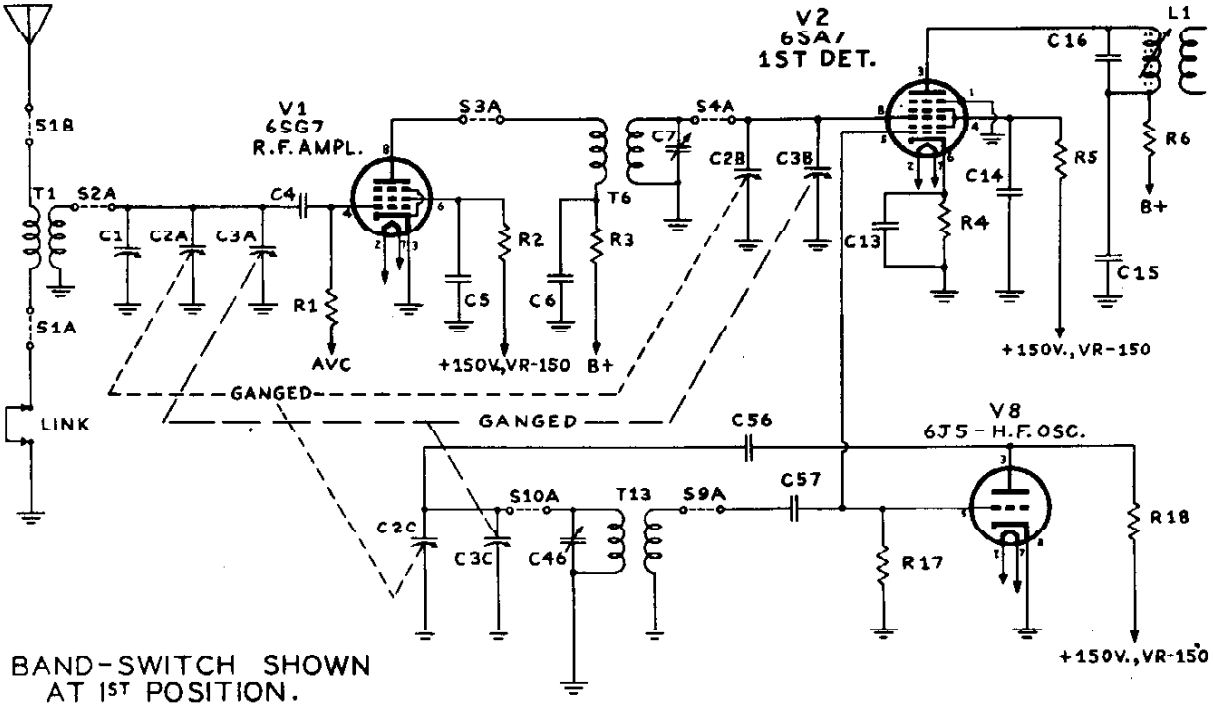
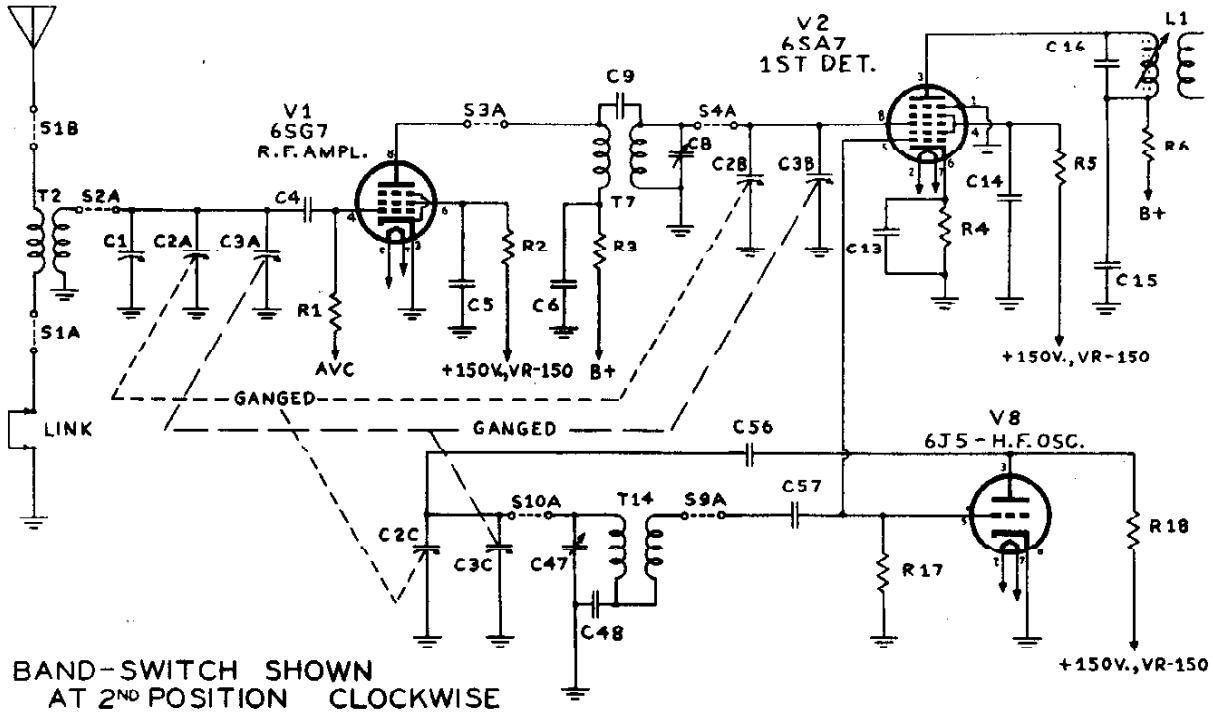
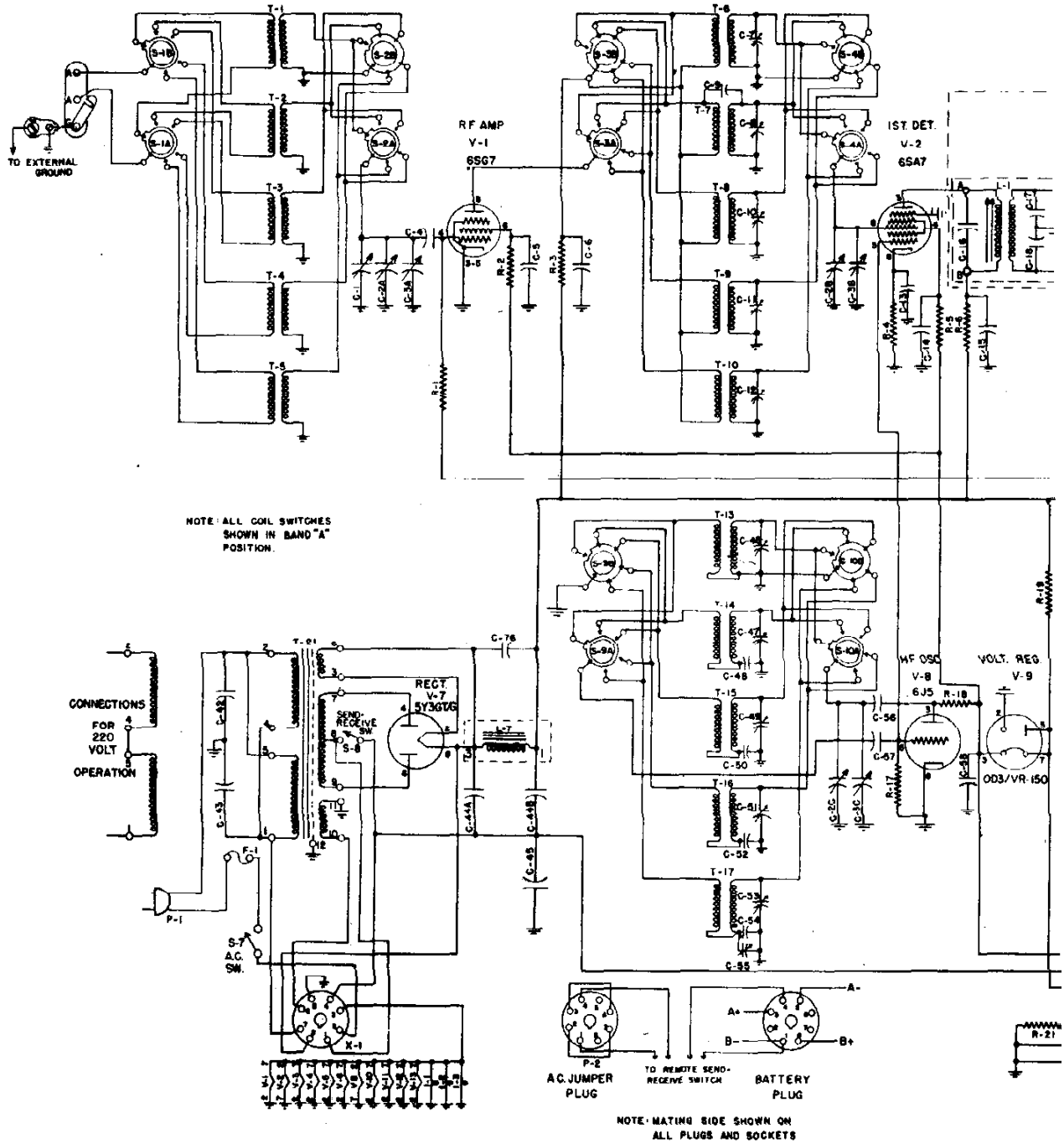
NATIONAL COMPANY, INC. MODEL NC-173

