INSTALLATION AND OPERATING INSTRUCTIONS

RADIO RECEIVER

IP-501-A

Engineering Department
Radiomarine Corporation of America
A Radio Corporation of America Service
75 Varick Street, New York, N. Y.

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RADIO RECEIVER TYPE IP-501-A
INSTRUCTION BOOK

This radio receiver is the epitome of classic regenerative radio receivers. The design originated in the Washington Navy Yard Radio Test Shop, starting with the SE-143 radio receiver, in 1916, and culminated in the IP-501-A as the next to the last of the line (the last was a metal cased version known in the Army as the BC-131, with duplicate versions in the Navy and Coast Guard). The IP-501-A radio receiver was used mainly in the maritime services aboard ship and at shore stations from about 1925 through 1942. By then it had become obsolete, except on the least of the merchant ships in the backwaters of the world. The original designs were built in the Washington Navy Yard Radio Test Shop, some under the direction of Professor Hazeltine, and subsequently built by the Wireless Specialty Apparatus Company, later acquired by RCA in the Radiomarine division. For the student of radio, this receiver represents the best of the 1920's detector and two-step designs, and on LF or MF, it is still hard to beat. This manual is a rekeying of a reprinted manual from the Radiomarine Corporation of America, Engineering Department dated 1936. (NA4G)

INTRODUCTION

This receiver was designed for the reception of radio telegraphic signals over the wavelength of 250 to 8000 meters (1200 to 37.5 Kc.). This band may be extended to include 18,000 meters (16.7 Kc.) by the addition of a type IP-503 loading unit.

The receiver comprises an inductively-coupled tuner, a vacuum tube detector and two-stage amplifier. Except for the compact grouping of these components in one cabinet this receiver differs only slightly from the well-known IP-501 receiver.[1]

[1] The IP-501 radio receiver was the commercial variant of the Navy Model SE-1420 radio receiver, originally built by the Wireless Specialty Apparatus Company, about 1920. It used a detector tube in the cabinet but had a separate cabinet with a two-stage audio amplifier. (NA4G)

The popularity which the earlier model (IP-501) enjoys is due to the following features:

a) Excellent sensitivity, resulting from the use of a regenerating (or oscillating) detector, low-loss tuned circuits, an efficient A.F. amplifier, and well-designed coupling control.

b) Wide wavelength range without changing inductance coils and without serious "dead-end" losses.[2]

c) Rugged construction, reliable operaton and good appearance.

These same features with additions and simplifications are found in this Model IP-501-A receiver.

THE ANTENNA CIRCUIT:

The antenna or primary circuit consists of a primary inductance coil and a variable air condenser connected in series.

The inductance of this circuit is varied by a 6-point switch which has blades arranged to short-circuit unused portions of the coil, thus reducing "dead-end" losses.

The variable condenser (capacity .00008 mfd. to .0015 mfd.) is of the self-balanced type. The knob used for fine tuning rotates the condenser through reduction gearing. Besides being engraved with 0-180 degree graduations, the condenser dial carries concentric half-circles, over which a pointer is lowered or raised in response to the setting of the primary inductance switch. This arrangement allows the operator to make calibration marks on the antenna condenser dial which helps in later tuning to a desired station or wavelength. Such a calibration holds good, of course, only for the particular antenna used while calibrating, and the dial should be marked with India ink or other removable substance only.

[2] "Dead-end" losses are those losses associated with floating ends of coils that increase stray capacitance across tuned circuits. Special shorting switches that dead-shorted across unused coil portions reduced such stray capacitances. (NA4G)

THE SECONDARY CIRCUIT:

The secondary inductance coil is similar in construction to the primary loading coil in that both are band-wound, using radio frequency cable (Litzendraht) on threaded bakelite cylinders. Each winding is impregnated with a moisture-proof compound. This secondary coil, with its 6-step switch is shunted by a variable air condenser, similar in construction to the primary condenser, except the capacity varies from about .0006 mfd. to .00075 mfd.

The scale on each secondary condenser has been individually calibrated in wavelength at the factory. This calibration is correct when the receiver is used under the following normal conditions. Loose coupling between antenna and secondary circuits, detector tube of the 201-A type, tickler adjusted so that detector just oscillates.

PRIMARY TO SECONDARY COUPLING:

One of the reasons for the good selectivity (sharp tuning) of this receiver lies in the design which gives easily controllable electromagnetic coupling between these two circuits with practically no undesirable electro-static coupling.

