

INSTRUCTION MANUAL

FOR THE

NATIONAL MODEL NC-88

RADIO RECEIVER

SECTION 1. DESCRIPTION

1-1. GENERAL

The new Model NC-88 is an excellent example of a communications-type receiver with that fine performance and rugged dependability so typical of all National Company products. The NC-88 has been designed to fill the needs of many varied classes, from the Amateur and Short Wave Listener to the many Commercial services and Civil Defense groups.

Eight miniature type tubes plus rectifier are utilized in the NC-88 in a modern superheterodyne circuit with a continuous frequency coverage of 540 kilocycles to 40 megacycles. Both voice and code telegraphy reception are provided to permit world-wide coverage over the entire range. The complete frequency coverage of the NC-88 is separated into four bands, with the entire main tuning dial and the 10, 11, 15, 20, 40 and 80 meter amateur bands on the bandspread dial calibrated directly in megacycles. A logging scale on the bandspread dial permits relative calibration of bandspread tuning anywhere within the range of the receiver, while clear markings on both dials, including location of the new civil defense frequencies, contribute greatly to ease of operation.

A phono jack has been installed on the rear of the NC-88 to accommodate most types of record players in use today, permitting the receiver to be used for music reproduction. Powerful, faithful audio is delivered to the built-in loudspeaker, while a two-position tone switch gives the listener his choice of crisp treble or rich bass response. The delayed automatic gain control circuit compensates for fluctuations in the strength of the received signal due to atmospheric conditions, etc., while an extremely effective automatic noise limiter circuit provides maximum suppression of most types of objectionable noise.

Two edge lighted slide-rule type lucite tuning dials add greatly to the handsome appearance of the steel cabinet enclosure making the NC-88 a distinctive addition to any room, while soft feet prevent marring of furniture.

1-2. AUDIO OUTPUT

Audio output is provided by the built-in five inch permanent magnet loudspeaker or at the headphone jack located on the front panel. The headphone load impedance is not critical, permitting use of a wide variety of headphones. The speaker is silenced when the headphones are inserted into the jack. A larger external speaker with an impedance of 4-8 ohms may be plugged into the headphone jack if so desired.

1-3. POWER REQUIREMENTS

The NC-88 requires a 105/130 volt, 50/60 cycle AC source of supply. Power consumption is approximately 62 watts.

1-4. FREQUENCY COVERAGE

The following table gives the frequency coverage of each band tuned by the NC-88 along with the letter designation of each band.

<u>Band</u>	<u>Frequency Range</u>	<u>Calibrated Bandspread</u>
A	540 to 1600 kc.	
B	1.6 to 4.7 mc.	80 meter amateur band
C	4.7 to 14.0 mc.	40 meter amateur band
D	14.0 to 40 mc.	10, 15 and 20 meter amateur bands

1-5. CONTROLS

The following controls appear on the front panel of the NC-88:

Antenna	ANL-Off
Main Tuning	Tone HI-LO
Bandspread Tuning	AM-CW
Sensitivity	Pitch
Receive-Standby Selector	A. C. Off-Volume

1-6. CIRCUIT

The stage associated with each of the nine tubes used by the NC-88 is given below, opposite the tube type.

<u>Tube Type</u>	<u>Stage</u>	<u>Tube Type</u>	<u>Stage</u>
6BA6	R. F. Amplifier	6AL5	2nd Detector, AGC and ANL
6BE6	Mixer	12AX7	1st Audio and C. W. Osc.
6C4	H. F. Oscillator	6AQ5	Audio Output Amplifier
6BD6	1st I. F. Amplifier	5Y3/GT	Rectifier
6BD6	2nd I. F. Amplifier		

SECTION 2. INSTALLATION

2-1. INSTALLATION PROCEDURE

Carefully remove the NC-88 from its packing box and proceed as follows:

1. Raise the hinged cover of the receiver by means of the two slots provided at the sides and make sure all tubes are seated firmly in their sockets.

2. Referring to Figure 1, locate the antenna terminal strip at the rear of the cabinet. Connections to this terminal strip are made by loosening the screw to be used and then wrapping the wire around the screw and tightening with a screwdriver so that the wire is held securely. The method to use in connecting the antenna to the receiver is as follows:

a. Single-Wire Type—The wire is connected to the left hand A terminal on the antenna terminal strip and the other A terminal connected to the G terminal by means of the metal link provided (see Figure 1).

b. Doublet Type—Connect each wire to a separate A terminal on the antenna terminal strip and disconnect the metal link from the A terminal.

c. Concentric Transmission Line (Coaxial Cable) Type—Connect the inner wire to the left hand A terminal on the terminal strip and the braided copper shield to the other A terminal, connecting this to the G terminal by means of the metal link.

3. Connect a wire from a good external ground (water pipe, radiator, etc. with the paint scraped off at the point of connection) to the terminal marked G on the terminal strip. This connection is not absolutely necessary but in certain localities a considerable reduction in noise may be effected. Refer to Figure 1 for an illustration of a typical

installation.

4. Turn the receiver off by rotating the A.C. Off-Volume control to the extreme counterclockwise position.

5. Connect the power cord to a 105/130 volt, 50/60 cycle AC source of supply. NOTE: Do not under any circumstance connect to a DC power line as serious damage to the receiver will result.

Your NC-88 is now ready for immediate operation; see Section 3 for a discussion of operating procedure.

2-2. ANTENNA RECOMMENDATIONS

The antenna input circuit of the NC-88 has been designed with a characteristic impedance of approximately 300 ohms but any mismatch will be compensated for by the antenna trimmer control and need not cause concern.

The NC-88 is designed to operate efficiently from varied types of antennae, making it readily adaptable to any installation, from one using simply a single wire to those using the most elaborate array tuned for a particular frequency. Where the receiver is to be used in a transmitting station probably the most effective solution is to connect the transmitting antenna to the receiver when the transmitter is not actually on the air. This may be accomplished by means of a suitable relay designed for antenna switching purposes. However, for most installations where the receiver is to be used over a wide range of frequencies the single wire type of antenna is recommended and is described below. Details on other types may be found in any of the numerous antenna books now on the market.

