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HANDBOOK
SERVICE INSTRUCTIONS

RADIO RECEIVER
MODEL SP-600-JX

(HAMMARLUND)

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SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. GENERAL.

1-2. The service instructions outlined herein pertain to the Radio Receiver, Model SP-600-JX rack mountings (See figure 1-1.), manufactured by the Hammarlund Mfg. Co. Inc., New York 1, N. Y. The radio receiver, designed for mounting in a standard 19-inch relay rack, has a light grey front panel, a top cover and a bottom plate. It is a 20-tube radio communications receiver with six frequency bands to provide for the continuous or crystal controlled fixed frequency coverage of the 0.54 to 54.0 mc frequency range.

1-3. The receiver operation is based on the superheterodyne principle of reception wherein all carrier frequencies are converted to a 455 kc intermediate frequency. To maintain performance, the receiver utilizes the system of double conversion, with an initial conversion frequency of 3,955 kc, for the three frequency bands above 7.4 mc.

1-4. The receiver self-contained stabilized power supply is designed to operate from a single phase 50- to 60-cycle, a-c source. The power transformer primary is provided with taps covering a line voltage range from 90 to 270 volts. The receiver is protected against overload by fusing the power transformer primary winding with a three ampere cartridge type fuse and the secondary plate winding with a three-eighths ampere pigtail type fuse. The primary fuse and a duplicate spare are contained in fuse holders on the rear apron and the secondary fuse is soldered between the power transformer terminal 11 and chassis ground.

CAUTION

To prevent damage, maintain the fuse complement.

1-5. The rear apron of the receiver contains an a-c outlet for an electric lamp or clock and terminals for a record player attachment. All attachments when used must be suited to operate from the available a-c source. Apart from the "PHONES" jack contained in the front panel (See 16, figure 1-2.), and the antenna input connector (See 7, figure 1-3.), all the receiver attachment means are located on the rear apron (See figure 1-3.).

1-6. PURPOSE AND LIMITATIONS.

1-7. The receiver is designed to provide amplitude-modulated or keyed cw signals as audio or i-f output and frequency-shift cw signals as i-f output. It is used in fixed and/or mobile operations such as are encountered at enclosed base stations, on shipboard, or when airborne, even when such activities are subject to wide ranges in temperature and humidity. The receiver is adequately treated with fungicidal varnish to condition it for tropical use.

1-8. The receiver is suited to two-way operational activities and to multi-receiver installations. It may be "desensitized" in the presence of a strong local carrier by front panel manual switch means, or, a relay connected to a rear apron receptacle may be hand-microphone activated to perform the switch function. The receiver design and shielding reduce its radiation characteristics to a possible minimum, thereby complying with shipboard regulations and enabling the receiver to be operated in close proximity to all other station equipment.

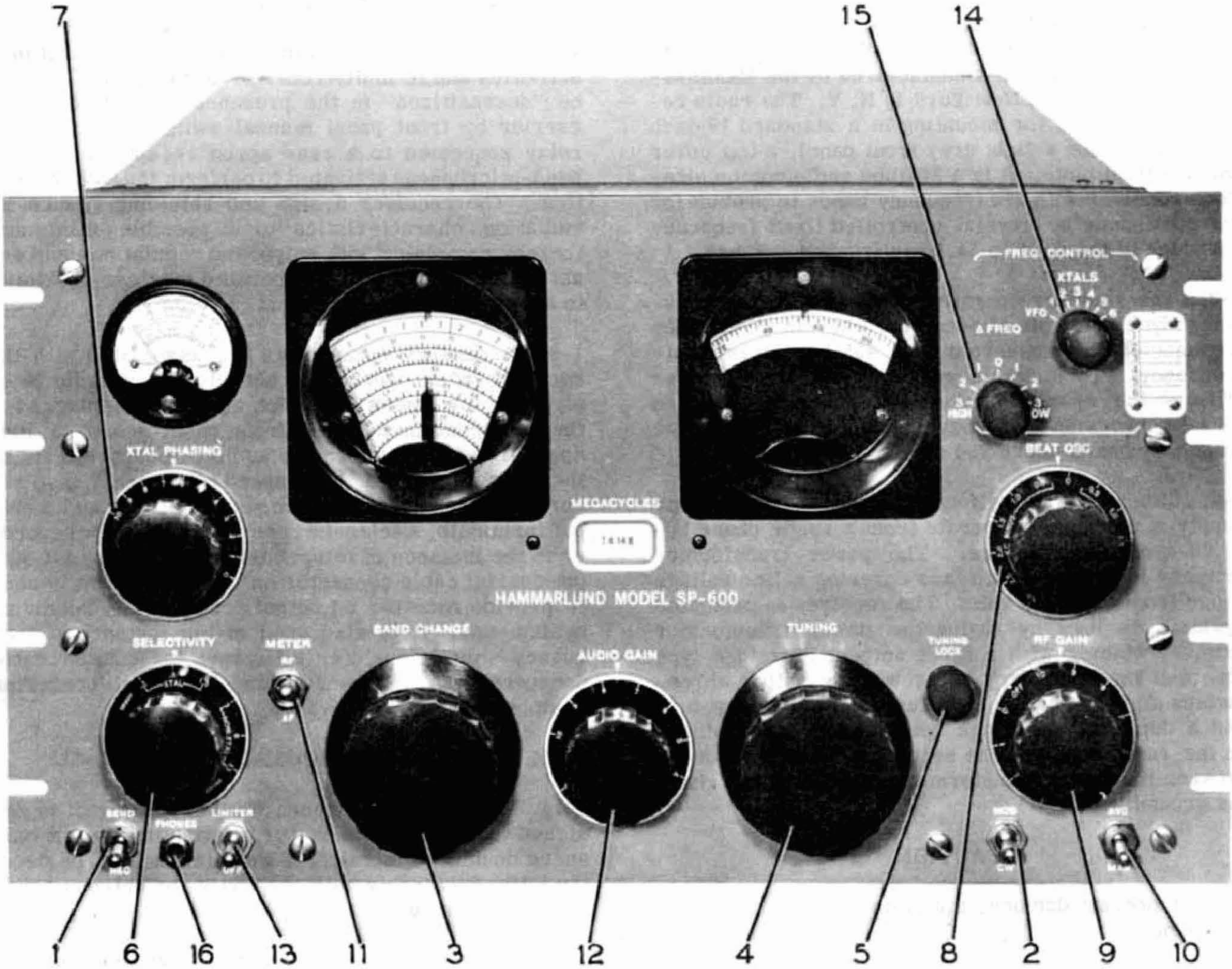
1-9. Accessory components are associated with the receiver in an operational activity. For radio telephone or low-speed telegraph a headset is plugged in the jack contained in the front panel and/or a loud speaker is connected to the audio output terminals on the rear apron. For high-speed telegraph a tape recorder is transmission line connected to the audio output terminals, a teleprinter replacing the tape recorder in the instance of teleprinter signals. The i-f output coaxial cable connector on the rear apron is used to provide receiver i-f output for diversity receiving system use. It is also used in the instance of frequency-shift teleprinter i-f output for coaxial cable connection to frequency-shift receiver converter equipment.

1-10. LEADING PARTICULARS.

1-11. The receiver antenna input coupling coil is designed to match a 100-ohm transmission line. A balanced doublet or straight wire antenna may be used, the latter preferably with one end of the antenna coupling coil grounded.

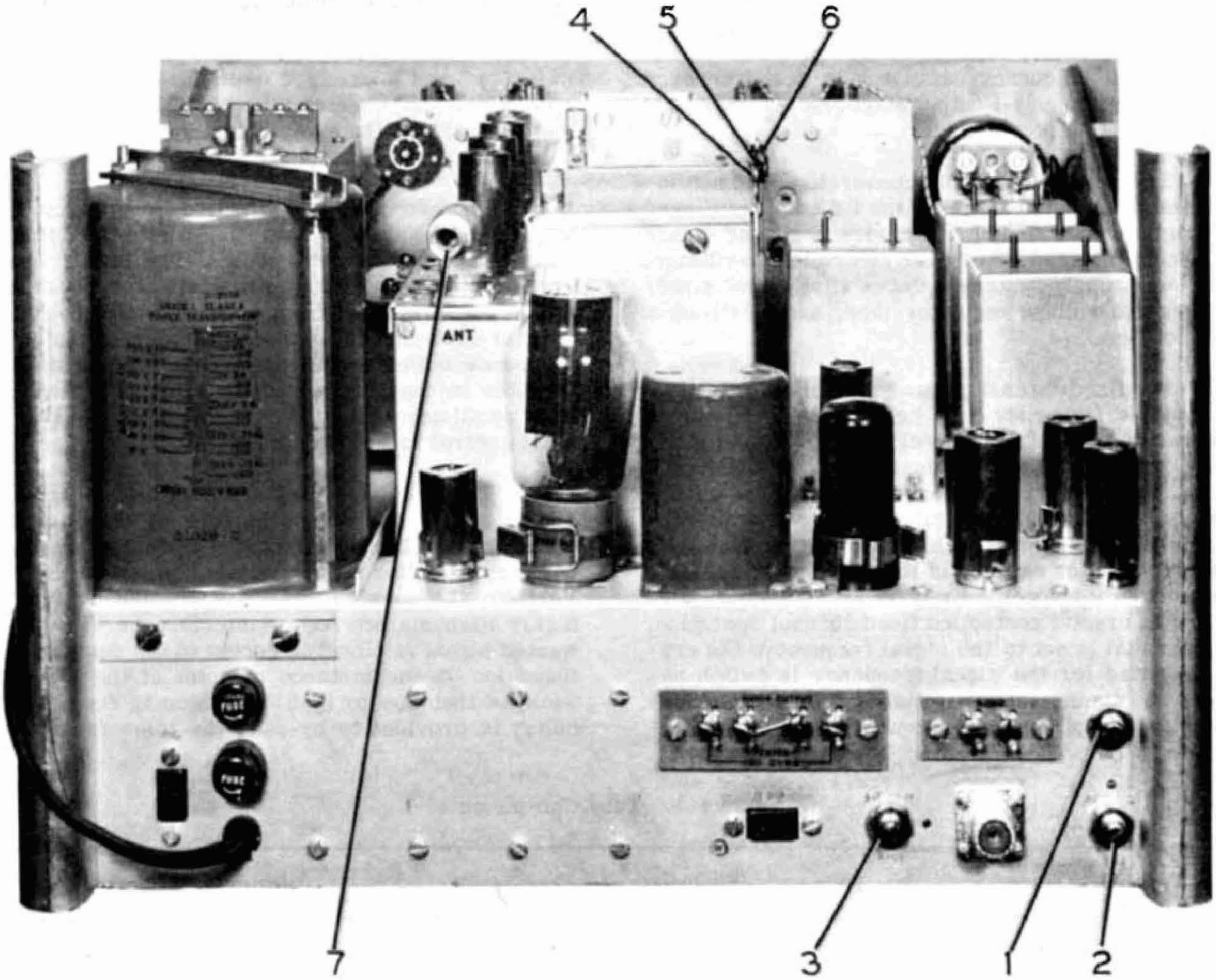
1-12. The receiver has a rotary turret which houses and provides for selecting any one of the six frequency bands. The large band change control knob is turned 360 degrees to indent an adjacent band. It may be turned and indented in either direction. A band indicator dial visible through a small front panel window indicates the frequency band selected. The control also aligns the dial frequency indicator of the main dial, with the proper dial frequency scale. The main dial has also an arbitrary scale which in conjunction with the vernier dial provides for continuous vernier scales over each frequency band for extremely accurate logging and resetability.

1-13. The single tuning control is large and flywheel balanced to provide operating ease at high traverse speeds. It controls both the main and vernier dials. An anti-backlash gear train maintains the extremely close calibration accuracy and provides for the accurate resetability. A tuning lock provides locking



1. "SEND" "REC" toggle switch
2. "MOD" "CW" toggle switch
3. "BAND CHANGE" control
4. "TUNING" control
5. "TUNING LOCK"
6. "SELECTIVITY" switch
7. "XTAL PHASING" control
8. "BEAT OSC" control
9. "RF GAIN" control
10. "AVC" "MAN" toggle switch
11. "METER" "RF" "AF" toggle switch
12. "AUDIO GAIN" control
13. "LIMITER" "OFF" toggle switch
14. "XTALS" switch
15. " Δ FREQ" control
16. "PHONES" jack

Figure 1-2. Radio Receiver, Front Panel View



1. "BFO INJ" control
2. "METER ADJ RF" control
3. "METER ADJ AF" control
4. Allen wrench, setscrew No. 6
5. Allen wrench, setscrew No. 8
6. Allen wrench, setscrew No. 10
7. Antenna input connector

Figure 1-3. Radio Receiver, Rear View of Chassis action without affecting the frequency setting. The tuning ratio from the tuning control to the main dial is 50 to one and the ratio from the vernier dial to the main dial is six to one.

1-14. The rotary turret places the antenna, first rf, second rf, and first heterodyne oscillator coil assemblies of each frequency band directly adjacent to their respective sections of the precise four gang variable air condenser used for tuning.

1-15. The circuit for single conversion includes two stages of r-f amplification, a mixer, a heterodyne oscillator, four stages of i-f amplification, a detector and an avc rectifier, a noise limiter and a meter rectifier, a beat frequency oscillator, a beat frequency buffer amplifier, an i-f output stage, an a-f amplifier, and an a-f output power stage.

1-16. The circuit for double conversion does not include the initial gate stage of the i-f amplifier, used for single conversion, but includes a second mixer and second heterodyne crystal controlled oscillator. The power supply system includes a full-wave power rectifier and voltage regulator tube, and a full-wave bias rectifier.

1-17. For fixed channel crystal controlled operation, the variable frequency first heterodyne oscillator is replaced by a fixed frequency crystal controlled oscillator. The crystal used is inserted in the frequency control unit which can accomodate from one to six crystals. Front panel crystal switching provides for the selection of the normal high stability continuously variable tuning or any one of the six crystal holders, crystal fitted for specific fixed frequency signal operation. For crystal controlled fixed channel operation, the main dial is set to the signal frequency; the crystal specified for the signal frequency is switch selected, and tuning is accomplished by the delta frequency control of the fixed frequency crystal controlled oscillator. When switching from continuously variable tuning to crystal operation for the same signal frequency, a slight retuning of the tuning control is desirable. The crystals are not supplied with the receiver but are purchased separately to signal frequency specification. On the three frequency bands below 7.4 mc the frequency of the crystal is the sum of the desired signal frequency plus 455 kc and on the three frequency bands above 7.4 mc it is the sum of the desired signal plus 3,955 kc, the allowable crystal frequency tolerance being 0.005 percent of frequency.

1-18. The receiver dual scale meter normally indicates the relative strength of the received signal in decibels from one microvolt when the r-f gain control is full on, and is used for tuning on avc. On depression of the panel meter switch the lower scale of the meter indicates the audio output power level in decibels from six milliwatts standard reference output.

1-19. The avc circuit is effective for mcw operation and for high-speed cw operation due to the increased time constant provided on cw. The beat frequency oscillator provides a high order of frequency stability and is relatively free from oscillator harmonics. Oscillator lock-in is eliminated through use of a beat frequency buffer amplifier. This feature makes it possible to tune signals sharply to zero beat. The beat oscillator buffer has an injection level adjustment control in its cathode circuit.

1-20. The receiver has switch means to provide a choice of any one of six degrees of selectivity, the three sharper band widths being realized through use of a crystal filter in the i-f section of the receiver. Further, the crystal filter has phasing provision to highly attenuate heterodyne interference when the unwanted signal is closely adjacent to the desired signal tuned in. In the instance of noise of the pulse type, such as that due to ignition systems, receiver circuitry is provided to by-pass the noise from the re-

Table 1-1. Tube Complement

JAN Type	Quant	Function	Reference Symbol
6BA6	7	Amplifiers; r-f, i-f, bfo buffer.	V1, V2, V7, V9, V10, V11, V12
6C4	3	Oscillators; var freq, 3.5 mc, bfo.	V4, V8, V13
6AC7	1	Oscillator; freq control.	V3
6BE6	2	Mixers; 1st, 2nd.	V5, V6
6AL5	3	Detector & avc, limiter & meter, bias rect.	V14, V15, V20
12AU7	1	Cathode follower & 1st audio.	V16A, V16B
6V6GT	1	Audio power output.	V17
5R4GY	1	Rectifier.	V19
OA2	1	Voltage regulator.	V18

Table 1-2. Fuse Complement

Bussman Part No.	Quant	Ampere Rating	Type	Reference Symbol
GJV-3/8	1	3/8	Pigtail lead	F2
AGC3	2	3	Cartridge	F1

ceiver audio output. One of the two receiver gain controls provides for adjusting the receiver sensitivity and the other provides for adjusting the receiver audio output level.

1-21. PERTINENT DATA.

1-22. TUBE COMPLEMENT. The 20 electron tube complement of the receiver is shown in table 1-1. The table identifies each tube by JAN type designation, circuit reference symbol and circuit function.

1-23. FUSE COMPLEMENT. The fuse complement of the receiver (See table 1-2.), comprises two fuses and a three ampere spare fuse. Each fuse is glass enclosed, instantaneous, indicating and commercially available. The table identifies each fuse by Bussman Mfg. Co. part number, ampere rating, circuit reference symbol and type.

1-24. FREQUENCY RANGE AND STABILITY. The six frequency bands provide the receiver with continuously variable tuning over the 0.54 to 54.0 mc frequency range. Also, fixed frequency crystal controlled operations may be carried on at any specific signal frequency within this tuning range. Subsequent to a 15 minute warm up period, the frequency drift of the receiver ranges from 0.001 to 0.01 percent of frequency, increasing with and depending on the signal frequency tuned in.

1-25. OUTPUT CHARACTERISTICS. The maximum undistorted power output of the receiver is two watts. The receiver audio output terminals, phones jack, and i-f output connector are respectively designed for 600-ohm, 8,000-ohm, and 70-ohm resistive matching loads. For an arbitrary level of 500 milliwatts of audio output there obtains 15 milliwatts of phone jack output; and with two microvolts receiver signal input the i-f output is a minimum of 200 millivolts.

1-26. TUNING BAND RANGES. The frequency tuning range of each of the six bands of the receiver are shown in table 1-3. The innermost scale of the main tuning dial is that for the lowest frequency range. The band numeral assigned each band is an arbitrary designation.

1-27. SENSITIVITY. The sensitivity of the receiver over the entire tuning range is two microvolts or better, for a signal-plus-noise to noise ratio of 10 to one at the audio output terminals.

1-28. SELECTIVITY. The selectivity curves for the six positions of the selectivity switch are shown in figure 1-4. The graph plot for each curve shows the kc off resonance, above and below the nominal two megacycles signal frequency for multiples of the resonance input, at which the receiver audio output level is equal to that chosen at resonance.

1-29. FIDELITY. The graph plots (See figure 1-5.), show the overall and the audio output attenuation versus frequency characteristics of the receiver.

1-30. REJECTION RATIOS. The 455 kc i-f rejection ratio of the receiver is 69 db at 600 kc dial setting and improves with increasing frequency over the three lower frequency bands, namely bands 1, 2, and 3. The 3,955 kc i-f rejection ratio of the receiver is a minimum of 94 db for any receiver main dial frequency setting within the receiver range over the three higher frequency bands, namely bands 4, 5, and 6. The image rejection ratio, at the high frequency end of each band, expressed as a voltage ratio and in decibels, is shown in table 1-4.

1-31. AUTOMATIC VOLUME CONTROL. The avc action maintains the receiver output constant within 14 db when the input is increased from two to 200,000 microvolts.

1-32. LINE SUPPLY REQUIREMENTS. The single phase, 50-to 60-cycle, a-c source used to provide input power to the receiver is connected to the 95, 105, 117, 130, 190, 210, 234, or 260 volt power transformer primary tap which most closely agrees with the available a-c line voltage. The receiver a-c line power consumption is 130 watts at 117 volts, 2.5 amperes, ac. The maximum starting current is two amperes.

Table 1-3. Tuning Band Ranges

Band No.	Frequency Range
1	0.54 to 1.35 mc
2	1.35 to 3.45 mc
3	3.45 to 7.40 mc
4	7.40 to 14.80 mc
5	14.80 to 29.70 mc
6	29.70 to 54.00 mc

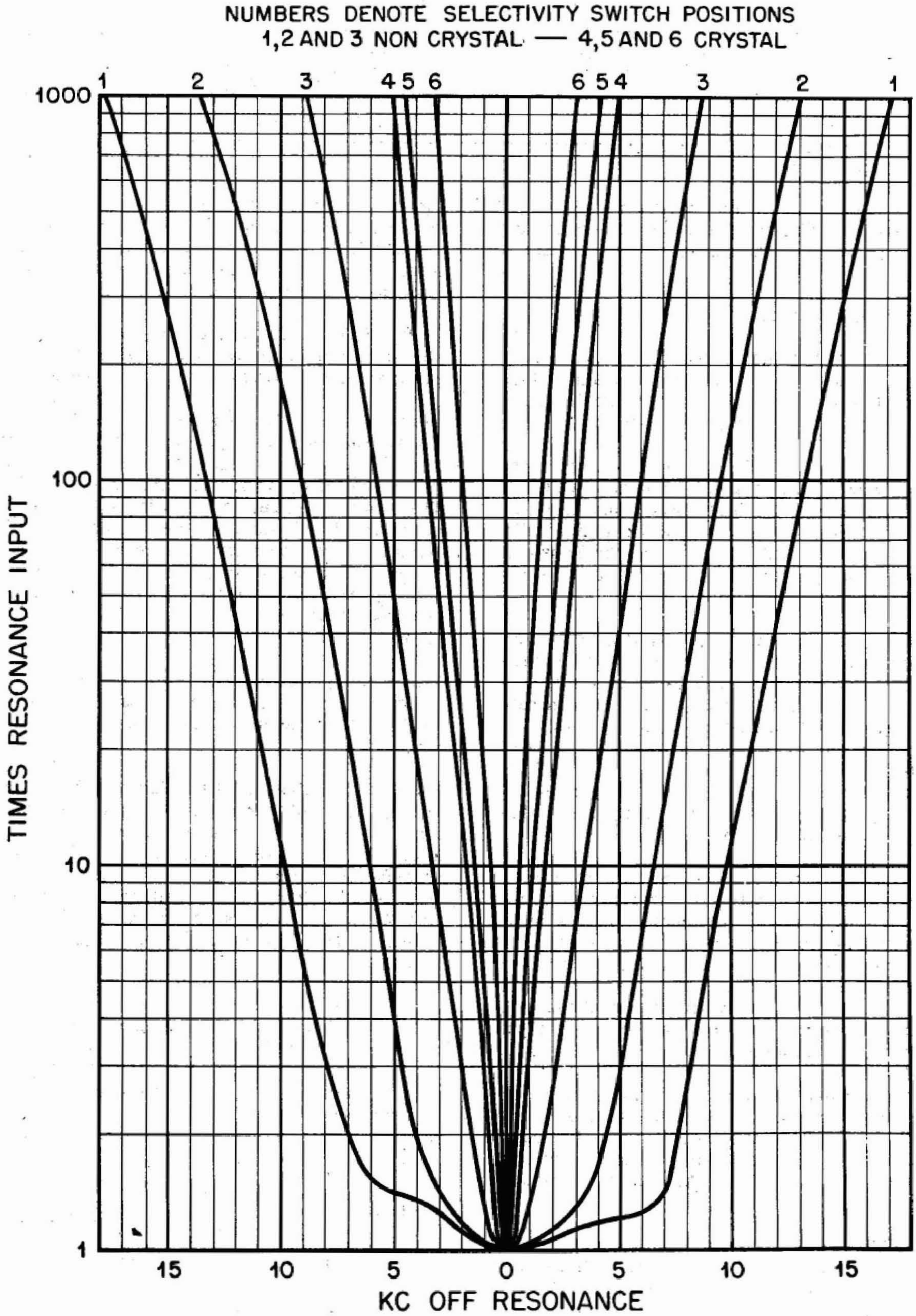


Figure 1-4. Overall Selectivity Curves at Two Megacycles

Table 1-4. Image Rejection Ratios

Band No.	Frequency	Image Rejection Ratio	
		Voltage Ratio	DB
1	1.35 mc	60,000	95
2	3.40 mc	10,000	80
3	7.40 mc	4,000	72
4	14.50 mc	300,000	109
5	29.50 mc	50,000	94
6	54.00 mc	5,000	74

1-33. TEMPERATURE AND HUMIDITY. The permissable ambient temperature of the receiver may range from 0°C (32°F) to 60°C (140°F), at a relative humidity as high as 95 percent.

1-34. OPERATING AND ADJUSTMENT CONTROLS.

1-35. The receiver operating and adjustment controls are respectively located on the front panel (See figure 1-2.), and on the rear apron (See figure 1-3.). The controls are referred to below by their front panel and rear apron designations.

1-36. "SEND" "REC". The "SEND" "REC" toggle switch (See 1, figure 1-2.), is used to switch the receiver from its receive condition to a "desensitized" condition in the presence of a strong local carrier.

1-37. "MOD" "CW". The "MOD" "CW" toggle switch (See 2, figure 1-2.), is used to switch in the bfo and to increase the avc time constant when "CW" is the mode of operation of the receiver.

1-38. "BAND CHANGE". The "BAND CHANGE" control (See 3, figure 1-2.), provides for choosing and indenting the frequency band of the receiver for the signal frequency to be tuned in.

1-39. "TUNING". The "TUNING" control (See 4, figure 1-2.), is used to tune in the signal to resonance.

1-40. "TUNING LOCK". The "TUNING LOCK" (See 5, figure 1-2.), locks the tuning mechanism at the tuning setting chosen.

1-41. "SELECTIVITY". The "SELECTIVITY" switch (See 6, figure 1-2.), provides choice as to three crystal and three non-crystal positions of receiver selectivity. The sharp crystal positions provide six db

SOLID CURVE is the fidelity of the audio frequency amplifier with input to phonograph terminals, and r-f gain control at min.

DOTTED CURVE is the overall fidelity at 2.5 mc; AM of 30 percent, selectivity switch in 13 kc position, and r-f gain control set for 10 mw reference level output.

In each instance, the output is measured across a 600-ohm resistive load and audio gain control set at max.

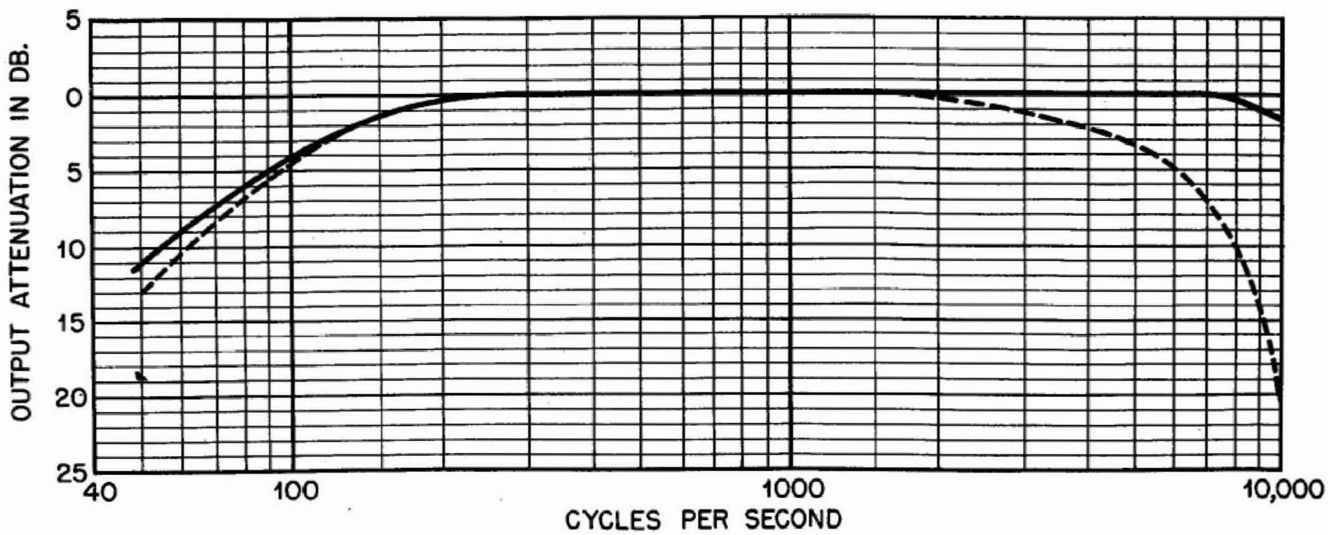


Figure 1-5. Audio and Overall Fidelity Curves

bandwidths of 0.2, 0.5, and 1.3 kc, and the broad non-crystal positions provide six db bandwidths of 3.0, 8.0, and 13.0 kc.

