INSTRUCTIONS FOR USE OF

U. S. NAVY

MEDIUM WAVE RADIO RECEIVER

TYPE SE 1420

RANGE 235 TO 7500 METERS

RADIO TEST SHOP
U.S. NAVY YARD
WASHINGTON, D.C.
MARCH, 1919

Submitted:

(signed, HORLE)

Expert Radio Aide

Approved:

(signed, W.A. Eaton)

Lieutenant, U.S.N.
Radio Officer

Prepared by L. SHAPIRO, Radio Electrician

RW 46A492A

Franklin Printing Co., Baltimore.

NOTE: If the operator is in urgent need of information that will give him a working knowledge of this receiver, he may find it profitable to begin by reading Sections III and IV, subsequently returning to the ‘‘Preliminary Notes’’ and the ‘‘Description of Receiver’’, Sections I and II.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued.)

III OPERATING INSTRUCTIONS (Continued).

IV. INSTALLATION AND CARE.

INSTRUCTIONS FOR USE OF

U. S. NAVY MEDIUM WAVE RADIO RECEIVER

TYPE SE 1420

I. PRELIMINARY NOTES.

Electromagnetic waves. --- Radio signals are conveyed through space by means of rapidly alternating magnetic and electrostatic fields which progress from their source at the speed of light (300,000,000 meters per second), forming ELECTROMAGNETIC WAVES. A spark transmitter produces a series or train of such waves at each spark. In most cases these waves are quickly stopped or ‘‘damped out’’ before the next spark occurs, and are known as DAMPED WAVES. An arc or tube transmitter produces sustained or continuous waves, which are known as UNDAMPED WAVES.

Wave-length. --- The speed of the electromagnetic waves, divided by the frequency or number of waves per second, gives the distance covered in the short interval of time during which one wave is produced. This distance is known as the WAVE-LENGTH, and is measured in meters. Wave-lengths in daily practical use range from 50 meters (about 160 feet) to 30,000 meters (about 19 miles).

Tuning. --- Any coil (or inductance) offers an obstacle or IMPEDANCE to the passage of alternating current, which increases when the frequency of the alternating current increases. Any condenser (or capacity) offers an impedance to the passage of alternating current, which decreases when the frequency of the alternating current increases. The impedance of a circuit comprising a coil and a condenser in series, but having no resistance, is the difference of the to component impedances. Consequently there is some frequency at which the two component impedances exactly neutralize, and the impedance of the circuit is zero. At this frequency the circuit is said to be RESONANT. In every practical case there is an unavoidable resistance in the circuit, so that the impedances cannot exactly neutralize, but can become a minimum equal to that resistance.

A circuit of this type responds most strongly to impulses at or near its resonant or NATURAL frequency or wave-length, and finds wide application as a selector in radio reception. In order to vary the resonant frequency, the inductance of the coil, the capacity of the condenser, or both, are usually made variable; and the operation of varying them to obtain resonance is known as TUNING.

Reception. --- Present-day reception employs three principal steps, which are illustrated in Figs. 3 and 4. First, the passing waves impinge upon a suitable ANTENNA and set up high-frequency alternating currents in a tuned primary or ANTENNA CIRCUIT. Secondly, the antenna circuit induces high-frequency alternating currents in a tuned SECONDARY CIRCUIT suitably linked or COUPLED with the antenna circuit. By this double tuning process a high degree of wave-length selectivity is obtained. Thirdly, the high-frequency secondary currents are DETECTED or caused to produce audible sounds in a telephone, with the aid of a vacuum tube or crystal.

Detection. --- An ordinary telephone diaphram will not vibrate readily at the frequencies of radio waves (or RADIO FREQUENCIES), which range from 10,000 to 6,000,000 cycles per second. Furthermore, any vibration at such frequency is almost or quite inaudible to the human ear. It is therefore necessary to convert an incoming signal into a pulsating current of AUDIO FREQUENCY --- from 300 to 2,000 cycles per second. In the detection of damped signals this is done by RECTIFICATION or conversion of the radio frequency alternating currents *a* to radio-frequency unidirectional pulsating currents *b* (Fig. 1). The effect of the latter is merged by the telephone into a deflection of the diaphragm which lasts as long as the waves continue; and inasmuch as the waves are interrupted and renewed with each spark at the transmitter, as shown at *a*, there is a deflection of the diaphragm with each spark or wave train, resulting in a note similar to the spark note, as shown at *c*.

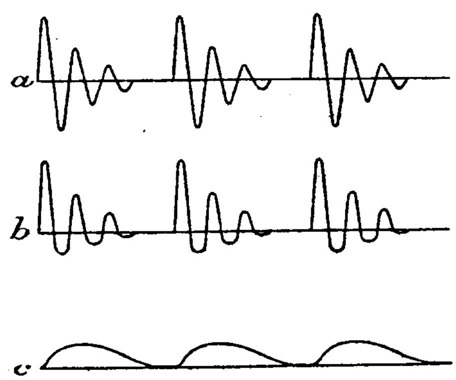

Fig. 1: ACTION OF A DETECTOR
a - Incoming impulses
b - Rectified current
c - Effective telephone pulses

Detection of undamped signals is usually accomplished by the HETERODYNE method, which consists of combining with the radio-frequency alternating current set up by the incoming waves *a* (Fig. 2), a local radio frequency alternating current or OSCILLATION *b* in the secondary circuit. This local oscillation has a frequency which differs by, say, 500 cycles per second from that of the incoming oscillation. At one instant, x--x, the two currents are IN PHASE --- that is, they increase and decrease together. At another instant, y--y, the two currents are opposite in phase --- that is, one increase while the other decreases. Thus the resultant current *c*, which is the sum of the two currents at any instant, changes in amplitude from a miximum to a minimum and back again, say, 500 types per second. This resultant current is detected by rectification, as shown at *d*, and gives a BEAT NOTE whose frequency is the difference between the frequencies of the incoming and the local oscillations, as shown at *c.*

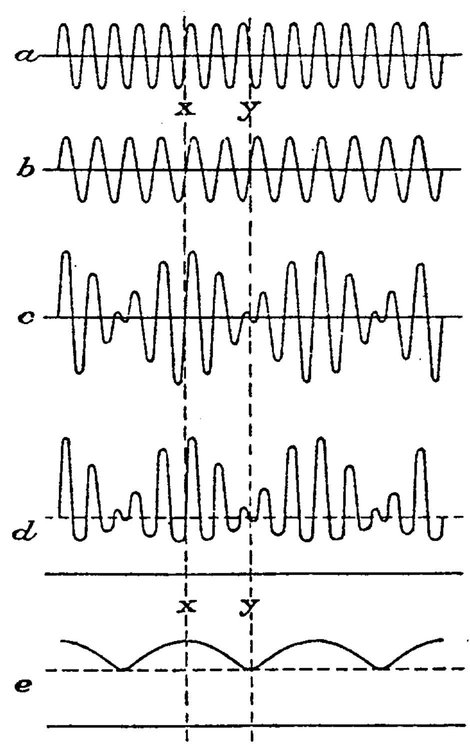

Fig. 2: PRINCIPLE OF HETERODYNE DETECTION

a – Incoming oscillation
b – Local oscillation
c – Resultant current
d – Rectified current
e – Effective telephone pulses

Rectifiers. --- The CRYSTAL is a familiar type of rectifier, consisting usually of a contact between a metallic point and a crystalline mineral substance. This has the property of UNILATERAL CONDUCTIVITY or ability to pass current in but one direction. The crystal is commonly connected in series with a condenser, the telephones being shunted across the condenser (see Fig. 3). Owing to the high inductance of the telephones, the rectified rado-frequency currents do not pass through the telphones, but charge the condenser; and the latter in turn discharges at audio frequency through the telephones.

