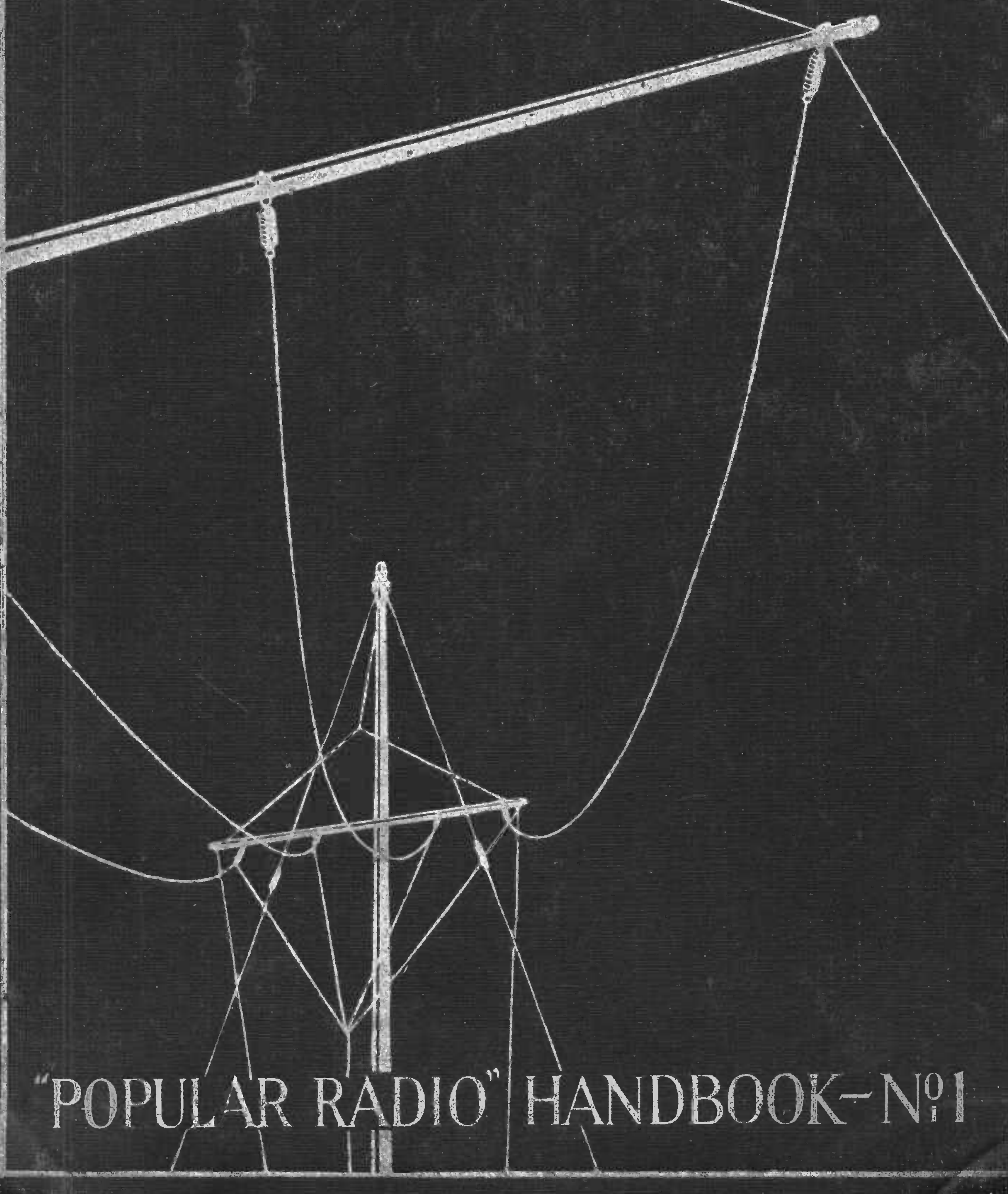
HOW TO BUILD YOUR RADIO RECEIVER

Edited by KENDALL BANNING *and* L. M. COCKADAY



"POPULAR RADIO" HANDBOOK—No. 1

HOW TO BUILD YOUR RADIO RECEIVER

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Popular Radio Handbook—No. 1

PUBLISHED BY POPULAR RADIO, INC.
627 WEST 43D STREET, NEW YORK
1924

Second Edition

CONTENTS

What This Book Tells You—

THIS book tells both the experienced amateur as well as the layman—the man who has had no special technical training and who has only the ordinary proficiency with tools—just exactly *how* to build his own radio receiving set, how to install it and how to operate it.

The book assumes that the reader has had no experience in radio work. For that reason it starts out with a brief description of the forty-four symbols commonly used in radio circuit diagrams; the layman who masters this A B C of the radio language will have little difficulty in reading the "hook-up" diagrams that constitute such an important basic feature of this volume.

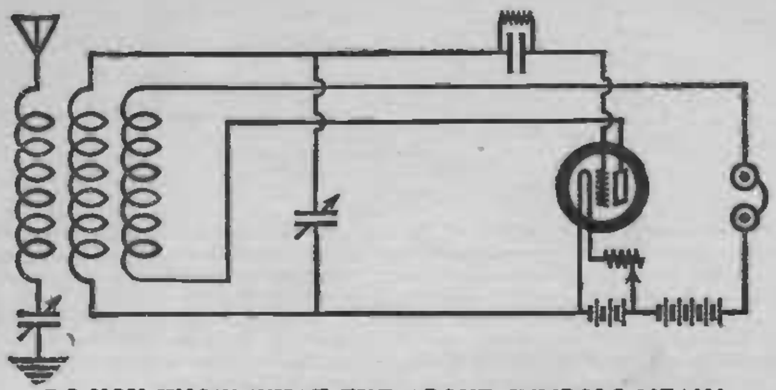
The seven receivers which have been selected for description range from the best of the small crystal sets (the parts of which cost only about $5.00) to one of the most highly sensitive and efficient vacuum-tube sets that science has yet devised—the remarkable improved four-circuit tuner and the regenerative super-heterodyne (the parts of which cost about $100.00). The receiving radius of these sets ranges between fifteen miles to nearly halfway around the world.

In order that the reader may derive the maximum results from these sets, the instructions for building are given in great detail. The parts specified have in all cases been selected, after extensive laboratory experiment, as the most efficient *for the particular set that is under consideration.* All of these parts are easily procurable.

The experimenter is advised to follow these instructions *exactly* and to use only the radio parts that are recommended. Other parts *may* prove satisfactory; the parts here specified *will* prove satisfactory.

The reader is advised that the principles of the receiving sets that are included in this book are patented, and that the following descriptions are published for the benefit of the radio fan, for his own use and for research and experimental purposes only.

—KENDALL BANNING



DO YOU KNOW WHAT THE ABOVE SYMBOLS MEAN?

Unless you do, you cannot understand the practical and useful hook-up drawings that constitute a fundamental part of this book. Read this chapter and learn how simple to understand these diagrams really are!

HOW TO

READ A DIAGRAM

THIS *chapter is written—and illustrated—for the very particular benefit of the radio fan who is unfamiliar with the common symbols used in the technical diagrams that explain radio circuits. A knowledge of these symbols is necessary to the understanding of "hook-up" drawings. In this article this information is presented in the most simple and comprehensive form.*

"WHERE may I obtain a 'picture-diagram' of the four-circuit tuner? I do not know how to read the regular diagrams."

This is one of the most frequent questions received by the technical editors of the radio periodicals.

It is evident that a large percentage of radio fans are unable to interpret the conventional, electric-circuit diagram. Rather than use the inferior picture method to bring home a circuit to the uninitiated, this chapter purposes to show the radio fan how to master the standard diagram. The task is surprisingly simple—much more simple than the uninitiated person is sometimes led to believe.

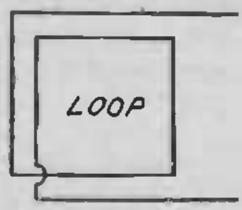
First of all, the student who wants to learn how to read a diagram must make himself familiar with the conventional symbols which are used in all hook-ups. Therefore, let us first consider the instruments that are most familiar in radio.

The following pages contain brief references to the instruments, together with the standard symbols that represents them. These symbols should be memorized before the beginner undertakes to read a diagram. After that the novice should be able to understand every circuit diagram in this volume.

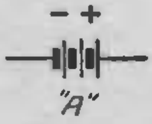
AMMETER—The ammeter is a device for measuring the current flowing in some particular circuit; for instance, it could be placed in the filament circuit of a vacuum tube to see how many amperes were being drawn from the storage battery.

The ammeter has two terminals and is always connected in series in the circuit.

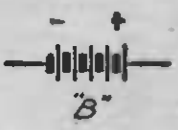
ANTENNA—The most common type of antenna (and one that gives universal satisfaction for receiving) is the single-wire "L" type, approximately 100 feet long. It is insulated at each end, preferably with a glazed-porcelain antenna insulator, and the lead-in to the receiving set is taken off at one end. Number 14 seven-strand bare copper wire is suitable.



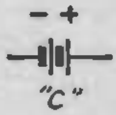
LOOP ANTENNA—The regulation outdoor antenna always gives reception over greater distances and also louder signals than the loop on the same receiving set. However, circumstances may make the use of a loop necessary; in this case the amplification will have to be increased considerably.



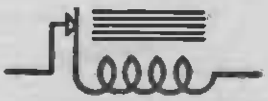
"A" BATTERY—Until recently the "A" or filament-lighting battery was almost universally of the storage type. Although made up of several cells, any "A" battery has two main terminals which connect to the filament of the tube; one of these terminals is positive and the other one is negative.



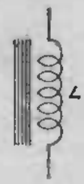
"B" BATTERY—The "B" battery is made up of a number of "flashlight" cells connected in series and seated together in a convenient container, there being fifteen of the cells in the 22½-volt size and a correspondingly larger number in the higher-voltage batteries. The large-type "B" battery will prove more economical for a permanent set.



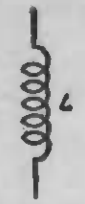
"C" BATTERY—With more than 67½ volts on the plate of the average tube it is advisable to connect a "C" battery in the grid circuit to bring the potential of the grid to the correct negative point with respect to the filament. One advantage of the "C" battery is that it cuts down the average plate current greatly and makes the "B" battery last much longer.



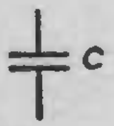
BUZZER—The chief uses of the buzzer in radio are for code practice and for testing out crystal detectors to find a sensitive spot. The buzzer for either of these purposes should (preferably) be one of the special high-frequency type. The note of an ordinary call buzzer is much too low.



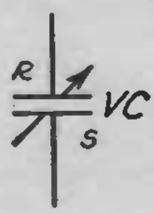
AUDIO-FREQUENCY CHOKE COIL—The audio-frequency choke coil consists of an iron core with a continuous winding, and has two connections, one to each end of the winding. The choke coil has a tendency to smooth out variations in current, thus making it a non-pulsating direct current.



RADIO-FREQUENCY CHOKE COIL—The uses of the radio-frequency choke coil are very similar to the audio-frequency choke coil except that it is constructed to operate at much higher frequencies and is therefore generally made with an air core. Such coils are used to prevent radio-frequency currents from entering a circuit where they are not desired.

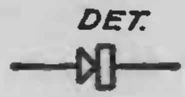


FIXED CONDENSER—The most satisfactory type of fixed condenser for receiving sets is the small mica condenser of reliable make. The fixed condenser has fundamentally two metal surfaces which are separated by an insulating sheet, although the metal surfaces may be made up of a large number of sheets. Such condensers are widely used in radio.



VARIABLE CONDENSER—The variable air condenser has become well standardized in form; it consists of a number of stationary plates, closely spaced and connected together, and approximately the same number of rotary plates which are also connected and which mesh between but do not touch the stationary plates.

COUNTERPOISE—When a ground connection is impossible or when a natural ground gives too high a wavelength on our transmitting set, we fall back on the counterpoise; this is placed below the antenna and far enough above ground to clear obstructions. The counterpoise may take the same form as an antenna.



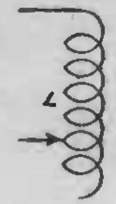
CRYSTAL DETECTOR—The crystal detector generally takes the form of a fine wire or "catwhisker" pressing lightly on some kind of mineral crystal; the common minerals are galena, silicon, pyrites, carborundum or one of the synthetic crystals. Within 15 to 25 miles of the large broadcasting stations the crystal set will give good, clear reception.

GALVANOMETER—The galvanometer is a delicate instrument for indicating a small electric current, but is not used for measuring current. That is, it may be used to show when the current is minimum or maximum, but not the exact value of it. The galvanometer is useful in bridge-measurement work where it is necessary to compare unknown electrical values.

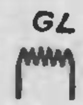
A.C. GENERATOR OR MOTOR—The A.C. generator finds little use in radio work except in spark transmitters but the motor is often used as a source of power for motor-generator sets when the local electric supply is alternating current. The A.C. generator or motor frequently has three terminals in the larger sizes.

D.C. GENERATOR OR MOTOR—The D.C. generator is used in radio work to produce the high-voltage plate supply for the better class of transmitters. There will usually be two connections for the generator and also two connections for the motor. The motor is also used to run generators on shipboard.

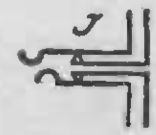
GRID CONDENSER—For the purpose of detection we must operate the tube at the knee of the "characteristic curve" by the use of a "C" battery or resort to the grid condenser, which isolates the grid and allows the negative charge on it to build up through several cycles instead of changing to positive at each half cycle as it would normally do.



VARIABLE INDUCTANCE—The variable inductance is merely a coil with provisions for using a part or the whole of it. There are two fundamental connections; one usually goes to the end of the coil and the other to a slider, clip, or inductance switch. If an inductance switch is used, taps are taken off the coil five to ten turns apart.



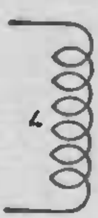
GRID-LEAK—With the grid-condenser method of detection some means must be provided to allow the negative charge on the grid of the tube to *leak off gradually;* otherwise the charge would build up until the tube was paralyzed. For this purpose a high-resistance path called the grid-leak is connected between the grid and the filament.



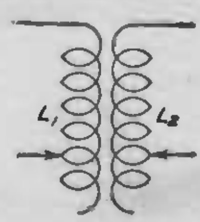
TELEPHONE JACK—The telephone jack gives us a means of using either the detector, or one or more stages of amplification at will. The ordinary jack for all but the last stage of amplification has four terminals. The last jack has two terminals connected in series in the plate circuit of the preceding tube. Jacks are used in the more modern sets.

GROUND—Fortunately a good ground *is* available to most of us; the solution of this important problem is the ordinary water-piping system of the house. The ground wire may be soldered to a brass fitting, or one of the faucets, or it may be connected directly to the pipe itself by means of a ground clamp. The pipe should be brightened up with a file.

KEY—The key is used for breaking up the high-frequency current into dots and dashes for radio telegraphy. In the old-time spark transmitters the keys were very ponderous. However, with continuous-wave apparatus there are places where even a small key may be inserted so that it will control the energy from several large vacuum tubes.



FIXED INDUCTANCE—The fixed inductance or coil is a continuous winding with two connections, one at the beginning and one at the end. It may take the form of the single-layer coil, bank-wound coil, spiderweb coil, honeycomb coil, etc. The purpose of the honeycomb coil is to decrease the distributed capacity.

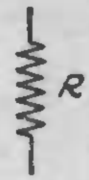


LOOSE COUPLER—The loose coupler is a less convenient device than the variocoupler, for coupling the primary and secondary circuits. The primary coil is stationary and is usually provided with a slider for varying the inductance by single turns. The secondary coil slides in and out of the primary to vary the coupling.

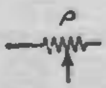
MICROPHONE—The ordinary carbon-grain microphone consists of two metal plates with a number of carbon grains between them. To one of the plates the diaphragm of the microphone is attached and the varying pressure of the diaphragm (caused by the sound waves) is transferred to the carbon grains. This varies the resistance of the electric circuit.

RECTIFIER TUBE—The rectifier tube is a two-element tube and will always have three terminals. Two of these are for lighting the filament and the third is the plate terminal of the tube. The connections of the rectifying circuit proper are to one of the filament terminals and the plate terminal. Such a tube may be used in an A. C. battery charger.

TELEPHONE PLUG—In connection with a jack, the telephone plug may be used to insert any given pair of telephones or any loudspeaker in the set instantly. There are usually only two connections to the plug, one to the tip and one to the sleeve, and the two terminals of the telephones or the loudspeaker are merely joined to these.



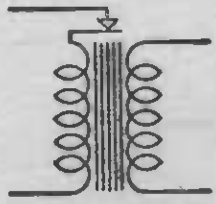
FIXED RESISTANCE—The fixed resistance can be used to couple amplifier circuits together, being placed in the plate circuit of one tube and the voltage drop across it used to operate the succeeding tube. Resistance coupling is not economical because a large quantity of the plate-circuit energy is lost in the resistance in the form of heat.



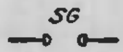
POTENTIOMETER — There are two principal uses for the potentiometer, the first being to vary the plate potential of a soft detector tube by connecting the negative "B" battery lead to the pointer of the potentiometer, and the second to vary the grid potential of radio-frequency amplifying tubes by connecting the grid return to the pointer.

RHEOSTAT — As the voltage of a battery gradually decreases with use, all tubes are designed to operate at a voltage somewhat less than that of the battery they are to be used with. The rheostat should, therefore, have sufficient resistance to cut the battery voltage down to the proper tube rating. The rheostat has two connections.

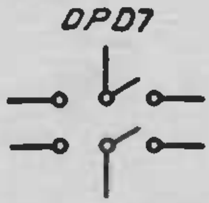
CHEMICAL RECTIFIER—The chemical rectifier cell usually consists of one lead and one aluminum electrode immersed in a saturated borax solution. For rectifying the plate current for vacuum tubes, a number of cells are connected in series, as the voltage is high and the current is rather low.



SPARK COIL — The spark coil is an instrument used to obtain a voltage high enough to jump a specified air gap, the discharge across the gap being used to send out waves at a radio frequency. The primary consists of a small number of turns and the secondary of many turns of fine wire.

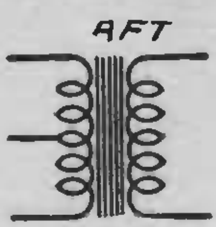


SPARK GAP—For any form of spark transmitter, some kind of spark gap must be provided. The gap may be a plain two-electrode gap, a quenched gap, or a rotary gap. The spark gap will always have two fundamental connections even if there are a large number of electrodes, such as in the more efficient quenched type of gaps.

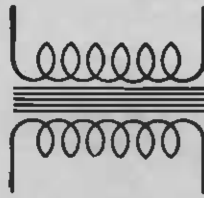


SWITCHES—The most common switches used in radio are the following: single-pole, single-throw (SPST) with two connections, single-pole, double-throw (SPDT) with three connections, double-pole, single-throw (DPST) with four connections and double-pole, double-throw (DPDT) with six connections.

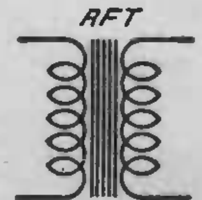
TELEPHONES—A good pair of telephones is essential for reception. There are two common types; in one the magnets act directly on the iron diaphragm and in the other they act on an iron armature which is mechanically connected to a mica or composition diaphragm.



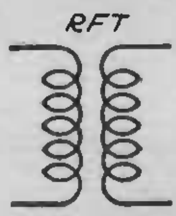
PUSH-PULL TRANSFORMER—For each stage of push-pull amplification we must have a special audio-frequency, input transformer with a tap at the center point of the secondary winding, and also a special audio-frequency output transformer with a tap at the center point of the primary winding.



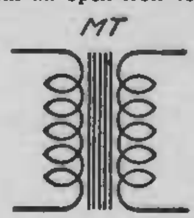
TRANSFORMERS—The transformer has two separate coils, both wound about the same closed iron core. The primary is the side connected to the source of power and has two terminals. The secondary is the side from which power is to be drawn at some voltage other than that impressed on the primary. Most transmitters use some form of transformer.



AUDIO-FREQUENCY TRANSFORMER—The audio-frequency transformer is merely a step-up transformer designed for voice-frequency currents. The primary is inserted in the plate circuit of one tube and the secondary in the grid circuit of the succeeding tube. The simple transformer has four terminals.

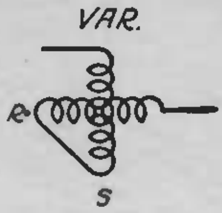


RADIO-FREQUENCY TRANSFORMER—The radio-frequency transformer operates on the same principle as the audio-frequency transformer, except that it is designed for high-frequency currents. It is often made with an air core. or at least with an open iron core,

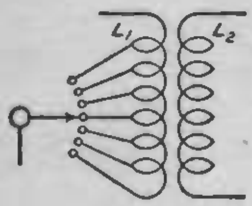


MODULATION TRANSFORMER—In order to couple together the microphone circuit and the grid circuit of a vacuum tube, a transformer must be used. Examples of this use are the grid-modulation, and Heising-modulation circuits. The modulation transformer is similar in appearance to the amplifying transformer.

VACUUM TUBE—The three-element vacuum tube has four terminals; two of these are the ends of the filament, the third is the grid, and the fourth is the plate. As there are no designations for these terminals on the tube itself, it is imperative to purchase a suitable vacuum-tube socket and follow out the circuit from the letters on it.

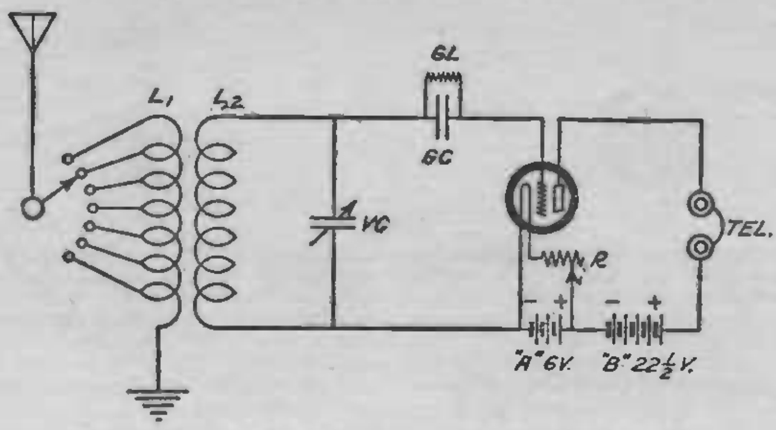


VARIOMETER—The variometer provides a continuously variable inductance (within the range of the instrument); it consists of two coils connected in series and mounted so that one rotates within the other. There are two connections to the variometer, one to the end of each coil; the opposite ends of the two coils are connected together.



VARIOCOUPLER—The variocoupler is one of the most widely used instruments for coupling and tuning the primary and secondary circuits; it consists of a stationary primary coil, and a secondary coil rotating within the primary coil, so that the coupling between them may be varied. The primary of the variocoupler is provided with taps for wavelength control.

VOLTMETER—The voltmeter is an instrument for measuring the potential difference (voltage) between two points in a circuit, that is, how much higher the voltage is at one point than at the other. For instance, it might be connected across the "A" battery to measure the difference in voltage between the positive and negative terminals.



A DRAWING FOR A STRAIGHT AUDION CIRCUIT

FIGURE 1: *Unless you know what these symbols mean, this diagram is unintelligible. This article tells you how to read it.*

How to Apply this Information to an Understanding of the Standard Diagram Above

From a reading of the foregoing the reader will notice that such instruments as the variable condenser, the variometer, the fixed condenser, the grid-leak, the rheostat, tuning coil, choke coil, battery and others have only *two* terminals.

The potentiometer has *three* terminals.

Most types of transformers have four terminals—two for the primary winding and two for the secondary winding. Push-and-pull transformers, it will be noticed, have five connections.

Tube sockets have four connections, one marked G for the grid, one marked P for the plate, and the other two marked F for the filament connections.

Variocouplers have a number of taps (inductance terminals) for the primary and two connections for the secondary.

Some of the other more complicated accessories have a large number of terminals; among these are motor generators, tapped coils and power transformers.

Consider the specific case of a variable condenser; if you see the symbol for this instrument in a circuit diagram you will always find two lines (wires) running to it, one from each side. If you were to connect this instrument in that particular circuit you would only have to connect these two wires to the two terminals that you would find on the condenser. This same line of reasoning holds true for instruments with three terminals, four, or more terminals.

In a variocoupler the primary coil is always the larger outside coil and the secondary is the smaller inside coil.

In a transformer (radio-frequency or audio-frequency) the primary terminals are marked P for the plate, and B for the wire going to the "B" batteries. The secondary terminals are marked G, for the grid wire and F for the wire leading to the filament.

The symbol for the vacuum tube, it will be noticed, contains four lead wires. The upper left-hand wire is the grid lead and when connecting up a vacuum-tube circuit this wire should always be connected to the terminal marked G on the tube socket. The upper right-hand wire is the plate lead and this should always be connected to the terminal marked P of the tube socket. The other two wire leads (in the diagram) are the filament connections and should be connected respectively to the terminals marked F on the tube socket.

Now let us study the diagram in Figure 1.

This is a standard diagram for a straight audion circuit. We will first pick out the instruments that are used in this circuit. By referring to the upper left-hand portion of the diagram we will find the triangular-shaped symbol for the antenna. Directly below it we find the symbol for a variocoupler. And below this we find the symbol for the ground. Then connected to the secondary of the variocoupler we find the symbol for a variable condenser. And in the center of the diagram we find the symbol for a vacuum tube. Directly below this we find the symbol for a rheostat and an "A" battery. Connected between the grid of the tube and the variable condenser we find the symbols for a fixed condenser and a grid-leak. To the right of the diagram at the top we find the symbol for the telephones and below this the symbol for a "B" battery. From this diagram, therefore, we learn that we need the following list of parts in order to make the set:

1—variocoupler;
1—variable condenser;
1—grid condenser;
1—grid-leak;
1—vacuum tube;
1—vacuum-tube socket;
1—rheostat;
1—"A" battery (for lighting the filament);
1—pair of telephones;
1—"B" battery (for supplying the plate current).

The next thing to do would be to obtain these parts of suitable sizes to incorporate in the set. The sizes for the various instruments are almost always given in the text of the article of which the diagram is a part. These sizes include the proper capacities for the variable condensers and fixed condensers, the proper resistances for the grid-leaks and rheostats, the proper type of tube to use for detector or amplifier and the proper voltages to use for the "A" batteries and "B" batteries.

To start wiring up a set like the one shown in the diagram the beginner should obtain the proper connecting wire, a soldering iron, some solder, soldering flux and a heavy red pencil.

A good layout for this particular set would be to mount the variocoupler at the left-hand end of the panel; place the variable condenser beside it, with the socket mounted alongside the variable condenser, at the right-hand end of the panel. The rheostat should be mounted on the panel directly in front of the vacuum-tube socket. The vacuum-tube socket should be mounted on the base with the plate and grid terminals turned toward the back of the set.

Now we should include on the left-hand end of the panel two binding posts, one for the antenna and one for the ground. At the right-hand end of the panel should be mounted six binding posts, the top two being for the telephone, the second pair for the "B" battery, and the bottom two for the "A" battery.

After the instruments have been mounted on a panel in a manner which will keep the connecting wires as short as possible, we should commence the actual wiring.

From the diagram we see that there is a wire running from the antenna to the switch arm of the variocoupler. Cut a piece of wire long enough for this purpose and solder one end of it to the back of the antenna binding post of the set. Then run the wire as direct and neatly as possible to the shaft of the switch arm on the panel.

When this is completed *take the red pencil* and cover the line you have just completed (on the diagram) with a red line.

In looking at the diagram hereafter you will know that you have already completed this connection; it will be evident at a glance.

Now you will notice from the diagram that there is a wire running from the ground to the bottom end of the variocoupler. Connect this to the back of the ground binding post and also to the variocoupler end. Then trace over this line on the diagram *with the red pencil.*

There are five taps to be connected to the swich points on the panel, from the primary winding of the variocoupler. Make these connections one by one and each time you complete one trace it over on the diagram *with the red pencil.* The primary circuit is then complete.

The top end of the secondary is then run direct to one terminal of the variable condenser. Make this connection and *use the red pencil.* It will be noticed that there is a joint from this wire leading over from the wire you have just connected which runs to one side of the grid-leak and one side of the grid condenser. Make this connection and trace over *with the red pencil.* Now connect a wire from the terminal marked G on the tube socket and run it to the opposite sides of the grid condenser and grid-leak to the connection you have just completed. Cover this *with a red pencil line.*

To get back to the variocoupler, we notice that there is a wire running from its bottom end over to the negative "A" battery. Make this connection on your set and again cover on the diagram *with the red pencil.*

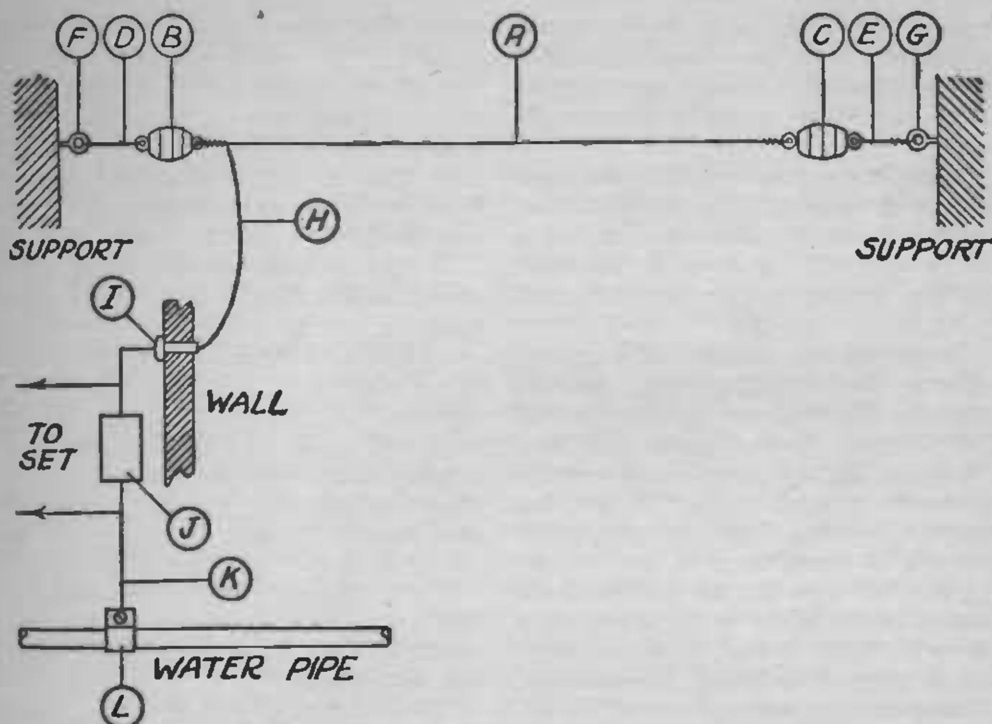
There are two branches from this wire, one to the remaining terminal of the variable condenser, and one to one of the terminals marked F on the tube socket. Make these connections separately, after which *use the red pencil* again.

Now there is a connection running from the positive "A" battery over to the negative "B" battery and this requires a wire connecting your A binding post and your B negative on your set. This wire also has a branch running to the pointer on the rheostat. Connect these and *mark off* on the diagram.

The other terminal of the rheostat is connected to the remaining terminal marked F on the tube socket. Do this and *mark off* on the diagram *with the pencil.* There are now two connections left to complete the wiring. One is a wire from the "B" battery positive to the telephones and this requires the connection of the binding post marked B and the nearest telephone binding post. The other wire should be connected between the remaining telephone binding post and the terminal marked P on the tube socket. *Mark off* the two last connections *with the red pencil.*

Now look at the diagram again. Are there any connections left *uncovered by the red pencil?* If not, the set is correctly connected and you have succeeded in reading an electric diagram!

Try this out and you will find that even the most complicated circuits are subservient to your wishes and you will never have any trouble and never will make any mistakes. There is nothing to it!



THE DETAILS FOR THE SINGLE-WIRE ANTENNA

FIGURE 1: *This schematic diagram shows how to install a receiving antenna from the water-pipe ground to the farthest support. All parts for the antenna are designated by letters which reappear in the text and the list of parts so that you can make no mistakes.*

HOW TO PUT UP AN

OUTDOOR RECEIVING ANTENNA

By ALBERT G. CRAIG

Here are the instructions for putting up the standard type of transmitting and receiving antenna such as is required for the successful operation of all of the sets described in this magazine

COSTS OF PARTS: *About $5.00*

HERE ARE THE ITEMS YOU WILL NEED—

Seven-strand, bare-copper wire, size No. 14 (enough for antenna A, supporting wires D and E, lead-in H, and ground lead K);
B and C—glazed porcelain insulators;
F and G—screw eyes;
I—glazed porcelain tube;
J—lightning arrester;
L—ground clamp.

A TRANSMITTING antenna is usually designed to fit the transmitting station, after due consideration has been given to its effective height and length in order to secure maximum radiation. On the other hand, a receiving antenna is often designed to fit the location, which is generally a satisfactory solution of the problem, as losses in the receiving antenna may be compensated by amplification, whereas any increase in transmitting power is necessarily costly.

Therefore let us consider the erection of an antenna from this viewpoint, not permitting, however, the use of a design that will cut down the efficiency of the system to an unsatisfactory point.

In general, the selection of a type of antenna for receiving only narrows down to the single or double-wire "L" or "T" type. Both of these types have the same "flat top" approximately parallel to the ground. The "L" type has the lead-in taken from one end, which gives it a resemblance to an inverted L; the "T" type has the lead-in in the center, which gives it the shape of a large T. Both of these types are directional along their length; consequently, if they can be pointed toward the desired transmitting stations, reception will be somewhat increased. On the other hand, a directional antenna will decrease the proportion of static received as these atmospherics come from all directions.

After you have decided on the "L" or "T" antenna (the L type is best for receiving), look over your available locations. If possible find two supports at least 30 feet high which will give an unbroken span of 100 to 150 feet or longer.

Do not run the antenna over or under any high-voltage electric light or power wires.

It will be best if one end (for the "L" antenna) or the center of the span (for the "T" antenna) is exactly over the window nearest the set, thus giving a *direct* lead-in.

Keep the wire at some distance (six feet if possible) from surrounding objects if you want to get the best results. For instance, if it is placed only one foot above a grounded metal roof, it will be practically equivalent to an antenna the same distance above the ground.

While masonry, wooden buildings and trees will not cause as poor results as a steel building, there will be a noticeable loss in signal strength if the antenna is run close to them for any considerable part of its length.

If two natural supports cannot be found to give the required unobstructed span, it will be necessary to provide one or both of them, probably by erecting a short pole. (It may be well to mention the fact that a wire strung back and forth several times to give a total length of 100 feet or a very short multiple-wire antenna containing that amount of wire is usually not at all satisfactory.)

Next, choose a point of entrance for the lead-in wire. This may be in the window frame, in the sash itself, or in the wall nearby.

Then select a ground. The most satisfactory ground is the nearest water pipe. Other less desirable grounds are the iron frame of the building or any large grounded metal system, such as the steam heating pipes.

Do *not* use the gas pipe for a ground as this is prohibited by the insurance companies.

Now that the general scheme for the entire antenna-ground system has been settled upon, let us consider the required apparatus, all of which is shown in Figure 1.

The antenna wire A, the short lengths of supporting wires D and E, the lead-in wire H, and the ground wire K may all be of seven-strand, bare-copper wire, size No. 14. The antenna insulators B and C should be a good grade of glazed porcelain, often being corrugated to give a longer insulating surface; F and G are two screw eyes large enough to take a firm hold in the antenna supports. The entrance bushing I, is a glazed porcelain tube long enough to pass entirely through the wall or the window sash as the case may be. The lightning arrester J, may be one of the small indoor vacuum-gap type and should be marked "Approved by the Underwriters' Laboratories." L is a good grade of ground clamp.

Summing up, it will be necessary to purchase the apparatus specified at the head of this chapter.

We may now proceed with the installation of the antenna.

First put the screw eyes F and G in the two supports. Then attach a one or two-foot length of wire E to insulator C and connect the other end of the wire to screw eye G; connect up insulator B, supporting wire D and screw eye F in the same manner. Note that the length of the supporting wires may have to be increased to clear obstructions. Feed the antenna wire out from the coil through insulator B and attach the free end to insulator C. Draw the wire taut and wrap the coiled end around the antenna wire by passing the entire coil around it about ten times; then uncoil sufficient wire for the lead-in H.

This method makes the antenna and lead-in continuous and saves soldering; with the "T" type antenna it is, of course, impossible to do this and the lead-in must be soldered to the center of the antenna before it is put up.

Next, bore a hole for the lead-in bushing with a slight slope downward toward the outside of the house, so that water will drip off instead of running inside; insert the bushing and pass the lead-in wire through it. Fasten the lightning arrester to the wall nearby and connect the lead-in to the top side of it, then run the wire to the antenna post of the receiving set.

It may be well to caution here that while only two antenna insulators and one porcelain tube have been called for, that some insulation such as a porcelain knob-insulator is necessary if either antenna or lead-in touches the house.

Prepare the "ground" by scraping the water pipe thoroughly, then attach the ground clamp and run the ground wire in the most direct line possible from it to the lower side of the lightning arrester, then on to the ground binding post of the receiving set.

THE COMPLETED SET

FIGURE 1: *How to adjust the crystal detector while rotating the switch that controls the tuning.*

HOW TO BUILD

AN EFFICIENT CRYSTAL RECEIVER

For local reception, the crystal set is still the simplest that will produce satisfactory results. Here is a re-creation of the famous Bureau of Standards receiver,* brought up to date with a suitable wavelength range.

COST OF PARTS: *About $5.00*

RECEIVING RANGE: *About 15 miles*

HERE ARE THE ITEMS YOU WILL NEED—

A. BASE.
Required:
One piece of seasoned wood, 8 by 5½ by ¾ inches;
four rubber-headed tacks.

B. SWITCH PANEL.
Required:
One piece of seasoned wood, 5¼ by 3½ by ½ inches; three No. 8 wood screws, 1½ inches long.

C. COVER (top removed).
Required:
Four pieces of seasoned wood, ¼-inch thick;
one piece, 5½ by 5⅛ inches;
two pieces, 4⅝ by 3½ inches;
one piece, 4¾ by 3½ inches;
brads or small screws.

D. TUNING INDUCTANCE.
Required:
One one-pint carboard carton;
two ounces No. 24 dcc copper wire.

E. TAP SWITCHES.
Required:
No. 24 (B. and S.) gauge spring brass sheet, 1 by 2 inches;
two knobs cut from one-inch fiber rod;
18 inches No. 20 (B. and S.) gauge piano wire.

*Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

two 8-32 brass machine screws 2 inches long;
eight 8-32 brass washers;
four 8-32 square brass nuts;
four 8-32 brass hexagon nuts.

F. Switch Points and Stops.
Required:
12 brass pins ⅛ to 3/32 of an inch in diameter and ¾-inch long;
four small brass pins, ½-inch long.

G. Crystal Detector.
Required:
One galena crystal mounted in a block of Wood's metal ½-inch in diameter and ¼-inch thick;
No. 24 (B. and S.) gauge spring brass sheet 2 by 2¼ inches;
eight inches of fine springy wire;
one 3/32-inch brass rod two inches long;
one ⅜-inch fiber rod ⅝-inch long;
two 8-32 brass machine screws one-inch long;
four 8-32 brass washers;
two 8-32 square brass nuts.

H. Binding Posts.
Required:
Four 8-32 brass machine screws, 1¼ inches long;
four 8-32 square brass nuts;
four 8-32 thumb nuts from dry cells;
eight 8-32 brass washers.

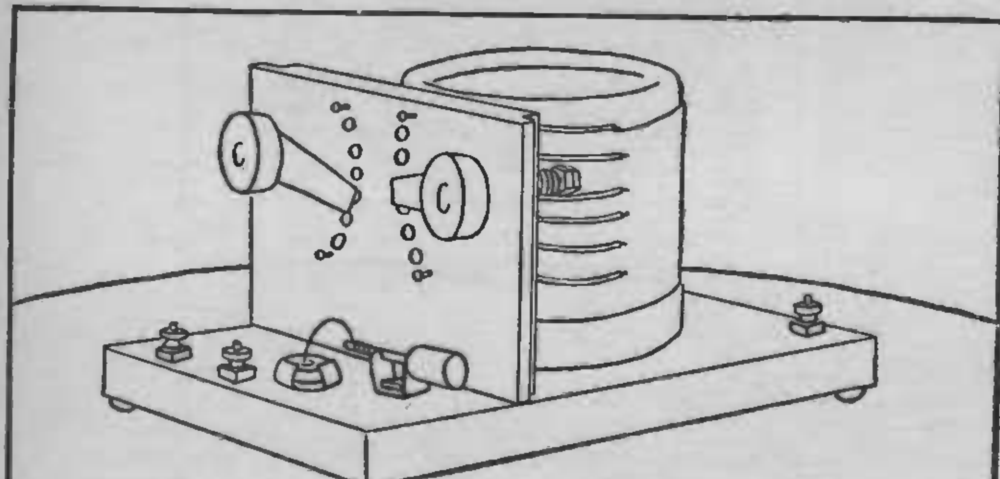
I. Connecting Wire.
Required:
Six feet No. 20 bare copper wire.

J. Miscellaneous:
Solder, *non-corrosive* soldering flux, stain and varnish (free from carbon pigment).

IN recent months the radio broadcasting services have been greatly improved. This development has been marked by a reduction of interference through the new assignment of wavelengths, a more uniform distribution of stations transmitting good musical programs (this includes the relaying of programs by wire before broadcasting) and a tendency for mediocre stations to discontinue transmission.

In the large communities there are now many thousands of people within a few miles of the Class B stations; from them comes a demand for simple receiving apparatus that requires a small monetary outlay. For this purpose a crystal set will give practically perfect reception.

A crystal set may be of rather elaborate construction or it may be very simple without reducing its efficiency. Its cost is then much less than a set equipped with a low-voltage tube.



THE COMPLETED SET WITH THE COVER REMOVED

Figure 2: *This shows what a neat-looking job can be made of the set if the experimenter takes the trouble to make every part as specified in this article.*

Other points, often overlooked, are clearness of signal, absence of distortion, and no operating cost. Although the crystal is a relatively insensitive device, there is no justification in statements frequently made in radio articles, which give the impression that there is a definite limit to its receiving range. From a low-power broadcast station the reliable receiving range of a crystal set is, say five miles; in winter the same set may receive high-power stations from a distance of three or four hundred miles.

