

RAL-7

**OPERATION
OF
RECEIVER UNIT CRV 46156**



**SIXTH UNITED STATES ARMY
PRESIDIO OF SAN FRANCISCO, CALIFORNIA**

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RADIO CORPORATION OF AMERICA

DEFENSE ELECTRONIC PRODUCTS

HADDON N. NEW JERSEY



26 February 1957

Headquarters Sixth United States Army
Presidio of San Francisco, California

Attention: AMAGZ-P
Ruth R. Gorton
Major, AGC
Assistant Adjutant General

Gentlemen:

In reply to your request of 20 February 1957 for permission to reproduce pages 17 thru 20, 25 thru 35, and 68 thru 71 of the catalog, (presumably instruction book) covering the "Model RAL-7, Radio Receiving Equipment, Class IIa, A-C operated, Range - 0.3-23 megacycles" furnished to the Navy Department by Radio Corporation of America, we are pleased to advise there is no objection to the reproduction of the material for use of members of Military Affiliated Radio System.

Very truly yours,

A handwritten signature in cursive script that reads 'R. H. Holmes'.

R. H. Holmes
Manager, Contracts

RHH:fs

OPERATION OF RECEIVER UNIT CRV 46156

- 10.1-2 "FREQUENCY BAND" Selector Control: This control serves as a means for changing the required inductance for the various radio-frequency bands. The switch pointer should be set on the band number falling between the frequencies which establish the desired frequency range. Frequencies are marked in megacycles.
- 10.1-3 "TUNING" Control: The tuning control varies the setting of the three-gang variable tuning condenser. The scale increases with frequency.
- 10.1-4 "ANTENNA TRIMMER" Control: This controls a variable trimmer capacitor for the antenna tuning stage (1st r-f grid circuit). In general, it is adjusted once for each band, preferably at the high-frequency end.
- 10.1-5 "RF TRIMMER" Control: This controls a variable trimmer capacitor for the second r-f tuned grid circuit. In general, it is adjusted once for each band, preferably at the high-frequency end.
- 10.1-6 "FREQ. VERNIER" Control: This control is a very small trimmer capacitor connected in the autodyne detector tuned circuit to obtain small variations in audio beat-note. The panel scale is zero at the center. Calibration and tuning are normally accomplished with the "Freq. Vernier" set at zero.
- 10.1-7 "FIL. VOLTS" Meter: The filament voltmeter indicates when the power is turned "On" and should read approximately 6 volts when the equipment is operating properly.
- 10.1-8 "AVC OFF-ON" Switch: This switch when in the "On" position, places the automatic volume control in operation; when in the "Off" position, it disconnects the automatic volume control. The automatic volume control is *not* intended for use on voice modulated signals.
- 10.1-9 "AVC LEVEL" Control: This control varies the bias on the AVC tube and thereby sets the volume level when the "AVC Off-On" switch is in the "On" position.
- 10.1-10 "REGENERATION" Control: This control varies the screen-grid potential of the autodyne detector, thus regulating the degree of feedback required for oscillation.
- 10.1-11 "SENSITIVITY" Control: This control varies the cathode potential of the two r-f tubes with respect to their grid potentials.
- 10.1-12 "AUDIO TUNING" Control: This 10-position switch selects the proper inductance in the audio-frequency variable attenuator circuit to permit this circuit to pass frequencies in the range of 450 to 770 or 770 to 1300 cycles depending upon the position of the audio tuning range switch (see 10.1-14). The switch positions are numbered to increase with respect to frequency.
- 10.1-13 Audio Tuning "OFF-ON" Switch: This switch places the audio-frequency variable attenuator in or out of the circuit.
- 10.1-14 Audio Tuning "450-770" or "770-1300" Switch: This switch selects the range of frequency in cycles in which the 10-position "Audio Tuning" control is operable.
- 10.1-15 "AUDIO BROAD-SHARP" Switch: This control places a low-pass filter in the audio circuit directly following the detector when the switch is placed in the "Sharp" position and removes the filter from the circuit when the switch is placed in the "Broad" position.
- 10.1-16 "OUTPUT" Meter: This rectifier type a-c meter indicates the audio-frequency output level delivered to the headphones. It is calibrated in decibels above and below zero level, which is 6 milliwatts of audio output.
- 10.1-17 "ADD DECIBELS" Switch: This range switch is used to read "Add Decibels" (algebraically) in connection with the "Output" meter. Five positions are provided: "Off," "15," "10," "5," and "0" in a clockwise direction.
- 10.1-18 "OSC. TEST" Button: This push button is connected from the detector cathode to ground. When it is depressed, it stops the detector from oscillating and produces a definite double click in the headphones. In many cases, the detector enters and leaves oscillation so gradually that it is necessary to use this button in order to determine whether or not the detector is oscillating.

10.1-19 "DC POWER OFF-ON" Switch: This switch is not used in the normal operation of this equipment and is accordingly wired out of the circuit by short-circuiting links located under the chassis (see Figure 6).

NOTE: HOWEVER, SHOULD OCCASION ARISE, THIS EQUIPMENT MAY BE OPERATED FROM A BATTERY SUPPLY CONSISTING OF SUITABLE FILAMENT AND PLATE BATTERIES. THIS METHOD OF OPERATION WILL REQUIRE OPENING OF THE SHORT CIRCUITING LINKS (SEE FIGURES 6 AND 20), AND CONNECTION OF CABLE W-201 AS INDICATED BY THE DOTTED LINES IN FIGURE 16. OPERATION OF THE RECEIVER WILL THEN BE CONTROLLED BY THE "DC POWER" SWITCH ON THE FRONT PANEL.

10.1-20 "PHONES" Jack: This jack provides termination for a pair of low-impedance (600-ohm) headphones.

10.2 Controls of Power Unit CRV-20131.

10.2-1 "OFF-ON" Switch: This switch located on the front panel controls all power to the power unit when not used in conjunction with a control unit.

10.2-2 Reference to Figure 16 shows that when the power unit is used in conjunction with the control unit, connection is made to the right-hand input terminals of the power unit. With this connection, the panel switch and the power unit fuses are disconnected from the circuit.

10.2-3 Current Regulator Switch: This switch is located under a terminal board at the right rear top of the chassis (see Figures 1 and 4) and should be thrown to the "In" position for this equipment. In this position, the proper primary connections to the transformer are made for operation with current regulation.

10.3 Controls of Control Unit CRV-23073.

10.3-1 For operation of Receiver No. 1, place the switch "On-Off 1" in the "On" position, the "1"- "mixed"- "2" switch in the "1" position and the "On-Off 2" switch in the "Off" position. The headphones should be plugged into one of the phone jacks on the control unit.

10.3-2 For operation of Receiver No. 2, proceed as in 10.3-1 above except that all switches should be thrown to the "2" position.

10.3-3 For simultaneous monitoring of the output from two receivers, both No. 1 and No. 2 "On-Off" switches should be placed in the "On" position and the "1"- "mixed"- "2" switch should be placed in the "mixed" position. The headphones should be plugged into one of the jacks on the Control Unit. The phone jacks on the receiver units are not controlled by the "1"- "mixed"- "2" switch. Two phone jacks are provided to permit simultaneous monitoring or operation by two operators.

10.4 CW Reception

10.4-1 To apply power to the equipment, the proper "Off-On" switch should be thrown to the "On" position. The filament voltmeter should indicate approximately 6 volts. Allow sufficient time for the tube heaters to reach their operating temperature. This time will probably be not less than 30 seconds.