The VACUUM TUBE is the most commonly used rectifier. It consists of an evacuated glass tube containing a FILAMENT made incandescent by current from a battery; a PLATE connected to the positive terminal of a battery whose negative terminal is connected to the filament; and a GRID of perforated sheet metal or wire-mesh interposed between the plate and the filament. The telephones are connected between the plate and the plate battery. The grid and the filament are connected to the terminals of the secondary circuit, so that the potential of the latter is impressed between them. Current from the plate battery flows through the space in the tube from the plate to the filament, and the magnitude of this current is affected by the potential of the grid, so that the tube acts as a relay. When all conditions are properly adjusted, an increase in grid potential increases the plate current materially, whereas a decrease in grid potential diminishes the plate current but slightly. Thus, when a radio-frequency alternating potential is impressed upon the grid, it produces a rectified radio-frequency current in the plate circuit.

Oscillators. --- The vacuum tube may be used to produce the local oscillation needed for heterodyne action. For this purpose there may be provided a coil known as a TICKLER, in series with the telephones and plate battery, and magnetically coupled to the secondary coil (see Fig. 4). Any change in grid potential produces a change in plate current, and this in turn induces, by magnetic coupling, a change in grid potential which accentuates the original change. Thus any slight initial oscillation in the secondary, which would die down very quickly without the vacuum tube and tickler, is built up to a magnitude depending upon the characteristics of the tube and the circuit, and is maintained indefinitely.

Regeneration. --- The tickler is of great value in the reception of damped as well as undamped waves. Even when the tickler coupling is not sufficient to produce oscillation in the secondary circuit, it serves to increase the amplitude and prolong the duration of each train of incoming oscillations, thereby strengthening or amplifying the resultant signal. This is known as REGENERATION, and its effect is greatest when the secondary circuit is on the verge of oscillation --- that is, when the succeeding trains of oscillations almost meet. When continuous oscillation takes place, the incoming trains overlap each other irregularly and change the clear note to an uneven hiss, becoming almost inaudible as the oscillation increases in strength.

II. DESCRIPTION OF RECEIVER.

The type SE 1420 receiver is intended for the reception of damped or undamped signals between 235 and 7500 meters. It permits the use of either the crystal or the vacuum tube detector, and contains within itself the receptacle and controls for the latter. Variable tickler coupling provides for regenerative amplification of damped signals. By virtue of thorough shielding, the receiver is highly selective and proof against local interference.

MISSING PAGE 9 TEXT GOES HERE.

If anyone has a copy of the original Page 9 of the SE 1420 manual, kindly forward a copy of it to NA4G (‘‘good in the book’’) so it can be included here to complete the manual reprint. Thanks/NA4G.

the antenna coil in which the coupling is a maximum. Thus the 45 degree mounting affords finer control of coupling than a rectangular mounting would afford.

Coupling coil shield. --- The coupling coil is provided with an electrostatic shield to prevent capacity coupling between the antenna and secondary circuits. This shield consists of an additional winding placed over the coupling coil wound in th eopposite direction to the latter, one terminal being connected to the low-potentila or ground end of the coupling coil, the other terminal being dead-ended (See Fig. 6). The shielding thus obtained is of course imperfect, so that some radio-frequency alternating current still flows by capacity coupling from the antenna coil through the coupling coil to ground, setting up an alternating voltage in the coupling coil, which is impressed upon the secondary circuit and the detector. An equal and opposite voltage is induced in the coupling coil by the capacity current flowing in the shielding coil, completely neutralizing the effect of capacity coupling upon the secondary.

Tickler. --- Oscillation is obtained by means of a TICKLER having a stationary part, wound on the main secondary coil tube (see Figs. 6, 8, and 9), in series with a rotatable part, wound on a spherical form, mounted inside the secondary coil tube (see Figs. 6 and 8). When the movable part is in the 180-degree position, its coupling to the secondary coil is added to that of the stationary part; and when it is in the zero position, its coupling is subtracted from that of the stationary part, practically neutralizing it. By virtue of this construction a full 180 degree rotation of the tickler is obtained when passing from minimum to maximum tickler coupling affording fine control as in the case of the coupling coil.

Inasmuch as most of Tap 1 is in the antenna coupling coil, it is necessary to resort to close coupling of the remainder of Tap 1, and of Tap 2, to the tickler in order to secure oscillation on these taps. Accordingly, the remainder of Tap 1 is placed directly over one side of the movable tickler coil, the stationary tickler coil being placed between it and Tap 2 (see Figs. 6, 8, and 9).

An OSCILLATION TEST push button is provided near the tickler knob. When this button is depressed it short-circuits the tickler and stops oscillation, changing the direct plate current and giving a click in the telephones.

Inductance switches. --- Every coil has a natural wave-length of its own due to the presence of capacity between its turns. In the Type SE 1420 receiver, the high-inductance sections of the antenna and secondary coils are resonant at wave-lengths within or near the operating ranges of the low-inductance sections. The latter, therefore, tend to induce oscillations in the former, dissipating energy and weakening signals. To overcome this each of the inductance switches is provided with a number of blaces to short-circuit the high-inductance sections when the low-inductance sections are in use, reducing the natural wave-lengths of the former by about one-half and bringing them well below the operating ranges of the latter.

Crystal-Audion switch. --- A four-pole double-throw ''anti-capacity'' switch is provided for making the connections shown in either Fig. 3 or Fig. 4. In the set of connections shown in Fig. 3, the grid, plate, and filament are disconnected, both battery circuits are opened to prevent drainage and waste, the terminals of the secondary circuit are connected to the ''Sec. Cond.'' binding posts, and the crystal binding posts are connected in series with the telephones across the secondary circuit. The ''Sec. Cond.'' binding posts may then be used for connections to the input terminals of a radio-frequency amplifier, provided that the crystal be disconnected from the ''Crystal'' binding posts (see Fig.6).

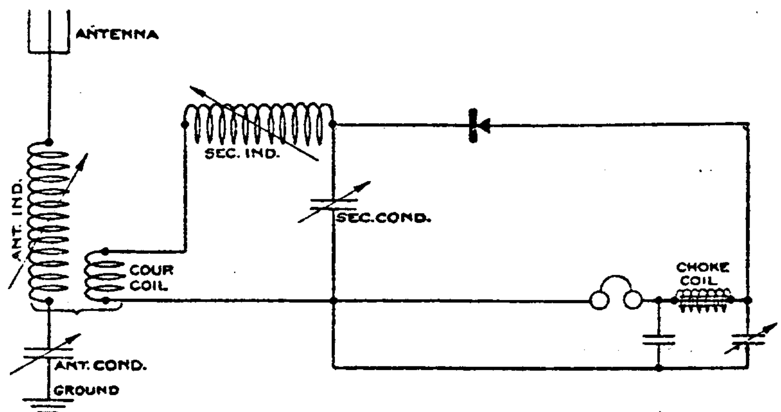

Fig. 3: SCHEME OF CONNECTIONS FOR CRYSTAL

In the set of connections shown in Fig. 4, the secondary circuit is connected between the grid and the filament, and the tickler, telephones, and plate battery are connected in series between the plate and the filament.

