# CHAPTER 1
# INTRODUCTION

## Section I. GENERAL

### 1. Scope

*a.* This manual contains field maintenance information for Radio Sets AN/PRC–9A and –10A (fig. 1). In addition, the theory of the equipment is presented. Installation, operation, and organizational maintenance instructions for this equipment are contained in TM 11–612, Radio Sets AN/PRC–8, –8A, –9, –9A, –10, and –10A, Operation and Organizational Maintenance.

*b.* Except for frequency differences, Radio Sets AN/PRC–9A and –10A are identical in structure, function, and circuit arrangement. Throughout the manual, with the above exception, both sets are treated as one. For detailed circuit differences, refer to the main schematic diagrams.

*c.* Forward comments on this manual directly to: Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N. J.

### 2. Forms and Records

*a. Unsatisfactory Equipment Reports.*

(1) DA Form 468 (Unsatisfactory Equipment Report) will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in AR 700–38.

(2) DD Form 535 (Unsatisfactory Report) will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in AR 700–38 and AF TO 00–35D–54.

*b. Damaged or Improper Shipment Report.* DD Form 6 (Report of Damaged or Improper Shipment) will be filled out and forwarded as prescribed in AR 700–58 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

*c. Preventive Maintenance Form.* DA Form 11–239 (Second and Third Echelon Maintenance Checklist for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) will be prepared in accordance with instructions on the back of the form (fig. 28).

## Section II. DESCRIPTION AND DATA

### 3. Description of Radio Set AN/PRC–9A or –10A

*a.* Radio Set AN/PRC–9A or –10A is a portable, low-power receiver-transmitter which provides voice communication over relatively short distances. It is battery-operated and carried by the operator. It may also be operated in an airplane or in a vehicular or semipermanent ground installation, in which case, Amplifier-Power Supply AM–598/U may be used to supply the power.

*b.* The receiver-transmitter and the battery are contained in two separate aluminum cases which are clamped together.

*c.* The receiver-transmitter case is clamped on top of the battery case, and the entire assembly is strapped to a carrying harness. The carrying harness is tied to belt suspenders, which when placed on an operator's back and properly adjusted to his combat belt, permits the radio set to be carried conveniently.

*d.* The receiver-transmitter case, which is of aluminum, fastens to the front panel to form a watertight inclosure. Each of the two cases has two spring clamps (fig. 2): Two clamps fasten the battery case to the receiver-transmitter case and the other two fasten the receiver-transmitter to

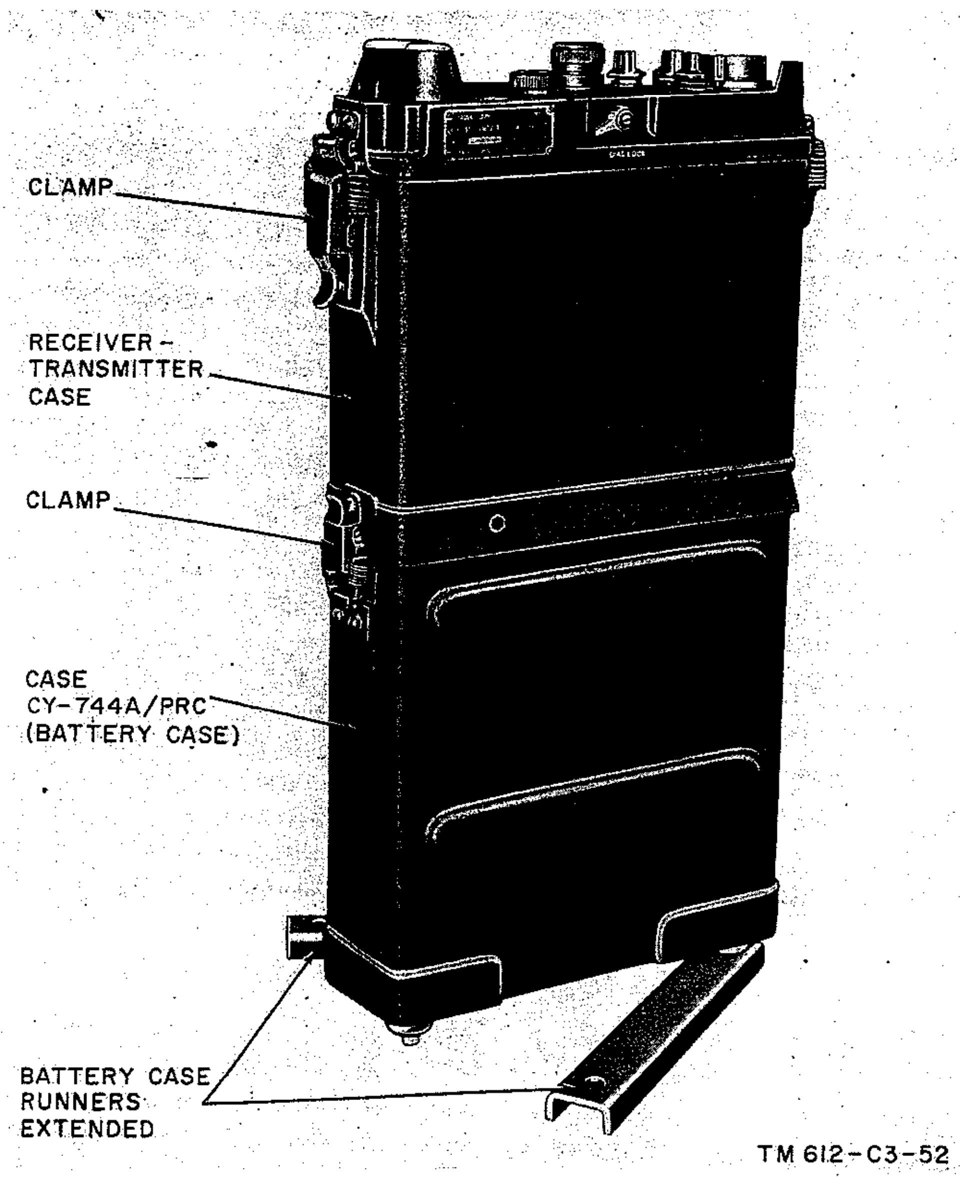



*Figure 2. Receiver-transmitter and battery cases connected.*

the receiver-transmitter case. A short eight-wire cable (fig. 29) (with a socket on one end, a battery plug on the other) is permanently mounted at the bottom of the case. The socket connects the receiver-transmitter to the battery when the receiver-transmitter chassis is slid into the case. A guide web, cast as part of the case, insures alignment of the receiver-transmitter plug and the case socket. The other connector is a battery plug on the free end of the cable. It plugs into the socket on the battery.

## 4. Technical Characteristics

*a. General.*

| | |
|---|---|
| Frequency range: | |
| Radio Set AN/PRC-9A. | 27 to 39 mc. |
| Radio Set AN/PRC-10A. | 38 to 55 mc. |
| Number of tubes | 14. |
| Type of modulation | Frequency modulation. |
| Type of transmission | Voice. |
| Power source: | |
| Man-pack | Battery BA-279/U (not supplied). |
| Vehicular | Amplifier-Power Supply AM-598/U (not supplied). |
| Types of antennas: | |
| Antenna AT-272A/PRC. | 3 feet long; demountable semirigid steel tape. |
| Antenna AT-271A/PRC. | 10 feet long; multisection whip type. |
| Tuning | Single calibrated dial continuously tunes both transmitter and reciever. |
| Calibration | Built-in calibrator provides 2.15-mc. calibration points throughout operating range. |
| Weight (man-pack) | 26 pounds (including components and battery). |

*b. Transmitter.*

| | |
|---|---|
| Power output: | |
| Radio Set AN/PRC-9A. | 1 watt. |
| Radio Set AN/PRC-10A. | .9 watt. |
| Oscillator | Electron-coupled Hartley, with automatic frequency control. |
| Microphone input impedance. | 150 ohms. |
| Distance range | 5 miles (may vary from 3 to 12 miles, depending on antenna used and siting conditions). |

*c. Receiver.*

| | |
|---|---|
| Type | Superheterodyne (single conversion). |
| Sensitivity | .7 microvolt with 1 mw. output, 15 kc. deviation, and a 12 db. signal-to-noise ratio. |
| Selectivity | 75 kc. at 6 db. down. |
| Output impedance | 600 ohms. |
| Type of reception | Frequency modulation. |
| Intermediate frequency | 4.3 mc. |

## 5. Common Name Versus Nomenclaure

| Nomenclature | Common name |
|---|---|
| Radio Sets AN/PRC-9A and -10A | Radio set. |
| Radio Receiver-Transmitters RT-175A/PRC-9 and RT-176A/PRC-10. | Receiver-transmitter. |
| Antenna AT-271A/PRC | Long antenna. |
| Antenna AT-272A/PRC | Short antenna. |
| Antenna Spring Section AB-129/PR | Spring section. |
| Amplifier-Power Supply AM-598/U | Vehicular power supply. |
| Bag CW-216A/PR | Carrying bag. |
| Battery BA-279/U | Battery. |
| Belt Suspenders M-1945 | Belt suspenders. |
| Carrying Harness ST-120A/PR | Harness. |
| Case CY-744A/PRC | Battery case. |
| Discriminator Transformer TF-204/U. | Discriminator can. |
| Handset H-33B/PT | Handset. |
| IF. Amplifier AM-427A/U | If. can. |
| Pulse-Sweep Generator O-325/U | Pulse-sweep generator. |

## 6. Radio Set Controls and Their Uses

All the operating controls of Radio Sets AN/PRC-9A and -10A, except the handset push-to-talk button, are located on or adjacent to the control panel of the radio sets (fig. 3). The following chart lists the controls and indicates their functions.

| Control | Function |
|---|---|
| POWER switch | In ON position, connects receiver-transmitter to power source.<br>In REMOTE position, connects receiver-transmitter to power source through the AUDIO receptacle and Control Group AN/GRA-6.<br>In CAL & DIAL LITE position, connects receiver-transmitter, calibration oscillator, and dial lamp to power source (spring-returned to ON when released). |
| TUNING | Tunes receiver and transmitter to desired frequency. |
| VOL | Adjusts the loudness of signals heard in the handset earphone. |
| SQUELCH | Sets the signal level below which noise is cut off when no signal is being received. Switch S2 operating in conjunction with R35 stops squelch operation when the SQUELCH knob is in the OFF position. |
| AUDIO | A 10-prong receptacle providing external connections for the handset, remote control, or relay cable. |
| LONG ANT | Screw-type jack to mount and connect the long antenna to the radio set. |
| SHORT ANT | Screw-type jack to mount and connect the short antenna to the radio set. |
| AUX ANT | Bayonet-type jack to connect coaxial line from the homing or auxiliary antennas (not supplied) to the radio set. |
| LITE CAP | Cap holds dial lamp E8 in place. Permits rapid change of dial lamp without removing receiver-transmitter from case. |
| POINTER ADJUST knob | Varies position of pointer on TUNING dial to provide accurate dial frequency calibration. |
| DIAL LOCK | Locks TUNING control so that operating frequency cannot be changed accidentally. |
| Push-to-talk button | When pressed, puts radio set in transmit condition. |

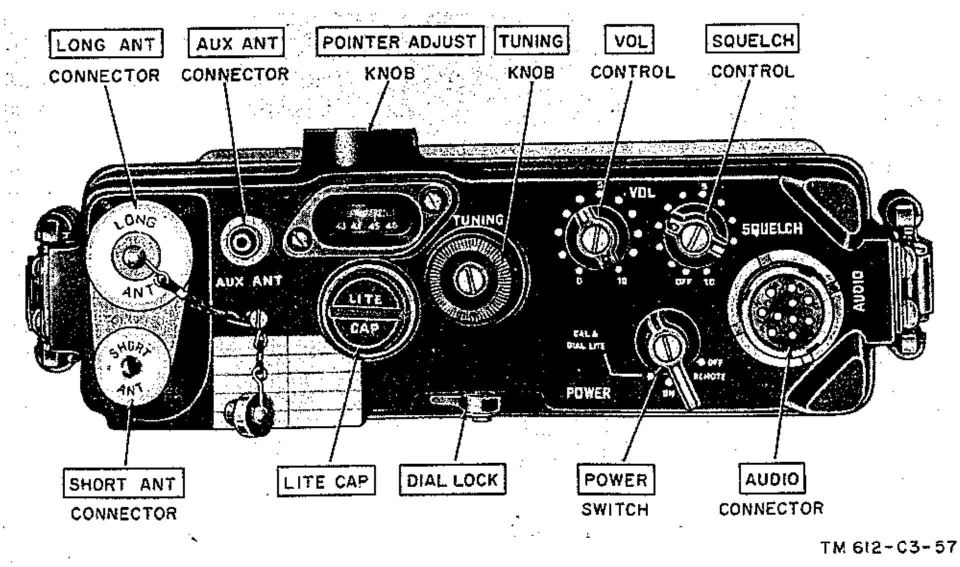



*Figure 3. Radio set control panel.*

# CHAPTER 2

# THEORY

## Section I. BLOCK DIAGRAM

### 7. General

Radio sets AN/PRC–9A and –10A consist of a battery (not supplied with the sets), a long or short antenna, and a receiver-transmitter. The receiver-transmitter includes an fm receiver, an fm transmitter, and a calibration circuit. The block diagram (fig. 4) shows the signal paths for each of these circuits.

### 8. Receiver Signal Path

(fig. 4)

A frequency-modulated (fm) signal picked up by the antenna in use is applied to first radiofrequency (rf) amplifier stage V4. The signal is further amplified by second rf amplifier V5 and applied to mixer stage V6. The incoming rf signal and the receiver oscillator signal heterodyne (beat together) in mixer stage V6 to produce an intermediate frequency (if.) of 4.3 megacycles (mc). This if. signal is amplified by the four if. amplifier stages (V101). These stages are contained in sealed cans V101 through V104 (fig. 32). The output of the fourth if. is at a constant amplitude and is fed to discriminator circuit T101 which converts if. signals to audio signals. The audio signals are amplified by audio amplifier V7 and are applied to the earphone of the handset.

A squelch circuit, which can be turned on or off, is used with the receiver. This circuit prevents tube and background noises from reaching the handset during intervals when no signal is reaching the receiver.

### 9. Transmitter Signal Path

(fig. 4)

*a.* Voice signals from the microphone of the handset (push-to-talk button in) are fed directly modulator stage V2. Here they are amplified and then applied to the transmitter oscillator circuit to vary its output frequency (fm). The transmitter oscillator output is applied through the antenna circuit to one of three antennas that may be used with the radio set.

*b.* Transmitter oscillator V3 is tuned from the control panel to operate at a frequency of 4.3 mc below that of the receiver oscillator. A portion of the transmitter oscillator output beats with receiver oscillator V8 in mixer stage V6. When the transmitter oscillator is on frequency, the mixer output is exactly 4.3 mc. This beat frequency is fed through the if. stages to the discriminator, which controls the transmitter oscillator frequency. When the mixed if. signal is exactly at 4.3 mc, the transmitter oscillator is locked in at its assigned frequency.

*c.* When the transmitter oscillator is off frequency, the mixer if. signal is either above or below 4.3 mc. This causes a frequency control voltage to be developed in the discriminator, which changes the bias of modulator tube V2. The plate current of the modulator tube therefore changes and causes the transmitter oscillator frequency to change in a direction opposite to its drift. Because of this automatic frequency control (afc) the transmitter oscillator frequency is constantly controlled at a frequency of 4.3 mc lower than that of the receiver oscillator frequency circuit. Further correction of the transmitter oscillator frequency is provided by a pulse-sweep generator circuit which operates whenever the frequency is beyond the control of the discriminator (about 80 kilocycles (kc) deviation) (as, for example, when the equipment is initially turned on). When the pulse-sweep generator operates, a low-frequency putt-putt sound can be heard in the earphone of the handset. This circuit very slowly varies the

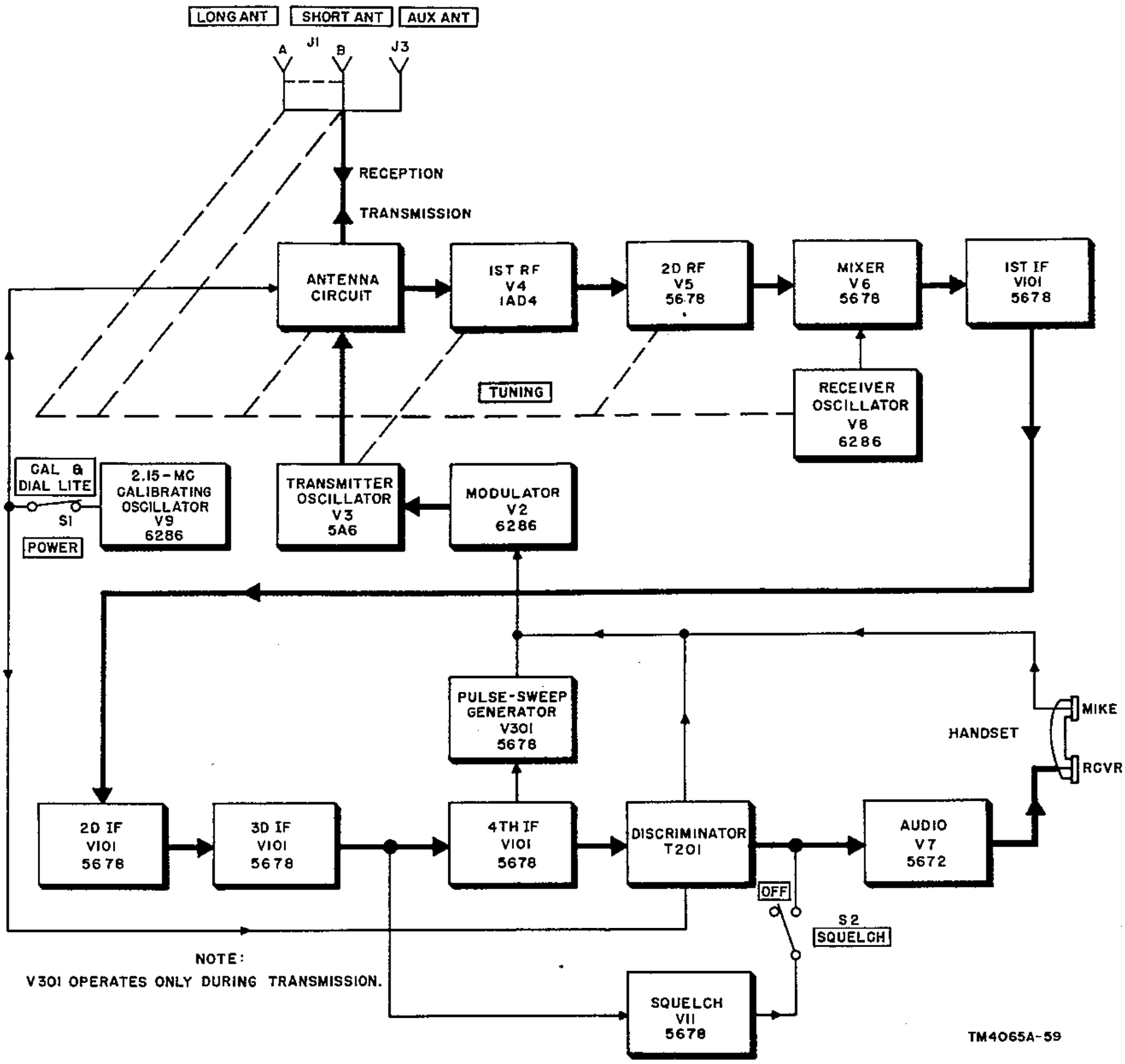



*Figure 4. Radio sets AN/PRC-9A and -10A receiver-transmitter, block diagram.*

transmitter oscillator frequency up to about 750 kc below and above the center frequency, until the transmitter frequency comes within range of the discriminator. The discriminator then takes over control and the pulse-sweep generator operation ends.

## 10. Calibration Signal Path

*a.* The 2.15-mc calibrating oscillator (V9) is a crystal-controlled oscillator used to aline the receiver-transmitter. Harmonics of the 2.15-mc calibrating oscillator are coupled to the rf and mixer circuits when POWER switch S1 is held in the CAL & DIAL LITE position (fig. 3). For example, if the receiver is tuned to a red-marked indication on the dial, such as 51.6 mc (or 35.6 mc on the AN/PRC-9A), the twenty-fourth harmonic of the 2.15-mc calibrating oscillator is picked up in the antenna circuit of the receiver. This 51.6-mc signal, after amplification in the receiver rf stages, beats with the receiver oscillator signal to produce an if. output from the mixer tube. The output is at 4.3 mc, or slightly off this frequency if the receiver is not correctly alined.

This signal is amplified through the four if. stages and applied to discriminator stage T201.

*b.* The output of 2.15-mc calibrating oscillator V9 is also fed into the discriminator circuit. Here its second harmonic frequency of 4.3 mc mixes with the incoming if. signal received through the if. stages. The beat frequency of these two signals is passed through audio amplifier V7 to the earphone of the handset. If the radio receiver is correctly alined, the incoming if. signal will be at exactly 4.3 mc, and a zero beat results. However, if the radio receiver is not correctly tuned, the receiver oscillator frequency will not be 4.3 mc above the rf frequency to which the TUNING dial is set and the incoming if. signal will be slightly off 4.3 mc. Hence when it beats with the 4.3-mc signal from the calibrating oscillator, an audio beat will result and be heard in the earphone of the handset.

*c.* If the rf and receiver oscillator tuned circuits are then varied slightly by means of the TUNING control a zero beat is obtained in the handset. The dial of the receiver is now slightly off 51.6 mc because of the TUNING control adjustment. Alinement of the receiver is accomplished by mechanically setting the dial pointer exactly on the 51.6-mc calibration point on the dial. This calibration insures that the receiver oscillator frequency is exactly 4.3 mc above the frequency shown on the dial of the receiver-transmitter and that the dial reading is correct. It also insures the accuracy of the transmitter frequency which is controlled with reference to that of the receiver oscillator.

## Section II. RECEIVER STAGES

### 11. Antenna Circuit

(fig. 5)

*a.* The antenna circuit is used for both transmitting and receiving. Any one of four antennas can be used. The long whip antenna (AT–271A/PRC) plugs into the LONG ANT connector J1A. Its circuit is tuned by coil L6 and adjusted by variable capacitor C12 (C12 is ganged with main TUNING capacitor C9). The short antenna (AT–272A/PRC) plugs into SHORT ANT connector J1B, and is tuned by coil L7 (L7 is also ganged with C9). An auxiliary antenna (TM11–612, par 11*d.*) plugs into AUX ANT connector J3. A homing antenna may also be plugged into the AUX ANT connector J3. When the long antenna is plugged into the LONG ANT connector J1A, a shorting strap on the plug of the long antenna connects C12 and L6. The signal picked-

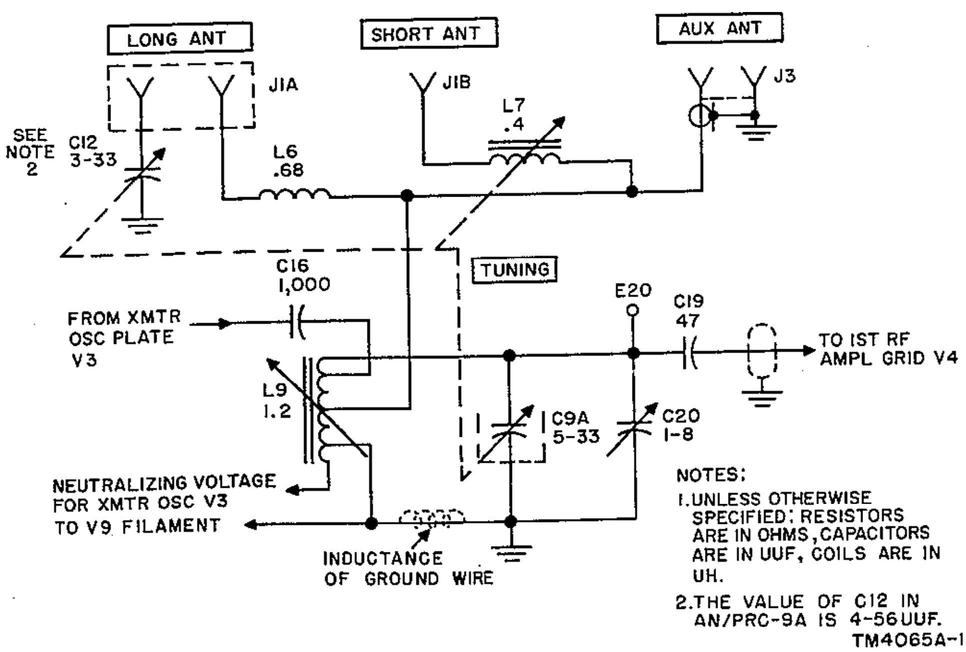



*Figure 5. Antenna circuit.*

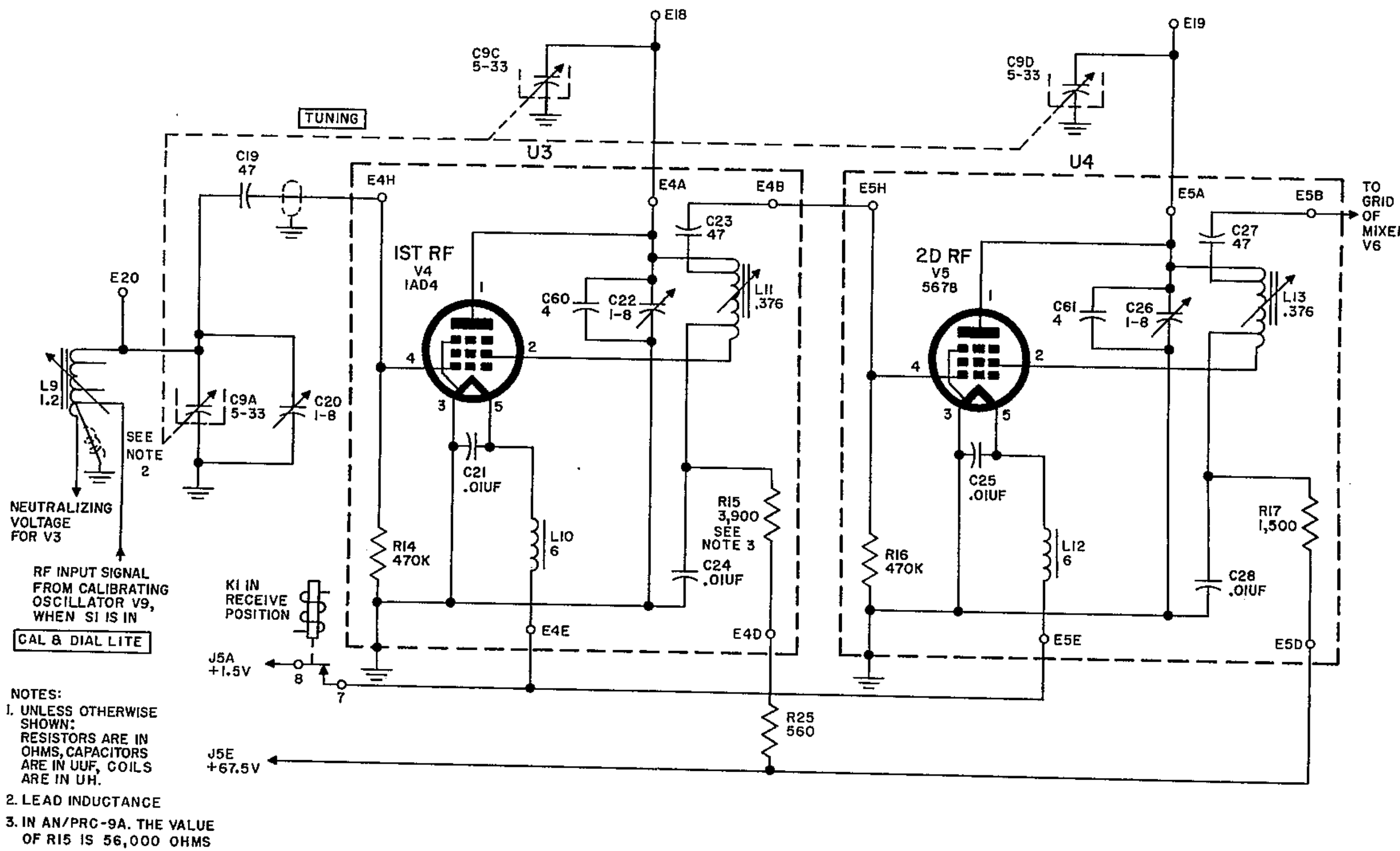



*Figure 6. First and second rf amplifiers V4 and V5, schematic diagram.*

up in the antenna is resonated in antenna coil L9. This coil, which fuctions as the plate coil of the transmitter oscillator and the grid coil of the first rf amplifier, is tuned by capacitor C9A, a section of the main TUNING capacitor. Capacitor C20 is a trimmer for high frequency (hf) tracking at the high end of the dial, and the adjustable iron core of antenna coil L9 provides low frequency (lf) tracking at the low end of the dial. Capacitor C19 couples the rf signal from the antenna coil to the grid of first rf amplifier V4.

*b.* The filament of 2.15-mc calibration oscillator V9 is returned to ground through the tap on antenna coil L9. Sufficient rf coupling exists between the coil and the grounding wire at the coil tap to couple the calibration signal and its harmonics inductively into the antenna coil. This signal can then be coupled into first rf stage V4 through C19.

## 12. First and Second Rf Amplifiers V4 and V5

(fig. 6)

*a. First Rf Amplifier.* The signal from the antenna circuit is applied through coupling capacitor C19 to the control grid of first rf amplifier V4, a pentode type 1AD4. The signal is amplified by V4 and is then fed through coupling capacitor C23 to the grid of second rf amplifier V5.

(1) Grid resistor R14 provides a dc return to ground. The plate tank circuit consists of C9C, C22, and C60 in parallel with L11. Capacitor C9C is a section of the TUNING capacitor. Coil L11 is adjustable for alinement of the rf amplifier at the low end of the dial. Capacitor C22 is adjustable for alinement at the high end of the dial. Capacitor C60, in parallel with C22, has a negative temperature coefficient. When changes in temperature occur, the value of L11 changes. The value of C60, however, changes in the opposite direction from that of L11 to minimize changes in the resonant frequency of the plate tank circuit. The rf signal is returned to ground through C24 from a tap on L11. The screen grid is connected to the opposite end of L11 from that of the plate to put an rf voltage at the screen that is opposite in polarity to that of the plate. This provides a negative feedback voltage that prevents oscillation of the amplifier.

(2) B+ is applied to the plate and screen through R25 and R15. Resistor R15 and capacitor C24 form a decoupling filter that isolates the B+ supply from rf voltages. Filament voltage is applied through contacts 8 and 7 of receive-transmit relay K1, in series with the rf choke L10 and V4 filament to ground. Capacitor C21 bypasses the filament for rf. Contacts 8 and 7 of K1 are open when the radio set is in the transmit condition, and are closed during reception. Consesequently the first rf stage, as well as second stage V5, operates only when the radio set is in the receive condition.

*b. Second Rf Amplifier.* The output signal from the plate circuit of V4 is applied through coupling capacitor C23 to the control grid of second rf amplifier V5. This tube, a pentode type 5678, amplifies the signal and feeds it through coupling capacitor C27 to the input circuit of mixer V6. The design of the second rf amplifier is basically the same as that of the first rf amplifier. B+ is applied to the plate and screen through R17. A decoupling filter formed by R17 and C28 isolates the B+ supply from rf voltages. Filament voltage is applied through contacts 8 and 7 of receive-transmit relay K1, in series with rf choke L12 and V5 filament to ground in the same manner that it is applied to first rf amplifier V4. The stage is therefore operative only when the radio set is in the receive condition.

## 13. Receiver Oscillator V8

(fig. 7)

*a.* The receiver oscillator supplies a signal 4.3 mc higher than the incoming frequency. During reception, the receiver oscillator signal beats with the incoming rf signal to produce the required if. signal. During transmission, the receiver oscillator signal beats with a portion of the transmitter oscillator signal that is coupled to the mixer, by capacitive coupling through C19 and the first and second if. stages, to produce a frequency control signal.

*b.* The receiver oscillator is a triode type 6286. The circuit is a series-fed Hartly oscillator in which plate-to-grid feedback occurs across L21. The rf feedback path is from the plate of the tube through C46 to ground and the lower portion of L21 to the cathode. The voltage in the plate (lower) section of L21 induces a voltage in the

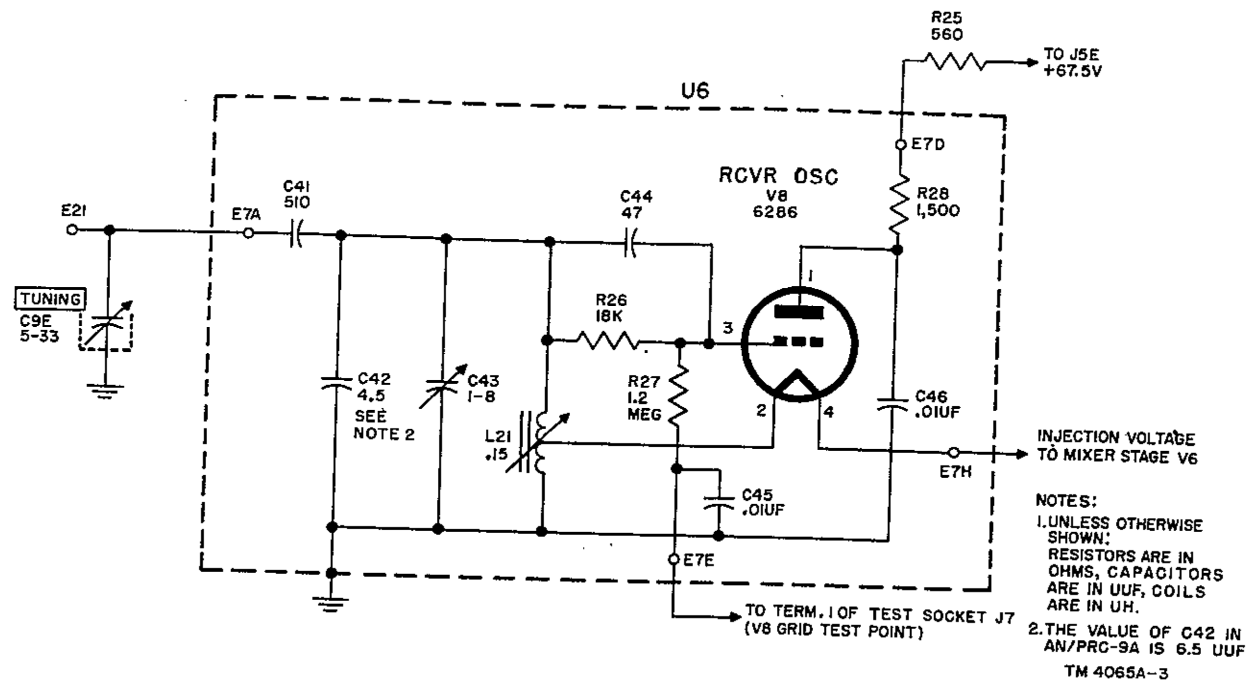



*Figure 7. Receiver oscillator V8, schematic diagram.*

grid (upper) section of the coil. The grid circuit extends from the grid (pin 3) through the parallel capacitor, resistor combination C44 and R26, and through the upper section of L21 to the cathode. The tuned circuit consists essentially of L21 in parallel with TUNING capacitor C9E. Capacitor C41 is a padder in series with C9E to provide better tracking. Capacitor C43 is a variable trimmer and C42 is for temperature compensation. The core of L21 is adjustable for alinement of the receiver osillator at the low end of the dial; C43 is adjustable for alinement at the high frequency end of the dial.

*c.* A portion of the receiver oscillator voltage is applied from the filament of V8 to the mixer stage. Filament power is applied to the receiver oscillator from the mixer filament circuit. B+ power is applied to the plate of V8 through R25 and decoupling resistor R28. Resistor R27 and capacitor C45 form a decoupling filter between the grid and a test point at terminal 1 of test socket J7. More current is drawn from the battery during transmit operation of the radio set, than during receive operation. Consequently the plate voltage supply to the receiver oscillator would differ, and would affect the frequency. To offset this change in voltage, resistor R25 is included in the B+ supply circuit.

## 14. Mixer V6

(fig. 8)

*a.* A signal is applied to the control grid of the mixer from the output of second rf amplifier V5 at the same time that a signal 4.3 mc higher than the incoming signal is applied to the filament from receiver oscillator V8. These two signals beat in the mixer to produce a frequency of 4.3 mc. The output of the mixer is tuned to this frequency which is called the *intermediate frequency* (if.). All frequencies outside of this if. band are rejected.

*b.* The output from second rf amplifier V5 is applied to the control grid (pin 4) of mixer V6, a pentode type 5678. Resistor R18 is the grid-leak bias resistor. The signal from the receiver oscillator (4.3 mc higher than the signal from the second rf amplifier) is applied across L16. Coil L16 is returned to ground through C29. A portion of the voltage across L16 is applied to the cathode of V6. The beating (mixing) of the rf signal (injected at the control grid) and the receiver oscillator signal (injected at the filament) produces an intermediate frequency of 4.3 mc in the plate circuit. The plate circuit consists of C30 and the primary of T2. This is a parallel circuit which is tuned to resonance at 4.3 mc. The voltage developed in this circuit is passed through

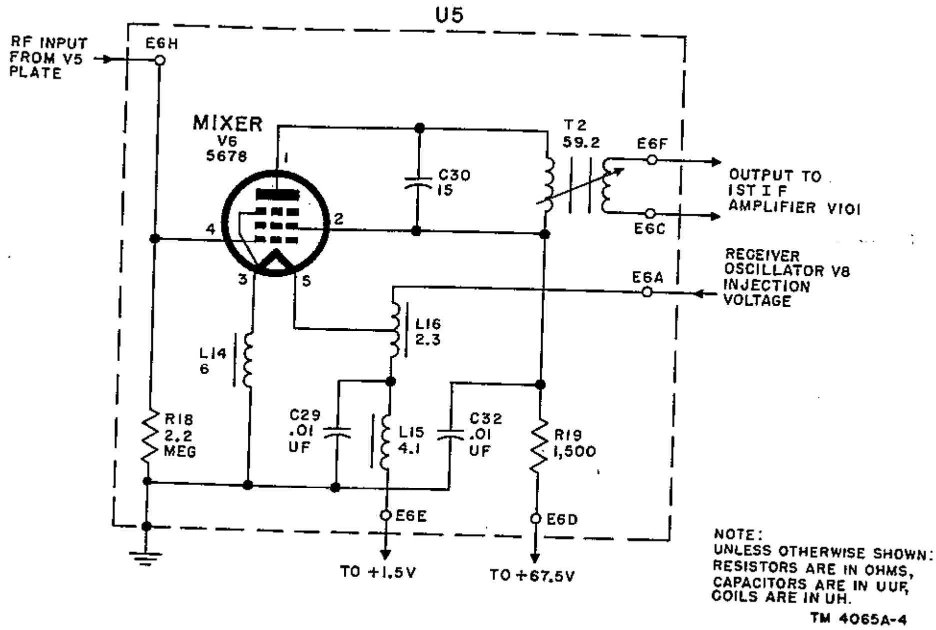



*Figure 8. Mixer V6, schematic diagram.*

transformer T2 to the grid circuit of first if. amplifier V101.

*c.* Filament voltage is applied to the filament through L15 and a portion of L16. Filter C29 and L15 decouple the direct current (dc) filament supply from rf voltages. Coil L14 keeps the filament above rf ground. B+ voltage is applied through R19 to the screen (pin 2) and through the primary of T2 to the plate (pin 1) of the tube. Resistor R19 and capacitor C32 form a B+ decoupling filter.

## 15. First, Second, Third, and Fourth If. Amplifiers V101

(fig. 9)

*a.* There are four if. amplifier stages in the receiver. These are all identical and have the same reference symbol, V101. Each stage is a hermetically sealed plug-in can. The reference symbols for these cans are U101, U102, U103, and U104. The four cans plug into sockets X7, X8, X9, and X10 and are identical as to components and com-

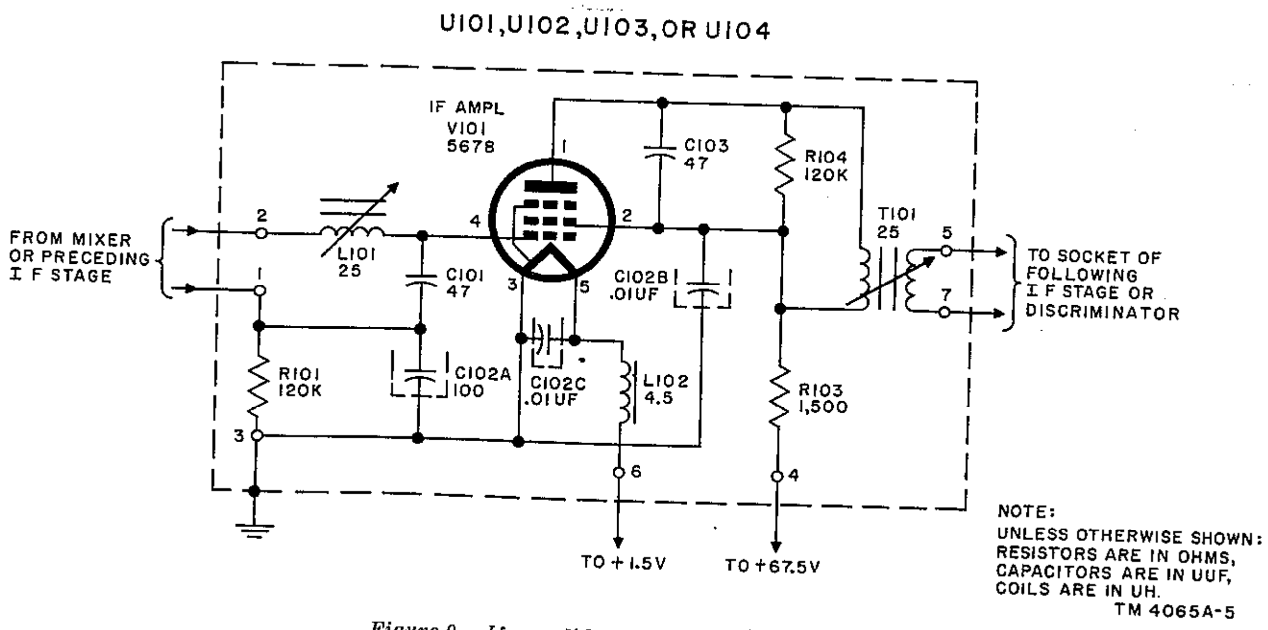



*Figure 9. If. amplifier V101, schematic diagram.*

ponent reference symbols. Therefore, a description of one of these stages covers all four if. stages.

*b.* The input signal is applied across terminals 1 and 2 of the can (not the tube) from the secondary of the transformer of the previous stage (either mixer V6 or another if. amplifier V101). The transformer secondary forms a series tuned circuit with L101 and C101. The circuit is resonant at 4.3 mc. The voltage across C101 is applied to the control grid of V101. The if. return to ground from C101 is through C102A. The dc return to ground is through R101. In each succeeding if. stage, the signal level is greater and the grid bias voltage developed across R101 is greater. At the third and fourth if. amplifiers, this bias voltage, together with the relatively low plate voltage, produces limiting action. This clips the positive and negative peaks from signals which exceed a certain amplitude and applies a signal of constant amplitude to the discriminator stage.

