SP-600 - JX17

COMMUNICATIONS RECEIVER

FOR

SINGLE AND DIVERSITY RECEPTION

INSTRUCTION AND SERVICE MANUAL

THE HAMMARLUND MANUFACTURING CO. INC.

460 W. 34TH St. New York 1, N. Y.

SP-600-JX17

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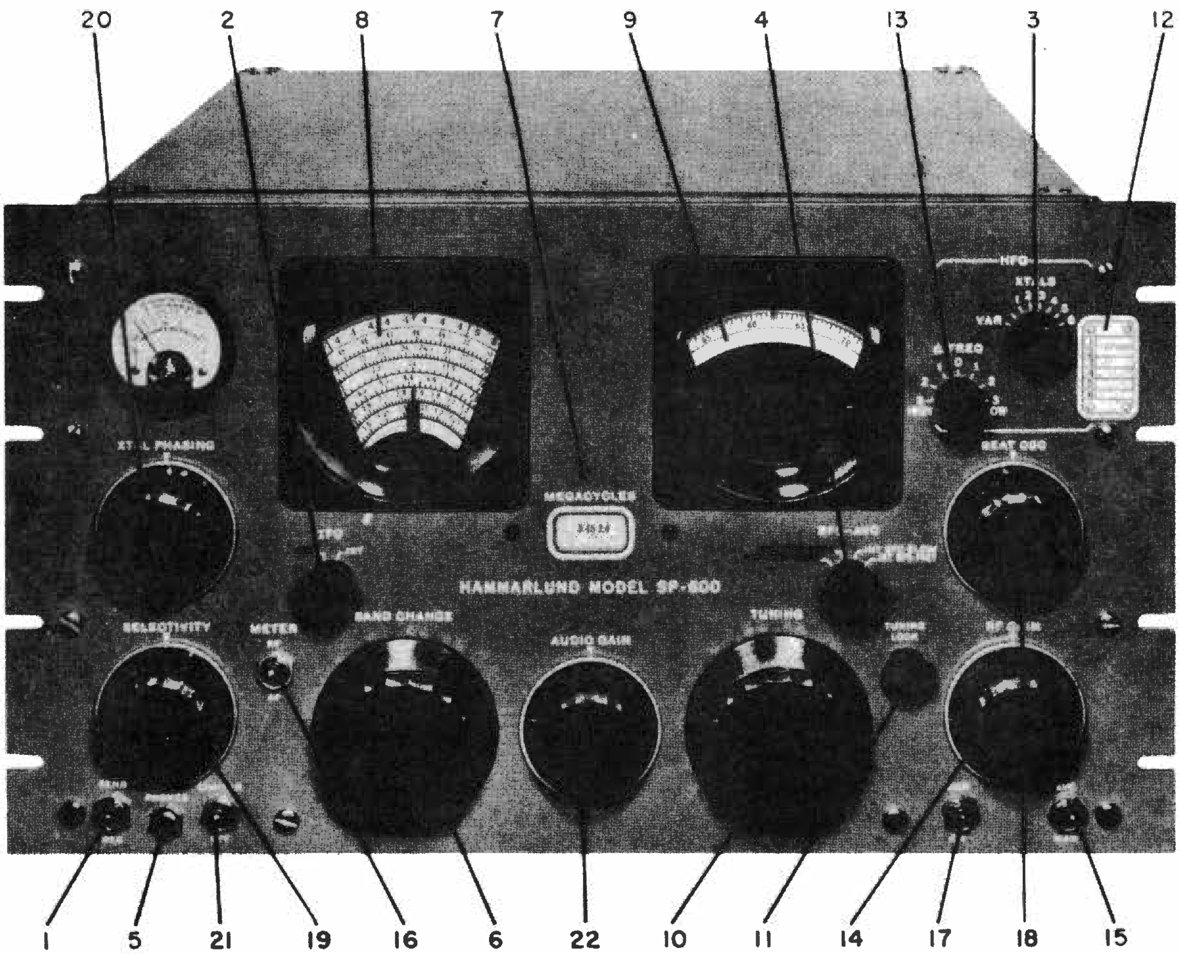


1. "SEND" "REC" switch
2. "IFO" "EXT" "INT" switch
3. "HFO" "VAR" "EXT" "XTALS" "1" "2" "3" "4" "5" "6" switch
4. "BFO-AVC" "EXT BFO" "SLOW" "FAST" "INT BFO" "SLOW" "FAST" switch
5. "PHONES" jack
6. "BAND CHANGE" control
7. "MEGACYCLES" window
8. Main tuning dial
9. Vernier dial
10. "TUNING" control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

Figure 1. Radio Receiver, Front Panel View

SECTION I

INTRODUCTION

The SP-600-JX17 is a 20-tube superheterodyne radio communications receiver designed specifically for diversity reception. The receiver is intended for use as either the "master" or "slave" unit for the reception of MCW, CW, suppressed carrier, or frequency-shift signals.

"Master-slave" relationship is established by interconnecting two or more receivers. These connections may be made between the beat-frequency and/or the heterodyne oscillators of each receiver, or between the receivers and an externally connected master oscillator common to each.

Frequency drift, after a 15 minute warm-up, ranges between .001 percent and .01 percent of frequency, depending on the frequency used. This is an unusual degree of frequency stability for variable tuned HF oscillators and closely approaches crystal stability.

The frequency control unit provides for fixed channel crystal-controlled operation on any six frequencies within the range from .75 to 54 megacycles. Front panel controls permit the selection of either the normal high stability, continuously variable tuning or fixed frequency operation. For crystal-controlled fixed-channel operation, it is only necessary to set the dial to the signal frequency, switch to the crystal frequency desired, and tune with the delta frequency control. Desired crystals may be purchased on special order from the Hammarlund Manufacturing Company.

The selectivity control provides 3 degrees of crystal and 3 degrees of non-crystal selectivity ranging from sharp (.2 Kc) to broad (13.0 Kc). The crystal filter in the SP-600-JX17 embodies the same circuit features that have proved so effective and desirable in Hammarlund Super-Pro receivers.

Two stages of radio frequency amplification are provided on all bands: single conversion is used for signal frequencies up to 7.4 megacycles, and double conversion, employing a crystal-controlled oscillator, for signal frequencies above 7.4 megacycles.

Four stages of IF amplification, detector and AVC rectifier, noise limiter and meter rectifier, beat frequency oscillator and buffer amplifier, IF output, AF amplifier and output power stage, are among the features of the SP-600-JX17, which are discussed fully under separate headings in this manual.

The Audio output circuit is designed for a 600-ohm load or line and is provided with a four-terminal split winding for balanced load operation. Maximum power output is approximately 2.0 watts. The headphone circuit when referred to an 8,000-ohm resistive load provides signals attenuated approximately 15 db below the 600-ohm power output. Either headphones, loud speaker or both may be used for reception of signals.

The receiver i.f. output or audio-output, connected to a suitable frequency-shift receiver converter and associated teletypewriter, provides for recorded copy of a teletype signal. A CW signal may be amplitude-modulated by an external tone generator connected to the receiver, so that a steady, audible (monitoring) tone is always heard when the transmitter carrier is on the air, whether signal intelligence is present, or not.

A single tuning control of special design permits maximum traverse speed as well as exceptional operating ease. It controls both the main and vernier dials. The main dial, in addition to being frequency-calibrated, includes an arbitrary scale in hundredths, while the vernier scale contains an arbitrary scale in units. These arbitrary scales, complemented by the anti-backlash gear train which governs dial movement, provide extremely accurate logging and resetability. A tuning lock assures positive locking action without affecting the frequency setting.

Radiation is negligible and complies with requirements for ship-board operation and for multi-receiver installations.

Although the antenna input circuit is designed for the coaxial cable connection of a wave antenna system, a conventional single wire antenna may be used.

The self-contained power supply of the SP-600-JX17 is designed for operation on a single phase 50 to 60 cycle alternating current power source. The power transformer primary is provided with terminals offering a range of line voltage from 90 to 270 volts.

The send-receive switch desensitizes the receiver but leaves the power on to provide for instant reception between transmissions.

The SP-600-JX17 is available as either a rack model, suitable for a mounting in a standard 19" relay rack, or as a cabinet model for table use.

SECTION II

CIRCUIT DESCRIPTION

General

The electrical circuitry of the SP-600-JX-17 is shown schematically in Figure 9. A block diagram, Figure 2, is provided to illustrate the arrangement and functions of the various circuit sections. The location of the various tubes is shown in Figure 3. The circuit for single conversion, used for signal frequencies up to 7.4 megacycles, consists of two stages of RF amplification V1 and V2; First Mixer V5; First Heterodyne Oscillator V4; four stages of IF amplification, V7, V9, V10 and V11; Detector, AVC Rectifier V14; Noise Limiter V15; Beat Frequency Oscillator V13; IF output and AF amplifier, V16A and V16B; Output Power Stage V17, and the Power Supply System which includes B Power Rectifier V19, C Bias Rectifier C20 and Voltage Regulator V18.

In the circuits for double conversion, used for signal frequencies above 7.4 megacycles the Second Mixer V6 and Second Heterodyne Oscillator V8 are substituted for the gate tube V7.

A precise rotary turret is used to change bands. It associates the RF tuner, sub-assemblies of the antenna coupling, the two-stage RF amplifier, and the first heterodyne oscillator of the band selected with the circuitry in the RF strip common to each band. In this way, each RF tuner sub-assembly is positioned directly adjacent to its respective tube and gang section of main tuning capacitor C1A-C1H.

Input Coupling - The antenna input coupling provides an optimum match for a 95-ohm coaxial cable line connected to antenna input connector V1. On bands, 1, 2, 3, and 4, the antenna RF transformer is secondary-tuned by dual section C1A-C1B of the main tuning capacitor; on bands 5 and 6, by section C1A only. A capacitor, such as C3 for band 1, is used so that the antenna circuit tracking matches that of the RF amplifier.

RF Amplifier - The V1 and V2 stages of the RF amplifer are identical, V1 is secondary-tuned by dual section C1C-C1D while V2 is secondary-tuned by dual section C1E-C1F of the main tuning capacitor. Complexed coupling is used in RF stages to maintain a more constant level of signal gain over the frequency levels of each band. High image rejection ratios are achieved through the use of three High Q tuned RF circuits and by double conversion on the three higher frequency bands. The high gain developed by two RF stages assures maximum sensitivity at high signal-to-noise ratios.

First Heterodyne Oscillator (variable V4) - First Heterodyne Oscillator V4 functions as a Colpitts oscillator for the three higher frequency bands and as a tuned-grid oscillator for the three lower frequency bands. Dual section C1G-C1H of the main tuning capacitor provides for the variable tuning of the oscillator. For single conversion, the oscillator frequency is 455 Kc higher than the signal frequency, while for double conversion the oscillator frequency is 3.955 mc higher than the tuned-in signal.

First Heterodyne Oscillator - (Crystal Controlled V3) - For services requiring extremely stable, fixed-frequency operation, a crystal controlled high frequency oscillator is provided. Instant change-over from variable to crystal controlled oscillator with a choice of six crystal positions is effected by a front panel XTALS control. A second front panel control marked Delta Frequency permits a tolerance adjustment of the crystal oscillator frequency over the ± .005% (purchased crystal tolerance) range.

For double conversion, the conversion oscillator output from V3 is augmented b V4.

Conversion oscillator output from V3 is availablt at HFO output connector socke J8 at the rear of the frequency control unit when the front panel control is in a crystal position; but when the front panel control is set to its EXT position, the conversion oscillator voltage for the receiver is that which is externally connecte to J8.

Intermediate Frequency Amplifier - Single conversion to 455KC is employed for signal frequencies below 7.4 mc. There are four stages of IF amplification incorporating the Hammarlund - patented filter circuit. Six positions of selectivity provide 6 db bandwidths of .2, .5, 1.3, 3, 8, and 13 kc. On the three narrower bandwidth positions the crystal filter is in operation. The crystal phasing control provides extreme selectivity for the high attenuation of closely adjacent interfering signals. Double conversion is employed for signal frequencies above 7.4 mcs. The signal is heterodyned to 3.955 mc by the First Mixer V5 and Heterodyne Oscillator V4, or V3 for high image rejection. The 3.955 mcs signal is then heterodyned to 455 KC by the Second Mixer V6 and the 3.5 mc Fixed Crystal-Controlled Oscillator V8 for selectivity. For double conversion, the tuned circuits and the 3.955 mc IF transformer T2 assure appropriate input to the Second Mixer V6. IF transformer T1 in the plate circuit of V5 is resonant to both 455 kc and to 3.955 mcs. For single conversion, the 455 kc signal path is to 455 kc IF gate V7; for double conversion, the 3.955 mc signal path is to Second Mixer V6. The prime function of V7 is to render the signal path through it an open circuit for double conversion and available to the signal for single conversion.

The 3.5 mc crystal-controlled heterodyne output from V8 is available at IFO connector socket J6 at the rear skirt of the receiver, when the front panel IFO switch is set to its INT position; but when the IFO switch is set to its EXT position, the 3.5 mc conversion oscillator for the receiver is that externally connected to J8, since V8 is now inoperative.

Detector and AVC - The V14 tube is used as a high level Detector and AVC rectifier. The AVC circuit is provided with separate time constants for CW and MCW operation. AVC and Diode output terminals provide for connections in diversity applications. The AVC bias developed is applied to V1, V2, V6, V7, and V9, but the bias to V1 and V2 is reduced through use of a voltage divider network (resistors R48 and R53).

The BFO-AVC switch provides choice as to a FAST or SLOW time constant. Since the switch functions also as a BFO switch, two positions, BFO FAST and BFO SLOW, are provided.

Beat Frequency Oscillator - The beat frequency oscillator employs a high capacity Colpitts circuit which provide a high order of frequency stability and minimizes oscillator harmonics. The Beat Frequency Oscillator V13, is coupled into the detector circuit through Buffer Amplifier V12, which eliminates oscillator lock-in. A front panel control varies the audio-beat frequency from zero beat to ± 3 kc.

The beat frequency oscillator output from V13 is available also at BFO connector socket K7 at the rear apron of the receiver when the front panel BFO switch is set to either its FAST or SLOW INT BFO positions; but when set to either of its FAST or SLOW EXT BFO positions, the functioning beat frequency oscillator for the receiver is that which is externally connected to J7, since the output from V13 is suppressed.