(a) When using a single RAL Series equipment, the "Off-On" switch on the power unit controls the power to the receiver.

(b) When using this equipment in combination with an RAK Series equipment, the proper "On-Off" switch on the control unit controls the power to the desired receiver.

10.4-2 To receive a signal whose frequency is known, throw the Audio Tuning and AVC "Off-On" switches to the "Off" position and the "Audio Broad-Sharp" switch to the "Broad" position and set the "Freq. Vernier" on zero.

10.4-3 Set the "Frequency Band" switch to the band number corresponding to the frequency range which includes the frequency of the station desired.

10.4-4 The "Tuning" control should be set to the desired frequency by reference to the calibration chart and the "Sensitivity" control should be advanced until a perceptible noise level is obtained. The "Antenna Trimmer" and the "R-F Trimmer" should be adjusted for *maximum* noise output.

CAUTION: KEEP "SENSITIVITY" CONTROL RETARDED. Due to the high degree of sensitivity incorporated in the equipment, the "Sensitivity" control can only be used near maximum under ideal conditions of low external noise level. For ordinary operating conditions, it is necessary to retard the "Sensitivity" control in order to avoid OVERLOADING THE RECEIVER WITH NOISE and masking the desired signal.

- 10.4-5 The "Regeneration" control should be set so that the detector is oscillating as evidenced by a double click heard in the headphones when the "Osc. Test" button is pressed and released.
- 10.4-6 The "Tuning" control should now be adjusted until the desired signal is heard and finally set to produce as near a 1000-cycle beat note as possible. Finally, adjust the "Antenna Trimmer" and "R-F Trimmer" for maximum signal.
- 10.4-7 Fine adjustment of beat note may now be obtained by the use of the "Freq. Vernier" control and this control may be used to follow transmitter or receiver drift.
- 10.4-8 In cases where the frequency of the signal is not known (such as when searching), excellent advantage may be taken of the uni-control feature, exercising care to keep the "Sensitivity" control at such a point as not to overload the receiver with noise.
- 10.4-9 The "AVC Level" control will maintain a substantially constant output signal level for wide fluctuation in the field intensity of the received signal. It materially assists in copying signals through heavy static because the static peaks are held to such a low value that the operator's attention is not distracted from copying the signals. To utilize this control, advance the "Sensitivity" control until the noise level is perceptible (not in excess of -10 db), then throw the "AVC Off-On" switch to the "On" position and adjust the "AVC Level" control until a copyable signal is obtained.
NOTE: TO USE THE "AVC LEVEL" CONTROL TO BEST ADVANTAGE, THE SIGNAL SHOULD BE HELD TO AS LOW A VALUE AS WILL PERMIT GOOD COPY.
- 10.4-10 Throwing the Audio Tuning "Off-On" switch to the "On" position will result in increased selectivity and reduced noise level permitting of improved reception. The desired signal may be tuned to produce any beat note within the range of 450 to 1300 cycles and audio tuning adjusted to produce a maximum response at this beat frequency. It will often be found easier to set the Audio Tuning to a desired frequency, such as 1000 cycles, and to adjust the CW beat note to this frequency by the Frequency Vernier, rather than to adjust the Audio Tuning to the beat frequency. The following table shows an approximate calibration of the audio tuning:

TABLE A—AUDIO TUNING

<i>Audio Tuning Switch 450-770</i>			<i>Audio Tuning Switch 770-1300</i>		
Tap	1—	450 cycles	Tap	1—	800 cycles
"	2—	475 "	"	2—	845 "
"	3—	500 "	"	3—	890 "
"	4—	530 "	"	4—	940 "
"	5—	565 "	"	5—	990 "
"	6—	600 "	"	6—	1040 "
"	7—	640 "	"	7—	1100 "
"	8—	680 "	"	8—	1160 "
"	9—	725 "	"	9—	1225 "
"	10—	770 "	"	10—	1300 "

- 10.4-11 Throwing the "Audio Broad-Sharp" switch to the "Sharp" position will result in increased selectivity and an improved signal-to-noise ratio. This filter accepts signals up to 1200 cycles and rejects signals above 1600 cycles.

10.5 ICW or Modulated Signal Reception:

- 10.5-1 The procedure is the same as outlined above with the exception that the "Regeneration" control should be maintained slightly below the setting which produces oscillation. There should not be a pronounced double click as the "Osc. Test" button is pressed.
- 10.5-2 Particularly on the higher frequencies, a considerable improvement in both sensitivity and selectivity results when the "Regeneration" control is set reasonably near but below the condition of oscillation.

- 10.5-3 The low-pass filter does not respond to frequencies appreciably higher than 1200 cycles which is inadequate for the proper reproduction of speech. The frequency characteristic of the "Audio Tuning" circuits is such as to be inadequate for the proper reception of speech.
- 10.5-4 When receiving ICW, the "Audio Tuning" may be used for the reception of a 450 to 1300-cycle modulated signal and the Audio Tuning "Off-On" switch should be thrown to the "Off" position except for this condition.
- 10.5-5 When receiving ICW, the "Audio-Sharp" condition may be used provided the frequency of modulation lies in the range of 250 to 1200 cycles.

XI PERFORMANCE

11.1 Sensitivity

- 11.1-1 Figure 8 gives approximate normal sensitivities for the various bands. The procedure and conditions of measurement are as follows: With "AVC-Off", "Audio-Broad", "Audio Tuning-Off", and with a 600-ohm non-inductive resistance at receiver output terminals, pure CW is applied from a signal generator to the receiver input through a 300-ohm non-inductive dummy antenna resistance. The output beat note is held at 1000 cycles (receiver tuned 1 kilocycle higher than signal). The regeneration control is set at standard oscillation (increased beyond critical oscillation to the point where the output drops 3 db or from 2.68 V. in 600 ohms at critical oscillation to 1.9 V. at standard oscillation). The "Sensitivity" control is set for 50 microwatts (0.173 V. in 600 ohms) noise output with no signal input. The microvolts input then required to produce 6 mw output (1.9 V. in 600 ohms) is measured.

NOTE: THE CRITICAL OSCILLATION POINT IS THAT ADJUSTMENT OF THE "REGENERATION" CONTROL PRODUCING THE MOST FEEBLE OSCILLATIONS, RESULTING IN MAXIMUM OUTPUT. THIS CONDITION IS USUALLY TOO CRITICAL TO EMPLOY AS AN OPERATING ADJUSTMENT BUT IS A REFERENCE SETTING FOR STANDARD AND MEASUREMENT COMPARISON.

- 11.1-2 It is to be expected that the sensitivity will vary from time to time due to atmospheric conditions, tube characteristics, external noise conditions, etc., so that unless the sensitivity is definitely low (as indicated by high input microvolts) no attempt should be made to improve performance.

11.2 Maximum Noise

- 11.2-1 Figure 9 shows approximate values of maximum receiver noise level for the various bands. This data will be found useful for a rough check on sensitivity. The method of measurement is to adjust the receiver as for sensitivity (see 11.1), switch off signal generator, increase "Sensitivity" control to maximum and measure output noise voltage. The measured values of noise may be expected to vary considerably due to atmospheric conditions, tube characteristics, external noise conditions, etc., so that unless the noise output is definitely low, no attempt should be made to improve performance and, in any case, the sensitivity should first be accurately checked as explained in Section 11.1.