This chapter describes a crystal set of satisfactory performance. All structural details are given so that one need not be in doubt as to dimensions. Attention is called to the importance of good mechanical design. This requirement includes convenience of adjustment, rigid connections, permanent contacts, light, stable contact of the fine wire on the crystal, elimination of jar-

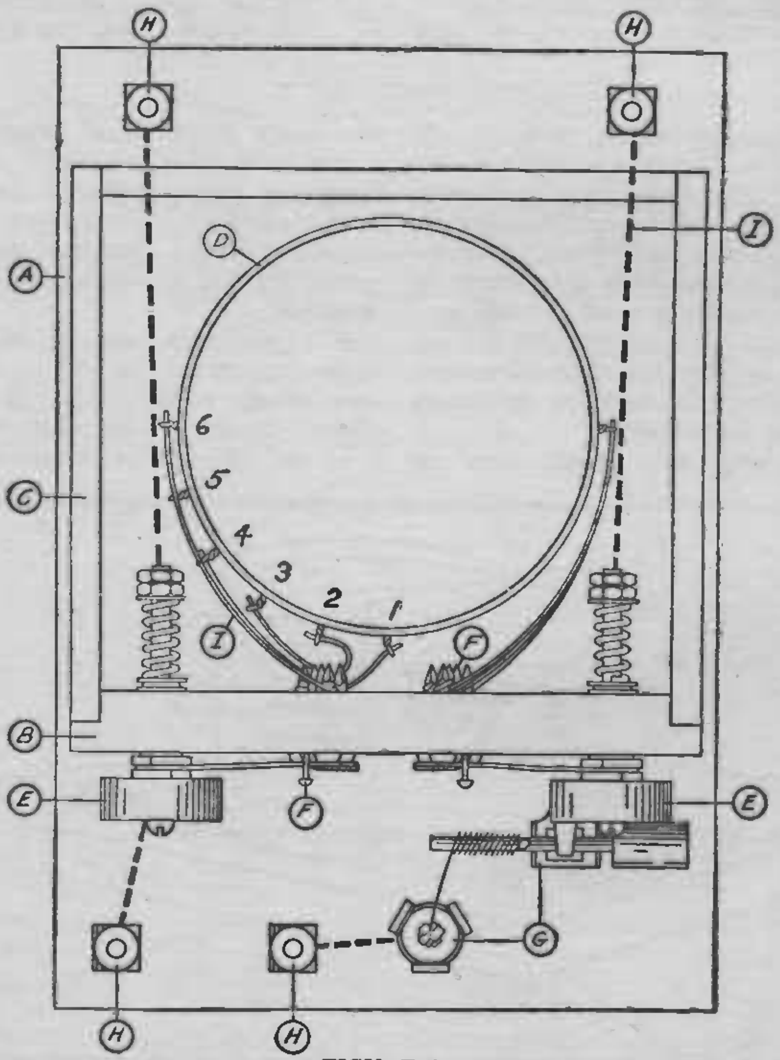


FIGURE 3

The working drawing of the set. This layout diagram shows the relative positions for all the instruments, as seen from above. The parts are designated by letters which reappear in the text and list of parts.

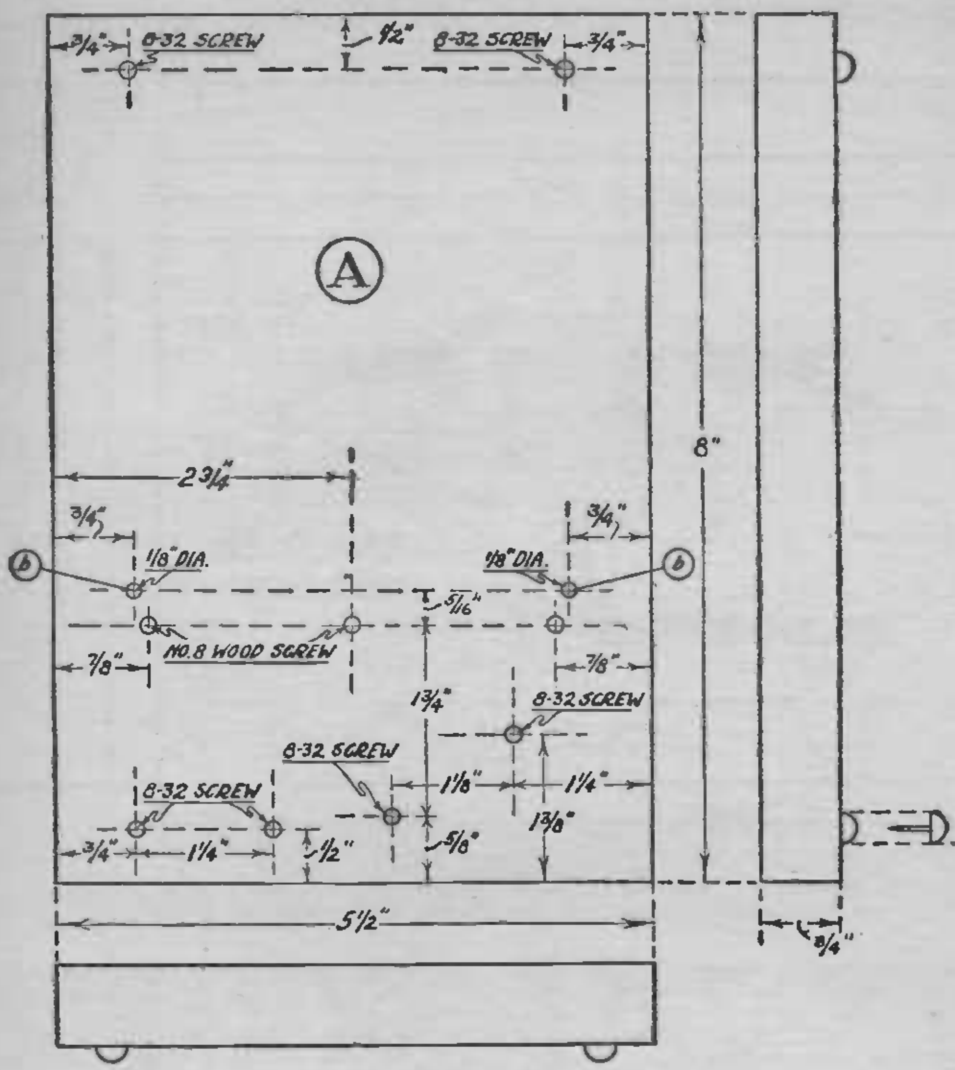


FIGURE 4

The dimensions of the base and the drilling plan. This drawing gives the front, side and top views of the base, together with the drilling data for the holes for the screws that are used to mount the instruments and binding posts.

ring and vibration from the tuning controls, and protection of parts from injury.

The parts of the set are arranged so that the connecting wires will be short and direct, and losses from unused turns on the tuning inductor have been reduced by cutting down the total number of turns. A variable condenser or phone condenser is not used. The former sometimes gives a little better selectivity but at the expense of signal strength; the latter is not necessary for broadcast reception. There is no objection to the use of wood for a switch panel. Tests show that there is less power loss in dry wood at radio frequencies than in the average insulating material used in radio panels.

Parts and Material

The completed set is shown in operation in Figure 1. Figure 2 is a picture of the set

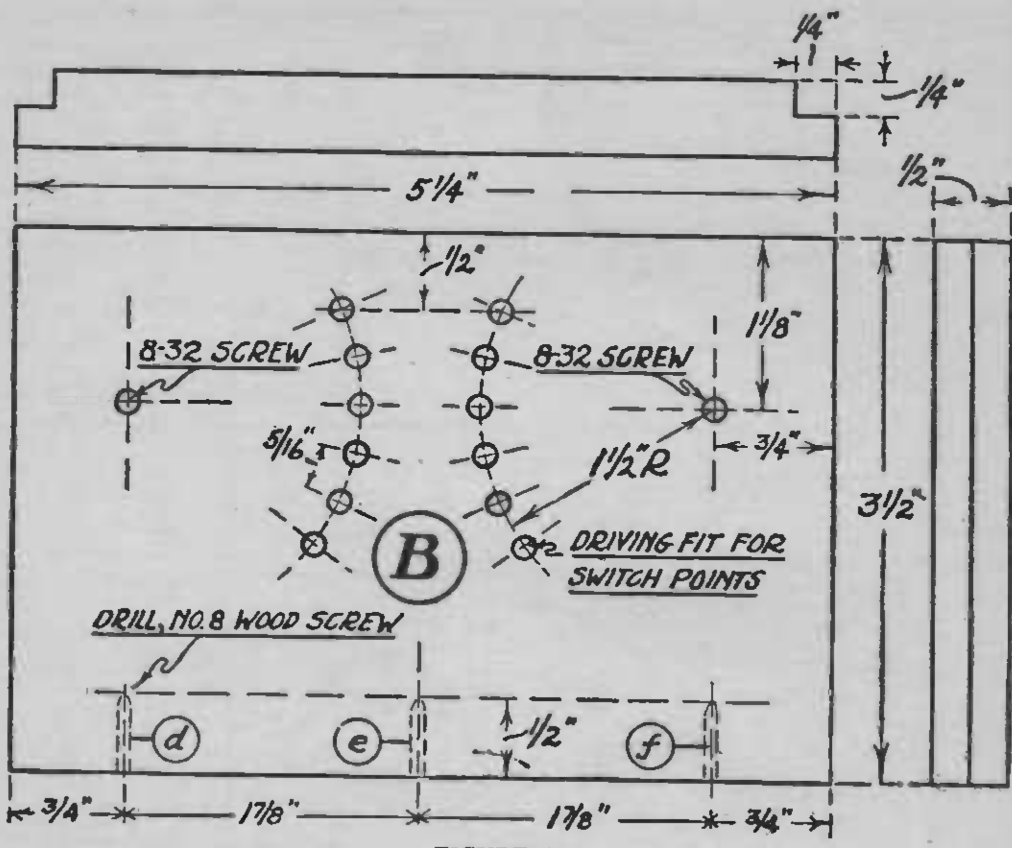


FIGURE 5
The dimensions of the switch panel and the drilling plan. This drawing gives the top, front and side views of the switch panel, together with the drilling data.

with cover removed. Figure 3 is a plan drawing and shows the parts and wiring. The list of parts printed at the head of this chapter names the specific items used and gives the material required to make them.

Construction

A. Base (Figure 4). All dimensions are given in the drawing.

B. Switch Panel (Figure 5). The spacing of the holes on the arcs is important to insure smooth operation of switches when switch points and switch blades are made as specified. Before the holes are drilled in the base and switch panel, these parts and the cover should be given a suitable finish. A dark finish will harmonize well with the exposed metal parts.

C. Cover (Figure 6). All dimensions are given in the drawing.

D. Tuning Inductance (Figure 7). This is made by winding wire on a one-pint cardboard carton, which as purchased, will be too long for the space requirements of the set. It is shortened to the dimensions shown in Figure 7a by cutting off a ring from the open end and also from the cover, and is here shown bottom side up with cover in place. The carton is wound with 76 turns of No. 24 dcc wire, starting with two small holes, b and e, and winding in the direction shown by the arrow. The wire fills the space between b, and the edge of the cover. In Figure 7 is shown the completed tuning inductance which has two terminals and ten intermediate taps. The terminals are made by forming the bare end of the wire into a small eye as shown. The intermediate taps are formed, while winding, by baring a ½-inch length of wire and twisting this into a small loop. The inductance may be dried in a warm oven.

E. Tap Switches (Figure 8). A completed tap switch is shown in Figure 8. Two switch blades are cut from No. 24 spring brass sheet, as shown in Figure 8a, with the grain of the metal running the long way. The end widths of switch blades are important and the edges of the blades must be bent up as shown, for smooth operation. Two knobs are cut from a fiber rod as shown at e, Figure 8. Two springs, as shown at b, Figure 8, are formed by wrapping 10 turns of No. 20 piano wire around a 3/16-inch rod clamped in a vise. The switch

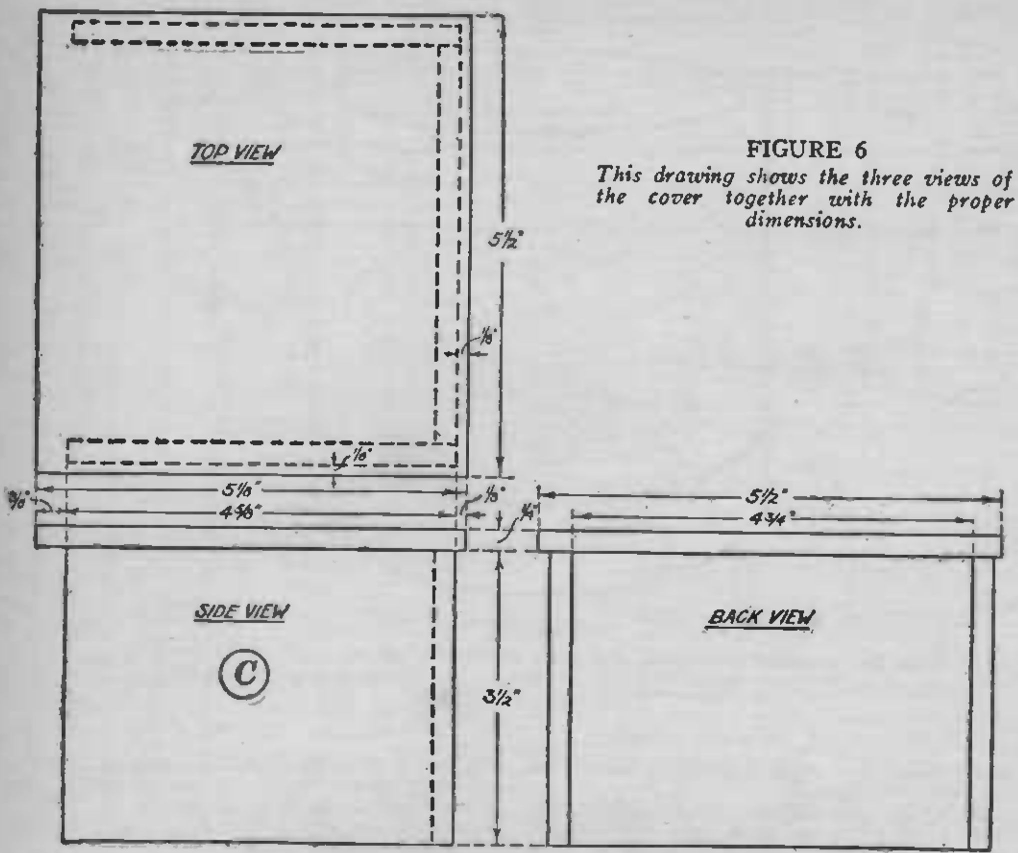


FIGURE 6
This drawing shows the three views of the cover together with the proper dimensions.

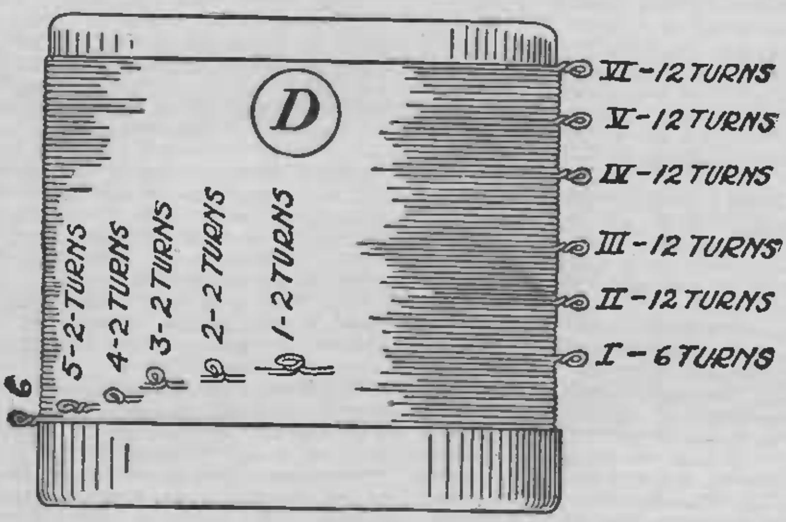


FIGURE 7
The completed inductance coil made on a pint-size container. This drawing shows the correct way to make the taps with the spacing between the taps indicated.

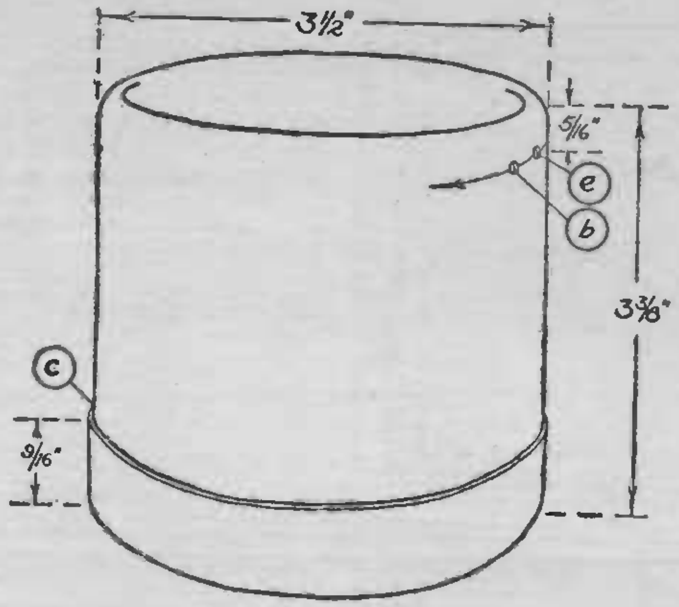


FIGURE 7A

How the container should be shortened by cutting off the end. This sketch gives the dimensions to which the tube should be cut down before starting the actual winding of the coil.

is assembled upon an 8-32 brass machine screw c, shown in Figure 8.

F. Switch Points and Stops (Figure 9). The switch points are made from 12 brass pins with heads surfaced off with a file or in a lathe. This work requires accuracy to insure smooth operation of switch blades. The switch stops are made from four small brass pins.

G. Crystal Detector (Figure 10). In Figure 10 are shown the assembled parts of the detector. These are: a clip b, holding a mounted crystal c; an 8-32 screw d, and nut e; a fine wire (catwhisker) f, wrapped around a rod g, and secured by a drop of solder h; a knob i; a rod-holder j; an 8-32 screw k, and a nut m.

The clip is cut and filed from No. 24 spring brass sheet as shown in Figure 10a, and bent into the shape shown in Figure 10. All brass sheet must be bent with caution, the bends being made slowly and kept well rounded.

The catwhisker is an 8-inch length of fine springy wire wrapped 20 times evenly around the rod g, and secured by a drop of solder h, so positioned that when the rod is placed in the holder the lateral movement will be equal to the diameter of the crystal. The fiber knob i, is forced on the other end of the rod.

In Figure 10b are shown the dimensions of the rod holder, cut and filed from spring brass sheet, so that the grain of the metal runs with the narrow tongue. When bent carefully into shape it appears as shown at j, Figure 10.

H. Binding Posts (Figure 11). Each binding post is made up of an 8-32 brass screw, two washers, square brass nut and a thumb nut taken from a dry cell. A groove b, is filed in two of the nuts to facilitate connections of telephone-receiver terminals.

How to Assemble the Set

Four rubber-headed tacks are driven into the corners of the bottom of the base as indicated in Figure 4. The panel (Figure 5) is laid face up on two supporting strips and the 12 switch points are forced into the holes, caution being observed to have the surfaces of all the points in the same plane.

The tap switches are placed in position as shown in Figures 3 and 8. The switch blades are bent as shown by the dotted lines, and when forced down upon the switch points by the spring b, final adjustments are made to secure smoothness of operation. The nuts f and k, are then locked.

The panel (Figure 5) is mounted by three wood screws passing through the base and into the holes d, e, and f. It then appears as shown in Figure 3.

The detector parts (shown in Figure 10) are loosely mounted—in the positions shown in Figure 3—the screw d, being cut off so that it will not project through the nuts. The four binding posts—shown in Figure 11—are then loosely inserted in the base (Figure 3). Connecting wires—shown in Figure 3—of No. 20 wire are run from the two rear binding posts up through two holes b (Figure 4) in the base, looped around and forced between the washers

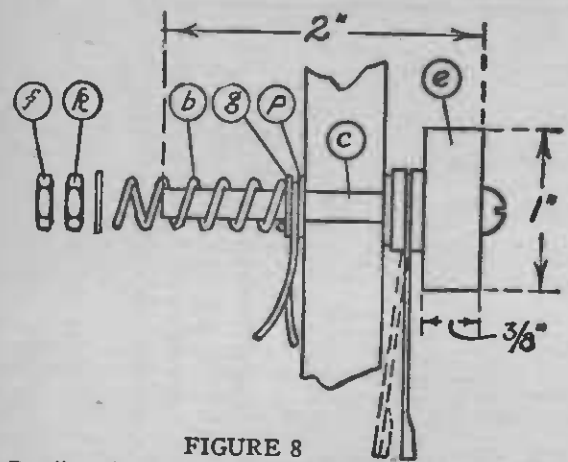


FIGURE 8
Details of the tap switch for wavelength control.

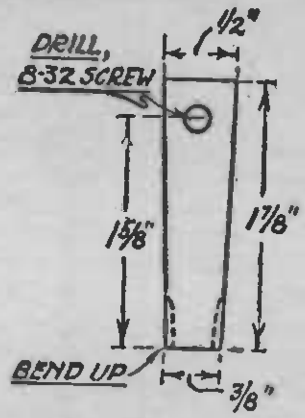


FIGURE 8A
How to cut out, drill and bend the switch blades.

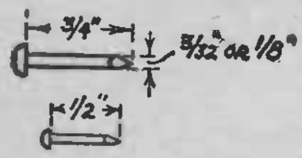


FIGURE 9
The dimensions for the switch points and stops.

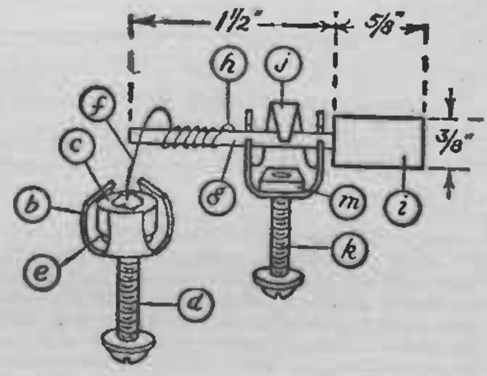


FIGURE 10
The complete detector assembly, showing the general arrangement of all the parts used.

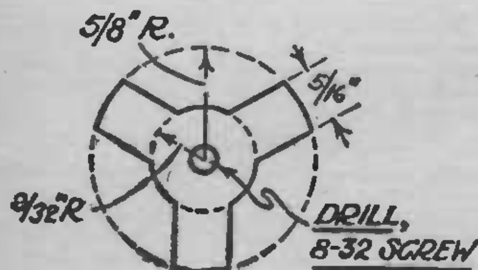


FIGURE 10A
How to drill and bend the clip for holding the crystal.

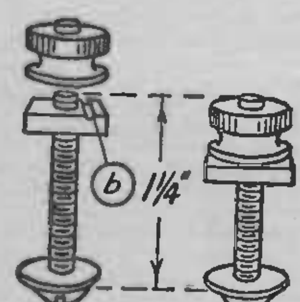


FIGURE 11
Sizes for the binding posts.

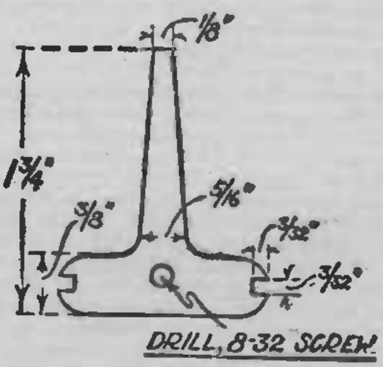


FIGURE 10B
The way to make the rod holder is shown here with the dimensions for drilling and shaping.

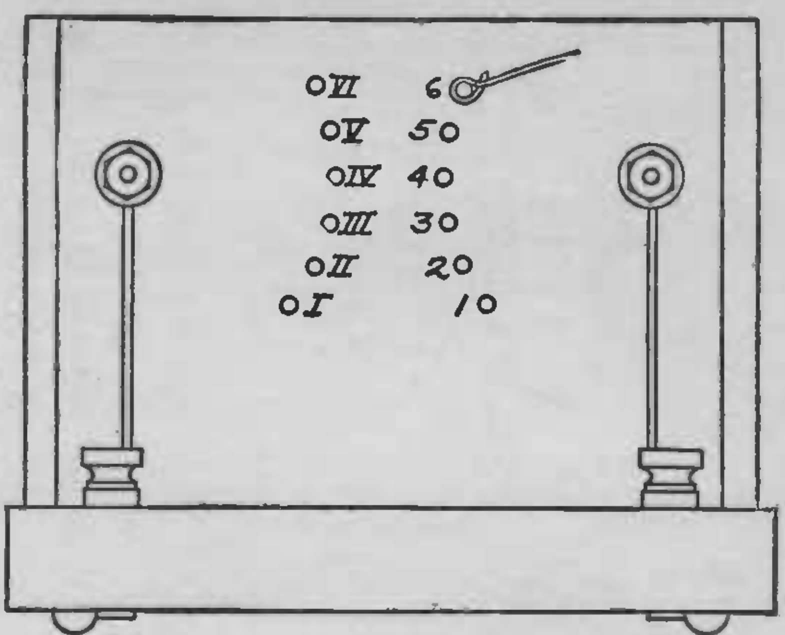


FIGURE 12

Assembling the panels and the switch points and binding posts. This is a view from the rear and shows how the switch points are forced into the holes drilled for them in the upright panel, and how the wire taps are connected one to each switch point. The two switch blades are connected by a wire to the two binding posts on the base.

g and p (Figures 3 and 8) back down through the base and thence connected to the left phone binding post and the screw securing the rod holder in place. One short length of wire connects the remaining phone binding post and the crystal. The wire ends are secured by looping around between the washers on the bottom of the base; the screws are then tightened until the nuts on top of the base become rigid. Before the crystal clip and rod holder are permanently secured in place a burr is formed on the edges which come in contact with the wood by bending down these edges slightly.

Twelve short lengths of No. 20 bare copper wire should be soldered to the switch points where they project through the rear of the panel as shown in Figure 12.

The cover of the tuning inductance is tacked to the base equally distant from the edges and one-half inch from the rear of the panel. The inductance is fitted into the cover and secured by glue or varnish. The location for the taps will be determined by referring to Figure 3. Tap 1 (Figures 3, 7, and 12), will be directly below switch point 1 (Figure 12). The twelve wires from the switch points (Figures 3 and 12) are formed into neat curves, cut off to the proper length so that they may just be inserted in the inductance taps, and soldered in place using a very small soldering iron and a small amount of solder. Switch points in Figure 12 are numbered to correspond to taps in Figure 7. Point 1, being most inaccessible is first soldered to tap 1.

The parts of the cover, shown in Figure 6, are fastened together with glue and brads (or small screws) forming the completed cover which gives the set the finished appearance shown in Figure 1.

How to Operate the Set

The antenna is connected to the right-hand rear binding post. The ground wire is connected to the left-hand rear binding post, thus bringing the phones near ground potential. The antenna wire is shown in Figure 1. An inspection is made of the mounted crystal to see that it is held firmly by the clip; the extreme end of the catwhisker should then be given a sharp diagonal cut with a pair of scissors.

Adjusting the set involves two operations:
(1) Securing a sensitive contact of the catwhisker;
(2) Tuning.

By means of the knob the point of the catwhisker is brought down lightly upon the crystal. The right switch blade is rotated slowly over its points and at each new position the left switch blade is rotated two or three times over its points. This operation explores all the inductance turns, two at a time. If there is no response in the phones, operations (1) and (2) are repeated and local stations should now be heard. Finally, when the switches are set at the most advantageous position, a more sensitive adjustment of the detector may be obtained by lifting the catwhisker and replacing lightly in various positions.

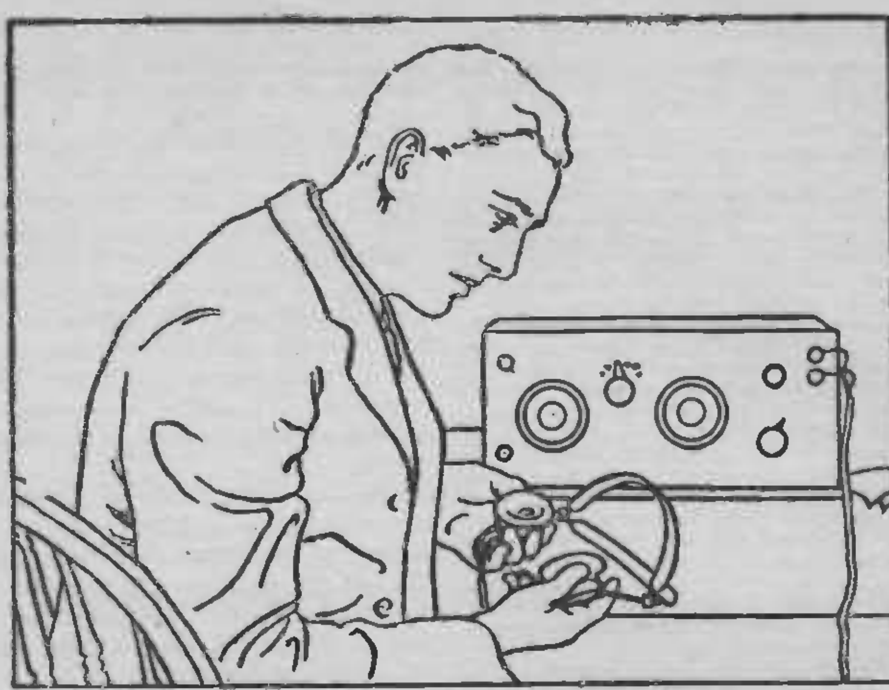
As the switch blades are moved *up* the wavelength of the set is increased. When the left switch advances one point the tuning inductance turns are increased by two. When this switch reaches point 6 the turns are increased somewhat less than two by advancing the right switch one point and returning the left switch to point 1. Thus, in tuning, as the successive turns are cut in, that part of the process which requires shifting both switches, will give a smaller wavelength increase.

The antenna may be a single wire 80 feet long (or two wires 50 feet long) and about 30 feet high. If the antenna is too large the number of inductance turns required to receive the shorter broadcast wavelengths will be so reduced that the signal strength will also be decreased. In this connection, most effective results will be obtained by keeping the antenna clear of obstructions and adjusting its length until signals from the longest wave broadcast station are heard with the switches near the upper points. With this set the writer obtained good recepton from a Class B station two and a half miles distant, using a small indoor antenna, but such an antenna is not recommended for a crystal set.

A telephone head-set having a resistance of 2,000 ohms or more will give good results. Reception from a considerable distance will be more satisfactory if phones priced above the conventional standard be used.

As the crystal is the life of the set, emphasis is laid upon the importance of securing a good one, which should not only be sensitive to weak signals, but which should give response from local stations at most random positions of the catwhisker. The crystal may be kept covered when the set is not in use, but after a time its surface may become insensitive. It may be cleaned with alcohol or soap and water and a clean brush.

The input terminals of a two-step, audio-frequency amplifier may be connected to the phone binding posts of this set and good volume of sound will be obtained from local stations. The use of the crystal detector gives signals of maximum clearness.



SIGNALS FROM LOCAL STATIONS CAN BE HEARD SEVERAL FEET FROM THE EARPHONES

How to set the dials for the initial tuning operations; the experimenter has tuned the receiver to 360 meters.

HOW TO BUILD THE

HAYNES DX RECEIVER

COST OF PARTS: *About $15.00*

RECEIVING RANGE: *From 500 to 1,500 miles*

HERE ARE THE ITEMS YOU WILL NEED—

A—Haynes 180° bank-wound variocoupler;
B—Haynes variable condenser, .00023 mfd;
C—Fada rheostat, 6 ohms;
D—Micadon fixed condenser, .00025 mfd.;
E—Fada panel-mounting socket;
F—switch and switch points;
G—tubular grid-leak, 2 megohms;
H—binding posts;
A1—three-inch knob and dial;
B1—three-inch knob and dial;
I—composition panel, 7"x15";
J—cabinet;
connecting wire;
varnished cambric tubing.

MOST of the radio receiving circuits that have stood the test of time and are in general use today fall into one of two classes as follows:

1. *The single-circuit regenerative tuner*, so called on account of the single-tuned circuit employed, is being incorporated in a good many receivers manufactured by well-known radio concerns. It is supplied in an attempt to meet the demand for a receiver that is easy to operate and on which fairly good long distance work can be done. It has the advantage of low cost of manufacture due to the few instruments used and the simplicity of the wiring.

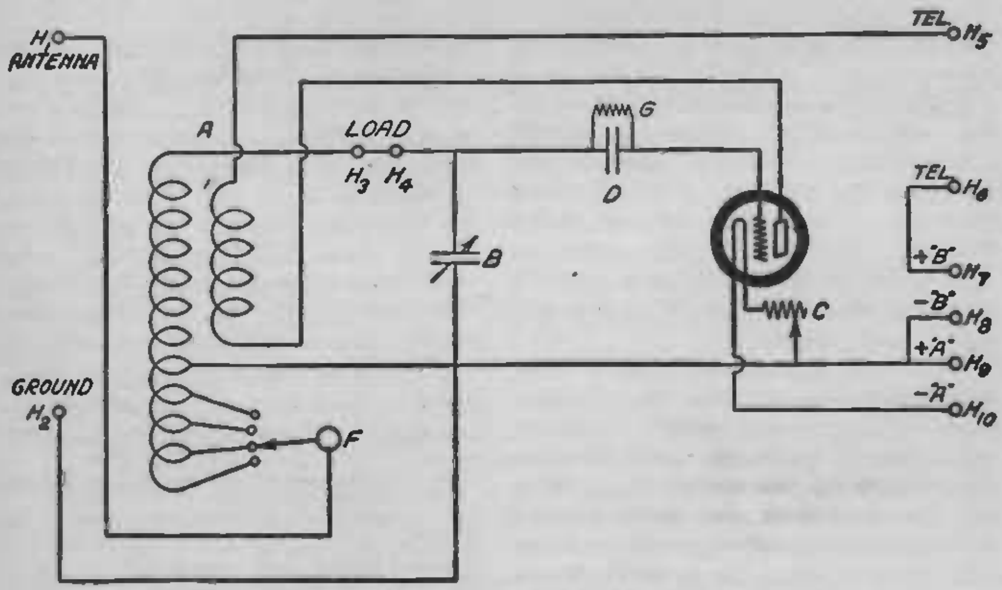
The tuner, however, has two marked disadvantages which prevents it from becoming very popular.

The first is a lack of selectivity. Hence, along the seacoast or near a metropolis which has one or more high power radio telegraph stations or where several broadcasting stations are operating, this type of circuit is hardly practicable, due to the great amount of interference prevalent.

The second disadvantage is that this circuit is an interference producer; that is, it is a transmitter while oscillating and sends out a strong CW wave which interferes with the reception in neighboring receiving sets.

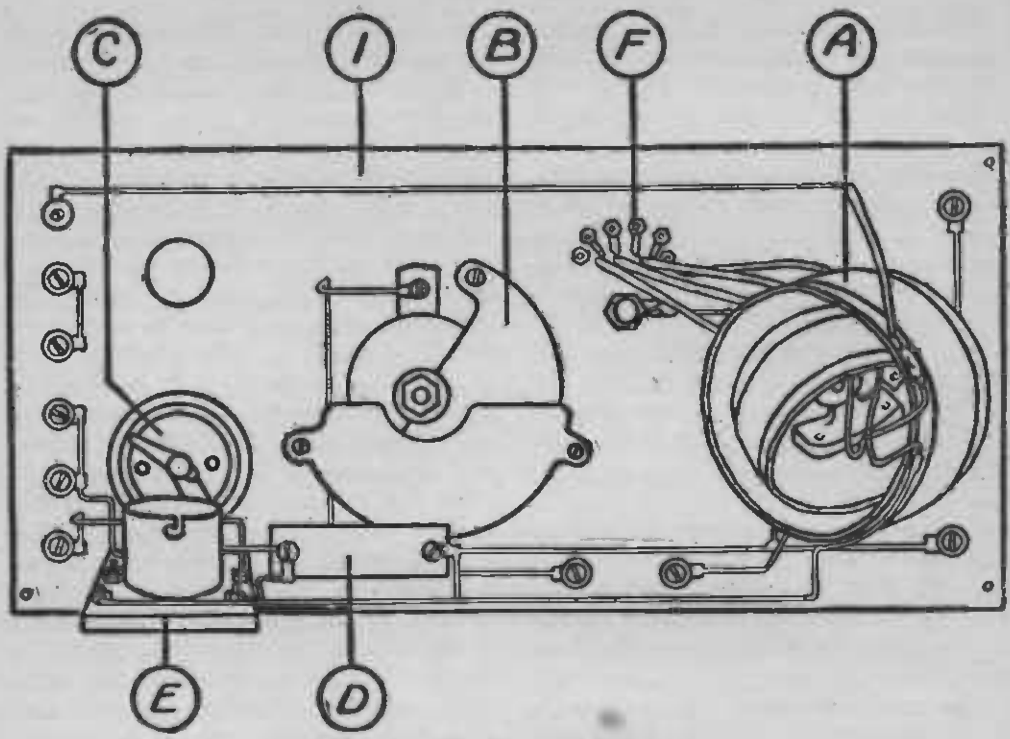
2. *The three-circuit regenerative tuner* receives its name from the fact that it contains three separately tuned circuits. It is an extremely good receiver capable of doing fine work in the hands of an experienced operator. It possesses efficiency and selectivity to a marked degree. But—it is a hard circuit to learn to operate properly. Unless the operator knows *what* he is doing and *why* he is doing it, he cannot hope to obtain the best possible results. Moreover, due to the several instruments used, it is rather costly and somewhat complicated in mechanical construction to say nothing of the complexity of the circuit and the difficulty of wiring it properly. While many radio experimenters build sets of this type which give them good results, it is seldom that one of these home-made, three-circuit receivers operates at maximum efficiency. This is because in such a receiver, so much depends upon small details in design and construction and careful balancing of the various circuits, points which require the knowledge and experience of a good engineer.

In the Haynes circuit, which is described here, practically nothing has been sacrificed. It is not a compromise, but possesses most of the good points of both of the above circuits with none of their disadvantages. The tuning is simple; similar to that of the ordinary single-tuned circuit. At the same time it is selective, making it possible to reduce interference to a minimum. Furthermore the audibility or strength of signals from nearby or long distance



THE ELECTRICAL CONNECTIONS FOR THE PARTS USED IN THE CIRCUIT

FIGURE 1: *The parts are here designated by the same letters that designate them in the text of the article and in the list of instruments.*



A REAR VIEW OF THE RECEIVER

FIGURE 2: *This picture of the interior of the set gives the novice an idea of the arrangement of the parts and shows him more clearly the exact connections than does the electrical diagram on the preceding page.*

stations is as good as in the three-circuit tuner.

Figure 1 is a schematic diagram of the new simplified regenerative circuit. Those familiar with radio diagrams will recognize the similarity of this hook-up with that of the regular triple-coil, tickler feed-back circuit—with one exception: *The primary circuit is semi-aperiodic* and is conductively coupled to the secondary grid circuit.

Ordinarily the editors do not recommend that any but the most experienced of our readers should attempt to make certain apparatus, partly because the average fan has neither the facilities nor the experience, and partly because the results of his efforts would in many (if not most cases) be unsatisfactory—and the circuit described would be blamed for the failure. For the benefit of the more experienced few, however, the specifications are submitted below.*

The heart of the circuit is the secondary tuning condenser. The best obtainable variable condenser should be used here, as a cheap one, particularly in this circuit, is very poor economy. Its maximum capacity should not be greater than .00023 mfds. A larger condenser makes the tuning too critical. For best results the condenser used should have a *low minimum capacity.*

Many modifications may suggest themselves to the builder to meet this particular fancy. However, the specifications

* The coupler specified for the Haynes and the super-heterodyne circuits:

A coupler which will be suitable for use in the Haynes circuit may be made by winding, on a 3½-inch composition tube, 65 turns of No. 22 DSC wire (for the secondary) and continuing this winding for ten turns more (for the primary). The primary is tapped at the second, fourth, sixth and tenth turns. Both the secondary and primary are on the stator tube. The rotor tube is a 3-inch tube with 35 turns of the same kind of wire, and is made for rotation over 180 degrees.

given in the following instructions will produce an exceptionally good receiver for both amateur and broadcast reception.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts printed at the head of this chapter includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with excellent results.*

All instruments listed are capable of panel mounting, making assembly a very simple task and providing a particularly neat layout.

How to Construct the Set

The first step in construction is to prepare the main panel I.

Almost any of the good, standard panel materials are suitable for this purpose.

If a dull or satin finish is desired on the panel, it may be done as follows:

After drilling has been finished, following the instructions and dimensions in Figure 3, a small quantity of ordinary machine oil is placed on the front side of the panel, and it is then rubbed with a fairly fine grade of emery cloth or steel wool. Rub in only one direction, back and forth lengthwise of the panel. When the surface has attained the desired finish, the panel should be cleaned off with a dry cloth, taking care to remove excess oil from the holes.

The builder can either have the panel engraved, and this is advised, as it adds to the appearance of the set immeasurably, or he can simply scratch indicating lines for the dials with a sharp pointed scriber and a ruler, filling them in with "flake white."

If the panel is to be "dulled" or "grained" as explained above, it may be laid out for drilling by using a sharp pointed punch or scriber. Guide lines may thus be scratched directly on the panel, where necessary, and punch marks made at points where holes are to be drilled. Care should be taken of course, that these lines are not scratched too deeply, so that they will disappear when the surface is rubbed down.

Next, mount the variocoupler A, by screwing onto the panel I, in the position indicated in Figures 2, 4 and 5, and attach the knob and dial A1, by means of a set-screw.

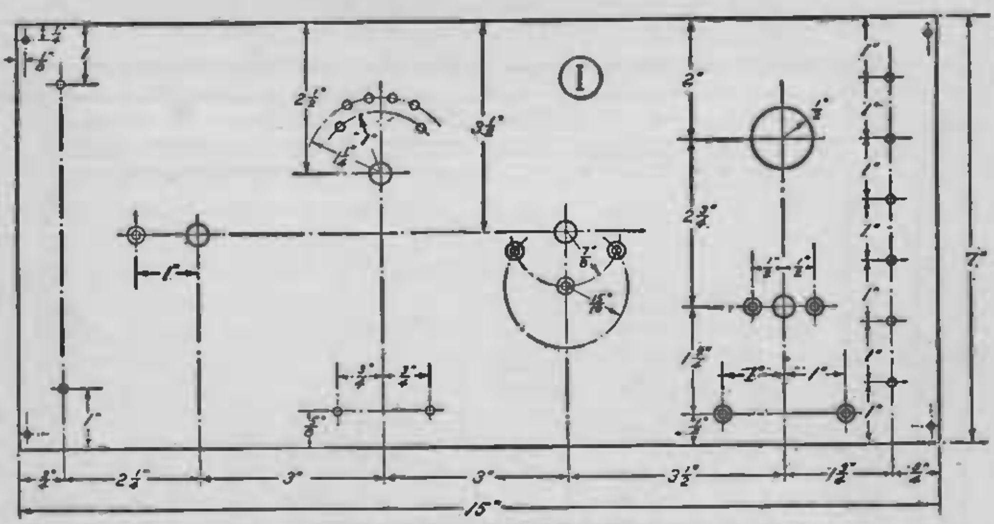
Then attach the condenser B, to the panel with three screws and put on the knob and dial B1, as shown in Figures 2, 4, and 5.

The socket E, may now be screwed to the panel as shown in Figures 2, 4, and 5.

Attach the rheostat C, and small knob C1, in the manner indicated in the drawings in Figures 4 and 5, and fasten the binding posts H, which are screwed to the panel by round head screws.

