

MODEL E-98

Nine-Tube, Four-Band, A-C Superheterodyne Receiver

Electrical Specifications

FREQUENCY RANGES

"Long Wave" (X)-----	150-410 kc
"Standard Broadcast" (A)-----	530-1,800 kc
"Medium Wave" (B)-----	1,800-6,400 kc
"Short Wave" (C)-----	6,400-23,000 kc

Intermediate Frequency

RADIOTRON COMPLEMENT

(1) Type-6K7-----	R-F Amplifier
(2) Type-6J7-----	Oscillator
(3) Type-6L7-----	First Detector
(4) Type-6K7-----	I-F Amplifier

Pilot Lamps (4)

POWER SUPPLY RATINGS

Rating A

105-125 volts, 50-60 cycles, 95 watts

Rating B

105-125 volts, 25-60 cycles, 95 watts

POWER OUTPUT

Undistorted ----- 2 watts

Maximum ----- 4.5 watts

ALIGNMENT FREQUENCIES

"Long Wave" (X)----- 175 kc (osc.), 350 kc (osc., det., ant.)

"Standard Broadcast" (A)----- 600 kc (osc.), 1,500 kc (osc., det., ant.)

"Medium Wave" (B)----- 6,000 kc (osc., det., ant.)

"Short Wave" (C)----- 20,000 kc (osc., det., ant.)

460 kc

(5) Type-6H6----- Second Detector and A.V.C.

(6) Type-6F5----- Audio Voltage Amplifier

(7) Type-6F6----- Power Output

(8) Type-5Z4----- Full-Wave Rectifier

(9) Type-6E5----- Tuning Tube

Mazda No. 46, 6.3 volts, 0.25 ampere

LOUDSPEAKER

Type ----- Electrodynamic

Impedance (v.c.) ----- 2.2 ohms at 400 cycles

Mechanical Specifications

Height -----	41 inches
Width -----	27 1/16 inches
Depth -----	14 7/16 inches
Weight (net) -----	95 pounds
Weight (shipping) -----	125 pounds
Chassis Base Dimensions -----	14 1/2 inches x 7 3/4 inches x 3 3/4 inches
Over-all Height of Chassis -----	9 inches
Operating Controls: (1) Music-Speech—Power Switch, (2) Volume, (3) Tuning, (4) Range Selector, (5) Tone	
Tuning Drive Ratios -----	20 to 1 and 100 to 1

General Description

This receiver represents the result of thorough development, design, and substantial manufacture. Noteworthy technical improvements have been applied in achieving marked advantages of operation, and efficiency of performance.

Model E-98 is a nine-tube, console-type, superheterodyne receiver with a twelve-inch electrodynamic loudspeaker. Design features incorporated in this receiver include a built-in doublet antenna coupler; improved plunger-type air-dielectric adjust-

able trimming capacitors in the antenna, detector, and oscillator coil circuits; tuned r-f amplifier; high-efficiency first detector (converter) with separate oscillator; magnetite core adjusted i-f transformers, low-frequency oscillator tracking, and wave-trap; two-point aural compensated volume control; music-speech switch; automatic volume control; phonograph terminal board; new selector dial; and a dust-proof electrodynamic loudspeaker.

Service convenience has been a controlling factor

in the layout of the chassis parts and wiring. The assembly of these various elements is such that the number of conductors is minimized, with all important connections being readily accessible. Trimming adjustments are located at accessible points. A double

The conventional type of superheterodyne circuit is used. It consists of an r-f amplifier stage, a first-detector (converter) stage, a separate oscillator stage, an i-f amplifier stage, a diode-detector—automatic-volume-control stage, an audio voltage-amplifier stage, a power-amplifier stage, a "Cathode Ray Tuning Indicator" and a full-wave rectifier.

A single-wire antenna, or a doublet antenna, when connected to the proper input terminals of the receiver, is coupled to the control grid of the Type-6K7 r-f amplifier tube through the tuned r-f transformer consisting of L6, L5, L4, L3, and L2. A unique method of switching is used. In the "Long wave" (X) band, L6 becomes the primary with L5, L4, L3,

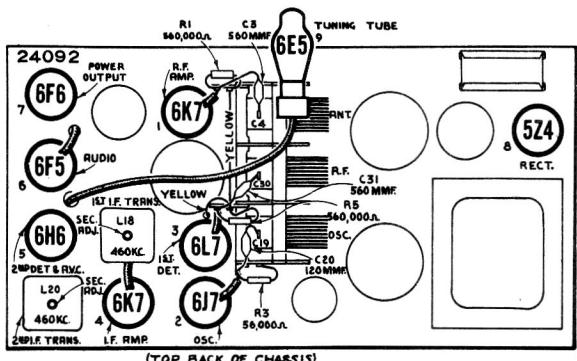


Figure 1—Radiotron and I-F Trimmer Locations

and L2 as secondary. In the "Standard broadcast" (A) band, L5 becomes the primary with L4, L3, and L2 as secondary (L6 shorted out). In the "Medium wave" (B) band, L4 becomes the primary with L3 and L2 as secondary (L6 and L5 shorted out). In the "Short wave" (C) band, L3 becomes the primary with L2 as secondary (L6, L5, L4, and tap on L4 shorted out). The tap on L4 is provided to prevent interaction with L3 and L2 when operating receiver in "Short wave" band. This method of switching reduces the total number of coils and leads, and results in having a low-loss primary and secondary winding for each band with high efficiency of operation.

The band switching of the detector circuits is similar to that of the antenna circuits. Coils L11 and L16 are always connected in series with the plate circuit of the Type 6K7 r-f amplifier tube. In the "Long wave" (X) band, L15, L14, L13, and L12 are connected in series as the secondary circuit. The ground of the coil system is at the low end of L15. L16 acts as the primary which transfers energy to the secondary L15. Capacitor C24 resonates primary L16 at the proper frequency. In the "Standard broad-

tuning-knob arrangement permits the choice of either a twenty-to-one or a hundred-to-one dial drive ratio. The latter permits ease of tuning, especially in the "Medium wave" and "Short wave" bands.

Circuit Arrangement

cast" (A) band L14, L13, and L12 are connected in series as the secondary circuit. The ground of the coil system is now between L15 and L14. L15 is used as the primary and is resonated at the proper frequency by capacitors C28 and C29 which are in shunt with this coil. Capacitor C24 is connected to transfer energy to the primary coil L15. In the "Medium wave" (B) band, L13 and L12 are connected in series as the secondary. The ground of the coil system is now between L14 and L13. L14 is used as the primary and is resonated at the proper frequency by capacitor C29 which is in shunt with this coil. L15 is shorted by the range selector. Capacitor C24 transfers the r-f energy from the plate circuit to the primary L14. In the "Short wave" (C) band, L12 is the secondary. The ground of the coil system is now between L13 and L12. L13 is used as the primary and is resonated to the proper frequency by capacitor C29. In addition, L11 acts as a high-frequency primary which resonates at about 20 mc and improves the gain at the high-frequency end of the "Short wave" band. Coils L15 and L14 are shorted by the range selector.

Separate windings are employed in the oscillator stage for each position of the range selector. The inherent stability of this circuit provides minimum frequency drift which is especially advantageous for high-frequency reception. The locally generated signal is capacitance coupled to control grid No. 2 of the Type 6L7 first detector.

I-F Amplifier

The intermediate-frequency amplifier consists of an Type-6K7 in a transformer-coupled circuit. The windings of these transformers are resonated with fixed capacitors, and are adjusted by molded magnetite cores (both primary and secondary) to tune to 460 kc.

Detector and A.V.C.