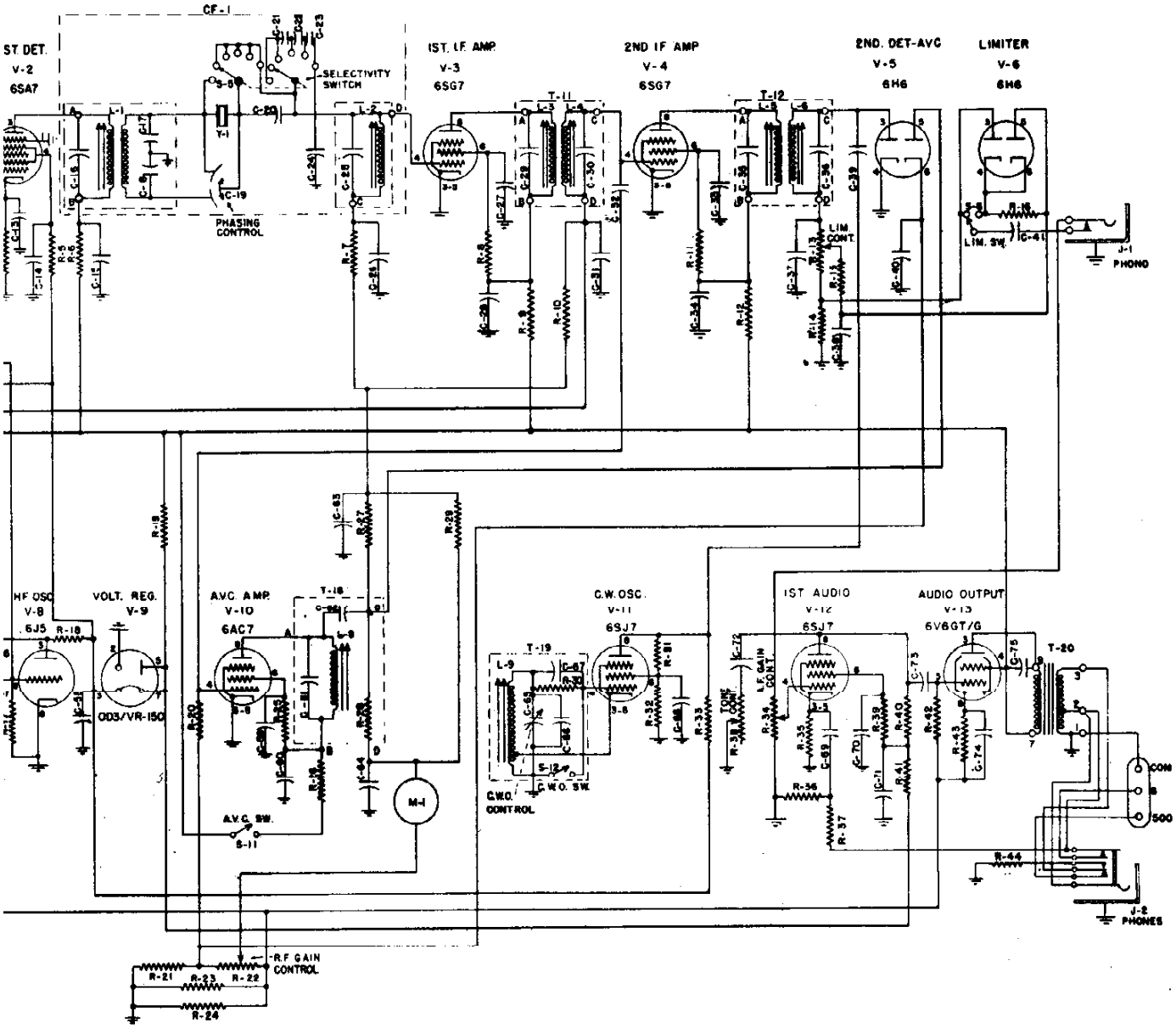


BAND-SWITCH SHOWN
AT 1ST POSITION.
BAND A
4.8-56 MC.



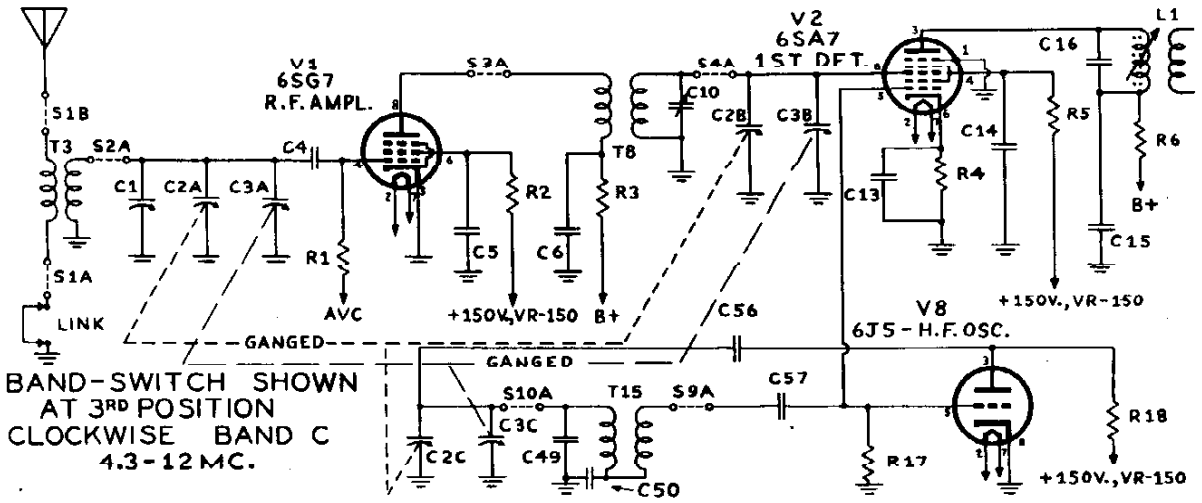
BAND-SWITCH SHOWN
AT 2ND POSITION CLOCKWISE
BAND B
12-31 MC

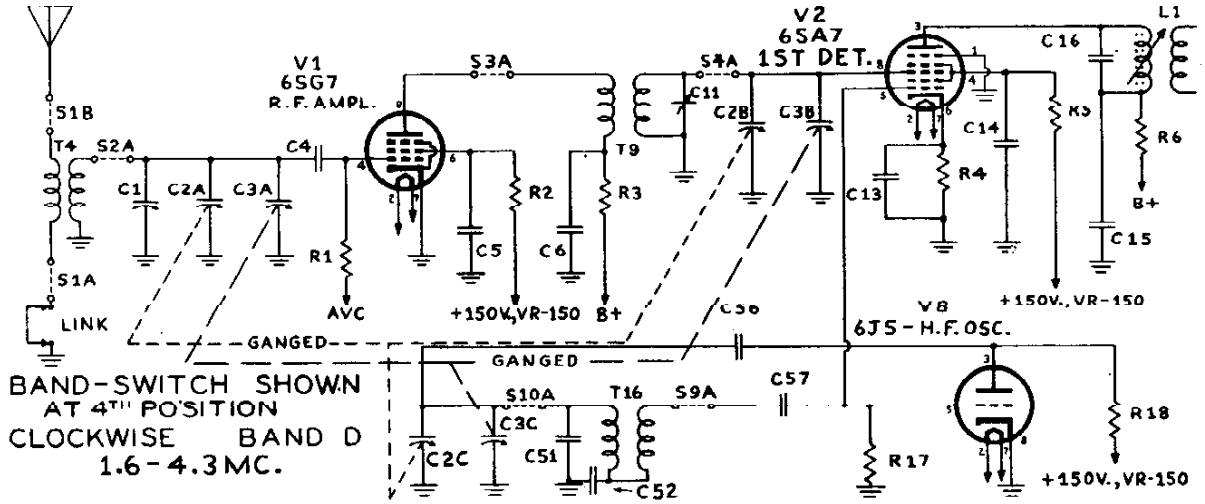

RF AMP
V-1
6SG7
IST. DET.
V-2
6SA7
TO EXTERNAL GROUND
NOTE: ALL COIL SWITCHES SHOWN IN BAND "A" POSITION.
CONNECTIONS FOR 220 VOLT OPERATION
RECT.
V-7
5Y3GT/G
SEND-RECEIVE SW.
S-8
A.C. SW.
S-7
HF OSC
V-8
6J5
VOLT. REG.
V-9
OD3/VR-150
P-1
P-2
X-1
A.C. JUMPER PLUG
TO REMOTE SEND-RECEIVE SWITCH
BATTERY PLUG
NOTE: MATING SIDE SHOWN ON ALL PLUGS AND SOCKETS

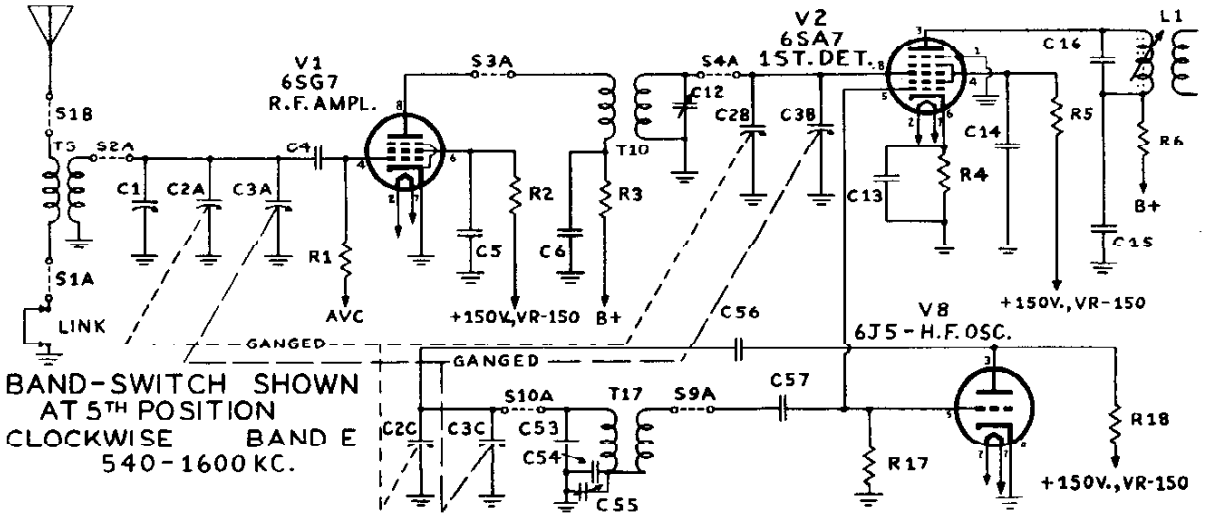


IF PEAK 455 KC

MODEL NC-173 NATIONAL COMPANY, INC.







