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HANDBOOK
SERVICE INSTRUCTIONS

RADIO RECEIVER
MODEL SP-600-JX-17

(HAMMARLUND)

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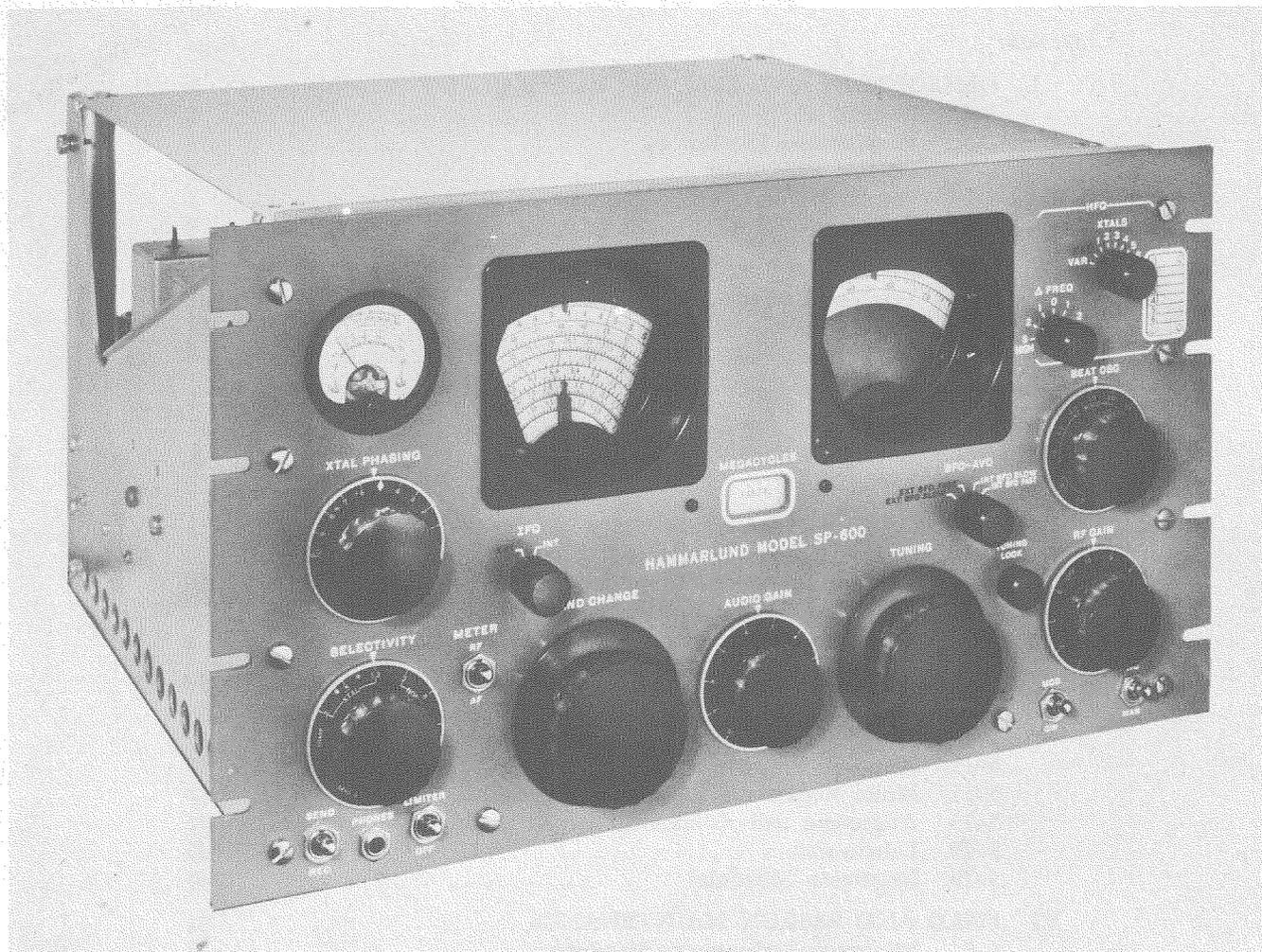


Figure 1-1. Radio Receiver, Diversity Model SP-600-JX-17 Rack Mountings



Figure 1-1. Radio Receiver, Diversity Model SP-600-JX-17 Rack Mountings

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. GENERAL.

1-2. The service instructions outlined herein pertain to the Radio Receiver, Diversity Model SP-600-JX-17 rack mountings (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, consists of a chassis and light grey front panel assembly to which are mounted a top cover and a bottom plate. It is a 20-tube radio communications receiver with six frequency bands for the continuously variable, selective reception of any signal within the frequency range of 0.54 to 54.0 mc. It has added provision for the fixed-frequency crystal-controlled reception of any signal within the frequency range of two to 30.0 mc.

1-3. The receiver is of the superheterodyne type. On the three lower frequency bands (0.54 to 7.4 mc) the signal tuned in is heterodyne converted to 455 kc. On the three higher frequency bands (7.4 to 54.0 mc) the signal tuned in is double heterodyne converted to 455 kc, the initial conversion frequency used being 3,955 kc.

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 and secondary plate windings. The primary and secondary fuses used are contained respectively in the "1.6A SLO" and "3/8A" "FUSE" holders (1 and 2, figure 1-3) on the rear apron of the receiver. A duplicate of each of these fuses, comprising the receiver spare fuse complement is located under the polystyrene "SPARE FUSES" cover (3), retained by the captive screw (4). The receiver "AC POWER" connector (5) provides for plug connecting the a-c line source to the receiver.

CAUTION

To prevent damage, maintain the fuse complement.

1-5. PURPOSE AND LIMITATIONS.

1-6. The receiver is designed for use in fixed and/or mobile operations such as are encountered at enclosed

base stations, aboard ship, or when airborne, even when such activities are subjected to wide ranges in temperature and humidity. The receiver is adequately treated with fungicidal varnish to condition it for tropical use. Its 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 such as is encountered in multi-receiver installations. It is suited to two-way operational activities and may be "desensitized" in the presence of a strong local carrier, through use of the "SEND" "REC" switch (1, figure 1-2) in its "SEND" position. The receiver is suited especially for use in frequency-shift space diversity receiving systems. When properly interconnected, two receivers may be operated so that one receiver is heterodyne slave connected to the other, or an externally connected master oscillator unit may be used to provide the heterodynes for both receivers. To provide for a common 3.5 mc crystal-controlled heterodyne between receivers, the "IFO" connector (6, figure 1-3) of each receiver is interconnected and the "IFO" "EXT" "INT" switch (2, figure 1-2) of the slave receiver is set to "EXT". Likewise, for the fixed-frequency crystal-controlled heterodyne, the "HFO OUTPUT" connector (figure 5-4) of each is interconnected, and the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2) of the slave receiver is set to "EXT". Likewise, for the bfo heterodyne, the "BFO" connector (7, figure 1-3) of each is interconnected, and the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2) of the slave receiver is set to one of its "EXT BFO" positions.

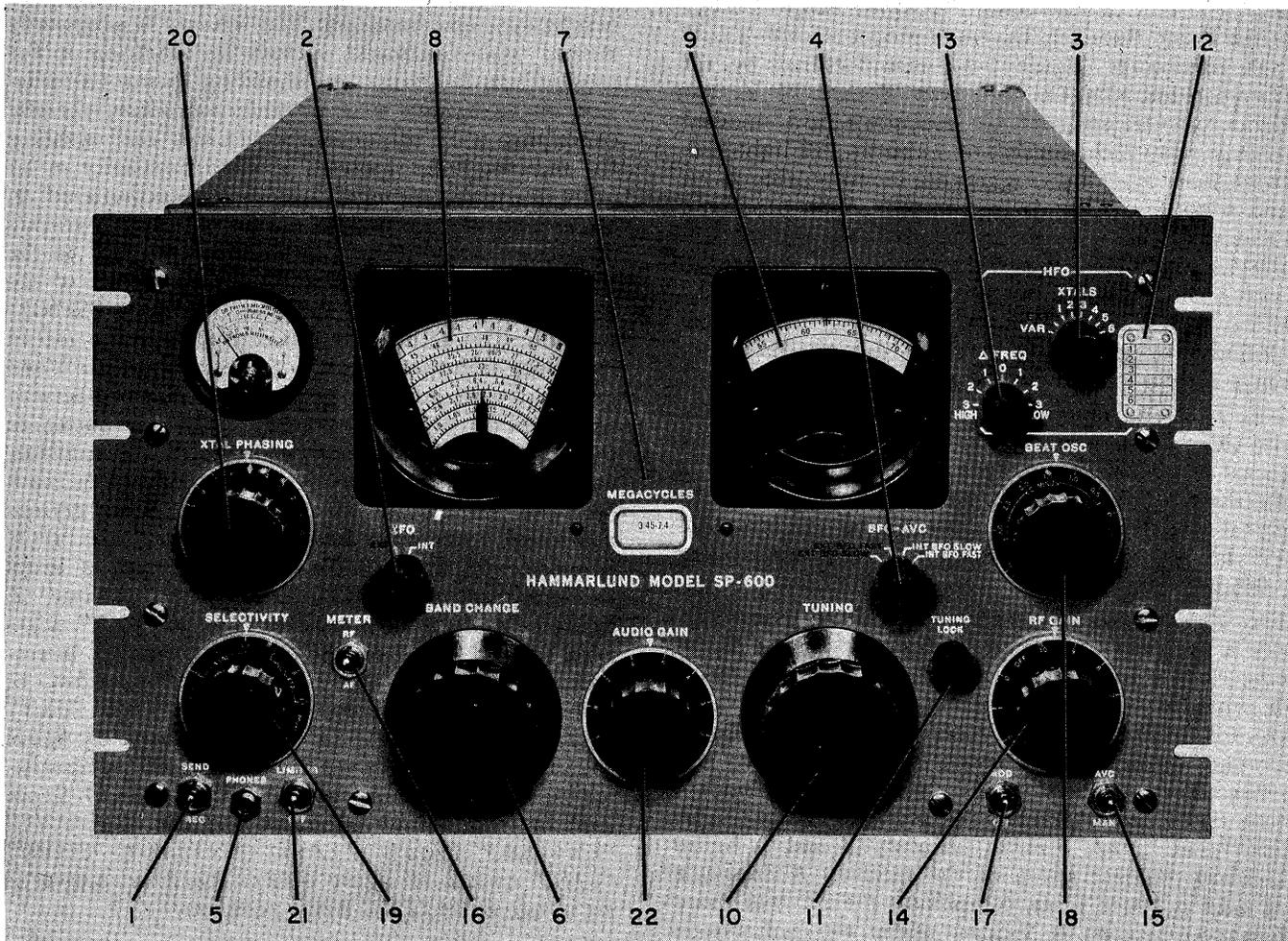
1-7. The receiver is designed to provide for the reception of amplitude-modulated, suppressed carrier, keyed-carrier, and frequency-shift signals. For the reception of radio telephone or low-speed (manual) telegraph a headset is plugged in the "PHONES" jack (5, figure 1-2) contained in the front panel, or a loud speaker is connected to the "AUDIO OUTPUT" terminals (8, figure 1-3) on the rear apron. For the reception of high-speed (automatic) telegraph, the receiver d-c output developed between the jumpered "DIODE OUTPUT" terminals (9, figure 1-3) and chassis ground, may be used to operate a tape ink recorder, or the receiver a-c output developed at the "AUDIO OUT-

PUT" terminals (8, figure 1-3) may be used to operate a recorder driving unit associated with the tape ink recorder. For the reception of frequency-shift teletype, the receiver 455-kc i-f output developed at the "IF OUTPUT" connector (10, figure 1-3) or the receiver a-f output developed at the "AUDIO OUTPUT" terminals (8, figure 1-3) may be used to operate suitable frequency-shift receiver converter equipment associated with a teletypewriter. For the reception of keyed-carrier, single or two-tone carrier teletype, the receiver a-f output developed at the "AUDIO OUTPUT" ter-

minals (8, figure 1-3) is used to operate suitable demodulator equipment associated with a teletypewriter.

1-8. LEADING PARTICULARS.

1-9. The receiver antenna system used is connected to the "ANT" input connector (11, figure 1-3). The receiver input impedance is designed to match a 95-ohm coaxial cable for optimum coupling. A straight wire antenna system, preferably of the Beverage (wave antenna) fishbone type, is used with the receiver.



- | | | |
|---|----------------------------|------------------------------|
| 1. "SEND" "REC" switch | 6. "BAND CHANGE" control | 15. "AVC" "MAN" switch |
| 2. "HFO" "EXT" "INT" switch | 7. "MEGACYCLES" window | 16. "METER" "RF" "AF" switch |
| 3. "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch | 8. Main tuning dial | 17. "MOD" "CW" switch |
| 4. "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch | 9. Vernier dial | 18. "BEAT OSC" control |
| 5. "PHONES" jack | 10. "TUNING" control | 19. "SELECTIVITY" switch |
| | 11. "TUNING LOCK" | 20. "XTAL PHASING" control |
| | 12. Plastic chart | 21. "LIMITER" "OFF" switch |
| | 13. "HFO" "Δ FREQ" control | 22. "AUDIO GAIN" control |
| | 14. "RF GAIN" control | |

Figure 1-2. Radio Receiver, Front Panel View

PUT" terminals (8, figure 1-3) may be used to operate a recorder driving unit associated with the tape ink recorder. For the reception of frequency-shift teletype, the receiver 455-kc i-f output developed at the "IF OUTPUT" connector (10, figure 1-3) or the receiver a-f output developed at the "AUDIO OUTPUT" terminals (8, figure 1-3) may be used to operate suitable frequency-shift receiver converter equipment associated with a teletypewriter. For the reception of keyed-carrier, single or two-tone carrier teletype, the receiver a-f output developed at the "AUDIO OUTPUT" ter-

minals (8, figure 1-3) is used to operate suitable demodulator equipment associated with a teletypewriter.

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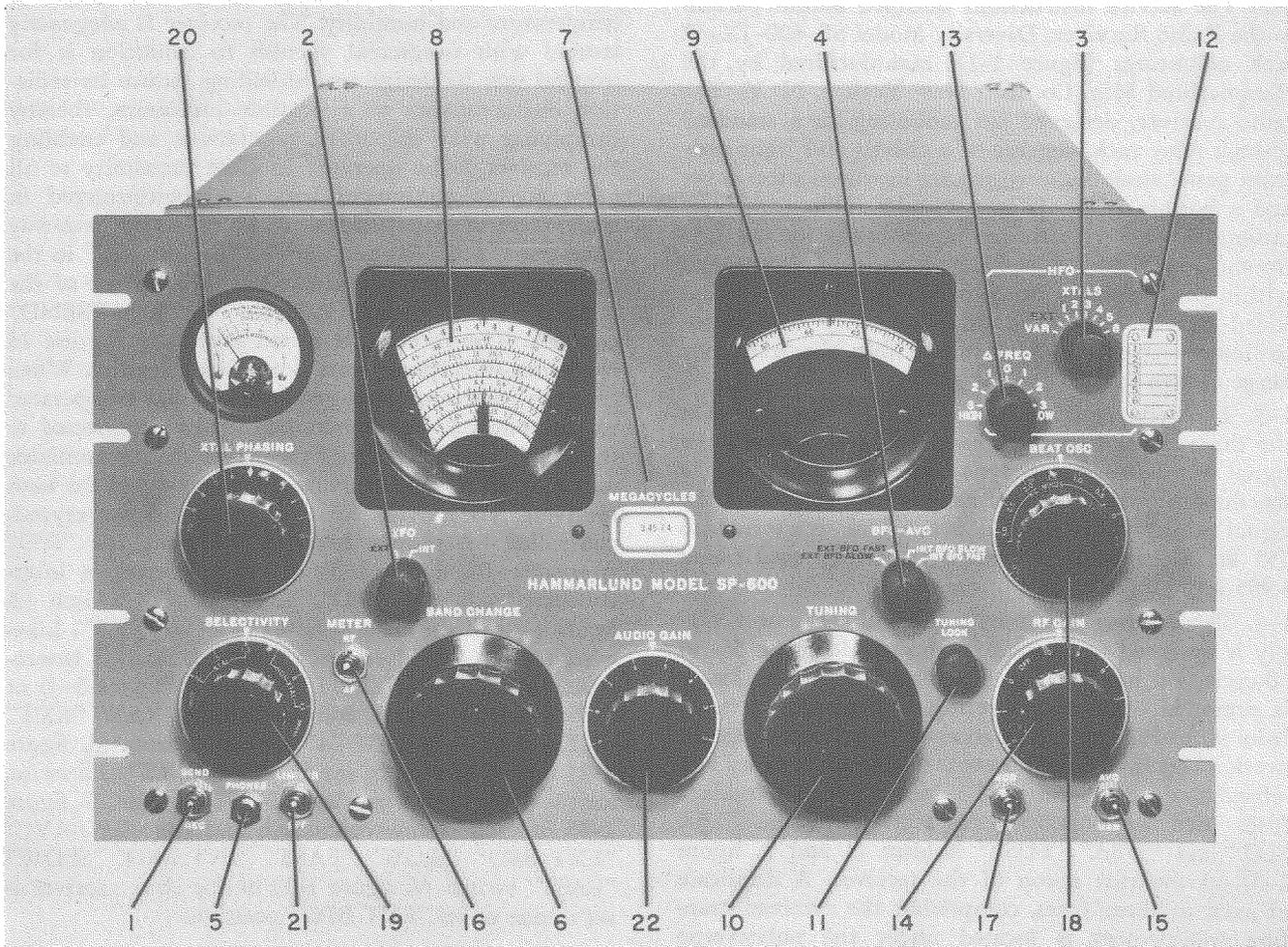
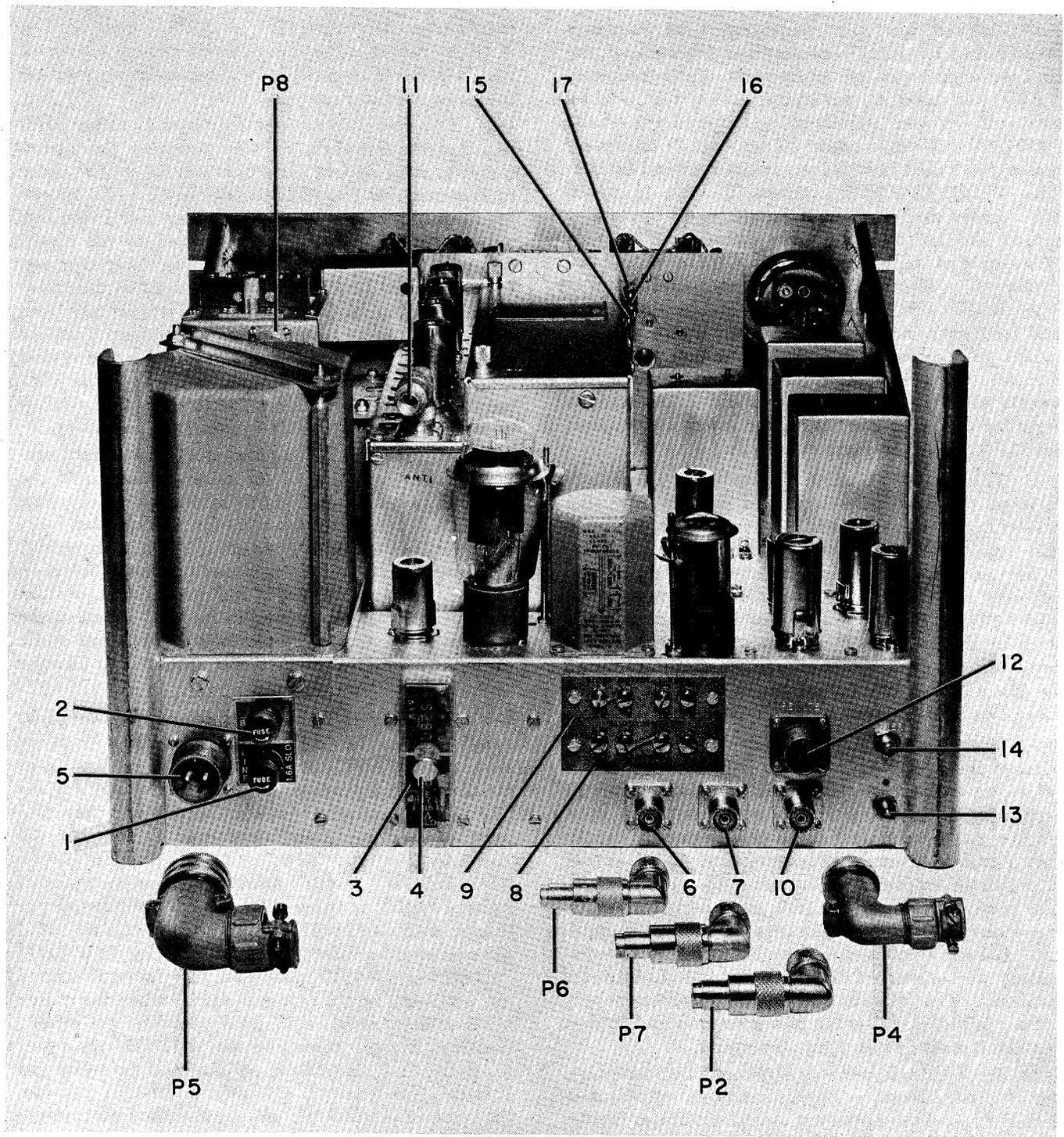


Figure 1-2. Radio Receiver, Front Panel View

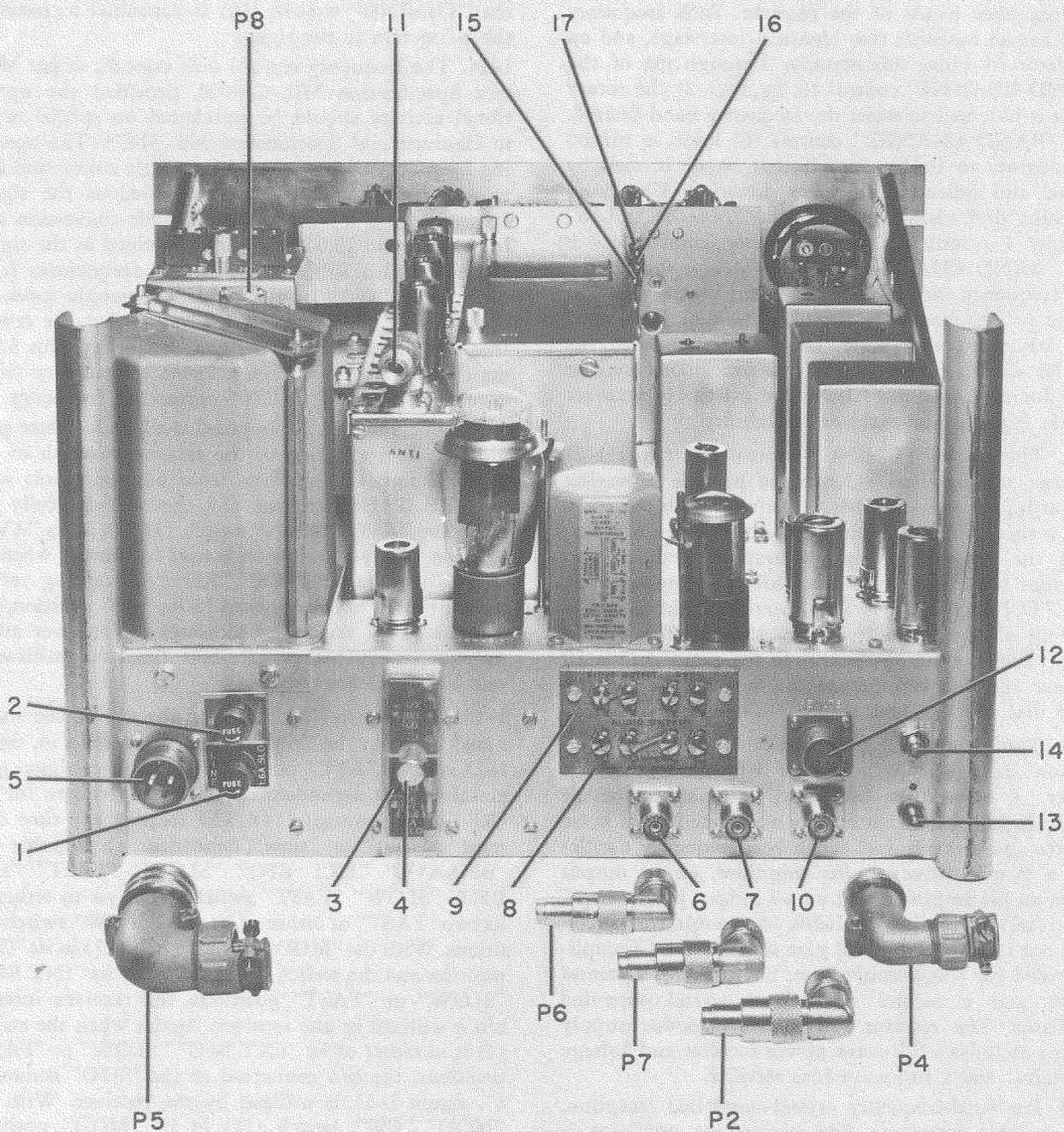
- | | | |
|---|----------------------------|------------------------------|
| 1. "SEND" "REC" switch | 6. "BAND CHANGE" control | 15. "AVC" "MAN" switch |
| 2. "IFO" "EXT" "INT" switch | 7. "MEGACYCLES" window | 16. "METER" "RF" "AF" switch |
| 3. "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch | 8. Main tuning dial | 17. "MOD" "CW" switch |
| 4. "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch | 9. Vernier dial | 18. "BEAT OSC" control |
| 5. "PHONES" jack | 10. "TUNING" control | 19. "SELECTIVITY" switch |
| | 11. "TUNING LOCK" | 20. "XTAL PHASING" control |
| | 12. Plastic chart | 21. "LIMITER" "OFF" switch |
| | 13. "HFO" "Δ FREQ" control | 22. "AUDIO GAIN" control |
| | 14. "RF GAIN" control | |

Figure 1-2. Radio Receiver, Front Panel View



- | | |
|-----------------------------|-----------------------------------|
| 1. "1.6A SLO FUSE" holder | 9. "DIODE OUTPUT" "AVC" terminals |
| 2. "3/4A FUSE holder | 10. "IF OUTPUT" connector |
| 3. "SPARE FUSES" cover | 11. "ANT" input connector |
| 4. Captive screw | 12. "REMOTE" connector |
| 5. "AC POWER" connector | 13. "METER ADJ RF" control |
| 6. "IFO" connector | 14. "METER ADJ AF" control |
| 7. "BFO" connector | 15. Allen wrench, No. 6 |
| 8. "AUDIO OUTPUT" terminals | 16. Allen wrench, No. 8 |
| | 17. Allen wrench, No. 10 |

Figure 1-3. Radio Receiver, Rear View of Chassis



- | | |
|-----------------------------|-----------------------------------|
| 1. "1.6A SLO FUSE" holder | 9. "DIODE OUTPUT" "AVC" terminals |
| 2. "3/8A FUSE" holder | 10. "IF OUTPUT" connector |
| 3. "SPARE FUSES" cover | 11. "ANT" input connector |
| 4. Captive screw | 12. "REMOTE" connector |
| 5. "AC POWER" connector | 13. "METER ADJ RF" control |
| 6. "IFO" connector | 14. "METER ADJ AF" control |
| 7. "BFO" connector | 15. Allen wrench, No. 6 |
| 8. "AUDIO OUTPUT" terminals | 16. Allen wrench, No. 8 |
| | 17. Allen wrench, No. 10 |

Figure 1-3. Radio Receiver, Rear View of Chassis

1-10. The receiver rotary turret houses the frequency determining r-f tuner subassemblies for each of the six frequency bands of the receiver. Each frequency band has an antenna, two identical interstage, and an oscillator r-f tuner subassembly. Through use of the "BAND CHANGE" control (6, figure 1-2) the rotary turret is indented to select the frequency band desired. The "BAND CHANGE" control (6) knob is turned 360 degrees to indent an adjacent band. It may be turned and indented in either direction. The band indicator dial visible through the "MEGACYCLES" window (7) indicates the frequency band selected. The "BAND CHANGE" control (6) also locates the dial frequency indicator of the main tuning dial (8) to the proper frequency scale on the dial. The main dial arbitrary outer scale, in conjunction with the vernier dial (9) scale provide a continuous vernier scale for each frequency band for extremely accurate station logging and receiver resetability.

1-11. The single "TUNING" control (10, figure 1-2) 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 of the receiver. The "TUNING LOCK" (11) provides locking 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.

1-12. The receiver circuitry available 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 a-v-c 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. The receiver circuitry available 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 a second heterodyne crystal-controlled oscillator. The receiver self-contained power supply system includes a full-wave power rectifier and voltage regulator, and a full-wave bias rectifier.

1-13. For fixed-frequency crystal-controlled reception, the variable frequency first heterodyne oscillator is replaced by a fixed-frequency crystal-controlled oscillator. This is done when the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2) is switched from its "VFO" to one of its "XTALS" "1" "2" "3" "4" "5" or "6" switch positions. The switch position chosen is that which is associated with and is fitted with a crystal suited to the frequency of the operational activity contemplated. The small plastic chart (12) is used to pencil in or ink-record, at the numbered line provided for each crystal holder, the applicable signal frequency of the crystal fitted in the holder. To provide for reception, the main dial is set to the signal frequency and tuning is accomplished

through use of the "HFO" "Δ FREQ" control (13). A slight tuning adjustment in the chosen setting of the "TUNING" control (10) is desirable, to resonate the r-f section to the signal.

1-14. The frequency control unit crystals, as per Military Specification MIL-C-3098, provided the operational activity should be purchased on special order to Hammarlund Specification No. 31473. The operating frequency of each crystal for single conversion use, to and including 7.4 mc, is specified as the signal frequency plus 455 kc; and for double conversion use, from 7.4 mc to 12.0450 mc, it is specified as the signal frequency plus 3,955 kc. For signal frequencies from 12.0450 to 30.0000 mc the third harmonic mode of operation of the crystal is used such that the crystal frequency specified is the signal frequency plus 3,955 mc divided by three. The allowable frequency tolerance of each crystal is 0.005 percent of frequency.

1-15. The receiver front panel dual scale meter provides an r-f indication of the relative strength of the received signal in decibels from one microvolt with the "RF GAIN" control (15, figure 1-2) fully on, when the "AVC" "MAN" switch (15) is in its "AVC" position. The r-f indication is used for tuning when on avc. When the "METER" "RF" "AF" spring return switch (16) is held depressed in its "AF" position, the lower scale of the meter indicates the receiver audio output power level in decibels from six milliwatts standard reference output.

1-16. The receiver provides for the avc of the signal tuned in when the "AVC" "MAN" switch (15, figure 1-2) is in its "AVC" position. The receiver signal gain maintained is dependent on the setting chosen for the "RF GAIN" control (14). The receiver avc time constant is "fast" or "slow" dependent on whether the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) is set to either of its two "FAST" or either of its two "SLOW" switch positions. With the "MOD" "CW" switch (17) in its "CW" position and the switch (4) in either of its "INT BFO" "SLOW" or "FAST" positions, the receiver internal bfo is utilized by the receiver. Again, when the switch (4) is in either of its "EXT BFO" "SLOW" or "FAST" positions, the bfo connected to the "BFO" connector (7, figure 1-3) is utilized by the receiver. With the "MOD" "CW" switch (17) in its "MOD" position, the receiver internal bfo may be switched on through the closing of a switch remotely connected to the "REMOTE" connector (12, figure 1-3), B and C pin terminals. The A and D pin terminals of the connector (12) provide for the tone modulation of a received c-w signal through use of an externally connected tone generator associated with the receiver. This is done when the receiver mode of operation used for the c-w reception is mcw, as is the case when the "MOD" "CW" switch (17) is in its "MOD" position, so that the receiver audio output developed is at a steady tone pitch with the accompanying advantages. For normal keyed carrier reception, the receiver

TABLE 1-1. TUBE COMPLEMENT

JAN TYPE	QUANT	FUNCTION	REFERENCE SYMBOL
6BA6	7	Amplifiers; r-f, i-f, b-f-o buffer.	V1, V2, V7, V9, V10, V11, V12
6C4	3	Oscillators; var freq., 3.5 mc, bfo.	V4, V8, V13
6AH6	1	Oscillator; freq control.	V3
6BE6	2	Mixers; 1st, 2nd.	V5, V6
6AL5	3	Detector and avc; limiter and meter; bias rect.	V14A, B; V15A, B; V20
12AU7	1	Cathode follower and 1st audio.	V16
6V6GT	1	Audio power output.	V17
5R4GY	1	Rectifier.	V19
OA2	1	Voltage regulator.	V18

"BEAT OSC" control (18) may be set to provide receiver single-tone output at any pitch within the range of plus or minus three kc from zero tone output. For frequency-shift reception, the two-tone receiver output provided is dependent on the setting chosen for the control (18) and on the carrier frequency-shift.

1-17. The receiver provides effective a-v-c action so long as the rate of signal fading does not approach the signal speeds used. Whenever the signal carrier is present at all times such as for m-c-w or frequency-shift reception, the "fast" receiver a-v-c time constant is used, since its use tends to overcome more rapid rates of selective and non-selective fading. When the signal is a c-w (keyed carrier) signal, use of the "slow" receiver a-v-c time constant is necessary to provide for the a-v-c bus, smoothing action with regard to the low frequencies comprising high-speed (automatic) c-w signals. The "slow" and "fast" receiver a-v-c time constants are both effective in the presence of slow fading. To effectively overcome rapid rates of fading, the space diversity receiving system used, usually utilizes two or three receivers, dependent on whether a frequency-shift or keyed-carrier, respectively, are to be received. The "AVC" terminals (9, figure 1-3) when interconnected between receivers in a space diversity receiving system, enable the more negative bias, developed by the signal on one receiver, to further reduce the weaker signal and noise due to the other receiver.

1-18. The receiver "SELECTIVITY" switch (19, figure 1-2) provides a choice as to any one of six degrees of receiver selectivity, the three narrower "SHARP" bandwidths being realized through use of the crystal filter forming part of the i-f section of the receiver. The crystal filter "XTAL PHASING" control (20) with the switch (19) in any one of its "SHARP" positions, provides for highly attenuating heterodyne interference even 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,

the receiver noise limiter, with the "LIMITER" "OFF" switch (21) in its "LIMITER" position, provides for the receiver noise to be bypassed from the receiver audio output.

1-19. PERTINENT DATA.

1-20. 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.

1-21. FUSE COMPLEMENT. The fuse complement of the receiver (table 1-2) comprises two fuses and a spare for each. Each fuse is glass-enclosed, indicating, and commercially available. The three-eighths ampere fuse is of the instantaneous type and the 1.6 ampere fuse is of the slow-blow time delay type. The table identifies each fuse by Bussman Mfg. Co. part number, ampere rating, circuit reference symbol, and type.

TABLE 1-2. FUSE COMPLEMENT

BUSSMAN PART NO.	QUANT-ITY	AMPERE RATING	TYPE	REFERENCE SYMBOL
AGC 3/8	2	3/8	Cartridge	F2
MDL 1-6/10	2	1-6/10	Cartridge	F1
A 125V FUSETRON				

1-22. FREQUENCY RANGE AND STABILITY. The six frequency bands of the receiver provide for continuous reception within the frequency range of 0.54 to 54.0 mc. Subsequent to a 15-minute warm-up period, the receiver frequency drift, as a percentage of the signal frequency tuned in, ranges from 0.001 to 0.01 percent. This frequency stability approaches that provided by the receiver for fixed-frequency crystal-controlled reception, within the frequency range of two to 30.0 mc.