- 11.2-2 If measuring equipment is not available, an approximate measurement may be made by adjusting the "Regeneration" control to critical oscillation and all other controls for maximum noise output. The antenna terminal should be connected to ground through a 300-ohm resistor preferably inside the receiver cabinet (to eliminate external noise pickup). In this case, the noise output should be approximately 3 db higher than the values shown in Figure 9. (This is twice the value of milliwatts shown therein.)

11.3 Selectivity and Overload Selectivity

- 11.3-1 Figures 10, 11 and 12 show Selectivity and Overload ratios for each band. Curves (1) show the selectivity to 100% modulated interference when the receiver is operated for CW reception. They correspond closely with actual conditions at the middle of the band and represent an average for the band. These data are taken by first adjusting the receiver as for sensitivity measurement (par. 11.1) with 6 mw output at resonance. The signal is then modulated 30% and the frequency varied. The ratios of inputs off resonance (required to produce 6 mw output) to the normal (resonant) input are noted and the data corrected by multiplying by 3.33 to simulate 100% modulated interference.

11.3-2 Curves (2) of Figures 10, 11, and 12 show the overload selectivity characteristics for each band. These curves correspond closely with actual conditions at the middle of the band and represent an average for the band. This data is taken by first adjusting the receiver as for sensitivity measurement (par. 11.1). With the resonant signal being received, a CW interfering signal is applied at various frequencies off resonance and the ratios of inputs off resonance (required to reduce the resonant signal output by 3 db) to the normal (resonant) input are noted.

11.4 Calibration

11.4-1 Figure 13 shows average frequency calibration curves and band coverage of this equipment. Table B gives the nominal frequency range of each band.

TABLE B

<i>Band</i>	<i>Frequency Range (Megacycles)</i>
1	0.3 — 0.49
2	0.49 — 0.8
3	0.8 — 1.33
4	1.33 — 2.08
5	2.08 — 3.4
6	3.4 — 5.5
7	5.5 — 8.8
8	8.8 — 14.3
9	14.3 — 23.0

XII

MAINTENANCE—TROUBLE LOCATION AND REMEDY

12.1 General

12.1-1 This equipment has been carefully adjusted at the factory for optimum performance and is designed to maintain this adjustment for long periods of time. If any major adjustments or repairs become necessary, it is recommended that such adjustments and repairs be made in a well equipped laboratory where the proper tools and measuring equipment are available. Before making any changes in receiver adjustment, it should be definitely ascertained that the difficulty being experienced is not the result of external or normal deteriorating influences such as worn out vacuum tubes, improper operating voltages, blown fuses, external noises, etc.

IN TESTING OR INSPECTING CIRCUITS IN THIS EQUIPMENT, CARE MUST BE EXERCISED NOT TO DISARRANGE R-F WIRING.

12.2 Equipment

12.2-1 Where standard laboratory equipment is not available, the following equipment is recommended for use in locating troubles.

12.2-2 Radio Receiver Analyzing Equipment, Model OE (or equivalent), consisting of one Type 22193 DC Voltmeter/Milliammeter/Ohmmeter; one Type 22194 AC Voltmeter/Capacity Meter; one Type 60001 Vacuum Tube Circuit Selector Unit.

12.2-3 Calibrated Test Oscillator, Model LN (or equivalent) — frequency range 0.3 to 23 megacycles.

12.3 Dead Receiver.

12.3-1 With "AVC-Off," "Audio Tuning-Off," "Audio-Broad" and "Sensitivity" control at maximum, increase the "Regeneration" control setting from minimum to maximum, depressing the "Osc. Test" button at intervals. If no clicks or noise outputs are heard in the phones on any band, the following procedure may be followed for location of trouble.

12.3-2 Check the vacuum tubes, particularly the detector tube.

12.3-3 Check the power supply (see 12.10).

12.3-4 Test the headphones and the output circuit wiring for short- or open-circuits.

12.3-5 Test the audio amplifier (see 12.11).

