moisture.
(2) Electrolytic action, often visible in the form of corrosion, takes place in resistors, coils, chokes, transformer windings, etc., causing eventual break-down.
(3) Break-down of insulation on hook-up wires and cables. Fungus growth accelerates deterioration.
(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs.

b. Tropical Maintenance. A special moisture-proofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and excessive moisture. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

38. Rustproofing and Painting

a. The protective covers and front panel of the transmitter are constructed of an aluminum alloy, with an iridite finish. Rust conditions normally will not be encountered. Corrosion of any nature should be removed by using cleaning solvent and crocus cloth, or No. 0000 sandpaper if necessary.

Caution: Do not use steel wool. Minute particles frequently enter the cabinet and cause harmful internal shorting or grounding of circuits.

b. Should painting be necessary, refer to TM 9–2851.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

39. General

a. The troubleshooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is limited necessarily in scope by the tools, test equipment, and replaceable parts issued, and by the existing situation. Accordingly, troubleshooting by the operators is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, cracked insulators, etc.

b. The following paragraphs in this section help in determining which stage is at fault and in localizing the fault in that stage to the defective item such as a tube or capacitor.

40. Visual Inspection

a. When Radio Transmitter T–208/U or T–417/GR fails to operate properly, a visual examination of the following items ordinarily will determine the faulty part:

(1) Wiring for loose or poorly soldered connections, frayed or burned insulation, or stretched leads.
(2) Terminal boards for broken lugs and signs of arcing.
(3) Crystal holders for breaks or cracks.
(4) Resistors for blistering or discoloration caused by overheating.
(5) Cables and plugs for breaks.
(6) Relays for broken or dirty contacts.
(7) Wires broken because of excessive vibration.
(8) Tubes for defects.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble appeared.

41. Troubleshooting by Use of Euqipment Performance Checklist

a. General. The equipment performance checklist will help the operator to locate trouble in the transmitter. The checklist gives the item to be checked, the conditions under which the item is checked, the normal indications, and the corrective measures that can be taken. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. The information in this column indicates the action to be taken and the settings of various switches and controls.

c. Normal Indications. The normal indications listed indicate what action should occur in the transmitter.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary (par. 62).

e. Equipment Performance Checklist.

	Item No.	Item	Action or condition	Normal indication	Corrective measures
PREPARATORY	1	Transmitter	Pretuned to desired operating frequency (pars. 18 and 19) and properly connected in radio set or system containing necessary additional equipment (par. 9).		
	2	TEST-OFF switch	Placed in OFF position.		
	3	TUNE-OPR switch	Placed in OPR position.		
	4	Frequency selector switch on control unit.	Turned to either FREQ 1 or FREQ 2 position, depending on choice of operating frequency.		
EQUIPMENT PREPARATORY	5	For T–278/U; VOLUME-OFF switch on Radio Set Control C–847/U. For T–416/GR; MAIN-POWER switch on control unit.	Turned toward VOLUME position.	POWER lamp on control unit lights.	Check fuses in equipment cabinet and transmitter power supply. Check POWER indicator lamps. Refer to paragraph 62.
EQUIPMENT PERFORMANCE	6	Handset H–33/PT	Push-to-talk switch depressed.	Filament power is applied to all tubes. For T–278/U; TRANSMIT lamp on control unit lights and transmitter power supply dynamotor can be heard. For T–416/GR; Blower fan in transmitter power supply can be heard.	Check fuses in the equipment cabinet and the transmitter power supply. Check push-to-talk switch on the handset. Refer to paragraph 62.
	7	Handset H–33/PT	Push-to-talk switch is released.	TRANSMIT indicator lamp of Radio Set Control C–847/U goes out. Dynamotor or blower fan motor becomes inoperative and quiets.	Check push-to-talk switch. Check transmitting relay in transmitter power supply.
	8	For T–278/U; VOLUME-OFF switch on Radio Set Control C–847/U. For T–416/GR; MAIN POWER switch on control unit.	Turned to the OFF position.	POWER lamp on control unit goes out.	Check VOLUME-OFF or MAIN POWER switch on control unit. For T–278/U, check power relay in transmitter power supply.

CHAPTER 4

THEORY OF OPERATION

42. General

This chapter contains the detailed theory of operation of Radio Transmitters T–208/U and T–417/GR. Since the transmitters depend on the other components of the system for the application and control of power, control circuits are also discussed in this chapter.

43. Block Diagram

(fig. 15)

Radio Transmitters T–208/U and T–417/GR are fm transmitters and have a frequency range of 25 to 50 mc. The signal path is shown in figure 15. A complete schematic is shown in figure 34.

a. Radio Transmitter T–208/U.

(1) *Rf oscillators.* Two crystal-controlled oscillator stages, V301 and V302, using 1AD4 tube, allow a quick change between two predetermined operating frequencies. The oscillator to be used is selected by a switch on the radio set control, which allows filament voltage to be applied to one oscillator and removed from the other. A crystal frequency of 1.5625 to 3.125 mc, depending on the crystal used, is fed to the control grid of modulator tube V303.

(2) *Phase modulator.* An audio signal from tube V313 ((11) below) also is applied to the control grid of phase modulator tube V303 (a type 1AD4). With rf and audio voltages being applied to the grid, a relative phase shift takes place between the signal components at the plate. The output of this stage is phase-modulated rf at the crystal frequency, with a deviation of 937.5 cycles for 100 percent modulation.

(3) *Buffer.* Buffer stage V304 (a type 5678) furnishes a constant load for the modulator and acts as an isolating stage. Its rf output is at the same frequency as the oscillator with a deviation of 937.5 cycles.

(4) *First doubler.* First doubler tube V305 (a type 5678) has a single-tuned plate circuit operating at twice the crystal frequency, with a deviation of 1,875 cycles. This output is applied to the grid of second doubler tube V306.

(5) *Second doubler.* Second doubler tube V306 (a type 5672) has a single-tuned plate circuit operating at four times the crystal frequency, with a deviation of 3,750 cycles. This output is applied to the grid of third doubler tube V307.

(6) *Third doubler.* Third doubler tube V307 (a type 3B4) has a single-tuned plate circuit operating at eight times the crystal frequency, with a deviation of 7,500 cycles. This output is applied to the grid of driver-doubler tube V308.

(7) *Driver-doubler.* Driver-doubler stage V308 (a type 2E24) has its plate circuit tuned to 16 times the crystal frequency, with a deviation of 15,000 cycles (15 kc). This stage is inductively coupled to the grid circuits of power-amplifier tubes V309 and V310.

(8) *Power amplifiers.* The power-amplifier stage consists of two tubes, V309 and V310, both type 2E24 tubes, operated in parallel. The pi-type plate tank is tuned resonance by a variable capacitor. A coarse adjustment of the antenna coupling is made by fixed capacitors, and a fine adjustment is accomplished by the variable capacitor. Power output from amplifiers passes through an antenna filter to attenuate undesired harmonics.

(9) *First audio amplifier.* Audio signals from the microphone of Handset H–33/PT, or signals from a radio receiver (re-

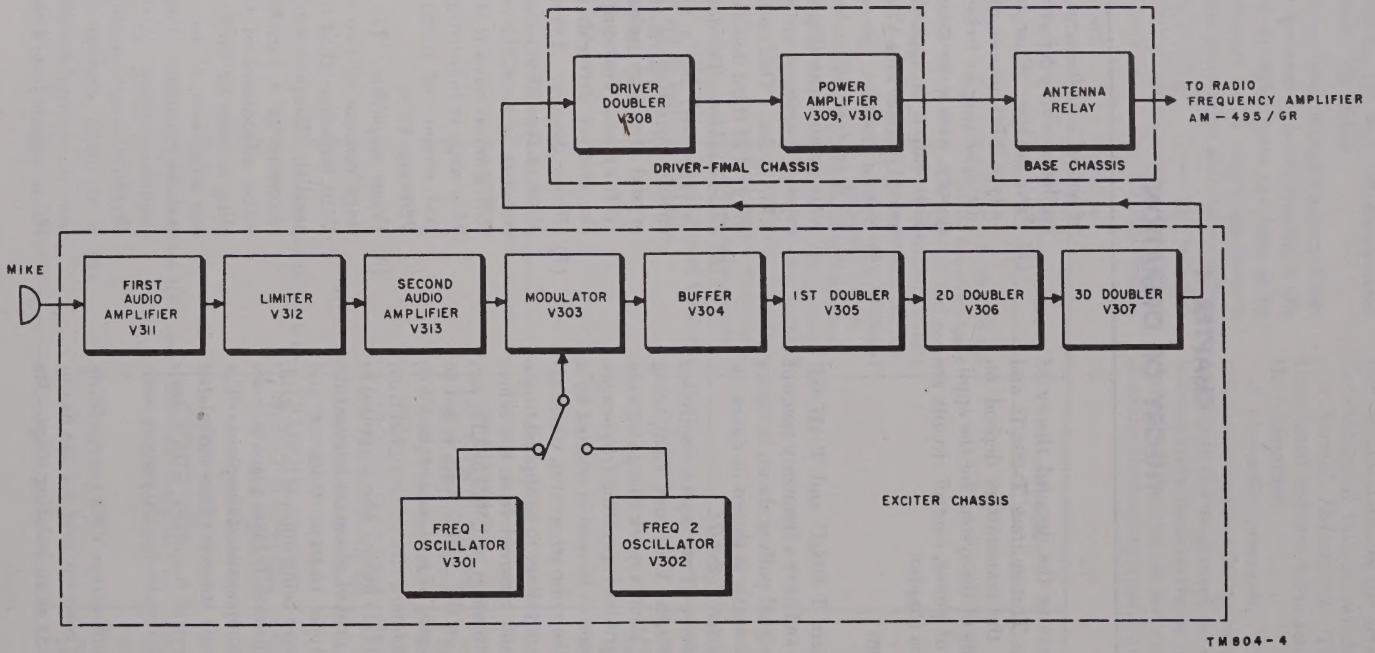


Figure 15. Radio Transmitter T–208/U or T–417/GR, block diagram.

transmission), are applied through an impedance-matching transformer and a high-pass filter to the control grid of first audio-amplifier tube V311 (a type 5678). The output of this stage is coupled to the grid of limiter tube V312.

(10) *Limiter.* Limiter tube V312 (a type 5672) serves to limit the amplitude of the audio signal. The output of this tube is passed through a low-pass filter network and is applied to the grid of the second audio amplifier.

(11) *Second audio amplifier.* Second audio-amplifier tube V313 is a type 5678 tube. The audio level of the amplified output of this tube is adjusted by the DEVIATION LEVEL control and is fed to the grid of phase modulator tube V303 (subpar. (2), above).

b. Radio Transmitter T–417/GR. The block diagram for Radio Transmitter T–417/GR follows the same sequence as Radio Transmitter T–208/U. Circuit components are identical in both models up to the driver-doubler stage. From this stage on, other tube types are used to increase the power output of the transmitter. Note the following major changes (figs. 34 and 35):

(1) *Driver-doubler.* A type 2E26 tube (V308) is used, which has its plate circuit tuned to 16 times the crystal frequency with a deviation of 15 kc. This stage is coupled to the grid circuits of power-amplifier tubes V309 and V310.

(2) *Power amplifiers.* The power-amplifier stages consist of two type 6146 tubes. The tubes are operated in parallel, as in Radio Transmitter T–208/U; however, the greater efficiency and power handling capability of the type 6146 tubes increases the usable output power.

44. Crystal Oscillator

(fig. 16)

Since the two oscillator stages are identical, only V302 is discussed to avoid repetition. Corresponding components in the V301 circuit have functions identical with those in the V302 circuit.

a. A crystal is connected between the screen and control grid of V302. When power is applied, an electrical strain is exerted on the crystal so that it vibrates mechanically at its resonant frequency and develops grid excitation voltage. The crystal acts as a tuned resonant circuit at the crystal frequency. Feedback is accomplished through the interelectrode capacitance of the tube.

b. Grid bias is developed by the current flow through R301. Capacitor C301 together with variable capacitor C303 may be used to correct the oscillator frequency if the crystal is not oscillating

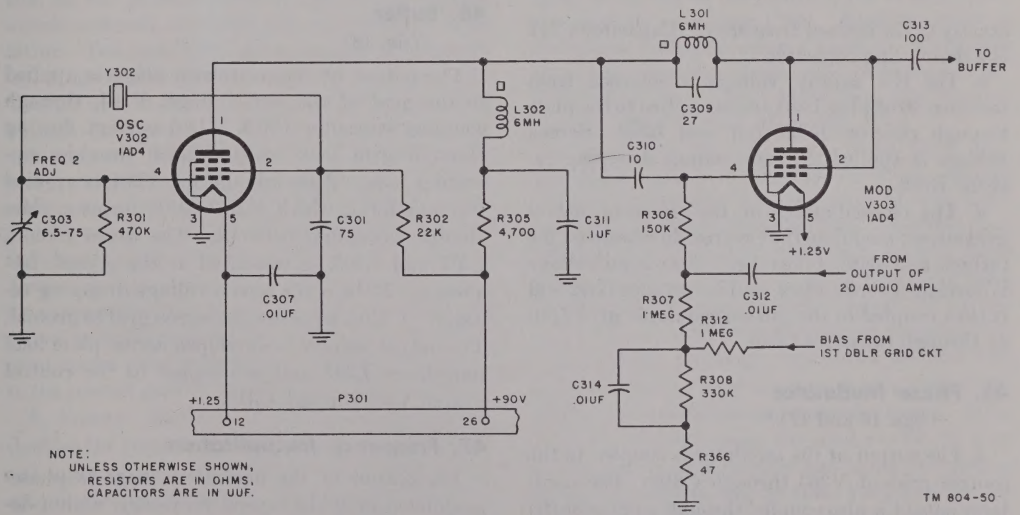


Figure 16. Oscillator and modulator stages.

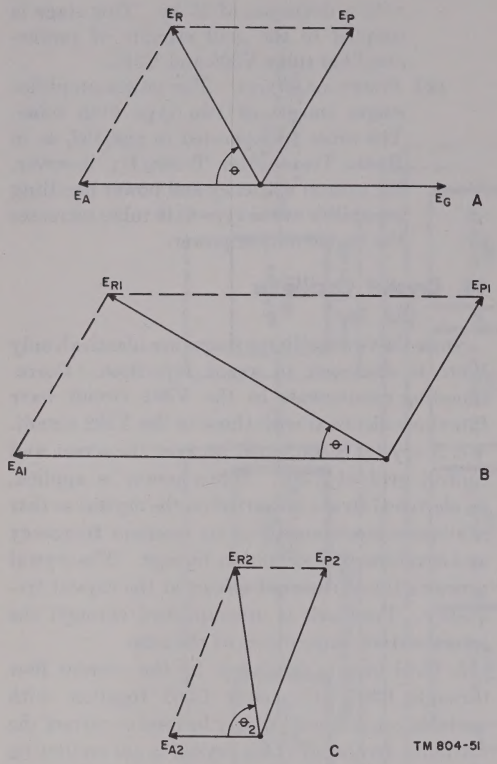


Figure 17. Modulator stage phase relationships.

exactly at the desired frequency. Capacitor C311 is a decoupling capacitor.

c. The B+ supply voltage is obtained from terminal 26 of plug P301 and is applied to the plate through resistor R305 and coil L302. Screen voltage is applied through voltage dropping resistor R302.

d. The rf oscillations in the screen-to-control grid circuit modulate the electron flow between the cathode and plate of the tube. The output voltage is developed across plate load inductance L302 and is then coupled to the phase-modulator grid (pin 4) through capacitor C310.