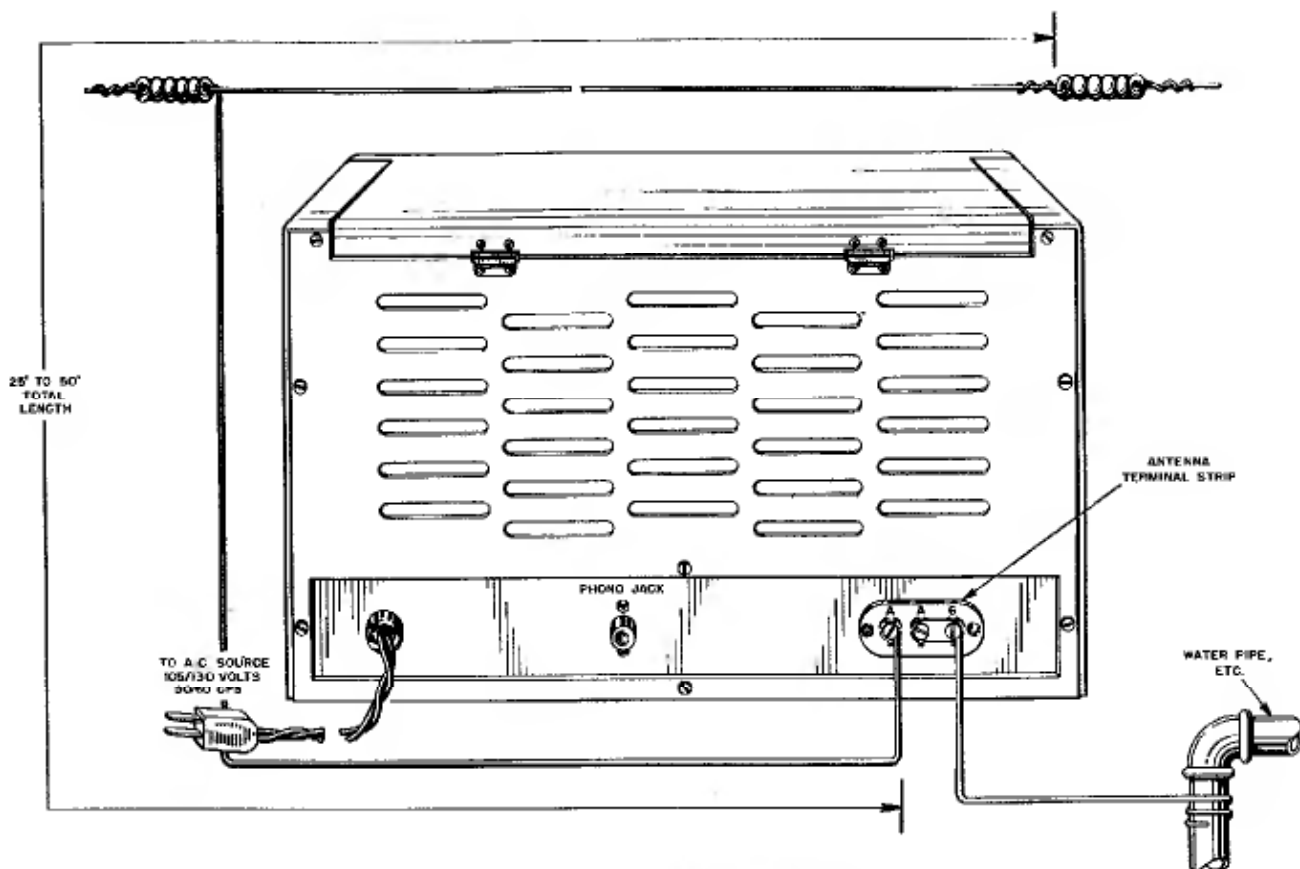


Figure 1. Typical Installation Plan

The single wire type of antenna is, as its name implies, merely a single length of wire which may or may not have an insulated covering. A total length of from 25 to 50 feet is recommended (i.e., the length of the wire from the receiver to the far end of the antenna) although this is not critical. The wire should be as high as possible and in the open, strung between two poles, the house and a pole, etc. with the wire insulated from the poles. One end of the wire is brought into the operating room and connected to the receiver, using standoff

insulators to prevent the wire from touching the house. It is not advisable to string the antenna to a tree unless some sort of strain relief is provided to allow for swaying of the tree in high winds which could cause the antenna to snap. NOTE: Extreme care must be taken when stringing the antenna in the vicinity of power lines. The antenna should be far enough away so that if it should snap it won't fall across these lines and cause a deadly short circuit.

SECTION 3. OPERATION

This section on operation of the NC-88 Receiver is presented to provide the operator with a clear understanding of his receiver in the shortest possible time, enabling him to operate it easily and efficiently.

3-1. CONTROLS

This discussion of controls is introduced prior to the actual operating instructions primarily to induce the layman to overcome that compelling urge to

"turn it on and see how the thing works". If he conscientiously reads this section and gains an understanding of the receiver instead of plunging headlong into the ether and perhaps being overcome by the seemingly garbled and innumerable transmissions being made, he will be able to calmly turn on the receiver and efficiently adjust the controls, the resultant being a source of never-ending listening enjoyment.

Proceeding from left to right on the front panel of the NC-88 the controls are:

Antenna -- intended to compensate for the many different types of antennae accommodated by the NC-88. Rotation of this control will, in most cases, produce a definite rise in volume of a signal or of receiver background noise. That position which produces maximum volume at the speaker is the optimum setting for a given frequency and antenna length and the Antenna control should be set at that position.

Main Tuning -- serves to vary the frequency of the receiver as indicated by the moveable pointer on the left hand dial. This control corresponds to the tuning control on the ordinary home radio and performs the same function, that of tuning in stations.

Bandsread -- performs essentially the same function as the Main Tuning control in that the receiver may be tuned using either. However, the Bandsread control performs a very valuable service by providing extremely fine tuning, enabling the operator to separate stations from one another much more easily than with the Main Tuning control. This feature will be found very useful on the crowded foreign and amateur bands where a number of stations occupy a very small portion of the main dial. For example, approximately seven complete rotations of the Bandsread control are required to change the frequency of the receiver the same amount as one complete rotation of the Main Tuning control.

Sensitivity -- determines the sensitivity (ability to receive weak or distant signals) of the receiver. For normal voice reception this control is left full "on" (extreme clockwise rotation). In the immediate vicinity of an exceptionally strong broadcast station, however, the Sensitivity control may be adjusted to prevent overload of the receiver.

For proper adjustment of the Sensitivity control for CW operation refer to paragraph 3-5.

Receive-Standby switch -- provides a means of quieting the receiver during transmission or other periods when it is desirable to resume reception without having to wait for the tubes to warm up. For normal reception this switch is kept in the Receive position. It MUST NOT be used to turn the receiver off since there is a power drain in either position with the A.C. Off switch turned on.

Selector -- a four-position switch used to determine the band of frequencies tuned by the receiver as indicated by the position of the red dot. When this switch is rotated the dot will be seen to stop at each of the letters A, B, C and D marked on the front panel designating the four bands tuned and corresponding to the identifying letters on the main

tuning dial scales.

ANL-Off switch -- controls the operation of the automatic noise limiter circuit. Placing this switch in the ANL position turns on the noise limiter and effectively reduces much objectionable noise, most commonly caused by fluorescent lights, automobile ignition, electric motors, etc., in the vicinity. The effect of the noise limiter will be most noticeable on the higher frequencies where noise is most likely to occur. Some slight reduction in volume may be noticed in the ANL position but this is a characteristic of the circuit used and does not indicate a defect of the receiver.

Tone HI-LO switch -- gives the operator his choice of two tone ranges depending upon the type of signal being received and his personal preference. The HI position produces a crisp, clear signal while the LO position imparts a rich bassness to music, etc.

AM-CW switch -- allows the operator to choose between AM voice reception and code telegraph (CW) reception. For normal voice or broadcast operation it should be left in the AM position, code reception requiring that it be left in the CW position. When in the CW position an audible tone of varying pitch is heard as the receiver is tuned to a station, this note being necessary for code reception but undesirable for voice. The CW position also disables the automatic gain control to eliminate the possibility of the beat oscillator overloading the automatic gain control circuit and reducing the sensitivity of the receiver.

Pitch -- provides a means of varying the pitch of the tone heard when the AM-CW switch is in the CW position and a signal is being received, this control being inoperative when the switch is in the AM position. Using the Pitch control the operator may select that note which is most pleasing to his ear for minimum listening fatigue over long periods of time.

A.C. Off-Volume -- corresponds to the volume control and on-off switch on the ordinary home radio, performing the dual function of turning the receiver on and off and controlling the audio volume. All power to the receiver is turned off with this control in the extreme counter-clockwise position and turned on as it is rotated a small amount clockwise, the extreme clockwise position producing maximum volume.

3-2. DIAL MARKINGS

Two slide-rule type tuning dials are used with the NC-88, one the main tuning dial and the other the bandsread tuning dial. This paragraph is intended

to give the operator an understanding of the marking system employed on each. During this discussion the operator should refer to the receiver itself in order to verify the points brought out.