The modulated signal as obtained from the output of the i-f stage is detected by an Type-6H6 twin-diode tube. The audio frequency secured by this process is transferred to the a-f system for amplification and final reproduction. The d-c voltage which results from detection of the signal is used for automatic volume control. This voltage, which develops across resistors R11 and R12, is applied as automatic control-grid bias to the r-f, first-detector, and i-f tubes. The other (auxiliary) diode of the Type-6H6 is used to supply residual bias to the controlled tubes under conditions of little or no signal. This diode, under such conditions, draws current which flows through resistors R10, R11, and R12, thereby maintaining the desired operating bias on such tubes. On

application of signal energy above a certain level, however, the auxiliary bias-diode ceases to draw current and the a.v.c. diode takes over the biasing function.

Audio System

The manual volume control consists of an acoustically tapered potentiometer in the audio circuit between the output of the detector-diode and the input grid of the Type 6F5 audio voltage-amplifier tube. This control has a two-point tone-compensating filter connected to it so that the correct aural balance will be obtained at different volume settings. Phonograph terminals are provided to feed the output of an external phonograph pickup to the control grid of the audio amplifier through this aurally compensated volume control.

The output of the voltage amplifier is resistance-capacitance coupled to the control grid of the Type 6F6 power-output tube. The output of this stage is transformer coupled to the voice coil of the electrodynamic speaker.

The "Music-speech" control consists of a switch S4 which, in the "Speech" position, places an additional capacitor C45 in shunt with the capacitor C44 in one of the tone compensating filters. This reduces the low-frequency response of the amplifier and provides maximum intelligibility of the voice frequencies.

Continuously variable tone control is effected by means of capacitor C48 and variable resistor R19 shunting the plate circuit of the output tube.

"Cathode Ray Tuning Indicator"

An Type -6E5 cathode-ray tuning tube is used as a means of visually indicating when the receiver is accurately tuned to the incoming signal. This tube consists of an amplifier section and a cathode-ray section built in the same glass envelope. A portion of the signal voltage developed across resistor R12 is used to actuate the grid of the amplifier section. Maximum voltage is applied to this grid when the receiver is tuned to resonance with an incoming carrier. This condition is evidenced by the minimum width of the dark sector on the fluorescent screen.

SERVICE DATA

The various diagrams in this booklet contain such information as will be needed to locate causes for defective operation if such develops. The values of the various resistors, capacitors, coils, etc., are indicated adjacent to the symbols signifying these parts on the diagram. Identification titles, such as C1, L2, R1, etc., are provided for reference between the illustrations and the Replacement Parts List. The coils, reactors, and transformer windings are rated in terms of their d-c resistance only. Resistance values of less than one ohm are generally omitted.

Alignment Procedure

There are fourteen adjustments required for the alignment of the oscillator, first-detector, and antenna-tuned circuits; one adjustment for the wave-trap; and four adjustments for the i-f system. Twelve of these adjustments are made with plunger-type air trimming capacitors and require the use of a **GE Stock No. 12636 Adjusting Tool**. Each of these capacitors has a lock nut for securing the plunger in place after adjustment. The remaining seven adjustments are made by means of screws attached to molded magnetite cores. These cores change the inductance of the particular coils in which they are inserted to provide exact alignment. All of these adjustments are accurately made during manufacture and should remain in proper alignment unless affected by abnormal conditions of climate or purported alterations for servicing, or unless altered by other means. Loss of sensitivity, improper tone quality, and poor selectivity are the usual indications of improper alignment. Such conditions will usually exist simultaneously. Correct performance of this receiver can only be obtained when these adjustments have been made by a skilled service engineer with the use of adequate and reliable test equipment. The manufacturer of this receiver

has such test equipment available for sale through its distributors and dealers.

This receiver requires a more or less involved method of alignment. However, if the following directions are carefully applied in the sequence given, normal performance of the instrument will be obtained.

The plunger-type air trimming capacitors have their approximate plunger settings tabulated on figure 5. If the plungers have been disturbed from their original adjustments, they may be roughly set to the specified dimensions prior to alignment.

In performing services on the oscillator, detector, and r-f circuits, the leads should be restored to their original positions, since the lead-dress is important for proper operation and dial calibration.

Precautionary Dressing of Leads Prior to Alignment (Refer to Figure 3)

Band "X"

1. Keep blue lead X of S1 to antenna coil L4-5 dressed away from chassis, and from yellow lead of S1 to antenna coil L5-6.
2. Keep blue lead X of S3 to detector coil L14-15 clear of chassis, coil shield, coil, and other leads.
3. Keep bus lead C5 to X of S1 apart from bus lead C6 to A of S1, and from chassis.

Band "A"

1. Keep green lead, terminal of S1 to antenna coil tap L-4, away from chassis, coil shield, and coil.
2. Keep bus lead C6 to A of S1 apart from bus lead C5 to X of S1, and from chassis.

Band "C"

Lead from C18 to oscillator coil L7 should be maintained as short and straight as possible.

For alignment, the test-oscillator frequency should be quite accurate. A convenient and reliable means of accurately checking the frequency of test oscillators, receivers, etc., is the **GE Stock No. 9572 Crystal Calibrator**.

