New Edition
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Twenty
Radio Phone Diag
and
HOOK-UPS
of
CRYSTAL and VACUUM TUBE REC
AMPLIFYING CIRCUITS, REGENERATIVE CIRCUITS, SENDI
with
Key Chart of Symbols and Pamphlet "How to Read Diagr

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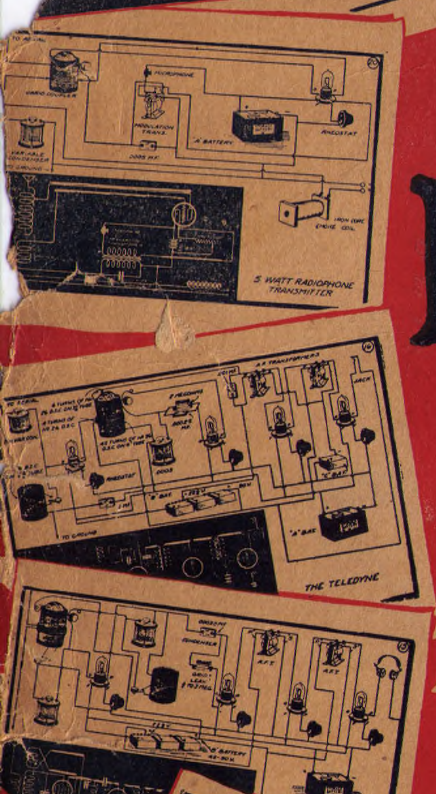

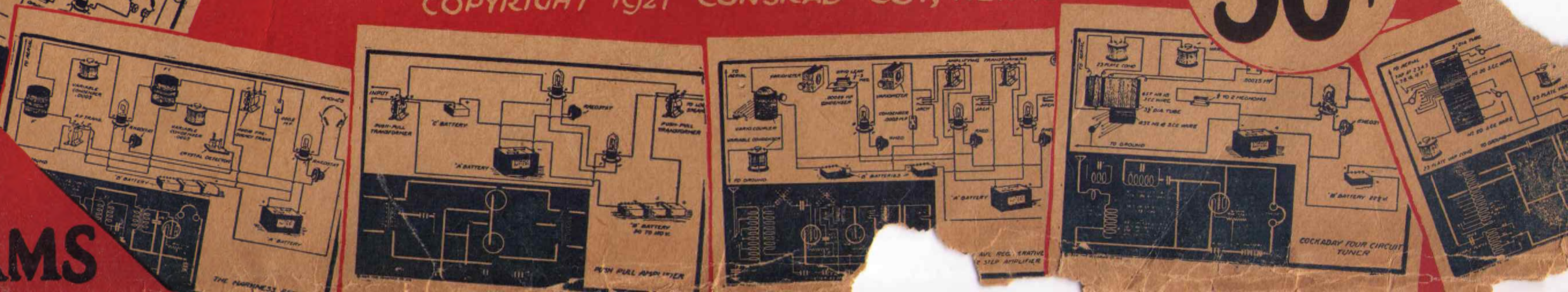

20
RADIO
DIAGRAMS

Twenty Radio Phone Diagrams and Hook-ups

OF

CRYSTAL AND VACUUM TUBE RECEIVERS

AMPLIFYING CIRCUITS, REGENERATIVE CIRCUITS AND SENDING CIRCUITS

WITH KEY CHART OF RADIO SYMBOLS

THE CONSRAD COMPANY, Inc., Publishers

64 CHURCH STREET, NEW YORK, N. Y.

HOW TO READ RADIO DIAGRAMS

RADIO diagrams or wiring circuits, also called "Hook-ups," can be presented in two ways, one of which is in *schematic* or symbolic drawing, in which each instrument and part is represented by a certain symbol. These symbols have been adopted by radio engineers for convenience sake, as well as for the speed and accuracy with which schematic diagrams can be drawn.

However, many people entering the radio field have no knowledge of these symbols, and for them radio diagrams are drawn in *perspective* drawing, in which each instrument is represented actually as you see it.

A *Key Chart* showing the perspective view of the instrument, its name and the schematic symbol representing it, will be found on the back of this instruction leaflet.

You will note that there is a certain definite reason for each symbol. A coil of wire is represented by a series of curls as may be seen by referring to the vario-coupler symbol (4) in the schematic diagram. Variable contacts such as provided for by a series of switch points and levers (5) are represented in the schematic diagram by arrows. The plates of condensers, regardless of the number, are represented (7 and 12) by two parallel straight lines. If the condenser is variable, an arrow (2) is drawn through the two lines at an angle. A resistance is always represented by a line resembling the teeth of a saw. If it is fixed, the connections are made to the extreme ends (6). If it is variable, one connection goes to one end and the other to an arrow as will be seen by referring to the rheostat symbol (10) in Fig. 2. The elements of the vacuum tube, namely, the filament, grid and plate, are clearly shown

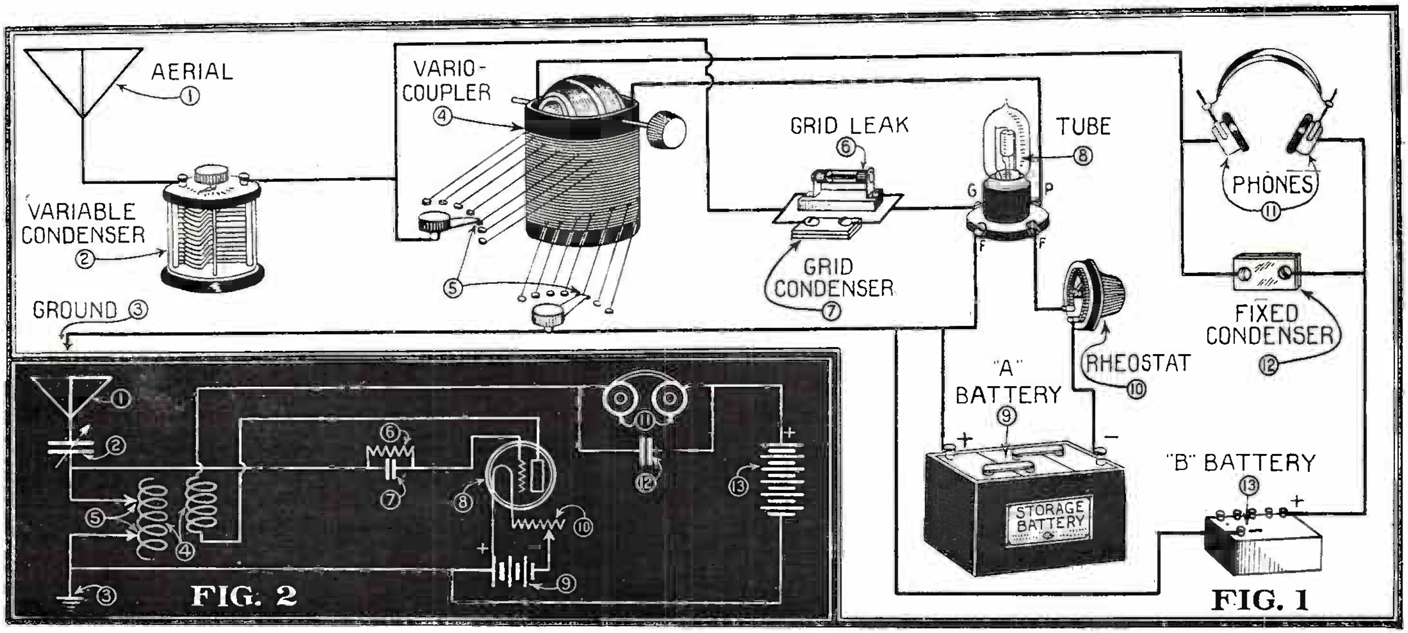

FIG. 2 FIG. 1

In our twenty diagrams we have shown all the circuits in picture form, (perspective) as well as in symbolic form, (schematic).

It is much simpler to read a schematic circuit as all the paths through the various instruments can be readily traced out. However, when the beginner connects up a set, it is easier for him to consult the perspective diagram, as he can see a picture of the actual instruments which he is using.

In order to learn how to read schematic circuits we give an example herewith. In Fig. 1 we show all the connections of a single-circuit regenerative tuner with each instrument pictured thereon. This is a perspective diagram. In Fig. 2, the same circuit is given in schematic form.

in the schematic diagram (8) while in the perspective diagram the binding posts which are connected to the elements are labeled. The derivation of the symbol representing the phones (11) is easily seen. Since each cell of a battery has two elements, they are taken in consideration in the symbol for the battery and since many cells are connected in series, they are represented as shown in the "A" and "B" battery symbols, (9 and 13).

By thus referring from Fig. 1 to 2 and to the Key Chart, the reader can very soon accustom himself to reading schematic diagrams. It is advantageous to practice the reading of schematic diagrams as most circuits in newspapers and magazines are represented in this form.

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(1) Double Slide Tuning Coil With Crystal Detector

This circuit is more selective and flexible than one using a single slide coil. The size of the coil depends upon the wave length to be received. This receiver may be used with any type of aerial. To tune the circuit, the slider connected to the ground in the diagram is moved until a station is heard; then the other slider connected to the aerial is moved slowly until the signals are heard at maximum intensity. The secondary circuit is adjusted by moving the other slider to improve the audibility. To reduce interference, the two sliders should be moved together so as to retain the same number of turns forming the primary circuit between them.

(2) Loose Coupler With Crystal Detector

In this circuit a loose coupler is used, which may be of any size and connected to any form of aerial. The advantage of the loose coupler over the ordinary tuning coil is that two circuits are used which may be coupled together more or less according to the intensity of signals to be received. When interference from another station is experienced, it may be cut out or reduced by loosening the coupling by moving the small coil outside of the primary.

(3) Single-Circuit Regenerative Tuner

The advantage of the single-circuit tuner are simplicity and ease of adjustment, two important features for the beginner. This circuit with which it is possible to receive telephony, continuous waves, and sparks signals consists of a vario-coupler with the secondary acting as a tickler coil. Such a circuit may be used for the reception of signals on any wave length by increasing the number of turns of the tapped inductance.

(4) Honeycomb Coil Receiver For All Wave Lengths

This is the standard circuit for a honeycomb coil receiving set with a vacuum tube detector. The coupling between the primary and secondary, and between the secondary and tickler or feed-back coil is variable so that fine tuning is possible as well as sharp adjustment of the regenerative effect obtainable with the tickler coil. By using the proper sizes of coils any wave length can be tuned with this receiver, in which there are no losses in unused part of windings, since the inductances are wound to the proper number of turns to cover a certain range of wave-lengths when shunted by a .001 M.F. variable condenser.

By means of the series-parallel switch in the primary circuit, the variable condenser may be short-circuited or used in series or parallel with the primary coil. When it is connected in series, it reduces the wave length of the circuit, while when it is in parallel, that is, connected across the coil, it increases the wave length. The coils used in this circuit are called honeycomb coils on account of the shape of the winding, which instead of being wound in layers, is wound in a special fashion with the turns crossing each other at a certain angle to improve the efficiency.

(5) Tuned Plate Regenerative Circuit

If the plate circuit of a vacuum tube detector is tuned by means of a variometer, it is possible to bring a vacuum tube to a point where its sensitiveness is very much increased, producing at this point high amplification of the received energy. By adjusting the plate inductance so that the vacuum tube produces oscillations, it becomes possible to receive continuous wave signals produced by transmitters using vacuum tubes, arcs, or high-frequency alternators.

(6) Standard Short Wave Regenerative Set

In the standard short wave regenerative circuit, shown in this drawing, the tuning of the grid and plate circuits is done by means of variometers producing a continuous variation of the inductance in both the circuits. For short wave reception this is best, as under these conditions the vacuum tube detector which is operated by potential, functions at maximum efficiency since there are little losses in any condensers—inductance alone being used. The vario-coupler is exactly the same apparatus as the loose coupler shown in diagrams Nos. 2 and 5, the only difference being that instead of pulling the small coil outside of the primary, it revolves one-quarter of a turn inside of it. When the turns are in the same plane, the inductance between the coils is maximum; while when the secondary or rotor coil is turned at right angles, there is no induction. This provides a means of obtaining a zero value of coupling.

(7) The Reinartz Circuit

The circuit illustrated does not possess any wonderful advantages for the reception of radio phone signals but when used for receiving C. W. (Continuous Waves), it stands out above all other types. The ease with which a C. W. station is tuned in and held without changing in strength is remarkable and the distance over which such signals can be received is a revelation to the uninitiated.

As will be seen from the diagram there are only two coils. Both of them are wound on the same tube; a space of about one-quarter of an inch being left between the two windings. These two coils might also be wound on a single spider web form, the inside diameter being about two inches. Approximately the same number of turns can be used as indicated.

It is quite necessary that the moveable plates of the two condensers be connected to the aerial and ground respectively. This aids in the tuning of the set as well as in holding signals. It will be further advantageous to use a vernier attachment on the condenser connected in series with the plate coil. If the builder desires he may shunt the phones and "B" battery with a mica fixed condenser having a capacity of a .001 mf.

(8) Cockaday Four Circuit Tuner

The unique feature of this circuit is the single turn inductance connected in series with the antenna and the stabilizer circuits. The single turn affects the stabilizer circuit which, in turn, affects the secondary. The wave length of the primary circuit is brought up by means of the tapped inductance coil connected in series with the single turn.

The stabilizer and secondary circuits are both wound on the same tube within one thirty-second of an inch of each other and the data on them is given in the drawing. The single turn consists of No. 14 bare copper wire and is wound directly over the stabilizer coil and about one-fourth of an inch from the beginning of it.

The primary loading inductance is wound on a separate tube three and one-half inches in diameter and tapped as indicated. Greater efficiency is obtained if this coil is bank wound. When the instruments are mounted, this coil should be placed in a non-inductive relation to the other coils.

The data given in the diagram is suitable for a wave length range of 150 to 550 meters. This circuit is extremely selective and gives excellent results on spark, continuous wave and radio phone reception.

(9) Short-Wave Regenerative Set With Two-Step Amplifier

When a two-step amplifier is used in conjunction with a short-wave regenerative receiver, the range is considerably increased because the signals are so amplified that they may be heard in the telephones while they would be barely readable with the detector tube alone. When it is desired to operate a loudspeaker, 60 or more volts should be used in a plate circuit of the vacuum tubes. There are no special connections for the loudspeaker which is merely inserted in place of the telephones.

(10) Detector and Two-Stage Amplifier With Automatic Filament Control Jacks

The advantage of automatic filament control in an amplifier is that it is not necessary to turn off the filament current of each tube when only the detector or one step of amplification is used. Plugging in the telephones in any of the jacks, opens and closes the proper circuits automatically. This is a great advantage, for the rheostats may be left adjusted in proper position all the time.

(11) Push-Pull Amplifier

Many radio amateurs desire to get as much volume as possible out of their receiving sets but find that when they carry the amplification to a certain point, great distortion takes place which often renders it practically impossible to understand the music or voice emanating from the loudspeaker. In order to overcome this difficulty, and still preserve the desired volume and in some cases even increase it, engineers have developed what is known as the push-pull audio frequency amplifier. This device uses two amplifying tubes connected in parallel. To use this amplifier which consists of two tubes, the receiving set itself must contain at least a detector and one stage of audio frequency amplification. The output of the latter is connected directly to the input binding posts of the two tube push-pull amplifier. The current then goes into a transformer where it is stepped up and fed to both of the two tubes. These tubes are so balanced that their energy is combined in the output transformer which connects to the loudspeaker and a maximum volume of sound with a minimum of distortion is obtained. The transformers wound on an iron cores having single primarys with two secondaries of an equal size on each transformer. The ratio between the two windings is approximately four to one. On the whole, the push-pull amplifier circuit will usually not give very much louder signals when used as shown in connection with a detector and one stage amplifier than a standard tuner employing a detector and two stages of audio frequency amplification. However, the reproduced sounds will be of such better quality and so free from distortion that the use of the extra tube will be fully justified.

(12) Reflex Circuits

By using a special hook-up employing a combination of both radio and audio frequency transformers, it is possible to make a single vacuum tube amplify both high and low frequencies in the same circuit. Usually a crystal detector is used for rectification in these circuits, but if desired a vacuum tube can be substituted for the same. However, the crystal detector will give clearer signals and will reduce the internal noises characteristic of some vacuum tube sets to practically a minimum. Careful adjustment of the potentiometer will also assist in this case. It is inadvisable to try to use either one of these illustrated circuits without this piece of apparatus. It should have a resistance of from 200 to 400 ohms.

In the one and two tube circuits we have indicated a vario-coupler and variable condenser for tuning. Any type of tube may be used in these circuits providing it is an amplifier with as small an internal capacity as possible and will stand a plate voltage of at least 45 volts. Higher voltages will give louder signals up to the paralyzing point of the tube.

A word as to the transformers. Standard audio frequency and radio frequency transformers will give good results and those designed for first and second stage work should be used in their respective places. It is quite necessary that the transformers be matched up correctly in order that good results be obtained.

(13) The Harkness Reflex

The popularity of the reflex circuits described in the above paragraphs has become very great since their introduction to the radio public. Many supposedly new reflex circuits have appeared since then, some of them good and some of them bad. We present herewith a description of one of the best of these outgrowths known as the Harkness Reflex. This circuit, as may be seen by glancing at the diagram, employs two vacuum tubes and a crystal detector. Such a set when properly connected with the correct transformers and other apparatus gives the results of three vacuum tubes and a crystal detector. The first tube is used twice, once to amplify at radio frequency and once at audio frequency. The crystal detector is used for rectification and as the signal passes into the first tube and is amplified at radio frequency, the crystal puts in its good work and sends the signal back to the grid circuit of the first tube. Here it is again amplified at audio frequency and fed directly into the second tube. The second tube is a straight audio frequency amplifier and it renders the signal very loud. This two tube set when constructed properly will furnish ample power to operate a loudspeaker. The unique feature of this set is the construction of the radio frequency transformers. These are labeled F and F1 in the diagram. The first one serves to tune the antenna and secondary circuit and is constructed as follows. On a 2⅝th inch tube, wind 60 turns of No. 24 D. S. C. wire. Directly over the center of this winding and separated from it by a layer of waxed paper, wind twenty turns of the same sized wire. This is for the antenna tuning transformer. The transformer between the first tube and the crystal detector, F1, is constructed in much the same manner and the secondary winding is the same. The primary, however, consists of 32 turns of No. 24 D. S. C. wire. Because of the peculiar method of connecting the instruments in this circuit, a stabilizing potentiometer is not necessary and without it the set does not generate continuous oscillations and, therefore, cannot radiate and annoy operators using nearby receiving sets. Furthermore, the absence of oscillation makes possible much clearer reception.

(14) Loop Aerial Receiver

Excellent results may be obtained with a loop or coil aerial when used with this two-tube circuit. The first tube acts as an amplifier, boosting the very weak current received in the loop so as to operate the second tube, which is the detector, at maximum efficiency. For the reception of short wave lengths, the loop, which is on wooden frame 4½ feet square, should be wound with four turns of No. 29 insulated wire with the turns spaced one-half an inch apart. The regenerative coupler consists of two coils L and L1, the latter turning inside of the former. Coil L consists of about 14 turns of No. 16 insulated wire, wound on a cardboard tube three inches in diameter. Coil L1, which can rotate half a turn, is wound with 60 turns of No. 26 single cotton wire.

(15) The Superdyne

A unique example of the use of the feed-back principle is found in the Superdyne receiver which has lately made its appearance and which has given excellent results. Instead of using feed-back to produce regeneration and consequently louder signals a tickler coil is used to control the oscillations in a radio frequency amplifier and prevent the usual noises encountered when using this type of receiver. The connections of this set are rather peculiar, that is, in the radio frequency plate circuit. As will be noticed, the leads to the rotor are reversed from the position which would ordinarily cause regeneration and instead of being connected directly to the plate, one of the leads goes to the high voltage of the "B" battery and the other to one side of a tuned impedance coil. This coil is tuned by means of a .0005 mf. variable condenser. Wonderful results have been obtained with this type of receiver as a point bordering very closely on oscillation can be reached in the radio frequency amplifying circuit without causing the tube to oscillate. Doing this, of course, makes the tube considerably more sensitive and allows much greater amplification. In order to use this receiver, it is necessary to construct the coils very carefully following the specific data given herewith and on the diagram. The best way you can go about constructing the coupler would be to purchase a standard vario-coupler and rewind it to suit the specifications given. After winding and tapping the secondary as indicated, wind directly over the center of four turns of No. 22 D. C. C. wire. Space these turns one-fourth of an inch apart and separate them from the secondary by means of a layer of waxed paper. The data on the tuned impedance coil is given and it should also be tapped as shown. The purpose of the taps on the impedance coil and the secondary is to allow a variation of wavelength. The approximate wavelength range using the smaller and larger sections of the two coils is from 176 to 358 meters and from 310 to 660 meters. Thus, it will be seen that this receiver can be used both on amateur wavelengths and for ordinary broadcast reception. Experiments with the Superdyne have shown that unless at least one stage of audio frequency amplification is used, the results are not very good. Therefore, it is advisable to use one and preferably two stages of audio frequency amplification. Thus, a loudspeaker can readily be operated.

(16) The Teledyne

Since war has been declared on oscillating and radiating receivers, attention has been turned to the addition of radio frequency amplification before the tuner; that is, between the tuner and the aerial and ground. Such an addition acts as a sort of a "muffler" and prevents oscillations which are generated in the detector circuit from reaching the aerial and thus causing interference by causing the set to act as a miniature transmitter. From the experimental work done along this line, the Teledyne has sprung. It is nothing more or less than a single stage of radio frequency amplification added in front of a standard untuned primary regenerative circuit. Because of the fact that the plate circuit cannot readily be brought to resonance with the grid circuit of the radio frequency amplifier, no potentiometer has been found necessary and very good results will be obtained without the use of this instrument. The construction of the coils as outlined herewith and on the diagram should be followed rather closely as these have been worked out to give the very best results. However, anyone who has constructed a receiver of the untuned primary type can readily add one stage of radio frequency amplification in the manner suggested. The secondary is first wound on a four inch tube and directly over the first turn of it is wound the first turn of the four which constitute the primary winding. These coils are wound in the same direction and separated by a layer of thin cardboard approximately 1/32nd of an inch thick. The result of this circuit is that one stage of radio frequency amplification builds up the incoming signals whereupon, they are detected and again built up by regeneration in the detector circuit. The standard two-stage audio frequency amplifier then brings the signals up to a point where they will very satisfactorily operate a loudspeaker. The use of a "C" battery is recommended as shown.

(17) The Hazeltine Neutrodyne Receiver

Tuned radio frequency amplification has not heretofore been used to a very great extent because of the difficulty encountered in keeping the amplifying tubes from oscillating due to the internal capacity of the tubes. However, Professor L. A. Hazeltine has perfected a method whereby this system of reception may be used with great satisfaction and without the usual distortion due to the oscillation of the amplifiers. This method merely makes use of two very small condensers connected as indicated at C1 and C2 in the diagram. These condensers as shown are nothing more than two pieces of bare copper wire enclosed in an insulating sleeve with their ends about three-quarters of an inch apart. Over the insulating sleeve is placed a copper tube, two and three-quarters of an inch long.

The transformer used in connection with this circuit consists of two fixed windings wound on a three inch tube. The primary is wound on top of this secondary and directly in the center of the same. Single layer winding is used for both.

When the instruments are connected up as shown in the diagram and a station tuned in, the filament of the first tube is extinguished. If signals still come through, the condenser C1 is adjusted by moving the copper tube, until they are inaudible. The first tube is then lit and the same done with the second. When these adjustments are made the condenser C1 and C2 are sealed. It is no longer necessary to adjust them until new tubes are used, and if the initial adjustment is made correctly it will be found that this circuit will operate consistently without any danger of oscillation in the radio frequency tubes throughout the entire band of wavelengths.

The condensers used for tuning the secondary of the radio frequency transformers may have a capacity of from .0003 to .0005 mf.

The antenna and secondary inductances may be honeycomb coils or if desired a variometer may be used with a center tap taken from the connection between the rotor and stator windings.

(18) Radio and Audio Frequency Amplifier

This amplifier circuit is extremely sensitive, and especially adapted for long distance reception with an outdoor aerial, or for use with an indoor loop. By applying a high plate voltage on the audio frequency amplifier tubes a loudspeaker may be operated with success. The loop aerial which may be used with such an amplifier should be of the same design as the one described in diagram 14.

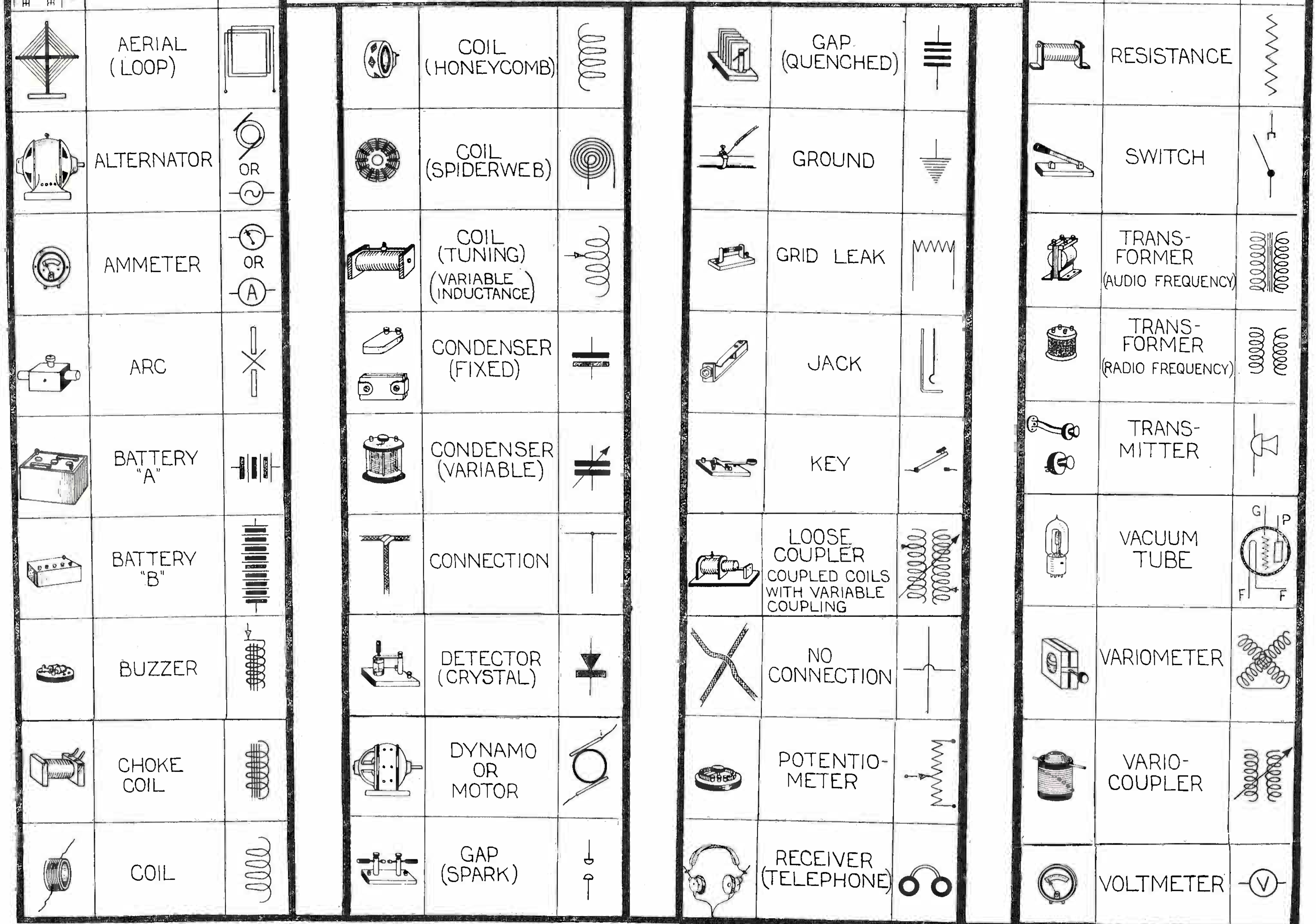
(19) The Super-Heterodyne

Great interest has been manifested in the Armstrong Super-Heterodyne. This is by no means a new circuit, having been developed during the war for use in France; but never until of late has it become very popular due to its former complexity and to the fact that it required an expert operator. However, the set has been simplified to such an extent that with six tubes great "DX" reception may be expected using headphones. If desired, a standard audio frequency amplifier may be added so as to use a loudspeaker. It will be noted that one of the tubes is used as an oscillator and coupled to the grid circuit of the first tube which acts as a detector. The frequency of the incoming signal is changed so that it is equivalent to that of a higher wavelength; about 3,000 meters with a set built following the data given herewith. The radio frequency transformers indicated should then be designed to operate efficiently on this wavelength. A signal is thus amplified at radio frequency and again detected. Just before it is detected, a tuned transformer is employed. It will be found that after the two condensers across the coils of this tuned transformer have once been set, they may practically be left in that position and most of the tuning done with the secondary and the oscillator condenser. The grid and plate coils of the oscillating circuit are wound on the same tube and No. 22 D. C. C. wire may be fixed. Six turns are wound on a rotor using the same sized wire and it is mounted within the 3½ inch tube. The rest of the constructional details and all the connections are shown on the diagram. This set, once it is put into operation and once the last R. F. transformer is tuned carefully, will give excellent results both as to ease of control and distance reception. The circuit is very sharp in tuning and will give excellent all-around results.

(20) Five Watt Radio Phone Transmitter

For low power radio phone transmission, this circuit will give very good results, being flexible and easy to adjust. The coil connected in the grid circuit can rotate inside of the inductance and permits a fine adjustment, securing maximum radiation for the power used. The modulation transformer amplifies the weak variations of current produced in the microphone transmitter so that the vacuum tube transmits the weakest sounds. The high voltage applied on the plate of the tube may be furnished by batteries, high-voltage dynamo, or rectified alternating current. The iron-core choke coil connected in one lead from the high-tension source prevents the high-frequency oscillations from flowing through the battery or dynamo, thus short-circuiting the variable condenser connected in the ground lead. The range of such an outfit when 500 volts are used on the plate, is about 25 to 30 miles.