NUMBERS DENOTE SELECTIVITY SWITCH POSITIONS
1,2 AND 3 NON CRYSTAL — 4,5 AND 6 CRYSTAL

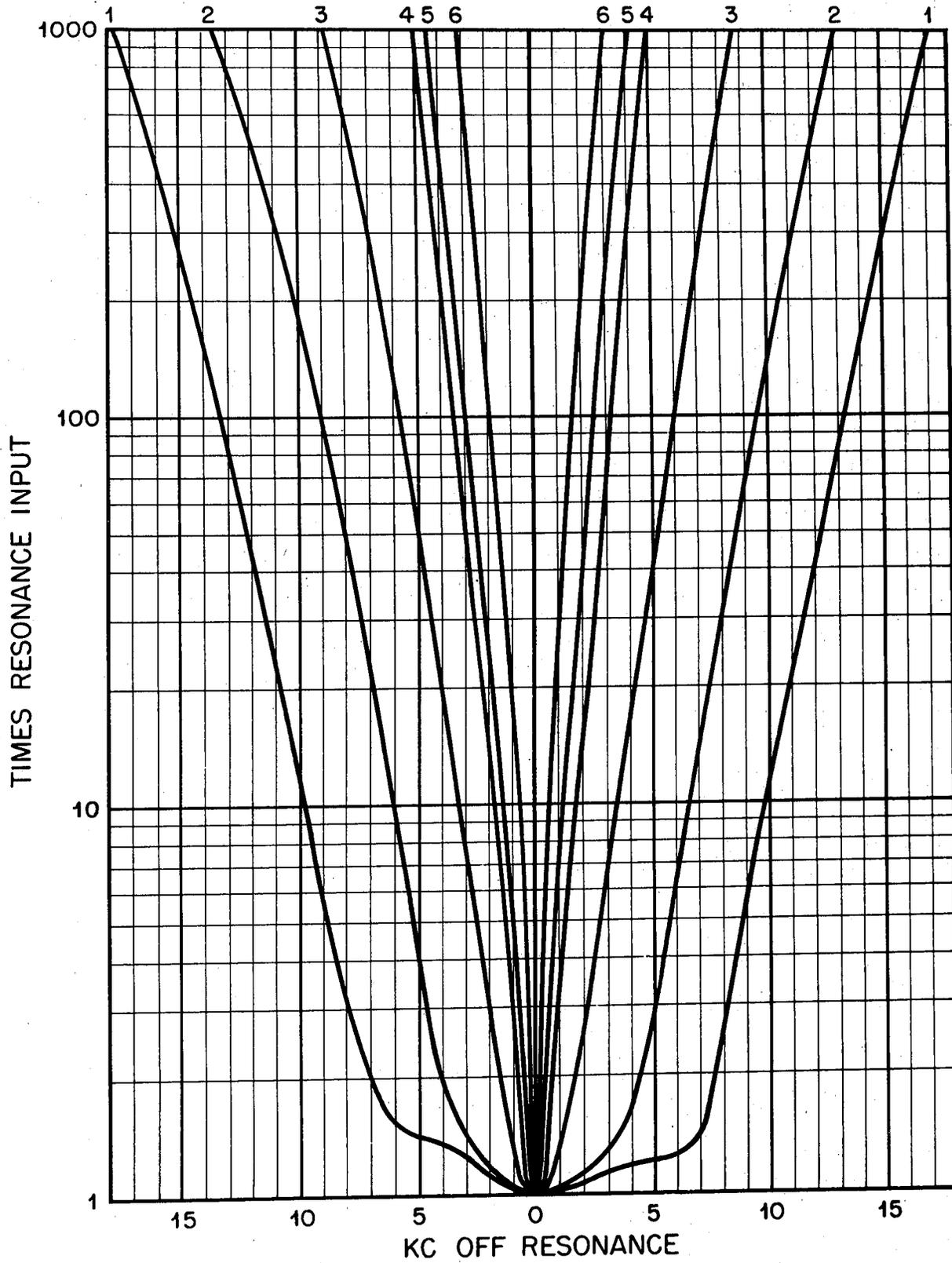


Figure 1-4. Overall Selectivity Curves at Two Megacycles

1-23. **TUNING BAND RANGES.** The tunable frequency range of each of the six frequency bands of the receiver is shown in the 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.

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

1-24. **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 to a 600-ohm load there obtains 15 milliwatts of phones output; and with two microvolts receiver signal input the i-f output to a 70-ohm load is a minimum of six-tenths of a milliwatt. The h-f-o, i-f-o, and b-f-o 70-ohm connector matching outputs are considered normal when the slave-connected receiver develops its minimum performance standards as specified in tables 5-1 and 6-1.

1-25. **SENSITIVITY.** The m-c-w sensitivity of the receiver to any signal frequency within its tuning range is two microvolts or better, for a signal-plus-noise to

noise power ratio of 10 to one at the receiver audio output terminals. Similarly, the c-w sensitivity of the receiver is 0.75 microvolts, or better.

1-26. **SELECTIVITY.** The receiver selectivity or band pass characteristics provided for each of the six positions of the selectivity switch are shown in figure 1-4. The semi-log graph plot shown for each curve shows the kc off resonance, above and below the nominal two megacycles signal frequency, for multiples of the resonant input, at which the receiver audio output level is equal to that chosen at resonance.

1-27. **FIDELITY.** The graph plots (figure 1-5) show the overall and the audio output attenuation in decibels, versus frequency characteristics of the receiver.

SOLID CURVE is the fidelity of the audio frequency amplifier with input applied between terminal 3 of R84 (figure 7-2), and ground, and with the 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.

1-28. **REJECTION RATIOS.** The image rejection ratios of the receiver, at the high frequency end of each receiver band, expressed as a voltage ratio and in decibels, is shown in table 1-4. The 455-kc i-f rejection ratio of the receiver is 69 db with the receiver tuning mechanism set to tune in a 600-kc signal. This ratio, applicable to single conversion, improves with frequency for bands 1, 2, and 3. The 3,955-kc i-f rejection ratio of the receiver, applicable to double conversion, is a minimum of 94 db with the receiver tuning mechanism set to tune in any signal within the frequency range of bands 4, 5, and 6.

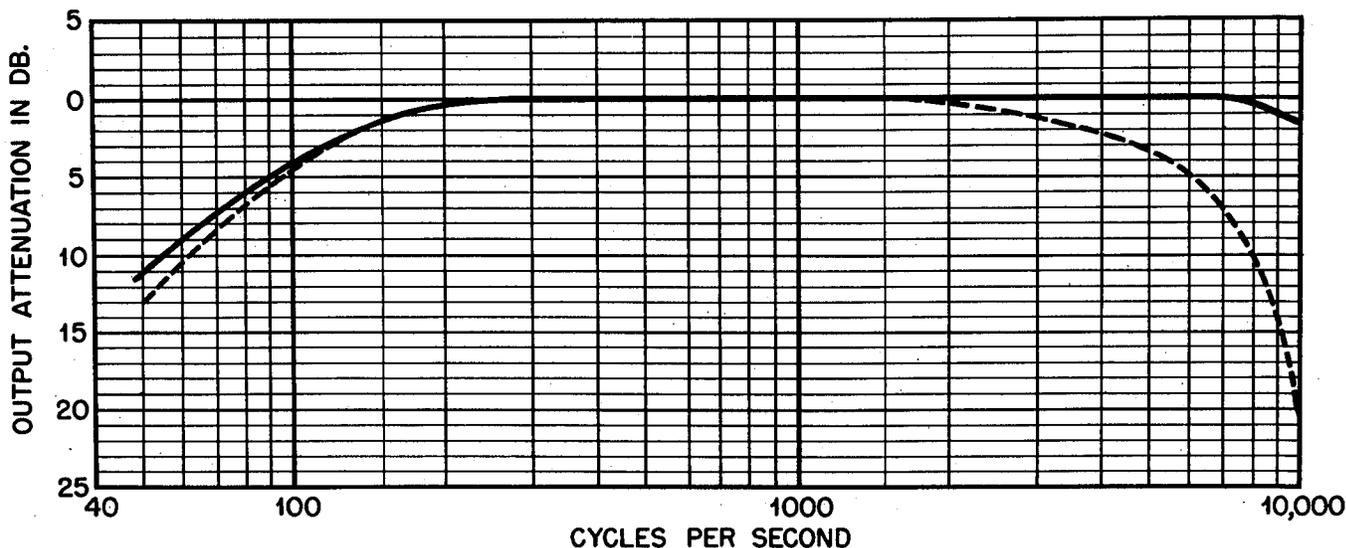


Figure 1-5. Audio and Overall Fidelity Curves

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

1-29. **AUTOMATIC VOLUME CONTROL.** The a-v-c action maintains the receiver output constant within 14 db when the input is increased from two to 200,000 microvolts.

1-30. **LINE SUPPLY REQUIREMENTS.** An a-c, single-phase, 50- to 60-cycle power source within the voltage range of 90 to 270 volts is required to provide input power to the receiver. The receiver power transformer 95, 105, 117, 130, 190, 210, 234, or 260 primary voltage tap used is that whose voltage rating most closely agrees with that of the available a-c source. For an a-c line voltage of 117 volts, the receiver current drain is 1.25 amperes and its power consumption is 130 watts. The maximum starting current is two amperes.

1-31. **TEMPERATURE AND HUMIDITY.** The permissible 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.

1-32. OPERATING AND ADJUSTMENT CONTROLS.

1-33. The receiver operating and adjustment controls, respectively, are located on the front panel (figure 1-2) and on the rear apron (figure 1-3). The controls are referred to below by their front panel and rear apron designations.

1-34. **"SEND" "REC".** The "SEND" "REC" switch (1, figure 1-2) is used to switch the receiver from its "REC" (receive) condition to a "desensitized" "SEND" condition in the presence of a strong local carrier. When switched back to "REC" the receiver is ready for instant use.

1-35. **"MOD" "CW".** The "MOD" "CW" switch (17, figure 1-2) in its "CW" position switches "on" the bfo of the receiver. The "MOD" position of the switch is used for m-c-w reception and the "CW" position of the switch is used for suppressed carrier and keyed-carrier reception; also for frequency-shift reception when the receiver audio output is required for the frequency-shift converter, or when the audio output is to provide monitoring signal to the receiver headset used.

1-36. **"BAND CHANGE".** The "BAND CHANGE" control (6, figure 1-2) provides for choosing and indexing the frequency band of the receiver within the frequency range of which is the signal frequency to be tuned in.

1-37. **"TUNING".** The "TUNING" control (10, figure 1-2) is used to tune in the signal to resonance.

1-38. **"TUNING LOCK".** The "TUNING LOCK" (11, figure 1-2) is used to lock the tuning mechanism at the tuning setting chosen.

1-39. **"IFO" "EXT" "INT".** The "IFO" "EXT" "INT" switch (2, figure 1-2) provides a choice as to the "INT" (internal) 3.5-mc double conversion crystal-controlled heterodyne oscillator of the receiver or that externally connected to the "IFO" connector (6, figure 1-3). When the switch is set to its "EXT" (external) position, the receiver oscillator is inoperative.

1-40. **"BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST".** The "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2), is associated separately both with the b-fo and a-v-c circuitry of the receiver. When it is set to either of its "INT BFO" "SLOW" or "FAST" positions, it provides for the use of the internal bfo of the receiver. When it is set to either of its "EXT BFO", "SLOW" or "FAST" positions, it provides for the receiver use of the external bfo connected to the "BFO" connector (7, figure 1-3). The separate switch arrangement is such that whether the switch is switched for use of the internal or externally connected bfo, the a-v-c time constant provided the receiver may be chosen as "SLOW" or "FAST". Either "SLOW" position of the switch provides for increasing the avc time constant substantially over that provided for either "FAST" position. In choosing the switch position desired, first determine whether the internal or an external bfo is to be used and then choose a slow or fast a-v-c time constant, as outlined in paragraph 1-17.

1-41. **"SELECTIVITY".** The "SELECTIVITY" switch (19, figure 1-2) provides choice as to three knob dial "XTAL" (crystal) and three "NON-XTAL" (non-crystal) positions of receiver selectivity. The six positions provide selectivity steps ranging from a "SHARP" to a "BROAD" knob dial indication. The "XTAL" switch positions provide six decibel bandwidths of 0.2, 0.5, and 1.3 kc, and the "NON-XTAL" switch positions provide six decibal bandwidths of 3.0, 8.0, and 13.0 kc.

1-42. **"XTAL PHASING".** The "XTAL PHASING" control (20, figure 1-2) is used to highly attenuate heterodyne interference closely adjacent to the desired signal. It provides this function only when the "SELECTIVITY" switch (19) is in one of its three "XTAL" knob dial positions.

1-43. **"BEAT OSC".** The "BEAT OSC" control (18, figure 1-2) is used to provide receiver single-tone output and two-tone output, respectively, for the reception

of a keyed-carrier or a frequency-shift signal, when operating cw. The pitch of the tone or tones, as applicable, is dependent on the chosen setting of the control. The control may be set on scale in either direction from its "O" knob dial position. It provides for a plus and minus three-kc tone range. To provide for suppressed carrier m-c-w reception, the control, when set to its "O" knob dial position, provides for the b-f-o output as the 455-kc reinserted carrier.

1-44. "RF GAIN". The "RF GAIN" control (14, figure 1-2) is used to switch the receiver "on" when turned clockwise from its "OFF" knob dial position to a point where a "click" is heard. The further clockwise turning of the control increases the r-f and i-f gain of the receiver. To prevent overloading the receiver r-f and i-f sections, when not on avc, the control is turned down somewhat from its maximum gain position, normally used when on avc. The control is turned down when on avc to reduce the sensitivity of the receiver during "off" and fading periods of the signal, so that the otherwise undesirable receiver noise output may be reduced. When two or more receivers are used in a space diversity receiving system, the "RF GAIN" control (14) of each receiver, apart from that with the lesser signal level, is set so that the signal level of each receiver is the same.

1-45. "AVC" "MAN". The "AVC" "MAN" switch (15, 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 (14). The "RF GAIN" control (14) is operative in either the "MAN" (manual) or "AVC" (avc) position of the "AVC" "MAN" switch.

1-46. "METER" "RF" "AF". The "METER" "RF" "AF" spring return switch (16, figure 1-2) is associated with the dual scale meter. In its normal "RF" position, with the "RF GAIN" control (14) full on, the switch provides for a calibrated r-f meter indication. When the switch is held in its depressed "AF" position it provides for a calibrated a-f meter indication.

CAUTION

To avoid meter damage, set "AUDIO GAIN" control (22, figure 1-2) fully counter-clockwise, then depress meter switch, and then slowly increase audio level to the desired meter scale indication.

1-47. "AUDIO GAIN". The "AUDIO GAIN" control (22, figure 1-2) is used to adjust the receiver audio output to a level providing for comfortable intelligible

reception. The receiver audio output is adequate to operate any recording equipment used, but make sure that the control position chosen provides for undistorted receiver output as specified in paragraph 1-24.

1-48. "LIMITER" "OFF". The "LIMITER" "OFF" switch (21, figure 1-2) in the "LIMITER" position provides for pulse-type noise, such as that due to ignition systems, to be bypassed from the receiver audio output. Unless such noise is interfering with the reception, keep the switch in its "OFF" position.

1-49. "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6". The "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2), when set to "VAR", switches the receiver for variable frequency reception. When the switch is set to one of its "XTALS" "1", "2", "3", "4", "5", or "6" switch positions, the receiver provides for fixed-frequency crystal-controlled reception at the signal frequency of the crystal contained in the holder associated with the switch position chosen. When the switch is set to "EXT" the fixed-frequency crystal-controlled first heterodyne oscillator, connected to the receiver "HFO OUTPUT" connector (see figure 5-4), replaces that, internal to the receiver, associated with each crystal switch position.

1-50. "HFO" " Δ FREQ". The "HFO" " Δ FREQ" control (13, figure 1-2) is used to accurately tune in the signal when the internal fixed-frequency crystal-controlled first heterodyne oscillator provides for fixed-frequency crystal-controlled reception. The control provides for a slight adjustment in the frequency of the oscillator, necessitated by the 0.005 percent frequency tolerance inherent to each crystal used; also refer to paragraph 1-14. The "HIGH" "3" "2" "1" "0" "1" "2" "3" "LOW" panel marking designates an arbitrary frequency scale for the control setting, a more clockwise setting indicating a relatively lower oscillator frequency.

1-51. "METER ADJ RF". The "METER ADJ RF" control (13, figure 1-3) is used to calibrate the r-f scale of the dual scale meter. With a 10-microvolt input signal and the "RF GAIN" control (14, figure 1-2) fully on, the "METER ADJ RF" control is set for an r-f meter scale reading of +20 db.

1-52. "METER ADJ AF". The "METER ADJ AF" control (14, figure 1-3) is used to calibrate the a-f scale of the dual scale meter. With a 600-ohm resistive load connected to the "AUDIO OUTPUT" terminals (8) 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 connector 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 is used (see figure 2-3) to load the i-f output connector and provides 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 MAINTENANCE

FIGURE AND INDEX NO.	HAMMARLUND PART NO.	NAME	APPLICATION
1-3, 15	11806-2	Wrench, Allen	Set Screw, No. 6
1-3, 16	11806-3	Wrench, Allen	Set Screw, No. 8
1-3, 17	11806-4	Wrench, Allen	Set Screw, No. 10
2-1	T8222	Pliers, Special	Spring, flat; for r-f tuners.

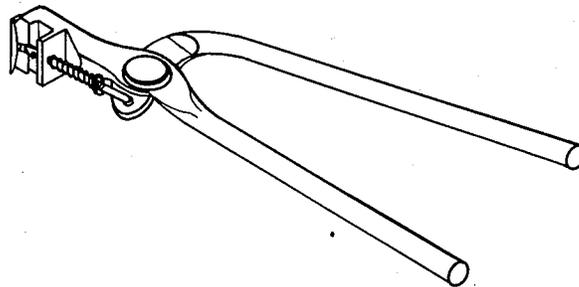


Figure 2-1. Special Pliers

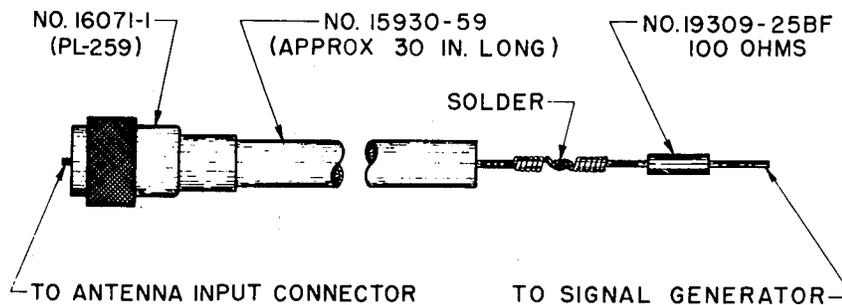


Figure 2-2. Antenna Cable

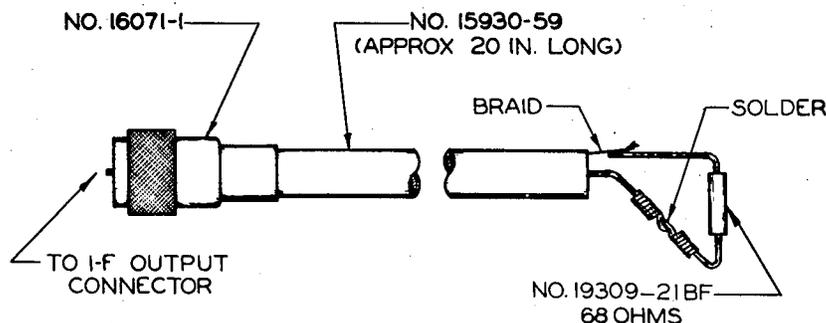


Figure 2-3. Cathode Follower Cable

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. PREPARATION FOR USE.

3-2. **UNCASING.** The radio receiver is packed at the factory, for shipment. The outer wooden case encloses a carton which contains the receiver proper and a bag containing the receiver cable plug connectors. The cable plug connectors are removed from the receiver for shipment purposes.

- a. Cut and fold back the steel straps, adjacent to the wooden case cover.
- b. Remove the cover nailed to the case.
- c. Remove carton containing receiver and plug connectors from case.
- d. Remove waterproof tape from folds in waterproof covering wrapped around carton, and then remove the waterproof paper wrapper; then open the carton.
- e. Remove wood frame from carton; also corrugated interiors comprising two side pieces, one front, one back, and one top, each accordion folded; also, the bag containing the receiver plug connectors.
- f. Remove the receiver and place it out of the way in a convenient place near its final location.
- g. Remove the receiver plug connectors from the outer cloth and inner paper bag containing them; also from plastic bags, as applicable.
- m. Put all packing material in the wooden case and store.

3-3. SETTING UP RECEIVER.

3-4. **PRIMARY TAP USED.** 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.

3-5. **PLUG CONNECTOR ASSEMBLIES.** Each plug connector assembly (see figure 1-3), removed from the receiver for purposes of shipment is listed in table 3-2. When unpacked, plug connect each to the receiver. Each plug connector assembly is identified in table 3-2 by plug connector reference symbol, Government Type designation of each assembly component, and location.

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

TABLE 3-2. PLUG CONNECTOR ASSEMBLIES REMOVED FROM RECEIVER FOR SHIPMENT

REFERENCE SYMBOL	GOVERNMENT TYPE DESIGNATIONS	CONNECTS TO
P2	PL-259; with reducing adapter UG-176/U and angle plug adapter M-359	10, figure 1-3
P4	AN 3108B-14S-2P; with cable clamp AN 3057-6	12, figure 1-3
P5	AN 3108B-18-3S; with cable clamp AN 3057-10	5, figure 1-3
P6	PL-259; with reducing adapter UG-176/U and angle plug adapter M-359	6, figure 1-3
P7	PL-259; with reducing adapter UG-176/U and angle plug adapter M-359	7, figure 1-3

3-6. RECEIVER COMPONENT CONNECTING CABLES. When two radio receivers provide for the space diversity reception of a frequency-shift signal, the crystal-controlled first, 3.5-mc second, and b-f-o heterodynes of either receiver may be separately cable-interconnected to the other receiver, to provide for a master-slave heterodyne relationship between the receivers. The fabricated cables required to do this are listed in table 3-3 and described in paragraph 3-7.

TABLE 3-3. RECEIVER HETERODYNE CONNECTING CABLES

DESIGNATION	APPLICATION
"HFO OUTPUT" connector, J8 cable.	Fixed freq, crystal-controlled first heterodyne osc output at J8.
"IFO" connector, J6 cable.	3.5 - mc crystal - controlled second heterodyne osc output at J6.
"BFO" connector, J7 cable.	Beat-frequency osc output at J7.

3-7. HETERODYNE CABLE FABRICATION. The receiver heterodyne cables (see table 3-3), terminate at each receiver in a type PL-259 connector plug fitted with a type UG-176/U reducing adapter. These fittings (see figure 1-3), for one end of each interconnecting cable, are supplied with each receiver. The interconnecting coaxial cable used (WE-724) is not supplied as part of the receiver proper. The length of WE-724 cable required to fabricate each heterodyne cable is dependent on the relative receiver locations.

When the receivers are mounted in the same rack, cable lengths approximating 30 inches will suffice, but actual measurements should be made for each connecting cable in each specific instance. To fabricate a heterodyne connecting cable, cut the WE-724 coaxial cable to the required length and then, using a sharp knife, expose the bare conductor to the extent of three-quarters of an inch. Then thread this end of the cable through the larger diameter end of the UG-176/U reducing adapter so that a quarter-inch of the coaxial cable shield may be exposed. Now locate the reducing adapter on the cable so that the exposed cable shield can be fully bent back over the end of the reducing adapter. Now expose the bare conductor for another quarter-inch. Then thread the cable, carrying the reducing adapter, into the PL-259 plug connector and tightly screw the reducing adapter and the PL-259 plug connector together. Unscrew the knurled sleeve of PL-259 and let it ride on the cable. The four small holes in the neck of PL-259 should show that the cable shield is tightly clamped between the neck of PL-259 and the reducing adapter. Soldering of the shield to the neck of PL-259 is optional. Use a click meter to assure that no shield strands engage the conductor and to indicate that the shield contacts the neck of PL-259. Then solder the bare conductor at the end of the pin terminal of PL-259, making sure that the solder does not add to the pin outer diameter. Then snip off any excess conductor extending past the pin terminal end. Now replace the knurled sleeve of PL-259, by screwing it back in place. Do likewise, as outlined, to the other end of the cable to complete the fabrication of the heterodyne connecting cable.

3-8. STORAGE.

3-9. When the radio receiver is to be stored, subsequent to use, remove the frequency control unit crystals referred to in paragraph 1-13 and the plug connector assemblies listed in table 3-2. Fully mesh the eight-section, four-gang variable air capacitor and then pack the receiver as outlined below in paragraph 3-10.

3-10. PACKING.

- a. Open the folded receiver carton and tape all edges with three-inch gummed kraft paper tape.
- b. Accordion fold the ends of a corrugated cardboard bottom for the carton, to act as a spring-board bottom for the receiver. Then place it in the carton with the accordion folds downward.
- c. Place the receiver in the carton and cover the receiver panel with wrapping paper.
- d. Put into carton, around receiver, accordion folded corrugated interiors, comprising two side pieces, one front, one back, and one top, with the accordion folds inward; also, one wood frame to act as a carton spacer.
- e. Put the receiver plug connectors listed in table 3-2 into the inner paper and outer cloth bags and place into carton at the side of the receiver. Use the

three plastic bags first, one each for each of the silver plated connectors; press to exclude air and then heat-seal.

f. Complete taping up carton using the three-inch tape.

g. Wrap carton in waterproof paper and seal all folds with three-inch waterproof tape.

h. Put waterproof wrapped carton containing receiver and plug connectors into wooden case.

i. Nail cover on wooden case.

j. Put two steel straps around case.

k. Stencil all markings on end of case.

l. Put address label on side of case.

SECTION IV THEORY OF OPERATION

4-1. GENERAL SYSTEM OPERATION.

4-2. The radio receiver is designed to provide for reception at each station in two-way single- or multi-receiver military operational activities. It is especially suited to dual-receiver frequency-shift space diversity receiving systems, since it provides for fixed-frequency crystal reception within the frequency range of two to 30.0 mc and has provision for the common use between receivers of its fixed-frequency crystal-controlled, first and second heterodynes. Further, it has provision for the common use between receivers of its b-f-o heterodyne; also, for the use of common avc. Also it is suited to any space diversity receiving system utilizing three or more receivers, especially so since a master heterodyne external oscillator unit may be used to provide the heterodynes for each receiver. Due to the interconnecting and jumper opening provisions provided on each receiver, the composite system d-c output available for use may be that from one receiver.

4-3. FREQUENCY-SHIFT SPACE DIVERSITY SYSTEM OPERATION.

a. BLOCK DIAGRAMS. Figures 4-1 and 4-2, each show in block diagram form the inter-relationship existent between two radio receivers and the other station components used in representative frequency-shift space diversity receiving systems. The system shown in figure 4-1 utilizes each receiver i-f output and that shown in figure 4-2 utilizes each receiver a-f output.

b. ANTENNA SYSTEM. To provide the frequency-shift space diversity signal to the two receivers, an antenna system, preferably of the Beverage wave antenna fishbone type, is coaxial cable connected to the antenna input connector of each receiver. To provide for the space diversity feature, the two antenna systems are spaced apart a distance equivalent to at least five times the wavelength of the nominal signal carrier tuned in.

c. AUXILIARY COMPONENTS. The teletype signal received is rendered audible and suitable for teletypewriter use through the use of auxiliary components associated with the receiving system. Apart from the headset and/or loud speaker monitor used, the auxiliary components used are dependent on whether the i-f or a-f output from each receiver is to provide for the composite signal. When each receiver i-f output is used, the "IF OUTPUT" connector (10, figure 1-3) of each receiver is coaxial cable connected to the separate input connector provided each on the frequency-shift receiver converter, forming part of the system. The frequency-shift receiver converter d-c pulse, signal output developed is suited to operate the teletypewriter connected to it, to provide a teletypewritten copy of the signal. When each receiver a-f output is used, the "AUDIO OUTPUT" terminals (8, figure 1-3) of each receiver are transmission line connected to the separate input terminals provided for each receiver on the radioteletype terminal equipment, forming part of the system. The radioteletype terminal equipment differentially wound relay is provided with the composite pulse d-c "space" output to one of its windings and with the composite pulse d-c "mark" output to its other winding, the "mark" and "space" pulses, respectively, causing the relay contacts, in series with the d-c line, to key the d-c current in the d-c line to the teletypewriter, to provide a teletypewritten copy of the signal, as before.

d. MASTER-SLAVE OPERATION. The two receivers may be operated in a master-slave heterodyne relationship through use of the receiver component connecting cables listed in table 3-3. Connect the cables between the two receivers and set the receiver controls as outlined in paragraph 1-6. When each receiver i-f output is used (refer to step "c" of subparagraph 4-3), and the bfo of each is used only to provide for its own monitoring output, then the use of common bfo heterodynes between receivers is optional.

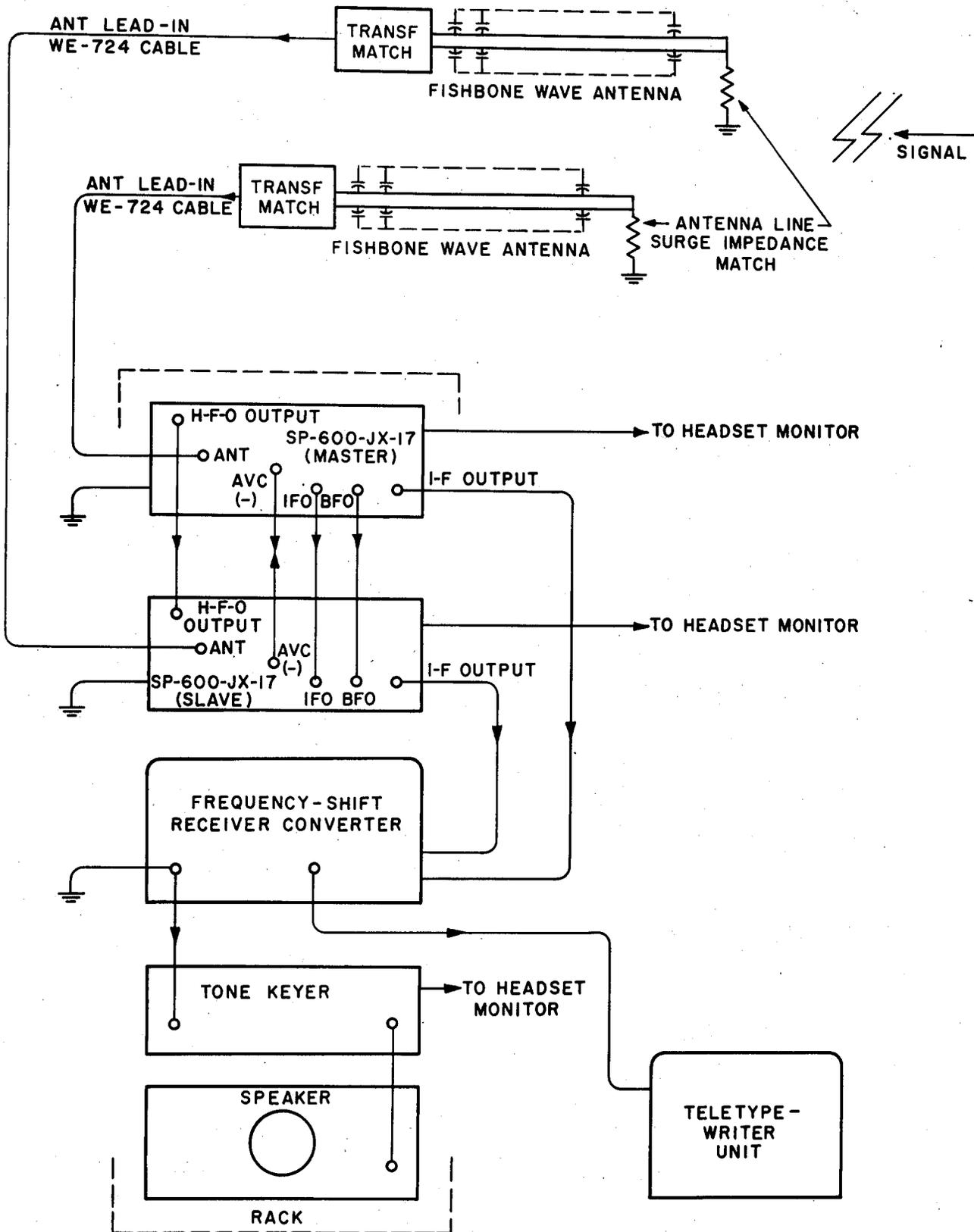


Figure 4-1. Frequency-shift Space Diversity, I-f Output Receiving System

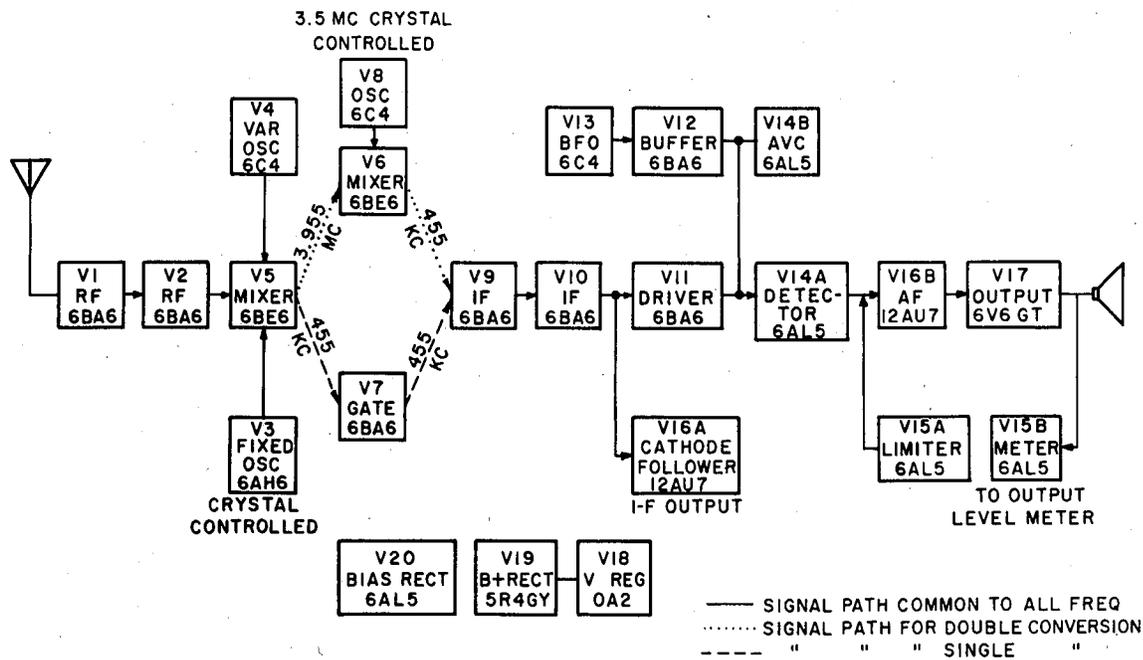


Figure 4-3. Radio Receiver, Block Diagram

the "BEAT OSC" control (18) of the master receiver is set to ± 2.55 -kc knob dial indication.

e. R-F GAIN ADJUSTMENT. To provide for the space diversity feature during reception, the gain of the receiver, initially receiving the stronger signal, is reduced through use of its "RF GAIN" control (14, figure 1-2) so that the i-f output provided by each receiver is approximately the same. This procedure becomes a monitoring function during reception whenever either receiver does not contribute its share to the composite output as is the case when its meter r-f indication is zero or continuously low compared to that of the other receiver. Through the use of common heterodynes between receivers, the monitoring requirements are facilitated and reduced to a practical minimum, since relative frequency drift between receivers is thereby eliminated.

4-4. RECEIVER FUNCTIONAL OPERATION.

4-5. BLOCK DIAGRAM. Figure 4-3 shows in block diagram form the inter-relationships existent between the internal circuits of the receiver. Each block incorporates an electron tube, or one section of a dual tube, as applicable. When properly installed and operated, the receiver provides the proper signal path for the signal tuned in. The receiver tuning is accomplished through the use of an eight-section four-gang tuning capacitor. The signal path through the receiver may be traced by referring to the block diagram. The receiver must be equipped with a suitable antenna system to provide for the proper reception of the signal.

4-6. The signal tuned in is selected, amplified, and provided with a high signal-to-noise ratio in V1 and V2, comprising the receiver two-stage r-f amplifier. It

is then heterodyned in the first mixer stage V5. V3 and V4, respectively, provide for the fixed-frequency crystal controlled and variable frequency, first heterodynes of the receiver. V3 is used for fixed-frequency crystal controlled reception and V4 is used to provide for continuously variable tuning. When V3 is used the crystal associated with it must be suited to the desired signal frequency.

4-7. The V5 mixer, heterodyned signal output is at a frequency of 455 kc for any signal frequency tuned in on the three lower frequency bands of the receiver. Here, the receiver single-double conversion switch (S4, figure 4-4), actuated by the "BAND CHANGE" control (6, figure 1-2), automatically assumes its single conversion position, to render operative and inoperative, respectively, the single and double conversion circuitry of the receiver. Thus for single conversion, the signal path is by way of the V7, 455-kc i-f gate to the input of the V9 and V10, two-stage 455-kc i-f amplifier. V7 provides some amplification but its prime function is to provide the 455-kc signal path for single conversion. The V5 mixer, heterodyned signal output is at a frequency of 3,955 kc for any signal frequency tuned in on the three higher frequency bands of the receiver. Here S4 assumes its double conversion position, to render operative the V6 second mixer and the V8, 3.5-mc heterodyne; also, to render V7 inoperative. Thus for double conversion, the signal path is by way of the V6 second mixer, where the 3,955-kc signal is heterodyned to 455 kc, to provide 455-kc input suited to the two-stage 455-kc i-f amplifier, as before. V9 and V10 develop almost all of the overall gain and selectivity of the receiver.