45. Phase Modulator

(figs. 16 and 17)

a. The output of the oscillator is coupled to the control grid of V303 through C310. The oscillator output is also coupled through a phase-shifting network, L301 and C309, to the plate of V303.

b. A, figure 17 represents the phase relationships of the voltages on the plate and grid of V303. E_G represents the voltage coupled to the grid of V303 through C310 and E_A represents the voltage at the plate due to grid action. E_P represents the voltage coupled directly to the modulator plate through the phase-shifting network. E_R will then represent the magnitude and phase of the resultant plate voltage.

c. When an audio signal is applied to the grid, the transconductance of the tube will vary at an audio rate. On the negative portions of the audio signal, E_{A1} will increase in magnitude. E_{P1} will not be affected. The resultant voltage, E_{R1}, will thus be changed in magnitude and phase as indicated in B, figure 17. C, figure 17 represents the voltages on the plate of V303 on positive portions of the audio signal. From the above, note that the phase-modulator output signal will vary in accordance with the amplitude of the audio signal.

d. For the magnitudes of E_P and E_A to be approximately equal, degeneration of the input signal, E_G, is necessary. This takes place across the grid-biasing network, R306, R307, R308, and R366, by coupling back a portion of E_A. R308 and C314 form a de-emphasis network so that the phase displacement of the modulator output signal will depend on the amplitude of the audio signal and not on the frequency of the audio signal.

46. Buffer

(fig. 18)

The output of the modulator stage is applied to the grid of the buffer stage, V304, through coupling capacitor C313. Grid current flowing through grid leak resistor R309 provides operating bias. Plate voltage for V304 is applied through R311, which with C315B forms a plate circuit decoupling network. The tuned circuit, C317 and L303, is resonated at the crystal frequency. R310 is the screen voltage-dropping resistor. C315A bypasses the screen grid to ground. The output voltage is developed across plate load impedance L303 and is coupled to the control grid of V305 through C318.

47. Frequency Multiplication

The output of the modulator stage is phase-modulated rf at the crystal frequency, with a deviation of 937.5 cycles for 100 percent modula-

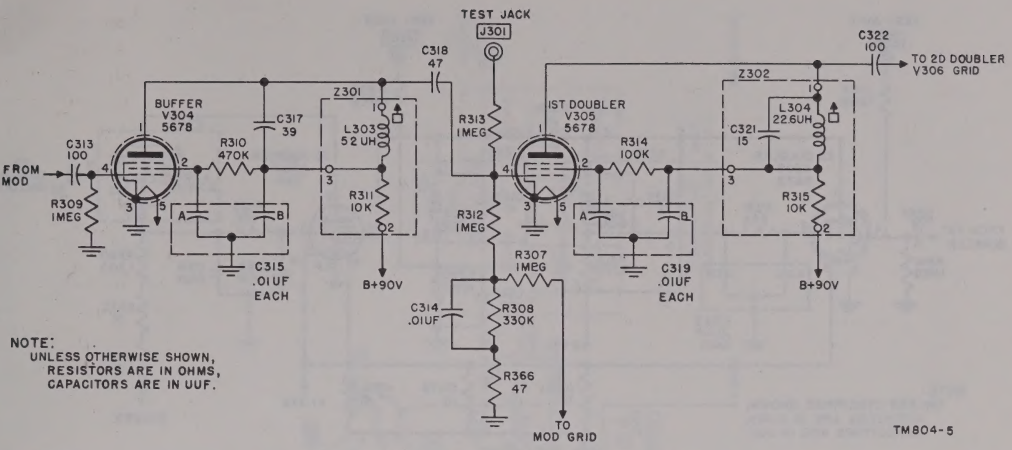


Figure 18. Buffer and first doubler stages.

tion. Subsequent frequency multiplication (16 times) is necessary to produce the desired 15-kc deviation at the output frequency. This frequency multiplication is accomplished by the four frequency-doubler stages.

a. First Doubler (fig. 18). The grid circuit of first doubler V305 is returned to ground through resistors R312, R308, and R366, and a bias is developed for the tube. A portion of this bias is fed back to the modulator tube grid for automatic deviation limiting. It limits the amount of deviation of the phase-modulated signal and thereby avoids excessive deviation caused by excess modulation. Test jack J301, which is connected through isolating resistor R313 to the control grid of tube V305, is used to determine the level of signal input voltage by measuring the bias voltage with no audio input. The plate of tube V305 receives its plate voltage through decoupling resistor R315, which is bypassed for rf voltages by capacitor C319B. The tuned circuit, capacitor C321 and inductance L304, is resonated at *twice* the crystal frequency. Resistor R314 is the screen voltage-dropping resistor. Capacitor C319A bypasses the screen grid to ground. The output voltage developed across plate load impedance L304 is coupled to the control grid of tube V306 by capacitor C322.

b. Second Doubler (fig. 19). Tube V306 doubles the frequency of the previous stage. Signal input is applied to the control grid through coupling capacitor C322. Rectified grid current flowing through grid leak resistor R316 provides operating bias. The signal input level is checked at jack J302 (connected to the control grid through isolating resistor R317). Voltage indications at this test point are used when tuning the first doubler stage. The plate of tube V306 receives its operating plate voltage through decoupling resistor R319, which is bypassed for rf voltages by capacitor C323B. The plate circuit is tuned to four times the crystal frequency by variable plate inductance L305 and capacitor C325. Rf voltage developed across plate load impedance L306 is coupled to the control grid of tube V307 by coupling capacitor C326. Resistor R318 is the screen voltage-dropping resistor. Capacitor C323A bypasses the screen grid to ground. Resistors R321, R375, and R376 drop the filament voltage to the proper operating value.

c. Third Doubler (fig. 19). Tube V307 doubles the frequency of the previous stage. Signal input is applied to the control grid of tube V307 through coupling capacitor C326. Rectified grid current flowing through grid leak resistor R320 and the action of C327, provide operating bias. The level signal input is checked at jack J303 (connected to the control grid through isolating resistor R322). Voltage indications at this test point are used as a guide when tuning the second doubler output and the third doubler input. Grid tank circuit Z304 tunes the grid circuit to four times the crystal frequency and helps to suppress harmonics. The plate of tube V307 receives its operating plate voltage through inductance L307.

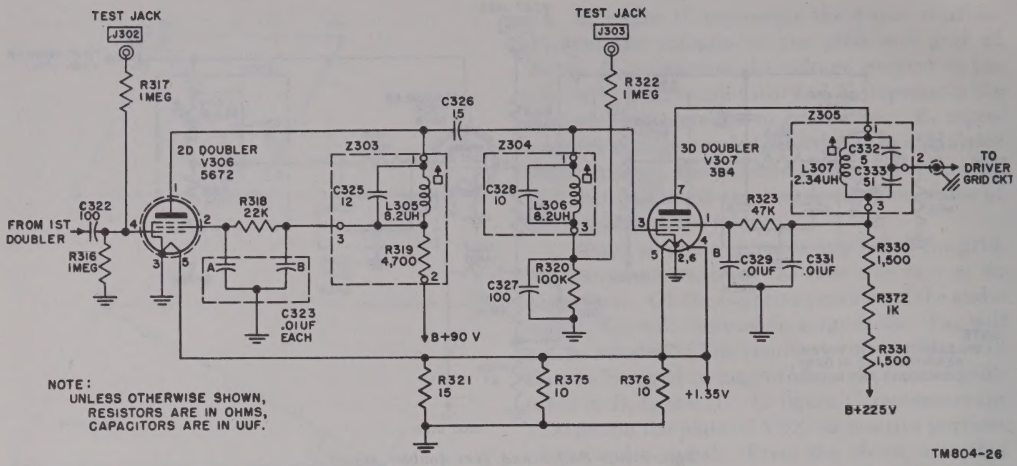


Figure 19. Second and third doubler stages.

Capacitor C331 bypasses the rf plate circuit to ground, and resistors R330, R372, and R331 act as decoupling resistors to prevent rf voltages from getting into the plate supply. The plate circuit is tuned to eight times the crystal frequency by Z305. Rf voltage developed across capacitor C333 is coupled by a shielded cable to the driver grid tank circuit. Resistor R323 is the screen voltage-dropping resistor. Capacitor C329B bypasses the screen grid to ground.

d. Driver-Doubler (fig. 20).

(1) Tube V308 doubles the frequency of the previous stage. Signal input is coupled to inductance L308. Inductance L308 and variable DRIVER GRID TUNE capacitor C337 make up a grid tank circuit which is tuned to eight times the crystal frequency. Capacitor C336 couples the tank output to the control grid of tube V308. DR GRID jack J304, connected to the grid input through resistor R332, provides a test point at which grid voltage on the driver-doubler grid may be measured when tuning the third doubler stage and the grid tank circuit of tube V308. Protective bias of −25 volts is applied to the grid through resistor R333.

(2) The plate of tube V308 receives its operating plate voltage through L311 and Z306. The plate circuit is tuned to 16 times the crystal frequency by variable DRIVER PLATE TUNE capacitor C343. Rf voltage developed across a part of inductance L312 is coupled to the grid circuit of the parallel power-amplifier stage. Capacitor C344 and rf choke L311 decouple plate circuit. Resistor R337 is the screen decoupling resistor. Capacitor C340 bypasses the screen grid to ground, and feedthrough capacitor C341 decouples the screen circuit from the screen supply. Switch S302 in the TUNE position reduces the screen voltage to tubes V308, V309, and V310 by the addition of resistors R349 and R350 in the screen supply circuit. Resistor R335 is used as a cathode-biasing resistor. C342 is part of the plate load for V308 and also blocks direct current (dc) from going to ground through L312. C335 and C338 function as rf bypass capacitors to ground for the test jack lead and protective bias leads, respectively.

48. Power Amplifiers and Antenna Filter (fig. 20)

a. The power-amplifier input is taken by the shielded cable through the partition and fed to the grid tank composed of variable capacitor C345 (FINAL GRID TUNE) and tapped inductance L313. The tank is tuned to 16 times the oscillator frequency. The input to the power-amplifier

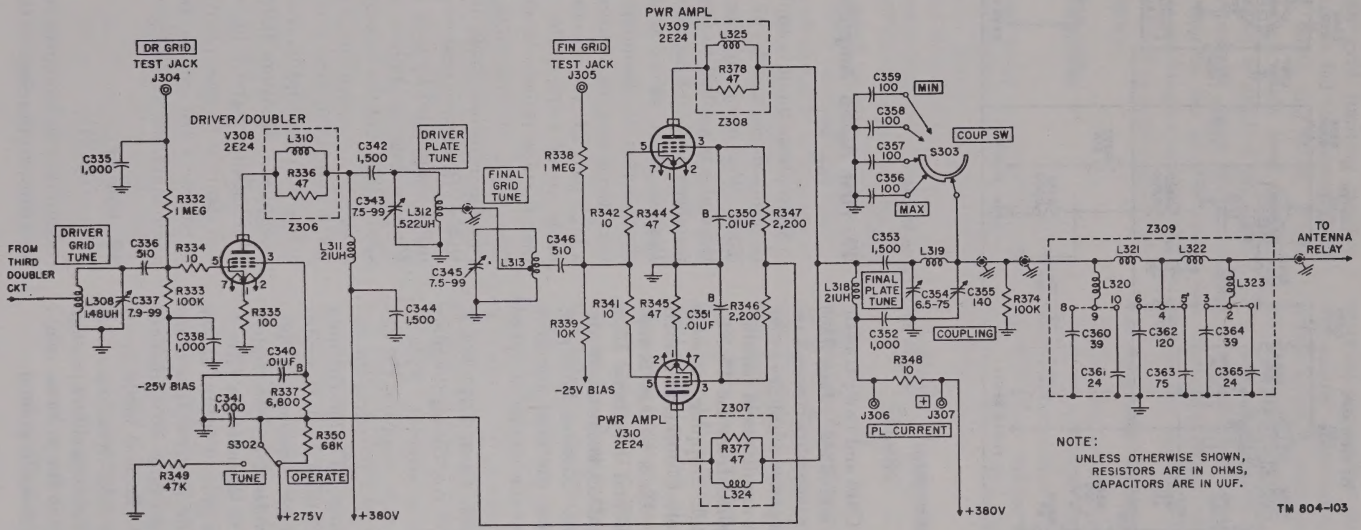


Figure 20. Driver-doubler and power amplifier.

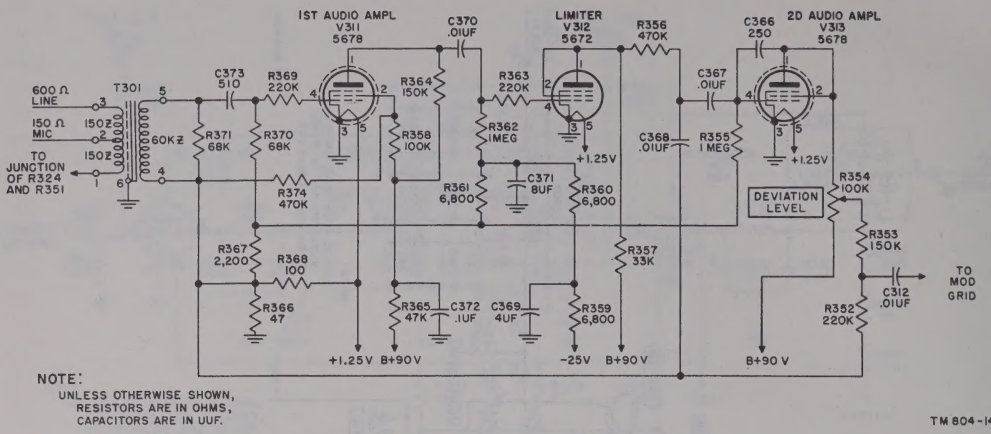


Figure 21. Audio stages.

grids is through capacitor C346 and two parasitic suppressor resistors, R341 and R342. Jack J305 (FIN GRID) is provided to measure through resistor R338, the input to the power-amplifier grids. The tubes operate as power amplifiers in parallel. The screen voltage is supplied from the TUNE-OPERATE switch through dropping resistors R346 and R347. Capacitors C350B and C351B bypass the screens for rf. Plate voltage is supplied through resistor R348 and inductance L318 which, in conjunction with C352, keeps the rf current from the power supply. Resistor R348 provides a means of measuring the final amplifier plate current by measuring the voltage dropped across the resistor.

b. The pi-tuning network, C354, L319, C355, C356, C357, C358, and C359, constitutes the plate tank and antenna coupling circuits. FINAL PLATE TUNE capacitor C354 resonates the circuit while the COUP SW (S303) selects the approximate amount of coupling. The fine coupling adjustment is made by COUPLING capacitor C355. The pi-circuit offers considerable harmonic attenuation and provides impedence matching of the output circuit to the antenna circuit. R373 provides a dc path to ground for the safety of operating personnel. The power output is applied to the antenna through filter Z309, that reduces harmonic radiation. Z309 is made up of inductances L320 through L323 and capacitors C360 through C365. This network allows passage of the operating frequency to the antenna relay, but diverts unwanted harmonics to ground.

