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RADIO REVIEW

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A Digest of the Latest Radio Hookups

Edited by S. Gernsback

Containing *Illustrated* Radio Encyclopedia

See Page 81

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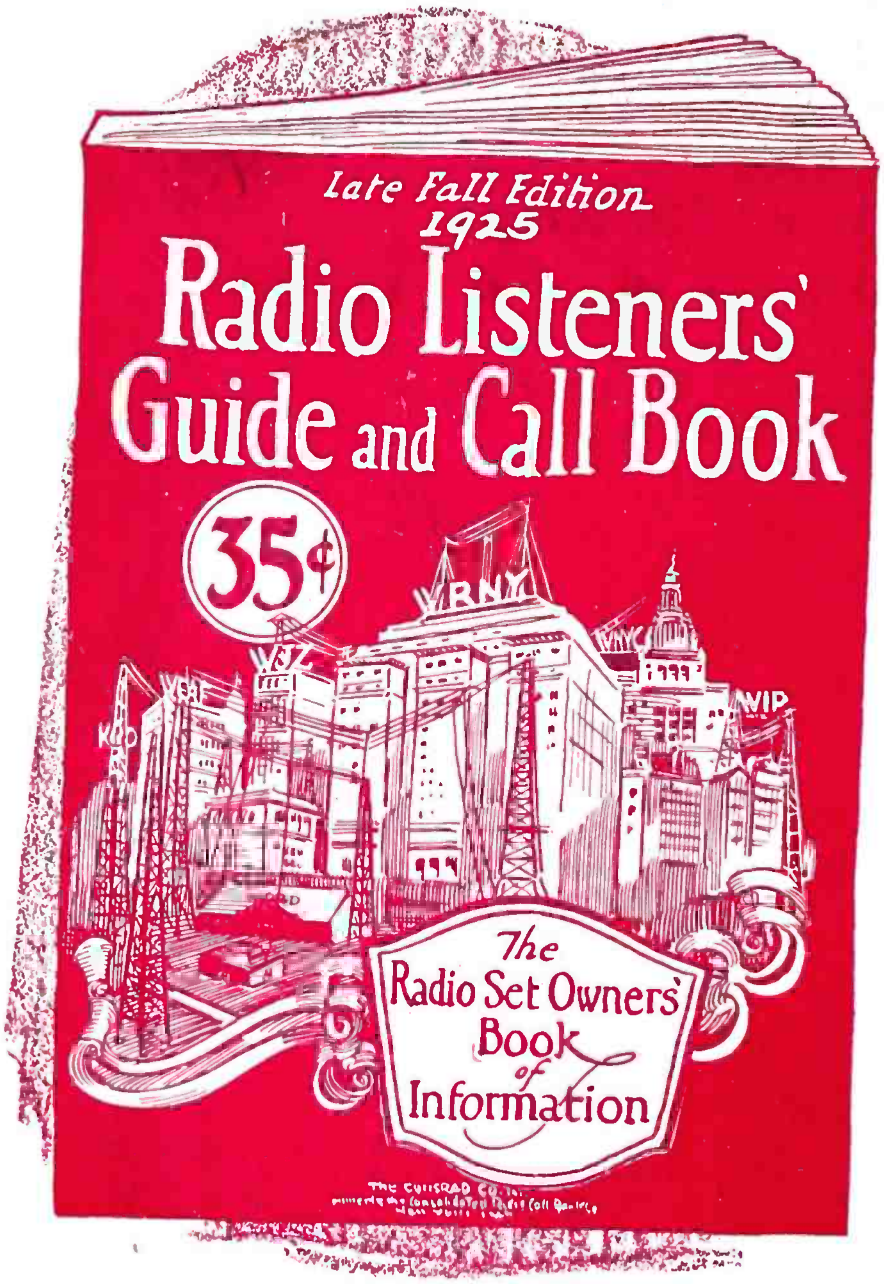

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RADIO REVIEW

REG. U.S. PAT. OFF.

A Digest of the Latest Radio Hookups from the Radio Press of the World

In This Issue

S. GERNSBACK'S RADIO ENCYCLOPEDIA

Third Installment

FROM the fact that the first issue of RADIO REVIEW was completely sold out at the newsstands everywhere it was forcibly evident that our new magazine had brought to the radio readers something they wanted. It was something they needed.

¶ For the second issue, to judge from the number of letters received every day, there has been even greater demand. Many readers have had to write to us for copies, finding the supply at their local newsstands already exhausted.

¶ We urge our readers to put in a standing order with their newsdealers, to save themselves such disappointment and to make sure of getting each issue of RADIO REVIEW as it comes out.

¶ As we promised our readers at the outset, the issue of the magazine from now on, beginning with this number, will be monthly. The next issue will be the October number.

¶ Among the numerous expressions of good wishes and interest which have been coming in constantly since we made our initial appearance, there have been many communications asking us if we would publish contributed articles. To do that would be obviously outside of the purpose which RADIO REVIEW has set for itself. As the name of the magazine implies its function is to review constructional data on new types of radio sets, and to digest the news and feature material on this subject contained in other magazines and the newspaper radio sections. Original manuscripts which have come to us with these requests for publication are therefore being returned to the authors, with this explanation of our inability to publish them.

¶ Some of our readers are asking us why we do not publish reviews of all the hook-ups and diagrams appearing in the various Radio publications. We reply that we review only such articles as are adjudged by our editorial staff to be of general interest and working use to our readers.

¶ It would be manifestly impossible to review all the articles in all the radio magazines and newspaper radio departments even for one month. But even if it could be done, that would not be performing the most useful service to our readers. Many of the articles published deal with material which has distinctly no value or no application for the home radio builder. Also, in all the mass of radio material being published each month, quantities of worthless hook-ups "get by."

¶ We feel that our essential service to our readers is our task of *selecting* out of all this stream of material. Our purpose is to sort out the things which will be worth their time and effort—to supply a guide and make available to them the material they need and want.

¶ Our first and chief aim is to offer our readers the best among the descriptions of new circuits, and to maintain a standard which will be an assurance that circuits or receivers noticed in the pages of RADIO REVIEW receive a place there because they represent the latest and most important developments in radio.

¶ If a hook-up is not reviewed in RADIO REVIEW, the reason is that it is not worth while—it has not come up to the test of merit. Further, we are not reviewing rehashed articles, nor articles "inspired" by some manufacturer having parts to sell.

¶ In our last issue, we explained to our readers that requests sent in for special technical information must be accompanied with a fee of one dollar, to meet the cost of extra work such requests impose on our technical staff. We are actually swamped with such requests at this moment, and must again call attention to this ruling. We announce with regret that it will be necessary to return inquiries for help on special points of construction if the remittance is not included as requested.

The Consrad Co., Inc.

233 Fulton Street PUBLISHERS New York, N. Y.

RADIO REVIEW

Reg. U.S. Pat. Off.

A Digest of the Latest Radio Hookups

Volume I

Number 3

SEPTEMBER, 1925

Contents *of* This Issue

RADIO REVIEW, SEPTEMBER, 1925 VOLUME I, NUMBER 3

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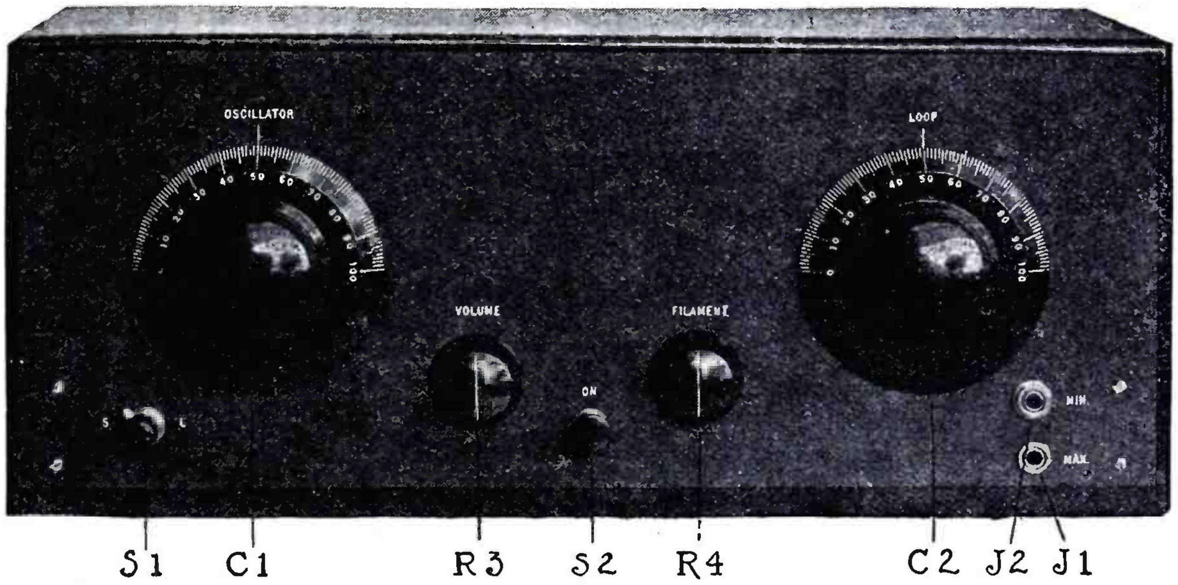
How to Build The Super-Autodyne

Complete Data for Constructing a Simplified Type of Balanced Super-Heterodyne Receiver

THE super-heterodyne described in this article has a number of features which commend it to the radio constructor. In the first place, it uses six tubes, with a total plate current consumption of 12 milliamperes. As for actual mechanical arrangement and layout, the author has done a very good bit of design, for the set is exceptionally easy to wire, and if the constructional outline is carefully followed there should be no difficulties from this source. The entire receiver has been concentrated in a 7x18-inch panel, a vastly more compact arrangement than one finds with most super-heterodynes. No reflexing is used. The quality of tone is excellent. It is somewhat difficult to tune this receiver, as the dial functions differ from those in the common types of super-heterodyne. The interested constructor will, however find that this is not merely "another super-heterodyne."

That it possess features which definitely lift it above the class of the best receivers heretofore developed—is the first requirement of any new receiving system in order that it may, in a measure, justify that age-old human cry of "something new under the sun." And if for purposes of differentiation it is elected to call this new receiver by a name which includes the word "dyne," then there must certainly be something to recommend it other than that its designer has managed to unearth some new prefix or suffix for that word. The receiver to be described has but two basic claims to the first of these requirements and one to the second—it uses but six tubes, and its name is as logical as that of the super-heterodyne.



Illustrations by Courtesy of Radio Broadcast (New York)

Fig. 1.—Front view of the super-autodyne receiver, assembled on a standard 7 x 18 x ¼-inch bakelite panel. The knob at the lower left is the wave-length change switch which controls the loop. The designation letters in this figure coincide with those in the list of parts, and in the remainder of the illustrations.

Essentially, the receiver is a super-heterodyne, employing an autodyne detector-oscillator, and what the writer believes to be an exceptionally efficient intermediate amplifier. Because of the use of the autodyne frequency-changer, the circuit has been called a "super-autodyne," which seems to be a more logical name than "super-heterodyne." It might be argued that the usual interpretation of the word "heterodyne" implies the use of a separate detector and oscillator to produce a beat note, whereas in this system but one tube is used (autodyne). The name at least serves to distinguish this system from the conventional ones.

The Super-Autodyne was recently described in *Radio Broadcast*, New York, and sponsored by that magazine as being one of the most efficient types of multi-tube sets thus far devised. The description and construction details of this set as given by *McMurdo Silver*, the designer, in *Radio Broadcast*, follow:

Theory of the Autodyne Circuit

The autodyne circuit, which is the most interesting feature, is worthy of explanation. The difficulty which has heretofore prevented the use of one tube for both detector and oscillator has been that of isolating the loop or pickup circuit from the local oscillator circuit. It has been impossible to couple a tuned pickup circuit to a tuned oscillator when the two are to operate but fifty or sixty kilocycles apart throughout the broadcast wavelength range, and not have the tuning of one section react on that of the other. Armstrong and Houck developed the second harmonic system, whereby the oscillator, working at double the desired wave, did not react greatly upon the loop circuit. Then, a harmonic of the oscillator was used for heterodyning. This meant two waves of sufficient power to cause radiation were being produced by the oscillator, which necessitated the use of a muffler tube ahead of the detector-oscillator to prevent radiation. Thus, two tubes were still used, though the gain in signal strength was equal to or slightly better than that obtained with a good regenerative detector and oscillator. At best, this system is not entirely satisfactory for home assembly.

Then came the development of the balanced autodyne circuit, by J. H. Pressley, a Signal Corps engineer, which performs the required function with one tube.

The actual first tube circuit is shown in Fig. 9. The coils L2, L3 are theoretically equal, as are the condensers CX, CX. Actually they cannot be made fixed and equal, so CX, CX are made adjustable, to obtain substantially a condition of equality. These units make up a bridge circuit, shown by the heavy lines. Since L2 equals L3, the potential across them is equal, so that it is also equal between points 3, and 4, and 5 and 6. Likewise, the potential across CX and CX is equal. Since the potential across 3 and 6 is the same for both inductance and capacity, then point 4, 5 and the connection between CX, CX are at equal potential, and are also theoretically at zero potential, since these points are neutral with respect to 3 and 6. Then, circuit B1, C2, B2, may be connected at these neutral points with substantially no reaction on the frequency of the bridge circuit. Further, as these points are neutral with respect to 3 and 6, no energy in the bridge circuit can get into B1, C2, B2, since there is no potential difference across these points of the bridge. Therefore, the frequency adjustment of the bridge circuit cannot react upon that of the B1, C2, B2, circuit, and vice versa.

Since the signal is ed from the loop and its tuning condenser to the oscillator, it will divide equally across the bridge arms. If a tube detector is connected across one capacity CX, the drop in potential may be used to cause rectification. The coil L1, coupled to L2, L3, causes the bridge circuit to oscillate at a frequency determined by these coils, CX, CX, and C1 which is made variable for the purpose of tuning the oscillator circuit. As previously explained, this energy cannot get into the loop circuit, so radiation is confined to what may be experienced from the oscillator coil system itself—a negligible amount.

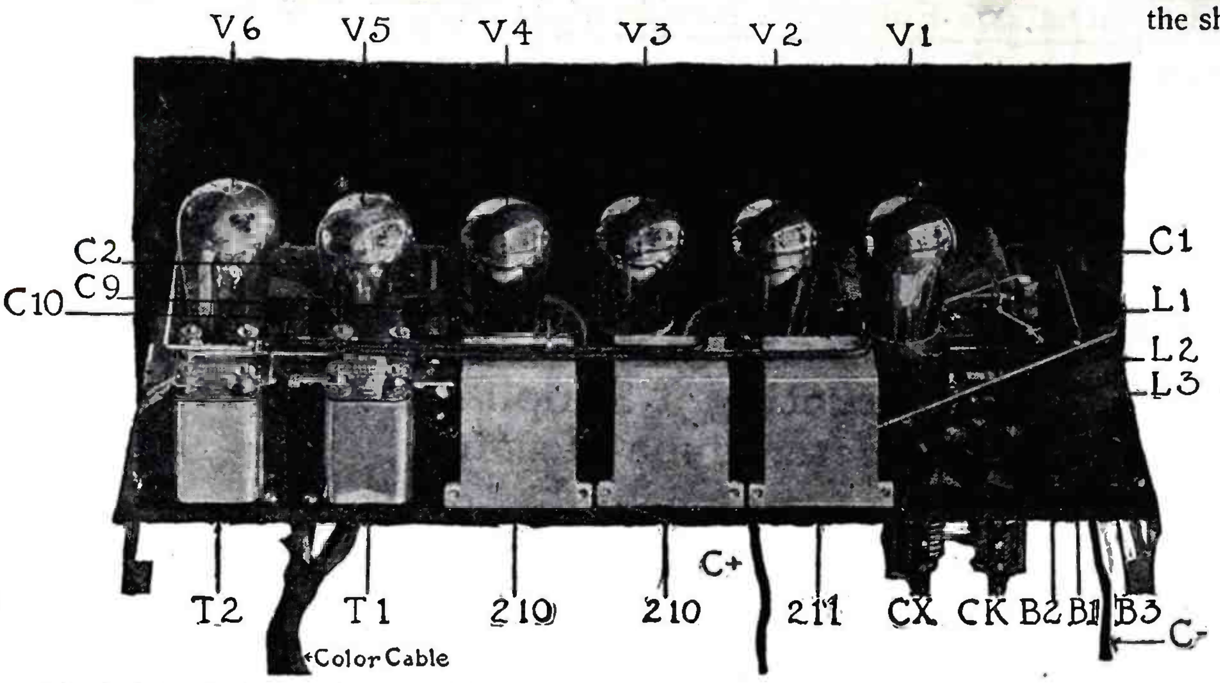


Fig. 2.—The completed receiver from the rear. Note how the color cable runs into the assembly, and how two of its leads terminate on the rear left posts of transformers T1 and T2. Condensers C9 and C10 should be fastened to the under side of the sub-panel, using holes provided in this socket-panel.

It is desirable that the losses in these circuits be kept low, particularly in C1, C2, CX and CX. Further, CX and CX should be quite small so as not to lessen the tuning range of the circuits, and in order that maximum voltage may be impressed upon the detector terminals. In some cases, it has been found possible to use the tube capacity for one condenser CX, while a very small variable was used for the other capacity.

Intermediate Amplifier

The intermediate amplifier is the only other unusual feature of the receiver. It employs but two stages and is on the order of those described by the writer in *Radio Broadcast* for October, 1924, and January, 1925. It differs, however, in that it employs transformers which are a compromise between the extreme selectivity of properly designed air-core coils, and the great stability and amplification of good iron core transformers. But two core laminations are used in each transformer, of 7-mil silicon steel, one in the shape of an "F" and one an "L."

Construction of the Set

The material required to build this receiver is listed below, with the designation letters used in the diagrams and cuts following the quantity of each item required. It is entirely permissible to substitute any other standard parts for those listed. The actual space available is such that if in some instances parts of larger or different dimensions are substituted, considerable difficulty will be encountered in making the units fit in the space provided. In the case of the r. f. transformers, it would be inadvisable to substitute, since the results of the receiver depend in a large measure upon the use of the types recommended.

2 C1, C2 S-M 301-A (or 305-A S. L. F.) Condensers.

2 4" Moulded dials, vernier type preferably.

1 R4 U. S. L. 6 ohm rheostat.

1 R3 U. S. L. 240 ohm potentiometer.

3 B1, B2, B3 insulated top binding posts.

1 J2 Carter 101 jack (1-spring).

1 J1 Carter 102-A jack (3-spring).

1 C-5, 211 S-M 211 filter with matched tuning capacity.

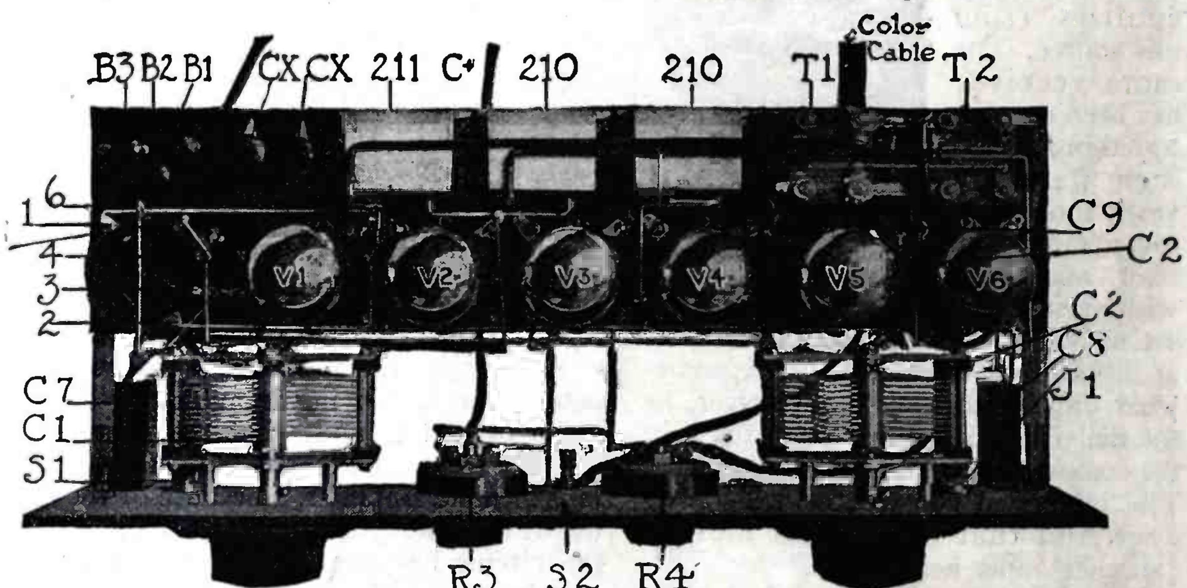


Fig. 3.—Details of the finished receiver from above. Note how the five leads of the color cable separate: one to the rheostat R3, one to the switch S1, two to T1, and one to T2. The gang-socket used in this particular model of the set is a home-assembly, and the springs are held by screws. In the factory product, the springs are held by hollow rivets which permit connections to be made from either above or below quite simply.

2 210, 210 S-M 210 charted intermediate transformers.

1 L1, L2, L3 S-M 101-B coupling unit.

1 S-M or Benjamin 6 gang socket shelf (536-201A, No. 537-199).

2 T1, T2 Thordarson 3½:1 or 2:1 transformers.

2 C7, C8 S-M or Dubilier .5 mfd. Condensers.

2 C3-C4 Muter .00025 mfd. condensers with 2 clips.

2 C9, C10 Muter .002 mfd. condensers.

1 C6 Muter .0075 mfd. condenser.

2 CX, CX Continental .000025 mfd. condensers.

1 R1 S-M or Muter .5 Meg. leak.

1 R2 S-M or Muter .2 meg. leak.

1 S1 Carter No. 3 jack switch (s. p. d. t.).

1 S2 Benjamin 8630 switch (s. p. d. t.).

1 S-M No. 701 color cable (5 leads).

1 pair Benjamin No. 8629 shelf brackets.

1 Bakelite Panley, 7 x 18 x ¼ inches.

Small parts: 29 6/32 R.H. N. P. machine screws ¾ inch.

2 6-R.H. N. P. machine screws 1½ inches.

31 6/32 nuts. 10 strips bus-bar.

1 spaghetti. 25 lugs.

Tools required: 1 hand-drill with drills and countersink, 1 soldering iron with rosin-core solder and non-corrosive paste, 1 side-cutting pliers, 1 screw-driver, hammer, and center-punch.

The Oscillator Coupler and General Assembly

The oscillator coupler may be made by winding two sections separated 1/16-inch apart on a 2¼-inch bakelite or condensite tube; each section containing twenty-eight turns of No. 28 d.s.c. wire. The rotor coil also consists of twenty-eight turns of the same size wire on a 1½-inch tube rotatable within the stator tube. See Fig. 12.

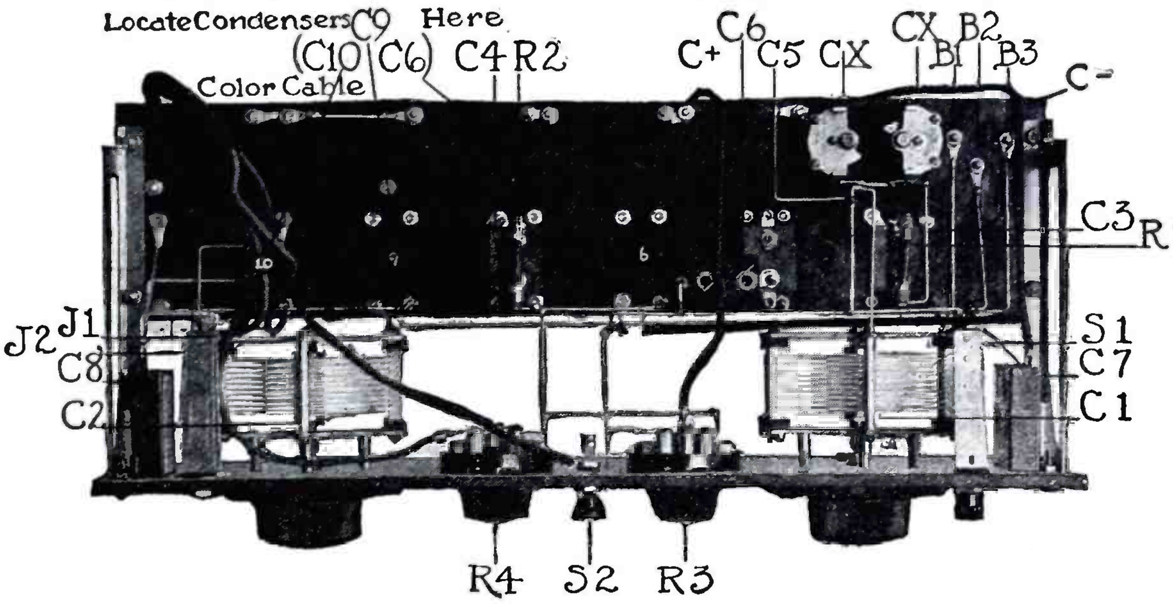


Fig. 4.—Bottom view. Condensers C6, C9 and C10 should be fastened to the sub-panel at the points shown, similarly to C3, C4 and C5. The proper hole locations are given in Fig. 7. Connections from C3 and C4 to the socket grid terminals are by means of lugs, just visible between the condensers and the nuts to the rear left. This view shows quite clearly how the by-pass condensers are held by the same screws holding the mounting brackets.

As soon as the materials have been procured, each item should be carefully examined to see that all screws and nuts are tight, and lugs placed as shown in the photographs, so that those on the various instruments will point in the best directions for short leads. Socket springs should be bent up to make good contact with tube pins. Condenser bearings should be adjusted to give the desired tension.

If the builder already has Benjamin sockets, the socket-shelf may be made up by drilling a piece of bakelite 17¼x 4¼x¼ inch in accordance with Fig. 7. The bases should be removed from the Benjamin sockets so that they may be fastened directly to the sub-base with their original screws. On each terminal will be found a round knurled nut, a hexagonal nut, and a round-headed screw. The screw should be put through the hole in the spring, pointing downward. The knurled nut is turned upon the screw under the spring, the screw pushed through its hole in the shelf, a lug placed over it if necessary, and the "hex" nut tightened up on the under side of the shelf. Care should be taken to prevent the spring from twisting as the nut is tightened, due to rotation of the screw. If this occurs, the socket will not ride evenly on its spring. Details of these operations may be obtained from Figs. 2, 3, and 4. Either UV-199 or standard UV-201A sockets may be used. They should be arranged so that their grid terminals come out at the left rear, as in Fig. 3.

The front panel may be laid out in accordance with Fig. 8, using a rule and scriber after which the hole locations should be punched with a center-punch or nail, and a hammer. After drilling the holes, the panel may be grained with fine sand-paper and oil, rubbing in one direction until the original polished finish has disappeared. After wiping the panel off with alcohol, indicating marks for the dials may be scratched as in Fig. 1, and filled with Chinese white. The sub panel should not be grained.

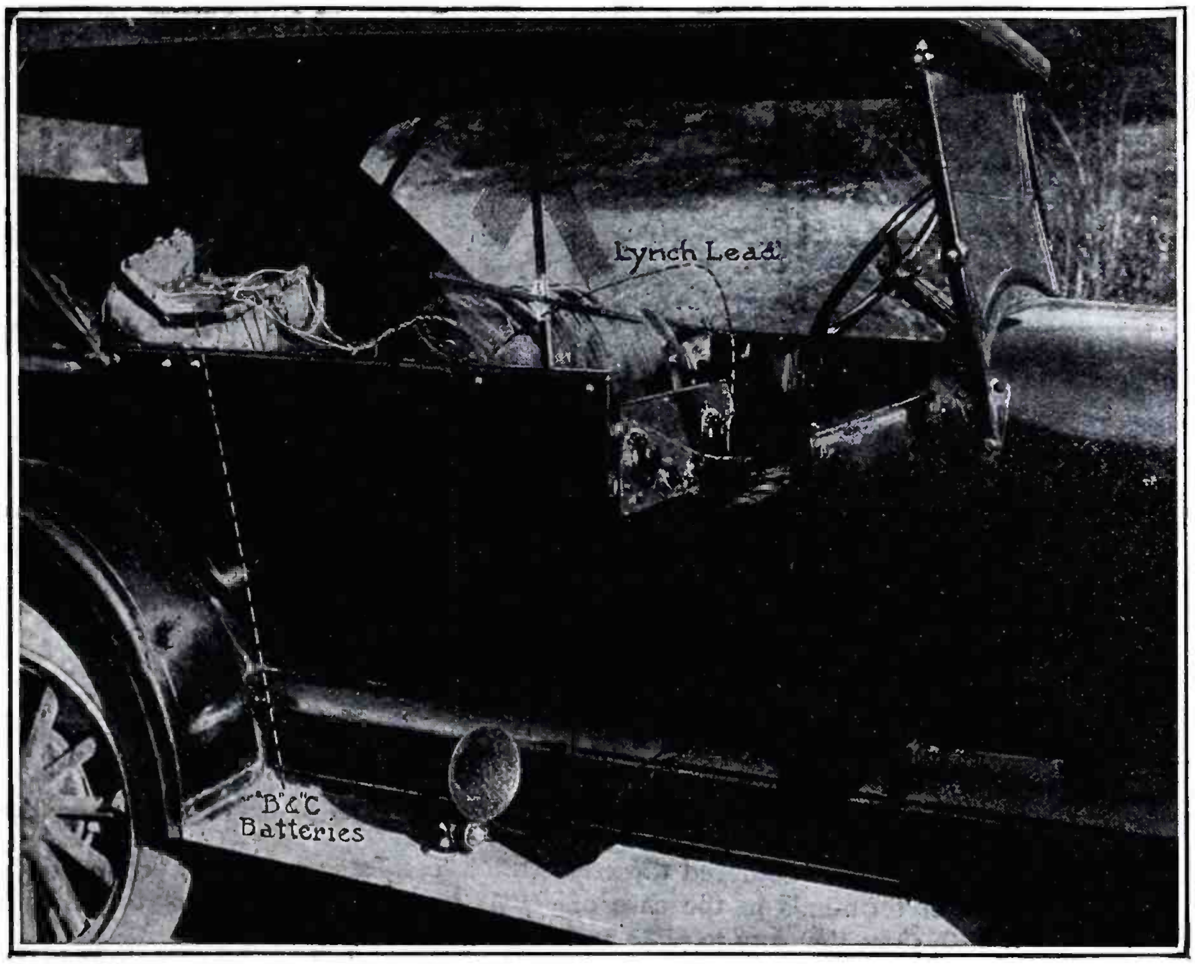


Fig. 5.—The receiver in an automobile. The A battery supply comes from the automobile by using the Lynch Lead. The rather dilapidated bag in the rear holds the B and audio amplifier C batteries. The Amplion loud speaker and the folding loop also go in this bag when not in use. Blanket-roll straps provide a convenient means for carrying the set itself.

Assembly of Parts

Before starting with the assembly, the photographs should be very carefully studied, to see just how each part is put on, and just where each of the different parts go. If the S-M or Benjamin shelf is used, it will be unnecessary to drill any additional holes, as these shelves are supplied completely drilled for the parts recommended.

Figs. 1, 3, and 4 should be examined to see how the parts are arranged on the panel. The condensers C1 and C2, the Carter jacks and jack-switch and the Benjamin switch should be put on the panel, followed by the rheostat and potentiometer. The posts of these latter instruments should be on the bottom, and their contact arms should point upward when their indicating arrows do likewise.

All parts should be put on the sub-panel as shown in the various photographs. In these C6, C9 and C10 are shown inconveniently located. They should be placed in the positions indicated in Fig. 4, on the under side of the shelf. They are held to the sub-panel by machine screws and nuts. Lugs placed between these condensers and the sub-panel may be soldered directly to the socket terminals in the case of C9 and C10, since they run to plate and F of sockets V5 and V6. Condensers C3 and C4 may have one of their contacts connected to the grid terminals of sockets V1 and V4 respectively in the same manner. Lugs for C5 should be placed on the upper side of the shelf, as well as on one terminal each of C3 and C4, since some of the condenser connections will be made from above.

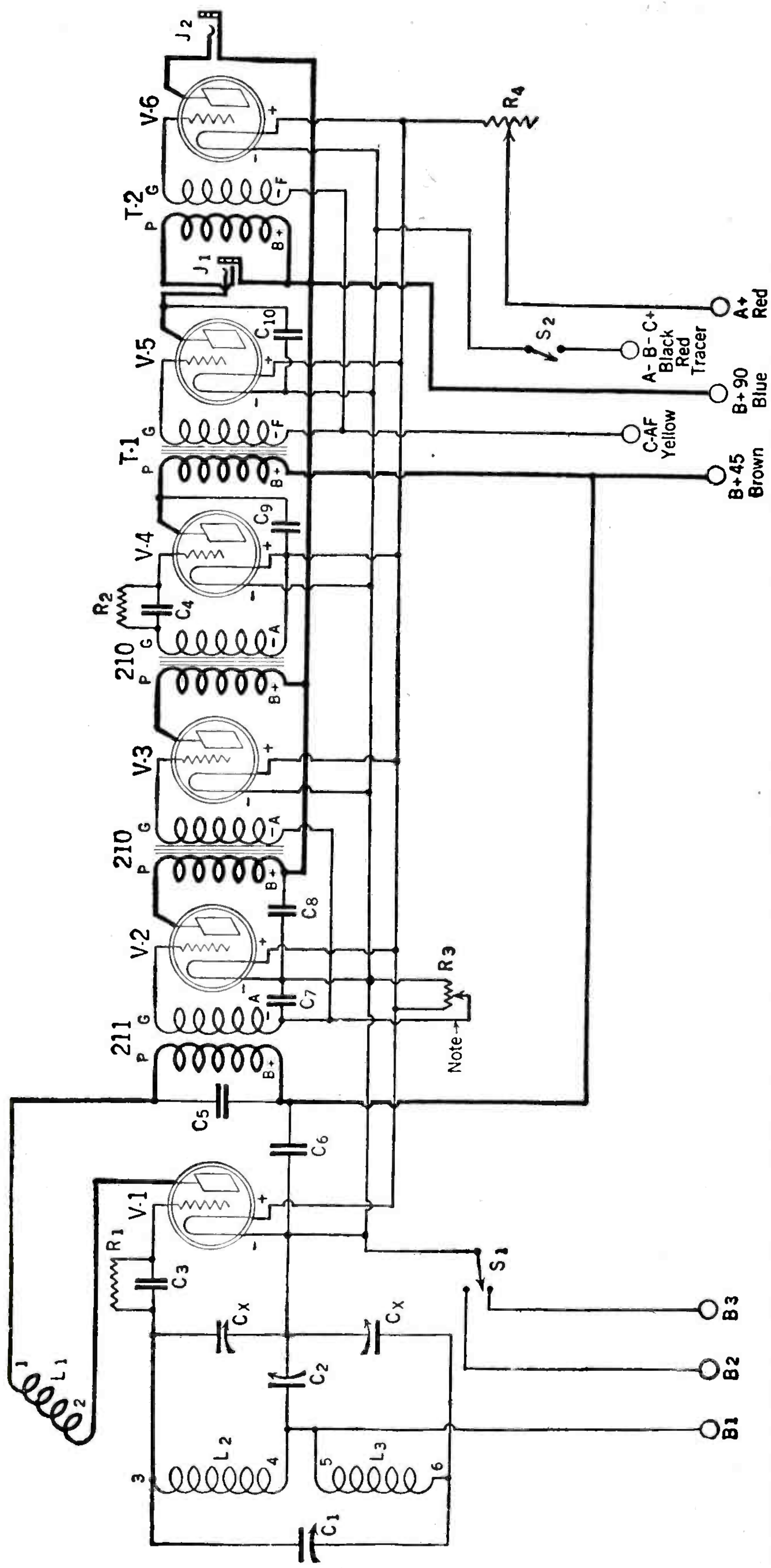


Fig. 6.—Complete wiring diagram of the super-autodyne receiver. If this diagram is used with the picture layout diagram when wiring the set, an error in connections is likely to be made. Consequently, use either one or the other and follow it out religiously.

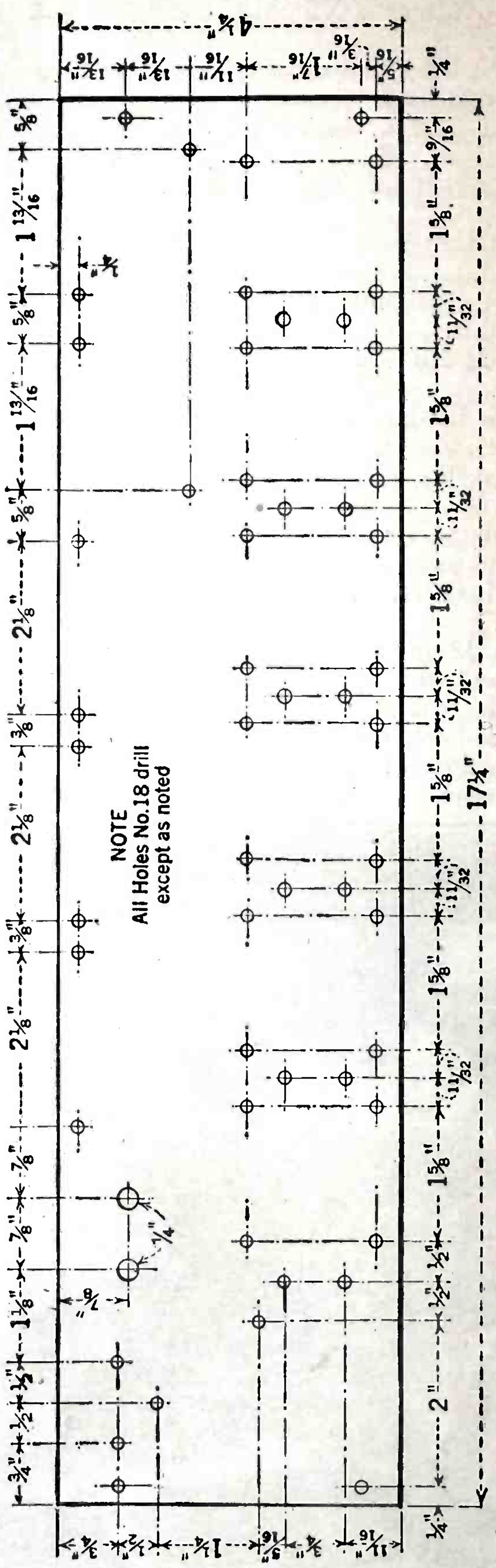


Fig. 7.—Layout for drilling the sub-panel. All dimensions for spacing holes are clearly given. However, these dimensions apply only to the use of the particular parts specified. When drilling this sub-panel great care must be taken to drill each hole accurately as trouble may arise in mounting the parts. It is a good plan to start the holes with a small drill about 1/16 inch in diameter and then enlarge them by re-drilling with the larger size drill. This method will insure accurately centered holes.

Wiring the Receiver

In wiring the receiver, a well-tinned iron should be employed in conjunction with rosin-core solder. A small amount of paste may be used on each connection if desired; but not on any of the fixed condensers. Here, connections may be soldered to lugs, or to the condensers directly.

Only two connections can be put on the panel alone. These are a connection between the rheostat and potentiometer, and one between the potentiometer and S1. (See Figs. 3 and 4.) Bus-bar should be used, straightened, carefully cut, and bent to proper length before any attempt is made to solder it in place. A long piece of bus-bar should not be soldered to a lug, and then bent and twisted until it reaches the other lug to which it is to be soldered. Each piece should be bent to fit properly, cut to size and then soldered in place.

Assembling on the Sub-Panel

Starting on the sub-panel, all the wiring visible on it in Fig. 3 should be put on, the shelf then turned over, and the wiring necessary on the bottom put in place. All of the r.f. and a.f. transformer cases are connected together, and in turn connected to the negative filament line, which joins the minus lugs of all sockets, just as the positive line joins all the plus terminals of the six sockets.

The Benjamin brackets should be fastened to the sub-panel, and in turn loosely fastened to the panel. The lugs of the bypass condensers C7 and C8 are bent at right angles, and slipped in between the brackets and fastening nuts, as in Fig. 4. This makes a solid mounting for these condensers, after the screws are tightened, as well as for the shelf-brackets. The balance of the wiring is then put in, running between the parts on the sub-panel and those on the panel. This will not be found difficult, particularly if spaghetti is used only where there is danger of two wires shorting, or a wire shorting on an instrument.

A C-battery is used on the r.f. amplifier. It connects to the two flexible leads marked C minus and C plus in the photographs. No provision is shown for it in the diagram, except the point marked "Note." At this point, the wire is broken, and a ten-inch lead of lamp cord soldered to the potentiometer arm for the C plus lead and another similar wire soldered to the joint between C7 and the A minus lugs of the 211 filter and its adjacent 210 transformer. This C-battery is 3 volts, and may be placed in the cabinet under the sub-shelf, since its leads should be short. It had best be wrapped in paper to prevent shorting on any of the wiring. For UV-201A tubes, these leads may be shorted and the battery eliminated entirely if the amplifier will oscillate without it.

The remaining battery leads are brought out through a color cable. In Fig. 6, the colors of the various wires in the cable used for different voltages are given. This was for one particular make of cord, used on an experimental set. It will be noticed that the black lead with red tracer is used for three connections, which are made between the batteries themselves by means of other wires.

Accessories and Testing

Assuming the receiver to have been wired, it is ready for test. The additional material required is as follows:

6 Radiotron tubes, UV-201A, or UV-199. DV-3 De Forest tubes may be substituted for 199's, but will require a standard-base socket shelf.

1 A-battery. This may be a storage battery, 6 volts, 90 ampere hours for UV-201A's, or it may be the battery used in an auto, tapped by means of Lynch Leads. For dry cell tubes, three dry cells may be used, or better yet, for home installation six in series-parallel.

1 B-battery. For permanent installation 90 volts, of large size 22, or 45 volt batteries should be used. For portable work, 67½ volts will be sufficient, of medium or small-size batteries, since the current drain is but 12 milliamperes for 201A tubes, and 9 milliamperes for 199's. (90 volts will give only slightly more volume than 67½, so it is hardly worth while to carry around the extra 22-volt battery.)

2 C-batteries. One 3-volt battery required in the set box for the r.f. amplifier, and one 4½-volt battery for the a.f. amplifier.

1 Loop with center tap. Any good tapped loop may be used, or one may be made by winding 16 turns spirally on a form about 24 inches square, tapped at the center, with ¼ inch between turns. This loop with eighteen turns, 3/16 inch apart, may be wound on the back of a cabinet large enough to hold the set, with the batteries beneath if desired.

1 loud speaker. The small Amplion is recommended for portable work, as it is a most excellent speaker, and delivers very good volume and quality. For home use, the Western Electric cone speaker is best, with its leads shunted by a .0075 mfd. condenser.

1 phone plug.

1 set Lynch Leads if the set is to be operated in a car, using the starting and lighting battery. The Lynch Lead may be made up from any double conductor wire. Several types of wire can be used, but the flexible, rubber covered lead is recommended. The wires, which should be colored for ease in identification, should be scraped on one end, for connection to the filament posts on the receiver. The other end of the lead should be connected to a plug which will fit into the dashboard connection to the automobile storage battery.

1 7 inch x 18 inch x 7 inch mahogany cabinet.

Connections

The A-battery should be connected to its leads, one tube inserted in a socket, switch S2 closed, and rheostat R4 just turned on. If the tube lights, it should be moved from socket to socket to see that all A connections are correct. The positive battery lead should then be connected to the B45 and B90 posts. If the tube lights, the wiring or assembly is faulty and should be checked. The tube should only light

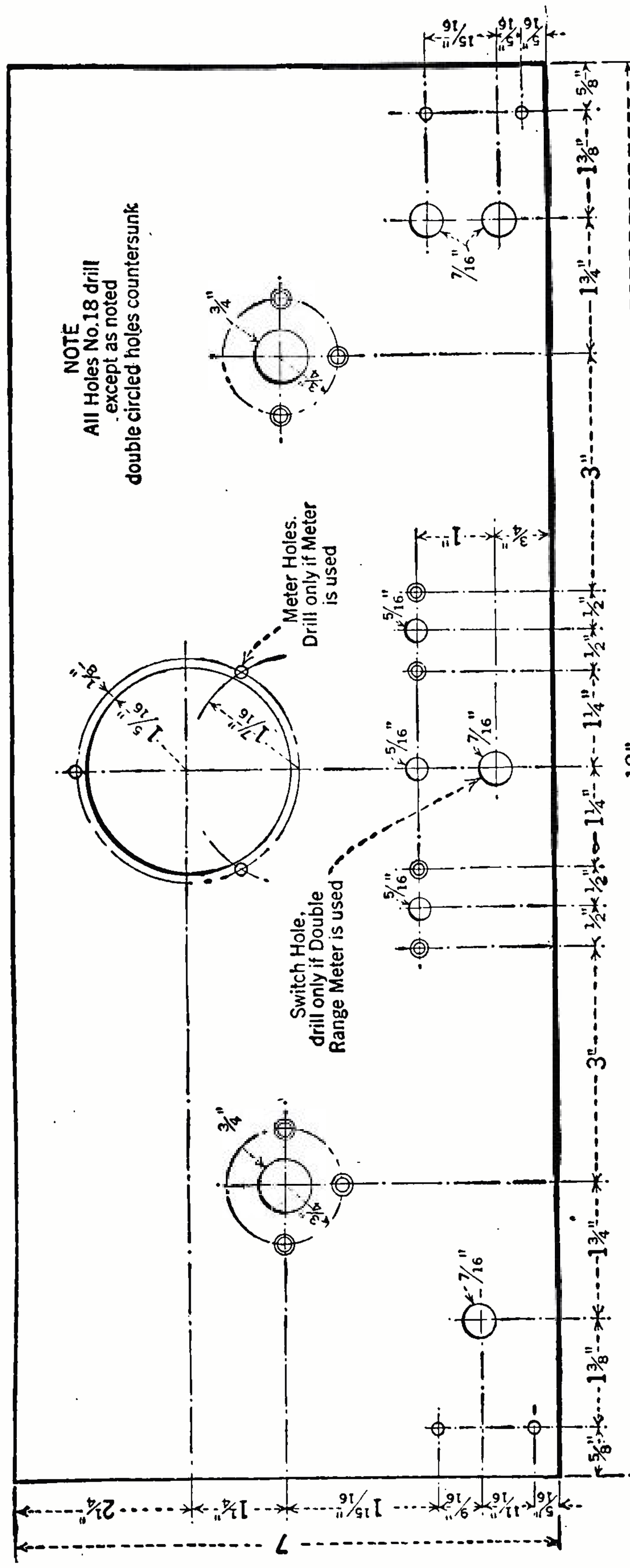


Fig. 8.—Panel drilling dimensions. If a meter is used with this set, which is strongly advised, the holes indicated should be drilled. The Weston double range voltmeter type 301, which may be used on the panel, requires the additional switch hole indicated.

when the A battery is connected to the A leads.

The remaining batteries may be connected, and the loop leads run to posts B1, B2, and B3. If the loop is spiral, B1 goes to the outside lead, B2 to the center and B3 to the inside. When switch S1 is to the left, or short position, only half the loop is used. When

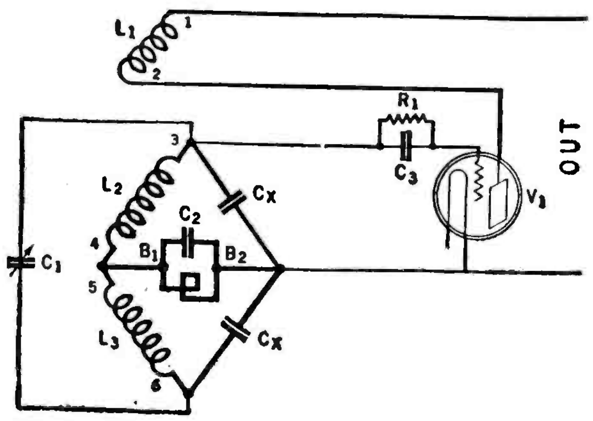


Fig. 9.—Diagram of the balanced autodyne circuit used in the super-autodyne receiver.

it is to the right, the whole loop is used. This means all low wave stations up to 380 meters will come in on dial C2 from 0 to 100 degrees. Stations from 350 meters up will come in on C2 with switch S1 thrown to the right, or long position. This means that in the long position, C2 will read about 20 for 345 meter stations, and about 70 for 536 meter stations. On the short position, C2 will read about 85 for 345 meter stations, and about 45 for 270 meter stations. These figures are approximate, but show that to cover the entire wave-length range, C2 must be varied from 0 to 100 degrees to go up to 370 meters with S1 to the left, then S1 turned to the right and the remaining wavelenth range secured by varying C2 again from 0 to 100, allowing, of course, for over-lapping. C1, the oscillator, starts around 18 for 270 meters, and brings in the lower heterodyne point of 536 meters at about 70. Two points can be found for each station on this dial, which will help in tuning, as when interference is experienced on one point, the other may be used.

Tuning and Testing the Completed Receiver

The first test should be to check tube V1 for oscillation. Insert only tube V1, set R4 just on and connect the phones in series with the B45 lead. Then touch lugs 3, or 6 of the coupler. If a plucking sound is heard, this tube is oscillating. If not, adjusting the rotor coil will cause it to oscillate. When this rotor winding is in the same plane as the stator windings, turning it 180 degrees around will either start or stop oscillation. When once set to produce oscillation, this coil should never be touched. If the tube squeals at low settings of C1, reduce R1 to .25-megohms, or try another .5 megohm

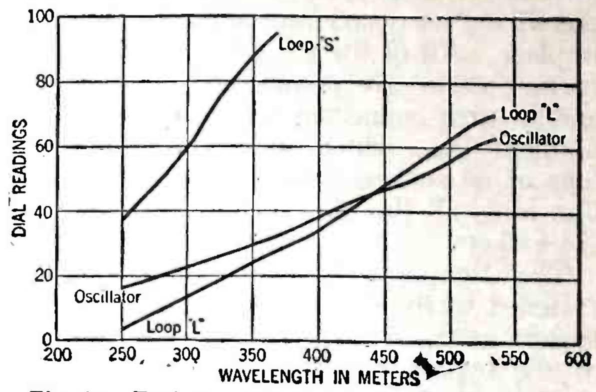


Fig. 10.—Typical tuning chart of a super-autodyne. The curve marked "Loop S" is for the loop condenser with the switch in the "L" position. Only one curve is shown for the oscillator. The curve embracing the upper heterodyne points would parallel the one given, starting about four degrees higher at 250 meters and ending about thirty degrees higher at 530 or 540 meters.

leak. Use the highest value of leak possible—(up to 1 meg). The receiver will probably squeal below 10 degrees on C1 in any case. R2 is not critical and may vary from 1 to 3 megohms.

With tube V1 oscillating constantly,

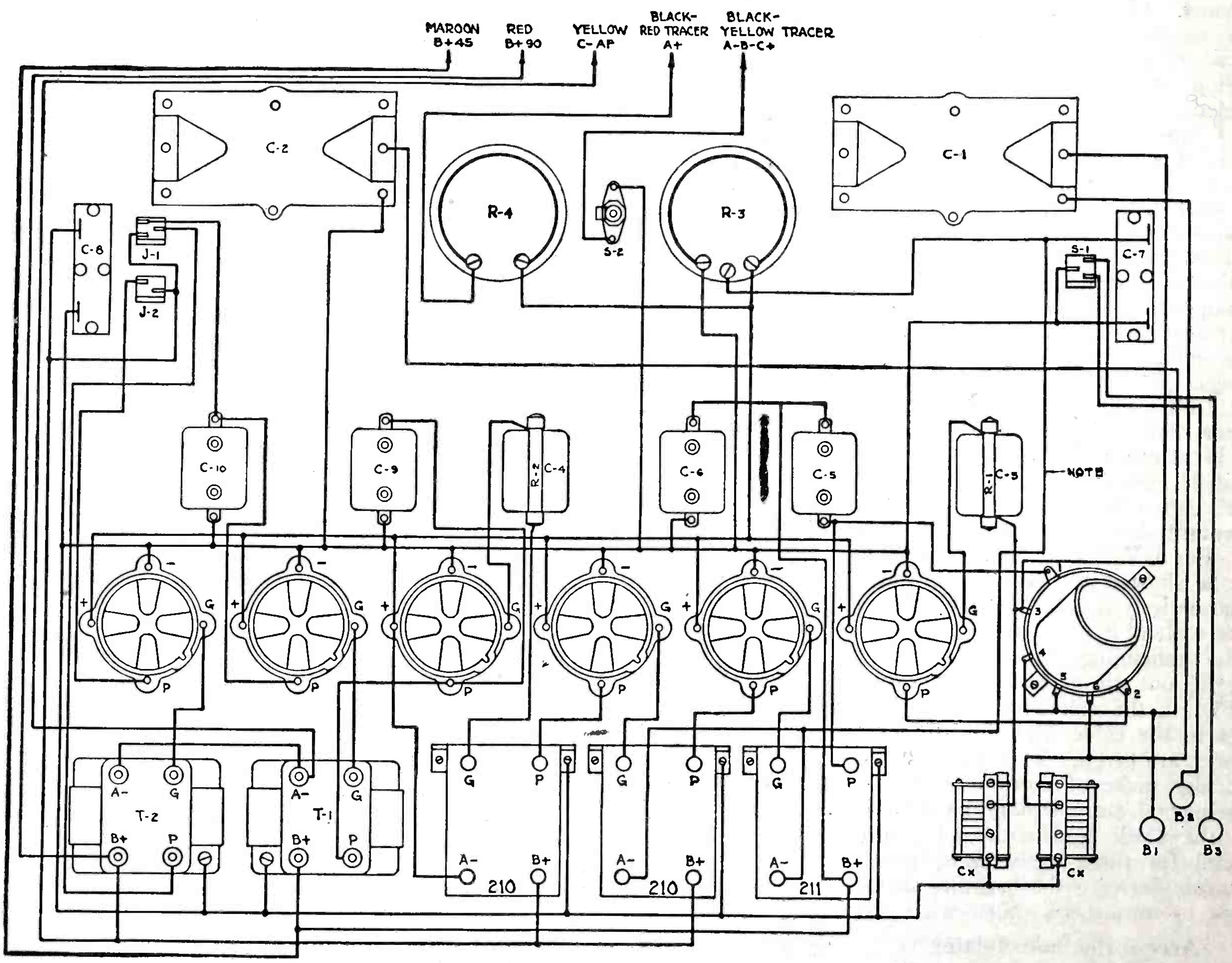


Fig. 11.—A picture wiring diagram of the super-autodyne. The location of every wire in the circuit is shown.

insert the remaining tubes in the set, turn the rheostat seven-eighths on for 201A tubes, or on one-third for 199's, and rotate the potentiometer from positive to negative. If both C1 and C2 are set at 100 degrees, a plunk will be heard at some point as R3 is adjusted, indicating amplifier oscillation. If C1 is adjusted, squeals will be heard. R3 should be set with its arm just positive of the point where squeals can be heard and either left set at this point, or used to control volume. Now, with S1 to the right, and C1 set at 50, rotate C2 over its entire range. A click will be heard near the center of its scale.

The condenser CX connected between terminals 3 and 4 of the coupling unit should now be slowly turned out in small steps until rotating C2 fails to produce a click. The receiver is now balanced and CX, CX should never be touched unless tube V1 is changed.

In tuning, C2 will appear rather broad, which is correct, while C1 will be extremely sharp. This permits of extremely easy logging, since C2 need only be set approximately correct, and C1 rotated in order to find a station. The chart in Fig. 10 will help in preliminary tuning. The set will log definitely, and a station once heard may be brought in again at the same settings of S1, C1 and C2, providing CX, CX have not been tampered with.

Due to the sensitivity of the circuit, a small amount of hand capacity may be noticeable on C1. This may be overcome by grounding the negative filament line to a piping system, or it may be compensated for by tuning-in a station, increasing C1 slightly until the volume begins to decrease, and removing the hands from the set. The signal will then return to full intensity. It will be evident in those few cases where it may be encountered, only on weak, low wave stations, and is seldom bothersome.

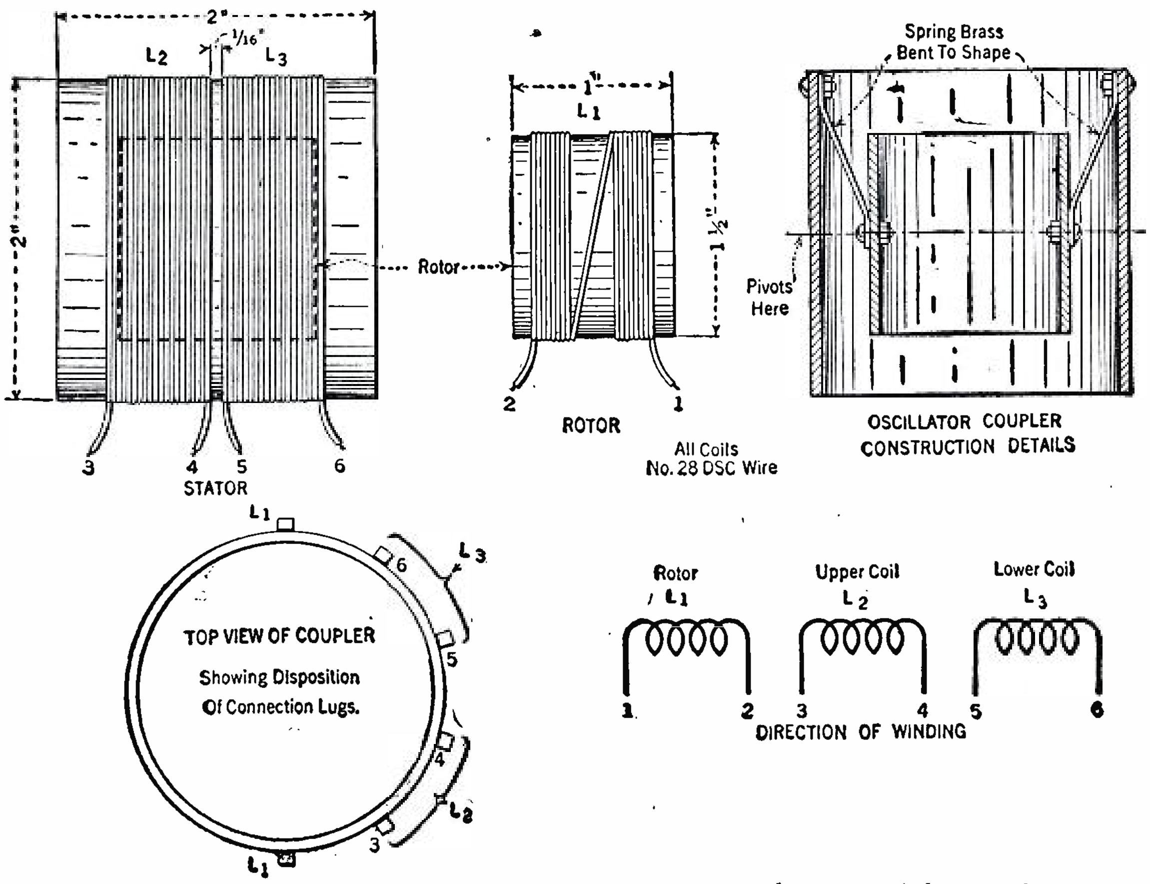


Fig. 12.—Details for construction of the oscillator coupler used in the super-autodyne receiver.

Where to Look for Trouble

One of the most exasperating things that the radio fan has to contend with in his enjoyment of the science is the location of that elusive trouble that seemingly defies all his efforts. Trouble shooting in its best is a rather tedious operation, but when it takes on the aspects of a jig-saw puzzle, with a half-dozen pieces missing, then the fan is apt to get disgusted and call in the first radio doctor that he meets.

How many of the fans who have called in this highly-esteemed gentleman have noted that the first thing that he does is to slip the plug in and out of each jack. Well, this little trick serves two different and distinct purposes. It informs the "doctor" whether or not he has plate current, and it also gives him a look at the jack contacts without opening the box. Many times the entire trouble can be traced to an imperfect jack contact. Often it is creeping flux on the soldered ends, which effectively shorts the circuits by destroying the insulating properties of the little pieces of formica piled between the springs. Sometimes it indicates that one of the springs is bent and not making contact.

Of course if he gets no click at all, the first thing he does is test his "B" batteries and trace the circuit. If everything shows O. K., he looks at each and every jack and the immediate circuits that run from it. Nine times out of ten he can tell from just placing the plug in the jack just about where the entire trouble lies.

Lately, however, the radio trade has been affected by a very strange malady. It manifests itself in the gradual falling off of signal volume for no reason whatsoever. This trouble does not show itself in the manner of the ninety and nine other radio troubles, but is quiet and well-behaved, but nevertheless serious enough to give the fan something to crease his brow about. After inspecting about four sets and hearing four reports the same, the idea that the tubes were "paralyzing" came to the front. Questioning the operators of the sets did not show that the tubes had been burnt any higher than necessary—but was this so?

It is most natural for the fan to turn his tube up the moment that he wants more volume, and it is ofttimes done unknowingly or thoughtlessly just to increase the volume, and quite evidently that is what has been done. The remedy in this case is to "boil the tubes" out, by placing them in their sockets, removing all the "B" battery from the set and running them at a low value of filament current for about an hour. Then, when the "B" battery is replaced, take good care to see that the filaments are left untouched when additional volume is needed.

When the set gets noisy and starts to "act up" under fairly good radio conditions, remove the tubes from the sockets and polish up the nibs of the tube, and see that each spring in the socket is firm. For no earthly reason, outside of slight vibration, a screw will work itself loose and cause no end of trouble in bad contact.—*N. Y. Herald-Tribune.*

The Three-Tube Rasla

How to Build this New Reflex Which Has Proven to Be One of the Best for Broadcast Reception

AT some time or other probably all of us have sat in some friend's home watching him twist the dials of his receiver on a hunt for some DX. Presently we hear some more or less squeaky music accompanied with certain other foreign noises. Our friend then turns around and asks: "Isn't that pretty good, considering it is coming from a station some twelve hundred miles away?" And we reply: "Yes, considering that it is coming twelve hundred miles. But if we were to strike out the appendage, "considering it is coming from a station twelve hundred miles away," how good would the music be? Answer: Not so good!

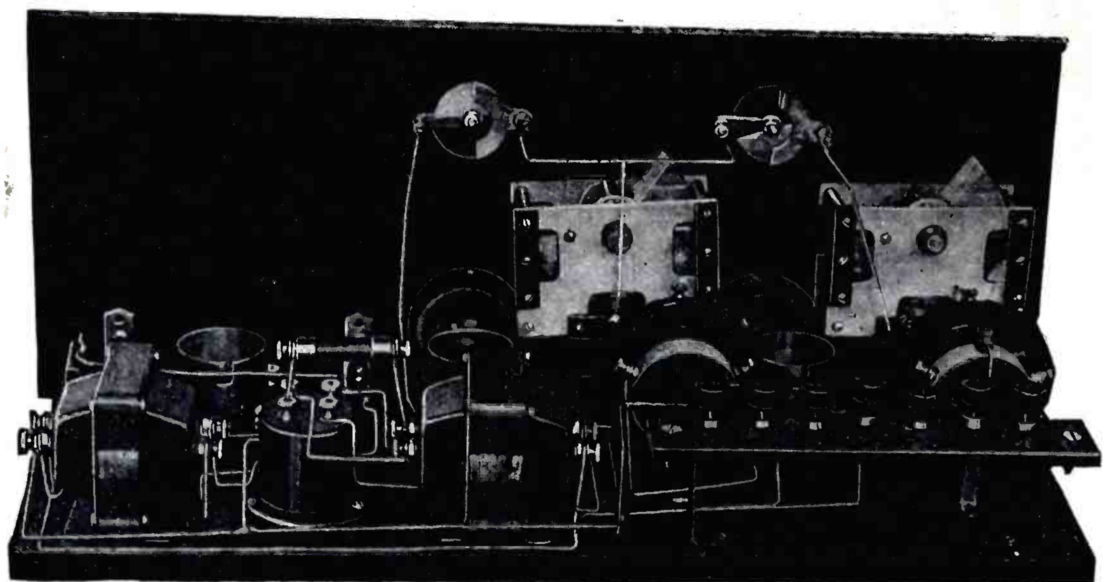


Illustration by Courtesy of Philadelphia Inquirer

A back panel view of the Rasla three-tube set. Carefully note the layout of the various parts and wiring of same.

After having tuned in a certain distant station several nights we soon lose interest in those particular call letters and instinctively we turn back to our local reception for the real satisfaction we expect from our receiver. Or, in other words, it seems that we subconsciously couple local reception with good quality, which is what we sooner or later demand from every receiver.

Another idea prevalent in the mind of the radio public is that three tubes are required for satisfactory volume from a radio set. While this is not strictly true, except under very unfavorable reception conditions, the fact nevertheless remains that the average man wants what he wants rather than what some one else thinks he should have.

These foregoing thoughts have had considerable bearing on the development of the Rasla three tube circuit. In designing this set the aim has been to increase the number of local stations available. Or, in other words, endeavor was made to design a circuit that will bring in a number of stations within a distance of a thousand miles or so with volume and quality comparable to that obtained from the stations in the immediate vicinity.

A complete description with constructional details of this set has recently been given by *J. Clyde Davidson*, the designer, in the radio section of the *Philadelphia Inquirer*. Mr. Davidson's article follows:

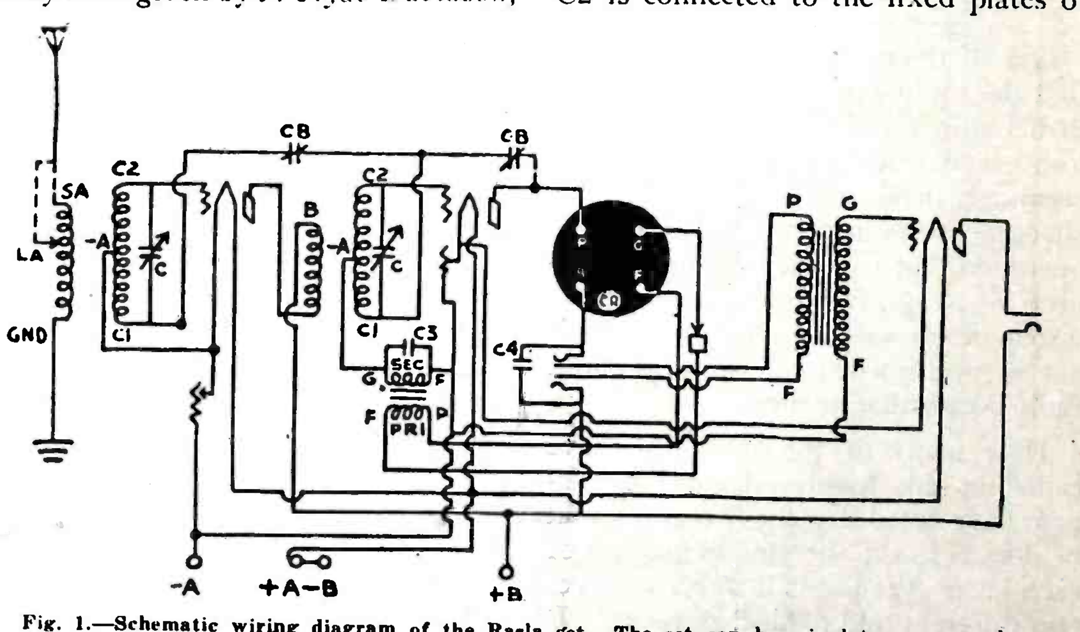


Fig. 1.—Schematic wiring diagram of the Rasla set. The set can be wired to correspond, following either this or the layout wiring diagram.

No great amount of technical skill is needed to build and wire this circuit. Figure 2 is a picture drawing of the exact layout of the interior of the set, and shows each piece of apparatus in relation to the other parts. It also clearly indicates the wiring connections needed. Figure 3 shows the panel layout. The set can be assembled in a 7x18 inch cabinet. There are seven terminals to appear at the back of the cabinet. Reading from left to right they are Ant. (long), Ant. (short), Gnd., —A, +A, —B, +B. These terminals should be mounted on a bakelite strip and supported so that the terminals do not come in contact with the wood.

From the binding post marked +A run a wire to each socket terminal marked +F. From the binding post marked —A run a wire to the wire connecting the two rheostats together. Join the other terminal of the left hand rheostat to the —F terminal of the first socket. The —F terminals of the other two sockets are connected to the free terminal of the second rheostat. A filament control switch may be inserted in the positive or negative lead if desired.

The wiring of the two antennae and the ground terminals is obvious and needs no further comment.

To wire the first grid circuit: From C1 two wires are run, one to the variable plates of the first large tuning condenser and the other to the fixed plates of the first balancing condenser. C2 is connected to the fixed plates of the first large tuning condenser and also to the first socket grid terminal. From —A of the tuner run a wire to the —F terminal of the first socket.

The second tuner type TD is connected as follows: Join the P terminal to the first socket terminal marked P, then connect the B terminal to the —B binding post. C1 is connected to the variable plates of the second large tuning condenser, and from this condenser terminal wires are run to the variable plate of the first balancing condenser and to the fixed plates of the second balancing condenser. C2 is connected to the fixed plates of the second large tuning condenser and to the second socket grid terminal. The —A terminal is connected to the G terminal of the 10:1 audio transformer.

To connect the "CR" transformer join the P terminal to the second socket P terminal. The B terminal goes to the upper terminal of the double circuit jack. Connect the G terminal to one end of the crystal detector. The F terminal goes to the P terminal of the 10:1 audio transformer. The F terminal on the primary side of the 10:1 audio transformer is connected to the other end of the fixed crystal detector. The F terminal on the secondary side of the 10:1 transformer goes to the —A binding post. A .00025 mf. fixed condenser is connected across the two secondary terminals of the 10:1 audio transformer. Then run a wire from the movable plate of the second balancing condenser to P on the CR transformer.

To complete the wiring of the double circuit jack connect the terminal next to the top to the P terminal of the 4:1 audio transformer. The bottom terminal of the jack is connected to the plus B binding post and to the bottom terminal of the single jack. The remaining double jack terminal goes to the F terminal on the primary side of the 4:1 transformer. Connect a fixed condenser (.002 to .005 mf.) across the two outside terminals of the double jack or to wires leading from them.

The G terminal of the 4:1 transformer is connected to the third socket G terminal. The remaining F terminal of this transformer goes to the —A binding post. The upper terminal of the single circuit jack goes to the third socket P terminal. The wiring is completed by joining the —B and plus A binding posts.

Front view of the three-tube Rasla. The first large dial is for the antenna tuning and the second for tuning the radio-frequency transformer.

The Parts to Obtain

The parts needed for constructing this set are inexpensive and can be purchased at almost any radio store. The accessories should all be of reputable manufacture since they determine to a great extent the results to be obtained.

One 7x18 cabinet.
One 7x18 panel.
One baseboard.
One CR Rasla transformer (new type).
One Rasla tuner.
One Rasla tuner, type TD.
One Rasla fixed detector.
Two Rasla "Lo-Cap" condensers.
One Modern 10:1 audio.
One Modern 4:1 audio.
Two 20 ohm rheostats.
Three sockets.
One single circuit jack.
One double circuit jack.
Two 13-17 plate condensers (.00029).
One fixed condenser (.00025 mf.).
One fixed condenser (.002 to .005 mf.).
Two four inch dials.
Seven binding posts.

This circuit will be found to have unusual merit in bringing in DX stations on a speaker. It is designed to work

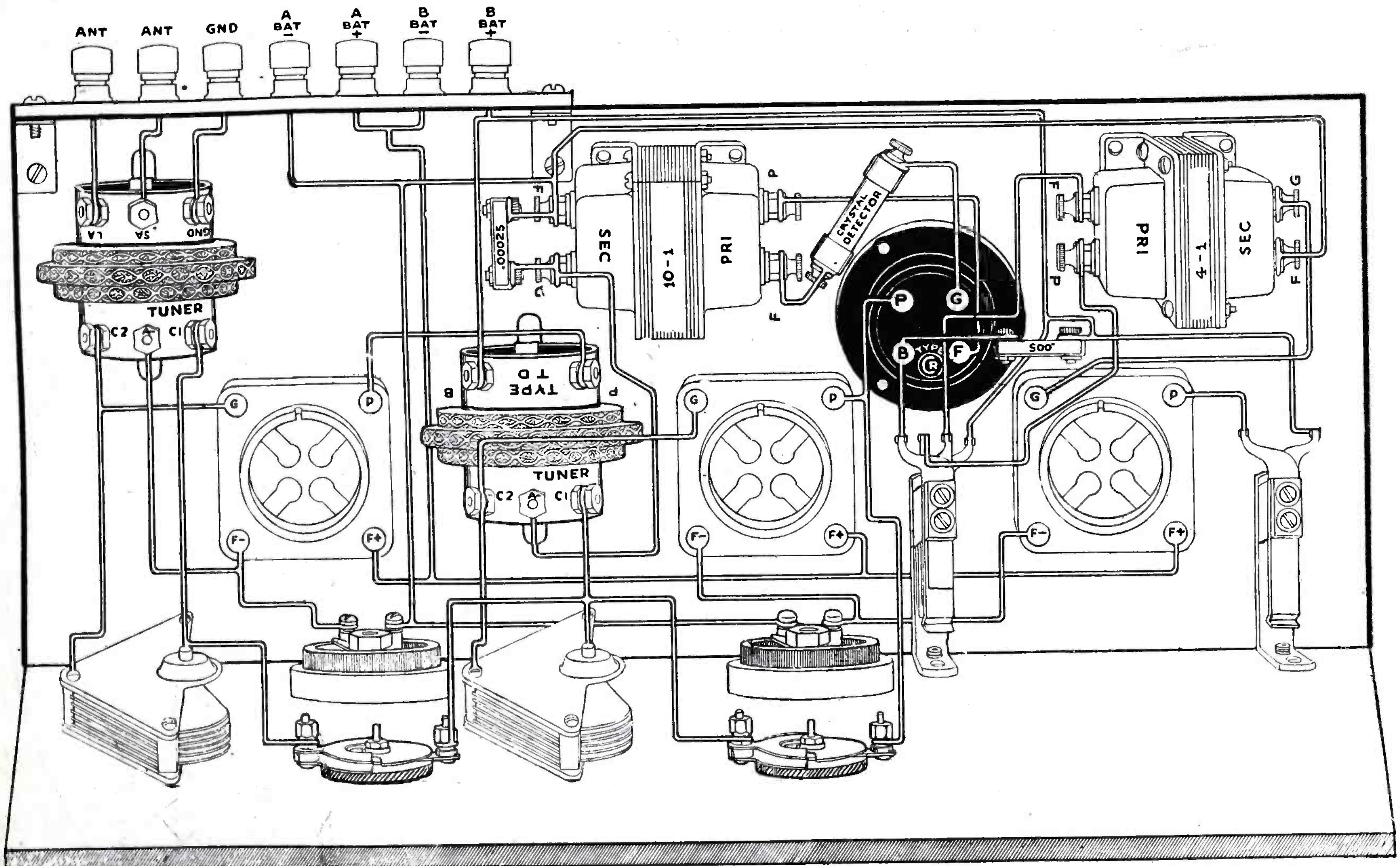


Fig. 2.—A combination panel and baseboard layout, showing the location and interconnections of all parts in the three-tube Rasla receiver.

best with a short antenna (50 to 80 feet long, including lead-in). An indoor antenna will give very satisfactory condenser in the antenna lead. Six volt tubes should be used with about 90 volts of B battery.

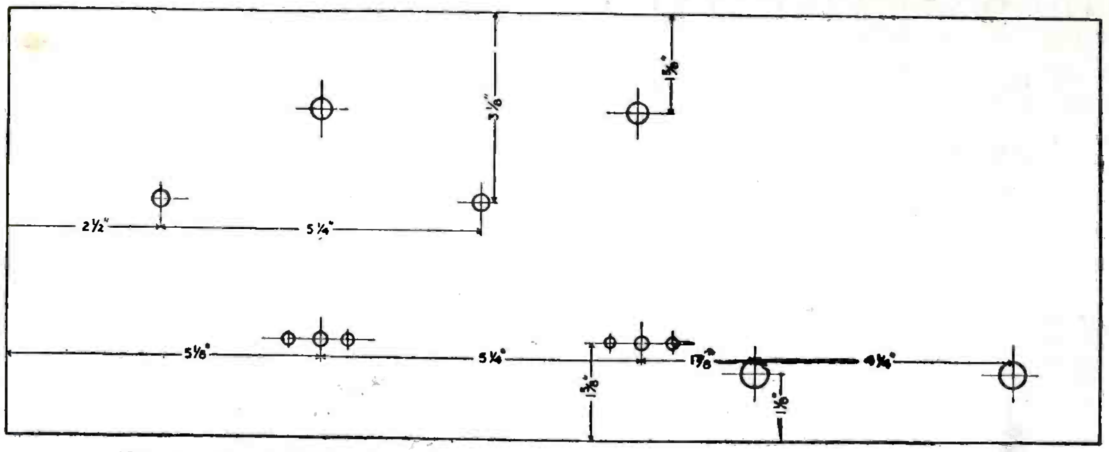


Fig. 3.—Panel drilling layout of the set, giving dimensions for drilling the holes.

results. If a longer antenna is used it may be necessary to insert a .00025 mf.

Little or no skill is required to operate the set. A station once logged can be again brought in by merely duplicating the two dial settings.

For most wave lengths the right hand balancing condenser should be left fixed at about maximum capacity, the volume being controlled by the left hand balancing condenser. On very high or very low wave lengths the second balancing condenser may need adjusting.

Use care in adjusting the two rheostats for maximum reception. If the rheostats are turned on too much the volume will be decidedly decreased. Should it be difficult to control the set by means of the small variable condensers in order to obtain clear undistorted tone production, it is advised to try disconnecting the .00025 mfd. fixed condenser from across the secondary of the 10:1 transformer.

An Easily Made Loop-Setting Chart

Log of Stations Indicates Position of Loop

HERE'S an idea for use in logging your loop receiver as suggested by *H. C.* in a recent issue of the *N. Y. Evening World.* One card suffices for a direction finder, station finder and dial-setting record.

First draw, on a square of white, heavy cardboard, a design like that shown in the accompanying illustration. The size that this is to be is determined by the diameter of the base of your loop, so that the base sets within the inner circle.

Next number the small spaces in the second circle from 1 to 64, or as many as you make spaces for on your card. Now cut out the design in circular form, leaving about half an inch margin outside the outer circle.

With a compass set the chart so that the arrow in the centre points north, or toward any fixed object whose location you can easily remember. Then place your loop in the centre.

As you receive a station on your loop, print the call letters of that station in the space within the outer circle that is in exactly the same direction that your loop is pointing. In the next inside space print the dial setting (your main tuning dial) at which the station is received. The next inner space is for setting down the wave length of that station. The numbers are for identification of loop settings in listing on another card or paper other stations that may be received on the same setting.

If you prefer, instead of listing wave lengths and dial settings, you can utilize all three spaces in each line for call letters only. The first method, however, is usually preferable and how entries are made is illustrated on the chart herewith. It is, of course, understood that this chart is accurate only if used in one given location.

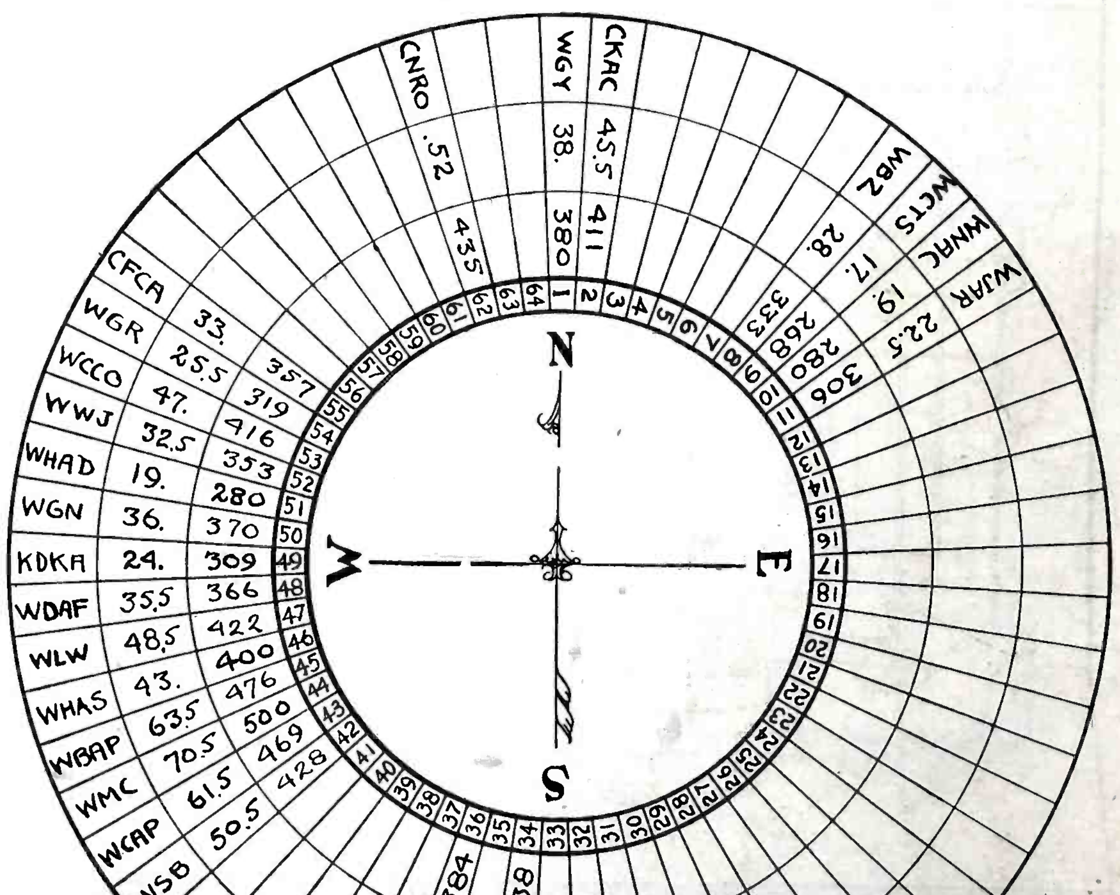


Illustration by Courtesy of N. Y. Eve. World

The Hoyt Augmentor Circuit

An Interesting Receiver for the Experimenter Has Several New Features

A VERY interesting form of radio frequency receiver as described herewith by *Francis R. Hoyt,* is presented by *Radio News,* New York.

Signal augmentation, as the name implies, is a system of radio frequency amplification or magnification in which the initial signal is augmented by a properly phased signal impulse of exactly similar character; this reinforcing impulse, however, has as its source a circuit which is entirely independent from that in which it ultimately comes to add its effect. The details of this action and reaction will be seen shortly, so for the moment suffice to say that the general electrical characteristics to the ear—or from an audible point of view—are somewhat similar to the well-known regeneration system. Although it will be obvious shortly that this apparent similarity ends with the audible characteristics, and that, unlike regeneration, the circuit does not radiate energy, cannot be made to distort a signal and is not subject to body capacity effects.

The distinguishing features of this new system might be set down in the following fashion:

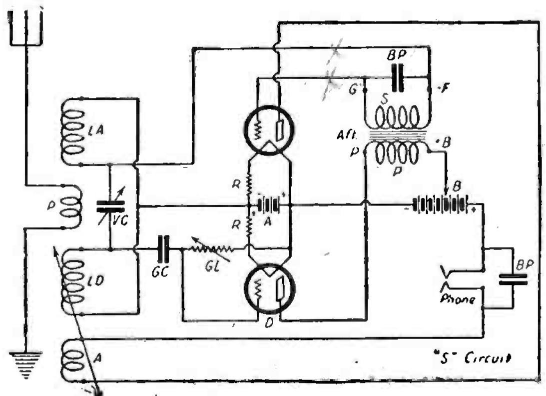


Fig. 1. The "S" circuit in which the tube functions as both an A.F. and R.F. amplifier.

