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TM 11-212-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE
RADIO SET AN/TRC-47

HEADQUARTERS, DEPARTMENT OF THE ARMY

MAY 1958

WARNING

DANGEROUS VOLTAGES

EXIST IN THE FOLLOWING UNITS:

Radio Receiver R–748(*)/TRC–47	240 VDC
Telephone Signal Converter CV–542/TRC–47	260 VDC
Radio Transmitter T–593(*)/TRC–47	345 VDC

TECHNICAL MANUAL
No. 11-212-35

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *20 May 1958*

RADIO SET AN/TRC-47
FIELD AND DEPOT MAINTENANCE

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CHAPTER 1

INTRODUCTION

1. Scope

a. These instructions are published for the use of personnel performing field and depot maintenance on Radio Set AN/TRC–47. The complete instructions for this equipment includes two other manuals as follows:

TM 11–212–10, Radio Set AN/TRC–47, Operator's Manual.

TM 11–212–20, Radio Set AN/TRC–47, Organizational Maintenance.

b. The repair parts and special tools list will be published separately.

c. Forward comments on this manual directly to Commanding Officer, U.S. Army Signal Publications Agency, Fort Monmouth, N. J.

2. Forms and Records

a. Unsatisfactory Equipment Reports. Fill out and forward DA Form 468 (Unsatisfactory Equipment Report, to Commanding Officer, U.S. Army Signal Equipment Support Agency) Fort Monmouth, N. J., as prescribed in AR 700–38.

b. Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army).

CHAPTER 2

THEORY

Section I. GENERAL THEORY OF RADIO SET AN/TRC-47

3. Transmitting Signal Path

(fig. 1, TM 11-212-10)

a. The 20-cycles per second (cps) ringing signal from the telephone is applied to the telephone signal converter where it is converted to a 800-cps signal which is used to modulate the transmitter.

b. Voice signals from the telephone are passed through the converter and modulate the transmitter without any change in quality and very little loss in amplitude.

4. Receiving Signal Path

(fig. 1, TM 11-212-10)

a. The signal transmitted by the transmitter is picked up by the receiver at the remote site.

b. The 800-cps ringing signal passes through the receiver and is applied to the converter where it is converted to 20-cps ringing voltage which will cause the phone connected to the converter to ring.

c. The voice signals transmitted by the set at one site are received by the remote set. The voice signal is passed by the converter without loss in amplitude.

Section II. THEORY OF RADIO RECEIVER R-748(*)/TRC-47

5. Block Diagram

Radio Receiver R-748(*)/TRC-47 is capable of receiving amplitude modulation (am) signals within a frequency range of 132 to 150 megacycles (mc) depending on the crystal used. The signal path is shown in the block diagram (fig. 1) and is discussed in *a* through *g* below. For complete circuit details, refer to the overall schematic diagram (fig. 54).

a. The radiofrequency (RF) amplifier V3 in Radio Receiver R-748(*)/TRC-47 is tuned to the transmitted frequency and amplifies the input signal. Its output is coupled to the first mixer V4.

b. First local oscillator quadrupler V1 is crystal-controlled and oscillates within the frequency range of 9.27 to 10.77 mc depending on the crystal used. Its plate circuit is tuned to the fourth harmonic of the crystal frequency. The output frequency of the oscillator quadrupler therefore is 37.08 to 43.08 mc and is coupled to tripler V2. The tripler further multiplies the frequency and its output is 111.24 to 129.24 mc. This signal is also coupled to the first mixer where it mixes with the 132- to 150-mc output of the RF amplifier V3.

c. The second local oscillator quadrupler is also crystal-controlled but operates at a fixed frequency of 6.425 mc. The plate circuit of second local oscillator V5A is tuned to the fourth harmonic of 6.425 mc, which is 25.7 mc. The output of first mixer V4 (20.7 mc) and the output of second local oscillator quadrupler V5A (25.7 mc) are coupled to the second mixer V5B. This stage is tuned to the difference frequency and the output of the second mixer is therefore 5 mc.

d. The 5-mc output of second mixer V5B is coupled in turn to the first and second IF amplifiers V6 and V7. Maximum signal amplification takes place in these stages.

e. The 5-mc output of the second IF amplifier V7 is coupled to the audio detector (one-half of V8) where the intelligence is extracted from the IF signal. The noise limiter tube (one-half of V11) keeps noise pulses from reaching the first audio amplifier.

f. The output of second IF amplifier V7 is also coupled to the automatic gain control (agc) detector (one-half of V10). One output of the agc detector is applied to the agc control section of V10. The output of the control section is fed back to, and

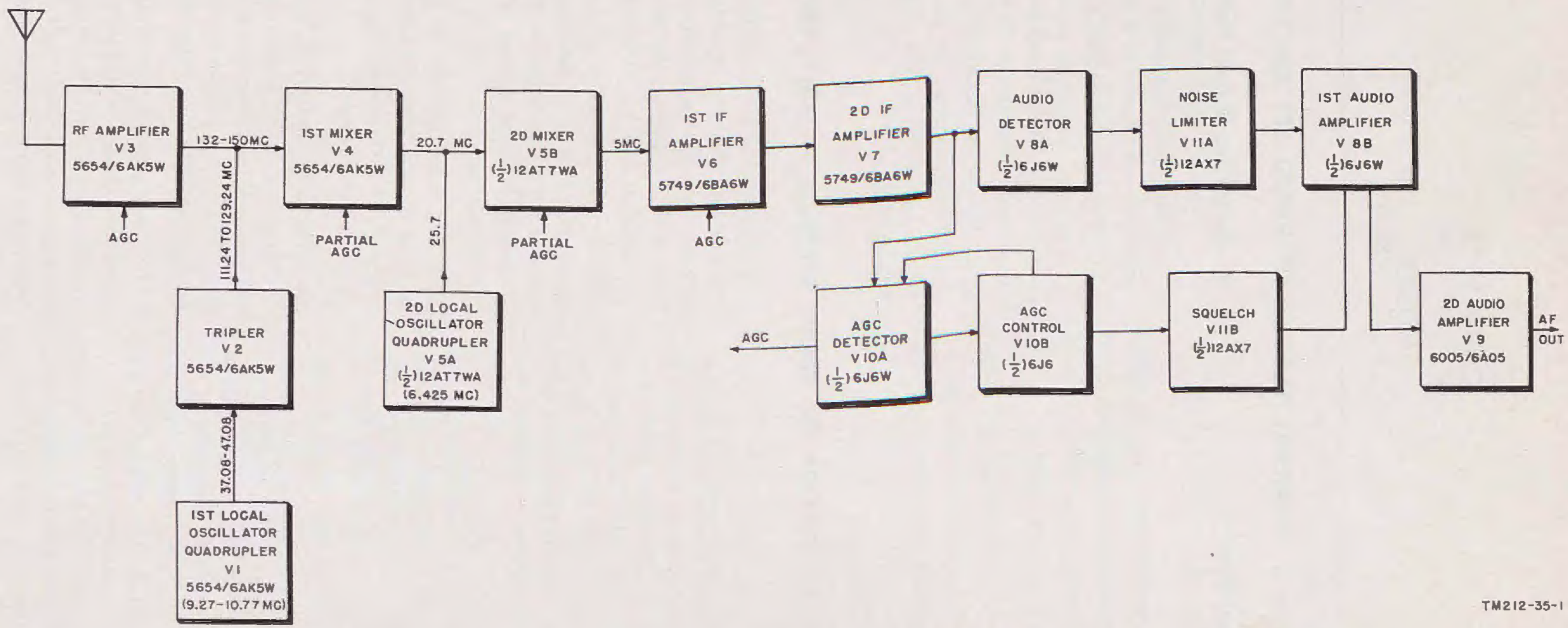


Figure 1. Radio Receiver R–748(*)/TRC–47, block diagram.

controls, the agc detector. The agc voltage developed by the agc detector is applied to the grids of the previous stages to control the gain as signal strength changes.

g. The squelch tube (one-half of V11) is controlled by the agc voltage. When signals of the correct level are not being received, the agc control tube allows the squelch tube to operate. The squelch tube then disables the first audio amplifier so that no audio is available at the output of the receiver.

h. The output of first audio amplifier V8B is coupled to second audio amplifier V9 where the final amplification takes place.

6. RF Input and Amplifier

(fig. 2)

a. Signals picked up by the antenna are fed through J1 to a circuit consisting of L4 and C18 connected in parallel. The input impedance of this circuit is 52 ohms. Capacitor C18 is variable so that the circuit may be tuned to the desired frequency. Inductance L4 is inductively coupled to the grid tank of RF amplifier V3.

b. RF amplifier V3 is a type 6AK5W tube used in a tuned-grid, tuned-plate circuit. The grid circuit is tuned by capacitor C20 which is in parallel with L5. Capacitor C21 is the bypass capacitor for agc resistor R11. The plate tank circuit consists of capacitor C24 and inductance L6. Capacitor C25 is the bypass capacitor for plate decoupling resistor R13. Resistor R12 is the screen grid resistor and C22 is the RF bypass for the screen grid.

7. First Local Oscillator Quadrupler

(fig. 3)

a. First local oscillator quadrupler V1 is a type 6AK5W tube used in a crystal-controlled, electron-coupled, oscillator circuit. The frequency of operation is determined by crystal Y1. The components in the grid circuit are selected so that crystals from 9.27 mc to 10.77 mc will cause oscillations in this circuit. The plate circuit of V1 is tunable, but with only enough range to pass the fourth harmonic of the crystal used in the grid circuit.

b. Resistors R1 and R2 and capacitor C1 and C2 are connected across crystal Y1 to form a feedback path. Feedback is introduced at the junction of R1 and R2 to sustain oscillations in the circuit. Capacitor C71 is connected across crystal Y1 for stability.

c. The plate tank circuit consists of inductor L1 and capacitor C5. Capacitor C4 and resistor R4 decouple the plate circuit. Resistor R3 and capacitor C3 make up the screen grid decoupling circuit.

8. Tripler

(fig. 3)

a. The output of V1 is coupled to the grid circuit of tripler V2, a 6AK5 pentode, by capacitor C7. The plate tank circuit of V2 is tuned to the third harmonic of the output of V1 (the 12th harmonic of the crystal frequency). The output of the tripler is inductively coupled to the mixer by L2, the plate tank inductance.

b. Resistors R5 and R6 make up the grid return circuit of the tripler. Resistor R7 and capacitor C9 are the cathode bias resistor and cathode bypass capacitor. Capacitor C10 and resistor R8 decouple the screen grid of V2. Capacitor C11 and resistor R9 decouple the plate circuit. The plate tank circuit consists of inductor L2 and capacitor C12. The output of the tripler is inductively coupled to the first mixer V4. Test jack J7 connects to the junction of R5 and R6 and is used to measure the input (first local oscillator output) to the oscillator tripler. Capacitor C8 and resistor R6 prevents RF from appearing at J7.

9. First Mixer

(fig. 4)

a. The RF amplifier and the first local oscillator signals are mixed in V4, a type 6AK5 tube. Inductor L7 is inductively coupled to both L2 and L6.

b. The grid tank circuit consists of inductor L7 and capacitor C27. Agc voltage is applied to the first mixer through decoupling resistor R14. Capacitor C28 bypasses R14.

c. The plate tank circuit of this stage consists of primary coil L8 and capacitor C30, of intermediate frequency (IF) transformer Z1. This transformer is slug-tuned to resonant sharply at 20.7 mc. The screen grid is decoupled by R15 and C29. The plate circuit is decoupled by R16 and C34.

10. Second Local Oscillator Quadrupler

(fig. 5)

a. Tube V5, a 12AT7 twin triode, is used as the second local oscillator and quadrupler. One of the triode sections (pins 1, 2, and 3) is connected as a conventional crystal-controlled oscillator. The crystal frequency is 6.425 mc. The plate circuit of V5 is tuned to the fourth harmonic, hence the output frequency of this tube is 25.7 mc or quadruple the crystal frequency.

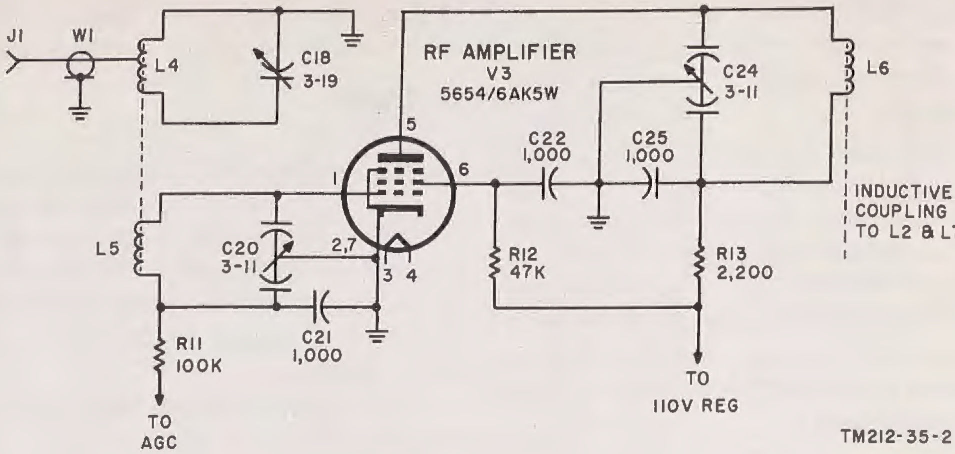


Figure 2. RF amplifier V3.

b. Resistors R18 and R19 and capacitors C36 and C37 form the feedback loop for the oscillator circuit, with RF injected at the junction of R18 and R19. Capacitor C15 and coil L3 form the plate tank circuit of the oscillator. Tuning is accomplished by adjusting the slug in L3.

11. Second Mixer

(fig. 5)

a. The output of second local oscillator V5A and the output of first mixer V4 both appear in the grid circuit of second mixer V5B. The output frequency of V5B is 5 mc (difference between 20.7 first mixer frequency and 25.7 second local oscillator frequency).

b. The output of the second local oscillator is coupled to the second mixer by capacitor C16. The output of the first mixer stage is transformer coupled to the second mixer by IF transformer Z1. The grid circuit of the second mixer is tuned to 20.7 mc by L9 and C31. Agc bias is applied through filter network R17 and C35.

c. The plate circuit of the second mixer is tuned to 5 mc by the primary of Z2 which consists of L10 and C38. Capacitor C40 and C42 and resistor R20 are the plate circuit decoupling network.

12. First and Second IF Amplifier

(fig. 6)

a. The output of V5B is coupled to the first IF amplifier by transformer. Z2 Tubes V6 and V7, type

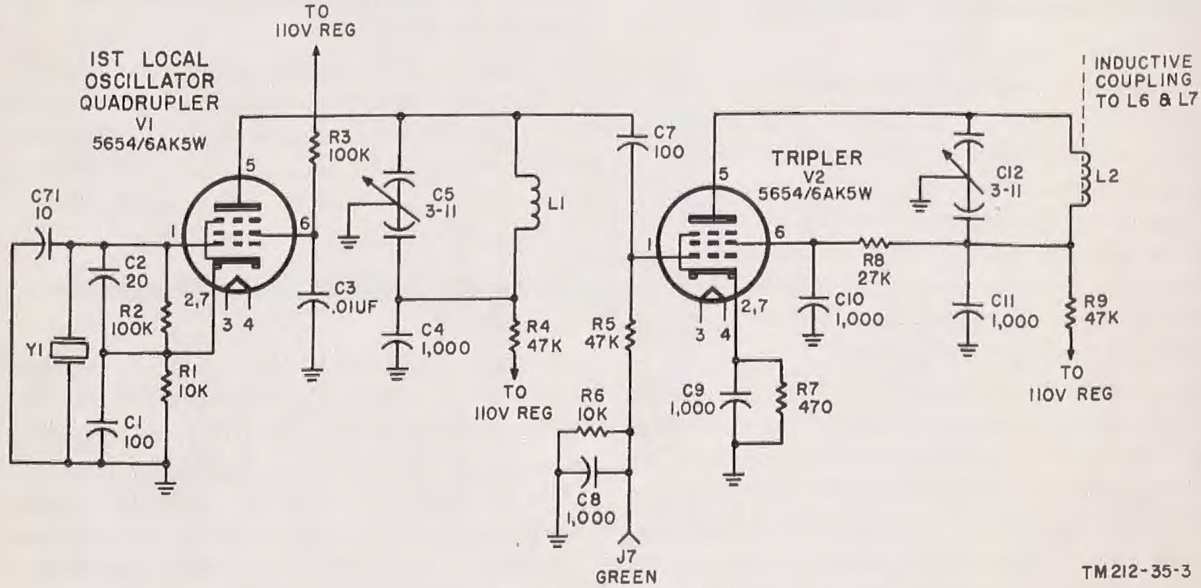


Figure 3. First local oscillator quadrupler V1 and tripler V2.

6BA6 pentodes, are the first and second IF amplifier tubes. The gain of V6 is controlled by agc voltage applied through R21 in Z2. The gain of V7 may be varied by the SENSITIVITY control which controls the bias voltage applied to the junction of grid resistors R24 and R33. Since both IF amplifiers are similar except for the SENSITIVITY control in the second IF stage, the description applies to both stages.

b. Resistor R21 and capacitor C41 make up the agc decoupling network for the first IF amplifier stage. Resistor R22 and capacitor C43 decouple the screen circuit and resistor R23 and capacitor C46 decouple the plate circuit.

13. Audio Detector, Noise Limiter and First Audio

(fig. 7)

a. The audio detector uses section A of tube V8, a 6J6W twin triode, as a diode. Grid pin 6 is used as the anode and plate pin 1 and cathode pin 7 are tied together and used as the cathode. The output of the 5-mc if strip appears across the terminals of L15 and C50. The anode (pin 6) of V8 is connected to the top of L15 and C50. The cathode of V8 (pin 7) is connected through R41, R29, and R27 to the bottom of L15 and C50.

b. The noise limiter tube uses section A of twin triode V11 (12AX7) connected as a diode. The noise limiter plate (pin 1 and 2 of V11) is connected to the junction of R29 and R41. The cathode of V11

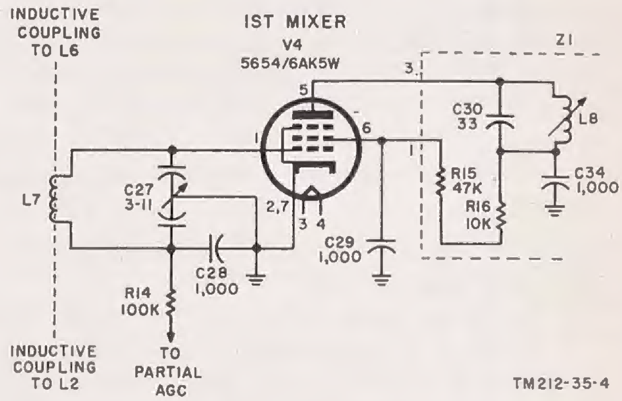


Figure 4. First mixer V4.

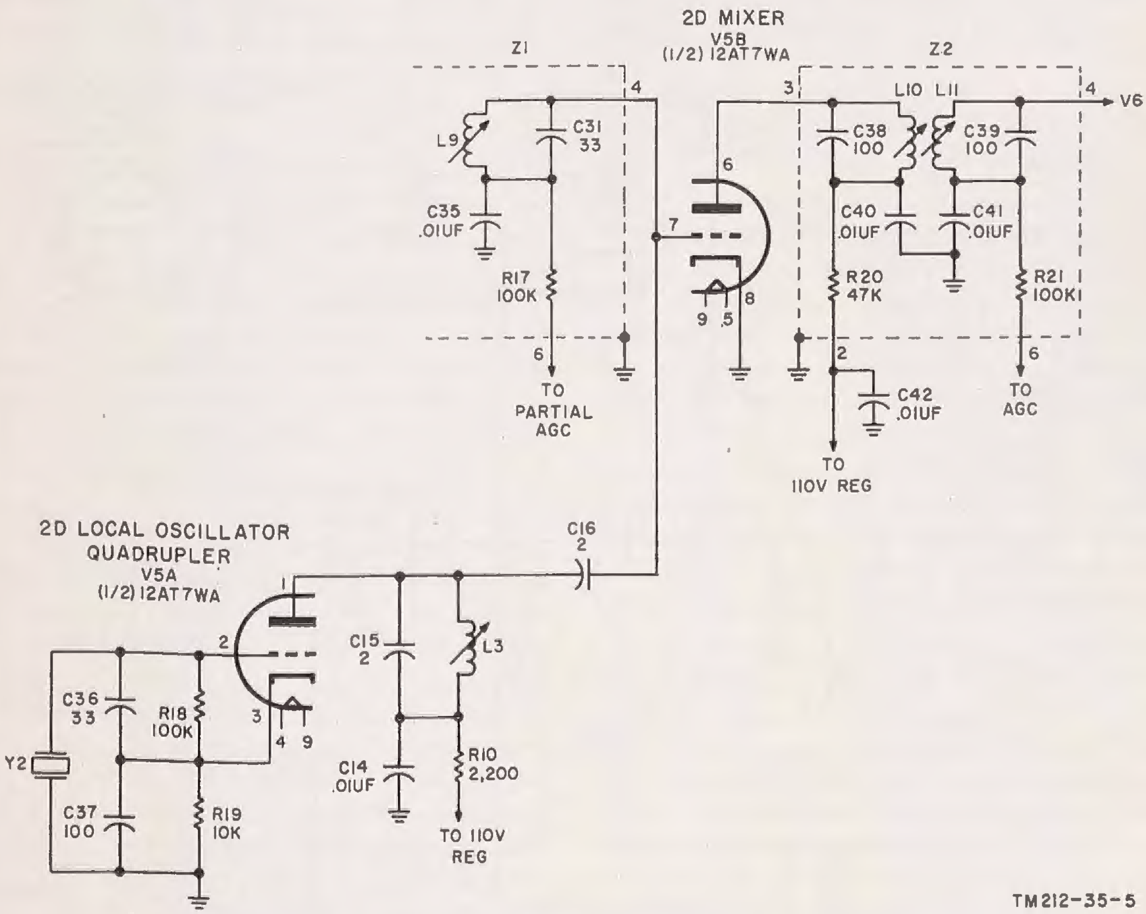


Figure 5. Second mixer V5B and second local oscillator quadrupler V5A.

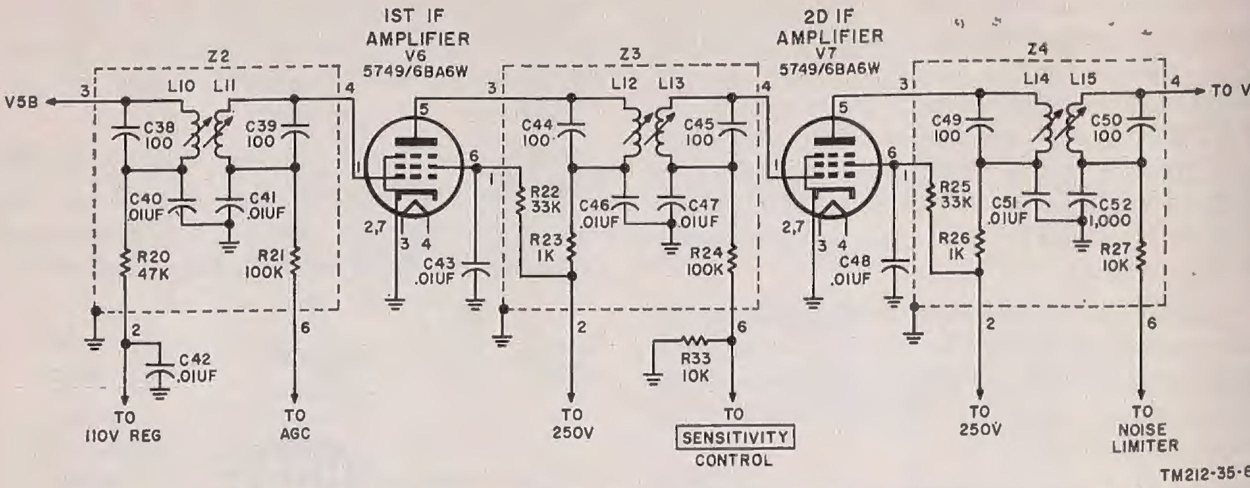


Figure 6. First and second IF amplifier V6 and V7.

(pin 3) is connected through R44 and R28 to the junction of R29 and R27.

(1) During normal operation (no noise), the detected signal appears as a dc voltage with an audio component across resistors R27, R29, and R41. The noise limiter tube will conduct under these conditions because the plate is more positive than the cathode. Capacitor C61 will charge up to the average of the sum of the voltage across R41 and half of R29. The reason for this is that when the noise limiter tube is conducting it has negligible resistance, leaving R44 and R28 as a voltage divider across R29. The signal applied between grid 5 and ground of V8, the first audio tube, is

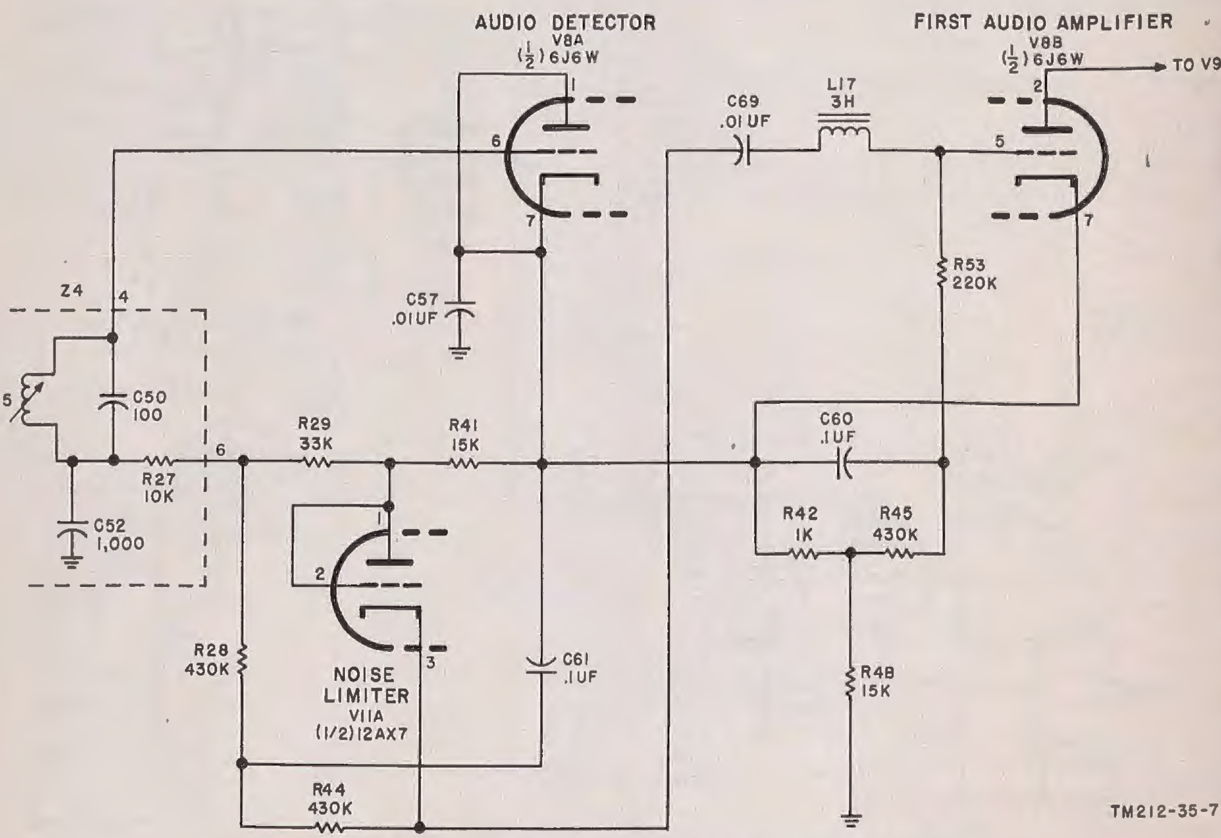


Figure 7. Audio detector V8A, noise limiter V11A and first audio amplifier V8B.

essentially the voltage across R41.

(2) When a noise impulse of fast rise time and short duration is received along with the normal audio signal, the current through R27, R29, and R41 will be increased for the duration of the noise peak. The increase in current flow makes the junction of R41 and R29 more negative than the cathode of the detector. The plate of the noise limiter is connected to this point and therefore will also be more negative than the detector cathode. As soon as the increase in voltage across R41 exceeds the voltage to which C61 has been charged, the noise limiter will be cut off because the plate will be more negative than the cathode. When the noise limiter is cut off, the path for current to flow through R28 and R44 is broken. The voltage now appearing between grid and ground of the first audio tube is the charge on capacitor C61. The charge across a capacitor does not change rapidly, therefore the noise pulse does not appear on the grid of the first audio amplifier tube.

14. Agc Detector and Control

(fig. 8 and 9)

The agc detector and control tube V10 is a type 6J6W twin triode that is used for three separate but related functions. Grid pin 6 and cathode pin 7 operate as a detector, plate pin 2, grid pin 5, and cathode pin 7, operate as a triode to control the operation of plate pin 1 and cathode pin 7 (fig. 9) which operate as the agc bias diode. Note that each of these circuits use the common cathode pin 7. These circuits are explained below.

a. The grid and cathode (pin 6 and pin 7) of V10A (fig. 8) operate as an agc detector diode which provides a dc voltage that is proportional to the received signal strength. RF current flows in the following manner; from the bottom of L15 and C50 to ground through C52 (fig. 8), from ground through C68 to the cathode of the agc diode (pin 7), through the diode, through C53, back to the other side of L15 and C50. The agc detector conducts only when the top of L15 and C50 is positive in respect to the bottom of L15 and C50. The network composed of R35, R37, C65 and C67 is a filter designed to remove the 5-mc RF ripple and produce a steady dc voltage across C67. The magnitude of this voltage is directly proportional to the amplitude of the 5-mc RF voltage which produced it and this, in turn, is proportional to the received RF signal strength.

b. Plate pin 2 of V10B is connected through R46 to +110 volts. Cathode pin 7 is connected through R39 and R40 to —110 volts. Assume that V10B is unbiased and allowed to conduct its maximum. Under these conditions, the resistance of V10B would be negligible. The resistance across the power supply would be approximately 125,000 ohms. Using ohms law, it can be shown that the cathode of V10B would be approximately 80 to 90 volts positive with regard to ground. The other extreme would be when V10B was biased to cutoff. Under these conditions, the resistance of V10B would be infinite and no current would flow and the cathode of V10B would be negative to ground by 110 volts. These two conditions of maximum conduction and no conduction are extremes which do not occur in normal operation. During normal operation grid pin 5 of V10B, which is connected to the junction of R37 and C67, will be negative proportional to the RF signal strength. Therefore the cathode of V10B will have a potential somewhere between the two extremes described above. A weak RF signal will cause the cathode to be positive by some value. As the RF signal becomes stronger the cathode will become less positive and finally, for a strong RF signal, the cathode will become negative.

c. The agc bias diode (fig. 9) consists of plate pin 1 and cathode pin 7. Plate 1 of V10A is connected through R34 to the junction of SENSITIVITY control R60 and resistor R38 (fig. 9). Resistors R30, R31, and R32 form a voltage divider which is in parallel with R34. Resistor R38, SENSITIVITY control R60, and resistor R33 are connected across the —110-volt supply and ground (fig. 9). The junction of R38 and SENSITIVITY control R60 to which plate pin 1 is connected may be varied in potential (—2.42 to —6.05 volts) by adjusting the SENSITIVITY control. This voltage is the no-signal bias for the various stages in the receiver.

d. The cathode of V10A (fig. 9) is positive with respect to ground when weak RF signals are being received. As the signal strength increases, the cathode becomes less positive and finally for strong signals negative. A detailed description of how this occurs may be found in *b* above. When the RF signal being received is weak, there is no agc action since the cathode of V10A is positive; its plate is negative (plate potential was established in *c*

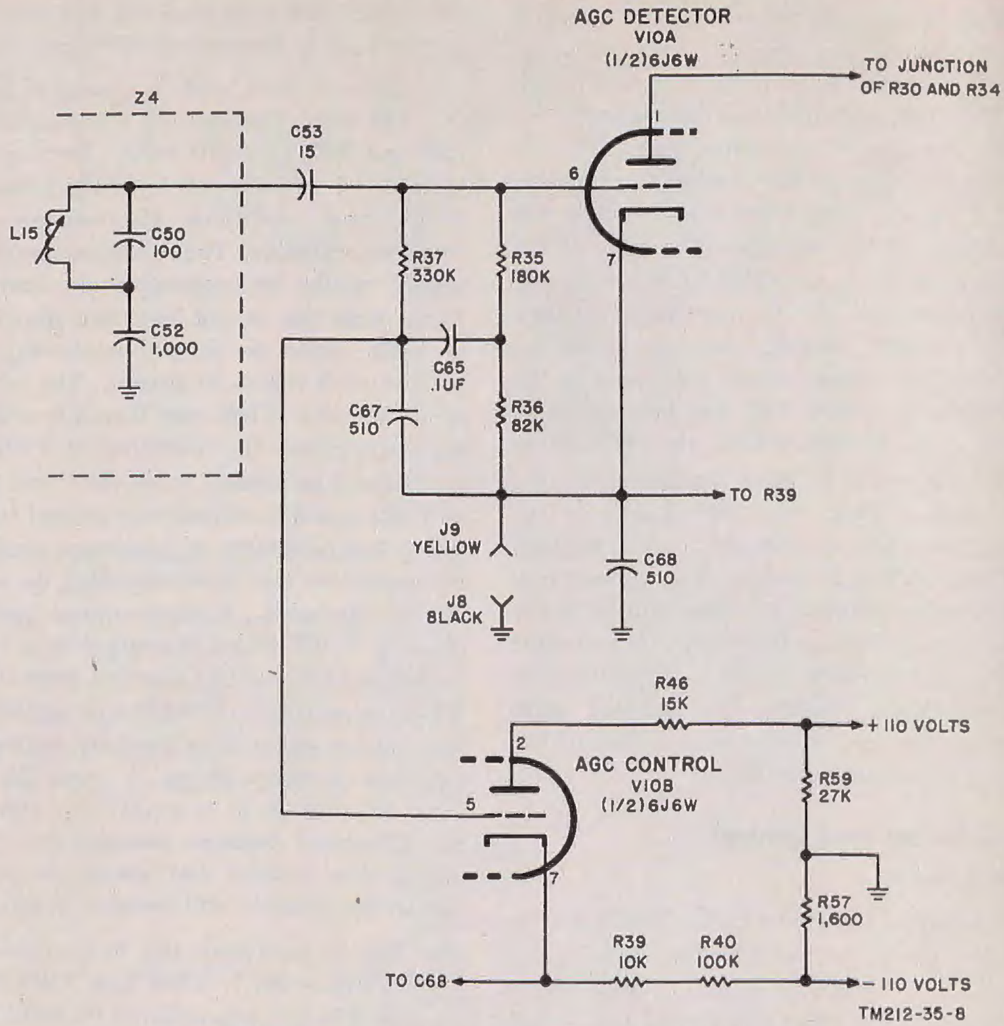


Figure 8. Agc detector V10A and agc control V10B.

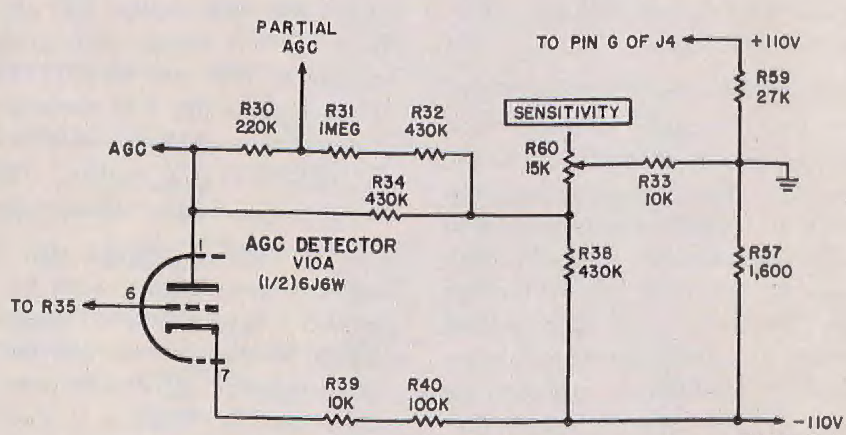


Figure 9. Agc detector V10A.

above) and conduction can not take place. As stronger RF signals are received, the cathode becomes less positive and finally negative. When the cathode is more negative than its plate, conduction takes place. The plate current path is through the resistive network consisting of R30, R31, and R32 in parallel with R34, through the power source back through R40 and R39 to the cathode. The plate current through the resistive network R30, R31, and R32 in parallel with R34 develops a voltage which is directly proportional to the received signal strength. This is the agc voltage.

15. Squelch Circuit

(fig. 10)

a. Squelch tube V11B is used to silence the audio portion of the receiver when there is no RF signal being received. This prevents the appearance of annoying hiss, crackle, and noise in the telephone. First audio amplifier V8B is allowed to conduct normally when an RF signal of the proper magnitude is being received. The bias voltage for V8B is developed across cathode resistor R42 (fig. 10) and appears between grid and cathode.

b. Plate voltage for squelch tube V11B is obtained from the junction of resistors R47 and R48 and applied through R45 (fig. 10). Resistors R47 and R48 are connected across the postive 110-volt supply and ground. The grid of squelch tube V11B is connected through R55 to the junction of R39 and R40. Resistors R39 and R40 are part of the agc circuit and the potential at the junction of R39 and R40 will vary as the RF signal strength varies (par. 14).

c. When a strong RF signal is being received, the junction of R39 and R40 will be negative in relation to ground. The grid of the squelch tube which is connected to the junction of R39 and R40 will also be negative. The negative voltage is sufficient to cut off the squelch tube. When the squelch tube does not conduct, it does not affect the bias on the grid of the first audio frequency (AF) amplifier. This allows normal operation of the AF amplifier.

d. When radio frequency signal of proper strength is not received, the potential at the junction of R39 and R40 becomes less negative. The grid of the squelch tube which is connected to this point will also become less negative and thus allow the squelch tube to conduct. The path of conduction for the squelch tube is as follows: plate current flows through R45, through the +110-volt power supply, to ground, back through cathode resistor R54 back to the plate. The flow of plate current through R45 will produce a greater voltage drop across that resistor, thereby increasing the cathode bias on first audio amplifier V8B, until the amplifier tube is cut off. This prevents the passage of any signals to the speaker and squelches the receiver.

16. Second Audio Amplifier

(fig. 11)

Capacitor C58 couples the audio signal from the first audio amplifier to the grid of second audio amplifier V9. Audio gain control R50 returns the grid of V9 to ground. Resistor R52 provides cathode bias for second audio amplifier V9 and is bypassed by C63. Output transformer T1 is the plate load for V9. Terminals 3 and 6 of T1 connect to the converter and terminals 3 and 4 connect to the loudspeaker.

17. Power Supply

(fig. 12)

External power is applied to the unit at J2. One side of jack J2 is connected to terminal 1 of transformer T2 in series with pins 10 and 11 of J3A, terminals L of J6 and P6, POWER switch S1, fuse F1, and terminals K of J6 and P6. The other side of jack J2 connects directly to terminal 2 and 4 of T2. Power transformer T2 has two primary windings to permit its use on either 115 or 230 volts alternating current (ac). For use on 115 volts, the primary windings are connected in parallel (terminals 1 and 3 connected together and 2 and 4 connected together). When used with 230 volts, the primary windings are connected in series by wiring a jumper between terminals 2 and 3 and applying power at terminals 1 and 4. A secondary winding of T2 (terminals 8 and 9) provides 6.3 volts for all tube heaters. A 5-volt winding (terminals 10 and 12) furnishes filament voltage for rectifier V14. Tube V14 is a full-wave rectifier and is followed by a conventional pi section filter consisting of C72A, L16, and C72B. Capacitor C72C provides filtering for the negative voltage. Across the output of the filter are three bleeder resistors (R57, R58, and R59) from which are tapped different voltages required by the receiver. The junction of R57 and R59 is grounded so that the ungrounded end of R57 is —110 volts with respect to ground. The ungrounded end of R59 is +110 volts in respect to ground. Voltage regulator tubes are connected across resistors R57 and R59 to stabilize the voltage at their terminals.

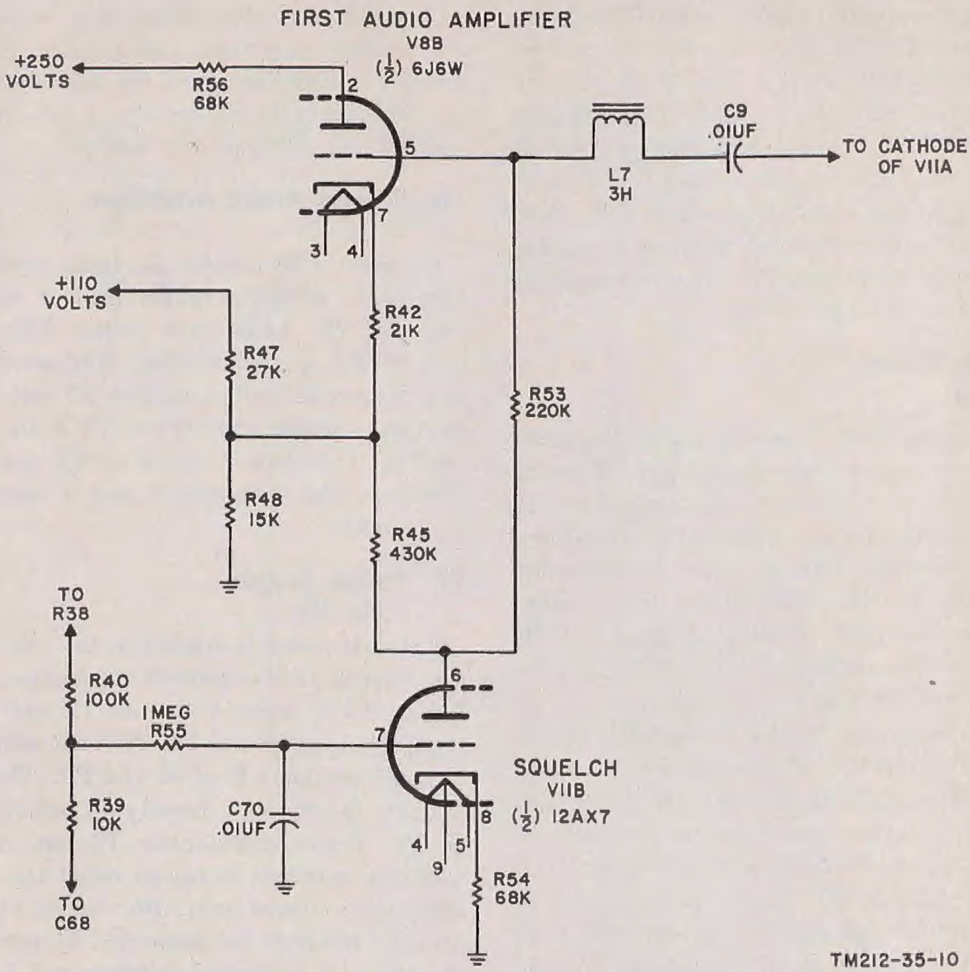


Figure 10. First audio amplifier V8B and squelch V11B.

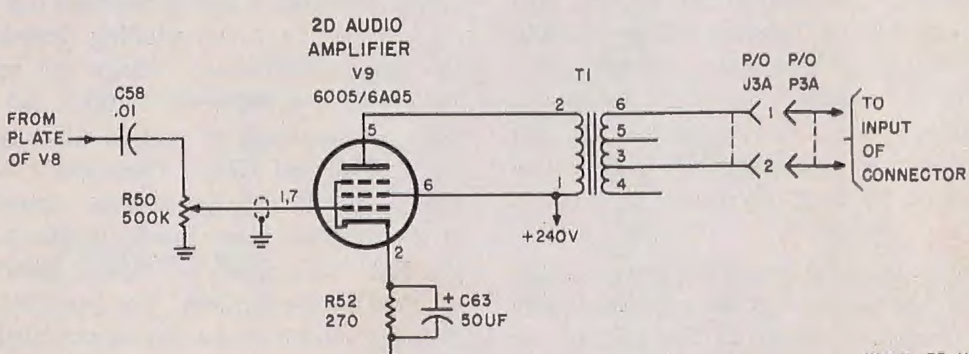


Figure 11. Second audio amplifier V9.

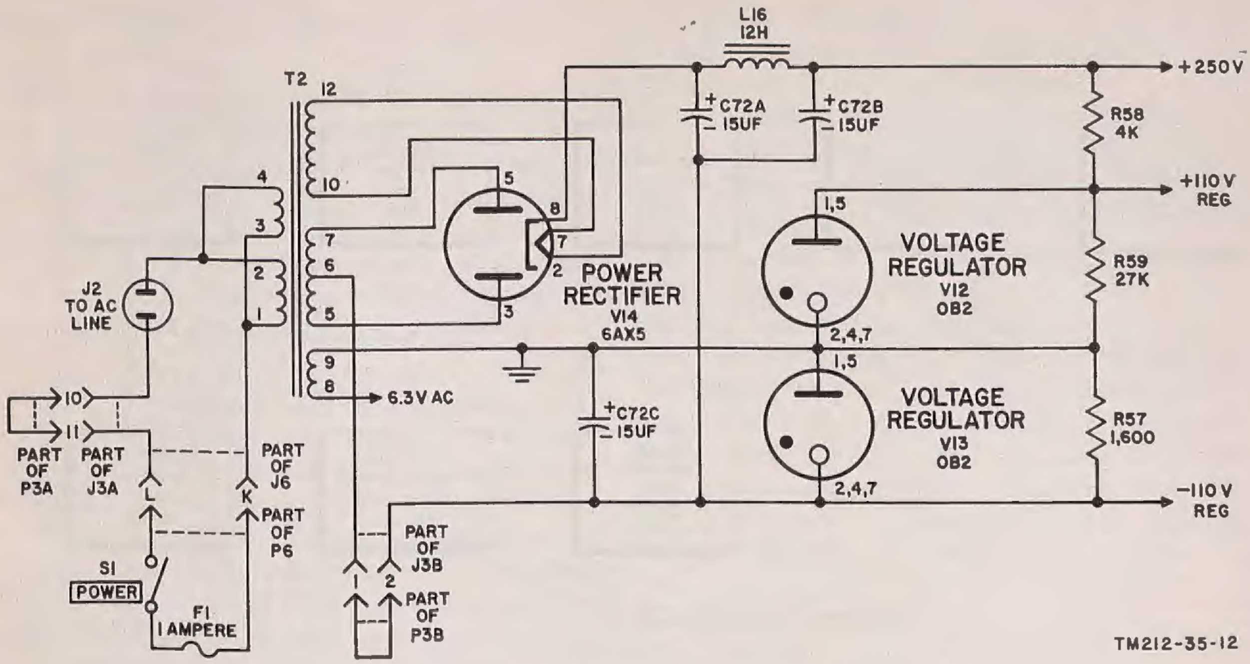


Figure 12. Power rectifier V14 and voltage regulators V12 and V13.

Section III. THEORY OF RADIO TRANSMITTER T–593(*)/TRC–47

18. Block Diagram

(fig. 13)

a. The transmitter uses a crystal oscillator circuit. The RF signal from the oscillator is tripled in each of two successive stages. The output of the second tripler stage is fed to the doubler-driver stage where it is doubled; the resultant signal (18 times the oscillator frequency) is used to drive the power amplifier (pa) stage. The output of the power amplifier is inductively coupled to the antenna.

b. If excitation is lost, the power output tube is protected against burn-out by the output control tube circuit which lowers pa plate current to a safe level.

c. It is possible to modulate the transmitter 100 per cent. This is accomplished with a push-pull modulator. The modulator is driven by a push-pull audio driver stage.