1-42. "XTAL PHASING". The "XTAL PHASING" control (See 7, figure 1-2.), functions to phase out and highly attenuate heterodyne interference closely adjacent to the signal when (6) is in sharp positions.

1-43. "BEAT OSC". The "BEAT OSC" control (See 8, figure 1-2.), is used to provide beat frequency audio output for cw operation. The tone pitch chosen by turning the "BEAT OSC" control in either direction may be at any frequency within the zero to three kc range provided. With the "BEAT OSC" control in its "O" knob dial position, the bfo provides for carrier reinsertion for single or double sideband mcw transmissions.

1-44. "RF GAIN". The "RF GAIN" control (See 9, figure 1-2.), is used to switch the receiver "on" when turned clockwise from its "OFF" knob dial position. The further clockwise turning of the control knob increases the r-f and i-f gain of the receiver. To prevent overloading of the r-f and i-f sections of the receiver, when not on avc the control knob is turned down somewhat. It is only turned down when operating on avc in order to adjust the sensitivity of the receiver so that undesirable noise output may be reduced during "off" and fading periods in the transmission of the received signal.

1-45. "AVC" "MAN". The "AVC" "MAN" toggle switch (See 10, figure 1-2.), is used to switch from avc to manual control of the receiver r-f and i-f gain, determined by the setting of the "RF GAIN" control (See 9, figure 1-2.). The "RF GAIN" control is operative in either position of the "AVC" "MAN" switch.

1-46. "METER" "RF" "AF". The "METER" "RF" "AF" spring return toggle switch (See 11, figure 1-2.), is associated with the dual scale meter. In the normal "RF" position, with the "RF GAIN" control (9) full on, the switch provides for an rf meter indication. When the switch is held in the depressed "AF" position it provides for an af meter indication.

CAUTION

To avoid meter damage, reduce audio level to zero, depress meter switch and then increase audio to the desired level.

1-47. "AUDIO GAIN". The "AUDIO GAIN" control (See 12, figure 1-2.), is used to adjust the audio output of the receiver to a level providing for comfortable intelligible reception.

1-48. "LIMITER" "OFF". The "LIMITER" "OFF" toggle switch (See 13, figure 1-2.), in the "LIMITER" position, provides receiver circuitry to by-pass pulse type noise, such as that due to ignition systems, from the receiver audio output.

1-49. "XTALS". The "XTALS" switch (See 14, figure 1-2.), is provided with switch positions designated "VFO", "1", "2", "3", "4", "5" and "6". The "VFO" switch position provides for variable frequency tuning and each of the "1", "2", "3", "4", "5", and "6" switch positions provide for fixed frequency crystal controlled operation at the signal frequency of the crystal contained in the holder associated with each switch position.

1-50. "Δ FREQ". The "Δ FREQ" control (See 15, figure 1-2.), is used in fixed frequency crystal controlled operations to accurately tune in the signal, the control providing for a slight operating adjustment in the crystal frequency. The "HI", "3", "2", "1", "0", "1", "2", "3", and "LOW" panel markings designate an arbitrary frequency scale for the control setting, a more clockwise setting of the control indicating a relatively lower crystal operating frequency.

1-51. "BFO INJ". The "BFO INJ" control (See 1, figure 1-3.), provides adjustment for the bfo injection voltage from the bfo buffer to the detector.

1-52. "METER ADJ RF". The "METER ADJ RF" control (See 2, figure 1-3.), provides for calibrating the r-f scale of the dual scale meter. With a 10 microvolt input signal and the "RF GAIN" control (See 9, figure 1-2.), full on, the "METER ADJ RF" control is set to provide an r-f meter scale reading of +20 db.

1-53. "METER ADJ AF". The "METER ADJ AF" control (See 3, figure 1-3.), provides for calibrating the a-f scale of the dual scale meter. With a 600-ohm resistive load connected to the audio output terminals and 1.9 volts or six milliwatts of audio output, the "METER ADJ AF" control is set to provide a zero db a-f meter scale reading.

SECTION II

TEST EQUIPMENT AND SPECIAL TOOLS

2-1. TEST EQUIPMENT.

2-2. No special test equipment is required to align, final test or service the radio receiver.

2-3. SPECIAL TOOLS.

2-4. The special tools procured for the maintenance of the radio receiver are listed in table 2-1. The receiver is provided with two Fahnstock type clips to hold the three Allen wrenches.

2-5. CABLE FABRICATION.

2-6. ANTENNA CABLE. The antenna fabricated cable (See figure 2-2.), is used to provide signal generator access to the antenna input coupling of the receiver. It comprises the parts, identified by Hammarlund part number, shown in figure 2-2.

2-7. CATHODE FOLLOWER CABLE. The cathode follower fabricated cable (See figure 2-3.), is used to provide for loading the i-f output connector and to provide means for connecting an output meter. It comprises the parts, identified by Hammarlund part number, shown in figure 2-3.

Table 2-1. Special Tools Required for Overhaul

Figure & Index No.	Hammarlund Part No.	Name	Application
1-3,4	111806-2	Wrench, Allen	Set Screw, No. 6
1-3,5	111806-3	Wrench, Allen	Set Screw, No. 8
1-3,6	111806-4	Wrench, Allen	Set Screw, No. 10
2-1	T8222	Pliers, Special	Spring, flat: for r-f tuners

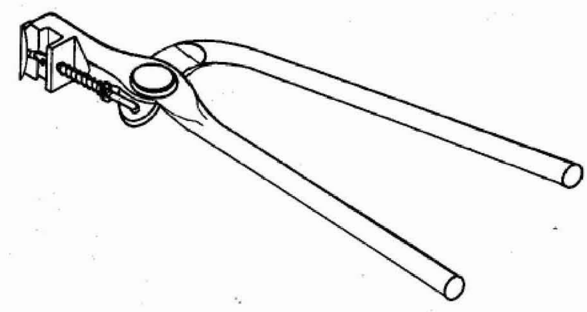


Figure 2-1. Special Pliers

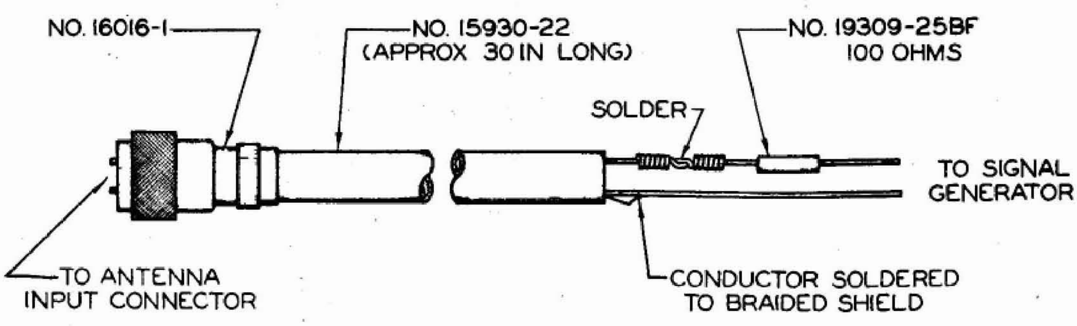


Figure 2-2. Antenna Cable

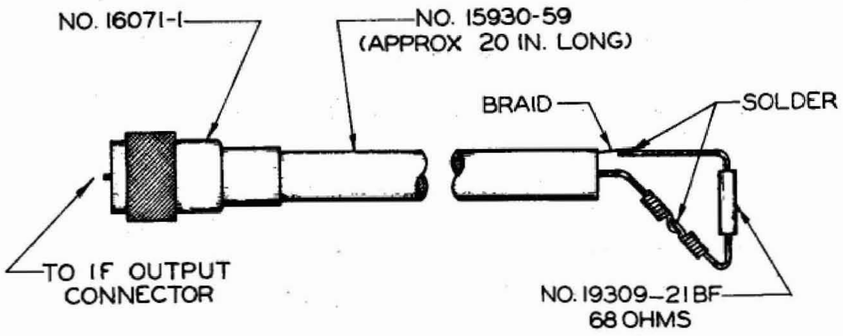


Figure 2-3. Cathode Follower Cable

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. PREPARATION FOR USE.

3-2. UNCRATING.

a. Remove the two steel band straps from the wood case.
b. Remove the cover nailed to the case.
c. Remove excelsior from around cartoned receiver.
d. Remove cartoned receiver from case.
e. Remove waterproof tape from folds in waterproof paper wrapped around cartoned receiver, and then remove the waterproof paper wrapper.
f. Open the carton and remove the inner carton containing the receiver.
g. Remove the vapor proof bag from around the inner carton.
h. Unflatten the corners of the inner carton and open it, removing the silica gel.
i. Remove wood frame from inner carton; also corrugated interiors comprising two side pieces, one front, one back, and one top.
j. Remove the receiver.
k. Put all packing materials in the wood case and store, but first unpack the cartoned spares.

Table 3-1. Power Transformer Tap Voltage Ratings

Tap No.	Voltage Rating
2	95
3	105
4	117
5	130
6	190
7	210
8	234
9	260

3-3. SETTING UP RECEIVER. When shipped, the radio receiver power transformer primary tap is connected to operate from a 50-to 60-cycle, 115 volt a-c source. The tap used is designed for a 117 volt a-c rating in accordance with standard practice. Table 3-1 shows the a-c source voltage rating of each primary tap, each of which is identified by the numerical designation assigned it on the bottom of the power transformer.

CAUTION

Choose the power transformer primary tap whose voltage rating is closest in agreement with the a-c source voltage.

3-4. STORAGE.

3-5. When the radio receiver is to be stored, subsequent to use, remove the separately ordered crystals contained in the frequency control unit crystal holders. Fully mesh the four gang variable air condenser and then pack the receiver as outlined below (Refer to paragraph 3-6.).

3-6. PACKING.

a. Open the folded receiver carton and tape all edges with two inch gummed kraft paper.
b. Accordion fold a corrugated cardboard bottom for the carton so that two ends of the corrugated cardboard bottom enable it to act as a spring board bottom.
c. Put the receiver in the carton and cover the receiver panel with wrapping paper.

d. Put into the carton, corrugated interiors comprising two side pieces, one front, one back, and one top; also one wood frame carton spacer.
e. Put into the carton one new bag of silica gel and tape up the receiver carton.
f. Flatten the carton corners and seal in a vapor proof bag.
g. Open the folded receiver outer carton and tape all edges with two inch gummed kraft paper.
h. Place the cartoned receiver in the outer carton and tape all sides with two inch gummed kraft paper.
i. Wrap outer carton in waterproof paper and seal all folds with waterproof tape.
j. Put excelsior in bottom of wooden case and place waterproofed receiver into case; also cartoned spares.
k. Fill case with excelsior to prevent receiver from moving around in the case.
l. Nail cover on wood case.
m. Put two steel band straps on case.
n. Stencil all markings on end of case.
o. Put address label on side of case.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL SYSTEM OPERATION.

4-2. The radio receiver is used to provide for reception at each station in two-way single or multi-receiver military operational activities. When the signal available to the receiving equipment is a space diversity signal two or more receivers are used, each fitted with its own doublet antenna in proper space relation to all others.

4-3. The system receiver components provide for the reception of amplitude-modulated, keyed, or frequency-shift carrier signals. The signal intelligence is derived from station components associated with the receiving equipment. In every instance a headset may be plugged in the phone jack contained on the front panel of the receiver to monitor the signal. In diversity receiving systems the headset is plugged in one of the phone jacks on the diversity panel to monitor the diversity system composite output. The diversity system composite output is the signal intelligence provided by the diversity equipment from the i-f output of the receiver whose signal level at any instant exceeds that from any other receiver by a pre-determined db difference. When, due to fading, the receiver i-f output falls off, another receiver whose i-f output level is higher by the required db difference takes over. The diversity panel, equipped with a loud speaker, has associated with it frequency-shift receiver converter equipment and/or a teleprinter or a tape recorder, as needed.

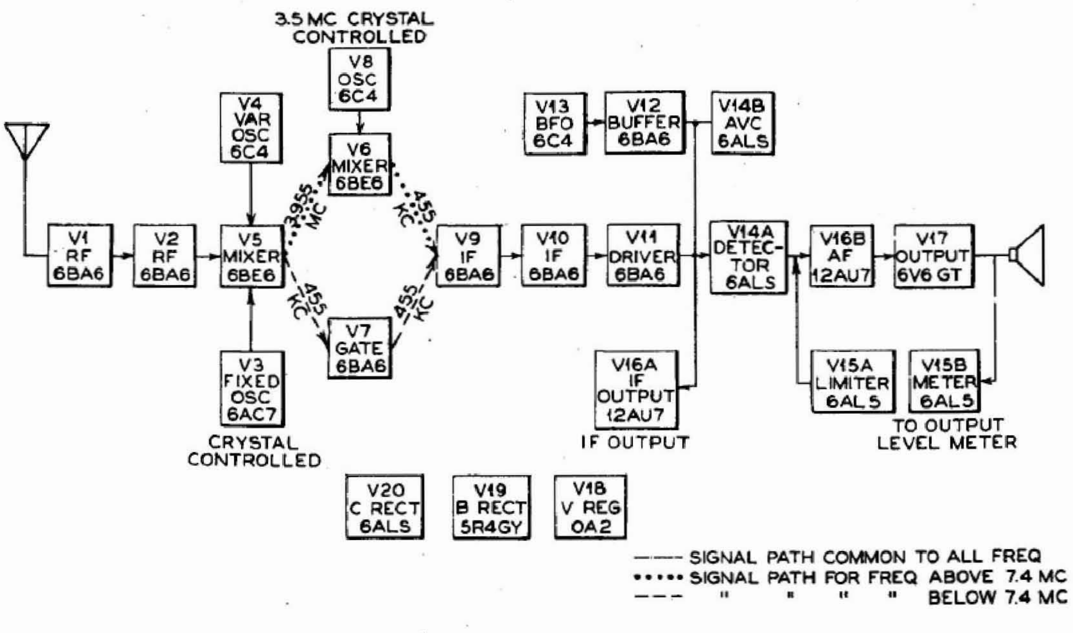


Figure 4-1. Radio Receiver, Block Diagram

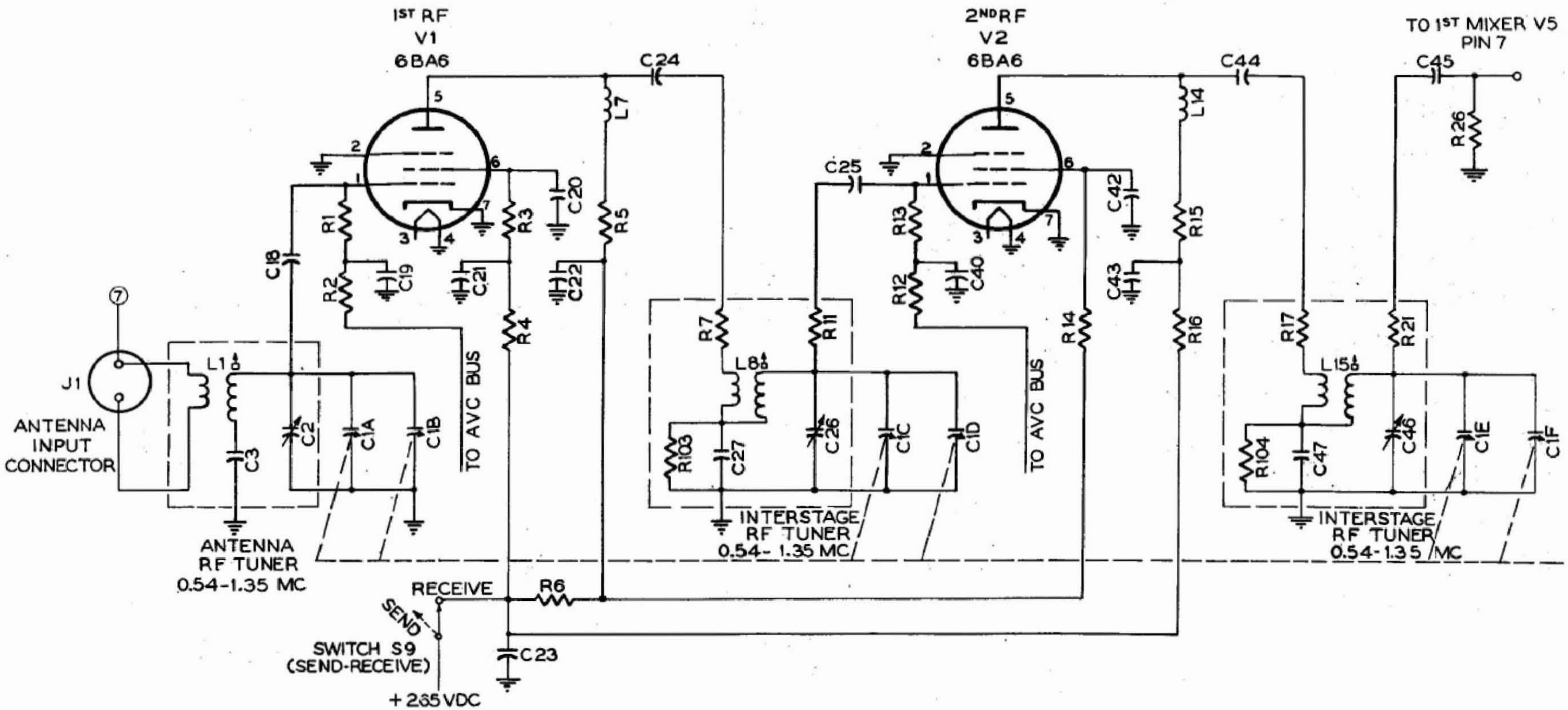


Figure 4-2. Antenna Input and Radio Frequency Amplifier Schematic Diagram

4-4. RECEIVER FUNCTIONAL OPERATION.

4-5. BLOCK DIAGRAM OUTLINE. Figure 4-1 shows the inter-relationships existent between the internal circuits of the receiver in block diagram form. Each block represents an electron tube, or each section of a dual tube, as applicable. The receiver is tuned to the desired signal impressed on the antenna by a four gang tuning condenser associated with the receiver signal selecting and first heterodyne oscillator circuitry. The path taken by the desired signal through the receiver may be traced by referring to the block diagram.

4-6. The signal carrier tuned in is selected, amplified, and provided with a high signal-to-noise ratio in the r-f amplifier consisting of V1 and V2. The output from the r-f amplifier and from V3 or V4 are mixed in the first mixer V5. V3 is the crystal controlled, fixed frequency oscillator and V4 is the variable frequency oscillator. V4 is used for continuous variable tuning and V3 is used for fixed frequency crystal controlled operation, the crystal associated with V3 being suited to the desired signal frequency.

4-7. When the signal frequency is below 7.4 megacycles, the V5 mixer output is at 455 kc. For this condition the receiver circuitry is automatically switched for single conversion, by the single-double conversion switch (See S4, figure 4-4.), so that this output, impressed on the V7 gate, provides output to the V9 first i-f amplifier. The V7 gate provides some i-f amplification but its prime function is to render closed the signal path through it for single conversion, as provided for by S4. When the signal frequency is above 7.4 megacycles, the V5 mixer output is at 3,955 kc. For this condition the receiver circuitry is automatically switched for double conversion by S4, so that this output and the V8, 3.5 mc crystal controlled oscillator output are impressed on and mixed in the V6 mixer whose output at 455 kc is coupled to the input of the V9 first i-f amplifier. The circuitry controlled by S4 is such that V7 is now open, while V6 and V8 are operative so that the signal path is that through V6. Thus no matter the signal frequency, the input to V9 is always at the 455 kc if. V9, V10, and V11 comprising the i-f amplifier, provide the signal at 455 kc with the desired selectivity and amplification, the output from the V11 driver also providing the 455 kc i-f signal at a suitable voltage and power level for subsequent use. The output from the V11 driver always follows three paths namely, to the V14A detector, to the V14B avc, and to the V16A i-f output. The V13 bfo is a stable oscillator whose nominal 455 kc i-f frequency of oscillation may be varied a maximum of three kc, plus or minus. When switched into the circuitry, its output is impressed on the V12 buffer whose output in turn feeds to the V14A detector. When the V13 bfo is detuned in either direction from its nominal 455 kc i-f frequency, it acts as a beat frequency oscillator. At its 455 kc i-f frequency it may be used as a local carrier source for suppressed carrier transmissions. When the desired signal at the antenna is mcw, the V13 bfo is not switched in the circuit. When the desired signal at the antenna is keyed cw or mcw suppressed carrier or single side band transmission the V13 bfo is switched in the circuit. The V14B avc provides automatic volume control by developing a negative bias potential proportional to the signal strength which may be applied to the grid circuitry of the r-f and i-f amplifier tubes. The V16A, i-f output, provides the signal at 455 kc as i-f output. This 455 kc output is available no matter the nature of the carrier modulation involved.

4-8. The V14A detector provides the signal intelligence, no matter the nature of the transmission, as audio output, bearing in mind that the prior manipulation of the 455 kc signal resorted to is dependent on the form in which it is received as signal input. The output from the V14A detector follows two paths, namely, to the V16B a-f amplifier, and to the V15A limiter. The V15A limiter provides for optional noise attenuation while the V16B a-f amplifier provides audio voltage output at a high enough level to drive the V17 output stage. The audio power output from the V17 output stage is available from separate secondary output transformer windings, the 600-ohm split winding being suitable for a matching loud speaker or transmission line while the 8000-ohm winding is suited to a headset which may be plugged in the phone jack on the front panel. The 600-ohm secondary winding is connected to the V15B meter diode to provide meter indication of the audio output level in relation to the standard reference output level of six milliwatts. When the meter switch is in its normal or non depressed position to indicate the signal input level in relation to one microvolt, V15B is not used in the circuitry involved. V20 is the bias rectifier, V19 is the d-c supply rectifier, and V18 is the voltage regulator.

4-9. SIMPLIFIED CIRCUIT THEORY. The circuit theory of the receiver is simplified by considering the receiver as comprising functional sections concerned with the form taken by the signal in its path through the receiver. These receiver sections concern the signal in its r-f form, in its i-f form, and in its a-f form, the self-contained power supply being considered separately.

4-10. The r-f section of the receiver is considered as comprising all circuitry such as that of the V1 and V2 r-f amplifiers, as well as the V3 fixed and V4 variable frequency oscillators.

4-11. The i-f section of the receiver is considered as comprising all circuitry such as the V5 mixer, the V6 mixer, the V8, 3.5 mc osc, the V7 gate, the V9 and V10 i-f amplifiers, and the V11 driver. The V16A i-f output, the V13 bfo, the V12 buffer, and the V14B avc comprise auxiliary circuitry.

4-12. The a-f section of the receiver is considered as comprising all circuitry such as the V15A limiter, the V16A a-f amplifier, the V17 output, the V15B meter diode, and the V14A detector.

4-13. The power supply of the receiver includes all circuitry such as the V18 voltage regulator, the V19 B-rectifier, and the V20 C-rectifier.

4-14. RF SECTION. Figure 4-2 is a simplified schematic diagram showing the antenna input transformer and the two stage r-f amplifier. The removable r-f tuner coil assemblies shown are those for the 0.54-

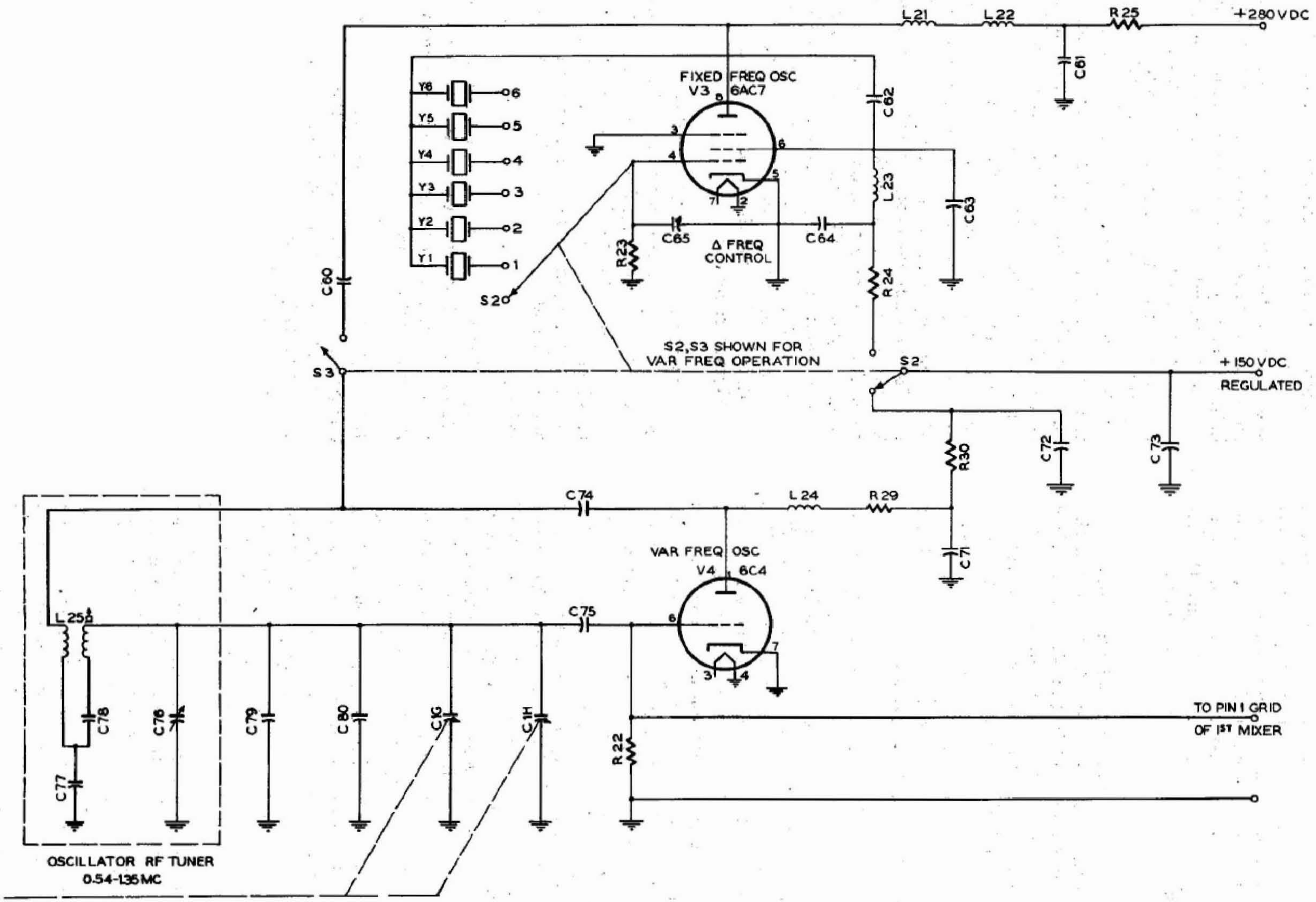


Figure 4-3. Variable and Fixed Heterodyne Frequency Oscillators Schematic Diagram

1.35 mc frequency band.

