

# **INSTRUCTION MANUAL**

for

## **THE**

## **NATIONAL**

# **NC-100**

## **COMMUNICATION**

## **RECEIVER SERIES**

**NC-100A**

**NC-100XA**

**NC-101X**

**NC-101XA**

A series of receivers which meets a wide range of high frequency and broadcast reception requirements.

PRICE 10 CENTS



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THE soundness of the original design of the NC-100 series of receivers has now, with time, proved its real worth. We have, however, an established policy whereby our receivers are constantly being improved and kept up to date. Many of the changes do not show, particularly where the outward appearance of the receiver is concerned, and their presence is discernible only by the higher standard of performance. In the present case, the revision includes the extremely effective series-valve noise limiter (developed in our laboratories) and alteration of the tone control and S-meter circuits. We have, of course, retained all the valuable features of the NC-100A design, such as the automatic plug-in coil system of band changing, and the combination full vision calibrated dial with its band spread vernier.

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NATIONAL COMPANY, INC.

MALDEN, MASS.

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# THE NC-100A RECEIVER

## GENERAL DESCRIPTION

THE NC-100A receiver is an eleven tube super-heterodyne covering all frequencies from 540 to 30,000 kc., in five ranges. The circuit employed on all ranges consists of one stage of R.F., separate first detector and high frequency oscillator, two I.F. stages, an infinite impedance diode detector and a transformer coupled push-pull pentode output stage. Maximum undistorted audio output is 7 watts. The second detector utilizes one set of elements of a dual triode; the other set of elements is utilized for the series-valve noise limiter. Separate sections of a second dual triode are used for the AVC and first audio amplifier. A separate tube is used as a beat frequency oscillator and is coupled to the second detector for C.W. reception. A built-in power supply provides all voltages required, including excitation for a dynamic speaker field having a resistance of 500 ohms.

Aside from the unusually high sensitivity and selectivity of this receiver, the outstanding feature is the unique system of automatic coil changing. The simplicity and efficiency of the arrangement combines all the desirable features of plug-in coils and coil switching. It is described in some detail later.

## TUBES

The NC-100A is supplied complete with tubes which are tested in the receiver at the time of alignment.

The tubes employed are as follows:

R.F. Preselector.....	6K7
First Detector.....	6J7
High Frequency Oscillator.....	6J7
First I.F.....	6K7
Second I.F.....	6K7
Second Detector, Limiter.....	6C8G
AVC, First Audio.....	6F8G
Beat Frequency Oscillator.....	6J7
Push-Pull Output (2).....	6F6G
Rectifier.....	80

## ANTENNA

The input circuit of the NC-100A is arranged for operation with either the doublet type or the single-wire type of antenna. There are two input binding posts. When using a single-wire antenna, the lead-in should be connected to one antenna post and the short flexible lead, which is connected to the chassis, should be clamped under the other terminal. An

external ground connection may or may not be necessary, depending upon the installation. The ground is usually desirable when receiving wavelengths above 100 meters, but for wavelengths below 50 meters, the use of a ground may actually weaken signals. Doublet antenna feeders should be connected directly to the input terminals and the flexible ground connection, mentioned above, is not used at all. The input impedance of the receiver varies over the total frequency range but averages about 500 ohms.

## OUTPUT CIRCUIT

As shown in the schematic diagram, Page 16, the output leads of the receiver are brought to a 4-prong socket, which is mounted at the rear of the chassis. The speaker furnished with the receiver is supplied with a cable and plug, which is simply plugged into this socket.

A headphone jack is mounted on the front panel and is wired in such a manner that the speaker is quiet when the phones are in use. The impedance of the headphones should be approximately 20,000 ohms, this being the usual impedance of phones having a total DC resistance of between 2000 and 3000 ohms. The receiver cannot be operated unless the speaker plug is inserted in its socket, even though the speaker itself is not being used.

## SPEAKER MOUNTING

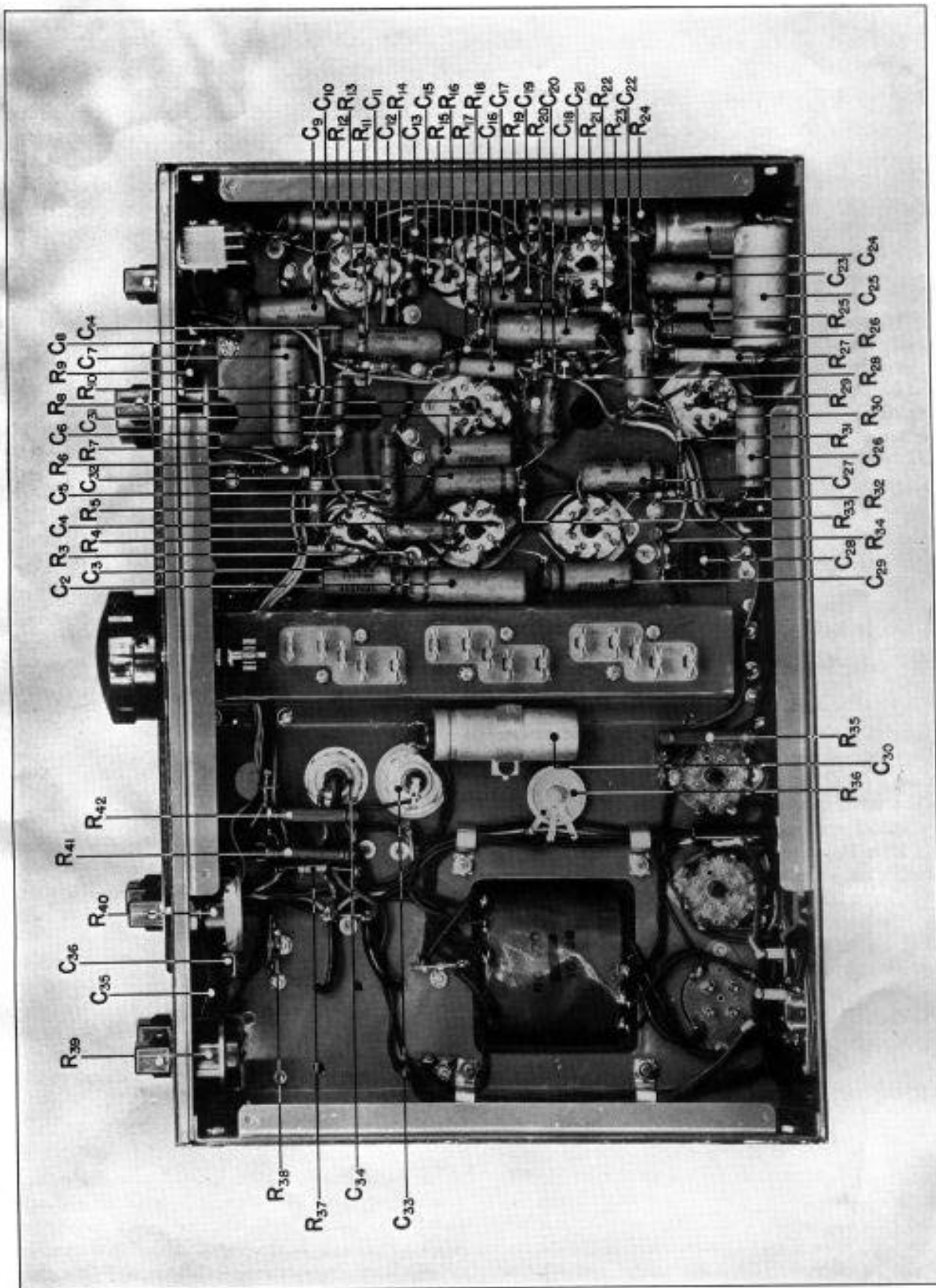
The speaker is supplied either in chassis form, unmounted, or mounted in a small cabinet finished to match the receiver. To obtain best tone quality the speaker should be mounted on a large baffle isolated mechanically from the receiver. The baffle should be of non-resonant material, so that it will not vibrate. A baffle three or four feet square will generally prove satisfactory. More uniform bass response will be obtained by increasing the baffle size up to about 9 feet square.

Mounting the speaker and receiver in the same cabinet, or console, is not recommended, since vibration from the speaker is apt to be transferred to the tubes, producing microphonic noises.

## CONTROLS

The main tuning dial is located near the center of the front panel and is of a new direct reading illuminated type with a pointer that moves radially in conjunction with the range shifting mechanism so as to indicate the proper scale at all times. In the case





Bottom View of NC-100A





of the NC-101X, the dial is of the multi-revolution instrument type operating through a spring-loaded gear train having a step-down ratio of 20 to 1. In tuning across any one coil range, the dial makes ten complete revolutions and since its diameter is four inches, the equivalent scale length is approximately twelve feet. There are fifty divisions about  $\frac{1}{4}$ " apart around the circumference of the dial and the index numbers are changed automatically as the dial is rotated by means of an epicyclic gearing, so that the calibration is numbered consecutively from 0 to 500. The index numbers are actually changing continuously, the shift occurring at the bottom of the dial where it is not ordinarily visible.

Through this mechanism it is thus possible to obtain a continuous dial reading from 0 to 500, with the result that all signals are well spread out on the scale, making tuning and logging both convenient and precise.

The tuning system is so arranged that the dial reading increases with frequency, as shown by the calibration curves on Page 13.

Immediately below the dial is the range selector knob which actuates the coil changing mechanism. This knob must be rotated approximately one turn to change from one range to another. The arrangement is unique in that each individual coil is completely shielded from all others and that only the coils actually in use are in any way connected in the circuit. This automatic "plug-in coil" system is extremely efficient. Dead spots, often occurring when using unshielded coils in conjunction with a switch are, of course, completely absent and the particular coils in use are in the best position both mechanically and electrically. The relatively large movement of the coils, when changing from one range to another, makes possible the use of rugged contactors of such construction that trouble-free performance is assured.

The five coil ranges are marked on the front panel in a horizontal line directly over the range selector knob. Each of the range markings has a small "window" in back of which an indicator appears when that particular coil assembly is plugged into the circuit.