4-8. V11 is the driver stage of the 455-kc i-f channel of the receiver. It provides the 455-kc i-f signal at a

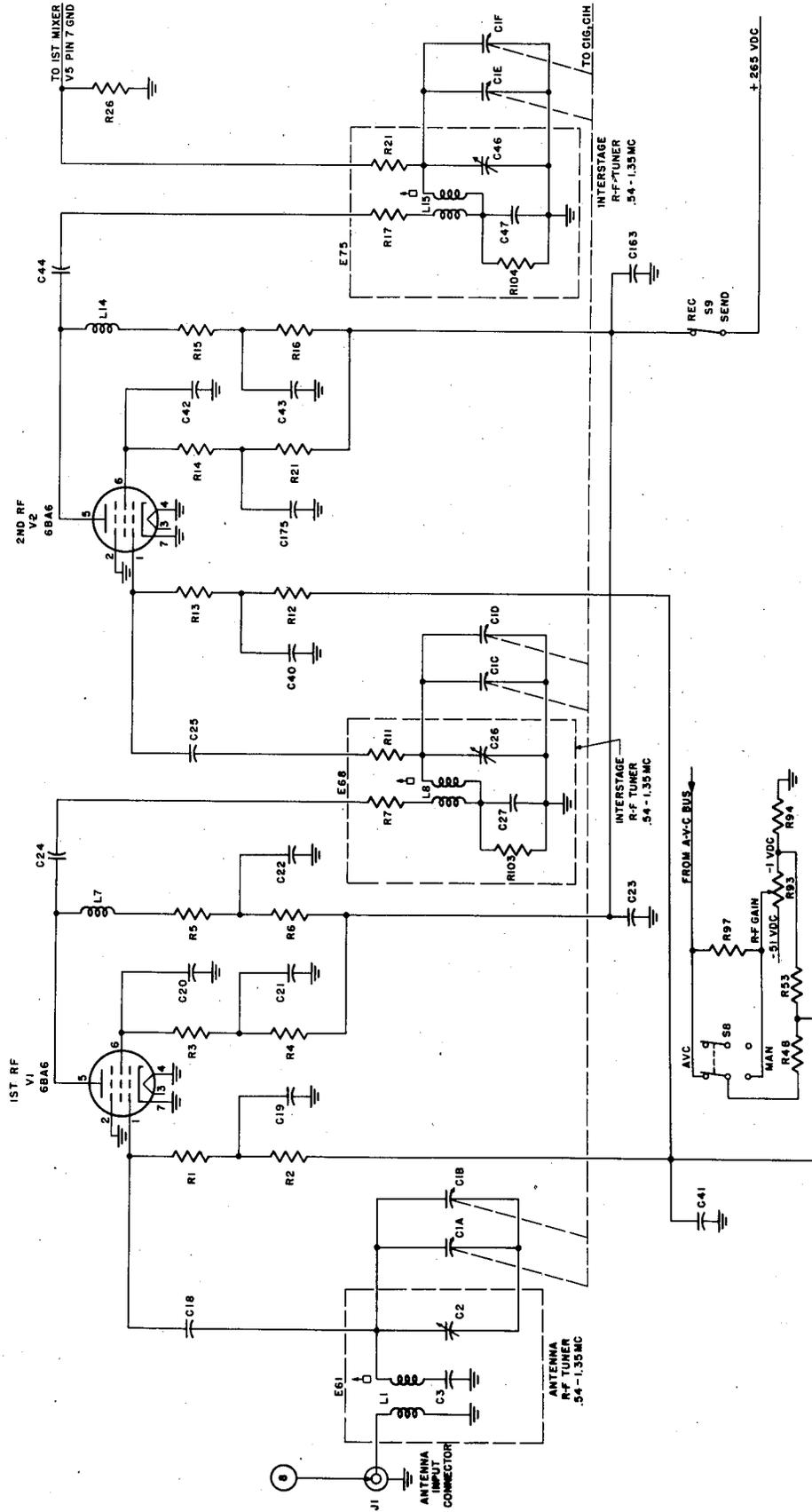


Figure 4-4. Antenna Input and Radio Frequency Amplifier Schematic Diagram

suitable voltage level to drive the V14A detector and the V14B avc, apart from isolating them from the output of the V9 and V10, two-stage i-f amplifier. The V16A, cathode follower, i-f output stage derives 455-kc i-f signal input from the output circuit of the V10, second i-f amplifier. It provides the 455-kc i-f signal output of the receiver at a power level suited to feed a 70-ohm matching load. The V14B avc develops a negative bias potential proportional to the signal level impressed to it from V11, whenever the signal level exceeds the avc delay bias used. The avc bias developed may be applied to V1, V2, V6, V7, V9, and V10 to provide for the avc of their gain.

4-9. The V13 bfo is operative when the "MOD" "CW" switch (17, figure 1-2) is set to "CW". It provides output at a nominal frequency of 455 kc which may be varied over a range of plus or minus three kc. When used, the V13 b-f-o output is fed to the V12 buffer stage, which, like the V11 driver, provides input to V14A and V14B. The output at 455 kc is used to provide the carrier for the reception of a suppressed carrier signal. It is used within the range of $455 \text{ kc} \pm 3 \text{ kc}$ to provide for the heterodyne reception of a keyed-carrier or frequency-shift signal.

4-10. The V14A detector, unidirectional output varies at the signal intelligence rate. Part of the d-c component of the output is used to bias off the V15A limiter. The a-c signal component is coupled to the V16B a-f amplifier. With the "LIMITER" "OFF" switch (21, figure 1-2) in its "LIMITER" position, the V15A limiter highly attenuates any pulse-type noise in the V14A detector output, by causing V15A to conduct.

4-11. The V16B a-f amplifier output is used to drive the V17 a-f power output stage. The V17 a-f power output stage is designed to match a 600-ohm resistive load or loud speaker connected to the "AUDIO OUTPUT" terminals (8, figure 1-3). It is also designed to match an 8,000-ohm headset connected to the "PHONES" jack (5, figure 1-2). With the "METER" "RF" "AF" spring return switch (16, figure 1-2) in its held depressed "AF" position, the V15B meter circuit provides for the front panel meter to indicate the receiver 600-ohm audio output in relation to the standard reference level output of six milliwatts. The receiver self-contained power supply comprises the V19, B+ rectifier and V18 voltage regulator, and the V20 Bias rectifier.

4-12. FUNCTIONAL SECTIONS. 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 receiver self-contained power supply is considered separately, as is all the auxiliary functional circuitry of the receiver.

4-13. The r-f section of the receiver is considered as comprising the circuitry of the two-stage r-f amplifier

V1 and V2, as well as that of the V3 crystal-controlled and V4 variable frequency heterodynes. The i-f section is considered as comprising the circuitry of the V5 mixer, the V7 gate, the V6 mixer, the V8, 3.5-mc crystal-controlled heterodyne, the V9 and V10 two-stage i-f amplifier, the V11 driver, and the V16A cathode follower. The a-f section is considered as comprising the circuitry of the two-stage a-f amplifier V16A and V17, the V14A detector, the V15A limiter, and the V15B meter rectifier. The self-contained stabilized power supply comprises the circuitry of the V19, B+ rectifier, the V18 voltage regulator, and the V20 Bias rectifier. The auxiliary circuits comprise those of the V13 bfo, the V12 buffer, and the V14B avc.

4-14. SIMPLIFIED CIRCUIT THEORY.

4-15. R-F SECTION. (See figures 4-4 and 4-5.) The r-f section develops reasonable constancy of gain, high image and adjacent channel selectivity, and high signal-to-noise ratios for any signal tuned in within the frequency range of the receiver. Further, the r-f section heterodyne detects the signal, both for variable tuning and fixed-frequency crystal-controlled reception, to render the signal acceptable to the i-f section of the receiver. Figures 4-4 and 4-5, together, are simplified schematic diagrams of the r-f section of the receiver. The removable r-f tuner subassemblies shown are those for band 1 (0.54-1.35 mc). Two identical interstage r-f tuners develop the required complex coupling on each band. On all bands mutual inductive coupling is provided by the r-f transformer contained in each of these r-f tuners. 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 capacitive coupling is provided by the manner in which the primary and secondary of each r-f transformer are interwound. Since the eight-section four-gang tuning capacitor sections are capacitively identical, a tracking capacitor is connected in series with the tuned secondary of the r-f transformer contained in the antenna r-f tuner of each band, to compensate for the tracking effect of the complex coupling of each interstage r-f tuner on each band. For variable tuning the oscillator r-f tuner of each band completes the tank circuit of the variable heterodyne. For crystal-controlled reception the oscillator r-f tuner of each band provides a convenient coupling arrangement from the crystal heterodyne to the first mixer.

4-16. V1 AND V2 R-F STAGES. (See figure 4-4.)

4-17. The V1 and V2 r-f stages (grid to grid) are identical for each band, each utilizing a Type 6BA6 electron tube. For band 1, the E61 antenna r-f tuner subassembly provides for antenna input coupling to V1, and the E68 and E75 identical interstage r-f tuner subassemblies provide for output coupling from each stage. The first three of the four dual-sections of the

main tuning capacitor C1A, C1B; C1C, C1D; C1E, C1F; and C1G, C1H are used to respectively resonate the secondaries of the r-f transformers L1, L8, and L15, respectively contained in E61, E68, and E75. The adjustable tuning cores of L1, L8, and L15 provide for alignment at the low frequency end and the C2, C26, and C46 trimmer capacitors provide for alignment at the high frequency end, of band 1. The use of the low impedance coupling capacitors C27 and C47 respectively contained in E68 and E75 necessitates the use of the tracking capacitor C3 contained in E61. C27 and C47 are respectively shunted by the R103 and R104 low time constant resistors so that when the S9 "SEND" "REC" switch (1, figure 1-2) is switched from "SEND" to "REC", C27 and C47 rapidly lose their charge. The equalizing resistors R7 and R17, respectively contained in E68 and E75, respectively act to equalize the self-resonance of the primaries of L8 and L15, so that in conjunction with the complex coupling used, they maintain the stage gain uniform over the frequency range of band 1. The grid stabilizing resistors R11 and R21, respectively, suppress any tendency to oscillation in the grid circuits of V2 and the first mixer V5.

4-18. V1 and V2 are 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 (1, figure 1-2). The d-c voltage is shunt-fed to the pin 5 plate of V1 through the blocking choke L7 and the impedance equalizing resistor R5. C24 is the plate blocking capacitor. The R6 resistor with the C22, C23, and C163 bypass capacitors forms a decoupling network. L14, R15, R16, C43, and C44 in the plate circuit of V2 perform the same functions that do their counterparts in the plate circuit of V1. The d-c voltage is shunt-fed to the pin 6 screen grid of V1 through the decoupling network comprising the resistor R4 and the capacitor C21. R3 is the screen dropping resistor and C20 the screen bypass capacitor. R21, C175, R14, and C42 in the screen grid circuit of V2 perform the same functions as do their counterparts in the screen grid circuit of V1. Negative bias is applied to the pin 1 grid of V1 through S8, and the resistors R1 and R2. R2 and the capacitors C19 and C41 form a decoupling network and have some effect on the a-v-c time constant. For V2, the resistors R12 and R13, and the capacitor C40 perform the same functions as do their counterparts in the grid circuit of V1. When S8, the "AVC" "MAN" switch (15, figure 1-2) is at "MAN", the -51 to -1 volt Bias rectifier supply voltage fed to V1 and V2 only ranges from -38.5 to minus one d-c volts and is dependent on the setting of the "RF GAIN" control (14, figure 1-2), since the resistors R48 and R53 act as a voltage divider. When S8 is at "AVC", the "RF GAIN" (14) is normally at maximum (minus one volt setting); the actual negative bias applied to V1 and V2 for any other setting of R93, the control (14), being a complex resultant of that developed at the junction of the resistors R48 and R53, which also

act as a voltage divider to the a-v-c negative bias voltage developed on the a-v-c bus. The resistor R97, while isolating the a-v-c bus from the Bias rectifier, still provides for the use of the "RF GAIN" control (14), even when S9 is set at "AVC".

4-19. The antenna input and r-f interstage circuits present a signal selective path to the signal tuned in. The signal voltage across the primary of L1 is that available at J1, the antenna input connector. It is mutually coupled to the secondary of L1 which is series resonant to the signal tuned in, to the extent of the proper tracking of the receiver. The resonant rise in signal developed across the secondary of L1 and C3 in series to ground is fed through the coupling capacitor C18 to the pin 1 grid of V1. The grid-leak resistor R1 and the bypass capacitor C19 isolate the signal to the grid circuit of V1 and provide it with a return path to ground. V1 amplifies the signal input to its grid and the amplified signal output of V1, fed through the coupling capacitor C24 and R7 in series, is complex coupled to the secondary of L8 which is series resonant to the signal, to the extent of the receiver tracking. The resonant rise in signal developed across the secondary of L8 in series with the parallel combination of R103 and C27, to ground, is fed through the coupling capacitor C25 to the pin 1 grid of V2. The grid-leak resistor R13 and the bypass capacitor C40 isolate the signal to the grid circuit of V2 and provide it with a return path to ground. V2 amplifies the signal input to its grid and the amplified signal output of V2, fed through the coupling capacitor C44 and R17 in series, is complex coupled to the secondary of L15 which is series resonant to the signal, to the extent of the receiver tracking. The resonant rise in signal developed across the secondary of L15 in series with the parallel combination of R104 and C47, to ground, is fed through R21 to the pin 7 grid of the first mixer V5. The R26 resistor is the grid-leak resistor at the pin 7 grid of V5, the first mixer.

4-20. V4 VARIABLE HETERODYNE.

(See figure 4-5.)

4-21. The V4 variable heterodyne is a tuned grid oscillator which utilizes a Type 6C4 electron tube. For band 1, the E85 oscillator r-f tuner subassembly completes the tank circuit of V4. The V4 variable heterodyne is operative when the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2) is set to "VAR". It is operative in the "EXT" or any one of the six "XTALS" positions of the S2, S3 switch (3) when the S4 single-double conversion switch S4 assumes its double conversion position, for reception on bands 4, 5, and 6. This is done so that the output of V4 adds to the output of the V3 crystal-controlled heterodyne, to provide sufficient heterodyne output for double conversion. C1G and C1H, comprising the fourth dual section of the main tuning capaci-

tor, are used to resonate the r-f transformer L25 contained in E85. L25 provides for mutual inductive feedback between the plate and grid circuits of V4. C79 and C80 are temperature-compensating capacitors. The adjustable tuning core of L25 provides for alignment at the low frequency end and the C76 trimmer capacitor provides for alignment at the high frequency end, of band 1. C78 is the tracking capacitor, C75 is the grid coupling capacitor, and R22 the grid-leak resistor. The coupling capacitor C77 tends to maintain the heterodyne output constant over the tuning range required for band 1.

4-22. V4 is supplied with d-c plate voltage from the self-contained B+ rectifier, +150-volt regulated supply, through the resistor R120, the "VAR" position of S3, the resistor R30, the impedance equalizing resistor R29, and the plate blocking choke L24. R120 and the capacitors C73, C100, and C101 form a decoupling network as does R30 with the capacitors C71 and C72. R29 and L24, together provide for a more uniform impedance over the frequency range of V4 than would L24 alone. C74 is the plate blocking capacitor, to isolate the d-c supply voltage from the tank circuit. V4 is self biased by the R22, C75 grid-leak resistor-capacitor combination. When S4 is in its double conversion position, the small portion of the +265-volt d-c supply voltage fed through the "REC" position of S9, the resistors R34, R30, R29, and L24 to the plate of V4, does not affect the operation of V4, as outlined for the "VAR" position of S3. However, when S3 is in its "EXT" or any one of its six "XTALS" positions, and S4 in its double conversion position, V4 provides sufficient output to aid V3, as outlined in paragraph 4-21. With V4 operative, the S2, S3 switch positions assumed render V3 inoperative.

4-23. The heterodyne output of V4, for bands 1, 2, and 3 is 455 kc higher, and for bands 4, 5, and 6 it is 3,955 kc higher, than the frequency of the signal tuned in. It is fed directly from the pin 6 grid of V4 to the pin 1 grid of the 1st mixer V5.

4-24. V3 CRYSTAL HETERODYNE. (See figure 4-5.)

4-25. The V3 crystal heterodyne is a Colpitts type of crystal-controlled oscillator which utilizes a Type 6AH6 electron tube. The V3 crystal heterodyne is operative when the "HFO" "VAR" "EXT" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2) is set to any one of its six "XTALS" positions, with which is associated a crystal suited to provide for the reception of a specific signal frequency. The V3 tank circuit is that between the pin 1 grid and pin 6 screen grid of V4, the screen grid acting as the oscillator plate element. The tank circuit consists of the crystal, which goes into parallel resonance, and across which the C63 and C65 capacitors are in series, with their junction grounded. The setting of C65 is controlled by the "HFO" " Δ FREQ" control (13, figure 1-2). The crystal frequency tolerance is 0.005 percent of frequency, the C65 capacitor adjustment made when tuning the receiver providing for the

V3 output to be the exact frequency to heterodyne the signal for which the crystal is intended. C65 does this since its effective shunt capacitance across the tank circuit may be varied sufficiently to adjust the frequency of oscillation of V4 over the frequency tolerance of the crystal.

4-26. V3 is supplied with d-c plate voltage from the self-contained B+ rectifier, +280-volt supply through the decoupling network consisting of the resistor R25, the capacitor C61, and the r-f choke L35. V3 is supplied with oscillator d-c screen grid voltage from the B+ rectifier, +150-volt regulated supply through the decoupling network (R120, C73, C100, and C101), the "XTALS" position, of S2, and the decoupling network consisting of the resistor R24, the capacitor C64, and the r-f choke L21. The capacitor C62 blocks the screen grid supply from the tank circuit of V3. R23 is the grid-leak resistor.

4-27. The crystal-controlled heterodyne output of V3, developed by electron coupling at the pin 5 plate, for bands 1, 2, and 3 is 455 kc higher, and for bands 4, 5, and 6 it is 3,955 kc higher, than the frequency of the signal tuned in. It should be noted, however, that the crystal-controlled reception of the receiver is intended only within the frequency range of two to 30 mc. The heterodyne output from the pin 5 of V3 is developed across the impedance presented by the wide band, filter band pass network consisting of the capacitor C45, the r-f coil L23, and part of the r-f autotransformer T35, to ground, the pass band provided covering the frequency range from approximately two to 34 mc, which is slightly wider than the crystal heterodyne frequency range for signals ranging from two to 30 mc, the range of the intended use of V3. The heterodyne output developed across the full winding of T35 is fed through the isolating resistor R71, the switch S3, the r-f transformer L25, and C75 to the pin 1 grid of the 1st mixer V5. Further, that portion of it between the tap of T35 and ground is available at the "HFO OUTPUT" connector (see figure 5-4) for frequency-shift space diversity system use by the slave receiver interconnected to the connector. The crystal heterodyne output of V3 provided for double conversion, is augmented by the output from V4, which is operative as outlined in paragraph 4-21. Since V3 is crystal controlled, V4 locks in with it, whereby the outputs from V3 and V4 become synchronized.

4-28. With the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2) at "EXT", the V3 crystal heterodyne is inoperative, since one arm of S2 provides for grounding the pin 1 grid of V3 and the other arm of S2 removes the +150-volt regulated supply from the oscillator plate, the pin 6 screen grid of V3. Also, since the latter arm of S3 assumes its "EXT" position, the impedance from the pin 5 plate of V3, presented by the resistor R102 and the capacitor C60 is effectively grounded by the capacitor C101, to provide a termination for the wide band, filter band pass network outlined in paragraph 4-27. With the

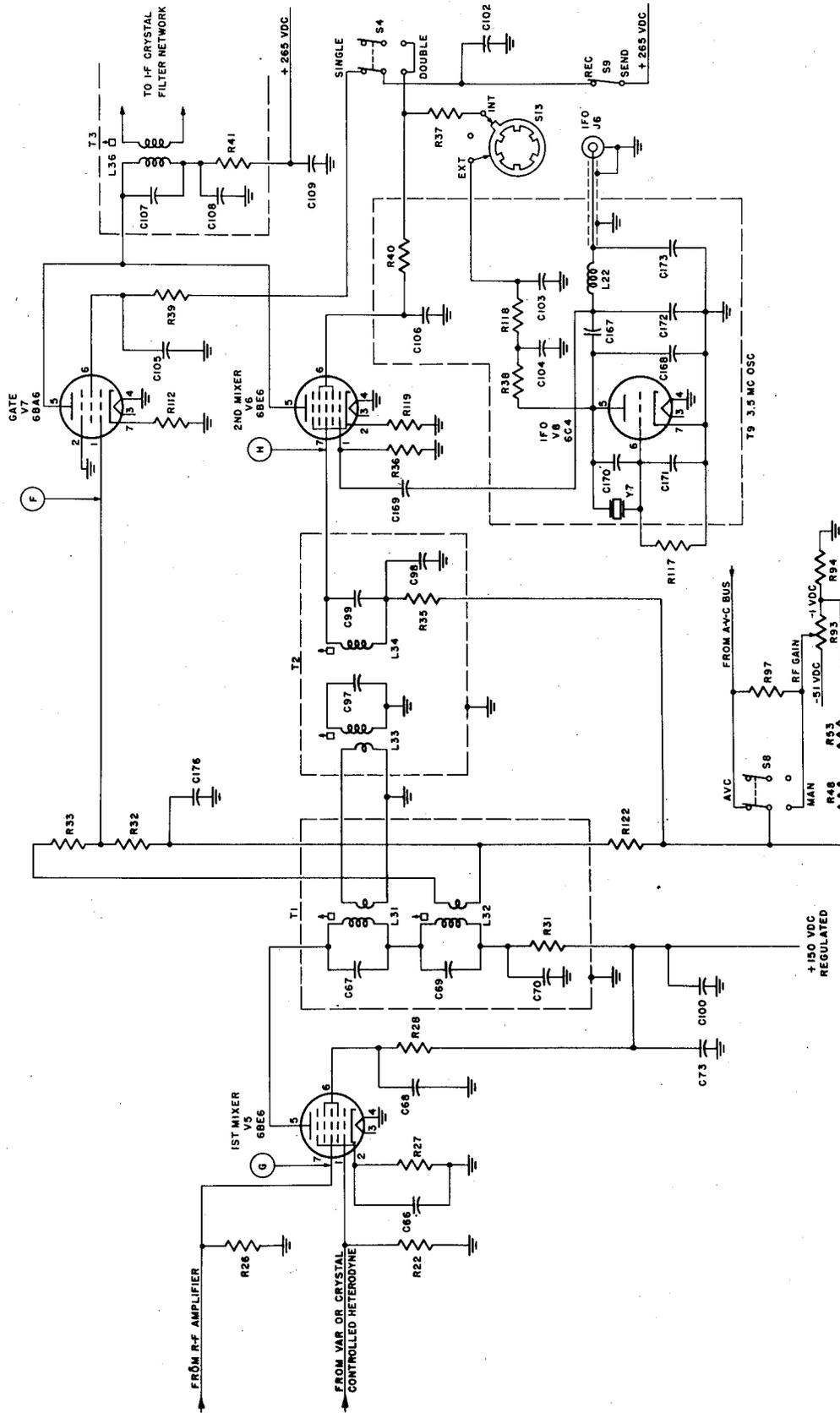


Figure 4-6. Single and Double Converter Schematic Diagram

switch (3) at "EXT", the V3 output from the "HFO OUTPUT" connector (see figure 5-4) of the master receiver is fed to the "HFO OUTPUT" connector of the receiver, now the slave receiver. It then develops a voltage across the full winding of T35 from which it is coupled to the pin 1 grid of the 1st mixer V5 as outlined in paragraph 4-27. For double conversion, the output of V4 in the slave receiver augments that derived from V3 in the master receiver.

4-29. I-F SECTION. (See figures 4-6, 4-7, and 4-8.) The i-f section provides for the single or double conversion of the signal to 455 kc; also, for almost all of the overall signal gain and selectivity, as developed by the 455-kc i-f crystal filter network and the 455-kc i-f amplifier. Further, it provides the 455-kc signal as the receiver i-f output and the 3.5-mc heterodyne for slave receiver use. The first mixer V5 heterodyne detects the signal to 455 kc or to 3,955 kc, respectively applicable to single and to double conversion. For double conversion, the signal is further heterodyned to 455 kc in the V6 second mixer. The selective circuitry provided the signal at 3,955 kc assures that high "image" rejection ratios are developed for signals tuned in on bands 4, 5, or 6, for which use is made of the double conversion. The single double conversion switch S4, activated by the "BAND CHANGE" switch (6, figure 1-2), in its single conversion position, renders the V7 gate operative so that the signal at 455 kc from V5 is provided with a path to the i-f crystal filter network at the input to the 455-kc i-f amplifier. When S4 is in its double conversion position, the V6 second mixer and the V8 3.5-mc heterodyne are rendered operative so that the signal at 3,955 kc may be heterodyne detected to 455 kc and again provide input to the i-f crystal filter network at the input to the 455-kc i-f amplifier. As such for single conversion, the double conversion path is inoperative, and vice versa. Figures 4-6 and 4-7, together, are simplified schematic diagrams of the i-f section of the receiver. Figure 4-8 is a further simplification of the i-f crystal filter, also shown in figure 4-7.

4-30. V5 FIRST MIXER. (See figure 4-6.)

4-31. The first mixer V5 uses a Type 6BE6 electron tube. The plate circuit of V5 is separately parallel resonant to 455 kc and to 3,955 kc, so that V5 can develop the heterodyne detected signal output, both for single and double conversion. For single conversion, the capacitor C69 and the r-f transformer L32 are parallel resonant to 455 kc. For double conversion, the capacitor C67 and the r-f transformer L31 are parallel resonant to 3,955 kc. In each instance alignment is provided through use of the adjustable tuning cores associated with L32 and L31. For single conversion L31 is a low impedance in series with the parallel resonant impedance presented by C69 and L32, and for double conversion L32 is a low impedance in series with the parallel resonant impedance presented by C67 and L31. V5 functions to electronically add the

inputs to its pin 7 (signal) grid and to its pin 1 (heterodyne) grid, the output developed in the plate circuit of V5 always comprising the heterodyne detected signal, which is at the difference frequency between the frequencies of its inputs. For single and double conversion, the 455-kc and 3,955-kc parallel resonant plate circuit of V5 respectively develop the V5 mixer output.

4-32. V5 is supplied with d-c plate and d-c screen grid voltage from the self-contained B+ rectifier, +150-volt regulated supply. The d-c voltage is fed to the pin 5 plate of V5 through the plate dropping resistor R31 and the primaries of L31 and L32; also to the pin 6 screen grid of V5 through the screen dropping resistor R28. C70 and C68, respectively, are the plate and screen grid bypass capacitors. The capacitors C70 and C100 in parallel provide for further bypass action to isolate the V5-output from the +150 volt regulated supply. V5 is self-biased by the R27 cathode resistor, bypassed by the C66 capacitor.

4-33. The V5 mixer is operative so that it provides for the rectification of the heterodyne input to the pin 1 grid, which is at a much higher level than is the signal input to the pin 7 grid. As such, the output of V5 always has a component which is the heterodyne detected output, the parallel resonant circuitry provided it, at 455 kc or at 3,955 kc, as applicable, favoring it as compared to the components at other frequencies developed in V5. The resistor R26 and R22, respectively, are the grid-leak resistors for the pin 7 and pin 1 grid circuits of V5. Each grid is biased negatively due to the cathode self bias provided V5. The signal input to V5 is that developed across R26; and the heterodyne input to V5 is that which acts across R22, which is also the grid-leak resistor for V4. When V4 is operative, the self bias it develops across R22 is in series with that developed by V5, but this is of no consequence, due to the magnitude of the self-bias of V5. For single conversion the V5 output is transformer-coupled by L32 to the V7 gate, and for double conversion the V5 output is transformer-coupled by L32 and the T2 i-f transformer assembly to the V6 second mixer.

4-34. V7 GATE. (See figure 4-6.)

4-35. The 455-kc i-f gate V7 uses a Type 6BA6 electron tube. The plate circuit of V7 is parallel-resonant to 455 kc through use of the i-f transformer L36 and the capacitor C107. C107 parallels the primary of L36, which is adjustable iron core tuned to 455 kc. V7 provides for some amplification but its main function is to provide the 455-kc signal path for single conversion.

4-36. V7 is supplied with d-c plate and d-c screen grid voltage from the self-contained B+ rectifier, +265-volt supply. The d-c voltage is fed to the pin 5 plate of V7 through the plate dropping resistor R41 and the primary of the i-f transformer L36. R41 and the capacitors C108 and C109 also form a decoupling network. The d-c voltage is fed to the pin 6 screen grid of V7 through the "REC" position of S9, the single conversion position of S4, and the screen dropping resistor

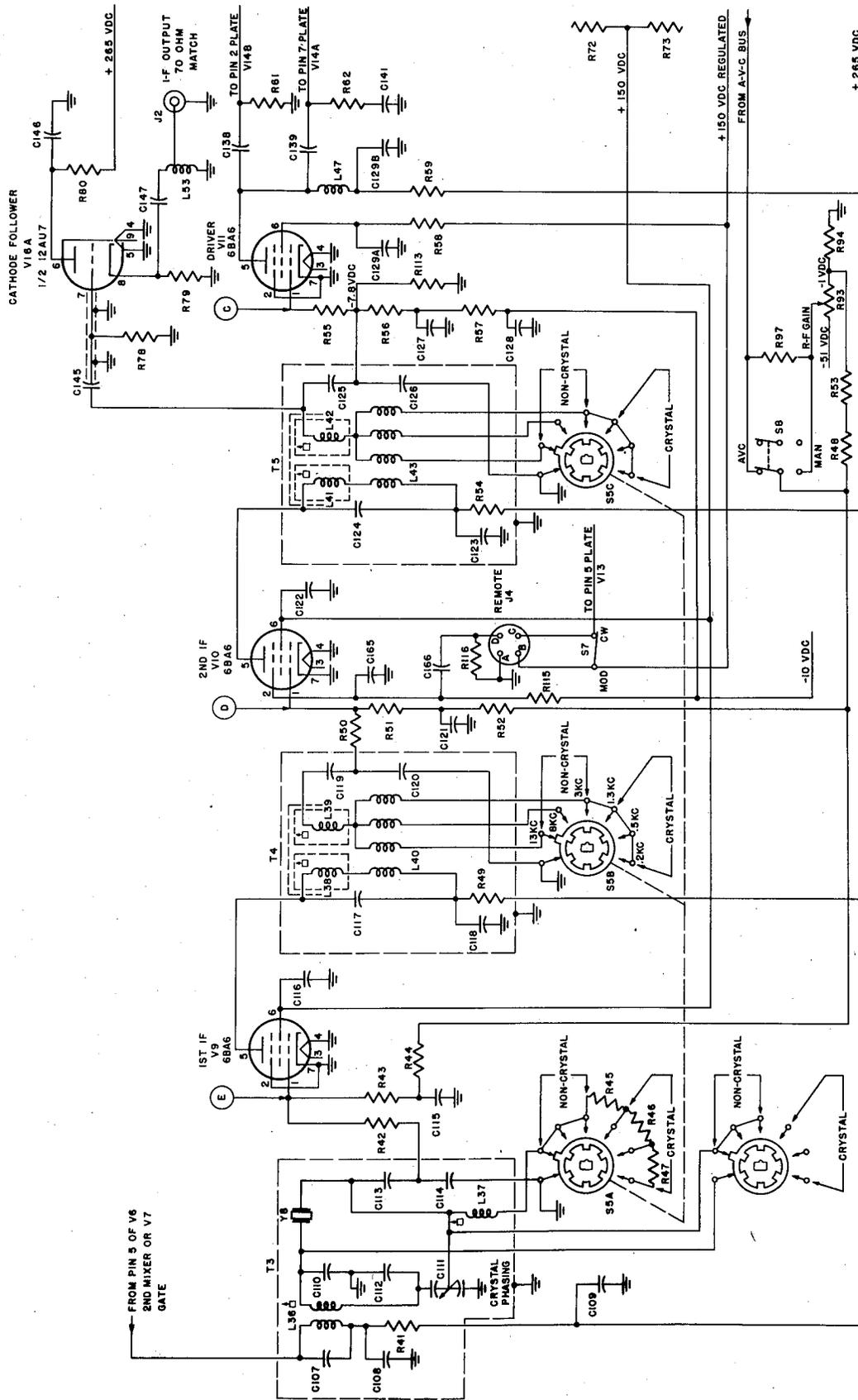


Figure 4-7. 455-Kc Intermediate Frequency Amplifier and Cathode Follower Schematic Diagram

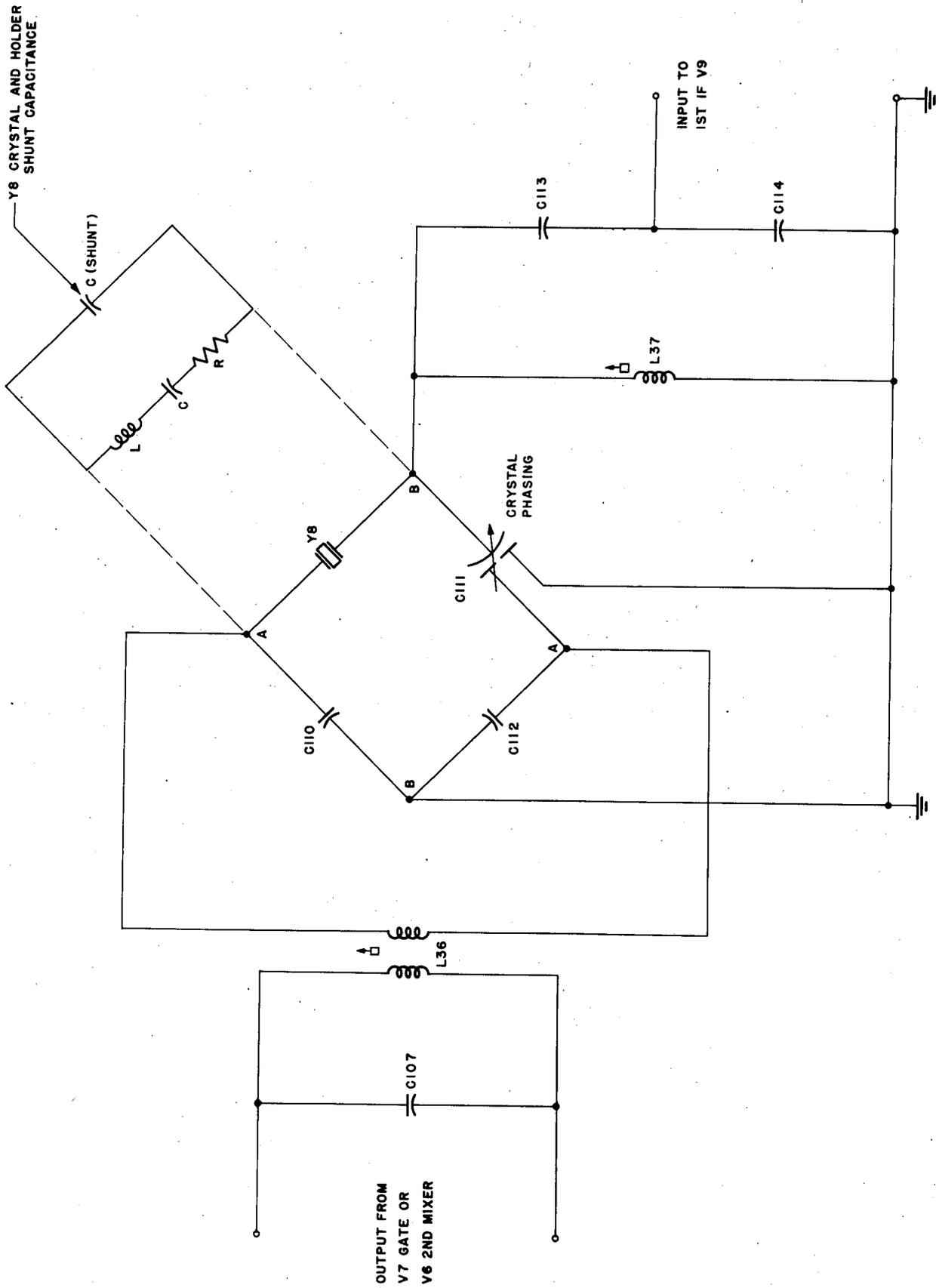


Figure 4-8. 455-Kc Crystal Filter Simplified Bridge Network

R39. C105 and C102 are bypass capacitors, respectively, associated with the screen of V7 and S4. V7 is provided with self-bias by the cathode resistor R112, which being unbypassed provides negative feedback to stabilize the stage. When S8, the "AVC" "MAN" switch (15, figure 1-2) is at "MAN", the -51 to -1 volt Bias rectifier supply voltage fed to V7 is dependent on the setting of the "RF GAIN" control (14, figure 1-2). When S8 is at "AVC", the "RF GAIN" (14) is normally at maximum (minus one-volt setting), the a-v-c negative bias applied to V7 being that developed on the a-v-c bus. The resistor R97, while isolating the a-v-c bus from the Bias rectifier, still provides for the use of the "RF GAIN" control (14), even when S9 is set at "AVC". The negative bias due to the "RF GAIN" control (14) for any control setting (other than minus one-volt setting) and that from the a-v-c bus is a complex resultant of that from the junction of R97 and the resistors R48 and R53, in series, which act as a voltage divider across the Bias rectifier supply between the movable arm of the R93 control (14) and the minus one-volt supply. For either position of S8 the negative bias is fed through the resistors R122 and R32 to the pin 1 grid of V7; actually, the resistor R33 and the secondary of the secondary of the r-f transformer parallel R32.