4-15. The r-f section of the receiver is concerned with maintaining the gain of the r-f amplifier reasonably constant over the frequency range of each band, apart from developing image rejection selectivity and high signal-to-noise ratios. To do this, two identical interstage r-f tuners provide for the required complex coupling on each band. On all bands mutual inductive coupling is provided by the r-f transformer contained in each r-f tuner. On the four lower frequency bands low impedance capacitive coupling is provided by a capacitor common to the primary and secondary circuits of the r-f transformer. On the two higher frequency bands high impedance capacitative coupling is provided by the manner in which the primary and secondary of each r-f transformer are interwound. On all bands a capacitor such as C3, on band 1, is included in the antenna r-f tuner, so that the antenna circuit tracks properly with each stage in the r-f amplifier, on each band.

4-16. The signal at the antenna input terminals develops a voltage across the primary of the L1 antenna transformer. The mutual inductive coupling between the primary and secondary windings of L1 provides for signal voltage across the circuit consisting of the secondary of L1 and C3 in series, and the parallel combination of C1A, C1B, and C2. C1A and C1B comprise the two sections of the first of the four ganged tuning condensers, while C2 is a trimmer condenser. The secondary voltage developed across the parallel combination of C1A, C1B, and C2, is impressed on the pin 1 grid of V1 the first r-f amplifier through means of the coupling capacitor C18. R1 is the grid-leak resistor.

4-17. The signal voltage output of V1, the first r-f amplifier is that developed due to its a-c plate loading comprising the impedance of the effective signal path from the pin 5 plate to ground. The path consists of the blocking capacitor C24, the equalizing resistor R7, the primary and the secondary reflected impedance of L8, and the parallel combination of the low impedance coupling R103 low time constant resistor and C27 capacitor. This effective a-c load impedance combination enables V1 to provide the desired gain for the signal input between its pin 1 grid and ground for the avc and/or adjustable fixed bias r-f gain control setting chosen.

4-18. V1 is supplied with d-c plate and d-c screen voltage from the self-contained B-rectifier + 265 volt supply through S9 the "SEND" "REC" switch (See 1, figure 1-2.). The d-c plate voltage to pin 5 is shunt fed through the blocking choke L7 and the impedance equalizing resistor R5. R6 is a bleeder resistance and with the C23 by-pass capacitor forms a decoupling network. The d-c screen grid voltage to pin 6 is fed through the decoupling resistor R4 and the screen dropping resistor R3. C20 is the screen grid capacitor and C21 the decoupling capacitor.

4-19. The signal output from V1 is compound low impedance coupled to the secondary of L8 through the mutual inductance between the primary and secondary of L8 and the parallel combination of R103 and C27. C1C and C1D in parallel are the second section of the ganged tuning condenser and are further paralleled by the C26 trimmer condenser. The effect of the compound coupling used is to maintain uniform gain over the frequency range, the equalizing resistor R7 acting to equalize the self-resonance of the primary of L8 while the resistor R103 provides a low time constant for C27 to discharge when switching the "SEND" "REC" toggle switch (See 1, figure 1-2.), from "SEND" to "REC". The signal voltage across the parallel combination of C1C, C1D, and C26 to ground is impressed on pin 1 of V2, the second r-f amplifier, through the R11 grid stabilizing resistor and the C25 coupling capacitor, R13 being the grid-leak resistor. The signal output from the pin 5 of V2 is available across the effective a-c plate loading comprising the series combination of the C44 coupling capacitor, the R17 equalizing resistor, the primary and reflected secondary of L15, and the parallel combination of R104 and C47.

4-20. The d-c plate voltage is shunt fed to pin 5 of V2 through the L14 blocking choke, the R16 decoupling resistor, and the R15 impedance equalizing resistor. C43 is the decoupling capacitor. The d-c screen grid voltage is fed to the pin 6 of V2 through the screen dropping resistor R14, C42 being the screen grid capacitor. As for V1, the B-rectifier +265 volt supply provides both the d-c plate and screen voltages.

4-21. C1E and C1F comprise the third section of the gang condenser and C46 is the trimmer condenser. The signal voltage across this combination to ground is impressed on the pin 7 of V7, the first mixer tube through the R21 grid stabilizing resistor and C45 coupling capacitor. R26 is the V7 grid-leak resistor.

4-22. Figure 4-3 is a simplified schematic diagram showing the variable frequency oscillator V4, and the crystal controlled fixed frequency oscillator V3, which oscillate 455 kc higher than the signal frequencies below 7.4 mc, and 3,955 kc higher for signal frequencies above 7.4 mc. The "XTALS" switch (See 14, figure 1-2.), comprising S2 and S3, in its "VFO" position provides the V4 variable freq osc with regulated +150 supply volts from the B-rectifier, disconnects the coupling between the V3, fixed freq osc and the tuned circuit, and isolates the V3 grid connection from the individual crystal holders.

4-23. The V4 variable freq osc is a tuned grid oscillator whose pin 1 plate is shunt fed from the +150 volt regulated B-rectifier supply. R29 is the impedance equalizing resistor, L24 the plate blocking choke, and R30, C71, C72 form a decoupling network, C73 being a by-pass capacitor associated with the S3 switch. C74 is the blocking capacitor, L25 provides mutual inductive feed back between plate and grid, and C78 is the tracking capacitor. C1G and C1H are the fourth section of the tuning condenser, C76 the trimmer condenser, and C79, C80 the oscillator temperature compensating capacitors. C77 tends to maintain the oscillator output constant over the tuning range while C75 is the grid coupling capacitor and R22 the grid leak resistance. The oscillator output is directly coupled from the pin 6 of V4 to the pin 1 of V5 the first mixer.

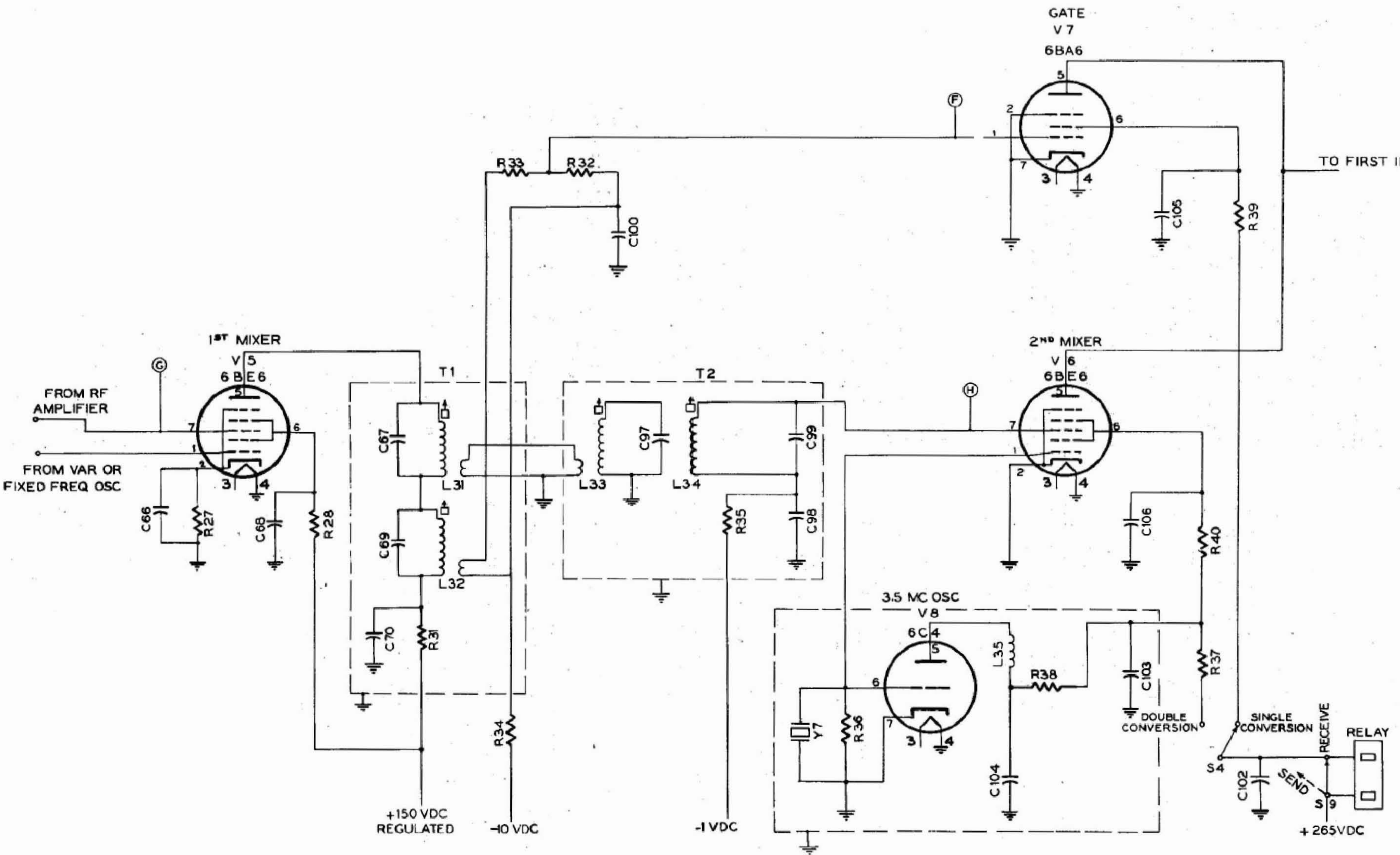


Figure 4-4. Single and Double Converter Schematic Diagram

4-24. The V3 fixed freq osc is a crystal controlled oscillator in which the S2 switch setting chosen may be any one of six crystal positions. The pin 8 plate is shunt fed from the +280 volt supply of the B-rectifier by way of the R25 decoupling resistor and the L21 and L22 blocking chokes. C61 is the decoupling capacitor. The oscillator screen pin 6 is fed from the +150 volt regulated supply of the B-rectifier through S2. R24 is the screen dropping resistor. The V3 fixed freq osc tube elements comprise the pin 4 grid and the pin 6 screen grid, the blocking feed-back capacitor being C62, the feed-back circuit being completed by way of the chosen crystal holder, and crystal, to the pin 4 grid. L23 provides inductive screen grid loading for oscillation, C64 is the by-pass capacitor, and C63 a by-pass capacitor serving as a low impedance path to ground to any very high frequencies generated. R23 is the self biasing resistor.

4-25. The oscillations of V3 are 455 kc or 3,955 kc higher than the signal frequency dependent on whether the signal frequency is respectively less than or greater than 7.4 mc. The frequency tolerance of the separately ordered crystal used is 0.005 percent of frequency, the C65 variable capacitor "Δ FREQ" control (See 15, figure 1-2.) providing for adjusting the crystal frequency of oscillation in the following manner. L23, being an inductance, results in the input impedance of the pin 4 grid of V3 to be a negative resistance paralleled by a capacitive reactance. The C65 "Δ FREQ" control varies the oscillator frequency by providing a variable capacity in shunt with the grid input effect of L23. The negative resistance neutralizes the equivalent resistance of the crystal causing the crystal to go into series oscillation, its exact frequency of oscillation being dependent on the setting of C65. The oscillator output is taken from the pin 8 plate by electron coupling and is impressed on the L25 transformer by the C60 coupling capacitor through the S3 switch. It is then fed from the secondary of L25 through the coupling capacitor C75 to the pin 1 grid of the first mixer V5.

4-26. For the fixed frequency crystal controlled operation of the receiver the gang condenser tuning position chosen is that at which the tuning indication is a maximum, provided in this instance when the gang condenser resonates the tuned circuitry in the r-f amplifier to the signal. For variable frequency operation, the gang condenser tuning position chosen is again that at which the tuning indication is a maximum, but provided in this instance when the setting of the gang condenser results in C1G, C1H to cause the V4 heterodyne frequency oscillations to be higher than the signal frequency by 455 kc or 3,955 kc, as applicable, to signal frequencies respectively below and above 7.4 mc.

4-27. IF SECTION. Figure 4-4 is a simplified schematic diagram showing the single and double converter system of the i-f section of the receiver. The input to the pin 7 of the V5 first mixer is the desired signal and that to pin 1 is from the V4 variable or V3 fixed freq osc. Both the plate and screen supply voltages are taken from the +150 volt regulated supply of the B-rectifier. R28 is the screen dropping resistor and C68 the screen by-pass capacitor. R31 is the plate dropping resistor and C70 the plate by-pass capacitor. L31 and L32 are respectively tuned to 3,955 kc and 455 kc and represent the plate loading for V5. R27 is the cathode resistor and C66 is the cathode by-pass capacitor.

4-28. For signal frequencies below 7.4 mc, applicable to the frequency band being outlined, the V5 first mixer output is at 455 kc so that the desired signal output at 455 kc shows up across the parallel resonant circuit consisting of C69 and the primary of L32; C67 and the primary of L31, being resonant at 3,955 kc, not representing much of a load impedance to 455 kc. The secondary of L32 is connected to the pin 1 grid of the V7 gate through the voltage divider consisting of R32 and R33. The desired signal across R32 is that applied to the pin 1 grid of V7, the by-pass capacitor C100 providing it with a low impedance ground return and the resistor R34 isolating it from the -10 volt C-rectifier supply.

4-29. When the desired signal is above 7.4 megacycles the 3,955 kc output from the V5 first mixer is developed across the primary of L31; C69 and the primary of L32, being resonant at 455 kc, not representing much of a load impedance to 3,955 kc. The L31 secondary output is link coupled to the primary of L33. The secondary of L33 is tuned to 3,955 kc by the C97 capacitor and mutually coupled to L34 likewise tuned to 3,955 kc by the C99 capacitor. The desired signal at 3,955 kc across C99 is then directly coupled to the pin 7 of the V6 second mixer. The R35 resistor isolates the desired signal from the minus one volt C-rectifier supply while the C98 by-pass capacitor provides the signal with a low impedance ground return.

4-30. With the desired signal above 7.4 mc, the single-double conversion switch (See S4, figure 4-4.), is in its double conversion position to provide the V6 second mixer and the V8 3.5 mc osc with the necessary supply voltages to render each operative, the switch at the same time disconnecting the supply voltage to the V7 gate to render it inoperative. The result is that the V8 pin 6, 3.5 mc crystal controlled oscillator output is now available to the pin 1 grid of the V6 second mixer so that the desired signal V6 mixer output is that at the difference frequency, namely 3,955 kc - 3500 kc or 455 kc.

4-31. The V8 3.5 mc oscillator comprises the 3.5 mc Y7 crystal and the R36 grid leak resistor, the tube plate-to-grid capacitance providing the necessary oscillator feed back. The +280 volt supply from the B-rectifier is fed to the V8 plate pin 5 through the S9 "SEND" "REC" toggle switch (See 1, figure 1-2.), and the S4 single-double conversion switch, a choice of signal frequency above 7.4 mc setting the conversion switch to its double conversion position. R38 and C103 form a decoupling network, and R37 and C102 isolate the oscillations from the B-rectifier. L35 is a choke providing inductive plate loading for oscillation, C104 providing for plate by-pass to ground.

4-32. The conversion switch S4 when in the double conversion position provides the V6 second mixer with screen supply voltage, R37 also acting as a screen bleeder resistor. R40 is the screen dropping

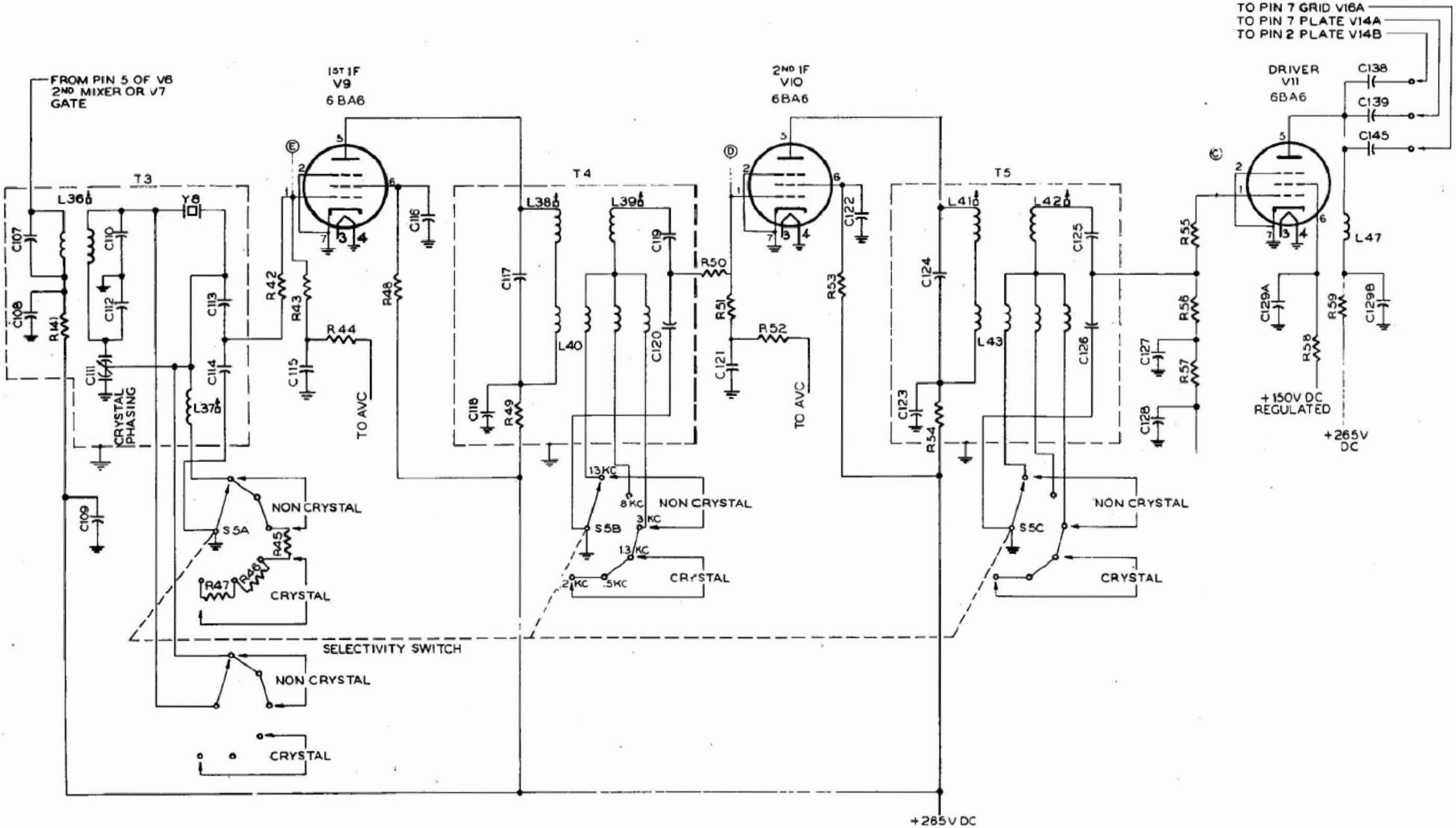


Figure 4-5. 455 kc Intermediate Frequency Amplifier Schematic Diagram

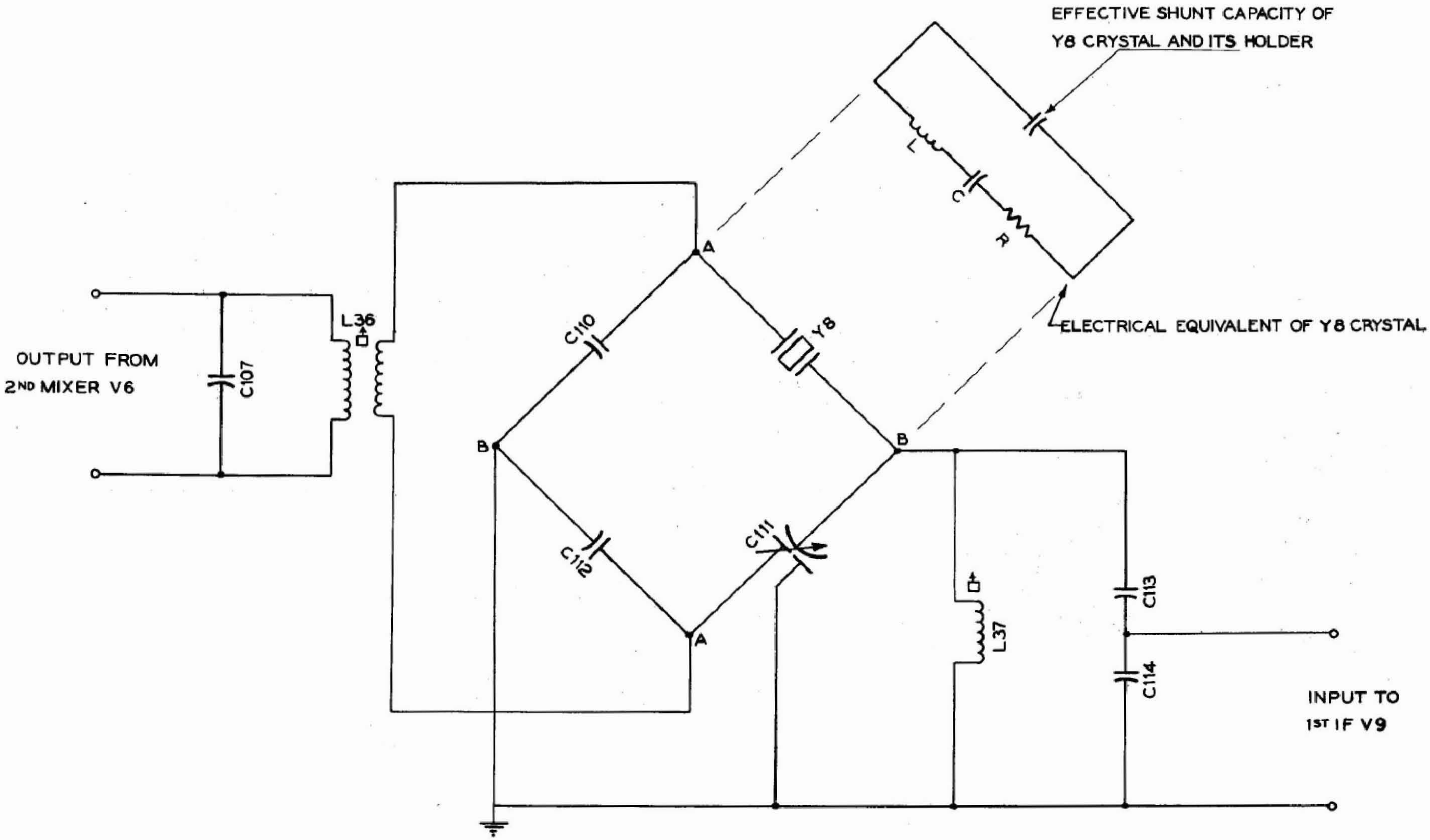


Figure 4-6. 455 kc Crystal Filter Simplified Bridge Network

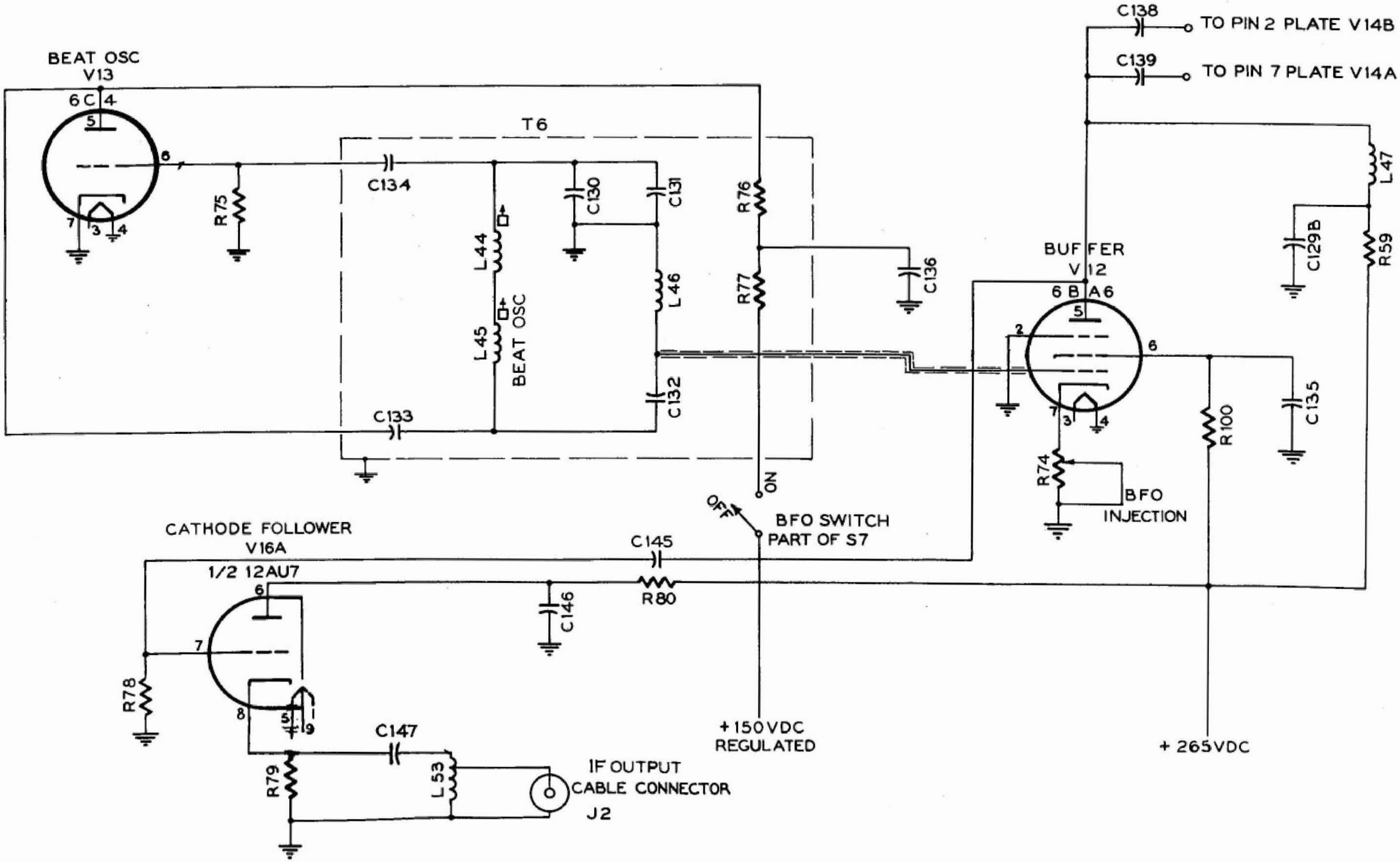


Figure 4-7. Beat Frequency Oscillator, Buffer, and Cathode Follower Schematic Diagram

resistor and C106 the screen by-pass capacitor. When S4 is in its single conversion position it provides for screen supply voltage to the V7 gate, R39 being the screen dropping resistor and C105 the screen by-pass capacitor. The desired signal output obtains from the pin 5 of the V7 gate when below 7.4 mc and from pin 5 of the V6 second mixer when above 7.4 mc. The +280 volt supply from the B-rectifier for the plate pins 5 of V6 and V7 is fed through the primary of the T3 i-f transformer assembly.

4-33. Figure 4-5 is a simplified schematic diagram of the 455 kc i-f amplifier. The i-f amplifier develops most of the amplification of the desired signal at 455 kc and provides almost all of the overall selectivity. The S5, A, B, and C sections of the "SELECTIVITY" switch (See 6, figure 1-2.), provide choice as to six degrees of selectivity, three of which are "NON-CRYSTAL" and three of which are "CRYSTAL" controlled. The three sections of S5, namely A, B, and C, are respectively associated with the input circuits of V9 the first i-f and V10 the second i-f amplifiers, and V11 the driver. S5A comprises two arms one of which shorts out the Y8 455 kc crystal in the three "NON-CRYSTAL" positions. The Y8 455 kc crystal is in the circuit in the three "CRYSTAL" positions.