49. First Audio Amplifier

(fig. 21)

Microphone input is applied to terminal 2 (150 ohm impedance match) of matching transformer T301. For retransmission of a received signal, the audio is applied to terminal 6 (600 ohm impedance match) of matching transformer T3001. Resistor R371 serves as an impedance balance shunt across the secondary. Audio signals pass from the secondary of transformer T301 through a high-pass RC (resistance-capacitance) network made up of C373, R370, R367, and R366, and then through resistor R369 to the control grid of tube V311. A bias voltage is fed to the grid through resistors R359, R360, R361, R370, and R369. Protection against excessively high audio input is provided by grid-limiting resistor R369. Plate voltage is applied through plate load resistor R364 and the decoupling network of R365 bypassed by capacitor C372. Resistors R366, R374, and R358, form a voltage-divider network across the plate supply, from which screen voltage is applied. Resistors R368 and R367 provide a hum-bucking network by establishing a grid circuit return to a center point of the filament supply. Capacitor C370 couples the output of the first audio amplifier to the following limiter stage.

50. Limiter

(fig. 21)

Amplified audio signals coupled through capacitor C370 are impressed on the control gride of lim-

iter tube V312 through grid limiting resistor R363. Grid bias voltage is fed to resistor R363 through resistors R362, R360, and R359. Plate voltage is applied through plate load resistor R357. The limiter output is applied to a network composed of low-pass RC filter R356 and capacitor C368. Coupling to the grid of tube V313 is made through dc blocking capacitor C367. The limiter clips the peaks off the audio signal for improved phase modulation.

51. Second Audio Amplifier

(fig. 21)

Tube V313 is the final audio amplifier and is used to drive phase-modulator tube V303. R355 is the grid load resistor. Bias is supplied from across resistors R367 and R366, which are part of a voltage-divider network across the −25-volt supply. The plate of tube V313 receives operating voltage through plate load resistor R354. The variable tap of resistor R354 (a control) is used as an adjustment of the audio level to be applied to the phase modulator. This adjustment controls the *deviation level.* The audio-output voltage is applied to the phase-modulator stage through C312 and R353. Resistor R352 connects to the filament supply center point (R366 and R368) to provide hum-bucking action. The plate of tube V313 is connected to the control grid through capacitor C366 to provide inverse feedback (to reduce distortion).

52. B+ Distribution

a. Figure 22 shows the B+ distribution in Radio Transmitters T–208/U and T–417/GR. TUNE-OPERATE switch S302 in the TUNE position places resistor R350 in series with the normal screen voltage-dropping resistors R337, R346, and R347, limiting the plate current of the driver and power-amplifier stages to a value that will not harm the tubes if the stages are detuned or misalined. Resistor R349 serves as an additional load for the screen supply when operating with switch S302 in the TUNE position.

b. Terminal 3 of plug P301 applies approximately 225 volts dc to a voltage-divider network consisting of resistors R329, R328, R327, R326, R325, R324, and R351, and filter capacitors C334A, C334B, and C330. A potential of 90 volts dc is tapped at the junction of resistors R325 and R326 and brought to terminal 27 of plug P301. Through external connections the voltage is applied to the transmitter at terminal 26 of plug P301, from which point it provides plate voltage for tubes V301 through V303.

c. The ungrounded side of R351 (+2 volts) is connected to terminal 1 of T301. This voltage is applied through external connections to the microphone circuit of the handset.

53. Filament Voltage Distribution

Figure 23 shows the distribution of filament power. Note that the application of filament power is controlled from outside the transmitter and therefore failure of all tubes in the same string to light will usually indicate a fault outside the transmitter.

54. Radio Transmitter T–208/U Control Circuits

(fig. 24)

The following description is based on the use of Radio Transmitter T–208/U in Radio Set AN/VRC–6(*) with Dynamotor-Power Supply DY–100/U.

a. With the VOLUME-OFF switch on Radio Set Control C–847/U turned clockwise toward the VOLUME position, the 6-volt dc power circuit is completed through fuse F801 in Electrical Equipment Cabinet CY–938(*)/VRC, fuse F1201 in Dynamotor-Power Supply DY–100/U, switch S1501B in Radio Set Control C–847/U, the jumper connection between terminals 1 and 2 of terminal board TB803, and the coil of relay K1203 in Dynamotor-Power Supply DY–100/U. This action energizes relay K1203. Two contacts close to complete the 6-volt dc power circuit through fuses F801 and F1201 and the closed contacts of relay K1203 to the heater element and thermostat of crystal heater E301 in the transmitter.

b. Pressing the push-to-talk switch on Handset H–33/PT energizes relay K1201 in the power supply by completing the 6-volt dc power circuit through fuses F801 and F1201, the closed contacts of relay K1203, the coil of relay K1201 in the power supply, and the closed contacts of the push-to-talk switch of the handset. With relay K1201 energized the following action occurs.

(1) Six volts dc from the power source is supplied through fuses F801 and F1201 and the closed contacts of relays K1203 and 2 and 7 of K1201 to terminal 1 of plug P301 for distribution to the fila-

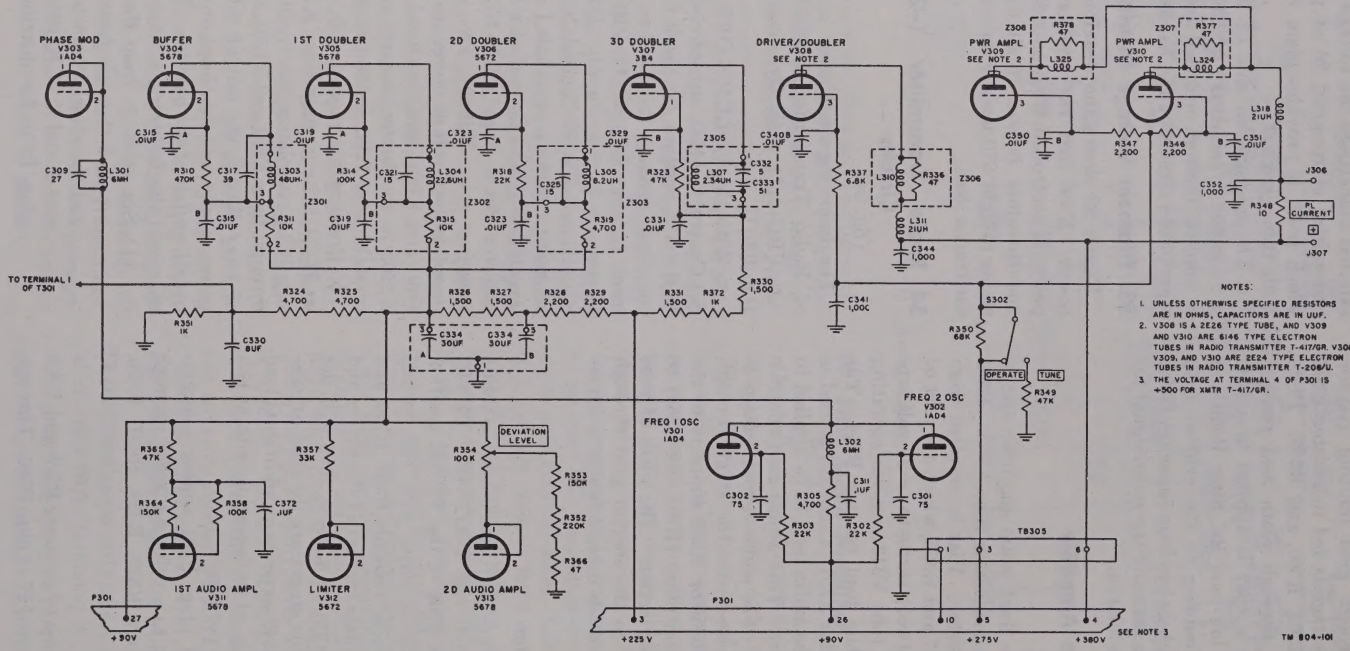


Figure 22. B+ distribution.

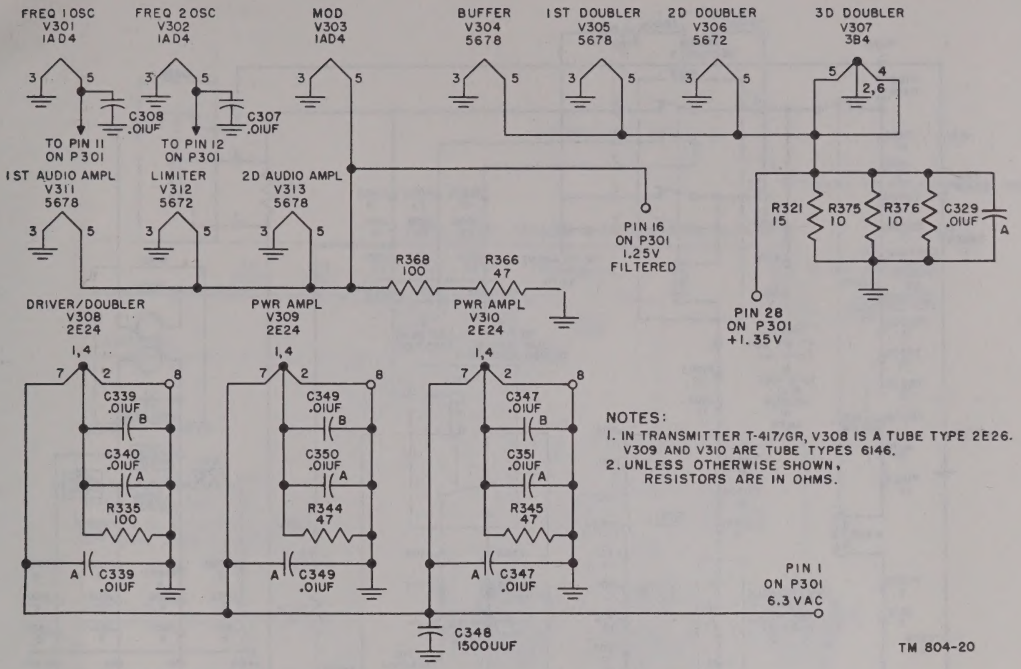


Figure 23. Filament circuit.

ments of tubes V308, V309, and V310 in the transmitter.

(2) The 1.25-volt dc supply is obtained by connecting the 6-volt dc power circuit through fuses F801 and F1201 and the closed contacts of relays K1203 and contacts 2 and 7 of K1201 to the voltage-dropping and regulating circuit in the power supply.

(3) Six volts dc is supplied from the power source through fuses F801 and F1201 and the closed contacts of relays K1203 and K1201 to the coil of relay K301 in the transmitter through terminal 29 of plug P301. This action energizes relay K301 and thereby connects the rf power output of the transmitter to the antenna.

(4) The TRANSMIT indicator lamp in the radio set control will light when K1201 is energized.

(5) Six volts dc is supplied from the power source through fuses F801 and F1201 and the closed contacts of relays K1203 and K1201 to the coil of relay K1202. This energizes the relay.

c. With relay K1202 energized, 6 volts dc from the power source is supplied through fuse F801 and the closed contacts of relay K1202 to dynamotor D1201 in the power supply. The dynamotor operates and supplies power to the following circuits:

(1) Minus 25 volts dc is supplied to terminal 6 of plug P301 in the transmitter for application to a filter and voltage-divider network, which proportions the bias voltage to tubes V308 through V313.

(2) Plus 225 volts dc is supplied to terminal 3 of plug P301 in the transmitter to provide plate and screen voltage to tubes V304 through V307 and V311 through V313.

(3) Plus 380 volts dc is supplied to terminal 4 of plug P301 in the transmitter to provide plate voltage to tubes V308 through V310.

(4) Plus 275 volts dc is supplied to terminal

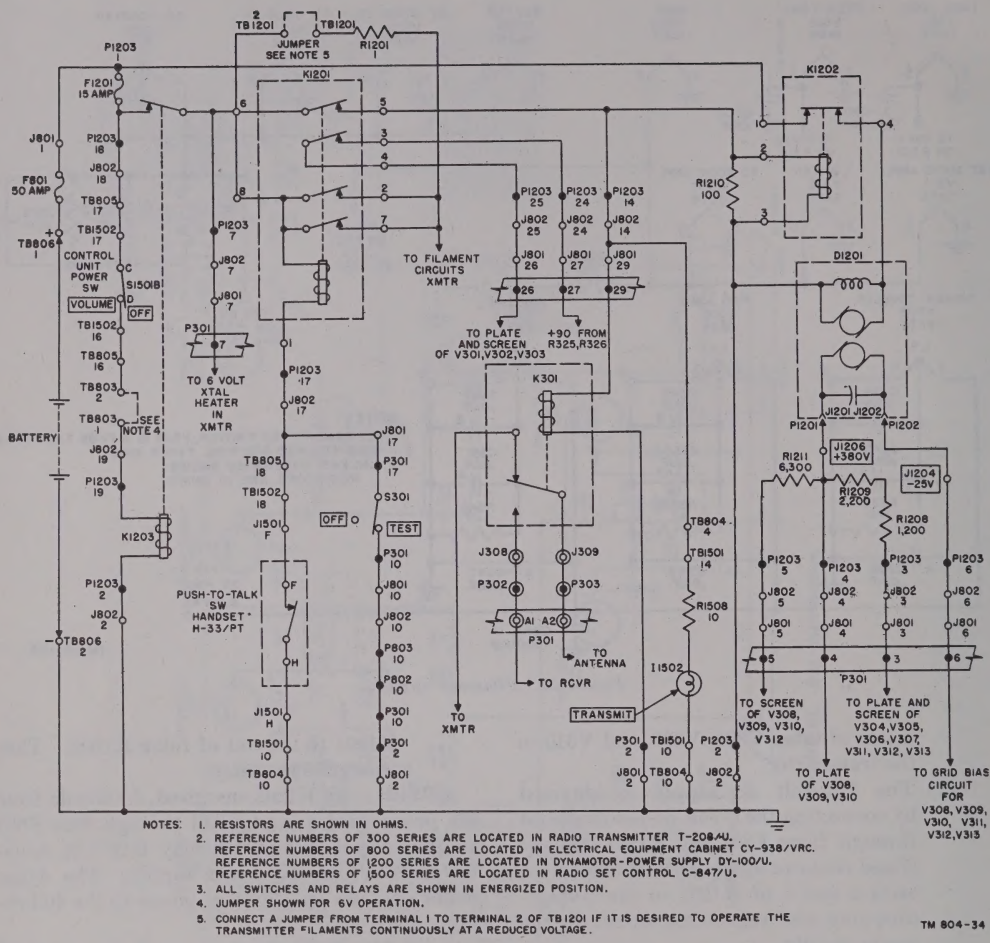


Figure 24. Radio Transmitter T–208/U, control circuits.