1. Extreme selectivity.
2. Sensitivity.
3. Tone quality.

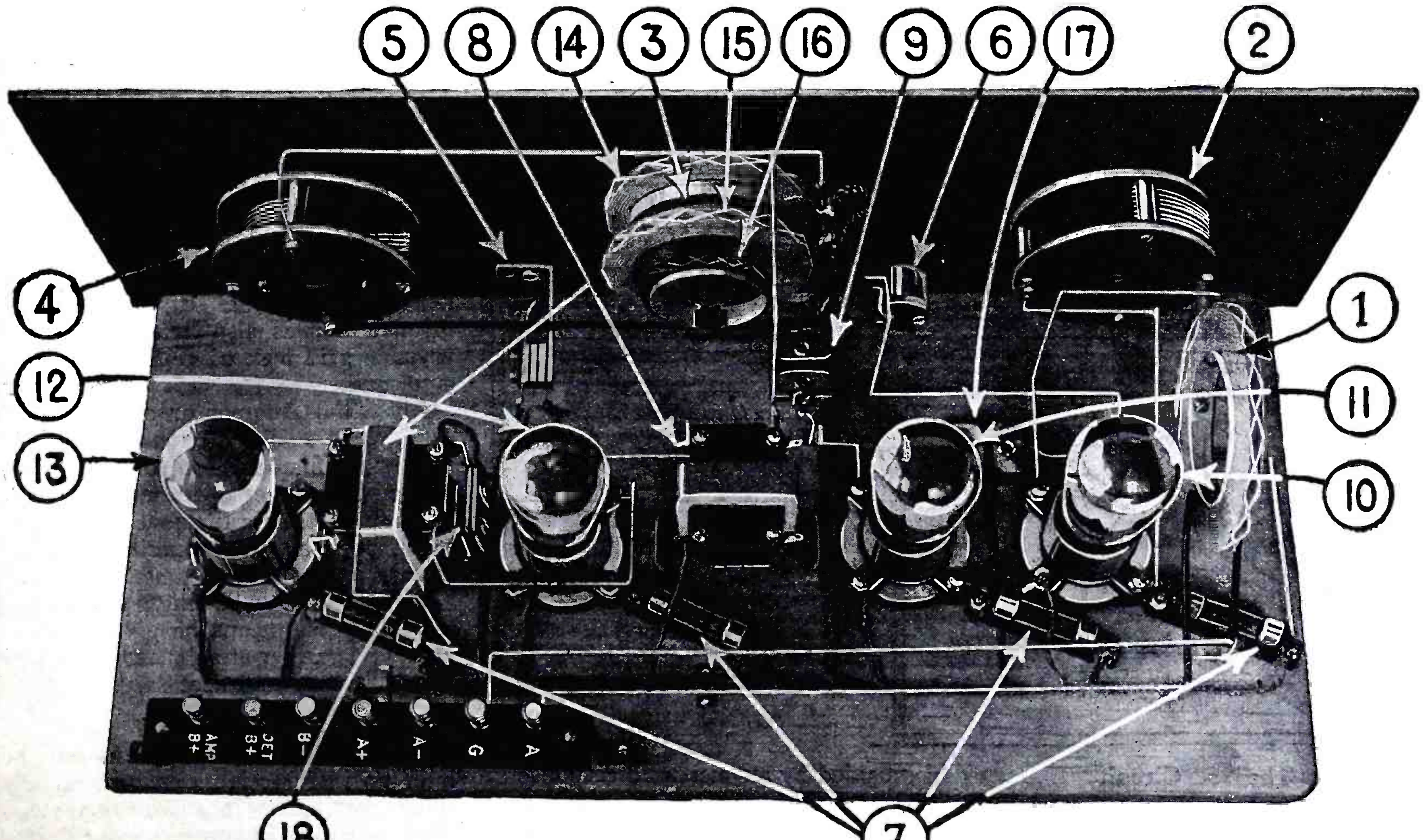
Whatever degree of popularity it has attained and is attaining can be attributed to these three qualifications.

The Fundamental Circuit

The fundamental augmentation circuit shown in Fig. 5 bears a striking superficial resemblance to two familiar types of radio circuits. This resemblance has led to its being confused with those circuits by the casual observer.

First: The variable coupling between the "Booster" and the grid coil (designated LD on the diagram) bears an outward similarity to the tickler form of regeneration; second: the parallel disposition of the two tubes, one at either end of the secondary inductance, appears to approximate "push-pull" circuits. The following description of the operation of the augmentation system may be of some assistance in dispelling those illusions.

An incoming wave of radio frequency energy passing through the primary coil (P) coupled to the secondaries LA and LD, would cause a corresponding voltage variation across the outside terminals of these secondaries which are connected to the grids of two tubes. This voltage would be of opposite polarity or phase at opposite ends of the coils. Consequently, the grid of one of these tubes would receive a positive charge, while the other would be acted



Illustrations by Courtesy of Radio News (New York)

Fig. 2. Rear view of receiver. 1, antenna coil; 2 and 4, variable condensers; 3, primary coil; 5, phone jack; 6, filament switch; 7, amperites; 8, A.F. transformers; 9, grid condenser; 10, R.F. tube; 11, detector tube; 12, augmentor tube; 13, A.F. tube; 14, detector inductance; 15, augmentor inductance; 16, augmentation coil; 17 and 18, by-pass condensers.

upon by a negative impulse. Now, one of these tubes is connected as an amplifier and the other as a detector (having a grid condenser in its grid circuit), therefore, when the amplifying tube is acting to magnify the positive impulse the detector tube is simultaneously rectifying or detecting the accompanying

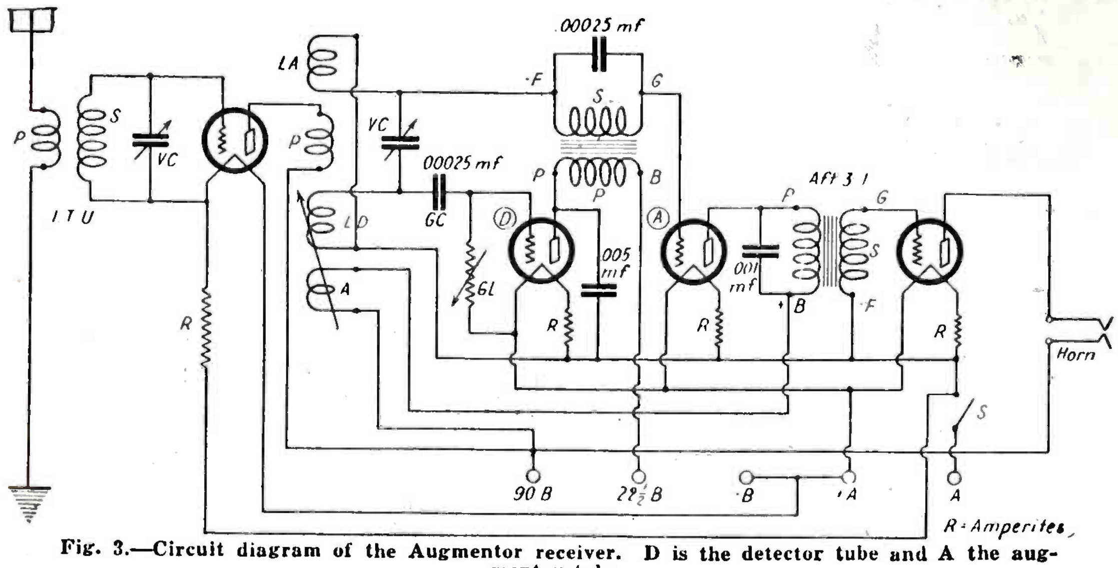


Fig. 3.—Circuit diagram of the Augmentor receiver. D is the detector tube and A the augmentor tube.

negative flow. Here the "Booster" coil comes into play, the magnified energy of the positive charge appearing in the plate circuit of the amplifying tube passes through the booster coil, where it is placed in the proper phase to lend

Panel view of Augmentor receiver.

its additive effect or augment the negative impulse at that moment being detected. The degree of this augmentation is regulated by the percentage of coupling.

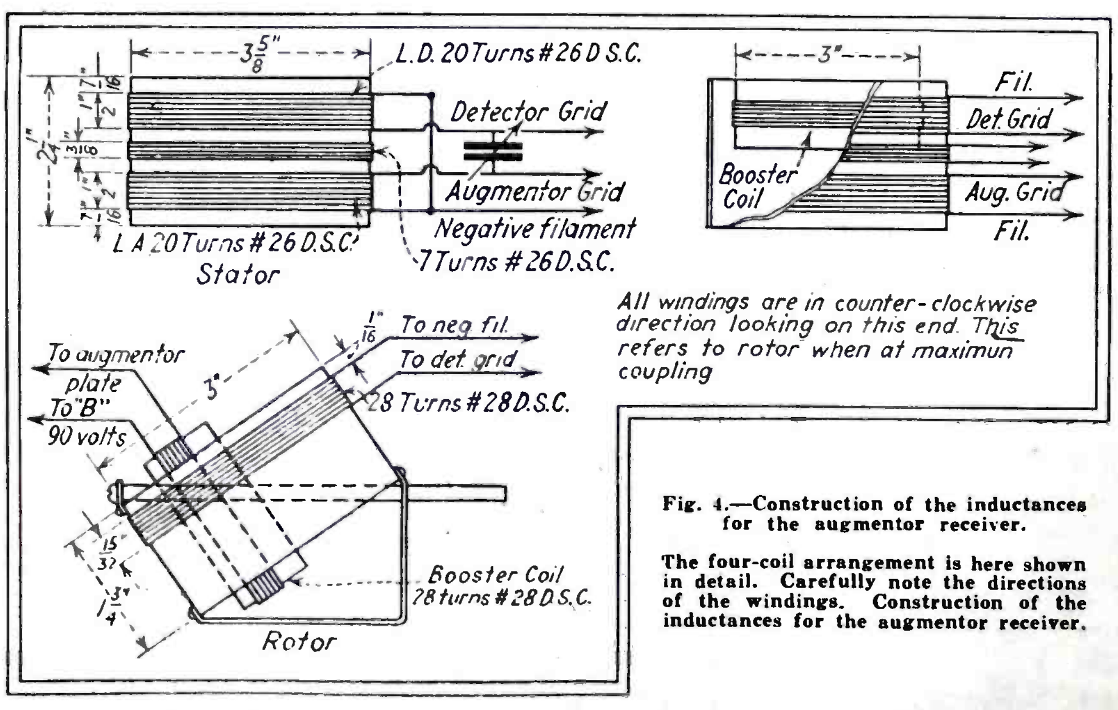


Fig. 4.—Construction of the inductances for the augmentor receiver.

The four-coil arrangement is here shown in detail. Carefully note the directions of the windings. Construction of the inductances for the augmentor receiver.

The "S" Circuit

The feeble radio frequency currents traveling through the augmentation or amplifying tube do not begin to load this tube to even a small degree of its amplification possibilities. It was, therefore, a logical conclusion that the tube should be so connected in the circuit that it could perform additional duty.

By the circuit combination shown in the diagram, Fig. 1, the augmentation tube is made to function both as a radio and as an audio frequency amplifier. This may be called a reflex arrangement, although the performance characteristics are somewhat different.

After the signal has been detected in the detector tube and changed from a radio to an audio frequency impulse, it is communicated to the primary of an audio frequency transformer whose secondary has been connected in series with the grid lead of the augmentor tube. In this way, audio frequency voltage variations taking place in the primary of the transformer are transferred to the grid of the tube after having been magnified or "stepped-up" by the transformer. Upon reaching the grid of the augmentation tube these voltages cause an increased current to flow in the plate circuit and this is accompanied by an increased response in the phones.

A small condenser is connected across the terminals of the secondary of the transformer to permit the incoming radio frequency currents to reach the grid of the tube. These currents would otherwise be retarded by the choking effect of the secondary winding.

Apparatus and Values

In the diagrams referred to in the preceding paragraphs, the various pieces of apparatus have been designated by symbols and no values have been shown. These values will be given later or will be found on the wiring diagram for the four-tube receiver—the symbols used are herewith explained:

LA—Augmentor inductance
P—Primary
LD—Detector inductance
A—Augmentation coil

The above four windings make up the augmentor coil.

VC—Variable condenser
A—Augmentor tube
D—Detector tube
R—Amperites
GC—Grid condenser
GL—Grid leak
BP—Bypass condenser
AFT—Audio transformer

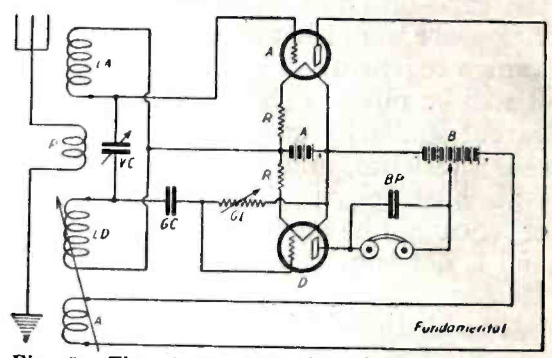


Fig. 5.—The circuit that shows the fundamental principle of this interesting receiver.

The values for all of the various pieces of apparatus except the grid leak (variable), which should be from 1 to 6 megohms; the variable condensers, which are of .0003 mfd. capacity, and the coils, which will be given later, have been shown on the schematic diagram of the four-tube set.

It is important that the bypass condenser in the semi-reflex stage be of reasonably accurate capacity, .00025 mfd., and it is also necessary that a variable grid leak of reliable make be employed.

Since the Augmentor circuit is exceptionally stable, particularly in the matter of filament control, it is considered that better operation is secured through automatic filament control devices, such as the amperite, than by manual control of rheostats.

Straight-line wave-length condensers should by all means be given preference, and vernier attachment or vernier dials will be found necessary.

Circuit Wiring

The augmentation system can be built up into receivers comprising any number of tubes from two to the practical limit, or, in other words, it is a principle of operation or fundamental circuit to which radio frequency and

(*Continued on Page* 18)

A Powerful Six-Tube Super-Heterodyne

Can Be Readily Assembled at Home from Standard Parts

ALONG with the increased power of broadcast stations and a decision of the Department of Commerce to turn loose the big broadcasters to down interference by their own increase of power, sets of the selectivity of the super-heterodyne are quite the vogue.

The beauty of building or owning a super is that one may have the satisfaction of knowing that one's set will give as much selectivity, clarity and volume as any.

These, in the order above mentioned, are what one may expect from a well constructed set.

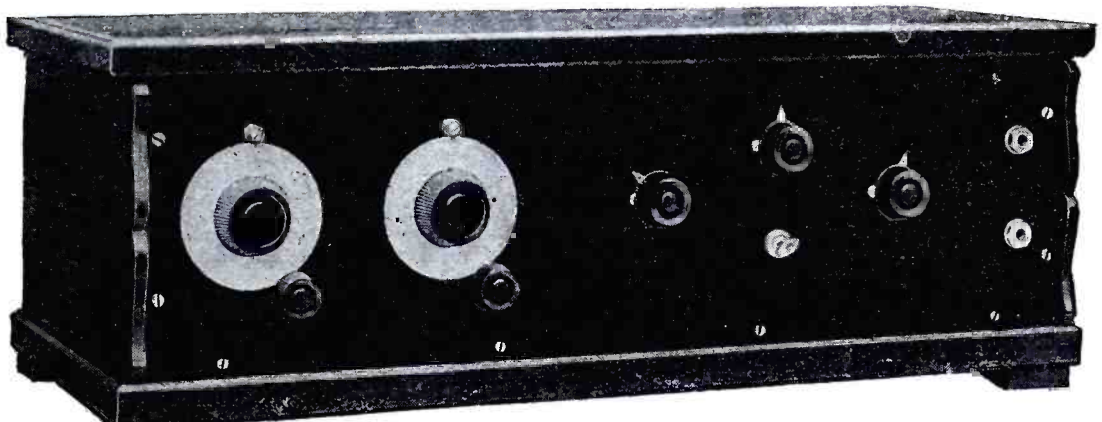
The set described and illustrated herewith is one which recently appeared in the *St. Louis Daily Globe-Democrat* and is similar in principle and theory to the standard super-heterodyne circuit.

It differs slightly, however, in a few minor details, which make it more desirable from a standpoint of economy, simplicity and portability.

It will be noted upon the circuit diagram that two stages of medium frequency amplification are used instead of the customary three. The reason for this is that a third stage of medium frequency amplification does not sufficiently improve the sensitivity to warrant its use in this set—bearing in mind that economy, simplicity and portability are the advantages which this "super" are supposed to have over the average. Then, too, from a standpoint of performance, it has been proven that two stages of intermediate frequency excel three for quiet operation, especially when interference is prevalent.

Antenna System

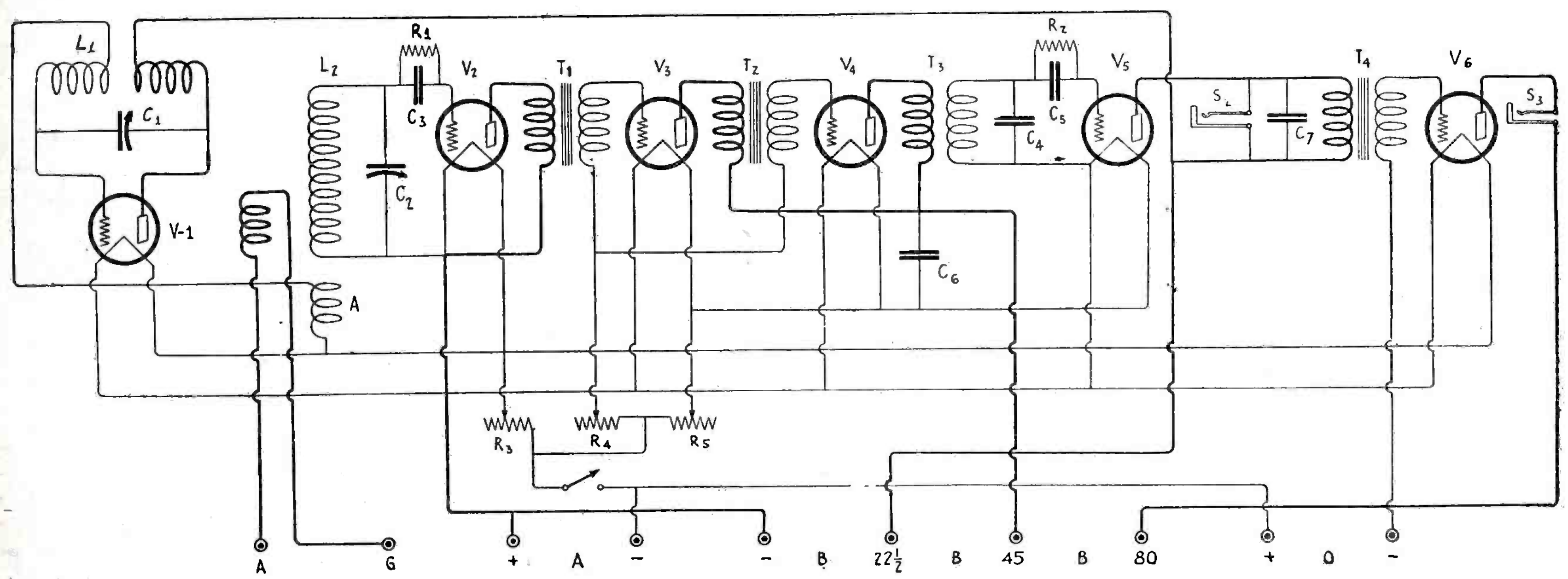
It has been found by experimenting with various types of antenna systems that the short antenna of 15 or 20 feet of No. 18 wire gives far better results



Illustrations by Courtesy of St. Louis Daily Globe-Democrat

A front view of the completed receiver showing the tuning and oscillator dial at the left and the rheostats and potentiometer at the right.

than as a loop, and is practically as portable, since it may be erected most anywhere with very little difficulty. Although a loop is not recommended for this set, it may be used with a fair degree of success.



Wiring diagram of the powerful six-tube super-heterodyne. The constants of the circuit are given in the list of parts for the set.

Small Battery Expense

Another advantage which will be appreciated by the operator is its very modest current consumption. With all six tubes lighted to proper brilliancy, the current drawn from the "A" battery is only about thirty-five hundredths (.35) ampere. Six ordinary 1½-volt dry cells, connected in two parallel groups of three cells, connected in series, will provide current enough for over a hundred hours of intermittent operation.

Perhaps the most important consideration from the viewpoint of economy is the small consumption of current from the "B" batteries. This has been reduced to the barest minimum without sacrificing efficiency. The six cubes consume only about nine milliamperes in the plate circuit, as compared to twenty-five to thirty-five mils consumed by other "supers."

One stage of audio amplification, provided the correct transformer is used, is sufficient to give comfortable volume on all signals with the "super." A second stage is very seldom necessary or satisfactory, unless a separate "B" battery is used.

Choice of Parts

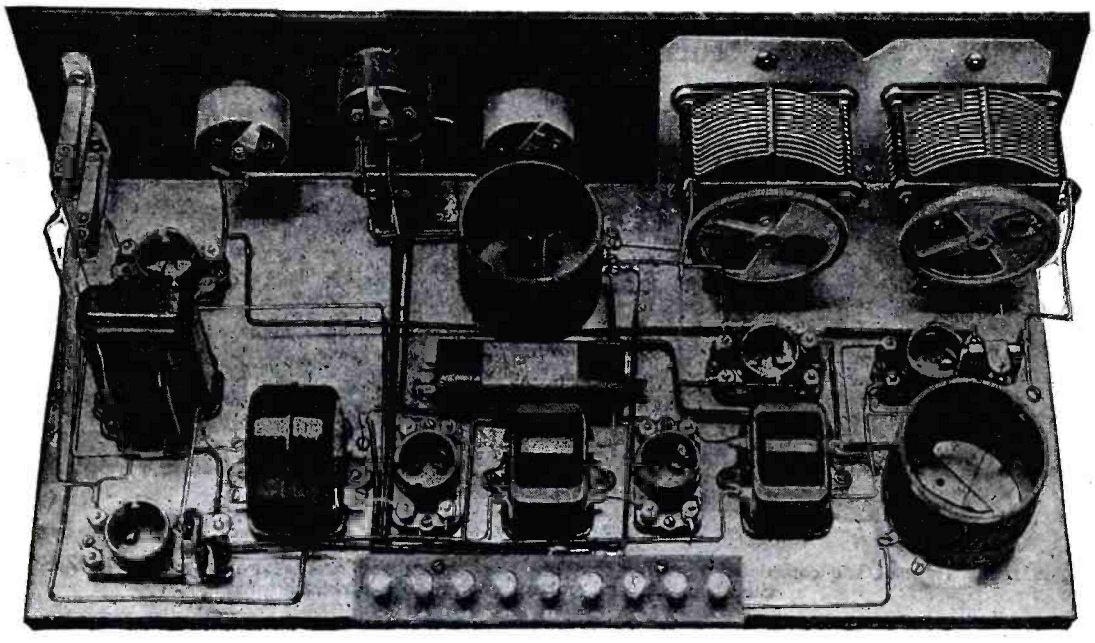
The reader will note that all the principal parts used in this set are General Radio. There are, of course, other parts which may be used, but the writer in building this set could not very well try out all of the countless combinations, and is not prepared to suggest substitutions. The numbers refer to types.

Necessary Parts

Before studying the construction of this "super" it would be well to look over this list of parts, which are necessary to build the set and note the code references to the instruments as they are mentioned in the instructions.

Pair Good Head Phones

Now comes the question of a loud speaker and the writer must leave this entirely to the individual. Speakers vary widely both in price and quality of reproduction. They should be compared on signals which show up both high and low tones. It is best to actually compare them on the same signal. The new hornless cone types have proven very satisfactory with this receiver.



Rear view of the completed six-tube super-heterodyne assembled from standard parts.

2 .0005 MF condensers C-1, C-2.
2 271 MF transformers T-1, T-2.
1 331 (30 kc) tuned transformer T-3.
1 285 audio transformer T-4.
2 30 ohm rheostats R-3, R-5.
1 200 ohm potentiometer R-4.
6 299 sockets.
1 277-C inductance coil L-1.
1 277-D coupling coil X-2.
2 dials.
1 condenser .5 MF. C-6.
1 battery switch 8-1.
2 open circuit jacks.
2 Dubilier 60-C grid condensers C-3, C-5.
1 2 megohm grid leak R-1.
1 5 megohm grid leak R-2.
1 .0005 MF. fixed condenser C-7.
10 Binding posts.
1 Bakelite panel 7x21x3-16."

A shield is strongly recommended to cover the base of the set and part of the panel that supports the oscillator condenser, C-1. It is important to shield this instrument in order to prevent body capacity effects.

The cabinet is, of course, up to the builder, but a set of this caliber should warrant a good cabinet, which should cost somewhere in the neighborhood of $10.

Accessories

6 UV-199 or C-299 vacuum tubes.
6 dry cells.
2 45-volt "B" batteries.
1 4½-volt "C" battery.

Constructing the Set

Wind one turn of No. 22 to No. 26 cotton or silk covered wire around the lower end of the coupling coil L-2. This furnishes the coupling between the first detector V-2 and the oscillator V-2. Be sure that this turn is at the ground end of the coil and wound in the same direction as the coil windings. The approximate location on the coil and in the circuit is indicated at "A" in the diagram. In laying out the panel place the condensers close enough to each other so that the tuning dials may be watched simultaneously when the set is being operated.

Place the hole for the shaft of condenser C-2 in the center of the height of the panel and three inches from the left edge as you face the front of the panel. Eight inches from the left edge of the panel center the shaft hole for the oscillator condenser C-1. Four inches in the right of the center of this (L-1) shaft hole place rheostat R-3. Two and a half inches further to the right draw a vertical line perpendicular to the bottom edge of the panel and upon the line locate the centers for the shaft holes for potentiometer R-4 and battery switch S-1. The potentiometer may be one and a half inches below the center. Two and a half inches to the right of the above described vertical line drill the hole for the shaft of rheostat R-5. Two and one-half inches from the right edge of the panel draw another vertical line perpendicular to the lower edge of this panel and on this line place the two jacks one above the other about two and one-half inches apart. Shaft holes for the condensers, rheostats, potentiometer and battery switch should be three-eighths of an inch. Those for the jacks should be fifteen-thirty-seconds of an inch. All other holes can be made with a No. 25 drill.

After the panel is drilled and countersunk wherever necessary it should be rubbed down with very fine emery to remove the glossy effect.

Then it should be rubbed with an oily rag to overcome the grayish effect and restore the panel to a smooth satin finish. If the panel is to be engraved it should be done at this point.

Shielding the Baseboard

The next step is to knock out a baseboard 19 inches by 9 inches of ⅝-inch stock, preferably soft white wood, since this is easily workable and free from knots. A thin shield of copper should be placed over the baseboard and behind the panel to shield the two condensers, as shown in the illustration. This does away with body capacity effects and serves as a common "A" connection which simplifies the wiring to a great degree.

Mount the apparatus on the panel and place the panel and baseboard together. Then the parts may be mounted on the baseboard without difficulty. The arrangement in the illustration seems to be most satisfactory from a standpoint of ease of assembly and efficiency of operation.

Now you are ready to wire. Probably the best material for this purpose is bus wire of a medium size and reasonably soft, so that if bends have to be straightened out and relocated the wire will not break or crack. The leads from grids and plates should be kept well separated. This actually adds to the efficiency of any multi-tube receiver.

Contrary to general custom, an open circuit jack is used at S-2. The primary impedance of the new General Radio audio transformer is so high that it does not appreciably affect the signal intensity when shunted across a pair of telephone receivers. Consequently the wiring is somewhat simplified by the use of the open circuit jack and the receiver may be used either with head phones, loud speaker or both.

No mention has been made so far of the fixed condenser indicated in the diagram at C-4. This condenser is built into the tuned filter transformer, T-3, and no external capacity is necessary here.

This Super-heterodyne is one of the simplest sets to wire after the layout is determined. After completing the wiring check it carefully and connect the antenna, ground and batteries.

(*Continued on Page* 21)

Learning the Code by Listening

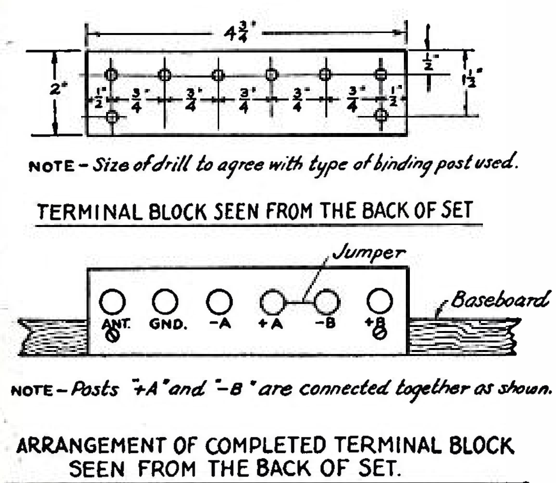
A Long-Wave Tuner for the Reception of Code Transmission Over Long Distances

THE average broadcast listener, popularly known as BCL, has been educated by bitter experience regarding the distance-getting propensities of various radio receivers. The gullible individual who still has faith in the old-fashioned Santa Claus usually wakes up sooner or later to the fact that European stations received in testimonials and the same stations heard in real life are two widely disassociated things. There is, however, a bright ray of hope for the disillusioned fan in an article in *Q S T*, Hartford, Conn., wherein it is pointed out that an extremely simple set will suffice to bring in the high-powered European stations transmitting commercial code. Code is really not any great mystery; however, read the article and be informed.

Have you ever wondered what "this code stuff" was about? It isn't hard to find out and there's endless interest in it after that. There are plenty of times when radiophone broadcasts get monotonous, but there's never a time when there isn't endless variety and entertainment in the dots and dashes.

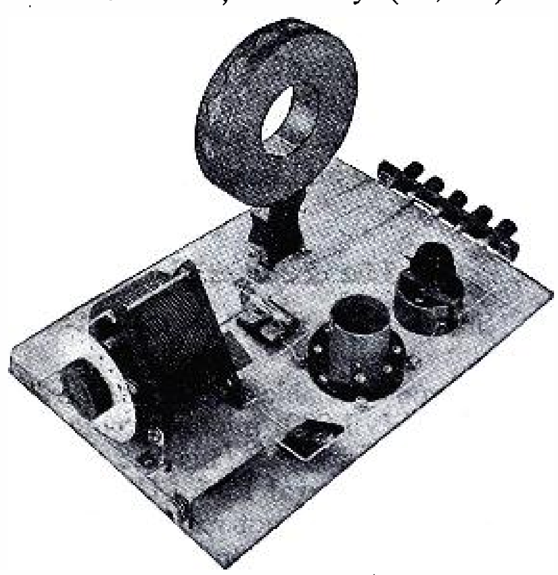
Where the Charm Comes In

Have you ever noticed that after a while even a seven-tube broadcast receiving set has reached its limits—there isn't anything more to accomplish? When you have logged stations all over the United States—Canada—Cuba—perhaps a few in Europe—that's all, there isn't any more.



Details of the binding post strip.

Not so with the telegraphic signals; you can log them with a *single receiving tube* and yet never come to the end of the possibilities. Up at 17,000 meters there's the steady whistle that wavers up and down in the form of dots and dashes—that's NSS, the naval station at Annapolis, Maryland. A bit further down is a fainter signal from YN at Lyon, France, which works at 15,100 meters, and still a bit below that are KET at Bolinas, California (13,345), WII at Chatham, Mass. (13,600), NPM at Honolulu (11,490), WSO at Marion, Mass. (11,600), POZ at Nauen, Germany (12,000)—but why go through the long waveband? They are scattered all over the world and can all be heard over amazing distances, for these stations are built for daily transoceanic work and the talk that goes between them is of national and international interest. Some of them speak slowly and droningly—as if designed for the beginner—others race along with machine-sending at such furious speeds that the words become bursts of sound and sentences are mere buzzes. No man can copy such matter, but there are machines that attend to it and make tape records. These are the stations above 5,000 meters.



Illustrations by Courtesy of QST (Hartford, Conn.)

The Long Wave Receiver

Next below that there are great groups of somewhat smaller stations; the Federal Telegraph string that handles messages up and down our Western coast, the United Fruit string that furnishes gilt-edge communication over Central America and the Gulf of Mexico, our Navy Yards that mostly sign calls beginning with NA, NP or NG (depending on their location on the Atlantic, Pacific or Gulf Coast), the Postal and Army stations that sign a variety of calls and handle much of their traffic in weird cryptic terms that the rest of us cannot understand. These stations are in general between 5,000 and 1,200 meters.

Then comes the biggest group of all—the almost countless shipboard stations and the great system of shore stations that work with them. If these stations are American they will be working above 600 meters, usually between there and 2,600 meters. If they are foreign they are likely to be working anywhere—including the 450-meter wave right in the center of the broadcast band. Many a time American stations are damned for horrible noises that actually come from an ancient spark set on board a British, Spanish, Italian or French ship that is just off our coast. Here again—wouldn't it be interesting to be able to make sure who he was and where he was?

Then there is a blank—600 to 200 meters contains practically no radio telegraphy, but below that there are signals a-plenty, all the way down to 5 meters—and they come from every civilized country and from a few others to boot.

But——

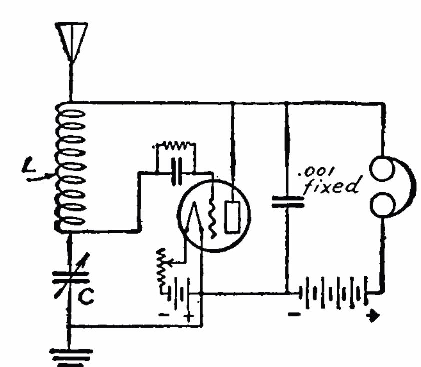
Yes—that's pretty fine—but what good is it unless I know the code?

Oh, pshaw!—the world is full of folks from 15 to 75 who have learned it—why can't you?

The answer is—*you can learn it,* and here's how.

How to Learn

There are several ways to learn. Possibly the best way of all is to start in with someone that can send well with a key and buzzer, and have that person spend a lot of time teaching you. This is all right if he has nothing else to do but to wait until you happen to feel like taking a lesson—but there's the rub.



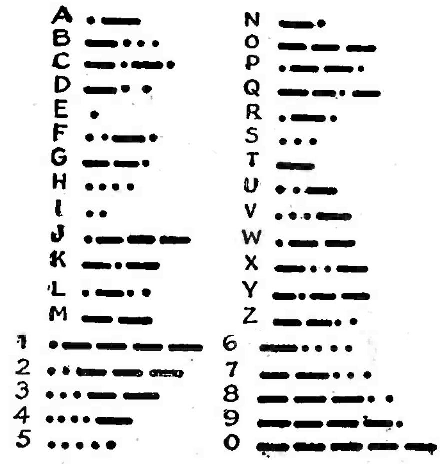
The circuit used.

The next best way is to listen to the slow-moving long-wave transatlantic stations, for they are *always* sending, and you can take a lesson when you want it.

The listening can be done with the simplest set in the world, and now we will discuss that.

The Simple Long-Wave Receiver

The set is (we hate to admit it) a "single circuit" affair. It isn't single circuit for any reason except that such an affair is cheap and easy to make and plenty good enough for code practice. The diagram, photograph and list of materials explains the whole business, nothing more is needed, hook up the set, turn on the filament and tune in NPL or WSO—then start spoiling paper and pencils.



Continental telegraph code.

If you keep at it the dots and dashes will begin to make words and sentences after a few nights, and after that you can start listening to the talk of the world instead of the United States alone.

And That Isn't All, Either——

Of course, you needn't stay on the long waves any longer than it takes to learn the code; after that you can drop down and listen to the crisp, laconic, ship-to-shore conversations that go on at every port of any importance; you can hear the cryptic letter-group code of the naval stations, and finally you can drop down and hear 9ZT at Minneapolis working other amateurs in 8 or 9 countries, or you can go clear down to 21 meters and hear John Reinartz working across the continent in *broad daylight* to Willis at Santa Monica, California, with a power that makes broadcast stations seem enormous.

Of course, the simple tuner shown here will not go down to 21 meters—but it will go down to the Navy Yard stations (1,200-2,600 meters) if you use a 300-turn honey-comb coil and it will get down to the ship-and-shore stations with a 100 or 150 turn coil. After that you are in Citizen radio, and that changes every 30 days, so we can't tell you what you will need by the time you have learned the code.

Come along and let's see that part of it together.

List of Materials

Nine feet of tinned No. 14 "bus" wire.

One good variable condenser, having capacity of 1,000 micro-microfarads (.001 microfarad). This set used a type 247-B General Radio Condenser, but the make does not matter.

Four brass angles to hold the condenser to the baseboard. ½ x 1 in.; angles may be obtained at the hardware store.

One good socket, the set used General Radio type 156.

One 30-ohm rheostat, the one shown is General Radio type 301.

One mica bypass condenser, capacity 1,000 micro-microfarads (.001 microfarads), the one shown being Dubilier type 600.

One mica (do not use paper) grid condenser with gridleak mounting. The one shown is Dubilier type 601, capacity 250 micro-microfarads (.00025 microfarads).

One gridleak, resistance 2 megohms.

Electrad or Durham Leak Recommended

6-1 General Radio 138-W binding posts or 6 8-32 roundhead brass machine screws with 2 hexagon nuts each.

One baseboard, 1 in. thick by 7½ x 12 in.

One rubber or bakelite strip 2 x 4¾ x ¼ in.

One single jack, open circuit type, Carter or Federal can be obtained anywhere.

One single coil-mounting *not* pivoted.

One 1,500-turn coil (5,000 to 15,000 meters). Other coils listed below. Screws, solder, etc.

The coil mounting and the coil can be obtained from Sears, Roebuck & Co., Montgomery Ward & Co., Charles Branston, Inc., Buffalo, N. Y.; The Coto Coil Co,, Providence, R. I., or Remler Radio Mfg. Co., San Francisco. For the commercial ship and shore stations a 100 or 150 turn coil may be used, for the 1,200-2,600 meter stations a 300 or 400 turn coil is correct. A 750-turn coil will bridge the gap from 2,600 to 5,000 meters, thus including the high-power shore stations.

The Hoyt Augmentor Circuit

(*Continued from Page* 14)

audio frequency amplification can be added at will.

The schematic wiring diagram for a four-tube set is shown in the illustration, Fig. 3, and a rear view photograph of a five-tube receiver of this type is shown in Fig. 2. This receiver is exactly the same as the four-tube, except that one additional audio frequency stage has been added.

This rear view photograph, Fig. 2, also serves to illustrate the preferred arrangement of the physical apparatus, the relation of the augmentor coil to the condensers and indicates how admirably this receiver lends itself to cable or "harness" wiring.

Coil Construction

Fig. 4 is an illustration of an augmentor coil which has been designed around standard sizes of tubing and of simple solenoid winding with the object in view of affording a construction which can be made up in the home. While the low-loss coils manufactured expressly for this circuit are quite naturally to be preferred, nevertheless, there are those experimenters who prefer to construct their own coils and to those who carefully follow the data given, a very satisfactory set of coils can be constructed from these specifications.

The rotor consists of a 1¼-inch length of 3-inch outside diameter bakelite tube, while the stator is a 2¼-inch length of 3⅝-inch bakelite tube.

The augmentor coil is wound on the rotor and is made by winding 28 turns of No. 28 D.S.C., beginning the winding 1/16-inch from the edge.

The LD or detector inductance is first wound on the stator, beginning 7/16-inch from the edge and consists of 20 turns of No. 26 D.S.C. wire. A space of ⅜-inch is then allowed and the LA or augmentor inductance is completed by winding 20 additional turns of No. 26 D.S.C. wire.

The P or primary winding is wound in the center of the ⅜-inch space above referred to and consists of 7 turns of No. 26 D.S.C. wire.

The direction of the turns of the windings is shown in the illustration, Fig. 4, as well as the proper terminal connections.

When the rotor is assembled in the stator, it should (at maximum coupling) mount so that it will be midway of the stator, or in other words, ¼-inch on either side below the outside edge of the stator tube. This is shown in the drawing.

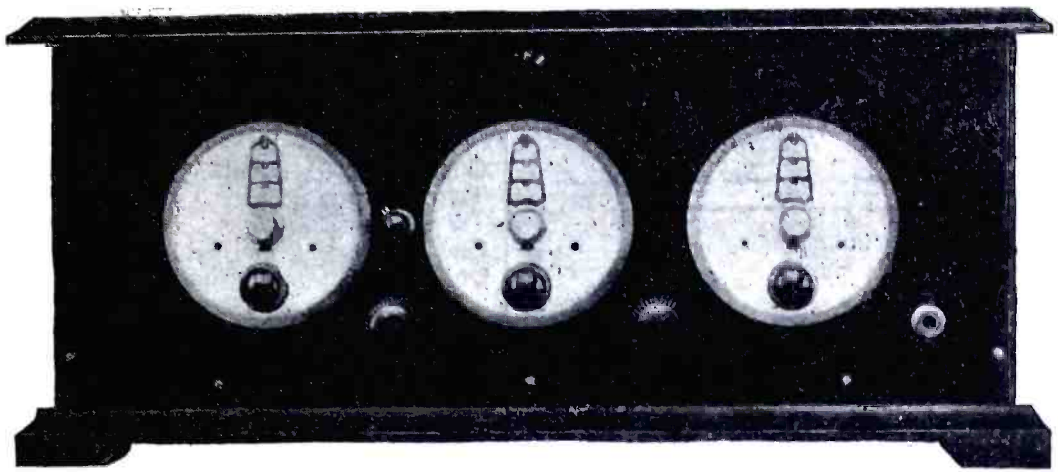
A Well Designed Short Wave Receiver

A Practical Set for the Amateur Who Desires Sensitivity without Too Great a Loss in Selectivity

THE broadcast craze is so widespread and all-important (to broadcast listeners) that we are apt to overlook the question of amateur reception, which is equally important (to the amateur). An extremely sensitive all generally efficient receiver for short waves has recently been described in detail by *R. E. Bogardus* and *R. A. Bradley* in *Wireless Age* as follows:

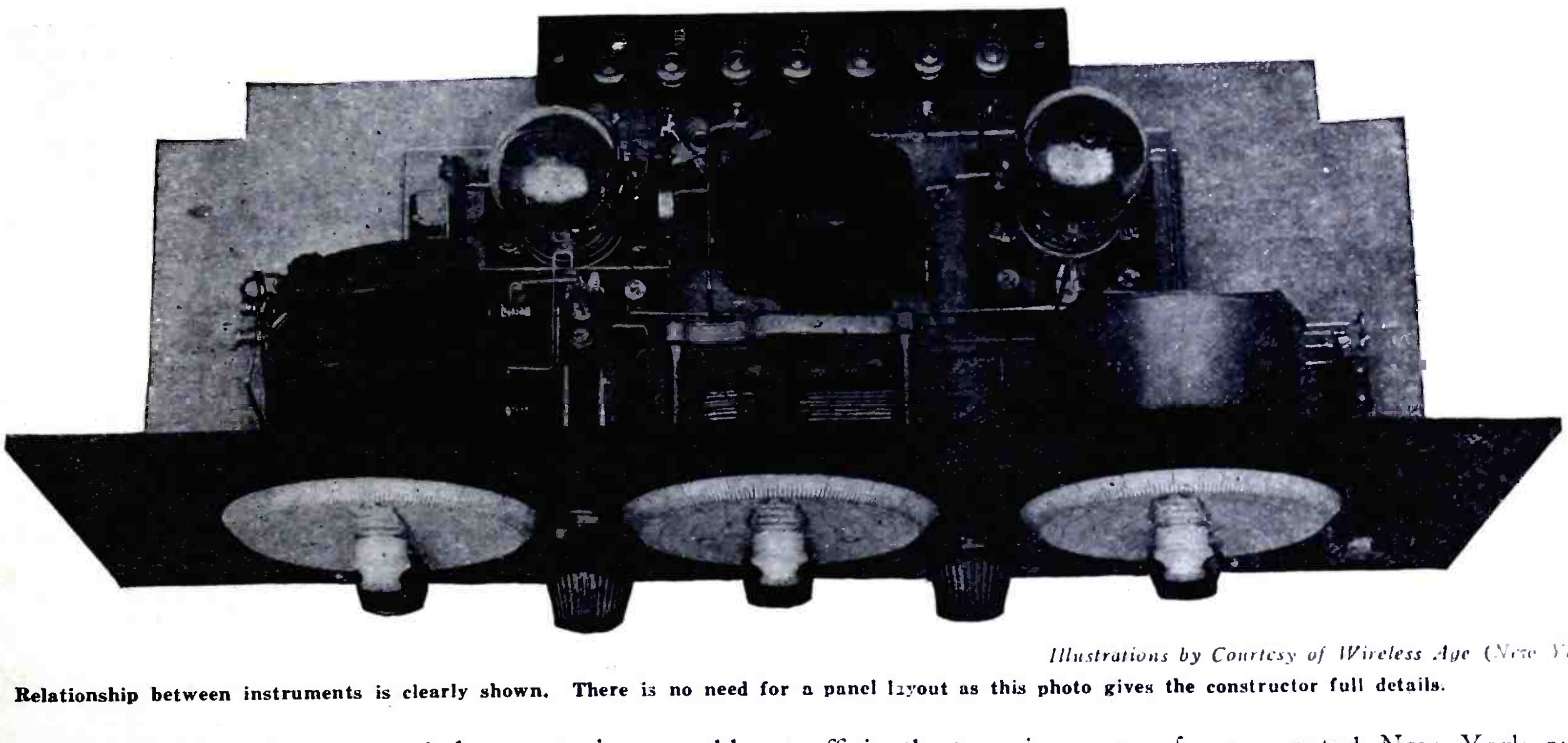
We have found, during many years of wireless reception, that invariably, when a weak signal was being read there came a splash of static or some other signal that always just made enough interference to kill the one signal desired. That usually caused a slight disturbance in our manner and usually the first person that spoke to us afterward wondered what had happened to cause such an outburst of disagreeableness. Well, who wouldn't, when we turn out the lights and hold our breath in order to copy those elusive signals? Even the scratch of a pencil made trouble at times. Is it not, therefore, natural to look around for some method of boosting those weak signals efficiently? We looked and looked, worked and worked, but somehow we always just missed it or were just beaten to it. We were still without that simplicity that is so necessary in telegraph work, especially on waves used by the amateur over the enormous space of a couple of hundred miles.

Then broadcasting came along with the result that better apparatus has been produced, most of which efficiently does what is requested of it, but still there remains the code work which apparently insists on being very weak. So, with the broadcast field well taken up by high-powered sets, it became too crowded and down the wave-length scale came the lower-powered sets. On these lower wave lengths our sets just would not efficiently tune in the signals and remain stable. We hunted for better condensers and finally got them—then coils, and got them also—but as much as we improved, just so much more, and many more, weak signals we heard. We looked and worked, but it was elusive. It had been a subject of long experimentation and, frankly, not one of great success. In fact, the efficiency of a genuinely good broadcast tuner of today leaves little to be desired—at least on waves above 300 meters—but below this point so much was to be desired that we have been spending many, many nights



A front view of the completed set. The balanced layout of the tuning controls on the panel presents an attractive appearance.

chasing the solution to its den, where capture was possible and eventually accomplished through a hint on an entirely different condition, though the idea needed developments. The idea came from a noted New York amateur, who does not wish his name published, and by the natural sequence of orderly experimentation the results described in this article came into being.

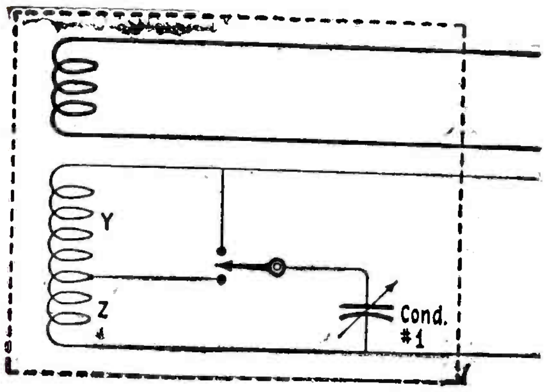


Illustrations by Courtesy of Wireless Age (New York)

Relationship between instruments is clearly shown. There is no need for a panel layout as this photo gives the constructor full details.

Due to the many and varied conditions existing in the receivers of our readers, we believed it would be best to simply describe, as far as possible, our own final work and leave the application of it to the individual. The improved circuit demonstrates the extreme need of increased initial grid voltage on the average detector tube and as finally worked out the circuit proves more efficient the lower the wave length operated upon.

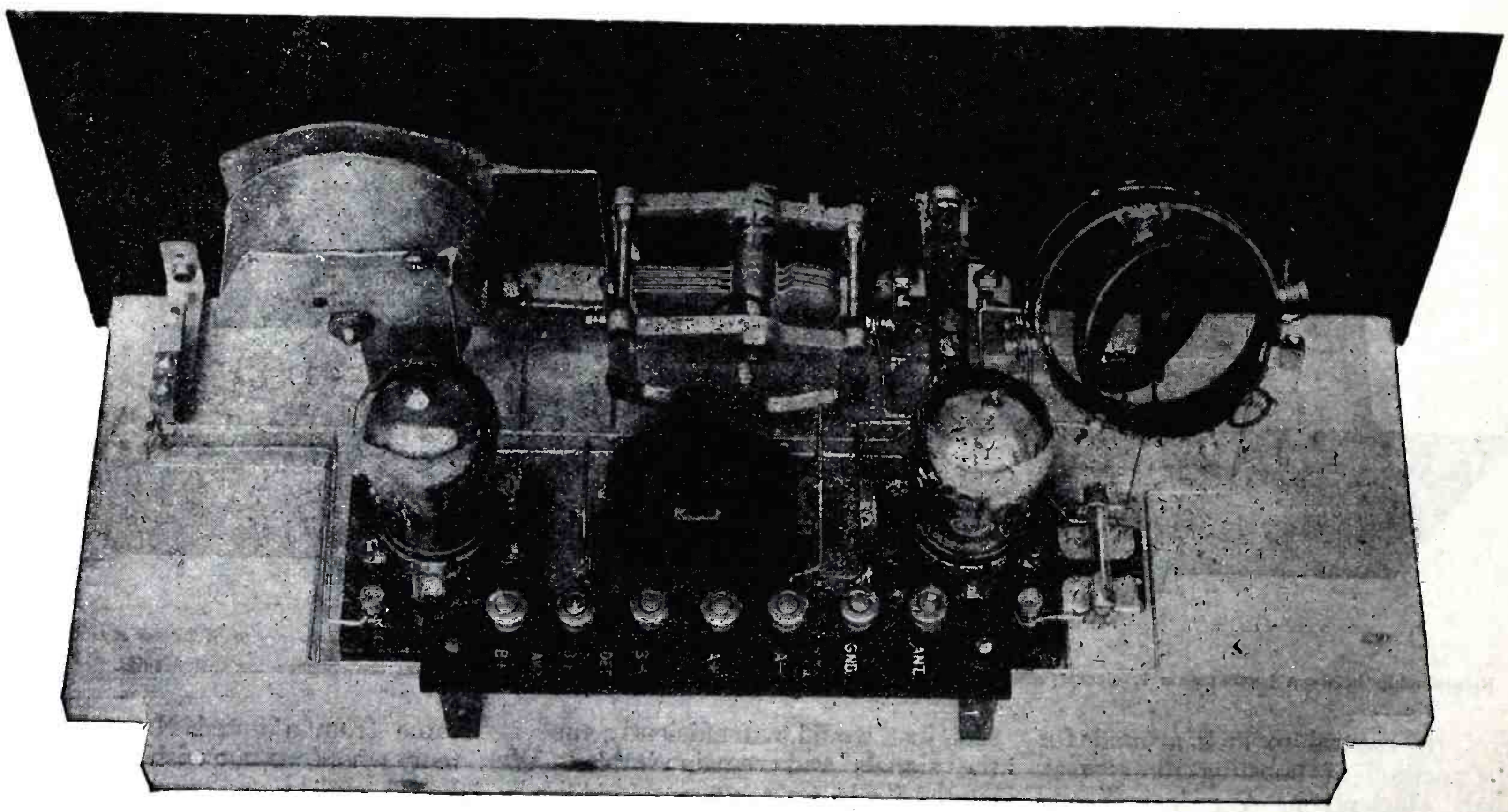
First, I will consider the very short wave band—that of 40-43 meters—as yet hardly noticed except for small bits of scattered use. Then we will cover the medium and extremely popular band of 75-85.6 meters as well as that



This is the way the secondary inductance is tapped.

interesting lower band used by broadcasters. Some very fine programs are relayed on this band without public knowledge because the average receiver will not go below the 300-meter point efficiently. Last, but not least, the slight change for the regular broadcasting band will be investigated for those who wish to slip below 300 meters.

For the very short band, 40-43 meters, Fig. 1 gives the complete circuit. One step of amplification is shown, but for loud speaker operation an additional step may be added. There is no need of showing that because it is only a repetition of the first step, and all of you have built two-step amplifiers before. The tuner is the main thing in this article.



The whole works of this new receiver. Short leads, efficient apparatus and forethought in the design and assembly are partly responsible for the records made.

Fig. 1 shows, within the dotted enclosure, the main and the important section. We used a standard Bremer-Tully Short Wave Tuner, normally 50-150 meter range, using a .0005 mfd. condenser with vernier. The standard connection gave the range of approximately 55 to about 280 meters, due to the wiring in the set, the larger condenser and the mutual tuning of the primary circuit. Using ground instead of counterpoise, the lower bands, 40-43 and 75-85 meters were covered by rewinding the secondary with 8 turns of No. 18 double cotton covered wire,

LIST OF MATERIALS

One 7" x 18" x 3/16" Radion Panel.
One Standard Bremer-Tully Tuner.
One .000125 mfd. Bremer-Tully Condenser Low Loss.
One .0005 mfd. Bradleydenser.
Two Howard Sockets
Two Bradleystats,
One Bradleyleak and grid condenser.
One Carter switch Single Pole Double Throw.
One Pacent Filament Control Jack.
Three Utravernier Dials.
One Hilco Precision By-pass Condenser.
Seven Binding Posts, etc.
One Cabinet.

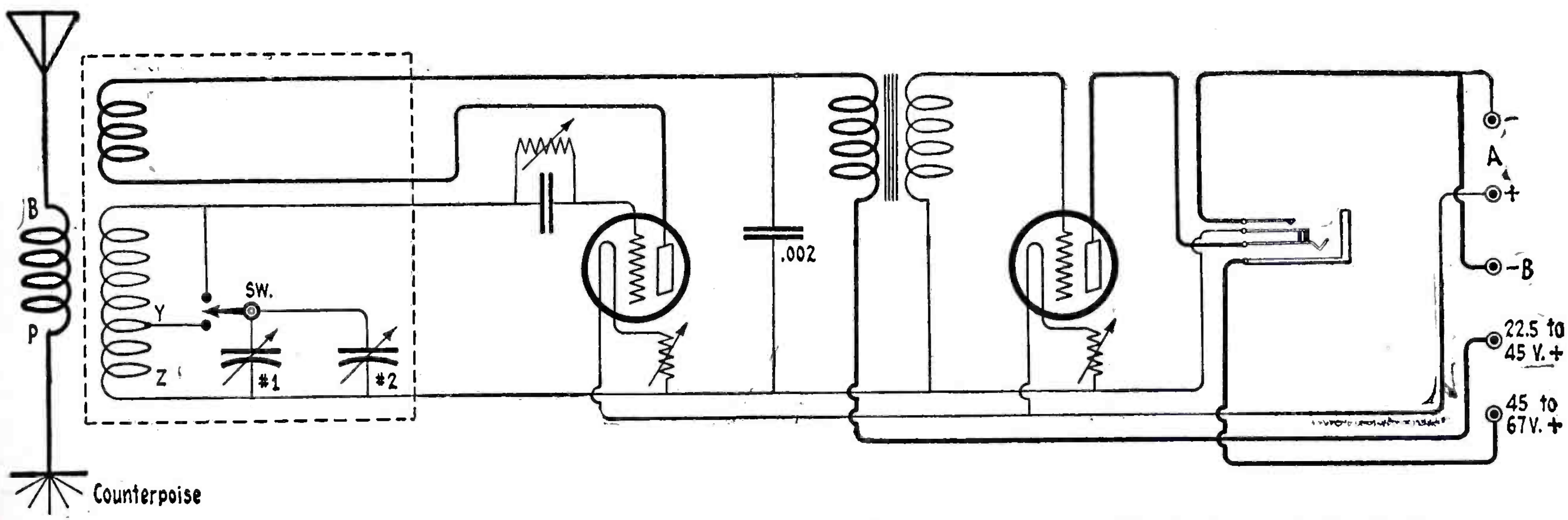
which occupied the entire space on the coupler form, being spaced approximately one-eighth inch apart. Now tap in the center, or the fourth turn (see diagram Fig. 2). "Y" has four turns and "Z" has four turns. Using the .0005 mfd. condenser, the tuning is now spread over the entire center section of the condenser scale, allowing many degrees per meter, and also—which is equally as important—it is possible to tune on both sides of this range. American amateurs have a 40-43 and 75-85 band, and our foreign friends have waves on both sides of ours, therefore we will not confine our range to our own waves. Note the placing of the wave changing switch. When using four turns of the coil the lower 15 or 20 degrees range is broadened out to cover a greater part of the scale. Throw the switch up to cover the entire coil and immediately we condense the scale reading, but materially enlarge the range of the tuner. With this connection in use the tuner will satisfactorily cover the middle band of 75-85 meters and well below the 40-43 meter band. In fact, it will tune to the natural period of the entire coil. This fundamental frequency is controlled by the minimum capacity of the condenser and its allied circuit, below which the tuner will not function. This holds true, even if the tapped portion of the coil only is being used. It will be well to note that this fact governs the minimum tuning range of any circuit utilizing inductance and capacity. Lower tuning ranges may be had only by the use of lower values of inductance, while the upper range is largely controlled by the values of capacity used. The tickler of the Bremer-Tully Short Wave Tuner does not have to be changed, but a variable grid leak is absolutely necessary, and must be adjusted for each band; that is to say, the tapped range will have one adjustment and the entire coil's range will have another. This, our friends, is the secret of the smoothness of reception. Should a fixed leak be placed in the set, howls and almost uncontrollable regeneration, with a very sharp oscillation point, will be your lot. This covers the fundamentals concerning this short wave section.

In the utilization of the 60-280-

meter band we use the standard B-T Tuner, upon which is normally 17 turns, taking in this instance a tap at the seventh turn, which, on my tuner, in conjunction with the condenser mentioned, covers a range of 60-106 meters. This places the tuning range of the 75-85-meter band to approximately the center of the tuning condenser scale, occupying 24 degrees with this 10-meter band, on a 100-degree scale. This gives plenty of room for the separation of signals on approximately the same wave length and also leaves plenty of tuning range on either side because I wished to go above the normal range in order that commercial telegraph and marine stations could be copied. In fact, my tuner covers the various Naval and commercial C.W. and phone bands up to and including the Naval radio compass stations which operate on 800 meters. On the lower broadcast bands (222 to 278 meters) a tap, so that "Y" contains 20 turns and "Z" has the remainder or 40 turns, will enlarge the original 20 degrees to that of the entire scale. Again, let us say, a variable grid leak is an essential.

Let us give you an actual instance to listen in, but on a set located in Brooklyn we have many times had every district within an hour. CB8 in Argentina is just as consistent as any local station.

You will note that when using the lower tapped section no condenser is connected to the grid leak, therefore, instead of losing signal strength through the losses, we simply have the reverse—a building up of wave trains, efficiently, due in part to the auto-transformer action of the apparently untuned section of the coil. This is, however, tuned by the mutual inductance and the resulting action is comparatively large.



The peculiar way in which the tuning condensers are connected across the secondary coil is a distinctive feature of this circuit.

of this band. With the entire coil in the circuit we efficiently receive the Canadian amateurs who operate on a wave length of 125 meters, and can tune to include all the allotted waves of American Class A broadcasting stations. This automatically takes in the still popular amateur band of 150-200 meters, on a desirable section of the tuning scale.

As mentioned, the present day good broadcast tuners cover the upper band in a manner to satisfy the most exacting. The broadcast band on the B-T Tuner with a .0005 mfd. condenser covers the scale of 10 to 50 degrees on my tuner. I use this large condenser of the work accomplished by Dr. A. L. Walsh, Radio 2BW in Northern New Jersey. Up to the time we placed this method of tuning in his hands for actual communication tests he had heard just exactly one foreign amateur, except, of course, Canadian amateurs. After its adoption he has, in the late afternoon and early evening, worked twelve British, two French, one Danish, one Italian, one Hungarian, one Cuban and innumerable Canadian stations, besides every American district, and has brought in our well-known Rice Expedition now in the Amazon, South America, with loud speaker volume consistently. We have little time

An explanation and an additional refinement as noted in the present tuner which is shown in the diagram is the use of a small capacity tuning condenser of .000125 mfd. capacity and the use of a loading condenser of .0005 mfd. The operator can reverse the procedure and use No. 2 condenser for tuning and use No. 1 condenser for the additional vernier. If both have the Ultravernier dials the set is in a condition for calibration when placed in the permanent receiving location. The counterpoise and ground connection should be adhered to.

A Powerful Six-Tube Super-Heterodyne

(*Continued from page* 16)

Then try one tube in all the sockets, turning on each rheostat slowly. By testing in this manner all the tubes will not blow if something is amiss.

Operation

It is usually more satisfactory, when getting accustomed to the set, to use the head phones and tune very slowly, keeping the dials in step. Turn the rheostat, R-3, about half way on, set the arm of the potentiometer on the negative side and increase R-5 until a rushing sound is heard. Then tune slowly until a station is brought in loud and clear.

Much has been written about matching tubes for the "super." This is easily done by interchanging the tubes until the potentiometer can be operated nearest the negative end without oscillation.

The best position for the rheostat and potentiometer will be found after a little experimenting, and these may be left set. The process of tuning then becomes rather a simple one with only two dials to manipulate. To get the best results these dials should be adjusted very slowly and carefully, because the "super" is a very selective and sensitive set.

The Evening World "Suitcase Six" Portable

A Six Tube Set Specially Designed for Efficient Operation on Dry Cells

WHILE summer radio is about at a close there are still a great number of uses for a compact portable receiver besides vacation purposes. In the following article from the *N. Y. Evening World, H. C.* describes a six tube receiver which employs three stages of radio frequency amplification, detector and two stage audio amplifier. This set can be conveniently placed in a suitcase with batteries, etc., for portable use, or in a wooden cabinet for stationary broadcast reception at home. Mr. H. C.'s article follows:

In designing the portable radio receiver described in this article, the writer was determined that it should have the following virtues, necessary to satisfactory operation under the widest possible range of circumstances.

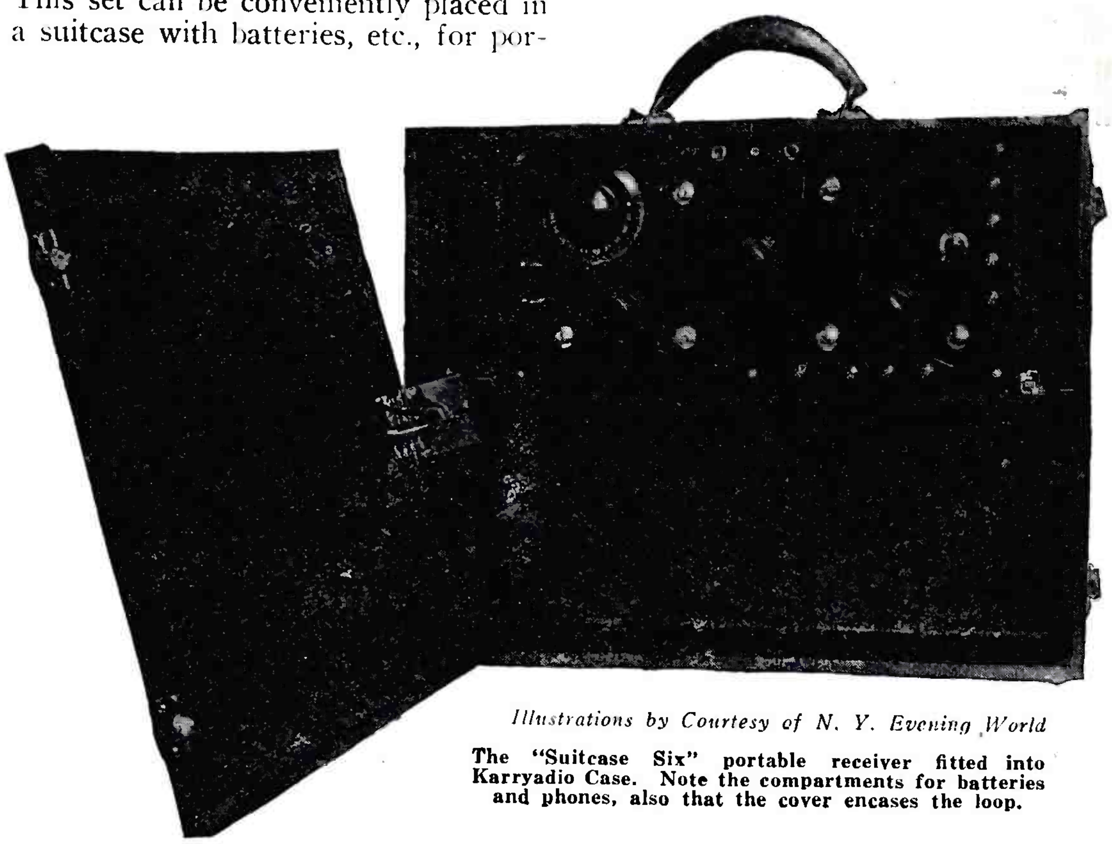
Operation on dry cell tubes, for battery economy, but without necessitating the usual selection from a great number of tubes of the few that would work well in the set.

Sufficient sensitivity not only to work on a small loop but also to guarantee satisfactory reception of programs when operated at a reasonable distance from broadcasters.

Enough selectivity for separation of all local stations when operated well within the city limits, yet with only one dial for tuning so that the set could be operated easily in the dark.

Unusual compactness so that it could be fitted into a small suitcase or special portable carrying case together with its entire equipment of loop, batteries and loud speaker, and keep within a weight limit that would permit of easy carrying.

Sufficiently easy and inexpensive to construct to be within the reach of the average radio enthusiast, who really would like to build, or have built for him, a portable summer receiver and at the same time be capable of winter use in the home without dismantling and reconstructing the set.

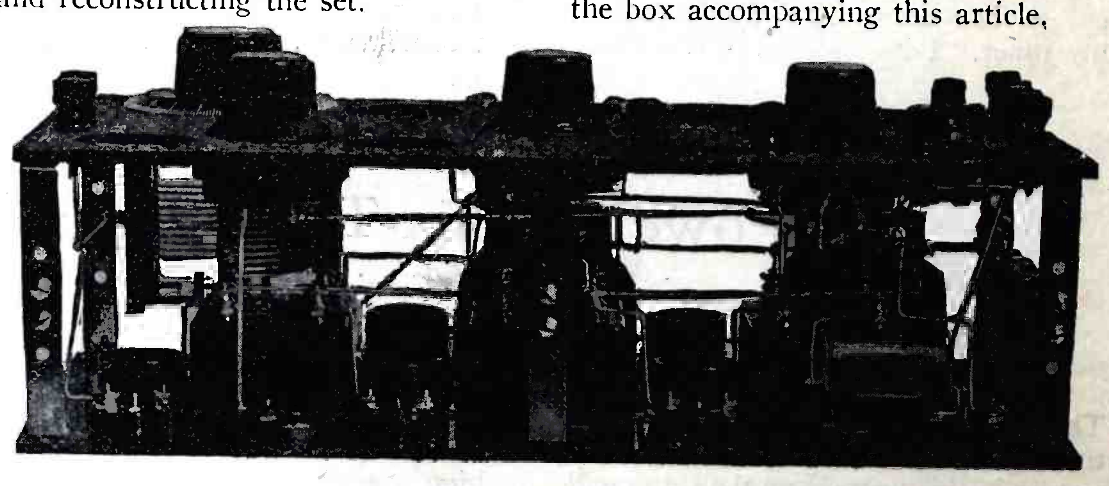


Illustrations by Courtesy of N. Y. Evening World

The "Suitcase Six" portable receiver fitted into Karryadio Case. Note the compartments for batteries and phones, also that the cover encases the loop.

For UV 199 or C 299 tubes, which are best for economical battery operation, reflex circuits, which necessitate a critical selection of these tubes, and more or less crystal adjustment, were passed in favor of a straight transformer coupled job, consisting of three R. F. stages, a tube detector, and two stages of audio frequency amplification. Here it was necessary to avoid some of the drawbacks often encountered in trying to use these tubes with standard radio frequency transformers designed for tubes of the 201A type, with their markedly different characteristics. A new transformer, specially designed for use with the 199 type tubes only, was tried with immediate success. This transformer is manufactured by the Werner Radio Company, makers of the transformers used in The Evening World's Resonatone receiver, which was described in the July issue of *Radio Review,* and is made in three numbers, W1, W2 and W3, for use in the order given in three successive stages of radio frequency amplification.

In the audio end, all-American transformers were used, 5 to 1 ratio in the first stage, 3 to 1 in the second. For tuning the loop an Amsco low loss variable condenser was chosen, not only because its small size fits it conveniently into the limited space provided, but also because it tunes very sharply. The rated maximum capacity is .00053 mfd. Other parts used are listed in the box accompanying this article.



A side view of the receiver removed from case. The radio frequency transformers and placement of parts are clearly seen in this photo.

After considerable experimenting the model shown in the photographs was evolved, combining all the desired features and built on a 7 by 14 inch panel, with a panel to baseboard depth of only 3½ inches.

Limited space prohibits a complete report of all tests made with this receiver, some of which were made in the city and some at points about twenty-five miles distant. It was found sufficiently selective for operation within four or five miles of the high-powered New York stations without any cross-talk interference, but is not recommended for use in close proximity to any powerful broadcaster without adding a tuned R. F. stage for increased selectivity. All tests with the completed receiver were made within the past month, and night-time reception of strong stations within 1,000

The set can be installed in a regular week-end case with wooden partitions as shown. The loop may be fixed in the cover of the case.

miles was frequently possible on the loud speaker. Its winter range should be excellent for real distance. At twenty-five miles from New York, worked on a beach at the water's edge, every New York station was received on a small portable speaker with good volume and knifelike selectivity during a very hot afternoon.

For winter use the receiver can be housed in a box with a hinged cover as shown, and occupy very little space. Although designed for 199-type tubes and dry cells, it will operate at greater volume with the Brightson True Blue "Power Plus" tubes, which fit the 199-type sockets and can be operated on a 6-volt storage battery without changing the rheostats already in the receiver.

In constructing the receiver, first have a baseboard cut the exact size of the 7x14 panel and three-eighths thick. The photos show that the writer used a radion baseboard as well as panel, but this necessitates drilling holes for mounting every piece of apparatus, so need not be used.

Next drill the panel as shown in the diagram, and mount on it binding posts, variable condenser, rheostats, potentiometer, phone tip jacks and filament switch. Also mount six of the brass angle brackets, one at each corner and one in the middle of each side as shown. These brackets can be purchased at the five and ten-cent store radio counters. Then close to the panel do the wiring connecting the rheostats and potentiometer to the filament switch, filament switch to A minus binding post, A plus post to B minus post, and .005 condenser across the phone tip jacks. Lugs should be used on each binding post.

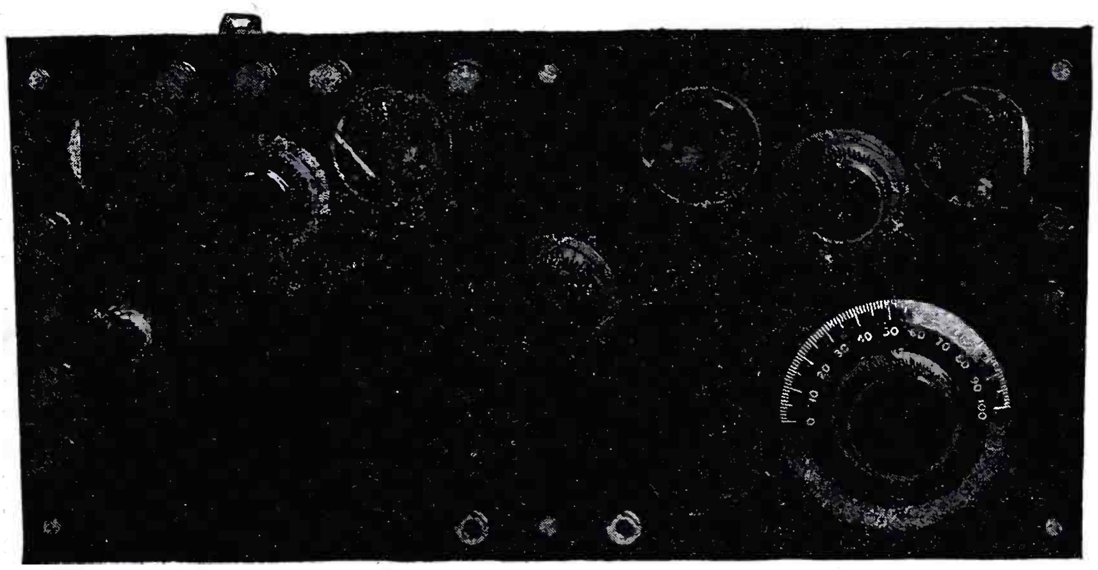
The holes in the panel for inserting the tubes should be cut one and one-half inches in diameter to permit removal or replacement of the tubes without taking the receiver from the case. A cutter for this purpose, fitting the ordinary bit brace, can be purchased at any large hardware store.

Next mount the transformers, sockets, bypass condenser and angle brackets on the baseboard in the relative positions shown in the diagram and wire the connections. There is not space here for step by step wiring instructions, therefore much will have to be left to the constructor's ingenuity. But remember to keep all wiring as close to the base and transformers as possible, because when panel and baseboard are joined together by the brackets clearance of all instruments and wiring must be carefully maintained.

Be sure to give the detector a positive grid return. This is accomplished by connecting the F terminal of the third R. F. transformer (W3) to the A plus-B minus line. On the other two R. F. transformers this terminal is connected in the conventional way to the A minus. To give the detector a plate voltage of 22½ volts the first B plus or detector battery connection binding post is connected to the B plus

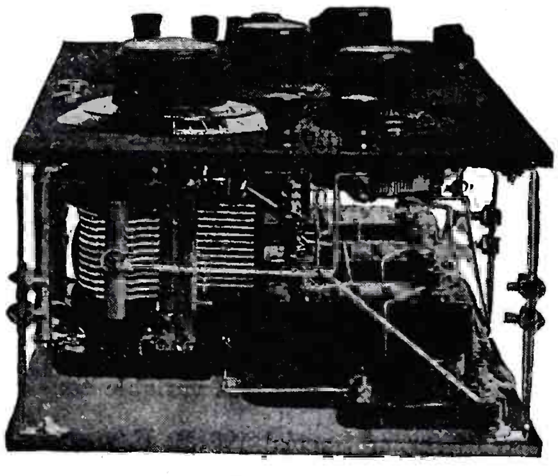
LIST OF PARTS

- 1 7x14 Radio panel.
- 1 7x14x⅜ baseboard.
- 1 .05 Amsco low loss variable condenser.
- 3 Werner Special 199 R. F. transformers, W1, W2, W3.
- 2 All American A. F. transformers, 5 to 1 and 3 to 1 ratio.
- 6 General Radio 199 sockets.
- 2 Amsco rheostats, 30 ohm and 6 ohm.
- 1 Amsco potentiometer, 400 ohms.
- 1 Carter Imp switch.
- 2 Carter phone tip jacks.
- 1 5 megohm Royalty grid leak.
- 1 Freshman .00025 grid condenser (small size).
- 2 Dubilier Micadon fixed condensers, .0005 and .005 mfd.
- 1 Dubilier by-pass condenser, 1 mfd.
- 1 3 inch dial.
- 10 Eby binding posts—2 Loop, 1 A minus, 1 A plus, 1 B minus, 1 B plus det., 2 B plus amp., 1 C minus, 1 C plus.
- 12 brass angle brackets (see article).
- 12 flat head half inch nickled machine screws and nuts.
- 12 round head machine screws and nuts.
- 12 lengths bus bar, 2 lengths spaghetti.
- 24 round head screws for mounting transformers, sockets and bypass condenser to baseboard.
- Soldering lugs.



Panel view of the "Suitcase Six" portable receiver.

terminal on the primary of the first A. F. transformer (5 to 1 ratio), the B plus terminal of the second A. F. transformer (3 to 1) and one of the phone tip jacks being, of course, con-



End view of the set.

nected to the third or 90 volt B plus binding post. The B plus terminals on the three R. F. transformers connect to the second or 67½ volt binding post.

to phone tip jack, C minus A. F. line to C minus binding post.

To make these connections easily, first fasten each connecting wire at its most inaccessible end, then bend and cut it so that the other end will come at the proper place when the set is fitted together. Soldering lugs on all binding posts will greatly help. When the brackets are bolted together the unit should be very rigid and firm. In the photographs the fastenings are shown made through the last holes in each bracket. The unit was afterward reduced half an inch in depth by fastening the brackets so that all three holes came together. If the post method is used instead of brackets, cut them at a length which will bring panel and baseboard within not less than three and one-eighth inches of each other, preferably three inches, to give proper clearance for dials when set is inserted in case.

The most complete case that can be used is the Karryadio, now on the mar-

The space left at the rear of the cabinet is of just the right length and width to accommodate three standard 1½-volt No. 6 dry cells for A battery and four upright type 22½-volt B battery units, and leaves sufficient space

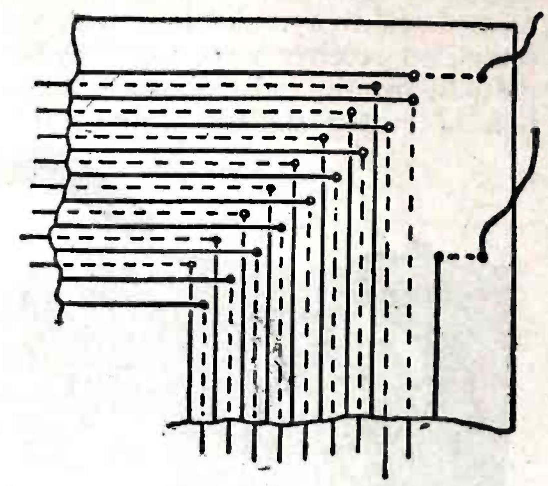
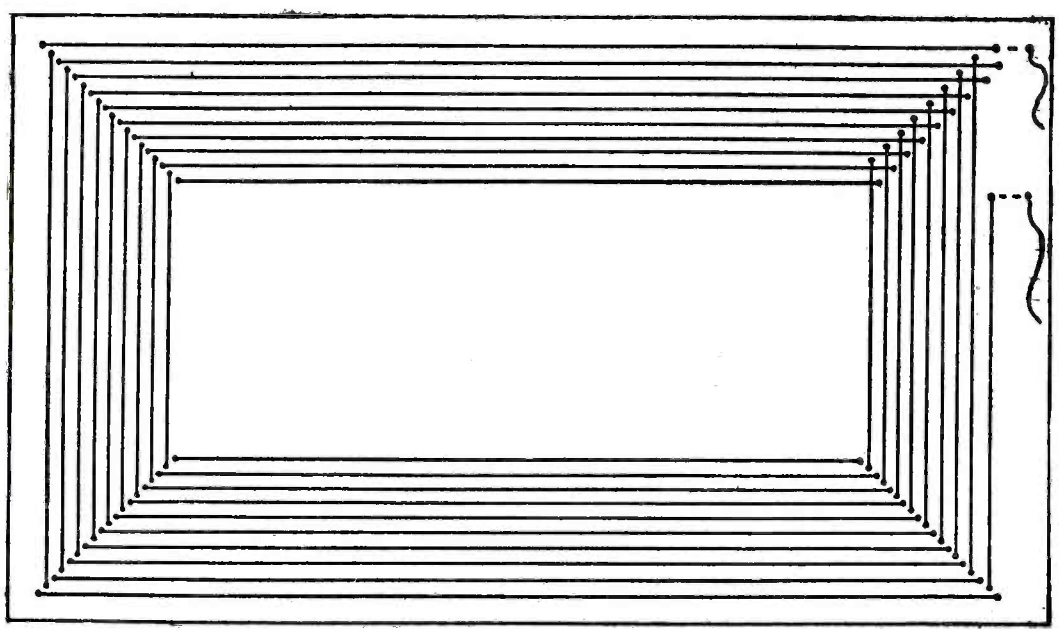


Diagram of "Start and Finish" corner, showing alternating winds of the wire.

above all batteries for stowing the loud speaker horn when it is collapsed. When this horn is collapsed the loud speaker unit should be removed and the horn stowed with the neck toward the loop end of the case.

Another photograph shows the "Suitcase Six" fitted into an ordinary small "week-end" suitcase, in a way that requires no marring of the case, which can at any time be restored to its original service merely by lifting out its radio contents.

The suitcase illustrated, a standard article obtained in a department store, is the smallest that can conveniently be used. The inside dimensions are 18¾ x10¾x5 inches. An unfastened quarter or three-eighth-inch partition is placed lengthwise of the case the exact length of the receiver. A second partition extends crosswise of the case at

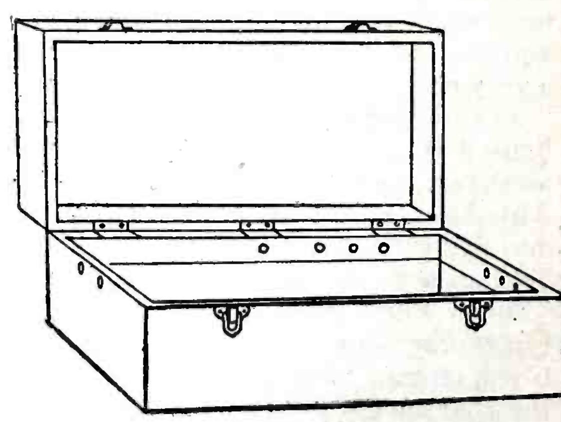


Winding diagram of suitcase cover loop, showing one side only.

As the set is being wired it is a good plan to keep fitting the panel and baseboard halves together to make sure no undesirable contacts are resulting. When the wiring is otherwise completed, there should be left only a few connections to be soldered with the panel and the baseboard permanently fastened together, and these should all be where they can easily be reached by the soldering iron. These connections are as follows: Minus filament line of three R. F. and two A. F. tubes of 6-ohm rheostat. Minus filament terminal of detector tube to 30-ohm rheostat. R. F. transformer minus filament line to panel minus filament line near switch and to bypass condenser. A plus-B minus line to A plus binding post. A plus-B minus line to one side of potentiometer. B plus 90-volt line to bypass condenser. B plus 22½, 67½ and 90-volt binding posts to corresponding lines. Grid of first R. F. tube socket to wire connecting fixed plates of condenser and loop binding post, plate of second A. F. tube socket

ket as a portable specialty, and illustrated in the photograph. This case has an overall size of 19 by 15 by 5½ inches, contains a special spiral loop wound in the pivoting cover of the case, and a collapsible loud speaker horn which can be fitted to any standard loud speaker unit.

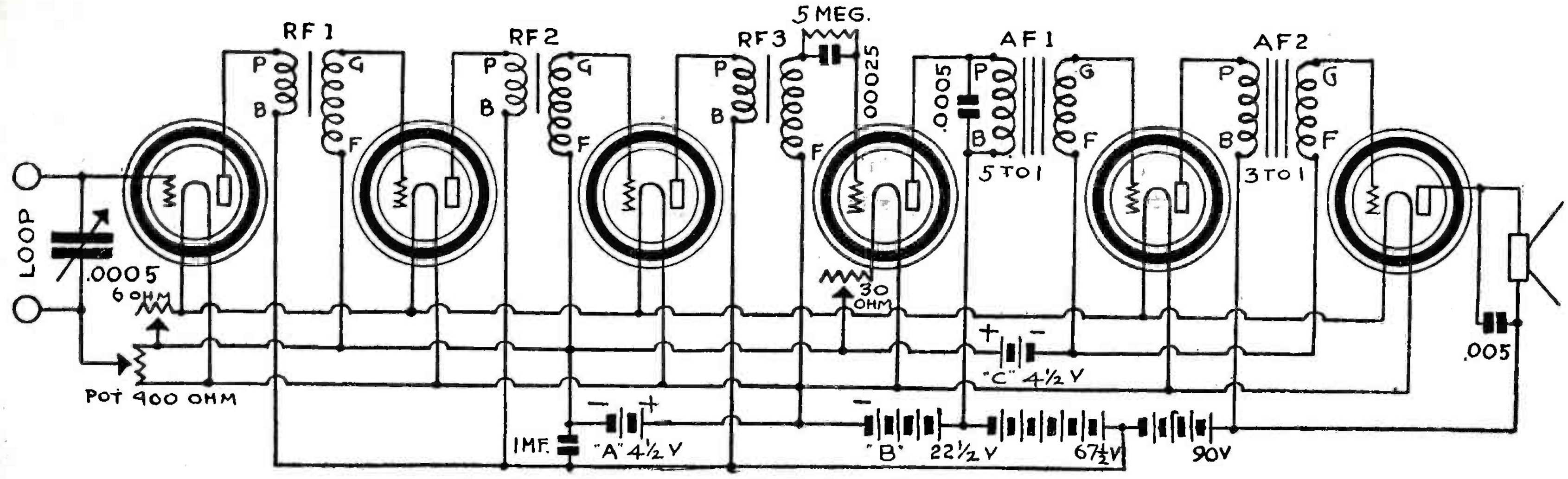
When the "Suitcase Six" is fitted into the Karryadio case, as illustrated in the photograph, a partition, which can be either of quarter-inch wood or of radion, and high enough to come just above the face of the receiver panel, is fastened lengthwise of the case and tightly pressed to the long side (rear) of the receiver, which occupies the front of the case. Two more partitions of the same height are used to close off the ends of the receiver and keep it in place in the case. The partition at the left leaves a space of just the right width to accommodate the C battery. The one at the right is used for stowing away the loud speaker unit when detached from the collapsible horn.



Small hinged top cabinet in which "Suitcase Six" can be housed for home use and still be portable as a receiver only.

the left end of the receiver, a short partition blocking off one end of this space near the front of the case, as shown. These partitions should be just barely more than the height of the receiver panel.