19. Crystal Oscillator

(fig. 14)

a. The operating frequency of the transmitter is controlled by a crystal oscillator circuit that will tune from 7.333 mc to 8.333 mc. The exact frequency is decided by the crystal used.

b. The oscillator tube is one-half of a 12AU7 twin triode tube (V1). Variable capacitor C2 has been placed in parallel with the grid tank circuit of the oscillator to compensate for the internal capacities of the tube. This capacitor will normally be used only when replacing V1A. The shunt capacitance across crystal Y1 must be exactly 32 micromicrofarads ($\mu\mu f$). A different shunt capacitance across Y1 will result in operation at a frequency other than that specified on the crystal case.

c. The oscillator grid-biasing resistor consists of R1 and R2 in series. In addition to providing grid bias for V1A, these two resistors form a voltage divider circuit so that a meter may be introduced to check oscillator grid current The cathode biasing resistor for V1A consists of R3 and R4 in series. Like the grid biasing resistors, the cathode resistors are two unequal values so that the meter may be introduced to check oscillator cathode current. Capacitor C1 in the oscillator grid circuit bypasses RF from the metering circuit. The oscillator plate tank circuit consists of C5 and L1 in parallel. The plate circuit of the crystal oscillator is tuned to the crystal frequency by L1. Resistor R5 is the plate isolation resistor and capacitor C6 is the RF bypass capacitor.

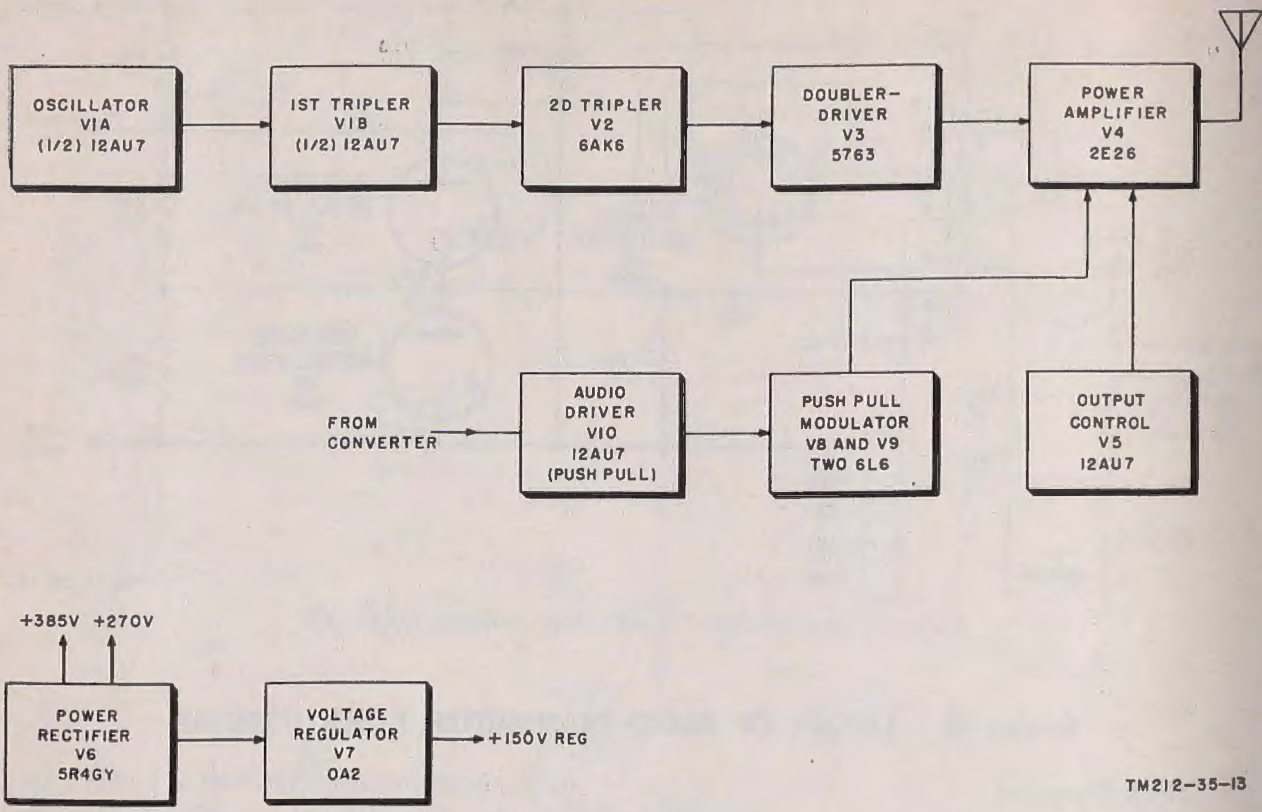


Figure 13. Radio Transmitter T-593(*)/TRC-47, block diagram.

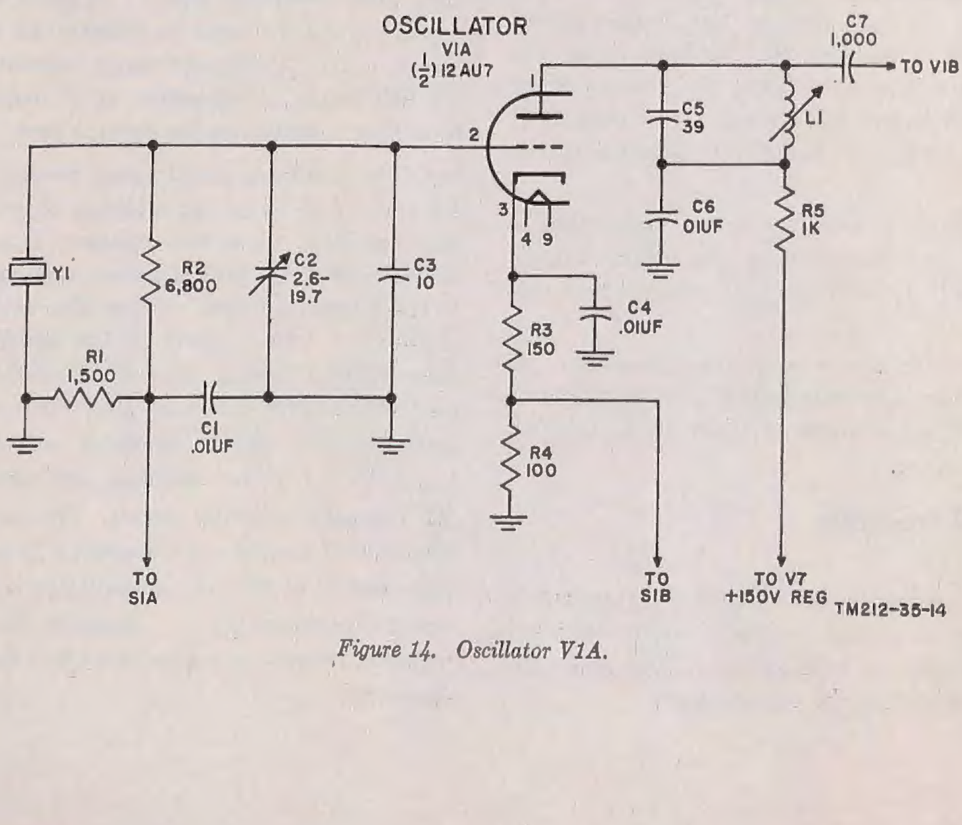


Figure 14. Oscillator V1A.

20. First Tripler
(fig. 15)

a. First tripler V1B uses one-half of a 12AU7 tube. The tripler is an RF amplifier, the plate tank circuit of which is tuned to the third harmonic of the input frequency. The input frequency is in the range of 7.333 mc to 8.333 mc, depending on the crystal used in the oscillator circuit. The output frequency of the tripler stage is in the 21.999- to 24.999-mc range, depending on the input frequency.

b. The grid circuit of the tripler is not tuned. Capacitor C7 couples the output of the oscillator to the grid of first tripler V1B. Resistors R6 and R7 are the grid-biasing resistor and and capacitor C8 is the RF bypass for the grid metering circuit. Resistors R8 and R9 are cathode bias resistors and capacitor C9 is the cathode bypass. As in the oscillator circuit, both the grid-biasing resistors and the cathode-biasing resistors have been divided to provide metering voltage.

21. Second Tripler
(fig. 16)

a. Second tripler stage V2 uses a 6AK6 pentode. The second tripler receives the third harmonic of the crystal frequency from the first tripler stage V1B. The output of V2 is tuned to the third harmonic of the input (ninth harmonic of crystal frequency). The output frequency of the second tripler covers a frequency range of 65.997 to 74.997 mc.

b. Capacitor C12 couples the RF output of V1B (first tripler) to the grid of V2 the second tripler. Resistors R11 and R12 are grid bias resistors. RF bypass capacitor C13 is used to bypass the meter. Resistors R13 and R14 are the cathode resistors and capacitor C14 is used for the RF bypass. Resistor R15 is the screen grid voltage dropping resistor and capacitor C15 is the screen RF bypass. Capacitor C16 and inductor L3 make up the plate tank circuit. Resistor R16 decouples the second tripler from B+. Capacitor C17 is the RF bypass for the plate circuit. The values of the plate circuit components are chosen so that it is possible to tune to only the third harmonic of the input signal. As in previous stages, the grid and cathode circuits are metered.

22. Doubler Driver
(fig. 17)

a. Doubler driver V3 uses a type 5763 tube as a combination frequency doubler and driver stage. The output of second tripler V2 (65.997 mc to 74.997 mc) is coupled to the doubler driver. The plate circuit of the doubler is tuned to twice the input frequency, thus making the output range of the doubler 131.994 to 149.994 mc. The doubler-driver stage also amplifies the signal to the proper level required to drive the power amplifier tube.

b. Capacitor C18 couples the signal from the preceding stage V2 to the grid of V3. Resistors R18 and R17 make up the grid biasing resistor. Capacitor C19 is the meter RF bypass. Resistors R19 and R20 are the cathode biasing resistors and capacitor C20 is the cathode RF bypass capacitor. Resistor R47 and capacitor C21 decouple the screen grid from the power supply. The plate tank circuit, a pi network, consists of C23, L5, C22, L4, L12 and C24. The plate circuit is tuned by L4.

23. Power Amplifier
(fig. 18)

a. Power amplifier stage V4 uses a type 2E26 beam power tube operated as a class C RF amplifier. Resistors R24 and R25 are the grid biasing resistors and C24 is the RF bypass for the metering circuit. The plate tank circuit consists of L6 and C26. The plate circuit is tuned by adjusting C26 which is variable. Coil L8 and capacitor C27 decouple the pa stage from the power supply. Capacitor C30 and C25 are both used to bypass the screen grid, and coil L11 prevents RF from entering the power supply. Resistors R26 and R27 are screen grid voltage dropping resistors.

b. The antenna is inductively coupled to the plate tank of the power amplifier by means of L6, the plate tank inductance, and L7, the antenna coupling coil. Inductor L7 and tuning capacitor C28 are physically mounted to that their distance from the power amplifier plate tank coil may be varied to control the amount of coupling. Output power is tapped off the antenna coil at the point where the impedance to ground as seen by the antenna is 52 ohms.

24. Output Control Tube
(fig. 18)

a. The 12AU7 twin triode V5 tube controls the power output of the power amplifier tube by varying the pa screen grid voltage. The output control tube will also prevent the flow of excessive current through the power amplifier tube when sufficient grid drive is lost.

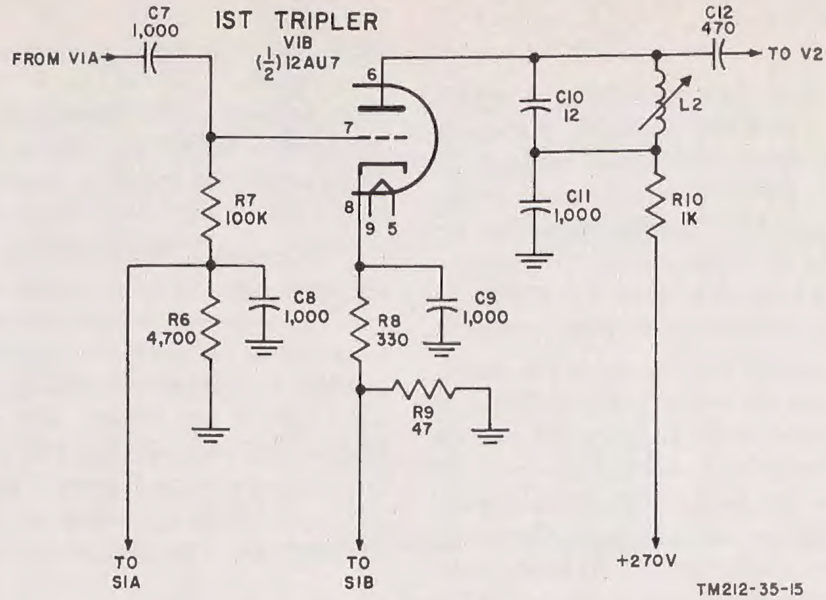


Figure 15. First tripler V1B.

b. The plate current of output control tube V5 and the screen current of the pa tube flow through resistors R26 and R27. The screen grid voltage of the pa tube is determined by the total current flowing through these resistors. The value of output control tube plate current therefore has an influence on the pa screen grid voltage. The plate current and, therefore, the power output of the pa tube can be changed by changing the pa screen grid voltage. The grid drive to the pa causes grid current to flow and develop a voltage across the resistors in the grid circuit of the pa tube. One of these resistors (R25) also appears between grid and ground of V5. The voltage developed across R25 therefore will bias output control tube V5 and control its conduction. Resistor R25 is adjustable and when varied, adjusts the grid bias on the clamper tube. This operation also controls the plate current of V5, the voltage across the pa screen resistors, the pa screen grid voltage, the pa tube current and, therefore, the pa power output. When the resistance is increased, the bias on the output control tube increases, its plate current decreases, and the pa screen grid voltage and power output increase.

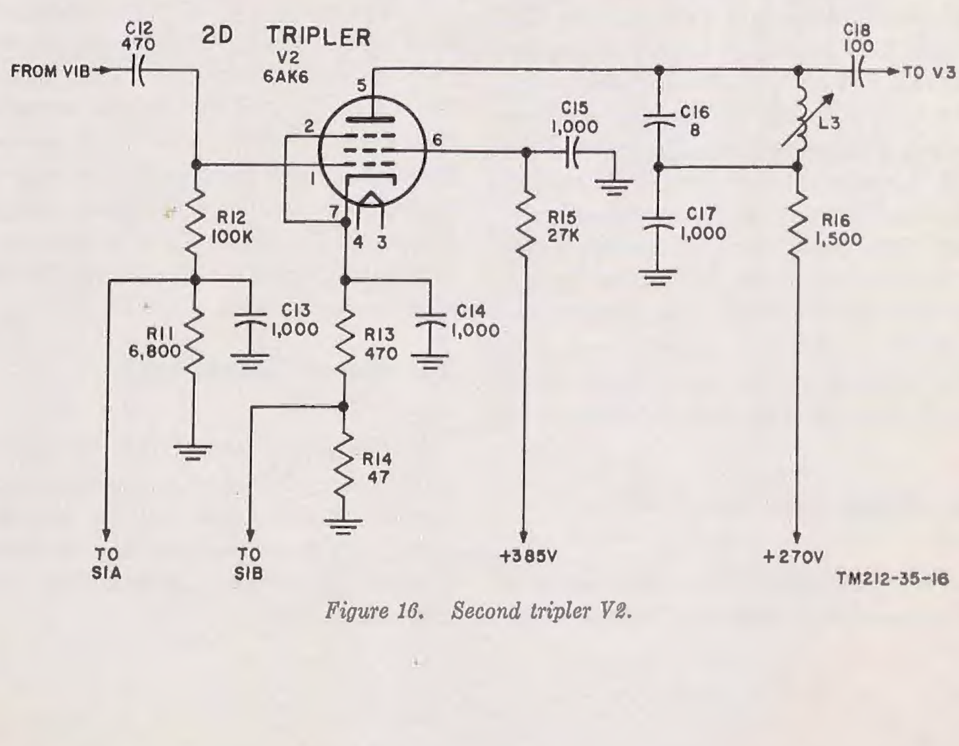


Figure 16. Second tripler V2.

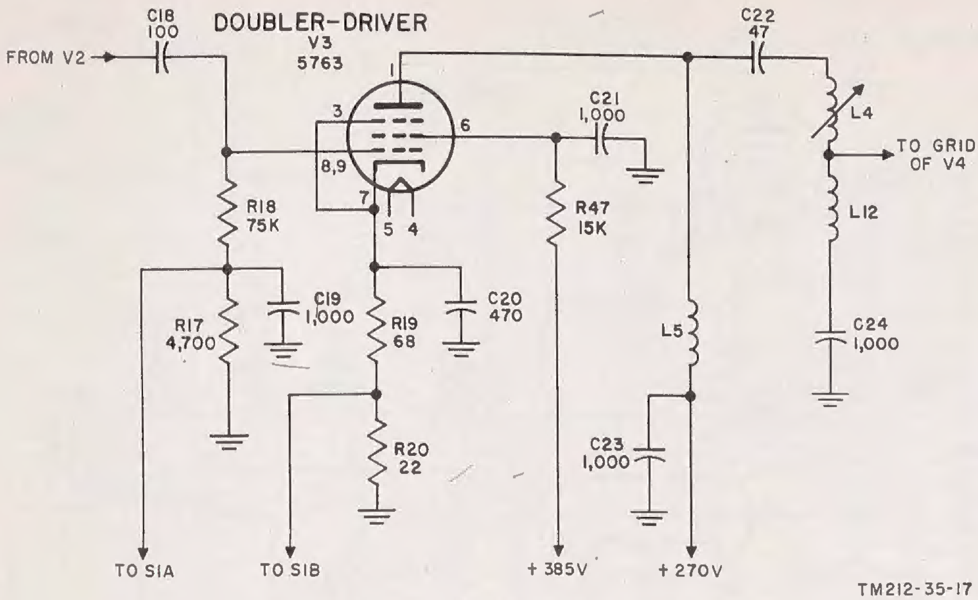


Figure 17. Doubler driver V3.

When the resistance of R25 is decreased, the reverse sequence occurs and the pa power output is decreased.

c. The bias on the pa grid is determined by the grid drive. If grid drive were lost, the pa tube would ordinarily conduct heavily, overheat, and possibly destroy itself. The output control tube prevents this by lowering the pa screen grid voltage under such conditions. When the proper pa grid drive is lost, the voltage drop across R25 decreases. The voltage drop across R25 is the bias for V5 and this drop in voltage causes a decrease in bias on this tube. The output control tube plate current increases; this causes a decrease in pa screen grid voltage, and thus prevents excessive pa plate current.

25. Modulator and Audio Driver

(fig. 19)

a. A combination of plate and screen modulation is used in this transmitter to obtain linear (undistorted) modulation and prevent carrier shift when the signal is heavily modulated. Distortion is reduced and the efficiency of the power amplifier is greater than it would be if only plate modulation had been used.

b. The modulator consists of two type 6L6 tubes, V8 and V9, connected in a push-pull circuit and biased to class AB. Resistors R37 and R38 are the cathode bias resistors for both tubes. Resistors R40 and R44 are the grid return resistors. Capacitor C39 is a frequency limiting capacitor. The signal from the push-pull driver is coupled to the grids of the modulator by C37 and C38.

c. The driver consists of both halves of a 12AX7 twin triode, connected in push-pull. The driver receives its input signal directly from a double potentiometer (R46A and R46B) which is a MOD GAIN control across the secondary winding of audio input transformer T3. Audio transformer T3 matches the 100,000-ohm MOD GAIN control to a 600-ohm balanced line. Resistors R42 and R43 are the plate load resistors for the driver.

26. Power Supply

(fig. 56)

All plate and filament voltages are supplied by power transformer T1. The transformer has a center-tapped high-voltage winding which supplies 480 volts to each plate of full-wave rectifier, V6. The center-tapped, 5-volt winding supplies the filament voltage required by the rectifier tube. The center tap of this winding is the positive high-voltage output terminal for the rectifier. A 6.3-volt winding provides filament voltage for the indicator lights and electron tube heaters. The rectified high voltage is filtered by a choke input filter consisting of L9 and followed by C33 and C34 in parallel. Tube V7, a type OA2 voltage regulator, regulates the plate voltage applied to the crystal controlled oscillator. Resistors R34 and R35 limit the cur-

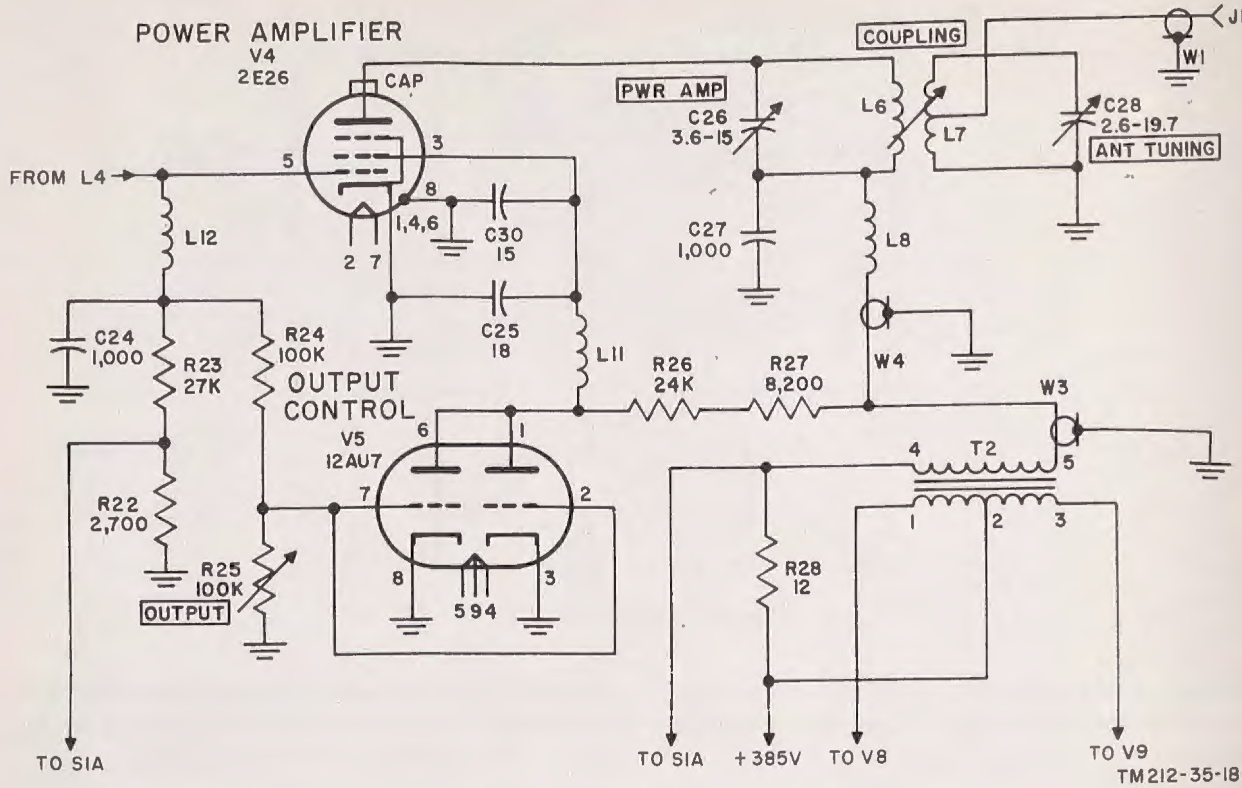


Figure 18. Power amplifier V4 and output control.

rent drawn by the voltage regulator and R36 acts as bleeder for the overall circuit.

27. Metering Circuits

(fig. 56)

a. A selector switch and tuning meter are included on the subpanel to facilitate tuning of the RF stages and adjustment of the modulation level. Selector switch (S1) is a two-wafer switch; each wafer has 12 positions. The two wafers are ganged and operate from one control knob on the subpanel. Switch positions 2 through 10 alternately indicate the grid current and cathode current of each of the stages from the oscillator stage through the doubler driver stage. Position 11 indicates power amplifier plate current (PAI_p). Position 1 is OFF and shunts both terminals of tuning meter M1 to ground. Position 12 indicates modulator cathode current ($MODI_k$). The switch connects the tuning meter to each stage through a voltage-dividing tap on the grid and cathode-biasing resistors. The values of the biasing resistors have been chosen to assure adequate metering voltage even through there are wide variations in power and voltage from stage to stage. Each grid resistor and each cathode resistor is divided into two unequal parts, and the values are determined by the ratio of the current flowing in the stage to the value required by the meter. The only exception to this occurs in metering the power output stage. The cathode of the power output stage goes directly to ground, making it impossible to meter cathode current. The pa is metered by inserting the meter and shunt resistor R28 in the B+ supply to that stage.

b. Correct polarity of the metering voltage is obtained by using a two-wafer switch instead of a single-wafer switch for selecting metering voltages. This makes it possible to reverse the polarity of the meter with respect to the circuit being measured. When reading oscillator grid voltages ($OSCI_g$) at position 2 of S1, the negative tap from the junction of R1 and R2 is fed directly to the negative side of M1 through S1A and the positive side is grounded by means of a contact on the opposite wafer, S1B. In position 3, positive cathode voltage is measured; therefore, the lead from the cathode resistors is connected to S1B and third contact of S1A is grounded. This system has been followed throughout the entire equipment, permitting metering indications for all functions regardless of polarity.

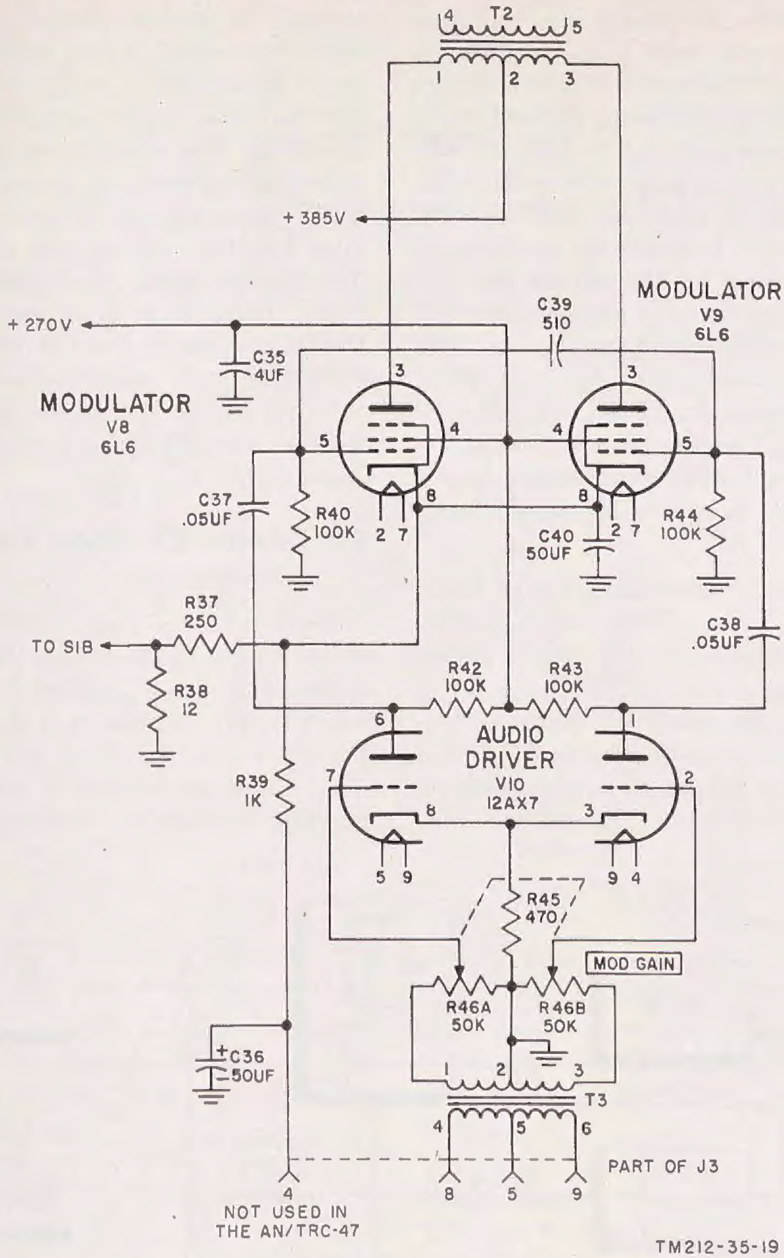


Figure 19. Push-pull driver V10 and push-pull modulators V8 and V9.

Resistors R30 and R31 are included to increase the series resistance of the meter to ground and to avoid changes in the bias of the tube being metered. Two resistors are used, one in each meter lead to avoid connecting the meter directly to ground, regardless of the polarity of the meter circuit.

Section IV. THEORY OF TELEPHONE SIGNAL CONVERTER CV–542/TRC–47

28. Block Diagram

(fig. 20)

a. The converter is an electronic hybrid network which provides facilities for interconnection of four-wire circuits of the radio system with standard two-wire circuits of telephone systems. It also supplies ringing voltages and circuits. Figure 20 shows a block diagram of the converter.

b. Incoming signals fed from the receiver to the converter are of two types, normal speech frequencies or a generated 800-cps signal to key the ringing circuit. Only one type of signal may be received at a time. Normal speech frequencies or the 800-cps keying signal are fed through the hybrid circuit and through signal transfer relay K1 to both the 800-cps detector circuit and ringing transfer relay K3. From K3 the signals are fed to the local telephone line to the switchboard. If an 800-cps keying signal is present, it is detected by the 800-cps amplifier detector and fed to dc amplifier relay actuator K4. This relay in turn actuates ringing transfer relay K3. When ringing transfer relay K3 is energized, control voltage is applied through K3 to the 20-cycle ringer power supply. The power supply then applies power to the 20 cps generator which in turn feeds a 20-cps ringing signal to the switchboard through ringing transfer relay K3.

c. Outgoing signals fed from a switchboard to the converter are of two types; a 20-cps ringing signal, or normal speech frequencies. The 20-cps ringing signal is fed through ringing transfer relay K3 to 20-cps relay detector K2, which is a frequency sensitive relay. Twenty-cps relay detector K2 is tied directly across the line so that all signals appearing on the line are applied to the detector and, conversely, the 20-cycle ringing signal applied to 20-cycle detector K2 is also applied to the line. This signal closes 20-cps relay detector which applies control voltage to signal transfer relay K1 to close this relay. The words "control voltage" are used to designate a source of power. The signal transfer relay applies control voltage to the 800-cps oscillator amplifier through the signal transfer relay. The 800-cps signal passes through signal transfer relay, hybrid V1, to the transmitter input. Normal speech frequencies are fed from the switchboard through normally closed contacts of ringing transfer relay K3 and the normally closed contacts of signal transfer relay K1 to the hybrid, then to the transmitter input.

29. Detector K2, 20-cps Relay
(fig. 21)

The switchboard applies a ringing signal of 20 cps at approximately 25 volts to J3 and J4 of the converter. This signal is applied through ringing transfer relay K3 contacts 11–2 and 13–7 (fig. 21) to the coil of relay K2 which is a frequency sensitive relay. Upon application of a 20-cps signal, relay K2 closes and applies +108 volts dc to the coil of

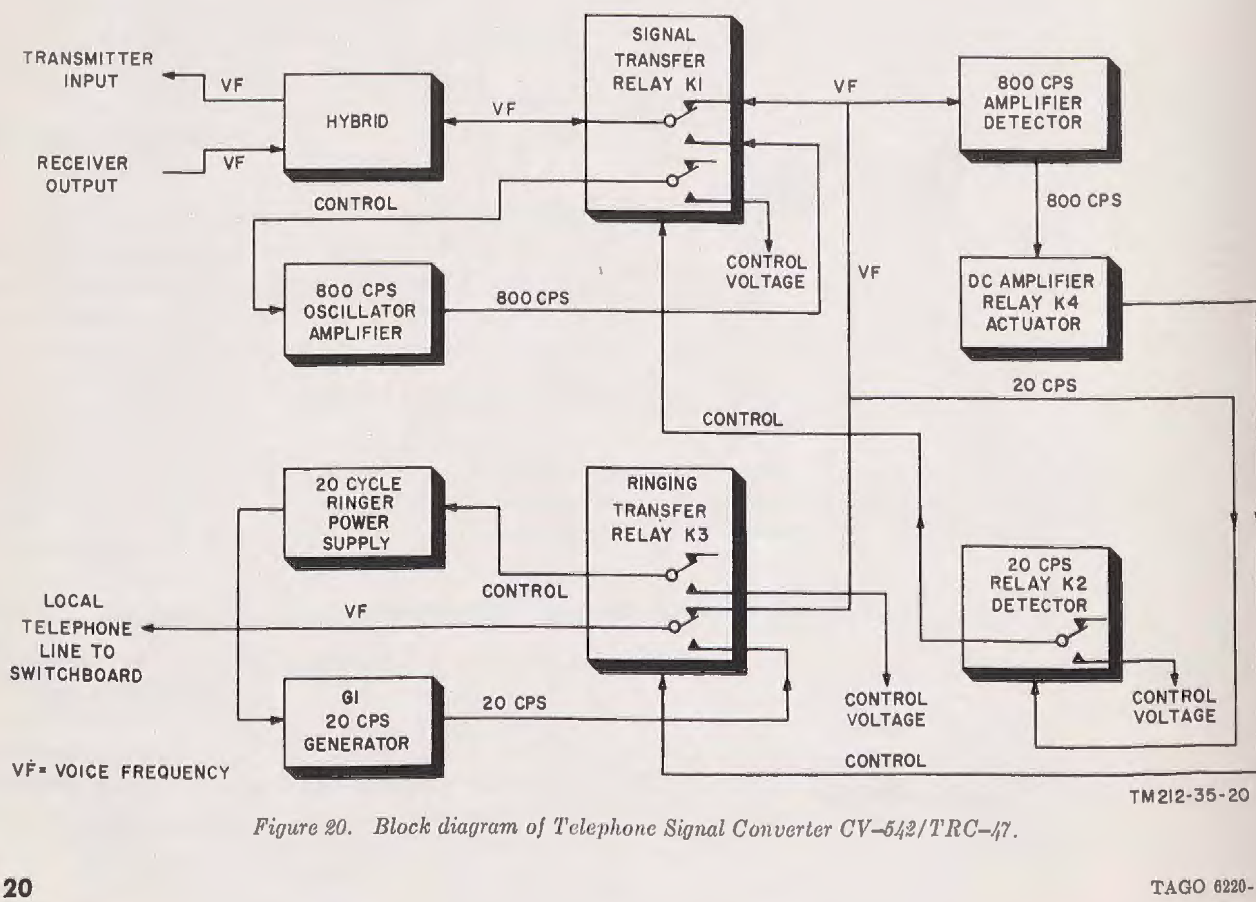


Figure 20. Block diagram of Telephone Signal Converter CV–542/TRC–47.

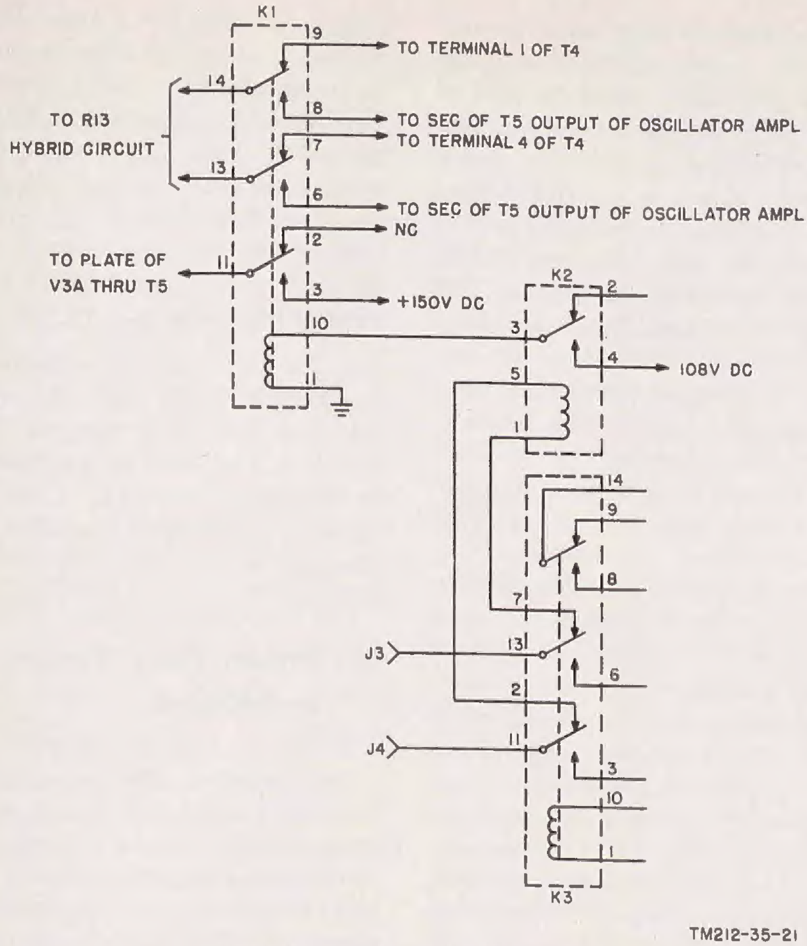


Figure 21. Sensitive relay K2, 20-cps.

signal transfer relay K1. This transfers the signal path from the telephone lines to the 800-cps oscillator amplifier and applies +150 volts dc to the 800-cps oscillator amplifier.

30. Oscillator and Oscillator Amplifier, 800-cps

(fig. 22 and 23)

a. The 800-cps oscillator uses a tuning fork assembly to generate a stable 800-cps ringing signal. The actual tuning fork is a U-shaped, metal element (A, fig. 22). The two arms of the U (the tines), when caused to move either by striking or pulling, will vibrate back and forth at a steady rate. This rate is fixed at the time of manufacture and is known as the *mechanical resonant frequency* of the tuning fork. Tuning fork assembly Y1 consists of such a tuning fork with two coils mounted between the tines. Each coil is wound on a permanent magnet core and has a permanent magnetic field surrounding it (B, fig. 22). The magnetic field exerts a force of attraction on the tines of the tuning fork, making them assume the position shown in B, figure 22.

b. At the instant that power is applied to oscillator tube V2B, capacitor C5 will charge as shown in C, figure 22. The path of the current charging C5 is through the input coil (terminals 3 and 1) of Y1. The temporary surge of current through the input coil of Y1 will cause a momentary change in the magnetic field surrounding the coil. Assume that the surge of current causes the magnetic field to momentarily increase. The tines of the tuning fork will be drawn closer to the input coil (D, fig. 22) than when in their normal rest position (B, fig. 22).

c. As C5 becomes charged, the current flow through the input coil falls to zero (C, fig. 22) and the magnetic field decreases to its normal value. The tines of the tuning fork attempt to snap back to their rest position shown in B, figure 22. The mass of the tines carries them beyond their rest position and they vibrate as shown in E, figure 22.

d. When the tines start to snap back towards their rest position, the motion of the tines causes them to change the permanent magnetic field of the output coil, thereby generating a voltage in that coil. The coils are wound so that this tine motion (away from the coils) causes a negative voltage at terminal 4 of Y1. This negative voltage is applied to the grid of V2A (fig. 23) and, when amplified by tubes V2A and V2B, appears at the plate of V2B as an amplified negative voltage. The plate voltage of V2B is fed back through R9 to the input coil, weakening its magnetic field and therefore allowing further motion of the tines in the same direction. This continues until the momentum of the tines causes them to go through their rest position and they are as far removed from the coils as their mechanical tension will allow. At that time, they start to snap back in the reverse direction. Motion in the reversed direction (going towards the coils) causes the tines to change the permanent magnetic field which generates a voltage of opposite polarity (positive) in the output coil. After amplification, the positive voltage is fed back to the input coil of tuning fork Y1, strengthens its magnetic field, and causes further motion of the tines (by magnetic attraction) in towards the coils. This motion continues until the times are again as close to the coils as their mechanical tension will allow at which time the motion is reversed and the cycle is started over again.

e. The motion of the tines from their innermost (closest to the coils) position (0 to 180, E, fig. 22) to their outermost position and back again (180 to 360, E, fig. 22) represents 1 complete cycle of the oscillator. As the tines move outward from their closest position, the oscillator output voltage (at the plate of V2B) goes negative. The voltage reaches maximum as the tines pass through their normal rest position. It then starts to return to zero as the tines slow down when approaching the limit of their outward travel. Thus, ½ cycle of the oscillator output corresponds to the outward travel and ½ cycle corresponds to the inward travel. The frequency of the output voltage is, therefore, determined by the number of reversals, or vibrations, of the tuning fork. This, of course, is the mechanical resonant frequency of the tuning fork which is the governing factor of the oscillator frequency.

f. Resistor R9 (fig. 23) controls the amplitude of the oscillator output by controlling the maximum deflection of the tuning fork tines. This is accomplished by limiting the value of feed-back current through, and therefore the magnetic field strength of, the input coil. The grid resistor for V2A is R11, the plate load resistor is R12, and the cathode resistor is R48. Tube V2A is coupled to V2B by means of capacitor C2. The grid resistor for V2B is R14, the plate load is R15. Capacitor C4, which is between the plate and grid of V2B, compensates for phase shift. Capacitor C1 is used to tune the input coil of tuning fork Y1.

g. The output of the oscillator is coupled by C5 to a voltage divider network composed of resistors R44 and R16. The input to 800-cycle amplifier tube V3A is adjusted by resistor R16 and is applied to the grid of tube V3A. Tube V3A amplifies this signal. The output of tube V3A is applied through plate-to-line transformer T5 to signal transfer relay K1.

31. Ring-in From Remote Radio Set to Switchboard

a. 800-cps Amplifier Detector (fig. 24). The receiver applies an 800-cps signal from the remote radio set through the hybrid stage (par. 33) and signal transfer relay K1 (contacts 13–7 and 14–9) to the 80-cps amplifier detector. This signal is fed into the grid of audio amplifier tube V3B through transformer T4, which is an impedance-bridging transformer across the 600-ohm telephone line. This signal is amplified and fed to the control grid of tube V4 through coupling capacitor C9. The positive portion of the signal is limited by the clipping action of diode CR1, thus tending to partially limit the signal to the control grid of tube V4. Consequently, there is no change in plate current or voltage drop across the plate load resistor of tube V4 during the positive portion of the input signal. The negative portion of the signal voltage applied to the control grid of tube V4 is not affected by diode CR1; consequently, this negative voltage decreases the voltage drop across the plate load resistor of tube V4 and results in an increase in voltage at the plate of the tube. When a very large ac input voltage is applied to the control grid of tube V4, the positive portion of the cycle is limited as before due to the clipping action of diode CR1. However, during the negative portion of the large ac input signal, tube V4 is driven toward cutoff; consequently, the maximum plate current and plate voltage change is reached. This limits the drive voltage to the input of tuning fork filter FL1.

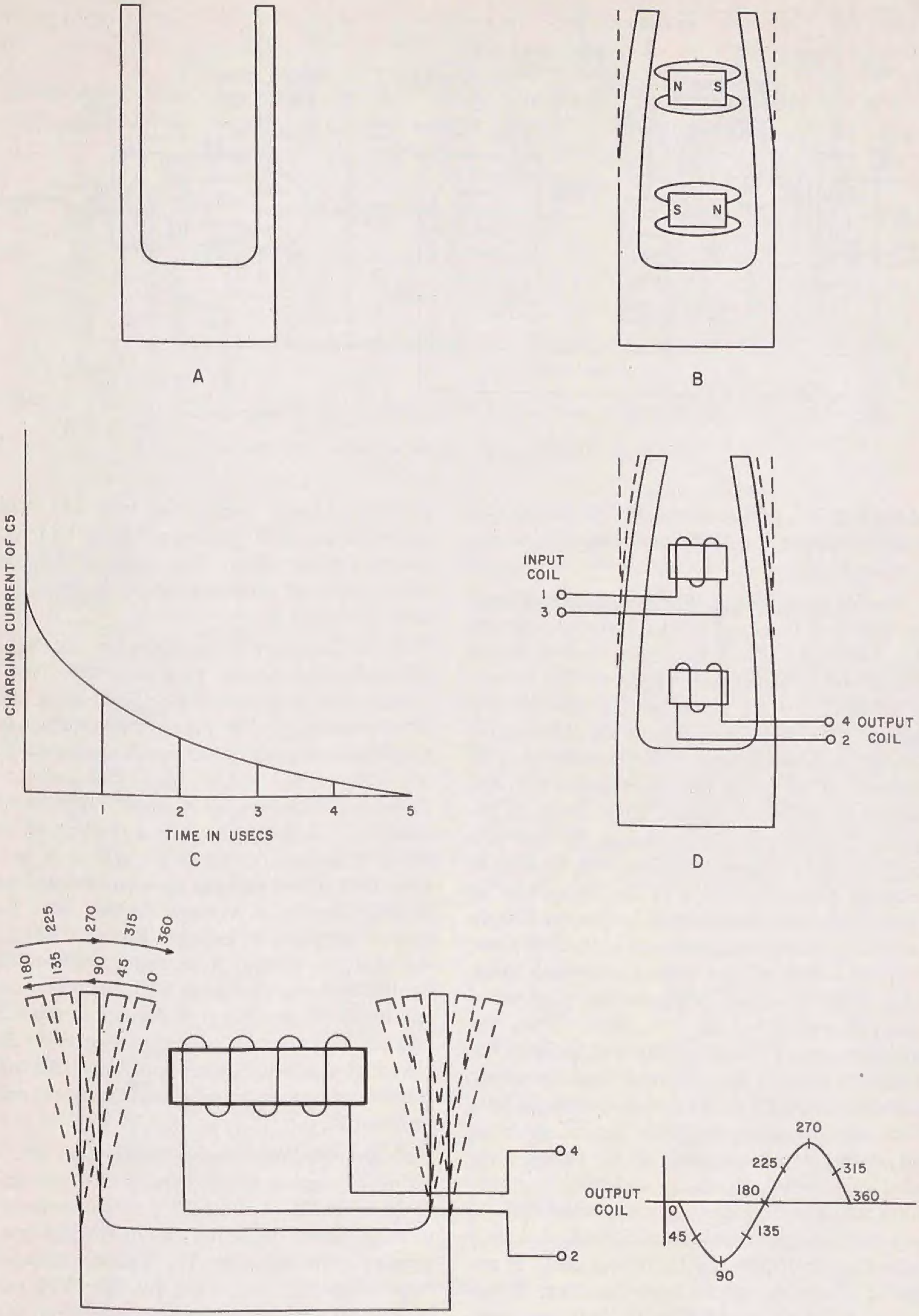


Figure 22. Tuning fork Y1.

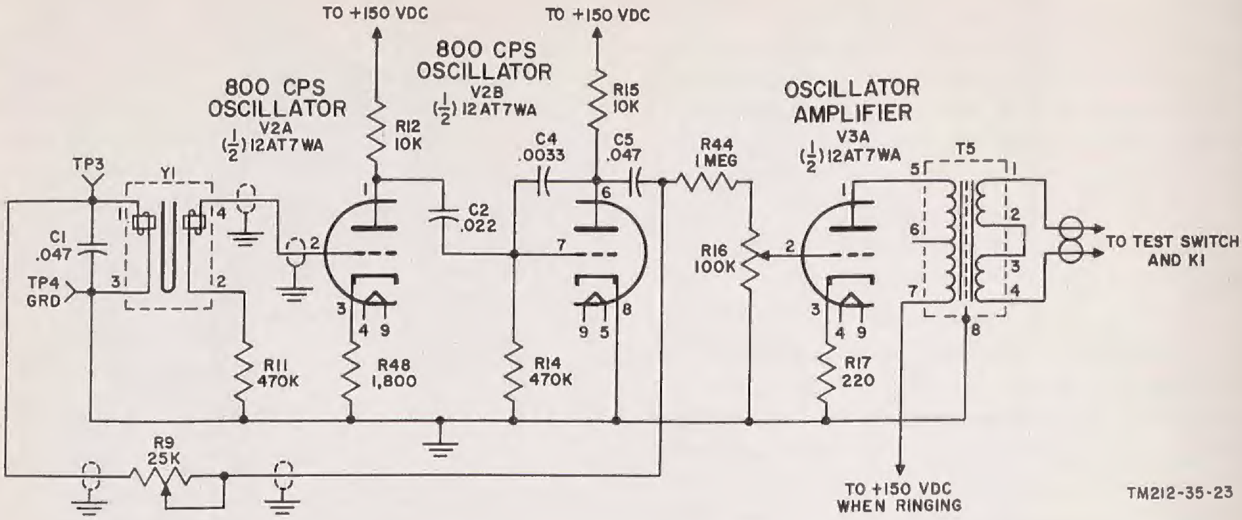


Figure 23. Oscillator and oscillator amplifier V3A, 800-cps.