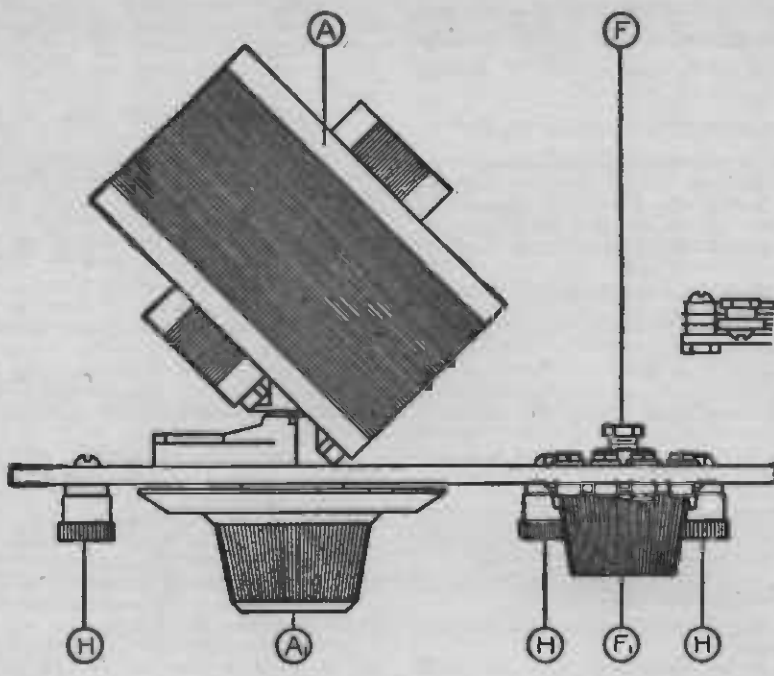
The small fixed condenser D, is supported by the wiring and this may be left until the set is connected up.

The last construction job to do is to mount the switch and switch points. This should be done as shown in Figures 2 and 4.



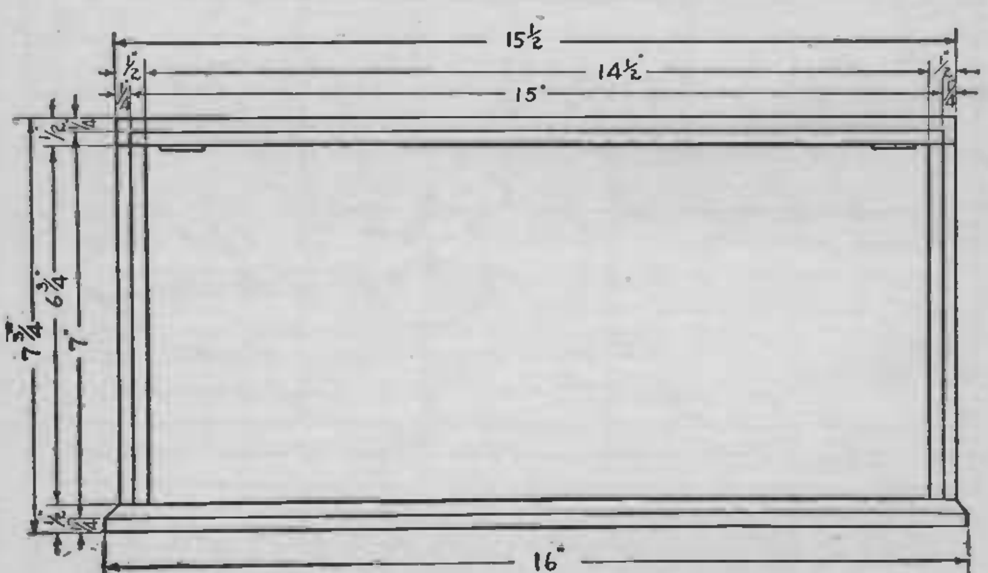
THE LAYOUT OF THE PANEL

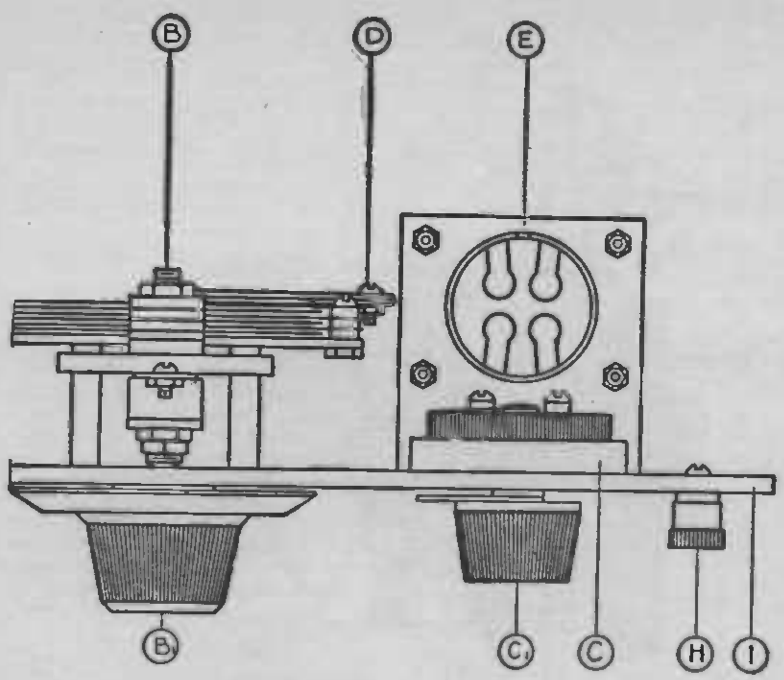
FIGURE 3: *This diagram gives the dimensions for the panel I and the spacing for the drill-holes for mounting the instruments that are specified in the text.*



THE WORKING DRAWING SHOWS HOW—

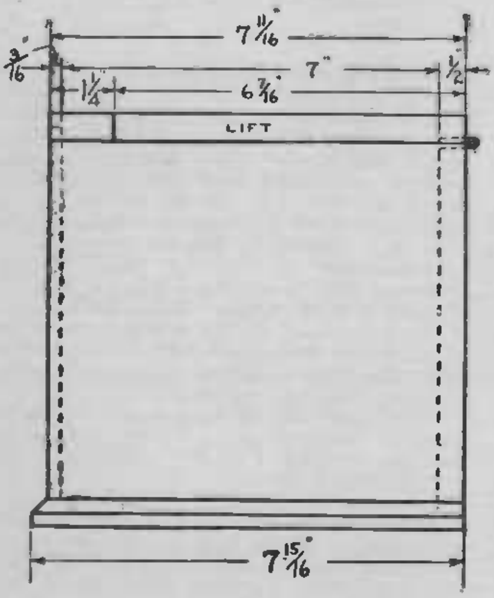
FIGURE 4: *A view of the set from above, showing the exact positions for the coupler, the condensers, the rheostat, the switch, the socket and the binding posts. The instruments will fit exactly as shown on this diagram if the drilling plan drawn in Figure 3 is followed out exactly.*





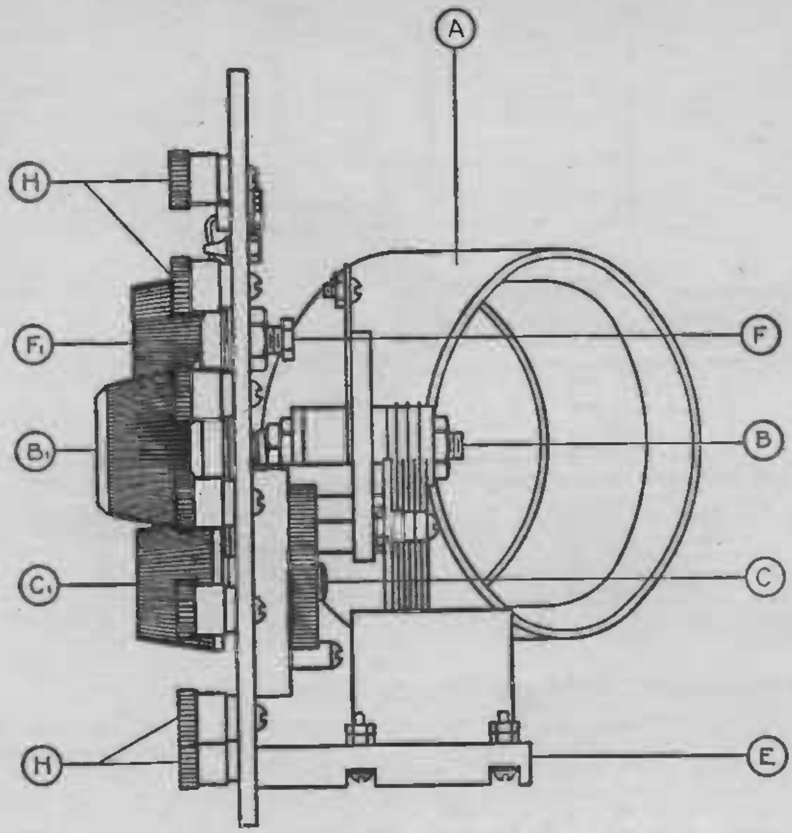
—TO PLACE THE INSTRUMENTS AND ASSEMBLE THE SET

It is recommended that the plan shown here be rigidly followed, as it has been carefully worked out and the instruments have been placed in their respective positions, as shown above, with a definite purpose in view—efficiency.



HOW TO BUILD THE CABINET

FIGURE 6: *The drawings at the left give the detailed instructions and dimensions for building the cabinet—which you can make yourself or which can be turned over to a cabinet maker. It should be finished in hardwood and polished or buffed according to the taste of the builder.*



A SIDE VIEW OF THE SET—AS SEEN FROM THE RIGHT

FIGURE 5: *In this drawing is shown the method of mounting the coupler, the condenser, the rheostat, the socket and the binding posts. The knobs and dials are fastened to the shafts of the instruments (where they protrude through the face of the panel) by set-screws.*

The outline of this set is as simple as it has been possible to make it and for this reason the use of telephone jacks has been eliminated; the telephones are connected direct to the two top right-hand binding posts.

The size and general plan for making the cabinet are shown in Figure 6, and this may be constructed of hardwood by the prospective builder, or the diagram may be cut out of the article and given to a cabinet maker who will be able to make the cabinet from the instructions contained therein. Or, it may be purchased from many of the radio stores, as it is of standard size.

When the work of construction is at last complete, all that remains is to correctly wire the instruments.

How to Wire the Set

Many people who take great pains with the mechanical appearance and construction of their apparatus, fall down miserably when it comes to wiring the set. This is unnecessary, as it takes little extra effort to wire a set neatly than it does to do it in a slipshod manner.

Number fourteen hard drawn tinned copper wire is recommended for this purpose or the square, tinned copper, bus-wire may be used if desired. "Spaghetti" (varnished cloth tubing) should only be used where necessary. A well designed set should need little of it. It is useful, however, for covering the leads from switch taps which are made with smaller wire. (No. 24 is suitable for this purpose.)

Small copper or brass lugs should be used on connections to binding posts, etc., and the connecting wires soldered firmly to these.

The method and general arrangement of the wiring can be easily followed in Figure 1. For those who cannot follow a regular diagram, Figure 2 should make it clear. The two posts marked "load" should be bridged (connected together) when receiving lower wavelengths. For longer waves a loading coil may be inserted between them.

The connections to lugs should be carefully soldered. Do not use acid as a flux, soldering paste may be used if care is taken not to use too much. Use very little and wipe it off again before applying the iron, otherwise it will spread over adjoining surfaces and cause corrosion and leakage in the set. The author uses "rosin core" solder almost exclusively rather than paste or acid. This is somewhat harder to handle, however, and the surfaces must be thoroughly cleaned before tinning. This solder used in conjunction with the paste is a satisfactory combination and quite easy to manipulate. Make the soldered joints neat. A small drop of solder, properly run over the joint, is just as effective and much neater in appearance than large gobs which disfigure the wiring.

Operating Data

After having connected batteries, phones, antenna and ground to their respective binding posts, insert the vacuum tube in its receptacle, making sure, however, that the rheostat is turned all the way to the left or "off" position.

Place the left hand or tickler dial A1, at O, and the condenser or tuning dial B1, at about 50. The switch knob, F1, should be placed on the tap which leads to the extreme end of the coil. Turn on filament current by rotating rheostat knob C1, until a slight hiss is heard in the phones, then turn back until hissing sound disappears. (This applies only to UV-200 or other "gas" tubes. For WD-11 or WD-12 tubes turn on rheostat until filament shows dull red.)

Rotate tuning dial B1, slowly until desired station is heard. The signal may then be made stronger by increasing tickler dial A1, gradually while at the same time retuning slightly with condenser B1. If this reduces the signal strength instead of increasing it, reverse connections to tickler or inside coil. The signal strength may be increased with the tickler up to the point where the set breaks into self-oscillation. This condition is recognized by the musical whistling note which is heard when the condenser B1, is moved slightly off tune. The set is in its most sensitive condition just before it begins to oscillate or, in other words, when it is regenerating at a maximum.

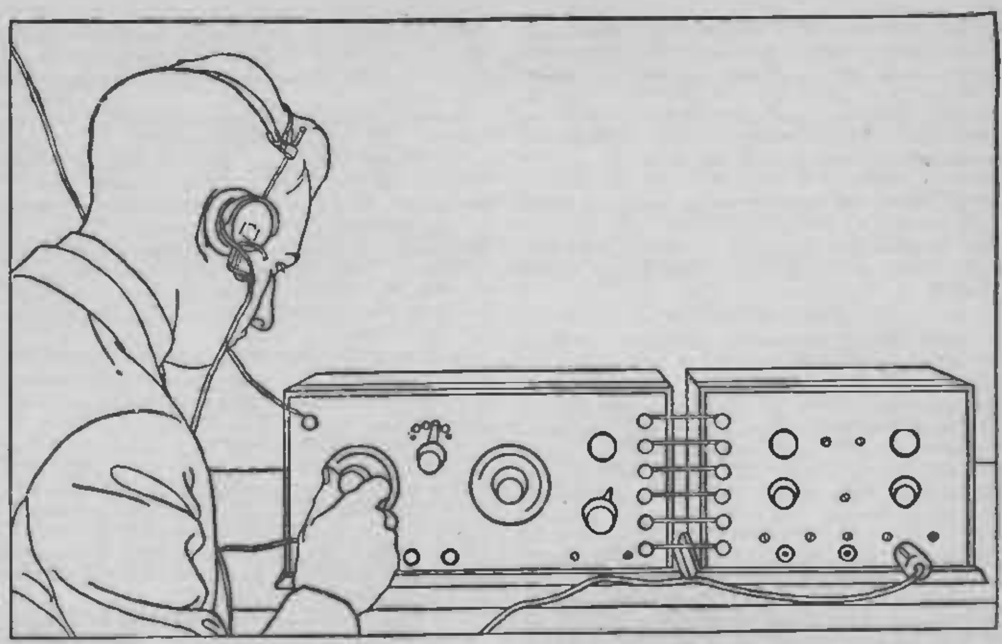
Loudest signal strength will usually be obtained when the primary switch F1, is set as indicated above, on the last tap, so as to include all ten turns on the primary circuit. However, if some undesired station is causing interference this switch should be moved back on one of the other taps and the set retuned. The further back this switch is moved or, in other words, the fewer turns of wire in the primary circuit, the sharper the set will tune.

The two binding posts marked "load" in Figures 1 and 2 can be omitted entirely unless it is desired to tune to wavelengths of over 550 meters.

The above instructions will give the novice a general idea of the operation of this set. After a few hours of operation he will become familiar with the tuning adjustments, enabling him to pick out the station he desires at will, and if his antenna and local conditions are at all favorable he should be able to do excellent long-distance work.

As an example of what this set is capable of doing the following is an instance: In a New York suburb, just outside of the city, using a one-wire antenna 35 feet high and 125 feet long, the following broadcasting stations were copied during one evening: Chicago, St. Louis, Louisville, Atlanta, Boston (WGI), Fort Worth, Texas. Minneapolis, and Havana, Cuba.

This was with a single-tube set built by the author and operated by an average business man who knew little or nothing about radio theory. The set was identical with the one described herein and the operator had had less than one week's experience with it.



THE COMPLETED AMPLIFIER

Here is the instrument (on the right) as it appears when connected to the tuner (on the left). It is equipped with jacks so that the detector or one or two stages of amplification may be used at will.

HOW TO MAKE A TWO-STAGE
AUDIO-FREQUENCY AMPLIFIER

COST OF PARTS: *About $15.00*

HERE ARE THE ITEMS YOU WILL NEED—

A—Ford-Mica amplifying transformers;
B—Fada panel mounting tube socket;
C—Dubilier mica fixed condenser, .002 mfd.;
D—Federal jacks, two double circuit and one single circuit;
E—Fada rheostats, 6 ohms;
F—Haynes-Griffin binding posts;
G—composition panel;
H—cabinet;
connecting wire;
varnished cambric tubing (spaghetti);
connecting tabs.

IN the design of an amplifier for use with a detector and tuning unit, to strengthen the currents which actuate the telephone receivers, there should be four main objects aimed at. These are:

A—Maximum amplification with a specified number of tubes.

B—Minimum noticeable distortion of signal currents.

C—Amplifier should work well on all types of tubes.

D—Simplicity in construction and operation.

Due to the fact that music and voice signals have such a wide range of frequencies, it is important that the transformers have a wide range also. This means that the amplifier should have a flat curve of response and that the curve should be as high in amplitude as possible. (The curve under consideration refers to "audibility amplification" plotted against "frequency.")

Here we see that the amplifier must

have A, at all frequencies within the audible range and so insure B; if the amplifier possessed A, at one particular frequency or band of frequencies, this frequency would be brought out and amplified more than the others and distortion would surely follow.

In the amplifier described, all these points have been incorporated by Mr. A. J. Haynes the designer; the radio fan should be able to make a first-class amplifier from these directions, with little trouble.

The amplifier was designed especially to go with the single-tube Haynes-circuit receiver (described on page 30 of this book), which it matches in size and general design, as is shown in the drawing at the head of this chapter. In this picture the cabinet at the left contains the tuning and detector unit and the cabinet at the right contains the amplifier unit.

The amplifier may be used, however, with any type of detector and with any tuning circuit that you have on hand. It will operate on the same "A" and "B" batteries that you use on your present tuning and vacuum-tube detector unit. For loudest results, however, an additional 45-volt "B" battery should be used on the amplifier.

The electrical circuit diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts given at the head of this article includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel for mounting them.

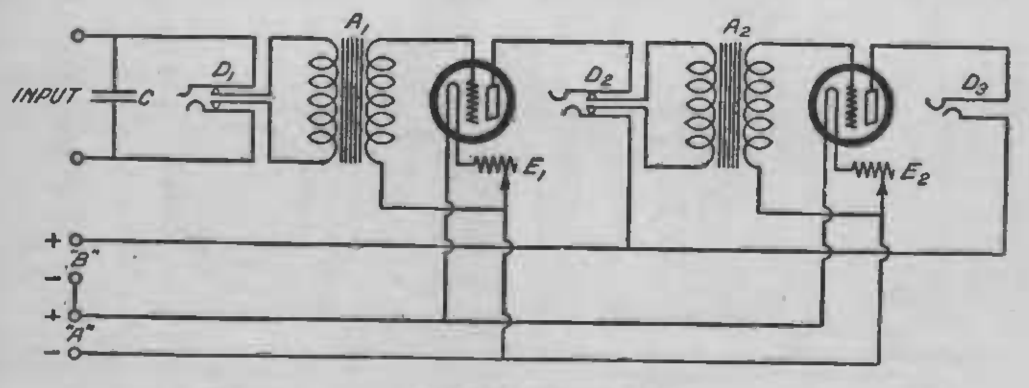
How to Construct the Amplifier

After procuring all the instruments for building the receiver, the amateur should set about preparing the panel G (shown in Figures 2, 3, 4, and 5).

First of all, the panel should be cut to the correct size (7 by 10 inches); then the edges should be squared up smoothly with a file. The center for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the



THE CIRCUIT DIAGRAM

FIGURE 1: *This gives the exact electrical connections for the apparatus used in the amplifier. The parts are designated by letters which correspond to those used in the text and in the other diagrams and illustrations.*

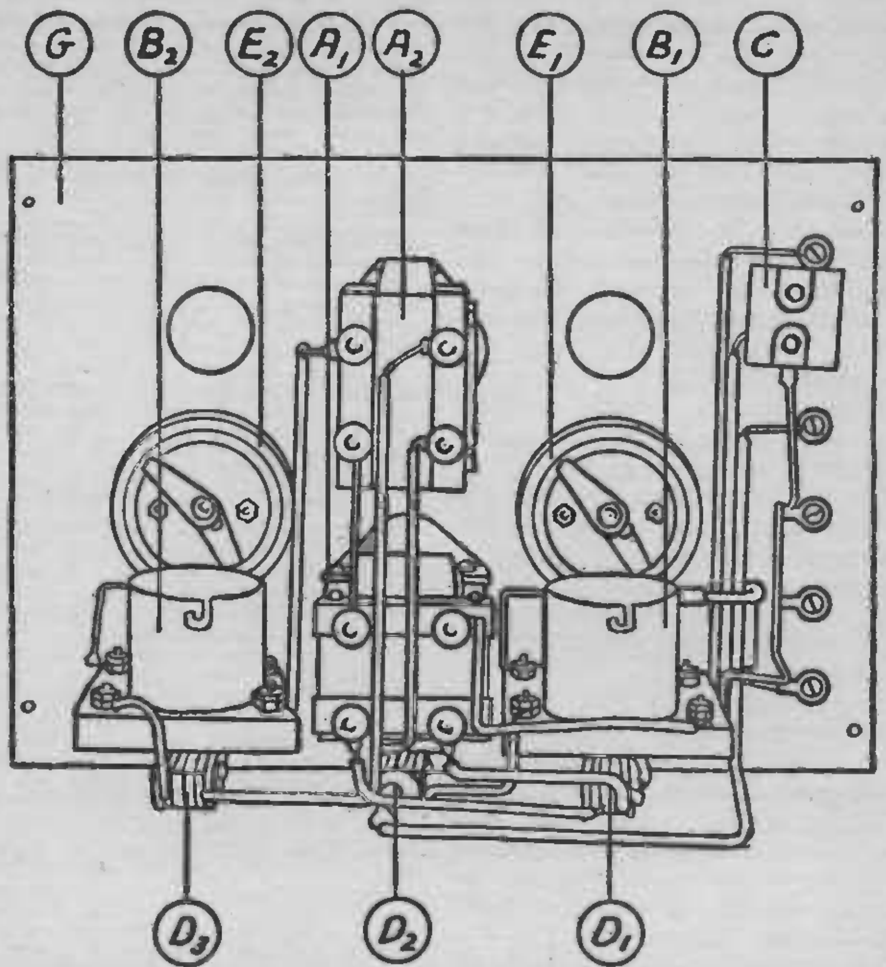


FIGURE 2: *This picture shows the interior arrangement of the apparatus.*

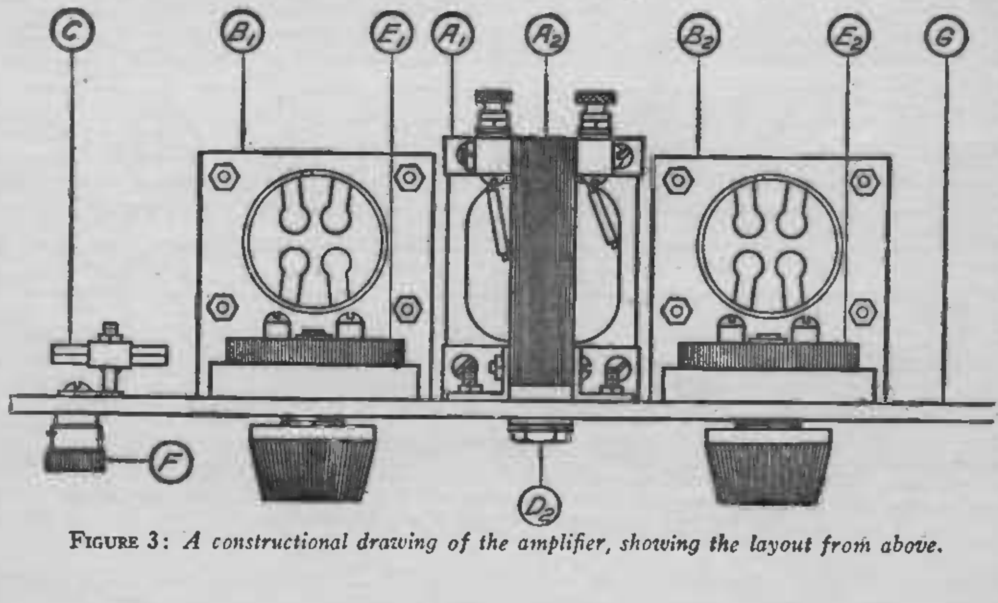
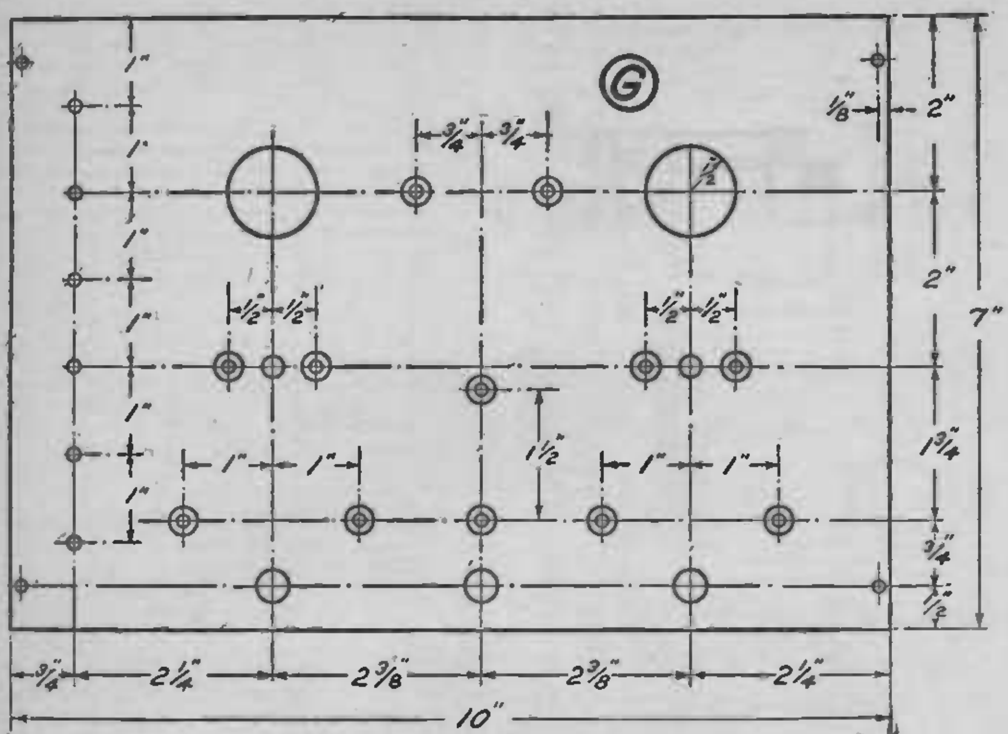


FIGURE 3: *A constructional drawing of the amplifier, showing the layout from above.*



HOW TO DRILL AND CUT THE PANEL

FIGURE 4: *This diagram gives the correct locations for the holes for the instruments and the binding posts. The holes outlined here with a double circle should be countersunk; the rest of the holes are straight drill holes.*

same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next the two transformers A, should be mounted as shown in Figures 2, 3 and 5, so that the letters beside the connection posts correspond to those of the photograph in Figure 2. The transformers are fastened to the panel G, by two screws to each transformer. The screws are inserted through the holes in the panel and through the brackets on the bottom of the transformers and fastened with hexagon nuts.

Three telephone jacks are used, which allow the phones or loudspeaker to be plugged in on either the detector, first or second stage of amplification as desired.

It will be noted that two of the jacks, D1 and D2, are double circuit; that is, with four spring leaves and connection points, while the third, D3, is a single-circuit jack with only two connections on it. The latter is for use in the last stage of the amplifier, while the former are used for the detector and first step.

These should be fastened to the panel G, in their respective positions as shown in Figures 2 and 5. It will be noticed that they are mounted sidewise instead of in the regular up and down position. This is necessary so that they will not interfere with the cabinet.

Now mount the two rheostats E, using two screws to each rheostat, as shown in Figures 3 and 5, and adjust the spring levers with the correct tension so that they run smoothly.

Then fasten the two tube sockets B, to the panel with flat-head screws as indicated in Figures 2, 3 and 5, and the construction work on the set will be complete.

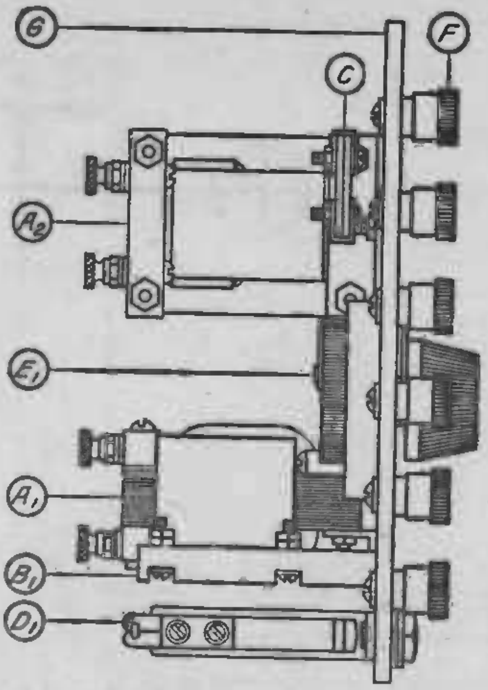
The condenser C, is supported by the wiring and may be left until that job is in process.

How to Wire the Amplifier

The constructional design of this piece of apparatus is such that the circuit wiring may be made as short as possible. This will be evident from an inspection of the photograph in Figure 2.

With the wiring diagram in Figure 1 before you, start wiring up the primary circuit of the first transformer, including the two top input binding posts, the condenser C, the terminals of the jack D1, and the two terminals of the transformer which are marked "B" and "P."

Then wire the filament circuit of the two tubes, including the rheostats, the two terminals



THE WORKING DRAWING OF THE SIDE ELEVATION

FIGURE 5: *The jacks are mounted on the lower part of the panel with the two transformers taking up the center section. The binding posts are arranged in a vertical line at the left edge of the panel.*

of the sockets marked "F," the terminals of the transformers marked "F," and the two lower binding posts, the lowest of which is the negative "A" battery connection and the other is the positive "A."

The third binding post from the bottom is for the negative "B" and it should be connected to the same wire as the second binding post from the bottom, the positive "A."

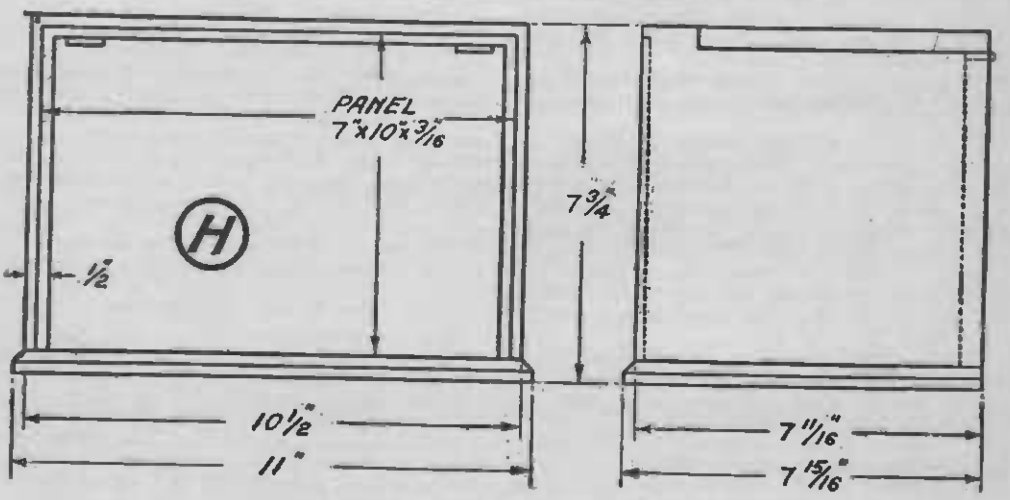
Now connect the post "G," on the first transformer to the grid terminal of the first tube.

Then, connect up the third binding post from the top, the positive "B" battery post, with the jacks D2 and D3, and wire the plate circuit of the first tube which includes the terminals on the jack D2 and the terminals on the second transformer "B" and "P."

Finish up by connecting the terminal "G" on the last transformer to the grid terminal of the last tube, and by connecting the plate terminal of the last tube to the jack D3, as shown.

Operating Data

The operation of this amplifier is extremely simple. It is connected to the receiver merely by bridging the binding posts straight across from the tuner and detector panel to the amplifier with the exception of the two "B" battery posts. When the same "A" and "B" batteries are used for both sets, as is almost invariably done, the "B" negative post of the amplifier is left disconnected altogether. The 45-volt "B" battery should be added to the 22½-volt "B" battery already in use for the detector, the negative post of the 45-volt battery being connected to the postive 22½-volt post of the smaller battery and the positive 45-volt post on the large battery is connected directly to the "B" positive post on the amplifier panel. The original connections from the 22½-volt "B" battery to the detector being left exactly as previously connected.



THE DIMENSIONS OF THE CABINET

This may be made by the builder himself, or the plan may be turned over to a cabinet maker. The woodwork may be done in any kind of hardwood that conforms to the owner's taste.

This arrangement allows the small battery to be used with the detector while the full voltage of both batteries, 67½ volts, is applied to the amplifier tubes.

To put the amplifier into operation place the telephone plug into the first, second or third jack, depending on whether you wish to listen in on the detector alone, the first or the second stage of amplification, and turn up the rheostats to the proper value.

The tubes should be burned as low as possible without impairing the signal strength or quality. Turning on the rheostats beyond this maximum point will only shorten the life of the tube.

If the receiver is tuned to a signal, the amplifier should immediately begin to work and produce a strong signal that will operate a loudspeaker successfully on the second stage of amplification.

Ten Good Rules for Broadcast Listeners

1. Don't try to hear DX till cold weather. Be satisfied to enjoy the nearer stations most of the time.

2. Don't be disappointed if an occasional storm interferes with your autumn radio evening. There are many fine concerts coming. You can't expect to find a pearl in every oyster nor to receive a record-breaking concert every night.

3. If you want louder signals, use a longer antenna, more tubes, higher plate voltage, more sensitive loudspeakers, and more careful tickler and receiver adjustment.

4. A pleasant signal filling a moderate sized room should be enough to give satisfaction. It is not worth while producing signals which deafen the neighbors. It is wasteful to insist on tremendous signals which are generallly less pleasant than moderate signals.

5. If your local station comes in too loudly and drowns others out, a smaller antenna will help in tuning him out, with a smaller condenser connected between antenna and ground. And if all measures to get rid of the local station fail, why not enjoy his concerts? He is working hard for you and it is nobody's fault that you are so close to him that you are bound to hear him. Broadcast stations have to be closer to some people than to others.

6. For the new longer waves above 450 meters, use a condenser connected between the antenna and ground terminals of your set.

7. A little patience in learning to handle your receiver yields rich returns in satisfaction from fine signals. Remember that "Rome wasn't built in a day" and keep on getting more and more familiar with your set and how it works.

8. It is a good idea to read Popular Radio and the radio column of a newspaper or two. It helps you to know how your set works and keeps you up-to-date in radio. Information of this sort is an aid in getting the concerts loud and clear.

9. Ask your radio dealer for advice; he can probably tell you what you want to know and will be glad to do so. The manufacturer of your set is also willing to help you get the desired results from its use.

10. Do not throw away the direction sheets or booklet that came with your set and with the tubes. Read all such material carefully now and then. If you have lost the direction sheets, write to the dealer or manufacturer for another. The direction sheets must answer most of the questions which have been puzzling you and preventing you from getting the best out of your set.

Useful Tips

For the radio experimenter, a useful article to have on hand is a small coil of bell wire. This is a copper wire of about No. 18, and it is wrapped with two thick coverings of waxed cotton thread. It comes in handy for connections when experimenting with new circuits.

* * *

Always turn down the rheostats when you first connect up a new set that you have just completed, and try out a single tube in the sockets before putting in all the tubes. This will save two or three tubes if you have made a mistake in the connections.

* * *

The radio experimenter who builds the whole or even part of his set should provide himself with a set of tools to work with that will enable him to make a good job of the construction. The following is a list of the tools which he will find are almost indispensable:

- 1 pair of 6-inch electrician's wire-cutting pliers;
- 1 pair of 4-inch electrician's wire-cutting pliers;
- 1 small breast drill capable of holding a ½-inch drill;
- 1 complete set of small drills up to ¾ inch;
- 1 brace and bit;
- 1 set of small files including round and triangular files;
- 1 countersink drill;
- 1 6-inch screwdriver with ¼-inch spade;
- 1 6-inch screwdriver with ⅛-inch spade;
- 1 8-inch screwdriver with ¼-inch spade;
- 1 electric soldering iron (½ pound);
- 1 can of soldering paste;
- ½ lb. of strip solder;
- 1 small center-punch;
- 1 pair of dividers;
- 1 15-inch brass-edge rule;
- 1 6-inch square;
- 2 small steel clamps;
- 1 small hand grindstone;
- 1 hacksaw and medium-sized blades.

* * *

When disconnecting a radio set take off the connections *at the batteries* first. If the wires are taken off in the set itself, they may touch each other accidently and ruin the batteries, whereas if the wires are taken off at the batteries there can be no possibility of a short-circuit.

* * *

Keep the distilled water in your storage "A" battery just above the level of the plates. If you do this the top part of the plates will remain "active"; if you do not, the portion above the water-line will not generate any current and you will have lost part of the ampere-hour capacity of the battery—it will not last as long for each charge.

* * *

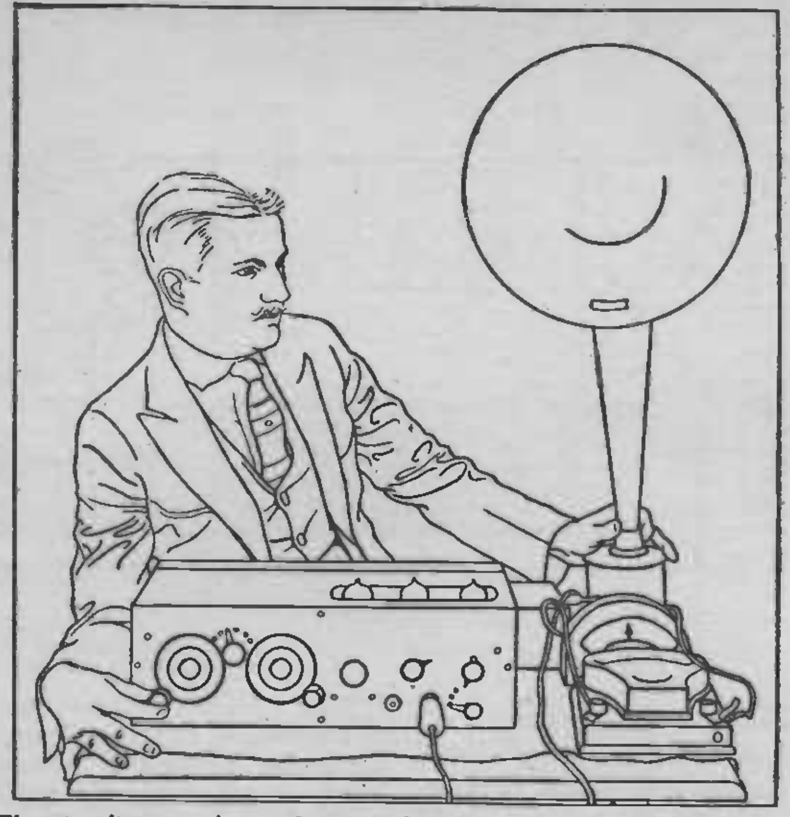
When using SCC copper wire to wind coils for a receiving set, be sure that the insulating wrapping of cotton is not damaged, as this may cause two adjacent turns of wire to short-circuit. If two turns do touch in this manner, the radio-frequency currents induced in the coil will induce a heavy secondary current in the short-circuited part which will drop the voltage across the whole coil so that the signal strength will be materially lowered. *Do not damage the insulation when winding the coils.*

* * *

Do not use shellac or any form of binder on the wire of the coils used in the four-circuit tuner. If you leave the coils dry they will work well but if they are covered with any form of insulating paint they are almost worse than useless.

* * *

Do not leave kinks in your telephone cords, as this will finally allow them to wear through the fine braided wire and result in a loose connection.



The set as it appears in actual use—small enough to keep in a bureau drawer. The demonstrator is the inventor, Laurence M. Cockaday (2XK).

HOW TO BUILD THE

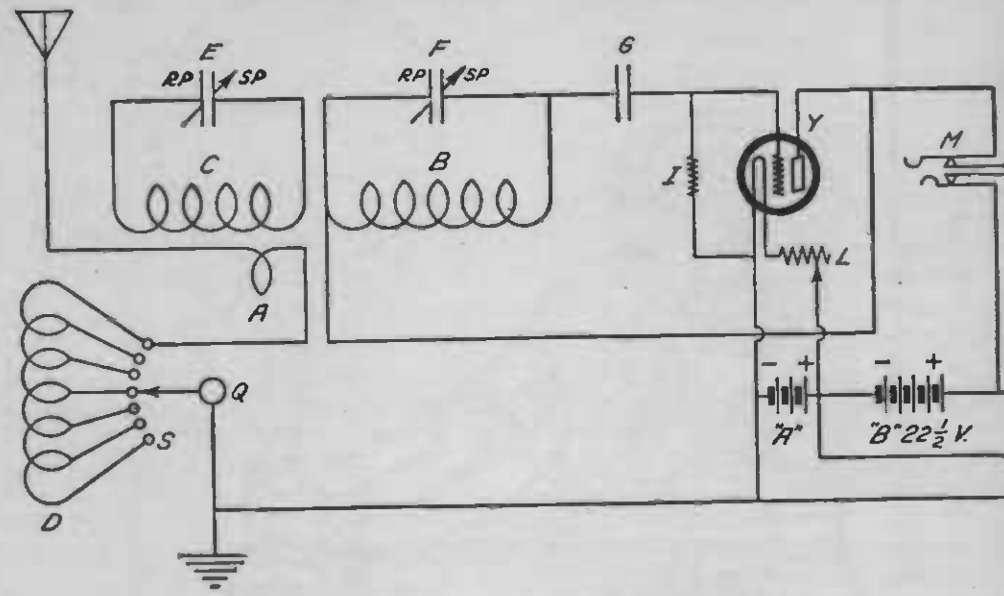
FOUR-CIRCUIT TUNER

COST OF PARTS: *About* $40.

RECEIVING RANGE: *Up to* 3,000 *miles.*

HERE ARE THE ITEMS YOU WILL NEED—

A—primary winding, consisting of a single turn of tinned copper bus-wire, 1/16 inch square;
B—secondary winding, consisting of 65 turns of No. 18 S. C. C. copper wire;
C—reaction-stabilizer winding, consisting of 34 turns of No. 18 S.C.C. copper wire; (Coils A, B and C are wound on a composition tube, the dimensions of which are shown in Figure 8).
D—antenna tuning coil, consisting of 43 turns of No. 18 S.C.C. copper wire, double bank-wound, on composition tube; (See Figure 8).
B1 and C1—3½-inch knobs and dials;
E and F—Se-Ar-De variable condensers, 17 plates, approx. .00035 mfd.;
G—Dubilier micadon fixed condenser, .00025 mfd.;
H—Dubilier micadon fixed condenser, .002 mfd.;
I—tubular grid-leak, 1 or 2 megohms;
J—Se-Ar-De combination sockets and rheostats;
K—De Forest socket;
L—Jenkins vernier rheostat;
M—Pacent or Federal jacks, one double-circuit and one single-circuit;
N—Jefferson amplifying transformers, small type;
O—Fada binding posts;
P—Composition panel;
Q and R—Haydon-Fenton switch lever and knob;



S—switch points;
T—Haydon-Fenton vernier controls;
U—brackets for mounting the De Forest socket;
V—phosphor-bronze spring contacts for mounting the grid-leak;
W—composition shelf panel;
X and X2—brass brackets for mounting shelf panel;
Y—detector tube;
Z—amplifier tubes;
one cabinet, of the dimensions shown in Figure 9; connecting wire, 1/16-inch square tinned copper bus-wire;
screws and nuts to fit.