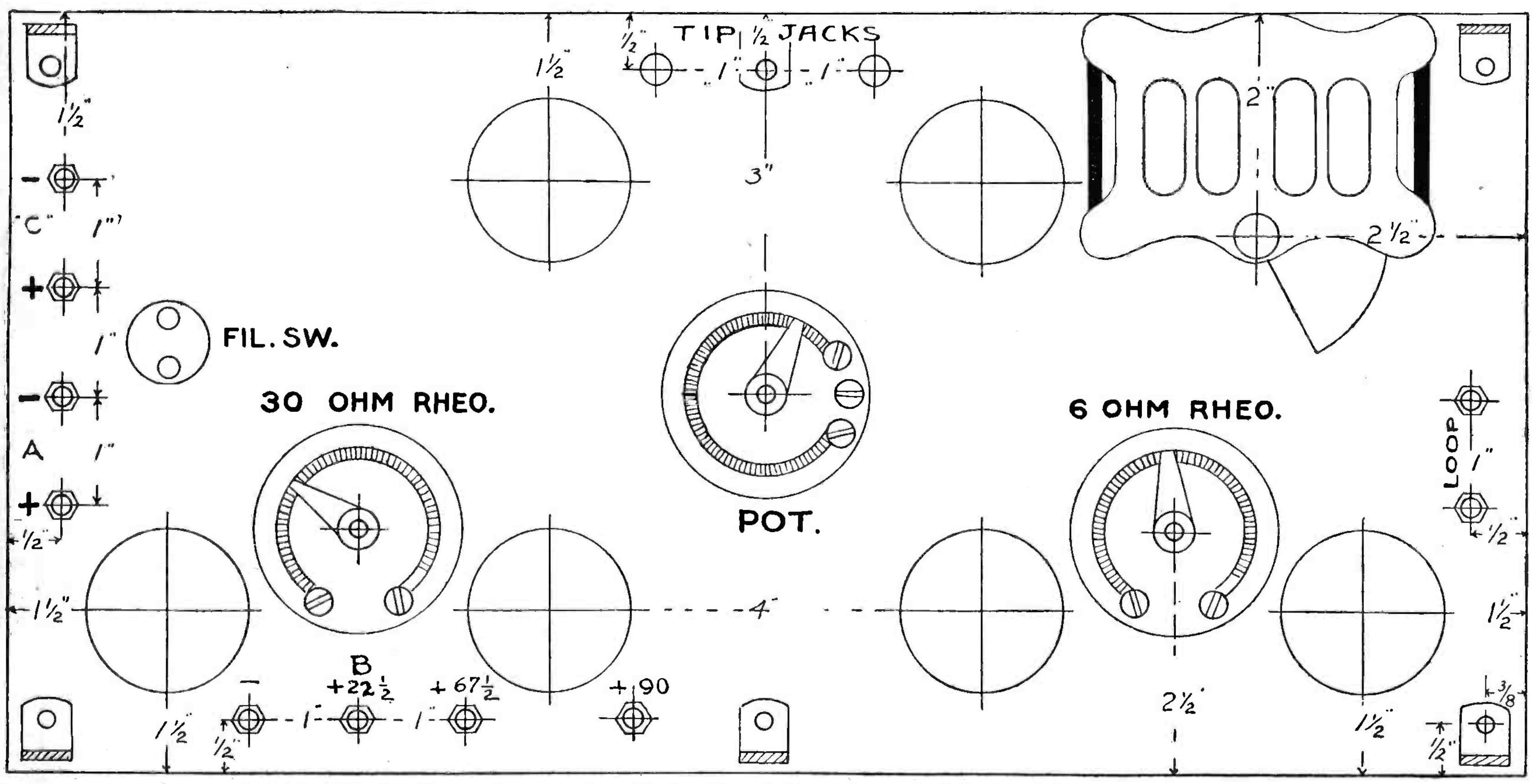
The small space mentioned last houses the C battery. The adjoining larger space is just right for six 4½-volt C batteries connected in parallel as an A battery. This combination will be found to perhaps give slightly more "kick" to the set than three ordinary 1½-volt cells in series, for which there is not room in the case, and will give service just as long, but is somewhat more expensive. Great care must be taken in connecting these 4½-volt batteries, as one or more of them inadvertently connected in series instead of



Complete wiring diagram of the "Suitcase Six" portable receiver.

parallel will immediately burn out the tubes.

The remaining space at the rear of the case houses four of the small 22½-volt B batteries, in series for 90 volts, at the end of the compartment next the A batteries. The space left at the right end takes a detached loud speaker unit and the bell of a Radion miniature loud speaker horn, the remainder of the



Panel layout for the receiver showing the location of the holes to be drilled and how parts are mounted.

horn resting, for transportation, across the B batteries. It would be advisable to use a loud speaker of the bakelite case type, such as a Baldwin, Operola, etc., to avoid inadvertent shorting of the B battery terminals in carrying the set around.

When this case is used a loop can be wound on very heavy cardboard or fibre for carrying in the pocket in the cover of the case. On a card 18 by 10½ inches, drill or punch a series of holes in each corner, as shown in the diagram, 3/16 inch apart. Now take 80 feet of stranded loop wire and start winding from two inner corners of the loop. The winds alternate through the holes and on opposing sides of the card so that when the loop is finished a double spiral has been wound, occupying both sides of the card, with the two ends, which we will call the start and finish of the loop windings, coming out near one outside corner. The loop should have nine and ten turns alternating on each side. Leave two or more feet of wire for the ends as you may want to operate the loop by leaning it against something or on a stand made by sawing a slot in a block of wood. One corner will require a double row of holes as shown in the diagram.

A regular suitcase of larger size can be used to good advantage, providing space for larger batteries and also a folding loop. The twelve-inch Gabe loop, a double spiral with remarkable pickup for its size, is now made in foldign form and is admirable for suitcase packing, as it stows away in a container only 13½x3x3 inches, as shown in the photograph. If the suitcase is large enough, a larger small horn, such as the Amplion Dragonfly, can be carried if preferred.

The fan who wants only the receiver itself portable, for small compass and light weight, or who wants to use the receiver at home as well as on vacation and outing, can make, or have made, a small cabinet like that shown in the drawing. The cabinet box should have inside dimensions just the right size to snugly admit the receiver, and with sides that rise three-quarters of an inch above the panel. The cover hinged at the back should have an inside depth of an inch and a quarter. Opposite each binding post a small hole should be neatly drilled in the case at the height of the hole in the binding post so that loop and battery leads may be left permanently connected and the cover be opened or closed without disturbing them.

A Short Wave Set of Unusual Merit

Full Details of a Short Wave Receiver for the Reception of Low Wave Distant Stations

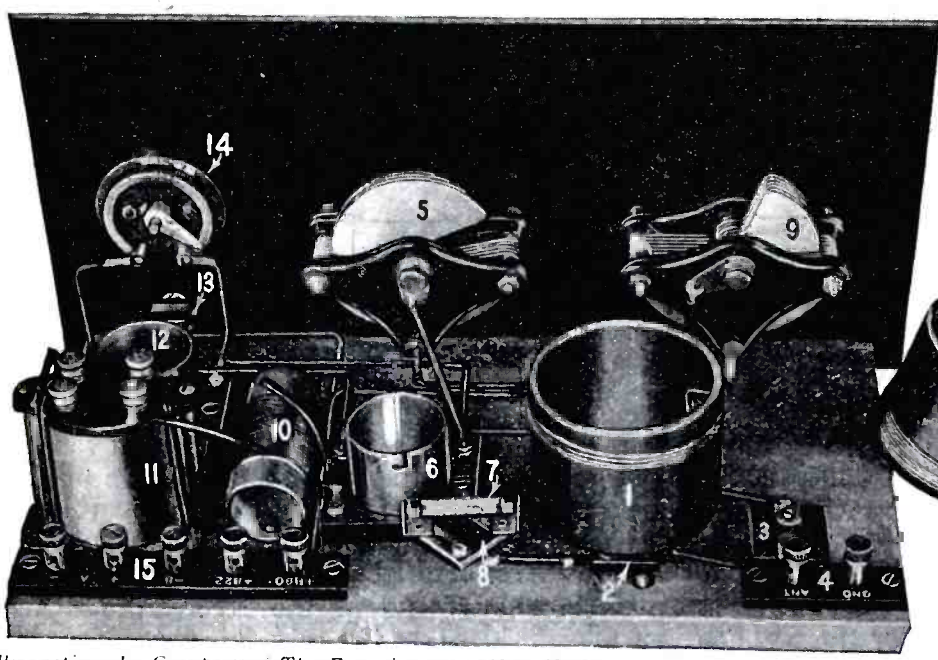
WITH so much talk of broadcasting on the lower wave bands and the description of so many efficient arrangements for reception of such waves it is no more than fair that some consideration be given our brother amateurs along the lines of receiving the extremely short-wave CW transmission.

Many amateurs have been heard over distances of several thousand miles in the past few years but the records now being made by amateurs using wave lengths of twenty, forty and eighty meters and the intermediate levels are little short of phenomenal. Like most of the short-wave amateur apparatus, the receiver is fundamentally due to John Reinartz, an indefatigable worker in these realms. A vote of thanks is certainly due *Alfred R. Marcy* for calling this receiver to the attention of the radio public. The article first appeared in *The Experimenter*, New York, and is given in the following:

Having blazed the way in our search of the possibilities of the shorter wave lengths for amateur communication, the Reinartz receiver stands today as the very best to be used for the purpose. What with the numerous peculiarities of the short waves, including maximum signal intensity at high noon, when the sun is shining brightly, the fact that it is only long distances which can be reliably bridged (1,000 miles and further) on wave lengths of 20 meters and lower, and the exceptionally clear and loud signals accompanied by periodic fading—all go to make the subject very entrancing and are sure to inspire every experimenter.

The set to be described is one that has been used for more than half a year, and has logged numerous stations in every part of the globe. When it is stated that west coast stations are heard regularly, that English, French, Dutch, Italian, South American and even Russian and African short-wave stations are heard with relative ease on this receiver, incredulity is excited in many people, but nevertheless such statement is true. Almost every evening reports from WJS, the Rice expedition in the jungles of the Orinoco, could be copied; 6's and 7's, almost never heard in the East on 200 meters, come "pounding in" like locals on 20, 40 and 80 meters!

Employing two tubes, a detector and audio-frequency amplifier, the set is readily adaptable for change in wave-length ranges from 20 to 200 meters. Arrangement is made such that it is possible to plug in four different coils for use in receiving. Thus, there is a 20-meter coil, one for 40, another for 80 and the last for 200 meters. In this

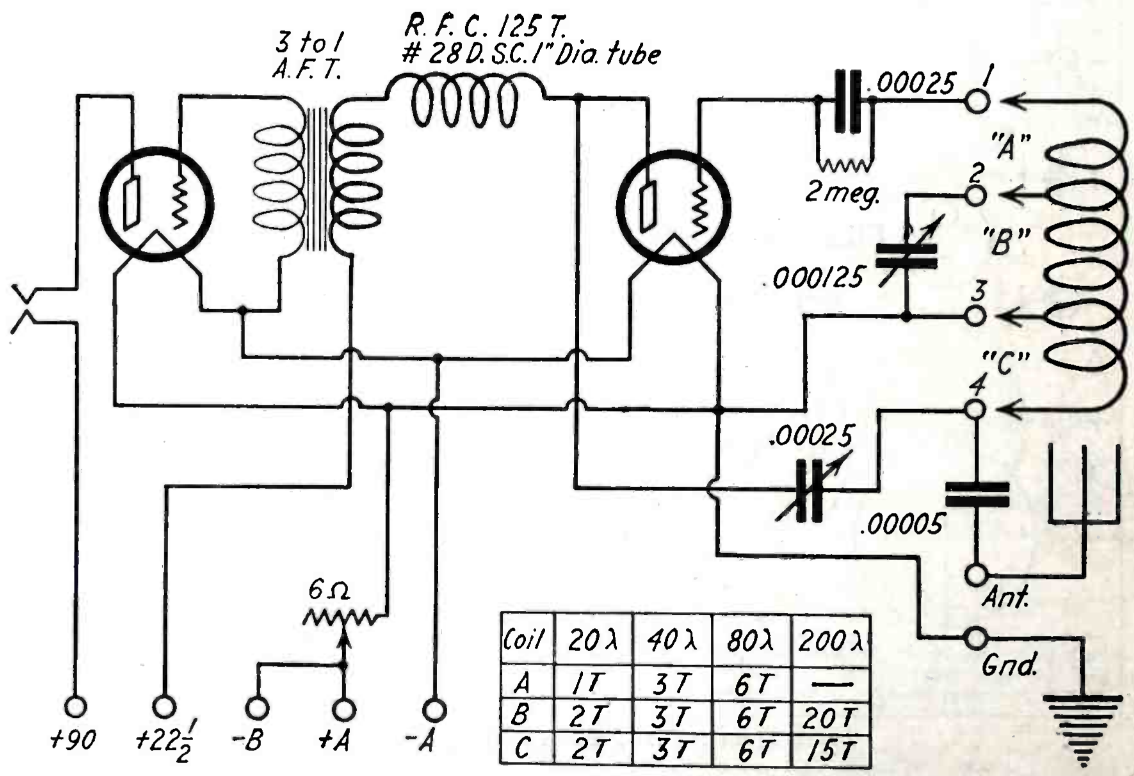


Illustrations by Courtesy of The Experimenter (New York)

The arrangement of the apparatus is clearly defined by the above photo. 1 is the coil; 2, coil mount; 3, antenna condenser; 4, terminal strip; 5, tuning condenser; 6, detector tube socket; 7, grid leak; 8, grid condenser; 9, feedback condenser; 10, radio frequency choke; 11, audio frequency transformer; 12, amplifier socket; 13, fone jack; 14, filament rheostat. Note extra coil alongside for different wave-length range.

LIST OF PARTS

- 1 .000125 mfd. variable condenser.
- 1 .00025 mfd. variable condenser.
- 2 Sockets.
- 1 Audio transformer.
- 1 6-Ohm rheostat.
- 1 Jack.
- 4 General radio coil forms.
- 1 General radio coil mount.
- 2 Binding post strips.
- 7 Binding posts.
- 1 .00005 mfd. condenser.
- 1 .00025 mfd. grid condenser.
- 1 2-Meghom grid leak.

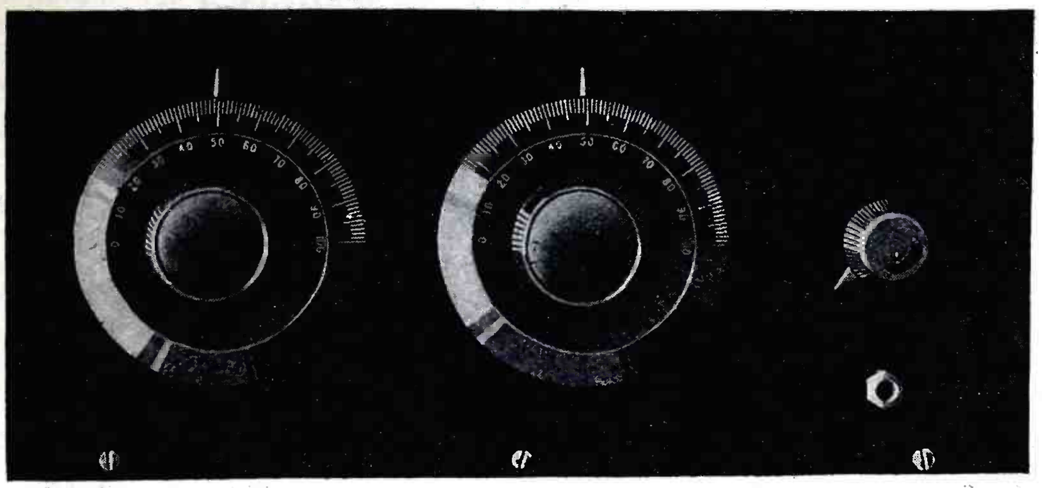


Coil	20λ	40λ	80λ	200λ
A	1T	3T	6T	—
B	2T	3T	6T	20T
C	2T	3T	6T	15T

Schematic wiring diagram of the short wave receiver which has given such excellent results.

way, an adequate frequency range is obtained and practical efficiency is kept at its highest.

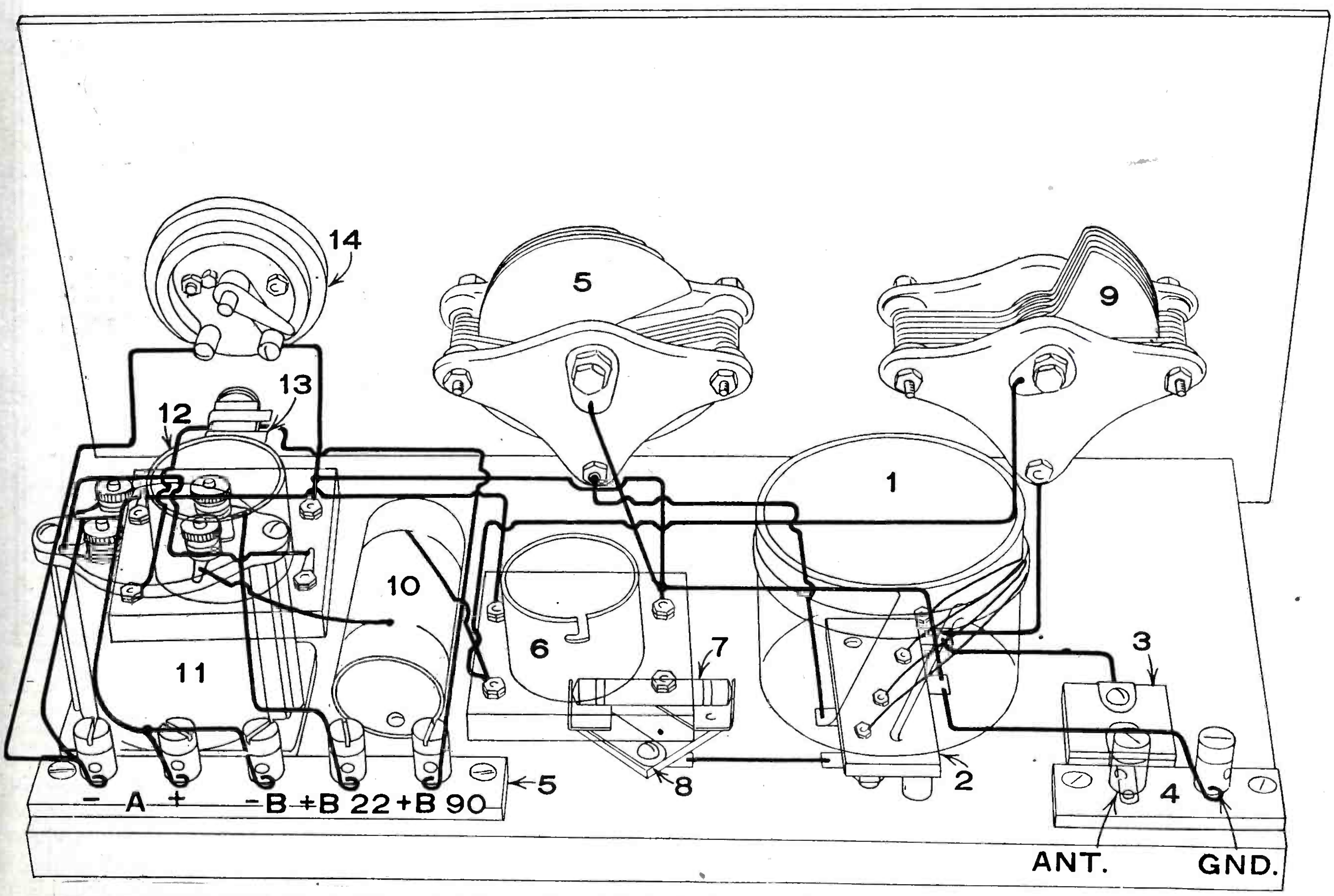
The set employs a single tuning condenser that has been modified so as inch in diameter. It is essential that the wiring be as short as is consistent with a neat layout of the parts. A 7" x 14" panel accommodates all the parts very nicely.



Showing the front panel of the receiver. The dial at the left is the regeneration control, while the one next to it is the tuning dial.

to give very fine tuning. Both the stator and the rotor plates have been cut, so that the minimum capacity of the condenser is very low. The feed-back

As will be seen in the wiring diagram, there is interposed a .00005 mfd. series fixed condenser in the antenna circuit. This is necessary in order to



Showing a clearly defined view of all the parts and apparatus used in the short wave receiver. The numbers correspond with those on the photograph and one should find no trouble in wiring the set correctly. Note how the plates of the tuning condenser are cut successively. This method allows extremely fine variations in frequency change, most necessary for proper operation in order to receive the high frequencies.

condenser has very little effect on the tuning, and it will need adjustment only when changing from one coil to another, and then a slight change will suffice.

The radio frequency choke is composed of 125 turns of No. 28 D.S.C. wire wound on a cardboard tube one

bring down the fundamental of the antenna for short-wave reception. For the best all around results, a single wire —No. 14 enamel—about 60 feet long, including lead-in, will do.

It has been established as a positive fact that the "A" type tubes are just as good as the dry cell type, in this particular kind of circuit. At least, one will not experience any difficulty in getting down to wave lengths of 20 meters or a little lower. It is not necessary to remove the bases of the tubes, nor is it advisable to dispense with sockets. These latter precautions are requisite only when such high frequencies as 30,000 K.C. and higher are to be generated.

As regards the construction of the various coils used, it will be necessary to procure four forms. Bakelite is good for such forms, as it is non-hygroscopic, is strong and suitable in every way. If at all possible, space-wound coils can be used, but it is worth while to bend one's efforts to procuring the material as outlined in this article. For the 20-meter coil, wind five turns of No. 16 D.S.C. and take a tap off at the first and third turns. A total of nine turns of wire will be required for the 40-meter inductance. This coil must be tapped at the third and sixth turns. For the 80-meter coil, eighteen turns tapped at the sixth and twelfth will be necessary. Finally, for the 200-meter coil, thirty-five turns tapped at the twentieth turn, thus giving twenty turns for the grid coil and fifteen turns for the plate inductance are needed. The coil form is 2¾ inches in diameter.

The tuning operation of the receiver

(*Continued on Page* 31)

The Super-regeno-dyne

An Unusually Sensitive Four-Tube Set, Constructed from Standard Parts

THE Super-regeno-dyne receiver has recently been presented in radio circles by the *Chicago Evening Post* radio supplement and is one of the most practical forms of four-tube sets for general broadcast reception that the radio fan would want to own. *Earl W. Scrogum,* who devised the circuit, describes the operation and construction of the set in *The Chicago Evening Post* as follows:

I've built and experimented with almost every conceivable hook-up, from crystals to supers, and I herewith present a genus of supers which "outsups" all others which I have ever built for volume, tone quality, selectivity and ability to get distance.

Characteristics of the circuit:

1. It is very selective and will easily cut out local stations.
2. It will bring in stations from coast to coast on the loud speaker under favorable conditions.
3. It is easy to tune and operate, as the two condenser dials are turned together and read the same when a station is tuned in providing they are properly adjusted.
4. A permanent log may be made.
5. There is no radiation when properly constructed and handled.
6. Stations can be tuned in without obtaining beat notes.
7. It has very good tone quality.
8. Construction is easy.

What more could one ask of a circuit?

Theory of Circuit

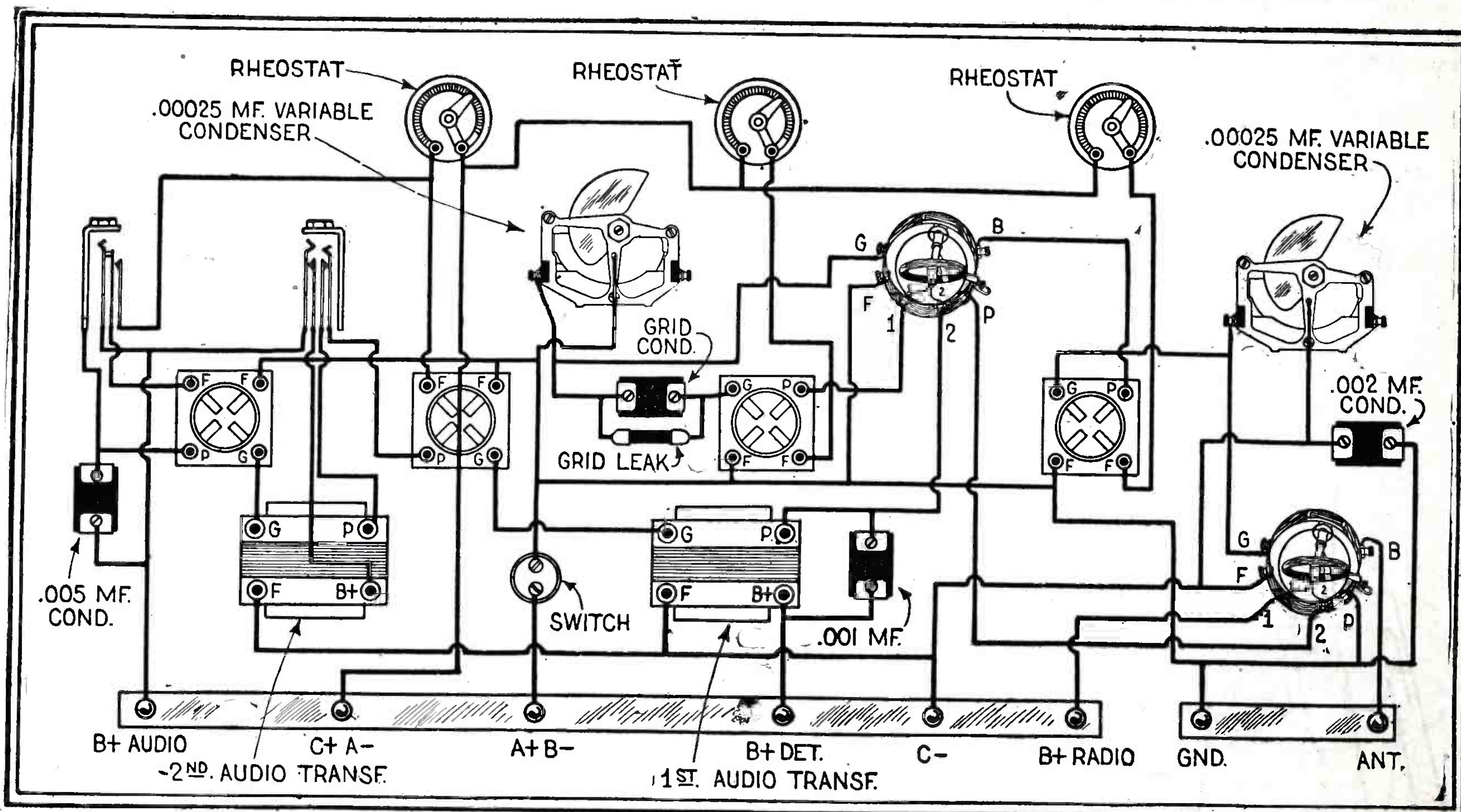
This circuit consists of a one-stage tuned radio-frequency, a regenerative detector and one or two stages of audio-frequency, as desired. The audio-frequency is of the conventional type of construction, and no more need be said about it, except, do not use inferior transformers or parts. A saving of a few cents may mean the difference between a good and a poor receiver.

The very smallest panel that should be used is a 7 by 24, as the best results cannot be obtained in any receiver when the parts are close together. The detector and radio-frequency coils, especially, should be well spaced and at least six inches apart.

Drill holes in the panel for the two variable condenser and detector-coil shafts at least six inches apart for the best results.

It is not necessary to shield the panel on the inside with metal, as there is no body capacity or hand effect on this set when properly constructed. A fixed condenser of .002 mfd. capacity must be used to connect the rotor plates of the radio-frequency variable condenser to the ground, as shown in the diagram.

Both detector and radio-frequency coils are of the three-circuit type, and the Bremer-Tully low loss three-circuit tuners were found to be the ideal coils for this circuit. Then I recommend the Bremer-Tully low-loss condensers, .00025 capacity (13-plate), to be used in conjunction with the coils. These make a well-matched set.



Illustrations by Courtesy of Chicago Evening Post

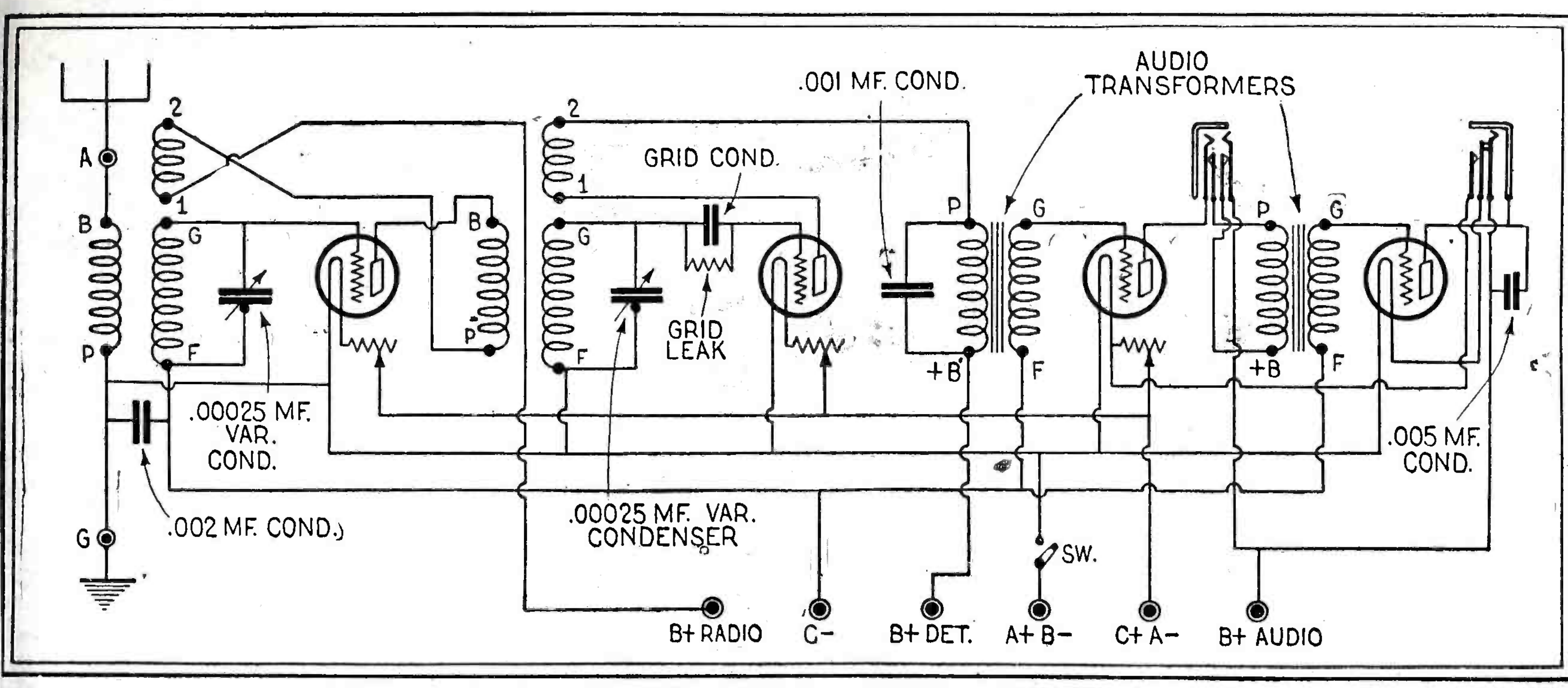
Picture wiring diagram of the super-regeno-dyne showing the connections to the various parts.

The picture diagram will show fans the proper way to wire up the parts.

Care should be taken in making all connections. Use bus bar wire. Do not use acid soldering flux in soldering up connections. Make all connections as short as possible and keep the plate and grid wires well separated. Grid wires should be short.

The radio-frequency coil is set back of the variable condenser on the left-hand side of the panel and its shaft is not connected on the outside of the panel. If this coil is set so that the shaft will be pointing toward the left-hand side of the cabinet it will be found to be a very convenient position for wiring and it will be at right angles to the detector coil.

The rotor of the radio-frequency coil acts as a reverse feed back and is merely set just below the point of oscillation on low wave-lengths as the neutralizer on a neutrodyne is set, only this is much easier and less critical.



Schematic circuit of the super-regeno-dyne receiver.

Detector Coil Reversed

It should be noted in the diagram that the detector coil connections are reversed, that is, the post-marked G is connected to the low potential parts of the circuit instead of the grid.

The post marked F on this coil is connected to the grid and stationary plates of the variable condenser. These connections are reversed so that the detector and radio-frequency coils will not be in phase or buck each other. It is important that all connections to coils and condensers be made exactly as shown in the diagram.

In the radio-frequency stage a connection is made from the B battery (radio B+) to post marked "1" on the coil. The current passes through the rotor coil, out at post marked "2," which is connected to post marked "P" of the detector coil. This is the aperiodic primary and the current passes through it and out at post marked "B," which is connected to the plate of the radio-frequency tube. On Bremer-Tully coils this aperiodic primary may be tipped up or down and set, thus getting various degrees of inductance, selectivity and volume. Likewise, the radio-frequency coil antenna inductance or primary may be tipped up or down, thus giving various degrees of selectivity. Local stations can be cut through easily. I live near WBCN and WMBB on the south side and am not troubled with any interference.

One 4½-volt C battery is sufficient for both audio and radio-frequency grid return. Use 90 volts on radio and audio-frequency and 20 to 30 volts on the detector.

Performance of Set

An aerial from fifty to seventy-five feet, including lead-in wire, will be found most satisfactory. I have brought in KFI, Los Angeles, with an inside aerial only thirty feet long with sufficient volume to be distinctly heard all over a seven-room apartment and I used UV-199 tubes. Do not get your aerial too long or you will lose selectivity, tone quality and distance. A single wire is the best.

I have tuned in KDKA, WGY, WBZ, WEAF, WDAF, WHAZ, KFKX and several others on the loud speaker with good volume and used no aerial whatsoever. Merely a ground wire. In operating without an aerial, fasten the ground wire to the aerial binding post for best results.

It will be noted that I have omitted a jack for the detector, as the set is more efficient without one. The detector is very seldom plugged in, so leave the jack out. In this age of loud speakers, at least one stage of audio-frequency is needed, so a jack is only provided for the first and second stages.

A variable grid leak will be found most satisfactory and use the very best.

After the set is constructed the next steps are the minor adjustments and testing.

Tuning the Set

First the rotor of the radio-frequency coil (inside the cabinet back of the condenser on the left-hand side) must be adjusted and set in position permanently.

The rotor of this coil acts as a reverse feed back and controls oscillation in the radio-frequency stage. It is adjusted to a point just below the oscillation point on low wavelengths, that is, when the two variable condenser rotor plates are about all the way out. If it is adjusted on high wavelengths it will break into oscillation when you turn down to low wavelengths and will be uncontrollable, and a readjustment will be necessary. It is somewhat similar to neutralizing a Neutrodyne with a neutralizing condenser, only here you are using a reverse feed-back coil and it is easier and less critical.

The rotor of the detector coil, which is controlled by a dial on the outside of the panel, controls the oscillation and pulls the radio-frequency tube as well as the detector tube up to the oscillation point for the various wavelengths.

If the set is properly made and adjusted the two condenser dials will read the same when a station is tuned in, thus making tuning easy. Turn both condenser dials slowly, so that the numbers read the same, and keep the set just below the oscillation point by adjusting the tickler or detector coil rotor dial in the center between the two condenser dials. The station should come in without any fuss. After adjusting each dial separately then for the loudest point the station is thus tuned in.

If the tickler coil is turned over the point of oscillation and the two variable condenser dials are turned together, then a station will produce a whistle or beat note. This may be done to find exceedingly distant stations, as it will be a great help. After the beat note is heard the tickler dial is readjusted and the station should come in. A slight adjustment of the two condenser dials may be needed.

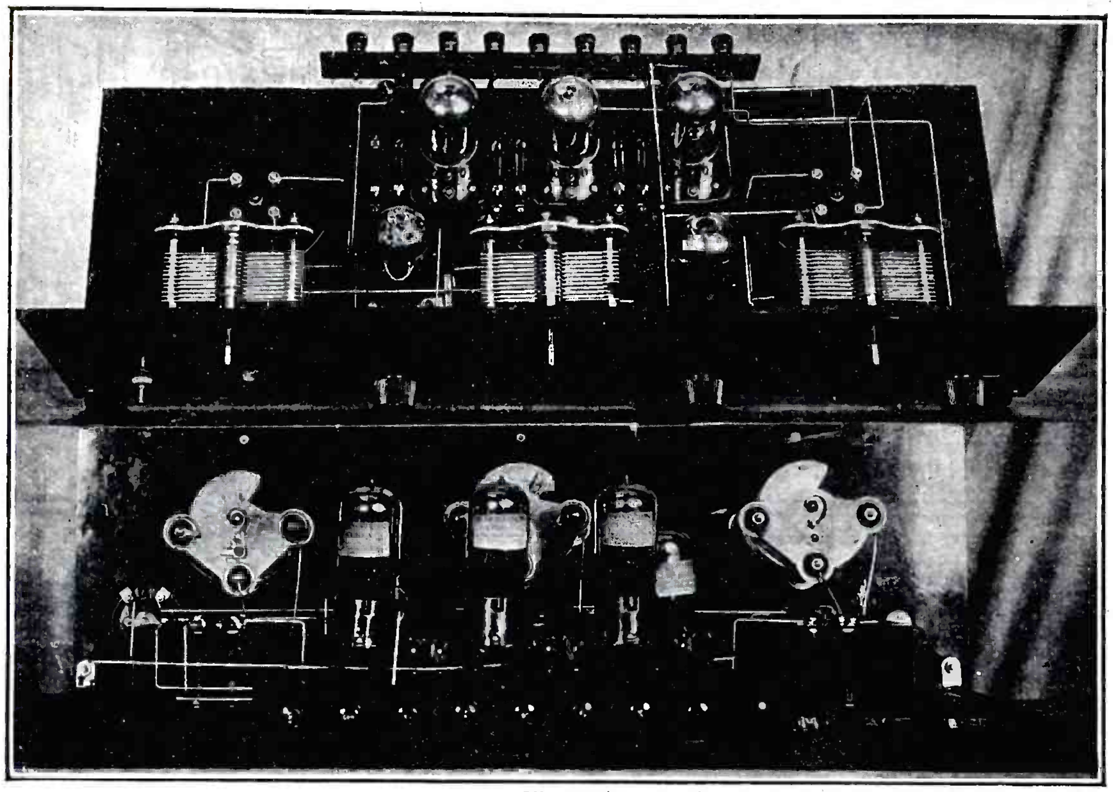
For those who construct this set, if they will follow the diagram carefully and connect all parts exactly as shown in the picture diagram, they will experience little difficulty.

If care is taken in construction, the best parts used, the reverse feed-back coil in the radio-frequency stage properly adjusted and set, the proper length aerial used and a high-grade loud speaker used, I am sure that all will be well pleased with results obtained and well paid for their small investment and work.

The Power House Set

A Tuned R. F. Receiver with Regenerative Detector and Resistance A. F. Amplifier

THE great American army of radio broadcast listeners is divided into two groups, the objects of which dictate largely the type of radio receiver they require. One class is the DX or distance fan who would rather get a single peep from a distant station amid a roar and crash of extraneous noises at 3 o'clock in the morning than listen to the most beautiful music close at hand. The other class want absolutely the best reproduction of the music and song from nearby stations, with DX incidental. This second group demands the best for real entertainment. The quality fan is just as critical as the distance fan, for while he does not stay up late listening nervously for the call letters of a distorted, fading signal, he sits calmly back and is quick to detect a hissing of the esses and the slurring of the ares, devising new ways and means to overcome this and render the reproduction more perfect.



Illustrations by Courtesy of Radio World (New York)

Fig. 1 (top), the assembly view of the circuit, as seen from a top angle. Lower photo (Fig. 2) is the rear view of the set.

To this second class, *John L. Munson* dedicates a receiver which appears to be ideal for quality of reproduction. Mr. Munson describes this set in *Radio World,* New York, as follows:

The set as shown in the accompanying photos and diagram is designed to give the most perfect program possible in both quality and volume combined with the greatest simplicity of control. In working out the design of this "Power House" set, all the existing types were investigated and their good and bad points noted. It was found that the most popular set in general use was the 5-tube neutralized and balanced receiver, employing two steps of radio-frequency amplification, detector and two steps of audio-frequency amplification. But defects were noted in such sets as follows:

1. Many receivers of this type were actually not balanced or neutralized properly and squealed and squawked more than a regenerative receiver.

2. There were too many control knobs fictitiously labelled "volume," "quality," etc., and it was observed that many persons knew nothing of the principles of these controls and used them indiscriminately, hoping by some odd chance to strike a good combination.

3. It was learned that many a set operated very poorly or was even entirely inoperative due to battery trouble. In investigating many such cases of inoperative receivers it actually became monotonous to hear the owners assure you that it couldn't be worn-out batteries, because they just bought new ones recently; but it often developed that perhaps the children turned the bulbs on and they burned several days or perhaps an "expert" friend tested the B batteries with an *ammeter* and pronounced them O. K. In any event battery trouble was the greatest cause of inoperative receivers.

4. Many a fan had constructed his own 5-tube receiver and it never did work properly in spite of his elaborate

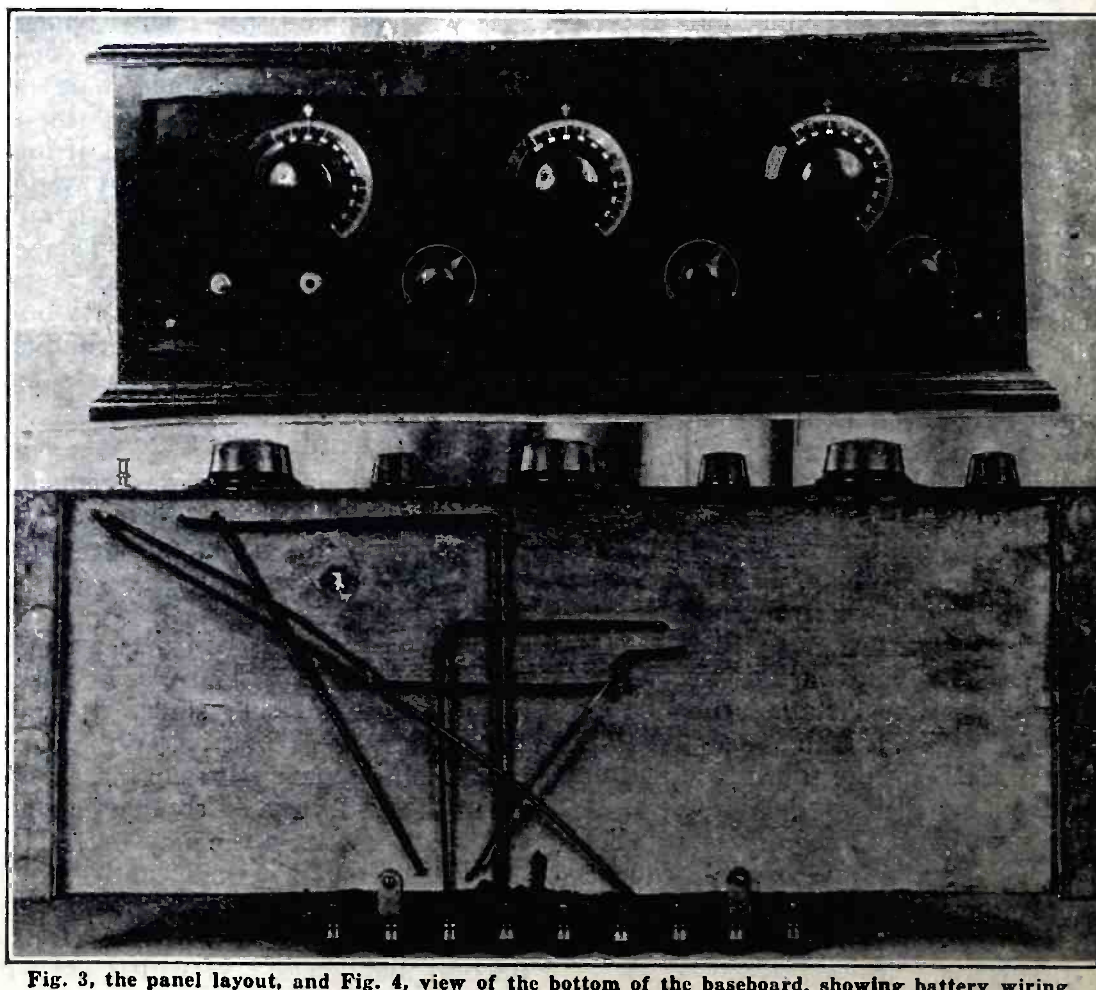


Fig. 3, the panel layout, and Fig. 4, view of the bottom of the baseboard, showing battery wiring.

workmanship and the helpful directions which accompanied his kit. In fact many of the present home-made 5-tube sets would give better results if the first two tubes were cut out entirely and only the detector and audio-amplifiers employed.

For these reasons the following points were decided upon and form the essential features of the set about to be described:

1. It should have a minimum of controls, consistent with efficiency.

2. It must omit all unnecessary apparatus.

3. It should be so simple that the average layman could construct it without trouble and have it equal the 4-tube sets.

Many schemes were tried. We used spider-web coils, basketweave coils, tube wound, D coils and others, but finally picked the toroidal coil. These should be of the proper inductance for the condensers used. The photographs show .0005 mfd. Heath Radiant condensers, the coils being in round housings to the rear of each condenser.

LIST OF PARTS

Three .0005 mfd. Heath Radiant Variable Condensers (No. 23A).
Three stage Heath Radiant Resisto Former.
Three Hi-Constron tubes for resistance AF.
Two Heath sockets (No. 206) for RF and detector.
One A battery switch S1.
Three Summit RF transformers.
Three rheostats.
One grid condenser .00025 mfd. (C4).
One grid leak, 2 meg. (R3).
One SC jack (J2).
One fixed condenser, .002 (C5).
Batteries, aerial wire, two 201A tubes, speaker, ground clamp, lead-in wire.

Resistance—coupled AF was used, because of the quality it produces. The set is wired left to right (Fig. 2) for the RF and detector, right to left on the audio. This brings the sole jack at left (Fig. 3). Heath's Radiant Resisto Former was used for the three AF stages. It is a complete unit, the wiring shown in Fig. 5 for the AF being unnecessary to follow, since the posts on the unit are marked.

The tubes used were Hi-Constron, a Cleartone product, especially adapted for resistance AF. The tube works as detector and RF amplifier, but is not recommended for such. It stands a very high plate voltage and is especially a resistance AF tube.

Those who decide to build the set, without using toroidal coils, may wind 10-turn primaries, 45-turn secondaries, on 3½" diameter tubings, for L1, L2, L3, L4, L5, L6, although L6 may require less than 45 and nearer 35. Spiderweb coils could be 15-turn primaries at hub, 50-turn secondaries, total diameter 5½". The wire is No. 22 SCC, but the toroids are better here.

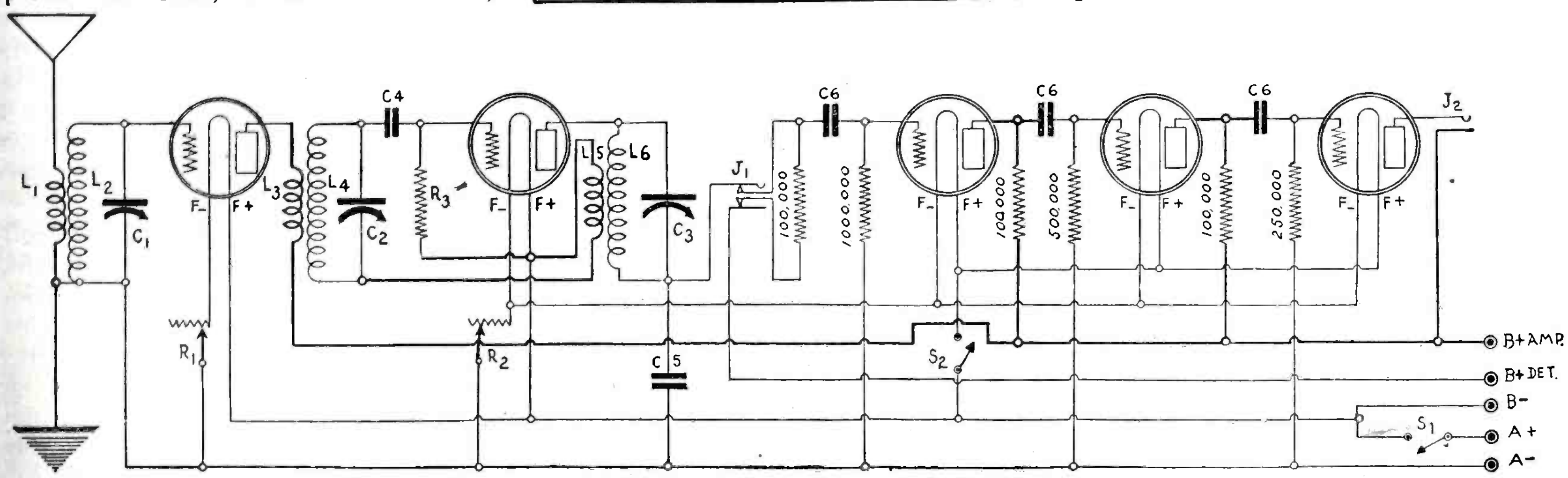


Fig. 5.—The circuit diagram. If a power rheostat is on hand it may be used for R2. Otherwise R2 would control only the detector tube, while the three audio tubes would have one rheostat and S2 would be omitted. Thus there would be three rheostats and one master A battery switch, as shown on the panel (see Fig. 3). The circuit employs a tuned RF stage ahead of a regenerative detector, followed by three stages of resistance AF. Note how the secondary L4 is put in inductive relationship to L6, the plate coil. The jack J1 may be omitted.

A Short Wave Set of Unusual Merit

(Continued from Page 27)

is not unlike that of most sets, but it must be kept in mind that the dial must be turned very carefully and slowly in order to pick up the short waves. It is very easy to pass over a dozen stations close together on the dial if care is not exercised. But having once tuned in a station, it is a simple matter to bring it in with exceptional volume. Patience is required and a steady hand.

If the antenna system absorbs too much energy, shorten it or else increase the amount of capacity in the feed-back condenser. When excessive absorption occurs, the set usually fails to oscillate properly over the entire wave-length range, creating what is known as "dead-spots." And, failing to oscillate means that the chances for reception of signals become nil.

It is well to repeat here that the condensers should be wired so that the rotors are at "ground" or low potential. In the case of the feed-back condenser, the rotor should be connected to the antenna.

There are a great many stations now operating on 80 meters. In fact, conditions are as bad on this wave length as they used to be on 200 meters.

Much better results can be had on 40 meters and still better on 20 meters, than on 80. It is obvious, therefore, that the near future will witness a general migration to the short wave-length bands. For daylight communication, 20 meters have been found an excellent medium, messages being steadily sent and received across thousands of miles of space when the sun is shining high over head. What a different condition that when operating on 200 meters! Heretofore daylight communication was not to be attempted, as it was wholly unreliable, but now with the use of 40 meters for night transmission and 20 for daylight, twenty-four hours of uninterrupted and ideal service can be obtained.

Most of the operators on the air who are using 20 and 40 meters employ pure D.C. current supply. Not only can they cover greater distances, but the note is usually of a particularly high-pitched character and is easily read through static. Fading is very marked on short wave lengths, and it has often been noticed by the writer that whenever the sun was obscured by a cloud, a 20-meter signal would be considerably weakened. Forty meters at night offers a splendid medium for long distance communication, and one should not be surprised to learn that within approximately a 500-mile radius you will not be able to work anyone nor perhaps hear any signals. Beyond this distance, signals come in like the proverbial "ton of brick."

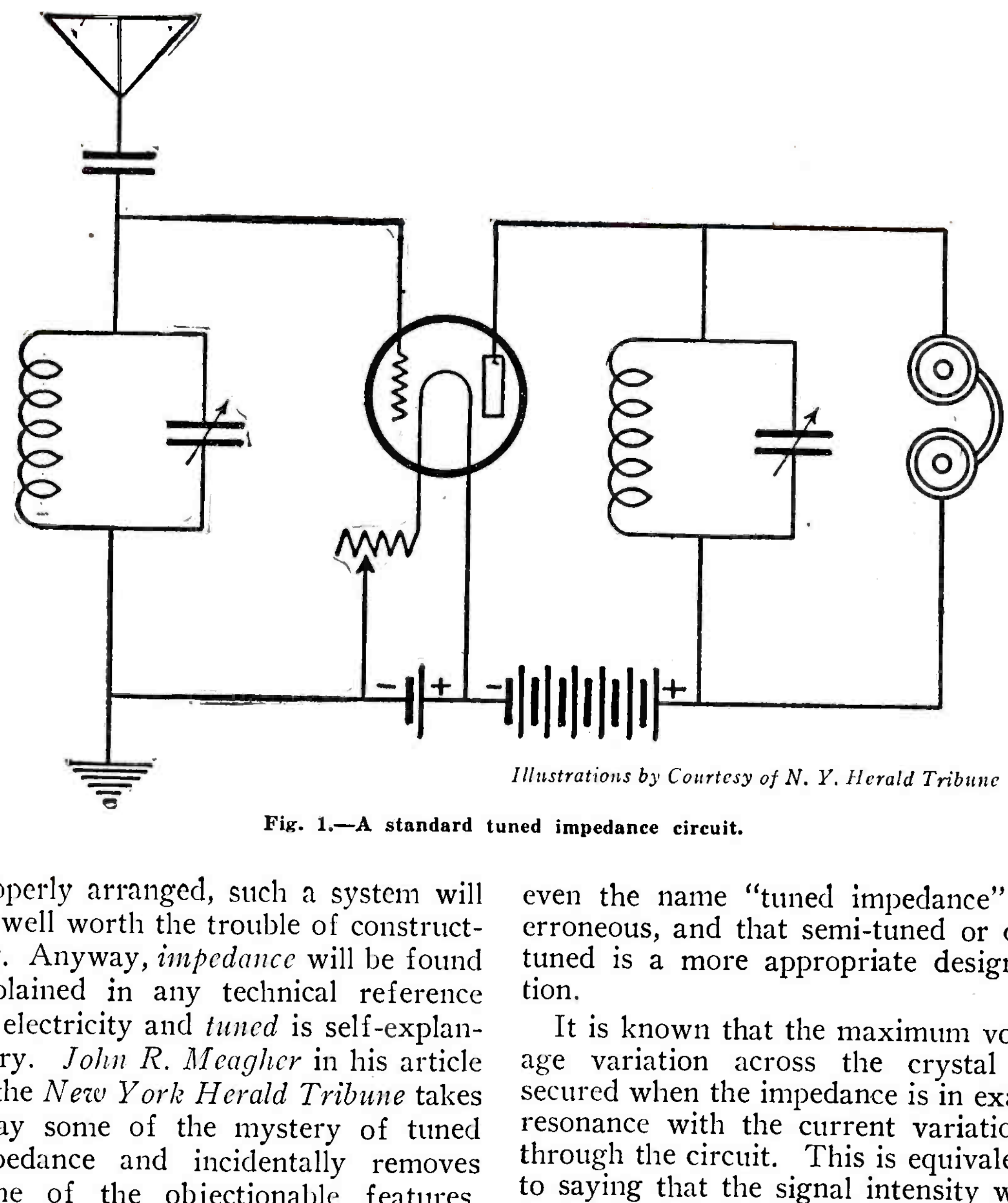
A One-Tube Tuned Impedance Set

If Properly Constructed Excellent Distance Results May Be Expected with this Receiver

THE broadcast fan and experimenter who keeps in touch with the latest circuits and is doubtless well acquainted with "tuned radio frequency," tuned "this" and tuned "that," may not readily find "tuned impedance" in his lexicon. Suffice it to say that if properly arranged, such a system will be well worth the trouble of constructing. Anyway, *impedance* will be found explained in any technical reference on electricity and *tuned* is self-explanatory. *John R. Meagher* in his article in the *New York Herald Tribune* takes away some of the mystery of tuned impedance and incidentally removes some of the objectionable features. The result is a highly satisfactory one-tube and crystal receiver, which is readily subjected to the conventional audio amplification for loud speaker work. The description follows:

Recently we had occasion to design a one-tube receiver for use with a short indoor antenna. The so-called "tuned impedance" method of radio-frequency amplification in conjunction with a crystal detector presented itself as being most satisfactory for the purpose, so we made a study of this system with an idea of developing the most efficient circuit.

The first point to be considered was the method of coupling or the type of tuned impedance to couple the tube and crystal. The usual condenser tuned impedance circuit is shown in Fig. 1. Here, on consideration, it became apparent that the condition for maximum efficiency has generally been overlooked. Indeed, we shall see that even the name "tuned impedance" is erroneous, and that semi-tuned or de-tuned is a more appropriate designation.



Illustrations by Courtesy of N. Y. Herald Tribune

Fig. 1.—A standard tuned impedance circuit.

It is known that the maximum voltage variation across the crystal is secured when the impedance is in exact resonance with the current variations through the circuit. This is equivalent to saying that the signal intensity will be greatest when the impedance is tuned to the frequency of the signal. But in the usual form of this circuit it is not possible to tune the impedance to the frequency of the signal because self-oscillation will be set up when the value of impedance is sufficient to make the plate voltage variations large enough to excite the grid through the grid-plate capacity.

Impedance vs. Self-Oscillations

The critical value of impedance to cause self-oscillation is generally very much lower than the maximum or infinite impedance that results when the circuit is in resonance with the incoming frequency.

Furthermore, as the plate filament resistance is in shunt to the impedance and as this resistance may be as low as 10,000 ohms, the tuning adjustment is not sharp, so that actually the usual circuit of this type is not selective, or at least no more so than any other plain regenerative receiver.

We have, then, the problem of obtaining maximum voltage variations across the crystal circuit, while at the same time limiting the voltage variation between plate and filament to a value where self-oscillation takes place only when the impedance is in exact resonance with the grid circuit.

A very simple solution for the problem is to provide means for shunting the plate circuit across only a portion of the impedance, so that while the impedance may be sharply in resonance with the grid circuit, yet the voltage variation across the plate portion may be restricted to a point where the tube is just on the peak of regeneration or the verge of self-oscillation.

Under such conditions the tuned impedance may really be tuned to the incoming frequency and the crystal circuit partakes of all the selective qualities of any tuned circuit.

As an indication of just what this amounts to, let us cite the case of our own experimental set.

At first, using the circuit of Fig. 1, when the grid circuit was tuned to a broadcasting signal on 455 meters, the plate impedance had to be adjusted to somewhere about 360 meters; a higher setting causing self-oscillation. With such tuning we frequently heard 360-meter stations quite well, even though the grid circuit was tuned to 455 meters! However, with the improved circuit of Fig. 2, both grid and plate circuits had to be tuned to the signal, and as a result we secured not only greater selectivity but also greater volume.

The curve of Fig. 3 shows that a tuned impedance circuit of the ordinary type is generally better termed a de-tuned impedance. For instance, if the wave length A is to be received and the impedance is tuned to that frequency, self-oscillation is caused owing to the fact that the impedance is too great, as explained previously. If, in order to stop self-oscillation, the impedance must be lowered to, say, a value of ten units, the wave length of the impedance must be changed to B, at which setting the impedance to the frequency A is only ten units. The circuit is consequently off tune or de-tuned.

The improved circuit permits one to control the amount of impedance without de-tuning the circuit. And, in addition, through use of an adjustable resistance in the grid circuit, together with an arrangement of parts to minimize capacitive and magnetic feed-back, a higher value of impedance may be used. Therefore, a greater voltage variation on the plate and a similarly increased variation across the crystal may be secured. And, in addition, because of the lower damping effect of the plate filament resistance, the impedance or resonance curve is much sharper and wave lengths other than that to which the circuit is tuned will pass through without causing interference.

The dotted line of Fig. 3 represents the impedance characteristic of the portion of the tuned circuit included between the plate and filament. The maximum value of this impedance may be changed by increasing or decreasing the portion of the circuit included in the plate circuit. An amount is chosen just sufficiently high to cause self-oscillation over the entire wave-length range when the resistance in the grid circuit is cut out. Self-oscillation or regeneration control is then effected entirely through adjustment of the grid circuit resistance.

A receiver of this type has many excellent features. The single stage of tuned radio-frequency amplification provides sensitivity, and consequently opens the possibility of long-distance reception, while the separately tuned circuits afford the necessary selectivity and the crystal assures excellent quality. All of this with but two main controls!

A glance at the picture drawing will reveal the simplicity of construction. The total cost need not exceed $25, and may be much less.

The list of parts is as follows:

- 2 23-plate variable condensers.
- 1 standard socket for panel mounting.
- 1 .0001 mfd. fixed mica condenser.
- 1 adjustable crystal detector.
- 1 30-ohm rheostat.
- 1 400-ohm potentiometer.
- 2 cardboard or bakelite forms (thin), 3 inches in diameter and 2 inches long.
- ⅛ pound of No. 28 double cotton covered wire.
- 1 7 x 14-inch panel and cabinet.

Binding posts, accessories, etc.

Making the Coils

On each form draw a line parallel to the axis and on each line, three-sixteenths of an inch from each edge, drill small holes to pass the binding post screw. Directly opposite these holes drill others for the fastening brackets.

Wind fifty turns of the No. 28 double cotton-covered wire on each form. Each coil will take about 1.2 inches of winding space.

Then mount each form on the end plate of its tuning condenser and connect the condenser terminals to the binding posts on the form.

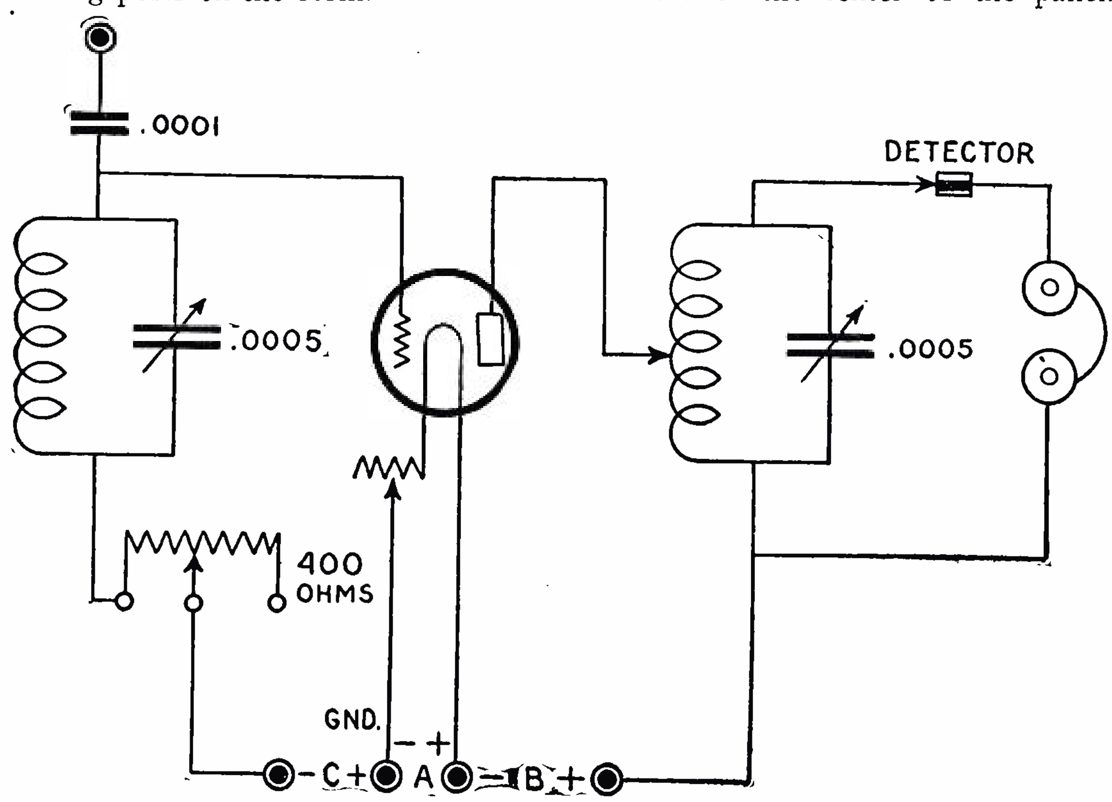


Fig. 2.—An improved tuned impedance circuit.

Take one coil, which is to be for the plate circuit, and make a tap at every tenth turn so there will be four taps in addition to the two ends of the winding. Make these taps by lifting a section of the desired turn with a blunt instrument and scraping off the cotton covering for about a quarter of an inch. Solder a small tab of copper foil to the exposed wire and slip a bit of tape or insulating cloth under the tap, so there will be no danger of shorting to the other turns. The tap should be made at a place convenient to the top of the panel, as connection to them is to be made with a metal clip.

Lay out the panel along the lines suggested in the sketches. The shaft holes for the condensers should be lo-

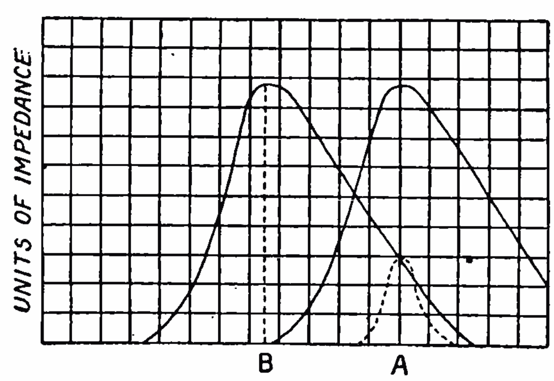


Fig. 3.—Graph showing value of impedance.

cated four inches from the bottom and three inches from each edge. The grid circuit condenser should be arranged so the coil will be at right angles to the plate coil in order to reduce magnetic coupling so the greatest amount of impedance may be used in the plate circuit.

Mounting the Parts

The rheostat and potentiometer shaft holes should be spaced about two inches from the bottom and five-twelfths inch from either end of the panel.

The crystal detector should be mounted in the center of the panel. The vacuum tube socket should be arranged so the opening for the tube extends in back of the rheostat and potentiometer. So it should be set back from the panel either on a wooden strip or with long extension mounting screws and spacing collars. The binding post strip also should be mounted back of the panel on extension threaded rods.

These details are shown in the sketches and will be better understood when all the material is at hand.

Wiring the Set

In wiring the set it is best to use round tinned bus bar or plain soft drawn copper wire for connections. Fasten all joints as securely as possible, using solder, if convenient.

Wire the filament circuit first. Connect a wire from the positive A battery binding post to the positive terminal of the tube socket; from the negative terminal of the tube socket to one of the two contacts on the rheostat, from the other rheostat contact to the negative A battery binding post on the strip.

The grid circuit next. Run a lead from the aerial binding post to one contact of the .0001 mfd. fixed condenser and solder the other contact of the same condenser to one terminal of the grid coil and condenser. Connect the other coil and condenser terminal to the right-hand contact, looking from the front, of the potentiometer. Connect the center contact of the potentiometer to the C battery binding post. Leave the third contact of the potentiometer vacant; it is not to be used.

Make the connection from the grid terminal of the socket to the proper binding post of the grid coil and condenser.

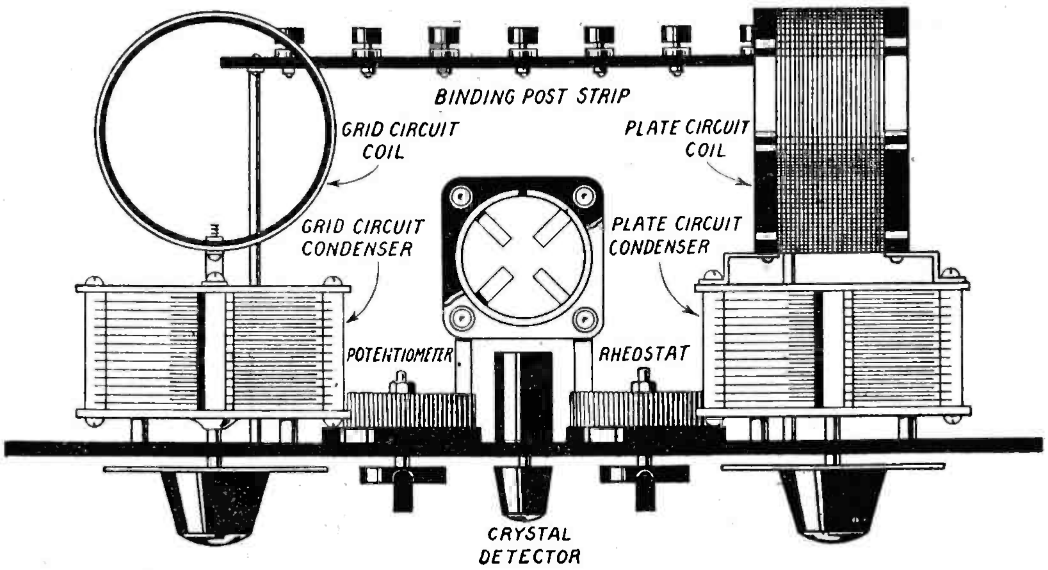


Fig. 4.—Picture diagram showing how the parts in the set may be arranged.

The plate and crystal circuits next. Solder a flexible and well-insulated lead to the plate terminal of the socket and make it sufficiently long to reach the row of taps on the plate coil. Solder a small clip to the free end of this wire and temporarily fasten the clip to one of the taps. Connect the binding post of the coil which is connected to the rotary plates of the condenser to the positive B battery binding post, and from there to one of the headset binding posts. Connect the other headset binding post to the crystal of the detector and connect the point of the crystal to the stationary plate contact of the variable condenser and coil.

Operating the Set

The set may be used with an aerial of almost any size, though where interference is usually encountered, as in the neighborhood of several powerful transmitters, it would be advisable to restrict the length to about 100 feet.

Any dry cell or storage battery type tube may be used. The UV199 is quite as good as any other for this set and is most economical in battery consumption. An adaptor must be used with it in order that the special base may be adapted to the standard socket.

Put the clip of the plate lead on about the center tap, for the time being, and try tuning the set.

It will be found the stations are tuned in at approximately identical settings of the two condenser dials.

Self-oscillation or regeneration should be under direct control of the adjustable grid circuit resistance; if manipulation of this control, so as to include resistance in the circuit, does not stop self-oscillation at any setting of the dials, the plate clip should be placed on a tap nearer the B battery connection so fewer turns will be included in the circuit. On the contrary, if the set does not oscillate when the tuning dials are adjusted to resonance and the resistance in the grid circuit is cut down, place the clip on a tap nearer the crystal connection to the coil. One of the taps will provide the desired control where the grid resistance can start or stop self-oscillation over the entire range. That tap should be used. When the proper tap is found the two variable condensers should be used as wave-length controls only; reserving to the grid resistance the function of regeneration control.

Proper adjustment of the crystal is not difficult in this type of circuit, as the regenerative effect seems to have a sensitizing action on the mineral.

The rheostat should be set for best signal strength with the lowest light from the filament and then left alone till the A battery starts to drop off in voltage.

If a UV199 tube is used with three standard size dry cells for the A battery and large size B batteries, the A battery should last for almost six months; and the B battery should stand up for even a longer period, thanks to the use of the C battery.

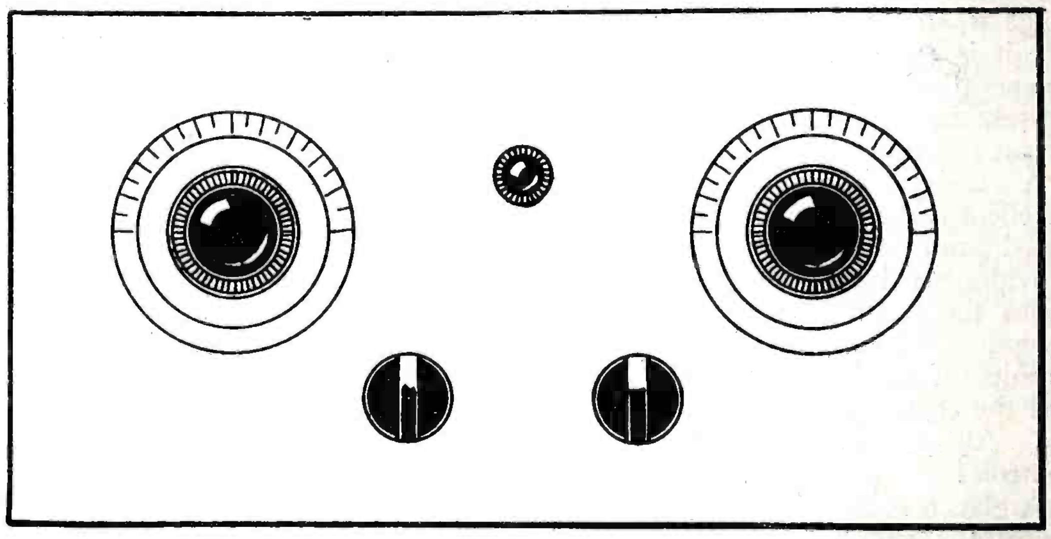


Fig. 5.—A suggested panel layout.

A standard two-stage audio-frequency amplifier may be added to this set and will provide good clear long-distance reception on the speaker that can be excelled only by much more complicated outfits.

The Resistance of Rheostats

MANY readers desire to know how to figure the resistance of a rheostat for certain types of tubes and for one or more tubes. Before one can determine the resistance of the rheostat it is necessary to know the voltage and the current of the tube and the number of tubes to be used from the one rheostat. If we know the voltage and the current it is only necessary to divide the voltage by the current to find the resistance.

For example if the voltage is six and the current one then the resistance should be six ohms. If the voltage is five and the current 1/4 ampere then the resistance of the rheostat should be twenty ohms.

Suppose we have two five-volt tubes to be controlled by one rheostat. In this case we add the amperage together and divide the voltage by the total current, thus giving us a resistance of ten ohms.

Suppose we wanted one rheostat to control four 201-A tubes. Add the amperage of each tube, which gives one ampere, and then divide the voltage (5) by this total current and we arrive at 5 ohms.—*N. Y. Evening World.*

How to Make the Clapp Receiver

Radio Frequency Tube Is Reflexed So As to Act as First Stage of Audio Amplification

THE set about to be described was designed by *James Klinton Clapp*, who is a graduate of the Massachusetts Institute of Technology, and at the time this set was designed he was technical radio editor of the *Boston Evening Transcript*, for which paper this set was designed. This particular interpretation of the Clapp receiver was built by *Charles H. Burnham*, a Boston experimenter, and is described in the following article from *The Christian Science Monitor*, Boston, Mass.

In the original design of the set under discussion certain conditions had to be met, one being that the set was to have not more than two tubes. Other conditions were that the set must give satisfactory headphone reception over considerable distances and loudspeaker operation over moderate distances.

Since the number of tubes available for use as amplifiers was limited, it was at once evident that a very sensitive detector must be employed. This limitation made it necessary to employ a tube detector, and to gain the utmost in sensitiveness, regeneration in the detector circuit was necessary. A comparative test of various tubes suitable for use as detectors showed that the performance of the D-21 Sodion tube was distinctly better than that of other tubes on the market, so that this type of tube was recommended by Mr. Clapp. The circuit, however, will operate with any of the usual tubes for a detector, but the results will not compare with those obtained with the D-21.

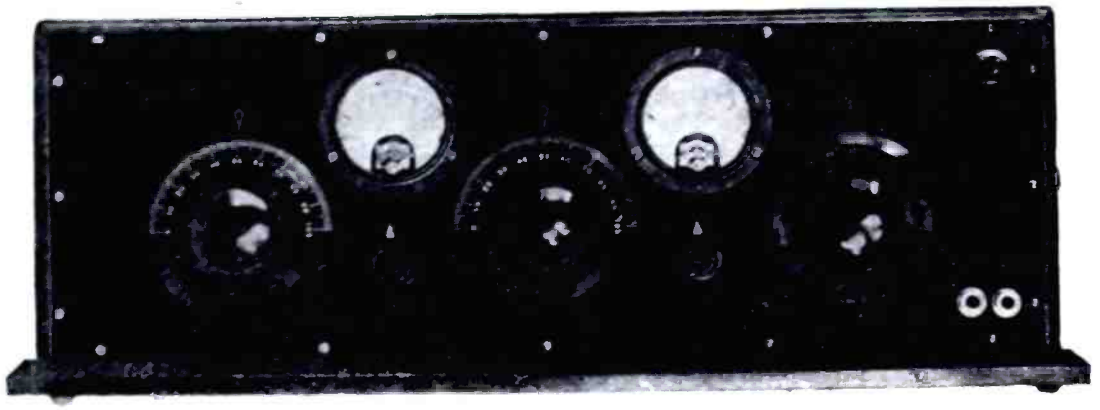
To provide increased sensitiveness to weak signals, and to some extent to provide for increased selectivity, a stage of radio-frequency amplification was found advantageous. The demand for both sensitivity and selectivity immediately limited the possible types of amplifier circuits to one of the "sharp tuned" class. As is well known, this type of circuit has an inherent tendency to oscillate, resulting in poor reception, so that some form of neutralizing had to be employed to stabilize the amplifier. There were a number of circuits available which would fulfil these conditions, and it remained to choose that type which offered the greatest possibilities in sensitivity and selectivity.

The combination of sensitive detector and sensitive radio-frequency amplifier resulted in a receiver circuit of remarkable range. However, the volume of signal obtained, even on comparatively nearby stations, was not markedly great. (A condition which does not meet the approval of the average listener.) It would have been a simple matter to add a stage of audio frequency amplification to obtain the desired volume of signal, but this method would have necessitated the use of a third tube, a procedure which it was necessary to avoid in keeping within the original limitations of two tubes. The radio-frequency tube was, therefore, made to serve for an audio-frequency amplifier tube by the process of "reflexing." Tests of this method of obtaining the desired audio amplification showed that the volume of the signal obtained was, to all intents and purposes, equal to that obtained from a separate tube.

In choosing a suitable type of radio-frequency amplifier circuit it was necessary not only to pick out a circuit which was simple and easy to stabilize when used as a "straight" radio-frequency amplifier, but also to choose a circuit such that the introduction of the necessary audio-frequency apparatus for reflexing would not render the balance of the circuit so critical as to be undesirable. After a number of trials of various well-known circuits, Mr. Clapp chose one which had qualities rendering it especially suited to the stabilization of a reflex tube. While this circuit is mentioned in technical literature ("Anti-Regenerative Amplification," L. M. Hull, QST, Jan., 1924, page 12), it had not been applied to the stabilization of a reflexed tube in so far as Mr. Clapp was aware.

Circuits Outlined

The circuits of the amplifier tube, showing the radio and audio frequency inputs, are shown in Figure 1. Here L-1 and L-2 compose a common form of fixed coupler, as used in many radiocast receivers. The signal desired is tuned in by means of the condenser C, the circuit L-2, C, being so proportioned as to cover the entire radiocast band of frequencies. In order to use the tube as a reflex amplifier, the secondary of an audio frequency transformer had to be introduced into the grid circuit of this tube, preferably between the tuning unit and the filament of the tube.



Illustrations by Courtesy of The Christian Science Monitor (Boston, Mass.)

Front view of the completed receiver built by Charles W. Burnham, a Boston experimenter.

The secondary winding of the transformer then became a part of the radio-frequency circuit, and, as the capacity of this winding is not generally large enough to provide an efficient by-pass for the radio-frequency currents, a small by-pass condenser, C-2, was provided across the terminals of this winding. The condenser C-2 had to be kept rather small, for if it were increased in size it would materially affect the audio-frequency amplification obtained from the transformer. A condenser of .00025 mfd. capacity provided an ample by-pass for the proper operation of the radio-frequency portion of the circuit, and at the same time had practically no effect on the operation of the audio-frequency transformer.

In most forms of neutralized radio-frequency amplifiers no use is made of the capacity of the secondary of the audio-frequency transformer or the by-pass condenser, if one is used, in the balancing of the circuit, and, as a matter of fact, the introduction of this condenser into the circuit often renders the proper stabilization very difficult to attain. In the form of circuit of Figure 1, this condenser forms a definite part of the balancing arrangement, so that, instead of being an undesirable factor, it becomes an absolute necessity. (In stabilizing a "straight" radio-frequency tube, a large honeycomb coil may be used in place of the audio-frequency transformer to obtain conditions for balance.) A second point of difference in this balancing circuit is that the internal capacity of the tube between grid and filament is utilized, as well as the internal capacity between plate and grid,

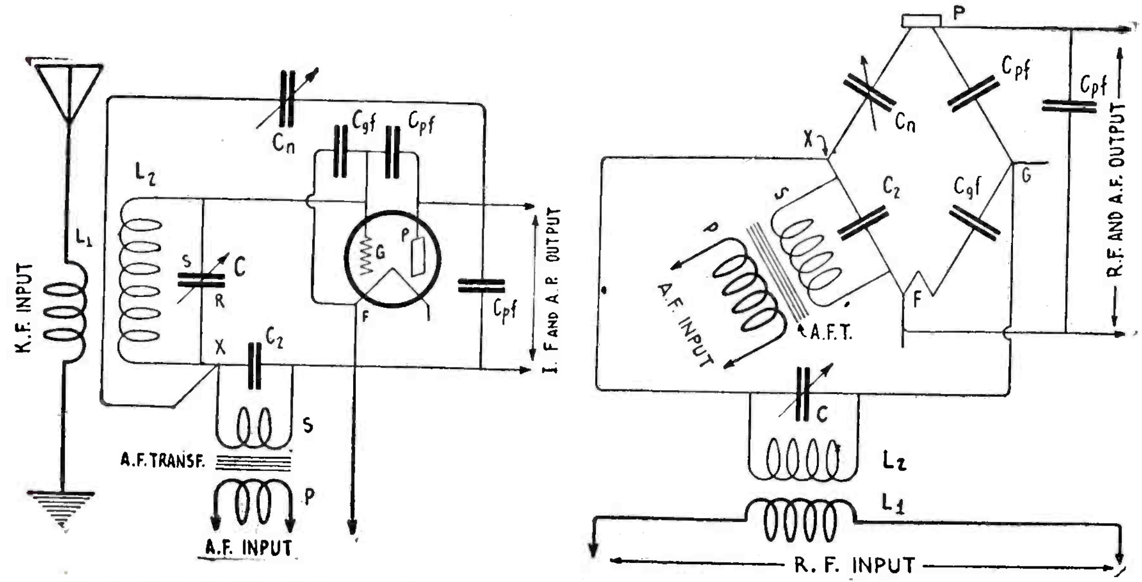


Fig. 1. The circuits of the amplifier tube showing the radio and audio frequency inputs. Fig. 2 at the right shows the schematic representation of the "Wheatstone Bridge" circuit employed in Fig. 1.

to obtain a balance. These capacities are represented in Figure 1 by the small condensers C-gf and C-pg, respectively.

Figure 2 shows the schematic representation of the "Wheatstone Bridge" circuit employed in Figure 1. The four corners of the bridge are respectively, the plate, grid, and filament of the tube, and the junction point "X" between the tuning circuit L-2, C, and the grid side of the audio-frequency transformer secondary. It will be noticed that all the arms of the bridge are capacitative, so that a balance is obtained between these four condensers for neutralization. Three of the four arms are fixed in capacity, so that all that is necessary to obtain a balance is to adjust C-n to the proper value. The method used in accomplishing this balance is given in detail later on. The capacity C-pf between plate and filament of the tube does not enter into the balancing arrangement.

The combination thus arrived at by Mr. Clapp, namely; one stage of tuned neutralized radio-frequency amplification, regenerative Sodion D-21 detector, and one stage of reflexed audio-frequency amplification, represents the results of trials of over twenty circuits, and gives the most in volume and sensitivity for radiocast reception, for the number of tubes involved.

Coil Windings

For the first radio frequency transformer a piece of bakelite tubing, three inches in diameter and three inches long, will be required. Use No. 24 D. C. C. copper magnet wire, starting the winding about one-half inch from one end of the tube. After the coil is completed, this will be called the top end of the transformer, and it will be found that the bottom end of the coil will be about one inch from the end of the tubing. This is to allow for any small brass angles which may be used to mount the coil on the baseboard. The wire may be securely fastened in place by passing the end through two small holes drilled through the tubing about one-quarter inch apart. Wind on 50 turns as closely and tightly as possible. Secure the end by passing it through two holes as was done at the top. This completes the grid circuit, or secondary, coil of the transformer.

Cut some strips of cardboard about one-half inch wide, and wind them around the outside of this secondary coil, having one edge of the strips even with the bottom end of the coil. Wind on enough of the cardboard to form a ring one-inch wide and one-eighth inch thick. On this ring wind the primary coil, making sure that the turns of the primary are wound in the same direction as were those of the secondary. The primary winding should have from 10 to 15 turns, depending upon the size of antenna with which the set is to be used. If the antenna is over 75 feet long, including the leadin, not over 10 turns should be used on the primary coil, but if it is not over 40 feet, including the leadin, 15 turns may be used without destroying the selectivity of the set. The ends of the primary winding may be passed through holes in the bakelite tubing, in the same manner as the ends of the secondary were secured. Figure 3 shows a sketch of the completed transformer, with the terminals of the windings marked with their proper connections.

The second radio-frequency transformer, used between the amplifier and the detector, is best wound on a variocoupler form, preferably of the 180-degree type. This is not necessary, however, and construction should not be held up simply because this type of mounting is not available. The essential thing is to get the proper number of turns on the stator windings, in order that the two variable condensers read alike, or nearly so. A common size of stator tubing is 3⅝ inches in diameter, and if this size is available, 40 turns of No. 24 D. C. C. wire will be just right. If the tube available is smaller than 3⅝ inches, more turns must be used, while if it is larger, fewer turns will be required.

A rough-and-ready rule which is handy here is to change the number of turns by two for every ⅛ inch difference in size between the tube available and the one of 3⅝ inch specified. Thus, for a three-inch tube we would use 40 + 5 × 2 or 50 turns, which comes out the same as specified for the first unit, which is wound on a three-inch tube. For a four-inch tube we would use 40 — 3 × 2 or 34 turns.

Now wind on a ring of cardboard strip at the end of the stator which is nearest to the rotor. The ring should be about ½ inch wide and ⅛ inch thick, as on the first transformer. Over this ring, and in the same direction as the first winding, wind the same number of turns as were used on the primary of the first transformer, using No. 24 D. C. C. wire. The ends of this winding may be fastened through holes drilled in the stator form. This completes the transformer.