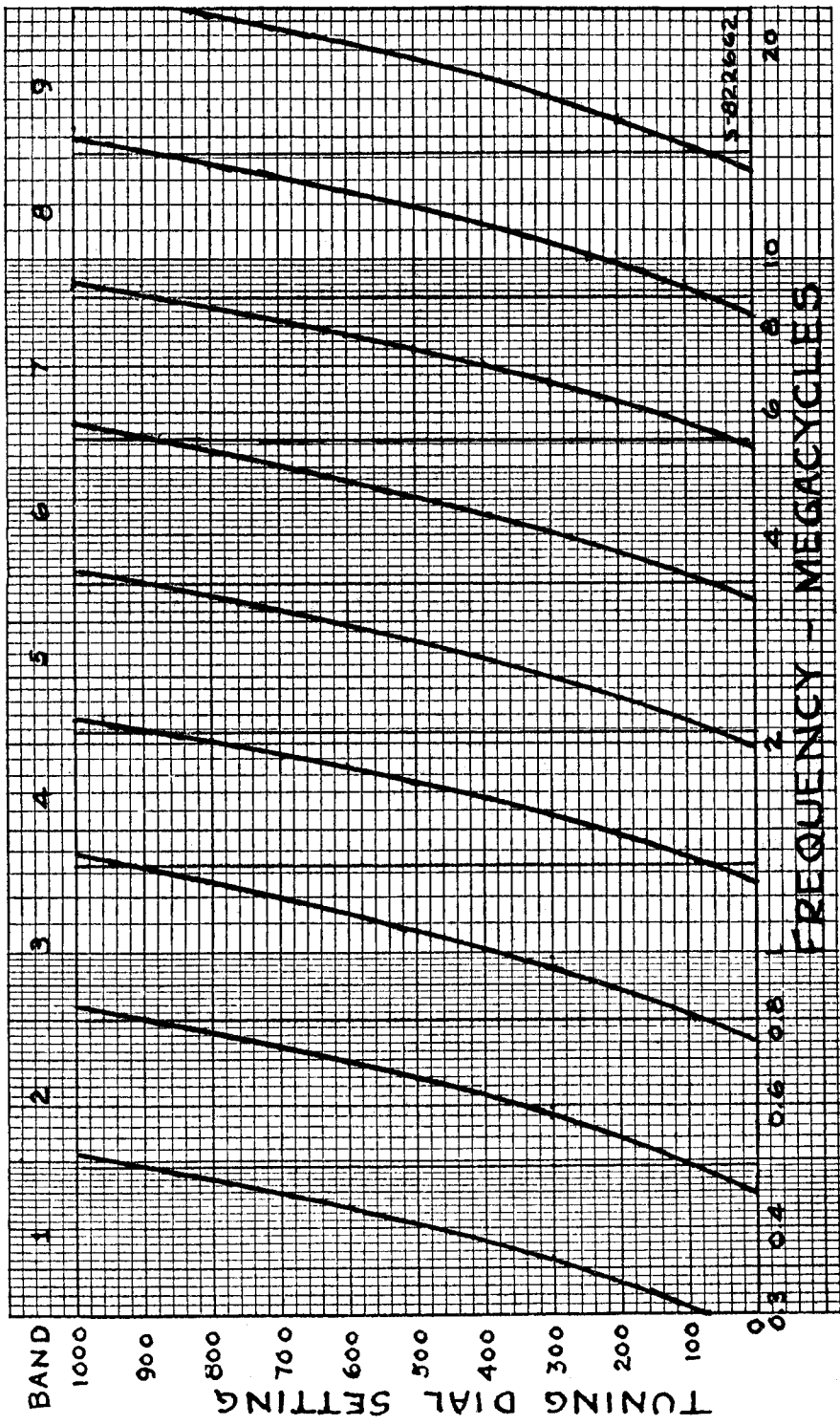


Figure 13—Average Frequency Calibration Curves

- 12.4 Weak Signals with Receiver Noise Level Normal.
- 12.4-1 If the receiver operates in a normal manner as indicated by the characteristic noise output (see 11.2) and no signals are in evidence, inspect the external antenna circuit.
 - 12.4-2 Withdraw the receiver partially from the cabinet and inspect the antenna connections.
- 12.5 Weak Signals with Detector Failing to Oscillate on All Bands.
- 12.5-1 With "AVC-Off," "Audio Tuning-Off" and "Audio-Broad," set the "Sensitivity" control at maximum, advance the "Regeneration" control and depress the "Osc. Test" button, noting whether the detector oscillates. If the detector fails to oscillate or oscillates with the "Regeneration" control near maximum on all bands, the following procedure should be followed:
 - 12.5-2 Check the power supply (see 12.10).
 - 12.5-3 Test the detector tube (see 12.13).
 - 12.5-4 Test the detector tube socket voltages (see 12.14).
 - 12.5-5 Test the detector circuit wiring (see 12.15).
 - 12.5-6 Test the switch contacts (see 12.16).
- 12.6 Weak Signals with Detector Oscillating Normally.
- 12.6-1 Test the power supply (see 12.10).
 - 12.6-2 Test the tubes (see 12.13).
 - 12.6-3 If the power supply and the tubes are satisfactory and the receiver noise level is definitely low (see 11.2), the trouble may be located in the output circuit, audio amplifier or r-f amplifier.
 - 12.6-4 Test the output circuit and the headphones for short- and open-circuits. If one side of the output circuit is grounded, the output will be reduced.
 - 12.6-5 Test the audio amplifier (see 12.11).
 - 12.6-6 Test the r-f amplifier (see 12.12).
- 12.7 Failure of Detector to Oscillate on some Bands; Other Bands Normal.
- 12.7-1 If the detector oscillates normally on some of the bands, it may be assumed that the power supply and the tubes are satisfactory and that the trouble is due to faulty band switch contacts or failure in the wiring between the band switch and portion of circuits used in the inoperative bands.
 - 12.7-2 Test the r-f (plate) and detector tube socket voltages, switching the "Frequency Band" switch on and off of the inoperative band (see 12.14).
 - 12.7-3 Test the detector circuit wiring on the inoperative bands (see 12.15).
- 12.8 Weak Signals on Some Bands; Other Bands Normal—Detector Oscillating Normally on All Bands.
- 12.8-1 If normal operation is obtained on part of the bands as indicated by normal receiver noise level (see 11.2), and if the detector oscillates normally on all bands, the trouble is localized in the portion of r-f circuits connecting to the band switch in the weak signal bands.
 - 12.8-2 Test the r-f tube socket voltages, switching the "Frequency Band" switch on and off of the weak signal bands (see 12.14).
 - 12.8-3 Test the r-f circuit wiring on the weak signal bands (see 12.15).
- 12.9 Panel Trimmer Controls.
- 12.9-1 Operation of these controls may be used as an indication of proper functioning of the associated tuned circuits.

- 12.9-2 In general, the setting for maximum response will vary for different bands and, in the case of the "Antenna Trimmer," for different antenna constants. These controls are designed to take care of normal minor variations in receiver alignment which occur over a period of time. A few divisions variation will normally occur over a given band due to slight mismatch of the inductances.
- 12.9-3 Failure of these controls to resonate the circuits, as indicated by maximum response on a signal or maximum noise output on all bands, indicates a defect in the respective circuits. Test the associated tube (see 12.13), tube socket voltages (see 12.14), and circuit continuity (see 12.15).
- 12.9-4 Failure of these controls to resonate the circuits on a particular band (other bands operating normally) indicates defects in the portion of the respective circuits connecting to the band switch on the particular band. Test tube socket voltages (see 12.14), switching the "Frequency Band" switch on and off of the inoperative band. If the voltages and circuit continuity are correct, the receiver alignment should be investigated (see 12.17).
- 12.9-5 An abnormally large change in either trimmer setting over a given band or failure to resonate at only one end of a band indicates that the tuning condenser section or the inductance used in the particular circuit and band has been damaged. If both trimmer settings change in the same direction over a band, this may indicate that the detector tuning condenser or inductance is at fault. (Refer to paragraph 12.17).

12.10 Power Supply.

- 12.10-1 If trouble is traced to the power supply, the following procedure may be followed:
- 12.10-2 Note the receiver panel voltmeter reading. This meter should read approximately 6 V. for normal operation and indicates the filament voltage which is obtained from a winding on the power transformer in the power unit. This also indicates that power is being supplied to the power unit and thus serves as a "power on" indicator.
- 12.10-3 If no voltage is indicated (assuming that the meter is not defective), test the a-c line voltage and fuses in the a-c line, control unit and power unit. Refer to Figure 16.
- 12.10-4 Partially remove the receiver from the cabinet and check the voltage at the power terminal board. Refer to Figure 16. The terminals are numbered from 1 to 9, No. 1 being nearest the panel. These voltages should measure approximately as follows:

TABLE C—RECEIVER TERMINAL VOLTAGES

<i>Terminal</i>	<i>Voltage</i>
1 or 9 to 6	180 V. DC
1 or 9 to 5	90 V. DC
2 to 3	5.9 V. AC

- 12.10-5 If the above voltages fail to check, test the a-c power supply voltage. Partially remove the power unit from its case and measure the power unit terminal voltages. Refer to Figure 16. The power unit terminals are numbered from 1 to 6, No. 1 being nearest the panel. These voltages should measure approximately as follows:

TABLE D

POWER UNIT TERMINAL VOLTAGES

<i>Terminal</i>	<i>Voltage</i>
1 to 5	180 V. DC
1 to 4	90 V. DC
2 to 3	5.9 V. AC

- 12.10-6 If the above voltages fail to check and the line input voltage and fuses are operative, test the power unit tubes (see 12.13).
- 12.10-7 Test the power unit circuits for continuity (see 12.15).

12.11 Audio Amplifier.

- 12.11-1 To determine if the audio amplifier is operating, partially withdraw the receiver from the cabinet and touch the grids of the detector and first a-f tubes. Pronounced clicks should be heard in the phones.
- 12.11-2 If the above test indicates a defect in the amplifier circuit with satisfactory power supply (see 12.10) and output circuit connections (see 12.3-3), the audio tubes should be checked (see 12.13) and the audio circuits tested (see 12.15).
- 12.11-3 If in the test of 12.11-1, a pronounced click is obtained when the first audio grid is touched, but touching the detector grid gives no indication, the trouble is located in the portion of the circuit between these two points.
- 12.11-4 If measuring equipment is available, the audio gain may be checked by application of 1000-cycle input to the first audio grid. The input required for zero level (6 milliwatts) output should be approximately 0.015 volt.