KEY-CHART TO RADIO SYMBOLS



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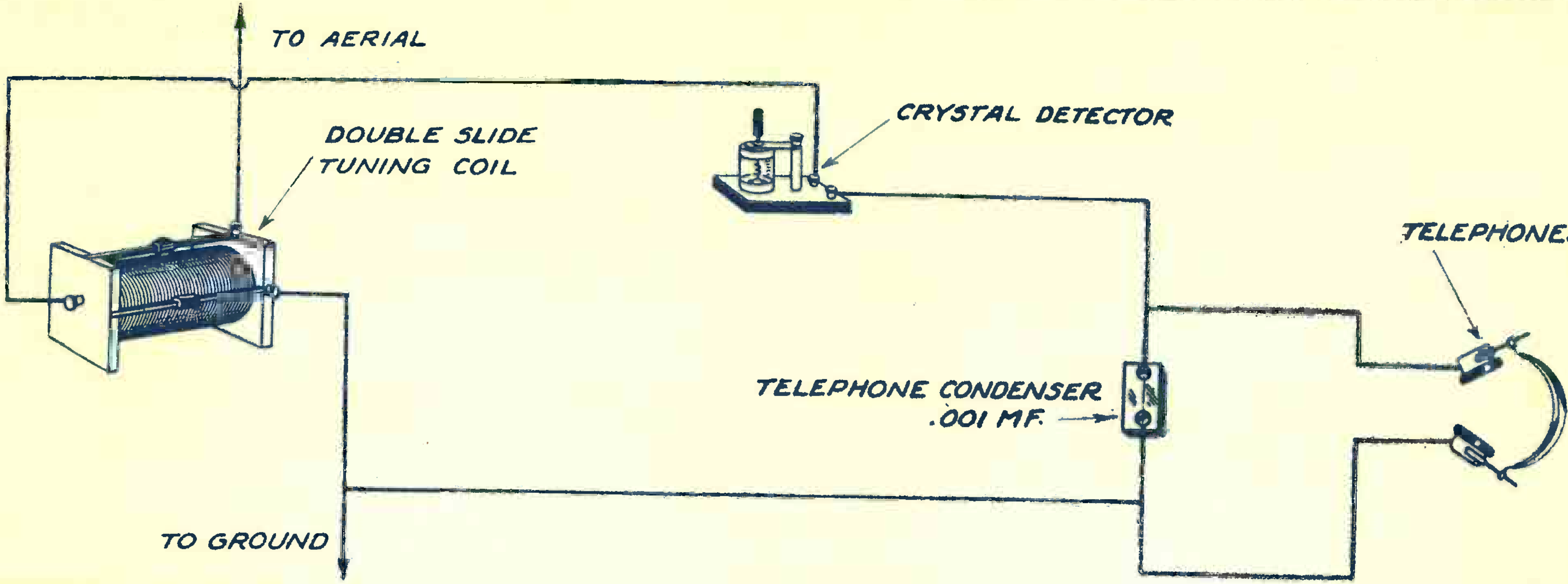

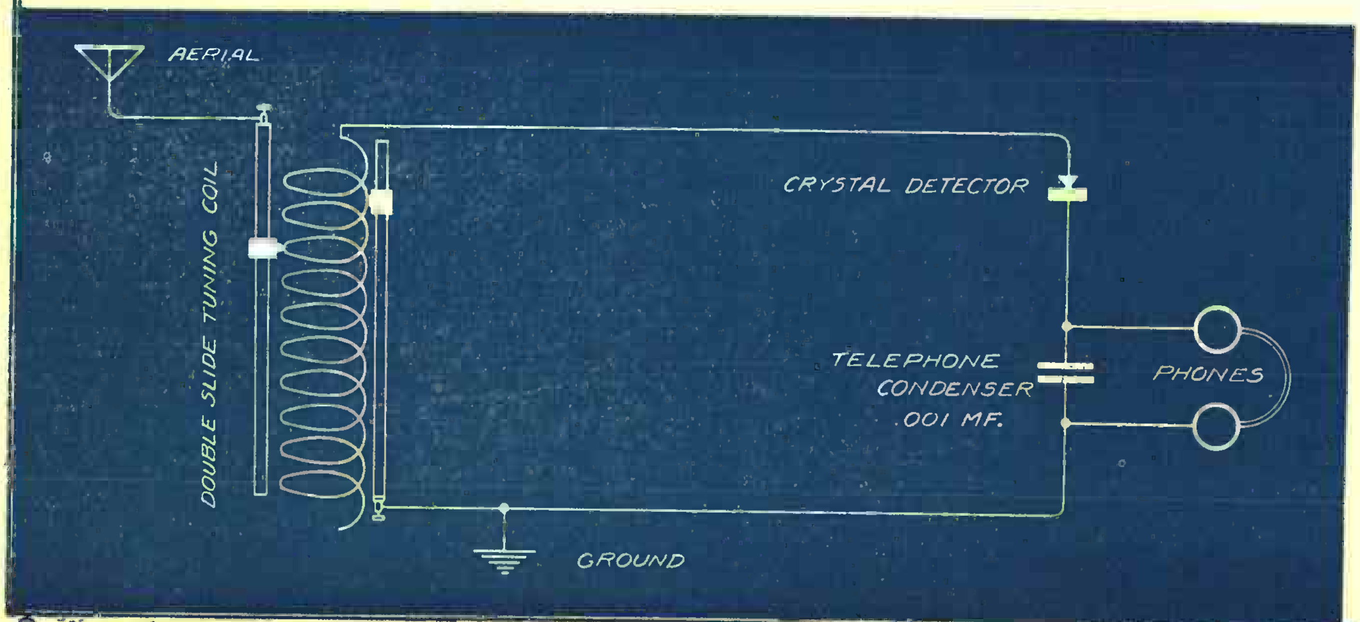

DOUBLE SLIDE TUNING COIL WITH CRYSTAL DETECTOR

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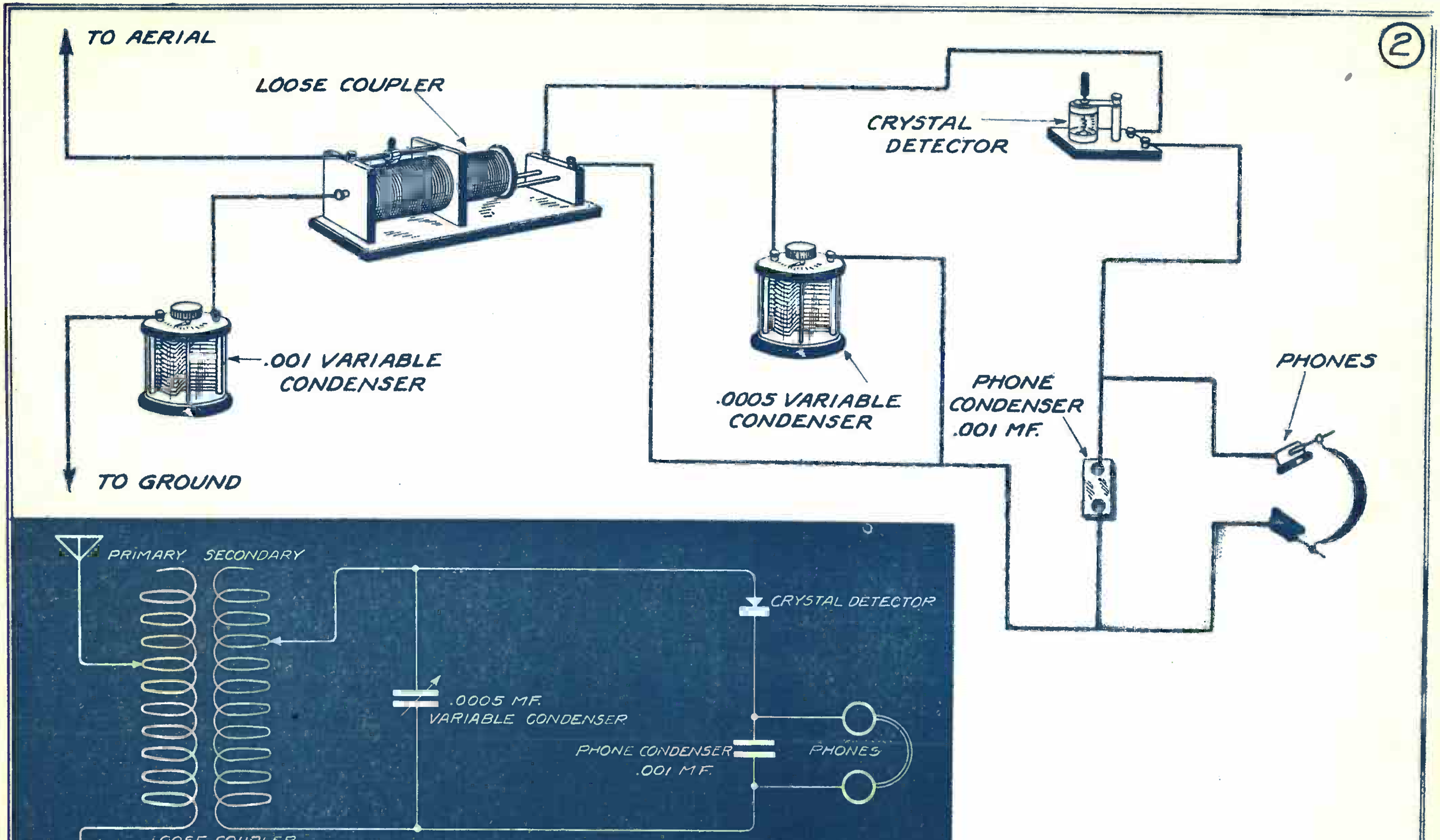

LOOSE CO[illegible] WITH CRYSTAL [illegible]

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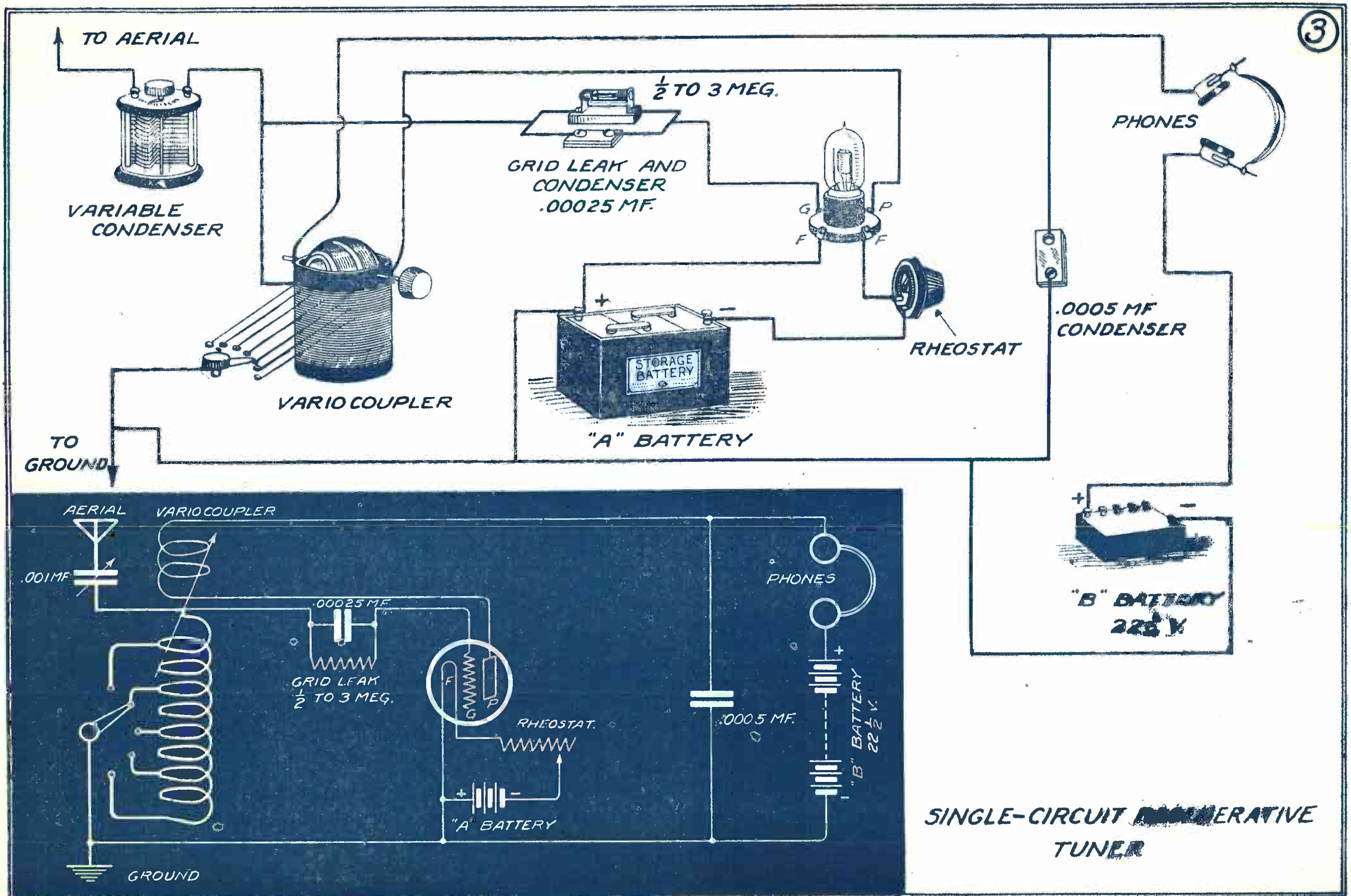

SINGLE-CIRCUIT [redacted]ERATIVE TUNER

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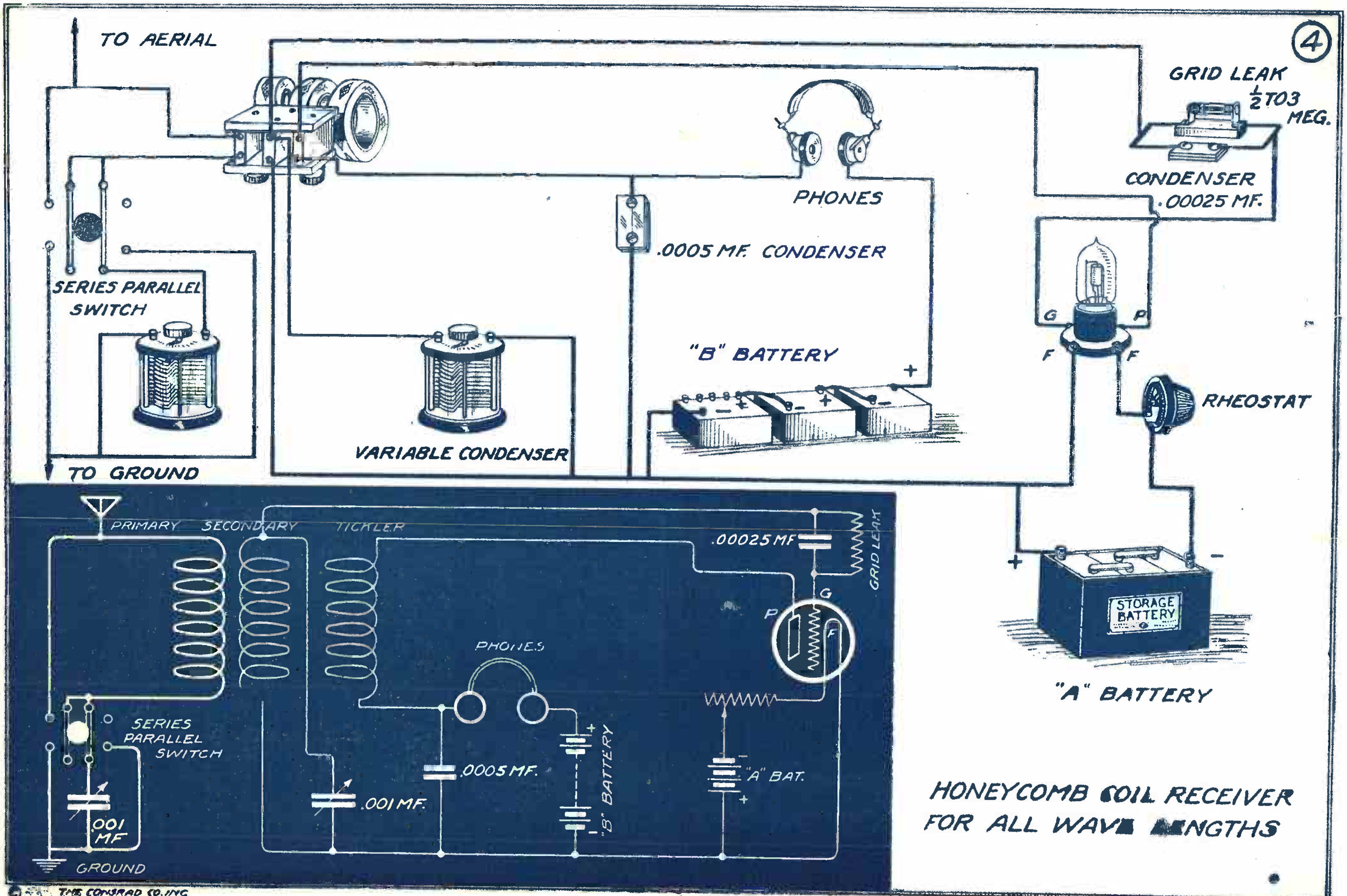

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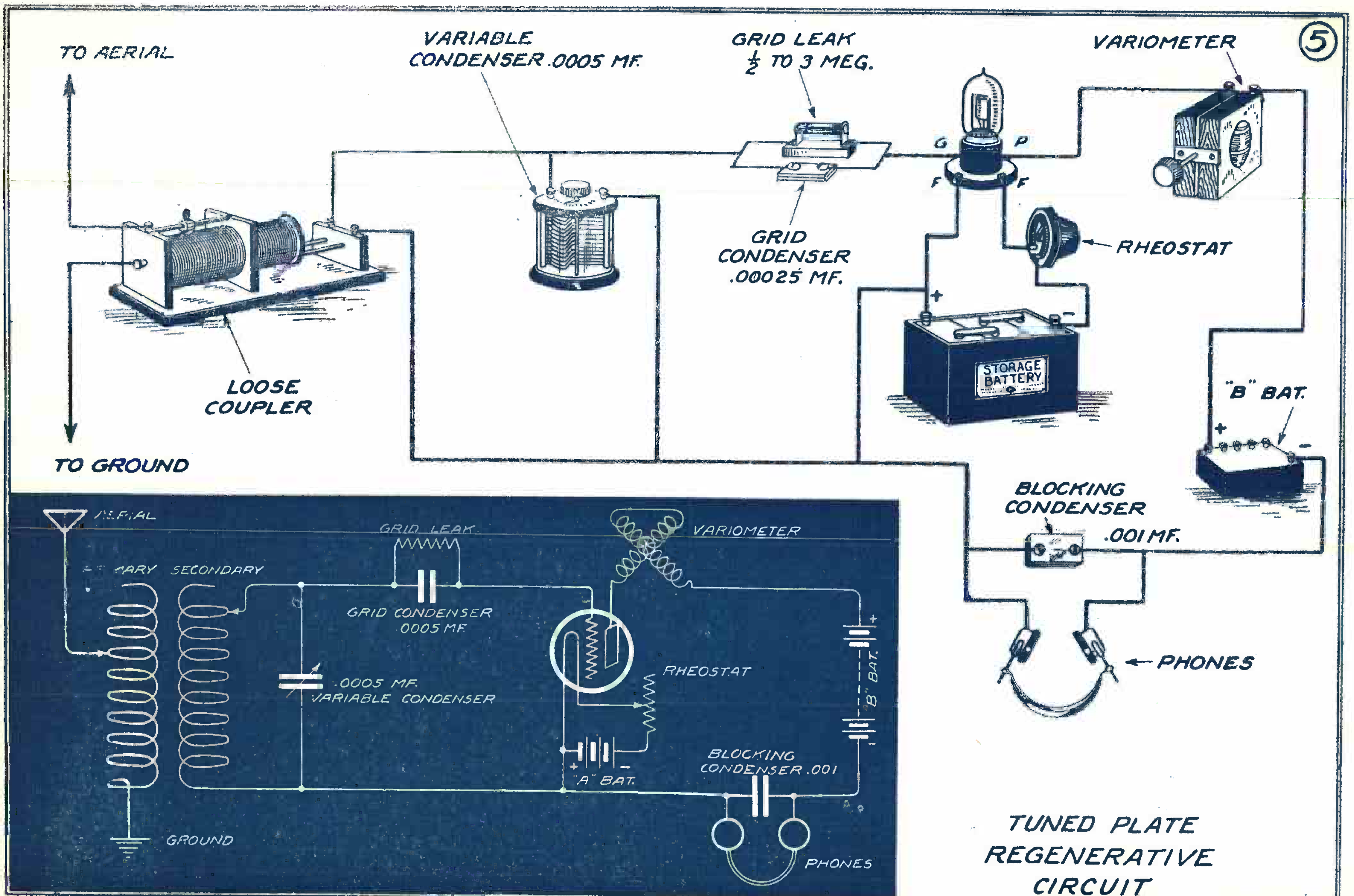

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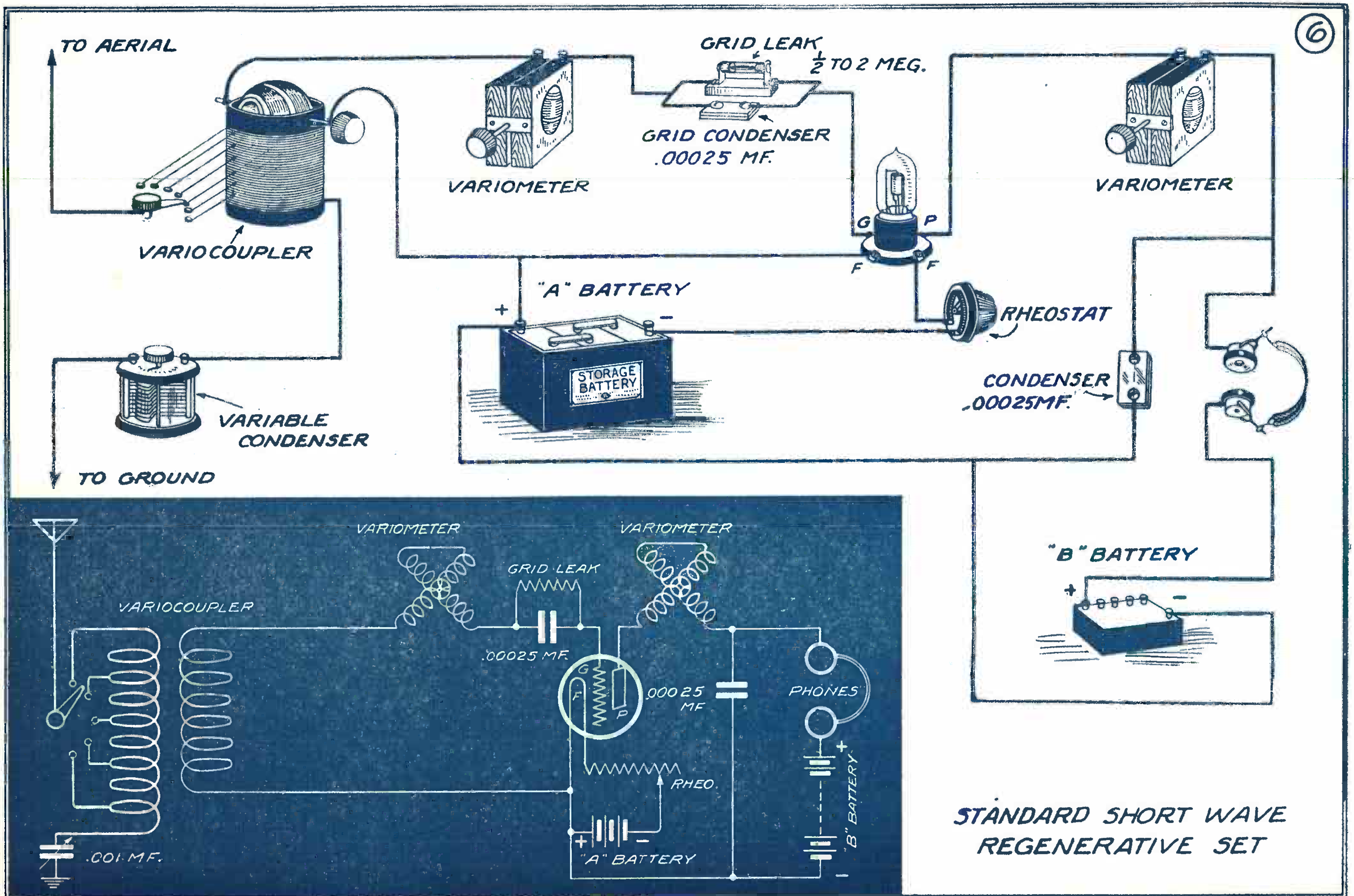

STANDARD SHORT WAVE REGENERATIVE SET

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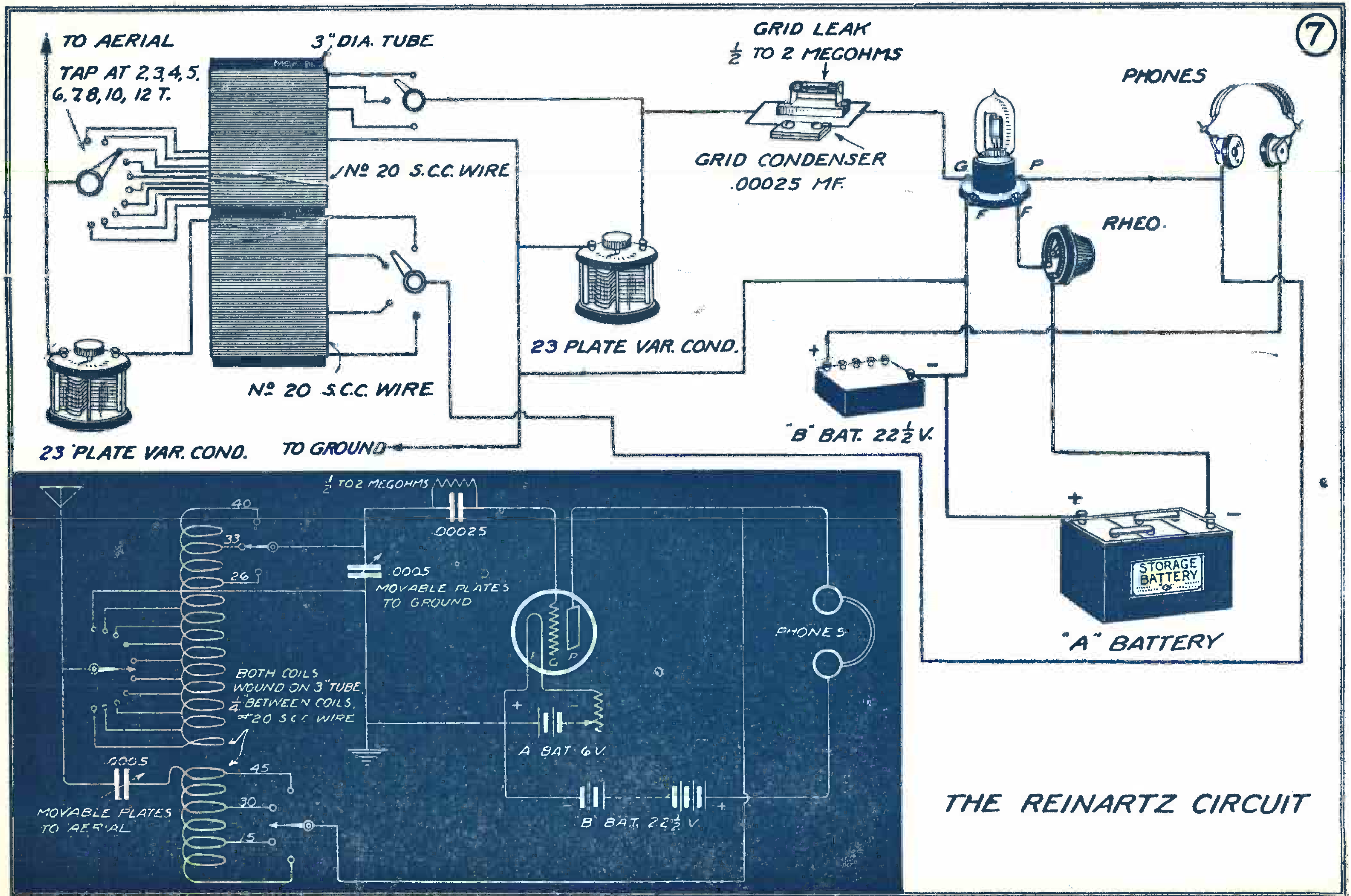

THE REINARTZ CIRCUIT

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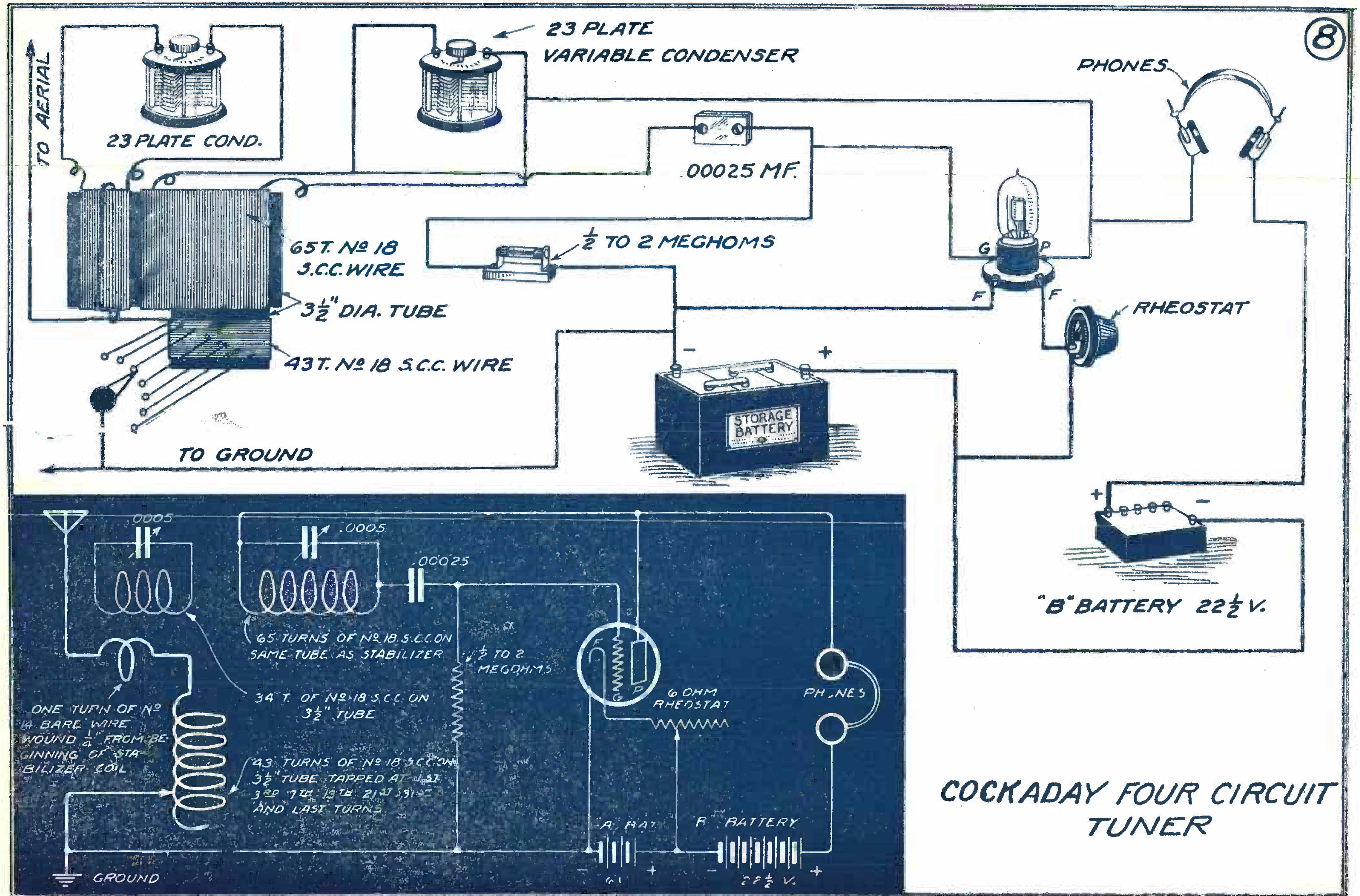

COCKADAY FOUR CIRCUIT TUNER

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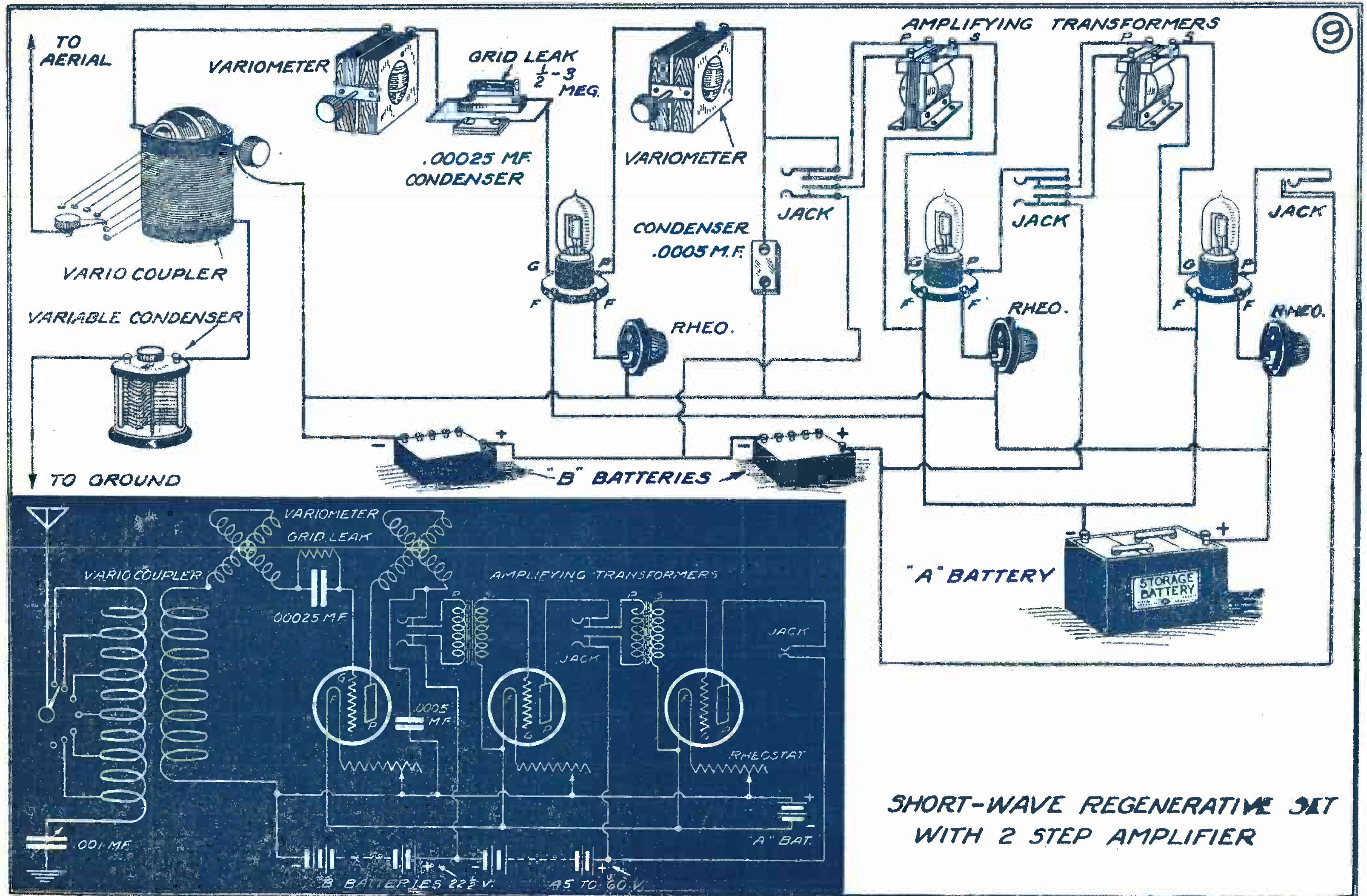