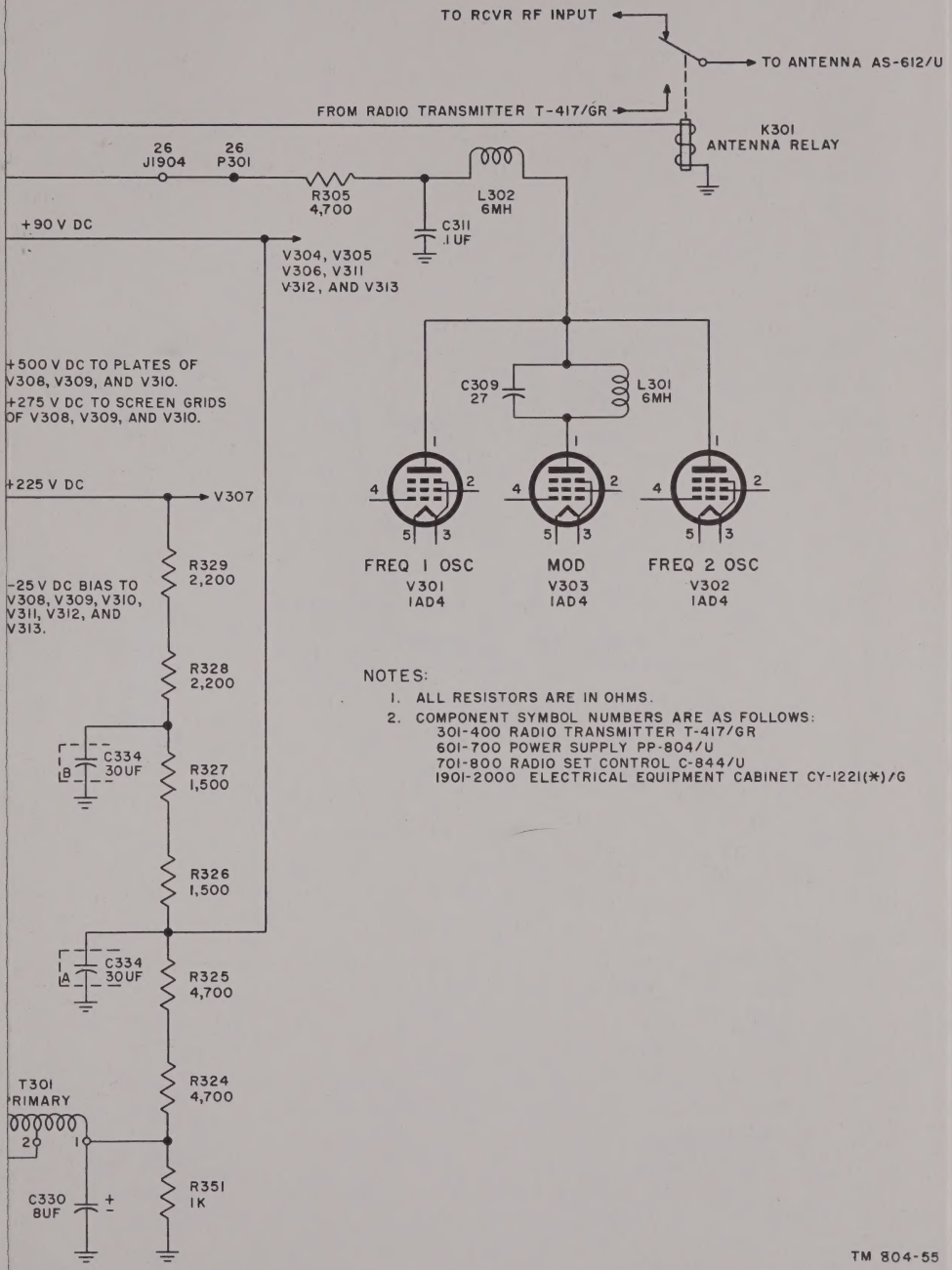
5 of plug P301 in the transmitter to provide screen voltage to tubes V308 through V310.

d. All the control circuits described above are set into action by operating two switches: the VOLUME-OFF switch at Radio Set Control C–847/U and the push-to-talk switch of Handset H–33/PT. During the initial tuning procedure, TEST-OFF switch S301 in the transmitter is used instead of the push-to-talk switch of the handset. Switch S301 parallels the handset switch and energizes relay K1201 in the power supply in the same manner as did the handset switch. The circuit is from the 6-volt dc source through fuses F801 and F1201, the closed contacts of relay K1203, the coil of K1201, and through switch S301 of the transmitter in the TEST position to ground. Power thus is applied to the transmitter in the same sequence as described for handset operation.

55. Radio Transmitter T–417/GR Control Circuits

(fig. 25)

The following information describes the application of B+ power of the transmitter when the



NOTES:

1. ALL RESISTORS ARE IN OHMS.
2. COMPONENT SYMBOL NUMBERS ARE AS FOLLOWS:
   301-400 RADIO TRANSMITTER T-417/GR
   601-700 POWER SUPPLY PP-804/U
   701-800 RADIO SET CONTROL C-844/U
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G

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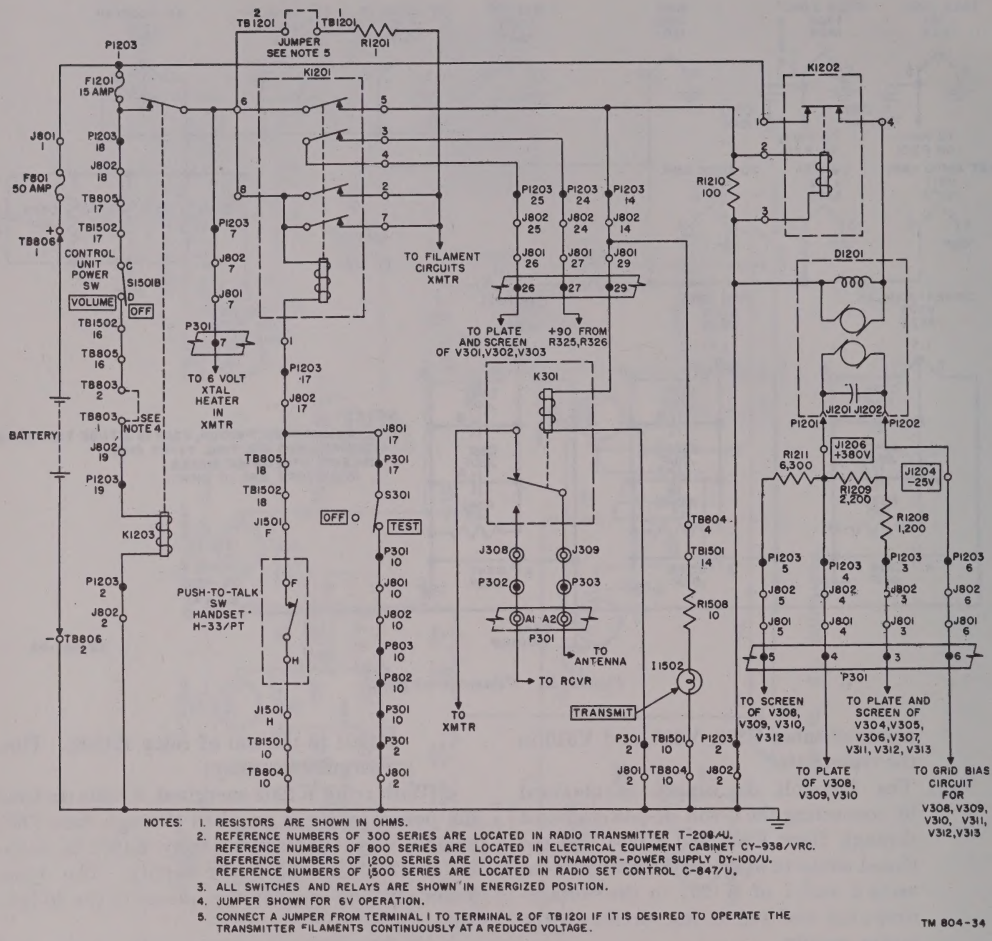


Figure 24. Radio Transmitter T–208/U, control circuits.

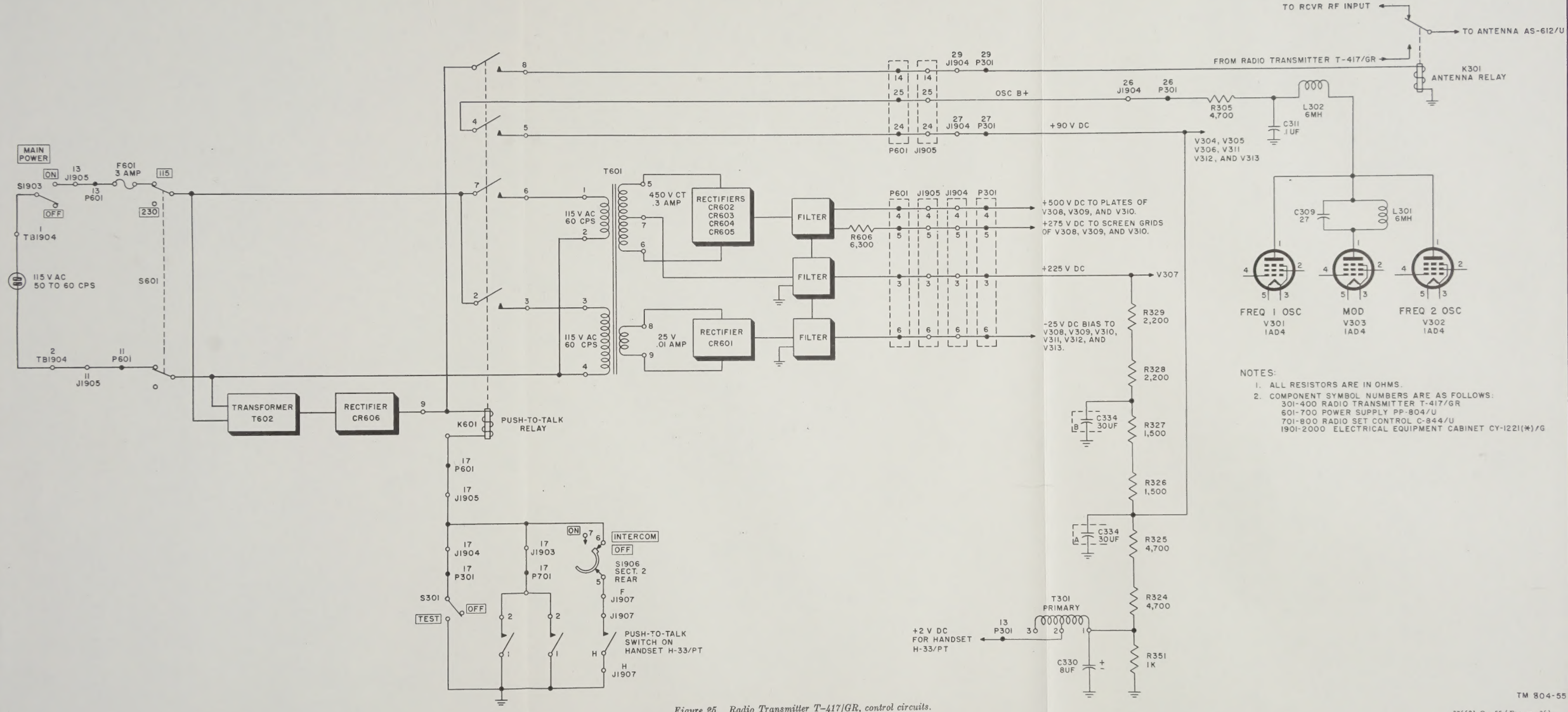
5 of plug P301 in the transmitter to provide screen voltage to tubes V308 through V310.

d. All the control circuits described above are set into action by operating two switches: the VOLUME-OFF switch at Radio Set Control C–847/U and the push-to-talk switch of Handset H–33/PT. During the initial tuning procedure, TEST-OFF switch S301 in the transmitter is used instead of the push-to-talk switch of the handset. Switch S301 parallels the handset switch and energizes relay K1201 in the power supply in the same manner as did the handset switch. The circuit is from the 6-volt dc source through fuses F801 and F1201, the closed contacts of relay K1203, the coil of K1201, and through switch S301 of the transmitter in the TEST position to ground. Power thus is applied to the transmitter in the same sequence as described for handset operation.

55. Radio Transmitter T–417/GR Control Circuits

(fig. 25)

The following information describes the application of B+ power of the transmitter when the



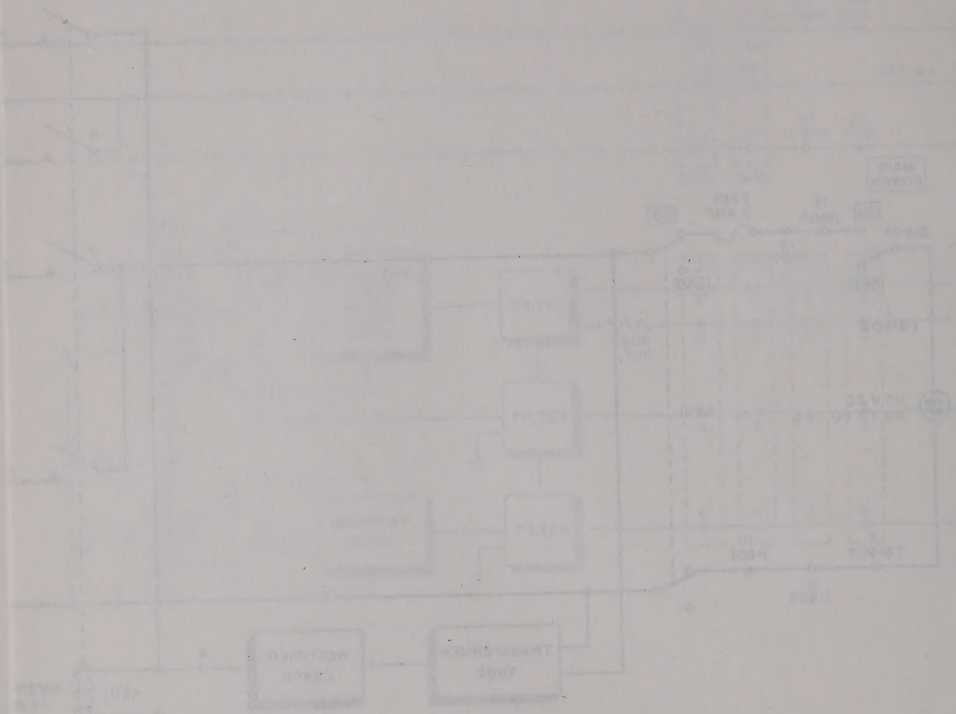
NOTES:

1. ALL RESISTORS ARE IN OHMS.
2. COMPONENT SYMBOL NUMBERS ARE AS FOLLOWS:
   301-400 RADIO TRANSMITTER T-417/GR
   601-700 POWER SUPPLY PP-804/U
   701-800 RADIO SET CONTROL C-844/U
   1901-2000 ELECTRICAL EQUIPMENT CABINET CY-1221(*)/G

Figure 25. Radio Transmitter T-417/GR, control circuits.