Front panel switch control MOD-CW renders V13 operative for CW operation. An external switch control connected to terminals BF of remote connector socket

AN3102A-14S-2S (J4) on the rear skirt may also be used to perform this function, since these terminals are in parallel with the contacts of the control switch.

Alternate to the use of the beat frequency oscillator to render a keyed-carrier CW signal intelligible, a local tone generator may be externally connected to terminals A and B of J4 to amplitude modulate the CW signal. The use of a local tone generator produces a steady tone even when the received carrier frequency drifts. J4 is furnished with connector plug A and 3108B-14S-2P and cable clamp AN3057-6.

Noise Limiter - The noise limiter circuit V15 limits the noise interference from ignition systems or other sources of pulse-type noise. A separate limiter control switch permits optional use of the limiter on any mode of operation when pulse type interference is present.

Audio Frequency Amplifier - A resistance-coupled amplifier triode V16B amplifies the audio-frequency signal from the detector.

Audio Output - The audio output to V17 is transformer-coupled through a split balanced winding to deliver 2.0 watts undistorted output to a 600-ohm load. The split balanced winding permits balancing of the direct kind in the output circuit, as used for teletype or similar service. A separate secondary winding provides attenuated audio signal output for headphone operation. This winding will deliver an output of 15 milliwatts into an 8000-ohm resistive load when the 600-ohm power secondary is delivering 500 milliwatts to a 600-ohm resistive load.

IF Output - A cathode follower, the V16A provides a 70-ohm impedance source of intermediate frequency (455kc) to socket SO-239 on the rear skirt of the chassis. Plug PL-259, and angle plug adapter M-359 used with coaxial cable RG-11/U are not supplied.

Power Supply - The power supply is an integral part of the receiver. It includes the B rectifier V19 and C rectifier V20, together with their respective low-pass filters and Voltage Regulator V18. The power transformer is provided with screw terminal primary taps, covering a power line source range of 90 to 270 volts, 50 to 60 cycles. The power transformer and filter components are protected by fuses in the primary and plate supply circuit.

Tuning Meter - The tuning meter is used on AVC operation to indicate the accurac of tuning and the relative strength of received signals. Depression of the Meter Switch converts the meter circuit for indication of output level in db from 6 milliwatts.

RF Gain Control and Power Switch - The RF gain control is provided for manual control of sensitivity to prevent overloading on strong signals when operating with the AVC-MANUAL switch in the "MANUAL" position. This control also operates when the switch is in the "AVC" position. The Power "ON-OFF" switch is operated at the counter-clockwise extremity of the RF gain control.

Send-Receive Switch - The send-receive switch desensitizes the receiver but leaves the power "on" to provide for instant reception between transmission periods.

Radiation - Advanced design and shielding of the high frequency, second conversior crystal and beat frequency oscillators has reduced radiation to a negligible point so that interference of this nature, common in multi-receiver installations, is reduced to a minimum.

SECTION III

INSTALLATION

Tubes and Packing - After unpacking the receiver see that all tubes are firmly in their sockets and that all packing material is removed from the receiver.

Power Supply - Make sure that the primary tap lead at the bottom of the power transformer is connected to the tap which most nearly agrees with the 50 to 60 cycle power source voltage. Power connector plug AN3108B-18-3S with cable clamp AN3057-10 with power cord and plug are furnished with the receiver.

Antenna - The input impedance at the antenna socket, SO-239, is designed to match a 95-ohm coaxial cable line. The plug connector PL-259, and angle plug adapter M-359, supplied with the receiver, are for use with RG-11/U coaxial cable (not supplied).

Speaker - The speaker should be of the permanent-magnet dynamic type and should include a speaker voice coil to 600-ohm line-matching transformer for connection to the 600-ohm audio output terminals of the receiver. Caution: When the 600-ohm output is not used connect a 600-ohm, 2-watt resistor to these terminals to avoid component damage from high transient peak voltages. For applications requiring the insertion of direct current control or indicating voltages, the jumper connecting the two balanced sections of the 600 ohm-output may be removed and the insertion circuit, such as a low resistance balancing potentiometer, connected in its place.

Headphones - Either high or low impedance headphones may be used by plug connection to the phone jack located at the lower left side of the front panel. The high impedance type is recommended.

Mounting - The receiver is designed for rack mounting. Top and bottom cover plates are supplied for mounting in a standard 19-inch rack. The panel is 10½ inches high. See Section VII. The receiver should be placed in a position which permits the free access of air.

Crystals for Frequency Control - Crystals Y1 to Y6 are not supplied with the receiver, but will be supplied on special order for any signal frequency within the range of from 2 to 30 megacycles. In order to insure correct crystal-controlled frequency operation, crystal units may be ordered from THE HAMMARLUND MFG. CO. INC. The order should specify the signal frequency for which each unit is to be used. See note at end of Table 5. To install crystals loosen the knurled thumb screw on top of the Crystal Control Unit T34 and push to the rear. Insert the crystals in the sockets. Bring the retainer spring assembly forward so that the springs press on top of the crystal holders, and tighten the thumb screw. Mark the signal frequency for which each crystal was selected in megacycles on the plastic chart provided for this purpose alongside the crystal switch S2. Pencil or ink may be used and can be erased if it is desired to change these figures at any time. The numerals on the chart should be used so that they agree with the numerals on the crystal socket positions, which are also indicated by the crystal selector switch.

Relay Connections - If external relay operation for the send-receive function is desired, connection may be made by soldering a twin conductor cable to the terminals of the Send-Receive switch S9. In this case S9 is left in the Send or Open position.

AVC and Diode Output - In diversity applications, the diversity feature is accentuated by interconnecting the AVC (-) bus between receivers, and utilizing a common ground (G) connection. This AVC connection is made when the IF or AF output of the system is used to provide for the intelligence due to a CW, MCW, or frequency-shift signal; but for voice signals only the audio output from one receiver is used. This is done by removing the DIODE OUTPUT jumper on each receiver apart from one; and connecting the negative (-) terminal of each to that of the one whose terminals remain jumpered.

IF Output - The IF output socket SO-239 at the rear skirt provides the signal at 455kc for diversity receiving system use. Connector plug PL-259 and angle plug adapter M-359 (supplied) should be used with RG-11/U coaxial cable (not supplied). The output provided to a 70-ohm resistive load is approximately 200 millivolts for normal sensitivity (2 microvolts input signal).

Master Slave Connections - In diversity applications the monitoring requirements imposed on the operator are severe, but may be kept at a minimum by use of common conversion and beat-frequency oscillators. Then the operator need concern himself mostly with the signal level in each channel and the signal tuning of the receivers.

To provide for V-3 crystal-controlled first heterodyne, and/or V-8 3.5 mc. crystal-controlled heterodyne, and/or V-13 beat-frequency oscillator output, respectively, from the master to the slave receiver, the HFO, IFO, and BFO sockets SO-239, at the rear skirt of each, furnished with plug PL-259, and angle plug adapter M-359 for IFO and BFO only, are interconnected. The coaxial cable RG-11/U suited for use is not supplied.

With the red front panel controls in each instance on one receiver set to a red panel marking, that receiver becomes the slave receiver, wherein its V-3 (HFO), V-13 (BFO) and its V-8 (IFO) are rendered inoperative.

Remote Connector - The REMOTE connector J4 is furnished with connector plug AN 3108B-14S-2P and cable clamp AN 3057-6. Use terminals A and B of J4 for connecting a local external tone source to modulate a CW signal and use terminals C and D of J4 to perform the function of the CW-MOD switch by another system panel switch, if desired.

SECTION IV

OPERATION

General - Before attempting operation of the SP-600-JX17 receiver, the operator should thoroughly familiarize himself with the functions and uses of the various controls. When referring to the controls in this description, the words in capital letters represent the part of the name adjacent to the control on the front panel or on the rear skirt of the chassis. For example, when referring to the SELECTIVITY control, the word, SELECTIVITY in capitals indicates the legend appearing adjacent to the control. Reference to photographs, Figs. 1 and 6, is suggested while reading this description. Front panel controls and dials are shown in Fig. 1 and rear controls and terminals are shown in Fig. 6.

Selectivity Control - The SELECTIVITY control is a 6-position switch which selects three crystal and three non-crystal degrees of selectivity, ranging from extremely sharp for CW reception to broad for good fidelity MCW operation. The SELECTIVITY control dial indicates the 6 db bandwidth at each setting.

Phasing Control - The CRYSTAL PHASING control is a differential type, variable air capacitor. It permits adjustment of the crystal selectivity characteristic for high attenuation of closely adjacent channel interference on either side of the signal frequency.

RF Gain Control - The RF GAIN control varies the overall gain of the receiver. This control is operative in either position of the AVC-MAN switch.

Power Switch - The power, or "on-off" switch is combined with the RF GAIN control. Complete counter-clockwise rotation of the RF GAIN control throws the power switch to the "off" position, as indicated on the RF GAIN control dial.

Audio Gain Control - The Audio Gain control varies the input voltage to the audio amplifier. This control is also operative in either position of the AVC-MAN switch.

Phone Jack - The PHONES jack is a single circuit jack operating with the sleeve grounded and is suitable to receive any standard single circuit phone plug. It is in the circuit at all times and is connected to a separate secondary winding of the audio output transformer, which provides an attenuated signal for headphones. See Section III, Installation.

Audio Output - The AUDIO OUTPUT is available at the four-screw terminal board at the rear of the chassis for connection to a 600-ohm load. See Section III, Installation.

Noise Limiter - The LIMITER control switches the noise peak limiter in or out of the circuit. This control is operative independently of any position of any other control. See Section II, Circuit Description.

AVC-Manual Switch - In the AVC position the AVC-MAN switch applies automatic bias potentials to the controlled RF and IF amplifier tubes, thereby holding the audio output relatively constant over a wide variation in the strength of received signals. This minimizes the variation of output due to fading of the received signal and prevents blasting and overloading when tuning through signals of greatly different strength while traversing a frequency band. In the AVC position the RF Meter circuit is operative for indication of tuning resonance and relative strength of received signals. The RF GAIN control is operative on AVC operation when necessary to control exceptionally strong signals or to reduce noise, but the RF meter is less effective when the RF GAIN control is below maximum setting. In the MAN position the AVC potential is removed from the controlled tubes and the gain of the receiver is manually controlled by the RF GAIN control.

CW-Modulation Switch - The CW-MOD control in the CW position energizes the beat frequency oscillator. In MOD position the beat frequency oscillator is inoperative and the conditions are established for either voice modulated or tone modulated signal reception.

Beat Frequency Oscillator - The BEAT OSC control varies the tuning of the 455 kc Beat Frequency Oscillator over a range from zero beat to plus or minus 3 kilocycles.

BFO-AVC Switch - The BFO-AVC control in either the EXT BFO SLOW or INT BFO SLOW positions connects an additional timing capacitor to the AVC circuit to accommodate the AVC circuit to automatic CW keying, as compared to either the EXT BFO FAST or INT BFO FAST positions, effective for MCW and frequency-shift reception. In either FAST or SLOW INT BFO positions, the internal BFO of the receiver is operative when the CW-MOD switch is at CW. In either FAST or SLOW EXT BFO positions, the BFO source connected to the BFO connector at the rear skirt is used by the receiver.

IFO Switch - The IFO switch in the INT position renders the internal 3.5 mc crystal-controlled conversion oscillator operative. In the EXT position the oscillator is inoperative, since the IFO of the master receiver (externally connected to the IFO connector at the rear skirt) is used.

Send-Receive - The SEND-REC control is a single-pole single-throw toggle switch. In the SEND position it desensitizes the RF amplifier, gate, second mixer and 3.5 mc oscillator tubes during transmission periods.

Tuning Control and Dials - The TUNING control rotates the main tuning capacitor as well as the main and vernier tuning dials. The main dial has six frequency band scales, calibrated in megacycles, and an arbitrary outer scale. The vernier dial has an arbitrary 0 to 100 scale. The numeral under the upper or fixed pointer of the main dial indicates the number of complete revolutions that have been made by the vernier dial at any setting. Thus, if the pointer for the outer scale of the main dial indicates over the figure "4" and the vernier dial indicates 87.6, the reading to log for this setting is "487.6". This precise mechanical vernier system divides the rotation of the main dial over each frequency band into approximately 600 vernier divisions, with one-half division calibration points. Since it is easy to estimate one-tenth divisions on the vernier scale, this divides each frequency band into approximately 6000 readable settings, providing extreme accuracy in the logging and resetting of stations.

Tuning Lock - The TUNING LOCK, located to the right of the TUNING control, provides a positive lock for the tuning mechanism without affecting the frequency setting when it is desired to prevent accidental shifting of the tuning.

Band Change - Each revolution of the BAND CHANGE control turns the turret, containing the RF and HF Oscillator coil, trimmer and switch contact assemblies, from one frequency band to the next. The turet has no stops and may be turned in either direction. A positive detent mechanism assures correct location of the various bands. The BAND CHANGE control simultaneously operates the small MEGACYCLES band indicating dial, located at the center of the panel and aligns the dial frequency indicator with the proper scale of the main dial.

Crystal Controlled HF Oscillator - The XTALS control selects one variable high frequency oscillator operation, any one of the six crystal positions. Correspondingly numbered crystal sockets are provided in the Crystal Control Unit. In its EXT position, the crystal-controlled first conversion oscillator source is connected to the HFO connector at the rear skirt. See Section III Installation. The DELTA FREQ control compensates for the small crystal frequency tolerance.

Meter Switch - The METER switch is a double-pole, double-throw toggle switch with spring return to the RF position. See Section II, Circuit Description, Tuning Meter.

Tuning Meter Controls - The METER ADJ RF control is used to adjust the resistance shunting the meter when the METER switch is in the normal, or RF position. It is adjusted to produce a reading of plus 20 db on the RF scale of the meter, with a 10 microvolt RF input signal and with the AVC-MAN switch in the AVC position. Depression of the METER switch to the AF position converts the meter circuit for indication of the AF power output level in db from 6 milliwatts. This switch is spring-returned to the RF position when released and should not be depressed for the AF scale unless the audio output has been adjusted for low power output by means of headphones or speaker. Failure to observe this precaution may result in damage to the meter. The meter ADJ AF control is used to regulate the meter current when operating on the AF scale. This control is adjusted to obtain a 0 db reading on the AF scale of the meter and is made with the audio power output from the 600-ohm AUDIO OUTPUT terminals adjusted to 6 milliwatts, or 1.9 volts across a 600-ohm resistive load.