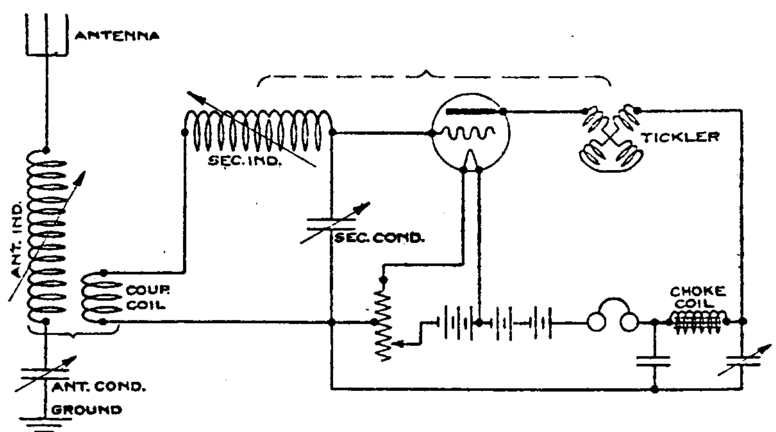

Fig. 4: SCHEME OF CONNECTIONS FOR VACUUM TUBE

Filament rheostat. --- The filament rheostat is of the squirrel-cage type. In order to secure best conditions for rectification, the grid is given a negative d. c. BIAS by connecting the low-potential terminal of the secondary coil to a fixed point on the filament rheostat, this point being between the negative terminal of the filament and the negative terminal of the battery (see Figs. 4, 5, 6, 8, and 9).

Tube mounting. --- The tube mounting may be clearly seen in Figs. 7, 8, and 9. It carries a four-contact bayonet-joint tube socket, suspended on springs in such a way as to be mechanically shock-proof, so that external vibrations will not produce vibration of the tube and consequent noises in the telephones.

Telephone condenser. --- A high-capacity mica condenser (55-63, Fig. 6) is connected between the tickler and the filament to act as a radio-frequency by-pass around the telephones and plate battery. When operating on the crystal detector this condenser is in series with the crystal and in shunt with the telephones (see pages 7 and 8 and Fig. 3). It is variable in six steps so as to permit approximate tuning with the telephone inductance to the note of the incoming signal. Incidently, it serves as an auxiliary oscillation control, as it offers greater impedance to radio-frequency plate current when set at a low value than when set to a high value, thereby making oscillation more difficult.

Telephone choke coil. --- If there is radio-frequency current in the telephones, any change in the capacity between them and other objects will detune the secondary. Such capacity change occur when the operator brings his hand near the condenser dials or knobs, and change the ‘‘beat note’’ in heterodyne detection. This is particularly undesirable with short waves, as their frequency is high and a small percentage detuning changes the ‘‘beat note’’ enough to make it inaudible. To keep radio-frequency current out of the telephones, a CHOKE COIL (56-57, Fig. 6) is placed in series with them. The inductance of this coil is high enough to prevent passage of radio-frequency current, but not high enough to materially impede the passage of audio-frequency current.

As an additional safeguard against radio-frequency current in the telephones, a fixed condenser (64-65, Fig. 6) is connected directly across their terminals to shunt away any radio-frequency current passing through the choke coil.

Grounding condenser. --- As an auxiliary to the shielding system, a high-capacity mica GROUNDING CONDENSER is connected between the filament rheostat and the shield. This definitely grounds the filament and batteries with reference to radio frequency and prevents the possibility of interference resulting from electrostatic coupling between the batteries and a nearby transmitter.

Test buzzer. --- A buzzer and controlling push button are provided for exciting the antenna circuit into damped oscillation at the wave-length to which it is tuned. The exciting circuit is capacitively coupled to the antenna circuit by means of a small metal tube or spiral wire surrounding the antenna lead and connected to the armature of the buzzer, the stationary contact of the buzzer being grounded (see Figs. 5, 6, 8, and 9). The buzzer enables the operator to tune the antenna and secondary circuits to each other approximately, and to test the performance of either a crystal or a vacuum tube detector.

III. OPERATING INSTRUCTIONS.

Operating requirements. --- The principal objects sought after in the operation of a radio receiver are loudness and clearness of signals, the elimination of undesired signals, including ‘‘static’’, and the picking up of unscheduled signals. These objects are to a certain extent antagonistic to each other, so that they cannot be attained simultaneously, as will be made evident in the consideration of the various phases of operation.

Vacuum tubes. --- The following types of vacuum tubes will operate satisfactorily in this receiver:

Type SE 1444 (Made by Moorhead Laboratories.)

Type CW 933 (Made by Western Electric Company, Type ‘‘J’’.)

Type CG 890 (Made by General Electric Company, Type ‘‘G’’.)

For producing oscillation, the Type CW 933 tube is considerably better than the other two; for detection, all three are roughly equal. The Type SE 1444 tube, however, takes about three-fifths as much filament current as either the Type CW 933 or the Type CG 890, and but one-fifth as much plate current as the Type CW 933 tube; and is for that reason to be preferred.

Adjustment of filament current. --- The proper adjustment of filament current is of vital importance in the operation of any tube. While an increase in filament current, within limits, makes a tube a better oscillator, it does not always improve the detector qualities of the tube, and it causes the filament to burn out sooner. The proper filament currents are as follows:

TUBE TYPE	FILAMENT CURRENT	
	For best detection	Maximum allowable
Type SE 1444	0.63-0.70 amperes	0.75 amperes
Type CW 933	1.00-1.30 ’’	1.40 ’’
Type CG 890	1.10-1.20 ’’	1.30 ’’

DO NOT AT ANY TIME UNDULY INCREASE THE FILAMENT CURRENT, AS IT WILL WEAKEN THE SIGNAL AND SHORTEN THE LIFE OF THE TUBE.

Filament battery and bias. --- As noted on page 11, the grid is given a negative bias potential by connection to a tap on the filament rheostat. This bias is essential to the operation of the tube as a detector. If the rheostat setting is increased sufficiently to bring the contact arm past the bias tap, the bias potential is diminished, and the rectifying qualities of the tube are impaired. This happens in an attempt to secure filament current with a run-down battery, and shoule be permitted only in an emergency. The bias tap is reached when the rheostat pointer is slightly below the horizontal position to the right (see Fig. 7).

Choice of plate voltage. --- The value of the plate voltage is second in inportance only to that of the filament current, and is governed by similar considerations. An increase in plate voltage in general improves a tube as an oscillator, but the close relation between plate voltage and bias potential for detection fixes the best values of plate voltage as follows:

TUBE TYPE	PLATE VOLTAGE	
	For best detection	Maximum allowable
Type SE 1444	37-45 volts	50 volts
Type CW 933	28-33 ’’	40 ’’
Type CG 890	37-45 ’’	50 ’’

Telephone condenser setting. --- The primary function of the telephone condenser is to tune the telephone circuit to the note of the received signal. This adjustment, however, is not sharply critical in its effect upon signal strength. For high-pitched notes, and for crystal operation, it will be found better to set the telephone condenser at 1 or 2, while for low-pitched notes it will be found better to set it at 5 or 6. A secondary function of the telephone condenser will be found necessary under certain conditions. For instance, it will be found that with most Type CW 933 tubes oscillation cannot be stopped at the lower wave lengths on tap 1 unless the telephone condenser is set at 1 or 2. Always make the final adjustment of oscillation strength with the tickler knob, however.

Tickler adjustment. --- Incidentally to its function of oscillation control, the tickler plays an important part in securing maximum loudness of detected signals and high selectivity. To secure this by regeneration in the case of damped signals, increase the tickler setting slowly and carefully until the signal in the telephones is loudest. If it is still further increased, oscillation will be set up in the secondary circuit, as evidenced by an irregular hissing sound accompanied by a reduction in strength of signal.

The adjustment of the tickler for heterodyne detection of undamped signals is almost as critical as that for detection of damped signals. With the secondary circuit in the oscillating condition, decrease the tickler setting slowly until the signal is loudest, at the same time retuning the secondary. THE LOUDEST SIGNAL IS OBTAINED WHEN THE OSCILLATION IS ON THE VERGE OF STOPPING, AND NOT WHEN IT IS STRONGEST.

Oscillation test. --- To test for the presence or absence of oscillation in the secondary circuit, press the button beneath the tickler knob. A dull click in the telephones, upon both depression and release, indicates the stopping and starting of oscillation. In the absence of oscillation no sound will be heard.