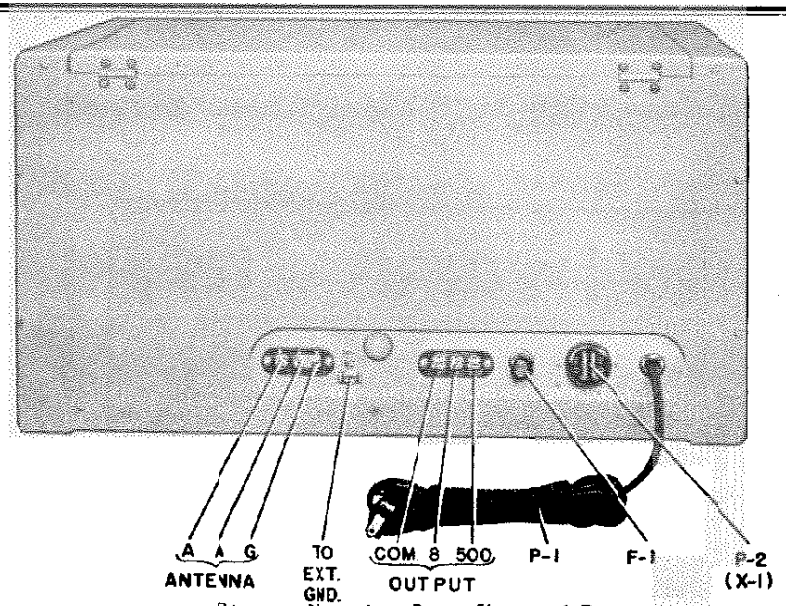


Figure No. 1. Rear View of Receiver

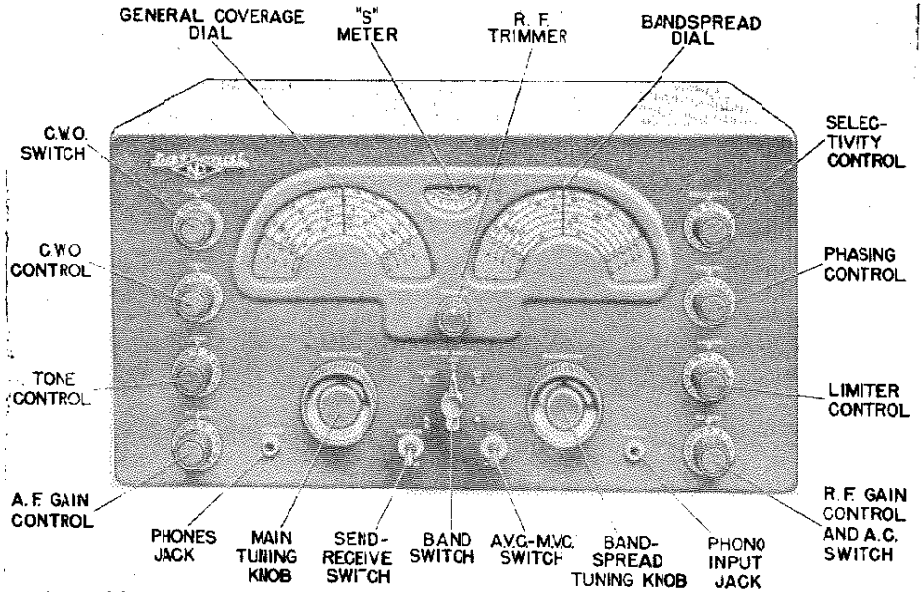


Figure No. 3. Front View of Receiver

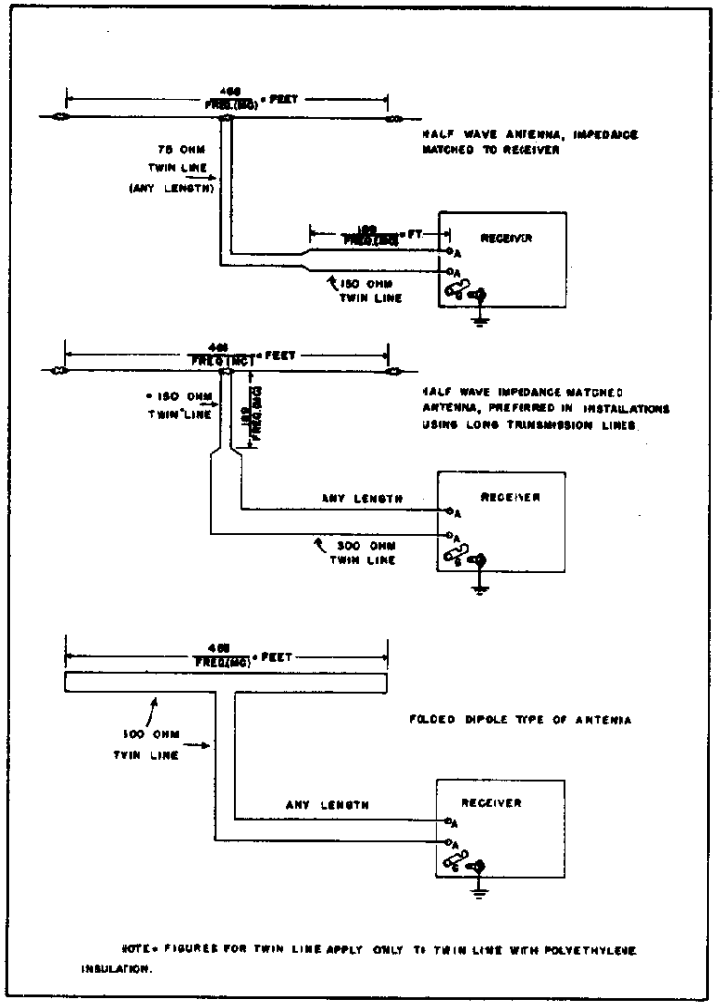


Figure No. 2. Typical Antenna Installations

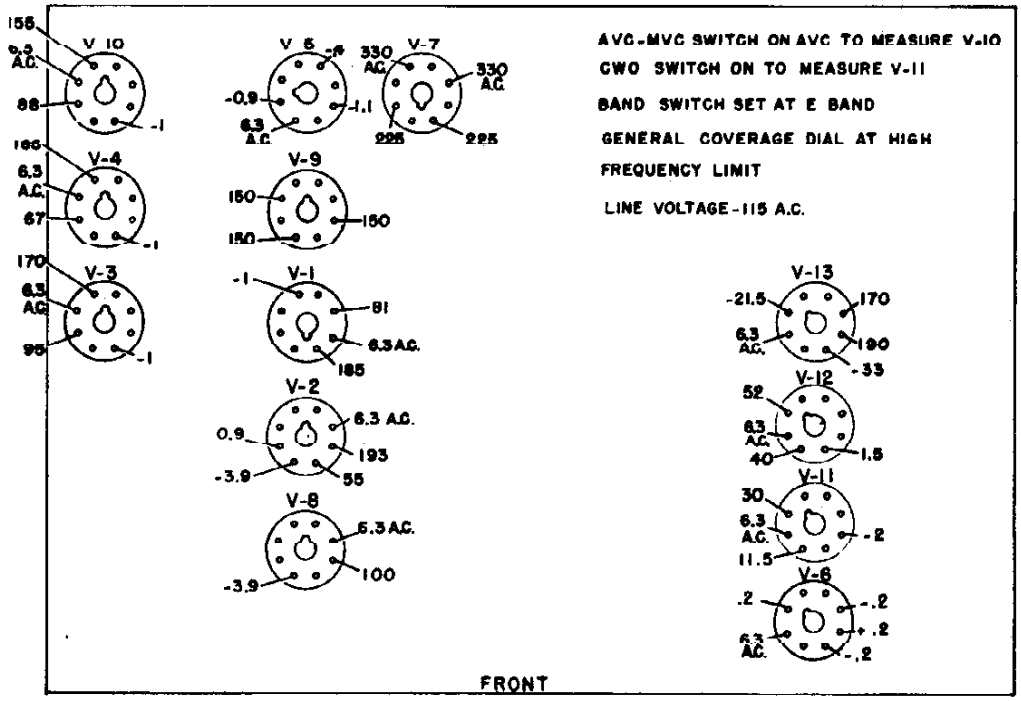


Figure No. 4. Tube Socket Voltages

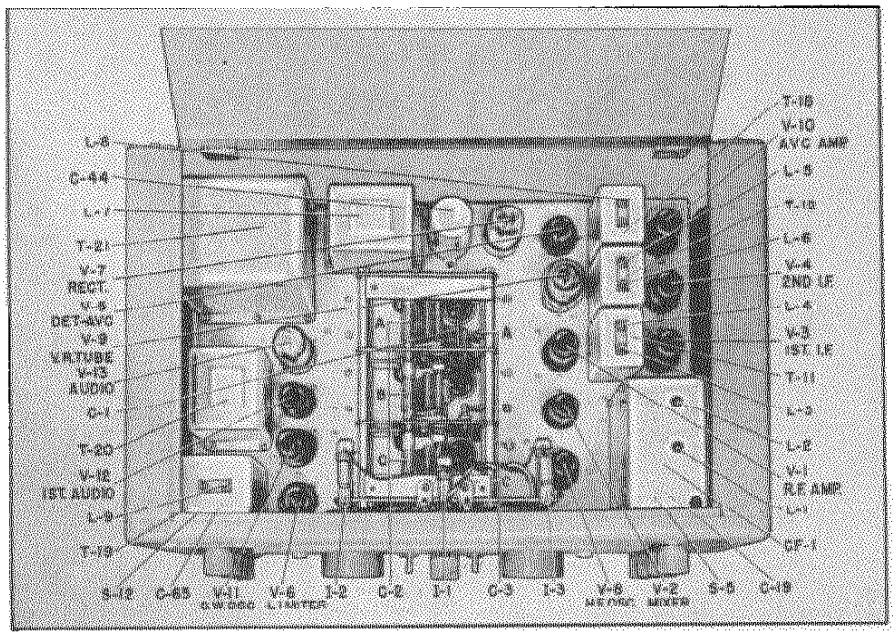


Figure No. 5. Top View of Receiver (Tuning Capacitor Cover Removed)

