CHAPTER 2
THEORY

Section I. BLOCK DIAGRAM

6. General

The radio set includes a battery (not supplied with set), a long and a short antenna, and a receiver-transmitter. The receiver-transmitter includes a transmitter, a receiver, and calibration circuits. The block diagram (fig. 2) shows the signal paths for each of these circuits and the relationships between them.

7. Receiver Signal Path (fig. 2)

A fm signal, picked up at the antenna, is applied through the antenna circuit and through a two-stage radio-frequency (rf) amplifier to the mixer stage. The receiver oscillator is tuned to a frequency 4.3 megacycles (mc) above the frequency of the incoming signal. The receiver oscillator signal beats with the incoming signal in the mixer stage where an output frequency of 4.3 mc is developed. This frequency is called the intermediate frequency (if.). The if. signal is amplified by a five-stage if. amplifier and applied to the discriminator. The discriminator converts the fm signal to an audio signal. The audio signal is amplified by the audio amplifier and is applied to the receiver of a handset.

8. Transmitter Signal Path (fig. 2)

Voice signals, applied from the microphone of the handset, are amplified in the modulator stage and applied to the input circuit of the transmitter oscillator. In this circuit, the audio amplitude variations cause the transmitter frequency to vary above and below its center frequency. The frequency-modulated output of the transmitter oscillator is applied to the antenna circuit and the antenna. A portion of the transmitter oscillator output beats with the receiver oscillator in the mixer stage. The output signal from the mixer is applied to the automatic frequency control (afc) driver stage. This signal is the afc signal. If the transmitter oscillator signal is the correct frequency, the afc signal produces no change in the transmitter oscillator frequency. If the transmitter oscillator signal tends to drift off frequency, the afc signal, applied to the transmitter oscillator stage through the afc driver stage and

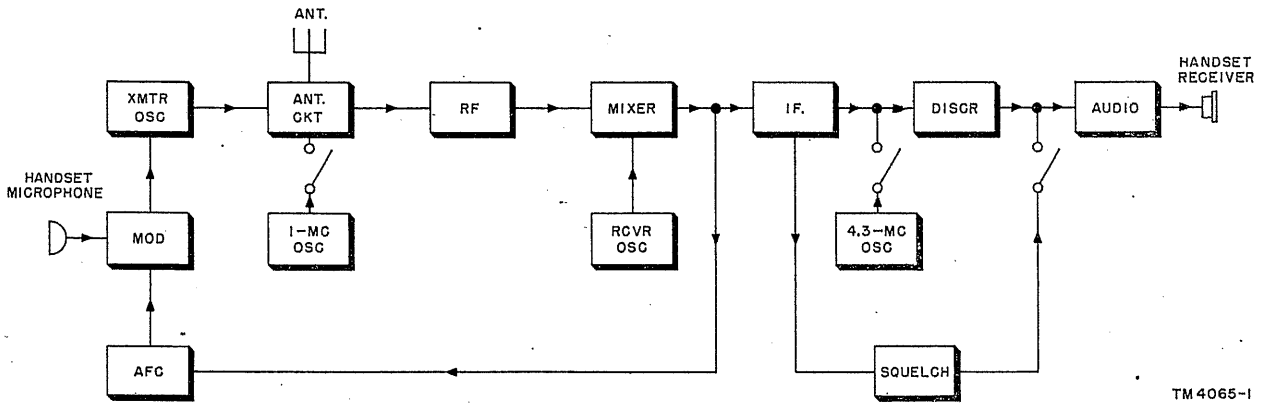


Figure 2. Receiver-transmitter, block diagram.

the modulator stage, reduces this drift to a negligible amount.

9. Calibration Signal Path

The receiver-transmitter contains two crystal-controlled oscillators. One of these is a 1-mc oscillator; the other is a 4.3-mc oscillator. Both of these oscillators are used to calibrate the receiver oscillator. During calibration, when the radio set is tuned to a whole number mc point, the harmonic of the 1-mc oscillator, which is equal to this whole number, is applied to the receiver antenna circuit and is amplified by the two-stage rf amplifier. This signal then beats with the receiver oscillator signal in the mixer and produces an if. signal. If the receiver oscillator is exactly on frequency, the if. signal frequency is 4.3 mc. As this if. signal is applied to the discriminator, it is beat with the accurately tuned 4.3-mc signal from the crystal-controlled 4.3-mc oscillator. When the receiver oscillator is on frequency, the beat frequency is zero. When the receiver oscillator is off frequency, an audio beat frequency is developed in the discriminator, amplified by the audio amplifier, and applied to the handset receiver. When the receiver oscillator is calibrated to produce a zero beat in the handset receiver, it is on frequency. For reference purposes, the control panel of the receiver-transmitter is shown in figure 3.

Section II. RECEIVER STAGES

10. Antenna Circuit (fig. 4)

The antenna circuit (which is used for both the transmitter and the receiver) has three connectors on the front panel (fig. 3) to which antennas may be connected. A long whip antenna (Antenna AT–271/PRC) plugs into LONG ANT connector J1. A shorting strap on the plug of the long antenna connects C12 and L6, which are necessary to tune the antenna circuit in Radio Sets AN/PRC–9 and –10. In Radio set AN/PRC–8, C12 and L6 are not included. (C12 is ganged with TUNING capacitor C9). A short antenna (Antenna AT–272/PRC) plugs into SHORT ANT connector J2. This antenna is tuned by L7 which also is ganged with TUNING capacitor C9. Antenna Equipment RC–292 or Homing Antenna AT–339/PRC (or AT–340/PRC) can be plugged into AUX ANT connector J3. The signal picked up in the antenna is applied to the tuned circuit consisting of L9, C9A, and C20. C9A is part of the TUNING capacitor. The iron core of L9 is adjustable for alinement of the radio set at the low end of the dial. C20 is a trimmer that is adjustable for alinement at the high

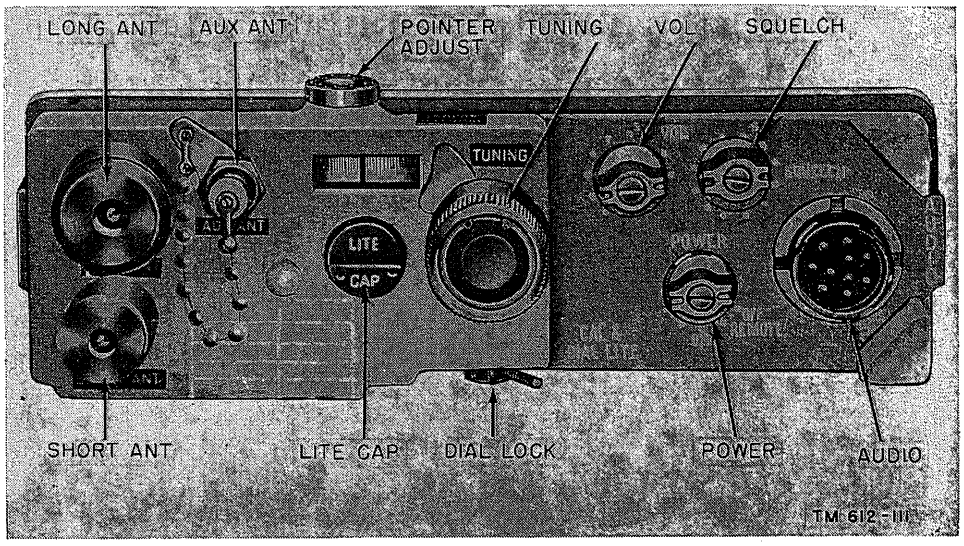


Figure 3. Control panel.

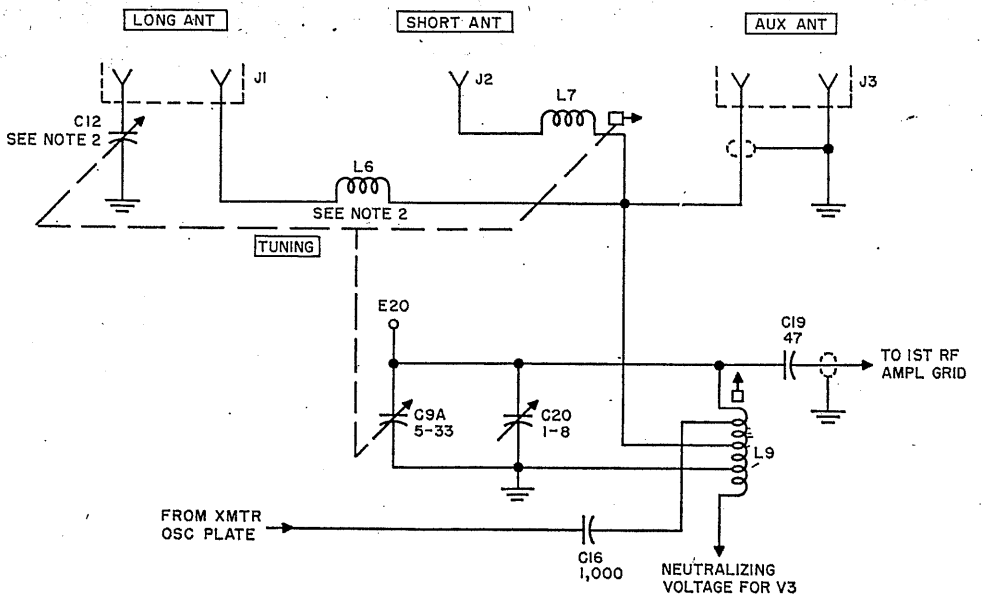


Figure 4. Antenna circuit.

end of the dial. C19 couples the signal from the antenna coil to first rf amplifier V4.

11. Rf Amplifiers
(fig. 5)

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 direct-current (dc) return to ground. The plate tank circuit consists of C9C, C22, and C60 in parallel with L11. C9C is a section of the TUNING capacitor. L11 is adjustable for alinement of the rf amplifier at the low end of the dial. C22 is adjustable for alinement at the high end of the dial. C60, in parallel with C22, has a negative temperature coefficient. When changes in temperature occur, the value of L11 changes. The value of C11, however, changes in the opposite direction from that of L11. This minimizes 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. This puts 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. In Radio Sets AN/PRC–8 and –9, the gain of the first and second rf amplifiers is higher than it is in Radio Set AN/PRC–10. In order to lower the gain of the rf amplifiers in these sets to provide greater stability, the plates of V4 and V5 are connected to taps on L11 and L13 instead of to the tops of the coils.

(2) B+ is applied to the plate and screen through R15. R15 and 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 and through rf choke L10. C21 bypasses the filament for rf. Contacts 8 and 7 of K1 are open when the radio set is in the transmit condition and the first rf amplifier is de-energized. This prevents the transmitter oscillator output (which is developed across L9) from being amplified by the first rf amplifier. This would overload the second rf amplifier and the mixer. For further details refer to the afc circuit (par. 21).

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 C47 to the input circuit of the mixer. The design of this amplifier is the same as that of the first rf amplifier except that filament voltage is applied directly to the filament instead of through the contacts of relay K1. This keeps the second rf amplifier in operation both for reception and transmission. During transmission, a portion of the transmitter oscillator signal is applied through R18 to the control grid of second rf amplifier V5. It is amplified by V5 and applied to the mixer where it beats with the receiver oscillator signal to form the afc signal (par. 21).

12. Receiver Oscillator
(fig. 6)

a. The receiver oscillator supplies a signal 4.3 mc higher than the frequency to which the receiver-transmitter is tuned. During reception, this signal beats with the incoming signal to produce the required if. frequency. During transmission, this signal beats with a portion of the transmitter oscillator signal to produce the afc signal.