Factors affecting oscillation. --- The factors affecting oscillation in the secondary circuit are as follows:

(1) VACUUM TUBE:

(a) Filament current

(b) Plate voltage.

(2) TICKLER SETTING.

(3) TELEPHONE CONDENSER SETTING.

(4) ANTENNA:

(a) Coupling

(b) Tuning.

The effect of the antenna upon the ease of oscillation in the secondary circuit, though not generally appreciated, is quite pronounced. When the antenna circuit is coupled and tuned to the secondary circuit, power is transferred to the former from the latter, producing oscillation in it. The amount of power expended in this way depends upon the charactistics of the antenna; so that different antennas differ in the magnitude of their effect upon the oscillation. An antenna of extremely high resistance may stop oscillation on taps 1 and 6. In this case AND IN NO OTHER it is permissible to raise the plate voltage to a certain extent --- say to 60 volts.

FAILURE TO OBTAIN OSCILLATION AT ANY WAVE-LENGTH SETTING WITH AN ORDINARY ANTENN INDICATES A DEFECTIVE TUBE, A DEFECTIVE RECEIVER, OR IMPROPER MANIPULATION.

Adjustment of coupling. --- The coupling plays a very important part in the performance of the receiver, and the operator should thoroughly acquaint himself with its action and use.

At low values of coupling, the reaction between the antenna and secondary circuits is slight, and the tuning of one circuit is virtually independent of the tuning of the other. Consequently two independent selections of wave-lengths by tuning are made in the two circuits, and the receiver as a whole is highly selective. This is a desirable condition when there are interfering signals at wave-lengths only slightly different from that of the desired signal, and may make loose coupling preferable to tight coupling even at the cost of loudness of signal.

Tight coupling introduces a reaction between the antenna and secondary circuits such that the tuning of one circuit affects the tuning of the other considerably over wide ranges. With tight coupling the entire receiver is but slightly more selective than one of the circuits alone. This is valuable in pick-up work, where unscheduled signals are sought.

Maximum loudness of signal is obtained with neither extremely loose nor extremely tight coupling, but with an intermediate OPTIMUM value of coupling, which may be found by trial and depends upon the wave-length setting and the characteristics of the antenna.

Tuning secondary to desired wave-length. --- To tune the secondary circuit to a desired wave-length, find the wave-length among those engraved on the secondary condenser dial (or estimate its position from the nearest engraved mark if it is not a standard Navy wave-length), set the secondary inductance switch to bring the pointer on the proper dial scale, and rotate the condenser to bring the pointer in line with the wave-length mark, using the find adjustment knob. When the desired wave-length occurs on two taps, the higher tap is generally to be preferred.

The dial engraving gives the correct setting when the Type SE 1444 tube is used, with 40 volts plate battery and 0.65 amperes filament current, the tickler being adjusted approximately to the point at which oscillation begins, and the antenna coupling being loose. Any departure from these standard conditions changes the secondary wave-length, the following being the important factors:

(1) DETECTOR.

(2) TICKLER SETTING.

(3) COUPLER SETTING.

(4) ANTENNA TUNING.

(1) The capacity of the detector affects the secondary tuning. A crystal detector or a ‘‘J’’ tube, Type CW 933, adds a higher capacity to that of the secondary condenser than a Moorhead tube, and consequently gives a higher wave-length than a given condenser setting.

(2) An increase in tickler setting increases the secondary wave-length, especially on taps 1 and 2. When operating on these taps do not increase the tickler setting beyond the point at which oscillation begins, as it reduces resonance with the secondary circuit and becomes the controlling factor in the tuning.

(3) On Tap 1, where the coupling coil forms the major part of the secondary inductance, an increase in coupler setting decreases the inductance and therefore the wave-length at a fixed condenser setting. This is due to a reaction from the short-circuited portion of the antenna coil.

(4) With close coupling, the antenna tuning reacts upon the secondary tuning, as stated on page 15.

The effects of (2), (3), and (4) upon the secondary tuning are particularly marked in heterodyne detection at short wave-lengths. ALWAYS BEAR IN MIND THAT THE SECONDARY DIAL ENGRAVING GIVES CORRECT WAVE-LENGTHS ONLY WHEN STANDARD CONDITIONS OBTAIN.

Tuning secondary for signal. --- The tuning of the secondary circuit depends upon whether damped or undamped signals are being received. In reception of damped signals, tune for maximum loudness. In heterodyne reception of undamped signals, silence is obtained when the secondary is in tune with the signal, and as the secondary is detuned to one side or the other, a low ‘‘beat note’’ is heard, which changes as the detuning progresses to a shrill note, finally becoming inaudible. The best ‘‘beat note’’ to use depends upon the individula ear. On short wave-lengths the ‘‘beat note’’ becomes inaudible with a very slight detuning, so that it may be missed entirely unless careful adjustment is made with the secondary condenser fine-adjustment knob.

Antenna tuning. --- For maximum signal strength tune the antenna accurately to the wave-length of the incoming signal, regardless of whether the latter is damped or undamped. In stand-by or pick-up work it is desirable to tune the antenna circuit to the secondary independently of incoming signals. This can be done by the following methods:

(1) ANTENNA DIAL CALIBRATION.

(2) COUPLING CLICKS.

(3) BUZZER SIGNAL.

(4) ‘‘STATIC’’.

In using any of these methods, it will be helpful to remember that, with most antennas, the wave-length range of any tap in the antenna circuit is roughly the same as the wave-length range of the corresponding tap in the secondary circuit. For instance, any wave-length found on tap 3 of the secondary circuit will usually be found on tap C of the antenna circuit.

(1) IF THE ANTENNA CONDENSER DIAL HAS BEEN CALIBRATED in accordance with the specific instrucitons given on page 17, simply set the antenna inductance switch and condenser dial to the wave-length indicated by the secondary dial. This is subject to whatever error exists in the secondary setting due to departure from standard conditions. It is also subject to error resulting from the action of external influences upon the antenna, such as the motion of large metallic bodies near the antenna, which would change the capacity of the antenna. However, this method of tuning the antenna circuit is sufficiently precise for practical stand-by or pick-up work.

(2) TO TUNE BY COUPLING CLICKS, tighten the coupling to 180 degrees, set the antenna inductance switch to the proper tap, and with the secondary circuit in the oscillating condition, rotate the antenna condenser back and forth. A click will be heard in the telephones at a certain position of the antenna condenser in rotation to the right, and at a different position in rotation to the left. Loosen the coupling gradually and these positions will approach each other, until a CRITICAL COUPLING is reached at which they coincide. At the point of coincidence the

antenna circuit is tuned to the secondary. If the coupling if further loosened the clicks will disappear. The detuning of the antenna circuit reacts upon the secondary and changes the frequency of oscillation until the antenna circuit is so far detuned that the reaction diminishes and the oscillation returns to normal. This occurs abruptly and produces the click heard in the telephones.

(3) TO TUNE BY BUZZER SIGNAL, adjust the buzzer to give a clear not when the button is depressed, and with the secondary in the non-oscillating condition, tune the antenna circuit for maximum buzzer signal in the telephone. This can be done equally well with a tube or a crystal detector. Close coupling gives a loud signal, but broadens the tuning.

(4) TO TUNE BY ‘‘STATIC’’, tune the antenna circuit until a low rumbling or hissing noise appears in the telephones. This may be done with any type of detector, whether the secondary is oscillating or not, but depends upon the regularity and intensity of the disturbances produced by atmospheric electricity, and sometimes fails because of the complete absence of such disturbances.

Calibration of antenna circuit. --- As soon as the operator has acquainted himself with the use of the various controls and adjustments, he should make it his first duty to calibrate the antenna circuit.