THE ideal receiving set should have the following five qualifications if it is to meet the needs of the discriminating radio amateur:

A—absolute elimination of interference;

B—unlimited distance range;

C—ease of tuning;

D—truthful reproduction;

E—low cost.

A, B, and C are dependent upon the method of tuning used and the system of detection. D and E, on the other hand, depend more closely upon the type of amplification used.

In designing this set the inventor has had these goals in view:

First, therefore, we have determined to use extremely loose coupling to insure the quality A; looser, in fact, than used in any other type of receiver. The step-up voltage ratio of the receiving transformer is 65 to 1. This insures an extremely high grid voltage even from weak signals.

Second, to insure a maximum distance range, and at the same time secure simplicity of tuning, and to hold the cost of construction to a minimum, it was decided to use the regenerative method of amplification as the closest approach to the ideal yet disclosed.

The main shortcomings of the standard regenerative circuit are well known; they may be summarized as follows:

a. A change in wavelength makes necessary a change in the regenerative control to keep the regeneration at a maximum.

b. It is extremely difficult to keep the circuits "stable," so that they will stay at the maximum amplification point. This is due to the fact that changes in the constants in the antenna circuit react on the grid circuit and throw the circuits in and out of resonance so that they oscillate for a few seconds and then cease, causing signals to come in strong for a while and then to die out, and also causing squeaking at intervals.

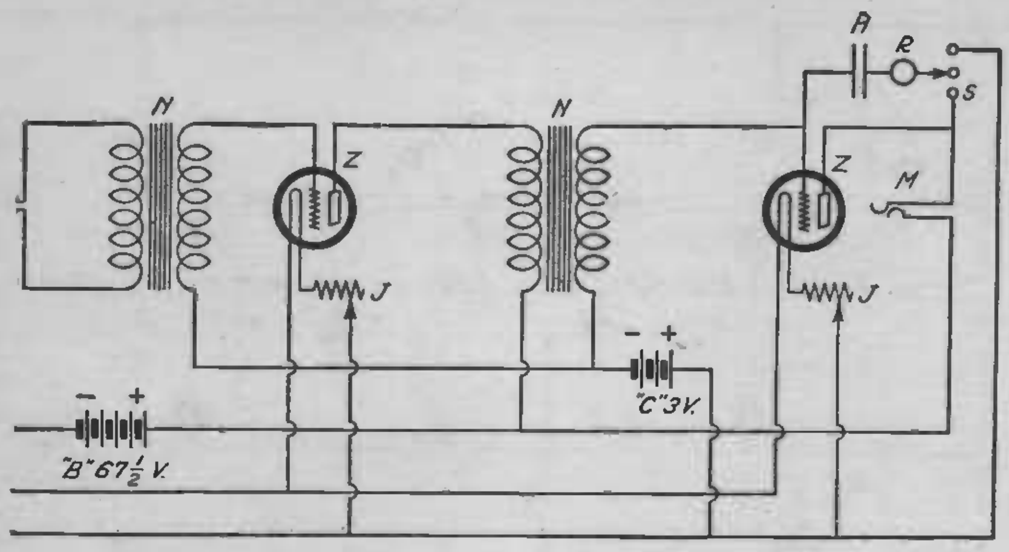
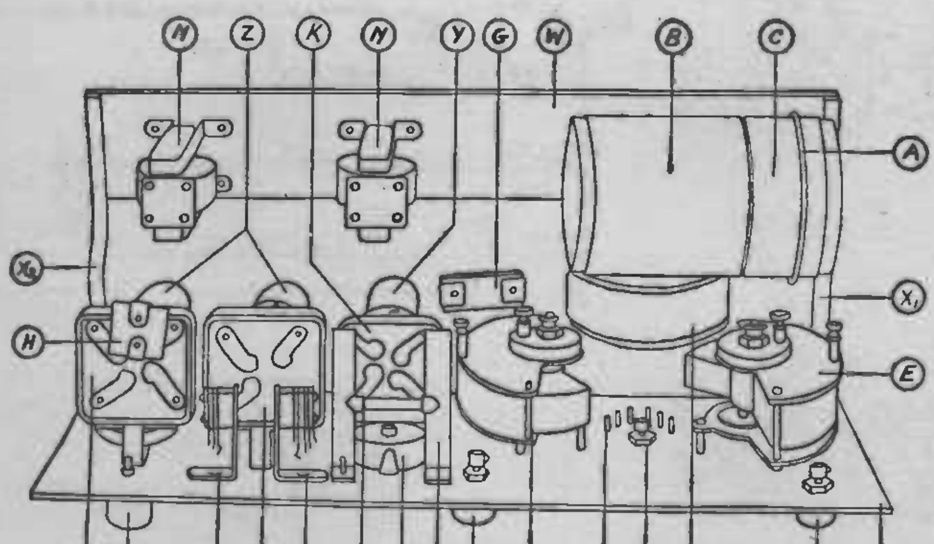


DIAGRAM OF THE FOUR-CIRCUIT TUNER

FIGURE 1: *Here are shown the exact electrical connections for the apparatus used in the circuit; the parts are designated by the same letters that appear in the text.*



AN INSIDE VIEW OF THE RECEIVER

FIGURE 2: *This picture gives the prospective builder of the Four-circuit Tuner a clear idea of how the instruments should be arranged in the proper positions. Notice that all of the inductances and transformers are placed well to the rear of the set, so that body capacity is eliminated while the set is being tuned. The mechanical drawings on the following pages give in greater detail the proper spacings and positions of the instruments.*

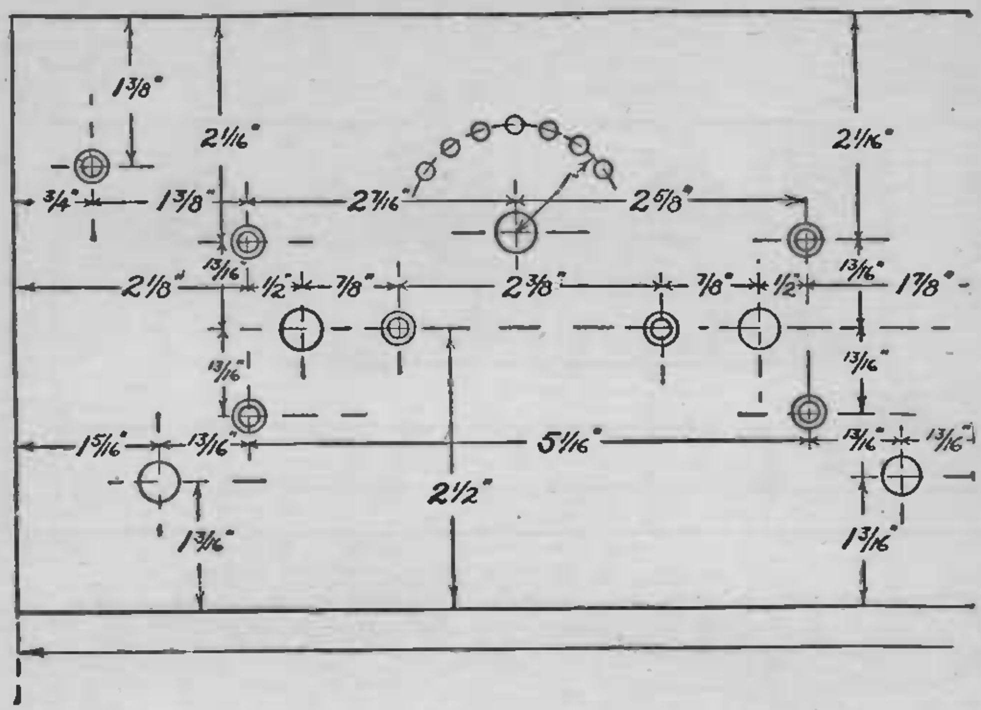


FIGURE 3
(above)

This diagram gives the exact dimensions for the main panel P; it also gives the drilling details for the holes for mounting the instruments.

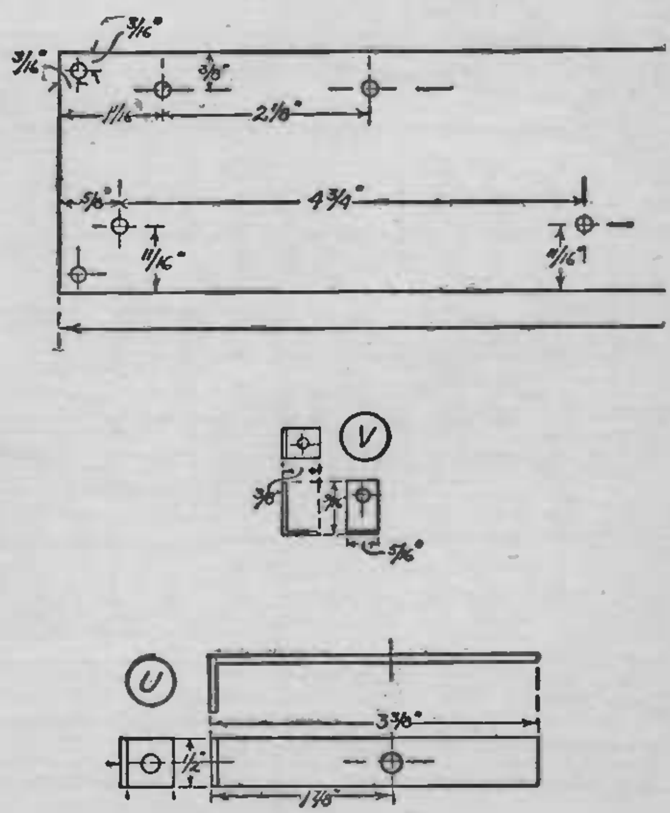
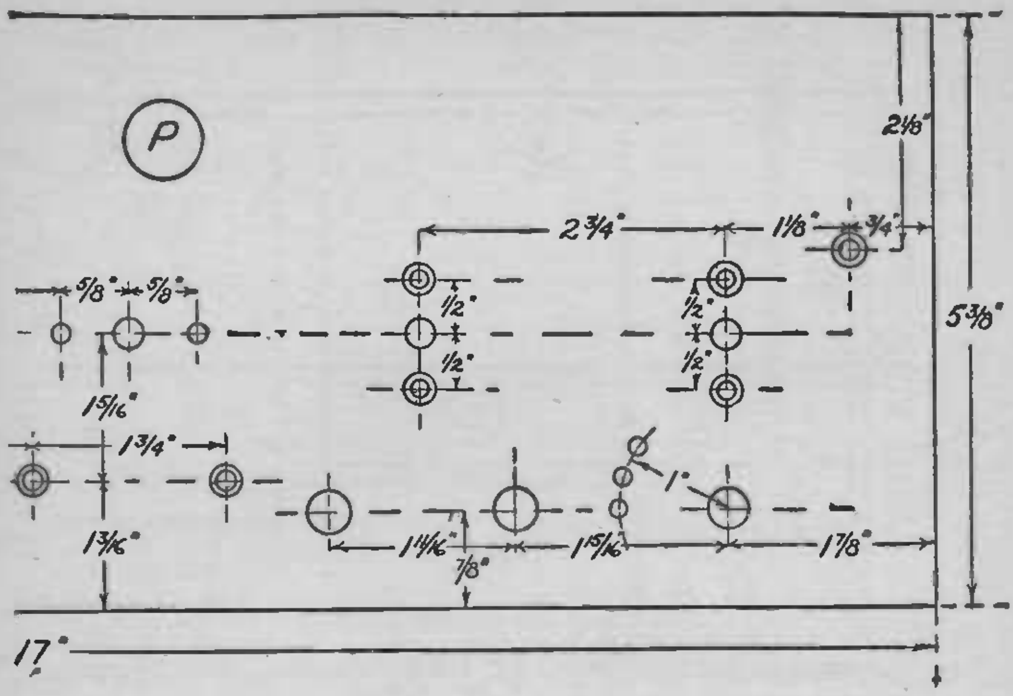
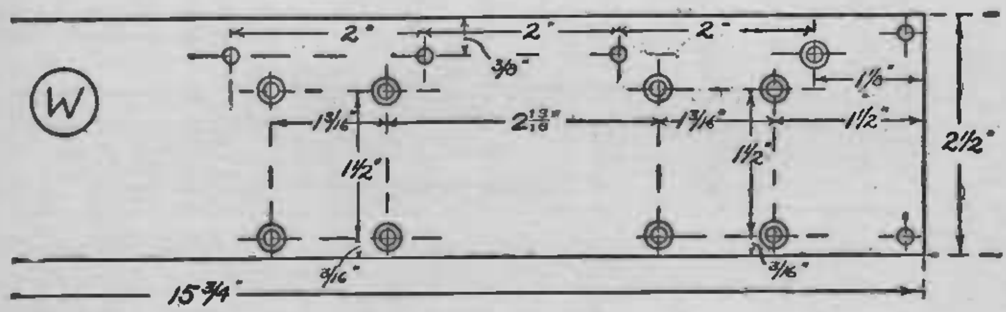
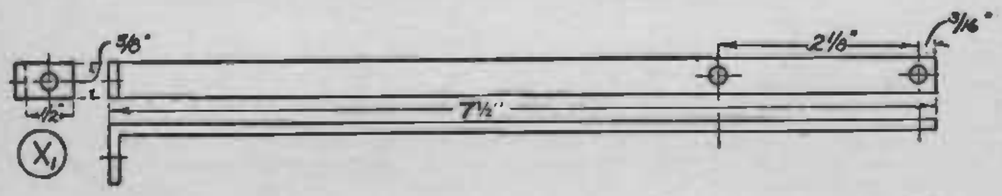


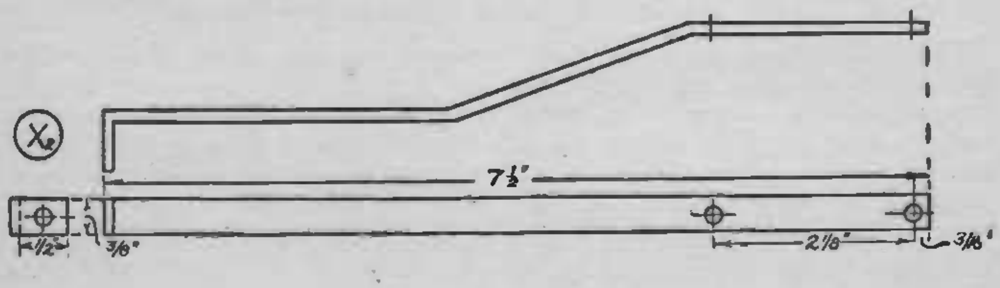
FIGURE 4
(at right)

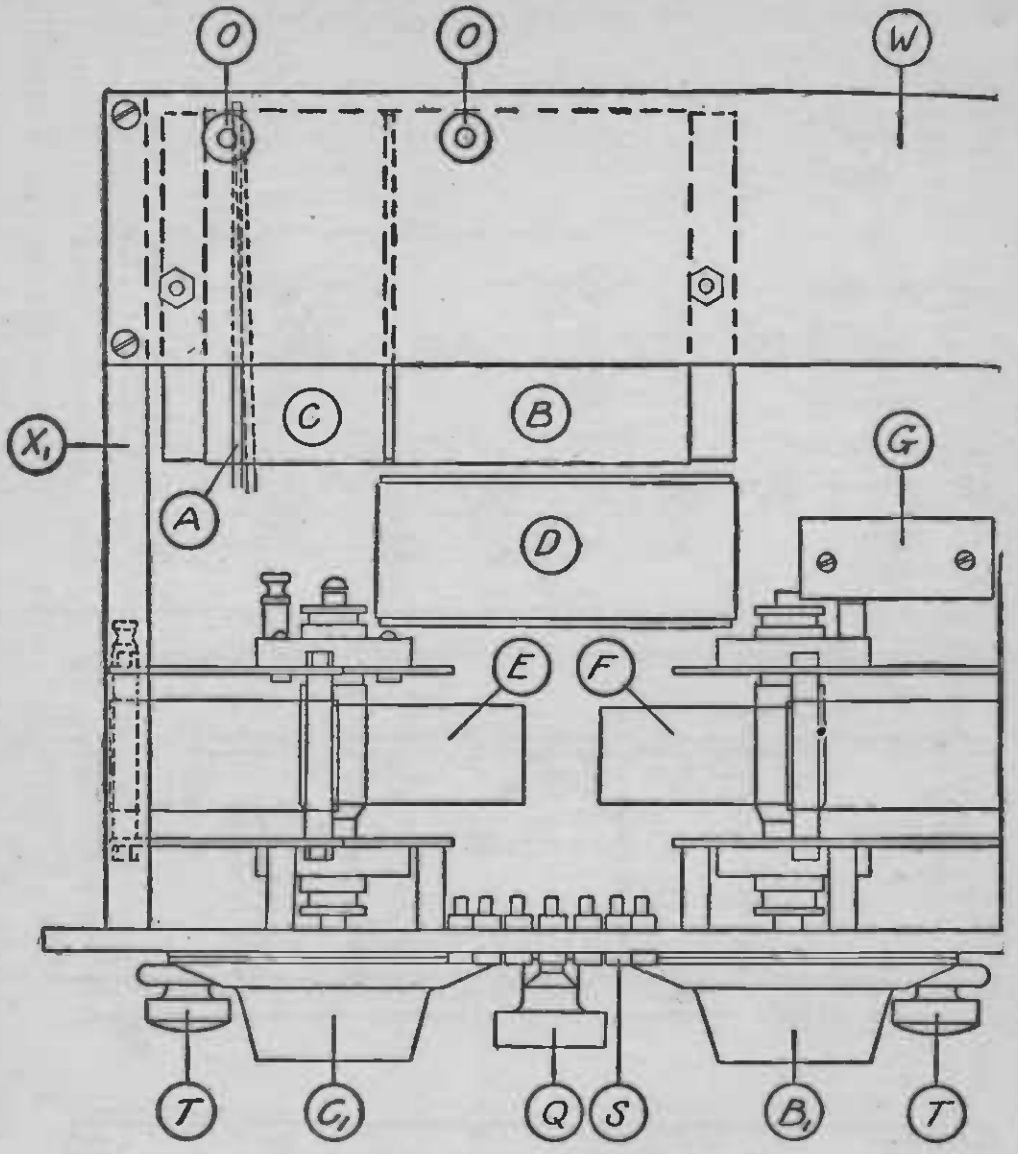
Here are shown the exact dimensions of the shelf panel and of the brass and phosphor-bronze brackets that are used for supporting the various parts of the set.


P
2 1/8"
2 3/4"
1 1/8"
3/4"
5/8"
5/8"
1/2"
1/2"
1/2"
1/2"
5 3/8"
1 5/16"
1 3/4"
1"
1 3/16"
1 1/16"
1 15/16"
1 7/8"
7/8"
17"


W
2"
2"
2"
3/8"
1 1/8"
1 3/16"
2 13/16"
1 3/16"
1 1/2"
1 1/2"
1 1/2"
2 1/2"
3/16"
3/16"
15 3/4"


3/8"
1/2"
2 1/8"
3/16"
7 1/2"
X1


X2
7 1/2"
1/2"
3/8"
2 1/8"
3/16"

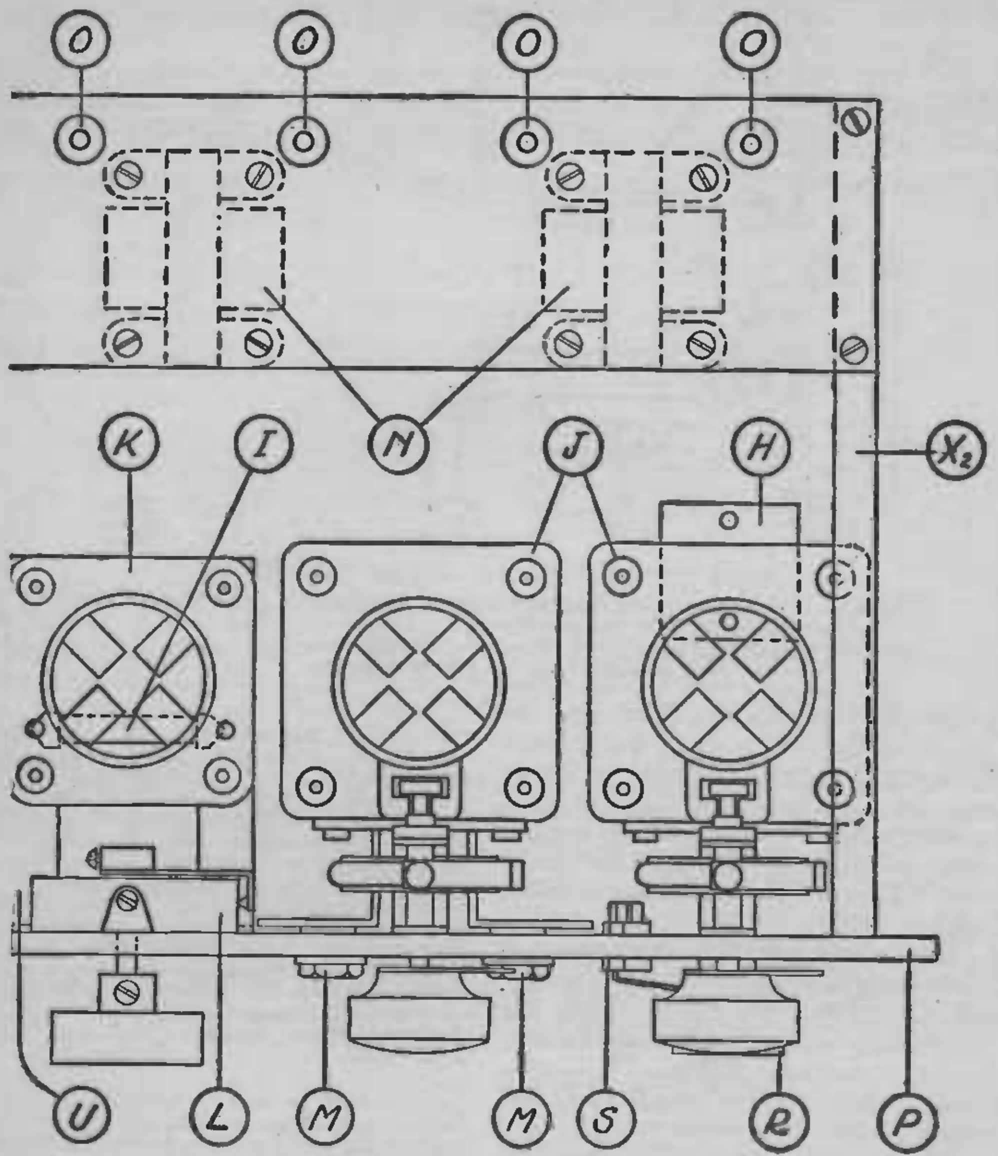


A WORKING DRAWING FOR ASSEMBLING THE SET

FIGURE 5: *A view of the set from above, showing the exact positions for the coils, condensers, transformers, tube sockets, switches, rheostats, and control dials. If the two panels used in the set are made as shown in Figures 3 and 4, the instruments will fit (as shown here) in a compact and efficient layout.*

Third, therefore, a more simple method for controlling regeneration has been adopted; it consists of an inductively-coupled stabilizer circuit whose function is to vary the effective A. C. resistance of the grid circuit of our tuner. This circuit is electrically isolated from all the other circuits in the receiver, but it is placed directly within the magnetic field surrounding the grid coil. It consists of a low-resistance coil shunted by a variable condenser which when it is rotated varies the reaction between the grid circuit and its own circuit.

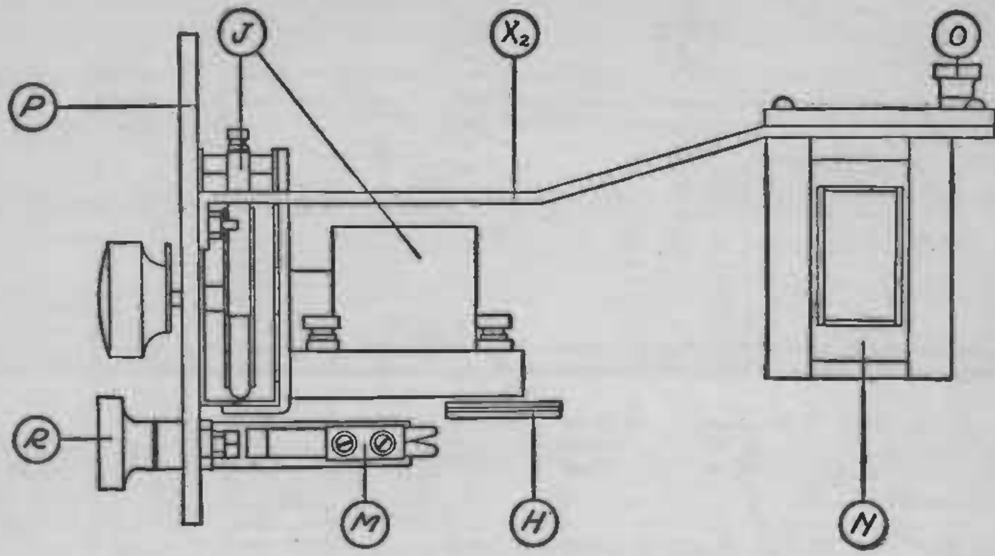
It is well known that the vacuum tube in a circuit will produce sustained oscil-



lations when the negative resistance of the system equals the positive resistance of the system. The standard regenerator accomplishes this result by varying the negative resistance upward to the correct value.

This circuit as it has been evolved, however, accomplishes the result by varying the positive resistance, downward, to the correct value. By this method no variometers, variocouplers, feedback coils, or tuned plate circuits are necessary. No variations of coupling are necessary, and the regeneration can be *set* and it will *stay put* over the entire wavelength range.

Another advantage of thé system is that the constants of the antenna system make little or no difference on the other circuits; in other words, the set can be tuned on one antenna of totally different characteristics from another antenna and the two antennas switched with the signal still remaining tuned in. When re-



SIDE VIEW OF THE SET—FROM THE RIGHT

FIGURE 6: *This diagram shows how the rheostats, tube sockets and jacks are fastened to the main panel, and how the amplifying transformers are hung from the shelf panel in the rear. The condenser H is hung directly under the last socket and is supported by the connecting wires.*

ceiving CW signals, the hands may be placed on the bare antenna wire without detuning the signal; in fact, the hands may be placed across the antenna and ground terminals. The antenna may be taken off or the ground lead taken away with signals still remaining tuned in but slightly weaker.

Fourth, to insure truthful reproduction there have been added to the two-stage audio frequency amplifier a control for eliminating tube noises and for clearing up music and voice signals. This device makes music sound just as if it were being played in the room where it is received.

The set, during a test period of several months, on all kinds and types of antennas, picked up about three quarters of all the broadcasting stations in the United States on a loudspeaker, and amateur stations in all the nine districts of this country and amateurs in other countries of this continent and in Europe.

The set as here described is not sensitive to body capacity and does not have to be externally shielded.

The electrical circuit diagram is shown in Figure 1.

The Parts Used in Building the Set

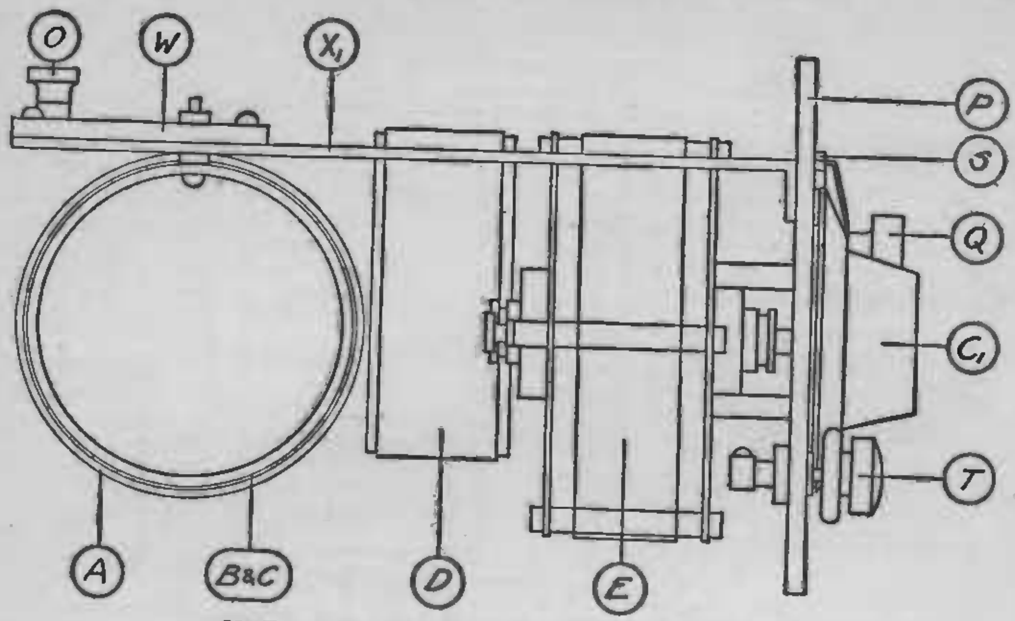
In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts given. The list of parts includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with excellent results. If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

After procuring all the instruments for building the receiver, the amateur should set about preparing the panel P (shown in Figures 2, 3, 5, 6 and 7).

First of all, the panel should be cut to the correct size (5⅜ by 17 inches); then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 3.

The holes outlined here with a double circle should be countersunk so that the flathead machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measur-



SIDE VIEW OF THE SET—FROM THE LEFT

FIGURE 7: *In this diagram is shown the method of attaching the tuning condensers to the main panel, and of attaching the coils A, B and C to the shelf panel. The antenna tuning coil D is suspended between the other coils and the condensers.*

ing the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull, permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, the condensers, E and F, should be fastened to the panel in their respective places, as shown in Figures 2, 5, and 7, and the dials B1 and C1 should be affixed as shown. These dials are fitted with a chuck which centers and holds fast to the shafts of the condenser without the use of set screws. This insures even running of the dials when they are revolved and eliminates wobbling.

The two combination sockets and rheostats J, should be mounted on the panel (two screws to each instrument) as shown in Figures 5 and 6.

The detector vernier rheostat L should also be mounted in its proper place by means of two screws (see Figure 5). The detector socket K will require two brass brackets U, for attachment to the panel, and these should be of the dimensions given in Figure 4. The two grid-leak phosphor-bronze springs V (shown in Figure 4) are mounted on these brackets, underneath the socket. Two holes will have to be drilled in the socket, one on each side (as shown in Figures 2 and 5) for fastening with brass nuts and bolts to the brackets U. The grid-leak springs are held by the same bolts.

The three rheostat knobs should now be connected to the shafts of the rheostats protruding from the front of the panel.

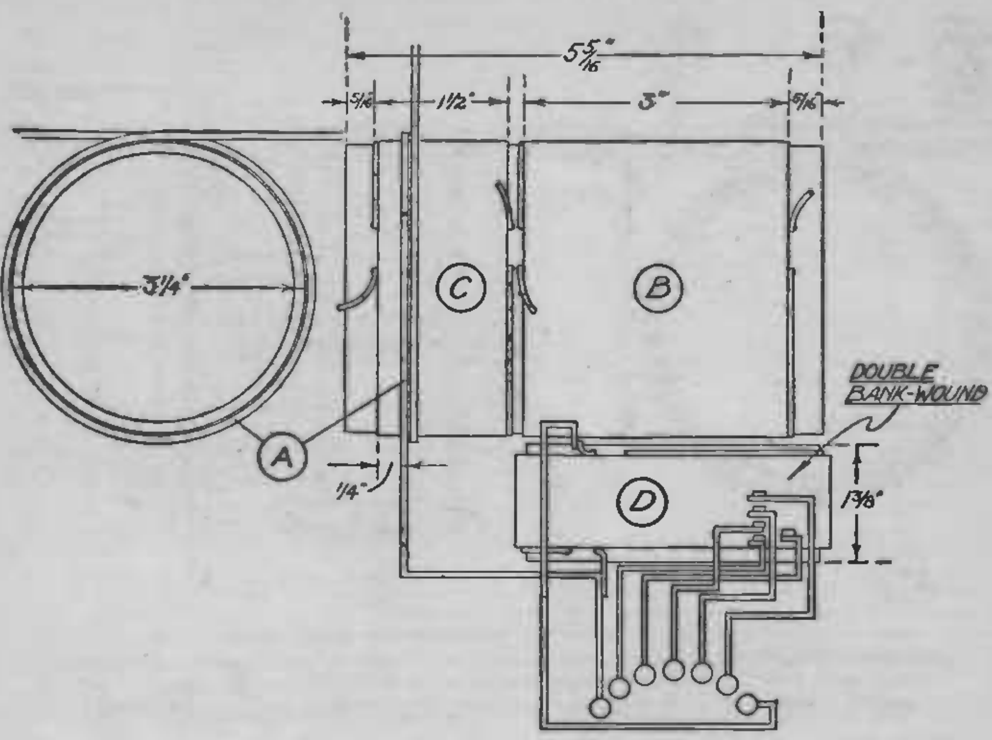
Place the switch points S in the proper holes drilled for them and fasten with small nuts on the rear of the panel as shown in Figures 2, 3, and 5. Insert the two switch levers Q and R and make fast in the proper manner with the nuts furnished with the apparatus.

Mount the two jacks M, the double-circuit jack at the left and the single-circuit jack at the right, as shown in Figures 2, 5, and 6.

It will be noted that the two jacks should be mounted "back to back," as the space is limited. (There is really no benefit derived from using a jack in the first stage because the same results can be obtained by burning the two amplifier tubes at a low filament temperature and thus getting the same results as from one stage. This will save the tubes as they will last longer, burning dimly, than one that burns brightly.)

The last job on the main panel is to mount the two vernier controls T, for the condensers E and F (see Figures 5 and 7). These are necessary on account of the sharpness of tuning in this set.

Next, cut and drill the shelf panel W, as shown in Figure 4 and prepare the two mounting brackets X1 and X2, shown in the same diagram. These are fastened to the shelf panel and also to the main panel P, as shown in Figures 5, 6, and 7. The straight bracket is used at the left side of the set. The irregular



HOW TO MAKE THE COILS

Figure 8: *Here are shown the dimensions for the coils and the method for connecting the single turn of wire A to the coil D and to the taps S. The positions of these coils in relation to each other should be observed strictly.*

shaped bracket X2 is used at the right side of the set, and the reason for using it is to allow space for all makes of tubes to fit into the last socket.

Now mount the two transformers N on the shelf W, using four screws to each transformer, as shown in Figures 2, 5, and 6.

The six binding posts O should be mounted in a straight line at the rear of the shelf and fastened underneath with nuts, in the regular manner.

In preparing the tuning elements great care should be exercised, for in the *exact* following of the instructions here given lies the success that can be had with the completed set.

First, cut the 3¼-inch tube to the right length, as shown in Figure 8. (If you have trouble in getting this size, use 3½-inch tubing; it will raise the wavelength only slightly.)

Start winding the coil C, finishing with 34 turns of No. 18 S.C.C. copper wire. Right next to this wind on the 65 turns of the same kind of wire for coil B. Then fasten the tube with the two coils wound on it to the shelf W with two screws and nuts (see Figure 5), and insert a washer between the shelf and the tube, as shown in Figure 7. This will leave a little space for the single turn A, which can be put on when the wiring is being done.

The antenna tuning coil, is a double-bank-wound coil on a tube the same diameter. The taps are taken off, one at the beginning of the coil, then one at the third turn, one at the 7th, 13th, 21st, 31st, and one at the end, the 43d turn.

In bank winding, the tube is shellaced with a light coat and while it is still wet, two turns are wound upon it.

Then the next turn is run up on top of the two turns that are already completed and a whole turn is put on.

When this turn is completed the wire is turned down on the tube again and another turn completed; the next turn is run up alongside the first top turn, then down, then up, and so on. In the set described the coil D was held in place by the stiff bus wiring, but it may be fastened to the shelf by a straight piece of brass and two screws and nuts (brass).

The two condensers G and H may be attached in the proper places when the wiring is being done, as they are held in place by the wiring.

How to Wire the Set

The design of this set is such that the grid-circuit wiring of each of the three tubes may be made extremely short and isolated from the other circuits. In fact, all the tuning circuits and leads are arranged so that short connections may be used. As this is the case the set may be wired with bus-bar, with little loss in efficiency.

A tinned-copper square wire is recommended. It should be about 1/16-inch square. All connections should first be shaped so that they will fit, and then soldered in place.

The binding posts along the back of the shelf W (design in Figure 5) are to be connected in the following manner:

First on left, antenna;

Second from left, ground;

First on right, amplifier "B," positive;

Second from right, detector "B," positive tap;

Third from right, "B," negative, and "A," positive;

Fourth from right, "A," negative.

It will be noticed in diagram (Figure 1) that the ground and the "A," negative, are connected together.

Start wiring the filament circuit, being sure to include the rheostats in the correct side of the filaments as shown in Figure 1. *This is important.*

Wire up the antenna circuit, including the placing of the single turn A, of the bus-wire, around the inductance in position shown in Figure 8 and connect to coil D and the taps S. One end of the loop A goes to the antenna post and the other goes to the first tap S and the beginning of coil D as shown. The switch lever Q is connected to the ground post.

Now wire the two leads from coil C, to the terminals of the condenser E.

Then start with the secondary wiring (coil B, condenser F, condenser G, and the grid-leak I) and connect exactly as shown in the diagram Figure 1.

Wire the plate circuit of the detector tube, including the jack, the primary of the first amplifying transformer and ending up at the detector "B," positive, binding post.

Next, finish up the first stage of amplification, and then continue with the second stage.

The last job to complete is to connect the condenser H to the switch lever R and the grid of the last tube, and also connect up the two end-taps S, as shown in Figure I. This is the tone control of the amplifier and will give the operator three separate adjustments.

After you have finished the job, sit down with some friend and check over the wiring once or twice before using the set. This will save you a lot of trouble in case you have made a mistake.

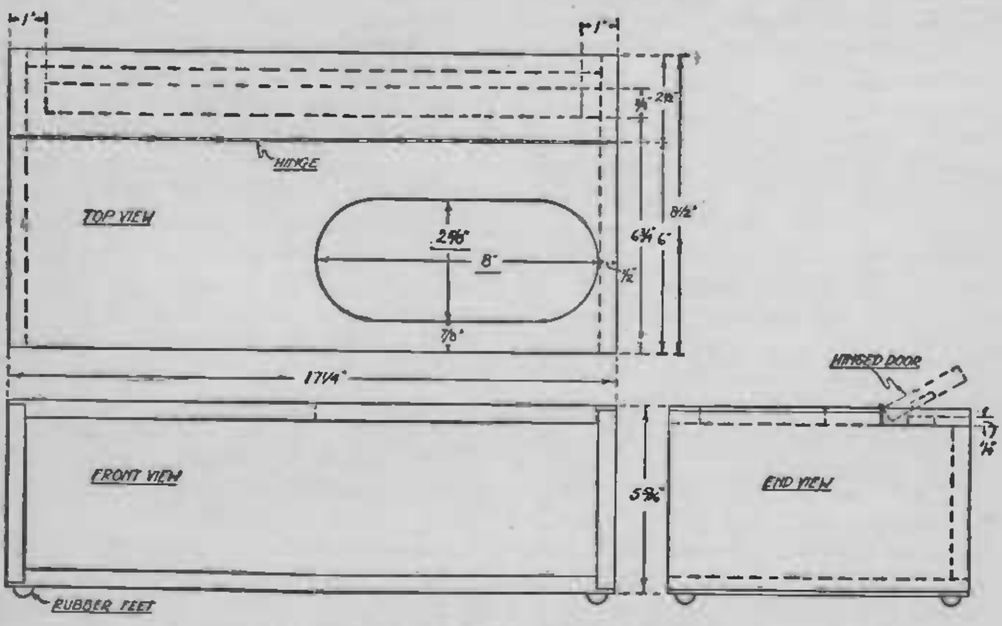
Operating Data

When using the set, the following hints will be of practical value:

The set may be used with any antenna that is about 100 feet long—the longer the better. It also works well with a multi-strand antenna.

By lifting up the little hinged door at the top and back of the cabinet, the connections may be made in the following order, to the antenna, ground and batteries, commencing at the left (looking at it from the front):

First post, the antenna;



HOW TO BUILD THE CABINET

FIGURE 9: *This working drawing of the cabinet, which contains all the necessary dimensions, may be turned over to a cabinet maker, who will be able to construct it of some hardwood—such as mahogany or oak. The hinge used is a section of piano hinge and may be finished in nickel.*

Second post, the ground;
Third post, the "A" negative;
Fourth post, the "A" positive and the "B" negative;
Fifth post, the "B" positive tap for the detector, 22½ volts;
Sixth post, the "B" positive for the amplifiers.

Close the lid.

All antenna tuning is done with the switch lever Q. All secondary tuning is done with the dial B1 and the vernier control T for that dial. Regeneration is controlled by the dial C1 and the vernier T for that dial.

Place the detector tube Y in the socket, and place the telephone plug in the first jack and turn up the filament rheostat all the way. Then turn it back so that the filament is left at three-quarters brilliancy.

Now take the plug out of the first jack and put it into the second. Insert the two amplifier tubes Z, and just touch the rheostat to the first wire on the rheostat. Do not turn them up any farther. This is the way they are supposed to operate; they should not be turned up higher, as it is unnecessary.

Set the dial C1 at 100, with the condenser "all in," and tune with the dial B1, until you pick up a signal. Then revolve the switch lever Q until the best tap is found. Turn up the rheostat L until the tube starts to oscillate and then turn it down slightly below this point. All further adjustments should be made with the two dials B1 and C1. The lower the value at which C1 is set the more the set will oscillate so that the regeneration can be easily controlled by the combined action of the two dials B1 and C1. You will soon get the knack.

Amateur CW signals should be tuned with the dial C1 somewhere between 0 and 80. All phone stations will be found to come in better with this dial somewhere between 60 and 100.

On dial B1, the amateurs tune between 0 and 15, and the broadcasting stations between 20 and 65. The antenna taps at the left will be best for amateur work, and the middle taps or the right taps for the broadcasting; it all depends on the size of the antenna, but you will soon learn the best taps to use with a little practice.

Practical Pointers

GASSY tubes such as used for detectors function at plate voltages between 16½ volts and 22½ volts; usually they function best at a plate potential of about 18 volts.

* * *

A RADIO set is no better than its weakest part.

* * *

Do not "test" any kind of a battery by "shorting" it with a pair of pliers or a wire, as this injures it. The best way is to use a voltmeter across the battery while it is discharging at its normal rate.

* * *

WHEN you finally *do* go to bed at night, after listening-in all evening (possibly well on into the morning) are you happy but tired and worn out? Well, then, your "A" battery may feel the same way, and it is a good plan to turn on the charger so that the battery may rest and recuperate while you retire and do the same thing. There is nothing like keeping a battery up to full charge to add to its life. A fully charged battery will also be a great help in enabling you to tune in and hold those long distance signals.