The main tuning dial has four scales marked A, B, C and D corresponding to the four bands of frequencies tuned by the NC-88, the position of the red dot on the Selector switch indicating which of these scales is to be read. For example, if the Selector switch is in the B position you would read the B scale, the second from the top. Heavy white lines have been placed on certain portions of the short wave bands corresponding to important frequencies along with a letter to designate the agency which uses each. That is, the letter A above a heavy white line indicates a band used chiefly by amateurs, while the letter F denotes use by foreign countries, the letter S, ships, and P, police. There are also small white circles at various points on the scales enclosing an identifying number or letter. These circles indicate the correct setting of the main tuning dial pointer when bandsread tuning is to be used on that band and are discussed in the paragraph on bandsread tuning. The two circles enclosing the letters CD on the broadcast band, however, indicate the two civil defense frequencies and are dealt with in the paragraph on those frequencies.

The Bandsread dial has five scales calibrated directly in megacycles plus a logging scale graduated from 0 to 100. These scales are identified by a letter to indicate the receiver band to be used for a particular amateur band and a number to indicate the amateur band being tuned, with the exception of the logging scale which is identified by the word Log. Six principal amateur bands have been calibrated on the dial, the Log scale serving for calibration purposes on any other band within the range of the receiver. The word Set enclosed by a pointer is placed near 86 on the Log scale to indicate the correct position of the bandsread pointer when tuning is being done with the Main Tuning control. The bandsread pointer MUST be on the Set mark for calibration of the main tuning dial to be accurate.

3-3. TUNING

Tuning of the NC-88 is accomplished by means of either the Main Tuning or Bandsread controls. Remember this: the calibration of the main tuning dial is accurate ONLY when the bandsread pointer is on the Set mark. With the Bandsread control properly set, tuning is accomplished by turning the Main Tuning control and reading the frequency directly from the main tuning dial. Similarly the main

tuning pointer must be at the proper setting to insure correct bandsread tuning calibration.

Bandsread tuning of the receiver offers this as its chief advantage: it enables the operator to spread a portion of any band over a larger range than is possible with the main tuning control. Where a large number of stations are crowded together such as on the foreign or amateur bands, the bandsread control permits them to be separated from each other much more easily than with the main tuning control so that only one signal is received at a time.

To utilize the bandsread tuning feature on any band within the frequency range of the Receiver proceed as follows: set the Selector switch at the receiver band to be tuned and set the main tuning pointer at the upper limit of the range of frequencies to be tuned. The receiver may now be tuned with the bandsread control, using the Log scale for relative calibration. That is, the frequency may be approximated by noting the position of the pointer on the Log scale. In the case of the 10, 15, 20, 40 and 80 meter amateur bands, the upper limit of each of these bands on the main tuning dial has been located in the center of a white circle enclosing a number identifying the band. For example, to tune the 40 meter amateur band set the switch on band C as indicated by the letter C to the left of the 40 meter scale. Then set the main tuning pointer in the center of the circle enclosing the number 40 and tune the receiver with the bandsread control, using the second scale from the top on the bandsread dial, the 40 meter scale, to determine the frequency.

It will be noticed by the operator that certain frequencies seem to have a large number of stations operating at certain times while at other times there is no activity at all. It has been found that the amount of activity one can expect on a given frequency is largely dependent on the time of day and season of the year and can be predicted with reasonable accuracy. The following table gives the approximate frequencies in megacycles of foreign broadcast bands and the approximate time of day and season of the year when best reception may be expected on those bands.

	<u>Summer</u>	<u>Spring-Fall</u>	<u>Winter</u>
Morning	15, 20 mc.	14, 18, 20 mc.	6, 20 mc.
Afternoon	6, 12 mc.	12, 14, 18 20 mc.	6, 11, 14, 18, 20 mc.
Evening	6, 15, 20 mc.	6, 12, 14, 18, 20, 27, 33 mc.	6, 9, 14, 18 mc.

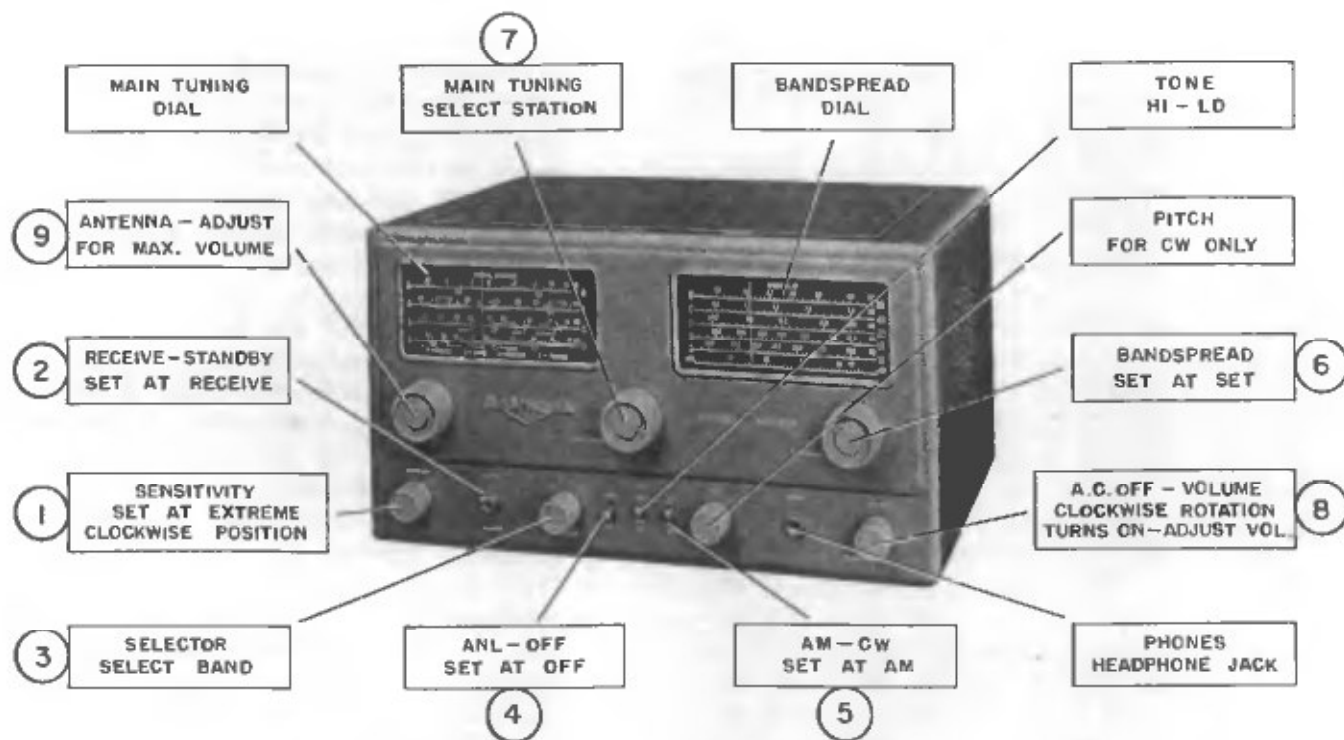


Figure 2. Simplified Operating Instructions

3-4. VOICE OR MUSIC RECEPTION

This paragraph outlines the correct procedure to be followed when setting up the NC-88 for voice or music reception and should be followed closely until the operator gains some degree of familiarity with his receiver. To facilitate tuning of the standard broadcast band all control settings to be observed have been marked in orange. Figure 2 contains pictorially the same information as is given in this paragraph.

