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RADIO REVIEW

Reg U S Pat Off

A Digest of the Latest Radio Hookups

Edited by S. Gernsback

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Containing
Illustrated
Radio Encyclopedia
See Page 81

Published by the
CONSRAD CO. Inc
NEW YORK CITY

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

Second Installment

WHEN we issued our first number of RADIO REVIEW we looked forward to a certain response from the Radio Fraternity, but we scarcely anticipated such outpouring enthusiasm from our readers.

¶ We have been literally swamped with a flood of congratulatory messages from all sides, and it has been impossible for the editors to reply individually to all of these communications. We wish, therefore, to express here our warm thanks and appreciation for this praise and encouragement.

¶ We propose to keep on improving RADIO REVIEW, assured that our efforts will meet with appreciation and further good-will on the part of our readers, who have so generously expressed their interest in this new magazine.

¶ In this, the second issue of RADIO REVIEW, we have taken a number of forward steps, which we think our readers will appreciate. The general make-up of the publication has been improved, the type style is larger and more readable, and the paper adopted with this issue is of a better grade. The illustrations are larger, making for much clearer exposition of detail.

¶ The editors are always glad to receive letters containing suggestions from our readers. Tell us what you want and how you want it, and we will give it to you.

¶ During the summer months, RADIO REVIEW will appear every alternate month. The second issue is presented as the July number and the next following will be the September number. Thereafter, it will appear monthly, the subscriber receiving twelve numbers in all.

¶ The volume of requests coming to us for special information on technical matters brings up a situation in which we must ask the co-operation of our readers. It has become manifestly impossible, even in this beginning, to divert as large a part of our staff to this service as would be necessary, without a small charge. Therefore, we are obliged to request that every inquiry for circuits in which a drawing is required be accompanied by a remittance of one dollar to defray the actual cost of work involved.

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 2**

JULY, 1925

Contents *of* This Issue

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Vol. I JULY, 1925 No. 2

How to Build the Popular Mechanics' Superheterodyne Eight

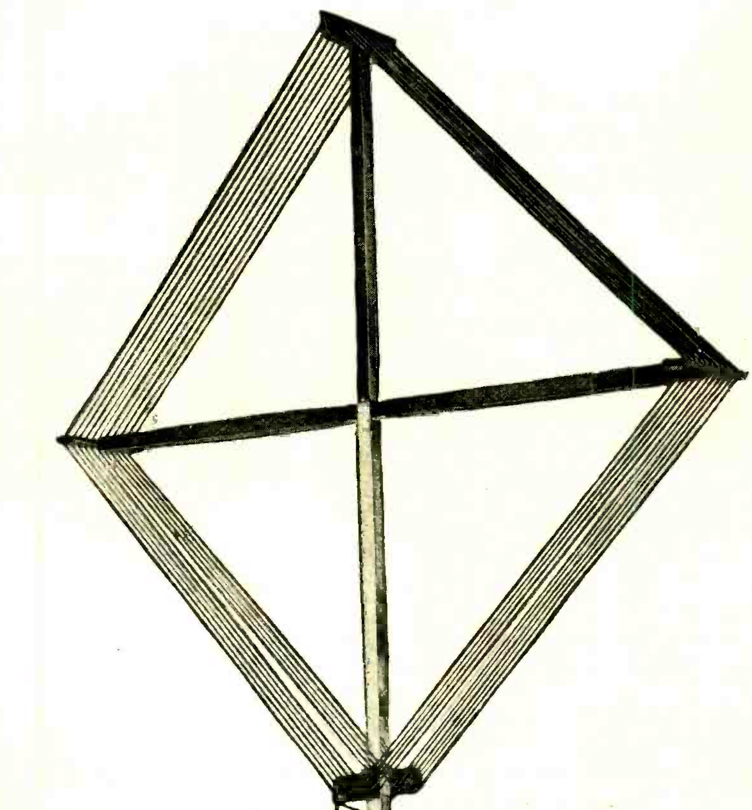
An Ultra Sensitive Radio Receiving Set

REPRESENTING the closest approach to perfection yet attained, the superheterodyne circuit well deserves its widespread popularity. It is the general opinion of radio experts that any advancement will not come until some discovery is made that will upset present methods of radio communication.

The superheterodyne receiver described herewith by *F. L. Brittin* in *Popular Mechanics* Magazine embodies all the most advanced ideas pertaining to this circuit. Nothing has been overlooked that would add to the efficiency of the instrument. Every piece of apparatus used in its construction has been carefully selected and thoroughly tested by the author; the completed instrument seemingly leaves little to be desired in selectivity, range and clarity of tone. All body-capacity effects have been eliminated by simple shielding, and the instrument is easily tuned, even by a novice, after a few minutes of instruction. The receiver can be built at a fraction of the cost of similar manufactured instruments, and has many refinements not yet included in the superheterodyne receivers on the market.

Any radio fan can build this instrument, with a few simple tools, if the directions are closely followed. All parts are standard, and easily obtained from any dealer in radio supplies. There are many good instrument kits on the market for the construction of superheterodyne receivers, but the instruments in such kits are intended for operation in a circuit especially designed by the manufacturer. Such kits should not be purchased with a view to using the instruments in the circuit described here, as any departure from those specified herein will result in loss of the perfect balance that is absolutely necessary in this type of receiver. The superheterodyne circuit employs a force that is extremely sensitive, and at the same time powerful, and cannot be compared to any other type of circuit.

Before attempting to build the set, read this article carefully. Obtain all the parts, even to the smallest items, such as screws, wire, lugs, etc., before starting actual construction. (See Page 6.) By doing this, you will find every step described much easier to follow. Equip yourself with a good small electric soldering iron, a small tin of non-acid soldering paste, and a coil of solid-wire



Illustrations by Courtesy of Popular Mechanics (Chicago, Ill.)

A view of the completed Superheterodyne Receiver, with collapsible loop extended and plugged into the jack in the cabinet lid.

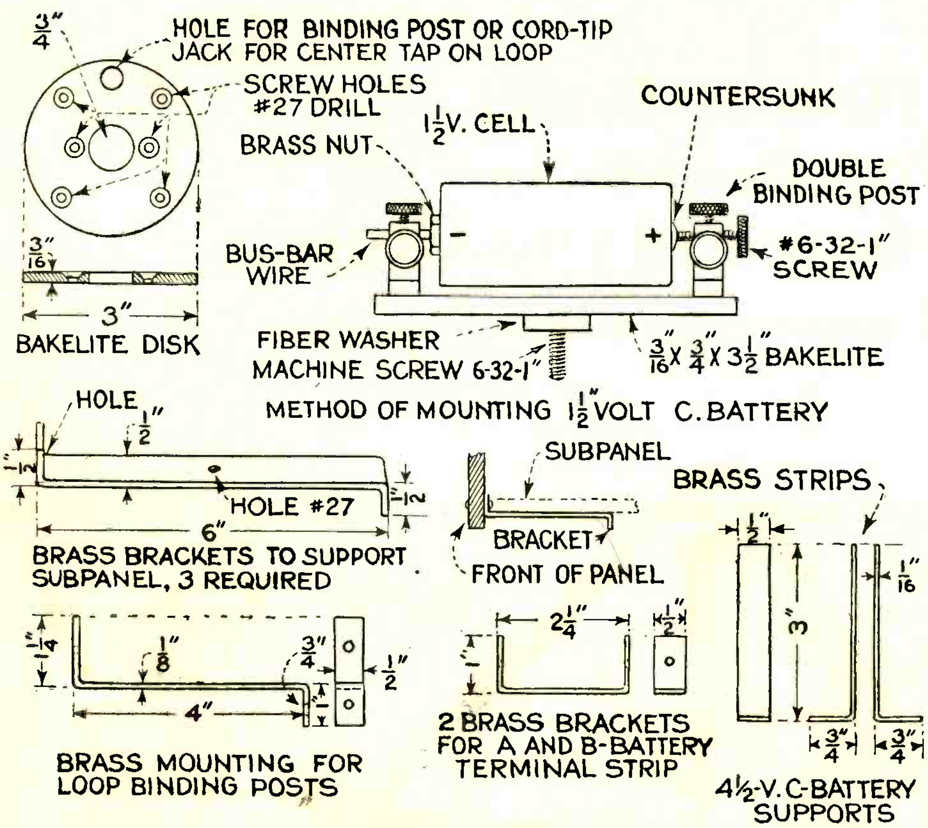
solder. It is essential that all connections be soldered, using lugs under all binding posts, and also under all terminal posts of sockets, rheostats, voltmeters, and transformers. Screw these lugs down tightly and solder the connecting wires of the circuit to them; use very little soldering paste, and wipe it off carefully before applying the solder, the paste is used more to clean the surface than to act as a flux, and a very thin film is sufficient. The paste has a tendency to run under the terminal posts and make poor connections unless this precaution is taken. This advice is given in advance of all other construction details because poorly soldered connections will cause failure, even if every other detail is followed exactly.

Some of the tools necessary are as follows: A pair of long-nosed pliers; blunt-nosed pliers; small side-cutting pliers; a small screwdriver; a heavy screwdriver; a small hacksaw; a hand drill; a center punch and a scriber. An ice-pick makes a good and easily obtained tool for this purpose. Do not make marks on the panel with a lead pencil.

Refer now to the drawing of the front-panel template. Obtain some heavy cardboard, such as bristol board, to make this. It is always best to make a template of the front panel so that the holes for mounting the various instruments can be properly located. The panel is of hard rubber or Bakelite, 7 by 26 by 3/16 in. in dimensions. Lay the panel on the bristol board and carefully outline it; then cut the bristol board to the exact size of the panel. On the template thus made locate the position of the holes for mounting the various instruments. Lay out this template exactly as shown in the drawing. In the template drawing the oscillator condenser is shown at the left of the panel, and the wavelength condenser to its right.

Be sure that the panel template is laid out exactly in accordance with the drawing as any departure from it will result in trouble later on.