Resistor R45 is a grid-leak resistor. Capacitor C11 couples the output of tube V4 to the input of tuning fork filter FL1.

b. Tuning Fork Filter. The tuning fork filter is composed of a U-shaped mechanical fork element within which are placed two coils, each of which is wound around a permanent magnet. The permanent magnets create a magnetic field around their respective coils. When an audio ac signal is applied to the terminals of the input coil, the magnetic field is changed at an audio rate corresponding to the frequency of the input signals. This change in the magnetic field results in a change in the pole strength of the permanent magnet, thus tending to vibrate the mechanical tines of the tuning fork at the same rate as the input signal frequency. Due to the mechanical resonant frequency of the fork tines, however, the tines will not sustain vibrations unless the input frequency is equal to the mechanical resonant frequency of the fork tines. When the input is the proper frequency required to cause the fork tines to vibrate, this vibration then conversely changes the magnetic field existing around the output coil at this audio rate, thus producing an ac signal at the output terminals of the tuning fork. Normal voice frequencies in the vicinity of the tuning fork resonant frequency do not produce 800 cps signals at the output terminals of filter FL1 since a sustained input of 800 cps (±.05 per cent) is required to obtain an output from the filter. Filter FL1 pases only sustained 800-cycle (±.05 per cent) signals to the grid of tube V5A. This 800-cycle signal is amplified by tube V5A. Resistor R24 is a cathode-biasing resistor for tube V5A, which is a class A amplifier. Resistor R23 is the plate load resistor for tube V5A. The output of tube V5A is coupled through capacitor C16 to dc amplifier relay actuator tube V5B.

c. Dc Amplifier, Relay Actuator (fig. 25). The 800-cycle signal from V5A is rectified by diode CR2, which is connected as a half-wave rectifier. The resultant positive pulses are smoothed out by a resistance-capacity filter circuit composed of resistor R28, capacitor C17, and load resistor R47. Resistor R28 serves as a ripple attenuator. The output of this filter circuit is a positive dc voltage which is applied directly to the grid of dc amplifier tube V5B. Fixed cathode bias is developed for this dc amplifier by a voltage divider from B+ to ground composed of resistors R33 and R34. When the positive voltage from the preceding filter is applied to the grid of tube V5B, the tube conducts, causing dc to flow through the coil of relay K4 to energize this relay. Contacts 4–6 of relay K4 are closed by this action, thus applying +108 volts dc control voltage to ringing transfer relay coil K3, terminal 10.

d. 20-cycle Ringer Power Supply (fig. 26). Energizing of ringing transfer relay K3 connects the cathode circuit of tube V8 through contacts 8–14 of relay K3 to the center tap of the power supply winding of transformer T6. The ac voltage from transformer T6 is rectified by tube V10 and fed through an L-section filter circuit comprised of capacitor C27 and resistor R43 to voltage regulator tube V8. Resistor R43 also acts as a current-limiting

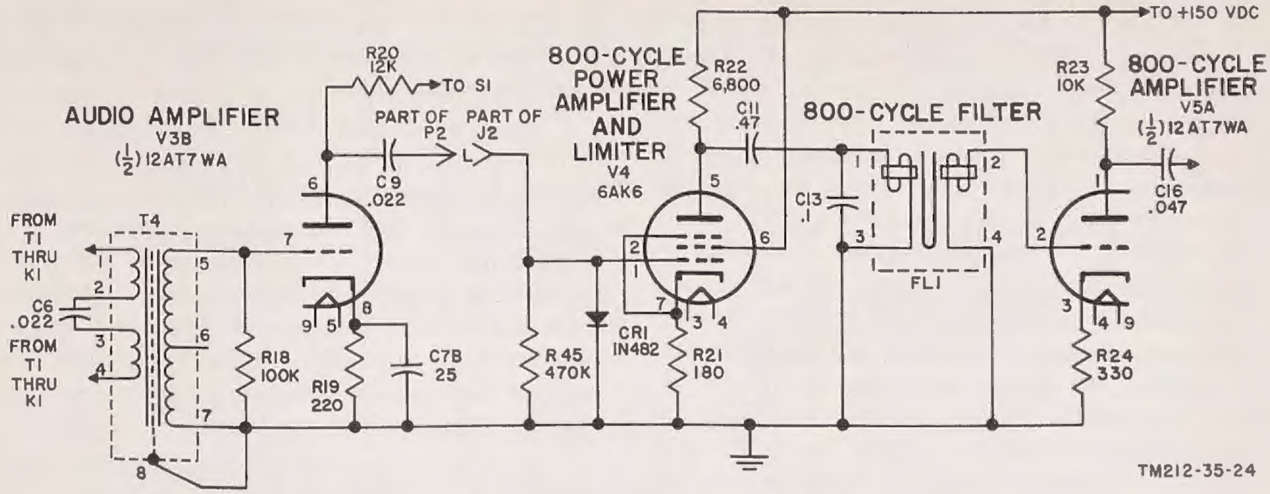


Figure 24. Amplifiers V3B, V4, and V5A, 800-cps.

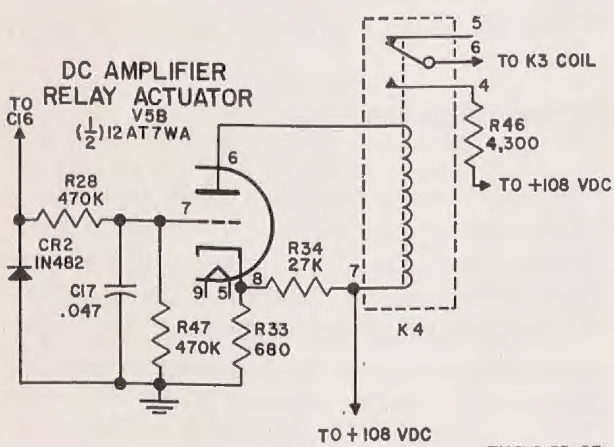


Figure 25. Dc amplifier, relay actuator V5B.

resistor to voltage regulator tube V8. Resistor R39 serves as a bleeder resistor. This supply furnishes voltage for the 20-cps generator.

32. Operation of 20-cps Generator

(fig. 27)

a. Vibrator Action. With no voltage applied to vibrator G2, the armature is at rest slightly to the left of midpoint between voltage contacts B–C and E–F with vibrator coil contact A closed. Vibrator coil contact A shorts out resistor R40 in this position. When 150 volts is applied to the input of generator G1, current flows from the negative side of the 20-cycle ringer power supply into terminal 1 of 20-cycle generator G1, through inductor

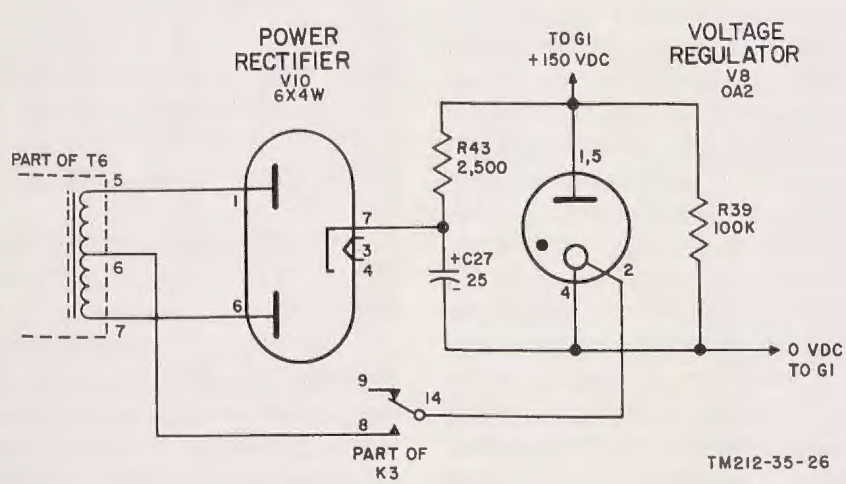


Figure 26. Generator power supply, 20-cps.

L3, through the vibrator winding, through vibrator coil contact A, through upper armature D, through inductor L4 and returns to the positive side of the 20-cycle ringer power supply. This flow of current energizes the vibrator winding. Since the armature is slightly off center to the left, the magnetic field pulls the armature (D and G) to the left, breaking vibrator coil contact A, thus inserting resistor R40 in series with the vibrator winding. With this added resistance in the circuit, the current flow decreases and causes the magnetic field to collapse and permits the armature (D and G) to move back to its rest position. Inertia carries the armature past its rest position. As the armature (D and G) passes the rest position, vibrator coil contact A is closed and the winding is reenergized, and the action repeats itself. As this action progresses, the armature (D and G) is deflected farther each cycle until its limitations are reached. Under this condition, armature D makes contact alternately with voltage contacts C and B and armature G makes contact alternately with contacts F and E.

b. Current Flow. When the armature closes the left set of voltage contacts C and F, current flows from the negative side of the power supply into generator G1 and terminal 1, passes through inductor L3, through lower armature G, through voltage contact F, through inductor L1, out of generator G1 at terminal 4, through the external load, back into generator G1 at terminal 3, through inductor L2, through voltage contact C, through upper armature D, through inductor L4, out of generator G1 terminal 2, and returns to the positive side of the power supply. When the armature closes the right set of voltage contacts B and E, the current through the external load reverses as follows: current flows from the negative side of the power supply into generator G1 at terminal 1, passes through inductor L3, through lower armature G through voltage contact E, through inductor L2, out of generator G1 at terminal 3, through the external load (in opposite direction of previous conditions) back into generator at terminal 4, through inductor L1, through voltage contact B, through upper armature D, through inductor L4, out of generator G1 terminal 2, and returns to the positive side of the power supply. Thus, an alternating current flows through the external load whose frequency is governed by the rate of vibration of vibrator G2, which has a normal vibration rate of 20 cycles per second.

c. Armature Buildup. Capacitor C21 and resistor R38, in parallel with the vibrator winding, decrease the time required for the armature to build up vibrations of sufficient amplitude to make and break the voltage contacts.

d. Spark Suppression Filter. A spark suppression filter is shunted across each of the voltage contacts and its associated armature. The series arrangement of resistor R29 and capacitor C19 serves as a spark suppression filter shunted across the upper armature and its right voltage contact. Similarly, resistor R35 and capacitor C22, resistor R30 and capacitor C18, and resistor R36 and capacitor C24 each serve as a spark suppression filter across their associated contacts and armature.

e. Current-Limiting Device. Ballast resistor RT1 serves as a current-limiting device to protect the 20-cps generator from shorted telephone lines.

f. Ringing Voltage. This generator supplies a 20-cps ringing voltage through ringing transfer relay K3 (fig. 25) contacts 3–11 and 6–13, directly to the switchboard.

33. Hybrid Circuits

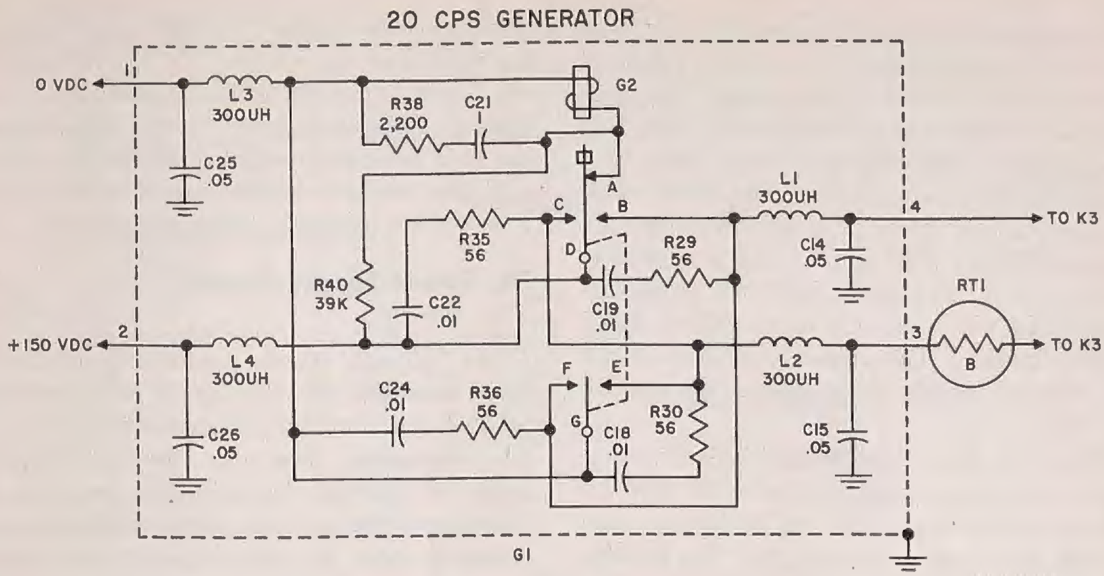
(fig. 28)

The hybrid stage provides a match between the receiver and the telephone and the transmitter and the telephone. The hybrid stage will also pass ring-in and ring-out signals. This paragraph describes how this is accomplished.

Note. During receiving and transmitting of voice frequencies, all stages of the converter except the hybrid stage remain inactive since these stages are keyed only by an 800-cps signal or a 20-cps signal.

a. Ring-in (800-cps) From Remote Set. The 800-cps ringing signal appears in the grid circuit of hybrid V1. Hybrid V1 will pass the 800-cps signal in the same manner as voice frequencies (*b* below). The 800-cps signal will not ring into the switchboard, which is sensitive to 20 cps only. To convert the 800-cps signal to 20 cps, the 800-cps signal is applied to the primary of T4 (fig. 24) and then passed through stages consisting of V3B, V4, FL1, V5A, V5B, and K4 (fig. 25). A detailed analysis of how these stages convert the 800-cps ringing signal to a 20-cps ringing signal is covered in paragraph 30.

b. Receiving Voice Frequencies From Remote Radio Set (fig. 28). The signal from the balanced audio output of the receiver is applied to terminals C and D of connector J1. This signal is developed across resistors R4, R5, and R6, connected in series. The resistors are in the grid circuit of V1, which is



TM212-35-27

Figure 27. Generator G1, 20-cps.

a 6AS6W dual control tube having two control grids. The construction of this tube is similar to a pentode except that the grid normally identified as a suppressor is designed to operate as a second control grid and will be referred to as *control grid 2.* The purpose of control grid 2 is to provide a secondary control of the electron stream. The audio signal (voice frequencies from the remote set) applied by the receiver causes electrons to flow through the resistive network. On the first half-cycle, electrons flow through resistors R4, R5, and R6 to develop a voltage across R4, which is negative with respect to ground, and across R5 and R6, which is positive with respect to ground. The first control grid (pin 1) of V1 is connected to the junction of R5 and R6, which is positive with respect to ground. The second control grid (pin 7) of tube V1 is connected to the center arm of R4, which, is negative with respect to ground. On the second half-cycle of the audio signal, electrons flow in the opposite direction and the above conditions are reversed. When control grid 1 is positive due to the input signal from the receiver, the flow of electrons from the cathode to plate of V1 increases. Control grid 2 is of the opposite polarity (negative) at this instant and is capable of controlling the electron stream and the increase caused by control grid 1 is canceled. The flow of electrons reaching the plate of V1 remains basically the same and, therefore, the plate current of V1 is increased very little. On the next half-cycle, when control grid 1 becomes negative, the flow of electrons from cathode to plate is decreased. Control grid 2 is positive and acts to increase the flow of electrons, again canceling the effect of control grid 1. As a result of the dual control grids working 180° out of phase, the incoming signal has very little effect on the plate current of V1.

c. Operation of Hybrid When Receiving. Since the plate circuit of V1 is not used in this phase of hybrid operation, the circuit can be simplified by redrawing V1 as a triode (fig. 29). The screen grid of V1 is located between control grid 1 and control grid 2. As in a normal pentode, dc screen current is flowing and the screen grid can be considered as the plate of a triode. The screen grid current of V1 flows through winding D of transformer T3. A dc current will establish a steady field and nothing will appear across winding C of T3. The audio signal (voice frequencies from the remote set) applied to control grid 1 of V1 will increase and decrease the flow of electrons from the cathode to the plate (screen grid) of V1. This increase and decrease will appear as an ac component to the dc screen grid current. The ac component introduced by the audio signal causes the magnetic field in winding D to vary and, by transformer action, an ac voltage (the audio signal) appears across winding C of transformer T3. The local telephone is connected across winding C of transformer T3 and the audio signal appearing across winding C will be heard in the telephone. The audio signal appearing across winding C of transformer T3 also appears across winding A of transformer T1 (fig. 29). Winding B of transformer T1 is in the cathode of V1 and therefore a feedback loop exists. The phase of the audio voltage across winding B is such that the degeneration that normally takes place in a unbypassed cathode is canceled. The audio signal also appears across the primary of transformer T4 and is amplified by V3B and V4 and is applied to the input of FL1. The audio signal will go no further since FL1 will react only to an 800-cps signal of proper duration. The voice frequencies do not contain 800-cps signals of the correct duration to trigger FL1.

d. 20-cps Ringing. The 20-cps ringing voltage from the switchboard appears across J3 and J4. The 20-cps voltage is converted to an 800-cps ringing voltage in the converter (par. 29). The 800-cps voltage appears across terminal A of transformer T1 and is passed by hybrid stage V1 (*e* below). The 800-cps voltage then appears across terminal E of transformer T2 with enough amplitude to modulate the transmitter which is connected across winding F of transformer T2.

e. Voice Frequencies From Local Telephone. The local telephone may be connected directly to J3 and J4 or through a switchboard and telephone line. The audio signal from the local telephone appears across winding A of transformer T1. During this phase of hybrid operation, there is no signal across R4, R5, and R6. The circuit operates as a grounded grid amplifier and may be redrawn (fig. 30). The audio signal from the local telephone, which appears across winding A of transformer T1, will induce a voltage (the audio signal) across winding B of transformer T1. Winding B of transformer T1 is in series with the cathode of hybrid V1. The audio voltage appearing across winding B will modulate the dc tube current of hybrid V1. The modulated current flows through winding E of transformer T2, which is in the plate circuit of hybrid V1. The modulated current induces an ac voltage (the audio signal) across winding F of transformer T2. Radio Transmitter T–593(*)/TRC–47, connected across winding F, will be modulated by the audio voltage. Figure 30 reveals that winding A of transformer T1 and winding C of transformer T3 are common. Therefore, the voice signal from the local telephone which appears across winding A of transformer T1 also appears across winding C of transformer T3. Transformer T1 is connected so that the voltage across winding B is in phase with the voltage across winding A. Transformer T3 is connected so that the voltage across winding D is 180° out of phase with the voltage across winding C. The voltage across winding A is induced in B and modulates the tube current as described above. The voltage across winding C is induced in winding D 180° out of phase with the modulated tube current which results in a very small change in screen grid voltage.

34. Power Supply Circuit
(fig. 31)

The 115-volt, 60-cps power is applied to converter connector J5. Connectors J6, J7, and J8 are parallel power outlets which furnish power to related equipment. The input circuit is connected in series with power switch S2 and fuse F1. Power transformer T6 has two primary windings to permit its use on either 115 volts ac or 230 volts ac. When using 115 volts, the primary windings are connected in parallel (terminals 1 and 3 connected together and 2 and 4 connected together). When using 230 volts, the primary windings are connected in series by wiring a jumper between terminals 2 and 3 and applying power at terminals 1 and 4. Power transformer T6 has three secondary windings. The first winding (terminals 5, 6, and 7) supplies plate power for the rectifier in the 20-cycle ringer power supply (par. 29). The second winding (terminals 11 and 12) provides 6 volts for all tube filaments and POWER indicator lamp DS1. The third winding (terminals 8, 9, and 10) supplies plate voltage to tubes V9 and V11 which are connected in parallel and are used as a full-wave rectifier, the transformer center tap being ground. The output of the rectifier is followed by a pi-section filter, using a resistor series element. This filter consists of capacitor C20B and C20A and resistor R37. Resistor R31 is a current-limiting resistor to voltage regulator tube V7, providing regulated +150 volts dc to the plates and screens of all tubes except the plate of tube V1. Bleeder resistor R27 is across the output of the filter and voltage regulator. There is also a series current limiter resistor, R32, from the cathodes of rectifier tubes V9 and V11 to voltage regulator tube V6. The output of this section of the power supply furnishes regulated +108 volts dc to the plate of tube V1. Capacitor C20B also serves as an input capacitor to the L-section filter composed of capacitor C20B and resistor R32. Tubes V6 and V7 are glow discharge gas tubes which have a constant voltage drop across the electrodes for a wide range of current flow. This constant voltage drop, in conjunction with current-

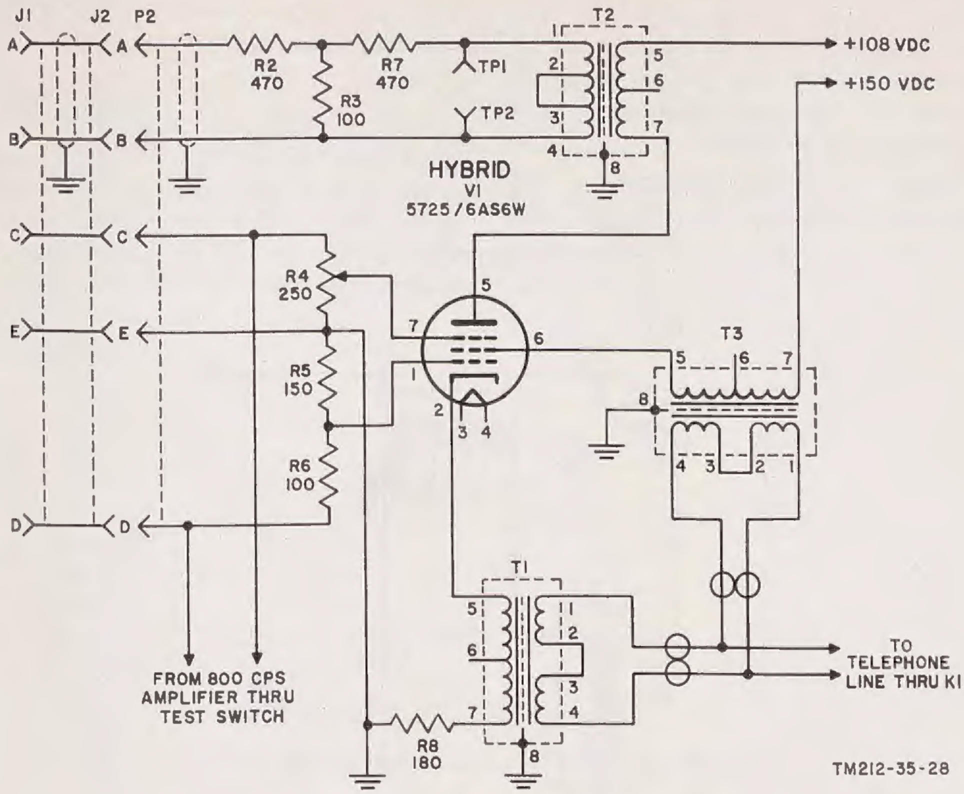


Figure 28. Hybrid V1.

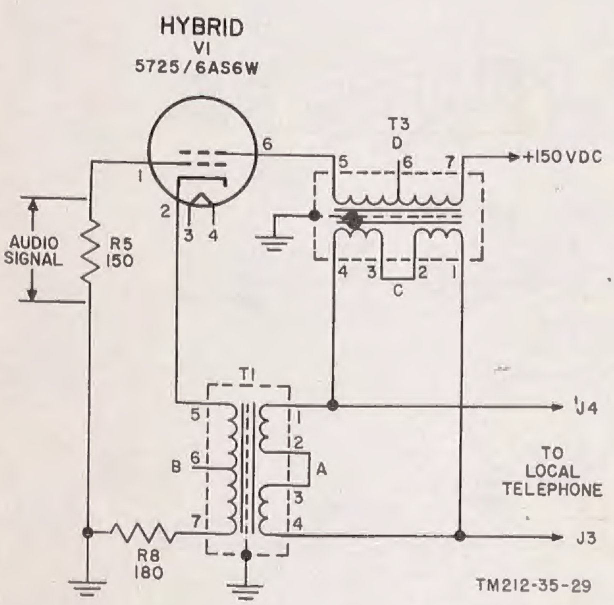


Figure 29. Simplified hybrid circuit receiving signal.

limiting resistors R32 and R31, acts as a variable voltage divider, thus tending to maintain a constant output potential at the junction of the current-limiting resistors and the voltage regulator tubes.

35. Operation of Test Switch S1

(fig. 58)

Test switch S1 is a four-pole, three-position, spring-return switch whose normal position is centered (OPERATE position). This switch is used to supply an 800-cps signal to the hybrid stage to simulate a received or transmitted signal for tuning, alining, or troubleshooting the converter.

a. In the OPERATE position, switch S1 is used to complete the normal circuits of the converter. Terminals 14 and 16 complete the circuit from telephone line connector J3 to ringing transfer relay K3. Terminals 1 and 11 furnish +150 volts dc to the plate of audio amplifier tube V3B.

b. In the RECEIVE position, switch S1 applies +150 volts dc through terminals 11 and 12 to oscillator amplifier tube V3A. the oscillator amplifier then applies an 800-cps signal through transformer T5 to terminals 3 and 7 of switch S1 and is fed through terminals 4 and 8, respectively, to the receiver side of the hybrid stage. Line load resistor R1 is substituted for the telephone line to simulate line load through terminals 13 and 16. In this condition, the 800-cps signal applied to the receiver

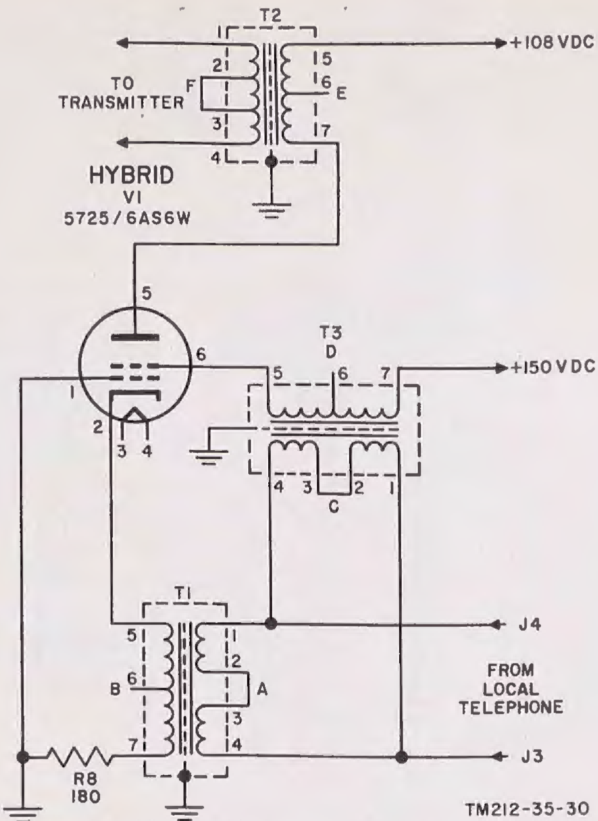


Figure 30. Simplified hybrid circuit transmitting signal.

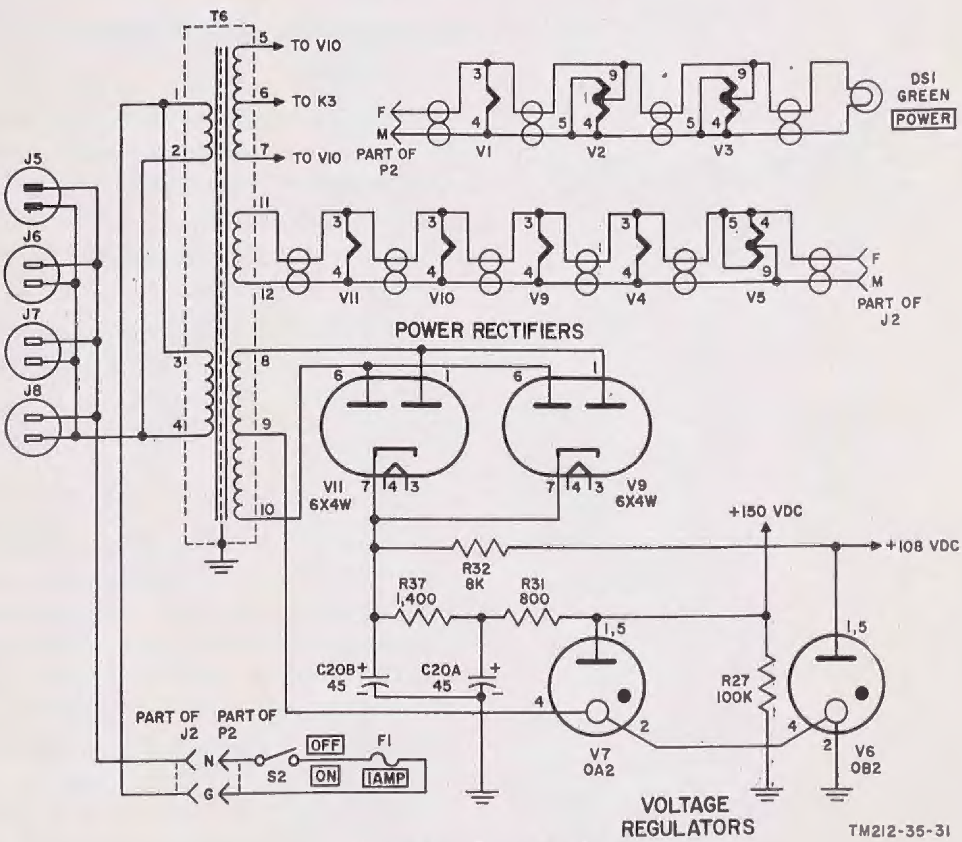


Figure 31. Power supply.

side of the hybrid stage is used to adjust converter rejection (transhybrid loss) or test ring-in circuits (par. 65).

c. In the TRANSMIT position, switch S1 applies +150 volts dc through terminals 11 and 2, through current-limiting resistor R10 to the coil of signal transfer relay K1, which closes the relay. Signal transfer relay K1 applies +150 volts dc through contacts 3 and 11 to the plate of oscillator amplifier tube V3A which applies an 800-cps signal through transformer T5, through contacts 6–13 and 8–14 of signal transfer relay K1 to the transmit side of the hybrid stage. This 800-cps signal is used to adjust the level of the 800-cps signal necessary to key the ringing circuits of remote Radio Set AN/TRC–47 and to adjust the receiver audio level to converter of remote Radio Set AN/TRC–47 (par. 65).

CHAPTER 3

INITIAL ADJUSTMENTS

Note. The procedures described in this chapter should be performed by a field radio repairman.

36. Test Equipment Required

The following test equipment is required for initial adjustment of the radio set:

a. Radio Frequency Wattmeter AN/URM–43A.

b. Audio Oscillator TS–382E/U.

c. Oscilloscope OS–8A/U.

d. Electronic Voltmeter ME–30B/U.

37. Input Power Adjustments

The radio set may be operated from either a 115- or 230-volt ac source. However, the connections at the primaries of the input power transformers must be adjusted for the source voltage to be used. Before the equipment is put into operation, check power transformers T1 on the transmitter (fig. 3, TM 11–212–10), T2 on the receiver (fig. 4, TM 11–212–10), and T6 on the converter (fig. 5, TM 11–212–10) and adjust the connections if necessary. For 115-volt operation, a lead should be soldered between terminals 1 and 3 and a lead should be connected between terminals 2 and 4. There should be no connection between terminals 2 and 3. For 230-volt operation, the reverse applies; there should be no connection between terminals 1 and 3 or between terminals 2 and 4 but a lead should connect terminals 2 and 3.

38. Power Output and Antenna Coupling Adjustment

(fig. 32)

To avoid damaging the power amplifier tube and to obtain efficient operation, the output stage must be coupled as tightly as possible to the antenna. Reductions in output power, therefore, should normally be made with the OUTPUT control and not by decoupling the antenna. However, the minimum output attainable with the OUTPUT control (completely counterclockwise) is 1 watt. If an output of less than 1 watt is desired, it is permissible to decouple the antenna after the OUTPUT control has been tuned completely counterclockwise. Only during the tuning of the power output stage (*d* below) is loose coupling desirable. The looser the coupling, the better the tuning indications. Make the power output and antenna adjustments as follows:

a. Open the transmitter front panel door and rotate the OUTPUT control (fig. 32) completely counterclockwise.

b. Turn the METER SWITCH on the front panel (fig. 32) to PA_{IP}.

c. Place the FIL switch in the ON position. Allow 5 minutes for the transmitter to warm up and place the PLATE switch in the ON position.

d. Rotate the OUTPUT control completely clockwise. Turn the PWR AMP control (fig. 32) until a *minimum* reading is obtained on the TUNING METER. Do not allow the reading to indicate more than .25 during this procedure. If the reading is higher than .25, loosen the coupling by turning the COUPLING control counterclockwise until the reading falls below the limit.

e. Adjust the ANT TUNING control until a *maximum* reading is obtained on the TUNING METER.

f. Increase the coupling by turning the COUPLING control clockwise until an indication of approximately .5 is obtained on the TUNING METER.

g. Readjust the PWR AMP control for a *minimum* reading on the meter and then readjust the ANT TUNING control for a *maximum* reading.

h. Turn the OUTPUT control completely counterclockwise. This produces a power output of slightly more than 1 watt which is desirable for the normal intended operation of the radio set. However, if a greater power output is desirable, connect

Radio Frequency Wattmeter AN/URM-43A across the transmitter output and turn the OUTPUT control clockwise until the desired output is indicated on the wattmeter.

Warning: Do not load the transmitter beyond 7 watts of output power. To do so may cause distorted modulation and possible carrier shift. In addition, the output tube may be damaged when transmitting more than 7 watts at the higher frequencies in the band.

39. Modulation Adjustment

Before operating the transmitter, it is necessary to adjust the modulation level so that the RF carrier is not modulated more than 100 per cent at the highest level of audio input. To do this:

a. Open the front panel door of the converter. Connect Audio Oscillator TS-382E/U to terminals TP1 and TP2 (fig. 33).

b. Connect Oscilloscope OS-8C/U to the transmitter output. Apply the signal directly to the oscilloscope vertical deflection plates and adjust its horizontal sweep frequency between 100 and 300 cps.

c. Place the ON-OFF switch on the converter front panel (fig. 12, TM 11-212-10) and the transmitter FIL switch (fig. 32) in the ON positions. Allow 5 minutes for the equipment to warm up and place the transmitter PLATE switch in the ON position.

d. Adjust Audio Oscillator TS-382E/U for a .125-volt, —16-decibel (referred to 1 milliwatt in 600 ohms (db)) output at 300 cps.

e. Open the front panel door of the transmitter. Adjust the MOD GAIN control (fig. 32) until the pattern on Oscilloscope OS-8A/U indicates 100 per cent modulation of the RF carrier. (Refer to TM 11-665, C-w and A-m Radio Transmitters and Receivers, for information on the use of an oscilloscope to determine the percentage of modulation.)

f. Disconnect the test equipment.

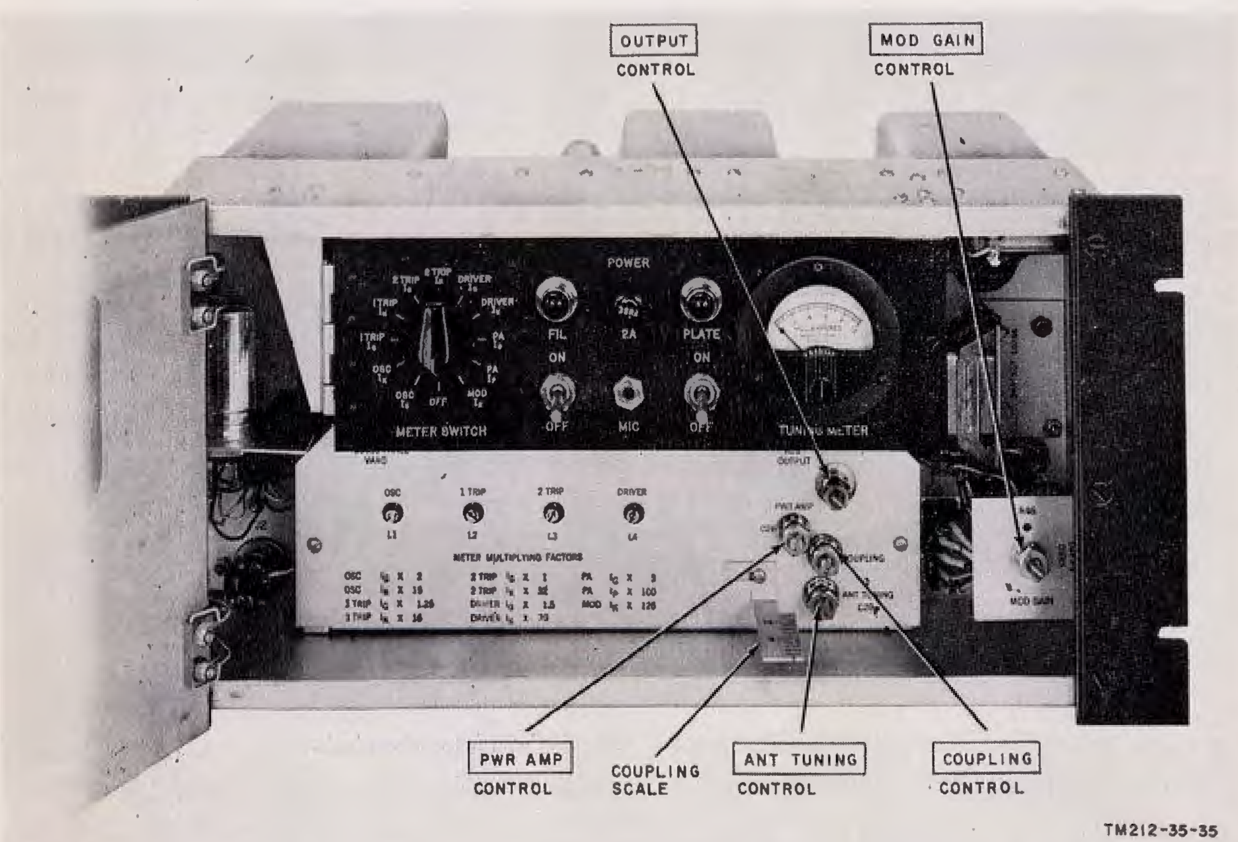


Figure 32. Radio Transmitter T-593(*)/TRC-47, controls.

40. Audio Level Adjustment

The level of the receiver audio supplied to the converter must be adjusted to the proper value. This adjustment requires the use of a complete radio link. The modulation adjustment must have been performed on the distant transmitter. Proceed as follows:

a. Connect Electronic Voltmeter ME–30B/U to terminals TP5 and TP6 on the converter (fig. 33).

b. Turn on the power in all units of both the distant and local radio sets.

c. While switch S1 (fig. 33) of the remote converter is held in the TRANSMIT position, adjust audio gain control resistor R50 (fig. 34) on the local receiver. Adjust the control until a reading of .1 volt ac is obtained on Electronic Voltmeter ME–30B/U.

d. Disconnect the test equipment.

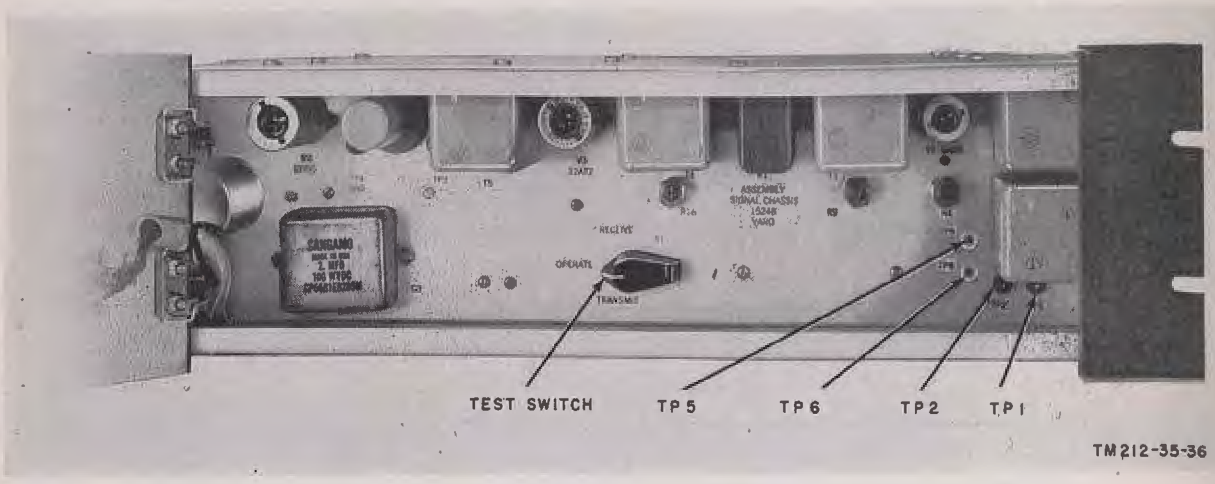


Figure 33. Telephone Signal Converter CV–542/TRC–47, internal controls.

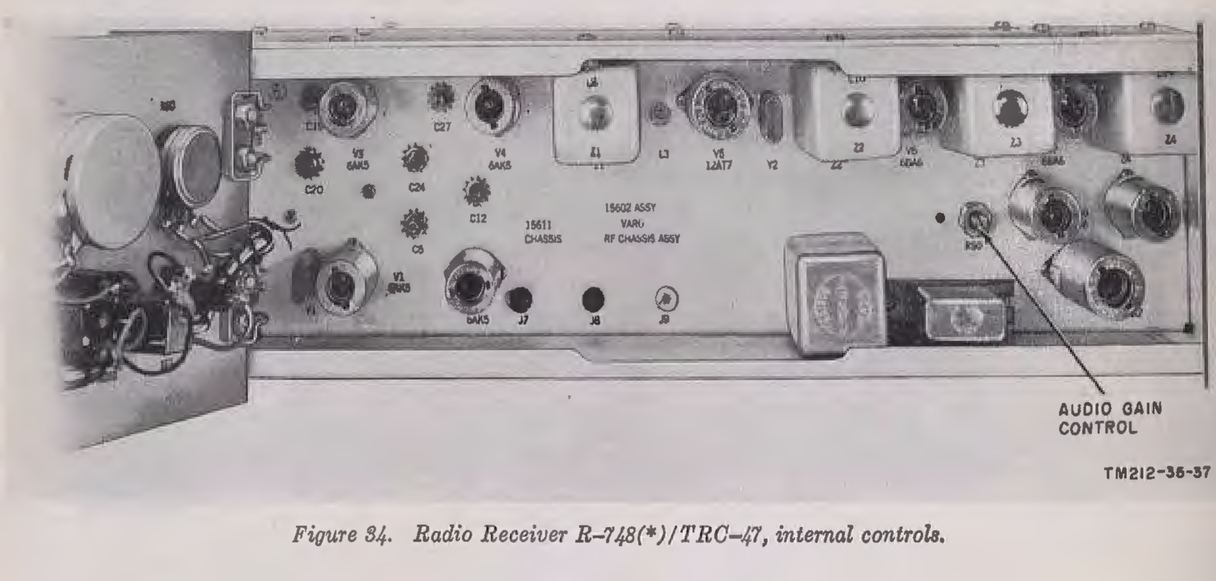


Figure 34. Radio Receiver R–748(*)/TRC–47, internal controls.

CHAPTER 4

TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

41. General Instructions

Troubeshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedure described in organizational maintenance. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational level, must be completed by means of sectionalizing, localizing, and isolation techniques. Section II provides *interunit* troubleshooting procedures which must be performed at the field maintenance level; sections III through V describe *intraunit* localizing and isolating techniques that must be performed at a field maintenance level.

42. Troubleshooting Procedures

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

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work, and to aid in tracing trouble in a defective radio set. Radio Set AN/TRC–47 consists of the receiver, the transmitter, and the converter. The first step is to locate the unit or units at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All meter readings, scope patterns, or other signs should be observed and an attempt made to sectionalize the fault to a particular unit.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. The equipment performance check list (TM 11–212–20) is a good operational test.

c. Localization. The tests listed below will aid in locating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements. Use the following methods of trouble localization:

(1) *Signal substitution.* Signal substitution (par. 50) will help in isolating a trouble to a specific circuit at fault.

(2) *Voltage and resistance measurements.* These measurements will help locate the individual part at fault. Use resistor and capacitor color codes (fig. 52 and 53) to find the value of the components. Use voltage and resistance diagrams (fig. 40, 44, and 48) to find normal readings, and compare them with readings taken.

(3) *Troubleshooting chart.* The trouble symptoms listed in the chart (par. 49) will aid in localizing trouble to a part.

(4) *Stage-gain measurements.* The stage-gain measurements (par. 51) will help to locate hard-to-find troubles in the individual stage or circuit.

(5) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles

should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Check the wiring and connections to the units of the set.

43. Test Equipment Required

The following chart lists test equipment required for troubleshooting Radio Set AN/TRC-47 together with the associated technical manuals and the assigned common names.

Test equipment	Technical manual	Common name
Electron Tube Test Set TV-2/U	TM 11-2661	Tube tester
Audio Oscillator TS-382E/U	TM 11-2684A	Audio oscillator
Spectrum Analyzer TS-723/U	TM 11-5099	Analyzer
Electronic Voltmeter ME-30B/U	TM 11-5132	Voltmeter
Signal Generator TS-497B/URR	TM 11-5030A	Signal generator
Electronic Multimeter TS-505/U	TM 11-5511	Multimeter
Fequency Meter AN/URM-32, w/Power Supply PP-1243/U	TM 11-5120	Frequency meter
Radio Frequency Wattmeter AN/URM-43A	TM 11-5133	Wattmeter
Tool Equipment TE-113		

Section II. INTERUNIT TROUBLESHOOTING

44. Faulty Operation

Faulty operation of the radio set may be caused by defective cabling between units, or a defect in the receiver, transmitter, or converter. Sectionalize the trouble to one of these units by means of the following checks; then localize and isolate the trouble. A schematic view of the branched cable assembly CX-4065/TRC-47 is shown in figure 35.

Note. Each of the following checks is independent of the others, and the equipment should be connected completely, except as specified for the particular procedure involved.

a. With the equipment turned off, remove each cable and check for continuity or shorts.

b. Turn the equipment on as described in the equipment performance checklist (TM 11-212-20).

45. Operational Check of Receiver

Place the SQUELCH-OPEN switch on the receiver in the OPEN position. A loud rushing noise should be heard in the loudspeaker. If the receiver is silent, refer to paragraph 49 and troubleshoot the receiver.

46. Operational Check of Converter

Check the converter by performing *a* and *b* below. If the results are not obtained, refer to paragraph 59 and troubleshoot the converter.

a. Place switch S1 on the converter in the RECEIVE position. This should cause the telephone or switchboard connected across J3 and J4 to ring.

b. Place switch S1 in the TRANSMIT position. Connect a vacuum tube voltmeter (vtvm) across TP1 and TP2 on the converter (fig. 33). The vtvm should indicate .1 volt ac.

47. Operational Check of Transmitter

The quickest way to check the transmitter is to attempt to make contact with the remote radio set. If the operator can successfully ring out and talk to the remote radio set, it can be assumed that the transmitter is operating. If the remote radio set cannot receive the transmitted signal or the signal is unsatisfactory, refer to paragraph 55 and troubleshoot the transmitter.