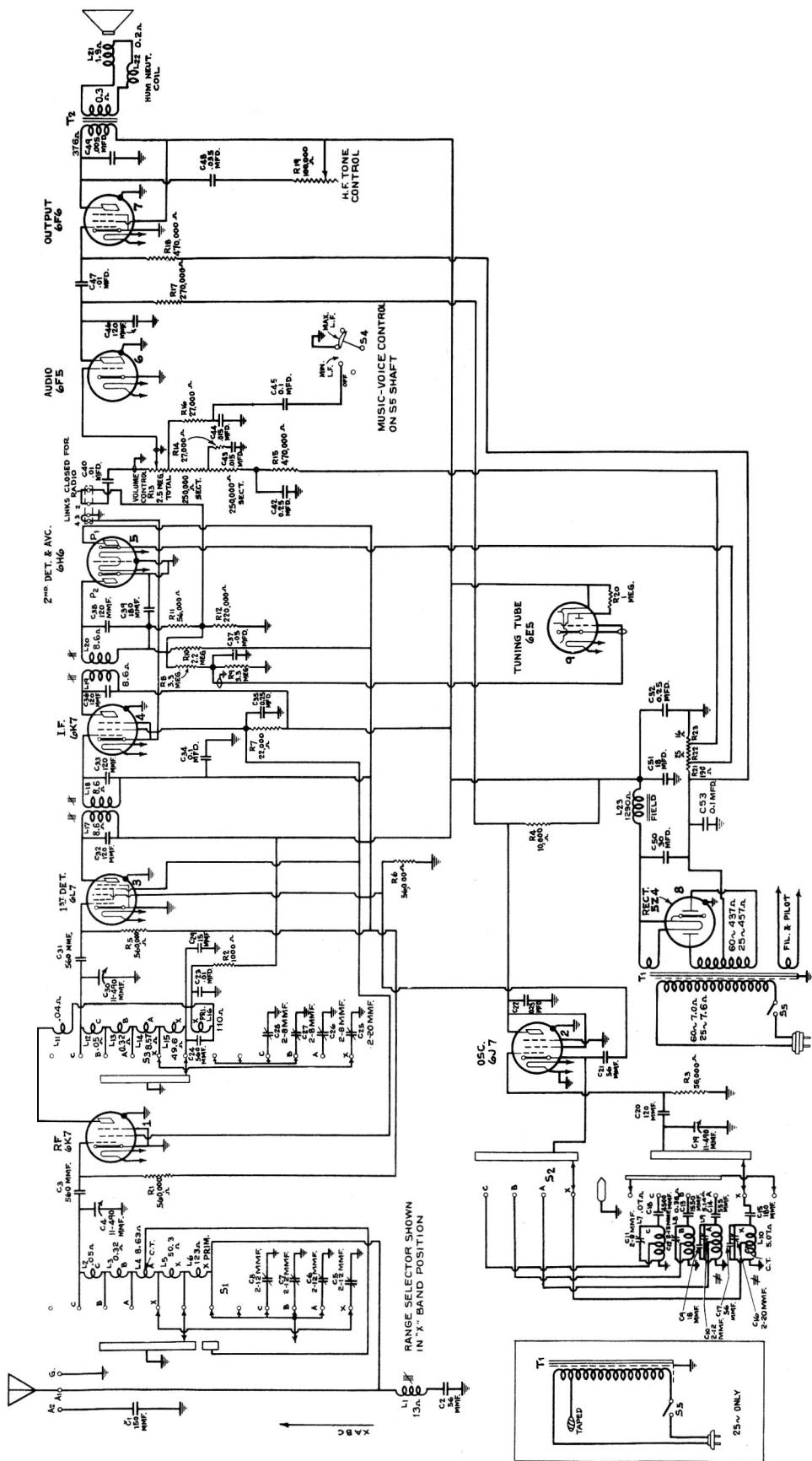


Figure 2—Schematic Circuit Diagram

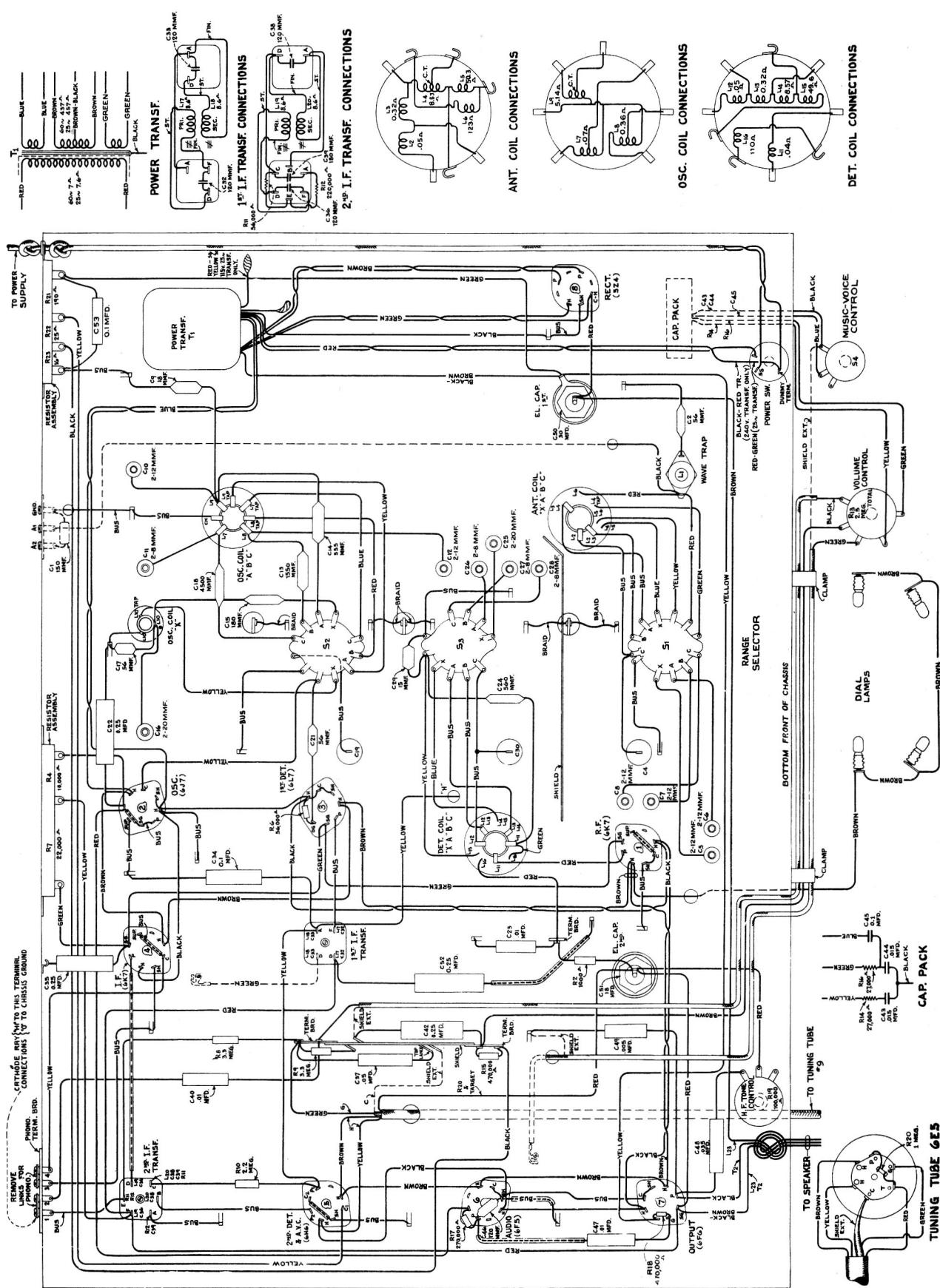


Figure 3—*Chassis Wiring Diagram*

If the test-oscillator signal cannot be heard as the receiver (heterodyne) oscillator air-trimmer plunger is changed from its minimum-capacity to maximum-capacity position (receiver dial and test oscillator set to the specified frequencies, and the correct oscillator air-trimmer used) it may be an indication that the test-oscillator frequency is outside the range covered by the air-trimmer. Under such conditions, when a more accurate setting of the test oscillator cannot be determined, set the oscillator air-trimmer plungers to the approximate settings given on figure 5. Tune the test oscillator until the signal is heard in the speaker. Each of two test-oscillator settings (the fundamentals or the harmonics of which are 920 kc apart) produce a signal. The lower-frequency test-oscillator setting should be used as this places the test-oscillator (signal) frequency 460 kc below the frequency of the receiver heterodyne oscillator.

Holes are provided in the top of the r-f and antenna coil cans on some models to enable a tuning check with the **GE Stock No. 6679 Tuning Wand**. The hole in the top of the detector coil can has a cinch button which must be removed before insertion of the tuning wand. When the brass end of the wand is inserted in the coil, the inductance of the coil is decreased. If this results in an increase of output, the respective air-trimmer capacitance should be decreased (plunger pulled out). If inserting the iron end of the tuning wand causes an increase in output, resulting from an increase of inductance of the coil, the respective air-trimmer capacitance should be increased (plunger pushed in). If the range of the air trimmer is not sufficient to give the desired results, the lead-dress may be changed in the particular circuit being aligned so as to cause the circuit to resonate within the range of the trimmer. An increase in the capacity-to-ground of the circuit will be required if the iron end of the tuning wand causes an increase of signal output when the air-trimmer plunger is full-in, while a decrease in the capacity-to-ground will be required if the brass end of the tuning wand causes an increase in signal output when the air-trimmer plunger is full-out.

Two methods of alignment are applicable—one requires use of the cathode-ray oscilloscope, and the other requires a voltmeter or glow-type indicator. The cathode-ray alignment method is advantageous in that the indication provided is in the form of a wave-image which represents the resonance characteristics of the circuit being tuned. This type of alignment is possible through use of apparatus such as the **GE Stock No. 9558 Frequency Modulator** and the **GE Stock No. 9545 Cathode-Ray Oscilloscope**. The output-indicator method should be performed with an instrument such as the **GE Stock No. 4317 Neon Glow Indicator**. Either of these methods require the use of a reliable test oscillator such as the **GE Stock No. 9595**. Both of these procedures are outlined below.

Cathode-Ray Alignment

Make alignment apparatus connections shown on figure 4. Remove the plug of the frequency-modulator

cable from the test-oscillator jack. Connect the receiver chassis to a good external ground. Connect oscilloscope "Vertical" input terminals as indicated on figure 3. Set oscilloscope power switch to "On" and adjust "Intensity" and "Focus" controls to give a clearly defined spot, or line, on the screen. Set oscilloscope "Ampl. A" switch to "On," "Vertical gain" control full-clockwise, "Ampl. B" switch to "Timing," "Range" switch to No. 2 position, and "Timing" switch to "Int." Place the "Sync." control, "Freq." control, and "Horizontal gain" control to about their mid-positions. For each of the following adjustments, the test-oscillator output must be regulated so that the image obtained on the oscilloscope screen will be of the minimum size for accurate observation. The receiver volume-control setting is optional.