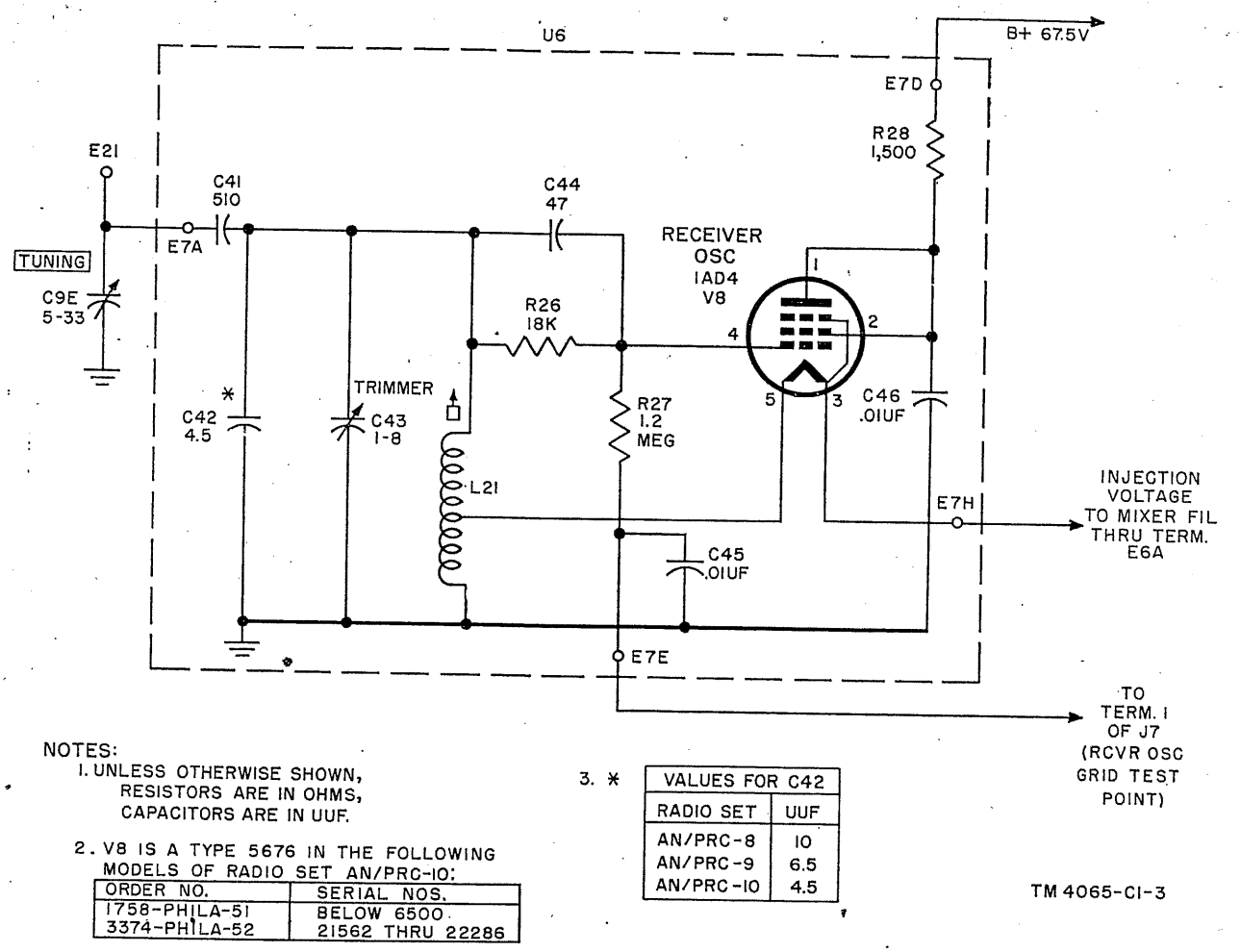
b. The receiver oscillator is a pentode type 1AD4. The plate and screen are tied together externally by a connection between pins 1 and 2 so that the tube operates as a triode. The circuit is a series-fed Hartley oscillator in which plate-to-grid feedback occurs across L21. The plate circuit is from the plate of the tube through C46 to ground and then up through the lower portion of L21 to the cathode. The voltage in the plate (lower) section of L21 induces a voltage in the grid (upper) section of the coil. The grid circuit extends from the grid (pin 4) through the parallel grid capacitor grid resistor combination of C44 and R26 and through the upper section of L21 to the cathode. The tuned circuit consists essentially of L21 in parallel with C9E. C41 is a padder capacitor in series with C9E and serves to reduce the effective capacitance of C9E and track the receiver oscillator 4.3 mc higher than the rf signal. C43 is a variable trimmer. C42 is a temperature compensating capacitor. The core of L21 is adjustable for alinement of the receiver oscillator at the low end of the dial; C43 is adjustable for alinement at the high 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 decoupling resistor R28. R27 and C45 form a decoupling filter between the grid and a test point at terminal 1 of test connector J7.

13. Mixer
(fig. 7)

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

b. The output from the second rf amplifier is applied to the control grid (pin 4) of mixer V6, a pentode type 5678. 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. 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 cathode) produces an intermediate frequency



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.

2. V8 IS A TYPE 5676 IN THE FOLLOWING MODELS OF RADIO SET AN/PRC-10:

ORDER NO.	SERIAL NOS.
1758-PHILA-51	BELOW 6500
3374-PHILA-52	21562 THRU 22286

3. *

VALUES FOR C42	
RADIO SET	UUF
AN/PRC-8	10
AN/PRC-9	6.5
AN/PRC-10	4.5

Figure 6. Receiver oscillator circuit.

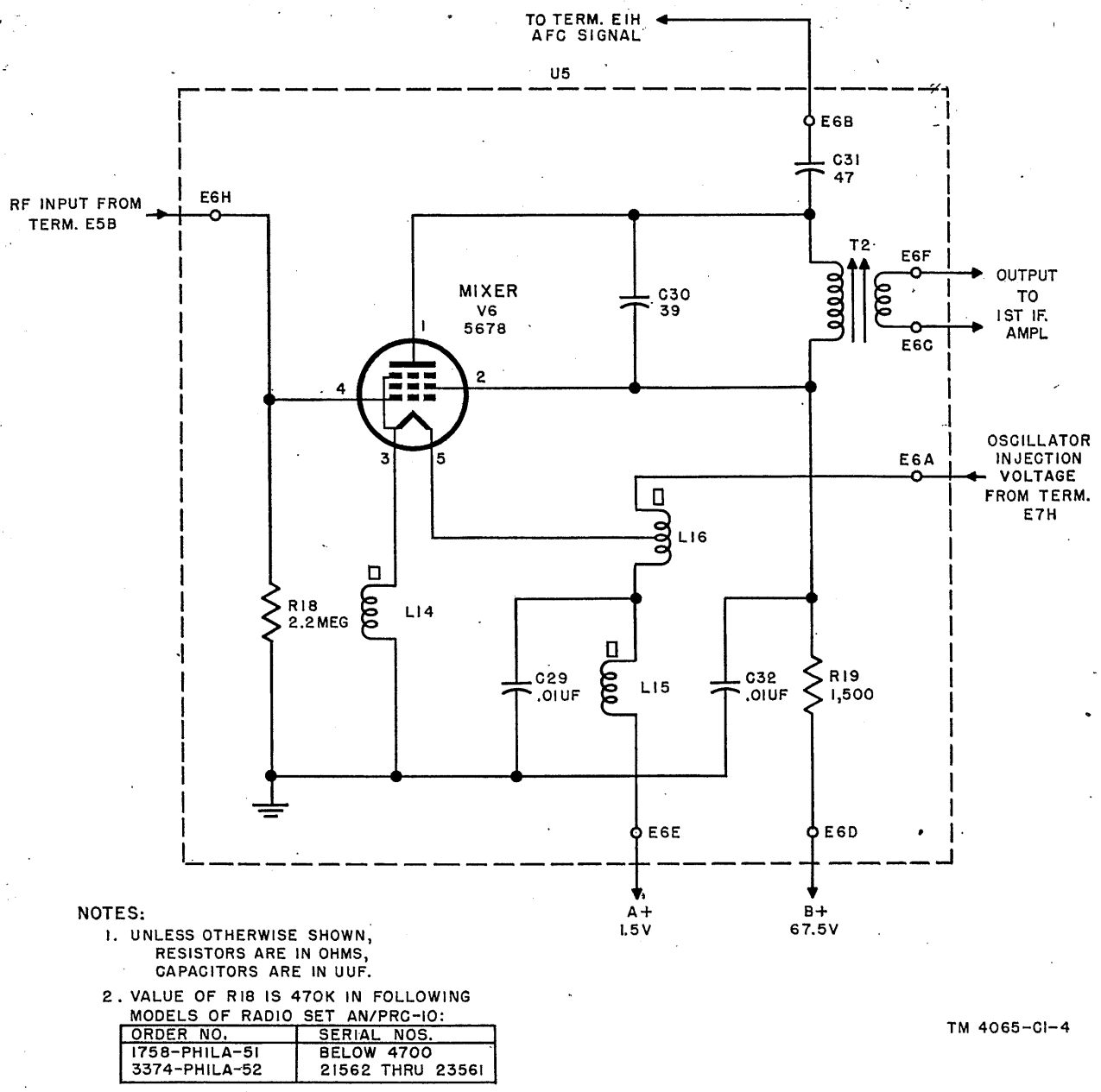
of 4.3 mc in the plate circuit. The plate circuit consists of C30 and the primary of T2. This is a parallel circuit which is tuned to resonance at 4.3 mc. The voltage developed in this circuit is passed through transformer T2 to the grid circuit of the first if. amplifier and through C31 to the grid circuit of afc driver V1.

c. Filament voltage is applied to the filament through L15 and through L16. C29 and L15 decouple the dc filament supply from rf voltages. 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. R19 and C32 form a B+ decoupling filter.

14. If. Amplifiers (fig. 8)

a. There are five if. stages in the receiver. These are all identical. Each stage is a hermetically sealed can. The cans have reference symbols U101, U102, U103, U104, and U105. The five cans plug into sockets X7, X8, X9, X10, and X11, respectively. Because the cans are identical, the components and the component reference symbols in each can are identical. Therefore, a description of one of these stages covers all five 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. The transformer secondary forms a series tuned circuit with L101 and C101 which 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 fourth and fifth



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. VALUE OF R18 IS 470K IN FOLLOWING MODELS OF RADIO SET AN/PRC-10:

ORDER NO.	SERIAL NOS.
1758-PHILA-51	BELOW 4700
3374-PHILA-52	21562 THRU 23561

TM 4065-CI-4

Figure 7. Mixer circuit.