*c.* The plate tuned circuit, consisting of C103 and the primary of T101, is resonant at 4.3 mc. Resistor R104, across this tuned circuit, broadens its response to the desired band width (approximately 100 kc). The output signal is passed through T101 to the next stage. The tuned circuit is alined to 4.3 mc by an adjustment of the powdered shell of transformer T101.

*d.* The 67.5-volt supply is applied to the plate through decoupling resistor R103 and the primary of T101. Voltage is applied to the screen from the top of R103. Screen rf is bypassed to ground through capacitor C102B. The 1.5-volt supply is applied to the filament through L102. Capacitor C102C and coil L102 form an rf filter to bypass filament rf to ground.

*e.* Choke coil L17 (fig. 57) prevents any unfiltered rf of the third and fourth if. stages from getting into the dc supply circuit. Bypass capacitor C33 helps prevent regeneration. Resistor R23 is an rf filter in the bias lead from the fourth if. stage to the squelch grid. Resistor R20 is a dropping resistor in the plate circuit of the third if. to limit its gain. Resistor R22 is an additional voltage dropping resistor in the plate circuit of the fourth if. stage for greater limiting action. Resistor R21 shunts the grid resistor of this same stage, to permit its operation as a multivibrator in conjunction with pulse-sweep generator stage V301.

## 16. Receiver Discriminator T201

(figs. 10 and 11)

*a. Discriminator Function.* Receiver discriminator T201 converts fm signals into audio signals. When a voltage at the if. center frequency (4.3 mc) is applied to the discriminator, the discriminator output is zero. When the input voltage is below this frequency, the discriminator output is a positive voltage; when the input voltage is above this frequency, the discriminator output is a negative voltage. Since the if. signal applied to the discriminator is fm, its frequency deviates below and above the if. center frequency. On each of these deviations, the discriminator output is alternately positive and negative. The amount of frequency deviation determines the magnitude of the discriminator output voltage (fig. 10). Since these deviations occur at an audiofrequency, the discriminator output voltage varies at an audio rate. The discriminator output is, therefore, an audio signal whose amplitude corresponds to the frequency deviation of the fm signal.

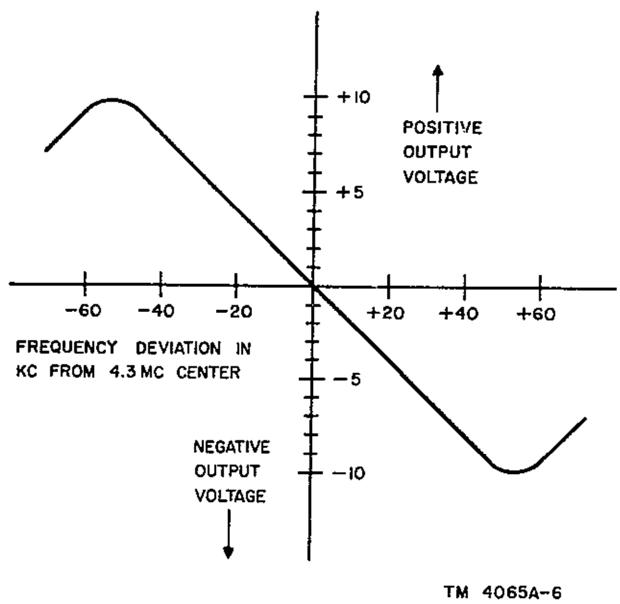



*Figure 10. Discriminator frequency response curve.*

*b. Circuit Arrangement.* The input to the discriminator is applied across transformer T202 (fig. 11). The secondary of this transformer in series with capacitor C202 is resonant at the intermediate frequency; thus maximum voltage develops across capacitor C202. The voltage across capacitor C202 is fed through coupling capacitor C203 to the center tap of coil L202. Capacitor

C205 is resonant with coil L202 at the intermediate frequency. Capacitor C204 produces a phase shift which unbalances the network for frequencies above and below the center if. Germanium crystals CR201 and CR202 rectify the if. and develop dc voltages across load resistors R201 and R202, respectively. Capacitor C206 bypasses the if. across these resistors, and C207 returns these frequencies to ground. Resistor R24 and tals. Therefore, a greater dc voltage is developed across resistor R201 than across resistor R202 for frequencies above the if., while a greater dc voltage is developed across resistor R202 for frequencies below the if. The difference between these two voltages is the output voltage of the discriminator.

*d. Discriminator Afc Operation.* In addition to demodulating received fm signals, the discrimi-

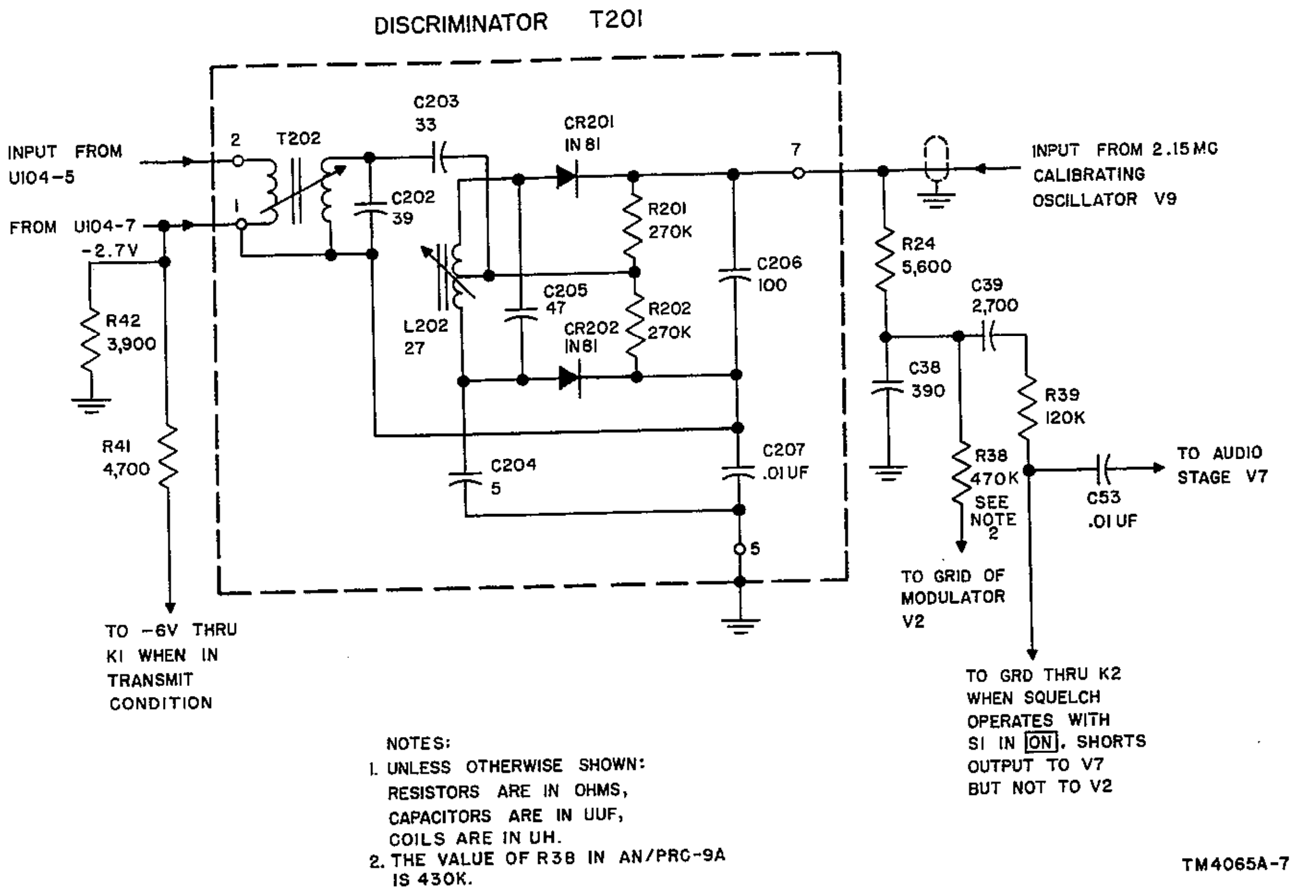



*Figure 11. Discriminator T201, schematic diagram.*

capacitor C38 form a deemphasis network which attenuates the high audiofrequencies.

*c. Discriminator Operation.* Frequencies above the if. apply a greater voltage across crystal rectifier CR201 than across crystal rectifier CR202. Frequencies below the if. apply a greater voltage across crystal rectifier CR202 than across rectifier CR201. The difference in voltage across the two crystals is proportional to the deviation above or below the if. center frequency. The dc current through resistors R201 and R202 is proportional to the if. voltage applied to their respective crystals.

nator provides an afc voltage for the transmitter. When the radio set is in transmit operation (relay k1 energized), negative bias voltage is applied to the low side of load resistor R202 through the input pin 1. This voltage, approximately of −2.7 volts, is developed at the junction of voltage-dividing resistors R41 and R42. The if. signal voltage coming through the receiver (as a result of the transmitter oscillation being picked-up in the receiver and converted to if. in the mixer) is fed into the discriminator. The deviation of this if. signal from the center frequency of 4.3 mc

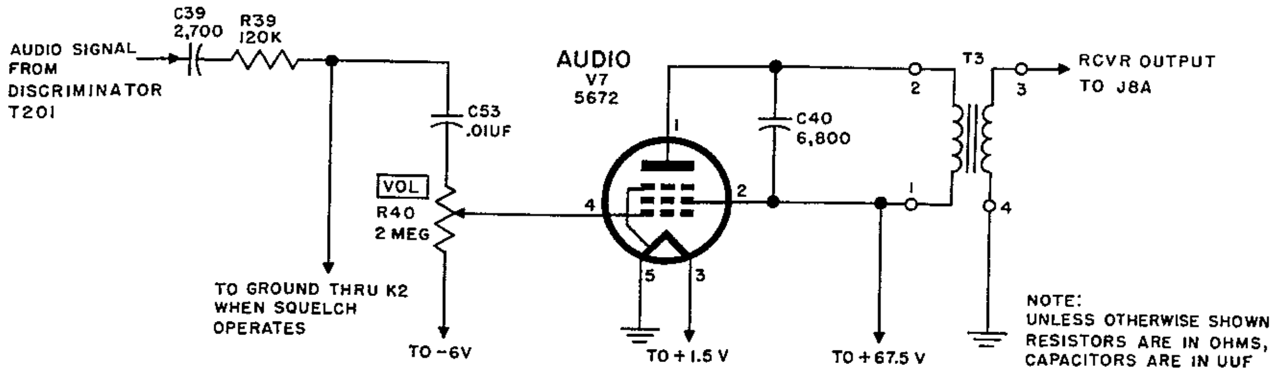



*Figure 12. Audio amplifier V7, schematic diagram.*

develops a discriminator output dc voltage. This voltage, however, is centered about the −2.7-volt level set by the negative input bias, instead of near ground potential as in receive operation. The correction control voltage is applied through resistor R38 to the grid of modulator tube V2. When the transmitter frequency is beyond the control range of the discriminator afc correction voltage, the fourth if. stage V101 operates in conjunction with pulse-sweep generator stage V301 as a slow cycling multivibrator. The discriminator stage is then practically unaffected by the rectangular wave form appearing at its input terminals. However, the 2.7-volt negative bias connected to its input pin 1, is still applied to the grid of modulator tube V2. The frequency control circuits of the transmitter are described in paragraph 23.

## 17. Audio Amplifier V7

(fig. 12)

The audio signal from the discriminator is fed through capacitor C39, resistor R39, capacitor C53 to resistor R40, the VOL control, which regulates the loudness of the sound in the handset receiver. From the arm of the VOL control, the audio signal goes to the grid, pin 4, of audio amplifier V7. Grid bias for this tube is provided by a connection from resistor R40 to the −6-volt bias supply. The audio output of the stage is coupled to the handset receiver through an impedance matching transformer T3, and a connection through AUDIO jack J8A on the control panel. Capacitor C40 assists in flattening the audio response curve by attenuating the higher frequencies more than the lower frequencies. Capacitor C39 is inserted in the input circuit between coupling capacitor C53 and the discriminator output, so that the squelch circuit may ground the audio input to V7 without affecting the discriminator afc voltage when in transmit operation. Resistor R39 is included in the circuit so that in retransmission operation, when the squelch circuit is inoperative, audio fidelity of the circuit is improved.

## 18. Squelch Circuit V11

(fig. 13)

*a.* Squelch circuit V11, when in use, grounds the discriminator output fed to audio stage V7. This prevents random noise from being heard in the handset receiver when no signals are being received. The squelch circuit may be turned ON or OFF manually by means of the SQUELCH control on the control panel.

*b.* Switch S2, ganged to the SQUELCH control, controls the squelch circuit by opening or closing the filament circuit of tube V11. This switch is open when the SQUELCH control is in the extreme counterclockwise (OFF) position and closed when the SQUELCH control is turned to the ON position. SQUELCH control R35 sets the operating point by adjusting the bias voltage for the control grid, pin 4, of the tube. This bias voltage can be either negative or positive, since the voltage-dividing network consisting of SQUELCH control R35 and resistor R36 is connected between the B+67.5 and −6-volt power supplies. Resistor R37 is an isolating resistor, which permits the fourth if. stage to bias the squelch tube when signals are being received.

*c.* The plate current of the tube operates relay K2. When the tube conducts, the relay is energized and shorts the output voltage from the discriminator to ground through contacts 3 and 4 of the relay. When a signal is received, the tube is biased to cutoff, thereby releasing the relay and permitting the signal to be heard in the handset

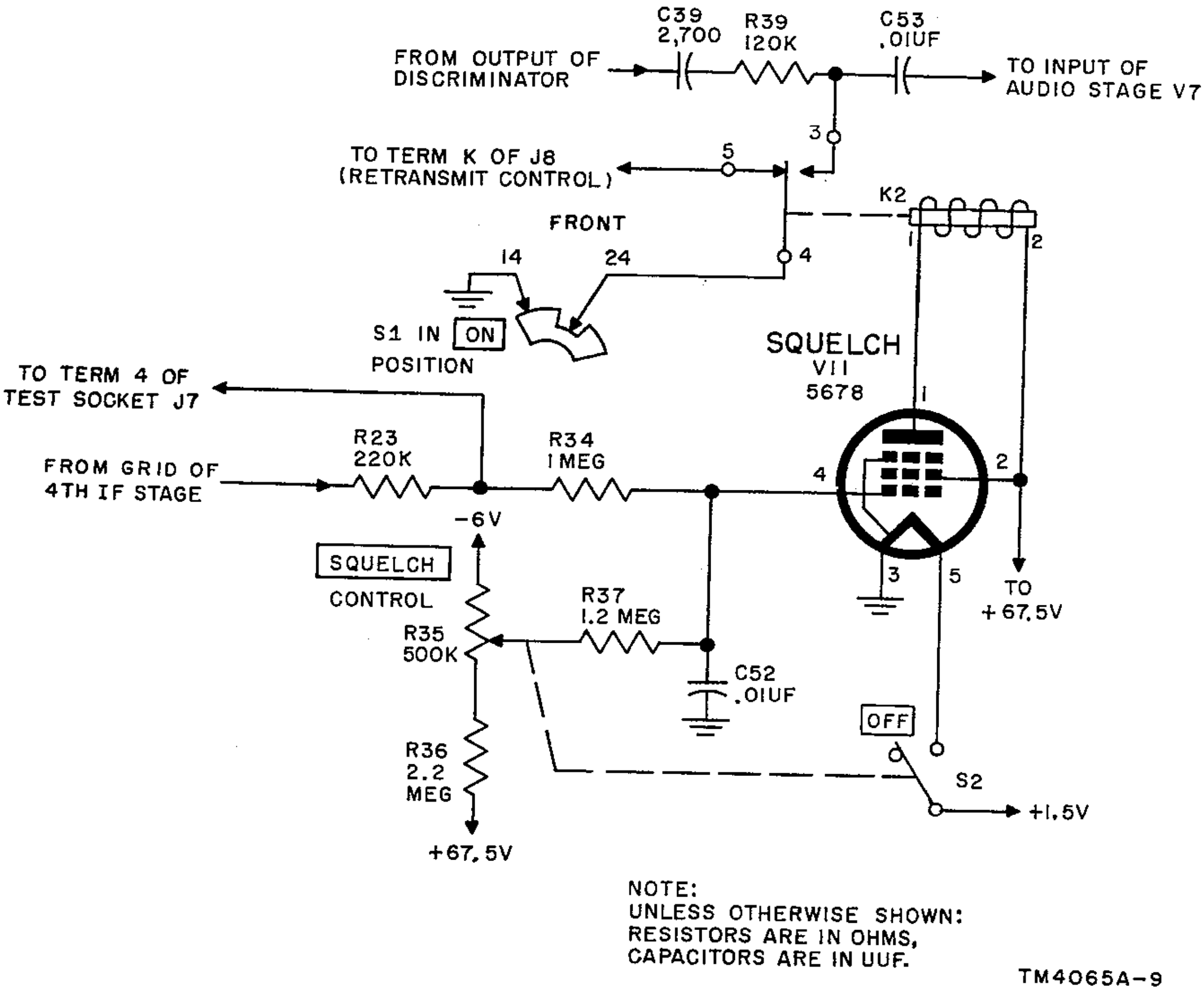



*Figure 13. Squelch circuit V11.*

receiver. Closed contacts 4 and 5 of relay K2 (in the released condition) complete a 6-volt circuit that is used in relay operation (fig. 26). Resistor R23 is an rf filtering resistor, and R34 is an impedance matching resistor. Capacitor C52 is an audio filter, preventing noise and spurious voltages from developing on V11. The connection to test socket jack J7–4 is for troubleshooting and alinement purposes.

## 19. The 2.15-mc Calibrating Oscillator V9
(fig. 14)

*a.* The 2.15-mc calibrating oscillator, tube V9, is a modified Pierce crystal oscillator. It receives its plate voltage through resistor R32 which isolates the plate rf signal from the B+ supply. Capacitor C48 couples the excitation feedback to the crystal, maintaining oscillation. The series arrangement of capacitors C47 and C49 provides the proper loading across the crystal for optimum crystal frequency. Capacitor C50 is the output coupling capacitor. The 2.15-mc crystal Y1, controls the oscillator frequency. Resistor R31 is the grid leak. Iron-core inductor L22 prevents rf voltages from entering or leaving by the positive filament lead. A direct connection couples the calibrating oscillator output from the filament of tube V9 through the ground tap on antenna coil L9 to the first rf amplifier stage. Rf harmonics of the oscillator are amplified in the rf stages and converted to 4.3-mc by the receiver oscillator and mixer stages. These harmonic frequencies provide beat notes at every calibrating point (designated by a red marker) on the tuning dial.

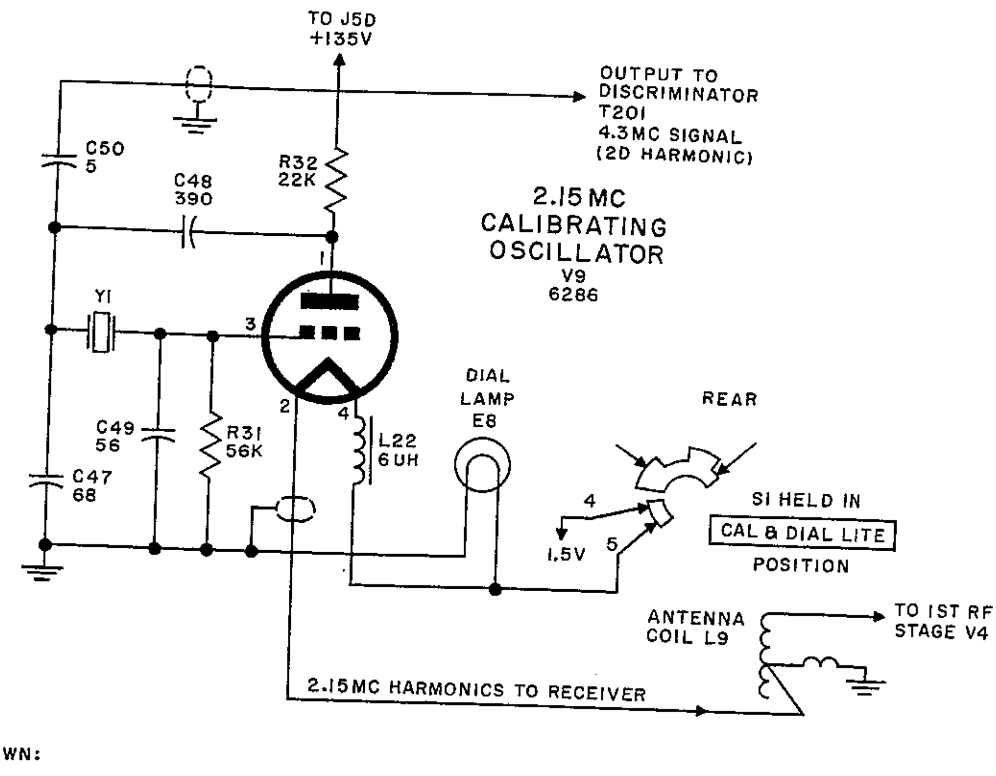



*Figure 14. The 2.15-mc calibrating oscillator (V9), schematic diagram.*

*b.* The dial lamp illuminates the dial for tuning and pointer adjustment during calibration. For this reason, it is turned on only when POWER switch S1 is in the CAL & DIAL LITE position. Dial lamp E8 is held in its socket by the LITE CAP on the front panel. The lamp power is obtained from the filament circuit of calibrating oscillator V9.

## 20. Pulse-Sweep Generator V301
(fig. 15)

*a. Function.* Pulse-sweep generator stage V301 operates with the fourth if. amplifier stage V101 as a multivibrator to locate the transmitter center frequency and place it within control of the afc circuit. This normally takes 1 or 2 seconds. The pulse-sweep generator stage then becomes inoperative and the fourth if. stage functions as a grid-limiting amplifier. The pulse-sweep generator circuit operates only in the transmit condition of the radio set, because in receive operation the filament voltage to V301 is disconnected by relay K1.

*b. Circuit Operation.* When the radio set is initially turned on for transmission, the following occurs.

(1) Filament voltage is connected to V301, and the tube begins to conduct. The drop in voltage occurring at the plate of V301 is coupled through R301 and C301 back to the grid circuit of V101 (in U104), and keeps this stage cut off. However, as the negative charge leaks off C301 through R101 and R21 (fig. 19), the first stage (V101 in U104) of the multivibrator circuit begins to conduct. The drop in voltage occurring in the plate circuit of this stage is coupled back through C302 to the grid of V301, and cuts off V301 to complete the multivibrator cycle. The cycle repeats when the negative charge leaks off C302 (through R303, R302, R21, and R101) and V301 again begins to conduct. The repetition frequency is very slow, approximately 5 cycles per second. Usually, after a second or two, the transmitter oscillator is sufficiently stabilized and operating at its correct center frequency. An afc signal will then be coming through the if. stages and, when this signal gets to develop approximately 8 volts of nega-

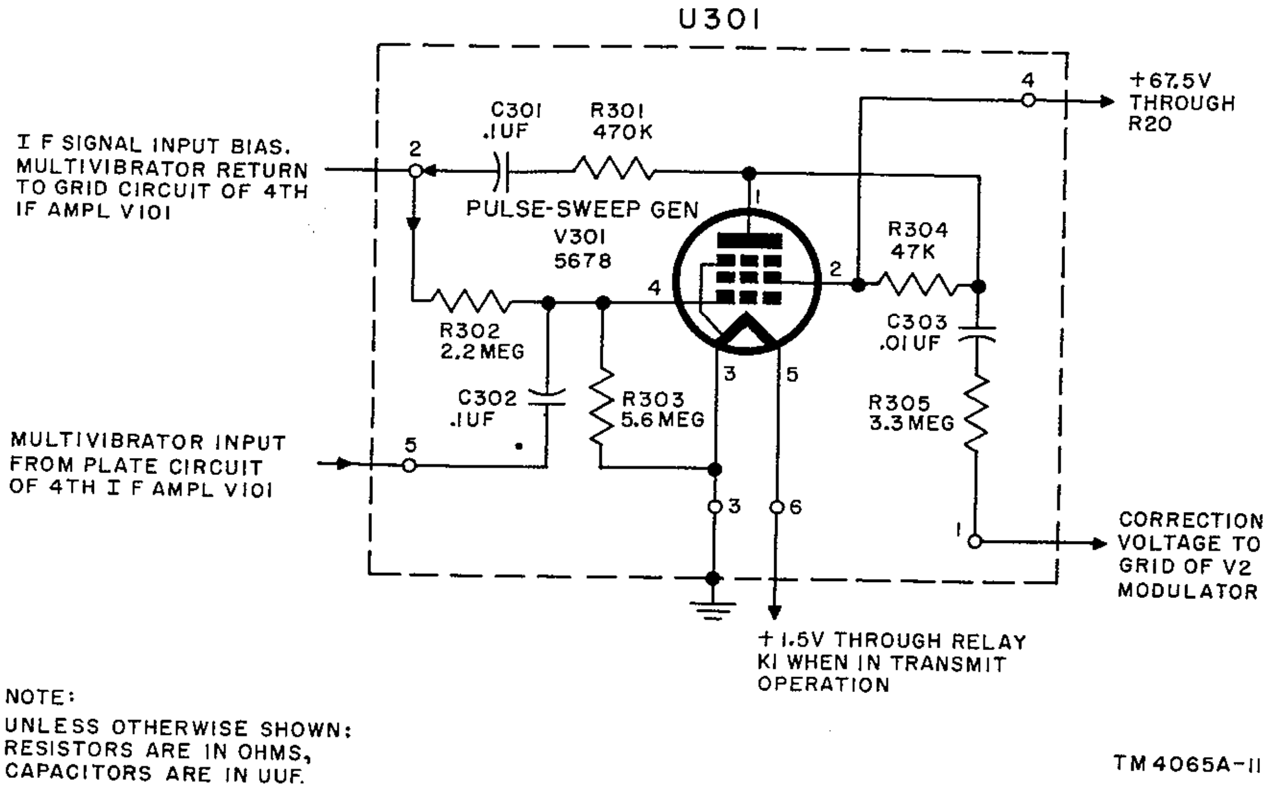



*Figure 15. Pulse-sweep generator V301, schematic diagram.*

tive bias in the grid circuit of V101 in U104, pulse-sweep generator V301 is cut off. Multivibrator action can resume only when the afc signal at the third if. output falls off, so that the cut off bias is removed from V301.

(2) The multivibrator output has a rectangular voltage wave form at the plate of V301. This rectangular wave is differentiated by C303 and R305. The high value of R305 and the other components in the circuit through which the voltage is returned to ground limits the differentiating action. The resultant output wave form applied to the grid of modulator V2 is therefore a voltage of slowly varying amplitude (fig. 19). In effect, this signal can be considered as a sawtooth voltage which continuously varies the modulator bias to sweep the transmitter oscillator over a wide frequency range.

*c. Circuit Arrangement.* Resistor R303 (fig. 15) is the grid-leak resistor. Resistor R302 couples the negative bias developed in the grid circuit of fourth if. amplifier V101 to cut off V301 and stop multivibrator action. Capacitor C302 provides the feedback path from the plate circuit of V101 (in U104) to the grid of V301, and capacitor C301 and resistor R301 provide the feedback path from the plate of V301 to the grid circuit of V101 (in U104). Resistor R301 is included to increase the time constant of the network which controls the length of time V101 (in U104) is held to cutoff. This is roughly about one-third the interval that V301 is held to cutoff by the time constant of C302, R303, and R302. Plate voltage is applied to V301 through decoupling resistor R20 and load resistor R304. Capacitor C303 and resistor R305 form a differentiating network which shapes the rectangular multivibrator wave form to the desired output. Filament voltage to V301 is applied through contacts 8 and 9 of relay K1 when the radio set is in transmit operation. Resistor R22 (fig. 19) is inserted in the plate supply circuit of V101 (in U104) and resistor R21 is shunted across grid-leak resistor R101 to permit the multivibrator operation of fourth if. stage U104 with pulse-sweep generator stage V301.

## Section III. TRANSMITTER STAGES

### 21. Modulator Stage V2

(fig. 16)

*a.* The modulator has two functions. It frequency-modulates transmitter oscillator V3, and it also controls the center frequency of the transmitter oscillator. Both of these functions are accomplished by the variation in inductance of transformer L4, whose primary is in the plate circuit of modulator tube V2. Transformer L4 has a ferrite core, common to both its primary and secondary windings. The characteristic of this core is such that changes in magnetic (and current) flux through it cause the inductance of both windings to change in value. An increase in flux and current produces a decrease in the value of the inductance, and a decrease in flux produces an increase in the value of the inductance. Since the primary of transformer L4 is in a bridge circuit with the plate of the modulator tube, changes in plate current will produce changes in magnetic flux through transformer L4 with resulting changes in inductance in both primary and secondary windings. The curve showing the variation in inductance of transformer L4 due to changing magnetic flux is shown in figure 17.

*b.* Transformer L4 is connected in a bridge circuit consisting of resistors R3, R4, R5, and the plate resistance of modulator tube V2. The primary winding of L4 is across this bridge network (fig. 16), which normally is in an unbalanced state. Consequently, some current will always be flowing through L4. However, an increase of current in V2 plate conduction causes a decrease in current through L4. When V2 tube conduction decreases, the current through L4 increases to cause a greater unbalance in the bridge network. Thus, the value of inductance in the secondary of L4 increases when the control voltage applied to the modulator grid is positive, and decreases when the control voltage is negative. Normally, with no correction voltage or modulation applied to V2, the bias on its grid is −2.7 volts in transmit operation.

*c.* Voice signal coming from the handset enter the radio receiver-transmitter through AUDIO jack J8C. From here, they are applied across series-connected load resistors R43 and R33, and through resistor R30 and blocking capacitor C51

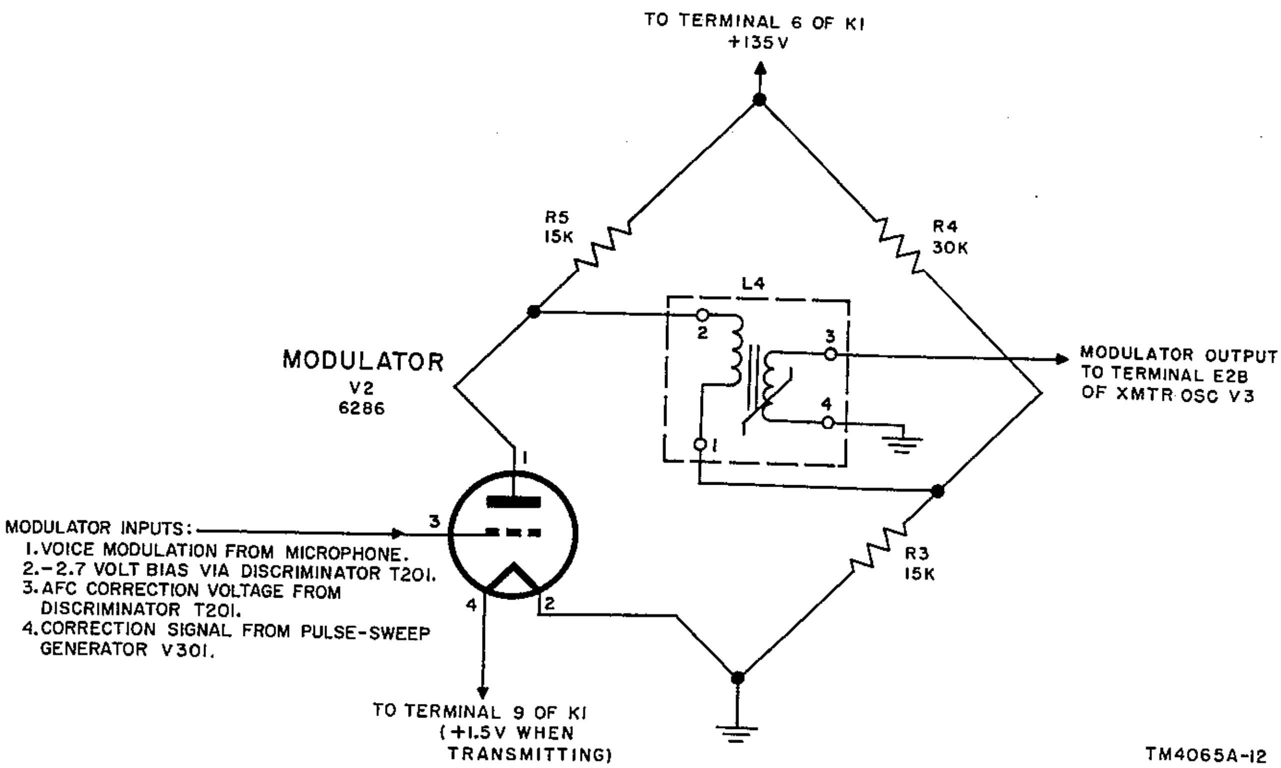



*Figure 16. Modulator stage V2, schematic diagram.*

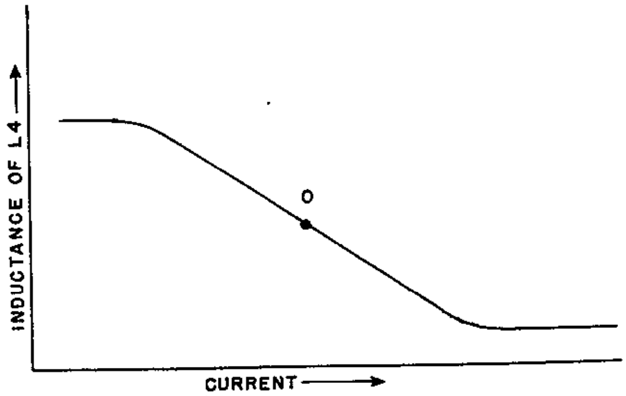



*Figure 17. Variation of inductance with current in L4.*

to the grid of modulator tube V2. This causes the plate current of V2 to change at an audio-frequency rate, which, in turn, causes the flux and the inductance of the windings in transformer L4 (fig. 16) to change. Since the secondary winding of coil L4 is in the tuned grid circuit of transmitter oscillator V3, changes in the value of the inductance of L4 produce changes in the transmitter frequency at an audio rate. The transmitter oscillator is, therefore, frequency-modulated by the audio signals.

*d.* Modulator tube V2 obtains its bias voltage through discriminator T202 (fig. 19) from the junction of voltage-dividing resistors R41 and R42, across the negative 6-volt supply to ground. This bias voltage, filtered by capacitor C38, is indirectly fed to the grid of V2. The voltage at the plate of V2 (fig. 16) is obtained through R5 from the 135-volt supply through contacts 5 and 6 of receive-transmit relay K1 (closed only during transmission). The filament voltage is obtained from the 1.5-volt supply through contacts 8 and 9 of relay K1 (closed only during transmission). The modulator therefore operates only during transmitting periods.

## 22. Transmitter Oscillator V3

(fig. 18)

*a.* The transmitter oscillator is an electron-coupled, neutralized Hartley oscillator. The oscillator section of V3 consists of the filament, the control grid, and the screen grid, its tuned circuit being located in the grid circuit (U2 can) of the tube. The plate circuit of the tube has no connection to the oscillator except through the electron coupling in the tube. Variations in frequency or loading in the plate circuit will, therefore, have little effect on the oscillator. This makes for a very stable oscillator.

*b.* The oscillator tuned circuit consists of coil L3 and capacitor C9B. Capacitor C11 is a trimmer, used for alinement of the transmitter at the hf end of the dial. Coil L3 is slug-tuned to permit alinement of the transmitter at the lf end of the dial. The secondary winding of coil L4 (not shown) is in parallel with part of coil L3 in the tuned circuit of the transmitter. Therefore, changes in the inductance of coil L4 will produce changes in the transmitter frequency.

*c.* Capacitor C10 couples the tuned grid circuit through filter E3 to the grid of the tube. Filter E3 is a resistor-inductor combination which prevents undesirable parasitic oscillations. Resistor R13 and capacitor C15 form a decoupling filter to prevent rf from being applied to terminal 2 of test socket J7 and to prevent test equipment from *loading* the circuit during test. Resistor R11 is the grid leak. Capacitor C14 and coil L5 form an rf filter for the −6-volt filament supply. Capacitor C13 keeps both sides of the filament at the same rf potential. Coil L8 and capacitor C18 keep radio frequency out of the B+ supply.

*d.* Capacitor C16 couples the output from the plate of tube V3 to its tank circuit, which consists of antenna coil L9 and TUNING capacitor C9A. Capacitor C20 is a trimmer, used for alinement of the transmitter at the hf end of the dial; coil L9 is slug-tuned to permit alinement of the transmitter at the lf end of the dial. Capacitor C17 provides partial neutralization by feeding back some of the voltage of the plate tank circuit to the grid circuit. This prevents undesirable oscillations.

*e.* A tap on coil L9 connects to LONG ANT jack J1A, SHORT ANT jack J1B, and AUX ANT jack J3. For semipermanent installations, an auxiliary antenna is connected to jack J3. This antenna is not tunable. Where semipermanent installations are not possible, a short antenna is used which connects to jack J1B. When greater range is desired, a long antenna is used which connects to jack J1A. Coil L7, in series with jack J1B, is adjustable. Its slug is attached by a wire

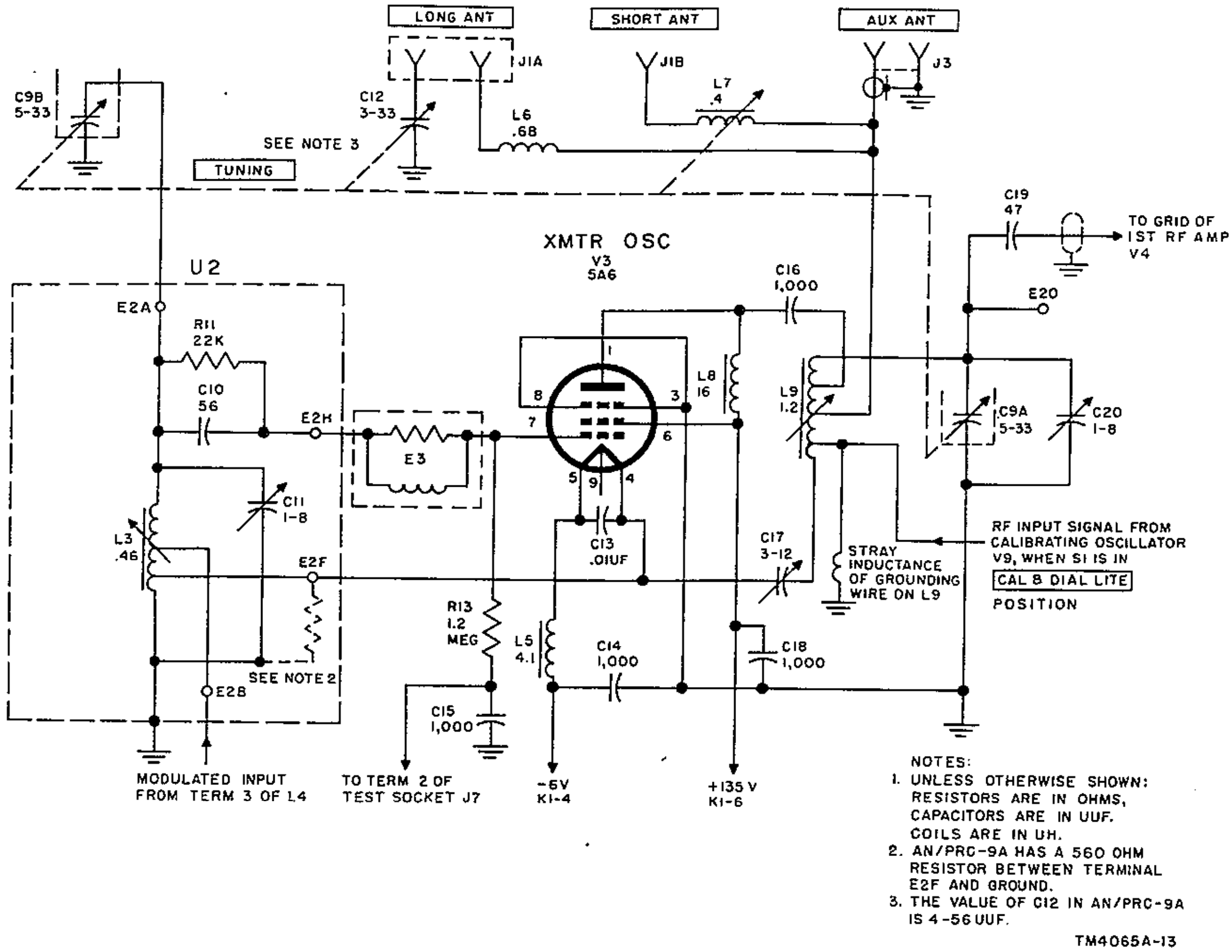



*Figure 18. Transmitter oscillator V3, schematic diagram.*

to the ear of a gear on the tuning drive assembly (fig. 42). Consequently, when the TUNING control is operated, the slug is moved inside the coil to vary the inductance in the antenna circuit, thereby tuning the short antenna. The tuned circuit for the long antenna includes fixed inductor L6 and capacitor C12. The rotor shaft of capacitor C12 is mechanically linked to the tuning shaft, and the long antenna is thereby tuned when the tuning control is operated. Plugging the long antenna into jack J1A, electrically connects C12 to coil L6 by a shorting strap in the plug of the long antenna. The voltage across coil L9 is coupled through capacitor C19 to the grid of first rf amplifier V4.

## 23. Transmitter Frequency Control

(fig. 19)

*a. General.* The transmitter oscillator output signal is affected by two circuits so that its center frequency is constantly 4.3 megacycles (mc) below that of the receiver oscillator. These two circuits are the afc circuit and the pulse-sweep generator circuit.