SHORT-WAVE REGENERATIVE SET WITH 2 STEP AMPLIFIER

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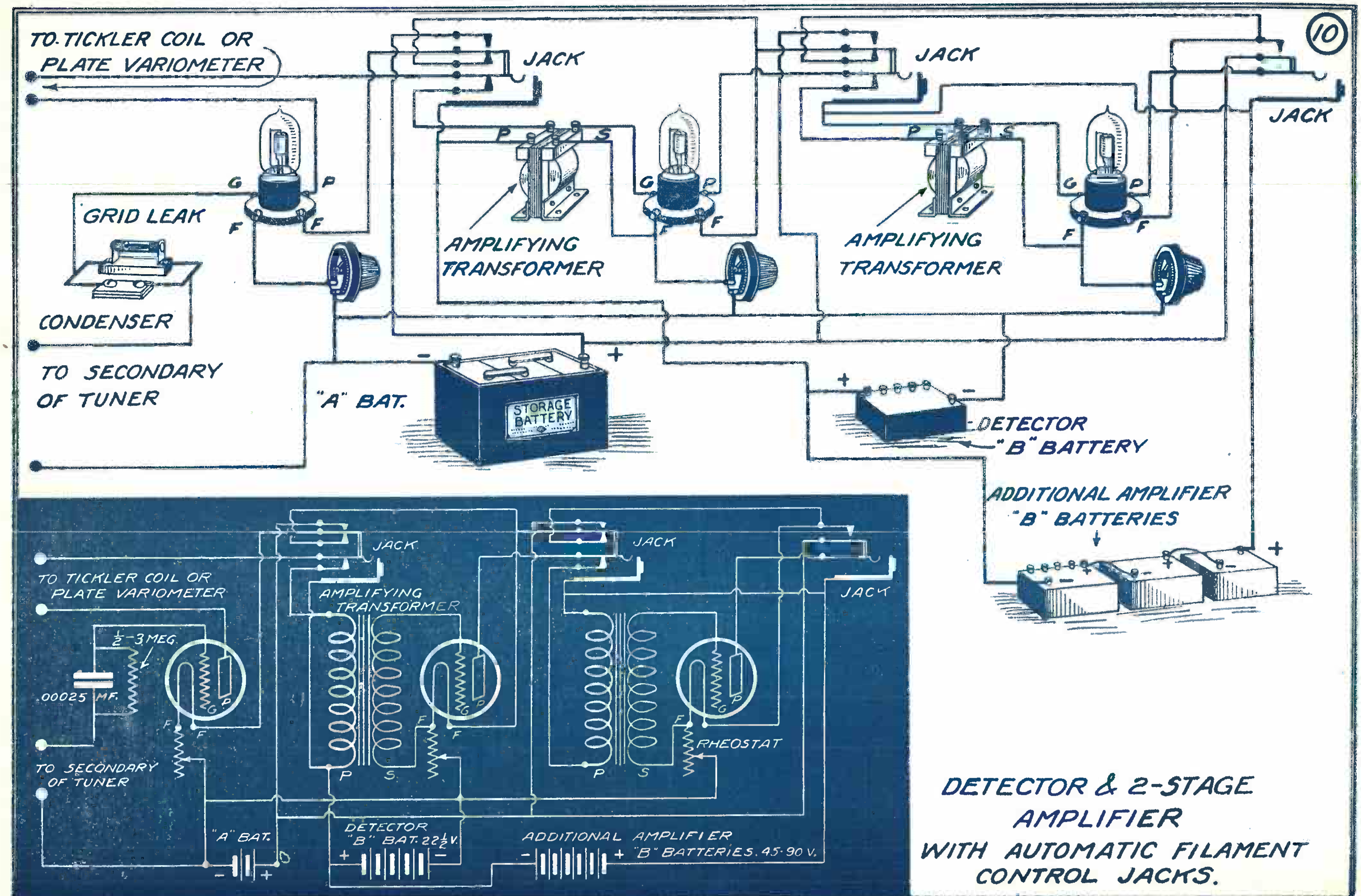

DETECTOR & 2-STAGE AMPLIFIER WITH AUTOMATIC FILAMENT CONTROL JACKS.

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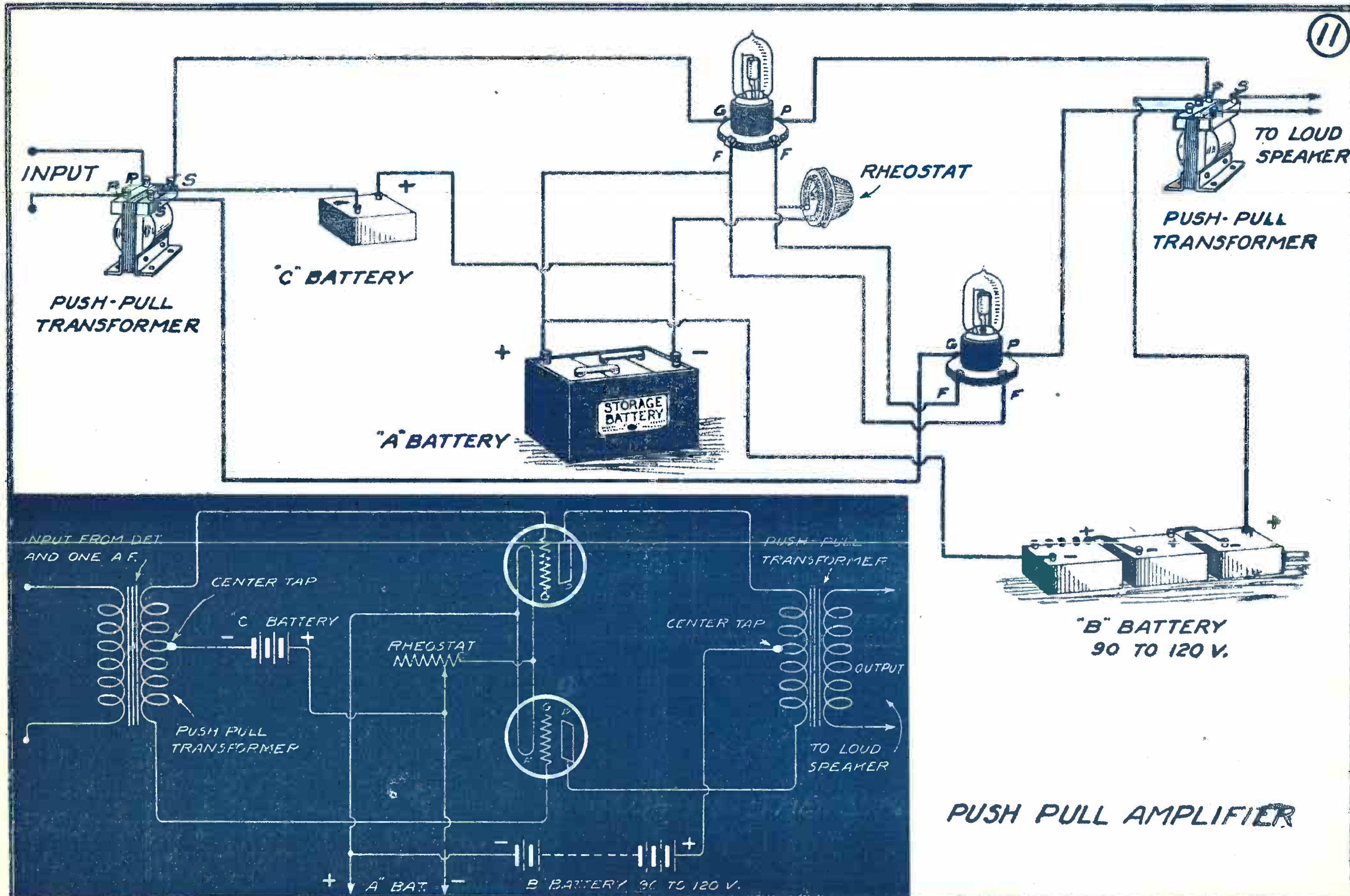

PUSH PULL AMPLIFIER

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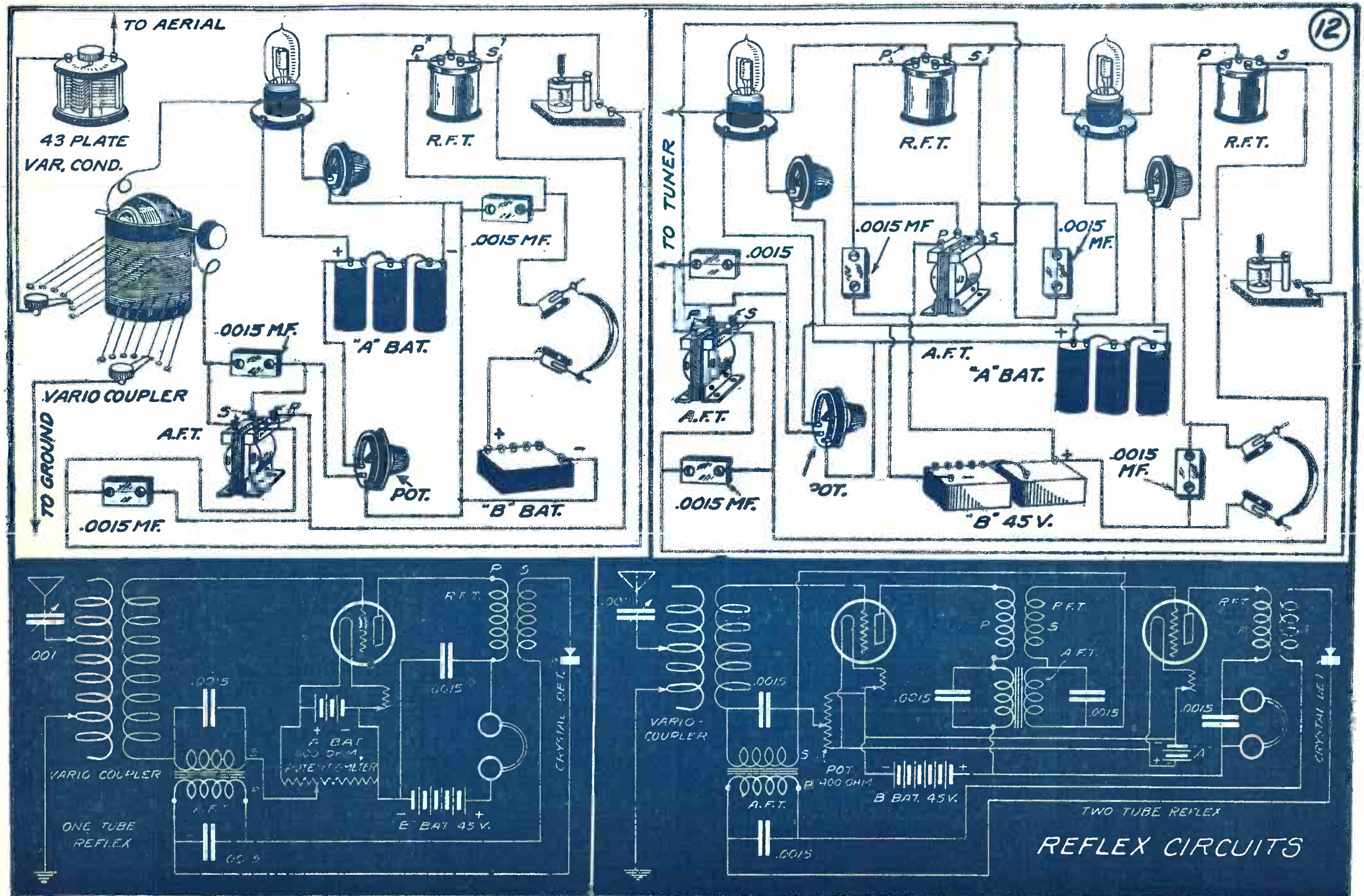

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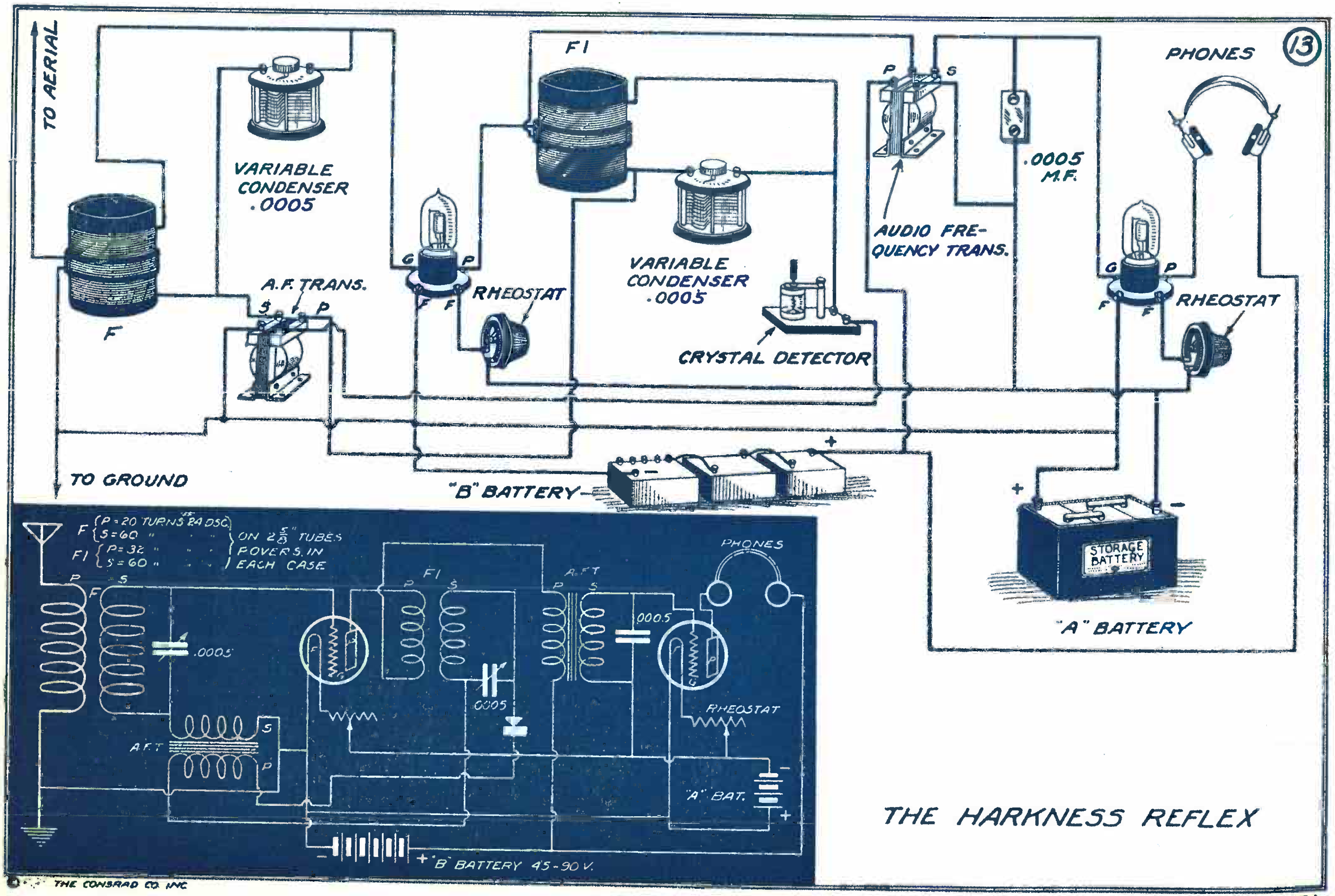

THE HARKNESS REFLEX

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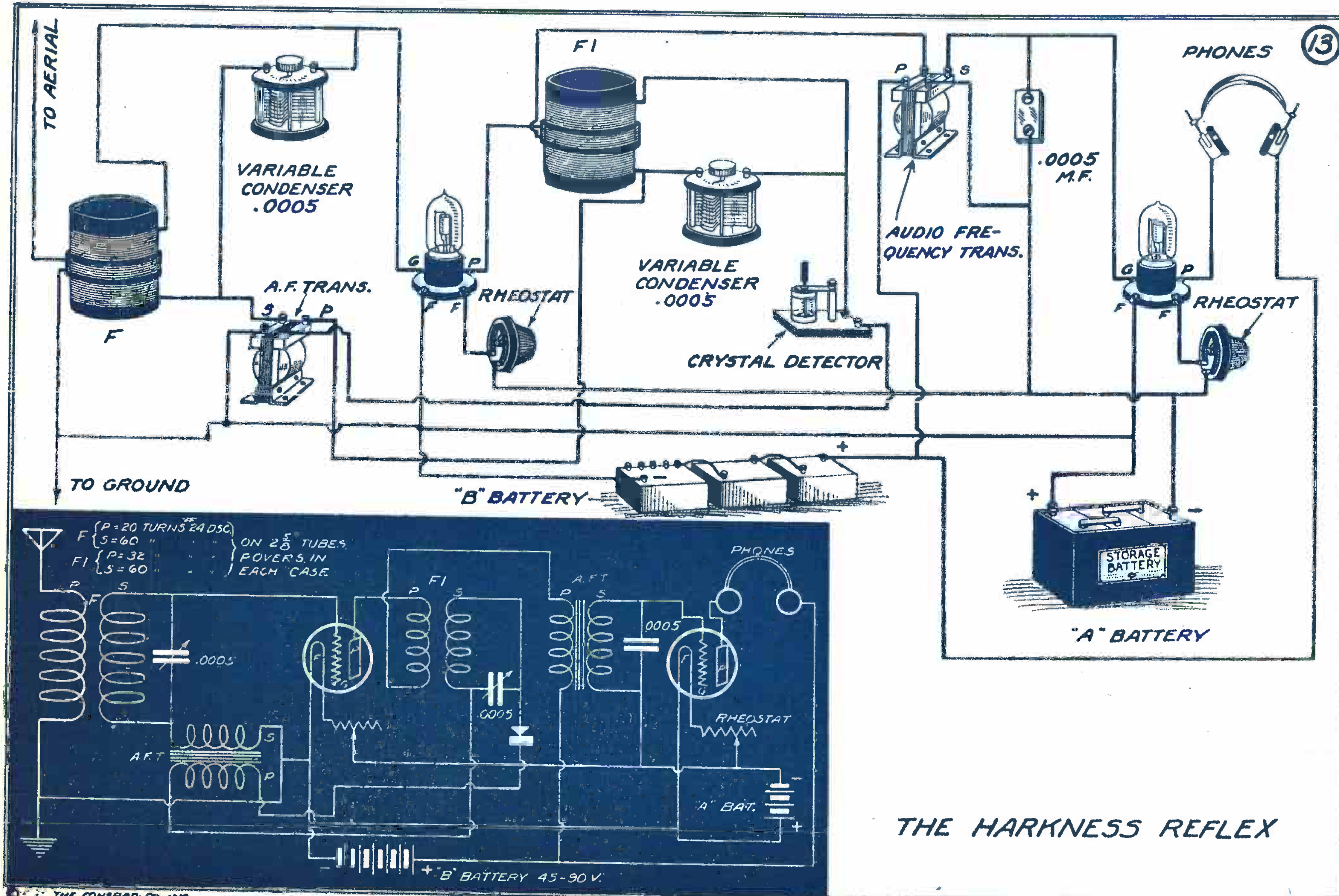

THE HARKNESS REFLEX

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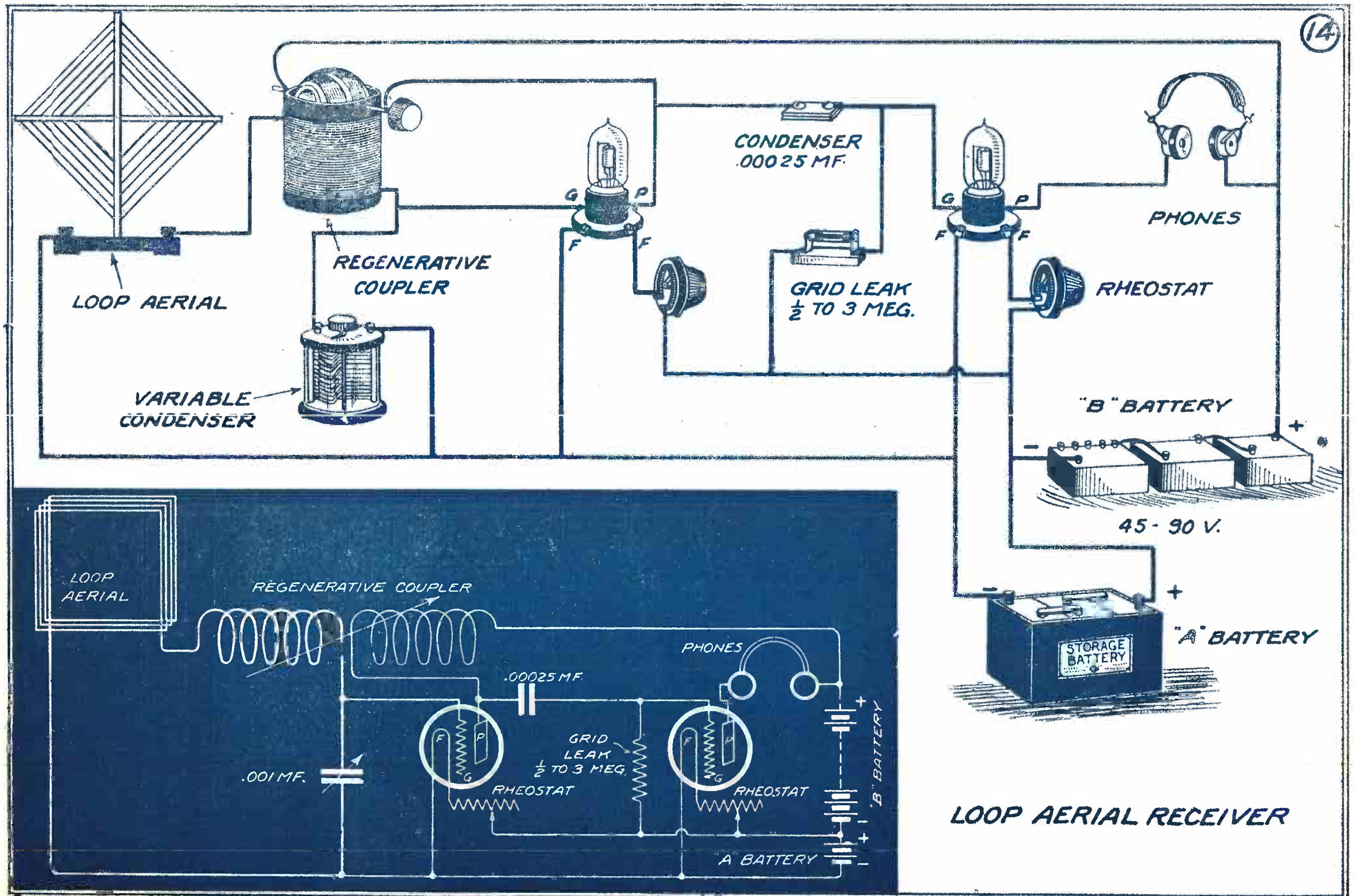

LOOP AERIAL RECEIVER

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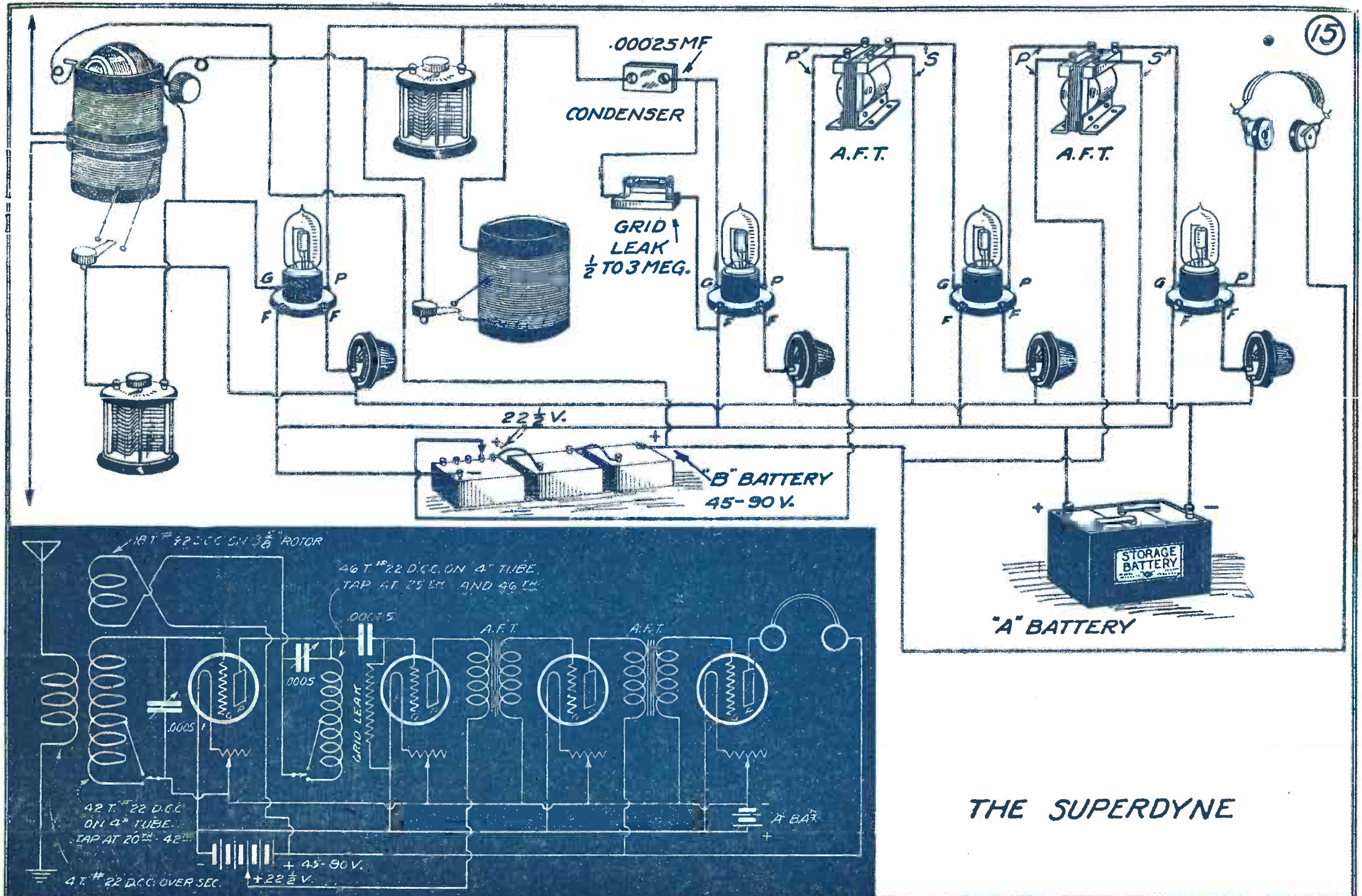

THE SUPERDYNE

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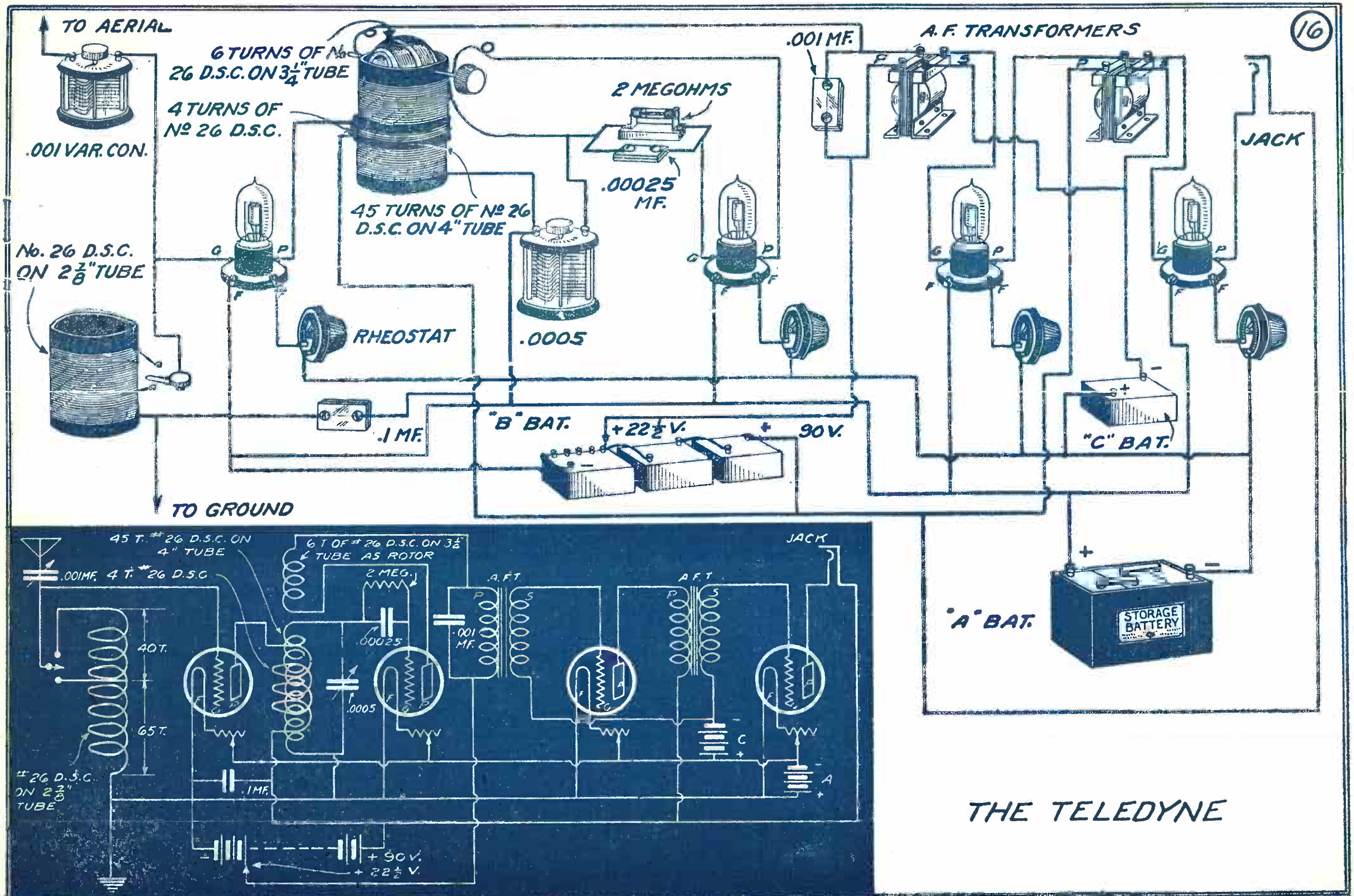