Starting at the left-hand side of the front panel the uppermost knob is the tone control for varying the frequency characteristics of the audio amplifier. The tone control circuit is such that normal audio range, indicated by "N" on the control plate, is near the extreme counterclockwise position. As the control is turned to the right, high audio frequencies are attenuated in such a manner that the response at 3000 cycles is decreased about 10 db. When the control is turned from the "N" position to the left, a

series condenser is switched into the circuit which cuts low audio frequencies so that the response at 100 cycles is down about 10 db. The tone control plate is labeled "High" at the left to indicate a high pitched audio characteristic with the lows weakened, and "Low" at the right where the low frequencies predominate. When receiving strong signals, free from interference, best audio quality will be obtained with the tone control set at "N." When receiving fairly weak signals through considerable interference, it is often helpful to adjust the tone control so that the noise will be reduced in relation to the signal.

A combination switch is used to control the power supply. In the extreme counterclockwise position the receiver is turned off; in the mid-position all heater circuits and the rectifier are turned on but no B voltage is applied; in the clockwise position the B+ is turned on to place the receiver in operating condition. In other words, the middle switch position is used for temporarily rendering the receiver inoperative as required during periods of transmission.

There are two insulated terminals mounted at the back of the receiver chassis, which are connected in parallel with the B+ switch. They are intended to serve as a convenient means for connecting a relay for automatically turning the receiver on and off.

The manual R.F. gain control is ordinarily used only for receiving C.W. signals but may, of course, be used as a conventional volume control if the operator does not wish to use the AVC system. With the automatic volume control circuits in operation, as explained later, the R.F. gain control is limited in its action and is useful principally in adjusting the maximum sensitivity of the receiver. For instance, if local noise and static level is high, the R.F. gain control need only be advanced to the point where the disturbance is just plainly audible. Signals may then be tuned in with the AVC on but interchannel noise will not be objectionably high. It will be found that after a signal is tuned in, further advancing the control has no effect on output, inasmuch as the AVC characteristic is practically flat.

At the right of the R.F. gain control is the noise limiter control. Its adjustment is covered fully in the Operating Instructions.

To the right of the range selector knob is the audio gain control, the primary purpose of which is to control volume (on either headphones or speaker) when using AVC. When using the manual R.F. control, the audio gain should not be retarded too far. If, for instance, it is set below three or four on the scale, audio output will be limited to the point where I.F. overload may occur before maximum output is reached.



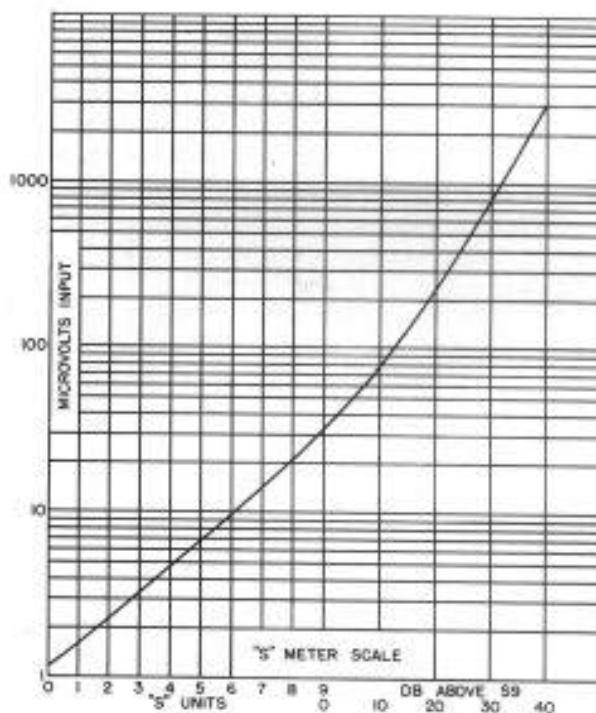
Automatic volume control and C.W. oscillator circuits are controlled by a combination switch having three positions. In the counterclockwise position the AVC circuits are in operation; in mid-position the AVC is turned off; in the clockwise position the C.W. oscillator is turned on, the AVC still being off.

The C.W. oscillator panel vernier tuning control varies the frequency of the oscillator over about 10 ke. The exact function of this control is explained fully in the Operating Instructions.

On models of the NC-100A having the crystal filter (NC-100XA, NC-101X and NC-101XA) two additional controls are provided, and these are mounted at the right-hand side of the tuning dial. The uppermost knob is the selectivity control of the crystal filter. With the filter in use, minimum selectivity will be found with the pointer nearly vertical. Rotating the knob in either direction from this position will increase selectivity. When the filter is not in use, the knob should be set at the point giving maximum volume and sensitivity.

Immediately below the selectivity control is the phasing control and crystal filter switch. Turning this control to zero disconnects the filter; at any other setting between 1 and 10, it acts as a phasing condenser for balancing the crystal bridge circuit, eliminating heterodynes, etc. The action of these two controls is explained in detail in the following section.

The exact layout of the controls differs in various models of the NC-100 series but all knobs are clearly labeled and are adjusted as recommended above.



## Operating Instructions

### PHONE OR BROADCAST RECEPTION

In receiving phone signals, the AVC may or may not be used, as desired. If it is *not* used, we suggest operating the audio gain control about halfway on and controlling the sensitivity with the R.F. gain control. If the operator prefers a "quiet" receiver, the audio control may be operated at 1 or 2. If AVC is used, the R.F. gain control *should be well advanced* and output is adjusted by the audio gain control only. The setting of the two gain controls is largely a matter to be determined by the preference of the operator and by receiving conditions. If, for instance, local noise or atmospheric static is high, it will be desirable to retard the R.F. gain control so that the sensitivity of the receiver will be held to a definite maximum. The C.W. oscillator may be used for locating carriers, in which case it is advisable to retard the audio gain control in order to avoid excessive volume when switching over to AVC. When tuning over any band, or when hunting for signals, the back-

ground noise between stations when using AVC may be objectionable. In this case, again, the audio control should be retarded and may even be turned to the off position, signals being shown by the tuning indicator.

### C.W. RECEPTION

When receiving C.W. signals, the C.W. oscillator must be turned on. Best signal-to-noise ratio will usually be obtained by retarding the audio gain and tone controls considerably and adjusting sensitivity with the R.F. gain control. Turning on the C.W. oscillator switch will, of course, result in a considerable increase in circuit noise, due to the increased sensitivity. As the oscillator vernier tuning control is turned back and forth, the characteristic pitch of this noise will change. When the characteristic pitch is fairly high, the "semi-single signal" properties of the receiver are very pronounced, one side of the audio beat note being several times louder than the other.



### PHONE RECEPTION USING THE CRYSTAL FILTER

The use of the crystal filter in phone reception is recommended particularly when the operator must contend with heavy interference, static, heterodynes, etc. Since such conditions prevail at most times in the amateur phone bands, the filter will be found particularly useful to amateur phone operators. To receive a phone signal when using the crystal filter, the filter is switched in by means of the phasing control and the phasing dial set at approximately mid-scale. The selectivity control is then adjusted for minimum selectivity, as indicated by maximum noise as the control is rotated back and forth. All phone signals will be greatly reduced in volume, making it necessary to advance both audio and R.F. gain controls. On the majority of signals, the maximum audio output of 7 watts will not be available when using AVC with the filter, since the carrier level is held constant at the second detector and side band power is reduced by the filter. The signals may then be tuned in the usual manner, but it will be found that the selectivity is very high, with the result that all audio frequency side bands above a few hundred cycles are comparatively weak. Normally, this would result in low intelligibility of the received signal, but since the background noise, static, etc., have been correspondingly reduced, the net result is usually an improvement. The tone control should always be fully advanced.

The principal advantage of the crystal filter, however, is its ability to eliminate heterodynes. Suppose, for instance, a signal has been carefully tuned in with reasonably good intelligibility and during the transmission an interfering station comes on, causing a bad heterodyne, inverted speech, etc. Ordinarily the desired signal would be "smeared," but careful adjustment of the phasing condenser will eliminate the heterodyne and the interfering station, in most cases, completely. Intelligibility will remain practically as good as before the interfering station came on.

From a practical standpoint, it is important that the crystal filter be used most of the time where such interference is apt to be encountered, as it is almost impossible to switch on the crystal filter and re-tune the desired signal through the heterodyne. The phasing adjustment will remove one signal only. If another interfering station comes on, however, only one heterodyne will be present, instead of the several resulting from three station carriers beating together.

### C.W. RECEPTION WITH THE CRYSTAL FILTER

To use the crystal filter for C.W. reception, the filter is switched in by means of the phasing control

and the phasing condenser set about midscale. The C.W. oscillator must be turned on. Advancing the R.F. and audio gain controls will result in a hollow, ringing sound, the pitch of which will depend upon the setting of the C.W. oscillator control. The actual pitch is not important as long as it is near the middle of the audio range, where the loudspeaker or phones have good sensitivity.

When a signal is picked up, it will be found that as the receiver is tuned *slowly* across the carrier the beat note will be very sharply peaked at the same pitch as that of the ringing noise, previously mentioned. All other parts of the beat note will be extremely weak and, furthermore, this peak will be found to occur on only one side of the audio beat note. The sharpness of the peak is determined by the selectivity control. At maximum selectivity, the peak is so sharp that it may be hard to find, whereas at minimum selectivity the peak will be very broad. If a signal is being received, after having been properly tuned in, and an interfering station comes on, the resulting heterodyne and interference may be eliminated by adjustment of the phasing condenser. This phasing adjustment is effective in eliminating interference regardless of the setting of the selectivity control.

### MEASUREMENTS OF SIGNAL STRENGTH "S" METER

The "S" meter serves to indicate the strength of a received signal. It is calibrated from 1 to 9 in arbitrary units which correspond, roughly, to the definition of the nine points of the "S" scale of the R-S-T system of amateur signal reports.