Preliminary to Operation - Turn the power switch "on" by turning the RF GAIN control clockwise and advance this control to "10". Note that the dial lamps light. Place the SEND-REC switch on REC and turn the BAND CHANGE control to the frequency band in which it is desired to operate. This should be done at least 15 minutes before using the receiver in order to permit the tubes to warm up. Insert the headphones plug in the PHONES jack or use speaker as desired. See Installation, Section III.

MCW Reception - Turn the TUNING LOCK to its extreme counter-clockwise position and turn the SELECTIVITY switch to 3 kc. Put the CW-MOD switch on MOD, the LIMITER switch to OFF, the AVC-MAN switch on AVC, the XTAL PHASING control at its center position and turn the XTALS switch to VFO. With the BAND CHANGE control in the proper position for the frequency band desired, as indicated by the MEGACYCLES dial, advance the AUDIO GAIN control until some noise is heard. Turn the TUNING control to indicate the desired frequency on the main dial and tune the signal for maximum response or indication on the RF Meter. At resonance the main dial reading should be within one-quarter of one percent of the signal frequency. Re-adjust the AUDIO GAIN control for the desired output level and as required to prevent overloading. Carefully tighten the TUNING LOCK by turning clockwise, if desired. The SELECTIVITY switch may be turned to the 8 kc or 13 kc position for improved high frequency response if the signal-to-noise ratio is sufficiently high. If the noise level is high, the SELECTIVITY switch should be turned to the bandwidth which provides the most intelligible reception and the LIMITER switch should be thrown "on". If the SELECTIVITY switch is used on one of the XTAL positions, the XTAL PHASING control may be adjusted to either side of its center position to attenuate an adjacent interfering signal. The RF GAIN control may be turned down somewhat to reduce noise during stand-by periods in the transmission when traversing the tuning range, or during deep fades of the signal. The RF Meter scale calibration is for maximum RF GAIN control operation and indicates only when the AVC-MAN switch is on AVC. When searching for very weak signals the CW-MOD switch may be thrown to CW and the BEAT OSC control set at "0". Locate and tune the signal to obtain zero beat and then throw the CW-MOD switch back to MOD.

The Crystal Frequency Control may be used for fixed-frequency operation at any signal frequency for which crystals have been provided. See Section III, Installation. Turn the XTALS switch to the numeral corresponding to that on the panel chart for the desired signal frequency. Set the main tuning dial to the signal frequency and adjust the Δ FREQ control to obtain zero beat with the CW-MOD switch on CW and the BEAT OSC control at "0". Throw the CW-MOD switch to MOD and adjust the TUNING control for maximum RF Meter indication or for maximum response.

CW Reception - The preliminary procedure for CW reception is the same as for MCW reception above. Place the CW-MOD switch on CW and with the BEAT OSC control at "0", tune the desired signal for zero beat. Adjust the BEAT OSC control, in either direction, to obtain the audio pitch desired. The AVC-MAN switch may be used in the position which gives the best reception. Adjust the desired output level by the AUDIO GAIN control when on AVC and by the RF GAIN control when on MAN. The RF Meter does not operate on the MAN position. The SELECTIVITY switch may be used in the XTAL positions, as found desirable, to reduce noise or to provide rejection of an interfering signal. The XTAL PHASING control is adjusted for minimum interference from an adjacent, interfering signal. If interference of this kind persists, further discrimination between the desired and the undesired signals may be realized by slightly detuning the desired signal to the opposite side of resonance from that on which the undesired signal is located and readjusting the XTAL PHASING control and the BEAT OSC control for the desired signal. The Crystal Frequency Control may be used as described under MCW Reception above.

If reception is to be suspended and resumed at short time intervals, the power should be left "on" and for such operation the SEND-REC switch should be thrown to SEND between reception periods. This keeps the receiver warm and ready for instant use.

When operation of the receiver is completed, turn the power "off" by extreme counter-clockwise rotation of the RF GAIN control.

SECTION V

MAINTENANCE

General - This receiver is designed for continuous duty and should normally require little attention beyond the replacement of tubes. An occasional cleaning of the gear teeth in the gear train is recommended to prevent a heavy accumulation of dust which may cause calibration error and improper operation of the gears. This may be done with a small stiff bristle brush, turning the controls to obtain access to the different portions of the gears. No grease or oil should be used on the gears. Operation and maintenance of the receiver will be greatly facilitated if the contents of this instruction book are thoroughly digested.

Some sectionalizing of faults is possible, if the fault is not existent on all of the frequency bands. Non operation of only the three lower frequency bands, indicates that the fault is associated with the circuits of tube V7. If only the three higher frequency bands are affected, the fault is associated with the circuits of V6 or V8. If only one single band is affected, refer to HF Oscillator and RF Coil Assemblies in this section.

Visual evidence of trouble is usually a burned or darkened resistor, which is usually the result of excessive current due to a short circuited capacitor or tube element on the load side of the resistor. In such a case, the short circuited capacitor or tube and the resistor should be replaced as indicated. Refer to Figures 7 to 12 and Table 5 for location and values of components. If the checks on tubes, fuses and visual inspection fail to disclose the fault, the tube socket voltages and resistances should be measured and checked against the value given in Tables 1 and 2. Any appreciable departure beyond a normal variation of approximately 15 percent from the values in these tables will generally indicate the component or circuit at fault. If the foregoing does not reveal the fault, then a stage by stage check of amplification should be made as shown in table 4. Any great difference from the values of input shown in the table will indicate the stage at fault. If a tuned circuit component, such as an IF transformer, RF or IF oscillator coil assembly is found defective, only the replaced unit need be realigned. Follow the alignment procedure in Section VI, for the unit involved.

The IF Transformers, Crystal Filter, Beat Frequency Oscillator and the 3.5 mc Crystal Controlled Oscillator assemblies are mounted on the chassis, independently of their respective shields. The shield can assemblies are easily removed for inspection of these units, without disturbing the soldered connections. When replacing these shields, make sure that the grounding springs are in place on the inductance adjuster screws before the shield is installed.

Vacuum Tubes - Weak or defective vacuum tubes are the most common cause of decrease in sensitivity, faulty performance or failure of operation in a receiver. In case of such faults, first remove the tubes and check them in a tube tester of reliable design. If a tube tester is not available, substitution of a new tube for each tube type and position should be tried. See Figures 2 and 3. Such substitution is best made, one tube at a time in order that the faulty tube may be detected by the improvement or restoration of performance by the new tube.

Locating Faults - If the dial lamps do not light when the power switch is turned on, check for a blown line fuse, F1 and replace it at the rear of the receiver from the spare fuses. If the dial lamps light but there is no sound at all in the headphones or speaker, check for a blown, minus B fuse, F2. If blown, replace. In replacing fuses, make sure that only a 1.6A Fusetron is inserted in the line fuse holder and that only a 3/8 ampere fuse is inserted in the minus B fuse holder.

Should neither fuse be blown, or if replacement of the fuses does not restore operation, the receiver should be removed from its rack and inspected for visual signs of trouble. The rack model receiver is provided with bottom and top cover plates which should be removed for purposes of inspection and repair.

IF Transformers - If a fault is traced to one of the variable coupled IF transformers, T4 or T5, check whether the fault exists on all positions of the selectivity switch S5, or only on one position of this switch. If the faulty operation occurs on only one switch position, check for continuity of the coupling coil associated with that position, check for imperfect soldered connections at the coil and switch terminals and check the switch contact involved. If faulty operation localized at one transformer exists on all positions of the selectivity switch, make the continuity check on the plate coils, on the main grid coil and on the wiring associated with these coils. Transformers T4 and T5 and Crystal Filter T3 have additional inner shield assemblies that are held in place by the tension nuts on the adjusting screws. To remove these shields, hold the adjusting screw with a screw driver to prevent turning the screws and losing the alignment adjustment and loosen the tension nuts, using another small screw driver engaging one of the slots. When replacing these shields and tension nuts, employ the same method and tighten the tension nuts just enough to prevent the adjusting screws from working loose.

Beat Frequency Oscillator - To remove the beat frequency oscillator T6, it will be necessary to set the crystal selector switch S2, on its number 3 position and loosen the four set screws in the rigid shaft coupling and the two set screws in the disc on the selector switch shaft. Slide the switch shaft forward through the coupling and disc. It may be necessary to remove burrs, caused by the set screws, from the switch shaft in order to slide the shaft through the disc. Now loosen the four set screws of the flexible coupling on the BFO shafts and slide the coupling forward on the BFO drive shaft in the front panel. Remove the BFO shaft bearing bracket by taking out the two screws holding it to the chassis. Unsolder the leads from the six terminals of the BFO unit at the underside of the chassis. Be careful to avoid overheating the wire of the shielded cable since this wire is insulated with polystyrene and is easily damaged by heat. Note that if this cable wire is grounded to its shield, there will be no beat frequency voltage input to the buffer tube V12 even though the beat oscillator is functioning properly. Therefore, with the shielded lead disconnected from the lug of the BFO unit, check with a continuity or ohmeter the connection of this wire to the buffer tube V12 and its freedom from the chassis. Carefully observe the wiring of the BFO unit for correct replacement. See T6 on Figure 12. Now remove the two screws holding the BFO shield can to the chassis and the two screws at the underside of the chassis and remove the BFO unit. When replacing the unit, follow the reverse procedure. Before tightening the two screws holding the unit to the chassis and the two screws holding the shaft bearing brackets, adjust the unit and shaft brackets to obtain alignment of the two shafts at the coupling. Make sure that the shield grounding spring is in place, with the bow of the spring downward against the tension nut, before replacing the shield can assembly.

Adjustment of BFO - With the AVC-MAN switch on AVC, and the SELECTIVITY control on the .2 kc position, tune in an unmodulated signal for maximum tuning meter reading. Set the CW-MOD switch to CW and with the BEAT OSC dial at 0, adjust the top screw of the BFO unit for zero beat. Turn the BEAT OSC dial to each 3 kc position and check the output beat frequency against a known audio frequency source such as a good audio oscillator. If the beat frequencies obtained at each 3 kc position is not within the range between 3 and 3.5 kc, loosen the set screws of the BFO shaft coupling and turn the shaft of the BFO with respect to the drive shaft and repeat the above, resetting the 0 adjustment by the top screw of the BFO unit each time until the above range is realized. One set screw should be used just tight enough to allow the drive shaft to operate the BFO shaft until the range is correct and then tighten both screws.

Crystal Switch Adjustment - If the mechanical drive of the crystal control switch has been disturbed, it should be adjusted as follows: Carefully slide the switch shaft through the disc and into the rigid coupling and, being careful not to turn the switch, tighten the four set screws in the rigid coupling, with the knob indicator on the number 3 position as originally set under Beat Frequency Oscillator. Now set the crystal switch on the number 1 position and, holding the disc in a counter-clockwise direction so that the end of the slot in the disc is against the drive pin, lightly fasten the set screws of the disc. When this disc is properly adjusted on the shaft, with the switch in the number 1 position, the connecting bar between the two discs should not be under tension and should exhibit a slight amount of play when tried with the thumb and forefinger. When so adjusted, tighten the set screws.

Crystal Control Unit - If it has been determined that the Crystal Control Unit is defective, it will be necessary to remove the unit for repair or replacement. Refer to Figure 11 and 12 and unsolder the lead of resistor R71 from switch S3 on the gear plate. Unsolder the black, black-white, blue-red and red-white leads of the crystal control unit from terminal strip E13 underneath the chassis and unsolder the red lead of the unit from filter capacitor C161. Remove the XTALS switch shaft, as described under Beat Frequency Oscillator. Loosen set screws and remove the delta C control knob. Remove the nut and lockwasher at the top of the bracket post adjacent to the power transformer and remove the bracket over the filter chokes. The front end of this bracket is slotted and engages a groove in a mounting post of the crystal control unit. Remove the four screws that secure the filter assembly panel to the mounting posts at each corner of this panel and move the filter assembly sufficiently to permit removal of the four screws holding the crystal control unit to the chassis. When these screws are removed, the unit may be taken from the receiver. In removing the unit and in subsequently handling it, be careful to avoid strain on the delta C shaft, or the delta C capacitor may be damaged. Remove the four screws holding each of three sides of the cover and spring the two top ends of the cover enough to make the flanges clear the top of the box. Hold these flanges apart to prevent their edges from damaging the RF chokes in the unit while sliding the cover off the crystal unit box. When the unit is to be replaced, follow the reverse of the above procedure. Follow the procedure under Crystal Switch Adjustment to properly reinstall the switch mechanism.

HF Oscillator and RF Coil Assemblies - If faulty operation occurs in only one frequency band of the receiver, the trouble should be found in one of the four coil assemblies for that band in the tuning unit turret. For example: Coil assemblies T13, 19, 25 and 31 should be examined if band 7.4 to 14.8 mc only, does not perform normally.. To remove these coil assemblies stand the receiver on its right or left side and remove the bottom cover plate from the tuning unit. Turn the band change control to place the band in question in its normal operating position and then turn the band change control two and one-half revolutions counter-clockwise. This will place the band coil assemblies parallel and at the bottom of the tuning unit. Now remove the two springs holding one coil assembly in the turret and carefully remove it by sliding it towards you and off the tongues of the shields. It is best to remove only one coil assembly at a time and inspect it for defects or substitute a replacement assembly if available. Caution: Make sure that the coil base is firmly seated and secured by its retaining springs before going to the next assembly or turning the band change control. Failure to do this may damage the switch spring contacts beyond repair. Repeat this procedure until the faulty assembly is found. In checking these assemblies, first check for continuity of the coils, particularly the small primary coils as in the RF Input assemblies, which are liable to damage if the receiver is operated in the presence of very strong transmitter signals. In replacing these coil assemblies be careful that the end of the assembly nearest the coil is toward the front of the receiver.

Mixer Plate Coil Assembly - Trouble in the Mixer Plate Coil Assembly T1, is indicated if the input required at pin 7 of V5 is found to be greatly different than the values shown in Table 4, and the gain from pin 7 of V6 is normal. To obtain access to the components of the mixer plate coil assemblies it is necessary to remove the crystal control unit and the filter assembly as described under Crystal Control Unit. The cover plate and shield of T1 may then be removed for replacement of a defective component. If the entire assembly is to be replaced, it will be necessary to unsolder all of the leads at both the bottom and top terminal boards of the unit. Refer to Figure 11 for components and wiring of T1.