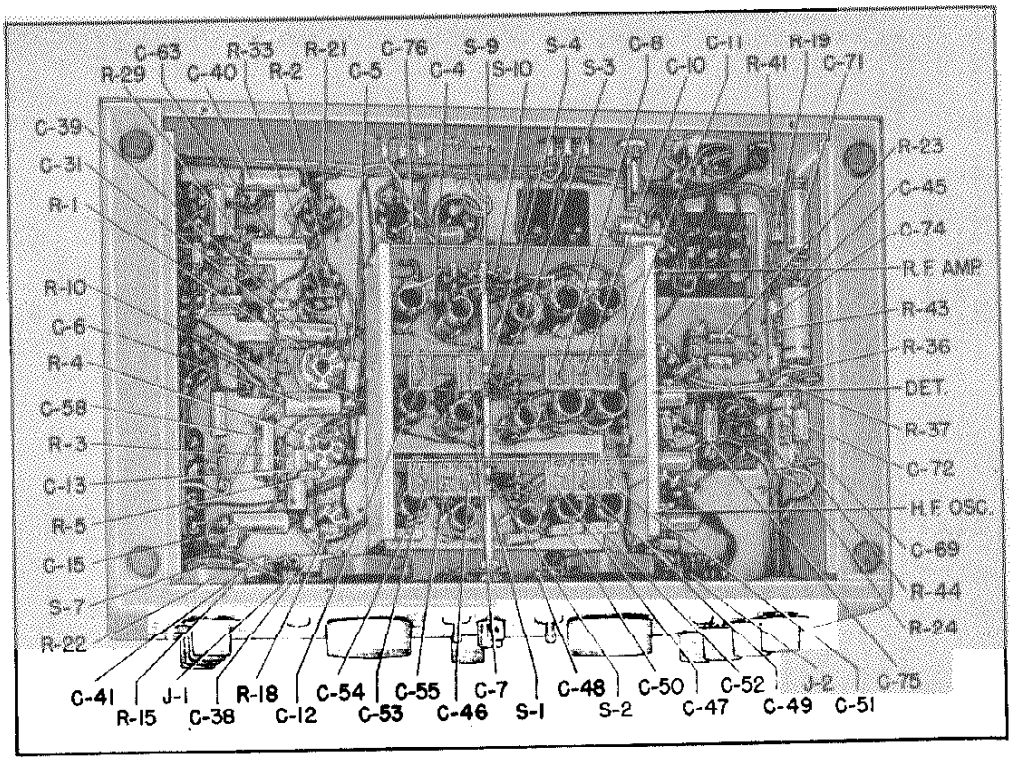


Figure No. 6. Bottom View of Receiver

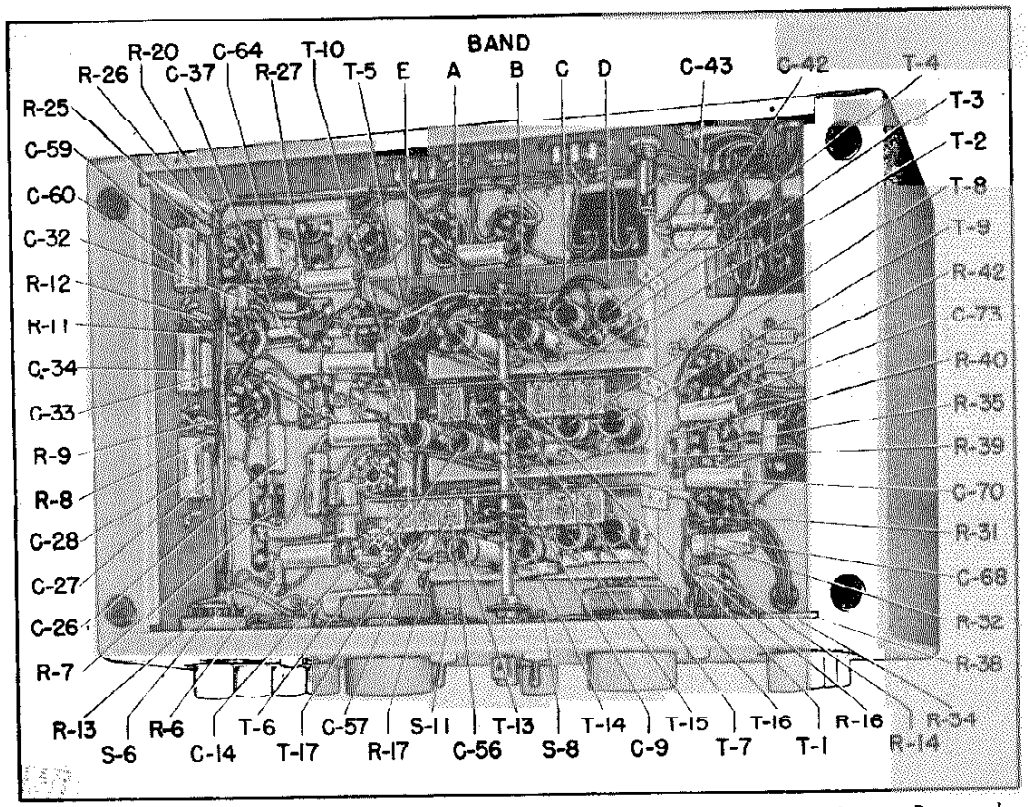


Figure No. 7. Bottom View of Receiver, Coil Compartment Side Plates Removed.

General

The new NC-173 Receiver features a wide frequency coverage which includes the conventional 540 to 31 mc. range and in addition encompasses the Amateur six meter band in its 48 to 56 mc. range. The tuning system employs separate directly-calibrated dial scales for general coverage and bandspread tuning. Calibrated bandspread tuning is provided for the main amateur bands i.e.; 6, 10-11, 20, 40 and 80. The NC-173 selectivity characteristic is adjustable over a wide range from broad band broadcast requirements to sharp amateur single signal CW reception. The adjustable selectivity plus high sensitivity assures the operator of optimum Receiver performance at all times.

The NC-173 also employs a voltage regulator tube to minimize frequency drift in the high frequency oscillator and also in the beat frequency oscillator. This assures a minimum of frequency drift for both phone and code reception.

These stabilized circuits plus a very effective new noise limiter enables the operator to cope with the most adverse receiving conditions.

Circuit

The NC-173 utilizes 13 tubes in a superheterodyne circuit, featuring such circuit refinements as an RF amplifier stage, a separate AVC amplifier, a voltage regulator for circuit stabilization and a double diode noise limiter.

The circuit employed on all bands consists of one stage of radio frequency amplification, a first detector and separate stabilized high frequency oscillator, two intermediate frequency amplifier stages, a diode type second detector, an audio limiter, a high gain audio stage and an audio output stage. The remainder of the Receiver includes automatic volume control, beat frequency oscillator, voltage regulator and rectifier circuits. The crystal filter is connected between the first detector and first IF stages.

Tube Complement

The NC-173 is supplied complete with tubes which are tested in the receiver at the time of alignment.

The tubes employed are as follows:

R.F. Amplifier	6SG7
First Detector	6SA7
H.F. Oscillator	6J5
First I.F. Amplifier	6SG7
Second I.F. Amplifier	6SG7
Second Det. - AVC Det.	6H6
AVC Amplifier	6AC7
Beat Frequency Oscillator	6SJ7
Limiter	6H6
1st. Audio	6SJ7
Audio Output	6V6GT/G
Voltage Regulator	OD3/VR-150
Rectifier	5Y3GT/G

Tuning System

The main tuning capacitor C-2 and the bandspread tuning capacitor C-3 are connected in parallel on all bands. Separate knobs with associated dial scales are used to operate these two capacitors to tune the frequency range of the Receiver in five bands as follows:

BAND	GENERAL COVERAGE	BANDSPREAD
A		48 - 56 Mc.
B	12 - 31 Mc.	27 - 30 Mc.
		14.0 -14.4Mc.
C	4.3 - 12 Mc.	7.0 - 7.3Mc.
D	1.6 - 4.3 Mc.	3.5 - 4.0Mc.
E	0.54 - 1.6 Mc.	

This tuning system requires that the bandspread dial be set at the proper point when using the general coverage dial and vice versa. The accuracy of the dial calibration will not be maintained unless these settings are properly observed. The correct setting of the *Bandspread* dial for general coverage tuning is at 180 on the linear scale. The following table lists the dial settings for bandspread tuning of the various amateur bands.

AMATEUR BAND	GEN. COV. DIAL SETTING
6	198 on Linear Scale
10-11	30.0 Mc.
20	14.4 Mc.
40	7.3 Mc.
80	4.0 Mc.

The flexibility of this tuning system should be noted. If bandspread coverage is desired on any band in the 540 kc. to 31 mc. range, the main tuning dial can be set at the high frequency end of the band to be spread and the *Bandspread* dial used for tuning. Stations may be logged and bandspread tuning calibrated by means of the 0 to 200 numerical scale on the *Bandspread* dial. In the 48 to 56 mc. range the *Bandspread* tuning dial only is used for tuning.

Band changing is accomplished by means of a highly efficient band switch.

Tuning of the first RF stage on all bands can be readily adjusted to compensate for a wide range of antenna loading conditions by means of the panel mounted antenna compensating capacitor.

Crystal Filter

Adjustable selectivity is obtained in the NC-173 by means of a crystal filter. This crystal filter is newly designed and incorporates features which make it highly flexible in its adjustments and superior in performance. The crystal filter provides uniform selectivity variation from the broad *Off* position to the sharp No. 5 position as well as phasing action for the attenuation of interfering signals. The broader selectivity positions are used during phone reception; the sharper selectivity positions are used during code reception.

Noise Limiter

A new concept in noise limiter design is introduced in the NC-173 Receiver. This new limiter could be termed "double action plus" and the noise limiting action is equally effective whether receiving phone or code signals (that is with the CW Oscillator On or *Off*). A threshold control on the front panel permits adjustment of the level at which limiting action starts.

Tone Control

The *Tone* control is a variable potentiometer functioning to adjust the tonal output of the audio amplifier. The control is helpful when receiving weak signals through interference.

Signal Strength Meter

A signal strength meter is associated with the AVC circuit. The S-Meter scale is calibrated in S units from 1 to 9 with approximately 4 db per S unit and in db above S-9 from 0 to 40 db. The "no signal" S-Meter reading does not require adjustment. If it is necessary to compare strong signals which cause the S-Meter to read off scale, the S-Meter sensitivity may be reduced by retarding the *RF Gain* control.

Antenna Input

Antenna input terminals are located at the rear of the receiver chassis near the center. The input circuit is suitable for use with a single wire antenna, a balanced feed line or a low impedance (70 ohm) concentric transmission line. The average input impedance is roughly 500 ohms.

Audio Output

Two audio output circuits are provided:

(1) A headphone jack is front-panel mounted and is wired so as to silence the loud-speaker on the insertion of the phone plug. The headphone load impedance is not critical allowing a wide range of headphone types to be used. Greater audio output at the headphone jack may be obtained, if desired. This is accomplished by unsoldering the headphone jack connection at terminal No. 2, the 8 ohm tap, on the audio output transformer and resoldering it to terminal No. 3, the 500 ohm tap.

(2) An output terminal strip is mounted at the rear of the Receiver having both 8 and 500 ohm terminals and a common ground terminal. The 8 ohm terminal is suitable for connection to the loud-speaker supplied with the NC-173 Receiver and the 500 ohm terminal may be used for connection to a 500 ohm line.

Power Supply

The NC-173 Receiver is designed for operation from a 110/120 volt or 220/240 volt 50/50 cycle power source. The Receiv-

er is stripped from the factory with the power transformer wired for 110/120 volt operation only. A few simple wiring changes in the dual primary of the power transformer are necessary to adapt the NC-173 Receiver for 220/240 volt operation. These changes are made directly on the power transformer terminal panel and are as follows:

(a) Remove the jumper between terminals 1 and 4 and between 2 and 5.