THE TELEDYNE

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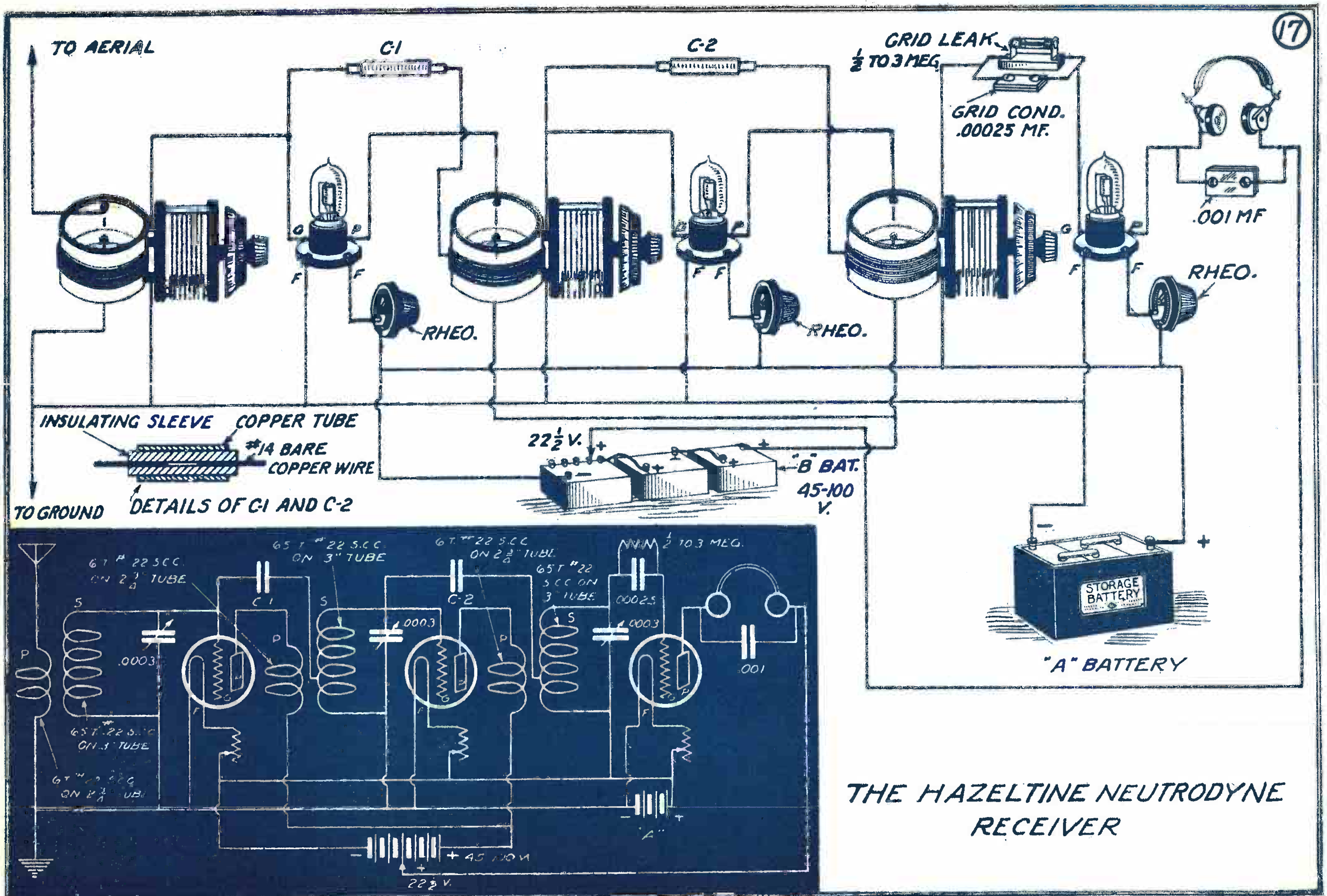

THE HAZELTINE NEUTRODYNE
RECEIVER

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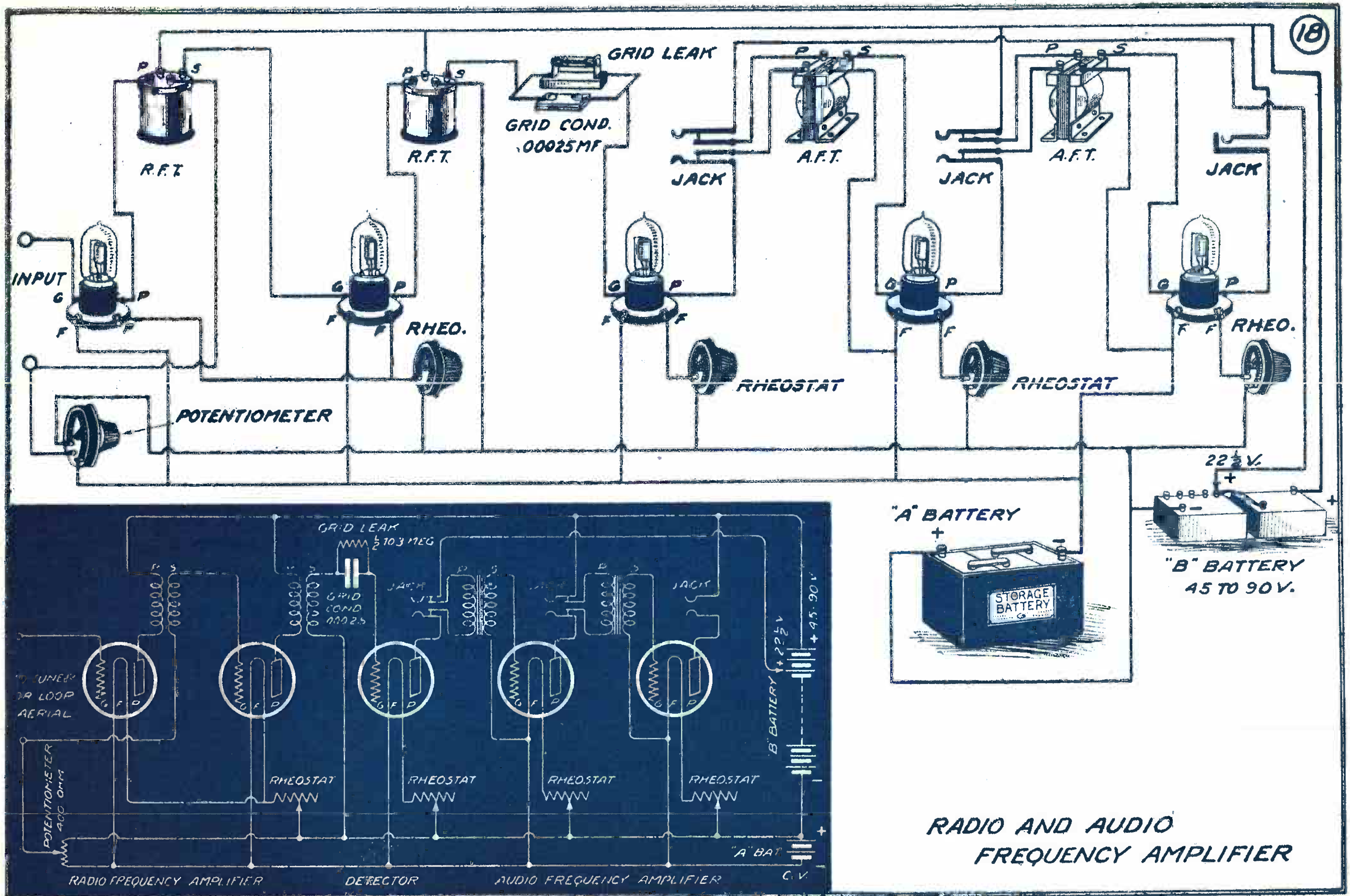
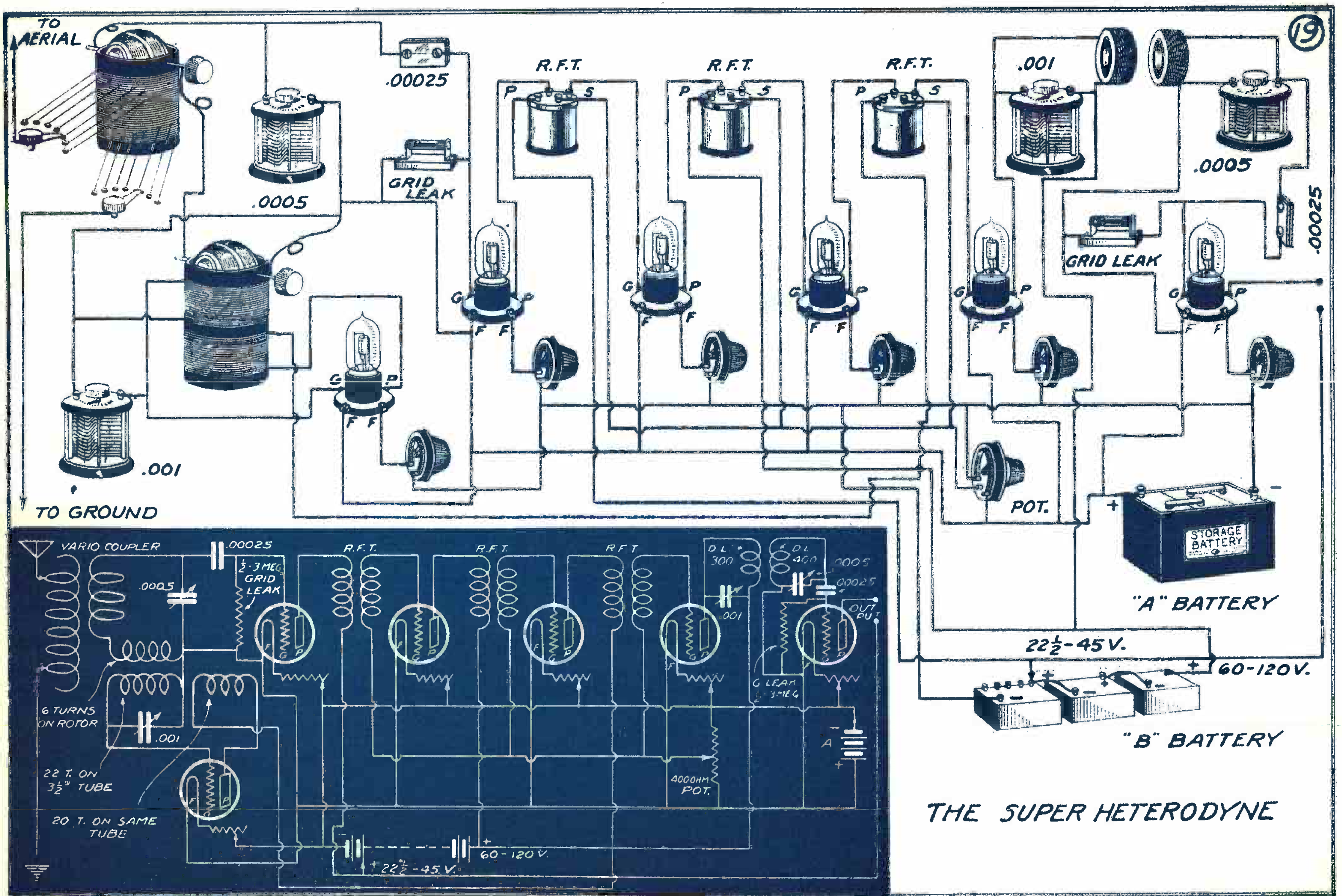


RADIO AND AUDIO FREQUENCY AMPLIFIER



THE SUPER HETERODYNE

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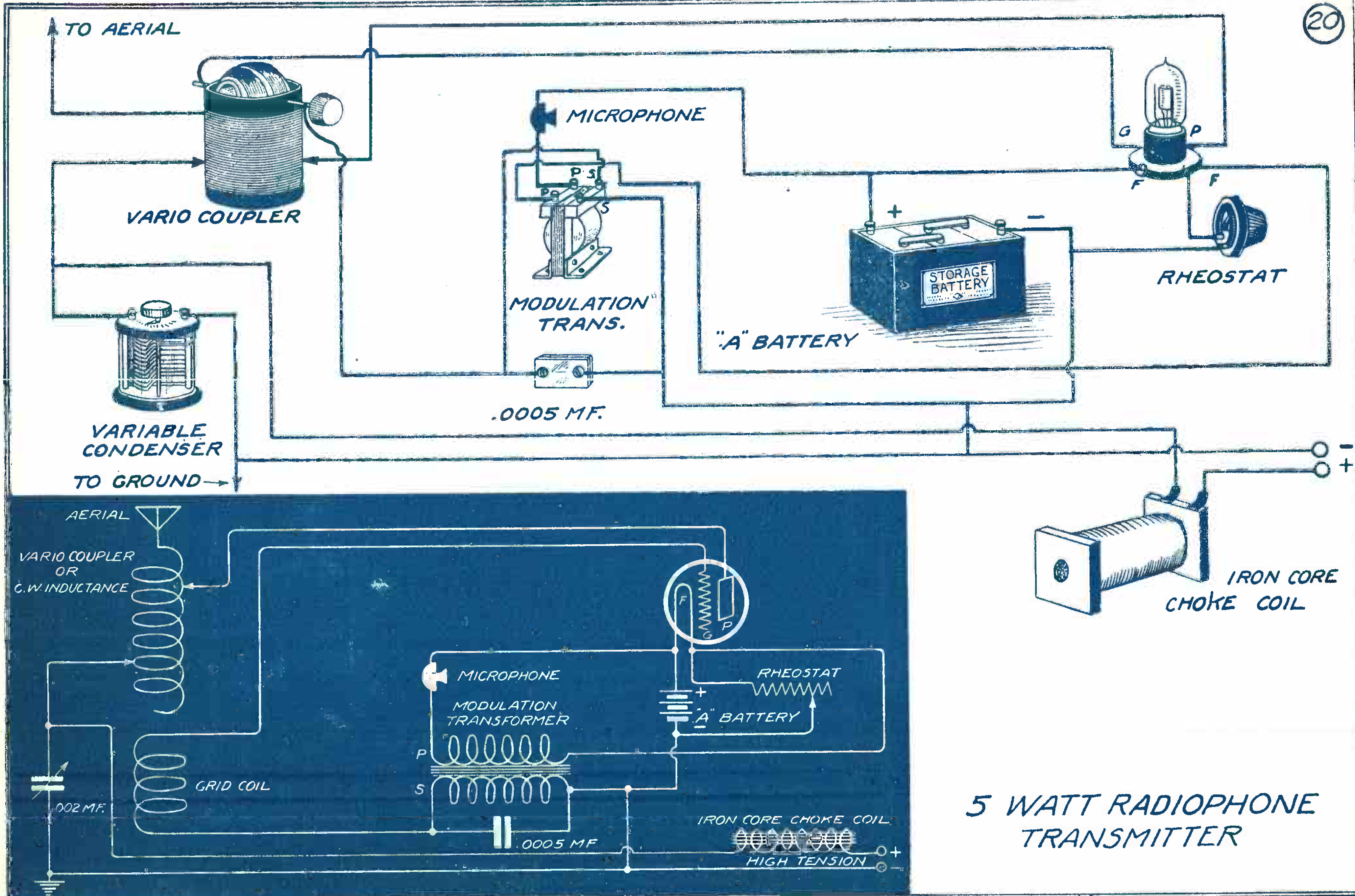

5 WATT RADIOPHONE TRANSMITTER

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Measurement of Wavelength of Distant Transmitting Station
Calibration of a Receiving Set

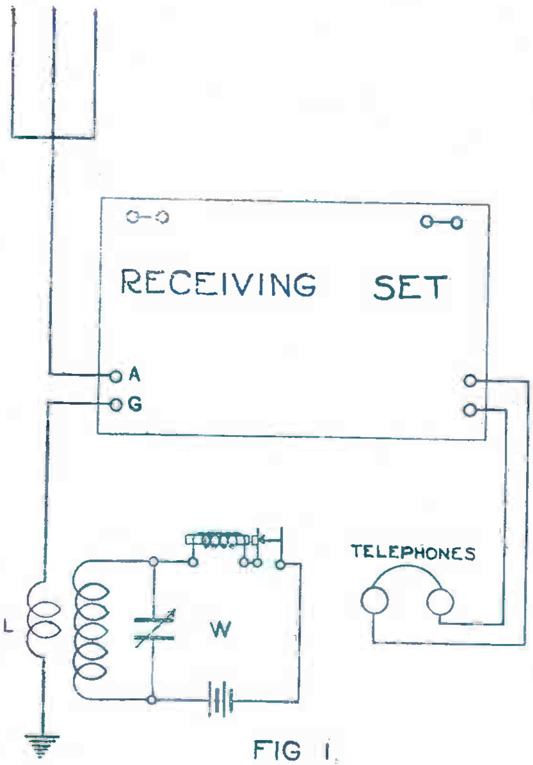

FIG 1.

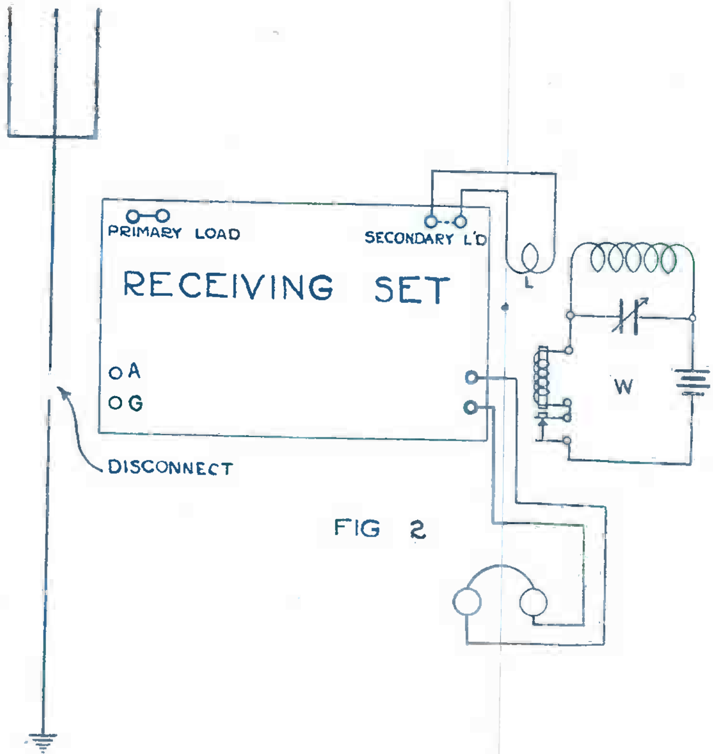

FIG 2

W—Wavemeter or driver.
L—Coupling coil of one or two turns.

MEASUREMENT OF WAVELENGTH OF DISTANT TRANSMITTING STATION

The apparatus required and the circuits employed are shown by figure 1 above. To obtain wavelength, first, using as loose coupling as possible, tune in signal on receiving set, next start buzzer connected to wavemeter (W) and adjust wavemeter until the maximum strength of signals is obtained in telephones connected to receiver. The wavelength of the wavemeter (W) is now the same as that used by the distant station.

CALIBRATION OF RECEIVING SET

First set up wavemeter so it will excite secondary (Fig. 2) of receiver. One or two small turns may be connected in series with secondary if wavemeter cannot be conveniently placed to excite it otherwise. Loosen coupling between primary and secondary of receiver as much as possible and set primary switches to shortest wavelength. Next adjust wavemeter to the lowest wavelength the receiver is designed for, and after starting buzzer, tune the secondary of the receiver until the maximum strength of signals is obtained in the telephones, which will be obtained when the receiver secondary is adjusted for the same wavelength as the wavemeter is tuned for. Note adjustment of receiver secondary when this has been accomplished and then increase wavelength setting of wavemeter by about 20 meters. Tune this wavelength in on the secondary and note adjustment. Continue in this way until you have the adjustment for every twenty meters over the entire range of the receiver. When you have accomplished this, plot your results on a piece of cross section paper.

When the secondary has been calibrated, the primary can be calibrated by using the circuit shown in Figure 1. From the table previously tabulated adjust secondary for lowest wavelength, and adjust wavemeter for the same wavelength. Now using a loose coupling tune primary until maximum strength of signals is obtained in telephones attached to receiver. Wavemeter, primary of receiver and secondary of the receiver are now all adjusted to the same wavelength. Continue in this way, noting setting of primary each time, until you have covered wavelength range of receiver again. A calibration curve for the primary can then be drawn similar to the one for the secondary.

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Measurement of Fundamental Wavelength of Antenna
Three Methods

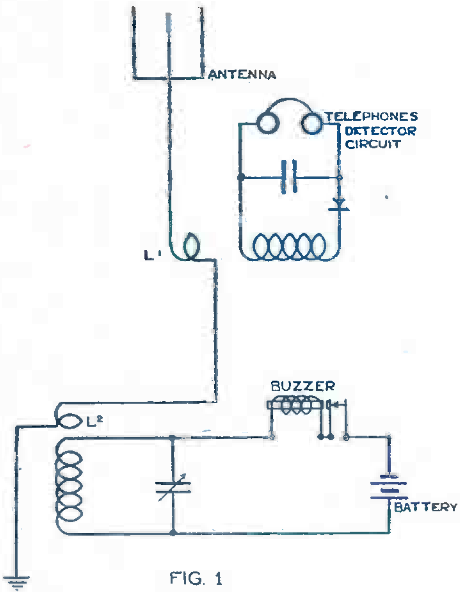

FIG. 1

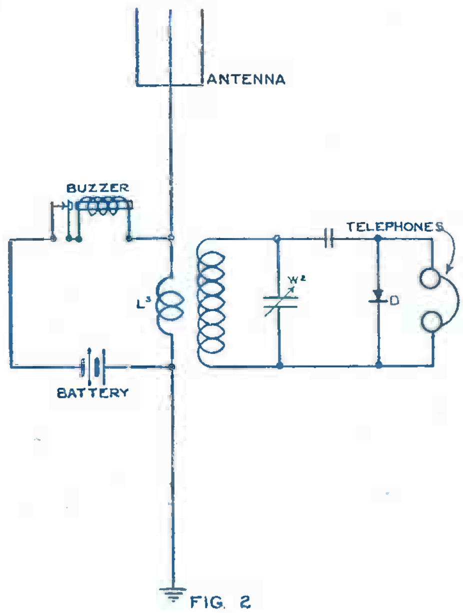

FIG. 2

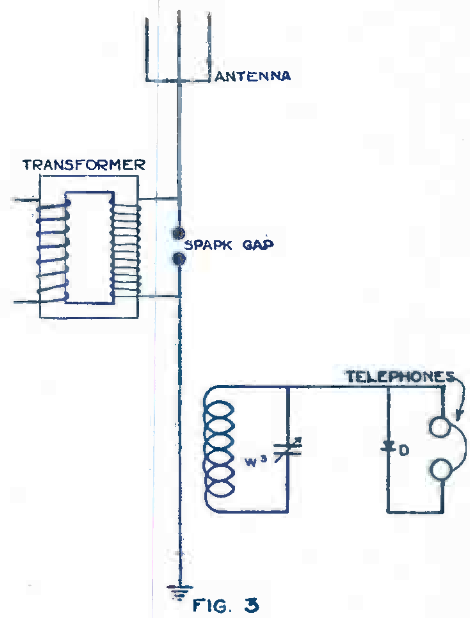

FIG. 3

(a) Buzzer excitation.

(b) Buzzer excitation.

(c) Spark excitation.

W_1—Wavemeter used as driver. (Fig. 1.)

W_2—Wavemeter used as detector circuit (Fig. 2).

W_3—Wavemeter used as detector circuit with detector connected unilaterally (Fig. 3).

L_1 L_2—Small loops used for coupling.

L_3—Small inductance of 1 or 2 turns.

(a) BUZZER EXCITATION

The apparatus required and the circuits employed are shown by Figure 1. Care must be taken that coils of wavemeter and detector circuits are placed so that no energy is transferred from one to the other except via loops L_1 and L_2 and the antenna circuit.

To measure the wavelength of antenna, start the buzzer and then tune wavemeter until maximum signals are obtained in the detector circuit.

(b) BUZZER EXCITATION

The apparatus required and the circuits employed are shown by Figure 2. A battery and buzzer are connected across a small series inductance of one or two turns L_3 and the wavemeter is used as a detector circuit to measure the wavelength. The error due to the inductance L_3 is small and can be neglected.

(c) SPARK EXCITATION

Connect antenna and ground to two sides of a plain open gap (Fig. 3) which is supplied with current from secondary of power transformer. Condenser and oscillation transformer must be disconnected from the circuit. Use wavemeter as a detector circuit to measure wave length.

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Measurement of Capacity

Substitution Method

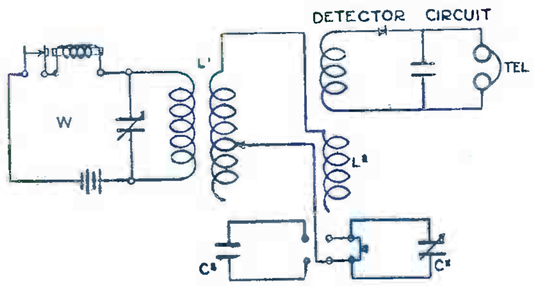


FIG. 1

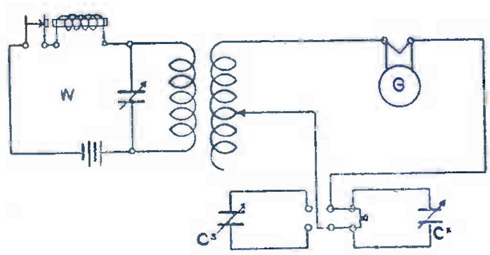
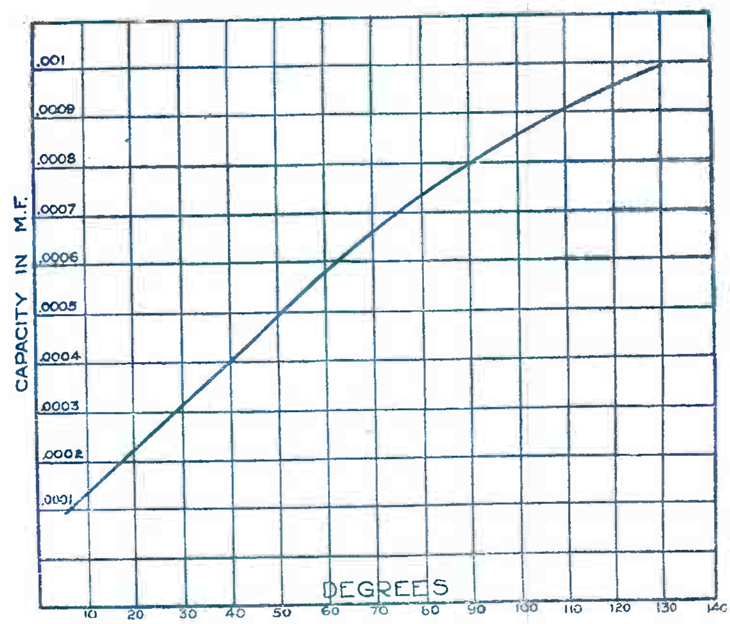


FIG. 2



L_1—Variable inductance.

L_2—Coupling coil.

C_s—Standard calibrated variable condenser.

C_x—Capacity to be measured.

G —Galvanometer and thermo element.

W—Wavemeter or driver.

The apparatus required and the circuits employed are shown by Figures 1 and 2 above. The principle of determining the capacity is the same in both figures, but different methods are employed to determine when the circuits are in resonance. In Figure 1 a detector and telephone receivers are employed; in Figure 2 a thermo element with a galvanometer.

To determine capacity of C_x start buzzer connected to wavemeter and with switch thrown so as to cut C_x in circuit, vary wavelength emitted by wavemeter until maximum strength of signals (Fig. 1) is obtained in telephone receivers, or a maximum deflection (Fig. 2) is obtained on galvanometer. When this has been accomplished, without disturbing the rest of the circuit, throw switch so as to disconnect C_x and connect C_s in circuit. Now vary capacity of C_s until maximum strength of signals or maximum deflection is obtained again. The capacity of C_s now equals the capacity of C_x and as the capacity of C_s is known, you have the capacity of C_x for this setting.

If C_x is a variable condenser you desire to calibrate, the capacity for every ten degrees of scale should be obtained by the method just outlined, and the resulst plotted on cross-section paper. An example of a calibration curve is shown above.

Note.—In the circuit shown in Figure 1 care must be taken to place the coils far enough apart and in such positions that there will be no direct transfer of energy from the driver to the detector circuit.

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Measurement of Inductance of a Coil or Circuit

(Two Methods)

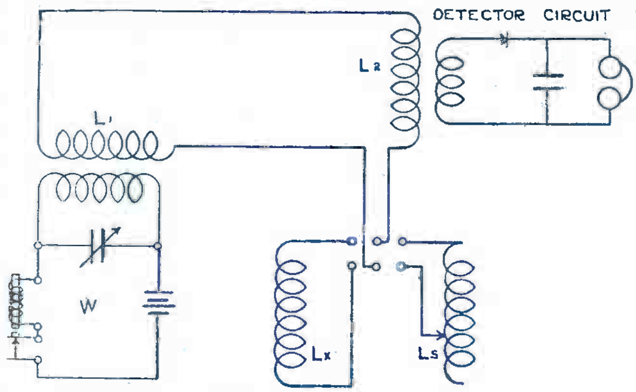

FIG. 1

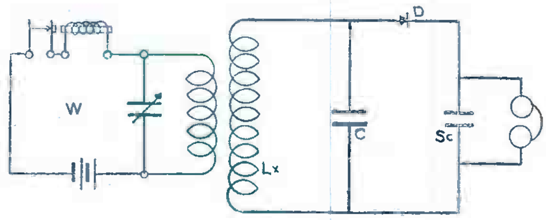

FIG. 2

W—Wavemeter or driver.
L_s—Calibrated variable inductance.
L_x—Inductance to be measured.
L_1 L_2—Coupling coils.
S_c—Stopping Condenser.

(a) SUBSTITUTION METHOD

The apparatus required and the circuits employed are shown by Fig. 1. To obtain inductance of L_x start buzzer and with switch thrown so as to connect L_x in circuit tune wavemeter until maximum strength of signals is obtained in telephones connected to detector circuit. Next without disturbing the rest of the circuit throw switch so as to disconnect L_x and to connect L_s in circuit. Now vary the inductance of L_s until maximum strength of signals is again obtained in telephones. Inductance of L_s now equals L_x and as the inductance of L_s is known you have the inductance of L_x. L_s is generally a variometer, or a variable inductance consisting of two rollers, one of metal and the other of an insulating material, with means for winding wire from one to the other to obtain a continuous variation of inductance.

(b) BY CALCULATION

The apparatus required and the circuits employed are shown by Fig. 2. To obtain inductance, start buzzer and tune wavemeter until maximum strength of signals is obtained in telephones. Let λ represent the wavelength obtained at this point. The inductance of L_x can can now be calculated by the following formula:

$$L_x = \frac{LC}{C}$$

where:

LC = Oscillation constant of λ.
C = Capacity in microfarads of C, Fig. 2.

If no tables giving oscillation constant are available the inductance can be calculated by this formula:

$$L_x = \frac{\lambda^2}{k^2 C}$$

where:

$k = 59.6$ if inductance in centimeters.
$k = 1882.$ if inductance in microhenries.

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Measurement of Antenna Inductance and Efficiency Capacity

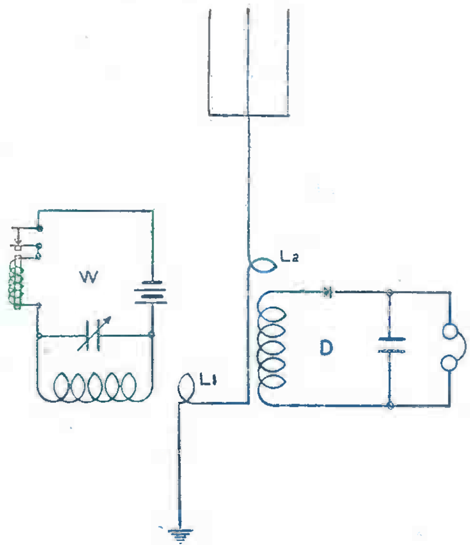

FIG. 1

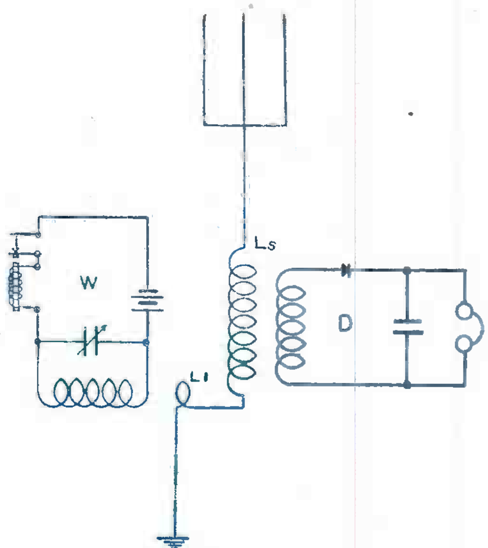

FIG 2

W—Wavemeter or driver.
L_1 L_2—Coupling coils.
L_s—Known inductance connected in series with antenna.
D—Aperiodic detector circuit.