4-37. For single conversion, V7 is operative so that the 455-kc signal output of the first mixer V5, fed through L32, is that developed across R33 and R32 in series. That portion of it across R32 is fed to the pin 1 grid of V7. The C176 capacitor provides a low impedance to ground, to complete the grid circuit of V7. The 455-kc signal output of V7 is that developed across the secondary of the L36 i-f transformer, which provides the input to the i-f crystal filter network. L36 is parallel-resonant to 455 kc, through use of the C107 capacitor which parallels the primary of L36. The adjustable iron core of L36 provides for alignment to 455 kc. C108 is the plate bypass capacitor.

4-38. V6 SECOND MIXER. (See figure 4-6.)

4-39. The second mixer V6 uses a Type 6BE6 electron tube. The pin 5 plate of V6 is connected in parallel with that of V7, the i-f gate, so that the outline provided for the plate circuit of V7 in paragraph 4-34 is that applicable to V6. The second mixer V6 heterodyne detects the 3,955-kc signal derived from the first mixer V5, to 455 kc. To do this V6 functions to electronically add the 3,955-kc signal and the 3.5-mc crystal-controlled heterodyne from V8. The output developed across the 455-kc parallel-resonant plate circuit of V6 always comprises the heterodyne detected signal, which is the difference-frequency between 3,955 kc and 3.5 mc, namely 455 kc. The 3.5-mc heterodyne frequency is chosen below that of the 3,955 kc signal so that the second harmonic of the 3.5 heterodyne (3.5 mc x2) does not lie within the frequency range of band 4 (7.4 to 14.8 mc), which is the lowest frequency band for which V6 is operative.

4-40. V6 is supplied with d-c plate and d-c screen voltage from the self-contained B+ rectifier, +265 volt supply. The d-c voltage is fed to the pin 5 plate of V6 as outlined in paragraph 4-36. The d-c voltage is fed to the pin 6 screen grid of V7 through the "REC" position of S9, the double conversion position of S4, and the screen dropping resistor R40. C106 is the screen bypass capacitor. V6 is provided with self-bias by the cathode resistor R119. Since the pin 1 grid of V7 the i-f gate, and the pin 7 grid of V6 derive negative bias through S8 in an identical manner, the outline provided in paragraph 4-36 is that applicable to V6. Here, the bias is applied through the resistor R35 and the secondary of the i-f transformer L34 to the pin 7 grid of V6. The resistor R36 is the grid-leak and C169 is the grid capacitor for the pin 1 (heterodyne) grid of V6.

4-41. For double conversion, V6 (also V8) is operative, so that the 3,955-kc signal output of the first mixer V5, fed through L31, is that developed across the secondary of the r-f transformer L33, parallel-resonant to 3,955 kc through use of the capacitor C97 and the alignment adjustment provided by the adjustable tuning core of L33. The 3,955-kc signal developed across the secondary of L33 is mutually coupled to the r-f coil L34, also parallel-resonant to 3,955 kc, through use of the capacitor C99 and the alignment adjustment provided by the adjustable tuning core of L34. The 3,955-kc signal developed across the secondary of L34 is that applied to the pin 7 grid of V6. R35 and the capacitor C98 isolate the signal to the pin 7 grid circuit of V6. Since L34 is loosely coupled to L33, and both are parallel-resonant to 3,955 kc, the 3,955-kc signal path to V6 has the necessary adjacent channel selectivity for double conversion to develop high "image" rejection ratios. V6 functions to rectify the heterodyne input to the pin 1 grid, which is at a much higher level than is the signal input to the pin 7 grid. As such, the output of V6 always has a component which is the heterodyne detected output, the 455-kc parallel-resonant circuitry provided, favoring it as compared to the components at other frequencies developed in the plate circuit of V6.

4-42. V8, 3.5-MC CRYSTAL-CONTROLLED HETERODYNE. (See figure 4-6.)

4-43. The 3.5-mc crystal-controlled heterodyne is a Hartley type of crystal-controlled oscillator which utilizes a Type 6C4 electron tube. The V8 crystal heterodyne is operative when S4 is in its double conversion position. The tank circuit consists of the Y7 crystal, which goes into parallel resonance. The capacitor C170 is connected across Y7 so that the frequency of the oscillations are within the ± 175 -cps frequency tolerance specification of the 3.5-mc crystal. The C168 capacitor assures that the plate circuit of V8 is capacitive, a necessary condition for the oscillations to be sustained. The C167 capacitor provides for loosely coupling the oscillator to its loading, and with C168, acts to provide the proper impedance match between V8 and the network consisting of the r-f choke L22

and the capacitors C172 and C173. The loading of V8 is always that due to the effective input impedance at the pin 1 grid of V6 and may also be that due to a 70-ohm load connected to the remote end of the 70-ohm coaxial cable, connected to the J6 "IFO" connector (6, figure 1-3). The full network between V8 and J6 is used to match the V8 output circuit to the 70-ohm load, if any. The 70-ohm load connected to J6 may be a slave receiver which would then derive the 3.5-mc crystal-controlled heterodyne from V8. Thus, whether V8 provides the 3.5-mc crystal-controlled heterodyne for itself or it is derived from the externally connected receiver, the 3.5-mc crystal-controlled heterodyne output and input terminations are such that the V6 second mixer in the master or slave receiver always is provided with the 3.5-mc crystal-controlled heterodyne at the required level.

4-44. V8 is supplied with d-c plate voltage from the self-contained B+ rectifier, +265 volt supply which is fed through the "REC" position of S9, the double conversion position of S4, the plate dropping resistor R37, the "INT" position of S13, the "IFO" "EXT" "INT" switch (2, figure 1-2), and the decoupling circuit, comprising the resistors R38 and R118 and the capacitors C103 and C104, to the pin 5 plate of V8. The R117 grid-leak resistor and the C171 grid capacitor, self-bias V8 so that the oscillations are self starting. Care must be taken that the value of R117 is correct, since, if low, the a-c component of grid current could shatter the crystal.

4-45. The 3.5-mc crystal-controlled heterodyne output of V8, developed at the junction of C167, C172, and L22, to ground, is that impressed across R36 through C169 to the pin 1 grid of the second mixer V6. That developed at the junction of L22 and C173 is fed to the "IFO" connector J6, for external slave receiver use.

4-46. 455-KC CRYSTAL FILTER CIRCUIT.

(See figures 4-7 and 4-8.)

4-47. The 455-kc crystal filter circuit does not use an electron tube. It is contained in the T3 i-f transformer subassembly and has associated with it the S5A dual section of the S5A, B, C "SELECTIVITY" switch (19, figure 1-2). The 455-kc crystal Y8 used in the circuit forms one arm of a bridge network whose other arms consist of the identical capacitors C110 and C112 and one section of the dual stator variable air capacitor C111, the "XTAL PHASING" capacitor (20, figure 1-2). The other section of C111 shunts the r-f coil L37 which is parallel-resonant to 455 kc with the capacitors C113 and C114 in series. Alignment to 455 kc is effected with the adjustable iron core of L37. As shown in figure 4-8 the Y8 crystal equivalent circuit consists of inductance L, capacitance C, and resistance R in series, all paralleled by the Y8 crystal and holder shunt capacitance C (SHUNT). The primary and secondary of the i-f transformer L36 are both parallel-resonant to 455 kc, the primary with the capacitor C107 and the secondary with the capacitors C110 and

C112 in series. Alignment to 455 kc is effected with the adjustable iron core of L37. The bridge network input and output terminals, respectively, are designated A-A and B-B in figure 4-8. As shown in figure 4-7 the "SELECTIVITY" switch (19) has six positions, three of which are designated "NON-XTAL" and three "XTAL". When S5A is in any one of the three "NON-XTAL" positions one of its dual sections shorts out Y8, while the other section provides for grounding L37, as shown in figure 4-8. When S5A is in any one of the three "XTAL" positions, resistance is interposed between L37 and ground. The sharper the selectivity position chosen the greater is the resistance added in series with L37. Thus for the "1.3 kc" "XTAL" selectivity position the resistor R45 is added in series with L37; for the ".5 kc" position R45 and the resistor R46; and for the ".2 kc" position R45, R46, and the resistor R47. To properly align the 455-kc crystal filter circuit, the C111 "XTAL PHASING" capacitor (20) is set initially to its mid-capacitive, knob dial diamond position at which point it exactly neutralizes the Y8 crystal and holder shunt capacitance C (SHUNT). In use C111, when offset in one direction, underneutralizes C (SHUNT) and when offset in the other direction overneutralizes C (SHUNT). Doing this means that that part of C111 forming part of the bridge network respectively, is decreased or increased, but this has no effect on the L36 alignment made, since the total capacitance of C111 is constant and effectively acts in parallel to C110 even though the bridge part of it is in series with C112, which has a much higher capacitance value than has C111. The position of C111 has some effect on the alignment position of L37 but again this is negligible, since L37 with C113 and C114 is a broadly tuned circuit for each of the "NON-XTAL" positions of S5A and even more so for each of the "XTAL" positions, due to the resistance added to it, as outlined herein above.

4-48. The 455-kc crystal filter circuit derives 455-kc signal input from the V7 gate or from the V6 second mixer, respectively operative for single and double conversion. The 455-kc signal, impressed to the bridge network terminals A-A, provides for the series resonance of the Y8 crystal so that, with S5A in a "XTAL" position and the "XTAL PHASING" control (20) at its knob dial diamond position, the Y8 arm of the bridge is a virtual short circuit, limited only by the series resistive impedance R of Y8. When the "XTAL PHASING" control (20) is offset from its diamond position, the Y8 crystal and holder shunt capacitance is partly unneutralized so that the Y8 crystal also goes into parallel resonance at some frequency near 455 kc, dependent on the setting chosen. When heterodyne interference also provides input to the bridge, the "XTAL PHASING" control (20) setting chosen is that which provides a high impedance parallel resonant rejection ditch in the Y8 crystal arm of the bridge, at the frequency of the interfering heterodyne, where-

by the interfering heterodyne becomes highly attenuated. Since Y8 is series-resonant to 455 kc, the signal developed across C110 is that available at the B-B output terminals of the bridge network and available across L37, parallel-resonant to 455 kc. That portion of it, from the junction of C113 and C114, to ground, provides the input to the first i-f amplifier V9.

4-49. The Y8 crystal filter circuit selectivity provided the 455-kc signal is dependent on the resistive impedance R of Y8 and that of the parallel-resonant circuit comprising L37, C113, and C114, since these resistive impedances are in series in the 455-kc signal path through Y8. When S5A is in any one of its three "NON-XTAL" positions, the selectivity provided the 455-kc signal in this path is that due to the parallel-resonant circuit alone, since Y8 is shorted by one section of S5A. When S5A is in any one of its three "XTAL" positions, the resistance added in series with L37 has the effect of decreasing the resistive impedance in series with that due to the Y8 crystal, now in the circuit. Thus, the smaller this effective resistance impedance in series with Y8, the closer does the selectivity of the crystal filter circuit approach that of the 455-kc crystal alone. The 6 db band widths developed and selected by the three "XTAL" bandwidth positions of the "SELECTIVITY" switch (19, figure 1-2) are ".2 kc", ".5 kc", and "1.3 kc". The three "NON-XTAL" bandwidths are mostly developed in the V9 and V10 i-f stages.

4-50. V9 AND V10 I-F STAGES. (See figure 4-7.)

4-51. The V9 and V10 i-f stages each utilize a Type 6BA6 electron tube and are otherwise similar, apart from the J4 "REMOTE" connector (12, figure 1-3) associated with V10. As such, the stage gain and selectivity developed by each is essentially the same even though V10 is loaded down somewhat by the grid input resistor R78 in the grid circuit of the V16A cathode follower. The three degrees of "NON-XTAL" selectivity provided the 455-kc signal are partly due to the selectivity developed in the 455-kc crystal filter circuit with the S5A section of the SELECTIVITY switch (19, figure 1-2) is in any one of its three "NON-XTAL" positions, but are mostly due to the selective circuits contained in the identical i-f transformer subassemblies T4 and T5, respectively associated with V9 and V10. The 6 db "NON-XTAL" bandwidths provided the 455-kc signal are "3 kc", "8 kc", and "13 kc". The three "NON-XTAL" switch positions of the S5A and S5B sections of the switch (19), respectively associated with T4 and T5, are each connected respectively to one of the three secondaries of the L40 and L43 i-f transformers, each of which comprises a primary winding identical to each secondary. The coefficient of coupling between the primary and each secondary, associated with a "NON-XTAL" position of the switch (19) is different, due to its physical spacing, that closest to the primary being associated

with the "13 kc" position, that next closest with the "8 kc" position, and that furthest away with the "3 kc" position of the switch (19). When the switch (19) is in any one of its "XTAL" positions, the secondaries of L40 and L43 used are those spaced furthest to their respective primaries. The iron cup shielded i-f coils L38, L39, L41, and L42 are identical. L38 and L41 respectively are in series with the primaries and L39 and L42 respectively are in series with the secondaries of L40 and L43. The full primaries and secondaries of T4 and T5 are parallel-resonant to 455 kc, the primaries respectively with the identical capacitors C117 and C124, and the secondaries, respectively with the capacitors C119 and C120 in series, and the capacitors C125 and C126 in series. Alignment to 455 kc is provided by the adjustable tuning cores of L38, L39, L41, and L42. The design of T4 and T5 is such that the mutual inductances due to L40 and L43 provide for the bandwidths developed to center about the nominal 455-kc resonant response of each tuned circuit. Further, each degree of selectivity developed is maintained to a high degree since the mutual inductance, within the tolerance maintained for the windings of L40 and L43, only affects the coefficient of coupling slightly. The reason for this is that the windings of L40 and L43 are only a small part of the full primary and secondary winding inductances of T4 and T5. Thus, even though L38, L39, L41, and L42 provide for high gain, the resultant tolerance of the coefficient maintained for L40 and L43 cannot affect more than slightly the gain developed for each degree of selectivity.

4-52. V9 and V10 are supplied with d-c plate voltage from the self-contained B+ rectifier, +265 volt supply. For V9 it is fed to the pin 5 plate through R49 and the primary of T4. For V10 it is fed to the pin 5 plate through R54 and the primary of T5. The resistor-capacitor combinations R49 and C118 and R54 and C123 form decoupling networks respectively in the d-c supply voltage line to V9 and V10. V9 and V10 are supplied with d-c screen grid voltage directly from the self-contained B+ rectifier, +150 volt supply. C116 and C122, respectively, are the screen grid capacitors for V9 and V10. Negative bias is applied to the pin 1 grid of V9 through the resistors R44 and R43, and likewise to the pin 1 grid of V10 through the resistors R52 and R51. The resistor-capacitor combinations R44 and C115, and R52 and C121 form decoupling networks and have some effect on the time constant of the a-v-c circuit. When S8, the "AVC" "MAN" switch (15, figure 1-2) is at "MAN", the -51 to -1 volt Bias rectifier supply voltage fed to V9 and V10 is dependent on the setting of the "RF GAIN" control (14, figure 1-2). When S8 is at "AVC", the "RF GAIN" (14) is normally at maximum (minus one volt setting), the actual negative bias applied to V9 and V10 being that developed on the a-v-c bus. The resistor R97, while isolating the a-v-c bus from the Bias rectifier, still provides for the use

of the "RF GAIN" control (14), even when S9 is set at "AVC". The pin 2 suppressor grid of V9 is grounded but negative bias is shunt fed from the Bias rectifier -10 volt supply to the pin 2 grid of V10 through the decoupling network comprising the resistor R115 and the capacitor C165. This is done so that external tone input to terminals A and D of the "REMOTE" connector (12, figure 1-3) may be impressed across the resistor R116 and fed through the coupling capacitor C166 to the pin 2 suppressor grid of V10, to modulate the 455-kc signal when of keyed-carrier form. Terminals B and C of the "REMOTE" connector (12) provide for external switch means to duplicate the function of the S7 "MOD" "CW" switch (17, figure 1-2) when at "CW", namely to provide the +150 volt regulated supply voltage from the B+ rectifier to the pin 5 plate of V13, the beat frequency oscillator.

4-53. The 455-kc signal output of the 455-kc crystal filter circuit developed across C114 is that impressed through the grid stabilizing resistor R42 to the pin 1 grid of V9. The amplified 455-kc signal output of V9 is that developed across the secondary of T4, that portion of it across C120 being fed through the grid stabilizing resistor R50 to the pin 1 grid of V10. The amplified 455-kc signal output of V10 is that developed across the secondary of T5, that portion of it across C126 being fed through the grid stabilizing resistor R55 to the pin 1 grid of V11, the i-f driver stage. The 455-kc signal developed across the full secondary of T5 and effective across the grid input resistor R78 of the V16A cathode follower, is fed to R78 through the coupling capacitor C145 to provide the 455-kc signal as input to the pin 7 grid of V16A.

4-54. V11 DRIVER STAGE. (See figure 4-7.)

4-55. The V11 driver stage utilizes a Type 6BA6 electron tube. It functions to isolate the loading due to the V14A detector and the V14B a-v-c rectifier from the V10 second i-f amplifier, so that the selectivity developed by the V10 stage is not impaired. Further, it provides the 455-kc signal to C14A and V14B at a level suited to their proper functioning.

4-56. V11 is supplied with d-c plate and d-c screen voltage from the self-contained B+ rectifier. The +265 volt supply is shunt fed to the pin 5 plate of V11 through the resistor R59 and the r-f choke L47. R59 and the capacitor C129B form a decoupling network. The +150 volt regulated supply is fed to the pin 6 screen grid of V11 through the resistor R58. C129A is the screen grid capacitor and with R58 forms a decoupling network. Negative bias is provided V11 from the -10 volt supply of the Bias rectifier. The resistors R57, R56, and R113 in series across the -10 volt supply provide for a -7.8 volt bias to be fed through the grid stabilizing resistor R55 to the pin 1 grid of V11. R57 and the capacitor C128 form a decoupling network.

4-57. The 455-kc signal output of V10 developed across C126 and impressed across the grid input resistor R56 is fed through R55 to the pin 1 grid of V11. The ca-

pacitor C127 completes the grid circuit of V11 and provides the 455-kc signal with a low impedance return to ground. V11, functioning as a power amplifier, develops 455-kc signal output across the resistor R61 and across the resistor R62. That coupled through the capacitor C138 to R61 is fed to the pin 2 plate of the V14B a-v-c rectifier and that coupled through the capacitor C139 to R62 is fed to the pin 7 plate of the V14A detector. The capacitor C141 provides a low impedance ground return for the 455-kc signal developed across R62.

4-58. V16A CATHODE FOLLOWER. (See figure 4-7.)

4-59. The V16A cathode follower utilizes one section of a Type 12AU7 electron tube. It functions as a power amplifier and acts as an impedance transformation device to provide a 70-ohm coaxial cable match to associated equipment connected to the J2 "IF OUTPUT" connector (10, figure 1-3).

4-60. V16A is supplied with d-c plate voltage from the self-contained B+ rectifier, +265 volt supply, through the plate dropping resistor R80. Self-bias is developed by the cathode resistor R79, the capacitor C145 isolating the negative bias to the grid circuit of V16A. The capacitor C147 blocks the d-c plate current from the r-f autotransformer L53.

4-61. The 455-kc signal output of V10, developed across C125 and C126 in series, is impressed across the grid-leak resistor R78 through the coupling capacitor C145 to the pin 7 grid of V16A. The 455-kc signal output of V16A is that developed between the pin 8 cathode of V16A and ground, since the plate 6 of V16A is effectively grounded by the plate bypass capacitor C146. The signal output level is at a somewhat lower level than the signal input, due to R79 also being in the grid circuit of V16A, whereby the negative feedback is incorporated in the stage. The stage provides the 455-kc i-f output through C147 and L53 to the load, 70-ohm coaxial cable connected to J2.

4-62. AUXILIARY CIRCUITS. (See figures 4-9 and 4-10.) The auxiliary circuits comprise the V13 beat-frequency heterodyne and V12 buffer shown in figure 4-9, and the V14B a-v-c rectifier circuitry shown in figure 4-10. V13, with V12, when rendered operative, function to provide a 455 ± 3 -kc heterodyne to render audible a keyed-carrier or frequency-shift carrier reception. At 455 kc the heterodyne is used for the carrier reinsertion of a suppressed carrier single or double side band signal. The heterodyne may also be fed to J7 for use by an externally connected slave receiver. V14B when rendered operative, functions to automatically control the gain of the receiver at the level chosen by the "RF GAIN" control (14, figure 1-2). The AVC provided is suited to any type of signal reception other than a hand-keyed signal; also for both slow and rapid fading so long as the signal speeds do not approach the rate of fading.

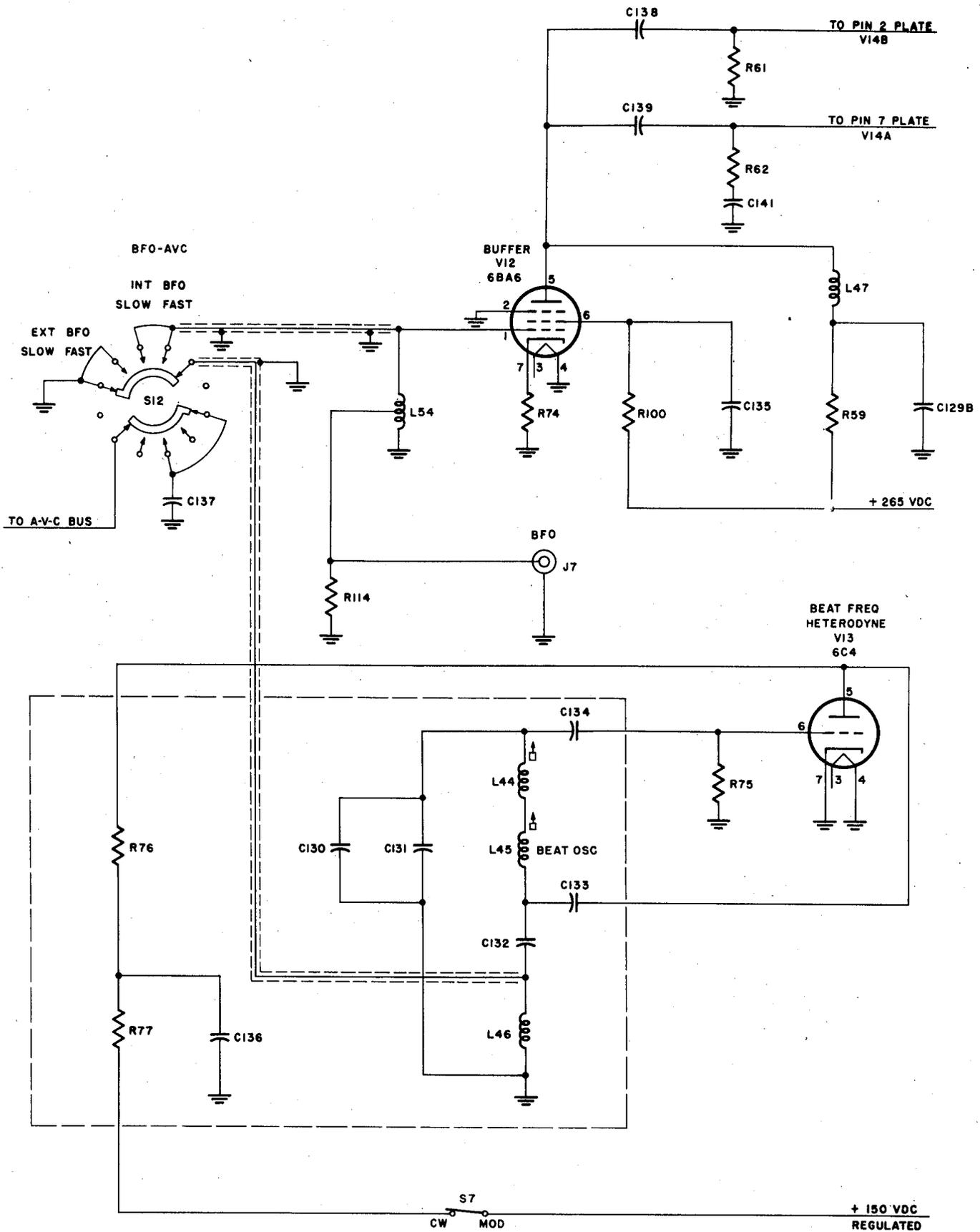


Figure 4-9. Beat Frequency Heterodyne and Buffer, Schematic Diagram

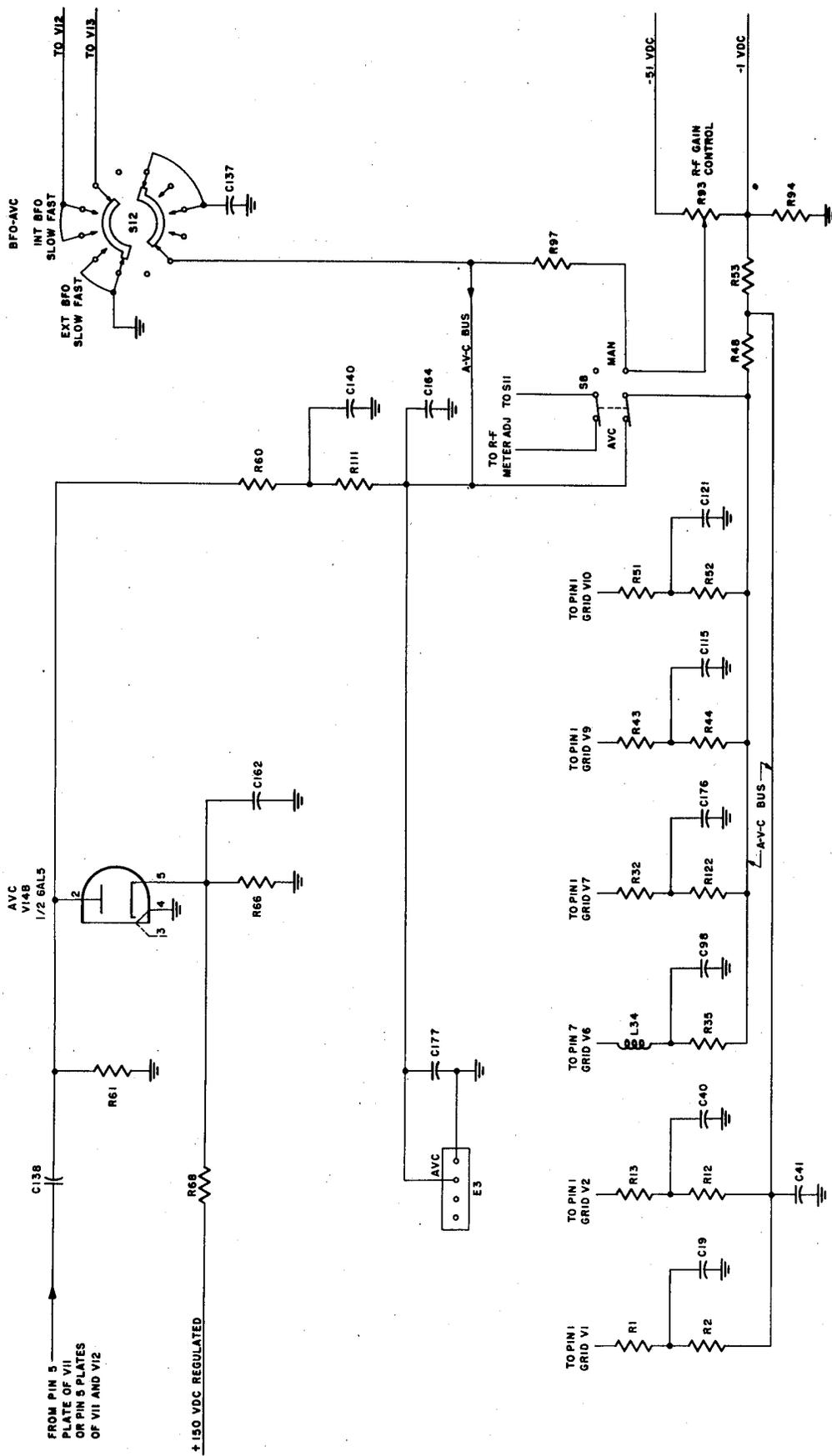


Figure 4-10. Automatic Volume Control System Schematic Diagram

4-63. V13 BEAT-FREQUENCY HETERODYNE.

(See figure 4-9.)

4-64. The V13 beat-frequency heterodyne utilizes a Type 6C4 electron tube. It is a high capacity Colpitts type oscillator which minimizes oscillator harmonic output and provides a high order of frequency stability. It is rendered operative when the "MOD" "CW" switch (17, figure 1-2) is set to "CW". The oscillator tank circuit consists of the capacitor C132 in series with the r-f coil L46 and with the parallel combination of the capacitors C130 and C131, all shunted by the r-f coils L44 and L45 in series. With the "BEAT OSC" control (18, figure 1-2), adjustable iron core of L45 set to its zero knob dial position, the adjustable iron core of L44 provides for oscillator alignment to 455 kc. The control (18) is used to adjust the oscillator frequency to any frequency within the range of 455 ± 3 kc. The capacitor C136 and the resistor R76 form a decoupling network.

4-65. V13 is supplied with d-c plate voltage from the self-contained B+ rectifier, +150 volt regulated supply, through the "CW" position of S7 and the plate dropping resistors R77 and R76 to the pin 5 plate of V13. The capacitor C133 blocks the plate voltage from the tank circuit. Self-bias is provided V13 by the grid-leak resistor R75 and grid-capacitor C134 combination. This is done so that the b-f-o oscillations are self-starting.

4-66. The b-f-o oscillations developed by V13 closely approximate the resonant frequency of the tank circuit itself. The tank circuit voltage developed across L46 is the b-f-o output fed to the S12 "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2), in the pin 1 grid circuit of the V12 buffer. When S12 is in either "EXT BFO" position the high voltage end of L46 is grounded, to suppress any output from V13. When S12 is in either "INT BFO" position, the b-f-o voltage across L46 is fed directly to the pin 1 grid of V12 by a shielded lead. This b-f-o voltage also, is impressed across the r-f autotransformer L54 whose tap is connected to the J7 "BFO" connector (7, figure 1-3), so that it may be fed to a slave receiver externally, 70-ohm coaxial cable, connected to J7. The 470-ohm resistor R114 loads down the tap connection to avoid any tendency towards circuit oscillation and yet not interfere with the 70-ohm match provided by the tap on L54.

4-67. V12 BUFFER. (See figure 4-9.)

4-68. The V12 buffer utilizes a Type 6BA6 electron tube. It derives input from V13 the bfo when the "MOD" "CW" switch (17, figure 1-2) is set to "CW". It is used to eliminate lock-in between the frequency of the b-f-o output and the 455-kc signal output from the V11 i-f driver stage, such that, for c-w reception, the receiver can be sharply tuned for zero beat audio output. Further, V12 isolates the V14A detector and the V14B a-v-c rectifier from the V13 bfo, and acts as a power amplifier to meet the load power requirements thereby imposed on it.

4-69. V12 is supplied with d-c plate and d-c screen voltage from the self-contained B+ rectifier, +265 volt supply. The d-c plate voltage is shunt fed through the resistor R59 and the r-f choke coil L47 to the pin 5 plate of V12. R59 and the C129B bypass capacitor form a decoupling network. The d-c screen voltage is fed through the screen dropping resistor R100 to the pin 6 screen grid of V12. C135 is the screen grid bypass capacitor. Self-bias is provided V13 by the cathode resistor R74, which being unbypassed, provides negative feedback to stabilize the stage.

4-70. The V13 b-f-o oscillations at 455 ± 3 kc are fed through either "INT BFO" switch position of S12 to the pin 1 grid of V12. When S12 is in either "EXT BFO" switch position, the 455 ± 3 -kc b-f-o input to V12 is that developed across L54, derived from an external source connected to J7, possibly that from a master receiver. The V12, 455 ± 3 -kc output is coupled through C138 across R61 to the pin 2 plate of the V14B a-v-c rectifier and through C139 across R62 to the pin 7 plate of the V14A detector. C141 provides a low impedance r-f ground for R62.

4-71. V14B AVC. (See figure 4-10.)

4-72. The V14B a-v-c rectifier utilizes one section of a Type 6AL5 electron tube. It is of diode type and negatively biased to incorporate a delay of -23 d-c volts. The resistors R66 and R68 act as a voltage divider across the +150 volt regulated supply, R66 providing for the negative delay bias used. V14B remains in a non-conducting state until the 455-kc signal input level from the V11 driver exceeds the delay bias and the potential loss due to the resistance drop in V14B itself. When operating cw, both V11 and the V12 buffer provide input to V14B, that from V12 being at 455 ± 3 kc. The input to V14B is fed through C138 across the diode input resistor R61 to the pin 2 plate of V14B. When V14B conducts, the unidirectional current flow is in such a direction as to make the pin 2 plate end of R61 negative to ground. This negative potential has level variations at the signal intelligence rate, which are smoothed out by the resistor-capacitor filter network comprising the resistors R60 and R111 and the capacitors C140, C164, and also C137, when the "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4, figure 1-2) is in a "SLOW" position. The negative a-v-c bias developed is always proportional to the carrier level of the signal tuned in and is directly fed to the "AVC" terminals of the "DIODE OUTPUT" "AVC" terminals (9, figure 1-3). The capacitor C177 filters the a-v-c line to E3 and has some effect on the overall a-v-c time constant effective. This a-v-c line provides for the a-v-c interconnection between receivers when use is made of common avc between receivers in a system.

4-73. When S8, the "AVC" "MAN" switch (15, figure 1-2) is at "AVC", the negative a-v-c bias developed is applied to the a-v-c bus, used to provide the a-v-c bias to V6, V7, V9, and V10. The resistors R48 and R53,

with R94, act as a voltage divider to the a-v-c bias developed, the a-v-c bias effective at the junction of R48 and R53 being applied to the a-v-c bus, used to provide this a-v-c bias to V1 and V2. R48 has some effect on the overall a-v-c time constant effective. The a-v-c bias to V1 and V2 is applied through the resistors R2 and R1 to the pin 1 grid of V1 and through the resistors R12 and R13 to the pin 1 grid of V2. The resistor-capacitor combinations C19, R2 and C40, R12, with C41, filter the a-v-c lines respectively to V1 and V2, and have some effect on the overall a-v-c time constant effective. The a-v-c bias to V6, V7, V9, and V10 is applied through the resistor R35 and the r-f coil L34 to the pin 7 grid of V6, through the resistors R122 and R32 to the pin 1 grid of V7, through the resistors R44 and R43 to the pin 1 grid of V9, and through the resistors R52 and R51 to the pin 1 grid of V10. The resistor-capacitor combinations C98, R35; C176, R122; C115, R44; and C121, R52 filter the a-v-c lines, respectively to V6, V7, V9, and V10 and have some effect on the overall a-v-c time constant effective. The resistor R97 isolates the a-v-c bus from the Bias rectifier but allows the negative bias from the Bias rectifier also to be applied to the a-v-c bus to control the gains of V1, V2, V6, V7, V9, and V10. The position of the movable arm of R93, the "RF GAIN" control (14, figure 1-2) determines this negative bias, which due to the Bias rectifier -1 volt tap, is never less than -1 volt. Thus the actual negative bias voltage effective is a complex resultant of that due to a-v-c action and that due to the setting of the "RF GAIN" control (14). In use, with S8 set at "AVC", the "RF GAIN" control (14) is usually at maximum (minus one volt setting) such that a-v-c negative bias beyond minus-one volt provides the a-v-c action. Since the resistors R48, R53, and R97 act as a voltage divider from the movable arm of R93 to the junction of R93 and R94, the most negative bias that the Bias rectifier provides due to the movable arm position of R93 is -28.8 volts to V6, V7, V9, and V10 and only -22 volts to V1 and V2. When S8 is set at "MAN" only R48 and R53 act as a voltage divider across R93 so that the most negative bias provided to V6, V7, V9, and V10 is -51 volts, and that to V1 and V2 is -38.5 volts.