* * *

ONE dead "B" battery connected in the plate circuit of a receiving set will make you think that there is a lot of static in the air and at the same time make you believe that the set has "gone wrong." Always test your "B" batteries with a small high-resistance voltmeter.

* * *

WHEN you connect up a set from a diagram, you will find it helpful to observe the following procedure:

Start at the antenna binding post and connect it to the instrument as shown in the diagram you are following. When this connection has been completed, draw over that connection on the diagram with a colored pencil. You will then know that that connection is complete. Then, from the other terminal of the same instrument connect a wire to the next instrument as shown on the diagram. Cover this connection on the diagram with a colored pencil line and do the same thing with every line on the diagram.

When all the connections are redrawn in colored pencil you will know that you have completed hooking up your set and that it has been done correctly. This will eliminate mistakes and make the job simple.

* * *

KEEP the terminals of the storage battery coated with a thin coat of vaseline and always be sure that no green, gray, or yellow substance is allowed to collect on them. This will corrode the clips or the copper wire which connects the battery with the set and may often cause noises in the set.

* * *

Do NOT let the telephone cord droop off the table and come into contact with the top of the storage battery, as there is always more or less strong acid on the top of the battery which will eat away the cloth covering on the telephone cords and allow the wires in them to short-circuit and thus make a lot of crashing, crackling sounds in the telephones.

* * *

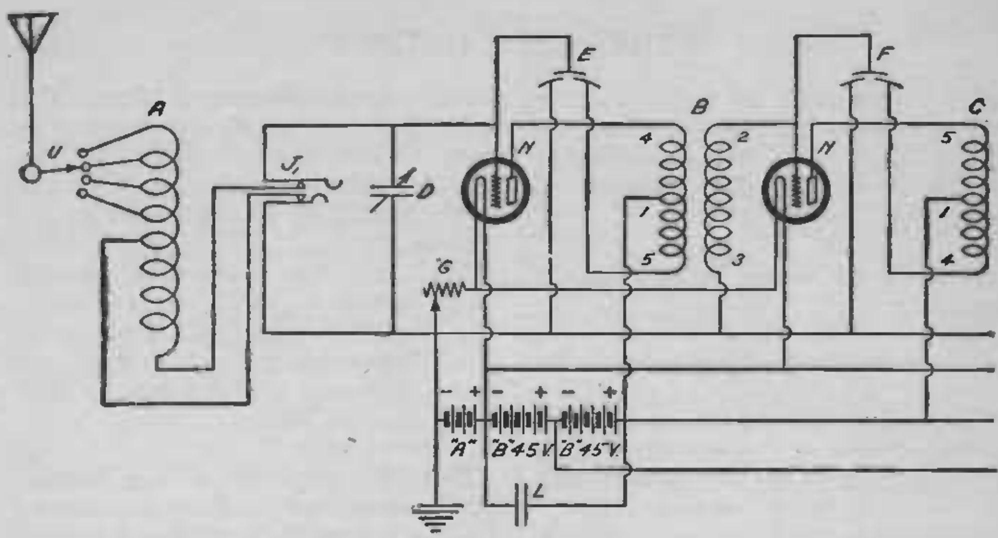
THE condensers used in the four-circuit tuner should be "low loss" condensers, especially the one used in the stabilizer (absorption) circuit. This is extremely important for if the condensers are poor, the losses will be great and the regenerative effect will be lost.

* * *

CLEAN away any excess soldering paste from the terminals of your set with alcohol and save yourself a lot of trouble in finding out what is wrong with the set.

* * *

MAKE the grid wires in that set of yours as short as possible.



CIRCUIT DIAGRAM OF THE NEW 5-TUBE RECEIVER

FIGURE 1: *The electrical connections for the instruments employed in this circuit are here shown and the parts are designated by letters which reappear in the text and also the list of parts, the photographs and the working diagrams.*

HOW TO BUILD A *TUNED*

RADIO-FREQUENCY RECEIVER

COST OF PARTS: *About $60.00*

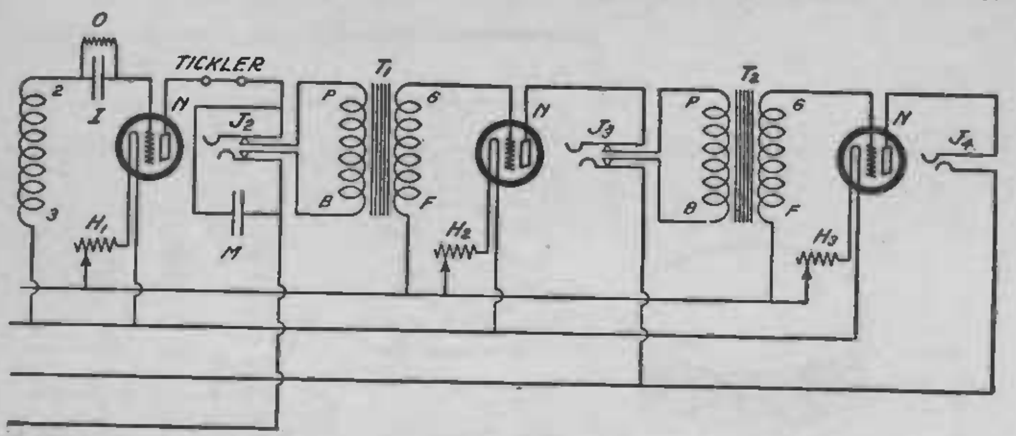
RECEIVING RANGE: *Up to 3,000 Miles*

HERE ARE THE ITEMS YOU WILL NEED—

A—coupler-coil consisting of 60 turns of No. 24 DSC copper wire wound on a composition tube, 4 inches in diameter. Taps are taken off at the 3rd, 6th, 8th, and 9th turns;
B and C—Telos vario-transformers, 180 to 510 meters;
D—Haynes variable condenser, .00025 mfd.;
E and F—Amsco variable compensating condensers and knobs;
G—Fada rheostat, 5 ohms;
H1, H2 and H3—Amsco rheostat, 50 ohms;
I—Dubilier micadon fixed condenser, .00025 mfd.;
J1, J2 and J3—Pacent jacks, double-circuit;
J4—Pacent jack, single-circuit;
K—Fada tube sockets;
L—Dubilier fixed condenser, .5 mfd.;
M—Dubilier fixed condenser, .005 mfd.;
N—UV 201-A or C-301-A tubes used throughout;
O—tubular grid-leak, 2 megohms;
P—composition panel;
Q—sub-panel made of well-dried hardwood;
R—4-inch dials;
S—3-inch dials;
T1—Amertran audio-frequency transformer;
T2—Jefferson large type transformer;
U—four-point switch;
V—cabinet;
W—composition connecting block with brass supports;
X—composition connecting block with brass supports;
connecting wire;
binding posts, etc.

FOR summer reception there is no better method for receiving than the use of radio-frequency amplification and a loop antenna—especially if the successive stages of amplification are tuned to the frequency of the incoming wave.

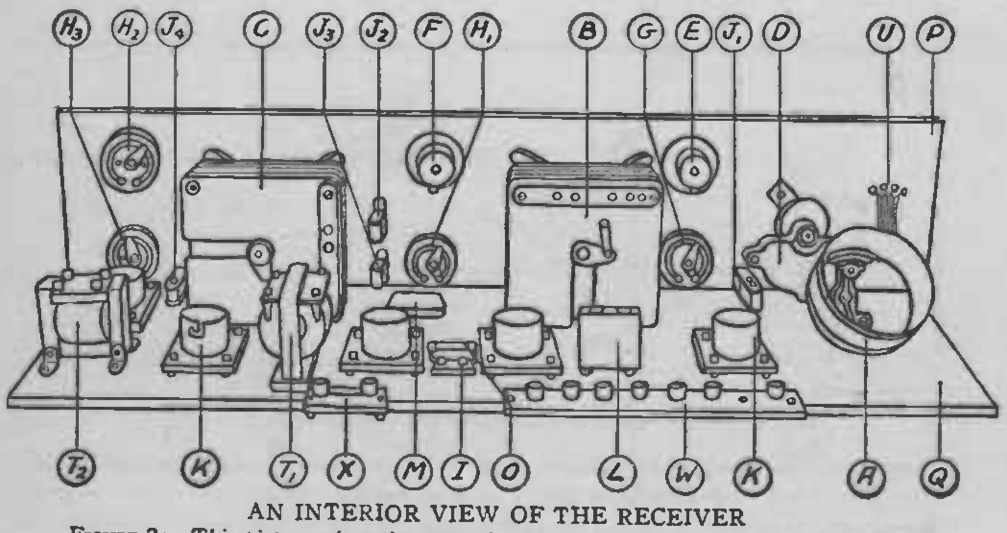
The reason is, that with a loop antenna, static is not picked up with such strength as it is with an ordinary



antenna, and the loop tuning circuit has a low decrement when it is shunted by a condenser for tuning, whereas the ordinary receiving antenna may have a resistance ranging from 10 to 40 ohms at the broadcasting wavelengths. This means that the loop will tune much sharper and therefore, much of the static can be eliminated. The tuned circuits in each stage of radio-frequency amplification also act as "traps" which let only the signals of a certain wavelength (to which they are tuned) through. In other words, these circuits seem to act as filters to static which seems to have no specific wavelength.

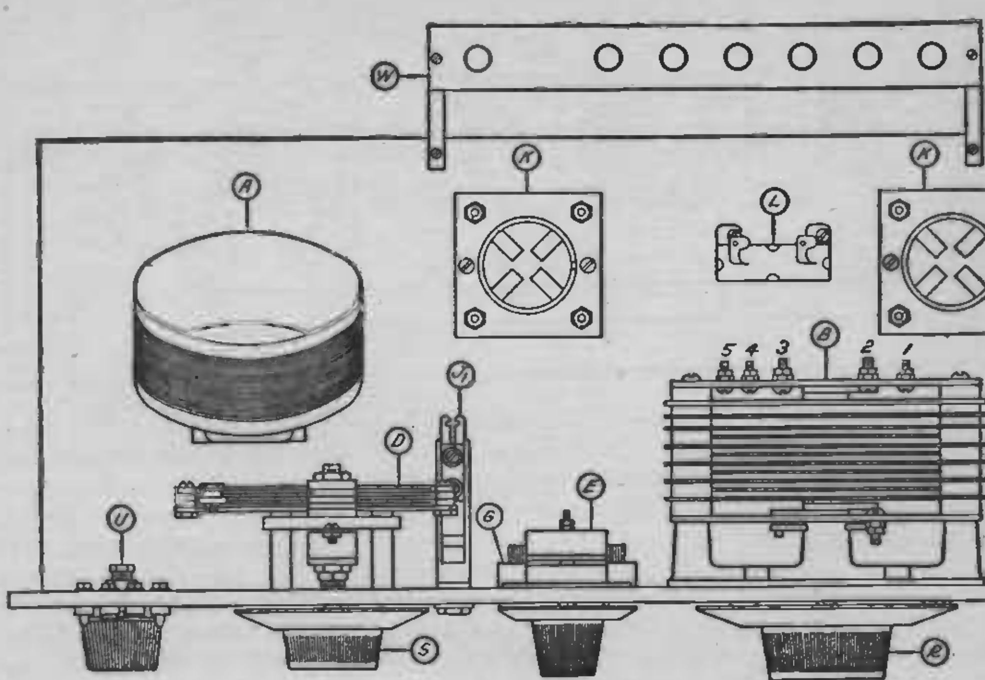
The set described in this chapter employs two stages of radio-frequency amplification and two stages of audio-frequency amplification, with a vacuum-tube detector. It can be used with a loop, with a short indoor antenna or with any type of outdoor antenna. The range with the loop or indoor antenna as far as tested up to the present writing seems to be about 1,000 miles. The range with the outdoor antenna has not been ascertained as yet, but stations 3,000 miles away have been logged with a loudspeaker with good volume.

When used with an antenna, the primary circuit is semi-aperiodic, as



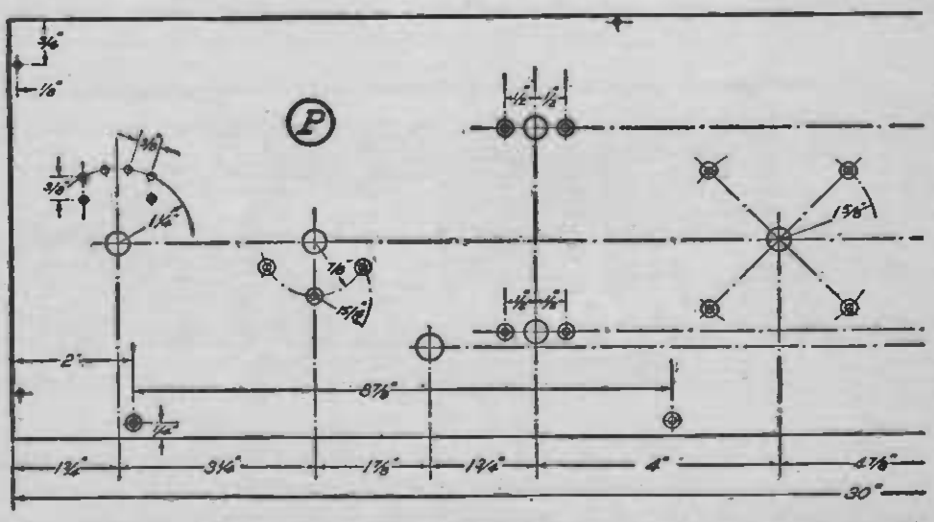
AN INTERIOR VIEW OF THE RECEIVER

FIGURE 2: *This picture gives the general arrangement of the instruments as viewed from the rear and with the cabinet removed. For more specific details of construction the builder should refer to the diagrams in Figures 3, 5, and 6, which are mechanical drawings of the top and end views, and which are drawn to scale.*



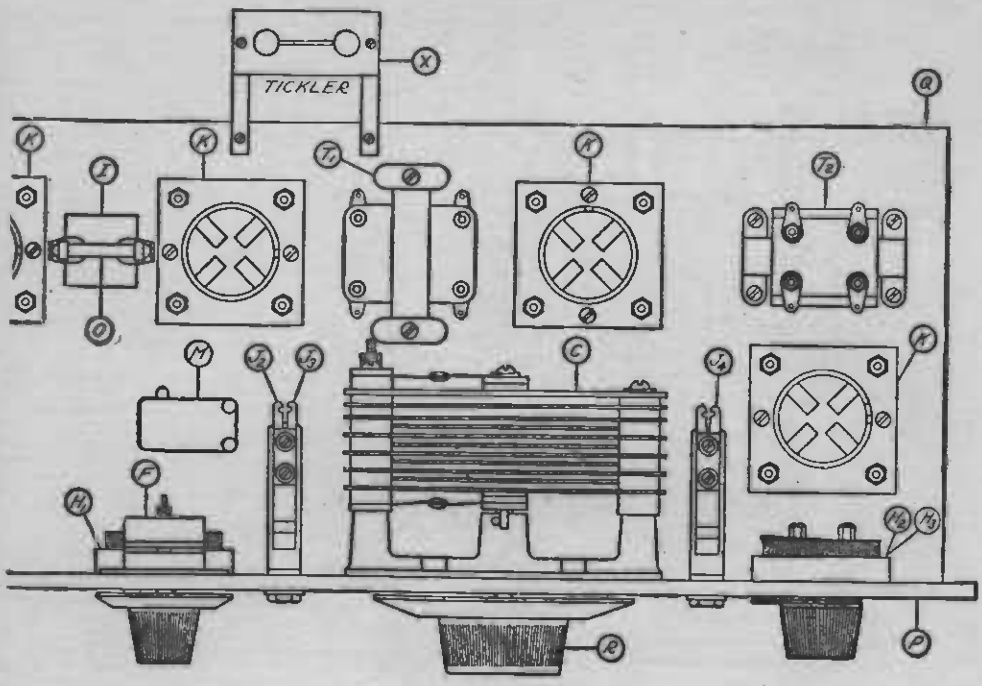
HOW TO PLACE THE INSTRUMENTS AND

FIGURE 3: *When bulding a radio receiving set from printed instructions it is usual for the amateur to use up some of the parts which he has on hand which he thinks "might do" as well. He is also accustomed to arrange the instruments as he sees fit. But our*

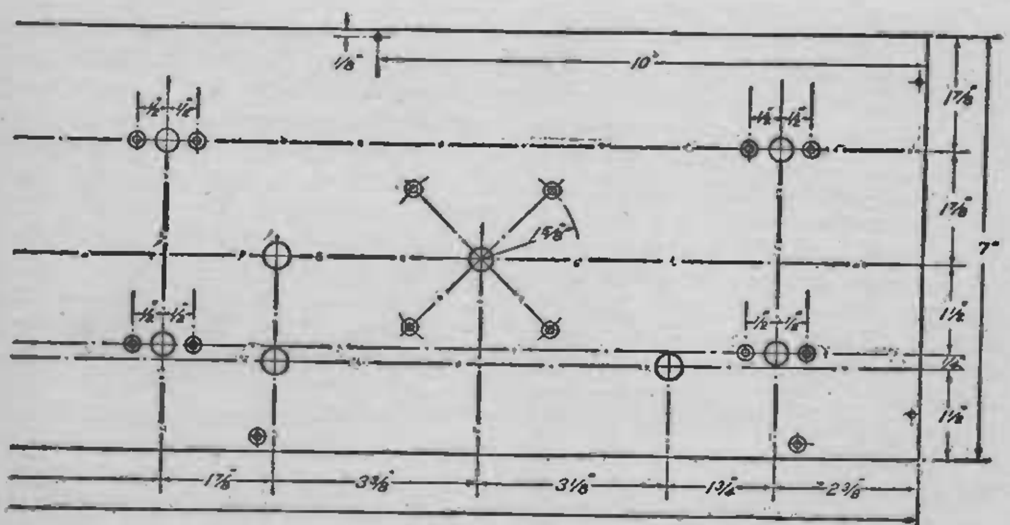


HOW TO PREPARE THE MAIN PANEL

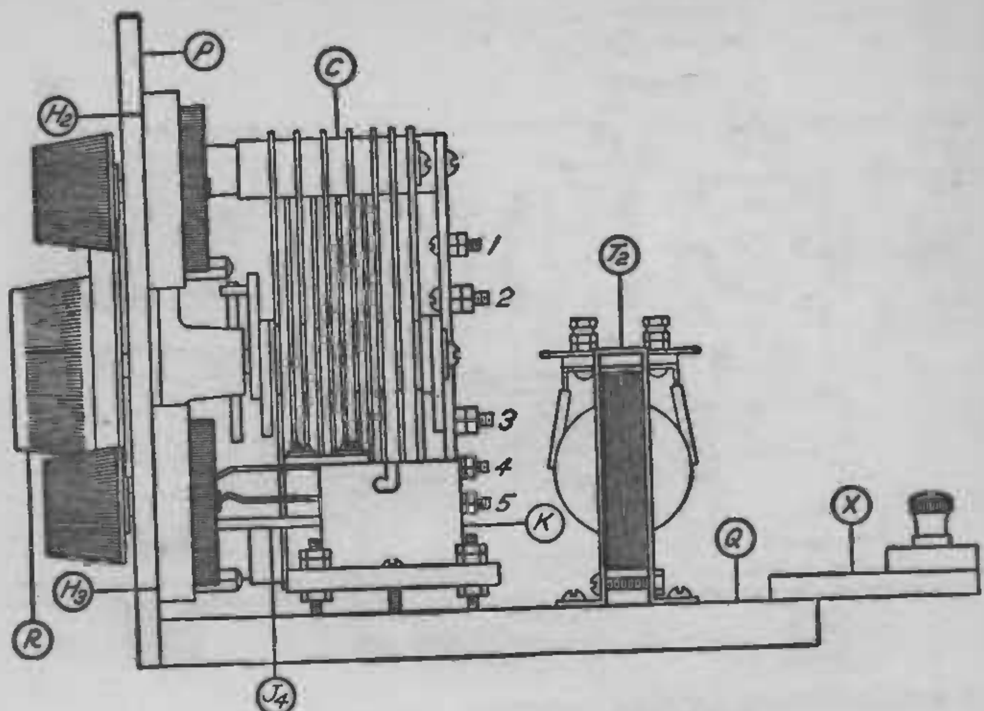
FIGURE 4: *The locations for the centers of the holes are given vertically and horizontally, as well as the proper arc for the centers of the switch points. The correct sizes*



ASSEMBLE THE SET ON TWO PANELS
readers are advised to follow the arrangement shown above, as it has been carefully worked out.



AND WHERE TO DRILL HOLES
for the holes will be decided by the builder by observance of the diameter of the shafts of the instruments and the supporting screws that go through the panel.



A VIEW OF THE SET FROM THE RIGHT

FIGURE 5: *This drawing shows clearly the method of mounting the vario-transformers, the transformers, the rheostats, the socket, the jack and the tickler block.*

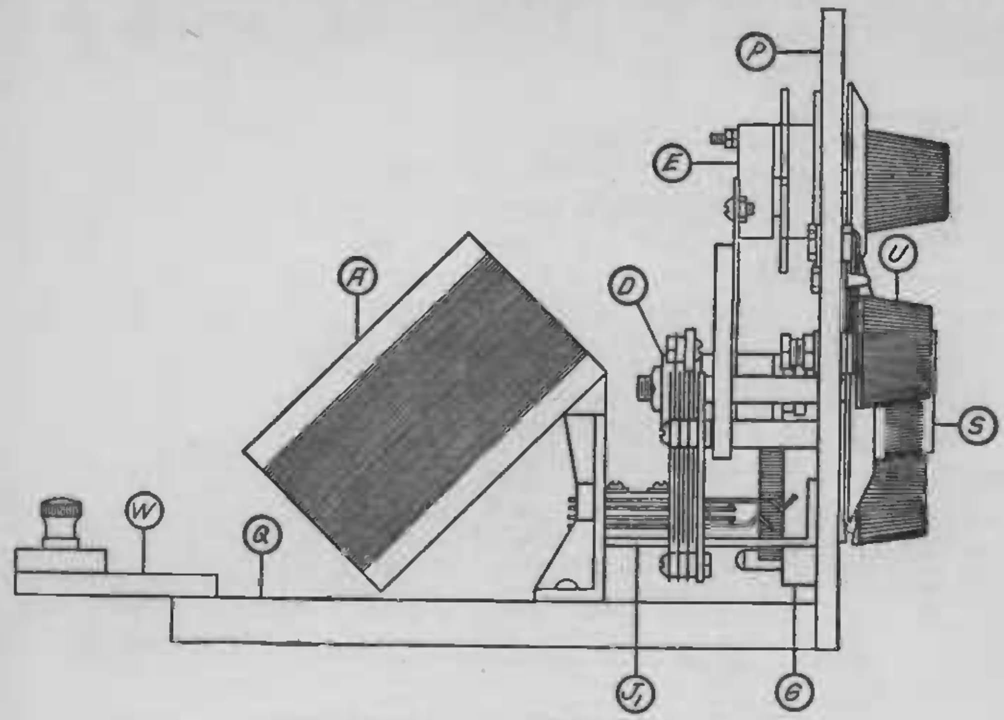
there are only a few turns of wire used (with taps). The primary circuit is conductively coupled to the secondary circuit which is tuned by means of a small variable condenser. When a loop is used it is plugged into a jack, for that purpose, which disconnects the coils from the circuit and switches the variable condenser across the loop so that the same condenser may be used for tuning the loop. Each stage of amplification is tuned to the frequency of the incoming wave by means of an ingenious vario-transformer, a development by Lester Jones, former radio aide of the Navy Department at Washington, D. C. This transformer tunes the output circuit of the tube to which it is connected, and also the input circuit of the next tube, in a single operation. It has an extra plate winding for inducing a neutralizing voltage on the grid of the preceding tube which, when used with the special compensating condenser, prevents oscillation in the circuits even when they are *exactly tuned*. When an ordinary radio-frequency amplifier is exactly tuned the circuits will burst into oscillation and reception of voice signals is impossible; a stabilizer potentiometer is sometimes used to partly overcome this difficulty.

With the circuit described, however, a potentiometer is *not* necessary. By slightly unbalancing the circuits after a signal has been tuned in—this is done with the compensators—regeneration can be employed in the separate stages of amplification so that the signals may be built up to an enormous strength, even from distant stations.

There is also a provision made in the set for connecting a variometer in the plate circuit of the detector to make use of the heterodyne search method for picking up distant stations.

The set will not re-radiate.

The diagram is shown in Figure 1.



VIEW OF THE SET FROM THE LEFT

FIGURE 6: *This drawing shows how to mount the variable condenser, the coupler-coil, the compensator condensers, the jack, and the battery connecting block.*

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts following.

¶ *The list of parts given at the head of this chapter includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel P, (shown in Figures 2, 3, 4, 5 and 6).

First of all the panel should be cut to the correct size, 7 by 30 inches.

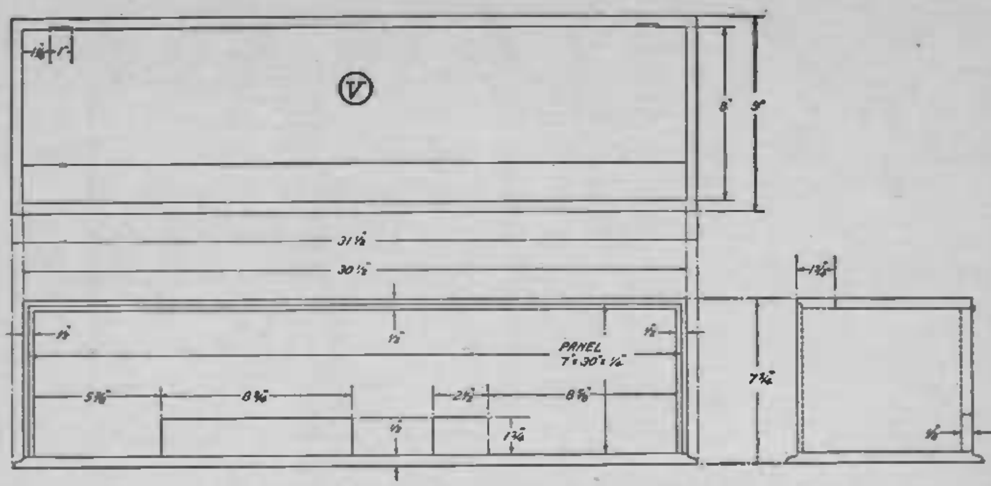
Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flathead machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

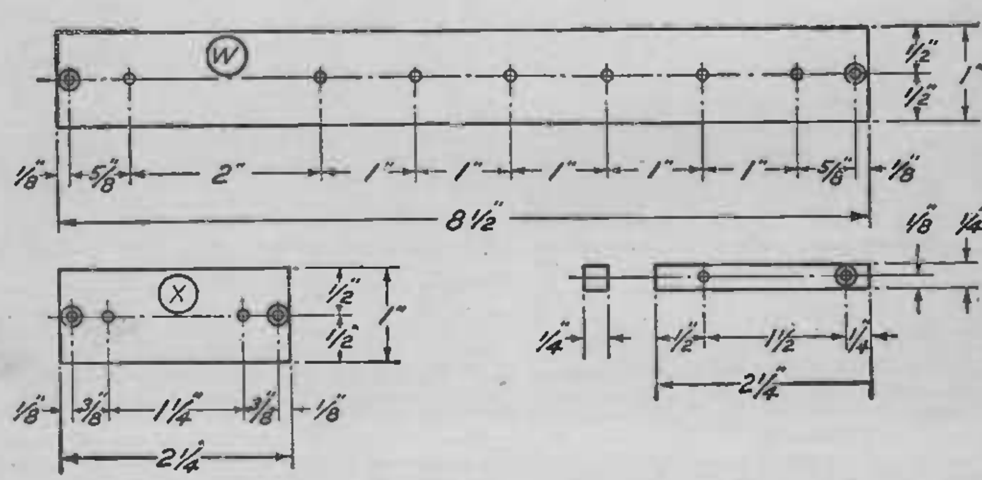
Next the sub-panel Q, should be cut to the correct size, 7 by 29 inches, and painted with a dark *insulating* paint, and fastened to the main panel P, with wood screws running through the face of the main panel and into the edge of the sub-panel. (See Figures 5 and 6.)

Then, the two vario-transformers B and C, should be mounted on the panel P, in their



THE DIMENSIONS OF THE CABINET

FIGURE 7: *Notice that the front of the cabinet is partly cut away so that the panel P sets flush with the cabinet. There are two rectangular holes cut in the back of the cabinet through which will project the two connecting blocks, so that all connections may be easily made in the rear and no unsightly wires will appear in front of the set when it is in operation.*

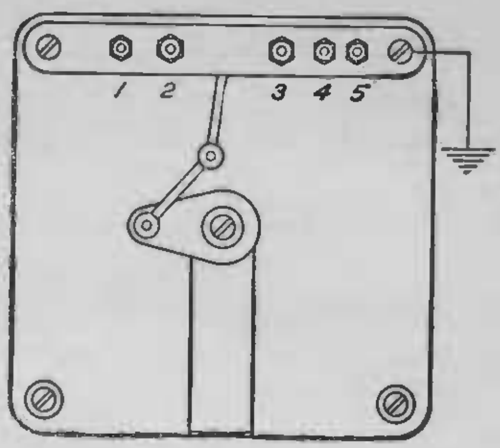


HOW TO MAKE THE CONNECTING BLOCKS

FIGURE 8: *The sizes for the connecting blocks W and X and the brass supporting pieces. Two of the $2\frac{1}{4}$-inch brass pieces are used for mounting each block.*

CONNECTION TERMINALS FOR THE VARIO-TRANSFORMERS

FIGURE 9: *No. 1 is the "B" battery tap, No. 2 goes to the grid, No. 3 goes to the negative "A" battery, and Nos. 4 and 5 are the plate and compensator connections. The aluminum frame of the transformer is grounded on one of the screws as shown.*



correct places as shown in Figures 2, 3 and 5. Four screws are used to mount each transformer. The large dials R, are then secured to the shafts of the instruments by tightening up the knobs.

Next mount the four rheostats G, H1, H2 and H3, in their respective places, two screws to each rheostat, and affix the knobs and pointers. (See Figures 2, 3, 5 and 6.)

Now fasten the two compensator condensers E and F, to the panel and attach the two small dials which are fastened with set screws. (Figures 2, 3 and 6.)

The switch and contact points U, should be installed on panel P, in front and slightly to the left of the coupler-coil A.

The variable condenser D, should be fastened in its place with three screws and equipped with the 3-inch dials S.

The coil A, should be mounted on the sub-panel Q, by means of a small bracket, as shown in Figure 6, or it may be fastened flat to the sub-panel in any manner that the builder may prefer.

Next mount the jacks J1, J2, J3, and J4, in their respective places in the holes drilled for them and shown in Figures 3 and 6. The fixed condensers I, L, and M, may be screwed to the sub-panel in the positions indicated in Figures 2 and 3.

The connecting-block W, and the tickler connecting block X, should be made of composition panel and equipped with brass supporting pieces. The blocks and the brass pieces should be of the dimensions given in Figure 8. When completed, the blocks should be fastened to the sub-panel Q, in the manner indicated in Figures 2, 3, 5, and 6.

The dimensions for the cabinet are given in Figure 7. It should be constructed of hardwood and polished in any style preferred by the builder.

How to Wire the Set

The grid wiring of the set should be kept as short as possible and should be isolated from the other circuit wiring as far as possible.

Start wiring with the antenna and ground binding posts (the first two left-hand posts, looking from the front in Figure 3) and connect up the coupler-coil A, and condenser D, as shown in the diagram in Figure 1. The first jack is used to "cut out" the antenna and ground and the coupler coil, when a loop antenna is used.

Wire up the first tube circuit to the vario-transformer B, and the compensator condenser E, as shown in the diagram, and continue on with the second tube circuit including the second vario-transformer C, and the condenser F. The connections for the posts on the vario-transformer are indicated in Figure 9.

Now wire up the detector circuit and the two stages of audio-frequency amplification as shown, including the transformers T1 and T2, the fixed condensers, and the other three sockets.

The "A" and "B" battery connections should be carefully traced through as well as the connections to the jacks to make sure that every connection is correct and that no circuits run foul of each other.

This will make sure that no tubes are destroyed when the circuit is put into operation.

A word of caution is here sounded against the use of excessive soldering paste on the jack connections and on and between terminals of condensers and other instruments. The paste contains acid and this causes leakage if allowed to remain between two connections. Only a very thin film of the paste is sufficient, and none should show on the insulation when the soldering is completed. If too much paste has been used by mistake, it should be removed by applying alcohol on a cloth; this will remove it readily.

Where the wires are fastened to binding posts and instrument terminals it is a good plan to use little copper tabs to which the wires can be soldered and then the tabs can be screwed down under the binding posts. Then if a mistake has been made in the wiring the posts can be loosened and the connection changed without leaving lumps of solder stuck all over the posts.

The third binding post from the left is the negative "A" battery, the fourth is for the positive "A" battery, the fifth the negative

"B" battery, and the sixth and seventh are the detector plate 45-volt positive "B" battery tap, and the amplifier 90-volt "B" battery connection, respectively.

After you have finished the wiring job, sit down with some friend and check over the wiring once or twice before connecting up the batteries.

This will save you a lot of trouble in case you have made a mistake in the connections.

Operating Data

When using the set the following hints will be of practical value.

The set may be used with any antenna or "lighting plug" outfit, or it may be used with a loop antenna.

After the batteries are connected, the tube rheostats should be revolved in a clockwise direction until the tubes are all lighted to the correct brilliancy and the compensating condensers should be set at about 50.

The vario-transformer dials should be set at the proper wavelength, roughly, and the variable condenser tuned until the signal is picked up. Then the best tap on the antenna switch should be selected, and the finer tuning with the vario-transformer made. Then the compensator condensers should be adjusted for the maximum signal and the vario-transformers finally reset for the best results.

Amateur stations will tune between 0 and 40 on the vario-transformers, and low wavelength broadcasting stations will tune somewhere between 40 and 65. The medium and high wavelength broadcasting stations will tune between 65 and 100 on the vario-transformer dials.

If an extremely loud signal is desired it would be advisable to connect a variometer between the tickler binding posts and this will be rotated when a signal has been tuned in to obtain regeneration in the detector circuit. If the variometer is not used the two tickler binding posts, which are in series with the plate circuit of the detector tube, should be connected together with a short piece of wire.

When used with the loop antenna the set is tuned in the same manner as with the outdoor or indoor antenna with the exception that the tapped switch is not used.

The set will tune from about 180 meters to 515 meters.

The range with an outdoor antenna should be several thousand miles and several hundred (upwards) with a loop, according to the kind of building the set is located in.

The loop is especially suitable for summer use, as it cuts down the reception of interfering static, so that the broadcasting from nearby stations at least is clear and enjoyable.

Tuning is extremely sharp on both the loop and the regular antenna.

Helpful Hints

ERECT your antenna as high as possible and give your radio set a good start.

* * *

NEVER run the antenna lead-in any long distance through the house. Make it as short as possible from the window where the wire is brought in. If the lead-in is long inside the house the walls and ceilings will absorb most of the radio-frequency energy that should be used in the set for producing signals; in other words the signals will be much reduced in strength.

Place the receiving apparatus near the window and run the ground wire to a *water pipe!*

* * *

MOST instructions for erecting single-wire antennas provide for cutting the wire at the insulator nearest the house, and then urge precautions against a bad connection between antenna and lead-in. Often this difficulty can be obviated by purchasing enough wire, in one piece, to reach from the far support to the set, or at least inside the house, so that no joints are exposed to the weather. Attach the far end of the wire first, then put the other end through the house insulator, draw the wire taut, and give it a few turns around itself before it is continued as the lead-in.

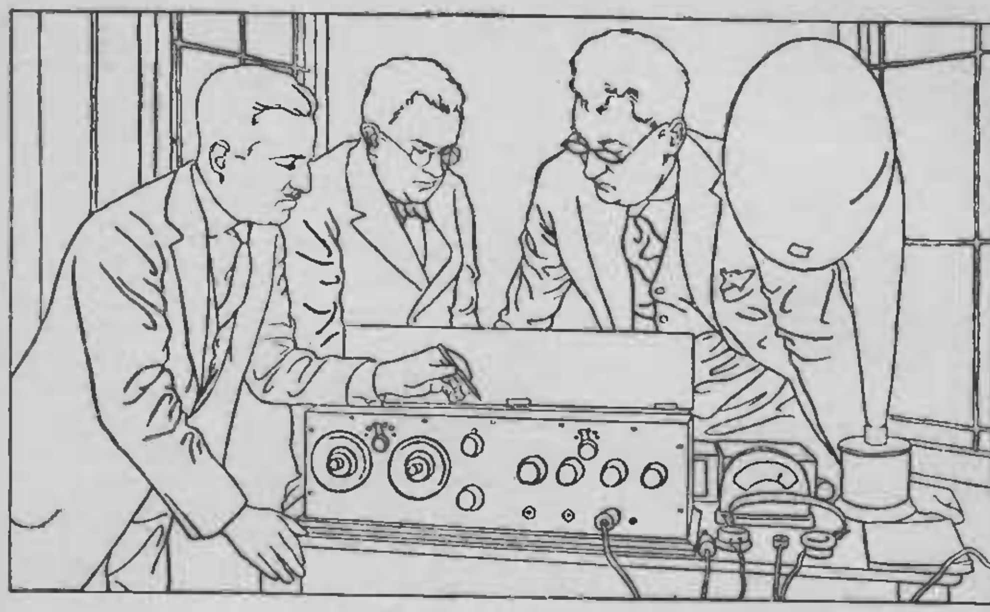
* * *

WHEN you solder connecting wires to the terminals of jacks for making connections to the telephones, it is important to keep soldering flux from running down onto the insulating segments which separate the different spring contacts.

If the flux runs down into the insulating segments it causes leakage and it is to this that many experimenters owe the trouble they have with their home-made sets.

Use only enough flux for the solder to take hold; a thin film is enough.

Another point to remember: be sure that the contacts make and break properly when you have finished.



THE COMPLETED SET

The inventor, L. M. Cockaday, is here shown demonstrating his experimental receiver to Dr. E. E. Free and Raymond F. Yates, in the experimental laboratory where the set was built.

HOW TO BUILD THE

IMPROVED 4-CIRCUIT TUNER

It is estimated that there are now in use about 500,000 four-circuit tuners—first announced in POPULAR RADIO for May, 1923. This chapter describes a remarkable development of this set—a development that provides for AUTOMATIC TUNING, practically unlimited distance range, maximum volume of sound, excellent reproduction and no interference. This set is probably the most important single contribution that has yet been made to the equipment of the radio fan.

—KENDALL BANNING

COSTS OF PARTS: *About* $95.00

RECEIVING RANGE: *Over* 3,400 *miles*

HERE ARE THE ITEMS YOU WILL NEED—

Four-circuit coil set, units A, B, C, D;

A—primary winding, consisting of a single turn of tinned-copper, bus-wire 1/16-inch square;

B—secondary winding, consisting of 65 turns of No. 18 DSC copper wire;

C—stabilizer winding, consisting of 34 turns of No. 18 DSC copper wire; (coils A, B and C are wound on a hard-rubber tube, 3¼ inches in diameter and 5 9/16 inches long);

D—antenna tuning coil, consisting of 43 turns of No. 18 DSC copper wire double bank wound and tapped on hard-rubber tube, 3¼ inches in diameter and 1⅝ inches long.

E and F—Amsco vernier variable condensers, 26 plates, .00046 (.0005) mfd. (with 4-inch knob-and-dial and vernier knob);

G and H—Amplex grid-densers (small variable condensers);

I—Bradley-leak, variable ¼ to 10 megohms;

J1, J2, J3, J4 and J5—Melco vacuum-tube sockets;

K—Amsco filament rheostat, 6 ohms;

L1, L2, L3—Amsco filament rheostats, 20 ohms;

M1, M2, and M3—Pacent jacks, two double-circuits and one single-circuit jack;

N1 and N2—Amertran audio-frequency amplifying transformers;

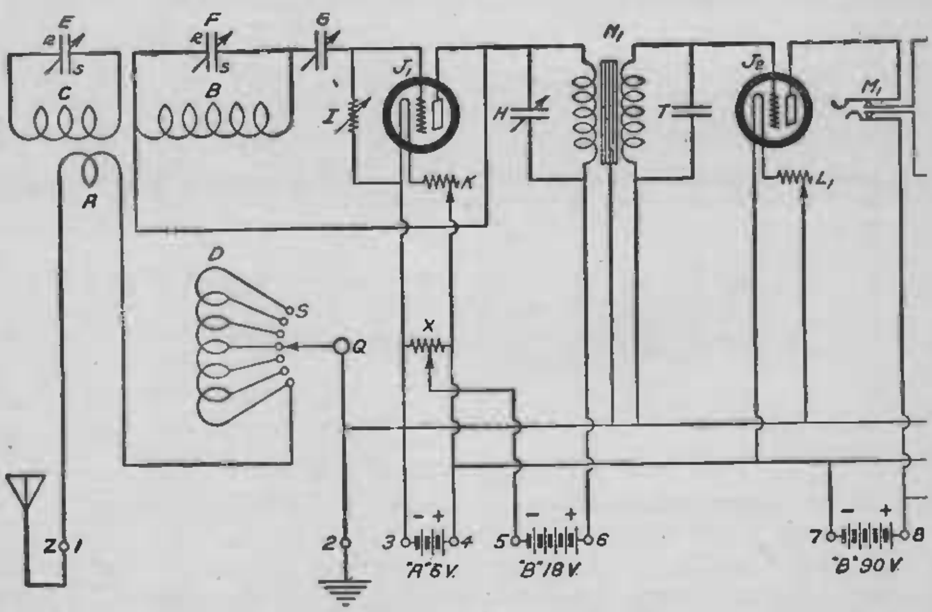
O—Como input "push and pull" transformer;

P—Como output "push and pull" transformer;

Q and R—switch levers and knobs;
S—switch points;
T—Dubilier mica fixed condenser .0005 mfd. (with lugs for transformer mounting);
U—Dubilier mica fixed condenser .00025 (with clips for grid-leak);
V—Durham variable grid-leak;
W1, W2 and W3—Lavite resistances, 48,000 ohms;
X—Amsco potentiometer, 400 ohms;
Y1, Y2, Y3—composition panels (7 by 24 inches), (3 by 2¾ inches), (and 1 inch by 12 inches). See Figures 7 and 9;
Z—binding posts;
AA—base;
AB—cabinet. (See Figure 8);
AC, AD and AE—brass brackets. See Figure 9;
varnished cambric tubing;
solder, etc.

THE letters telling of the radio enthusiasts' experiments and success with the four-circuit tuner have been pouring in so fast that the author has not had time even to try all the suggestions that they contain. Nevertheless he has managed to investigate every suggestion for improvement of seemingly worth-while value that has come in and has picked out the good ones received and applied them to the set. Along with this have come letters from fans who have built the four-circuit set described on pages 45 to 56 of this book and have for some reason or other not had the success with it that they should have had. Some have found the set ideal on local reception but poor on DX; some have found it wonderful for DX reception but not of enough volume on local stuff. Some write in that their set does not oscillate freely; some say that their set oscillates too much.