RF Tube Platform - If the receiver fails to perform normally on any of the six frequency bands and the previous tests indicate that performance of the IF and audio frequency amplifiers is normal, (including the gain check in accordance with Table 4 for the input to pin 7 of V5) the fault is indicated to be in the RF Tube Platform or in the main tuning capacitor. Before removing the RF Tube Platform, it is advisable to remove the top shield cover and inspect the main tuning capacitor connections. Refer to Figures 8 and 11. Observe that the tuning capacitor is operating properly when the tuning control is rotated. Using a miniature tube adapter, see Section VI alignment, apply a modulated rf test signal successively to pin 1 of V1 and V2 and to pin 7 of V5. For each of these positions of the adapter and signal, tune through the proper dial setting for the signal frequency used. Gain of the order of 5 or 6 should be indicated for each stage and loss of signal will indicate the section to be investigated for the fault. No signal output, when the input signal is applied to pin 7 of V5, will indicate trouble in the HF oscillator section of the unit. With the covers removed from the tuning capacitor and T1, refer to Figure 11 and unsolder the blue, white-black, red-white, red-green, yellow-black and blue-red leads that come from the tube platform at the top of T1. Unsolder the leads from the tuning capacitor rotors, stators and ground straps at each section. Unsolder the lead from the tube platform at S3. Turn the Band Change control one-half turn from any band position in order to have the band switch contacts disengaged and leave the band switch in this position until the RF tube platform is replaced, otherwise irreparable damage to the switch contacts will occur. Remove the four screws at the corners of the top of the platform and the four screws at the side flange and carefully remove the platform. In handling be careful to prevent damage to the switch contacts of this assembly. When the unit is ready to be replaced, follow the reverse of the above procedure.

Main Tuning Capacitor - If it is necessary to replace the main tuning capacitor, the procedure is as follows: Remove the top cover and unsolder the leads of the capacitor as described under RF tube Platform. Bring the capacitor to full mesh by means of the tuning control. Carefully remove the spring and drive link at the front of the capacitor. Remove the single screw that secures the capacitor frame front plate to the gear plate, looping a piece of small wire around the spacing washer between the capacitor and gear plate. The front capacitor plate is located and held in position by two dowel pins and will not move when the front screw is taken out. Now hold the capacitor by its frame with one hand and remove the rear supporting screw and spacer. The capacitor may now be moved to the rear, to disengage the dowel pins, and lifted from the receiver. Follow the above procedure in reverse when replacing the capacitor.

SECTION VI

ALIGNMENT

The alignment of a modern communications receiver requires precision instruments and a thorough knowledge of the circuits involved. Since this receiver is a double super-heterodyne type, the alignment procedure is even more involved than usual.

Under normal service the receiver will stay in alignment for extremely long periods of time, consequently realignment should not be attempted unless all other possible causes of a particular trouble have been eliminated. When it has been determined that any realignment should be made, a great deal of caution should be exercised in making the adjustments, since any required readjustment should not entail more than a slight angular motion of the adjusting screw.

ALIGNMENT OF THE IF STAGES

The low frequency IF should be aligned first. The recommended method for aligning the low frequency IF involves the use of a sweep frequency signal generator and an oscilloscope. Since these instruments are not available at the average service station the alternate method using an amplitude modulated signal generator and an output meter will be described first. The additional information required for the visual alignment method will be covered in a later paragraph.

The signal generator should be coupled to the grid of the mixer tube V5 through a capacitance of approximately .01 mfd. A miniature tube adapter will be required to make the mixer grid connection available. A suitable adapter, A/N No. CV-49519, is available as Part No. 977 from Alden Manufacturing Co., 117 N. Main Street, Brockton, Mass. An output meter should be connected across the output of the receiver or the speaker voice coil. The receiver controls should now be set as follows:

Control	Position
Selectivity	See text
Send--Receive	Receive
CW--Mod	Mod
Phasing	Arrow
AVC--MAN	Man
Audio Gain	Set for approx. 20 volts output
RF Gain	See text
Band Switch	1.35--3.45 mc
Dial	2.5 mc
BFO-AVC	Int. Bfo fast
IFO	Int.

The signal generator should be modulated 30 percent at 400 cycles. Turn the selectivity switch to the 3 kc position and advance the RF Gain control to maximum. Set the signal generator frequency to 455 kc and adjust its output until some deflection is noted on the output meter. Refer to figure 3 for the location of the various alignment adjustments. Adjust L42, L41, L39, L38, L36, and L32 for maximum output, reducing the signal generator output and the RF Gain control as required to prevent overload or excessive output. Now turn the selectivity switch to the narrowest position, .2 kc, and adjust the signal generator frequency for the maximum output. This establishes the correct signal frequency by the 455 kc crystal for the IF amplifier and the frequency of the signal generator should not be disturbed for the remainder of the low frequency i.f. alignment, unless it should be to re-check this establishment of crystal frequency to make sure that the signal generator frequency has not drifted during the alignment. The selectivity switch is now turned to the 3 kc position and L42, L41, L39, L38, L36 and L32 are again adjusted for maximum output. Before changing this set-up the BFO should be turned on by throwing the CW-Mod switch to CW and checked for zero beat with the BFO knob dial at its zero reading. If necessary L44 should be adjusted for zero output. This check and adjustment of the BFO should be done with the signal generator carrier unmodulated.

The Procedure for the visual method of aligning the low frequency IF, using the double image system, should be the same as the above except that the adjustments are made for both maximum amplitude and coincidence of the oscilloscope images. The oscilloscope vertical input should be connected across the diode detector load resistance, from the junction of R64 and R65 to chassis.

The high frequency IF should be aligned next. Set the band switch to the 7.4--14.8 mc band. The selectivity switch should be in the 3 kc position. Adjust the signal generator frequency to 3.955 mc and adjust L31, L33, and L34 for maximum output.

The 3.5 mc crystal used in the second conversion oscillator circuit is held to a very close frequency tolerance and may be used as a frequency standard at multiples of 3.5 mc from 10.5 mc upwards. In order to do this, in view of the complete shielding against radiation from this oscillator, it will be necessary to temporarily connect a two foot length of insulated wire to the antenna terminal and dress the free end of this lead around the tube shield on the 3.5 mc oscillator tube V8. This test should, of course, be removed except while in use as a frequency standard.

ALIGNMENT OF THE RF AMPLIFIER & HF OSCILLATOR

To adequately align the RF Amplifier and HF Oscillator an accurately calibrated signal generator and an output meter are required. The frequencies required are shown in table 3. The location of the adjustments is shown in Figure 3. The use of Table 3 and Figure 3 should be made in following this part of the alignment which will now be described for one frequency band. The same procedure should then be followed for the other frequency bands.

To align the .54-1.35 mc band the signal generator is coupled to the antenna input terminal through a 100-ohm carbon resistor. The generator should be modulated 30 percent at 400 cycles and the output meter connected across the receiver output terminals. The receiver controls should be set as follows:

Control	Position
Selectivity	3 kc
Send-Receive	Receive
CW-Mod	Mod
AVC-Man	See Text
Audio Gain	Set for approx. 20 volts output
RF Gain	See text
Band Switch	Set for band to be aligned
Limiter	Off
HFO	Var

Set the receiver and signal generator dials to .56 mc. The RF Gain control should be set at maximum and the AVC-MAN switch set on AVC. The HF Osc. L adjustment shown in Figure 3, should now be set for maximum output. Then the Ant., 1st RF and 2nd RF L adjustments should be set for maximum output. The receiver and signal generator dials are now set to 1.3 mc and the C adjustments, shown in Figure 3, should be adjusted for maximum output in the same order, beginning with the Osc C adjustment and then making the C adjustments for the Ant, 1st RF and 2nd RF. This procedure should be carefully repeated until no increase in output can be realized. The AVC-MAN switch should then be set to MAN and the signal generator should be set for approximately 3 micro volts. The L and C adjustments should now be checked for maximum output, adjusting the RF Gain control as found necessary to maintain the output at approximately 20 volts.

Following the frequencies, shown in Table 3, align the remaining bands using the same procedure as above.

TUBE SOCKET VOLTAGES-TABLE 1

Voltage to chassis. Measurements made with Weston Model 663 Volt-Ohmmeter, except those indicated by asterisk were made with Measurements Corp. Model 62 VTVM. The 500 volt scale was used for all voltages above 10 volts and the 10 volt scale for voltages below 10 volts. Line voltage 117, no signal input. Audio Gain control at minimum and CW-MOD switch on "CW".

TUBE	SOCKET Pin Numbers 1	2	3	4	5	6	7	8	9	Mode of Operation
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, external 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

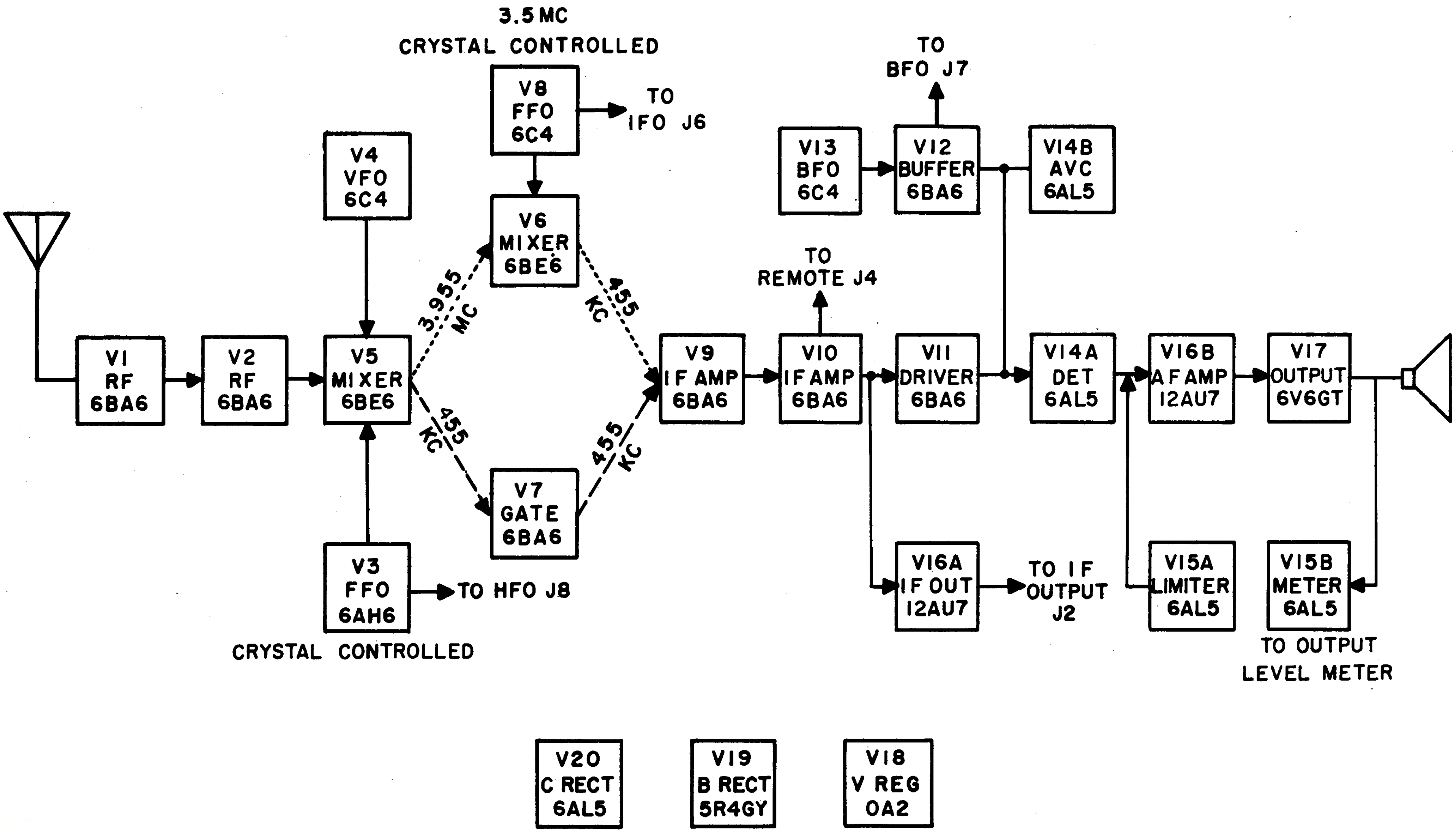
TUBE	SOCKET Pin Numbers 1	2	3	4	5	6	7	8	9	Mode of Operation
V7	-54	-	6.3ac	-	265	0	0	-	-	r-f gain min, freq above 7.4 mc
V8	0	-	6.3ac	-	-	-	-	-	-	freq below 7.4 mc, i-f-o switch at internal.
V8	75	-	6.3ac	-	75	-17	-	-	-	freq above 7.4 mc, i-f-o switch at internal
V9	-1	-	6.3ac	-	205	90	-	-	-	r-f gain 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
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

TUBE SOCKET TERMINAL RESISTANCE-TABLE 2

Resistance to chassis. Measurements made with Weston Model 663 Volt-Ohmmeter.

Tube removed from socket under measurement. Audio Gain Control at maximum, RF Gain Control at minimum. Limiter Switch "OFF". CW-MOD Switch on "CW". AVC-MAN Switch on "AVC".