4-34. The signal voltage at 455 kc is impressed on the primary of L36 which with C107 is parallel resonant to 455 kc. The signal voltage is that from the pin 5 of V6 in the instance of double conversion and that from the pin 5 of V7 in the instance of single conversion. C108, R41, and C109 form a decoupling network, C108 providing a low impedance ground return for the desired signal input to T3. The secondary of L36, being mutually coupled to its primary, provides for the signal voltage to develop across the secondary tuned circuit comprising the secondary of L36, C110, and C112. C110 and C112 are equal in value and their junction is grounded to provide a mid-point connection in the secondary circuit also resonant to 455 kc. Y8, the i-f crystal, is series resonant at 455 kc and its effective holder and shunt capacity is totally neutralized by part of the C111 condenser when its "XTAL PHASING" control (See 7, figure 1-2.) is set to its mid point scale diamond marking. This is so since C110, C112, the holder and crystal shunt capacity of Y8, and part of C111 form the four arms of a balanced bridge network. The input to the bridge is between A-A and the output from the bridge is between B-B, (See figure 4-6.). The bridge output load impedance is L37 paralleled by C113, C114 in series, parallel resonant to 455 kc. R45, or R45 in series with R46 and/or R47 may be connected in series with L37 as provided for by the S5A switch. The part of C111 not part of the bridge arm is always in parallel to C113, C114 in series, the circuit arrangement and capacitance values involved being such that the circuit is always properly aligned to 455 kc even when C111 is moved from its diamond mid scale setting to provide for phasing out undesired heterodyne interference closely adjacent to the desired signal at 455 kc.

4-35. The Y8 crystal is the electrical equivalent of a series tuned circuit, resonant to 455 kc, and consisting of inductance, capacity, and resistance. Due to its holder and shunt capacitances the crystal is also parallel resonant to a frequency slightly higher than 455 kc. When the desired signal at 455 kc is available as input to the bridge, the Y8 crystal goes into series resonance, the low impedance path through it being limited only by the crystal resistance. The desired signal at 455 kc uses this path and becomes available to the bridge load across B-B. This is so even when the bridge is unbalanced since the crystal and holder shunt capacities only affect the parallel resonant frequency of oscillation of the crystal.

4-36. When an undesired signal, closely adjacent in frequency, to the desired signal at 455 kc, also provides input to the bridge across A-A, C111 may be set to provide for parallel crystal resonance at the undesired signal frequency, the crystal parallel resonance providing a high impedance path to the undesired signal to phase it out or highly attenuate it so that it does not show up as output across B-B.

4-37. The Y8 crystal filter circuit becomes more selective the higher the resistance in series with L37. The higher said resistance the lower becomes the figure of merit or Q of the total tuned secondary of the T3 transformer assembly. This decrease in Q results in the series resistive impedance of the parallel resonant circuit in series with the Y8 crystal to decrease thereby resulting in the selectivity of the filter circuit to increase, tending to approach that of the Y8 crystal alone.

4-38. When the "SELECTIVITY" switch (See 6, figure 1-2.), is in any one of the three "NON-XTAL" positions for S5A the Y8 crystal is shorted out but the circuit tuning is not disturbed since the selectivity or band width is wide and no portion of C111 the crystal phasing condenser can appreciately affect it. When S5A is in the broadest "XTAL" position of selectivity, R45 is in series with L37. When S5A is in the next "XTAL" position, R45 and R46 are in series with L37, while for the sharpest "XTAL" position of S5A, R45, R46, and R47 are in series with L37. S5A in its "NON-XTAL" positions has no influence with regard to selectivity. The desired signal is impressed on pin 1 of V9 the first i-f amplifier from the junction of C113 and C114 through the grid stabilizing resistor R42. R43 is the grid leak resistor.

4-39. The plate and screen grid +265 supply voltages for V9 are obtained from the B-rectifier. R48 is the screen dropping resistor and C116 the screen by-pass capacitor. R49 and C118 form a decoupling network.

4-40. The V9 first i-f amplifier is coupled to the V10 second i-f amplifier by the tuned primary and secondary T4 i-f transformer. L38 and L39 are adjustable core tuned while the C117 capacitor provides for primary parallel resonance at 455 kc. The secondary of T4 provides for the three degrees of selectivity when S5B is in the non crystal position. L40 provides for the coefficient of coupling between its primary and each of its three secondaries to be progressively smaller (more physical spacing) so that for the resonant frequency of 455 kc, three progressively narrower bandwidths or degrees of selectivity are provided. The secondaries of L40 are all the same so that L39 can be adjustable core tuned to 455 kc, the

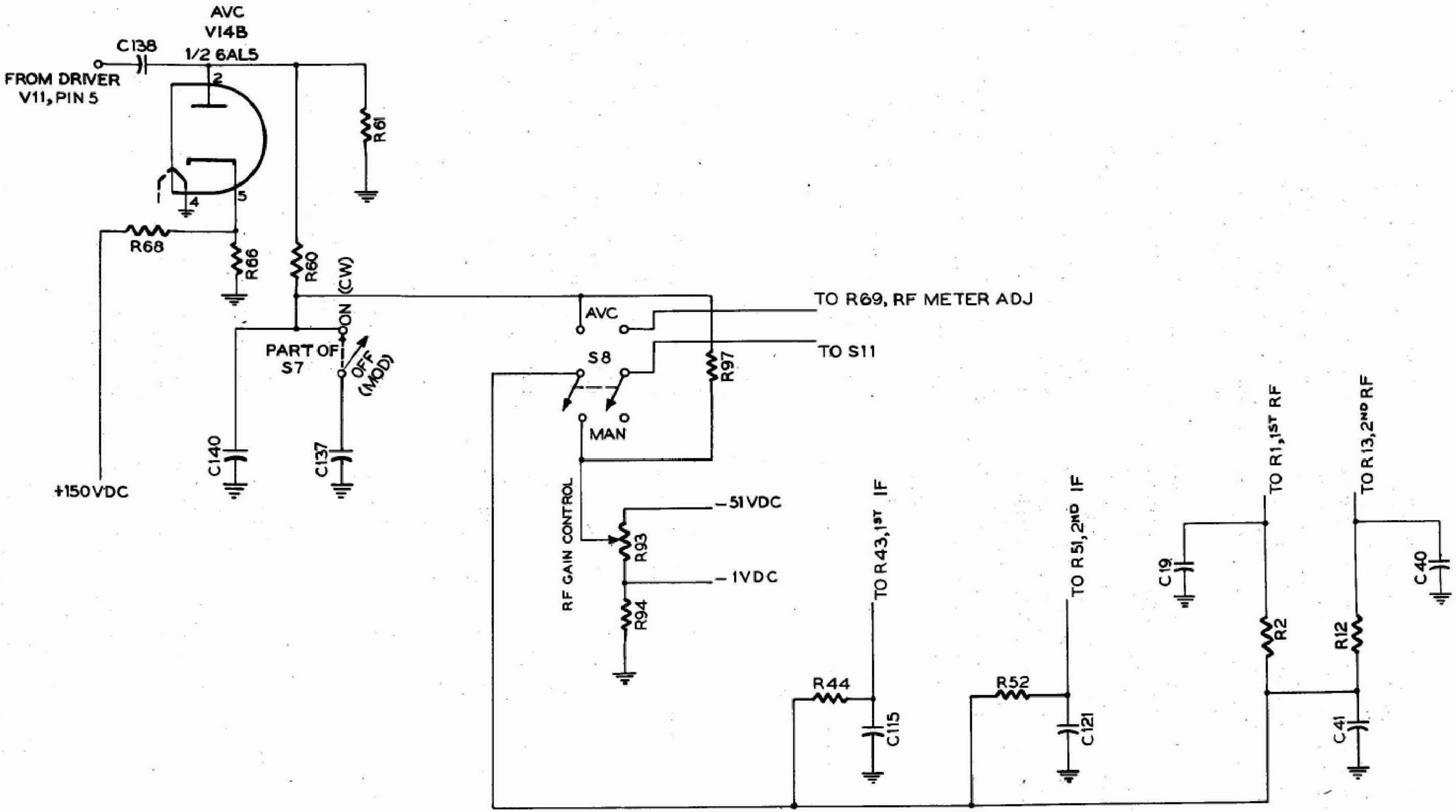


Figure 4-8. Automatic Volume Control System Schematic Diagram

nominal centered frequency for each degree of selectivity. C119 and C120 in series are in parallel resonance with the secondary of T4 for each position of S5B. The desired signal output from the junction of C119 and C120 is fed through the grid stabilizing resistor R50 to pin 1 of V10, the second i-f amplifier. R51 is the grid-leak resistor.

4-41. V10, the second i-f amplifier is supplied with plate and screen +265 supply volts from the B-rectifier. For the screen grid, R53 is the screen dropping resistor and C122 the screen by-pass capacitor. For the plate, R54 is the plate dropping resistor and C123 provides a low impedance ground return to the desired signal. The V10 second i-f amplifier is coupled to the V11 driver by the tuned primary and secondary T5 i-f transformer. L41 and L42 are adjustable core tuned while the C124 capacitor provides for primary parallel resonance at 455 kc. The primary of T5 comprises L41 and the primary of L43 in series. C125 and C126 in series tune the secondary of T5, comprising L42 and any one secondary of L43 in series, each of the three non crystal positions of S5C being associated with one secondary of L43. When "SELECTIVITY" switch (See 6, figure 1-2.), is in the "XTAL" position, S5B and S5C always involve the secondaries of L40 and L43 which provide the narrowest selectivity of the three "NON-XTAL" positions. The desired signal output from the V10 second i-f amplifier is that developed between the common connection of C125 and C126, and ground.

4-42. The output from the V10 second i-f amplifier is fed through the R55 stabilizing resistor to the pin 1 grid of the V11 driver. R56 is the grid-leak resistor and R57, C127 a decoupling network. C128 further decouples or isolates the desired signal from the -10 volt C-rectifier supply to the pin 1 grid of the V11 driver. The screen grid supply voltage to the V11 driver is derived from the +150 volt regulated supply from the B-rectifier. R58 is the screen dropping resistor and C129A the screen by-pass capacitor. The +280 volt supply to the pin 5 plate of V11 is derived from the B-rectifier, L47 is the isolating choke, R59 the plate dropping resistor, and C129B the plate by-pass capacitor. The effective a-c plate loading of V11 comprises all circuitry from the pin 5 plate of V11 connected through C138, C139, and C145 to ground.

4-43. AUXILIARY CIRCUITS. Figure 4-7 is a simplified schematic diagram of the V13 bfo, the V12 buffer, and the V16A i-f output cathode-follower. The V13 bfo employs a high capacity Colpitts circuit which provides a high order of frequency stability and minimizes oscillator harmonics. The S7 "MOD" "CW" switch (See 2, figure 1-2.), in its "CW" position provides +150 volt regulated supply from the B-rectifier to the pin 5 plate of V13. R77 is the plate dropping resistor and R76, C136 a decoupling network. C134 is the grid coupling capacitor and R75 the grid-leak resistance. C133 is the fed back capacitor, C132 acts as a blocking capacitor, and L44 is the adjustable core tuned resonant inductance. L45, the bfo frequency adjusting, adjustable core tuned coil is in series with L44 in the tuned circuit comprising L44, L45 in series with C132, L46, and the parallel combination of C130 and C131. L46 provides input impedance to ground for the pin 1 grid of the V12 buffer. The V13 bfo output is fed from the common connection of C132 and L46 by a shielded lead to the pin 1 grid of the V12 buffer.

4-44. The V12 buffer amplifier eliminates lock-in between the bfo output frequency and the V11 driver 455 kc output so that the desired signal may be sharply tuned to zero beat, apart from providing bfo injection control to suit operating conditions. R74 is the adjustable self-biasing resistor for the V12 buffer. The +265 volt supply for the screen grid of V12 is provided by the B-rectifier, R100 being the screen dropping resistor and C135 the screen by-pass capacitor. The pin 5 plate of the V12 buffer is directly connected to the pin 5 plate of the V11 driver so that the +280 volt supply from the B-rectifier, as for V11, provides it with d-c plate voltage.

4-45. The V11 driver and V12 buffer, desired mixed output, is fed to C138, C139, and C145 in parallel in the instance of cw operations; the bfo, in turn the V12 buffer, provides no output when the S7 "MOD" "CW" switch (See 2, figure 1-2.), is in its "MOD" or "off" position. The V11 driver output is coupled through the C145 capacitor to the pin 7 grid of the V16A cathode follower. R78 is the grid-leak resistance, R79 the self biasing cathode resistor, and C147 a blocking capacitor. L53 is a tapped auto-transformer to provide a 70 ohm impedance match for coaxial cable i-f output.

4-46. The +265 volt supply to the pin 6 plate of V16A is supplied from the B-rectifier through the R80 dropping resistor. C146 is a capacitor used to by-pass the V16A plate to ground.

4-47. Figure 4-8 is a simplified schematic diagram of the automatic volume control circuit. V14B, the avc diode is provided with a delay bias from the +150 volt regulated supply from the B-rectifier. The +150 volt regulated supply is loaded by the resistors R68 and R66 in series, the delay bias being the voltage across R66, making the pin 5 cathode of V14B positive in relation to ground. R61 is the input resistive impedance and the plate loading resistor for V14B, enabling the pin 2 plate of V14B to be negative by the delay bias with respect to pin 5 the cathode of V14B.

4-48. The desired signal at 455 kc is fed across R61 to the pin 2 plate of V14B through the blocking capacitor C138, V14B not conducting until the amplitude of the desired signal in the positive sense exceeds the delay bias. When the desired signal causes V14B to conduct, the resultant voltage drop across R61 is negative to ground. The V14B avc starts to conduct when the signal input to the receiver is two microvolts such that any signal input greater than same results in the pin 2 plate of V14B to be at a negative d-c potential to ground. This negative d-c potential is at an average level proportional to the signal carrier and varies in instantaneous level in accordance with the signal intelligence. The avc bus is directly connected to the plate of V14B, the resistor R60 and the capacitor C140 acting as a filter to smoothe out the intelligence variations in the negative d-c potential applied to the

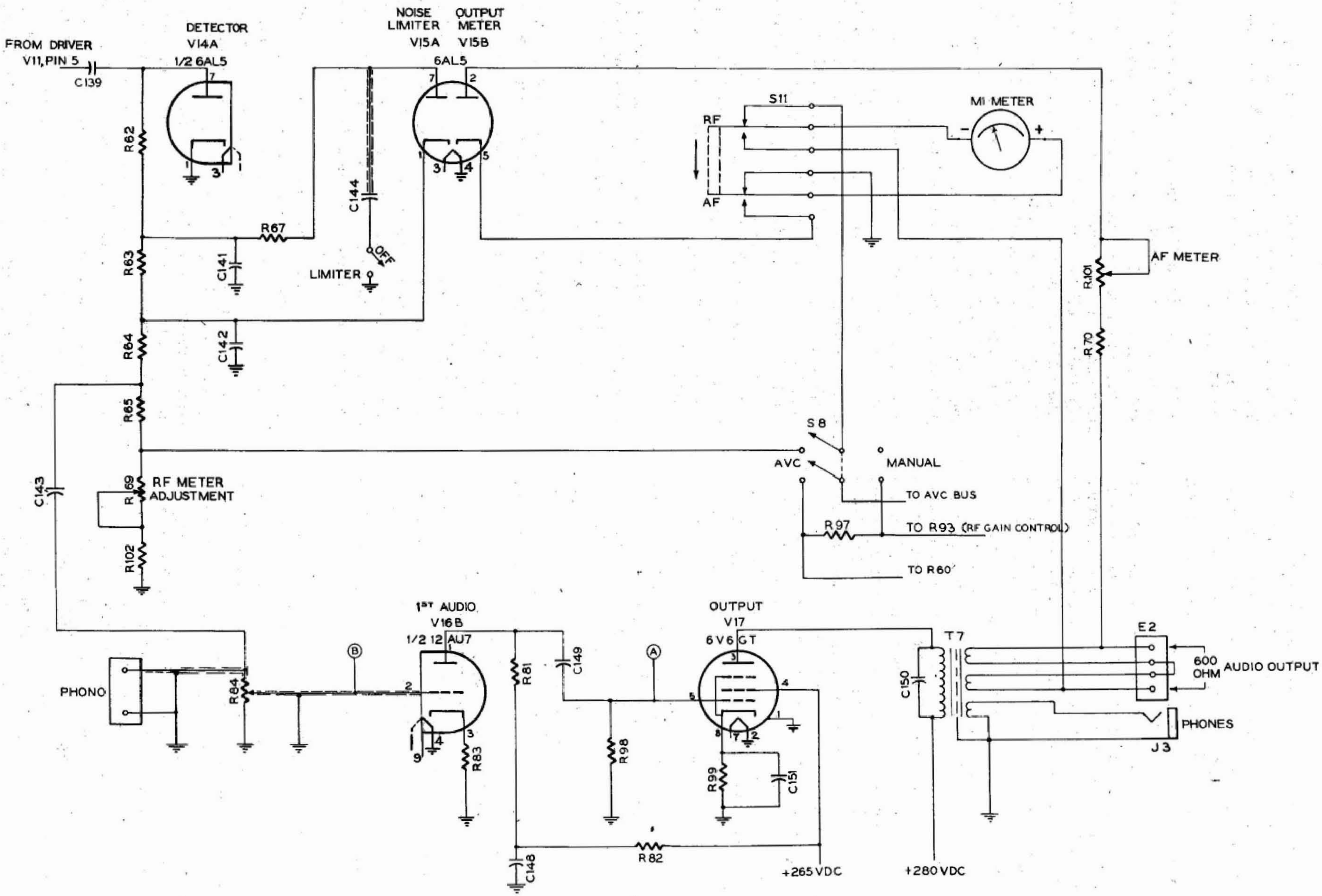


Figure 4-9. Audio Frequency Section Schematic Diagram

avc bus. When the S8 "AVC" "MAN"switch (See 10, figure 1-2.), is in its "AVC" position, the avc bus provides for the negative d-c bias to be applied to the r-f and i-f amplifier stages V1, V2, V9, and V10. V1 is decoupled from the avc bus by R2, C19, and C41, V2 by R12, C40, and C41, V9 by R44 and C115, and V10 by R52 and C121, each of these decoupling networks having some effect on the total avc time constant mostly determined by the values of R60 and C140. When the S7 "MOD" "CW" switch (See 2, figure 1-2.), is in its "CW" position, C137 is added to the network in parallel with C140 so that the avc time constant is increased sufficiently to provide smoothing action to overcome the lower audio rate of intelligence variations of the avc bias in the instance of high-speed telegraph.

4-49. When the S8 "AVC" "MAN" switch (See 10, figure 1-2.), is in its "AVC" position, R60, R97, R93, and R94, all in series act as a voltage divider with regard to the avc d-c bias potential developed across R61 so that the avc d-c bias actually available is that from the junction of R61, R97, to ground. Also, the negative bias determined by the setting of the "RF GAIN" control (See 9, figure 1-2.), is also on the avc bus, so that the gain of the r-f and i-f amplifier stages is initially dependent on the position of the control. For avc R93 is set to maximum, that is to provide a minus one volt bias, but when reception is noisy due to a fading signal, R93 is turned down somewhat to favor the signal in relation to the noise. When S8 is in its "MAN" position, the avc bias available to the r-f and i-f amplifier stages is negligible since the avc bus is now at a low resistance to ground, so that the negative bias effective is only that due to the "RF GAIN" control. R93 in series with R94 is provided with -51 volts d-c supply from the C-rectifier. The minus one volt tap provided by the R94 resistor across this negative bias is to assure that the controlled d-c grid voltage to the r-f and i-f tubes provides the desired receiver performance at maximum gain apart from providing a minus one volt d-c bias to the pin 7 grid of the V6 second mixer.

4-50. The effective negative bias control voltage to the first r-f amplifier is impressed through R1 to the pin 1 grid of V1, that for the second r-f amplifier through R13 to the pin 1 grid of V2, that for the first i-f amplifier through R43 to the pin 1 grid of V9, and that for the second i-f amplifier through R51 to the pin 1 grid of V10.

4-51. AF SECTION. Figure 4-9 is simplified schematic diagram of the detector, audio amplifier, noise limiter, and meter circuit. The desired signal output from the V11 driver is coupled through the C139 blocking capacitor to the pin 7 plate of the V14A detector, whose pin 1 cathode is grounded. The input resistance of V14A is R62, C141 providing a low impedance ground return. The network, comprising the resistors R62, R63, R64, R65, R69, and R102, in series, represents the V14A detector d-c load. The a-c load of V14A comprises the network combination of R62, C141, R63, C142, R64, R65, R69, R84, R102, and C143. When the S6 "LIMITER" "OFF" toggle switch (See 13, figure 1-2.), is in its "LIMITER" position the C144 capacitor in series with R67 shunts C141, representing further a-c loading. The percentage modulation the detector can handle without distortion is dependent on the ratio of said a-c to said d-c loading impedance.

4-52. The V14A detector conducts when its pin 7 plate is positive with respect to its pin 1 cathode or ground due to the desired signal input between said plate and ground. This results in the detector V14A output to provide for the desired signal and a d-c component whose average level is proportional to the signal input to V14A. The d-c component results in ground being positive with respect to the pin 7 plate of V14A. The V15A noise limiter in series with R67 is directly connected across R63 so that the pin 7 plate of V15A is negative with regard to its pin 1 cathode, such that V15A does not conduct. When the switch S6 is in its "LIMITER" position, C144 is charged to the average negative d-c potential to ground existent from the common connections between R62, R63 and ground. The time constant of the R67, C144 combination is such that the d-c voltage level at the junction of R62, R63, follows the variations due to the audio signal, but cannot follow the rapid variations due to the noise. When a burst of noise is impressed on V14A, the result is that the noise bursts when of positive phase to ground, and at an amplitude sufficient to make the plate of V15A positive, cause V15A to conduct, such that C144 provides for a low impedance to ground from the junction of R63, R64, so that the noise is by-passed from the audio section of the receiver. R67 is also included in the circuitry so that when C144 is switch connected to ground, the impedance from the junction of R62, R63 is not too low to ground, as otherwise audio frequencies would be by-passed to ground through C144.

4-53. The audio output of the V14A detector is that available from the junction of R64 and R65, to ground, and is impressed on the blocking capacitor C143 in series with the R84 "AUDIO GAIN" control (See 12, figure 1-2.), C143 blocking out the d-c component output of the detector. The input to R84 may also be that from a record player pickup connected to the phonograph terminals. The movable arm of R84 is directly connected to the pin 2 of the V16B first audio amplifier by a shielded lead whose sheath is grounded.

4-54. The average d-c component current output from the V14A detector is used to determine the amplitude of the desired signal input to the receiver antenna terminals. The fixed percentage of said d-c current, dependent on the setting of the R69 potentiometer, the "METER ADJ RF" control (See 2, figure 1-3.), in series with R102 to ground, is fed through the S8 "AVC" "MAN" switch (See 10, figure 1-2.), to the meter when S8 is in its "AVC" position and S11 the "METER" "RF" "AF" switch (See 11, figure 1-2.), is in its normal "RF" position. By adjusting R69 so that the meter reads +20 db for a 10 microvolt signal input at the antenna, the meter reading in db is always the ratio of the desired signal input level with respect to one microvolt. When S8 is in its "MAN" position the meter circuit is open.

4-55. The +265 volt supply from the B-rectifier is fed to the pin 1 plate of V16B through the R82 dropping

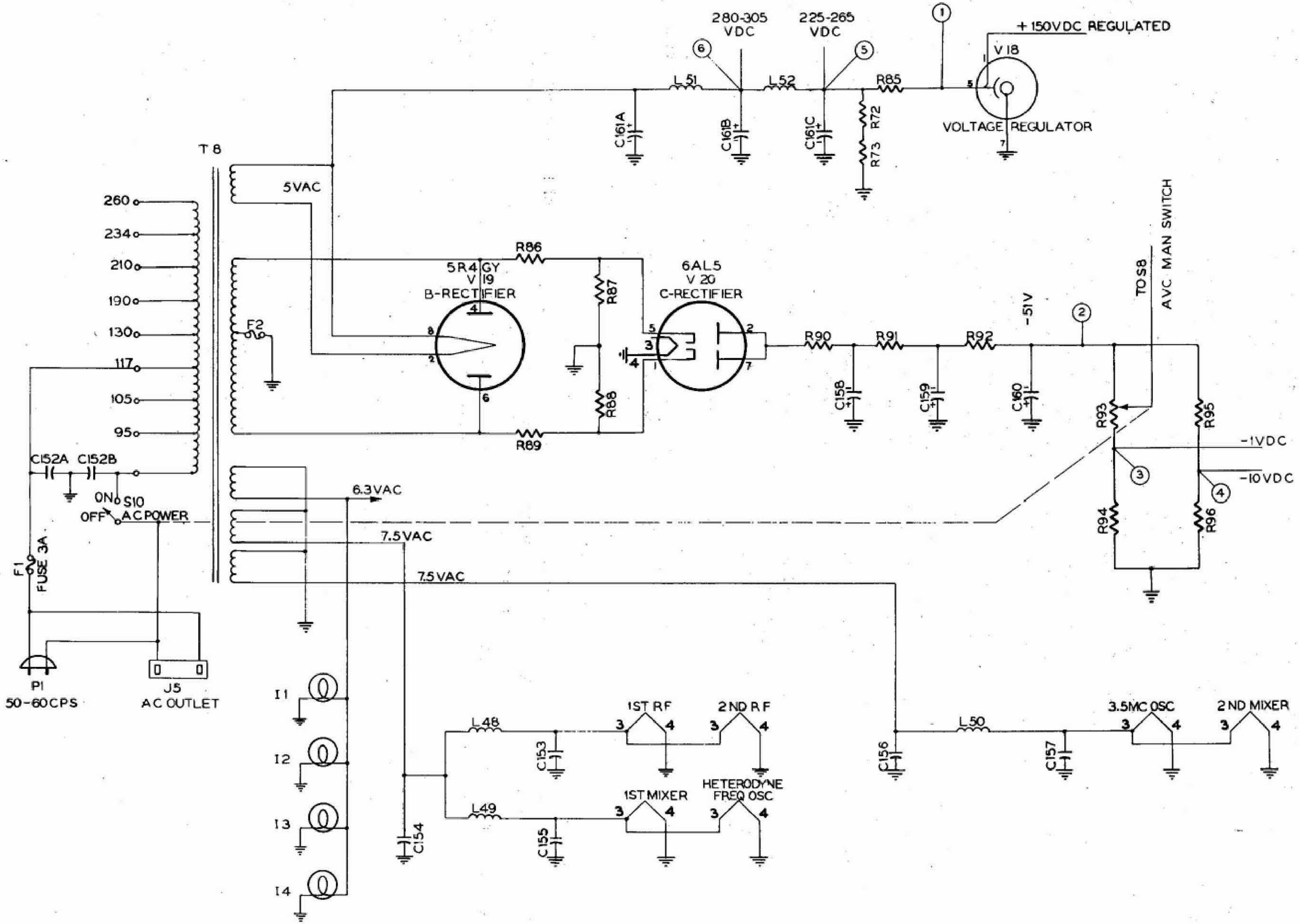


Figure 4-10. Self-contained Stabliized Power Supply Schematic Diagram

resistor. R81 is the plate load resistor, C148 the plate load by-pass capacitor, and R83 the cathode resistor. The desired audio output from V16B, resistance coupled to V17, the output stage, is coupled to the pin 5 grid of V17 through the blocking capacitor C149. R98 is the grid leak resistance.

4-56. The V17 output stage is self biased by the R99 cathode resistance, suitably by-passed by the C151 cathode by-pass capacitor. The + 265 volt supply volts for the screen grid of V17 is derived from the B-rectifier which also provides adequate screen-grid filtering. The + 280 volt supply for the plate of V17 is also derived from the B-rectifier.