Probably no two operators will agree on just how strong a signal must be to warrant an S-9 report. After making measurements on a large number of amateur signals, the present meter scale was chosen and we believe it will provide a good practical means of giving accurate reports. The accompanying curve shows the relation between the meter reading and the actual signal input to receiver in microvolts.

Before making a measurement on a signal, certain receiver adjustments must be made. The control switch should be in the MVC position, the crystal filter off and the selectivity control set for maximum sensitivity. After pressing in the meter switch, the R.F. gain should be fully advanced; at which point, the meter should read 0. The receiver is now adjusted and the strength of any signal may be measured by throwing the AVC switch on and tuning for maximum meter deflection. The audio gain control does not have any effect on the R.F. adjustments or upon the meter reading, so that it may be





retarded as much as necessary to prevent audio overload.

The above procedure will hold true when checking either phone or C.W. stations. It is, however, impossible to obtain a continuous check on C.W. signals, as the beat oscillator must be off.

#### RECEPTION USING THE NOISE LIMITER

The circuit of the series-valve noise limiter is described in some detail in the October 1939 issue of QST and definitely eliminates noise peaks or pulses of short duration which exceed the amplitude of the desired signal. When the control is in the counter-clockwise position, the limiter is practically inactive, although it will have some effect on extremely loud noise. As it is turned to the right, the limiting action becomes increasingly pronounced until at the extreme clockwise position the signal itself will be affected to some extent.

When receiving phone signals, no special technique is needed to operate the limiter except in

cases where the noise peaks are extremely strong as compared to the signal, and under such conditions it is often helpful to turn the AVC off and carefully adjust the R.F. gain control and limiter knobs for best signal-to-noise ratio. The reason for this is that exceptionally strong noise peaks, or noise of a steady nature, tend to take control of the AVC circuits and reduce receiver sensitivity to a point where weak signals cannot be heard. This is, of course, quite normal but can usually be overcome by turning the AVC off.

When receiving C.W. signals, it is recommended that AVC be turned off. The R.F. gain control should be well advanced, care being taken not to increase gain to the point where the signal begins to "thump" and overload the receiver. It is at the point just below overload that the noise limiter will be most effective. It will be found that the amplification of the receiver is high enough to produce the effect described above even when the desired signal is a fraction of a microvolt.

## Alignment and Service Data

### TUBES

Individual tubes of the same type will vary slightly in their characteristics and it is well to remember this fact when replacements become necessary. Even though the circuit is designed to reduce the effect of such variations to a minimum, the high frequency oscillator and I.F. tubes should be selected with some care. A replacement high frequency oscillator should be checked in the receiver to make sure that the inter-electrode capacities are the same as those of the tube originally employed. This is easily determined by noting any change in calibration at the high frequency end of any coil range. The change should not exceed two or three dial divisions. Compensation for small variations in tube capacity may be made by changing the position of the oscillator grid lead with relation to the body of the tube.

Substitution of new tubes in the I.F. amplifier may possibly alter overall gain and selectivity characteristics. Instructions for realignment are given in detail in the following pages.

Two other points should be checked when trying the new high frequency oscillator; a fairly strong steady signal should be tuned in, preferably on some frequency above 10 mc.; the C.W. oscillator should be turned off; jarring the receiver or lightly tapping the tube, should not show any evidence of noise in

the output. Next turn on the C.W. oscillator to make sure that the tube does not introduce "modulation hum" on the carrier. The tube should again be lightly tapped to see whether or not its characteristics change.

### R.F. AND I.F. OSCILLATOR ALIGNMENT

All circuits are carefully and accurately aligned before shipment, using precision crystal oscillators which insure close conformation to the calibration curves. No readjustments will be required, therefore, unless the receiver is subjected to extremely rough handling. Do not attempt to make any adjustments without first determining the exact function of each trimmer condenser and the effect that it will have upon performance.

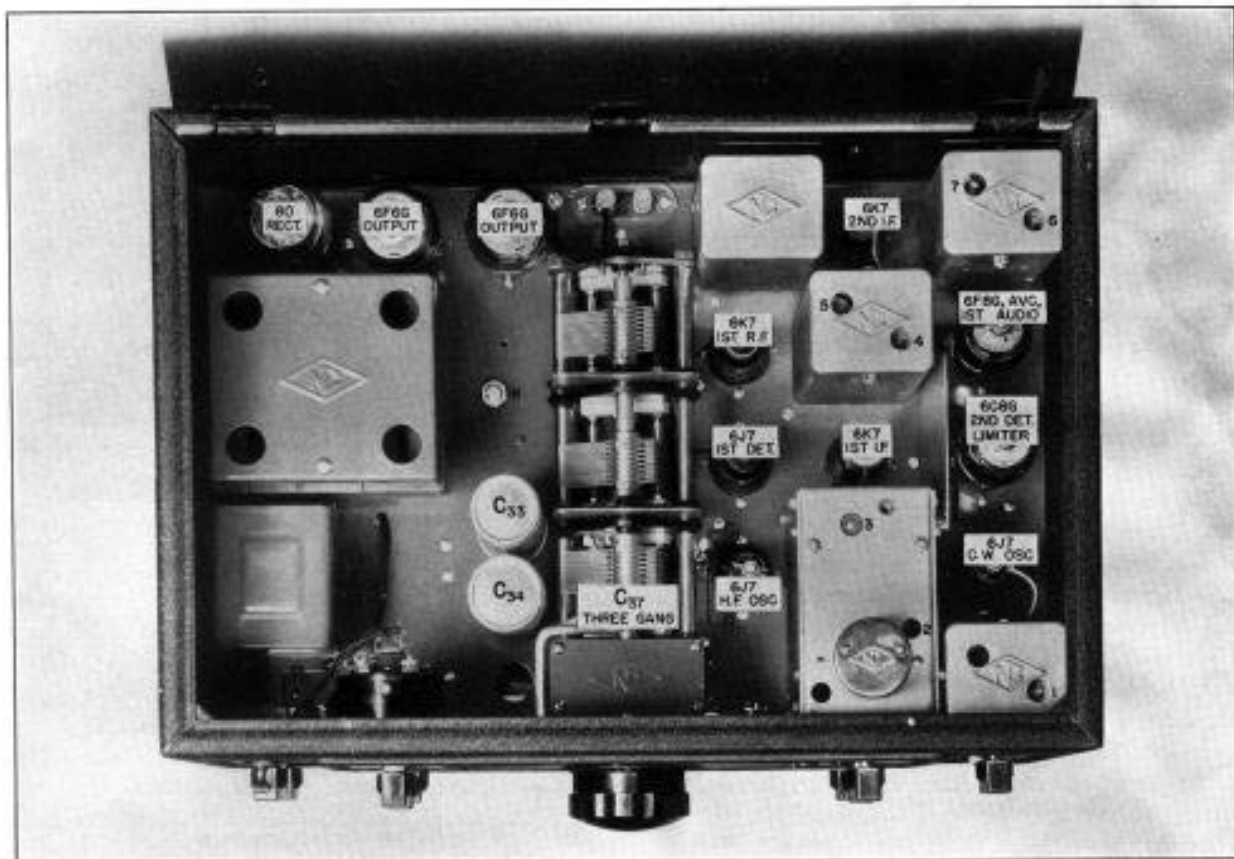
The coil group which is plugged into the circuit at any time is the one directly underneath the 3-gang tuning condenser at the center of the chassis. The coil nearest the front of the receiver is the high frequency oscillator, the middle coil is the first detector, and the coil nearest the antenna-ground binding post strip is the R.F.

As shown in the photographs, there are two holes in each coil compartment; of each pair, the one nearest the front of the receiver is directly over the trimmer condenser.

Complete alignment of any one coil range is made







Top View of NC-100XA

as follows: Set the tuning dial near the high frequency end of the range and check the dial reading by means of an accurate test oscillator or a signal of known frequency; readjustment should be made if the dial reading is in error by more than 2 per cent.

Correction for calibration is made by adjustment of the high frequency oscillator trimmer (nearest the front of the receiver). A screw driver with a metal shaft may be used, but the shaft should not touch the aluminum casting while the trimmer is being turned. If the dial reading is found to be too low, more trimmer capacity is needed and vice versa. In adjusting the R.F. and first detector trimmers, no signal is necessary, correct alignment being indicated by maximum background noise. This background noise should be fairly loud when the R.F. and audio gain controls are fully advanced, the crystal filter being switched off. Furthermore, the background noise will be approximately the same on all ranges. The first detector trimmer will have much greater effect upon the amplitude of this noise than the R.F. trimmer, but actually the setting of each is equally important.

With calibration correct at the high frequency end

of the range, the dial should be rotated toward the lower numbers. The background noise may vary slightly over the range but should not get appreciably weaker except in the case of the .54 to 1.3 mc. coils. Ganging is checked by pressing one of the outside rotor plates of the oscillator condenser sideways toward the stator, but not enough to make the plates touch. The same check may be applied to the first detector and R.F. tuning condensers. Any bending of the rotor plates should make the background noise definitely weaker. A similar check can, of course, be made by bending the rotor plates out, away from the stator, care being taken not to bend the plates so far that they will not return to their original position.

On the two highest frequency ranges, it may be possible to make the initial oscillator adjustment incorrectly. There are two settings of the oscillator trimmer condenser which will tune in the desired signal at the proper point on the dial; of these, the higher frequency setting (least trimmer capacity) is correct. In checking the ganging of the 13.5 to 30 mc. range, the R.F. condenser has little effect upon the background noise at the low frequency end of the



scale and at this one point it is better to use a test signal. Should any error in tracking be found on one range, it is probable that the same error will be present on all ranges and correction may be made by permanently bending the rotor plates of the tuning condenser section in question.