(1) Pulse-sweep generator V301 circuit operates only when the transmitter oscillator is relatively far off center frequency, from about 80 kc to approximately 750 kc. Normally, this is the case only when the equipment is initially started, or has been in *receive* operation for an extended time. The pulse-sweep generator circuit consists of fourth if. stage U104 and pulse-sweep generator stage V301. These two stages operate together as a multivibrator, generating a rectangular voltage wave shape of very slow frequency (about 5 to 10 cycles per second). This output is partially differentiated, so that it resembles a sawtooth sweep

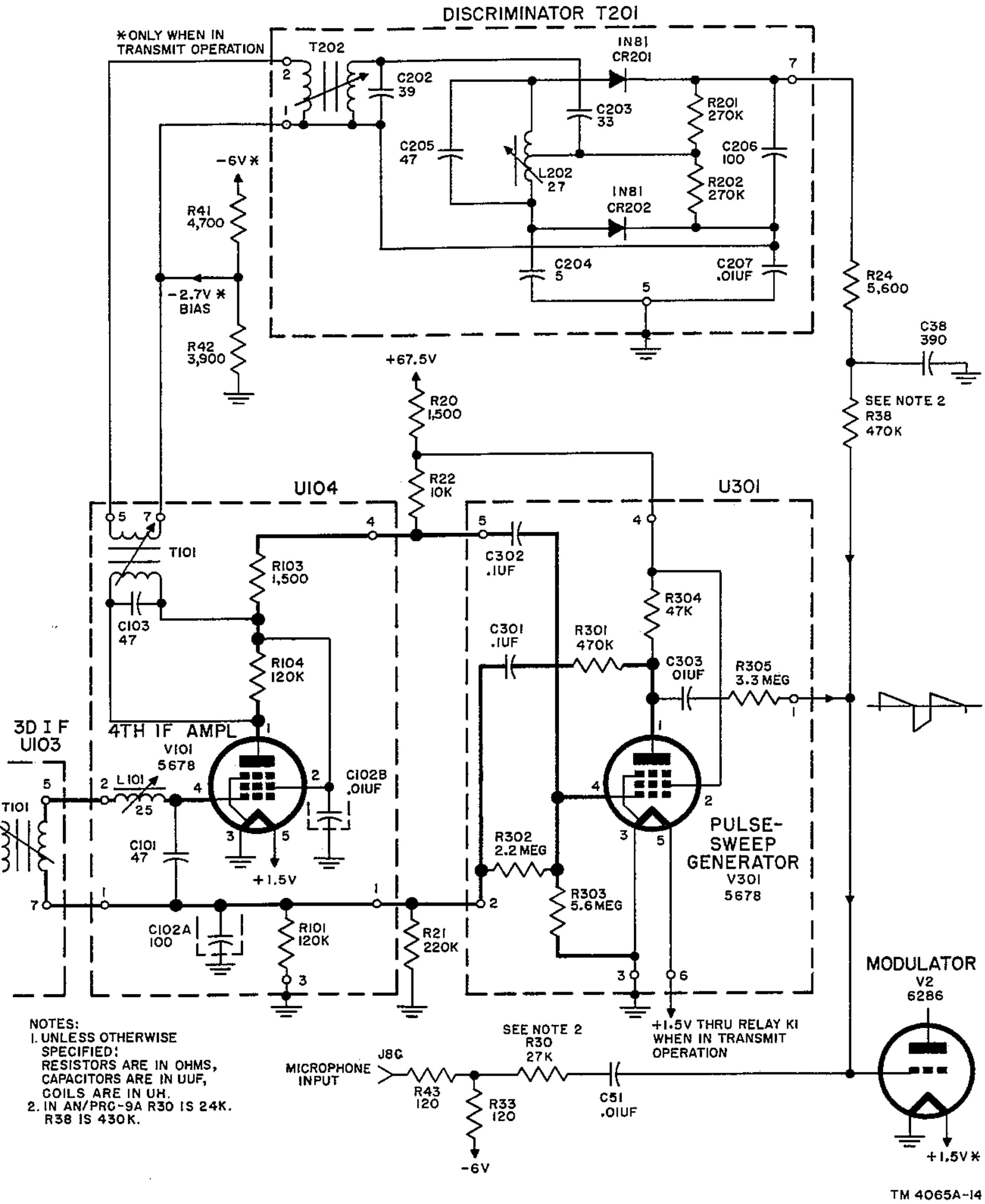



*Figure 19. Transmitter frequency control diagram.*

voltage. This varying voltage is applied to the grid of modulator tube V2 which, in turn, varies the frequency of the transmitter oscillator. When the transmitter frequency is on (or near) the center frequency, the if. output signal of third if. amplifier stage U103 develops sufficient negative bias to cut off the multivibrator operation. This usually occurs in 1 or 2 seconds. The pulse-sweep generator circuit sweeps the transmitter over a wide frequency range until the proper frequency is located, whereupon the afc circuit takes over frequency control.

(2) The afc circuit uses receiver discriminator stage T201 to provide an afc voltage which compensates for transmitter frequency deviations up to approximately 80 kc of center frequency. The afc circuit is described in *b* below; the pulse-sweep generator circuit is more fully described in paragraph 20.

*b. The Afc Signal.* When Radio Set AN/-PRC–9A or AN/PRC–10A is in *transmit* operation, the transmitter oscillator signal is picked up in the mixer stage. Here it heterodynes with the receiver oscillator signal to produce an if. output at the mixer plate. This is the afc signal. If the transmitter oscillator center frequency is correct, the center frequency of the afc signal is 4.3 mc. If the center frequency of the transmitter oscillator is too high, the center frequency of the afc signal is below 4.3 mc; if the center frequency of the transmitter is too low, then the center of the afc signal is above 4.3 mc. In any case, this afc signal is amplified through the four if. stages and applied to discriminator stage T201.

*c. Afc Operation.* The discriminator afc operation is described in paragraph 16*d*. Except for a negative direct current a (dc) bias of −2.7 volts being applied at the discriminator input when in *transmit* operation, the action of the discriminator is identically the same as in *receive* operation. In *transmit*, the output of the discriminator provides the afc correction voltage.

(1) The afc correction voltage is a dc signal which controls the bias on modulator tube V2, so that the modulator in turn may regulate the frequency of transmitter oscillator V3.

(2) The deviation of the afc signal from the center frequency of 4.3 mc develops a discriminator output dc voltage. This voltage is centered about the −2.7-volt level set at the junction of resistors R41 and R42. The discriminator output voltage is applied through resistor R38 to the grid of modulator tube V2. It causes the modulator to shift the frequency of the transmitter to compensate (correct) for deviations of the transmitter oscillator from the center frequency.

(3) When the transmitter frequency is beyond the control range of the discriminator afc correction voltage, such as upon initially starting the transmitter, there is little or no signal at the third if. stage output. The pulse-sweep generator circuit then operates and the afc circuit has practically no effect. However, the negative dc bias connected to the input, pin 1 of T201, is still effective on the grid of modulator tube V2.

## Section IV. CONTROL CIRCUITS

### 24. Voltage Distribution

(fig. 20—See foldin in back of Manual)

Operating voltages of 67.5 and 135 volts dc are received through terminals E and D of plug P1. The voltages are fed to the plates and screens of the tubes as follows:

*a. Receiver Power-Supply Circuits.* All of the receiver stages except 2.15-mc calibrating oscillator V9 are fed plate and screen voltages from the 67.5-volt supply. The circuits are thus interrelated, and a defect in one stage may affect the operation of many other stages. The receiver oscillator, mixer, if., and audio stages all have their filament circuits operating in both the *receive* and *transmit* conditions. Only the two rf stages have their filament circuits disconnected when relay K1 is in the *transmit* condition. The routing of the 67.5-volt potential to the various stages is shown in detail in figure 20, and is summarized as follows:

(1) The first rf and receiver oscillator stages connect to the 67.5-volt supply bus

through resistor R25. This resistor is included so that oscillator stage V8 receives the same voltage in both the *transmit* and *receive* conditions of the radio set. In the *transmit* condition, more current is drawn from the power source which lowers the 67.5-volt supply and, thereby, affects the receiver oscillator frequency. During the receive condition, the increase in current is adding offset by resistor R25 and by adding the first rf stage in parallel with the receiver oscillator stage.

(2) The third and fourth if. stages have dropping resistor R20 in their circuit. Resistor R22, through which the fourth if. stage is fed plate and screen voltage, permits the stage to be operated as part of a multivibrator with pulse-sweep generator stage V301. This stage may operate only when the radio set is in the *transmit* condition.

(3) The plate of squelch tube V11 obtains its voltage through the solenoid of relay K2. The SQUELCH control (S2 and R35) regulates the operation of the stage by opening and closing the filament circuit and by varying the grid bias on V11 (par. 18).

(4) The receiver oscillator, first rf, second rf, and mixer cans all have the B+ potential applied through terminal D of the individual box plug-in connector. The four if. cans and the pulse-sweep generator can have the B+ potential applied through pin 4 of the base connector in each can.

(5) The 2.15-mc calibrating oscillator, V9, receives its operating potential through R32 from the 135-volt supply. The stage is operative, however, only when the POWER switch is in the CAL & DIAL LITE position.

*b. Transmitter Power-Supply Circuits.*

(1) B+ power for transmitting is received through closed contacts 5 and 6 of receive-transmit relay K1 (when energized) and terminals D of connectors J5, J6, and P1, from the 135-volt dc source.

(2) Modulator stage V2 connects to B+ potential through R5 in one branch of a bridge network (par. 21). The screen grid of transmitter oscillator V3 connects directly to the 135-volt supply; its plate is connected to the same supply bus through inductance coil L8.

(3) Positive operating potentials obtained through a voltage-dividing network (formed by R8, R7, R23, and R21) are applied to the grid circuits of cans U104 and U301 for operation of the pulse-sweep generator circuit.

(4) Positive potential applied to the grid of squelch tube V11, through R34 from the junction of R7 and R23, causes plate conduction in V11 when the radio set is being used in relay operation. In handset operation, the junction of R8 and R7 is returned to ground through terminal J8D; the push-to-talk button is held in so that the circuit through R34 has no effect on V11. When V11 conducts, plate current through K2 energizes the relay to ground the sidetone of the retransmitted signal in the radio set.

## 25. Control Circuits

(fig. 21—See foldin in back of Manual)

Distribution of operating voltages from the power source (either Battery BA–279/U or Amplifier-Power Supply AM–598/U) to the radio receiver-transmitter is controlled by POWER switch S1 and the push-to-talk button on the handset. Control Group AN/GRA–6 may also be used to control power distribution in the set. The functions of these controls are explained in *a* through *f* below.

*a. POWER Switch S1* (fig. 21). The POWER switch is a rotary wafer-type four-position selector switch. When this switch is in the OFF position, there is no ground return for the A, B1, B2, and C voltages supplied (contacts 24 and 11 of S1 are not connected to ground), and no power is applied to the radio set.

*b. POWER Switch at ON* (fig. 21). All four voltage supplies are returned to ground through contacts 14 and 2 of S1. The filament circuits of all the receiver tubes except squelch tube V11 are completed. Squelch tube V11 is supplied filament voltage when the SQUELCH control knob is turned away from its extreme counterclockwise position, thereby closing switch S2. Plate and screen voltages are supplied to all receiver tubes. Plate voltage is supplied to the squelch tube through the winding of squelch relay K2. The set is in the receive condition when the push-to-talk switch is open.

*Note.* B+ voltages are also supplied to the plate circuits of pulse-sweep generator tube V301 and 2.15-mc calibrating oscillator V9. However, these tubes do not operate when their filament circuits are open.

*c. POWER Switch at ON, and Push-To-Talk Switch Held In* (fig. 21). Pressing in the push-to-talk switch of the handset completes the microphone circuit in the handset, and also the 6-volt circuit to the coil of relay K1. (The handset plugs directly into AUDIO connector J8 on the receiver-transmitter control panel, except when in relay or remote operation.) When relay K1 energizes, contacts 3 and 4 close, contacts 7 and 8 open, and contacts 8 and 9 and 5 and 6 close. Contacts 3 and 4 complete the 6-volt filament circuit of transmitter oscillator tube V3, and apply dc voltage across the handset microphone. The opening of contacts 7 and 8 breaks the filament circuits of first and second rf amplifiers V4 and V5. The closure of contacts 8 and 9 completes the 1.5-volt filament circuits to pulse-sweep generator and modulator tubes V301 and V2. The closure of contacts 5 and 6 connects the 135-volt supply to the plate circuits of transmitter oscillator and modulator tubes V3 and V2. Transmitter oscillator V3 and modulator V2 are now operating; pulse-sweep generator V301 is able to operate if the transmitter is far off frequency, or if other circuits are not operating properly. The receiver tubes, with the exception of the rf amplifiers, are also all operating. (They provide the audio sidetone and afc signal which control the transmitter frequency.) The radio set is now in the *transmit* condition. When the push-to-talk switch is released, the radio set is returned to the *receive* condition.

*d. POWER Switch at ON, in Relay Operation* (figs. 21 and 26). In relay operation, both unattended radio sets at the relay station have their POWER and SQUELCH controls turned on. Both radio sets are in the *receive* condition, with squelch relays K2 energized. When the radio set at either end of the communications link begins to transmit, its signal is received by the radio set at the relay station tuned to that particular carrier frequency. This received signal caused squelch relay K2 in the receiving radio set to release, and completes a 6-volt circuit through J8K to relay K1 of the companion radio set at the relay station. Relay K1 operates and the companion (or second) radio set then goes into retransmit operation. In retransmit operation, positive dc voltage is applied to the grid circuit of V11 so that the tube is constantly conducting to keep squelch relay K2 energized. The contacts of relay K2, which are then closed, ground the audio sidetone of the signal retransmitted (relayed) by the radio set. Except for this difference, operation of the radio set is essentially the same in the *retransmit* condition as in the *transmit* condition. The radio set remains in the *retransmit* condition as long as a carrier signal is being received by its companion radio set in the *receive* condition. The radio set in the *retransmit* condition will not be affected by any station transmitting on its frequency, because the two rf stages in its receiver section are inoperative. When the receiving radio set at the relay station no longer receives a carrier signal, squelch relay K2 energizes. This action breaks the 6-volt circuit across relay K1 of its companion radio set in the *retransmit* condition. Relay K1 then releases to remove the positive voltage applied to the grid circuit of V11, and places the radio set in the *receive* condition.

*e. POWER Switch at CAL & DIAL LITE* (fig. 21). The set is in the *receive* condition when the POWER switch is held in the CAL & DIAL LITE position. In addition, the filaments of 2.15-mc calibrating oscillator V9 and dial lamp E8 are heated through contacts 4 and 5 of S1. The set is then ready for calibration. The spring-return action of the POWER switch in the CAL & DIAL LITE position prevents the switch from being left in this position. Unless held back, the switch will return to the ON position.

*f. POWER Switch at REMOTE* (fig. 21).

(1) In the REMOTE position of the POWER switch, all four voltage supplies are connected to AUDIO jack J8J instead of to ground. Power can now be applied to the set only when jack J8J is connected to ground. This connection is made through a relay circuit in remote Control Group AN/GRA-6, which connects terminal J to grounded terminal B. Remote Control Group AN/GRA-6 includes Local Control C-434/GRC and Remote Control C-433/GRC as two of its basic components (fig. 22).

(2) The SET 1 cable of Local Control C-434/GRC is plugged into AUDIO jack

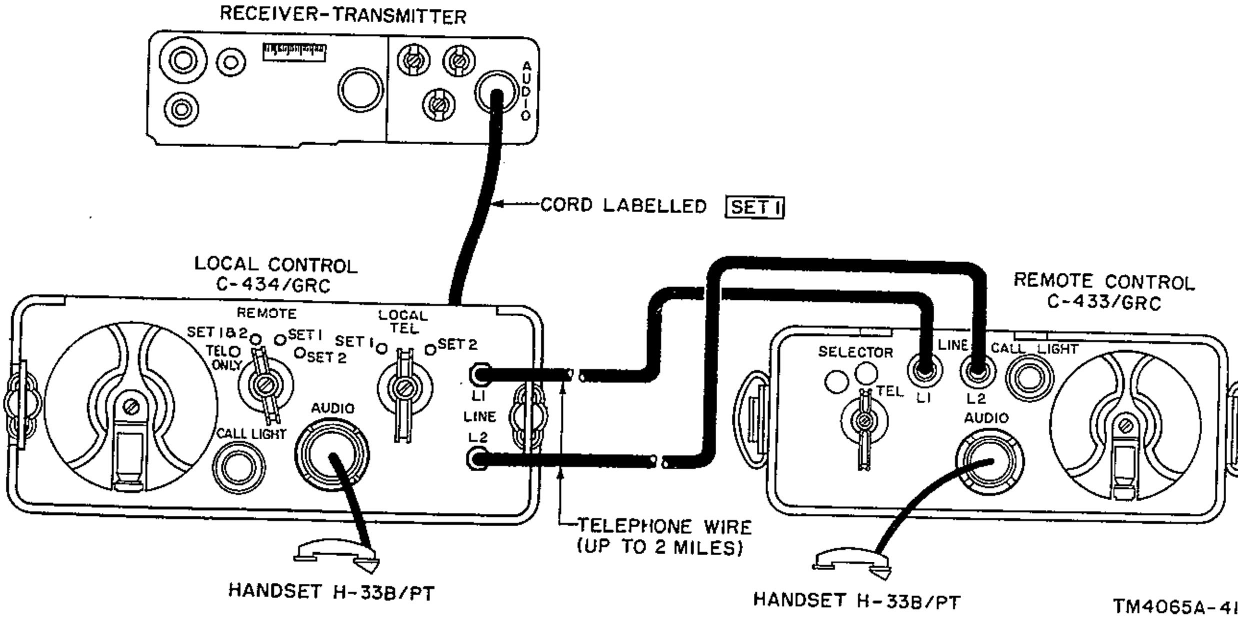



*Figure 22. Connections to Control Group AN/GRA-6.*

J8 of the radio receiver-transmitter. Remote Control C–433/GRC is connected to the local control unit by a two-wire telephone line whose maximum length may be 2 miles (fig. 22). On the local control unit, the LOCAL switch is set at TEL and the REMOTE switch is set at SET 1. On the remote control unit, the SELECTOR switch is set to the left write-in position and the push-to-talk button on the handset is pressed and then released. With the above settings on the local control unit, jack J8J in the radio set is grounded through a relay circuit in the local control unit and power is applied to the receiver section of the radio set.

(3) When the push-to-talk button is pushed in, on the handset that is plugged into the remote control unit, relays are actuated in the local control unit. This action completes the circuits from jack J8F to jack J8H, and from jack J8C to jack J8E through the handset microphone. These circuits energize receiver-transmit relay K1 in the radio set and complete the microphone input circuit. The radio set is then in the *transmit* condition. Releasing the push-to-talk button returns the set to the *receive* condition. Turning the SELECTOR switch on the remote control unit away from the left write-in position, breaks the connection from jack J8J to ground and turns off all power in Radio Set AN/PRC–9A or AN/PRC–10A.

## 26. Handset Operation

(figs. 23 and 24)

The operation of the handset during the *receive* and *transmit* conditions is described in *a* and *b* below.

*a. Listening.* The POWER switch S1 is in the ON position. The SQUELCH control is also on (away from its extreme counterclockwise OFF position) and adjusted. The −B, −A, and +C

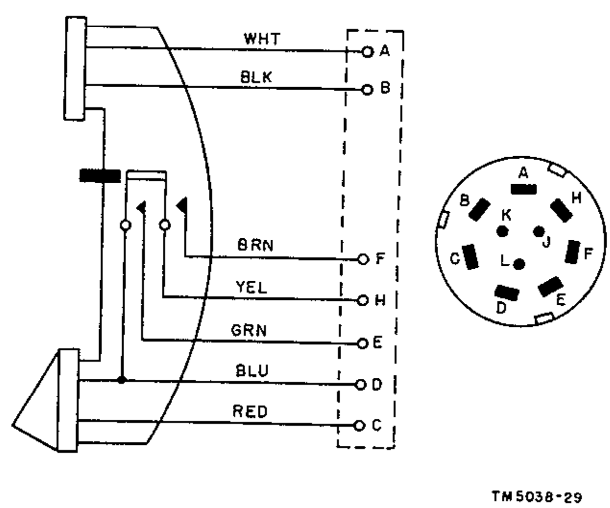



*Figure 23. Handset H–33B/PT, schematic diagram.*

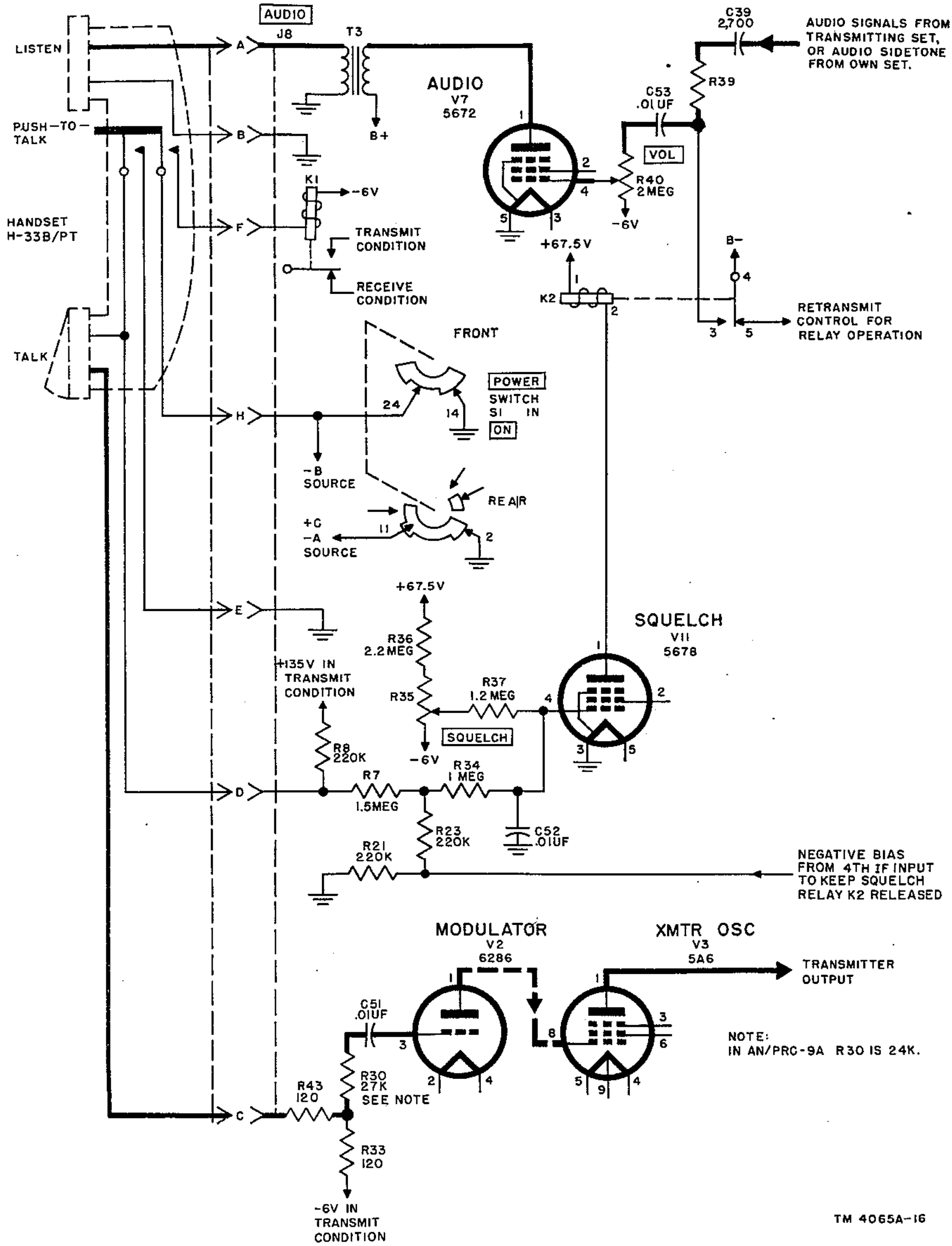



*Figure 24. Handset operation.*

sides of the power source are all returned to ground through POWER switch S1, thereby applying power to the receiver-transmitter. Relay K1 is in its released condition, so that the receiver-transmitter is in the *receive* condition. Operating voltages are applied to all the tubes in the receiver section, but not in the transmitter section. Signals received from the transmitting radio set at the other end of the radio communication link are converted, amplified, and applied through the discriminator stage to the grid of audio amplifier stage V7. The output of the audio stage feeds into the earphone of Handset H–33B/PT. When no signal is being received, squelch tube V11 conducts to energize K2, and contacts 4 and 3 close to ground the audio input to V7. Noise voltages and weak signals are thus squelched. When a signal is being received, negative bias developed across R23 in the fourth if. amplifier stage cuts off conduction in squelch tube V11 and releases relay K2 so that the received signal may be heard in the handset.

*b. Talking.* The POWER switch and SQUELCH control are in the same positions as for listening. However, the handset push-to-talk button is pushed in, and held in until through talking.

(1) The push-to-talk switch closes two sets of contacts. One set of contacts completes a 6-volt dc circuit to energize receive-transmit relay K1. The second set of contacts completes a dc circuit through the handset microphone, and grounds a positive potential in the grid circuit of V11 to keep squelch relay K2 released. These actions immediately place the receiver-transmitter in the *transmit* condition. Voice frequencies spoken into the handset microphone are fed to the grid of modulator stage V2, which frequency-modulates transmitter oscillator V3.

(2) When relay K1 energizes, it disables rf amplifiers V4 and V5 in the receiver section and connects operating voltages to the tubes in the transmitter section. A very small amount of rf energy from transmitter oscillator V3 is picked-up in the receiver section, converted, amplified through the if. stages, and passed through the discriminator. The output audio signal is applied to audio stage V7. Audio sidetone is thus heard in the earphone of the handset, while talking into the mouthpiece.

*Note.* If the radio set were being used in relay operation, terminal D would not be grounded through the push-to-talk switch. Positive potential in the grid circuit of V11 would then cause V11 to conduct, energize K2, and ground the input to audio state V7.

## 27. Relay Operation

(fig. 25, fig. 26—See foldin in back of Manual)

*a.* In relay operation, the POWER switch of both radio sets must be turned to ON, and the SQUELCH control adjusted for squelch operation. When no signals are being sent in either direction (and the transmitter carriers are off), squelch relays K2 in both sets are energized and pulled in. They release only when negative bias developed from the received signal in the fourth if. amplifier cuts off plate conduction in squelch V11. Consequently, when neither of the two terminal (or end) stations is transmitting, both radio sets at the relay station are in the *receive* condition.

*b.* When radio set No. 1 starts transmitting, its carrier signal is received only by radio set No. 2 which is tuned to its frequency. The signal received by radio set No. 2 develops a negative bias voltage in the fourth if. amplifier stage.

(1) The negative voltage developed in the grid circuit of the fourth if. amplifier is applied to the grid of squelch tube V11 and cuts off its conduction to deenergize squelch relay K2. Upon being deenergized, relay K2 breaks contacts 3 and 4 (through which the audio signal in radio set No. 2 is grounded), and makes contacts 5 and 4 to complete a dc circuit that energizes relay K1 of radio set No. 3. When relay K1 energizes radio set No. 3 is in the *transmit* condition. The audio output of radio set No. 2 is fed through pin J8A, the relay cable, and pin J8C of radio set No. 3 to the modulator input circuit of radio set No. 3. This set retransmits the signal on its carrier frequency to radio set No. 4. The carrier frequencies of the two radio sets at the relay station differ by at least 3 mc.

(2) When relay K1 of radio set No. 3 is energized, a positive bias from the junction of R7 and R23 is applied to the grid circuit of squelch V11. This keeps tube

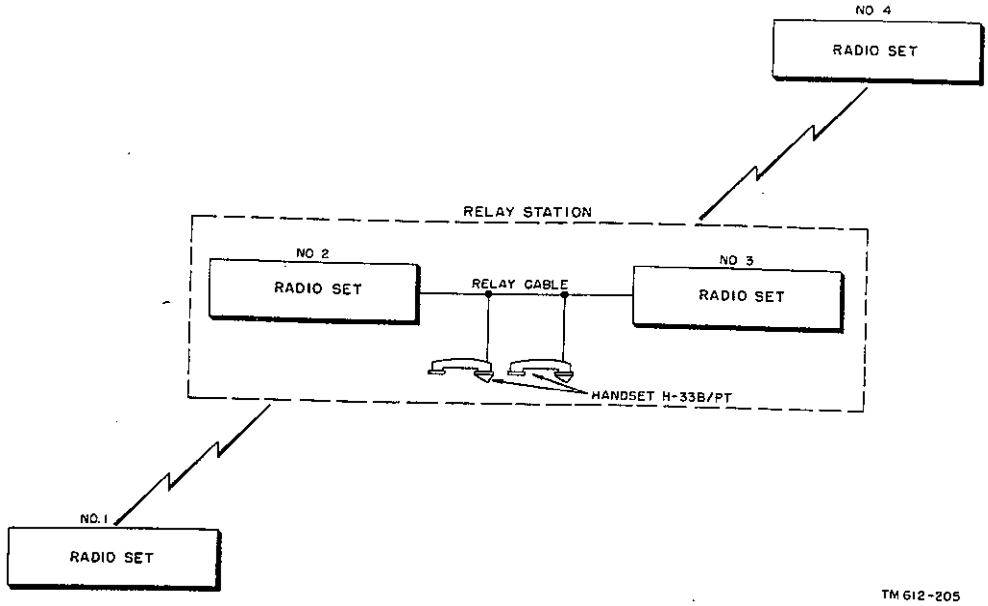



*Figure 25. Radio Sets arranged for relay operation.*

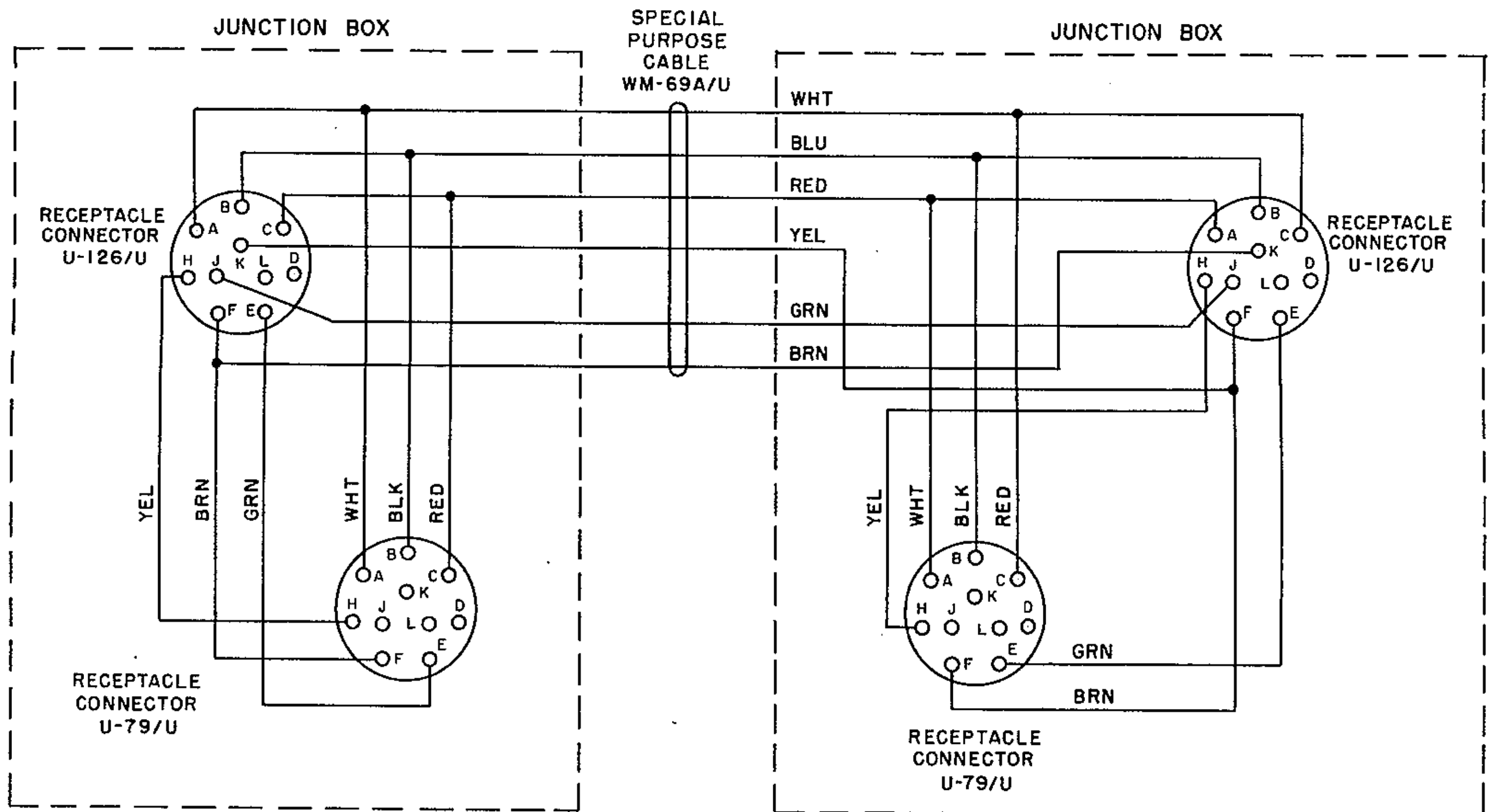
V11 conducting and relay K2 in its plate circuit energized. No signal or other voltage can then develop a negative bias to cut off conduction of V11. Contacts 3 and 4 of relay K2 ground the sidetone of the retransmitted signal developed in the circuit of radio set No. 3. However, when a handset plugged into the connector of Cable Assembly CX–1961/U has its push-to-talk button pushed in, the junction point of R8 and R7 is grounded. This removes the positive bias on V11 which stops tube conduction and deenergizes relay K2. Contacts 4 and 5 close and permit sidetone to be heard in the handset.

(3) Radio set No. 3 is shown in the *retransmit* condition with modulator V2 and transmitter oscillator V3 operative. However, when radio set No. 1 stops transmitting, the negative bias on squelch tube V11 of radio set No. 2 is removed. Tube V11 resumes conduction and squelch relay K2 energizes. This breaks the energizing circuit for receive-transmit relay K1 in radio set No. 3. Both sets at the relay station are now again in the *receive* condition.

*c.* When radio set No. 4 starts transmitting, its carrier signal is received only by radio set No. 3 which is tuned to its frequency.

(1) The signal received by radio set No. 3 develops a negative bias voltage in the if. stage. The negative voltage developed in the grid circuit of the fourth if. amplifier stage is applied to the grid of squelch tube V11 and cuts off its conduction to release relay K2. When released, relay K2 breaks contacts 3 and 4 through which the received audio signal in radio set No. 3 is grounded, and makes contacts 5 and 4 to complete a dc circuit that energizes relay K1 of radio set No. 2. When relay K1 is energized it puts radio set No. 2 in the *retransmit* condition. The audio output of radio set No. 3 is fed through pin J8A, the relay cable, and pin J8C of radio set No. 2 to the modulator input circuit of radio set No. 2 which, in turn, retransmits the signal on its carrier frequency to radio set No. 1.

(2) When relay K1 of radio set No. 2 is energized, a positive bias is applied to the grid circuit of squelch V11 in radio set No. 2. This keeps V11 conducting and squelch relay K2 in its plate circuit energized. No signal voltage can then develop a negative bias to cut off conduction of V11. The sidetone of the retransmitted signal developed in the circuit of radio set No. 2 is grounded through contacts 3 and 4 of relay K2, unless a




NOTE:
THE BROWN (F TO K) AND YELLOW (K TO F) WIRES ARE SIZE NO. 18.

TM 4065-CI-14

*Figure 27. Electrical special purpose cable assembly CX–1961/U.*

handset is plugged into cable assembly CX-1961/U and its push-to-talk button is held in. Although figure 26 shows only radio set No. 2 in the *receive* condition and radio set No. 3 in the *retransmit* condition, their conditions are identically reversed when radio set No. 4 transmits to radio set No. 1. If radio set No. 1 starts to transmit at the same time that radio set No. 4 begins to transmit, only one squelch relay K2 (in radio set No. 2 or No. 3) at the relay station will release. This is the relay in which the plate current of V11 is first cut off. It is highly improbable that the tubes in both radio sets will ever cut off simultaneously.

*d.* The two handsets which plug into Cable Assembly CX-1961/U are so connected that the handset located near radio set No. 2 may receive and transmit over radio set No. 2; the handset located near radio set No. 3 may receive and transmit over radio set No. 3. The handset earphone is connected across terminals A and B of the handset connector (fig. 26). The handset microphone is connected across terminals C and E through two normally open contacts of the push-to-talk switch. The other two contacts of the push-to-talk switch short terminal F to H when the switch is pushed in. Terminals A and B of the handset located near radio set No. 2 are connected through the relay cable to terminals A and B of AUDIO jack J8 on radio set No. 2. Since the audio output of radio set No. 2 appears across these terminals, it is fed into the handset near set No. 2. Similarly, the audio output of radio set No. 3 is fed to the handset located near this set. The retransmission cable (fig. 27) is approximately 15 feet long, and the two radio sets can be arranged so that one operator can handle both handsets, if necessary.

*e.* When the push-to-talk button on the handset located near radio set No. 2 is pushed in, the handset microphone circuit is completed to the modulator input circuit of radio set No. 2 by the closure of contacts C and E. The receive-transmit relay (K1) circuit of this set is also completed by the closure of the contacts across F and H. This puts radio set No. 2 in the *transmit* condition, and the operator at this handset may transmit over radio set No. 2. Similarly, when an operator presses the push-to-talk button on the handset located near radio set No. 3, he may transmit over that set. The handsets which are plugged into the relay cable have dominating control over the direction of transmission when they are used to transmit.

*f.* The lead on the relay cable which interconnects terminals J of the two radio sets, enables the relay station to be operated remotely by means of Control Group AN/GRA-6 (par. 27*f*). For this remote relay type of operation, the POWER switch on each set must be set at REMOTE. Power to the radio sets at the relay station may then be turned on or off from Control Group AN/GRA-6. Reception and transmission is possible in one direction through one of the relay sets by an operator at the control unit. When an operator is stationed with the Local Control C-434/GRC unit, he may, by turning its REMOTE switch between SET 1 and SET 2, enable an operator stationed with the Remote Control C-433/GRC unit to receive and transmit through the relay station in either direction.

# CHAPTER 3

# TROUBLESHOOTING

*Note.* This chapter contains information pertinent to field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and the skill of the repairman.

## Section I. PREVENTIVE MAINTENANCE

### 28. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring.

### 29. General Preventive Maintenance Techniques

*a.* Use No. 000 sandpaper to remove corrosion.

*b.* Use a clean, dry, lint-free cloth or a dry brush for cleaning. If necessary, wipe any parts, including electrical contacts, with a cloth moistened with cleaning compound; then wipe the parts dry with a cloth.

***Warning:*** Prolonged breathing of cleaning compound fumes is dangerous. Make sure adequate ventilation is provided. Cleaning compound is flammable; do not use near a flame.

### 30. Use of Preventive Maintenance Form (fig. 28)

*a.* DA Form 11–239 is a preventive maintenance checklist to be used by third echelon repairman.

*b.* Items not applicable to Radio Sets AN/PRC–9A and –10A are lined out on figure 28. References in the ITEMS block in the figure are to paragraphs in this manual which contain additional maintenance information pertinent to the particular item.

### 31. Performing Preventive Maintenance

For daily and weekly preventive maintenance instructions, see TM 11–612.

***Caution:*** Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation. For operating instructions, refer to TM 11–612.

*a.* Inspect seating of pluck-out items, such as tubes, plug-in cans, and crystals (figs. 32 and 33).

*b.* Inspect electron tubes externally for apparent breakage without removing the tubes from their sockets.

*c.* Inspect fixed capacitors for leaks, bulges, and discoloration (figs. 32 and 33).

*d.* Inspect relay K1 and relay K2 (fig. 33) for loose mountings, burned, pitted, or corroded contacts, misalined contacts, and insufficient spring tension.

*e.* Inspect TUNING capacitor C9 (fig. 33) for dirt, moisture, misalinement of plates, and loose mountings.

*f.* Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.

*g.* Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.

*h.* Clean and tighten switches within each subchassis.

*i.* Lubricate equipment as specified in paragraph 73.

*j.* Check batteries for low voltage.

*k.* Inspect the cases for leaking waterproof gaskets and worn or loose parts.

*l.* Inspect moistureproofing and fungiproofing treatment.

*m.* If deficiencies noted are not corrected during inspection, indicate action taken for correction.

## Section II. GENERAL TROUBLESHOOTING TECHNIQUES

### 32. Extent of Instructions

Troubleshooting at a field maintenance level includes all the techniques outlined for organizational maintenance and any other techniques that may be required to isolate a defective part. 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 isolating techniques.

### 33. Troubleshooting Techniques

*a.* Troubleshooting must be systematic to be effective. It is not often possible to observe a trouble symptom and immediately diagnose the cause correctly. Generally it is necessary to perform a *sequence* of operational checks, observations, and measurements before the fault can be found. Usually the trouble is first traced to a unit, then to a portion of the unit, and finally to the defective part. This sequence is commonly referred to as the sectionalization, localization, and isolation of trouble.

*b.* Sectionalization means determining which particular unit of the system is at fault. This can usually be determined through visual checks, operational procedures, or by substitution with interconnecting cables and units known to be in operating condition.

*c.* Localization means tracing the fault within the unit to the circuit, subassembly, or component responsible for the abnormal operation of the set. This can usually be accomplished by inspection, specialized tests and measurements, and component substitution.

*d.* Isolation means tracing the localized fault to the defective part or cause of trouble. Some faults, such as leaky capacitors, burned-out resistors, rf arcing, and shorted transformers, can often be found by sight, smell, and hearing. Most faults within a circuit or stage, however, must be found by checking continuity and taking voltage and resistance measurements.

*e.* Do not apply power to the radio set unless the operational symptoms are known and are of such nature as to eliminate the possibility of further damage. If the symptoms are not known, disconnect the battery plug from the equipment and check the power circuits for shorts and/or grounded circuit (par. 38).

*f.* Troubleshooting an intermittent requires skill, patience, and institution. Intermittents are troubles that appear and disappear without any apparent reason. If present, this type of trouble often may be made to reappear by tapping or lightly jarring the equipment. It is possible that the trouble may exist because of external conditions such as a poor cable connection etc. The important point to remember when troubleshooting an intermittent, is that the radio set is not normal and must be repaired since it may break down during operation. By tapping with an insulated device, it is often possible to localize the intermittent to a single stage, or components of a specific circuit. Inspect closely for mechanical causes, and check sealed components. The intermittent fault can be caused by something physically defective in a sealed can.

### 34. Electron Tube Replacement Procedure

To reduce waste of material where electron tubes are needlessly discarded as faulty, observe the following:

*a.* When replacing tubes, *do not discard tubes* merely because they fall *on or slightly above* the minimum acceptable value when checked in a tube tester. It is possible that a certain percentage of new tubes will fall near the low end of the acceptable range of the tube specification and, therefore, begin their operational life at a value close to the tube tester *retention limit.* Do not discard these tubes because they may provide satisfactory performance throughout a long period of operational life. Some circuits, for example oscillator circuits, may function with one tube and not another—even though both tubes are new. If practicable, retain any removed tube until its condition is checked by a suitable test instrument.

*b.* Be especially careful when withdrawing a miniature tube from its socket. *Pull it straight* *out.* The external pin and the wire lead sealed in the glass base are two different metals that are butt-welded together where the pin appears to enter the glass. Rocking or rotating the tube causes bending, which tends to break this weld or cause a resistance or intermittent joint to develop.