4-57. The audio output from the V17 output stage is available from either one or both of the secondary windings of the T7 output transformer. One of these windings is connected to the phone jack and is designed for 8000 ohm headphones, the other of these windings is of the balanced split type connected to the four separate terminals of the audio output terminal board, which when connected series aiding are designed to match a 600 ohm resistive load, which may be a loud speaker. The phones, speaker, or other loading when connected, reflect an impedance to the primary of T7 which is the load impedance of the V17 output stage. The primary of T7 carries the + 280 volt supply to the pin 3 plate of V17. The primary of T7 is shunted by the C150 capacitor to by-pass spurious high frequencies from the audio output. The audio output available across the 600 ohm audio output terminals is impressed between the pin 2 plate and the pin 5 cathode of the V15B meter tube by way of R70 a limiter resistance, in series with R101, the "METER ADJ AF" control (See 3, figure 1-3.), through the S11 "METER" "RF" "AF" switch (See 11, figure 1-2.), when in its "AF" position, and the meter itself. The "METER ADJ AF", R101, is adjusted so that when the audio output across the 600 ohm output is six milliwatts the "AF" meter reading in db is zero, such that the "AF" meter indication of the audio output is that in db with respect to the six milliwatt standard reference output.

4-58. POWER SUPPLY. Figure 4-10 is a simplified schematic diagram of the self-contained stabilized power supply incorporated in the receiver. T8, the power transformer, comprises the tapped primary and five secondary windings. P1, the a-c source plug, is in parallel with the a-c outlet. F1 is the primary three ampere fuse. S10 is the a-c power switch built into the "RF GAIN" control (See 9, figure 1-2.). C152A and C152B by-pass to ground any interference picked up on the a-c power cord.

4-59. The 5 volt secondary winding provides a-c filament power for the V19 full-wave rectifier. The 6.3 volt winding provides a-c power to the I1, I2, I3, and I4 pilot lamps all in parallel, as well as to the V20, C-rectifier, and to all other tubes apart from V1, V2, V4, V5, V6, and V8. One of the two 7.5 volt secondary windings provides a-c filament power to V1, V2, V4, and V5, while the other does the same for V6 and V8. The network comprising L50, the r-f choke, and the by-pass capacitors C156, C157, effectively isolates any radio frequency pick up through T8 from the V6 and V8 filaments. L48 in conjunction with C153 and C154 does likewise for the filaments of V1 and V2, while L49 in conjunction with C154 and C155 takes care of the V4 and V5 filaments. The high voltage secondary winding, providing parallel a-c input common to the B- and C-rectifiers, has its center tap to ground fused by the F2 three-eighths ampere pigtail type fuse.

4-60. The B-rectifier comprises the V19 rectifier, a low pass filter, the R85 dropping resistor and the V18 voltage regulator tube. The low pass filter consists of the L51 and L52 audio chokes and the C161A, C161B, and C161C electrolytic condensers. The high voltage secondary winding a-c input to the V20 full-wave C-rectifier tube is impressed on pins 1 and 5, the cathodes of V20, through the R86 and R89 dropping resistors, R87 and R88 providing for voltage divider balanced loading to ground. The C-rectifier comprises the V20 rectifier, a low pass filter, and the R93, R94, R95, R96 bleeder network. The low pass filter consists of the R90, R91, and R92 dropping resistors and the C158, C159, C160 electrolytic condensers. R93 is the "RF GAIN" control (See 9, figure 1-2.), while R94 in series with it provides for a minus one volt supply voltage. The maximum C-bias voltage available from the "RF GAIN" control is -51 volts. R95 and R96 are in series across the -51 volts, their junction providing a -10 volt supply voltage.

4-61. FUNCTIONAL OPERATION OF MECHANICAL COMPONENTS.

4-62. The mechanical design features incorporated in the receiver chassis (Refer to paragraph 1-12 and 1-13.), enable the receiver to maintain the high performance standards for which it is known. The receiver compact, precise rotor turret assembly is such that the receiver circuit design provides receiver sensitivity at high signal-to-noise ratios. The tuning mechanism involving the anti-backlash gear train, results in maximum benefit to be derived from the crystal filter circuit in the i-f section of the receiver.

4-63. The receiver incorporates a precise four gang variable air tuning condenser in which each of the ganged condensers comprises two separate condenser sections. Each section is matched and maintained to extremely close tolerances, even as between receivers. This tuning condenser unit is mounted at one end by a single machine screw which carries a precise washer for spacing the unit from the gear-train plate used for mounting. Two dowels precisely locate it by machine hole fits for each dowel in the gear-train plate. The other end of the tuning unit is provided with a clearance hole to ride freely on a stud screwed to the turret assembly housing. The ganged rotor plates on the condenser are coupled to the gear-train drive through means of a link plate coupling held in place by a "U" shaped spring.

4-64. The front panel tuning lock when used clamps the vernier dial, thereby rendering the gear-train inmovable, even though the front panel friction drive flywheel loaded tuning knob is free to turn.

4-65. All the coil adjustable cores and variable air trimmer condensers have positive flat spring means to maintain their adjustment settings chosen. The rear apron adjustment controls are of the screw type, thereby providing rigid adjustment means not subject to accidental shift.

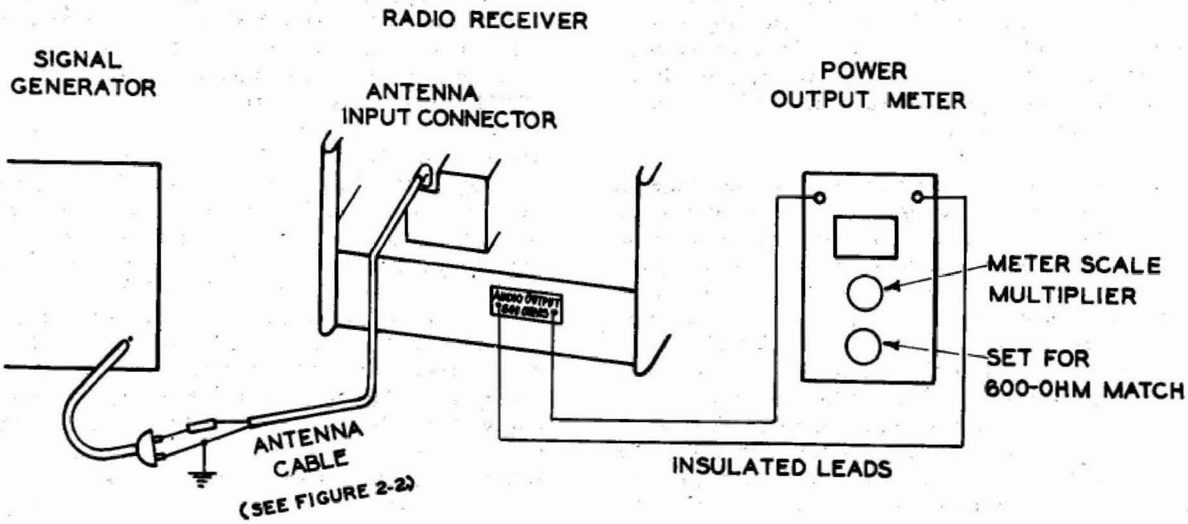


Figure 5-1. Receiver Sensitivity Test Set-up

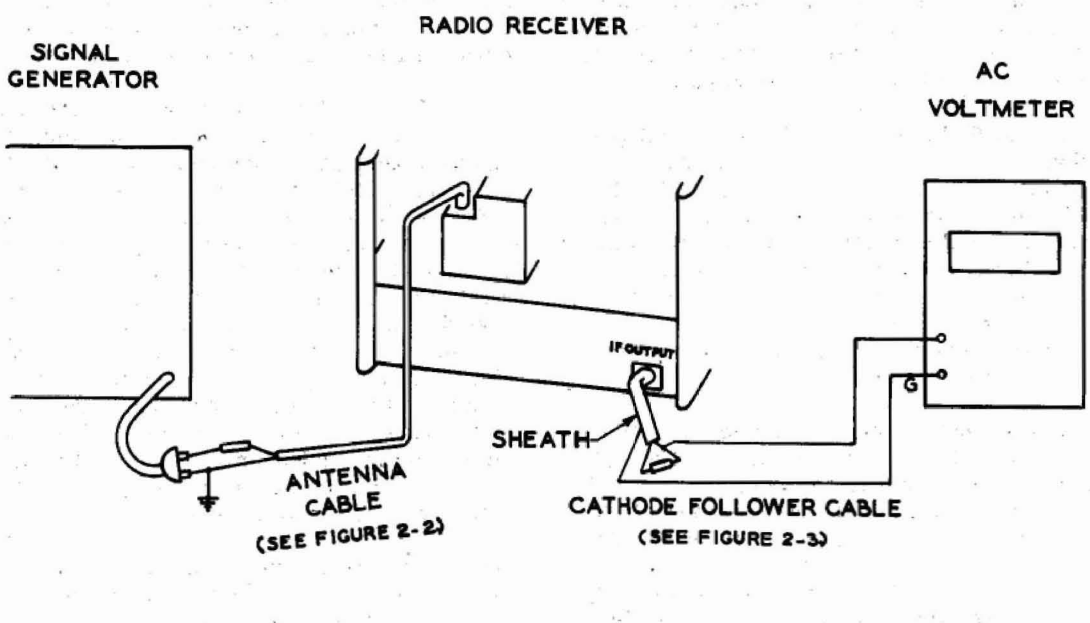


Figure 5-2. Receiver Cathode Follower Test Set-up

SECTION V

OPERATIONAL AND ORGANIZATIONAL MAINTENANCE

5-1. GENERAL.

5-2. The radio receiver is designed to maintain its minimum performance standards for long periods of time. These minimum performance standards are test equipment measurements or checks made to determine whether the receiver is to be maintenance approved for operational use, or serviced.

5-3. PRELIMINARY RECEIVER CHECKS. On initial receipt or subsequent to servicing and alignment, the radio receiver should be subjected to certain preliminary checks. These checks are made to render assurance that the receiver is in good operating condition before further time is taken to measure receiver performance. The preliminary checks made are the following:

a. Check to see that the loud speaker is connected and that the headset is plugged in.

b. Turn the receiver "on" and note that pilot lamps light up; if not, turn the receiver "off" and replace the three ampere fuse.

c. Note that all glass enclosed electron tube filaments light up, that the V18 voltage regulator tube shows a faint violet glow, and have hand protected when noting by feel that the V3 metal enclosed tube is warming up; if not replace each defective tube.

d. Tune in, in turn, an mcw signal (voice or music) and a cw signal (telegraph), on each band, both for continuously variable and fixed crystal controlled operation, and check the operating controls for each mode of operation as to function (Refer to paragraphs 1-36 thru 1-53.). Check the mechanical performance of each control by feel, for tightness, looseness, switch action, and indentation, as applicable. Check the r-f and audio gain controls for noisy operation by operating each control in turn while listening for receiver noise output with no signal input.

e. Indicate by tag the reason for servicing the receiver when its output is "dead" or distorted, when one or more good tubes do not light up, or for a mechanical defect.

5-4. RECEIVER PERFORMANCE TESTS. When the preliminary checks made show no cause for receiver maintenance, the test measurements outlined in table 5-1 are made on the receiver. Failure to meet each minimum performance standard defined in the table requires that the receiver be serviced within the scope provided by the present maintenance activities.

Table 5-1. Receiver Performance Tests

Test	Adjustment Procedures	Minimum Performance Standard	Trouble Location
Sensitivity for a 10:1 signal-plus-noise to noise power ratio.	Connect equipment as shown in figure 5-1. Signal generator. Adjust sig gen output, AM of 30 percent at 400 cps, to approx three uv level. Radio receiver. Set for MAN mcw and tune in any signal gen signal, keeping r-f gain control full on and selectivity switch set to 3 kc position. Adjust audio gain control for a ref level rec output of 10 mw. Signal generator. Switch "off" the AM of 400 cps to measure the rec noise output; then switch back "on" and adjust signal gen output to provide for a 10:1 signal-plus-noise to noise ratio on the power output meter. Radio receiver. Readjust audio gain to provide 10 mw output at the 10:1 ratio. Note and record the knob dial setting of the control.	Two uv, or less, rec input at any signal freq within tuning range of rec.	IF section; V9, V10, V11, T3, T4, and/or T5 with regard to gain. RF section; V1, V2, and/or any one of the r-f tuner coil assemblies for band involved with regard to signal-plus-noise to noise ratio.

Table 5-1. Receiver Performance Tests (cont)

Test	Adjustment Procedures	Minimum Performance Standard	Trouble Location
Selectivity	Connect the equipment as shown in figure 5-1. Repeat Sensitivity Test adjustments choosing a two mc signal. Then switch the rec selectivity switch to its 13.0 kc position. Note and record the receiver uv input. Successively increase the receiver input by 10, 100, and 1000 times, detuning the rec on either side of resonance in each instance such that the output level of 10 mw is maintained. Note and record in each instance the receiver deviation in kc from resonance. Repeat procedure for 8.0, 3.0, 1.3, 0.5, and 0.2 kc positions of rec selectivity switch. Plot on semi-log graph paper the 10, 100, and 1000 times log ordinate resonance input of the kc off resonance deviations on either side of resonance, as abscissae. Compare the resultant graphs with those shown for the six switch positions in figure 1-4.	Selectivity of rec to approx that shown for each selectivity switch position in figure 1-4.	IF section; T3, T4, and/or T5.
Rated Power Output	Connect equipment as shown in figure 5-1. Repeat Sensitivity Test adjustments. Then advance audio gain control to provide the rec rated output of at least two watts.	Two watts, or more, of rec audio output at two uv input.	AF section; V16B, V17, and/or T7.
Rated i-f Output	Connect equipment as shown in figure 5-2. Repeat Sensitivity Test adjustments.	Min rec i-f output of 200 mv to 70 ohm resistive i-f output load, for two uv input.	Auxiliary circuit section; V16A.
Image Rejection Ratio	Connect equipment as shown in figure 5-1. Repeat Sensitivity Test adjustments and measure rec sensitivity at signal freq shown in table 1-4. In turn set the signal gen 910 kc greater than freq shown for bands 1, 2, and 3, and 7910 kc greater than freq shown for bands 4, 5, and 6, in table 1-4 and note the signal gen input to the rec for the 10 mw reference level output. Ratio the signal gen input at each image freq to that for the corresponding sensitivity measurement made to determine the voltage ratios expressing the image rejection ratios shown in table 1-4.	See table 1-4 for Image Rejection Ratios.	RF section; antenna r-f tuner and/ or one or both interstage r-f tuners of band concerned; all with regard to the preselection provided by the tuned circuitry involved.

Table 5-1. Receiver Performance Tests (cont)

Test	Adjustment Procedures	Minimum Performance Standard	Trouble Location
455 kc, i-f Rejection Ratio	Connect equipment as shown in figure 5-1. Repeat Sensitivity Test adjustments and measure rec sensitivity at 600 kc signal gen freq. Keeping rec tuned to 600 kc signal freq, set signal gen to 455 kc signal. Increase 455 kc signal input level to rec to get the 10 mw reference level output. Ratio rec input at 455 kc to that for sensitivity test measurement made and express in db to get 455 kc i-f rejection ratio.	455 kc, i-f rejection ratio 69 db, at 600 kc, increasing with signal freq tuned in on bands 1, 2, or 3 of rec.	RF section: antenna r-f tuner and/or one or both interstage r-f tuners of band concerned; all with regard to the preselection provided by the tuned circuitry involved.
3,955 kc, i-f Rejection Ratio	Repeat Sensitivity Test adjustments and measure rec sensitivity at 7.6 mc signal gen freq. Keeping rec tuned to 7.6 mc signal freq, set signal gen to 3,955 kc signal. Increase 3,955 kc signal input level to rec to get the 10 mw reference level output. Ratio rec input at 3,955 kc to that for sensitivity test measurement made and express in db to get 3,955 kc i-f rejection ratio.	3,955 kc, i-f rejection ratio a min of 94 db for any signal freq tuned in on bands 4, 5, or 6 of rec.	
Rec cw performance	Adjust the rec for cw reception and tune in a signal gen cw signal. Note that bfo control adjustment varies rec tone output range, plus or minus three kc from zero beat. Measure pitch of rec tone by zero beating the headset output from an audio freq gen with the rec output to the loud speaker. Check bfo freq stability by noting that rec tone output is constant in freq for each setting of the bfo control. Disconnect signal gen and tune in a cw signal. Switch the rec for avc operation and adjust r-f gain control noting that rec background noise is not enhanced, such that reception of high-speed telegraph is impaired. Reconnect signal gen and adjust for a cw signal closely adjacent to that tuned in on the rec. Note heterodyne interference in rec output may be attenuated by adjusting the rec crystal phasing control. Refer to paragraph 1-42.	Beat freq osc range plus or minus three kc, at constant freq for setting of bfo control. No impairment in cw reception of high-speed telegraph when on avc. Attenuation of heterodyne interference by adjustment of crystal phasing control.	Auxiliary circuit section; V13, and/or V12.

5-5. TROUBLE LOCATION. The receiver comprises functional sections (Refer to paragraph 4-9 thru 4-13), which may be subjected to separate analysis. In instances where the receiver fails to meet a minimum performance standard, the performance test involved provides for localizing the receiver fault to a functional receiver section (See table 5-1.). The receiver fault may be further localized within a specific receiver section in the manner outlined herein below (Refer to paragraph 5-8.).

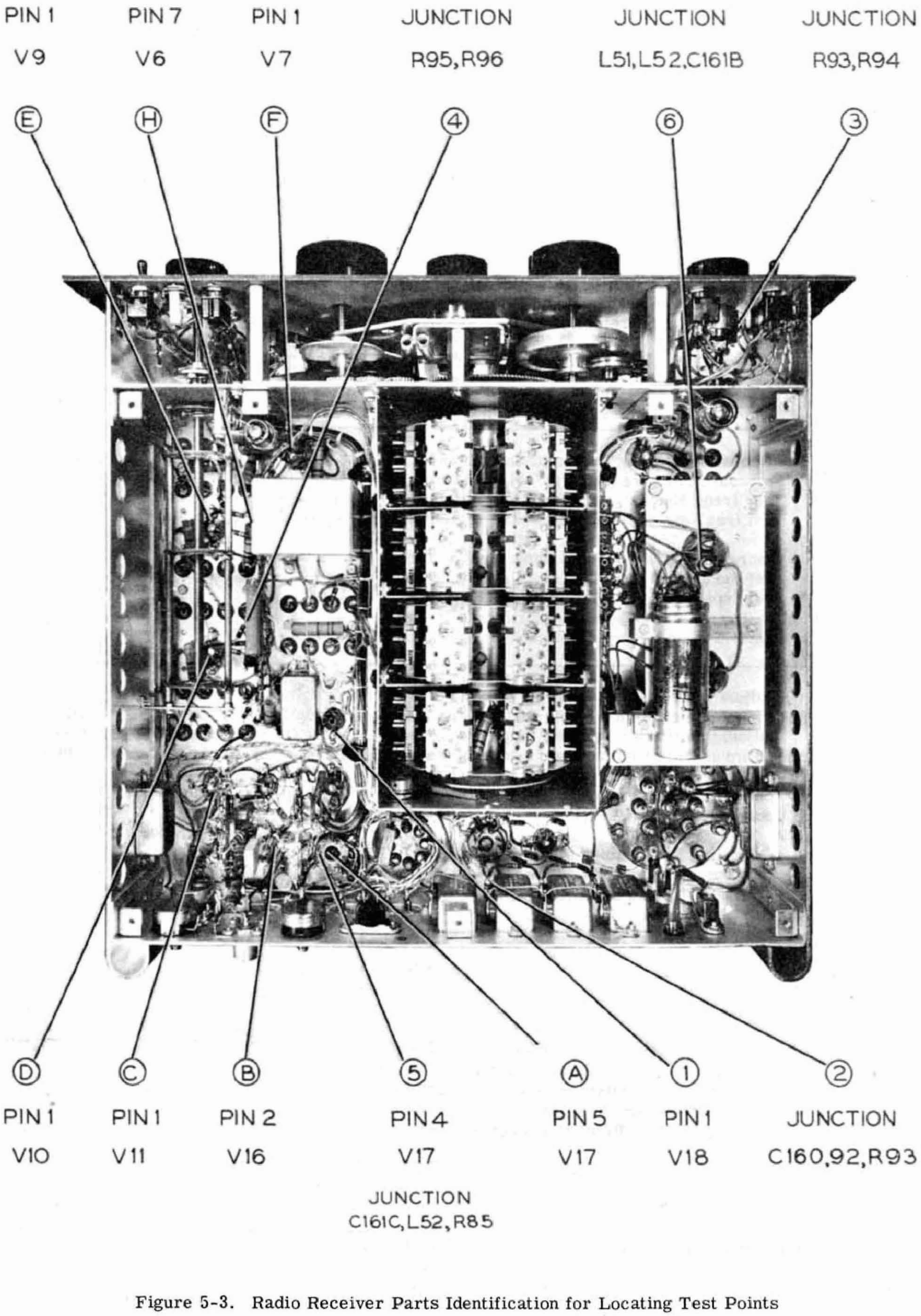


Figure 5-3. Radio Receiver Parts Identification for Locating Test Points

5-6. SYSTEM (TROUBLE) ANALYSIS.

5-7. The system components comprising an operational activity are separately analysed to determine the system fault, the nature of the fault directing attention to a specific component. With regard to the radio receiver the preliminary receiver checks (Refer to paragraph 5-3.), and the receiver performance tests (Refer to table 5-1.), when made, determine whether the radio receiver is the cause of the system fault. The receiver faults, within the scope of the present maintenance activities, may be determined by a step-by-step test point procedure or analysis.

5-8. TEST POINT ANALYSIS. The test point analysis used to localize the receiver fault is a step-by-step procedure involving the test point data listed in tables 5-2 and 5-3. Table 5-2 provides test point indications with regard to the self-contained power supply section and table 5-3 with regard to the other sections of the receiver, to the extent that a possible cause of an abnormal indication is an electron tube and/or a specific subassembly within a receiver section, designed for easy replacement. In instances where the fault persists the receiver servicing is beyond the scope of present maintenance activities and must be subjected to Field and Fasron maintenance.

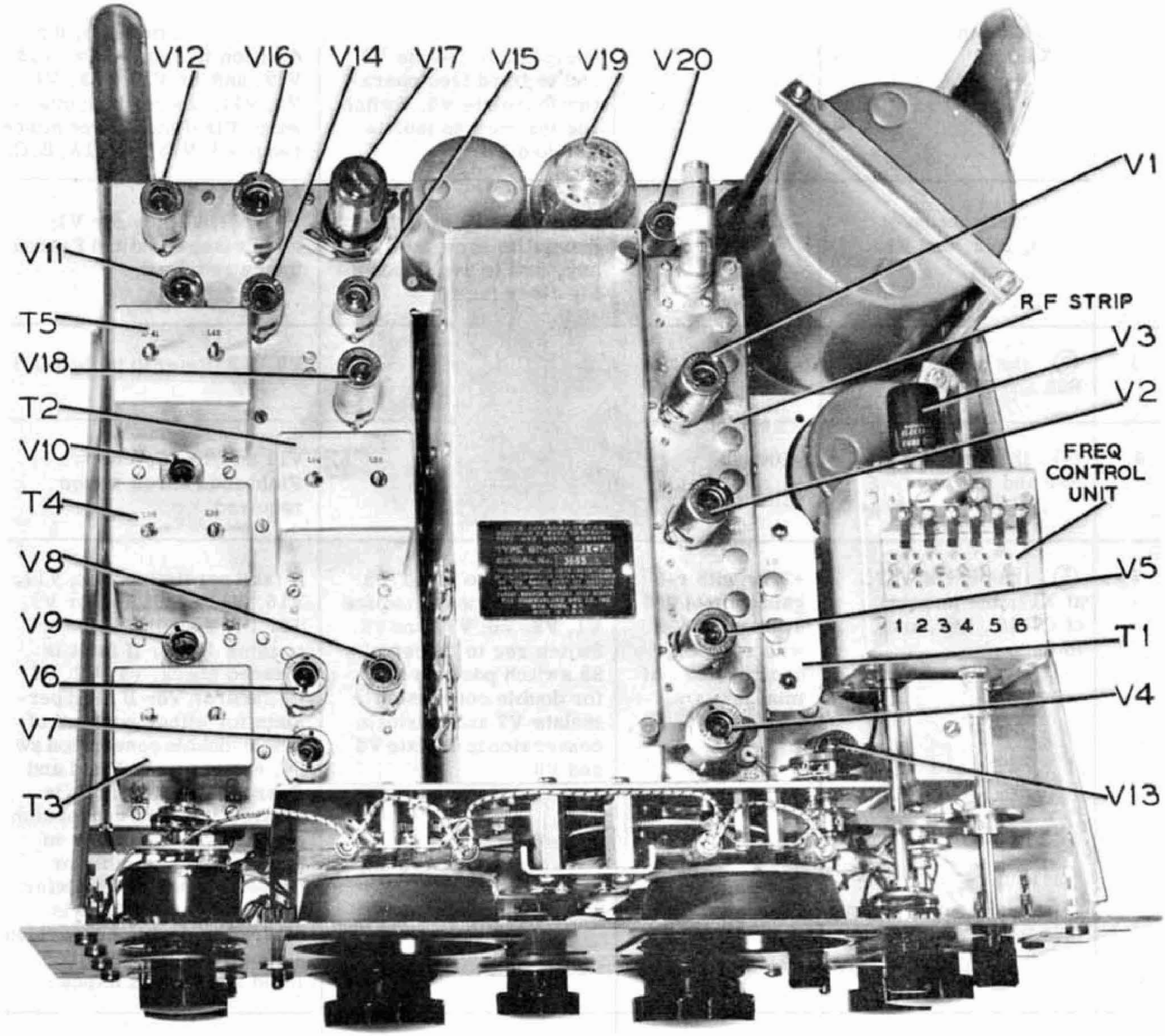


Figure 5-4. Radio Receiver, Top View of Chassis

5-9. To perform the test point checks in table 5-2, remove the receiver bottom plate and identify each test point from the parts identification provided in figure 5-3. Then turn the receiver a-c power switch "on" and use a d-c vacuum tube voltmeter or a 20,000 ohm-per-volt d-c voltmeter to measure the d-c voltage between each test point and the receiver chassis ground. In the instance of one or more abnormal indications make each test point check with the possibly defective electron tubes (See figure 5-4.), designated in the table for each step, removed and replaced, in turn. If the abnormal indication persists refer to table 5-3 as indicated for steps 3, 5, and 6 in table 5-2. If the abnormality persists for steps 1, 2, and 4 in table 5-2 after steps 1 thru 6 have been performed, the receiver requires Field and Fasron maintenance. In instances where the abnormality is cleared by changing one or more electron tubes, then performing the minimum performance standard tests may show the receiver to be normal.

Table 5-2. Power Supply Section Test Point Data

Step	Test Point	Test Point Indication	Receiver Adjustments	Possible Cause of Abnormal Indication
1	①, the pin 1 of V18, at X18.	+150v	Switch rec for var freq operation to isolate V3 and to fixed freq operation to isolate V4. Switch rec for mcw to isolate V13 and T6.	F-2 (See figure 5-3.), if indication is only + 15v. V18, V19, and/or V20. V3, V4, V5, V11, and/or V14; otherwise, Field and Fasron mtnce required. V13. C161A, B, C.
2	②, the junction of C160, R92, and R93.	-51v	Switch rec S8 switch to manual to show fault, if any, and to avc to possibly clear fault.	V10, V9, V2, and/or V1; otherwise, Field and Fasron mtnce required.
3	③, the junction of R93 and R94.	-1v		V6. T2 (Refer to table 5-3.).
4	④, the junction of R95 and R96.	-10v		V11 and/or V7; otherwise, Field and Fasron mtnce required.
5	⑤, the pin 4 of V17, at X17, the junction of C161C, L52, and R85.	+228v with r-f gain control R93, at max. +265v with r-f gain control R93, at min.	Switch rec to "send" S9 switch position to isolate V1, V2, V6, V7, and V8. Switch rec to "receive" S9 switch position and for double conversion to isolate V7 and to single conversion to isolate V6 and V8.	If fault persists check, V17, V16, V11, V10, and/or V9. T3, T4, and/or T5 (Refer to table 5-3.). If fault is cleared check, V1, V2, V6, V7, and/or V8. If fault persists for either position of single-double conversion sw S4, rec requires Field and Fasron mtnce. If fault is cleared in single conversion sw position, trouble is in 3.5 mc osc assembly or screen circuit of V6 (Refer to table 5-3.). If fault is cleared in double conversion sw position, rec requires Field and Fasron mtnce.
6	⑥, the junction of L51, L52, and C161B.	+280v with r-f gain control R93, at max. +305v with r-f gain control R93, at min.		V17 and/or V3. T7 (Refer to table 5-3.).