12.12 R-F Amplifier.

- 12.12-1 A defective r-f amplifier may be detected by abnormal operation of the trimmer controls (see 12.9), "Sensitivity" control, or by first ascertaining that the remainder of the circuit is operative.
- 12.12-2 With the "Sensitivity" control at minimum, a barely audible hum should be noted and it should be possible to hear the detector go into oscillation if the "Regeneration" control is advanced rapidly. With the detector oscillating, the characteristic double click should be heard when the "Osc. Test" button is depressed. Further tests indicating normal operation of detector output and audio amplifier circuits are noted under 12.11.
- 12.12-3 If a fault is located in the r-f amplifier by the above methods with normal power supply (see 12.10) and antenna connections (see 12.4-2), it should be determined whether the trouble exists on all bands or on only one or more particular bands.
- 12.12-4 If the trimmer operation is not normal, refer to paragraph 12.9.
- 12.12-5 If the trimmer operation is normal and low sensitivity as indicated by the tests outlined in paragraph 11.1 is obtained on all bands, test the r-f amplifier tubes (see 12.13), socket voltages (see 12.14) and circuit continuity (see 12.15).
- 12.12-6 If trouble is located on a particular band or bands with other bands operating normally, check the socket voltages (see 12.14) and circuit continuity (see 12.15), switching the "Frequency Band" switch on and off of the inoperative band. Check the "Frequency Band" switch (see 12.16).
- 12.12-7 Before making extensive circuit tests, an attempt should be made to localize the trouble in the first or second amplifier stage. This may be done by applying input from a test oscillator to the respective grids.

12.13 Tube Characteristics.

- 12.13-1 If trouble is traced to tubes in a portion of the circuit, the trouble may be quickly checked by replacing the doubtful tube with a tube of known characteristics and re-checking the performance of the equipment.
- 12.13-2 Tubes may be tested for open heaters or shorts between elements by use of a continuity meter or click test with the precaution that the rated voltage of the filament is not exceeded.
- 12.13-3 Tubes will be found to deteriorate gradually with use, resulting in a gradual reduction in performance of the equipment. It is therefore advisable to replace tubes after 1000 hours of service or to measure them at regular intervals to determine if the limit of serviceability has been reached. Table E gives standard characteristics for the tubes used in this equipment and low limits of "emission" and "transconductance." A test of "emission" is usually sufficient to indicate the condition of a tube, but a better correlation between test results and actual conditions is obtained by measurement of "transconductance." Actual operating voltages on the tubes as used in this equipment are appreciably lower than the ratings shown in the table so that extended tube life is assured.

TABLE E—TUBE CHARACTERISTICS

Tube Type	Fil. Volts	Fil. Current (Amps.)	Plate Volts	Screen Volts	Grid Bias Volts	Plate Current (MA.)	*Emission Current (MA.)	Screen Current (MA.)	AC Plate Resistance (Ohms)	Ampl. Factor	Average Transcond. (Micromhos)
-6D6	6.3	0.3	250	100	- 3	8.2	100	2.0	800,000	1280	1600
-41	6.3	0.4	250	250	-18	32	200	5.5	68,000	150	2200
-874	..	..	90	..	..	30	..	(striking voltage 125 V.)			
-876	50	1.7	..	..	..	..	..	..	.....	....	....
-5Z3	5.	3.0	..	..	..	..	240	..	.....	....	....
-5Z3	(AC voltage per plate 500 RMS—Max. DC Output Current 250 M.A.)										

Tube Type	Low Limits	
	*Emission (MA.)	Transconductance (Micromhos)
-6D6	50	1200
-41	70	1300
-874	..	....
-5Z3	..	....
-5Z3	190	....

*For "emission" tests, all grids are connected to the plate and are 50 volts positive with respect to the cathode or filament, except the Type -5Z3 tube on which a potential of 40 volts is used with both plates connected together.

12.13-4 Measurement of "emission" and "transconductance" is not always an absolute indication of the condition of tubes for their various applications, particularly in the case of detector tubes and AVC tubes. An unsatisfactory detector tube is best indicated by its oscillating properties. A tube which does not function properly in the detector stage may often be used in an amplifier stage without loss in performance. A low output tube may often be utilized in the AVC position.

12.14 Tube Socket Voltages.

12.14-1 Measurement of socket voltages may be used as a check on power supply and receiver circuit connections.

12.14-2 The following table gives average tube socket voltages for this equipment. These voltages are not operating voltages and will vary considerably with different types of voltmeters. The values stated below apply for the Model OE Radio Receiver Analyzing Equipment.

TABLE F—TUBE SOCKET VOLTAGES

Due to change in load when one tube is removed, the voltages measured at the tube sockets are somewhat higher than the corresponding voltages of Tables C and D.

Tube Type	Function	Plate	Screen	Supp.	Cath.	Grid	Heater
-6D6	1st RF	190	90	0	0	0	6
-6D6	2nd RF	175	90	0	0	0	6
-6D6	Detector	150	45	0	0	0	6
-6D6	Audio	185	170	0	0	0	6
-41	Output	200	200	..	0	0	6
-41	AVC	0	0	..	185	0	6

In making the above measurements the receiver should be operated at normal supply voltage and allowed to warm up for approximately 10 minutes before taking readings. Readings are taken by removing one tube at a time and measuring voltages between the socket terminals and ground. Set "AVC Level-10," "AVC-Off," "Regeneration-10" "Sensitivity-10," "Audio Tuning-Off," "Audio Broad." Figure 23 shows socket terminal arrangements.

TABLE G—TUBE OPERATING VOLTAGES AND CURRENTS

Tube	Function	Plate	Plate	Screen	Screen	Cathode	Supp.	Heater	Note	
		E	MA.	E	MA.	E	E	E		
-6D6	1st RF	140	4.5	72	1.2	3-40	3-40	5.8 (AC)	1	
-6D6	2nd RF	80	4.5	72	1.1	3-40	3-40	5.8 (AC)	1	
-6D6	Detector	50-140	0.0-2.5	17-30	0.0-0.4	0	17-30	5.8 (AC)	2	
-6D6	Audio	50	1.2	27	0.3	1.5	1.5	5.8 (AC)		
-41	Output	115	11.0	120	1.75	7.5	—	5.8 (AC)		
-41	AVC	0	0	0	0	180	—	5.8 (AC)	3	
-5Z3	Rectifier	230 AC—from each plate to ground							4.9 (AC)	

The above are average operating voltage and current values as obtained by measurement with a Model OE Radio Receiver Analyzing Equipment. Readings were taken under the following test conditions: Receiving Equipment in normal operative condition, antenna disconnected, line voltage 115, current-regulator tube IN, "AVC-Off," "Sensitivity" control on 10 (see Note 1), "Regeneration" control on 5 (see Note 2), "Frequency Band" switch on "1," and "Tuning" control on 0-0. DC voltages measured to heater (ground).

Note 1. Cathode to heater voltage varies with position of "Sensitivity" control. Average limits are shown.

Note 2. Detector voltages and currents vary with position of "Regeneration" control. Average limits are shown.

Note 3. Cathode to heater voltage measured with "AVC Level" control at maximum.

For the above measurements with the Model OE Radio Receiver Analyzing Equipment, the lowest possible voltmeter scale should be used, as follows:

Voltages	Meter	Resistance	Voltages	Meter	Resistance
0/1	0/1	20,000	10/25	0/25	500,000
1/2.5	0/2.5	50,000	25/50	0/50	1,000,000
2.5/5	0/5	100,000	50/100	0/100	2,000,000
5/10	0/10	200,000	100/250	0/250	5,000,000

The color code used for bus wiring between the "Frequency Band" switch and coils is shown in the following table:

**TABLE H
BUS WIRING COLOR CODE**

Ant. and plate leads.....	Red		
Tuned circuit "high".....	White		
Tuned circuit "low" (taps).....	Green		
Det. cathode circuit.....	Blue		
Bands 1	4	7.....	1 dot
2	5	8.....	2 dots
3	6	9.....	3 dots

In cases where a single lead is used for more than one band, the number of dots correspond with the lowest frequency band for which the lead is used.