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. R104 is across this circuit to broaden its response to the desired bandwidth (aprx. 100 kilocycles (kc)). The output signal is passed through T101 to the next stage.

d. The 67.5-volt supply is applied to the plate through decoupling filter R103 and C102D and through the primary of T101. From the top of R103, voltage is applied to the screen through an additional decoupling filter consisting of R102 and C102B. The 1.5-volt supply is applied to the filament through contacts 8 and 7 of receiver-transmit relay K1 and L102. C102C

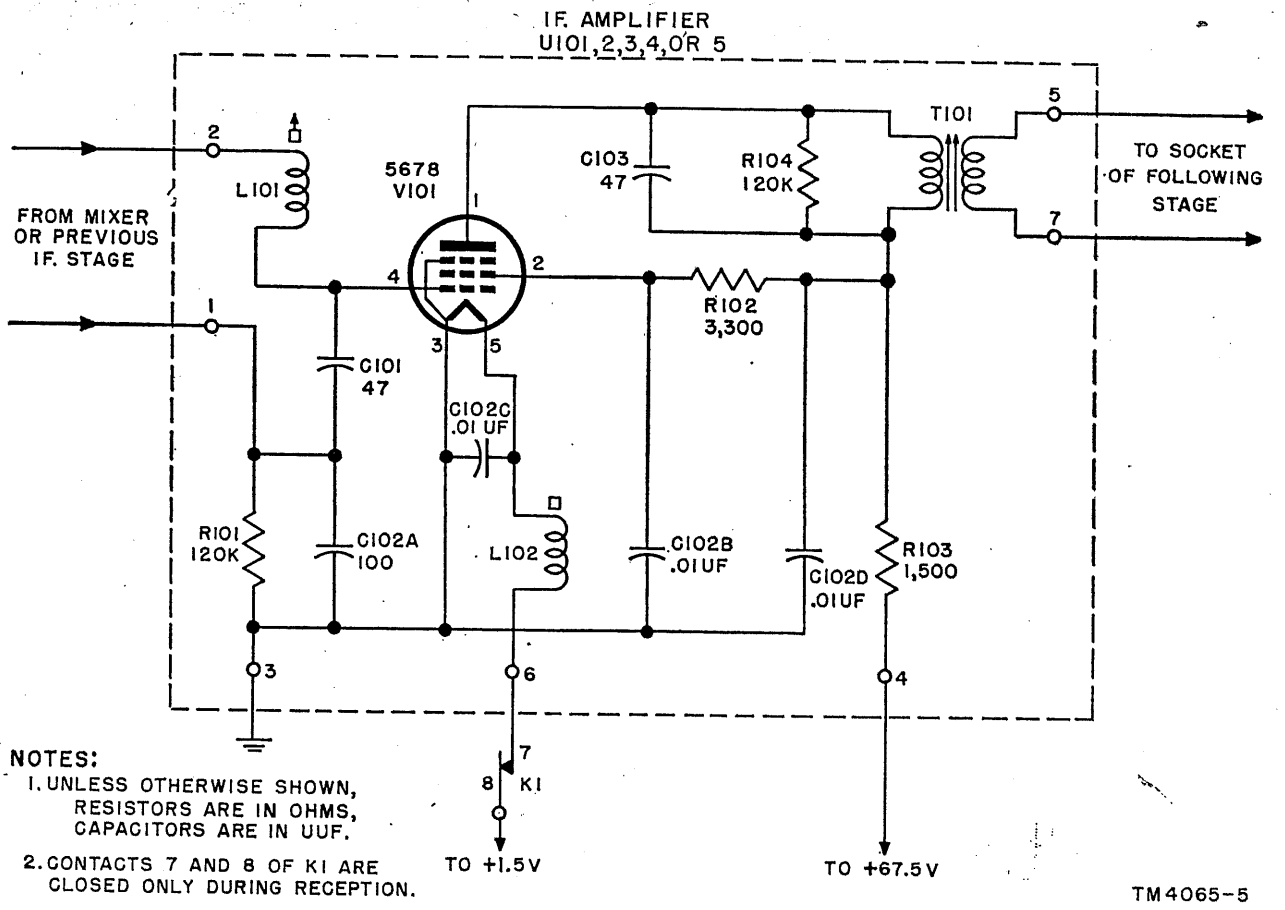


Figure 8. If. amplifier circuit.

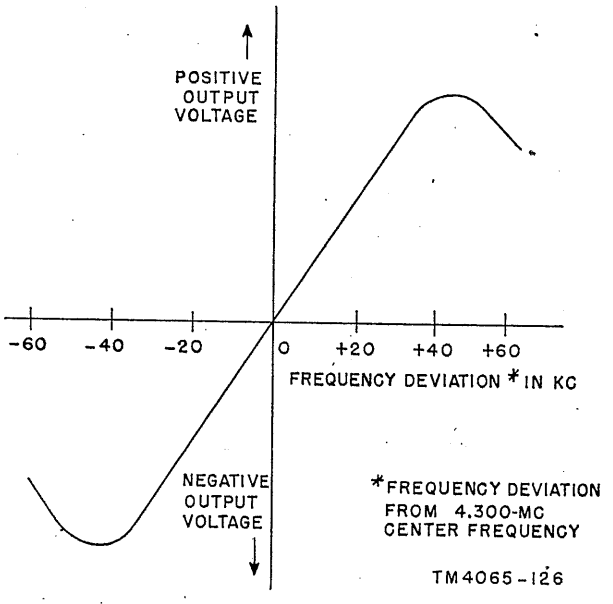


Figure 9. Discriminator frequency response curve.

and L102 form an rf filter which keeps rf out of the filament.

15. Receiver Discriminator (figs. 9 and 10)

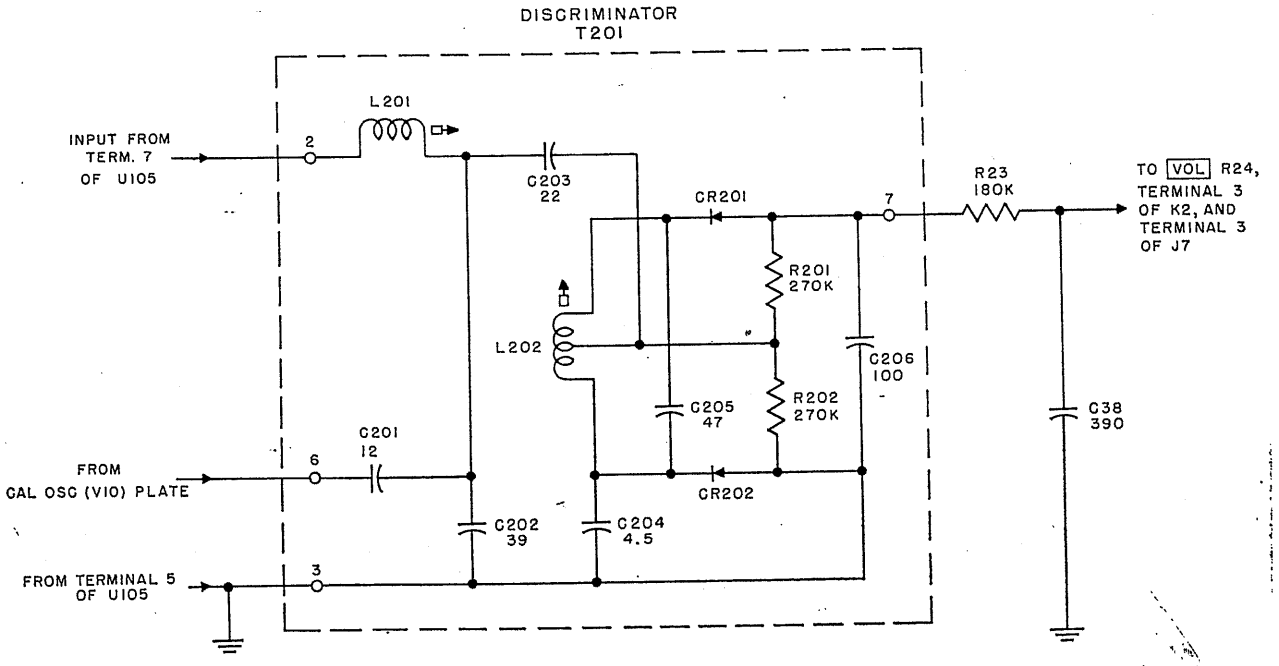
a. Discriminator Function. The receiver discriminator changes fm signals to audio signals. The if. signal applied to the discriminator is frequency modulated and shifts above and below the 4.3-mc center frequency at an audio rate. The amplitude of the modulating voltage at the transmitter determines the amount of deviation of the transmitter rf carrier and the receiver if. signal. The output voltage of the discriminator varies with the frequency of the input signal as shown in figure 9. The discriminator output, therefore, is an audio signal. The amplitude of the audio signal is proportional to the frequency deviation (shift) of the

fm signal. The frequency is equal to the frequency with which these deviations occur.

b. Circuit Operation. The series circuit consisting of the secondary of T101 of the fifth if. amplifier (fig. 8), and L201 and C202 in the discriminator can (fig. 10), is tuned to 4.3 mc. The voltage across C202 is coupled through M203 to the discriminator tuned circuit consisting of L202 and C205. This circuit also is tuned to the if. frequency (4.3 mc). C204 unbalances the upper and lower halves of the discriminator circuit. This unbalancing is necessary in order to produce unequal ac voltages across CR201 and CR202 when the if. signal is above or below 4.3 mc. The ac signal in this circuit is rectified by crystal rectifiers CR201 and CR202 to produce dc voltages across R201 and R202. At the if. center frequency, these voltages are equal and opposite so that the dc output of the discriminator is zero. When the signal shifts above the if. center frequency, the dc voltage across R201 exceeds that across R202 and the discriminator output voltage is positive. When the signal shifts below the if. center frequency, the dc voltage across R202 exceeds that across R201 and the discriminator output voltage is negative. As the frequency of the if. signal keeps shifting at an audio frequency, the polarity and amplitude of the discriminator output voltage keeps shifting at an audio frequency. The output voltage, which is an audio signal, is obtained at terminal 7 of T201 and is applied through if. decoupling filter B23 and C38 to VOL control R24. C206 provides a return to ground for if. from CR201. When the radio set is being calibrated, the signal from the 4.3-mc calibration oscillator is applied to the discriminator circuit through terminal 6 of C201. The value of C201 is made small to decouple the calibration oscillator circuit from the discriminator input circuit.

16. Audio Amplifier
(fig. 11)

The audio output from the discriminator is applied to VOL control R24 and from the movable contact on R24 through C39 to the control grid of audio amplifier V7. R25 is the grid-leak resistor. A bias of —6 volts is applied through this resistor from the 6-volt supply.



NOTE:
UNLESS OTHERWISE SHOWN,
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UUF.

TM 4065-CI-5

Figure 10. Discriminator circuit.

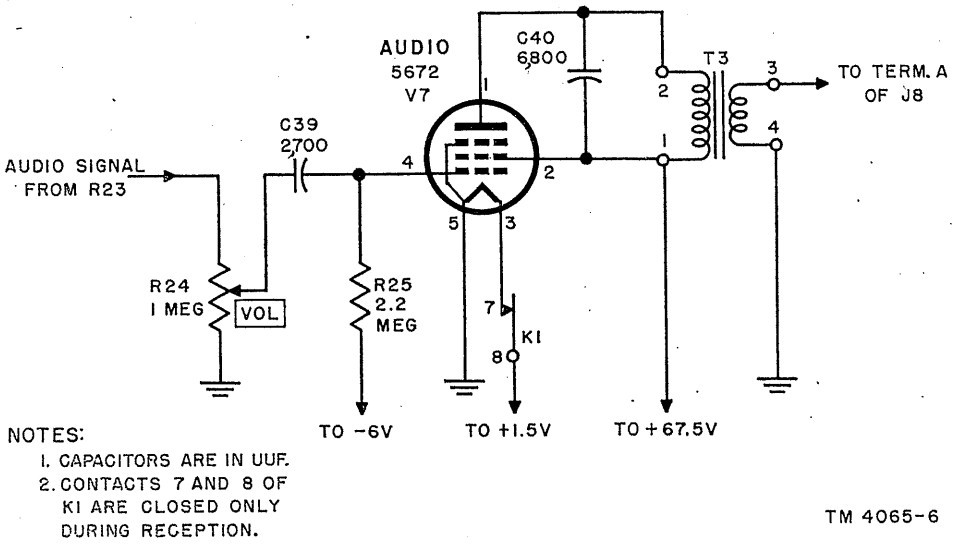


Figure 11. Audio amplifier circuit.