The apparatus required and the circuits employed are shown by figures 1 and 2 above. Wavemeter and detector circuit inductances should be placed at right angles to each other to prevent the transfer of energy except through antenna circuit. After connections have been made as shown in Figure 1, start buzzer and tune wavemeter W until maximum strength of signals is obtained in telephones. As loose a coupling as possible should be used. When maximum signals are obtained note the wavelength.

Next insert a known inductance L_s which should be large enough to increase the fundamental wavelength (four times) in series with the antenna, and obtain the wavelength of the antenna with this inductance inserted in the same way as outlined above.

Next by formula (1) below find the LC values for the two wavelengths just obtained.

where:

(1) $$LC = \frac{\lambda^2}{k^2}$$

LC = Oscillation constant.
k = 59.6 if inductance in centimeters.
k = 1882 if inductance in microhenries.

The capacity of the antenna can now be obtained by the following formula (2):

where:

(2) $$C_a = \frac{LC_s}{L_s}$$

LC_s = Oscillation constant of wavelength obtained with L_s in series with antenna.
L_s = Value of series inductance.

The inductance of the antenna can now be found by dividing the LC constant obtained with no inductance in series with the antenna by the capacity of the antenna. Formula (3).

where:

(3) $$L_a = \frac{LC_f}{C_a}$$

L_a = Inductance of antenna.
LC_f = Oscillation constant for fundamental wavelength of antenna.
C_a = Capacity of antenna.

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Measurement of Effective Antenna Capacity

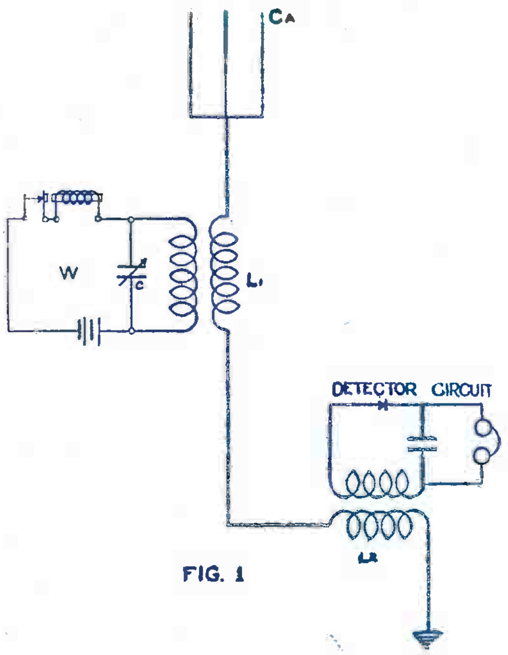

FIG. 1

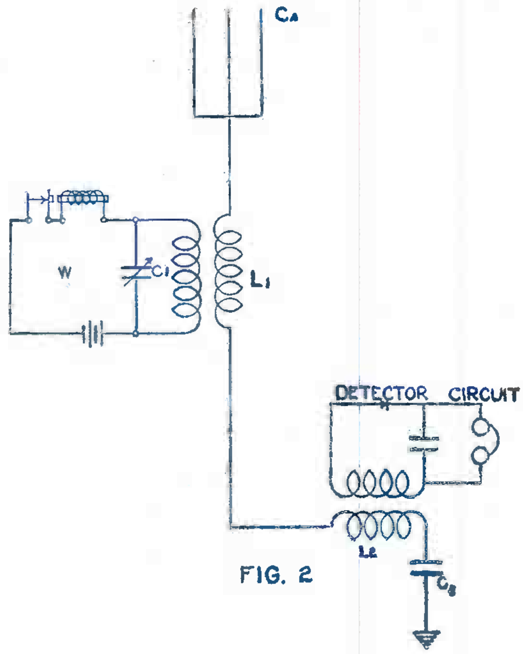

FIG. 2

L_1 L_2—Coupling coils.

W—Wavemeter or driver.

C_s—Condenser inserted in series with antenna.

METHOD (a)

The apparatus required and the circuits employed are shown by figures 1 and 2 above. To obtain the effective capacity of the antenna, vary the wavelength of W (Fig. 1) until maximum strength of signals is obtained in telephones connected to detector circuit. Note wavelength.

Next insert a known capacity C_s in series with the antenna (Fig. 2) and obtain the wavelength in the same way as outlined above. Note this wavelength. (The condenser inserted in series with the antenna must be of such size that it does not make over ten per cent. difference in the wavelength.) The capacity of the antenna may now be obtained by the following formula:

$$C_a = \frac{C_s\,(\lambda^2 - \lambda_1^2)}{\lambda_1^2}$$

where:

C_a = Capacity of antenna.
C_s = Capacity of series condenser (Fig. 2).
λ = Wavelength without condenser in series with antenna.
λ_1 = Wavelength with condenser in series with antenna.

METHOD (b)

The procedure is exactly the same as with method (a) except that instead of using the wavelength of the driver circuit W, the capacity of the condenser is noted. This allows the effective capacity of an antenna to be measured when a calibrated variable condenser is available by means of the following formula:

$$C_a = \frac{C_s\,(C - C_1)}{C_1}$$

where:

C_a = Capacity of antenna.
C_s = Capacity of series condenser (Fig. 2).

C = Capacity of driver condenser W when driver circuit is in resonance with antenna circuit. (Fig 1.)
C_1 = Capacity of driver condenser W when resonance is obtained with series condenser C_s is in circuit. (Fig. 2.)

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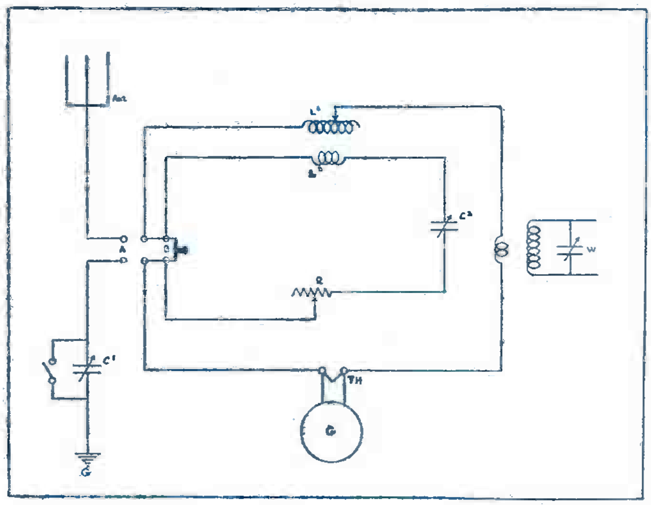
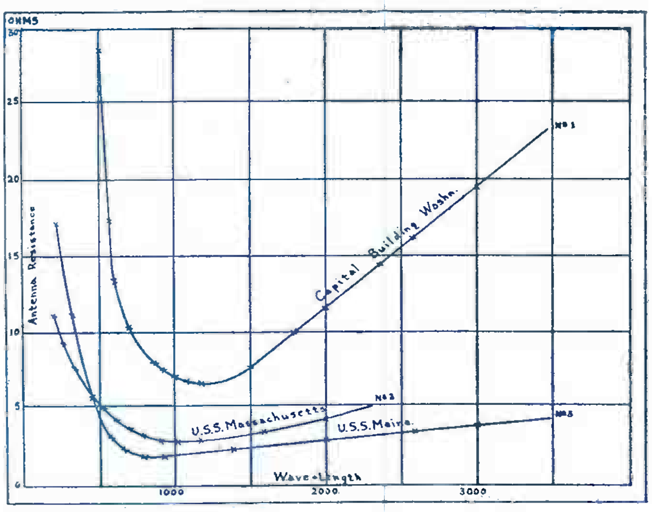
Measurement of Antenna Resistance

(Method described by Bu. Standards Bul. Vol. 9—L. W. Austin.)

Substitution Method





L_1 —Tuning inductance.

C_1 —Variable air condenser for obtaining wave lengths below fundamental.

Th —Thermo element.

G —Galvanometer.

C_2 —Variable air condenser set at capacity of antenna to be measured.

L_2 —Small inductance to represent antenna inductance. (This has little influence on results and may be omitted.)

R —Resistance inserted in dummy antenna circuit to reduce current in this circuit to same value as obtained with antenna connected.

W —Wave meter, or other form of exciting circuit.

The apparatus required and circuits employed are shown by above diagram. The method in brief, is the substitution of an air condenser in place of the antenna and ground, keeping the inductance common to both circuits and introducing resistance in the dummy antenna circuit until the current becomes the same as that obtained with the antenna and ground connected. When this is accomplished the antenna resistance at the wave length used is the same as the inserted resistance R.

EXAMPLE.

Set wave meter or driver (W) to desired wave length and with antenna and ground connected (switch thrown to position "A") tune with L_1 until resonance is reached. (This being indicated by maximum deflection of G.) If wave length is below fundamental it will be necessary to open switch shorting C_1. Now throw switch to B and vary C_2 until resonance is reached. Compare galvanometer deflections with switch thrown to A and B and insert resistance at R until deflection is the same with switch in either position. The resistance of the antenna for the wave length used is the same as the inserted resistance.

Proceed in the same way until the antenna resistance is obtained on enough wave lengths to allow a curve to be drawn similar to those shown above.

Above measurements should be made when there is no static and when receiving conditions are good.

It will be found that beginning with short wave lengths, antenna resistance falls rapidly until a wave length not quite twice the fundamental is reached. From this point the antenna resistance increases slowly if the ground resistance is low (Curves 2 and 3), and rapidly if it is high (Curve 1). The antenna resistance of a land station varies due to changing ground conditions.

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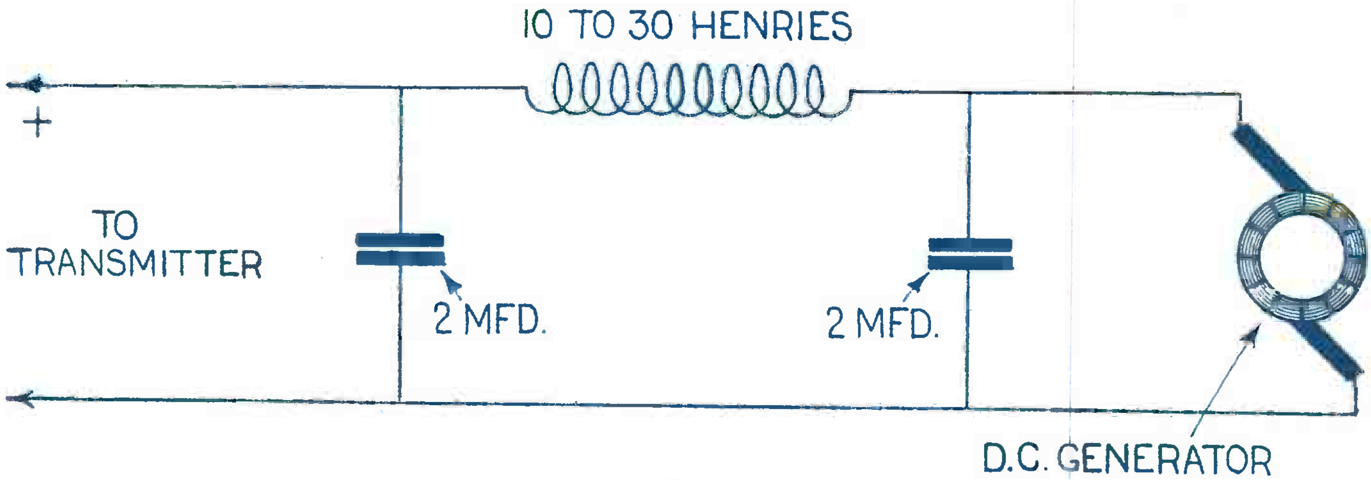
Proper Filtration of the D.C. Plate Supply



Amateur filters have, to date, been haphazard affairs at best consisting of a choke coil and condensers of whatever values of capacity and inductance may be on hand. The new regulations governing amateur stations introduce a clause to the effect that a license to use the frequencies between 1500 kilocycles and 2000 kilocycles (150-200 meters) will be issued where the plate supply source is "adequately filtered." It is further stated that, "—— a filter is not deemed adequate where the supply modulation exceeds five percent." This calls for an exceedingly good filtering arrangement which in the case of a high potential source of direct current from a motor-generator set should consist of at least ten henries inductance value in an iron core choke coil, with a shunt capacity of not less than four microfarads. Capacity alone, to the value of fifty to sixty microfarads is fairly satisfactory but is generally more costly than the somewhat better choke coil—shunt condenser combination.

In the case of rectified A. C. supply, an inductance of 30 to 50 henries is recommended with a shunt capacity of two microfarads across the line on either side of the choke in the familiar "brute force" arrangement shown diagramatically above. In applying for an amateur radio station license, the applicant should sketch his filter system on the application form and clearly show all value of capacity and inductance comprising such filter. This will enable the district Supervisor of Radio to judge whether your filter system is adequate and sufficient to entitle you to the wider band of frequencies.

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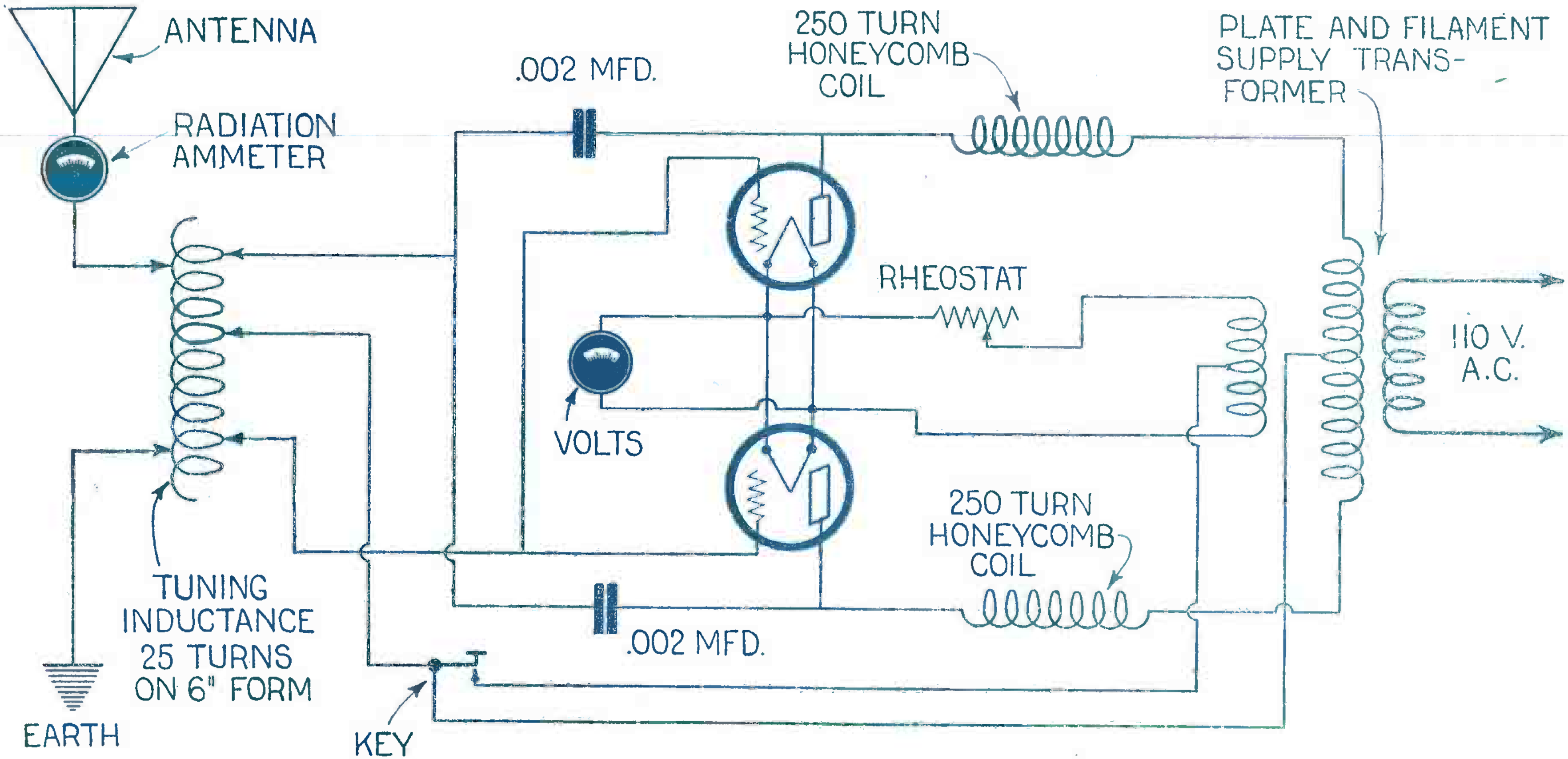
Hartley Circuit Employing Full Wave Self-Rectification



It has been thought advisable to include a circuit suitable for five or fifty watt pliotrons using full wave self-rectification of the A. C. plate supply, raised to the proper potential by means of a standard plate supply transformer which also carries a filament supply winding. While this circuit, due to its A. C. supply, is not recommended for cities or congested districts, it has proven very satisfactory in less populated communities where the slight A. C. hum is not objectionable.

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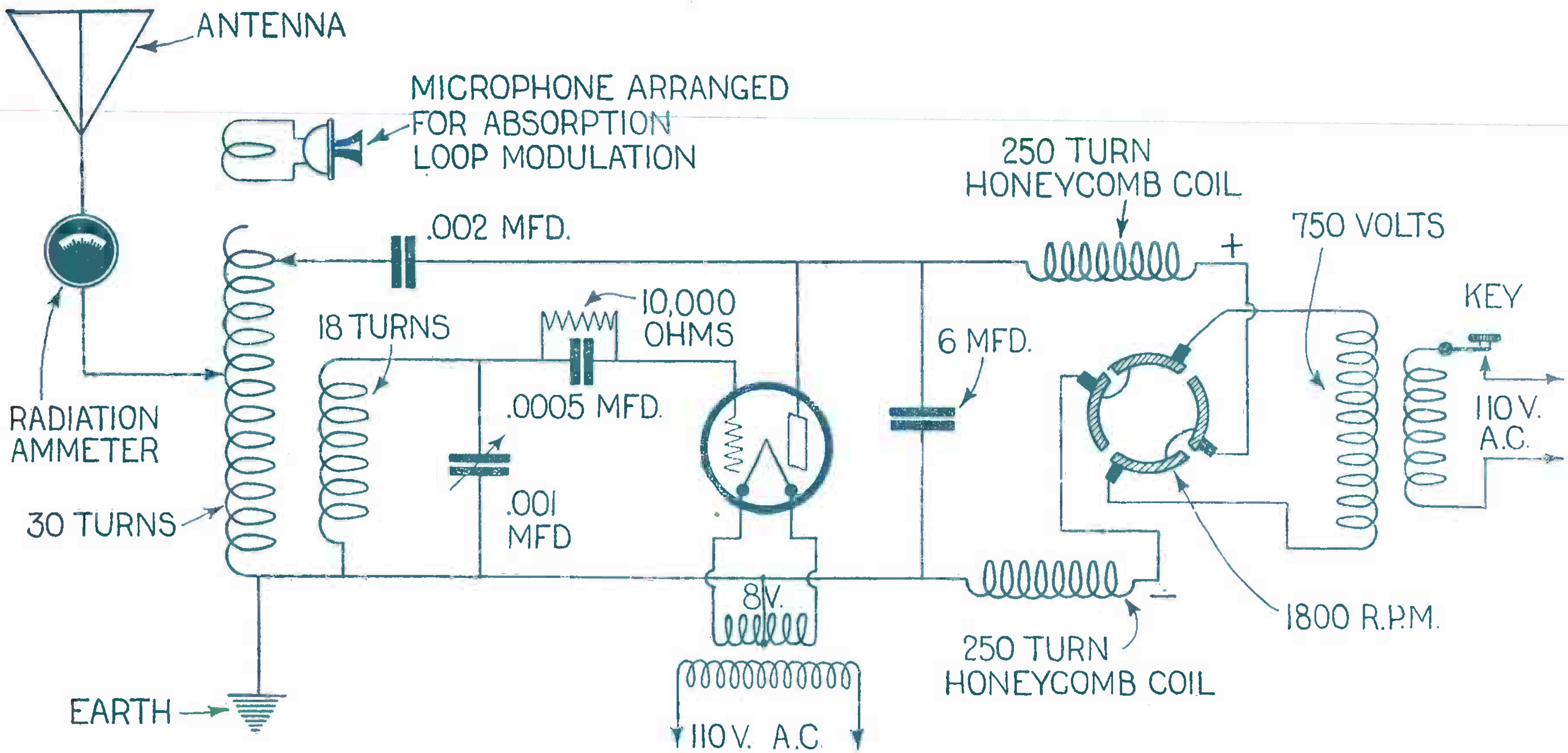
Five Watt C.W. Transmitter with Synchronously Rectified A.C. Plate Supply Source



Much long distance work of late has been accomplished through the use of synchronously rectified alternating current of commercial frequencies as a source of plate potential. This scheme is rapidly gaining in favor and is gradually replacing the messy and inefficient chemical rectifiers. The construction of a four segment rectifier is extremely simple and merely consists of an insulating drum or rotor mounted on the shaft of a small motor and arranged with brushes placed in the relative positions indicated in the diagram. A very pleasing note is produced by this means and high efficiency attained.

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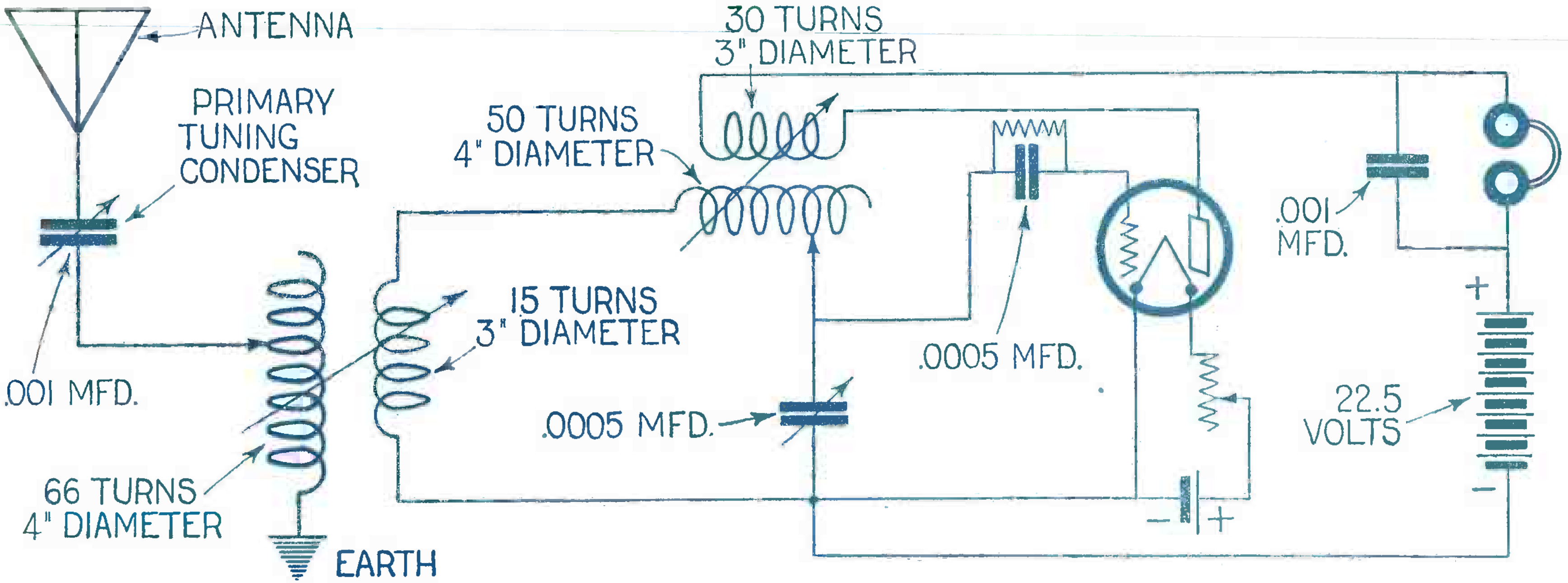
Navy Standard Regenerative Receiving Circuit



What is probably one of the most stable and satisfactory of the regenerative receiving circuits, and probably the least known, is the Navy Standard two circuit receiver employing the tickler feed-back principle. Such a circuit offers a good degree of selectivity with a minimum of apparatus and is quickly and easily adjusted to the desired frequencies. It is equally effective on both amateur and broadcast reception and by use of the proper values of inductance capacity will respond efficiently to any wave length in use today. Constants suitable for 150-650 meter reception are indicated in the diagram above.

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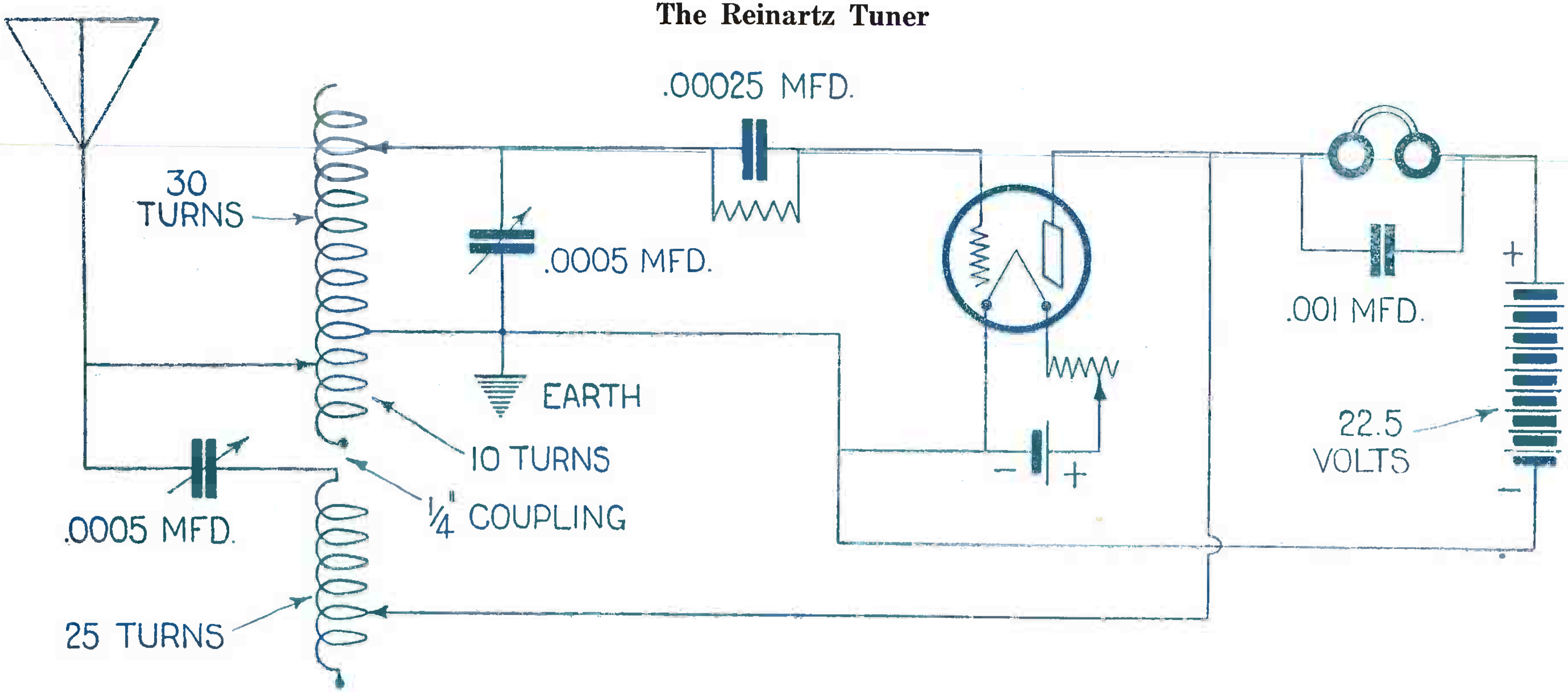
The Reinartz Tuner



Among amateurs using C. W. transmission, it is generally conceded that the Reinartz receiving circuit is to date the ideal C. W. receiver for all around use. This is nothing more than a combination of the tuned plate and tickler feed-back circuits but is one which produces remarkable results with a minimum of tuning controls. The case of operation and lack of body capacity are of especial benefit in tuning quickly to the elusive whistles of C. W. transmitters. The circuit and all constants for Reinartz tuner to cover a wave range of from 150 to 450 meters appear above. To reach the higher wave-lengths of broadcasting stations and even the 600 meter commercial transmissions, it is merely necessary to add twenty-five turns to the antenna inductance. This will raise the fundamental minimum of the circuit slightly, due to added capacity effects but not to the extent where it is objectionable from the viewpoint of average amateur operations.

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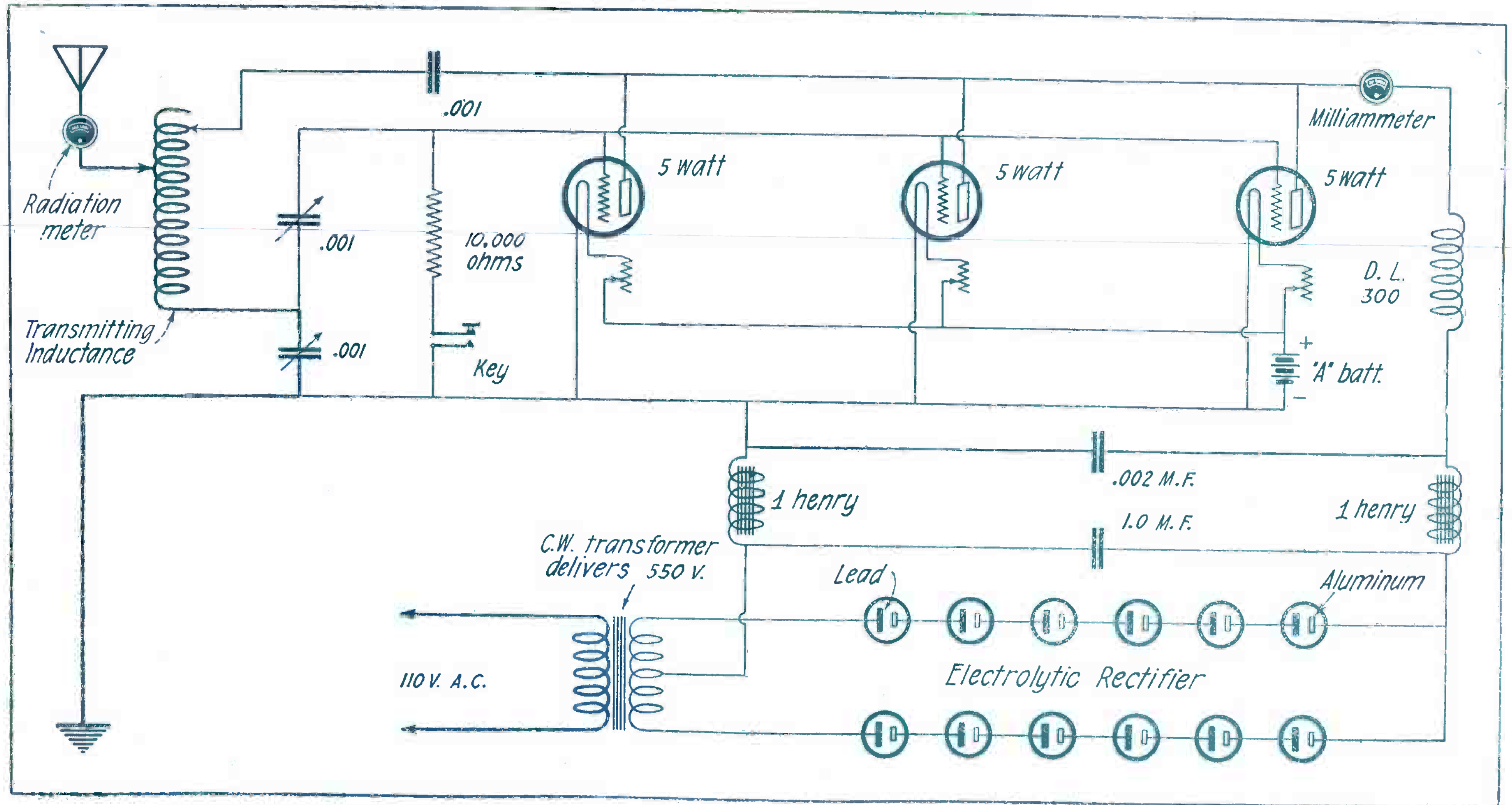
A 15 Watt C. W. Transmitter



An exceptionally stable and easily operated C. W. transmitter may be connected up as shown herewith. A Standard C. W. transformer delivering 550 volts is used in connection with a 12 jar electrolytic rectifier. Any standard make of apparatus would give very good results in this circuit and in connecting it up care should be taken to see that the aluminum plates of the rectifier are connected to the plate circuit of the tubes.