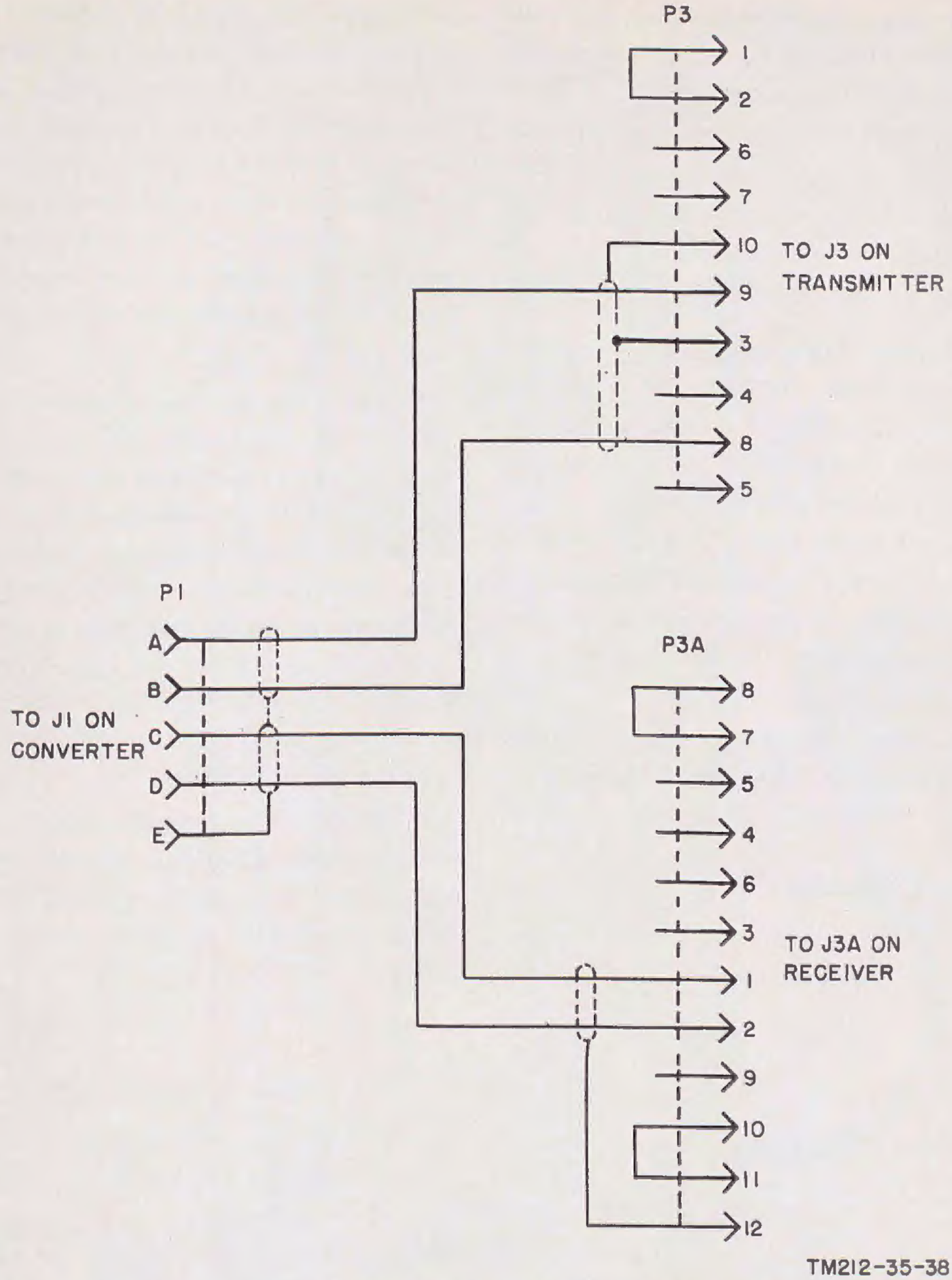


Figure 35. Electrical Special Purpose Branched Cable Assembly CX-4065/TRC-47, schematic diagram.

Section III. TROUBLESHOOTING RADIO RECEIVER R-748(*)/TRC-47

48. Checking Receiver Filament and B+ Circuits for Shorts

a. When to Check. When any of the following conditions apply, check for short circuits and clear the troubles before applying power.

(1) When abnormal symptoms reported from operational tests (equipment performance checklist TM 11-212-20) indicate possible power supply troubles.

(2) When interunit sectionalization procedures (par. 45) have indicated possible power supply trouble.

b. Conditions for Tests. To prepare for the short-circuit tests:

(1) Disconnect the antenna from J1, cable assembly from J3A, and the power cable from J2 on the receiver.

(2) Remove the receiver from the equipment cabinet.

(3) Remove all the tubes, dial lamps, and crystals.

(4) Turn the ON-OFF switch to ON.

c. Measurements. Make the resistance measurements indicated below. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

(1) The resistance from pin 8 of XV14 to ground should measure 20,000 ohms. If this value is not obtained, start at the filter circuit and check the B+ line until the defect is found.

(2) The resistor from pin 2 of XV13 to ground should measure 1,600 ohms. If this is not found, check C72C.

49. Localizing Troubles

a. General. Procedures are outlined in the following chart for localizing troubles to the audio-frequency (AF), IF, and RF sections of the receiver, and for localizing troubles to a stage within the various sections. Location of parts is shown in figures 36, 37, 38, and 39. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in localization of troubles to a particular stage, use the techniques outlined in paragraph 52 to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting chart is designed to supplement the operational checks detailed in the equipment performance checklist (TM 11–212–20) and the interunit sectionalization checks described in paragraphs 44 and 45. If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist (TM 11–212–20) and proceed until the trouble is located.

Caution: If operational symptoms are not known, or they indicate the possibility of short circuits within the receiver, make the short-circuit checks described in paragraph 48 before applying power.

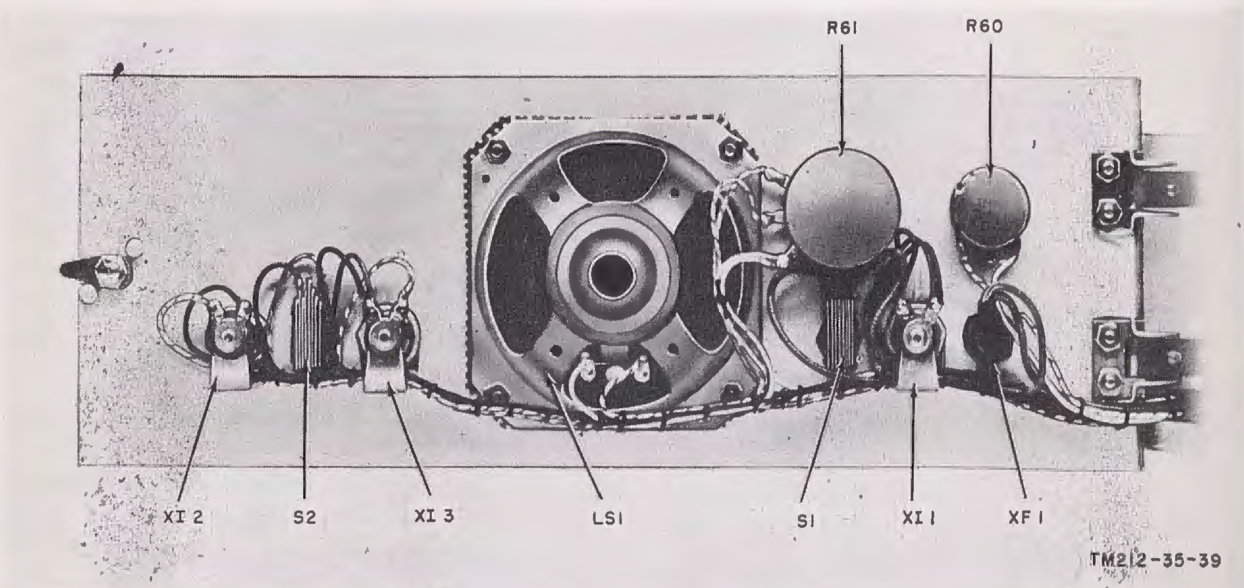


Figure 36. Receiver front panel, location of components.

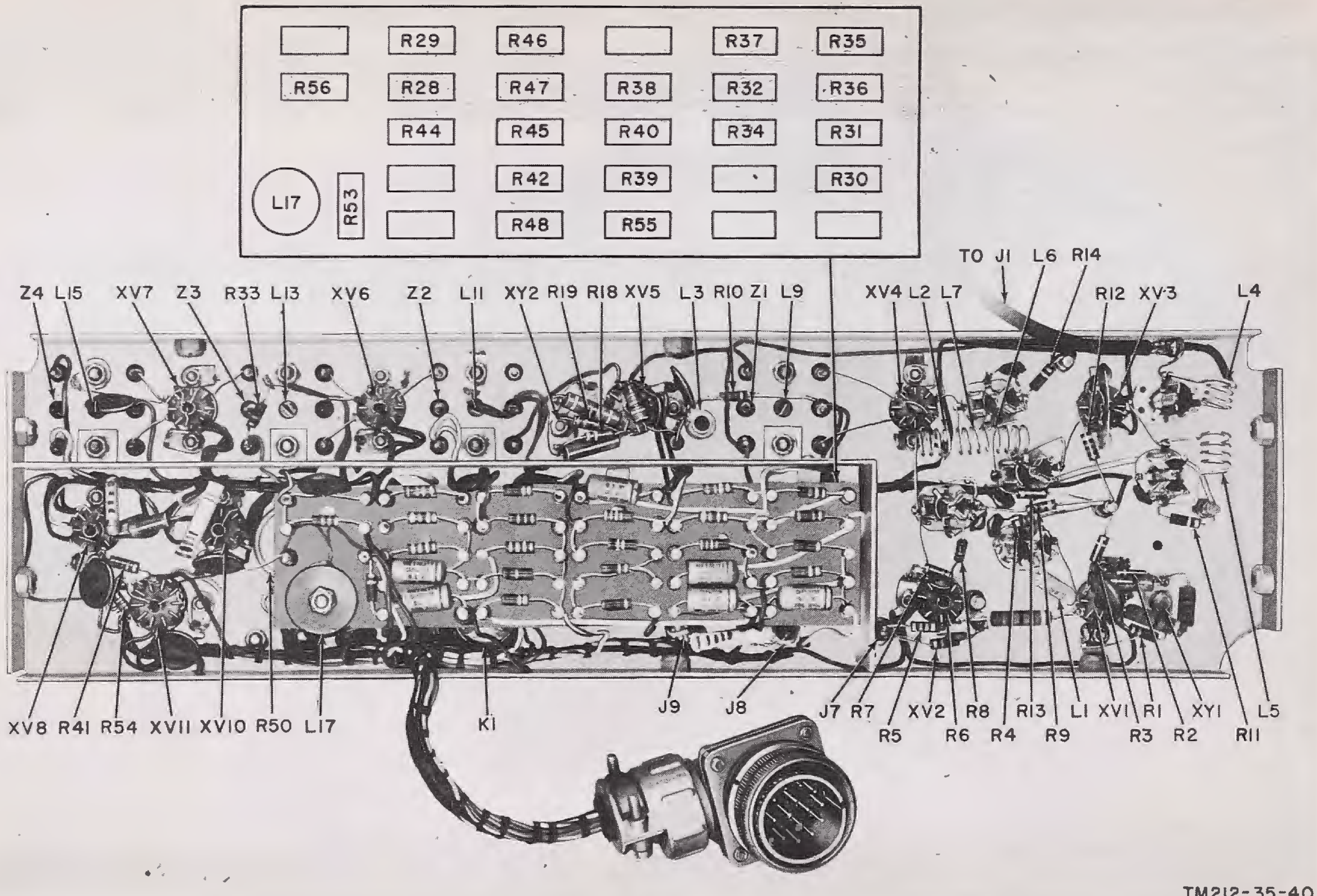


Figure 37. Radio Receiver R–748(*)/TRC–47, RF chassis inductors and resistors.

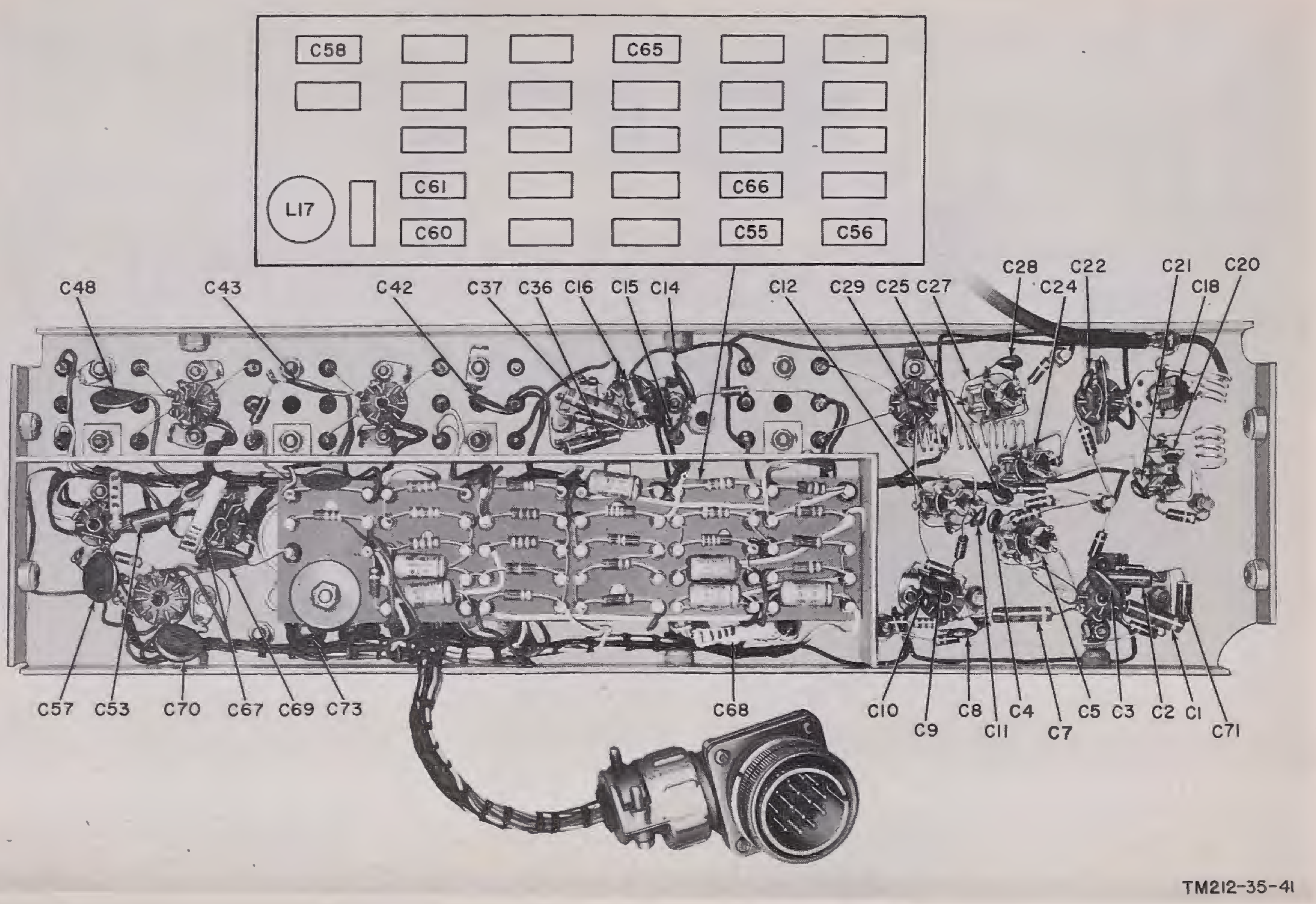


Figure 38. Radio Receiver R–748(*)/TRC–47, RF chassis capacitors.

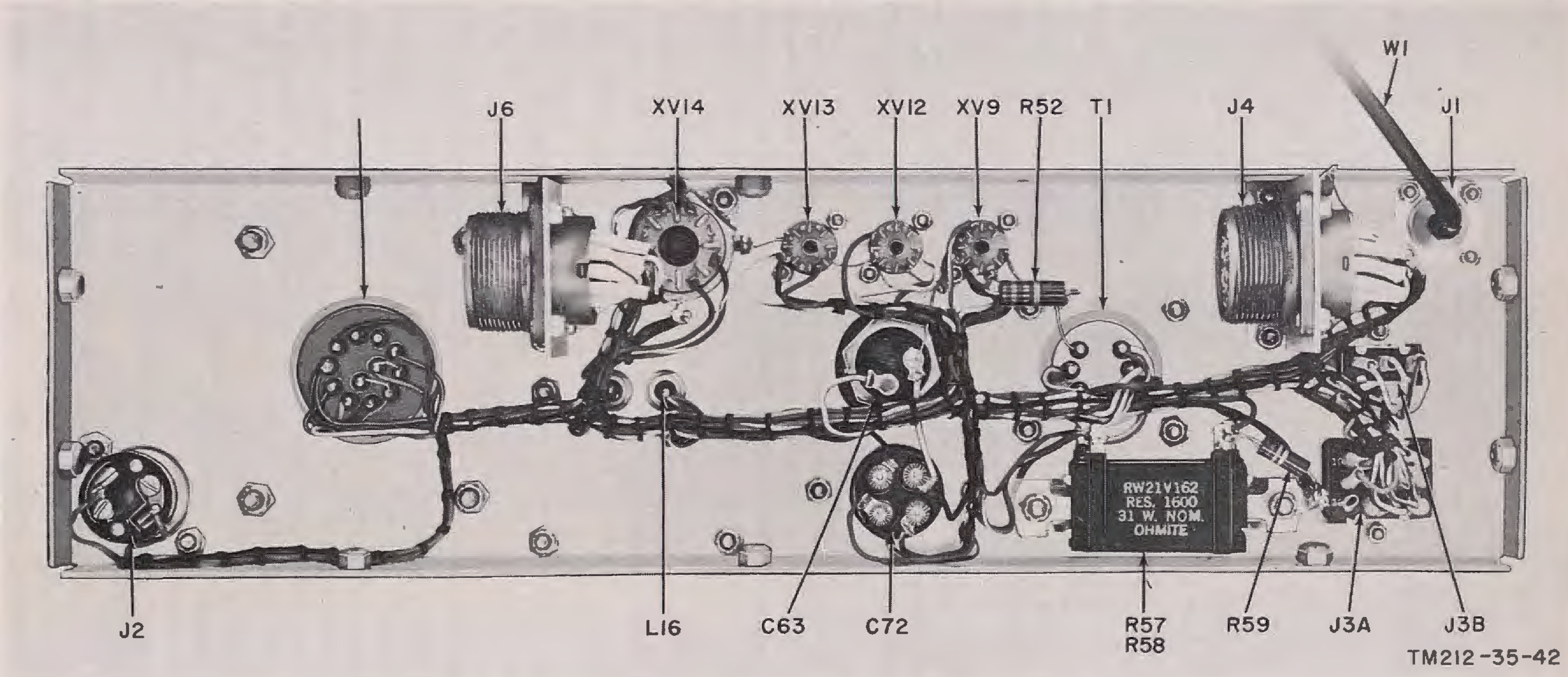


Figure 39. Radio Receiver R-748(*)/TRC-47, power supply, location of components.

c. Receiver Troubleshooting Chart.

Note. Perform the operations given in the equipment performance check list in TM 11–212–20 before using this chart.

Item	Symptom	Probable cause	Corrective measures
1	POWER indicator lamp does not light with ON-OFF switch in ON position.	Defective ON-OFF switch. Defective power transformer T2.	Check components with an ohmmeter; replace if necessary.
2	No high voltage.	Defect in power supply stage.	Refer to paragraph 52 to isolate defective component.
3	No audio at speaker with signal being received and:	Defective speaker LS1. Open VOLUME control R61. Shorted L pad R61.	Check components; replace if necessary.
	High voltage at J9 and normal voltage of 58 volts at jack J7.	Defect in IF, mixer, RF, second local oscillator, or AGC detector and amplifier stages.	Refer to paragraphs 51 and 52 to isolate defective component.
		Defective SENSITIVITY control R60.	Check with ohmmeter; replace if necessary.
	High voltage at jack J9 but abnormal voltage at jack J7.	Defect in first local oscillator or tripler stages.	Refer to paragraph 52 to isolate defective part.
	Normal voltage of 58 volts at jack J9 but REC light will not light.	Defective noise limiter and squelch stage or audio detector and first audio amplifier stage.	Refer to paragraph 52 to isolate defective part.
	Normal voltage at jack J9 and REC light lighted.	Defective second audio amplifier stage.	Refer to paragraph 52 to isolate defective part.
4	Audio heard at speaker but STDBY light remains lighted.	Defective relay K1.	Check relay for shorted winding or sticking contacts; repair or replace.
5	No signal being received but REC light remains lighted.	Defective audio detector and first audio amplifier stage.	Refer to paragraph 52 to isolate defective component.
		Sticking contacts on relay K1.	Repair or replace relay.
6	No signal being received and receiver will not squelch.	Defective noise limiter and squelch stage or AGC detector and amplifier stage.	Refer to paragraph 52 to isolate defective component.
		Shorted SQUELCH-OPEN switch S2.	Check with ohmmeter; replace if necessary.
7	Weak audio signals heard at speaker.	Weak or insensitive RF, IF, or audio stages.	Refer to paragraph 51 to determine weak stage.

50. Signal Substitution

a. General. Signal substitution procedures help to localize troubles to a stage of the receiver. An externally generated signal is substituted for the signal normally present in each stage. The test equipment required for the tests (*b–f* below) is listed in paragraph 43. In the following tests, ground one side of the signal generator or audio oscillator to the receiver chassis and connect the other side to the receiver test point indicated. For the tests described in *b* through *f* below, the positive lead of Electronic Multimeter TS–505/U must be connected to yellow test jack J9 on the receiver, and the negative lead to black test jack J8. If the results described in the following tests are not obtained, refer to paragraph 52 and check the stage or stages in question.

b. Audio Frequency Tests. Start these tests at the last audio stage and work back to the first stage.

(1) Set Audio Oscillator TS–382E/U to an audio signal of 1,000 cps.

(2) Place the SQUELCH-OPEN switch in the OPEN position.

(3) Apply the audio signal at the grid (pin 7) of V9. Listen for an audio note at the loudspeaker.

(4) Apply the audio signal at the grid (pin 5) of V8. The output at the loudspeaker should increase since the injected signal

was passed through another stage of amplification.

(5) Place the SQUELCH-OPEN switch in the SQUELCH position.

c. Intermediate Frequency Test. Start the tests with the last IF stage and work back to the first IF stage.

(1) Set Signal Generator TS-497B/URR to deliver a 5-mc signal.

(2) With no signal input to the receiver, the voltage at J9 is approximately 58 volts.

(3) Apply the 5-mc signal at the grid (pin 1) of V7. The voltage at J9 should decrease. Adjust the output of the signal generator so that the voltage at J9 does not go below 15 volts.

(4) Apply the 5-mc signal at the grid (pin 1) of V6. The voltage at J9 should decrease.

(5) Apply the 5-mc signal at the grid (pin 7) of V5B. The voltage at J9 should decrease.

Note. Do not allow the voltage measured at J9 to fall to zero or below. As the test signal is moved back stage by stage, adjust the magnitude of the test signal so that 15 volts is maintained at J9.

d. Second Mixer and Second Local Oscillator Quadrupler.

(1) Set the signal generator to deliver a 20.7-mc signal.

(2) Apply the signal at the grid (pin 1) of V4. The voltage at J9 should decrease.

e. RF Amplifier, First Mixer, First Local Oscillator, Quadrupler, and Tripler.

(1) Set the signal generator to the frequency at which the receiver is tuned.

(2) Apply the output of the signal generator between the grid (pin 1) of first mixer V3. The voltage at J9 should decrease.

51. Localizing Trouble by Stage Gain Measurement

The information in *a* and *b* below supplements the signal substitution information presented in paragraph 50. It may be used when the output of the receiver is abnormally low or distorted.

a. Connect the receiver to a power source and set the controls as follows:

(1) SENSITIVITY fully clockwise.

(2) Potentiometer R50 (audio gain control) fully clockwise.

(3) SQUELCH-OPEN switch in SQUELCH position.

b. Make the following tests:

(1) Disconnect the speaker and connect a 4-ohm resistor in its place. Connect Electronic Multimeter TS-505/U across the resistor.

(2) Use Audio Oscillator TS-382E/U and apply a 1,000-cps signal between pin 5 of V8 and ground. Carefully adjust the output level of the audio oscillator until exactly 1 watt of power is being dissipated in the 4-ohm resistor. (A reading of 2 volts on the multimeter connected across the resistor indicates a dissipation of 1 watt.

(3) Use the multimeter and measure the voltage appearing across potentiometer R50. This measurement may also be made between pin 1 of V9 and ground. An indication of 6 volts indicates that the second audio stage is operating satisfactorily and providing about a 40-decibel (db) power gain. Record the reading obtained.

(4) Apply the audio signal at pin 3 of V11 and again adjust the output level until 1 watt (2 volts) is developed across the 4-ohm resistor. Measure the voltage appearing at pin 5 of V8. A voltage of .3 indicates the first audio amplifier has a voltage gain of 20 (26 db).

(5) Set audio gain control R50 to midposition.

(6) Use the signal generator and apply a 5-mc signal, modulated 30 per cent at 1,000 cps, at terminal 4 of Z4. Adjust the signal generator to maximum output and record this value. Connect the multimeter to pin 6 and ground of Z4. Adjust the signal generator frequency for a maximum dc voltage. Do not adjust the tuning of L15. Record the exact dc voltage. Keep the multimeter connected to pin 6 of Z4 and ground.

(7) Apply the modulated 5-mc signal to pin 4 of Z3. Carefully readjust the signal generator frequency for maximum indication on the multimeter.

(8) Lower the output of the signal generator until the multimeter indicates exactly the same voltage as recorded in (6) above. Compare this signal level with that of (6) above. A ratio (or gain) of 2 indicates

the stage has a gain of 6 db and is functioning normally.

(9) Disconnect the multimeter from Z4. Connect the positive lead to yellow test jack J9 and negative test lead to black test jack J8. The signal generator is connected to pin 4 of Z3 and ground. Adjust the output of the signal generator until the voltage at J9 decreases to 15. If the voltage does not drop to 15, record the voltage to which it does drop. Record the signal generator output voltage at this point.

(10) Apply the signal at pin 4 of Z2. Lower the generator output voltage until the multimeter indicates 15 volts at J9. Record the output voltage of the signal generator. Compare this reading with that recorded in (9) above. A gain of 40 (32 db) is normal.

(11) Apply a signal of exactly 20.7 mc at pin 4 of Z1. Record the exact signal level from the signal generator required to obtain 15 volts at J9. Compare this signal level with that recorded in (10) above. A gain of 10 (20 db) is normal.

(12) For the remainder of this test, the signal generator is tuned to the operating frequency of the receiver. Apply the signal to pin 1 of V4. Adjust the signal level so that the multimeter at J9 indicates 15 volts. Record this signal level and compare it with the signal level in (11) above. A gain of 5 (14 db) is normal.

(13) Apply the signal generator at pin 1 of V3. Adjust the output of the signal generator so that the multimeter at J9 will indicate 15 volts. Record the output level of the signal generator and compare it with the output level in (12) above. A gain of 20 (26 db) is normal.

(14) Apply the signal generator to the receiver at J1. Adjust the output of the signal generator so that the multimeter at J9 will indicate 15 volts. Record the output of the signal generator and compare it with the output in (13) above. A gain of 10 (20 db) is normal.

52. Isolating Trouble Within a Stage

When trouble has been localized to a stage, either through operational checks or signal substitution (par. 50), use the following techniques to isolate the defective part.

a. Test the tube involved, either in a tube tester or by substituting the same type tube which is known to be operating normally.

b. In a stage where a crystal is used, substitute the same type crystal which is known to be operating normally.

c. Take voltage measurements at the tube sockets (fig. 40) and other points related to the stage in question.

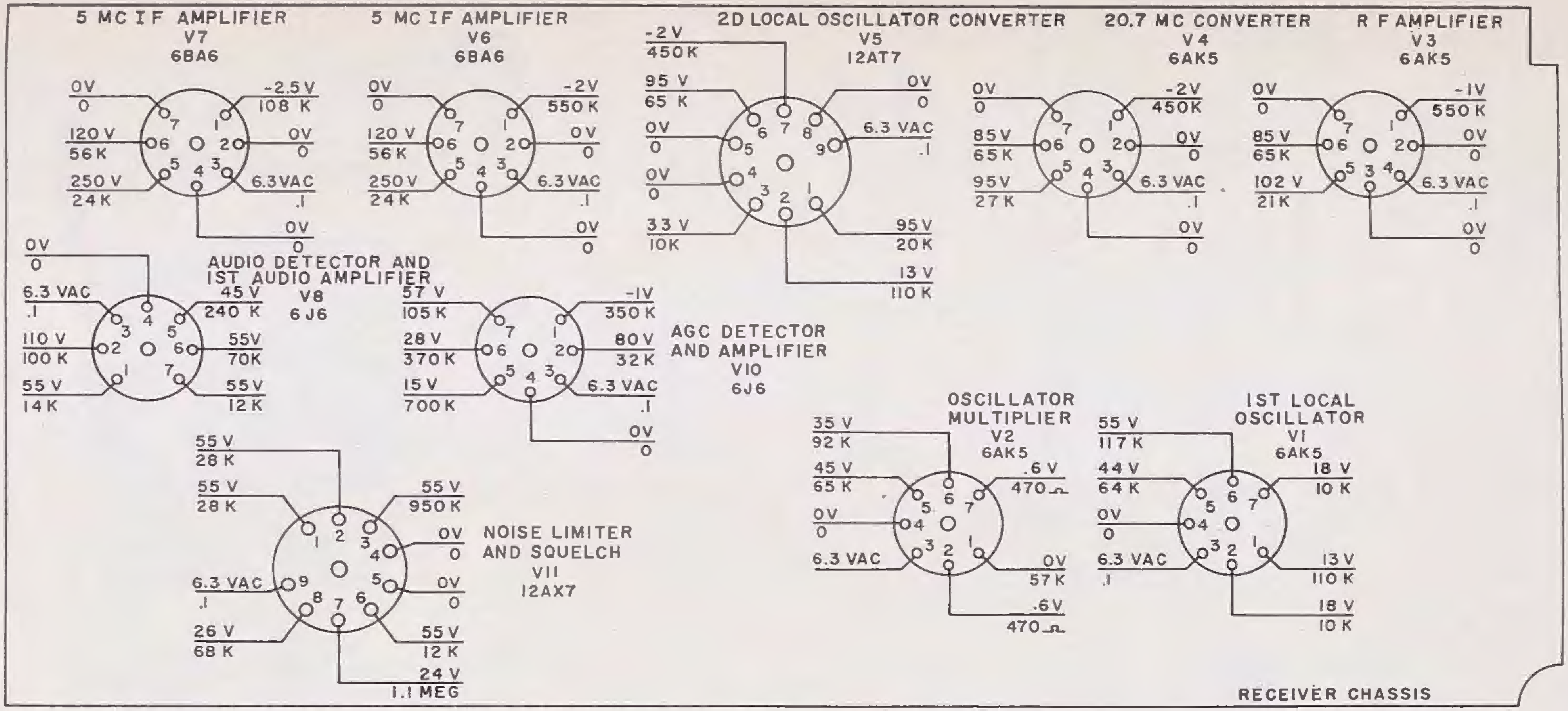
d. If voltage readings are abnormal, take resistance readings (fig. 40) to isolate open or short circuits. Refer also to the dc resistances of transformers and coils (par. 53).

e. If signals are weak and all checks fail to indicate a defective part, check the stage gain of the receiver (par. 51).

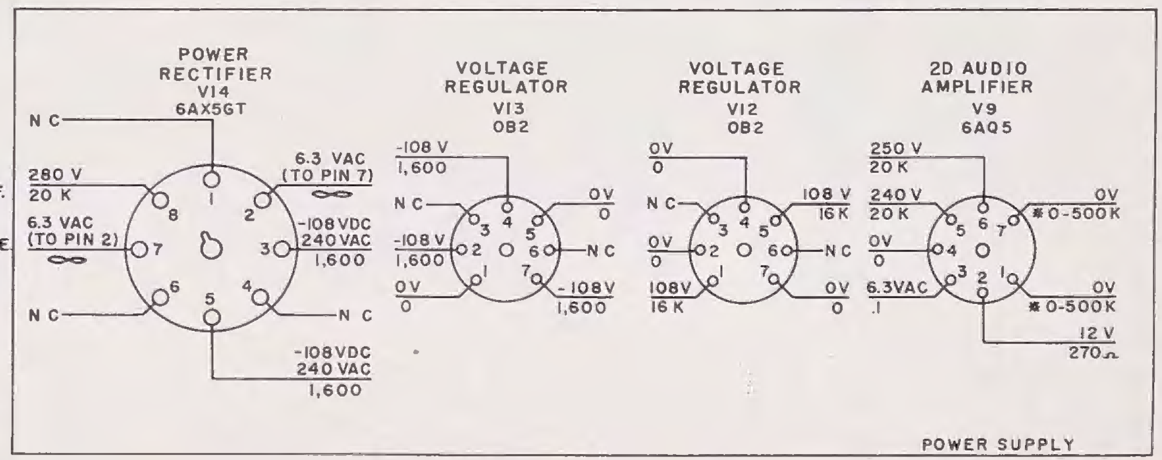
f. Use the wiring diagram (fig. 55) to circuit trace and locate the various components.

53. Dc Resistances of Transformers and Coils

Transformer or coil	Terminals	Resistance (ohms)
T1	1–2	322
	3–4	less than 1
	3–5	27.5
	3–6	61.2
T2	For 115-volt operation, the two primary windings are connected in parallel: Terminal 4 and 2 connected together and terminals 1 and 3 connected together. Measure resistance between the joined terminals.	
	4, 2 to 1, 3	1.3
	For 230-volt operation, the two primary windings are connected in series (2 and 3 connected). Measure resistance between terminals.	
	1–4	5
	Measure secondary resistance between the following terminals:	
	8–9	less than 1
	10–12	less than 1
	5–7	105
L16		150
L17		600



1. LINE VOLTAGE 115 VAC.
2. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
3. VOLTAGES MEASURED TO GROUND WITH A 20,000-OHMS-PER-VOLT METER.
4. NC INDICATES NO CONNECTION.
5. VOLTS MEASURED WITH POWER ON, RESISTANCE MEASURED WITH POWER OFF.
6. NO SIGNAL INPUT.
7. [SENSITIVITY] CONTROL FULLY CLOCKWISE.
8. CRYSTALS REMOVED FROM BOTH OSCILLATORS.
9. [SQUELCH] SWITCH IN [OPEN] POSITION.
10. ✱DEPENDENT ON SETTING OF AUDIO GAIN CONTROL R50.
11. ALL VOLTAGE AND RESISTANCE MEASUREMENTS ARE MADE TO GROUND.



TM212-35-43

Figure 40. Radio Receiver R-748(*)/TRC-47, tube socket voltage and resistance diagram.

Section IV. TROUBLESHOOTING RADIO TRANSMITTER T–593(*)/TRC–47

54. Checking Transmitter Filament and B+ Circuits for Shorts

a. When to Check. When any of the following apply, check for short circuits and clear the troubles before applying power.

(1) When abnormal symptoms reported from operational tests (equipment performance checklist, TM 11–212–20) indicate possible power supply trouble.

(2) When interunit sectionalization procedures (par. 47) have indicated possible power supply trouble.

b. Conditions for Tests. To prepare for the short-circuit test:

(1) Disconnect the antenna cable from J1 on the transmitter, the cable assembly from J3 on the transmitter, and the power cable from J2 on the transmitter and J7 on the Converter.

(2) Remove the transmitter from the equipment cabinet.

(3) Remove all tubes, dial lamps, and crystals.

(4) Turn the ON-OFF switch to ON.

c. Measurements. Make the resistance measurements indicated below. If abnormal results are obtained, make the isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

(1) The resistance from pin 8 of XV6 to ground should be 57,000 ohms. If there is no resistance or low resistance, start with the filter circuit and check the B+ circuit until the defect is found.

(2) One side of the filament circuit should have a resistance of .1 ohm above ground. If this slight resistance is not present check capacitors C74, C75, and C76.

55. Localizing Trouble

a. General. Procedures are outlined in the following chart for localizing troubles to the oscillator, tripler, driver, power amplifier, and modulator stages of the transmitter. Location of parts is shown in figures 41, 42, and 43. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in localization of trouble to a particular stage, use the techniques outlined in paragraph 56 to isolate the trouble to a particular part.

b. Use of Chart. Troubleshooting chart supplements the operational checks detailed in the equipment performance check list (TM 11–212–20) and the interunit sectionalization check described in paragraph 47. If no operational symptoms are known, begin with item 1 of the equipment performance checklist (TM 11–212–20) and proceed until the trouble is located.

Caution: If operational symptoms are not known, or they indicate the possibility of short circuits within the transmitter, make the short checks described in paragraph 54 before applying power.

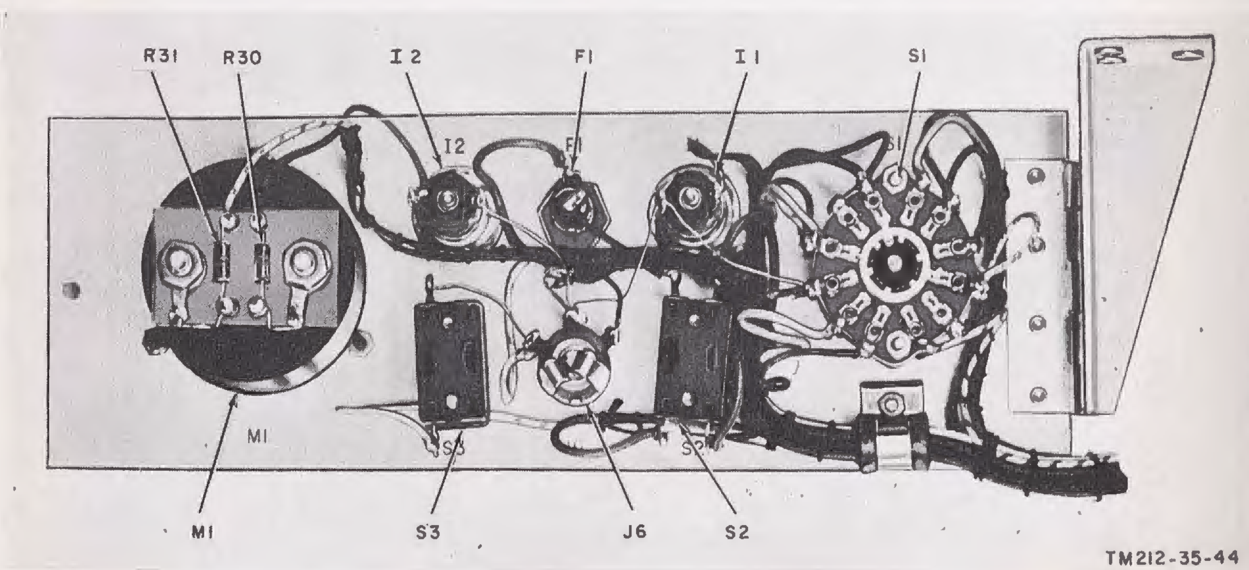


Figure 41. Transmitter panel, location of components.

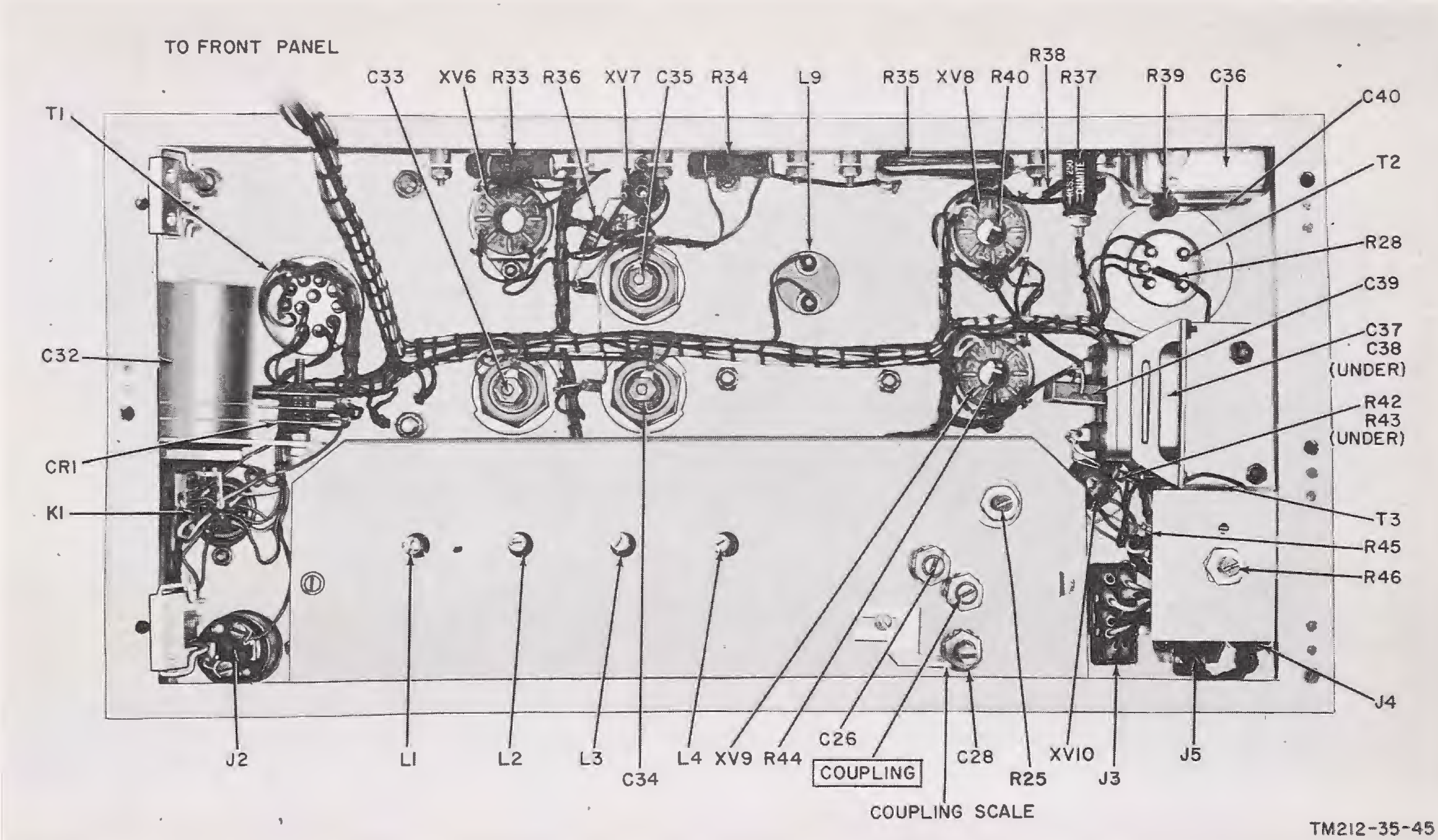


Figure 42. Radio Transmitter T–593(*)/TRC–47, main chassis, location of components.

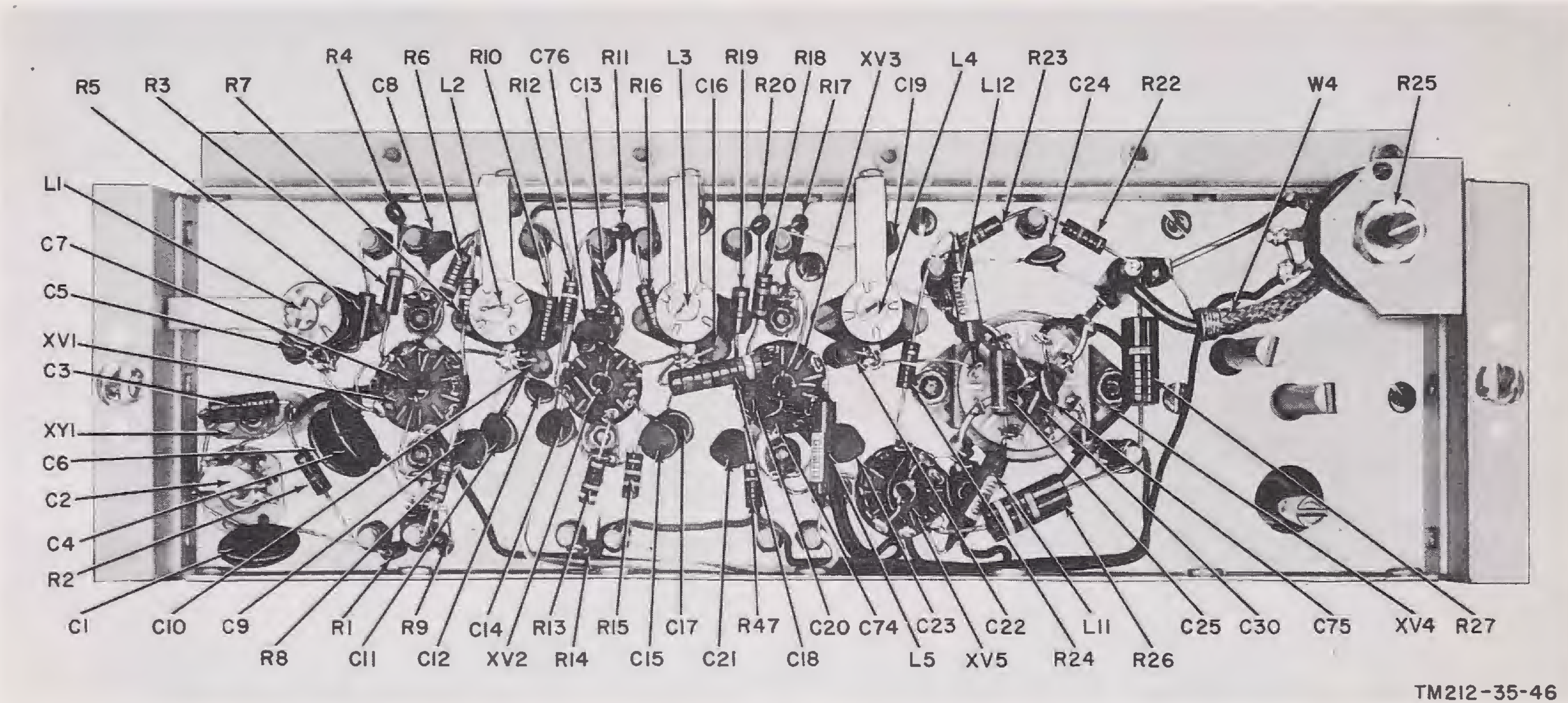


Figure 43. Radio Transmitter T–593(*)/TRC–47, RF subchassis, location of components.

c. Transmitter.

Note. Perform the operations in the equipment performance checklist before using this chart.

Item	Symptom	Probable trouble	Correction
1	FIL indicator lamp does not light.	FIL switch S2 defective.	Use an ohmmeter to check the switch; replace, if defective.
2	PLATE indicator lamp does not light.	PLATE switch S3 defective. Rectifier CR1 defective. Relay K1 is defective. Transformer T1 is defective.	Use an ohmmeter to check the switch; replace, if defective. Use voltmeter to check CR1; replace, if defective. Replace K1. Replace transformer T1.
3	The TUNING METER shows abnormal indication when the METER SWITCH is in the OSC_{Ig} position (normal reading .42). or The TUNING METER shows abnormal indication when the METER SWITCH is in OSC_{IK} position (normal reading .44).	A component in the oscillator stage is defective. Defective TUNING METER. Defective METER SWITCH.	Refer to paragraph 56 and follow the isolating procedures listed. Check TUNING METER; replace, if defective. Check switch with ohmmeter; replace, if defective.
4	The TUNING METER shows abnormal indication when the METER SWITCH is in the 1 $TRIP_{Ig}$ position (normal reading .44). or The TUNING METER shows abnormal indication when the METER SWITCH is in the 1 $TRIP_{IK}$ position (normal reading .32).	A component in the first tripler stage is defective.	Refer to paragraph 56 and follow the isolating procedures listed.
5	The TUNING METER shows abnormal indication when the METER SWITCH is in the 2 $TRIP_{Ig}$ position (normal reading .44). or The TUNING METER shows abnormal indication when the METER SWITCH is in the 2 $TRIP_{IK}$ position (normal reading .54).	A component in the second tripler stage is defective.	Refer to paragraph 56 and follow the isolating procedures listed.
6	The TUNING METER shows abnormal indication when the METER SWITCH is in the $DRIVER_{Ig}$ position (normal reading .37). or The TUNING METER shows abnormal indication when the METER SWITCH is in the $DRIVER_{IK}$ position (normal reading .41).	A component in the driver stage is defective.	Refer to paragraph 56 and follow the isolation procedures listed.