In every case, the trouble can be run down and it is almost always found to be due to a *mistake in connections* or to *apparatus of poor design or poor quality* that has been incorporated in the set. It should be remembered that a set is no better than its poorest part, and if one such part is used in the set, the whole set will be dragged down to this level. A poorly designed instrument can never be boosted up to the level of a good one by



THE COMPLETE WIRING DIAGRAM THAT INCLUDES—

FIGURE 1: *This diagram shows how to hook up the various instruments and parts in the circuit. It will be noticed that all the parts are given a designating letter*

placing it in a circuit in company with good ones.

The improved circuit which is here described, besides having its recognized qualities of (A) unusual selectivity, (B) unlimited distance range, (C) ease of tuning, (D) truthful reproduction, also incorporates the following new features:

E—wavelength range, 150 to 675 meters;
F—wavelength calibration;
G—automatic tuning;
H—power amplification;
I—simpler construction;
J—adjustable circuit values.

The feature E makes the circuit suitable for amateur, broadcast, and commercial reception from CW, telephone, or spark transmitters.

Feature F allows the operator to set the dials for any particular wavelength he wishes to receive on, with the assurance that he will immediately pick up the station he is trying to get, without interference—providing the station is transmitting at the time.

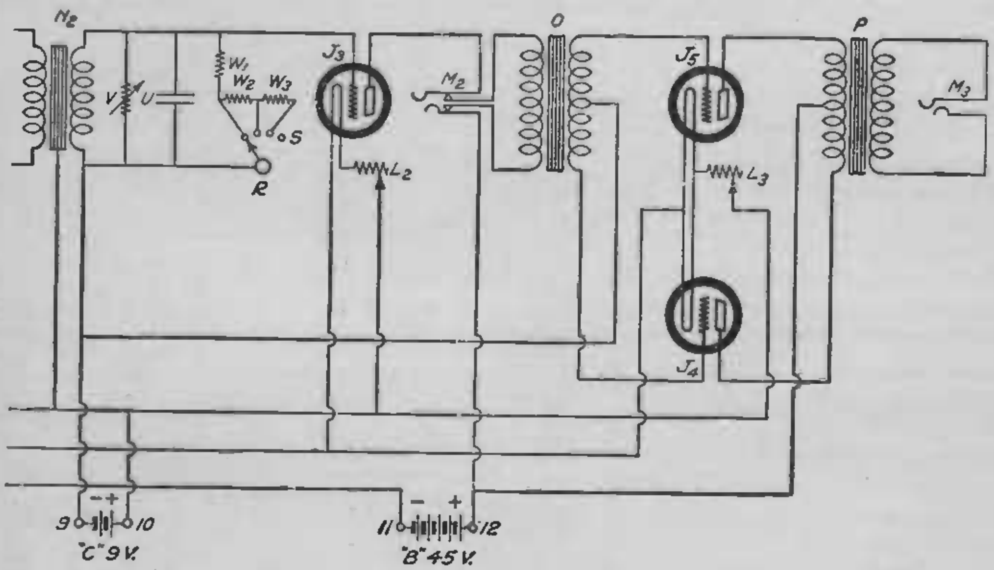
Feature G allows of tuning by a novice, even though he has no conception of what is happening when he adjusts the dials to the given settings.

Feature H allows of loudspeaker reception of DX* within 3,000 miles, and on account of the quality assured by the "push and pull" amplifier system, the reproduction of music and voice signals will be pure and undistorted.

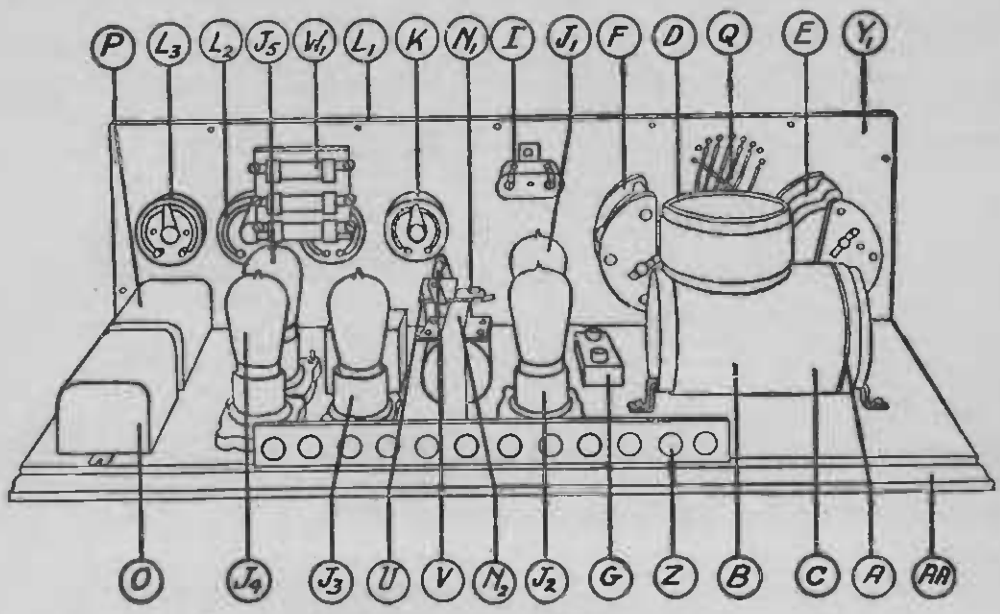
Feature I is important because in building the first four-circuit tuner it was necessary to make special brackets for mounting the instruments, which were almost beyond the scope of the amateur builder. The new set is a structure in which all the instruments, except those that are mounted directly upon the panel, are fixed to the base, which is made of hard walnut wood. By this construction all the instruments are easily accessible and may be wired up with little difficulty.

Feature J is important because the various people who build the set may find that their set may oscillate too freely

*Amateur slogan for "long distance."



—THE TUNER, AUDIO AMPLIFIER AND POWER AMPLIFIER
which is the same as that given for the same units in the list of parts and the text. The binding posts are numbered. This eliminates the possibility of mistakes in wiring up.



THE REAR VIEW OF THE SET

FIGURE 2: *This picture shows the general arrangement of all of the instruments fastened to the panel or the base. The exact locations for the instruments are shown in Figure 4.*

or not enough and if the grid condenser, the by-pass condenser, and the grid leak are made variable, these difficulties can be overcome and the set put into critical, regenerative condition.

The cabinet for the set is of simple construction; it consists of three sides fastened together which may be fixed onto the base and the panel by screws running through the base and the panel. The receiver is built on a 7x24-inch panel which is a standard size and can be obtained from any dealer.

Of course, the receiver does not re-radiate; this is really important in these days when closely coupled regenerative receivers are the rule, and we have so much whistling and squeaking accompanying reception in a locality where a number of these re-radiating receivers are in use.

The set is not susceptible to body capacity and needs no shielding at all; this is taken care of by the wiring of the set itself.

The wiring diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel Y1, (shown in Figures 2, 3, 4, 5, 6 and 7).

First of all the panel should be cut to the correct size, 7 by 24 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 7.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next mount the condensers, E and F on the main panel Y, by means of three screws each, and attach the knobs-and-dials. Be sure that the plates of the condensers are "all out" when the dial settings read zero. This is important if the calibration curve is to be used. Also be sure that the vernier plates of the condensers are "half in and half out" when the word "vernier" reads horizontally across the vernier knobs. Then mount the variable grid-leak I, on the panel with two screws, see Figures 2, 3 and 4.

Now mount the potentiometer X directly beneath the grid-leak by means of two screws.

Fasten the 6-ohm rheostat K directly above the hole for the first jack M1 by means of two more screws. The three 20-ohm rheostats L1, L2 and L3 should now be mounted in their respective positions to the right of the 6-ohm rheostat K.

Then mount the two switch levers and knobs Q and R on the panel, and also the switch points S. (See Figures 2, 3, 4 and 6.)

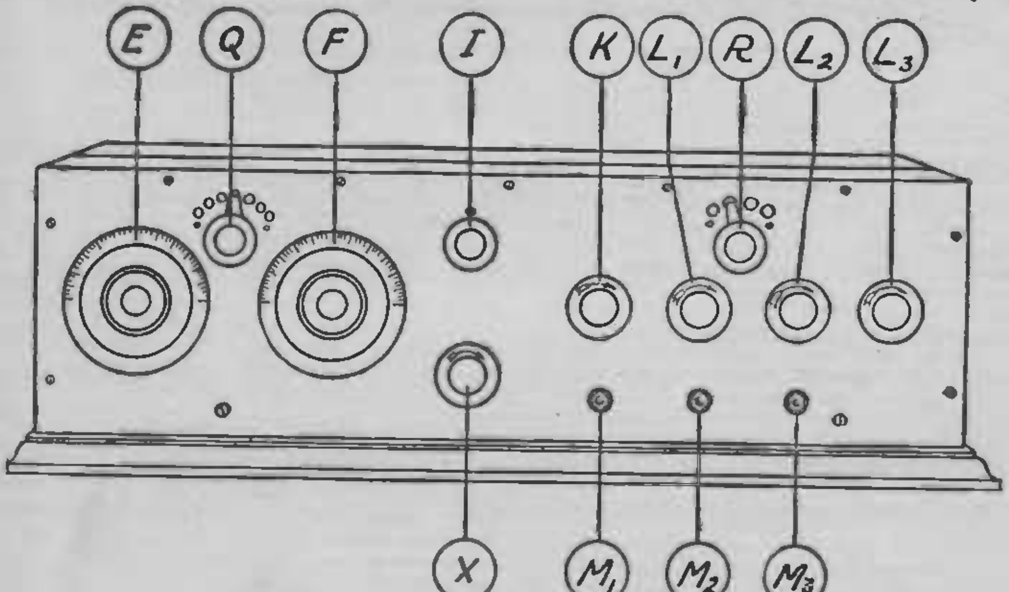
Next mount the three jacks M1, M2 and M3 in their respective places at the lower right end of the panel.

The correct positions on the panel for all these various instruments are shown in Figure 3, where all the knobs and parts are designated by the same letters as appear in the text.

The complete panel should now be attached to the wooden base by means of two small angle-brass brackets AC, see figures 2, 4, 5 and 9. The two holes for these brackets are shown in the drilling plan of the panel Y1 in Figure 7.

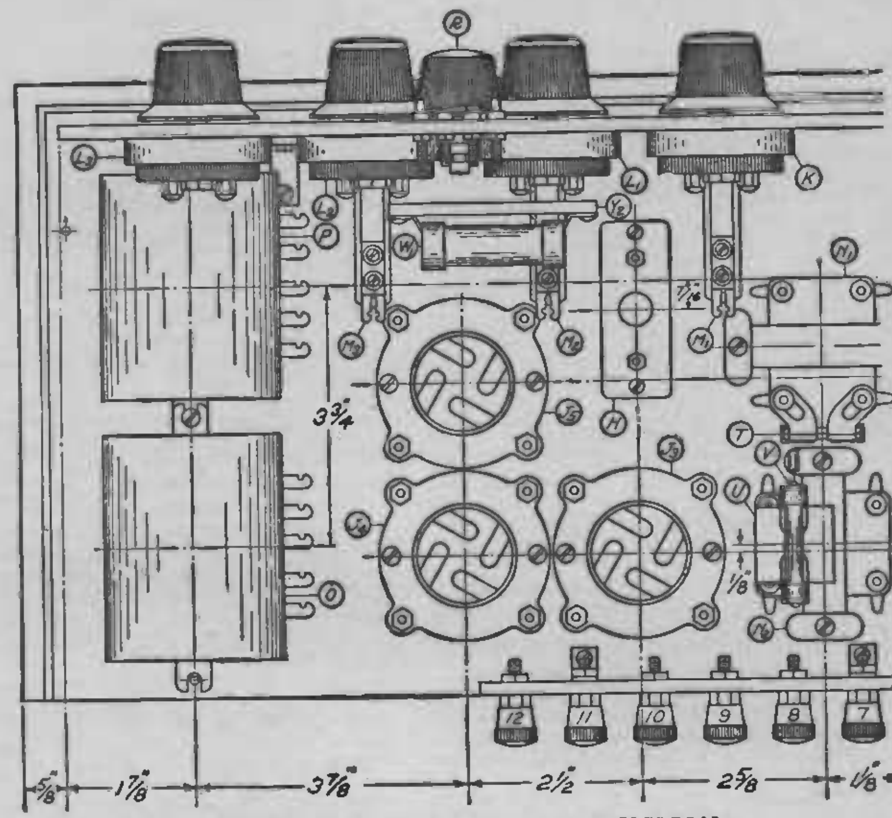
Now mount the coil set A, B, C and D with two screws fastened through the brackets AE as shown in Figure 4. Then fasten the five tube sockets J1, J2, J3, J4 and J5 in their respective places as shown in Figure 4.

Next fasten the two transformers N1 and N2 to the base, as shown in Figures 2 and 4. The first transformer N1 is attached to the base by slipping the small metal leg underneath the detector socket and fastening with the same screw as that used for one side of the detector socket. This gives close spacing. It will be noted that these two transformers are placed at right angles to each other. It should also be noted that the sockets are mounted with the slot facing a specific direction so that the grid terminals will be closest to their respective points of connection. (See



THE PANEL VIEW OF THE RECEIVER

FIGURE 3: *This gives an idea of how the set looks from the front and as the dials and knobs are marked with letters which correspond to the instruments to which they are attached, the prospective operator will have no trouble in locating the various tuning controls as they are explained in the instructions for tuning automatically.*



THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 4: *Here are shown the correct positions for the various instruments. The positions are given, center to center, for all instruments.*

Figure 4.) This makes for short leads.

The next job will be to mount the transformer O at the rear of the base, and the transformer P close to the panel Y1. These two transformers are fastened to the base by means of two screws, one through the leg of transformer P near the panel, and one through the remaining leg of this transformer and the adjacent leg of transformer O. The remaining leg of transformer O will be held by one of the screws which are inserted up through the base and which hold the cabinet to the base.

Now mount the condenser T across the secondary terminals of the first transformer N1 and mount the condenser U and the grid-leak V across the secondary terminals of the second transformer N2. This is clearly shown in Figure 4.

The next job is to screw the two small rectangular-shaped variable condensers G and H in their respective positions as shown in Figure 4. These two instruments are mounted by two screws for each condenser.

Now cut the small connection block Y3 out of composition panel material, to the size shown in Figure 9 and drill for the binding posts. This panel should then be mounted on the base AA. by means of three small brass brackets AD constructed as shown in Figure 9. See Figures 2, 4 and 5 for mounting the connecting block.

The last job is to cut the small composition panel Y2 for mounting the three resistances W1, W2 and W3. This is done as shown in Figure 9, which gives the dimensions for drilling and shows the manner in which the units are mounted. As this panel is supported by the wiring of the set, the directions for mounting it will be left until later.

How to Wire the Set

The design of this set is such that the grid-circuit wiring of each of the five tubes may be made extremely short and isolated from the other circuits. In fact, all the tuning circuits and leads are so arranged that short connections may be used. As this is the case, the set may be wired with bus-bar with little loss in efficiency.

A tinned-copper wire is recommended. It should be about 1/16-inch square. All connections should first be shaped so that they will fit and then soldered in place. Start wiring the filament circuit as shown in the diagram in

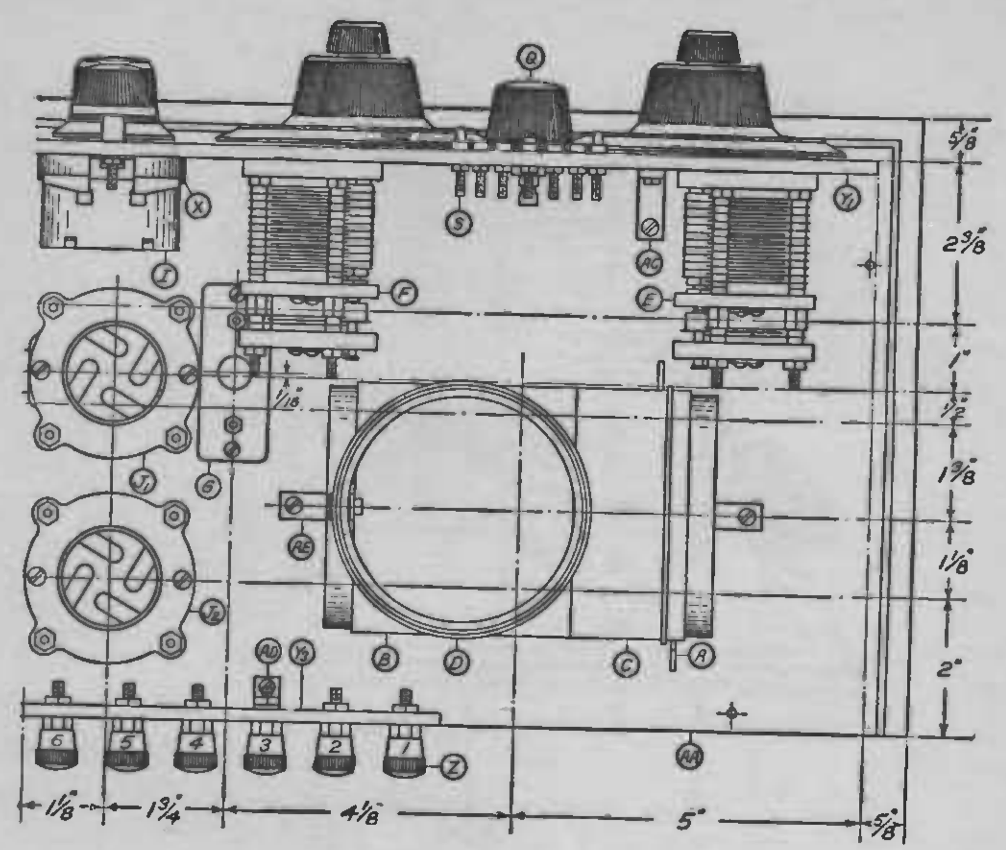


Figure 1. Be sure to include the rheostats in the correct side of the filament circuits. *This is important!*

In wiring up the potentiometer X be sure that the left-hand post of this instrument is connected to the negative "A" battery and the right-hand post is connected to the positive "A" battery.

Run a wire from the antenna post and loop it around coil C, one turn (forming winding A) spaced ¼ inch in from the outer end of the winding as shown in Figure 4. Run the other end of this loop over to the top end of coil D and from there over to the first switch point on the panel Y1, then connect up the rest of the switch points to their respective taps on the coil D. The switch lever Q should now be connected to the ground binding post and the negative "A" battery post on the connection block Y3.

Now wire up the two condensers E and F as shown in Figure 1, with the rotor and stator plates connected as shown in the diagram. Then wire up the grid circuit of the detector tube which includes the condenser G and the grid-leak I.

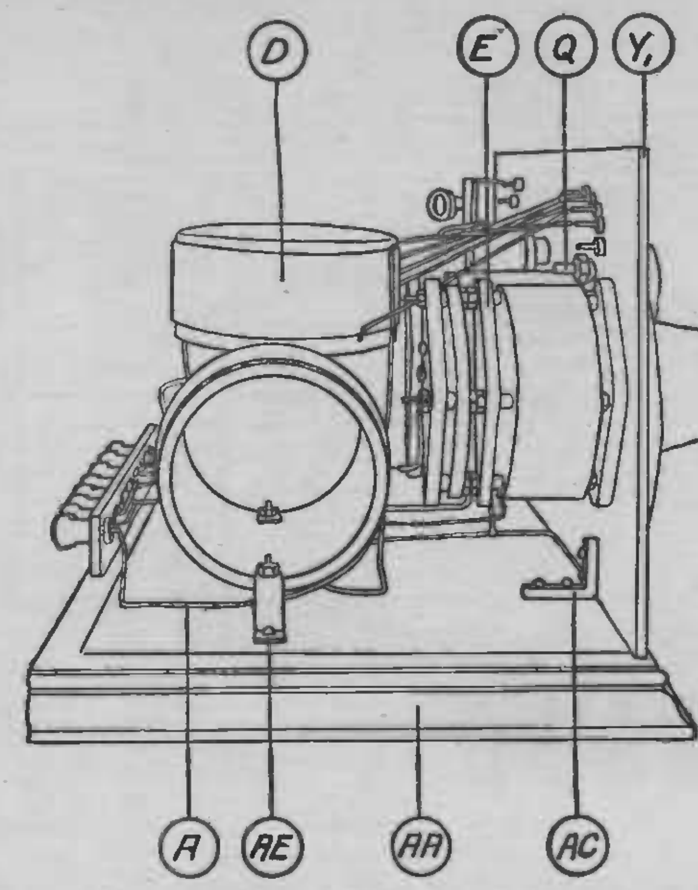
Run a wire from the middle post on the potentiometer X to the detector negative "B" post on the connection block. This is the fifth post from the right (looking at the set from the rear). The sixth post should be connected with a wire over to the B+ terminal of the primary side of the first transformer N1 with the remaining terminal connected to the plate terminal of the first tube socket. Now connect the small variable condenser H, by two wires, across the primary of this same transformer N1.

Next connect up the secondary of transformer N1 to the correct terminals of the second tube socket.

Then wire up the plate circuit of the second tube which includes the primary of the second transformer N2 and the first jack M1. The seventh binding post on the connecting block is for the negative 90-volt amplifier "B" battery and the eighth post is for the positive 90-volt amplifier "B" battery, which is connected to the second-tube plate circuit.

Now connect up the secondary circuit of the second transformer N2 to the grid circuit of the third tube. The ninth binding post on the connecting block is for the negative "C" battery and the tenth binding post is for the positive "C" battery.

The resistances W1, W2 and W3 which are fastened to the small panel Y2 are now connected with bus-wire to the switch points S and switch lever R and also to the secondary terminals of the second transformer N2 as in-



VIEW OF THE SET AS SEEN FROM THE LEFT

FIGURE 5: *This picture shows the way to mount the condensers and the coil set, and specifically, the manner of attaching the single turn of bus-bar for the coil A.*

dicated in the wiring diagram and shown in Figures 1, 2, 4, and 6.

Now connect the plate circuit of the third tube which includes the second jack M2 and the proper connections on the input transformer O which are printed on the bottom of the transformer. The eleventh post is for the negative terminal of the extra 45-volt "B" battery used on the two last stages of amplification. This post should be connected by a wire to the eighth post. The twelfth post is the positive terminal of the extra forty-five volts of "B" battery. This should be connected to the plate circuit of the three last tubes as shown in the wiring diagram in Figure 1.

Now connect the remaining terminals of the input transformer O to the grid circuit of the last two tubes, including the "C" battery connection.

Connect up the plate circuit of the last two tubes which includes the primary connection to the output transformer P.

The last job in wiring is to connect the two secondary terminals of transformer P to the two terminals of the last Jack—M3. This completes the wiring.

How to Install the Set

After the set has been completely wired, the cabinet may be attached by means of wood screws inserted up through the base into the bottom edges of the cabinet and by smaller wood screws (nickel plated) inserted through the panel into the edges of the cabinet.

The binding posts Z on the connection block will now protrude through the slot cut for them in the back of the cabinet.

To connect the set, do the following:

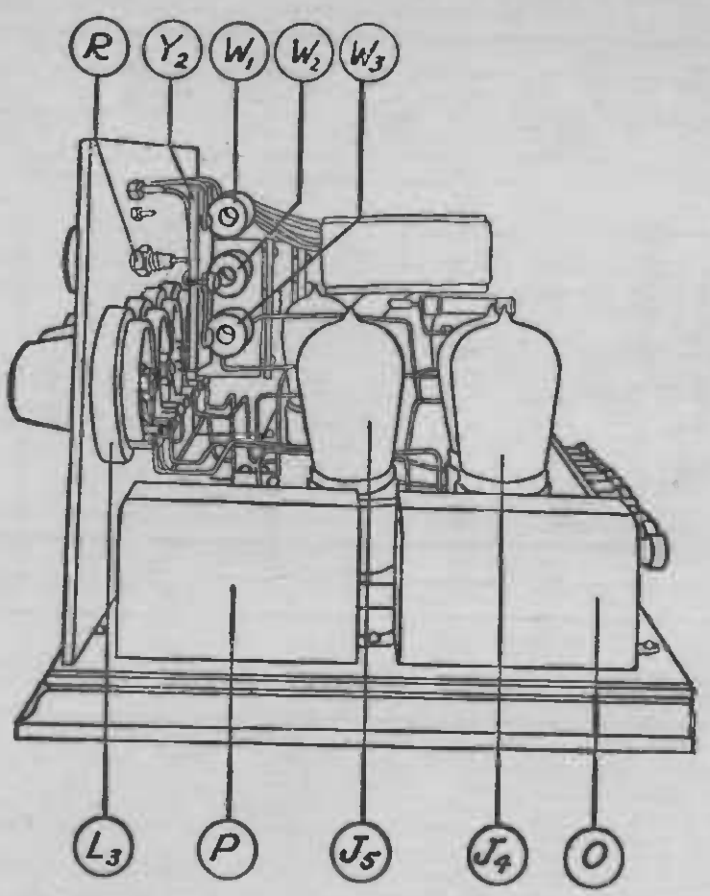
Attach the antenna wire to the first binding post at the right (looking from the rear).

Attach the ground wire to the second post from the right.

The third post from the right should be connected to the negative "A" battery, 6 volts.

The fourth post from the right should be connected to the positive "A" battery, 6 volts.

The fifth post from the right should be con-



VIEW OF THE SET AS SEEN FROM THE RIGHT

FIGURE 6: *This view gives a better idea of how to mount the two push-pull transformers and the rheostats and resistances.*

nected to the detector negative "B" battery, 18 or 20 volts.

The sixth post from the right should be connected to the detector positive "B" battery, 18 or 20 volts.

The seventh post from the right should be connected to the amplifier negative "B" battery, 90 volts.

The eighth post from the right should be connected to the amplifier positive "B" battery, 90 volts.

The ninth post from the right should be connected to the negative "C" battery, 9 volts.

The tenth post from the right should be connected to the positive "C" battery, 9 volts.

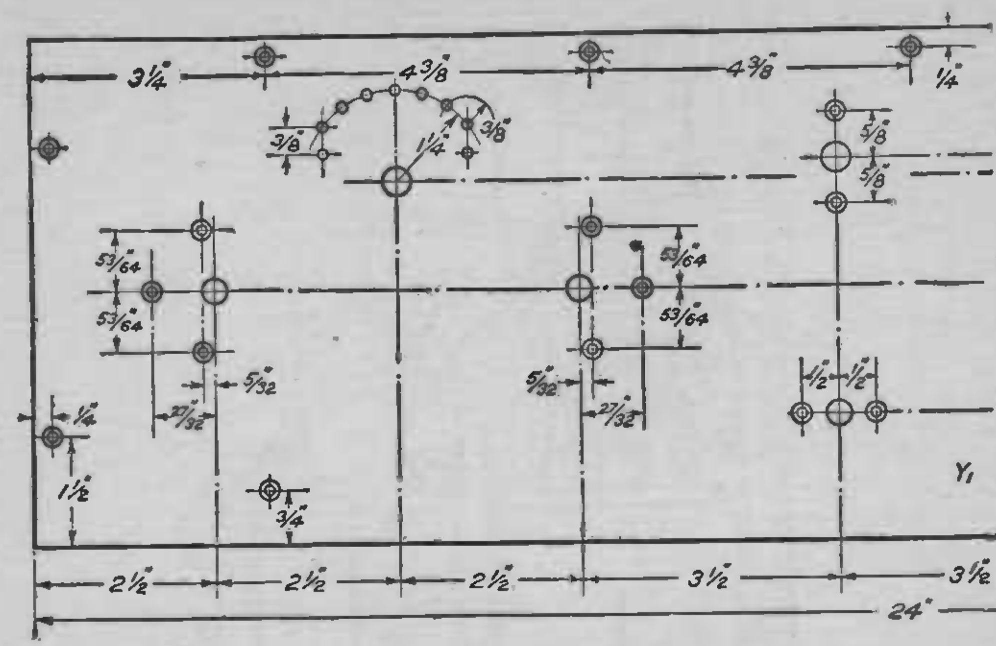
The eleventh post from the right should be connected to the extra amplifier negative "B" battery, 45 volts.

The left-hand post should be connected to the extra amplifier positive "B" battery. 45 volts.

For the detector, insert one UV-200 or one C-300 vacuum tube in the first socket J1.

Insert one UV-201-a or one C-301-a tube in each of the remaining sockets J2, J3, J4, and J5.

If the telephones are to be used, the plug should be inserted in the first jack M1, and the first two tubes lighted by turning the rheostat knobs K and L1. Turn rheostat K up about three-quarters of the way. Turn rheostat L1 up about the same distance. This will allow of reception from local and distant stations with the headphones. If the DX stations should be very far away and too weak on the first stage, take the plug out of the first jack and insert it into the second jack M2. Then turn up the rheostat L2 about three-quarters of the way, and the signals will now be amplified sufficiently to allow reception without trouble. If a loudspeaker is to be used, it may be plugged into this same second jack M2, which should give sufficient volume. However, if the DX signals are not quite loud enough in this jack, the loudspeaker plug should be withdrawn and inserted into the third jack M3 and the rheostat L3 turned up nearly all of the way. This will produce plenty of volume even on stations located on the other side of the continent.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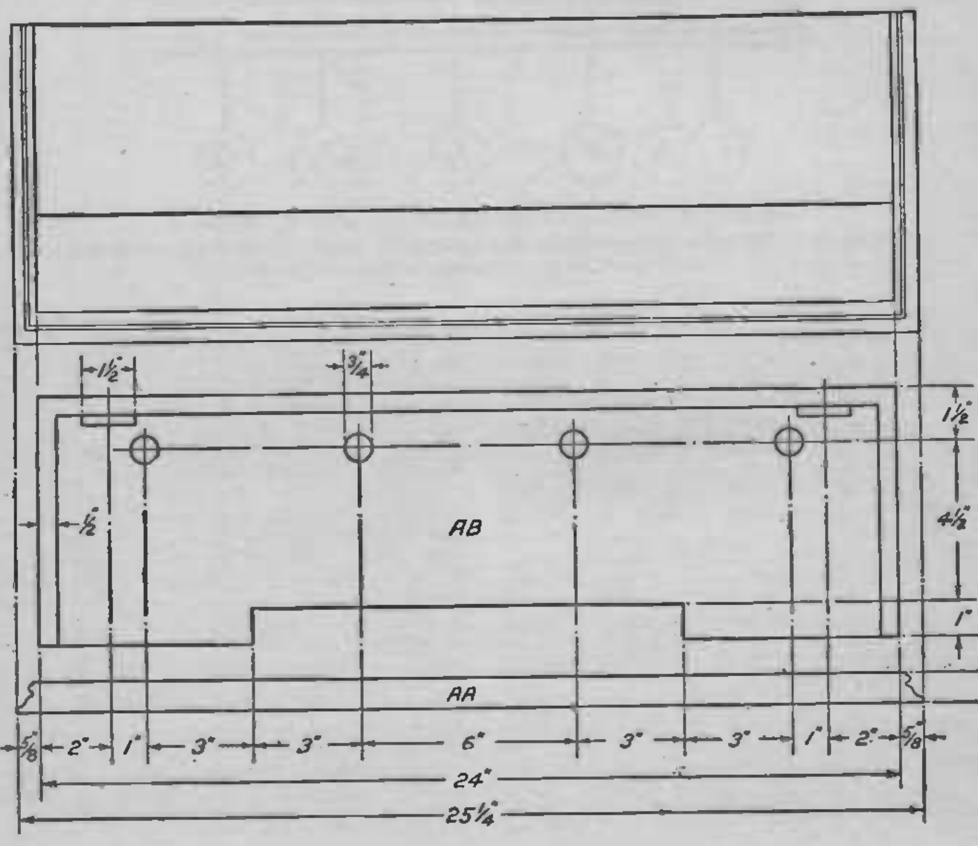
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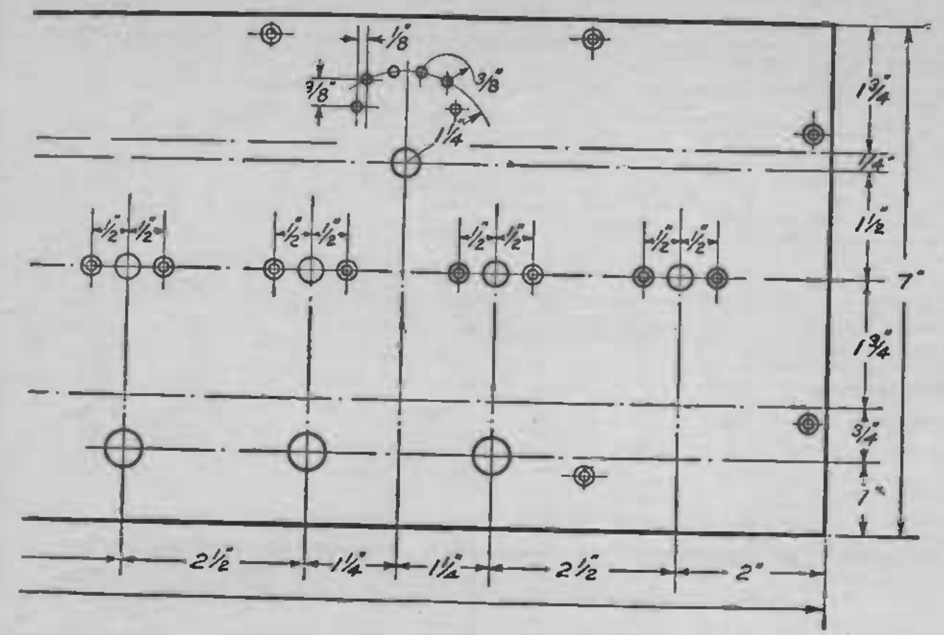


THE DRILLING PLAN FOR THE PANEL

FIGURE 7: *This drawing shows where to drill the holes for mounting the instruments. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk.*

Be sure to use a loudspeaker which is capable of handling quite considerable amounts of power, otherwise it will chatter on account of the diaphragm or armature hitting the magnets.*

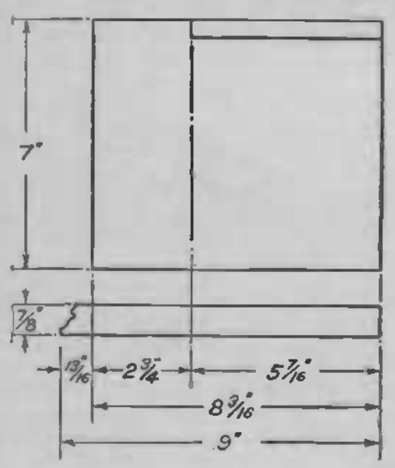
Now to put the set into actual operation: First set the two grid-densers. These are two small semi-variable condensers in which the plates are pressed together or released by a thumb-screw, increasing or decreasing the capacity. The condenser G should be set with the screw turned "all out" (counter-clockwise). The condenser H should be set the same way and generally it should be turned back about 1½ complete turns (clockwise). However, this depends on how the set is wired and what the quality of the detector tube happens to be. If the set does not oscillate enough, turn it counter-clockwise until it does. If it oscillates too much, turn it clockwise. If screwed down too far it will broaden the tuning. The correct adjustment can be found when the set has been in operation a few days.

Now refer to the tuning chart given in Figure 10. This is something new in tuning. The curve in the diagram shows how to tune the receiver for the various wavelengths used in broadcasting.

There are two scales on the chart, one, running up along the left side of the chart, is marked into degrees, 0 to 80, which corresponds to the two dial settings on the condensers E and F. The other, running across the lower side of the chart, is marked in wavelengths, 220 to 580 meters.

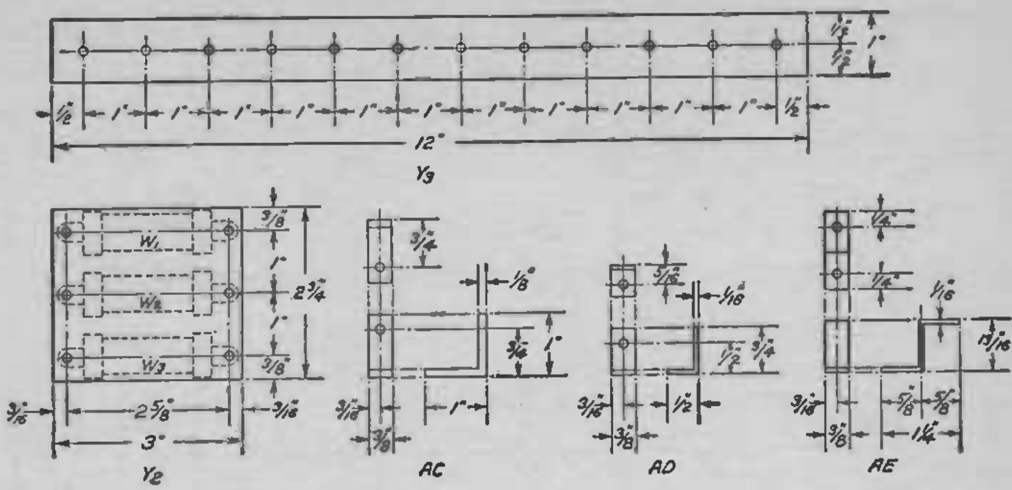
Pick out the wavelength of the local station

* With the power amplifier in this set, and a 10-D Western Electric loudspeaker (with the transformer removed), signals can easily be heard from the author's laboratory window, over the valley to the next hill, which is about half a mile or so away.



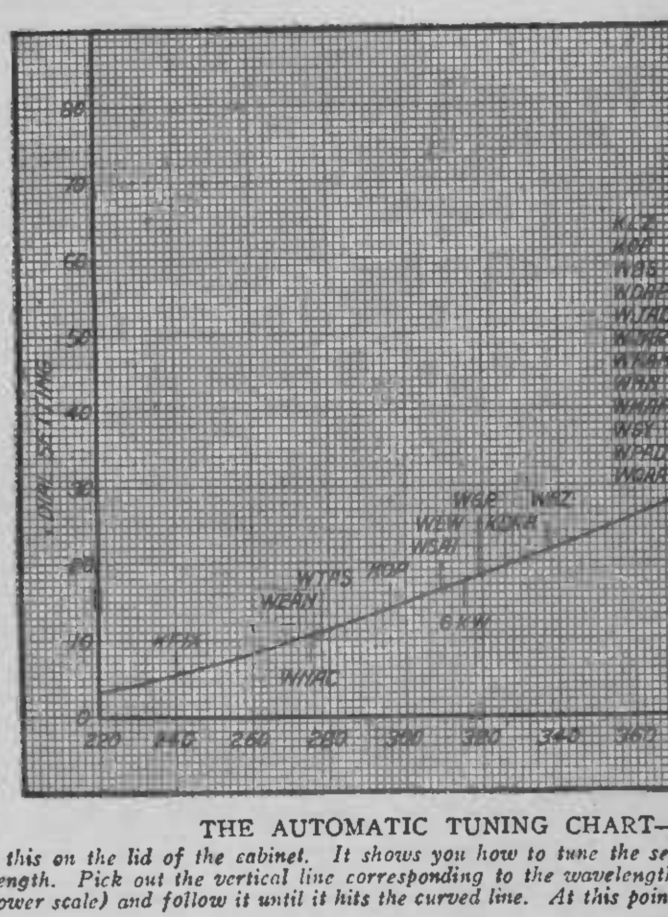
THE DIMENSIONS FOR THE CABINET

FIGURE 8: *This diagram (which contains the top, front, and side measurements for the walnut cabinet) may be turned over for construction to a competent cabinet maker who can build it from these directions exactly the right size for the panel.*



DETAILS OF THE SMALL PANELS AND BRACKETS

FIGURE 9: *This drawing gives the necessary data for making the two small panels for the connecting block and the resistances, and for making the small brass brackets for mounting the main panel, the connecting block and the coil set.*



THE AUTOMATIC TUNING CHART—

FIGURE 10: *Paste this on the lid of the cabinet. It shows you how to tune the set for a given wavelength. Pick out the vertical line corresponding to the wavelength you want (on the lower scale) and follow it until it hits the curved line. At this point*

on the chart and follow up the vertical line which runs through this point on the chart, until it crosses the curved black line. At this point, follow the horizontal line on the chart, which crosses the same spot, until it fetches up at the left side of the chart. This will give the proper dial settings for the two condensers E and F, for that particular wavelength.

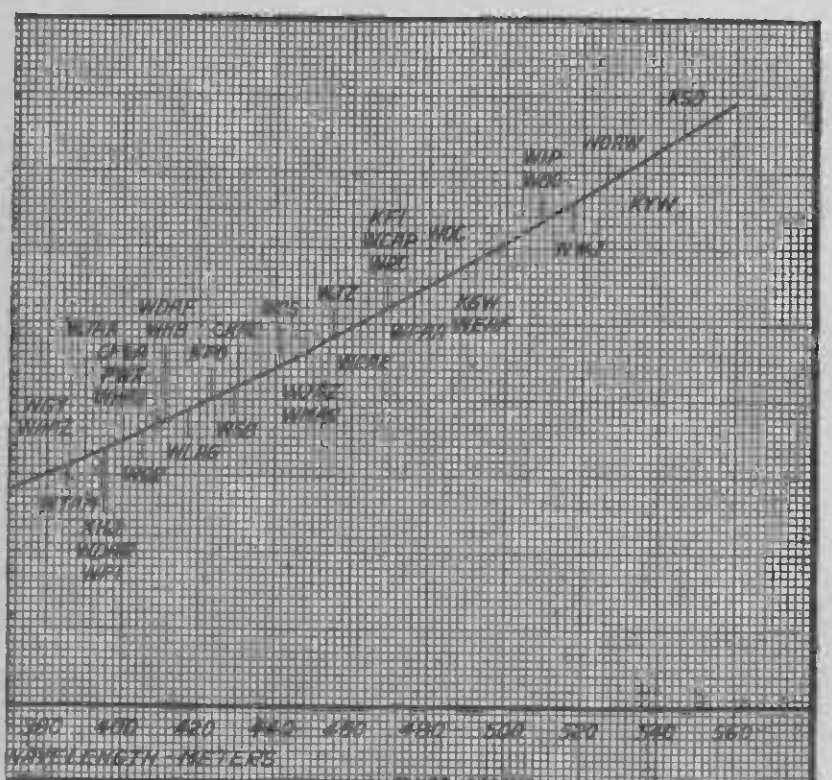
First, in tuning in a station, see that the two small vernier knobs are set so that they read horizontally, then set the two large dials at the setting found on the chart for the given wavelength. *Immediately, the station desired should be heard* (provided it is transmitting at the time). Then swing the switch lever Q to the proper point for the antenna wavelength (loudest point). Now further increase the volume by adjusting the vernier of condenser F, and finish up with condenser E's vernier. In tuning in the first station received the proper settings for the grid-leak I should be made. This will be found to be with the knob rotated somewhere near all the way out (counter-clockwise). Then the proper setting of the detector rheostat K, and the potentiometer X should be made. The potentiometer should be set about half way. Rotating the potentiometer knob clockwise increases regeneration by varying the resistance of the plate circuit and the "B" battery potential applied to the detector tube. Rotating this knob counter-clockwise decreases regeneration.

The switch R is used to control the volume output of the second and third stages of amplification; by placing the switch lever R on the first point (tap) the volume will be decreased and by swinging it to the right, point by point, the volume will be increased in steps. It is seldom necessary to use the last point to the right, even on DX.

The call letters on the chart include some of the larger broadcasting stations heard and logged by the author with this set, and probably do not include many stations that would be heard by listeners on the west coast. For these people, it would be a simple matter to write in, on the chart, some of their more familiar stations.