Having installed the receiver as described in Section 2, proceed as follows:

1. Rotate the Sensitivity control to the extreme clockwise position.
2. Place the Receive-Standby switch in the Receive position.
3. Turn the Selector switch to the band to be used (band A is the broadcast band).
4. Place the ANL-Off switch in the Off position.
5. Place the AM-CW switch in the AM position for voice reception.
6. Set the Main Tuning dial pointer at the desired frequency.
7. Set the Bandsread pointer on the Set mark (near 86 on the LOG scale).
8. Turn the receiver on by rotating the A.C. Off-Volume control clockwise and adjust the volume

to the desired level.

9. Adjust the Antenna control for the position of maximum volume.

Adjustments During Operation

After the receiver has been placed in operation the following adjustments may improve reception of a desired signal:

1. The Sensitivity control should be adjusted according to the strength of the received signal. For strong local broadcast stations the best position will be 1/2 to 3/4 turn clockwise, while the extreme clockwise position is optimum for reception of weak signals.
2. Placing the ANL-Off switch in the ANL position will effectively suppress most types of objectionable noise which might interfere with the signal.
3. The Tone HI-LO switch may be placed in that position which produces the most desirable response according to the type of signal being received.

3-5. CODE TELEGRAPHY (CW) RECEPTION

For CW reception the Receiver should be placed in operation as described in paragraph 3-4 for voice reception with the following changes:

1. Set the AM-CW switch at CW.

2. Set the Sensitivity control at approximately mid-position.

3. Adjust the Pitch control so that the red dot on the knob is at the top center position.

4. Turn the A.C. Off-Volume control to the extreme clockwise position.

5. Tune the receiver until a "zero beat" with the signal is obtained. As the receiver is tuned to a CW signal a tone of varying pitch is heard, starting with a high note and going down until a position is found where no tone is present. As the receiver is tuned further in the same direction a note will again be heard, varying from a low pitch to a higher. The midpoint of these two notes, or the position which produces no audible tone, is called "zero beat" and it is this point to which the receiver should be tuned.

6. Adjust the Pitch control to that position which provides the most pleasing signal for the operator to copy and set the Sensitivity control for the desired volume.

It will be noted that for CW operation the functions of the Sensitivity and A.C. Off-Volume controls are interchanged, the latter being left full on, and the Sensitivity control used as the volume control.

3-6. PHONO OPERATION

The NC-88 has been equipped with a phono jack (see Figure 1) which will accommodate a standard phono tip plug so that a record player not equipped with an amplifier may be operated through the audio circuits of the receiver. If the record player has other than a standard phono tip plug, the correct fitting can be readily installed. The NC-88 has a

high impedance phono input circuit and is suitable for use with crystal pickups. Variable reluctance type cartridges cannot be used both because their output is too low without an additional amplifier and special compensation is required for correct tonal reproduction.

To connect the phonograph for operation through the receiver, first place the receiver in operation as described in paragraph 3-4, but rotate the Sensitivity control to the extreme counterclockwise position. Plug the phono tip plug into the phono jack on the receiver and adjust the A.C. Off-Volume control for the desired volume. The A.C. Off-Volume and Tone controls perform their normal functions during phono operation.

3-7. THE CIVIL DEFENSE FREQUENCIES

Recently the Federal Communications Commission authorized the frequencies 640 and 1240 kilocycles for use by broadcast stations in the event the United States should be placed under threat of air attack. In that event all transmitters will be required by law to immediately cease all operation, with broadcast stations resuming operation on only those two frequencies. Accordingly, these frequencies have been clearly marked on the A scale of the NC-88 and are identified by circles enclosing the letters, CD. To receive either of these two frequencies place the receiver in operation for the broadcast band and set the Bandsread pointer on the Set mark. Then set the Main Tuning dial pointer in the center of either of the two circles and the receiver will be set up for proper reception of emergency bulletins.

SECTION 4. ALIGNMENT DATA

Realignment of the NC-88 should not be necessary until the receiver has been in use for a considerable length of time, when aging of components may gradually produce a change in individual electrical characteristics and cause the receiver to suffer a loss of sensitivity. Realignment should not be attempted until it has been definitely established as necessary by a check of receiver performance against normal expected performance. In no case must realignment be attempted by any person not thoroughly familiar with communications type receivers.

In general, realignment of the NC-88 may be divided into two steps:

1. I.F. Alignment

2. R.F. Alignment

Paragraph 4-1 gives the procedure for aligning the intermediate frequency amplifier stages while paragraph 4-2 outlines alignment of the oscillator and mixer stages. See Figures 3 and 4 for location of alignment adjustments.

4-1. I. F. ALIGNMENT

The intermediate frequency of the NC-88 is 455 kilocycles, the resonant frequencies of the two

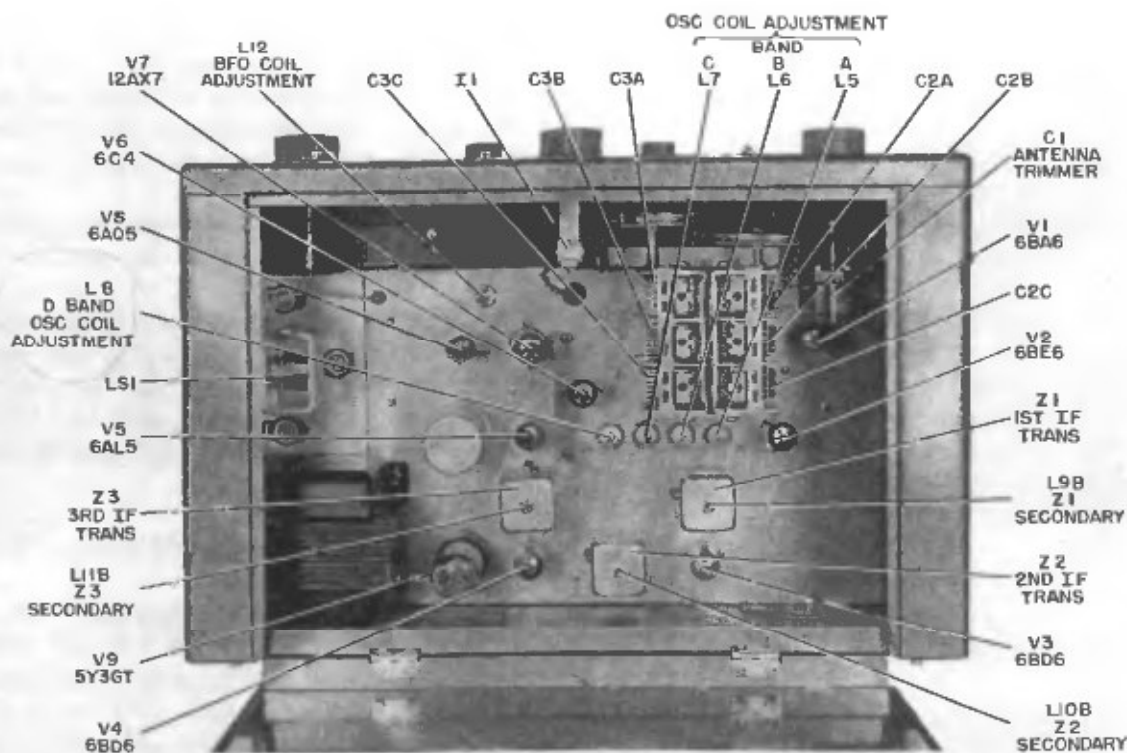


Figure 3. Component Locations, Top View of Receiver

I.F. transformers and the detector input transformer being determined by the two adjustable iron cores within each transformer. L.F. alignment of the NC-88 is conventional, working back from the detector input to the mixer output while adjusting first the secondary and then the primary of each transformer in turn. A thin screwdriver with an insulated handle and a 1/16" blade which will fit into the recess in the adjustable cores will serve as an aligning tool. The primary of each transformer is accessible from underneath the chassis through a hole in the shield can, while the secondary is accessible through the hole in the top of the can.