The plate circuit consists of the primary of T3, which is shunted by C40 to reduce the output of the higher audio frequencies. The secondary of T3 is connected across terminal A of AUDIO connector J8 and ground. (The handset receiver is connected to these terminals.) The 1.5-volt supply is applied to the filament through contacts 8 and 7 of receiver-transmit relay K1. When the radio set is transmitting, these contacts open to disable the audio amplifier. The 67.5-volt supply is applied directly to the screen grid of the tube and through the primary of T3 to the plate.

17. Squelch Circuit
(fig. 12)

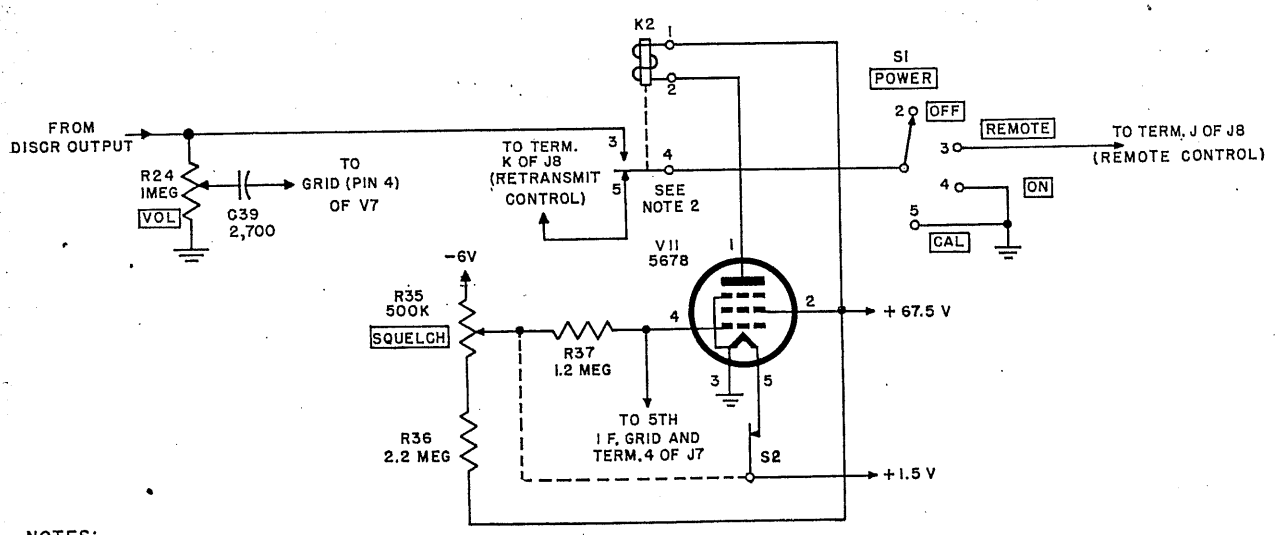
a. When the squelch circuit is operating, it grounds the audio output from the discriminator and silences (squelches) the receiver. The high side of VOL control R24 is connected to contact 3 of squelch relay K2. When K2 is energized, contacts 3 and 4 close and a circuit is completed through these contacts and the ON or CAL position of the POWER switch to ground. (In some earlier models, terminal 4 of K2 was connected directly to ground.) When SQUELCH control R35 is turned to its extreme counter-clockwise position, it opens switch S2 which is in series with the filament of V11. This de-energizes the tube and disables the squelch circuit.

b. The plate current of V11 operates K2. This current is controlled by the grid bias voltage at pin 4 of V11. R35 and R36 form a voltage divider between the —6-volt supply and the +67.5-volt supply. The adjustable tap on R35 is set to apply a low negative voltage (approximately 1.7 volts) to the control grid of the tube through grid current limiting resistor R37. This bias voltage allows just enough plate current to flow to energize (pull in) K2. When the receiver picks up a signal, it develops a negative bias voltage at the grid of the fifth if. amplifier. This voltage is applied to the control grid of V11. When this voltage exceeds 2.5 volts, it reduces the plate current below the value necessary to keep K2 pulled in. K2 releases, breaking the connection between contacts 3 and 4 and removing the short from the audio circuit. This unsquelches the receiver. When the signal stops, K2 pulls in again and squelches the receiver.

c. Contacts 4 and 5 of K2 are used only when two radio sets are used for retransmission (fig. 23). R37 decouples R35 from the grid circuit of the fifth if. amplifier.

18. Calibration Oscillators
(fig. 13)

a. 1-mc Calibration Oscillator. The 1-mc calibration oscillator, V9, is a modified Pierce oscillator. Feedback from plate to grid is through C48 and crystal Y1. C48 and C47 form a voltage divider which determines the amount of feedback voltage applied to the grid circuit. R29 is the grid-leak resistor. C47 and C49 provides



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. TERMINAL 4 OF RELAY K2 IS CONNECTED DIRECTLY TO GROUND IN THE FOLLOWING SETS:

RADIO SET	ORDER NO.	SERIAL NOS.
AN/PRC-8	1758-PHILA-51	BELOW 115
AN/PRC-9	1758-PHILA-51	BELOW 6
AN/PRC-10	1758-PHILA-51 3374-PHILA-52	BELOW 9100 BELOW 26020

3. R36 IS 560K IN RADIO SETS AN/PRC-10 ON ORDER NO. 1758-PHILA-51 WITH SERIAL NUMBERS BELOW 4700.
4. POWER SWITCH SI VIEWED FROM END OPPOSITE KNOB.

TM 4065-CI-6

Figure 12. Squelch circuit.

the proper loading across crystal Y1 for good frequency stability. L22 keeps the cathode above ground potential for rf. R30 is the plate voltage-dropping resistor. Crystal Y1 accurately controls the oscillator frequency at 1 mc. The oscillator voltage is applied from pin 5 of the filament to antenna coil L9. For the theory discussion of receiver calibration, see paragraph 9.

b. 4.3-mc Calibration Oscillator. The 4.3-mc oscillator, V10, is a Pierce electron-coupled oscillator. The screen grid (pin 2) operates as the plate of a triode oscillator. The plate (pin 1) is electron coupled to the triode oscillator through the tube electron flow. Because the output is taken from the plate circuit of the tube, electron coupling isolates the output loading from the oscillator circuit. The output voltage at the plate is coupled to the discriminator input circuit where it beats against the if. frequency produced by the mixing of the receiver oscillator signal with a harmonic of the 1-mc oscillator. The oscillator section of the tube consists of the filament, control grid, and screen grid. This circuit is very similar to the 1-mc oscillator circuit. Voltage is fed back from the screen (pin 2) to the control grid (pin 4) through C52 and crystal Y2. C52 and C50 form a voltage divider which determines the amount of feedback voltage applied to the grid circuit. R31 is the grid-leak resistor. C50 and C51 provide the proper loading across crystal Y2 for good frequency stability. L23 provides rf isolation between the filament of V11 and the 1.5-volt supply. R33 and C54 form a decoupling filter between the B+ supply and the plate and screen of the tube. R32 is the plate load resistor. R34 is the oscillator plate load resistor. (The screen grid, pin 2, is the plate of the triode oscillator.)

c. Filament and Dial Light Circuits. The 1.5-volt supply is applied through the CAL position of the POWER switch to the filament of V9 and V10 and to dial light E8. These three circuits are in parallel. E8 and the filament of V10 are returned directly to ground. The filament of V9 is returned to ground through a portion of antenna coil L9 (figs. 51 through 54).

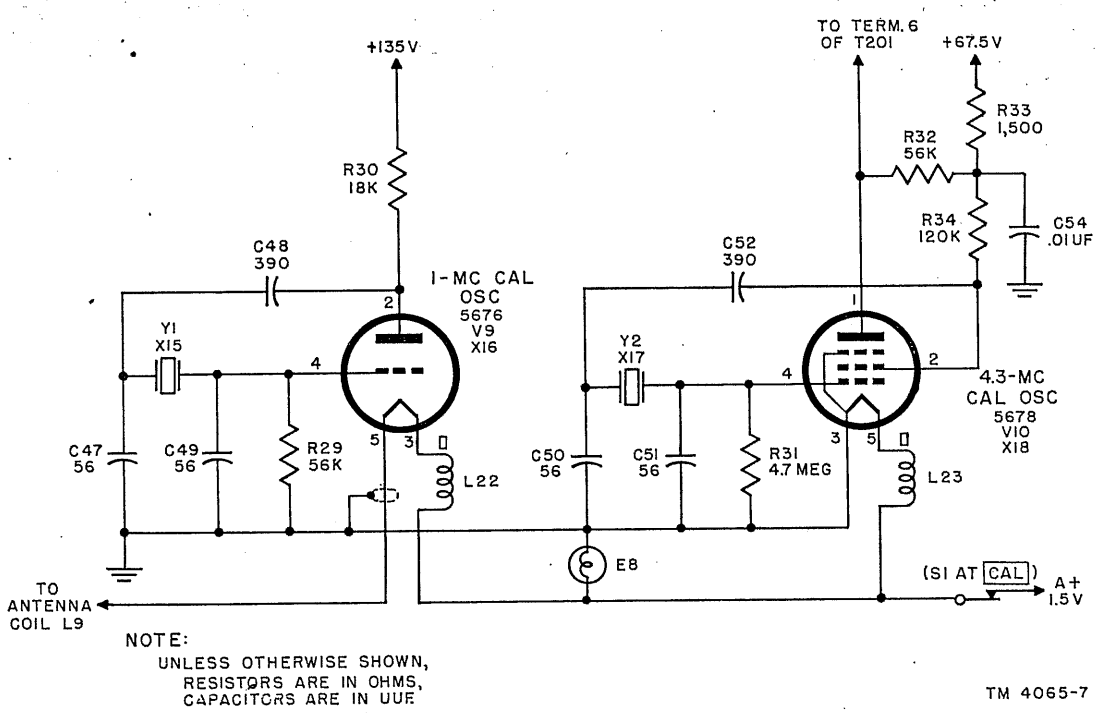


Figure 13. Calibration oscillator circuits.

Section III. TRANSMITTER STAGES

19. Modulator
(fig. 14)

a. The modulator has two functions. It frequency-modulates the transmitter oscillator and is also a part of the afc circuit that prevents the transmitter oscillator from drifting off frequency. Both functions are accomplished by the variation in inductance of transformer L4 when the plate current of V2 varies. The afc circuit is explained in paragraph 21.

b. Transformer L4 is operated near its magnetic saturation point. When the current through L4 is increased, its permeability and inductance decrease. When the current through L4 is decreased, its permeability and inductance increase. This is shown on figure 15. The primary of L4 is in the plate circuit of V2. Therefore, changes in the plate current of V2 produce changes in the inductance of the primary and secondary windings of L4. The secondary winding of L4 is in parallel with a portion of L3 (which is part of the tuned grid circuit of transmitter oscillator V3). Therefore, changes in the inductance of the secondary of L4 produce changes in the frequency of the transmitter oscillator. When these changes occur at a rate which corresponds to the frequency of the audio signal coming from the microphone of the handset, the transmitter oscillator is frequency modulated by this audio signal.

c. Voice signals are applied from the microphone of the handset through transformer T1 to the grid of V2. C7 is the audio-frequency

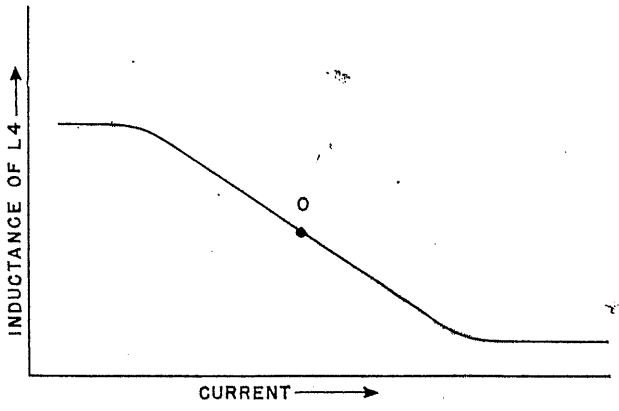


Figure 15. Variation of inductance with current in L4.