5-10. Table 5-3 is intended for use in conjunction with table 5-2 and any of the Receiver Performance Tests made in accordance with table 5-1. Table 5-2 refers to table 5-3 in those instances where the possible cause of the abnormal indication may be due to T3, T4, T5, T7, or the 3.5 mc osc assembly, the test point indications in table 5-3 providing for isolating the receiver fault specifically to the subassembly involved.

5-11. To perform the test point checks in table 5-3, each test point is identified through use of the figure 5-4 which identifies the location of the electron tube complement of the receiver. Each test point, apart from test point Ⓖ, the pin 7 of V5, is accessible from the bottom of the receiver with the bottom plate removed (Refer to figure 5-3.). A miniature tube adapter renders accessible the test point Ⓖ. To check the test point indications, turn the receiver a-c power switch "on" and use an a-c vacuum tube voltmeter or a 20,000 ohm-per-volt a-c voltmeter to measure the audio test point signal voltages to the receiver chassis ground. The signal generator microvolt r-f output provides for the r-f or i-f test point voltages, to the receiver chassis ground.

Table 5-3. Receiver Sections Test Point Data

Step	Test Point	Test Equipment Control Position	Receiver Adjustments	Normal Indication	Possible Cause of Abnormal Indication
1	Ⓐ pin 5, V17	Couple 400 cps audio freq gen output thru 0.01 uf between test point and ground at level for 20v rec output to 600 ohm resistive load across rec audio output term.	Audio gain control at max.	Rec input approx 3.5 v.	V17 and/or T7.
2	Ⓑ pin 2, V16B	Same as step 1.	Same as step 1.	Rec input approx 0.3 v.	V16B.
3	Ⓒ pin 1, V11	Couple 455 kc signal, 400 cps AM of 30 percent, thru 0.01 uf between test point and ground at level for 20 v rec output to 600 ohm resistive load across rec audio output term.	Rec switched for mcw, audio gain control at max, and limiter switch in "off" position.	Rec input approx 0.35 v.	V11, V14, V15, and/or V16A.
4	Ⓓ pin 1, V10	Same as step 3.	Same as step 3; also r-f gain control at max, S8 switch in "manual" position, and band switch set for 1.35-3.45 mc.	Rec input approx 6000 uv.	V10 and/or T5.
5	Ⓔ pin 1, V9	Same as step 3.	Same as step 4.	Rec input approx 110 uv.	V9 and/or T4.
6	Ⓕ pin 1, V7	Same as step 3.	Same as step 4.	Rec input approx 40 uv.	V6, V7, and/or T3.

Table 5-3. Receiver Sections Test Point Data (cont)

Step	Test Point	Test Equipment Control Position	Receiver Adjustments	Normal Indication	Possible Cause of Abnormal Indication
7	Ⓖ pin 7, V5	Same as step 3.	Same as step 4.	Rec input approx 65 uv.	V5 and/or T2.
8	Ⓗ pin 7, V6	Couple 3,955 kc signal 400 cps AM of 30 percent, thru 0.01 uf between test point and ground at level for 20 v rec output to 600 ohm resistive load across rec audio output term.	Same as step 4 but band switch set for 7.40-14.8 mc.	Rec input approx 250 uv.	V6, V7, and/or V8. 3.5 mc osc assembly.
9	⑦ rec antenna input	Connect equipment as shown in figure 5-1. Repeat Sensitivity Test adjustments, choosing signal for any rec freq band or rec freq band with abnormal indication (Refer to table 5-1.).	Same as for Sensitivity Test (Refer to table 5-1.).	Rec input two uv, or less.	V1, V2, and/or V3 for fixed freq operation, and/or V4 for var freq operation; any of r-f tuners for freq band concerned.

5-12. REMOVAL.

5-13. RF TUNER COIL ASSEMBLY. To remove any one of the four r-f tuner coil assemblies on a specific frequency band the turret assembly is indented so that the r-f tuner coil assemblies for the specific frequency band show fully in the opening provided by removing the tuning unit shield. Each coil assembly is firmly held in place by two flat springs, one at either end of the isolantite base forming part of the r-f tuner coil assembly proper. To remove a flat spring, grasp it with the special pliers (See figure 2-1.), at its inward full length edge, pressing downward while pulling inward with a circular motion to remove it. Do the same for the other flat spring associated with the r-f tuner coil assembly concerned and then lift out the r-f tuner coil assembly.

5-14. IF TRANSFORMER AND 3.5 MC OSC ASSEMBLIES. To remove the T5, T4, T3, T2, and 3.5 mc osc (See figures 5-3 and 5-4.), subassemblies, remove the shield can first, by removing the four No. 6-32 machine screws which hold the shield can in place. Then unsolder the externally connected leads to the subassembly terminals. To remove the subassembly remove the two No. 6-32 machine screws which attach it to the receiver chassis.

5-15. MINOR REPAIR AND REPLACEMENT.

5-16. TUBES. To replace the tubes V3, V17, V19 (See figure 5-4.), the tube socket clamp must first be unclamped on each tube by spreading the clamp retainer out from the tube, so that the tube may be drawn out from its tube socket for replacement. To replace the tubes V1, V2, V5, V6, V7, V8, V9, V10, V11, V12, V13, V14, V15, V16, V18, V20, the respective tube shield is first removed by twisting counter-clockwise while exerting inward pressure. These tubes are all of the pin type and are preferably removed for replacement with the appropriate tube remover. To replace the tube V4, the knurled screw, holding the tube shield rigid, is loosened. Then the tube shield is turned counter-clockwise, while exerting inward pressure, to remove it. The tube is of the pin type and is removed for replacement with the appropriate tube remover.

WARNING

Turn receiver "off" and protect hands against severe burns when removing tubes.

5-17. IF TRANSFORMER AND 3.5 MC OSC ASSEMBLIES. The removal procedure, (Refer to paragraph 5-14.), is reversed to replace any one of th. i-f transformer and 3.5 mc osc assemblies. The T2, T3, T4, T5 (See figure 5-4.), i-f transformer assemblies, of which T4 and T5 are identical, and the 3.5 mc osc assembly (See figure 5-3.), may be respectively identified by visual comparison with their counterpart shown in figure 5-5.

5-18. RF TUNER COIL ASSEMBLIES. The removal

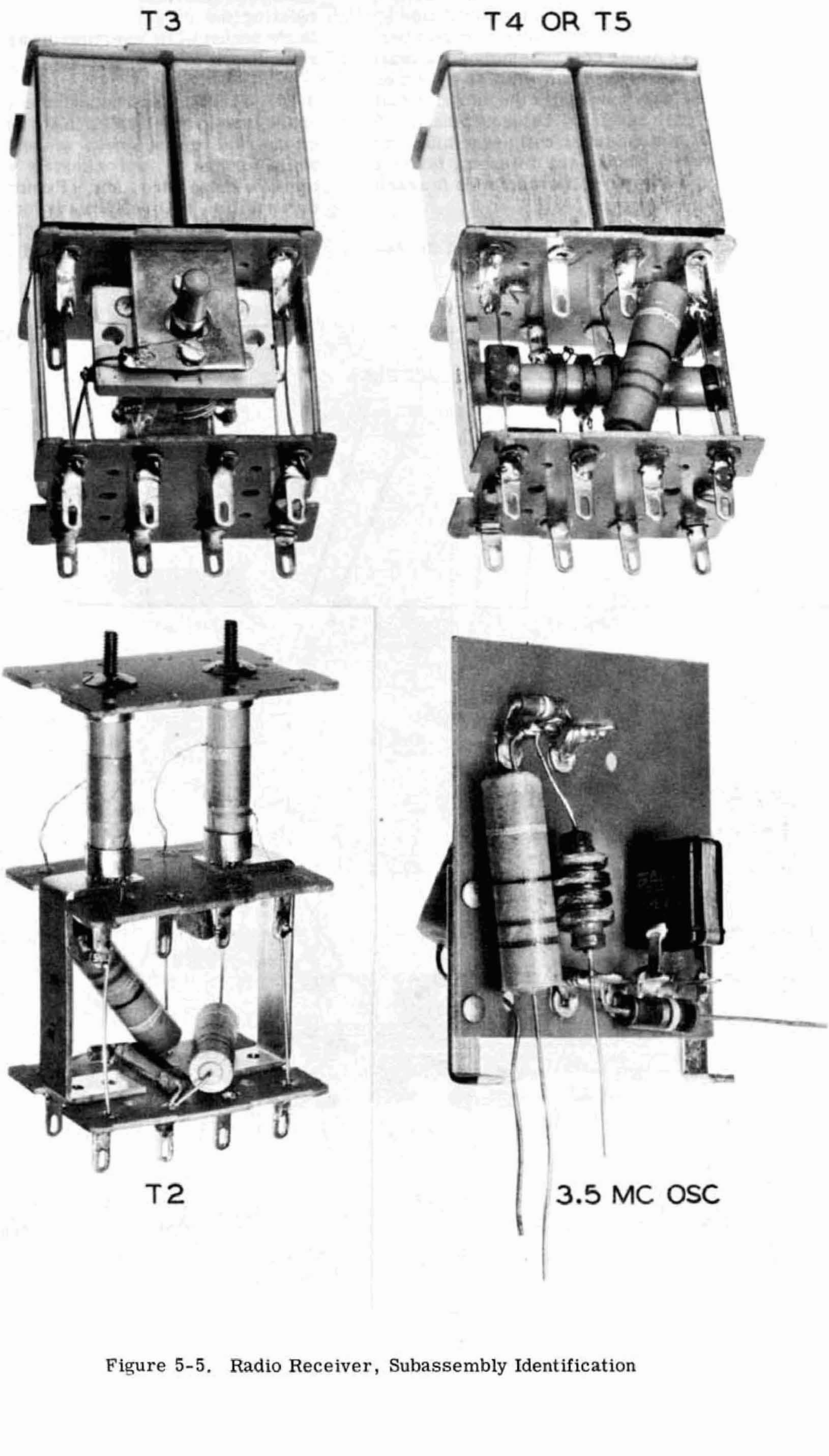


Figure 5-5. Radio Receiver, Subassembly Identification

procedure, (Refer to paragraph 5-13.), is reversed to replace any one of the r-f tuner coil assemblies. Each r-f tuner coil assembly is stamp identified on its isolantite base with its Hammarlund part number. When replacing an r-f tuner coil assembly care must be taken to make the replacement with an r-f tuner coil assembly whose part number is the same as that of the r-f tuner coil assembly being replaced. It should be noted that the r-f tuner coil assemblies for each band, as between bands, are different, but that the two inter-stage r-f tuner coil assemblies for each band are identical, (See figure 5-3.).

5-19. PILOT LAMPS. The four pilot lamps of the receiver are of the bayonet type and are replaced by lifting the individual pilot lamp socket off its support, twisting the pilot lamp counter-clockwise in relation to its socket while exerting inward pressure, and then removing it for replacement.

5-20. FUSES. To replace the three ampere fuse or spare fuse, each located in its respective fuse holder on the rear apron, press in the top of the fuse holder while turning it approximately 45 degrees in a counter-clockwise direction. Removing the pressure in this position will release the fuse, spring clamped to the top of the fuse holder. The fuse and the top of the fuse holder can then be pulled apart to release the

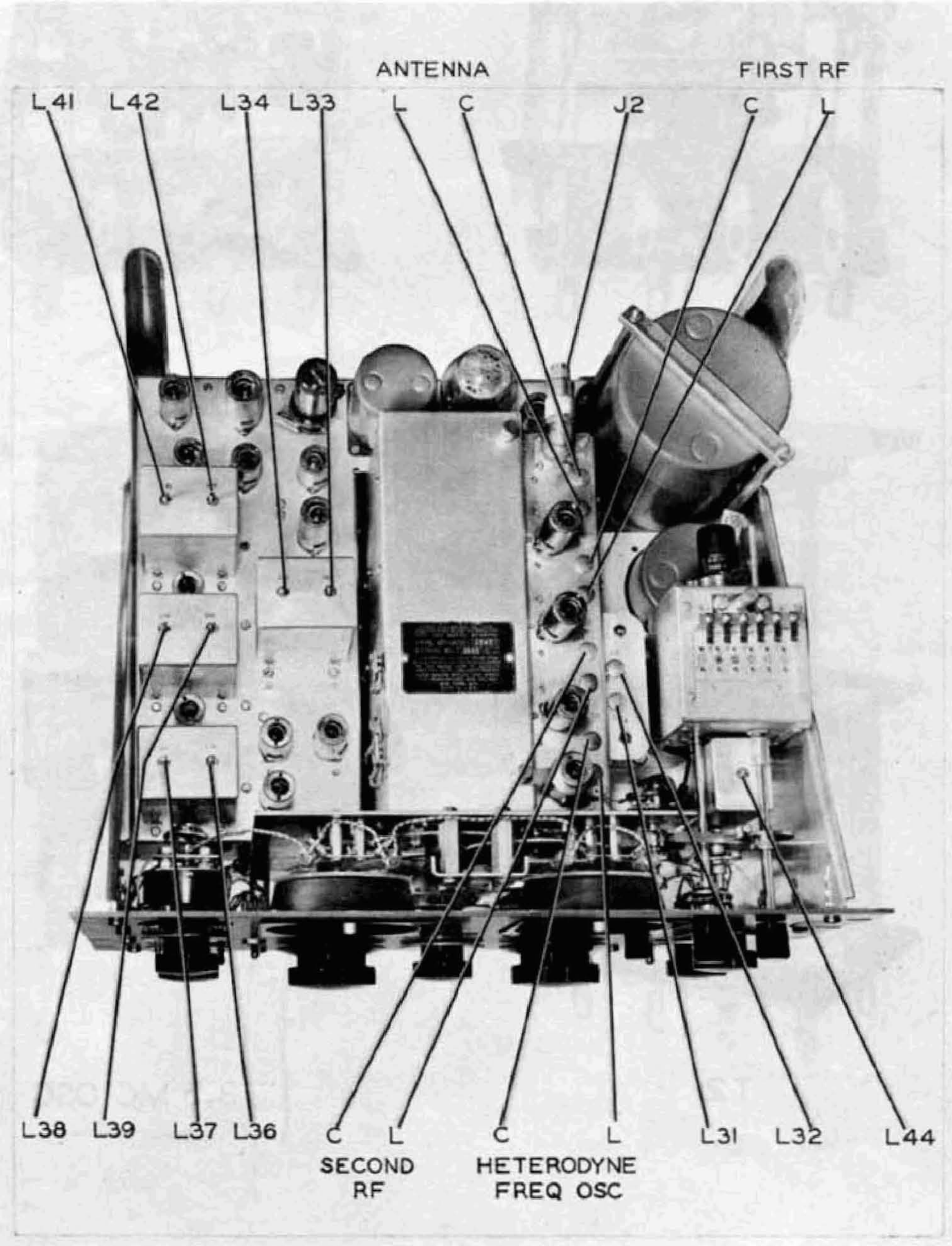


Figure 5-6. Radio Receiver, Alignment Adjustments

fuse for replacement. When a spare three ampere fuse is available other than that provided in the spare fuse holder it is preferably used so that in an emergency a spare fuse is always in the spare fuse holder.

5-21. To replace a three-eighths ampere pigtail type fuse soldered between the power transformer terminal 11 and chassis ground, the pigtail leads are unsoldered, to release the blown fuse for replacement.

CAUTION

Make sure that the holder type fuse is stamp designated three amperes and the pigtail type fuse three-eighths ampere.

5-22. CRYSTALS. To replace a crystal, separately ordered for a specific signal frequency, loosen the knurled thumb screw on top of the crystal holder and push the retainer spring assembly to the rear. Then remove the crystal from its crystal socket. Insert the new crystal ordered for the same signal frequency in the crystal socket which carried the removed crystal, bring the retainer spring assembly forward so that the springs press down on the crystals contained in the crystal holder, and tighten the thumb screw. The new crystal is inserted in the crystal holder which carried the removed crystal so that the plastic chart and crystal selector switch numeral designations for the crystal signal frequency remain that corresponding to the numerical designation of the crystal holder. If for any reason a different crystal holder is used for the crystal, the numeral on the plastic chart used to record the crystal signal frequency should correspond to the numeral designating the crystal holder and crystal selector switch used. Pencil or ink, subject to erasure, may be used to mark the plastic chart.

5-23. ALIGNMENT AND ADJUSTMENT.

5-24. TUBE REPLACEMENT. The radio receiver does not require alignment subsequent to tube replacement. When V4 (See figure 5-4.), the variable frequency oscillator tube is replaced, check the main dial calibration especially at the high frequency end of each frequency band by tuning in stations of known frequency or, refer to table 6-1. If the calibration is not one quarter of one percent of frequency or better, over the frequency range of the receiver, realign the variable frequency oscillator only, as follows:
a. Set up for the Sensitivity Test, (See table 5-1.), with the receiver main dial set at the heterodyne freq osc alignment frequencies, (See table 5-4.), in turn.
b. Remove the metal button to align C, for the heterodyne freq osc, (See figure 5-6.). No more than a very slight angular aligning screwdriver adjustment is needed to maximize the rec output, observed with the alignment screwdriver away from the C, trimmer capacitor.

5-25. RF TUNER COIL ASSEMBLY REPLACEMENT. When one or more of the four r-f tuner coil assemblies on any frequency band of the receiver are replaced, realign the alignment adjustments of the r-f tuner coil assembly concerned.
a. Set up for the Sensitivity Test, (See table 5-1.), and remove the metal buttons to align L and C for the antenna, the first rf, the second rf, and/or the heterodyne freq osc (See figure 5-6.), r-f tuner coil assemblies, as applicable.
b. Align, in turn, the L and C for the band concerned at the receiver alignment freq shown in table 5-4, for maximum receiver output, repeating the procedure until no further increase in output results.

5-26. IF TRANSFORMER REPLACEMENT. When one or more of the T2, T3, T4, T5 (See figure 5-5.), i-f transformers are replaced, realign the i-f stage of the receiver concerned in the following manner:
a. Set up for the Sensitivity Test, (See table 5-1.), and to get at L41, L42 for T5, L38, L39 for T4, L37, L36 for T3, and L34, L33 for T2, remove the appropriate metal buttons (See figure 5-6.), to render accessible the adjustable tuning cores of the applicable i-f transformer.
b. Align in turn the adjustable tuning cores for the replaced i-f transformer only, for maximum receiver output, repeating the procedure until no further increase in output results.

5-27. LUBRICATION.

5-28. The lubrication provided the radio receiver at the factory need not be renewed at any time during the life of the receiver. The life of the receiver within the scope of the present maintenance activities may be considered ended whenever the receiver is rejected for operational use. At such time, the field maintenance activities concerned, when servicing the receiver, determine the necessity for receiver depot overhaul, which, dependent on the receiver overhaul requirements, may involve re-lubrication of the receiver. The r-f tuner coil assemblies and the first i-f transformer contain adjustable air condensers which are properly lubricated at the factory so that the full lubrication requirements of the receiver are maintained even subsequent to the use of spares for purpose of receiver subassembly replacements.

Table 5-4. Alignment Frequency and Adjustment Designations

Freq Band in mc.	0.54-1.35	1.35-3.45	3.45-7.4	7.4-14.8	14.8-29.7	29.7-54.0
Adjust L at	0.56	1.4	3.75	7.5	15.0	30.0
Adjust C at	1.3	3.4	7.15	14.5	29.0	52.0

5-29. INSPECTION SCHEDULE.

5-30. Subsequent to operational use, the radio receiver, upon receipt by the present maintenance activities, should be checked with regard to the recorded operational performance data compiled by the operational personnel. In instances where the receiver servicing requirements are beyond the scope of the present maintenance activities (Refer to paragraph 5-8.), send the receiver to field maintenance; otherwise, check the receiver for performance (Refer to paragraph 5-4.). If the receiver meets its performance requirements it can be maintenance released for further operational use.

SECTION VI

FIELD AND FASRON MAINTENANCE

6-1. MINIMUM PERFORMANCE STANDARDS.

6-2. The minimum performance standards for the radio receiver, in addition to those given in table 5-1 are specified in table 6-1. The performance of the receiver, as determined by the sectional gain requirements of each tube stage, enables added minimum receiver performance data to be specified. Table 6-2 lists the added receiver minimum performance data in terms of receiver normal test point indications for the step-by-step analysis of receiver trouble.

Table 6-1. Receiver Performance Tests

Test	Adjustment Procedures	Minimum Performance Standard	Trouble Location
Overall Fidelity	Connect equipment as shown in figure 6-1. Repeat Sensitivity Test adjustments, but use external AM of 30 percent at 400 cps. Advance audio gain control to max and set r-f gain control to maintain 10 mw reference level output. Then switch the selectivity switch to its 13.0 kc position. Note the uv input to the rec and maintain the AM of 30 percent as the db output level is recorded at chosen freq in the 50 to 10,000 cps audio freq range. Plot the output db difference for the chosen audio freq from zero db reference at 400 cps as ordinates against the audio freq as abscissae on semi-log graph paper and compare with the corresponding curve in figure 1-5.	Overall rec fidelity to approx that of figure 1-5.	IF section; T1, T3, T4, and/or T5 for signals below 7.4 mc and T1, T2, T3, T4 and/or T5 for signals above 7.4 mc; with regard to all transf functioning to provide the proper circuit selectivity.
Audio Fidelity	Connect equipment as shown in figure 6-2. Set the output meter to provide a 600-ohm matching load. Set the rec r-f gain control to min and the audio gain control to max. Set the audio freq gen for 400 cps at an input level to rec to provide for 10 mw rec output.	Audio fidelity of rec to approx that of figure 1-5.	AF section; T7, C148, C149, and/ or C150.

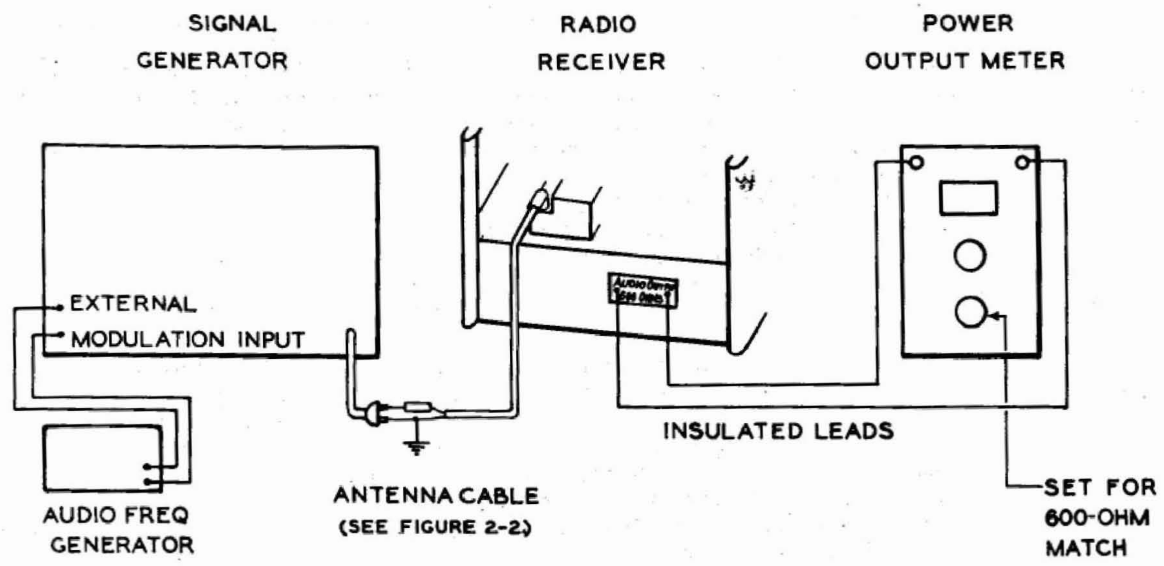


Figure 6-1. Receiver Overall Fidelity Test Set-up

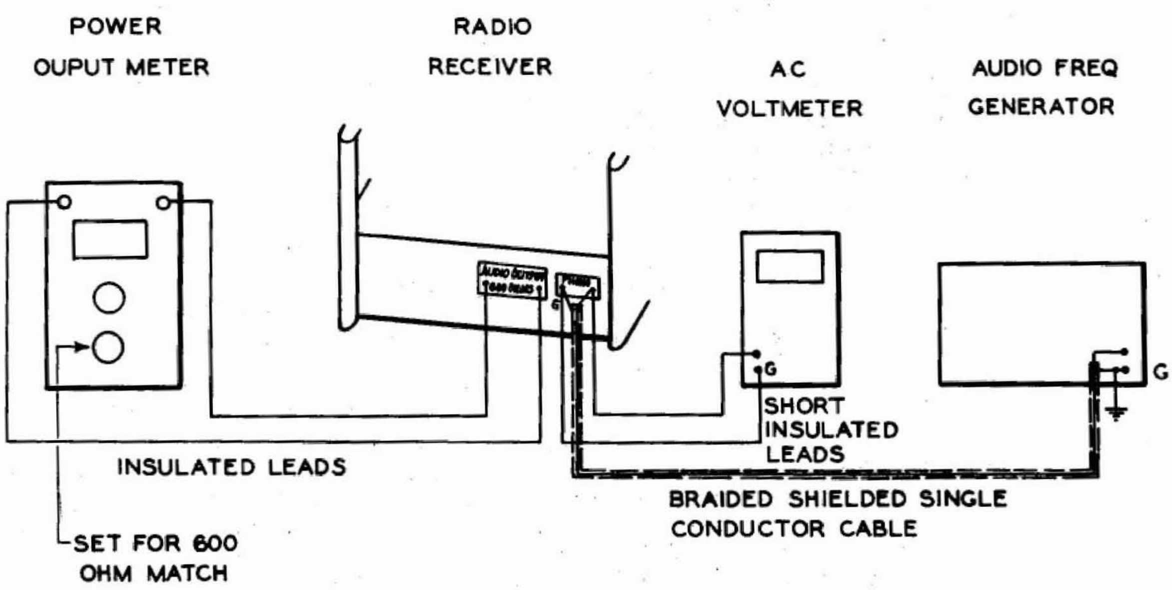


Figure 6-2. Receiver Audio Fidelity Test Set-up

Table 6-1. Receiver Performance Tests (cont)

Test	Adjustment Procedures	Minimum Performance Standard	Trouble Location
Audio Fidelity (continued)	Note the input a-c voltmeter level to rec phonograph term and maintain as output db readings are recorded at freq in the range from 50 to 10,000 cps. Plot the output db difference for the chosen audio freq from zero db reference at 400 cps as ordinates against the audio freq as abscissae on semi-log graph paper and compare with the corresponding curve in figure 1-5.	Audio fidelity of rec to approx that of figure 1-5 (continued).	AF section; T7, C148, C149, and/ or C150 (continued).
Frequency Accuracy	Turn rec "on" and allow a 15 minute warm up period with rec switched for cw operation. <u>Method A. Use crystal calibrator.</u> Connect crystal calibrator to rec so that input level to rec is approx same as that from transmitted cw or available secondary standard tuned in on rec. Adjust crystal calibrator for rec zero beat with freq std, evidenced by low freq beat note for the proper crystal calibrator harmonic output choice. For crystal calibrator of 100 kc fundamental freq, provided with sub-harmonie freq output at intervals of 10 kc, retuning the rec at 10 kc intervals provides for checking the rec main dial freq calibration at each zero beat main dial setting. <u>Method B. Use rec 3.5 mc osc.</u> Connect two-foot length of insulated wire to rec antenna input and dress free end around rec 3.5 mc osc V8 tube shield. Use 3.5 mc osc output at intervals of 3.5 mc above 10.5 mc as a secondary freq std.	Main dial calibration accuracy is one quarter of one percent over freq range of rec, or better.	RF section; main tuning condenser sections C1G -C1H if main dial calibration is off on all bands; osc r-f tuner assembly of band concerned.
AVC Action	Connect equipment as shown in figure 5-1. Repeat Sensitivity Test adjustments and then vary rec input from two to 200,000 uv.	Rec output to remain constant within 14 db, or not to be more than 251.0 mw.	
Freq Stability	Repeat Sensitivity Test adjustments (See table 5-1.), for a crystal controlled signal freq for each band. Allow rec to warm up for 15 minutes and note main and vernier dial readings for signal freq tuned in on rec at half hour intervals over a three hour period. Calculate difference between each reading and initial reading and express each as a percent of initial reading.	Max deviation on Band No. 1, 0.05 percent, on Band No. 2, 0.04 percent and on Band Nos. 3, 4, 5, and 6, 0.02 percent.	RF section; capacitors C79, C80, (See figure 4-3.).