***Caution:*** Flat subminiature tubes that are tested in the flat subminiature sockets of tube testers may be inadvertently inserted in reverse. This places B+ on the filament and causes the tube filament to burn out. To prevent this, *always line up the red mark on the tube with the red mark on the tube socket.*

## 35. Additional Troubleshooting Data

Refer to the following list of figures when troubleshooting the radio set:

| Figure | Title |
|---|---|
| 57 | Radio Sets AN/PRC-9A, and -10A, schematic diagram. |
| 4 | Radio Set AN/PRC-9A and -10A, receiver-transmitter, block diagram. |
| 21 | Control circuit diagram. |
| 55 | Radio receiver-transmitter RT-179A/PRC-10, wiring diagram. |
| 56 | If. chassis, wiring diagram. |
| 30 | Voltage and resistance measurements, bottom and rear of chassis. |
| 31 | Voltage and resistance measurements, top and front of chassis. |
| 23 | Handset H-33B/PT, schematic diagram. |
| 20 | Voltage distribution in Radio Receiver-Transmitter RT-176A/PRC-10. |
| 35 | First rf box U3, inside view. |
| 36 | Second rf box U4, inside view. |
| 37 | Receiver oscillator box U6, inside view. |
| 38 | Mixer box U5, inside view. |
| 39 | If. subchassis with shield removed. |
| 53 | MIL-STD resistor color codes. |
| 54 | MIL-STD capacitor color codes. |

## 36. Test Equipment Required

The test equipment required for troubleshooting Radio Sets AN/PRC-9A and -10A is listed below. A common usage name is indicated after each component.

| Nomenclature | Common name |
|---|---|
| Audio Oscillator TS-382A/U | Audio oscillator. |
| Battery Tester TS-183/U | Battery tester. |
| Electronic Multimeter ME-6A/U or Voltmeter ME-30A/U. | Millivoltmeter. |
| Electronic Multimeter TS-505/U. | Vtvm. |
| Electron Tube Test Set TV-7/U. | Tube tester. |
| Frequency Meter TS-174B/U | Frequency meter. |
| Multimeter TS-352A/U | Multimeter. |
| Multimeter TS-297/U | Multimeter. |
| Output Meter TS-585A/U | Output meter. |
| RF Wattmeter ME-11/U | Wattmeter. |
| Signal Generator AN/URM-48 | Rf signal generator. |
| Signal Generator AN/URM-25 | If. signal generator. |
| Panoramic Indicator IP-173/U | Panoramic indicator. |

# Section III. TROUBLESHOOTING RADIO SETS AN/PRC-9A AND -10A

***Warning:*** The B battery voltages of the battery pack are high enough to produce shock and may be dangerous to life. Disconnect the battery pack when working on the equipment.

## 37. General Troubleshooting

The tests listed below will aid in finding the source of trouble. To be effective, follow the procedure in the order given. First localize the trouble to a single stage or circuit. Then isolate the trouble within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The servicing procedure is summarized as follows:

*a. Inspection.* An inspection locates any visible trouble. Through inspection alone, the repairman may frequently discover the trouble or determine the stage in which the trouble exists. Thoroughly inspect the equipment before performing the troubleshooting procedures. This inspection may locate the trouble.

*b. Short-Circuit Checks.* These measurements (par. 38) prevent further damage to the radio set from possible short circuits.

*c. Troubleshooting Chart.* This chart (par. 40) is useful in localizing common troubles in an orderly sequence.

*d. Individual Stage Checks.* Individual stage checks (pars. 41-53) utilize the signal substitution method, voltage and resistance measurements, and any other special checks that are indicated for a specific circuit. This procedure is used to locate the stage in which the trouble exists and then to locate the defective component.

*e. Stage Gain Sharts.* These charts (pars. 55 and 56) are used to locate defects that reduce the sensitivity of the set but do not make it inoperative.

## 38. Short-Circuit Checks

Release the two snap catches that fasten the receiver-transmitter case to the battery case, and separate the two cases by a few inches. Remove the battery plug from the battery socket. Then release the two snap catches that fasten the front panel of the receiver-transmitter to its case, and remove the receiver-transmitter panel and chassis assembly from its case.

*a. Battery Cable.* With an ohmmeter, measure the resistance between each pin of plug P1 on the battery cable (fig. 29) and each of the remaining pins. Also measure the resistance between each pin of plug P1 and the receiver-transmitter case. Any reading below infinity indicates a defective plug or battery cable.

*b. POWER Switch S1.* With the POWER switch at OFF and then at REMOTE, measure the resistance between pins B, F, and J of connector J5 and chassis ground. Any reading below infinity indicates a defective switch (or connector J5) (fig. 21).

***Caution:*** Do not make this test with the POWER switch at ON. Also, do not contact pin A of connector J5 with the ohmmeter prod. Failure to observe either of these precautions may ruin tubes in the radio set because of the ohmmeter battery being connected, through the test prods, across the 1.5-volt filament circuits.

*c. B+ Supply Circuits.* Measure the resistance from terminals D and E of J5 to chassis ground. Any reading below 50 megohms at terminal D and 5 megohms at terminal E, indicates a defect in the 135-volt or 67.5-volt supply circuit, respectively (fig. 21).

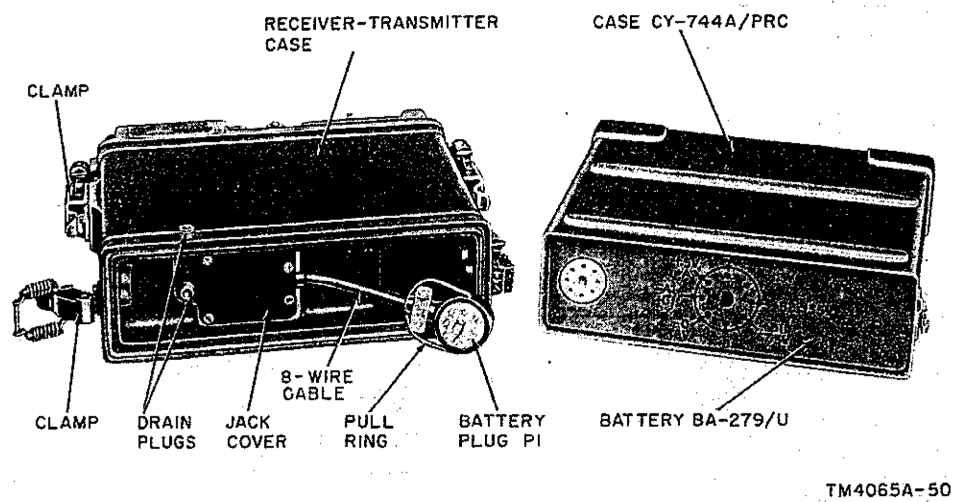
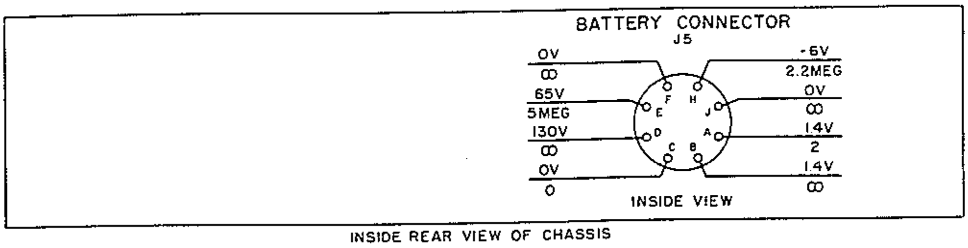


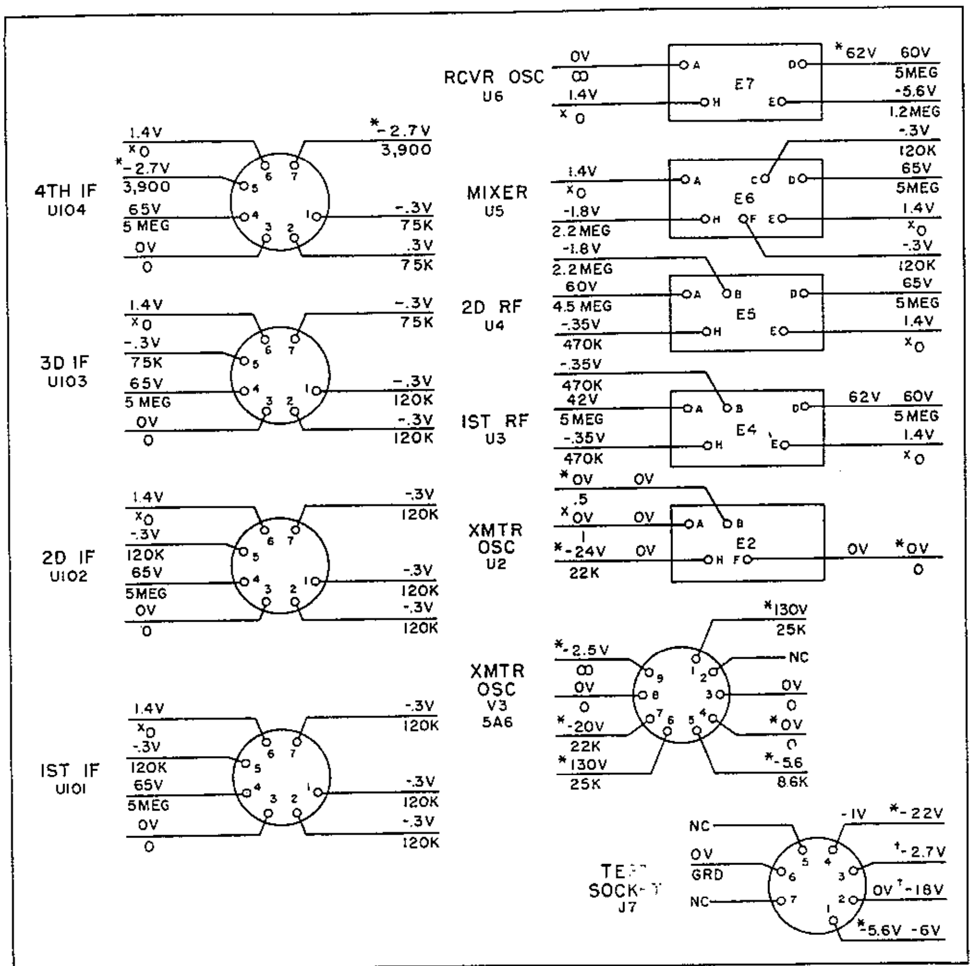

*Figure 29. Battery and receiver-transmitter cases, separated.*

## 39. Purpose and Use of Troubleshooting Chart

The troubleshooting chart is used to localize trouble in the receiver-transmitter, the battery, or in connections between the battery and the receiver-transmitter. This chart lists the symptoms obtained by the repairman while making a few simple tests. Connect the radio set as in normal operation, with the receiver-transmitter in its case and connected to the battery case. The troubleshooting chart also indicates how to localize trouble in the audio, if. or rf stage of the radio set. The individual stage checks described in paragraphs 41 through 53 can be used to supplement this procedure to locate the defective stage. After the trouble has been localized to the stage or circuit, tube checks and voltage and resistance




INSIDE REAR VIEW OF CHASSIS




BOTTOM VIEW OF CHASSIS

NOTES:

1. ALL VOLTAGES MEASURED WITH VTVM, WITH RADIO SET IN RECEIVE CONDITION, POWER SWITCH AT ON, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, AND HANDSET OUT UNLESS OTHERWISE INDICATED.
2. VALUES BELOW THE LINE ARE IN OHMS MEASURED WITH VTVM WITH BATTERY CABLE OUT, POWER SWITCH AT OFF, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, V3 OUT, AND HANDSET OUT.
3. * INDICATES VOLTAGE MEASURED WITH V3 IN AND RADIO SET IN TRANSMIT CONDITION.
4. † INDICATES VOLTAGE (MEASURED WITH V3 IN AND RADIO SET IN TRANSMIT CONDITION) WHICH DIFFER SLIGHTLY IN INDIVIDUAL SETS.
5. × TO AVOID BURNING OUT FILAMENTS, USE OHMMETER ON RANGE OF R X 10 OR GREATER.
6. NC INDICATES NO CONNECTION.

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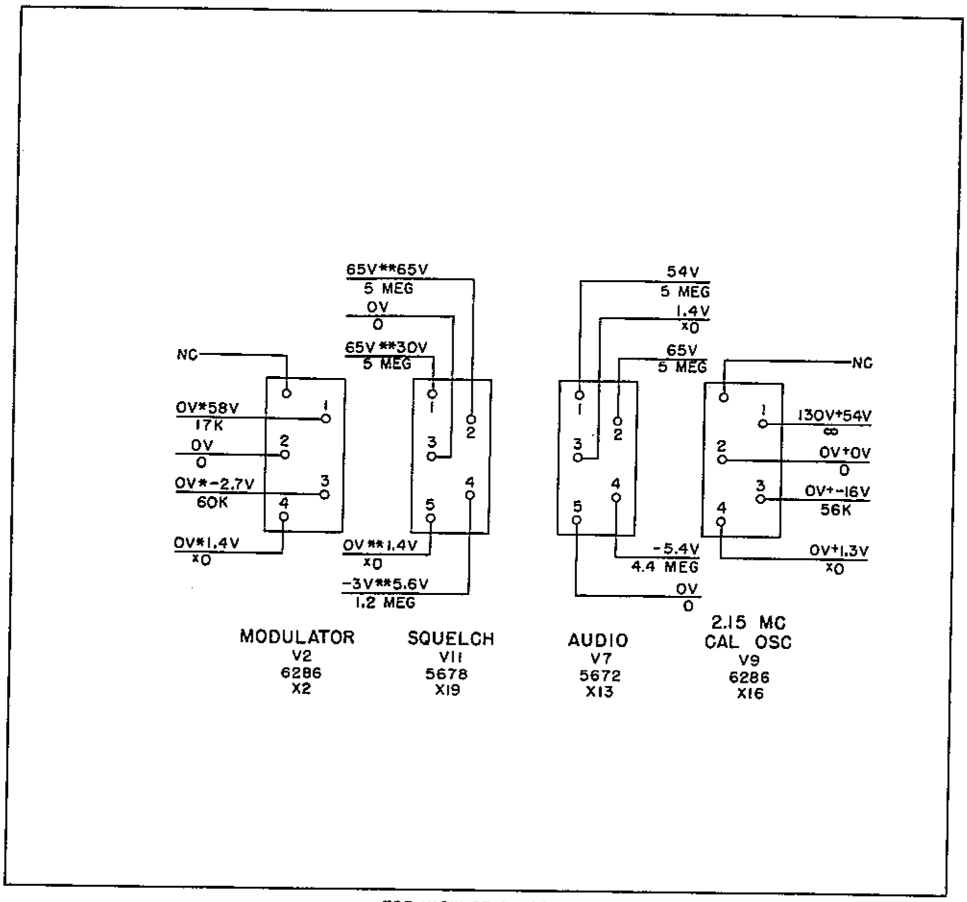
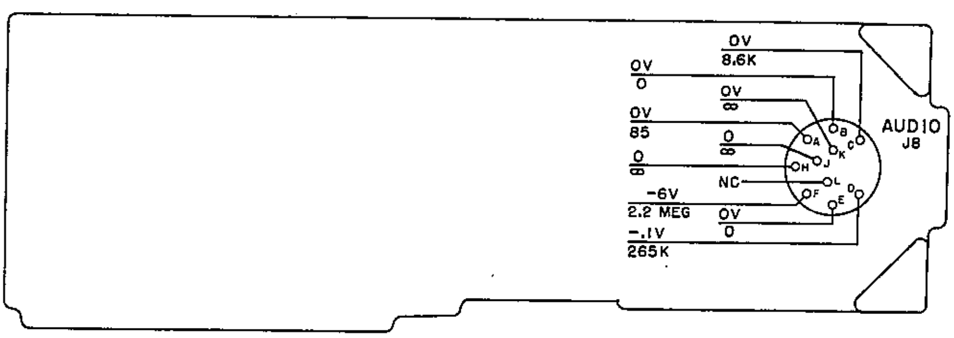
*Figure 30. Voltage and resistance measurements, bottom and rear of chassis.*




TOP VIEW OF CHASSIS




FRONT VIEW OF PANEL

NOTES:

1. ALL VOLTAGES MEASURED WITH VTVM WITH RADIO SET IN RECEIVE CONDITION, POWER SWITCH AT ON, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, AND HANDSET OUT UNLESS OTHERWISE INDICATED.
2. VALUES BELOW THE LINE ARE IN OHMS MEASURED WITH VTVM WITH BATTERY CABLE OUT, POWER SWITCH AT OFF, SQUELCH CONTROL AT OFF, VOL CONTROL AT EXTREME CLOCKWISE POSITION, V3 OUT, AND HANDSET OUT.
3. + INDICATES VOLTAGE MEASURED WITH POWER SWITCH HELD AT CAL & DIAL LITE.
4. * INDICATES VOLTAGE MEASURED WITH V3 IN AND RADIO SET IN TRANSMIT CONDITION.
5. ** INDICATES VOLTAGE MEASURED WITH SQUELCH CONTROL AT EXTREME CLOCKWISE POSITION.
6. NC INDICATES NO CONNECTION.
7. x TO AVOID BURNING OUT FILAMENTS USE OHMMETER ON RANGE OF R x 10 OR GREATER.

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*Figure 31. Voltage and resistance measurements, top and front of chassis.*

measurements are used to locate the defective part. Voltage and resistance measurements are shown on figures 30 and 31. When using troubleshooting chart, perform the steps in the order in which they are given. Correct each defect before proceeding with the next step.

## 40. Troubleshooting Chart

| Step | | When to perform | What to expect | What to do next | |
|---|---|---|---|---|---|
| No. | Procedure | | | When results are normal | When results are not normal |
| 1 | Make an operational test. (Either repeat items 1–12 of the equipment performance checklist in TM 11–612, or follow steps 1*a*–1c below.) | (a) When the operation symptoms have not been determined.<br>(b) After the possibility of short circuits has been eliminated. | The normal indications listed in the equipment performance checklist. | Step 2 | The corrective procedure referenced in the equipment performance checklist. |
| 1*a* | With battery, antenna, and handset installed, turn VOL control to 10, SQUELCH control to OFF, and POWER switch to ON. | Same as for step 1 | Rushing noise in handset receiver. | Step 1*b* | Replace weak battery. Inspect for broken lead in battery cable or at J5, J6, or P1. Check the handset. |
| 1*b* | Turn SQUELCH control clockwise until rushing noise stops. | When normal results are obtained in step 1*a*. | Rushing noise stops | Step 1*c* | Isolate trouble in the squelch circuit. Replace V11, clean or replace squelch relay K2, check SQUELCH control (S2 and R35). |
| 1*c* | Turn SQUELCH control to OFF, hold POWER switch in CAL & DIAL LITE position, rotate TUNING control slowly from low to high end of dial. | When normal results are obtained in step 1*b*. | Dial lamp lights<br>Beat notes are heard at every calibration point on the dial. | Step 1*d* | Replace dial lamp E8.<br>Isolate trouble in circuit of 2.15-mc calibrating oscillator V9 or receiver oscillator V8. If beat notes are heard at some points, isolate trouble in circuit of V8. |
| 1*d* | Tune in another radio set that is transmitting; adjust the VOL control as necessary. | When normal results are obtained in step 1c. | Voice signals are heard | Step 2 | Check antenna connections. Replace weak battery. |
| 2 | With POWER switch at ON, press push-to-talk switch on handset and talk into microphone. | After receiver section is found normal. | Audio sidetone in handset receiver. A putt-putting sound may momentarily be heard at first. | Radio set is in operating condition; Step 3. | (a) If rushing noise is heard, check action of push-to-talk switch and relay K1.<br>(b) If continuous putt-putting sound is heard, transmitter is inoperative.<br>Isolate trouble in circuits of modulator V2 and transmitter oscillator V3. |

## 40. Troubleshooting Chart—Continued

| Step | | When to perform | What to expect | What to do next | |
|---|---|---|---|---|---|
| No. | Procedure | | | When results are normal | When results are not normal |
| 3 | Test for intermittents by tapping, jarring, or vibrating equipment while in operation. | After radio set passes all preceding operational tests. | Continued normal operation if radio set is not intermittent. | Step 4 | Localize the intermittent; isolate trouble and correct. |
| 4 | Check audio amplifier stage V7 (par. 43). | After trouble in the radio set persists, and a more detailed procedure is indicated. | Audio signals | Step 5 | Isolate defect and then correct. |
| 5 | Check discriminator action of T201 (par. 44). | After step 4 | Beat note as frequency of signal generator is varied. | Step 6 | Replace discriminator can T201. |
| 6 | Check if. amplifier stages U101 through U104 (par. 45). | After step 5 | −5-volt if. output at pin 4 of J7 with signal generator at 4.3-mc and 80,000 μv signal level at pin 5 of X8; 500 μv at pin 2 of X8 and 140 μv at pin F of E6. | Step 7 | Replace defective if. can. |
| 7 | Check mixer stage V6 (par. 46). | After step 6 | −5-volt if. output at pin 4 of J7 with signal generator at 4.3-mc and 140 μv signal level at E19. | Step 8 | Isolate trouble in mixer box U5. |
| 8 | Check receiver oscillator stage V8 (par. 47). | After step 7 | −3-volt minimum negative grid bias at pin 1 of J7. | Step 9 | Isolate trouble in receiver oscillator box U6. |
| 9 | Check rf amplifier stages V4 and V5 (par. 48). | After step 8 | −5-volt if. output at pin 4 of J7 with signal generator tuned to dial frequency and the 60 μv signal level at E18; 6 uv at E20. | Step 10 | Isolate trouble in rf. box U3 or U4. |
| 10 | Check squelch amplifier V11 (par. 49). | After step 9 | Squelch relay K2 inoperative when SQUELCH control is OFF. When SQUELCH control is on but at minimum, relay should be inoperative and about −3 to −5 volts on pin 4 of V11. | Step 11 | Isolate trouble in squelch circuit. |
| 11 | Check transmitter oscillator stage V3 (par. 50). | After step 10 | Normal power output registering on output meter. About −20 volts at pin 2 of J7. | Step 12 | Aline stage; check circuit;replace tube V3. |
| 12 | Check modulator stage V2 (par. 51). | After step 11 | Sidetone of modulation heard in handset. About —2.4 volts bias at pin 3 of V2 in transmit operation. | ~~Step 13~~ | Replace tube V2. Check afc circuit. |
| 13 | Check pulse-sweep generator stage V301 (par. 52). | After step 12 | Putt-putting sound in handset receiver when in transmit operation and receiver oscillator V8 is shorted by shorting E21 to chassis. | Step 14 | Replace defective U301 can. |
| 14 | Check 2.15-mc calibrating oscillator stage V9 (par. 53). | After step 13 | About −2.5 volts across R31, as measured with vtvm. | | Replace tube V9; change crystal Y1. |

## 41. Test Setup for Individual Stage Checks

Bench tests of the radio receiver-transmitter require connection to various test equipments. The test connections vary from test to test, and upon whether the receiver or transmitter section is being tested. Typical connections for receiver testing are shown on figure 51, and connections for transmitter testing are shown on figure 52. The equipment may be powered from the battery pack, as in normal operation. No special power source is required.

*a. Connections for Receiver Testing.* For most receiver tests, the test equipment will be connected as shown in figure 51.

(1) Connect 600-ohm 5-watt resistor across the audio output pins A and B of J8 for all tests or connect an output meter, such as TS–585A/U, set for 600-ohm terminating impedance. Connect a millivoltmeter, such as the ME–6A/U, or ME–30A/U across output pins A and B of J8.

(2) Connect the high side of a vtvm, such as TS–505/U, to either pin 1, 3, or 4 of test socket J7, and the low side to chassis ground. For the input to the receiver, connect an rf signal generator (AN/URM–48) to AUX ANT connector J3 through the impedance-matching network shown in figure 51. When feeding a test signal from a signal generator (rf or if.) into the receiver at some point on the chassis, use a 1,000-$\mu\mu$f capacitor in series with the hot side of the signal generator input lead.

*b. Connections for Transmitter Testing.* For most transmitter tests the test equipment will be connected as shown in figure 52.

(1) A 50-ohm dummy load, nonreactive between 38 and 55 mc (27 and 39 mc in AN/PRC–9A), should terminate the transmitter output across AUX ANT connector J3 and chassis ground. This load is provided by RF Wattmeter ME–11/U. The frequency meter INPUT cable is loosely coupled to the radio set by coiling it around or near AUX ANT connector J3.

(2) Fabricate a test cable (fig. 52) with a mating plug at one end (for connection to AUDIO connector J8) and at the other end connect the leads to a terminal board. Label the terminals, corresponding to the pins on J8. Then connect a single-throw, double-pole switch, headphones, and Audio Oscillator TS–382A/U as shown in figure 52. Use ½-watt resistors of the values shown on the diagram to provide the proper impedance-matching network. Connect the millivoltmeter across the 10-ohm resistor to measure the audio signal voltage. For tests not requiring audio input, the headphones may be plugged directly into J8 instead of the test terminal board. The test switch permits either the transmitter to be turned on (closing the switch), or the receiver (switch open), functionally replacing the handset push-to-talk switch. The headphones functionally replace the handset receiver, so that this setup can be used to hear sidetone, listen for zero beat, and otherwise assist in servicing the radio set.

## 42. Individual Stage Checks

When making individual stage checks, refer to figures 32 and 33 for location of components and test points. Individual stage checks are made with the receiver-transmitter removed from its case and powered by a bench test battery pack. (See par. 10*b*(4) of MWO SIG 11–612–6.) If a bench test battery pack is not available, J5 of the receiver-transmitter chassis may be plugged directly into the socket of Battery BA–279/U. When a Battery BA–279/U is used, use an extension cable between the battery and the receiver-transmitter chassis. This cable must have two plugs, one to mate with the battery socket and the other to mate with J5, and with leads from terminal A on one plug connected to terminal A on the other, B to B, C to C, and so on. The cable should be about 2 to 5 feet.

***Caution:*** Accidental shorting of the +67.5-volt or +135-volt supplies to ground causes several tubes to burn out either when the POWER switch is at OFF and the handset push-to-talk button is pressed, or when the POWER switch is at REMOTE. Therefore, when making checks inside the receiver-transmitter chassis, be sure that the POWER switch is not at REMOTE and that the handset push-to-talk button is not depressed when the POWER switch is at OFF.

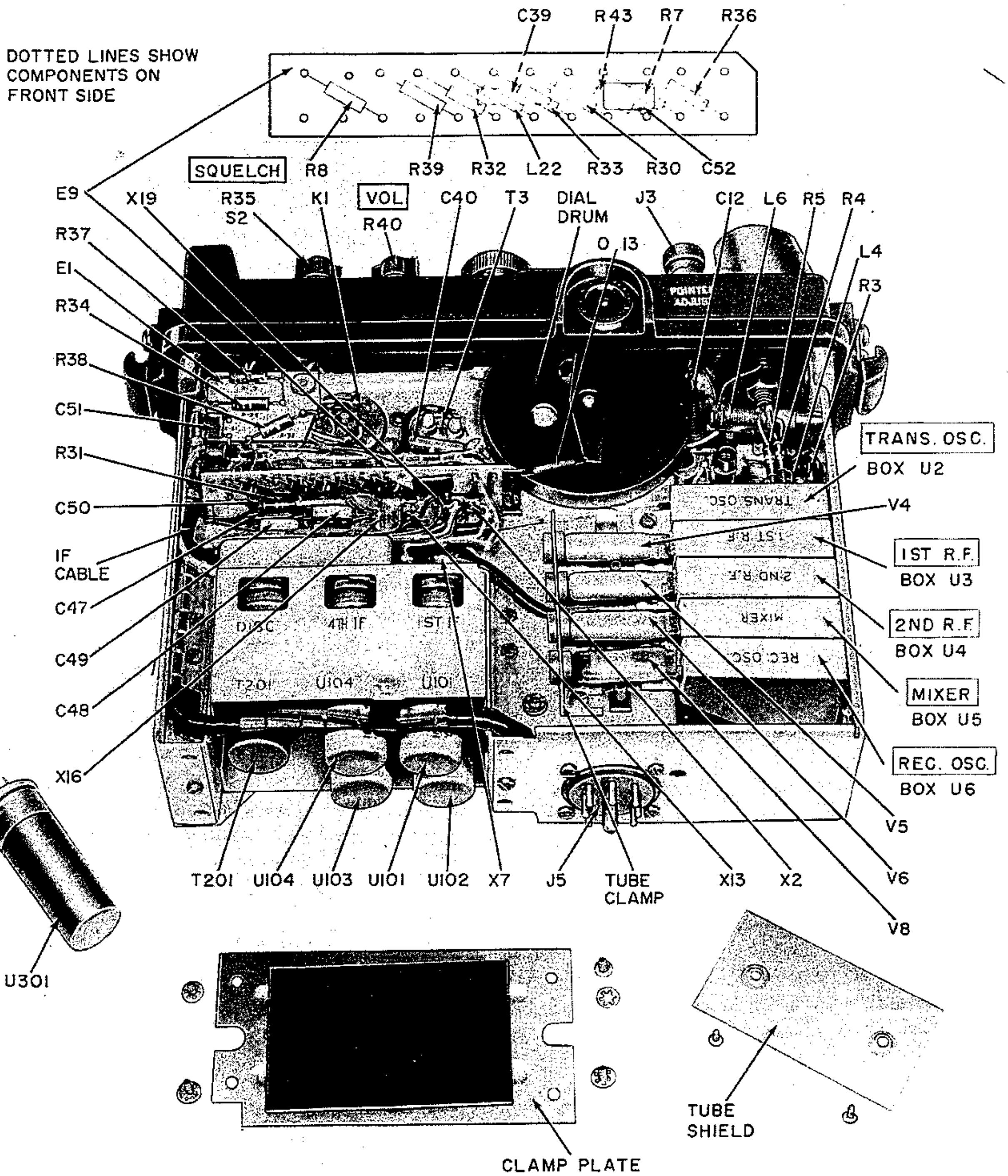



*Figure 32. Receiver-transmitter chassis, top view.*

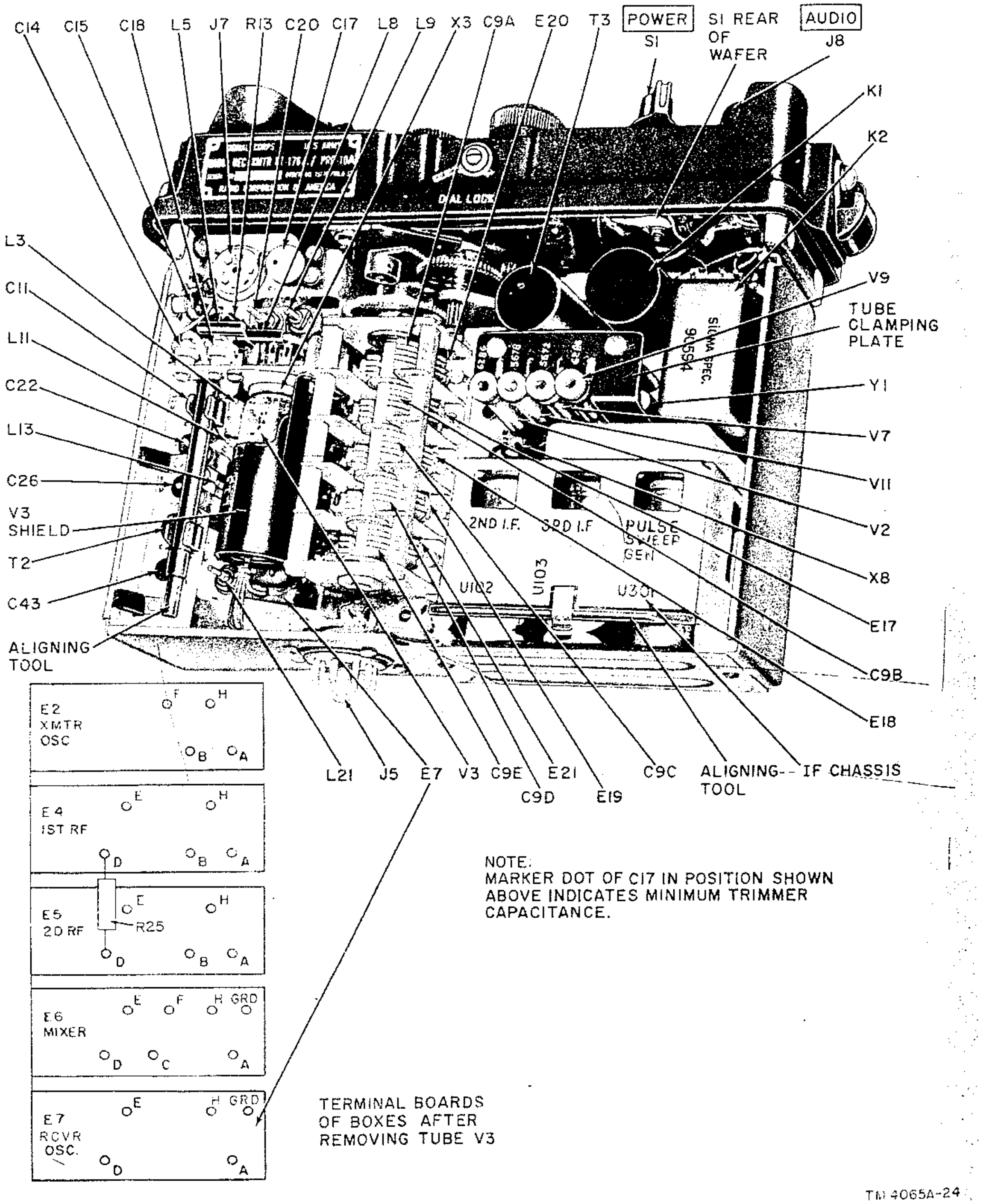



*Figure 33. Receiver-transmitter chassis, bottom view.*

## 43. Audio Amplifier V7

*a.* Remove the receiver-transmitter chassis from its case and connect it to the power source. Then proceed as follows:

(1) Set the POWER switch at ON.
(2) Set the SQUELCH control at OFF.
(3) Set the VOL control to its extreme clockwise position.
(4) Connect a handset to the AUDIO connector.

*b.* Connect the output of a 400- or 1,000-cycle audio oscillator across terminal 3 of output transformer T3 (fig. 32) and ground. The audio signal should be heard in the handset receiver. If no signal is heard, disconnect power from the receiver-transmitter and make an ohmmeter check of T3 and connections from T3 to the handset.

*c.* Connect a .01-$\mu$f capacitor to the end of the ungrounded lead of the audio oscillator, and connect the other end of this capacitor to terminal 2 of T3. The audio signal should be heard in the handset. This checks the primary of T3.

*d.* Connect the audio oscillator across the grid (pin 4) of V7 (socket X13) and ground. The signal heard in the handset receivers should be much louder than in *b* and *c* above if the output voltage of the audio oscillator is kept constant. If no noticeable increase in loudness is obtained, replace V7.

*e.* Connect the audio oscillator across pin 3 of test socket J7 (fig. 33) and ground. The signal in the handset should be almost as loud as in *d* above. Slowly turn the VOL control counterclockwise. The loudness of the tone in the handset should be reduced gradually until it is inaudible. The complete absence of a signal at the handset may be caused by a defective SQUELCH relay K2, by a short in C38, (fig. 39), capacitator C39 (fig. 32) grounded, or a short in VOL control R40. (fig. 32).

## 44. Discriminator T201

Put a 1,000-$\mu\mu$f capacitor in series with the hot lead of the if. signal generator, which is putting out an amplitude-modulated, 4.3-mc if. signal. Remove the fourth if. can, and apply this signal to pin 5 of socket X10 (fig. 39). This point connects to the input of the discriminator. Shift the if. signal generator output frequency above and below 4.3 mc while listening for a signal in the handset. The audio tone should be heard only when the signal is slightly above or below 4.3 mc. If no tone is heard, replace the discriminator can.

## 45. If. Amplifiers U101 Through U104

*a.* Feed an unmodulated 4.3-mc signal to pin 5 of socket X8 (second if. can), and connect a vtvm (10-volt range) to pin 4 of test connector J7. The negative bias voltage obtained at pin 4 of J7 indicates the level of signal at the input to the fourth if. amplifier and should change when the amplitude of the signal applied at pin 5 of X8 is changed. If no indication is obtained, interchange the third and fourth if. cans. If an indication is now obtained, place the good can back into the fourth if. socket and test a new can in the third if. socket. However, if no indication is obtained after interchanging the two cans, either both cans are bad or the trouble is in external operating input circuit. Substitute new cans.

*b.* An alternate check of the fourth if. can may be performed by connecting the vtvm to pin 3 of J7 and applying a 4.3-mc signal to pin 5 of X8. Vary the if. signal frequency above and below 4.3 mc. The vtvm reading should vary from positive to negative as the frequency is varied.

*c.* Apply the 4.3-mc signal to pin 2 of X8. The added gain of the second if. amplifier is now obtained, and the signal output level of the if. signal generator that is required to produce the same output voltage at the vtvm should now be less than that obtained in *a* above. If no indication is obtained on the vtvm or if the input signal level required to produce the same output voltage on the vtvm is not considerably less than in *a* above, replace the second if. can.

*d.* Apply the 4.3-mc if. signal to pin 2 of X7 (first if. can). Vary the output control of the generator so that the reading on the vtvm (connected to pin 4 of J7) is the same as that obtained in *c* above. The input signal level should now be considerably less than that applied in *c* above. If it is not, replace the first if. can.

## 46. Mixer V6

Apply the 4.3-mc signal through a 1,000-$\mu\mu$f capacitor to terminal E19 of main TUNING capacitor C9. If no indication is obtained at the vtvm, replace the mixer tube or box and aline the receiver-transmitter. If an indication is obtained at the vtvm, change the frequency of the signal generator from 4.3-mc to the receiver-transmitter frequency (as indicated on its TUNING dial).

If a vtvm indication is obtained, the mixer and receiver oscillator are operating. If no vtvm indication is obtained, receiver oscillator V8 is not operating or is off-frequency.

## 47. Receiver Oscillator V8

*a.* To check whether receiver oscillator V8 is operating, connect the vtvm across terminal 1 of J7 and ground. This measures the grid-leak bias voltage of V8. If V8 is oscillating, the bias voltage will be $-3$ volts or more; if it is not oscillating, the bias voltage will be zero.

*b.* If no bias voltage is obtained, replace tube V8; if this does not correct the trouble, remove V3 and make resistance and voltage checks at E7 (fig. 33). Be sure to disconnect the power source from the receiver-transmitter before making resistance checks. Replace any defective component.

*c.* After replacing the defective component, aline the receiver oscillator (par. 98).

## 48. Rf Amplifiers V4 and V5

Tune the receiver-transmitter to the middle of its frequency range. Tune the rf signal generator to the same frequency and apply a 330-$\mu$f signal through a 1,000-$\mu\mu$f capacitor to test point E19 (output of second rf amplifier). Approximately $-5$ volts dc should be indicated on the vtvm connected to pin 4 of J7. Then apply this signal (at levels approximating those given in par. 55) successively to test points E18, E20, and to the antenna jacks. Test points E18, E19, and E20 are lugs on the stators of C9C, C9D, and C9A respectively (fig. 33). The defective point is indicated by a loss of signal and no indication on the vtvm. Check voltages and, after disconnecting power, check resistances in the defective stage or circuit.

## 49. Squelch Amplifier V11

Slowly turn the SQUELCH control clockwise until squelch relay K2 is energized (pulls in). If the relay armature does not pull in (listen for a clicking sound), check the relay circuit. If this is not the trouble, replace V11. Also check for low battery voltages. If these tests do not locate the trouble, make voltage and resistance check on the entire squelch stage.

## 50. Transmitter Oscillator V3

*a.* Press the push-to-talk button on the handset, and listen to the receive-transmit relay K1. If the relay armature does not pull in, no clicking round will be heard. Turn off power and check the energizing circuit of relay K1.

*b.* Connect RF Wattmeter ME-11/U to the AUX ANT connector. Press the push-to-talk button on the handset. The rf power output should be approximately 1 to 1.5 watts. An alternate check of the transmitter oscillator operation is to measure the negative voltage in the grid circuit at pin 2 of test socket J7. This voltage should be about $-20$ volts.

*c.* If the power output of the transmitter oscillator is low, replace V3. If it is still low, aline this stage (par. 100).

*d.* If replacing V3 fails to result in any output from the transmitter oscillator, make a complete voltage and resistance check of this stage (fig. 30).

## 51. Modulator V2

*a.* Off-frequency transmitter operation and lack of modulation may be caused by a defective modulator stage. Check the bridge circuit, V2, and L4; replace defective components. The bias at pin 3 of V2 should be $-2.4$ volts when in transmit operation. If it is not, then check the source voltage ($-2.4$) at the junction of the resistors R41 and R42.

*b.* If the transmitter frequency is correct but there is no modulation, check the audio input circuit. This includes the handset microphone, capacitor C51, resistors R30, R33, and R43, and the 6-volt supply.

*c.* If the modulation is satisfactory but the transmitter oscillator drifts off-frequency, a defect exists in the afc circuit. Check the discriminator stage (par. 44), capacitor C38, and resistor R38 in the discriminator output circuit (fig. 11) to the modulator stage.

## 52. Pulse-Sweep Generator U301

*a.* While pressing the handset push-to-talk button, disable receiver oscillator V8 by placing a finger on lug E21 (fig. 33) on the stator of main TUNING capacitor C9E. A *putt-putting* sound should be heard in the handset receiver, indicating that the pulse-sweep generator circuit is operating.

*b.* If no *putt-putting* sound is heard and it has been ascertained that the fourth if. stage is normal (par. 45), replace pulse-sweep generator can V301. If this does not help, then check the pulse-sweep circuit (fig. 19).

## 53. 2.15-mc Calibrating Oscillator V9

*a.* While holding the POWER switch at CAL & DIAL LITE, measure the voltage across R31 (fig. 32) with a vtvm. Connect the low side of the vtvm to the grounded side of R31. The measured voltage should be about minus 2½ volts. If no negative voltage is obtained, the stage is not oscillating. Replace crystal Y1.

*b.* If the oscillator still does not operate, check the circuit for shorted or open capacitors, defective resistors, and broken leads. Check to see that plate voltage is being applied to V9.

## 54. Localizing Trouble to Stage by Stage Gain Measurements

Stage gain measurements are useful in locating a defective stage when the radio set is operating with reduced sensitivity. Under such conditions, the gain of each stage is compared with the required gain for that stage. The stage that shows a gain appreciably below its required gain then may be checked carefully by resistance and voltage measurements to locate and repair the defect.

## 55. Receiver Rf Stages and Antenna Circuit

The gain of the rf stages and the antenna circuit is checked by feeding an rf signal input voltage into the radio set from an rf signal generator. This produces a constant grid voltage at the fourth if. grid (terminal 4 of test socket J7) when the input signal voltage is applied to the various stages. Make all rf measurements at the center of the frequency range of the radio set being tested. If the gain is low, replace the tube of the stage being tested; then aline the radio set. If the gain is still low, remove the rf box and make resistance measurements to locate the trouble.

*a. Test Conditions.*

(1) Vtvm connected across terminal 4 of test socket J7 and ground (fig. 51).

(2) SQUELCH control at OFF.

(3) Vary frequency control of signal generator slightly until maximum output is obtained.

(4) Input signal voltage is adjusted to produce a reading of −5 volts on the vtvm. Although input voltages may show some variation from one set to another, the gain for similar stages should be fairly consistant. The stage gain shown in the fourth column of the chart in *b* below is calculated from the ratio of two successive input voltage readings. For example, the stage gain of 5.5 is the ratio of 330 : 60.

(5) Use a 1,000-μμf capacitor in series with the hot lead of the rf signal generator except when the signal is applied to AUX ANT connector J3.

*b. Stage Gain Chart.*

| Input signal (uv) (approx) | Input terminal | Reading at terminal 4 of J7 (dc volts) | Stage gain | Remarks |
|---|---|---|---|---|
| 330 | E19 | −5 | ------ | Provides first figure from which to calculate gain. |
| 60 | E18 | −5 | 5.5 | Gain of second rf stage. |
| 6 | E20 | −5 | 10 | Gain of first rf stage. |
| 1.5 | J3 | −5 | 4 | Gain of antenna circuit. (Use 33-ohm resistor in series with hot lead of generator instead of 1,000-μμf capacitor.) |

## 56. Receiver If. and Discriminator Stages

One set of conditions is given for an overall measurement of the gain of all the if. stages because it is difficult to reach the sockets of the last three if. stages. Location of the defective stage is accomplished by the substitution of a spare if. can.