### I.F. AND CRYSTAL ALIGNMENT INSTRUCTIONS

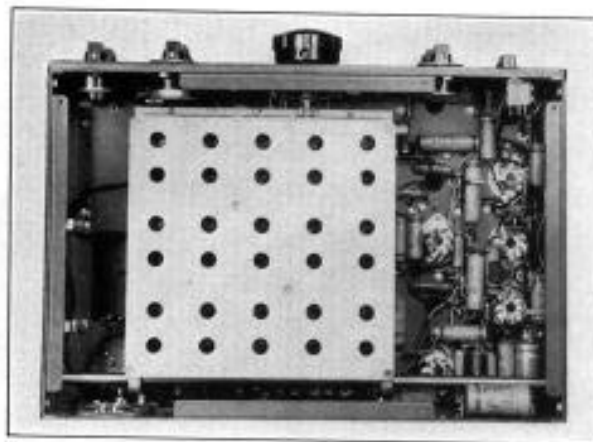
Before attempting to check the alignment or adjust a single signal receiver it is essential that the operator be familiar with the principles involved and the type of performance to be expected.

A receiver of this type is simply a superheterodyne which may be adjusted to have extremely high selectivity on all signals. The effective width of the selectivity curve is only a few cycles, usually between 20 and 100. This means that when tuning in a given C. W. signal, tuning is going to be very sharp and the dial must be turned slowly in order to avoid missing the signal entirely. As compared to the straight superheterodyne, the single signal receiver is about 100 times as selective. The straight super will pick up a signal and will reproduce both sides of the audio beat note at about the same strength; that is, the carrier whistle may be varied from either side of zero beat up to about 3000 cycles when the receiver is tuned and the whistle will remain about the same strength at any pitch. The single signal receiver, however, being 100 times as sharp, will not perform in this manner, but as the receiver is tuned across the carrier the audio response will be very sharply peaked at one certain pitch of the carrier whistle. Detuning the receiver a small fraction of a degree, while it changes the pitch only slightly, will make the signal much weaker, since it has been detuned from the sharp selectivity peak.

*The main point to remember when considering single signal receivers is that they are simply ultra selective superheterodynes, which must be tuned exactly to the signal and that the beat oscillator must be detuned from the crystal frequency in order to obtain an audible beat note.*

#### PRELIMINARY ADJUSTMENTS—THE I.F.

From the above explanation, the reader will see that it is absolutely essential that the I.F. transformers be aligned to the crystal, since the two must work together. This alignment may be accomplished in a number of ways. If the I.F. transformers are far out of adjustment, it is necessary to connect an external crystal oscillator which uses the crystal from the receiver. This oscillator is put in operation and is coupled to the first detector of the receiver.



BOTTOM VIEW

*The coil assembly is shown midway between the 1.3-2.8 mc. and 2.7-5.4 mc. ranges.*

In most cases no actual connection will be required since the field from the oscillator will be sufficiently strong to be picked up, even with the I.F. far out of adjustment. If coupling is required, a lead twisted around the grid cap of the detector tube and run near the oscillator tank coil, will be suitable. The beat oscillator is turned on and adjusted until the crystal signal is picked up. The pitch of the beat note is not important as long as it is well inside the audible range.

All the I.F. transformers are now adjusted for maximum signal. This adjustment need not be made with any great degree of precision, since the crystal will not oscillate at exactly the same frequency to which it will be resonant in the receiver. The phasing control should be set at 0.

The I.F. adjustments are indicated on the layout diagram, Page 9, Nos. 3 to 7, inclusive.

The crystal filter output coupling condenser, adjustment No. 2, serves as a fixed I.F. gain control and, in general, *should not* be touched.

The crystal may now be removed from the oscillator and installed in the receiver. Throw the switch to connect the crystal for single signal reception. Set the selectivity control for maximum selectivity; that is, with the pointer rotated all the way to the right. Now, tune in a steady signal from a local oscillator or monitor. Tuning very slowly across the carrier, there should be one point at which the signal will peak very sharply. The audio pitch of this peak will be nearly the same as the pitch of the beat used when the crystal oscillator was being picked up.

#### THE BEAT OSCILLATOR

Once the peak has been found, it would be well for the operator to familiarize himself with the



action of the beat oscillator control by changing its tuning in order to obtain an audio note which is most pleasing to copy, or which coincides with any peaks in the loudspeaker or headphones. It makes little difference to which side of the audio beat the beat oscillator is tuned. After a satisfactory pitch has been found, tune the signal by means of the tuning dial so that the signal goes down through zero beat and up to approximately the same pitch on the other side. This response is, of course, much weaker than that of the peak and it may be necessary to turn up the volume control in order to obtain fair volume. The phasing, or balancing, condenser is now adjusted until the signal is WEAKEST. Normally, this setting is near mid-scale.

#### THE SELECTIVITY CONTROL

The action of the selectivity control may now be checked. With the receiver tuned exactly as it was before adjusting the phasing condenser, the selectivity control should be rotated and it will be found that the signal will be loudest at a certain setting. This setting is usually found with the pointer nearly vertical. The setting giving this maximum response is that at which the selectivity of the crystal filter is minimum. Since even at this minimum selectivity the crystal filter is much more selective than the straight super, the signal will be weaker than that obtainable when the crystal is cut out.



THE COMPLETE COIL ASSEMBLY

Permanence of circuit characteristics is assured by the rigid cast aluminum shield and by air dielectric trimmer condensers with R-39 insulation.

When a pure steady signal is carefully tuned to a single signal peak, the selectivity control should have practically no effect upon signal strength. If there is any form of modulation, however, the signal will be loudest when the selectivity control is set for minimum selectivity, since this adjustment allows a greater width of signal or modulation to be passed.

#### FINAL I.F. ADJUSTMENT

The final adjustment of the I.F. transformers may now be made. Set the control for maximum selectivity, carefully tune in a steady signal until it is exactly on the crystal peak, and adjust each of the I.F. transformer tuning condensers for maximum signal strength. (*In almost all cases where the I.F. amplifier has once been aligned to the crystal, this check is all that would be required, and it is not necessary to put the crystal in an external oscillator.*) Even if the I.F. amplifier is considerably out of alignment, the crystal frequency may be found by employing a strong local signal from a monitor or frequency meter, slowly tuning across it while listening for a peak in the audio beat note. If the peak is found at a very high audio pitch it will be necessary to change the tuning of the beat oscillator so that the audio peak will be well inside the limits of audibility. It is probable that if the peak signal is found at all, the I.F. amplifier will not be far out of tune and the readjustments required will be small.

Since the I.F. transformers are tuned with air dielectric condensers, the adjustments when once made are permanent and need only be checked when new tubes are substituted, provided of course the receiver is not subjected to severe mechanical shocks or vibration.

#### CHECKING CRYSTAL ACTION

The crystal response, or crystal activity, may be easily checked as follows: With the signal tuned in exactly as mentioned in the previous paragraph and the selectivity control set at maximum selectivity, disconnecting the filter (by turning the phasing knob to 0), should weaken the signal slightly. There will, of course, be a great increase in tube hiss, background noise, and interfering signal, but the actual strength of the desired signal should be weaker. It is possible, of course, to obtain a louder signal in the straight super connection by resetting the selectivity control and this is quite normal. The fact that a signal is weakened when using the crystal filter is relatively unimportant, inasmuch as the filter is only used when interference or static is present, and such interference





will be made about 100 times weaker, thereby greatly improving the readability of the signal.

A crystal which is found to be a poor resonator should be carefully removed from the holder and both crystal and plates cleaned with alcohol, gasoline, carbona, ether, or some similar fluid. In reassembling the holder care must be taken to see that the crystal is free between the plates; that is, that there is a suitable air gap (usually two or three thousandths) between the plates and the crystal and that the crystal is free to move sideways in any direction.

### **Special Instructions for the NC-101X and NC-101XA Receivers**

The NC-101X is a special model of the NC-100X receiver, employing the same circuit, etc., but covering only the five low-frequency amateur bands. Each of these bands is spread out over the major portion of the dial and, as shown by the accompanying calibration curves, each band starts at 50 and ends at 450. The curves are accurate to about .25% of the operating frequency.

All operating instructions, circuit data, alignment and service notes contained in the NC-100 Instruction Manual apply to the NC-101X receiver, except those sections referring to the calibration and alignment of the high frequency circuits.

Complete alignment of any coil range is made as follows: Set the tuning dial at 450, and check the calibration curve by means of an accurate test oscillator. Readjustment of the high frequency oscillator trimmer condenser should be made if the calibration is in error by more than 20 dial divisions. Check the alignment of R.F. and 1st Det. circuits by setting the trimmers for maximum background noise. (See Page 9.) Re-check the H.F. Oscillator, then turn the

The fibre pieces may be removed if desired as they serve only to protect the crystal in shipment.

#### **"S" METER ADJUSTMENT**

If it should happen that the "S" meter network gets out of balance, the procedure for correction is as follows: Disconnect the antenna and turn the CONTROL switch to MVC, set the R.F. GAIN full on. Then, by means of a screw driver, adjust the balancing control (No. 8, receiver top view) until the meter reads 0.

dial to 50, and note the calibration. Ganging is tested by checking R.F. and 1st Det. trimmer adjustments.

The design of the high frequency circuits, particularly that of the H.F. Oscillator, is such that frequency drift is extremely small, after the receiver has reached its operating temperature. It should be remembered, however, that the band spread tuning arrangement tends to magnify a small change in frequency. For instance, on the 20 meter band, each dial division represents only 1000 cycles. Ten kilocycles will, therefore, be spread over about two-and-one-half inches of scale length, even though the actual frequency change is but .07 of one percent. Only a comparatively few amateur transmitters will maintain constant frequency to such a high degree of precision, even with crystal control.

There should be ample room for air to circulate on all sides of the receiver, in order to reduce drift to a minimum. Do not pile magazines or papers on the cover and do not install the receiver in a small console or in a closely fitting compartment or bookcase.

### **Supplementary Instructions for Battery Models**

The Battery Operated Types of the NC-100A series are identical in operation and adjustment to the standard AC models. Battery power drain is reduced by using a single 6F6G output tube. The recommended speaker is an 8-inch permanent magnet type.

Normal operation of the NC-100B series may be obtained by using either a combination of batteries or a properly filtered battery operated vibrator pack or gen-e-motor to supply 6 volts to the heater and approximately 180 volts to the receiver B circuits.