I.F. alignment is accomplished as follows:

1. Set the receiver controls for normal voice operation as described in paragraph 3-4.
2. Disconnect the antenna from the antenna terminal strip and rotate the Sensitivity control to the extreme counterclockwise position.
3. Connect the output lead of an accurately calibrated, modulated signal generator through a 0.01 mfd capacitor to the stator of the center section of the main tuning capacitor and connect the ground lead to any convenient chassis point.
4. Connect an A.C. voltmeter across the secondary of the output transformer. This connection may be made directly to the loudspeaker terminals.
5. Tune the signal generator to exactly 455 kilocycles and turn the modulation on. Adjust the output

of the signal generator and the volume control of the receiver for a suitable deflection of the volt meter. Set the voltmeter on the lowest usable scale.

6. Using the proper aligning tool, adjust first the secondary and then the primary of Z-3 for maximum deflection of the meter.

7. In the same manner, tune Z-2 and Z-1 for maximum indication on the output meter.

8. Repeat the above procedure making sure that all adjustments have been correctly made.

At this point the alignment of the beat frequency oscillator may be checked by placing the AM-CW switch in the CW position and turning off the signal generator modulation. Using the Pitch control tune the BFO until zero beat with the test signal is obtained. Zero beat should occur with the red dot on the Pitch control at the top dead center position. If zero beat occurs with the dot in any other position realignment of the beat frequency oscillator is necessary and may be accomplished as follows:

1. Set the Pitch control so the red dot is at top center.
2. Locate L-12 on top of the chassis and adjust the tuning screw until zero beat is obtained.

4-2. R. F. ALIGNMENT

The first step in aligning the R.F. section of the NC-88 is to determine whether or not the receiver

calibration is correct and, if found to be incorrect, whether it is a mechanical or electrical error. Incorrect mechanical calibration is evidenced by the frequency readings being off a certain equal linear amount on all bands, while incorrect electrical calibration produces readings which are off on one band only or a different amount on each band.

To effect mechanical correction of calibration of the main tuning dial, set the rotors of the main tuning capacitor flush with the stators. Hold the Main Tuning control with one hand to keep the capacitor from moving and set the pointer at the first marker on the C scale (just to the left of 4.7 mc). The procedure for mechanical correction of bandspread

calibration is the same except that correction is made with the bandspread capacitor and pointer. The correct pointer setting is at zero on the log scale.

Table 4-1 gives, in proper order, the adjustments to be made for alignment of the oscillator and mixer stages of the NC-88. For all of these adjustments the modulated output of a signal generator is connected to the antenna input terminals through a standard dummy antenna of 300 ohms and the A.C. voltmeter connected across the loudspeaker terminals. On the A, B and C bands the oscillator operates on the high side, the D band operates on the low side.

TABLE 4-1. ALIGNMENT DATA

Step	Band	Adjust Signal Source to:	Set Main Tuning Dial at:	Set Bandspread Dial at:	Adjust to Receive Test Signal:	Adjust for Maximum Output
1	A	1.6 mc.	1.6 mc.	Set	C-39	C-9
2	A	0.6 mc.	0.6 mc.	Set	L-5	
3	A	Repeat steps 1 and 2				
4	B	4.0 mc.	4.0 mc.	Set	C-40	C-10
5	B	1.6 mc.	1.6 mc.	Set	L-6	
6	B	Repeat steps 4 and 5				
7	C	14.0 mc.	14.0 mc.	Set	C-41*	C-11**
8	C	5.0 mc.	5.0 mc.	Set	L-7	
9	C	Repeat steps 7 and 8				
10	D	30.0 mc.	30.0 mc.	Set	C-42**	C-12*
11	D	15.0 mc.	15.0 mc.	Set	L-8***	
12	D	Repeat steps 10 and 11				

* If signal is found at two settings use setting closest to minimum capacity.

** If signal is found at two settings use setting closest to maximum capacity.

*** To set L-8, unscrew the slug as far as possible. The second signal obtained while screwing the slug back in is the correct one.