Tube	Socket Pin Numbers									Mode of Operation
	1	2	3	4	5	6	7	8	9	
V1	1800K	0	-	0	16.7K	50K	0	-	-	
V2	1800K	0	-	0	16.7K	50K	0	-	-	
V3	23K	0	-	-	15K	17K	0	-	-	Crystal freq control positions 1-6
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 operation
V5	47K	150	-	0	19K	22K	26K	-	-	
V6	22K	0	-	0	17.4K	infinity	1100K	-	-	freq bands below 7.4 mc
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
V8	infinity	infinity	2	0	62 K	9.5K	0	-	-	freq bands above 7.4 mc, i-f-o switch at internal
V8	infinity	infinity	2	0	infinity	9.5K	0	-	-	freq bands above 7.4 mc, i-f-o switch at external
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	-	-	



——— Signal path common to all frequencies
— — — Signal path for frequencies above 7.4 mc
- - - - - " " " " below 7.4 mc

FIG. 2
BLOCK DIAGRAM

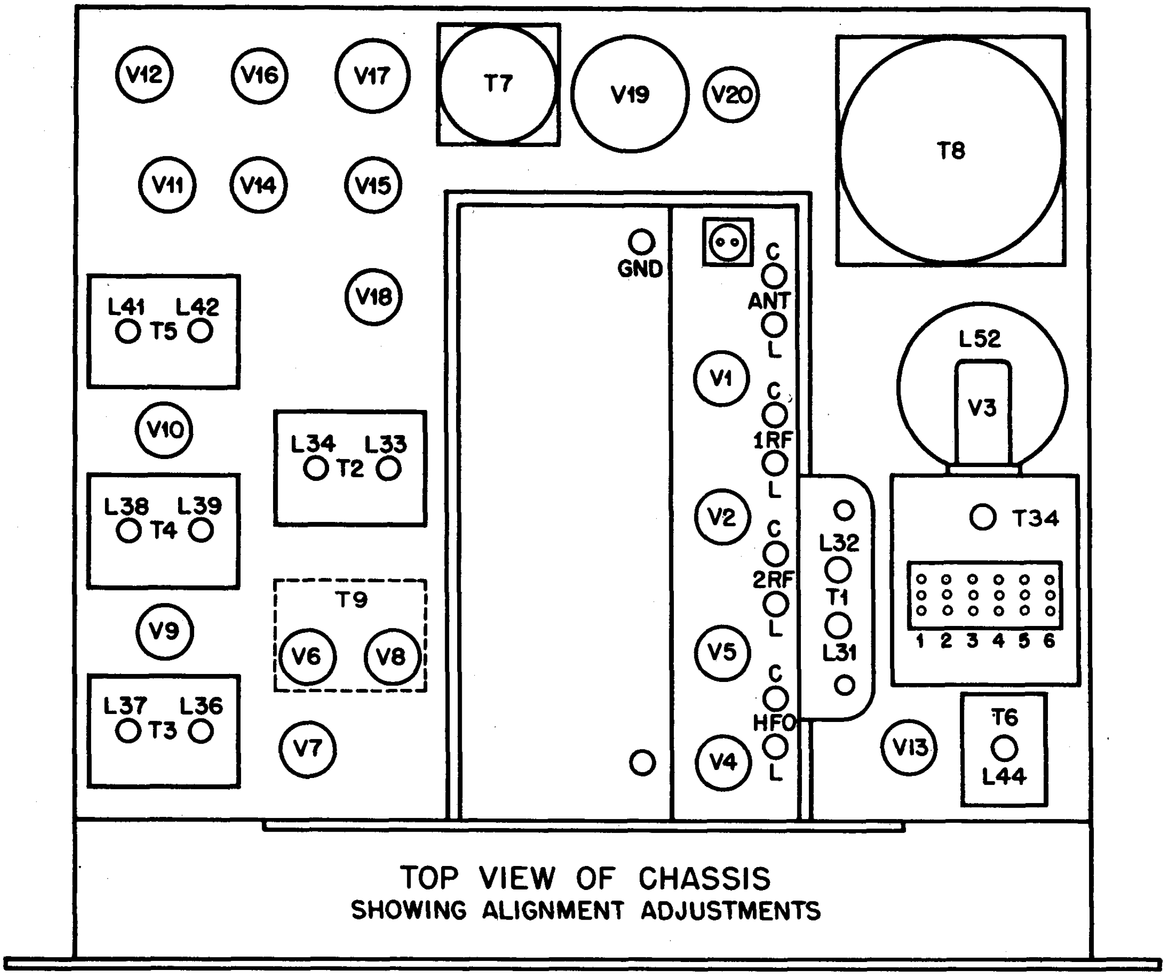


FIG. 3

•AUDIO AND OVERALL FIDELITY CURVES•

SOLID CURVE is the fidelity of the audio frequency amplifier with input applied between terminal 3 of R84 (Figure 10) 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.

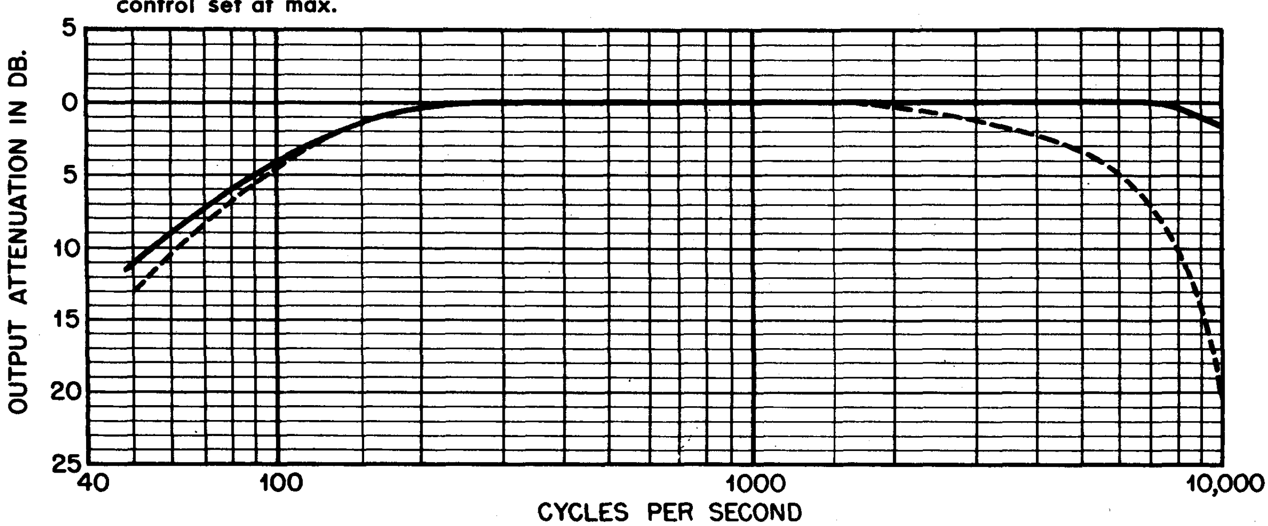


FIG. 4

TABLE No. 3

RF AND HF OSCILLATOR ALIGNMENT FREQUENCIES AND ADJUSTMENT DESIGNATIONS

FREQ. BAND IN MC	.54—1.35	1.35—3.45	3.45—7.4	7.4—14.8	14.8—29.7	29.7—54.0
RF & HF OSC ADJUST L AT.	.56	1.4	3.75	7.5	15.0	30.0
RF & HF OSC ADJUST C AT.	1.3	3.4	7.15	14.5	29.0	52.0

TABLE No. 4

APPROXIMATE SIGNAL INPUT AT IF & AF STAGES FOR 20 VOLTS OUTPUT

Output measured across a 600 ohm resistive load at output terminals of receiver. RF signals modulated 30 percent at 400 cycles. Signals applied to tube grids through a .01 mfd capacitor. Selectivity switch at 3 kc AVC — MAN switch on MAN. CW — MOD switch on MOD, RF Gain and Audio Gain at maximum.

BAND SWITCH	FREQUENCY	INPUT TO	APPROX. INPUT
Any	Audio 400 cycles	Pin 5, V17	5.5 volts
Any	Audio 400 cycles	Pin 2, V16B	.5 volts
1.35—3.45 mc	Mod RF 455 kc	Pin 1, V11	.6 volts
1.35—3.45 mc	Mod RF 455 kc	Pin 1, V10	15000 microvolts
1.35—3.45 mc	Mod RF 455 kc	Pin 1, V9	300 microvolts
1.35—3.45 mc	Mod RF 455 kc	Pin 1, V7	75 microvolts
1.35—3.45 mc	Mod RF 455 kc	Pin 7, V5	90 microvolts
7.40—14.8 mc	Mod RF 3.955 mc	Pin 7, V5	70 microvolts
7.40—14.8 mc	Mod RF 3.955 mc	Pin 7, V6	100 microvolts

• SELECTIVITY CURVES
Overall at 2 Megacycles •

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

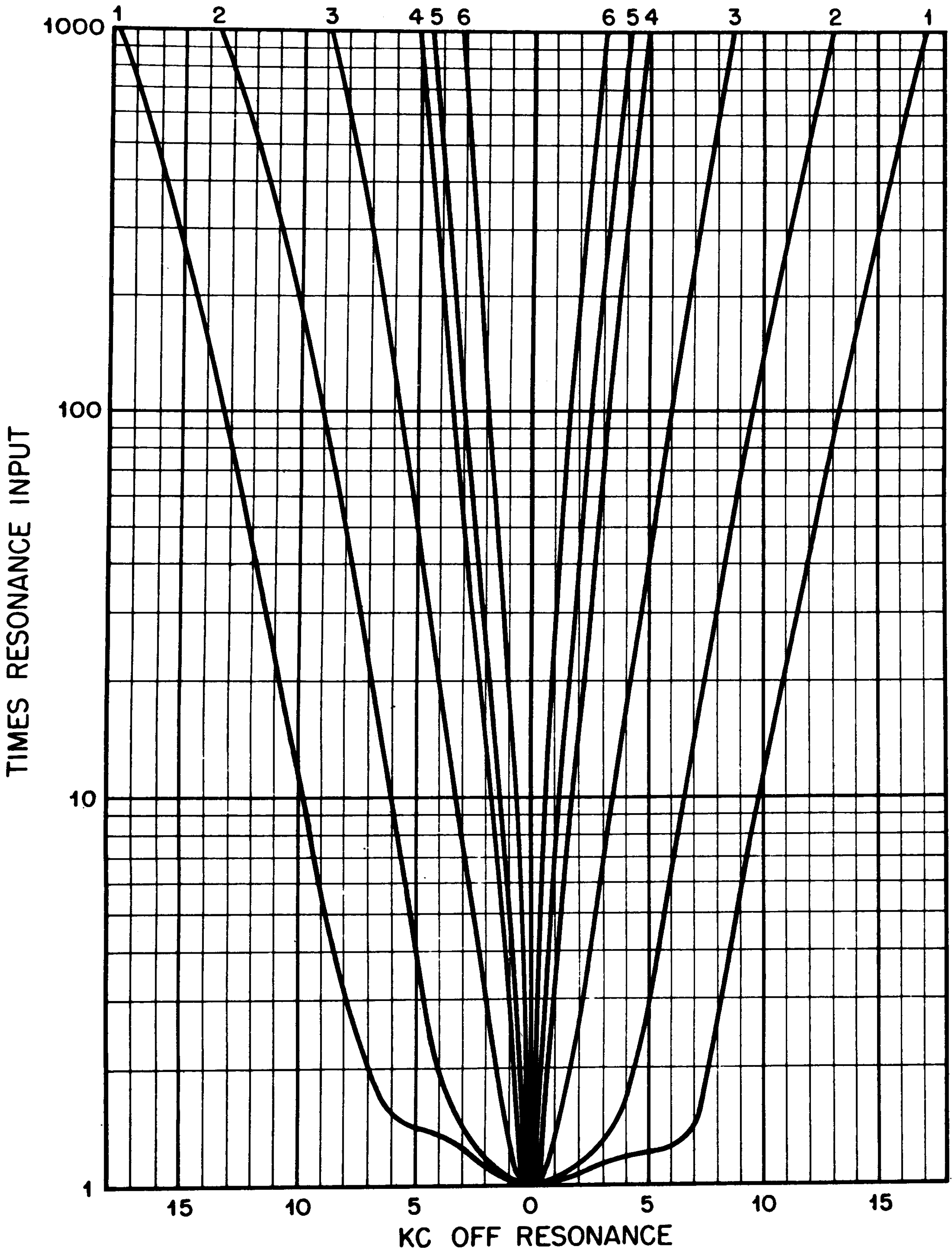
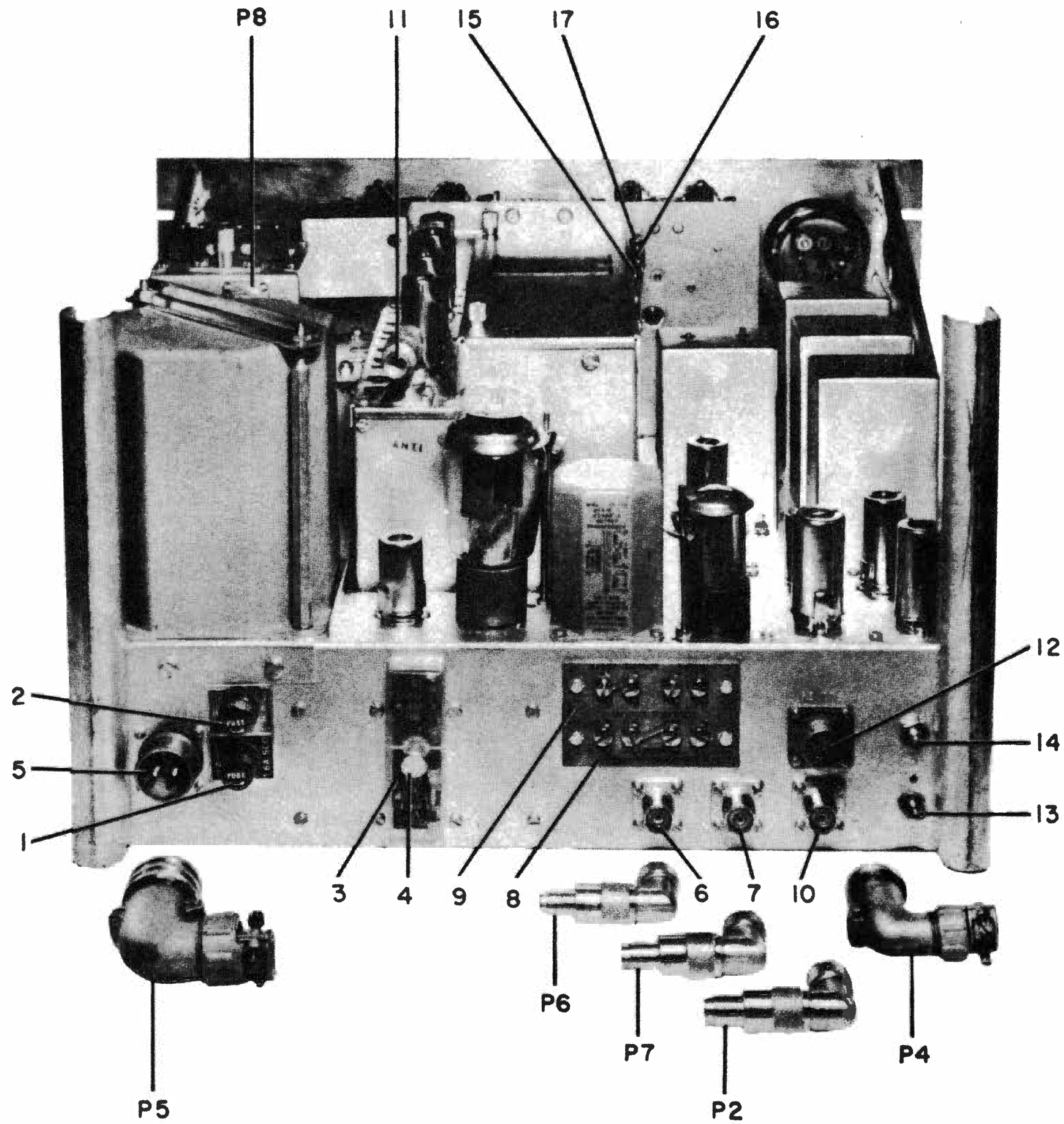


FIG. 5



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

P2, P4, P6 & P7 Optionally supplied to non-service users.