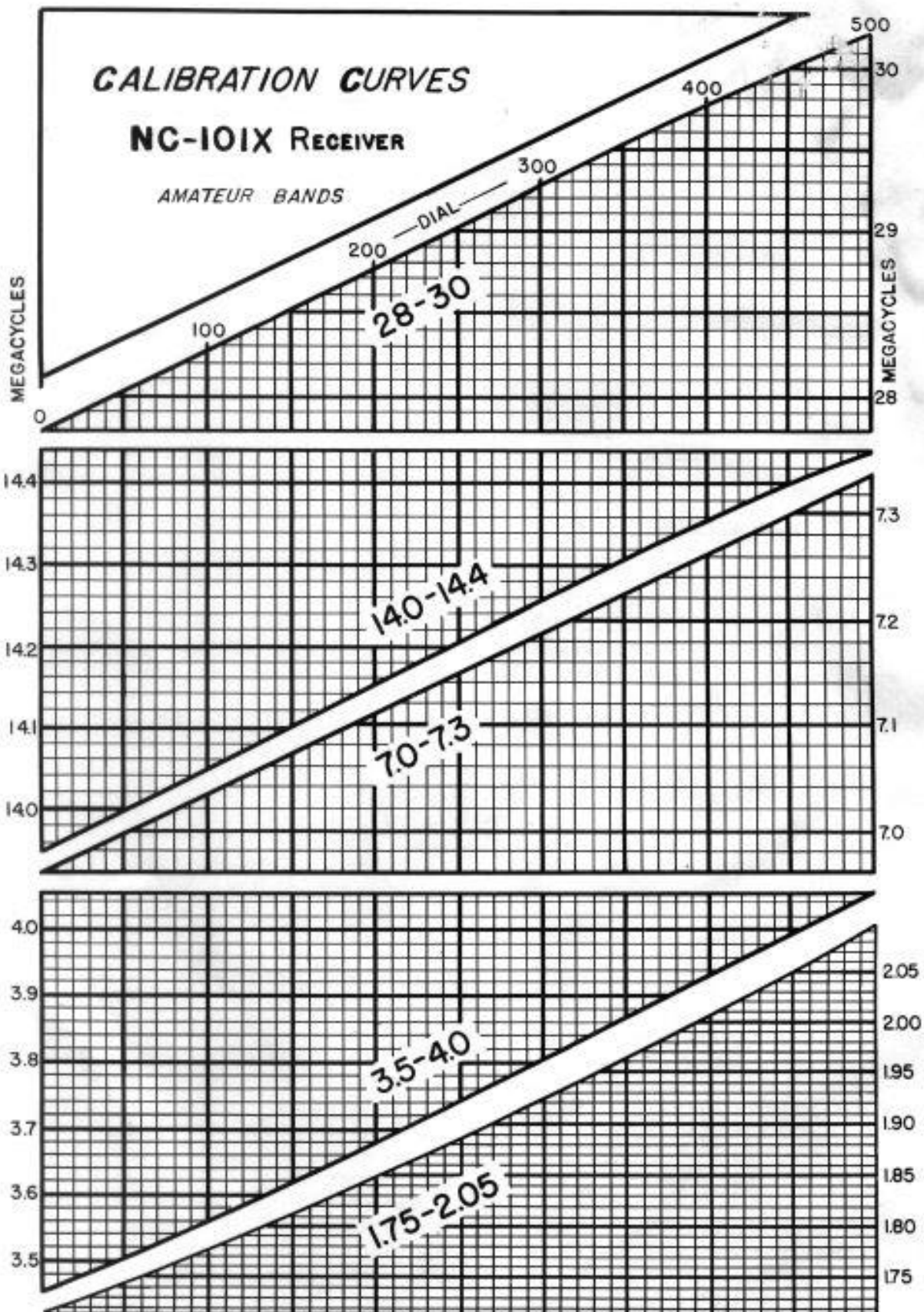
Receivers primarily designed for battery operation can be used with an external power pack, such as

the National Type 5886, for operation from AC lines. When used in this manner, the four prong plug attached to the receiver power cable should be inserted in the socket outlet of the power unit. For use with other power supplies, the cable plug may be unsoldered and the wires connected to the outlet terminals of the power unit.

On special order, a battery-operated vibrator pack can be built into any model of the NC-100B series. When ordering, add symbol "V" to battery model catalog type numbers. An external Vibrator Pack, Type 686, is also available.







## CAPACITOR AND RESISTOR LIST\*

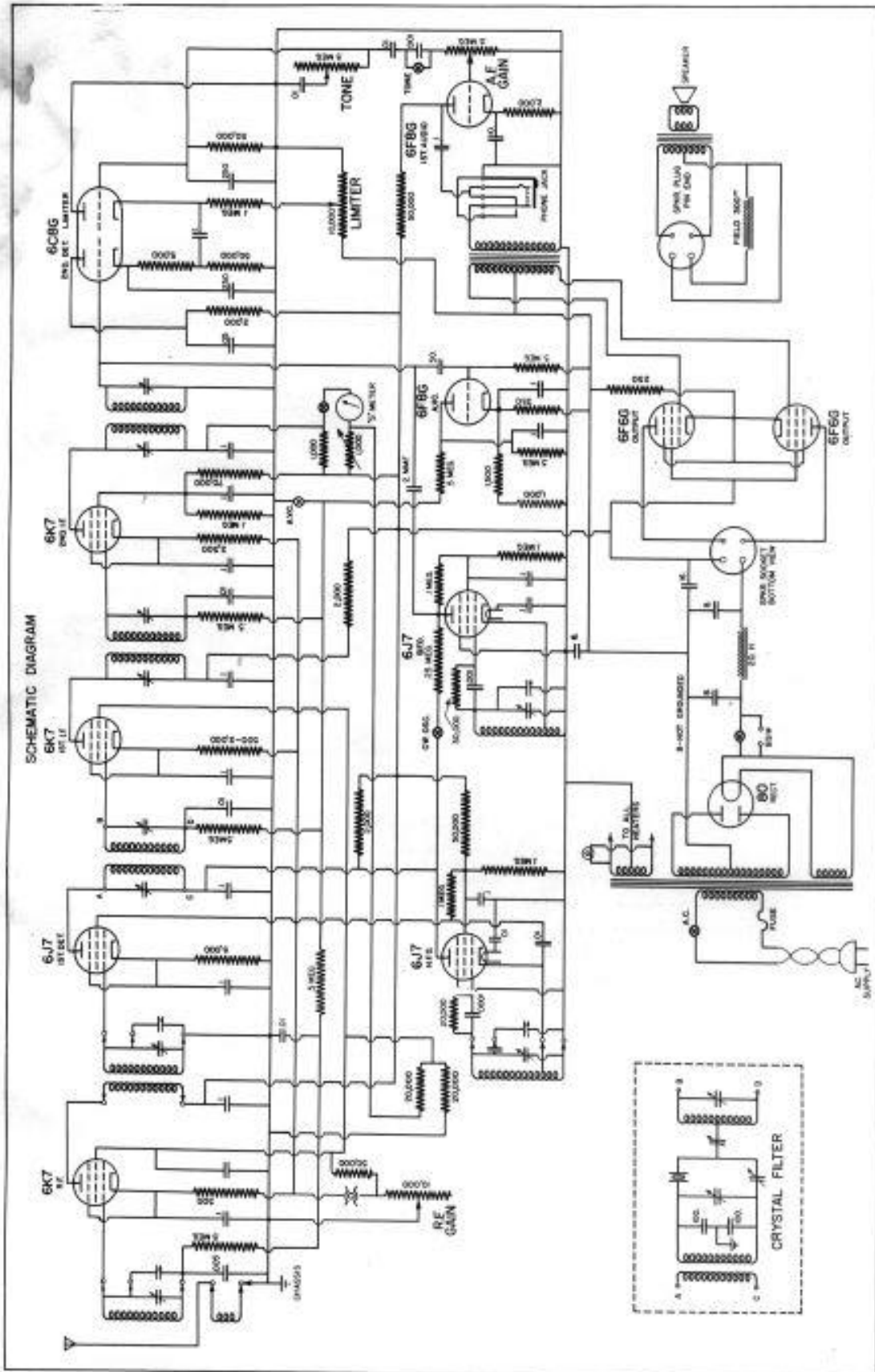
<i>Symbol</i>	<i>Function</i>	<i>Type</i>	<i>Rating</i>
C <sub>1</sub>	H.F. Osc. Grid	Mica	.0001 mfd., 500 Volt
C <sub>2</sub>	R.F. B+ Bypass	Paper	.1 mfd., 600 Volt
C <sub>3</sub>	H.F. Osc. Screen	Paper	.1 mfd., 400 Volt
C <sub>4</sub>	H.F. Osc. Coupling	Paper	.01 mfd., 400 Volt
C <sub>5</sub>	H.F. Osc. Heater Bypass	Paper	.01 mfd., 400 Volt
C <sub>6</sub>	1st I.F. Grid Filter	Paper	.01 mfd., 400 Volt
C <sub>7</sub>	1st Det. B+ Bypass	Paper	.1 mfd., 600 Volt
C <sub>8</sub>	1st Aud.-Output Coupling	Paper	.1 mfd., 600 Volt
C <sub>9</sub>	C.W. Osc. Heater Bypass	Paper	.1 mfd., 400 Volt
C <sub>10</sub>	C.W. Osc. Screen Bypass	Paper	.1 mfd., 400 Volt
C <sub>11</sub>	C.W. Osc. Coupling	Bakelite	1. mmf., 400 Volt
C <sub>12</sub>	Limiter Output Bypass	Mica	.00025 mfd., 500 Volt
C <sub>13</sub>	Lim.-1st Audio Coupling	Paper	.01 mfd., 400 Volt
C <sub>14</sub>	1st I.F. B+ Bypass	Paper	.1 mfd., 600 Volt
C <sub>15</sub>	2nd Det. Cathode Bypass	Mica	.00025 mfd., 500 Volt
C <sub>16</sub>	R.F. Grid Filter	Paper	.01 mfd., 400 Volt
C <sub>17</sub>	2nd Det. Plate Bypass	Paper	.05 mfd., 600 Volt
C <sub>18</sub>	2nd I.F. B+ Bypass	Paper	.1 mfd., 600 Volt
C <sub>19</sub>	AVC Input Coupling	Mica	.00005 mfd., 500 Volt
C <sub>20</sub>	2nd I.F. Grid Filter	Paper	.01 mfd., 400 Volt
C <sub>21</sub>	AVC Plate Bypass	Paper	.1 mfd., 400 Volt
C <sub>22</sub>	2nd I.F. Cathode Bypass	Paper	.1 mfd., 400 Volt
C <sub>23</sub>	AVC Cathode Bypass	Paper	.1 mfd., 400 Volt
C <sub>24</sub>	1st Audio Cathode Bypass	Electrolytic	10. mfd., 50 Volt
C <sub>25</sub>	2nd Det.-Lim. Audio Coupling	Paper	1. mfd., 200 Volt
C <sub>26</sub>	2nd I.F. Screen Bypass	Paper	.1 mfd., 400 Volt
C <sub>27</sub>	R.F. Screen Bypass	Paper	.1 mfd., 400 Volt
C <sub>28</sub>	R.F. Grid Filter	Mica	.005 mfd., 300 Volt
C <sub>29</sub>	R.F. Cathode Bypass	Paper	.1 mfd., 400 Volt
C <sub>30</sub>	B- to Chassis Bypass	Electrolytic	8. mfd., 200 Volt
C <sub>31</sub>	1st I.F. Cathode Bypass	Paper	.1 mfd., 400 Volt
C <sub>32</sub>	1st Det. Cathode Bypass	Paper	.1 mfd., 400 Volt
C <sub>33</sub>	B+ Filter	Electrolytic	16. mfd., 350 Volt
C <sub>34</sub>	B+ Filter	Electrolytic	8.-8. mfd., 475 Volt
C <sub>35</sub>	Tone Control	Paper	.01 mfd., 400 Volt
C <sub>36</sub>	Tone Control	Mica	.001 mfd., 500 Volt
C <sub>37</sub>	Main Tuning	Air	225 mmf., 3 Gang
R <sub>1</sub>	H.F. Osc. Grid	Carbon	20,000 Ohm, ½ Watt
R <sub>2</sub>	Limiter Control	Wire Wound	10,000 Ohm, Variable
R <sub>3</sub>	1st Det. Screen	Carbon	100,000 Ohm, ½ Watt
R <sub>4</sub>	H.F. Osc. Volt. Div.	Carbon	100,000 Ohm, ½ Watt
R <sub>5</sub>	H.F. Osc. Screen	Carbon	50,000 Ohm, 1 Watt
R <sub>6</sub>	1st Audio Plate	Carbon	50,000 Ohm, 1 Watt
R <sub>7</sub>	1st Det. Plate Filter	Carbon	2,000 Ohm, ½ Watt