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Radio Amateur's Practical Design Data

IN the preparation of this collection of data and information, compiled by HOWARD S. PYLE,* and the Staff of Radio News Magazine, the thought constantly uppermost in the minds of the publishers, was to present, in clear, understandable form, the most popular C. W. transmitting and receiving circuits together with the necessary tables and data to enable the amateur to intelligently handle his equipment and get the most from it.

¶ Intelligent operation of an amateur station does not mean the throwing together of some standard circuit with the parts on hand, with no idea of the value of the capacities, inductances and resistances entering into the complete assembly. True, such haphazard methods work, in nine cases out of ten, if the radiation ammeter may be considered an indication, but the gain in efficiency—in actually knowing that each part is performing its function to its greatest possible efficiency, gives an added zest to the actual operations and a higher standing among his fellows to the amateur who KNOWS his station.

¶ It has been made simple, through the use of the accompanying tables and formulae as well as circuit diagrams, for the amateur to select the circuit best suited to his purpose and to intelligently build up, step by step, a really efficient amateur station, measuring his various units as they enter into the construction and finally posting such data in convenient form by means of the chart provided.

¶ The advantages of such systematic methods are obvious and it is with the desire to further the cause of better amateur radio that the accompanying data is offered.

THE PUBLISHERS.

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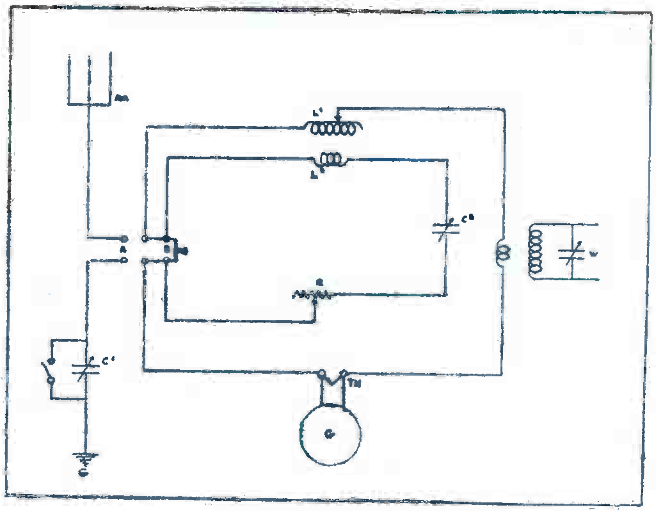
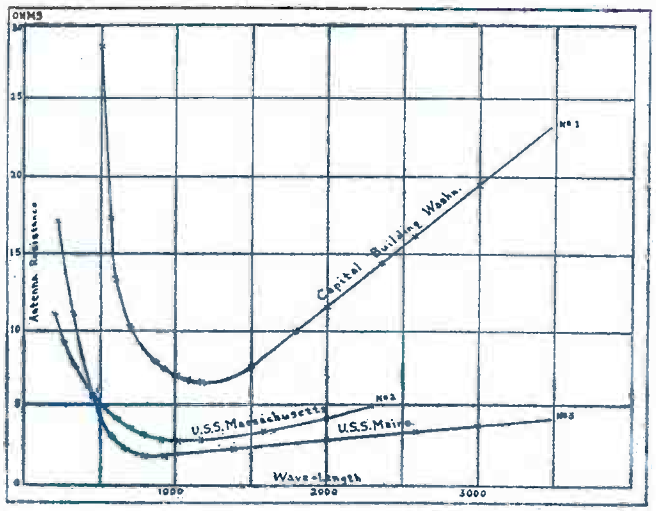
Measurement of Antenna Resistance

(Method described by Bu. Standards Bul. Vol. 9—L. W. Austin.)

Substitution Method





L_1 —Tuning inductance.

C_1 —Variable air condenser for obtaining wave lengths below fundamental.

Th —Thermo element.

G —Galvanometer.

C_2 —Variable air condenser set at capacity of antenna to be measured.

L_2 —Small inductance to represent antenna inductance. (This has little influence on results and may be omitted.)

R —Resistance inserted in dummy antenna circuit to reduce current in this circuit to same value as obtained with antenna connected.

W —Wave meter, or other form of exciting circuit.

The apparatus required and circuits employed are shown by above diagram. The method in brief, is the substitution of an air condenser in place of the antenna and ground, keeping the inductance common to both circuits and introducing resistance in the dummy antenna circuit until the current becomes the same as that obtained with the antenna and ground connected. When this is accomplished the antenna resistance at the wave length used is the same as the inserted resistance R.

EXAMPLE.

Set wave meter or driver (W) to desired wave length and with antenna and ground connected (switch thrown to position "A") tune with L_1 until resonance is reached. (This being indicated by maximum deflection of G.) If wave length is below fundamental it will be necessary to open switch shorting C_1. Now throw switch to B and vary C_2 until resonance is reached. Compare galvanometer deflections with switch thrown to A and B and insert resistance at R until deflection is the same with switch in either position. The resistance of the antenna for the wave length used is the same as the inserted resistance.

Proceed in the same way until the antenna resistance is obtained on enough wave lengths to allow a curve to be drawn similar to those shown above.

Above measurements should be made when there is no static and when receiving conditions are good.

It will be found that beginning with short wave lengths, antenna resistance falls rapidly until a wave length not quite twice the fundamental is reached. From this point the antenna resistance increases slowly if the ground resistance is low (Curves 2 and 3), and rapidly if it is high. (Curve 1). The antenna resistance of a land station varies due to changing ground conditions.

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Measurement of Antenna Inductance and Efficiency Capacity

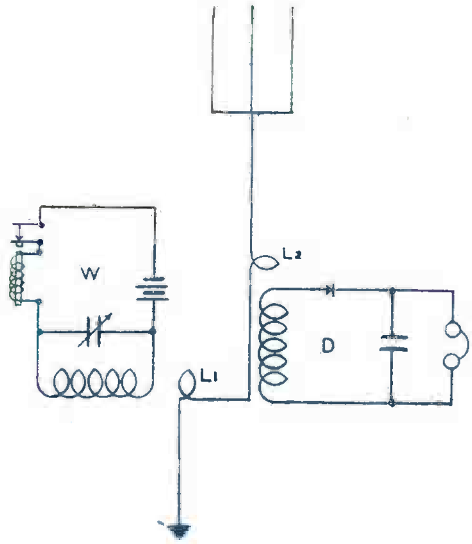

FIG. 1

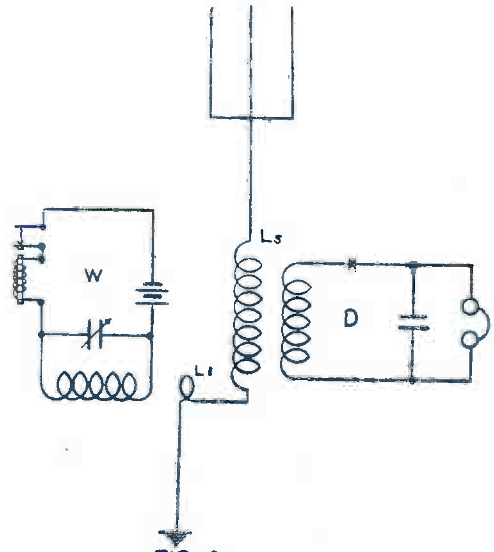

FIG 2

W—Wavemeter or driver.
L_1 L_2—Coupling coils.
L_s—Known inductance connected in series with antenna.
D—Aperiodic detector circuit.

The apparatus required and the circuits employed are shown by figures 1 and 2 above. Wavemeter and detector circuit inductances should be placed at right angles to each other to prevent the transfer of energy except through antenna circuit. After connections have been made as shown in Figure 1, start buzzer and tune wavemeter W until maximum strength of signals is obtained in telephones. As loose a coupling as possible should be used. When maximum signals are obtained note the wavelength.

Next insert a known inductance L_s which should be large enough to increase the fundamental wavelength four times) in series with the antenna, and obtain the wavelength of the antenna with this inductance inserted in the same way as outlined above.

Next by formula (1) below find the LC values for the two wavelengths just obtained.

where:

(1) $$LC = \frac{\lambda^2}{k^2}$$

LC = Oscillation constant.
k = 59.6 if inductance in centimeters.
k = 1882 if inductance in microhenries.

The capacity of the antenna can now be obtained by the following formula (2):

where:

(2) $$C_a = \frac{LC_s}{L_s}$$

LC_s = Oscillation constant of wavelength obtained with L_s in series with antenna.
L_s = Value of series inductance.

The inductance of the antenna can now be found by dividing the LC constant obtained with no inductance in series with the antenna by the capacity of the antenna. Formula (3).

where:

(3) $$L_a = \frac{LC_f}{C_a}$$

L_a = Inductance of antenna.
LC_f = Oscillation constant for fundamental wavelength of antenna.
C_a = Capacity of antenna.

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Measurement of Effective Antenna Capacity

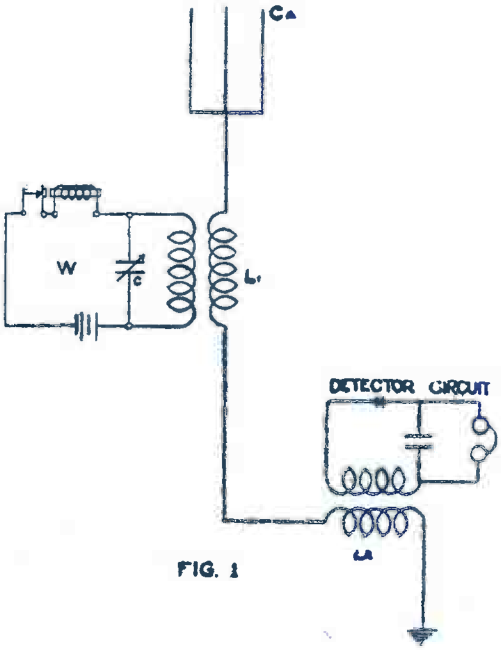

FIG. 1

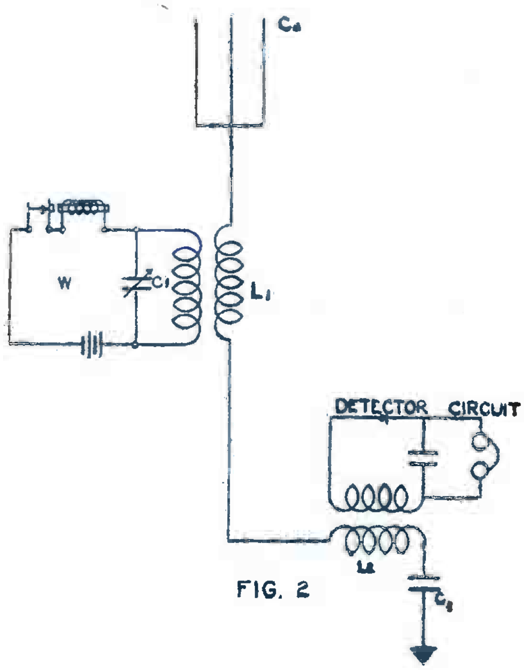

FIG. 2

L_1 L_2—Coupling coils.

W—Wavemeter or driver.

C_s—Condenser inserted in series with antenna.

METHOD (a)

The apparatus required and the circuits employed are shown by figures 1 and 2 above. To obtain the effective capacity of the antenna, vary the wavelength of W (Fig. 1) until maximum strength of signals is obtained in telephones connected to detector circuit. Note wavelength.

Next insert a known capacity C_s in series with the antenna (Fig. 2) and obtain the wavelength in the same way as outlined above. Note this wavelength. (The condenser inserted in series with the antenna must be of such size that it does not make over ten per cent. difference in the wavelength.) The capacity of the antenna may now be obtained by the following formula:

$$C_a = \frac{C_s\,(\lambda^2 - \lambda_1^2)}{\lambda_1^2}$$

where:

C_a = Capacity of antenna.
C_s = Capacity of series condenser (Fig. 2).
λ = Wavelength without condenser in series with antenna.
λ_1 = Wavelength with condenser in series with antenna.

METHOD (b)

The procedure is exactly the same as with method (a) except that instead of using the wavelength of the driver circuit W, the capacity of the condenser is noted. This allows the effective capacity of an antenna to be measured when a calibrated variable condenser is available by means of the following formula:

$$C_a = \frac{C_s\,(C - C_1)}{C_1}$$

where:

C_a = Capacity of antenna.
C_s = Capacity of series condenser (Fig. 2).

C = Capacity of driver condenser W when driver circuit is in resonance with antenna circuit. (Fig 1.)
C_1 = Capacity of driver condenser W when resonance is obtained with series condenser C_s is in circuit. (Fig. 2.)

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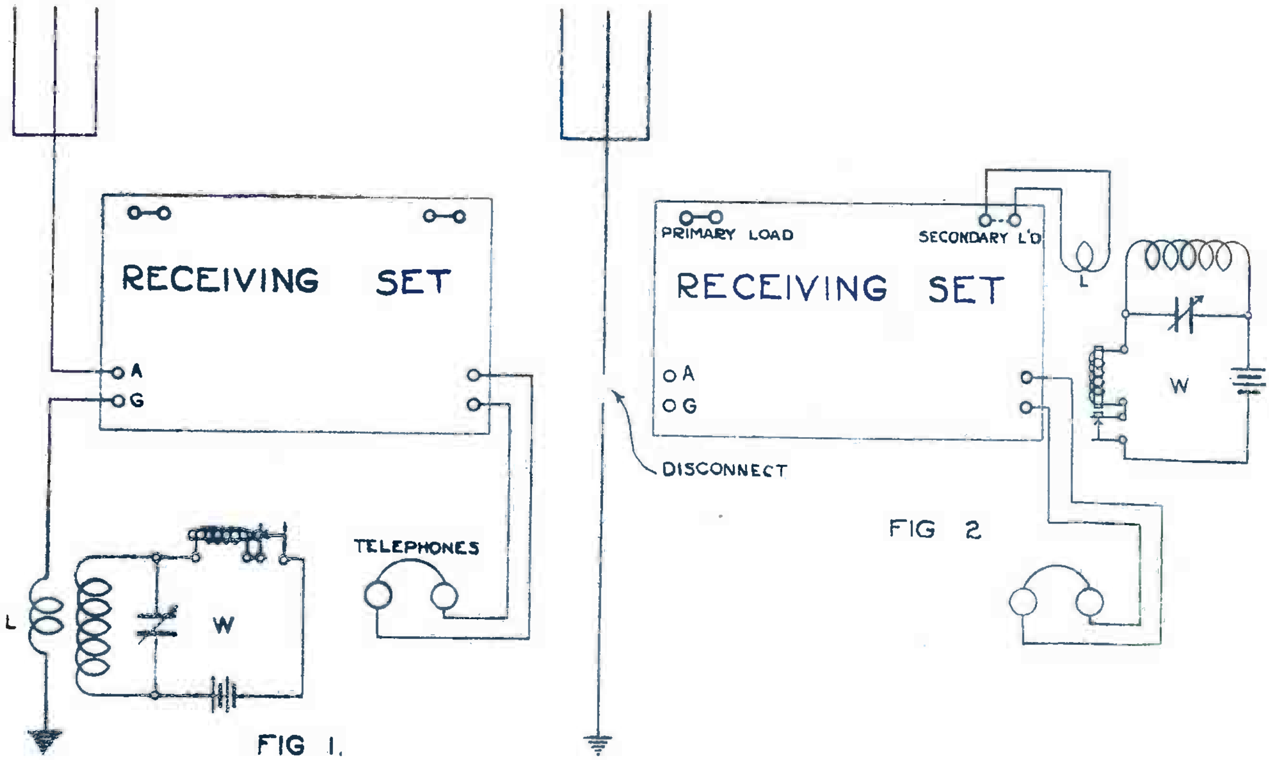
Measurement of Wavelength of Distant Transmitting Station
Calibration of a Receiving Set



W—Wavemeter or driver.
L—Coupling coil of one or two turns.

MEASUREMENT OF WAVELENGTH OF DISTANT TRANSMITTING STATION

The apparatus required and the circuits employed are shown by figure 1 above. To obtain wavelength, first, using as loose coupling as possible, tune in signal on receiving set, next start buzzer connected to wavemeter (W) and adjust wavemeter until the maximum strength of signals is obtained in telephones connected to receiver. The wavelength of the wavemeter (W) is now the same as that used by the distant station.

CALIBRATION OF RECEIVING SET

First set up wavemeter so it will excite secondary (Fig. 2) of receiver. One or two small turns may be connected in series with secondary if wavemeter cannot be conveniently placed to excite it otherwise. Loosen coupling between primary and secondary of receiver as much as possible and set primary switches to shortest wavelength. Next adjust wavemeter to the lowest wavelength the receiver is designed for, and after starting buzzer, tune the secondary of the receiver until the maximum strength of signals is obtained in the telephones, which will be obtained when the receiver secondary is adjusted for the same wavelength as the wavemeter is tuned for. Note adjustment of receiver secondary when this has been accomplished and then increase wavelength setting of wavemeter by about 20 meters. Tune this wavelength in on the secondary and note adjustment. Continue in this way until you have the adjustment for every twenty meters over the entire range of the receiver. When you have accomplished this, plot your results on a piece of cross section paper.

When the secondary has been calibrated, the primary can be calibrated by using the circuit shown in Figure 1. From the table previously tabulated adjust secondary for lowest wavelength, and adjust wavemeter for the same wavelength. Now using a loose coupling tune primary until maximum strength of signals is obtained in telephones attached to receiver. Wavemeter, primary of receiver and secondary of the receiver are now all adjusted to the same wavelength. Continue in this way, noting setting of primary each time, until you have covered wavelength range of receiver again. A calibration curve for the primary can then be drawn similar to the one for the secondary.

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Measurement of Fundamental Wavelength of Antenna
Three Methods

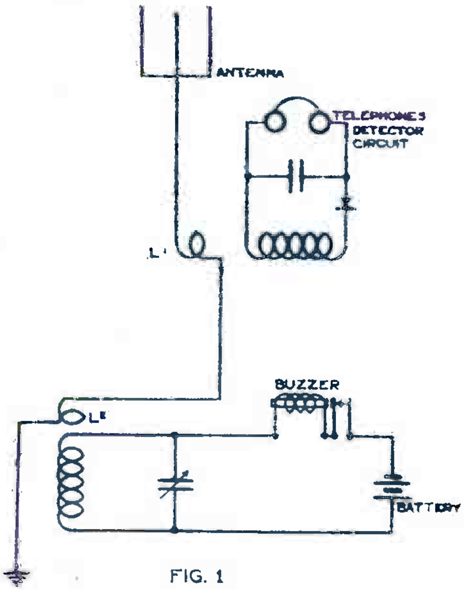

FIG. 1

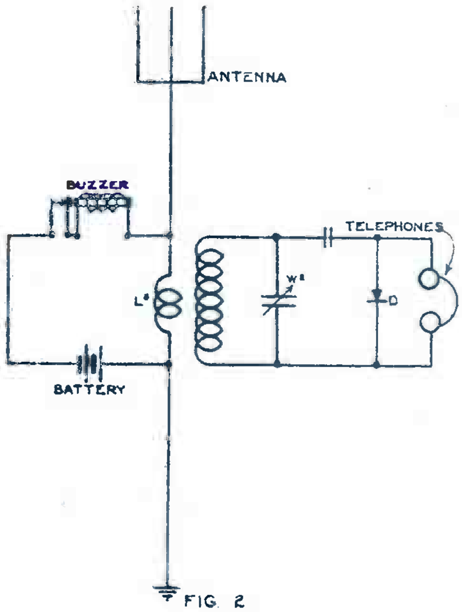

FIG. 2

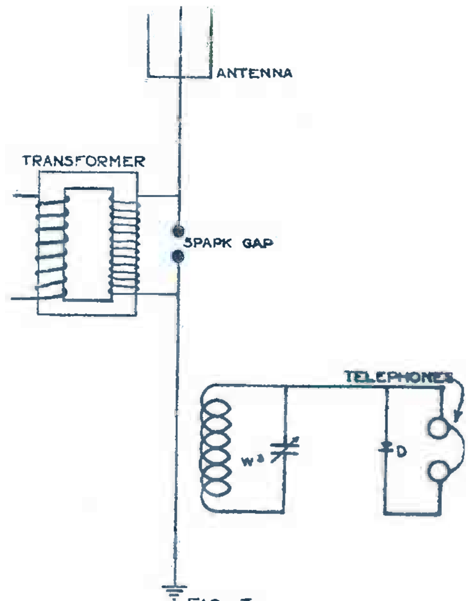

FIG. 3

(a) Buzzer excitation.

(b) Buzzer excitation.

(c) Spark excitation.

W_1—Wavemeter used as driver. (Fig. 1.)

W_2—Wavemeter used as detector circuit (Fig. 2).

W_3—Wavemeter used as detector circuit with detector connected unilaterally (Fig. 3).

L_1 L_2—Small loops used for coupling.

L_3—Small inductance of 1 or 2 turns.

(a) BUZZER EXCITATION

The apparatus required and the circuits employed are shown by Figure 1. Care must be taken that coils of wavemeter and detector circuits are placed so that no energy is transferred from one to the other except via loops L_1 and L_2 and the antenna circuit.

To measure the wavelength of antenna, start the buzzer and then tune wavemeter until maximum signals are obtained in the detector circuit.

(b) BUZZER EXCITATION

The apparatus required and the circuits employed are shown by Figure 2. A battery and buzzer are connected across a small series inductance of one or two turns L_3 and the wavemeter is used as a detector circuit to measure the wavelength. The error due to the inductance L_3 is small and can be neglected.

(c) SPARK EXCITATION

Connect antenna and ground to two sides of a plain open gap (Fig. 3) which is supplied with current from secondary of power transformer. Condenser and oscillation transformer must be disconnected from the circuit. Use wavemeter as a detector circuit to measure wave length.

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Measurement of Inductance of a Coil or Circuit

(Two Methods)

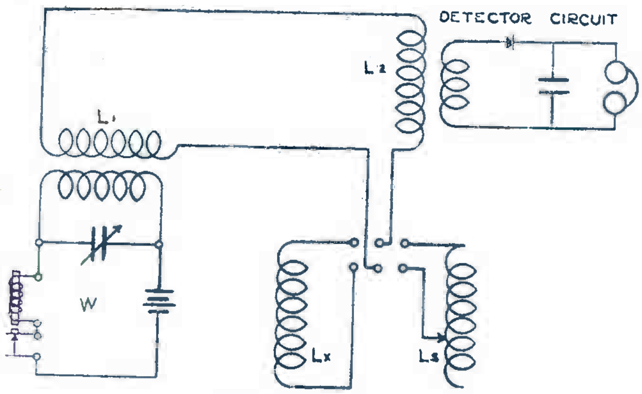

FIG. 1

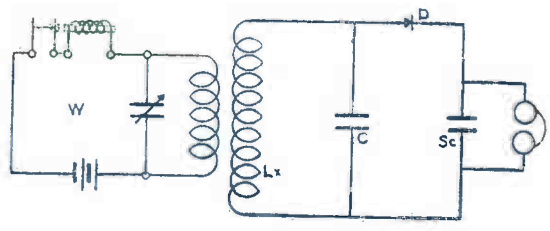

FIG. 2

W—Wavemeter or driver.
L_s—Calibrated variable inductance.
L_x—Inductance to be measured.
L_1 L_2—Coupling coils.
S_c—Stopping Condenser.

(a) SUBSTITUTION METHOD

The apparatus required and the circuits employed are shown by Fig. 1. To obtain inductance of L_x start buzzer and with switch thrown so as to connect L_x in circuit tune wavemeter until maximum strength of signals is obtained in telephones connected to detector circuit. Next without disturbing the rest of the circuit throw switch so as to disconnect L_x and to connect L_s in circuit. Now vary the inductance of L_s until maximum strength of signals is again obtained in telephones. Inductance of L_s now equals L_x and as the inductance of L_s is known you have the inductance of L_x. L_s is generally a variometer, or a variable inductance consisting of two rollers, one of metal and the other of an insulating material, with means for winding wire from one to the other to obtain a continuous variation of inductance.

(b) BY CALCULATION

The apparatus required and the circuits employed are shown by Fig. 2. To obtain inductance, start buzzer and tune wavemeter until maximum strength of signals is obtained in telephones. Let λ represent the wavelength obtained at this point. The inductance of L_x can can now be calculated by the following formula:

$$L_x = \frac{LC}{C}$$

where:

LC = Oscillation constant of λ.
C = Capacity in microfarads of C, Fig. 2.

If no tables giving oscillation constant are available the inductance can be calculated by this formula:

$$L_x = \frac{\lambda^2}{k^2 C}$$

where:

k = 59.6 if inductance in centimeters.
k = 1882. if inductance in microhenries.

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Measurement of Capacity

Substitution Method

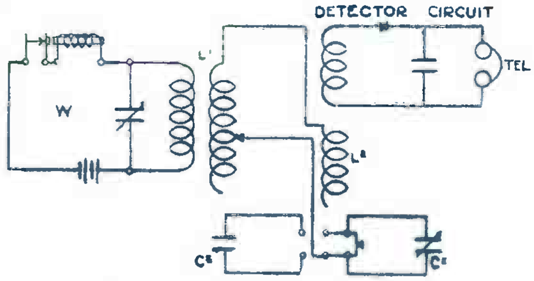


FIG. 1

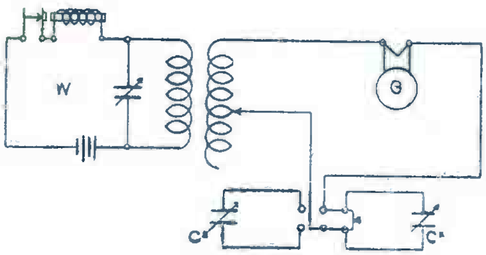
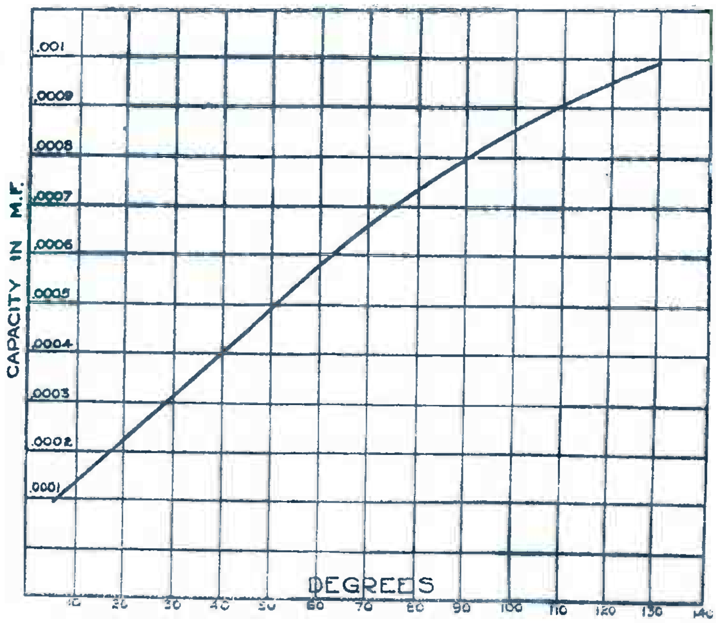


FIG. 2



L_1—Variable inductance.

L_2—Coupling coil.

C_s—Standard calibrated variable condenser.

C_x—Capacity to be measured.

G —Galvanometer and thermo element.

W—Wavemeter or driver.

The apparatus required and the circuits employed are shown by Figures 1 and 2 above. The principle of determining the capacity is the same in both figures, but different methods are employed to determine when the circuits are in resonance. In Figure 1 a detector and telephone receivers are employed; in Figure 2 a thermo element with a galvanometer.

To determine capacity of C_x start buzzer connected to wavemeter and with switch thrown so as to cut C_x in circuit, vary wavelength emitted by wavemeter until maximum strength of signals (Fig. 1) is obtained in telephone receivers, or a maximum deflection (Fig. 2) is obtained on galvanometer. When this has been accomplished, without disturbing the rest of the circuit, throw switch so as to disconnect C_x and connect C_s in circuit. Now vary capacity of C_s until maximum strength of signals or maximum deflection is obtained again. The capacity of C_s now equals the capacity of C_x and as the capacity of C_s is known, you have the capacity of C_x for this setting.

If C_x is a variable condenser you desire to calibrate, the capacity for every ten degrees of scale should be obtained by the method just outlined, and the resulst plotted on cross-section paper. An example of a calibration curve is shown above.

Note.—In the circuit shown in Figure 1 care must be taken to place the coils far enough apart and in such positions that there will be no direct transfer of energy from the driver to the detector circuit.

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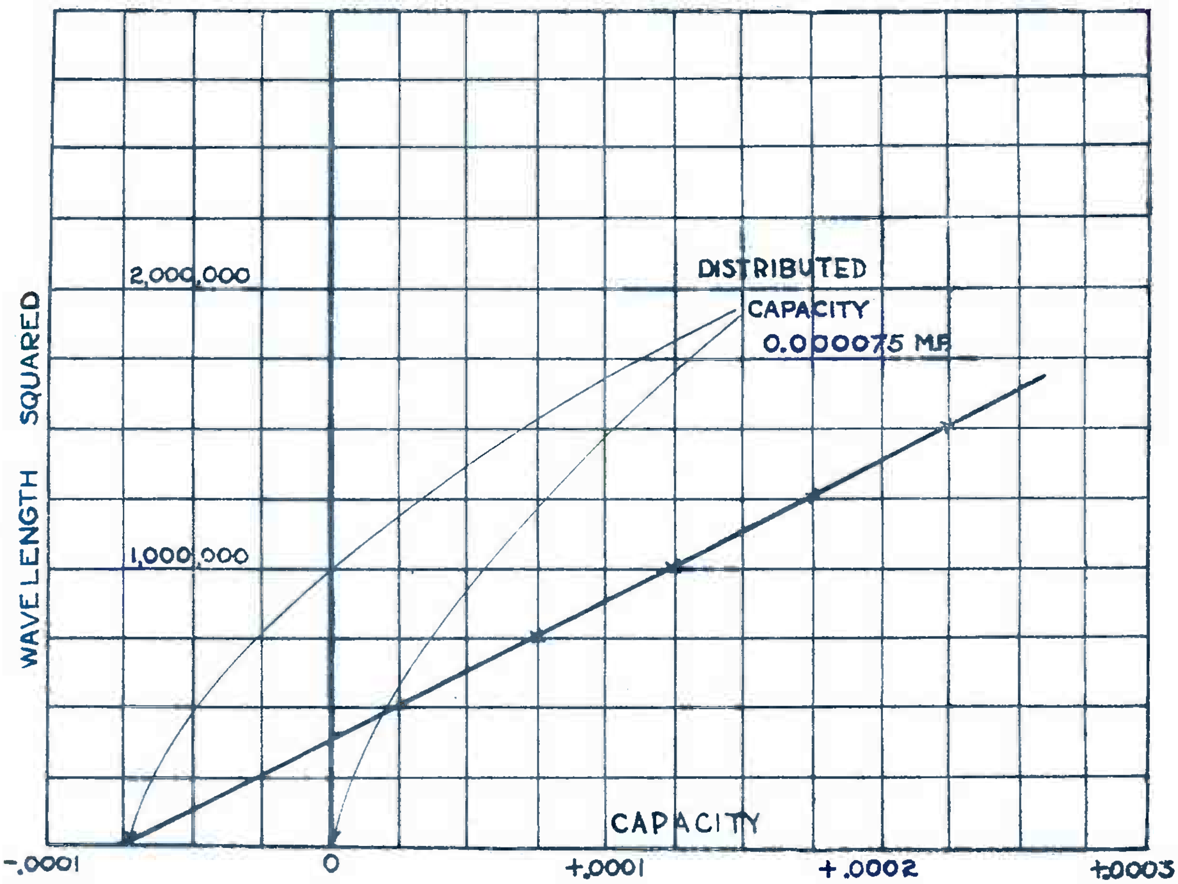
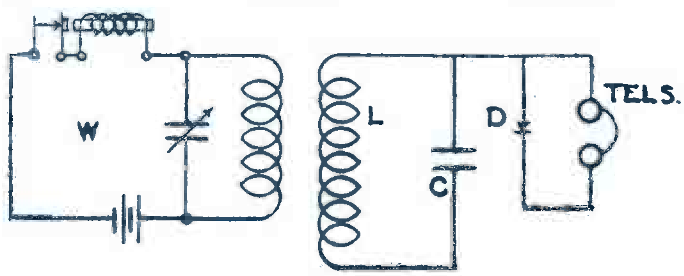
Measurement of Distributed Capacity of an Inductance





W—Wavemeter or other form of driver.
L—Inductance being measured for distributed capacity.
C—Calibrated variable condenser.
D—Detector.