4-74. AF SECTION. (See figure 4-11.) The a-f section detects the 455-kc signal carrier and develops the a-f power output of the receiver. Further, it has provision for meter indications of r-f signal strength and of a-f power output. Also, it has a noise limiter to highly attenuate pulse type noise, such as that due to ignition systems.

4-75. V14A DETECTOR. (See figure 4-11.)

4-76. The V14A detector utilizes one section of a Type 6AL5 electron tube. It is of the diode type to keep distortion to a possible minimum, the distortion actually decreasing with increase in input signal level. The modulation percentage that can be handled by V14A with a possible minimum of distortion is almost

100 percent, and is dependent on the ratio of the a-c to d-c loading of V14A. The resistor-capacitor combination which determines this loading is proportional and chosen so that its effective RC time constant is relatively low, since otherwise V14A could not follow the rapid signal level variations due to high percentages of modulation without serious distortion. The d-c loading of V14A is the series combination of the resistors R62, R63, R64, and R65, and the effective resistance of the potentiometer R69 connected as a rheostat. When S8, the "AVC" "MAN" switch (15, figure 1-2) is at "AVC", the resistance of the front panel M1 meter, in parallel with R69 is part of the d-c loading. The a-c loading of V14A is the vector sum of the impedance of all paths to ground through the capacitors C141, C142, C143, and C144 when the S6 "LIMITER" "OFF" switch (21, figure 1-2) is at "LIMITER". At audio frequencies, the a-c loading of C141 and C142 is almost negligible since each presents a high capacitive reactance, as compared to the resistance in series or parallel to them; also the low capacitive reactance of C143 and C144 are almost negligible since the former is in series with the high resistance of R84, the "AUDIO GAIN" control (22, figure 1-2), and the latter with the high resistance of R67. However, in the presence of noise, when V15A the noise limiter is operative, the percentage modulation handling capabilities are reduced somewhat since the low capacitive reactance of C144 then effectively parallels C142, to ground.

4-77. The 455-kc signal from the pin 5 plate of V11, and for c-w reception also that at 455 ± 3 kc, applied to V14A through the capacitor C139, is that across R62, the input resistor of V14A. The decoupling networks comprising R63, C141 and R64, C142 isolate the signal to R62. V14A conducts for positive signal excursions above ground, causing a unidirectional current flow such that the pin 7 plate of V14A attains a negative potential slightly less than each peak of input signal, due to the potential loss in the internal resistance of V14A. The a-c variations of the detected signal become impressed across R84, the "AUDIO GAIN" control (22, figure 1-2) due to the coupling provided by C143. The audio voltage from the movable arm of R84 to ground is the audio voltage input to the V16B first audio stage.

4-78. The unidirectional current flow in R63 provides negative bias to cut off the V15A noise limiter connected across it. Also, R93, the "METER ADJ RF" control (13, figure 1-3) provides for the control of the unidirectional current flow through it so that the portion flowing through the M1 meter, with the S8 "AVC" "MAN" switch (15, figure 1-2) at "AVC", may be controlled to properly calibrate the r-f scale of M1.

4-79. When noise of the pulse type becomes input to V14A, its detector action is as outlined for the signal in paragraph 4-77. However, when S6 is set to its noise "LIMITER" position, the audible rate of the

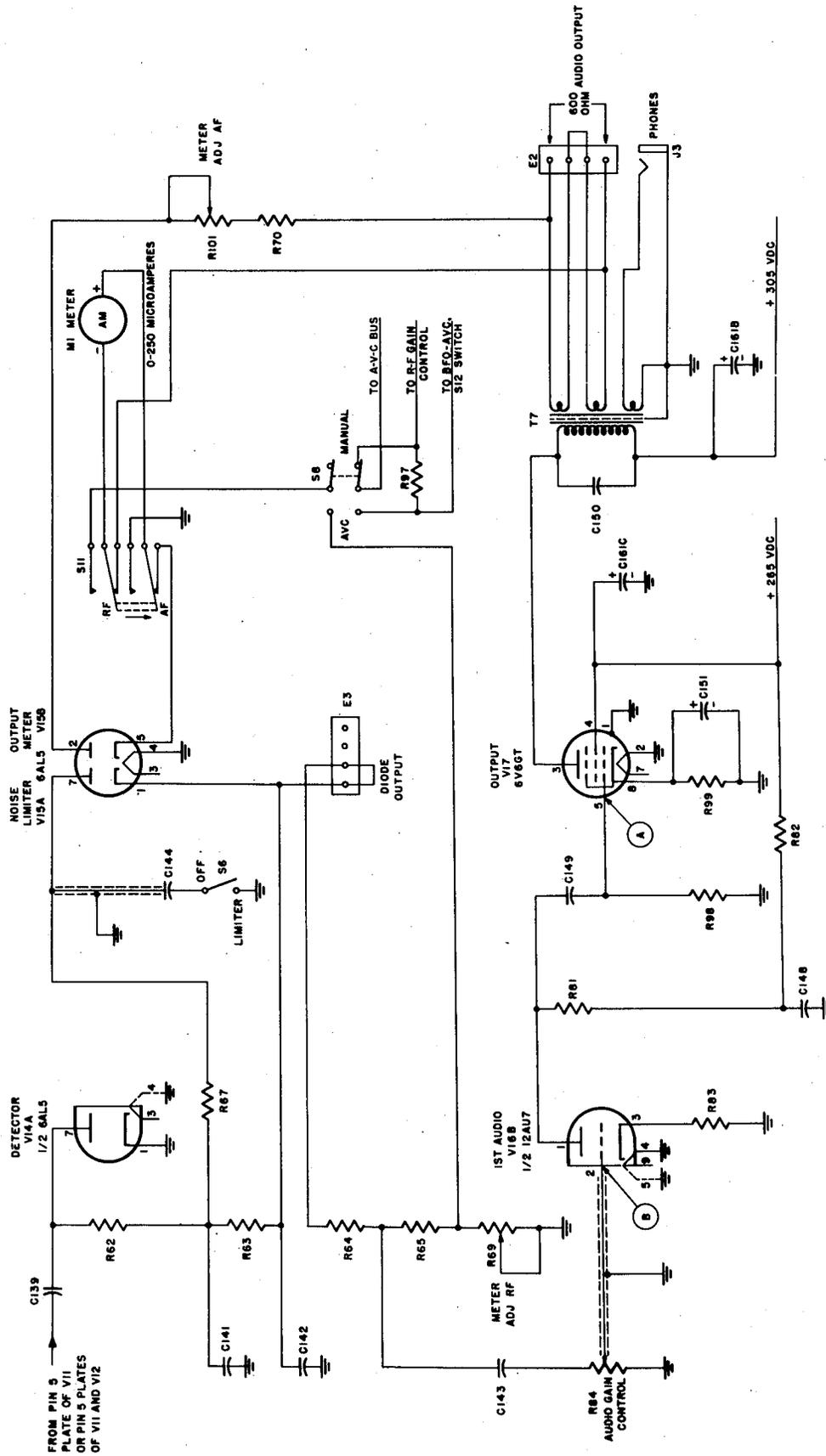


Figure 4-11. Audio Frequency Section Schematic Diagram

noise and the signal do not appear as audio output to V16B, the first a-f amplifier. This is due to the V15A noise limiter rectifier, which conducts for the interval of each noise spike so that C144 is virtually connected between the junction of R63 and R64, to ground. C144 then presents a low capacitive impedance to bypass the noise and the signal to ground. In the absence of noise, the resistance of R67 is high enough so that C144 does not normally bypass the a-c signal to ground, that is when V15A is not conducting.

4-80. For c-w reception, the unidirectional current output variations of V14A are at the audio frequency difference between the 455-kc signal and the 455 ± 3 -kc b-f-o buffer output. Since the a-f tone exists only when both outputs obtain, it provides for the intelligence. For frequency-shift reception, the signal is at 455 kc \pm say a carrier shift of 425 cps so that the difference in pitch between the two b-f-o tones resultant render the signal audible, but not intelligible.

4-81. The "DIODE OUTPUT" terminals of the E3, "DIODE OUTPUT" "AVC" terminals (9, figure 1-3) provide for the use of the receiver d-c output to operate recording equipment connected to E3. Also, the jumper connection at E3, when opened for one receiver in a space diversity receiving system, enables the other receiver to develop the composite output of the system.

4-82. V15A NOISE LIMITER. (See figure 4-11.)

4-83. The V15A noise limiter utilizes one diode section of a Type 6AL5 electron tube. When S6 is in its "LIMITER" position, and noise input to V14A, the detector, causes V15A to conduct, C144 is virtually connected to the junction of R63 and R64, so that a low impedance path is provided the noise to ground. Since this path through C144, to ground, is of much lower impedance than that through C143, the audio coupling capacitor, the audible noise and a-f signal are bypassed from the a-f system of the receiver.

4-84. The polarity the signal develops across R63 makes the plate of V15A negative in relation to its cathode, since V15A is connected across R63. Thus, in the absence of noise V15A is an open circuit, the noise limiter capacitor C144 charging up to the average negative potential existent at the junction of R62 and R63, to ground. The RC time constant, due to R67 and C144, enables the voltage across C144, due to its charge, to follow the a-f variations of the unidirectional potential existent between the junction of R62 and R63, and ground. When the V14A detector output comprises unidirectional negative noise spikes to ground, the RC time constant of R67 and C144 cannot follow the rapid excursions due to the spikes so that the voltage at the junction of R62 and R63 to ground does not change for the intervals of each noise spike. However, the voltage at the junction of R63 and R64, to which the V15A cathode is connected, does follow the sharp increase in negative voltage due to each noise spike, so that the cathode potential of V15A becomes

more negative than that at its plate, whereby V15A conducts, to provide for the noise limiter action.

4-85. V16B FIRST AUDIO STAGE.

(See figure 4-11.)

4-86. The V16B first audio stage utilizes one section of the Type 12AU7 electron tube. It functions as a negative feedback a-f amplifier to stabilize the stage, especially so for low a-f input, due to setting R84, the "AUDIO GAIN" control (22, figure 1 2) nearly fully counter-clockwise. This is so since for this condition the plate resistance of V16B is of the order of the resistance of R84, effective in the grid circuit of V16B.

4-87. V16B is supplied with d-c plate voltage from the self-contained B+ rectifier, +265 volt supply, through the decoupling network comprising the resistor R82 and the capacitor C148, and the plate resistor R81 to the pin 1 plate of V16B. Self-bias and the negative feedback is developed by the plate current flow in the cathode resistor R83.

4-88. The a-f variations of the V14A detected signal output are applied to the pin 2 grid of V16B. Use is made of a shielded cable lead between the movable arm of R84 and V16B. The capacitor C143 isolates the d-c component of the V14A detector output and provides filter action to develop the a-f signal across R84, the "AUDIO GAIN" control (22, figure 1-2). The a-f signal voltage between the movable arm of R84 and ground provides the input to V16B. The V16B amplified output is that developed across R81, the plate load resistor, the capacitor C148 providing R81 with a low impedance ground connection. The V16B stage output is impressed across the R98 grid input resistor of V17, the a-f power stage, through the coupling capacitor C149, to the pin 5 grid of V17.

4-89. V17 A-F POWER STAGE. (See figure 4-11.). The V17 a-f power stage utilizes a Type 6V6GT electron tube. It is resistance coupled to V16B, the first audio stage, and develops the a-f power output of the receiver. The T7 output transformer, connected to the E2, "AUDIO OUTPUT" terminals (8, figure 1-3), provides for a 600-ohm matching load or loudspeaker to load the stage. T7 also provides for an 8,000-ohm matching headset to be plug connected to J3 the "PHONES" jack (5, figure 1-2.) The two secondary windings of T7 connected to E2 are of the balanced split type, connected series aiding at E2 by a jumper connection. The common connection at the jumper is used to balance out the d-c transmission line current in the winding, when local teletypewriter operations make use of the line, apart from any normal use of the line to provide for the a-f signal at its remote end. When S11, the "METER RF AF" switch (16, figure 1-2) is held depressed in the "AF" position, the M1 meter circuit, apart from the externally connected 600-ohm load, loads the secondary winding of T7 connected to E2.

4-90. V17 is supplied with d-c plate and d-c screen voltage respectively from the self-contained B+ rectifier, +305 and +265 volt supplies. The former is fed through the primary of T7 to the pin 3 plate and the latter directly to the pin 4 screen grid, of V17. The capacitors C161B and C161C of the B+ rectifier respectively act as the plate and screen bypass capacitors. Self-bias is developed by the d-c plate current flow in the cathode resistor R99. The capacitor C151 isolates the self-bias developed to the grid circuit of V17.

4-91. The a-f signal input to the stage is that from V16B impressed across R98 to the pin 5 grid of V17. The a-f signal power output of the stage is that developed in the load connected to E2, and/or that connected to J3. The capacitor C99 shunts the primary of T7 so that the spurious high a-f output responses of the receiver, if any, do not get through T7 to the receiver load.

4-92. V15B A-F OUTPUT METER RECTIFIER. (See figure 4-11.)

4-93. The V15B a-f output meter utilizes one diode section of the Type 6AL5 electron tube. It is operative when S11, the "METER" "RF" "AF" switch (16, figure 1-2), is held depressed in its "AF" position, and a-f output voltage is effective across the secondary of T7 connected to E2. It acts to rectify the a-f voltage applied between its pin 2 plate and pin 5 cathode, by way of the M1 meter, S11 in its AF position, the limiting resistor R70, and R101 the "METER ADJ RF" control (14, figure 1-3) potentiometer connected as a rheostat. R101 provides for the calibration adjustment of the unidirectional current flow in M1, the resistor R70 limiting this current to a predetermined maximum. In the absence of a suitable 600-ohm external load connected to E2 the current flow in M1 could be excessive, sufficiently so to damage it.

4-94. The a-f signal voltage alternate cycles which make the pin 2 plate of V15B positive in relation to its pin 5 cathode, cause V15B to conduct. Since the secondary winding resistance of T7 connected to E2 is much lower than the 600-ohm load, most of the unidirectional current flow is through the winding as compared to that in the 600-ohm load. Since the unidirectional current flow through the M1 meter is proportional to the a-f signal voltage developed by V15B, the M1 meter "AF" indication may be adjusted through the use of R101 to be proportional to the a-f power output of the receiver, at the "AUDIO OUTPUT" terminals (8, figure 1-3).

4-95. V18, V19, AND V20 SELF-CONTAINED STABILIZED POWER SUPPLY. (See figure 4-12.) The self-contained stabilized power supply is designed to operate from a 50- to 60-cps, 90 to 270 volt, single phase, a-c source. It provides the a-c line power as output to meet the various B+, bias, and a-c filament voltage requirements of the receiver. The T8 power

transformer primary has eight taps, each with a different a-c voltage rating, that used being that which most closely approximates the voltage rating of the a-c source available. The "AC POWER" connector (5, figure 1-3) provides for plug connecting the a-c source to the receiver. The "RF GAIN" control (14, figure 1-2), when turned clockwise from its knob dial "OFF" position, switches the S10 switch to its "on" position whereby the a-c source voltage is applied to the primary of T8. A 1.6-amp, slow blow fuse F1 and a three-eighths ampere fuse F2 respectively protect the primary and high voltage secondary of T8, from overload. Each fuse is of the cartridge type and contained in a cartridge type holder respectively designated "1.6 A SLO FUSE" holder (1, figure 1-3) and "3/8 A FUSE" holder (2). The capacitors C152 and C174 are included to bypass the ground any possible r-f interfering voltage on the a-c source line to the receiver. T8 is completely enclosed in a grounded steel case to reduce to a possible minimum the direct pickup of such interference.

a. B+ RECTIFIER. The B+ rectifier utilizes a Type 5R4GY rectifier tube for the full wave rectifier V19. It provides the +150 volt regulated, the +90 to +150, the +228 to +265, and the +280 to +305 supply voltages used by the receiver. The +150 volt regulated supply is stabilized by V18, a Type OA2 voltage regulator tube. The voltage regulation of each of the three unregulated supply voltages is dependent on the setting of the "RF GAIN" control (14, figure 1-2), the supply voltages effective being lowest with the control (14) set at maximum. The use of the filter input capacitor C161A to the two reactor-capacitor low pass filter sections L51, C161B, and L52, C161C, results in maximum B+ rectifier d-c voltage output for the a-c plate voltage used. The a-c plate voltage to ground, applied to each of the pin 4 and pin 6 plates of V19, from the high voltage secondary winding of T8, ranges from 315 to 317.5 a-c volts, again dependent on the setting of R93, the "RF GAIN" control (14). V19 derives filament power from the five-volt a-c secondary winding of T8. Each half cycle of a-c plate voltage applied to V19 maintains the positive d-c potential developed across C161A, the a-c ripple voltage also effective across C161A being bypassed to ground by the two-section low-pass filter. The resistors R72 and R73 in series act as a bleeder to maintain the B+ rectifier d-c voltage regulation within reasonable limits when part of the load is removed, as is the case when the S9 "SEND" "REC" switch (1, figure 1-2) is at "SEND". The resistor R85 is used to limit the current flow through V18, which, with R85, forms part of the d-c load of V19. The d-c voltage to ground across V18 is the stabilized +150 volt regulated supply; the junction of R72 and R73 to ground is the +90 to +150 volt supply; the junction of R85, R72, C161C, and L52 is the +228 to +265 volt supply; and the junction of L51, L52, and C161B is the +280 to +305 volt supply.

b. **BIAS RECTIFIER.** The bias rectifier utilizes a Type 6AL5 electron tube for the full wave rectifier V20. It provides the minus one volt, the -10 volt, and the -1 to -51 bias voltages used by the receiver. The resistor pairs R86, R87 and R89, R88 each act as a voltage divider so that the a-c voltage to ground, applied to each of the pin 5 and 1 cathodes of V20, from the high voltage secondary winding of T8, ranges from 131 to 132 a-c volts, dependent on the setting of the "RF GAIN" control (14, figure 1-2), that effective being lowest with the control (14) at maximum. The low pass filter network connected to the paralleled pins 2 and 7 of V20 comprises the three identical resistor-capacitor sections R90, C158; R91, C159; and R92, C160. V20 derives filament power from the 6.3 volt a-c secondary winding of T8. Each half cycle of a-c plate voltage to V20 maintains the -51 volt d-c potential developed by V20, the superimposed a-c ripple voltage also developed being bypassed to ground by the three section low pass filter. The resistors R95 and R96 act as a bleeder network for V20, their junction providing for the -10 volt d-c bias supply. Likewise, the junction of R93, the "RF GAIN" control (14) and R94 provide for the minus one volt d-c bias supply. The movable arm of R93 provides for the -1 to -51 volt d-c bias range. The resistors R56, R57, and R113 within the receiver proper, connected across the -10 d-c volt supply, provide a bias of -7.8 d-c volts at the junction of R56 and R113 for use by V11.

c. **A-C FILAMENT SUPPLY.** The a-c filament supply requirements of the receiver are developed in the four secondary filament windings of T8. The five volt winding provides the a-c filament power for V19 as outlined in step "a" of paragraph 4-95. The 6.3-volt winding provides the a-c filament power for V20 as outlined in step "b" of paragraph 4-95; also for the pilot lamps E101, E102, E103, and E104; and for the receiver tubes V3, V7, V9, V10, V11, V12, V13, V14, V15, V16, and V17. One of the 7.5-volt windings provides a-c filament power for the receiver tubes V1, V2, V4, and V5, and the other does likewise for V6 and V8. Each provides for 6.3 a-c filament volts, due to the a-c voltage drop in the r-f chokes L48 and L49 in series with one, and the a-c voltage drop in the r-f choke L50 in series with the other. The r-f choke-capacitor combinations of C154, L48, C153; C154, L49, C155; and C156, L50, C157, respectively, decouple V1, V2; V5, V4; and V8, V6 with regard to any r-f interference that appears at the input or output terminals of each network. The

decoupling networks are confined to V1, V2, V4, V5, V6, and V8, which comprise the critical circuitry of the receiver.

4-96. FUNCTIONAL OPERATION OF MECHANICAL COMPONENTS.

4-97. The precise mechanical design of the receiver enables it to maintain the high performance standards for which it is known. The receiver compact rotor turret assembly outlined in paragraph 1-10 is such that it provides for locating the r-f tuner subassemblies for the frequency band indented, closely adjacent to the respective sections of the eight-section four-gang tuning capacitor and electron tube associated with each, whereby circuit losses are kept to a possible minimum, such that the receiver sensitivity developed at high signal-plus-noise to noise ratios is a possible maximum for the frequency range covered by the receiver. The receiver clocklike anti-backlash gear-train mechanism outlined in paragraph 1-11 is such that it provides for the perfect tuning and resetability of the receiver, apart from the frequency stability incorporated in its design. Also, it results in maximum benefit to be derived from the selective i-f crystal filter circuit forming part of the i-f section of the receiver.

4-98. Each section of the eight-section four-gang tuning capacitor is matched and maintained to extremely close tolerances, even as between receivers. This tuning capacitor 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 has a clearance hole to ride freely on a stud screwed to the turret assembly housing. The ganged rotor plates of the unit are coupled to the gear-train drive through the use of a link plate coupling held in place by "U" shaped spring.

4-99. The front panel tuning lock, when used, clamps the vernier dial, to lock the gear-train mechanism, even though the flywheel loaded, front panel friction drive tuning knob remains free to turn. All coil, adjustable iron cores have flat spring nuts and all variable air trimmer capacitors have flat spring mountings to maintain their adjustment settings chosen. The rear apron adjustment controls are of the screw type to provide rigid adjustment means not subject to accidental shift.

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; also that the

switches designated ifo, bfo-avc, and hfo are not set to their red front panel external position designations.

b. Turn the receiver "on" and note that pilot lamps light up; if not, turn the receiver "off" and replace the 1.6-ampere fuse.

c. Note that all glass enclosed electron tube filaments light up and that the V18 voltage regulator tube shows a faint violet glow; if not, replace each defective tube.

d. Tune in, in turn, an m-c-w signal (phone or tone) and a c-w 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 as outlined in paragraphs 1-34 thru 1-50. 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 operat-

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.	<p>Connect equipment as shown in figure 5-1.</p> <p><i>Signal generator.</i> Adjust sig gen output, AM of 30 percent at 400 cps, to approx three uv level.</p> <p><i>Radio receiver.</i> Set for mcw and tune in any signal gen signal, keeping r-f gain control full on with no avc and selectivity switch set to 3-kc position. Adjust audio gain control for a ref level rec output of 10 mw.</p> <p><i>Signal generator.</i> 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.</p> <p><i>Radio receiver.</i> Readjust audio gain to provide 10 mw output at the 10:1 ratio. Note and record the known dial setting of the control.</p>	Two uv, or less, rec input at any signal freq within tuning range of rec.	I-f section; V9, V10, V11 T2, T3, T4, and/or T5 with regard to gain. R-f section; V1, V2, and/or any one of the r-f tuner subassemblies for band involved with regard to signal-plus-noise to noise ratio.

* Refer to paragraph 5-4.

TABLE 5-1. RECEIVER PERFORMANCE TESTS (CONT)

TEST	ADJUSTMENT PROCEDURES	MINIMUM PERFORMANCE STANDARD	TROUBLE LOCATION
Selectivity	<p>Connect the equipment as shown in figure 5-1.</p> <p>Repeat Sensitivity Test adjustments choosing a two mc signal.</p> <p>Then switch the rec selectivity switch to its 13.0-kc position. Note and record the receiver uv input.</p> <p>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.</p> <p>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.</p> <p>Plot on semi-log graph paper, as ordinates, the 10, 100, and 1000 time log 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.</p>	Selectivity of rec to approx that shown for each selectivity switch position in figure 1-4.	I-f section; T2, T3, T4, and/or T5.
Rated Power Output	<p>Connect equipment as shown in figure 5-1.</p> <p>Repeat Sensitivity Test adjustments.</p> <p>Then advance audio gain control to provide the rec rated output of at least two watts.</p>	Two watts, or more, of rec audio output at two uv input.	A-f section; V16B, V17, and/or T7.
Rated I-f Output	<p>Connect equipment as shown in figure 5-2.</p> <p>Repeat Sensitivity Test adjustments.</p>	Min rec i-f output of 200 mv to 70-ohm resistive i-f output load for two uv input.	I-f section; V16A.
Image Rejection Ratio	<p>Connect equipment as shown in figure 5-1.</p> <p>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.</p>	See table 1-4 for Image Rejection Ratios.	R-f 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	<p>Connect equipment as shown in figure 5-1.</p> <p>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.</p>	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.	R-f 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	<p>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.</p> <p>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.</p>	3,955 kc, i-f rejection ratio a min of 94 db for signal freq tuned in on bands 4, 5, or 6 of rec.	
Rec c-w Performance	<p>Adjust the rec for c-w reception and tune in a signal gen c-w 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.</p> <p>Check bfo freq stability by noting that rec tone output is constant in freq for each setting of the b-f-o control.</p> <p>Disconnect signal gen and tune in c-w 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.</p> <p>Reconnect signal gen and adjust for c-w carrier 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 described in paragraph 1-42.</p>	Beat freq osc range plus or minus three kc, at constant freq for setting of b-f-o control. No impairment in c-w 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.

ing 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, for a mechanical defect, or if either or both of the fuses F1 and F2 continue to blow when replaced.

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, as outlined in paragraph 5-5.

5-5. TROUBLE LOCATION. The receiver comprises functional sections described in paragraphs 4-12 and 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 in paragraph 5-8.

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

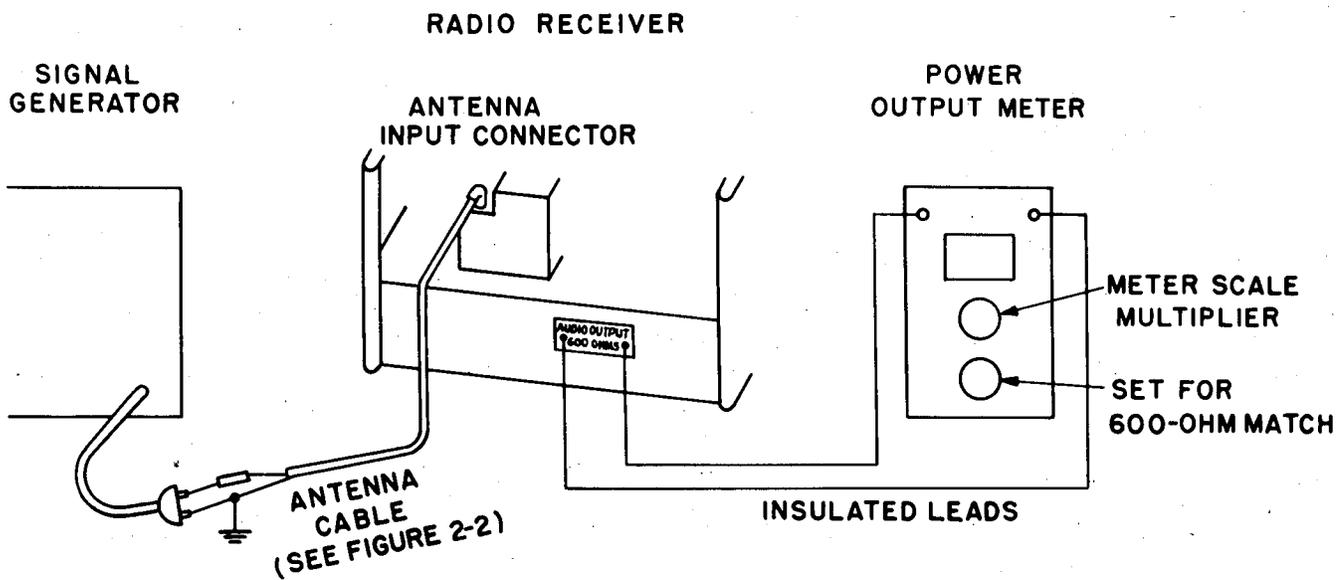


Figure 5-1. Receiver Sensitivity Test Set-up

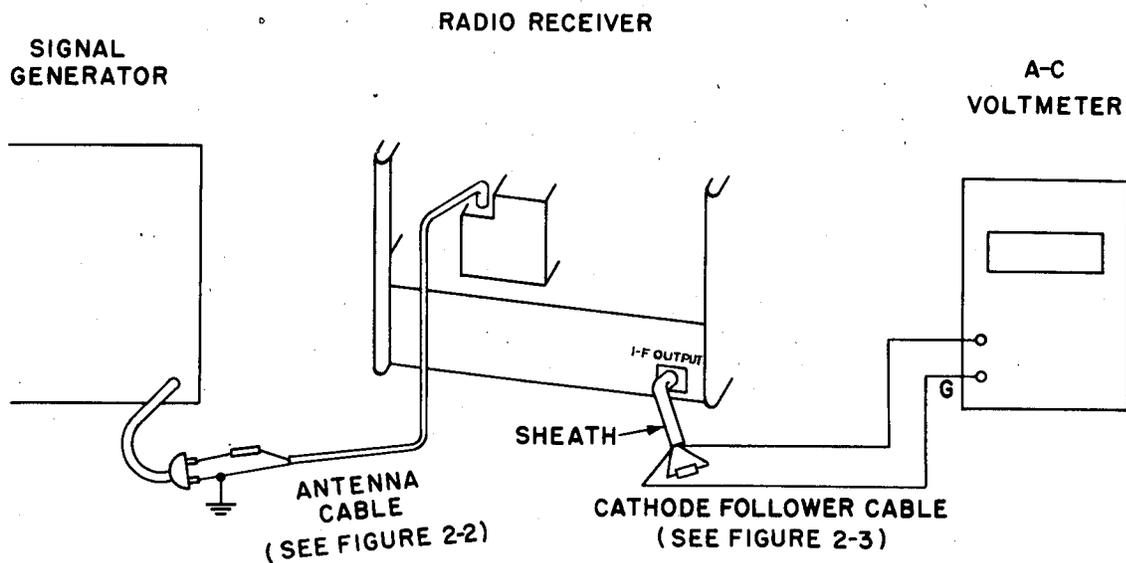


Figure 5-2. Receiver Cathode Follower Test Set-up

receiver the preliminary receiver checks outlined in paragraph 5-3, and the receiver performance tests shown in 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. Further, the test point indications (see figure 7-5) provide for rapidly locating the supply voltage distribution points within the receiver proper, as well as those of the self-contained power supply. To make use of this data, set the receiver controls as applicable to the corresponding test point in table 5-2. 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.

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, but note that resistors R76 and R77 isolate plate of V13, even when V13 is defective.	F2 (see figure 1-3), if indication is only +15v. V18, V19, and/or V20. V3, V4, V5, V11, and/or V14; otherwise, Field and Fasron mtnc required, but check C161A, B, C.
2	2, the junction of C160, R92, and R93.	-51v	Set r-f gain control R93, at min. Switch rec S8 switch to manual to show fault, if any, and to avc to possibly clear fault.	V10, V9, V7 and/or V6; T2 (refer to table 5-3); otherwise, Field and Fasron mtnc required.
3	3, the junction of R93 and R94.	-1v	Switch rec S8 switch to manual and set r-f gain control at max.	V7. T2 (refer to table 5-3).
4	4, the junction of R95 and R96 at E17.	-10v	None.	Field and Fasron mtnc required. Note that the junction of resistors R56 and R113 at T5 provide for -7.8 d-c volts to V11.
5	5, the pin 4 of V17, at X17, the junction of C161C, L52, and R82.	+228v +265v	R-f gain control R93, at max. R-f gain control R93, at min. Switch rec to S9, "send" switch position to isolate V1, V2, V6, V7, and V8. Switch rec to S9, "receive" switch position and S4 for double conversion to isolate V7 and to single conversion to isolate V6 and V8; also S13 to "external" position to isolate 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, and/or V7. If fault persists for both positions of signal-double conversion sw S4, rec requires Field and Fasron mtnc. If fault is cleared in single conversion sw position, trouble is in 3.5-mc crystal heterodyne subassembly (refer to table 5-3), if S8 at external clears fault; otherwise it is in screen circuit of V6. If fault is cleared in double conversion sw position, rec requires Field and Fasron mtnc.
6	6, the junction of L51, L52, and C161B.	+280v +305v	Switch rec for var freq operation to isolate V3. R-f gain control R93, at max. R-f gain control R93, at min.	V17 and/or V3. T7 (refer to table 5-3).
7	7, the junction of R72 and R73.	+90v +150v	R-f gain control R93, at max. R-f gain control R93, at min.	V10 and/or V9; otherwise, Field and Fasron mtnc required.

* Refer to paragraphs 5-8 and 5-9.

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	A pin 5, V17	Couple 400 cps audio freq gen output 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.	Audio gain control at max.	Rec input approx 5.5v.	V17 and/or T7.
2	B pin 2, V16, section B	Same as step 1.	Same as Step 1.	Rec input approx 0.5v.	V16B.
3	C 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 0.6v.	V11, V14, and/or V15.
4	D 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 15,000 uv.	V16A, V10 and/or T5.
5	E pin 1, V9	Same as step 3.	Same as Step 4.	Rec input approx 300 uv.	V9 and/or T4.
6	F pin 1, V7	Same as step 3.	Same as Step 4.	Rec input approx 75 uv.	V6, V7, and/or T3.
7	G pin 7, V5	Same as step 3.	Same as Step 4.	Rec input approx 90 uv.	V5 and/or T2.
8	H 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 100 uv.	V6, V7, and/or V8. 3.5-mc crystal heterodyne subassembly.
9	8 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.

* Refer to paragraphs 5-10 and 5-11.

Note

The fungicidal varnish at a soldered joint must be pierced to make a positive electrical contact.