After the template is completed, lay it on the panel and clamp it at the edges with small C-clamps, so that the template cannot shift on the panel while locating the holes for the instruments. Now, with the center punch or icepick, carefully mark the center of each hole through the template into the panel; make each mark in the panel deep enough so that no errors will be made when drilling, then remove the template from the panel. Always drill the panel from front to back, never from back to front. It will be noted that the oscillator and the wavelength condenser holes, shown with the double circle, are to be countersunk for machine screws. A No. 27 drill is used for all screw holes, and an 11/32-in. drill for the shafts of the condensers and rheostats. The rheostats are of the new single-hole mounting type, and have a little projection at the outer edge, on the side that goes next to the panel. This point is for the purpose of preventing the rheostat from turning out of position; drill a small hole part way into the rear of the panel to fit it, being careful not to drill the hole any deeper into the panel than is necessary to take the point and permit the rheostat to lie flat against the panel. The rheostats are mounted with the terminals up, to facilitate the wiring of the circuit. The potentiometer is mounted in the same manner as the rheostats, except that the terminals are turned down. After the rheostats are fitted to the panel, remove them. Now drill the holes for the voltmeters; this will not be easy unless one is equipped with an expanding or wing bit. It will be best to have these holes drilled in the local machine shop. It is necessary first to make the 3/16-in. cut-out at the lower edge of the hole for the voltmeter; this is done with a ⅜-in. drill, right on the line of the larger hole, and the latter, 2 9/16 in. in diameter, is then drilled. The 3/16-in. cut-outs are to take the shafts of the little pointers and switches on the voltmeters. Place the voltmeters in the holes and mark off the mounting-screw holes. The exact location of these holes will be found when the voltmeters are fitted into place on the panel; care should be taken in marking and drilling them so that the voltmeters will be lined up correctly when the screws are placed in position. Use a No. 27 drill for the holes and nickelplated screws for mounting the voltmeters. They provide a check on the condition of the A- and B-batteries at all times and prevent using excessive filament voltage.



Various constructional details; method of mounting flashlight cells, disk for loop mounting, binding posts, C-battery and subpanel brackets.

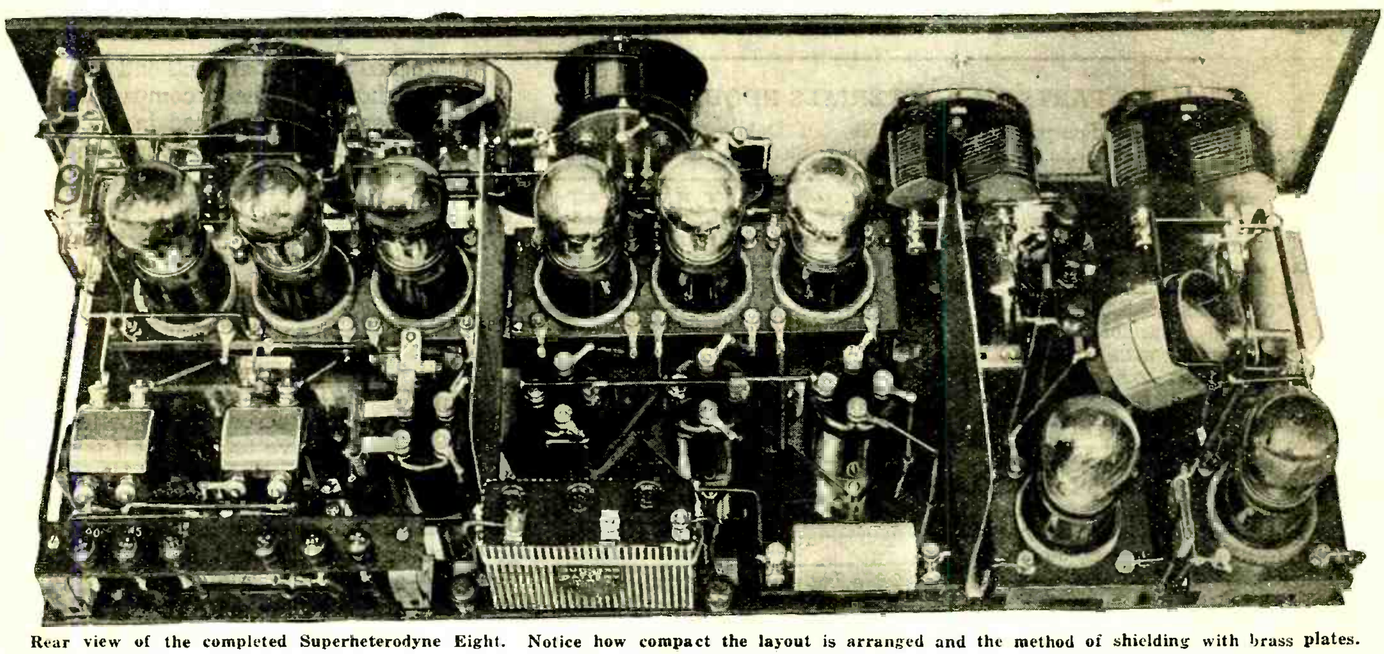
In the upper right-hand corner of the panel will be found the ¾-in. hole for mounting the red pilot light; the socket for this is of a standard nickelplated auto dash-light type and mounted on the front of the panel. The lamp is a 2-cp. 6-volt double-contact bulb, and can be had in colors; this lamp is lighted whenever the instrument is in operation and reminds the operator not to leave the instrument without first cutting off the A-battery from the tubes; this feature will be appreciated by anyone who has inadvertently left his tubes lighted, and returned later to find his A-battery run down. The screw holes above and below the ¾-in. hole are for the nickelplated machine screws used to mount the pilot-lamp socket.

Directly below the pilot lamp are the holes for mounting the horn jack, and lower down, the hole for the phone jack; these holes are 7/16 in. in diameter. The horn jack is of the filament-control type, and the second audio-frequency amplifying tube remains unlighted until the plug from the horn or loud speaker is pushed into this jack. The author has found it unnecessary to use the loud speaker in the horn jack on many stations, even some 500 or more miles away, because the volume obtained when the loud speaker is plugged into the phone jack is more than sufficient; there is really more amplification than one knows what to do with, unless the instrument is detuned. For extremely distant stations, however, the second step of audio-frequency amplification can be used to good advantage. The phone jack is of the open-circuit type. The hole for mounting the push-pull filament switch is located directly below the phone jack; this hole is drilled with the 11/32-in. drill. Use the No. 27 drill for the holes at the lower edge of the panel, to mount the brass brackets that support the bakelite subpanel. The drilling of the front panel is now finished. If there are any instruments mounted on this panel, remove them, and the panel is ready for engraving; this can be dispensed with, if desired, and transfers or other markers used; however, engraving adds much to the appearance of the completed instrument, and good work can be obtained in most any city for from 3 to 5 cents a letter; for the arrows around the rheostat knobs the cost is from 12 to 15 cents each.

The next step after the panel has been engraved, and the builder has the instrument-mounting holes (a safety-razor blade is handy for this purpose); be sure that the foil does not touch any of the instruments when they are mounted on the panel. The writer used a 3-in. square of mica between each of the rheostats and the panel, and also between the potentiometer and the panel. Thin mica sheet was used, and a hole sufficiently large for the shafts of the instruments cut with the points of a pair of dividers. This is an extra precaution, but insures that no metal on the rheostats or potentiometer will come in contact with the foil. Use a little alcohol for removing any traces of shellac remaining on the panel.

The brass brackets for supporting the sub-panel are then screwed to the lower part of the panel and make contact at this point with the foil, for grounding the shield; these brackets are made from ⅛-in. brass strip, ½ in. wide and 7 in. long. A ½-in. bend is made at each end in the manner shown in the detail drawing. There are three of these brackets, and holes for the machine screws used to mount all the instruments of the latter can now be mounted in their proper positions, after soldering lugs have been placed under all the instrument terminals. The front panel is then completed.

The subpanel can be either formica or bakelite, ⅛ by 9 by 25 in. in dimensions; refer to the subpanel layout and note the cut-out, ¾ in. deep and 14 in. long; this is to clear the lower part of the rheostats mounted on the front panel. A small cut-out will also be necessary at the left front end of the subpanel, to clear the back of the push-pull switch; the size of this can readily be determined upon assembly. Assemble the various instruments on the subpanel and use a scriber to locate the mounting holes. All holes in the subpanel can be drilled with a No. 27 drill. Be careful to locate the various instruments on the subpanel exactly as shown in the layout. Note that two three-gang sockets are used. The first socket unit at the left is for the second detector and the two audio-frequency amplifying tubes; the two audio-frequency amplifying transformers are

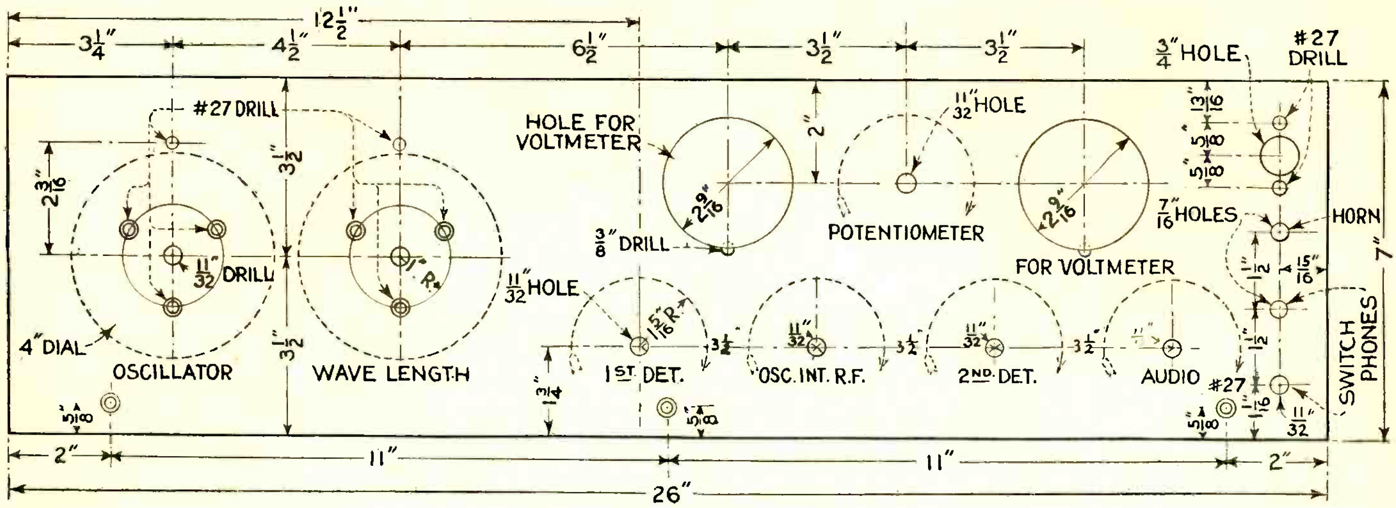


Rear view of the completed Superheterodyne Eight. Notice how compact the layout is arranged and the method of shielding with brass plates.