Adjust the filament current and plate voltage to the proper values (see page 13). Set the secondary condenser accurately to the wave-length ‘‘F’’ (238 meters) on tap 1. Obtain oscillation in the secondary circuit. Set the antenna inductance switch on tap A and tune the antenna circuit to the secondary by means of ‘‘coupling clicks’’, as described above. BE SURE TO ADJUST BOTH THE COUPLING COIL AND THE TICKLER TO THE LOWEST SETTINGS AT WHICH CLICKS OCCUR. If due care is exercised, the clicks produced by rotating the antenna condenser in opposite directions should not be farther apart than two degrees. Set the antenna condenser midway between the two click positions and mark the position of the pointer on the dial with pen and ink, first using a soft rubber eraser to remove grease from the dial if necessary. Write under this mark the letter ‘‘F’’. Proceed in a similar manner for all the wave-lengths obtainable with the secondary, marking any wave-length which occurs on two taps of the antenna circuit at two places on the dial (for instance, wave-length ‘‘G’’ and ‘‘H’’ are apt to occur on both taps A and B). The antenna calibration so obtained will be found invaluable in facilitating the work of the operator.

ANY CHANGE WHATEVER IN THE STRUCTURE, WIRES, OR CONNECTIONS OF THE ANTENNA, OR THE ERECTION OR MOTION OF LARGE METALLIC BODIES IN THE VICINITY OF THE ANTENNA, DESTROYS THE ACCURACY OF THE ANTENNA CALIBRATION. IN THE EVENT OF SUCH A CHANGE IT IS THE DUTY OF THE OPERATOR TO ERASE THE WRITING ON THE DIAL AND RECALIBRATE THE ANTENNA CIRCUIT.

Adjustment of crystal detector. --- To adjust a crystal detector, connect one cell to the ''Buzzer Battery'' binding posts and adjust the buzzer for a clear note. Throw the Crystal-Audion switch to the left, set the antenna and secondary circuits at the same wavelength with the assistance of the dial calibrations, and locate by trial a sensitive point for contact on the surface of the crystal, which will give a good buzzer signal. If an antenna calibration has not yet been made, the operator may tune by means of the buzzer and the crystal, provided he can find a point on the latter which is at all sensitive, though it be a poor one.

Stand-by work. --- Occasionally the operator is called upon to listen for a particular station sending on a particular wave-length. Even in such cases there is generally some uncertainty as to the exact wave-length, because of slight inaccuracies in the tuning of both the sending and receiving apparatus. Therefore reduce the selectivity or broaden the tuning by the use of tight coupling. If the signals are expected to be very faint, sacrifice broadness of tuning to a certain extent and adjust the coupling to or slightly above the optimum value, as judged from experience. With the aid of the dial calibrations, set the antenna and secondary circuits to the wave-length of the sending station, and the tickler slightly below or slightly above the point at which oscillation begins, depending upon whether the expected signals are damped or undamped.

Pick-up work. --- Ordinarily the operator's duty is to maintain a steady watch for signals within the range of the receiver, recording everything he can read. For picking up powerful signals only, tight coupling and miximum tickler setting will facilitate his work. A damped signal will come in with a hissing noise and will be readily recognized. On the other hand, if the operator is required to listen for the faintest audible signals, as is more usually the case, he must constantly keep the coupling value and the tickler setting slightly below or slightly above the point at which oscillation begins, depending upon whether damped or undamped signals are sought.

The search for signals consists of continual tuning of the antenna and secondary circuits, keeping the two circuits in tune with each other and traversing the entire wave-length range back and forth repeatedly.

Final adjustment. --- When a signal has been found, make careful adjustment of all controls with to aims in view: loud signals and the exclusion of undesired or interfering signals. Bear in mind that the latter aim is fully as important as the former, because no matter how loud the signal may be, another signal, even though somewhat fainter, may make reading difficult or impossible. If necessary sacrifice loudness in order to eliminate interference. If the interfering signal has a wave-length slightly higher than that of the desired signal, detune both receiver circuits slightly toward lower wave-length, and vice versa. In short, use the utmost care and exert every effort to secure an intelligible message whenever possible.

Standard wave-lengths. --- The following is a list of the standard Navy wave-lengths within the range of the Type SE 1420 receiver:

WAVE-LENGTH IN METERS	NAVY LETTER DESIGNATION
238	F
300	G
378	H
476	I
600	J
675	
756	L
850	
952	M
1075	
1200	N
1350	
1512	O
1700	
1905	P
2150	
2400	Q
2700	
3024	S
3400	
3810	T
4300	
4800	U
5400	
6048	V
6800	
7620	W

IV. INSTALLATION AND CARE.

Weight and size. --- The weight of the complete receiver, not including the box cover, is 32 pounds. The overall dimensions, not including the cover and cover fastenings, are as follows:

Length	20 inches
Height	11-3/8 inches
Depth (including knobs)	10-1/8 inches
Depth (not including knobs)	9 inches

In choosing a location for the receiver, bear in mind that the operator's convenience in manipulating the control knobs and recording messages simultaneously.

Securing to table. --- Fasten the receiver to the table by means of small brass angles and wood screws. In case there is no room for the angles, remove the receiver from the box by unscrewing the ten fastening screws in the front of the panel, drill holes in the bottom, and secure the box to the table by means of wood screws. Do not leave the receiver unfastened on board ship, as the motion of the ship may cause damage to it.

Wiring. --- Use waterproof lead covered duplex cable for battery leads, and single bare copper or rubber covered wire for antenna, ground, crystal, and amplifier leads. Use no wire smaller than No. 14 American Wire (B. and S.) guage.

Amplifier connections. --- To connect in an audio frequency amplifier, such as the Type SE 1000 amplifier, for example, connect the ‘‘Telephone’’ binding posts of the receiver to the ‘‘Input’’ binding posts of the amplifier. To connect in a radio frequency amplifier, such as the Type SE 1405 amplifier, connect the lower ‘‘Sec. Cond.’’ binding post the the filament, and the upper ‘‘Sec. Cond.’’ binding post to the grid, of the first amplifier tube.

Cleaning. --- While the appearance of the receiver has no direct bearing upon the reception of signals, it is an indication of the care which the operator bestows upon his apparatus and the quality of his work in general. A few minutes a day devoted to improving the appearance of the receiver will be found conducive to careful manipulation and will be profitably spent. Clean and polish the box, panel, and exposed metal parts with a soft dry cloth. Clean the buzzer contacts with crocus cloth of the finest emery cloth obtainable. Remove the receiver from the box occasionally and go over all parts carefully, wiping off accumulated dust and cleaning all corroded metal surface.

Repair. --- Every receiver is thoroughly inspected and tested, and freed from all defects, before being sent into service. The coils, condensers, and wiring are delicate and may easily be injured, and should under no circumstances be tampered with.