Item	Symptom	Probable trouble	Correction
7	The TUNING METER shows abnormal indication when the METER SWITCH is in the PA_{Ig} position (normal reading .58). or The TUNING METER shows abnormal indication when the METER SWITCH is in the PA_{Ip} position (normal reading .24).	A component in the power amplifier stage is defective.	Refer to paragraph 56 and follow the isolation procedures listed.
8	The TUNING METER shows abnormal indication when the METER SWITCH is in the MOD position (normal reading .66).	A component in the modulator stage or the driver stage is defective.	Refer to paragraph 56 and follow the isolation procedures listed.

56. Isolating Trouble Within a Stage

When trouble has been localized to a stage, use the following techniques to isolate the defective part.

a. Test the tube involved, either in a tube tester or by substituting the same type tube which is known to be operating normally.

b. In a stage where a crystal is used, substitute the same type crystal which is known to be operating normally.

c. Take voltage measurements at the tube sockets (fig. 44) and other points related to the stage in question.

d. If voltage readings are abnormal, take resistance readings (fig. 44) to isolate open or short circuits. Refer also to the dc resistance of transformers and coils (par. 57).

e. If the output of the transmitter is weak and all checks fail to indicate a defective part, check the tuning of the transmitter (par. 63).

f. Use the wiring diagram (fig. 57) to circuit trace and locate the various components.

57. Dc Resistances of Transformers and Coils

Transformer and coils	Terminals	Resistance (ohms)
T1	3–4	1
	1–2	1
	8–10	less than 1
	5–7	100
	11–12	less than 1
T2	1–3	126
	4–5	140
T3	1–3	5570
	4–6	36.7
L9	1–2	78

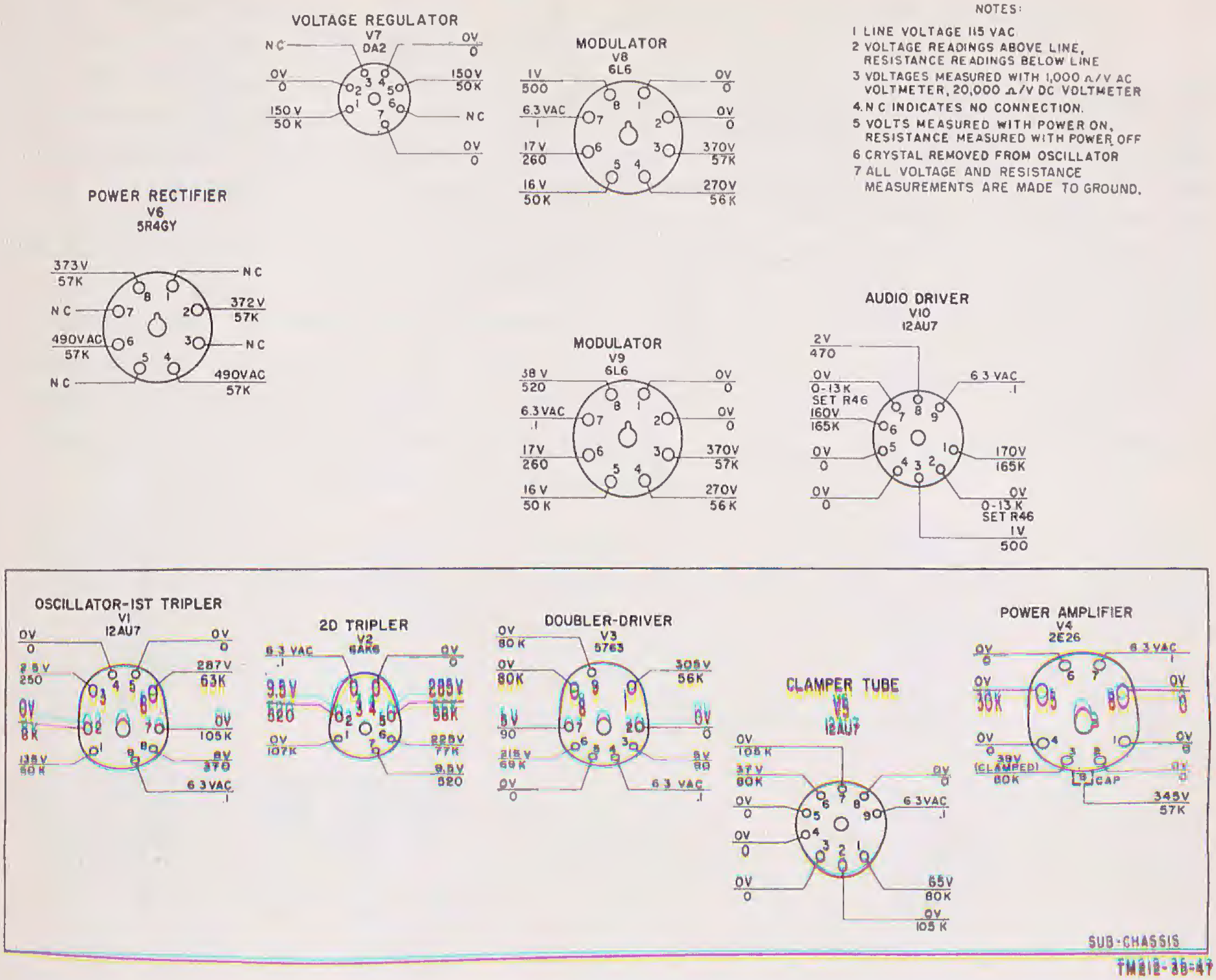


Figure 44. Radio Transmitter T-593(*)/TRC-47, Tube socket voltage and resistance.

Section V. TROUBLESHOOTING TELEPHONE SIGNAL CONVERTER CV-542/TRC-47

58. Checking Converter Filament and B+ Circuits for Shorts

a. When to Check. When any of the following conditions apply, check for short circuits and clear the troubles before applying power. When abnormal symptoms reported from operational tests (equipment performance checklist, TM 11-212-20) indicates possible power supply trouble. When interunit sectionalizing procedures (par. 46) have indicated possible power supply trouble.

b. Conditions for Tests. To prepare for the short-circuit tests:

(1) Disconnect the cable assembly from J1 on the converter; three power cables from J7, J8, and J5; and telephone or telephone line from J3 and J4.

(2) Remove the converter from the equipment cabinet.

(3) Remove all tubes and dial lamps.

(4) Turn the ON-OFF switch to ON.

c. Measurements. Make the resistance measurements indicated below. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the converter.

(1) The resistance from pin 7 of XV9 and XV11 to ground should be 25,000 ohms. If there is no resistance or low resistance, start with the filter circuit and trace the B+ circuit until the short circuit is found.

(2) Inspect the filament pins at each tube socket to determine whether the metal

braid on the filament leads has shorted the filament voltage.

59. Loalizing Troubles

a. General. Procedures are outlined in the following chart for localizing troubles to a specific section of the converter, and for localizing troubles to a stage within a section. Location of parts is found in figures 45, 46, and 47. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in localization of trouble to a particular stage, use the techniques outlined in paragraph 60 to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting chart is designed to supplement the operational checks detailed in the equipment performance checklist (TM 11–212–20) and the interunit sectionalization checks described in paragraph 46. If no operational symptoms are known, begin with item 1 of the equipment performance checklist (TM 11–212–20) and proceed until trouble is located.

Caution: If operational symptoms are not known, or they indicate the possibility of short circuits within the converter, make the short-circuit checks described in paragraph 58 before applying power.

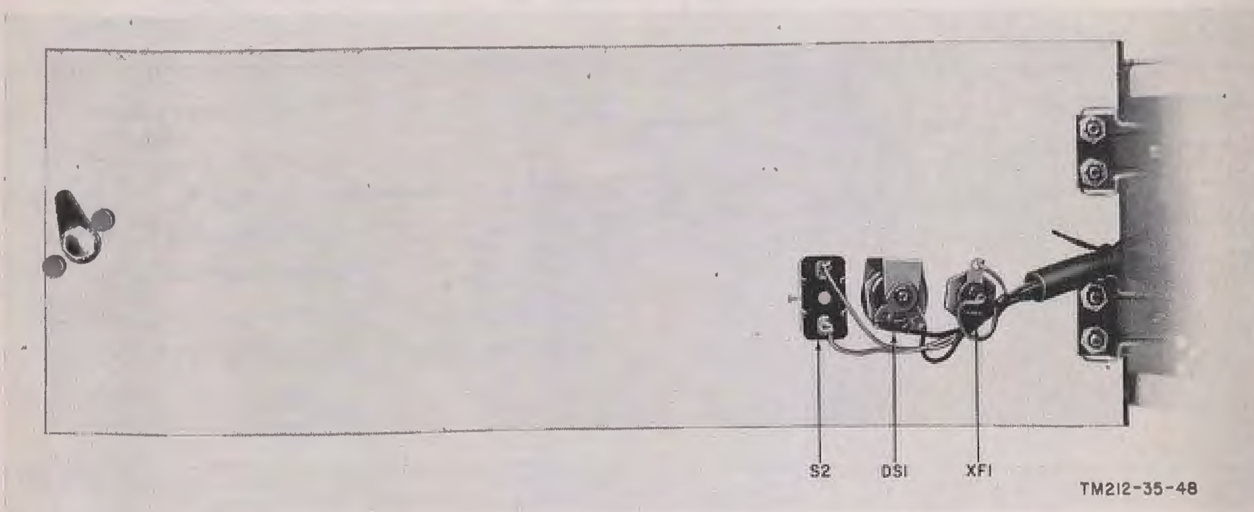


Figure 45. Telephone Signal Converter CV–542/TRC–47, panel, location of components.

c. Converter.

Note. Perform the operations in the equipment performance checklist before using this chart.

Item	Symptom	Probable trouble	Correction
1	The green POWER lamp does not light when the power ON-OFF switch is placed in the ON position.	Defective switch.	Use an ohmmeter to check switch; replace, if defective.
2	No high voltage.	Defective transformer T6.	Check power transformer T6; replace, if defective.
3	Speech is normal at field telephone connected across J3 and J4 but the telephone does not ring.	A defect in V3B, V4, FL1, V5A, or V5B. Relay K4, K3, or G1 (20-cps generator).	Refer to paragraph 60 and follow the isolating procedure listed. Place a jumper from pin 4 to pin 6 of K4. ***Caution:*** There is high voltage at this point; be careful.

Item	Symptom	Probable trouble	Correction
			With the jumper in place, the field phone should ring. If it does, replace K4. If the phone does not ring, move it to terminals 3 and 6 of K3. With jumper above in place, if phone rings replace K4 if not check G1.
4	No speech at field telephone and the telephone does not ring.	Hybrid stage V1 defective.	Refer to paragraph 60 and follow the isolation procedures listed.
		Switch S1.	Check the switch for continuity; replace, if defective.
5	Operator speaking into field telephone can modulate transmitter but cannot ring out with the 800 cps.	20-cps sensitive relay K2 or relay K1 is defective.	Place a jumper from pin 4 of relay K2 to pin 3. ***Caution:*** Pin 4 has high voltage; be careful. If relay K1 closes, replace K2. If relay K1 does not close, check it. Replace, if defective.
		The 800-cps oscillator or the oscillator amplifier is defective.	To check the operation of the 800-cps oscillator, connect a vtvm between TP3 and TP4. If the 800-cps oscillator is working, the meter should indicate 1.3 volts ac. If the voltage is missing, or is low, exchange Y1 and FL1 and adjust R16 for 1.3 volts ac. If the proper voltage is still not obtained, replace Y1 and FL1 in their proper sockets, refer to paragraph 60, and follow the isolating procedure listed.

60. Isolating Trouble Within a Stage

When trouble has been localized to a stage, use the following techniques to isolate the defective part.

a. Test the tube involved, either in a tube tester or by substituting the same type tube which is known to be good.

b. In the converter, FL1 and Y1 are interchangeable and may be used to check for proper operation. The 20-cps generator, G1, is a plug-in item and a unit known to be good may be substituted for a suspected one.

c. Take voltage measurements at the tube sockets (fig. 48) and other points related to the stage in question such as test points.

d. If voltage readings are abnormal, take resistance readings (fig. 48) to isolate open or short circuits. Refer also to the dc resistances of transformers and coils (par. 61).

e. If the ringing circuits of the converter still do not operate properly, check the adjustments described in paragraph 65.

f. Use the wiring diagram (fig. 59) to circuit trace and locate the various components.

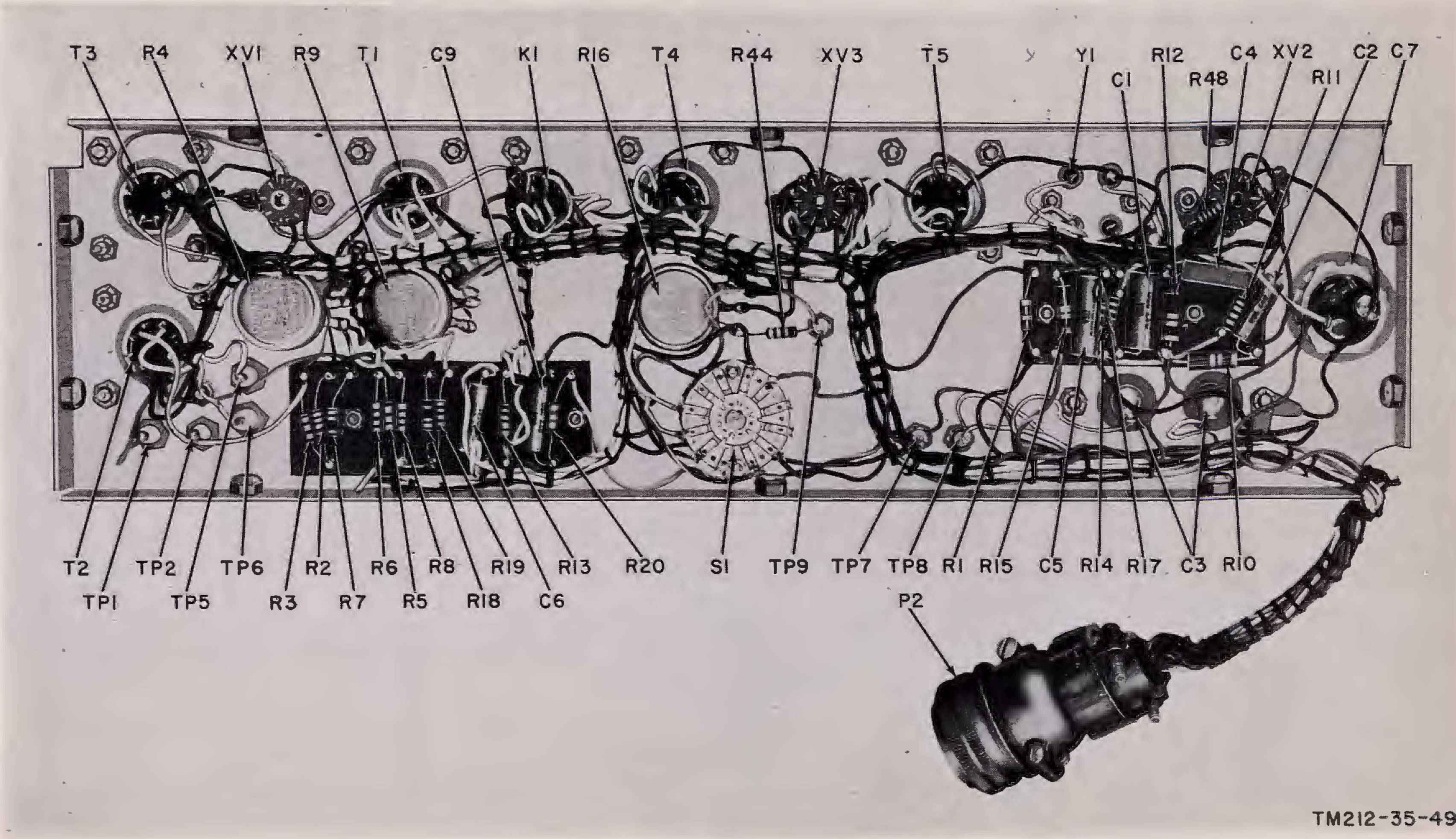


Figure 46. Telephone Signal Converter CV-542/TRC-47, signal chassis, location of components.

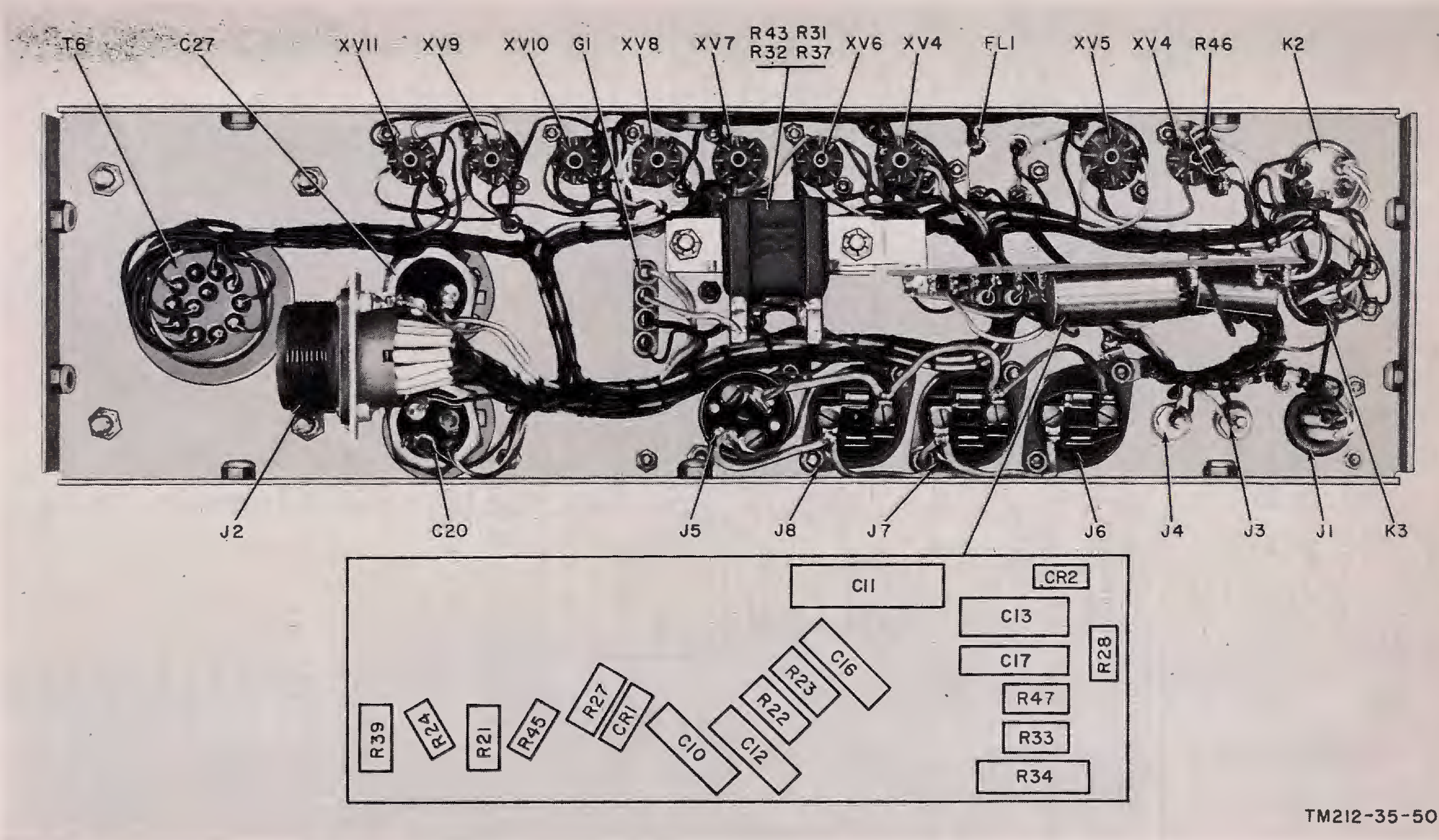
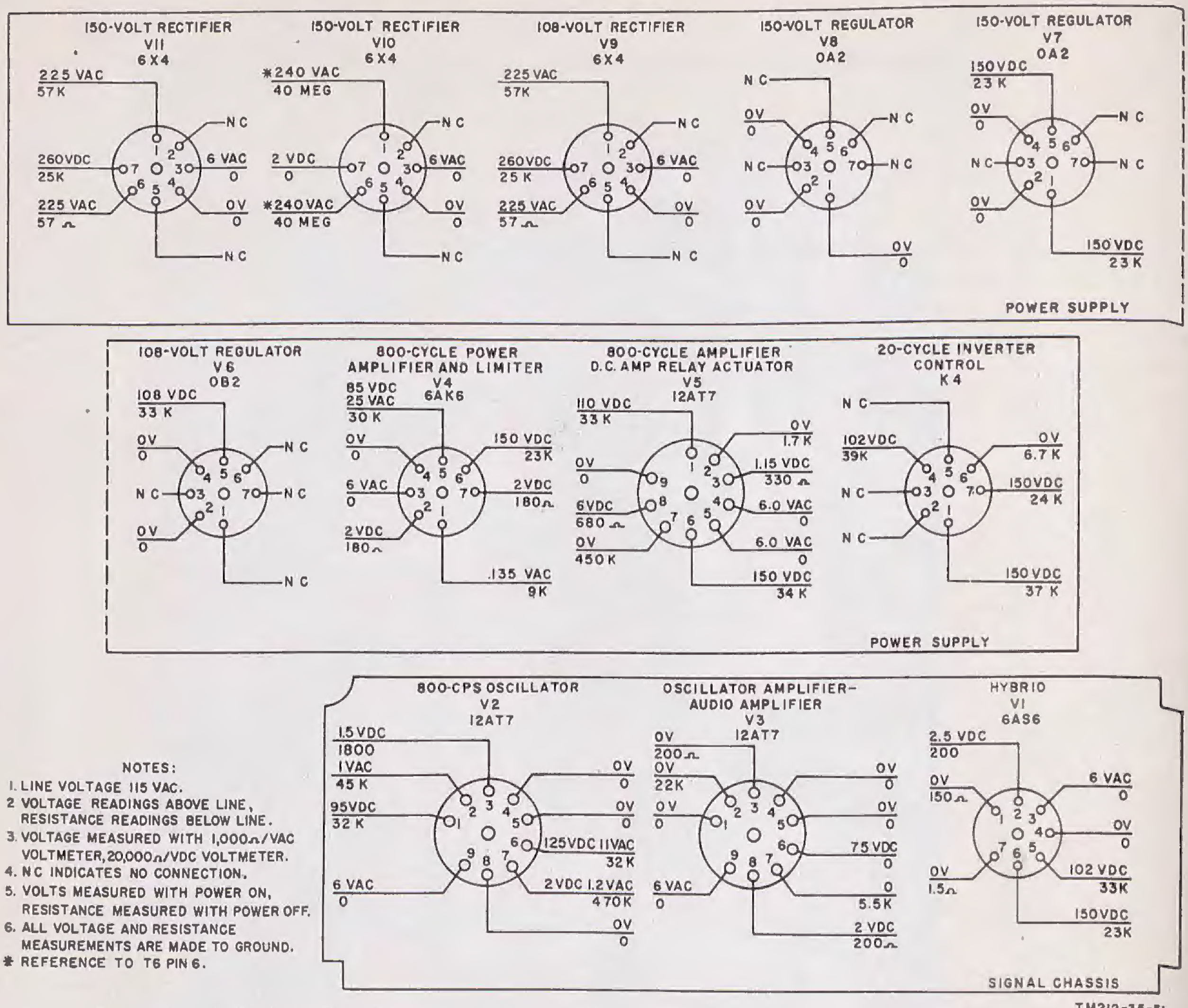


Figure 47. Telephone Signal Converter CV–542/TRC–47, power supply, location of components.



NOTES:
1. LINE VOLTAGE 115 VAC.
2. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
3. VOLTAGE MEASURED WITH 1,000 Ω/VAC VOLTMETER, 20,000 Ω/VDC VOLTMETER.
4. NC INDICATES NO CONNECTION.
5. VOLTS MEASURED WITH POWER ON, RESISTANCE MEASURED WITH POWER OFF.
6. ALL VOLTAGE AND RESISTANCE MEASUREMENTS ARE MADE TO GROUND.
* REFERENCE TO T6 PIN 6.

Figure 48. Telephone Signal Converter CV-542/TRC-47, tube socket, voltage and resistance diagram.

61. Dc Resistance of Transformers in Converter

Transformer	Terminals	Resistance (ohms)	Transformer	Terminals	Resistance (ohms)
T1 and T3	1–2	6.2	T5	1–2	60
	3–4	6.2		3–4	60
	1–4	12.4		1–4	120
	5–6	8.5		5–6	500
	6-7	8.5		6–7	500
	5–7	17		5–7	1000
T2	1–2	65	T6	1–2	3.8
	3–4	65		3–4	3.8
	1–4	130		5–6	50
	5–6	145		6–7	50
	6–7	145		5–7	100
	5–7	290		8–9	325
T4	1–2	230		9–10	325
	3–4	230		8–10	650
	5-6	3000		11–12	Less than 1
	6–7	3000			
	5–7	6000			

CHAPTER 5

ALINEMENT

62. Test Equipment Required for Alinement

The following test equipment is required for the alinement of the radio receiver, transmitter, and converter.

Item	Common name	Technical manual
Electronic Multimeter TS-505/U.	Multimeter	TM 11-5511
Electronic Voltmeter ME-30B/U.	Voltmeter	TM 11-5132
Signal Generator TS-497B/URR.	Signal generator	TM 11-5030A
Radio Frequency Wattmeter AN/URM-43A.	Wattmeter	TM 11-5133
Telephone Set TA-43/PT.	Telephone set	TM 11-337

63. Transmitter Tuning

Normally, it is only necessary to make the initial adjustments described in chapter 3. A complete tuning of the transmitter is necessary only when the frequency is changed or after components or tubes are replaced.

a. Presettings.

(1) Set the PLATE switch to OFF.

(2) Set the FIL switch to OFF.

(3) Place the METER SWITCH at OFF.

(4) Insert the proper crystal in the crystal holder. The frequency of the proper crystal is found by dividing the desired operating frequency by 18.

(5) Turn L1 and L2 fully counterclockwise.

(6) Decouple the antenna by turning the antenna COUPLING control (fig. 32) until the end of the control shaft is at a 5 on the coupling scale (fig. 32).

(7) Set resistor R25 to its midposition.

(8) Connect the wattmeter to the transmitter antenna.

b. RF Tuning Procedure.

(1) Turn the FIL switch to ON and wait 1 minute, then turn the PLATE switch to ON.

(2) Place the METER SWITCH in the 1 $TRIP_{Ig}$ position.

(3) Slowly turn the shaft of L1 clockwise until a peak indication is approached on the TUNING METER. Continue tuning L1 slowly clockwise until the TUNING METER indicates maximum (approximately .44).

Caution: When tuning L1 and L2 to a frequency between 132 and 135 mc, two points of resonance may occur, depending on which end of the winding the iron core is near. To operate at the proper end of the coils, always begin the tuning procedure with the tuning shafts rotated counterclockwise to the end of their travel.

(4) Place the METER SWITCH in the 2 $TRIP_{Ig}$ position. Adjust L2 clockwise for a maximum indication on the TUNING METER (approximately .44).

(5) Place the METER SWITCH in the $DRIVER_{Ig}$ position. Adjust L3 for a maximum indication on the TUNING METER (approximately .37).

(6) Place the METER SWITCH in the PA_{Ig} position. Adjust L4 for a maximum indication on the TUNING METER (approximately .58).

(7) Place the METER SWITCH in the PA_{Ip} position. Rotate OUTPUT control R25 completely clockwise. Be sure that the COUPLING control is adjusted for minimum coupling. Tune PWR AMP tuning control C26 for minimum indication on the TUNING METER (approximately .24).

(8) Adjust ANT TUNING control C28 for maximum indication on the TUNING

METER. Increase the coupling by turning the COUPLING control clockwise until a maximum RF output is indicated on the wattmeter connected to the transmiter antenna.

(9) Retune PWR AMP tuning control C26, for minimum, and ANT TUNING control C28 for maximum.

(10) Adjust OUTPUT control R25 counterclockwise until the wattmeter connected to the antenna indicates 7 watts.

Caution: Do not load the transmitter beyond 7 watts. To do so may cause distorted modulation and possible carrier shift. In addition, the output tube may be damaged.

c. *Modulation.* The adjustment for proper modulation is described in paragraph 39.

64. Receiver Alinement

It is not necessary to realine the entire receiver when its operating frequency is to be changed. Only the RF stages need be realined for this purpose. The tuning of the IF stages is the same for all operating frequencies and, therefore, need not be adjusted. To change the operating frequency, proceed with *b* below. If, for any reason (such as the replacement of tubes or other parts in the IF stages), it becomes necessary to realine the IF stages, proceed with *a* below. For complete receiver alinement, start with the IF stages and perform the procedures in *a* and *b* below.

a. *IF Alinement.* To aline the IF stages:

(1) Place the ON-OFF stwitch in the ON position, the SQUELCH-OPEN switch in the SQUELCH position, and the SENSITIVITY control fully clockwise.

(2) Connect the positive lead of Electronic Multimeter TS–505/U to the yellow test jack J9, and the negative test lead to black test jack J8 (fig. 34).

(3) Remove crystal Y1 from the first local oscillator quadrupler, and crystal Y2 from the second local oscillator quadrupler.

(4) Connect Signal Generator TS–497B/URR between pin 1 of V7 and ground. Tune the signal generator to deliver a 5-mc signal. Adjust its output level so that the voltage at J9 (indicated on the multimeter) is 15. *Do not permit the voltage at J9 to drop to zero at any time during the alinement.*

(5) Tune L15 for minimum indication on the multimeter connected to J9. Tune L14 for minimum indication. As L14 and L15 are tuned, it may be necessary to reduce the RF signal strength to prevent the voltage at J9 from going to zero or going negative. Retune L15 after tuning L14.

(6) Move the point of signal injection to pin 4 of V6. Tune L13 and then L12 for minimum. Retune L13 after tuning L12.

(7) Move the point of signal injection to pin 1 of V5B. Tune L11 and then L10 for minimum. Retune L11 after tuning L10.

(8) Replace crystal Y2 in the second oscillator quadrupler.

(9) Connect the signal generator to pin 1 of V4. Adjust the signal generator to deliver 20.7 mc.

(10) Tune L9 and L8 for minimum indication on the multimeter. Retune L9 after tuning L8.

(11) Tune L3 for a minimum indication on the multimeter.

Note. Keep the output of the signal generator low. Do not allow the voltage at J9 to fall to zero or go negative.

(12) Repeat step (10) and (11) for best indication.

b. *RF Alinement.*

(1) The first local oscillator crystal, Y1, determines the operating frequency of the receiver. To determine the proper crystal frequency for a desired operating frequency, use the following formula:

$$Fx = \frac{Fo - 20.7}{12}$$

Where Fx = frequency of crystal Y1
Fo = operating frequency desired

Example: If 132 mc is the desired operating frequency, the crystal frequency needed (Y1) is found in the following manner:

$$Fx = \frac{Fo - 20.7}{12} = \frac{132 - 20.7}{12} = \frac{111.3}{12} = 9.275$$

Fx = Y1 = 9.275 mc

(2) Connect the negative lead of the multimeter to green test jack J7, and the positive test lead to black test jack J8.

(3) Tune C5 for a maximum voltage reading at J7.

(4) Remove the multimeter from jacks J7 and J8.

(5) Connect the positive lead of the multimeter to yellow test jack J9, and the negative lead to black test jack J8.

(6) Connect the signal generator to antenna jack J1. Adjust the output of the signal generator to the desired frequency.

(7) Tune C12 for minimum multimeter reading at J9.

Note. Signal injection should be kept at a level sufficient to maintain at least 15 volts indication at J9. Reduce the signal strength as often as necessary to maintain this level. Do not permit the voltage to drop to zero or below. If adjusting C12 has very little effect on the multimeter reading, preset C27, C24, C20, and C18 in order, until an indication is observed. Resume alinement procedure and tune C12 for minimum indication.

(8) Tune C27 for a minimum indication on the multimeter.

(9) Tune C24 for a minimum voltage at J9 and retune C27. Adjust these capacitors until the best indication is obtained.

(10) Tune C20 and then C18 for a minimum voltage at J9.

65. Converter Alinement

a. Presetting.

(1) Turn resistors R4, R9, and R16 (fig. 33) to the full counterclockwise position.

(2) Turn the POWER switch to ON.

(3) Disconnect the telephone line from connectors J3 and J4, and the cable assembly from connector J1.

b. 800-cps Oscillator Feedback Adjustment. To adjust the necessary feedback in the local 800-cps oscillator:

(1) Connect the ungrounded lead of the voltmeter to TP3, and the grounded lead to TP4.

(2) Adjust R9 (fig. 33) until the voltmeter indicates 2.2 volts. Lock resistor R9.

c. 800-cps Oscillator Output Adjustment. To adjust for the proper level of 800-cps signal necessary to key the ringing circuits at the remote radio set:

(1) Connect the voltmeter to TP1 and TP2.

(2) Hold switch S1 in the TRANSMIT position and adjust R16 until the voltmeter indicates .1 volt.

d. Transhybrid Loss Adjustment. To adjust converter rejection (transhybrid loss):

(1) Connect the voltmeter to TP1 and TP2 (fig. 33).

(2) Hold switch S1 in the RECEIVE position, and adjust resistor R4 until the voltmeter reads .08 volt.

CHAPTER 6

FINAL TESTING

66. Purpose of Final Testing

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation.

67. Test Equipment Required for Final Testing

The following items are required for final testing:

Item	Common name	Technical manual
Electronic Voltmeter ME-30B/U.	Voltmeter	TM 11-5132
Signal Generator TS-497B/URR.	Signal generator	TM 11-5030A
Spectrum Analyzer TS-723A/U.	Sound analyzer	TM 11-5097
Audio Oscillator TS-382E/U.	Audio oscillator	TM 11-2684A
Oscilloscope OS-8A/U	Oscilloscope	TM 11-1214
Telephone Set TA-43/PT.	Telephone set	TM 11-337
Electronic Multimeter TS-505/U.	Multimeter	TM 11-5511
Radio Frequency Wattmeter AN/URM-43A.	Wattmeter	TM 11-5133
RF Adapter UG-28A/U	Tee connector	
1,500-ohm resistor		
600-ohm resistor		

68. Test Conditions

All tests are to be performed with the operating controls of the equipment under test adjusted for normal operation unless otherwise specified in a particular test. All external cables should be disconnected. The equipment under test must be connected to a 110-volt 60-cps power source. When testing the transmitter or receiver, connect the power source to jack J2. Connect a jumper between terminals 1 and 2 of jack J3 on the transmitter and between terminals 10 and 11 of jack J3A on the receiver. When testing the converter, connect the power source to jack J5. No jumper connection is needed.

69. Receiver Sensitivity

(A, fig. 49)

a. Place the SENSITIVITY and VOLUME controls and R50 in their fully clockwise positions. Place the SQUELCH-OPEN switch in the OPEN position.

b. Disconnect the speaker. Connect Electronic Voltmeter ME-30B/U in parallel with a 600-ohm resistor between terminal 1 of J3A and the uppermost terminal on resistor R61 (on the rear of the front panel).

c. Tune the receiver to 150 mc.

d. Connect Signal Generator TS-497B/URR to receiver input terminal J1 (on the rear of chassis) and adjust it to the receiver frequency. Modulate the signal 30 per cent at 1,000 cps.

e. Set the signal generator output level at zero. Throw the SQUELCH-OPEN switch to SQUELCH.

f. Increase the signal generator output until the squelch circuit opens, as indicated by the front panel lights (STDBY light goes out, REC light goes on). Note the signal generator output. It should be 7.25 microvolts (μv) or below.

g. Throw the SQUELCH-OPEN switch to OPEN.

h. Adjust the signal generator output to 2.2 μv. Record the db output of the receiver as indicated on the voltmeter.

i. Turn off the modulation of the signal generator and again record the db output of the receiver. This reading should be 10 db or more below the reading obtained in *h* above.

j. Retune the receiver to 141 mc and repeat *d* through *i* above.

k. Retune the receiver to 132 mc and repeat *d* through *i* above.

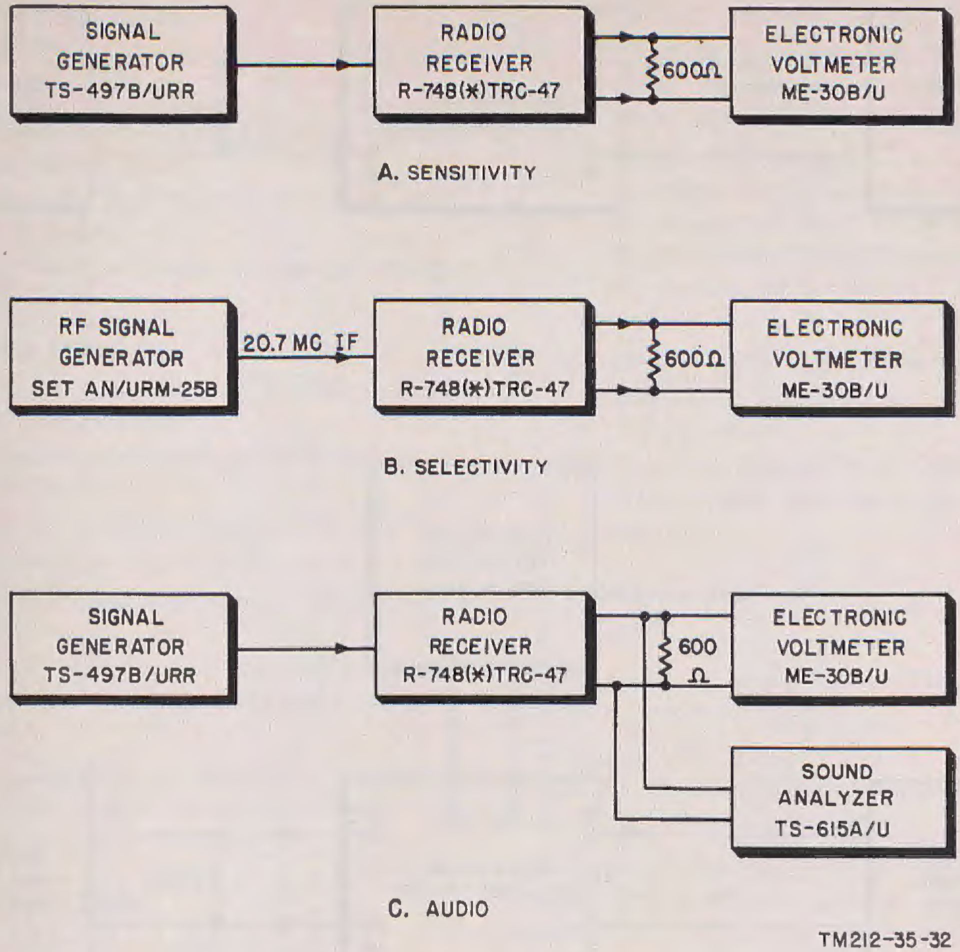


Figure 49. Setup for receiver tests.

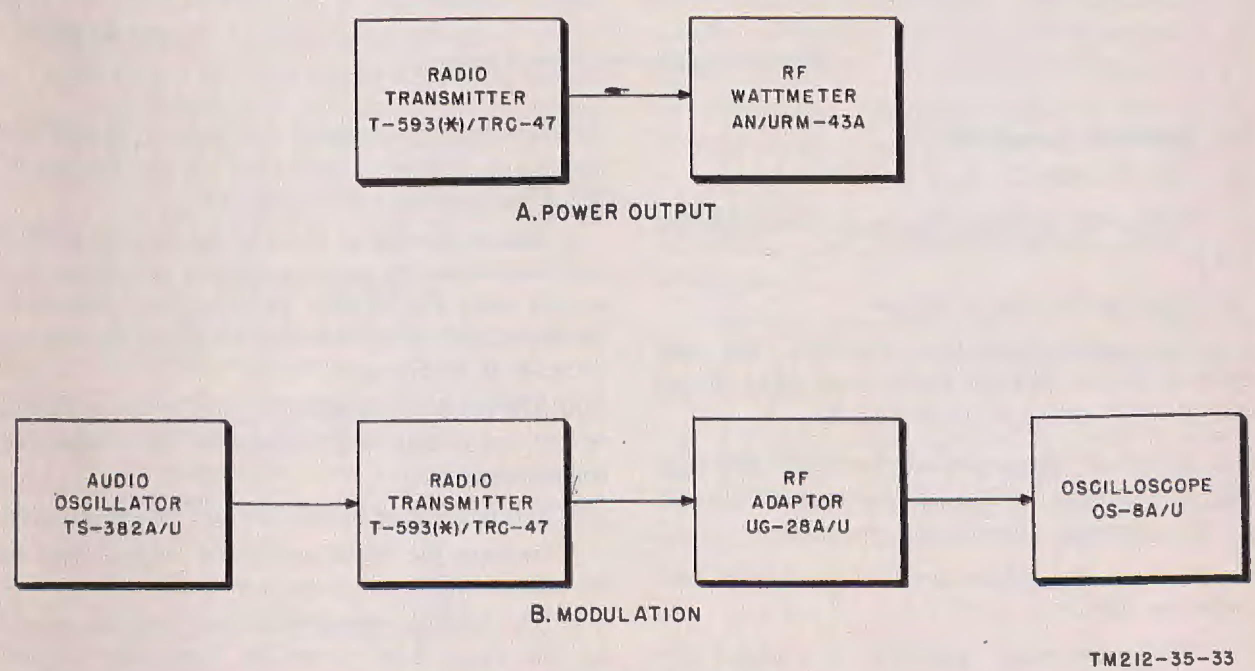


Figure 50. Setup for transmitter tests.

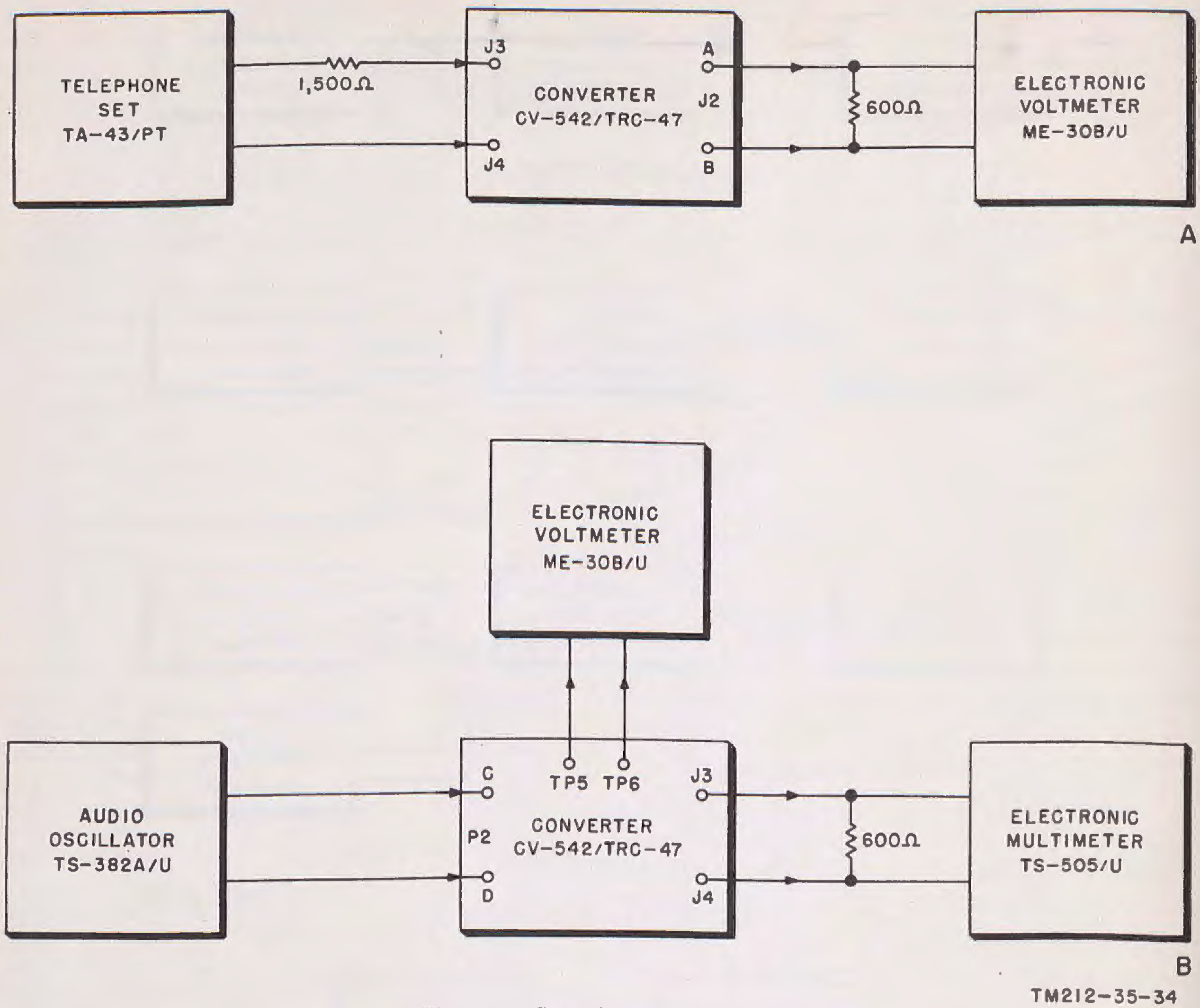


Figure 51. Setup for converter tests.

70. Receiver Selectivity

(B, fig. 49)

a. Repeat the procedures given in paragraph 69*a* and *b*.

b. Tune the receiver to 132 mc.

c. Use Signal Generator TS-497B/URR and apply a 200-μv 20.7-mc signal, modulated 30 per cent at 1,000 cps to pin 7 of tube V5.

d. Adjust the frequency of the signal generator until a maximum receiver audio output is indicated on the voltmeter. Record this reading.

e. Increase the output level of the signal generator to 400 μv.

f. Detune the signal generator to a higher frequency until the receiver audio output returns to the same level as recorded in *d* above. Record the increase in frequency indicated by the reading of the signal generator frequency dial.

g. Return the dial to the original frequency (20.7 mc) and detune the signal generator to a lower frequency until the receiver audio output returns to the same level as recorded in *d* above. Record the decrease in frequency.

h. The readings obtained in *f* and *g* above should be not more than ±20 kilocycles (kc) from the original frequency.

i. Return the dial to 20.7 mc and repeat *d* above.

j. Increase the signal generator output level to 200,000 μv and repeat *f* and *g* above.

k. The readings obtained in *i* and *j* above should be not more than ±120 kc from the original frequency.

71. Receiver Audio Tests

(C, fig. 49)

a. Output Test.

(1) Tune the receiver to any frequency within its operating range.

(2) Repeat the procedures given in paragraph 69*a*, *b*, and *d*.

(3) The voltmeter should indicate at least 30 db.

b. Distortion Test.

(1) Tune the receiver to any frequency within its operating range.

(2) Repeat the procedure given in paragraph 69*a*, *b*, and *d*.

(3) Connect Spectrum Analyzer TS–723/U to the output of the receiver.

(4) Adjust the signal generator output level to 725 μv.

(5) Adjust the receiver VOLUME control until the voltmeter indicates a level of 30 db.

(6) The distortion indicated by the sound analyzer should be not more than 8 per cent.

72. Transmitter Tests

a. Power Output (A, fig. 50).

(1) Connect Radio Frequency Wattmeter AN/URM–43A to the transmitter output.

(2) Tune the transmitter to 132 mc.

(3) Adjust the transmitter OUTPUT control for maximum output. The wattmeter should indicate at least 7 watts.

(4) Tune the transmitter in turn to 141 and 150 mc and repeat (3) above at each frequency.

b. Modulation Test (B, fig. 50).

(1) Tune the transmitter to 132 mc and adjust it for a 7-watt output.

(2) Connect Audio Oscillator TS–382E/U to terminals 8 and 9 of jack J3 at the rear of the transmitter. Set the audio oscillator for a 300-cps signal and adjust its output level to .07 volt.

(3) Use RF Adapter UG–28A/U to connect the modulated RF output from the transmitter directly to the vertical deflection plates of Oscilloscope OS–8A/U.

(4) Observe the modulation indicated by the wave form on the oscilloscope and adjust the transmitter MOD GAIN control. Adjustment of the MOD GAIN control should be capable of producing 100 per cent modulation.