made sure that all holes have been drilled, and that those so marked have been countersunk, is to fit the sheet of tinfoil on the back of the panel. This tinfoil sheet is 6 by 24 in. in size; coat one side of the foil with a good grade of orange shellac and stick it on the back of the panel. The foil should be placed on the panel ¼ in. from the end where the oscillator and wave length condensers are to be mounted, and ½ in. from the top and bottom of the panel; it will now reach across the panel to a point about 1¾ in. from the other end; this is clearly seen in the photo of the rear-panel assembly. The foil will stick tightly to the panel and effectually shield the instrument from any hand capacity when tuning. Before the shellac has had time to dry hard, cut away the foil from around the panel on the brackets are drilled through the upturned end of each, using a No. 27 drill. A hole is also drilled through the center of each bracket for the short ½-in. machine screws used to mount the subpanel on the brackets. The turned-down ends of the brackets then form supports for the subpanel and rest on the bottom of the cabinet; the brackets hold the subpanel ½ in. above the bottom of the cabinet and permit wiring under the subpanel. Remember that the subpanel is not yet mounted on the brackets; the latter are supporting the front panel by means of machine screws through the upturned ends; the screws used have flat black-japanned heads, and are counter-sunk flush with the front of the panel. The brackets act as a support for the front panel and placed directly back of their respective tubes. These transformers have a ratio of 3 to 1 and are so placed that the grid and plate terminals are as close as possible to the respective grid and plate terminals of the tube sockets, which allows short and direct leads. This precaution should be taken with all the transformers in regard to the plate and grid leads. The tuned-stage transformer is placed next to the first audio-frequency transformer. On this transformer will be found three little mounting brackets placed under the terminals; the .00025-mfd. fixed condenser is connected across the grid and filament posts on two of these brackets; the third bracket is also placed under the grid terminal and provides a mounting for one side of the .0005-mfd. grid condenser and the 2-meg.

grid leak, which is mounted on clips attached to the grid condenser. This assembly is clearly shown in the wiring diagram. Place soldering lugs under every terminal on transformers and sockets, and also put lugs on all fixed condensers not furnished with them. These lugs can be attached to the condensers by means of short brass machine screws. Never solder directly to any condenser of this type, as the heat from the iron will destroy the efficiency of the condenser.

The .5-mfd. by-pass condenser is placed flat under the second detector-tube socket, with the terminals toward the front panel, making connection easy to the lever of the potentiometer and the negative-A line. Directly back of the audio-frequency transformers, at the back edge of the subpanel, mount the brackets for supporting the terminal strip. These are made of 1/16 by ½ by 4¼-in. brass strips, turned up 1 in. at each end and drilled as shown in the accompanying illustration of the detailed bracket pieces. Fasten them to the subpanel with brass machine screws. The terminal strip consists of a piece of 3/16 by 1 by 7-in. bakelite. Drill this strip for the binding posts and engrave the various B-battery voltages as indicated on the strip. Place soldering lugs under these posts and mount the strip on top of the brackets with short brass machine screws. The 1-mfd. by-pass condenser is connected across the B-battery from the A negative to B 90-volt posts. At the right of the terminal strip is a binding post on the subpanel; this post is for the positive lead of the 4½-volt C-battery. A lead from the negative A-battery line is also run to the base of this post under the subpanel. This binding post is for the convenience in wiring; the lead from the negative-A line to the positive of the C-battery can be taken direct, eliminating the binding post if so desired. This completes the assembly of this section on the subpanel. A brass shield is then placed between this section and the next, as shown in the subpanel layout and rear view of the set. The shield is made of 26-gauge sheet brass, 6¼ by 6½ in. in size. The long side is bent at right angles ¼ in. from the end, to form a mounting base for the shield; two holes are drilled through the flange, and the shield is secured to the subpanel with short machine screws. A soldering lug is placed under one of the machine screws on the underside of the subpanel for the purpose of grounding the shield. This applies to both shields and the tinfoil shield on the back of the front panel is grounded by means



FRONT-PANEL TEMPLATE

Layout template for drilling the front panel. This can be measured off on a sheet of bristol board to the given dimensions.

LIST OF PARTS AND MATERIALS REQUIRED

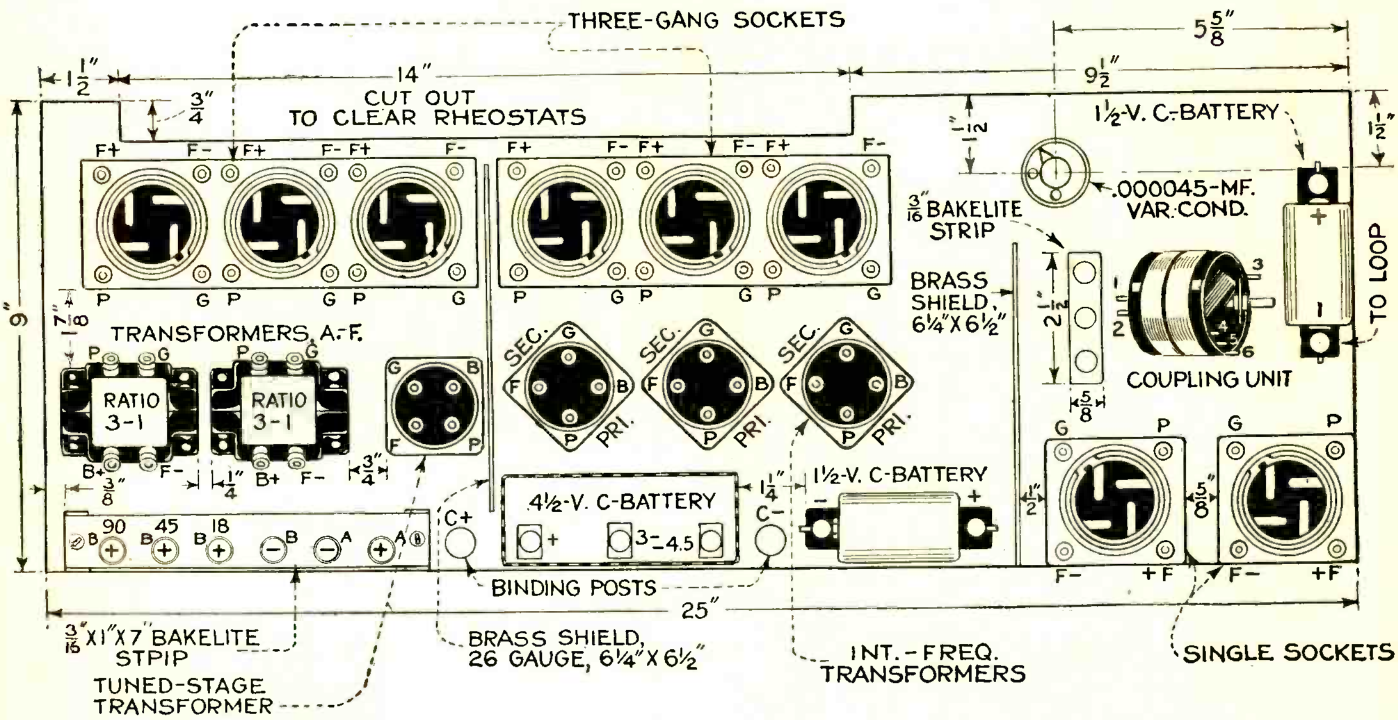
1 3/16 by 7 by 26 in. radion panel mahoganized (or black)	$ 4.00
1 ⅛ by 9 by 25 in. formica or bakelite sub-panel	3.38
3 No. 600 Remler intermediate-frequency transformers	18.00
1 No. 610 Remler tuned-stage transformer	6.00
2 No. 631 Remler .0005-mf. capacity units (variable condensers), complete with dials	10.00
1 No. 620 Remler coupling unit	3.00
2 No. 619 Frost shock-absorber sockets, 3-gang type, standard base	6.50
2 No. 618 Frost shock-absorber sockets, single, standard base	2.50
1 No. 651 Frost vernier rheostat, 6-ohm, single-hole mounting type	1.25
2 No. 650 Frost rheostats, 6-ohm, single-hole mounting type	2.20
1 No. 657 Frost rheostat, 25-ohm, single-hole mounting type	1.25
1 No. 654 Frost potentiometer, 400-ohm, single-hole mounting type	1.25
1 No. 233 Frost jack, open-circuit type	.70
1 No. 235 Frost jack, filament-control type	.95
1 No. 608 Frost push-pull filament switch	.30
1 No. 250 Frost loop jack and plug complete	1.50
1 No. 860 Chelton midget variable condenser .000045-mf., table-mounting type	1.75
2 R-12 All-American audio-frequency transformers, ratio 3 to 1	9.00
1 No. 55 Jewell voltmeter 0-8 volts, d.c., three-circuit type	10.00
1 No. 55 Jewell voltmeter, combination A and B, 0-10 and 0-100	10.00
1 Mathiesen collapsible loop, three-terminal type	12.50
1 No. 601 Dubilier micadon condenser .006-mf.	.75
3 No. 601 Dubilier micadon condensers .0025-mf.	1.20
1 No. 601 Dubilier micadon condenser .0005-mf., with grid-leak clips	$ .45
1 No. 601 Dubilier micadon condenser .00025-mf., plain	.35
1 Dubilier by-pass condenser .5-mf.	.90
1 Dubilier by-pass condenser 1-mf.	1.25
1 Daven grid leak, 2 meg	.50
2 1½-volt flashlight cells	.40
1 bakelite disk 3/16 by 3 in. in diameter	.15
1 auto dash-light socket, nickel, flush-mounting type	.35
1 auto lamp, 2 cp., 6-volt (red if possible)	.30
1 strip of bakelite, 3/16 by 1 by 7 in.	.14
2 strips of bakelite 3/16 by ¾ by 3½ in.	.16
6 binding posts, Eby type, with engraved tops for A and B-bats	1.20
5 binding posts, plain	.50
20 2-foot lengths of tinned-copper bus-bar wire	.75
15 3-foot lengths of good-grade black spaghetti tubing	1.80
7 doz. tinned-copper lugs, long type, round hole	.70
1 strip of bakelite, 3/16 by ⅝ by 2½ in.	.06
4 double binding posts	.40
1 sheet tinfoil, 6 by 24 in.	.10
2 brass sheets .016 in. thick, 6¼ by 6½ in.	.40
3 brass brackets ⅛ by ½ by 7 in.	.45
1 brass bracket ⅛ by ½ by 6 in.	.10
2 brass brackets 1/16 by ½ by 4½ in.	.15
1 4½-volt Burgess C-battery	.40
8 6/32 brass machine screws, 1½ in. long, with nuts	.10
2 6/32 brass machine screws, 1 in. long, with nuts	.05
15 6/32 brass machine screws, ¾ in. long, with nuts	.15
26 6/32 brass machine screws, ½ in. long, with nuts	.30
6 wood screws, nickelplated, oval head, 1 in. long	.10

of lugs under the brass supporting brackets that go under the subpanel. The lugs are all connected together with one wire which runs to the negative binding post of the A-battery. This is done after all circuit wiring has been completed.