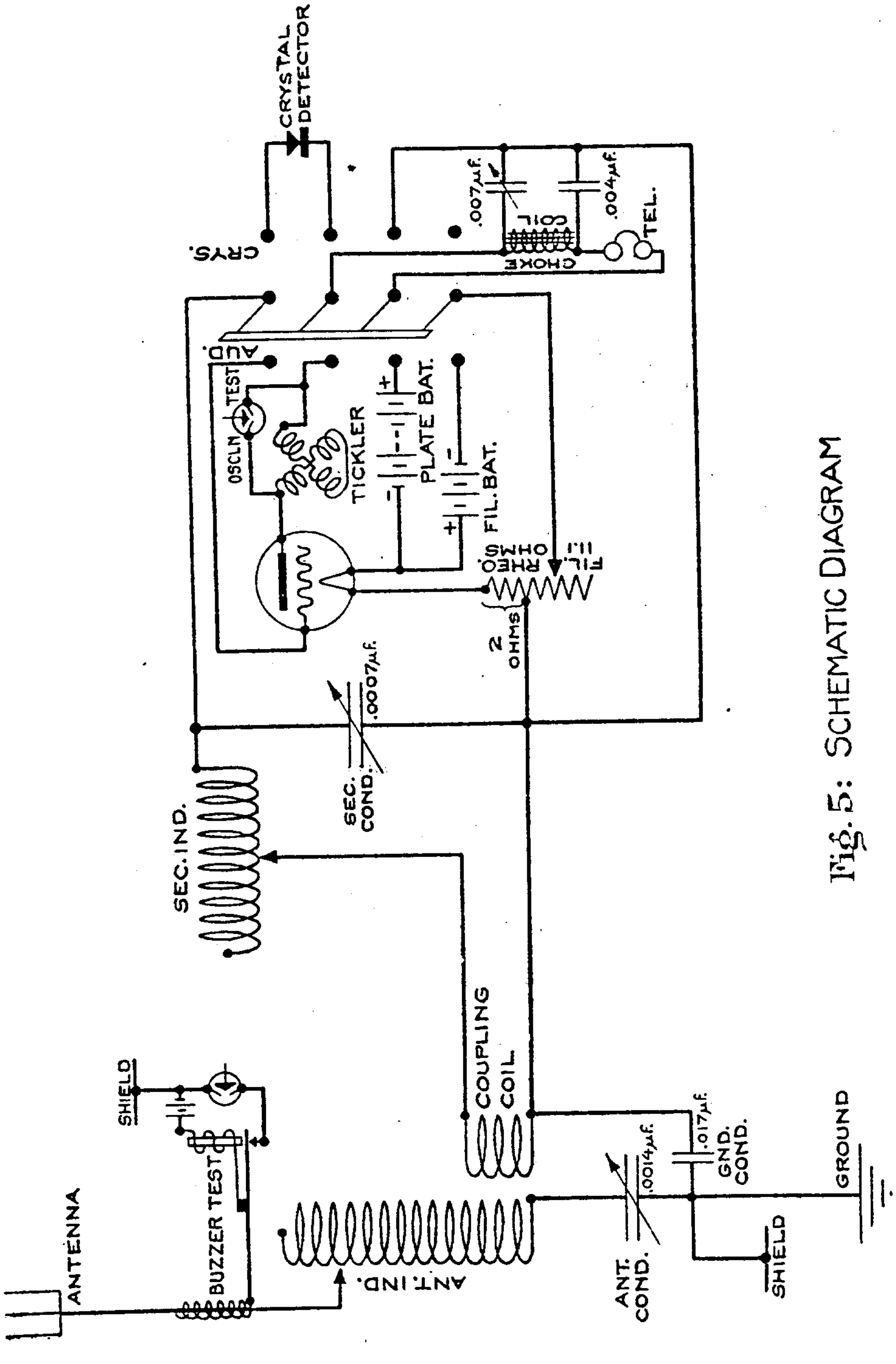

Fig. 5: Schematic Diagram

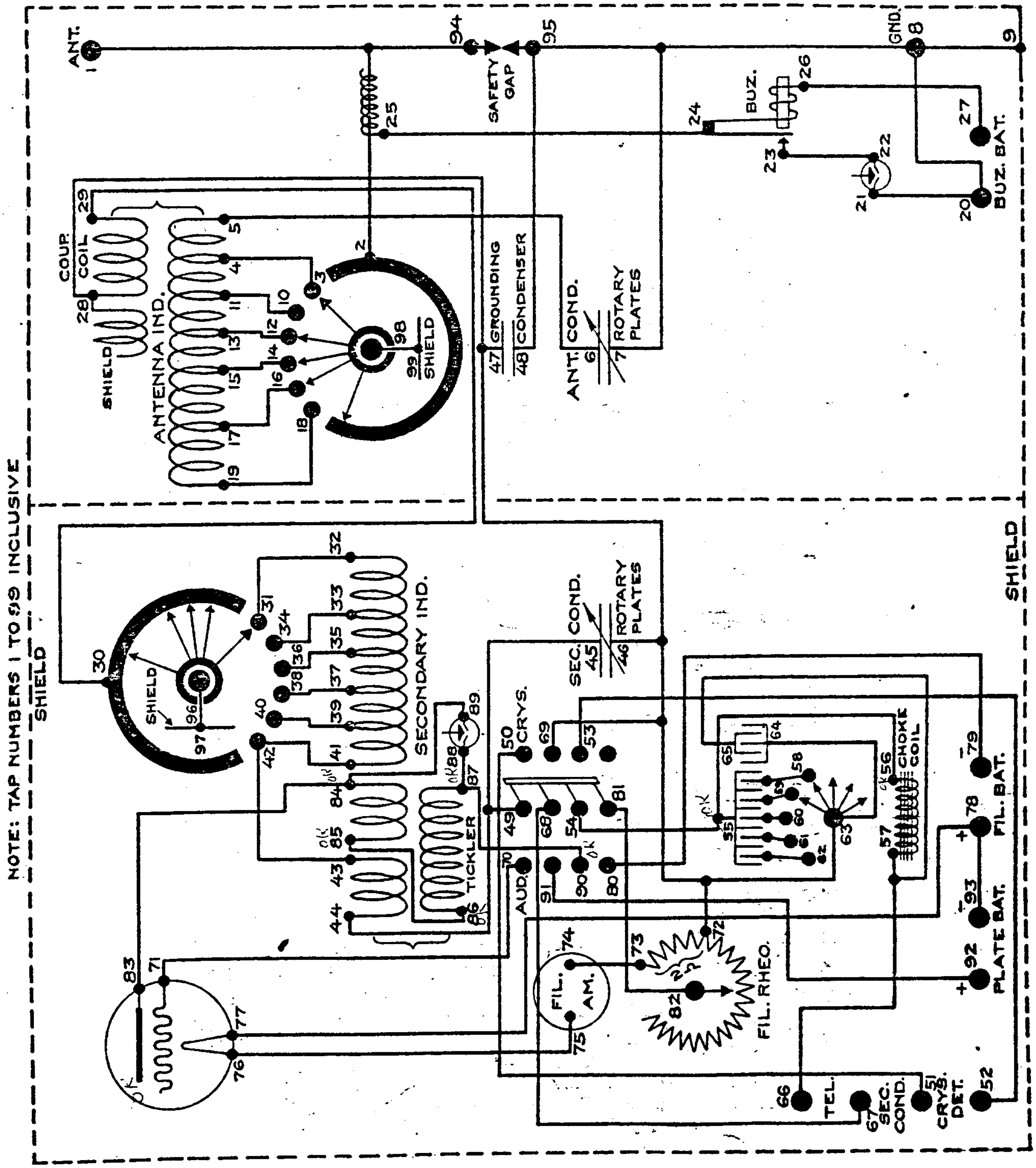

Fig. 6: WIRING DIAGRAM

LENGTH (NOT INCLUDING COVER FASTENINGS)— 20 INCHES
HEIGHT— 11⅛ "
DEPTH (INCLUDING KNOBS)— 10⅛ "
DEPTH (NOT INCLUDING KNOBS)— 9 "
WEIGHT— 32 POUNDS