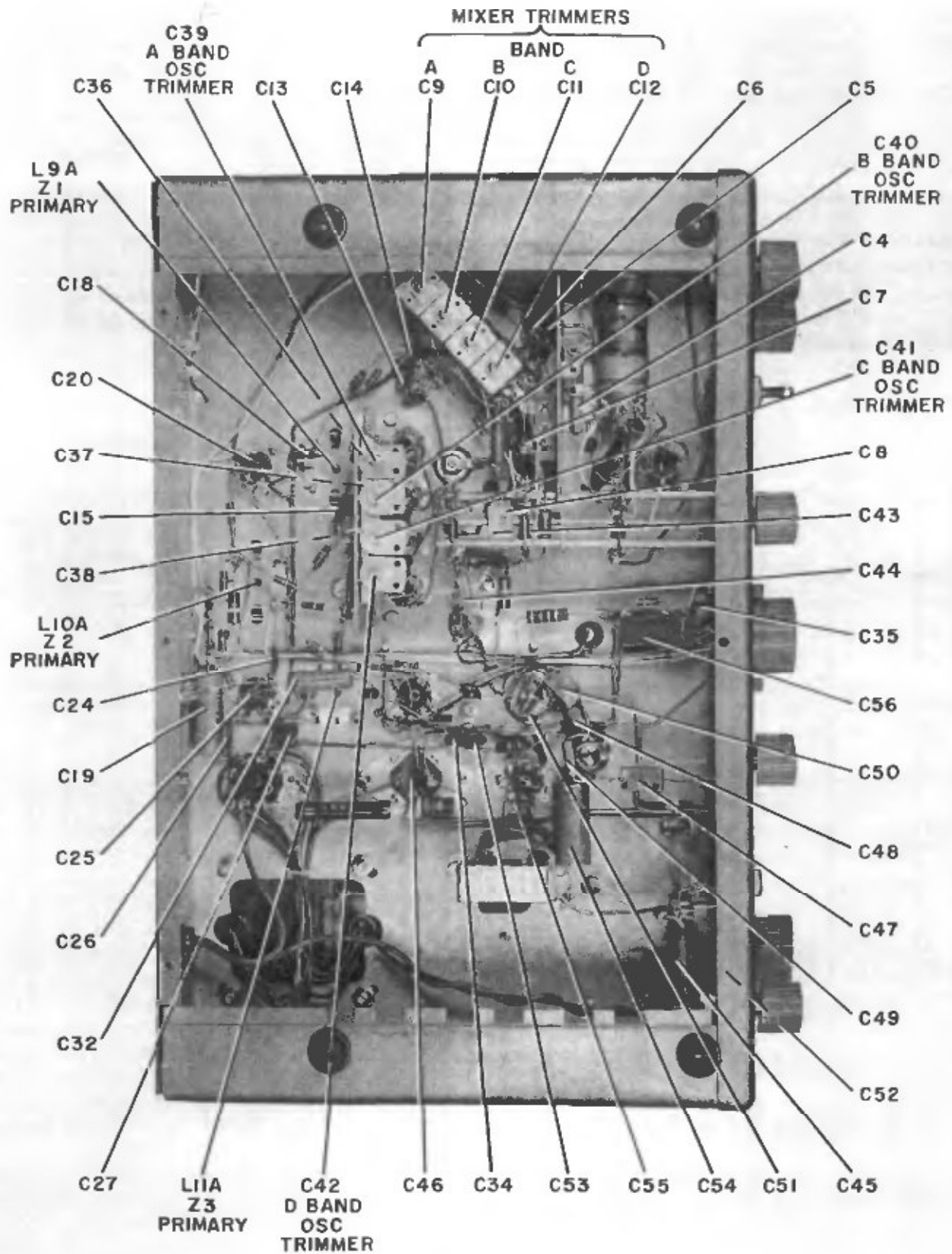


Figure 4. Capacitor and Alignment Adjustment Locations, Bottom View of Receiver

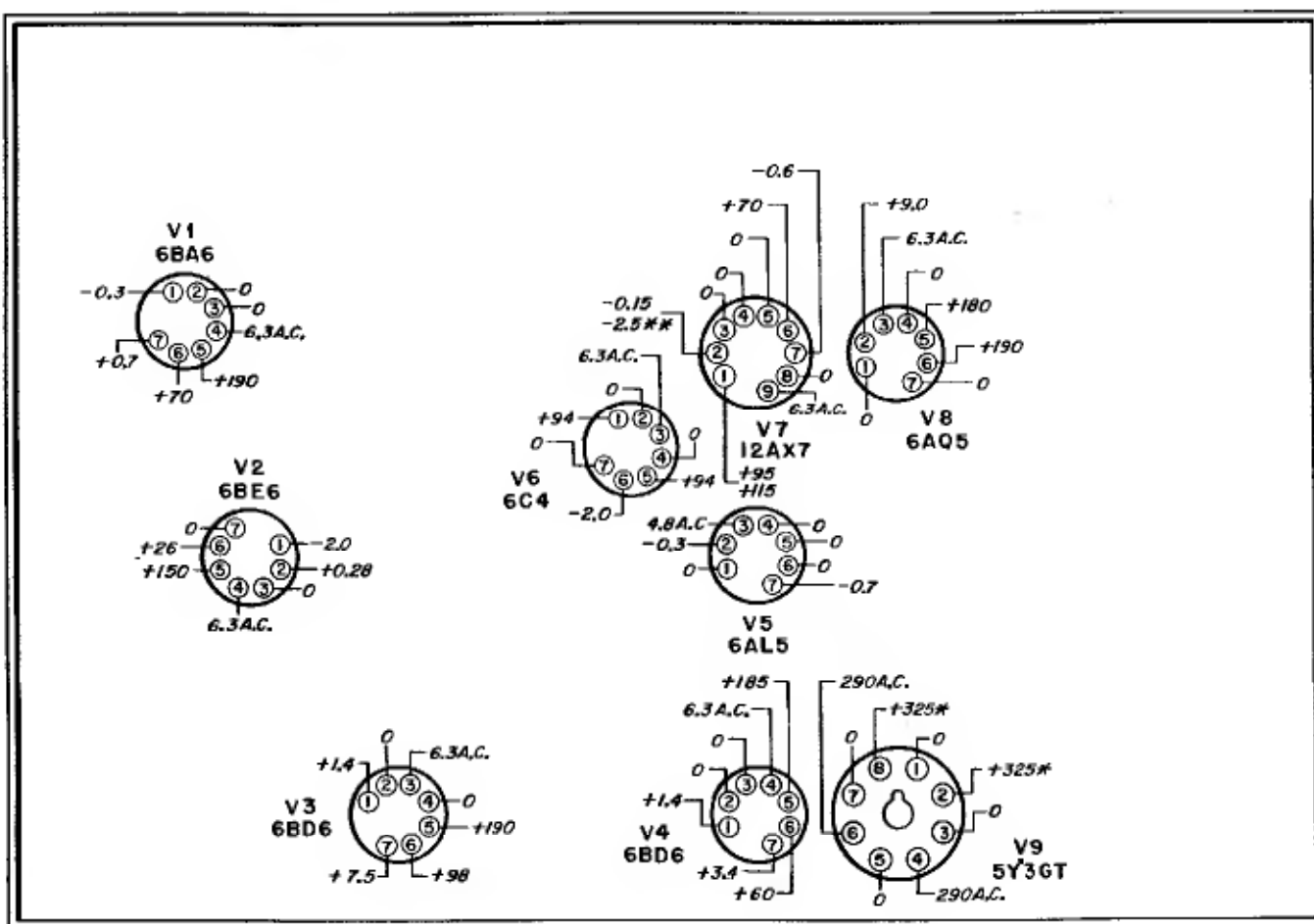
4-3. VOLTAGE DATA

In order to facilitate any servicing which might be required on the NC-88, Figure 5 is presented and includes a diagram of tube locations as viewed from underneath the chassis together with voltage measurements taken using a high impedance vacuum-tube voltmeter between the pins of each tube and the chassis. Except where otherwise noted, all voltages are DC and obtained with an input voltage of 115 VAC to the receiver. The following control settings

must be observed when taking voltage measurements:

Sensitivity	Extreme clockwise position
Receive-Standby	Set to Receive
Selector	Set to band A
ANL-Off	Set at Off
Tone HI-LO	Set at HI
AM-CW	Set at CW
A.C. Off-Volume	Extreme clockwise position
Bandspread	Place on Set mark
Main Tuning	Set to 700 kilocycles

FRONT



ALL READINGS PLUS OR MINUS 10 %

* 5.0A.C. BETWEEN PINS 2 AND 8 OF V9

** AM-CW SWITCH SET TO CW

Figure 5. Tube Socket-to-Chassis Voltage Measurements

4-4. DIAL STRINGING

Should the dial string mechanism require repair refer to Figure 6.