In order to obtain regeneration, the rotor coil is coupled back on the grid circuit, or secondary coil of this transformer, the rotor coil being connected in the plate circuit of the detector tube. In this method the variation in coupling, accomplished by moving the rotor with respect to the stator, is the means used for regulating regeneration. The rotor coil must not be too large or else it will be difficult to control oscillation in the detector circuit. A coil of from 25 to 30 turns of No. 24 D. C. C. wire on a cylindrical rotor form 3 inches in diameter is ample for the Sodion D-21 tube.

If one of the usual type of tubes is used as detector the number of turns on the rotor will have to be cut down considerably, depending upon the ease with which the tube oscillates. If a ball form of rotor is used a few turns should be added, while if the cylindrical form is larger than 3 inches a few turns should be removed. The number of turns is not critical, and it may be 30 turns irrespective of the size or form of rotor used. This rotor should be wound in the same direction as the primary and secondary coils of the second transformer. Figure 4 shows a sketch of the completed second transformer with its rotor, and with the terminals marked with their proper connections.

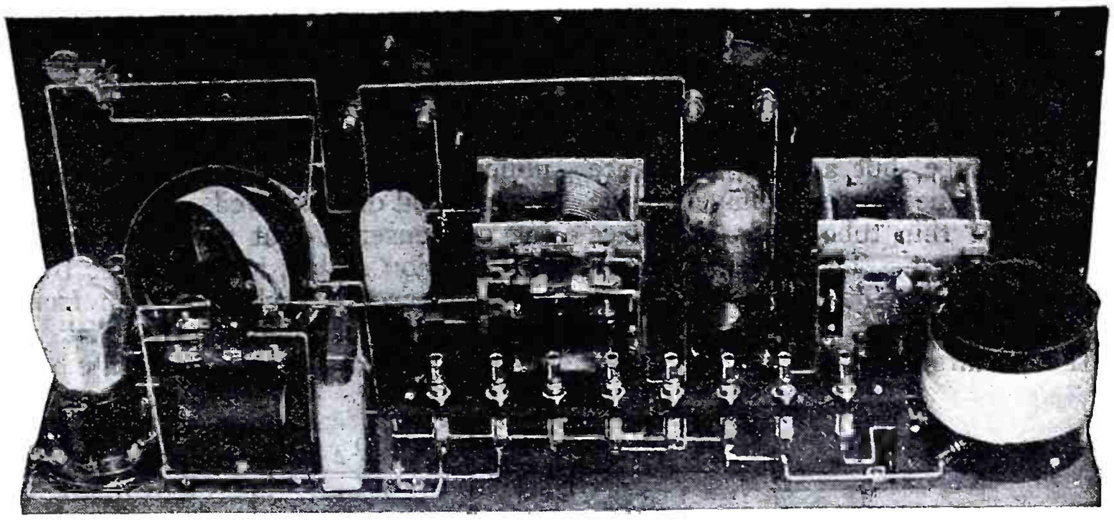
Set Construction

The accompanying photograph shows an interpretation of the Clapp receiver worked out by Charles H. Burnham. The panel arrangement and wiring layout are clearly shown.

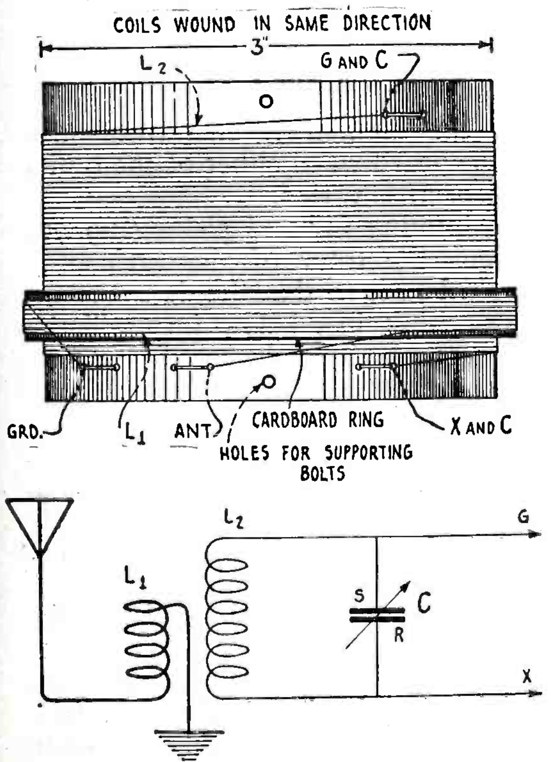
The best size of panel to use is 7 x 21 inches, as this is the size which will fit a standard cabinet. The baseboard for this size panel should be 6¾ x 20 inches. This will allow the whole set to be slipped into a cabinet which is 7 inches deep back of the panel. It is not essential that the parts be mounted as shown, as far as the operation of the set is concerned, and the constructor may use his own discretion and ingenuity as to the panel layout and location of parts.

In wiring the set the usual precautions should be taken against having grid and plate wires parallel to each other, and all leads should be as short and direct as is possible and still keep the wiring neat. Extreme care should be used in wiring the radio frequency transformers, as it is very important that these transformers be wired correctly. On the first transformer the top of the primary winding is connected to the ground, and the bottom of this same winding is connected to the antenna. The top of the secondary winding is connected to the stator plates of the tuning condenser C, and to the grid of the first or reflex amplifier tube. The bottom of the secondary winding is connected to the rotor plates of the tuning condenser C, and to the junction point "X." These connections are plainly shown in the accompanying diagram.

On the second radio-frequency transformer the end of the secondary winding which is farthest away from the primary winding is connected to the stator plates of the tuning condenser C-1 and to the grid condenser GC on the detector tube. The other end of the secondary winding is connected to the rotor plates of the tuning condenser C-1, and to the nearest negative "A" battery lead. If any other tube than the Sodion D-21 is used, this latter connection should be made to the positive "A" battery instead of the negative. The end of the primary winding nearest the center of the stator is connected to the top terminal of the telephone jack. The other end of the primary winding is connected to the plate terminal of the reflex amplifier tube socket. This is the familiar "reversed" primary connection. If the coupler is of the 180-degree type care must be used in the connections of the rotor, but if it is of the 90-degree type no particular attention need be paid to the order in which the rotor connections are made, unless the rotor can be moved through only 90 degrees. In such case the connections should be made as for the 180-degree type.



A rear panel view of the receiver built by Mr. Burnham. Note the neat arrangement of parts and wiring. This set can be built from standard parts.



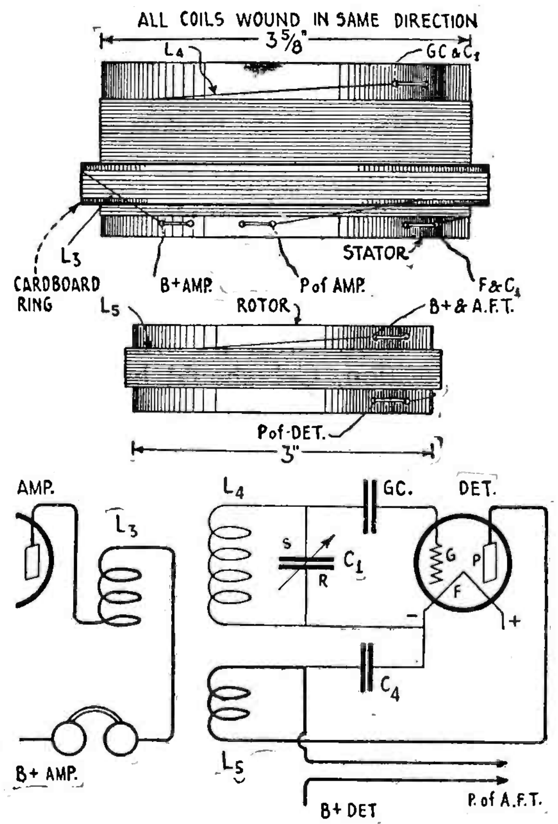


Fig. 3. The completed transformer with the terminals marked for proper connections. Fig. 4 at the right shows the second transformer with its rotor and terminals marked for connections.

In the diagram the rotor form is indicated as outside the stator form merely for clearness. In position, the rotor would be moved upward until it is wholly or partly covered by the stator. With the rotor windings in the same direction as the stator windings the connections are as follows: the end of the rotor nearest to the grid terminal of the stator is connected to the plate terminal of the primary of the reflexed audio-frequency transformer, usually marked "P." The end of the rotor farthest from the grid terminal of the stator goes to the plate terminal of the detector tube. If the windings of the rotor are in the opposite direction to those of the stator the above rotor connections will be reversed. These connections are all clearly indicated in Figure 3. It will be noted that a by-pass condenser C-4 is placed between the end of the rotor coil attaching to the primary of the audio transformer, and the negative "A" battery line. The value of this condenser should be .001 mfd.

The mounting of the balancing condenser, C-n, will depend upon the arrangement of the other apparatus. This condenser is usually mounted where it can be held in place by the wiring of the set. Since it should not be touched once the set is properly balanced, there would be no advantage in mounting it on the panel, especially as it would disarrange the panel design and would be very apt to be thrown out of adjustment. For a balancing condenser, one with at least 5, or better, 7 standard size plates, or one with maximum capacity equal to such a condenser, must be used. The usual type of "Neutrodon" or "Midget" condenser is not suitable for use in this circuit. In the photograph of the back of the set, the knob of a special balancing condenser for this circuit will be seen between the two tuning condensers, and just behind the first tube.

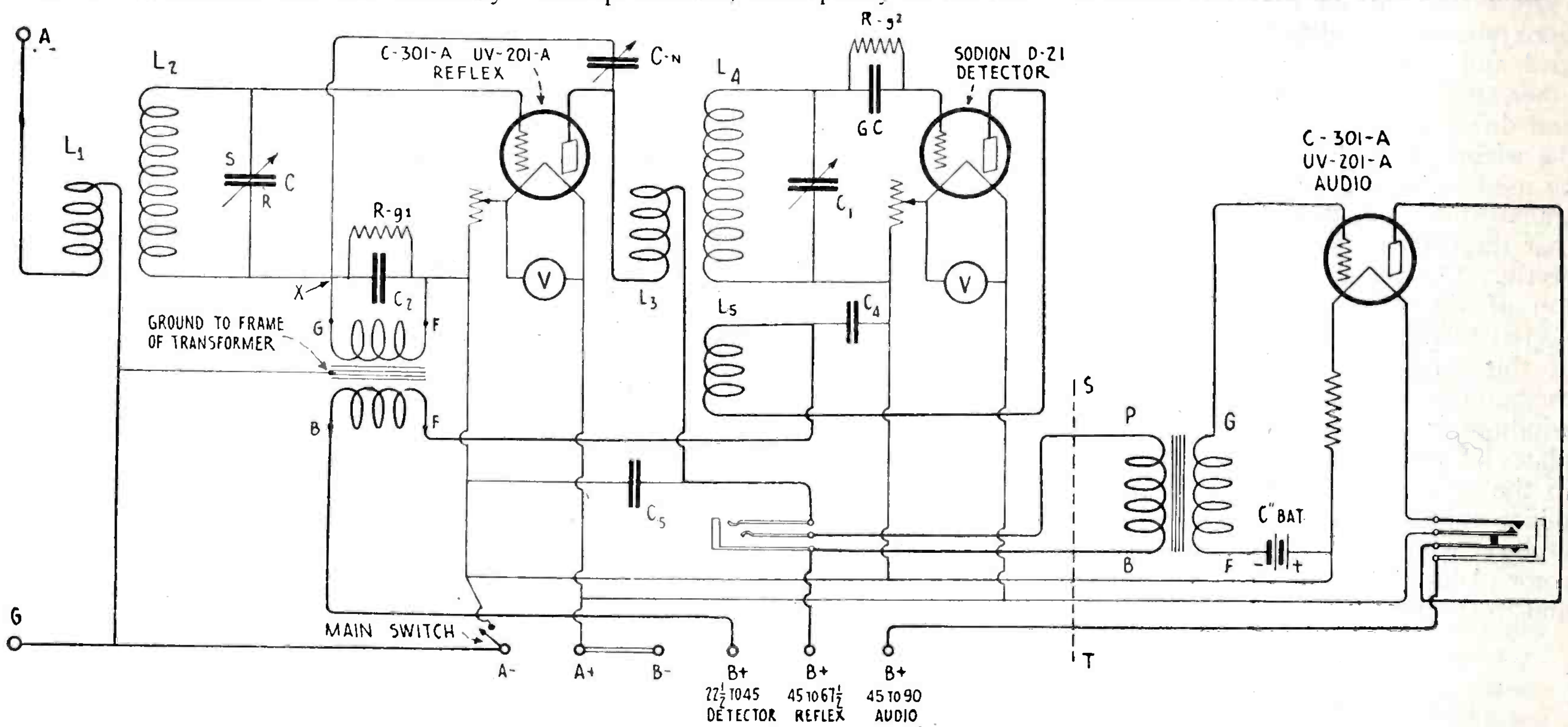
The wiring of the third tube, which is a "straight" audio-frequency amplifier that has been added to the original two tube set, is clearly shown in figure 3. The dotted line ST marks the point at which the third tube is added to the two tube set. The by-pass condenser C-5 is of .001 mfd. capacity, and is for the purpose of preventing a shift in the tuning of the receiver, which would otherwise be experienced in changing from two tube to three tube operation. This condenser is not necessary when the third tube is not put into the set, but is sometimes found to be of advantage even on a two-tube set.

In order not to upset the symmetry of the panel, no rheostat is used on the third tube, but a fixed resistance set to give the proper voltage on the filament of this tube takes the place of the rheostat. The tube is turned on and off by a filament control jack for the last stage.

If the directions for the assembly lead to its proper binding post, and insert the "B" battery leads.

To balance the set, first set the tuning condensers C and C-1 at maximum. Set the rotor of the variocoupler at minimum. Set the balancing condenser C-n at minimum. In case the special balancing condenser is used, it should be set so that the moving plate is just barely touching the mica disk. Insert the telephone plug in the first jack and light the reflex amplifier tube only. Have the antenna and ground disconnected. Set the tuning condenser C-1 at about 80 (on a 100 division scale), and vary the tuning condenser C back and forth from 70 to 90, rather rapidly. If a click or thump is heard, the capacity of the bal- If the clicks are still not heard, simply omit the neutralizing condenser and all the process involved in balancing.

The next step is to attach the antenna and ground and light the detector tube. If the detector tube used is of the Sodion D-21 type, it will have to burn for a minute or two until the heater has had an opportunity to warm up the tube, before the full results can be obtained. If volt meters are used, both tubes should be turned up to five volts, but if no volt meters are used, it is a good plan to test the voltage on the filaments with a small pocket volt meter and mark the setting of the rheostats, so that the tubes will not be overloaded. When the rotor is advanced far enough to throw the detector tube into oscilla-



Complete wiring diagram of the Clapp set as constructed by Mr. Burnham and shown in the accompanying photographs.

of the radio-frequency transformers have been closely followed, and the tuning condensers have maximum capacities of .0005 mfd., the tuning range of the receiver will be from 180 to 585 meters, more than covering the present band of broadcast wavelengths. Furthermore the two tuning condensers will read practically alike throughout the tuning range of the receiver, on the two tube set. On the three tube set the first, or antenna tuning condenser, will gain slightly on the second tuning condenser as the capacity is increased.

After checking up the wiring according to Fig. 3, insert the tubes in the sockets and connect the "A" battery to the proper binding post. Now turn on the filament switch and rheostats. If the tubes light the "A" battery circuit is correct. Next, disconnect the negative "A" lead and insert it in the binding posts intended for the positive "B" battery leads. When this is done, if the tubes light up, there is an error in the connections which must be found and eliminated before the "B" battery can be safely connected with the set. If the tubes do not light, it is safe to replace the negative "A" ancing condenser should be increased until this thump has been eliminated.

When the click or thump has been eliminated, with the condensers at about 80 on the scale, or if there is no thump heard with the condensers in this position, C-1 should be set at about 30 and C should be varied from about 20 to 40. More capacity will have to be added to the balancing condenser until the thump is entirely removed with this setting of the tuning condensers. This process should be repeated with C-1 set at 20 and then at 10. If, as the capacity of the balancing condenser is increased, a howl should be heard, it will be necessary to turn up the rheostat of the amplifier tube.

In some cases no click will be heard until the condensers are down as low as 5 or 10 on the scale. This is no indication of an error in the circuit, but, in all probability, is due to the particular tube being used as an amplifier. If no clicks appear in any position of the condensers, it is possible that the tube is automatically neutralized by the "stray" capacities of the wiring and of the apparatus. If no clicks can be obtained, try another tube in this socket.

tion, the familiar regenerative squeal will be heard when either of the tuning condensers is varied.

In hunting for and picking up new stations the rotor of the varicoupler should be set so that the detector tube is operating just below its oscillation point, and both condenser dials should be moved together. The dials should stay in step with each other if the coils have been accurately wound. If the dials do not stay in step, it is no sign that the set is not operating properly, and on the three tube set, as was said before, the dial of C will gain slightly on the dial of C-1 as the dial readings increase.

The plate voltage on the reflex amplifier tube should not be over 67½ volts, and it will probably be found that the tube will operate very well with but 45 volts on the plate. The plate voltage to be used on the Sodion D-21 tube depends very largely upon the tendency of the tube to oscillate. If it oscillates readily with a plate voltage of 22½ volts and no grid leak at R-g2, this combintaion will give satisfactory operation. If the tube will not

(*Continued on Page* 43)

A One-Control Regenerative Set

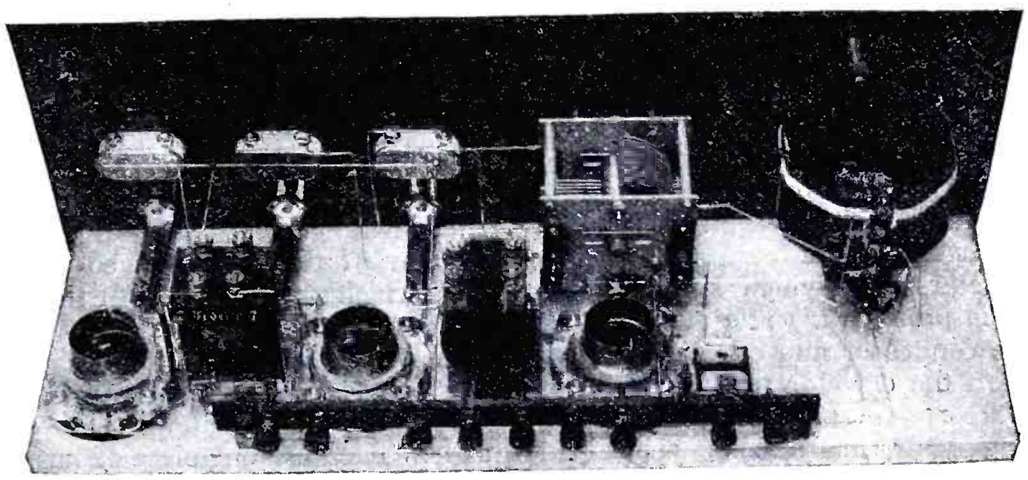
A Simple and Reliable Regenerative Receiver Employing a "Pickle Bottle" Wound Tuner

THE simplest form of a regenerative type of tuner is found in the "fixed untuned primary, tuned secondary, rotatable tickler coil." This unit is made up in many forms today and most of them are advertised as being "low-loss," or of low loss construction. The adjective "low" permits a wide and varied scope and does not confine itself to any upward or downward limit with respect to these losses. In other words, low-loss may mean, from some manufacturers' standpoint, anything from sort of low to so low that the losses cannot be measured.

R. A. Bradley describes a three-tube receiver in *Wireless Age*, New York, which employs several features in the way of low-loss design. Mr. Bradley's description follows:

For the past year radio fans have been literally swamped with various types of coil windings which have been more or less efficient. But in presenting the low-loss coupler in the "pickle bottle" form of winding we believe that a superior development of low-loss winding has been achieved. In the first place, one criticism to be found with some types of regenerative tuners is the fact that the rotor and stator windings are of different design. For instance—the rotor winding of spider-web form and the stator winding of basket-weave form. It is at once apparent that high inductance cannot be obtained from this combination because the magnetic lines of force do not coincide.

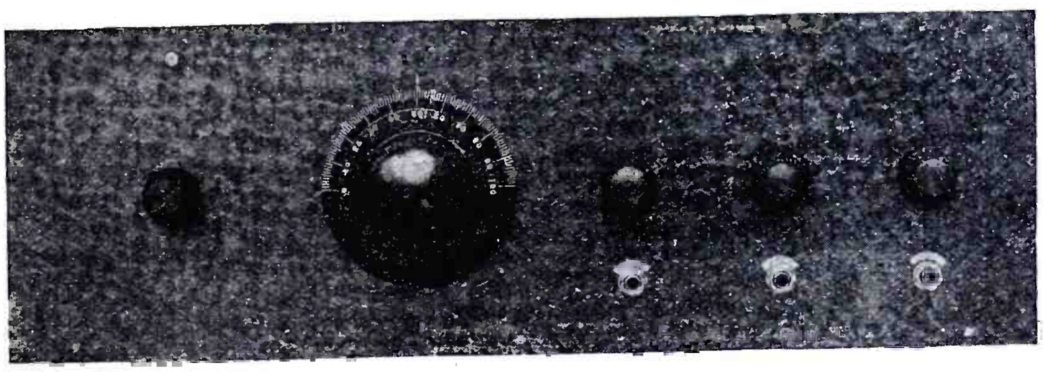
In the low-loss coupler used in this receiver all three windings are the same form although the diameters differ. The greatest source of loss in an inductance coil is the capacity and energy absorption in the tubing which supports the coil. If this can be removed as it is in the low-loss coupler used in this receiver the direct result is sharper tuning and greater signal strength, which are of course the essential features for DX reception. The only dielectric in the field of this coil is the insulated strip for mounting purposes and the one for the binding post connections. The coil form is self-supporting because of the nature of its formation and good large sized wire is used in its makeup.



Illustrations by Courtesy of Wireless Age (New York)

Back of panel showing all parts. The connections to the Pyrex tube sockets may be made either to a screw at the terminal or as we have it here, soldered to the socket prong contacts, themselves.

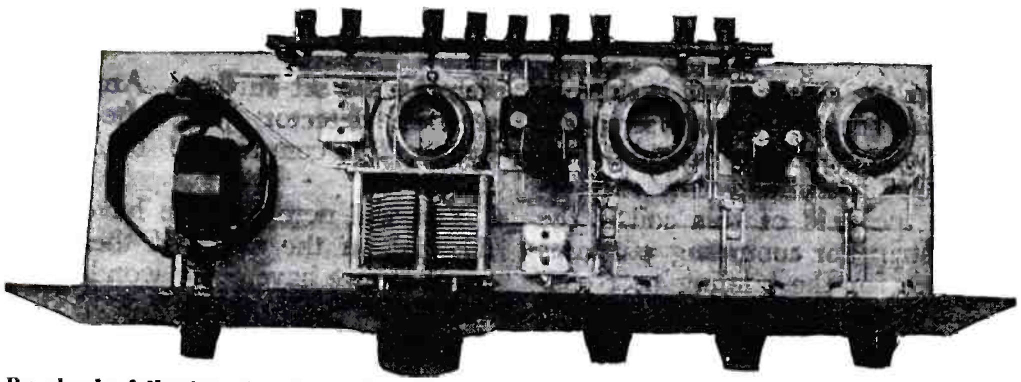
In connecting up the instrument, as will be shown later, it is possible to ground the main shaft which turns the rotor coil. This places the framework of the unit at ground potential and helps to prevent any capacity effect from the end of the dial. For anyone wishing to construct the standard three-circuit regenerative set, which still maintains its popularity due to its economy of parts and ease and simplicity of construction, we know of nothing to compare with the results obtained with low-loss coils and low-loss condensers. The receiver as shown employs various little conveniences which may be eliminated if desired to simplify the set further. Among these are the detector jack, the filament switch, the complicated binding post strip.



Front panel layout of the set. The frieze finish insuline panel forms a stunning background for the single dial and the rheostats and nickeled jacks.

You will note that we have omitted the dial on the shaft of the low-loss coupler. we have often wondered why a dial is used in this connection. The tickler coil and secondary coil is maxisides, nine times out of ten the home builder is not concerned how to place the dial when the coupling between the tickler coil and secondary coil is maximum or zero. The dial should be set so that as you turn the dial from zero to one hundred you should approach the regeneration point and pass it before 100 is reached. If you have your instrument adjusted in this manner then your dial reading may mean something to you, but personally we prefer to use simply a knob with which the fingers can fit closely around and adjust our tickler action in that manner. The condenser dial is an entirely different matter. Here your dial reading essentially mean something and it is very important that the plates should be entirely "in" when the dial is set at one hundred and completely "out" when the dial is set at zero.

The numbers themselves on the dial mean nothing at all. However, they should be used to draw comparisons. We have said this many times before, but there are still those who do not see the reason for it. Let us take the dial readings for this particular tuner as an example. WEAF was tuned in at 66 on the condenser dial and WJZ at 45½. The former's wave was 492 and the latter's, 455. Now if we are looking for a station whose wave-length is between 455 and 492 then we will know that on the dial this station should be received between the other two and the comparison of wave-length made with the dial readings. The curve for the National Condenser shunted across the tuner is unusually good. The stations are well separated and the tuning very sharp. The wave-length range of this receiver ran from below 200 meters to 575, covering all possible broadcasting requirements with the exception of the few stations below 100 meters, for which special apparatus is necessary. The arrangement of the condenser and coupler with respect to the detector tube is the most satisfactory arrangement. By so placing your instruments your grid leads as well as your other leads are made especially short. The wire runs from the stator plates of the variable condenser to the coil and from the other side of the tuning condenser to the grid condenser.

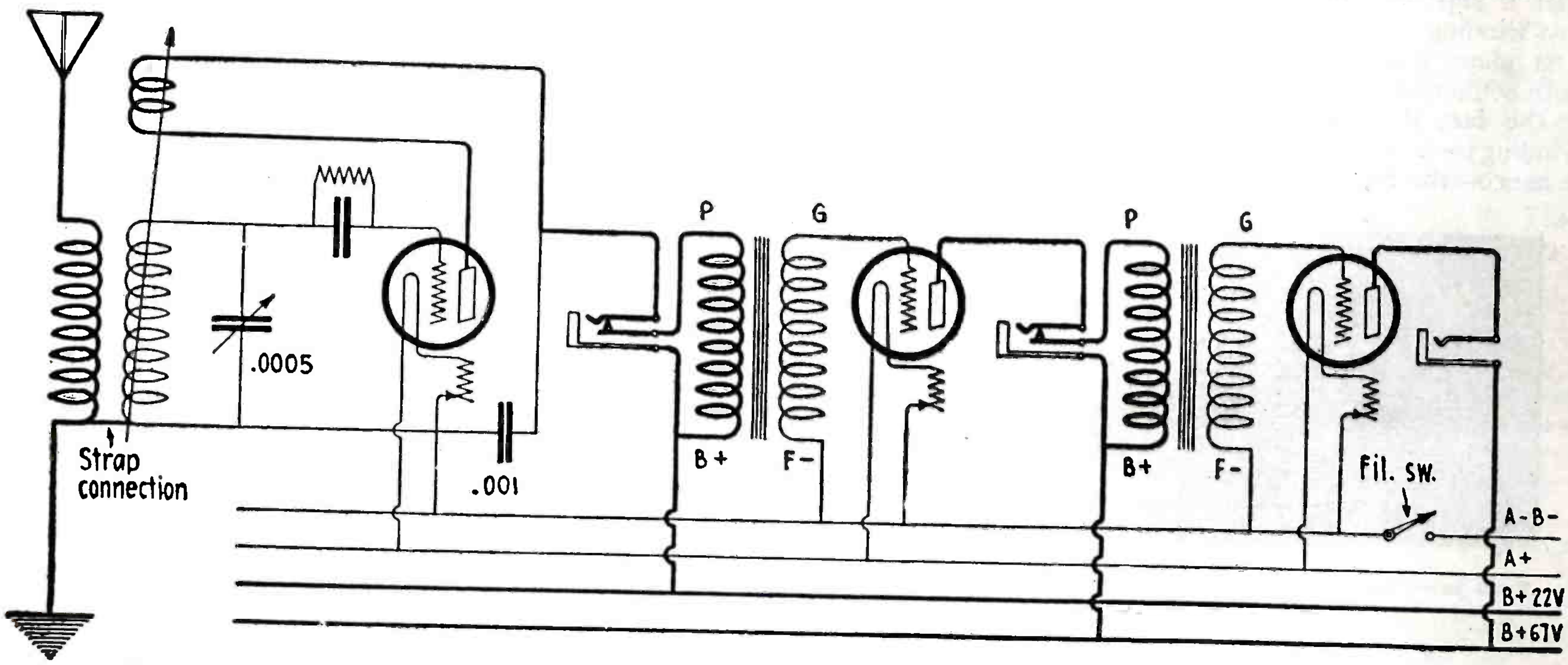


By closely following this illustration, the wiring of the receiver will be easily accomplished. Note the short straight connections of bare bus-wire.

view of the set will be helpful in this matter. The detector tube socket is directly behind the variable condenser. Line up your various pieces of apparatus so that the shafts are in straight line down the center of the panel. If a 7-inch panel is used, a pencil line drawn 3½ inches from either edge will serve well for this purpose. The audio frequency transformers are mounted between tube sockets, as this is the only logical arrangement. Keep these along the rear of the baseboard so that the jacks which protrude back of the panel will not interfere.

In wiring up the set figure out in your own mind beforehand all the places that connection will have to be made. Then use one piece of bus wire and connect the two furthermost instruments. If this is done correctly it will then be possible to, somewhere along its length, take off connections to the other instruments. Let us take, for instance, the positive filament lead. This runs from the last amplifier tube socket to the A plus binding post with several pieces of apparatus in between. One connection is made from your last socket to the binding post. Then with short pieces of bus wire connect the other tube sockets into the circuit. In the negative filament lead this is done the same way. It runs from the last Bradleystat on the second stage audio tube to the ground and A minus binding post. All the Bradleystats are placed in the negative leads. This negative lead runs to the ground binding post and places the negative A battery lead at ground potential throughout the circuit. As the rotary plates of the variable condenser and its entire framework are connected to the negative filament that is likewise at ground potential no hand capacity effects are noticeable even on the finest tuning. For best results with this receiver we recommend a UV-200 in the detector, but for general use the UV-201A will be very satisfactory. The Bradleystats were specified because they provide excellent control of tube filaments. We have always taken exception to the use of a rheostat as a tuning device for we still insist that all the tuning should be done with the tuning controls. However, when you are trying for that elusive DX station and you have little more than a faint carrier wave to work upon it is a real pleasure to know that a slight adjustment of a Bradleystat on the detector tube will bring it in.

You are undoubtedly wondering why we called this a one-control receiver when it has a tuning condenser and a variable tickler coil. Simply this: The manufacturers of this coil have so designed the tickler coil with respect to the secondary, that the circuit will oscillate over the entire range of the secondary tuning condenser with but a very small change in the tickler. In tuning this receiver properly and as it should be done it will be noticed that it is possible to keep the detector circuit just on this side of the oscillating point without varying the tickler coil more than a few degrees, consequently it is necessary to adjust the tickler only when the very finest tuning is to be done. All but this latter can be done by merely rotating the condenser dial to previously determined settings and the stations will roll in.



The circuit diagram of the one-control regenerative receiver is the familiar three-coil circuit, known in so many different forms.

Construction of the Low Loss Receiver

Secure for your baseboard for this receiver a piece of straight grained white pine and place your transformers and tube sockets on it temporarily so that you may make in your own mind a tentative lay-out for the placing of the instruments. A glance at the illustrations, particularly the one of the top

A Really Efficient Broadcast Receiver

A Set that Combines the Cardinal Virtues of Sensitivity, Selectivity and Tone Quality

ONE sometimes finds it tiring in reading the reports of new types of receiving sets, to learn that each is the absolute acme of perfection, and may also find cause to wonder at the never-ending supply of superlatives available to radio editors (some editors, at least), in their description of the new marvels. Now after this brief railing at the frailties of human nature as exemplified by some radio editors in introducing a receiver to the public, it would not be seemly on our part to stress very heavily the virtues of the five-tube set described by *Joseph H. Kraus* in *The Experimenter,* New York. We shall leave it to the reader who builds this receiver to sing its praises—as he is certain to do. The article follows.

"What type of receiver do you own, Bill, and you, Jack?" Indeed, quite an at sea, and the contradictory advices that he receives from his friends only add to his perplexity.

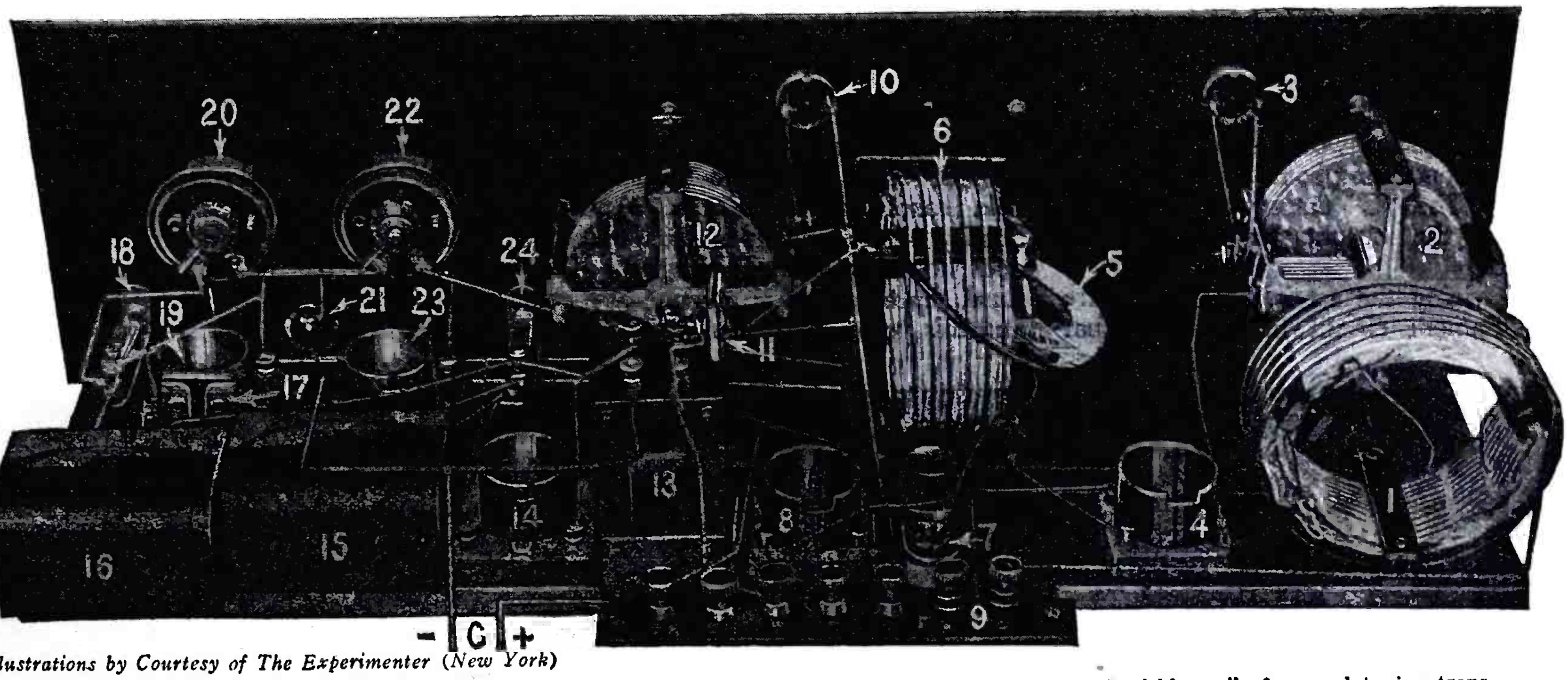
The really excellent set pictured on these pages is one that will, undoubt-

PARTS REQUIRED

- 2 Bruno .0005 variable condensers.
- 1 Genwin RFT.
- 1 Genwin coupler.
- 2 Caldwell sockets.
- 3 Federal sockets.
- 1 Federal transformer.
- 2 Como push-pull transformers.
- 3 Cutler-Hammer toggle switches.
- 1 Federal 30-ohm rheostat.
- 1 Federal 20-ohm rheostat.
- 1 Bradleyleak.
- 2 Dubilier .001 fixed condensers.
- 1 Dubilier .00025 fixed condenser.
- 2 Rasco jacks (one 2-circuit and one filament control).
- 7 Rasco binding posts.
- 1 Rasco binding post strip.
- 3 General Radio 3-inch vernier dials.

The data for the construction of the various parts are as follows: The primary winding of the radio frequency transformer consists of six turns of No. 14 bare copper wire which is supported by means of thin bakelite strips. The secondary is wound in stagger fashion and contains 45 turns of No. 16 D.C.C. in a 3½-inch diameter circle. A double section .0005 mfd. condenser is used for tuning. The next coils, the primary and the secondary of the detector input circuit are of the same dimensions as those of the first transformer. The tickler coil contains 50 turns of No. 24 D.C.C.

The panel is 7" x 24" and is fastened to a baseboard upon which all the apparatus not on the panel proper is mounted. Note carefully the disposition of the various parts. It is essential that the same relative layout



-Illustrations by Courtesy of The Experimenter (New York)

1 is the radio frequency transformer; 2, first tuning condenser; 3, switch; 4, radio frequency socket; 5, tickler coil; 6, second tuning transformer; 7, variable grid leak; 8, detector socket; 9, terminal strip; 10, switch; 11, by-pass condenser; 12, second tuning condenser; 13, audio transformer; 14, amplifier socket; 15 and 16, push-pull transformers; 17, by-pass condenser; 18, filament control jack; 19, last amplifier socket; 20, amplifier tube rheostat; 21, filament switch; 22, detector tube rheostat; 23, input socket of push-pull amplifier, and 24, double circuit jack.

ordinary question, which one hears occasionally. And when the answer from Bill shows that he owns a five-tube tuned radio frequency receiver, while Jack owns a three-tube three-circuit regenerative set, we may be inclined to believe that the five-tube set gives its owner much superior results. Evidently, to some, it will appear that due to the fact that Bill's set has five tubes, it is undoubtedly better than Jack's. Yet, Jack claims all and even more for his set than does Bill!

Thus is the man who is about to construct his first successful set rather

edly, "bring home the bacon." Combining radio frequency amplification and regeneration, the receiver also has one step of transformer coupled audio and one stage of push-pull. Distance, clarity and volume are its outstanding points of excellence. What more could one desire?

A feature of this set is that it has a small wave-length change switch allowing a range of from 180 meters to 400 and from 350 to 600 meters. The set is thus made very selective and little, if any, interference is experienced.

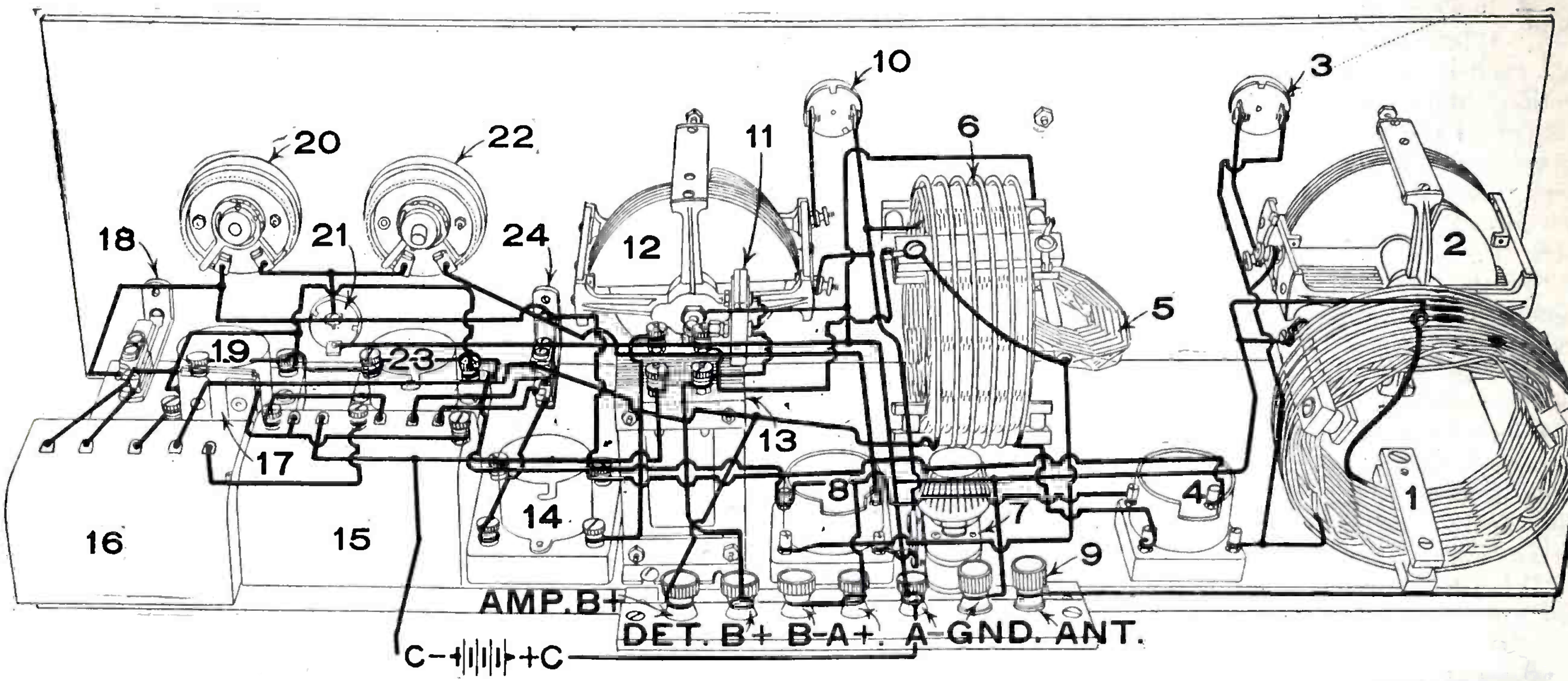
be used, otherwise trouble may be had on account of inductive or capacitative feed-back which cause squealing.

Vernier dials are used, there being three of them, two for tuning and a third for regeneration control. Other refinements include the variable grid leak for the detector tube, and the fact that either the type 201A or 216A tubes can be employed for the push-pull amplifier. The 216A tubes are to be used wherever possible. The amplification constant of these tubes is so much greater than that of the others that it becomes an easy task to bring in distant stations with the volume of locals.

Again, because broadcast stations are reducing their wave-length, this receiver will find many adherents. A double circuit-jack is provided after the one stage of audio and sufficient volume with which to receive the local stations can be had. All connections are brought out to binding posts arranged on a rack. Although the amplifier uses a "C" battery, it is not

A few words about the operation and the results obtained with this receiver will stimulate more interest in those who are undecided concerning the type of receiver they should like to build. At 7 or 8 o'clock in the evening, when as many as ten powerful local stations, broadcasting on wave-lengths from the lowest to the highest assigned, the set has proved its superior qualities by bringing in stations over 2,000 miles away with loud speaker

many advocates to the idea and enhance their appreciation of the set. If, for instance, a station is transmitting on 375 meters and trouble is experienced from interference when using one setting of the wave-length change switch, the simple expedient of changing the position of the switch and retuning to 375 meters will in most cases clear up the trouble. In other words, we have a super-selective receiver which is entirely different from the



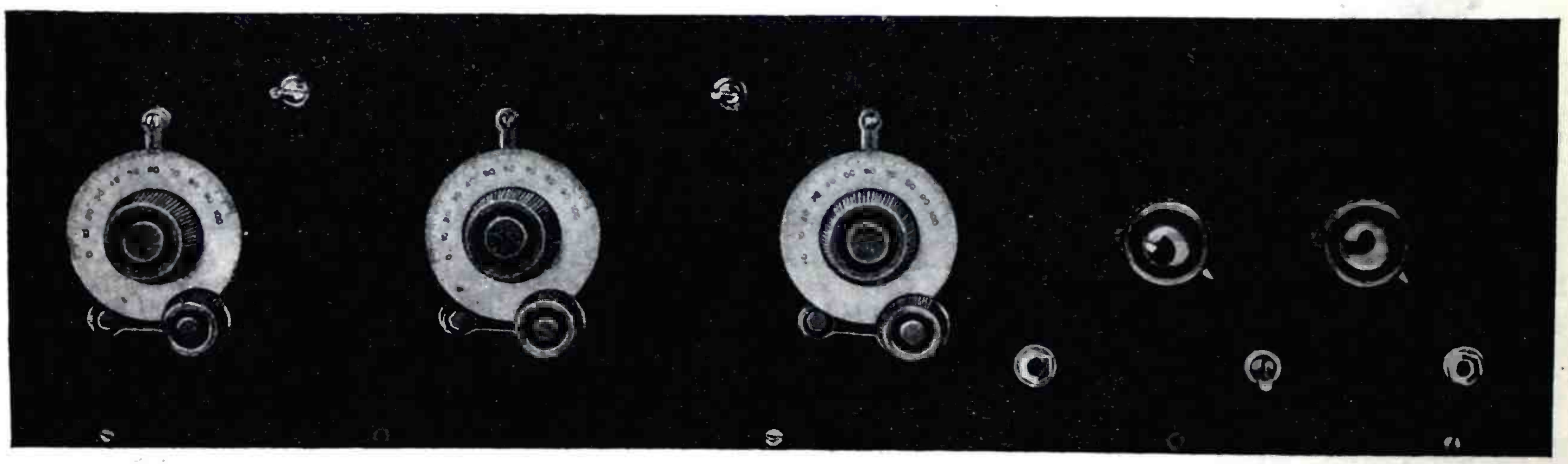
Layout and wiring of the set, showing the parts are mounted on the panel and baseboard. The figures correspond to those in the photo of back view.

shown in the photo and blueprint diagram because it would complicate matters by concealing some of the connections. The "C" battery is placed on top of the output push-pull transformer.

In wiring the set it is best to wire the filament circuit first. Note that

volume. Then as evening draws on, Cuba, the West Coast and Canadian stations come rolling in with remarkable ease and steadiness. And the quality of the music is such that one does not turn away in disgust. Pure tonal reproduction is at once apparent and this point is stressed because qual-

usuel set. With other types of receivers, trouble is generally experienced when approaching wave-lengths of 300 meters and lower. This greatly handicaps the set and in many cases eliminates the possibility of receiving stations within this band. And again, the crowding of the stations that oc-



Panel view of the receiver. The three larger dials at the left are the tuning controls. Between them on the upper part of the panel are the two switches. To the right of the panel can be seen the detector and amplifier rheostats.

the last jack is of the filament control type. This is so because it would be needless waste of battery current, if one wanted to listen-in on the one-step of amplification alone to keep the push-pull amplifier tubes burning. Only two rheostats are necessary, one for controlling the amplifier tubes, both audio and radio, and the other for controlling the detector tube.

ity should come first when considering the building or purchasing of a radio receiver.

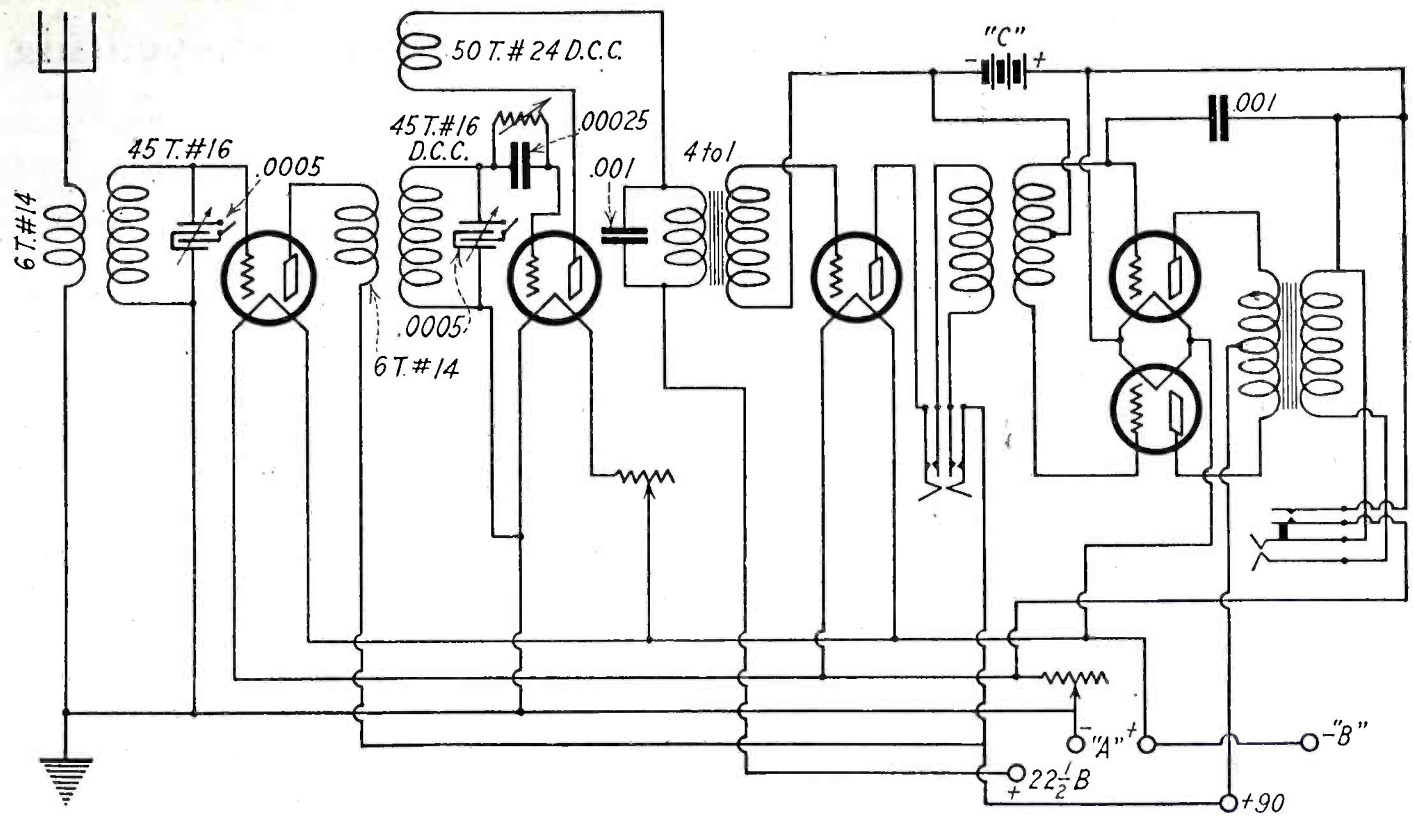
Again, with the general tendency of the broadcast stations to begin the use of the lower wave-lengths in transmission—the only feasible outlet for them—the simple switching arrangement which allows the receiver to go down to as low as 180 meters—will find

curs at the lower end of the dial spoils the chances for reception of many of them. With the use of the features incorporated for wave-length change, we completely overcome this difficulty.

From the above, therefore, it can be seen that the set is ideal from every standpoint.

An antenna about 100 feet long of a single copper wire, clear of all surroundings, will do very nicely. The coupling of the antenna primary coil is fixed and is of the semi-tight variety which allows a good degree of freedom from interference.

For selectivity and for volume and quality the set ranks among the very best. Enough can be inferred from the statement made concerning the use of the push-pull amplifier. As a conclusion, it is well to bear in mind that the idea of using a double section condenser to allow both high and low wave reception is without doubt a real step forward towards the time when many of the broadcast stations will be down on the shorter waves which makes for greater efficiency.



For those who prefer wiring their receiver from a schematic diagram, the accompanying circuit will serve the purpose. Particular care should be taken in placing the various instruments at proper distances from one another so that magnetic coupling does not cause distortion. Note the variable grid leak and the small single-pole wave-length change toggle switches, features which augment the flexibility of the receiver. All connections, as can be seen, with the exception of the "C" battery, are brought to a small binding post rack which facilitates quick terminal connections.

How to Make the Clapp Receiver

(*Continued from Page* 38)

oscillate under these conditions it will be necessary to increase the plate voltage to 45 volts and insert a grid leak at R-g2 of about 1 megohm. On the third, or audio-frequency amplifier, tube the plate should not have over 67½ volts unless a "C" battery is used, in which case the plate voltage may be increased, as the "C" battery voltage is increased, in accordance with the circular which comes wrapped with each tube.

To guarantee good quality from the receiver it will probably be necessary to use a grid leak at R-g1. The value of this leak will depend upon the quality of signal obtained, and should be kept as high as possible to eliminate any possibility of materially reducing the signal strength. If the parts recommended are used, the value of this grid leak will be from .05 to .5 megohms. A variable leak is not recommended.

If it is desired to keep the first cost down as much as possible the set may be constructed with but two tubes, and the necessary space for the insertion of a third tube can be left. The third tube may then be added at any time without disturbing the panel layout or the original wiring of the set in any way.

Following is a list of the constants in Fig. 3: L1 and L2, first radio-frequency transformer described in text. L3, L4, L5, second radio-frequency transformer and rotor described in text. C and C1, variable condensers .0005 mfd. maximum capacity. C2 and GC, fixed condensers .00025 mfd. capacity with grid leak clips attached. C4 and C5, fixed condensers .001 mfd. capacity. Cn, balancing condenser described in text. R-g1, grid leak .05 to .5 megohms. R-g2, grid leak .5 to 2 megohms.

Following is a list of parts used in the set illustrated: 1 bakelite panel 7x21 in., preferably 3/16 in. thick. 2 .0005 mfd. National type DX condensers with 4 in. dials. 3 Na-Ald standard base sockets. 2 General Radio type 301 rheostats 30 ohms. 1 Samson, 3-to-1 audio-frequency transformer. 1 Samson 6-to-1 audio-frequency transformer. 1 bakelite tube 3 in. long 3 in. diameter. 1 vario-coupler form as described in text. ¼ pound No. 24 D.C.C. copper magnet wire. 1 Federal No. 1422-W closed circuit jack (3 prongs, for first stage). 1 Federal No. 1435-W singlet circuit filament control jack for last stage. 1 Yaxley No. 10 midget filament switch. 1 4 in. Bell dial, plain, to match National dials. 2 fixed condensers .00025 mfd. capacity with grid leak clips (Splitdorf). 2 fixed condensers .001 mfd. capacity (Splitdorf). 1 balancing condenser, special. 8 Yaxley "Imp" phone jacks and tips (in place of binding posts). 3 small markers for dial indicators. 2 Weston type 301 panel mounting volt meters 0 to 8 volts. 1 Cutler-Hammer fixed resistance 25 ohms. Hard rubber strips for binding rack. 12 lengths bus bar wire. 1 4½-volt "C" battery. 1 cabinet for 7x21 in. panel. 2 C-301-A tubes. 1 Sodion D-21 tube, 1 six-volt storage battery. 2 45-volt blocks "B" batteries. Antenna, ground, phones, loudspeaker.

A Stable Seven-Tube R. F. Receiver

English Experimenters Develop New Method of Preventing Oscillation in Multi-Tube Sets

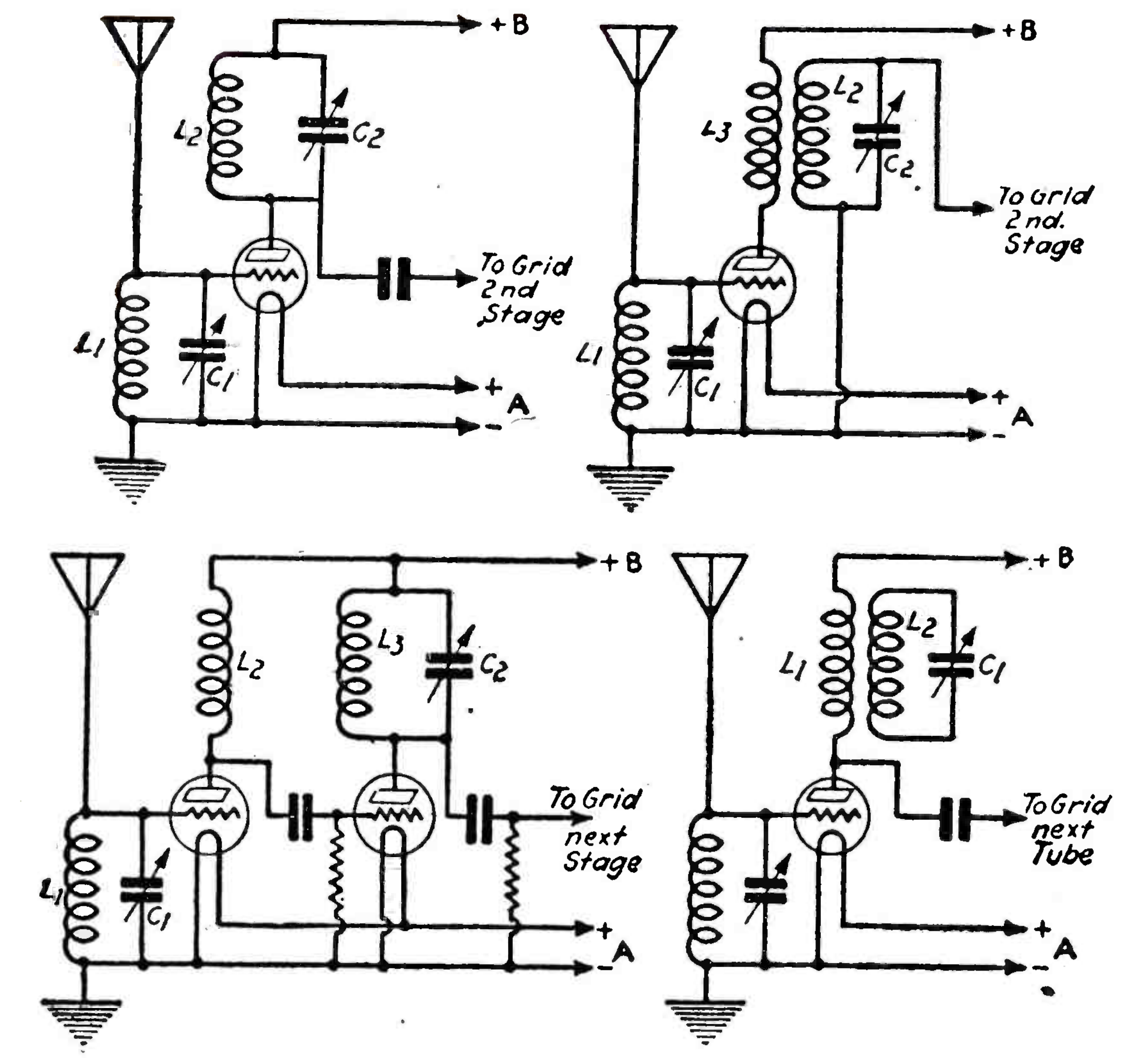
THE value of multi-stage radio frequency amplification is well known, as is also the difficulty in controlling oscillation where several stages are employed. Our esteemed English contemporary, *Mr. A. Dinsdale,* has contributed some valuable data to this subject in the following article which originally appeared in the *New York Herald Tribune.*

Radio-frequency amplification has engaged the attention of experimenters both here and on the other side of the Atlantic for some time past, but with the exception of the super-heterodyne all the systems so far devised have proved unsatisfactory when applied to more than at most three stages.

The reason for this difficulty with multi-stage R. F. amplification lies in the fact that self-oscillation of the R. F. tubes is difficult or impossible to control. Many different methods of preventing this unwanted oscillation have been tried by introducing into the circuit different stabilizing devices.

One of the earliest and best known ways of stabilizing tuned R. F. stages was to impress a small positive potential upon the grids of the R. F. tubes by means of a potentiometer connected across the A battery. This device by introducing damping into the circuit effectively prevented self-oscillation, but at the expense of efficiency, for damping, either artificial or natural, is the last thing desired in R. F. circuits.

A later and much more efficient means of obtaining stability is the well known neutrodyne method, which needs no explanation here.



Illustrations by Courtesy of N. Y. Herald Tribune

Fig. 1. Tuned plate coupling. Fig. 2. Tuner transformer method. Fig. 3. Illustrates the principle of the new British method of coupling R. F. stages, alternating tuned with untuned circuits. Fig. 5. Principle of wave-trap tuning.

Cause of Instability

It will be of advantage here to consider in detail exactly why ordinary tuned R. F. amplifiers are unstable unless special stabilizers are introduced, for upon a true appreciation of the causes depends a clear understanding of the latest British method of obtaining stability in an almost unlimited number of stages.

In Figs. 1 and 2 are shown the two methods of interstage coupling most generally employed, that shown in Fig. 1 being known as the tuned plate method and that in Fig. 2 as the tuned transformer method.

Considering the method shown in Fig. 1 when handling this circuit in actual practice, the two circuits L1C1 and L2C2 are tuned to exactly the same frequency, and it is when this condition of things is arrived at that the circuit, theoretically, is operating at its maximum efficiency.

Practically, the tube immediately breaks into more or less violent self-oscillation, and nothing further may be done till these oscillations are stopped.

The case in Fig. 2 is exactly the same, for, although the inductance L2 is not actually included in the plate circuit of the tube, it is coupled to it through the inductance L3, and coupled very tightly.

Now, everybody knows that, in order to obtain regeneration or to cause a tube to oscillate, it is necessary to couple the plate to the grid in some fashion. This is usually done magnetically, by means of a tickler coil inserted in the plate lead, and coupled to the grid coil, but it can also be done by capacity coupling.

In Figs. 1 and 2 the coupling is obtained capacitatively, the coupling condenser consisting of the elements of the tube itself, which form a condenser of sufficient size to cause regenerative coupling in the case of the two low-loss circuits in exact resonance.

This was the position as faced by John Scott-Taggart, the well known British designer. He set out to find means of overcoming the difficulty without introducing more or less inefficient stabilizers.

It is obvious that, in order to prevent any possibility of coupling between the plates and grids of R. F. tubes some other method of coupling the stages must be found, but on the broadcast wave band the efficient methods available are limited.

The most efficient methods are those shown in Figs. 1 and 2, of which the former is the better. Resistance-capacity coupling will not function on wave-lengths below 1,000 meters, nor will iron-core transformers.

There only remains, therefore, the air-core choke method, which, though not so efficient as tuned plate coupling, works fairly well, and has the advantage of being practically aperiodic.

In order to produce a stable circuit, therefore, Scott-Taggart alternated tuned circuits with untuned circuits, as in Fig. 3. In this diagram the first circuit, L1C1, being the aerial circuit, is necessarily tuned and constitutes also the grid circuit of the first R. F. tube.

The grid circuit being tuned, the plate circuit must therefore be untuned, and the choke coupling, L2, between the first and second stages is thus employed. This choke coupling constitutes also the grid circuit of the second tube, and as it is aperiodic the plate circuit of this tube may be tuned. The more efficient tuned plate coupling, L3C2, can, therefore, be employed between the second and third stages.

This method immediately proved successful, for the stability is perfect, regeneration being necessary, in fact, to make the set oscillate.

Degree of Sensitivity

The degree of sensitivity obtainable, however, is not so great per stage as is the case when all stages are tuned and stabilized. To obtain the degree of amplification given by two stages of tuned R. F. three stages of the alternating system are necessary, but this fact is counterbalanced by the adaptability of the system to any number of stages, so that a degree of sensitivity comparable with the super-heterodyne can be obtained. The designer of the system successfully applied it to seven stages of R. F. amplification.

The first obvious drawback is, of course, the number of controls, but if the tuned stages are matched all the condenser dials can be mechanically coupled together, or multiple condensers can be fitted.

A seven-tube circuit, giving five stages of R. F. amplification, is shown in Fig. 4, regeneration being included. It is advisable always to employ an odd number of stages, so that the maximum R. F. amplification may be obtained with a minimum number of controls.

Standard components having the usual values may be used in such a circuit. For the chokes Nos. 150, 200 or 250 plug-in coils may be used, the exact value depending on the wave length to which the receiver has to be tuned, but this adjustment is not very critical.

As soon as this circuit was published in England large numbers of sets were made up on this principle by fans all over Europe, Africa and Australia, but it was soon found that, although extraordinarily sensitive and absolutely stable, there was a lack of selectivity which rendered it unsuitable for DX work in crowded areas.

The circuit was therefore modified by the introduction of wave traps into all the tuned circuits, which modification immediately elevated the system into the super-heterodyne class as regards selectivity, while reducing the sensitivity by only a very small amount.

The method used is illustrated in Fig. 5, which illustrates a method of coupling which is a modification and at the same time a combination of Figs. 1, 2 and 3.

There are two kinds of wave traps. In one method the interfering station is cut out, leaving the desired signals, and in the other the selectivity of the receiver is increased to such a pitch that the interfering signals cannot get through.

The latter method is the more scientific and is the one adopted in Fig. 5. The explanation of the principle is as follows:

If the trap circuit L2C1 were not present the coupling between the first and second tubes would be by means of the inductance L1 only—i. e., entirely aperiodic. Thus all interferences present in the aerial circuit would be passed on to the next stage.

By introducing the trap circuit and tuning it exactly to the frequency of the desired signals the coil L1 no longer remains entirely aperiodic. Since L1 is tightly coupled to L2 it comes under the influence of the trap circuit and is inclined to respond more to the frequency of that circuit.

If, on the other hand, L2C1 is not accurately tuned to the incoming frequency L1 reverts to its original aperiodic condition.

Now, a choke coil, to produce an appreciable amount of amplification, must consist of a considerable number of turns, otherwise there will be no build-up, or increase in amplitude, of the oscillations flowing through it. That is to say, if L1 consists of relatively few turns it will act as a virtual short circuit to the oscillations transferred to the plate circuit by the grid.

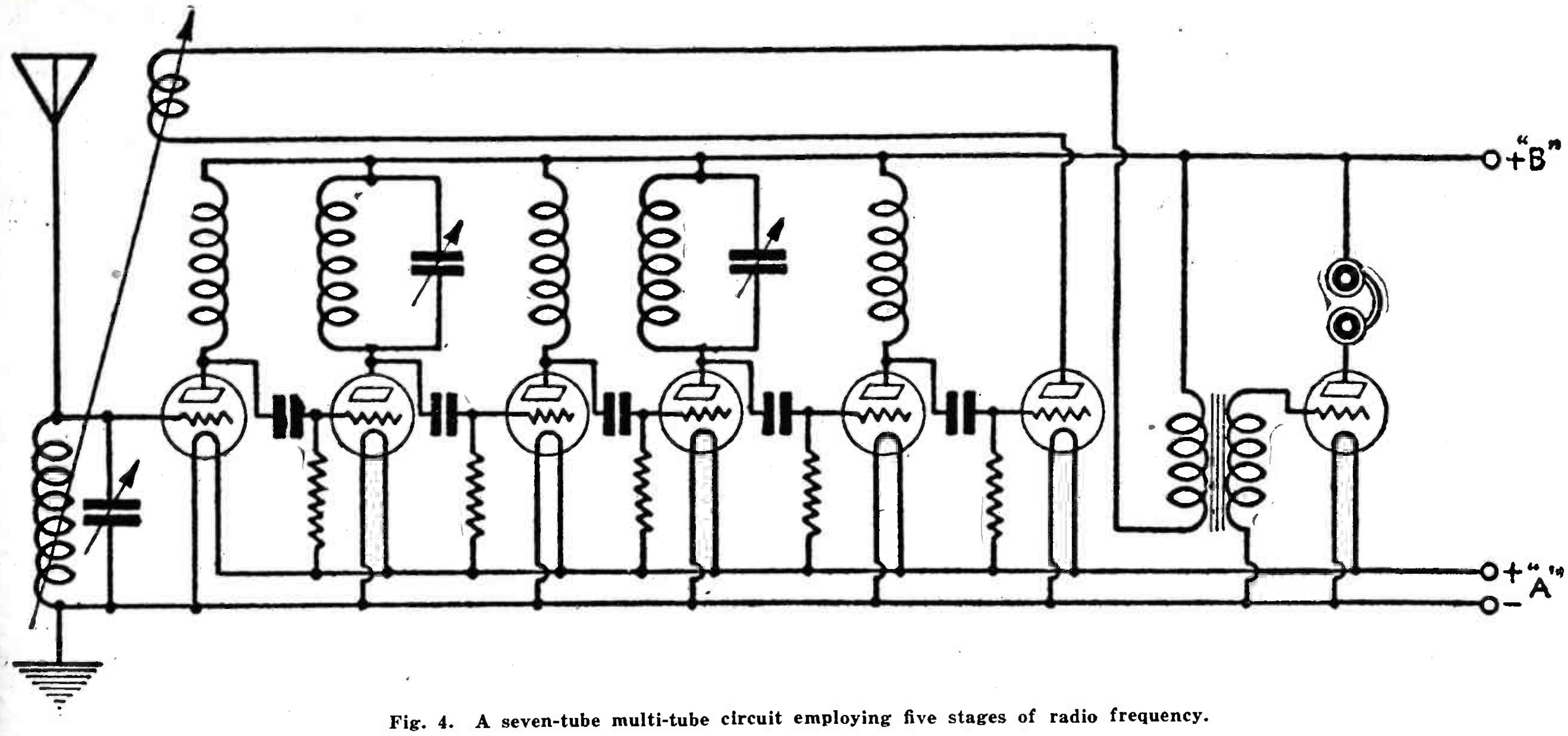


Fig. 4. A seven-tube multi-tube circuit employing five stages of radio frequency.

Applying Wave Traps

In practice, the circuit L2C1 may consist of any of the usual forms of low-loss inductance, say 60 turns, tuned by a low-loss condenser of .0005 mfd. capacity.

L1, which is tightly coupled to L2, may consist of a coil of 25 turns, or less. As low a number as 8 turns has been used with success, the determining factor being the degree of volume required as against the degree of selectivity necessary. Eight turns will give very much greater selectivity than 25 turns, and the loss of volume will only be slight. The point is one which the individual experimenter can with advantage decide for himself.

Fig. 6 is the same as Fig. 4, redrawn to include wave traps in all the tuned circuits. Except for the aperiodic coils, the components are all standard, and the number and arrangement of the various stages are given just as a suggestion to the experimenter.

As a matter of fact, the writer strongly recommends the reader to commence experiments with only three stages of R. F., as the selectivity will be found to be so great, in a well laid out receiver using good low-loss components, that two condensers will be found quite enough to handle.

Regeneration has also been included in Fig. 6, and this, besides increasing the sensitivity of the receiver, will, of course, increase the selectivity as well. Vernier condensers are a necessity with this set.

Coil Design and Arrangement

It matters little whether the tickler coil is coupled to the aperiodic aerial coil or to the wave trap inductance. Those who prefer to use plug-in coils can use an ordinary three-coil holder in this position.

Similarly, as suggested above, plug-in coils, mounted inside the cabinet, may be used for the interstage R. F. chokes, which are shown variable in Fig. 6. This variability is desirable because, in a sense, a choke coil of this sort is not absolutely aperiodic. A coil which will present sufficient impedance to a certain frequency to cause the necessary build-up of oscillation amplitude, will present a negligible impedance to another much lower frequency.

Thus, if plug-in coils are used, they can be changed to suit the wave length being received. Nos. 150, 200 or 250 will cover the American broadcast band satisfactorily.

board. This is a point for the experimenter himself to settle.

The interstage R. F. wave trap coils may be wound as cylindrical coils, and the few turns of the aperiodic plate coils wound over the central part of the winding. In this way turns can easily be put on or taken off during the course of experiments. The aerial coils can be made up in the same manner, if plug-in coils are not used.

There is, of course, no reason why special low-loss coils of the various basket-wound types should not be made up, the few turns of the aperiodic coils being wound on the same former to insure tight coupling.

Having familiarized himself with the method of tuning, the experimenter may proceed to add as many stages of R. F. as he pleases, but if more than three are employed it is practically essential that a multiple condenser be used in conjunction with carefully matched coils.

There should be no special difficulty about this, and if found necessary special micrometer condensers can be paralleled across the main condenser sections to make up for small discrepancies in the tuning of the various circuits. It will be neecssary, however, to take great care to prevent any interaction between tuned stages or instability will result.

These remarks apply with equal

sitions shown, but at right angles to the panel.

The coils for the second stage may conveniently be mounted on the end of the associated tuning condenser.

Grid condensers and leaks are standard and have not been shown, in order to avoid overcomplication of the sketch.

Results Obtainable

An active interest in the super-heterodyne method of reception has only recently been taken in England, but it bids fair to die an untimely death in the face of this new "home-grown" system of R. F. amplification.

Even with the original circuit shown in Fig. 4 some wonderful results were obtained by fans who were not troubled by local QRM. In fact, nobody had anything to say about the sensitivity of the system; the only complaint was lack of selectivity. Now that this has been so vastly improved British fans are rapidly converting their sets.

Using only three stages of R. F. and no A. F., many Britishers report loud-speaker signals from American stations almost every night, with an unusual absence of fading and freedom from distortion. This alone speaks volumes for the efficiency of the receiver, for, although many different types of receivers in use in England today will bring in American stations regularly,

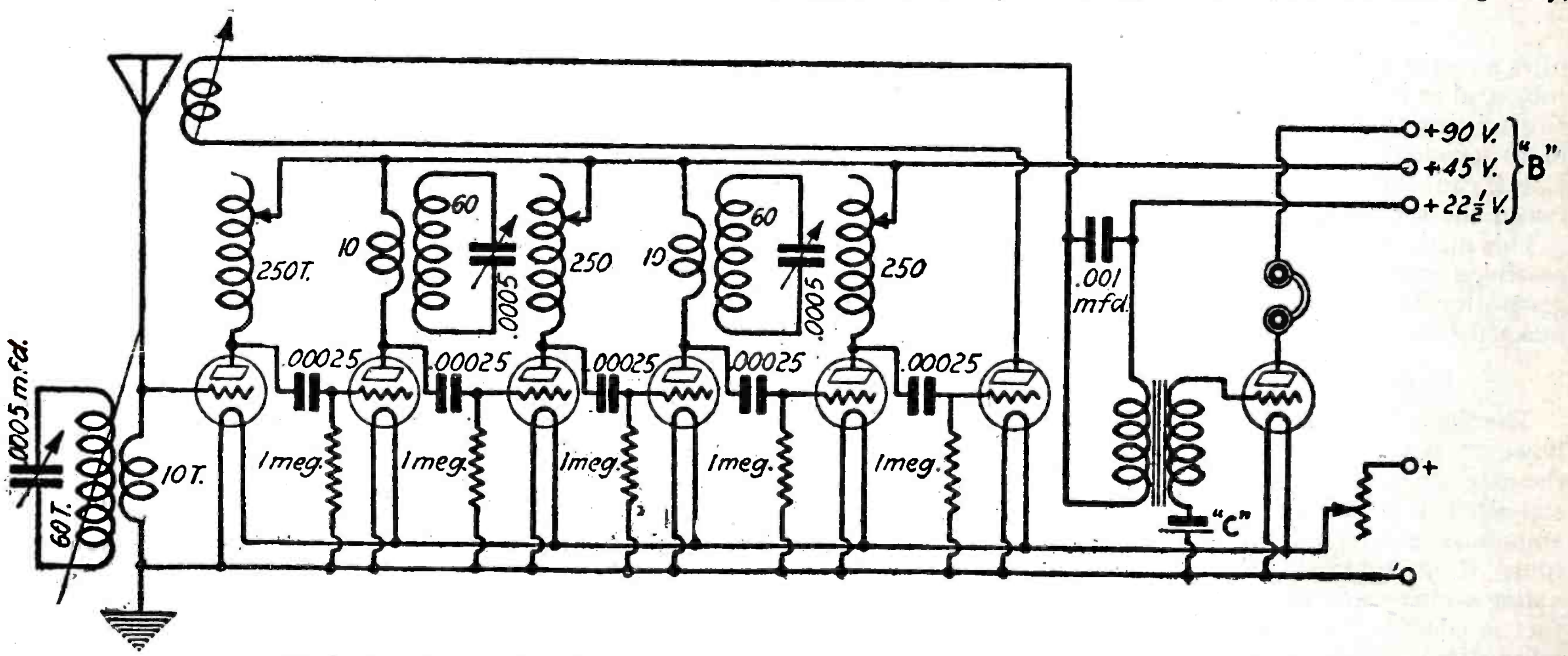


Fig. 6. A similar circuit to that shown in Fig. 4, with the system of wave trap tuning adapted to it.

An alternative choke coil which can be made up by those who desire maximum possible efficiency on any given wave length, consists of 150 turns of No. 40 s. s. c. resistance wire wound on a former about 2¾ inches in diameter. Tappings are taken to a ten-point rotary switch from the ends of the coil, and from the fiftieth turn. From the fiftieth turn to the 120th, tappings are made at every tenth turn.

The switch for this coil may be mounted on the face of the panel, or, more conveniently, on the end of the coil, which can be mounted on the base-

force to any arrangement employing this system.

Suggestions of Lay-Out

The main thing to bear in mind when arranging the lay-out is to avoid overcrowding in the R. F. circuits and to so arrange all coils that no interaction can occur between them. If this point is not attended to and interaction takes place, not only will much of the selectivity of the set be lost, but it may also become unstable.

If plug-in aperiodic choke coils are used they should be mounted in the po-

fading, swinging and "night effect" distortion are almost always present.

As regards selectivity, it has been found possible, within a mile or so of the local station, to completely tune it out and receive uninterruptedly upon a wave length within a few meters of it.

Certain slight modifications will no doubt be necessary to adapt the circuit, in practice, to the different characteristics of American tubes, but a trial bench hook-up should soon clear up this, and other minor points, and the American fan will probably be interested in giving the system a trial.

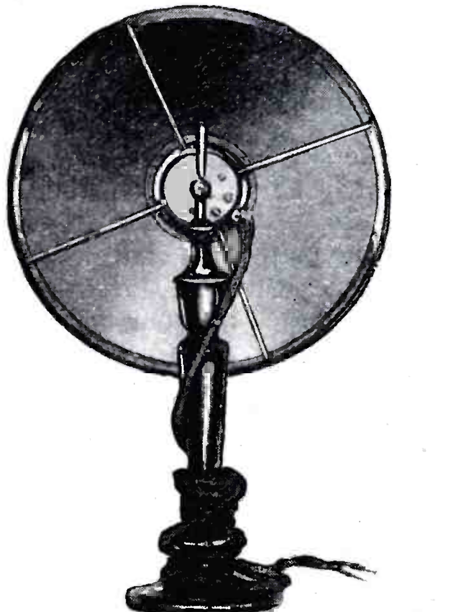
An Inexpensive Cone Type Loudspeaker

The Latest Type of Conical Loudspeaker, Designed for the Experimenter with a Modest Purse

MANY ardent radio fans will be indebted to *Jay Hollander* for the constructional data of this cone type speaker without the necessity of pledging the family jewels. Mr. Hollander tells his story in *Radio News,* New York, as follows:

Ever since the appearance on the market last season of the cone type loud speaker with paper diaphragm, it has taken the premier place among such apparatus and has proved to be the best reproducer of speech and music to put in an appearance on the radio market.

But the price of the commercial types is pretty high, high enough, in fact, to make them almost out of the reach of the ordinary fan. For some time the writer contemplated the problem of getting together sufficient cash to buy one of these units, and finally, having discovered that such was almost impossible, decided to build one as the only possible way in which he might



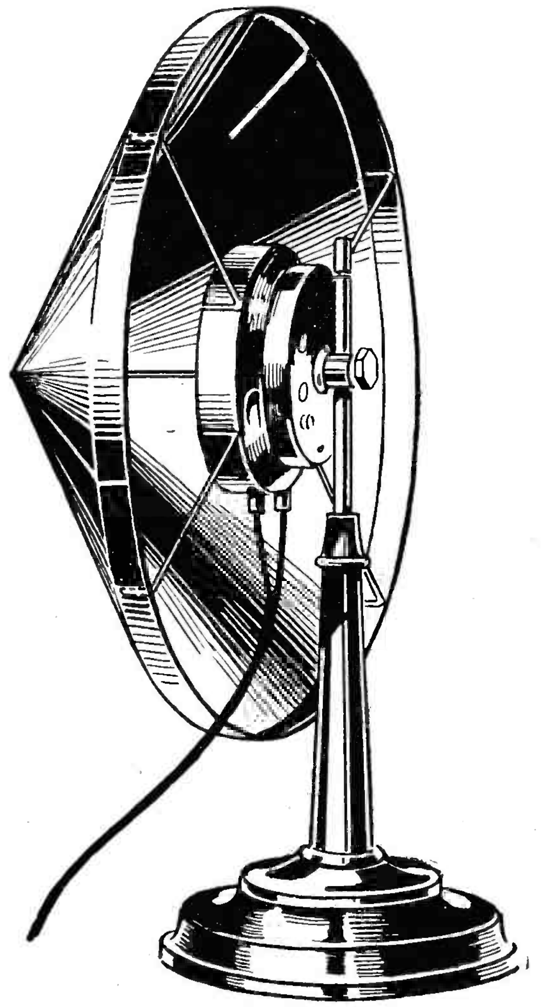
-Back view of the completed loud speaker mounted on a candle stick.

get the desired purity of tone from his radio set. (He has, of course, a resistance-coupled radio amplifier on a super-het.)

Having purchased a great deal of his radio supplies at the five-and-dime, he was wandering over near the radio counter one day, dreaming of the cone loud speaker, when he was hit by the great idea. Here it is: On that counter is a lamp shade; here is a candlestick; there's a lot of drawing paper at home and an old receiver—ergo, the great corporation won't get thirty "bucks" out of me and I'll still have a cone loud speaker.

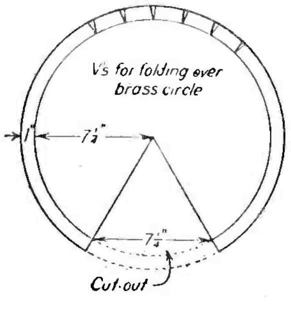
Here is how the trick is turned:

The lamp shade gave the idea, the remainder was simple. The details follow. First secure a piece of heavy brass sheeting and cut a strip one inch wide and about 37 inches long—this



Illustrations by Courtesy Radio News (New York)
Above is a clear schematic constructional diagram of the loud speaker.

dimension is for a cone about 12 inches in diameter, which is a good size. For perfect reproduction, any smaller size will not give the best results. As a matter of fact, if absolutely perfect reproduction is desired, the cone would have to be at least eight feet in diameter. This is out of the question, however, and for the smaller sizes we must depend upon the formation of harmonics



The layout of the paper cone which forms the vibrating member of speaker.

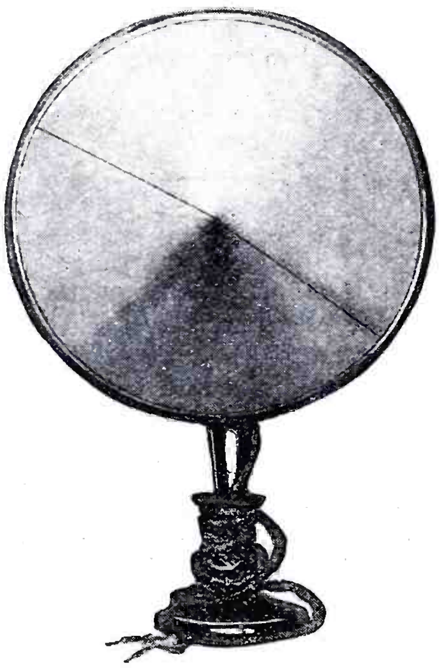
for the reproduction of the very low notes.

Back again to the construction. After the strip of brass has been cut, it is rolled into as nearly a perfect circle as possible. The ends are connected by soldering a small piece under them.

The supports are then made for the phone unit. These consist of three or four heavy wires, soldered to the under side of the ring and run in toward the center, where they are again soldered to a second brass ring much like the first, except that its diameter is such as to fit snugly around the case of the unit to be used.

This second ring need not have its ends soldered together, but it may have a jumper fixed around the rear and equipped with a set screw for adjusting the tension of the diaphragm. The writer tried this idea on his first speaker, but found it unnecessary for good operation.

The cone is then made. If the diameter of one foot is being adhered to,



Front of loudspeaker. The total cost of this speaker should not exceed $5.00.

the cone must be 8¼ inches in radius. This gives the completed cone a pitch of about four inches, deep enough for practice. After the circle is cut, another circle is marked with a radius one inch less; this marks off the point at which the paper is to be folded over the brass ring. Now, on this dotted line measure a distance across a chord of 7¼ inches. This marks the points at which the paper is to be cut to form the cone. Lines are drawn through these points to the center and then the paper is cut along them.

For fastening the paper to the brass ring, small V's are cut in the edge about every thirty degrees around the circumference from the edge of the paper to the dotted line, which is one inch closer to the center. A large number of very small V's will give better results than a small number of big ones, so do not be afraid of cutting the V's.

The writer used an extra good grade of photo-mounter paste to stick the paper to brass ring, and it served its purpose excellently. Shellac, however, is better. Some trouble may be experienced with this operation, but a few trials will give a good idea of the best paste to employ.

Following the completion of the speaker thus far, the next point is the installation of the connecting rod between the cone and the unit which is to be employed. A piece of bus bar will serve admirably, if there is not an available piece of brass rod around the work-bench. The matter of attaching it to the diaphragm of the phone is very simple. Be careful that a good, tight connection is made but that, at the same time, the area covered by the connection is as small as possible. That is to say, see to it that the solder used covers as little of the diaphragm space as possible.

The attachment to the cone is not quite so simple a matter. The writer used two small brass cones two inches in diameter, one on the outside of the apex of the paper cone and the other on the inside. Then the connecting rod was attached to these cones with a suitable threaded end by means of nuts.

Those who do not care to spend the necessary time to make the other pair of cones and the threaded rod may use the bus bar and a bit of well-spread sealing wax. The end of the bus bar may be bent to lie flat on the outside of the cone. Then the attachment is made firm by dipping about two inches of the surface of the cone into melted sealing wax. A little practice will enable the builder to swing the cone into the wax so that a most workmanlike job results. The final touch is added by placing a few drops of the wax on the inside of the apex of the cone where the wire comes through.