We will now consider the middle section; this embraces the three intermediate-frequency transformers and their respective tube sockets, also the 4½-volt C-battery, the 1½-volt C-battery for the potentiometer and the negative lead to the filament posts of the intermediate-frequency transformers. The filament posts of these transformers are all connected together with one bus bar, and this lead is taken to the negative post of the 1½-volt battery. The binding post shown between the two C-batteries in this section is for the negative lead from the 4½-volt C-battery, which goes to the filament posts of the two audio-frequency amplifying transformers. The 1½-volt C-battery consists of a cell from a flashlight battery, and is mounted on a 3/16 by ¾ by 3½-in. strip of bakelite. Holes are drilled at each end of the strip for mounting double binding posts, of which the lower screws secure through the center of the bakelite strip for a 1-in. brass machine screw, and a fiber washer is used to support the entire unit above the subpanel. The unit is then mounted in the position indicated. The intermediate-frequency transformers are mounted on the panel in the position shown, to allow the grid and plate leads to be made as short as possible. Next comes the second shield; this is exactly like the preceding one, and is mounted in the same manner, except that it is placed far enough back to clear the wave-length condenser This completes the assembly of the middle or intermediate-frequency section.

The third, and last, section to the right contains the coupling unit mounted on the subpanel, and it will be noted that the soldering lugs on this unit are numbered as shown in the diagram. Care should be taken when soldering the wire to these small terminals; do not hold the soldering iron to them any longer than sufficient to make a good connection. At the left of the coupling unit is a 3/16 by ⅝ by 2½-in. strip of bakelite, on which is mounted three binding posts. This strip is mounted on a ⅛ by ½ by 6-in. the table-mounting type and is placed on the subpanel at a point directly between the oscillator condenser and the wave-length condensers on the front panel. When soldering the leads to this condenser, substitute lugs for the copper tabs and solder the wire to the lugs. At the right of the coupling unit is another of the 1½-volt batteries; this is mounted in the same manner as the 1½-volt C-battery previously described. There is a .0025 mfd. fixed condenser across this battery; this condenser is mounted on the battery unit with bus bar looped under the double binding posts.

At the rear of the subpanel in this section are the sockets for the first detector tube and the oscillator tube; these are of the single type and are mounted on the subpanel with brass machine screws, 1¼ in. long. The oscillator socket is mounted at the extreme right of the subpanel and the first detector socket at the left of the oscillator. This detector tube is of the C-300 or UV-200 soft type; all the other tubes used in the instrument are of the UV-201A or C-301A type. This completes the assembly of the oscillator and first detector section.



Layout of the subpanel, showing the location of the various parts, giving dimensions for placement.

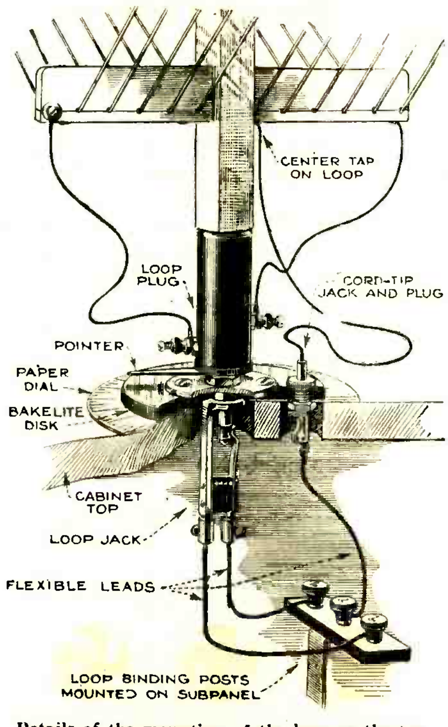
the leads from the circuit, and the upper ones hold two short lengths of bus bar or two No. 6-32 machine screws to support the dry cell and also make the positive and negative connections; a small brass nut is soldered to the zinc shell at the base of the cell, holding the cell in place by means of the bus bar. The positive contact is made at the other end of the cell by countersinking a very small hole in the brass positive terminal just deep enough to allow the bus bar or screw to support this end of the cell and make a good contact. A hole is drilled bracket bent as shown so as to form a 1¼-in. base, and also bent for ¾ in. at the top. This binding-post assembly is for the purpose of connecting the three flexible leads from the loop jack and cord-tip jack mounted in the top of the cabinet to their respective leads, as shown in the loop-connection drawing. Green silk-covered lampcord is very good for these leads; they should be just long enough to allow the lid of the cabinet to be opened, and can be bunched through a small screw-eye near the hinge of the cabinet.

The midget variable condenser is of

Complete all the wiring possible on the subpanel before attaching the front panel, then screw down the subpanel to the brackets already mounted on the front panel, and complete the wiring. Use tinned-copper bus bar for the entire circuit, and cover with a good grade of black "spaghetti" tubing. The leads from the switch points on the voltmeters can be made with smaller flexible rubber-covered wire if desired.

Keep the negative and positive A-battery leads underneath the subpanel and close together, so as not to form any induction loops in the circuit. This also applies to all other leads. Avoid forming loops; keep all grid and plate leads as short and direct as possible, and do not parallel grid and plate leads. All wiring under the subpanel is run direct from point to point. See that the machine screws that go through the subpanel do not touch the wood bottom of the cabinet. The brass brackets elevate the subpanel ½ in. above the cabinet base, and this allows plenty of room for all screws and wiring to clear the cabinet base. The instrument is now completed and ready to place in the cabinet.

Prepare the lid of the cabinet for mounting the loop jack by drilling a ¾-in. hole through the lid at a point just back of the center, then cut a disk of 3/16 in. bakelite, 3 in. in diameter, for mounting the loop jack; drill this for the oval-head nickel-plated wood screws, as shown in the diagram, and also drill a hole at the back of the center in this disk to mount a phone-tip jack for the center tap on the loop. This hole must be drilled so that the cord-tip jack clears the loop-jack flange. Drill another ¾-in. hole through the lid to clear the cord-tip jack. When the loop jack is mounted, no metal should come in contact with the lid. If the reader desires to log the loop there are extra paper-dial charts furnished with the oscillator and wave-length condensers, and one of these dials can be fastened under the bakelite disk that forms the mounting for the loop jack. A disk of celluloid covers the dial and prevents soiling, and at the same time tends to hold the paper dial flat on the cabinet; the loop aerial can then be rotated and logged. When making the station log, enter the call letters of the station, then the wave length, then the reading on the oscillator condenser, next the reading on the wave-length condenser, and last the position of the loop. The loop is directional and helps materially in cutting out interference. To mount the loop on the loop-jack plug, cut off 1 in. of the fiber shell of the plug and make a wooden plug, 11/16 in. in diameter and long enough to come flush with the top of the loop plug when driven into the latter; then drill a hole through it from end to end to take a 5/16 in. brass dowel pin, 2¾ in. long, which is fitted snugly into the wooden plug and the latter is then pushed into the loop plug. This will then allow about 2 in. of the brass pin to stick up above the top of the loop plug, and as the end of the loop is already drilled to take a pin of this size all that is necessary is to place the loop on the pin and push the wooden plug into the loop jack. For those who would rather not mount their loop on the lid of the cabinet, but prefer to have the loop separate, a mounting base comes with the loop and this is provided with three double binding posts to take the three loop leads. If this is used, the three leads from the binding posts mounted on the subpanel must be brought out through holes drilled in the rear of the cabinet. This completes the loop installation. If desired, a pointer taken from an old rheostat can be soldered to the bottom of the loop-jack plug to work over the paper



Details of the mounting of the loop on the top of the cabinet, showing the connections to the binding posts.

dial on the cabinet top. This will assist in logging the loop.

Remove the loop, and drill holes through the rear of the cabinet in line with the binding posts for the A and B batteries. Small hard-rubber bushings, such as are used in the bases of electric table lamps, are shellacked into the holes. These are not essential, but add much to the appearance of the cabinet. Use flexible rubber-covered fixture wire for connecting the A and B batteries to the binding posts. The A-battery consists of a 6-volt 80-amp.-hr. storage battery, and the B-battery of either four 22½-volt heavy-duty B-battery units, or two 45-volt units. These are connected in series and tapped off at the first 18-volt positive tap for the plate of the first detector tube and the plate of the oscillator tube; this will be seen by referring to the wiring diagram. The 45-volt positive B-battery tap is for the plate of the second detector tube and the plates of the three intermediate-frequency amplifynig tubes. The 90-volt positive tap is for the plates of the two audio-frequency amplifying tubes. The instrument is then ready for the tubes.

Take one tube and place it successively in each socket, after pushing in the push-pull filament switch and turning up the rheostats; this will show if there is any error in the filament wiring and eliminates the possibility of burning out all eight tubes. If the tube lights correctly, all the tubes can now be placed in their sockets, being careful to put the C-300 or UV-200 detector tube in the first-detector socket. Set the rotor of the coupling unit at the loosest coupling; see the photo for the approximate position. We are now ready to adjust the instrument under operating conditions.

Take the plug off the end of the loop and place the loop on the extra base that comes with it; take three flexible leads from the loop binding posts in the instrument out to the loop. This will permit the cabinet lid to be raised so that the midget variable condenser and the rotor of the coupling unit can be adjusted for best results under operating conditions. When these have once been set for maximum clarity and volume there will only be two variable adjustments to make in tuning; these are made with the oscillator condenser and the wave-length condenser, and, of course, the position of the loop in regard to the location of the station being received. The rotor of the coupling unit and the midget variable condenser will only require the first adjustment and need not be touched again.

To pick up a broadcasting station:

1. Set the potentiometer about one-quarter of the way up from the lower-left side.

2. Turn up the four rheostats gradually, keeping all four pointers at approximately the same position, and continue until you can hear a soft hum from the tubes.

3. Set the wave-length condenser at any point, say 30°.

4. Rotate the dial of the oscillator condenser 10 to 15° on each side of this mark, moving it slowly and listening for a sound.