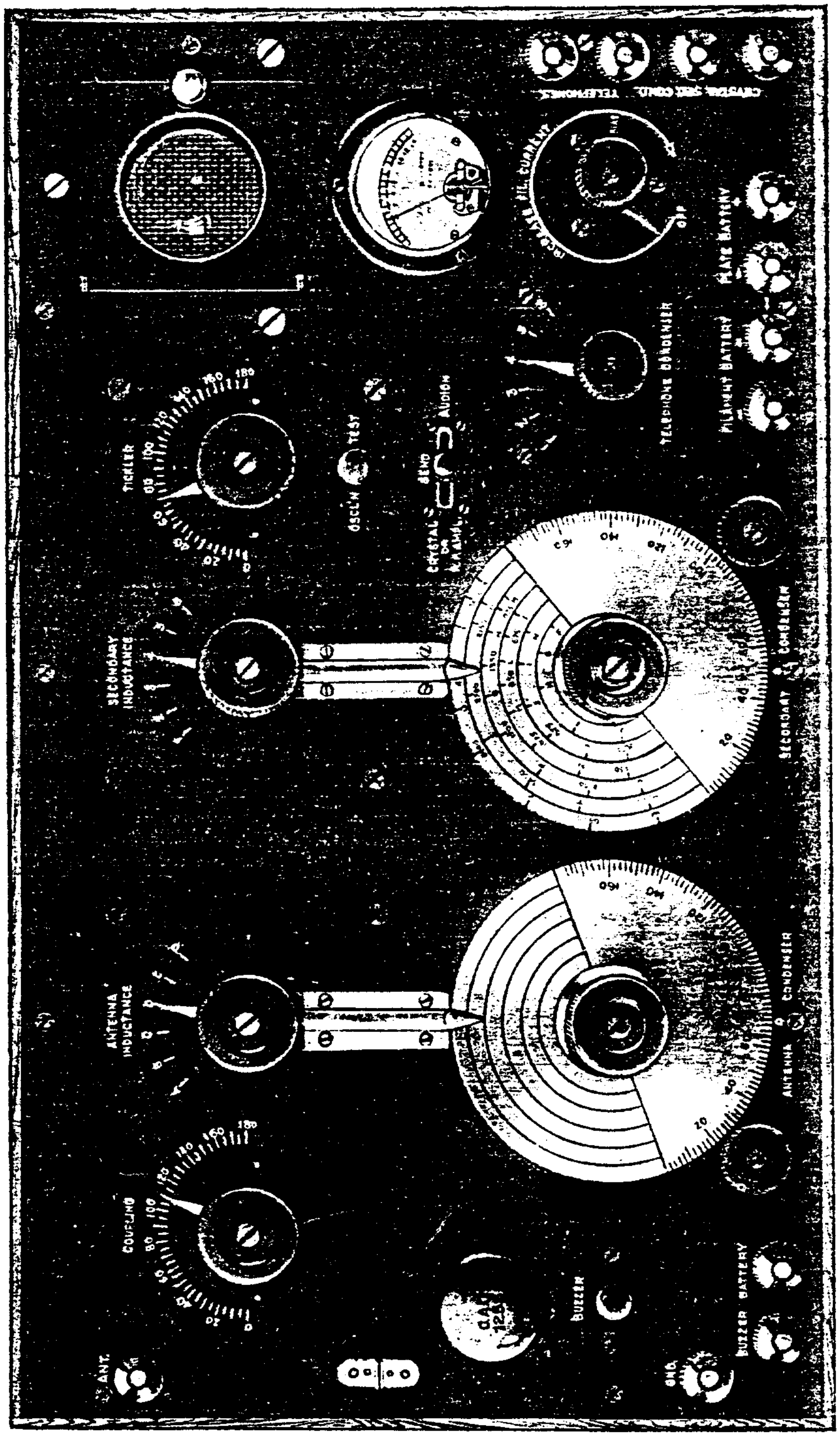

FIG. 7.

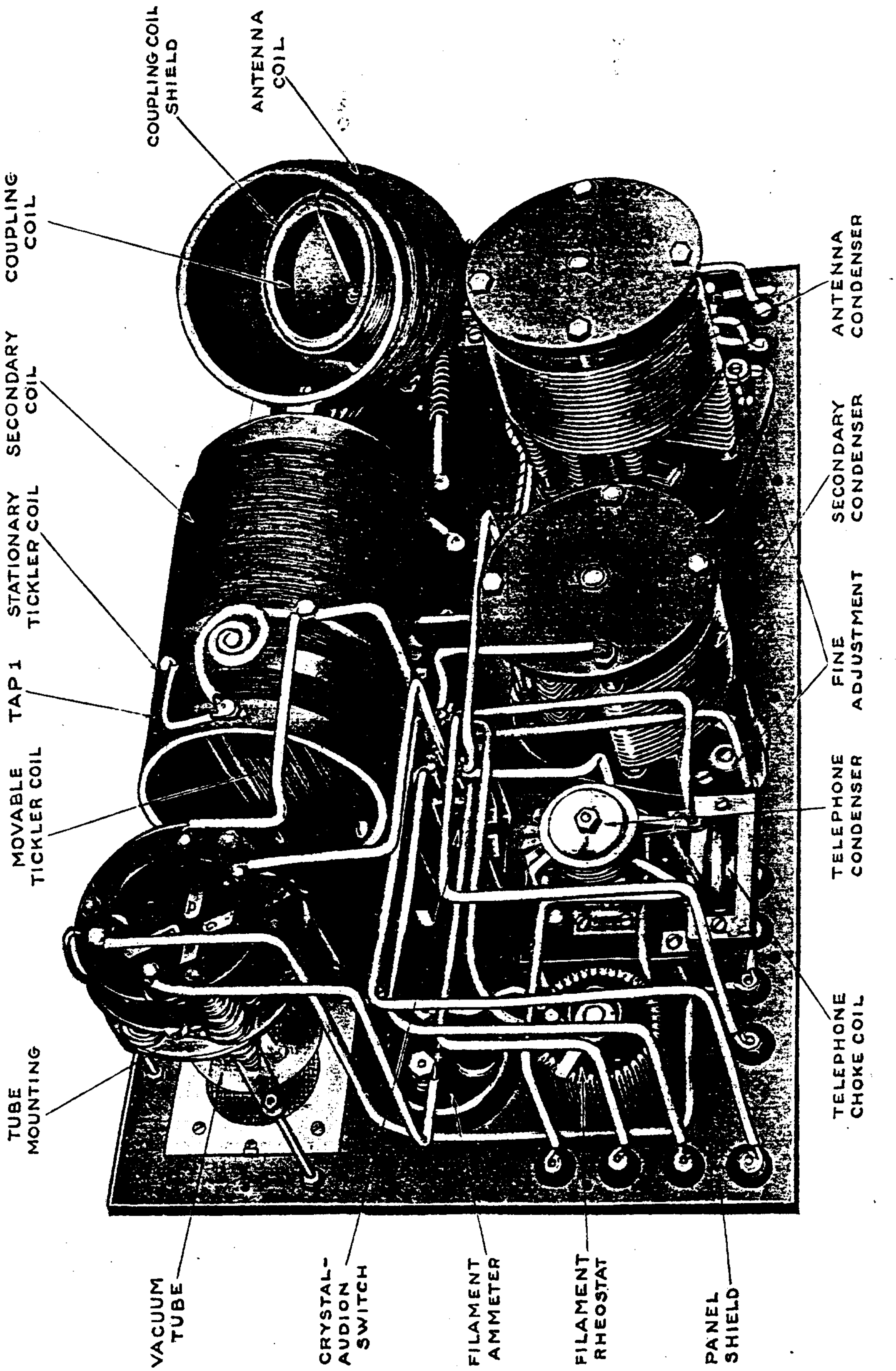
COUPLING COIL SHIELD
ANTENNA COIL
COUPLING COIL
SECONDARY COIL
STATIONARY TICKLER COIL
TAP 1
MOVABLE TICKLER COIL
TUBE MOUNTING
VACUUM TUBE
CRYSTAL-AUDION SWITCH
FILAMENT AMMETER
FILAMENT RHEOSTAT
PANEL SHIELD
TELEPHONE CHOKE COIL
TELEPHONE CONDENSER
FINE ADJUSTMENT
SECONDARY CONDENSER
ANTENNA CONDENSER

FIG. 8.