I-F Adjustments

- Connect the "Ant." output of the test oscillator to the grid cap of Type-6K7 i-f tube (with grid lead in place) through a .001-mfd. capacitor, with "Gnd." to receiver chassis. Tune the test oscillator to 460 kc and place its modulation switch to "On" and its output switch to "Hi."
- Turn on the receiver and test oscillator. Increase the output of the test oscillator until a deflection is noticeable on the oscilloscope screen. The

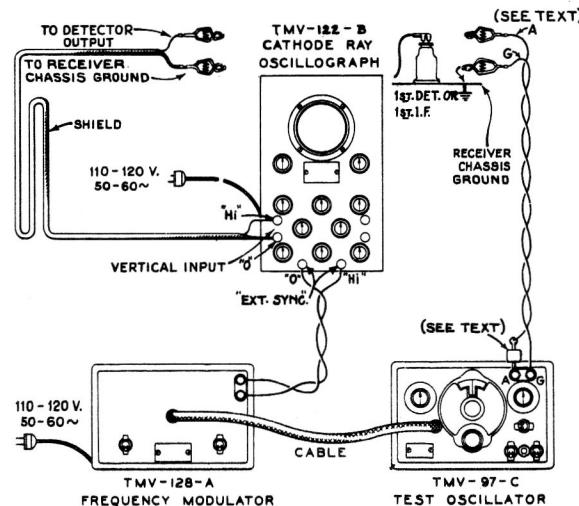


Figure 4—Alignment Apparatus Connections

figures obtained represent several waves of the detected signal, the amplitude of which may be observed as an indication of output. Cause the wave-image formed (400-cycle waves) to be spread completely across the screen by adjusting the "Horizontal gain" control. The image should be synchronized and made to remain motionless by adjusting the "Sync." and "Freq." controls.

- Adjust the two magnetite core screws L20 and L19 (see figures 1 and 7) of the second i-f transformer (one on top and one on bottom) to produce maximum vertical deflection of the oscilloscopic image. This adjustment places the transformer in exact resonance with the 460-**kc** signal.

(d) The sweeping operation should follow using the frequency modulator. Shift the oscillograph "Timing" switch to "Ext." Insert plug of frequency-modulator cable in test-oscillator jack. Turn the test-oscillator modulation switch to "Off." Turn on the frequency modulator and place its sweep-range switch to "Hi."

(e) Increase the frequency of the test oscillator by slowly turning its tuning control until two separate, distinct, and similar waves appear on the screen. If only one wave appears, increase the "Freq." control on the oscillograph to obtain two waves. These waves will be identical in shape, totally disconnected, and appear in reversed positions. They will have a common base line, which is discontinuous. Adjust the "Freq." and "Sync." controls of the oscillograph to make them remain motionless on the screen. Continue increasing the test-oscillator frequency until these forward and reverse curves move together and overlap, with their highest points exactly coincident. This condition will be obtained at a test-oscillator setting of **approximately 575 kc**.

(f) With the images established as in (e), re-adjust the two magnetite core screws L20 and L19 on the second i-f transformer so that they cause the curves on the oscillograph screen to become exactly coincident throughout their lengths and have maximum amplitude.

(g) Without altering the adjustments of the apparatus, shift the "Ant." output of the test oscillator to the input of the i-f system, i.e., to the RCA-6L7 first-detector grid cap, through a .001-mfd. capacitor (with grid lead in place). Regulate the test-oscillator output so that the amplitude of the oscillographic image is approximately the same as used for adjustment (f) above.

(h) The two first i-f transformer magnetite core screws L18 and L17 (one on top and one on bottom) should then be adjusted so that they cause the forward and reverse curves to become coincident throughout their lengths and have maximum amplitude. The composite wave obtained in this manner represents the resonance characteristic of the total i-f system. Lack of symmetry or irregularity of the resultant image will indicate the presence of a defect in the i-f system.

R-F Adjustments

Make receiver dial adjustments as outlined by "Selector dial," figure 9. Alignment must be made in sequence of "Wave-trap," "Short wave" band, "Medium wave" band, "Standard broadcast" band, and "Long wave" band.

"Wave-Trap" Adjustment

(a) Connect the output of the test oscillator to the antenna terminal "A1" through a 200-mmfd. (**important**) capacitor. Remove the plug of the frequency-modulator cable from the test-oscillator

jack. Turn test-oscillator modulation switch to "On." Shift the oscillograph "Timing" switch to "Int." Place receiver range selector in "Standard broadcast" position. Set the receiver dial to a position of no extraneous signals **near 600 kc**. Tune the test oscillator to 460 kc. Adjust the wave-trap magnetite core screw L1 to the point which causes minimum amplitude of output (maximum suppression of signal) as shown by

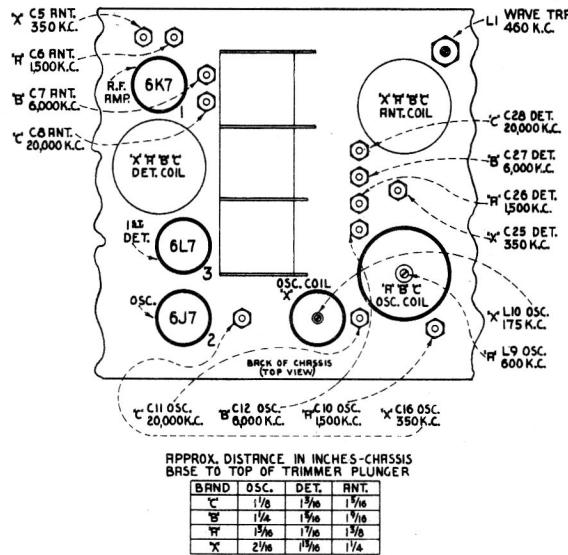


Figure 5—R-F Trimmer Locations

the waves on the oscillograph. An increase of the test-oscillator output may be necessary before this point of minimum amplitude, obtained by correct adjustment of wave-trap screw, becomes apparent on oscillograph screen.

"Short Wave" Band

(b) Connect the "Ant." output of the test oscillator to the antenna terminal "A1" of the receiver through a 300-ohm resistor. Set the receiver range selector to its "Short wave" position and its dial pointer to 20,000 kc. Adjust the test oscillator to 20,000 kc. Adjust oscillator air-trimmer C11 until maximum (peak) output is reached. Two peaks may be found with this circuit. The peak with minimum capacitance (plunger near out) should be used. Tighten lock nut. Adjust detector air-trimmer C28 until maximum (peak) output is reached, while slightly rocking the gang tuning condenser back and forth through the signal. Two peaks may be found with this circuit. The peak with maximum capacitance (plunger near in) should be used. Tighten lock nut. Adjust antenna air-trimmer C8 until maximum (peak) output is reached while slightly rocking the gang tuning condenser back and forth through the signal. Two peaks may be found with this circuit. The peak with maximum capacitance (plunger near in) should be used. Tighten lock nut. Check the image frequency by changing the receiver dial setting to 19,080

kc. The image signal should be received at this position indicating that the adjustment of **C11** has been correctly made. No adjustments should be made while checking for the image signal.

"Medium Wave" Band

(c) Place receiver range selector to its "Medium wave" position with its dial pointer set to 6,000 kc. Tune the test oscillator to 6,000 kc. Adjust oscillator air-trimmer C12 to produce maximum (peak) output as shown by the waves on the oscilloscope. Two peaks may be found with this circuit. The peak with minimum capacitance (plunger near out) should be used. Tighten lock nut. Adjust the detector air-trimmer C27 for maximum (peak) output while slightly rocking the gang tuning condenser back and forth through the signal. Two peaks may be found with this circuit. The peak with maximum capacitance (plunger near in) should be used. Tighten lock nut. Adjust antenna air-trimmer C7 to produce maximum (peak) output. Tighten lock nut.