(b) Connect a jumper between terminals 4 and 5.

A drawing of both possible primary circuits is shown on the Schematic Diagram.

Normal power consumption is approximately 83 volt-amps. The built-in power unit supplies all voltages required by the heater and B supply circuits - 4.1 amperes at 6.3 volts and 92 milliamperes at 225 volts, respectively. A 2 ampere fuse is connected in one side of the AC input line to protect the receiver circuits against any voltage surges in the power line or short circuits in the Receiver. This fuse is mounted in an extractor post at the rear of the receiver and is easily removed for examination or replacement.

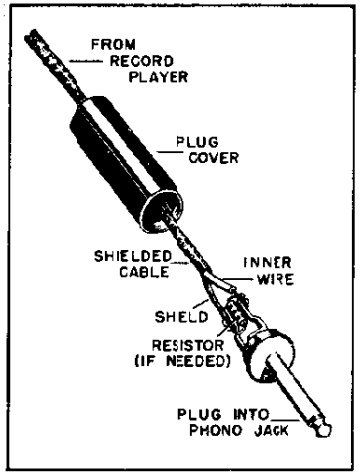
Loud Speaker

The loud-speaker supplied with the table model NC-173 is of the permanent magnet field type and is mounted in a cabinet finished to match the Receiver. The loud-speaker impedance is 8 ohms and connects to the 8 ohm Receiver output circuit.

Pick-up Jack

A pick-up jack is mounted on the front panel and can be used to connect auxiliary apparatus, such as a phonograph pick-up, to the audio system of the Receiver. This input circuit is high impedance and feeds into the high gain 6SJ7 first audio amplifier stage. The *Audio Gain* and *Tone* controls are operative with this connection.

Most record players are terminated in a single shielded wire. As the Phono input jack on the NC-173 is designed to accomodate a phone plug, it is necessary that this single shielded wire be attached to a phone plug. If the output circuit of the record player is low impedance (less than 100,000 ohms) better results will be obtained if a suitable resistor, with a value as specified for the particular record player, is connected across the phone plug to properly load the record player output circuit. The accompanying illustration shows how these connections can be made.



INSTALLATION

Arrangement

The Receiver and loud-speaker may be arranged in any desired position although it is not recommended that the loud-speaker be placed on top of the Receiver as undesirable microphonics may result.

Antenna Recommendations

The antenna input circuit of the Receiver is arranged for operation from either a single-wire antenna, a doublet antenna or other types having impedances of 70 ohms or more. The antenna terminal strip, at the rear of the Receiver, has three terminals, two are for antenna connections and the other for a ground. The ground terminal has connected to it a metal link which is used to ground one antenna lead as necessary. With balanced antenna systems, such as the doublet type, the metal link is not used. With an unbalanced system, such as the single-wire antenna, it is desirable to ground the unused antenna terminal by means of the metal link. For an unbalanced system of the concentric transmission line type, it is recommended that the outside of the concentric line be grounded directly to the ground lug below the antenna terminal strip. The external ground connection to the ground lug below the antenna terminal strip should be maintained at all times.

For best impedance matching to the antenna input circuit, an antenna with a 300 to 600 ohm transmission line is recommended. If a doublet type with a 300 to 600 ohm balanced transmission line is used the metal grounding link should not be used. For optimum results the antenna should be cut to the proper length corresponding to the desired operating frequency. See Fig. No. 1. It must be remembered that an antenna installation of this type will have maximum efficiency over a narrow band of frequencies near the frequency for which the antenna was designed and will be most useful in installations where the Receiver is tuned to one frequency or narrow band of frequencies. For other frequencies it would be desirable to connect the two transmission line leads together at one antenna post and the metal link used to ground the other post. The antenna is thus utilized as a single wire type.

The most practical antenna for use in installations where the Receiver is to be used over a wide range of frequencies is the single wire type. An antenna length of from 50 to 100 feet is recommended. The antenna lead-in should be connected to one antenna post and the metal link used to ground the other post.

In an installation where the Receiver is to be used as the receiving unit in a transmitting station, the most efficient operation will usually result from use of the transmitting antenna as a receiving antenna also. This is especially true if the transmitting antenna is of the multi-element, directional type as the same antenna gain is available for both receiving and transmitting--a very desirable condition. For switching the antenna from transmitter to receiver, an antenna change-over relay with good high-frequency insulation is recommended. A second relay for controlling the transmitter plate supply and the Receiver B+ circuit may be used to achieve single-switch control of the station. This second relay should be a double pole, single throw type having one normally open pair of contacts and one normally closed pair of contacts.

Installation Procedure

After unpacking the Receiver and Speaker procede as follows:

(1) Seat A.C. jumper plug and all tubes firmly in their sockets.

(2) Connect the loud-speaker to the 8 ohm output terminals at the rear of the Receiver.

(3) Connect a good external ground to the screw-type lug located at the rear of the Receiver below the antenna terminal strip.

(4) Connect the antenna as recommended in paragraph 2-2.

(5) Connect the power cord to a 115 volt, 50/60 cycle AC source of supply.

(6) Set controls as recommended in Section 3 for reception of signals.

NOTE

Where the Receiver is located in the field of a relatively powerful transmitter, it is advisable to provide some means of preventing damage to the Receiver antenna coil. If a separate receiving antenna is used, a means for disconnecting or grounding the antenna during transmission periods should be provided.

Battery Operation

The NC-173 may be operated in portable or emergency service by connecting batteries to the terminals of the power socket located at the rear of the receiver. The AC jumper plug may be rewired for battery connection or if changeover operation is desired any octal plug or octal tube base may be used. In any of the above circumstances the battery plug used should be wired according to the drawing shown on the schematic diagram. A 6 volt heater supply (storage battery) should be connected to terminals 3 and 5 and 135 to 250 volt "B" supply connected to terminals 1 and 8. The recommended "B" voltage supply for battery economy is between 135 and 180 volts. The voltage regulator tube will not ignite with this recommended "B" supply but regulation is not required for battery operation. A suggested refinement is to include a switch in the A+ lead so that the tube heaters may be turned off when the receiver is not in use without the necessity of removing the battery plug from the battery socket. The Receiver's "B" switch may be used to silence the receiver with battery operation the same as for AC operation.

The recommendations of Section 3, Operation apply to the battery powered NC-173 Receiver.

Loud Speaker

If the installation is such that the loud-speaker will be placed close to the receiver the most desirable position is at the side

OPERATION

Controls

All controls are identified by front panel markings for ease of identification. The controls are located in a symmetrical manner and are arranged for ease of operation.

The five positions of the *Band Switch* are marked with identifying band letters plus the Amateur bands covered in each band corresponding to the band designations on the dial escutcheons. The *Band Switch* does not have any limit stops so that band changing may be accomplished with a minimum of *Band Switch* turning.

The *General Coverage* dial knob operates the main tuning capacitor and turns the main dial scale through a combination pinch drive and anti-backlash gear train. The main dial scale is calibrated directly in frequency for each band covered and also carries a 0-200 linear scale for auxiliary logging purposes. The main dial escutcheon is marked with the frequency band limits in megacycles and also with band letter designations which correspond to the *Band Switch* markings.

The *Bandspread* tuning dial knob operates the bandspread tuning capacitor and bandspread dial scale through a combination pinch drive and anti-backlash gear train which is similar to that used for general coverage tuning. The bandspread dial scale is marked directly in frequency for the amateur 6, 10-11, 20, 40 and 80 meter bands and also has a 0-200 linear scale for bandspread logging on other than the frequency calibrated bandspread frequencies.

The *RF Trimmer* control operates a tuning capacitor trimmer which is connected across the first RF Amplifier main tuning capacitor section. The *RF Trimmer* can be used to tune the first RF Amplifier stage properly under a wide variety of antenna loading conditions.

The *RF Gain* control adjusts the amplification of the RF and IF Amplifier stages. Clockwise rotation of the control increases Receiver gain. The *AC Power* switch is associated with the *RF Gain* control and AC power is turned *On* as the *RF Gain* control is advanced from *AC Off* to *0* on the scale.

The *AF Gain* control adjusts the amount of audio voltage applied to the first audio tube. Clockwise rotation of the control increases the Receiver audio power output. The *AF Gain* control is operative when an audio signal is applied to the *Phono* input jack.

The *Limiter* control is used both to switch the limiter into the circuit and also to adjust the threshold at which limiting action starts. The limiter is turned on as the *Limiter* control is advanced from *Off* to *0* and the threshold is lowered as the control is advanced toward 10. Any noise peak voltages in excess of this adjustable threshold are prevented from reaching the audio amplifier. The limiter circuit is of the double diode type and is equally effective for either phone or CW reception.

The *Tone* control is used to vary the frequency characteristic of the audio portion of the Receiver. Turning this control toward 10 on its scale increasingly attenuates the lower frequencies.

The *CWO Switch* and *CWO* control are used for radiotelegraph code reception. The *CWO Switch* is used to turn the CW Oscillator On and the *CWO* control is used to adjust the pitch of the CW note. At zero on the CWO scale, the CW Oscillator is tuned to the Receiver's intermediate frequency.

The *Phasing* and *Selectivity* controls adjust the operation of the crystal filter. Receiver selectivity is made progressively sharper as the Selectivity control is turned from *Off* toward 5 on its scale. The *Phasing* control is inoperative with the *Selectivity* control in the *Off* position. The *Phasing* control is used to attenuate interfering signals and is connected in a bridge circuit so that the bridge can be balanced to reject the undesired signal frequency.

The *Send-Receive* switch is used to quiet the Receiver during transmission periods or other times when it is desirable to be able to turn on the Receiver immediately after a period of silence (i.e. not having to wait for the tubes to warm up). The *Send-Receive* switch is connected in the B- circuit and functions when the Receiver operates from batteries as well as during normal AC operation. The *Send-Receive* switch should not be used to silence the Receiver after the completion of an operating period. The Receiver should be turned *Off* by turning the *RF Gain* control to the *AC Off* position.

External (remote) stand-by control of the Receiver may be accomplished by connecting a switch or relay to terminals 3 and 4 of the AC jumper plug as shown on the Schematic Diagram. This is a parallel arrangement thus permitting the *Send-Receive* switch to remain operative with the external switch or relay in the circuit.

The *AVC-MVC* switch is used to adjust the Receiver for either Automatic Volume Control or for Manual Volume Control operation. Automatic Volume Control can be used for either phone or code reception. The AVC time constants have been adjusted so that Receiver gain does not change appreci-

ably during average code speed reception.