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push-to-talk switch is depressed or the TEST OFF switch is placed in the TEST position. Relay K601 in Power Supply PP–804/U is the push-to-talk relay. It is energized by grounding one side of its solenoid, thus completing a 6.5-volt circuit from CR606. Energizing the relay completes the following circuits:

a. Primary power is applied through contacts 7 and 6 and contacts 2 and 3 of K601 to transformer T601 in Power Supply PP–804/U, thereby providing an output from plug P601. Jacks J1905 and J1904 in Electrical Equipment Cabinet CY–1221(*)/G connect this output to plug P301 of the transmitter for distribution to the bias, plate, and screen-grid circuits of the transmitter.

b. The closing of contacts 5 and 4 completes a 90-volt dc circuit from a voltage-divider network in the transmitter to V301, V302, and V303.

c. The 6.5-volt dc from CR606 in Power Supply PP–804/U is applied to antenna relay K301 by the closing of contacts 8 and 9 of relay K601. This voltage energizes the antenna relay.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing Radio Transmitters T–208/U and T–417/GR be careful of the high dc voltage in the power-amplifier stage. Always disconnect the patch cord and discharge capacitors C330 and C334 before making resistance checks.

56. Troubleshooting Procedures

The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the *major component or circuit* responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults, such as burned-out resistors, rf arcing, and shorted transformers, often can be located by sight, smell, or hearing. The majority of faults, however, must be localized by *checking voltage and resistance.*

a. System Sectionalization. System sectionalization is discussed in the system instruction book for the particular radio set used.

b. Component Sectionalization and Localization. The tests listed below aid in isolating the source of trouble. To be effective the procedure should be followed in the order given. First, trouble should be localized to a single stage or circuit. Then the trouble may be isolated within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection (par. 40) is to locate any visible trouble. Through this inspection alone, the repairman frequently may discover the trouble, or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the transmitter, which might occur through improper servicing methods.

(2) *Resistance measurements.* These measurements (par. 60) may prevent further damage to the units from possible short circuits caused by faulty components.

(3) *Operational test.* The operational test (par. 41*e*) is important because it frequently indicates the general location of trouble.

(4) *Troubleshooting chart.* The trouble symptoms listed in this chart (par. 62) will aid greatly in localizing trouble.

(5) *Intermittents.* In all these tests, the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping ar jarring the set. *Do not tap the subminiature type tubes.* It is possible that the trouble is not in the transmitter itself but in the installation (antenna, interconnections, etc.) in this event, test the installation.

57. Troubleshooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the troubleshooting data below:

Fig.	Par.	Description
3	----	Transmitter tube locations.
10	----	Transmitter crystal oven, exploded view.
11	----	Left side of transmitter.
12	----	Bottom view of transmitter.
13	----	Test points and alinement locations.
22	----	B+ distribution.
23	----	Filament circuits.
24	----	Radio Transmitter T–208/U, control circuits.
25	----	Radio Transmitter T–417/GR, control circuits.

Fig.	Par.	Description
26	----	Tube socket voltage and resistance measurements.
27	----	Terminal board voltage and resistance measurements.
28	----	Right side of transmitter.
29	----	Radio Transmitters T–208/U or T–417/GR, front panel removed.
30	----	Exciter subchassis, bottom view.
32	----	Resistor color codes.
33	----	Capacitor color codes.
34	----	Radio Transmitter T–208/U, schematic diagram.
35	----	Radio Transmitter T–417/GR driver and final stages, schematic diagram.
	63	Dc resistances of transformers and coils.

58. Test Equipment Required for Troubleshooting

The test equipment required for troubleshooting Radio Transmitters T–208/U and T–417/GR is listed in the following table. The technical manuals associated with the test equipment are also listed.

Test equipment	Technical manual or bulletin
Multimeter TS–352/U or TS–297/U----	TM 11–5527 and TM 11–5500.
Electronic Multimeter TS–505/U------	TM 11–5511.
Tube Tester I–177 or Electron Tube Test Set TV–7/U.	TM 11–2627 and TM 11–5083.
Tube test data [1]----------	TB 11–2627–2.

[1] This data is needed when Tube Tester I–177 is used.

59. General Precautions

Whenever the transmitter is serviced, observe the following precautions:

a. Be careful when dust covers are removed; high dc voltage is exposed.

b. Careless replacement of parts often makes new faults inevitable. Observe the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer or filter, has a number of connections, tag each lead to it.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not use a large soldering iron when soldering small resistors or ceramic capacitors. Overheating the small parts may ruin the part or change its value.

(4) Do not allow drops of solder to fall into the set, since they may cause short circuits.

(5) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to locate.

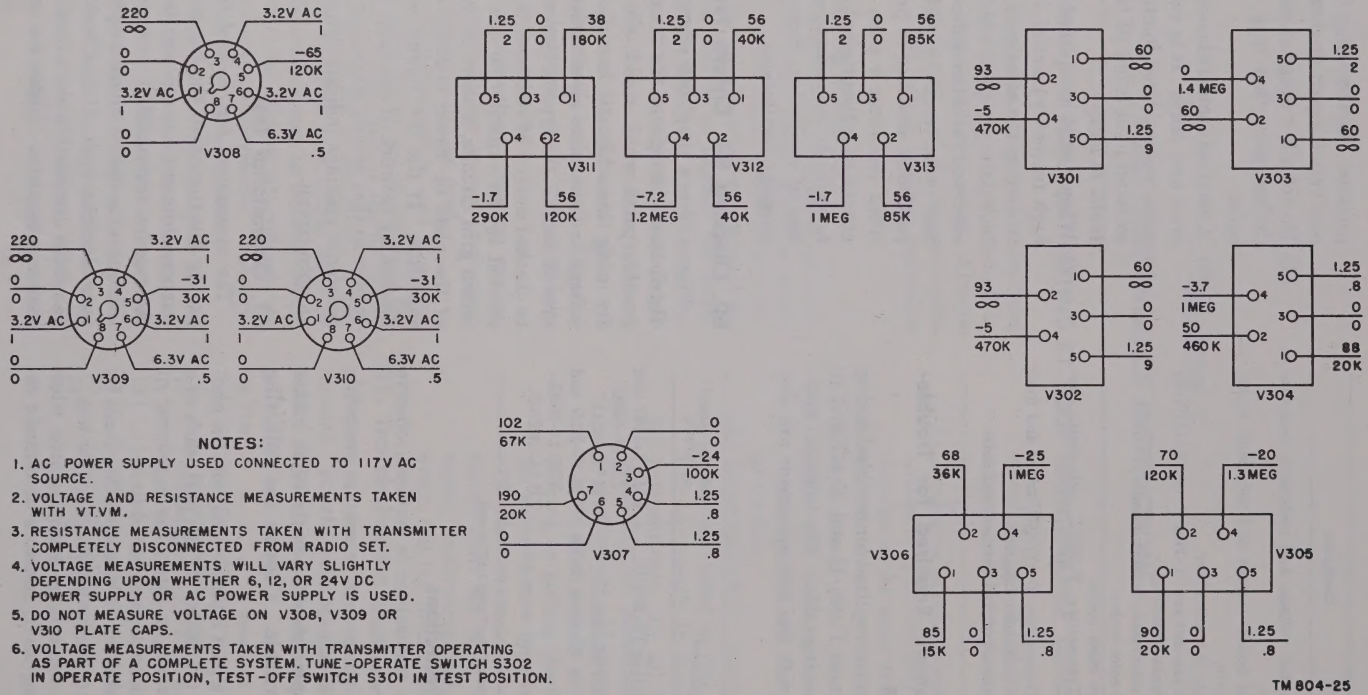
(6) When a part is replaced in a vhf (very-high-frequency) circuit, it must be placed in exactly the same position as the original part. A part which has the same electrical value but different physical size may cause trouble in vhf circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in loss of oscillation, decreased output, or parasitic oscillations.

60. Checking B+ Circuits for Shorts

Figure 22 is a simplified schematic of the B+ distribution throughout the transmitter and the possible paths which could offer short circuits. By using this schematic in conjunction with the voltage and resistance measurements found in figures 26 and 27, the typical causes for trouble can be checked easily. If resistance is low, check for a shorted bypass capacitor in one of the plate or screen grid circuits, a short in the wiring in one of the plate or screen circuits, or leakage in a capacitor. If the B+ circuit is shorted in the decoupling network of one stage, it may drop the voltage so that several stages are affected. High resistance readings indicate defective resistors or an open circuit.

61. Operational Test

The operational test is used to check for the proper functioning of the transmitter. For this purpose a dummy antenna may be used instead of the regular transmitting antenna. Operate the transmitter as described in the equipment performance checklist (par. 41). Check to see that all functions described in the normal indications column are completed. Listen for crackling or buzz-



NOTES:

1. AC POWER SUPPLY USED CONNECTED TO 117V AC SOURCE.
2. VOLTAGE AND RESISTANCE MEASUREMENTS TAKEN WITH VTVM.
3. RESISTANCE MEASUREMENTS TAKEN WITH TRANSMITTER COMPLETELY DISCONNECTED FROM RADIO SET.
4. VOLTAGE MEASUREMENTS WILL VARY SLIGHTLY DEPENDING UPON WHETHER 6, 12, OR 24V DC POWER SUPPLY OR AC POWER SUPPLY IS USED.
5. DO NOT MEASURE VOLTAGE ON V308, V309 OR V310 PLATE CAPS.
6. VOLTAGE MEASUREMENTS TAKEN WITH TRANSMITTER OPERATING AS PART OF A COMPLETE SYSTEM. TUNE-OPERATE SWITCH S302 IN OPERATE POSITION, TEST-OFF SWITCH S301 IN TEST POSITION.

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Figure 26. Tube socket voltage and resistance measurements.

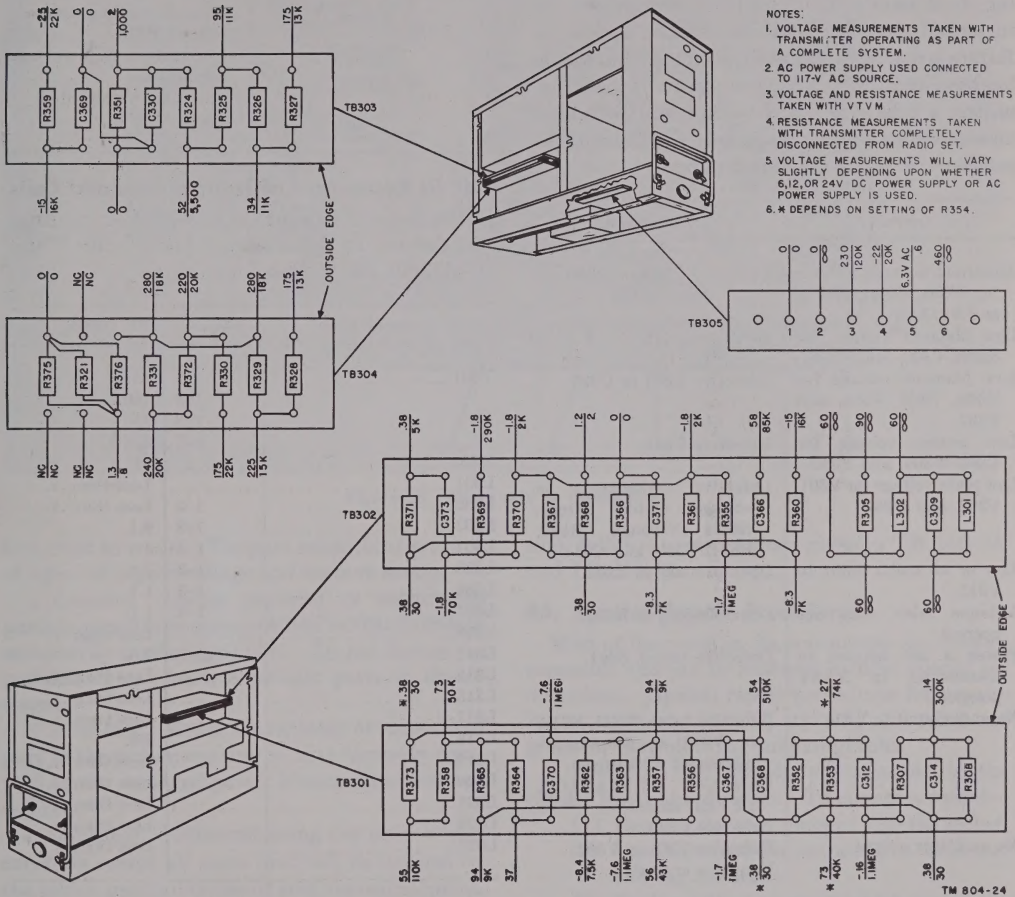


Figure 27. Terminal board voltage and resistance measurements.

ing noises which indicate high-voltage arcing. Check for smoke and the odor of burned or overheated parts.

62. Troubleshooting Chart

Since operation of the transmitter depends entirely upon other system components, the following chart assumes that all system components are in normal operating condition and that equipment failure is due to the transmitter. Once the trouble has been localized to a stage or circuit of the transmitter, a tube check and voltage and resistance measurements of this stage or circuit should be sufficient to isolate the defective part.

Symptom	Probable trouble
Abnormal filament voltage for V303, V311, V312, and V313.	Defective R368 or R366.
Low filament voltage for V308, V309, and V310.	Defective C348.
Low filament voltage for V304, V305, V306, and V307.	Defective R321 or C329.
Low screen voltage for V308, V309, and V310.	Defective C341.
Low plate voltage for V301, V302, and V303.	Defective components in voltage divider circuit (R324 through R329, R351, C330, and C334).
Low or no audio input to V311.	Open primary in T301.
Antenna relay does not operate.	Open winding in K301.
Power is not applied to transmitter in TEST position.	Defective switch S301.
No audio input to V303	Defective tubes (V311, V312, or V313, or components associated with tubes). Defective DEVIATION LEVEL control. Defective C312.
No oscillator output	Defective V301 or V302. Defective crystal.
No output from any one stage (V303 through V310).	Defective tube. Defective coupling capacitor. Defective plate tuning coil. Open or shorted resistor.
Low or no output from transmitter.	Defective COUP. SW. Defective components in filter or coupling network. Defective R374. Incorrect antenna filter strap connections. Transmitter misalined. Defective C344.

63. Dc Resistances of Transformers and Coils

The dc resistances of the transformer windings and the coils of Radio Transmitters T–208/U and T–417/GR are listed below—

Transformer or coil	Terminals	Ohms
T301	1–2	75.
	1–3	150.
	2–3	75.
	4–5	5,000.
K301		52.
L301		Less than .1.
L302	1–3	Less than .1.
L303	1–3	9.1.
L304	1–3	4.
L305	1–3	1.1.
L306	1–3	1.1.
L307	1–3	1.1.
L308		Less than .1.
L311		2.6.
L312		Less than .1.
L313		Less than .1.
L317		Less than .1.
L318		2.6.
L319		Less than .1.
L320		Less than .1.
L321		Less than .1.
L322		Less than .1.
L323		Less than .1.