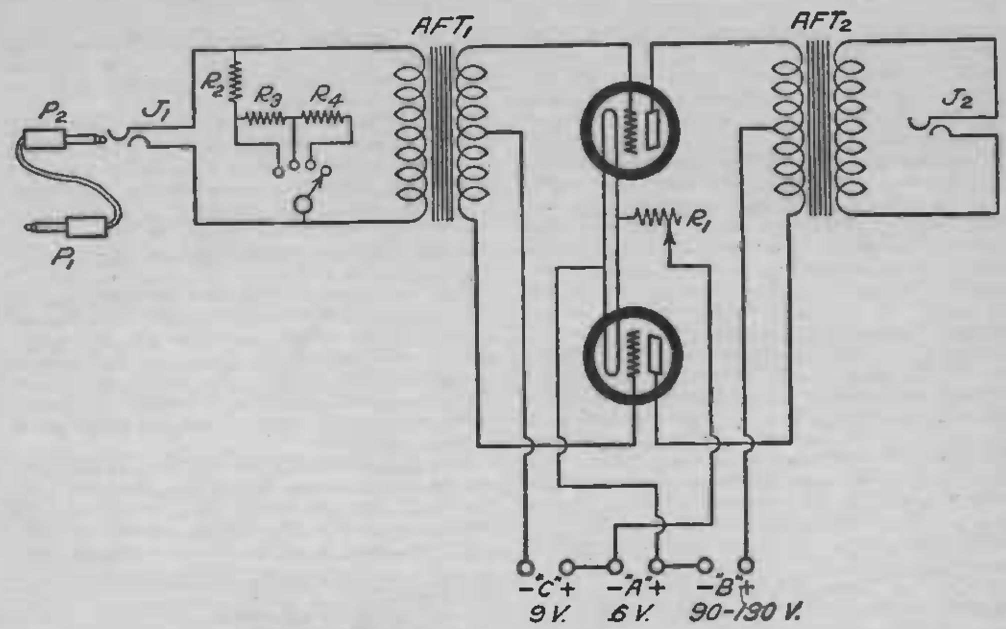
It is suggested that the builders of this set, cut out the chart in Figure 10 and paste it in the lid of the cabinet for ready reference. It works on all sets that use the condensers and coils specified; it works on any antenna, and it works for anybody who can read and set the dials.

The control is automatic.



—FOR PICKING UP BROADCASTING STATIONS

follow the horizontal line, intersecting the same point on the curve, and read the proper setting for bcth dials on the left-hand scale. Thus for station PWX the wavelength is 400 meters and the correct dial setting for the condensers E and F is 34½ and 34½



HOW TO WIRE THE AMPLIFIER PANEL

FIGURE 1: *This diagram gives the proper connections for all the instruments and parts that go into the amplifier cabinet which may be placed alongside the right-hand side of the set. The power amplifier is plugged into the second stage of amplification by means of the plug P1.*

HOW TO IMPROVE THE THREE-TUBE

FOUR-CIRCUIT TUNER

For the benefit of the many experimenters and radio fans who have built the Four-circuit Tuner described on pages 67 to 79 of this book and who may not want to tear it down to build the new and improved tuner described in the preceding chapter, we are giving in this article the necessary instructions for adding to the old set in order to bring its efficiency up to that obtained in the improved set.

COST OF PARTS: ***About $30.00***

RECEIVING RANGE: ***Up to 3,400 miles***

THE PARTS YOU WILL NEED—

One pair of Como push-and-pull amplifying transformers;
one filament rheostat, 20 ohms;
two vacuum-tube sockets;
one switch lever;
four switch points;
two switch stops;
one Bradley-leak;
one Amplex grid-denser;
two single-circuit jacks;
two telephone plugs;
six binding posts;
one panel, 5 inches by 8 inches;
one cabinet to match set;
one Amertran amplifying transformer;
three Lavite resistances, 50,000 ohms each.

IN order to improve the old set and make it as efficient as the five-tube set described in the January issue it would be advisable to use the Amertran transformer for the first stage of amplification and shunt the primary winding with the small variable condenser (the grid-denser). The fixed grid-leak should also be replaced, and the Bradley-leak inserted instead. This will help greatly in increasing the sensitivity and will allow of nicer adjustment of the circuit.

This includes all of the improvements necessary on the set itself. The rest of the work includes laying out one stage of power amplification on the new panel so that it may be (when placed in the new cabinet) set next to the old three-tube set on the right side. This will give the same volume and characteristics as the new five-tube set.

The new panel (which is the same height as the one in the old set) should be laid out with a neat arrangement of the rheostat and the two jacks. The two jacks should preferably be placed on the same horizontal line as in the receiver, and one should be at the left of the panel and one at the right. One of these is used, in connection with the two telephone plugs and two pieces of stranded wire, for connecting the output of the receiver with the input of the power amplifier. Place one plug in the last jack of the receiver and the other plug in the first jack of the amplifier.

The switch lever and switch points should be mounted on the amplifier panel and connected to the resistances. These are used for controlling the volume output of the amplifier.

The wiring diagram for the complete amplifier is shown in Figure 1. The same "A" battery should be used as for the receiver but a separate "B" battery would be preferable for the amplifier. Two UV-201-a tubes are recommended. Be sure to use the correct value of "C" battery as indicated on the diagram.

When you want to use the set alone *without* the power amplification, merely take out the interconnecting plug and insert the telephone plug on your telephones or loudspeaker. If you want to listen *with* the power amplification insert the interconnecting plug into the proper jack on the set and the proper jack on the amplifier and insert the loudspeaker plug into the last jack of the amplifier tubes and listen in.

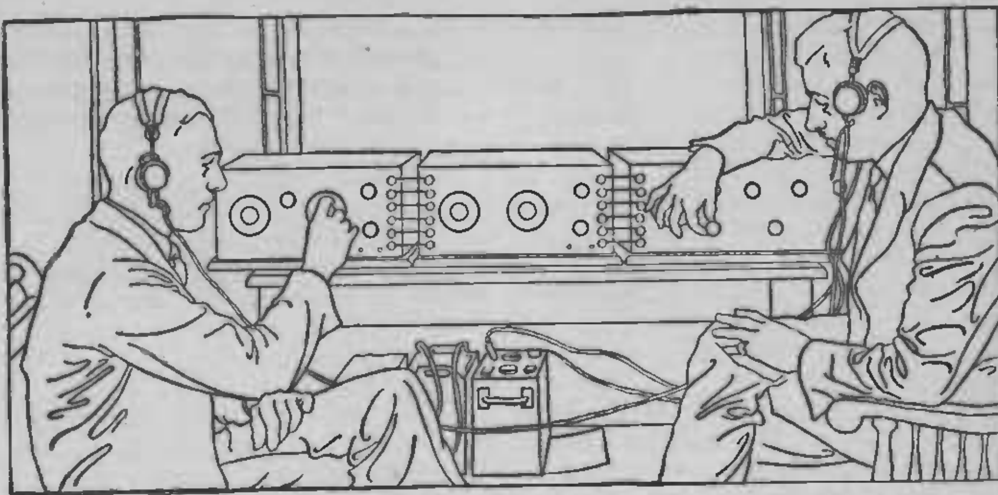
The addition has a good appearance and it is worth while for those who have the three-tube set and do not wish to tear it down to make the five-tube set.

Working Blueprints of This Receiver

IN *order to accommodate readers who may desire actual-size diagrams of the 5-tube Improved 4-circuit Tuner described on pages 67 to 79, a set of three blueprints has been prepared, consisting of—*

One panel pattern (actual size);
One instrument layout;
One picture diagram of all parts, showing the wiring.

This set of three prints will be forwarded, postage prepaid, upon receipt of $1.10.



THE TWO DESIGNERS DEMONSTRATE THEIR EXPERIMENTAL SET

The new receiver consists of three parts in separate cabinets. The tuner at the left is being operated by Mr. Haynes, the builder of the set; the oscillator is in the center and the amplifier at the right is being adjusted by Mr. Cockaday.

HOW TO BUILD THE NEW REGENERATIVE SUPER-HETERODYNE RECEIVER

COST OF PARTS: *About $100.00*
RECEIVING RANGE: *Up to 3,400 Miles*

HERE ARE THE ITEMS YOU WILL NEED—

(K2, K3, and K4)—Haynes-Griffin special oscillator coupler;
K1—knob and dial, 3 inch;
L—Fett and Kimmel Micro-tube variable condenser, .0005 mfd.;
L1—knob and dial, 3 inch;
M—Fada panel mounting socket;
N—filament rheostat, 20-30 ohms;
O—Micadon fixed condenser, .005 mfd.;
P1 to P12—binding posts;
Q—composition panel;
R—cabinet.

THE super-heterodyne receiver is the most *sensitive* receiver yet developed. If it is properly designed it is also the most *selective*. Its one drawback, heretofore, has been its *complexity*—complexity of construction and operation. This and the fact that the amateur and broadcast listener cannot afford such a costly piece of apparatus as it has been up to this time has kept the super-heterodyne from gaining the popularity that it justly should have received.

However, the super-heterodyne (or any other type of set) must have the following qualities before it can ever be acclaimed by the multitude as a really popular circuit.

1. *It must be selective.*
2. *It must be sensitive.*
3. *It must be easy to construct.*
4. *It must be inexpensive.*
5. *It must be easy to operate.*
6. *It must be economical from an "A" battery standpoint.*

Although the super-heterodyne meets the first two points better than any other known type, it has always been termed the "Rolls-Royce" of radio. But, beside being the most selective and sensitive it was also complicated, expensive, and could not be built by any but the most experienced engineers. It has always imposed a heavy strain on the "A" battery on account of the large number of tubes necessary to take advantage of its extraordinary amplifying powers. These factors have kept it, up to the present time, as the "lord of all radio receivers," but unfortunately they have also limited its use to a chosen few who have had the price, the ability and the patience to master its complications.

The author of this article has long realized the possibilities of this wonderful circuit and he has, for a period of six months, devoted much time to research for the purpose of developing a simplified super-heterodyne that is worthy of the name.

Of course, with the new low-filament-consumption vacuum tube such as the C-301-A and the UV-201-A, the set can now be made efficient as far as "A" battery loading is concerned.

It is now possible to burn four tubes with less filament current than one tube would have taken a year ago.

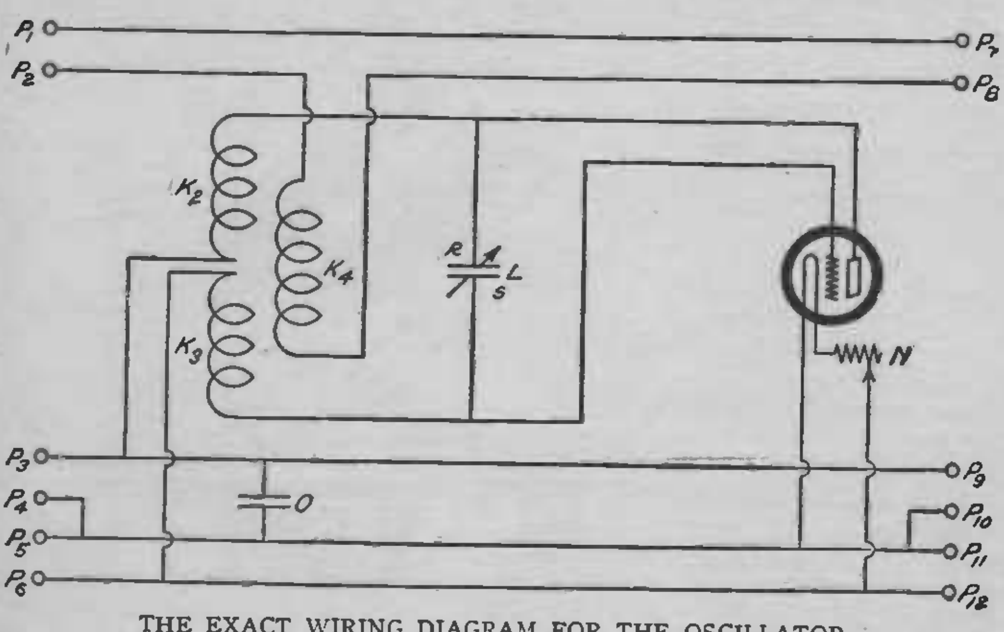
This fact covers the point raised in the 6th requirement specified at the head of this article.

The circuit as finally evolved (and as will be described in this article) has only two operating controls; for this reason it really *is* simple to operate (Point No. 5.)

The circuit has been so simplified and the parts used so reduced to essentials, that it is relatively inexpensive. (Point No. 4.)

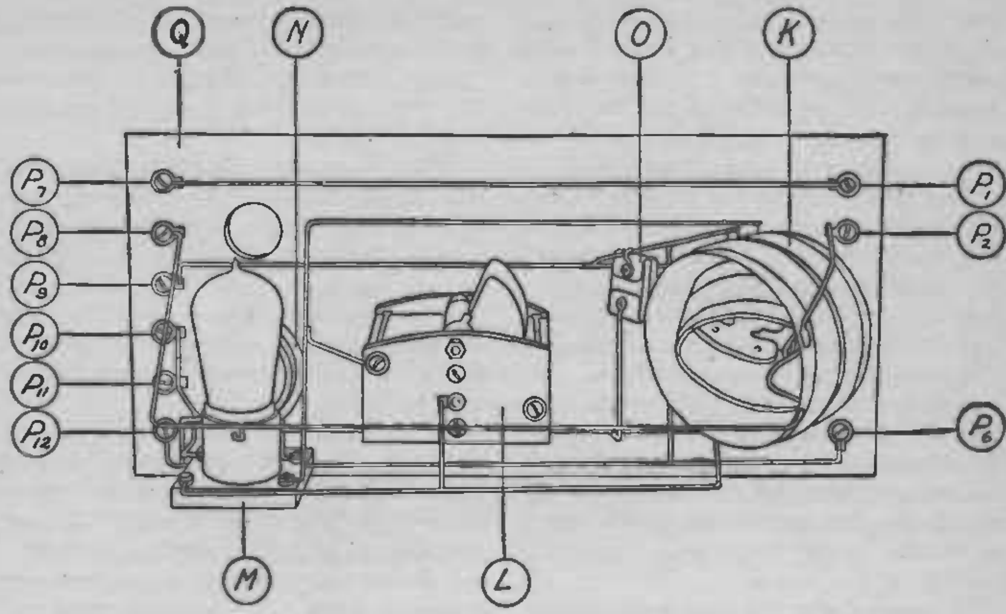
In its final form the set is really simple to construct. (Point 3.) It can be built in units. This places the super-heterodyne right where it ought to be as the ultimate in radio-reception apparatus but within the reach of anyone who is ordinarily handy with tools and who can afford to experiment with radio at all.

Some of the new features incorporated into the design of the set which make it so suitable for DX reception over wavelengths between 180 and 600



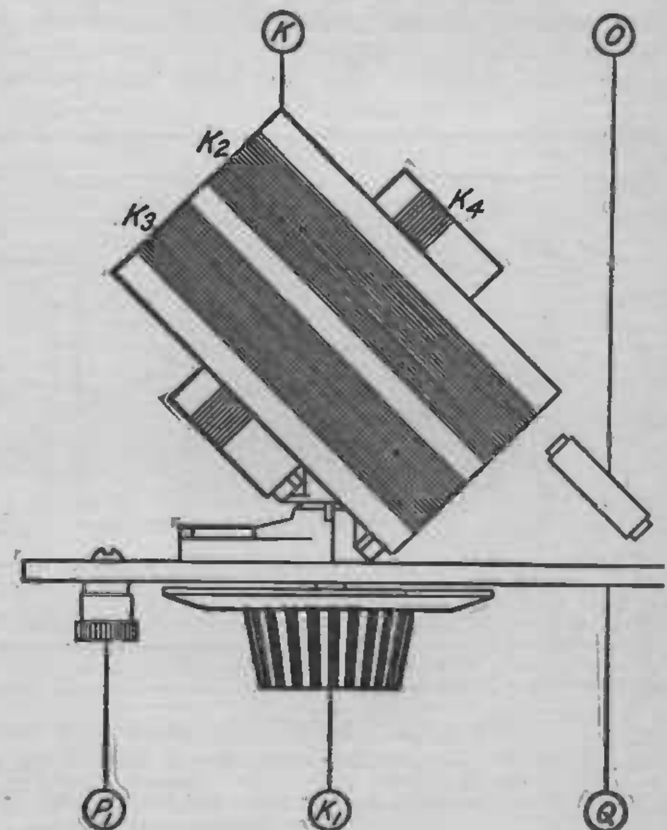
THE EXACT WIRING DIAGRAM FOR THE OSCILLATOR

FIGURE 1: *This diagram shows how to wire up the oscillator panel including the special oscillator coupler, the heterodyne condenser, the tube and the fixed condenser. The binding posts are numbered so that the experimenter will have no trouble in connecting up.*



THE INTERIOR OF THE OSCILLATOR

FIGURE 2: *(Above). The parts are designated by letters which reappear in the text and in the other diagrams and drawings. This actual photograph of the instruments indicates the simplicity of the set and should dispel any fears the prospective experimenter may have that its construction is difficult.*



HOW THE PARTS ARE ASSEMBLED

FIGURE 3: *(At right). The diagram extending across the bottom of these two facing pages is a working drawing of the oscillator; it shows the general arrangement of the parts as they are viewed from above.*

meters are the following:

The use of the first tube as a *radio-frequency amplifier.*

The use of a heterodyne oscillator *coupled to the plate circuit* of the first tube (instead of to the grid circuit as is usual).

The use of a new type of air-core, radio-frequency transformer which is *sharply tuned to a wavelength of 3,000 meters.**

The use of *regeneration* in the radio-frequency amplifier (which greatly boosts up signal strength without complicating the control.)

The *elimination of the variable-tuned circuits* at the input of the radio-frequency amplifier.

The *reduction of the tuning controls to two knobs*, one for the wavelength and one for the heterodyne oscillator.

The successful use of *regeneration* in the first-tube circuit.

The use of the Haynes circuit *for tuning.*

The use of the *new Thoriated-filament vacuum tubes throughout* (six tubes).

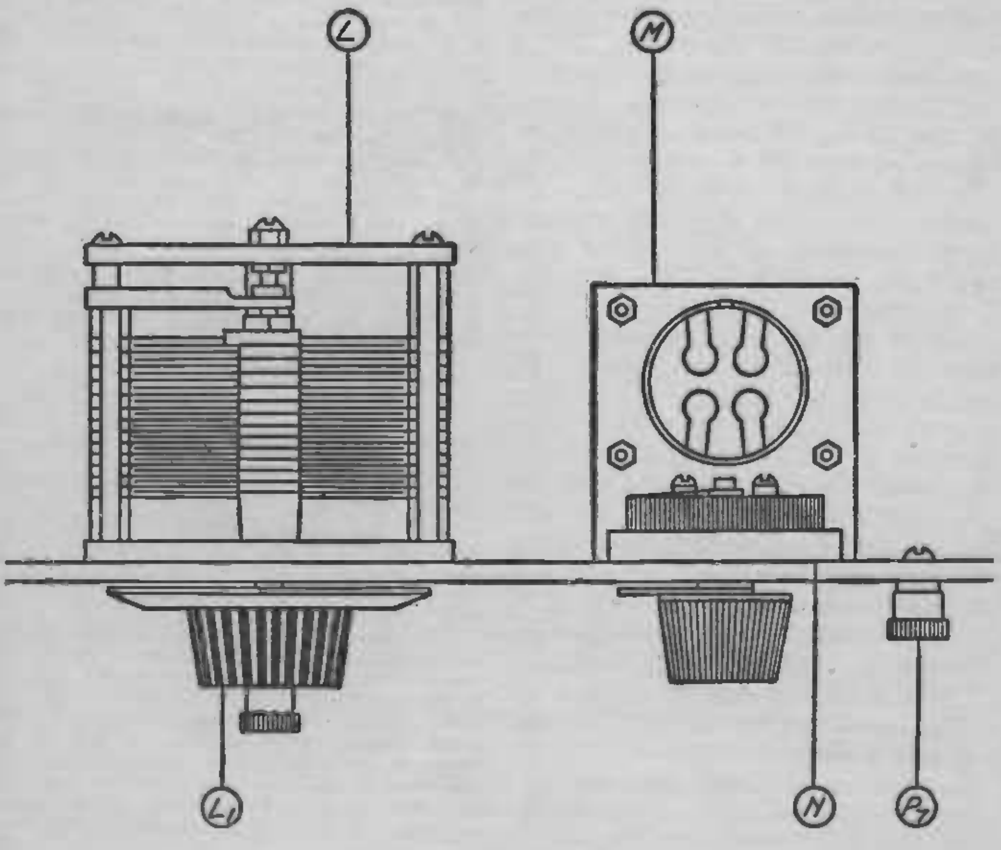
The use of a *new oscillation coupler* for the oscillator.

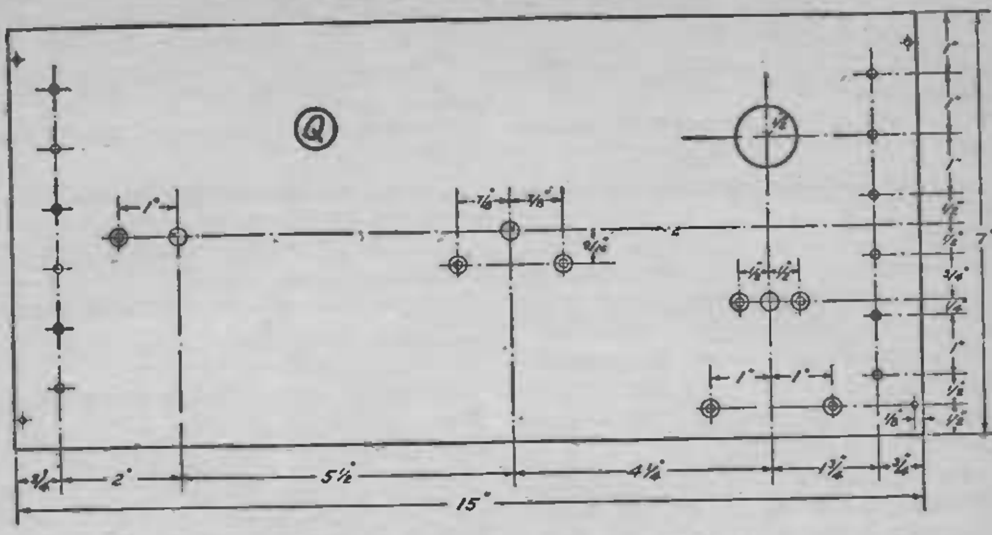
The set is constructed in three parts; the *tuner*, the *oscillator*, and the *radio-frequency amplifier.*

The tuner is described on pages 30 to 37 of this volume.

The oscillator will be described in this article. The radio-frequency amplifier will be described in the chapter following (on pages 90 to 97) along with a full, detailed description of the proper way to set up the complete receiver, and how to adjust and tune it. Although the receiver will bring in (in

*The Editors wish to thank Mr. McMurdo Silver for the important work that he has contributed toward the perfection of the radio-frequency transformers.





THE DRILLING PLAN FOR THE PANEL

FIGURE 4: *This drawing shows where to drill the holes in the panel for mounting the instruments and attaching the binding posts. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk.*

New York City) all the western broadcasting stations and DX amateur transmitters throughout the country, on a loudspeaker, without any audio-frequency amplification, if the builder so desires he may use the two-stage amplifier described on pages 38 to 43 of this book. This will produce too much volume on almost any signals for the ordinary home, but there are some folks who like a lot of volume, and this will give it to them.

All of the units described here are mounted in standard-sized cabinets, and the binding posts are arranged so that they may be simply bridged across from one unit to another when the cabinets are arranged side by side. The batteries are connected to the end unit and the other units are fed through the bridging binding posts. This does away with any unsightly, sprawling connections. The general appearance of the complete set (without the audio-frequency amplifier) is shown in the photograph on page 82.

The actual wiring diagram for the oscillator is shown in Figure 1.

The Parts Used in Building the Oscillator

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts given at the head of this chapter includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Oscillator

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel Q (shown in Figures 2, 3, 4 and 5).

First of all the panel should be cut to the correct size, 7 by 15 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, mount the variable condenser L, by means of two screws inserted through the panel as shown in Figures 2, 3, and 5. The dial L1, should then be fastened to the shaft of the condenser by means of a set-screw.

Now, fasten the oscillator coupler K, in its correct place (Figures 2, 3, and 5) by a single screw and attach the knob and dial K1. The three windings of the coupler are designated as K2, K3, and K4, but these designations are for wiring up and will be considered later.

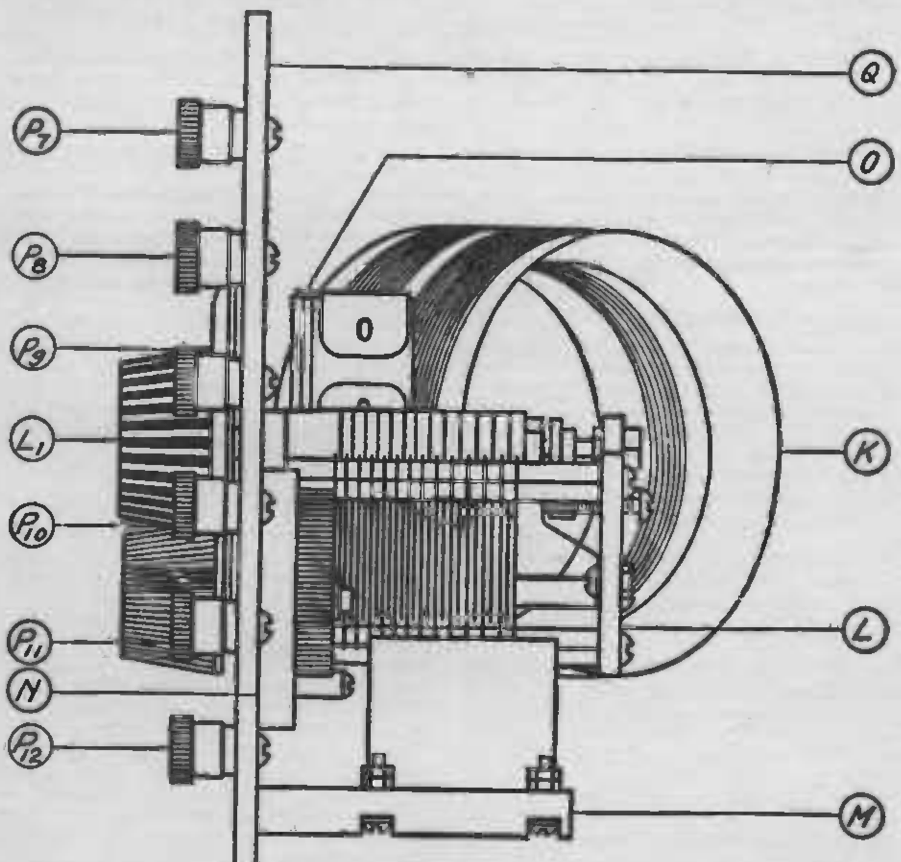
An oscillator coupler may be made on two similar sized tubes as the coupler for the Haynes circuit. The larger tube (stator) contains two windings spaced ¼ inch apart. These windings K2 and K3 contain ten turns each of No. 22 DSC wire. The rotor winding K4 has 15 turns of the same size wire.

When this is done, mount the socket M, by two screws fastened through the panel, and mount the rheostat N, just above the socket. The arrangement of these two parts is clearly shown in Figures 2, 3, and 5.

The fixed condenser O, can be left until the wiring is done as it is to be supported by the connecting wires and does not need to be mounted on the panel.

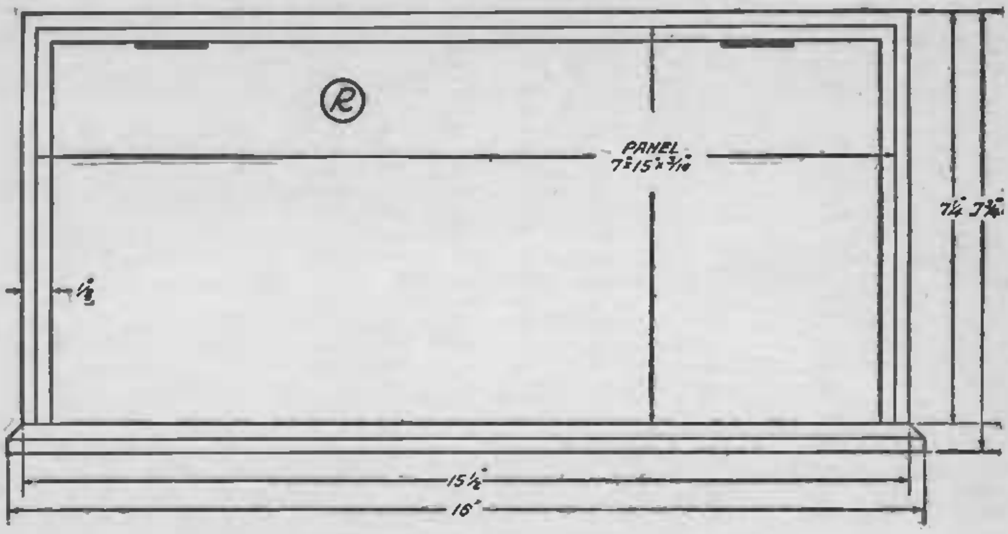
Now fasten on the binding posts P, as indicated in Figures 2, 3, and 5 by inserting a screw through the panel for each one. The various binding posts are designated in the diagrams by numbers from 1 to 12, but these are only given for ease of identification in wiring. All the binding posts are exactly alike.

The dimensions for the cabinet are given in Figure 6. This cabinet may be made by anyone who is handy with carpenter's tools, or, the



THE SIDE VIEW OF THE OSCILLATOR

FIGURE 5: *This mechanical drawing gives the side elevation of the instruments as they should be fastened to the panel. The binding posts are mounted in a vertical line at each end of the panel.*



THE DIMENSIONS FOR THE CABINET

FIGURE 6: *This diagram (which contains the front and side measurements for the hardwood cabinet) may be turned over for construction to the cabinet maker or a cabinet of this size may be obtained from almost any radio supply store.*

drawing in Figure 6 may be turned over to a cabinet maker. It should be made of hardwood finished to suit the owner's taste. However, as the cabinet for this set is a standard size, it may be procured from almost any radio store; merely ask for a cabinet for a 7 by 10-inch panel.

How to Wire the Oscillator

The oscillator should be connected up with bus-wire in the following manner:

Run a straight piece of tinned-copper bus-wire from the binding post marked P1, to the post marked P7, as shown in Figure 1. P1, is the top binding post on the left-hand side of the panel (looking from the front). P7, is the top binding post on the right side of the panel (also looking from the front of the panel).

Next, connect binding post P2, with one end of the rotor winding K4, (of the oscillation coupler K,) with a wire and connect the other end of the winding K4, with the binding post P8.

Now run a wire from P3, to P9, and also connect another wire to this piece and run it to the inside end of the stator winding K2, (of the coupler K). From the outside end of the winding K2, run a wire direct to the plate terminal of the socket M.

Then run a wire from binding post P4, direct to P5, and from there over to P11, and on to P10. The condenser should now be connected by two bits of wire between P3, and P5.

When this has been done, run a wire from P11, to one filament terminal of the socket M, and from the other filament terminal connect a wire to the rheostat N. From the other side of the rheostat a wire should be connected direct to P12.

Now, connect binding posts P6, and P12, with a wire, and run a connection from P6, up to the inside end of the winding K3, (of the coupler K). The other end of the winding K3, should be run to the grid terminal of the socket M.

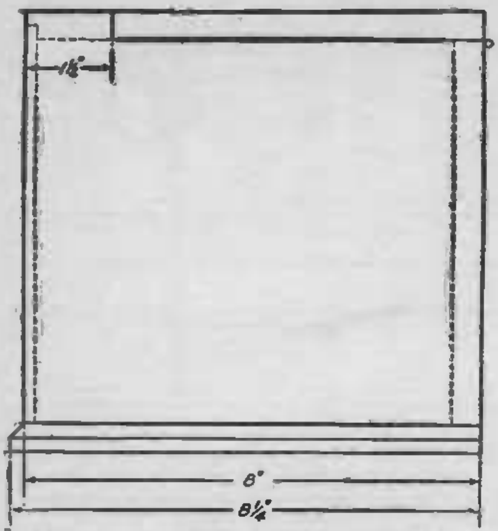
Finally connect the variable condenser L, between the plate and grid leads (from the socket M), being sure that the rotor plates of the condenser are connected to the plate lead and the stator plates of the condenser are connected to the grid lead as indicated in the wiring diagram in Figure 1.

This completes the wiring.

What the Oscillator Does

Almost every radio fan who operates a regenerative set is familiar with the whistle accompanying reception of a radio-broadcast signal when the detector is *oscillating*. We know that this is caused by the incoming radio-frequency current combining with the radio-frequency current generated by the vacuum tube when it is allowed to oscillate. However, when the wavelength of the oscillating receiving circuit is varied slightly *off* the wavelength of the incoming signal, the whistling note heard in the receivers goes up in pitch. In other words, when the frequency of the local oscillations (generated in the receiver) is identical with the frequency of the signals being received, the whistle is *not* heard. The two sets of oscillations are then in synchronism or in phase with each other.

When the frequency of the local oscillations is varied either up or down, slower or faster than the frequency of the received



oscillations, a whistle is heard which starts with a low pitch and gradually increases till it goes way up and up above audibility. The greater the difference in frequency between the local oscillations and the received oscillations, the higher the "beat note" will be. As stated before if we further increase the difference in frequency the note will become inaudible and if it is increased sufficiently a *beat will be produced which will have a radio-frequency wavelength of its own.* The oscillator (or heterodyne as it is more widely known) does this when used for this purpose. It generates an oscillating, radio-frequency current, the frequency of which can be varied at will, so that it will heterodyne or beat with the incoming signals and produce another signal like the incoming signal, only on a higher wavelength!

In this way the incoming signal can be *reproduced* on a higher wavelength, in this case 3,000 meters, at which wavelength, radio-frequency amplification can be carried on with enormously greater efficiency than on the original wavelength!

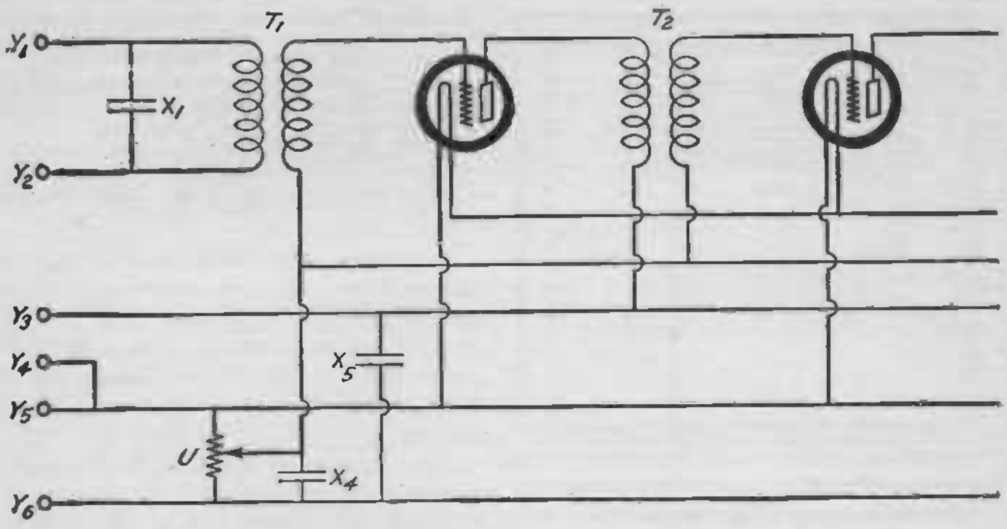
This is the secret of the super-heterodyne; it permits of super-amplification at a radio-frequency by means of a heterodyne.

In the oscillator, just described, the frequency of the local oscillations is varied by rotating the condenser L, by means of the knob L1.

For those who want to own a receiver that will literally reach out to the corners of the earth and pick out a whisper to re-create it into a mighty shout, here is the set to make. Contrary to belief, it really is a simple set to tune.

For those who decide to build it we recommend starting work on the tuner described on pages 30 to 37 of this book. Then build the oscillator described here; in the following chapter, pages 90 to 97, we will describe the radio-frequency amplifier unit. This will be the complete set, unless you want to use audio-frequency amplification, which really is not necessary unless a terrific signal from a loudspeaker is desired. You may get the information on the audio amplifier described on pages 38 to 43 of this book.

The second part of this article also tells all about connecting up and tuning the complete super-heterodyne receiver, and it is accompanied with full operating data.



HOW TO BUILD THE NEW REGENERATIVE

Super-heterodyne Receiver

PART II

Part 1 of this article told how to make the oscillator for the super-heterodyne; it also gave an outline of the salient points of this type of receiver and described what it was and what it would do. Some of the new points involved in the amplifier unit are described in detail in the following article.

COST OF PARTS: *About $40.00*

RECEIVING RANGES: (*See* PART I, *page 82*)

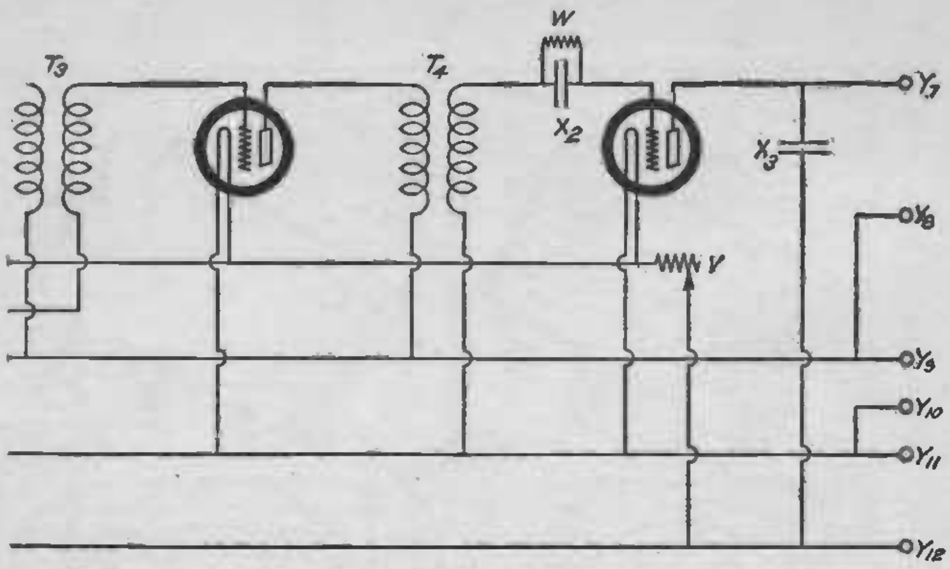
HERE ARE THE ITEMS YOU WILL NEED—

S1 to S4—vacuum-tube sockets;
T1 to T4—four Haynes-Griffin transformers, one input and three radio-frequency transformers, 3,000 meters;
U—Fada potentiometer, 200 ohms;
V—Fada filament rheostat, 6 ohms;
W—tubular grid-leak, 2 megohms;
X1—Dubilier mica condenser, .0005 mfd.;
X2—Dubilier mica condenser, .00025 mfd.;
X3—Dubilier mica condenser, .002 mfd.;
X4—Dubilier paper condenser, .5 mfd.;
X5—Dubilier paper condenser, .5 mfd.;
Y1 to Y12—binding posts;
Z1—composition panel;
Z2—wooden sub-panel, 6¼ x 14 x ½ inches.

FIRST of all, when they started work on this set, the designers tested out the various makes of transformers for radio frequencies between 2,000 and 6,000 meters. After long experimentation, they decided that there would be a distinct advantage in a transformer which would not involve the use of an iron core. It was decided that they needed a transformer that would be *sharply* tuned to *one particular wavelength* to which all incoming signals could be heterodyned.

This, of course, would insure much sharper tuning, in the set as a whole, than would be possible with a radio-frequency transformer which responded to signals over a relatively wide band of wavelengths.

After still more experimentation with



THE ELECTRICAL WIRING DIAGRAM FOR THE AMPLIFIER AND DETECTOR

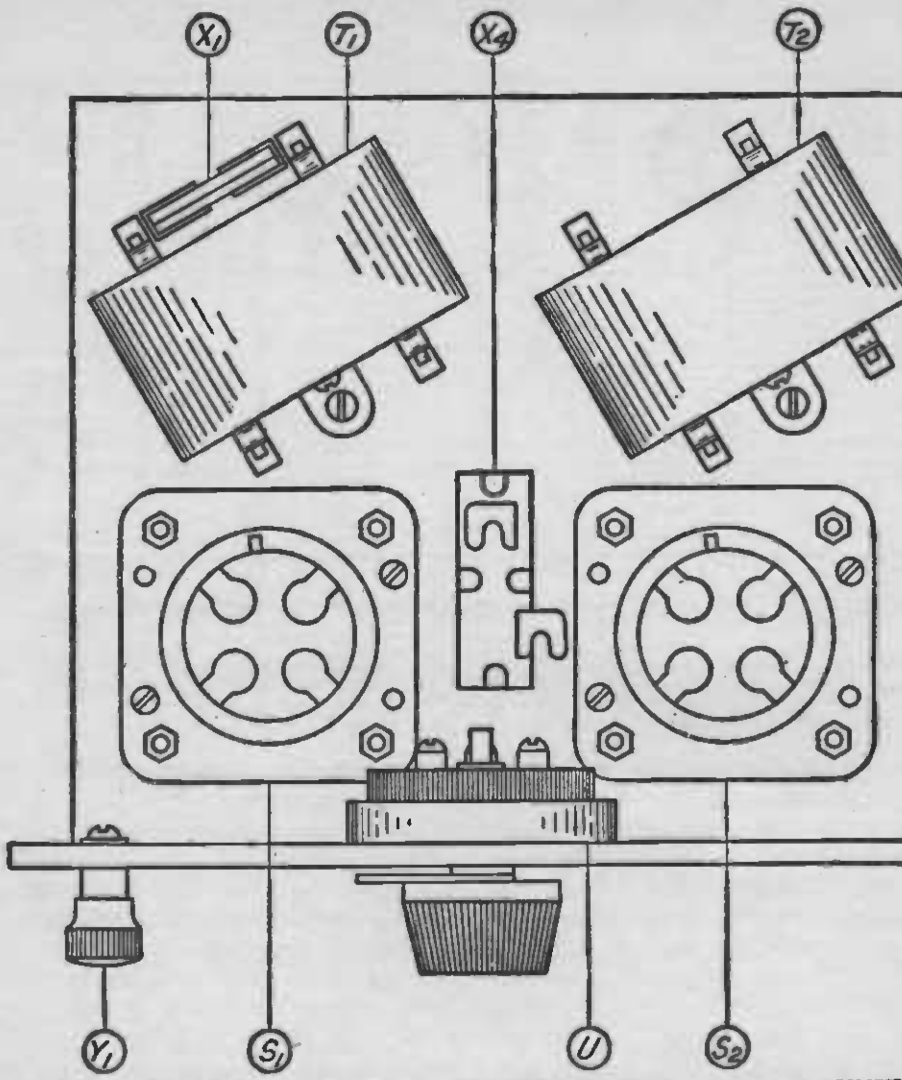
FIGURE 1: *By following this circuit, the amateur experimenter may be sure of obtaining the proper connections for the instruments. The parts are designated by the same letters that appear in the other diagrams and the text.*

air-core transformers which were built up with variations in the turn ratios, variations in the fundamental wavelengths, variations in the magnetic coupling, and variations in the resistance of coils (this involved many trials with windings of different sizes of wire) it was decided to use a transformer that was extremely sharply tuned on 3,000 meters. This was found better than the somewhat higher wavelengths more generally used in super-heterodyne amplifiers in that the possibility of cutting out some of the side bands due to critical tuning was less than at the higher wavelengths. This wavelength also was found to be relatively free from interference. (The reader will note that the authors do not describe how to make these transformers or any other parts of radio apparatus which they consider beyond the scope of the amateur experimenter's handiwork. It is much better that he should buy the parts and be sure of satisfaction in his experiments than that he should waste a lot of time and energy and finally get unsatisfactory results.)