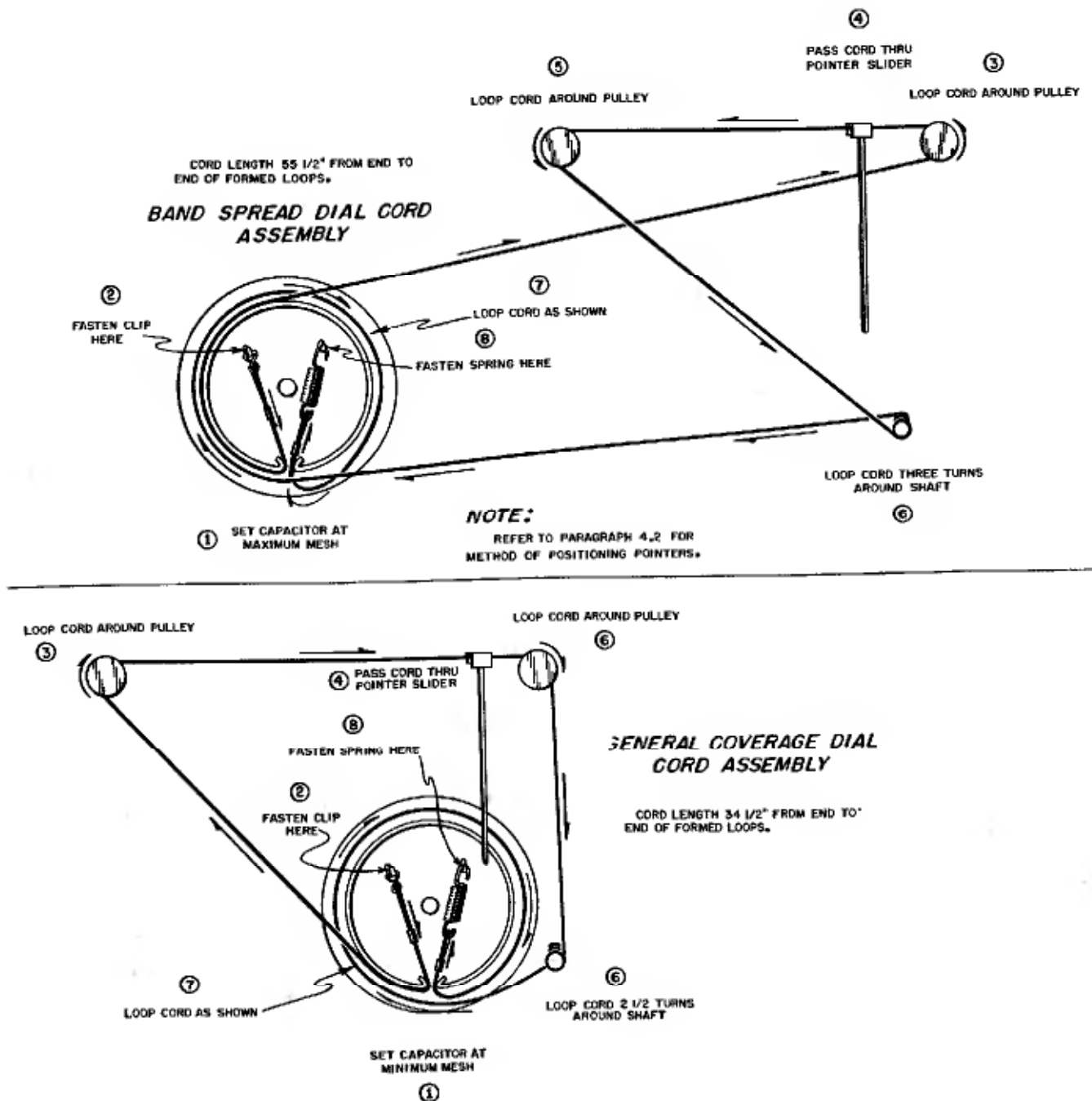


Figure 6. Dial Cord Stringing Guide

PARTS LIST

Symbol	Description	Nat. Co. Type
CAPACITORS		
C1	Air Variable, 5-50 mmf	S662-1
C2	Air Variable, 3-section, 10-37 mmf per section	P706-2
C2A	Part of C2	
C2B	Part of C2	
C2C	Part of C2	
C3	Air Variable, 3-section, 13-454 mmf per section	P705-2
C3A	Part of C3	
C3B	Part of C3	
C3C	Part of C3	
C4	Mica, 220 mmf	J665-44
C5	Ceramic, disc type, 0.01 mf	K946-2
C6	Ceramic, disc type, 0.01 mf	K946-2
C7	Ceramic, disc type, 0.01 mf	K946-2
C8	Mica, 510 mmf $\pm 5\%$	J665-57
C9	Variable, mica, 2.2-40 mmf	D832-5
C10	Variable, mica, 2.2-40 mmf	D832-5
C11	Variable, mica, 2.2-40 mmf	D832-5
C12	Variable, mica, 2.2-40 mmf	D832-5
C13	Ceramic, disc type, 0.01 mf	K946-2
C14	Ceramic, disc type, 0.01 mf	K946-2
C15	Ceramic, disc type, 0.01 mf	K946-2
C16	87 mmf; part of Z1	
C17	87 mmf; part of Z1	
C18	Ceramic, disc type, 0.01 mf	K946-2
C19	Paper, 0.1 mf, 400 v	Q693-34
C20	Ceramic, disc type, 0.01 mf	K946-2
C21	Not used	
C22	87 mmf; part of Z2	
C23	87 mmf; part of Z2	
C24	Ceramic, disc type, 0.01 mf	K946-2
C25	Ceramic, disc type, 0.01 mf	K946-2
C26	Ceramic, disc type, 0.01 mf	K946-2
C27	Ceramic, disc type, 0.01 mf	K946-2
C28	110 mmf; part of Z3	
C29	110 mmf; part of Z3	
C30	100 mmf; part of Z3	
C31	100 mmf; part of Z3	
C32	Paper, 0.01 mf, 400 v	Q963-19
C33	Not used	
C34	Ceramic, disc type, 0.01 mf	K946-2
C35	Ceramic, disc type, 0.01 mf	K946-2
C36	Mica, 470 mmf $\pm 5\%$	J665-55
C37	Mica, 0.001 mf $\pm 5\%$	J665-70
C38	Mica, 0.003 mf	J666-30
C39	Variable, ceramic, 5-20 mmf	E311-2
C40	Variable, ceramic, 5-20 mmf	E311-2

Symbol	Description	Nat. Co. Type
C41	Variable, ceramic, 2.5-6 mmf	E311-1
C42	Variable, ceramic, 2.5-6 mmf	E311-1
C43	Mica, 220 mmf	J665-44
C44	Mica, 0.001 mf	J665-71
C45	Paper, 0.047 mf, 400 v	Q693-28
C46	3-section, 20 mf per section, $\pm 20\%$, 450 v	H325-2
C46A	Part of C46	
C46B	Part of C46	
C46C	Part of C46	
C47	Mica, 270 mmf	J665-47
C48	Paper, 0.01 mf, 400 v	Q693-19
C49	Mica, 220 mmf	J665-44
C50	Mica, 270 mmf	J665-47
C51	Ceramic, 47 mmf	D825D-447
C52	Paper, 0.01 mf, 400 v	Q693-19
C53	Ceramic, disc type, 0.01 mf	K946-2
C54	Electrolytic, 25 mf, 50 v	E338-4
C55	Ceramic, disc type, 0.01 mf	K946-2
C56	Paper, 0.047 mf, 400 v	Q693-28

All capacitors are fixed, $\pm 10\%$ tolerance, 500 volts working except where noted otherwise.

RESISTORS		
R1	Fixed, 470,000 ohms	J569-57
R2	Fixed, 68 ohms	J569-11
R3	Variable, wire wound, 10,000 ohms	K349-3
R4	Fixed, 47,000 ohms	J569-45
R5	Fixed, 15,000 ohms	J571-39
R6	Fixed, 33 ohms	J569-7
R7	Fixed, 220 ohms	J569-17
R8	Fixed, 150,000 ohms	J569-51
R9	Fixed, 220 ohms	J569-17
R10	Fixed, 270,000 ohms	J569-54
R11	Fixed, 2,200 ohms	J569-29
R12	Fixed, 100,000 ohms	J569-49
R13	Fixed, 680 ohms	J569-23
R14	Fixed, 100,000 ohms	J569-49
R15	Fixed, 2,200 ohms	J569-29
R16	Fixed, 47,000 ohms	J569-45
R17	Fixed, 270,000 ohms	J569-54
R18	Fixed, 270,000 ohms	J569-54
R19	Fixed, 1 megohm	J569-61
R20	Fixed, 1 megohm	J569-61
R21	Fixed, 15,000 ohms, 1 watt	J571-39
R22	Fixed, 150 ohms	J569-15
R23	Fixed, 47,000 ohms	J569-45
R24	Fixed, 100,000 ohms, 1 watt	J571-49
R25	Fixed, 150,000 ohms	J569-51

PARTS LIST (CONT'D)

Symbol	Description	Nat. Co. Type
R26	Fixed, 6,800 ohms	J569-35
R27	Fixed, 2.2 megohms	J569-65
R28	Fixed, wire wound, 2,000 ohms, 10 watt	M707-2
R29	Fixed, 4,700 ohms, 2 watt	J572-33
R30	Fixed, 4,700 ohms	J569-33
R31	Variable, 1,500 ohms	K915-16
R32	Fixed, 47,000 ohms, 1 watt	J571-45
R33	Fixed, 100,000 ohms	J569-49
R34	Fixed, 10 megohms	J569-73
R35	Variable, 500,000 ohms, with SPST switch	K347-1
R36	Fixed, 470,000 ohms	H569-57
R37	Fixed, 270 ohms, 1 watt	J571-18
R38	Fixed, 22 ohms, 1 watt	J571-5
R39	Fixed, 10 ohms	J569-1
R40	Fixed, 10 ohms	J569-1
R41	Fixed, 2.2 megohms	J569-65
R42	Fixed, 68 ohms	J569-11
R43	Fixed, 2,200 ohms	J569-29

All resistors 1/2 watt, $\pm 10\%$ except where otherwise noted.