Now for the unit. The second brass ring was made to fit snugly around the outside of the receiver case. The receiver slips into this and the diaphragm with the extension installed. Remember that if the connections to the cone and to the diaphragm are not made at absolute right angles, trouble in plenty is liable to result. The sounds of the Philharmonic Symphony coming through will resemble nothing so much as a hurdy-gurdy around the corner if the angles are not right.

But for argument's sake, let's assume that they are as they should be and go ahead with the discussion. If the second stage of the amplifier is husky, the cone will not help any in the matter of clarity of reproduction if the phone is used as is. The chances are that the diaphragm will constantly rebut itself against the pole pieces of the magnets, giving a nice, metallic twang. This is corrected by the installation of a couple of thin shims of copper or brass placed between the edge of the diaphragm and its bearing around the receiver case.

The thinnest possible metal sheet should be used for this purpose. If there is some old shielding material around the house, it will come in handy. Cut two or three circles from it just to fit on the edge of the receiver case where the diaphragm rests. A few trials will give the proper number of them to be employed. Keep the diaphragm as close to the pole pieces as possible, so long as it does not strike when the town's prize prima donna takes her high C.

Now for the finishing touches. In the dime store mentioned in the first paragraph, at the lamp counter, will be found a great assortment of decorative ribbons which are ordinarily used to bind the edges of home-made lamp shades. A little of this will cover the edge of the brass circle where the paper cone was pasted to it. This enhances the appearance of the completed instrument several per cent., making it look even more like the thirty dollars saved.

Storage Battery Notes

RADIO fans returning after a summer vacation will find a lot to do toward getting their receiving sets in shape for the fall and winter months.

One of the first things to look after is the storage battery. It should be taken out in the yard, where it can be examined with safety to the carpet and furniture. A greenish white deposit may be found clinging to the positive pole. The best way to remove this is to take a tea kettle full of hot water and pour the contents slowly over the corroded substance until it disappears. The top of the battery may also be cleaned in this way, but care should be taken to prevent the water from getting inside the battery. An old scrubbing brush will accelerate the cleaning process.

The water on the surface will soon dry off and the top of the battery should be clean and dry. The terminals should be scraped clean with a file or knife. The positive pole of the battery should be encircled with a small red circle of paint. This should be a bright red or pink so as to distinguish the positive from the negative pole.

The negative pole should be cleaned with a file so as to insure a good electrical connection. Other exposed lead leads of the battery may be given a heavy coat of black "asphaltum" or vaseline so as to prevent further dirt from accumulating.

Outside Protection

Look at the outside of the battery and see if the container needs a coat of asphaltum, which is acid and waterproof and will prevent decay of the wood. It is good to give it several coats for protection. Acid spilling over during a charge will not affect the container if this simple precaution is taken.

The next move is to unscrew the vent caps and look down into the cells. See if the solution covers the plates by about half an inch above the plates. If you can see the tops of the plates, it is a sign that the battery needs some distilled water at once. It is impossible to measure the condition of the battery with a hydrometer if the liquid is too low. It is not a good plan to measure it after adding distilled water either, as the measurement will be far from accurate.

If the cells need filling get some distilled water from the battery service station or the corner drug store. Fill the cells with a hydrometer syringe, not with a metal funnel.

Do not use rain water from a metal leader pipe. As soon as the water touches metal or paint it is no longer fit for battery use. The water gathered from the sky in the earthen ware container may be put away in bottles for future use.

Put the battery on charge for a few hours, at least until it starts to gas. It may be charged an hour after gassing without harm. Then read the weight of the electrolyte with a good hydrometer. Below is a table of the proper readings for storage batteries:—

1,300 — (New battery) Fully charged.

1,280—(Not new battery) Fully charged.

1,250—Battery half charged, needs charging.

1,225—Going dead.

1,200—Gone.

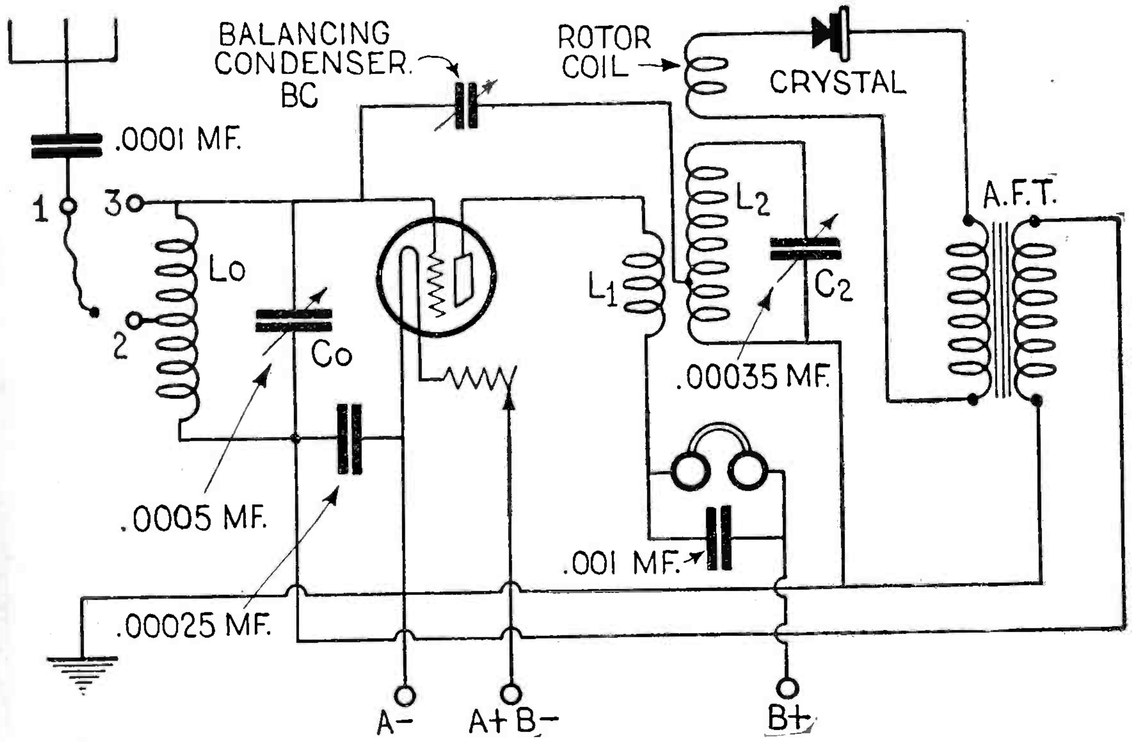
Never let the battery stay in operation on the receiving set until the tubes become dim. This will ruin the battery. Charge it every time it gets down to 1,250.

If the battery will not take a charge after being on twelve hours, it has probably sulphated. It is best to rush it over to the battery service station, where it can be examined. Take it to the service station of the company which manufactured the battery. The battery may have to stay on slow charge for several days to bring it back to normal conditions.—*N. Y. Telegram & Eve. Mail.*

The "Floating" Circuit Reflex Receiver

Sharp Tuning of Output to Crystal Detector Is Obtained with One Tube

WITH the introduction of the reflex set in this article, a novel step is taken in the construction of reflex receivers and, in fact, any receiver using a crystal detector with a tuned input circuit to the rectifier.



Illustrations by Courtesy of The Christian Science Monitor (Boston, Mass.)

The circuit diagram of the "Floating" circuit single tube set using Browning-Drake units.

This magazine has received a number of requests for data on a one-tube reflex that would really have satisfactory selectivity, that would be simple to construct and have a good tone. We believe that this receiver attains this goal. The set demands quite a little practice in tuning to get the utmost out of distance reception. The actual credit for the departure in this design goes to Glenn H. Browning, who is well known as co-designer of the Browning-Drake receiver. Details for construction of the set as given herewith appeared in *The Christian Science Monitor,* Boston, Mass. The description follows:

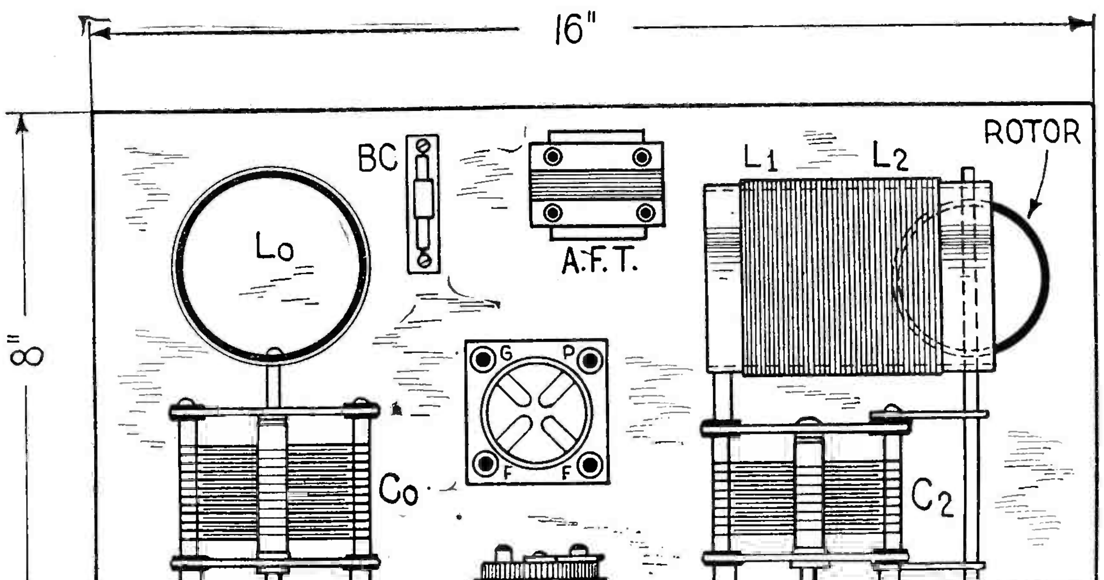
This set is quite unusual inasmuch as it does not have the crystal detector connected across secondary of the second tuned circuit. The fact that the crystal is connected to the rotor coil of the regenaformer (Browning-Drake coupling coil unit) instead of across the secondary makes the set tune extremely sharp, without losing volume.

The reason for this will be readily understood when the reader considers that a crystal has a very low resistance when compared to a vacuum tube detector, and so when connected to a tuned circuit makes the loss in that circuit so great that the selectivity is entirely spoiled. Upon considering the schematic diagram shown, many will wonder what function the coil L2, tuned with the capacity C2, plays in the set.

Let us briefly describe the action that takes place in the circuit. The signal from the sending station is received on the antenna-ground system, and is tuned in by LoCo. A considerable voltage is built up on the grid filament of the vacuum tube by this coil and condenser from a comparatively small voltage in the antenna. This radio frequency voltage passes easily through the .00025 condenser and is amplified by the tube. This amplified energy passes through the coil L1, and induces a voltage on coil L2. The coil L2 in conjunction with the capacity C2 builds up a large oscillatory current which induces a voltage on the rotor coil. This voltage is impressed on the crystal which rectifies the modulated radio frequency currents, and changes them to audio frequencies. The audio frequency is then amplified in the audio transformer (AFT), which impresses these audio frequencies back on the grid filament of the vacuum tube. The tube amplifies these audio signals which are made audible by the telephone receivers.

It will be noticed that the same tube not only acts as a radio frequency amplifier, but also amplifies the audio signals. The balancing condenser shown in the circuit is useful inasmuch as it keeps the circuit LoCo from breaking into oscillations when the condenser C2 is being tuned to resonance.

The outstanding feature is the coil L2 with its tuning condenser C2, which may practically be described as a floating circuit. In some ways it resembles a wave-trap. This coil sharply tunes the signals that it picks up from L1. Then the signals that are passed onto the crystal circuit are those that are wanted. Splendid selectivity is the re-

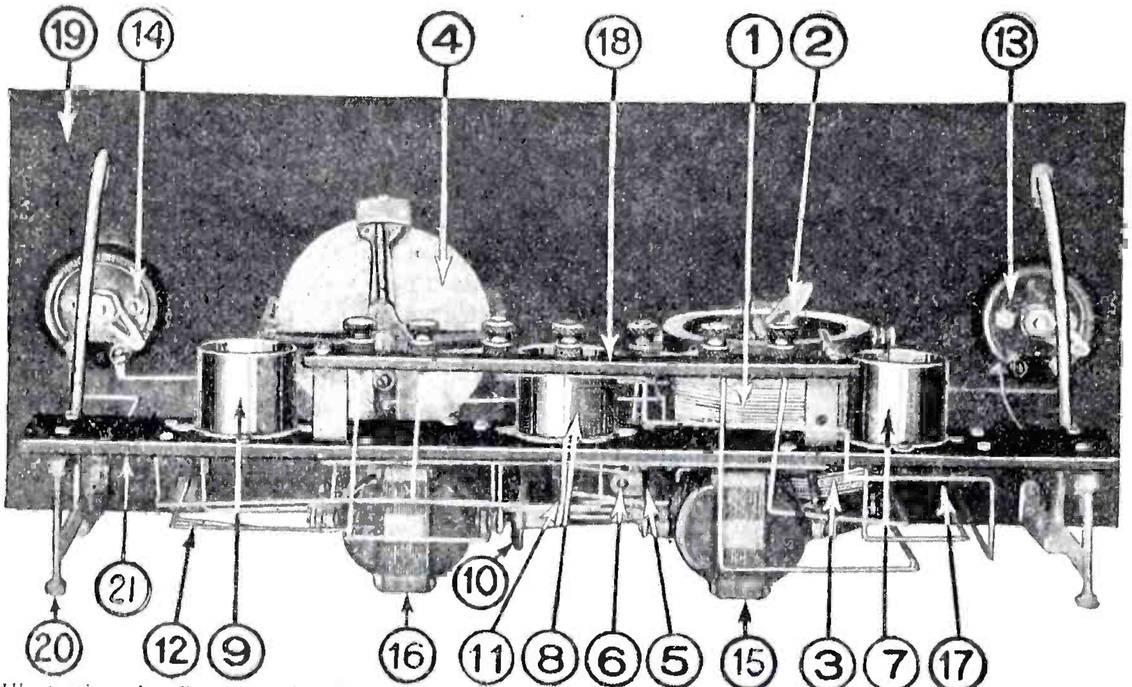


Layout of parts for a single tube set. An insulated shaft may be brought out to the front of the panel from the small balancing condenser in order to keep the tube operating at the most efficient point.

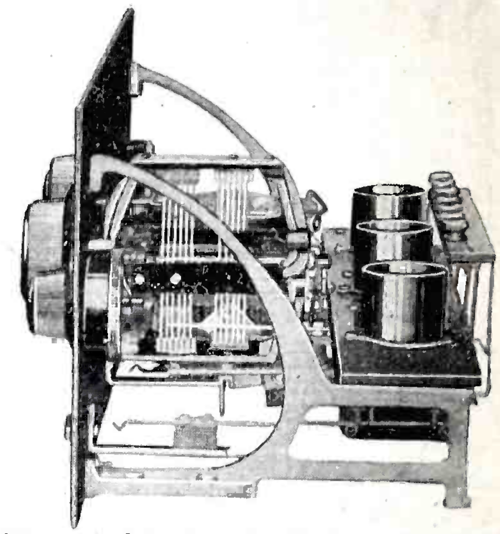
(*Continued on Page 74*)

An Efficient 3-Circuit Tuner

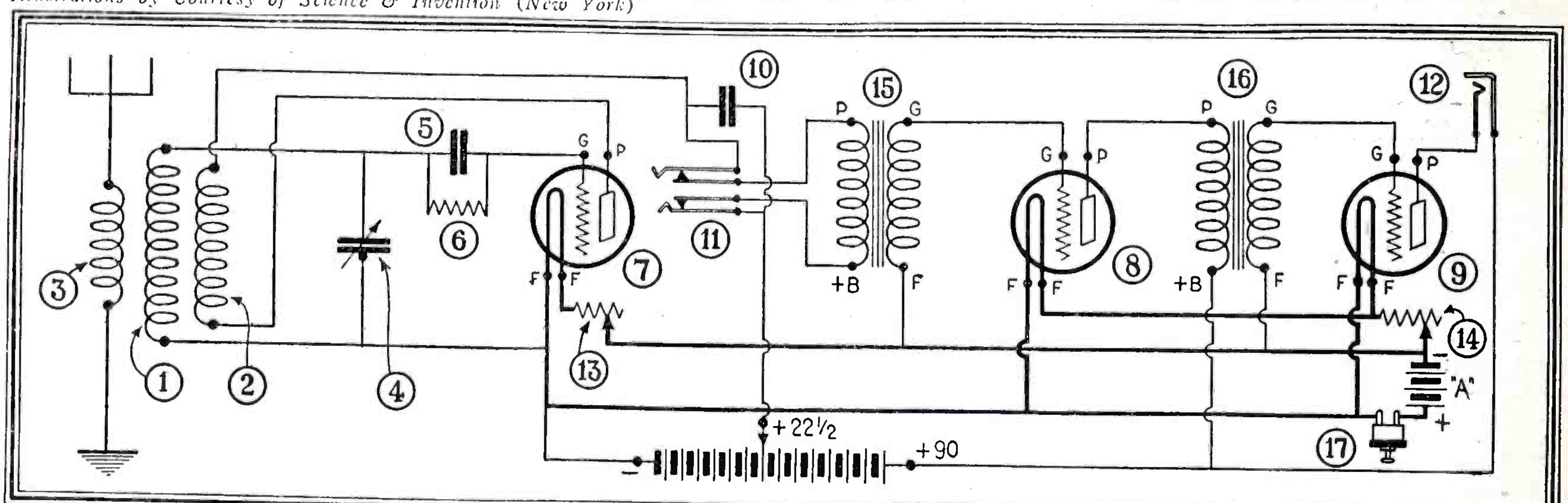
Construction Completely Illustrated in Pictures and Diagrams



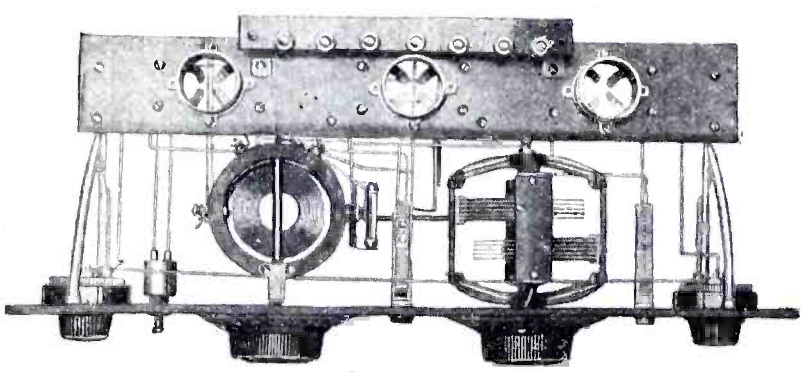
Illustrations by Courtesy of Science & Invention (New York)

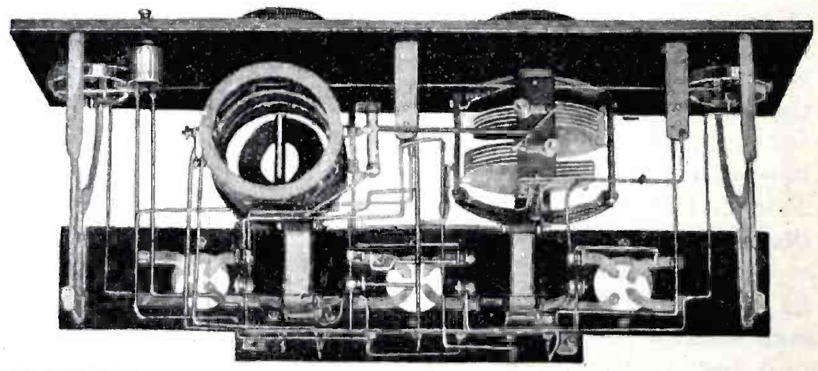


The up-to-date three-circuit tuner shown on this and the two succeeding pages appeared in recent issue of *Science and Invention* magazine and is described by *A. P. Peck.* The numbers on the photographs at the left are carried through this entire article.

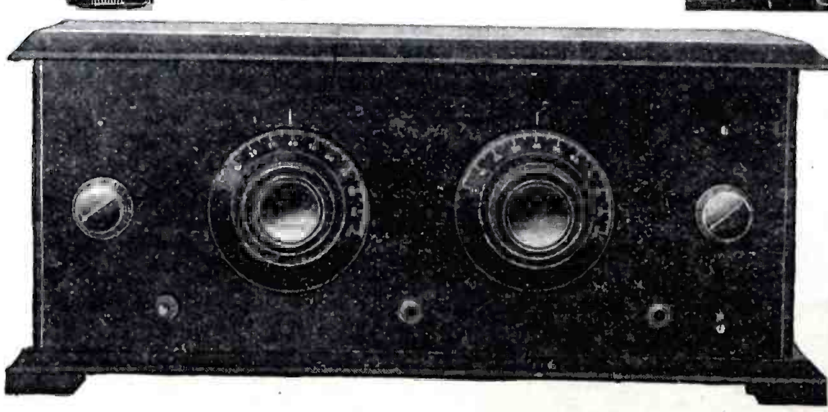


The complete schematic circuit diagram of the three-circuit tuner under discussion is given directly above. Note that here each instrument is assigned a specific number. By referring from this diagram to the photograph above, it will be seen that the connections to each instrument can be carefully checked, and the wires leading from that instrument to the others can be followed out quickly and accurately.

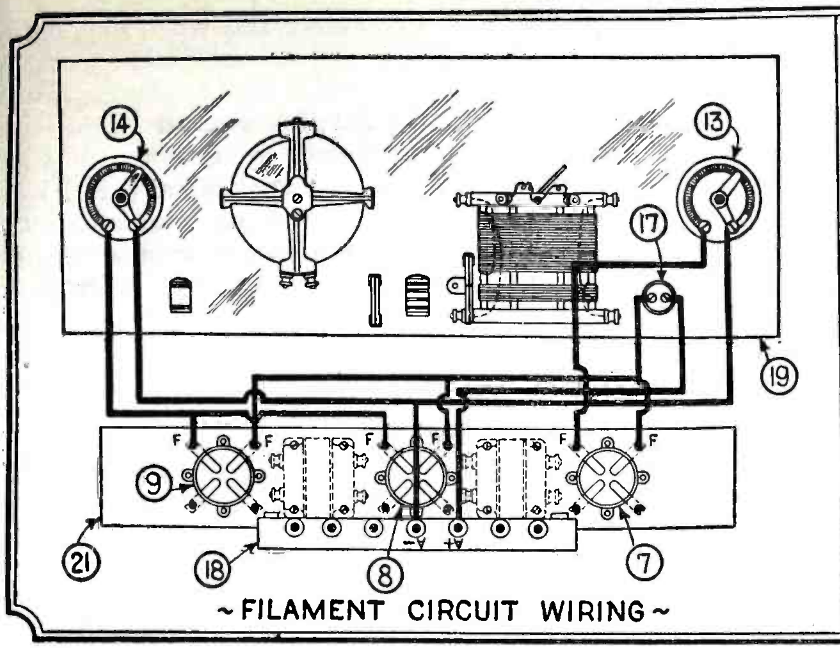




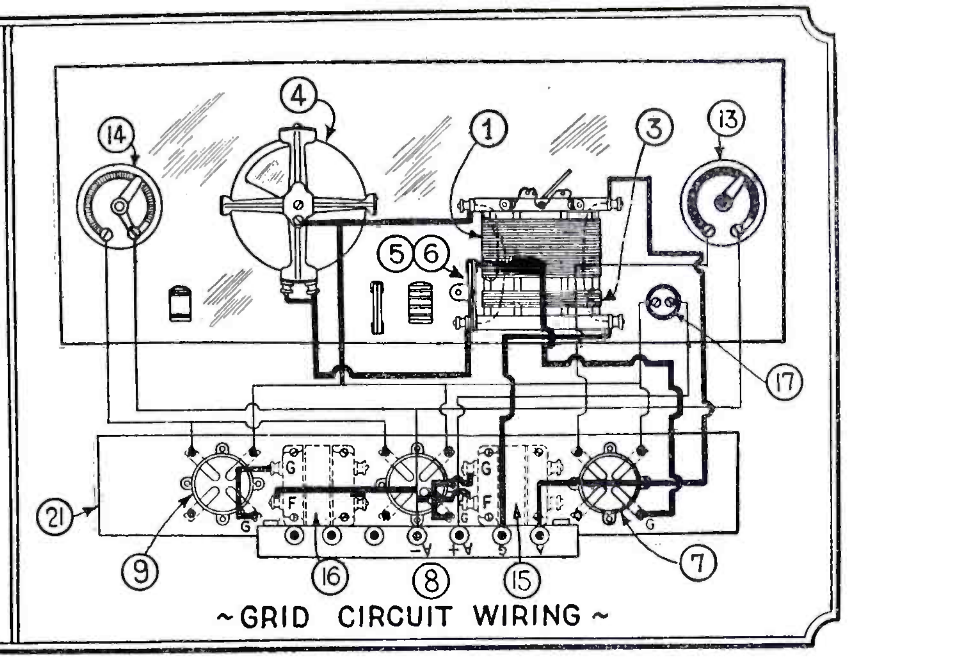
A top view of this receiving set is given directly above. Note the simple wiring and the neat arrangement of all of the parts. The long narrow strip supporting the sockets is in turn supported by the end brackets. The sockets shown are of the shell type without bases although of course standard sockets equipped with bases may be substituted. In such an event it will not be necessary to drill the large holes necessary when shell-type sockets are used.



A bottom view of the tuner is given directly above, and a panel view of the entire unit placed in its cabinet at the left. In the above view, the placing of the audio frequency transformers and the springs of the sockets can be easily seen. The mounting of the grid leak and condenser on a binding post of the coupler or tuning coil can also be seen as may also the exact position of the phone or blocking condenser, 10 in the diagram above. The grid leak and condenser are numbers 6 and 5 respectively.

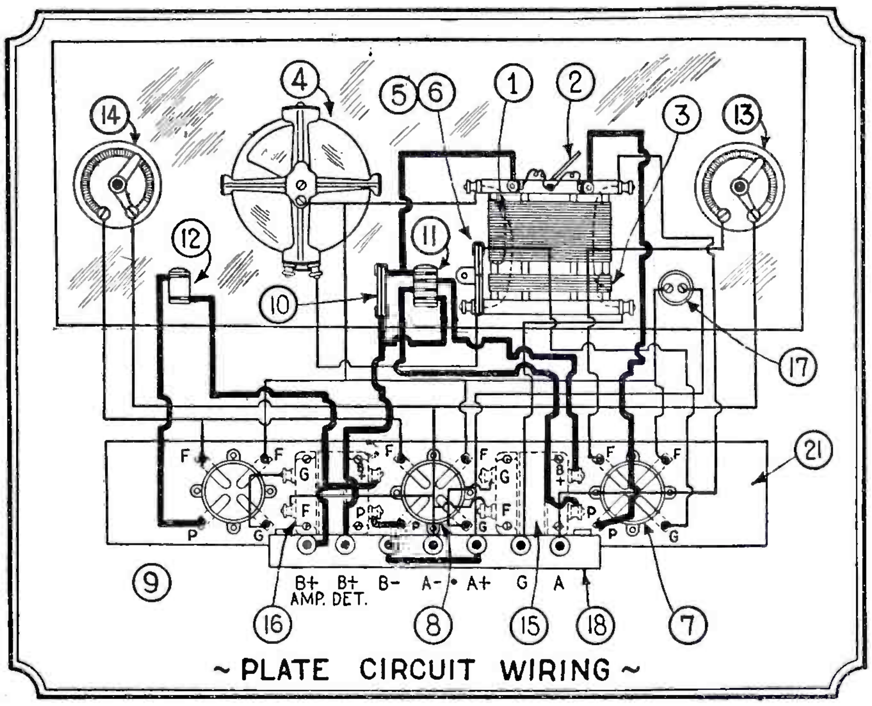


~FILAMENT CIRCUIT WIRING~



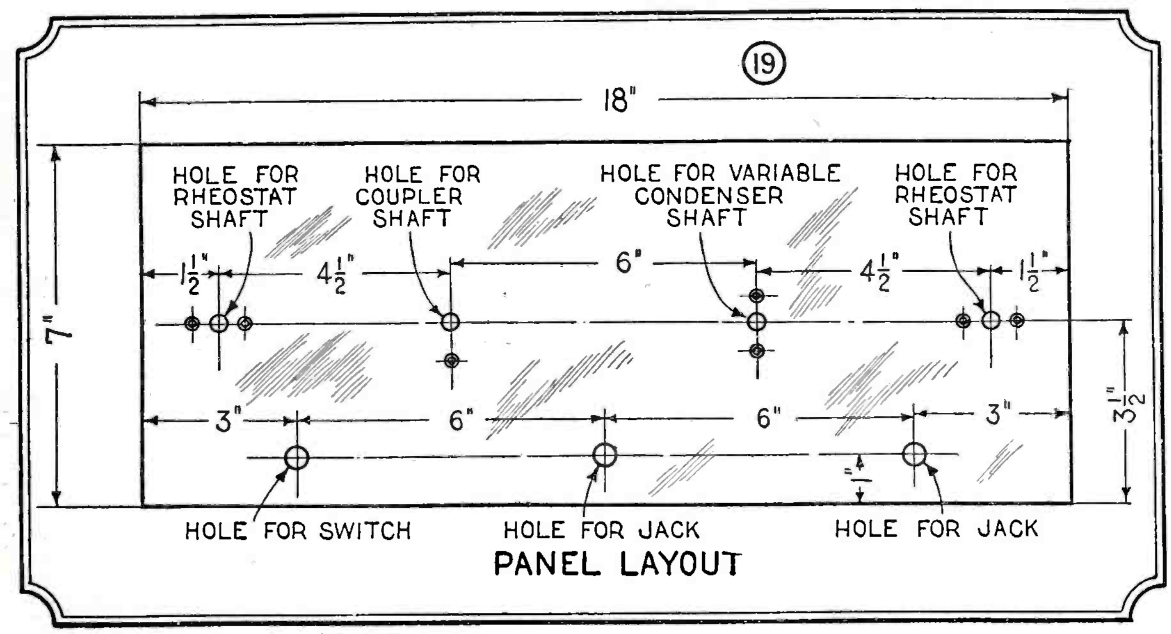
~GRID CIRCUIT WIRING~

On this page, we introduce a radically new system of showing the various steps in the wiring of a radio set. We have divided the circuits into three distinct and separate groups and are showing them above and at the right in the order in which the wiring should be done. First, the filament circuit is to be wired. Begin at the A+ binding post, connect up the switch, 17, and then the three sockets. Then from the A— post connect the two rheostats 13 and 14 and the remaining filament springs on the sockets. By proceeding in this manner, the work of wiring the set is exceedingly simplified and the chances of making wrong connections reduced to a minimum. Stick to the specific section of the circuit that you are wiring at one time and you will find that the work will progress in a very satisfactory manner.

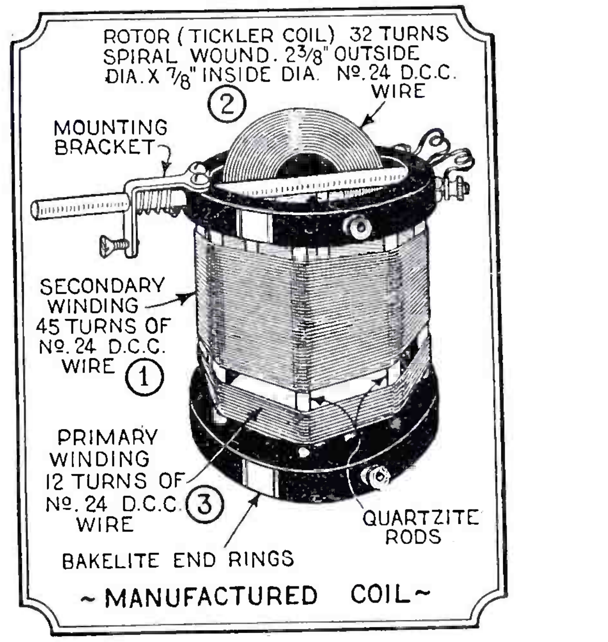


~PLATE CIRCUIT WIRING~

After the filament circuits are wired, the next step is the grid circuits. These are detailed above in heavy lines, the wires of the filament circuit which are already in place being shown in fine lines. In making these connections, one wire, that from the secondary of the coil to the grid leak and condenser is eliminated by mounting the grid condenser directly on the binding post of the coil as shown at 5 and 6 above. The grid leak and condenser used in this particular set are of the combined type, the clips for mounting the grid leak being fastened directly to the condenser. The plate circuit wiring is the next and final step and is illustrated at the left. Here again the connections already made, those of the filament and grid, are indicated in thin lines and those to be made, the plate circuit, in heavy lines.



PANEL LAYOUT



~MANUFACTURED COIL~

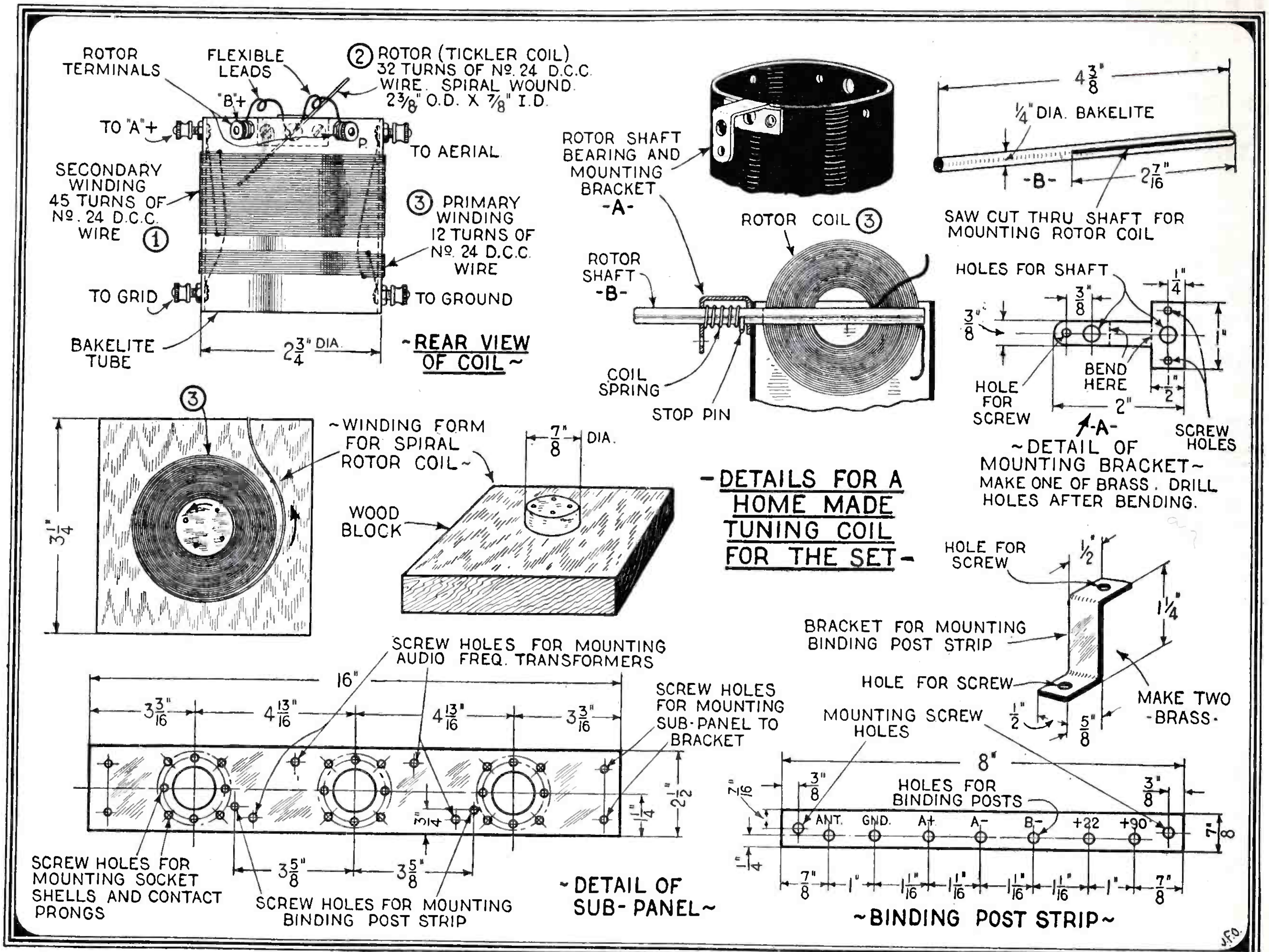
In laying out the panel of a new receiving set, the builder either mars or enhances the final appearance of the entire unit. If the holes are not properly centered and drilled, the dials will not line up and the result will be an unsymmetrical layout. To avoid this, use the panel layout given directly above. The distance between the holes in the panel and their positions thereon in relation to each other are shown. If a different type of condenser than that illustrated in the photos on the opposite page is used, the mounting holes for the same will have to be changed. However, keep the shaft holes in the same position.

A highly efficient manufactured coil for use in this set is illustrated above. The numbers thereon indicate the windings and are for reference to the photo and diagram on the opposite page and the diagrams above. If you do not purchase a coil of this type, you can make one of your own.

IN the presentation of this constructional article to the radio public, the writer has departed somewhat from the beaten track and instead of offering a circuit diagram, one or two photos of the set and letting the reader guess at the rest, he has, with the assistance of the artist, Joseph F. Odenbach, worked up what he considers to be one of the most complete radio articles ever published in any periodical.

Several photographs and a circuit diagram are published on the preceding page, and three progressive wiring diagrams, a panel layout, and a complete drawing of a manufactured coupler shown above. The constructional details are given on the page following.

Let us first assume that you have not bought one of the manufactured couplers and are desirous of making one yourself. A simple type is illustrated in detail below. The first requisite is a thin bakelite or paraffined cardboard tube 2¾ inches in diameter by 3¼ inches long. In one end of this tube drill two holes for the grid and ground binding posts and in the other end, four holes for the A+, B+, plate and aerial binding posts. At this end fastening to the tube and panel. After you have assembled this mounting bracket on the stator, place a ¼-inch bakelite rod, 4⅜ inches long in a vise and very carefully cut along the length of the rod with a hacksaw for a distance of 2 7/16 inches. This is shown at B above. The rotor coil which in this particular set is of the pancake type, as such a type has been found most efficient, is next to be wound and requires careful workmanship. It is ing with collodion and when dry, carefully remove from the block, using a thin bladed knife if necessary. Turn over and paint the untreated side with collodion. Solder the ends of the wire to two flexible leads, slip the coil into the slot in the bakelite rod and bind the rod in two or three places with strong wax thread. Apply a drop of collodion at the points where the coil and rod touch. Assemble the rotor in the stator, using a coil spring and stop



The details of the various home-made parts to be used in conjunction with the set described on the two succeeding pages are given above. A home-made coil of exceedingly simple design, but one which will operate very efficiently is detailed as is also the sub-panel and binding post strip.

three other holes are to be drilled, one for the shaft and the other two for the small machine screws which hold the mounting bracket in place. After these holes are drilled and the posts mounted, wind the primary and secondary coils following the data given in the rear view of the coil above. Leave a space of about ¼ of an inch between these two windings.

From fairly heavy strip brass, cut a piece, the details of which are shown at A above. Bend at the indicated points and drill the necessary holes. The two large ones will be of just sufficient size to allow the shaft to slip through and turn easily but must not be so large as to allow the shaft to wobble. The other holes are for not a hard proposition, however, and you only need be careful in order to insure good results. Provide a winding form as shown and after fastening one end of the No. 24 D.C.C. wire in a slot in the round center portion, start with the winding, proceeding a fraction of a turn at a time and holding that portion which has already been wound in place with the fingers of the left hand, guiding the wire with the right. After three or four turns have been wound, place a drop of collodion on the winding and let it dry for a few seconds. It will hold the wire firmly in place. Do this every few turns, in order to keep the winding smooth and firm. When 32 turns have been wound, coat the whole upper surface of the wind- pin as shown and the coupler will be complete. The stop pin may consist of a short thin machine screw passing through a hole in the shaft and fastened with a nut so that the end of the machine screw will strike the mounting bracket and prevent a complete rotation of the coil.

The details of the sub-panel are given, although they need not be followed if standard sockets are used. The latter can be mounted directly on the sub-panel by drilling only two holes for fastening. The binding post strip is also detailed.

Brackets for the binding post strip are shown and serve to off-set that strip from the socket panel and to provide better and easier construction and connections.

A Home-Made B Battery Eliminator

An Easily Constructed Device Which Can Be Assembled in a Very Short Time

IN a little less than one year half a dozen makes of B battery eliminators have appeared on the radio market and to-day the radio listener may forever discard his dry-cell plate supply for the new and up to date method of using the house lighting circuit. These electrical devices transform the 110-volt alternating house lighting current into direct current by means of a special circuit, giving a continuous source of current for the plates of the radio frequency, detector and audio amplifier tubes.

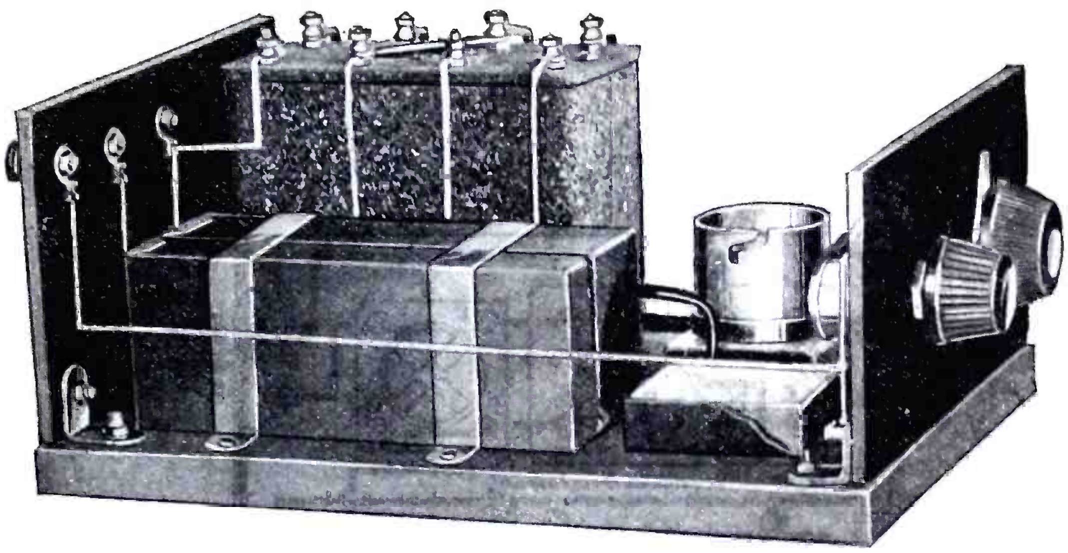
The radio fan who can tap the house lighting circuit in his house should investigate the various B battery eliminators and install one for his receiving set. Run down batteries will be a thing of the past, and the receiving set will perform remarkably well for an indefinite period of time with only the necessary attention given to the charging of the storage battery.

Most of these eliminators consume very little current. In fact, one-tenth of a cent an hour would be a fair estimate for the average B eliminator. This cost is considerably less than operating the set with dry-cell batteries. It also gives the satisfaction of knowing that there will always be a good live source of plate current "on tap" at any time.

The majority of the rectifiers make use of a vacuum tube as a rectifier, while one or two systems employ small jars containing a rectifying solution and electrodes for transforming the alternating into direct current. Unless a step-up transformer is used in such a rectifier to increase the 110-volt supply before it is rectified it is impossible to get much more than 80 or 90 volts.

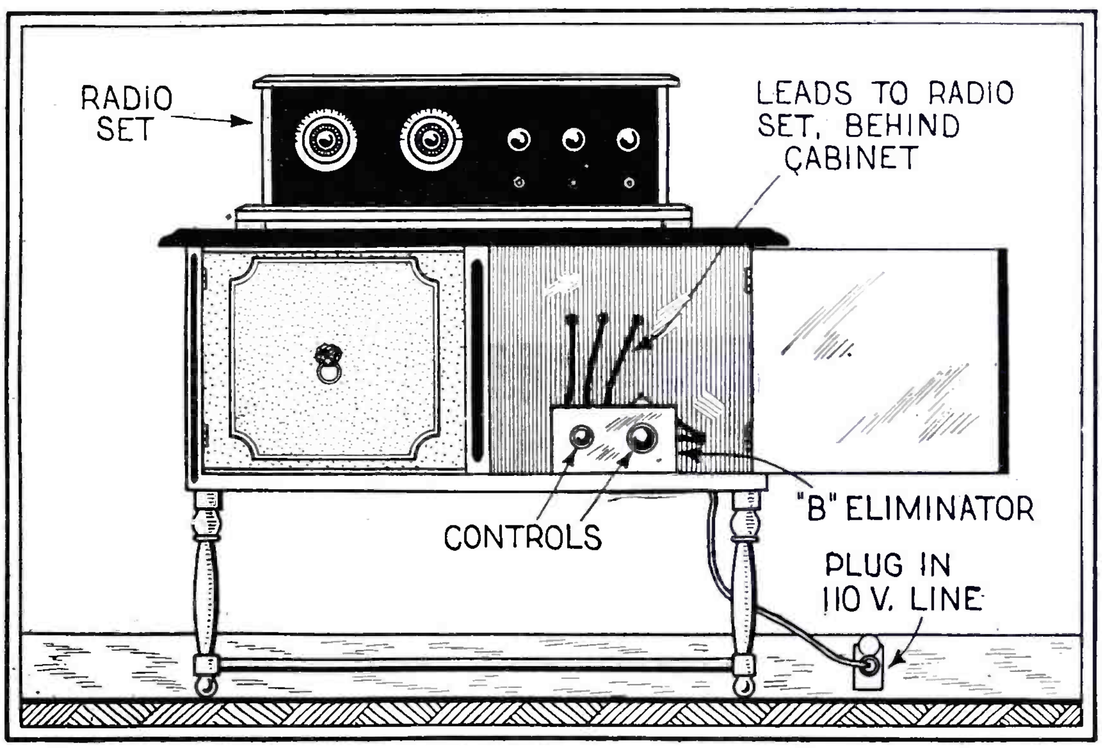
George M. Meyer describes one of these B battery devices in *The New York Herald Tribune* radio section as follows:

Owing to the high cost of manufactured B battery eliminators, few radio fans have considered their use and continue to use dry-cell batteries. It is now possible to build a successful B battery eliminator to work on 110-volt alternating current with but a few parts, and the radio fan is in a better position to put one together himself thereby deriving all the benefits of the commercial product at a cost considerably less.



Illustrations by Courtesy of N. Y. Herald Tribune

The completed B battery eliminator showing the 2 and 4 microfarad condensers with metal straps holding them to the baseboard.



A convenient way to install the B battery eliminator in a radio cabinet, thus keeping it out of sight.

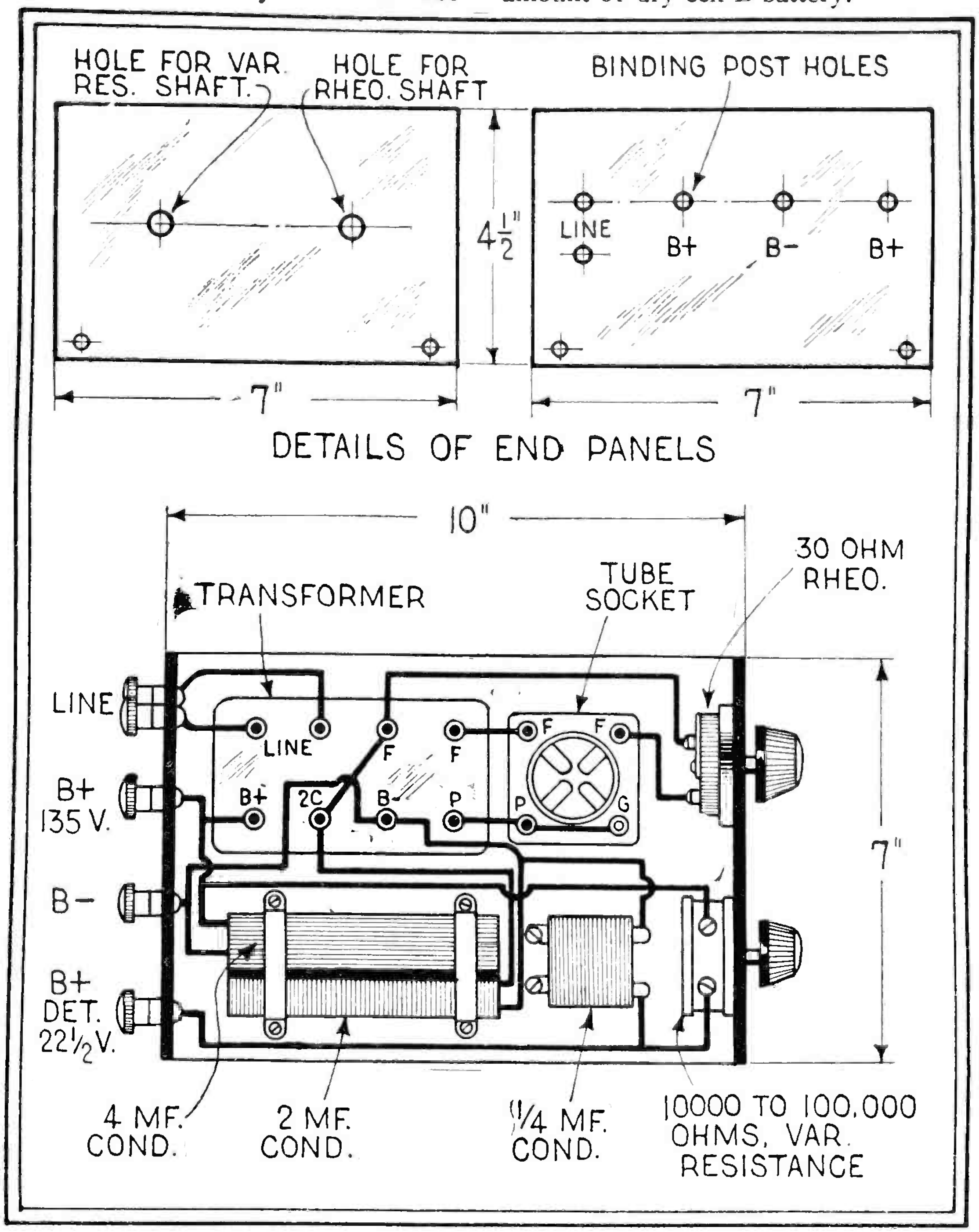
The writer constructed such an outfit and found it to work remarkably well on every set it was tried on. He is at present running one on his five-tube receiver and no trouble has been had with it since the first of the year. This eliminator makes use of a transformer encased in wax, small choke coil also included in the transformer case, some 1-microfarad condensers, a standard socket, rheostat, tube and a 10,000 to 100,000 ohm resistance of the carbon compression type. This can be mounted behind a small panel or in a box or even wired up in the cabinet of the receiving set. The accompanying photos and layout show how this device may be constructed for convenient use beneath your radio table.

If a 4 microfarad condenser cannot be obtained to be shunted across +B and —B leads from the transformer, four 1 microfarad condensers can be connected together in parallel as shown in the wiring diagram. Two 1 microfarad condensers may also be employed in this way in order to obtain the equivalent of a 2 microfarad condenser to be connected across terminals 2C and —B, that is, if the constructor finds he cannot obtain a condenser unit of 2 microfarads.

Uses 201-A Tube

The rectifier makes use of but a single UV201-A or C301-A tube, which is controlled by a 20-ohm rheostat. If not more than 18 or 20 milliamperes are passed through the tube it will last for a long while as a rectifier. Sets such as the five-tube tuned radio frequency or neutrodyne receivers should be equipped with a C battery to cut down the current consumption in the plate circuit.

There are a number of rectifier tubes on the market at the present time which can be used with this outfit if desired. However, any 201-A will do, even a discarded one which will not work well on the receiving set may be used in the eliminator.



Dimensions for drilling the two small panels and detailed layout of the unit.

Furnishes Steady Current

The eliminator described herein is capable of supplying 135 volts for the amplifiers provided not more than 15 milliamperes are taken from the eliminator. This can be determined by placing a meter in the plate circuit. When current in excess of 15 mills is drawn through the tube the voltage drops to 90 or slightly higher, but will still give sufficient current and voltage to operate the set equal to a similar amount of dry cell B battery.

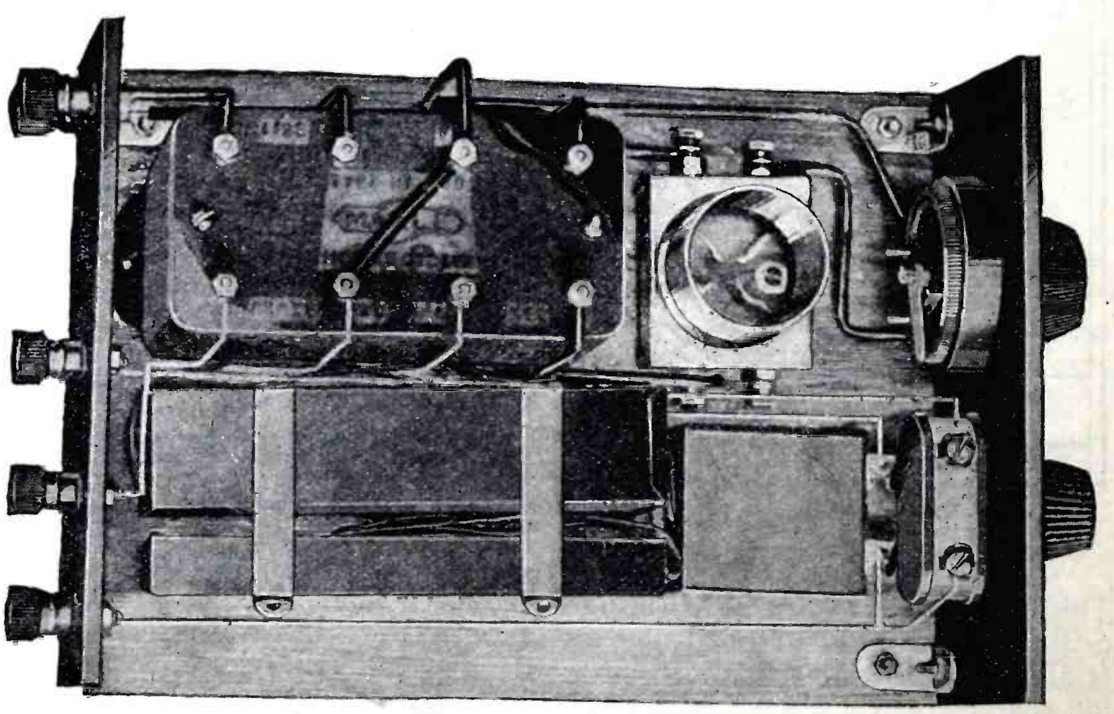


Photo showing the top view of the B battery eliminator.

The eliminator circuit is shown in the accompanying diagram and can be wired by any one within an hour or two. Follow the circuit carefully and make it as compact as necessary. Placing the instruments close together will do no harm.

In the accompanying photos is shown an arrangement of the parts mounted on a baseboard 7 x 10 inches. Two bakelite panels, size 4 x 7 inches, are attached to the baseboard as indicated in the layout by means of small brass angle brackets. One panel holds five binding posts, three for the B battery supply and two for connection to the 110 volt A. C. line. On the other panel the variable resistance (10,000 to 100,000 ohms) and rheostat for tube is mounted, see sketch of panels. This arrangement makes a suitable unit to be installed in a console radio table, allowing the B battery supply leads to be connected to the set from behind the table and easily accessible for control by the operator from the front of the cabinet as shown in the accompanying sketch.

However, any arrangement to suit the constructor will prove satisfactory providing the circuit is carried out according to the wiring diagram with parts specified.

The circuit is arranged so that the detector tube may be operated by means of the rectifier without the slightest trace of alternating current hum. The 10,000-ohm resistance will allow a micrometer adjustment on the plate voltage of the detector tube. The voltage may be regulated to suit any tube. It starts in at about 15 volts and can be increased to 45 if necessary in steps of a fraction of a volt at a time.

Voltmeter Not Necessary

A false impression will be obtained if the voltage of the eliminator is read with a voltmeter. Do not use one to measure the output but be satisfied with the fact that it works. The voltmeters generally used for measuring B bat-

(Continued on Page 60)

Construction of a Selector Tuner

A Tuning Unit for Receivers Located in Congested Radio Areas

A. KUBIAC, writing in *Radio News,* New York, has contributed a most noteworthy article on the subject of eliminating interference in congested sections. This matter of tuning out powerful local signals is a subject of considerable importance, either for the DX addict or the listener who finds that some nearby station saturates his set to the exclusion of all signals within a wide band of wave lengths. Read the article in the following and perhaps you will be able then to remove some of the "cuss" from the "concussion" of nearby stations.

Many of our most popular "new inventions" in radio receivers are not new and startling discoveries, but merely modern adaptations of old well-founded theories; theories set down by the pioneers of the radio art. These pathfinders have indeed blazed the trail so well that the fundamental principles, and many of the circuits, are still as useful now in solving our problems as they were in the early days of radio.

The Problem

Let us apply the above philosophy to our present-day difficulties. Take for instance the ever increasing problem of

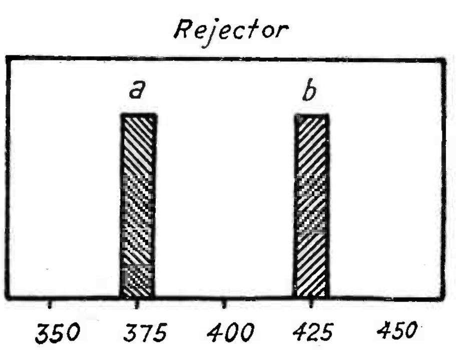


FIG. 1

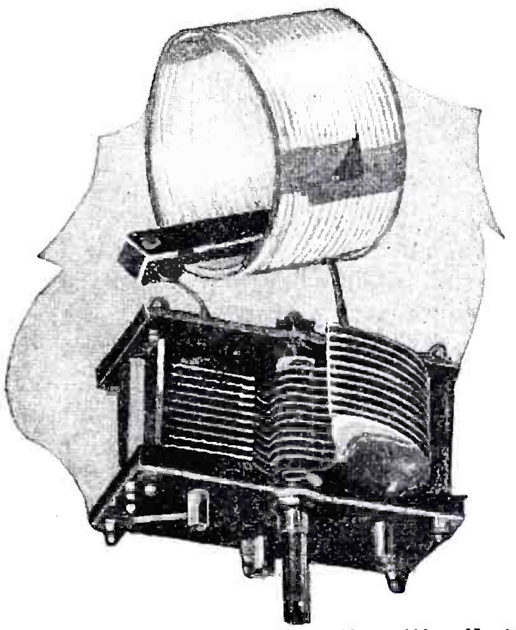
The shaded portion, a, represents the part tuned out by the wave trap and b is another interfering wave.

eliminating interference, especially as it exists in the vicinity of New York and other large cities. Imagine trying to use a single circuit receiver to tune in a concert from WOC on 484 meters, with WEAF only a mile away hammering in on 492 meters, and WJZ on 455 meters, with a half-hundred ships and shore stations operating so close that they scatter "forced oscillations" through all wave-lengths.

A wave trap is very effective in eliminating interference caused by one nearby station, but then how are we going to suppress the interference from a dozen other stations? We are going to go back about ten years and see how it was done in those days.

Rejector Circuit

The use of the "rejector" and "acceptor" combination for the elimination



Illustrations by Courtesy of Radio News (New York)

The elements of a wave trap. Both coil and condenser should have the lowest resistance possible.

of extremely severe interference, though not generally known to the public, is not new. In fact, such systems were used by the British during the war, and aboard our own battleships, even to the present time, with complete satisfaction.

The superiority of the "rejector system" over the "wave trap" in eliminating interference, not only on one narrow wave-length band, but on all wave-lengths, can readily be understood by referring to Figs. 1 and 2. Consider the base line Fig. 1 as the scale of wave-lengths embracing the broadcast stations. If we desire to receive a special concert from a distant station on a wave-length of 400 meters, we will encounter interference from a local station transmitting on 375 meters. This interference can be cut out by tuning the wave trap, connected in the conventional manner as shown in Fig. 3, to the interfering wave on 375 meters. The action of the wave trap in this case is to cut out the signals within a narrow band, as represented by the shaded portion (a), Fig. 1, from passing through the receiver. This method works out fine when there exists only one source of local interference. However, if we have another on 425 meters as indicated by the shaded portion (b), the problem becomes much more complicated. It is not practical to employ two wave traps, for if they do not possess exceptionally low losses, it is very difficult to preventing cutting out the desired signal also, while attempting to cut out the interference. Even if this condition did not exist, the use of two wave traps would add two more controls to the receiver, while the use of a "rejector" circuit adds but one. Furthermore, even with its single control, the "rejector" is superior to two wave traps as you will see with reference to Fig. 2. Note the opposite characteristics of the two circuits. Here, as in Fig. 1, the shaded portion represents the area covered by the wave-lengths that are prevented, by the action of the rejector, from passing into the receiver. In other words all waves are rejected excepting that to which the circuit is tuned, and this is passed on to the "acceptor" circuit of the receiver.

How the Circuit Works

In order to understand the function of wave traps, rejector circuits, and acceptor circuits as they are applied here in suppressing interference, it will be necessary to compare the resonance phenomena in a series circuit with the phenomena of parallel resonance. To avoid confusion in the various terms

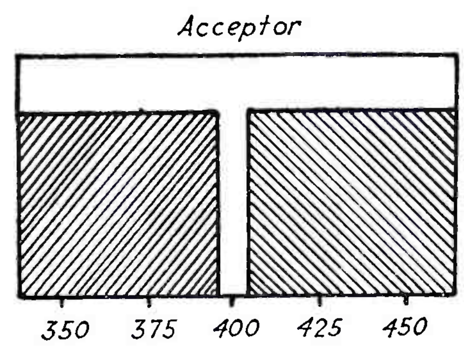


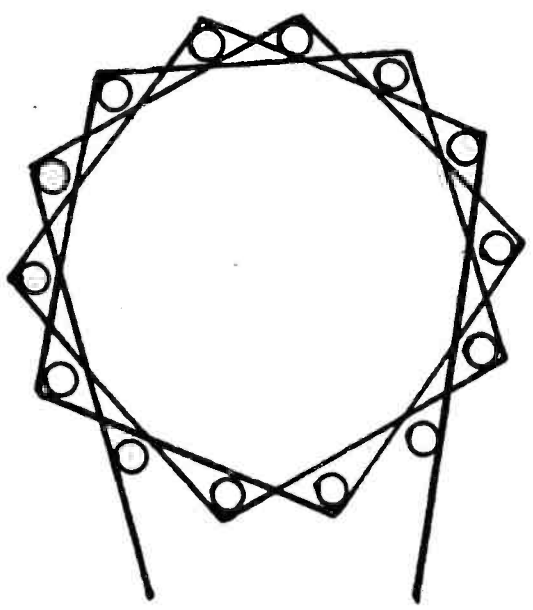
FIG. 2

With the "rejector" the unshaded portion is the only wave that gets through to the receiver.

used in this article we will associate the word "rejector" with the "parallel resonant circuit"; and the word "acceptor" with the "series resonant circuit," which is correct as you will see later.

A parallel circuit consists of an inductance and a capacity in parallel as shown at (a), Fig. 5, with the source of alternating potential applied at the points marked (X). This circuit will have a resonant point at some wave-length determined by the values of inductance and capacity in the circuit, one or the other of which should be made variable so that this circuit can be tuned to resonance with the externally applied current, which in this case is the current in the antenna caused by the incoming radio signal. The parallel resonant circuit acts like a very high impedance in the main circuit preventing the flow of current at the one frequency, to which it is tuned but it offers no impedance to currents of other than the resonant frequency. This condition is fully met when the parallel circuit contains zero resistance, therefore, it is important that circuits of this kind be carefully designed to reduce the losses to the smallest possible extent. The greater the losses in the parallel circuit, the greater will be the tendency for current at the resonant frequency to flow in the main circuit, thereby defeating the purpose for which the rejector circuit is used.

The series circuit shown at (b), Fig. 5, consists of a coil and a condenser



Showing method of using pegs for winding low resistance coils.

in series, with the source of alternating potential applied at the points marked X. The action of this circuit at resonance is directly opposite to that of the parallel circuit. The impedance introduced into the main circuit by the parallel circuit at the resonant frequency is very great, while the impedance due to the series combination is negligible.

Combining the Circuits

It is easily seen that if it is desired to have a current of a certain frequency in a circuit, but to exclude currents of all other frequencies, it is only necessary to combine the series circuit and the parallel circuit into one as shown at Fig. 4. The inductance L_1 and the capacity C_1 constitute the parallel or rejector circuit, while the inductance L_2 and the capacity C_2 make up the series of acceptor circuit. The inductance L_3 is the coupling coil to the receiver. The operation of this combination is a little difficult as the tuning is rather sharp; however, once the adjustment is made it will remain fixed for a given wave-length, and a calibration curve can be made to aid in tuning.

In the case mentioned in the previous paragraphs where we desire to tune in a distant station on 400 meters, but have local interference both on 375

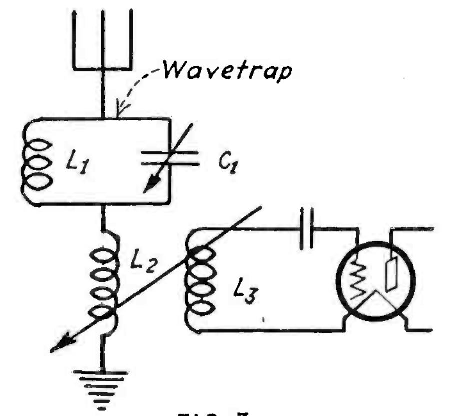


FIG. 3

Note the location of parallel and series resonant circuits.

meters and on 425 meters, it is not necessary to tune the rejector circuit to the interfering waves, for the acceptor circuit eliminates all signals except that to which it is tuned, as illustrated by the shaded portion in Fig. 2. Consequently, if the rejector is tuned to the desired signal on 400 meters (750 kilocycles), it rejects the current at this frequency due to the high impedance that it introduces into the circuit as mentioned before, but acts as a low resistance path to earth for currents of all other frequencies caused by interfering stations. Now you will remember that the series circuit behaves exactly the opposite, so that if we tune this circuit to 400 meters (750 kilocycles) it offers a high impedance to interfering frequencies, but negligible impedance at the resonant frequency, therefore it accepts the current that was rejected by the parallel circuit and transfers it to the receiver through the inductance L_3. The operation, then, is simply that of tuning the rejector and the acceptor both to the frequency of the desired signal.

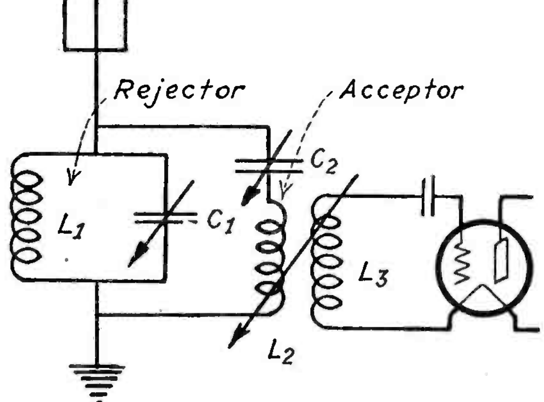


FIG. 4

The hook-up of the acceptor-rejector set with detector tube.

If both the acceptor and rejector circuits are calibrated, and if they are geared together, the number of controls is reduced and the operation is simplified to a large degree. Again, if straight-line frequency condensers are used, accurate dial settings can be made and the result is an instrument which will serve for many purposes.

Wave Trap

There are several wave traps on the market that have sufficiently low losses to give good results when used as a rejector. All wave traps are essentially "parallel circuits." The only difference between a trap circuit and a rejector circuit, as you can see by comparing Fig. 3 and Fig. 4, is the manner in which the parallel circuit is used with relation to the receiver. The point that detemines whether a parallel circuit will function satisfactorily as a rejector is its resistance. It must have very low resistance, not only ohmic resistance, but also that caused by nearby metallic objects, and by dielectric losses, in both the coil and condenser. A circuit which has the plates of the condenser mounted in the magnetic field of the coil will not work, nor will it work if the coil has too great distributed capacity caused by heavy shellac or dope on its winding.

In order to insure having a circuit

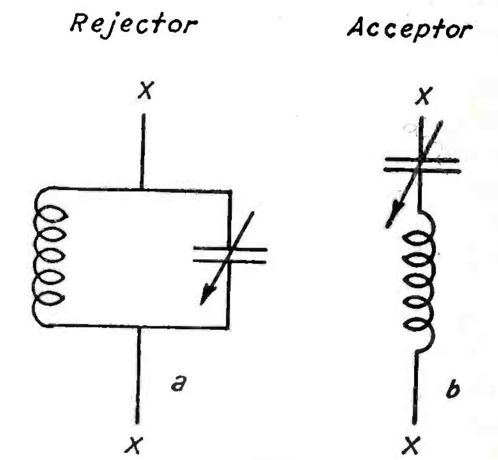


FIG. 5

The two primary circuits which form the heart of the acceptor-rejector system.

that will produce satisfactory results it is best that you construct it yourself according to the following specifications, which you will notice adhere to high capacity and low inductance in the circuit, but in a manner which lends itself more readily to the use of standard apparatus.

Draw a 3 inch circle on a pine board and arrange 14 pegs equally spaced about this circle (ten penny nails will do). Wind 20 turns of number 14 D.C.C. magnet wire around these pegs as shown in Fig. 7, binding each turn in several places with shoemaker's thread as it is wound on. After the 20 turns are wound on and securely tied, the pegs can be removed, leaving the coil self supporting. Do not impregnate the coil with shellac or varnish.

A back view of the panel showing the arrangement of the apparatus is shown at Fig. 8. The panel is of bakelite and the size, 6x9 inches, affords ample room for spacing of the parts. The four binding posts are connected

(*Continued on Page* 58)

A Selective Three-Tube Reflex

A Single Control Receiver Employing Radio Frequency Amplifier and Crystal Detector

A REFLEX receiver that possesses selectivity to the extent that a powerful local broadcasting station can be tuned out and another station operating on a wave length close to the first tuned in, is at the present time something to be looked forward to. In other words, that is the ideal which so many manufacturers are working for, but have not yet attained very successfully.

The reflex receiver described herewith by *William A. Schudt, Jr.*, from the *N. Y. Telegram and Evening Mail* Radio Section has exceptionally good selectivity. In addition to the tuning its volume is increased twofold with the selectivity. This is contrary to the usual proceedings, whereby the volume is usually decreased when the selectivity is increased.

Present day receiving sets employing any form of radio frequency (tuned R. F.) usually combine several variable condensers so that they can be controlled by one shaft, thereby bringing the number of controls down to one. Such a practice is all right for medium results, but beyond that it is a failure. Local stations can nearly always be tuned at the same dial reading when more than one variable condenser is used. Therefore, if local reception is the only object in view, all the variable capacities can be coupled to one shaft.

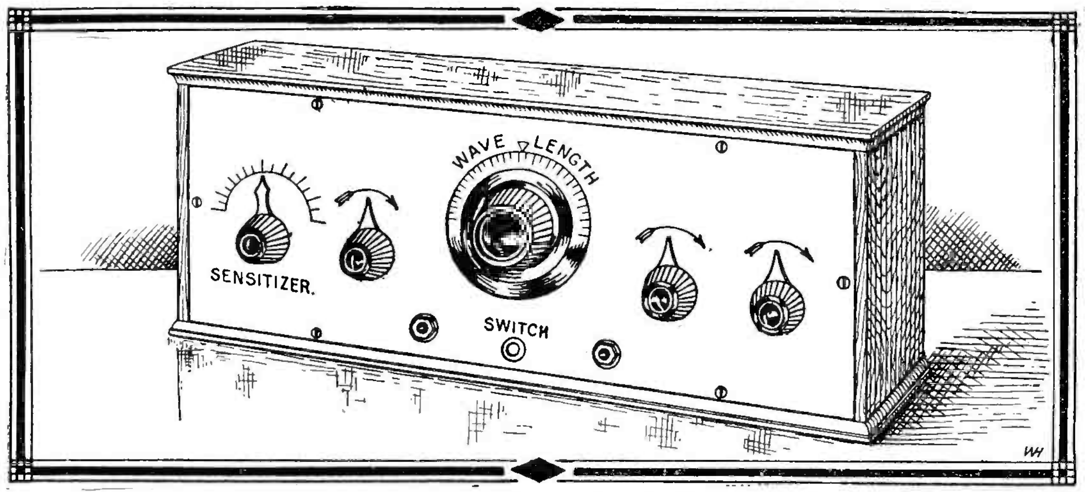
Tuning in distant stations with all of the condensers controlled by one dial is quite a task, since you cannot possibly get resonance unless each one of the radio frequency circuits is tuned separately and carefully. Of course, it is another thing when each coil is designed for use with a special condenser and all condensers in turn connected up to the one shaft. Even in this manner utmost efficiency is not obtainable, because various objects surrounding the coils and condensers tend to prevent any standardization of such units. On the other hand, several prominent manufacturers of radio equipment have solved the problem to a certain extent and can successfully operate several variable condensers on one shaft, but as was stated before, the utmost of efficiency is not obtainable at the present time.

Avoid Coupling Condensers

It is seen, then, that in designing the reflex set so that really good selectivity will be had one must not couple the two variable condensers. In this case only one is used and therefore the set is actually one of single control.

The receiver about to be described embodies a special form of reflex which is far more efficient than just the straight reflex set. Greater selectivity is obtained, ease of control, and greater volume is had with three tubes.

All of the apparatus can be mounted on a 7x18 inch panel.



Illustrations by Courtesy of N. Y. Telegram & Eve. Mail

Fig. 1.—Front view of completed set showing panel arrangement. Note single tuning control.

Necessary Parts

A list of the parts necessary for the construction of this super reflex set follows:—

One three circuit low-loss tuner.

One 23-plate .0005 mfd. variable condenser (low-loss type).

One iron core radio frequency transformer (untuned).

Three low ratio audio transformers.

One crystal or mineral detector (fixed preferable).

Three tube sockets.

Six binding posts mounted on rack.

One double circuit jack.

One single circuit jack.

Two variable grid leaks.

One battery switch.

Three 30 ohm rheostats.

One .001 mfd. fixed condenser.

One panel, 7x18 inches.

One baseboard, suitable for use with 7x18 inch panel.

Necessary dials, bus bar, and supports.

One knob to be used on sensitizer shaft to match up with knobs of rheostats.

One cabinet, 7x18 inches.

The panel should be laid out before anything else is done.

A piece of white cardboard the exact size of the panel is procured. With the aid of a ruler and compass the panel template is laid out to suit the builder. A very good lay-out is shown in the drawing elsewhere on this page.

The variable condenser is mounted in the centre of the panel with two of the rheostats on the right hand side, while one rheostat and the sensitizer control are placed on the left hand side. The jacks and battery switch are clearly shown mounted below the large dial in the centre.

As soon as the panel template is finished fasten it to the front of the panel by means of clamps. Small pieces of cardboard are used under the clamps to prevent them from marring the panel. Then impress the markings upon the face of the panel with a centre punch.

The baseboard is mounted or fastened to the panel first, following it by the condenser and rheostats. Care should be given to correct placing of the three circuit tuner. It is placed so that its magnetic field does not take in any part of the variable condenser.

The placement of the various transformers, tube sockets, and other instruments is clearly shown in the drawing.

Novel Wiring Method

Once all of the apparatus is in place the wiring should be started. In this case there are bound to be quite a few changes made before the set will be in proper working order. On account of this latter reason we are presenting a novel method of wiring so that it will be easier for the builder.

It may have occurred to many builders of radio sets after they have finished wiring with heavy bus bar to reverse a few transformer leads or try placing a certain lead at another point of vantage to see if it will increase the signal strength. If it has occurred to them they undoubtedly spent a few hot, blue, smokish minutes trying to bend or stretch the heavy connectors to their new positions. In order to save this excess energy and to be able to reverse one or all leads that can be reversed the set should be wired with No. 28 D. C. C. wire. Of course, this is only temporary and will be replaced, wire for wire, with heavy bus bar just as soon as the correct reversals are found.

Step by Step Process

Following is a word diagram of the reflex set, the schematic diagram being shown below.

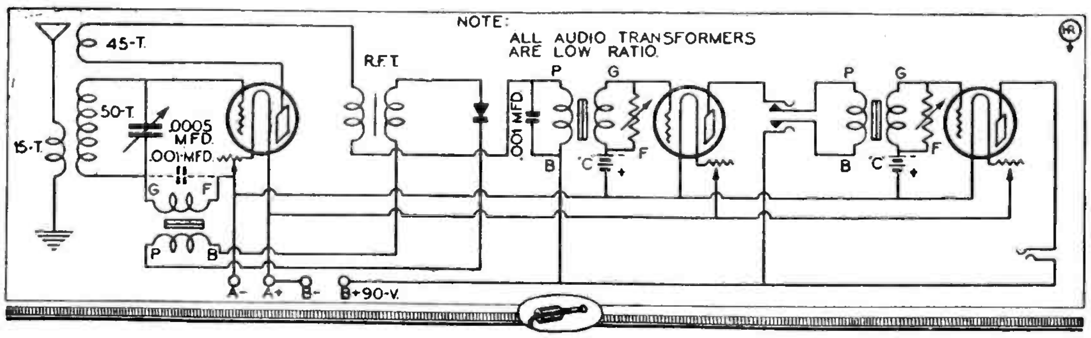


Fig. 2.—This schematic diagram should be easy to follow as the sensitizer coil and balance of the radio frequency circuit closely resembles the wiring of an ordinary three circuit tuner.

Connect first with the No. 28 wire, replacing later with bus bar.

From the binding post marked ANT a wire is connected to the top end of the primary coil. Now run a lead from the post marked GND to the other end of the primary.

Now comes the secondary circuit, and one must take great care here, for a mistake will end in complete failure. The end of the secondary nearest the tickler rotor is connected to the fixed plates of the variable condenser and also to the grid post of the first tube socket. The other end of the secondary is brought to the rotary plates of the variable condenser and to one end of the audio transformer. The other end of the transformer goes to the "A" minus lead.

Before wiring the primary circuit of the audio transformer one will find it much easier to finish up the plate circuit of the first tube. From the plate post on the first tube socket a wire is run to one end of the sensitizer coil, which is known as the tickler coil of the three circuit tuner. Now run a lead from the other side of the sensitizer to one side of the radio frequency transformer. Continuing the wiring, connect a lead to one side of the primary of the second audio transformer from the other side of the untuned radio frequency transformer.

Other Connections

As we transform our energy into the secondary of the radio frequency transformer let us also continue wiring this part of the set. The top end of the secondary is connected to one end of the crystal detector, while the other end of the crystal detector is connected to one side of the primary of the first audio frequency transformer, the opposite side of the audio transformer being placed in connection with the other side of the untuned radio frequency transformer. (Reference should be made to the schematic diagram from time to time.)

Going back to the second audio transformer, connect a wire to the vacant post on the primary side to the binding post marked "B" plus. This "B" plus is also connected to the lower prongs of the two jacks. A fixed mica condenser of .001 mfd. is connected across the primary of this audio transformer.

It hardly seems necessary to go into word diagram for the rest of the audio frequency amplifier, since it is of conventional design, except for the two variable resistances which are shunted or connected directly across the secondaries of the audio transformers.

All of the grid return leads are connected together and in turn connected to the filament circuit and then to the "A" battery minus binding post. The other filament posts on the three sockets are connected together and then to the binding posts marked "A" plus and "B" minus. So much for that.

A by-pass condenser may have to be shunted across the secondary of the first audio frequency transformer, In fact, it is not a bad plan to try this condenser both in and out of the circuit.

The leads to the first audio frequency transformer should be reversed to find the best operating polarity. This is very important, and when the correct wiring for the whole row of transformers is found the frail wires should be replaced by strong bus bar.

Try Reversing Leads

If it be not too late, we might stress that the audio transformer should be of the lowest possible ratio.

Because of the use of a crystal detector, the clarity of this particular set is as nearly perfect as any radio set tested by this department.

As in the construction of all radio receiving sets, the results obtained depend entirely on the quality of apparatus used in it, and this cannot be advised any too strongly with this reflex receiver. Use good transformers, especially the untuned radio frequency transformer, which is of the iron core type and should be of the very best quality.

Construction of a Selector Tuner

(Continued from Page 56)

as shown with bus wire. Do not allow the wiring to hug the panel, but bend it up so that it is an inch from the panel. The basket-wound coil is mounted so that it is two inches from the panel by using the lead wires as legs, and aside from a small fibre bracket (not shown) this is all the mounting used. The fixed condenser has two capacities, one of .001 mfd. and the other of .002 mfd. and the manner of connecting to the three-point switch is clearly shown. Use a good grade mica condenser here. The variable condenser is connected directly to the bus wire as shown. It is advisable to mount the panel in a cabinet.

If the receiver is of the loose-coupled type employing a primary series condenser, or even if it is the popular single circuit receiver with a series tuning condenser, the parallel circuit can be connected directly to the antenna and ground terminals of the receiver, in which position it will function as a rejector, and the receiver as the acceptor. If the receiver does not employ a series circuit for tuning, it will be necessary to construct such a circuit and couple it to the receiver as shown at Fig. 4.

In operating the rejector, be careful to avoid coupling between the rejector and the receiver.

List of Parts

1 6"x9"x1/8" Bakelite Panel
1 6"x6"x9" Cabinet
1 .001 Variable Condenser
1 .001 Mica Fixed Condenser
1 .002 Mica Fixed Condenser
1 1½" Switch Lever
3 Contact Points and 2 Stops
4 Binding Posts
25 feet No. 14 D.C.C. Wire
2 feet Bus Wire

Some Good Reflex Hookups

Simply Constructed Reflex Sets for the Home Radio Builder

THE following article by *J. R. Balsley*, which appeared in *The Experimenter*, New York, might be entitled "Much From Little," as it has to do with the job of making one lone tube do the work of two or more. Of course it is about one tube reflex circuits and previous to having read over the information and data given, we had an idea that we had seen all the one tube systems possible. Our ideas have since undergone a change as you will see in reading the following:

It seems that the popular demand for a low-priced, long-range, easily-operated receiver has not been met satisfactorily by any device so far described in any of the radio magazines.

Super-regenerators are far from satisfactory for reception of music because of the distortion that is an inherent feature of this type of receiver. Furthermore, they depend on strong oscillations of the close-coupled antenna circuit to produce results and this creates a disturbance in all nearby receivers.

The reflex type of receiver seems to be the one with which we may expect ducing the antenna resistance sufficiently to pass very weak signals.

The most effective method for practically reducing the antenna resistance is, of course, through regeneration. Using a feed-back coil in the plate cir-

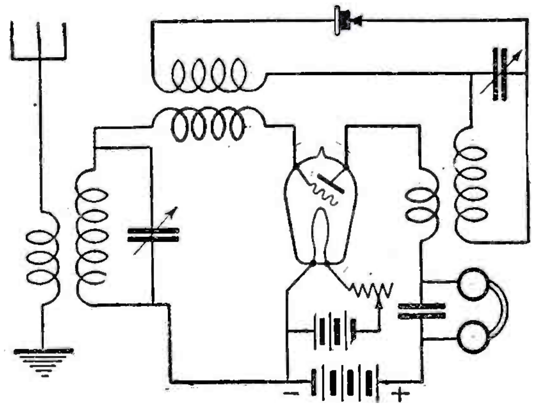
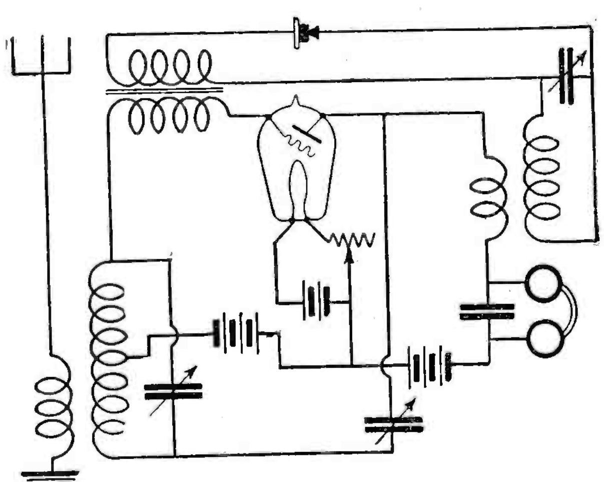


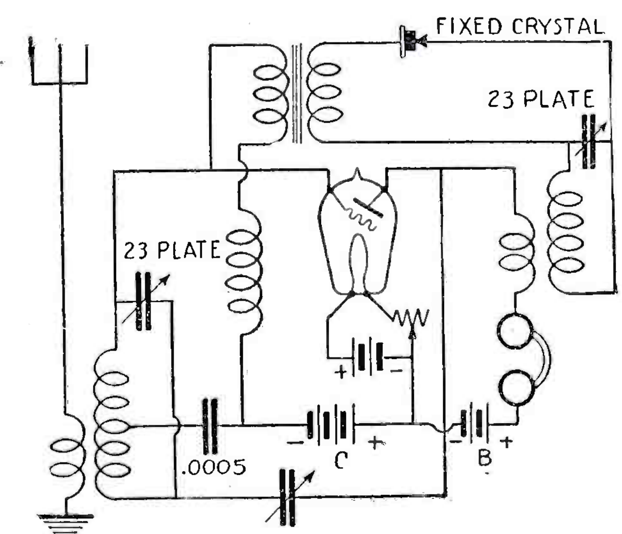
Fig. 1. A one-tube reflex receiver using a crystal for detector. Volume is good and distance greatly increased by the addition of the reflex system.

cuit of a single tube reflex is very unsatisfactory, because the tendency of the tube to oscillate at the high incoming frequencies makes the set very unstable. Using a set constructed as in Fig. 1, great care must be taken to keep tuner (A) and transformer (B) perimenter to introduce regeneration in the usual way and get results.