Then there was the consideration of a suitable means for coupling the output circuits of the tuner* and the oscillator† to the radio-frequency amplifier. In most amplifiers which are broadly tuned, the input circuits is usually tuned fairly sharply by means of two honeycomb coils placed in inductive relation and shunted by two variable condensers. In adjusting such a set the proper coupling had to be found by experiment; then the two condensers had to be adjusted to the best resonance point of the radio-frequency transformers. This, of course, helped in sharpening up the operation of the set, but it added the adjustments of coupling and double-circuit tuning to the set.

In the amplifier described in this chapter the input transformer is designed with a high step-up voltage ratio; at the same time, by shunting the

*See pages 30 to 37.
† See pages 82 to 89.



THE WORKING DRAWING FOR ASSEMBLING THE AMPLIFIER UNIT

FIGURE 2: *This layout shows the spacings for the instruments, the transformers, the sockets, rheostats, condensers, potentiometer, and the two rows of binding posts.*

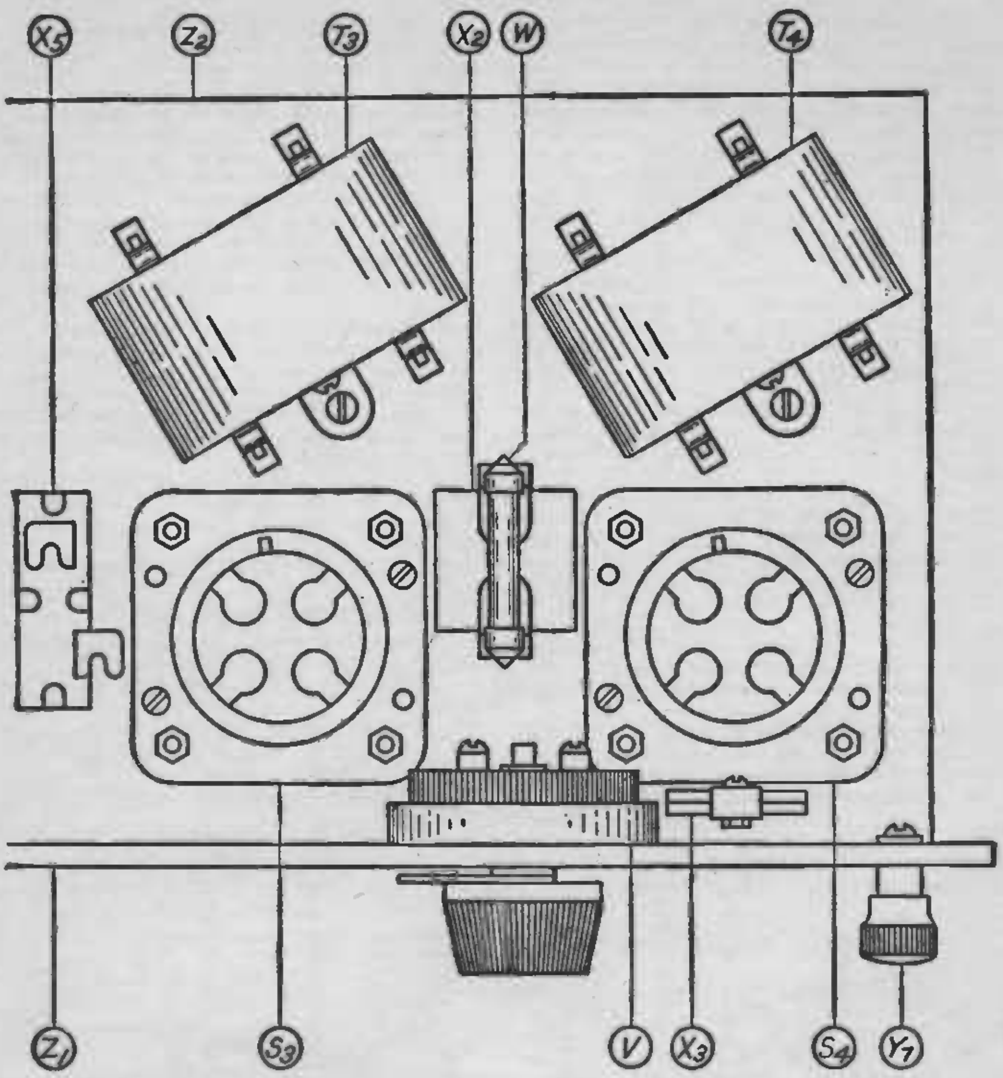
primary coil with a fixed condenser of the proper capacity, the correct wavelength (corresponding to the wavelength of the other transformers) is automatically adjusted, thus eliminating all the adjustments that have heretofore been regarded as necessary.

The amplifier contains three steps of tuned-radio-frequency amplification which is fixed in wavelength and also the detector (vacuum tube). It is a simple matter to build the unit and it is also a simple matter to operate it, There are only two knobs on the set; a regeneration control (potentiometer) which has to be adjusted only once, and one rheostat which controls the filament of all four tubes.

The exact electrical wiring diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily



determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and the list of parts below.

¶ *The list of parts given at the head of this chapter includes the exact instruments used in the particular set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used with equally good results.*

If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel Z1, (shown in Figures 2, 3, 4 and 6).

First of all the panel should be cut to the correct size, 7 by 15 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 4.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next the sub-panel Z2, should be cut to the correct size, 6¼ by 14 inches, and painted with a dark *insulating* paint, and fastened to the main panel Z1, with wood screws running through the face of the main panel and into the edge of the sub-panel. (See Figures 4 and 6).

Now mount the potentiometer U on the main panel with two screws, and likewise the filament rheostat V, as shown in Figures 2 and 6.

Next, screw the four sockets S1, S2, S3, and S4 to the sub-panel Z2 by means of two brass screws to each socket. Secure the two paper condensers in a similar manner, X4 between the sockets S1 and S2 and X5 between the sockets S3 and S4. (See Figures 2, 3 and 6.)

Mount the input transformer T1, as shown in Figures 2 and 6, by a single brass wood-screw, and do the same thing similarly with the radio-frequency transformers T2, T3, and T4.

These transformers are wound in two slots cut out of a piece of hardwood. The core for the windings should be ⅝ inch in diameter. The slots for the primary and the secondary windings should be ¼ inch wide and the two slots separated by a distance of ⅛ inch. For the input transformer wind, on the primary, 300 turns of No. 36 DSC wire. For the secondary wind 1,000 turns of the same size of wire. For the other three transformers, wind, on the primary, 850 turns of No. 36 DSC wire and for the secondary wind on 1,000 turns.

As the three condensers X1, X2 and X3 are supported by the wiring they may be left until the set is connected up. The condenser X2 should be of the type of micadon that has two clips for mounting the grid-leak directly upon it.

Now mount and fasten, with screws on the rear of the panel, the twelve binding posts Y1 to Y12, in two vertical lines of six each, one line at one end of the panel and one line at the other. These binding posts should be fastened in the proper holes drilled for them in the main panel Z1.

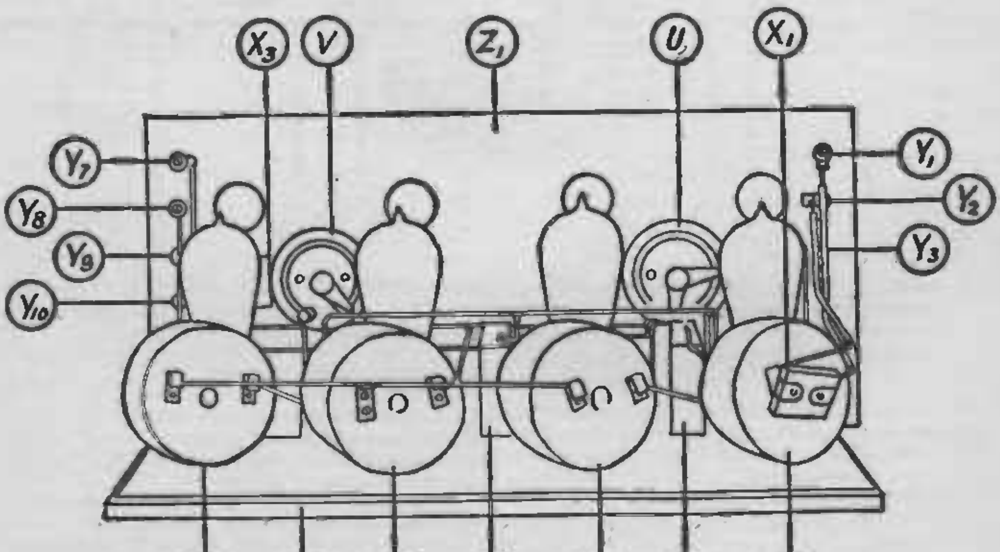
A standard cabinet may be obtained for the amplifier; just ask for a 7 x 15-inch cabinet. The dimensions for this cabinet are shown in Figure 5.

The construction work is now completed.

How to Wire the Amplifier

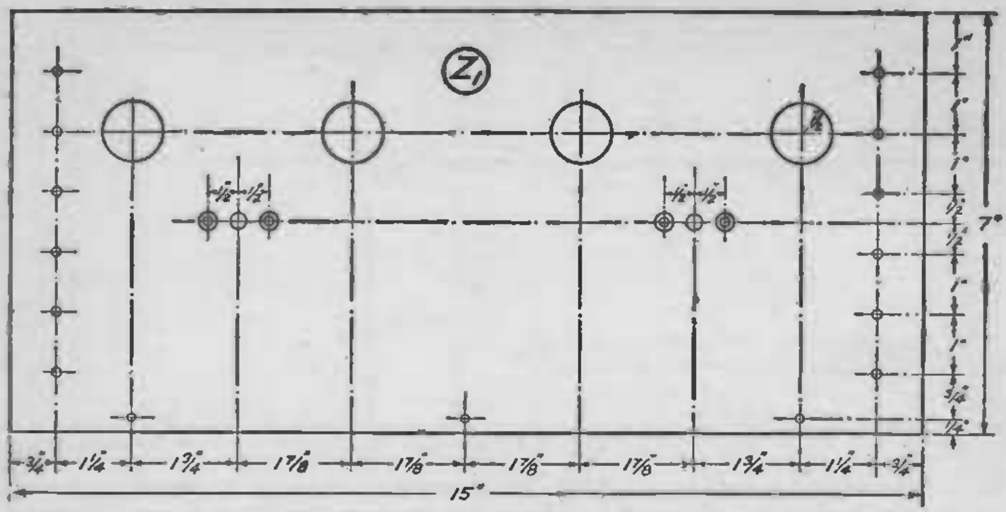
The amplifier should be connected up with bus-wire in the following manner:

Connect one end of the primary coil of the transformer T1 with binding post Y1. (Posts Y1 to Y6 are located on the left-hand end of the panel, looking from the *front* and posts Y7 to Y12 are located at the right-hand end of the panel, also looking from the *front*. The wiring



A VIEW OF THE AMPLIFIER FROM THE REAR

FIGURE 3: *Here is shown the general arrangement of the apparatus which is mounted partly on the main panel and partly on the sub-panel or base-board.*



THE DIMENSIONS FOR THE MAIN PANEL

FIGURE 4: *By following this diagram, the correct size of the panel will be assured together with the correct spacing for the holes for the screws which hold the parts, and the shafts of the instruments which protrude through the face of the panel.*

diagram in Figure 1 should be reversed if you figure out the connections from the *back* of the panel.)

The other end of the primary coil should be connected to post Y2 and the condenser X1 should be connected directly across the primary wires of the transformer.

Next connect three separate wires straight across from post Y3 to Y9, from Y5 to Y11 and from Y6 to Y12. Then connect posts Y4 and Y5 together and connect posts Y10 and Y11 together, with short bits of the bus-wire.

The next job will be to connect potentiometer U across the two wires connecting Y5 to Y11 and Y6 to Y12. The mid-connection on the potentiometer should be connected to one side of the condenser X4 and one end of the secondary of T1, T2 and T3. The remaining end of T1 secondary winding should be connected to the grid terminal of the socket S1. Likewise with the remaining end of the secondary windings of T2 and T3; they should be connected to the grid terminals of sockets S2 and S3, respectively.

Now connect the remaining side of condenser X4 to the bottom wire attached to post Y6.

Then connect the condenser X5 across Y3 and Y6 binding posts, anywhere suitable along the two long wires connecting these two posts to posts Y9 and Y12, respectively.

Now connect condenser X3 across post Y7 and Y12.

Run a wire from Y12 to the pointer on the rheostat V. The other end of the rheostat should be connected to one of the filament terminals on each of the sockets S4, S3, S2 and S1. The remaining filament terminals on these four sockets should all be connected to the long wire connecting posts Y5 and Y11. From this same wire run another wire to one end of the secondary winding of the transformer T4. The other end of this winding should be connected direct to one side of the condenser X2 and the grid leak W. The other side of these two instruments should be connected to the grid terminal of the socket S4.

Connect the plate terminal of the socket S1 to one end of the primary winding of transformer T2. The other end of the primary T2 should be connected to the long wire connecting posts Y3 and Y9.

Do the same thing with the plate terminal of socket S2 and the primary winding of transformer T3.

Do the same thing with the plate terminal of socket S3 and the primary winding of transformer T4.

The last wiring job will be to connect the plate terminal of socket S4 to post Y7 and the hook-up will be complete.

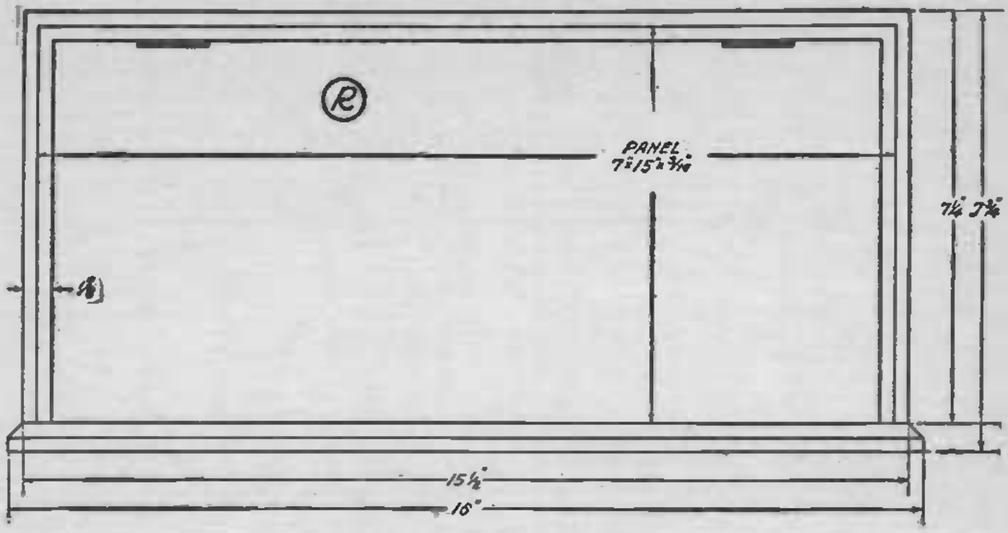
Operating Data

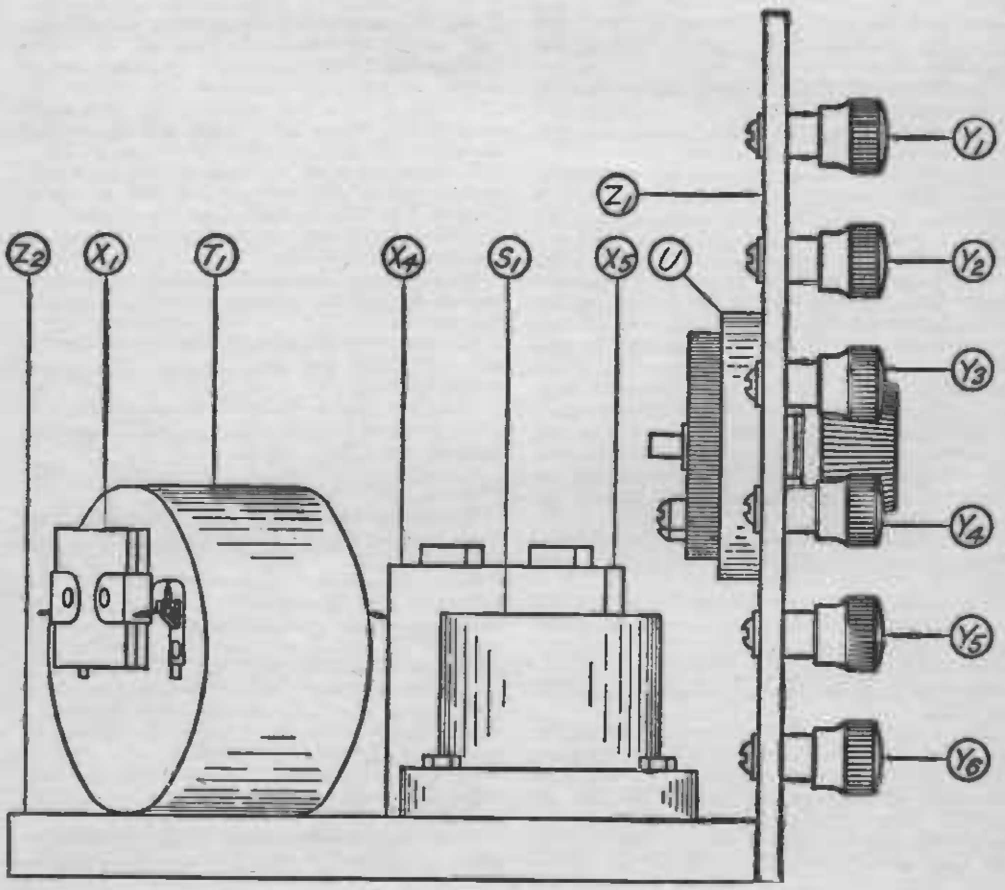
To set up the various units after they have been completed and put in their cabinets is a simple matter.

First, place the Haynes tuning unit at the left-hand side of the table and next to it, on the right, place the oscillator. Then, at the right of the oscillator, place the amplifier unit that you have just completed. You may also place the two-stage audio-frequency amplifying unit at the right of the radio-frequency unit if a terrific signal is required—but this is not recommended by the author.

As all the cabinets are of the same size and finish they make a neat business-like appearance.

Now, just bridge across from one binding post on one unit to the binding post opposite


R
PANEL
7"×15"×3/16"
7¼"
7⅜"
15½"
16"


Z2
X1
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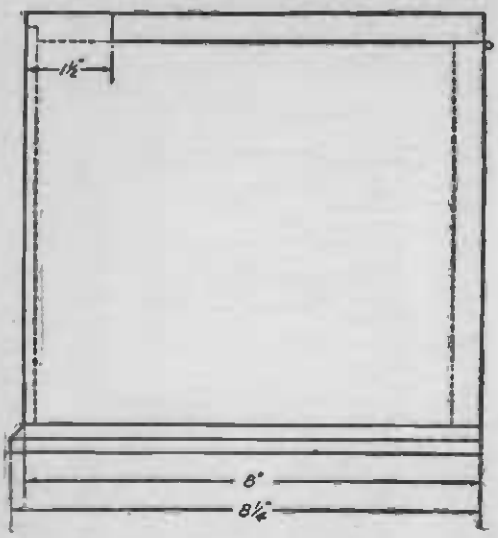
Y3
Y4
Y5
Y6



THE DIMENSIONS FOR THE CABINET

FIGURE 5: *This diagram (which contains the front and side measurements for the hardwood cabinet) may be turned over for construction to the cabinet maker or a cabinet of this size may be obtained from almost any radio supply store.*

it on the next unit as they stand together. This will give you six connections between the tuner unit and the oscillator unit, six between the oscillator unit and the radio-frequency amplifier unit, and so on.

Now, to connect the batteries and phones, do the following:

Connect the negative "A" battery to the post Y12 on the amplifier unit.

Connect the positive "A" battery to the post Y11 on the amplifier unit.

Connect the negative "B" battery to the post Y10 on the amplifier unit.

Connect the positive "B" battery to the post Y9 on the amplifier unit.

Connect one terminal of the telephones to the post Y8 on the amplifier unit.

Connect the remaining terminal of the telephones to post Y7.

Connect the antenna and ground to the two left-hand posts on the tuner.

All the other units will then be automatically connected to the batteries and to each other.

Next, place in the sockets six UV-201-a vacuum tubes, making sure before doing so that the rheostats in all the units are turned *off*.

Put the receivers on your head, but not too near your ears, and turn up the tubes to the correct brilliancy.

Then start with the initial adjustment. Place the regenerative control knob A1 on the tuner at a low value (say at 10). Place the oscillator-coupler knob K1 at a high value (near 100). Place the antenna switch F1 on the second tap from the left. Set the wavelength knob B1 at 40. Place the heterodyne control knob L1 at about 40. Then adjust the potentiometer knob on the amplifier, by turning in a clockwise motion until a loud rushing noise is heard in the telephones. Turn the potentiometer just a little further on beyond this point.

The initial adjustment is finished, now to tune in a station.

Turn the heterodyne adjusting knob L1 slowly in one direction or the other until you hear a signal. Then bring in the signal louder by adjusting with the wavelength knob B1. (These are the two knobs that you will use altogether for tuning; B1 to tune to wavelength and L1 to heterodyne the signals).

When you have these two adjustments made the best you can get them, start and go over all the other adjustments you have already made and thus get the set working, once and for all, at the highest efficiency.

When this is *once* done, you need not bother with the other adjustments again; they are only necessary to get the set working properly.

To get other stations, you may change the setting of B1 and find the corresponding setting for L1 to bring in this wavelength. You will find that for a given setting on B1 there will be a given setting on L1.

The regenerative control A1 should only be used on extremely distant stations where it will be found a great help in making the signals audible.

When you have mastered the tuning method, you will find that you can tune in anything, no matter what the distance, if the wavelength is within the range of the tuner (180 to 550 meters) and if the static is not too strong.

You will find little interference and great sensitivity in such a set and the reception will be extraordinarily clear.

←AT LEFT: A VIEW OF THE AMPLIFIER FROM THE LEFT-HAND SIDE

FIGURE 6: *This view gives a better idea of the grouping of the transformers, rheostats, condensers, sockets and binding posts, when considered from a "depth" standpoint. It should be noticed that the condenser X1 is mounted directly on the terminals of the input transformer T1.*

Broadcasting Stations in the U. S. of 50-watt Power or More

Call Letters	*Location of station*	*Power (watts)*	*Wave-length (meters)*	*Freq. (kilo-cycles)*
KDKA	East Pittsburgh, Pa.	1,000	326	920
KDPM	Cleveland, Ohio	250	270	1,110
KDPT	San Diego, Cal.	50	249	1,230
KDYL	Salt Lake City, Utah	50	360	833
KDYM	San Diego, Cal.	50	252	1,190
KDYS	Great Falls, Mont.	50	360	833
KDYX	Honolulu, Hawaii	100	360	833
KDZB	Bakersfield, Cal.	100	240	1,250
KDZE	Seattle, Wash.	100	455	660
KDZF	Los Angeles, Cal.	500	278	1,080
KDZI	Wenatchee, Wash.	50	360	833
KDZR	Bellingham, Wash.	50	261	1,150
KFAD	Phoenix, Ariz.	100	360	833
KFAE	Pullman, Wash.	500	360	833
KFAF	Denver, Col.	500	360	833
KFAJ	Boulder, Col.	100	360	833
KFAN	Moscow, Idaho	50	360	833
KFAP	Butte, Mont.	100	360	833
KFAR	Hollywood, Cal.	200	280	1,070
KFAU	Boise, Idaho	150	270	1,110
KFAY	Medford, Ore.	50	283	1,060
KFBB	Havre, Mont.	50	360	833
KFBG	Tacoma, Wash.	50	360	833
KFBK	Sacramento, Cal.	100	283	1,060
KFBU	Laramie, Wyo.	50	283	1,060
KFCF	Walla Walla, Wash.	50	360	833
KFCL	Los Angeles, Cal.	500	360	833
KFCM	Richmond, Cal.	100	360	833
KFCY	Le Mars, Iowa	50	252	1,190
KFCZ	Omaha, Neb.	100	258	1,160
KFDH	Tucson, Ariz.	150	360	833
KFDJ	Corvallis, Ore.	50	360	833
KFDO	Bozeman, Mont.	50	248	1,210
KFDV	Fayetteville, Ark.	200	360	833
KFDX	Shreveport, La.	100	360	833
KFDY	Brookings, S. Dak.	100	360	833
KFEC	Portland, Ore.	50	360	833
KFEL	Denver, Col.	50	360	833
KFEQ	Oak, Neb.	150	360	833
KFEV	Douglas, Wyo.	100	263	1,140
KFEX	Minneapolis, Minn.	100	261	1,150
KFEZ	St. Louis, Mo.	100	360	833
KFFA	San Diego, Cal.	50	242	1,240
KFFQ	Colorado Springs, Col.	100	360	833
KFFV	Lamoni, Iowa	100	360	833
KFFX	Omaha, Neb.	250	278	1,080
KFFY	Alexandria, La.	100	275	1,090
KFGC	Baton Rouge, La.	100	254	1,180
KFGH	Stanford University, Cal.	500	360	833
KFGJ	St. Louis, Mo.	250	266	1,130
KFGX	Orange, Tex.	500	250	1,200
KFHA	Gunnison, Col.	50	252	1,190
KFHD	St. Joseph, Mo.	100	226	1,330
KFHF	Shreveport, La.	150	266	1,130
KFHH	Neah Bay, Wash.	50	283	1,060
KFHJ	Santa Barbara, Cal.	100	360	833
KFHR	Seattle, Wash.	100	270	1,110
KFHU	Mayville, N. Dak.	50	261	1,150
KFHX	Hutchinson, Kans.	50	229	1,310
KFI	Los Angeles, Cal.	500	469	640
KFIF	Portland, Ore.	100	360	833
KFIO	Spokane, Wash.	50	252	1,190
KFIQ	Yakima, Wash.	50	224	1,340
KFIX	Independence, Mo.	250	240	1,250
KFIZ	Fond du Lac, Wis.	100	273	1,100
KFJA	Grand Island, Neb.	100	244	1,230
KFJC	Seattle, Wash.	100	233	1,290
KFJD	Greeley, Col.	50	236	1,270
KFJJ	Carrollton, Mo.	50	236	1,270
KFJK	Bristow, Okla.	100	233	1,290
KFJM	Grand Forks, N. D.	100	229	1,310
KFJR	Stevensville, Mont.	50	258	1,160
KFJX	Cedar Falls, Iowa	50	229	1,310
KFJY	Fort Dodge, Iowa	50	246	1,220
KFKA	Greeley, Col.	50	248	1,210
KFKB	Milford, Kan.	500	286	1,050
KFKX	Hastings, Neb.	500	286	1,050
KFLR	Albuquerque, N. M.	100	254	1,180
KGB	Tacoma, Wash.	50	252	1,190
KGG	Portland, Ore.	50	360	833
KGN	Portland, Ore.	100	360	833
KGU	Honolulu, Hawaii, Waikiki Beach	250	360	833
KGW	Portland, Ore.	500	492	610
KHJ	Los Angeles, Cal.	500	395	760
KHQ	Seattle, Wash.	100	360	833
KJR	Seattle, Wash.	100	270	1,110
KJS	Los Angeles, Cal.	750	360	833
KLS	Oakland, Cal.	250	360	833
KLX	Oakland, Cal.	250	360	833
KLZ	Denver, Col.	500	360	833
KMJ	Fresno, Cal.	250	273	1,100
KNJ	Roswell, N. Mex.	500	250	1,200
KNT	Aberdeen, Wash.	250	263	1,140
KNV	Los Angeles, Cal.	100	256	1,179
KNX	Los Angeles, Cal.	100	360	833
KOB	State College, N. Mex.	500	360	833
KOP	Detroit, Mich.	500	286	1,050
KPO	San Francisco, Cal.	500	423	710
KQI	Berkeley, Cal.	500	360	833
KQV	Pittsburgh, Pa.	500	360	833
KQW	San Jose, Cal.	50	360	833
KRE	Berkeley, Cal.	50	278	1,080
KSD	St. Louis, Mo.	500	546	550
KTW	Seattle, Wash.	500	360	833
KUO	San Francisco, Cal.	150	360	833
KUS	Los Angeles, Cal.	100	360	833
KUY	El Monte, Cal.	50	256	1,170
KWG	Stockton, Cal.	100	360	833
KWH	Los Angeles, Cal.	500	360	833
KYW	Chicago, Ill.	1,000	536	560
KZM	Oakland, Cal.	50	360	833
KZN	Salt Lake City, Utah	500	360	833
KZV	Wenatchee, Wash.	50	360	833
WAAB	New Orleans, La.	100	268	1,120
WAAC	New Orleans, La.	400	360	833
WAAF	Chicago, Ill.	200	286	1,050
WAAK	Milwaukee, Wis.	100	280	1,070
WAAM	Newark, N. J.	250	263	1,140
WAAN	Columbia, Mo.	50	254	1,180
WAAW	Omaha, Neb.	200	360	833
WAAZ	Emporia, Kan.	100	360	833
WABE	Washington, D. C.	50	283	1,060
WABF	Mount Vernon, Ill.	100	234	1,280
WABI	Bangor, Me.	50	240	1,250
WABL	Storrs, Conn.	100	283	1,060
WABM	Saginaw, Mich.	100	254	1,180
WABN	La Crosse, Wis.	250	244	1,230
WABP	Dover, Ohio	100	266	1,130
WBAA	West Lafayette, Ind.	250	360	833
WBAD	Minneapolis, Minn.	100	360	833
WBAH	Minneapolis, Minn.	500	417	720
WBAN	Paterson, N. J.	100	244	1,230
WBAO	Decatur, Ill.	50	360	833
WBAP	Fort Worth, Tex.	750	476	630
WBAV	Columbus, Ohio	500	390	770
WBAW	Marietta, Ohio	250	246	1,220
WBAY	New York, N. Y.	500	492	610
WBBD	Reading, Pa.	50	234	1,280
WBL	Anthony, Kan.	100	261	1,150
WBT	Charlotte, N. C.	500	360	833
WBZ	Springfield, Mass.	750	337	890
WCAD	Canton, N. Y.	250	280	1,070
WCAE	Pittsburgh, Pa.	500	462	650
WCAG	New Orleans, La.	50	268	1,120
WCAH	Columbus, Ohio	100	286	1,050
WCAJ	University Place, Neb.	500	360	833
WCAK	Houston, Tex.	50	360	833
WCAL	Northfield, Minn.	250	360	833
WCAM	Villanova, Pa.	150	360	833
WCAO	Baltimore, Md.	50	360	833
WCAP	Washington, D. C.	500	469	640
WCAR	San Antonio, Tex.	150	360	833
WCAS	Minneapolis, Minn.	100	246	1,220
WCAT	Rapid City, S. D.	50	240	1,250
WCAU	Philadelphia, Pa.	250	286	1,050
WCAX	Burlington, Vt.	50	360	833
WCAY	Milwaukee, Wis.	250	261	1,150
WCAZ	Carthage, Ill.	50	246	1,220
WCBB	Greenville, Ohio	100	240	1,250
WCBD	Zion, Ill.	500	345	870
WCE	Minneapolis, Minn.	250	360	833
WCK	St. Louis, Mo.	100	360	833
WCM	Austin, Tex.	500	360	833
WCX	Detroit, Mich.	500	517	580
WDAB	Tampa, Fla.	250	360	833
WDAF	Kansas City, Mo.	500	411	730
WDAG	Amarillo, Tex.	100	263	1,140
WDAH	El Paso, Tex.	100	286	1,120
WDAI	Syracuse, N. Y.	100	246	1,220
WDAK	Hartford, Conn.	100	261	1,150
WDAL	Jacksonville, Fla.	100	360	833
WDAO	Dallas, Tex.	50	360	833
WDAP	Chicago, Ill.	500	360	833

Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WDAR	Philadelphia, Pa	500	395	760
WDAU	New Bedford, Mass	100	360	833
WDAX	Centerville, Iowa	100	360	833
WDAY	Fargo, N. D.	50	244	1.230
WDBC	Lancaster, Pa	50	258	1,160
WDBF	Youngstown, Ohio	50	261	1,150
WDM	Washington, D. C.	50	360	833
WDT	New York, N. Y.	500	405	740
WEAA	Flint, Mich	150	280	1,070
WEAF	New York, N. Y.	500	492	610
WEAH	Wichita, Kan	50	244	1,230
WEAI	Ithaca, N. Y.	500	286	1,050
WEAJ	Vermillon, S. D.	200	283	1,060
WEAM	North Plainfield, N. J.	100	252	1,190
WEAN	Providence, R. I.	100	273	1.100
WEAO	Columbus, Ohio	500	360	833
WEAP	Mobile, Ala	100	360	833
WEAR	Baltimore, Md	50	360	833
WEAS	Washington, D. C.	50	360	833
WEAU	Sioux City, Iowa	100	360	833
WEAY	Houston, Tex	250	360	833
WEB	St. Louis, Mo	500	360	833
WEV	Houston, Tex	50	360	833
WEW	St. Louis, Mo	100	261	1,150
WFAA	Dallas, Tex	500	476	630
WFAB	Syracuse, N. Y.	200	234	1,280
WFAH	Port Arthur, Tex	150	236	1,270
WFAJ	Asheville, N. C.	50	360	833
WFAN	Hutchinson, Minn	100	360	833
WFAT	Sioux Falls, S. D.	100	360	833
WFAV	Lincoln, Neb	500	275	1,090
WFI	Philadelphia, Pa	500	395	760
WGAN	Pensacola, Fla	50	360	833
WGAQ	Shreveport, La	100	360	833
WGAW	Altoona, Pa	100	261	1,150
WGAY	Madison, Wis	100	360	833
WGAZ	South Bend, Ind	50	360	833
WGI	Medford, Hillside, Mass	500	360	833
WGL	Philadelphia, Pa	500	360	833
WGR	Buffalo, N. Y.	500	319	940
WGV	New Orleans, La	100	360	833
WGY	Schenectady, N. Y.	1,000	380	790
WHA	Madison, Wis	500	360	833
WHAA	Iowa City, Iowa	100	283	1,060
WHAB	Galveston, Tex	200	360	833
WHAD	Milwaukee, Wis	100	280	1,070
WHAG	Cincinnati, Ohio	200	222	1,350
WHAH	Joplin, Mo	250	360	833
WHAI	Davenport, Iowa	50	360	833
WHAM	Rochester, N. Y.	100	360	833
WHAP	Decatur, Ill	50	360	833
WHAS	Louisville, Ky	500	400	750
WHAV	Wilmington, Del	50	360	833
WHAZ	Troy, N. Y.	500	380	790
WHB	Kansas City, Mo	500	411	730
WHD	Morgantown, W. Va	250	360	833
WHK	Cleveland, Ohio	500	360	833
WHN	New York, N. Y.	100	360	833
WIAB	Rockford, Ill	50	252	190
WIAC	Galveston, Tex	100	360	833
WIAJ	Neenah, Wis	100	224	1,340
WIAK	Omaha, Neb	200	278	1,080
WIAO	Milwaukee, Wis	100	360	833
WIAR	Paducah, Ky	100	360	833
WIAS	Burlington, Iowa	100	360	833
WIK	McKeesport, Pa	500	234	1,280
WIP	Philadelphia, Pa	500	509	590
WJAB	Lincoln, Neb	500	360	833
WJAD	Waco, Tex	150	360	833
WJAG	Norfolk, Neb	200	360	833
WJAN	Peoria, Ill	100	280	1,070
WJAQ	Topeka, Kan	100	360	833
WJAR	Providence, R. I.	50	360	833
WJAS	Pittsburgh, Pa	500	360	833
WJAX	Cleveland, Ohio	500	390	770
WJAZ	Chicago, Ill	1,000	448	670
WJD	Granville, Ohio	50	229	1,310
WJH	Washington, D. C.	50	273	1,100
WJX	New York, N. Y.	500	360	833
WJY	New York, N. Y.	500	405	740
WJZ	New York, N. Y.	500	455	660
WKAA	Cedar Rapids, Iowa	100	268	1,120
WKAF	Wichita Falls, Tex	100	360	833
WKAP	Cranston, R. I.	200	360	833
WKAQ	San Juan, P. R	100	360	833
WKAR	East Lansing, Mich	250	280	1,070
WKAV	Laconia, N. H	50	254	1,180
WKY	Oklahoma, Okla	100	360	833
WLAG	Minneapolis, Minn	500	417	720
WLAH	Syracuse, N. Y.	250	234	1,280
WLAJ	Waco, Tex	150	360	833
WLAK	Bellows Falls, Vt	500	360	833

Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WLAL	Tulsa, Okla	100	360	833
WLAN	Houlton, Me	250	283	1.060
WLAW	New York, N. Y.	500	360	833
WLB	Minneapolis, Minn	100	360	833
WLW	Cincinnati, Ohio	500	309	970
WMAB	Oklahoma, Okla	100	360	833
WMAC	Cazenovia, N. Y.	200	261	1,150
WMAF	Dartmouth, Mass	100–500	360	833
WMAH	Lincoln, Neb	100	254	1,180
WMAJ	Kansas City, Mo	250	275	1,090
WMAK	Lockport, N. Y.	500	360	833
WMAL	Trenton, N. J.	50	256	1,170
WMAP	Easton, Pa	50	246	1,220
WMAQ	Chicago, Ill	250	448	670
WMAV	Auburn, Ala	500	250	1,200
WMAY	St. Louis, Mo	100	280	1,070
WMAZ	Macon, Ga	50	268	1,120
WMC	Memphis, Tenn	500	500	600
WMU	Washington, D. C.	100	261	1,150
WNAC	Boston, Mass	100	278	1,080
WNAD	Norman, Okla	100	360	833
WNAM	Evansville, Ind	500	360	833
WNAN	Syracuse, N. Y.	100	286	1,050
WNAP	Springfield, Ohio	100	231	1,300
WNAS	Austin, Tex	100	360	833
WNAT	Philadelphia, Pa	100	360	833
WNAV	Knoxville, Tenn	500	236	1,270
WNAX	Yankton, S. D.	100	244	1,230
WNJ	Albany, N. Y.	55	360	833
WOAA	Ardmore, Okla	100	360	833
WOAC	Lima, Ohio	50	266	1,130
WOAG	Belvidere, Ill	100	224	1,340
WOAH	Charleston, S. C.	100	360	833
WOAI	San Antonio, Tex	500	385	780
WOAL	Webster Groves, Mo	500	229	1,310
WOAN	Lawrenceburg, Tenn	150	360	833
WOAO	Mishawaka, Ind	50	360	833
WOAP	Kalamazoo, Mich	50	240	1,250
WOAT	Wilmington, Del	50	360	833
WOAV	Erie, Pa	100	242	1,240
WOAW	Omaha, Neb	500	526	570
WOAX	Trenton, N. J.	100	240	1,250
WOAZ	Stamford, Tex	100	360	833
WOC	Davenport, Iowa	500	484	620
WOI	Ames, Iowa	100	360	833
WOK	Pine Bluff, Ark	500	360	833
WOO	Philadelphia, Pa	500	509	590
WOQ	Kansas City, Mo	500	360	833
WOR	Newark, N. J.	500	405	740
WOS	Jefferson City, Mo	500	441	680
WPAB	State College, Pa	500	360	833
WPAC	Okmulgee, Okla	200	360	833
WPAD	Chicago, Ill	500	360	833
WPAH	Waupaca, Wis	250	360	833
WPAK	Agricultural College, N. D.	250	360	833
WPAL	Columbus, Ohio	100	286	1,050
WPAM	Topeka, Kan	100	360	833
WPG	New Lebanon, Ohio	50	234	1,280
WQAA	Parkersburg, Pa	500	360	833
WQAC	Amarillo, Tex	100	360	833
WQAD	Waterbury, Conn	50	242	1,240
WQAE	Springfield, Vt	50	275	1,090
WQAM	Miami, Fla	100	360	833
WQAN	Scranton, Pa	100	280	1,070
WQAO	New York, N. Y.	100	360	833
WQAQ	Abilene, Tex	100	360	833
WQAS	Lowell, Mass	100	266	1,130
WRAA	Houston, Tex	200	360	833
WRAL	St. Croix Falls, Wis	100	248	1,210
WRAM	Galesburg, Ill	250	244	1,230
WRAO	St. Louis, Mo	100	360	833
WRAV	Yellow Springs, Ohio	100	360	833
WRAX	Gloucester City, N. J.	100	268	1,120
WRAY	Scranton, Pa	100	280	1,070
WRAZ	Newark, N. J.	50	233	1,290
WRC	Washington, D. C.	500	469	640
WRK	Hamilton, Ohio	200	360	833
WRL	Schenectady, N. Y.	500	360	833
WRM	Urbana, Ill	500	360	833
WRW	Tarrytown, N. Y.	150	273	1,100
WSAB	Cape Girardeau, Mo	100	360	833
WSAC	Clemson College, S. C.	500	360	833
WSAD	Providence, R. I.	100	261	1,150
WSAH	Chicago, Ill	500	248	1,210
WSAI	Cincinnati, Ohio	500	309	970
WSAJ	Grove City, Pa	100	360	833
WSAK	Middleport, Ohio	70	258	1,160
WSAP	New York, N. Y.	250	360	833
WSAW	Canandaigua, N. Y.	100	275	1,090
WSB	Atlanta, Ga	500	429	700
WSL	Utica, N. Y.	100	273	1,100
WSY	Birmingham, Ala	500	360	833

Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WTAC	Johnstown, Pa.	150	360	833
WTAJ	Portland, Me.	50	236	1,270
WTAM	Cleveland, Ohio	1,000	390	770
WTAN	Mattoon, Ill.	100	240	1,250
WTAP	Cambridge, Ill.	50	242	1,240
WTAQ	Osseo, Wis.	100	226	1,330
WTAR	Norfolk, Va.	100	280	1,070
WTAS	Elgin, Ill. (portable)	500	275	1,090
WTAT	Boston, Mass.	100	244	1,230
WTAW	College Station, Tex.	50	280	1,070
WTG	Manhattan, Kan.	1,000	360	833
WWAC	Waco, Tex.	50	360	833
WWAD	Philadelphia, Pa.	50	360	833
WWAE	Joliet, Ill.	500	227	1,320
WWAX	Laredo, Tex.	50	360	833
WWB	Canton, Ohio	100	268	1,120
WWI	Dearborn, Mich.	50	273	1,100
WWJ	Detroit, Mich.	500	517	580
WWL	New Orleans, La.	100	280	1,070

THE latest developments in radio receiving sets, together with descriptions of the most efficient circuits and of the more important inventions and significant laboratory experimental work, are recorded monthly in the magazine, POPULAR RADIO, *published at 627 West 43d Street, New York City.*

A comprehensive list of responsible manufacturers of approved radio parts and supplies may be found in the advertising section of that magazine.

PRESS OF WILLIAM GREEN, NEW YORK