"Standard Broadcast" Band

(d) Remove the 300-ohm resistor from between the test-oscillator "Ant." post and receiver antenna terminal "A1" and insert a **200-mmfd.** capacitor

in its place. Place receiver range selector to "Standard broadcast" position with receiver dial pointer set to 600 kc. Tune the test oscillator to 600 kc. Adjust oscillator magnetite core screw L9 (top of large oscillator coil can) for maximum (peak) output as shown by the waves on the oscilloscope screen.

(e) Set receiver dial pointer to 1,500 kc. Tune test oscillator to 1,500 kc (1,500-3,100- kc range) and increase its output to produce a registration on the oscillograph screen. Carefully adjust the oscillator, detector, and antenna air-trimmers C10, C26, and C6, respectively, to produce maximum (peak) output as shown by the waves on the oscillograph screen. Shift the oscillograph "Timing" switch to "Ext." Place the frequency modulator sweep-range switch to its "Lo" position and insert plug of the frequency-modulator cable in test-oscillator jack. Turn test-oscillator modulation switch to "Off." Re-tune the test oscillator (increase frequency) until the forward and reverse waves show on the oscillograph screen and become coincident at their highest points. This will occur at a test-oscillator setting of approximately 1,680 kc. Adjust trimmers C10, C26, and C6 again, setting each to the point which produces the best coincidence and maximum amplitude of the images.

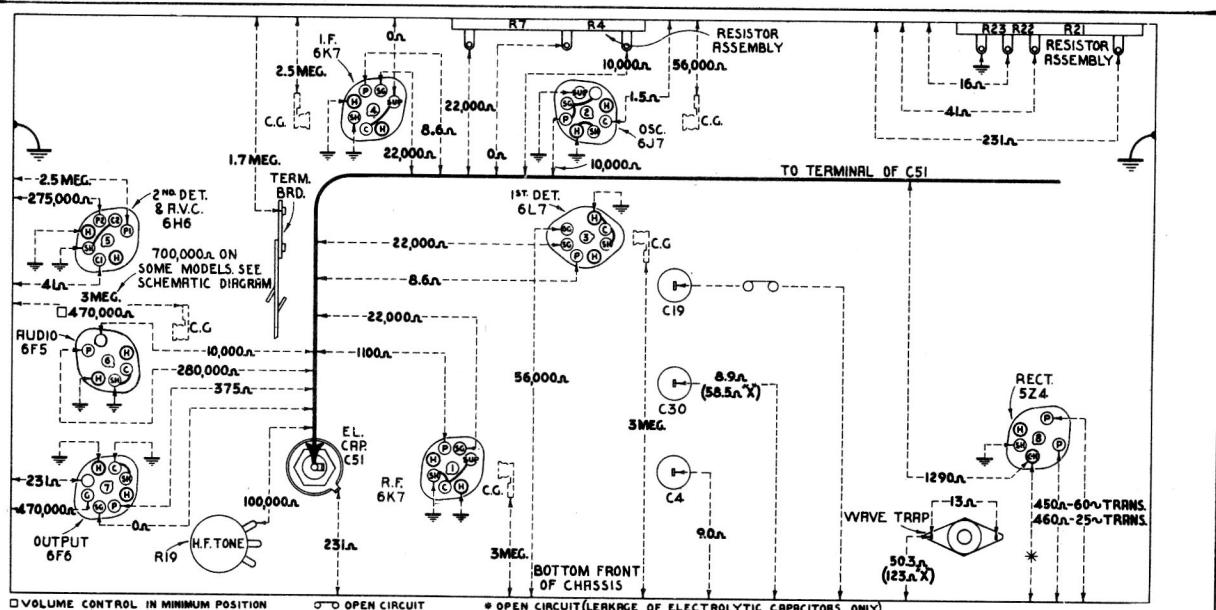


Figure 6—Resistance Diagram

Power supply disconnected—Radiotrons in sockets—Tuning condenser in full-mesh—Range selector in “Standard broadcast” position—Volume control maximum—Tone control clockwise

The resistance values shown between Radiotron socket contacts, grid caps, resistors, and terminals to receiver chassis ground or other pertinent point on figure 6, permit a rapid continuity check of the circuits. The use of this diagram in conjunction with the Schematic Circuit Diagram, figure 2, and Wiring Diagram, figure 3, will permit the location of certain troubles which might otherwise be difficult to ascertain. Each value as specified should hold within \pm 20%. Variations in excess of this

limit will usually be indicative of trouble in circuit under test. In all cases of measuring the resistance between points of the circuit and ground, it will be necessary to connect the negative terminal of the resistance meter to chassis-ground. If the polarity of the resistance meter is not known, it may be readily ascertained by connecting a d-c voltmeter of indicated polarity across the terminals of the device.

(f) Remove the plug of the frequency-modulator cable from the test-oscillator jack. Turn test-oscillator modulation switch to "On." Set oscillograph "Timing" switch to "Int." Tune test oscillator to 200 kc (200-400-kc range). Tune receiver for maximum response to this signal at a dial reading of approximately 600 kc. The third harmonic of the 200-kc signal is used for this adjustment. Shift oscillograph "Timing" switch to "Ext." Insert the plug of the frequency-

Radiotron Cathode Current Readings
Measured with Milliammeter Connected at Tube Socket
Cathode Terminals under Conditions Similar to
Those of Voltage Measurements

(1) Type-6K7-R-F	7.5 ma.
(2) Type-6J7-Osc.	5.4 ma.
(3) Type-6L7-1st Det.	6.4 ma.
(4) Type-6K7-I.F.	7.5 ma.
(5) Type-6H6-2nd Det.-A.V.C.	—
(6) Type-6F5-A.F.	0.3 ma.
(7) Type-6F6-Power	41 ma.
(8) Type-5Z4-Rect.	72 ma.*
(9) Type-6E5-Eye	3.0 ma.

(*Cannot be measured at socket)

modulator cable in test-oscillator jack. Turn test-oscillator modulation switch to "Off." Re-tune the test oscillator (increase frequency) until the forward and reverse waves show on the oscillograph

screen. This will occur at a test-oscillator setting of approximately 230 kc. Disregarding the fact that the two images may or may not come together, adjust the oscillator magnetite core screw L9 (top of large oscillator coil can) to produce maximum (peak) amplitude of the images. Shift the oscillograph "Timing" switch to "Int." Remove the plug of the frequency-modulator cable from the test-oscillator jack. Turn the test-oscillator modulation switch to "On." Repeat adjustments in (e) above to compensate for any changes caused by the adjustment of L9 core, tightening lock nuts on C10, C26, and C6, respectively, after each is adjusted.

"Long Wave" Band

(g) Shift the oscillograph "Timing" switch to "Int." Remove the plug of the frequency-modulator cable from the test-oscillator jack. Turn the test-oscillator modulation switch to "On." Place receiver range selector to its "Long wave" position. Set the receiver dial pointer to 175 kc. Tune the test oscillator to 175 kc and increase its output until a deflection is noticeable on the oscillograph screen. Adjust oscillator magnetite core screw L10 (located on top of small oscillator coil can) so that maximum (peak) amplitude of output is shown on the oscillograph screen.