Figure 6. Radio Receiver, Rear View of Chassis

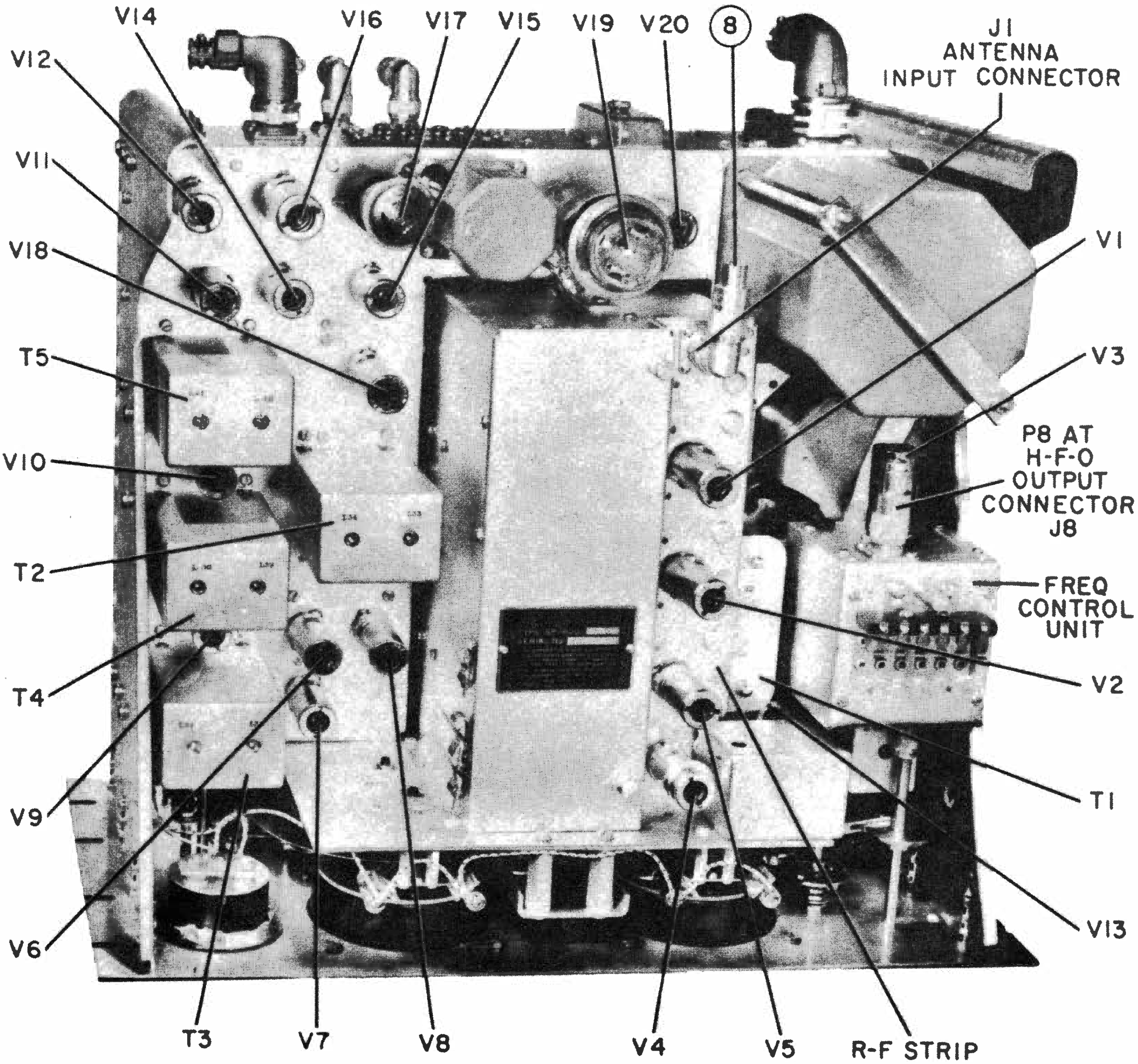


Figure 7. Radio Receiver, Top View of Chassis

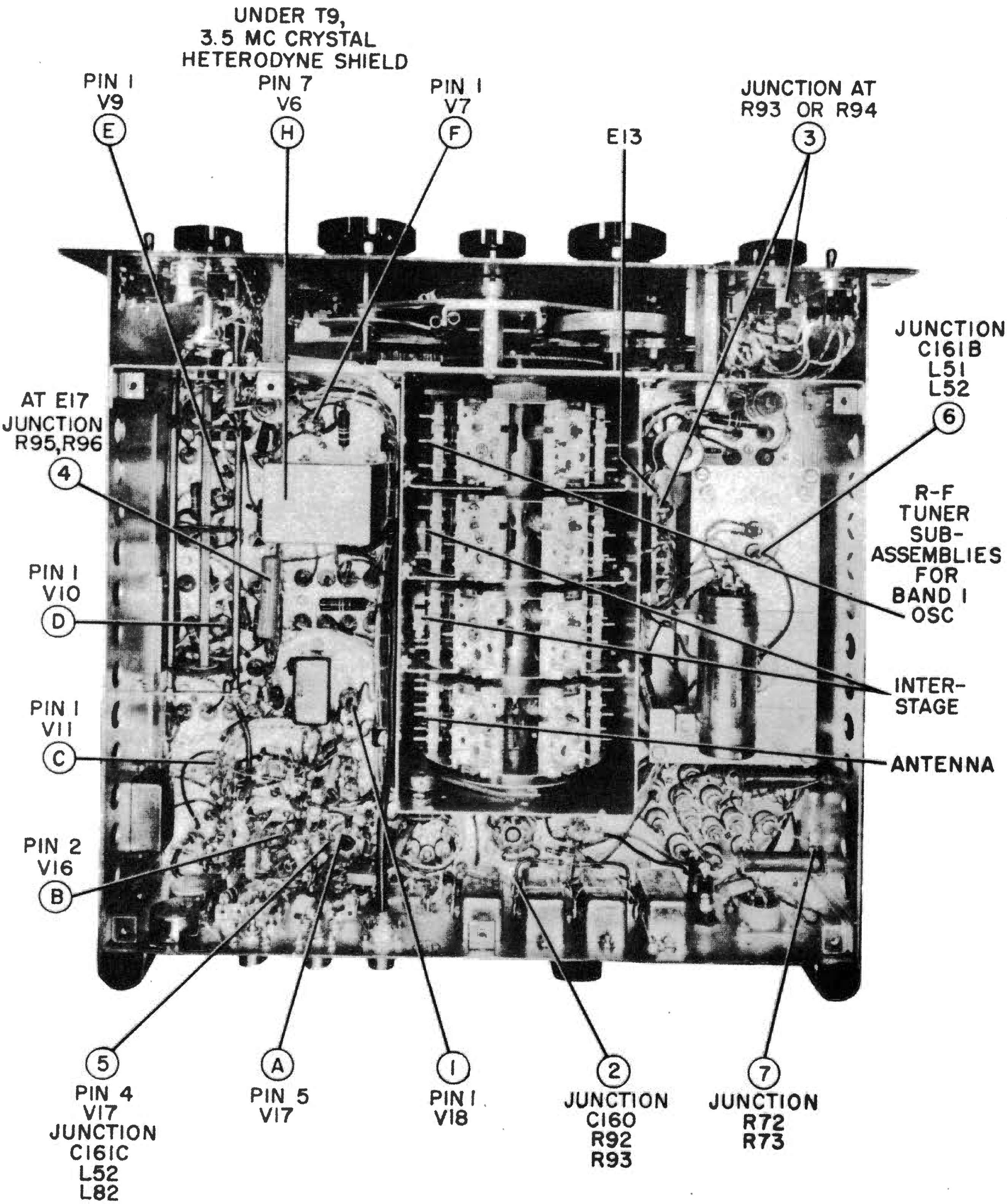


Figure 8. Radio Receiver, Parts Identification for Locating Test Points

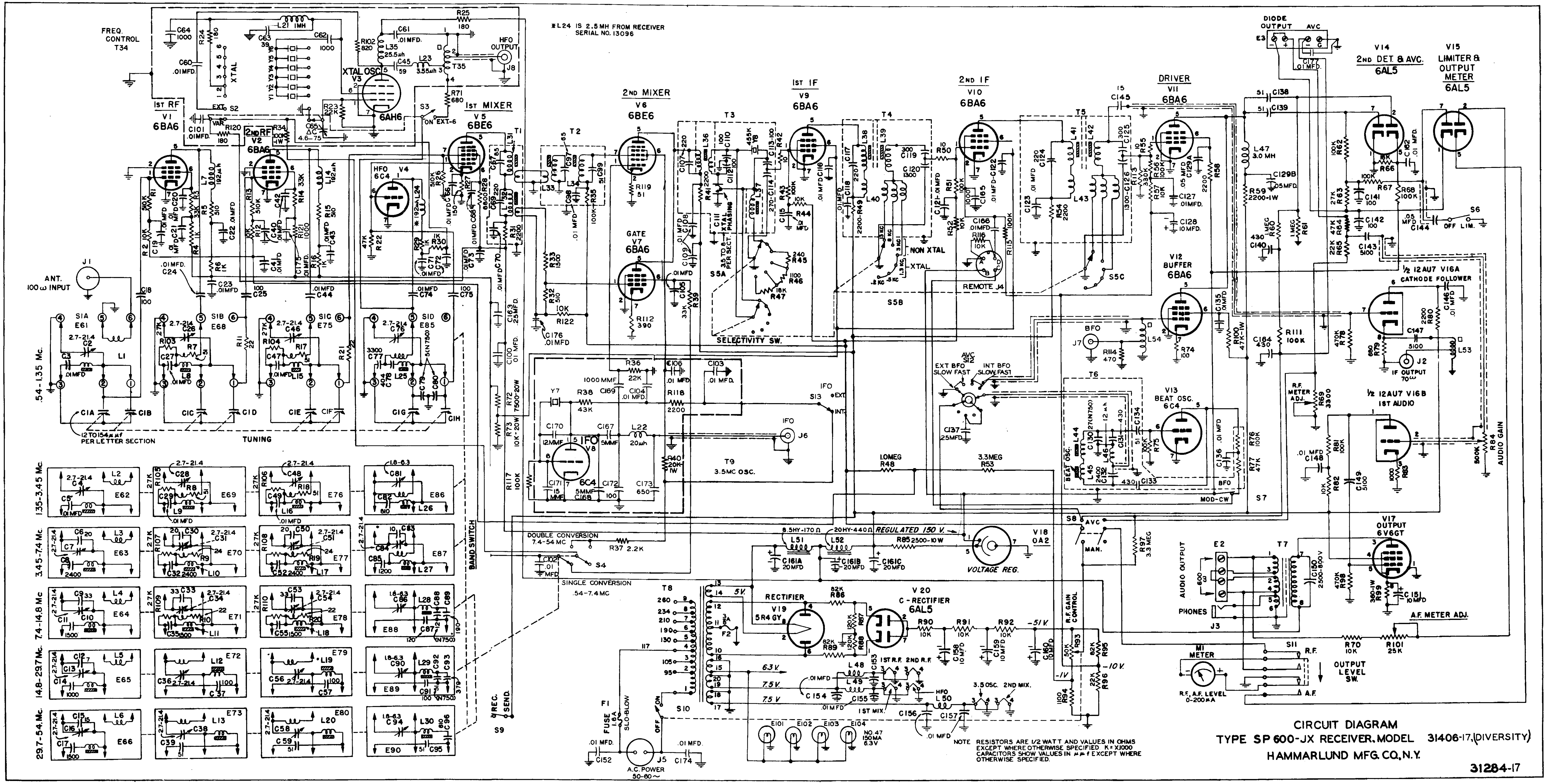
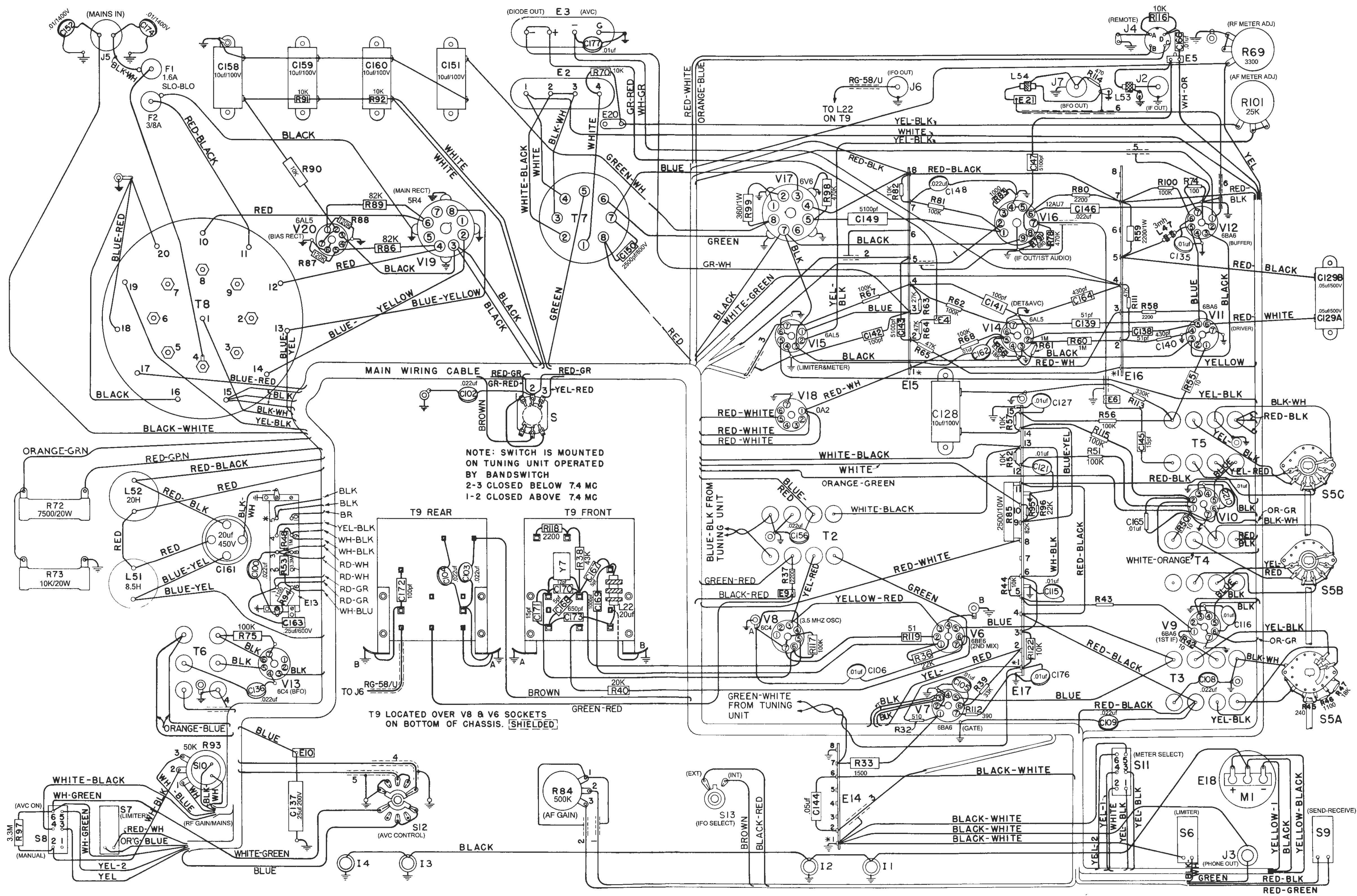