The set described herein will, I believe, make it possible for any experimenter to build a really good single tube regenerative reflex receiver. There are no original ideas introduced, and it does not have to support a triple-expansion, cross compound double-acting, ultra, super, some kind of a dyne name, so I believe it will be looked upon with favor by the builder who has to watch his expenditures.

The tuner is built with a split secondary which would normally cause the tube to oscillate at all times were it not for the small balancing condenser which makes it possible to control oscillations under any circumstances, and therefore gives the set stability. The grid-plate capacity of the UV-199 tube is .0000042 mfd. and of the 201-A tube is .000009 mfd. so that any small variable condenser with a range of 1 to 10 micro-microfarads will be satisfactory and the tube may be kept just below the point of oscillation with a (C) battery in the grid return, thereby making possible amplification at both radio and audio frequencies.





Illustrations by Courtesy of The Experimenter (New York)

Fig. 2. Another method of reflexing using one tube and crystal detector. The primary is semi-aperiodic, the secondary is 60 turns tapped at the 30th turn. Both variable condensers are of .0005 mfd. capacity. Fig. 3 at the right shows another one-tube reflex circuit. This circuit is very selective as well as being unusually sensitive. Both condensers are 23-plate (.0005 mfd.). In connection with a good aerial and ground system very good results may be obtained from any of these circuits. A hard tube is used in each circuit.

to accomplish the greatest results with the minimum of parts. Many experimenters have constructed single tube reflex receivers that produce the desired results, but unfortunately the majority of them are discarded as unsatisfactory for one reason or another.

Almost any single tube reflex will amplify signals within 30 or 40 miles sufficiently to operate a loud speaker, but most of them fall down miserably on DX work simply because there has been no good method suggested for re- out of inductive relation to insure stability even though the damping effect of the tuned crystal circuit tends to make the set more stable. Capacity between carelessly arranged wires will often cause the tube to oscillate. Except with a very good antenna, this set is not satisfactory for DX receiving without some method for reducing the antenna resistance. Inasmuch as great care must be taken to construct the receiver as described, it is evidently almost impossible for the average ex-

The secondary of the audio transformer may be connected in series with the input coupler as in Fig. 2 or in parallel as in Fig. 3. The last named is the suggested method inasmuch as tests have shown this to be the most efficient. In the parallel connection it is necessary to insert a choke in the audio circuit, otherwise the secondary of the coupler would be short circuited due to the capacity between windings of the audio transformer. It is also necessary to insert the small stopping condenser shown to keep from short circuiting the audio transformer.

The tuner and transformer should have about 10 turns on the primary and 65 on the secondary if wound on a 3-inch form. The secondary is wound first an the primary is wound directly over the secondary separated by a piece of waxed paper. I used No. 28 SCC wire. To make a neater job, buy two neutroformers which will be exactly right.

Mount the two coils on the rear plates of the condensers and place their axes at right angles. By this method the entire set may be built behind a 6-inch by 7-inch panel.

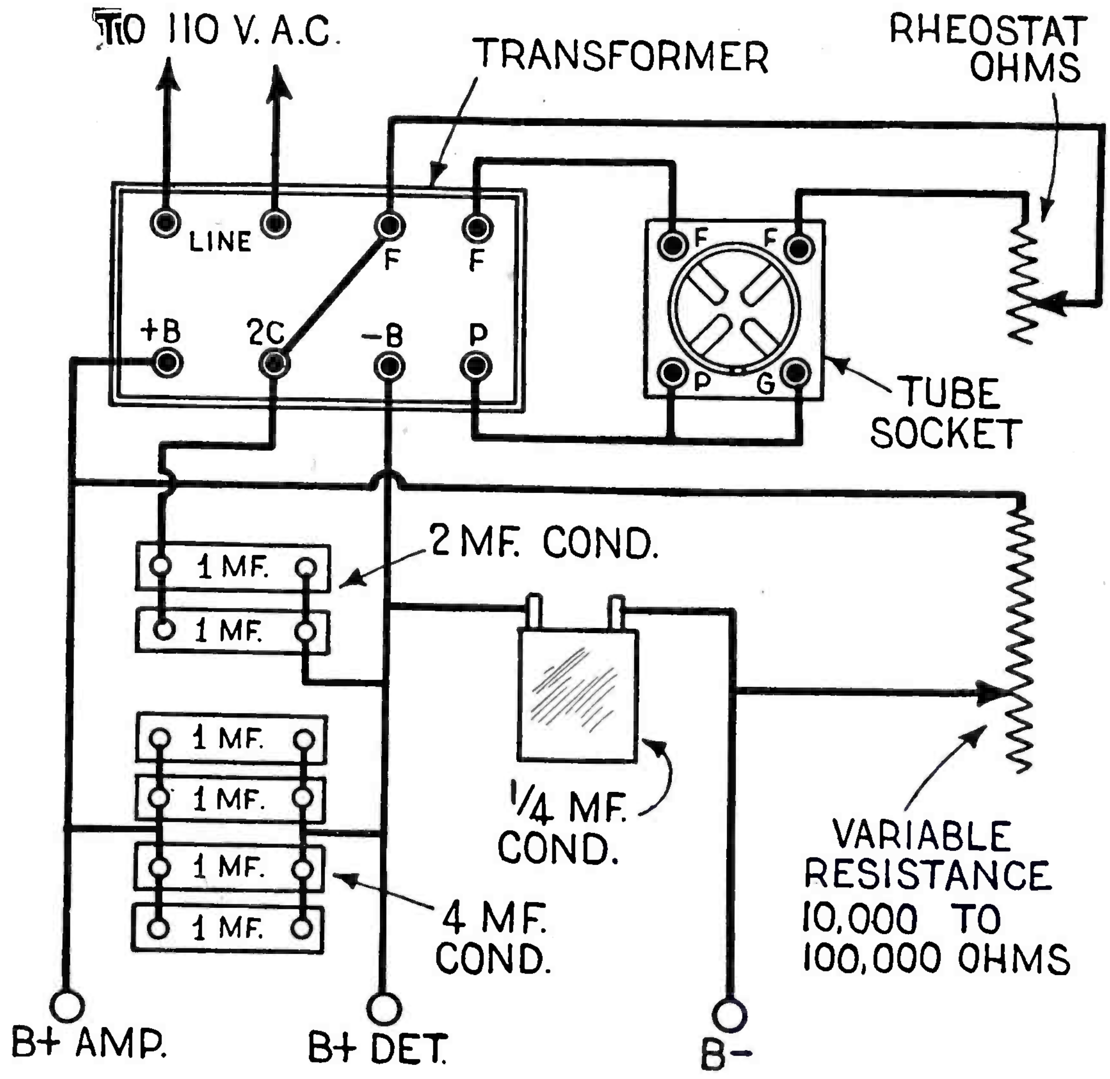
Here at Green Bay, Wis., both coasts are heard regularly, and it is possible to hear the Chicago stations (125 miles) on the loud speaker using an (A) tube with 90 volts on the plate. KDKA comes in sufficiently strong for the loud speaker every night, and WBZ has been heard several times almost as loud as the Chicago stations. One of these built for a friend in Philadelphia, Pa., has proved very satisfactory, and he reports having heard the Pacific coast on several occasions.

A Home-Made "B" Battery Eliminator

(*Continued from Page* 54)

tery voltages consume so much current that the drop in voltage would be too great to get an accurate reading.

1 Dubilier or ¼-microfarad condenser.
1 20-30 Ohm rheostat.



Schematic diagram for connecting the unit. Note that this diagram shows how to connect two sets of 1 microfarad condensers together in order to obtain the desired capacity.

So let well enough alone and be contented that the device works the receiving set without worrying about how much voltage your tubes are getting.

Parts Required

Following are a list of parts necessary for the eliminator. All together with the exception of the tube, the cost should not exceed $20 and perhaps less, if better prices are found on the articles listed:

1 Marle transformer, type 200.
1 Dubilier 4 microfarad condenser.
6 1-microfarad condensers.
1 10,000 to 100,000 Bradleyohm.
1 Standard socket for 201-A tube.

The fixed condensers can be purchased in almost any up-to-date radio supply house. Dealers can supply you with the rest of the material as well. A few lengths of bus wire should be on hand or any other kind of wire will do.

Circuit Pointers

Wire the circuit up in any manner, as it does not require special instructions except in a few cases. Take notice that the plate and grid wires are connected together on the socket. The transformer is designed so that terminals are provided for choke coil, filament supply of rectifier, negative B and positive B. The detector tap is taken from the condenser bank, as shown.

The rheostat and 10,000 ohm resistance may be mounted on a small panel for convenience. Once they are adjusted, however, there is little need for readjusting, unless the lighting circuit happens to take a sudden drop or big increase. This seldom happens and in this event the change will be scarcely noticeable.

Operation of Rectifier

Connect the three wires, plus B, minus B and 22-volt tap to the receiving set. Check over the wiring to make sure everything is correct and then insert a rectifier tube in the socket. Plug in the extension cord to the lamp fixture near by and everything is ready for operation. Turn on the filament rheostat. Do not turn it up as high as you would do with a receiving set tube. The rectifier will work just as well with the filament burning dimly.

If you happen to hear a slight hum, don't get excited and think the device is no good. Perhaps the detector is getting too much or too little current. Adjust the 10,000-ohm resistance until everything is good and clear. This will work best with a very loose adjustment of the resistance. If you have wired it properly, the set should work just as it did with B batteries.

It is not suitable for super-hets or six and seven tube outfits that are "juice eaters." The eliminator works very fine on a standard regenerative set of from one to three tubes. It will also supply current for a five-tube neutrodyne or tuned radio frequency set, provided the proper C battery is installed.

From time to time it may be necessary to readjust the filament rheostat. As the transformer windings do not stand over a quarter of an ampere for the rectifier tube it is unwise to use more than this amount of current.

A Compact Super-Heterodyne

Construction of a Reliable Super-Heterodyne that Occupies Little Space without Loss of Efficiency

MOST radio fans have been educated to regard a super-heterodyne receiver as a bulky proposition, and in fact the term "super" rather seems to imply something of gigantic proportions. It may seem paradoxical, therefore, to attempt to make a compact super-heterodyne. As a matter of fact, however, there is no particular reason why such a set should occupy all outdoors, as the earlier models appeared to do. Considerable progress has been made along these lines and the compact model recently described by *D. J. Hall* in *Radio News*, New York, and given in the following, should be of much interest to radio fans.

At the beginning of the Super-Heterodyne period, that set usually occupied more room, with its necessary accessories, than the piano or the kitchen stove. But as time went on and improvements were made in its design, its size was constantly decreased, until today there are forms of it which occupy no more room than the regulation detector and two-step, or the Neutrodyne.

This diminution has been made possible through two causes: First, the perfection of the dry cell or dull emitter vacuum tube; and, second, through advances in set design.

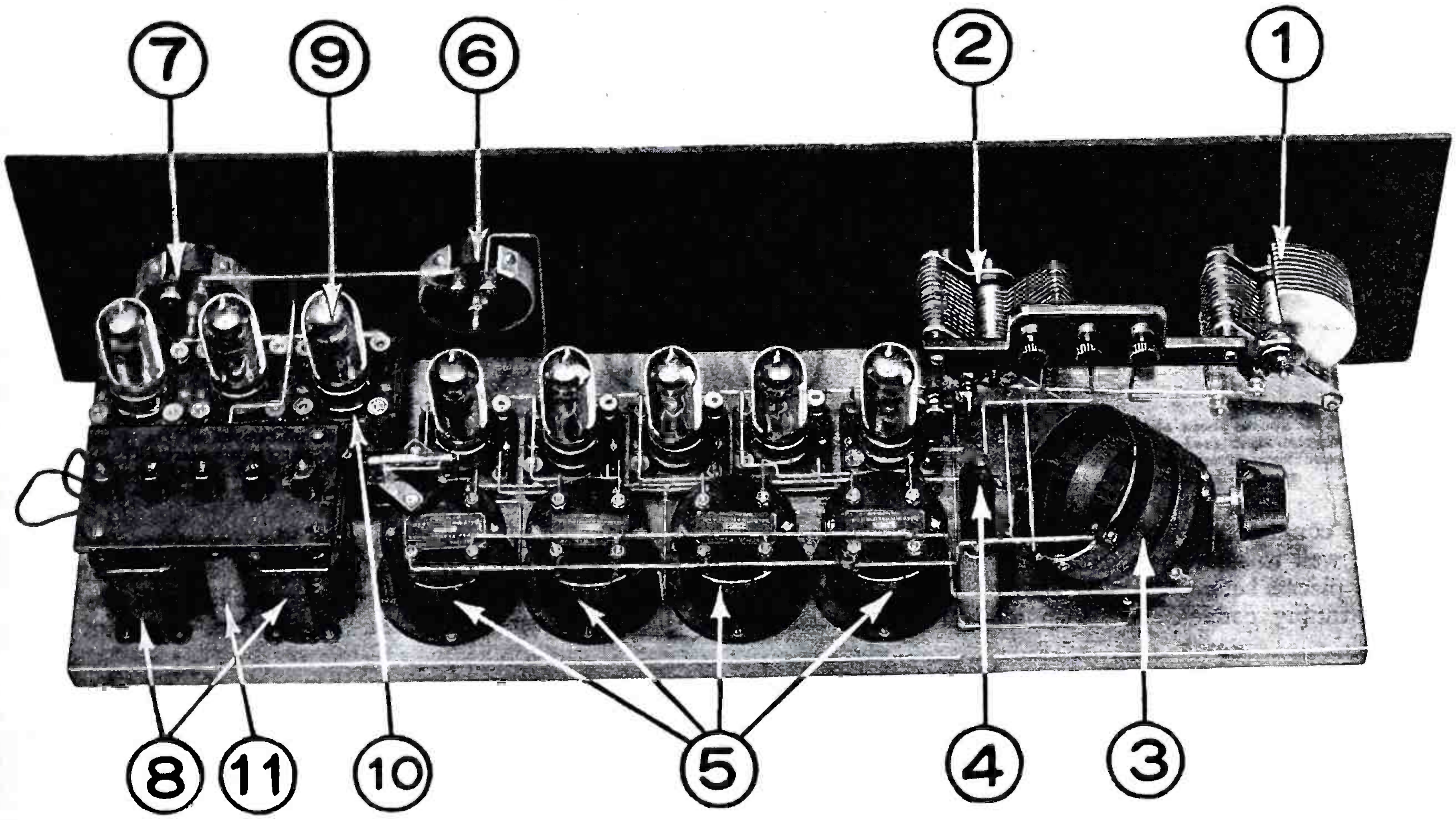
In the present instance, we give two examples of the compact Super-Heterodyne. One form is for stationary use, in the home, while the other may be fitted into a suitcase or other traveling bag for portable use. The first is shown in Fig. 1. In this case little change is made in the conventional wiring or the principle of the set, the hookup following closely the standard eight-tube design with only the addition of a small condenser in the plate circuit of the first tube so the regenerative feature may be incorporated.

With the home model, it will be noted that the arrangement of the parts is substantially the same as they appear on the hook-up, *i. e.*, oscillator, first detector, intermediate frequency amplifier, second detector and the audio stages. It is the same sequence as followed in drawing the plan of the circuit.

Under this system, the wiring is much easier as well as the placement of the parts. In the second instance, every possible advantage has been taken of space, with the result that the parts are all situated as closely as possible to each other. Fig. 2 shows the back-of-panel arrangement in the compact form. The usual baseboard is dispensed with and the instruments are mounted upon a sub-panel which is placed across the center of the panel proper. This supporting device is of copper or aluminum or other metal and serves as a shield as well as a support for the apparatus.

For the completion of a portable set from the arrangement shown in Fig. 2, it is only necessary to select the proper size and shape in traveling bags and then install the panel. Of course, one compartment must be left for the accommodation of the batteries and the loop. A built-in loud speaker will be a bit more trouble to negotiate, but it can be arranged easily, as shown in the accompanying photograph.

One important point which must not be overlooked in such a set is that the



Illustrations by Courtesy of Radio News (New York)

Fig. 1. By far the simplest method of mounting and assembling a Super-Heterodyne is the "open" plan as shown above. It simplifies wiring but entails the use of much more space than some of the other plans given with this article. 1 is the oscillator condenser and 2 is the tuning condenser; 3, pick-up coil for the oscillator; 4, "C" battery; 5, intermediate frequency transformers 6 and 7, tube controls; 8, audio frequency transformers; 9, second detector; 10, gang sockets; 11, by-pass condenser. © Baldwin Pacific Co.

entire interior of the case, that is, the set, should be lined with copper or other metallic foil for the purpose of shielding the completed set from outside induction.

Too, in connection with this point it might be well to note the small shield which is placed between the oscillator and the tuning condenser. With all the instruments placed in such proximity, the shielding of the set is advisable.

One advantage is gained through the more compact arrangement which is not had in the first one, namely, a symmetrical arrangement of the panel front. In the second instance, the dials are placed one on each side of the vertical center line of the panel, and the other controls, including the jack, are grouped around them. In the first instance, the two dials are at the left end of the panel with the remainder of the instruments strung along the panel to the end.

In the construction of the second set for portable use, a collapsible loop is, of course, included in the equipment and a compartment left in the case for it.

To the experienced radio fan, it is obvious that the arrangement of the Super-Heterodyne is probably the most compact possible with the use of standard tubes. And one point which he will not miss is the use of three "C" batteries, which cut the consumption of "B" battery current to the neighborhood of 12 milliamperes with all tubes operating.

Many experimenters have long since learned the advantage of using the 199 type of tube in the construction of

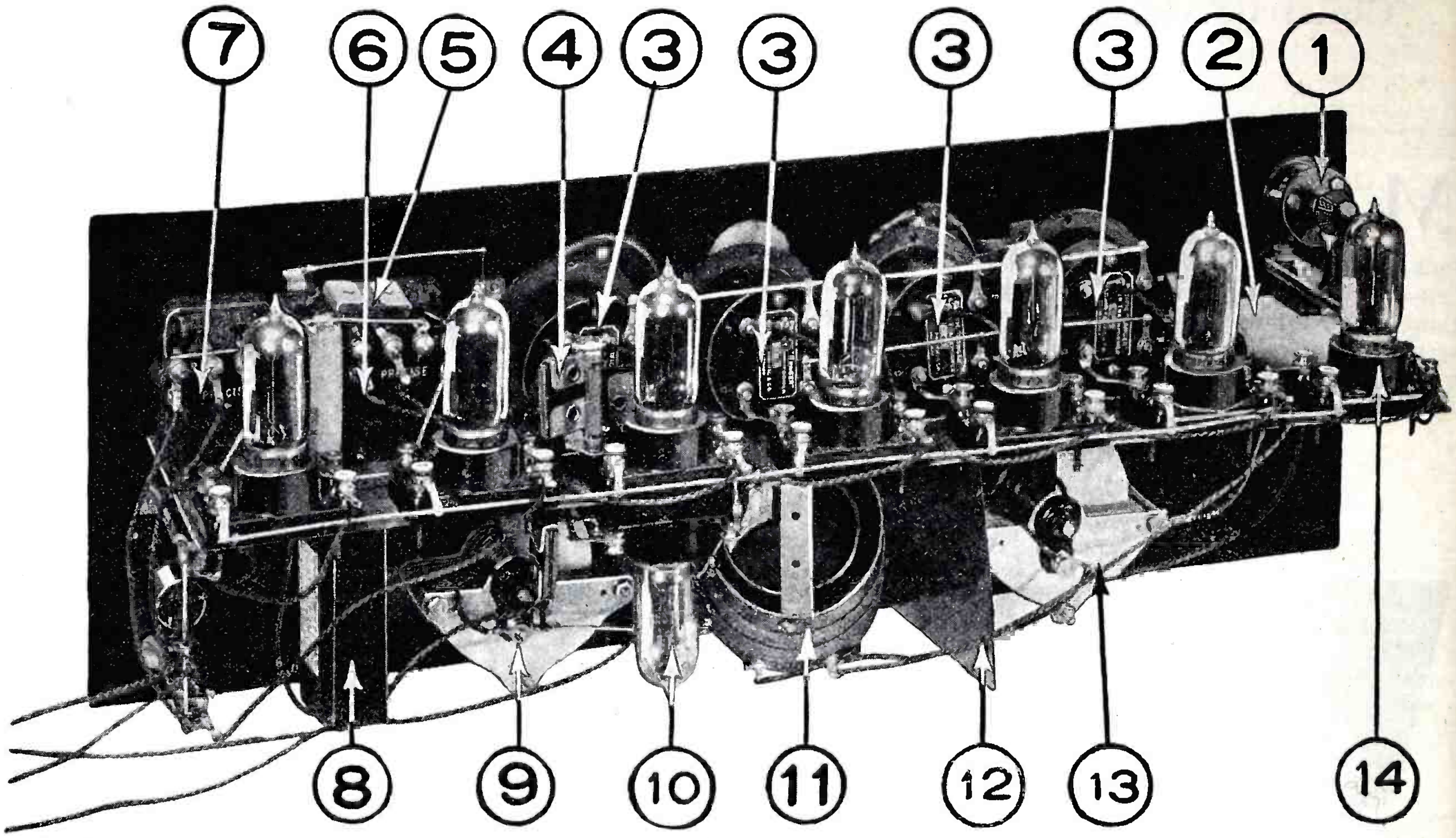
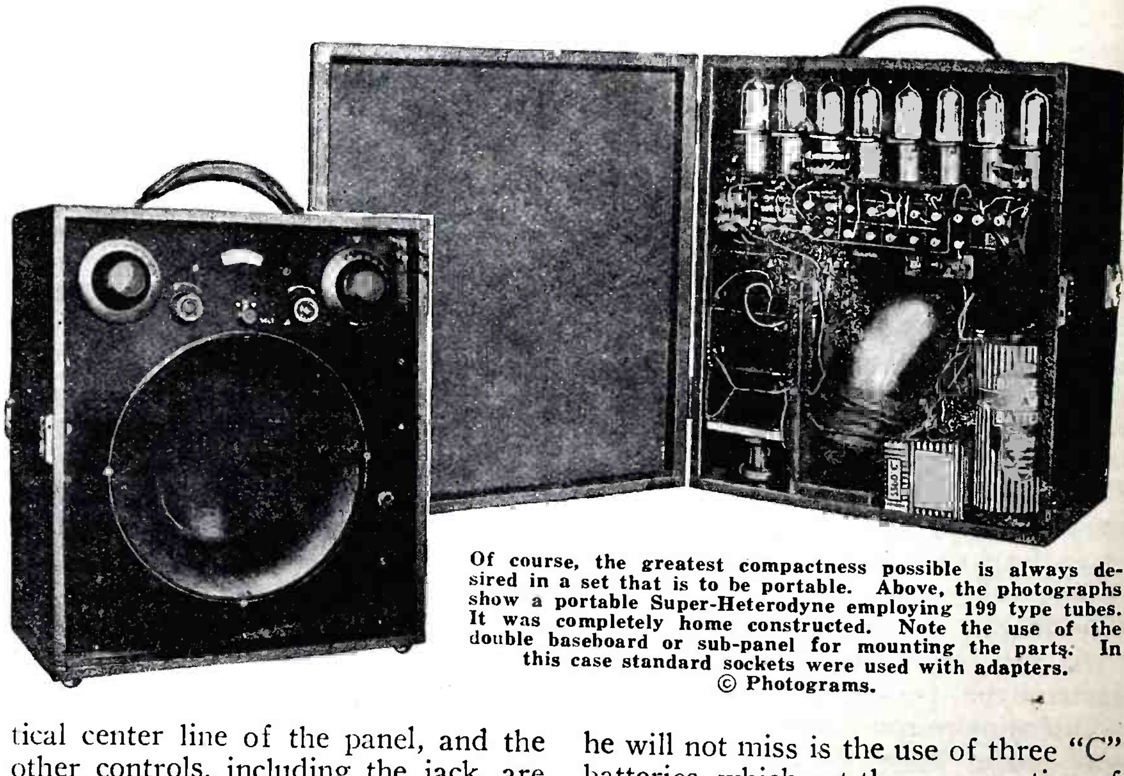


Fig. 2. The above photo shows an extremely compact Super-Heterodyne. As is shown, the whole trick lies in the placement of the apparatus. 1 is the regeneration feed-back condenser; 2, "C" battery; 3, the intermediate transformers; 4, the grid leak and condenser on the second detector; 5, by-pass condenser across the first audio frequency transformer; 6 and 7, the audio frequency transformers; 8, by-pass condenser; 9, oscillator condenser; 10, oscillator tube; 11, pick-up coupler; 12, shielding; 13, tuning condenser; 14, first detector. Photo © Baldwin Pacific Co.

LIST OF PARTS

1 Oscillator coupler.
1 Filter transformer.
4 Intermediate radio frequency transformers. (Note—These four instruments should be all of the same manufacture and should be matched.)
2 .0005 mfd. variable condensers—and be sure they go up to .0005.
1 .006 mfd. fixed condenser.
3 .0025 mfd. fixed condensers.
3 .00025 mfd. fixed condensers.
1 .0005 mfd. fixed condenser.
1 Mfd. fixed condenser.
2 Six-ohm rheostats.
1 Small vernier variable condenser.
2 Audio frequency transformers, 3:1 ratio.
1 Open circuit jack.
1 Filament control jack.
8 199 type tube sockets.
8 199 type tubes.
8 Binding posts.
1 Panel, 6 by 26 to 30 by 3/16 inches.
1 Base, same size, ⅞ inch thick.
2 4½-volt "C" batteries.
1 1½-volt "C" battery.
2 45-volt "B" batteries.
1 4½-volt "A" battery, storage or dry cells.
30 feet of tinned copper wire, No. 14.
Miscellaneous screws, nuts, etc.

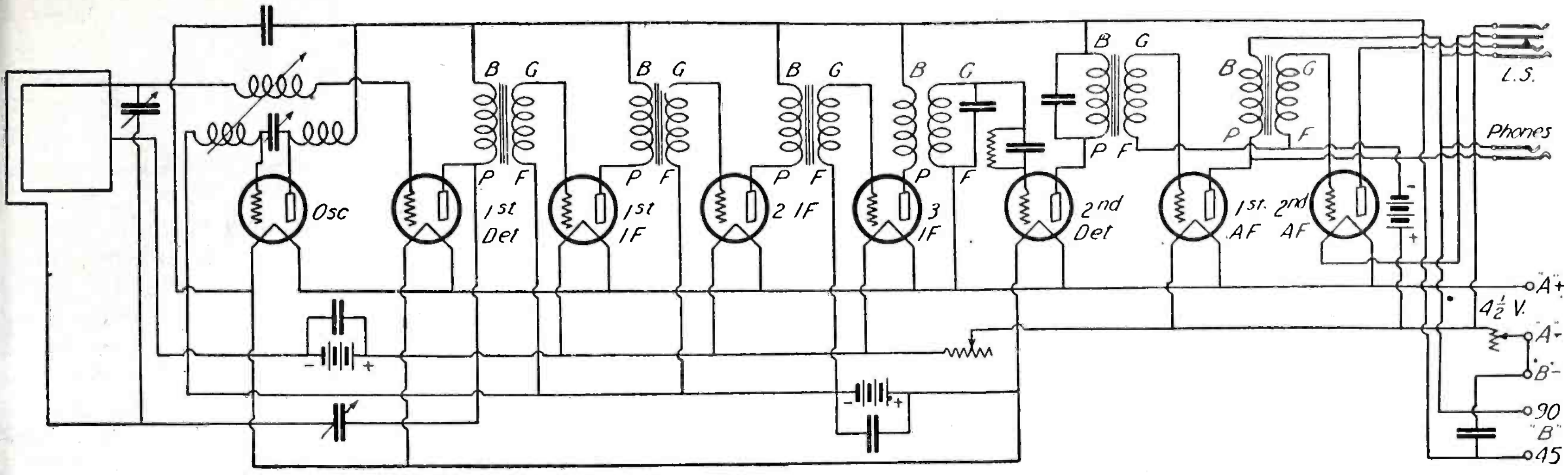


Of course, the greatest compactness possible is always desired in a set that is to be portable. Above, the photographs show a portable Super-Heterodyne employing 199 type tubes. It was completely home constructed. Note the use of the double baseboard or sub-panel for mounting the parts. In this case standard sockets were used with adapters. © Photograms.

compact sets. It has the distinct advantage of consuming a great deal less "A" battery current than the standard tube, gives almost the same amount of

By placing the tubes on one shelf and laying the intermediate transformers on a second one just beneath the tubes and making the connections as

tubes was possible. However, if the set is to be a purely portable one, this adjunct is hardly necessary, and may be dispensed with to advantage.



The standard Super-Heterodyne hook-up is given above. The sets described in this article all follow this plan for their wiring. Note the variable condenser employed from the plate of the first detector to the loop. This gives regeneration, adding greatly to the signal strength and sensitivity of the set.

amplification and serves very well as both detector and oscillator.

With the aid of these tubes one of the most compact and efficient portable Super-Heterodyne sets possible may be constructed. Fig. 4 gives a photograph of the set, completely homemade, including the built-in loud speaker.

short as possible, the set, complete, is housed in a cabinet smaller than the regulation traveling case. The placement of the parts is obvious from the photograph, though the experimenter will have to select the size and dimensions for himself. In this instance, standard sockets were employed with adapters so that an interchange of

And here let a word be said about the practicability of Super-Heterodynes in portable form. If you must build a portable set, make it a Super-Heterodyne, since the interlocking of magnetic fields will have less deleterious effect than in any other type of outfit, and this is a point of no mean importance.

Super-Heterodyne Operation

SUPER-HETERODYNE sets have two outstanding advantages, the efficient use of a loop antenna and extreme simplicity of manipulation, usually two dials with a battery switch. These sets, however, have one characteristic which should be given consideration when the purchase of such a set is contemplated. They are extremely sensitive to interference and induction from alternating current wires.

Super-heterodyne sets are quite apt to give trouble when used in a steel-framework building, although not always. Masses of metal of almost any nature are quite apt to shield the set, more or less, this being true of any set using a loop. Sometimes the shielding effect is manifested more in a diminishing of the directional effect of the loop than otherwise.

An instance of this shielding effect was furnished not long ago by a super-heterodyne set which was installed in a home at a spot in close proximity to a steel safe built into a partition. Moving the set away from the mass of metal resulted in a decided improvement in performance.

Operation of any electric motor in a home is quite likely to be picked up by a super-heterodyne in the form of an annoying noise. Violet ray machines, flashing signs, defective trolley rails or wires, elevator motors and contactors, defective electric heating devices and other similar sources of make and break in an electric current are almost certain to produce noise in the "super-het."

Those contemplating the construction of a super-heterodyne would do well to investigate the conditions of the room where the set is to be operated. —*Philadelphia Public Ledger.*

How to Drill Glass Panels

UNFORTUNATELY, glass has a habit of cracking just as the last hole is being bored. Drilling glass is a tedious job, to say the least, although there are two methods in which it may be done.

The first is by allowing hydrofluoric acid to eat its way through and the second is the old-fashioned method of drilling with carborundum and turpentine.

In both cases the panel, after being cut to size, must be spotted with a glass cutting tool for location of holes.

When using the drilling methods, patience is surely a virtue: without it, cracked panels will be the reward. The materials required are a hand drill, a three-cornered file and a small quantity of carborundum, and some turpentine, which can be obtained at any paint supply house.

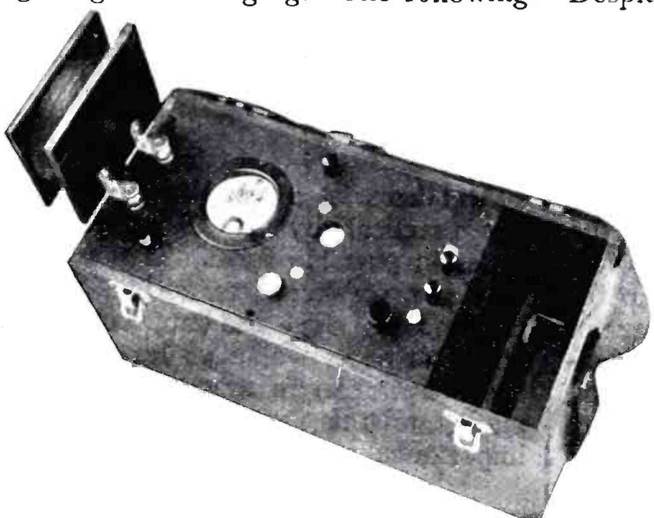
The very tip end is broken off the three-cornered file, and the remaining length, which should not be longer than three inches, is clamped in the hand drill and used the same as if drilling hard rubber. A light pressure is used and fairly high speed.

Frequent application of turpentine must be made to the point. Alternations can be made from the file point to that of a piece of jointed carborundum fastened in the same manner in the drill. As the drilling proceeds, lighter and lighter pressure must be used, as the glass is naturally weakened at the point of drilling. It is suggested that the constructor try drilling a hole or two in some scrap glass to get the "knack" before he tries it on an expensive glass panel.—*Lansing State Journal.*

How to Make a Good Wavemeter

Complete Data for Constructing a Practical Wavemeter

THE radio fan who dabbles in experimental work with various forms of receivers will find a wavemeter an almost indispensable article to have in the workshop. It will have a variety of uses and save endless figuring and changing. The following description of an efficient wavemeter is the result of considerable intensive study on the parts of *John L. Clayton* and *L. W. Hatry.* The article appeared in *QST,* Hartford, Conn.



Illustrations by Courtesy of QST (Hartford, Conn.)
The completed wavemeter.

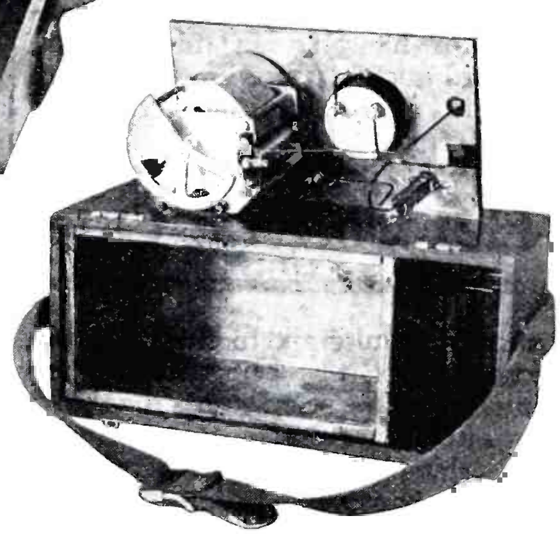
The requirements of a wavemeter are accuracy and ruggedness. A wavemeter consists of a tuned circuit containing a variable condenser, a fixed coil and an indicating device. The goodness of your variometer, then, depends on the condenser and the coil—the indicating device does not matter so much.

The variable condenser must, first, be well built and, second, low-loss. The plates should be heavy, well spaced, and very firmly bound together with large-surfaced separators and husky supporting rods. The bearings must be metal, should have no play in any direction, and should be substantial and smooth-running. Cone bearings, in particular, are good. A geared vernier becomes a necessity on the shorter waves or with high capacity condensers.

The coil must be non-changing in its constants which are inductance, resistance, and distributed capacity. The last two named should be kept low. To accomplish these things the coil form should be strongly built, the coil tightly wound and the wire bound so that the position of the turns can not vary; and the coil terminals firm and non-changeable in their relation to each other.

Since the wavemeter was built to use more than one coil, all wavelengths from about 15 meters up can be covered. It is ruggedly enough built to withstand the abuse of ordinary use without much damage to its calibration. Despite the inaccuracy of buzzer excitation, the buzzer on the meter has proved its value for rough checking numberless times. However, the buzzer can be left out.

The tuning condenser used in this meter is a General Radio type 239 of 1000 $\mu\mu$f. capacity. The critical tuning on the short waves due to the capacity of the condenser can be taken care of by substituting a dial for the small knob usually on the vernier control. In fact, for precision, it will be difficult to get a better arrangement than obtainable with the extra dial on the vernier; particularly if this dial is one of the 360 degree type of which there are a number on the market at present.



The wavemeter removed from the case, showing the parts on the panel.

For accuracy of measurements, shielding the inside of the wavemeter box and the back of the supporting panel, is practically a necessity—especially at the short waves. It is suprising the amount of detuning which will occur through body capacity if the meter is not shielded carefully. The shielding in this case being made of 25 gauge sheet copper in the form of a box with soldered seams for the inside of the case of the wavemeter, and a flat sheet for the panel. The panel shielding is held on by mounting screws of the meter, etc. The edges of the copper box are bent over the shoulder to which the panel is screwed, and to these edges the panel shielding makes contact when the panel is in place. This shielding is connected to a binding post, on the panel, which is connected to ground when the meter is in use. Thus the instruments in the meter are completely shielded so that there is no capacity effect to the hand, and no pick-up of energy by the wiring or instruments of the meter.

The indicating instrument is a 100-milliampere full-scale reading hot-wire galvanometer. A thermo-galvanometer would be preferable because of its greater sensitivity, and because it would stand a much greater overload without burning out. With a hot-wire instrument it was found possible to read to the 9th harmonic of an oscillator, whereas with the thermo-couple it was found possible to read to the 15th harmonic of the same oscillator wave at the same power.

The window used for viewing the back-of-panel dial is made by drilling a hole in the panel and backing it with a piece of mica or celluloid with an indicating line scratched on the back and filled with india ink. The window in the panel should be larger than the one shown.

The back-of-panel dial is a General Radio 4″ diameter one without the knob and fitted with a special bushing according to Fig. 5. Care must be used in centering this bushing. The shaft of the condenser was cut off enough to avoid touching the panel. The knob removed from the dial is large and an excellent one to use on the vernier with a bushing to make it fit the 3/16″ shaft.

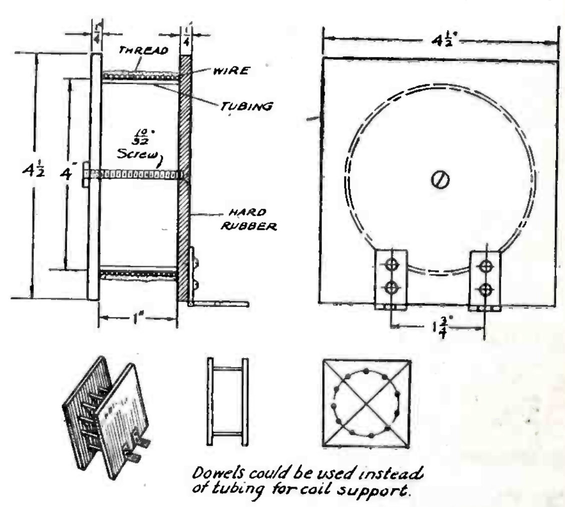


FIG. 1 DETAILS OF COILS FOR WAVEMETER

The coils for this meter are made according to Fig. 1. A six-inch diameter would be better because of the larger field of that size of coil which permits you to get a greater distance from the oscillator or other source of energy whose wave-length is being measured. Also it would undoubtedly be convenient to have a plug mounting on the coil that would permit of its rotation without the necessity of having to move the entire wavemeter. The position of the wavemeter coil in relation to the source to which it is coupled has a direct bearing on the energy being picked up. A manner in which a plug mounting might be constructed is shown in Fig. 4. While it is true that such a method of mounting is not low-loss, we believe its convenience overshadows that objection. Another advantage is that Fig. 4 only requires standard parts and is easy to construct for that reason. The winding of the coils themselves may be done easily and conveniently by using wire of a size to completely fill the form width with the number of turns to be used. After the wire is wound on the coil form it should be covered with a thick layer of waxed shoemaker's thread to exclude moisture and to make a permanent coil.

The coils used with this meter are as follows: A single turn of ¼-inch copper tubing eight inches in diameter, which gives a wavelength range of 15 to 62 meters; a coil of 5 turns of No. 12 D.C.C. with a range of 40 to 110 meters; a coil of 13 turns of No. 14 D.C.C. wire with a range of 65 to 264 meters; a coil of 31 turns of No. 22 D.C.C. with a range of 140 to 650 meters.

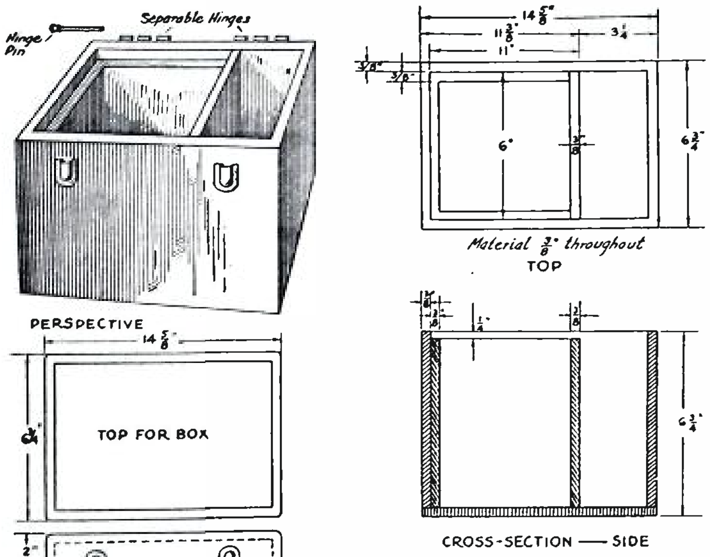


FIG. 2 WAVE-METER BOX

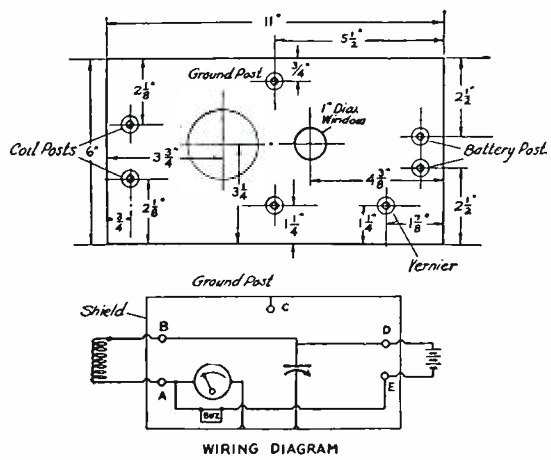


FIG. 3

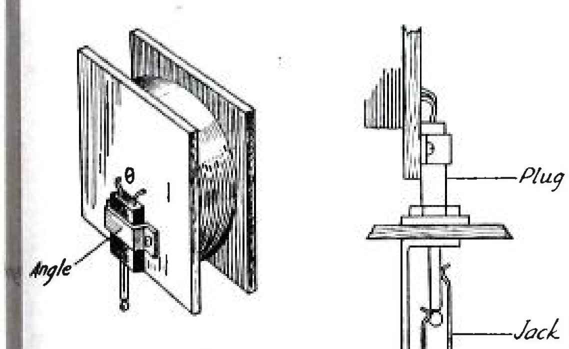


FIG. 4 POSSIBLE PLUG MOUNTING FOR WAVE-METER COILS MAKES COILS ROTATABLE

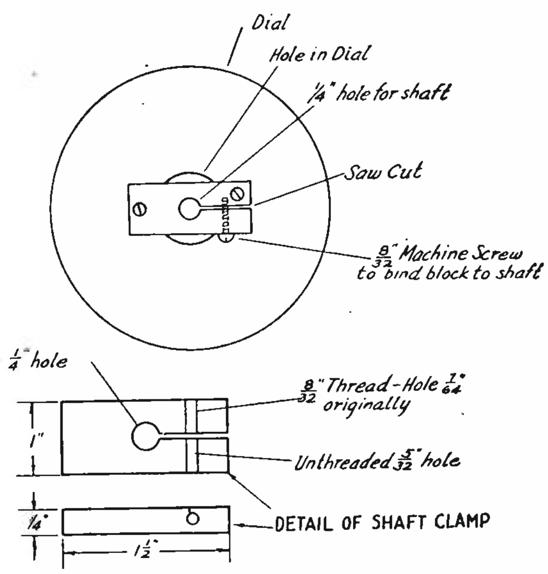


FIG. 5

On a 100 degree condenser scale, the useful portion is from 10 to 90, and on a 180 degree scale, from 15 to 165.

You will notice from the wiring diagram in Fig. 3 that any instrument in the meter can be taken off from some pair of binding posts, independent of the others. The variable condenser off of posts B and C. The Galvanometer off of A and C. The buzzer off of A and E. You should preserve this feature in the wavemeter you build, merely as a matter of convenience.

The top of the wavemeter box could have a handle in place of the webbed strap used. The hinges are the type with removable pins so that the top can be completely removed when the instrument is being used—this is a really convenient feature. The corners of the box should be protected with metal, as shown in the photographs.

Proper Antenna Installation

A MATTER of great importance to the radio broadcast listener in suburban communities is the proper construction of his outside antenna.

For an antenna having one end fastened to a tree and the other to a support on the house, precautions should be taken to overcome breaking and wave-length changes. To prevent these two annoyances from happening, the end of the antenna to be fastened to the tree should be well insulated and the insulator held by a rope capable of supporting the weight of the aerial.

This rope should then be run through a pulley which is securely screwed to the tree. To the end of the rope sufficient weight must be attached to keep the antenna taut. With this method of antenna construction breakage is impossible if the supporting rope is strong, and wave-length change is not encountered if the end of the aerial wire is kept five feet from the branches of the tree.

Another place where aerial construction in suburban communities is difficult is the raising of the wires above the roof. It is detrimental to efficient operation to have the aerial less than five feet above the roof. In most cases it is possible to secure some form of mast to two chimneys or to raise a mast upon the roof itself.

But if this cannot be done permission should be obtained to fasten one end of the aerial to the next house and then place the insulators so that the aerial wire proper is five feet or more from all parts of the roof or house at both ends.

The lead-in must also be properly insulated for efficient operation. A poor lead-in is as bad, if not worse, than a poor aerial. Keep the lead-in wire, which should be No. 14 covered wire, at least five feet from all walls. Bring it into the house preferably by means of a porcelain tube fitted in a hole drilled either in the window pane or through the sash. Of the two the window pane is to be preferred.—*N. Y. Herald-Tribune.*

How to Build a UV-199 Audio Amplifier

Details of a Compact Amplifier Unit Using Dry Cell Tubes

WHAT is desired in audio frequency amplifiers is not a maximum of signal strength, but fine tonal quality. This two step audio frequency amplifier which any broadcast fan can easily construct, will give amplification speaker volume with a minimum of noise and distortion. The details of construction by *Kenneth M. Swezey* from *Science & Invention* magazine is given in the following:

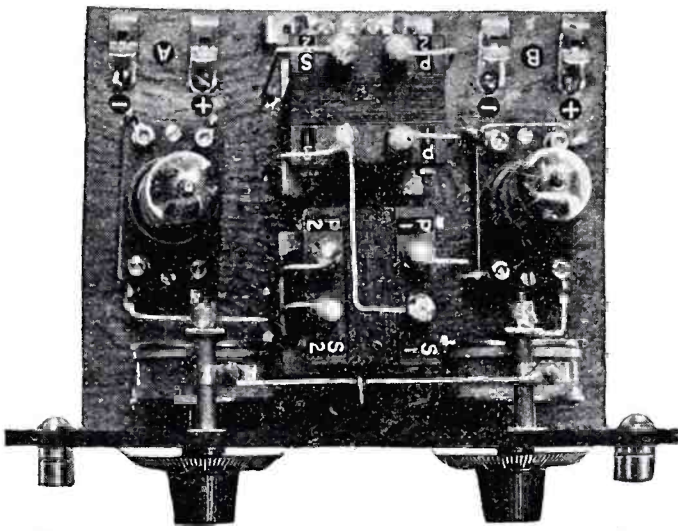


Fig. 1.—Top plan view showing arrangement of parts on baseboard.

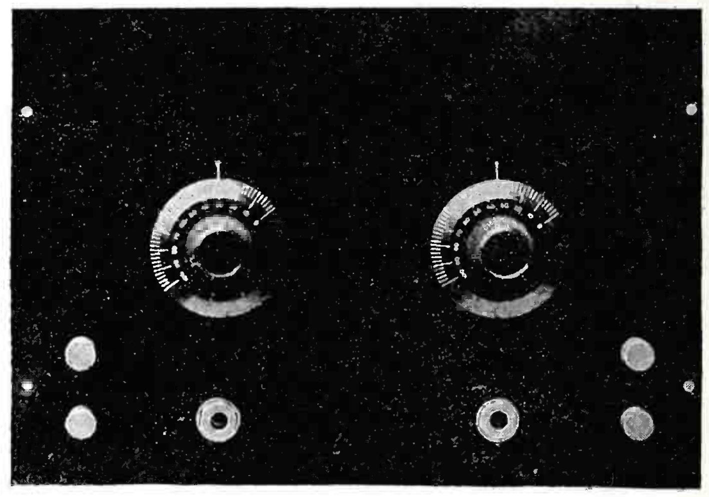


Fig. 2.—Front panel view showing spacing of parts mounted on panel.

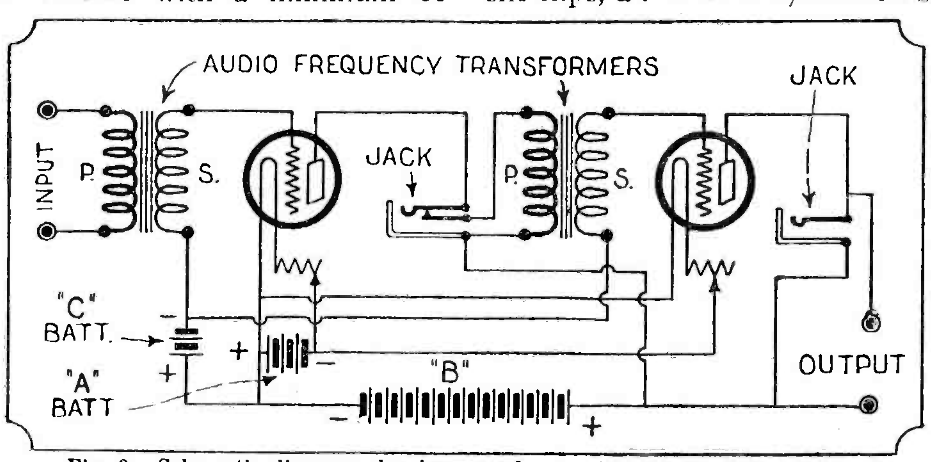


Fig. 3.—Schematic diagram showing complete wiring details for amplifier.

The diagram below shows materials required. Besides two low-ratio A.F. transformers, there are used two 30 ohm rheostats, two UV-199 sockets, two jacks, four binding posts. six clips, a 7 x 10 x 3/16 inch bakelite or hard rubber panel, two 2-inch dials, a hardwood sub-base, ½ x 6 x 7¼ inches, and the necessary bus bar and spaghetti for connections. The layout of the parts and panel is obvious from the photographs. Much of the wiring is led through holes in the sub-base and distributed underneath. The transformers have their cores at right angles to each other. All battery connections are terminated in the Fahnstock clips on the baseboard and this facilitates easy connections. A provision is made for the "C" battery which will vary, usually, between 3 and 7 volts. Ninety volts are used as the "B" battery supply for the two tubes.

Note the clean cut appearance of the amplifier unit. Simplicity and care were the keynotes in its construction. It is the happy medium between a high ratio transformer coupled amplifier and a resistance coupled amplifier. Primarily, it embodies qualities which are inherent in both, to a certain extent. No by-pass condensers or resistance leaks are used because they are not necessary with UV-199 tubes.

Preventing Tube Blowouts

THIS is an old trick, but it works just as well today as it ever did. When trying out a new set for the first time many people insert all the tubes in the sockets and hook on all the batteries and pull the switch. This method often results in sending $10 or $15 worth of tubes to the scrapheap in about one-tenth of a second.

The proper way to avoid trouble of this kind, is, first, to connect the A battery to the B battery binding-posts. Then run a wire between the binding posts meant for the positive and negative connections of the A battery. Insert the tubes and turn on the rheostats. Then pull the switch. If any of the tubes light there is something wrong, and it will not be safe to connect on the B battery.

If none of the tubes light when connected in this way, disconnect the A battery and connect in its proper place, being sure to remove the wire first placed across the A binding posts. Be sure the switch and rheostats are in the "off" position, and in connecting the B battery always connect the end of the wires to the receiver before connecting to the battery. This avoids any danger of accidentally flicking a lead against a filament connection in the set.

If necessary to change or tighten any connections inside the receiver, always first remove tubes and disconnect batteries. A screwdriver easily slips, and it makes a very good electrical connection between two pieces of bus bar. A B battery shorted for even a minute or two will lose a large percentage of its life.—*Radio Times, New York.*

A Non-Radiating Low Loss Receiver

A Novel Method of Utilizing Wasted Radio Frequency Currents without Producing Radiation

MANY attempts have been made to reconcile the obvious advantages of radio frequency amplification and regeneration with the attendant difficulties in control. Such a combination has a tendency toward radiation and is hard to adjust as a general rule. If steps such as neutralization or grid-plate capacity-leak combinations are taken to iron out oscillating, there is a corresponding energy loss.

Sidney E. Finkelstein presents through the *N. Y. Telegram and Evening Mail* Radio Section, a system permitting radio frequency amplification in conjunction with a regenerative detector, at the same time retaining comparative simplicity of control and reducing radiation to a negligible figure. The article follows:

The plate of a detector tube delivers not only rectified current—that is, impulses that will actuate earphones and hence are termed audible—but also delivers radio frequency current.

Unless a regenerative detector tube is used, embodying tickler action in the plate, or impedance tuned plate or capacity coupling with control of regeneration through the rheostat, these radio frequency currents may be rated as losses. That is, energy exists which may serve some useful purpose, but it is put to no use.

Where a stage of radio frequency amplification is used ahead of a tube detector and regeneration is employed it is found in either the R. F. stage or in the detector stage. In either case there may be radiation all over the broadcast band. Some insist that if the detector be regenerative, the non-regenerative tube ahead of it theoretically serves to block the emission of squeals, but experience hardly proves this to be the case. A neutralizing condenser may be used, but there is a sacrifice of efficiency in reception on those waves, or that narrow band of the broadcast belt, for which the set is neutralized. Regeneration can scarcely be used in both R. F. and detector stages because the set would be hard to handle. Indeed, with one R. F. stage ahead of the detector and either stage regenerated there is normally trouble enough in tuning the set.

Multiplying R. F. Signals

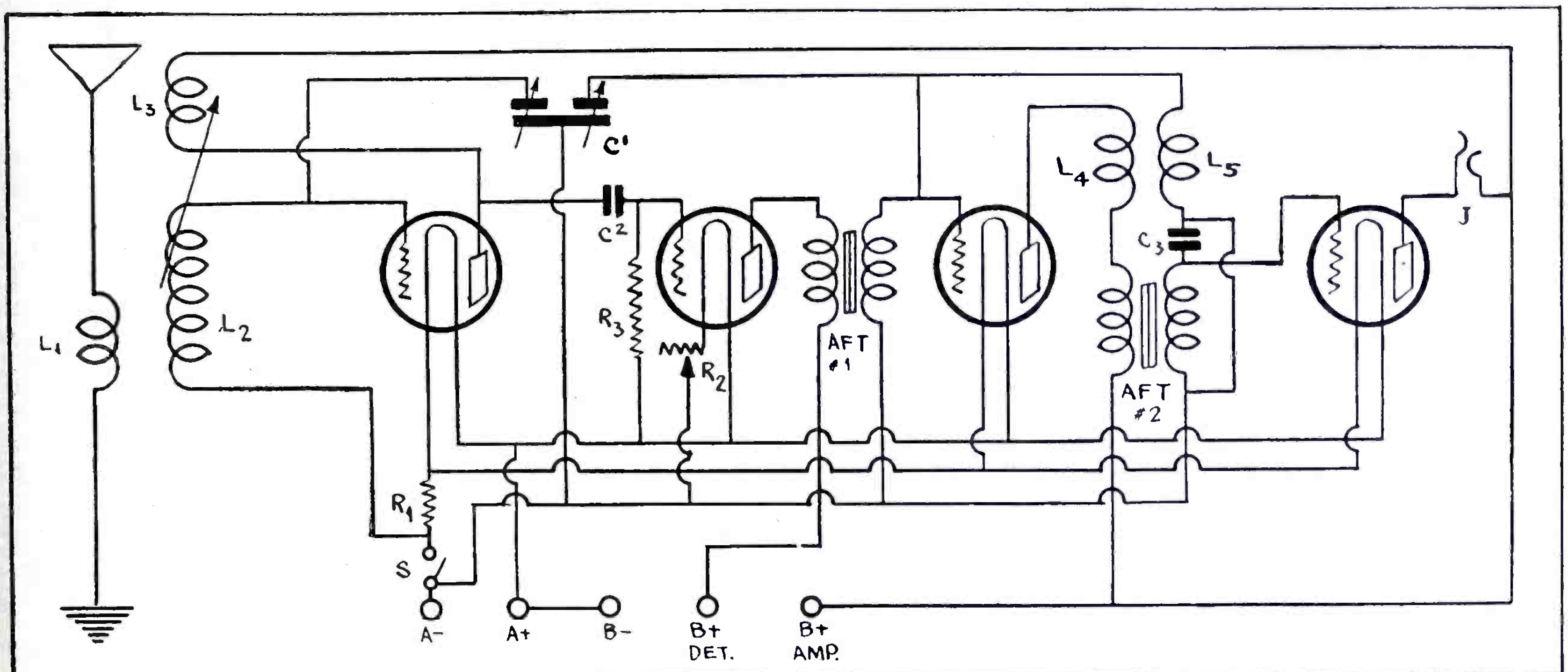
A novel method of employing a regenerative R. F. stage and still capitalizing some of the radio frequency current otherwise lost in the detector tube is shown in Fig. 1. This is a circuit devised by Herman Bernard, and, so far as the author knows, has never before been published. It is not a trick circuit. On inspection it will be found to be standard until you reach the grid of the first A. F. tube. From the plate of that tube the combined radio frequency and audio frequency currents pass through the primary of a radio frequency transformer, L4, on which the audio currents have no effect, and thence to the beginning of the primary of the second audio frequency transformer.

Coupled to the aperiodic primary of the R. F. transformer is L5, the conventional secondary of an R. F. T. The radio frequency current is passed from the R. F. T. primary to the secondary by induction. The beginning of the R. F. T. secondary connects to the grid of the first audio tube and to the variable condenser, the end to minus A. This secondary is tuned by the variable condenser C1, the same condenser that tunes L2, the secondary of the three circuit tuning coil.

This condenser C1 is of the double type—that is, it has a common rotor, connected to A minus, the .0005 mfd. stators being connected respectively to the grids of the first and third tubes. These are the R. F. and first audio tubes.

The condenser used has four sections of 11 plates each. By connecting two outside and two inside binding posts on this condenser with bus bar, each stator became 22 plates, or .0005 mfd. In Fig. 1 the condenser is shown as C1, with each .0005 mfd. stator represented by a short horizontal line and the common rotor represented by the straight line under them.

The theory of the circuit is that radio frequency currents not only pass out of the detector tube at the plate, but when this plate is connected to an audio frequency transformer primary there is still a passage of radio cur-



Illustrations by Courtesy of N. Y. Telegram & Eve. Mail

Fig. 1.—Complete schematic diagram of the three tube non-radiating receiver.

rents across the audio transformer. These currents are picked up by the R. F. transformer L4, L5. Their return to the radio frequency side of the circuit is accomplished, to a degree, through this same path. If the radio impulses are regarded as instantaneous it will be easy to realize that if they are in the audio part of the circuit they are in the radio part, and if they are tuned at any place they are tuned for all purposes. However, in their passage through the audio transformer, AT1, they encounter the impedance of primary and secondary. They suffer some obstruction, due to this fact. When a heterodyned note is struck due to over-regeneration, and commonly recognized as a "squeal," just so much of the squeal, theoretically, to the right of the first audio tube is handled just the same as a squeal whose escape into the antenna is blocked by a resistance. The method of using resistance such as a potentiometer in series with the aerial to kill out squeals is a familiar one. The method occasions losses, which in the aerial circuit may prove serious. But when such losses are only at the expense of radio current that otherwise would be a complete loss, there is, as in the Bernard salvage circuit, a net gain.

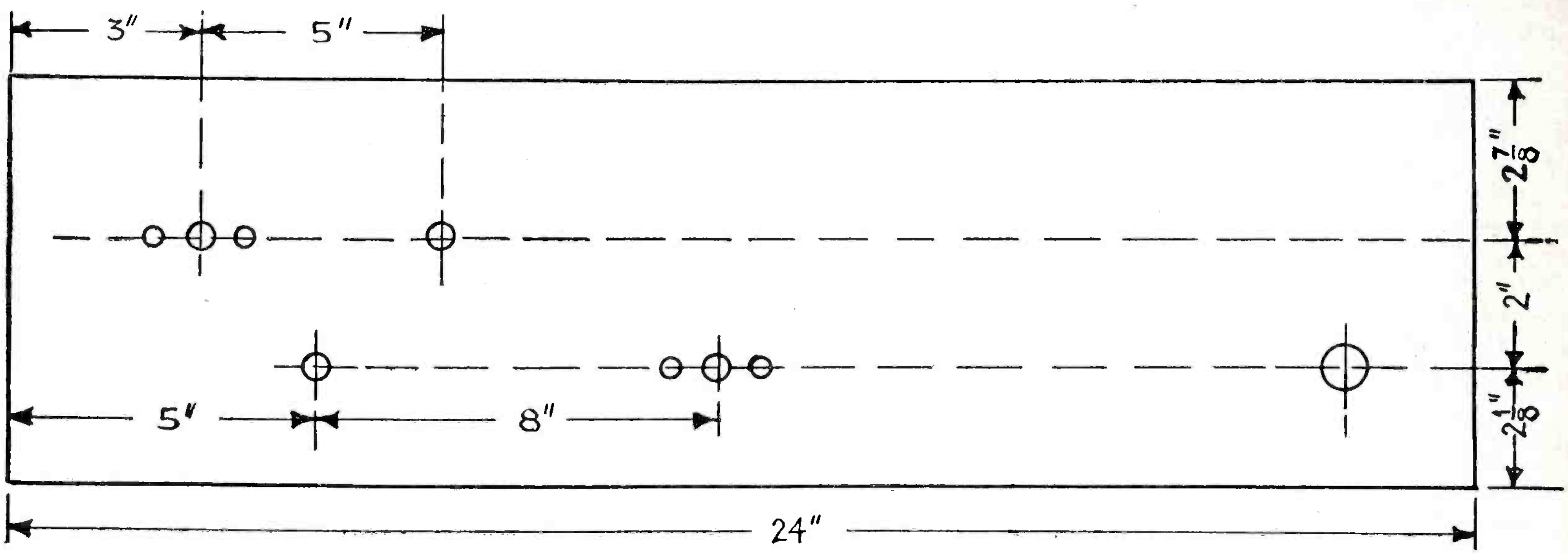


Fig. 2.—Suggestive layout for panel showing exact location of holes.

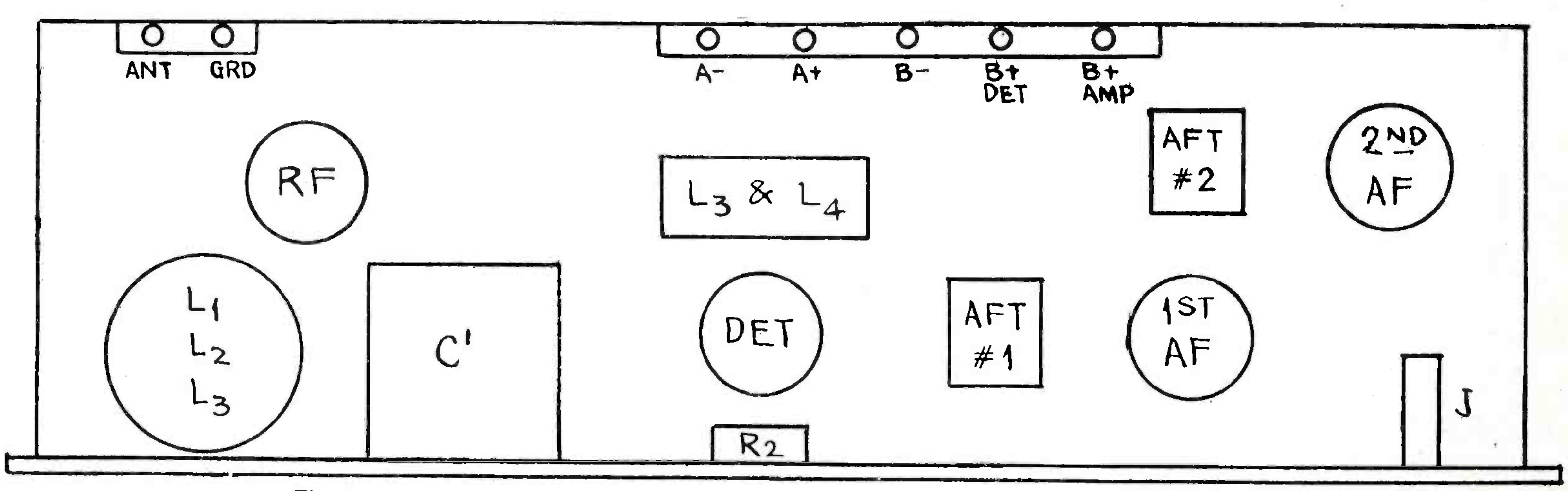


Fig. 3.—Arrangement of parts on baseboard and relative location of parts mounted on panel.

In tuning the set the writer found that not only did it not radiate above 425 meters, but from 425 to 549.1 meters it did not produce a heterodyned note at all, while regeneration was present all the while.

The difference between heterodyning and squealing, as commonly understood, is that the heterodyned note may be produced and heard from the receiver itself, but if the annoyance is confined to the point of reception and not inflicted on neighbors, the set is not regarded as one that is "squealing." Even much of the heterodyning on waves lower than 425 meters was blocked (although not completely stifled) in its path to the antenna.

Capacitative Coupling

The R. F. and detector tubes are coupled capacitatively, the grid condenser C2 bringing the radio frequency current over. R3 is a variable grid leak on a mounting connected from the grid post of the detector tube to the A plus. This eliminates one control. Also, the use of a variable condenser to tune two stages with one motion (the R. F. and first audio grids) eliminates one control. Hence, there are only two controls instead of four. One is a wave length control, the other a regeneration control.

Some may wonder if sufficient transfer of energy is accomplished by the theoretically reversed flow across the first audio transformer. The electrostatic field of the variable condenser is common to both tubes whose grids are tuned, and there is energy passing there.

The action in the first audio tube is, of course, in the nature of reflex.

Standard coils are used. L1, L2, L3 is a three circuit variocoupler. Nearly all of the commercial products have an inductance in the secondary suitable for tuning with a .0005 mfd. variable condenser. The R. F. transformer must have the same inductance, naturally, because a condenser with stators of equal and matched capacity tunes both. If the coils are not matched a given setting of the condenser will represent two different wave lengths. However, a company that makes a coupler and an R. F. T. will have the two secondaries identical.

The home constructor, if he desires to make his own coils, may do so as follows:—

No. 20 double cotton covered wire may be used, or No. 20 double silk covered. If a four inch outside diameter tubing two inches high is to constitute the stator of the variocoupler, wind thirty-one turns for L2. The primary L1 consists of six turns. The rotor should be small enough to turn conveniently inside the stator and consists of thirty-four turns, seventeen on each side of where the shaft protrudes. All windings are in the same direction. The radio frequency transformer is wound on another tubing, identical

(*Continued on page* 74)

A Short Wave Unit for Broadcast Sets

An Excellent Adapter for Broadcast Receivers to Permit Reception of Lower Wave Lengths

SHORT waves are becoming more and more popular. It is safe to predict that within a few months many broadcast stations will be transmitting on wave-lengths too low to be received on the present broadcast receivers. The present receivers have a tuning range of about 200 to 600 meters. There are nearly 600 broadcast stations in the United States, all operating within this range, which is now so crowded that considerable interference results. In order to relieve the situation, it is proposed to reduce the broadcast wave-length band to 150 meters or lower, instead of 200 meters, and thereby make room for the many new stations which are bound to spring up this fall. This means that the present broadcast receivers will not be able to tune down to the 150-meter stations unless radical changes are made. It is the purpose of this article to describe a very simple unit, easily constructed by the average broadcast listener, that will enable him to receive the short waves on his present set without making any changes.

Clyde J. Fitch, writing in *Radio News,* New York, thus outlines the need for an adapter to permit reception of lower wave lengths and describes the unit as follows:

The unit is very inexpensive. Almost all of the parts in the broadcast receiver are made use of without changes. It may be used with any type of broadcast receiver, including the super-heterodyne, but this article will describe its use mainly with a 5-tube, tuned radio frequency set, because this is the most popular broadcast receiver in this country.

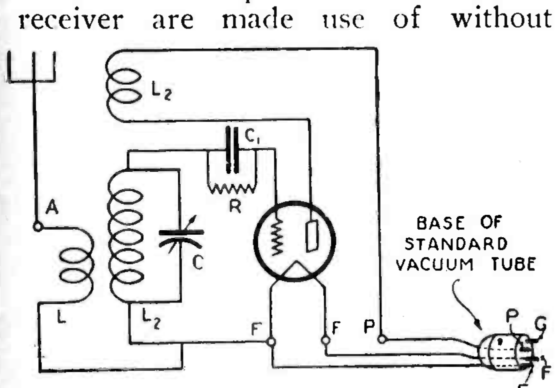
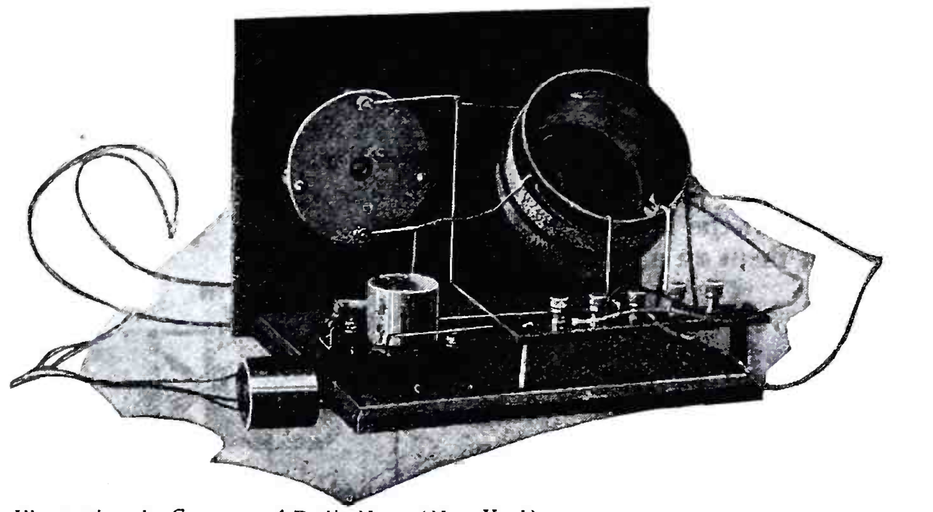


FIG. 1

The wiring diagram of the short-wave adapter is a simple three-circuit tuner.

The short-wave adapter is of the same general construction as the standard single-tube short-wave regenerative receiver with tickler feed-back. It may be designed to cover any of the amateur wave-length bands. Those who are interested in amateur telegraphy and who now own a broadcast receiver would do well to build this adapter. The following parts are required, practically all of which are standard:



Illustrations by Courtesy of Radio News (New York)

The arrangement of the apparatus in the adapter for short waves. Note the base of a vacuum tube used as a connector.

PARTS REQUIRED

1 7" x 10" Panel.
1 6½" x 9" Baseboard.
1 Short-wave tuning condenser, .00025 mfds.
1 Short-wave tuner.
1 Standard vacuum tube socket.
1 Grid condenser and grid leak.
4 Binding posts.
1 Burned-out UV-201A tube.
1 7" Cabinet.
10 Feet bus-bar wire.

The illustrations show the simplicity of the device. Fig. 1 shows the circuit diagram, which is merely a regenerative circuit designed to receive the short-wave stations. The antenna A is that used for broadcast reception, and is merely disconnected from the broadcast receiver and connected to the adapter. L is the primary, L_1 the secondary, and L_2 the tickler of the short-wave tuner. There are many short-wave tuners now on the market designed for amateur reception, any of which may be used. Diagrams are usually furnished with the tuners and the connections are marked, so there is little chance of making an error in building and wiring the adapter.

C is the short-wave tuning condenser. It should, of course, be of good and stable mechanical construction. A variable condenser with a maximum capacity of .00025 mfds. will be found suitable. The grounded rotor type is preferable, as the rotor side can be grounded or connected to the filament circuit, as shown, so as to eliminate body capacity effects. A straight-line wave-length condenser is preferable, although a straight-line capacity one will suffice.

C_1 is a .00025 mfd. fixed grid condenser and R is a 1 to 3 megohm grid leak. F, F, and P are binding posts connected to a flexible three-conductor cord terminating in the base of a burned-out vacuum tube, shown in detail in Fig. 3.

The Plug Connector

To connect the adapter to the broadcast set a special plug is required. The plug is shown in Fig. 3. It is made from the base of an old, burned-out, standard vacuum tube, such as the UV-201A. The base is removed from the tube by heating it, which softens

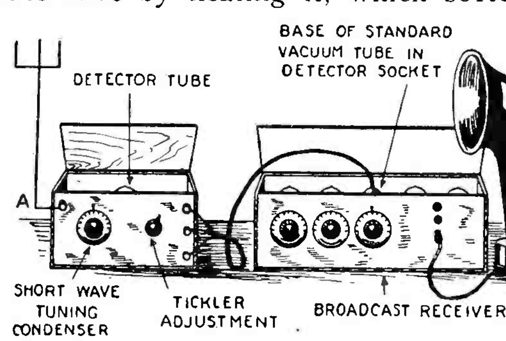


FIG. 2

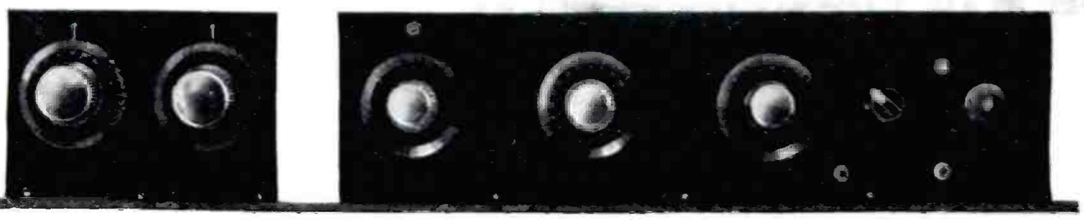
How the adapter is connected to the detector tube socket of the broadcast receiver.

the cement. The solder should be removed from the tube-prongs first.

A wooden plug is turned out to fit inside the metal base, as shown. It is glued in place, but before gluing the three-conductor flexible cord must be connected to the socket prongs.

At the right of Fig. 3 is shown the bottom view of the tube base with the filament prongs marked F, F, the plate prong P, and the grid prong G. These are shown with relation to the pin that holds the tube in the socket. The prongs F, F, P, are the only ones used and are shown in black. The wires in the three-conductor cord are soldered to these three prongs. The wires should be of different colors or should have markers so the other ends can be correctly connected to the three binding posts marked F, F, P on the adapter.

The panel is drilled to suit the short-wave tuner and condenser purchased. Templates are furnished with the in-



Panel view of the short-wave adapter and a standard receiver. Only the dials of the adapter are used in tuning the combined sets.

struments to facilitate drilling. As the drilling of different makes of apparatus is different, no dimensions are given. Four binding posts are mounted on the panel or, if the builder prefers, he may mount them on a bakelite strip in the rear.

After you have screwed the panel to the baseboard and mounted the instruments, they should be connected according to Fig. 1, which shows the working diagram. About 10 feet of bus-bar wire will be required. The adapter may then be placed in a 7x10 radio cabinet, as shown in Fig. 2.

How to Use the Adapter

Now that the adapter is finished, the builder no doubt wonders how to place it into service. This is very simple. The diagram of connections is shown in Fig. 2. *First,* try out the broadcast receiver, and be sure that it is in good working condition with the loud speaker plugged in on the second stage of audio amplification. *Second,* disconnect the antenna from the broadcast receiver and connect it to the antenna post A of the adapter. *Third,* remove the detector tube from the broadcast receiver and place it in the socket of the adapter. *Fourth* and last, insert the special plug connector with the three-conductor cord in the detector socket of the broadcast receiver. Short-wave stations may then be tuned in on the adapter and heard in the loud speaker.

The operation of the apparatus is

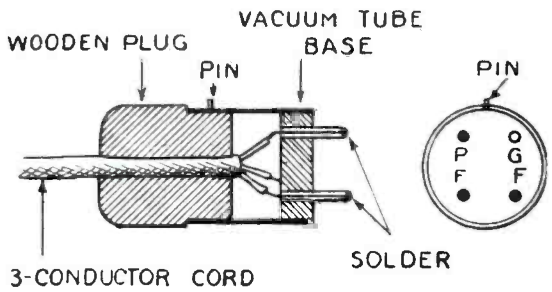


FIG. 3

How a vacuum tube base may be made into a connector for the short-wave adapter.

simple. By inserting the special plug into the detector socket of the broadcast set, we supply "A" battery current for the adapter tube through the leads marked F, F. "B" battery current is supplied through the lead marked P. The two-stage amplifier in the broadcast receiver amplifies the short-wave stations received on the adapter. The detector rheostat on the broadcast receiver controls the filament current of the tube in the adapter. The tuning dials on the broadcast receiver are not in use, all tuning being done on the condenser in the adapter. The radio frequency amplifier tubes in the broadcast receiver may be turned out, as they are not in use.

This gives us a detector and two-stage audio amplifier. Head-phones may be plugged into the detector or first-stage audio amplifier jack of the broadcast set when using the adapter. No ground connection is used on the adapter because the adapter is grounded through the filament connections of the broadcast receiver.

It seems needless to say that this adapter is designed for use with sets employing standard 6-volt storage battery tubes, such as the UV-201A or C-301A. For use with a broadcast set employing dry cell tubes, a dry cell tube socket should be placed in the adapter instead of a standard socket, and the connection plug should be made from the base of a dry cell tube base.

When used with a super-heterodyne, the second detector should be removed from the super and placed in the adapter, and the plug placed in the empty detector socket of the super. If a loop aerial only is used with the super, it should be removed and one binding post of the loop should be connected to the antenna post of the adapter. This will give fairly good results. An outdoor aerial is preferable. This adapter cannot be used with broadcast sets employing crystal detectors. If no ground is employed on the broadcast receiver, the filament circuit should be grounded.

"Low Lossing" the Antenna Not Easy; Short Aerial Best

THE resistance of an antenna grows with its inductance and capacity because it is not physically possible to accomplish very much toward "low-lossing" the antenna. Increasing the inductance increases the distributed capacity and its consequent resistance increase. Increasing the capacity increases the dielectric or voltage gradient of the dielectric with its consequent resistance increase.

Generally, it is for all practical purposes best to hold both the inductance and capacity of the antenna down so that sufficient energy is built up for signals of the medium wavelengths and secure selectivity in this portion of the receiving system by coupling. This means comparatively short antenna, but just as efficient as far as losses are concerned. The reabsorbing effect on antenna resistance on the input circuit and its control by reduction of coupling and the use of aperiodic tuning, as first brought out by the writer some time ago and now generally accepted, should also be considered.

To summarize, analyze the inductance and capacities of your receiver and readjust, if necessary, your antenna to meet the conditions of "low loss" as you would consider this feature in your inductances and capacities, as the same holds true for both. Having complied with all of these, the maximum in selectivity will be had and signals will appear in your loud speaker that were never there before. The quality of the signals will also be improved, due to the reduction of interference and "blanket effects" encountered in "broad" receivers.

While speaking of quality, this writer is going to take it upon himself to severely criticize all of those who are giving so little attention to the subject of quality of reception. After all, radio receivers from the public viewpoint, are musical instruments, and it is really only through the phenomena of radio that the music played at one point is brought to the public through their receivers. So they consider, and naturally so, that their instrument is a musical device and demand musical qualifications of it, and that's what they consider when they listen on the loud speaker. Of course it is not expected that a good quality preserving receiver can express its best through a poor loud speaker, any more than can a poorly talented artist sing well a good song or play well a good instrument. So make sure that your receiver is as near as possible distortionless and selective. A good loud speaker will provide the rest to give you real radio enjoyment.

Let manufacturers rate their receivers on the basis of selectivity and then on the sensitivity of their receivers in terms of voltage amplification with a standard input. Let them also rate their inductances and capacities on the basis of what their reactance resistance ratio is and not alone their equivalent resistance. With these facts known, it will be easy to determine the quality of radio receivers and inductances and capacitances.—*The Chicago Evening Post.*

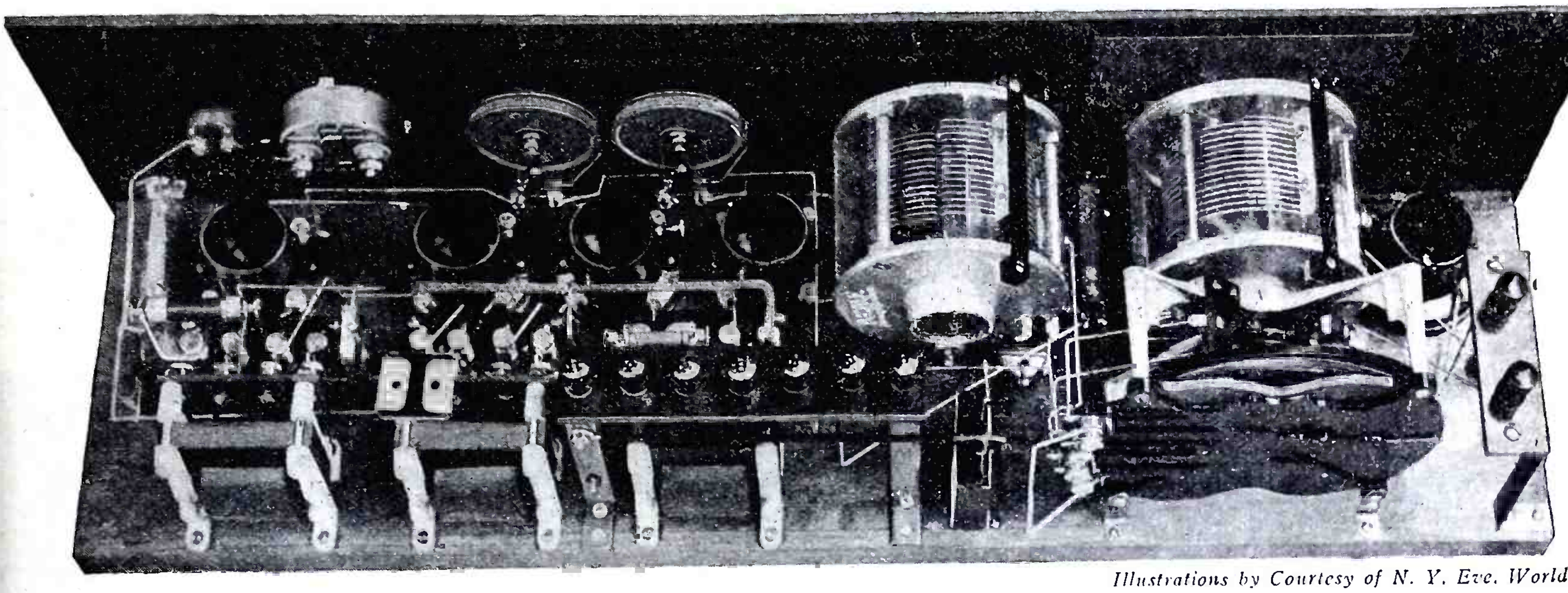
The D-Coil Acme Reflex

An Extremely Sensitive Reflex Set for Operation on a Small Loop

A SHORT time ago the Acme D coil was introduced in an Acme circuit which employed a Sodion tube as a detector. This same D coil is now presented in a stage of tuned radio frequency amplification added ahead of the conventional four tube Acme reflex

It is also interesting to report that in these tests a standard 18-inch pancake loop was used on the four-tube set, while on the five-tube set the loop measured only 12 inches on a side, wound with Litz wire in a double spiral on Radion cross-arms.

shown. From this diagram any who have the four-tube reflex already assembled can easily figure the necessary new connections for adding the D coil stage. But there is one important change in the circuit that should not be overlooked. You will note that the or-



Illustrations by Courtesy of N. Y. Eve. World

Back of panel showing the layout arrangement of the parts and wiring.

circuit for increased sensitivity and selectivity, both of which it unquestionably accomplishes.

To assure himself that this combination lived up to every claim made for it *H. C.* constructed the model shown in the accompanying photos, and then worked it, in a comparative test, directly against the original four tube circuit. Mr. *H. C.* describes this set and his tests in the *N. Y. Evening World* as follows.

The first test was for selectivity. The writer's two broadest local stations are WNYC and WEAF. On the four-tube set there was a leakage from WNYC all the way down to WEAF, and sometimes through it, and WEAF and WJZ, while never interfering with each other, left no silent gap between them. With the D coil set WNYC and WEAF were completely separated, both tuning out within a few degrees on the dial, while WEAF and WJZ were well isolated.

The next test was for sensitivity. WCBD, at Zion, Ill., was chosen for the purpose. There was a noticeable increase in volume when this station was tuned in on the D coil set. This was found also to be the case in briefly tuning to a half-dozen other stations of varying distances.