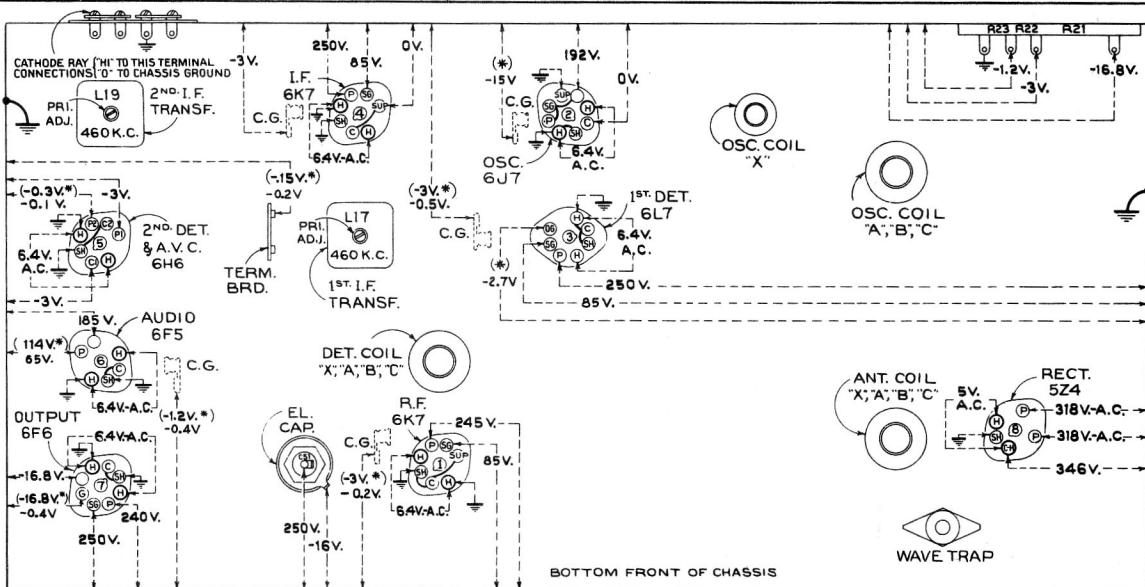


Figure 7—Radiotron Socket Voltages, Coil, and I-F Trimmer Locations

Measured at 115 volts, 60-cycle supply—Tuned to approximately 1,000 kc—No signal being received—
Volume control minimum

Note: Two voltage values are shown for some readings. The higher value shown in parenthesis with asterisk () indicates operating conditions without voltmeter loading. The lower value is the actual measured voltage and differs from the higher value because of the additional loading of the voltmeter through the high series circuit resistance.*

The voltage values indicated from the Radiotron socket contacts, grid caps, resistors, and terminals to receiver

chassis ground on figure 7 will assist in locating cause for faulty operation. Each value as specified should hold within $\pm 20\%$ when the receiver is normally operative at its rated line voltage. Variations in excess of this limit will usually be indicative of trouble in the basic circuits. To duplicate the conditions under which the voltages were measured requires a 1,000-ohm-per-volt d-c meter, having ranges of 10, 50, 250, 500, and 1,000 volts. Use the nearest range above the specified measured voltage. A-c voltages were measured with a corresponding a-c meter.

(h) Set receiver dial pointer to 350 kc. Tune test oscillator to 350 kc. Adjust the oscillator, detector, and antenna air-trimmers C16, C25, and C5 to produce maximum (peak) output as shown by the waves on the oscilloscope screen. Without disturbing the connections, shift the oscilloscope "Timing" switch to "Ext." Place the frequency-modulator sweep-range switch to its "Hi" position and insert plug of frequency-modulator cable in test-oscillator jack. Turn test-oscillator modulation switch to "Off." Re-tune the test oscillator (decrease frequency) until the forward and reverse waves show on the oscilloscope screen and become coincident at their

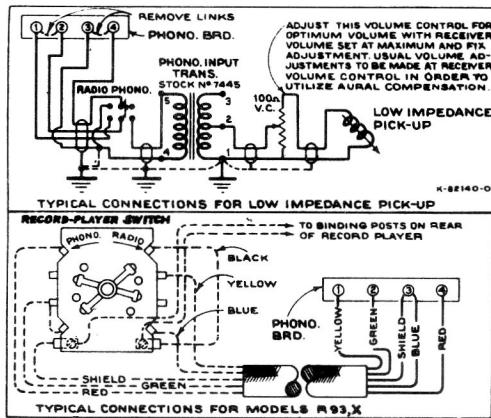


Figure 8—Pick-Up Wiring

highest points. This will occur at a test-oscillator setting of approximately 198 kc. This setting places the test-oscillator frequency to 175 kc. The second harmonic is now used for the 350 kc adjustment. Adjust air-trimmers C16, C25, and C5, again, to produce maximum amplitude of the images and best coincidence throughout their lengths.

(i) Re-tune the receiver to approximately 175 kc so that the forward and reverse waves appear on the oscilloscope screen. Adjust the oscillator magnetite core screw L10 to produce maximum (peak) amplitude of the waves, disregarding the fact that the two images may or may not come together.

(j) Shift the receiver dial setting to 350 kc without altering any other adjustments (frequency modulator still in operation). Adjust air-trimmers C16, C25, and C5, respectively, to produce maximum amplitude and best coincidence of the waves. These adjustments compensate for any changes caused by the adjustment of the magnetite core screw L10. Tighten lock nuts on C16, C25, and C5, respectively, after each is adjusted.

Output Indicator Alignment

Attach the output indicator across the loudspeaker voice-coil circuit. Advance the receiver "Volume" control to its maximum position, letting it remain in such position for all adjustments. For each adjusting operation, regulate the test-oscillator output so that

the signal level is as low as possible and still be observable at the receiver output. Use of such small signal will obviate broadness of tuning which would otherwise result from a.v.c. action on a stronger one.

I-F Adjustments

(a) Connect the "Ant." output of the test oscillator to the grid cap of the RCA-6L7 first detector tube (with grid lead in place) through a .001-mfd. capacitor, with "Gnd." to receiver chassis. Tune the test oscillator to 460 kc. Place its modulation switch to "On" and its output switch to "Hi."

(b) Adjust the two magnetite core screws L20 and L19 (see figures 1 and 7) of the second i-f transformer to produce maximum (peak) output.

(c) Adjust the two first i-f transformer magnetite core screws L18 and L17 to produce maximum (peak) output. It is advisable to repeat the adjustment of all i-f magnetite core screws to assure that the interaction between them has not disturbed the original adjustments.

R-F Adjustments

Make receiver dial adjustments as outlined by "Selector dial," figure 9. Alignment must be made in sequence of "Wave-trap," "Short wave" band, "Medium wave" band, "Standard broadcast" band, and "Long wave" band.

"Wave-Trap" Adjustment

(a) Connect the "Ant." output of the test oscillator to the antenna terminal "A1" on the receiver through a 200-mmfd. (important) capacitor. Place the receiver range selector to its "Standard broadcast" position and set the dial pointer to a position of no extraneous signals near 600 kc. Tune the test oscillator to 460 kc. Adjust the wave-trap magnetite core screw L1 to the point which causes minimum output (maximum suppression of signal). An increase of the test-oscillator output may be necessary before the point of minimum output, obtained by adjustment of wave-trap screw, becomes apparent on the output indicator.

"Short Wave" Band

(b) Connect the "Ant." output of the test oscillator to the antenna terminal "A1" through a 300-ohm resistor. Set the receiver range selector to its "Short wave" position and its dial pointer to 20,000 kc. Adjust the test oscillator to 20,000 kc. Adjust oscillator air-trimmer C11 until maximum (peak) output is reached. Two peaks may be found with this circuit. The peak with minimum capacitance (plunger near out) should be used. Tighten lock nut. Adjust detector air-trimmer C28 until maximum (peak) output is reached, while slightly rocking the gang tuning condenser back and forth through the signal. Two peaks may be found with this circuit. The peak with maximum capacitance (plunger near in) should be used. Tighten lock nut. Adjust

antenna air-trimmer **C8** until maximum (peak) output is reached, while slightly rocking the gang tuning condenser back and forth through the signal. Two peaks may be found with this circuit. The peak with maximum capacitance (plunger near in) should be used. Tighten lock nut. Check the image frequency by changing the receiver dial setting to 19,080 kc. The signal should be received at this position indicating that the adjustment of **C11** has been correctly made. No adjustments should be made while checking for the image signal.