\* Parts Showing in Photos on Pages 4 and 9.



<i>Symbol</i>	<i>Function</i>	<i>Type</i>	<i>Rating</i>
R <sub>8</sub>	1st I.F. Cathode Bias	Carbon	500-2,000 Ohm, ½ Watt
R <sub>9</sub>	Audio Gain Control	Composition	500,000 Ohm, Variable
R <sub>10</sub>	1st I.F. Grid Filter	Carbon	500,000 Ohm, ½ Watt
R <sub>11</sub>	C.W. Osc. Volt. Div.	Carbon	100,000 Ohm, ½ Watt
R <sub>12</sub>	C.W. Osc. Plate Filter	Carbon	250,000 Ohm, ½ Watt
R <sub>13</sub>	C.W. Osc. Screen	Carbon	100,000 Ohm, ½ Watt
R <sub>14</sub>	Limiter Output	Carbon	50,000 Ohm, ½ Watt
R <sub>15</sub>	2nd Det. Load	Carbon	50,000 Ohm, ½ Watt
R <sub>16</sub>	2nd Det. I.F. Filter	Carbon	5,000 Ohm, ½ Watt
R <sub>17</sub>	1st I.F. Plate Filter	Carbon	2,000 Ohm, ½ Watt
R <sub>18</sub>	2nd Det. Plate Filter	Carbon	2,000 Ohm, ½ Watt
R <sub>19</sub>	Limiter Input	Carbon	100,000 Ohm, ½ Watt
R <sub>20</sub>	R.F. Grid Filter	Carbon	500,000 Ohm, ½ Watt
R <sub>21</sub>	AVC Plate Filter	Carbon	500,000 Ohm, ½ Watt
R <sub>22</sub>	AVC Grid	Carbon	5. Megohm, ½ Watt
R <sub>23</sub>	AVC Plate	Carbon	500,000 Ohm, ½ Watt
R <sub>24</sub>	1st Audio Cathode Bias	Carbon	2,000 Ohm, ½ Watt
R <sub>25</sub>	AVC Volt. Div.	Carbon	1,000 Ohm, 2 Watt
R <sub>26</sub>	AVC Volt. Div.	Carbon	1,500 Ohm, 2 Watt
R <sub>27</sub>	AVC Cathode Bias	Carbon	350 Ohm, 2 Watt
R <sub>28</sub>	2nd I.F. Grid Filter	Carbon	500,000 Ohm, ½ Watt
R <sub>29</sub>	2nd I.F. Volt. Div.	Carbon	100,000 Ohm, ½ Watt
R <sub>30</sub>	2nd I.F. Screen	Carbon	70,000 Ohm, ½ Watt
R <sub>31</sub>	2nd I.F. Cathode	Carbon	2,500 Ohm, ½ Watt
R <sub>32</sub>	R.F. Cathode Bias	Carbon	500 Ohm, ½ Watt
R <sub>33</sub>	1st Det. Cathode Bias	Carbon	5,000 Ohm, ½ Watt
R <sub>34</sub>	R.F. Grid Filter	Carbon	500,000 Ohm, ½ Watt
R <sub>35</sub>	Output Cathode Bias	Carbon	250 Ohm, 2 Watt
R <sub>36</sub>	S Meter Adjustment	Wire Wound	1,000 Ohm, Variable
R <sub>37</sub>	S Meter Bridge	Carbon	1,000 Ohm, ½ Watt
R <sub>38</sub>	R.F. Gain Bleeder	Carbon	50,000 Ohm, ½ Watt
R <sub>39</sub>	Tone Control	Composition	500,000 Ohm, Variable
R <sub>40</sub>	R.F. Gain Control	Wire Wound	10,000 Ohm, Variable
R <sub>41</sub>	B+ Volt. Div.	Carbon	20,000 Ohm, 2 Watt
R <sub>42</sub>	B+ Volt. Div.	Carbon	20,000 Ohm, 2 Watt