MISCELLANEOUS		
E1	Antenna terminal strip	E261-3
E2	Knobs, large (3 used)	SA:5292-2
E3	Knobs, small (4 used)	SA:9305
I1	Pilot light, type 47	F136-11
J1	Headphone jack	K314-1
J2	Phono jack	J993-1
L1	R.F. coil, bands A,B,C	SB:1517
L2	R.F. coil, band D	SB:1519
L3	Mixer coil, bands A,B,C	SB:1518
L4	Mixer coil, band D	SB:1520
L5	Variable, iron core; band A oscillator coil	SB:1573-1
L6	Variable, iron core; band B oscillator coil	SB:1574-1
L7	Variable, iron core; band C oscillator coil	SB:1575-1
L8	Variable, iron core; band D oscillator coil	SB:1576-1
L9A	Variable, iron core; Z1	Part of Z1

Symbol	Description	Nat. Co. Type
L9B	primary Variable, iron core; Z1	Part of Z1
L10A	secondary Variable, iron core; Z2 primary	Part of Z2
L10B	Variable, iron core; Z2	Part of Z2
L11A	secondary Variable, iron core; Z3	Part of Z3
L11B	primary Variable, iron core; Z3	Part of Z3
L12	secondary Variable, brass core, BFO coil	SA:5361
P1	A.C. line cord and plug, 2-wire	E544-1
S1	3-deck, 6-section rotary switch	S245-1
S2	Slide switch, SPDT	L209-2
S3	Toggle switch, SPST	E230-2
S4	Slide switch, SPDT	L209-2
S5	Slide switch, SPDT	L209-2
S6	A.C. Off switch, SPST	Part of R53
T1	Audio output transformer, 5,000 ohms primary to 3.2 ohms secondary	K313-3
T2	Power transformer, 105/130 volt, 50/60 cycle AC primary, secondary 300-0-300 vac at 100 ma, 5 vac at 2.0 amp and 6.3 vac at 3.0 amp	K316-5
V1	Tube, type 6BA6	
V2	Tube, type 6BE6	
V3	Tube, type 6BD6	
V4	Tube, type 6BD6	
V5	Tube, type 6AL5	
V6	Tube, type 6C4	
V7	Tube, type 12AX7	
V8	Tube, type 6AQ5	
V9	Tube, type 5Y3GT	
Z1	1st I.F. Transformer, 455 kc	Q242-2
Z2	2nd I.F. Transformer, 455 kc	Q242-2
Z3	Det. Input Transformer, 455 kc	Q242-1
Z4	Printed circuit type PC-71	R983-1
LS1	Loudspeaker, 5-inch permanent magnet	J726-1

Standard Form Warranty

Adopted by the Radio Manufacturers Association, Inc.

This equipment is warranted to be free from defective material and workmanship and repair or replacement will be made of any part which under normal installation, use and service discloses defect, provided the unit is delivered by the owner to the manufacturer or through the authorized radio dealer or wholesaler from whom purchased, intact, for examination, with all transportation charges prepaid to the factory, within ninety days from the date of original shipment from the factory, and provided that such examination discloses in the manufacturer's judgment that it is thus defective.

This warranty does not extend to any radio products which have been subjected to misuse, neglect, accident, incorrect wiring, improper installation, or to use in violation of instructions furnished by the manufacturer, nor extend to units which have been repaired or altered outside of the factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith of other manufacture.

Any part of a unit approved for remedy or exchange hereunder will be remedied or exchanged by the authorized radio dealer or wholesaler without charge to the owner.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for the manufacturer any other liability in connection with the sale of their radio products.

National Company, Inc. reserves the right to make any change in design or to make addition to, or improvements in, its products without imposing any obligations upon itself to install them in its products previously manufactured.

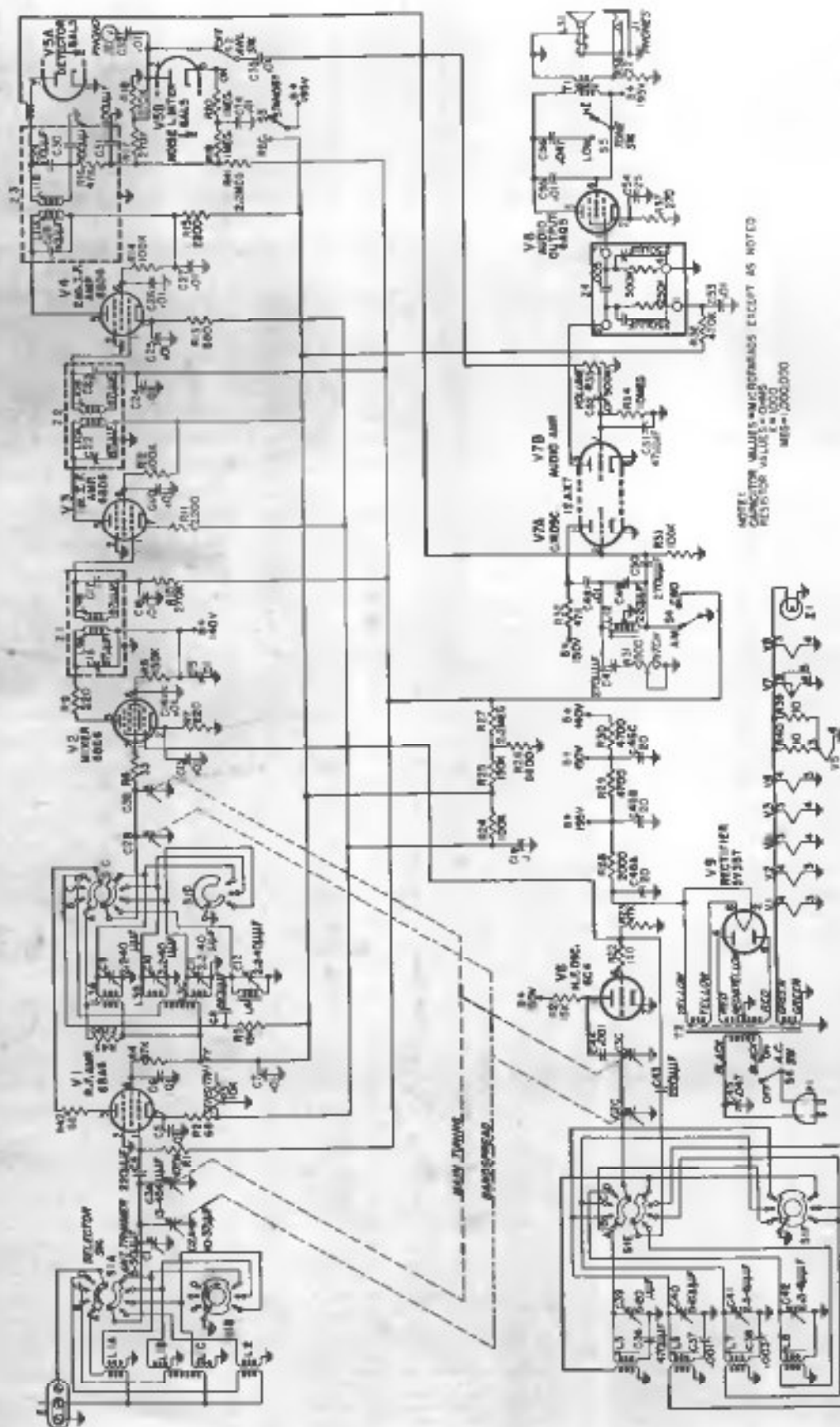


Figure 8. Schematic Diagram

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