"Medium Wave" Band

(c) Place receiver range selector to its "Medium wave" position with the receiver dial pointer set to 6,000 kc. Tune the test oscillator to 6,000 kc. Adjust oscillator air-trimmer **C12** to produce maximum (peak) output. Two peaks may be found with this circuit. The peak with minimum capacitance (plunger near out) should be used. Tighten lock nut. Adjust the detector air-trimmer **C27** for maximum (peak) output while slightly rocking the receiver gang tuning condenser back and forth through the signal. Two peaks may be found with this circuit. The peak with maximum capacitance (plunger near in) should be used. Tighten lock nut. Adjust antenna air-trimmer **C7** to produce maximum (peak) output. Tighten lock nut.

"Standard Broadcast" Band

(d) Remove the 300-ohm resistor from between the test-oscillator "Ant." post and receiver antenna terminal "A1" and insert a 200-mmfd. capacitor in its place. Place receiver range selector to its "Standard broadcast" position with the receiver dial pointer set to 600 kc. Tune the test oscillator to 600 kc. Adjust the oscillator magnetite core screw **L9** (top of large oscillator coil can) for maximum (peak) output.

(e) Set receiver dial pointer to 1,500 kc. Tune test oscillator to 1,500 kc and regulate its output until a slight indication of output is visible. Carefully adjust the oscillator, detector, and antenna air-trimmers **C10**, **C26**, and **C6**, respectively, to produce maximum (peak) output.

(f) Tune test oscillator to 600 kc. Tune the receiver to pick up this signal **near** 600 kc, disregarding the dial reading at which it is best received. Adjust oscillator magnetite core screw **L9** (top of large oscillator coil can) for maximum (peak) output while slightly rocking the gang tuning condenser back and forth through the signal. Repeat adjustments in (e) above to compensate for any change caused by adjustment of **L9** magnetite core screw, tightening lock nuts on **C10**, **C26**, and **C6**, respectively, after each is adjusted.

"Long Wave" Band

(g) Place receiver range selector to its "Long wave" position, with dial pointer set to 175 kc. Tune the test oscillator to 175 kc and increase its output until a slight indication of output is visible.

Adjust oscillator magnetite core screw **L10** (top of small oscillator coil can) for maximum (peak) output.

(h) Set receiver dial pointer to 350 kc. Tune test oscillator to 350 kc. Adjust the oscillator, detector, and antenna air-trimmers **C16**, **C25**, and **C5**, respectively, to produce maximum (peak) output.

(i) Tune test oscillator to 175 kc. Tune receiver to pick up this signal **near** 175 kc, disregarding the dial reading at which it is best received. Adjust oscillator magnetite core screw **L10** (top of small oscillator coil can) for maximum (peak) output while slightly rocking the gang tuning condenser back and forth through the signal. Repeat adjustments in (h) above to compensate for any changes caused by the adjustment of the magnetite core screw **L10**. Tighten lock nuts on **C16**, **C25**, and **C5**, respectively, after each is adjusted.

Selector Dial

Figure 9 illustrates the relation of the various parts of the dial mechanism when in its "Standard broadcast" position with the range switch likewise turned to its "Standard broadcast" position. In re-assembling the dial after repairs, see that the gears are meshed

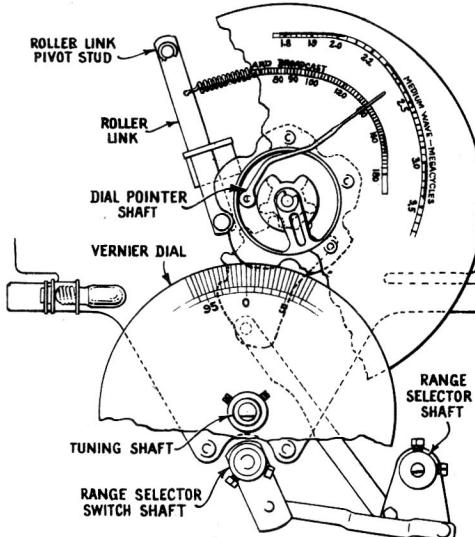


Figure 9—Selector Dial Change Mechanism

in accordance with the diagram, at the same time noting that the range switch is in its "Standard broadcast" position and the lever attached to the range switch shaft placed in the position shown.

To adjust the dial mechanism, set the range switch to its "Standard broadcast" position. Place a straight-edge across the center of the dial so that its edge is even with the lower (end) marking at both the low-frequency and high-frequency ends of the dial. Under such conditions the straight-edge should be parallel with the top of the chassis base. If the straight-edge is not parallel with the top of the chassis base, loosen the nut on the rear of the roller link pivot stud and

move the stud up or down until the link roller moves the dial to the desired position so that the end calibration marks obtain the position mentioned above. Tighten the nut on the roller link pivot stud.

Set the gang tuning condenser to its maximum capacity position. Adjust the dial pointer to the low-frequency (end) mark on "Standard broadcast" scale. This is a friction adjustment.

With the gang tuning condenser plates still in full mesh, loosen the two set screws on the vernier-dial hub. Rotate the vernier dial until the "0" marking is in a vertical plane above the center of the shaft. Tighten set screws.

Phonograph Terminal Board

A terminal board is provided for connecting a phonograph into the audio amplifying circuit. Typical methods of connecting a low-impedance pickup, or Models R-93 and R93X Record Players are shown on the Schematic Diagram (figure 8).

Antenna and Ground Terminals

These receivers are equipped with an antenna-ground terminal board having three terminals. These terminals are marked "A2," "A1", and "G", the latter being the ground terminal and should always be connected to a good external ground.

The transmission line leads of antenna systems,

having no receiver coupling units, should be connected to terminals "A2" and "A1". When receiver coupling units are supplied with antenna kits, they should be connected to terminals "A1" and "G". Connect a single wire antenna to terminal "A1".

Loudspeaker

Centering of the loudspeaker voice coil is made in the usual manner with three narrow paper feelers after first removing the front paper dust cover. This

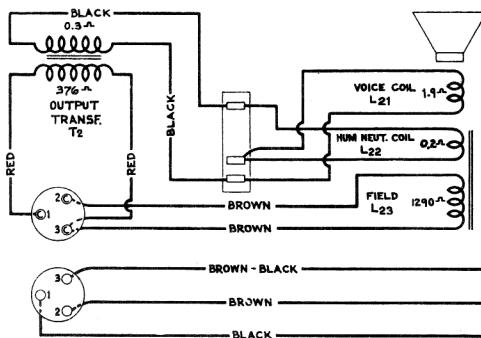


Figure 10—Loudspeaker Wiring

may be removed by softening its cement with a very light application of acetone using care not to allow the acetone to flow down into the air gap. The dust cover should be cemented back in place with ambroid upon completion of adjustment.