Section II. REPAIRS

64. Replacement of Parts

When replacing parts in Radio Transmitters T–208/U and T–417/GR, observe the precautions given below.

a. Tagging Leads. Tagging leads is essential to assure that correct rewiring will be made when a part is replaced. Use small tags or short pieces of adhesive tape to identify all wires in accordance with their connections. Identify every lead that is to be removed.

b. Parts and Substitutions. When damaged parts must be replaced, identical parts should be used. If identical parts are not available and the damaged component is beyond repair, a substitu-

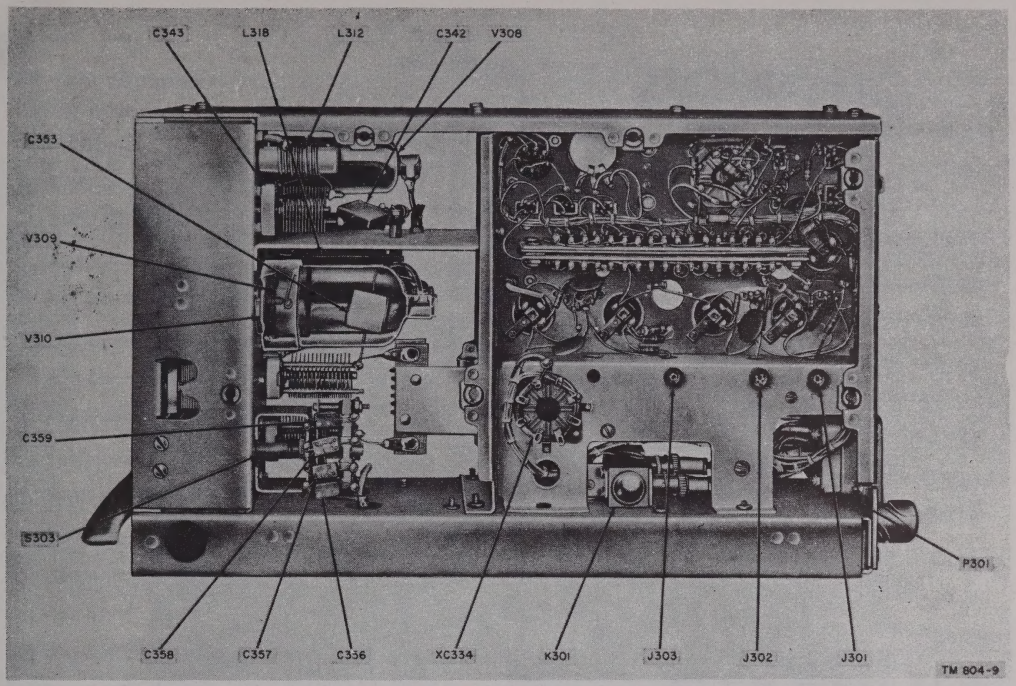


Figure 28. Right side of transmitter.

tion must be made. The part substituted must be of equal or higher voltage and current rating.

c. Location. Locate replaced or substituted parts in exactly the same position as that formerly occupied by the damaged part. Do not change the position of any part, especially parts in the rf stages.

d. Mounting. Mount the replaced or substituted part in the same mounting as that formerly occupied by the damaged part. Fasten all mountings securely.

e. Soldering. Before soldering any connections, carefully scrape all parts that will be touched by the solder, until all traces of rust, corrosion, paint, or varnish are removed. Remove the scrapings with a small clean brush. Tin all surfaces to be soldered. Wrap the wire around the lug to obtain mechanical support. Use a small amount of solder to make the connection and use sufficient heat to make the solder flow evenly around the tinned surfaces.

f. Retropicalization. If the parts to be replaced require special treatment, such as retropicalization, follow the instructions given in TB SIG 13, and TB SIG 72.

65. Special Repair Procedures

Most of the parts in the transmitter are readily accessible and can be replaced without special instructions. Special repair procedures for repairing or replacing sockets, crystals, and tubes are given in the following subparagraphs.

a. Sockets. All sockets are attached to the chassis by means of rivets. To change a socket—

(1) Remove the part plugged into the socket.
(2) Unsolder the wires connected to the socket and tag the leads.
(3) Drill out the two rivets which fasten the socket to the chassis.
(4) Substitute a new socket and fasten it with rivets or machine screws, lockwashers, and nuts.
(5) Resolder the wires to the socket.
(6) Clean the unit thoroughly to remove chips and solder drops.
(7) Check the new connections with those shown in the schematic for that unit.

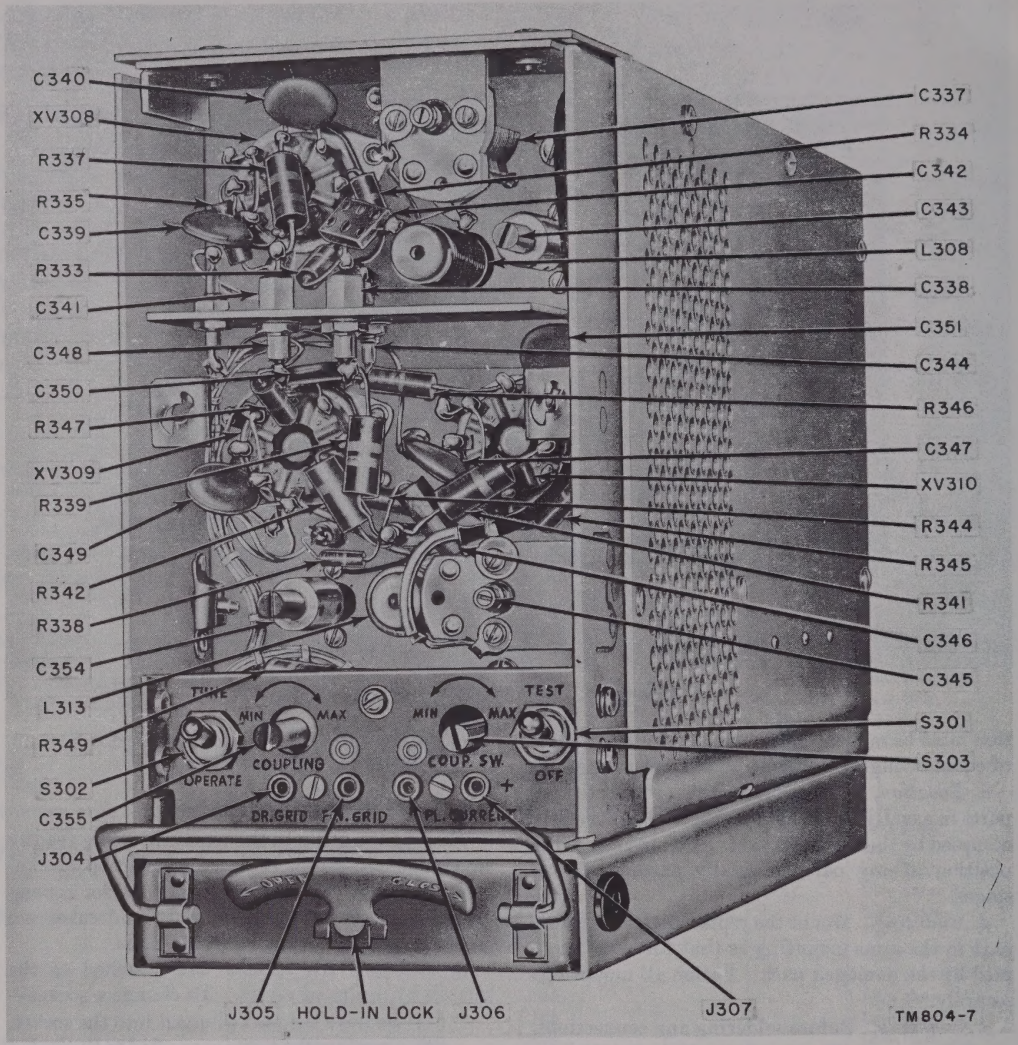


Figure 29. Radio Transmitter T–208/U or T–417/GR, front panel removed.

b. Subminiature-Type Tubes. To remove a subminiature-type tube, lift the hold-down clip away from the tube and then *very gently* lift the tube from its socket. The red dot on the side of the tube must be located next to the red dot painted on the chassis. Under the chassis, pin number 1 is the pin closest to a red dot painted directly on the chassis. The remaining pins are numbered as shown in figure 26. Replacement tubes may be furnished with long leads attached, which must be cut to a length suitable for insertion in the tube socket. Carefully cut the leads with a sharp cutter.

66. Refinishing

Instructions for refinishing badly marred panels are given in TM 9–2851.

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67. Test Equipment Required for Alinement

a. Frequency Meter. Use Frequency Meter TS–174/U, or equal, to check the operating frequency of the transmitter. The TS–174/U is covered in TM 11–5044.

b. Deviation Monitor. The deviation monitor used should be capable of indicating 15-kc deviation at the transmitter operating frequency. Panoramic Indicator IP–173/U (covered in TM 11–5086) and Signal Generator AN/URM–48 (covered in TM 11–1257) may be used.

c. Audio Oscillator. Audio Oscillator TS–382A/U (covered in TM 11–2684A), or equal, will be needed to supply audio modulation to the transmitter for the deviation limit adjustment.

68. Crystal Frequency Adjustment

Variable capacitor C303 and C304 (FREQ 2 and FREQ 1, fig. 13) allow slight adjustment of the crystal operating frequency. These controls should be left in their center positions. Use a frequency standard meter comparable to the unit described in paragraph 67*a*. To make the adjustment perform the following steps.

a. Connect the transmitter to a proper noninductive load resistor.

b. Tune the transmitter as described in paragraph 19 and leave the TUNE-OPERATE switch in the TUNE position.

c. Set up the frequency meter on the assigned transmitter frequency, following instructions supplied with the meter.

d. For T_T208/J, turn the VOLUME-OFF switch on Radio Set Control C–847/U toward a volume position and set the frequency selector switch to FREQ 2. For T–417/GR, place the MAIN POWER switch on the CY–1221(*)/G in the ON position.

e. Turn the TEST-OFF switch on the transmitter to the TEST position.

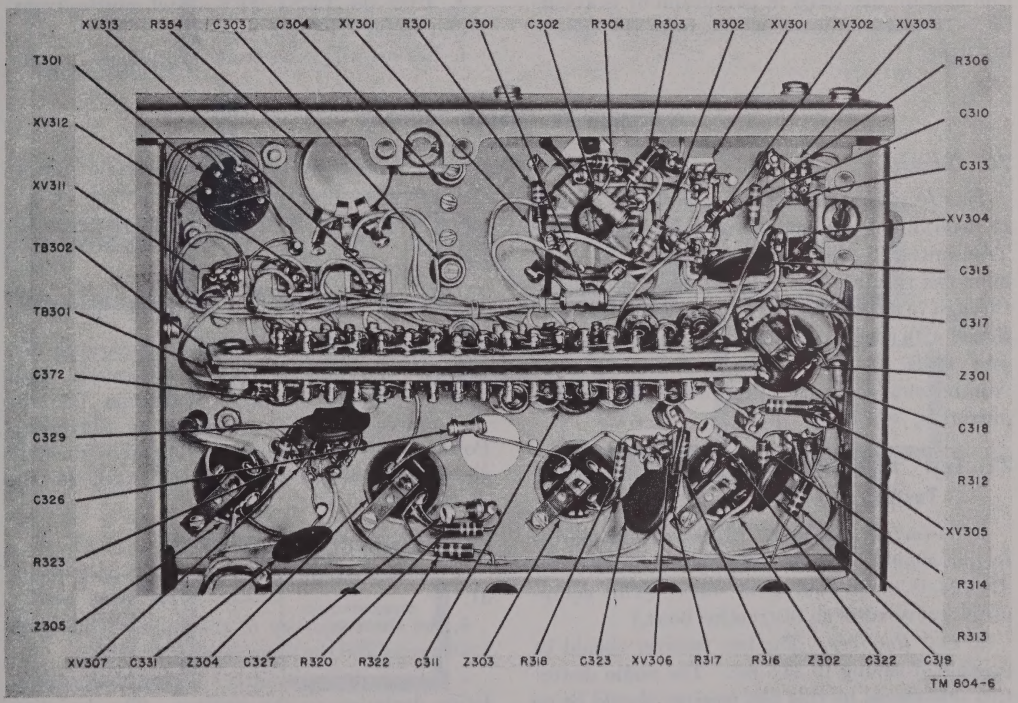


Figure 30. Exciter subchassis, bottom view.

f. Adjust capacitor C303 (fig. 11) until the correct transmitter frequency is indicated on the frequency meter.

g. Set the frequency selector switch on the control to FREQ 1.

h. Set up the frequency meter to the desired transmitter frequency.

i. Adjust capacitor C304 (fig. 11) until the correct transmitter frequency is indicated on the frequency meter.

j. Turn the TEST-OFF switch to the OFF position.

k. Turn the VOLUME-OFF switch on the Radio Set Control C–847/U to the OFF position (T–208/U). Turn the MAIN POWER switch on CY–1221(*)/G to the OFF position (T–417/GR).

69. Deviation Level Adjustment

Resistor R354 (DEVIATION LEVEL) allows adjustment of the maximum deviation level. Adjustment should not be attempted unless the deviation monitor described in paragraph 67 is available. To make adjustments, perform the following steps:

a. Set up the equipment as shown in A, figure 31. The audio oscillator connects to the 600-ohm audio input terminals of the transmitter. For Radio Transmitter T–208/U this connection is to terminals 9 and 10 of terminal board TB801 in Electrical Equipment Cabinet CY–938(*)/VRC. For Radio Transmitter T–417/GR this connection is to terminals 5 and 10 of terminal board TB1902 in Electrical Equipment Cabinet CY–1221(*)/G.

b. Set the frequency of the audio oscillator at 1,000 cycles and the input level at minimum.

c. Apply power to the radio set.

d. Set the TEST-OFF switch on the transmitter to the TEST position.

e. Tune the deviation monitor to the transmitter signal, following instructions supplied with the monitor.

f. Set the audio oscillator output to 200 millivolts (.2 volts).

g. Observe the modulation deviation on the monitor and adjust the DEVIATION LEVEL control R354 (fig. 11) on the transmitter for a deviation of 15 kc.

h. Turn the TEST-OFF switch on the transmitter to the OFF position.

i. Remove all power from the radio set.