(af) ground return for the secondary of T1. In earlier models, C8 and R10 form a voltage divider across the secondary of T1. C8 pre-emphasizes the higher audio frequencies. In later models, C8 is replaced by R12 (note 3, fig. 14). (This new R12 should not be confused with an R12 used in earlier models in the grid circuit of V3.) The audio signals at the grid of V2 cause the plate current of V2 to change at an audio frequency. This causes the inductance of L4, and the frequency of transmitter oscillator V3, to change at an audio frequency.

d. The grid bias circuit for V2 is shown on figure 16. In this circuit, there are two dc voltage sources in series. The first is the negative grid-leak bias voltage developed across R11 by transmitter oscillator V3. The second is the output voltage of the afc discriminator circuit which is developed across C6 (par. 21). When the transmitter oscillator is on frequency, the output voltage of the discriminator circuit is zero. However, when the transmitter oscillator drifts off frequency, a positive or negative dc voltage is developed across the output of the afc discriminator, depending on whether the frequency drift of the transmitter oscillator is up or down. The vector sum of the voltage across R11 and the afc output voltage is the bias voltage at the control grid of V2.

e. The +135-volt supply is applied from contact 6 of receive-transmit relay K1 (fig. 14) and the primary of L4 to the plate of V2. The 1.5-volt supply is applied from contact 9 of K1 to the filament of V2. Both pairs of contacts are closed only during transmission, so V2 operates only during transmission.

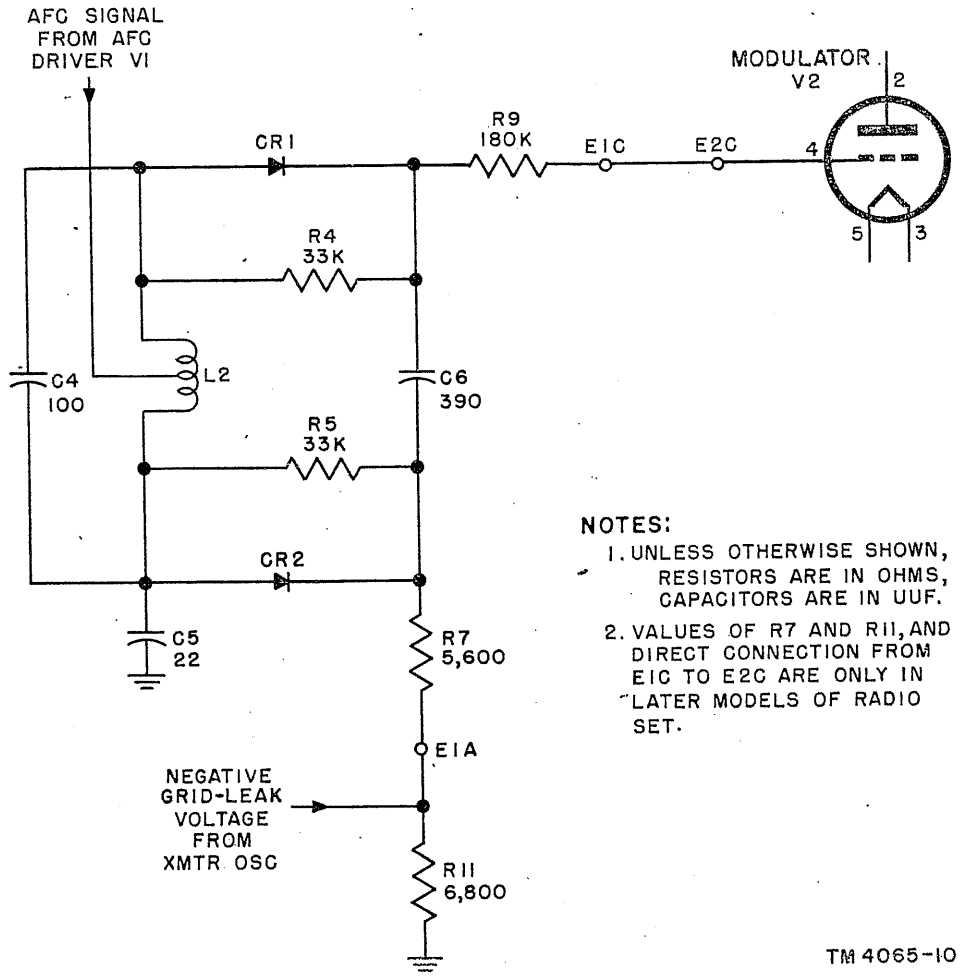


Figure 16. Grid bias circuit for modulator.

20. Transmitter Oscillator (fig. 17)

a. Transmitter oscillator V3 is an electron-coupled, neutralized output, Hartley oscillator. The oscillator section of the tube consists of the filament, the control grid, and the screen grid. The plate circuit of the tube has no connection to the oscillator section except through the electron coupling in the tube. Variations in frequency or loading in the plate circuit therefore do not affect the stability of the oscillator.

b. The oscillator tuned circuit consists of L3 and C9B. C11 is a trimmer used for transmitter oscillator alinement at the high end of the dial. L3 is slug-tuned to permit alinement at the low end of the dial. The lower tap on L3 is connected to the filament of V3. The portion of L3 between this tap and ground is in the plate section of the Hartley oscillator. (In Radio Sets AN/PRC–8 and –9, this section of L3 is shunted by R6 to provide the proper value of rf plate voltage.) The screen grid (pin 6), which operates as the plate of the oscillator section, is returned to ground through C18 and then back through the lower section of L3 to the filament of V3. The remaining portion of L3 is in the grid circuit of the oscillator. The upper tap on L3 is connected to the secondary of L4 which is in parallel with the portion of L3 below this tap. Changes in the inductance of L4 produce changes in the resonant frequency of the transmitter-oscillator tuned circuit and, therefore, produce changes in transmitter frequency. The tuned circuit is coupled to the control grid of V3 through C10 and parasitic suppressor E3. On earlier models R12 is a grid-leak resistor connected directly between the control grid and cathode of V3. On later models R12 has been omitted and the values of R13 and R11 have been reduced to provide the relatively low dc path from control grid to cathode that was provided by R12. In models from which R12 has been omitted, the return from ground to cathode is made through the lower portion of L3. R13 and C15 form a decoupling filter to prevent rf from being applied to terminal E1A of the afc driver box.

c. The plate (pin 1) of V3 is coupled through C16 to the tank circuit consisting of L9 and C9A. C20 is a trimmer used for alinement of the transmitter oscillator at the high end of the dial. L9 is slug-tuned to permit alinement at the low end of the dial. The portion of L9 below ground potential and C17 provides a path for a neutralizing (compensating) voltage to the cathode of V3. This neutralizing voltage minimizes frequency variations caused by variations in antenna loading. (Variations in antenna loading are produced when different antennas are used or when the distance between the antenna and some object such as a house, tree, vehicle, or ground, is varied.) Frequency variations caused by variations in antenna loading are greater at the high end of the dial than at the low end. Neutralizing adjustment, therefore, is made only at the high end of the dial. This adjustment is made during alinement of the transmitter oscillator.

d. Output coil L9 is tapped down for connection to the antenna jacks. This decreases the transmitter-oscillator frequency variations due to variations in antenna loading. L9 is connected to three antenna jacks. J1 is the LONG ANT jack, J2 is the SHORT ANT jack, and J3 is the AUX ANT jack. When the long antenna is plugged into J1, the connector on the end of this antenna makes a direct connection between C12 and L6, which are used only in Radio Sets AN/PRC–9 and –10 to tune the long antenna. C12 is ganged with TUNING capacitor C9. The short antenna plugs into J2 and is tuned by L7 which is ganged with C9. An auxiliary antenna, used for semipermanent installations is connected to J3. No tuning is provided for this antenna.

e. The output of the transmitter oscillator is coupled through C19 to the control grid of first rf amplifier V4 to develop an afc signal. In most models of Radio Set AN/PRC–10, a direct connection is made from the filament of V3 through R8 to the control grid of second rf amplifier V5. The filament of V3 is above rf ground. This provides an alternate path for the transmitter oscillator signal. The afc circuit is explained in paragraph 21.

f. The +135-volt supply is applied through contacts 5 and 6 of K1 to the screen (pin 6)

and from the screen through L8 to the plate (pin 1) of V3. Contacts 5 and 6 of K1 are closed only when the set is transmitting. L8 isolates the plate and the screen for rf. The negative 6-volt supply is connected through contacts 3 and 4 of K1 and rf choke L5 to the filament of V3. C13 is an rf bypass across the filament. C14 and L5 decouple the rf voltage in the filament of V3 from the negative 6-volt supply.

21. Afc Circuit

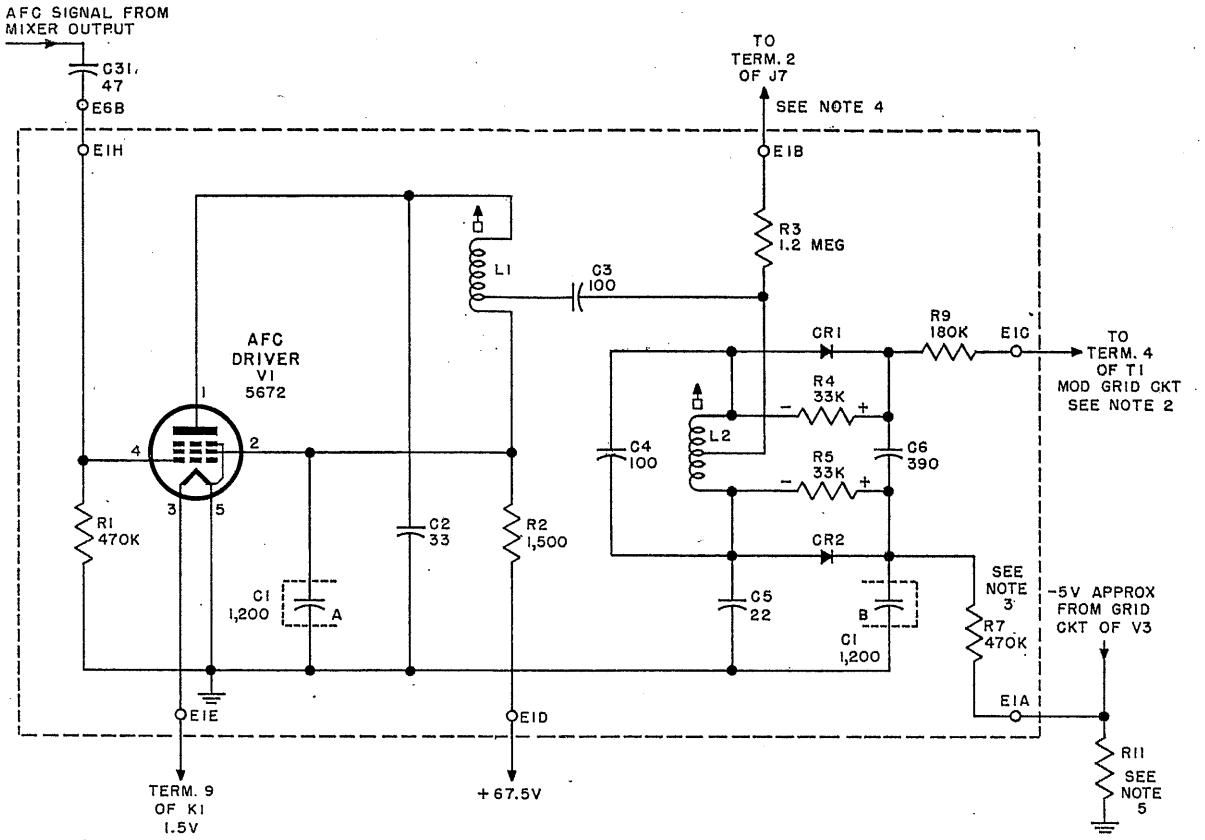
a. The purpose of the afc circuit is to prevent the transmitter oscillator from drifting off frequency. The transmitter oscillator signal is coupled through C19 (figs. 51–54) to the control grid of first rf amplifier V4. (The first rf amplifier does not operate during transmission because its filament circuit then is open.) From the grid of V4 it is passed through the grid-to-plate interelectrode capacitance of V4 (in Radio Sets AN/PRC–8 and –9) and through distributed wiring capacitance to the control grid of second rf amplifier V5. This is a high impedance path; therefore, only a weak signal reaches the grid of the second rf amplifier. The output of the transmitter oscillator is weaker in Radio Set AN/PRC–10 than in Radio Sets AN/PRC–8 and –9. Therefore, in Radio Set AN/PRC–10, a lower impedance path is provided from the filament of transmitter oscillator V3 (the filament is above rf ground potential) through R8 to terminal E5H which connects to the control grid of second rf amplifier V5. The signal at the control grid of V5 is amplified and applied to mixer V6, where it beats with the receiver oscillator signal to produce an if. output at the mixer plate. A portion of this if. is coupled through C31 to the control grid of afc driver V1. This is the afc signal (fig. 18). When the transmitter oscillator is on frequency, the center frequency of the afc signal is 4.3 mc; when the transmitter oscillator frequency is too high, the center frequency of the afc signal is below 4.3 mc; when the transmitter oscillator frequency is too low, the center frequency of the afc signal is above 4.3 mc.