REPLACEMENT PARTS

Stock No.	Description	Stock No.	Description
	RECEIVER ASSEMBLIES		
12806	Board - 3-contact antenna and ground terminal board.....	S-1592	Capacitor - 0.25 Mfd. (C42,C35).....
12863	Board - 4-contact and 2-link phonograph terminal board.....	5212	Capacitor - 18 Mfd. (C51).....
12929	Bracket - Mounting bracket for L.F. tone control or volume control....	12467	Capacitor - 30 Mfd. (C50).....
5237	Bushing - Variable condenser mounting bushing assembly - Package of 3.....	12923	Coil - Antenna coil and shield XABC bands (L2,L3,L4,L5,L6).....
11625	Cable - Tuning lamp cable and socket	12924	Coil - Detector coil and shield XABC bands (L11,L12,L13,L14,L15,L16)....
12511	Cap - Grid contact cap - Package of 5	12709	Coil - Oscillator coil and shield ABC bands only (L7,L8,L9).....
12884	Capacitor - Adjustable trimmer (C16, C25).....	12881	Coil - Oscillator coil and shield X band only (L10).....
12807	Capacitor - Adjustable trimmer (C11, C27,C28).....	12859	Compensator Pack - Comprising two sections .015 Mfd. each, one section .1 Mfd. and two resistors 27,000 ohms each (C43,C44,C45,R14,R16)....
12714	Capacitor - Adjustable trimmer (C5, C6,C7,C8,C10,C12,C26).....	12922	Condenser - 3-gang variable tuning condenser (C4,C19,C30).....
12896	Capacitor - 15 Mmfd. (C29).....	12664	Core - Adjustable core and stud for Stock No.12654.....
12722	Capacitor - 18 Mmfd. (C9)....	12800	Core - Adjustable core end stud for Stock No. 12709.....
12895	Capacitor - 56 Mmfd. (C17).....	12882	Core - Adjustable core and stud for Stock No. 12881.....
12723	Capacitor - 56 Mmfd. (C2,C21).....	12006	Core - Adjustable core and stud for Stock No. 12652 and 12653.....
12724	Capacitor - 120 Mmfd. (C20,C46).....	12870	Dial - Vernier dial and disc assembly
12404	Capacitor - 120 Mmfd. (C32,C33,C36, C38).....	5226	Lamp - Dial lamp - 6.3 volt - Package of 2.....
12725	Capacitor - 150 Mmfd. (C1).....	12868	Link - Range switch and band indicator operating link, complete with set screws.....
12894	Capacitor - 180 Mmfd. (C15).....	5112	Resistor - 1,000 ohm, carbon type, 1/4 watt (R2).....
12406	Capacitor - 180 Mmfd. (C39).....	11282	Resistor - 56,000 ohm, carbon type, 1/10 watt (R11,R3).....
12727	Capacitor - 555 Mmfd. (C14).....	11286	Resistor - 56,000 ohm, insulated type 1/4 Watt (R6).....
12537	Capacitor - 560 Mmfd. (C3,C24,C31).....	11398	Resistor - 220,000 ohm, carbon type, 1/10 Watt (R12).....
12729	Capacitor - 1,550 Mmfd. (C13).....		
12728	Capacitor - 4,500 Mmfd. (C18).....		
4838	Capacitor - .005 Mfd. (C49).....		
4883	Capacitor - .001 Mfd. (C23,C40,C47).....		
5196	Capacitor - .035 Mfd. (C48).....		
4836	Capacitor - .05 Mfd. (C37).....		
4791	Capacitor - 0.1 Mfd. (C34,C53).....		
5170	Capacitor - 0.25 Mfd. (C22,C52).....		

REPLACEMENT PARTS—E-98

Stock No.	Description	Stock No.	Description
11453	Resistor - 270,000 ohm, carbon type, 1/10 Watt (R17).....	12012	Coil - Field coil (L23).....
11172	Resistor - 470,000 ohm, carbon type, 1/4 Watt (R15).....	11469	Coil - Neutralizing coil (L22).....
11452	Resistor - 470,000 ohm, carbon type, 1/10 Watt (R18).....	12667	Cone - Reproducer cone and dust cap (L21).....
11397	Resistor - 560,000 ohm, carbon type, 1/10 Watt (R1,R5).....	5118	Connector - 3-contact male speaker cable connector.....
12013	Resistor - 1 Meg., Carbon type, 1/10 Watt (R20).....	9696	Reproducer, complete.....
12679	Resistor - 2.2 Meg., insulated, 1/4 Watt (R10).....	11253	Transformer - Output transformer (T2).....
12928	Resistor - 3.3 Meg., insulated, 1/4 Watt (R8,R9).....	11886	Washer - Spring washer to hold field coil securely - Package of 5.....
12927	Resistor - Voltage divider resistor, comprising one 16 ohm, one 25 ohm and one 190 ohm sections (R21,R22, R23).....		DRIVE ASSEMBLIES
12715	Resistor - Wire wound resistor, comprising one 10,000 ohm and one 22,000 ohm sections (R4,R7).....	10705	Ball - 5/32 inch dia. steel ball for planetary drive - Package of 20...
4669	Screw - No. 8-32-5/32 set screw for link Stock No. 12868-Package of 10	10941	Ball - 1/8-inch dia. steel ball for planetary drive bearing - Package of 20.....
3903	Screw - No. 8-32-3/16 headless, cup point set screw for Stock No.12870 -Package of 20.....	12904	Bushing - Plate and bushing assembly for planetary drive mounting.....
12925	Shaft - Range switch and band indicator operating shaft and hub assembly.....	12905	Coupling - Flexible coupling and shaft assembly, complete.....
12651	Shield - Coil shield for Stock Nos. 12923 and 12924.....	12909	Dial - Band indicating dial and cam.assembly.....
12710	Shield - Coil shield for Stock No. 12709.....	12899	Drive - Variable tuning condenser drive complete - including mounting bracket, drive,dial scale and indicator, less vernier dial,Stock No.12870 and link, Stock No.12868.
12883	Shield - Coil shield for Stock No. 12881.....	12906	Gear - Anti-lash drive gear,complete
12926	Shield - Chassis end shield and rubber mounting foot assembly- Package of 2.....	12910	Gear - Sector gear and link assembly for band selector.....
12008	Shield - I.F. transformer shield for Stock Nos. 12652 and 12653.....	12908	Indicator - Station selector indicator pointer.....
12607	Shield - I.F. transformer shield top for Stock No. 12652.....	8051	Link - Link and roller assembly, complete with spring.....
12581	Shield - I.F. transformer shield top for Stock No. 12653.....	12911	Screen - Dial lamp screen and light diffuser.....
5119	Socket - 3-contact female connector for speaker leads.....	4669	Screw - set screw for flexible coupling or gear,Stock Nos.12905 and 12906 - Package of 10.....
11195	Socket - 5-contact 524 Radiotron socket.....	12901	Shaft - Direct drive shaft and pinion gear for planetary drive.....
11198	Socket - 6-contact 6F5, 6H6, 6K7 or 6L7 radiotron socket.....	12900	Shaft - Vernier drive shaft for planetary drive.....
11196	Socket - 8-contact 6F6 or 6J7 Radiotron socket.....	12903	Spring - Tension spring for planetary drive bearing - Package cf 10.....
11222	Socket - Upper right or lower left hand dial lamp socket.....	12907	Spring - Tension spring for gear, Stock No.12906-Package of 10.....
13095	Socket - Upper left or lower right hand dial lamp socket.....	8052	Spring - Tension spring for link, Stock No. 8051 - Package of 5.....
11381	Socket - Tuning lamp socket and cover		MISCELLANEOUS ASSEMBLIES
12007	Spring - Retaining spring for core Stock Nos. 12006,12664,12800 and 12882-Package of 10.....		
12920	Switch - Range switch (S1,S2,S3)....	11996	Bracket - Tuning lamp mounting bracket and clamp.....
12921	Tone Control - High frequency tone control (R19).....	12666	Cover - Reproducer cover assembly...
12860	Tone Control - Low frequency tone control and power switch (S4,S5)...	12915	Crystal - Station selector escutcheon and crystal.....
12652	Transfer - First I.F.Transformer, complete (L17,L18,C32,C33).....	12742	Escutcheon - Tuning lamp escutcheon.....
12918	Transformer - Power transformer, 105-125 volt,50-60 Cycle (T1)....	12699	Knob - Large station selector knob..
12857	Transformer - Power transformer, 105-125 volt, 25 cycle (T1).....	11347	Knob - Low frequency tone control and power switch or high frequency tone control knob - Package of 2.....
12653	Transformer - Second I.F. transformer complete (L19,L20,C36,C38,C39,R11, R12).....	12700	Knob - Small (vernier) station selector knob.....
12654	Trap - Wave trap, complete (L1)....	11210	Screw - Chassis mounting screw assembly - Package of 4.....
12861	Volume Control (R13).....	11349	Spring - Retaining spring for knob, Stock Nos. 11347 and 12700 Package of 5.....
	REPRODUCER ASSEMBLIES	4982	Spring - Retaining spring for knob, Stock No. 12699 - Package of 10.....
12641	Board - 3-contact reproducer terminal board.....		
12640	Bracket - Output transformer mounting bracket and clamp.....		