The secondary coupling coil is so mounted and rotated inside the primary coil, by the knob marked "COUPLING" that the magnetic coupling is continuously varied from a maximum value to zero when the pointer swings over the 180 degree scale.

THE TICKLER:

The tickler in this receiver is of the variometer type, inductively coupled to a portion of the secondary winding and so proportioned as to effectively control regeneration and oscillation over the entire wavelength range of the receiver.

By rotating the TICKLER knob, mounted on the shaft of this variometer, the amount of energy fed back from the plate to the grid circuit of the detector is under the control of the operator. In this way, maximum signal strength can be obtained by regenerative reception of spark or ICW signals or by autodyne reception of C.W. signals.

The push button marked “OSC TEST”, when depressed, short circuits the tickler, stopping oscillations and producing a loud click in the telephones. If no click is heard when the butten is pressed, it indicates the tickler has not been advanced far enough to cause the detector to oscillate.

USE OF CRYSTAL DETECTOR:

In the emergency resulting from the failure of all vacuum tubes or batteries, it becomes necessary to use an external crystal detector connected across the binding posts marked “CRYSTAL”. The anti-capacity switch is thrown to the “CRYSTAL” position and the telephone plug is inserted in the “DET” jack. To assist in adjusting the crystal detector, a buzzer is provided.

THE BUZZER CIRCUIT:

The pearl push-button switch mounted near the buzzer closes the circuit through the buzzer and an 1-1/2 or 2 volt external battery connected to the posts “BUZZER BATTERY”.

Do not use more than 2 volts.

A lead from the buzzer is capacitively coupled to the antenna circuit so that while the buzzer is in operation a fairly loud note is heard in the telephones when the crystal detector is in adjustment.

THE VACUUM TUBES:

Raising the metal door in the upper right-hand corner of the panel gives access to the three tube sockets. These are supported on a shock-proof mounting to reduce noise due to vibration. From left to right the tubes service as: detector, first-stage audio and second-stage audio amplifiers. It is intended that UX-201-A or UV-201-A Radiotrons be used with this receiver.

THE FILAMENT CIRCUIT:

The filament rheostat acts as master rheostat to regulate the filament voltage on all of the tubes. The telephone jacks are equipped with filament control contacts so that the insertion of the plug in any of the jacks lights the filaments of the desired tubes.

There is a small fixed resistor in series with each tube so that voltage changes due to plugging tubes in or out are not serious. However, the filament voltage as indicated by the filament voltmeter should be readjusted when necessary after inserting the telephone plug in the desired jack. The rated filament voltage for 201-A Radiotrons is 5 volts. this rating should not be exceeded. Many operators obtain satisfactory results at 3.5 volts, and thus greatly prolong the life of the Radiotrons.

INSTALLATION OF RECEIVER:

The antenna and ground connections are made to the proper binding posts. The following batteries should be provided: Filament, or “A” battery, a storage battery giving 6 volts at .75 amperes, a “B” battery furnishing 45 volts. The “C” battery binding posts should be short circuited. (If desired, a 90 volt “B” battery with a 45 volt tap may be used, connected so that the wire from the +90 volt terminal runs to the farthest right-hand post now marked “+45”. In this case, a -4.5 volt “C” battery must be used.

After the proper connections are made the vacuum tubes should be inserted in their sockets.

OPERATION:

Throw the transfer switch to the “TUBE” position. Place the telephone plug in the desired jack and adjust the filament voltage to 5 volts by means of the rheostat.

TUNING TO A KNOWN WAVELENGTH. Assuming the wavelength of the desired station is known:

1. Set Secondary Condenser at this wavelength.

2. Set Coupling pointer at maximum, 180 degrees.

3. Advance tickler control until detector just oscillates.

4. Place Primary Inductance switch on same point as Secondary Inductance switch. Rotate Primary Condenser until "double click"[3] in telephones indicates the antenna circuit is in tune with the secondary circuit.

5. If autodyne reception is not desired, stop the detector oscillating by reducing the tickler setting.

6. Slowly move both the primary and the secondary condensers back and forth for the loudest signals.

For sharper tuning, decrease the coupling to say, 60–90 degrees and retune both the primmary and the secondary condensers.