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 figures 5-3 and 7-5. 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

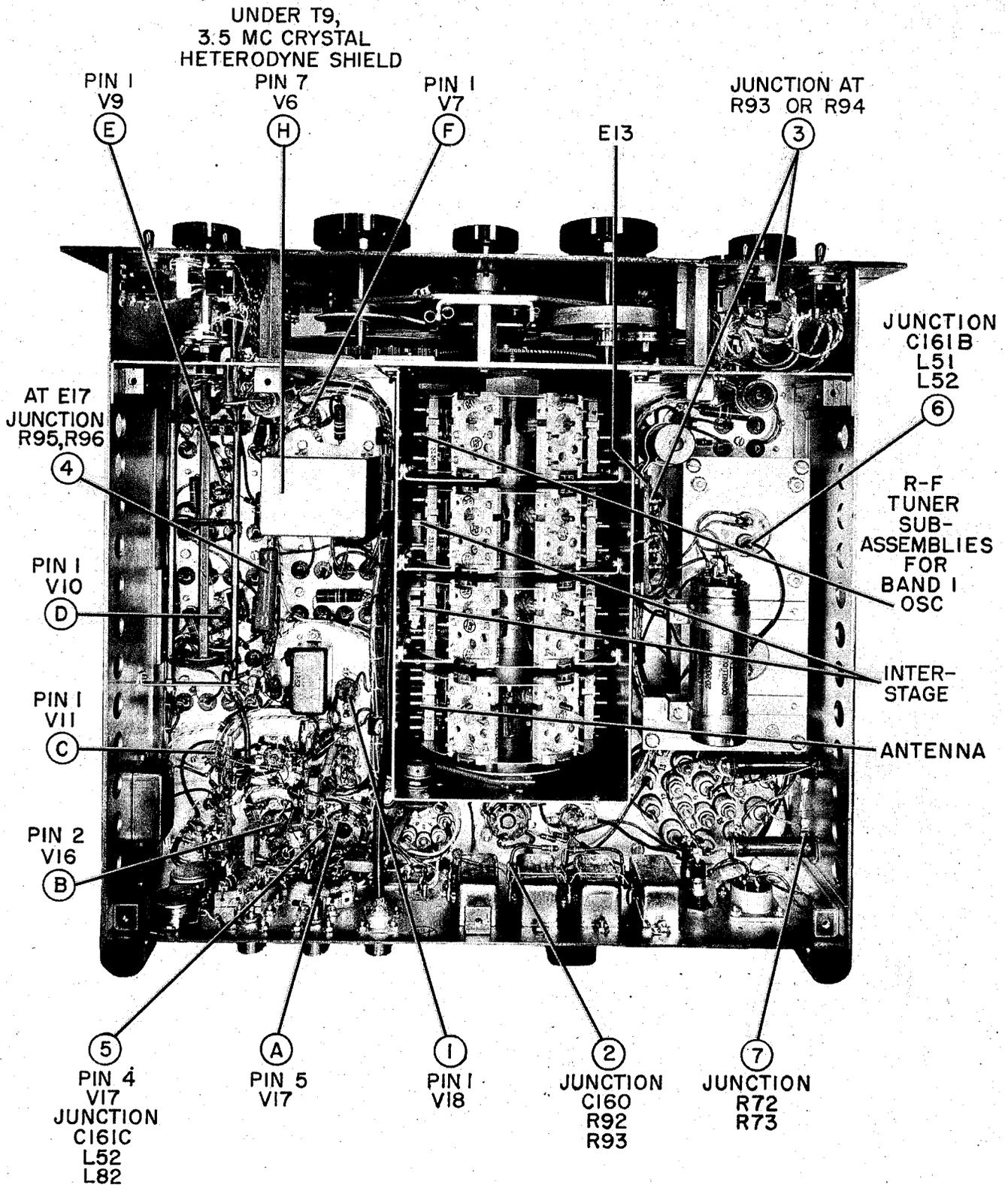


Figure 5-3. Radio Receiver, Parts Identification for Locating Test Points

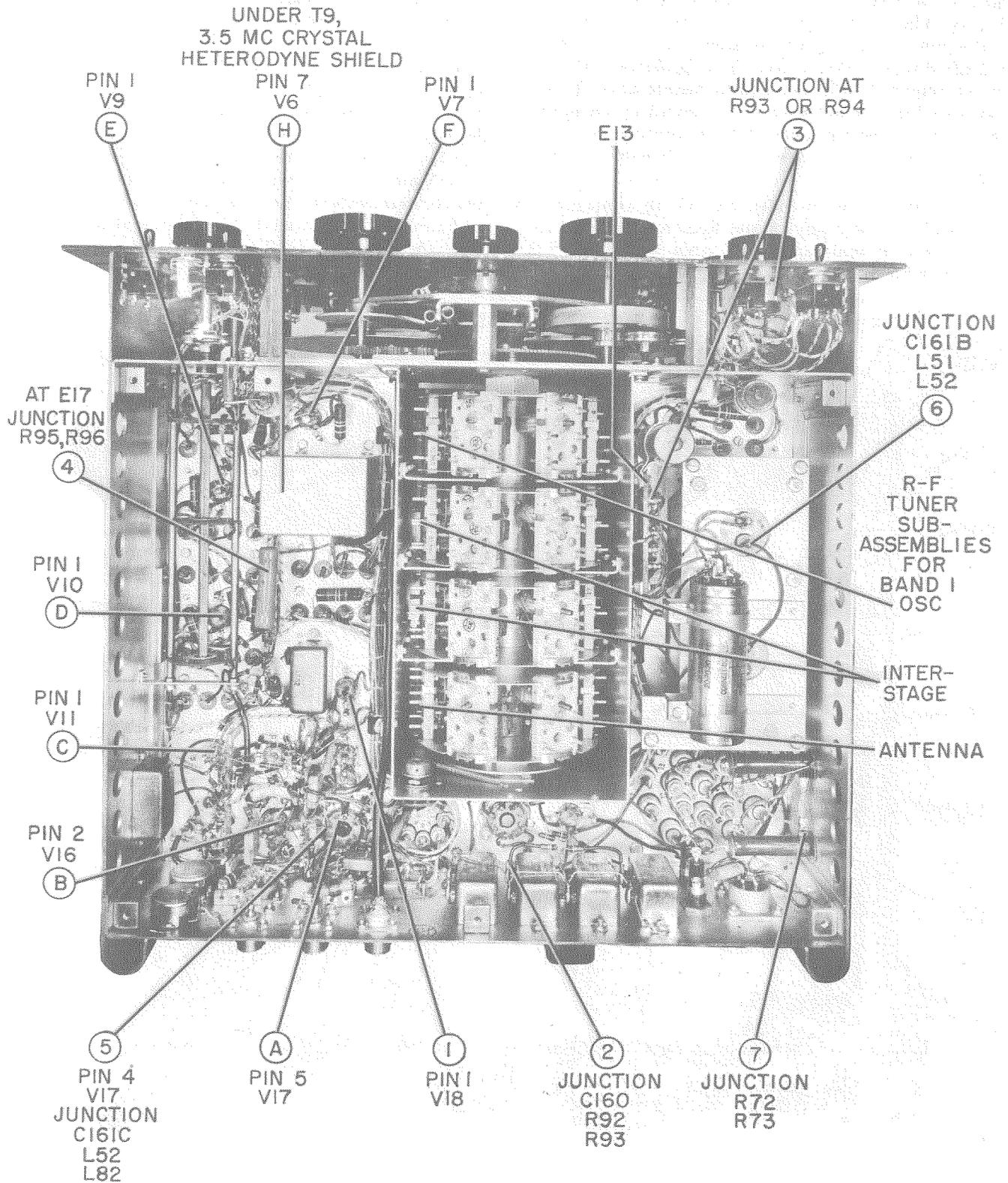


Figure 5-3. Radio Receiver, Parts Identification for Locating Test Points

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 2, 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.

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 T2, T3, T4, T5, T7, or the 3.5-mc crystal heterodyne subassembly, 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 antenna input connector J1 and the electron tube complement of the receiver. Each test point, apart from test point G, the pin 7 of V5, is accessible from the bottom of the receiver with the bottom plate removed as shown in figure 5-3. A miniature tube adapter renders accessible the test point G. To check the test point indications, turn the receiver a-c power switch "on" and

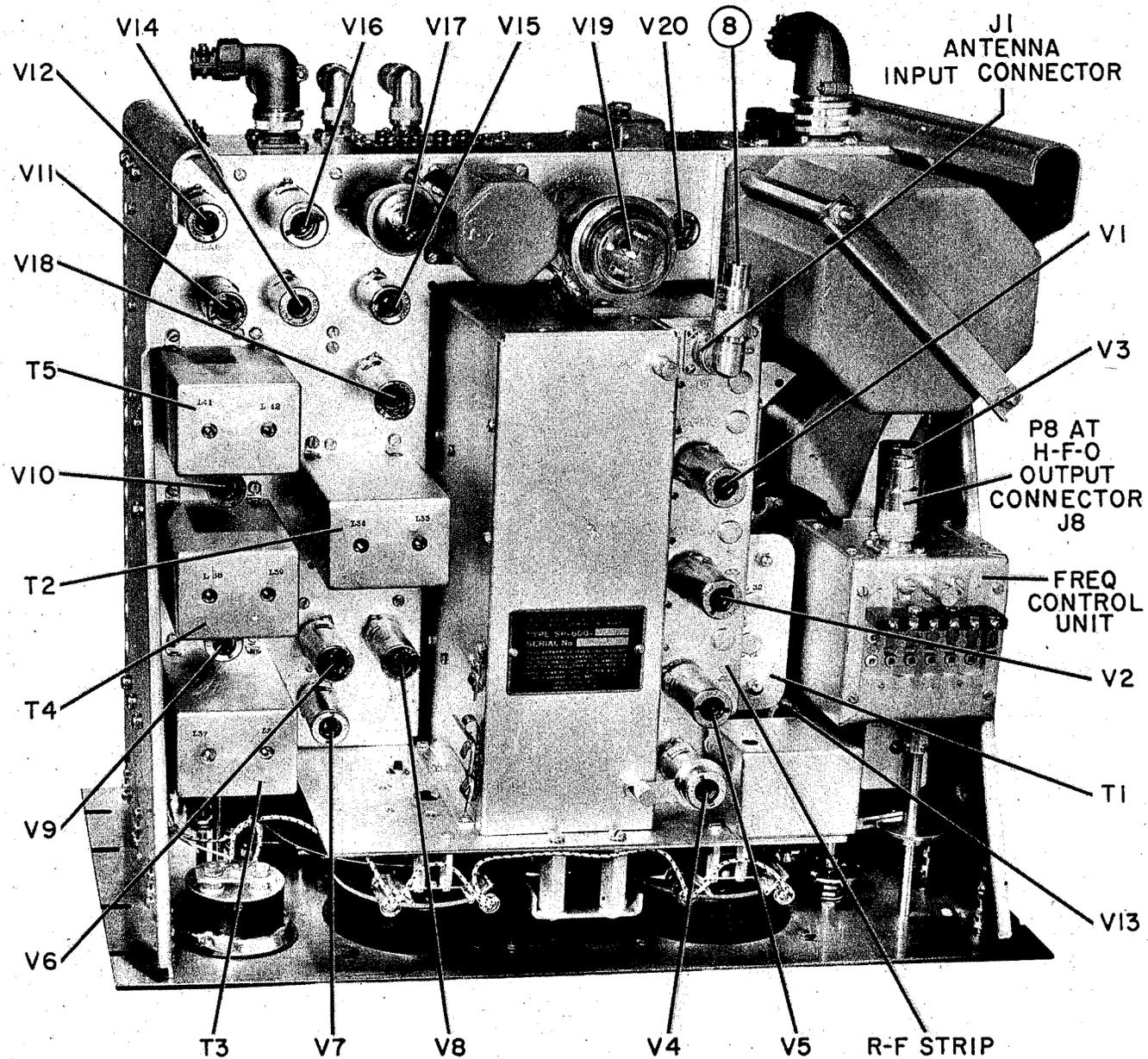


Figure 5-4. Radio Receiver, Top View of Chassis

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 2, 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.

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 T2, T3, T4, T5, T7, or the 3.5-mc crystal heterodyne subassembly, 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 antenna input connector J1 and the electron tube complement of the receiver. Each test point, apart from test point G, the pin 7 of V5, is accessible from the bottom of the receiver with the bottom plate removed as shown in figure 5-3. A miniature tube adapter renders accessible the test point G. To check the test point indications, turn the receiver a-c power switch "on" and

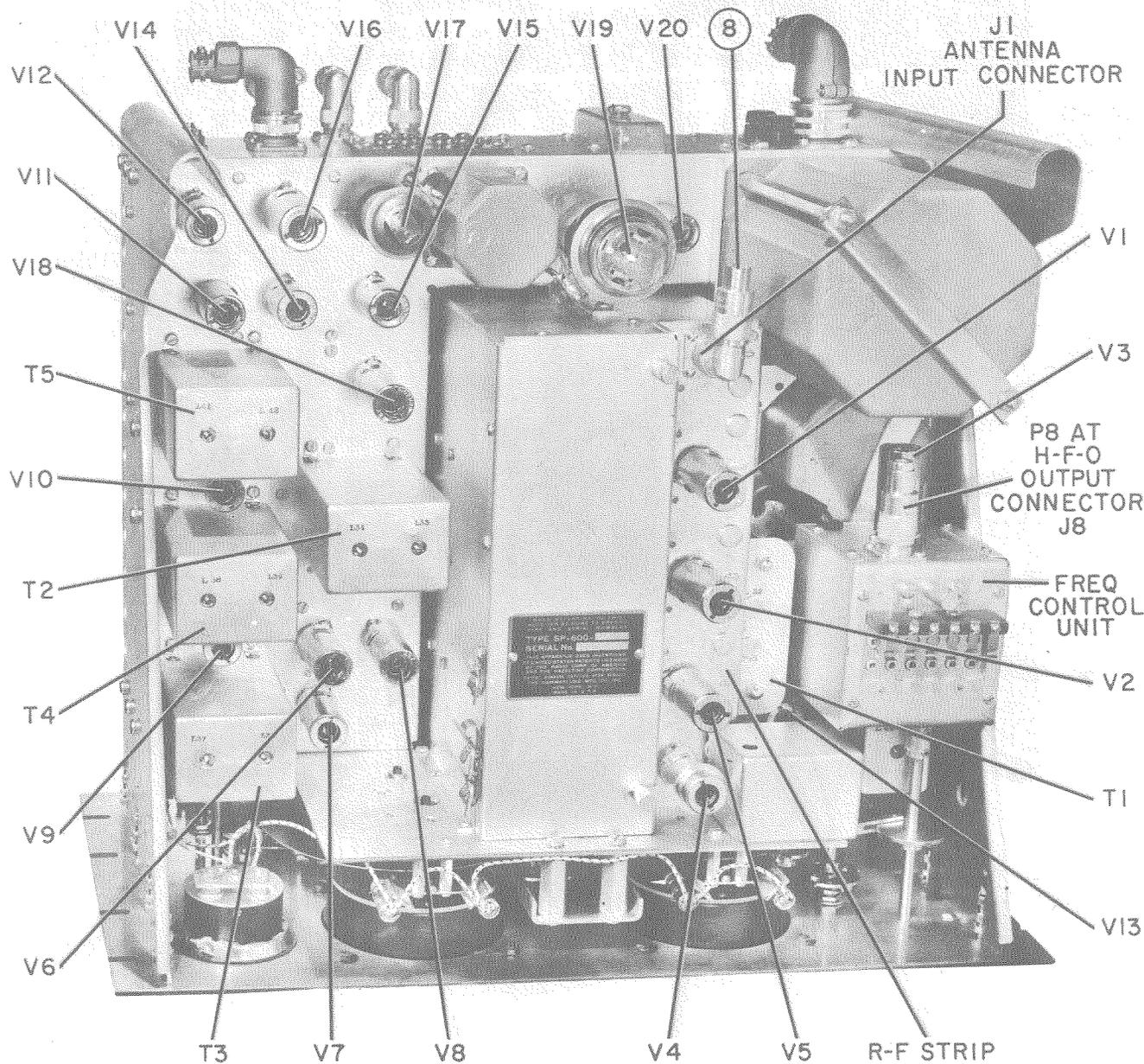


Figure 5-4. Radio Receiver, Top View of Chassis

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.

5-12. REMOVAL.

5-13. R-F TUNER SUBASSEMBLY. To remove any one of the four r-f tuner subassemblies on a specific frequency band the turret assembly is indented so that the r-f tuner subassemblies 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 subassembly 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 subassembly concerned and then lift out the r-f tuner subassembly.

5-14. I-F TRANSFORMER AND 3.5-MC CRYSTAL HETERODYNE SUBASSEMBLIES. To remove the T5, T4, T3, T2, and 3.5-mc crystal heterodyne (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 V17 or V19 electron tube (see figure 5-4), each tube top hat type of clamp must first be removed. Do this by pressing inward on the top hat spring while lifting the top hat clamp off the tube. Then the tube may be drawn out from its tube socket for replacement. The top hat type of tube clamp is replaced by seating it on the top of the tube so that the vertical bolt adjacent to it can be threaded through the hole in the top hat spring with pressure providing for a ratchet motion until the top hat is firmly seated in place. To replace the V1, V2, V3, V5, V6, V7, V8, V9, V10, V11, V12, V13, V14, V15, V16, V18, V20 electron tubes, 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 V4 electron tube, 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. I-F TRANSFORMER AND 3.5-MC CRYSTAL HETERODYNE SUBASSEMBLIES. The removal procedure outlined in paragraph 5-14 is reversed to replace any one of the i-f transformer and 3.5-mc crystal heterodyne subassemblies. The T2, T3, T4, T5 (see figure 5-4), i-f transformer subassemblies, of which T4 and T5 are identical, and the 3.5-mc crystal heterodyne subassemblies (see figure 5-3), may be respectively identified by visual comparison (see figure 5-5).

5-18. R-F TUNER SUBASSEMBLIES. The removal procedure outlined in paragraph 5-13 is reversed to replace any one of the r-f tuner subassemblies. Each is stamp-identified on its isolantite base with its Hammarlund part number. When replacing an r-f tuner subassembly care must be taken to make the replacement with one whose part number is the same as that of the one being replaced. It should be noted that the r-f tuner subassemblies for each band, as between bands, are different, but that the two inter-stage r-f tuner subassemblies (see figure 5-3) for each band are identical.

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 1.6-ampere or three-eighths ampere fuses, 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 fuse for replacement.

5-21. To get at both the 1.6-ampere and the three-eighths ampere clip mounted spare fuses, turn the captive knurled screw at the "SPARE FUSES" cover (3, figure 1-3) counter-clockwise, to remove the cover and screw. When either of the spare fuses are available otherwise, they are preferably used so that in an emergency spare fuses are always on hand.

CAUTION

Make sure that the holder-type fuses are stamp-designated 1.6 and three-eighths ampere and that each is located in its holder so designated.

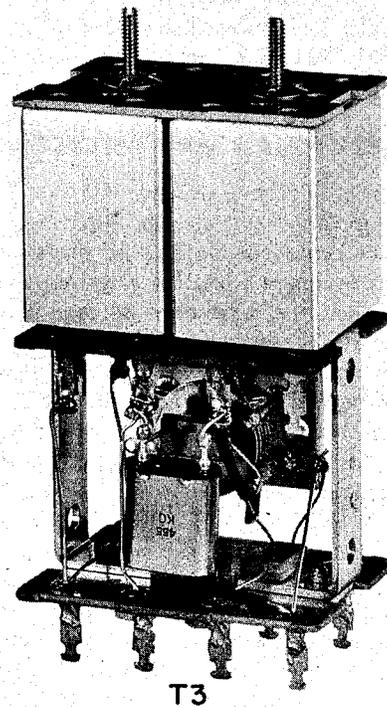
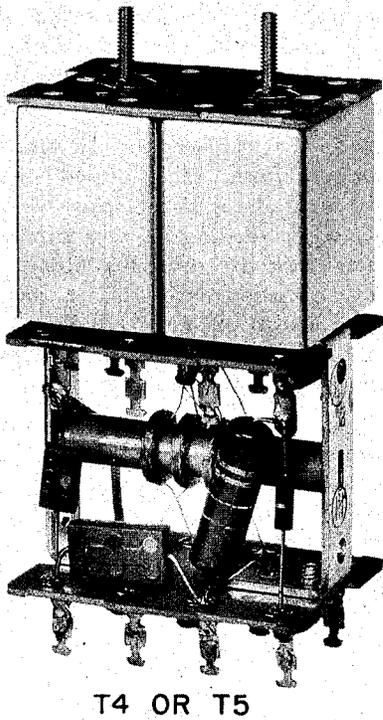
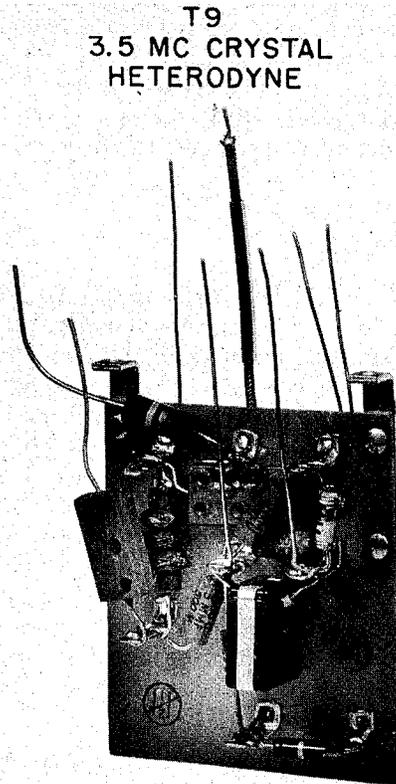
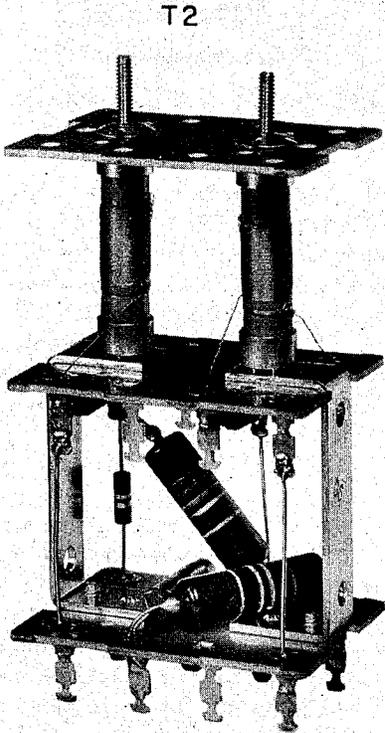


Figure 5-5. Radio Receiver, T2, T3, (T4 or T5), and T9, Subassembly Identification

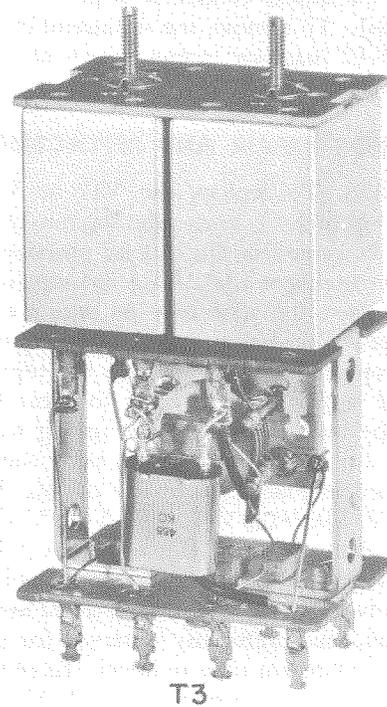
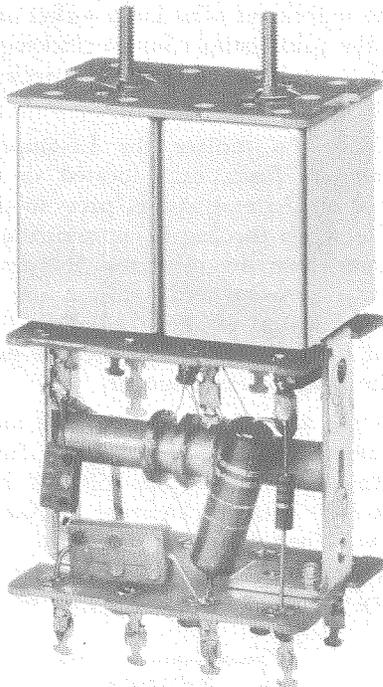
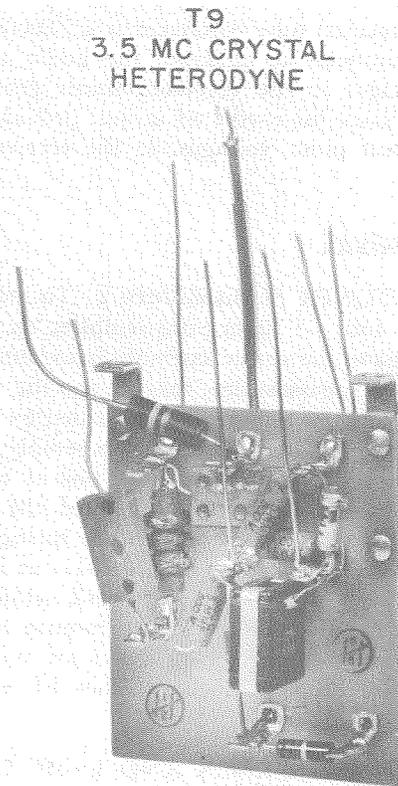
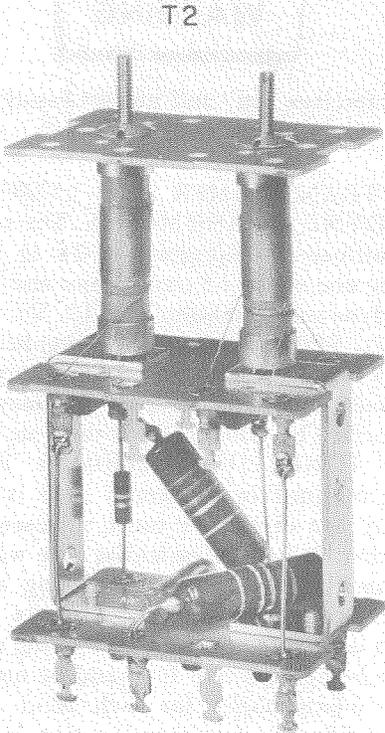


Figure 5-5. Radio Receiver, T2, T3, (T4 or T5), and T9, Subassembly Identification

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. SUBSEQUENT TO TUBE REPLACEMENT.

The radio receiver does not require alignment subsequent to tube replacement. When V₄ (see figure 5-4), the variable frequency heterodyne 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 heterodyne only, as follows:

a. Set up for the Sensitivity Test (see table 5-1), with the receiver main dial set at the variable heterodyne alignment frequencies (see table 5-4), in turn.

b. Remove the metal button to align C, for the variable frequency heterodyne (see figure 5-6). No more than a very slight angular aligning screwdriver adjustment is needed to maximize the receiver output, observed with the alignment screwdriver away from the C, trimmer capacitor.

5-25. **SUBSEQUENT TO R-F TUNER SUBASSEMBLY REPLACEMENT.** When one or more of the four r-f tuner subassemblies on any frequency band of the receiver are replaced, realign the alignment adjustments of the r-f tuner subassembly 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 variable frequency heterodyne (see figure 5-6), r-f tuner subassemblies, as applicable.

b. Align, in turn, the L and C for the band concerned at the receiver alignment frequency shown in table 5-4, for maximum receiver output, repeating the procedure until no further increase in output results.

5-26. **SUBSEQUENT TO I-F 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 locate L₄₁ and L₄₂ for T₅, L₃₈ and L₃₉ for T₄, L₃₇ and L₃₆ for T₃, and L₃₄ and L₃₃ for T₂ (see figure 5-6), to determine 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 subassemblies and the T₃, i-f transformer contain adjustable air capacitors 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 the present receiver maintenance subassembly replacements.

5-29. INSPECTION SCHEDULE.

5-30. Table 5-5 outlines the inspection schedule requirements of the radio receiver. The table designates the nature of each inspection made and the time interval subsequent to which each is repeated. Inspection differs from test in that it is concerned with the me-

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

chanical characteristics of the receiver as compared to its electrical characteristics.

5-31. 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 as outlined in paragraph 5-8, send the receiver to field maintenance; otherwise, perform the preliminary receiver checks as outlined in paragraph 5-3 and then, if warranted, check the receiver for performance as outlined in paragraph 5-4. If the receiver meets its performance requirements, it can be maintenance-released for further operational use.

TABLE 5-5. INSPECTION SCHEDULE

INSPECTION	TIME	INSPECTION	TIME
Completeness and satisfactory condition of the equipment.	25 hrs.	Meter case and glass not damaged, and meter zero adjustment screw to provide positive pointer setting.	175 hrs.
Suitability of location and installation for normal operation.	25 hrs.	Tubes not to have loose envelopes, cracked sockets, nor broken pins; also tube sockets to have sufficient spring tension; all to be dry, clean, and not charred.	750 hrs.
Receiver, receiver windows, and associated components such as headset, cables, antenna system, etc., clean and dry.	25 hrs.	Container enclosed fixed capacitors for no bulges, leaks, nor discoloration (leaks are evident first at the capacitor terminals; also at pin point holes in the container).	750 hrs.
Holder type fuses, all tubes, dial lamps, freq control unit crystals, and r-f tuner subassemblies, all seated properly.	25 hrs.	All variable air capacitors for uniform plate spacing, no loose mountings; cleanliness and dryness.	750 hrs.
All inter-connecting cables and leads tightly connected to their receiver terminations.	25 hrs.	Resistors, bushings, and insulators for no cracks, chipping, blistering, nor discoloration; cleanliness and dryness.	750 hrs.
All controls not loose, scraping, nor binding; gear train not misaligned and gears not worn nor chipped, all evidenced by other than normal operation.	25 hrs.	Terminals of wire-wound resistors and container enclosed capacitors for no loose lugs nor loose contacts; cleanliness.	750 hrs.
CAUTION		Switches, transformers, chokes, potentiometers and terminal boards for rigid mounting.	750 hrs.
Disconnect a-c power source from receiver before making any of the following checks.		Band change switch for no bent or broken "V" contacts.	750 hrs.
All receiver exposed metal surfaces and those of associated components, connectors, etc., not corroded.	175 hrs.	Terminal boards for no loose terminals, cracks, nor breaks.	750 hrs.
Receiver main cable, wiring, rubber channel at top plate, and external cabling not cut, broken, frayed, deteriorated, kinked, strained, nor mildewed, as applicable.	175 hrs.	Power transformer and audio output transformer for no evidence of overheating.	750 hrs.
Interior surfaces of receiver windows and dials, clean and dry.	175 hrs.	Soldered joint, r-f coil, and r-f choke fungiproofing for no punctures; if so, for no damage in each instance to each so coated.	750 hrs.

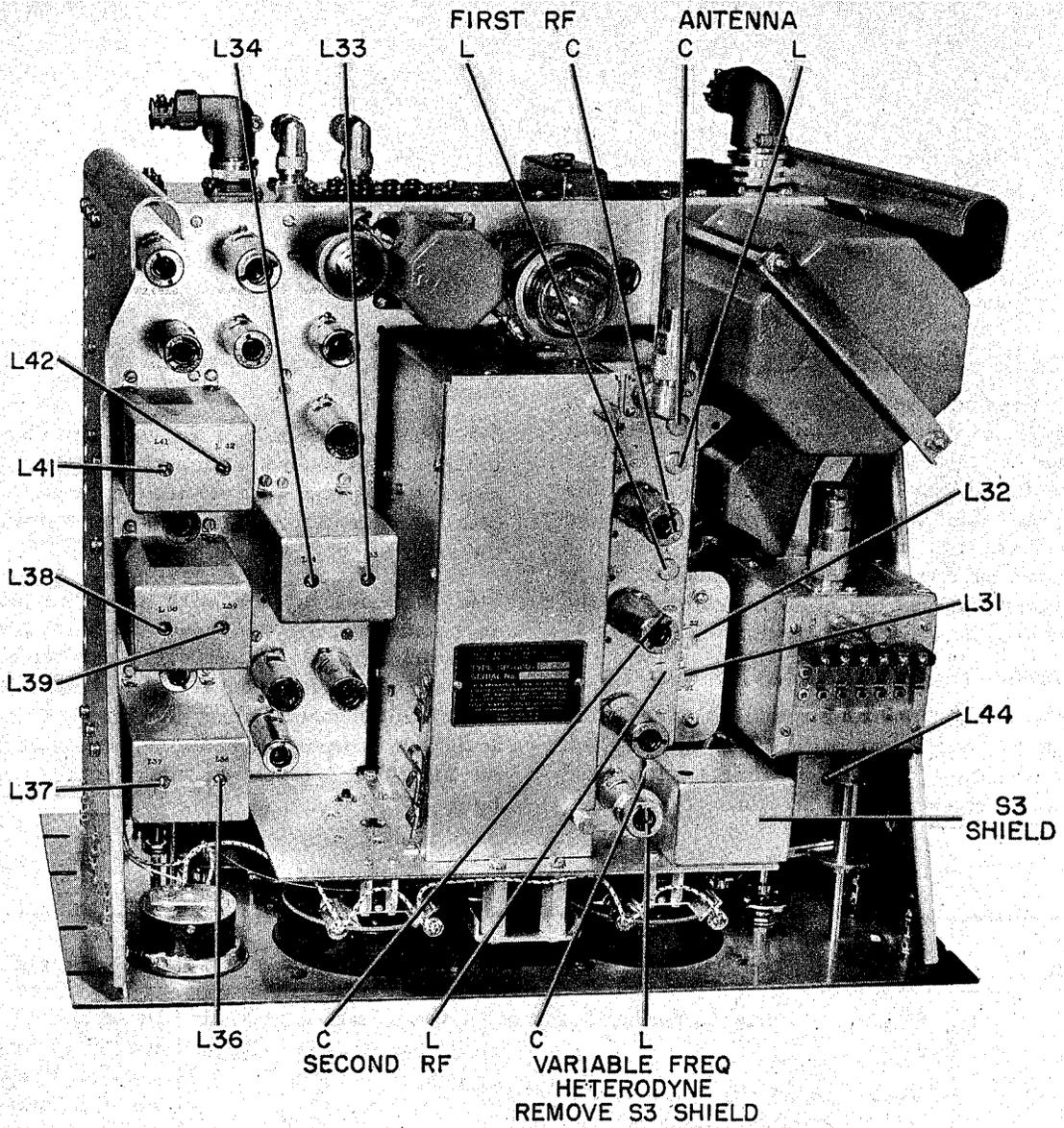


Figure 5-6. Radio Receiver, Alignment Adjustments

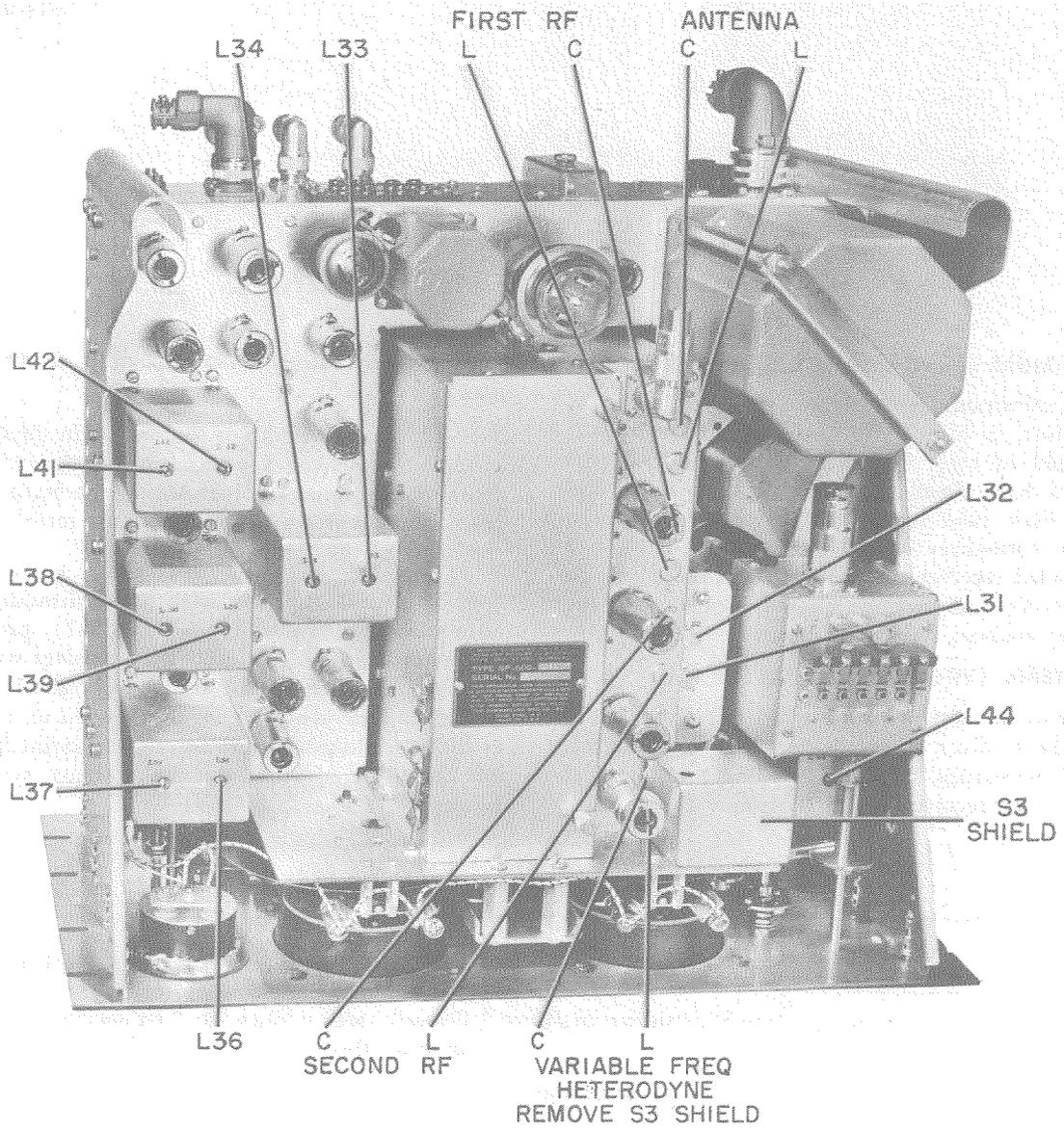


Figure 5-6. Radio Receiver, Alignment Adjustments

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.

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), provides 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).

TABLE 6-1. RECEIVER PERFORMANCE TESTS*

TEST	ADJUSTMENT PROCEDURES	MINIMUM PERFORMANCE STANDARD	TROUBLE LOCATION
Overall Fidelity	<p>Connect equipment as shown in figure 6-1.</p> <p>Repeat Sensitivity Test adjustments, but use external AM of 30 percent at 400 cps.</p> <p>Advance audio gain control to max and set r-f gain control to maintain 10 mw reference level output.</p> <p>Then switch the selectivity switch to its 13.0-kc position.</p> <p>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.</p>	Overall rec fidelity to approx that of figure 1-5.	I-f section; T1, T3, T4, and/or T5 for signal 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.

* Refer to paragraph 6-2.