b. The afc signal is amplified by afc driver V1. The plate tank circuit of V1 consists of C2 and L1, which are tuned to 4.3 mc (fig. 18). C1A is the screen bypass and also returns L1 to ground for rf. The 67.5-volt supply is applied through R2 to the screen and then through L1 to the plate of V1. R2 and C2 decouple the plate and screen from the B+ supply. R1 is the grid-leak resistor. The 1.5-volt supply is applied to the filament through contacts 8 and 9 of K1. These contacts are closed only during transmission.

c. A portion of the afc signal voltage across L1 is applied through C3 to the afc discriminator circuit. L1 is tapped down to prevent the discriminator circuit from varying the load of the plate tank circuit of V1. The discriminator circuit develops a positive voltage across C6 when the center frequency of the afc signal is above 4.3 mc, a negative voltage when the center frequency of the afc signal is below 4.3 mc, and zero voltage when the center frequency of the afc signal is at 4.3 mc. The bias voltage at the control grid of modulator V2 is equal to the vector sum of the dc voltages developed across R11 and C6 (fig. 16). The voltage across R11 is part of the grid-leak bias voltage developed by V3. This is a constant negative voltage. The voltage across C6 varies when the transmitter oscillator drifts off frequency. When the transmitter oscillator frequency is too high, the center frequency of the afc signal is below 4.3 mc and the voltage across C6 becomes negative. This reduces the plate current of V2, increases the inductance of L4, and reduces the transmitter oscillator frequency to its proper value (par. 19*b*). When the transmitter oscillator frequency is too low, the center frequency of the afc signal is above 4.3 mc and the voltage across C6 becomes positive. This increases the plate current of V2, lowers the inductance of L4, and raises the transmitter oscillator frequency to its proper value.

d. C4 and L2 are tuned to 4.3 mc. CR1 and CR2 are germanium diode rectifiers which produce dc outputs across the R4 and R5 respectively. C6 connects CR1 to C1B which provides the if. return to ground. C1B also returns CR2 to ground for if. C5 is an unbalancing capacitor which provides stable discriminator opera-

tion. This unbalancing capacitor prevents the development of equal and opposite if. currents which would cause the discriminator output to be zero at all frequencies. R9 and R7 are if. isolating resistors which prevent if. signals from being radiated outside the afc box. R3 is an if. decoupling resistor between the afc circuit and terminal 2 of test socket J7 which is used for measuring the dc voltage at the center tap of L2.



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. IN RADIO SETS AN/PRC-10 ON ORDER NO. 15176-PHILA-52 WITH SERIAL NUMBERS 4001 AND UP, AND IN LATER MODELS ON ORDER NO. 15178-PHILA-52, E1C IS CONNECTED TO E2C INSTEAD OF TO TERMINAL 4 OF T1.
3. R7 IS 5,600 OHMS IN THE FOLLOWING RADIO SETS:

RADIO SET	ORDER NO.	SERIAL NOS.
AN/PRC-9	15176-PHILA-52	4976 AND UP
AN/PRC-10	15176-PHILA-52	4001 AND UP
	15178-PHILA-52	LATER MODELS

4. CONNECTION FROM E1B TO TERM. 2 OF J7 IS NOT MADE IN THE FOLLOWING SETS:

RADIO SET	ORDER NO.	SERIAL NOS.
AN/PRC-8	3374-PHILA-52	668 THRU 1127
AN/PRC-10	15176-PHILA-52	21562 THRU 27681

5. VALUES OF R11 FOR DIFFERENT MODELS OF THE RADIO SET ARE SHOWN IN THE FOLLOWING CHART:

ORDER NO.	VALUE IN OHMS		
	AN/PRC-8	AN/PRC-9	AN/PRC-10
1758-PHILA-51	270K	330K	470K
3153-PHILA-51	270K	330K	470K
3374-PHILA-52	270K	330K	470K
15176-PHILA-52	270K	330K (SERIAL NOS. 1 THRU 4975)	470K (SERIAL NOS. 1 THRU 4000)
		5,600 (SERIAL NOS. 4976 THRU 8926)	6,800 (SERIAL NOS. 4001 THRU 12433)
15178-PHILA-52	——	——	470K (EARLY MODELS) 6,800 (LATER MODELS)
3432-PHILA-52	——	——	6,800

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Figure 18. Afc circuit.

22. Power Sources

a. Battery BA–279/U. Battery BA–279/U is the power source for the radio set when it is pack mounted. The battery voltages are available at an eight-terminal receptacle. The schematic diagram and a test chart of the battery are shown on figure 19. The battery and receiver-transmitter cases are shown separated on figure 20.

b. Amplifier-Power Supply AM–598/U. Amplifier-Power Supply AM–598/U (TM 11–5055) is the power source for the radio set in 24-volt vehicular installations. It supplies approximately the same voltages as Battery BA–279/U. These voltages are available at an eight-terminal receptacle similar to the one on Battery BA–279/U.

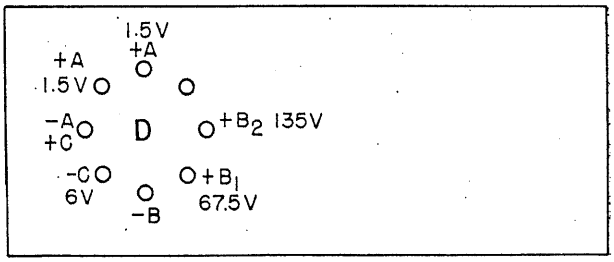
23. Control Circuits (fig. 21)

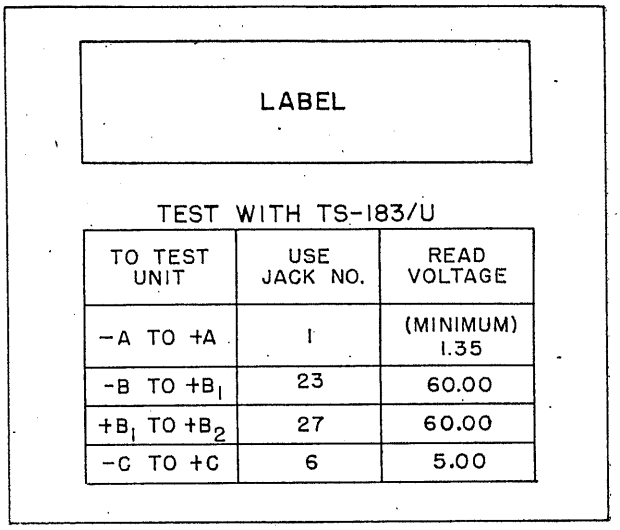
Application of power to the radio set is controlled by POWER switch S1. Receive-transmit control is provided by the handset push-to-talk button. Additional controls are provided by SQUELCH switch S2, and by Control Group AN/GRA–6.

a. POWER Switch at OFF. When this switch is at OFF, there is no ground return for the A, B_1, B_2, and C voltage supplies and no power is supplied to the radio set.

b. POWER Switch at ON. In this position of the switch, all four voltage supplies are returned to ground. The filament circuits of all receiver tubes except squelch tube V11 are completed. The filament circuit of V11 is completed when SQUELCH switch S2 is closed. Plate and screen voltages are supplied to all receiver tubes and to calibration oscillators V9 and V10. This puts the receiver in operation. (The calibration oscillators do not operate because their filament circuits are open.)

c. POWER Switch at ON, Push-To-Talk Button Pressed. When the handset push-to-talk button is pressed, it disables the receiver and operates the transmitter. Two pairs of contacts on the push-to-talk switch close and complete circuits through receive-transmit relay K1 and through the handset microphone.





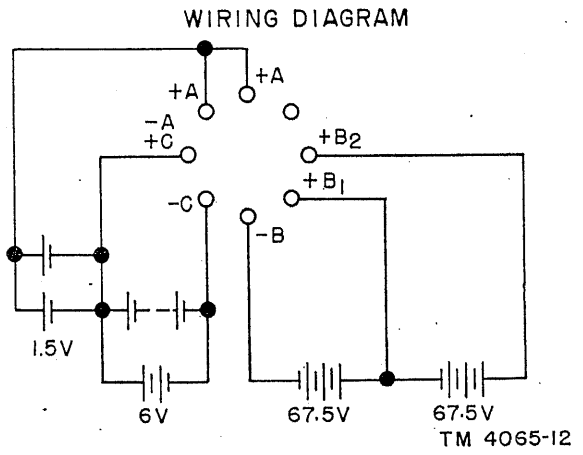


Figure 19. Battery BA–279/U schematic diagram and test chart.