*a. Condition.*

(1) Vtvm connected between terminal 4 of J7 and ground (fig. 51).
(This is grid bias voltage of the fourth if. amplifier.)

(2) SQUELCH control at OFF.

(3) Input signal is 4.3-mc; 1,000-μμf capacitor is connected in series with output lead of signal generator.

*b. If. Stage Gain Chart.*

| Input signal (uv) | Terminal | Vtvm reading (volts) |
|---|---|---|
| 500 | Pin 2 of X7 | −5 |

*c. Discriminator.*

(1) Increase the output of the signal generator until the vtvm reading no longer increases. This is necessary to operate the limiter at saturation.

(2) Change the vtvm lead from terminal 4 of J7 to terminal 3. The vtvm will now measure the dc output of the discriminator.
(3) Shift the signal generator frequency 30 kc above, then 30 kc below 4.3 mc. An output of 4.5 to 8 volts at each of these frequencies indicates normal discriminator sensitivity.

## 57. Receiver Audio and Squelch Stages

*a. Audio Amplifier.* Apply a 2-volt, 1,000-cps signal to the grid (pin 4) of audio amplifier V7. Connect Multimeter TS-352A/U, adjusted to provide a 600-ohm load, across terminal 3 of transformer T3 and ground. The output reading must be at least 7.5 milliwatts (mw).

*b. Squelch Circuit.*

(1) Short AUX ANT connector J3 to ground.
(2) Turn the SQUELCH control slowly clockwise to the point where squelch relay K2 just pulls in (rushing noise stops).
(3) Measure the voltage at terminal 4 of J7 with the vtvm. This voltage should be between −1.5 and −2 volts (squelch pull-in bias voltage).
(4) Slowly turn the SQUELCH control counterclockwise to the point where K2 just releases. The voltage at terminal 4 of J7 should now be about −2.5 volts (or about 1 volt more negative than the pull-in bias voltage). If the difference between the two readings is considerably more than 1 volt, the squelch circuit is defective.

## 58. Transmitter Modulator and Afc Discriminator Stages

The measure of modulator sensitivity is the amount of frequency shift of the transmitter with a given change in modulator (V2) grid voltage.

*a.* Tune the receiver-transmitter to the center of its frequency range.

*b.* Press the push-to-talk button of the handset to operate the transmitter and check the frequency with Frequency Meter TS-174B/U. The frequency should be the frequency indicated on the dial.

*c.* Short terminal 3 of J7 to ground. The frequency of the transmitter should change by more than 500 kc as measured by the frequency meter.

*d.* Remove the short. The transmitter frequency should be the same as in *b* above.

## 59. Isolating Trouble Within a Stage

When trouble has been localized to a stage other than a sealed plug-in type unit, use the following techniques to isolate the defective part.

*a.* Test the tube involved, either in a tube tester or by substituting a similar type tube known to be in good operating condition.

*b.* Take voltage measurements at the tube sockets (figs. 30 and 31) and other points related to the stage in question.

*c.* If voltage readings are not normal, disconnect power and take resistance readings (figs. 30 and 31) to isolate open and short circuits. If the stage in question is a removable box type, remove the unit from the chassis. Open its cover, and resistance-check the unit with reference to the main schematic diagram. Also, refer to figures 34 through 38 showing inside views of these boxes.

*d.* If signals are weak (below the normal average reading) and all checks fail to indicate a defective part, check the alinement of the radio set (pars. 95–100).

## 60. Dc Resistances of Transformers, Coils, and Relays

Resistance measurements of the components shown in the following chart should give readings approximately as shown. Components (L101, L102, L202) inside sealed cans that cannot be measured from the outside, are not included.

| Symbol | Terminals | Ohms |
|---|---|---|
| K1 | 1–2 | 43 |
| K2 | 1–2 | 16, 000 |
| L3 | | (*) |
| L4 | 1–2 | 3, 000 |
| L4 | 3–4 | (*) |
| L5 | | (*) |
| L8 | | (*) |
| L9 | | (*) |
| L10 | | (*) |
| L11 | | (*) |
| L12 | | (*) |
| L13 | | (*) |
| L14 | | (*) |
| L15 | | (*) |
| L16 | | (*) |
| L21 | | (*) |
| L22 | | (*) |
| T3 | 1–2 | 2, 200 |
| T3 | 3–4 | 85 |
| T101 | 5–7 | (*) |
| T102 | 1–2 | (*) |

*Measures less than 1 ohm.

# CHAPTER 4

# REPAIRS

## Section I. GENERAL

### 61. General Precautions and Techniques for Replacement of Parts

Most of the parts in Radio Set AN/PRC–9A and –10A are readily accessible and replaceable. Careless replacement, however, may cause new troubles. Observe the following precautions and techniques in addition to the organizational maintenance instructions given in TM 11–612.

*a.* When replacing tubes, use the same type tube as the one that was removed. Be sure that the tube is correctly oriented above the socket before attempting to insert it. Insert with a firm but gentle pressure. *Do not use force.*

*b.* Before unsoldering a component, locate and identify each lead. This assures proper replacement.

*c.* When soldering, be careful not to allow the soldering iron to touch adjacent components. Use only a small pencil-type soldering iron, and the minimum amount of solder necessary to make a good electrical joint.

*d.* Do not allow drops of solder to fall into the set.

*e.* When parts with the same voltage or power rating cannot be obtained, use a part with a higher and not a lower rating. Locate the part in the same position as the original part.

*f.* When a part is replaced in the rf or if. circuits, place the new part in the exact position occupied by the old part. A part that has the same electrical value but different physical size may cause trouble in high frequency circuits. Give particular attention to proper grounding. Use the same ground as in the original wiring. Failure to observe these precautions can result in decreased gain or in oscillation.

*g.* After repairs are completed, field organizations will brush moistureproofing and fungiproofing varnish on exposed surfaces of the equipment. Moisture and Fungus Proofing Equipment MK–2/GSM may be requisitioned for this purpose. Complete moistureproofing and fungiproofing will be accomplished at depots after repairs have been completed.

### 62. Replacement of Plug-in Cans

Six plug-in cans are used in the receiver-transmitter. They consist of four yellow if. amplifier cans (U101–U104), one blue discriminator transformer can (T201), and one red pulse-sweep generator can (U301). The cans are color-coded for proper identification.

*a. Removal.* Remove the four screws that hold the retaining clamp plate in place on the back of the chassis (fig. 32) and remove the plate. Remove the individual cans by pulling them straight out.

*b. Replacement.* Aline the pins, which are located on the can, with the holes in the socket and push the can in place. Be sure that the cans are placed in the correct sockets. Refer to the designation on the cans and chassis. Replace the clamp plate and the four screws that hold it in place.

### 63. Tube Replacement

All accessible tubes and the six plug-in cans are shown on figures 32 and 33. The tubes inside the if. amplifier and pulse-sweep generator cans are not directly accessible because the cans are hermetically sealed. When defective, the cans must be replaced, and defective cans should be turned in for repair (par. 75–94). Electron tubes and plug-in cans carried as running spares are shown in TM 11–612.

*a. Modulator, Squelch, Audio, and 2.15-mc Calibrating Oscillator Tubes.* To remove any one of these tubes (V2, V11, V7, and V9), first remove the clamping plate (fig. 33). Unfasten the two securing screws and remove the tube clamp. Remove the desired tube by pulling it straight up. When replacing these tubes, be sure that the red mark on the tube corresponds to the red mark on the tube socket. After the tubes are in place, return the tube clamp and tighten the two screws that secure the clamp over the four tubes.

*b. First and Second Rf Amplifier, Mixer, and Receiver Oscillator Tubes.* These tubes (V4, V5, V6, and V8) are mounted on the box assemblies (fig. 32). Remove and replace as follows:

(1) Remove the two screws that secure the tube shield (or cover plate), and remove the shield.

(2) Loosen but do not remove the two screws that secure the tube clamp for the four tubes; remove this clamp by sliding it away from the tubes.

(3) Remove the desired tube by pulling it straight out. When replacing a tube, be sure that the red mark on the tube corresponds to the red mark on the socket.

(4) Before installing a new V6 (mixer) tube, break the electrical connection between the external tube coating and pin 3 of the tube. An ohmmeter check should indicate a reading of infinity between pin 3 and the metallic tube coating.

(5) After all four tubes are inserted into the sockets on the boxes, replace the tube clamp and tighten the two holding screws.

(6) Replace the tube shield and tighten its two holding screws.

*c. Transmitter Oscillator Tube.* Remove the shield of tube V3 (fig. 33) by taking out the three screws that hold it to the chassis. (Two screws fasten into the chassis underneath the alining tool and the third screw is at the tube socket base.) Pull the tube straight out from the socket. Do not rock or twist it, because this may damage the tube. Replace the tube by lining up the base pins with the holes in the socket and pushing until the tube is firmly seated. Replace the tube shield and secure it with its three fastening screws. Clamp the alining tool back in place.

## 64. Crystal Replacement

The receiver-transmitter has one crystal Y1 located in the 2.15-mc calibrating oscillator stage. It can be removed and replaced after taking off the tube clamping plate (fig. 33) which holds the four tubes and crystal firmly in place. No polarity need be observed when replacing crystal Y1.

## 65. Dial Lamp Replacement

*a.* Unscrew the LITE CAP on the front panel.

*b.* While holding a hand under the opening, turn the receiver transmitter so that the control panel faces down, and shake slightly until the dial lamp drops out into the hand.

*c.* To insert a new lamp, hold the control panel face up and insert a lamp into the opening.

*d.* Screw on the LITE CAP.

## 66. Replacement of Box Assemblies

Five box assemblies are used in the receiver-transmitter. They consist of the transmitter oscillator, first rf, second rf, mixer, and receiver oscillator boxes (U2, U3, U4, U5, and U6, respectively). Refer to figure 32.

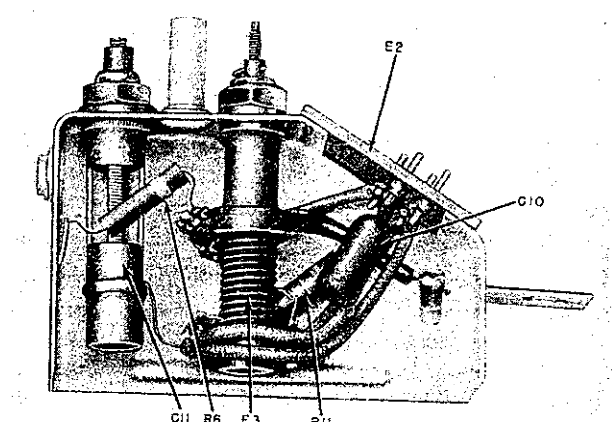



*Figure 34. Transmitter oscillator box U2, inside view.*

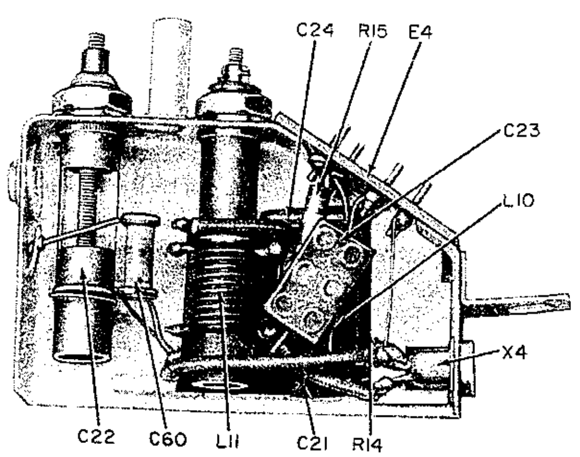



*Figure 35. First rf box U3, inside view.*

*a. Removal.*

(1) First remove the transmitter tube V3 (par. 66*c*).

(2) Remove the tube from each box (except the transmitter oscillator box). Refer to paragraph 63*b* for the removal procedure.

(3) Unsolder the leads on the terminal board of the box.

(4) Unfasten the three screws that secure the box to the chassis. One screw is on the side, one on the bottom of the chassis, and one on the top. The box can now be lifted out of the chassis.

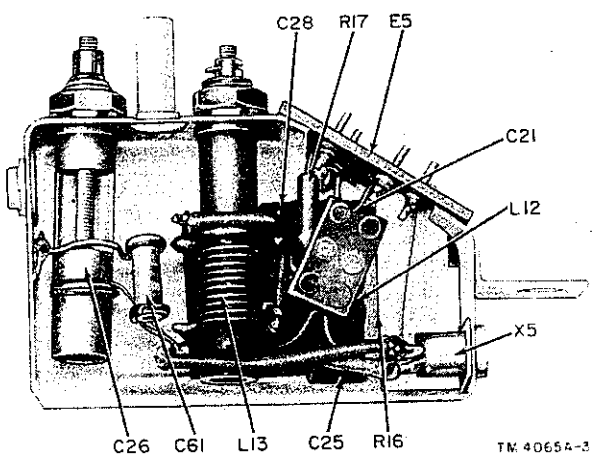



*Figure 36. Second rf box U4, inside view.*

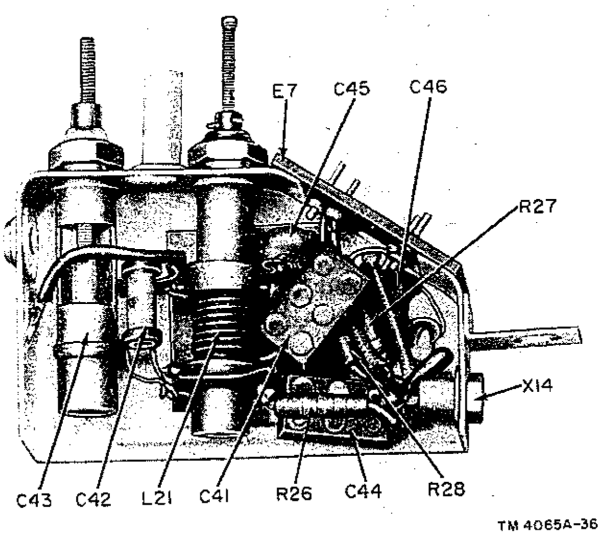



*Figure 37. Receiver oscillator box U6, inside view.*

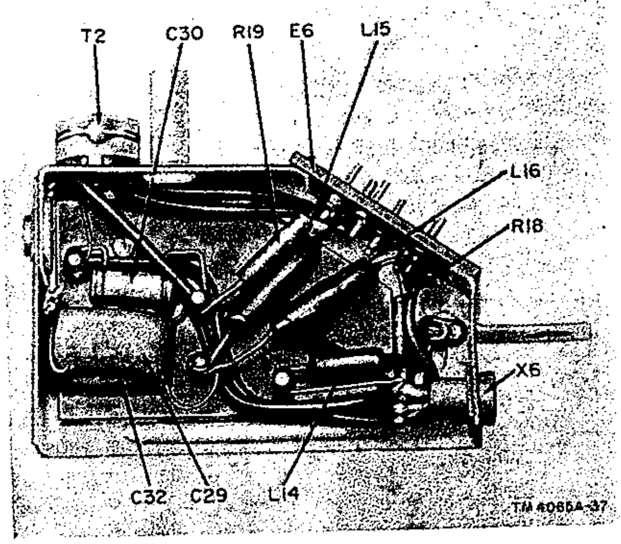



*Figure 38. Mixer box U5, inside view.*

*b. Replacement.*

(1) Place the box in position, tightly screw the three mounting screws.

(2) Solder the leads on the terminal board of the box.

(3) Replace the tube in the socket of the box.

(4) Replace the transmitter oscillator tube V3 (par. 63*c*).

## 67. Replacement of if. Subassembly

The if. subassembly is supplied as a spare *without* the six plug-in cans. The if. subassembly, can be removed and replaced as follows:

*a. Removal.*

(1) Remove the four screws that hold the clamp plate in place on the back of the chassis (fig. 23) and remove the plate.

(2) Unsolder two leads (one brown and one orange) on terminal board E9 which connect to socket X7 on the if. subassembly. Remove a two-conductor shielded cable at socket X7 and unsoldering the two leads and the shield.

(3) Unfasten the two screws at the rear of the chassis and the four screws from the top of the chassis. The if. subassembly is now free for removal except for unsoldering six leads and a ground bus which come out of the socket X11 corner in a laced cable. This should be done at the points on the chassis to which these leads connect.

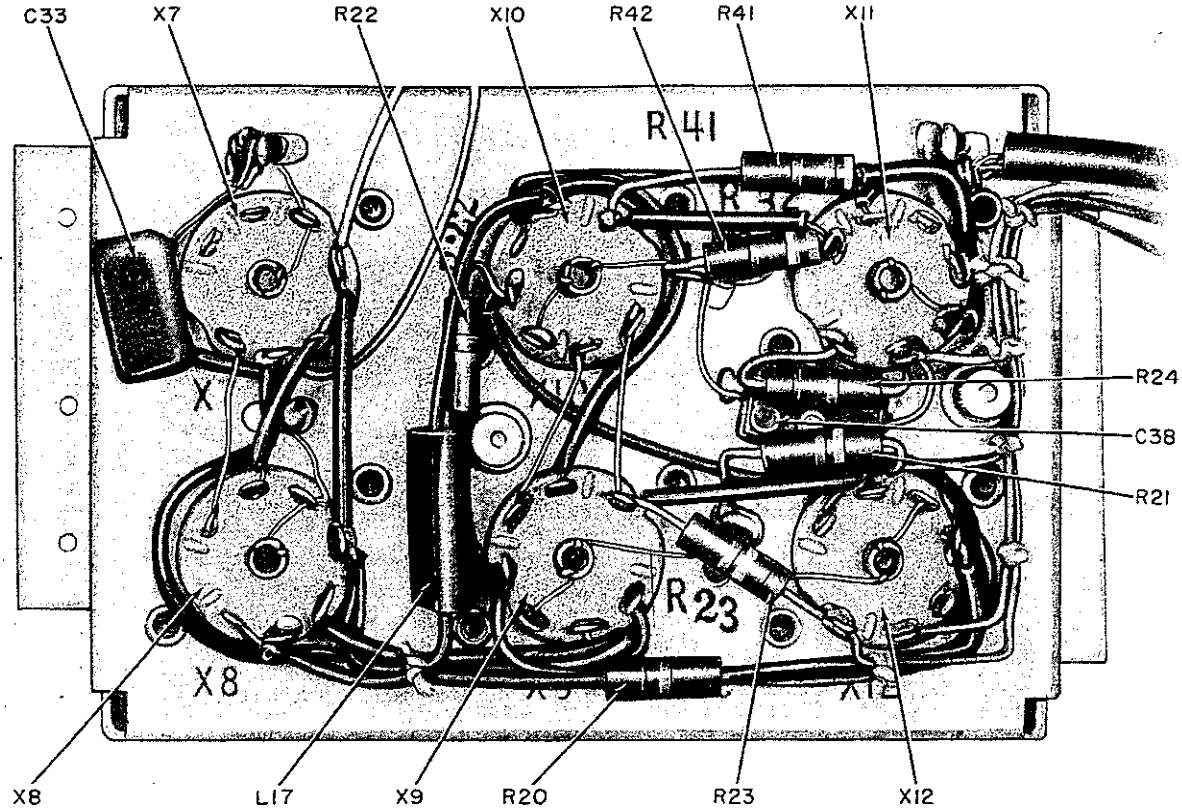



*Figure 39. If. subchassis with shield removed.*

*b. Replacement.*

(1) Place the if. subassembly in position. Dress the laced cable into place, and solder each lead to the terminal from which it (or the old corresponding lead) was disconnected.

(2) Tighten the if. subassembly to the chassis with the six mounting screws previously removed.

(3) Solder the orange and brown leads back on to the terminals of E9 from which they were disconnected. Also replace the two-conductor shielded cable.

(4) Install the six plug-in cans, if previously removed. Replace the cover plate and the four screws that hold it in place.

## 68. Replacement of TUNING Capacitor C9

*a. Removal.*

(1) Remove transmitter oscillator tube V3 as described in paragraph 63*c*.

(2) Operate the TUNING control until the gang is fully meshed.

(3) Unsolder the five leads and four grounding wires from the five sections of the TUNING gang assembly.

(4) At the dial drum (fig. 32), remove the spring between the pointer and terminal board E9. Also loosen the two screws through the two openings in the dial drum. Unfasten the socket-head screw in the center of the dial drum. Remove the screw together with the pointer, lockwasher, and flat washer, so that the dial drum may be removed.

(5) Remove the mixer and receiver oscillator tubes (V6 and V8 as described in paragraph 63*b*, so that the third mounting screw of the gang assembly can be reached.

*Note.* If the gang is going to be replaced, apply the scissor-gear tension clip (fig. 40) to the gang scissor gear to maintain shear tension on the two sections of the scissor gear. An alternate method is to tie a small piece of bus wire between the two sections (bottom view fig. 36).

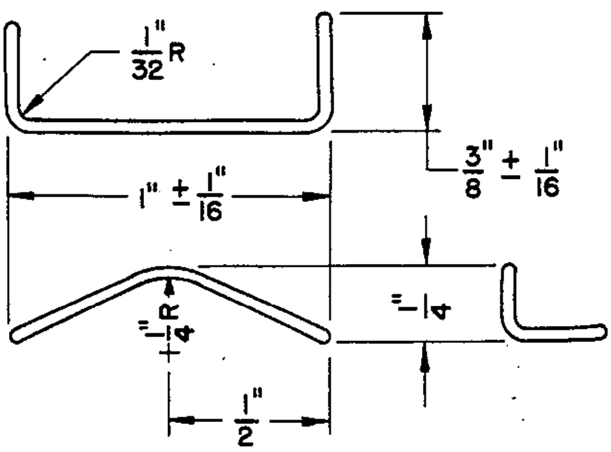



*Figure 40. Scissor-gear tension clip.*

(6) Unfasten the two screws previously loosened under the dial drum, and the third screw under the two tubes just removed. The tuning gang can then be lifted out of the chassis.

*b. Replacement.*

(1) Carefully position the gang assembly back in place, and be sure that the scissor gear meshes smoothly with the tuning-drive mechanism.

*Note.* The gang assembly should be fully meshed when being replaced.

(2) Secure the gang assembly to the chassis with the three mounting screws previously removed.

(3) Replace the mixer and receiver oscillator tubes.

(4) Replace the dial drum, the pointer, and the spring between the pointer and terminal board E9.

(5) Solder the five leads and the ground wires back to the five sections of the gang assembly.

(6) Replace the transmitter tube V3.

(7) Calibrate and realine as described in paragraphs 97 through 100.

## 69. Replacement of Miscellaneous Items

*a. Relay K1.*

(1) To remove relay K1, unsolder 14 leads on 9 pins in the base of the relay (fig. 33). Unfasten the two hexagonal nuts through which the relay mounting studs are secured to the chassis. Before one of these nuts (on the longer stud) can be unfastened, it is necessary to move the terminal board E1. Remove its mounting nut, and in the diagonally opposite corner unfasten its one mounting screw. Lift up the board so that the corner through which the relay stud extends can be cleared of the stud. Slip the spacer off the stud and then remove the hexagonal nut.

(2) To replace, insert the relay so that its longer mounting stud comes through the small terminal board. Secure the relay with the two hexagonal nuts previously removed. Solder the leads to the relay pins.

*b. Squelch Relay K2.*

(1) To remove squelch relay K2 (fig. 33), unfasten the two mounting screws from the top side of the chassis. One of these screws also secures a grounding lug to the chassis. From the bottom side of the chassis, unsolder seven leads on five terminals in the base of the relay.

*Note.* To facilitate replacement of K2, it may be necessary to disconnect the control panel from the chassis. This partial disassembly is described in paragraph 70.

(2) To replace, solder the leads back to the terminals, and then fasten the relay to the chassis with the two screws previously removed.

## 70. Partial Removal of Control Panel for Servicing

***Caution:*** Removal of the panel should be performed only when repair or maintenance of the radio set makes it absolutely necessary.

*a.* Release the clamps on the receiver-transmitter case (fig. 29), and remove the chassis (with control panel attached).

*b.* Unsolder the leads at J3 between the AUX ANT connector J3 and terminal 4 of L6, and the lead at L6 between the LONG ANT connector J1A and terminal 5 of L6. Refer to figure 41. Note the positions of the leads so that they may be reconnected properly.

*c.* Remove the two screws that hold the chassis to the tuning drive mechanism. These two screws are located underneath the dial drum, and are accessible through the holes in the dial drum after

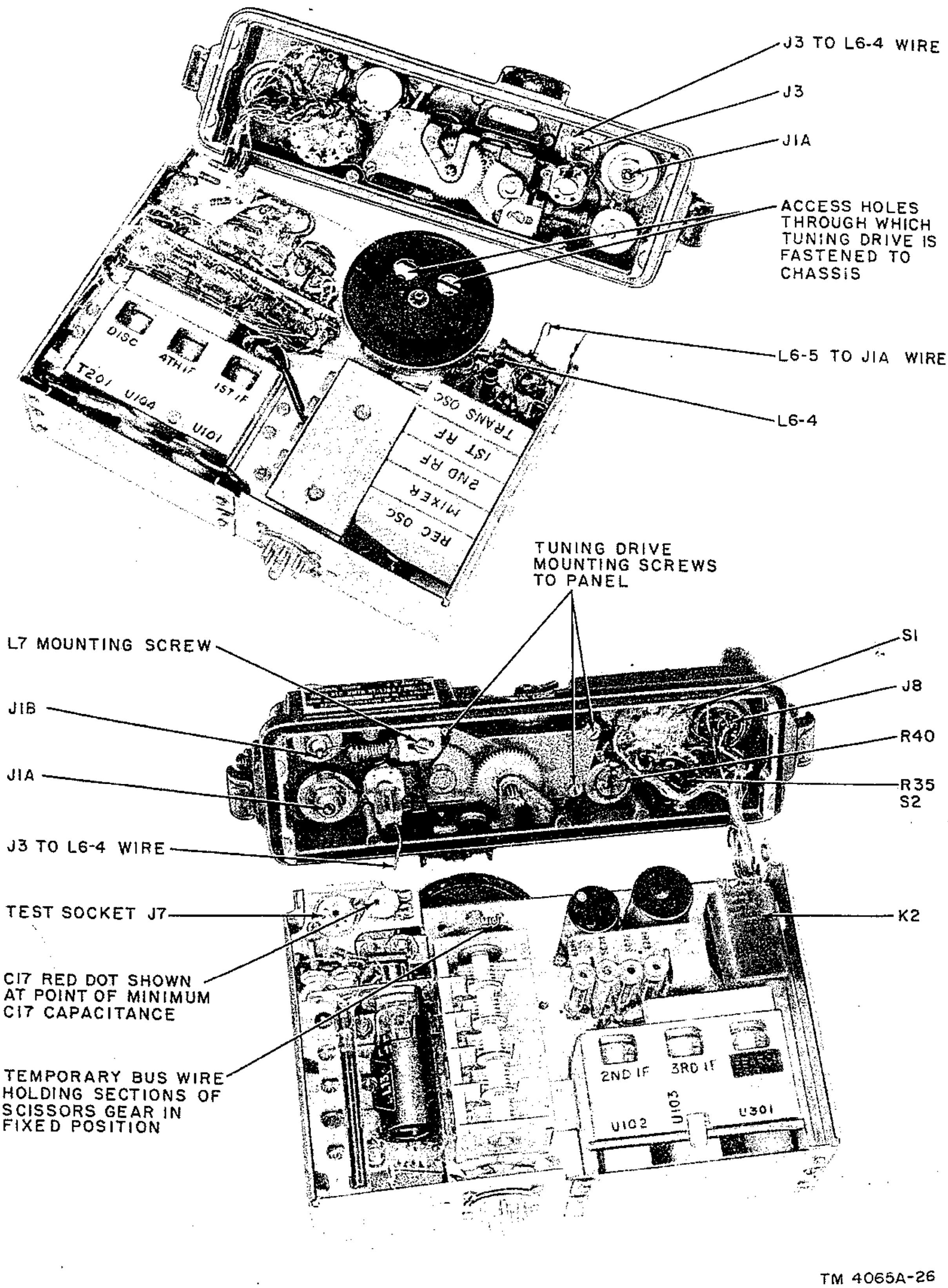



*Figure 41. Control panel partially disassembled from chassis for servicing, bottom and top views.*

the dial drum has been properly positioned by the TUNING dial. These positions of the TUNING dial are approximately 46.7 and 48.8. Be careful not to remove the two mounting screws of the tuning gang assembly. They also are accessible through the other two holes of the dial drum when the gang is fully meshed.

*d.* Apply the spring tension clip (fig. 40) to the gang scissor gear. This maintains shear tension on the two sections of the scissor gear when the scissor gear is disengaged from the tuning-drive mechanism. An alternate method is to tie a small piece of bus wire between the two sections of the scissor gear, as shown in the bottom view of figure 41.

*e.* Remove the four screws, two on each side, that hold the control panel to the chassis. Carefully separate the chassis from the control panel for servicing. Remove the dial pointer and spring from the dial drum. Save them for replacement with the removed hardware.

## 71. Replacement of Components on Control Panel Assembly

(fig. 42)

These components include the AUDIO connector (J8), SQUELCH control (S2 and R35) VOL control (R40), POWER switch (S1), tuning drive (O 22), and the electrical components (C12, L7) on the tuning drive assembly.

*a. Replacement of POWER, SQUELCH, and VOL Controls.*

(1) To remove any one of these items, first remove the control panel for servicing (par. 70). Then unfasten the center screw of the TUNING control knob, remove the screw and knob, unscrew the panel nut, slip the control out from behind the panel, and unsolder the electrical connections.

(2) To replace, position the control in place, make electrical connections, secure the control firmly to the panel with the fastening nut, and replace the control knob.

*b. Replacement of AUDIO Connector.*

(1) After removing the control panel (par. 70), unsolder the leads connector J8, unscrew the panel nut, and remove the connector.

(2) To replace, insert the connector from behind the control panel, secure it with the panel nut, and resolder the leads.

*c. Replacement of Tuning Drive Mechanism* (figs. 42 and 43).

(1) After removing the control panel (par. 70), unfasten the center screw, of the TUNING knob and remove the knob. Unsolder three leads: one at capacitor C12 between the grounding lug on J1A and C12, the second at L7 between the AUX ANT connector J3 and terminal 1 of L7, and the third also at L7 between the SHORT ANT connector J1B and terminal 2 of L7. Note position of leads so that they may be reconnected properly. Unfasten the screw at the head of the DIAL LOCK control. Remove the screw, lockwasher, and flat washer; pry off the lever (O 2). Unscrew the threaded stud assembly, and lift it out. Loosen the three mounting screws that secure the tuning drive to the control panel. If necessary, loosen the mounting screw that secures the bracket of L7 to the casting (after marking its position) to gain access to the mounting screw below the casting top surface. Remove the tuning drive assembly; be careful that the stop plate (O 19) and rectangular nut (H7) underneath the bracket (O 6) do not slip off the tuning shaft.

(2) Before replacing the tuning drive assembly, check the condition of the two gaskets (O 14) on the tuning shaft, and the two gaskets (O 9) on the threaded stud of the DIAL LOCK mechanism. Replace if necessary. Place the bracket (O 6) in position on the tuning shaft with the stop plate (O 19) and rectangular nut (H7) (fig. 42). Place the assembly in position and insert the tuning shaft through the hole in the control panel. Look down through the DIAL LOCK opening and, with a thin-bladed screw driver, position the bracket, nut, and plate below, so that the threaded stud may be inserted into the nut. After threading the stud into the nut, and observing that one end of the bracket has not slipped off the shaft, secure the tuning drive assembly to the control panel. Fasten the three mounting screws evenly and tightly. Replace the

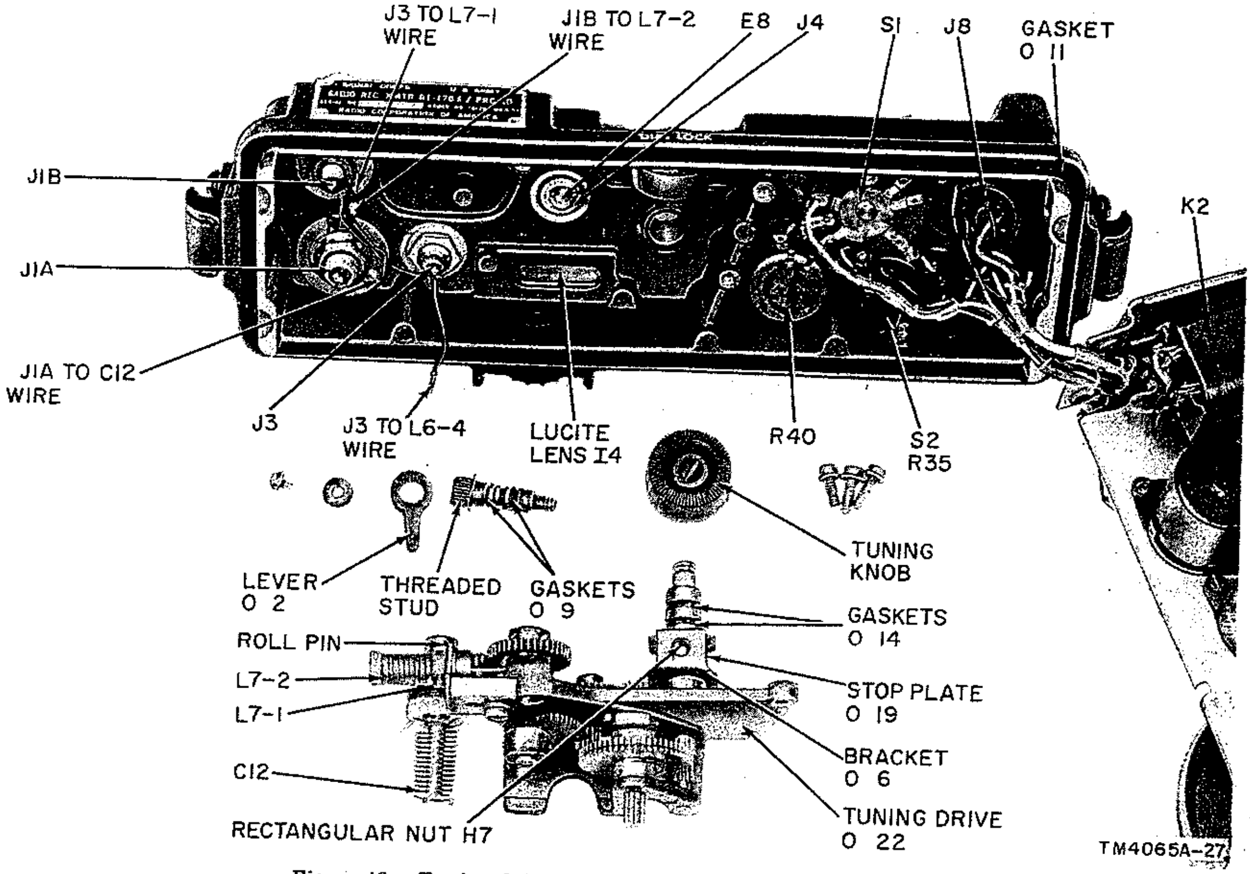



*Figure 42. Tuning drive disassembled from control panel.*

TUNING control knob and rotate the shaft to check for binding.

(3) Thread the DIAL LOCK stud into the rectangular nut until the TUNING shaft begins to lock. Just before locking, fit the lever (O 2) on the head of the stud so that the lever may be turned to lock the tuning shaft. Secure the lever with the washers and screw previously removed.

(4) Solder the three leads previously disconnected.

(5) If the mounting screw of L7 was removed, replace and tighten it in its original position. Coil L7 is adjusted when its mounting screw (see bottom view in fig. 42) appears between the center and end of the elongated hole in the mounting bracket. The mounting screw should be closer to the end at the outer edge of the bracket, so that the adjacent tuning drive screw hole will be less covered by the mounting bracket.

*d. Replacement of C12, Coil and Slug of L7 on the Tuning Drive Assembly* (figs. 42 and 43). These three electrical items are provided as spares, and after tuning drive assembly is removed, these spares can be replaced as follows:

(1) To replace the coil of L7, unfasten the screw which secures its mounting bracket to the aluminum casting of the tuning drive mechanism. Slip out the coil gently so that the slug of L7 does not fall off the casting ear into which it is hooked. Slip the new coil over the slug and secure it to the casting with the single mounting screw previously removed.

(2) To replace the slug of L7, first remove the coil as described in (1) above. Then slip off the slug and hook the new slug on the casting ear. Slip the coil over the slug, and secure it to the casting.

(3) To remove capacitor C12, drive out the roll pin through which its shaft is linked to the gear train. Slip off the gear, and

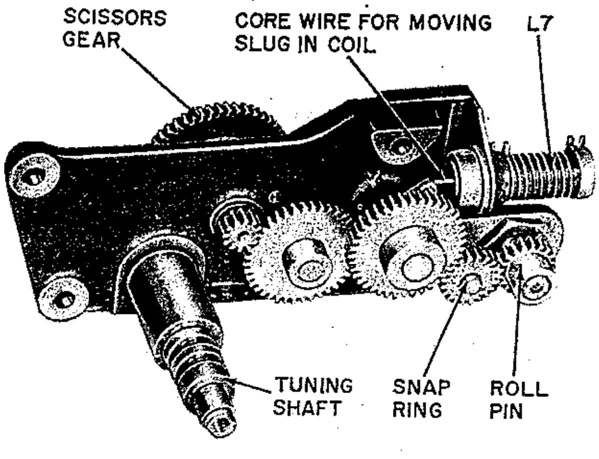



*Figure 43. Tuning drive O 22.*

then unscrew the hexagonal retaining nut that secures the capacitor to the casting. Remove the capacitor. To replace C12, position it in place on the casting and secure it tightly with the retaining nut. Instead of replacing the removed gear, remove the adjacent gear after first taking the snap ring off its shaft. Now replace the gear on the capacitor shaft, pinning it in place with the roll pin. Turn the tuning shaft fully counterclockwise and adjust the capacitor shaft so that its rotor is entirely between the stator plates. Maintain this alinement position, and carefully mesh the removed gear back into the gear train, secure it on the shaft with the snap ring.

## 72. Replacement of Control Panel

***Caution:*** Complete removal of the panel is a complicated operation. It should be performed only when repair or maintenance of the radio set makes it absolutely necessary.

*a. Complete Removal of Control Panel from Chassis.*

(1) Remove the panel as described in paragraph 70.

(2) Unfasten the center screws of the TUNING, VOL, SQUELCH, and POWER controls on the panel, and remove the knobs. Unscrew the panel nuts on the VOL, SQUELCH, and POWER controls and on the AUDIO connector so that they may slip out when the panel is removed.

(3) Remove the tuning drive assembly (par. 71) and LITE CAP socket J4. The control panel should now be completely free of the chassis.

*b. Replacement of Panel.*

(1) Replace LITE CAP socket J4, dial lock and tuning drive assembly (par. 71*c*), AUDIO connector, TUNING knob, POWER switch, and the VOL and SQUELCH controls on the control panel.

(2) Carefully position the control panel back in place over the chassis.

(3) Replace the panel on the chassis with the four 6–32 by ¼-inch binder-head screws, which were previously removed. The scissor gear of the tuning gang and the pinion of the tuning drive should smoothly mesh in their original positions.

*Note.* If other than the same (original) control panel is being replaced, mechanically aline the panel and chassis assembly as described in *c* below.

(4) Remove the spring tension clip (or bus wire) from the TUNING gang scissor gear. Replace the drum dial pointer and dial pointer spring in their original positions.

(5) Replace the two mounting screws that fasten the tuning drive mechanism to the chassis. These screws can be reached through the openings in the dial drum.

(6) Solder the two leads back to their original connections; one lead at LONG ANT connector J1–A extending coil L6, and the second lead at terminal 4 of L6 extending from AUX ANT connector J3.

*c. Mechanical Alinement of Panel and Chassis Assembly.* A jig (fig. 44) is required to assure correct mechanical alinement of the panel and chassis assembly so that it fits properly in its case.

(1) *Fabrication of jig.*

(*a*) Make the jig from a salvaged receiver-transmitter case (fig. 29).

(*b*) Remove the eight-pin male battery plug and flexible eight-wire cable from the bottom of the case; leave the female receptacle intact.

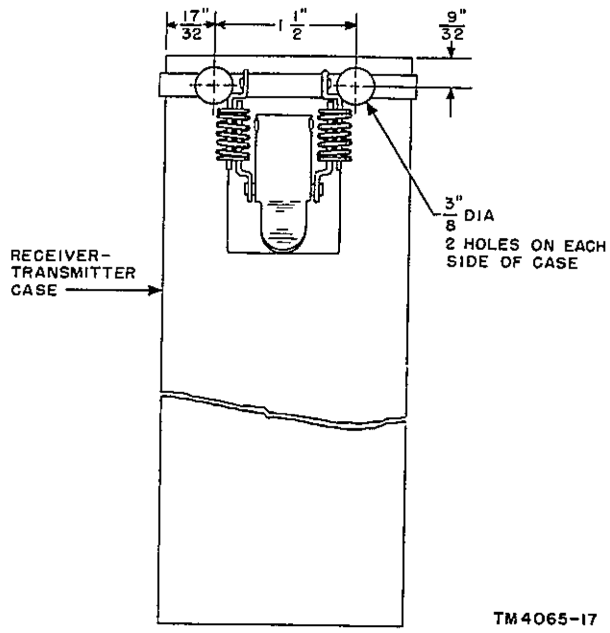



*Figure 44. Holes in jig used for panel and chassis alinement.*

(*c*) Remove the two clamps located on each side near the back (bottom) of the case.

(*d*) Drill four ⅜-inch diameter holes, two on each side of the case, near the front (top), as shown on figure 44.

(2) *Use a jig.*

(*a*) Loosen the four 6–32 by ¼-inch long binder-head machine screws that fasten the panel to the chassis. These screws are located two on each side of the chassis, just behind the edge of the panel.

(*b*) Secure the case jig in a vertical position in some convenient location. Insert the chassis (with panel attached) in the case jig and fasten the case jig clamp.

(*c*) Tighten the four 6–32 screws that fasten the panel to the chassis. These screws are accessible through the four ⅜-inch holes in the jig.

(*d*) The panel and chassis assembly is now correctly alined. Remove the assembly from the case jig by opening the clamps. It will now fit correctly when installed in its own receiver-transmitter case.

## 73. Lubrication of Tuning Drive Mechanism (fig. 45)

*a.* The tuning drive mechanism O 22 is the only lubricated assembly in the radio set. With normal care and use, it is expected that the assembly will never require additional lubrication (after leaving the factory) for the life of the radio set. If the chassis is exposed to moisture and dirt and there is corrosion or dirt on the gears, cleaning and lubrication is necessary. To thoroughly clean and lubricate the tuning drive mechanism, remove the control panel from the chassis of the receiver-transmitter (par. 70), and then remove the tuning drive mechanism from the control panel (par. 71*c*). *This should be performed only when absolutely necessary.*

*b.* Clean the tuning drive mechanism with Cleaning Compound (Federal Stock No. 7930-395-9542); be careful not to get it on other parts. Dry with a clean cloth while tuning the mechanism so that all portions will become clean and dry.

*c.* Use a small toothpick or No. 20 AWG bare wire and apply 1 drop of lubricating oil to all bearings and shafts except the gears. Use Oil, Lubricating, Preservative, Special (PL Special) in accordance with MIL–L–644A specification. Keep oil away from the two gaskets (O 6) on the tuning shaft to prevent damage to the seals. Apply this lubricating oil to the surfaces of the stop disk so that the oil may work down between the disks.