FIG. 9

CIRCUIT DIAGRAM OF RECEIVER



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

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 ELECTRICAL WIRE IS OF AWG SIZE NO. 22 (BBR NOS. 1425 OR 1426). THE SHIELDED INSULATED CABLE IS OF AWG SIZE NO. 24 AND HAS 16, NO. 36 STRANDS (ALPHA NO. 1248-PL). THE COAXIAL CABLE (RG-58/U) IS AS PER JAN-C-17.

FIG. 10

CONNECTION DIAGRAM - RECEIVER CHASSIS

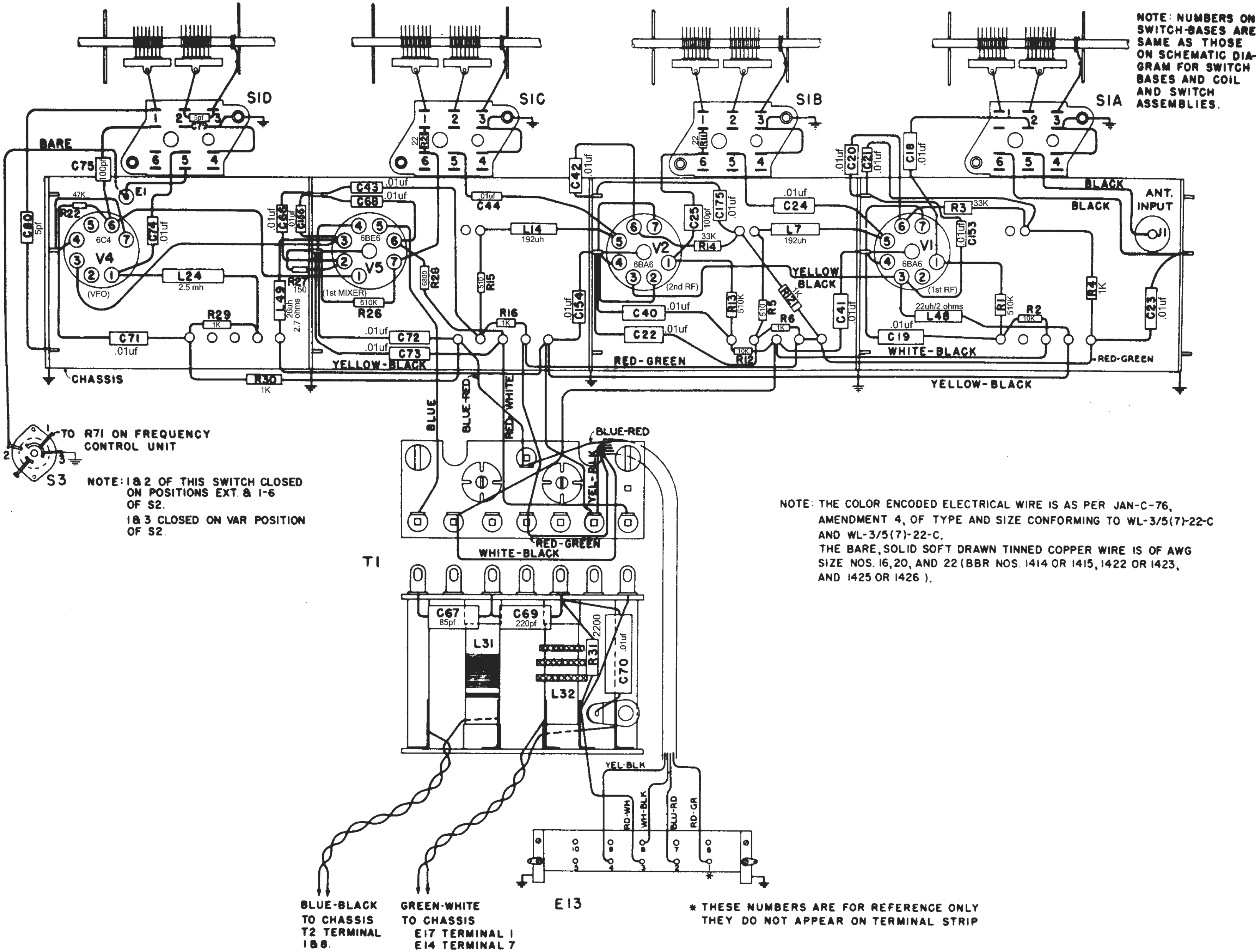
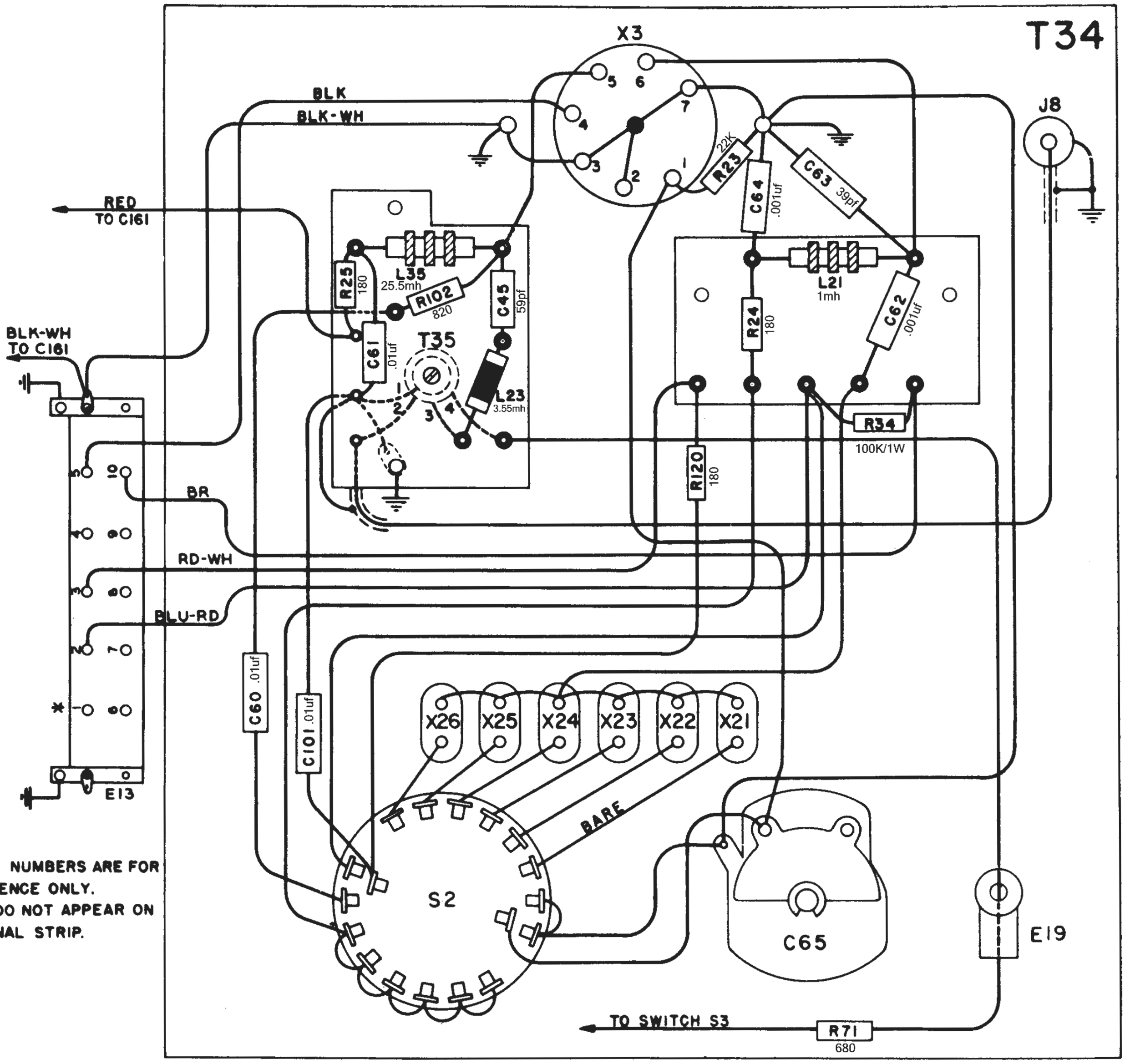


Figure 11. Radio Receiver, Tuning Unit Connection Diagram



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

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 12. Radio Receiver, Frequency Control Unit Connection Diagram

Symbol Designations	Description	Hammarlund Part No.
C1A to H	Capacitor, Variable, 8 sections	34001-G1
C3,C5,C19-C24 C27,C29,C40,C44 C47,C49,C60,C61 C66,C68,C70-C74 C101,C105,C115,C116 C121,C122,C127,C135 C153-C155,C166 C175,C176	Capacitor, .01 mfd	23034-19
C6,C30,C50	Capacitor, 20 mmf	23003-41C
C8,C32,C52,C132	" 2400 mmf	23011-40C
C9,C33,C53	" 33 mmf	23003-45C
C11,C17,C35,C55	" 1500 mmf	23011-62C
C12	" 7 mmf	23061-168F
C14,C62,C64,C165 C169	" 1000 mmf	23011-58C
C15,C145,C171	" 15 mmf	23061-155J
C18,C25,C37,C57 C75,C91,C110,C112 C113	" 100 mmf	23003-94C
C39,C59,C95 C99,C134	" 51 mmf	23003-87C
C45	" 59 mmf	23071-72
C63	" 39 mmf	23003-47C
C65	" Variable	11726-G109
C67	" 85 mmf	23071-59
C69,C107,C117 C124	Capacitor, 220 mmf	23003-102C
C77	" 3300 mmf	23011-69C
C78	" 404 mmf	23071-67
C79,C80,C167 C168	" 5 mmf	23023-8UJ
C82	" 810 mmf	23072-53
C83	" 10 mmf	23003-2B
C85	" 1200 mmf	23011-60C
C87	" 120 mmf	23071-50
C88,C170	" 12 mmf	23023-65UJ
C89	" 190 mmf	23071-64
C92,C138,C139	" 51 mmf	23023-45UJ
C93	" 379 mmf	23071-63
C96	" 610 mmf	23072-52
C97	" 65 mmf	23071-58
C98,C100,C102-C104,C106,C108 C109,C118,C123 C136,C146,C148 C156,C157,C162	" .01 mfd	23034-19
C111	" Variable	11776-G1
C114	" 270 mmf	23003-104C
C119,C125	" 300 mmf	23003-105C
C120,C126	" 1300 mmf	23011-61C
C128,C151,C158 C159-C160	Capacitor, 10 mfd, 100V HS Can, Electrolytic	15462-1
C129A,B	Capacitor, 2x.05 mfd HS Can, Paper	15461-1