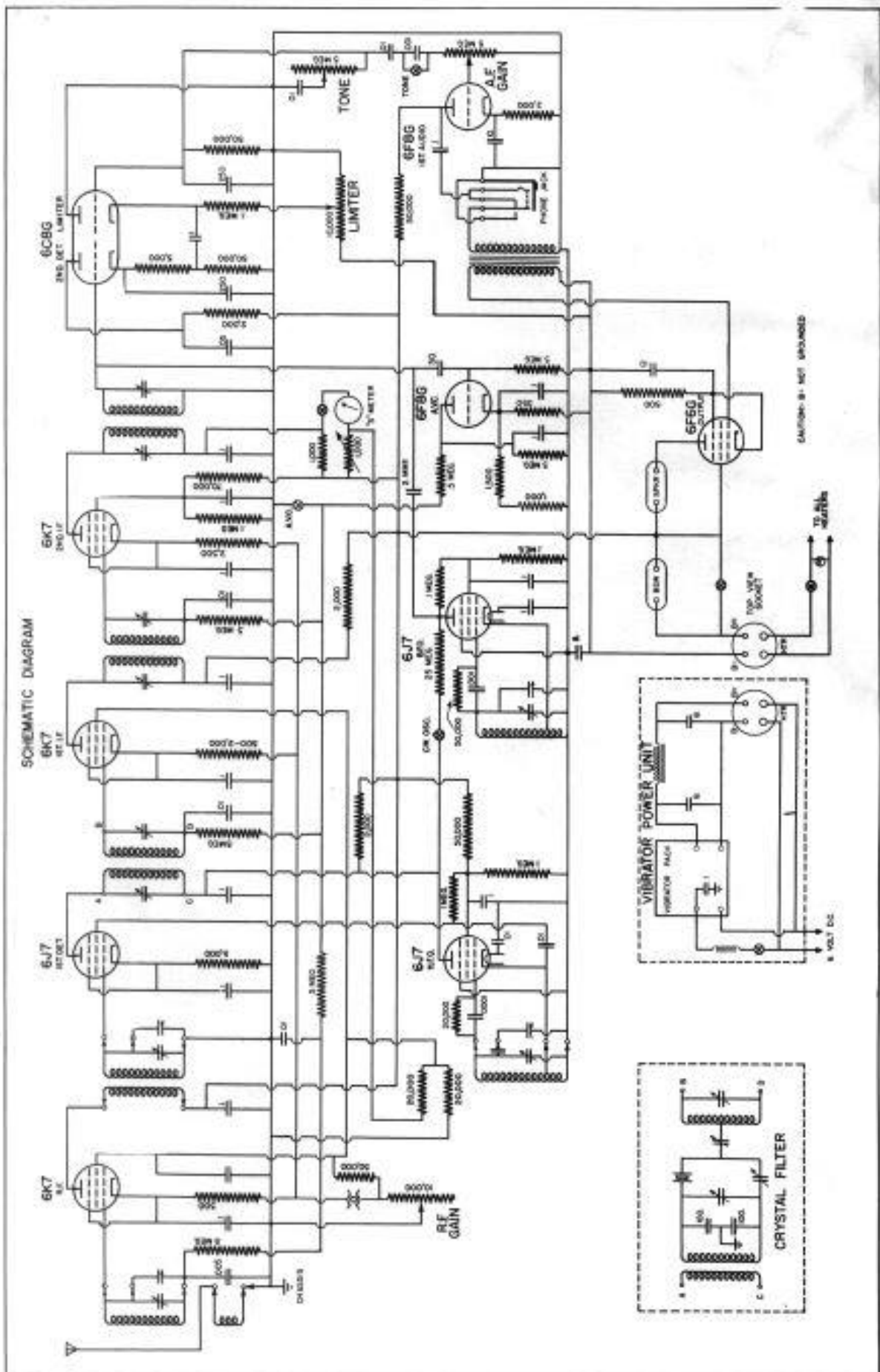




A.C. Operated NC-100A

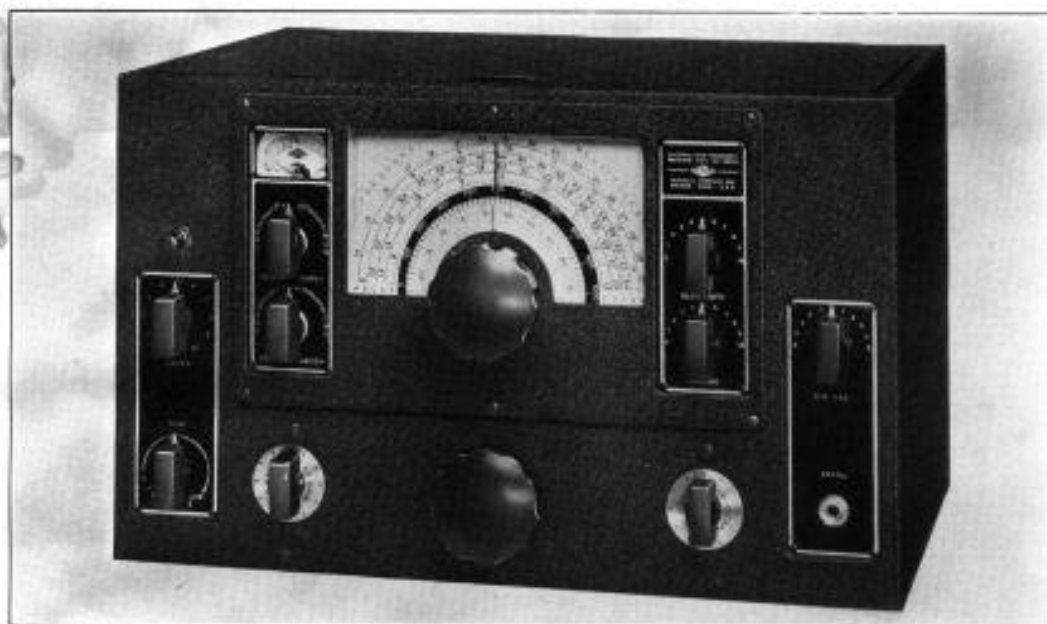






Battery Model NC-100AB

# NATIONAL NC-100A



**NC-100A** Receiver, complete with tubes, 115 volt, 60 cycle built-in power supply and 10" dynamic speaker in cabinet. **List Price, \$200.00**

**NC-100SA** Receiver, as above but with 12" Rola G-12 High Fidelity Speaker chassis. **List Price, \$222.50**

**NC-100AB**, Battery Model, 6 volt heater and 180 volt B required, 8" PM Speaker in cabinet. **List Price, \$184.17**

**NC-100XA** Receiver, same as NC-100A above but having crystal filter with both variable selectivity and phasing controls. **List Price, \$237.50**

**NC-100XSA** Receiver, same as NC-100XA but with 12" Rola G-12 High Fidelity Speaker chassis. **List Price, \$260.00**

**NC-100XAB**, Battery Model, 6 volt heater and 180 volt B required, 8" PM Speaker in cabinet. **List Price, \$221.67**

**NC-101X** or **NC-101XA** Receiver, complete with tubes, crystal filter, built-in 115 volt, 60 cycle power supply and 10" dynamic speaker in cabinet. **List Price, \$215.00**

**NC-101XB** or **NC-101XAB**, Battery Models, 6 volt heater and 180 volt B required, 8" PM Speaker in cabinet. **List Price, \$200.00**

Any Battery Model, NC-100AB series, with built-in 6 volt DC operated vibrator pack, symbol V added to type numbers. **Additional List Price, \$40.00**

**Type 686** Vibrator Pack, 6 volt DC operated, for use with any NC-100AB series receiver. **List Price, \$45.00**

230 volt, 50 or 60 cycle operated models of NC-100A series Receivers. **Additional List Price, \$5.00**

25 cycle operated models of NC-100A series Receivers. **Additional List Price, \$10.00**

**RRA** Steel angle pieces designed for mounting table models of NC-100 receivers in a standard relay rack. Specify receiver type when ordering.

**List Price, per pair, \$2.50**

*Prices subject to change without notice*





## NATIONAL NHU

This specialized communication receiver is a superheterodyne covering the range from 27 to 62 MC in three ranges, each being calibrated on a direct reading full-vision dial.

The circuit uses three acorn tubes (956 RF, 954 First Detector, and 955 Oscillator) followed by three IF stages using 6K7's. A 6C8G Twin Triode is used as an infinite-impedance diode detector, and as a noise limiter. An additional 6C8G acts as first audio and as a carrier-off noise suppressor. Two 6SJ7's are used for the

CW oscillator and for the AVC, which is amplified and delayed. The output employs a 6V6G.

The mechanical details of the NHU are unique. One large knob on the panel slides in or out to engage either the tuning condenser or the range-changing system. Inertia-type tuning is used, with a ratio of approximately 70 to 1. The pointer is positively driven by rack and pinion, and moves vertically when the coil range is changed so that it always points to the proper frequency. The coils are mounted radially in a cast aluminum turret which is easily turned into position by the knob on the panel. Directly above the coil turret is the three-gang straight-line-frequency tuning condenser. The RF circuit and tubes are built completely inside the frame of the condenser, thus making a compact assembly with the shortest possible leads from coils to condensers to tubes.

All features and controls commonly found in high-quality communication receivers are incorporated in the NHU, including a wide range crystal filter.

**Type NHU** Receiver, table model, complete with tubes, 8" speaker with cabinet and coils covering from 27 to 62 MC, but without power supply, for 6 volt AC operation, black finish. **List Price, \$275.00**

**Type NHU-B** Receiver, same as above but for battery operation, 6 volt heater and 180 volt B required. **List Price, \$275.00**

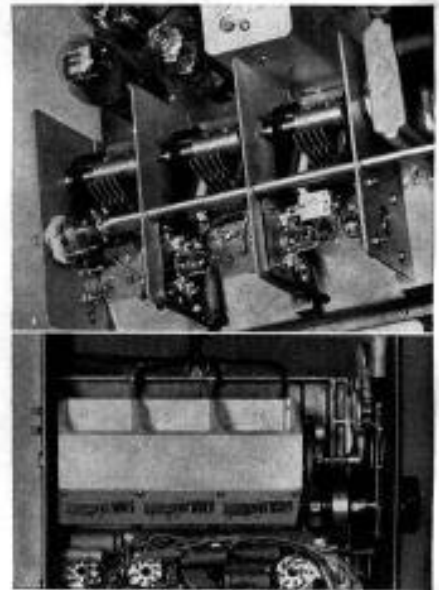
**Type NHU-20** Receiver, same as NHU but with 20 Meter Coil. **List Price, \$290.00**

**Type NHU-20B** Receiver, same as above but for battery operation, 6 volt heater and 180 volt B required. **List Price, \$290.00**

Relay rack models of above receivers. Additional. **List Price, \$20.00**

**Type 5856** Power Supply, table model with rectifier, for AC model. **List Price, \$29.50**

**Type SPU-56** Relay rack power supply with rectifier. **List Price, \$49.50**



## NATIONAL ONE-TEN

Designed chiefly for the experimenter, the One-Ten Receiver fulfills the need of the experimenter for an adequate receiver to cover the field between one and ten meters.

A four tube circuit is used, composed of one tuned R.F. stage, a self-quenching super-regenerative detector, transformer coupled to a first stage of audio which is resistance coupled to the power output stage. Tubes required: 954-R.F., 955-Detector; 6C5-1st Audio, 6F6-2nd Audio.

**Type 110** Receiver and 6 sets of coils, without tubes, speaker or power supply.

**List Price, \$85.00**

**Type 5886** Power Supply for above receiver, with tube.

**List Price, \$29.50**

Shipping Weights: Receiver, 16 lbs.—No. 5886 AB pack, 17 lbs.

Complete Catalog No. 300 on request.