(5) Set the audio oscillator in turn to 1,000, 2,000, 3,000, and 4,000 cps, and repeat (3) and (4) above.

(6) Tune the transmitter to 150 mc with a 7-watt output and repeat (2) through (5) above.

73. Converter Test

(fig. 51)

Place switch S1 in the OPERATE position, and proceed as follows:

a. Connect the line terminals of Telephone Set TA–43/PT, in series with a 1,500-ohm resistor, to jacks J3 and J4 on the converter.

b. Connect Electronic Voltmeter ME–30B/U, in parallel with a 600-ohm resistor, to terminals A and B of plug P2.

c. Crank the hand generator of the telephone set at a speed of approximately 200 revolutions per minute and observe the reading on Electronic Voltmeter ME–30B/U. It should be .1 volt ac.

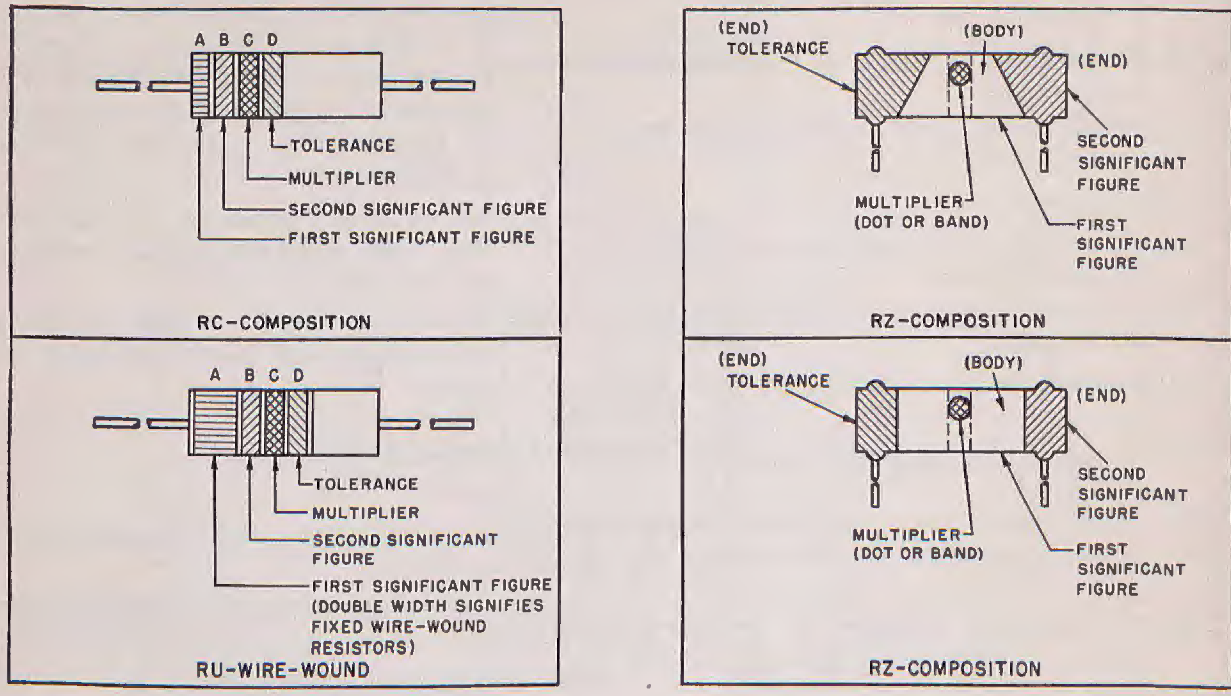
d. Disconnect Electronic Voltmeter ME–30B/U from terminals A and B of plug P2 and connect it to test jacks TP5 and TP6. Connect Audio Oscillator TS–382E/U to terminals C and D of P2. Adjust the audio oscillator for an output frequency of 800 cps.

f. Connect Electronic Multimeter TS–505/U to jacks J3 and J4. Connect a 600-ohm resistor across jacks J3 and J4.

g. Adjust the output level of the audio oscillator until Electronic Voltmeter ME–30B/U indicates .1 volt ac. Observe the reading on Electronic Multimeter TS–505/U. It should be at least 25 volts.

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.

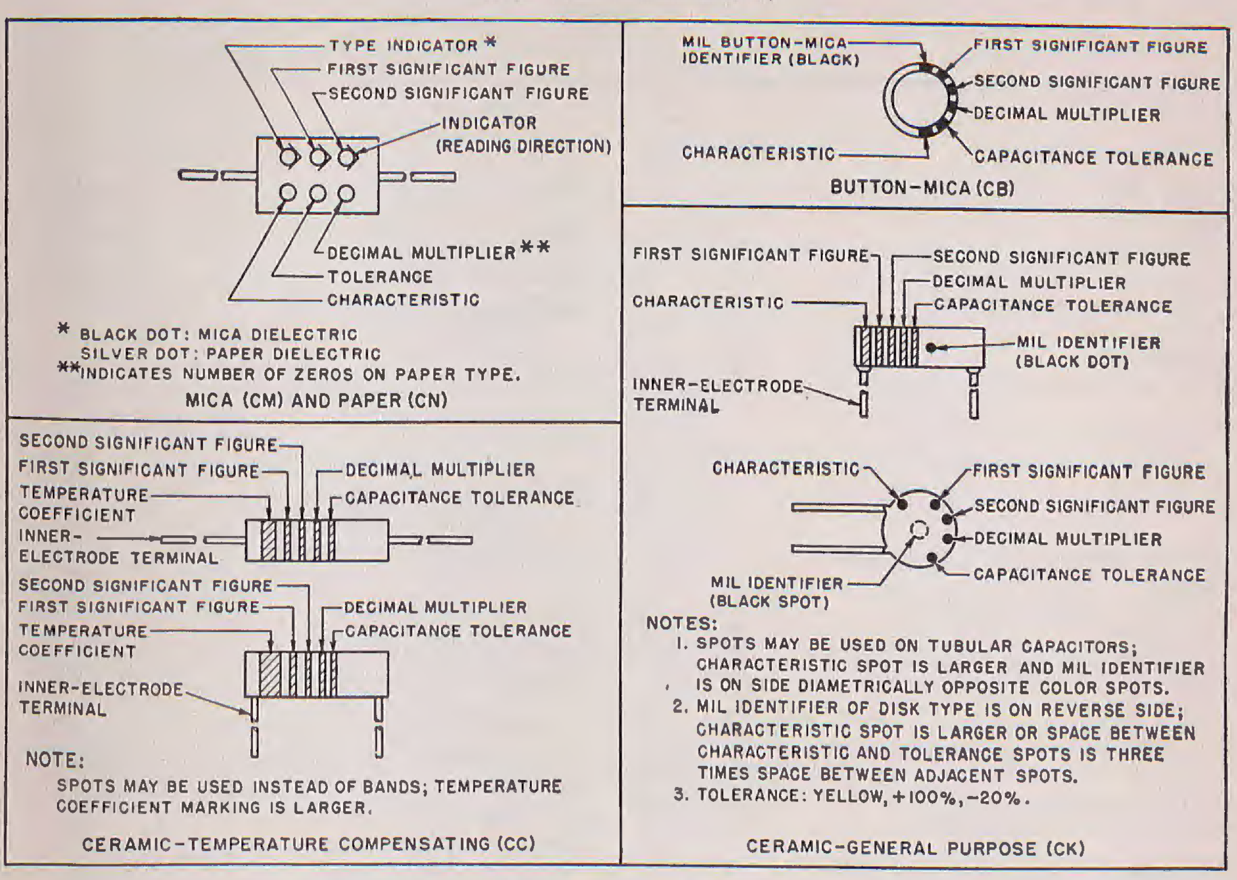
EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 52. MIL–STD resistor color code marking.

CAPACITOR COLOR CODE MARKING

(MIL-STD CAPACITORS)



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	CC 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.

STD-C8

Figure 53. MIL-STD capacitor color code marking.

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[AG 413.44 (30 Apr 58)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

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Gen Depot (2) except Atlanta Gen Depot (none)
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Sig Depot (17)
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Sig Lab (5)
USA Sig Pub Agcy (8)
USA Pictorial Cen (2)
USASSA (Phila, Pa) (13)
USASSA (Chicago, Ill) (1)
USA Sig Engr Agcy (1)
Sandia Base, AFSWP (5)
White Sands Sig Agcy (13)
USA Elct PG (1)
USA Comm Agcy (2)
WRAMC (1)
USAAMS (1)
Engr Maint Cen (1)
AFIP (1)
Mil Dist (1)
USA Corps (Res) (1)
Sectors, USA Corps (Res) (1)
JBUSMC (2)
Units org under fol TOE:
11–7 (2)
11–16 (2)
11–57 (2)
11–127 (2)
11–128 (2)
11–500 (AA-AE) (2)
11–557 (2)
11–558 (2)
11–592 (2)
11–597 (2)
44–145 (2)
44–147 (2)
44–445 (2)
44–446 (2)
44–447 (2)
44–448 (2)
44–545 (2)
44–546 (2)
44–547 (2)

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1958—440510

TECHNICAL MANUAL

Field and Depot Maintenance.

RADIO SET AN/TRC-47

TM 11-212-35 }
CHANGES No. 2 }

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *24 January 1961*

TM 11-212-35, 20 May 1958 is changed as follows:

Page 16, figure 16. (As deleted by C 1, 22 Jul 60) Delete "+385V" below R15 and connect the lower end of R15 to the lower end of R16.

Page 22, paragraph 31*a*, line 5. (As changed by C 1, 22 Jul 60) Change "80-cps" to 800-cps.

Page 30, figure 31. (As deleted by C 1, 22 Jul 60) Delete horizontal line from top terminal of J6 and connect top terminal of J6 to terminal 1 of T6.

Page 51, figure 44. (As changed by C 1, 22 Jul 60) Make the following changes:

Tube V1, pin 6. Change "287V" to **200V.**

Tube V2, pin 5. Change "285V" to **195V.**

At pin 6, change "225V" to **155V.**

Page 60, chapter 6. Make the following changes: Insert section II heading above the existing material:

Section II. FINAL TESTING

Insert section I before section II:

Section I. FOURTH ECHELON TESTING PROCEDURES

65.1. General

a. Testing procedures are prepared for use by Signal Field Maintenance Shops and Signal Service Organizations responsible for fourth echelon maintenance of signal equipment to determine the acceptability of repaired signal equipment. These procedures set forth specific requirements that repaired signal equipment *must* meet before it is returned to the using organization. The testing procedures may also be used as a guide for testing equipment repaired at third echelon if the proper tools and test equipment are available. A summary of the performance standards is given in paragraph 65.16.

b. Each test depends on the preceding one for certain operating procedures and where applicable, for test equipment calibrations. Comply with the instructions preceding the chart before proceeding to the chart. Perform each test in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Test equipment control settings and Equipment under test control settings* columns; then perform each specific test procedure and verify it against its performance standard.

65.2. Test Equipment and Other Equipment Required.

All test equipment and other equipment required to perform the testing procedures given in this section are listed in the following charts and are authorized under TA 11-17, Signal Field Maintenance Shops, and TA 11-100(11-17), Allowances of Signal Corps Expendable Supplies for Signal Field Maintenance Shop, Continental United States; or are repair part items of the subject equipment authorized for stockage at fourth echelon levels.

a. Test Equipment.

Nomenclature	Federal stock No.	Technical reference
Electric Light Assembly MX-1292/PAQ	6696-537-4470	TM 11-5540
Signal Generator TS-497(*)/URR[a]	6625-669-0258	TM 11-5030 TM 11-5030A
Output Meter TS-585(*)/U[b]	6625-244-0501	TM 11-5017
Frequency Meter AN/URM-81	6625-669-0081	TM 11-5096
Spectrum Analyzer TS-723(*)/U[c]	6625-668-9418	TM 11-5097

* These changes supersede C 1, 22 July 1960.

Nomenclature	Federal stock No.	Technical reference
R F Wattmeter AN/URM-43(*)[d]	6625-635-9186	TM 11-5133
Audio Oscillator TS-382(*)/U[e]	6625-192-5094	TM 11-2684
Electronic Voltmeter ME-30(*)/U[f]	6625-669-0742	TM 11-5132
Oscilloscope OS-8(*)/U[g]	6625-568-4898	TM 11-1214A
Electronic Multimeter TS-505(*)/U[h]	6625-243-0562	TM 11-5511A

[a] Indicates TS-497A/URR, TS-497B/URR, and TS-497C/URR.
[b] Indicates TS-585B/U and TS-585C/U.
[c] Indicates TS-723/U, TS-723A/U and TS-723B/U.
[d] Indicates AN/URM-43A and AN/URM-43C.
[e] Indicates TS-382/U, TS-382B/U, TS-382D/U, TS-382E/U, and TS-382F/U.
[f] Indicates ME-30A/U, ME-30B/U, and ME-30C/U.
[g] Indicates OS-8B/U, OS-8C/U, and OS-8E/U.
[h] Indicates TS-505/U, TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U.

b. Other Equipment.

Nomenclature	Federal stock No.	Technical reference
Telephone Set TS-312/PT	5805-543-0012	TM 11-2155
Decade Resistor TS-578B/U[a]	6625-224-6134	TM 11-5512
Radio Receiver R-220/URR	5820-642-8144	TM 11-882
Headset HS-30-U	5965-164-7259	None
Cord CD-605 (used with HS-30-U)	6625-170-9608	None
Microphone M-52/U	5965-646-4678	None
Electrical Power Cable Assembly CX-3743/U[b]	5995-578-7236	None
Adapter Connector UG-201A/U	5935-201-3090	None
Adapter Connector UG-107B/U	5935-149-3304	None
Connector, plug electrical[b]	5935-242-2300	None
Connector, plug electrical[b]	5935-149-2822	None
Connector, plug[b]	5935-243-3489	None
Hookup wire No. 20 AWG (approximately 14 ft)[c]	6145-160-5317	None
Hookup wire No. 20 AWG (approximately 4 ft)[c]	6145-160-5318	None
Hookup wire No. 20 AWG (approximately 4 ft)[c]	6145-160-5300	None

[a] Any 1,500-ohm, 1-watt resistor may be used in lieu of the TS-578/U.
[b] Indicates repair part item of AN/TRC-47.
[c] Any No. 20 AWG hookup wire may be used.

65.3. Special Requirements

a. It is desirable but not mandatory that these tests be conducted in a screen room.

b. The RF-IF switch on Spectrum Analyzers TS-723/U and TS-723A/U does not exist on the TS-723B/U. The use of the TS-723B/U for these tests is not affected by the omission of the RF-IF switch.

c. Reference to RANGE switch selections in the chart for converter tests apply to Electronic Multimeters TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U. Corresponding control settings for the TS-505/U appear in parentheses adjacent to those for the lettered models.

d. The labeling of certain controls differs on Audio Oscillator TS-382A/U. References to controls in the charts apply to the TS-382B/U, TS-382D/U, TS-382E/U, and TS-382F/U. If the TS-382A/U is used to perform these tests, use the control that corresponds to that given in the test procedure.

e. The location and labeling of certain controls and receptacles differ on Signal Generator TS-497A/URR from Signal Generators TS-497B/URR and TS-497C/URR. References to controls, control settings, and receptacles in the charts apply to TS-497A/URR. If either TS-497B/URR or TS-497C/URR is used to perform the tests, use the control, control settings, and receptacles that correspond to those given in the test procedure.

f. To perform the test on the receiver, fabricate a special purpose test cable as illustrated in figure 48.1.

g. To perform the tests on the transmitter, fabricate a special purpose test cable as illustrated in figure 48.2.

h. To perform the test on the converter, fabricate a special purpose test cable as illustrated in figure 48.3. It is recommended but not required that wires be color coded.

i. Any amplitude-modulated transmitting equipment, having the proper frequency range, may be used as a test transmitter for the operational test given in paragraph 65.8.

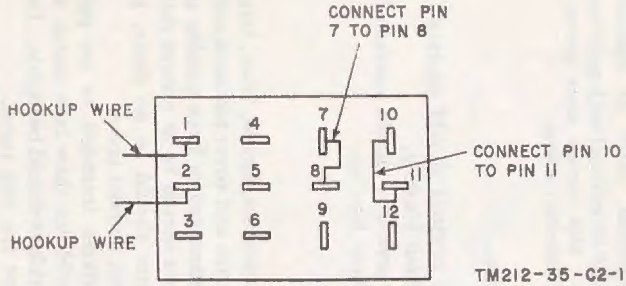


Figure 48.1. (Added) *Receiver special purpose test cable.*

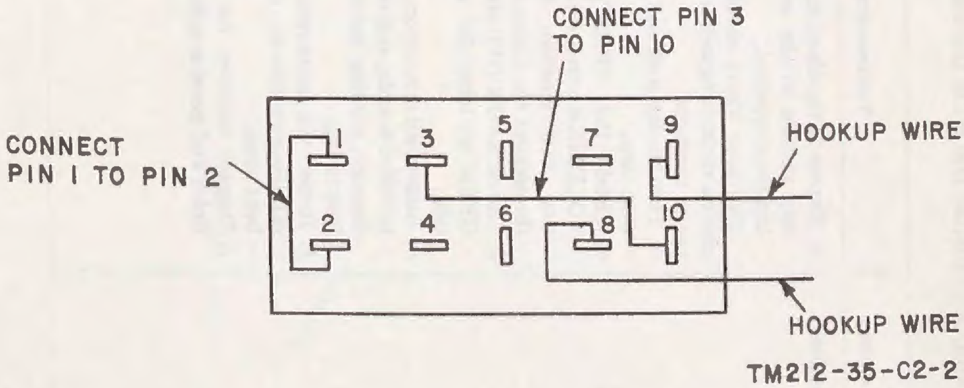


Figure 48.2. (Added) *Transmitter special purpose test cable.*

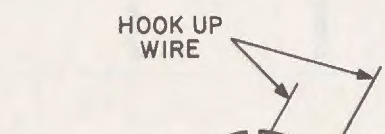


Figure 48.3. (Added) *Converter special purpose test cable.*

65.4. Physical Tests and Inspection for Receiver

a. Test Equipment and Materials.

Electric Light Assembly MX–1292/PAQ

b. Test Connections and Conditions. Make no connections to the receiver during these tests. Check for the mfp varnish after repair and before assembly of the receiver. Connect the mercury vapor lamp and install the wide transmission filter.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	MX–1292/PAQ 245 V FOR M V LAMP switch: ON	Controls may be in any position.	*a.* Expose to the direct rays of the lamp any portion of the equipment that has been repaired. ***Caution:*** **There should be no varnish on variable capacitor plates or connector contacts.** *b.* Turn the lamp off and proceed to the next step.	*a.* All chassis surfaces and repaired component parts or connections should be covered with mfp varnish. ***Note.*** **Mfp varnish glows grayish-green when exposed to the lamp.** *b.* None.
2	None.	Same as step No. 1.	*a.* Check the SENSITIVITY and VOLUME controls for smooth operation and freedom from binding throughout the limits of travel. *b.* Check the ON-OFF and SQUELCH-OPEN switches for correct operation.	*a.* All controls should operate freely without binding. *b.* All switches should operate freely without binding.
3	None.	Same as step No. 1.	*a.* Inspect all connectors, lamps, fuses, terminal boards, and cover plates for damage, missing parts, or incorrect fuse ratings. *b.* Inspect the entire receiver for physical damage (dents, punctures and bent areas). *c.* Inspect receiver for condition of finish and panel markings.	*a.* Connectors, lamps, fuses, terminal boards, and cover plates should not be damaged or have missing parts. Fuses should be of correct rating. *b.* There should be no dents, punctures, or bent areas. *c.* Surfaces intended to be painted should not show bare metal. Panel markings should be legible. Do not paint the rear panel. ***Note.*** **Touchup painting is recommended in lieu of refinishing whenever practicable. Screwheads, receptacles, and carrying handles will not be painted or polished with abrasives.**

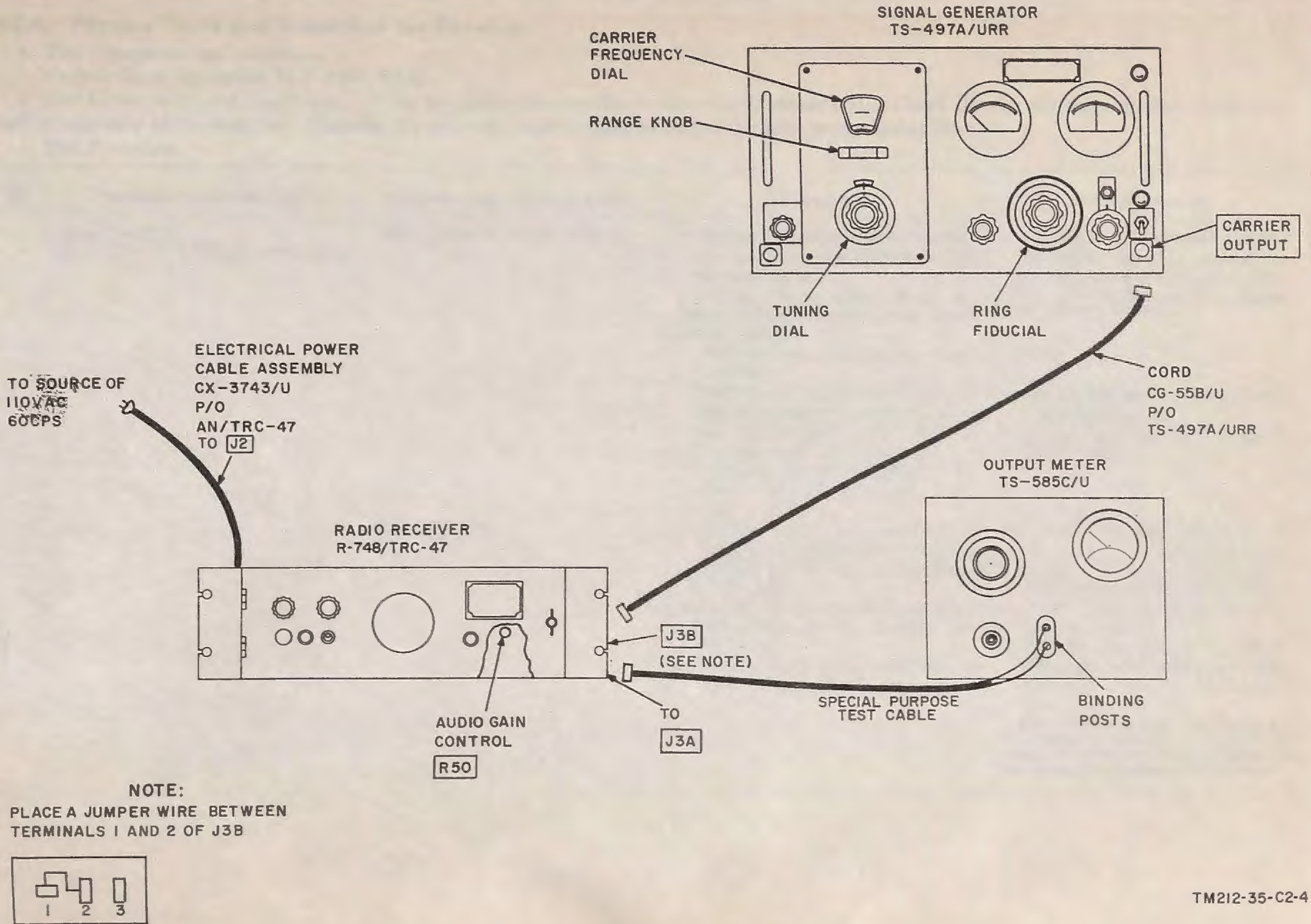


Figure 48.4. (Added) *Receiver sensitivity tests.*

65.5. Receiver Sensitivity Tests

a. Test Equipment and Materials.
Signal Generator TS–497A/URR
Output Meter TS–585C/U
Special purpose test cable (fig. 48.1)
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)

b. Test Connections and Conditions. Connect equipment as shown in figure 48.4.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	TS–497A/URR Range knob: 78-180 mc, band E Tuning knob: Same operating frequency as receiver. MICROVOLTS: MIN Ring fiducial: Red line indication on meter 1000-400-OFF-EXT: 1000 MOD: Full scale (30) indication on meter EXT. PULSE: OFF TS–585C/U Impedance control: 60 (X 10 bracket) MULTIPLY BY: 100	SENSITIVITY: Fully clockwise VOLUME: Fully counterclockwise ON-OFF: ON OPEN-SQUELCH: OPEN Audio gain control R50: Fully clockwise	*a.* Set the signal generator MICROVOLTS dial to 5 and adjust the tuning knob for maximum indication on the output meter. *b.* Set the OPEN-SQUELCH switch on the receiver to SQUELCH and set the MICROVOLTS control on the signal generator to .1. *c.* Gradually increase the MICROVOLTS dial on the signal generator until the REC lamp on the front panel of the receiver lights. (STBY lamp goes out.) *d.* Note the setting on the MICROVOLTS dial of the signal generator. *e.* Set the MICROVOLTS dial on the signal generator to .1 before proceeding to the next step.	*a.* None. *b.* None. *c.* None. *d.* The setting of the MICROVOLTS dial of the signal generator should be not more than 10. *e.* None.
2	Controls remain as last indicated in step No. 1 except: TS–585C/U MULTIPLY BY: 0.1 TS–497A/URR 1000-400-OFF-EXT: OFF MICROVOLTS: 5	Same as step No. 1.	*a.* Adjust audio gain control R50 on the receiver until the output meter indicates 0.1 milliwatt (1 on the 0 to 50 scale). *b.* Set the output meter MULTIPLY BY switch to X 10 and the signal generator 1000 - 400 - OFF - EXT switch to 1000. *c.* Adjust the signal generator MICROVOLTS dial for an indication of 1 milliwatt on the output meter by using the following procedure: (1) Adjust the signal generator MICROVOLTS dial for an indication on the output meter of 40 milliwatts (4 on the 0 to 50 scale). (2) Set the output meter MULTIPLY BY switch to X1. (3) Adjust the signal generator MICROVOLTS control for an indication on the output meter of 1 milliwatt (1 on the 0 to 50 scale). (4) Set the output meter MULTIPLY BY switch to 0.1. (5) Adjust the signal generator MICROVOLTS dial for an indication on the output meter of 1 milliwatt (10 on the 0 to 50 scale). *d.* Set the signal generator 1000-400-OFF-EXT switch to OFF. *e.* Adjust the audio gain control R50 on the receiver until the output meter indicates 0.1 milliwatt (1 on the 0 to 50 scale). *f.* Set the signal generator 1000-400-OFF-EXT switch to 1000. *g.* Adjust the signal generator MICROVOLTS dial for an indication on the output meter of 1 milliwatt (10 on the 0 to 50 scale). *h.* Repeat *d*, *e*, *f*, and *g* above until no further adjustments are necessary to give an output meter indication as follows: (1) 0.1 milliwatt (1 on the 0 to 50 scale) when the signal generator 1000-400-OFF-EXT switch is set to OFF. (2) 1 milliwatt (10 on the 0 to 50 scale) when the signal generator 1000-400-OFF-EXT switch is set to 1000. *i.* Note the setting on the signal generator MICROVOLTS dial. *j.* Leave the signal generator and the receiver on.	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* None. *g.* None. *h.* None. *i.* Setting on the signal generator MICROVOLTS control should be not more than 4.5. *j.* None.

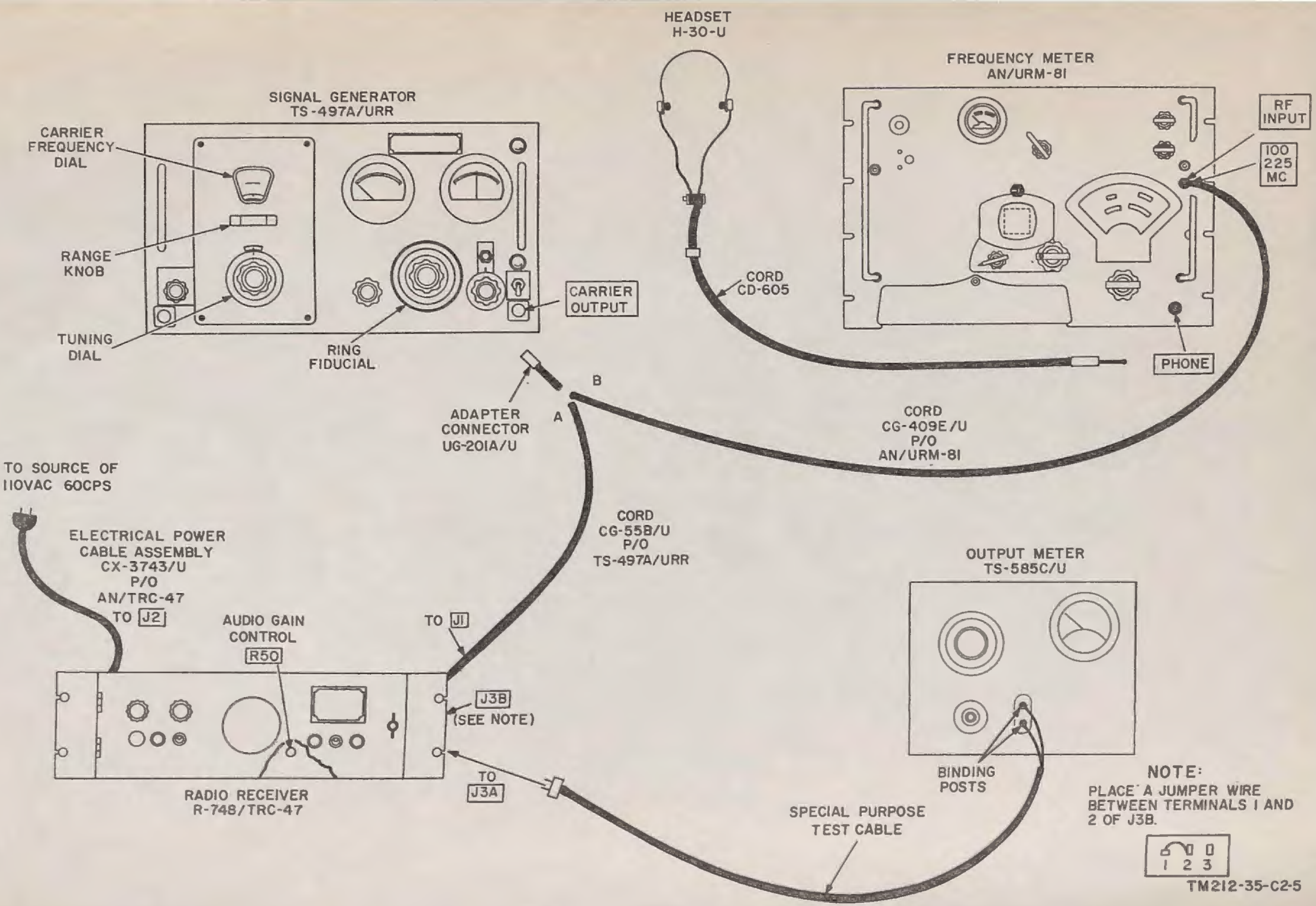


Figure 48.5. (Added) *Receiver selectivity tests.*

65.6. Receiver Selectivity Tests

a. Test Equipment and Materials.
Signal Generator TS–497A/URR
Frequency Meter AN/URM–81
Output Meter TS–585C/U
Headset HS–30–U
Cord CD–605 (used with HS–30–U)
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)
Adapter Connector UG–201A/U
Special purpose test cable (fig. 48.1)

b. Test Connections and Conditions. Connect the equipment as shown in A, figure 48.5.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	TS–497A/URR Range knob: 78–180 mc, band E Tuning knob: Same operating frequency as receiver. MICROVOLTS: MIN Ring fiducial: Red line indication on meter 1000-400-OFF-EXT: 1000 MOD: Full scale (30) indication on meter EXT. PULSE: OFF TS–585C/U Impedance control: 60 (X10 bracket) MULTIPLY BY: 1 AN/URM–81 POWER: ON FUNCTION SWITCH: COARSE RANGE: 110–225 CHECK: Any position COARSE: Any position FINE: Any position LEVEL: Any position	SENSITIVITY: Fully clockwise Volume: Fully counterclockwise ON-OFF: ON OPEN-SQUELCH: OPEN Audio gain control R50: Fully clockwise	*a.* Set the MICROVOLTS control on the signal generator to 1 and adjust the tuning knob for maximum indication on the output meter. Note and record the indication on the output meter. *b.* Set the MICROVOLTS control on the signal generator to 2. *c.* Turn the signal generator tuning knob clockwise, increasing the frequency, until the indication on the output meter is the same as recorded in *a* above. *d.* Connect the equipment as shown in B, figure 48.5. *e.* Using the instructions in the calibration book to operate the frequency meter, determine the exact frequency of the signal generator. Note and record the frequency of the signal generator. *f.* Connect the equipment as shown in A, figure 48.5. *g.* Turn the signal generator tuning knob counterclockwise, decreasing the frequency, until the indication on the output meter is the same as recorded in *a* above. *h.* Connect the equipment as shown in B, figure 48.5. *i.* Using the instructions in the calibration book to operate the frequency meter, determine the exact frequency of the signal generator. Note and record the frequency of the signal generator. *j.* Subtract the frequency recorded in *i* above from that of *e* above. Note the difference in frequency.	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* None. *g.* None. *h.* None. *i.* None. *j.* The difference frequency should be not less than 40 kc.
2	Controls remain as last indicated in step No. 1 except: TS–497A/URR MICROVOLTS: 1K	Same as step No. 1	*a.* Connect the equipment as shown in B, figure 48.5 and repeat steps No. 1*c*, *d*, *e*, *f*, and *g*. *b.* Leave the signal generator and the receiver on and turn the frequency meter off.	*a.* The difference frequency should be not more than 240 kc.

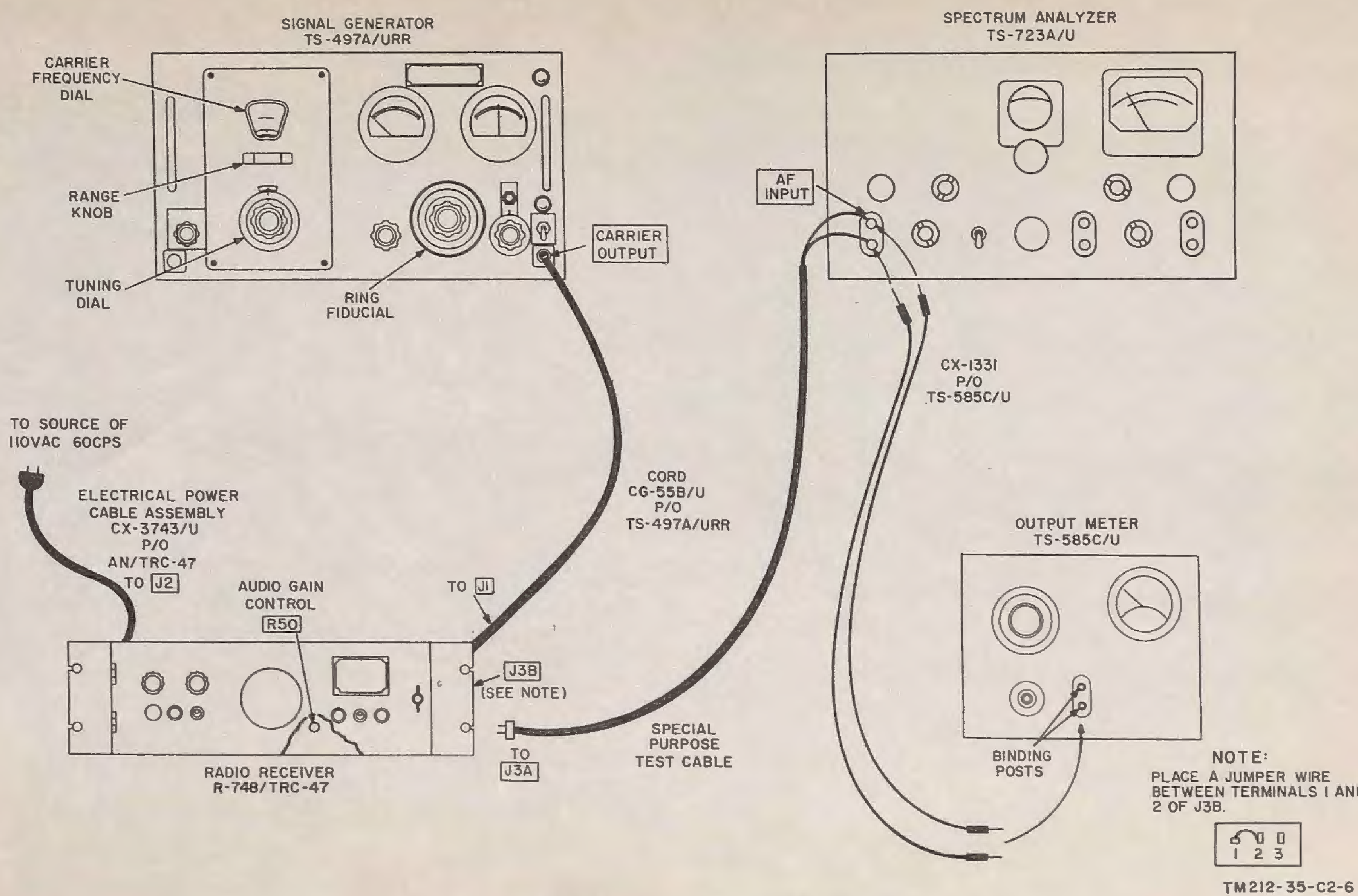


Figure 48.6. (Added) *Receiver audio and AVC tests.*

65.7. Receiver Audio and AVC Tests

a. Test Equipment and Materials.

Spectrum Analyzer TS–723A/U
Signal Generator TS–497A/URR
Output Meter TS–585C/U
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)
Special purpose test cable (fig. 48.1)

b. Test Connections and Conditions. Connect the equipment as shown in figure 48.6. Do not turn the TS–723A/U on until instructed to do so in test procedure.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	TS–497A/URR Range knob: 78–180 mc, band E Tuning knob: Same operating frequency as the receiver. MICROVOLTS: 5 Ring fiducial: Red line indication on the meter. 1000-400-OFF-EXT: 1000 MOD: Full scale (30) indication on meter EXT. PULSE: OFF TS–585C/U Impedance control: 60 (X10 bracket) MULTIPLY BY: 100	SENSITIVITY: Fully clockwise VOLUME: Fully counterclockwise ON-OFF: ON OPEN-SQUELCH: OPEN Audio gain control R50: Fully clockwise	*a.* Adjust the signal generator tuning knob for maximum indication on the output meter. Note the indication on the wattage scale of the output meter. *b.* Record the indication on the db scale of the output meter. *c.* Set the signal generator MICROVOLTS control to 100K. Note the indication on the db scale of the output meter.	*a.* Output meter should indicate not less than 800 milliwatts (8 on the 0 to 50 scale.) *b.* None. *c.* Output meter indication should not increase more than 6 db (0 to 17 db scale) from the indication in *b* above (test procedure). *Note.* The AVC characteristic in *c* above includes the instability of the TS–497A/URR. The actual AVC characteristic of the receiver is 2 db.
2	Controls remain as last indicated in step No. 1 except: TS–723A/U AF–RF: AF INPUT: MIN Freq RANGE: X10 FREQUENCY: 100 on turning dial Function switch: SET LEVEL Meter range switch: 100% BALANCE: Fully counterclockwise ON-OFF: ON TS–497A/URR MICROVOLTS: 5	Same as step No. 1.	*a.* Measure the distortion of the receiver by using the following procedure: (1) Slowly rotate the TS–723A/U INPUT control clockwise until the TS–723A/U meter indicates full scale deflection (1.0 on the 0 to 1.0 scale). (2) Turn the TS–723A/U function switch to DISTORTION. (3) Adjust the TS–723A/U upper FREQUENCY control (coarse) until a sharp dip is indicated by the TS–723A/U meter needle. (4) Adjust the lower FREQUENCY control (fine) for minimum meter indication. (5) Adjust the BALANCE control for minimum meter indication. (6) Repeat (4) and (5) above until no further interaction occurs. (7) Note the distortion as indicated on the TS–723A/U. *b.* Turn off the signal generator and the spectrum analyzer.	*a.* Indication on the TS–723A/U meter should not exceed 20% (0.2 on the 0 to 1.0 scale). *Note.* This distortion indication includes the inherent distortion of the TS–497A/URR. The actual distortion of the receiver is less than 18%. *b.* None.

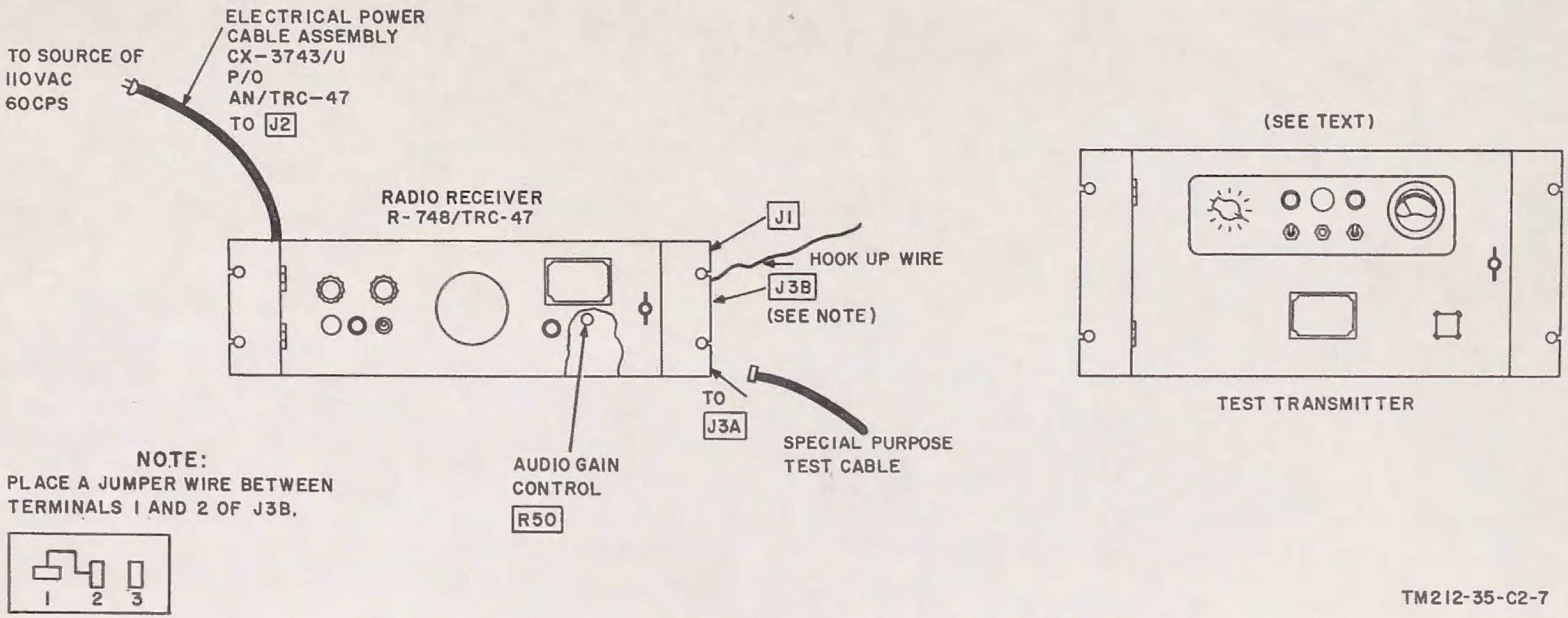


Figure 48.7. (Added) *Receiver operational test.*

65.8. Receiver Operational Test

a. Test Equipment and Materials.
Transmitter (am type, frequency range 125 to 150 mc)
Special purpose test cable (fig. 48.1)
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)
Hookup wire (approximately 1 ft)

b. Test Connections and Conditions. Connect the equipment as shown in figure 48.7.

c. Test Procedure.

Control settings test equipment	Control settings equipment under test	Test procedure	Performance standard
Control settings will depend upon the type of test transmitter used.	SENSITIVITY: Fully clockwise VOLUME: Midposition ON-OFF: ON OPEN-SQUELCH: OPEN Audio gain control R50: Fully clockwise.	*a.* Have an assistant tune the test transmitter to the same operating frequency as the receiver. *b.* While the assistant is speaking into the microphone, observe the quality of voice reproduction from the receiver speaker. *c.* Turn off all equipment.	*a.* None. *b.* Voice reproduction should be intelligible and free from noise and hum. *c.* None.

65.9. Physical Test and Inspection for Transmitter

a. Test Equipment and Materials.
Electric Light Assembly MX–1292/PAQ

b. Test Connections and Conditions. Make no connections to the transmitter during these tests. The check for the mfp varnish will be made after repair and before assembly of the receiver. Connect the mercury vapor lamp and install the wide transmission filter.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	MX–1292/PAQ 245 V FOR M V LAMP switch: ON	Controls may be in position.	*a.* Expose to the direct rays of the lamp any portion of the equipment that has been repaired. ***Caution:* There should be no varnish on variable capacitor plates, wafer switch, relay contacts, or connector contacts.**	*a.* All chassis surfaces and repaired components, parts, or connections will be covered with mfp varnish. *Note.* Mfp varnish glows grayish-green when exposed to the lamp.
			b. Turn the lamp switch to OFF and proceed to the next step.	*b.* None.
2	None	Same as step No. 1.	Check the FIL., PLATE, and METER switches for correct operation.	All switches should operate freely without binding.
3	None	Same as step No. 1.	Inspect the TUNING METER for broken glass and damaged pointer.	Meter should be in good condition.
4	None	Same as step No. 1.	*a.* Inspect all connectors, lamps, fuses, terminal boards, and cover plates for damage, missing parts, or incorrect fuse ratings.	*a.* Connectors, lamps, terminal boards, and cover plates should not be damaged or have missing parts. Fuses should be of correct rating.
			b. Inspect the entire transmitter for physical damage (dents, punctures, or bent areas).	*b.* There should be no dents, punctures, or bent areas.
			c. Inspect transmitter for condition of finish and panel markings.	*c.* Surfaces intended to be painted should show no bare metal. Panel markings should be legible. Do not paint rear panel. *Note.* Touchup painting is recommended in lieu of refinishing whenever practicable. Screwheads, receptacles, and carrying handles will not be painted or polished with abrasives.