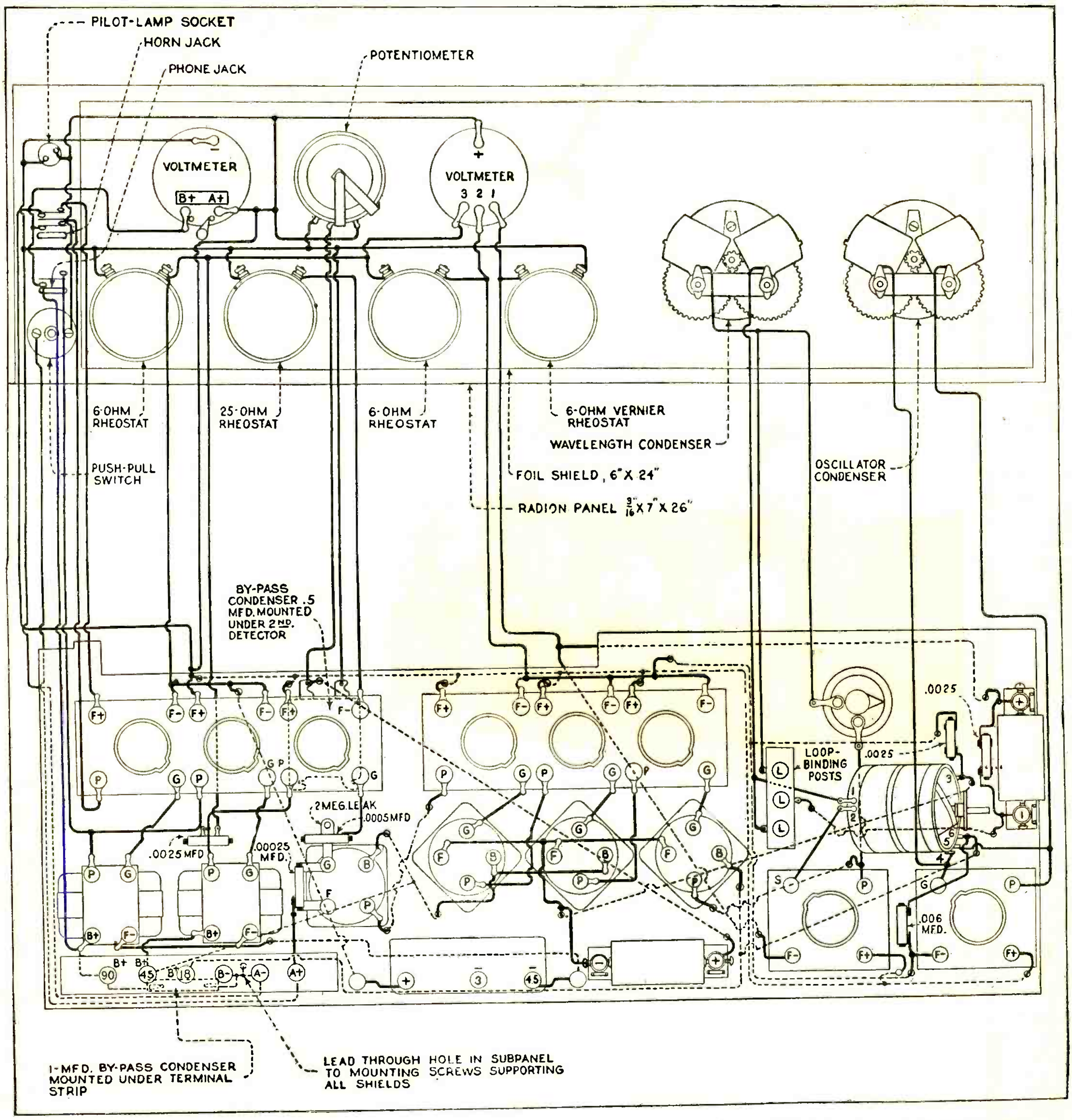
5. If a click or whistle, indicating the presence of waves from a station, is heard, but no words or music can be brought in, turn up the third rheostat from the right-hand end, marked oscillator and intermediate-frequency, and also turn up the first rheostat at the extreme right-hand end of the panel, marked audio.

6. When the point is found at which the broadcast comes in the strongest, it may be that the volume is still insufficient. Then turn up the left-hand rheostat, marked first detector, until the volume is sufficient. If a whistle

is heard, turn up the audio rheostat until the whistle is gone.

7. If nothing is picked up at the first setting of the condensers move the wave-length condenser up to 10°, and again rotate the dial of the oscillator condenser from 10 to 15° on either side of the corresponding mark. Continue this process over the entire range of the dial.

8. If nothing is heard when the two dials have been moved over the whole range it may be that the oscillator tube is not oscillating. Turning up the two rheostats as described in No. 5 should remedy the trouble. Another way of determining whether the oscillator tube is oscillating is to touch its grid terminal with the finger. If it is oscillating, a click will be heard when the terminal is touched and again when the finger is removed.

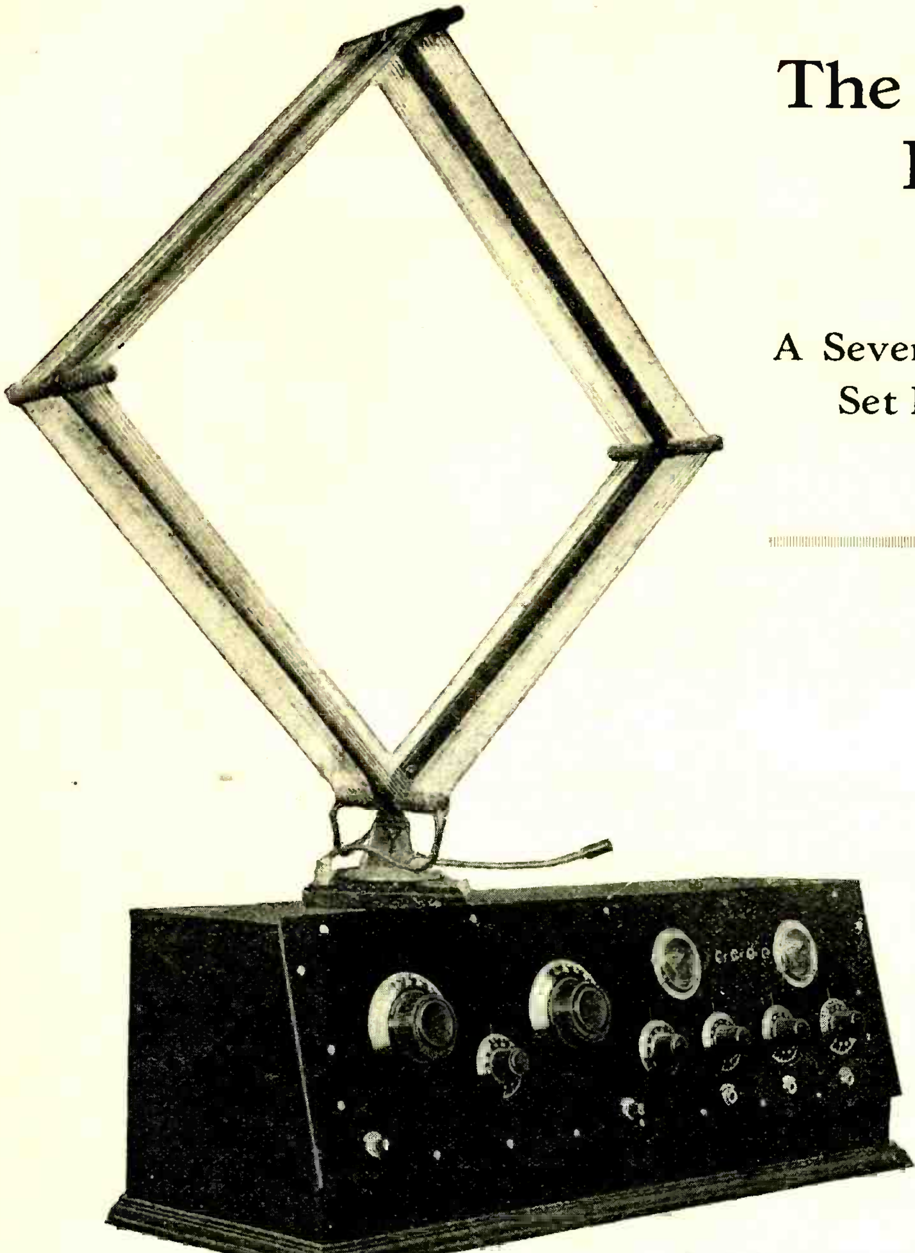


Complete wiring diagram for the Superheterodyne Eight, showing every wire in its proper position. Care should be taken to run every wire exactly as shown, not only to save time in wiring the instrument, but to avoid induction loops. Wires under subpanel are shown dotted, wires above in full lines.

If the instrument has been built according to the construction details outlined in this article one will not have long to wait for a station. Rotate the loop from time to time, as this will often enable stations to be picked up that otherwise may be unheard, as the loop is directional. After the instrument has been checked and properly adjusted for maximum results, take off the temporary loop leads and replace the loop plug on the loop. Close the cabinet and push the plug into the loop jack, and plug the center loop lead into the phone-tip jack. See that the loop plug makes proper connection in the jack; if it does not, the wave-length condenser will have no tuning value and it will be noticed at once. If the loop plug goes too far down in the jack, use washers between plug and jack.

The Evening World Resonatone Receiver

A Seven-Tube Super-Broadcast Set Designed for Ultimate Efficiency



Illustrations by Courtesy of N. Y. Evening World

Photograph of De Luxe Model, Resonatone Super-Broadcast Receiver. Type of loop admirably suited to the circuit is shown. While a standard 18-inch pancake loop will give very good general results and is slightly more directional in its effect with consequently slightly sharper tuning of the receiver, the 20-inch box type in the photo picks up noticeably more energy from far distant broadcast stations and has a variable feature that tends to greatly reduce static and noise level interference in a highly sensitive receiver.

A PARTICULARLY efficient combination of radio frequency and audio frequency amplification is presented in this article from *The N. Y. Evening World Radio Section.* It was introduced as The Evening World Resonatone Super-Broadcast Receiver and its construction is described in detail by its designer, *H. Conklin,* who built the special De Luxe model shown in the illustrations.

In a special test reported by The N. Y. Evening World, this receiver, in one evening, during a period after the last local broadcaster signed off, brought in forty-six stations on the loud speaker only, and without in any case using the added stage of push-pull A. F. amplification which is furnished in the receiver.

At the conclusion of this test KFI was again tuned in, plugged into the push-pull amplification, and selections and announcements clearly copied fifty feet from the loud speaker.

During five weeks from the time when the circuit was first experimentally laid out on a board to its final completion as a receiving set, 118 stations were logged, in the course of testing, all on the loud speaker, and using only five tubes. These stations were located in sixty-six cities, representing twenty-four States, three Canadian provinces, Cuba, Porto Rico and Mexico, and the majority of them were logged several times. There is not sufficient space here for publishing this complete log, but forty cities, including fifty-two stations, all over 500 miles distant from New York City, were logged. H. C.'s description of the receiver follows:

The circuit employed in the Resonatone is a combination of well known principles, all in standard practice, as the diagram will show. Its extreme sensitivity is derived from the employment of four stages of radio frequency amplification, with unusually efficient R. F. transformers. Its selectivity is obtained by tuning the first of these stages as well as the loop, and with properly engineered low loss, straight line condensers.

There are only two major controls, the two large tuning dials. Such is the stability of this circuit and this receiver that potentiometer and rheostat adjustments are much less than ordinarily critical.

Only five tubes are employed on all local reception except when unusual volume is required. The sixth and seventh tubes, in the push-pull amplification unit, are used when it is desired to bring distant programs up to approximately local volume. An unusual feature of this receiver is the fact that the loud speaker can be plugged into the push-pull jack without "losing" the weakest distant signal and having to hunt for it again by returning. Another unusual feature is the ability to regulate this push-pull amplification, without distortion, on the strongest local broadcasting, from the veriest whisper of sound up to full volume, using ordinary UV-201A or C301A tubes throughout.