6-3. SYSTEMS (TROUBLE) ANALYSIS.

6-4. Prior to the systems trouble analysis of the radio receiver, the receiver defect, with which it is tagged, is checked, its nature possibly providing for the rapid isolation of the receiver fault. To isolate the receiver fault to a specific tube, subassembly, or part, use is made of table 6-2.

6-5. The step sequence of the test point data provided in table 6-2 is backward through the receiver to render assurance that the receiver section between each test point and the receiver audio output terminals is not the cause of the receiver fault.

6-6. Table 6-2, together with the minimum performance standards (See tables 5-1 and 6-1.), provide for the systems trouble analysis of the receiver with regard to the path taken by the signal through the receiver. The circuit elements, which are referred to in table 6-2 as the possible cause of abnormal test point indication, are identified by their circuit reference symbol (See figure 7-1.).

6-7. The test points defined in table 6-2 are all, apart from test point Ⓖ, accessible from the bottom of the receiver with the bottom plate removed. In the instance of test point Ⓖ, the pin 7 of the tube V5 (See figure 5-4.), a miniature tube adapter renders the test point accessible.

Table 6-2. Systems Trouble Analysis Chart

Step	Test Point	Test Equipment Control Position	Receiver Control Position	Normal Indication	Possible Cause of Abnormal Indication
1	Ⓐ pin 5, V17	Couple 400 cps audio freq gen output thru 0.01 uf between test point and ground at level for 20 volts rec output to 600 ohm resistance load across rec audio output term.	Audio gain control at max.	Rec input approx 3.5 volts.	Tube V17, Transf T7. Capacitor C150 or C151. Resistor R98 or R99. Switch S11. Term board E2.
2	Ⓑ Pin 2, V16B	Same as step 1.	Same as step 1.	Rec input approx 0.3 volts	Tube V16, section V16B. Capacitor C148 or C149. Resistor R83. Potentiometer R84.
3	Ⓒ Pin 1, V11	Couple 455 kc signal gen output, 30 percent AM of 400 cps, thru 0.01 uf between test point and ground at level for 20 volts rec output to 600 ohm resistive load across rec audio output term.	Selectivity switch set for three kc band width, rec set for mcw, manual operation, r-f and audio gain controls at max, band switch set for 1.35-3.45 mc, limiter in "off" position.	Rec input approx 0.35 volts.	Tubes V11, V14, V15 or V16, section V16A. Capacitor C127, C128, C129A, C129B, C138, C139, C140, C141, C142, C143, or C145. Resistor R55, R56, R61, R62, R64, R65 or R102. Potentiometer R69.
4	Same as step 3.	Same as step 3.	Same as step 3.	Rec input approx 0.60 volts. Min rec i-f output of 200 mv to 70 ohm resistive i-f output load.	Tube V16, section V16A. Capacitor C145, C146, or C147. Resistor R78 or R79. Autotransf L53. IF output socket J2.
5	Ⓓ pin 1, V10	Same as step 3.	Same as step 3.	Rec input approx 6000 uv.	Tube V10. Transf T5. Switch S5, section C. Capacitor C121 or C122. Resistor R51.

Table 6-2. Systems Trouble Analysis Chart (cont)

Step	Test Point	Test Equipment Control Position	Receiver Control Position	Normal Indication	Possible Cause of Abnormal Indication
6	(E) pin 1, V9	Same as step 3.	Same as step 3.	Rec input approx 110 uv.	Tube V9. Transf T4. Switch S5, section B. Capacitor C115 or C116. Resistor R43 or R50.
7	(F) pin 1, V7	Same as step 3.	Same as step 3.	Rec input approx 40 uv.	Tubes V6 or V7. Transf T3. Switch S5, section A. Capacitor C100 or C105. Resistor R32 or R42.
8	(G) pin 7, V5	Same as step 3.	Same as step 3.	Rec input approx 65 uv.	Tube V5. Transf T1. Capacitor C66 or C68. Resistor R26, R27, or R33.
9	Same as step 8.	Couple 3,955 kc signal gen output 30 percent AM of 400 cps, thru 0.01 uf between test point and ground at level for 20 volts rec output to 600 ohm resistive load across rec audio output term.	Selectivity switch set for three kc band width, rec set for mcw, manual operation, r-f and audio gain controls at max, band switch set for 7.40-14.8 mc, limiter in "off" position.	Rec input approx 40 uv.	Tube V5, V6, or V8. Transf T1 or T2. 3.5 mc osc assembly. Capacitor C66, C68, or C106. Resistor R26 or R27.
10	(H) pin 7, V6	Same as step 9.	Same as step 9.	Rec input approx 250 uv.	Tube V6 or V8. Transf T3, 3.5 mc osc assembly. Capacitor C106. Resistor R42.
11	(7) rec antenna input.	Couple signal gen output, at 30 percent AM of 400 cps, at any rec tunable freq thru means of antenna input cable to test point at level for 20 volts rec output to 600 ohm resistive load across rec audio output term.	Selectivity switch set for three kc band width, rec set for continuous tuning mcw manual operation, r-f and audio gain controls at max, band switch set for signal band required, signal tuned in, limiter in "off" position.	Rec input approx two uv.	Tube V1, V2, or V4. RF coil assy, any on band used. Crystal switch S3. RF strip (See figure 5-4.). Gang condenser C1, A, B, C, D, E, F, G, H. Antenna input socket J1.
12	Same as step 11.	Same as step 11.	Same as step 11, but set rec for fixed freq operation.	Rec input approx two uv.	Tube V1, V2, or V3. RF coil assy, any on band used. Crystal switch S3. Crystal selector switch S2. RF strip. Gang condenser C1, A, B, C, D, E, F, G, H. Crystal control unit. Antenna input socket J1.

Table 6-2. Systems Trouble Analysis Chart (cont)

Step	Test Point	Test Equipment Control Position	Receiver Control Position	Normal Indication	Possible Cause of Abnormal Indication
13	Same as step 11.	Same as step 11, but vary rec input from two to 200,000 uv.	Same as step 11, but switch rec to avc operation.	Rec output of 20 volts, to remain constant within 14 db, or not to be more than 100 volts.	Tube V14, section V14B. Capacitor C138, C140, C141, C19, C40, C115, or C121. RF strip. Resistor R44, R52, R60, R61, R66, R68, or R97. Potentiometer R93. Switch S8.
14	Same as step 11.	Same as step 13.	Same as step 13, but switch rec for cw reception and remove tube V12.	Same as step 13.	Capacitor C137.
15	Same as step 11.	Same as step 11, but signal input level at 10 uv.	Same as step 13.	Meter M1 to indicate + 20 db r-f scale indication.	Potentiometer or adjustment of R69. Resistor R102. Switch S8 or S11. Meter M1.
16	Same as step 11.	Same as step 11.	Same as step 13, but turn down audio gain control for 1.9 volts rec output.	Meter M1 to indicate zero db a-f scale indication, when S11 meter switch is held in depressed position.	Tube V15, section V15B. Potentiometer or adjustment of R101. Resistor R70. Switch S8 or S11.
17	Same as step 12.	Same as step 11, but signal gen modulation "off".	Same as step 11, but rec set for cw operation, one kc tone output.	Rec input approx 0.75 uv.	Tube V13 or V12. Beat osc assy T6. Capacitor C135 or C136. Resistor R75. Potentiometer or adjustment of R74.

6-8. REMOVAL. For removal, the procedure outlined for each of the following subassemblies must be adhered to, also refer to paragraph 5-13 and 5-14.

6-9. FREQUENCY CONTROL UNIT (See figure 5-4.).
a. Unsolder black, black/white, blue/red, and red/white leads from terminal strip E13 (See figure 5-3), and solid red lead from filter capacitor.
b. Remove front panel "XTALS" switch (See 14, figure 1-2.), knurled knob.
c. Disconnect "Δ FREQ" control (See 15, figure 1-2.), flexible coupling.
d. Loosen two No. 6-32 set screws in "XTALS" switch shaft arm eccentric drive.
e. Loosen four No. 8-32 set screws to disconnect "XTALS" switch fixed coupling.
f. Unsolder capacitor at "XTALS" switch.
g. Remove supporting bracket No. 8-32 nut and washer from stud adjacent to audio filter choke.
h. Remove four No. 8-32 mounting screws from bottom of chassis to lift out crystal control unit.

NOTE

When replacing unit, set the two switches S3 and S2, comprising the "XTALS" switch, respectively, fully clockwise and to first crystal position, before tightening S2 fixed coupling and S3 eccentric drive. Then locate S2 eccentric drive to drive end of its groove, back it up slightly, and tighten. Make sure arm of eccentric drive is normal to the shaft of S3 which it drives.

6-10. MIXER TRANSFORMER, T1. To remove the mixer transformer T1 (See figure 5-4.), the crystal control unit is first removed, (Refer to paragraph 6-9.), then:

Table 6-3. Tube Socket Terminal Voltages

The voltages shown are all to chassis from the respective tube socket pins. Use a 20,000 ohm per volt voltmeter or a d-c vacuum tube voltmeter to make the measurements. Keep the a-c line voltage at 117 volts, and adjust the receiver for cw operation, but with no signal input and the audio gain control at min.

TUBE	Socket Pin Numbers									MODE OF OPERATION
	1	2	3	4	5	6	7	8	9	
V1	-1	-	6.3ac	-	200	90	-	-	-	r-f gain max
V1	-54	-	6.3ac	-	260	235	-	-	-	r-f gain min
V2	-1	-	6.3ac	-	210	100	-	-	-	r-f gain max
V2	-54	-	6.3ac	-	260	240	-	-	-	r-f gain min
V3	-	6.3ac	-	-	-	0	-	265	-	r-f gain max, var freq osc operation
V3	-	6.3ac	-	-	-	150	-	265	-	r-f gain max, crystal freq control
V3	-	6.3ac	-	-	-	0	0	290	-	r-f gain min, var freq osc operation
V3	-	6.3ac	-	-	-	150	0	280	-	r-f gain min, crystal freq control
V4	130	-	6.3ac	-	130	-	-	-	-	r-f gain max or min
V5	-	1.2	6.3ac	-	140	110	-	-	-	r-f gain max or min
V6	-	-	6.3ac	-	225	-	-1	-	-	r-f gain max, freq below 7.4 mc
V6	-	-	6.3ac	-	260	-	-1	-	-	r-f gain min, freq below 7.4 mc
V6	-	-	6.3ac	-	225	90	-1	-	-	r-f gain max, freq above 7.4 mc
V6	-	-	6.3ac	-	260	105	-1	-	-	r-f gain min, freq above 7.4 mc
V7	-11	-	6.3ac	-	225	170	-	-	-	r-f gain max, freq below 7.4 mc
V7	-11	-	6.3ac	-	260	190	-	-	-	r-f gain min, freq below 7.4 mc
V7	-11	-	6.3ac	-	225	0	-	-	-	r-f gain max, freq above 7.4 mc
V7	-11	-	6.3ac	-	260	0	-	-	-	r-f gain min, freq above 7.4 mc
V8	0	-	6.3ac	-	0	-	-	-	-	freq below 7.4 mc
V8	30	-	6.3ac	-	30	-	-	-	-	freq above 7.4 mc
V9	-1	-	6.3ac	-	205	90	-	-	-	r-f gain max
V9	-54	-	6.3ac	-	260	235	-	-	-	r-f gain min
V10	-1	-	6.3ac	-	205	90	-	-	-	r-f gain max
V10	-54	-	6.3ac	-	260	235	-	-	-	r-f gain min
V11	-11	-	6.3ac	-	210	145	-	-	-	r-f gain max
V11	-11	-	6.3ac	-	240	145	-	-	-	r-f gain min

Table 6-3. Tube Socket Terminal Voltages (cont)

TUBE	Socket Pin Numbers									MODE OF OPERATION
	1	2	3	4	5	6	7	8	9	
V12	-	-	6.3ac	-	210	40	-	-	-	r-f gain max, bfo injection max
V12	-	-	6.3ac	-	240	45	-	-	-	r-f gain min, bfo injection max
V13	25	-	6.3ac	-	25	-	-	-	-	r-f gain max or min
V14	-	-	6.3ac	-	22	-	-	-	-	r-f gain max or min
V15	-	-	6.3ac	-	-	-	-	-	-	r-f gain max or min
V16	50	-	1.5	-	-	210	-	6.4	6.3ac	r-f gain max
V16	52	-	1.6	-	-	240	-	7.4	6.3ac	r-f gain min
V17	-	-	260	228	-	-	6.3ac	12	-	r-f gain max
V17	-	-	280	265	-	-	6.3ac	13	-	r-f gain min
V18	150	-	-	-	150	-	-	-	-	r-f gain max or min
V19	-	300	-	-	-	-	-	300	-	r-f gain max, 5.0 ac pin 2 to pin 8
V19	-	320	-	-	-	-	-	320	-	r-f gain min, 5.0 ac pin 2 to pin 8
V20	-	-96	6.3ac	-	-	-	-96	-	-	r-f gain max
V20	-	-97	6.3ac	-	-	-	-97	-	-	r-f gain min

Table 6-4. Tube Socket Terminal Resistances

The resistance values shown are all to chassis from the respective tube socket pins, with the tube removed from the socket under measurement. Use a volt-ohmmeter to make the measurements. Keep the audio gain control at max, the r-f gain control at min, the limiter off, and set the rec for cw avc operation.

Tube Socket	Socket Pin No.									Mode of Operation
	1	2	3	4	5	6	7	8	9	
V1	1800K	0	-	0	48K	80K	0	-	-	
V2	1800K	0	-	0	48K	80K	0	-	-	
V3	0	-	0	47K	0	46K	-	46K	-	crystal freq control positions 1-6
V4	infinity	infinity	-	0	infinity	47K	0	-	-	crystal freq control positions 1-6
V4	48K	infinity	-	0	infinity	47K	0	-	-	var freq osc operation
V5	47K	150	-	0	48K	53K	500K	-	-	
V6	22K	0	-	0	46K	infinity	100K	-	-	freq bands below 7.4 mc
V6	22K	0	-	0	46K	70K	100K	-	-	freq bands above 7.4 mc
V7	115K	0	-	0	46K	infinity	0	-	-	freq bands above 7.4 mc

Table 6-4. Tube Socket Terminal Resistance (cont)

Tube Socket	Socket Pin No.									Mode of Operation
	1	2	3	4	5	6	7	8	9	
V7	115K	0	-	0	46K	80K	0	-	-	freq bands below 7.4 mc
V8	-	-	-	0	infinity	22K	0	-	-	freq bands below 7.4 mc
V8	-	-	-	0	150K	22K	0	-	-	freq bands above 7.4 mc
V9	1300K	0	-	0	52K	80K	0	-	-	
V10	1300K	0	-	0	52K	80K	0	-	-	
V11	125K	0	-	0	48K	50K	0	-	-	
V12	0	0	-	0	48K	145K	*	-	-	*zero to 1K (bfo injection control)
V13	-	-	-	0	195K	100K	0	-	-	
V14	0	812K	-	0	16K	0	220K	-	-	
V15	94K	infinity	-	0	infinity	0	220K	-	-	
V16	150K	500K	1K	0	0	46K	470K	680	-	
V17	0	0	46K	46K	470K	infinity	-	360	-	
V18	118K	-	-	-	78K	-	0	-	-	
V19	-	46K	0	55	-	55	-	46K	-	
V20	50K	65K	-	0	50K	0	65K	-	-	

a. Remove chassis side shield by removing 10 No. 10-32 and two No. 6-32 screws from side, and four No. 10-32 screws on front panel.
b. Remove two No. 6-32 cap nuts to remove mixer cover.
c. Remove six No. 6-32 screws to remove mixer shield.
d. Unsolder all 10 leads at top terminal board.
e. Unsolder all five leads at bottom terminal board.
f. Remove four No. 6-32 screws to remove mixer transformer.

6-11. RF STRIP (See figure 5-4.).
a. Remove 10 No. 6-32 screws to remove top shield from tuning unit assembly.
b. Unsolder 12 bus leads from r-f strip and four ground straps from main tuning condenser.
c. Remove mixer cover by removing the two No. 6-32 cap nuts.
d. Unsolder blue, blue/red, the top white/black, the top red/green, red/white, and yellow/black leads from r-f strip.
e. Unsolder bare wire from r-f strip to "XTALS" switch (See 14, figure 1-2.).
f. Turn front panel "BAND CHANGE" control (See 3, figure 1-2.), exactly half way between indentations, i.e. as between two band positions.
g. Remove four No. 6-32 screws from top of r-f strip.
h. Remove four No. 6-32 screws from side of r-f strip.
i. Remove r-f strip.

6-12. GANG CONDENSER.
a. Unsolder 12 bus leads from r-f strip and four ground straps from gang condenser.
b. Mesh the gang condenser fully.
c. Remove loop spring and link arm from gang condenser rotor arm.
d. Remove one No. 10-32 screw and spacer from front mounting plate.
e. Hold the condenser by its frame and remove one No. 10-32 screw and stud from the rear of tuning unit.
f. Move condenser to the rear to clear dowel pins and lift the condenser out.

NOTE

To replace a gang condenser, the main dial pointer must line up with the first line marking on the main dial when the gang condenser is fully meshed. This may necessitate the mounting re-adjustment of the main tuning dial. The front panel must be removed to get at the main dial mounting screws.

6-13. FRONT PANEL.
a. Remove bfo, r-f gain, tuning, band change, and audio gain control knobs from front panel.
b Remove nuts on all toggle switches and on phones jack contained in front panel.
c. Remove the 10 No. 10-32 front panel mounting screws and washers.
d. Disconnect all four flexible couplings to front panel shafts.
e. Remove the meter strip from its meter terminal mounting.

6-14. MAIN DIAL. To remove the main dial, the front panel is first removed (Refer to paragraph 6-13.). Then loosen the three flat head main dial mounting screws to relocate the main dial, so that with the gang condenser fully meshed, the main dial frequency pointer lines up with the main dial first line marking.

6-15. CIRCUIT BREAKDOWN. The circuit of the radio receiver is shown subdivided according to function (See figures 4-2 thru 4-10.), to clarify the operation of each receiver section (Refer to paragraphs 4-9 thru 4-60.). In instances where the radio receiver fails to meet specific minimum performance standards and attention is drawn to a specific functional section (See tables 5-1 and 6-1.), the figures 4-2 thru 4-10, as applicable, are used to perform the sectional trouble analysis of the receiver to which the receiver fault has been localized. To do this the receiver sections that follow the section suspected to contain the fault are checked by the appropriate step test point check (See table 6-2.), as compared to performing each step test point check in instances where the fault has not been localized to a specific section of the receiver. The step test point checks (See table 6-2.), are then performed for the faulty section to further localize the section fault.

6-16. TUBE SOCKET VOLTAGE AND RESISTANCE CHARTS. The tube socket voltage chart (See table 6-3.), and the tube socket resistance chart (See table 6-4.), provide for isolating the receiver section fault to the receiver section circuitry concerned with providing each section tube with its proper a-c filament and d-c supply voltages.

6-17. When the step test point checks (See table 6-2.), have localized the receiver fault to specific circuitry comprising the receiver section, use is made of the tube socket voltage chart (See table 6-3.), to determine whether the tube socket terminal voltages of the tube contained in the faulty circuitry agree with the normal indications provided on the chart. The tube socket terminals which show abnormal voltage indications are noted and the receiver turned "off". Use is then made of the tube socket terminal resistance chart (See table 6-4.), to check the affected tube terminals with regard to each affected tube terminal resistance to ground, as provided for the tube on the chart. These tube terminal resistance checks are made with the tube removed from the receiver. Through means of figures 4-2 thru 4-9, apart from 4-6, as applicable, the abnormal tube socket terminal resistance circuitry is traced to ground or to a supply voltage point. Since the tube socket terminal, with the tube removed, is an open circuit point, the resistance check from the terminal to ground provides for tracing the resistance to ground from each resistor in the circuitry to ground. This is done by making checks for the resistance to ground at each resistor in turn, the normal resistance to ground being provided by subtracting the resistance value of the resistor or resistors between the check point and the tube socket terminals from the terminal socket resistance value provided for the tube terminal in the table 6-4. When this is done and a supply voltage point is reached, the same procedure for figure 4-10, the self-contained power supply section circuitry provides for the to ground resistance from each supply voltage point, the resistance to ground from the minus one volt d-c bias being determined at test point ③, Step 3, the junction of R93 and R94 (See table 5-2.), and the resistance to ground from the -10 volt d-c bias being determined at the test point ④, Step 4, the junction of R95 and R96 (See table 5-2.). The R60 and R97 resistors (See figure 4-8.), of the automatic volume control functional circuitry are checked individually, and not to ground, in instances where either one is suspected of causing the receiver section fault. When checking R32 and R33 (See figure 4-4.), whose resistance values are respectively 510 and 1500 ohms, note that their resistance in parallel is only approximately 380.6 ohms. In instances where the r-f strip is the cause of the receiver fault, the r-f strip must be removed to determine what resistor, capacitor, or other part is shorted, open, or of the wrong value, etc., as applicable, even though the tube socket voltage and resistance charts provide for locating the r-f strip fault to a specific tube socket terminal.

6-18. ALIGNMENT AND ADJUSTMENTS. The alignment sequence for the radio receiver is to align the 455 kc i-f section first, then to align the 3,955 kc double converter, and finally the r-f and heterodyne frequency oscillator section, for each band.

NOTE

> Do not attempt to align the receiver unless tube socket voltages (See table 6-3.), and tube socket terminal resistances (See table 6-4.), are normal. Exercise caution during realignment since slight angular alignment adjustments should realign the receiver.

6-19. The receiver alignment and adjustment procedures (See table 6-5.), outline the step sequence to align and adjust the receiver. When a receiver repair confines the receiver realignment to a specific receiver section, only the appropriate alignment or adjustment step(s) need be performed. The receiver controls are referred to in the table by their front panel designations (See figure 1-2.), the screwdriver adjustment controls by their rear apron designations (See figure 1-3.), and the screwdriver alignment means by the circuit L or C reference symbols (See figure 5-6.), of the trimmer condensers and adjustable core tuning coils, as applicable, which are positioned for alignment for the band indented by the "BAND CHANGE" control (See 3, figure 1-2.). The figure illustrating the test equipment set-up for each step is referenced in the table column outlining the test equipment adjustments made. The receiver 455 and 3,955 kc i-f alignment procedures (See table 6-5.), are outlined both for output meter and oscilloscope indication of which, the latter is the preferred method.

Table 6-5. Receiver Alignment and Adjustment Procedures

Step	Test Equipment Adjustment	Receiver Control Positions	Alignment or Adjustment Means
1	Output Meter Indication. Test set up (Refer to paragraph 6-7.). Signal gen input of 455 kc, 30 percent 400 cps AM, using adapter, between the test point ⓖ, the pin 7 grid of V5 mixer, and ground, thru 0.01 uf, at signal level to show some deflection on power output meter set for 600 ohm rec audio output term matching load. Reduce signal level as rec is aligned to below 200 uv, to prevent rec overload.	"SEND" "REC" switch (See 1, figure 1-2.), to "REC". "MOD" "CW" switch (2) to "MOD". "AVC" "MAN" switch (10) to "MAN". "SELECTIVITY" switch (6) to "3" kc. "AUDIO GAIN" control (12) at max; use approx 20 volts output meter indication. "BAND CHANGE" control (3) for 1.35 - 3.45 mc band. "TUNING" control (4) for 2.5 mc. "XTAL PHASING" control (7) to arrow. "RF GAIN" control (9) at max, then as rec alignment is made reduce to prevent excessive output.	Adjust in turn, L42, L41, L39, L38, L36, L32, for max output.
2	Adjust signal gen freq for max rec output to establish correct signal freq for i-f amplifier by the Y8, 455 kc crystal and maintain this signal gen setting unless to recheck to render assurance signal gen freq has not drifted.	"SELECTIVITY" switch (6) to "0.2" kc position, others as in step 1.	None.
3	Same as for step 2.	"SELECTIVITY" switch (6), back to "3" kc position, others as in step 1.	Readjust in turn, L42, L41, L39, L38, L36, L32, for max output.
4	Same as for step 2.	"SELECTIVITY" switch (6) to "1.3" kc position, others as in step 1.	Adjust L37 for max output.
5	Same as step 2 but switch "off" signal gen AM.	Same as step 4, but with "MOD" "CW" switch (2) in "CW" position. Set "BEAT OSC" control (8) to "0" dial position. Allow 15 minute warm up period.	Adjust L44 for zero output.
6	Same as step 1, but signal gen input of 3,955 kc, 30 percent 400 cps AM.	"SELECTIVITY" switch (6) to "3" kc position. "BAND CHANGE" control (3) for 7.4 - 14.8 mc band, "TUNING" control (4) not moved, others as in step 1.	Adjust in turn, L31, L33, L34, for max output.

Table 6-5. Receiver Alignment and Adjustment Procedures (cont)

Step	Test Equipment Adjustment	Receiver Control Positions	Alignment or Adjustment Means
7	Test set up (See figure 5-1.). Signal gen input of 0.56 mc, 30 percent 400 cps AM, using antenna input cable (See figure 2-2.), to antenna input socket J2 (See figure 5-6.), at signal level to show some deflection on power output meter across 600 ohm rec audio output term. Reduce signal level as rec is aligned to prevent rec overload. Note. To maintain accuracy of signal gen freq (Refer to Table 6-1.).	"SELECTIVITY" switch (6) to "3" kc position. "SEND" "REC" switch (1) to "REC". "XTALS" switch (14) to "VFO". "MOD" "CW" switch (2) to "MOD". "AUDIO GAIN" control (12) at max; use approx 20 volts output meter indication. "BAND CHANGE" control (3) for 0.54 - 1.35 mc band. "TUNING" control (4) for 0.56 mc main dial indication. "LIMITER" "OFF" switch (13) to "OFF". "RF GAIN" control (9) at max. "AVC" "MAN" switch (10) to "AVC".	Adjust in turn, L25, L1, L8, L15, for max output.
8	Same as for step 7, but signal gen input of 1.3 mc, 30 percent 400 cps. AM. See note in step 7.	Same as for step 7, but set "TUNING" control (4) for 1.3 mc main dial indication.	Adjust in turn, C76, C2, C26, C46, for max output.
9	Repeat step 7 and step 8 in sequence.	Repeat step 7 and 8 in sequence.	Repeat step 7 and step 8 in sequence until no further increase in output results.
10	Same as step 9, but set signal gen level to approx three uv.	Same as step 9, but set "AVC" "MAN" switch (10) to "MAN". "RF GAIN" control (9) set to maintain approx 20 volts output meter indication as rec is aligned.	Same as step 9, repeat as needed.
11	Same as step 7, but signal gen input of 1.4 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but "BAND CHANGE" control (3) for 1.35 - 3.45 mc band, "TUNING" control (4) for 1.4 mc, main dial indication.	Adjust in turn, L26, L2, L9, L16, for max output.
12	Same as step 8, but signal gen input of 3.4 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but set "TUNING" control (4) for 3.4 mc main dial indication.	Adjust in turn, C81, C4, C28, C48, for max output.
13	Repeat step 11 and step 12 in sequence.	Repeat step 11 and step 12 in sequence.	Repeat step 11 and step 12 in sequence until no further increase in output results.