PROPER ADJUSTMENT OF COUPLING:

Radio operators know that loose coupling gives greater selectivity, and sharper tuning. Many of them believe that loose coupling also means reduction in signal strength. This is not necessarily true. For every wavelength within the range of the receiver there is a degree of coupling which will give the most satisfactory results from the combined viewpoint of signal strength and sharpness of tuning. This is called "Critical Coupling". Figure 1 illustrates how selectivity and received signal vary for different degrees of coupling. The conditions under which these curves were taken were with the tickler at zero and with both the primary and the secondary circuits tuned to 800 meters, then coupled as marked on each curve. The conclusions drawn from Figure 1 are:

1. The looser the coupling, the sharper the resonance curve (the greater the selectivity) but looser than critical coupling considerably reduces the signal strength.

2. Close coupling makes the receiver resonant to two wavelengths at the same time; one below and one above the desired wavelength, 800 meters. Such broad tuning is useful for "stand-by" reception.

Critical coupling occurs at that adjustment at which the primary circuit produces no reaction on the secondary circuit. This fact fortunately makes

[3] Double click is explained in a later paragraph.

it easy for the operator to test the receiver adjustment to ascertain if the coupling is approximately at this desired critical value.

TO TEST FOR CRITICAL COUPLING. Assume that the secondary condenser is set at the desired wavelength. Advance the tickler slightly beyond the oscillating point. Rotate the primary condenser slowly back and forth, noting the "double click" in the telephones as the primary passes through resonance with the secondary circuit. As the coupling is loosened these "double clicks" will merge into one faint click. At this setting the receiver is adjusted for critical coupling.[4] Observe that the value of critical coupling changes with wavelength.

"THE DOUBLE CLICK" is familiar to operators of oscillating receivers. This sound in the telephones results from the sudden change of plate current when the detector stops and starts oscillating due to the primary wavelength being varied through that at which the oscillating secondary is set. The greater the distance, on the primary condenser dial, between these "clicks" the closer the coupling between the circuits.

Before we obtain this "double click" indication, we must have (a) antenna connected so that the primary circuit is complete and can be resonated to the secondary; (b) the tickler so set that the detector oscillations are neither too strong nor too weak; and (c) the coupling adjusted to be at least greater than critical.

CALIBRATION OF PRIMARY CONDENSER DIAL:

This should be done only after the receiver is installed, permanently wired, and connected to the antenna with which it is to be used. While calibration is often carried out by tuning to distant transmitters, the entire primary dial may be calibrated by the "double click" method. With the secondary dial set at the desired wavelength, advance the tickler until the detector is oscillating. Adjust for critical coupling and mark the primary

[4] This critical coupling point is that point at which the detector is not overloaded and pulled out of oscillation as the primary tuning is swept past the desired wavelength. Critical coupling is then that point at which the primary is sufficiently uncoupled from the secondary so as to have no effect on the detector oscillation, and thereby giving maximum signal strength for any particular received signal. Looser coupling can be advantageous if the desired signal is sufficiently strong, and will increase the selectivity of the detector at the expense of signal strength. In general, for maximum selectivity, use the minimum coupling possible to still adequately receive the desired signal. (NA4G)

condenser at the point where the "double clicks" merge into one faint click, using India ink or other removable substance. Repeat the process for the principal wavelengths used.

GENERAL:

1. When a powerful, nearby transmitter suddenly starts to transmit, the operator needs a quickly operated volume control. Use the filament rheostat.

2. The factors affecting regeneration (after the secondary condenser is fixed at the desired wavelengths) are:

The tickler

The tuning of the primary

The coupling, primary to secondary

The filament rheostat

3. If using a break-in system, care should be taken to see that the spacing of the receiver protective gap does not exceed the thickness of a sheet of newspaper. If this gap is too wide, the high voltage may jump inside the receiver and burn the primary winding and switch.

4. If the vibration of the ship causes tube noises, try interchanging the detector and amplifier tubes.

5. The buzzer battery, when used, should be insulated from ground and from the filament source. Use a single dry cell.

6. *Reception Through Static.* Loose coupling, 40–60 degrees, slight detuning of the primary, and an oscillating detector helps. Dimming the filaments to a point where the sensitivity does not seriously suffer, helps to limit the noise from the loud crashes.

7. *Reactivation of Vacuum Tubes.* If the filaments of any of the 201-A tubes are accidently subjected to excessive voltage, the tube may fail to function although the filament may not be burned out. Such tubes often can be restored to normal usefulness by re-activating their filaments. With

the plate battery disconnected, burn the filament of the tube at 15 volts for 1 minute, then reduce the voltage to 7.5 volts for 10 minutes.