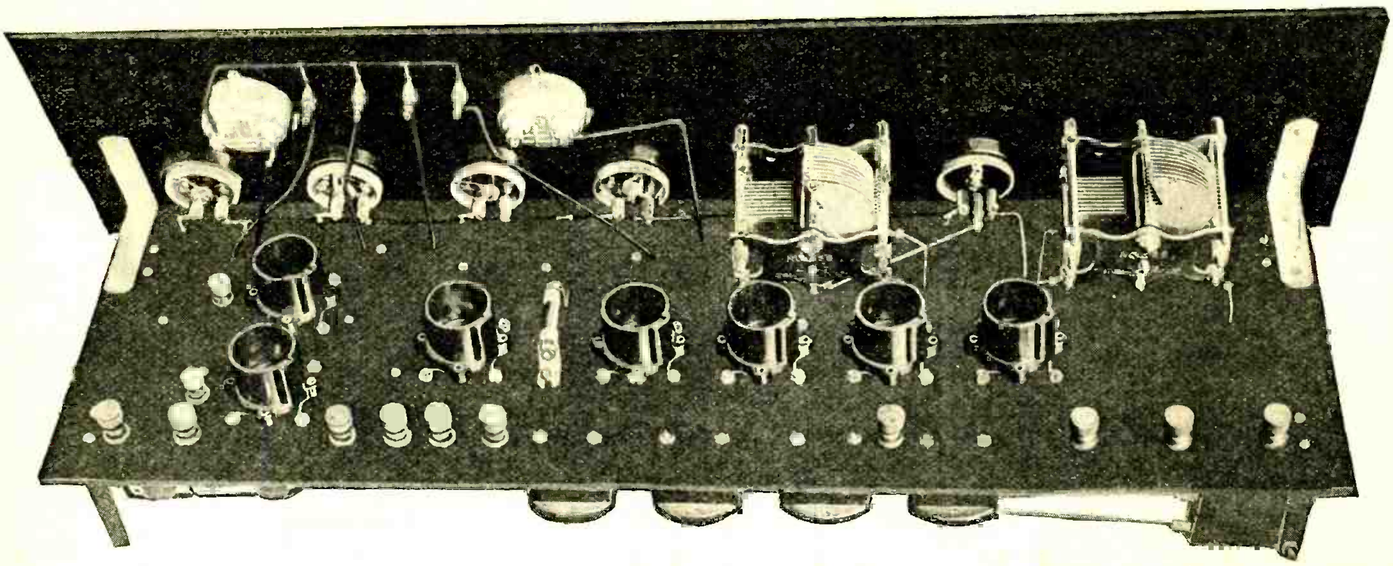
Special Parts Used

This receiver introduces to amateur constructors a new radio frequency transformer, made by the Werner Radio Manufacturing Company of Brooklyn, N. Y. To this transformer the great efficiency of the receiver is in no small part due, as it possesses an unusual degree of selectivity and sensitivity. An unusual advantage of these transformers is the fact that three or more, used in a multi-stage circuit, can be placed closely together without in any way affecting stability. In the Resonatone receiver, three types are used, the W1, W2 and W3, so designed that they overlap their peaks into a satisfactorily flat curve with an un- plate and grid terminals slipped directly over the plate and grid terminals of the transformers. (See photograph and shelf template.)

Two meters are shown on the panel in the photograph. One is for an ammeter and the other for a voltmeter registering from 0 to 120 volts. The permit even finer tuning, especially on those stations which "come in on a hair line."

Panel and Shelf Templates

In drilling the panel and shelf follow the template measurements for locating the holes. The best plan would



General view of receiver removed from cabinet, showing panel assembly and top assembly of shelf-type baseboard looking from the rear. Note how terminals of R. F. transformers come up through shelf, P and G of tube sockets, with bases removed, mounting directly on plate and grid terminals of transformers. A. F. transformers also hang from shelf, 90 per cent. of the wiring being hidden from view.

usually high amplification level. The tuned stage tunes another Werner Transformer designed for the purpose —the W. T.

In the audio frequency end of the circuit, in which push-pull amplification forms the last stage, it is well to select a make which includes both types of transformers, designed to work in that combination. It is well also to use transformers of the same ratio in the first two stages.

Both the loop and the stage of tuned radio frequency are tuned with .0005 mfd. variable condensers. For sharpest tuning and best general results only a properly designed low loss condenser should be used, preferably of the straight line type. Those shown in the photograph are Type 51-D, No-Loss, Pyrex Insulated Condensers made by the General Instrument Company.

A good fixed crystal should be used as a rectifier; a variable crystal only makes an added control. A fixed crystal of the cartridge type that can easily be changed by slipping it into and out of two clips or brackets is the most convenient form. A glance at the photograph will show how this is mounted on the shelf for accessibility.

Care should be taken in the selection of rheostats and potentiometer to select easy moving ones that are quiet in operation.

In this De Luxe Model, the radio frequency transformers are hung from the shelf with their four binding posts projecting through to the top. Benjamin tube sockets, with their detachable bases removed, are mounted with their

PARTS USED IN RESONATONE DE LUXE MODEL

Radion panel (mahoganite), 30½x8½.
1 Radion shelf (mahoganite), 28¾x9.
2 General Instrument .0005 mfd. no-loss condensers.
1 Werner W-1 R. F. transformer.
1 Werner W-2 R. F. transformer.
1 Werner W-3 R. F. transformer.
1 Werner WT-coil tuned R. F. transformer.
2 Modern 4 to 1 A. F. transformers.
2 Modern push-pull transformers.
1 Rasla fixed crystal.
7 Benjamin clara-tone tube sockets (standard).
1 Sterling R. 32p 0-3 amp. panel type DC ammeter.
1 Sterling R. 344 0-120 volt panel type DC voltmeter.
1 Amsco 400-ohm potentiometer.
1 Amsco 6-ohm rheostat.
1 Amsco 10-ohm rheostat.
2 Amsco 20-ohm rheostats.
1 Carter single circuit jack.
2 Carter double circuit jacks.
2 Carter jack switches.
4 Benjamin switches (new type)
13 Eby binding posts.
2 4-inch dials.
1 mfd. Dubilier by-pass condenser.
6 mica fixed condensers (see diagram).
6 large brass angle brackets (see article).
5 small brass angle brackets.
30 ½-inch flat head nickeled machine screws, ⅛-inch diameter, with nuts to match.
12 extra nuts as above.
12 ⅝-inch flat head nickeled wood screws.
8 lengths black spaghetti.
15 lengths No. 14 bus bar.
6 doz. tinned copper terminal lugs.

holes as shown exactly accommodate Sterling meters. Between the meters are four Benjamin switches, one for each plate voltage used.

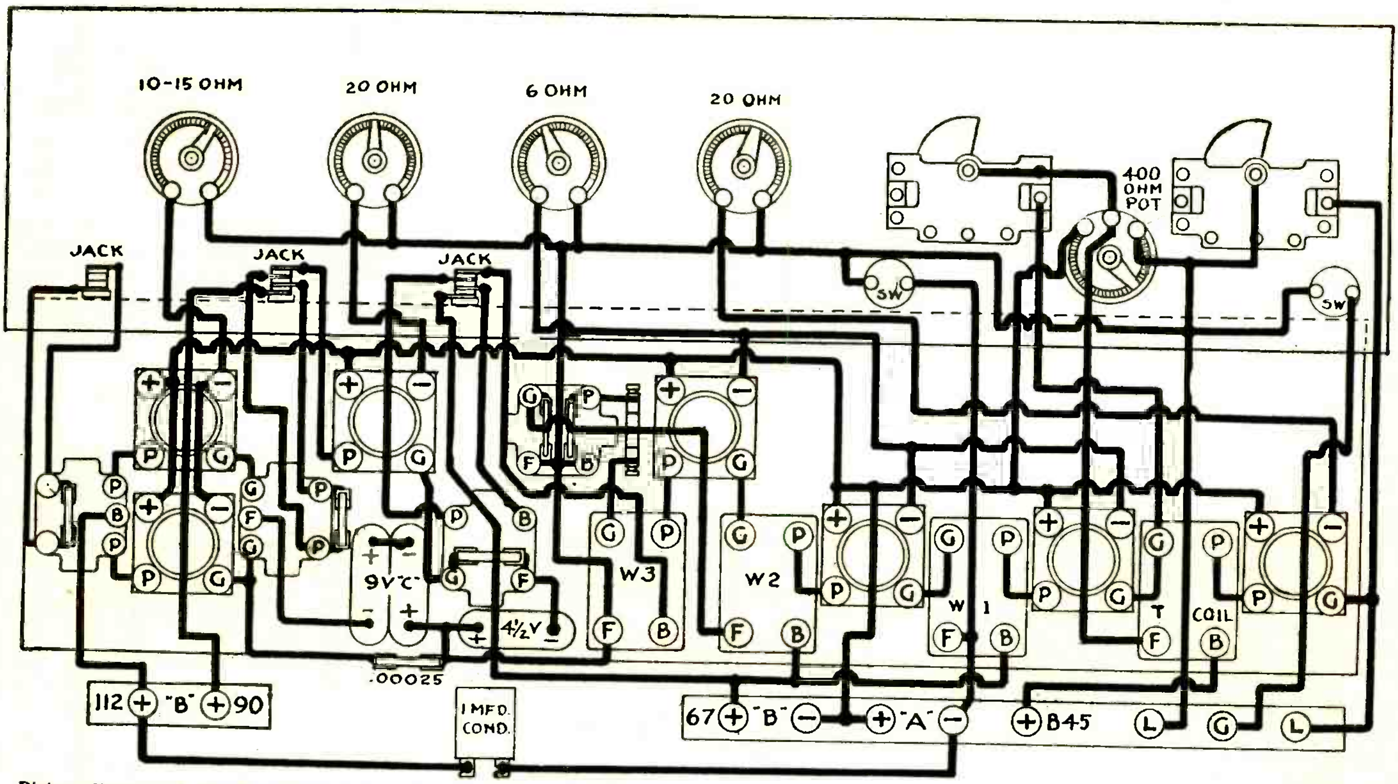
As tuning on distant stations is quite sharp with this receiver the selection of dials is important. Not only for appearance but also for facility in handling, four-inch dials should be used, with broad, deeply milled knobs that can be firmly gripped, if plain dials are chosen. A vernier type dial will be to draw a template of your own on a piece of paper, the exact size of shelf and panel, carefully measuring it off with rule and square. The caption under each diagram explains the purpose of each hole marked.