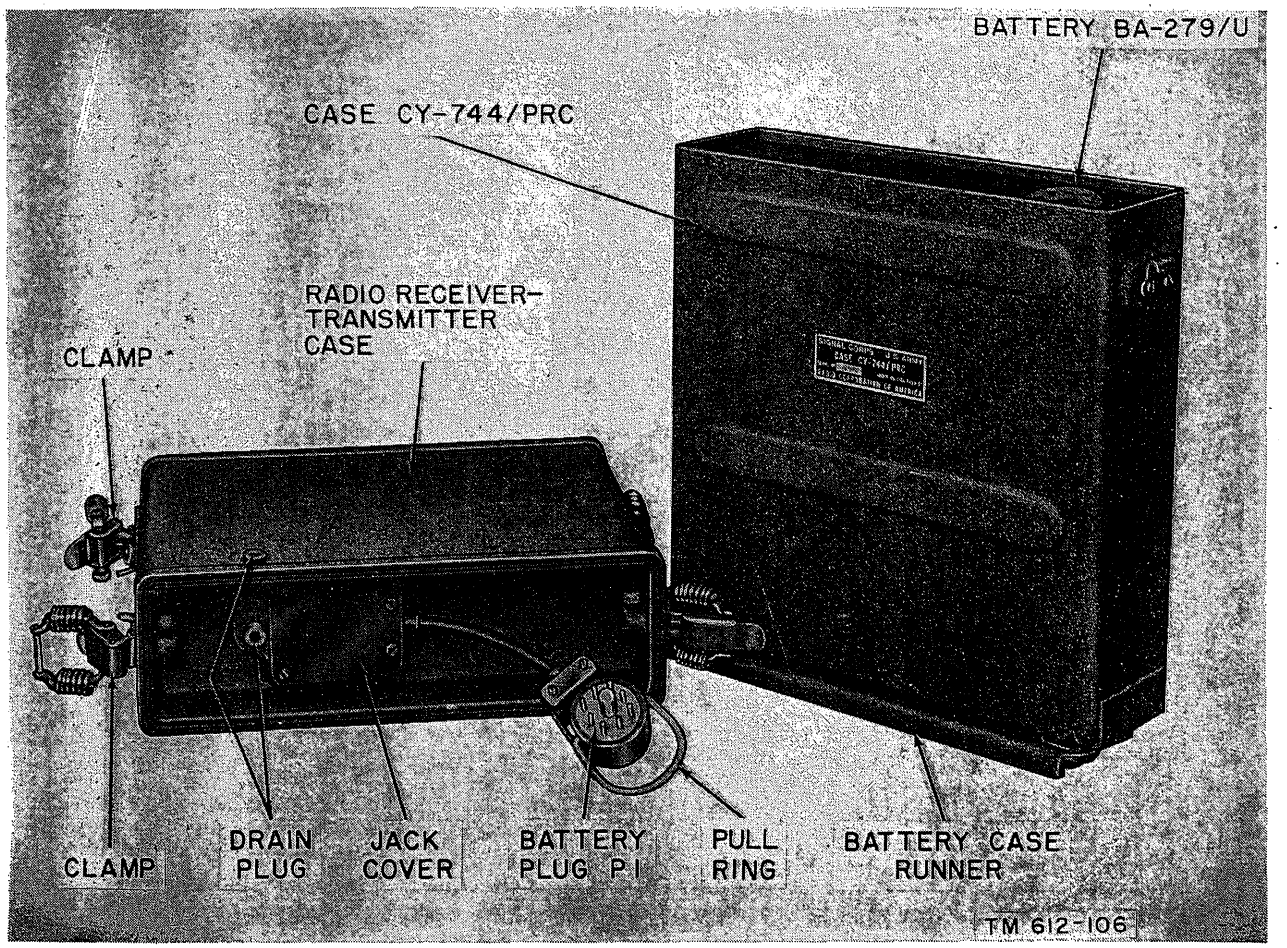


Figure 20. Battery and receiver-transmitter cases, separated.

(1) One pair of contacts completes a circuit from the 6-volt supply through the coil of receive-transmit relay K1. When the relay pulls in, contacts 3 and 4 close, 7 and 8 open, 8 and 9 close, and 5 and 6 close. The closure of contacts 3 and 4 completes the 6-volt filament circuit of transmitter oscillator V3. The opening of contacts 7 and 8 breaks the filament circuits of first rf amplifier V4, the if. amplifiers (U101 through U105), and audio amplifier V7. The closure of contacts 8 and 9 completes the 1.5-volt filament circuits of afc driver V1 and modulator V2. The closure of contacts 5 and 6 connects the 135-volt supply to the plate of transmitter oscillator V3.

(2) The second pair of contacts of the handset push-to-talk switch completes the microphone circuit. This circuit extends from the 1.5-volt supply through contacts 8 and 9 of K1, the primary of microphone transformer T1, the handset microphone, the handset switch, chassis ground, and back through the ON position of POWER switch S1 to the negative terminal of the 1.5-volt supply.

d. POWER Switch at CAL & DIAL LITE. When the switch is at CAL & DIAL LITE, it completes the same circuits as when it is at ON. It also completes a circuit from the 1.5-volt supply through the filaments of the two calibration oscillators (V9 and V10) and through dial lamp E8. This puts the receiver and the calibration oscillators in operation and turns on the dial light. (The CAL & DIAL LITE position of the switch is spring loaded and the switch returns to the ON position when it is released.)

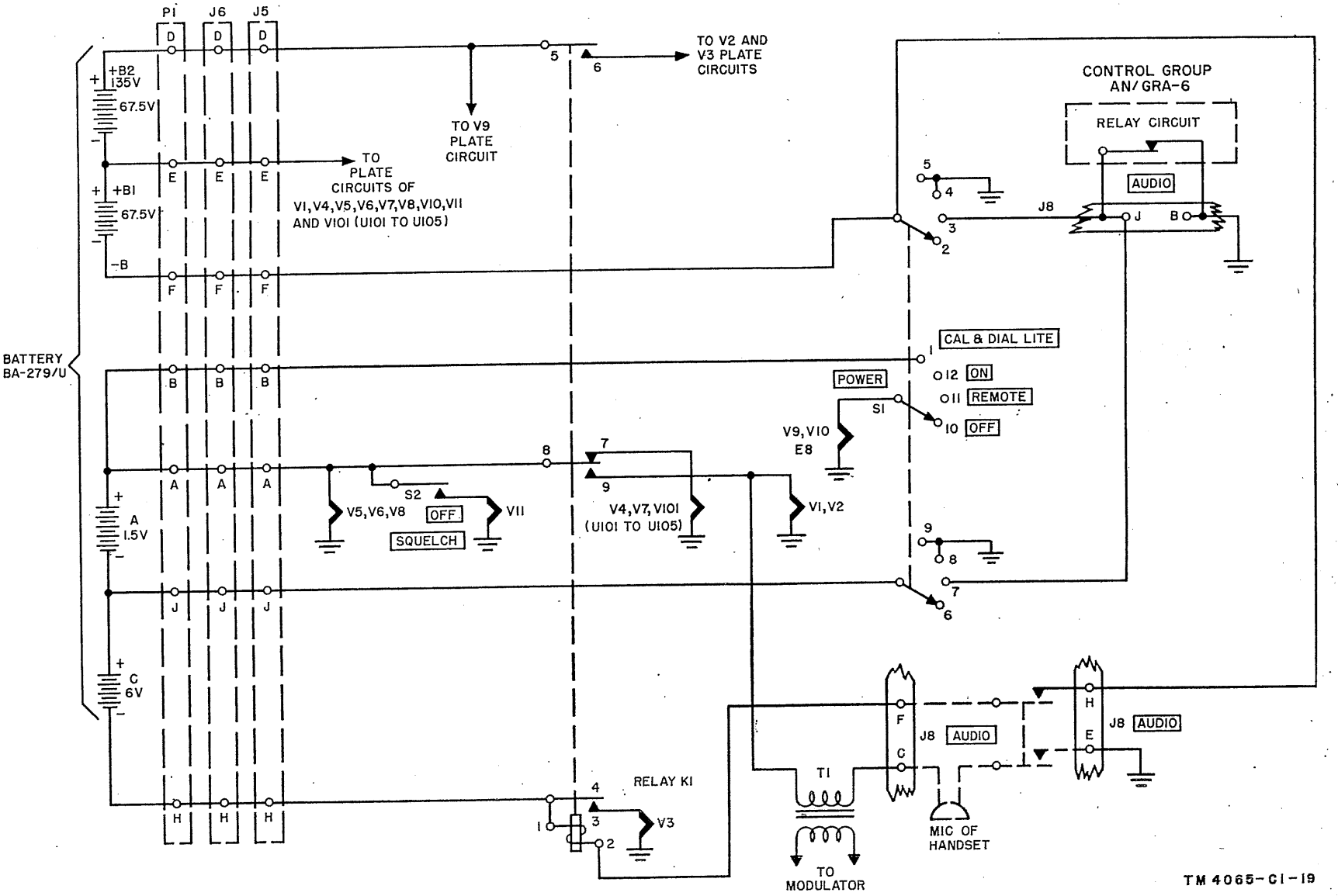


Figure 21. Control circuits.

e. POWER Switch at REMOTE. When the switch is at REMOTE, power can be applied to the receiver-transmitter only through Control Group AN/GRA–6 which is used for remote control of the radio set. In this position of the switch, the voltage supplies are not returned to ground but are connected to terminal J of AUDIO connector J8. Power is applied to the receiver-transmitter when switching action in the control group connects terminal J of J8 to chassis ground. Additional switching in the control group connects terminal F of J8 to ground. This completes the circuit through receive-transmit relay K1 and puts the transmitter in operation. Appropriate connections from the control group to the radio set also are made for reception and transmission of audio signals. For details on Control Group AN/GRA–6, refer to TM 11–5038.

Section V. RELAY OPERATION

24. Arrangement of Radio Sets for Relay Operation
(fig. 22)

Two radio sets connected by a relay cable are used as a relay station. The relay station operates unattended and passes signals in both directions. Sets 1 and 2 (fig. 22) are tuned to one frequency while Sets 3 and 4 are tuned to a second frequency. Two handsets are connected to the relay cable. The handset located nearer to Set 2 is used to receive and transmit through Set 2 while the one located nearer to Set 3 is used to receive and transmit through Set 3. Electrical Special Purpose Cable Assembly CX–1961/U (fig. 24) is used as the relay cable.

25. Relay Circuit Theory
(fig. 23)

a. The relay cable completes circuits between two radio sets which make relay operation possible. These circuits are shown on figure 21.