12.14-3 If trouble exists on a particular band, the tube socket voltages should be measured on both the inoperative band and on an operative band to indicate which portion of the circuit is at fault.

12.14-4 If a source of trouble is localized in a particular portion of the circuit by the above analysis, this portion of the circuit should be tested for continuity and inspected (see 12.15).

12.15 Circuit Continuity.

12.15-1 After tracing a fault to a particular portion of the circuit by the foregoing tests, the circuit should be systematically inspected, tested for continuity, short circuits, ground or failure of component parts, with power off. Refer to following drawings:

Diagram	Figure
Receiver Unit Schematic.....	17
Receiver Unit Connection.....	20
Power Unit Schematic.....	18
Power Unit Connection.....	21

12.15-2 If an ohmmeter is available, point-to-point resistance measurements will be useful in locating faults. The following tables indicate the approximate resistances in this equipment.

TABLE I
RECEIVER UNIT POINT-TO-POINT RESISTANCES

<i>Points</i>	<i>Resistance</i>	<i>Condition</i>
Terminal No. 6 to	1st RF plate 10,000 ohms	
" "	2nd RF plate 20,000 ohms	
" "	Detector plate 30,000 ohms	
" "	Audio plate 120,000 ohms	
" "	Output plate 5,125 ohms	"AVC-Off"
" "	Output plate 4,800 ohms	"AVC-On"
" "	AVC cathode 0	"AVC Level — 10"
" "	AVC cathode 9,740	"AVC Level — 0"
" "	1st RF screen 18,000 ohms	
" "	2nd RF screen 18,000 ohms	
" "	1st AF screen 500,000 ohms	
" "	Ground 9,740 ohms	
Terminal No. 5 to	Detector screen 28,800 ohms	"Regeneration — 10"

<i>Points</i>	<i>Resistance</i>	<i>Condition</i>
Ground to	Detector screen..... 10,000 ohms	"Regeneration — 0"
" "	1st RF grid..... 110.5	"Frequency Band — 1"
" "	2nd RF grid..... 1.0 megohms	
" "	Detector grid..... 2.2 megohms	
" "	Audio grid..... 100,000 ohms	
" "	Output grid..... 1.0 megohms	
" "	AVC-screen grid plate. 3,500 ohms	
Terminal No. 7 to No. 8	40 ohms	"Add Decibels Off"
Ground to No. 7.....	20 ohms	"Add Decibels Off"
" " " 8.....	20 ohms	"Add Decibels Off"

The above values apply for the receiver unit alone—external cables disconnected, all tubes out of sockets, and receiver set on "Frequency Band—1," and "Tuning—0."

12.15-3 Power unit point-to-point resistances are approximately as noted in the following table:

TABLE J
POWER UNIT POINT-TO-POINT RESISTANCES

<i>Points</i>	<i>Resistance</i>	<i>Condition</i>
Terminal No. 2 to No. 3.....	1.0 ohms	
Terminal No. 1 to No. 5.....	20,000 ohms	
Terminal No. 1 to No. 4.....	23,000 ohms	
-5Z3 socket (fil. to fil.)	0.15 ohms	
-5Z3 socket (plate to plate)	250 ohms	
R-H power line terminals.....	Infinite	"On-Off Switch—Off"
R-H power line terminals.....	7.0 ohms	"On-Off Switch—On"
Power terminals to ground.....	Infinite	

Above values apply for the power unit alone (external cables and wiring disconnected) with all tubes in sockets and with current-regulator tube "In" (the condition of operation of the power unit with this equipment).

12.15-4 Component parts may be identified by cross reference from the item numbers in Figures 17 and 18.

12.16 "Frequency Band" Switch.

12.16-1 To inspect the "Frequency Band" switch and circuit connections, the large plate on the bottom of the chassis may be removed. This switch has been carefully aligned at the factory, the four contacts on each section being accurately adjusted for equalized pressure and maximum contact area. Readjustment of the switch should rarely be found necessary.

IF ANY MAJOR REPAIRS ON THE SWITCH ASSEMBLY BE FOUND NECESSARY, SUCH REPAIRS SHOULD BE MADE IN A WELL EQUIPPED LABORATORY SINCE SERIOUS MECHANICAL MISALIGNMENT OF THE CONTACTS OR MISALIGNMENT OF HIGH-FREQUENCY INDUCTANCES DUE TO DERANGEMENT OF R-F WIRING MAY RESULT.

In order to readjust or replace switch parts and for access to switch wiring, it will be necessary to remove the switch retaining brackets mounted inside the switch compartments at the bottom of the chassis. After removal of the large plate on the bottom of the chassis, the switch retaining bracket for a particular compartment may be removed without removing the brackets for other compartments. The brackets are mounted by means of screws at the partition shields.

When the switch retaining bracket is replaced, the switch stator sections must be first accurately positioned so that the movable contacts exactly center on the fixed contacts when the switch is set to positions determined by the detent. The retaining

bracket is then mounted in position with the adjusting screws backed off. Finally, the adjusting screws must be screwed in to just touch the stators, then backed off to leave a very slight clearance (approximately .005 in.), then locked by means of the lock nuts. UNDER NO CONDITION SHOULD SCREWS EXERT FORCE AGAINST THE STATORS AS THIS WILL CAUSE BENDING, WITH CONSEQUENT BINDING OF THE SWITCH SHAFT.

CAUTION: DO NOT ALIGN BY MEANS OF SCREWS.

- 12.16-2 Switch contacts may be tested by pressing the movable contact down on its fixed contact with a tool of insulating material. Associated circuits should be checked for loose contacts before disturbing the switch assembly.
 - 12.16-3 The switch is self-cleaning and should wipe itself clean if rotated back and forth over the questionable contact several times. Should further cleaning become necessary, the rotating member may be pressed down against the fixed member far enough to permit disengaging the "C" washer from its slot in the rotating hub at the back of the fixed member. If the "C" washer is removed, the rotating member may be slid along the shaft away from the fixed member permitting access to the contacts. Care must be taken not to compress the springs farther than necessary or they will require readjustment.
 - 12.16-4 Should necessity of replacing a switch section arise, the switch shaft must be removed, the switch section connections unsoldered at the switch plate, the new section inserted, connections soldered, and switch shaft replaced. Receiver alignment should then be checked (see 12.17). To remove switch shaft, remove taper pin fastening the bevel gear to the switch shaft. Remove the bearing bushing at the end of the shaft opposite the drive and slide the shaft out, taking care that none of the switch sections are binding on the shaft. When replacing the shaft, see that the bevel gears are properly meshed to provide alignment between switch position and position indicated by the panel control before pinning.
- 12.17 Receiver Alignment.
- 12.17-1 Receiver alignment may be readily checked by observing operation of the panel trimmers (see paragraph 12.9 and Figure 6). These trimmers should resonate the respective tuned circuits at any point in their range. A rough indication may be obtained by noting the increase in receiver noise level as the trimmers are tuned through resonance. For accurate alignment check, the receiver must be adjusted as for sensitivity measurements (see 11.1). This adjustment may be approximated with sufficient accuracy for most purposes by setting the "Sensitivity" control at "9" and the "Regeneration" control at approximately 1/2 division above critical oscillation.
 - 12.17-2 Bands 1-2-3. Adjust trimmer C-141 to bring the panel "RF Trimmer" settings for the high-frequency ends of bands 1, 2 and 3 as near zero as possible.
 - 12.17-3 Bands 4-5-6. Adjust trimmer C-140 to bring the panel "RF Trimmer" settings for the high-frequency ends of bands 4, 5 and 6 as near zero as possible.
 - 12.17-4 Bands 7-8-9. Adjust trimmer C-139 to bring the panel "RF Trimmer" settings for the high-frequency ends of bands 7, 8 and 9 as near zero as possible. Set trimmer C-137 to bring panel "Antenna Trimmer" settings for the high-frequency ends of bands 7, 8 and 9 as near zero as possible.
 - 12.17-5 The following table gives nominal frequencies and approximate dial settings which should be used in aligning the receiver.