No hole dimensions are given. Simply measure the diameter of the instrument shaft or switch or jack or binding post that is to pass through the hole, and select the size drill required for it. Mounting screw holes for condensers and rheostats can be drilled from templates furnished with the instruments.

The holes in the panel marked F, and also the holes in the shelf marked F, are for the flat head nickeled machine screws that hold the brackets fastening the panel and shelf together and the legs that support the receiver when it is out of the cabinet. The small diagrams on page 16 show how this is done. Nuts should be secured for the screws. Use the diagram for bending these brackets at the required angle as the cabinet plans exactly correspond. Three small brackets mount downward, and two of the large ones upward. The large ones should be three inches long on each angle, about three-quarters of an inch wide and one-sixteenth of an inch thick. The small ones, of the same thickness, should be three-quarters of an inch long and one-half inch wide. The two additional ones mount the crystal. These can all be purchased ready bent at right angles and with holes already drilled to fit the template drilling measurements at the 5 and 10 cent store radio counter. Otherwise do not drill the screw holes in the brackets until they have been shaped to panel and shelf, when they can be marked for drilling so that holes will correspond. The four remaining large brackets form the legs.

Some additional drilling is necessary for wiring that passes through the shelf. Follow the measurements given in the accompanying diagram (top view), working on top of the shelf. These holes are all at the front of the shelf, near the panel. A one-eighth inch drill is the right diameter.

Now we're ready for assembling, but there will be eight more holes to drill, so we will start there. Group the four audio frequency transformers, exactly as shown in the illustration on the underside of the shelf. To help guide you it would be well to temporarily put the three jacks and the filament jack switch in place at the bottom of the panel and temporarily fasten shelf base and panel together. The shelf can be laid on the table with the panel hanging down over the edge. The two audio transformers should be "toed" as shown, with the secondary of the first one (at your left in the photograph) and the primary of the second one toward the panel. The input and output transformers of the push-pull combination should face each other, as shown, on the ends with three terminals. In the photograph the input transformer is the one on your left. When these are all set in place, mark for mounting screw holes, two for each transformer at opposite corners of the base. When these eight holes are drilled, disassemble panel and shelf.



Picture diagram of circuit for seven-tube model. For a five-tube model the circuit ends at the second double jack, which then should be a single jack. This diagram shows actual connections but not exact wiring arrangement.

Assembling Directions

Start the assembly by first mounting on the panel the potentiometer and four rheostats. It is presumed that the drilling of the panel has been completed by including screw holes for mounting condensers, rheostats and the two panel meters, which were purposely indicated, these varying with the make of instrument used.

Facing the panel, first at your left is the potentiometer. Next to this, at your right, is a 20-ohm rheostat which controls the first R. F. tube. Next comes the 6-ohm rheostat controlling the second, third and fourth tubes. Next comes the other 20-ohm rheostat controlling the fifth tube or second A. F. amplifier. Finally the 10-ohm rheostat controlling the two push-pull tubes. Now mount soldering lugs on the two terminals of each rheostat and the three potentiometer terminals.

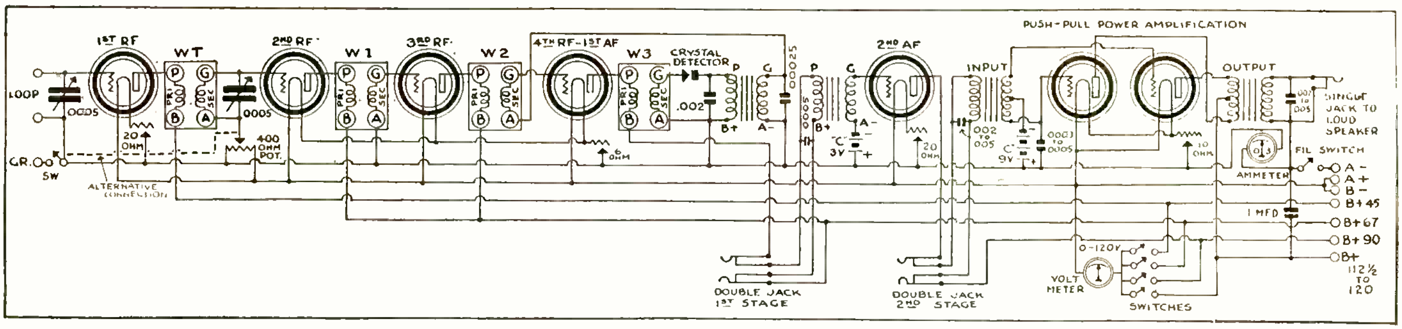
Next mount the two panel meters, the ammeter at your left, the voltmeter at your right. Insert the four switches with the connecting lugs extending up and down from each, not crosswise. Now mount the three jacks and two jack switches. Starting at your left, the two switches come first, then the two double jacks, and, last, the single jack. Do not mount the condensers yet, as they will be in your way when wiring.

Now start the shelf assembly. Place and keep the shelf with the front toward you as all directions will read for this position. Put in the thirteen binding posts, in the order described, with a soldering lug on each underneath the shelf. Binding post positions are indicated by the A holes in the shelf template. Reading from the left across the back they are 1, ground; 2 and 3, loop; 4, B plus 45; 5, A minus; 6, A plus; 7, B minus; 8, B plus 67½; 9, B plus 90; 10, B plus 112½-120.

Two of the C battery posts line up directly under the B plus 90 post, first C plus, below C minus 3-V. The other is between the two push-pull sockets.

Mount the four Werner R. F. transformers by removing the milled screw caps and thrusting the four terminals of each up through the holes drilled in the shelf, marked B in the shelf template, first slipping a soldering lug over each terminal so that it is between shelf and transformer. It would be advisable to mark on the bottom of each transformer, in each corner, the terminal markings of each binding post above, as a guide to wiring later when spring, which is very thin. The next three sockets mount in the same way to the transformer terminals, G on G and P on P, leaving the G terminal of the last transformer free. The remaining three sockets mount with the round headed terminal screws thrust down, first through the socket springs, then through one each of the larger nuts, and countersinking the shelf holes to take the heads. We are now ready to start the wiring. Do not attempt to exactly follow the wiring shown in the photos as it will be somewhat changed in the model we are now constructing.

It is important that you bear in mind, in following instructions, that every direction given reads with the



Schematic diagram of the circuit employed in the Resonator Super-Broadcast Receiver. One stage tuned radio frequency, two stages straight transformer coupled radio frequency, one stage transformer coupled radio frequency reflexed with one stage audio frequency amplification, one stage straight audio frequency and a final stage of push-pull audio frequency amplification. Fixed crystal used as a rectifier in place of detector tube. Note switch that optionally cuts ground connection in or out of A-minus line. Also alternate connection from first condenser to moveable arm of the potentiometer instead of the "A" battery negative in case oscillation is found difficult to control.

these terminal markings will be hidden. (See photo.)

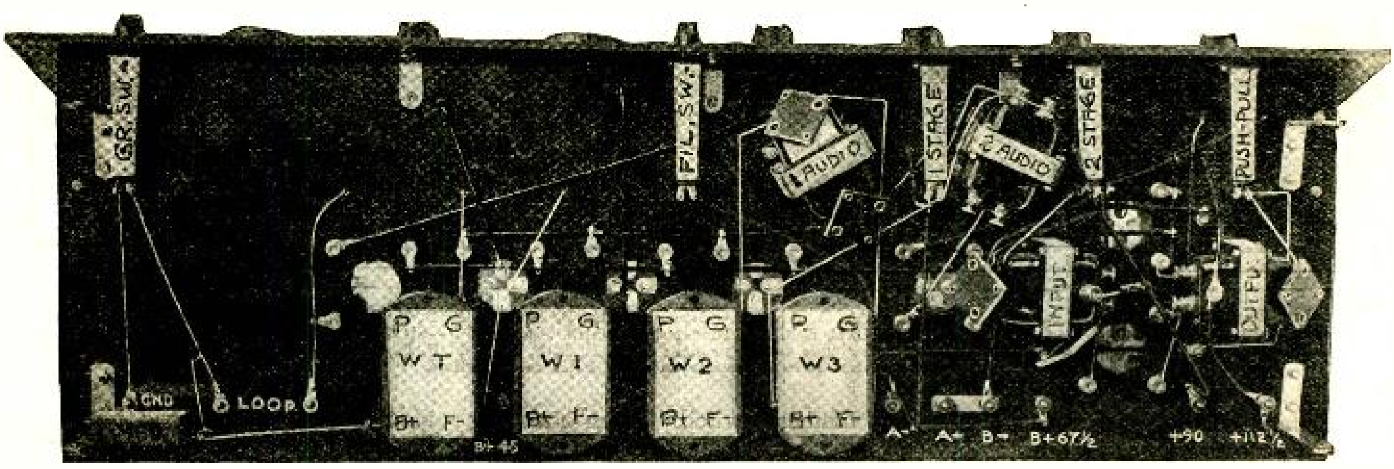
Mount in the order shown in the photograph. Temporarily fasten them with the screw caps, which may have to be reversed to grip. The transformers should mount with the P and G terminals toward the front and the B plus and F minus at the rear. This is imperative.

Next mount the seven Benjamin sockets. These detach from the base, then through the shelf (holes marked C on template), fastening underneath with the screw caps under which, in each case first has been slipped a soldering lug. The leftover round lock nuts can now be used in place of the screw caps for fastening the transformers at the rear posts.

Now mount the fixed crystal rectifier. The accompanying diagram shows how the two mounting brackets are slotted to take the threaded ter- panel or front of the assembly away from you. In other words with the back of the shelf toward you whether it is turned face up or bottom up. The two wiring hole diagrams were drawn from these positions so that the identifying letters would read correctly in both cases.

The Filament Circuit

Wire all the filament lines fist. First lay the panel face down with the bot-



Bottom of the shelf, showing the position and wiring of the various parts. Note the short direct leads which are made between connecting points.