Table 6-5. Receiver Alignment and Adjustment Procedures (cont)

Step	Test Equipment Adjustment	Receiver Control Positions	Alignment or Adjustment Means
14	Same as step 13, but set signal gen level to approx three uv.	Same as step 13, but set rec controls as in step 10.	Same as step 13, repeat as needed.
15	Same as step 7, but signal gen input of 3.75 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but "BAND CHANGE" control (3) for 3.45 - 7.4 mc band, "TUNING" control (4) for 3.75 mc.	Adjust in turn, L27, L3, L10, L17, for max output.
16	Same as step 8, but signal gen input for 7.15 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but set "TUNING" control (4) for 7.15 mc main dial indication.	Adjust in turn, C84, C7, C31, C51, for max output.
17	Repeat step 15 and 16 in sequence.	Repeat step 15 and step 16 in sequence.	Repeat step 15 and step 16 in sequence until no further increase in output results.
18	Same as step 17, but set signal gen level to approx three uv.	Same as step 17, but set rec controls as in step 10.	Same as step 17, repeat as needed.
19	Same as step 7, but signal gen input of 7.5 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but "BAND CHANGE" control (3) for 7.4 - 14.8 mc band, "TUNING" control (4) for 7.5 mc.	Adjust in turn, L28, L4, L11, L18, for max output.
20	Same as step 8, but signal gen input for 14.5 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but set "TUNING" control (4) for 14.5 mc main dial indication.	Adjust in turn, C86, C10, C34, C54, for max output.
21	Repeat step 19 and step 20 in sequence.	Repeat step 19 and step 20 in sequence.	Repeat step 19 and step 20 in sequence until no further increase in output results.
22	Same as step 21, but set signal gen level to approx three uv.	Same as step 21, but set rec controls as in step 10.	Same as step 21, repeat as needed.
23	Same as step 7, but signal gen input of 15.0 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but "BAND CHANGE" control (3) for 14.8 - 29.7 mc band, "TUNING" control (4) for 15.0 mc.	Adjust in turn, L29, L5, L12, L19, for max output.
24	Same as step 8, but signal gen input for 29.0 mc, 30 percent 400 cps AM. See note in step 7.	Same as step 7, but set "TUNING" control (4) for 29.0 mc main dial indication.	Adjust in turn, C90, C13, C36, C56, for max output.
25	Repeat step 23 and step 24 in sequence.	Repeat step 23 and step 24 in sequence.	Repeat step 23 and step 24 in sequence until no further increase in output results.

Table 6-5. Receiver Alignment and Adjustment Procedures (cont)

Step	Test Equipment Adjustment	Receiver Control Positions	Alignment or Adjustment Means
26	Same as step 25, but set signal gen level to approx three uv.	Same as step 25, but set rec controls as in step 10.	Same as step 25, repeat as needed.
27	Same as step 7, but signal gen input 30.0 mc 30 percent 400 cps AM. See note in step 7.	Same as step 7, but "BAND CHANGE" control (3) for 29.7 - 54.0 mc band, "TUNING" control (4) for 30.0 mc.	Adjust in turn, L30, L6, L13, L20,for max output.
28	Same as step 8, but signal gen input for 52.0 mc 30 percent 400 cps AM. See note in step 7.	Same as step 7, but set "TUNING" control (4) for 52.0 mc main dial indication.	Adjust in turn, C94, C16, C38, C58, for max output.
29	Repeat step 27 and step 28 in sequence.	Repeat step 27 and step 28 in sequence.	Repeat step 27 and step 28 in sequence until no further increase in output results.
30	Same as step 29, but set signal gen level to approx three uv.	Same as step 29, but set rec controls as in step 10.	Same as step 29, repeat as needed.
Alternative for steps 1 thru 5.	<u>Oscilloscope Indication.</u> Test set up (See figure 6-3.). Sweep signal gen input of 455 kc, ±20 kc approx FM, using adapter, between the test point Ⓖ, the pin 7 grid of V5 mixer, and ground, thru 0.01 uf, and oscilloscope vertical input across the diode detector load resistance from the junction of R64 and R65 to chassis, at level and sweep to provide good oscilloscope image.	Same as steps 1 thru 5.	Same as steps 1 thru 5, but make adjustments for both max amplitude and oscilloscope image coincidence, using crystal filter as a reference to establish correct nominal 455 kc freq of sweep signal gen as in step 2.
Alternative for step 6.	Same as Oscilloscope Indication for Alternative for steps 1 thru 5, except that sweep signal gen input used is 3,955 kc, ± 20 kc approx FM.	Same as step 6.	Same as step 6, but make adjustments for both max amplitude and oscilloscope image coincidence.

6-20. LUBRICATION. The radio receiver requires no lubrication during the life of the receiver. The life of the receiver within the scope of the present maintenance activities is ended whenever the receiver is subjected to depot overhaul. The receiver overhaul requirements may necessitate re-lubrication at the depot. All the receiver subassemblies provided as replacements may be used as such, since any which incorporate moving parts requiring lubrication, have been properly conditioned at the factory for immediate use.

6-21. MAINTENANCE AND INSPECTION SCHEDULE. The present maintenance activities should inspect each radio receiver to be serviced, prior to and subsequent to any repair and test work done. The inspection prior to repair provides for all the receiver mechanical defects to be determined and then repaired without the needless movement of the receiver back and forth between the repair bench and test, apart from providing for the immediate determination as to whether the receiver defects are within the scope of the present maintenance activities. The inspection subsequent to repair and test provides assurance that the receiver, when released, will maintain performance for long periods of time.

6-22. Often, the receiver life may be prolonged by the care taken to make a receiver repair, such that other parts are not damaged or weakened when the faulty part is replaced. Thus, the receiver should be thoroughly examined as to the physical perfection of each of the parts comprising it, the replacement of any discolored or otherwise damaged part providing for the preventive maintenance of the receiver.

6-23. The receiver should be inspected for dirt, dust, corrosion; tropicalization of r-f coils, chokes, and soldered joints; evidence of oil leakage; loose assemblies, trimmers, and adjustable cores; poor soldering, and partially broken leads. When the removal of accessible dirt, etc., bares deep seated dirt in the receiver movable parts, the receiver requires depot overhaul.

6-24. The receiver should be inspected according to the proper functioning of all controls (Refer to paragraph 5-3d.). The receiver design utilizes the spring action of various types of springs to maintain mechanical performance and for purposes of furnishing positive electrical grounding between moving parts.

a. Inspect the "U" shaped loop spring used to retain the main tuning condenser drive link to see that it is properly seated and not stretched due to receiver having been subjected to excessive shock, due to dropping in transit.

b. Inspect the three double "U" spider loop springs used in the gear-train assembly for anti-backlash, to see that each is properly seated and not mis-shaped.

c. Inspect, by removing all r-f tuner coil assemblies except those on one band, the knife action of the contact pins on the r-f tuner coil assemblies, to see that the "V" contact spring blades for the r-f tuner coil assemblies on the r-f strip are spread uniformly, not broken, and provide positive electrical contact, as evidenced by a clean track made at contact points.

d. Inspect the forked end play flat spring at the rear of the turret assembly to see and feel that it bears up against turret rotor for no rotor end play, as evidenced by a clean track made at area of contact.

e. Inspect the wavy flat spring at the front of the turret rotor assembly for wavy shape.

f. Inspect the three flat springs used to provide electrical grounding to the turret rotor shaft by noting that each at area of rotor contact leaves a clean track.

g. Inspect the crystal holder six flat springs to see each provides positive holding action to inserted crystals.

h. Inspect flat spring for grounding each i-f transformer shield, two flat springs used to retain each r-f coil, and two flat springs used to retain r-f tuner coil assemblies, to see that positive spring action is provided.

i. Inspect two helical springs on band change detent switch to see switch provides positive detent action; also inspect similar type springs, one each, used to provide indicator slide action and holding action of conversion switch located at the rear of the turret rotor assembly.

6-25. Each of the possible mechanical faults of the receiver, unless attended to at the first opportunity available, may eventually result in receiver failure during an operational activity. The performance of the necessary preventive maintenance within the scope of the present maintenance activity should as a consequence be carefully evaluated before the receiver is released for use. In instances where the preventive maintenance is within the scope of depot mainte-

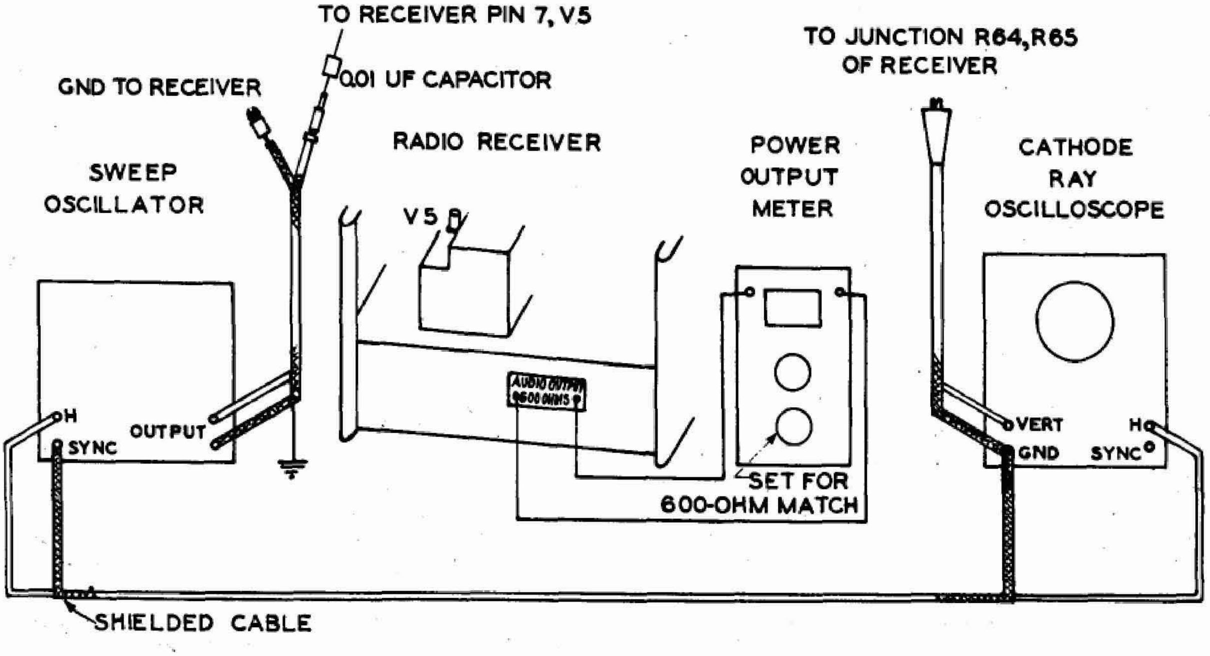


Figure 6-3. Receiver 455 kc and 3,955 kc Alignment KRT Indication Test Set-up

nance, the receiver must be sent to the depot for depot analysis with regard to the need for the immediate repair of the preventive maintenance indicated.

6-26. OVERHAUL SCHEDULE. The overhaul schedule for the radio receiver is dependent entirely on the operating conditions the receiver is subjected to when in use. When the present maintenance activities repair a receiver and subject it to the preventive maintenance outlined (Refer to paragraphs 6-21 thru 6-25.), the receiver overhaul schedule is determined whenever the receiver is sent to depot maintenance for overhaul. A receiver which provides satisfactory performance such that no occasion arises to check it for preventive maintenance in connection with repair, should be periodically scheduled for overhaul according to table 6-6.

Table 6-6. Receiver Overhaul Schedule

CLASS OF SERVICE	MONTHS ELAPSED TIME
Fixed Station	12
Field Station	6
Mobile Field	3
Airborne	3
Any, at high Relative Humidity and/or Temp.	1

SECTION VII

DIAGRAMS

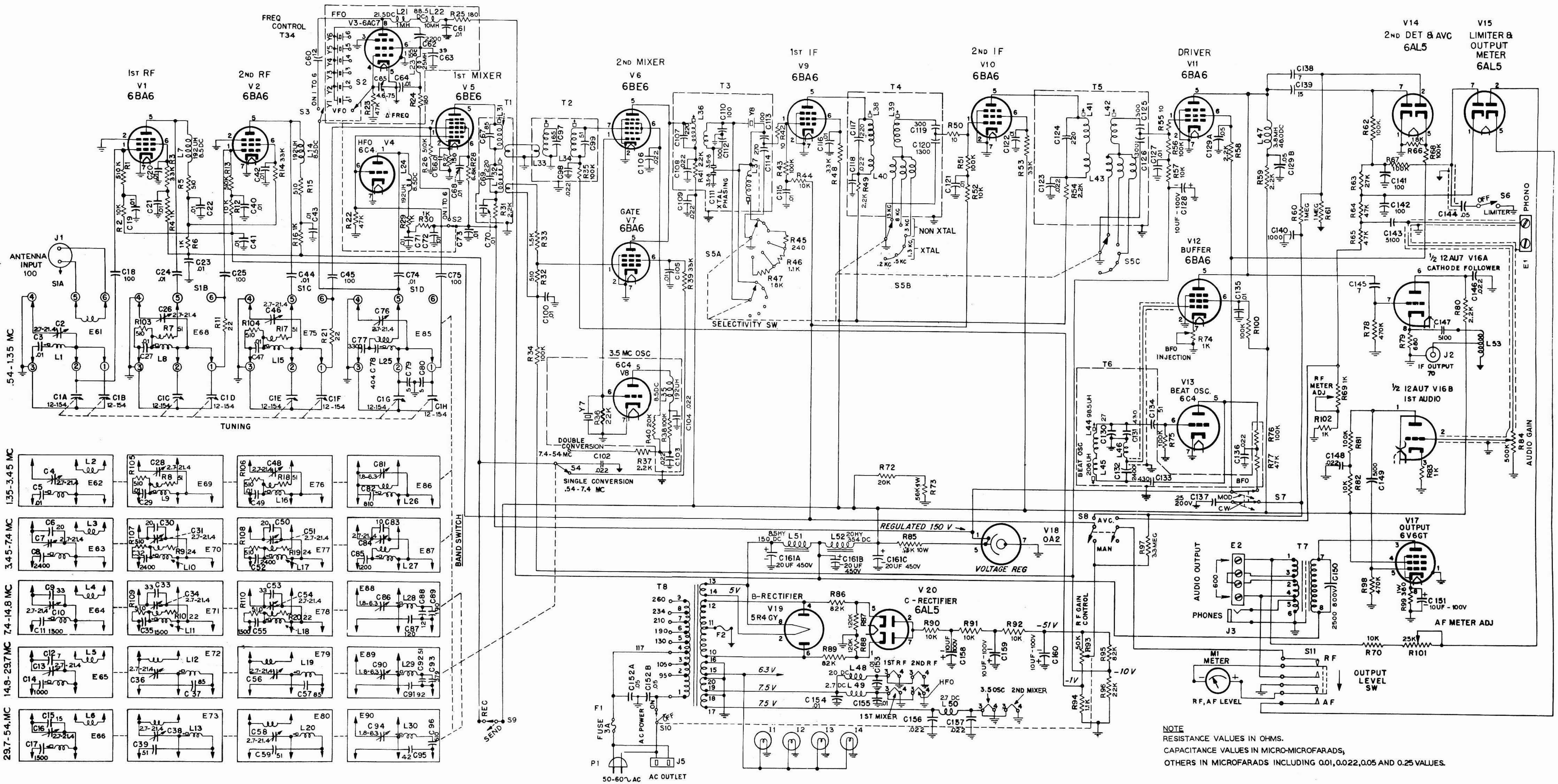


Figure 7-1. Radio Receiver, Schematic Diagram

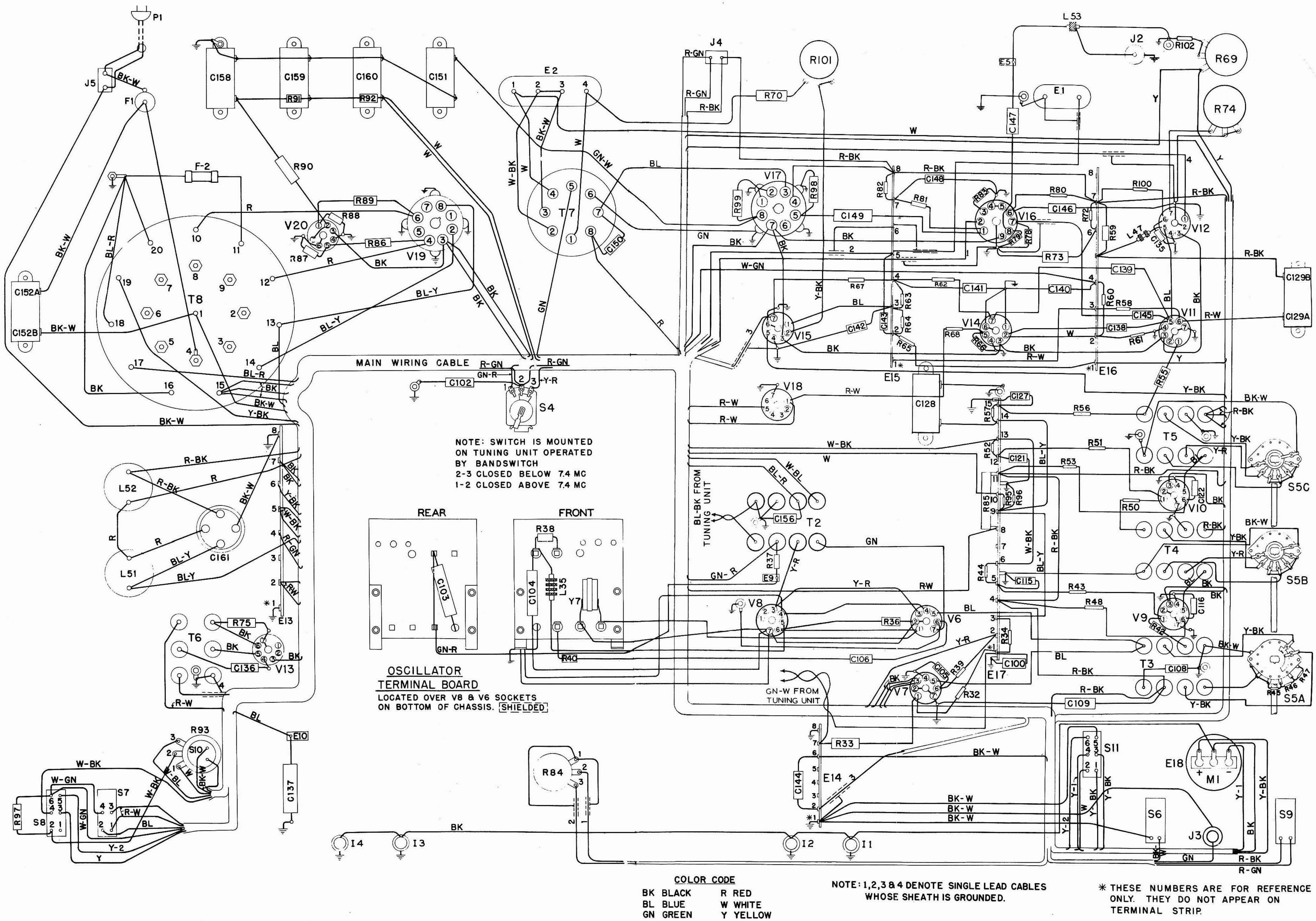


Figure 7-2. Radio Receiver, Chassis Connection Diagram

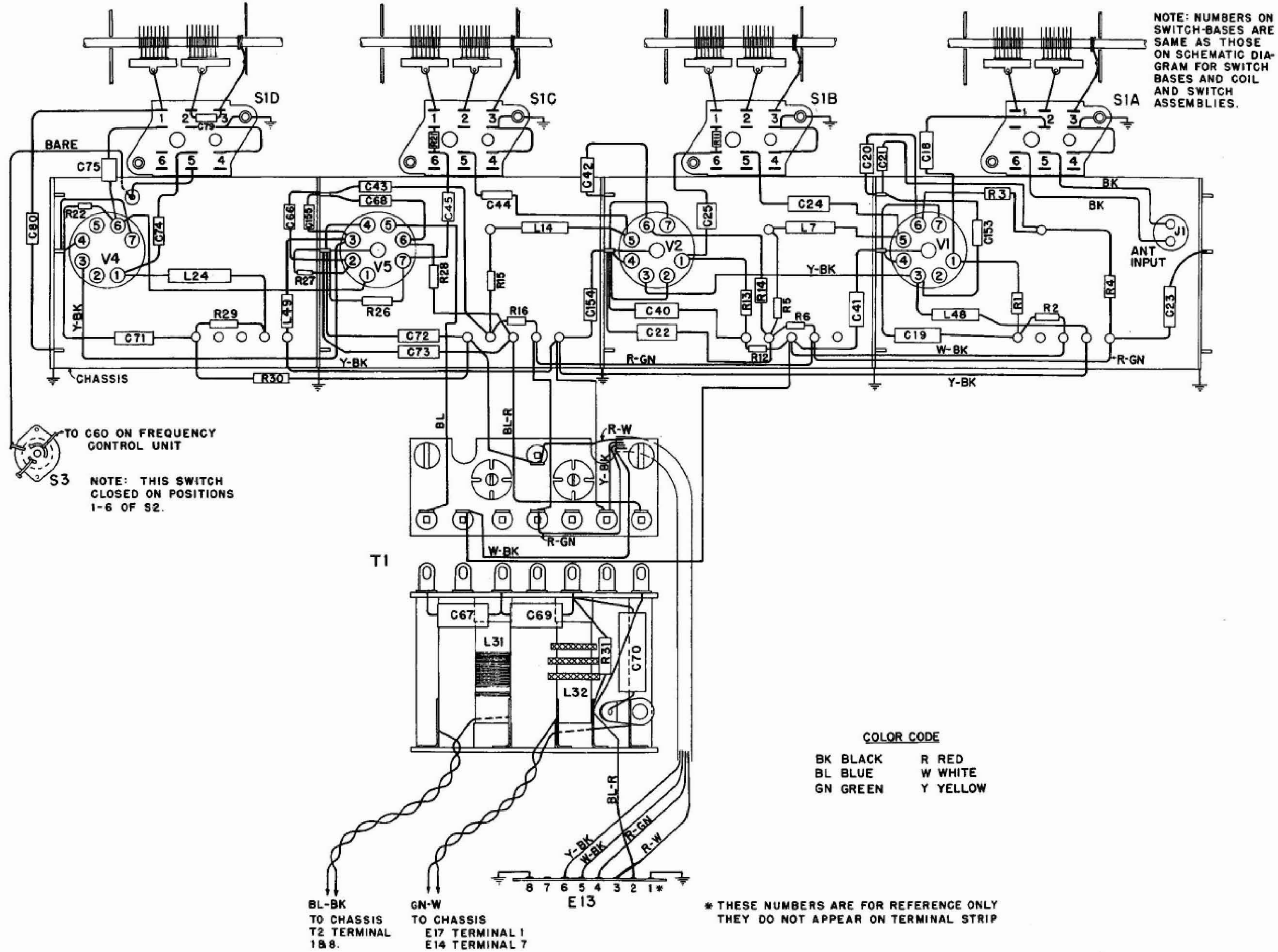
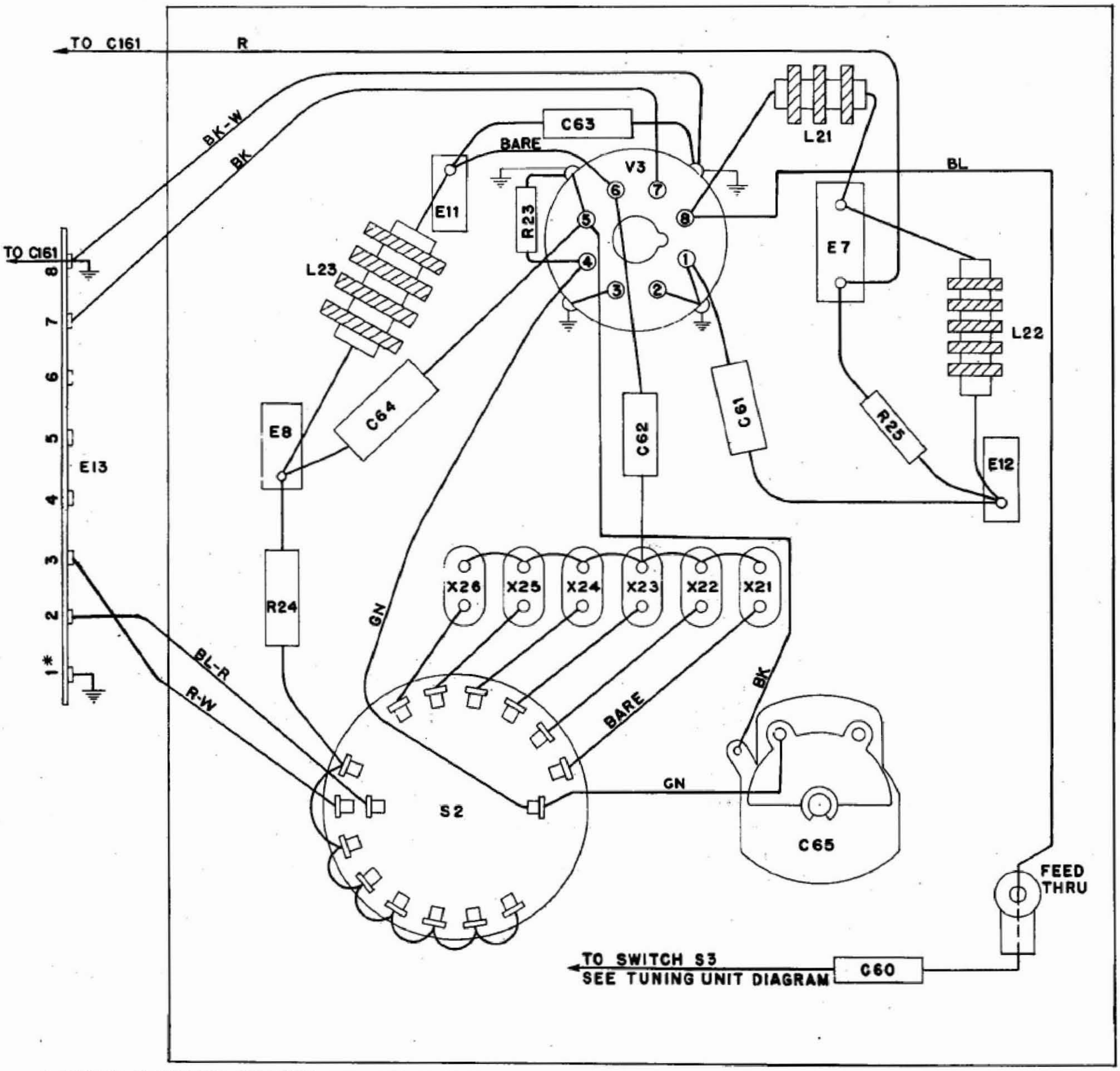


Figure 7-3. Radio Receiver, Tuning Unit Connection Diagram



* THESE NUMBERS ARE FOR REFERENCE ONLY. THEY DO NOT APPEAR ON TERMINAL STRIP.

COLOR CODE

BK BLACK	R RED
BL BLUE	W WHITE
GN GREEN	Y YELLOW

Figure 7-4. Radio Receiver, Frequency Control Unit Connection Diagram

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