TABLE 6-1. RECEIVER PERFORMANCE TESTS (CONT)

TEST	ADJUSTMENT PROCEDURES	MINIMUM PERFORMANCE STANDARD	TROUBLE LOCATION
Audio Fidelity	<p>Connect equipment as shown in figure 6-2.</p> <p>Set the output meter to provide a 600-ohm matching load.</p> <p>Set the rec r-f gain control to min and the audio gain control to max.</p> <p>Set the audio freq gen for 400 cps at an input level to rec to provide for 10 mw rec output.</p> <p>Note the input a-c voltmeter level to rec 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.</p>	Audio fidelity of rec to approx that of figure 1-5.	A-f section; T7, C148, C149, and/or C150.
Frequency Accuracy	<p>Turn rec "on" and allow a 15 minute warm-up period with rec switched for c-w operation.</p> <p><i>Method A. Use Crystal calibrator.</i></p> <p>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.</p> <p>Adjust crystal calibrator for rec zero beat with freq std, evidenced by low freq beat note for the proper crystal calibrator harmonic output choice.</p> <p>For crystal calibrator of 100 kc fundamental freq, provided with sub-harmonic 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.</p> <p><i>Method B. Use rec 3.5-mc crystal heterodyne.</i> Connect two-foot length of insulated wire to rec antenna input and dress free end around rec 3.5-mc crystal heterodyne V8 tube shield. Use 3.5-mc heterodyne output at intervals of 3.5 mc above 10.5 mc as a secondary freq std.</p>	Main dial calibration accuracy is one-quarter of one percent over freq range of rec, or better.	R-f section; main tuning capacitor sections C1G-C1H if main dial calibration is off on all bands; osc r-f tuner subassembly of band concerned.

TABLE 6-1. RECEIVER PERFORMANCE TESTS (CONT)

TEST	ADJUSTMENT PROCEDURES	MINIMUM PERFORMANCE STANDARD	TROUBLE LOCATION
A-v-c 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.	
Frequency 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.	R-f section; capacitors C79, C80 (see figure 4-5).

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	A 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 5.5 volts.	Tube V17. Transf T7. Capacitor C149, C150, or C151. Resistor R98 or R99. Switch S11. Term board E2.
2	B pin 2, V16B	Same as step 1.	Same as step 1.	Rec input approx 0.5 volts.	Tube V16, section V16B. Capacitor C143, C148, or C149. Resistor R81 or R83. Potentiometer R84.
3	C 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 0.6 volts.	Tubes V11, V14, or V15. Capacitors C125, C126, C127, C128, C129A, C129B, C138, C139, C141, C142, or C143. Resistors R55, R56, R57, R113, R61, R62, R64, or R65. Potentiometer R69. Diode output jumper at E3.
4	D pin 1, V10	Same as step 3.	Same as step 3.	Rec input approx 15,000 uv.	Tube V10. Transf T5. Switch S5, section C. Capacitor C119, C120, C121, C122, C165 or C166. Resistor R51.

* Refer to paragraphs 6-3 thru 6-7.

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
5	Same as step 3.	Same as step 3.	Same as step 3.	Same as step 4. 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.
6	E pin 1, V9	Same as step 3.	Same as step 3.	Rec input approx 300 uv.	Tube V9. Transf T4. Switch S5 section B. Capacitor C113, C114, C115, or C116. Resistor R43 or R50.
7	F pin 1, V7	Same as step 3.	Same as step 3.	Rec input approx 75 uv.	Tubes V6 or V7. Transf T3. Switch S5, section A. Capacitor C176 or C105. Resistor R32, R42, or R112.
8	G pin 7, V5	Same as step 3.	Same as step 3.	Rec input approx 90 uv.	Tube V5. Transf T1. Capacitor C66 or C68. Resistor R22, 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 bandwidth, 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 70 uv. <i>Note.</i> Use a d-c vtvm at pin 6 grid of V8 and/or pin 1 of V6 to determine presence of heterodyne of the order of -10 volts dc.	Tube V5, V6 or V8. Transf T1 or T2. Capacitor C66, C68, or C106. Resistor R22, R26, or R27. For no V8 heterodyne output. 3.5-mc crystal heterodyne subassembly. Capacitor C169. Resistor R36 or R119. Connector J6.
10	H pin 7, V6	Same as step 9.	Same as step 9.	Rec input approx 100 uv. See Note in step 9 above.	Tube V6 or V8. Transf T3. 3.5-mc crystal heterodyne subassembly. Capacitor C106. Resistor R42.
11	8, rec antenna input connector.	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 bandwidth, 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. <i>Note.</i> Use d-c vtvm at pin 6 grid of V4 and/or pin 1 grid of V5 to determine presence of heterodyne of order of -10 volts dc.	Tube V1, V2, or V4. R-f tuner subassy, any on band used. Crystal switch S3. Gang capacitor C1, sections A, B, C, D, E, F, G, or H. Antenna input socket J1. R-f strip (see figure 5-4), capacitor C44, C42, C40, C25, C24, C22, C20, C19, or C18. Resistor R13 or R1. For no V4 heterodyne output. Capacitors C74, C75, C79, or C80. Resistor R22.

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
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. <i>Note.</i> Use d-c vtvm at pin 1 grid of V3 and/or V5 to determine presence of heterodyne of order of -10 volts dc.	Tube V1, V2, or V3. R-f tuner subassy any on band used. Crystal switch S3. Crystal selector switch S2. Gang capacitor C1, sections A, B, C, D, E, F, G, or H. Antenna input socket J1. (See step 11 above.) For no V3 heterodyne output. Frequency control unit, Y 1-6 crystal used. Capacitor C62, C63, C65, or C75. Resistor R23 or R22.
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 for avc, in either "fast" position of S12.	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, C164, C177, C19, C40, C41, C98, C176, C164, C115, or C121. R-f strip resistor R2 or R12. Capacitor C19, C40, or C41. Resistor R44, R52, R122, R35, R60, R111, R48, R53, R60, R61, R66, R68, or R97. Potentiometer R93. Switch S8 or S12.
14	Same as Step 11.	Same as step 13.	Same as step 13, but switch rec for either "slow" position of S12.	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. 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, one-kc tone output, and S12 set to either internal b-f-o position.	*Rec input approx 0.75 uv.	Tube V13 or V12. Beat freq heterodyne subassy T6. Capacitor C135 or C136. Resistor R74 or R75. Switch S12.

6-7. The test points defined in table 6-2 are all, apart from test points G and 8, accessible from the bottom of the receiver with the bottom plate removed. Each test point is identified through use of figures 5-3, 5-4, and 7-5. In the instance of test point G, the pin 7 of the tube V5 (see figure 5-4), a miniature tube adapter, renders the test point accessible. Test point 8 is accessible at the top of the receiver chassis.

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. The removal procedures outlined are limited to those in paragraphs 6-9 thru 6-14, which are somewhat complex.

6-9. FREQUENCY CONTROL UNIT.

(See figures 5-4 and 6-3.)

- a. Unsolder black, black/white, blue/red, brown, and red/white leads from terminal strip E13 (see figure 5-3), and red lead from filter capacitor.
- b. Remove front panel "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2), knurled knob.
- c. Disconnect "HFO" "Δ FREQ" control (13, figure 1-2), flexible coupling.
- d. Loosen two No. 6-32 set screws in switch (3) shaft arm eccentric drive.
- e. Loosen four No. 8-32 set screws to disconnect switch (3) fixed coupling.

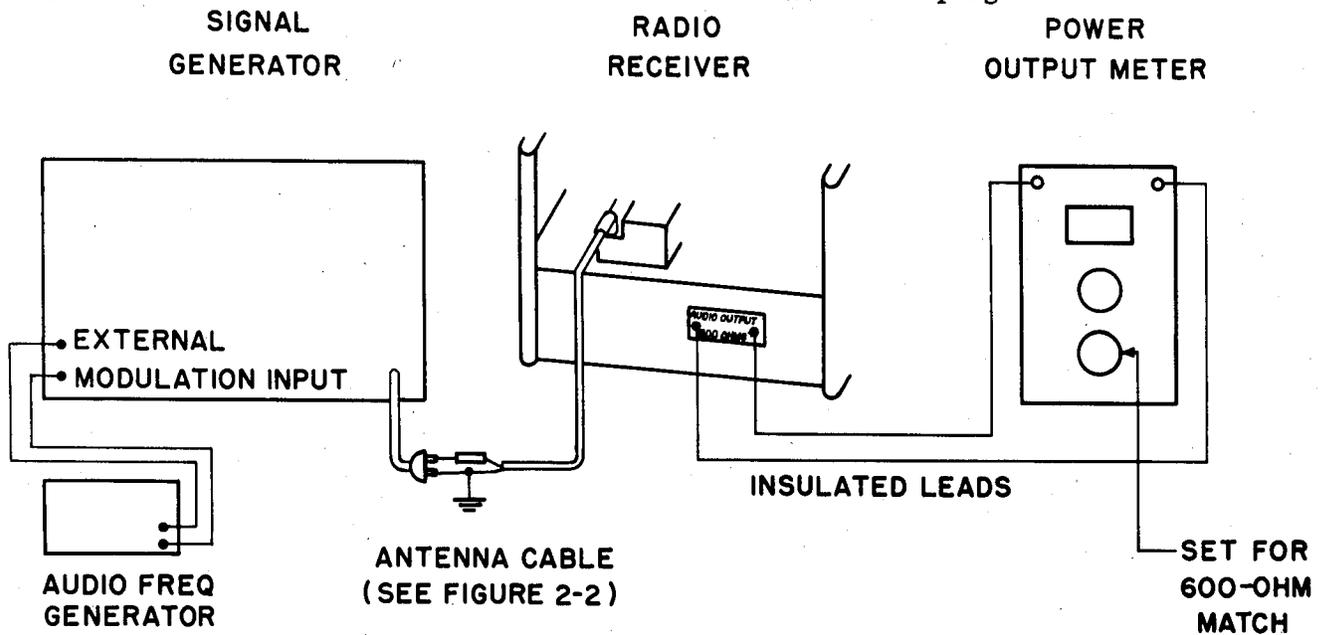


Figure 6-1. Receiver Overall Fidelity Test Set-up

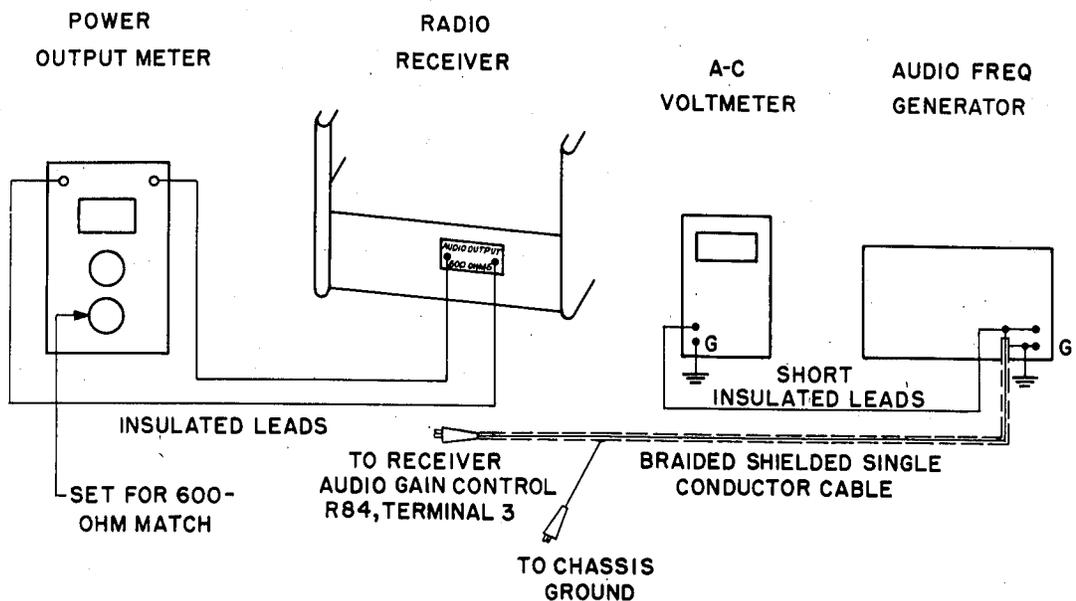


Figure 6-2. Receiver Audio Fidelity Test Set-up

- f. Unsolder resistor at switch (3).
- 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 frequency control unit.

Note

When replacing unit, set the two switches S3 and S2, comprising the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" 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 figures 5-4 and 6-4), the frequency control unit is removed first as outlined in paragraph 6-9; then:

- 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.

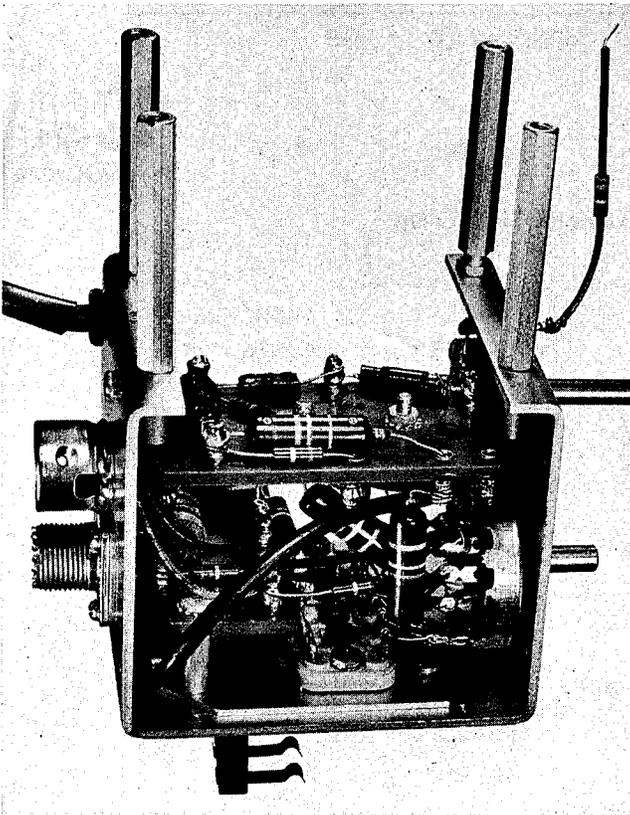


Figure 6-3. Radio Receiver, Frequency Control Unit with Shield Cover Removed

- 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. R-F STRIP. (See figures 5-4 and 6-5.)

- 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 capacitor.
- 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 S3 of the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2).
- f. Turn front panel "BAND CHANGE" control (6, figure 1-2), and hold 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. FOUR GANG CAPACITOR.

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

Note

To replace a four-gang capacitor, the main dial pointer must line up with the first line marking on the main dial when the four-gang capacitor 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, ifo, bfo-avc, and audio gain control knobs from front panel.
- b. Remove nuts on all toggle and the i-f-o and b-f-o-a-v-c 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.

- f. Unsolder resistor at switch (3).
- 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 frequency control unit.

Note

When replacing unit, set the two switches S3 and S2, comprising the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" 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 figures 5-4 and 6-4), the frequency control unit is removed first as outlined in paragraph 6-9; then:

- 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.

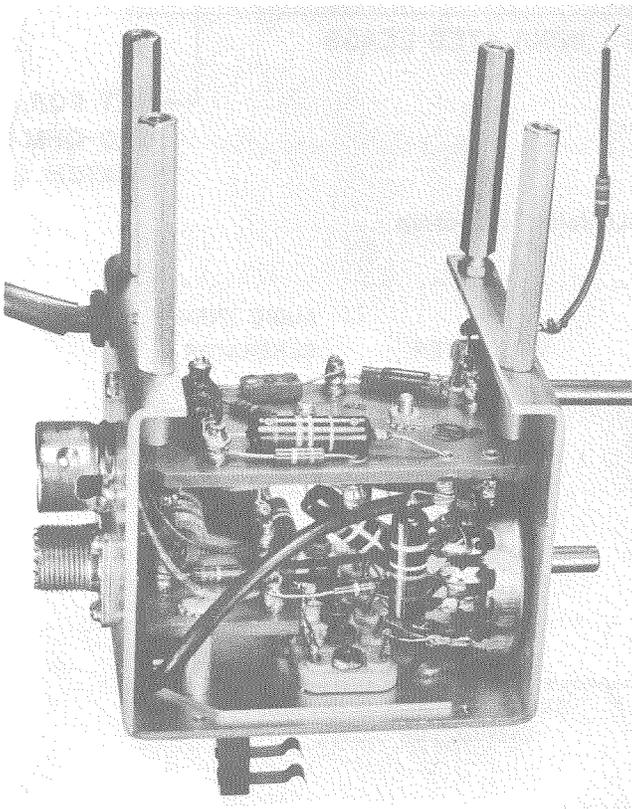


Figure 6-3. Radio Receiver, Frequency Control Unit with Shield Cover Removed

- 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. R-F STRIP. (See figures 5-4 and 6-5.)

- 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 capacitor.
- 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 S3 of the "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3, figure 1-2).
- f. Turn front panel "BAND CHANGE" control (6, figure 1-2), and hold 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. FOUR GANG CAPACITOR.

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

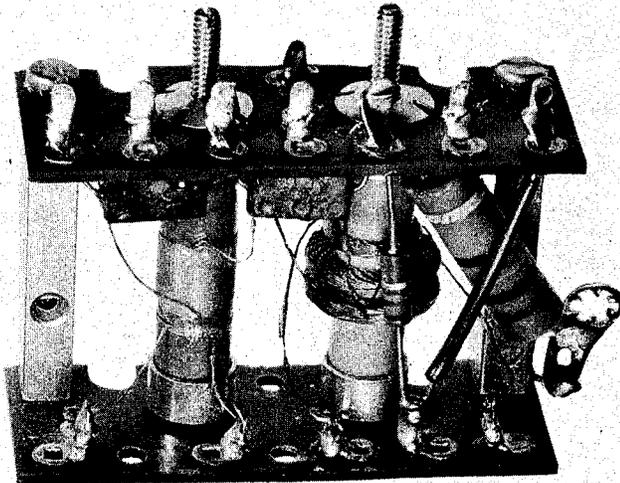
Note

To replace a four-gang capacitor, the main dial pointer must line up with the first line marking on the main dial when the four-gang capacitor 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, ifo, bfo-avc, and audio gain control knobs from front panel.
- b. Remove nuts on all toggle and the i-f-o and b-f-o-a-v-c 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.

T1
MIXER TRANSFORMER



T6
BEAT-FREQUENCY
HETERODYNE

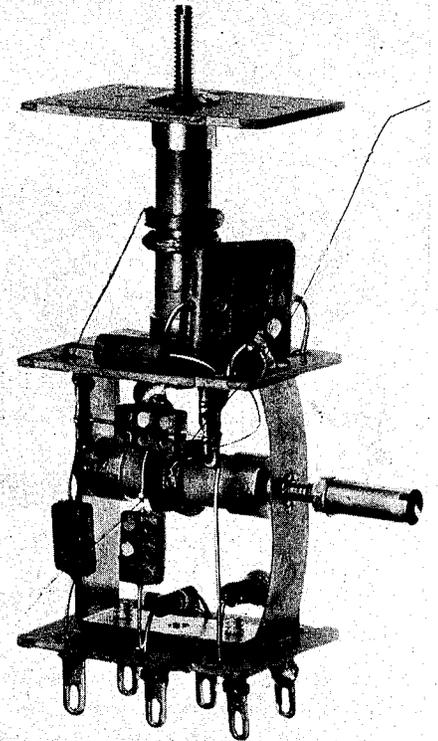


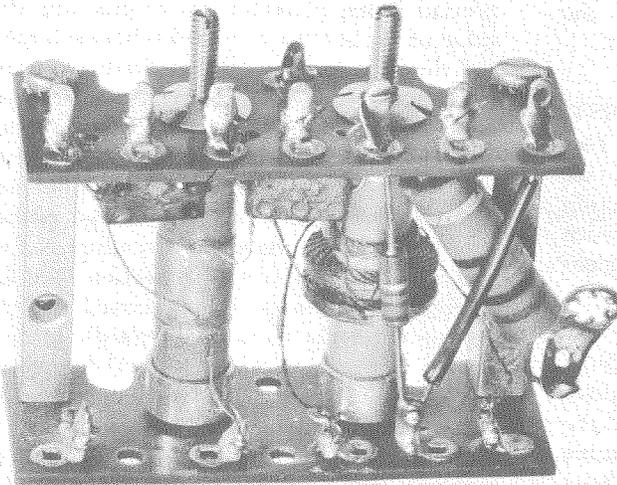
Figure 6-4. Radio Receiver, T1 and T6 Subassembly Identification

6-14. MAIN DIAL. To remove the main dial, the front panel is first removed as outlined in paragraph 6-13. Then loosen the three flat head main dial mounting screws to relocate the main dial, so that with the four-gang capacitor 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 4-4 thru 4-12), to clarify the operation of each receiver section outlined in paragraphs 4-14 thru 4-95. In instances where the receiver fuses

F1 and/or F2 blow due to abnormal current drain (overload), a resistance check (see table 6-4) is made first for the self-contained power supply section (see figure 4-12 and refer to paragraph 6-16). Otherwise, 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 4-4 thru 4-11, 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

T1
MIXER TRANSFORMER



T6
BEAT-FREQUENCY
HETERODYNE

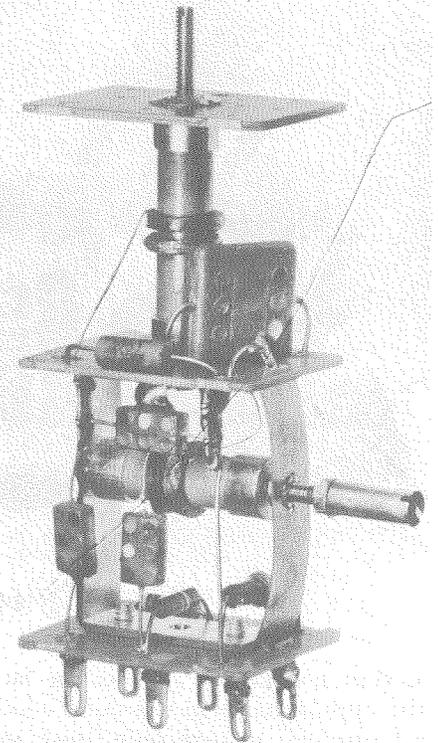


Figure 6-4. Radio Receiver, T1 and T6 Subassembly Identification

6-14. MAIN DIAL. To remove the main dial, the front panel is first removed as outlined in paragraph 6-13. Then loosen the three flat head main dial mounting screws to relocate the main dial, so that with the four-gang capacitor 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 4-4 thru 4-12), to clarify the operation of each receiver section outlined in paragraphs 4-14 thru 4-95. In instances where the receiver fuses

F1 and/or F2 blow due to abnormal current drain (overload), a resistance check (see table 6-4) is made first for the self-contained power supply section (see figure 4-12 and refer to paragraph 6-16). Otherwise, 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 4-4 thru 4-11, 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

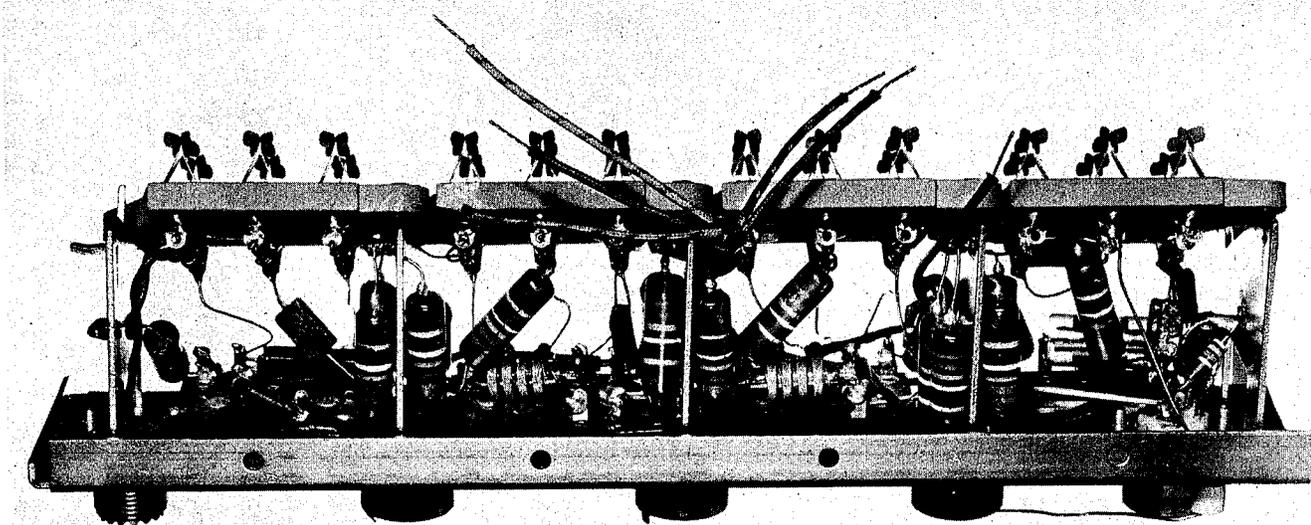


Figure 6-5. Radio Receiver, R-f Strip Identification

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 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 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 4-4 thru 4-11, apart from 4-8, as applicable, as well as through use of figure 7-5, 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 determining 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 or abnormal 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 it is easy to determine whether the resistor(s) from the terminal is normal or abnormal, such that the point of the fault is easily determined. When a supply voltage point is reached (see figure 7-5), the same procedure is applied to the self-contained power supply section (see figure 4-12). In figure 4-12, with V20 removed, the resistance to ground from the minus one volt d-c bias at test point 3, Step 3, the junction of R3 and R94 (see table 5-2) is 1100 ohms, and the resistance to ground from the -10 volt d-c bias at the test point 4, Step 4, the junction of R95 and R96 (see table 5-2) is 19K. The resistors R48, R53, R60, R61, R97, and R111 (see figure 4-8), of the automatic volume control functional circuitry are checked individually, and not to ground, in instances where one or more is suspected of causing the receiver section fault. When checking R32 and R33 (see figure 4-6), whose resistance values are respectively 510 and 1500 ohms, note that their resistance in parallel is only approximately 380.6 ohms. The resistance to ground at the junction of R56 and R57 (see figure 4-7) is 27.2K. 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.

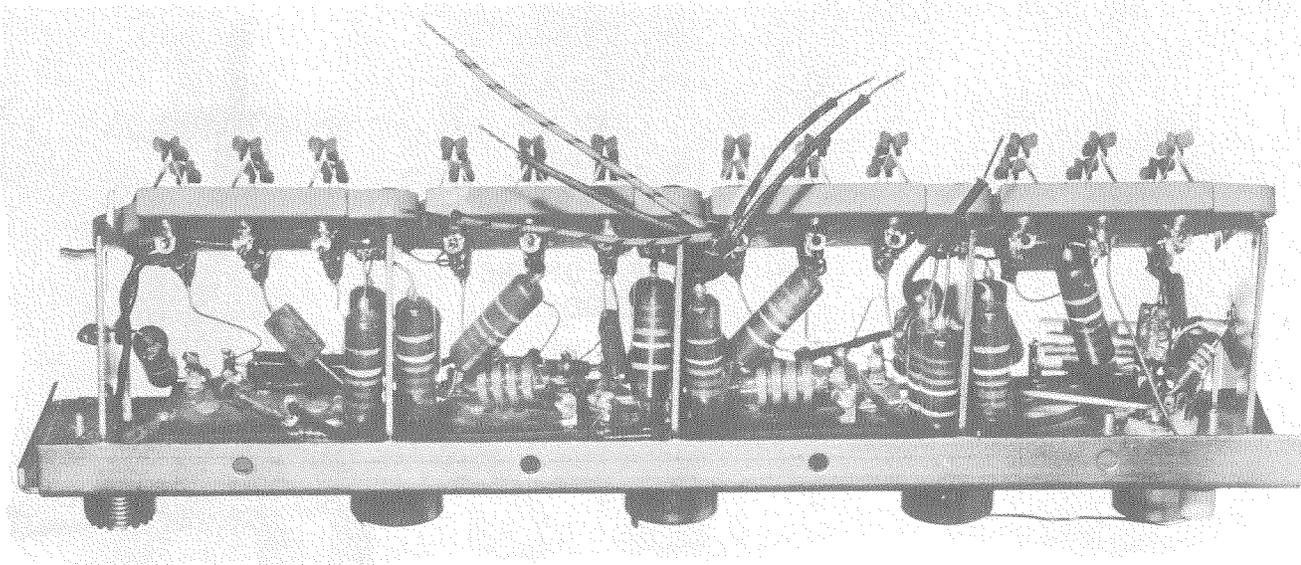


Figure 6-5. Radio Receiver, R-f Strip Identification

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 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 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 4-4 thru 4-11, apart from 4-8, as applicable, as well as through use of figure 7-5, 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 determining 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 or abnormal 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 it is easy to determine whether the resistor(s) from the terminal is normal or abnormal, such that the point of the fault is easily determined. When a supply voltage point is reached (see figure 7-5), the same procedure is applied to the self-contained power supply section (see figure 4-12). In figure 4-12, with V20 removed, the resistance to ground from the minus one volt d-c bias at test point 3, Step 3, the junction of R3 and R94 (see table 5-2) is 1100 ohms, and the resistance to ground from the -10 volt d-c bias at the test point 4, Step 4, the junction of R95 and R96 (see table 5-2) is 19K. The resistors R48, R53, R60, R61, R97, and R111 (see figure 4-8), of the automatic volume control functional circuitry are checked individually, and not to ground, in instances where one or more is suspected of causing the receiver section fault. When checking R32 and R33 (see figure 4-6), whose resistance values are respectively 510 and 1500 ohms, note that their resistance in parallel is only approximately 380.6 ohms. The resistance to ground at the junction of R56 and R57 (see figure 4-7) is 27.2K. 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.

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 manual c-w 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	95	—	—	—	r-f gain max
V1	-41	—	6.3ac	—	260	245	—	—	—	r-f gain min
V2	- 1	—	6.3ac	—	210	95	—	—	—	r-f gain max
V2	-41	—	6.3ac	—	260	245	—	—	—	r-f gain min
V3	0	—	—	6.3ac	285	0	—	—	—	r-f gain max, var freq osc operation
V3	-12.5	—	—	6.3ac	285	140	—	—	—	r-f gain max, crystal freq control
V3	0	—	—	6.3ac	305	0	—	—	—	r-f gain min, var freq osc operation
V3	-12.5	—	—	6.3ac	300	140	—	—	—	r-f gain min, crystal freq control
V3	0	—	—	6.3ac	285	0	—	—	—	r-f gain max, ex- ternal operation
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	—	-55	—	—	r-f gain min, freq below 7.4 mc
V6	—	—	6.3ac	—	225	80	- 1	—	—	r-f gain max, freq above 7.4 mc
V6	—	—	6.3ac	—	260	75	-55	—	—	r-f gain min, freq above 7.4 mc
V7	- 1	—	6.3ac	—	215	125	3.4	—	—	r-f gain max, freq below 7.4 mc
V7	-54	—	6.3ac	—	265	245	.4	—	—	r-f gain min, freq below 7.4 mc
V7	- 1	—	6.3ac	—	215	0	0	—	—	r-f gain max, freq above 7.4 mc
V7	-54	—	6.3ac	—	265	0	0	—	—	r-f gain min, freq above 7.4 mc
V8	0	—	6.3ac	—	0	—	—	—	—	freq below 7.4 mc, i-f-o switch at internal
V8	75	—	6.3ac	—	75	-17	—	—	—	freq above 7.4 mc, i-f-o switch at internal
V9	- 1	—	6.3ac	—	205	90	—	—	—	r-f gain max
V9	-54	—	6.3ac	—	260	150	—	—	—	r-f gain min
V10	- 1.25	-10	6.3ac	—	200	92	—	—	—	r-f gain max
V10	-54	-10	6.3ac	—	240	140	—	—	—	r-f gain min
V11	- 7.8	—	6.3ac	—	210	140	—	—	—	r-f gain max

TABLE 6-3. TUBE SOCKET TERMINAL VOLTAGES (CONT)

TUBE	SOCKET PIN NUMBERS									MODE OF OPERATION
	1	2	3	4	5	6	7	8	9	
V11	- 7.8	—	6.3ac	—	235	140	—	—	—	r-f gain min
V12	0	—	6.3ac	—	192	72	.9	—	—	r-f gain max
V12	0	—	6.3ac	—	215	80	1	—	—	r-f gain min
V13	20	—	6.3ac	—	20	- 3.3	—	—	—	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	57	—	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 c-w a-v-c operation.

TUBE	SOCKET PIN NUMBERS									MODE OF OPERATION
	1	2	3	4	5	6	7	8	9	
V1	1800K	0	—	0	16.7K	50K	0	—	—	Crystal freq control positions 1-6
V2	1800K	0	—	0	16.7K	50K	0	—	—	
V3	23K	0	—	—	15K	17K	0	—	—	
V3	0	0	—	—	15K	infinity	0	—	—	Var freq or external
V4	infinity	infinity	—	0	infinity	47K	0	—	—	Crystal freq control positions 1-6
V4	19K	infinity	—	0	infinity	47K	0	—	—	Var freq osc opera- tion
V5	47K	150	—	0	19K	22K	26K	—	—	Freq bands below 7.4 mc
V6	22K	0	—	0	17.4K	infinity	1100K	—	—	
V6	22K	0	—	0	17.4K	37.4K	1100K	—	—	Freq bands above 7.4 mc
V7	980K	0	—	0	17.4K	infinity	390	—	—	Freq bands above 7.4 mc
V7	980K	0	—	0	17.4K	48K	390	—	—	Freq bands below 7.4 mc

TABLE 6-4. TUBE SOCKET TERMINAL RESISTANCES (CONT)

TUBE	SOCKET PIN NUMBERS									MODE OF OPERATION
	1	2	3	4	5	6	7	8	9	
V8	infinity	infinity	2	0	62K	9.5K	0	—	—	Freq bands above 7.4 mc, i-f-o switch at internal
V8	infinity	infinity	2	0	infinity	9.5K	0	—	—	
V9	1100K	0	—	0	17.5K	9.5K	0	—	—	
V10	1100K	117K	—	—	17K	9.5K	0	—	—	
V11	93K	0	—	0	17.5K	19K	0	—	—	
V12	1.2	0	—	—	17K	61K	100	—	—	
V13	—	—	—	—	160K	100K	0	—	—	
V14	0	816K	—	0	15.6K	0	196K	—	—	
V15	69K	infinity	—	0	infinity	0	196K	—	—	
V16	125K	500K	1K	0	0	17.4K	470K	680	—	
V17	0	0	15.6K	15.2K	470K	infinity	—	360	—	
V18	118K	—	—	—	20K	—	0	—	—	
V19	—	15.8K	0	42	—	40	—	15.8K	—	
V20	49K	65K	—	0	49K	0	65K	—	—	

6-18. SUPPLY VOLTAGE DIAGRAM.

6-19. The supply voltage diagram (see figure 7-5) shows the actual B+ and bias supply voltage paths for the +280 to +305, for the +228 to +265, for the +90 to +150, for the +150 regulated, for the —one to —51, for the —10, and for the —7.8 d-c supply voltages derived from the self-contained power supply of the receiver. The —7.8 d-c voltage supply is that developed across the resistor R113 which with the resistors R56 and R57 acts as a voltage divider across the —10 d-c volt supply. When S8, the "AVC" "MAN" switch (15, figure 1-2) is at "MAN", the junction of the resistors R48 and R53 provide for the —one to —38.5 d-c volt bias supply applied to V1 and V2. When S8 is at "AVC", the resistor R97 is interposed in series with R48 and R53, so that the bias range provided by R93, the "RF GAIN" control (14, figure 1-2) is from —one to —21.8 d-c volts. Actually, when S8 is at "AVC", R93 is normally set at maximum (—one d-c volt bias). Figure 7-5 also shows all the resistor-capacitor boards of the receiver, their interconnections, and the receiver item(s) at which each resistor and/or capacitor terminates, data useful for rapidly isolating a receiver fault. Figure 7-5 facilitates the trouble shooting procedure in the following manner. When the d-c voltage at a tube socket pin reads abnormal and a resistance check is made to isolate the fault, the use of figure 7-5 provides for rapidly determining whether the resistance to ground progressively closer to each resistor-capacitor

board terminal is normal, or not. Figure 7-5 also shows each capacitor liable to be the cause of the fault due to being short-circuited or leaky.

6-20. Table 6-5 lists the d-c resistance of each choke, coil, and transformer winding used in the receiver. In instances where the d-c resistance is very low, the table indicates that a continuity "click" check suffices. The d-c resistance data is used to determine whether a coil or winding is defective due to being open, partially so due to broken strands (one broken strand is permissible), or has shorted turns. The data is useful too when making resistance measurements in circuits containing the coil or winding. In each instance a resistance tolerance of plus or minus 15 percent is to be expected since the data provided represents practical averages determined for lots of each item.

6-21. ALIGNMENT AND ADJUSTMENTS. The alignment sequence for the radio receiver is to align the 455-kc i-f section channel first, then to align the 3,955-kc i-f section channel and finally the r-f and heterodyne of the r-f 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.