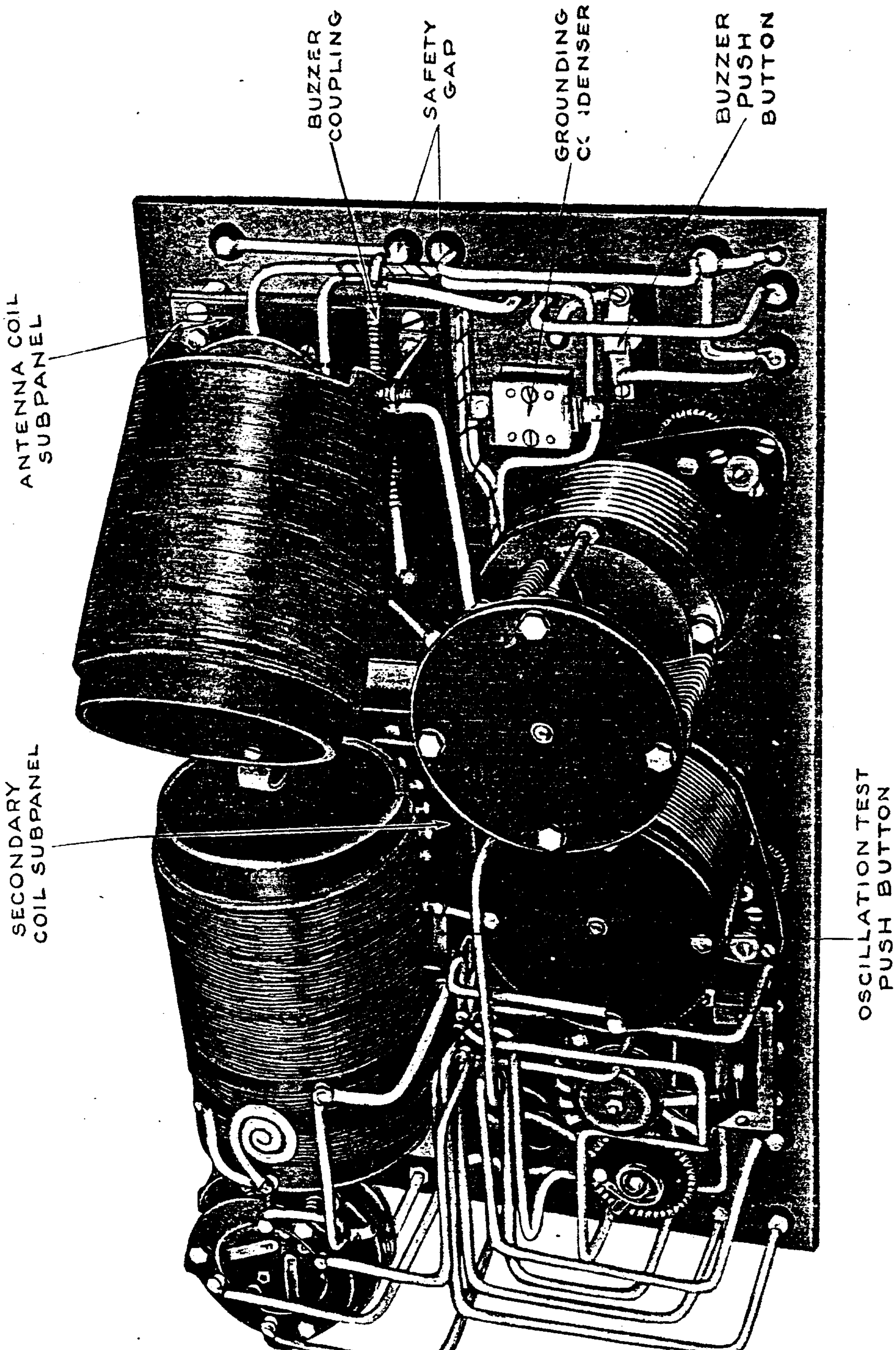
BUZZER COUPLING
SAFETY GAP
GROUNDING
BUZZER PUSH BUTTON
ANTENNA COIL SUBPANEL
SECONDARY COIL SUBPANEL
OSCILLATION TEST PUSH BUTTON

FIG. 9.

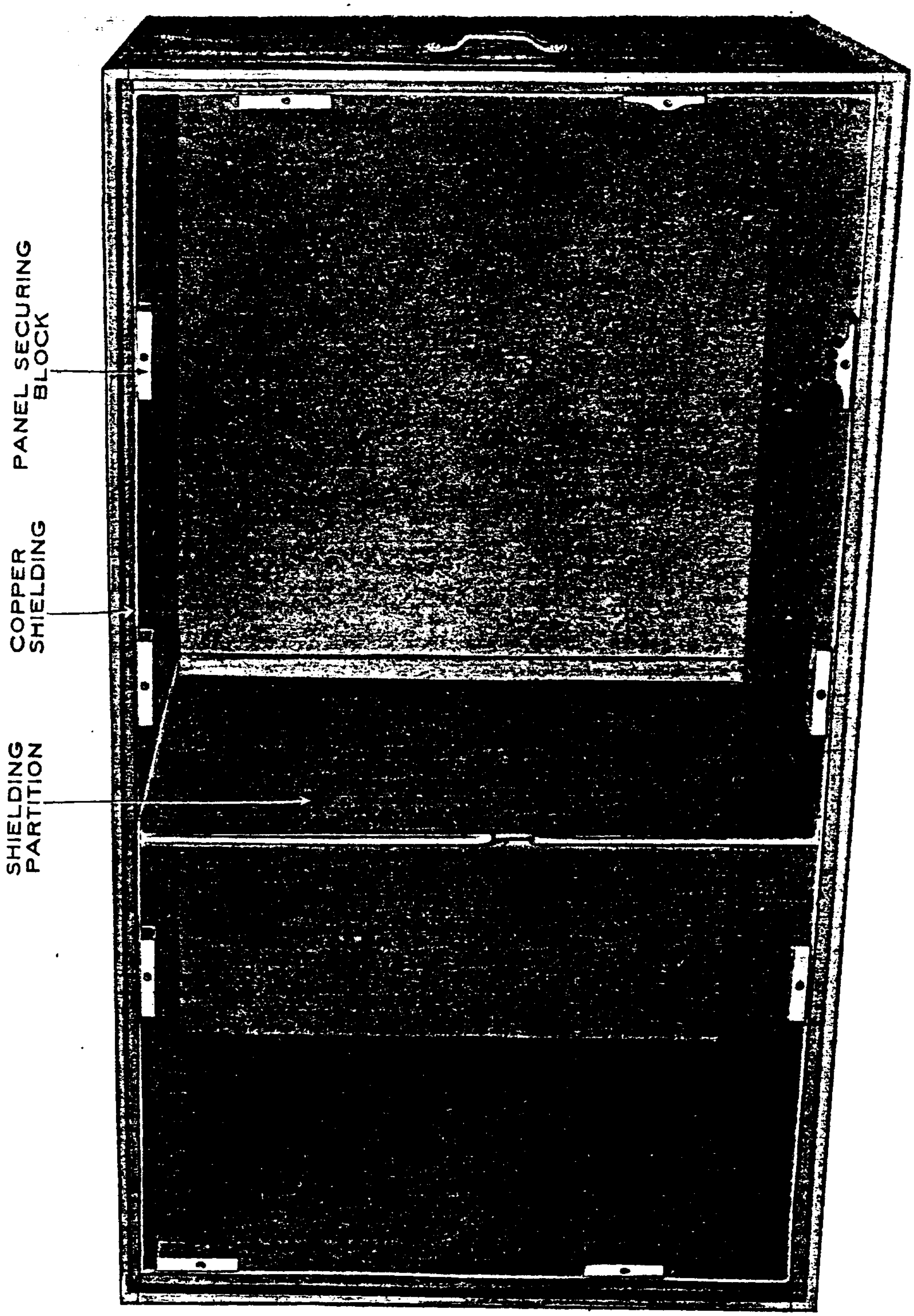
PANEL SECURING BLOCK
COPPER SHIELDING
SHIELDING PARTITION

FIG. 10.