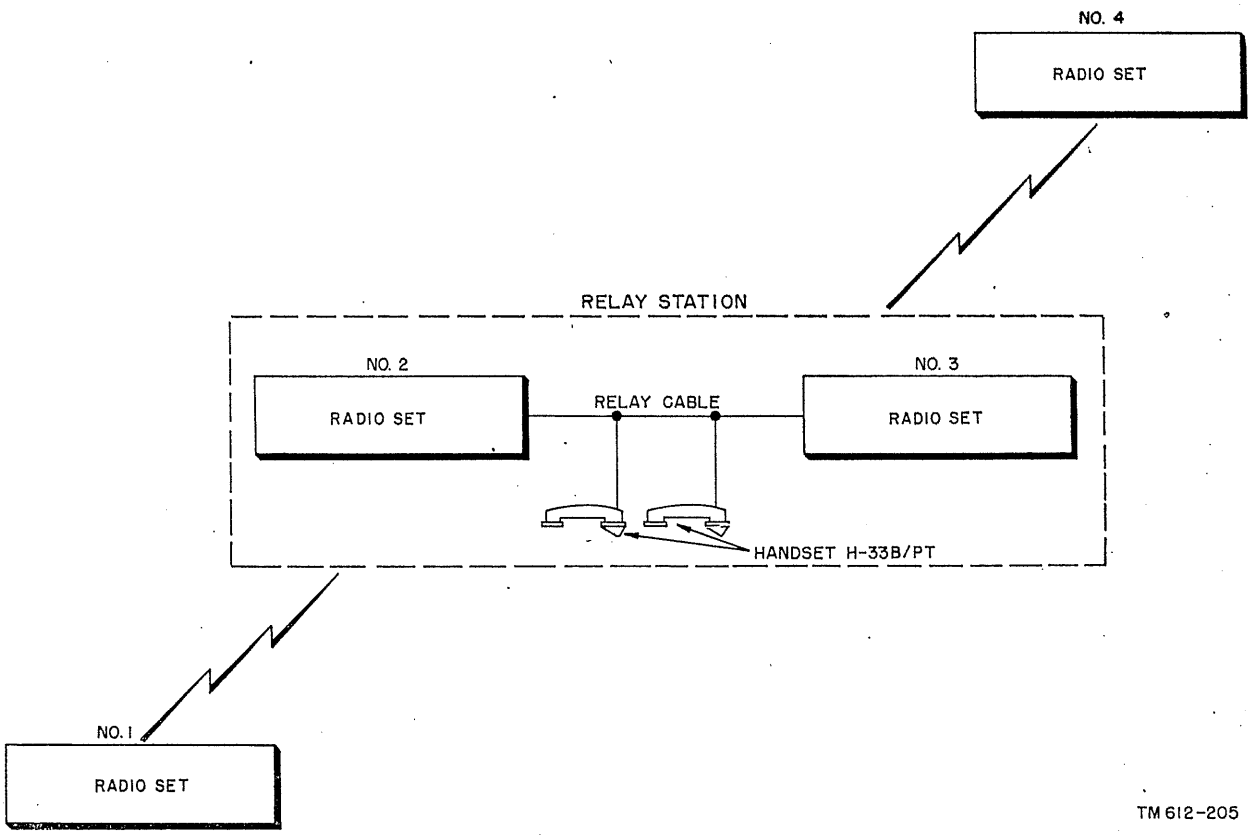
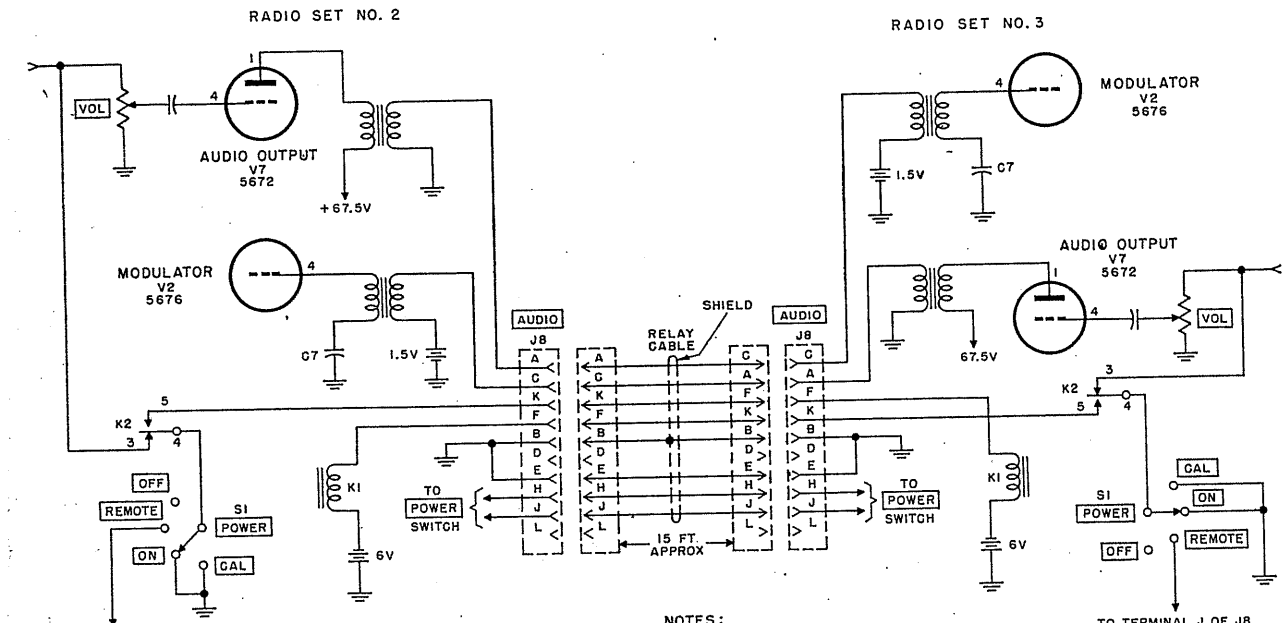


Figure 22. Arrangement of radio sets for relay operation.

The relay station is set up with the two radio sets in the receive condition and with the receivers squelched. This means that squelch relay K2 is pulled in, contacts 3 and 4 are closed, and 4 and 5 are open. If a signal now should be transmitted by Set 1 (fig. 22), this signal is picked up by Set 2 and its squelch circuit is disabled (par. 17). Squelch relay K2 in this set releases and contact 4 transfers from contact 3 to contact 5. When contacts 4 and 5 of K2 close in Set 2, they complete the 6-volt circuit through the coil of receive-transmit relay K1 in Set 3 and energize this relay. When K1 is energized, it disables the Set 3 receiver and operates the Set 3 transmitter. Simultaneously, the opening of contacts 3 and 4 of K2 in Set 2 unsquelches the Set 2 audio signal and this signal is amplified by Set 2 audio output amplifier V7 and fed through the relay cable to the grid circuit of modulator V2 in Set 3. The audio output of V2 then is used to modulate the signal transmitted by Set 3. Set 3 transmits at a different frequency from the incoming signal to Set 2. The Set 3 signal is picked up by Set 4 which is tuned to the same frequency as Set 3. When Set 1 stops transmitting, squelch relay K2 in Set 2 pulls in, contacts 4 and 5 open, receive-transmit relay K1 in Set 3 releases, the Set 3 transmitter is disabled and the Set 3 receiver is again put in operation. When a signal is transmitted by Set 4, it produces the same series of operations in the opposite direction.

b. Figure 24 is a detailed wiring diagram of the relay cable. The relay cable is ordered as Retransmission Cable Kit MK–126/G which consists of Electrical Special Purpose Cable Assembly CX–1961/U and Cable Assembly Case CY–1251/U. The cable assembly consists of Special Purpose Cable WM–69A/U with a junction box at each end. Each junction box contains two connectors, Receptacle Connector U–126/U and Receptacle Connector U–79/U. Receptacle Connector U–126/U is plugged into the AUDIO connector of the radio set and Handset H–33/PT is plugged into Receptacle Connector



NOTES:

1. SQUELCH ON AND SQUELCH RELAYS ENERGIZED.
2. RELAY CABLE NOT SUPPLIED WITH EQUIPMENT.
3. POWER SWITCH S1 AT ON; S1 VIEWED FROM END OPPOSITE KNOB.
4. RELAY CABLE CONNECTIONS TO HANDSETS NOT SHOWN.
5. TERMINAL 4 OF RELAY K2 IS CONNECTED DIRECTLY TO GROUND IN THE FOLLOWING SETS:

RADIO SET	ORDER NO.	SERIAL NOS.
AN/PRC-8	1758-PHILA-51	BELOW 115
AN/PRC-9	1758-PHILA-51	BELOW 6
AN/PRC-10	1758-PHILA-51	BELOW 9100
	3374-PHILA-52	BELOW 26020

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Figure 23. Relay circuit.

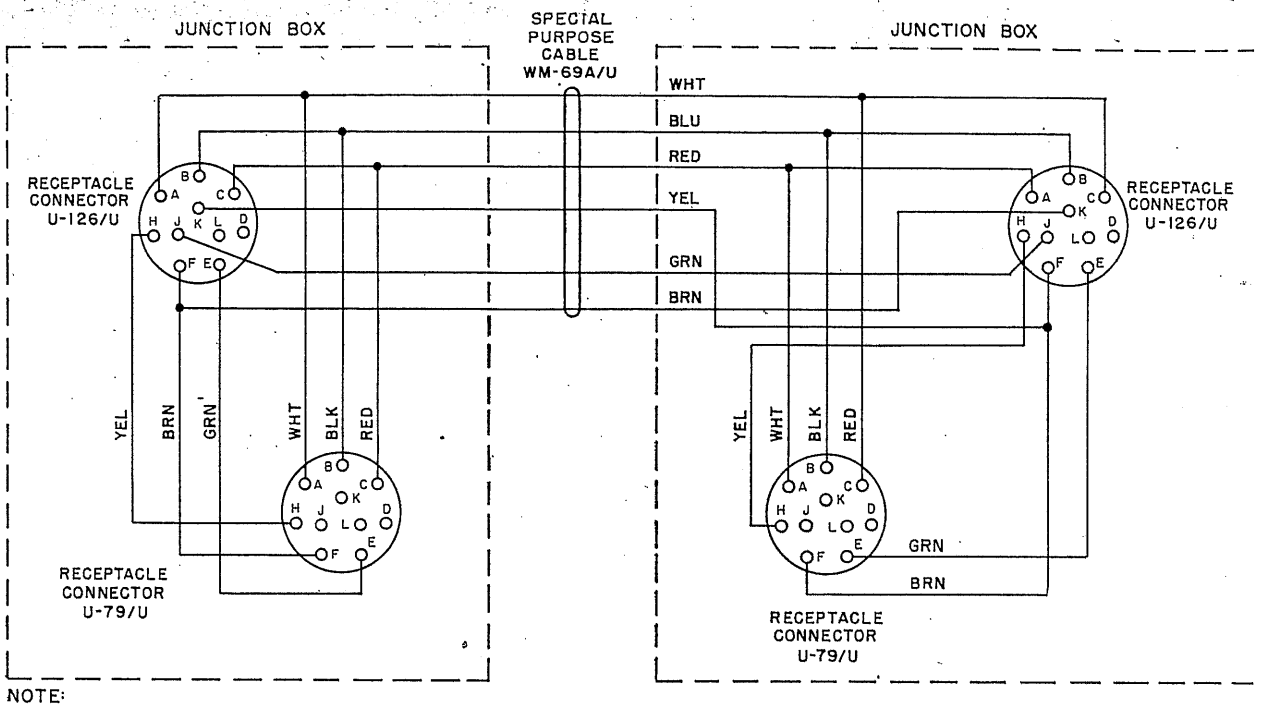

Figure 24. Electrical special purpose cable assembly CX-1961/U.

U-79/U. The handsets are not needed for the actual retransmission but they are necessary when squelch and volume adjustments are made in setting up the relay station. The handset plugged into the left junction box is used for receiving or transmitting on the left-hand radio set; the one on the right-hand side is used for receiving and transmitting on the right-hand radio set. The receiver of each handset is connected through the relay cable to terminals A and B of the radio set near which it is located (figs. 24 and 25). Audio output is supplied from these terminals. When the push-to-talk button is pressed, it completes two circuits. One circuit is through receive-transmit relay K1 and puts the radio set in the transmit condition. The other circuit is through the microphone of the handset and enables audio signals from the microphone to be applied to the transmitter.

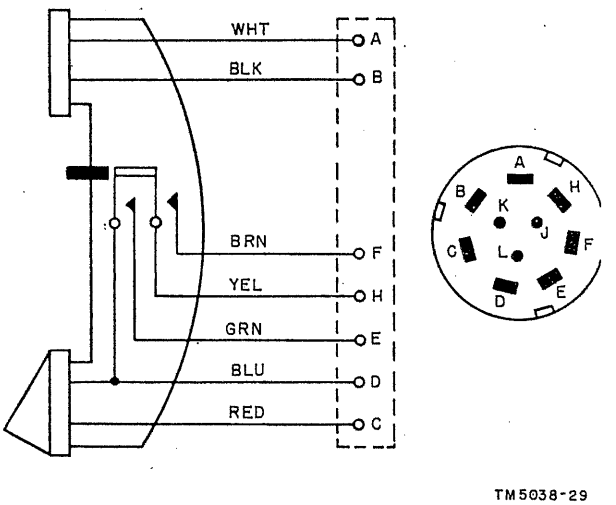

Figure 25. Handset H-33/PT, schematic diagram.