MAINTENANCE:

The bakelite panel may be wiped off with a cloth moistened with a light machine oil, followed by a dry cloth. Keep all connections tight and storage battery terminals clean. Do not remove the receiver from the case unless absolutely necessary. Do not use metal polish on the nickel plate fittings. Rubbing with a soft dry cloth should keep the nickel bright.

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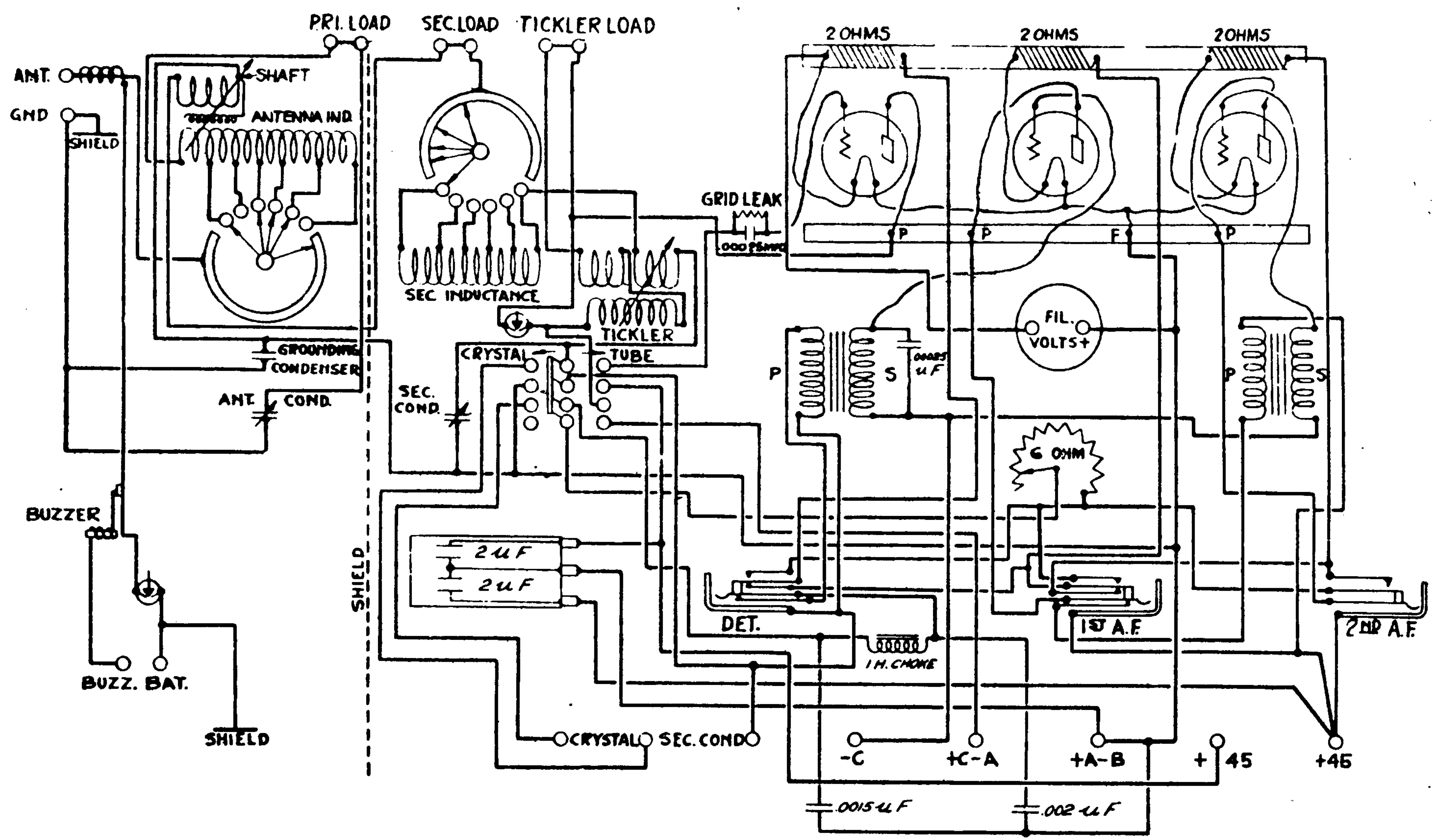

IP501A RECEIVER—WIRING DIAGRAM