Phone Reception

After the equipment is properly installed, as outlined in Section 2, it is placed in operation by adjusting the receiver controls as follows:

1. Advance the *RF Gain* to a point between 8 and 10.
2. Set the *Send-Receive* switch at Receive.
3. Set the *AVC-MVC* switch at *AVC*.
4. Turn the *CWO* switch to *Off*.
5. Set the *Selectivity* Control at *Off*.
6. Set the *Phasing* control at *0*.
7. Set the *Limiter* control at *Off*.
8. Set the *AF Gain* control to the point providing the audio volume desired by the operator.
9. Adjust the *Tone* control to give the desired audio characteristic.

The Receiver is now adjusted for the reception of phone signals and will tune to the frequency indicated by the tuning dial and band switch settings. Set the *RF Trimmer* control for maximum S-Meter reading after the desired station has been selected, or alternately in the absence of a signal the *RF Trimmer* may be set for maximum Receiver background noise.

The tuning system in the NC-173 is arranged for ease of operation and accuracy of calibration. However, it is necessary that the proper settings of the *General Coverage* and *Bandspread* dials be observed for tuning of signals. For general coverage tuning the *Bandspread* dial must be set at 180 on its linear scale; for bandspread tuning the *General Coverage* dial must be set at the proper point corresponding to the Amateur band being tuned. The *General Coverage* dial settings for bandspread tuning of the various amateur bands are listed in Section 1. The various "set points" are marked directly on the *General Coverage* dial scale at the upper frequency limit of the amateur band being tuned and are easily located by the identifying circular markers. As stated in Section 1, tuning of the 6 meter band is accomplished by use of the *Bandspread* dial entirely. The correct setting of the *General Coverage* dial for 6 meter band operation is at the scale marker position located at approximately 198 on the linear scale.

The *Band Switch* setting determines the band of frequencies which the Receiver will tune at any one time. The dial scale in use is indicated by the identifying markers on the dial escutcheons which correspond to the markings on the *Band Switch* control.

With the *AVC-MVC* switch set in the *AVC* position, the *RF Gain* control should be advanced as far as receiving conditions permit, or until background noise becomes objectionably loud. Audio output should be adjusted entirely by means of the *AF Gain* control. The operator must remember that automatic volume control action will be restricted unless the *RF Gain* control is fully advanced.

The *AVC-MVC* switch may be set at the manual volume control position, in which case the operator must be careful not to advance the *RF Gain* control to a point where IF or audio amplifier overload occurs. Such overload is indicated by distortion. In general, the *AF Gain* control may be set at a fixed position and the *RF Gain* control used to adjust the volume of the audio output.

If a signal is weak and partially obscured by background noise and static, best signal-to-noise ratio will be obtained by turning the *Tone* control towards 0 on its scale. The most effective setting must be determined by trial as too much attenuation of the higher audio frequencies will impair the intelligibility of speech.

When a signal is accompanied by static peaks or noise pulses of high intensity and short duration, the best signal-to-noise ratio will be obtained by advancing the *Limiter* control clockwise from the *Off* position. The best setting must be determined by trial as too much limiter action will impair the audio quality.

The selectivity of the receiver is adjusted by means of the crystal filter *Selectivity* control. The normal setting of the *Selectivity* control in phone reception is at one of the positions affording broad selectivity. Positions marked *Off*, *1* or *2* are recommended. Selectivity may be progressively increased by turning the *Selectivity* control to positions *3*, *4* or *5*. The evidences of increasing selectivity will be the attenuation of the higher frequency audio tones of the signal as well as sharper tuning. Increasing selectivity too much will attenuate these higher tones to such an extent that phone signals will become unintelligible.

The *Phasing* control is used to eliminate or attenuate interfering heterodynes. The normal setting of the *Phasing* control with the crystal filter *On* for phone reception is at *0* on the scale. If, after a signal has been tuned in, an interfering signal causes a heterodyne or whistle the *Phasing* control should be adjusted until interference is reduced to a minimum. The setting of the *Phasing* control which provides maximum attenuation of the heterodyne will depend on the pitch of the heterodyne whistle. If the beat note is above 1000 cycles, the optimum *Phasing* control setting will be near one end of the scale or the other, depending upon whether the interfering signal has a higher or lower frequency than the desired signal. The *Phasing* control is inoperative with the *Selectivity* control in the *Off* position, but the *Phasing* control is operative at all other *Selectivity* control settings.

C.W. Reception

The Receiver is placed in operation for the reception of CW signals in the same manner as that outlined for phone reception, (Section 3-2), except that the *CWO* switch should be set at *On* and the *CWO* control set at mid-scale. The CW code characters are made audible by the heterodyning action of the CW Oscillator with the incoming signal. The frequency of the CW Oscillator can be varied by rotation of the *CWO* control.

The sensitivity of the receiver should be adjusted by means of the *RF Gain* control and the audio volume by means of the *AF Gain* control. When receiving CW characters with slow keying or long pauses during keying it may be desirable to set the *AVC-MVC* switch at *MVC* so that the receiver gain does not change during keying pauses. In this case, the *AF Gain* control should be set at a fixed position and the audio volume adjusted by means of the *RF Gain* control. In either of the above cases, care should be taken not to advance the *RF Gain* to a point where IF or audio amplifier overload will occur.

The action of the *Tone* and *Limiter* controls will be similar to that described under Section 3-2. However, in CW reception it will be possible to advance these controls considerably further than is desirable in phone reception since audio distortion is relatively unimportant.

Turning the *CWO* control to either side of zero will change the characteristic pitch of the receiver background noise thus providing a means of adjusting the audio beat note to the operator's preference. The pitch will become higher as the CWO oscillator is detuned from the IF Amplifier.

A distinct advantage in the reception of weak signals through interference can be realized by the use of the "single-signal" properties of the NC-173 Receiver. The CW oscillator should be detuned until the pitch of the receiver background noise is roughly 2000 cycles. Under this condition the audio beat note of any CW code signal will show a broad peak in output at approximately 2000 cycles. This peak is easily found by rotating the tuning dial slowly through the carrier of a received signal. This peak will appear on one side of "zero beat" only and on the other side of "zero beat" the 2000 cycle note will be considerably weaker. It should be noted that depending on the frequency of the interfering signal better receiving conditions will be obtained by detuning the CWO on one side of zero than on the other. The beat setting of the CWO can only be determined by trial settings on either side of zero until optimum results are obtained.

Crystal filter operation for CW reception is similar to that described in Section 3-2 with the exception that it is possible to utilize maximum selectivity without the loss of intelligibility experienced in phone reception. When maximum selectivity is employed, i.e. *Selectivity* control at *5*, tuning is very critical and care must be taken to assure proper tuning. At this setting the "single-signal" effect, previously described, is very pronounced. When tuning across the carrier of a received signal the audio beat note is very sharply peaked at a definite audio frequency. The maximum response indicates the proper dial setting. The pitch of the beat note peak may be adjusted by use of the CWO control to provide an audio tone

pleasing to the operator. With the Receiver tuned to "crystal peak" an interfering signal may be attenuated by proper setting of the *Phasing* control since this control does not appreciably affect the desired signal.

Measurement of Signal Strength

The S-Meter in the NC-173 Receiver furnishes a means for the measurement of signal strength of incoming signals. To utilize the S-Meter the following control settings must be observed: *RF Gain* at 10, *AVC-MVC* at *AVC*, *Selectivity* at *Off*, and *Phasing* at 0. The *RF Trimmer* should be adjusted for maximum S-Meter reading of a particular incoming signal. The *CWO Tone*, *Limiter* and *AF Gain* control settings do not affect meter readings.

Tuning the Receiver to a signal will cause a meter deflection indicating the signal strength in S-units or in decibels above the S-9 level.

In instances where a strong signal causes the S-Meter to read off scale the S-Meter sensitivity may be reduced by retarding the *RF Gain* control until an on scale reading is obtained. Without disturbing the setting of the *RF Gain* control the comparative strength of this strong signal may be compared with other signals.

SERVICE AND TEST DATA

Tube Failures

The partial or complete failure of a vacuum tube in the Receiver may reduce the sensitivity, produce intermittent operation, or cause the equipment to be completely inoperative. If tube failure is suspected all tubes should be checked in suitable tube testing equipment, or by replacement with tubes of proven quality. Care should be taken that any tubes removed for checking purposes be returned to their original sockets thereby reducing the necessity for realignment.

Tubes of the same type will vary slightly in their individual characteristics and this fact should be borne in mind when replacements become necessary. The high frequency oscillator and I.F. tubes should be chosen with care to select a replacement which most nearly approaches the characteristics of the original tube. A replacement high frequency oscillator tube can be readily checked by noting any change in dial calibration, particularly in the amateur bandspread bands. Substitution of new I.F. amplifier tubes may possibly alter overall gain and selectivity characteristics. Instructions for realignment are given in detail in Section 5-2.

Circuit Failures

All components parts in the NC-173 Receiver have been carefully selected to assure an ample factor of safety yet failure may occur in individual cases. The most common failure, excluding tubes, will probably be due to a defective capacitor or resistor. Measurement of voltage in accordance with Section 4-4 will most likely indicate where failure has occurred. A bypass capacitor which has failed may cause overload of associated resistors. These resistors should be checked for any change in resistance value. An overloaded or shorted resistor will sometimes be evidenced by scorching or discoloration on the surface of the resistor. An open capacitor, often the cause of oscillation or loss of sensitivity, may be checked by temporarily connecting a good capacitor across it. Intermittently poor connections can usually be located by lightly tapping each part with a piece of insulating material.

Stage Gain Measurements

The sensitivity measurements listed below are made with the equipment set up as specified in Section 3-2 except that the *AVC-MVC* switch should be set at *MVC* and the *AF Gain* control at *10*. The signal generator should be adjusted to deliver a test signal of 455 kc. plus or minus 2 kc. either modulated or unmodulated. The high output lead should be connected through a 0.001 capacitor to the pin of the tube as specified in the following table and the ground lead connected to the receiver chassis.

With 1 watt output at the audio output terminals the test signal should be within the limits specified below. It is important that the proper output impedance matching be observed, i.e., 8 or 500 ohms depending upon which terminal is used, when making these tests.

The *Band Switch* must be set at the mid-position between the A and B bands.

TERMINAL	TEST SIGNAL
Mixer Grid	13 ± 3 Microvolts
First IF Grid	170 ± 30 Microvolts
Sec. Det. Grid	33,000 ± 6,000 Microvolts

Voltage Tabulation

All voltage measurements are made with the Receiver controls adjusted for normal operation as outlined in Section 3-2 except that the *AVC-MVC* switch should be set at *MVC* and the *AF Gain* control at *10*, except as noted on Figure No. 4. A high-impedance vacuum tube voltmeter should be used to make these measurements. Readings taken with any other type of instrument will differ greatly from those shown on Figure No. 4. All voltages are measured between specified terminal and chassis.