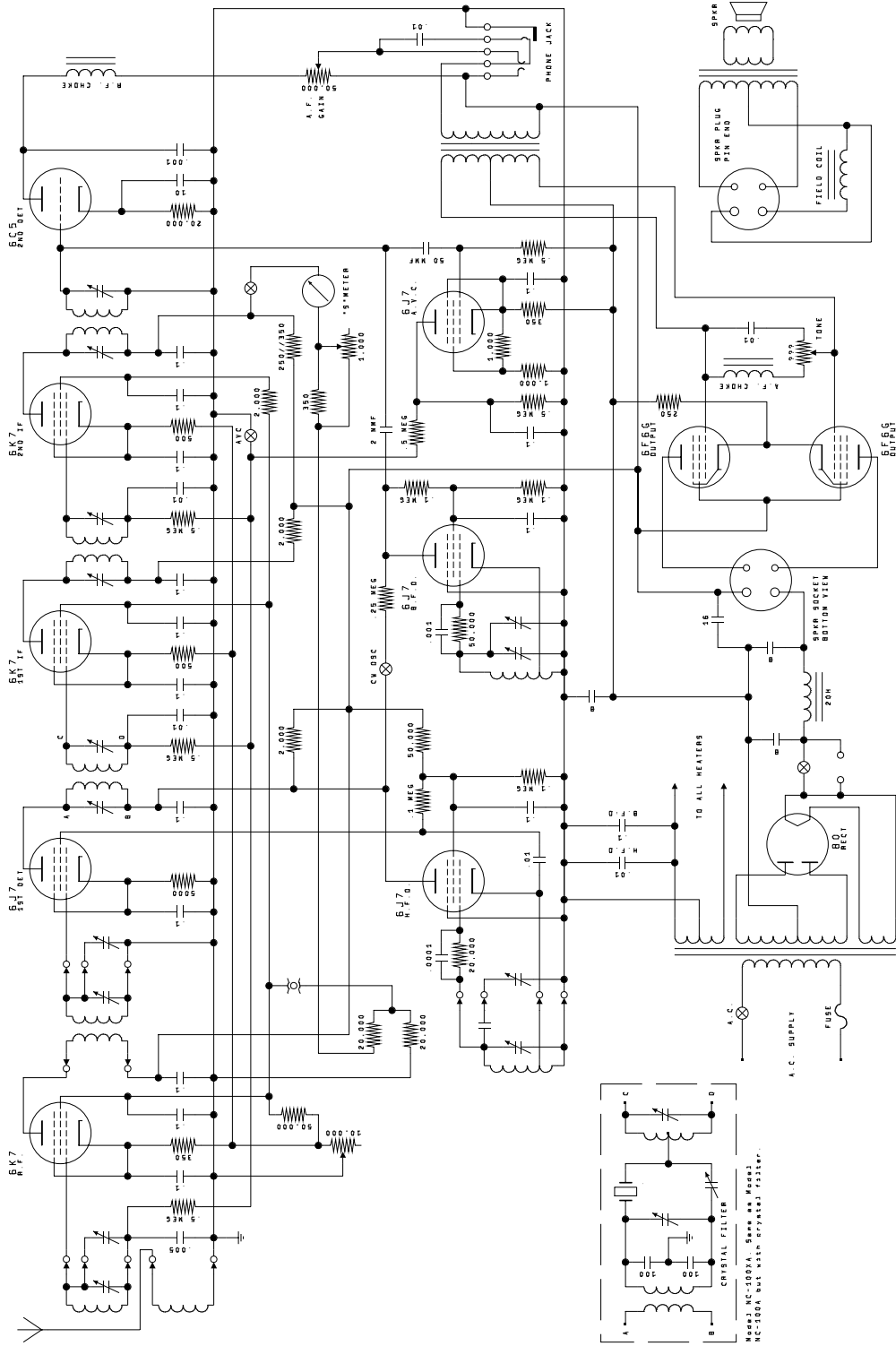




**NATIONAL COMPANY, INC.**  
**MALDEN, MASS.**  
**U. S. A.**



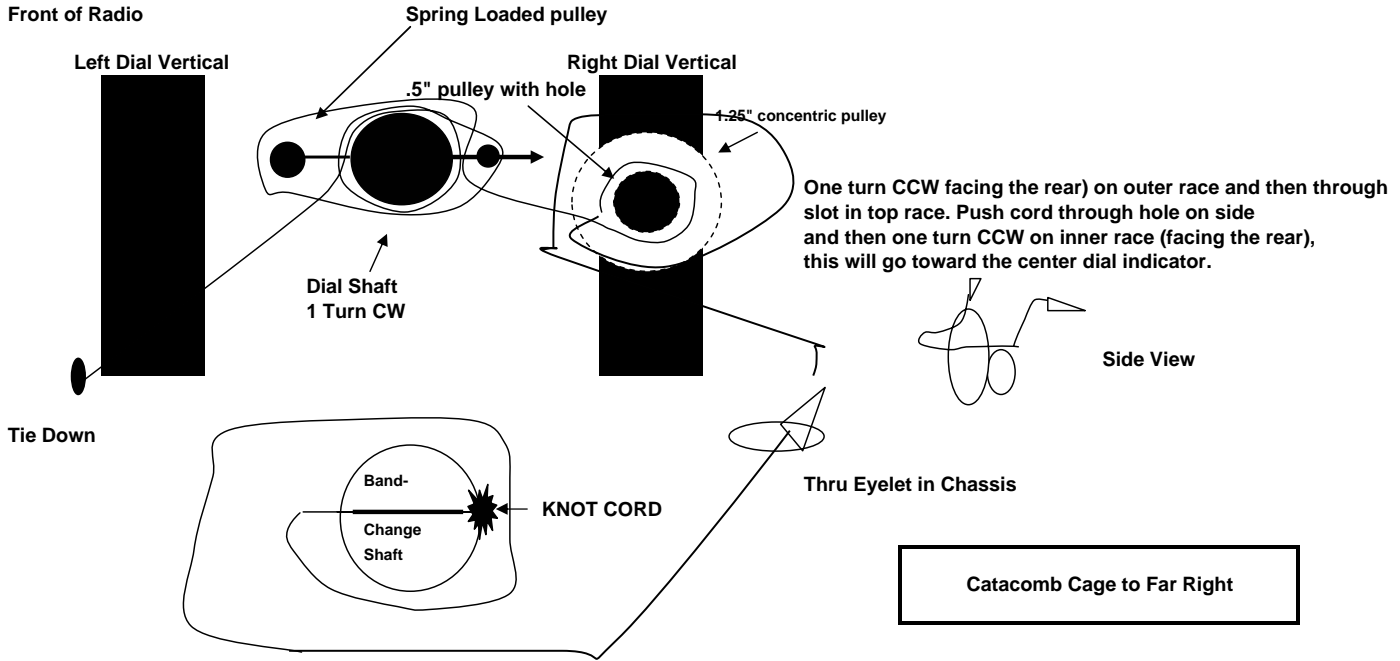
SCHEMATIC DIAGRAM



A.C. Operated NC-100A, early model

National NC-100A Family of Catacomb Radios  
Dial Stringing Instructions

Front of Radio



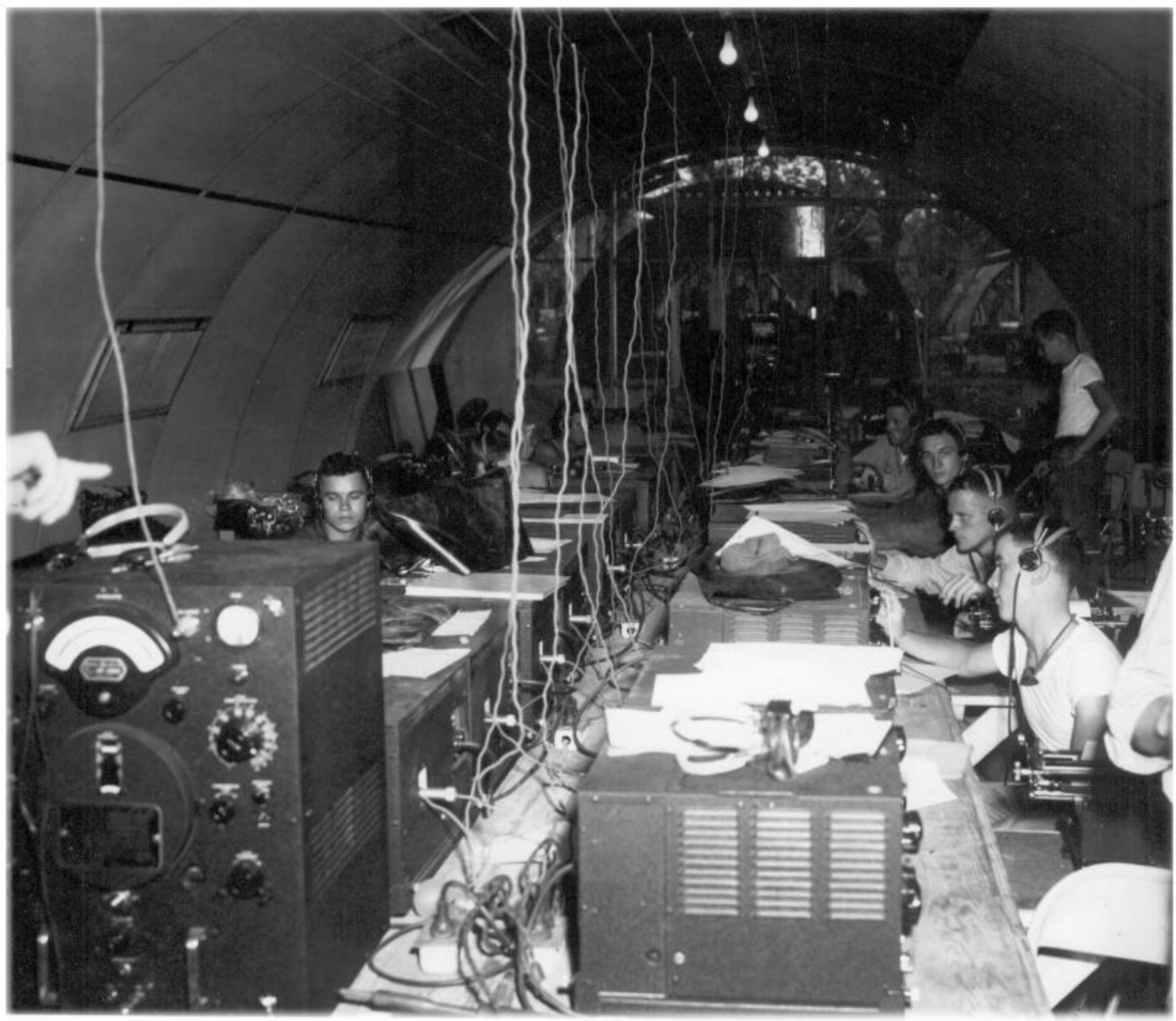
With Catacomb at extreme right side wind 5 turns of cord. .028 diameter cord is just right.  
CCW around dial shaft

Drawing furnished by William Fizette W2DGB  
Resketched and submitted by Stanley Adams W4SBA  
[stanleybadams@yahoo.com](mailto:stanleybadams@yahoo.com)









# Tube Radio Australia