Symbol Designations	Description	Hammarlund Part No.
C130	Capacitor, 27 mmf	23023-71UJ
C131,C133	" 430 mmf	23003-109C
C137	" .25 mfd, 200V	23911-79E
C140,C164	" 430 mmf	23003-109C
C141,C142	" 100 mmf	23024-24SL
C143,C147,C149	" 5100 mmf	23015-16A
C144	" .05 mfd	23911-77E
C150	" 2500 mmf, 800V	23070-40
C152,C174,C177	" .01 mfd, 1400 V	23034-26
C161A,B,C	" 320 mfd, 450V, HS Can, Electrolytic	15463-1
C163	Capacitor, .25 mfd, 600V	23915-1
C172	" 100 mmf	23003-94
C173	" 650 mmf	23071-73
E1	Insulator, Bushing	16619-5
E2	4 Screw Terminal, Audio Output	31141-1
E3	4 Screw Terminal, Diode and AVC	31480-1
E4	1 Solder Terminal Strip (left)	16650-9
E5	2 Solder Terminal Strip	16650-12
E6-E10	1 Solder Terminal Strip (right)	16650-11
E11	9 Post Terminal Board	33914-G1
E12	7 Post Terminal Board	33915-G1
E13	10 Post Terminal Board	33928-2
E14	6 Solder Terminal Strip	16650-10
E15-E16	8 Solder Terminal Strip	31163-G1
E17	15 Solder Terminal Strip	31162-G1
E18	3 Solder Terminal Strip (meter)	31454-G1
E19	Insulator, feed-thru	31482-1
E61	RF Tuner, includes C2,C3,L1 and switch contacts for S1A	31387-G1
E62	RF Tuner, includes C4,C5,L2 and switch contacts for S1A	31390-G1
E63	RF Tuner, includes C6,C7,C8,L3 and switch contacts for S1A	31393-G1
E64	RF Tuner, includes C9,C10,C11,L4 and switch contacts for S1A	31396-G1
E65	RF Tuner, includes C12,C13,C14,L5 and switch contacts for S1A	31399-G1
E66	RF Tuner, includes C15,C16,C17,L6 and switch contacts for S1A	31405-G1
E68	RF Tuner, includes C26,C27,L8,R7,R103 and switch contacts for S1B	31386-G1
E69	RF Tuner, includes C28,C29,L9,R8,R105 and switch contacts for S1B	31389-G1
E70	RF Tuner, includes C30,C31,C32,L10, R9,R107, and switch contacts for S1B	31392-G1
E71	RF Tuner, includes C33,C34,C35,L11, R10,R109, and switch contacts for S1B	31395-G1
E72	RF Tuner, includes C36,C37,L12 and switch contacts for S1B	31398-G1
E73	RF Tuner, includes C38,C39,L13 and switch contacts for S1B	31404-G1
E75	RF Tuner, includes C46,C47,L15,R17, R104 and switch contacts for S1C	31386-G1
E76	RF Tuner, includes C48,C49,L16,R18, R106 and switch contacts for S1C	31389-G1

Symbol Designations	Description	Hammarlund Part No.
E77	RF Tuner, includes C50,C51,C52,L17,R19 R108 and switch contacts for S1C	31392-G1
E78	RF Tuner, includes C53,C54,C55,L18,R20 R110 and switch contacts for S1C	31395-G1
E79	RF Tuner, includes C56,C57,L19 and switch contacts for S1C	31398-G1
E80	RF Tuner, includes C58,C59,L20 and switch contacts for S1C	31404-G1
E85	RF Tuner, includes C76,C77,C78,L25 and switch contacts for S1D	31385-G1
E86	RF Tuner, includes C81,C82,L26 and switch contacts for S1D	31388-G1
E87	RF Tuner, includes C83,C84,C85,L27 and switch contacts for S1D	31391-G1
E88	RF Tuner, includes C86,C87,C88,C89,L28 and switch contacts for S1D	31394-G1
E89	RF Tuner, includes C90,C91,C92,C93 L29 and switch contacts for S1D	31397-G1
E90	RF Tuner, includes C94,C95,C96,L30 and switch contacts for S1D	31403-G1
E101-E104	Dial Lamp, No. 47 Mazda	16004-1
F1	Fuse, 1.6A Fusetron	15893-1
F2	Fuse, 3/8 Amp	15928-13
J1,J2,J6-J8	Connector Socket,ANT,IF,IFO,BFO, and HFO	16111-1
J3	Phone Jack	5066-1
J4	Connector Socket, remote	15991-4
J5	Connector Socket, power	15966-2
L7,L14,L35	RF Choke, 192 Microhenrys	15612-G1
L21	RF Choke, 1 millihenry	15617-G1
L22	RF Choke, 20 Microhenrys	15621-1
L23	RF Choke, 3.55 Microhenrys	15623-1
L24	RF Choke, 2.5 Millihenrys	15627-1
L35	RF Choke, 25.5 Microhenrys	15622-1
L46	RF Choke, 12 Microhenrys	15615-2
L47	RF Choke, 3.0 Millihenrys	15616-G1
L48	RF Choke, 2 ohms DC	15611-1
L49,L50	RF Choke, 2.7 ohms DC	15613-1
L51	1st Filter Choke, 8.5 Hy, 170 ohms DC	31030-2
L52	2nd Filter Choke, 20 Hy, 440 ohms DC	31031-2
L53,L54	If Automtransformer, If output & BFO External	31488-1
M1	Tuning meter	4903-2
P1,P2,P6-P8	Connector plug, ANT,IF,IFO,BFO, and HFO	16071-1
	Connector (for P1,P2,P6,P7)	16112-1
	Adapter, reducer (for P1,P2,P6-P8)	16642-1
P4	Connector plug, remote	16188-1
	Clamp, Cable (for P4)	16120-3
P5	Connector Plug, power clamp	16189-1
	Cable (for P5)	16120-5
R1,R13,R26	Resistor, 510K, 1/3 watt	19317-76BF

Symbol Designations	Description	Hammarlund Part No.
R2,R12,R44,R52 R57,R70,R82 R90-R92,R116 R122	Resistor, 10K, ½ watt	19309-278BF
R3,R14,R39	Resistor, 33K, ½ watt	19309-282BF
R4,R6,R16,R29 R30,R83,R121	Resistor, 1K, ½ watt	19309-49BF
R5,R15,R32	Resistor, 510 ohms, ½ watt	19309-170BF
R7,R8,R17,R18 R119	Resistor, 51 ohms, ½ watt	19309-193BF
R9,R19	Resistor, 24 ohms, ½ watt	19309-189BF
R10,R11,R20,R21	Resistor, 22 ohms, ½ watt	19309-9BF
R22,R64,R65,R77	Resistor, 47K, ½ watt	19309-89BF
R23	Resistor, 22K, ½ watt	19309-178BF
R24,R25,R120	Resistor, 180 ohms, ½ watt	19309-31BF
R27	Resistor, 150 ohms, ½ watt	19309-31BF
R28	Resistor, 6800 ohms, ½ watt	19309-69BF
R31,R37,R41,R49 R54,R58,R80 R118	Resistor, 2200 ohms, ½ watt	19309-57BF
R33	Resistor, 1500 ohms, ½ watt	19309-53BF
R34	Resistor, 100K, 1 watt	19310-191
R35,R43,R51 R56,R62,R67 R68,R75,R76,R81 R100,R115,R117	Resistor, 100K, ½ watt	19309-97BF
R36,R96	Resistor, 22K, ½ watt	19309-178BF
R38	Resistor, 43K, ½ watt	19309-222
R40	Resistor, 20K, 1 watt	19310-179BF
R42,R50,R55	Resistor, 10 ohms, ½ watt	19309-1BF
R45	Resistor, 240 ohms, ½ watt	19309-201BF
R46,R94	Resistor, 1100 ohms, ½ watt	19309-208BF
R47,R66	Resistor, 18K ½ watt	19309-79BF
R48,R60,R61	Resistor, 1 megohm, ½ watt	19309-121BF
R53,R97	Resistor, 3.3 megohms, ½ watt	19309-133BF
R59	Resistor, 2200 ohms, 1 watt	19310-57BF
R63,R103,R110	Resistor, 27K, ½ watt	19309-83BF
R69	Resistor, Variable, 3300 ohms	15366-1
R71,R79	Resistor, 680 ohms, ½ watt	19309-45BF
R72	Resistor, 7500 ohms, 20 watt	19397-41
R73	Resistor, 10K, 20 watt	19397-43
R74	Resistor, 100 ohms, ½ watt	19309-167
R78,R98	Resistor, 470K, ½ watt	19309-113BF
R84	Resistor, Variable, 500K	15342-11
R85	Resistor, 2500 ohms, 10 watt	19396-1
R86,R89,R95	Resistor, 82K, ½ watt	19309-287BF
R87,R88	Resistor, 120K, ½ watt	19309-181BF
R93	Resistor, Variable, 50K includes switch S10	15342-21
R99	Resistor, 360 ohms, 1 watt	19310-211BF
R101	Resistor, Variable, 25K	15342-4
R102	Resistor, 820 ohms, ½ watt	19309-266
R111	Resistor, 47K, ½ watt	19309-284BF
R112	Resistor, 390 ohms, ½ watt	19309-162BF

Symbol Designations	Description	Hammarlund Part No.
R113	Resistor, 330K, ½ watt	19309-241BF
R114	Resistor, 470 ohms, ½ watt	19309-169BF
S1A,B,C,D	Switch base and spring assembly	31234-G1
S2	Crystal Selector Switch, rotary	15879-2
S3	Crystal switch, rotary	31469-1
S4	Switch, conversion	15862-2
S5A,B,C	Selectivity Switch, Rotary	15856-1
S6,S7,S9	Toggle Switch SPST	15864-1
S8	Toggle Switch, DPDT	15867-1
S10	Switch "ON-OFF" part of R93	-
S11	Switch, DPDT, Spring return	15880-1
S12	Switch, BFO-AVC, Rotary	31469-3
S13	Switch, IFO, Rotary	31469-2
T1	IF Transformer, mixer plate, 455KC and 3,955 kc (with shield can) includes C67,C69,C70,L31,L32,R31	31183-G1
T2	IF Transformer, 3,955 kc (with shield can) includes C97,C98,C99,L33,L34,R35	31116-G2
T3	IF Transformer, Crystal filter (with shield can) includes C107,C110,C111, C112,C113,C114,L36,L37,R41,& Y8	31114-G2
T4	IF Transformer, 455KC (with shield can) includes C117,C118,C119,C120,L38,L39, L40,R49	31102-G2
T5	IF Transformer, 455KC, (with shield can) includes C123,C124,C125,C126,L41,L42,L43, R54	31102-G2
T6	Oscillator Subassembly, BFO (with shield) can) includes C130,C131,C132,C133,C134, L44,L45,L46,R76,R77	31106-G1
T7	AF Transformer, audio output	31086-2
T8	Power Transformer	31029-2
T9	Oscillator Subassembly, 3.5mc, includes C103,C104,C167,C168,C169,C170,C171,C172 C173,L22,R38,R40,R118,Y7	31131-G2
T34	Oscillator Subassembly, Frequency control unit, includes V3,P8,R23,R24,R25,R34,R71, R120,C45,C60,C61,C62,C63,C64,C65,C101,E11, E12,E19,L21,L23,L35,T35,S2,J8,X21,X22,X23 X24,X25,X26,X3	31409-2
T35	RF Transformer, autotransformer, 2 taps	33922-G1
X1-X3,X6-X15 X18-X20	Tube socket, miniature	15984-4
X4	Tube socket, miniature ceramic, less center shield	15989-5
X5	Tube socket, miniature ceramic, with center shield	15989-3
X16	Tube socket, noval	16100-1
X17,X19	Tube socket, octal	16082-1
X21-X26	Crystal socket, ceramic for crystals Y1 to Y6	16092-5
Y1-Y6	Crystal Unit Cr-18/U, see note below	31473-spec
Y7	Crystal, 3.5 mc	31130-1

Symbol Designations	Description	Hammarlund Part No.
Y8	Crystal, 455 kc	31471-1
Miscellaneous	Button, plug	29619-2
	Chart, plastic, front panel	31463-1
	Core, adjustable tuning (red lacquer end)	31013-1
	Coupling, Flexible, stiff	415-G2
	Coupling, Flexible, soft	415-G3
	Cover, fuse, spare	31494-1
	Coupling, rigid	31275-G1
	Dial Lamp Socket Assembly	31453-1
	Dial, band indicator	31201-G1
	Dial, Main	31438-1
	Dial, Vernier	31439-1
	Dial, with knob (RF Gain)	31227-G1
	Dial, with knob (Audio Gain)	31227-G2
	Dial, with knob (Crystal Phasing)	31227-G3
	Dial, with knob (Beat Frequency Osc.)	31227-G4
	Dial, with knob (Selectivity)	31227-G5
	Glass, Main or Vernier dial	31281-1
	Glass, band indicator	31282-1
	Holder, fuse	15923-1
	Knob (Tuning lock)	31462-G1
	Knob, black (Δ Freq)	31434-G1
	Knob, red (IFO,BFO-AVC,XTALS)	31434-G2
	Knob (Tuning, Band Change)	31215-G1
	Packing, for top cover	31477-1
	Retainer, tube, includes small top hat	16141-2
	Retainer, tube includes large top hat	16140-2
	Screw, captive, spare fuse cover	31495-1
	Shell, hood for J6	16641-1
	Spring, anti-backlash, spider	31239-1
	Spring, Band Change Detent	31205-1
	Spring, Conversion Switch	31125-1
	Spring, Crystal Retaining	31417-1
	Spring, IF adjuster grounding	31023-1
	Spring, Indicator Slide	31126-1
	Spring, Retainer for RF Coils	31004-1
	Spring, Retainer for RF Tuners	31003-1
	Spring, turret rotor end play	31278-1
	Wrench, Set Screw No. 6	11806-2
	Wrench, Set Screw No. 8	11806-3
	Wrench, Set Screw No. 10	11806-4

NOTE: Crystals supplied on special order, per Hammarlund Specification No. 31473, for use in the Crystal Frequency Control Unit, see page 8, shall be made in accordance with Signal Corps Specification CR-18/U. The frequency tolerance shall be within plus or minus .005%. The holder shall be in accordance with HC-6/U or CR-7.

The Signal Frequency for which the crystal is to be used shall be stamped on the top of the holder.

The oscillator or actual crystal frequency for a given signal frequency shall be determined from the following:

Signal Frequency MC	Add IF Frequency MC	Mode of Operation
00.75000 to 07.39999	0.455000	Fundamental
07.40000 on 3.45 to 7.40 band	0.455000 (see note below)	Fundamental
07.40000 on 7.40 to 14.8 band	3.955000 (see note below)	Fundamental
07.40001 to 12.04499	3.955000	Fundamental
12.0450 to 44.04499	3.955000 and divide sum by 3	3rd Harmonic
44.0450 to 54.00000	3.955000 and divide sum by 4	4th Harmonic

NOTE: Since 7.40 mc is the signal frequency at which the intermediate frequency is changed for double conversion and since this signal frequency occurs at the high frequency end of the 3.45 to 7.40 mc band and also at the low frequency end of the 7.40 to 14.8 mc band, it is necessary to specify frequency band as well as Signal Frequency when ordering crystals for exactly 7.40 mc signal operation.

13755
65166

63183