Late the following evening the D coil set alone was worked for about an hour on a small horn equipped with a

PARTS REQUIRED FOR THE SET

1 7x26 Radion panel.
1 7x25 ¼ baseboard.
1 Acme D coil and condenser unit.
1 Acme .0005 variable condenser.
1 Acme R2 R. F. transformer.
1 Acme R3 R. F. transformer.
1 Acme R4 R. F. transformer.
3 Acme A2 A. F. transformers.
1 Carter 6 ohm rheostat.
1 Carter 20 ohm rheostat.
1 Carter single circuit jack.
1 Carter jack switch.
1 Carter Imp switch.
5 Naald De Luxe tube sockets.
1 Sterling 100 v. panel mount voltmeter.
1 1 mfd. Dubilier by-pass condenser.
1 .005 Dubilier fixed condenser.
1 .002 Dubilier fixed condenser.
1 .0004 Dubilier fixed condenser.
2 .00025 Dubilier fixed condensers.
1 Daven 50,000 ohm resistance.
8 Read 'em binding posts as indicated.
1 length Belden braid.
2 3-inch Amsco dials.
1 1x7 binding post strip.
1 1x4 binding post strip.
4 brass b. p. strip brackets, bus bar and spaghetti as required.

Baldwin headphone unit, and reception was easily had from WIP, KDKA, WEBH, KYW, WCX, WRC, KFKX, KSD, WOAW, WQJ, WSB and WBAP, reception from the latter station being rather faint, as the night was none too good for DX reception.

As many readers may wish to build the entire set in one complete unit a diagram of the whole circuit is published herewith. All parts are standard and can readily be assembled as

der of the three Acme R. F. transformers has been changed, whereas in the conventional four-tube reflex circuit they follow in numerical sequence, R2, R3 and R4; when the D coil is added the order should be R3, R2, R4.

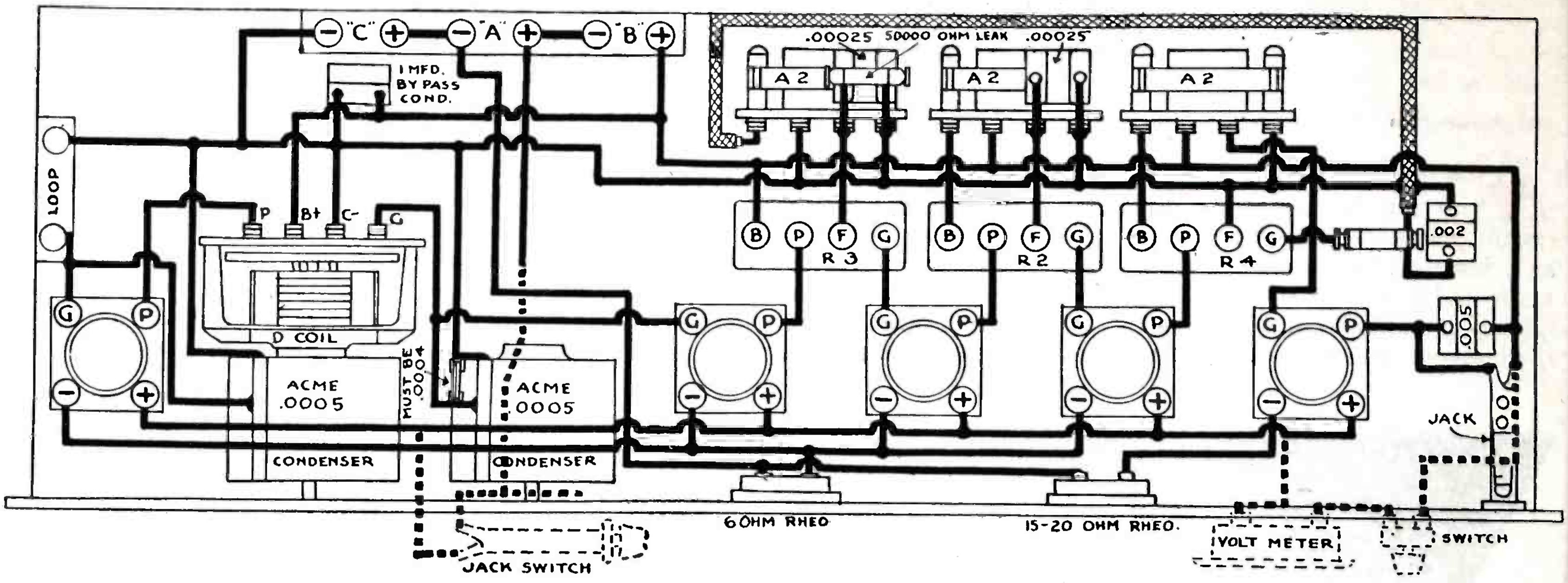
Although this set can be compacted on a 7x24 panel and baseboard, the writer, after studying the circuit, preferred using a 7x26 panel, which is also a standard size, in order to get the arrangement shown in the photograph.

If you add the D coil unit to an already constructed four-tube Acme reflex, you disconnect the potentiometer part of the pot rheo, as no potentiometer is used with this circuit. In the writer's set two rheostats are used, one a 6-ohm for controlling the first four tubes the other a 20-ohm on the last tube, which is a straight audio amplifier, to relieve the load on the other rheostat which may heat if forced to feed five tubes.

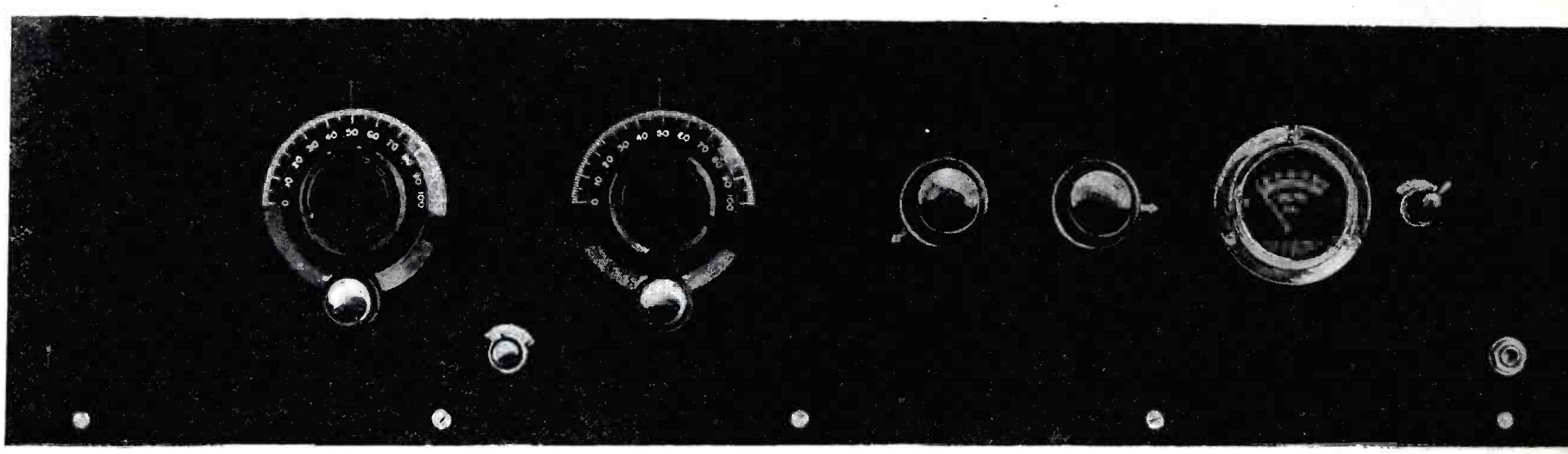
In the writer's set a jack switch is placed near the baseboard between the two variable condensers, cutting in to the A plus line for turning the filaments on and off as indicated by dotted lines in the diagram. A volt-meter is indicated because it provides an instantaneous check on B battery condition. Its connection is indicated optionally by dotted lines. The switch should never be left turned on longer than is necessary for a quick voltage reading.

It will also be noted in the photograph that the shielded lead from the first audio transformer to the crystal passes well over the R. F. transformers, about midway between the tubes and the binding post strip. This arrangement applies only to this particular job of construction.

In operation the set differs radically from the potentiometer control used in the four tube reflex. Wave length is tuned on the first condenser, while the second condenser, operating over a much narrower scale, acts as an oscillation control, bringing the set toward the oscillation point as the capacity of the condenser is decreased. It is in effect a sensitivity and volume and quality control all in one, and its setting will vary with each station tuned in. Once mastered, the tuning of this set is very easy. A few minutes' practice on the locals and you are ready to go after DX.



Detailed layout of the Acme D-coil reflex showing the wiring of parts.


Front panel layout. The two tuning dials at the left are provided with vernier controls.

Tips on Construction

SLIP a piece of paper under each connection when soldering. If a bit of solder or paste falls, the paper will catch it and prevent smearing up the baseboard. A wet rag around a binding post will keep it from melting when you are soldering near it.

* * *

Jab screws in a cake of soap before you start them, if you would prevent splitting the baseboard. Also do not put screws near each other in line with the same grain of wood; stagger them.

* * *

If there is a possibility of the rheostats shorting on the shield on the panel, cut a piece of mica and place it between the rheostat and the metal shield.

* * *

If you have troublesome oscillations in your radio-frequency set, try varying the angle of the coils with relation to each other.

* * *

To square up the edge of a panel or any other piece of bakelite, use a common wood plane that has been set finely.

To solder a tip on a phone cord, wrap 20 or 30 turns of No. 34 or 36 wire around the bare wire of the cord, tin it, hold the solder-filled tip over a gas jet and, when it is still hot, the previously prepared cord can be forced into the opening.

* * *

When using flashlight cells of the 4½-volt variety as C batteries, bore holes in the contact prongs on the cells and use binding posts to hold the leads instead of solder. This makes replacement of batteries easier.—*The Atlanta Journal.*

A Short Wave Loop Receiver

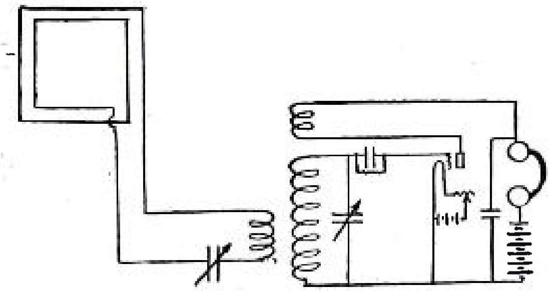
Simple Directions for Building a One-Tube 80-Meter Set Which Brings in DX Stations Galore

THERE is hardly an amateur who has not tried his luck with a loop receiver, and as a result there are very few who do not say "bah" whenever one is mentioned. The results fell so far short of expectations that the whole system came to be looked upon as a farce. Some of the more ambitious finally make fairly good records by using a half dozen or so tubes.

Alexander Maxwell, in *Radio* Magazine, describes a one-tube 80-meter set which, from all indications, appears to be practical for reception on a loop. The details for building this set as given by Mr. Maxwell are as follows:

The circuit is the conventional primary, secondary and tickler which has proved its worth time and time again. There is nothing freakish and there are no tricks to the operation. Of course it is understood that to be really efficient the set must be low-loss.

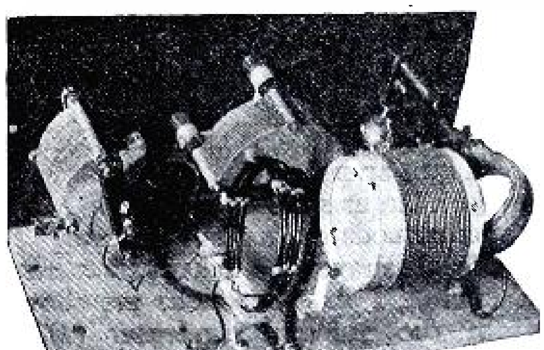
The loop is wound on a wooden frame 18 in. across. The rims are not needed, but if the loop is to be put in a place where it is liable to be bumped they make good fenders. Do not use any patent varnish on the frame. Shellac excludes the moisture and is a fairly good insulator. The wire should be as large as possible. The best way to insure your loop being a failure is to use No. 30 wire. Ribbon antenna is good, but in anything larger than that eddy currents will detract from the signal strength. On this loop No. 10 enameled wire was used. Five turns spaced 1½ in. apart are about right. The loop is suspended from the end of a bracket arm fastened to the



Circuit diagram of the short wave loop receiver.

wall and may be swung, by means of a handle at the lower corner.

The rest of the set is standard low-loss equipment. The primary coil consists of 5 turns of No. 12 enameled wire wound on an oatmeal box. They are then slipped off the end of the box and held together with string. The coupling is not critical, and the coil may be fastened permanently, but it makes the set slightly more flexible if it is movable. The primary condenser is an 11 plate. This will tune from 60 to 125 meters.



Illustrations by Courtesy of Radio (San Francisco, Cal.)

The one-tube 80-meter loop receiver.

The secondary is wound on an ice cream carton. These are as nearly a perfect dielectric as can be found. The paper is saturated with paraffin. It is light, moisture proof, and very strong. Have the bottom of the carton at the end facing the primary. The tickler rotates in the open end. The secondary is wound with 15 turns of bell wire. The coil should be placed so that there is a minimum of dielectric in its field. A strip of thin wood screwed to the carton and in turn fastened to the baseboard makes an ideal support—the secondary condenser has 15 plates, giving the circuit the same range as the loop.

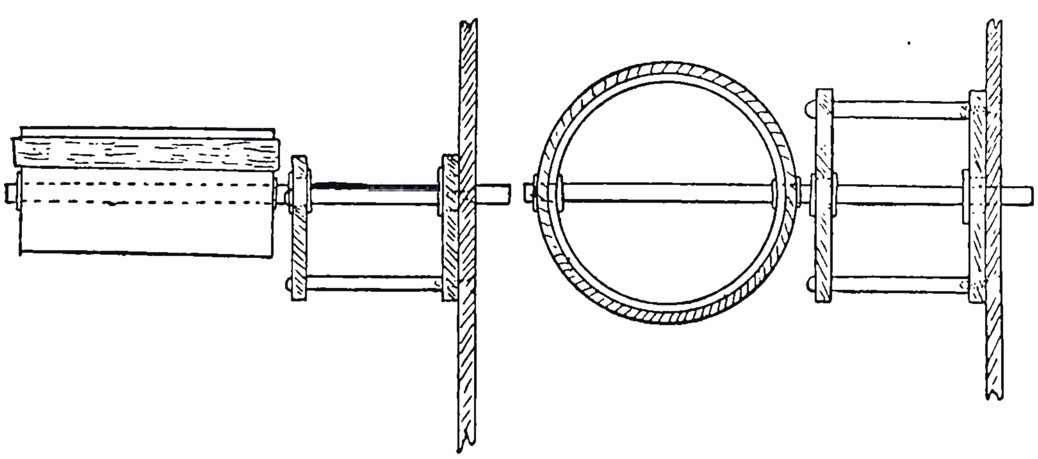
The tube is a 201A mounted in a pyrex glass socket. Later a WD12 without a base was used, and results were slightly better.

The rheostat is a Howard 25 ohm. The make is not important as long as it serves the purpose.

The unique part of the set is the tickler mounting. A trip was made to the "suregyp" radio and sporting goods emporium around the corner and the mouldiest and highest loss condenser in stock was picked. It cost $1.05. As soon as Joe reached home he took it all apart and threw the plates into the garbage can. From a piece of brass curtain rod of the same diameter as the shaft was cut a 9 in. piece. The wreck of the condenser was now reassembled. The tickler coil was wound on a cardboard tube, and the tube fastened to the shaft by means of washers jammed on and then soldered in place. There is some end play, but not enough to hurt. The bearing runs smooth and all cussing is eliminated for the tickler quits rotating the moment the hand leaves the dial. The number of turns used in the tickler has to be found by experiment. It will be close to twelve.

Don't do too nice a job of wiring. Keep all wires clear of the baseboard and avoid right angles and other fancy stuff. Bell wire will easily carry all the current, so there is no need of using bus bar. The set may be mounted on a panel or in a soap box. The farther the set is from the cabinet the better it works. Have the battery leads as short as possible. If they are over 2 ft. long place r. f. chokes consisting of 25 turns of No. 30 wire each one as close to the set as possible.

When running the set, the first thing noticed is the grave-like silence. This continues until the set is tuned to the wave of a transmitting station, then that signal has the undisputed field, unless the static is very strong, or there is another station in the line of the one being listened to who is on exactly the same wave.



Details of the tickler coil mounting.

The best procedure in tuning is to set the bulb to oscillating and then swing the loop till a whistle is heard. Stop turning the loop and swing the secondary condenser to resonance, and there is the station. It was noticed that signals were much louder on the same wave as our transmitter. When the aerial switch was opened they decreased in audibility. The set was simply acting as a very loosely coupled receiver with no directional effect whatsoever. The short wave fones come in fine and with a fair audibility. When the loop and secondary circuits are exactly in resonance the set oscillates so violently the tube spills over. Detune the secondary slightly and maximum volume will be obtained.

The advantage of a receiver of this type is that the entire set is low loss. It gets away from coupling a low loss set to a high loss antenna and still higher loss ground.

The "Floating" Circuit Reflex Receiver

(*Continued from Page* 49)

sult. In addition to KDKA and WGY being audible on the loud speaker when the set was used in Cambridge, Mass., Chicago, Cincinnati, Philadelphia and New York stations have been logged with regularity.

Construction

The layout of apparatus is shown in Fig. 2. The parts may simply be mounted on a baseboard, as the condensers of the Browning-Drake units are equipped with feet for this purpose, as the constructor may probably desire to add a stage of audio-frequency amplification.

The parts necessary for the set are:

2—National Browning-Drake Units, consisting of one coupling unit with variable condenser and one radio-frequency coil with variable condenser.

1—AmerTran 3-1 audio transformer.

1—.0001 fixed condenser.

1—.00025 fixed condenser.

1—Three-plate vernier or tubular type condenser for balancing.

1—Tube socket.

1—Rheostat, 30 ohms.

1—Crystal detector, fixed type.

5—Binding posts.

1—Panel size 7 x 16 inches and baseboard, size 8 x 16 inches.

Of course, if the constructor decides to add an audio amplifier, he will have to use a larger size panel and baseboard to accommodate the parts for same.

Fig. 1 shows the schematic wiring diagram. Two connections are shown from the antenna condenser (.0001 mf.) to the coil Lo. If a large antenna is being used, such as 100 feet or more, point 1 to point 2 should be connected. If a short antenna is used, point 1 to point 3 will be connected, instead of point 1 to point 2. Never make connections from both 1 to 2, and also from 1 to 3. In connecting the parts, it is advisable to have a .00025 by-pass condenser close to the negative filament of the tube socket as this makes the leads carrying the radio frequency short. Be sure to ground the rotor plates of the .00035 mf. tuning condenser, as this eliminates body capacity.

To Balance the Set

The balancing of the receiver is comparatively easy. Set the .00035 at, say, 20 divisions on the scale. Then turn the .0005 condenser (Co), to see if any clicks or misses are heard in the receivers, which would mean that circuit LoCo was oscillating. If this circuit tends to oscillate at any place, the balancing condenser should be adjusted until oscillations are stopped.

The tuning of the set will be found to be sharp, and it is advisable to place a long insulated rod on the balancing condenser, so that it may be controlled from the front of the set, and used as a tuning control. The rotor coil will need very little adjustment, being set most of the time in the same plane as the secondary of the regenaformer (coupling coil).

For extremely distant stations and good loud speaker reception on medium distant stations a stage of audio should be added to this set. This may be done by placing the primary of an audio transformer in place of the headphone and then connecting the secondary to a tube in the usual manner.

A Non-Radiating Low Loss Receiver

(*Continued from Page* 68)

with the one used, and the number of turns and kind of wire are the same, there being no rotor, however.

Turn Ratios

If Litz cable or its equivalent is preferred, wind a ten turn primary, leave ¼ inch space, then wind a forty turn secondary. The tubing in that case is 3 inches outside diameter and is 3½ inches high. The rotor, about 2¼ inches diameter, has thirty-six turns, eighteen on each side of the shaft hole.

Basket weave and spiderweb variocouplers are difficult to make at home, due to the necessity for mechanical firmness, which usually requires factory facilities. This type of coil may be used to advantage also.

If the commercial products are to be purchased, matched coils are made by Wallace, Globe (broadcast type), ARC, Eastern pickle bottle and Bruno. The Globe is basket wound, the Wallace spiderweb, the ARC is form wound and something on the order of Uncle Sam, &c. Any existing commercial coupler or R. F. T. may be converted for use in the set by adjusting turns on the secondaries. If the primaries are larger or smaller on your coil than described here, let the primaries remain as they are, as their inductance value in commercial products is usually all-sufficient for any circuit.

In wiring the set notice that there is a rheostat in the detector tube, negative leg. This rheostat, R2, should be of the vernier type, a Bradleystat, Filko-Stat or the like, in conjunction with a UV-200 or C-300 tube. If a Sodion tube, D-21 type, is used, it will detect about as well as the other type, but only a 6-ohm rheostat should be used. No other tube except one of these three will work well as the detector here. R1 is a balanced resistance, controlling the filaments of the three amplifier tubes (amperite).

Tickler Connections

Be careful to connect the tickler at the plate post of the R. F. tube and connect one side of the variable grid leak, R3, to the grid post of the detector tube socket. If you miss up on either of these connections the set will not work well, possibly not at all.

Item C3 is a .005 mfd. fixed condenser, mounted on the secondary of the second A. F. transformer, one side to the G post, the other to the F post.

In connecting the grid returns—that is, the ends of the coils whose beginnings go to grid—remember to make these connections to the "A" battery minus, not to the negative filament. The grid returns should not have to pass through these resistances.

Properly constructed, the set will operate efficiently and will bring in DX stations aplenty with considerable volume.

Shielding to Avoid Losses

MANY constructors of radio sets have been advised to shield condensers, coils, tubes and transformers to eliminate feedback from various parts of the set to other parts. Also it has been the general impression that shielding with copper or brass is necessary in order to eliminate hand capacity effects when tuning. Shielding has its purpose, but if it is improperly done or done when not necessary its introduction is very likely to cause excessive losses in a radio circuit.

In the first place, it is not necessary to place a metal shield behind the panel and between the panel and the condenser. With modern low-loss condensers having metal end-plates and rotary plates which are connected to these metal end plates act as shields within themselves. If the condensers are properly wired in to the circuit no body capacity will be noted when the hand is removed from the tuning dial.

If your set is a neutrodyne and you have tried to conserve panel space by crowding the condensers, there may be severe feed-back from one condenser to the next. This will mean that the set will have to be over-neutralized in order to prevent oscillation, or the feed-back may be so severe that it will be impossible to neutralize it at all on some wavelengths. Some experimenters, and manufacturers, too, insert metal shields or partitions between the condensers. These shields are connected to the ground. They do prevent feed-back and they do also cause rather severe losses. The obvious remedy is to design the set so that there will be sufficient space between the condensers to prevent any feed-back.

An audio-frequency amplifier employing transformer coupling and having more than two stages will probably have to be shielded. Here the introduction of shielding will not cause any losses to speak of. The shielding should preferably be of copper or brass. Number 12 gauge is thick enough. Iron or sheet steel can be used but to be as effective as brass or copper, the iron would have to be one-tenth of an inch thick.

In radio-frequency circuits in no case should any shielding be placed nearer than one inch to any coils, tubes or condensers. There are only one or two standard circuits which really require shielding, notably the super-heterodyne and other forms of circuits in which a comparatively powerful oscillator tube is used and in which there are a mixture of different radio frequencies beating on each other. In a super-heterodyne we have enough energy to suffer a few losses due to shielding if, by so doing, we cut down the tendency toward oscillation.

To be effective at all the shielding must be complete—almost airtight. Thin tinfoil, copper-foil or aluminum-foil will not be effective. The shielding should be at least of 12-gauge stock.—*QST, Hartford, Conn.*

"Circuitgrams" via Radio

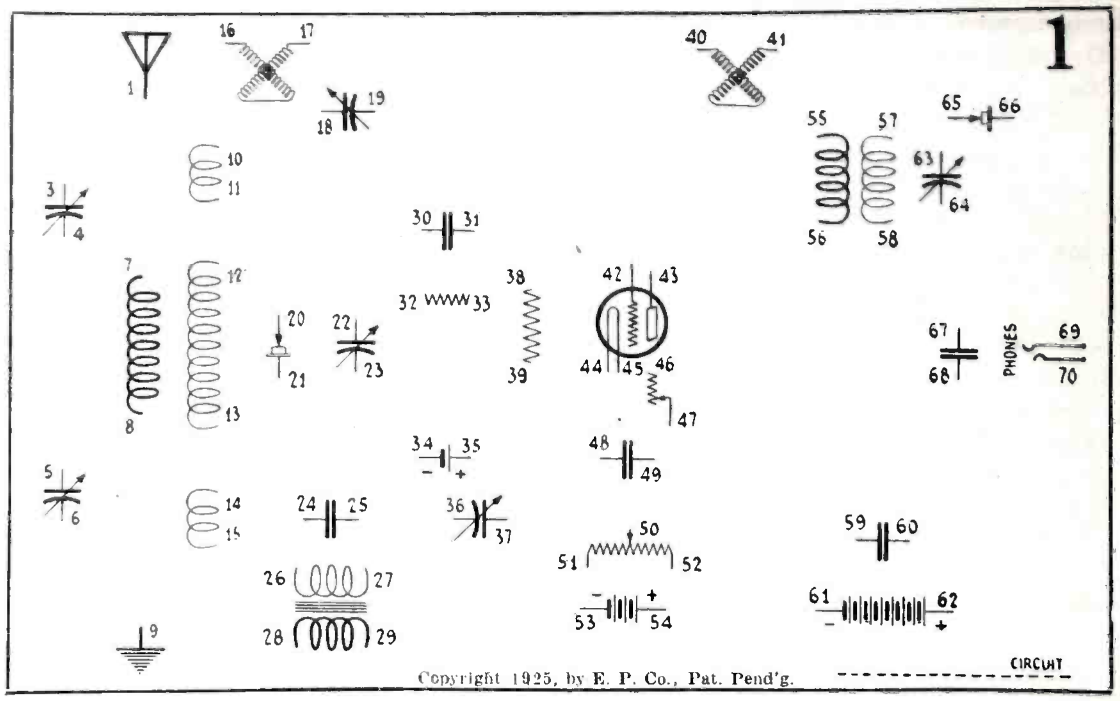
Prominent Stations Employ Novel Method to Broadcast Radio Circuits

HERE is somewhat of a novelty in connection with the broadcast station operated by the owners of RADIO NEWS magazine. The new station WRNY, located at the Roosevelt Hotel, New York, and operating on a wavelength of 258.5 meters, now broadcasts the new radio circuitgrams once a week, on Mondays at 9 P. M., and other stations in the country are following suit. This is a regular weekly feature, which has become popular in the radio fraternity.

Hugo Gernsback, editor of RADIO NEWS, who has originated the circuitgram, on which patents are pending, has kept in mind the fact that the radio fans are always on the lookout for the latest radio hook-up. New hook-ups are originated almost every week, and it is the purpose of WRNY to broadcast these the moment they make their appearance.

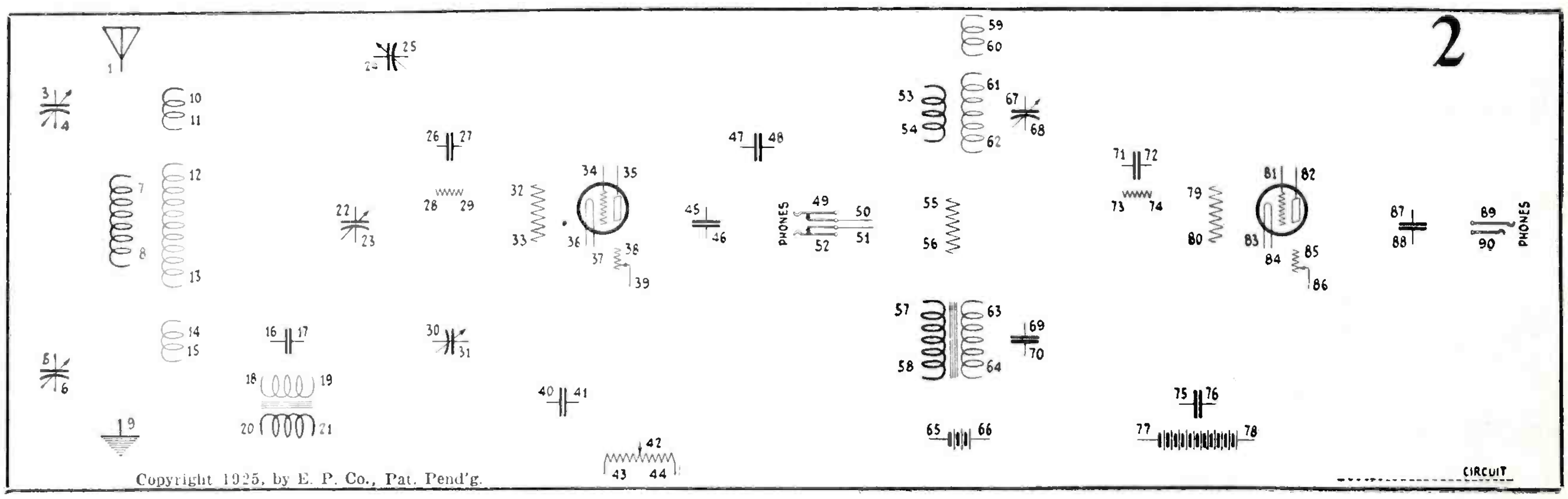
The method of broadcasting any and all circuitgram hook-ups is extremely simple. The WRNY announcer first states what sort of hook-up it is, whether it is a regenerative, a reflex, a super-heterodyne circuit, or what not. He then advises that you use circuitgram blank 1, 2, 3, 4 or 5—whichever is best suited for the occasion.

Suppose the hook-up of a single-tube, tuned radio frequency reflex circuit is to be broadcast. The announcer then speaks as follows:



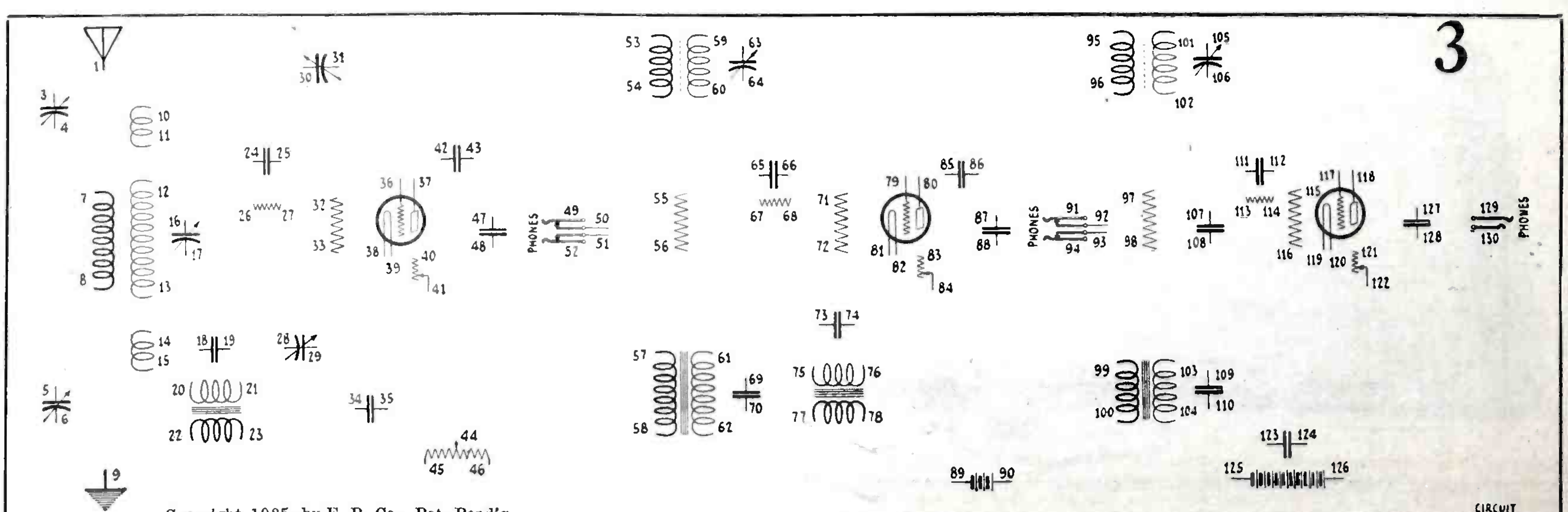
"We shall now broadcast a tuned radio frequency reflex hook-up. Please refer to circuitgram No. 1, single tube."

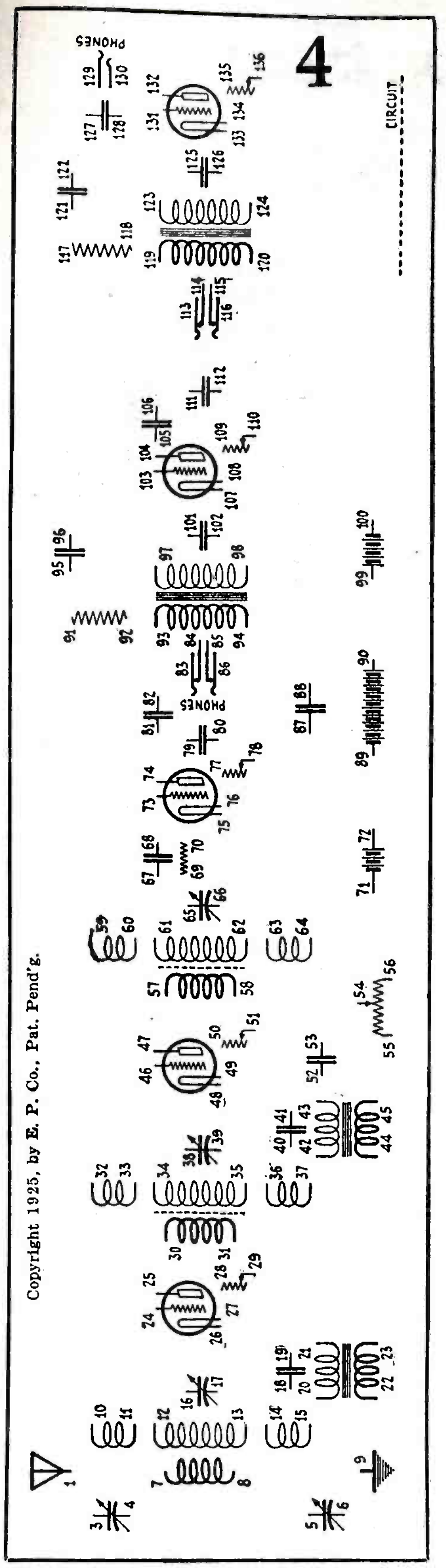
The announcer then reads off the connection numbers as follows: "Connect 1-7, 8-9, 12-42, 13-23, 22-12, 13-28, 9-29, 8-47, 44-54, 45-46, 47-53, 26-64, 27-66, 43-55, 56-69, 57-63, 63-65, 58-64, 70-62, 61-54."



As he slowly reads these numbers, all you have to do is take them down. After reading off all numbers, the announcer repeats them, so you can go over your record and make sure that you have copied all numbers correctly.

If any special information is needed, as, for instance, in the completed hook-up shown in Fig. 6, the announcer gives such information immediately after the numbers have been read. Thus, for instance, he gives the number of turns and size of wire of coils





7-8 and 12-13; the ratio of transformer 26-27, 28-29; what crystal to use in 65-66; and all other necessary information.

And that is all there is to it. After the announcer has finished, all you have to do is take your record with the key numbers and fill in the lines on the circuitgram. You will then have a complete hook-up, as shown in Fig. 6. This is simplicity itself, and provides not only a lot of entertainment, but useful instruction as well.

It will be noted that the blank circuitgrams shown on these pages have been laid out in such a manner that it is possible to broadcast any modern hook-up, no matter what circuit is used.

Thus, for instance, it will be seen that the one-tube hook-up circuitgram provides for any possible circuit that could be used, such as detector, regeneration, reflex, radio frequency or for any combination of these employing a single tube.

As will be noted from illustration No. 6 the instruments that are not used in any particular hook-up are simply left unconnected. For this reason, even though the reader does not listen in to WRNY in order to take advantage of new hookups that are being broadcast, he can now draw his own hookups on the circuitgrams, without the necessity of first drawing the usual radio symbols.

It is interesting to note that it takes only two minutes to broadcast a hook-up of the type shown in Fig. 6.

The Experimenter Publishing Company has prepared a tablet with blank circuitgram forms similar to those illustrated here, containing a goodly quantity of blanks. They will be furnished at 25c per tablet, sent postpaid.

Address your request for "Circuitgram" Tablet to Experimenter Publishing Co., 53 Park Place, New York City.

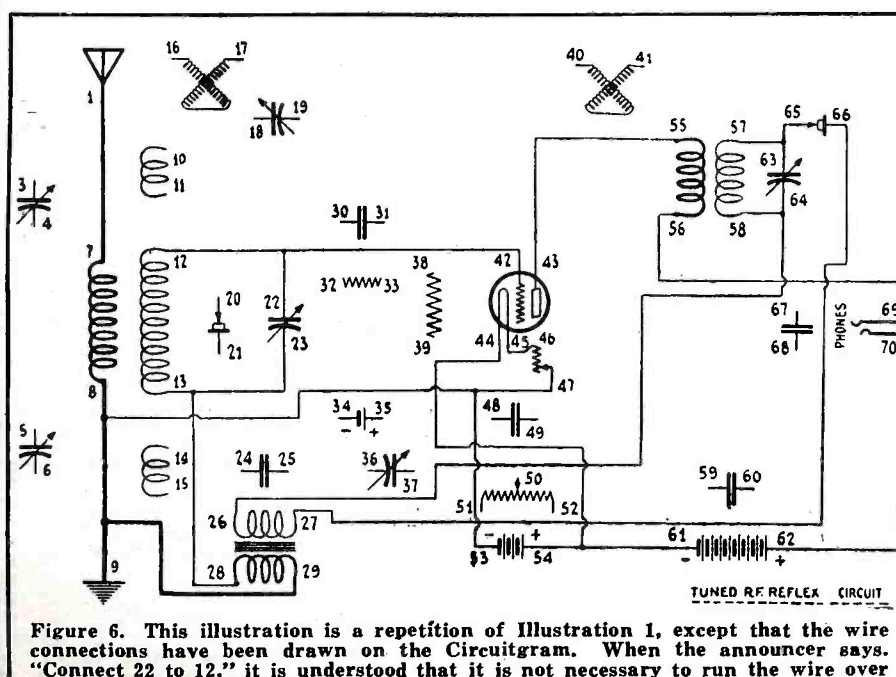
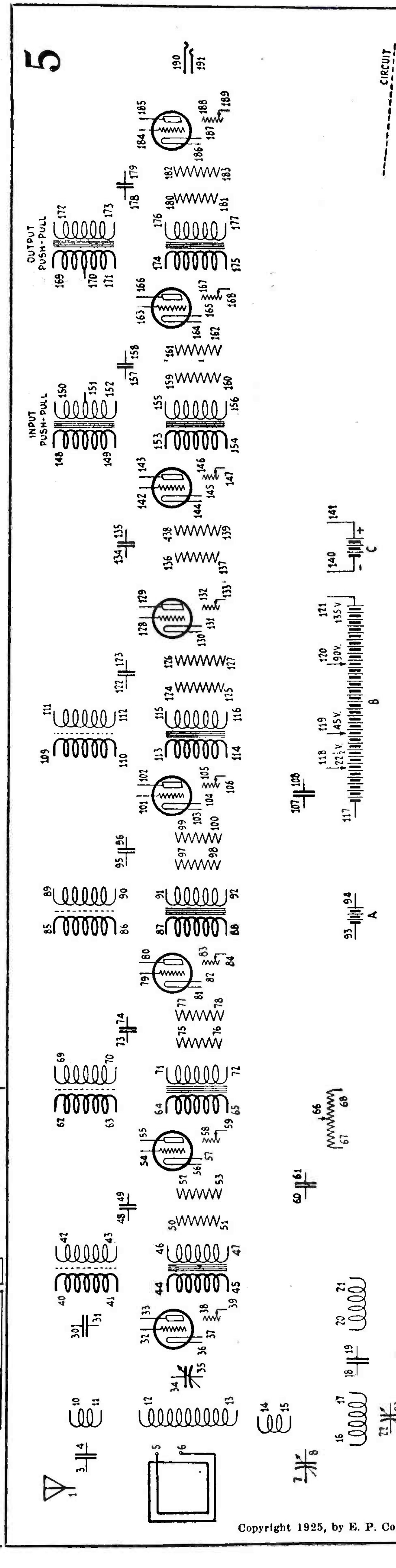


Figure 6. This illustration is a repetition of Illustration 1, except that the wire connections have been drawn on the Circuitgram. When the announcer says. "Connect 22 to 12," it is understood that it is not necessary to run the wire over where the figure 12 is, but simply making connection on the 12 wire is sufficient. The same is the case with 13-28, and other similar ones.



Here is the most complicated of all—the super-heterodyne Circuitgram. Provision is made for 9 tubes, but of course any number of tubes as mentioned by the announcer at WRNY can be used. It will be seen that the intermediate transformers have dotted lines in them. The reason is that sometimes, as for instance in the Tropadyne circuit, iron core transformers are used, whereas in the Ultradyne circuit air core coils would be used. The announcer, when giving the details of the set, will give the information indicating whether the intermediate coils are iron core or air core. It will be noted that both aerial and loop are used, and provision has also been made for push-pull transformers if such should be used in a special circuit. In case it should be necessary to advise the use of resistance-coupled amplification, it will be seen that the new Circuitgram provides for this as well. It is of interest to note that a complicated diagram, as, for instance, a 7-tube super-heterodyne can be completely broadcast within ten minutes, giving all the details of the circuit, repeating numbers, etc.

The New Radio Stamp Fad

Here is the DX Radio Stamp Album just like the ones we owned in our youth, in which were placed the rare stamps of the countries of the world. Some were hard to get, some couldn't be purchased for love or money; but the fun of the hobby was the seeking of rare stamps and the eventual possession. So it will be with the DX Radio Stamp Album. There will probably be some stamps you will never be able to own, but there will be many you will be proud to have and be able to show to other radio enthusiasts. It's an interesting game. Below the Album is shown the "Proof of Reception Cards" of which a generous supply is furnished with each Album. A dime placed in the hole in the card and sent to the station you heard brings back a stamp for your Album.

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This beautiful EKKO Stamp Album, illustrated above, will be given away absolutely free with a subscription to any one of our four magazines: *"Radio News," "Science and Invention," "The Experimenter," "Motor Camper and Tourist."*

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With the Album is furnished a large Crams comprehensive radio map of the United States and Canada; a supply of "Proof of Reception Cards" and also some stickers. The Album contains a list of broadcast stations of the United States and Canada with wave-lengths and columns for recording dial setting, a table of stations arranged according to wave-lengths and a section for log records.

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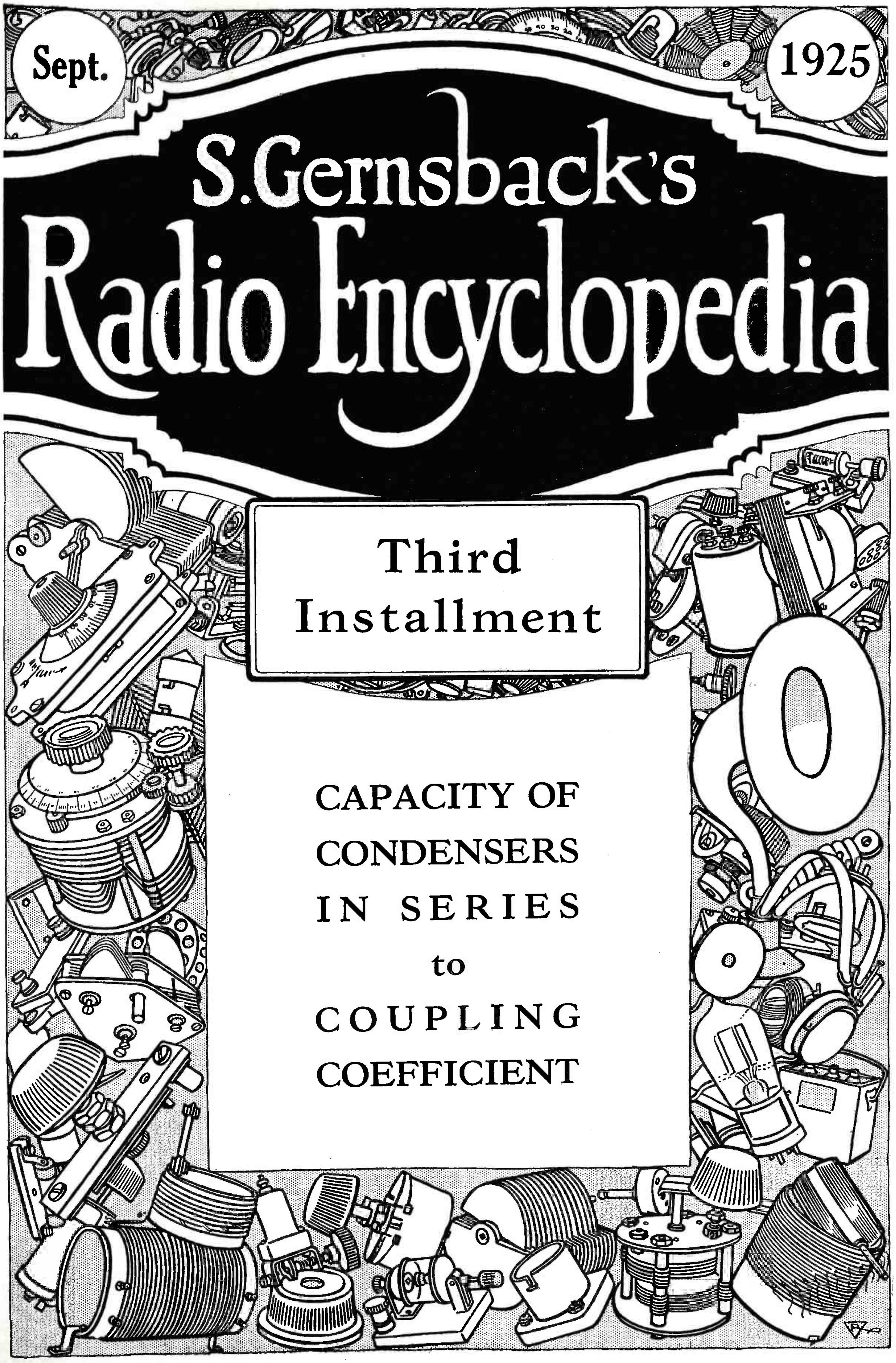


Sept. 1925

S. Gernsback's Radio Encyclopedia

Third Installment

CAPACITY OF CONDENSERS IN SERIES to COUPLING COEFFICIENT

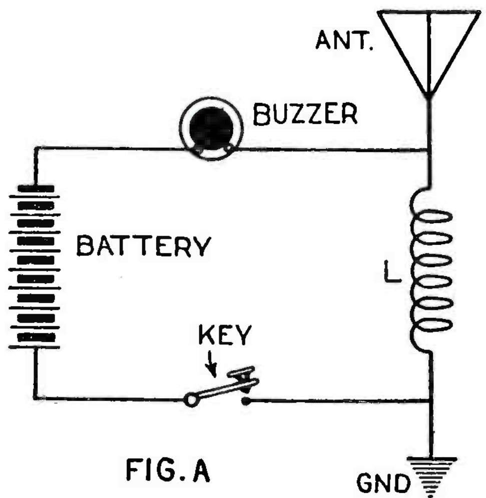
Printed in the United States of America

CAPACITY OF CONDENSERS IN SERIES—When several condensers are connected in series with each other the resultant capacity is always less than the capacity of the smallest condenser in the group. The capacity of condensers in series is given as follows:

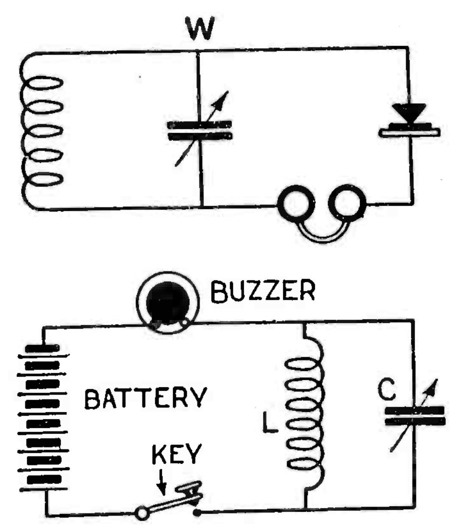
$$\text{Capacity} = \cfrac{1}{\cfrac{1}{C_1} + \cfrac{1}{C_2} + \cfrac{1}{C_3}, \text{ etc.}}$$

The resultant capacity is thus the reciprocal of the sum of the reciprocals of the several capacities. (See *Condenser, In Series.*)

CAPACITY MEASUREMENT OF ANTENNA—A simple method for the measurement of the capacity of an antenna as given by Austin follows: The illustrations show the general arrangement. The inductance L in Fig. A is a coil that will increase the wavelength (natural) of the antenna system 4 or 5 times; C is a calibrated variable condenser and W a standard wavemeter. In operation the coil L is connected in the antenna circuit, the buzzer is used to excite the antenna circuit and the wavelength is measured by w. The coil L is then taken out of the antenna circuit and shunted by the condenser C. The condenser C is then varied until the wavelength of the combined coil L and condenser C is the same as that obtained before with the coil in the antenna circuit but without the variable condenser. The capacity of the condenser now will be approximately that of the antenna, ignoring the distributed inductance of the antenna system. Fig. A shows the first operation, the measurement of the antenna with the coil in the circuit, and Fig. B shows the measurement of the wavelength of the coil and condenser. (See *Mutual Capacity, Wavemeter, Natural Wavelength,* also *Distributed Capacity.*)



The first operation in the measurement of the antenna. The wavemeter is shown below.



Circuit for the measurement of wavelength of coil and condenser.

CAPACITY MUTUAL—See *Mutual Capacity.*

CAPACITY RESISTANCE—The resistance to alternating currents offered by a body possessing electric capacity. (See *Capacity,* also *Resistance.*)

CAPACITY SWITCH—Any switch used in a circuit to introduce or cut out capacity (condenser).

CAPACITY (UNIT OF)—The unit of capacity is the farad. A condenser has a capacity of 1 farad when 1 coulomb is required to raise its potential from zero to 1 volt. Since the farad is very large, its millionth part, or the microfarad is generally used.

CARBON—A non-metallic chemical element used for many purposes in electricity and radio. It exists in three forms, two crystalline and one non-crystalline. The first two are diamond and graphite, the third charcoal. Carbon is used as an electrode in electric arcs, as one of the poles in certain types of primary cells, as a material in place of wire for various forms of resistance, and as brushes in motors and generators. (See *Diaphragm, Carbon.*)

CARBON RHEOSTAT—A rheostat or variable resistance using carbon in place of the customary wire. In its simplest form a carbon rheostat may be merely a piece of carbon having a sliding contact. This is shown in Fig. 1. Owing to the relatively high resistance of carbon used in this manner, such a controlling resistance will generally be termed a *potentiometer* (q.v.) and used as such.

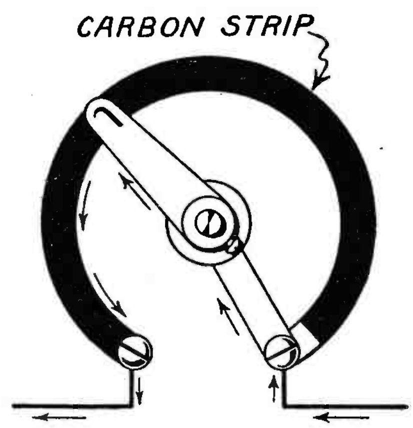


Fig. 1.—A carbon rheostat with a rotary sliding contact.

The most practical form of a carbon rheostat is known as a carbon pile rheostat. This type uses a number of flat pieces of carbon of relatively low resistance placed together and arranged with a knob and screw in such manner that the pressure can be varied. This change in pressure alters the resistance of the mass and allows control of the current for vacuum tubes. The same principle is used for very high resistances as well as for low values. The principle will be seen from the illustration Fig. 2.

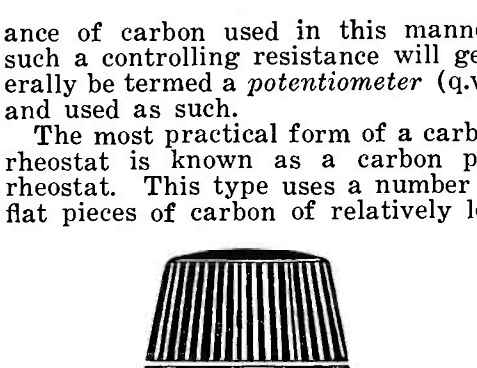


Fig. 2.—A carbon pressure type rheostat.

CARBORUNDUM—An abrasive material, a product of the electric furnace, composed of silica and carbon. It is used in radio as a crystal rectifier, although the strides of radio have practically rendered it obsolete, many other better crystals being in use. The chief difficulty with its use as a rectifier or crystal detector was the fact that for efficient operation it required a cell or battery and potentiometer to regulate the current flowing through it. The simple crystal circuit using a carborundum detector is shown in the illustration. C is a tuning coil, D the carborundum crystal and contact, P a potentiometer and T the head phones. (See *Rectifier,* also *Detector.*)

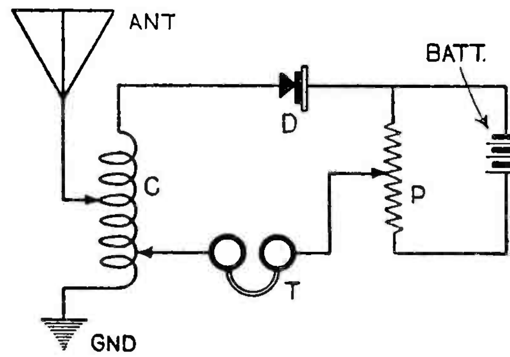


Diagram of a radio circuit employing a carborundum crystal detector.

CARDBOARD TUBING—Tubing made of laminations of paper pasted together. They are used for home made coils of all descriptions, and while not as efficient as the composition tubing, can be used for many purposes without any great loss. As a general rule it is better to use some of the numerous compositions, such as bakelite or rubber compounds.

CARPENTIER, JULES—French radio expert. Born in Paris, in 1854, he joined the Ecole Polytechnique in 1871, and in 1876 was appointed principal stores engineer of the Lyons Railway Company, making a special study of electricity. For his work in electricity he obtained in 1881 the cross of Chevalier of the Legion of Honor. One of the early pioneers of radio in France, he founded the Compagnie Generale Radiotelegraphique, afterwards absorbed in the Compagnie Generale de Telegraphie sans Fil. Carpentier is a member of the Academie des Sciences, Commander of the Legion of Honor, and President of many scientific societies.

CARRIER WAVE—The *continuous wave* (q.v.) of radio frequency generally thought of as carrying the voice or music waves from the radio broadcasting station. Actually it is a radio wave of high frequency, which is altered in amplitude by the music or speech transmitted. In action, this continuous wave has another wave super-imposed on it. This other wave having wave form and amplitudes determined by the voice or other sounds being transmitted. The illustration shows the carrier wave, the waves representing speech or music and the combination of the two. This effect of varying the amplitude or strength of a continuous wave by means of some sort of program is known as *modulation.* (q.v.) The wave representing the speech or music is imposed on the carrier wave resulting in the combined wave which reaches the listener and is translated by suitable apparatus into approximately the same sounds that are transmitted. (See *Modulation, Broadcasting,* also *Speech Vibrations.*)

CARRYING CAPACITY—See *Current Carrying Capacity.*

CARTRIDGE FUSE—A fuse in which the fuse wire is surrounded by some non-inflammable substance, enclosed in a cartridge-like tube and having brass lugs soldered to caps at ends. Used to prevent the hot wire from "flying" when fused. (See *Fuse.*)

CASCADE—A term applied to pieces of apparatus connected together in series, particularly vacuum tubes. In this case, the arrangement would be such that each vacuum tube would amplify the signal output of the preceding tube. The tubes will be so connected that the output of one is introduced as input to the next and so on, the total result being greatly increased signal strength from the output of the last tube. This term may apply to either radio frequency or audio frequency amplification. (See *Amplifier, Radio Frequency,* also *Audio Frequency.*) A simple cascade arrangement is shown in the illustration. Fig. 1 is a circuit with two stages of cascade radio frequency amplification, and Fig. 2 a circuit using two stages of audio

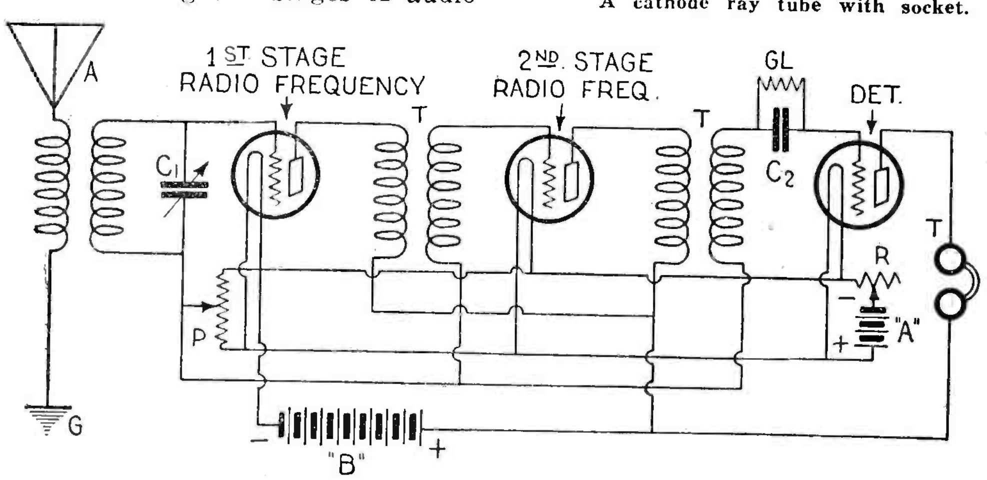


Fig. 1.—Circuit diagram showing two stages of cascade radio frequency amplification and detector.

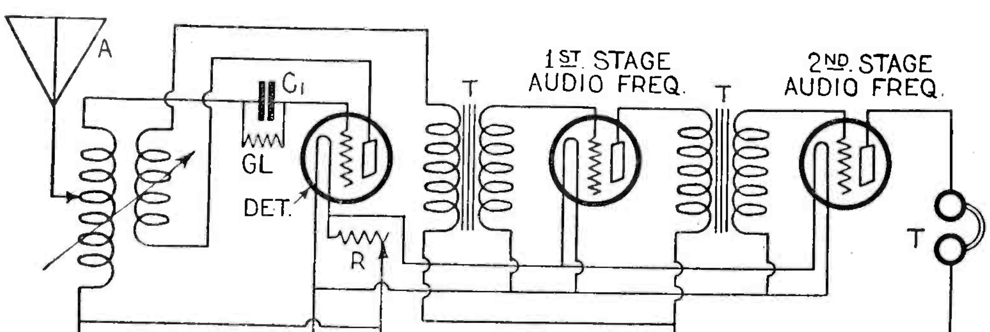


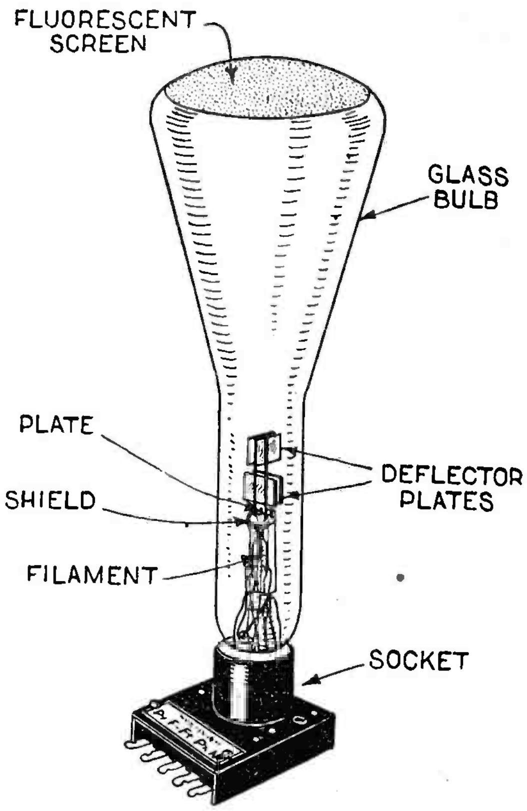
Fig. 2.—Diagram of detector and two stage cascade audio frequency amplifier.

frequency amplification with the usual detector tube in each case. A combination of both radio frequency and audio frequency stages of amplification might also be used, the term cascade amplification also applying here.

CATHION or CATION—The charged particles which appear at the cathode or move toward it through the electrolyte of an electrolytic cell. (See *Anode.*)

CATHODE or KATHODE—A *negative electrode.* The term is often applied to the filament of a vacuum tube to distinguish it from the anode or plate. (See *Cell, Electrolysis,* also *Anode.*)

CATHODE RAY TUBE—A vacuum tube having a high vacuum, that is from which practically all air has been exhausted, used in the production of



A cathode ray tube with socket.

cathode rays. These tubes in their modern form are used for many purposes in studying the nature and form of electric waves. The illustration shows one of the latest types of tube, known as the *Cathode Ray Oscillograph.* This tube is used for the following purposes: examination of the wave forms of various rectifiers, study of wave forms of different types of generators, study of vacuum tube characteristics, examination of the characteristics of X-ray and other types of tubes, examination of radio frequency waves modulated as in broadcasting, measurement of hysteresis and dielectric loss in various materials, study of phenomena in arcs and sparks, together with numerous other associated effects. The development of this tube is one of the marvels of science, enabling the research engineer to virtually see the electric wave, and to study exhaustively, electric phenomena otherwise invisible.

The Western Electric modification of the Braun Cathode ray tube or oscillograph, is a three electrode glass tube about 30 centimeters (about twelve inches) long, in the form of a cylinder an inch and three-quarters wide, spreading out in conical shape, the tube being about three and a half inches wide at the top. The *cathode* is a filament coated with active oxides and arranged to emit the number of electrons required for the cathode rays, at a dull red heat. The *anode* or plate is a small platinum tube set very near the filament. Between the filament and the anodes is a small circular screen having a hole just a little smaller than the circular filament. A battery of several hundred volts is connected between the filament and plates with the positive terminal connected to the plate. The electrons emitted from the hot filament are controlled by this field in the same manner as in an ordinary vacuum tube. A small portion of these electrons pass completely through the tubular anode and constitute the *cathode* rays. These rays are passed between two pairs of deflecting plates set at right angles to each other, and fly against the large end of the tube. This end is covered with a fluorescent mixture which renders the rays visible. These rays are deflected in various ways. For example, if an alternating current is applied the visible spot on the screen will be drawn out into a line. (See *Electron, Vacuum Tube,* also *Wave Analysis.*)

CATHODE RAYS—The stream of electrons or electrical particles sent out from the *cathode* or filament of a vacuum tube. These rays are negatively charged. (See *Cathode, Electrons, Vacuum Tube* also *Oscillograph.*)

CAT-WHISKER—The fine wire used with certain crystal detectors to make contact with the crystal. Usually a springy metal such as phosphor bronze wire.

"C" BATTERY—One or more small

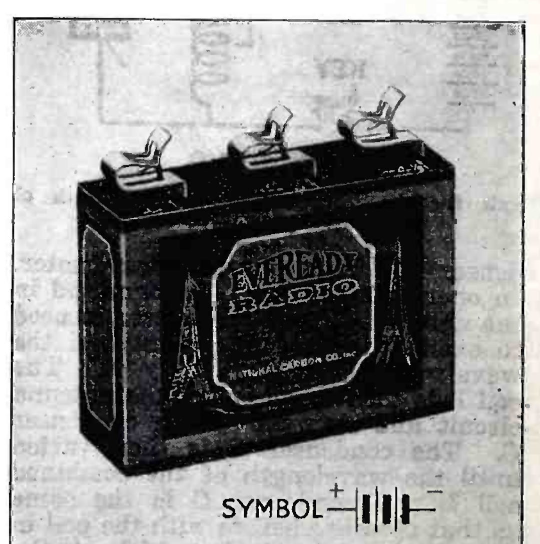


Fig. 1.—A 4½ volt "C" battery. This type of battery has a common positive terminal and is tapped at negative terminals for 3 and 4½ volts.

cells having a voltage generally between 2 and 10 volts, used in the grid

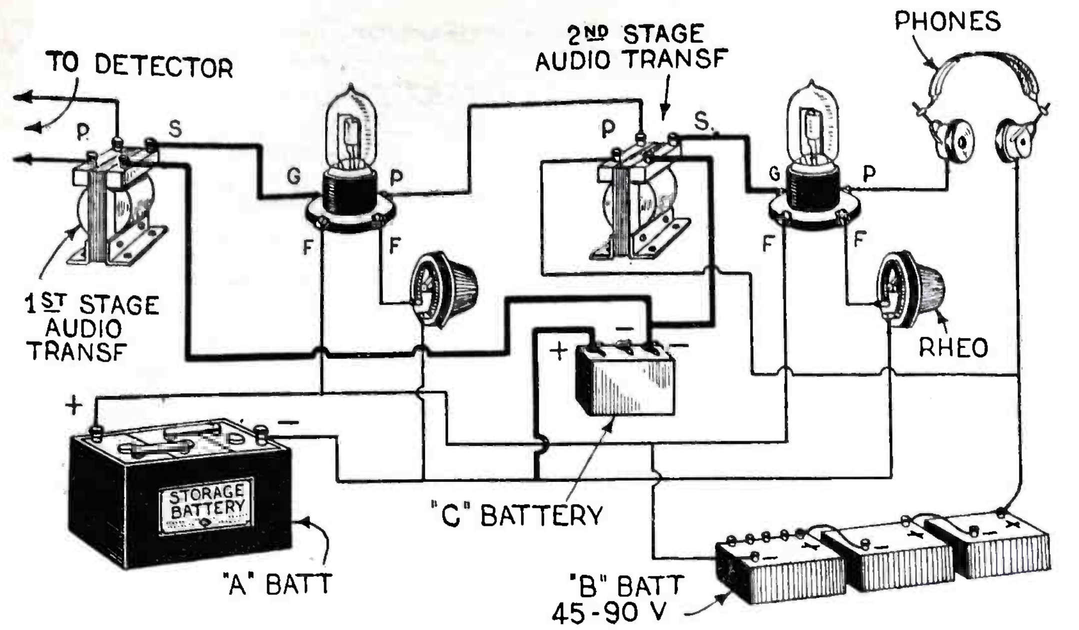
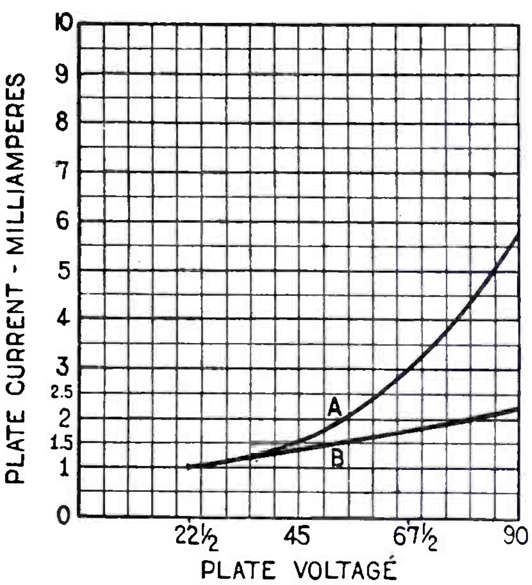


Fig. 2.—A diagram showing how the "C" battery is connected in the audio frequency amplifier.

circuit of an amplifier tube for the purpose of impressing a negative potential on the grid of the tube. The method of connecting it in the circuit is shown in Fig. 2. Fig. 1 shows a typical 4½ volt "C" battery. (See also *Grid Bias* and *"C" Battery Curve.*)

"C" BATTERY CURVE—In order to show the effect of a "C" battery on the consumption of current from the "B" battery in an audio amplifier, a *curve* (q.v.) may be drawn as in the illustration. In this case the test was made with a type UV 201A tube used as a one stage *audio frequency amplifier* in



Test conducted on UV201A tube using single stage audio amplifier with conventional circuit. Plate Voltage—Abscissae. Plate Current in milliamperes—ordinates. A—Consumption curve without "C" Battery. B—Consumption curve with "C" Battery. (Note: 1.5 ma. at 45v plate rising to 5.75 ma. at 90v plate without "C". With "C" Battery consumption maximum is 2¼ ma. at 90v.)

a conventional circuit. It is readily apparent on referring to the lines A and B that when the "C" battery is in use the consumption of current by the plate is much less than without it.

CELL—A cell is one of the four chief sources of electric energy. In a cell the energy is created by an *electro-chemical* process, using in its simple form two unlike metals immersed in a dilute acid or alkaline solution. In the illustration Fig. 1 the common form of electric cell is shown. C is a strip of *carbon* and Z a strip of *zinc*. These are placed in the jar in a conducting solution of sal ammoniac. If the exposed terminals from the carbon and zinc strips are connected together by a piece of wire, current will flow from one side of the cell to the other through the wire. The current flows from the carbon or *positive* pole to the *negative*

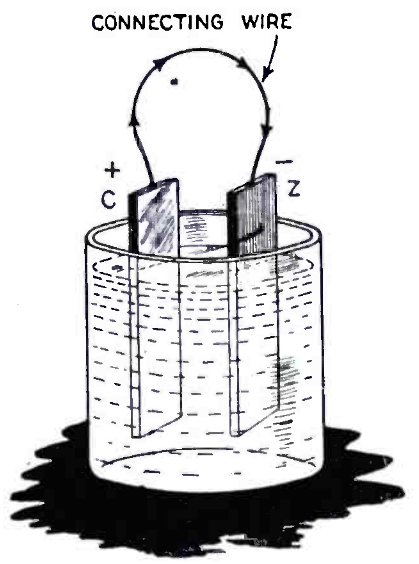


Fig. 1.—Common form of electric cell.

or zinc pole through the wire, completing the circuit through the solution from zinc to carbon. (See *Current, Direction of Flow.*) The cell described is known as a *primary cell.*

In Fig. 2 a simple *storage cell* or *secondary cell* is shown. In this case

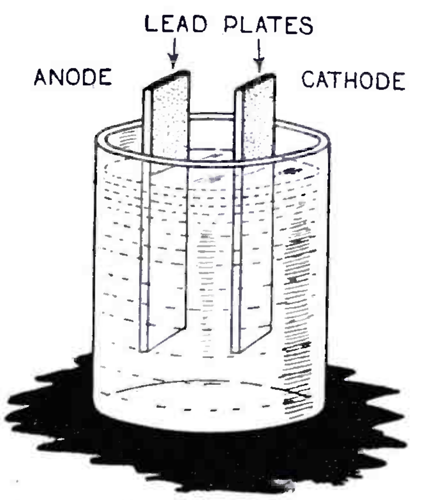


Fig. 2.—Storage or secondary cell.

there are two lead plates immersed in a dilute solution of sulphuric acid. A source of primary current (primary cell) may be connected to the secondary cell in the manner shown in Fig. 3 and after being connected for a certain length of time it will be found that the energy of the primary cell has been transferred to the secondary cell and stored in it. This process of placing

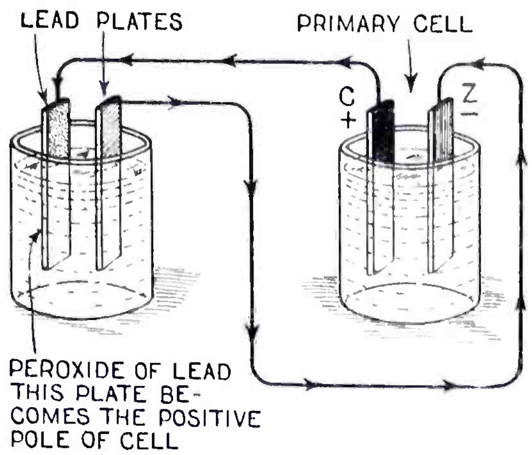


Fig. 3.—Primary cell connected to secondary or storage cell.

electric charges in a secondary cell is known as *charging*, and the current stored up in it is known as the *charge*. Now, if the wire is connected from one terminal to the other it will be found that electric energy can be withdrawn in a similar manner to that of the primary cell. A secondary cell may contain several plates and several of these cells may be connected together to form a storage battery. (See *Storage Battery, Current, Production of*, also *Anode* and *Cathode*.)

CELL, SECONDARY—When a *primary cell* is connected to a *storage* or *secondary cell*, the current from the primary cell flows into the secondary cell and in effect deposits energy in that cell. Then when the charging source (the primary cell) is withdrawn, the secondary cell can be used in practically the same manner as the primary cell. A wire connected from one terminal to the other will permit passage of current. The action of storing up energy in a storage cell is approximately as follows: When the charging current flows from plate to plate through the solution in the secondary or storage cell, the plate connected to the *positive* (+) *pole* (carbon or copper) of the primary cell, receives a brown coating of *peroxide of lead*. At the same time the other plate becomes spongy or porous. Now as one plate has received a coating while the other remains unchanged as far as its surface is concerned—it acts as a primary cell if the charging source is taken away and the two terminals connected. It now has all the essentials of an ordinary chemical cell. As long as the coating of peroxide of lead remains on the surface of one of the plates, the cell will be capable of delivering current.

When the coating has been worn off or eaten away the cell is said to be in a discharged condition. It will then be necessary to go through the same process of connecting a primary source to the terminals in order to again deposit peroxide of lead on one plate. It will therefore be evident that when the *storage cell* is charged, *current* is not actually stored in it, although in effect it has received potential energy. What has actually occurred is that the current supplied to the cell during the charging process has produced electro-chemical changes, making the plates dissimilar and thus producing a difference of potential. (See *Current, Production of*). The *voltage* or *electromotive force* of primary cells varies from .06 to 1.5 volts according to the nature of the elements used and the grade of the *electrolyte* (q.v.). Secondary or *storage cells* of the lead plate type produce from 2.1 to 2.6 volts. (For more complete explanation of the theory and action of a secondary cell, see *Storage Battery.* See also *Electro Motive Force, Current* and *Voltage.*)

CELL, THEORY OF PRIMARY—It has been explained under the heading *Cell,* that a primary cell produces electrical energy by chemical action. More specifically the action of a simple cell is as follows: When the copper and zinc, or carbon and zinc placed in a cell are connected together by a conductor, (wire or other conducting object) the acid in the case of a sulphuric acid solution, attacks the surface of the zinc plate and forms a compound known as zinc sulphate. While this sulphate is being formed some of the hydrogen contained in the sulphuric acid is liberated in the form of bubbles which appear on the copper plate. Some of these bubbles escape into the surrounding air by rising to the surface of the solution, but others cling to the surface of the copper plate and gradually cover it with a film of hydrogen. It may be said here that the decomposition of the zinc plate in the acid solution furnishes the *electro-motive force* required to cause the flow of current between the plates, through the solution and through the conductor. Now, hydrogen is a non-conductor, and as the hydrogen gradually covers the copper plate, the surface of the plate in contact with the solution gradually decreases. The flow of *current* from zinc plate to copper plate in the solution is thus gradually diminished, until eventally we can imagine the copper plate as being entirely covered with hydrogen and no longer in contact with the solution. In addition to this insulating action of the hydrogen, it tends to set up a current within the cell in the opposite direction to the normal flow of current produced by the chemical action. A cell in this condition is said to be "polarized," and various means have been used to cut down or eliminate the *polarization effect.* The purpose of these various means is to prevent the hydrogen bubbles clinging to the surface of the copper plate, thus allowing them to escape to the top of the solution and thence into the surrounding air. (*See Polarization, Current, Voltage, also Storage Cells.*)

CENTIMETER—A measure of length in the metric system. It is one hundredth part of a meter, or approximately .3937 inch. It is used as the unit of length in the Centimeter Gram Second System (q.v.).

CENTIMETER GRAM SECOND or C. G. S. A system of units of measure employed in practically every branch of engineering, particularly in electrical practice. It is a decimal system, the centimeter being the unit of length, the gram the unit of weight and the second the unit of time. All other units are derived from these three. When the magnitude of a quantity is spoken of, it refers to the relative magnitude of the quantity when compared with some other quantity of the same nature. The magnitude used as a standard of comparison is termed a unit. Thus, if the length of a body is measured in feet, as for example, ten feet, it means that the magnitude of the body is ten times unity or ten times one foot. Similarly a *current* of ten *amperes,* is a current of magnitude ten times as great as the unit quantity—one ampere. Now an ampere is the practical unit of rate of flow of electric current. The unit has a certain definite value. (See Ampere.) The magnitude of any other similar quantity measured in amperes will mean a value equal to a certain number of units. In addition to the C. G. S. system of units, there is a practical system. This is commonly used for ordinary calculations. Under this system, the following are the main units: The *volt* is the practical unit of *electro-motive force;*—the force required to maintain a flow of current of one ampere through a resistance of one ohm. The unit of *current strength* or rate of flow of current is the *ampere;*—the strength of current maintained by a force of one volt through a resistance of one *ohm.* The unit of *resistance* is one *ohm,* and is the resistance of a *conductor* or *circuit* that will permit the passage of a current of one ampere under the force of one volt. The unit of *quantity* is the *coulomb,* which is the quantity of current flowing in a circuit when one ampere passes a given point during one second of time. The *watt* is the practical unit of *electrical power,* being the power of a current of one ampere flowing in a circuit under the pressure of one volt.

It will thus appear that the practical system is actually based on the C. G. S. system. Calculations of an involved nature necessarily make use of the C. G. S. system, and when multiples or sub-multiples are used they are expressed in Greek and Latin prefixes. For example, a million ohms is 10^6 ohms and is expressed as a *meg-ohm.* "Meg" being derived from *mega millian.* Similarly a millionth of an ampere is expressed as a *micro-ampere* or 10^{-6} AMPERE. The various units under the C. G. S. and practical systems are taken up in detail under the respective headings, as *JOULE, ERG, DYNE* and so forth. (See also *Inductance (Unit of); Capacity (Unit of); Electrostatic Units and Electromagnetic Units.*)

C. E. M. F.—The abbreviation for *counter electromotive force* (q.v.).

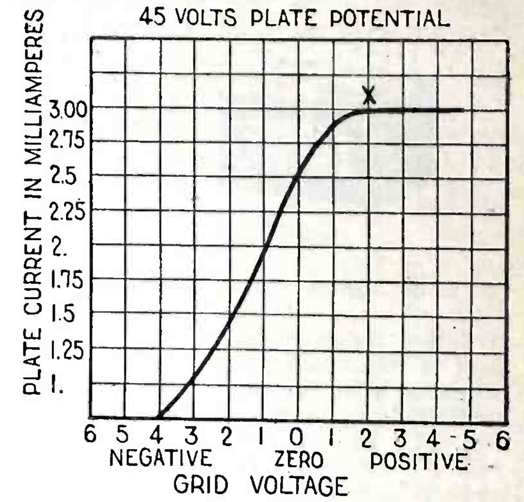
C. G. S. UNIT OF CURRENT—The absolute *electromagnetic unit of current.* It is the current which when passed through a conductor bent into a circle of one centimeter radius will attract or repel a unit magnetic pole placed at its center, with a force of one *dyne* (q.v.).

CERUSITE—A kind of mineral used as a rectifier in some types of *crystal detectors.* It is a carbonate of lead having a whitish-grey color. This mineral is not as good a rectifier as some of the others, but has the advantage of more uniform sensitivity over practically its entire surface. (See *Crystal Detectors.*)

CHALCOPYRITE—A crystal used in a *pericon detector,* which is composed of zincite and chalcopyrite in contact with each other. It is a combination detector suitable for use where it is subject to jarring, since it has nearly uniform characteristics over its entire surface. It works without the aid of an electric battery.

CHARACTERISTICS—A term broadly applied in electricity to refer to any distinguishing feature in electrical apparatus. In radio usage the term is generally applied to *vacuum tubes.* The characteristic of a tube is understood as the relation between the potential (voltage) at the *grid* (q.v.) and the resulting current obtained from the *plate.* (q.v.) It may also occasionally refer to other features of a tube, such as its current requirements or amplifying quality as distinct from the ratio of *grid voltage* to *plate current.* (See *Characteristic Curve, Vacuum Tube Characteristics;* also *Plate Current.*)

CHARACTERISTIC CURVE—A diagram showing graphically in the form of a curved line the relation of changing values. Thus, in the case of a *vacuum tube,* a change in the *grid* voltage produces certain changes in the *plate* current (q.v.) and these changes may be plotted as curves. The temperature of a wire carrying current increases with increase in the *current*



Characteristic chart of vacuum tube grid and plate voltage.

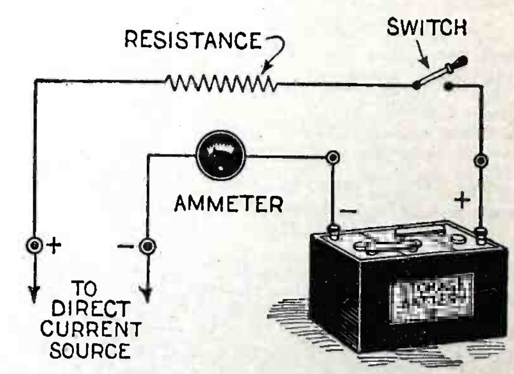
passing through it, and this increase may be shown by a curve. (See *Vacuum Tube Characteristics.*)

CHARGE—The presence of electricity in a body. Is usually defined as an excess or deficit of *electrons* (q.v.) on an insulated body. In the case of a *condenser* (q.v.) after it has accumulated electrical energy it is said to be in a charged condition, or to have an *electro-static charge.* The charge in a *condenser* is measured in *coulombs.* (q.v.) A *storage battery* is said to contain a charge when it has been connected to a source of direct current for a length of time, and the hydrometer test shows the electrolyte at proper specific gravity.

CHARGE, SPACE—See *Vacuum Tubes,* also *Space Charge.*

CHARGED BODY—Any body that has accumulated electrical energy. (See *Charge.*)

CHARGER, STORAGE BATTERY—Any means of controlling the current delivered from a primary source for the purpose of charging *storage batteries* or other *secondary cells.* Chargers are made in many forms and are designed for either direct or alternating current. Direct current chargers consist of certain resistances, with the necessary meters and switches. A simple form of direct current charger is shown in the illustration. In constructing a direct current charger there are several important details that must be



Charging storage battery from direct current source.

taken into consideration. The plates of a storage battery require certain charging rates in amperes, depending on the size and number of the plates. That is to say, the manufacturer specifies that when charging, a certain number of amperes must be passed to the battery from the charging source for a definite number of hours. This figure may be decreased but not increased. As an example, some storage batteries will take a charge of five amperes without injury to the plates, which rate would be ruinous for other batteries. Now the question of obtaining the proper amount of charging current arises. The majority of house lighting systems have a voltage of from 110 to 125 volts. (Reference is now made only to direct current systems, alternating current chargers being taken up later on.) According to *Ohm's Law* (q.v.) the current flowing in a circuit is directly proportional to the *voltage* and inversely proportional to the *resistance.* Voltage is the product of resistance times the current, the resistance in ohms and the current in amperes. Therefore if we desire a current of five amperes from a source of 110 volts, it is necessary to have a resistance of a value in ohms which, when multiplied by the current in amperes,—five in this case—will produce 110. Conversely, we can divide the voltage—110 by the current—5 to obtain the correct resistance. This would indicate a resistance of 22 ohms. There is another factor which enters into the problem however, the back pressure, or Counter Electromotive Force exerted on the charging source by the battery. In the case of a six volt storage battery, this will be six volts. This must be subtracted from the voltage of the charging source to obtain the effective value. Thus, the effective value in this case would be 110 — 6 or 104 volts. Then as explained before, dividing the voltage by the current required, we find that it is 104 ÷ 5 or approximately 21 ohms. Then by placing a resistance of 21 ohms in the circuit, as shown in the illustration, and connecting the battery as indicated, a charge of five amperes can be applied to the battery. The same result can be obtained by placing an ordinary electric lamp in series in place of the resistance. (See *Lamp Bank.*) The *internal resistance* of the battery is very small compared to that of the line resistance, and can be ignored. A point to remember is that the voltage of the charging source must always be higher than that of the storage battery, because, as explained above, the back or *counter electromotive force* of the battery, must be subtracted from the voltage of the charging source to indicate the effective voltage. Thus, if the battery exerts a counter electromotive force of six volts and the charging source is only six volts the counter force would be equal to the charging force and there would be no charging current. When *direct current* is not available and *alternating current* is used to charge the battery, it will be necessary to change it to direct current. For this purpose it is essential that some form of *rectifier* be used. This rectifier may be of a chemical, mechanical or electrical type. These various forms will be taken up under their separate headings. (See *Rectifier, Balkite, Tungar, Rectigon, Electrolytic Rectifier, Tube Rectifier.*)

CHARGING—The act of expending electrical energy to place a charge in or on a battery or body. The term is used generally to indicate the process of impressing electrical energy on the *storage battery* elements for the purpose of making the battery a secondary source of electricty. (See *Charger, Chemical Rectifier* also *Tube Rectifier.*)

CHARGING BOARD—A term used synonymously with *charging panel* to denote an arrangement for controlling the current used for charging *storage batteries.* It generally consists of an insulated panel with various *switches, fuses* and *resistances* thereon to limit the amount of current delivered, and at the same time furnish a ready means of connecting and disconnecting the various circuits connected through it. The fuses act as safety devices and break the circuit when too great a current is delivered. (See *Fuse, Switch, Charger.*)

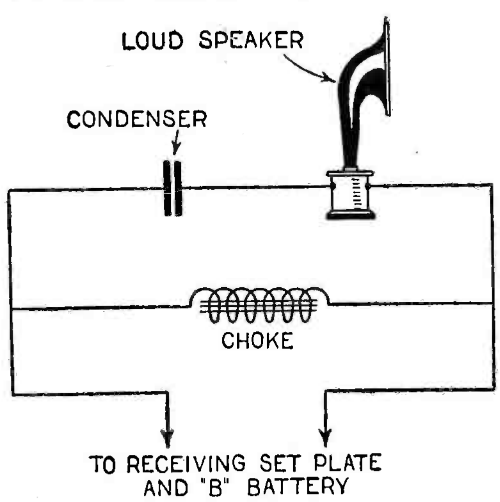
CHEMICAL RECTIFIER—Device for changing alternating current to direct current. (*See Electrolytic Rectifier.*)

CHLORIDE BATTERY A type of storage battery for heavy duty operation. The positive plate is made of lead with a number of holes pierced in it and each filled with a coil of pure lead. This coil is forced into the holes during manufacture and is said to enable the battery to withstand heavy discharge without damage to the plates. (See *Storage Battery.*)

CHLORIDE CELL—A cell (q.v.) which uses in most cases, a positive plate having lead as the active material, the negative plate being made of metallic zinc. A solution of chloride of zinc is used, from which the name is derived. (See *Chloride Battery.*)

CHOKE OR CHOKING—The action of a device in a circuit wherein it tends to choke, or hold back, certain forms of current or certain *frequencies* while permitting others to pass freely, or to oppose fluctuations in the strength of the current passing through it in the circuit.