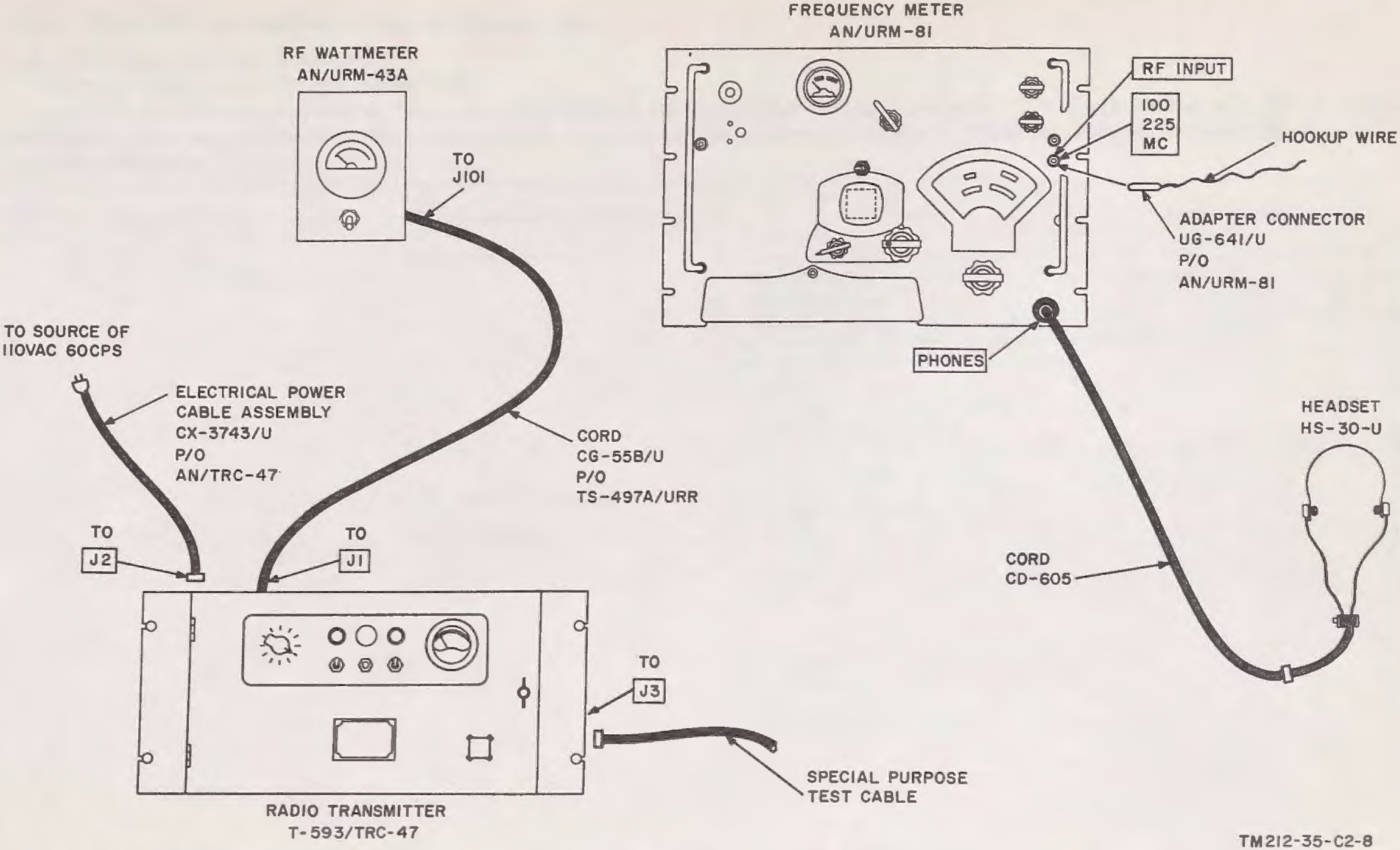


Figure 48.8. (Added) *Transmitter power output and frequency tests.*

65.10. Transmitter Power Output and Frequency Tests

a. Test Equipment and Materials.
Frequency Meter AN/URM–81
RF Wattmeter AN/URM–43A
CG–55B/U (p/o TS–497A/URR)
Headset HS–30–U
Cord CD–605 (used with HS–30U)
Special purpose test cable (fig. 48.2)
Hookup wire (approximately 1 ft)
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)

b. Test Connections and Conditions. Connect the equipment as shown in figure 48.8.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	AN/URM–81 POWER: ON FUNCTION SWITCH: COARSE RANGE: 110–225 CHECK: Any position COARSE: Any position FINE: Any position LEVEL: Mid-position AN/URM–43 60W–15W: 15W	FIL: ON PLATE: OFF	*a.* Set the PLATE switch on the transmitter to ON. Note the indication on the AN/URM–43A. *b.* Set the PLATE switch on the transmitter to OFF.	*a.* AN/URM–43 should indicate not less than 4 watts and not more than 5 watts (0 to 15 scale). *b.* None.
2	Same as step No. 1	Same as step No. 1.	*a.* Set the PLATE switch on the transmitter to ON. *b.* Using the instructions in the calibration book to operate the frequency meter, determine the exact frequency of the transmitter. Note this frequency. *c.* Set the PLATE switch on the transmitter to OFF. *d.* Turn off the frequency meter but leave the FIL switch at ON.	*a.* None. *b.* Frequency of the transmitter should be within + or − 8kc of the frequency marked on the front panel of the transmitter. *c.* None. *d.* None.

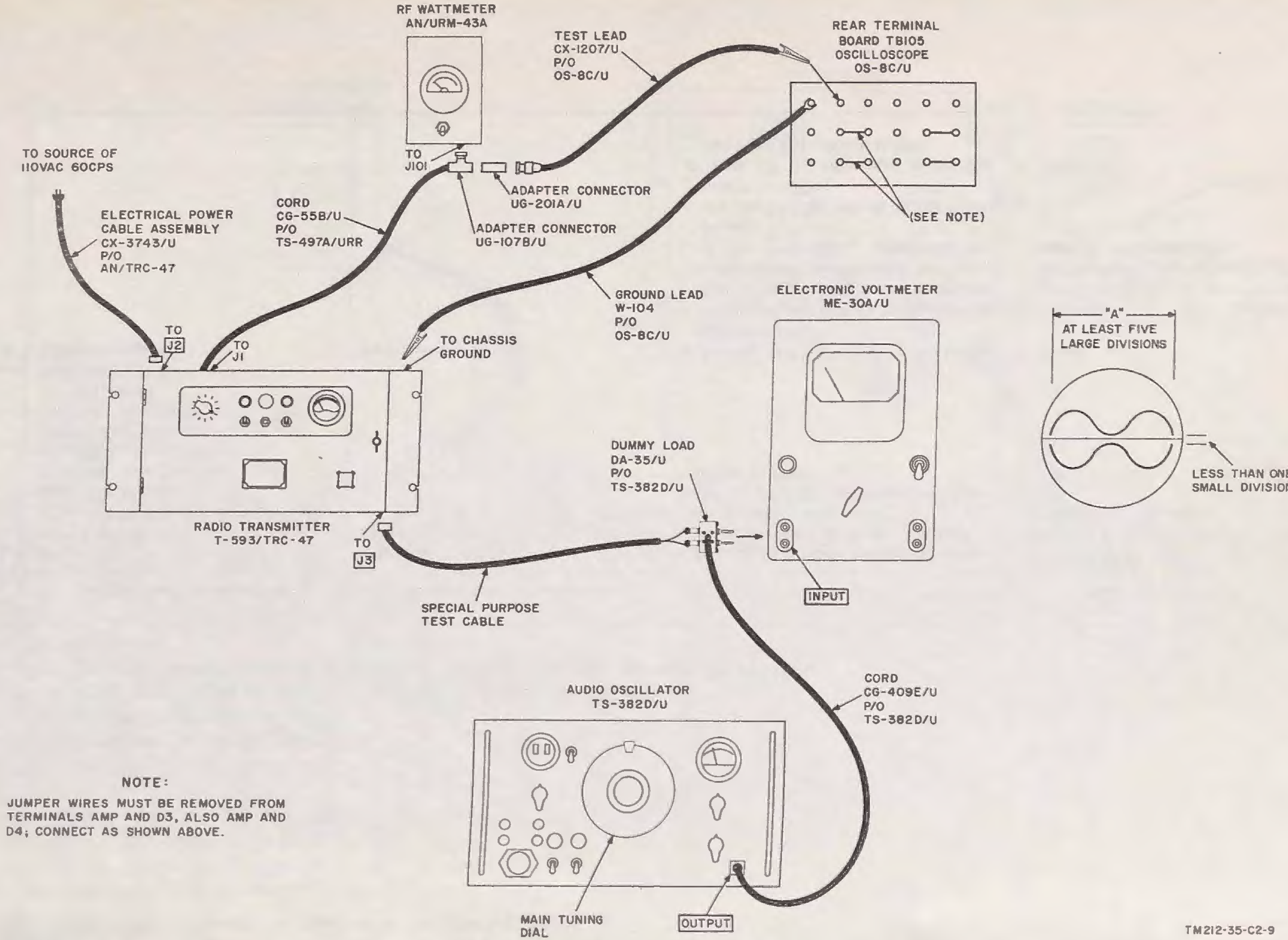


Figure 48.9. (Added) *Transmitter modulation tests.*

65.11. Transmitter Modulation Tests

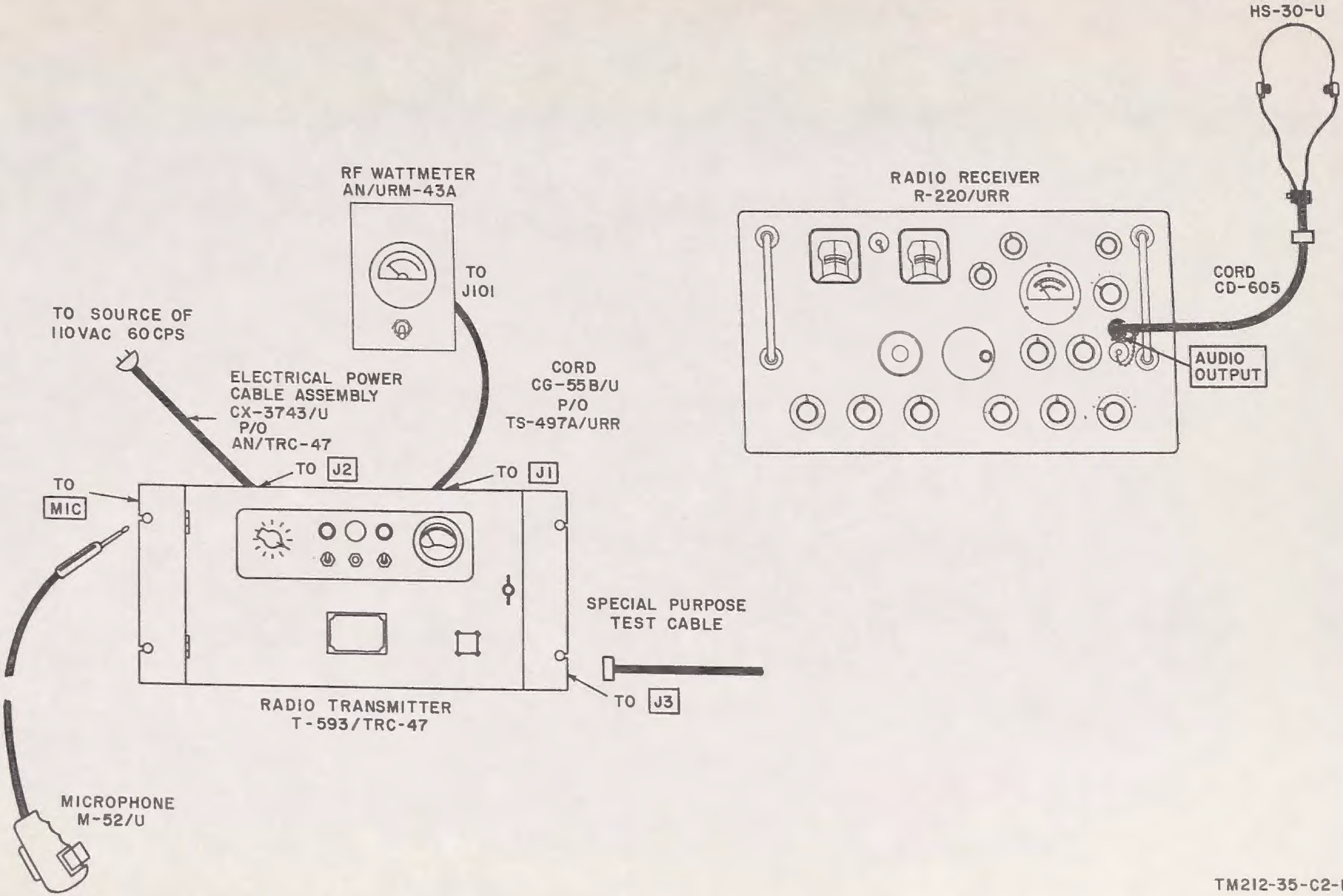
a. Test Equipment and Materials.

Audio Oscillator TS-382D/U
Electronic Voltmeter ME-30A/U
Oscilloscope OS-8C/U
R. F. Wattmeter AN/URM-43A
Cord CG-55B/U (p/o TS-497A/URR)
Special purpose test cable (fig. 48.2)
Adapter Connector UG-201A/U
Adapter Connector UG-107B/U
Electrical Power Cable Assembly CX-3743/U (p/o AN/TRC-47)

b. Test Connections and Conditions. Connect the equipment as shown in figure 489.

c. Test Procedure.

Control settings test equipment	Control settings equipment under test	Test procedure	Performance standard
TS-382D/U HEATER: ON OSC: ON FREQUENCY METER: OFF Main tuning dial: 100 OUTPUT CONTROL: Fully counterclockwise OUTPUT MULTIPLIER: .1 ME-30A/U Power switch: ON Range selector switch: .1 AN/URM-43A 60W-15W: 15W OS-8C/U VERT. ATTEN: Any position VERT. GAIN: Any position HOR ATTEN: Sweep HOR GAIN: Maximum counterclockwise COARSE FREQUENCY: 100-475 VERNIER FREQUENCY: Any position SYNC. SELECTOR: INT. LOCKING: Any position	FIL: ON PLATE: OFF	*a.* Adjust the INT, FOCUS, HOR. POS, and VERT. POS controls on the oscilloscope until the trace (a single spot) is centered on the screen. ***Caution:*** **To prevent burning of the screen on the cathode-ray tube, adjust the INT control so that the trace is not brighter than is necessary to be seen with the light shield extended.**	*a.* None.
		b. Adjust the HOR GAIN on the OS-8C/U for a trace (straight line) over at least five large divisions of the scope face.	*b.* None.
		c. Set the PLATE switch on the transmitter to ON.	*c.* None.
		d. Gradually increase the OUTPUT CONTROL on the TS-382D/U until the point of minimum voltage on the oscilloscope pattern is less than 1 small division vertically but is not zero (indicated by a bright spot). The pattern should be similar to that shown in A, figure 48.9. *Note.* The VERNIER FREQUENCY and LOCKING controls on the OS-8C/U may require adjustment to obtain this pattern.	*d.* None.
		e. Set the PLATE switch on the T-593/TRC-47 to OFF. Note the indication on the ME-80A/U.	*e.* ME-30A/U. should indicate between 0.06 and 0.08 volts (0.6 to 0.8 on the 0 to 1.0 scale).
		f. Turn off all of the equipment except the transmitter.	*f.* None.



TM212-35-C2-10

Figure 48.10. (Added) *Transmitter operational test.*

65.12. Transmitter Operational Test

a. Test Equipment and Materials.

Radio Receiver R–220/URR
R. F. Wattmeter AN/URM–43A
Headset HS–30–U
Cord CD–605 (used with HS–30–U)
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)
Microphone M–52/U
Cord CG–55B/U (p/o TS–497A/URR)
Special purpose test cable (fig. 48.2)
Hookup wire (approximately 1 ft)

b. Test Connections and Conditions. Connect the equipment as shown in figure 48.10.

c. Test Procedures.

Control settings test equipment	Control settings equipment under test	Test procedure	Performance standard
R–220–URR OPERATION: AGC B. F. OSCILLATOR: OFF NOISE LIMITER: OFF AUDIO RESPONSE: WIDE SELECTIVITY: 10 R. G. GAIN-SQUELCH: Fully clockwise BAND SELECTOR: 6 TUNING: Same frequency as the transmitter AUDIO GAIN 1: Midposition AUDIO GAIN 2: Midposition METER: CARRIER DIAL LIGHT: OFF CALIBRATE: OFF AN/URM–43A 60W–15W: 15W	Fil: ON PLATE: OFF	*a.* Have an assistant speak while pressing the push-to-talk switch. Adjust the TUNING control on the R–220/URR for maximum audio in the headsets. *b.* Observe the quality of voice reproduction in the headset. *c.* Turn off all equipment.	*a.* None. *b.* Voice reproduction should be intelligible. *c.* None.

65.13. Physical Tests and Inspection for Converter

a. Test Equipment and Materials. Electric Light Assembly MX–1292/PAQ.

b. Test Connections and Conditions. Make no connections to the converter during these tests. Check the mfp varnish after repair and before assembly of the receiver. Connect the mercury vapor lamp and install the wide transmission filter.

c. Test Procedure.

Step No.	Test Equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	MX–1292/PAQ 245 V FOR M V LAMP switch: ON	Controls may be in any position.	*a.* Expose to the direct rays of the lamp any portion of the equipment that has been repaired. *Note.* There should be no varnish on wafer switch contacts or connector contacts.	*a.* All chassis surfaces and repaired component or connections should be covered with MFP varnish.
			b. Turn the lamp switch to OFF and proceed to the next step.	*b.* None.
2	None.	Same as step No. 1.	Check the ON-OFF switch for correct action.	ON-OFF switch should operate freely without binding.
3	None.	Same as step No. 1.	*a.* Inspect all connectors, lamps, fuses, terminal boards, and cover plates for damage, missing parts, or incorrect fuse ratings.	*a.* Connectors, lamps, terminal boards, and cover plates should not have damaged or missing parts. Fuses should be of correct rating.
			b. Inspect the entire converter for physical damage (dents, punctures, and bent areas).	*b.* There should be no dents, punctures, and bent areas.
			c. Inspect converter for condition of finish and panel markings.	*c.* Surfaces intended to be painted should show no bare metal. Panel markings should be legible. Do not paint the rear panel. *Note.* Touchup painting is recommended instead of refinishing whenever practicable. Screwheads, receptacles, and carrying handles will not be painted or polished with abrasives.

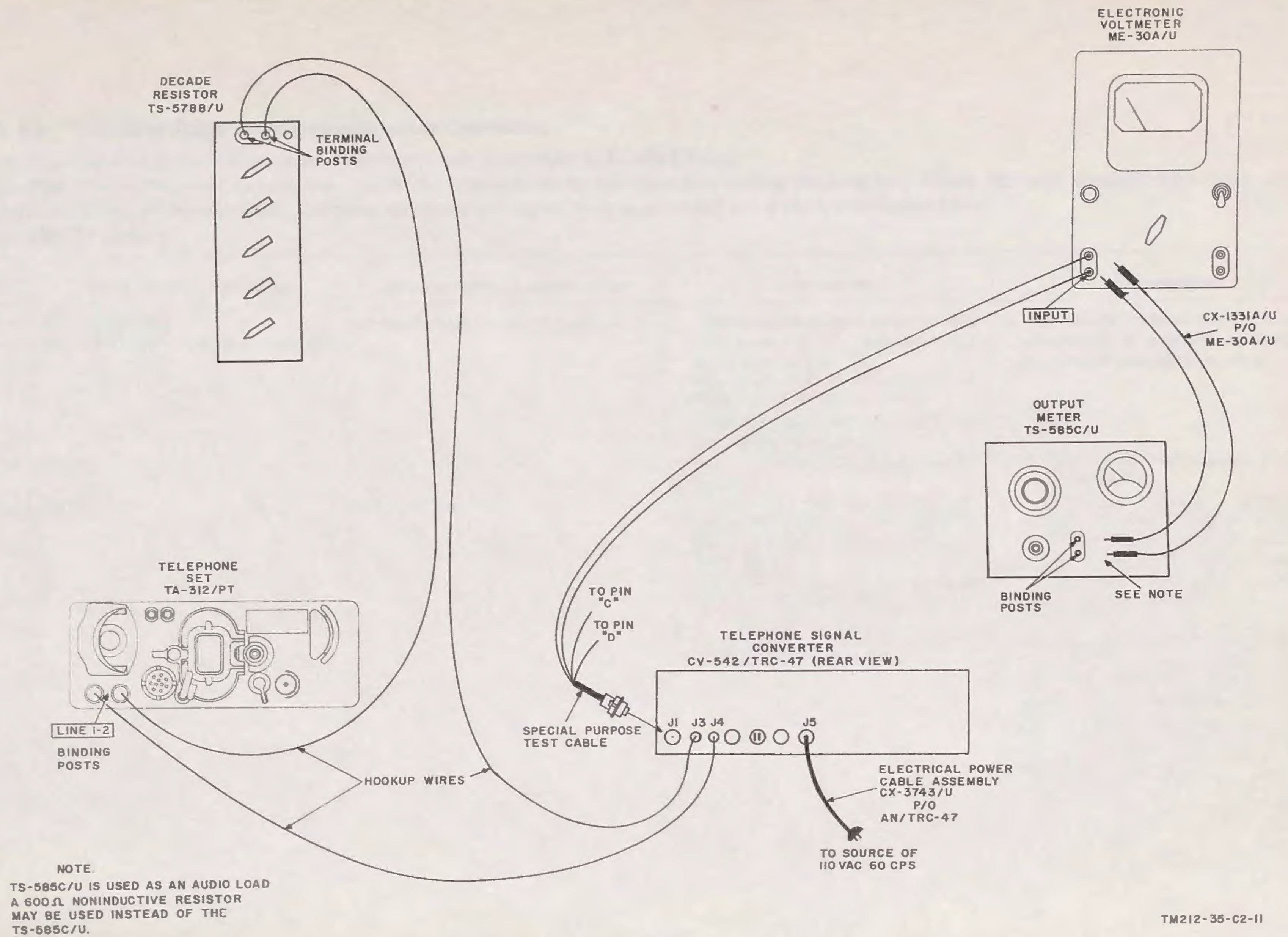


Figure 48.11. (Added) *Converter 800-cps oscillator output test.*

65.14. Converter 800-cps Oscillator Output Tests

a. Test Equipment and Materials.

Decade, Resistor TS–578B/U
Telephone Set TA–312/PT
Output Meter TS–585C/U
Electronic Voltmeter ME–30A/U
Special purpose test cable (fig. 48.3)
Hookup wire (approximately 6 ft)
Electrical Power Cable Assembly CX–3743/U (p/o AN/TRC–47)

b. Test Connections and Conditions. Connect equipment as shown in figure 48.11.

c. Test Procedure.

Control settings test equipment	Control settings equipment under test	Test procedure	Performance standard
TS–578B/U TEN THOUSANDS: 0 THOUSANDS: 1 HUNDREDS: 5 TENS: 0 UNITS: 0 TA–312/PT CB–LB–CBS: LB ME–30A/U Power switch: ON Range selector switch: .3 TS–585C/U MULTIPLY BY: 100 Impedance control: 60 (X 10 bracket)	ON-OFF: ON	*a.* Turn the GENERATOR HAND CRANK rapidly while observing the ME–30A/U. Note the indication on the ME–30A/U. *b.* Leave the ME–30A/U and the converter on.	*a.* ME–30A/U should indicate not less than 0.1 volts. (1 on the 0 to 3 scale). *b.* None.

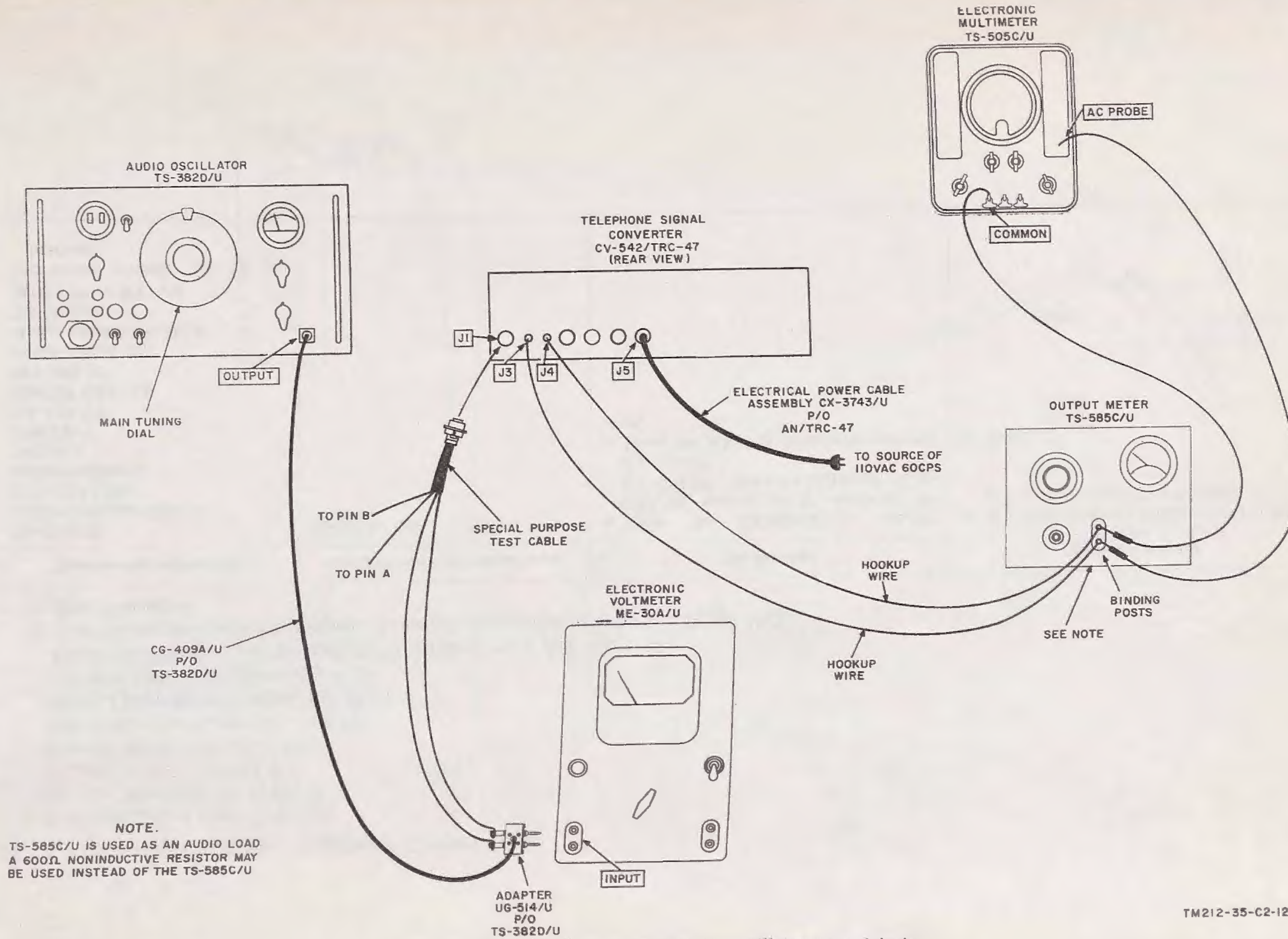


Figure 48.12. (Added) *Converter 20-cps oscillator output tests.*

65.15. Convertor 20-Cps Oscillator Output Tests.

a. Test Equipment and Materials.

Audio Oscillator TS–382D/U
Output Meter TS–585C/U
Electronic Voltmeter ME–30A/U
Electronic Multimeter TS–505C/U
Special test cable (fig. 48.3)
Hookup wire (approximately 4 ft)
Electrical Power Cable assembly CX–3743/U (p/o AN/TRC–47)

b. Test Connections and Conditions. Connect the equipment as shown in figure 48.12.

c. Test Procedure.

Control settings test equipment	Control settings equipment under test	Test procedure	Performance standard
TS–382D/U HEATER: ON OSC: ON FREQUENCY METER: OFF Main tuning dial: 80 OUTPUT CONTROL: Maximum counterclockwise OUTPUT MULTIPLIER: XI ME–30A/U ON-OFF: ON Range selector switch: .3 TS–585C/U MULTIPLY BY: 100 Impedance control: 60 (X 10 bracket) TS–505/U FUNCTION: AC RANGE: 50V(40V)	ON-OFF: ON	*a.* Adjust the OUTPUT CONTROL on the TS–382D/U until an indication of 2 volts (2 on the 0 to 3 scale) is obtained on the ME–30A/U. Note the indication on the TS–505/U. *b.* Turn off all test equipment.	*a.* Indication on TS–505/U should be not less than 24 volts (2.4 on the 0 to 5 scale). *b.* None.

65.16. Summary of Performance Standards

a. RADIO RECEIVER R-748/TRC-47.

(1) Squelch sensitivity — 10 uv max, (modulation 30 percent at 1,000 cps)

(2) Signal plus noise to noise ratio — 4.5 uv max for 10 to 1 ratio (modulation 30 percent at 1,000 cps)

(3) Selectivity — ±20 kc minimum, 6 db down and ±120 kc maximum, 60 db down

(4) Audio power output — 800 mw min (with 5-uv input modulation 30 percent at 1,000 cps)

(5) AVC Action — 2 db max variation (when signal input is varied from 5 uv to 10,000 uv)

(6) Distortion — 18 per cent max (with 5-uv signal input modulated 30 percent at 1,000 cps)

b. RADIO TRANSMITTER T-593/TRC-47.

(1) Carrier power output — 4 watts minimum, 5 watts maximum

(2) Frequency stability — 0.005 percent

(3) Modulation capability — 100 percent max (with .06 volts at 1,000 cps input to the modulator)

c. TELEPHONE SIGNAL CONVERTER CV-542/TRC-47.

(1) 800-cps output level — 0.1 volt min into 600 ohm load

(2) 20-cps output level — 24 volts minimum into 600-ohm load

Figure 56 (fold-out). (As changed by C1, 22 Jul 60) Make the following changes:

Add "+385V" at the junction of R26 and R27.

Delete the connection between R15 and the +385-volt line (R47 still is connected to the line).

Show a connection from the lower end of R15 to the lower end of R16.

Add "+270V" at pin 4 of V8 and V9.

Add a resistor (3,000 ohms, 5 watts) in the 270-volt line between the connections to R16 and L5

Figure 58 (fold-out). (As deleted by C1, 22 Jul 60) Delete horizontal line from top terminal of J6 and connect top terminal of J6 to terminal 1 of T6.

BY ORDER OF THE SECRETARY OF THE ARMY:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:
R. V. LEE,
Major General, United States Army,
The Adjutant General.

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11-7
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11-98
11-117
11-155
11-500 (AA-AE) (4)
11-557
11-587
11-592
11-597

NG: State AG (3); units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see AR 320-50.

☆ U. S. Government Printing Office: 1961—570507

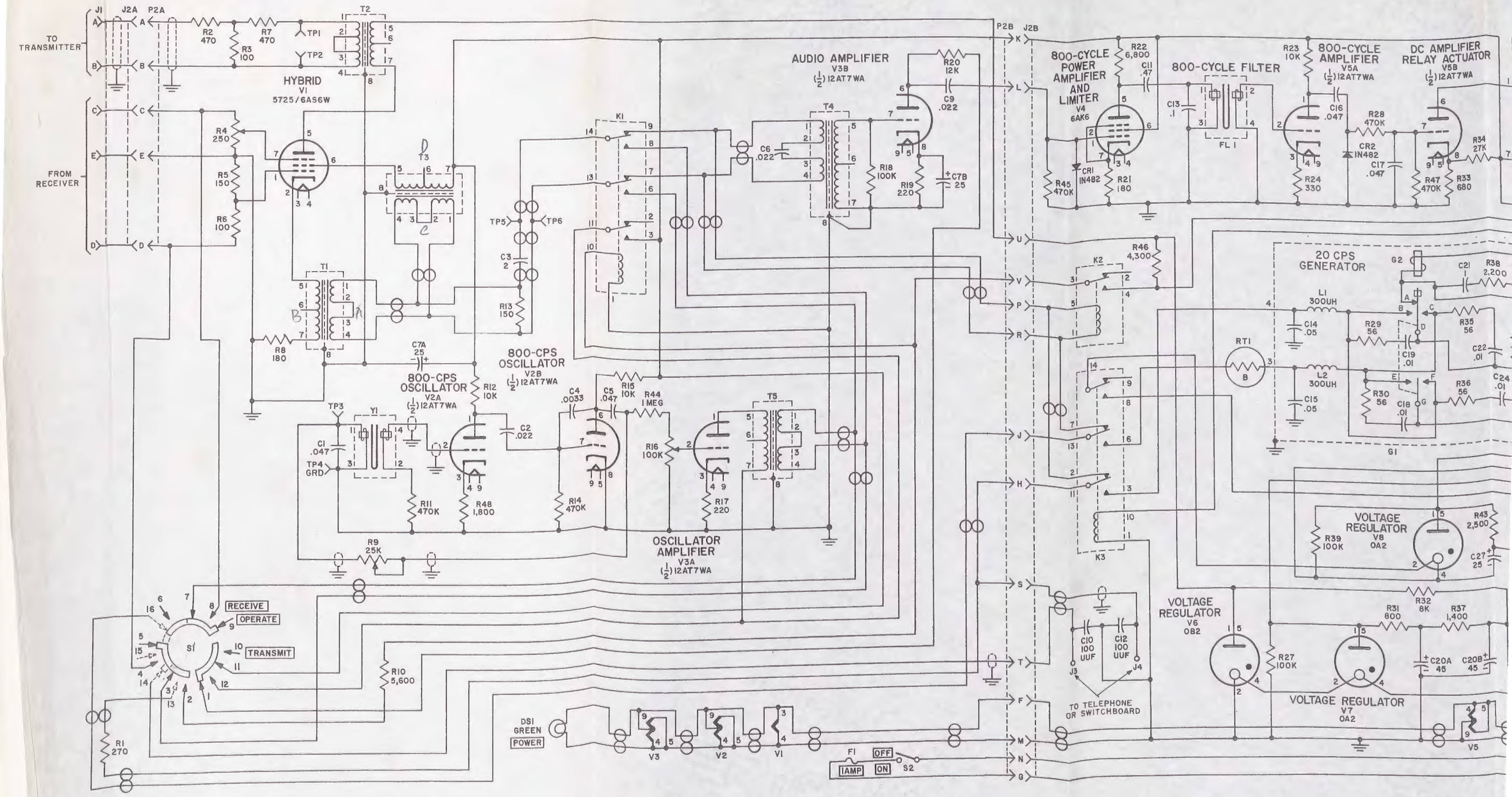


Figure 58. Telephone Signal Converter CV-542/TRC-47, schematic diagram.

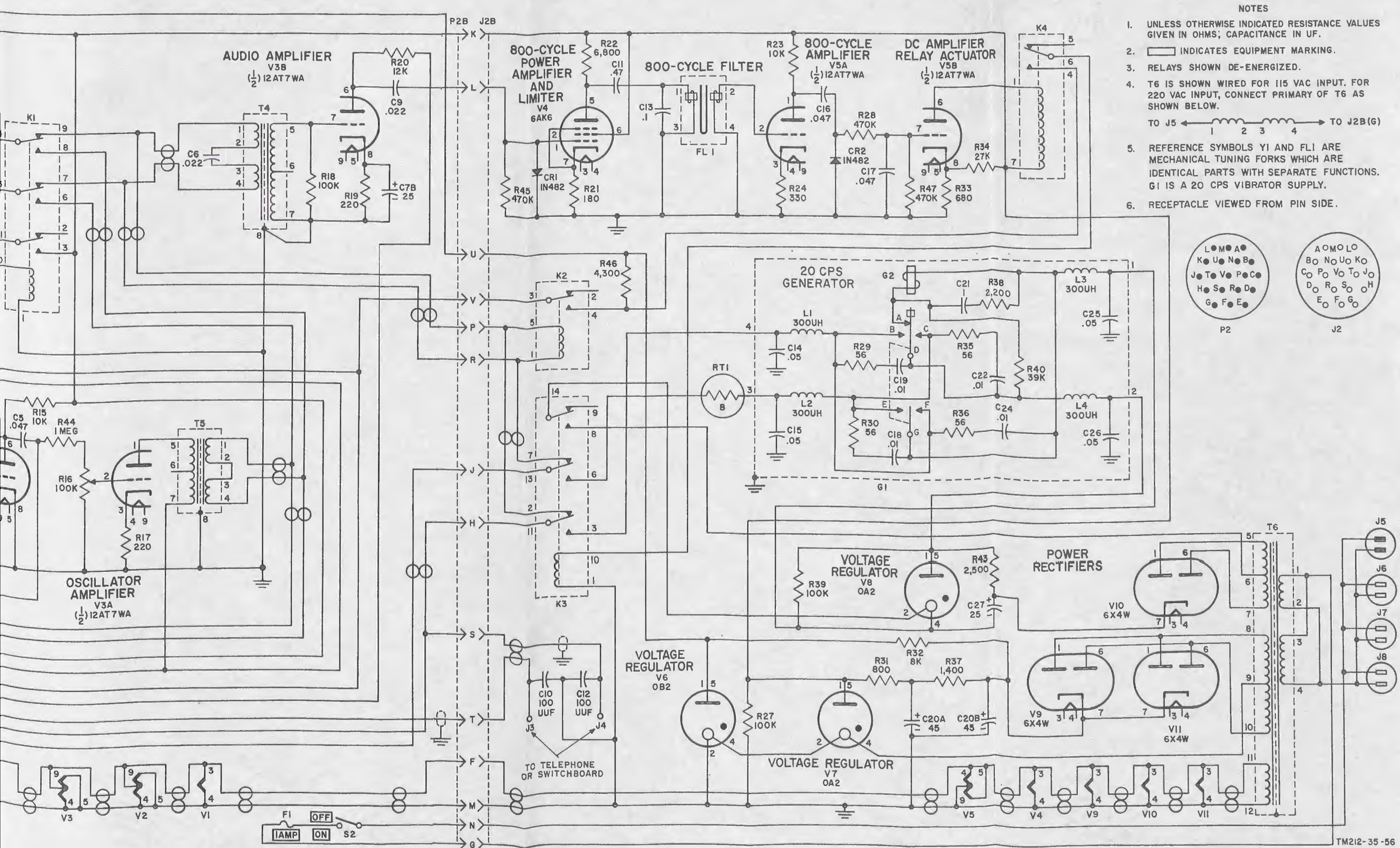


Figure 58. Telephone Signal Converter CV-542/TRC-47, schematic diagram.

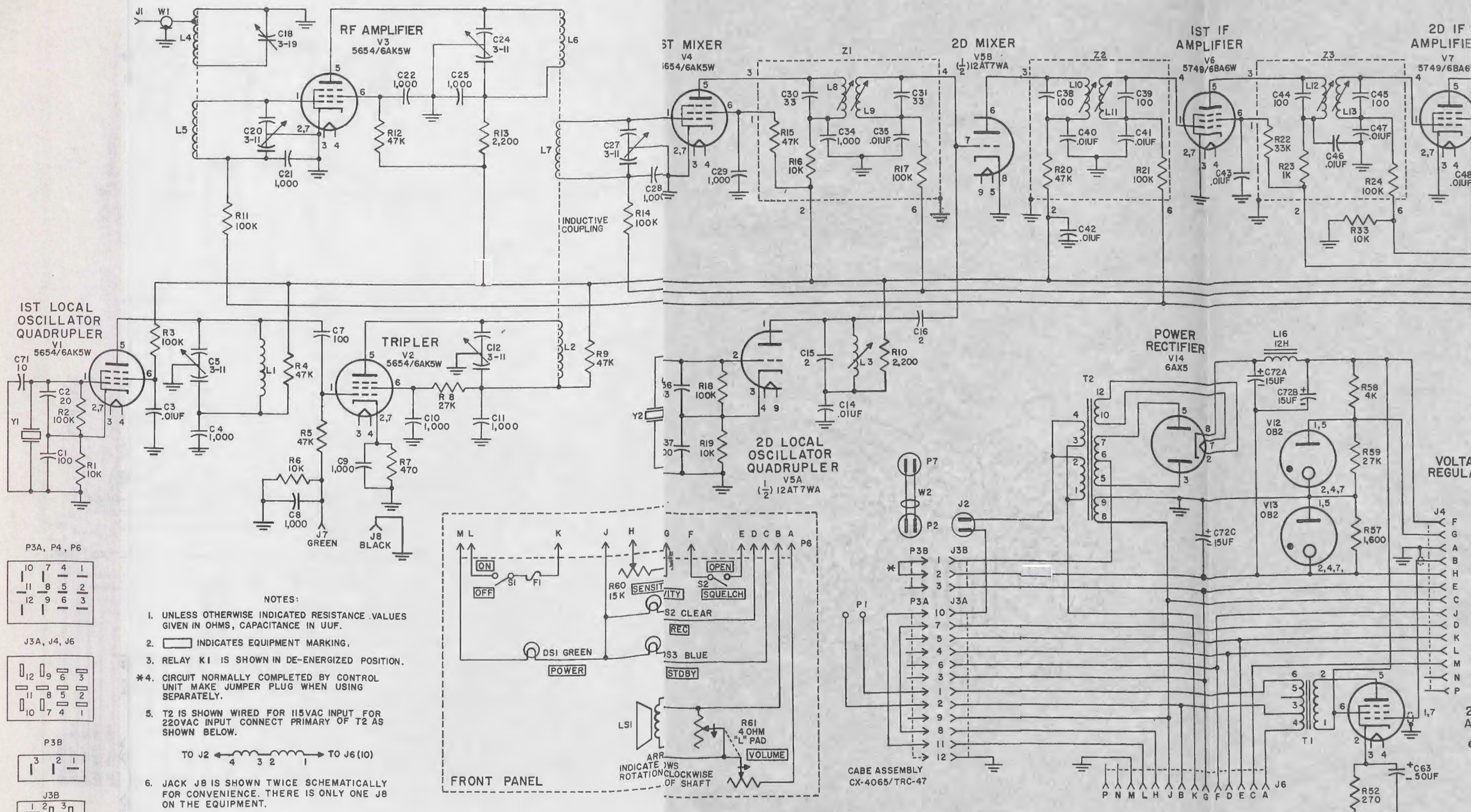


Figure 54. Radio Receiver R–748(*)/TRC–47, schematic diagram.

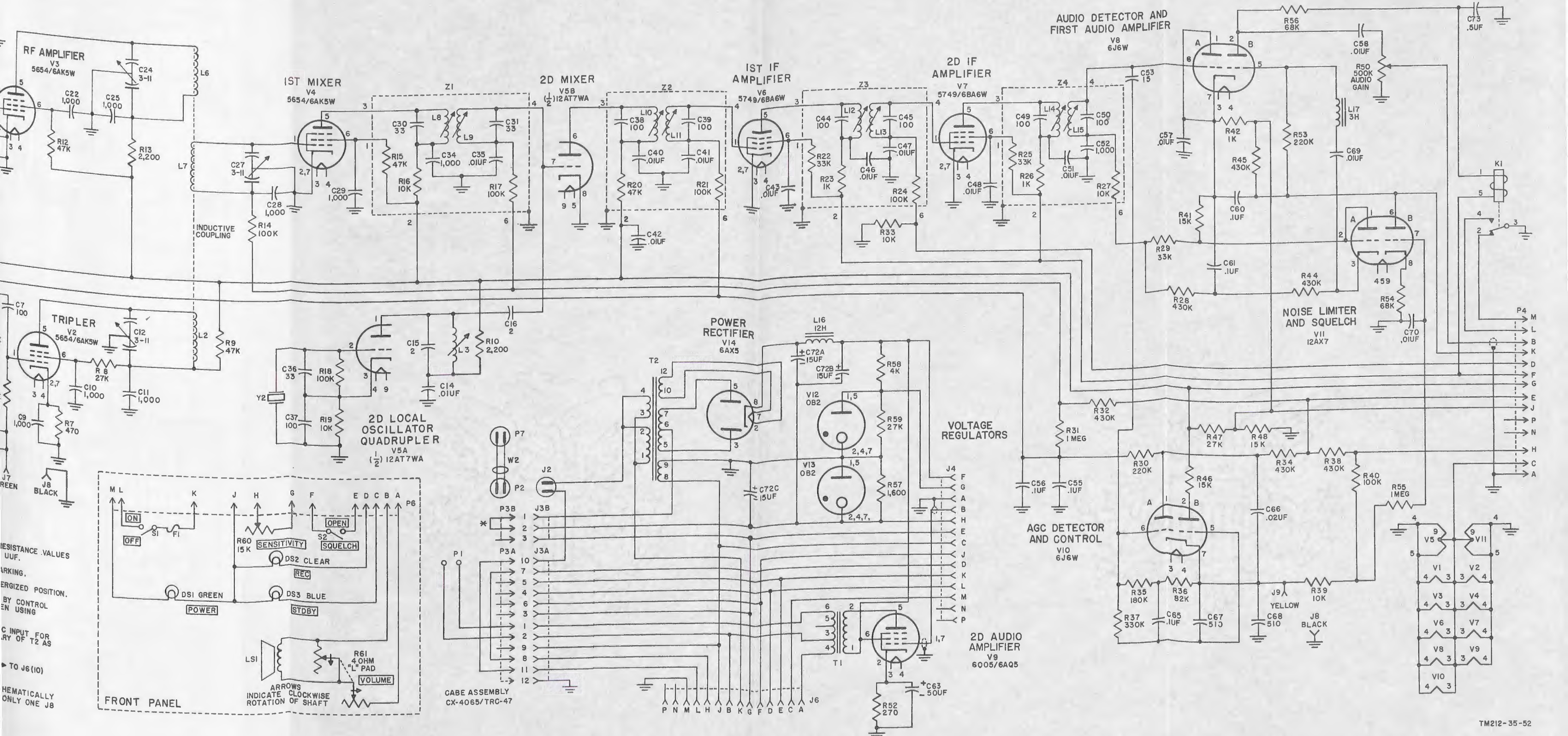


Figure 54. Radio Receiver R-748(*)/TRC-47, schematic diagram.

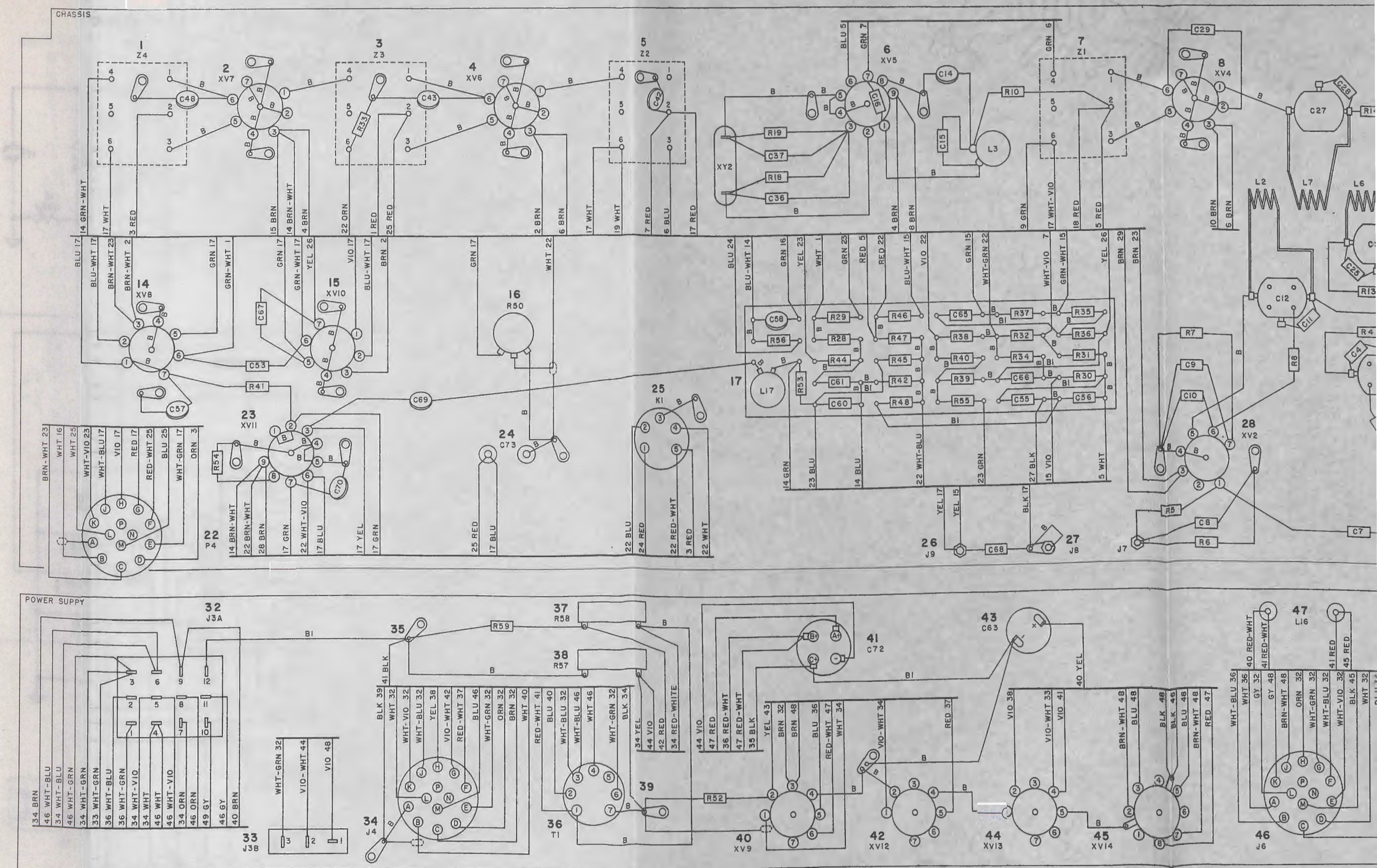
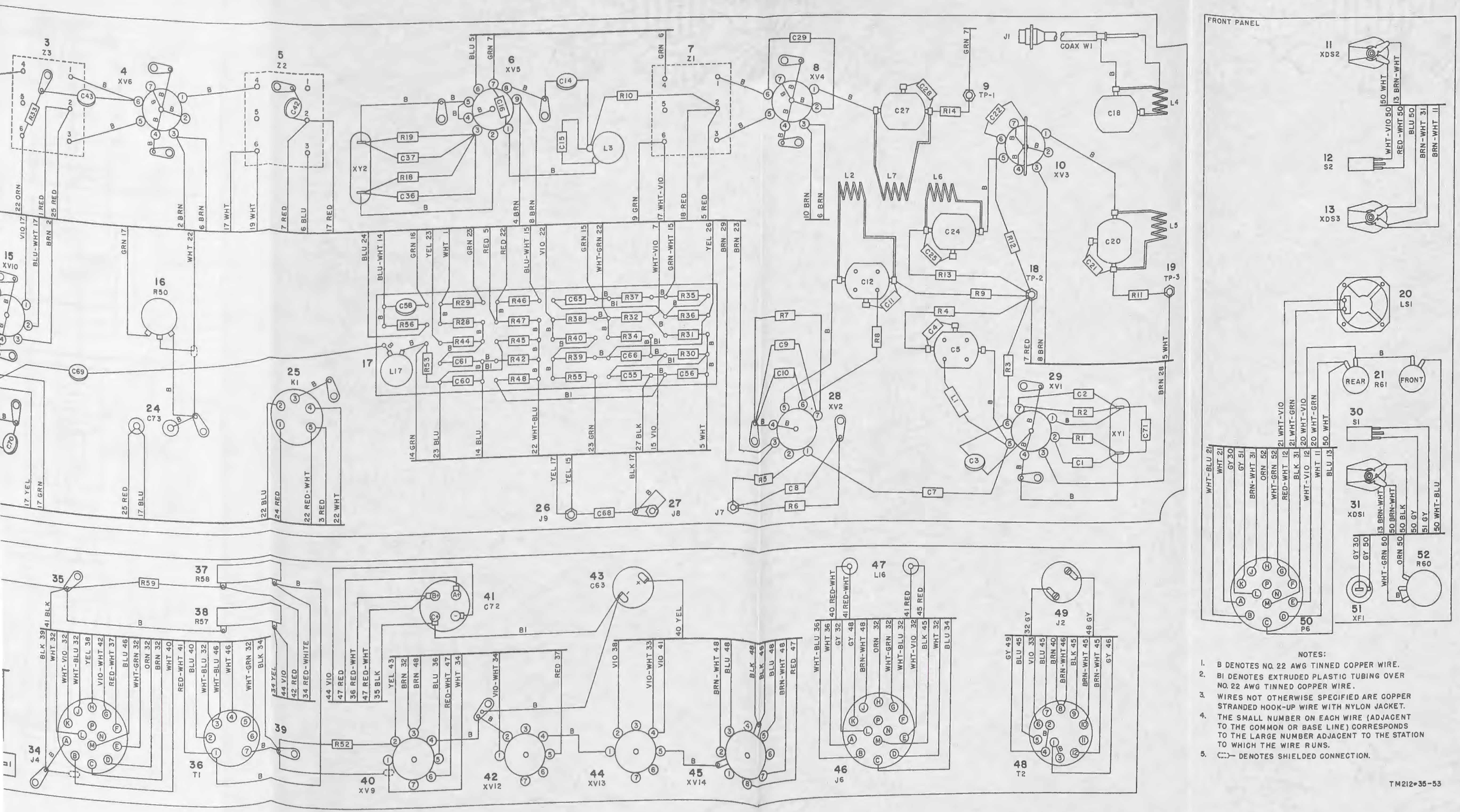


Figure 55. Radio Receiver R-748(*)/TRC-47, wiring diagram.