**TABLE K
ALIGNING FREQUENCIES**

<i>Band</i>	<i>Nominal Frequency (KC)</i>	<i>Dial Setting (Approx.)</i>
1	300- 490	79-892
2	490- 800	89-896
3	800- 1,330	85-898
4	1,330- 2,080	64-847
5	2,080- 3,400	57-885
6	3,400- 5,500	69-880
7	5,500- 8,800	58-910
8	8,800-14,300	73-912
9	14,300-23,000	83-858

12.17-6 As noted in paragraph 12.9-5, an abnormal change in either trimmer setting over a given band, or failure to resonate at only one end of a band indicates that the tuning condenser section or the inductance used in the particular circuit and band has been damaged. If both trimmer settings change in the same direction over a band, this may indicate that the detector tuning condenser or inductance is at fault. Such conditions on the higher frequency bands may result if the wiring between the band switch and tuned circuit inductances is disarranged.

UNLESS THESE CONDITIONS SERIOUSLY IMPAIR OPERATION, NO ATTEMPT SHOULD BE MADE TO REPAIR INDUCTANCE OR TUNING CAPACITOR ALIGNMENT OR REPLACE COILS. THESE OPERATIONS SHOULD VERY RARELY BECOME NECESSARY AND SHOULD BE DONE ONLY IN A WELL EQUIPPED LABORATORY.

12.18 Lubrication.

12.18-1 Mechanical moving parts such as tuning condenser drive mechanism, band switch drive mechanism, and bearings should be periodically inspected and, if necessary, lightly greased with a non-fluid mineral oil or light grease such as Grade A of Navy Department Specification 14G 1. Lubrication of electrical contacting surfaces is not advisable unless tendency for cutting appears; when required, a light grease such as vaseline should be used very sparingly, all surplus grease being removed.

12.19 Cleaning.

12.19-1 ABRASIVE SUBSTANCES SUCH AS EMERY CLOTH, STEEL WOOL, ETC., SHOULD NEVER BE USED FOR CLEANING IN OR ABOUT ANY PART OF THIS EQUIPMENT.

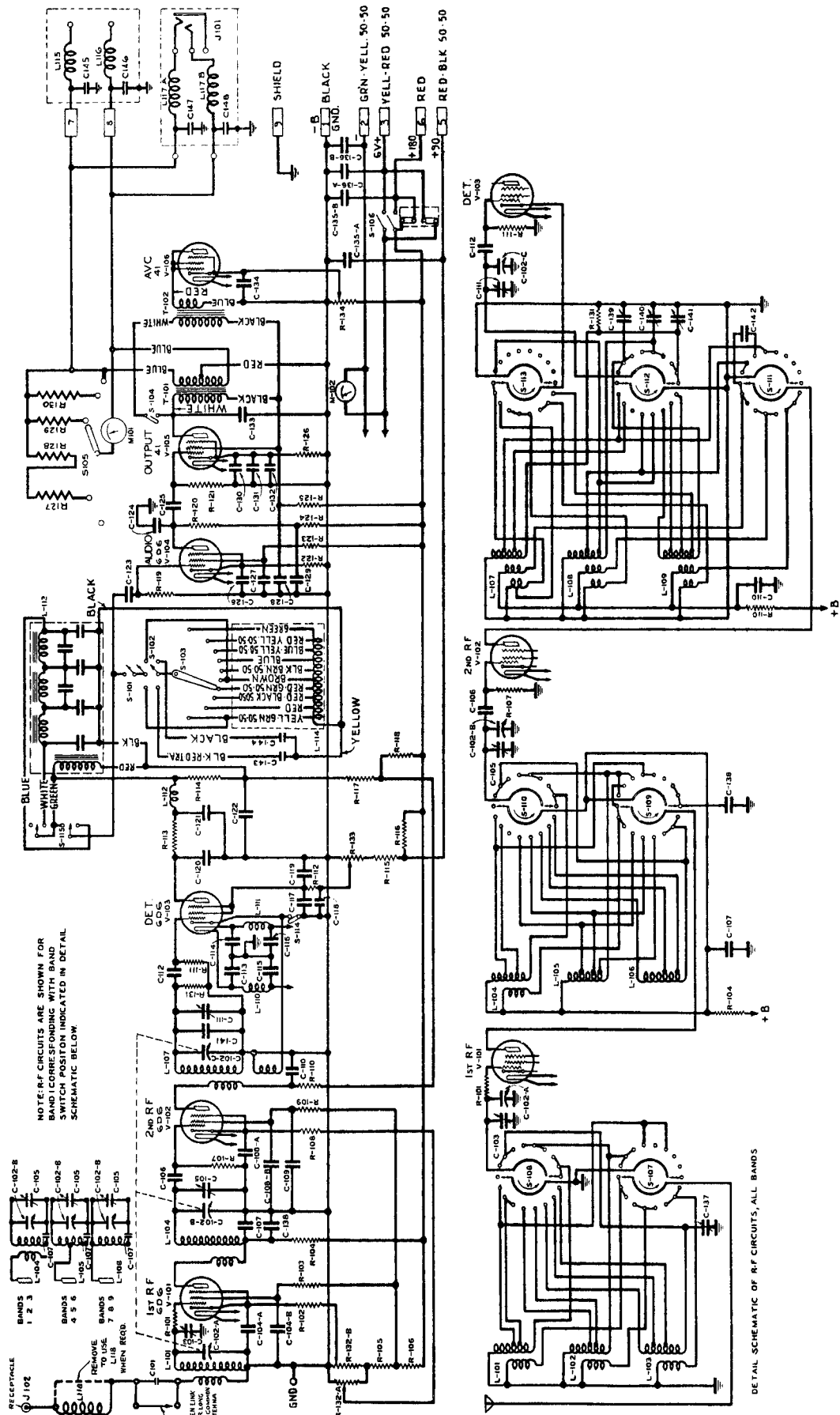


Figure 17—Schematic Diagram, Receiver Unit CRV-46156 (T-621284)