The apparatus required and the circuits employed are shown by the above diagram. To obtain the distributed capacity of L, take wavemeter readings with a number of different values of C. Plot these readings against the wavelength squared on a piece of cross-section paper. (See example above. The result will be practically a straight line. Continue this line to the negative value of C, which negative value of C will be the distributed capacity of the inductance under test.

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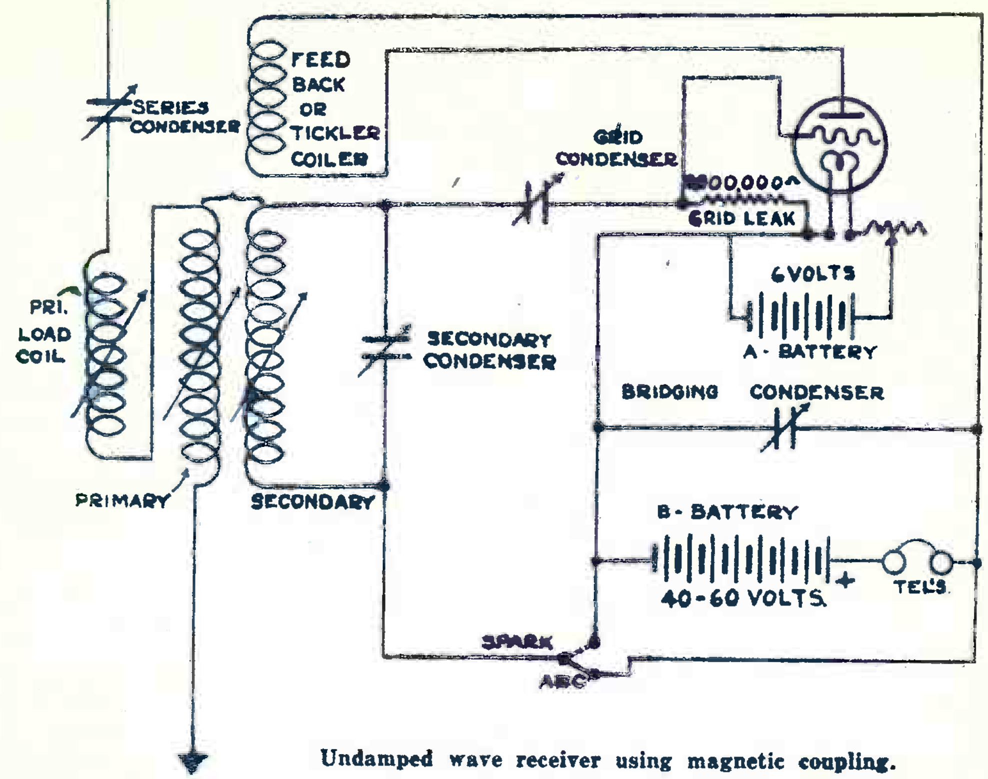
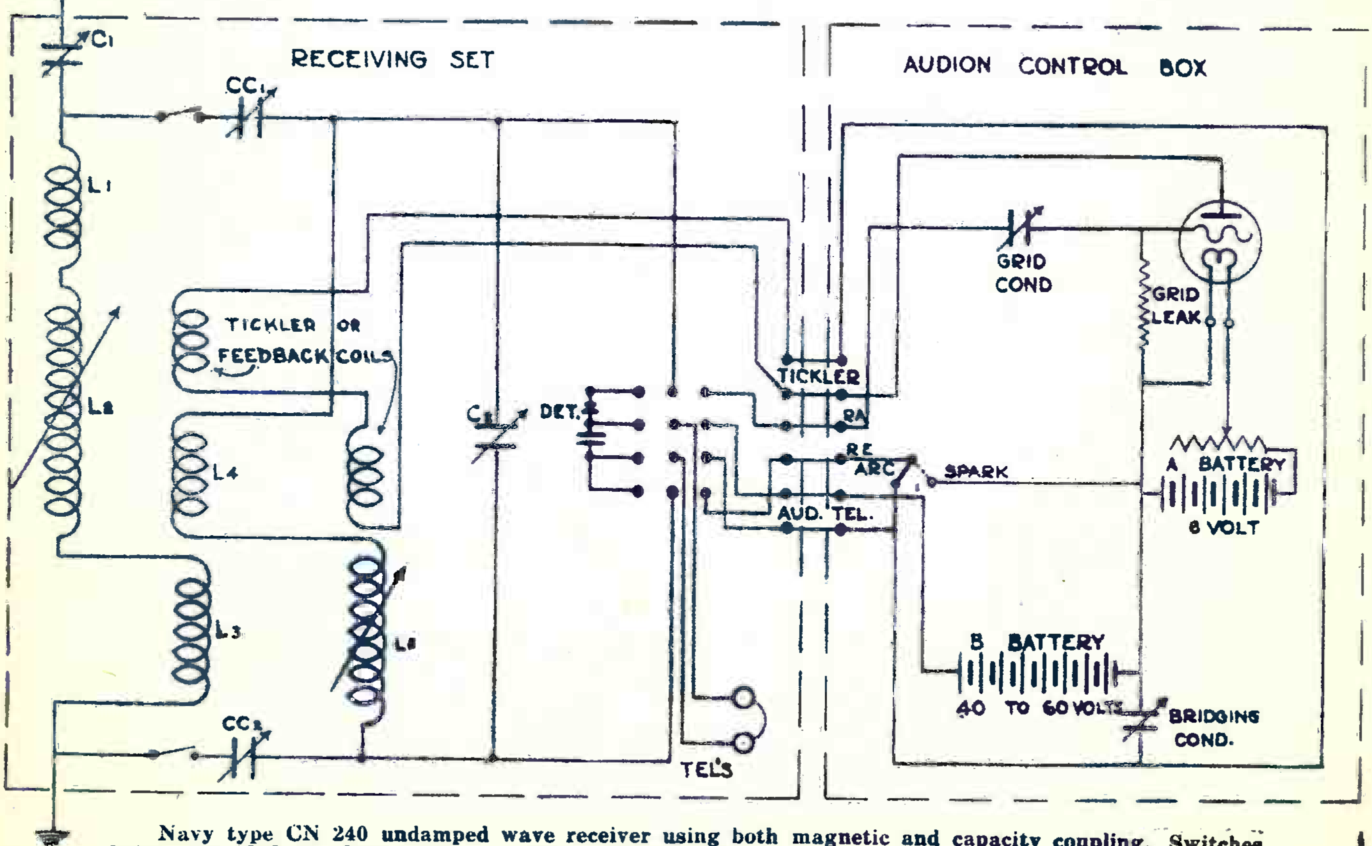
Undamped Wave Receiver Diagrams



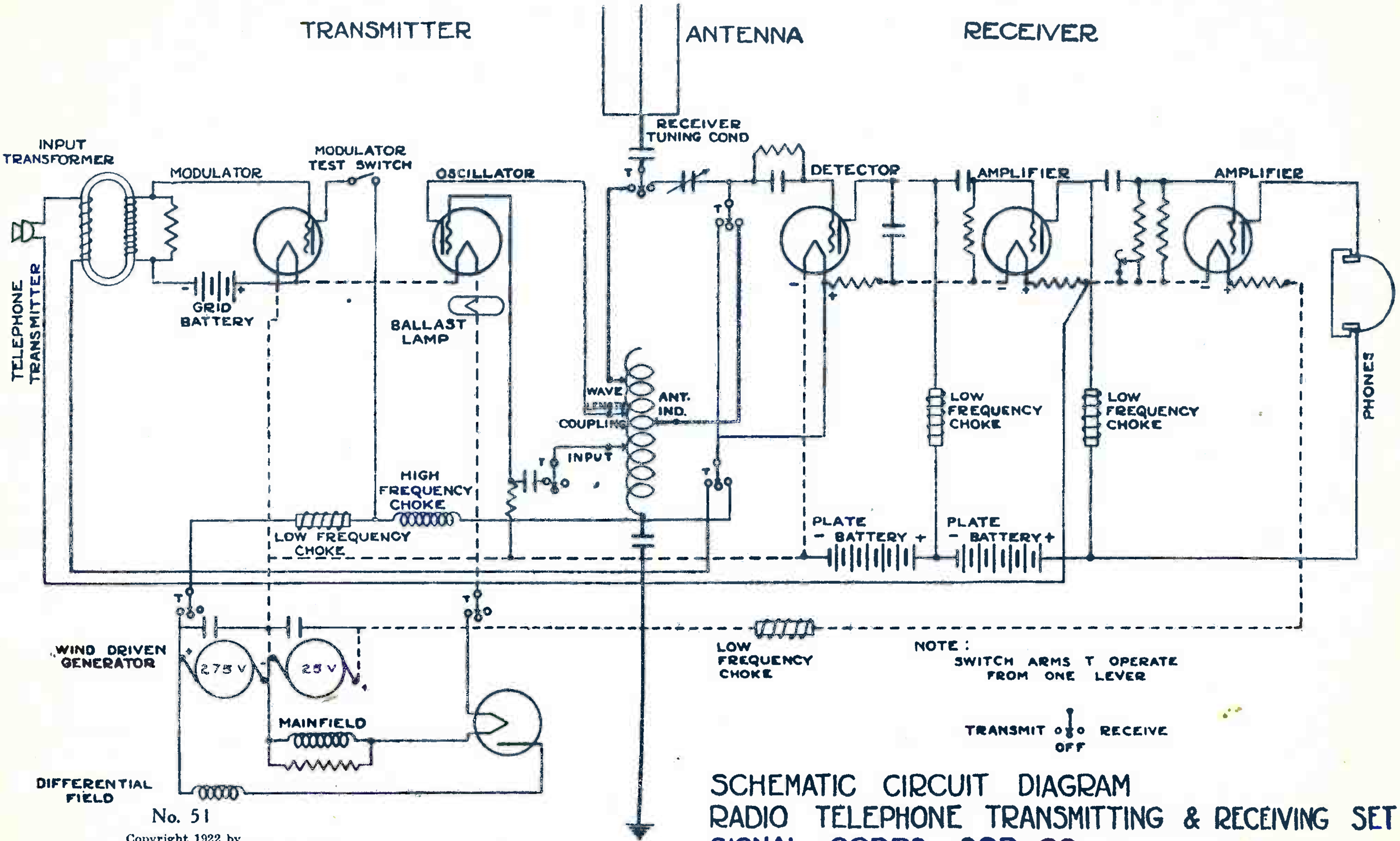
Undamped wave receiver using magnetic coupling.



Navy type CN 240 undamped wave receiver using both magnetic and capacity coupling. Switches being provided to disconnect capacity coupling when coupling condenser set at zero degrees.

Constants of Navy Type CN 240 Receiver

$C_1 = 0.005$ mf.
$L_1 = 8.5$ milli-henries
$L_2 = 21.5$ " "
$L_3 = 1.$ " "
$L_4 = 1.1$ milli-henries
$L_5 = 20.0$ " "
$C_3 = 0.0018$ mf
CC_1-$CC_2 = 0.0008$ mf



SCHEMATIC CIRCUIT DIAGRAM
RADIO TELEPHONE TRANSMITTING & RECEIVING SET
SIGNAL CORPS SCR-68

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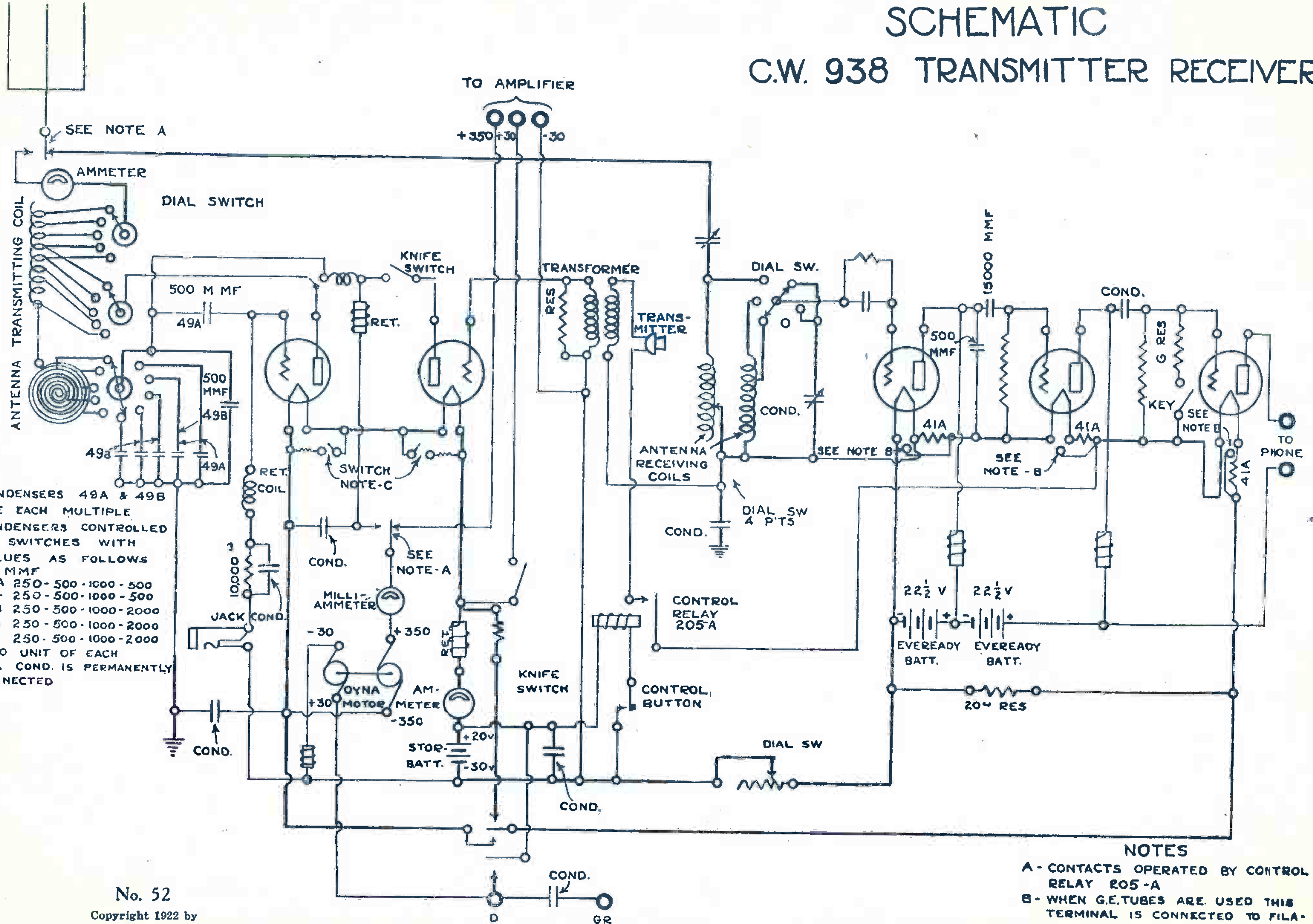
SCHEMATIC
C.W. 938 TRANSMITTER RECEIVER



CONDENSERS 49A & 49B ARE EACH MULTIPLE CONDENSERS CONTROLLED BY SWITCHES WITH VALUES AS FOLLOWS IN MMF

49A 250-500-1000-500
- 250-500-1000-500
49a 250-500-1000-2000
- 250-500-1000-2000
- 250-500-1000-2000

1-500 UNIT OF EACH 49A COND. IS PERMANENTLY CONNECTED

NOTES

A - CONTACTS OPERATED BY CONTROL RELAY 205-A

B - WHEN G.E. TUBES ARE USED THIS TERMINAL IS CONNECTED TO FILAMENT OF TUBE THEREBY SHORTING 41-A RESISTANCE.

C - WHEN CW 931 TUBES ARE USED THIS SWITCH IS CLOSED

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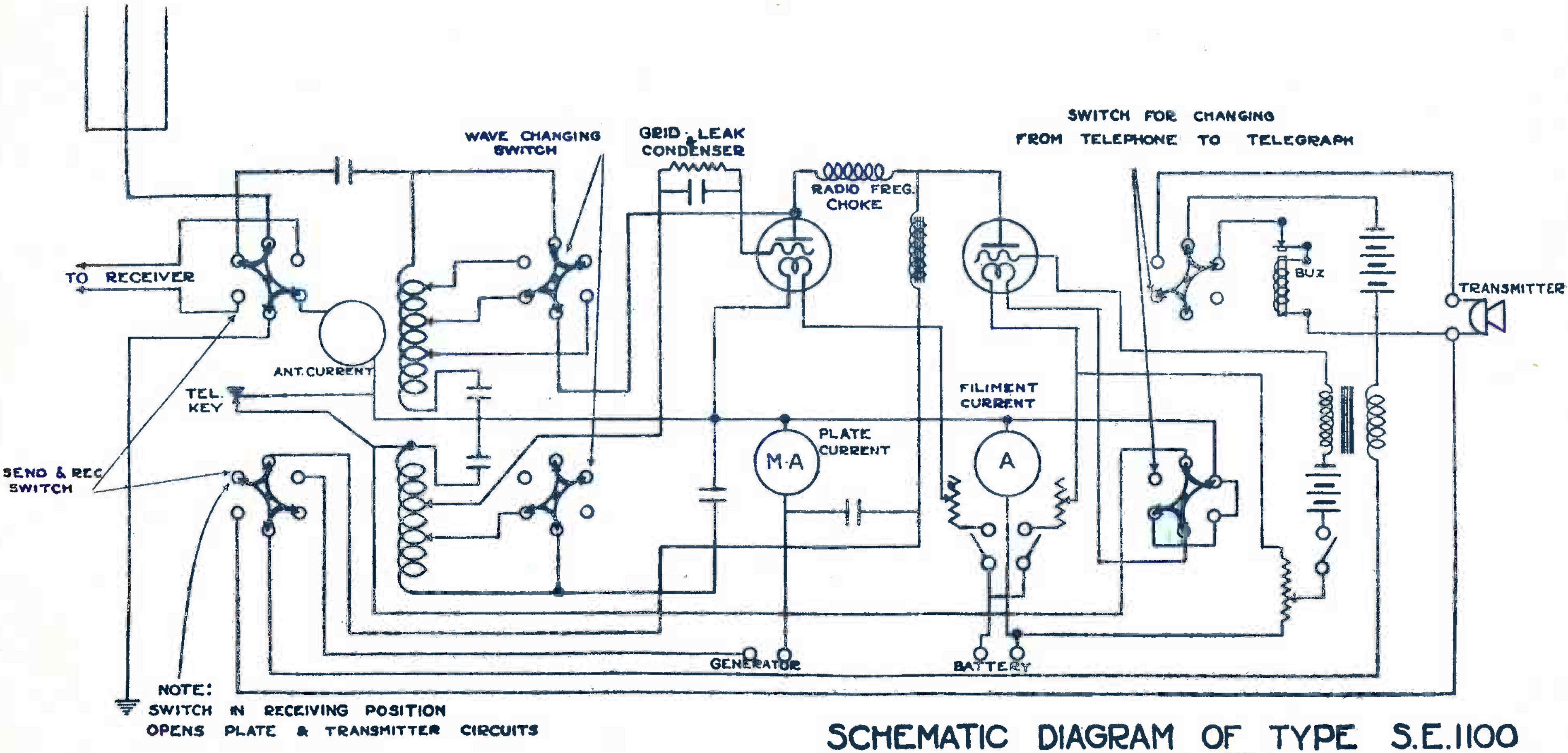

SCHEMATIC DIAGRAM OF TYPE S.E.1100 (NAVY FLYING BOAT) TELEPHONE & TELEGRAPH TRANSMITTER

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Table Giving Oscillation Constant and Frequency, for Wavelengths Between 200 and 20,000 Meters

L C in Microhenries and Microfarads

Meters	n	L C	Meters	n	L C	Meters	n	L C	Meters	n	L C
200	1,500,000	0.01129	1000	300,000	0.2816	1800	166,670	0.9120	8000	37,500	18.0
210	1,428,500	0.01239	1010	297,030	0.2870	1810	165,750	0.9224	8100	37,040	18.5
220	1,364,000	0.01362	1020	294,120	0.2927	1820	164,840	0.9327	8200	36,590	18.9
230	1,304,200	0.01490	1030	291,260	0.2986	1830	163,940	0.9425	8300	36,140	19.4
240	1,250,000	0.01624	1040	288,450	0.3045	1840	163,040	0.9530	8400	35,710	19.9
250	1,200,000	0.01755	1050	285,710	0.3105	1850	162,220	0.9634	8500	35,290	20.3
260	1,153,800	0.01901	1060	283,000	0.3161	1860	161,290	0.9741	8600	34,880	20.8
270	1,111,000	0.02052	1070	280,370	0.3222	1870	160,430	0.9844	8700	34,480	21.3
280	1,071,300	0.02209	1080	277,780	0.3283	1880	159,580	0.9948	8800	34,090	21.8
290	1,034,300	0.02372	1090	275,230	0.3345	1890	158,730	1.0056	8900	33,710	22.3
300	1,000,000	0.02530	1100	272,730	0.3404	1900	157,890	1.0164	9000	33,330	22.8
310	967,700	0.02704	1110	270,270	0.3467	1910	157,060	1.0265	9100	32,970	23.3
320	937,500	0.02884	1120	267,850	0.3531	1920	156,300	1.0375	9200	32,610	23.8
330	909,100	0.03069	1130	265,480	0.3595	1930	155,440	1.0485	9300	32,260	24.3
340	882,400	0.03250	1140	263,150	0.3660	1940	154,630	1.0597	9400	31,910	24.9
350	859,100	0.03446	1150	260,860	0.3721	1950	153,840	1.0706	9500	31,590	25.4
360	833,300	0.03648	1160	258,610	0.3787	1960	153,060	1.0811	9600	31,250	25.9
370	810,800	0.03856	1170	256,400	0.3853	1970	152,280	1.0923	9700	30,930	26.5
380	789,500	0.04070	1180	254,230	0.3921	1980	151,510	1.1035	9800	30,610	27.0
390	769,200	0.04277	1190	252,100	0.3988	1990	150,750	1.1148	9900	30,310	27.6
400	750,000	0.04503	1200	250,000	0.4052	2000	150,000	1.1256	10000	30,000	28.1
410	731,700	0.04733	1210	247,930	0.4121	2100	142,850	1.2412	10200	29,410	29.3
420	714,300	0.04968	1220	245,900	0.4190	2200	136,360	1.3624	10400	28,845	30.4
430	697,700	0.05198	1230	243,900	0.4260	2300	130,430	1.4893	10600	28,300	31.6
440	681,800	0.05446	1240	241,930	0.4326	2400	125,000	1.6218	10800	27,780	32.8
450	666,700	0.05700	1250	240,000	0.4397	2500	120,000	1.7597	11000	27,275	34.0
460	652,200	0.05960	1260	238,090	0.4469	2600	115,380	1.9026	11200	26,785	35.3
470	638,300	0.06225	1270	236,220	0.4541	2700	111,110	2.0520	11400	26,315	36.6
480	625,000	0.06485	1280	234,370	0.4610	2800	107,140	2.2070	11600	25,860	37.9
490	612,200	0.06757	1290	232,560	0.4683	2900	103,450	2.3663	11800	25,425	39.2
500	600,000	0.07039	1300	230,760	0.4757	3000	100,000	2.533	12000	25,000	40.4
510	588,200	0.07327	1310	229,010	0.4831	3100	96,770	2.705	12200	24,590	42.0
520	576,900	0.07606	1320	227,270	0.4906	3200	93,750	2.883	12400	24,275	43.3
530	566,000	0.07903	1330	225,560	0.4978	3300	90,910	3.085	12600	23,860	44.4
540	555,600	0.08208	1340	223,870	0.5053	3400	88,240	3.255	12800	23,435	46.0
550	545,400	0.08518	1350	222,220	0.5130	3500	85,910	3.448	13000	23,075	47.6
560	535,700	0.08836	1360	220,590	0.5208	3600	83,330	3.648	13200	22,275	49.2
570	526,300	0.09141	1370	218,970	0.5281	3700	81,080	3.854	13400	22,390	50.4
580	517,200	0.09467	1380	217,390	0.5359	3800	78,950	4.065	13600	22,060	52.0
590	508,500	0.09803	1390	215,830	0.5438	3900	76,920	4.281	13800	21,740	53.2
600	500,000	0.1014	1400	214,380	0.5518	4000	75,000	4.500	14000	21,430	55.2
610	491,800	0.1047	1410	212,760	0.5598	4100	73,170	4.732	14200	21,125	56.8
620	483,700	0.1082	1420	211,260	0.5674	4200	71,430	4.966	14400	20,835	58.4
630	476,200	0.1117	1430	209,790	0.5755	4300	69,770	5.206	14600	20,550	60.0
640	468,700	0.1154	1440	208,340	0.5837	4400	68,180	5.451	14800	20,270	61.6
650	461,500	0.1188	1450	206,900	0.5919	4500	66,670	5.700	15000	20,000	63.2
660	454,500	0.1225	1460	205,470	0.5998	4600	65,220	5.956	15200	19,735	65.2
670	447,800	0.1263	1470	204,080	0.6081	4700	63,830	6.219	15400	19,480	66.1
680	441,200	0.1302	1480	202,700	0.6165	4800	62,500	6.486	15600	19,230	68.4
690	434,800	0.1341	1490	201,340	0.6250	4900	61,220	6.759	15800	18,990	70.4
700	428,600	0.1378	1500	200,000	0.6335	5000	60,000	7.038	16000	18,750	72.0
710	422,500	0.1419	1510	198,680	0.6416	5100	58,820	7.32	16200	18,520	74.0
720	416,700	0.1459	1520	197,360	0.6502	5200	57,690	7.61	16400	18,295	75.6
730	411,000	0.1501	1530	196,070	0.6590	5300	56,600	7.91	16600	18,070	77.6
740	405,400	0.1540	1540	194,800	0.6670	5400	55,560	8.21	16800	17,855	79.6
750	400,000	0.1583	1550	193,560	0.6760	5500	54,550	8.51	17000	17,645	81.2
760	394,700	0.1625	1560	192,310	0.6849	5600	53,570	8.83	17200	17,440	83.2
770	389,600	0.1668	1570	191,060	0.6938	5700	52,630	9.15	17400	17,240	85.2
780	384,600	0.1714	1580	189,860	0.7028	5800	51,720	9.47	17600	17,045	87.2
790	379,800	0.1756	1590	188,670	0.7118	5900	50,850	9.81	17800	16,855	89.2
800	375,000	0.1801	1600	187,500	0.7204	6000	50,000	10.1	18000	16,665	91.2
810	370,400	0.1847	1610	186,340	0.7295	6100	49,180	10.5	18200	16,485	93.2
820	365,900	0.1893	1620	185,190	0.7387	6200	48,550	10.8	18400	16,305	95.2
830	361,400	0.1941	1630	184,050	0.7480	6300	47,620	11.1	18600	16,130	97.2
840	357,100	0.1985	1640	182,930	0.7573	6400	46,870	11.5	18,800	15,955	99.6
850	352,900	0.2034	1650	181,820	0.7662	6500	46,150	11.9	19000	15,795	101.6
860	348,800	0.2082	1660	180,730	0.7756	6600	45,450	12.3	19200	15,625	103.6
870	344,800	0.2132	1670	179,640	0.7852	6700	44,780	12.6	19400	15,465	106.0
880	340,900	0.2179	1680	178,570	0.7946	6800	44,120	13.0	19600	15,305	108.0
890	337,100	0.2229	1690	177,510	0.8037	6900	43,480	13.4	19800	15,155	110.4
900	333,300	0.2280	1700	176,460	0.8134	7000	42,860	13.8	20000	15,000	112.4
910	329,700	0.2332	1710	175,440	0.8231	7100	42,250	14.2			
920	326,100	0.2381	1720	174,420	0.8329	7200	41,670	14.6			
930	322,600	0.2434	1730	173,410	0.8422	7300	41,100	15.0			
940	319,100	0.2487	1740	172,410	0.8520	7400	40,540	15.4			
950	315,900	0.2541	1750	171,430	0.8620	7500	40,000	15.8			
960	312,500	0.2595	1760	170,460	0.8720	7600	39,470	16.3			
970	309,300	0.2647	1770	169,490	0.8821	7700	38,960	16.7			
980	306,100	0.2704	1780	168,540	0.8916	7800	38,460	17.1			
990	303,000	0.2759	1790	167,600	0.9019	7900	37,980	17.6			

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Table Giving Oscillation Constant and Frequency, for Wavelengths Between 200 and 20,000 Meters