ALIGNMENT DATA

General

All circuits in the NC-173 Receiver are carefully aligned, before shipment, using precision crystal controlled oscillators which insure close conformability to the dial calibration. No realignment of the various adjustments will be required, therefore, unless the receiver is tampered with or damaged in transit.

The necessity for any realignment can be determined by checking the performance of the Receiver against its normal operation as outlined in Section 3. In no case should realignment be attempted unless tests indicate that such realignment is necessary. Even then, it must be remembered that the NC-173 is a communications receiver and should not be serviced or realigned by any individual who does not have a complete understanding of the functioning of the equipment and who has not had previous experience adjusting a similar type of receiver.

The RF coil groups are mounted in an aluminum compartment which is directly below the main tuning capacitor. The HF oscillator coils are nearest the front panel, the first detector coils are in the center of the compartment and the RF coil group is nearest the rear of the Receiver.

All HF oscillator and first detector coils have individual general coverage trimmer capacitors. The E band has also a general coverage variable series padding capacitor. These capacitors are identified in Figure No. 6.

The IF transformers, crystal filter AVC amplifier and CW oscillator transformers all have individual permeability-tuned iron core inductors with screw-adjustments for alignment purposes. These adjustments are identified on figure No. 5.

Before proceding with the alignment of any circuit of the Receiver, the equipment must be set up as specified in Section 2-3, except that the antenna lead-in must be disconnected. An output meter having an 8 or 500 ohm resistive load should be connected to the matching terminal on the Receiver's output terminal strip. If it is so desired a high impedance AC voltmeter having a resistive load of over 8 ohms may be connected to the phone output jack and used in place of the output meter. The *RF Gain* control should be set at *10* and the *Tone* control at *0*.

Alignment of the equipment may be divided into two major steps:

(1 IF and AVC Amplifier Alignment.
(2 General Coverage Alignment.
  (a) HF Oscillator.
  (b) First Detector.

The circuits *must* be tuned in the above order when complete alignment is necessary.

5-21F and AVC Amplifier Alignment

The intermediate frequency of the NC-173 Receiver is 455 kilocycles, plus or minus 2 kilocycles. The exact frequency is determined by the quartz crystal resonator Y-1.

The preliminary alignment procedure is as follows:

(1 Connect the high output lead of an accurately calibrated signal generator to the stator portion of the detector section of the main tuning capacitor, C-25, and the grounded lead to any convenient grounded

point on the chassis. This is a direct connection to dummy antenna being required.

(2) Set the *CWO* switch at *On*.

(3) Set the *AVC-MVC* switch at *MVC*.

(4) Set the *Phasing* control at *0*.

(5) Set the *Selectivity* control at *5*.

(6) Set the *AF Gain* control at *10*.

(7) Turn the modulation of the signal generator off to provide a steady CW test signal.

Adjust the output attenuator of the signal generator to provide a signal of approximately 100 microvolts and vary the tuning control of the signal generator slowly between the frequencies of 453 and 457 kilocycles. At some frequency between these limits the IF amplifier of the receiver will show a very sharply peaked response, as indicated on the output meter. The absence of such a sharply peaked response will serve to indicate that the crystal resonator, Y-1, is defective. The *CWO* control must be set to provide an audible beat note at all times.

While making IF amplifier adjustments, it will be necessary to retard the attenuator of the signal generator if the readjustment increases IF amplifier gain to a point where overload occurs. Without altering the frequency setting of the signal generator set the *Selectivity* and CWO switches at *Off*, and turn the modulation of the signal generator *On*. The IF tuned inductors L-1 through L-6 should each be carefully adjusted to give a maximum reading on the output meter. The order in which these adjustments are made is not important.

To align the AVC amplifier turn the *AVC-MVC* switch to *AVC*. Adjust L-8 of transformer T-18 until a well-defined dip is observed in the output meter readings. The setting of L-8 where this dip occurs will provide maximum AVC action.

Turn the modulation of the signal generator *Off* and turn the *CWO* switch *On* and set the *CWO* control at *0* at which setting the CW oscillator should be at zero beat with the test signal. If zero beat does not occur at *0*, readjust the tuneable inductor L-9 of transformer T-19 for the correct setting.

General Coverage Alignment

The control settings used for alignment are as outlined in Section 3-2 except that the *AVC-MVC* switch should be at *MVC*. Throughout the alignment procedure outlined below it is important that the *Bandspread* dial is set at 180 on the linear scale.

(a) HF Oscillator

Alignment is effected as follows: Set the *Band Switch* at the position indicating the band to be aligned. Set the *General Coverage* tuning dial near the high frequency end of the band. Connect a signal generator to the antenna input terminals through a standard dummy antenna and accurately tune the signal generator to deliver a signal of the same frequency as that indicated by the receiver dial setting. If, when this signal is tuned in, the dial reading is too high, decrease the capacity of the HF oscillator circuit trimmer until the signal appears at the proper point on the dial. Conversely, low dial readings are corrected by increasing the capacity of this trimmer to make correction. Care should be taken to insure that the HF oscillator is tuned to the fundamental frequency and not the image. This can be checked by tuning to the image frequency which should appear 910 kilocycles below the fundamental frequency and be considerably weaker. If the image does not appear at the lower dial setting the HF Oscillator trimmer capacity must be decreased until the fundamental and image frequencies appear at the proper points on the dial.

(b) First Detector

Adjust the signal generator to deliver a modulated signal near the high frequency limit of the band to be checked, tune the receiver to give maximum output, as indicated on the output meter. Adjust the first detector trimmer capacitor until the output reading shows maximum. If these trimmers require considerable realignment, it may be necessary to readjust the high frequency oscillator trimmer in order to maintain correct calibration.

An alternate method of aligning the first detector stage in the event a signal generator is not available is to set the first detector trimmer capacitors for maximum background noise. It will be found that trimmer settings under this method are sufficiently sharp to provide good alignment, although the adjustment must be made with care to avoid alignment to the image.

PARTS LIST

Symbol	*Function*	*Type*	*Rating*
	CAPACITORS		
C-1	BF Trimmer	Air	Variable
C-2	Main Tuning	Air	Variable
C-2A	BF Amp. Tuning	Air	Part of C-2
C-2B	1st Det. Tuning	Air	Part of C-2
C-2C	HF Osc. Tuning	Air	Part of C-2
C-3	Bandspread Tuning	Air	Variable
C-3A	BF Amp. Bandspread Tuning	Air	Part of C-3
C-3B	1st Det. Bandspread Tuning	Air	Part of C-3
C-3C	HF Osc. Bandspread Tuning	Air	Part of C-3
C-4	BF Amp. Grid Coupling	Mica	0.001 mfd., 300 VDCW
C-5	BF Amp. Screen Bypass	Paper	0.01 mfd., 600 VDCW
C-6	BF Amp. Plate Filter	Paper	0.05 mfd., 600 VDCW
C-7	A Band 1st Det. Trimmer	Mica	Variable
C-8	B Band 1st Det. Trimmer	Mica	Variable
C-9	B Band 1st Det. Pri. to Sec. Coupling	Ceramic	10 mmf., 500 VDCW
C-10	C Band 1st Det. Trimmer	Mica	Variable
C-11	D Band 1st Det. Trimmer	Mica	Variable
C-12	E Band 1st Det. Trimmer	Mica	Variable
C-13	Mixer Cathode Bypass	Paper	0.1 mfd., 400 VDCW
C-14	Mixer Screen Bypass	Paper	0.01 mfd., 600 VDCW
C-15	Mixer Plate Filter	Paper	0.05 mfd., 600 VDCW
C-16	Crystal Filter Input Tuning	Mica	510 mmf., 500 VDCW
C-17	Crystal Filter Bridge	Ceramic	85 mmf., 500 VDCW
C-18	Crystal Filter Bridge	Ceramic	50 mmf., 500 VDCW
C-19	Crystal Filter Phasing	Air	Variable
C-20	Crystal Filter Coupling	Ceramic	10 mmf., 500 VDCW
C-21	Selectivity Adjusting	Ceramic	25 mmf., 500 VDCW
C-22	Selectivity Adjusting	Ceramic	100 mmf., 500 VDCW
C-23	Selectivity Adjusting	Ceramic	100 mmf., 500 VDCW
C-24	Selectivity Adjusting	Ceramic	50 mmf., 500 VDCW
C-25	Crystal Filter Output Tuning	Mica	510 mmf., 500 VDCW
C-26	1st IF Grid Filter	Paper	0.01 mfd., 600 VDCW
C-27	1st IF Screen Bypass	Paper	0.01 mfd., 600 VDCW
C-28	1st IF Plate Filter	Paper	0.05 mfd., 600 VDCW
C-29	T-11 Primary Tuning	Mica	510 mmf., 500 VDCW
C-30	T-11 Secondary Tuning	Mica	510 mmf., 500 VDCW
C-31	2nd IF Grid Filter	Paper	0.1 mfd., 400 VDCW
C-32	2nd IF Grid to AVC Grid Coupling	Ceramic	47 mmf., 500 VDCW
C-33	2nd IF Screen Bypass	Paper	0.01 mfd., 600 VDCW
C-34	2nd IF Plate Filter	Paper	0.05 mfd., 600 VDCW
C-35	T-12 Primary Tuning	Mica	510 mmf., 500 VDCW
C-36	T-12 Secondary Tuning	Mica	510 mmf., 500 VDCW