CHOKE COIL—A coil of wire possessing considerable *self-inductance* and relatively little *resistance.* These coils are used in various ways and for a variety of purposes. When connected in a direct current circuit, and possess-



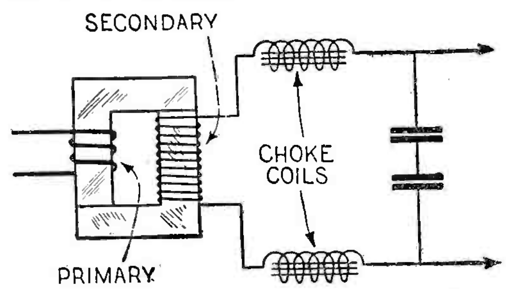
Method of using choke coil in connection with loud speaker.

ing the proper value, they have a tendency to prevent any fluctuations in the current and thus keep the current smooth. An example of its use is with a *loudspeaker.* A *condenser* will permit passage of *high frequency* (*alternating*) *currents* such as we find in radio reception, but will effectively block direct currents. On the other hand a choke coil will pass direct current without offering any appreciable resistance, but will retard the *modulated currents* (q.v.) It will be apparent then that by a proper combination of the two (Choke Coil and Condenser) as in the illustration, the direct currents can be shunted around the loud speaker and thus prevent injury to it, while the necessary modulated currents are allowed to pass through without difficulty. Another use for the Choke is in a circuit carrying alternating currents. In this case the choke will limit the current in the circuit without loss, whereas an ordinary resistance, while it would limit the current, would dissipate a certain amount of energy. Chokes may be made with iron cores of the open or closed type, for *low frequency currents,* or may only have air for the core when used in *high frequency* circuits. The closed core type is the more common form. The formula most commonly used in determining the inductance of a choke coil in *henries* is as follows:

$$L = \frac{1.257 \times \mu \times A \times N^2 \times 10^8}{l}$$

Where L is the inductance in henries.
μ is the permeability. (This varies from about 1000 to 2000 in most cases).
A is the effective area of iron cross section (square centimeters).
N is the number of turns of wire.
l is the length of iron path (in centimeters).

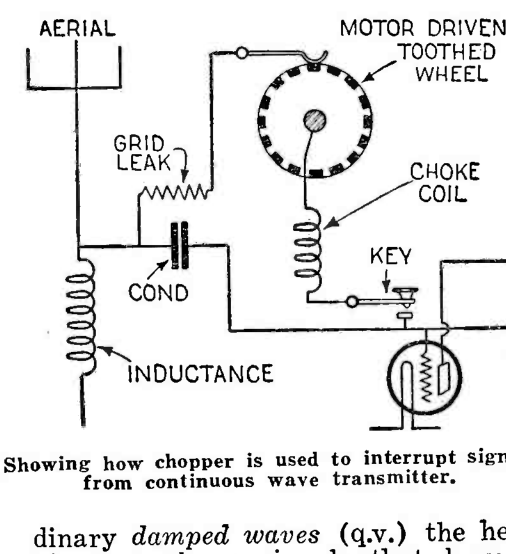
CHOKE, HIGH FREQUENCY — A choke coil of high *self-inductance* (q.v.) used in transmitting circuits to prevent puncture of the secondary



Position of choke coils in transmitting circuit.

windings of the *transformer* (q.v.). When the condensers in a transmitting circuit are charged or discharged, a back pressure is exerted on the windings of the transformer supplying the high voltage. The illustration shows the position of these choke coils in the transmitting circuit. (See *Back Oscillation.*)

CHOPPER—A device used in the aerial circuit of a *continuous wave* (q.v.) transmitter to break up the continuous trains of waves into separate groups and thus permit them to become audible. In the case of reception of ordinary *damped waves* (q.v.) the head phone produces signals that have a frequency of vibration equal to the number of wave trains per second. When the transmitted waves are con-



Showing how chopper is used to interrupt signals from continuous wave transmitter.

tinuous there is obviously no interval, that is, there are no groups of waves and they are therefore inaudible in the usual receiving apparatus. The *chopper* is only necessary when *crystal detectors* are used for reception. (See *Ticker, Beat Reception and Continuous Wave Transmission.*)

CIRCUIT—The path followed by an electric current passing from its source through a wire conductor or series of such *conductors*, and back again to its starting point. A *closed circuit* is one that is continuous and will permit the passage of current. An *open circuit* is one that is not continuous and, being broken or open at some point, will not permit passage of the current. The term is used very commonly, and broadly covers any system for the conducting of electric current from its source, through some electrical instrument or appliance and back to the starting point.

CIRCUIT BREAKER—Generally speaking, any device for automatically breaking or opening a circuit and thus preventing flow of current through the circuit. More specifically, it may be a device similar to a *switch*, used to automatically open the circuit when the current falls below a certain point, or rises above a certain fixed value. Thus an *overload circuit breaker* is an arrangement which will automatically open the circuit if the current becomes too great. This is shown in Fig. 1. It is a simple form and consists of an *electro magnet* which requires a certain force to operate it. When the current in the circuit reaches a certain point, the magnet operates, pulling down the bar "A" against the action of the spring "P," and thus breaking the circuit. As long as the current is not more than that fixed by the requirements of the circuit—the magnet being arranged in accordance with the particular requirements — the current flows, the breaker operating to open the circuit only when more than the desired current is introduced into the circuit. In the illustration we can consider "S1" and "S2" as the source of current, "M" as an electro-magnet in series with the motor "D," and "A-B" a switch, in which "A" has attached to it a piece of soft iron. Now if the current required for the motor is ten amperes, the magnet can be so designed that it will not act on the bar "A" until 15 amperes flow through it. Thus, as long as the current is less than this, the circuit is continuous, but if the current is increased to 15 amperes, the magnet operates and attracts the bar "A," breaking its contact with "B" and thus opening the circuit. In Fig. 2 a simple *underload breaker* is shown. In this case the operation is the reverse of that of the *overload breaker*. Here the bar "A" is held down in contact with "B" by the magnet "M" thus keeping the circuit closed through the motor "D". Now assume that the motor requires ten amperes and the magnet requires the same amount to hold the bar "A" in place against "B". If then the current in the circuit falls below ten amperes, the magnet can no longer hold the bar "A" against the action of the spring "P" and it rises, breaking the contact between "A" and "B" and thus opening the circuit. These circuits are of course only assumed for the purpose of illustrating the theory of circuit breakers. Actually the system is generally much more elaborate. Circuit breakers are used for many purposes—chiefly to prevent any sudden increase or decrease of current in a circuit, and to control the flow of current for charging batteries. (See *Charger-Storage Battery.*)

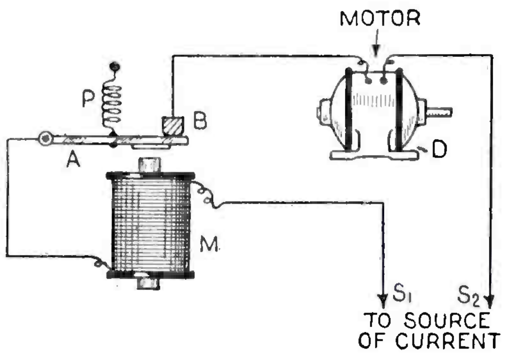


Fig. 1. Overload Circuit Breaker.

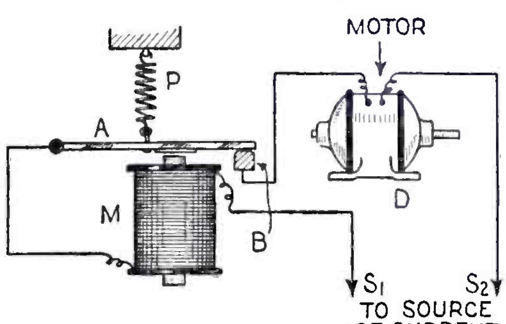
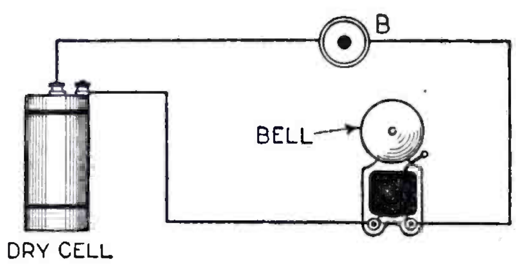


Fig. 2. Underload Circuit Breaker.

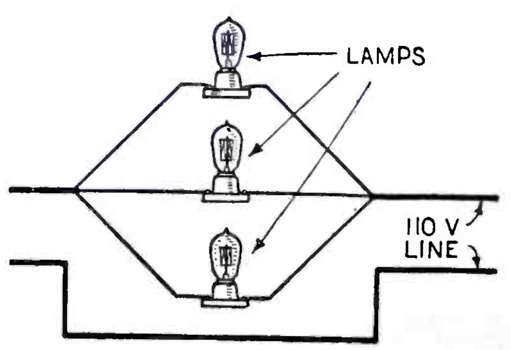
CIRCUIT, BROKEN—A circuit that is not continuous, having been opened either purposely, or due to some defect in the circuit. The term is usually applied where the circuit is opened by the breaking of a wire, or through a faulty contact.

CIRCUIT, OPEN — A circuit which is open and through which current cannot flow, or a circuit which is normally open but which can be closed at will by pressing a key or button. A common example of open circuit is in the case of an electric bell circuit. The illustration shows such a circuit. Normally it is open and current does not flow to the bell, but on pressing the button B, the circuit is closed and current passes to the bell. (See *Circuit*, also *Closed Circuit.*)



Open circuit which can be closed by pressing button "B".

CIRCUITS, PARALLEL — Circuits starting at a common point and ending at a common point. The illustration shows three *parallel circuits*. Actually each one is a part of the whole circuit. (See *Parallel Resistances.*)



Three parallel circuits.

CIRCULAR MIL—The cross-sectional area of conductors (wires) is usually designated in terms of circular mils. A circular mil is the area of a circle having a diameter of one thousandth of an inch. Thus a wire having a diameter of one quarter of an inch is said to have an area of 250 circular mils. (See *Square Mil.*)

CLEAT—A form of porcelain *insulator* used in house wiring. They are generally arranged in two parts, with corresponding grooves in which the wire is held, and are nailed or otherwise fastened to the wall. Cleats are about the cheapest form of insulator and where the voltages used are low, are quite as effective as the more elaborate types. Cleats are much used in radio work, both for insulating lead in wires coming from the aerial, and for insulating the aerial itself.

CLERK-MAXWELL, JAMES—Born at Edinburgh, Scotland, in 1831, and educated at Edinburgh and Cambridge University, he became Professor of Natural Philosophy at Aberdeen, 1856-69, and Professor of Physics and Astronomy at King's College, London, 1860-65. In 1871 he became the first holder of the new chair of experimental physics at Cambridge, where he died, November 15, 1879. Clerk-Maxwell was recognized in his later years as one of the greatest authorities on physics of his time, and his fame has been steadily increasing since his death. Radio owes Clerk-Maxwell a deep debt. Electricity was the chief study of his lifetime, and his first important paper on the theory of *electro-magnetism* was communicated to the Royal Society in 1867. In 1873 he published his "Electricity and Magnetism," a work on the subject which has never been surpassed. In it he formulated his famous *electro-magnetic theory* of light and his theories on electric waves, which developed into the modern system of wireless telegraphy and telephony through the experiments of Hertz.


James Clerk-Maxwell.

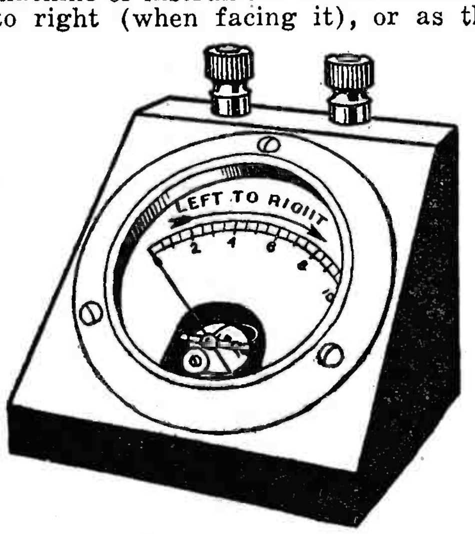
CLIMAX—A high resistance nickel steel alloy, used extensively in *rheostats* (q.v.). It is one of the cheapest and most practical alloys for low-temperature resistance wire. Its chief properties are as follows: Maximum working temperature 540 degrees centigrade, resistance in microhms per cubic centimeter at 20 degrees centigrade, 87.2; temperature coefficient per degree centigrade, .00054, and having a specific gravity of 8.14.

CLIPS—A clamp connector used for various purposes in radio receiving and transmitting circuits. (See *illustration.*) In a receiving set a clip may be used at the end of a flexible wire for the purpose of varying the connection to the various "B" battery taps; clips are very frequently used in

Type of clip in general use.

making the connections to the storage "A" battery, and for many other purposes about the receiving set. One of their principal uses in the transmitter is in connection with the leads to the oscillation transformer. Flexible leads with clips attached come from the other units of the transmitter and are clamped at will along the various turns of the oscillation transformer until the point giving the desired wave length or highest radiation reading is found.

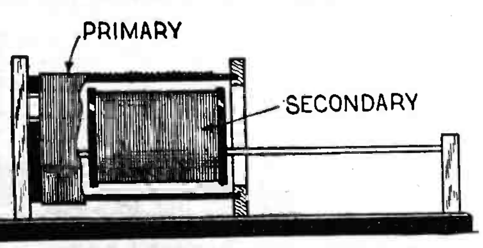
CLOCKWISE—A term used to indicate that the rotating part of an electrical machine or instrument moves from left to right (when facing it), or as the



Indicator needle moves from left to right in clockwise motion.

hands of a clock. In the illustration the needle or pointer of the meter moves in a clock-wise direction. In an electrical measuring instrument this is always true where the zero point is at the left part of the dial. The opposite is known as *counter-clockwise.* When looking at the *armature* of a motor or generator, if the rotating part moves from left to right it is said to have a clock-wise motion.

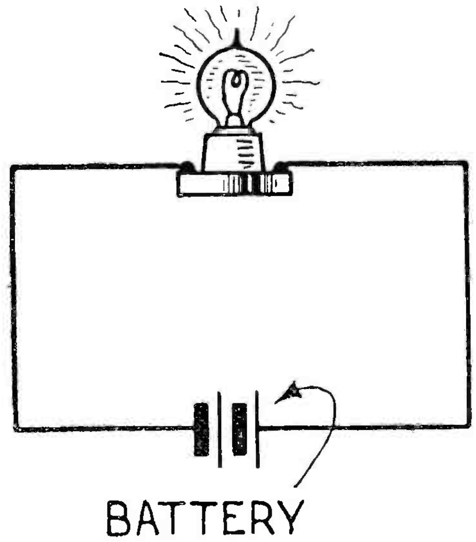
CLOSE COUPLING The arrangement of two coils acting as *primary* and *secondary,* placed close together in such manner that the coupling or electrical relation between them is close. In the



Loose coupler with secondary placed to produce close coupling.

illustration the secondary coil is shown entirely within the primary. In other words the transfer of energy will be large in this case as the coupling is close. If the secondary is withdrawn a certain distance from the primary, the effect is referred to as loosening the coupling, and the coils are then said to be *loose coupled,* the transfer of energy from one to the other being considerably less than in the case of close or *tight coupling.* (See *Coupling.*)

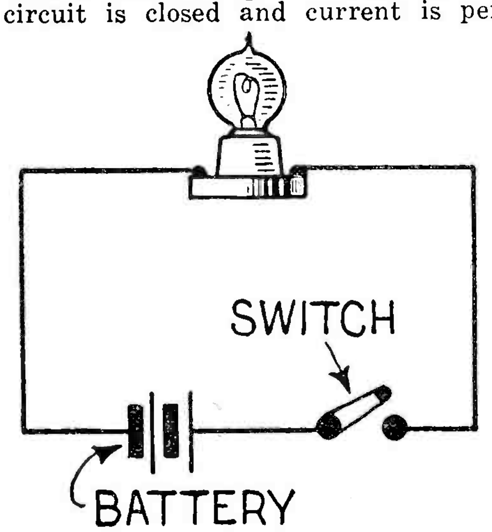
CLOSED CIRCUIT—A circuit which permits the continuous flow of electricity. The illustration shows an or-



-1A-

Circuit closed.

dinary dry cell connected in circuit with a small lamp. In Fig. 1A the circuit is closed and current is per-



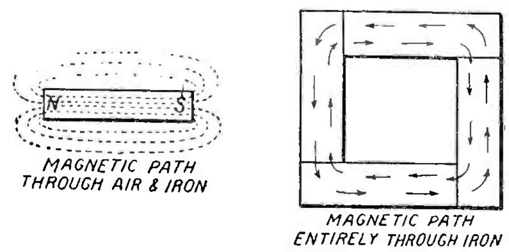
-1B-

Circuit open by means of switch.

mited to flow to the lamp. In Fig. 1B the circuit is open and no current can flow. A closed circuit is therefore an electrical circuit that is continuous. (See *Circuit,* also *Open Circuit.*)

CLOSED CIRCUIT CELL—A cell that can be used in a closed circuit for a considerable length of time without the impairing effects of *polarization* (q.v.) An *open circuit* cell is one that can only be used intermittently, as for example, with an electric bell where the circuit is only closed for a brief period. If an open circuit cell is used in a circuit that remains closed for some time, polarization sets in and ruins the cell in a very short time. An open circuit cell might be used with the *test buzzer* (q.v.) because in this case the circuit is closed intermittently as the key is depressed. (See *Cell.*)

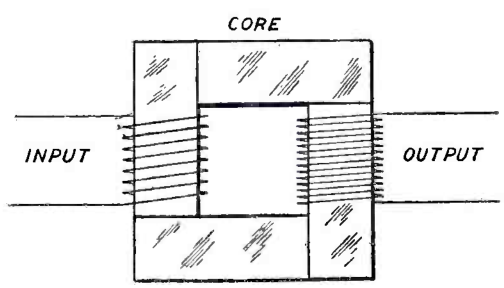
CLOSED CORE—A core (q.v.) used in *transformers, chokes,* etc., which is continuous, forming a *closed magnetic path.* The illustration shows the difference between a closed core and an open core. In the open core type, one end is the north pole, the other the south pole, whereas in the closed core,



Open core above on left, closed on right.

there are obviously no poles. The closed core type is occasionally referred to as a *non-polar* core. (See *Core, Transformer,* also *Choke.*)

CLOSED CORE TRANSFORMER—A *transformer* (q.v.) having a *closed core.* In the illustration the magnetic path, or core, is continuous, being made of strips of uniform size. This form



Closed core transformer.

of core is known as "*laminated.*" An efficient transformer is generally made with a closed core. A transformer may be for a variety of purposes, such as *step-up, step-down, audio frequency* or *radio frequency.* (See *Transformer.*)

C. M.—Abbreviation for circular mil. (q.v.)

Cm.—The abbreviation for *centimeter,* the unit of length in the C. G. S. system (q.v.).

COCKADAY CIRCUIT—A popular radio receiving circuit devised by the American experimenter, Lawrence M.

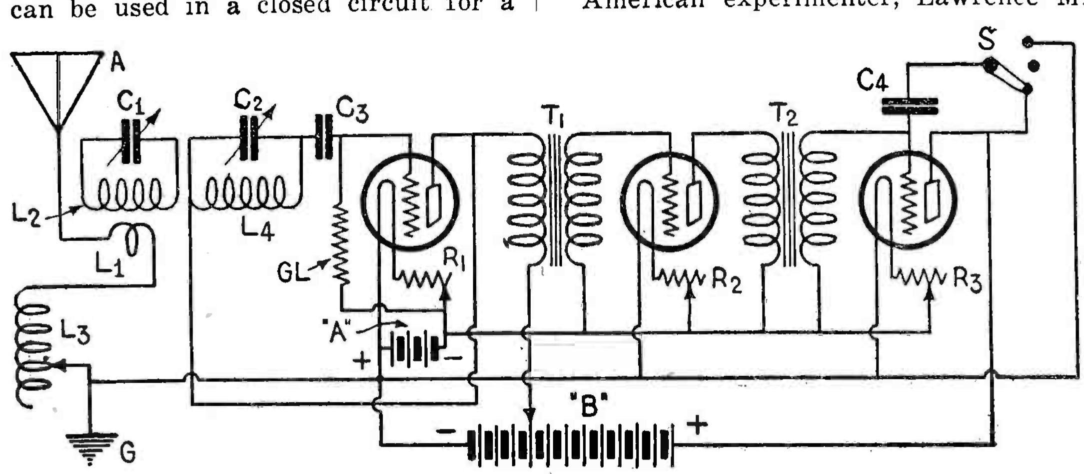


Fig. 1. Original 3 tube Cockaday Circuit.

Cockaday. It includes several radical features not found in the usual systems. Receivers using this circuit are generally made in three, four or five tube types. The chief value of this circuit lies in its extreme selectivity. It is usually referred to as a four circuit receiver, owing to the addition of a sensitizing circuit to the regular three circuit regenerative system. The diagram for the three tube receiver is given in Fig. 1. Here the primary or aerial tuning circuit is seen to have a single turn of wire, L1, wound around another coil L2, which is shunted by a variable condenser C1, thus forming a separate closed, tunable circuit, coupled very loosely with the antenna circuit. The primary, or antenna circuit, has in addition to the single turn, a bank wound coil L3 connected in the ground side of the open circuit and tapped to permit coarse tuning. Thus, the primary is coupled inductively to the separate closed circuit, which in turn is inductively coupled to the grid or secondary circuit containing a coil L4 shunted by the condenser C2, allowing tuning.

The tone of the music is varied by means of the novel arrangement using a condenser C4 connected to a three point switch. When the switch is placed in the center position the condenser is eliminated from the circuit and the wiring is standard. With the switch on the top tap, the grid of the tube is connected to the ground, thus by-passing a portion of the oscillations and giving a smooth soft tone with a certain loss of volume. With the switch arm on the bottom tap, the grid of the last tube is connected to the plate circuit, thus producing a different note due to the added grid-plate capacity. Coil L2 in the grid circuit is tuned by means of C1, which is a variable condenser of .0005 mfd. capacity.

A peculiarity of the circuit is that the length of the antenna has no bearing on the tuning. This is due to the *semi-aperiodic primary* and the fact that the sensitizing or pick-up coil is only one turn of wire, the inductance of which, compared to the whole inductance of the aerial circuit, is so small that any change in the over-all inductance has little, if any, effect.

This circuit, while originally having three tubes, has been arranged in conjunction with a standard *push-pull audio amplifier*, as shown in Fig. 2, making a five tube set with great power and possessing the characteristic of the original circuit with increased amplification. (See *Push-pull, Cockaday Coil* also *Regenerative Receiver.*)

COCKADAY COIL—The coil used in the *Cockaday circuits.* It comprises four windings, i.e. tapped primary, separate closed circuit coil, grid or secondary winding and a single turn looped around the closed circuit coil. (See *Cockaday Circuit.*)

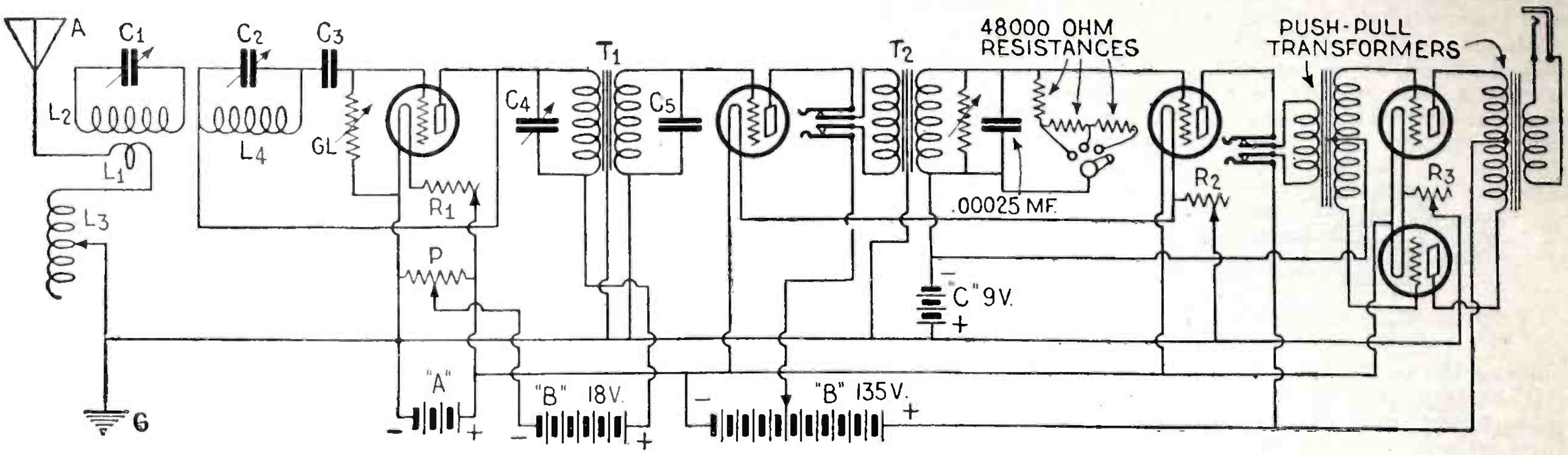


Fig. 2. Cockaday Circuit with push-pull amplifier.

CODE—Telegraph codes consist of characters formed by combinations of dots, dashes and spaces which represent letters, numerals, and punctuation marks. These characters are sent out by the radio operator with the aid of electrical impulses, and by using suitable receiving apparatus the receiving operator hears the incoming signal and is thus able to interpret the various combinations of dots and dashes and reproduce the original message. The Morse Code of characters came into general use in wire telegraphy shortly after the establishment of that means of communication. In this system, which is also called the "American Morse Code," some of the characters are made up with so-called spaces which are part of the group signal, and are necessary in distinguishing those characters. The International Morse code is a modified form of the American Morse code, and no spaces are used in the characters of the International Code. The International Morse Code is used all over the world for radio telegraphy, and for wire telegraphy in almost every country except the United States, Canada and parts of Australia. The American Morse, owing to the fact that there are fewer dashes in the characters, is about

LETTERS	MORSE	CONTINENTAL
A	· —	· —
B	— · · ·	— · · ·
C	· · ·	— · — ·
D	— · ·	— · ·
E	·	·
F	· — ·	· · — ·
G	— — ·	— — ·
H	· · · ·	· · · ·
I	· ·	· ·
J	— · — ·	· — — —
K	— · —	— · —
L	——	· — · ·
M	— —	— —
N	— ·	— ·
O	· ·	— — —
P	· · · · ·	· — — ·
Q	· · — ·	— — · —
R	· · ·	· — ·
S	· · ·	· · ·
T	—	—
U	· · —	· · —
V	· · · —	· · · —
W	· — —	· — —
X	· — · ·	— · · —
Y	· · · ·	— · — —
Z	· · · ·	— — · ·
&	· · · ·	
1	· — — ·	· — — — —
2	· · — · ·	· · — — —
3	· · · — ·	· · · — —
4	· · · · —	· · · · —
5	— — —	· · · · ·
6	· · · · · ·	— · · · ·
7	— — · ·	— — · · ·
8	— · · · ·	— — — · ·
9	— · · —	— — — — ·
0	———	— — — — —
.	· · — — · ·	· · · · · ·
,	· — · —	· — · — · —
:	— · — · ·	— — — · · ·
;	· · · · ·	— · — · — ·
?	— · · — ·	· · — — · ·

Morse and Continental Codes.

5% more rapid than the International Morse. The American Morse and International (Continental) Codes are given herewith.

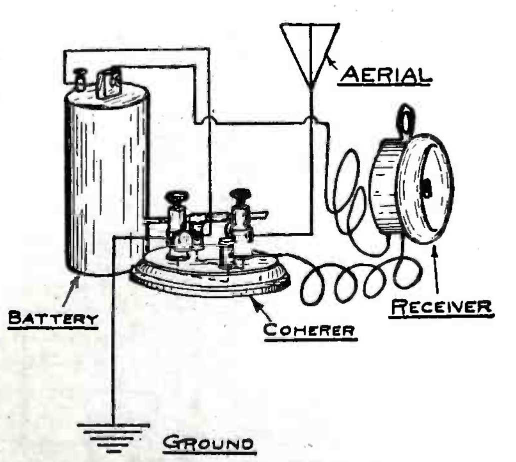
COEFFICIENT—In algebra, a number or multiplier of a *symbol.* Thus in the expression 5Y, the coefficient is 5. In electricity, and in its radio application, it is a number expressing the relation or ratio between quantities, one of the quantities generally being unity (1) as a basis or standard for the coefficients. For example, let us assume a copper wire is carrying an electric current, the *resistance* of the wire at 32 degrees Fahrenheit being one *ohm.* If we consider the resistance of the wire at 32 degrees to be unity, or one, then its resistance at any other temperature will be some number or coefficient times one.

To make this clearer, let us take the ratio of an inch to a foot. An inch is one-twelfth, or approximately .0833, of a foot. Any number of inches multiplied by this fraction will give another number in feet. Therefore we say that the coefficient, or multiplier, of an inch as compared to a foot is .0833. A coefficient is thus any number by which a quantity must be multiplied to give another quantity.

In radio the most common cases of coefficients are the following. The *coefficient of coupling* is the ratio between the *mutual inductance* (q.v.) (between the two coils, *primary* and *secondary*) and the square root of the product of the total *self-inductances* (q.v.) in the two circuits containing the coils. Similarly, the coefficient of amplification is the ratio of the effect produced with an *amplifier* (q.v.) to the effect produced without an amplifier. (See *Mutual Induction Coefficient,* also *Self-induction Coefficient.*)

COHEN, LOUIS, Ph. D.—Born in Russia, Dec. 16, 1876. Educated at Armour Institute of Technology, University of Chicago and Columbia University. Noted for his formulae and tables for the calculation of alternating current problems. He has written a book on the subject. Has evolved many formulas for the measurement of inductance and capacity. Has secured a number of patents on radio apparatus.

COHERER—A device formerly employed for detecting *radio waves.* In its original form it consisted of two metal rods separated by a narrow space in a glass tube and the gap between the rods filled with nickel and silver



Coherer used in radio receiving circuit.

filings. It was found that when the *electromagnetic waves* or signals were passed through the coherer the particles of filings clung together and became *conductors.* Then by using some device such as the tapper hammer of an electric bell to strike the glass tube, again separating the particles after each signal, it was possible to keep the coherer constantly in a state of change between a *conductive* and a *non-conductive* condition, thus making the signals audible. There were many variations of this type of *detector,* which, however, is now obsolete. (See *Marconi Coherer.*)

COIL—A term having very broad application in electricity and radio. It may be used to designate any arrangement of a number of turns of wire, usually copper, and used for almost any purpose in the production of electric and magnetic effects or phenomena. The most common significance of a "coil" in radio is in reference to a number of turns of insulated wire wound on various forms and used for *tuning* (q.v.). The term *inductance coil* is generally used, although actually, any coil of wire will have inductance. Coils come in countless numbers and variety for many purposes. A coil may be used not alone for tuning—that is to adjust a receiver or transmitter to resonance with incoming or outgoing signals; it may be used to connect two circuits, in which case it is known as a *coupling coil;* it may be used with a *core* (q.v.) of iron wire, or laminated pieces, as a *choke coil* (q.v.) or it may be used in connection with *high frequency* apparatus, such as used by physicians. Coils are generally referred to by individual names indicating their construction or use. (See *Inductance, Tuning Coil, Vario-coupler, Choke Coil, Honey Comb Coil, Pancake Coil, Spider Web Coil, Lorenz Coil, Duo Lateral Coils.*)

COIL ANTENNA—Or Loop Aerial. An antenna (aerial) constructed by winding the wire around a square form. The coil (or loop) antenna, because of its comparatively small size, is often mounted on a frame work which may be rotated. If one end of the coil is pointed toward the broadcasting station, the antenna (aerial) will pick up its signals with maximum intensity, but if the coil is rotated from that position the signals from that station grow weaker, until when the plane of the loop is at right angles with the intercepted signals no sound will be obtained. It is a part of the radio compass used at sea. (See *Loop-Aerial.*)

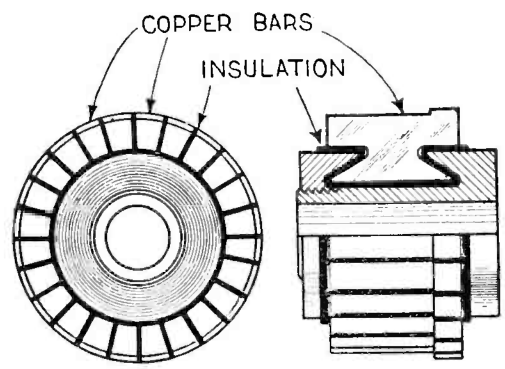
COLLECTOR RINGS—Insulated metal rings attached to the *armature* (q.v.) of an *alternator* (generator of alternating current) in such fashion that the alternating currents can be collected and communicated to the *brushes* without change, these rings are used to collect alternating current from that type of generator and brushes are used to collect direct current from a direct current generator.

COLLODION—A solution used by surgeons to cover slight abrasions or wounds, forming a protective coating similar to skin. It has been adapted to radio use as an insulating coating and is used as a binder on coils of various forms. It has been found more efficient than shellac for this purpose. A solution of pyroxylin or soluble guncotton in ether, with a certain amount of alcohol, depending on the purpose for which intended. When used as a coating for coils it serves as an insulator and also to hold the coils in place, but it should be sparingly applied.

COMBINATION DETECTOR—A detector composed of two different crystals in contact, instead of one crystal with a fine wire to search out the sensitive spots. Some combination detectors are composed of silicon and antimony; zincite and bornite; lenzite and cerusite, and zincite and chalcopyrite. These detectors all function without a battery and are simple to operate.

COMMON CONNECTIONS—A term often applied to a connection that joins several points. For example, in most radio receivers the binding posts for battery connections are arranged so that the "B—" and the "A+" or "A—" are connected to the same point. That is to say the post is a common connection for these leads. The term is also applied to a battery, as a *"B" battery,* which is used for both *detector* and *amplifier.* It is then known as a common "B" battery. The other method would, of course, be to use separate batteries for the detector and amplifier.

COMMUTATOR—In general electrical use, a device for reversing the direction of electric currents in a circuit. A *commutator* as used with a *generator* usually consists of a number of pieces called *segments,* mounted on a circular form but carefully insulated from each other. The illustration shows a com-



Front and side view of Commutator.

mon form. In the case of an ordinary motor, the commutator is employed to distribute the current to the windings and in a direct current generator it serves to furnish a direct current to the brushes although the current collected from the windings of the *armature* is alternating.

COMPASS, RADIO — See *Direction Finder, Goniometer,* also *Bellin-Tosi Direction Finder.*

COMPONENT—A part of the whole. In mechanics it is one of the parts of a stress or strain (mechanical force). In electricity, *component currents* are the several currents into which a single current may be assumed to be separated, so that if assumed to be acting together they would produce the equivalent effect of the actual current. Thus also, component *E. M. F.'s (electromotive forces)* are understood as the several components into which any electro motive force may be divided. *Impedance* (q.v.) is said to consist of two components, the actual resistance and the apparent resistance present in the opposition offered to the flow of current termed the *reactance* (q.v.) by a circuit. For instance, the total current in the plate circuit of a vacuum tube responding to high *frequency grid voltages* may be considered as made up of two components, viz., a steady or constant current and a high frequency component superimposed on it.

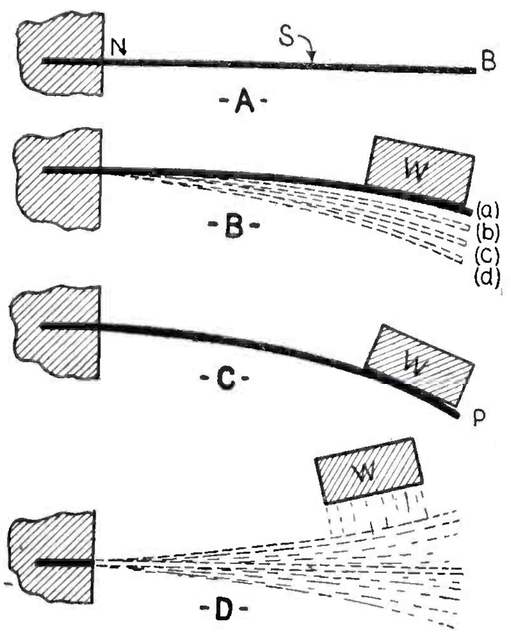
COMPRESSED AIR CONDENSER—A condenser which uses compressed air as the *dielectric* or insulating material between the plates. This type of condenser is used chiefly in transmitting circuits. (See *Condenser.*)

COMPOUND MAGNETS—A combination of several *permanent magnets.* (See *Magnets, Compound.*)

COMPOUND WOUND—A *dynamo* or *motor field magnet* wound with two *field windings,* one of which is connected in series, the other in parallel with the *armature* (q.v.).

CONDENSER—In electricity or radio practice a *condenser* consists of two or more conducting surfaces placed in relation to each other and separated by an insulating medium such as air, impregnated paper, mica, etc. The conducting surfaces are generally referred to as *plates* or *electrodes* (q.v.) and the insulating material is known as the *dielectric* (q.v.). Condensers are used in radio for a variety of purposes, their broad use being to allow tuning. In action, a condenser permits charges of electricity known as *electrostatic charges* (q.v.) to be stored up and released periodically, according to the frequency desired. They may also be used to exclude certain types of energy. (See *Condenser, By Pass,* also *Filter.*) The action of a condenser may be compared to that of a spring when placed under a mechanical strain. In the illustration Fig. 1A a flat spring S is shown in a normal position, NB. In 1B a weight W is placed on the surface of the spring. This weight will force the spring down from its normal position to one of the positions (a), (b), (c) or (d), according to the force exerted and the strength of the spring. If a heavier weight is then placed on the spring it will depress still further until we can imagine a point P in Fig. 1C at which the elasticity of the spring is used up and the opposition is such that it will no longer depress and comes to rest. When the weight is removed the spring will fly back into normal position, Fig. 1D, and in doing so will vibrate back and forth a number of times, thus producing, or rather, returning the energy that was stored in it during the moment of stress.

Considered as analagous to a *condenser,* in the above case the weight can be likened to the electrical charge applied to the condenser, the *resistance* of the spring may be considered somewhat similar to the *capacity* of the



Spring analogy of a condenser.

condenser, or the power returned on release of the spring may be regarded as the electrical power released by the condenser when the charging force is removed. The capacity of the condenser then will be seen as the ability to store up energy placed in it.

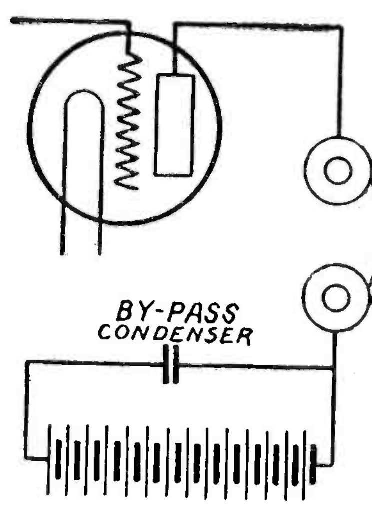
In the case of the spring, if too great a force is exerted, it may break down or as would actually happen, the elasticity would be lost. The same applies in the case of a condenser. If the charging force is too great, it may exceed the dielectric strength of the condenser and result in puncturing the insulating material between the plates. (See *Breaking Down of Dielectric.*) The energy obtainable from a charged condenser will be equal to the charge placed in it providing there is no leakage or other loss. In a well-designed condenser the leakage will be so negligible that it need not be taken into consideration.

The relation between the charge in a *condenser,* the *voltage* applied and the *capacity of the condenser* is expressed as $Q = C \times E$, where Q is the quantity of the charge in *coulombs,* E the potential in *volts* and C the capacity in *farads.* (See *Capacity, Condenser, Variable; Condenser Fixed; Condenser Transmitting,* also *Condenser Curves.*)

CONDENSER, AIR—See *Air Condenser.*

CONDENSER, ANTENNA—See *Aerial Tuning Condenser.*

CONDENSER, BY-PASS—A condenser, usually of the fixed (q.v.) type arranged in a circuit in such manner that currents of a certain frequency will pass freely around any obstruct-



By-pass condenser across "B" battery.

ing object, as, for instance, a high resistance element necessary to the circuit. An example of the use of a condenser in this manner is shown in the case of a "B" battery where the battery has a high internal resistance. A fixed condenser is placed across the terminals of the battery without injury to it and offers a path of low resistance for the high frequency radio currents.

CONDENSER CURVES—Curves showing the relation of variations in wavelength, frequency, and capacity with

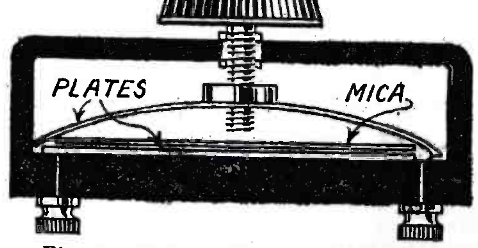


Fig. 1. Compression type condenser.

rotation of the dial of a variable condenser. Three types of condensers are shown here, the *compression,* Fig. 1, the *straight line capacity,* Fig. 2, and the *square law,* Fig. 3. In Fig. 1A is shown the relation of capacity and wavelength changes when the dial of a sample compression condenser was rotated. The condenser was shunted

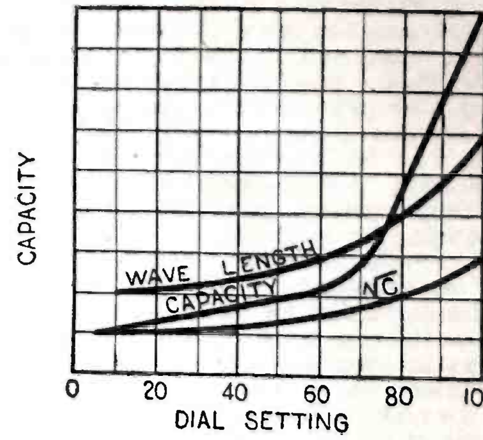


Fig. 1A. Curve for compression type condenser.

across a fixed coil. It will appear that the increase in capacity is gradual at the lower part of the range but increases very rapidly at the upper

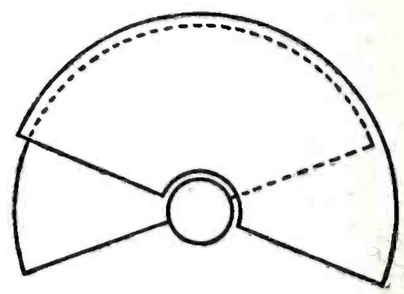


Fig. 2. Straight line condenser.

ranges. This is due mainly to the relation of the curvature of the upper plate to the lower plate as will be seen from the illustration, Fig. 1. These

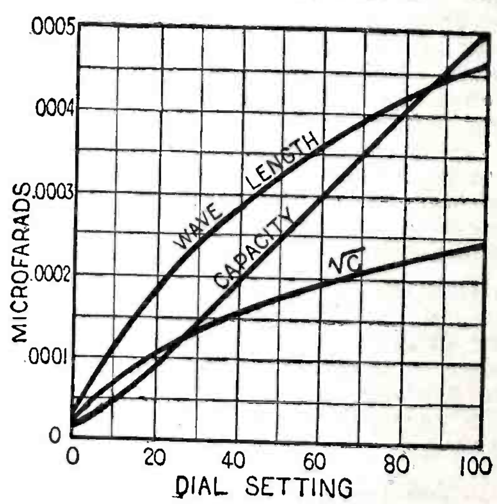


Fig. 2A. Curve for straight line condenser.

condensers are very satisfactory on about the lower two-thirds of their range, but through the remainder of their range a very slight adjustment of the knob causes an extremely large change in capacity, making them very difficult to handle near their maximum capacity. Fig. 2 shows the shape of the variable plates in the straight line capacity condenser and Fig. 2A illustrates the relation of wave-length and capacity changes with rotation of the dial. Here the capacity depends upon the overlapping area and is therefore proportional to the angle of rotation of the movable plates. The capacity curve appears as a practically straight line running diagonally across the chart. The wave-length, however, changes rapidly at the lower range and very gradually at the upper range as indicated by the wave-length curve. Fig.

3 shows the shape and disposition of rotor and stator plates of a condenser so designed as to read directly in wave-length from the settings of the dial.

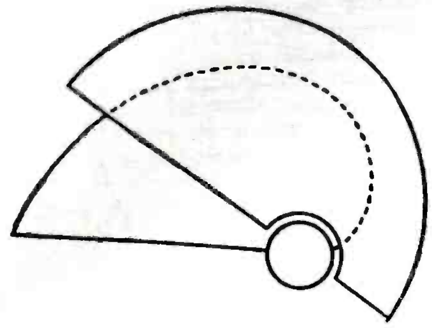


Fig. 3. Square law condenser.

This is known as a square law condenser, and the relational curves are shown in Fig. 3A. Here we find the wave-length curve a straight line and

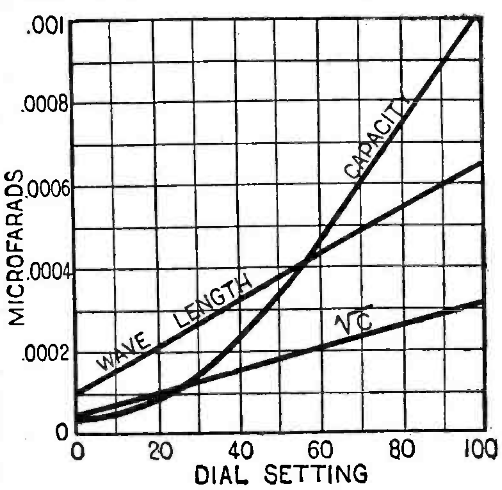


Fig. 3A. Curve for square law condenser.

directly proportional to the angle through which the dial is turned. The line indicating the square root of the capacity $\sqrt{C}$ is a straight line, and as the wavelength is the product of the square root of the capacity multiplied by a constant (varying with the individual condenser) the wavelength curve must also be a straight line.

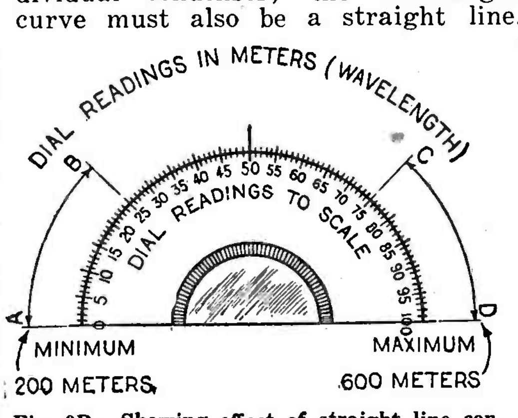
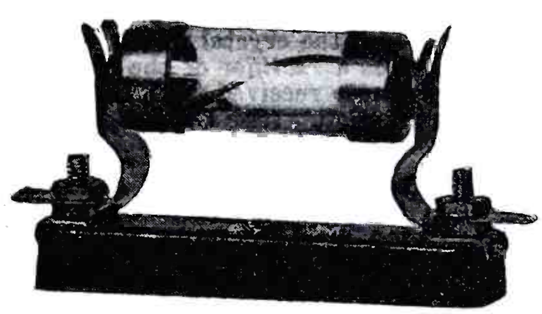


Fig. 3B. Showing effect of straight line condenser on dial reading.

Such condensers are much used in wave meters (q.v.). Condensers are also made so that the frequency curve is a nearly straight line, varying more or less directly as the angle of rotation of the plates. Fig. 3B illustrates the result when an ordinary straight line capacity condenser is arranged with a dial calibrated directly in meters. It appears that the readings are bunched at the lower range (A to B) and spread out at the upper ranges (C to D). The reason for this can readily be seen by glancing at the curve Fig. 2A.

CONDENSER, FIXED—A *condenser* which has a fixed or constant capacity, allowing no variation of the value. (See *Condenser*, also *Condenser, By-Pass*.)

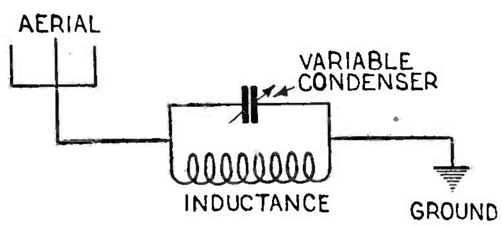
CONDENSER, GRID—A condenser, generally of low capacity, of the fixed or variable type, used in series with the grid of the *detector tube* to prevent excessive charges from affecting the *grid*. These condensers generally have a capacity between .00025 and .0005



Grid leak and condenser.

micro farads. Due to the blocking action of these condensers, a high resistance, known as a *grid leak* (q.v.) is placed across the condenser or from the grid to filament, thus allowing the accumulated charges to leak off the grid of the tube in time for the grid to be free for the succeeding electric charge. The grid leak may be considered as a valve controlling the amount of energy that the detector can efficiently take care of without overload. (See *Grid Leak*.)

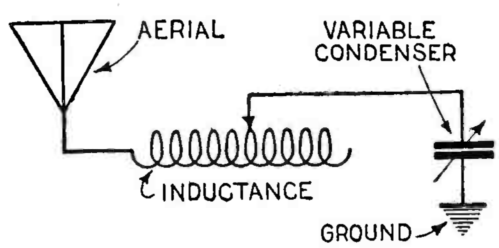
CONDENSER, IN PARALLEL—A condenser arranged in a circuit in such manner that the current is divided between it and the other condenser or coil with which it is connected. The



Coil and condenser in parallel.

illustration shows a *variable condenser* connected in parallel with a coil, both placed in series between aerial and ground and forming a tuned primary or aerial circuit. (See *Parallel Connections*.)

CONDENSER, IN SERIES—A condenser connected in a circuit with other condensers or coils in such manner as to form a continuous path, allowing the current to pass through each unit with-



Coil and condenser in series.

out dividing. The illustration shows a condenser connected in series with a *tuning coil*, aerial and ground, thus forming a tuned primary or aerial circuit. (See *Condenser, in Parallel*, also *Series Connections*.)

CONDENSER, MICA—A condenser, usually of the fixed type, employing sheets of mica as the dielectric or insulating material between the plates. The condensers of small capacity used in receiving circuits are generally made with mica as a dielectric, but owing to its cost and thickness it is seldom used in low-power, high-capacity condensers. Mica is also used in condensers for high-power work such as transmitting, when the capacity is low. (See *Condenser*.)

CONDENSER, PHONE—A fixed condenser of comparatively low capacity used across the *telephone receivers* to allow a by-pass for a certain portion of the currents and thus prevent undue strain on the phones. (See *Condenser, By-Pass*.)

CONDENSER, TRANSMITTING—See *Condenser, Mica*.

CONDENSER, VARIABLE—Any condenser so arranged as to allow variation of its capacity. This may be accomplished in many ways, the usual method being to have the plates divided so that one series is movable with respect to the others, the capacity changing with the rotation of the variable plates. (See *Condenser*.)

CONDUCTANCE — Sometimes called the conductivity. The quality of a given conductor in virtue of which it facilitates the flow of an electric current. A *conductor* (q.v.) is a body having large *conductance* and an *insulator* (q.v.) is one having negligible conductance. *Conductance* is thus the opposite of *resistance*. The unit of conductance is the *mho*, the reciprocal of *ohm*. The symbol is obviously derived from ohm, reversed. It is the conductance of a column of mercury 106.3 cm. (centimeters) long, 1 square mm. (milimeter) in cross-sectional area and of a weight of 14.4521 grams.

CONDUCTIVE COUPLING—The association of one circuit with another by means of inductances (coils) mutual to both circuits.

CONDUCTIVITY, SPECIFIC—The reciprocal of Specific Resistance; being a standard of reference for comparing the conductances of different substances. (See *Specific Resistance, Conductance*.)

CONDUCTOR—Any substance that offers small *resistance* to the passage of electric currents may be termed a *conductor*. This term is the opposite of *insulator*, but there is actually no line of demarcation between the two, since any insulator will permit the passage of current when sufficiently high voltages are used. For all practical purposes, however, a conductor is considered as material that presents little difficulty to the passage of current. The most common conductor is copper, usually in the form of wire. An idea of the relative conductivity (power of carrying electric current possessed by various substances, pure copper being taken as standard) of various substances can be gained from the table following. The materials on the left are comparatively good conductors given in the order of their conductivity, while those on the right are poor conductors and generally used for resistances. (Note: A *resistance* is used to retard the flow of electricity without necessarily stopping it entirely, whereas an insulator is used to stop the passage of current.)

Silver	
Copper	
Brass	German Silver
Gold	Platinum Silver
Aluminum	Manganin
Zinc	Mercury
Platinum	Graphite or carbon
Iron	
Nickel	
Tin	

There are, of course, many other substances that can be classed as good conductors, or as poor conductors, but the above are more generally known and used. It is a peculiar fact that while good conductors become less conductive as their temperature is raised, insulators lose a certain amount of their insulating properties as their temperature is raised. As too great current in a conductor will cause heat, and as explained above, cause lessening of conducting ability, it will be obvious that for the fullest efficiency a conductor will necessarily be arranged to carry the required current without undue heating. It is understood also that conductors in any part of a radio circuit should be carefully gauged as to size and the effective cross-section of the conductor determined, in order to offset the losses due to heating. It must not be assumed from the foregoing that the larger the wire the greater the efficiency—in fact a large wire is often less satisfactory than a small one in high frequency circuits.

When the conductor is to carry direct current the only consideration is to have the wire large enough to prevent heat losses and at the same time not be too bulky. Where the conductor is to carry *high-frequency* (q.v.) currents there are other factors to consider. High frequency currents are said to travel only on the outside of the wire (see *Skin Effect*) and therefore it is possible to use very fine wire for this purpose when the very low current values obtaining in reception are in question. A phenomenon that must be given attention, however, is that of *distributed capacity* (q.v.). (For more complete explanation of this subject see *Low-loss Coils*. See also *Bus bar*.)

CONNECTING UP or HOOKING UP—These general terms are used in radio to refer to the process of wiring a receiver or any particular part of a receiver or other circuit.

CONSTANT—A quantity or magnitude, which does not vary, derived from actual experiment, which is included as a factor in most formulas for the purpose of bringing theoretical calculations into agreement with experience. Constants are much used in radio calculations. As an illustration, different dielectric or insulating materials used in a condenser have different constants which must be taken into consideration when calculating the capacity of the *condenser*. Thus, as a dielectric, air at ordinary pressure is taken as the standard, the constant being stated as 1. Flint glass has a high dielectric value, its constant being stated as 10.10, other materials varying according to their comparison with air as a standard. (See *Dielectric*.)

CONSTANT CURRENT—An unvarying *current*. The term "constant" is applied to *voltage* when it is steady and unchanging, to *resistance* when it is fixed and unvarying, or to almost any value that does not change.

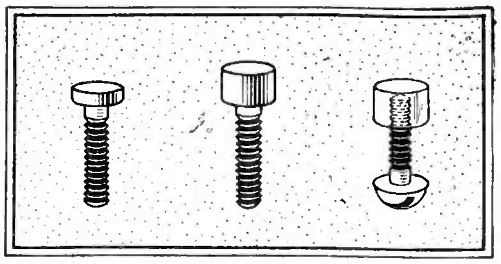
CONSUMPTION, CURRENT — The term usually employed to denote the current required or consumed by any part of an electrical circuit or by the circuit itself. A resistance in a circuit consumes a certain amount of energy because it dissipates it as heat energy. A filament in the case of a vacuum tube, requires a certain amount of current to heat it to brilliancy. If the filament thus requires one-quarter of an ampere we say its current consumption is one-quarter ampere. (See *Plate Consumption*.)

CONSUMPTION, PLATE—The current required to energize the plate of a vacuum tube. (See *Plate Consumption*.)

CONTACT BREAKER—A contrivance for quickly and automatically making or breaking an electrical circuit normally existing between two contacts. (See *Circuit Breaker*.)

CONTACT DETECTOR—A form of crystal detector in which a small wire, or "catwhisker," as it is called, makes contact with the crystal in the detector and acts as a *rectifier* of the *high frequency waves* received from the broadcasting station. (See *Crystal Detector—Theory of Operation*.)

CONTACT POINTS, or SWITCH POINTS—Generally refers to a small flat-headed machine screw used as a contact point for a *switch*. The illustration shows the types mostly used.



Various contact points.

Leads from various points of a tapped coil may be connected to the several contacts in order to permit variation of the *inductance*. A "contact point" may also mean any point in an electrical circuit at which contact is made to close the circuit.

CONTACT RECTIFIER—See *Contact Detector*.

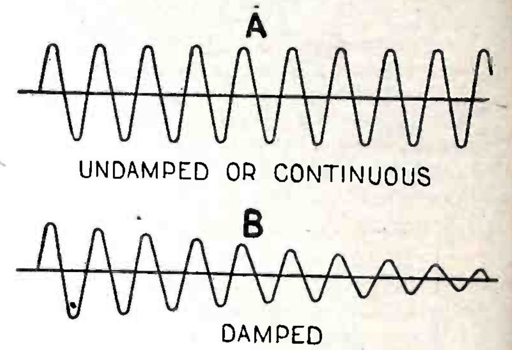
CONTACT RESISTANCE—When two connecting surfaces in a circuit carrying electrical energy do not make absolute or perfect contact, a certain amount of *resistance* (q.v.) results. In any part of a radio circuit where two wires or *conductors* are joined to form a circuit, it is essential that they make a positive contact. The wires used for connections in a radio receiver are generally soldered or fastened tightly by nuts or bolts, or machine screws in order to form a good contact. If this is not done, energy may be wasted, due to the resistance at the point of contact.

CONTINUOUS OSCILLATIONS—Each oscillation or vibration being of the same amplitude as the preceding one. (See *Sine wave*.)

C. W.—Abbreviation for continuous wave (q.v.).

CONTINUOUS DIRECT CURRENT—A *direct current* which flows steadily without interruption or reversal. The current supplied from a battery for radio use is continuous direct current, while that portion of the *high frequency alternating current* which is rectified by a *vacuum tube* detector is called *pulsating direct current*, as there is an interval of time between the rectified half of each incoming wave, due to the other half not being rectified. (See *Current, Pulsating Direct, Pulsating Current*, also *Rectification*.)

CONTINUOUS WAVES—Also called *Undamped* or *Sustained waves* and usually referred to as *C. W. Electromagnetic waves*, the separate oscillations (each vibration) of which are of constant or unvarying amplitude. In Fig. A a series of *oscillations* (q.v.) are shown. It will appear that one oscillation or *cycle* is of the same amplitude as the preceding one—the amplitude (q.v.) being considered as the height of the wave above the straight line representing time or its depth below that line. Each loop above the line or below it represents an *alteration* (q.v.) (the increase in current to maximum and back to minimum in either direction)—the loops above the line being considered as *positive alternations* and those below the line as *negative alternations*. Now it is evident from the sketch that each succeeding alternation has the same strength (amplitude) as that preceding it, and the same is true of the complete cycle, consisting of one alternation in each direction. Thus the waves are continu-



Series of undamped and damped waves.

ous, or constant, as far as amplitude is concerned. Now in Fig. B the amplitude is not constant—it decreases with each succeeding alternation and hence with each succeeding cycle (two alternations). After a comparatively few oscillations the current has decreased to zero, that is, the oscillations have died out completely. In this case the percentage of decrease in amplitude from one cycle to another is known as *decrement* or *damping*. Thus continuous waves may be considered as waves in which, with any train or group of oscillations, each succeeding oscillation has the same amplitude as that preceding it.

CONTINUOUS WAVES—KEY MODULATED—Continuous waves (q.v.) which have been broken into dots and dashes of the telegraphic code by means of a *telegraphic key*, these signals being made audible at the receiving end by the use of an oscillating receiver.

CONTINUOUS WAVES—MODULATED AT AUDIO FREQUENCY—The process of variation of the frequency (vibration) of waves radiated by a broadcasting station in accordance with the sound waves is known as modulation. Frequencies from 10,000 down to about 32 are audible to the human ear and are known as audio frequencies. Hence continuous waves which are modulated at *audio frequencies* are waves which have been modulated (varied) by having the voice or music impressed on the *microphone* at the broadcasting station, which in turn causes the strength of the radiated electric wave to vary so as to correspond electrically to the sound vibrations at the microphone.

CONTINUOUS WAVE SIGNALS—See *Continuous Waves*.

CONTINUOUS WAVE TRANSMISSION—System of radio telegraphy using waves as described under "Continuous Waves."

CONVECTION CURRENTS—When a hot and a cold body are separated by a fluid which is free to circulate, heat is transferred from the hot to the cold body by currents of the fluid itself flowing from one to the other; similarly, all parts of a fluid which is being heated quickly come to approximately the same temperature. This transfer of heat by currents of the fluid itself is called "convection." In electricity "Convection Currents" are currents arising from the motion of charged particles thrown off in electrified streams, i.e., the flowing of charged air particles in streams from the pointed end of a highly electrified conductor, sometimes called "electric wind."

CONVENTIONAL—This term is much used in radio to denote a form established by custom. A conventional circuit for some particular purpose is understood as a circuit which has been generally used and which is generally considered as standard. Broadly, the most common form or use of anything. The conventional method of amplifying signals of *audio frequency* is by means of *audio frequency transformers*. Any other means is unconventional, although it may produce similar results.

CONVERSION FACTORS—A numerical factor which gives relation between the magnitude of a quantity expressed in terms of one system of units, and the same quantity expressed in terms of any other system of units. For example, the yard is regarded in the United States as 3600/3937 meter (a meter is approximately 39.37 inches). We say, therefore, that the conversion factor between the yard and the meter is 3600/3937 because any number of yards multiplied by this figure or factor will give the result in meters. (See *Capacity Conversion Factors.*)

CONVERTER—A term applied generally to any mechanical, electrical or electro-chemical device which will convert or change one form of energy to another. More specifically in electricity the term is used in reference to (1) a dynamotor designed with two *armatures*, mounted on one shaft, one being a motor armature driven by the original current, the other armature generates new current; this is also called a "motor-dynamo" and it can transform continuous (direct) current to higher or lower voltages, or, (2) a rotary electrical device used to change direct to alternating current or vice versa. (See *Rotary Converter.*)

COORDINATES—A thing of the same rank with another thing may be termed a coordinate. For example, lines by means of which the position of any point as of a curve may be defined with respect to certain fixed lines. In the illustration Fig. 1 lines known as axes

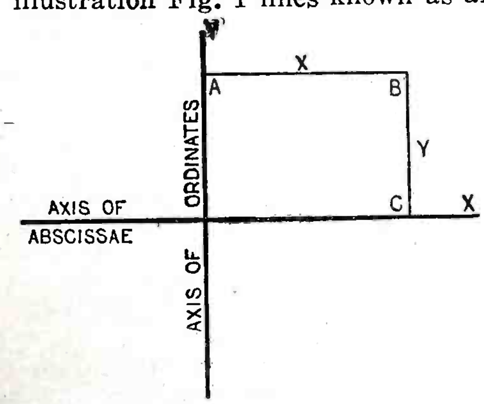


Fig. 1. Axis of coordinates.

of coordinates are shown. Such a system as this will be the basis for curves (q.v.) showing the relation between varying values. If we assume the horizontal line X as the axis of abscissas, all distances measured parallel to this line will be known as abscissas; distances measured parallel to the vertical line Y being referred to as ordinates. The line A-B is parallel to the axis of abscissas X and is therefore an abscissa. The line B-C is parallel to the axis of ordinates and is referred to as an ordinate. Now if we place a number of lines parallel to each axis (ordinates and abscissas) and assign to each of them a certain value, such as amperes, to each abscissa, and volts to each ordinate, a line can be drawn through a

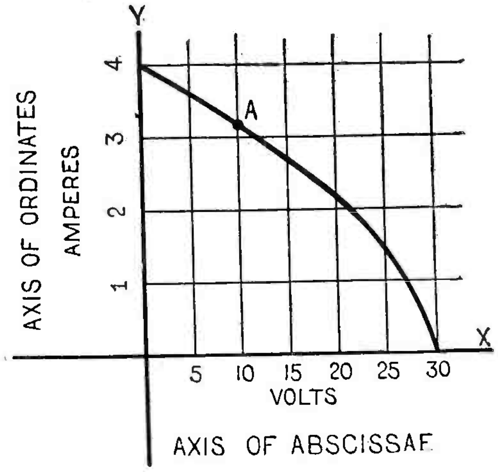


Fig. 2. Curve showing assumed value of current in amperes under assumed voltages.

number of points to represent the various values of each quantity as related to the other. Thus, in Fig. 2 we have a purely hypothetical curve representing the assumed value of current in amperes under assumed voltages. In the example, the curve at point A shows approximately three amperes under a pressure of ten volts. This imaginary curve is, of course, shown merely for the purpose of illustrating the meaning of coordinates, ordinates, abscissa, etc. (See *Abscissa, Characteristic curve,* also *Graph.*)

COPPER PYRITES—Sometimes referred to as *Chalcopyrite*. It is used in radio reception as one of the elements of a *crystal rectifier* (detector) generally in conjunction with zincite or tellurium.

COPPER SULPHATE—A salt of copper. Also known as blue vitriol or copperas. A copper sulphate solution is sometimes used as a preservative for wooden aerial masts. It is used in certain forms of primary cells (devices for transforming chemical action into electric current) and also produces sulphuric acid when subjected to *electrolysis* (q.v.).

CORD, PHONE—The cord or flexible wire used to connect a *headset* (phone) or *loudspeaker* to the terminals of a receiver. Phone cord is usually copper tinsel wrapped around a cotton cord, the whole covered by braided silk or cotton threads. It cannot be used to carry high currents, but is efficient for the comparatively low currents flowing through the phone circuit of a radio receiver. Some phone cords are also formed of a number of fine copper wires covered with a suitable insulating material.

CORE—The central portion of a piece of certain electrical apparatus. Thus the center of a coil will be the *core*, irrespective of its nature, whether air or iron. The core of a *choke coil* (q.v.) is usually made of a bundle of soft iron wires or strips of iron. The core of the closed type is called a *laminated core*, being made up of laminations or layers of the core metal. (See *Choke or Choking Transformer, Closed Core.*)

CORE LOSSES—The losses due to the *stray currents* (q.v.) set up in an iron core while under the stress (strain) of a *magnetic field* (q.v.). Also losses due to *hysteresis* and *eddy-currents*. (See *Magnetic flux, Eddy current,* also *Hysteresis.*)

CORE TRANSFORMER (Iron)—A transformer having the wire wound over an *iron core*, the iron forming a path for the *magnetic lines of force*, as distinguished from a *transformer* in which there is no iron core—called *air core*. (See *Transformer.*)

CORONA—The Latin word meaning crown, originally applied to the crown shaped lights occurring in the *aurora borealis*. In electrical parlance it refers to the luminous discharge which occurs along high tension transmission lines or the aerial wires of a high power radio transmitting station. (See *Brush Discharge;* also *Corona Loss.*)

CORONA LOSS—The energy loss due to corona discharge. (See *Corona;* also *Brush Discharge.*)

CORRECTION FACTORS—A formula for the measurement of certain values is generally made by using certain conditions or types of apparatus as a standard. For example a formula for calculating the inductance of a coil is made by using a particular type and shape of coil as the standard. Therefore the formula will be essentially correct for this type of coil, assuming that its shape and other characteristics are the same. If, however, the nature of the coil to be tested differs from that of the standard coil in some way not covered by the formula, a system of correction must be used to adjust the formula to the particular case. Thus, the formula for inductance of coils takes into consideration the size of the wire or the number of turns, the length of the coil, its diameter and so on. However, it does not take into consideration the ratio between the length of the coil and its diameter. For this purpose a correction factor (necessary consideration) is needed to correct the result of the formula to fit the individual occasion. This correction factor is generally referred to as a *constant* (q.v.), its value being determined generally from a chart prepared to cover various ratios of length to diameter.

CORROSION—Chemical action which causes destruction of the surface of a metal. In the case of iron it is generally rust, corrosion of copper being due to oxidation, or perhaps the action of stray currents causing *electrolysis* (q.v.). This effect is very often noted in the case of an aerial wire where the wire is necessarily exposed to the action of the atmosphere, rain, etc. The effect is particularly important and undesirable where the lead in wire is joined to the aerial.

If the two wires are not soldered securely or at all, corrosion may set in, which will produce in time a high resistance connection and waste the valuable energy of the incoming signals. This is the main point of danger in an aerial system and the best protection is to solder the joint carefully. As a matter of fact the remainder of the wire may corrode to a considerable extent without disastrous effect. In the case of copper, the wire very quickly corrodes when exposed. For this reason insulated wire is sometimes used for the aerial. As the current received by an aerial travels only on the outer surface of the wire (see *Skin Effect*), and a corroded surface is not a particularly efficient conductor, there seems to be some basis for the use of insulated wire for this purpose. Another instance of corrosion is in a soldered joint within a receiving set. All soldered joints should be carefully wiped to remove any trace of *acid flux* (q.v.), which may remain to produce a destroying chemical effect on the wire and cause loss of energy. (See *Electrolysis*, also *High Resistance Joint.*)

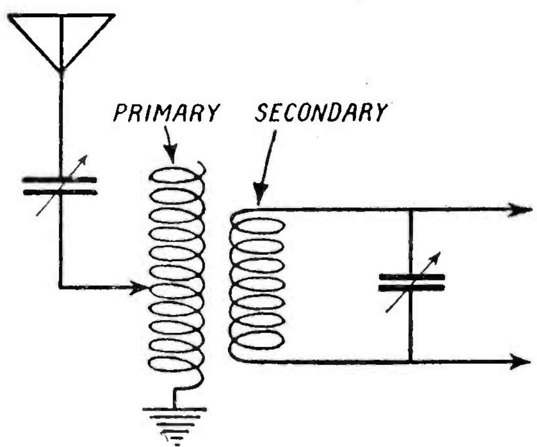
COULOMB—The practical unit for electrical quantity. It is defined as the quantity of electricity delivered by a current of one *ampere* flowing for one second. Therefore a *coulomb* of electricity will pass each second in a circuit having one *ohm* of resistance and a pressure of one *volt.* It is also used to express the quantity of electricity which a condenser having one *farad* of capacity will absorb when placed under a pressure of one volt. (See *Capacity, Electro-static, Volt, Ampere Hour, Practical Units, CGS Units.*)

COUNTER ELECTROMOTIVE FORCE—Commonly known as *Counter E. M. F.* It is an opposing electromotive force which tends to resist or act against the original electromotive force. It may be introduced in a circuit to prevent any fluctuation of the original force. (See *Back Electromotive Force*, also *Choke Coil.*)

COUNTERPOISE—A *counterpoise* is generally a second aerial suspended either below the main aerial or to one side of it. It is used more often in transmitting stations in place of the usual ground connection, but is occasionally also used in reception where it is impossible to obtain an efficient ground. (See *Aerial.*)

COUPLE, THERMO ELECTRIC—See *Thermo-Couple.*

COUPLED CIRCUITS—The term generally used to refer to circuits that are joined by *coupling.* (q.v.) In the illustration the *primary circuit* (the aerial ground and tuning devices) is



Circuit in which primary and secondary are joined by inductive coupling.

coupled or joined to the *secondary circuit* by *inductive* coupling. That is to say, the signals impressed on the *primary circuit* are transferred to the *secondary circuit* by means of *inductive coupling;* when the lines of magnetic force around the primary coil cut the secondary coil, a voltage is set up in this coil which causes a current to flow in the secondary circuit, and it is then said the coils are "inductively coupled", there being no connecting wires between them. Signals might be transferred to the secondary circuit by any of several means, but in each case the method of joining the two for the purpose of effecting a transfer of energy is referred to as "coupling the circuits." (See *Coupling.*)

COUPLER—See "Coupler—(Loose)" and "Coupler—(Vario)".

COUPLER—(LOOSE)—A tuner used in a radio receiver, consisting of a primary and secondary coil so constructed that the secondary coil slides on rods in and out of the primary coil. When the secondary is entirely within the primary the coupling is said to be "tight," and as the secondary is withdrawn from the primary the coupling becomes "loose," depending upon the distance which the coils are separated.

COUPLER—(VARIO)—Form of tuner used in a radio receiver, having primary and secondary coils arranged in such a manner that the secondary rotates on a shaft within the primary. The degree of coupling is governed by the variation of the angle between the axes of the two coils.

COUPLING—The relation of one coil of wire carrying alternating currents to another in which energy is set up by the first coil. It is used to define the intimacy between the primary and secondary windings of various types of *oscillation transformers, couplers* and *tuning devices.* This transfer of energy may be produced in several ways, as by *inductive coupling, conductive coupling* or *electro-static coupling.* The more common method is to place the primary and secondary coils in close proximity and produce the energy in the secondary through induction. The illustration Fig. 1 shows a simple two slide tuning coil which is divided into a primary and secondary by *conductive* coupling. Here the transfer of energy from the aerial and ground, or primary circuit, to the secondary circuit (detector and phones) is accomplished with little loss of energy as the circuit is through wire conductors. This is also known as *direct coupling.* Now in Fig. 2 a simple form of *loose-coupler* is shown. This device is made in numerous forms, the principle of operation however, being the same in all cases. Here one coil, the secondary in this case, is made to fit into the larger coil which is the primary. The energy flowing in the primary coil induces or sets up a similar current in the secondary by reason of its proximity. The energy in the secondary, however, will not be as great as in the case of Fig. 1 where it is transferred directly through a wire conductor. The coupling shown in Fig. 2 will on the other hand, permit much closer adjustment to the desired signals.

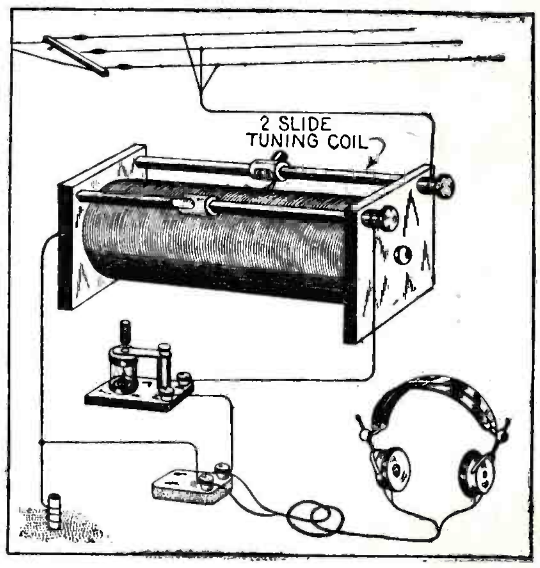


Fig. 1.—Two slide tuner divided into primary and secondary circuits by conductive coupling.

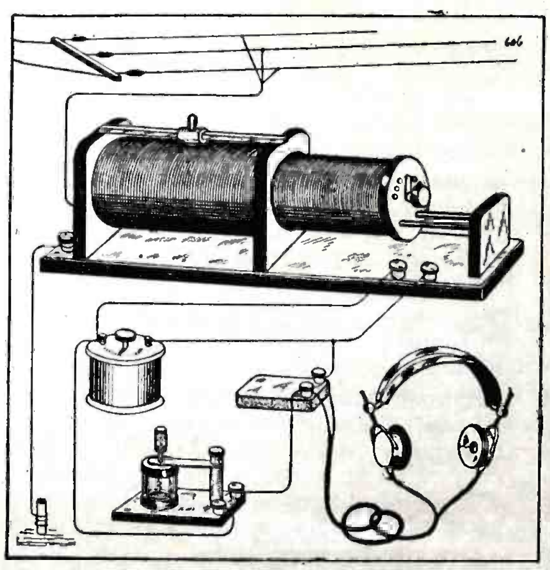


Fig. 2.—Circuit in which primary and secondary are inductively coupled by loose coupler.

The other method is known as *capacitive* or *electrostatic coupling.* This is shown in Fig. 3. Here the secondary coil is not in direct inductive relation to the primary, in fact it might well be almost any distance away were it not for the loss in efficiency due to long connections. The connection between the primary and secondary coils is by means of condensers. The transfer takes place through these and is determined by the setting of the condensers. It will appear that from a standpoint of maximum transfer of energy, the direct or *conductive coupling* system is best. The factor of tuning enters here however, and must be considered. In order to eliminate undesired signals the various systems of coupling are resorted to. It is known that *selectivity*—the ability to tune out undesired signals while receiving the desired signals—is often obtained only at the expense of a certain amount of energy or volume. It is a safe assumption therefore, that if there is any such thing as maximum efficiency in tuning apparatus, it must be a general term covering both selectivity and volume.

Coupling in its various forms is intended to refer not only to receiving circuits but to transmitting circuits as well. Its application in transmitting is covered under the heading *Spark transmission* (q.v.).

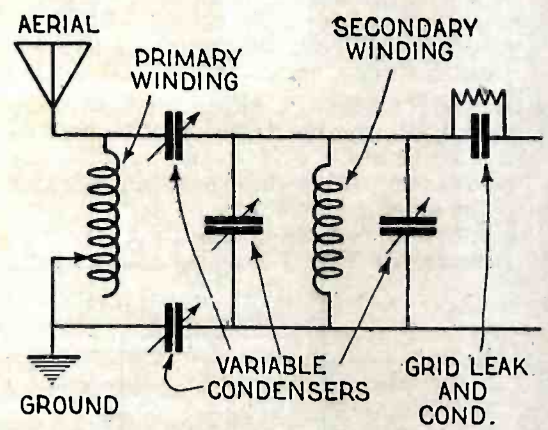
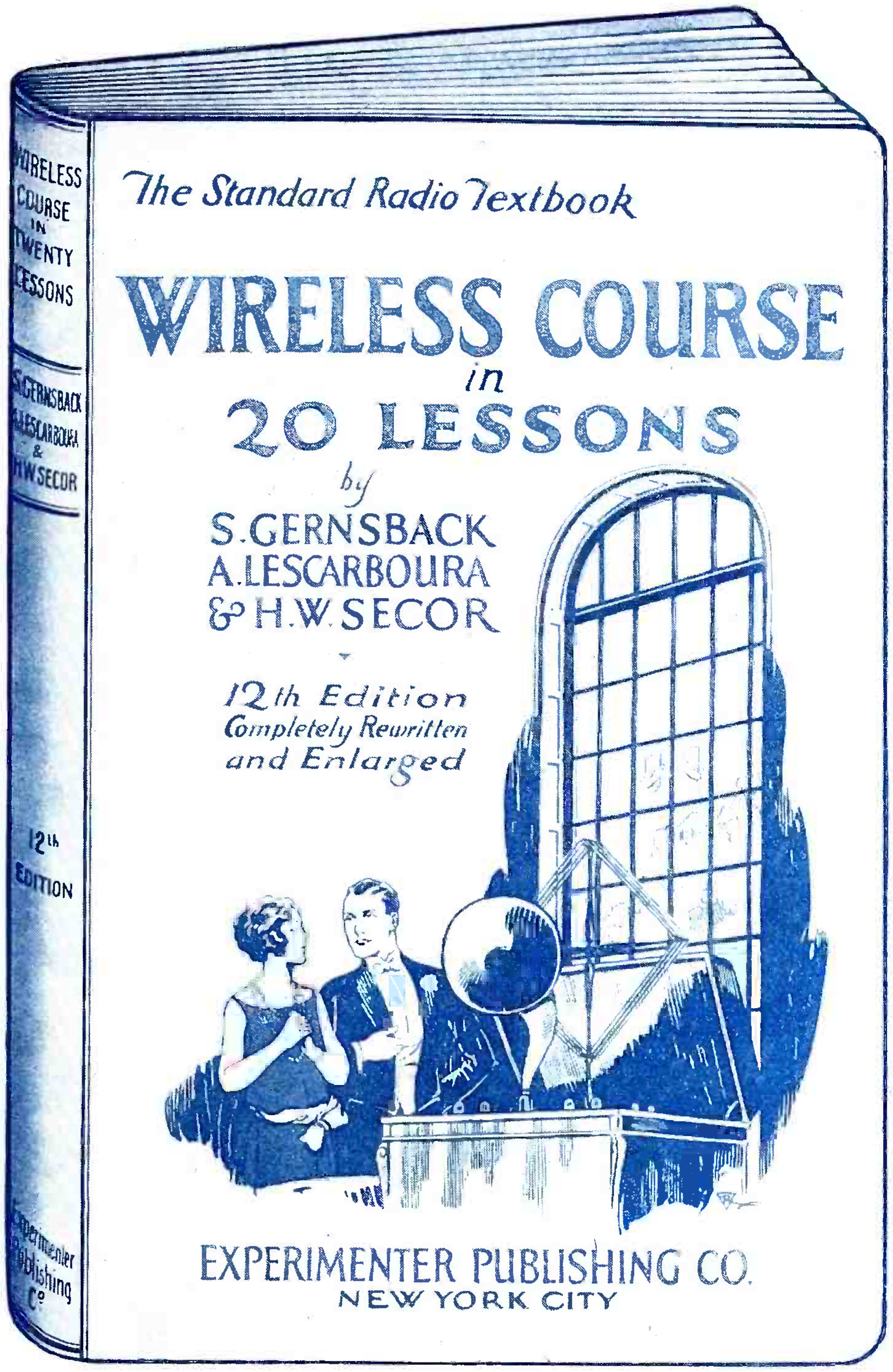


Fig. 3.—Electrostatic coupling between primary and secondary by means of variable condensers.

COUPLING COEFFICIENT — The closeness of *coupling* is specified by a quantity representing the ratio of the *mutual inductance* between two coils to the square root of the product of the two *self inductances.* In its practical sense coupling coefficient refers to the inductive relation of two coils. Coupling coefficient is defined as the ratio

$$\frac{Xm}{X. X_2}$$

Where Xm is the mutual or common reactance X is the total inductive or capacitive reactance in the primary circuit and X_2 the similar reactance in the secondary circuit. (See *Coupling, Mutual Inductance.*)



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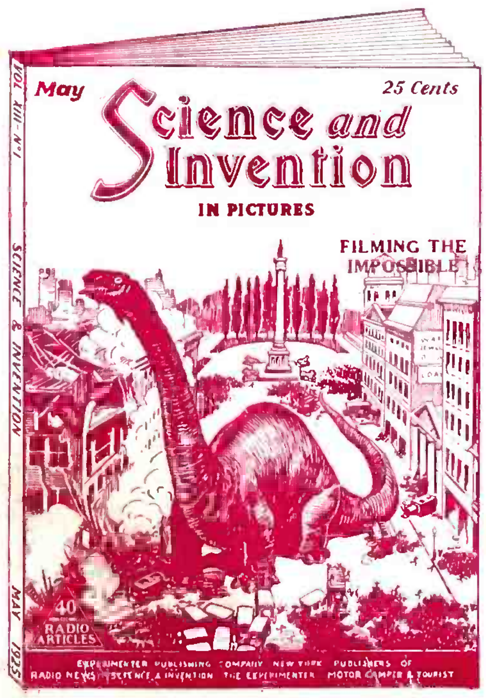

Beginner's Radio

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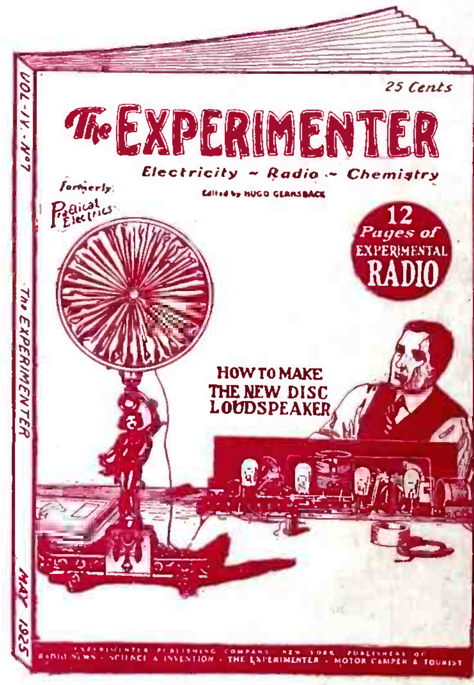

Radio for the "Radio Tinker"

THE EXPERIMENTER concentrates its entire radio section to the problems of the radio "Tinker," covering the real practical problems of the day that affect the receiving apparatus of the Amateur station.

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