*d.* Apply grease sparingly to the teeth of the scissor gears, meshing gears, and pinions, as shown in figure 45. Use grease in accordance Grease, Aircraft and Instruments (GL), MIL–G–3278 specification. Work the grease in and spread it by turning the dial shaft several times from one end of travel to the other. Wipe off the excess lubricant from the sides of the gears and pinions.

## 74. Dial-Drum Adjustment After Replacement

*a.* Turn the TUNING capacitor exactly to its fully meshed position. This brings the low-frequency end of the dial scale opposite the dial window.

*b.* Turn the POINTER ADJUST knob and center the pointer midway between its two extremes of travel.

*c.* Position the dial drum so that the full-width line, located just below the lowest frequency mark on the dial, is lined up with the pointer. Tighten the Allen-head screw in the center of the tuning dial drum. Use a wrench and spanner to hold the bevel gear.

*Caution:* If the wrench and spanner are not used to hold the bevel gear during tightening and loosening of the Allen-head screw, damage to the bevel gear will result.

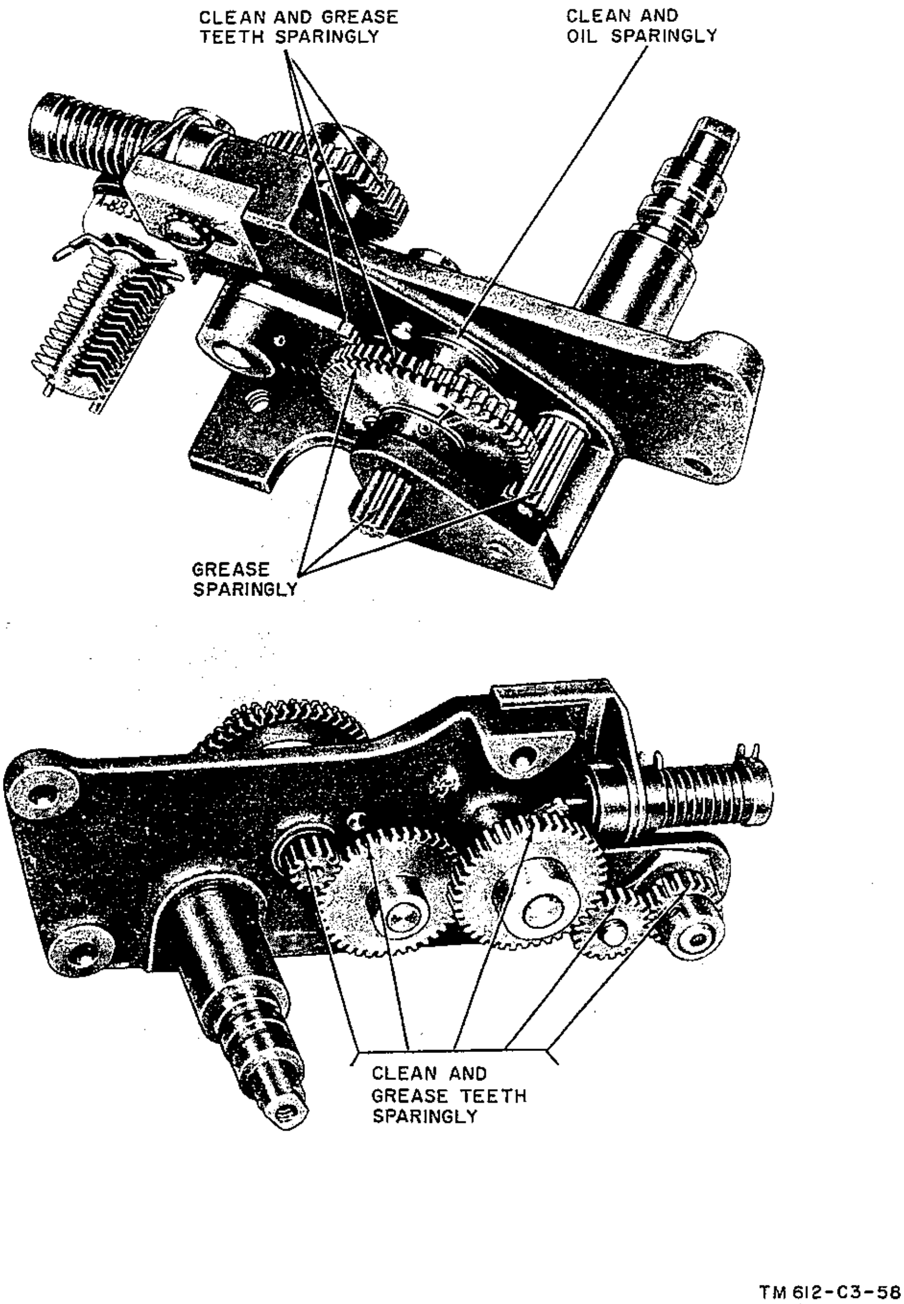



*Figure 45. Tuning drive mechanism, lubrication points.*

## Section II. REPAIR AND TEST OF IF. AMPLIFIER, DISCRIMINATOR, AND PULSE-SWEEP GENERATOR PLUG-IN UNITS

### 75. General

The repair and test of defective if. amplifier, discriminator, and pulse-sweep generator plug-in units are described in paragraphs 76 through 94. The basic repair and test procedure includes the unsealing process, the electrical troubleshooting and maintenance of a plug-in unit, and the resealing process for a repaired plug-in unit.

### 76. Test Equipment Required

The following equipment is used to test if. amplifiers V101, discriminator transformer T201, and pulse-sweep generator V301 plug-in units.

*a. Rf Signal Generator.* Rf Signal Generator Set AN/URM-25A or equivalent is used to furnish a 4.3-mc signal for testing the if. amplifier plug-in units.

*b. Multimeter.* Electronic Multimeter ME-6A/U, Voltmeter ME-30A/U or equivalent is used for discriminator transformer alinement and stage gain voltage measurements.

*c. Oscilloscope.* Oscilloscope OS-8A/U or equivalent is used for testing the pulse-sweep generator.

*d. Audio Oscillator.* Audio Oscillator TS-382A/U or equivalent is used to furnish a 10-cycle signal for the pulse-sweep generator test.

*e. Test Chassis.* This test chassis must be fabricated. The components and their values are shown in figure 46.

*Note.* The test chassis or similarly constructed device may be used until a suitable test set is standardized.

*f. Plug-in Test Cans.* Three plug-in test cans must be fabricated from spare if. plug-in cans. The modification to these cans is shown in figure 47.

*g. Battery and Battery Cable.* Battery BA-279/U and a battery cable are used to supply power to the test chassis.

### 77. Modifications to If. Amplifier Cans for Test Purposes

(fig. 47)

*a.* For test can No. 1, modify a plug-in unit in the following manner:

(1) Remove the leads from pin 1 of J101 and pin 2 of J101. Remove the lead from pin 4 of V101.

(2) Connect pin 1 of J101 to pin 4 of V101.

(3) Paint the can with a large numeral "1".

*b.* For test can No. 2 (for gain), modify a plug-in unit as follows:

(1) Remove R101. Connect a shorting wire across pins 3 and 4 of T101.

(2) Paint the can green, and print a large numeral "2" on the top.

*c.* For test can No. 2 (for alinement), strip a defective plug-in unit, and proceed as follows:

(1) Connect detector 1N81 between pins 2 and 7 of J101 (plate to pin 2 and cathode to pin 7).

(2) Connect a 100-$\mu\mu$f capacitor and 120K resistor (in parallel) across pins 7 and 3 of J101.

(3) Ground pins 1 and 3 of J101.

(4) Paint the can orange, and print a large numeral "2" on the top of the can.

### 78. Special Tools Required

The following tools are necessary to unseal, repair, and reseal the plug-in units.

*a.* A small pencil-type, 6-volt soldering iron.

*b.* One 100-watt and one 200-watt soldering irons, with specially prepared tips (fig. 48) for unsealing the can.

*c.* A 300-watt soldering iron with specially prepared tip (fig. 48) for resealing the can.

*d.* Bench fixture for holding the if. unit by the base rim and that is capable of fixing the if. unit in any position or angle desired. This device can be made from a rod one end of which is a ball that is positioned under spring tension, and other end terminated by an alligator-actuated rim fitting around the base of the plug-in unit.

### 79. Test Setup

*a.* Connect the test equipment to the test chassis (fig. 46). The test chassis includes sockets for the modified plug-in units, the 4.3-mc calibration-oscillator circuit, test sockets, and switches. On figure 47, the removed components of the modified if. test can units are shown in dotted lines and the added connections are shown in extra heavy lines. Figures 49 and 50 show two views of the discriminator, if. amplifier and pulse-sweep generator with cover removed.

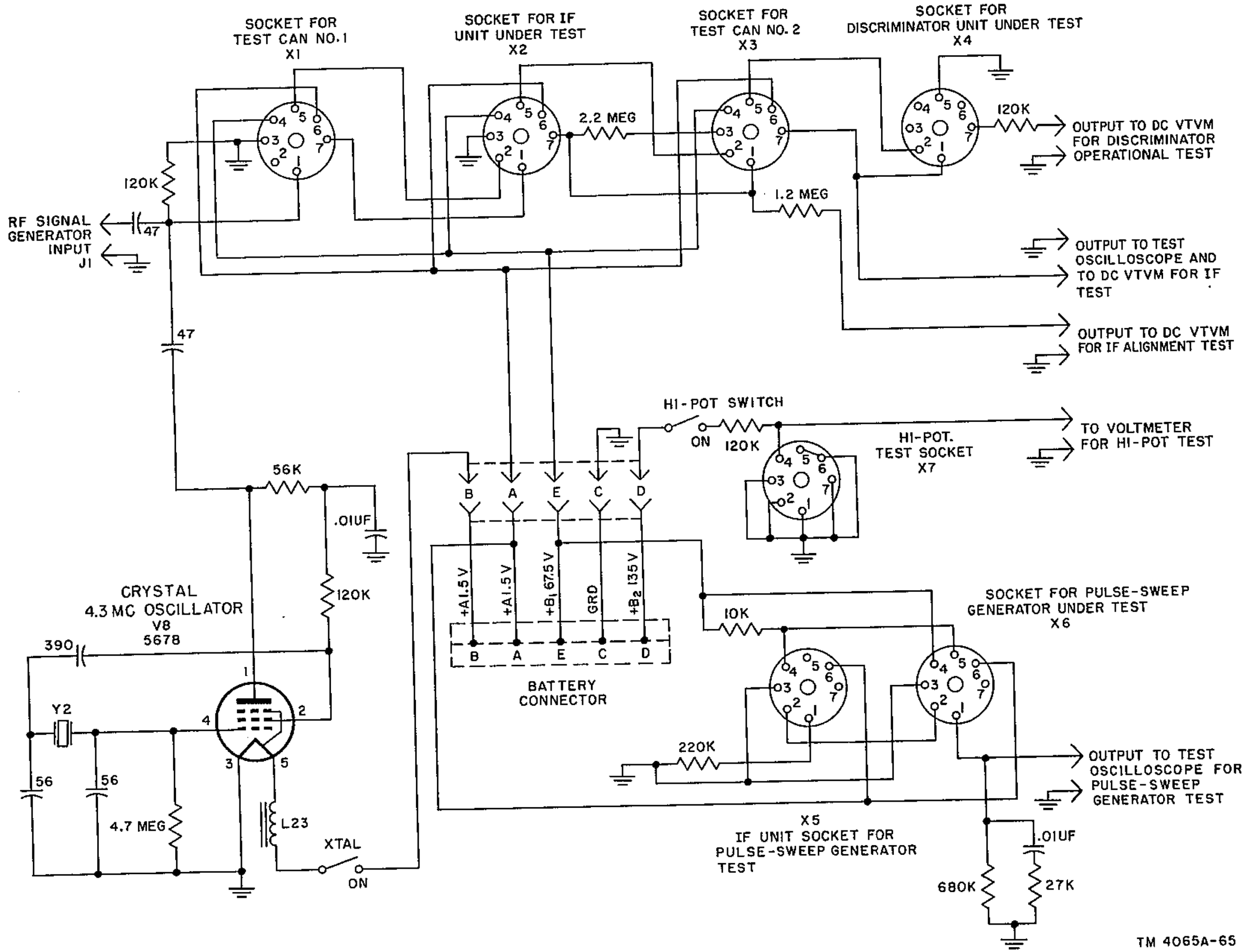



*Figure 46. Test chassis schematic diagram.*

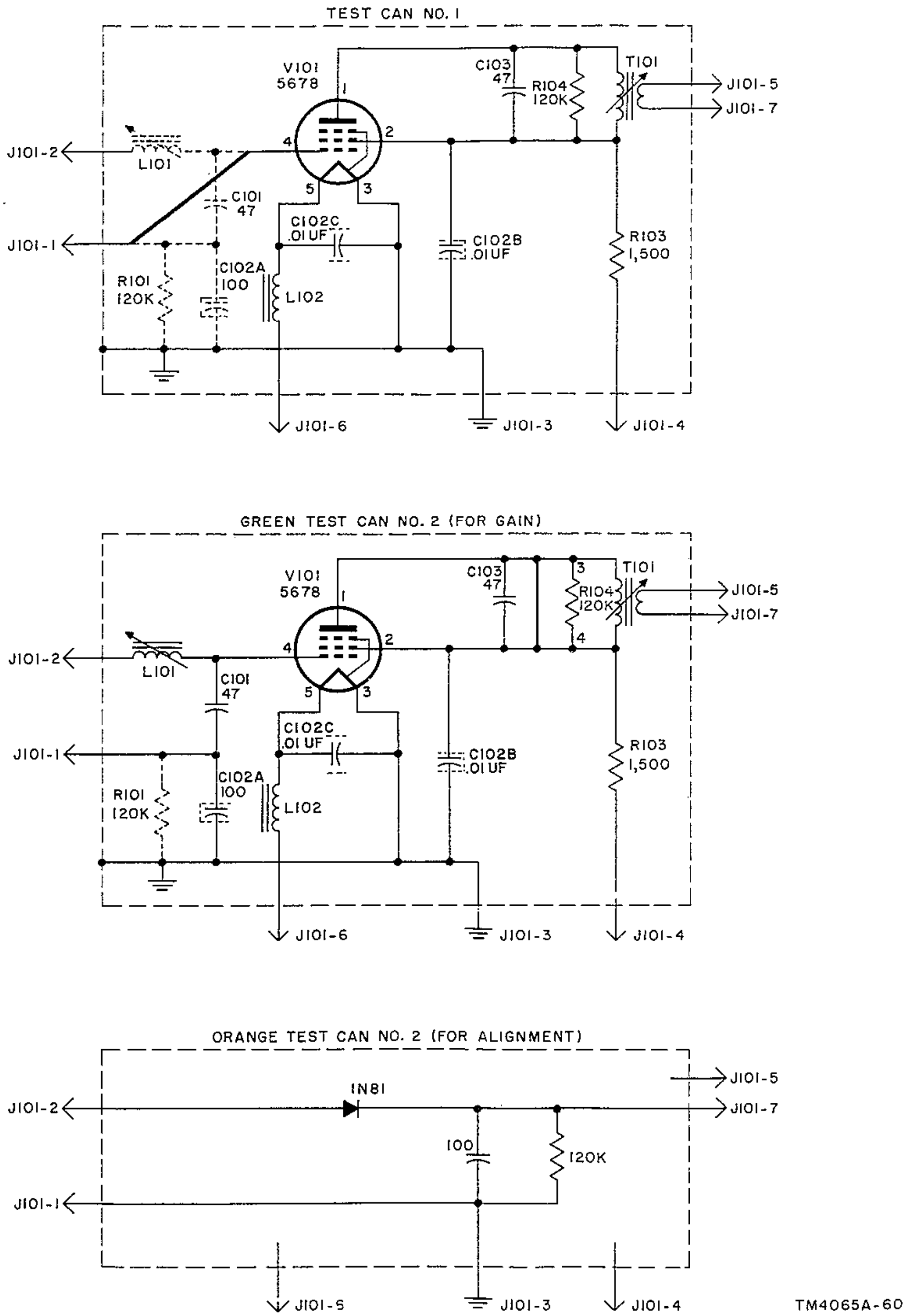



*Figure 47. Modified if. amplifier plug-in test cans.*

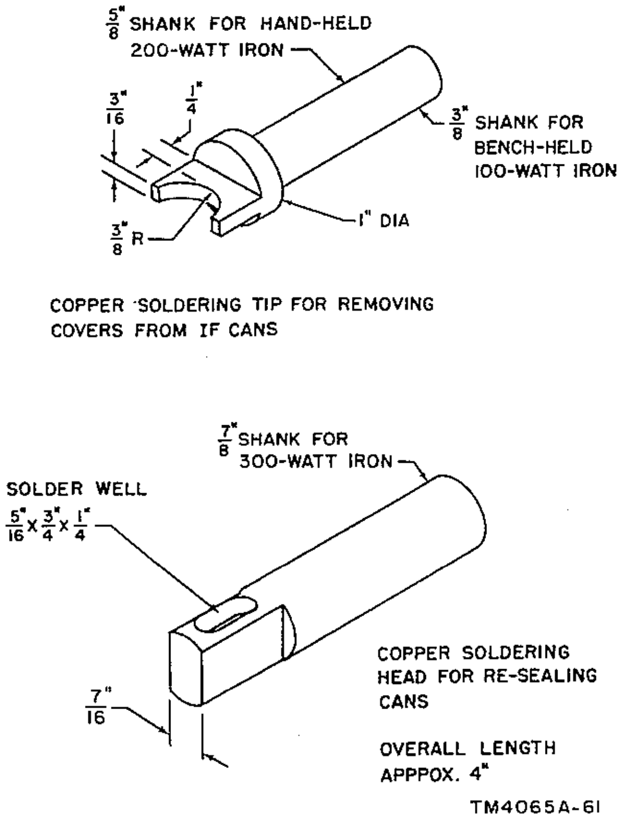



*Figure 48. Soldering iron tips.*

*b.* The battery and battery cable are the same as those used in the receiver-transmitter equipment. The test chassis requires 1.5-volt filament power, 67.5 volts and 135 volts dc power sources.

## 80. Unsealing Plug-in Units

*a.* Remove the fungus-resistant varnish on the cover of the can.

*b.* Anchor the 100-watt soldering iron with the special semicircular soldering tip (fig. 48), so that the iron will not move. Hold the 200-watt soldering iron in one hand, and clamp the circular base on the unit between the two semicircular soldering tips. Press the soldering iron so that the unit is held securely in the vertical position with its base facing upward. The assembly is held secure by the base rim and not by the shell of the can. Hold the cover of the can with one hand while holding the iron with the other hand.

*c.* As the rim of the base heats, apply pressure to rotate the cover. As soon as the solder around the rim starts to melt and the cover is felt to give, pull it straight down. Painting the rim with soldering flux may help the removal. Keep the tips clean. As the cover is pulled off, the strip of insulation is pulled off also, thereby preventing solder scrapes from getting on the unit chassis. While the unit is still warm, strike it gently on the bench to shake excess solder off the rim.

***Caution:*** Do not overheat the can. The shells are not force-fitted onto the rims, and do come off easily once the solder starts to flow. Overheating will damage the insulators around the pins in the base.

## 81. Tube Replacement Procedures

The replacement and repair of tube should only be attempted by trained technicians that have the proper tools. To replace a tube, proceed as follows:

*a.* Bend and lift the tube clamping wire until it can be brought under the tip of the tube. Be careful not to damage the tube.

*b.* Lift the tube up and then slightly off to a side to facilitate unsoldering the tube leads.

*c.* Unsolder the tube leads to the chassis and remove the tube.

*d.* Cut the leads of the new tube to proper size (use old tube as reference). Slide the new tubing on the leads that require it and then bend all leads to their approximate final position. Resolder the leads. Dress the tube and leads into position, and then slip the clamping wire back over the tube tip.

## 82. Troubleshooting Defective If. Amplifier Plug-in Units

Troubleshooting the if. amplifier units after they have been opened consists of an inspection for visible faults, a continuity and circuit check, a high potential test, and an operational check for open capacitors. If all these tests do not locate the fault, then the tube is probably defective.

*a. Inspection.*

(1) Check L101 and T101 (fig. 49) assemblies for a loose bobbin, a cracked or loose ring, or a split terminal board. These faults could be the cause of intermittent operation.

(2) Check for cracked or broken components.

(3) Check for stray particles, which may be causing a shorted or grounded circuit.

(4) Check for solder splashes, which may have occurred when the cover was removed.

*b. Continuity and Circuit Check.* The resistance measurements made with an ohmmeter should conform to the following chart:

| Checks | From | | To | | Indications (ohms) |
|---|---|---|---|---|---|
| | Pin | Of | Pin | Of | |
| T101 output winding | 3 | T101 | 4 | T101 | Approx 1. |
| Continuity through T101 | 5 | J101 | 7 | J101 | Approx 1. |
| Continuity through L101 | 2 | J101 | 2 | L101 | Approx 1. |
| C101 | 2 | J101 | 1 | J101 | Infinity. |
| R101 | 3 | J101 | 1 | J101 | 120K. |
| Continuity | 3 | J101 | Chassis | | 0. |
| C102B | 3 | J101 | 4 | J101 | Infinity. |
| R103 | 4 | T101 | 4 | J101 | 1,500. |
| V101 filament, L102 | 6 | J101 | Chassis | | 25. |

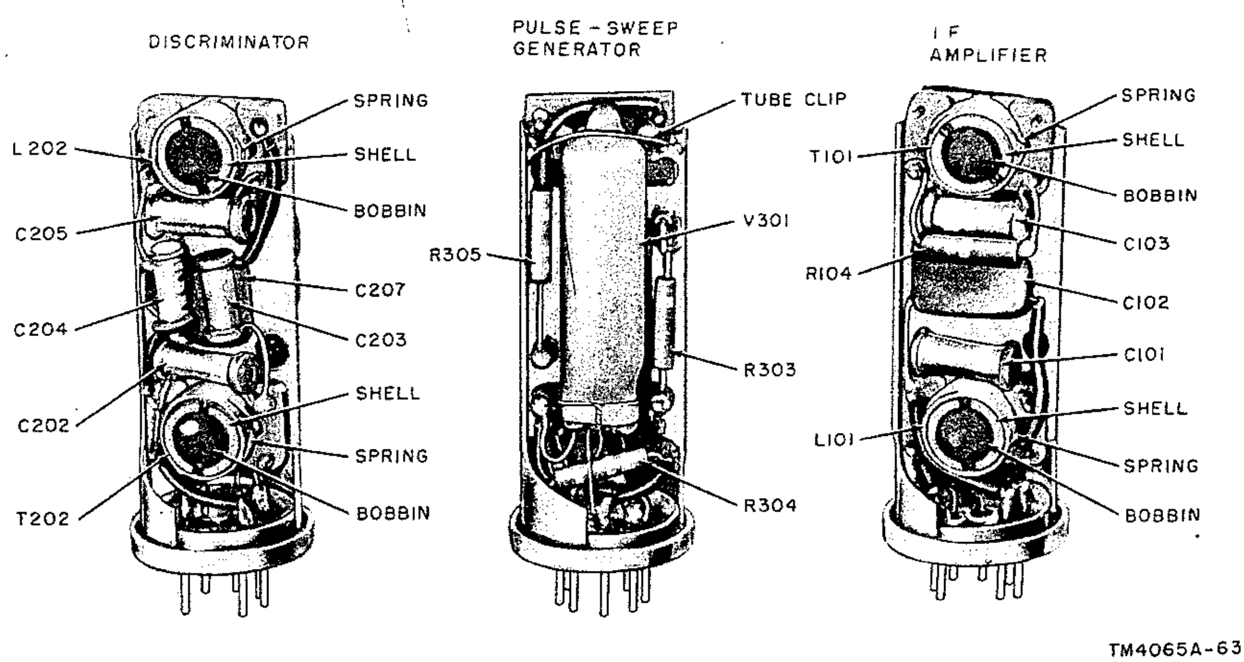



*Figure 49. Discriminator, pulse-sweep generator and if. amplifier plug-in units with covers removed.*

***Caution:*** When checking tube filament for continuity, ohmmeter must be in ×10 (or a higher scale) or the ohmmeter battery will burn out the tube filament. *Never* check filament with ohmmeter in the ×1 scale. The resistance of L102 is less than 1 ohm.

*c. High Potential Test.* Before making the operational test, always check for breakdowns under high potential as follows:

(1) Insert the unit into the high potential test socket (fig. 46) on the test chassis. Hold down the high potential switch and observe the indication on the voltmeter that is connected to the high potential output terminals. It should read approximately 135 volts. While testing, tap the can gently to check for an intermittent circuit.

(2) If the voltmeter reads zero, the unit is shorted. Reading much lower than 135 volts indicates leakage in the unit. Circuit check for the cause of trouble, as

outlined in *b* above. If this should not reveal the fault, then the trouble is probably a faulty capacitor.

## 83. Operational Check

Before making the operational check, always test the if. unit for high potential short; also check L101 and T101 for open or shorted windings. Use an if. test unit known to be in good operating condition for troubleshooting defective plug-in units. This test unit can be used to obtain typical voltage indications, signal generator input levels, and vtvm output indications and to assist in zero-beating the signal generator frequency to 4.3 mc. To make the operational check, proceed as follows:

*a.* Insert the if. plug-in unit under test into the ×2 IF. UNIT test socket. Connect the signal generator, oscilloscope, and dc vtvm, as shown in figure 46.

*b.* Tune the signal generator to 4.3 mc, and feed this signal into the test chassis at a high level (on the order of 50,000 microvolts or more). Turn on the 4.3-mc crystal oscillator circuit on the test chassis. If there is no indication of a beat note on the oscilloscope or of an output on the dc vtvm, then increase the signal generator output.

*c.* Check for an open capacitor by temporarily connecting a 47-$\mu\mu$f capacitor across C103 (fig. 49), and then across C101. If neither of these tests causes an output indication, connect a .01-$\mu$f capacitor from the chassis to C102C, C102B, and finally to C102A. If neither of these tests causes an output, tune L101 and T101.

*Note.* An output indication will be obtained only if the signal generator is tuned to 4.3 mc, inductor L101 and transformer T101 is tuned to 4.3 mc, and no open capacitors exist in the circuit. Once an indication is obtained, it is easy to determine whether the trouble is caused by misalinement of L101 and/or T101, or to a defective component.

*d.* If the trouble can not be traced to an open or shorted capacitor, misalinement, or other fault, then check the tube. Do this by substituting an if. plug-in unit known to be in good operating condition for the suspected plug-in unit.

## 84. Repair and Replacement of Transformer T101

*a.* A split or crack in the terminal (and mounting) board of T101 (fig. 49) can be repaired by using a special cement (Armstrong's adhesive A–2 or equivalent). Paint on the cement and allow the cement to set into a solid bond.

*b.* A cracked shell (ring) can be replaced by a new ring, without changing the entire transformer assembly. Unthread the cracked shell. Remove broken fragments and clean out and insert a new shell. Thread it in carefully, without forcing. Make sure the spring applies sufficient tension to hold the ring securely in position.

*c.* If a winding of T101 is open, replace the entire T101 assembly. To remove T101, first unsolder the leads of C103 and R104 (fig. 49) at terminals 3 and 4 of T101.

*d.* Bend and lift the tube clamping wire until it can be brought under the tip of the tube. Be careful not to damage the tube.

*e.* Unsolder the leads at the four terminals of T101 on the tube side of the chassis. The tube may be lifted out of the way. Figure 49 shows a partial assembly of the if. chassis. The terminal board of T101 is secured to the chassis by two lugs. These lugs pass through slots in the chassis and are twisted and soldered. Melt the solder at these two lugs, straighten the lugs, and push out the defective T101 transformer assembly, one side at a time.

*f.* Install the new T101 assembly; orient it so that the open ends of the spring are on the right side, the same as the L101 assembly (fig. 49). The L101 bobbin has a blue mark on it.

*g.* Insert the mounting lugs through the chassis slots, twist them securely, and solder. Replace the leads on the terminals of T101. Dress the tube and leads into position, and then slip the clamping wire back over the tip of the tube.

*h.* Aline the if. plug-in unit (par. 87).

## 85. Repair and Replacement of Inductor L101

*a.* A split or crack in the terminal (and mounting) board of L101 can be repaired by using cement (par. 84*a*).

*b.* A cracked shell can be replaced by a new ring, without changing the entire L101 assembly (par. 84*b*).

*Note.* The shell, or ring, used in the L101 and T101 assemblies are identical and interchangeable. The bobbins (core and winding assembly) are not the same.

*c.* To remove L101, unsolder the leads on all four of its terminals. Free the tube so that it can be shifted out of the way. Figure 49 shows a cutaway view of the if. plug-in unit. The terminal board of L101 is secured to the chassis by two lugs.

These lugs pass through slots in the chassis and are twisted and soldered. Melt the solder at these two lugs, straighten the lugs, and push out the defective L101 assembly, one side at a time.

*d.* Replace the new L101 assembly; orient it so that the open ends of the spring are on the right side, the same as the T101 assembly. Check to see that the bobbin has a red mark on it, indicating it to be a T101 assembly.

*e.* Insert the mounting lugs through the chassis slots, twist them securely, and solder. Replace the leads on the terminals of L101. Dress the tube and leads back into position.

## 86. Stage Gain

To check the stage gain of an if. plug-in unit, proceed as follows:

*a.* Connect an if. plug-in unit known to be in good operating condition into the X2 IF. UNIT test socket. Replace orange test can No. 2 with green test can No. 2 for gain test.

*b.* Adjust the signal generator frequency to 4.3 mc (unmodulated signal). Set the signal level so that an output indication is observed on the dc vtvm. Note the signal level.

*c.* Replace the good if. test unit with the repaired plug-in unit. Check the level of the unmodulated signal required to produce the same output indication on the dc vtvm. It should be within ±15 percent of the old level.

## 87. Alinement of If. Plug-in Units

To aline the if. plug-in unit, proceed as follows:

*a.* Connect the test equipment to the test chassis as shown in figure 46 (for alinement), with the oscilloscope and dc voltmeter connected to their proper outputs and the signal generator to the test chassis input. Insert the if. plug-in unit into the X2 IF. UNIT test socket on the test chassis. Check to see that test can No. 1 and orange alinement test can No. 2 are in their proper sockets.

*b.* Tune the signal generator to 4.3 mc, and feed this unmodulated signal at a level of 50,000 microvolts (or more) into the test chassis. Switch on the 4.3-mc crystal oscillator circuit on the test chassis. Tune the signal generator for zero-beat indication on the oscilloscope; this sets the input frequency exactly to 4.3 mc. Turn off the 4.3-mc crystal oscillator circuit.

*Note.* If no beat note is observed, and no indication is seen on the vtvm, the if. plug-in unit may be completely out of alinement. Tune L101 and T101 until an output is obtained. Adjust the signal generator to the crystal oscillator frequency (4.3 mc), and continue as below.

*c.* Adjust the movable rings of L101 and T101 for peak output on the vtvm. It may be necessary to reduce the output level of the signal generator as L101 and T101 are adjusted. When L101 and T101 are tuned to peak output, vary the signal generator frequency to each side of 4.3-mc and check whether the output indication drops. This method can be used to check the if. at peak output.

*d.* Detune the L101 and T101 adjustment slightly without the cover, so that when the cover is placed on the can, the if. will return to 4.3-mc.

*e.* Place the cover on the can and repeat the procedure given in *d* above, if necessary, until peak output is obtained.

## 88. Troubleshooting and Opened Pulse-Sweep Generator Plug-in Unit

Troubleshooting the pulse-sweep generator plug-in unit consists of an inspection for visible faults, a continuity and circuit check, a high potential test, and an operational check. If these tests do not locate the fault, then the tube is probably defective.

*a. Inspection.*

(1) Check for cracked, broken, or loose components.

(2) Check for stray particles, which may be causing a shorted or grounded circuit.

(3) Check for solder splashes, which may have occurred when the cover was removed.

*b. Continuity and Circuit Check.*

(1) The resistance measurements made with an ohmmeter should conform to the following chart:

| Checks | From | | To | Indications (ohms) |
|---|---|---|---|---|
| | Pin | Of | | |
| R302, R303 | 2 | J301 | Ground | 7.8 meg. |
| R301 | 1 | V301 | C301 | 470K. |
| R304 | 1 | V301 | Pin 4 of J301 | 47K. |
| R305 | 1 | J301 | C303 | 3.3 meg. |

(2) To check capacitors C301, C302, and C303 (fig. 50), disconnect one end of the capacitor to be checked and connect across it a known good capacitor of the same value. Proceed with the opera-

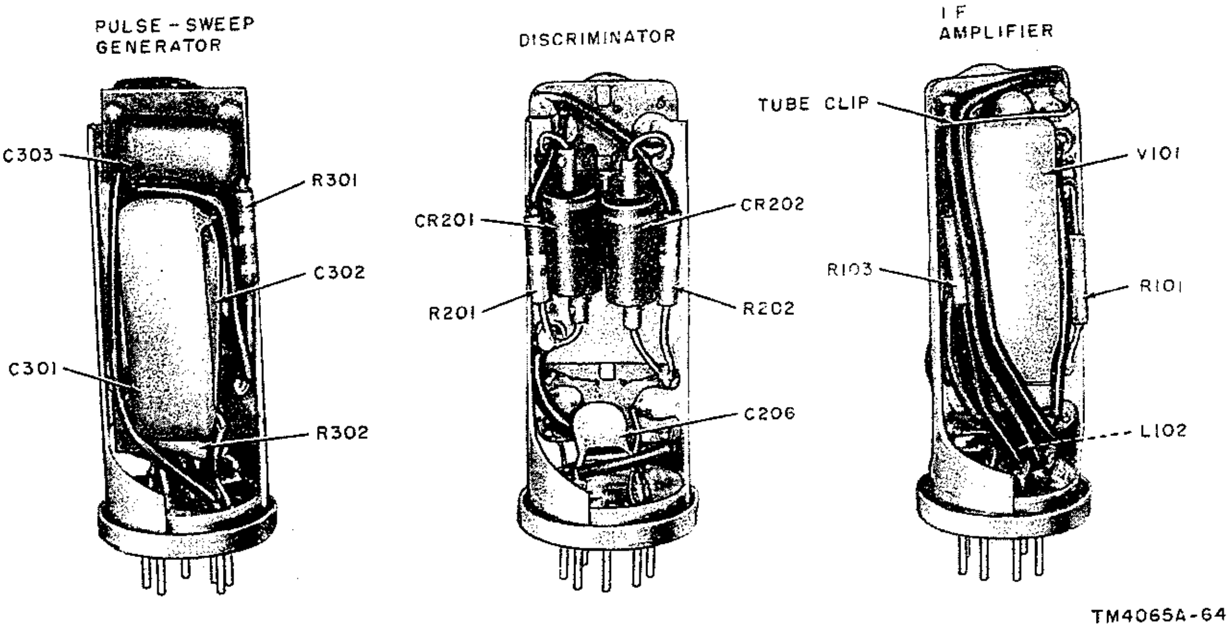



*Figure 50. Pulse-sweep generator, discriminator and if. amplifier plug-in units with covers removed.*

tional check and if requirements are met the part in question can be considered defective.

*c. High Potential Test.* The high potential test is the same as that in paragraph 82*c*.

*d. Operational Test.*

(1) *Preparatory adjustments.*

(*a*) Calibrate the timing oscillator in the oscilloscope by applying a 10-cycle audio signal from the audio oscillator to the vertical plates. Mark the position of the sweep rate knob when it is set at the maximum position at which the trace of the unit under test will "lock in." Use this mark to determine the correct knob position if it is ever moved.

(*b*) Calibrate the oscilloscope for voltage readings by applying a known 10-cycle signal of 3.55 volts rms (10 volts peak to peak) to the vertical plates and adjust the vertical gain of the oscilloscope for 20 graph divisions (2 div=1 volt).

(2) *Test procedure.*

(*a*) Before making the operational check, always test the pulse-sweep generator plug-in unit for high potential shorts.

(*b*) If the pulse-sweep generator unit checks good in the high potential test, remove the power and place the unit in pulse-sweep generator test socket X6.

(*c*) Place a known good if. plug-in unit in socket X5.

(*d*) Connect the calibrated oscilloscope to the pulse-sweep generator output jack.

(*e*) Observe the output frequency on the calibrated oscilloscope. The frequency should not exceed *10 cycles per second.*

(*f*) While still observing the oscilloscope pattern, note the output voltage peaks. These peaks should not exceed −3 volts and +2 volts.

(*g*) Replace the cover and seal as described in paragraph 94.

## 89. Troubleshooting an Opened Discriminator Plug-in Unit

Troubleshooting the discriminator plug-in unit consists of an inspection for visible faults, a continuity and circuit check, and an operational test. This circuit has no tube, therefore it does not require a high potential test.

*a. Inspection.* Follow the instructions in paragraph 88*a* for this inspection.

*b. Continuity and Circuit Checks.*

(1) With an ohmmeter, make the following checks:

| Checks | From— | | To— | | Indication (ohm) |
|---|---|---|---|---|---|
| | Pin | Of | Pin | Of | |
| T202, primary | 1 | J201 | 2 | J201 | 0 |
| T202, secondary | 1 | J201 | 2 | T202 | 1 |
| R201, R202 | 7 | J201 | 1 | J201 | 540K |
| L202 | *CR201 | ------ | CR202 | -------- | 1 |

*Disconnect CR201 and CR202 from R201 and R202 when this check is made. The forward resistance of these crystal rectifiers should be 500,000 ohms and the reverse resistance should be 330 ohms minimum.

(2) If these checks do not reveal the fault, then check each capacitor by disconnecting one end of the capacitor to be checked and placing a known good capacitor in the circuit in its place. Replace any faulty capacitor and then proceed with the operational check.

*c. Operational Check.* Refer to figure 46 for the test equipment setup and proceed as follows:

(1) Place three good if. plug-in units in test sockets X1, X2, and X3 of the test chassis.

(2) Place the discriminator plug-in unit in test socket X4.

(3) Set the rf signal generator for an output of 4.3 mc at a 50,000-uv level.

(4) At the discriminator output jack on the test chassis, note the voltmeter reading. Tune the signal generator for zero output on the voltmeter. This zero reading *must* occur within ±5 kc of the 4.3-mc center frequency.

(5) The signal generator should be tuned to 30 kc above the discriminator center frequency. Note the output voltage on the voltmeter.

(6) Tune the signal generator to 30 kc below the discriminator center frequency. Note the output voltage on the voltmeter. This voltage must be at least 75 percent of the voltage reading in the previous procedure.

(7) Detune the signal generator off center frequency until a maximum reading is obtained on the voltmeter. Note the frequency reading. Detune the signal generator in the opposite direction until a maximum voltage output is obtained. The sum of these two frequencies away from the center frequency is the bandwidth and must be at *least* 100 kc.

(8) If any or all of the requirements listed can not be obtained a component failure or misalinement is present. To realine the discriminator, proceed as follows:

(*a*) Repeat the procedure in (1) above.

(*b*) Adjust L202 for zero output at 4.3 mc.

(*c*) Tune the signal generator to 30 kc above the center frequency. Note the discriminator output voltage on the voltmeter. Tune the signal generator to 30 kc below the center frequency and note the discriminator output voltage on the voltmeter. To make these two voltages equal each other as much as possible, tune T202. Two voltages of the same value rarely occur but the closer the voltages are to each other, the better the circuit is balanced.

(*d*) The discriminator must meet the requirements previously listed.

(*e*) Replace the cover and reseal (par. 94).

## 90. Repair and Replacement of Transformer T202

*a.* A split or crack in terminal (and mounting) board of T202 (fig. 49) can be repaired by using a special cement (par. 84*a*).

*b.* A cracked shell (ring) can be replaced by a new ring, without changing the entire transformer assembly (par. 84*b*).

*c.* If a winding of T202 is open, the entire T202 assembly must be replaced. To remove T202, first unsolder the leads of C202, C207, and C203 at terminals 1 and 2 of T202.

*d.* Unsolder the leads that connect to terminals 3 and 4 of T202.

*e.* The terminal board of T202 is secured to the chassis by two lugs. These lugs pass through slots in the chassis, are twisted and soldered. Melt the solder at these two lugs, straighten the lugs, and push out the defective T202 assembly, one side at a time. Orient the new T202 assembly so that the open ends of the spring are on the right side.

*f.* Check to see that the bobbin has a yellow mark on it, indicating it to be the L202 assembly.

*g.* Insert the mounting lugs through the chassis slots, twist them securely, and solder. Replace the leads on the terminals of T202. Dress the leads into position.

*h.* Inspect, aline, and test the discriminator plug-in unit (par. 89).

## 91. Repair and Replacement of Inductor L202

*a.* A split or crack in the terminal (and mounting) board of L202 can be repaired by using cement (par. 84*a*).

*b.* A cracked shell can be replaced by a new ring without changing the entire L202 assembly (par. 84*b*).

*Note.* The shell, or ring, used in the L202 and T202 assemblies are identical and interchangeable. The bobbins (core and winding assembly) are not the same.

*c.* To remove L202, unsolder the leads on terminals 2, 3, and 4. The terminal board of L202 is secured to the chassis by two lugs. These lugs pass through slots in the chassis and are twisted and soldered. Melt the solder at these two lugs, straighten the lugs, and push out the defective L202 assembly, one side at a time.

*d.* Orient the new L202 assembly so that the open ends of the spring are on the right side. Check to see that the bobbin has a green mark on it, indicating it to be a T202 assembly.

*e.* Insert the mounting lugs through the chassis slots, twist them securely, and solder. Replace the leads on the terminals of L202. Dress the leads into the proper position.

*f.* Inspect, aline, and test the discriminator plug-in unit as described in paragraph 89.

## 92. Inspection of a Repaired Plug-in Unit

After test, repair, and alinement of the plug-in units, it is important that a close mechanical inspection be given before resealing them.

*a. Solder Faults.*

(1) Inspect all soldered points to see that none are unsoldered or cold solder joints.

(2) Remove solder splashes, wire segments, lumps of rosin, and other foreign objects. Check for tiny pieces of solder that may have stuck to leads or lodged between leads.

(3) Check for excessive solder. Sufficient spacing should exist around all soldered joints to eliminate the possibility of a shorted or grounded circuit.

*b. Broken Parts.*

(1) Check to see that the rings (shells) on inductors and transformers are not chipped so that they can be rotated by the alinement tool. If defective, replace these shells.

(2) Inspect capacitors. They should not be chipped or broken and they should not lie on the chassis at any point.

(3) Check resistors. They should not be chipped, burned, or broken and their color coding should be readable.

(4) Check to see that the terminal boards are not broken or split. Repair or replace if defective (par. 84*a*).

(5) Check to see that the tube is not chipped at the base or at the tip.

*c. Loose Parts.*

(1) Touch the bobbins and shells; they should feel secure and not loose. A loose shell may be caused by the spring wire becoming unsoldered. The bobbin is cemented on to the base; if it becomes loose, change the entire assembly.

(2) Check to see that there is no solder, dirt, metal, insulation, etc. lodged between components, ready to come loose.

*d. Lead Dress.*

(1) Check all leads to be sure they are properly dressed, and are neither too taut nor too slack.

(2) The tube should lie on the chassis. Its envelope is coated with a metallic conductive paint and is grounded by a wire (around its base) connected to tube pin 3 and chassis ground. If this lead should become ungrounded or the metallic coating breaks off the wire around the tube base, the stage may become regenerative, noisy, and cause trouble. Check to see that no ungrounded items are shorted to the grounded metallic coating of the tube.