TABLE 6-5. D-C RESISTANCE OF COILS AND WINDINGS

REFERENCE SYMBOL	ITEM WINDING OR TERMINALS	OHMS	REFERENCE SYMBOL	ITEM WINDING OR TERMINALS	OHMS
T7	1-3	41.6	L25	P	115
	2-4	41.3		S	6.8
	5-6	685.0	L31	P	Click
	7-8	426.0		S	1.17
T8	1-9	30.8	L32	P	5.35
	10-12	62.3		S	0.68
	13-14	0.47	L33	P	Click
	15-16	0.47		S	1.65
	17-18	0.42	L34		1.55
	19-20	0.42			
T35	1-2	Click	L35		0.71
	1-3	Click	L36	P	5.39
	1-4	Click		S	2.77
L1	Primary (P)	1.43	L37		9.42
	Secondary (S)	9.0			
L2	P	Click	L38, L39, L41, L42		3.62
	S	1.4			
L3 thru L6, L10 thru L13, L17 thru L20, L27 thru L30	P	Click	L40, L43	Per pie	1.47
	S	Click			L44
L7, 14, 24		8.5	L45		2.50
			L46		1.31
L8, L15	P	Click	L47		46.0
	S	9.2	L48		2.0
L9, L16	P	Click	L49, L50		2.7
	S	1.25			
L21		21.5	L51		150.0
L22		0.61	L52		354.0
L23		0.20	L53, L54	Start to finish	9.0
				Start to tap	6.0

6-22. The receiver alignment and adjustment procedures (see table 6-6) 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 capacitor and adjustable core tuning coils, as applicable, which are positioned for alignment for the band indicated by the "BAND CHANGE" control (6, figure 1-2). The figure illustrating the test equipment set-up for each step is referenced in the table column out-

lining the test equipment adjustments made. The receiver 455- and 3,955-kc i-f alignment procedures (see table 6-6), are outlined both for output meter and oscilloscope indication of which the latter is the preferred method.

6-23. 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.

6-24. 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 assurances that the receiver, when released, will maintain performance for long periods of time.

TABLE 6-6. RECEIVER ALIGNMENT AND ADJUSTMENT PROCEDURES

STEP	TEST EQUIPMENT ADJUSTMENT	RECEIVER CONTROL POSITIONS	ALIGNMENT OR ADJUSTMENT MEANS
1	<p><i>Output Meter Indication</i></p> <p>Test set-up (refer to paragraph 6-7).</p> <p>Signal gen input of 455 kc, 30 percent 400 cps AM, using adapter, between the test point G, 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.</p> <p>Reduce signal level as rec is aligned to below 270 uv, to prevent rec overload.</p>	<p>"SEND" "REC" switch (1, figure 1-2), to "REC".</p> <p>"MOD" "CW" switch (17) to "MOD".</p> <p>"AVC" "MAN" switch (15) to "MAN".</p> <p>"SELECTIVITY" switch (19) to "3" kc.</p> <p>"AUDIO GAIN" control (22) at max; use approx 20 volts output meter indication.</p> <p>"BAND CHANGE" control (6) for 1.35-3.45 mc band.</p> <p>"TUNING" control (11) for 2.5 mc.</p> <p>"XTAL PHASING" control (20) to arrow.</p> <p>"RF GAIN" control (14) at max, then as rec alignment is made reduce to prevent excessive output.</p>	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 (19) to "0.2" kc position, others as in step 1.	None.
3	None.	"SELECTIVITY" switch (19), back to "3" kc position, others as in step 1.	Readjust, in turn, L42, L41, L39, L38, L36, L32 for max output.
4	None.	"SELECTIVITY" switch (19), to "1.3" kc position, others as in step 1.	Adjust L37 for max output.
5	Same as step 2 but with signal gen AM, switched "off".	Same as step 4, but with "MOD" "CW" switch (17) in "CW" position, and "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch (4) set at either "SLOW" or "FAST" "INT BFO". Set "BEAT OSC" control (18) 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.	<p>"SELECTIVITY" switch (19) to "3" kc position.</p> <p>"BAND CHANGE" control (6) for 7.4-14.8-mc band.</p> <p>"TUNING" control (10) not moved, others as in step 1.</p>	Adjust, in turn, L31; L33, L34, for max output.

TABLE 6-6. RECEIVER ALIGNMENT AND ADJUSTMENT PROCEDURES (CONT)

STEP	TEST EQUIPMENT ADJUSTMENT	RECEIVER CONTROL POSITIONS	ALIGNMENT OR ADJUSTMENT MEANS
7	<p>Test set-up (see figure 5-1).</p> <p>Signal gen input of 0.56 mc, 30 percent 400 cps AM, using antenna input cable (see figure 2-2), to antenna input socket J1 (see figure 5-6), at signal level to show some deflection on power output meter across 600-ohm rec audio output term.</p> <p>Reduce signal level as rec is aligned to prevent rec overload.</p> <p><i>Note.</i> To maintain accuracy of signal gen freq, (refer to table 6-1), regarding frequency accuracy.</p>	<p>"SELECTIVITY" switch (19) to "3" kc position.</p> <p>"SEND" "REC" switch (1) to "REC".</p> <p>"HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch (3) to "VAR".</p> <p>"MOD" "CW" switch (17) to "MOD".</p> <p>"AUDIO GAIN" control (22) at max; us approx 20 volts output meter indication.</p> <p>"BAND CHANGE" control (6) for 0.54-1.35-mc band.</p> <p>"TUNING" control (10) for 0.56-mc main dial indication.</p> <p>"LIMITER" "OFF" switch (21) to "OFF".</p> <p>"RF GAIN" control (14) at max.</p> <p>"AVC" "MAN" switch (15) to "AVC".</p>	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 (10) 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 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 (15) to "MAN".	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 (6) for 1.35-3.45-mc band, "TUNING" control (10) 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 (10) 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.
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 (6) for 3.45-7.4-mc band, "TUNING" control (10) for 3.75 mc.	Adjust, in turn, L27, L3, L10, L17, for max output.

TABLE 6-6. RECEIVER ALIGNMENT AND ADJUSTMENT PROCEDURES (CONT)

STEP	TEST EQUIPMENT ADJUSTMENT	RECEIVER CONTROL POSITIONS	ALIGNMENT OR ADJUSTMENT MEANS
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 (10) 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 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 (6) for 7.4-14.8-mc band. "TUNING" control (10) for 7.5 mc. Set "IFO" "EXT" "INT" switch (2) at "INT".	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 (10) 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 19, but "BAND CHANGE" control (6) for 14.8-29.7-mc band, "TUNING" control (10) 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 19, but set "TUNING" control (10) for 29.0-mc main dial indication.	Adjust, in turn, C90, C13, C36, C56, for max output.
25	Repeat steps 23 and 24 in sequence.	Repeat steps 23 and 24 in sequence.	Repeat step 23 and step 24 in sequence until no further increase in output results.
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 19, but "BAND CHANGE" control (6) for 29.7-54.0-mc band, "TUNING" control (10) 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 (10) 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.

TABLE 6-6. RECEIVER ALIGNMENT AND ADJUSTMENT PROCEDURES (CONT)

STEP	TEST EQUIPMENT ADJUSTMENT	RECEIVER CONTROL POSITIONS	ALIGNMENT OR ADJUSTMENT MEANS
30	Same as step 29, but set signal gen level to approx three uv.	Same as step 28, but set rec controls as in step 10.	Same as step 29, repeat as needed.
Alternative for steps 1 thru 5.	<i>Oscilloscope Indication</i> Test set-up (see figure 6-6). Sweep signal gen input of 455 kc, ± 20 kc approx FM, using adapter, between the test point G, 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 jumpered "DIODE OUTPUT" terminals of the "DIODE OUTPUT" "AVC" terminals (9, figure 1-3), 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.

6-25. 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.

6-26. The receiver should be inspected for dirt, dust, corrosion; tropicalization of r-f coils, chokes, and

soldered joints; evidence of oil leakage; loose sub-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.

6-27. The receiver should be inspected according to the proper functioning of all controls as outlined in step "d" of paragraph 5-3 and with regard to each inspection listed in table 5-5. Further, the receiver design

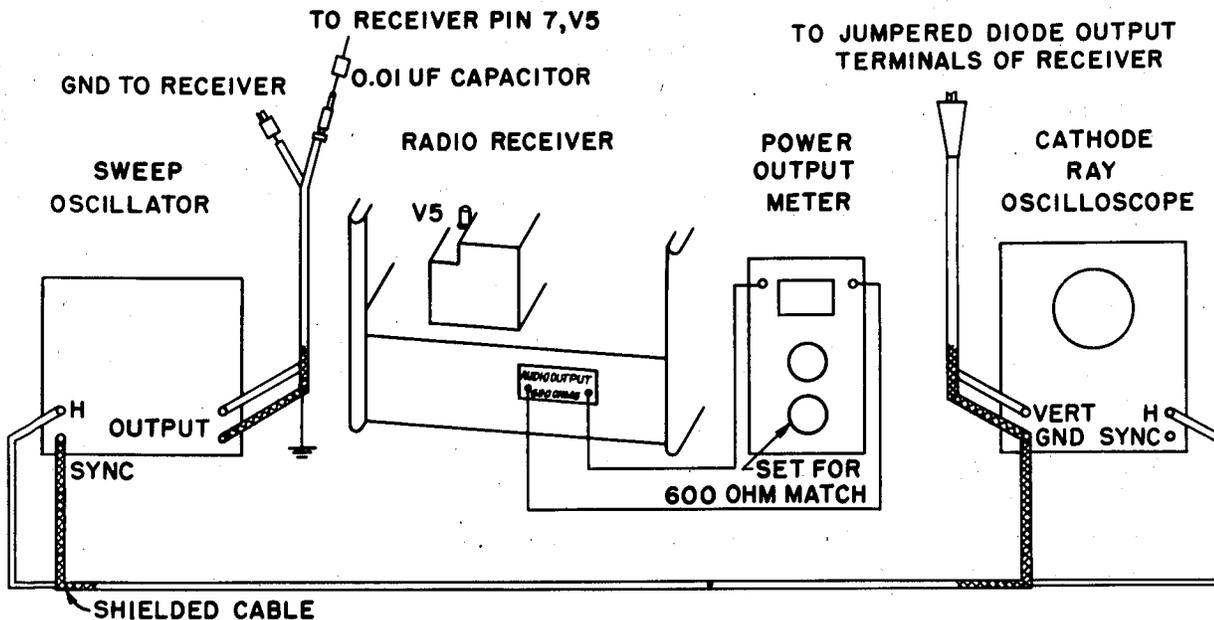


Figure 6-6. Receiver 455 kc and 3,955 kc Alignment KRT Indication Test Set-up

utilizes the spring action of various types of springs to maintain mechanical performance and for purposes of furnishing positive electrical grounding between moving parts. These are inspected as outlined in paragraphs 6-28 to 6-36.

6-28. Inspect the "U" shaped loop spring used to retain the main tuning capacitor 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.

6-29. 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 misshaped.

6-30. Inspect, by removing all r-f tuner subassemblies except those on one band, the knife action of the contact pins on the r-f tuner subassemblies, to see that the "V" contact spring blades for the r-f tuner subassemblies 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.

6-31. 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.

6-32. Inspect the wavy flat spring at the front of the turret rotor assembly for wavy shape.

6-33. 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.

6-34. Inspect the crystal holder six flat springs to see that each provides positive holding action to inserted crystals.

6-35. 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 subassemblies, to see that positive spring action is provided.

6-36. Inspect two helical springs on band change detent switch to see that 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.

6-37. 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 maintenance, 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.

6-38. **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 in paragraphs 6-24 thru 6-37, the receiver overhaul schedule is determined whenever the receiver is sent to depot maintenance for overhaul. A receiver in use 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 6-7. In this instance, the actual work done on the receiver may be of a minor nature, if any.

TABLE 6-7. 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

AN 16-45-434

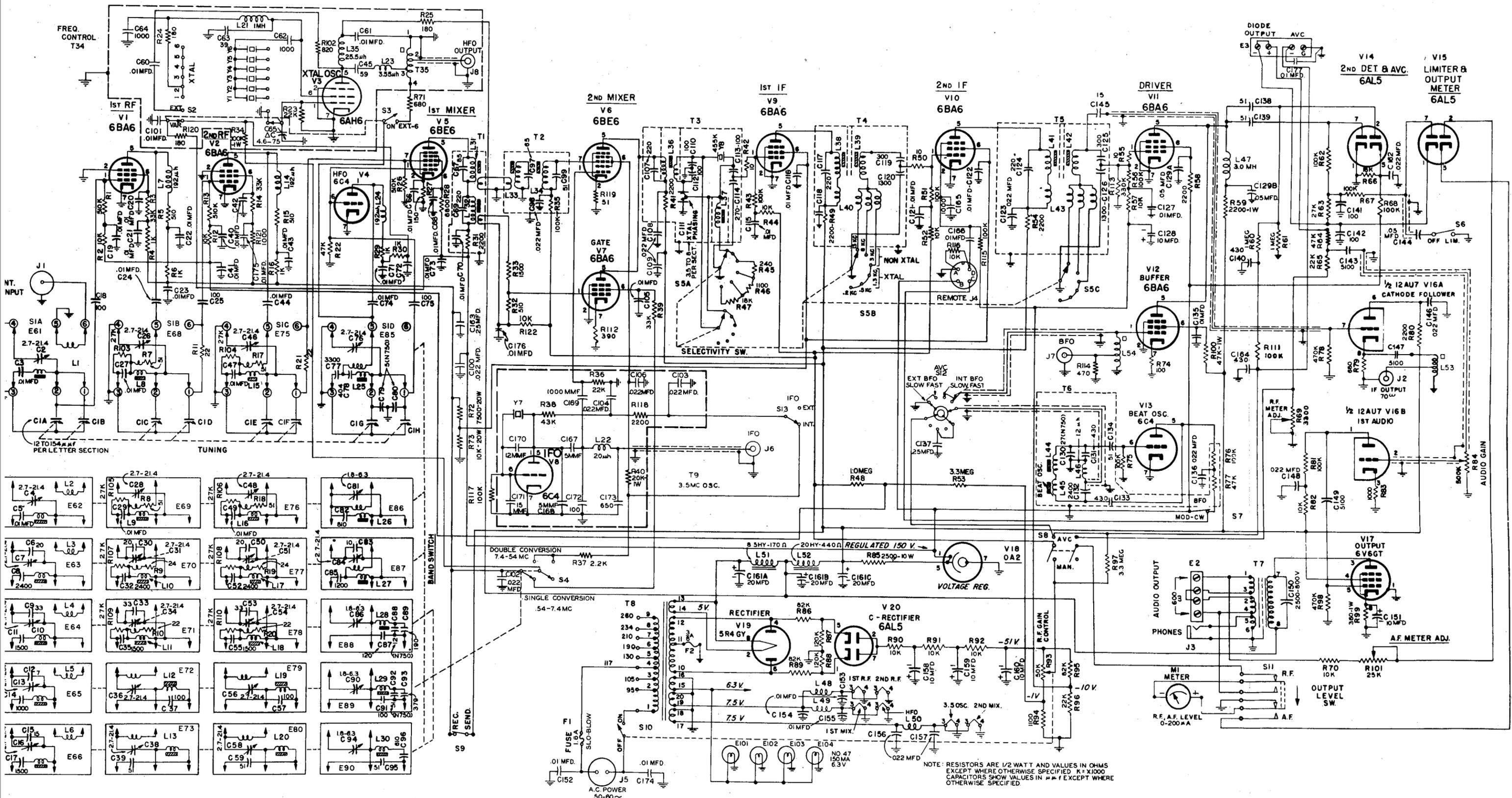


Figure 7-1. Radio Receiver, Schematic Diagram.

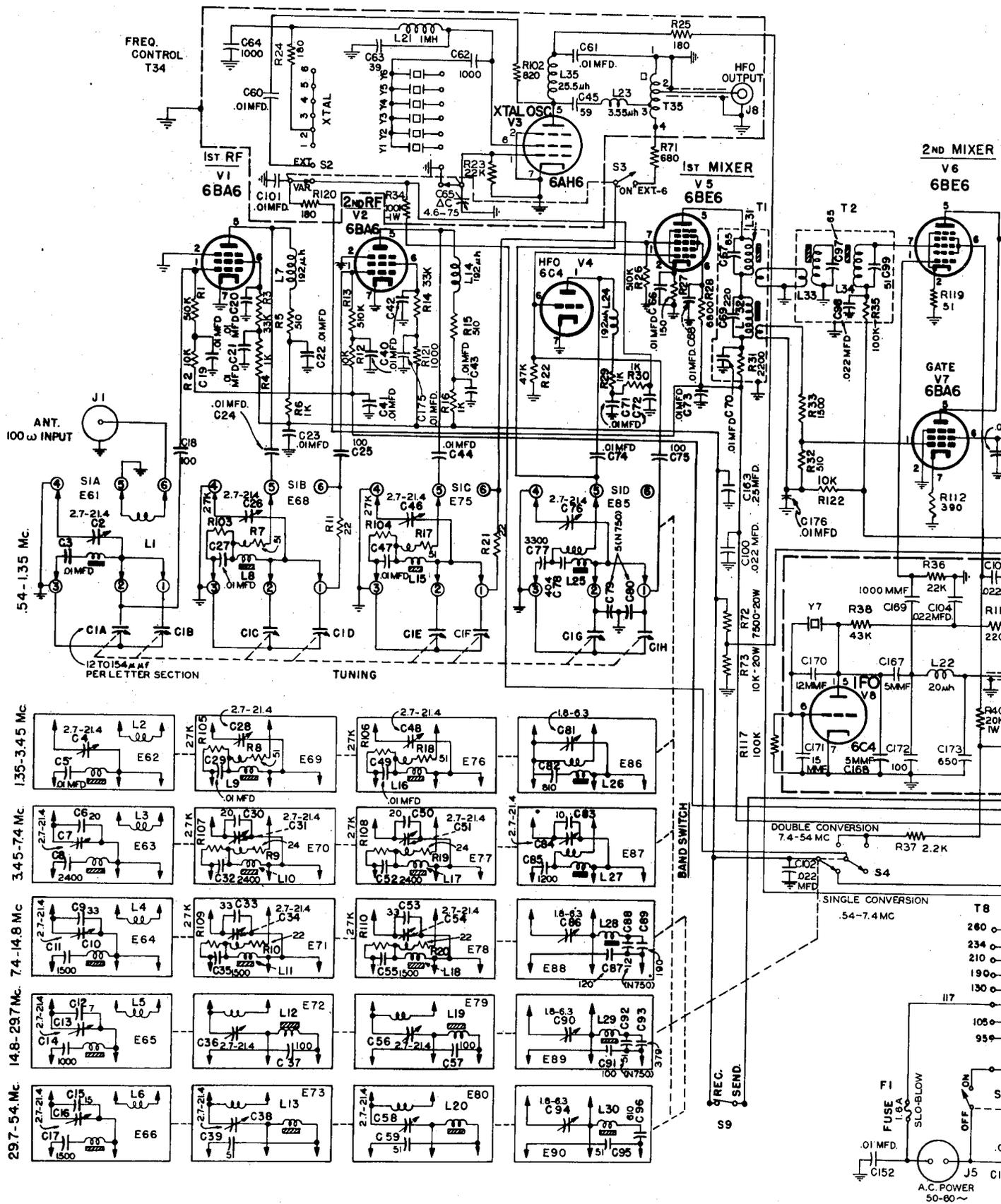


Figure 7-1. Radio Receiver, Schematic Diagram

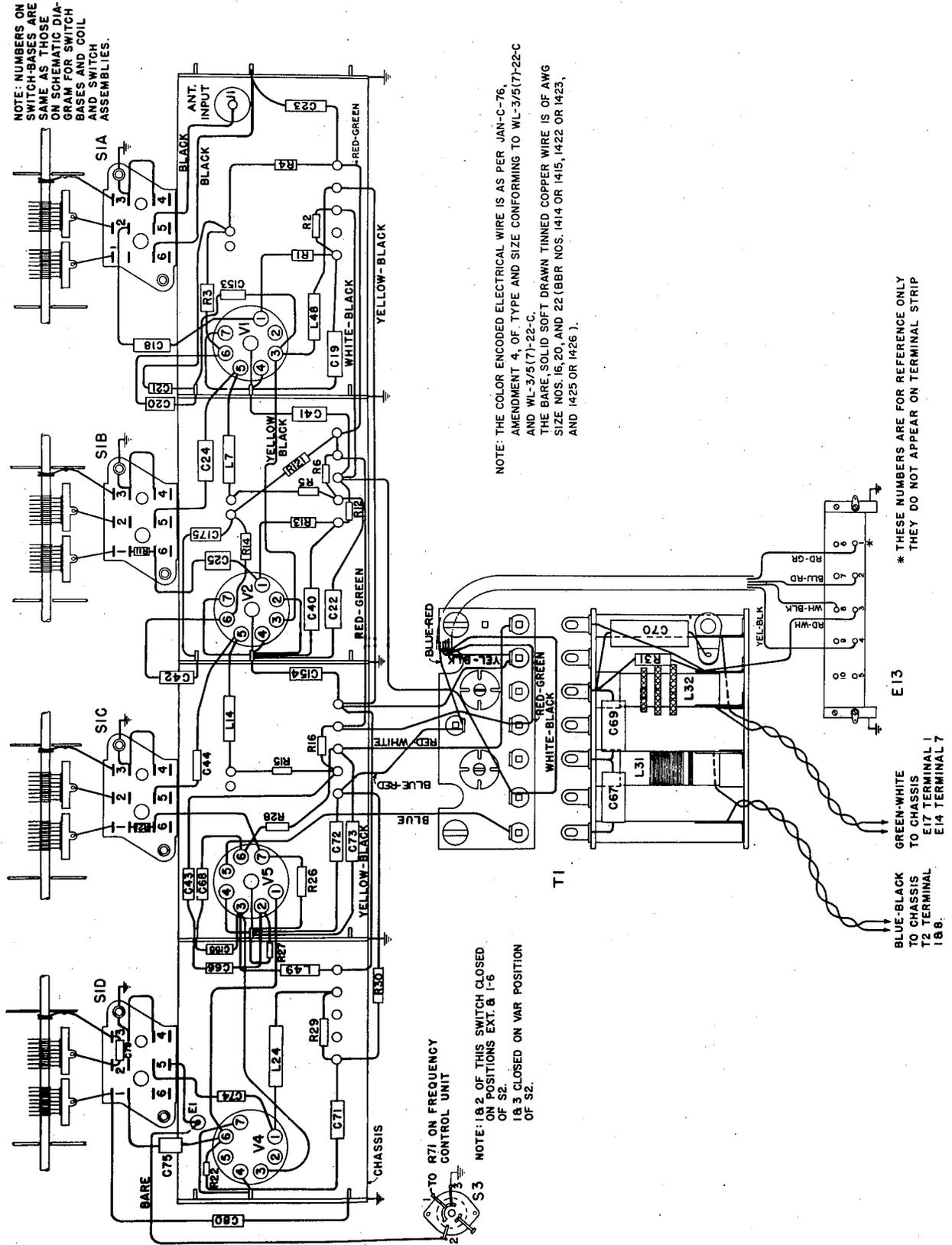
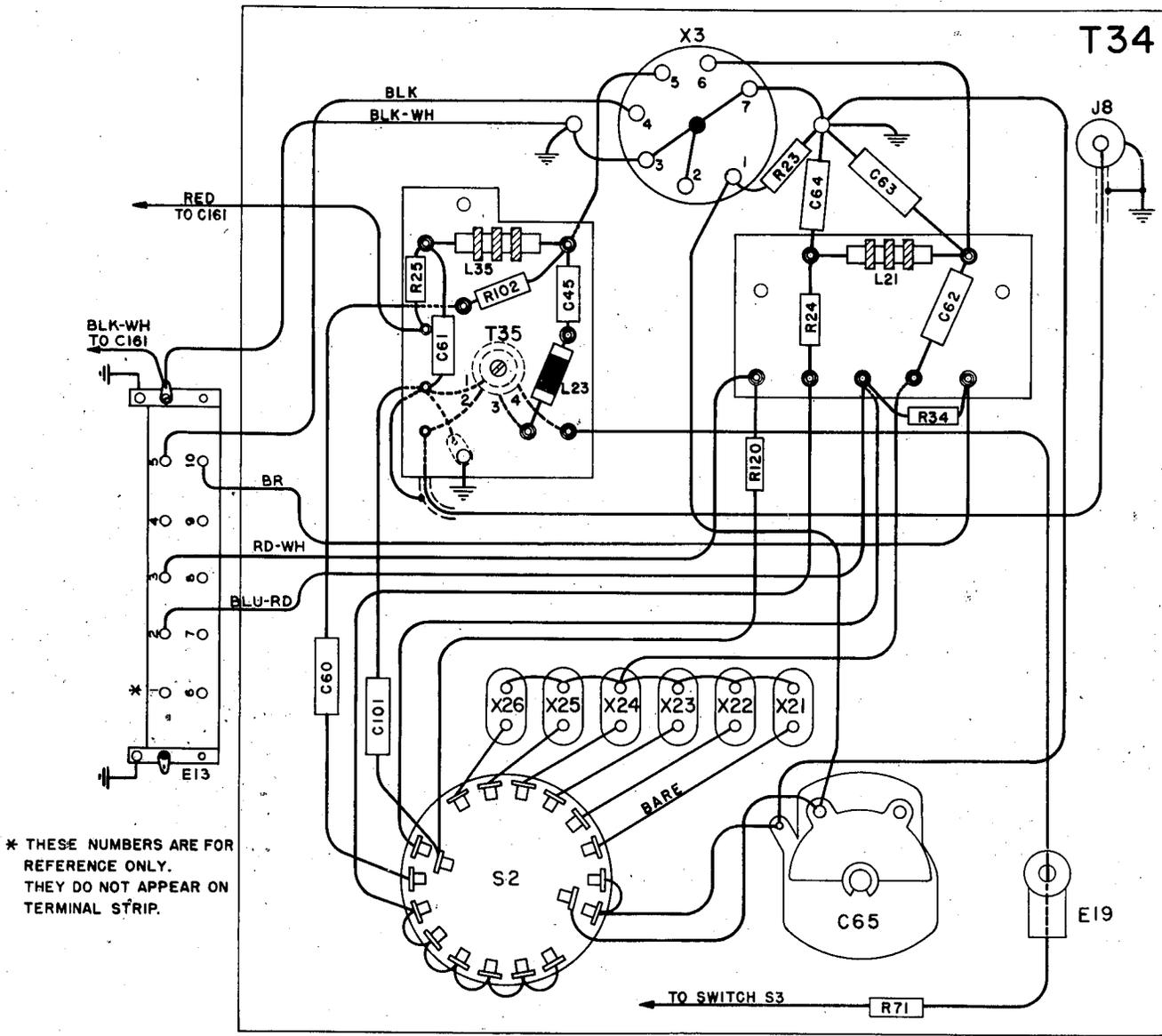
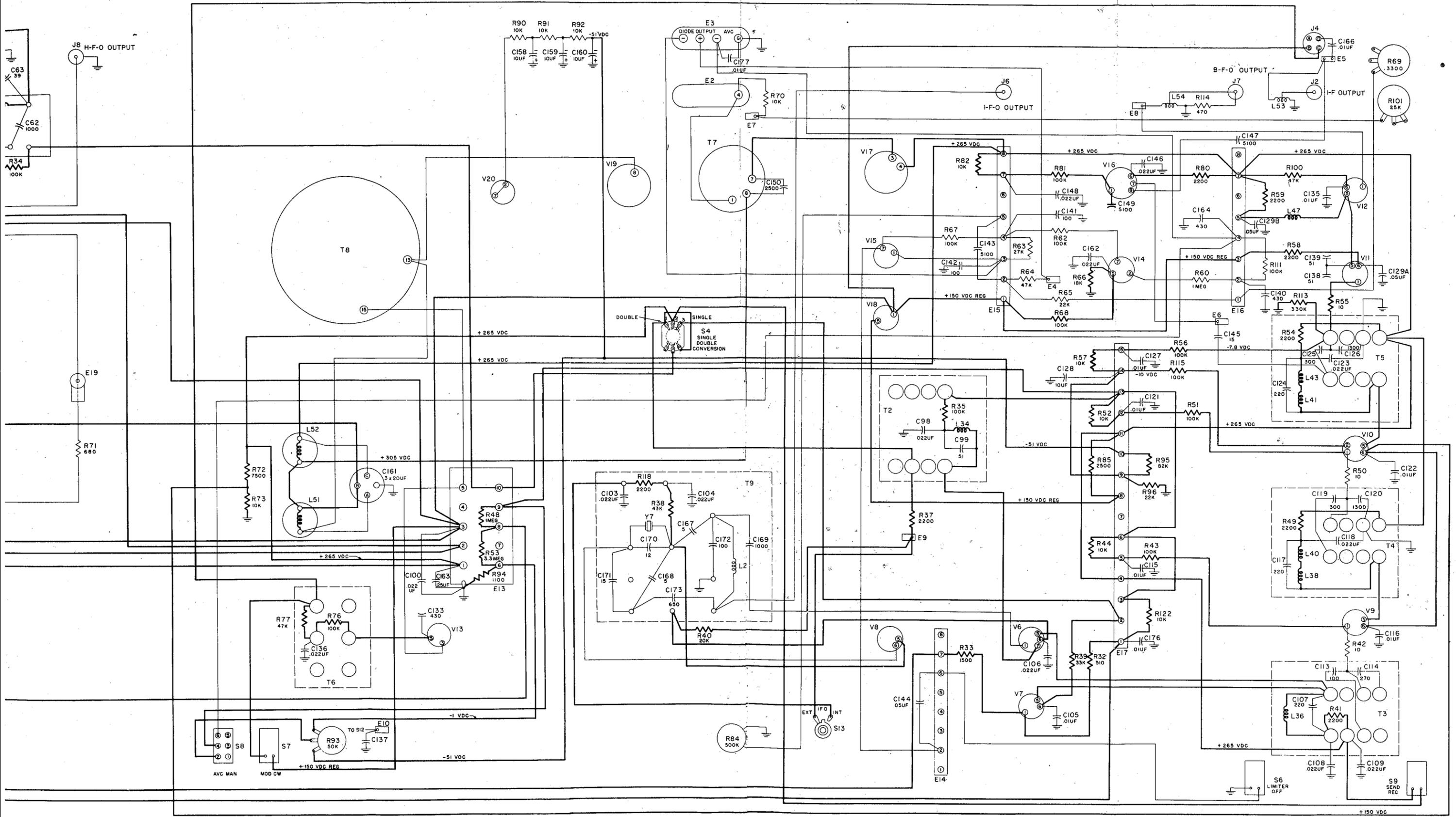


Figure 7-3. Radio Receiver, Tuning Unit Connection Diagram



NOTE:
 THE COLOR ENCODED ELECTRICAL WIRE IS AS PER JAN-C-76, AMENDMENT 4, OF TYPE AND SIZE CONFORMING TO WL-3/5(7)-22-C. THE BARE, SOLID SOFT DRAWN TINNED COPPER WIRE IS OF AWG SIZE NO. 20 (BBR NOS. 1422 OR 1423). THE SHIELDED INSULATED CABLE IS OF AWG SIZE NO. 24 AND HAS 16, NO. 36 STRANDS (ALPHA NO. 1248-PL).

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



- NOTES:
1. 117 V A-C INPUT.
 2. NO SIGNAL INPUT.
 3. B+ AND BIAS D-C SUPPLY VOLTAGE DISTRIBUTION SHOWN BY HEAVY LINEWORK.
 4. RESISTOR-CAPACITOR BOARD TERMINATIONS SHOWN BY LIGHT LINEWORK.
 5. UNLESS SHOWN OTHERWISE, RESISTORS IN OHMS, AND CAPACITORS IN UUF.
 6. USE VTVM FOR -V; USE VOLT-OHMMETER ON 500V SCALE TO PREVENT CIRCUIT LOADING.
 7. USE THE S9 SEND REC SWITCH TO ISOLATE THE +228 TO +265 V D-C SUPPLY FROM V1, V2, AND S4, THE SINGLE DOUBLE CONVERSION SWITCH, THEN USING S4 IN SINGLE AND DOUBLE POSITIONS RESPECTIVELY TO ISOLATE SUPPLY FROM V4, V6, V8, AND S13, AND FROM V7, THEN USE S13 THE IFO EXT INT SWITCH IN EXT POSITION TO ISOLATE V8.
 8. USE THE S7 MOD CW SWITCH IN MOD POSITION TO ISOLATE +150 V D-C REGULATED SUPPLY FROM V13.
 9. USE THE S2, S3 HFO VAR EXT CRYSTALS 1, 2, 3, 4, 5, 6 SWITCH IN ANY POSITION OTHER THAN VAR TO ISOLATE THE +150 V D-C REGULATED SUPPLY FROM V4; USE IN VAR POSITION TO ISOLATE SUPPLY FROM V3.
 10. SET THE S8 AVC MAN SWITCH TO MAN AND RANGE THE R93 R-F GAIN CONTROL FROM MAX TO MIN TO CHECK -1 TO -51 V D-C BIAS SUPPLY TO V6, V7, V9, AND V10, THAT TO V1 AND V2 THEN RANGES FROM -1 TO -38.5 V D-C.
 11. SEE TEXT PARAGRAPH 6-18 FOR OVERALL USE OF THIS DIAGRAM.

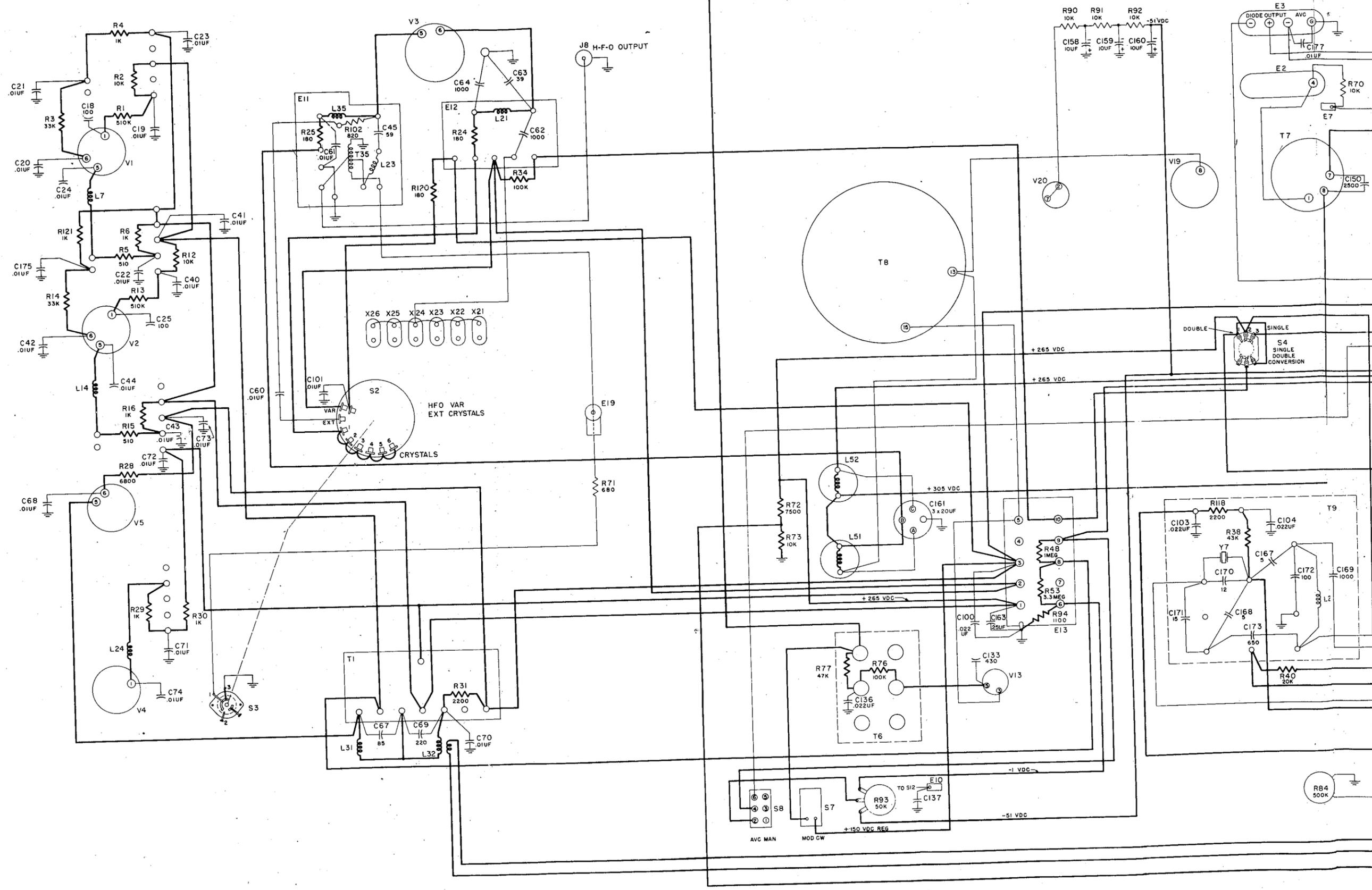


Figure 7-5. Radio Receiver, B+ and Bias Supply Voltage Distribution, and Resistor-capacitor Board Terminations

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