Symbol	Function	Type	Rating
	CAPACITORS (Continued)		
C-37	2nd Det. Load	Mica	270 mmf., 500 VDCW
C-38	Limiter Plate Filter	Paper	0.1 mfd., 400 VDCW
C-39	Det. Plate to BFO Plate Coupling	Ceramic	10 mmf., 500 VDCW
C-40	AVC Cathode Bypass	Paper	0.1 mfd., 400 VDCW
C-41	1st Audio Coupling	Paper	0.01 mfd., 600 VDCW
C-42	AC Line Bypass	Paper	0.01 mfd., 600 VDCW
C-43	AC Line Bypass	Paper	0.01 mfd., 600 VDCW
C-44	Power Supply Filter	Elec.	8+8 mfd., 475 VDCW
C-44A	Power Supply Filter	Elec.	Part of C-44
C-44B	Power Supply Filter	Elec.	Part of C-44
C-45	B Minus Bypass	Elec.	25 mfd., 50 VDCW
C-46	A Band HF Osc. Trimmer	Mica	Variable
C-47	B Band HF Osc. Trimmer	Mica	Variable
C-48	B Band HF Osc. Padder	Mica	0.0085 mfd., 300 VDCW
C-49	C Band HF Osc. Trimmer	Mica	Variable
C-50	C Band HF Osc. Padder	Mica	0.0042 mfd., 300 VDCW
C-51	D Band HF Osc. Trimmer	Mica	Variable
C-52	D Band HF Osc. Padder	Mica	1250 mmf., 500 VDCW
C-53	E Band HF Osc. Trimmer	Mica	Variable
C-54	E Band HF Osc. Padder	Mica	420 mmf., 500 VDCW
C-55	E Band HF Osc. Padder	Mica	Variable
C-56	HF Osc. Plate Coupling	Mica	0.001 mfd., 300 VDCW
C-57	HF Osc. Grid Coupling	Ceramic	100 mmf., 500 VDCW
C-58	B Supply Filter	Paper	0.1 mfd., 400 VDCW
C-59	AVC Amp. Screen Bypass	Paper	0.01 mfd., 600 VDCW
C-60	AVC Amp. Plate Filter	Paper	0.05 mfd., 600 VDCW
C-61	1-18 Tuning	Mica	510 mmf., 500 VDCW
C-62	AVC Amp. to AVC Coupling	Mica	0.001 mfd., 300 VDCW
C-63	AVC Bus Filter	Paper	0.1 mfd., 400 VDCW
C-64	S-Meter Bypass	Paper	0.01 mfd., 600 VDCW
C-65	1-19 Tuning	Air	Variable
C-66	CW0 Tuning	Mica	270 mmf., 500 VDCW
C-67	CW0 Grid Coupling	Mica	270 mmf., 500 VDCW
C-68	CW0 Osc. Screen Bypass	Paper	0.1 mfd., 400 VDCW
C-69	1st Audio Cathode Bypass	Elec.	25 mfd., 50 VDCW
C-70	1st Audio Screen Bypass	Paper	0.1 mfd., 400 VDCW
C-71	1st Audio Plate Filter	Paper	0.1 mfd., 400 VDCW
C-72	Tone Adjusting	Paper	0.005 mfd., 500 VDCW
C-73	2nd Audio Grid Coupling	Paper	0.1 mfd., 400 VDCW
C-74	2nd Audio Cathode Bypass	Elec.	25 mfd., 50 VDCW
C-75	2nd Audio Tone	Paper	0.005 mfd., 500 VDCW
C-76	Power Supply Filter	Paper	0.1 mfd., 400 VDCW
	RESISTORS		
R-1	RF Amp. Grid	Fixed	100,000 Ohms, 1/2 W.
R-2	RF Amp. Screen Filter	Fixed	33,000 Ohms, 1/2 W.
R-3	RF Amp. Plate Filter	Fixed	2,200 Ohms, 1/2 W.
R-4	Mixer Cathode	Fixed	220 Ohms, 1/2 W.
R-5	Mixer Screen Filter	Fixed	33,000 Ohms, 1/2 W.
R-6	Mixer Plate Filter	Fixed	2,200 Ohms, 1/2 W.
R-7	1st IF Grid Filter	Fixed	470,000 Ohms, 1/2 W.
R-8	1st IF Screen Filter	Fixed	33,000 Ohms, 1/2 W.
R-9	1st IF Plate Filter	Fixed	2,200 Ohms, 1/2 W.
R-10	2nd IF Grid Filter	Fixed	470,000 Ohms, 1/2 W.
R-11	2nd IF Screen Filter	Fixed	100,000 Ohms, 1/2 W.
R-12	2nd IF Plate Filter	Fixed	2,200 Ohms, 1/2 W.
R-13	Limiter Control	Variable	100,000 Ohms, 1 W.
R-14	Limiter Plate	Fixed	68,000 Ohms, 1/2 W.
R-15	Limiter Plate Filter	Fixed	270,000 Ohms, 1/2 W.
R-16	Limiter Load	Fixed	270,000 Ohms, 1/2 W.
R-17	HF Osc. Grid	Fixed	22,000 Ohms, 1/2 W.
R-18	HF Osc. Plate	Fixed	47,000 Ohms, 1/2 W.
R-19	VR Dropping	Fixed	2,200 Ohms, 2 W.
R-20	AVC Amp. Grid	Fixed	470,000 Ohms, 1/2 W.
R-21	Voltage Divider	Fixed	330 Ohms, 1/2 W.
R-22	RF Gain Control	Variable	10,000 Ohms, 1.5 W.
R-23	Voltage Divider	Fixed	1,800 Ohms, 2 W.
R-24	Voltage Divider	Fixed	1,800 Ohms, 2 W.
R-25	AVC Amp. Screen Filter	Fixed	33,000 Ohms, 1/2 W.
R-26	AVC Amp. Plate Filter	Fixed	2,200 Ohms, 1/2 W.
R-27	AVC Filter	Fixed	470,000 Ohms, 1/2 W.
R-28	AVC Load	Fixed	33,000 Ohms, 1/2 W.
R-29	AVC Filter	Fixed	100,000 Ohms, 1/2 W.
R-30	CW Osc. Grid Bias	Fixed	47,000 Ohms, 1/2 W.
R-31	CW Osc. Screen Filter	Fixed	100,000 Ohms, 1/2 W.
R-32	CW Osc. Screen Bleeder	Fixed	100,000 Ohms, 1/2 W.
R-33	CW Osc. Plate	Fixed	220,000 Ohms, 1/2 W.
R-34	AF Gain Control	Variable	500,000 Ohms, 1 W.
R-35	1st Audio Cathode	Fixed	2,200 Ohms, 1/2 W.
R-36	Inverse Feedback Voltage Divider	Fixed	100 Ohms, 1/2 W.
R-37	Inverse Feedback Voltage Divider	Fixed	10,000 Ohms, 1/2 W.
R-38	Tone Control	Variable	500,000 Ohms, 1 W.
R-39	1st Audio Screen Filter	Fixed	470,000 Ohms, 1/2 W.
R-40	1st Audio Plate	Fixed	100,000 Ohms, 1/2 W.

Symbol	Function	Type	Rating
	RESISTORS (Continued)		
R-41	1st Audio Plate Filter	Fixed	47,000 Ohms, 1/2 W.
R-42	2nd Audio Grid	Fixed	470,000 Ohms, 1/2 W.
R-43	2nd Audio Cathode	Fixed	270 Ohms, 2 W.
R-44	Headphone Load	Fixed	470 Ohms, 2 W.
	MISCELLANEOUS		
CF-1	Crystal Filter		455 Kc.
F-1	AC Line Fuse	Cart.	2 Amp., 250 V.
I-1	S-Meter Lamp	No. 47	0.15 Amp., 6-8 V.
I-2	Dial Lamp	No. 47	0.15 Amp., 6-8 V.
I-3	Dial Lamp	No. 47	0.15 Amp., 6-8 V.
J-1	Phono Jack		Multi-Circuit
J-2	Phones Jack		Multi-Circuit
L-1	CF-1 Input Tuning	Variable	Iron-Core Inductor
L-2	CF-1 Output Tuning	Variable	Iron-Core Inductor
L-3	T-11 Input Tuning	Variable	Iron-Core Inductor
L-4	T-11 Output Tuning	Variable	Iron-Core Inductor
L-5	T-12 Input Tuning	Variable	Iron-Core Inductor
L-6	T-12 Output Tuning	Variable	Iron-Core Inductor
L-7	Filter Choke	No. 80	17 Henries
L-8	T-18 Tuning	Variable	Iron-Core Inductor
L-9	T-19 Tuning	Variable	Iron-Core Inductor
M-1	Signal Strength Meter	S-Meter	
P-1	AC Line Plug and Cord		2 Contact
P-2	AC Jumper Plug	Octal	
S-1	RF Trans. Switch	Rotary	DP 5 Position
S-1A			Part of S-1
S-1B			Part of S-1
S-2	RF Trans. Band Switch	Rotary	DP 5 Position
S-2A			Part of S-2
S-2B			Part of S-2
S-3	1st Det. Trans. Band Switch	Rotary	DP 5 Position
S-3A			Part of S-3
S-3B			Part of S-3
S-4	1st Det. Trans. Band Switch	Rotary	DP 5 Position
S-4A			Part of S-4
S-4B			Part of S-4
S-5	Selectivity Control Switch	Rotary	DP 6 Position
S-6	Limiter Switch		S.P.D.T.
S-7	AC Line Switch		S.P.S.T.
S-8	Send - Receive Switch	Toggle	S.P.S.T.
S-9	HF Osc. Band Switch	Rotary	DP 5 Position
S-9A			Part of S-9
S-9B			Part of S-9
S-10	HF Osc. Band Switch	Rotary	DP 5 Position
S-10A			Part of S-10
S-10B			Part of S-10
S-11	AVC Switch	Toggle	S.P.S.T.
S-12	CW Osc. Switch	Rotary	S.P.D.T.
T-1	RF Amp. Trans.	A Band	
T-2	RF Amp. Trans.	B Band	
T-3	RF Amp. Trans.	C Band	
T-4	RF Amp. Trans.	D Band	
T-5	RF Amp. Trans.	E Band	
T-6	1st Det. Trans.	A Band	
T-7	1st Det. Trans.	B Band	
T-8	1st Det. Trans.	C Band	
T-9	1st Det. Trans.	D Band	
T-10	1st Det. Trans.	E Band	
T-11	2nd IF Trans.		455 Kc.
T-12	Det. Input Trans.		455 Kc.
T-13	HF Osc. Trans.	A Band	
T-14	HF Osc. Trans.	B Band	
T-15	HF Osc. Trans.	C Band	
T-16	HF Osc. Trans.	D Band	
T-17	HF Osc. Trans.	E Band	
T-18	AVC Amp. Trans.		
T-19	CW Osc. Trans.		455 Kc.
T-20	Audio Output Trans.		
T-21	Power Transformer		
V-1	RF Amplifier	6SG7	
V-2	Mixer	6SA7	
V-3	1st IF Amp.	6SG7	
V-4	2nd IF Amp.	6SG7	
V-5	2nd Det.-AVC	6H6	
V-6	Limiter	6H6	
V-7	Rectifier	5Y3GT/G	
V-8	HF Osc.	6J5	
V-9	Voltage Regulator	OD3/VR-150	
V-10	AVC Amp.	6AC7	
V-11	CW Osc.	6SJ7	
V-12	1st Audio	6SJ7	
V-13	Audio Output	6V6GT/G	
X-1	Battery Socket	Octal	
Y-1	Crystal Resonator		455 Kc.