L C in Centimeters and Microfarads

Meters	n	L C	Meters	n	L C	Meters	n	L C	Meters	n	L C
200	1,500,000	11.29	1000	300,000	281.6	1800	166,670	912.0	8000	37,500	18000
210	1,428,500	12.39	1010	297,030	287.0	1810	165,750	922.4	8100	37,040	18500
220	1,364,000	13.62	1020	294,120	292.7	1820	164,840	932.7	8200	36,590	18900
230	1,304,200	14.90	1030	291,260	298.6	1830	163,940	942.5	8300	36,140	19400
240	1,250,000	16.24	1040	288,450	304.5	1840	163,040	953.0	8400	35,710	19900
250	1,200,000	17.55	1050	285,710	310.5	1850	162,220	963.4	8500	35,290	20300
260	1,153,800	19.01	1060	283,000	316.1	1860	161,290	974.1	8600	34,880	20800
270	1,111,000	20.52	1070	280,370	322.2	1870	160,430	984.4	8700	34,480	21300
280	1,071,300	22.09	1080	277,780	328.3	1880	159,580	994.8	8800	34,090	21800
290	1,034,300	23.72	1090	275,230	334.5	1890	158,730	1005.6	8900	33,710	22300
300	1,000,000	25.30	1100	272,730	340.4	1900	157,890	1016.4	9000	33,330	22800
310	967,700	27.04	1110	270,270	346.7	1910	157,060	1026.5	9100	32,970	23300
320	937,500	28.84	1120	267,850	353.1	1920	156,300	1037.5	9200	32,610	23800
330	909,100	30.69	1130	265,480	359.5	1930	155,440	1048.5	9300	32,260	24300
340	882,400	32.50	1140	263,150	366.0	1940	154,630	1059.7	9400	31,910	24900
350	859,100	34.46	1150	260,860	372.1	1950	153,840	1070.6	9500	31,590	25400
360	833,300	36.48	1160	258,610	378.7	1960	153,060	1081.1	9600	31,250	25900
370	810,800	38.56	1170	256,400	385.3	1970	152,280	1092.3	9700	30,930	26500
380	789,500	40.70	1180	254,230	392.1	1980	151,510	1103.5	9800	30,610	27000
390	769,200	42.77	1190	252,100	398.8	1990	150,750	1114.8	9900	30,310	27600
400	750,000	45.03	1200	250,000	405.2	2000	150,000	1125.6	10000	30,000	28100
410	731,700	47.33	1210	247,930	412.1	2100	142,850	1241.2	10200	29,410	29300
420	714,300	49.68	1220	245,900	419.0	2200	136,360	1362.4	10400	28,845	30400
430	697,700	51.98	1230	243,900	426.0	2300	130,430	1489.3	10600	28,300	31600
440	681,800	54.46	1240	241,930	432.6	2400	125,000	1621.8	10800	27,780	32800
450	666,700	57.00	1250	240,000	439.7	2500	120,000	1759.7	11000	27,275	34000
460	652,200	59.60	1260	238,090	446.9	2600	115,380	1902.6	11200	26,785	35300
470	638,300	62.25	1270	236,220	454.1	2700	111,110	2052.0	11400	26,315	36600
480	625,000	64.85	1280	234,370	461.0	2800	107,140	2207.0	11600	25,860	37900
490	612,200	67.57	1290	232,560	468.3	2900	103,450	2366.3	11800	25.425	39200
500	600,000	70.39	1300	230,760	475.7	3000	100,000	2533	12000	25,000	40400
510	588,200	73.27	1310	229,010	483.1	3100	96,770	2705	12200	24,500	42000
520	576,900	76.06	1320	227,270	490.6	3200	93,750	2883	12400	24,275	43300
530	566,000	79.03	1330	225,560	497.8	3300	90,910	3085	12600	23,860	44400
540	555,600	82.08	1340	223,870	505.3	3400	88,240	3255	12800	23,435	46000
550	545,400	85.18	1350	222,220	513.0	3500	85,910	3448	13000	23,075	47600
560	535,700	88.36	1360	220,590	520.8	3600	83,300	3648	13200	22,275	49200
570	526,300	91.41	1370	218,970	528.1	3700	81,080	3854	13400	22,390	50400
580	517,200	94.67	1380	217,390	535.9	3800	78,950	4065	13600	22,060	52000
590	508,500	98.03	1390	215,830	543.8	3900	76,920	4281	13800	21,740	53200
600	500,000	101.4	1400	214,380	551.8	4000	75,000	4500	14000	21,430	55200
610	491,800	104.7	1410	212,760	559.8	4100	73,170	4732	14200	21,125	56800
620	483,700	108.2	1420	211,260	567.4	4200	71,430	4966	14400	20,835	58400
630	476,200	111.7	1430	209,790	575.5	4300	69,770	5206	14600	20,550	60000
640	468,700	115.4	1440	208,340	583.7	4400	68,180	5451	14800	20,270	61600
650	461,500	118.8	1450	206,900	591.9	4500	66,670	5700	15000	20,000	63200
660	454,500	122.5	1460	205,470	599.8	4600	65,220	5956	15200	19,735	65200
670	447,800	126.3	1470	204.080	608.1	4700	63,830	6219	15400	19,480	66100
680	441,200	130.2	1480	202,700	616.5	4800	62,500	6486	15600	19,230	68400
690	434,800	134.1	1490	201,340	625.0	4900	61,220	6759	15800	18,990	70400
700	428,600	137.8	1500	200,000	633.5	5000	60,000	7038	16000	18,750	72000
710	422,500	141.9	1510	198,680	641.6	5100	58,820	7320	16200	18,520	74000
720	416,700	145.9	1520	197,360	650.2	5200	57,690	7610	16400	18,295	75600
730	411,000	150.1	1530	196,070	659.0	5300	56,600	7910	16600	18,070	77600
740	405,400	154.0	1540	194,800	667.0	5400	55,560	8210	16800	17,855	79600
750	400,000	158.3	1550	193,560	676.0	5500	54,550	8510	17000	17,645	81200
760	394,700	162.5	1560	192,310	684.9	5600	53,570	8830	17200	17,440	83200
770	389,600	166.8	1570	191,060	693.8	5700	52,630	9150	17400	17,240	85200
780	384,600	171.4	1580	189,860	702.8	5800	51,720	9470	17600	17,045	87200
790	379,800	175.6	1590	188,670	711.8	5900	50,850	9810	17800	16,855	89200
800	375,000	180.1	1600	187,500	720.4	6000	50,000	10100	18000	16,665	91200
810	370,400	184.7	1610	186,340	729.5	6100	49,180	10500	18200	16,485	93200
820	365,900	189.3	1620	185,190	738.7	6200	48,550	10800	18400	16,305	95200
830	361,400	194.1	1630	184,050	748.0	6300	47,620	11100	18600	16,130	97200
840	357,100	198.5	1640	182,930	757.3	6400	46,870	11500	18800	15,955	99600
850	352,900	203.4	1650	181,820	766.2	6500	46,150	11900	19000	15,795	101600
860	348,800	208.2	1660	180,730	775.6	6600	45,450	12300	19200	15,625	103600
870	344,800	213.2	1670	179,640	785.2	6700	44,780	12600	19400	15,465	106000
880	340,900	217.9	1680	178,570	794.6	6800	44,120	13000	19600	15,305	108000
890	337,100	222.9	1690	177,510	803.7	6900	43,480	13400	19800	15,155	110400
900	333,300	228.0	1700	176,460	813.4	7000	42,860	13800	20000	15,000	112400
910	329,700	233.2	1710	175,440	823.1	7106	42,250	14200			
920	326,100	238.1	1720	174,420	832.9	7200	41,670	14600			
930	322,600	243.4	1730	173,410	842.2	7300	41,100	15000			
940	319,100	248.7	1740	172,410	852.0	7400	40,540	15400			
950	315,900	254.1	1750	171,430	862.0	7500	40,000	15800			
960	312,500	259.5	1760	170,460	872.0	7600	39,470	16300			
970	309,300	264.7	1770	169,490	882.1	7700	38,960	16700			
980	306,100	270.4	1780	168,540	891.6	7800	38,460	17100			
990	303,000	275.9	1790	167,600	901.9	7900	37,980	17600			

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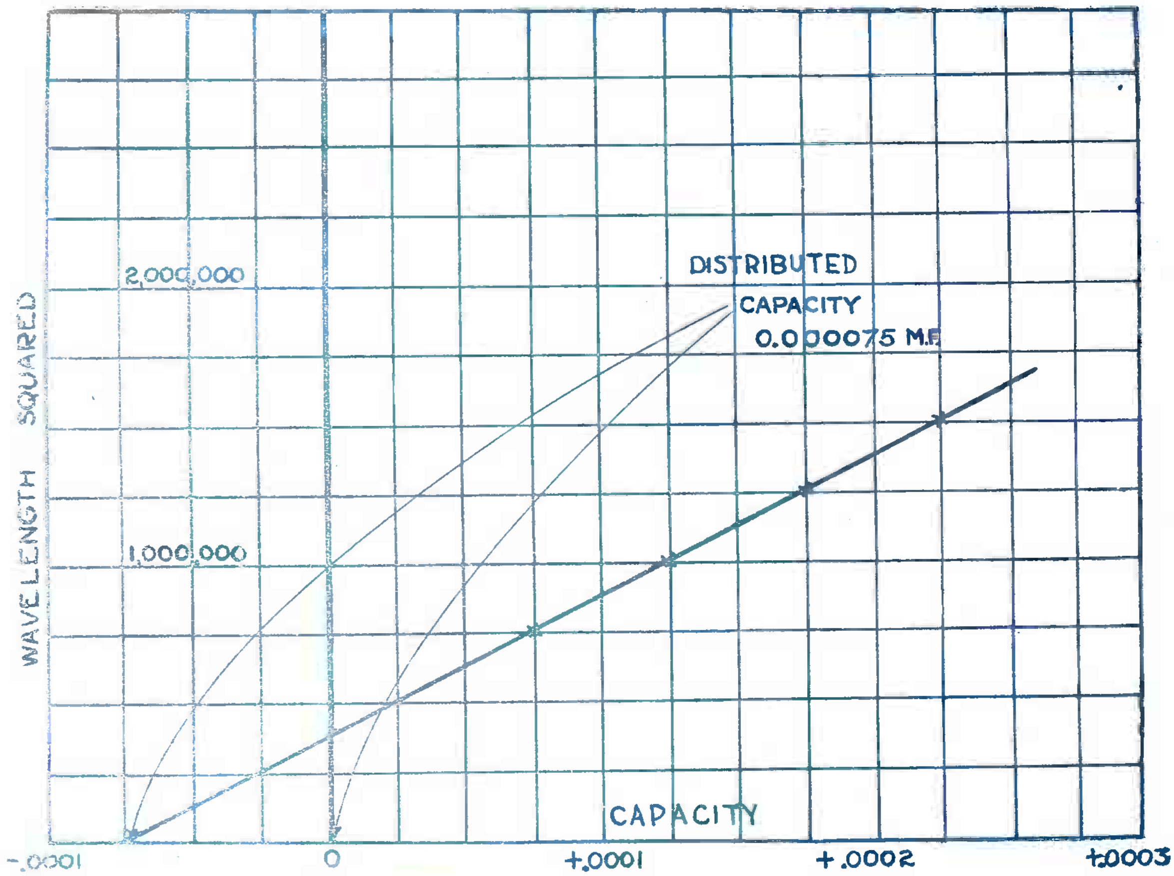
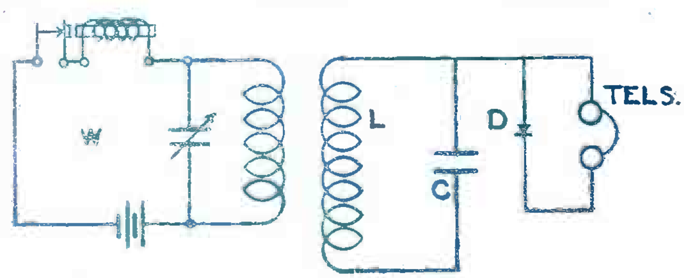
Measurement of Distributed Capacity of an Inductance





W—Wavemeter or other form of driver.
L—Inductance being measured for distributed capacity.
C—Calibrated variable condenser.
D—Detector.

The apparatus required and the circuits employed are shown by the above diagram. To obtain the distributed capacity of L, take wavemeter readings with a number of different values of C. Plot these readings against the wavelength squared on a piece of cross-section paper. (See example above. The result will be practically a straight line. Continue this line to the negative value of C, which negative value of C will be the distributed capacity of the inductance under test.

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Wavelengths of Inductance Coils

It is sometimes desired to find the wavelength of a particular coil used in series with an antenna and variable condenser. This can easily be found by obtaining the inductance of the coil in mil-henries and from this the wavelength. Table 1 below gives the inductance in milli-henries of various numbers of turns of No. 26 S. S. C. wire wound on a 3½ inch core. Table 2 gives the inductance of various numbers of turns of the same size wire wound on a 5 inch core From these two tables you can then obtain the wavelength to which the coil will tune by referring to tables 3 and 4. The former is for use in connection with an antenna having a capacity of .0001 mf. and the latter for an antenna with a capacity of .0002 mf. The condensers indicated in tables 3 and 4 are placed in series with the coil and the ground.

TABLE 1

Inductance in mil-henries.	Number of turns.	Length in inches.	Feet of wire required.
0.10	25	0.46	25
0.16	34	0.63	36
0.20	39	0.72	42
0.25	44	0.81	49
0.40	58	1.07	63
0.60	75	1.38	80
0.80	92	1.70	100
0.85	96	1.78	104
1.00	108	2.00	118
1.20	123	2.28	133
1.80	164	3.03	176
2.00	180	3.33	190
3.00	242	4.48	250
4.00	304	5.62	310
5.00	366	6.77	370
8.00	550	10.20	550

TABLE 2

Inductance in mil-henries.	Number of turns.	Length in inches.	Feet of wire required.
2.00	120	2.22	160
2.00	158	2.93	215
4.00	194	3.58	265
5.00	228	4.22	310
8.00	324	6.00	450
10.00	384	7.10	530
12.00	450	8.30	625

TABLE 3

Inductance in mil-henries.	Shortest wave-length in meters.	Longest wave-length in meters with 0.0005 mf.	Longest wave-length in meters with 0.001 mf.
0.10	103	169	179
0.20	146	238	253
0.40	207	337	358
0.85	300	490	.515
1.80	400	700	760
2.00	420	750	800
4.00	600	1080	1130
5.00	660	1200	1250
10.00	900	1700	1790
30.00	1600	2900	3100

TABLE 4

Inductance in mil-henries.	Shortest wave-length in meters.	Longest wave-length in meters with 0.0005 mf.	Longest wave-length in meters with 0.001 mf.
0.10	169	225	240
0.16	210	285	305
0.20	240	320	340
0.25	270	355	380
0.40	340	450	480
0.60	420	550	590
0.80	480	630	680
1.20	585	775	840
1.80	720	950	1020
3.00	930	1220	1320
5.00	1200	1600	1700
8.00	1500	2000	2150
12.00	1850	2400	2650
16.00	2150	2800	3050

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Table Giving Oscillation Constant and Frequency, for Wavelengths Between 200 and 20,000 Meters

L C in Microhenries and Microfarads

Meters	n	L C	Meters	n	L C	Meters	n	L C	Meters	n	L C
200	1,500,000	0.01129	1000	300,000	0.2816	1800	166,670	0.9120	8000	37,500	18.0
210	1,428,500	0.01239	1010	297,030	0.2870	1810	165,750	0.9224	8100	37,040	18.5
220	1,364,000	0.01362	1020	294,120	0.2927	1820	164,840	0.9327	8200	36,590	18.9
230	1,304,200	0.01490	1030	291,260	0.2986	1830	163,940	0.9425	8300	36,140	19.4
240	1,250,000	0.01624	1040	288,450	0.3045	1840	163,040	0.9530	8400	35,710	19.9
250	1,200,000	0.01755	1050	285,710	0.3105	1850	162,220	0.9634	8500	35,290	20.3
260	1,153,800	0.01901	1060	283,000	0.3161	1860	161,290	0.9741	8600	34,880	20.8
270	1,111,000	0.02052	1070	280,370	0.3222	1870	160,430	0.9844	8700	34,480	21.3
280	1,071,300	0.02209	1080	277,780	0.3283	1880	159,580	0.9948	8800	34,090	21.8
290	1,034,300	0.02372	1090	275,230	0.3345	1890	158,730	1.0056	8900	33,710	22.3
300	1,000,000	0.02530	1100	272,730	0.3404	1900	157,890	1.0164	9000	33,330	22.8
310	967,700	0.02704	1110	270,270	0.3467	1910	157,060	1.0265	9100	32,970	23.3
320	937,500	0.02884	1120	267,850	0.3531	1920	156,300	1.0375	9200	32,610	23.8
330	909,100	0.03069	1130	265,480	0.3595	1930	155,440	1.0485	9300	32,260	24.3
340	882,400	0.03250	1140	263,150	0.3660	1940	154,630	1.0597	9400	31,910	24.9
350	859,100	0.03446	1150	260,860	0.3721	1950	153,840	1.0706	9500	31,590	25.4
360	833,300	0.03648	1160	258,610	0.3787	1960	153,060	1.0811	9600	31,250	25.9
370	810,800	0.03856	1170	256,400	0.3853	1970	152,280	1.0923	9700	30,930	26.5
380	789,500	0.04070	1180	254,230	0.3921	1980	151,510	1.1035	9800	30,610	27.0
390	769,200	0.04277	1190	252,100	0.3988	1990	150,750	1.1148	9900	30,310	27.6
400	750,000	0.04503	1200	250,000	0.4052	2000	150,000	1.1256	10000	30,000	28.1
410	731,700	0.04733	1210	247,930	0.4121	2100	142,850	1.2412	10200	29,410	29.3
420	714,300	0.04968	1220	245,900	0.4190	2200	136,360	1.3624	10400	28,845	30.4
430	697,700	0.05198	1230	243,900	0.4260	2300	130,430	1.4893	10600	28,300	31.6
440	681,800	0.05446	1240	241,930	0.4326	2400	125,000	1.6218	10800	27,780	32.8
450	666,700	0.05700	1250	240,000	0.4397	2500	120,000	1.7597	11000	27,275	34.0
460	652,200	0.05960	1260	238,090	0.4469	2600	115,380	1.9026	11200	26,785	35.3
470	638,300	0.06225	1270	236,220	0.4541	2700	111,110	2.0520	11400	26,315	36.6
480	625,000	0.06485	1280	234,370	0.4610	2800	107,140	2.2070	11600	25,860	37.9
490	612,200	0.06757	1290	232,560	0.4683	2900	103,450	2.3663	11800	25,425	39.2
500	600,000	0.07039	1300	230,760	0.4757	3000	100,000	2.533	12000	25,000	40.4
510	588,200	0.07327	1310	229,010	0.4831	3100	96,770	2.705	12200	24,590	42.0
520	576,900	0.07606	1320	227,270	0.4906	3200	93,750	2.883	12400	24,275	43.3
530	566,000	0.07903	1330	225,560	0.4978	3300	90,910	3.085	12600	23,860	44.4
540	555,600	0.08208	1340	223,870	0.5053	3400	88,240	3.255	12800	23,435	46.0
550	545,400	0.08518	1350	222,220	0.5130	3500	85,910	3.448	13000	23,075	47.6
560	535,700	0.08836	1360	220,590	0.5208	3600	83,330	3.648	13200	22,275	49.2
570	526,300	0.09141	1370	218,970	0.5281	3700	81,080	3.854	13400	22,390	50.4
580	517,200	0.09467	1380	217,390	0.5359	3800	78,950	4.065	13600	22,060	52.0
590	508,500	0.09803	1390	215,830	0.5438	3900	76,920	4.281	13800	21,740	53.2
600	500,000	0.1014	1400	214,380	0.5518	4000	75,000	4.500	14000	21,430	55.2
610	491,800	0.1047	1410	212,760	0.5598	4100	73,170	4.732	14200	21,125	56.8
620	483,700	0.1082	1420	211,260	0.5674	4200	71,430	4.966	14400	20,835	58.4
630	476,200	0.1117	1430	209,790	0.5755	4300	69,770	5.206	14600	20,550	60.0
640	468,700	0.1154	1440	208,340	0.5837	4400	68,180	5.451	14800	20,270	61.6
650	461,500	0.1188	1450	206,900	0.5919	4500	66,670	5.700	15000	20,000	63.2
660	454,500	0.1225	1460	205,470	0.5998	4600	65,220	5.956	15200	19,735	65.2
670	447,800	0.1263	1470	204,080	0.6081	4700	63,830	6.219	15400	19,480	66.1
680	441,200	0.1302	1480	202,700	0.6165	4800	62,500	6.486	15600	19,230	68.4
690	434,800	0.1341	1490	201,340	0.6250	4900	61,220	6.759	15800	18,990	70.4
700	428,600	0.1378	1500	200,000	0.6335	5000	60,000	7.038	16000	18,750	72.0
710	422,500	0.1419	1510	198,680	0.6416	5100	58,820	7.32	16200	18,520	74.0
720	416,700	0.1459	1520	197,360	0.6502	5200	57,690	7.61	16400	18,295	75.6
730	411,000	0.1501	1530	196,070	0.6590	5300	56,600	7.91	16600	18,070	77.6
740	405,400	0.1540	1540	194,800	0.6670	5400	55,560	8.21	16800	17,855	79.6
750	400,000	0.1583	1550	193,560	0.6760	5500	54,550	8.51	17000	17,645	81.2
760	394,700	0.1625	1560	192,310	0.6849	5600	53,570	8.83	17200	17,440	83.2
770	389,600	0.1668	1570	191,060	0.6938	5700	52,630	9.15	17400	17,240	85.2
780	384,600	0.1714	1580	189,860	0.7028	5800	51,720	9.47	17600	17,045	87.2
790	379,800	0.1756	1590	188,670	0.7118	5900	50,850	9.81	17800	16,855	89.2
800	375,000	0.1801	1600	187,500	0.7204	6000	50,000	10.1	18000	16,665	91.2
810	370,400	0.1847	1610	186,340	0.7295	6100	49,180	10.5	18200	16,485	93.2
820	365,900	0.1893	1620	185,190	0.7387	6200	48,550	10.8	18400	16,305	95.2
830	361,400	0.1941	1630	184,050	0.7480	6300	47,620	11.1	18600	16,130	97.2
840	357,100	0.1985	1640	182,930	0.7573	6400	46,870	11.5	18,800	15,955	99.6
850	352,900	0.2034	1650	181,820	0.7662	6500	46,150	11.9	19000	15,795	101.6
860	348,800	0.2082	1660	180,730	0.7756	6600	45,450	12.3	19200	15,625	103.6
870	344,800	0.2132	1670	179,640	0.7852	6700	44,780	12.6	19400	15,465	106.0
880	340,900	0.2179	1680	178,570	0.7946	6800	44,120	13.0	19600	15,305	108.0
890	337,100	0.2229	1690	177,510	0.8037	6900	43,480	13.4	19800	15,155	110.4
900	333,300	0.2280	1700	176,460	0.8134	7000	42,860	13.8	20000	15,000	112.4
910	329,700	0.2332	1710	175,440	0.8231	7100	42,250	14.2			
920	326,100	0.2381	1720	174,420	0.8329	7200	41,670	14.6			
930	322,600	0.2434	1730	173,410	0.8422	7300	41,100	15.0			
940	319,100	0.2487	1740	172,410	0.8520	7400	40,540	15.4			
950	315,900	0.2541	1750	171,430	0.8620	7500	40,000	15.8			
960	312,500	0.2595	1760	170,460	0.8720	7600	39,470	16.3			
970	309,300	0.2647	1770	169,490	0.8821	7700	38,960	16.7			
980	306,100	0.2704	1780	168,540	0.8916	7800	38,460	17.1			
990	303,000	0.2759	1790	167,600	0.9019	7900	37,980	17.6			

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Table Giving Oscillation Constant and Frequency, for Wavelengths Between 200 and 20,000 Meters

L C in Centimeters and Microfarads

Meters	n	L C	Meters	n	L C	Meters	n	L C	Meters	n	L C
200	1,500,000	11.29	1000	300,000	281.6	1800	166,670	912.0	8000	37,500	18000
210	1,428,500	12.39	1010	297,030	287.0	1810	165,750	922.4	8100	37,040	18500
220	1,364,000	13.62	1020	294,120	292.7	1820	164,840	932.7	8200	36,590	18900
230	1,304,200	14.90	1030	291,260	298.6	1830	163,940	942.5	8300	36,140	19400
240	1,250,000	16.24	1040	288,450	304.5	1840	163,040	953.0	8400	35,710	19900
250	1,200,000	17.55	1050	285,710	310.5	1850	162,220	963.4	8500	35,290	20300
260	1,153,800	19.01	1060	283,000	316.1	1860	161,290	974.1	8600	34,880	20800
270	1,111,000	20.52	1070	280,370	322.2	1870	160,430	984.4	8700	34,480	21300
280	1,071,300	22.09	1080	277,780	328.3	1880	159,580	994.8	8800	34,090	21800
290	1,034,300	23.72	1090	275,230	334.5	1890	158,730	1005.6	8900	33,710	22300
300	1,000,000	25.30	1100	272,730	340.4	1900	157,890	1016.4	9000	33,330	22800
310	967,700	27.04	1110	270,270	346.7	1910	157,060	1026.5	9100	32,970	23300
320	937,500	28.84	1120	267,850	353.1	1920	156,300	1037.5	9200	32,610	23800
330	909,100	30.69	1130	265,480	359.5	1930	155,440	1048.5	9300	32,260	24300
340	882,400	32.50	1140	263,150	366.0	1940	154,630	1059.7	9400	31,910	24900
350	859,100	34.46	1150	260,860	372.1	1950	153,840	1070.6	9500	31,590	25400
360	833,300	36.48	1160	258,610	378.7	1960	153,060	1081.1	9600	31,250	25900
370	810,800	38.56	1170	256,400	385.3	1970	152,280	1092.3	9700	30,930	26500
380	789,500	40.70	1180	254,230	392.1	1980	151,510	1103.5	9800	30,610	27000
390	769,200	42.77	1190	252,100	398.8	1990	150,750	1114.8	9900	30,310	27600
400	750,000	45.03	1200	250,000	405.2	2000	150,000	1125.6	10000	30,000	28100
410	731,700	47.33	1210	247,930	412.1	2100	142,850	1241.2	10200	29,410	29300
420	714,300	49.68	1220	245,900	419.0	2200	136,360	1362.4	10400	28,845	30400
430	697,700	51.98	1230	243,900	426.0	2300	130,430	1489.3	10600	28,300	31600
440	681,800	54.46	1240	241,930	432.6	2400	125,000	1621.8	10800	27,780	32800
450	666,700	57.00	1250	240,000	439.7	2500	120,000	1759.7	11000	27,275	34000
460	652,200	59.60	1260	238,090	446.9	2600	115,380	1902.6	11200	26,785	35300
470	638,300	62.25	1270	236,220	454.1	2700	111,110	2052.0	11400	26,315	36600
480	625,000	64.85	1280	234,370	461.0	2800	107,140	2207.0	11600	25,860	37900
490	612,200	67.57	1290	232,560	468.3	2900	103,450	2366.3	11800	25,425	39200
500	600,000	70.39	1300	230,760	475.7	3000	100,000	2533	12000	25,000	40400
510	588,200	73.27	1310	229,010	483.1	3100	96,770	2705	12200	24,500	42000
520	576,900	76.06	1320	227,270	490.6	3200	93,750	2883	12400	24,275	43300
530	566,000	79.03	1330	225,560	497.8	3300	90,910	3085	12600	23,860	44400
540	555,600	82.08	1340	223,870	505.3	3400	88,240	3255	12800	23,435	46000
550	545,400	85.18	1350	222,220	513.0	3500	85,910	3448	13000	23,075	47600
560	535,700	88.36	1360	220,590	520.8	3600	83,300	3648	13200	22,275	49200
570	526,300	91.41	1370	218,970	528.1	3700	81,080	3854	13400	22,390	50400
580	517,200	94.67	1380	217,390	535.9	3800	78,950	4065	13600	22,060	52000
590	508,500	98.03	1390	215,830	543.8	3900	76,920	4281	13800	21,740	53200
600	500,000	101.4	1400	214,380	551.8	4000	75,000	4500	14000	21,430	55200
610	491,800	104.7	1410	212,760	559.8	4100	73,170	4732	14200	21,125	56800
620	483,700	108.2	1420	211,260	567.4	4200	71,430	4966	14400	20,835	58400
630	476,200	111.7	1430	209,790	575.5	4300	69,770	5206	14600	20,550	60000
640	468,700	115.4	1440	208,340	583.7	4400	68,180	5451	14800	20,270	61600
650	461,500	118.8	1450	206,900	591.9	4500	66,670	5700	15000	20,000	63200
660	454,500	122.5	1460	205,470	599.8	4600	65,220	5956	15200	19,735	65200
670	447,800	126.3	1470	204.080	608.1	4700	63,830	6219	15400	19,480	66100
680	441,200	130.2	1480	202,700	616.5	4800	62,500	6486	15600	19,230	68400
690	434,800	134.1	1490	201,340	625.0	4900	61,220	6759	15800	18,990	70400
700	428,600	137.8	1500	200,000	633.5	5000	60,000	7038	16000	18,750	72000
710	422,500	141.9	1510	198,680	641.6	5100	58,820	7320	16200	18,520	74000
720	416,700	145.9	1520	197,360	650.2	5200	57,690	7610	16400	18,295	75600
730	411,000	150.1	1530	196,070	659.0	5300	56,600	791(	16600	18,070	77600
740	405,400	154.0	1540	194,800	667.0	5400	55,560	8210	16800	17,855	79600
750	400,000	158.3	1550	193,560	676.0	5500	54,550	8510	17000	17,645	81200
760	394,700	162.5	1560	192,310	684.9	5600	53,570	8830	17200	17,440	83200
770	389,600	166.8	1570	191,060	693.8	5700	52,630	9150	17400	17,240	85200
780	384,600	171.4	1580	189,860	702.8	5800	51,720	9470	17600	17,045	87200
790	379,800	175.6	1590	188,670	711.8	5900	50,850	9810	17800	16,855	89200
800	375,000	180.1	1600	187,500	720.4	6000	50,000	10100	18000	16,665	91200
810	370,400	184.7	1610	186,340	729.5	6100	49,180	10500	18200	16,485	93200
820	365,900	189.3	1620	185,190	738.7	6200	48,550	10800	18400	16,305	95200
830	361,400	194.1	1630	184,050	748.0	6300	47,620	11100	18600	16,130	97200
840	357,100	198.5	1640	182,930	757.3	6400	46,870	11500	18800	15,955	99600
850	352,900	203.4	1650	181,820	766.2	6500	46,150	11900	19000	15,795	101600
860	348,800	208.2	1660	180,730	775.6	6600	45,450	12300	19200	15,625	103600
870	344,800	213.2	1670	179,640	785.2	6700	44,780	12600	19400	15,465	106000
880	340,900	217.9	1680	178,570	794.6	6800	44,120	13000	19600	15,305	108000
890	337,100	222.9	1690	177,510	803.7	6900	43,480	13400	19800	15,155	110400
900	333,300	228.0	1700	176,460	813.4	7000	42,860	13800	20000	15,000	112400
910	329,700	233.2	1710	175,440	823.1	7106	42,250	14200			
920	326,100	238.1	1720	174,420	832.9	7200	41,670	14600			
930	322,600	243.4	1730	173,410	842.2	7300	41,100	15000			
940	319,100	248.7	1740	172,410	852.0	7400	40,540	15400			
950	315,900	254.1	1750	171,430	862.0	7500	40,000	15800			
960	312,500	259.5	1760	170,460	872.0	7600	39,470	16300			
970	309,300	264.7	1770	169,490	882.1	7700	38,960	16700			
980	306,100	270.4	1780	168,540	891.6	7800	38,460	17100			
990	303,000	275.9	1790	167,600	901.9	7900	37,980	17600			

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98 Park Place
New York City
Price 10c.

Antenna Characteristics

AMATEUR RADIO STATION..........................
(call)

Owner.. Location...

Measurements by.. Date..

WAVE LENGTH	RESISTANCE	CAPACITY	FREQUENCY
meters	ohms	mfds.	kc/s
meters	ohms	mfds.	kc/s
meters	ohms	mfds.	kc/s
meters	ohms	mfds.	kc/s
meters	ohms	mfds.	kc/s

To be posted in station.

Show fundamental wave length in red; normal working wave in green; other wave length adjustments in black.

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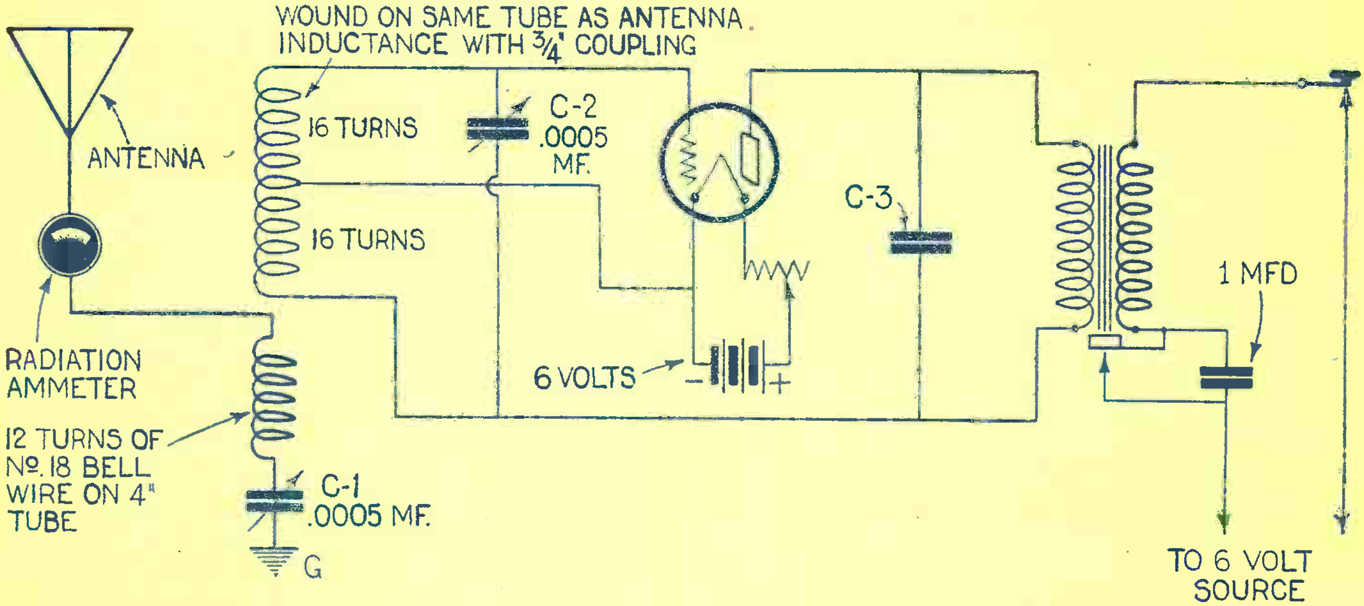
A Spark Coil I. C. W. Transmitter



If you have difficulty in obtaining the high voltage for supplying the plate of a five watt transmitting tube, you may overcome this very easily by using the above hook-up, which is arranged for interrupted continuous wave transmission. Almost any small ignition coil or spark coil (up to one inch) may be used, but care should be taken to see that a very good high potential condenser of fixed value, C-3 is bridged across the secondary. The proper capacity can be readily determined by making up a makeshift spark gap of two darning needles, firmly held apart at a distance of about one-fortieth of an inch (about the thickness of a piece of blotting paper). Capacity should then be added across the gap in steps until a value is reached which just permits a discharge across the gap. This represents a potential of five hundred volts, approximately, which is a safe value to apply to the plate of a five watt power tube.

The circuit shown, by reason of its inductive coupling to the antenna, insures a pure, non-swinging signal and entire absence of undesirable harmonic frequencies. The antenna circuit is tuned by the capacity C-1 while the frequency of the generating circuit can be adjusted to resonance by means of the variable capacity, C-2. This is an ideal circuit arrangement for the beginner as well as the more advanced transmitting amateur.

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