Section IV. FINAL TESTING

70. General

This section is intended as a guide to be used in determining the quality of a repaired Radio Transmitter T–208/U or T–417/GR. The minimum test requirements outlined in paragraphs 72 through 75 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

71. Test Equipment Required for Final Testing

a. Distortion Analyzer. Measurements for distortion should be made with Spectrum Analyzer TS–723/U or an equivalent unit. (This equipment is covered in an instruction book.)

b. Test Receiver. The test receiver should be capable of tuning to 36.5 mc. The audio distortion introduced by this test receiver should be no more than 4 percent at the audio level used for testing. The frequency response curve of the receiver must be known.

c. Audio Voltmeter. Two audio voltmeters are required. These should be Multimeters TS–352/U, or equivalent.

d. Deviation Monitor. Refer to paragraph 67*b*.

e. Audio Oscillator. Refer to paragraph 67*c*.

f. Rf Wattmeter. The rf wattmeter used should be Radio Frequency Wattmeter TS–118/AP (covered in TM 11–1038) or equivalent. Power output measurements will be approximately 25 watts for the T–208/U and 45 watts for the T–417/GR.

72. Deviation Limit Check

a. Connect the equipment as shown in A, figure 31.

b. Set the frequency of the audio oscillator at 1,000 cycles and the input level at 5 volts.

c. Operate the transmitter and observe the modulation deviation on the monitor. The deviation should not exceed 18 kc.

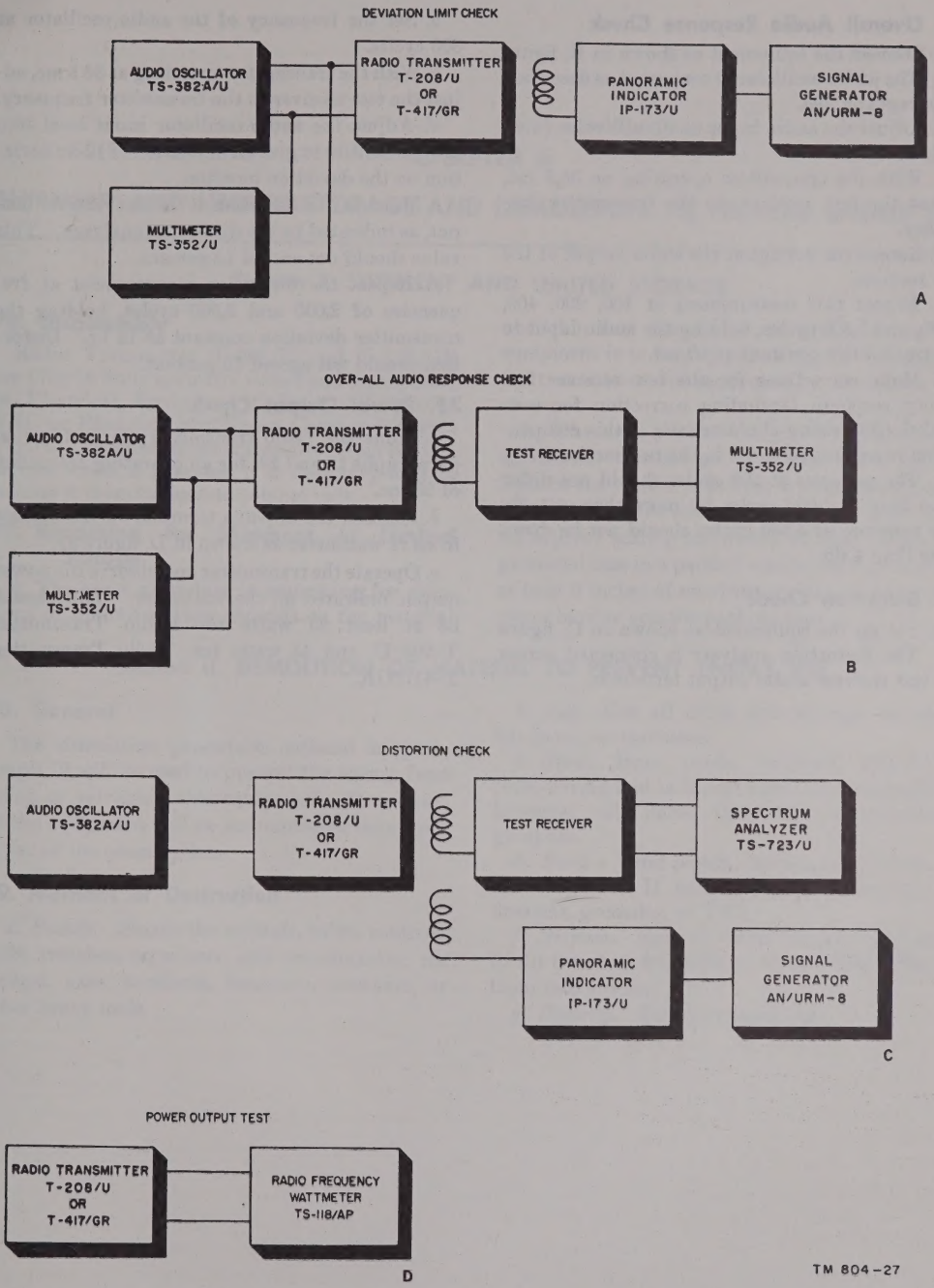


Figure 31. Test block diagrams.

73. Overall Audio Response Check

a. Connect the equipment as shown in B, figure 31. The audio oscillator is connected as described in paragraph 69*a*.

b. Adjust the audio input to 40 millivolts (mv) at 1,000 cycles.

c. With the transmitter operating on 36.5 mc, adjust the test receiver to the transmitter frequency.

d. Record the voltage at the audio output of the test receiver.

e. Repeat this measurement at 100, 200, 400, 2,000, and 3,500 cycles, holding the audio input to the transmitter constant at 40 mv.

f. Make corrections for the test receiver frequency response (including correction for a 6-decibel (db) rising characteristic if this compensation is not incorporated in the test receiver).

g. The response at 100 cycles should not differ from that at 1,000 cycles by more than ±1 db. The response at 3,500 cycles should not be down more than 4 db.

74. Distortion Check

a. Set up the equipment as shown in C, figure 31. The distortion analyzer is connected across the test receiver audio output terminals.

b. Set the frequency of the audio oscillator at 800 cycles.

c. With the transmitter operating at 36.5 mc, adjust the test receiver to the transmitter frequency.

d. Adjust the audio oscillator input level into the transmitter to give an indication of 12-kc deviation on the deviation monitor.

e. Measure the distortion at the test receiver output, as indicated by the distortion analyzer. This value should not exceed 10 percent.

f. Repeat the distortion measurement at frequencies of 2,000 and 3,500 cycles, holding the transmitter deviation constant at 12 kc. Distortion should not exceed 10 percent.

75. Power Output Check

a. Tune the radio transmitter, as outlined in paragraphs 18 and 19, for an operating frequency of 25 mc.

b. Connect the antenna terminal on the cabinet to an rf wattmeter as shown in D, figure 31.

c. Operate the transmitter and observe the power output indicated on the wattmeter. This should be at least 25 watts for Radio Transmitter T–208/U and 45 watts for Radio Transmitter T–417/GR.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

76. Disassembly

Radio Transmitter T–208/U and T–417/GR are plug-in units normally stored and transported in Electrical Equipment Cabinet CY–938(*)/VRC or Electrical Equipment Cabinet CY–1221(*)/G. To separate the transmitter from the system in which it operates, it is necessary only to remove it from the system cabinet unit.

77. Repacking for Shipment or Limited Storage

a. The exact procedure in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Normally, the transmitter will be housed in the cabinet for storage.

b. Whenever practicable, place a dehydrating agent such as silica gel inside the inner carton. Protect the transit case with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected case in a padded wooden case, providing at least 3 inches of excelsior padding between the paper barrier and the packing case.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

78. General

The demolition procedure outlined in paragraph 79 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

79. Methods of Destruction

a. Smash. Smash the crystals, tubes, controls, coils, switches, capacitors, and transformers; use sledges, axes, handaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut all cords and wiring; use axes, handaxes, or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet, and chassis.

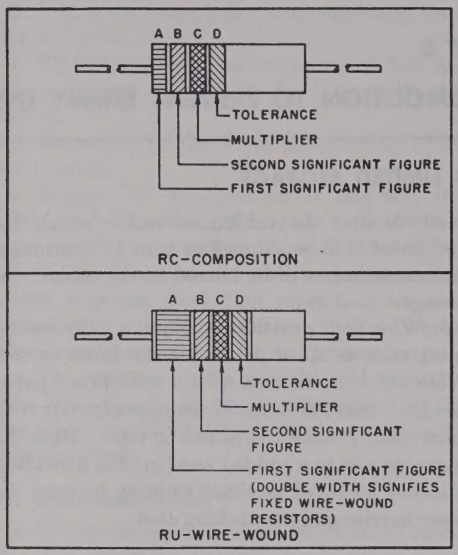
e. Explode. If explosives are necessary, use firearms, grenades, or TNT.

f. Dispose. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

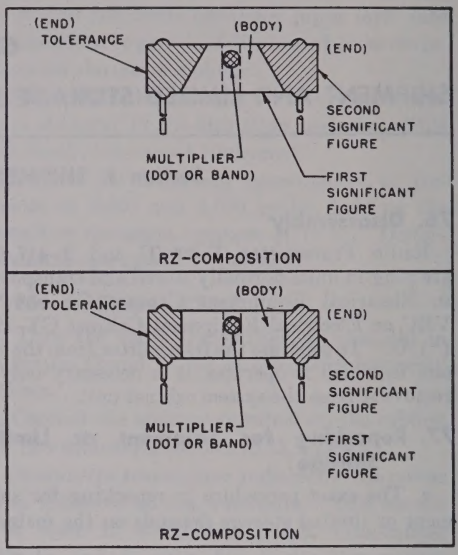
g. Destroy. Destroy everything.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)



RADIAL-LEAD RESISTORS (UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	±20
BROWN	1	BROWN	1	BROWN	10	SILVER	±10
RED	2	RED	2	RED	100	GOLD	±5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

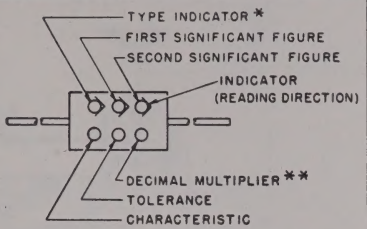
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-RI

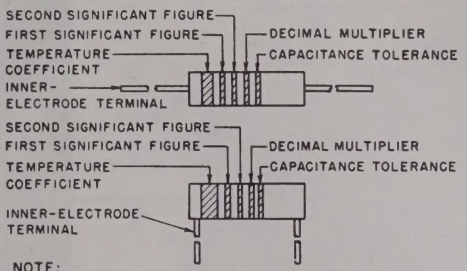
Figure 32. Resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



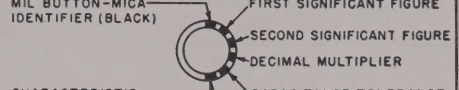
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

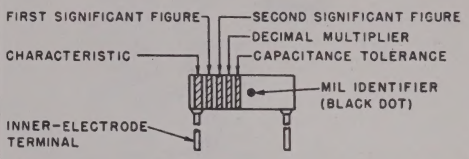


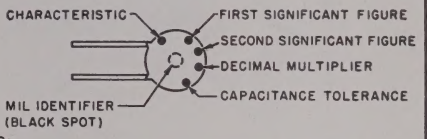
NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



BUTTON-MICA (CB)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

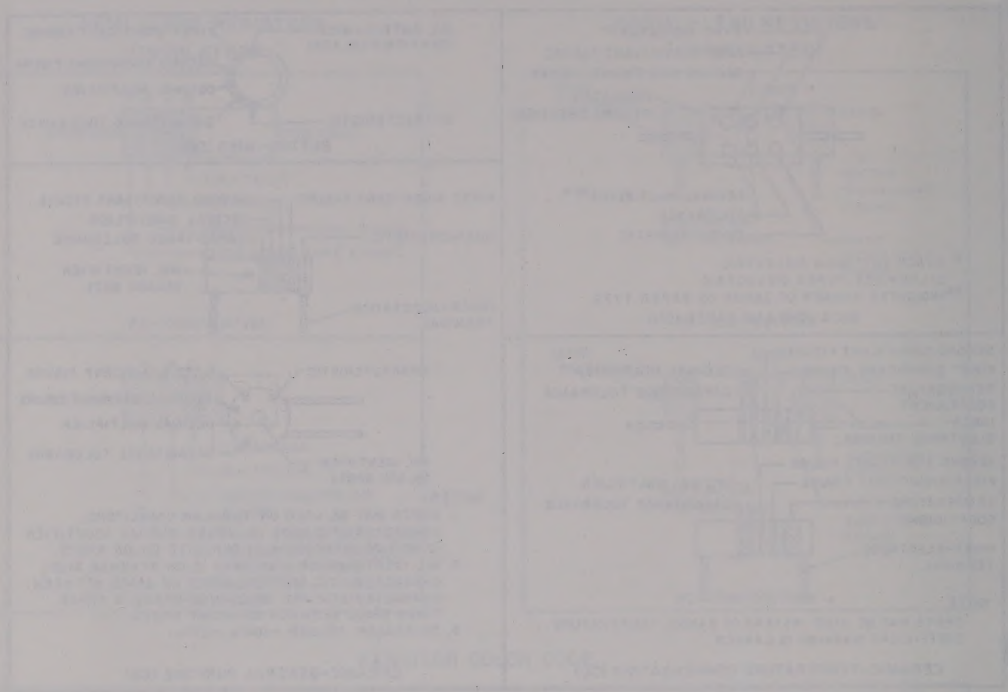
CERAMIC-GENERAL PURPOSE (CK)

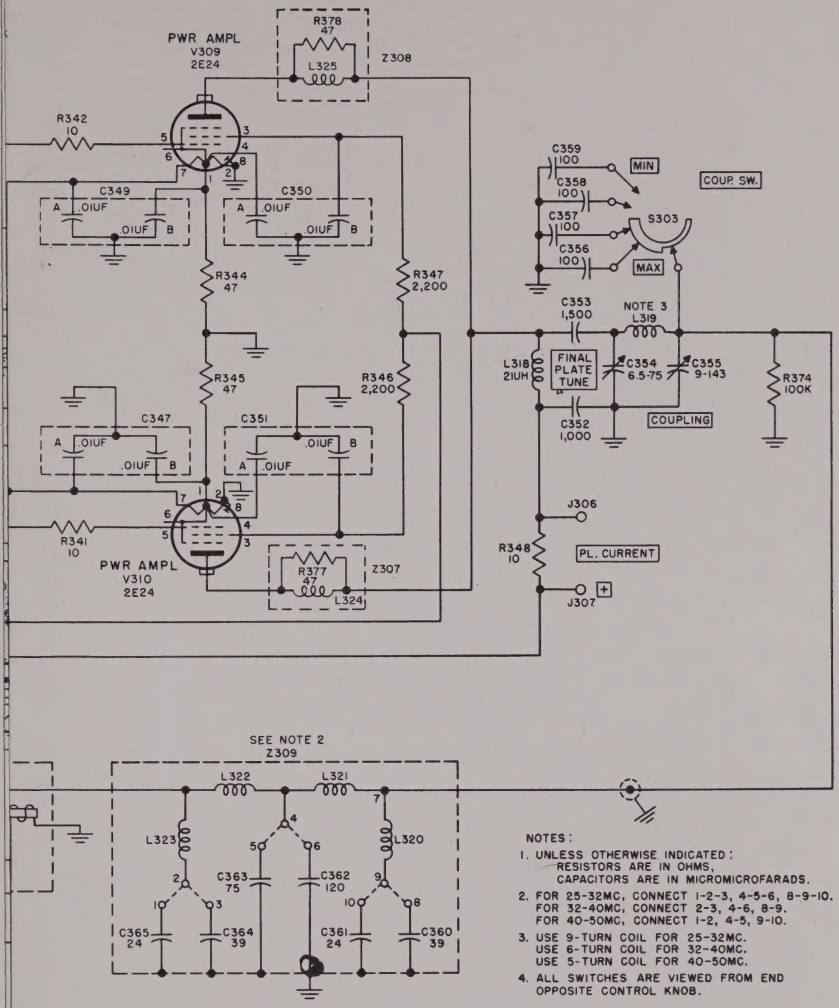
CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

Figure 33. Capacitor color codes.





NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTORS ARE IN OHMS,
   CAPACITORS ARE IN MICROMICROFARADS.
2. FOR 25-32MC, CONNECT 1-2-3, 4-5-6, 8-9-10.
   FOR 32-40MC, CONNECT 2-3, 4-6, 8-9.
   FOR 40-50MC, CONNECT 1-2, 4-5, 9-10.
3. USE 9-TURN COIL FOR 25-32MC.
   USE 6-TURN COIL FOR 32-40MC.
   USE 5-TURN COIL FOR 40-50MC.
4. ALL SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB.



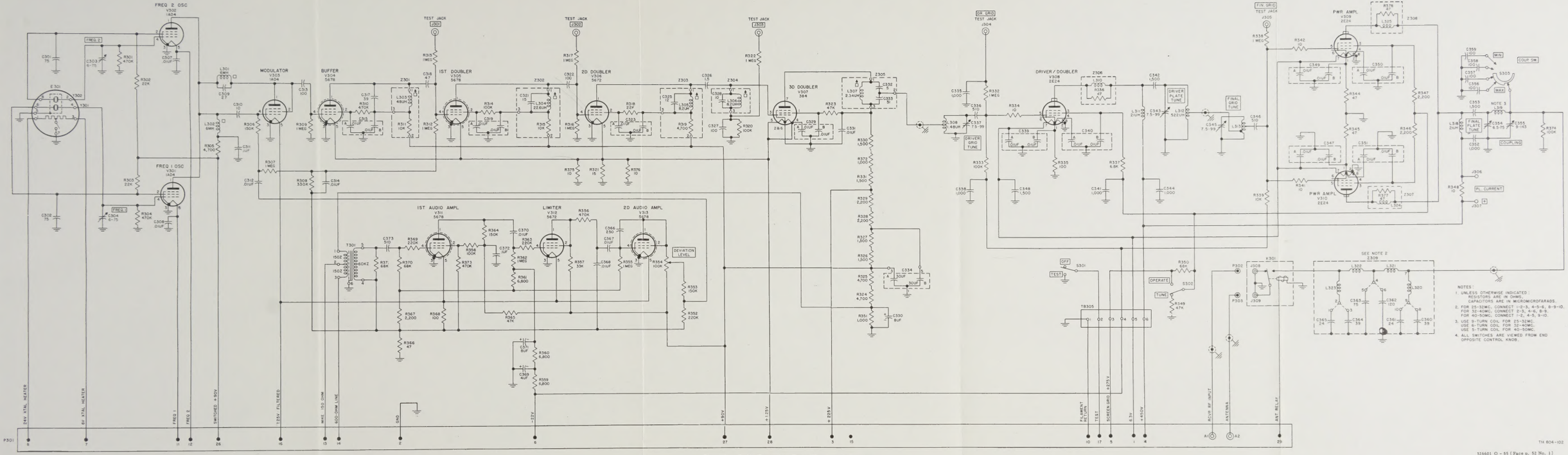


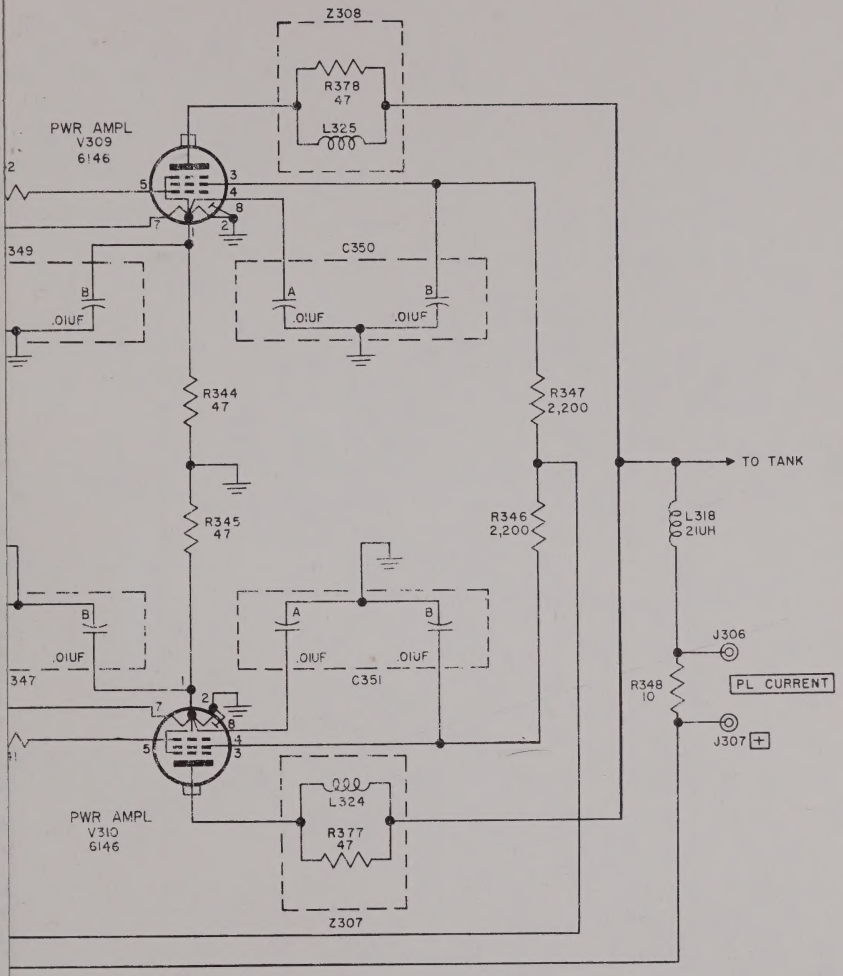
Figure 84. Radio Transmitter T-208/U, schematic diagram

NOTES:
1. UNLESS OTHERWISE INDICATED:
   RESISTORS ARE IN OHMS.
   CAPACITORS ARE IN MICROMICROFARADS.
2. FOR 25-32MC, CONNECT 1-2-3, 4-5-6, 8-9-10.
   FOR 32-40MC, CONNECT 2-3, 4-6, 8-9.
   FOR 40-50MC, CONNECT 1-2, 4-5, 9-10.
3. USE 9-TURN COIL FOR 25-32MC.
   USE 6-TURN COIL FOR 32-40MC.
   USE 5-TURN COIL FOR 40-50MC.
4. ALL SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB.

TM 804-102

328601 O - 55 (Face p. 52 No. 1)

GPO 829-029-6



NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTORS ARE IN OHMS,
   CAPACITORS ARE IN UUF.
2. BOXED ITEMS ARE CONTROLS.
3. REMAINDER OF RADIO TRANSMITTER T-417/GR STAGES ARE SAME AS RADIO TRANSMITTER T-208/U

TM 804-35

(Face p. 52 No. 2)

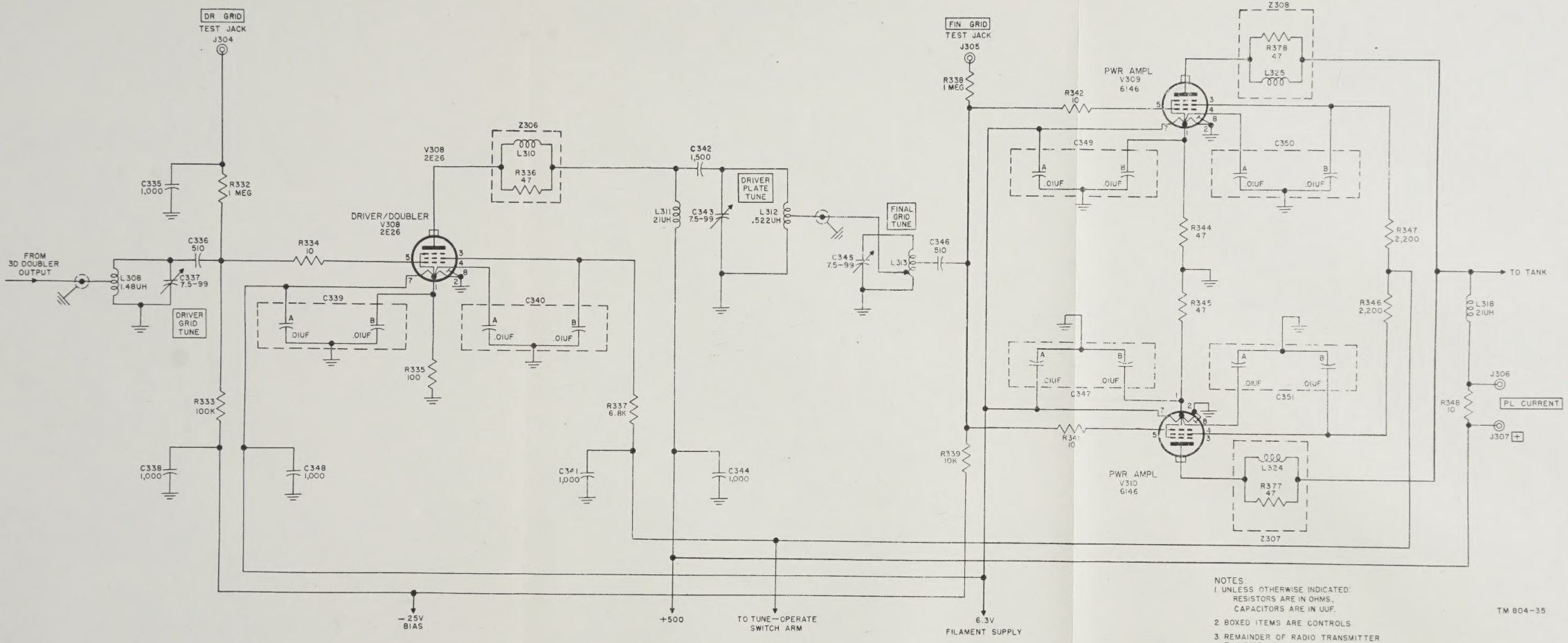
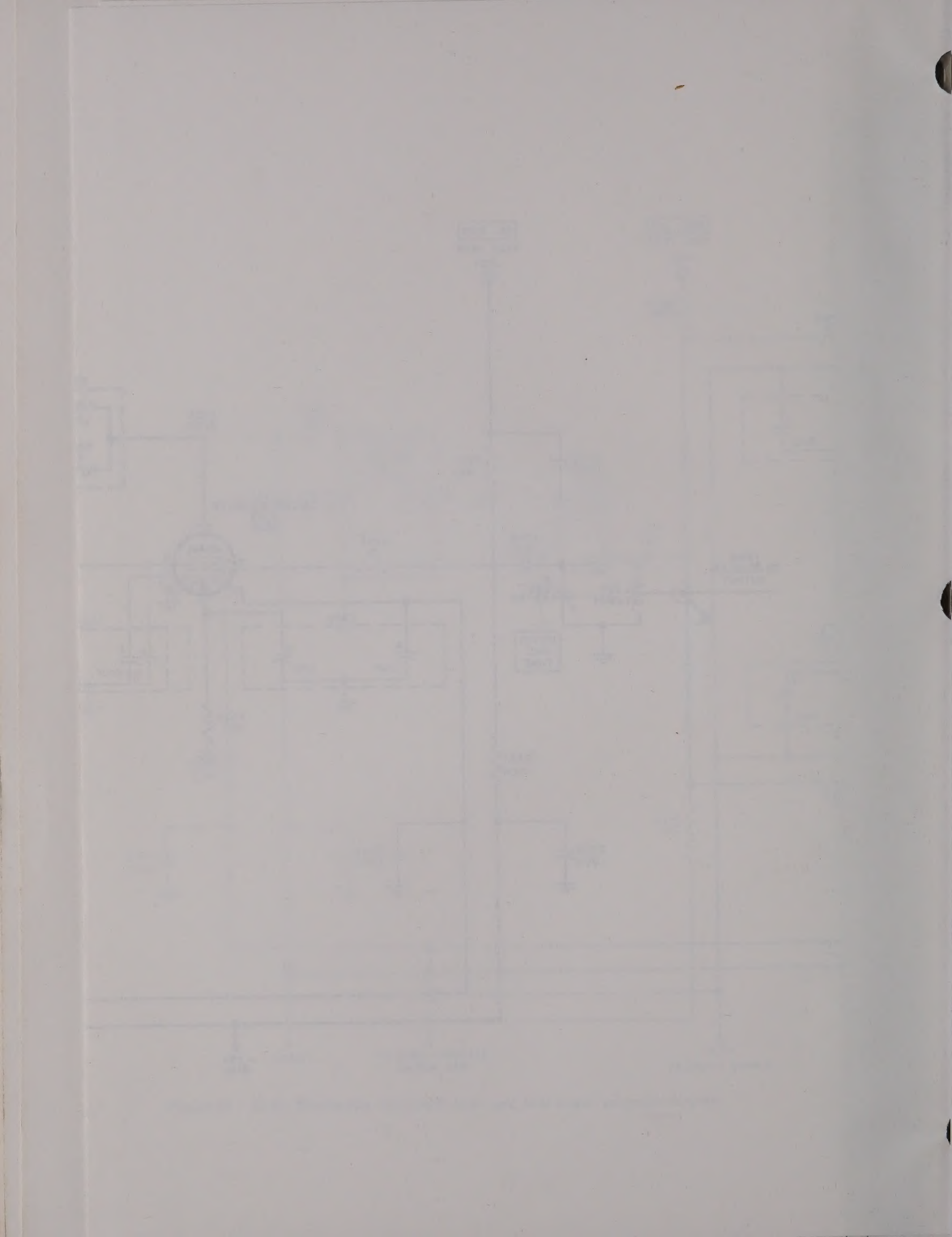


Figure 35. Radio Transmitter T-417/GR driver and final stages, schematic diagram

NOTES:
1. UNLESS OTHERWISE INDICATED:
   RESISTORS ARE IN OHMS,
   CAPACITORS ARE IN UUF.
2. BOXED ITEMS ARE CONTROLS.
3. REMAINDER OF RADIO TRANSMITTER T-417/GR STAGES ARE SAME AS RADIO TRANSMITTER T-208/U.

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(Face p. 52 No. 2)



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[AG 413.44 (18 Nov 54)]

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