NOTES:

1. B DENOTES NO. 22 AWG TINNED COPPER WIRE.
2. BI DENOTES EXTRUDED PLASTIC TUBING OVER NO. 22 AWG TINNED COPPER WIRE.
3. WIRES NOT OTHERWISE SPECIFIED ARE COPPER STRANDED HOOK-UP WIRE WITH NYLON JACKET.
4. THE SMALL NUMBER ON EACH WIRE (ADJACENT TO THE COMMON OR BASE LINE) CORRESPONDS TO THE LARGE NUMBER ADJACENT TO THE STATION TO WHICH THE WIRE RUNS.
5. ⊂⊃— DENOTES SHIELDED CONNECTION.

TM212-35-53

Figure 55. Radio Receiver R-748(*)/TRC-47, wiring diagram.

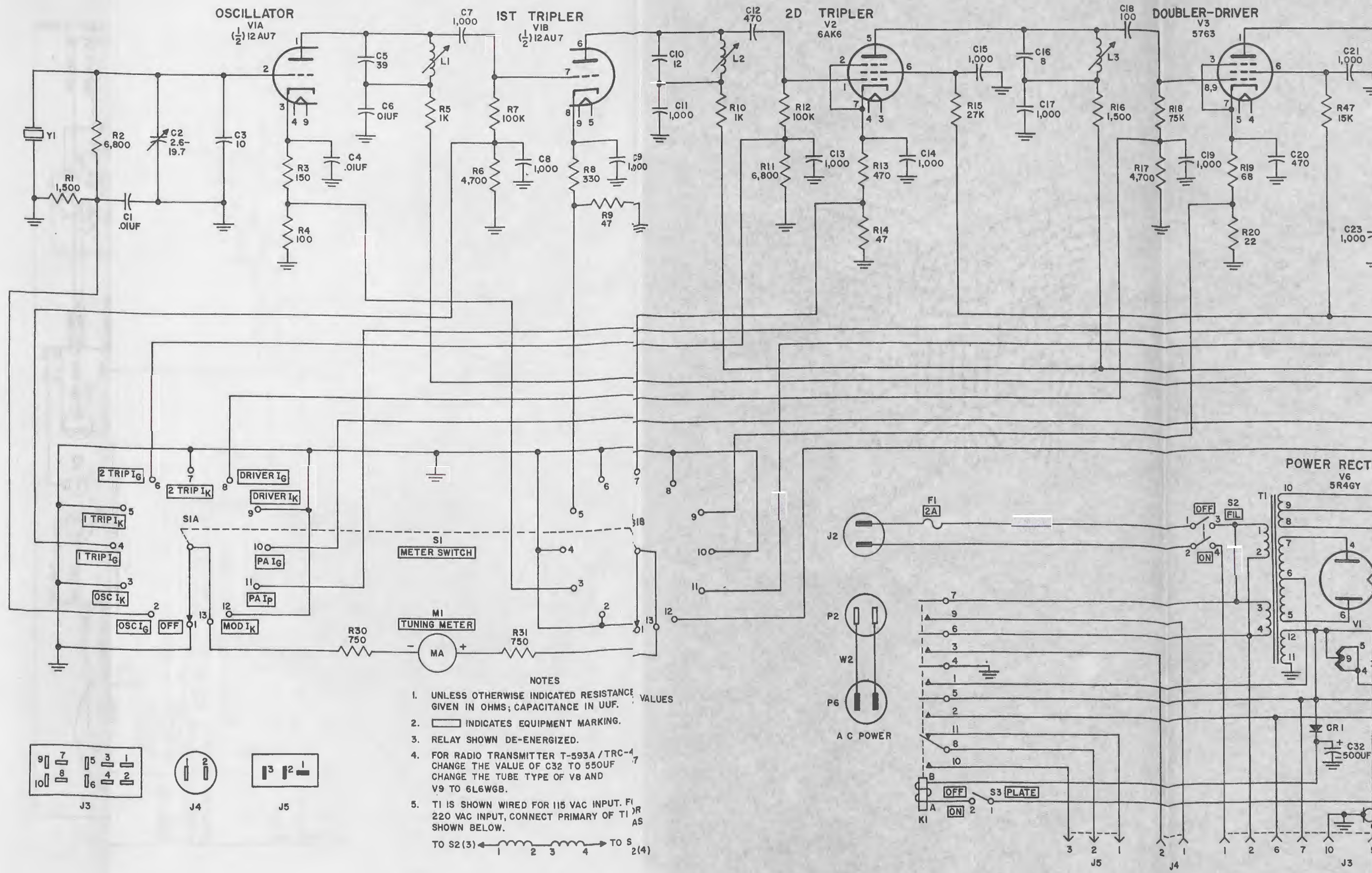


Figure 56. Radio Transmitter T-593(*)/TRC-47, schematic diagram.

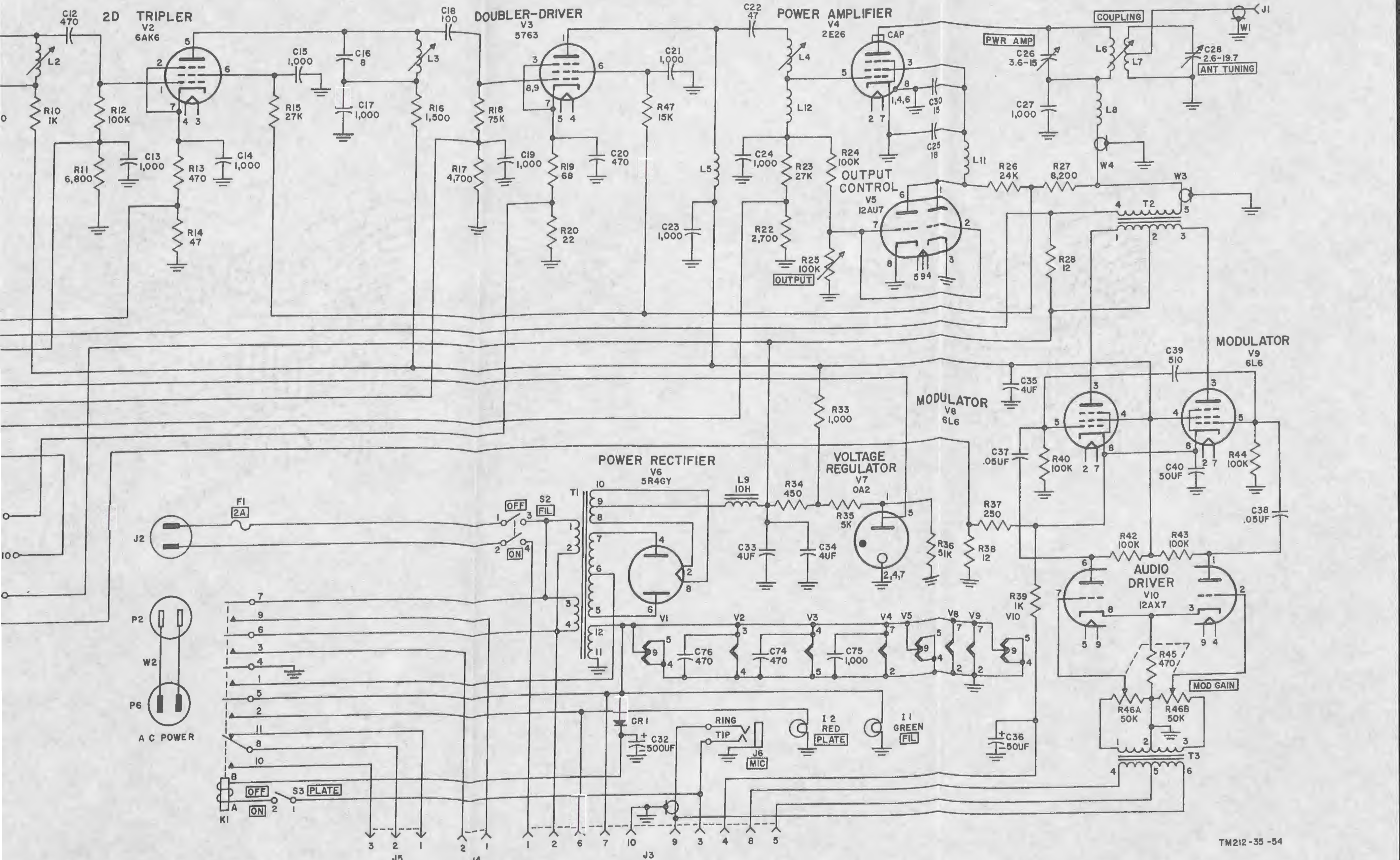


Figure 56. Radio Transmitter T–593(*)/TRC–47, schematic diagram.

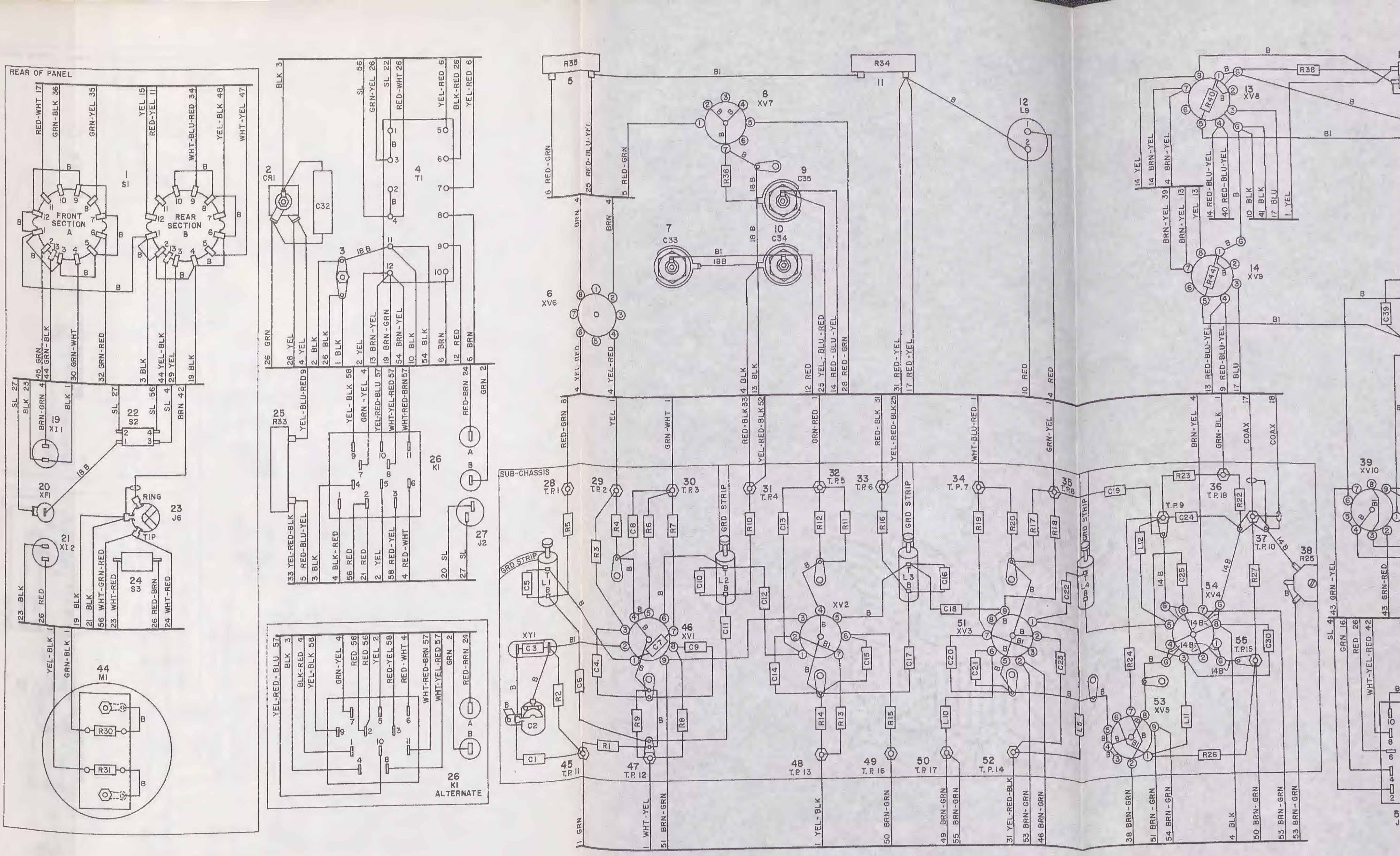


Figure 57. Radio Transmitter T-593(*)/TRC-47, wiring diagram.

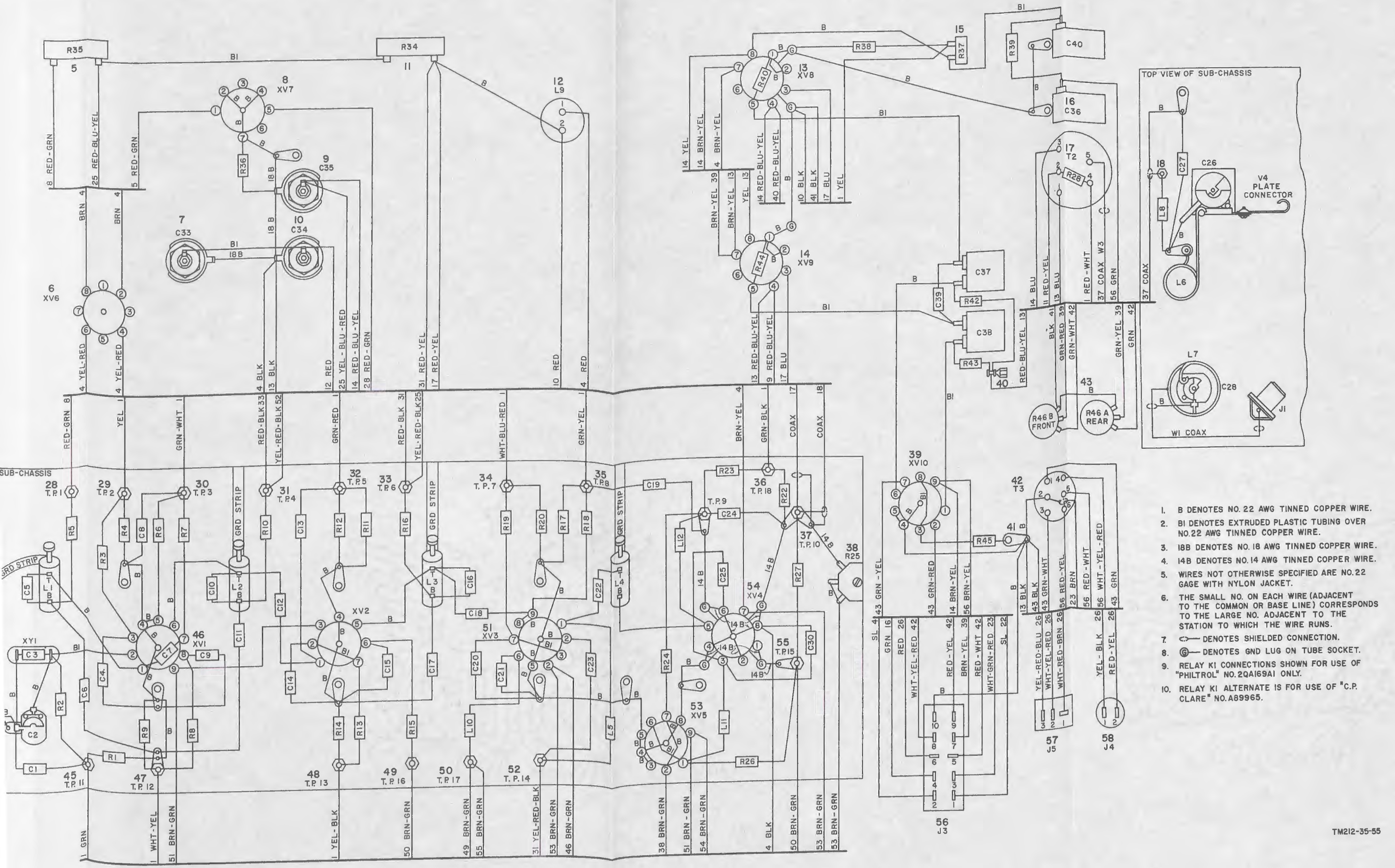


Figure 57. Radio Transmitter T–593(*)/TRC–47, wiring diagram.

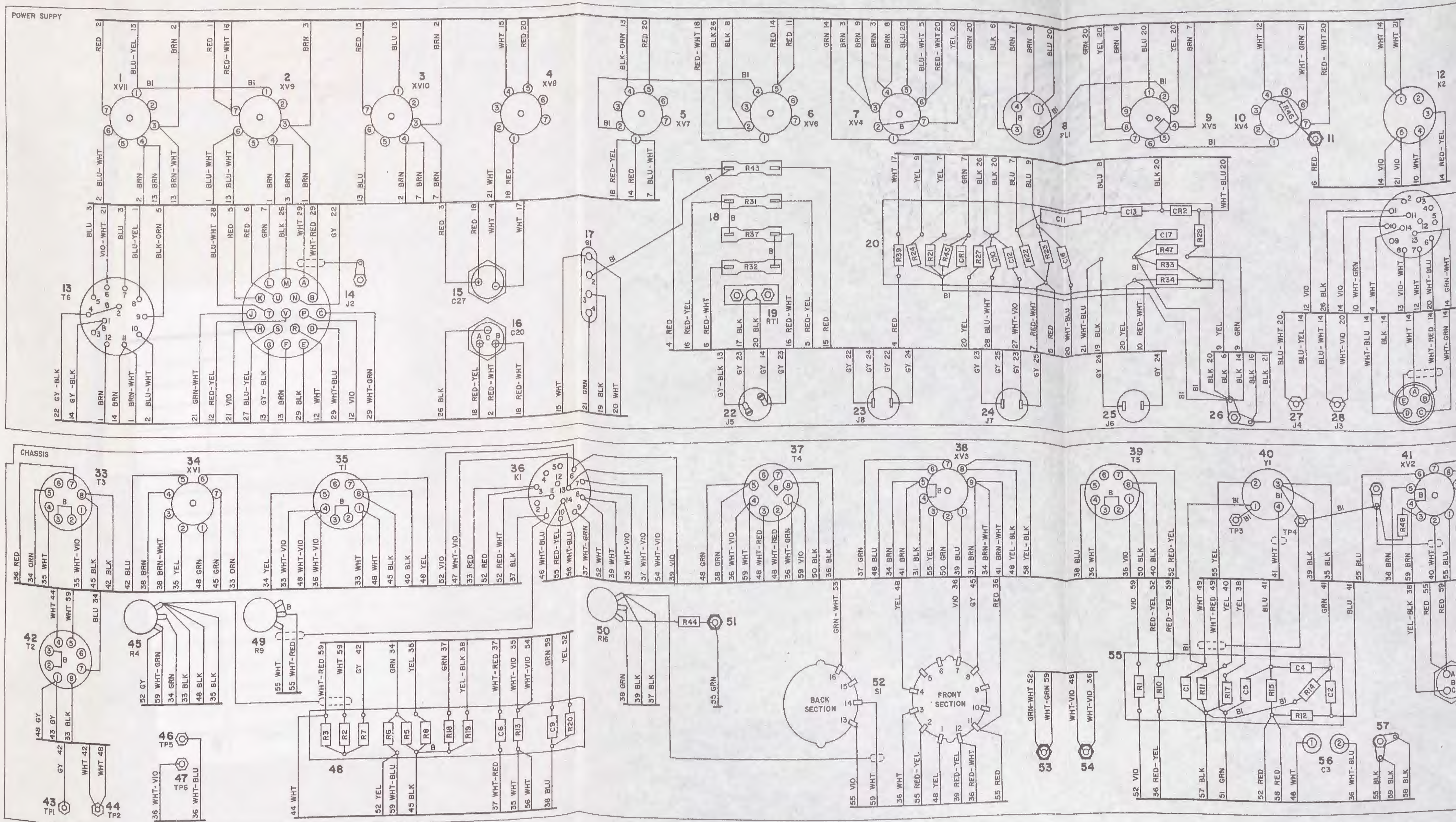
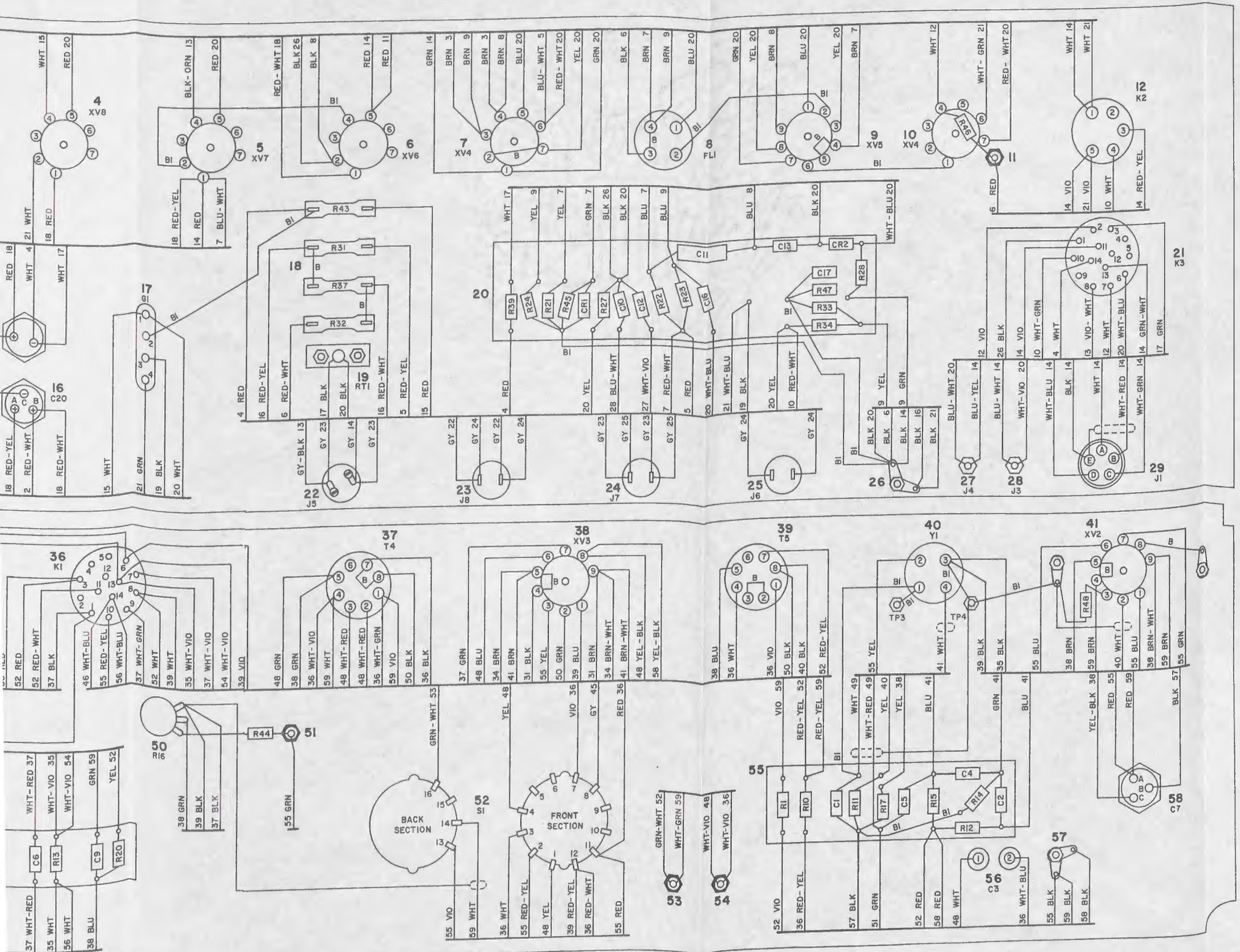


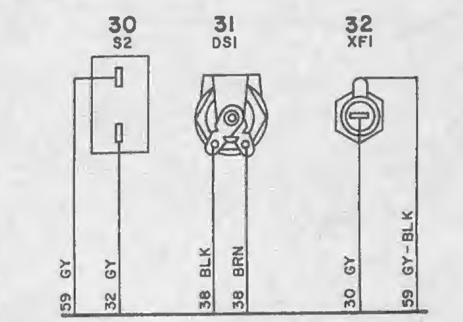
Figure 59. Telephone Signal Converter CV-542/TRC-47, wiring diagram.



NOTES:

1. B DENOTES NO. 22 AWG TINNED COPPER WIRE.
2. BI DENOTES EXTRUDED PLASTIC TUBING OVER NO. 22 AWG TINNED COPPER WIRE.
3. WIRES NOT OTHERWISE SPECIFIED ARE COPPER STRANDED HOOK-UP WIRE WITH NYLON JACKET.
4. (dashed oval symbol) DENOTES SHIELDED CONNECTION.
5. THE SMALL NUMBER ON EACH WIRE (ADJACENT TO THE COMMON OR BASE LINE) CORRESPONDS TO THE LARGE NUMBER ADJACENT TO THE STATION TO WHICH THE WIRE RUNS.

FRONT PANEL



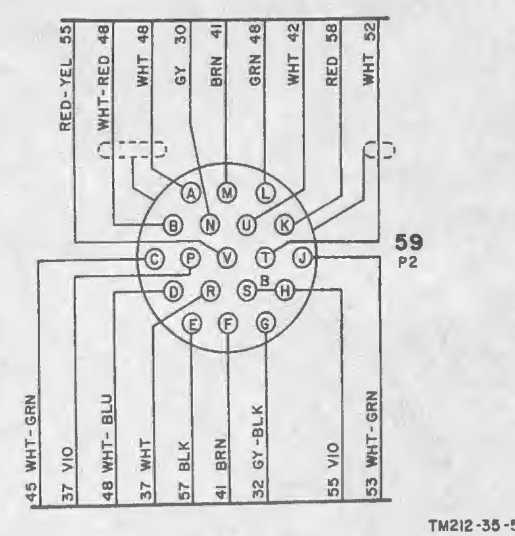


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Figure 59. Telephone Signal Converter CV-542/TRC-47, wiring diagram.

TM 11-212-35 FIELD AND DEPOT MAINTENANCE, RADIO SET AN/TRC-47—1958

TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE RADIO SET AN/TRC-47

TM 11-212-35
CHANGES No. 3

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *14 September 1961*

TM 11-212-35, 20 May 1958, is changed as follows:

Page 2, paragraph 1. Delete subparagraph *c* and substitute:

c. Forward comments on this publication directly to Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: SIGMS-PA2d, Fort Monmouth, N. J.

Paragraph 2*a,* line 3. Change the address to: Commanding Officer U. S. Army Signal Materiel Support Agency, ATTN: SIGMS-ML, Fort Monmouth, N. J.

Page 4, figure 1. Between "TRIPLER V2" and "1ST LOCAL OSCILLATOR QUADRUPLER V1" blocks, change "47.08" to: 43.08.

Page 17, paragraph 26, line 8. After the fourth sentence, add: Fuse F2 protects circuit components from damage if a short circuit occurs in the B+ line.

Page 28, paragraph 34. Delete the second sentence and substitute: Connectors J7 and J8 are parallel power outlets which furnish power to related equipment. Connector J6 is connected in parallel with the primary windings of T6 to furnish power to the ventilating fan.

Page 30, figure 31. Change rating of fuse F1 from "1 AMP" to: 2 AMP.

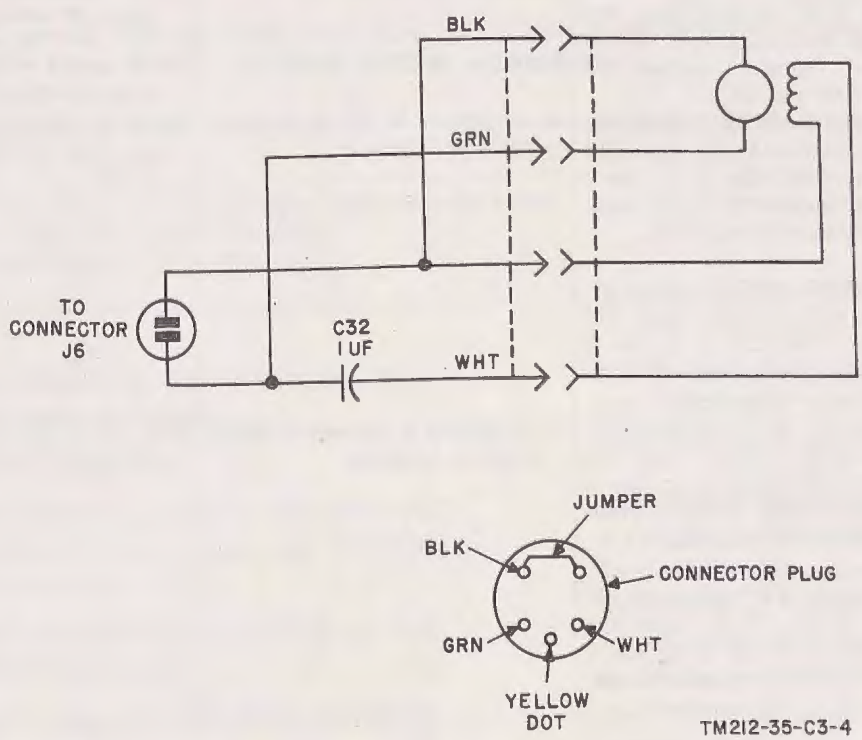

Figure 31.1. (Added) *Ventilating fan, schematic diagram.*

35.1 Ventilating Fan

(fig. 31.1)

(Added)

A ventilating fan is mounted on the rear removable panel of Electrical Equipment Cabinet CY-2126/TRC-47 to prevent overheating of the transmitter, receiver, and converter which are mounted in the equipment cabinet. The ventilating fan is positioned to blow air out of the cabinet. Ac voltage is applied to the ventilating fan motor from connector J6 (fig. 31) of the power supply. Capacitor C32 provides the required phase shift to the field winding for motor starting. ON-OFF switch S2 on the front panel of the converter controls the operation of the fan.

Page 49, paragraph 55*c*, chart. Delete the chart and substitute the following:

c. Transmitter.

Note. Perform the operations in the equipment performance checklist before using this chart.

Item	Symptom	Probable trouble	Correction
1	FIL indicator lamp does not light	FIL switch S2 defective.	Use an ohmmeter to check the switch; replace, if defective.
2	PLATE indicator lamp does not light.	PLATE switch S3 defective.	Use an ohmmeter to check the switch; replace, if defective.
		Rectifier CR1 defective.	Use voltmeter to check CR1; replace, if defective.
		Relay K1 is defective.	Replace K1.
		Transformer T1 is defective.	Replace transformer T1.
3	The TUNING METER shows abnormal indication when the METER SWITCH is in the OSCig position (normal reading between 0.35 and 0.5). or	A component in the oscillator stage is defective.	Refer to paragraph 56 and follow the isolating procedures listed.
	The TUNING METER shows abnormal indication when the METER SWITCH is in OSCik position (normal reading between 0.45 and 0.6).	Defective TUNING METER.	Check TUNING METER; replace, if defective.
		Defective METER SWITCH.	Check switch with ohmmeter; replace, if defective.
4	The TUNING METER shows abnormal indication when the METER SWITCH is in the 1 TRIPig position (normal reading between 0.35 and 0.6). or The TUNING METER shows abnormal indication when the METER SWITCH is in the 1 TRIPik position (normal reading between 0.3 and 0.6).	A component in the first tripler stage is defective.	Refer to paragraph 56 and follow the isolating procedures listed.
5	The TUNING METER shows abnormal indication when the METER SWITCH is in the 2 TRIPig position (normal reading between 0.4 and 0.6). or The TUNING METER shows abnormal indication when the METER SWITCH is in the 2 TRIPik position (normal reading between 0.35 and 0.6).	A component in the second tripler stage is defective.	Refer to paragraph 56 and follow the isolating procedures listed.

Item	Symptom	Probable trouble	Correction
6	The TUNING METER shows abnormal indication when the METER SWITCH is in the DRIVERig position (normal reading between 0.3 and 0.6). or The TUNING METER shows abnormal indication when the METER SWITCH is in the DRIVERik position (normal reading between 0.35 and 0.65).	A component in the driver stage is defective.	Refer to paragraph 56 and follow the isolation procedures listed.
7	The TUNING METER shows abnormal indication when the METER SWITCH is in the PAig position (normal reading between 0.3 and 0.6). or The TUNING METER shows abnormal indication when the METER SWITCH is in the PAip position (normal reading between 0.3 and 0.85).	A component in the power amplifier stage is defective.	Refer to paragraph 56 and follow the isolation procedures listed.
8	The TUNING METER shows abnormal indication when the METER SWITCH is in the MOD position (normal reading between 0.5 and 0.8).	A component in the modulator stage or the drive stage is defective.	Refer to paragraph 56 and follow the isolation procedures listed.

Page 51, figure 44. Make the following changes:

Tube V1, pin 6. Change "63K" to: 66K.

Tube V2, pin 5. Change "56K" to: 59K.
pin 6. Change "77K" to: 80K.

Page 52, paragraph 59*c*, chart. Add item 1.1 after item 1.

Item	Symptom	Probable trouble	Correction
1.1	The ventilating fan does not operate when the power ON-OFF switch is placed to the ON position.	Defective fan motor.	Use an ohmmeter to check the motor; replace if defective.

Page 57, paragraph 63 Delete subparagraph *b* and substitute the following:

b. RF Tuning Procedure.

(1) Turn the FIL switch to ON and wait 1 minute, then turn the PLATE switch to ON.

(2) Place the METER SWITCH in the 1 TRIPig position.

(3) Slowly turn the shaft of L1 clockwise until a peak indication is approached on the TUNING METER. Continue tuning L1 slowly clockwise until the TUNING METER indicates maximum (between 0.4 and 0.6 ma).

Caution: When tuning L1 and L2 to a frequency between 132 and 135 mc, two points of resonance may occur, depending on which end of the winding the iron core is near. To operate at the proper end of the coils, always begin the tuning procedure with the tuning shafts rotated counterclockwise to the end of their travel.

(4) Place the METER SWITCH in the 2 TRIPig position. Adjust L2 clockwise for a maximum indication on the TUNING METER (between 0.5 and 0.6 ma).

(5) Place the METER SWITCH in the DRIVERig position. Adjust L3 for a maximum indication on the TUNING METER (between 0.3 and 0.6 ma).

(6) Place the METER SWITCH in the PAig position. Adjust L4 for a maximum indication on the TUNING METER (between 0.3 and 0.6 ma).

(7) Place the METER SWITCH in the PAip position. Rotate OUTPUT control R25 completely clockwise. Be sure that the COUPLING control is adjusted for minimum coupling. Tune PWR AMP tuning control C26 for minimum indication on the TUNING METER (between 0.3 and 0.6 ma).

(8) Adjust ANT TUNING control C28 for maximum indication on the TUNING METER. Increase the coupling by turning the COUPLING control clockwise until a maximum RF output is indicated on the wattmeter connected to the transmitter antenna.

(9) Retune PWR AMP tuning control C26, for minimum, and ANT TUNING control C28 for maximum.

(10) Adjust OUTPUT control R25 counterclockwise until the wattmeter connected to the antenna indicates 7 watts.

***Caution:* Do not load the transmitter beyond 7 watts. To do so may cause distorted modulation and possible carrier shift. In addition, the output tube may be damaged.**

Page 58, paragraph 64*a*(6), line 2. Change "4 of V6" to: 1 of V6.

Paragraph 64*a*(7), line 2. Change "1 of V5B" to: 7 of V5B.

Page 59, paragraph 65*c*(2), line 3. Change ".1 volt" to: 1 volt.

Page 60, chapter 6 (page 1 of C 2). Make the following changes:

Change the title of chapter 6 to: **FOURTH ECHELON TESTING PROCEDURES AND FINAL TESTING**

Add the following note below the chapter heading:

Note. The final testing procedures are the same as the fourth echelon testing procedures. For final testing information, refer to paragraphs 65.1 through 65.16

Delete the heading of section I.

Delete section II.

BY ORDER OF THE SECRETARY OF THE ARMY:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General.

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USAAVNBD (1)
USAATBD (1)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (2)
OS Base Comd (2)
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MDW (1)
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USATC Armor (2)
USATC Engr (2)
USATC FA (2)
USATC Inf (2)
Svc Colleges (2)
Br Svc Sch (2)
GENDEP (2) except
Atlanta GENDEP (None)
Sig Sec, GENDEP (5)
Sig Dep (12)
Ft Monmouth (63)
AFIP (1)
WRAMC (1)
AFSSC (1)
USAEPG (2)
EMC (1)
USACA (2)
USASEA (1)
USA Caribbean Sig Agcy (1
USA Sig Msl Spt Agcy (12)
USASSA (20)
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Army Pictorial Cen (2)
USAOMC (3)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
AMS (1)
Sig Fld Maint Shops (2)
JBUSMC (2)
Units org under fol TOE:
(2 cy each UNOINDC)
11–5
11–7
11–16
11–55
11–57
11–96
11–97
11–98
11–117
11–155
11–500 (AA–AE, RM–RT) (4)
11–555
11–557
11–587
11–592
11–597

NG: State AG (3); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1961—610503

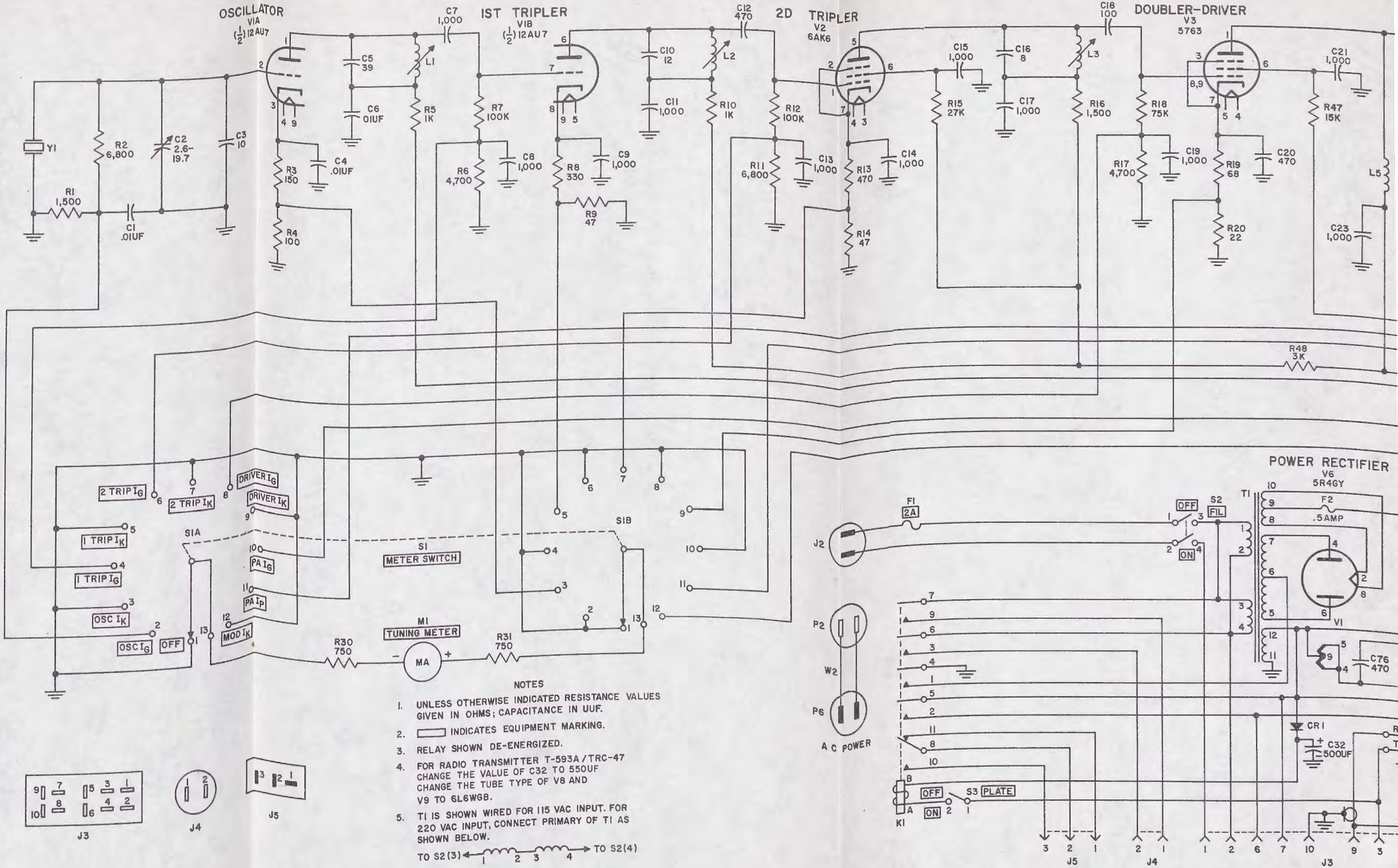

Figure 56. (Superseded) Radio Transmitter T-593(*)/TRC-47, schematic diagram.

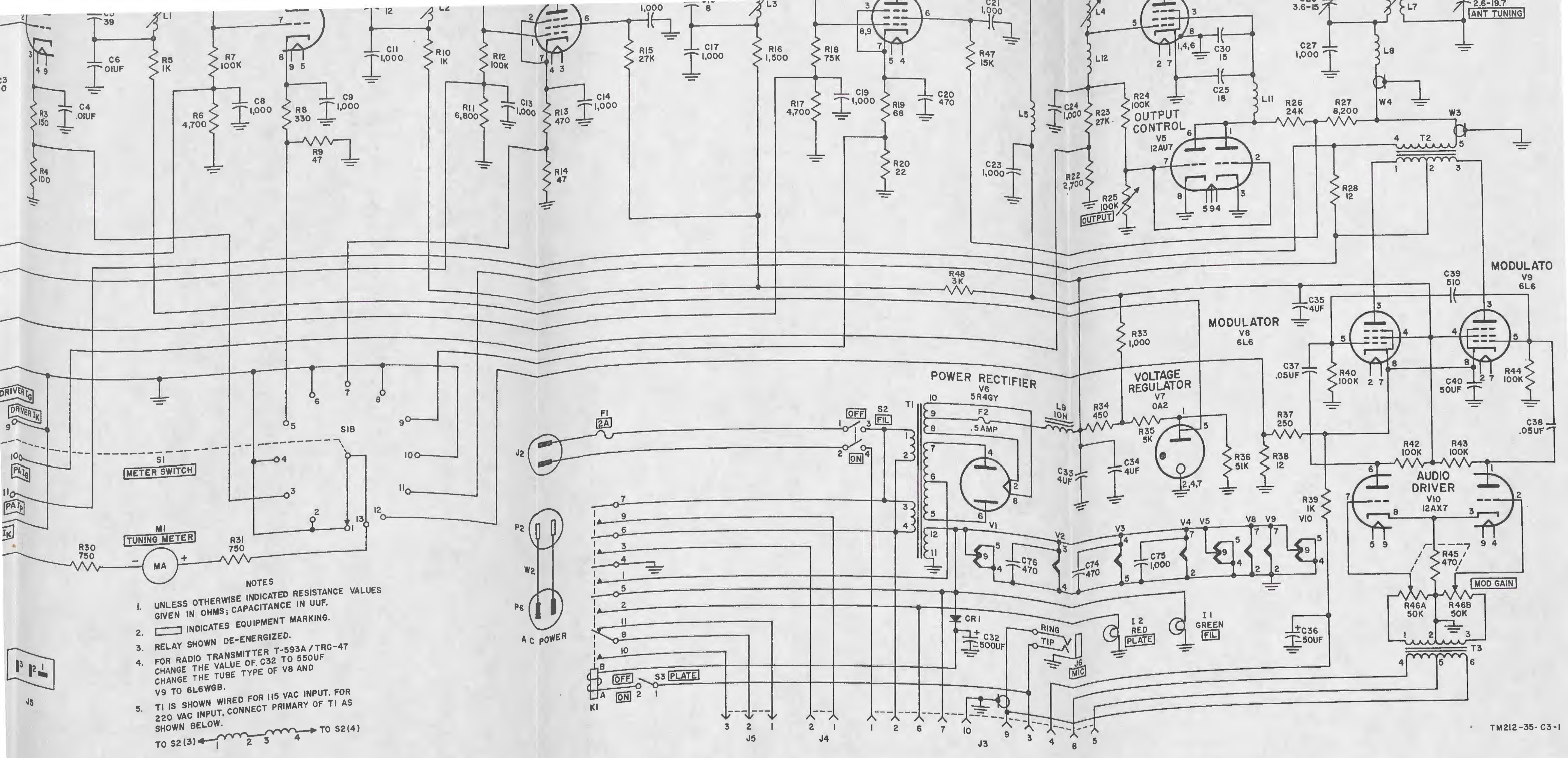

Figure 56. (Superseded) Radio Transmitter T-593(*)/TRC-47, schematic diagram.