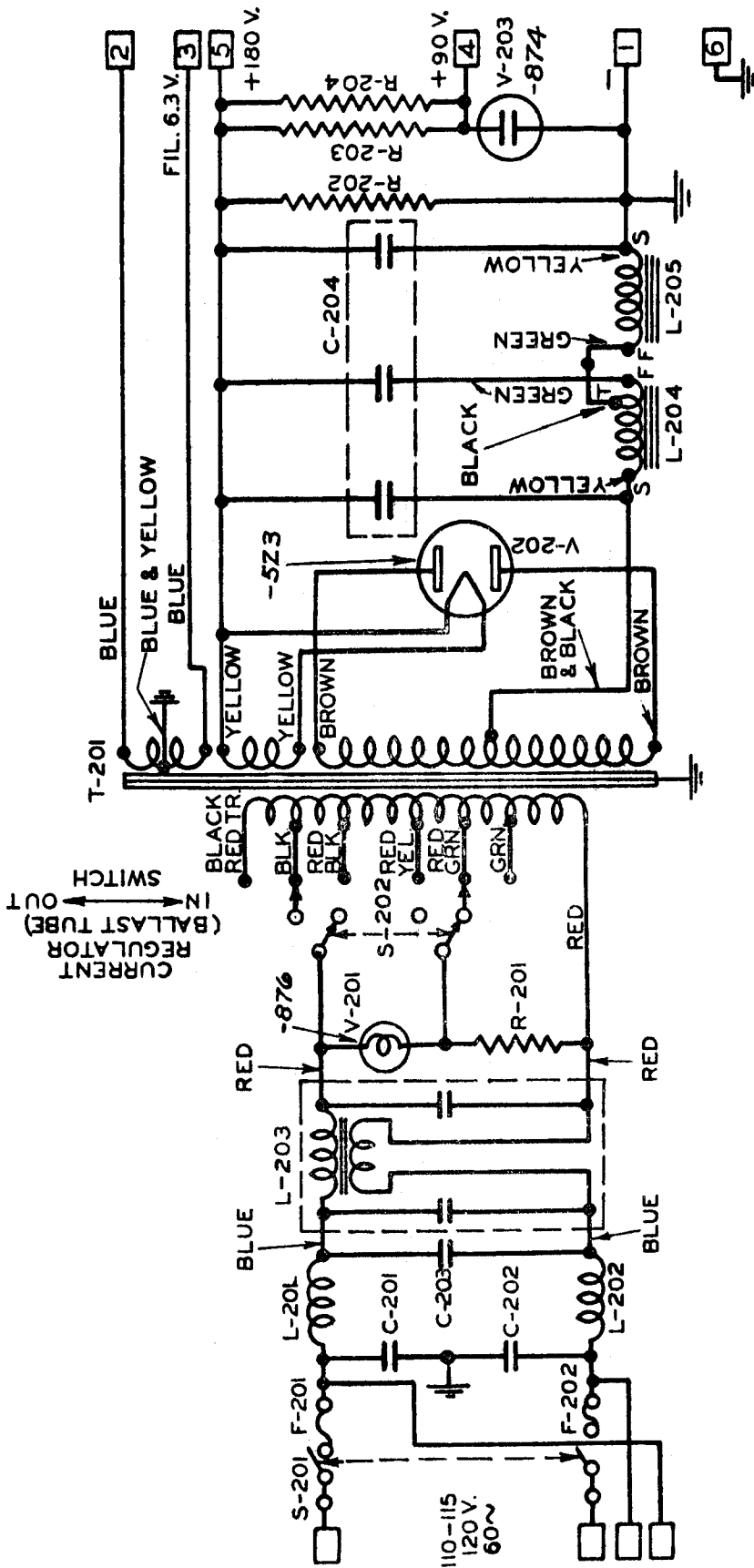


Figure 18—Schematic Diagram,
Power Unit CRV-20131 (M-422922)

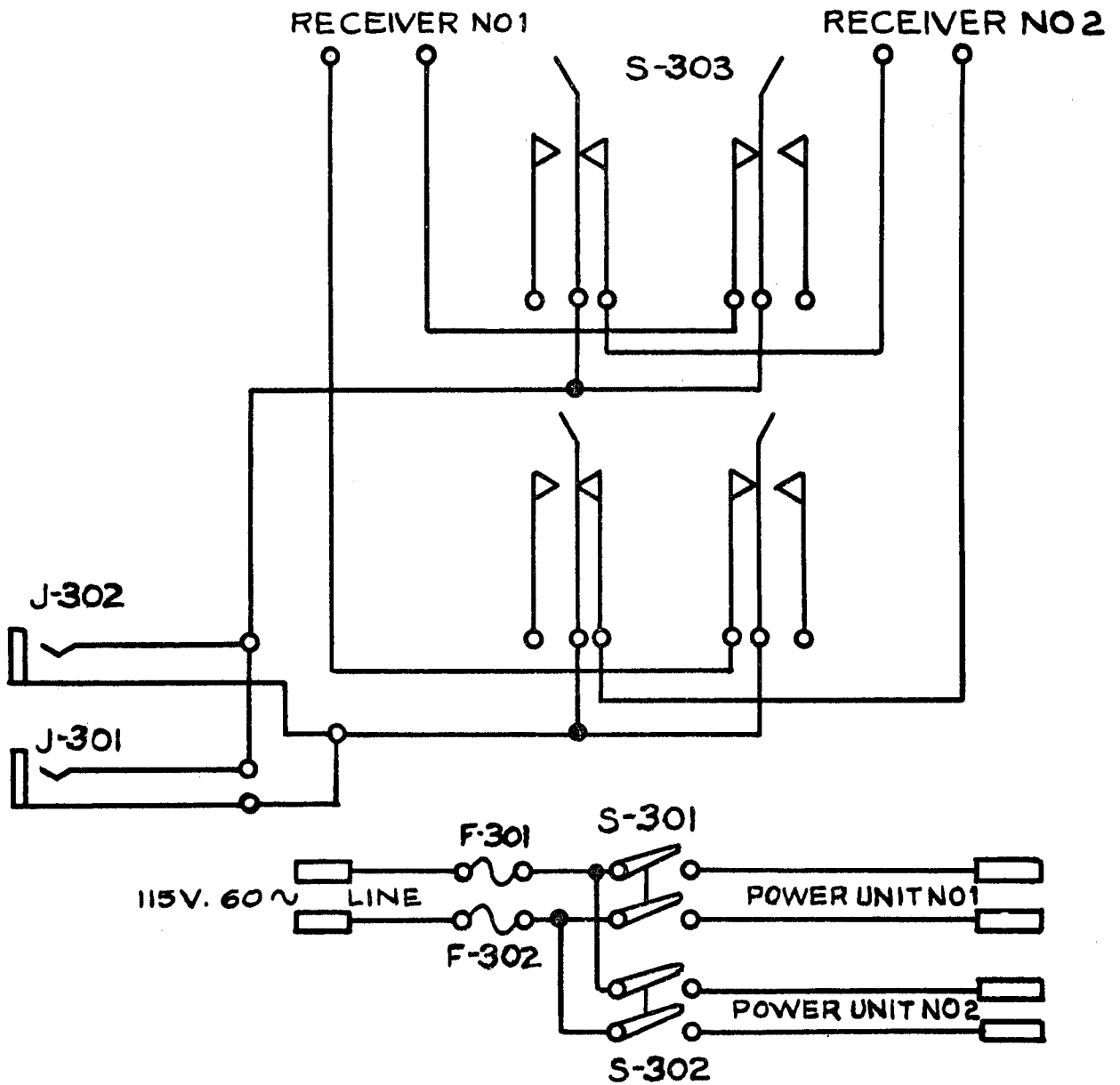


Figure 19—Schematic Diagram,
Control Unit CRV-23073 (M-407021)