(3) Check to see that the insulation on the insulated leads is not frayed, burned, cut, too short, bruised, or damaged.

*e. Outer Shell (Cover).*

(1) Inspect the outer shell of the can to see that there are no sharp edges or pieces of solder inside the shell (par. 94).

(2) Check the fit of the can. The assembly should slide easily into the shell without forcing, and should go in full length

without the tip of the tube touching the shell. On Sonotone-type tubes (which physically are a trifle longer than the Raytheon-type tubes) this should be carefully checked. This can be done by cutting out a window in an old shell, and checking all assemblies in it before sealing in a new shell.

*f. Wiring connections.* If repair work was done that required leads to be removed and replaced, check the wiring connections. Refer to the appropriate schematic diagram to check the wiring.

***Caution:*** Do not place an ohmmeter across the filament circuit of a tube; the battery of the ohmmeter may burn out the 1.25-volt filament winding.

## 93. High Potential Test and Alinement of Repaired Plug-in Units

Before testing a repaired unit, inspect it as outlined in paragraph 92.

*a. High Potential Test for If. Amplifier and Pulse-Sweep Generator Units.*

(1) Insert the plug-in unit into the hi-pot test socket (fig. 46). Hold down the hi-pot test switch and observe the voltmeter indication. It should read 135 volts. Tap the assembly gently to check for an intermittent circuit.

(2) Repeat the test after placing a cover over the assembly. Be sure a new sheet of insulation is placed between the cover and the assembly.

*b. Alinement.* Aline the unit and reseal it.

## 94. Resealing Plug-in Unit

Replace the cover of the units with new shells if available. If a shell must be reused, clean off the solder by painting on flux, then dipping the lower portion of the shell into a pot of melted solder, and slowly withdrawing the shell. The top of the cover should also be cleaned, and the hole left in the center of the top.

*a.* Fit the sheet of insulation around the assembly, and close the shell over the assembly. The cover should fit snug into the rim of the base.

*b.* Prepare a well of melted solder on the special soldering tip of the 300-watt iron. The soldering iron should be anchored rigid.

*c.* Hold the unit in a horizontal position. Use a gripper to hold the cover at one end, and another gripper to hold the base pins at the opposite end. Exert just sufficient pressure at each end so that the cover is seated all the way in the rim of the base.

*d.* Lower the if. unit over the soldering iron so that the seam to be soldered is in the well of the molten solder. Then slowly rotate the if. unit horizontally about its axis, so that the circular seam rolls through the molten solder and becomes sealed.

*e.* Test the solder seal at the base by applying air under pressure (2 pounds per square inch) through the hole in the top of the can, or by blowing into it and immersing in water. No bubbles should appear, indicating an airtight seal at the base.

*f.* Complete the sealing of the if. unit by soldering the hole at the top of the cover. Do not let excessive solder enter the can.

*g.* Coat the cover with a moisture- and fungus-resistant varnish, after masking the base so that the pins and underside of the base are not affected.

*h.* After resealing the repaired plug-in unit, check it electrically before placing it into service.

# CHAPTER 5

# ALINEMENT

## 95. Test Equipment Required for Alinement

The following test equipment is required for alinement of Radio Sets AN/PRC–9A and –10A:

| Item | Technical manual |
|---|---|
| Signal Generator AN/URM–48 | TM 11–1257 |
| Electronic Multimeter TS–505/U | TM 11–5511 |
| Rf Wattmeter ME–11/U | |
| Frequency Meter TS–174B/U | TM 11–5044 |

## 96. Discriminator, If., and Pulse-Sweep Generator Alinement

These plug-in units are all hermetically sealed and properly alined at the factory. Consequently, if any one of these units is found to be out of alinement or defective, substitute a good unit for the defective unit. The test, repair, and alinement of the defective plug-in unit can be performed by a skilled technician by following the procedures outlined in paragraphs 75 through 94.

## 97. Mixer Alinement

(fig. 51)

To aline the mixer stage, proceed as follows:

*a.* Connect the vtvm across terminal 4 of test socket J7 to ground.

*b.* Apply a 4.3-mc signal to test point E19 (fig. 33) through a 1,000-$\mu\mu$f blocking capacitor. Tune the rf signal generator input to exactly 4.3 mc, by holding the POWER switch in CAL & DIAL LITE position while adjusting the input signal for a zero beat in the handset.

*c.* Set the POWER switch to ON. Use the alinement tool (mounted on the chassis) to adjust the core of T2 (fig. 33) for maximum negative voltage on the vtvm. *Do not apply excessive pressure because transformer T2 is fragile and can be easily broken.*

## 98. Receiver Oscillator Alinement

(fig. 51)

*a.* Center the pointer of the receiver-transmitter (fig. 3) to the middle of its extremes of travel. Turn the main TUNING capacitor to its fully meshed position. When this is done, a marker line, located just below the lowest frequency mark on the dial drum, should be within one-half of a small division of the dial from the previously set pointer. If this condition is not possible, readjust the dial drum as instructed in paragraph 74.

*b.* Set the receiver-transmitter to 38.7 mc (27.95 mc on AN/PRC–9A). Calibrate the rf signal generator to this frequency (use Frequency Meter TS–174B/U), and then connect it into the radio set through AUX ANT connector J3. Connect the vtvm across terminal 4 of test socket J7 and ground. Adjust coil L21 (fig. 33) in the receiver oscillator for maximum negative voltage on the vtvm. Reduce the output voltage of the signal generator to a level just enough to enable a peak reading to be obtained on the vtvm. Check against unwanted signal pickup from other sources by varying the output control of the signal receiver. The vtvm reading should vary correspondingly.

*c.* Set the receiver-transmitter to 53.75 mc (38.7 mc on AN/PRC–9A). Calibrate the signal generator to this frequency. Adjust capacitor C43 (fig. 33) in the receiver oscillator for maximum voltage on the vtvm.

*d.* Repeat procedures in *b* and *c* above until no further adjustments of L21 and C43 are necessary for peak output at the low and high frequency ends of the band. Finish the alinement at the high frequency end with adjustment of C43.

## 99. Rf Alinement

(figs. 51 and 52)

*a.* Set the receiver-transmitter to 38.7 mc (27.95 mc on AN/PRC–9A). Calibrate the rf signal generator to this frequency. Connect the vtvm across terminal 4 of test socket J7 and ground.

*b*. Connect the rf signal generator in series with a 33-ohm resistor to the AUX ANT connector J3. Vary the rf signal generator tuning dial slightly until maximum reading on the vtvm is obtained. Adjust coils L13, L11, and L9 (fig. 33) in that order for maximum reading on the vtvm, while reducing the rf signal generator output voltage to a level just sufficient for peak reading

*c*. Tune the receiver-transmitter and rf signal generator to 53.75 mc (38.7 mc on AN/PRC–9A). Vary the rf signal generator tuning dial slightly for peak reading on the vtvm. Adjust capacitors C26, C22, and C20 (fig. 33) in that order for maximum reading on the vtvm.

*d*. Repeat the adjustments of L13, L11, and L9 at 38.7 mc and C26, C22, and C20 at 53.75 mc, until no further adjustments are necessary for peak output.

*e*. Check the receiver alinement with the crystal-controlled 2.15-mc calibrating oscillator V9 as follows. Connect a handset to AUDIO connector J8. Hold the POWER switch in CAL & DIAL LITE position and slowly rotate the TUNING control from the low end of the dial to the high end. A beat note should be heard at each red-marked calibration point on the dial. If satisfactory results are not obtained, repeat the alinement procedures for the mixer, receiver oscillator, and rf amplifier stages. A summarized chart for the receiver alinement is given below.

*Receiver alinement*

| Step | Tune rf signal generator to (mc) | | Apply input to | Adjust TUNING capacitor for | Set POWER switch to | Adjust | Indication (vtvm or handset) |
|---|---|---|---|---|---|---|---|
| | AN/PRC-9A | AN/PRC-10A | | | | | |
| 1a | 4. 3 | 4. 3 | Test point E-19 through a 1,000 $\mu$f capacitor. | ---------- | CAL & DIAL LITE. | Rf signal generator. | Zero beat in handset. |
| 1b | 4. 3 | 4. 3 | Test point E19 through a capacitor. | ---------- | ON---------- | T2 core---------- | Peak negative voltage. |
| 2a | 27. 95 | 38. 7 | AUX ANT J3---------- | 38.7 calibration mark (27.95 mc on AN/PRC-9A). | ON---------- | L21---------- | Peak negative voltage. |
| 2b | 38. 7 | 53. 75 | AUX ANT J3---------- | 53.75 calibration mark (38.7 mc on AN/PRC-9A). | ON---------- | C43---------- | Peak negative voltage. |
| 3a | 27. 95 | 38. 7 | J3 through a 33-ohm resistor- | 38.7 mc (27.95 mc on AN/PRC-9A). | ON---------- | L13, L11, L9--- | Maximum reading. |
| 3b | 38. 7 | 53. 75 | J3 through a 33-ohm resistor- | 53.75 mc (38.7 mc on AN/PRC-9A). | ON---------- | C26, C22, C20-- | Maximum reading. |
| 4 | ---------- | ---------- | ---------- | Vary slowly from 38 to 55 mc (27 to 39 mc on AN/PRC-9A). | CAL & DIAL LITE. | ---------- | Zero beat at each calibration point on dial. |

*Note.* Connect Handset H-33B/PT into AUDIO connector J8, and connect vtvm across to pin 4 of test socket J7 and ground.

## 100. Transmitter Alinement

(figs. 33 and 52)

Aline the transmitter only after the receiver has been alined. Proceed as follows:

*a.* Turn the stem of coil L3 clockwise to the bottom position.

*b.* Turn C11 to the position where the top of the stem is flush with the bottom of the mounting plate on which the mounting brackets for the alinement tool are located.

*c.* Adjust neutralizing capacitor C17 to minimum capacitance; that is, the red dot on the movable portion is farthest from the two mounting holes at the base of the capacitor. Maximum capacitance is indicated when the red dot is on the side of the two mounting holes and between them.

*d.* Connect the wattmeter between AUX ANT jack J3 and chassis ground.

*e.* Connect the ground lead of the vtvm to chassis ground; connect the dc probe to pin 3 of test socket J7. Zero the pointer on the vtvm.

*f.* Set the frequency meter to 39 mc (28 mc for AN/PRC–9A), and let it transmit at this frequency. Hold the POWER switch of the radio set in CAL & DIAL LITE position. Turn the TUNING control to 39 mc (28 mc on AN/PRC–9A), and adjust it for zero beat in the handset. Lock the TUNING control (with the DIAL LOCK lever) at this frequency. Release the POWER switch to ON. The receiver-transmitter is now set at the low-end alinement frequency, and the frequency meter acts as a standard frequency reference.

*g.* Lock the radio set in transmit operation by taping down the push-to-talk button on the handset, or fabricate a spring clip for use in holding down the button. Disable the afc circuit by removing the second if. plug-in can (U102) and the pulse-sweep generator plug-in can (U301).

*h.* Adjust the frequency meter for use as a heterodyne detector at 39 mc, and tune L3 until zero beat is obtained in the headset of the frequency meter. The low end of the transmitter is now tuned to exactly the same frequency as the low end of the receiver.

*i.* Adjust L9 for maximum rf power output (as indicated on the wattmeter or its equivalent). Readjust L3 for zero beat.

*j.* Set the frequency meter to 54 mc (38 mc for AN/PRC–9A), and let it transmit at this frequency. Replace plug-in cans U102 and U301. Unlock the push-to-talk button on the handset, so that the radio set is in the receive condition. Hold the POWER switch in CAL & DIAL LITE position. Turn the TUNING control to 54 mc (38 mc on AN/PRC–9A), and adjust for zero beat in the headset at this frequency. Release the POWER switch to ON. The receive-transmitter is now set at the high-end alinement frequency, and the frequency meter acts as a standard frequency reference at the high end.

*k.* Lock the radio set in the transmit operation by taping down the push-to-talk button on the handset, or fabricate a spring clip for use in holding down the button. Again remove plug-in cans U102 and U301 to disable the afc circuit.

*l.* Adjust the frequency meter for use as a heterodyne detector, and tune C11 until zero beat is obtained in the headset of the frequency meter. Adjust C20 for maximum rf power output (as indicated on the wattmeter), and then readjust C11 for zero beat. The high end of the transmitter is now tuned to exactly the same frequency as the high end of the receiver. Replace plug-in cans U102 and U301.

*m.* Adjust the neutralizing capacitor C17 so that the transmitter frequency shift is less than 1,000 cycle when the wattmeter is removed and the AUX ANT center conductor is shorted to its outer conductor. Short the AUX ANT conductors in the most direct and shortest way possible. Measure the frequency shift on the frequency meter. This neutralizing adjustment may be made only at the high-end alinement frequency.

*n.* Remove the AUX ANT short, and reconnect the wattmeter. Readjust C20 for maximum power output and then C11 for zero beat on the frequency meter headset while it is set at the 54-mc (38 mc on AN/PRC–9) high-end alinement frequency.

*o.* Repeat the low-end, high-end, and neutralizing alinement procedures (*f–n* above) until no further adjustment is necessary.

*p.* Check the transmitter alinement at 54 mc (38 mc on AN/PRC–9A) as follows: Connect a vtvm to pin 3 of test socket J7. Measure the voltage with the transmitter operating at 54 mc (38 mc on AN/PRC–9A) into the wattmeter connected to J3. Turn off power, remove the wattmeter from AUX ANT J3, and short the center conductor of J3 directly to its outer conductor. Turn on power, and with the transmitter operating into the shorted antenna jack, check for a change in the voltage reading on the vtvm. It should not change more than .2 volt. A summarized chart of the transmitter alinement is given below.

*Transmitter alinement*

| Step | Set frequency meter to | Adjust radio set TUNING control (mc) to | | Position of push-to-talk switch | Adjust | Indication |
|---|---|---|---|---|---|---|
| | | AN/PRC-9A | AN/PRC-10A | | | |
| 1*a* | 39 mc (transmit) (28 mc for AN/PRC-9A). | 28 | 39 | Receive | TUNING control to 39 mc (28 mc on AN/PRC-9A). | Zero beat in radio set handset. |
| 1*b* | 39 mc (heterodyne) (28 mc for AN/PRC-9A). | 28 | 39 | Transmit | L3 | Zero beat in frequency meter headset. |
| 1*c* | ---------- | 28 | 39 | Transmit | L9 | Maximum rf output on wattmeter. |
| 1*d* | 39 mc (heterodyne). Repeat step 1*b* | 28 | 39 | Transmit | L3 | Zero beat in frequency meter headset. |
| 2*a* | 54 mc (transmit) (38 mc for AN/PRC-9A). | 38 | 54 | Receive | TUNING control to 54 mc (38 mc on AN/PRC-9A). | Zero beat in radio set handset. |
| 2*b* | 54 mc (heterodyne) (38 mc for AN/PRC-9A). | 38 | 54 | Transmit | C11 | Zero beat in frequency meter headset. |
| 2*c* | ---------- | 38 | 54 | Transmit | C20 | Maximum rf output on wattmeter. |
| 2*d* | 54 mc (heterodyne). Repeat step 2*b* | 38 | 54 | Transmit | C11 | Zero beat in frequency meter headset. |
| 3*a* | 54 mc (heterodyne) (38 mc for AN/PRC-9A). | 38 | 54 | ---------- | C17 | Less than 1,000-cycle frequency shift when AUX ANT is shorted. |
| 3*b* | 54 mc (heterodyne) (38 mc for AN/PRC-9A). | 38 | 54 | ---------- | C11 | Zero beat in frequency meter headset. |
| 3*c* | ---------- | 38 | 54 | ---------- | C20 | Maximum rf output on wattmeter. |
| 3*d* | 54 mc (heterodyne) (38 mc for AN/PRC-9A). | 38 | 54 | Transmit | C11 | Zero beat in frequency meter headset. |
| 4 | Repeat steps 1*a* through 3*d* until no readjustments are necessary. | | | | | |
| 5 | Check alinement by observing less than .2 volt change on vtvm when wattmeter is removed and J3 shorted. | | | | | |

*Note.* Connect wattmeter to AUX ANT jack J3; and connect vtvm to pin 3 at test socket J7.

# CHAPTER 6

# FINAL TESTING

## 101. Purpose of Final Testing

The tests described in paragraphs 102 through 127 are made to assure that a repaired equipment meets minimum performance standards before being issued for service. If the equipment fails to pass any of these tests, troubleshooting and repair procedures must be performed to correct the trouble.

## 102. Test Equipment Required for Final Testing

Test equipment required for final testing Radio Set AN/PRC–9A and –10A is as follows:

*a. Rf Signal Generator.* The rf signal generator (Signal Generator AN/URM–48 or equivalent) must supply up to 1,000 microvolts (uv) at 20 to 100 mc; must have up to 25 kc deviation; must have modulating frequencies of 250, 400, 1,000, 2,500, and 5,000 cps, or provide for external modulation; and must have an output impedance not exceeding 50 ohms.

*b. If. Signal Generator.* The if. signal generator (Signal Generator I–208 or equivalent) must supply a 4.3-mc signal with an output of at least .2 volt. The signal frequency must be continuously variable between 4.27 and 4.33 mc.

*c. Audio Oscillator.* The audio oscillator (Audio Oscillator TS–382/U or equivalent) must supply audio signals from 250 to 5,000 cps.

*d. Millivoltmeter.* The millivoltmeter (Electronic Multimeter ME–6A/U, Voltmeter ME–30A/U (or equivalent) must be able to measure ac voltage in millivolts.

*e. Frequency Meter.* The frequency meter (Frequency Meter TS–174B/U or equivalent) must be capable of measuring frequencies from 27 to 55 mcs.

*f. Electronic Voltohmmeter.* The electronic voltohmmeter (Electronic Multimeter TS–505/U or equivalent) must be able to measure dc voltages and must have an input resistance of not less than 10 megohms on all voltage ranges.

*g. Output Meters.* The output meter (Output Meter TS–585A/U or equivalent) must read directly in mw and must offer an impedance of 600 ohms.

*h. Panoramic Indicator.* The panoramic indicator (Panoramic Indicator IP–173/U or equivalent) must be capable of indicating deviation frequencies from 5 to 17 kc.

*i. Rf Wattmeter.* The rf wattmeter (Rf Wattmeter ME–11/U or equivalent) must be capable of accurately reading radio-frequency power outputs from 0 to 2 watts. It must have a termination impedance of 50 ohms (nonreactive).

*Note.* To aid in servicing, a cable may be made that has a plug for mating with J8 at one end and a terminal board at the other end. Test connections could then be made to this terminal board for independently turning on and off the transmitter, headset connections, and audio oscillator input.

## 103. Test Setup and Standard Conditions for Receiver Testing

Most of the tests on the receiver section are performed under the standard conditions listed below and illustrated in figure 51. Modifications from this basic setup are covered in the paragraphs for the individual tests.

*a.* Connect a 33-ohm resistor as dummy antenna in series with the rf signal generator. Connect a 50-ohm terminating resistor across the rf signal generator (fig. 51). Use ½-watt carbon resistors.

*b.* Connect the output meter across terminals A and B of AUDIO connector J8. Set the impedance control knob of the output meter for 600 ohms. Connect the millivoltmeter in parallel with the output meter; connect the *hot* side of the millivoltmeter to pin A. Pin B connects to chassis ground.

*c.* Apply an rf input signal of .7 microvolt 15-kc deviation at 1,000 cps to AUX ANT connector J3. This will be referred to as the *standard rf input.*

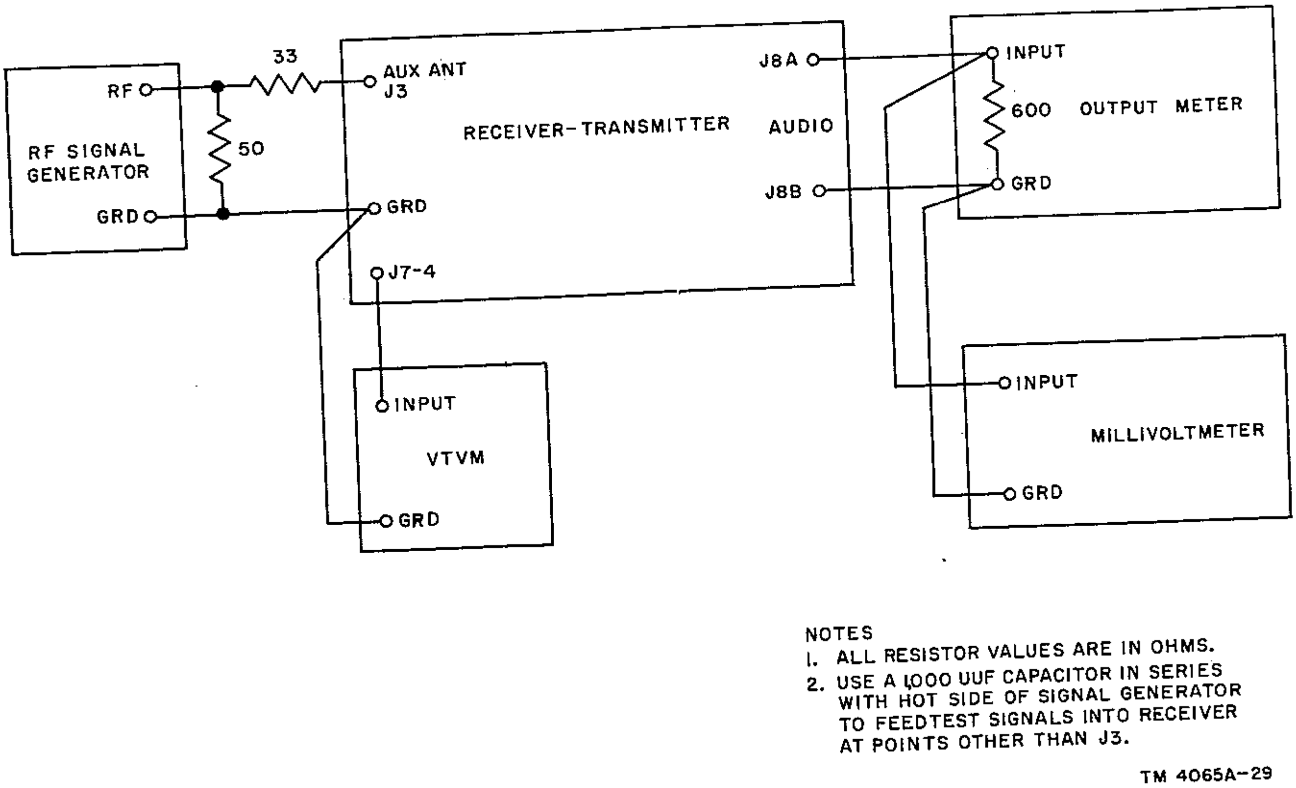



*Figure 51. Connections for receiver testing.*

*d.* Maintain the audio output level (at terminal A of AUDIO connector J8 across a 600-ohm load impedance) constant at 1 milliwatt by adjustment of the VOL control. This will be referred to as the *Standard audio output.*

*e.* Connect an electronic voltohmmeter (vtvm) across pin 4 of test socket J7 to ground.

## 104. Receiver Quieting Sensitivity

*Note.* The following tests are made at signal frequencies of 39, 47, and 54 mc with Radio Set AN/PRC-10A, and 28, 33, and 38 mc with Radio Set AN/PRC-9A. All the signal frequencies shown in parentheses are used only with the AN/PRC-9A.

The receiver quieting sensitivity test measures the ratio of the receiver noise output with no signal input to the receiver noise output with an unmodulated signal input. The receiver volume control should be set for *standard audio output* (par. 103*d*) with *standard rf input* (par. 103*c*).

*a.* Connect the radio receiver-transmitter as shown in figure 51. Set the rf signal generator to supply a 39-mc (28-mc) signal at 1.5 uv of unmodulated output.

*b.* Adjust the radio set for 39 mc (28 mc). Tune the signal generator for maximum limiter grid voltage on the vtvm, and then adjust the fine tuning of the signal generator for maximum dip on the audio voltmeter. Turn the SQUELCH control to OFF.

*c.* Reduce the signal generator output to .7 uv, and turn on frequency modulation of 15-kc deviation at 1,000 cps.

*d.* Adjust the radio set VOL control for 1 milliwatt of audio output power. The set is now adjusted for standard audio output with standard rf input.

*e.* Reduce the rf signal generator output to zero, and note the db reading on the output meter.

*f.* Set the rf signal generator for 1.5 uv of unmodulated carrier output. The db drop from that noted in *e* above should be at least 16 db (17 db in AN/PRC-9A).

*g.* Repeat the test at 47 mc (33 mc) and at 54 mc (38 mc).

## 105. Receiver Operating Sensitivity and Squelch Sensitivity

The operating sensitivity test measures the ratio of the standard audio output with standard modulated input to the audio output with unmodulated signal input. It is a signal-plus-noise to noise test in which the receiver volume control is preset for *standard audio output* with *standard rf input*. The squelch sensitivity test measures the ratio of the modulated signal input needed to release K2 when the SQUELCH control is at maximum to the modulated signal input needed to release K2 when the SQUELCH control is set at the minimum level, which energizes K2.

*a.* Connect the radio receiver-transmitter as shown in figure 51. Set the rf signal generator to supply an unmodulated standard rf input signal at 47 mc (33 mc).

*b.* Turn the SQUELCH control to OFF. Set the radio set to the rf signal generator frequency, and then tune the input signal for maximum limiter grid voltage on the vtvm. Adjust the rf signal generator fine tuning for maximum dip on the output meter.

*c.* Adjust the rf signal generator for modulation of 15-kc deviation at 1,000 cps. The indication on the output meter should not be less than 1.2 milliwatts.

*d.* Adjust the radio set VOL control for 1 milliwatt of output (standard output).

*e.* Turn off the rf signal generator modulation. There should be a minimum drop of 11 db (12 db in AN/PRC–9A). This is the db measure of receiver operating sensitivity.

*f.* Turn the modulation on, and decrease the rf signal generator output to zero.

*g.* Turn the SQUELCH control clockwise until the audio (noise) output cuts off due to relay K2 energizing.

*h.* Turn the SQUELCH control counterclockwise until audio output returns (relay K2 releases). Audio should reappear within three dots on the SQUELCH control scale. Repeat the procedures given in *g* above.

*i.* Increase the rf signal generator input until the audio output returns. This should occur before the rf signal generator output reaches 2 microvolts.

*j.* Turn the SQUELCH control to maximum clockwise position.

*k.* Increase the rf signal generator input until the audio output returns. At this point, the input should be less than 100 microvolts. The rf signal generator input in this procedure (SQUELCH control at maximum) should be at least four times as great as the input obtained in *i* above. This is a measure of squelch sensitivity.

*l.* Turn the SQUELCH control to OFF, and repeat the test at 54 mc (38 mc).

## 106. Receiver Overall Selectivity

This test measures the receiver band width at two points on the voltage response curve: at two times down and at 1,000 times down. The centering of the response curve about the carrier frequency is also checked.

*a.* Connect the radio receiver-transmitter as shown in figure 51. Turn the SQUELCH control to OFF. Set the rf signal generator to supply an unmodulated signal of 1 microvolt at 47 mc (33 mc).

*b.* Tune the radio set to 47 mc (33 mc), and then adjust the rf signal generator for maximum limiter grid voltage on the vtvm. Adjust the fine tuning for maximum dip on the output meter.

*c.* Set the rf signal generator input for −5 volts of limiter grid voltage on the vtvm. Note the input required.

*d.* Double the rf signal input noted in *c* above. Now vary the frequency of the input signal on both sides of the resonant frequency until the same meter reading (−5 volts) is observed on each side. Note the frequency deviations from the carrier frequency. Their sum should be between 72 and 88 kc (65 and 85 KC with AN/PRC–9A). Their difference divided by 2 should be less than 4 kc (5 kc).

*e.* Increase the rf signal input to 1,000 times the input noted in *c* above. Again vary the frequency of the input signal until the reference meter reading (−5 volts) is observed on each side of the center frequency. Note the frequency deviations. Their sum should not exceed 280 kc.

*Note.* In *d* and *e* above, vary the frequency of the rf signal generator in a slow uniform manner so that irregularities in the response characteristic, if they exist, can be observed.

*f.* The center frequency of the overall selectivity curve is that frequency between the two frequencies at the two times down points (*d* above). The center frequency should be within 4 kc (5 kc) of the carrier frequency.

## 107. Spurious Responses

Spurious responses are responses to undesired signals. A good radio receiver should have a high rejection ratio for such unwanted signals.

*a.* Connect the radio receiver-transmitter as shown in figure 51. Apply an unmodulated 1-microvolt input signal at 47 mc (33 mc).

*b.* Measure the voltage at terminal 4 of J7 (limiter grid voltage) with a vtvm and record these readings.

*c.* Increase the rf signal generator output voltage 100,000 times (100 db) and tune the rf signal generator from 2 to 100 mc while observing the voltage reading at terminal 4 of J7. At those frequencies that produce a limiter grid voltage greater than the readings recorded in *b* above, decrease the rf signal generator voltage to a value that will produce the same limiter grid voltage reading. The ratio of this signal voltage to 1 uv (2.5 uv on AN/PRC-9A) is the rejection ratio for that frequency.

*d.* The rejection ratio of spurious responses, including those of the image frequency (dial frequency plus 8.6 mc), should be greater than 60 db (voltage ratio of 1,000). The rejection ratio of the if. should be greater than 100 db (voltage ratio of 100,000).

## 108. Receiver Limiting

*a.* Connect the radio set as shown in figure 51. Set the rf signal generator to supply a 3-uv signal with 15 kc deviation at 1,000 cps on a carrier frequency of 47 mc (33 mc).

*b.* Adjust the receiver volume control for standard audio output, and note the db reading.

*c.* Increase the rf input signal to 1,000 uv. The audio output should not vary more than 1 db for any input variation between 3 and 1,000 uv.

## 109. Receiver Audio Fidelity

*a.* Connect the radio set as shown in figure 51. Set the rf signal generator to supply a 10-uv signal with 15 kc deviation at 1,000 cps on a carrier frequency of 47 mc (33 mc).

*b.* Adjust the receiver volume control for 2.5 mw audio power output. Note the db reading on the output meter, and use it as a zero reference in determining the db gain or loss at the test audio frequencies shown below. The audio response of the receiver should be within the limits given below.

| Audio frequency (cps) | Response |
|---|---|
| 1,000 | 0 db (2.5 mw level). |
| 250 | +4 to −2 db. |
| 400 | +5 to 0 db. |
| 2,500 | −10 to 0 db. |
| 5,000 | −50 to −12 db. |

## 110. Af Power Output

*a.* Connect the radio set as shown in figure 51. Set the rf signal generator to supply a 10-uv signal with 15 kc deviation at 1,000 cps on a 47-mc (33-mc) carrier frequency.

*b.* Turn the VOL control to its maximum clockwise position. The output meter should be at least 6 mw.

## 111. Microphonics

*a.* Connect the rf signal generator to the radio set as shown in figure 51. Connect either a handset or a headset to AUDIO connector J8, so that the audio output may be heard.

*b.* Set the rf signal generator to supply a 10-uv unmodulated input signal at 47 mc (33 mc). Tune the radio set to this frequency, and turn the VOL control to its maximum clockwise position.

*c.* Tap on the case with a rubber mallet, while listening for microphonics in the receiver output. No objectionable noises should be heard.

## 112. Discriminator Tests

*a. Discriminator Center Frequency.*

(1) Connect the vtvm to pin 3 of test socket J7. Connect the handset to AUDIO connector J8.

(2) Apply an unmodulated 140-uv 4.3-mc signal to test point E19 (mixer grid) through a .006-$\mu$f capacitor.

(3) Hold the POWER switch in CAL & DIAL LITE position, and tune the rf signal generator for zero beat.

(4) Increase the rf signal generator output to 5000 uv.

(5) If the discriminator is exactly on center frequency, the vtvm should read zero. If not, adjust the fine tuning of the rf signal generator until the vtvm reads zero. The amount of deviation from the 4.3-mc frequency setting should not exceed ±4 kc (±5 kc).

*b. Discriminator Linearity and Band Width*

(1) Connect the radio set and apply an unmodulated 4.3-mc signal to E19 as described in *a* above.

(2) Hold the POWER switch in CAL & DIAL LITE position, and tune the rf signal generator for zero beat. Note the setting of the rf signal generator.

(3) Increase the rf signal generator frequency 30 kc, and note the discriminator voltage.

(4) Continue increasing the input signal frequency until a peak voltage is reached. Note the frequency deviation from the 4.3-mc setting.

(5) Decrease the rf signal generator 30 kc below the 4.3-mc setting, and note the discriminator voltage.

(6) Continue decreasing the input signal frequency until a peak voltage is reached. Note the frequency deviation from 4.3 mc.

(7) The voltages observed in (3) and (5) above should be at least 4.5 volts; the smaller reading should be at least 75 percent of the larger reading.

(8) The sum of the frequency deviations observed in (4) and (6) above should be at least 100 kc.

## 113. Frequency Stability

*a.* Couple a frequency meter to receiver oscillator V8, and set the TUNING dial to 55 mc (39 mc).

*b.* Turn on the radio set, and after no more than 30 seconds, measure the receiver oscillator frequency.

*c.* Check to see that the battery supply voltages are as follows:

| | |
|---|---|
| A | 1.4 v dc |
| $B_1$ | 65 v dc |
| $B_2$ | 130 v dc |
| C | −5.6 v dc |

*d.* Measure the receiver oscillator frequency at 5-minute intervals for 30 minutes. The frequency drift of the receiver oscillator should not exceed 9 kc in the first 30 minutes of operation.

## 114. Reception Test

Screw the short antenna to the SHORT ANT jack. With a similar radio set located at least 50 feet away and tuned to the same frequency, voice signals transmitted from that radio set should be clear and of good quality in the radio set being tested.

## 115. Test Setup and Standard Conditions for Transmitter Testing

Most of the tests on the transmitter section are performed under the standard conditions listed below and shown on figure 52. Modifications from this basic setup are explained in the paragraphs for the individual tests.

*a.* Connect the rf wattmeter between AUX ANT connector J3 and ground. A resistor of 50 ohms (nonreactive between 28 and 55 mc) can be used instead to terminate the transmitter output if a wattmeter is not available.

*b.* Apply an audio input signal of 85 millivolts (330 millivolts for AN/PRC–9A) at 1,000 cps to pin C (mike input) of AUDIO connector J8, through the impedance network shown in figure 52.

*c.* Connect a millivoltmeter across the audio input to the transmitter.

*d.* Couple the frequency meter antenna around the rf wattmeter cable or AUX ANT connector J3.

## 116. Transmitter Frequency

Check the transmitter tuning alinement at 39 mc (28 mc), 47 mc (33 mc), and 54 mc (38 mc), as follows:

*a.* Connect the radio set as shown in figure 52, except that the handset should be plugged into AUDIO connector J8.

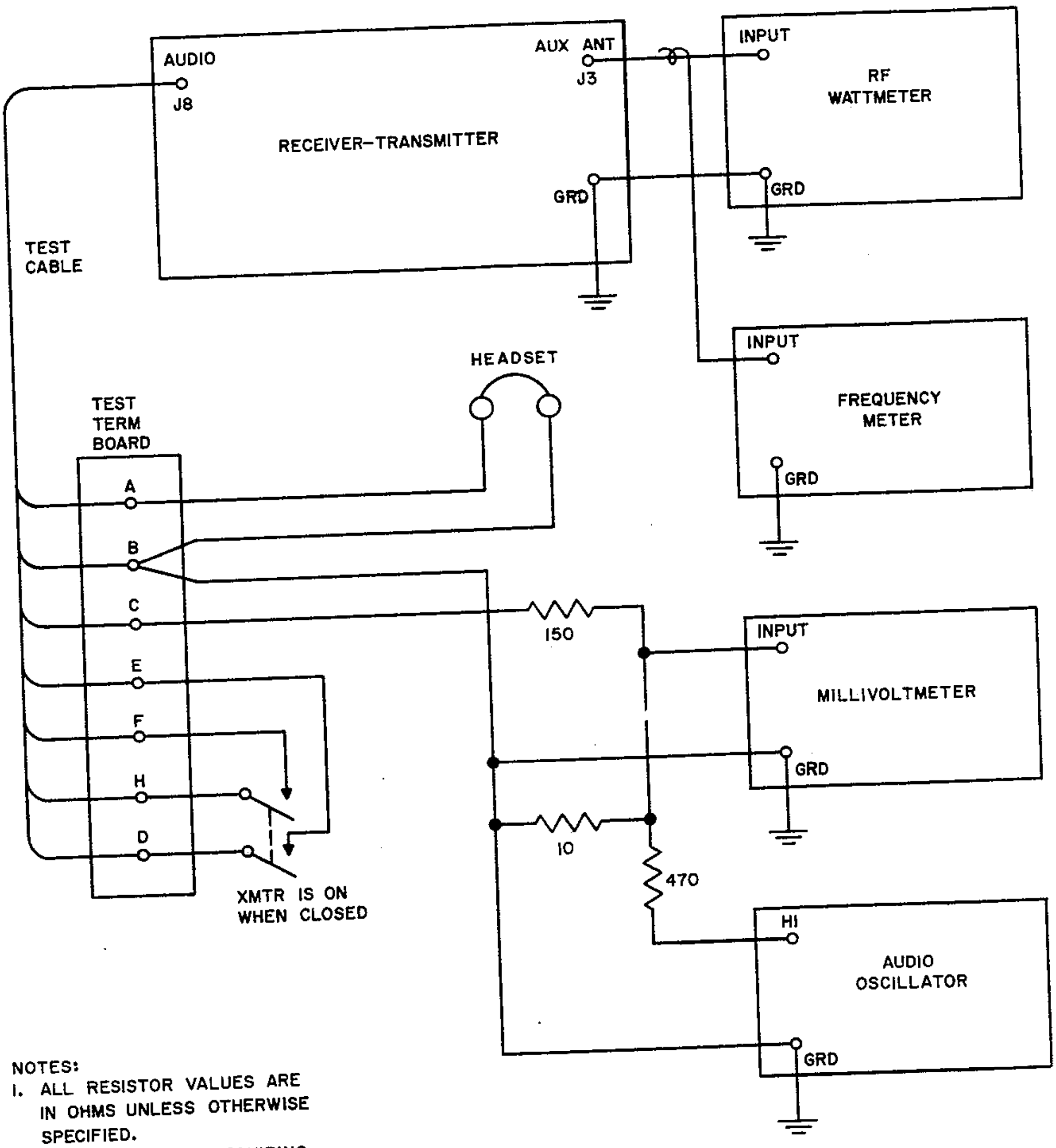
*b.* Tune the radio set and the frequency meter to 39 mc (28 mc). Let the frequency meter transmit at this frequency, while holding the radio set POWER switch in CAL & DIAL LITE position. Adjust the TUNING control for zero beat in the handset. Lock the TUNING control at this frequency. Release the POWER switch to ON.

*c.* Press in the handset push-to-talk button. Check the transmitter frequency by heterodyning it with the frequency meter, and measuring the frequency deviation. It should not exceed ±5 kc.

*Note.* With the reception of a strong signal, the transmitter may not lock in. By slowly turning the heterodyne detector standby switch to OFF, then to ON again, the transmitter will lock in at the proper frequency.

*d.* Note the transmitter output power on the rf wattmeter. The rated maximum power output is .8 watt (1 watt in AN/PRC–9A).

*e.* Turn off power and disable the afc circuit by temporarily removing second if. plug-in can U102 and pulse-sweep generator plug-in can U301. Turn the radio set on again in transmit operation. Measure the frequency deviation between the transmitter signal and the 39-mc (28-mc) heterodyning signal of the frequency meter. It should not exceed ±50 kc (±75 kc for AN/PRC–9A). Replace U102 and U301.




NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. FOR TESTS NOT REQUIRING AUDIO INPUT, HANDSET H-33B/PT MAY BE PLUGGED INTO J8 INSTEAD OF TEST CABLE SETUP.

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*Figure 52. Connections for transmitter testing.*

*f.* Repeat the above tests at 47 mc (33 mc) and at 54 mc (38 mc). The deviation at 47 mc (33 mc) without afc may go up to ±100 kc (±150 kc in AN/PRC-9).

## 117. Automatic Frequency Control

*a.* Connect the radio set as shown in figure 52, except that the handset should be plugged into AUDIO connector J8.

*b.* Set the frequency meter to 54 mc (38 mc), and let it transmit at this frequency. Hold the POWER switch of the radio set in CAL & DIAL LITE position. Turn the TUNING control to 54 mc (38 mc), and adjust it for zero beat in the handset. Lock the TUNING control (with the DIAL LOCK lever) at this frequency, and let it remain there for the rest of this test. Release the POWER switch to ON.

*c.* Adjust the frequency meter for use as a heterodyne detector, and record the 54-mc (38-mc) frequency setting.

*d.* Tune the transmitter by adjusting capacitor C11 (fig. 33), so that zero beat is heard in the headset of the frequency meter.

*e.* Turn off power and disable the afc circuit by temporarily removing second if. plug-in can U102 and pulse-sweep generator plug-in can U301. Turn the radio set on again in transmit operation. Again tune the transmitter by adjusting C11, so that zero beat is heard in the headset.

*f.* Temporarily increase the frequency setting of the frequency meter to 500 kc above 54 mc (38 mc.). Press in the handset push-to-talk button, and once again aline C11 for zero beat in the headset.

*g.* Replace U102 and U301. Return the frequency setting to 54 mc (38 mc). Press in the handset push-to-talk button. The transmitter carrier frequency should be within ±10 kc of the heterodyne detector frequency.

*h.* Again remove U102 and U301. Temporarily decrease the frequency setting of the frequency meter to 500 kc below 54 mc (38 mc). Turn on the transmitter and adjust C11 for zero beat in the headset.

*i.* Return the frequency meter setting to 54 mc (38 mc.) Replace U102 and U301. Press in the handset push-to-talk button; the transmitter frequency should be within ±10 kc of the heterodyne detector frequency.

*j.* After completing this test, if within limits, realine the transmitter oscillator to 54 mc (38 mc) (par. 100).

## 118. Transmitter Modulation Capability

This test measures the frequency deviation with audio inputs at several frequencies, and should be made with the transmitter operating at 39 mc (28 mc), 47 mc (33 mc), and 54 mc (38 mc), as follows:

*a.* Connect the radio set as shown in figure 52, except couple the panoramic indicator instead of the frequency meter around AUX ANT connector J3. Connect the if. signal generator so that the frequency deviation may be measured.

*b.* Adjust the audio oscillator output so that 85 millivolts (330 millivolts for AN/PRC-9A) of audio signal is indicated on the vtvm. Measure the frequency deviation with the transmitter operating at 39 mc (28 mc), 47 mc (33 mc), and 54 mc (38 mc). The deviation should be within the limits listed below, for the following three audio input signals.

| Audio input frequency (cps) | Transmitter frequency deviation (kc) | |
|---|---|---|
| | AN/PRC-9A | AN/PRC-10A |
| 400 | 4 to 10 | 4 to 10 |
| 1,000 | 5 to 13 | 5 to 17 |
| 2,500 | 5 to 13 | 5 to 17 |

## 119. Transmitter Rf Power Output

*a.* Connect the rf wattmeter between AUX ANT connector J3 and chassis ground, as shown in figure 52.

*b.* Operate the transmitter at frequencies of 39 mc (28 mc), 47 mc (33 mc), and 54 mc (38 mc). The power output should not be less than 6.8 watt (1 watt for AN/PRC-9A) at each of the three frequencies.

## 120. Neutralization

*a.* Connect the rf wattmeter between AUX ANT connector J3 and chassis ground. Connect the vtvm to pin 3 of test socket J7 and chassis ground. Plug the handset into AUDIO connector J8, and place the radio set in transmit operation. Tune the radio set to 54 mc (38 mc) at the high end of the frequency range.

*b.* Note the discriminator voltage observed on the vtvm.

*c.* Remove the rf wattmeter, and note the change in discriminator voltage under no-load condition.

*d.* Short circuit the inner conductor of J3 to the outer conductor, and note the change in discriminator voltage under short circuit condition.

*e.* The changes in discriminator voltage, in both *c* and *d* above, should not exceed .2 volt.

## 121. Transmission Test

*a.* Receive voice transmissions from a transmitter in a similar radio set at least 50 feet away. Signals should be heard clearly and distinctly.

*b.* Tap the radio set under test with a rubber mallet. Extraneous noises or microphonics should not be present.

## 122. Receiver-Transmitter Testing

Tests relating to both receiver and transmitter sections, as well as to system operation, are given in paragraphs 123 through 127.

## 123. Dial and TUNING Control Operation

These tests check the TUNING knob movements, ability to reset to the same frequency, and dial lock operation.

*a.* Adjust the frequency meter for operation as a heterodyne detector at 54 mc (38 mc). Plug the handset into AUDIO connector J8. Connect the rf wattmeter to AUX ANT connector J3. Set the TUNING control to 54 mc (38 mc), and place the radio set in transmit operation. Tune the radio set for zero beat in the headset of frequency meter.

*b.* Place a piece of masking tape on the TUNING knob, and a second piece of masking tape on the panel that faces the first piece. Draw a straight line through each, so that the TUNING knob may be moved and then brought back to precisely the same position by lining up the two marks on the pieces of masking tape. Do this while the control is set at zero beat.

*c.* Release the handset push-to-talk button so that the radio set is in receive condition. Rotate the TUNING control one full turn clockwise, and then counterclockwise back to the original setting so that the two lines on the masking tape line up with each other.

*d.* Operate the push-to-talk button. The beat note heard in the heterodyne detector output should not be more than ±10 kc. Repeat the test several times to be sure that this limit is met. This test checks the backlash in tuning drive assembly O 22.

*e.* Release the push-to-talk button so that the radio set is in receive condition. Set the TUNING control to the 53.75-mc (38.7-mc) calibrate check point. Hold the POWER switch in CAL & DIAL LITE position while adjusting the TUNING control for zero beat in the handset. Now move the POINTER ADJUST control so that the pointer is exactly on the dial 53.75-mc (38.7-mc) calibrate mark.

*f.* Release the POWER switch to ON. Turn the TUNING control clockwise approximately one megacycle on the dial, and then return it to the 53.75-mc (38.7-mc) calibrate marker. Hold the POWER switch in CAL & DIAL LITE position. The frequency of the signal in the audio output should not be greater than 50 kc. Repeat this test at least five times, first turning the control clockwise and then counterclockwise. This test checks the backlash between the tuning gang and the dial drum. It should be repeated at the 47.3-mc (34.4-mc) calibrate check point.

*g.* Check the tuning DIAL LOCK operation as follows: With the POWER switch in CAL & DIAL LITE position, adjust the TUNING control for zero beat in the handset at the 53.75-mc (38.7-mc) calibrate point. Release the POWER switch, and then operate the DIAL LOCK lever to lock the tuning dial. Place the POWER switch back in the CAL & DIAL LITE position. The audio beat note in the receiver output should not exceed 250 cps (70 cps for AN/PRC–9A). Repeat the test at least five times. This shows approximately how far off center frequency the radio set is detuned, when the tuning shaft is locked. An excessive degree can be caused by misalinement or looseness of the tuning drive assembly to the control panel. This may be accompanied by binding or uneven action in the TUNING control operation.

## 124. System Fidelity

*a.* Operate the transmitter of one radio set at 47 mc (33 mc), with audio modulation of .1 volt (.3 volt for AN/PRC–9A) at 1,000 cps. Receive its transmitted signal in a similar type receiver at least 50 feet away. Adjust the VOL control of this receiver for 1 mw of audio output, as observed on the output meter. This output is used as a reference level.

*b.* Check the audio output level when the modulating frequency is changed to the frequencies given below. Do not readjust the VOL control

√

after it is set for 1 mw output at 1,000 cps. The audio response for the system should be within the limits as shown in the following tables:

(1) Audio response for Radio Set AN/PRC-9A is as follows:

| Audio frequency (cps) | Response (db) |
|---|---|
| 1,000 | 0 (1 mv reference). |
| 150 | −13.5 to −5.5. |
| 400 | −3 to +3. |
| 2,500 | −13 to −5. |
| 5,000 | −50 to −12. |

(2) Audio response for Radio Set AN/PRC-10A is as follows:

| Audio frequency (cps) | Response (db) |
|---|---|
| 1,000 | 0 (1 mw reference). |
| 250 | −3 to +2. |
| 400 | −2 to +4. |
| 2,500 | −13 to −5. |
| 5,000 | −50 to −12. |

## 125. Parasitic Oscillations

With the radio set operated alternately as a receiver and a transmitter at 47 mc (33 mc), note the reception in an adjacent radio receiver as the latter is slowly tuned from 20 to 100 mc. Listen for disturbing effects. No parasitic oscillations should be received at all settings of the radio set controls.

## 126. Relay Operation

Set up four radio sets as shown in figure 25. Theory and detailed connections for this operation are in paragraph 27. Radio sets No. 1 and No. 2 are tuned to the same frequency. Radio sets No. 3 and No. 4 are tuned to a second frequency, which differs from the first frequency by a few megacycles. Radio sets No. 2 and No. 3 make up the relay station. Radio sets No. 1 and No. 4 each should be about 1 mile from the relay station and in opposite directions. With operators at radio sets No. 1 and No. 4, signals should be received clearly and distinctly from both directions without any noise.

## 127. Remote Operation

Set up the radio set and Control Group AN/GRA-6 as shown in figure 22. Set up Remote Control C-433/GRC about 1 mile from the radio set. Set up another radio set next to the remote control, but not connected to it. In Local Control C-434/GRC, set the LOCAL switch at TEL, the REMOTE switch at SET 1, and the switch inside the case on the chassis at BELL. On the remote control, set the SELECTOR switch at the left write-in position, and the switch inside the case on the chassis, at BELL. On the radio set that is to be operated remotely, set the POWER switch at REMOTE. Tune this set and the one next to the remote control unit to the same frequency. When an operator presses the push-to-talk button on the handset that is plugged into the remote control, he transmits over the set located 1 mile away, while another operator receives on the set next to the remote control. When the operator presses the push-to-talk button of the handset plugged into the receiver next to the remote control, he transmits over that set and the other operator receives on the handset that is plugged into the remote control. Communication in both directions should be clear and distinct.

Section - Demolition - not copied

(Figure 55—See foldin in back of Manual)

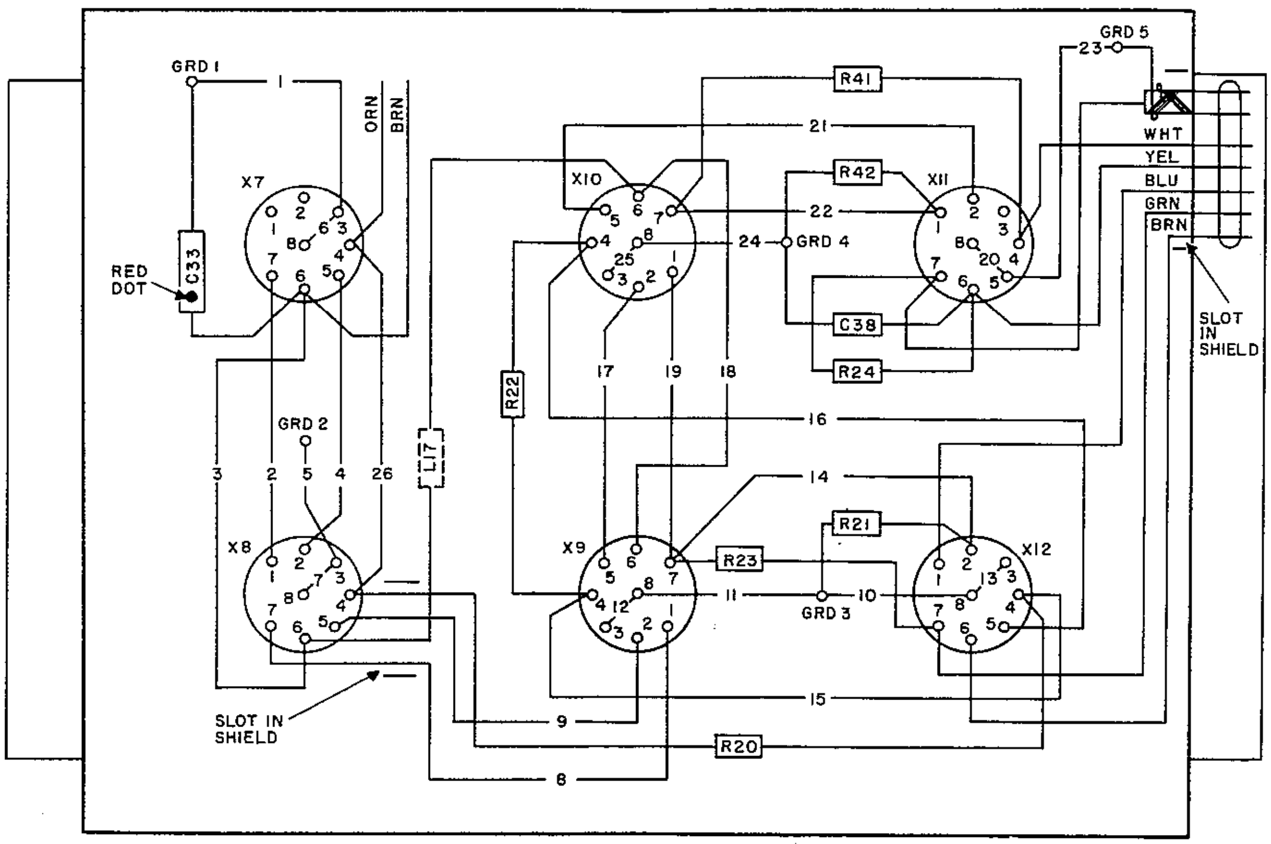


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*Figure 56. If. chassis, wiring diagram.*

(Figure 57—See foldin in back of Manual)

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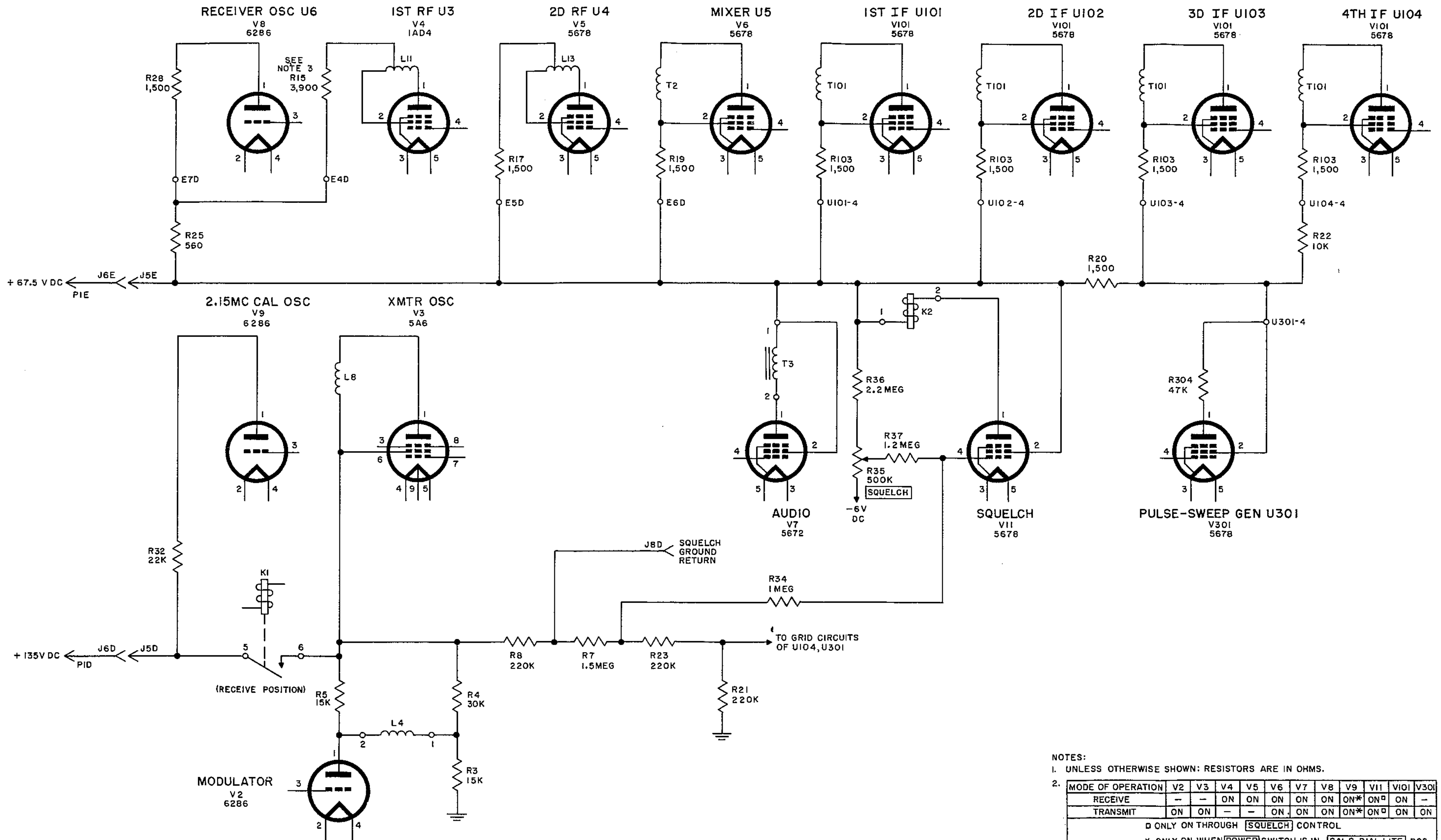
[AG 413.44 (8 May 56)]




NOTES:

1. UNLESS OTHERWISE SHOWN: RESISTORS ARE IN OHMS.
2.

| MODE OF OPERATION | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V11 | V101 | V301 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RECEIVE | — | — | ON | ON | ON | ON | ON | ON* | ON□ | ON | — |
| TRANSMIT | ON | ON | — | — | ON | ON | ON | ON* | ON□ | ON | ON |

□ ONLY ON THROUGH [SQUELCH] CONTROL

* ONLY ON WHEN [POWER] SWITCH IS IN [CAL & DIAL LITE] POS.

3. IN AN/PRC-9A, THE VALUE OF R15 IS 56,000 OHMS.

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*Figure 20. Voltage distribution in Radio Receiver-Transmitter RT-176A/RRC-10*

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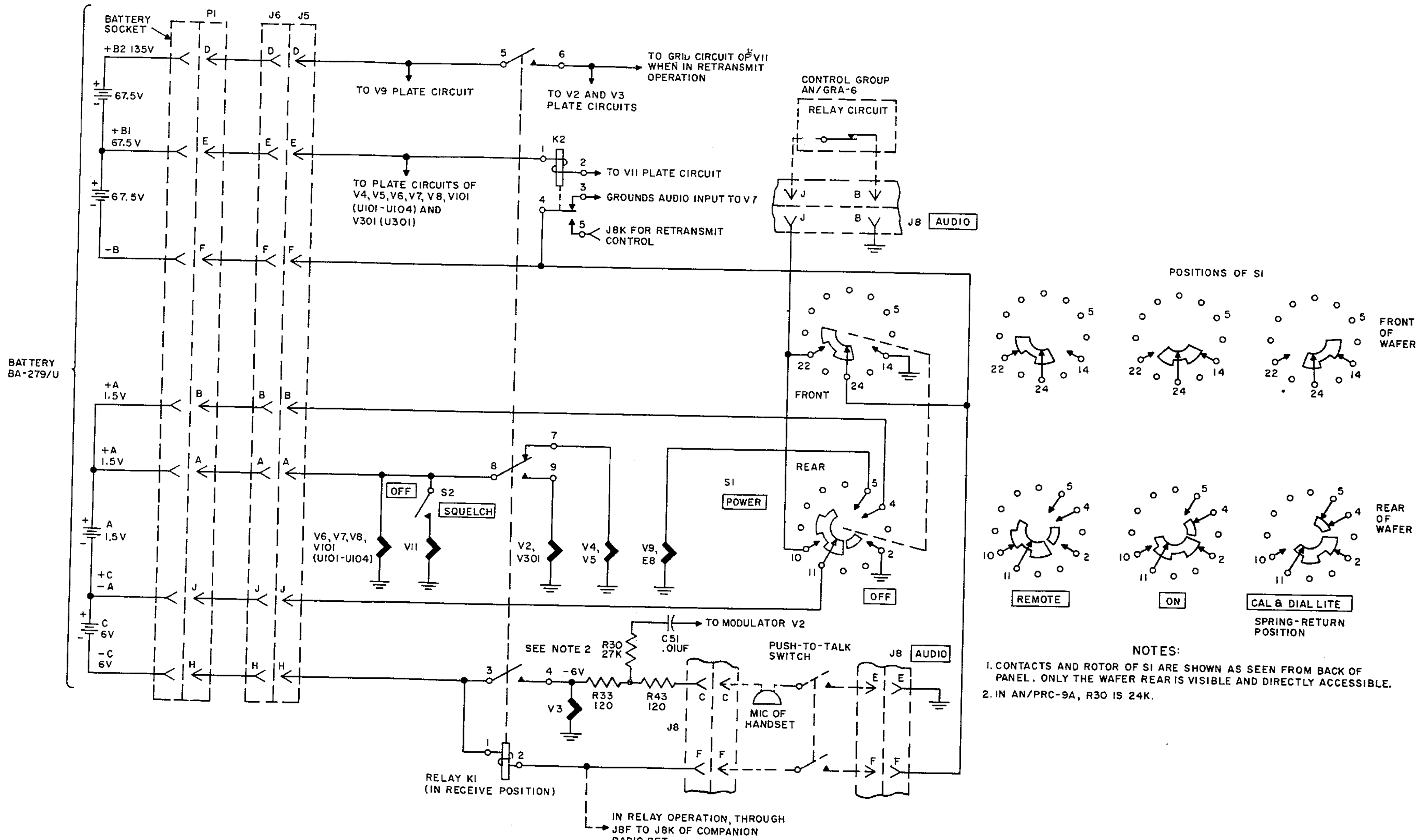


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*Figure 21. Radio Set AN/PRC-9A and AN/PRC-10A, control circuit diagram.*

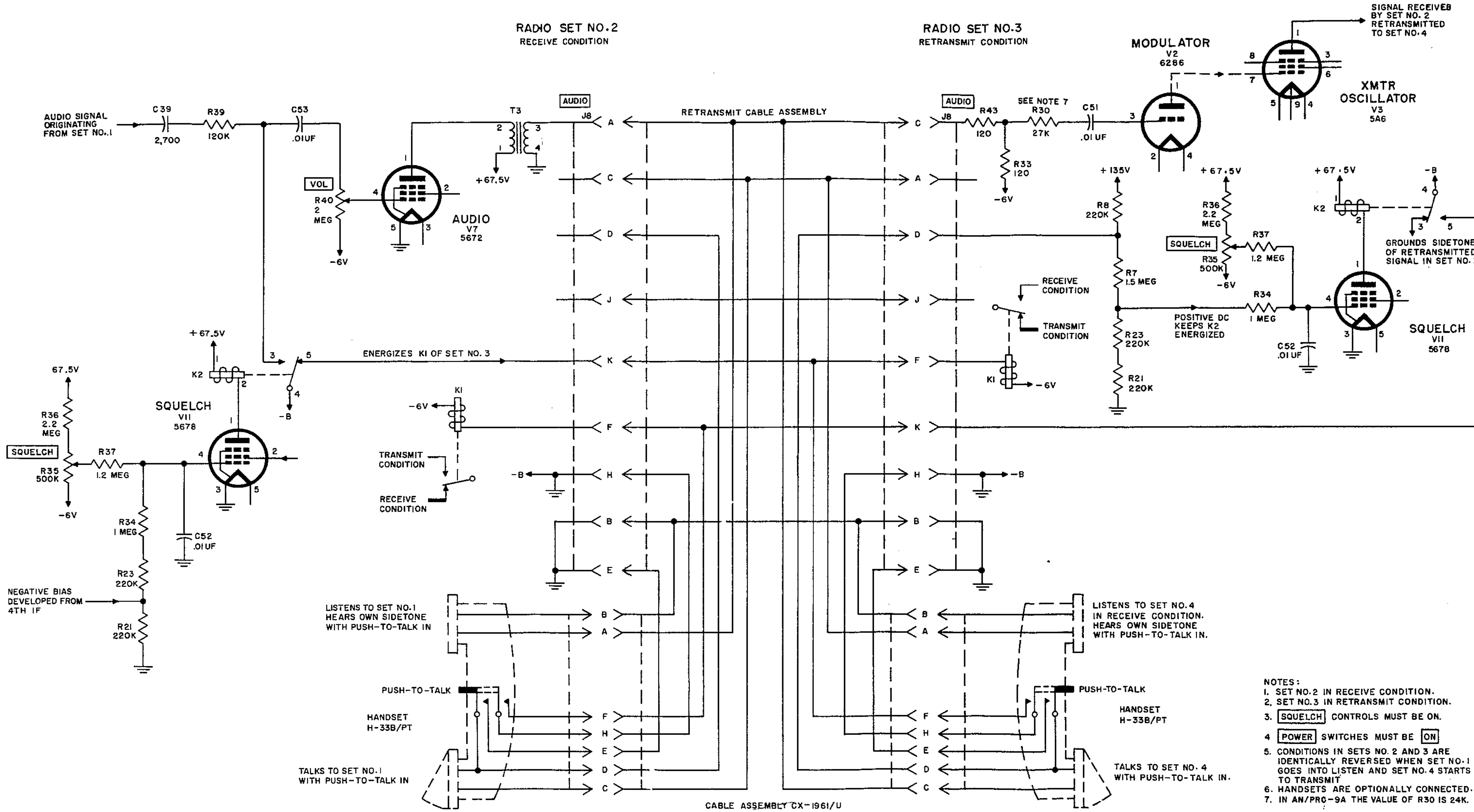


*Figure 26. Radio Sets AN/PRC-9A and AN/PRC-10A, relay operation control circuit*

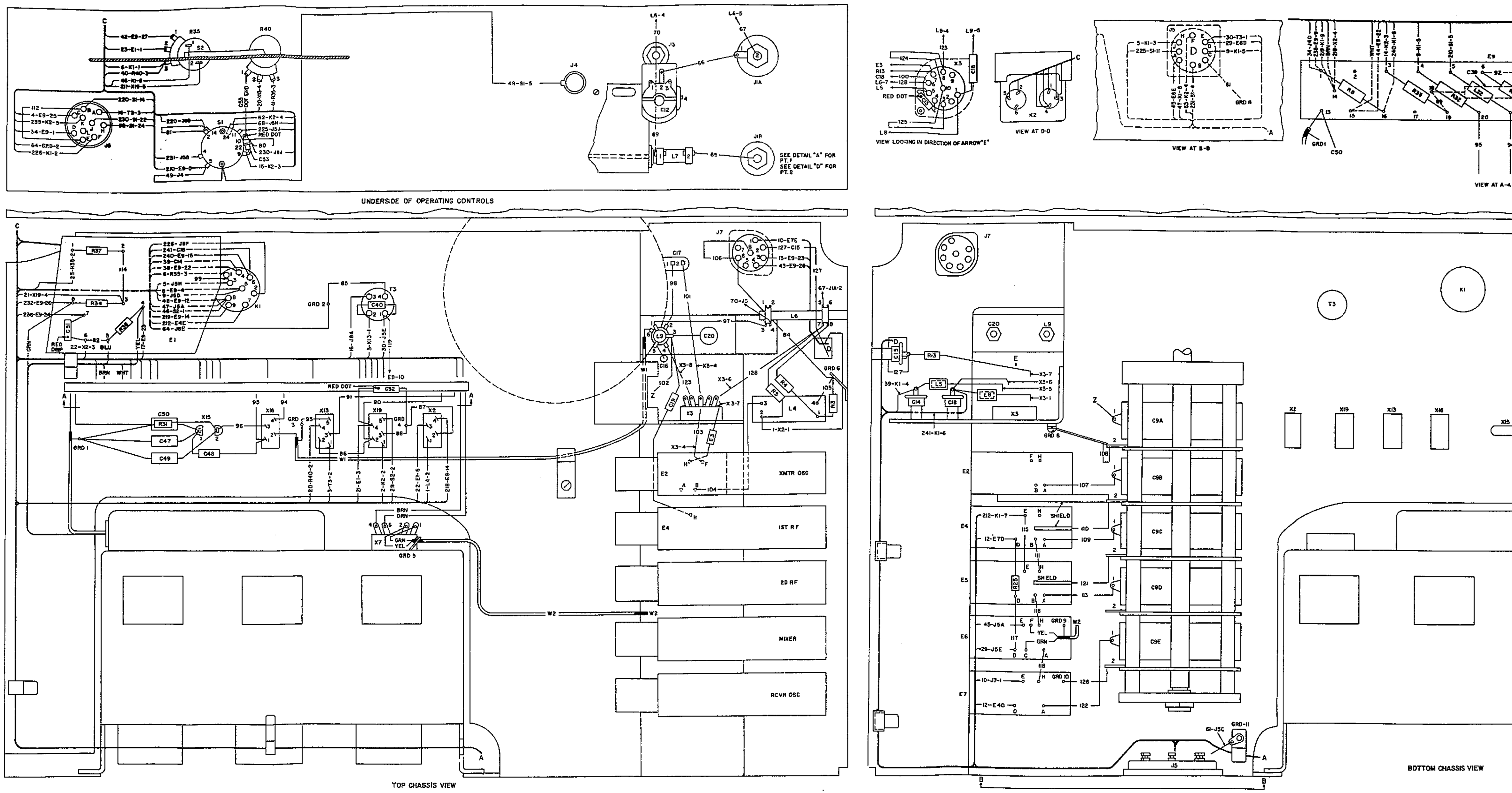


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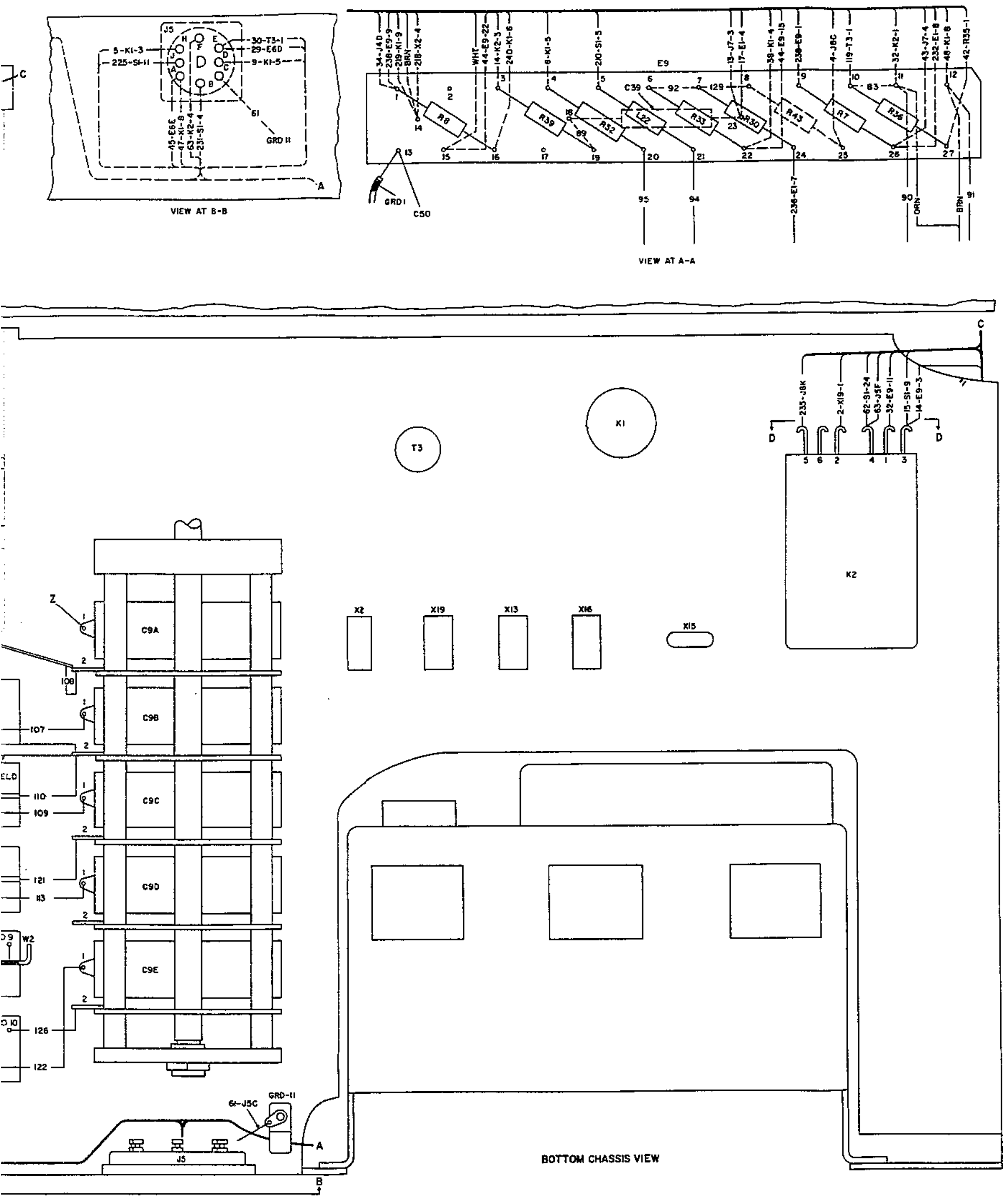
*Figure 55. Radio Receiver-Transmitter RT-176A/PRG-10, wiring diagram.*




| WIRE TABLE | |
|---|---|
| WIRE NO. | DESCRIPTION |
| 1-6 | WIRE BLUE |
| 8-10 | WIRE RED |
| 12-17 | WIRE YELLOW |
| 20-23 | WIRE GREEN |
| 29-34 | WIRE ORANGE |
| 38-44 | WIRE WHITE |
| 45-49 | WIRE BROWN |
| 59-73 | WIRE BLACK |
| 80-129 | WIRE TINNED COPPER .059 DIA. |
| 210-212 | WIRE BRN/YEL TR |
| 216-220 | WIRE BRN/WHT TR |
| 225-226 | WIRE BLK/WHT TR |
| 230-232 | WIRE BLK/RED TR |
| 235-238 | WIRE BLK/YEL TR |
| 240-241 | WIRE WHT/VIOLET TR |

NOTES:
1. NUMBERS IN WIRES, REFER TO WIRE TABLE
2. CODING AT ENDS WIRES INDICATES WIRE NUMBERS AND DESTINATION, THUS, 13-J7-3, 13= WIRE NUMBER, J7= JACK AND 3= TERMINAL 3 OF J7 AS INDICATED ON THIS DRAWING.

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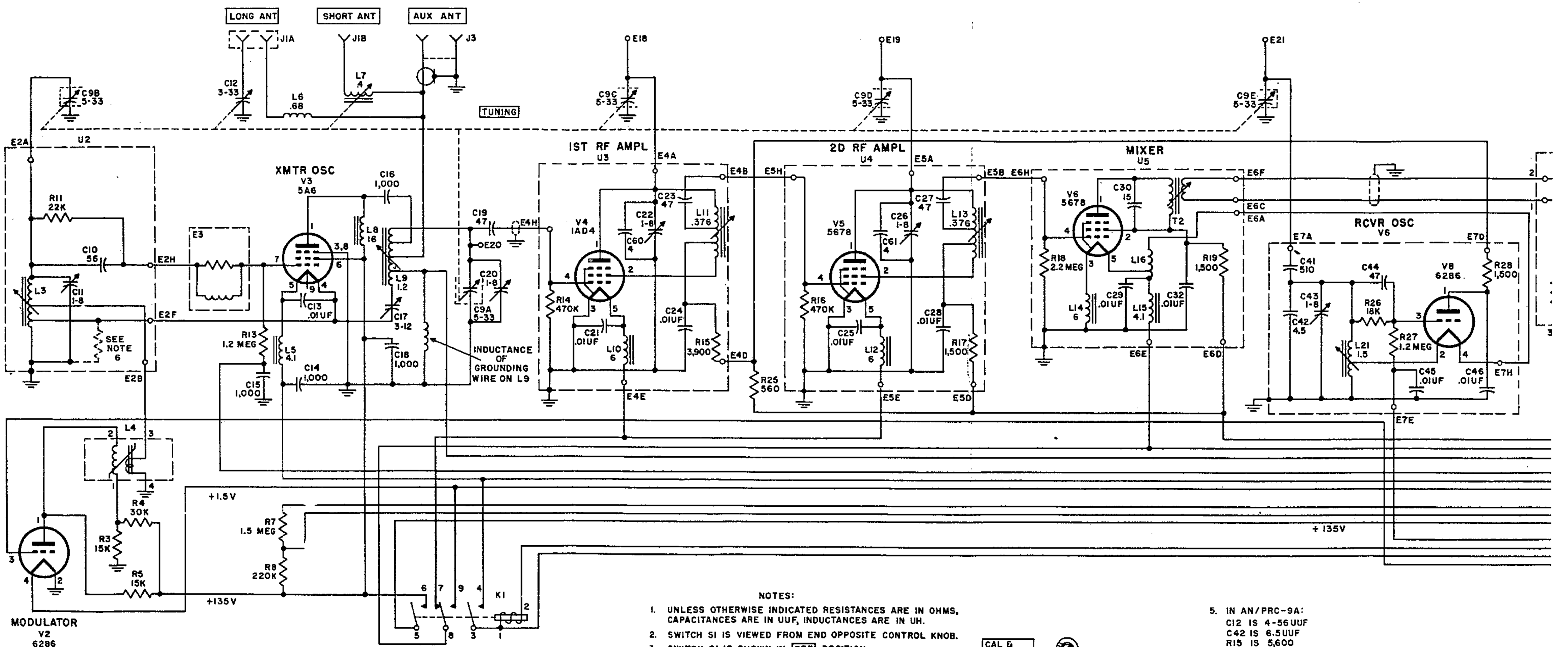
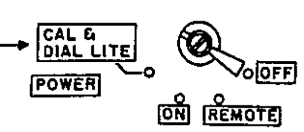
*iring diagram.*



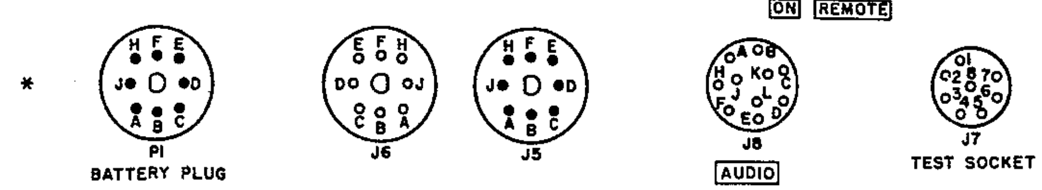

NOTES:

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF, INDUCTANCES ARE IN UH.
2. SWITCH S1 IS VIEWED FROM END OPPOSITE CONTROL KNOB.
3. SWITCH S1 IS SHOWN IN OFF POSITION.
4. ▭ INDICATES EQUIPMENT MARKING.




5. IN AN/PRC-9A:
   C12 IS 4-56UUF
   C42 IS 6.5UUF
   R15 IS 5,600
   R30 IS 24K
   R38 IS 430K
6. IN AN/PRC-9A, R6 560 OHMS IS CONNECTED BETWEEN TERMINAL E2F OF U2 AND GROUND.

*

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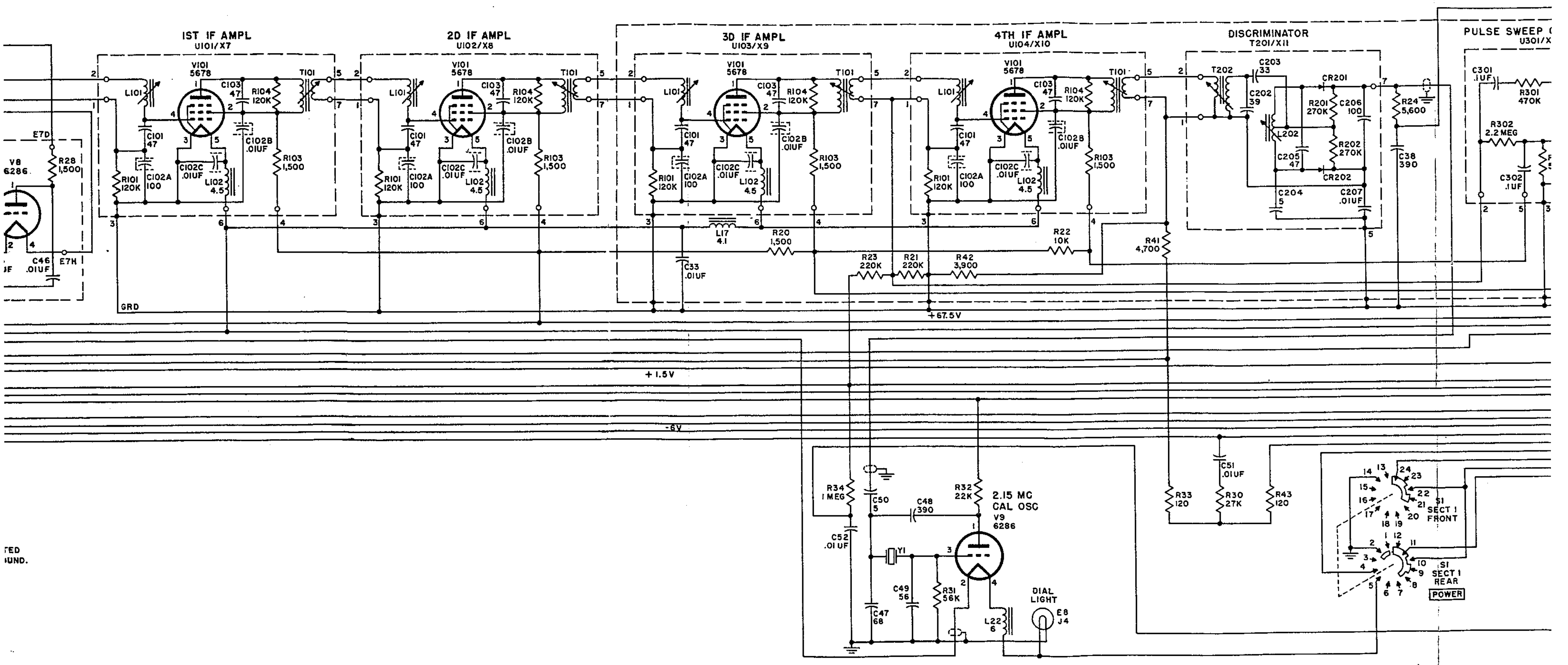


Figure 57. Radio Set AN/PRC-9A and -10A, schematic diagram.

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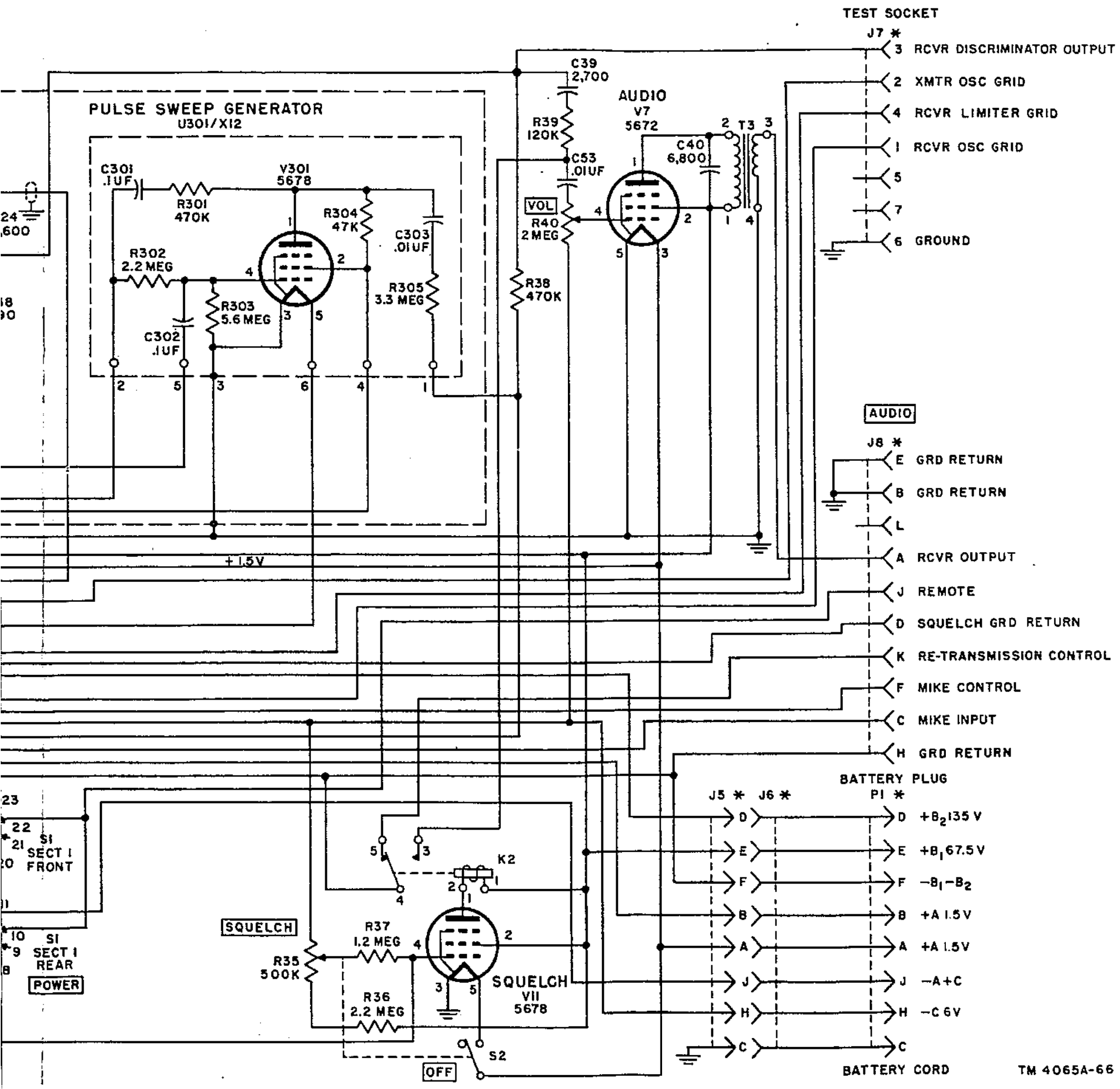


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