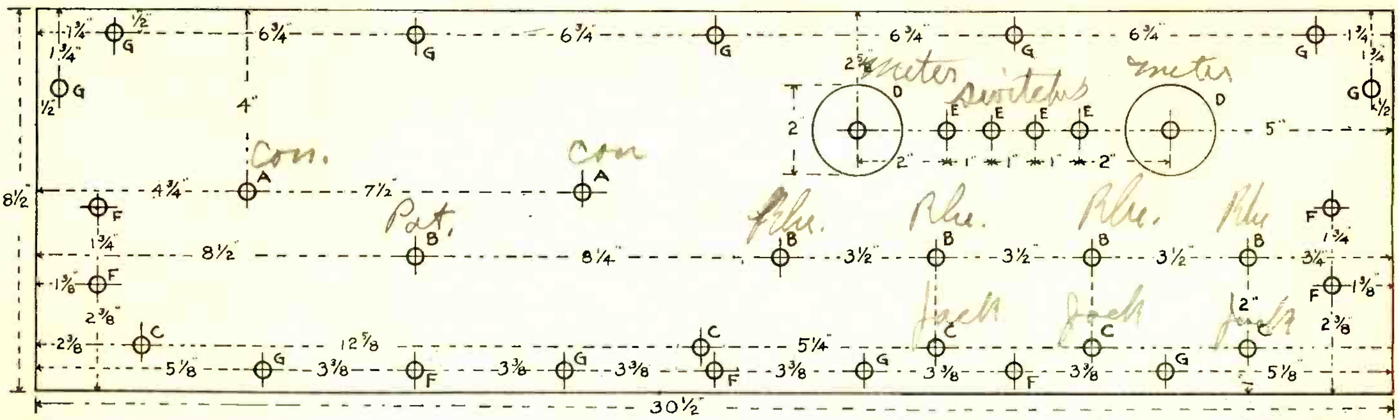
which we do not use, by removing the four binding posts. Better leave one undetached as a guide for mounting the others. All mount in the same position, with the two filament terminals to the front. When demounted, these consist only of the four springs. Unscrew the front line of caps from the transformer terminals, and in their place screw tightly down eight of the larger nuts left with the discarded socket terminals. Now slip the plate (P) spring on the first socket over the first or P terminal of the first transformer, which is the T coil. Fasten with one of the smaller left-over nuts, being careful not to bend or twist the minal screws in order to make them adjustable for varying lengths. Fasten the crystal into the two brackets. The bracket with the two slots slides over the P terminal post of the last R. F. transformer and fastens with a nut. The other bracket fastens with a round headed screw (one left over from the discarded tube socket terminal posts) passed down through the shelf at the hole marked D in the original shelf template and secured underneath with a nut, under which a lug should be placed.

Now mount the four A. F. transformers as already provided for, using flat headed machine screws and nuts tom toward you. Set the right hand (on your right hand) lugs on the rheostats and potentiometer vertically downward and connect them all with a length of spaghetti covered bus bar, letting it project one inch beyond the potentiometer lug for a connection to be made later.

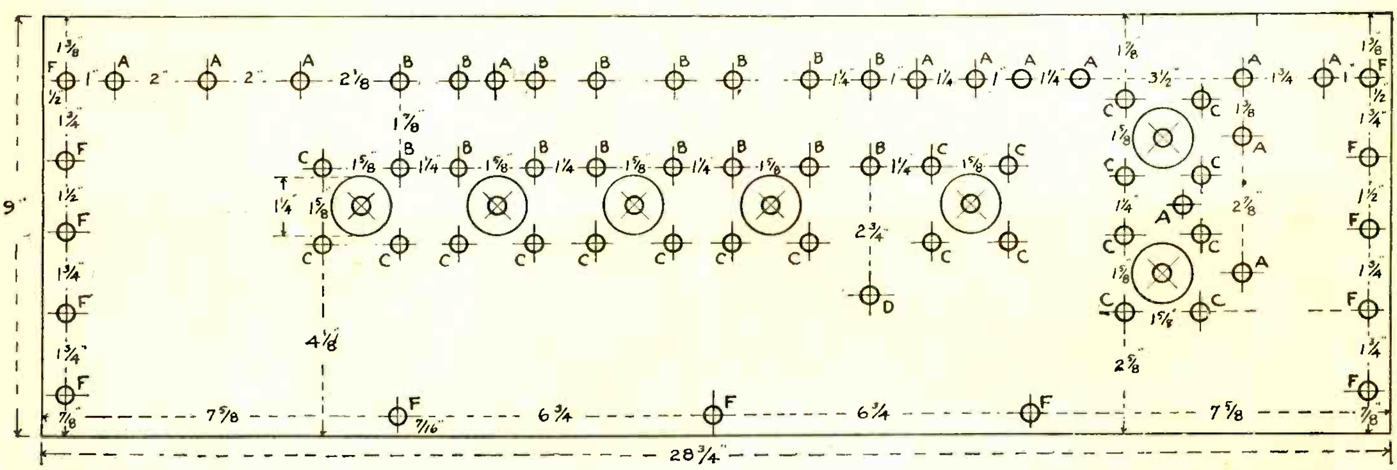
Now set the panel temporarily aside and place the shelf in front of you, bottom up, remembering to keep the front edge away from you. Turn the lugs on the right hand (all directions read your right and your left) or A plus terminals of the five-tube sockets vertically toward you and connect them with a length of spaghetti covered bus bar, leaving a little over a half-inch projecting at the right beyond the fifth socket on your right. Now connect the two A plus terminals of the two push-pull sockets in the same way. Then from a point midway between the A plus and grid terminals of the push-pull socket nearest the panel, bring a spaghettied lead around the left-hand push-pull transformer, solder to the length of wire left on the other A plus line, continue to the A C and through to a 20 ohm rheostat above it. Next a spaghettied lead connecting the A minus terminals of the two push-pull sockets and continuing through hole A to 10 ohm rheostat. Now carry a spaghettied lead from the A plus terminal of the first tube socket, through hole G, to unconnected side terminal of potentiometer.

Next carry a spaghettied lead from the A minus battery binding post, curving around to right hand lug on right) and No. 2 the second one. From the movable plate connecting lug No. 1 condenser bring a bare lead down through hole Q and diagonally across to the first loop binding post. From where this lead comes through hole Q connect another lead to one lug of the ground jack switch. From the other lug of the switch carry a lead to the ground binding post.

While you are about it carry another bare lead from the second loop



Template diagram for drilling panel, giving exact measurements from centre to centre of holes and from edges of panel. Only shaft holes of instruments, &c., are indicated as mounting templates usually accompany such apparatus and vary with different makes. Drill sizes are omitted for the same reason. A, A—Variable condenser shafts; B, B, B, B, B—Potentiometer and rheostat shafts; C, C, C, C, C—Ground and filament switches and jacks; D, D—2-inch circular holes for panel mount meters; E, E, E, E—B-plus meter switches; F, F, F, F, F, F, F—Machine screws for supporting brackets; G, G, G, G, G, G, G, G, G, G, G—Wood screws for fastening panel to cabinet.



Template diagram for shelf. A, A, A, A, A, A, A, A, A, A, A, A, A—Binding posts; B, B, B, B, B, B, B, B, B, B, B, B, B, B, B, B—R. F. transformer binding posts; C, C, C, C, C, C, C, C, C, C, C, C, C, C, C, C, C, C—Tube socket machine screws; D—Fixed crystal cartridge bracket; E, E, E, E, E, E—One and one-quarter inch circular holes under tube socket prongs; F, F, F, F, F, F, F, F, F, F, F, F, F—Machine screws for supporting brackets. See note in article on other holes to be drilled.

plus battery binding post, then to the B minus post directly at its left.

Next connect, with a spaghettied lead, the A minus terminals of the second, third and fourth of the five tube sockets that are in line. Continue this wire widely around the first Audio transformer, to escape the crystal mounting nut, then through the hole marked D in the shelf and solder to the remaining lug on the rheostat. This lug and the other corresponding lugs on the rheostats and potentiometer should be set horizontally.

Next carry a spaghettied lead from the A minus terminal of the first (left) tube socket, along the shelf diagonally to hole E and through to the 20 ohm rheostat above it. Next a spaghettied lead from the A minus of the fifth socket, curved around transformer to hole jack filament switch. From other lug on switch a spaghettied lead through hole M to first terminal (zero side) of panel mount ammeter. Then a lead from other terminal of ammeter straight down to common A minus line that connects the rheostats.

The lighting circuit is now completed and you can test it by connecting an A battery to the two binding posts and inserting a tube successively in each socket with the rheostats turned partly on and the switch also turned on. If any or all fail to light check your wiring for fault.

Other "A" Minus and Grid Leads

You can now mount your two variable condensers on the panel. No. 1 will designate the first one (on your binding post to the grid terminal of the first tube socket and then, curving around to well escape the A minus terminal of the socket, pass through hole P and connect to the fixed plates of No. 1 condenser. Then from the movable plates of this same condenser take a bare lead to the A minus side of the potentiometer which was left with an inch of wire projecting for soldering this connection.

Next carry a lead from the middle terminal of the potentiometer to the movable plates of No. 2 condenser, thence spaghettied through hole O and across to the F minus terminal lug of the first of the four R. F. transformers, designated in the photograph as W-T. Be sure to keep this well away from the 45V binding post nut. Then from the fixed plates of the condenser bring a bare lead down through hole N, elevated about three-quarters of an inch and then down to the grid terminal lug of the same transformer, the W-T.

Now from the F minus terminal lug of the second R. F. transformer, the W-1 take a spaghettied lead across to

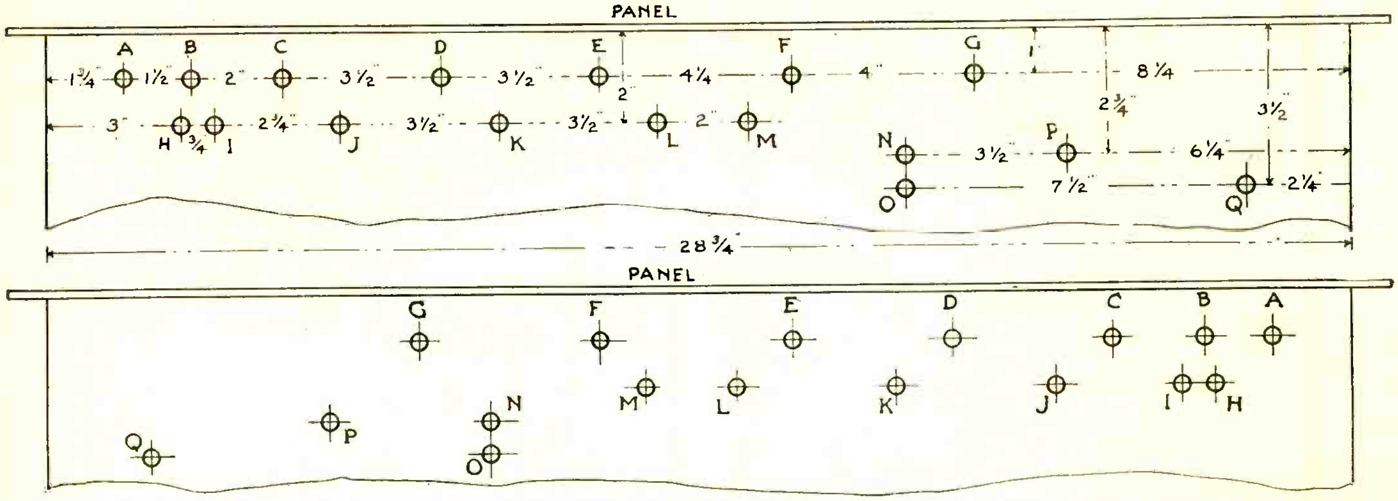
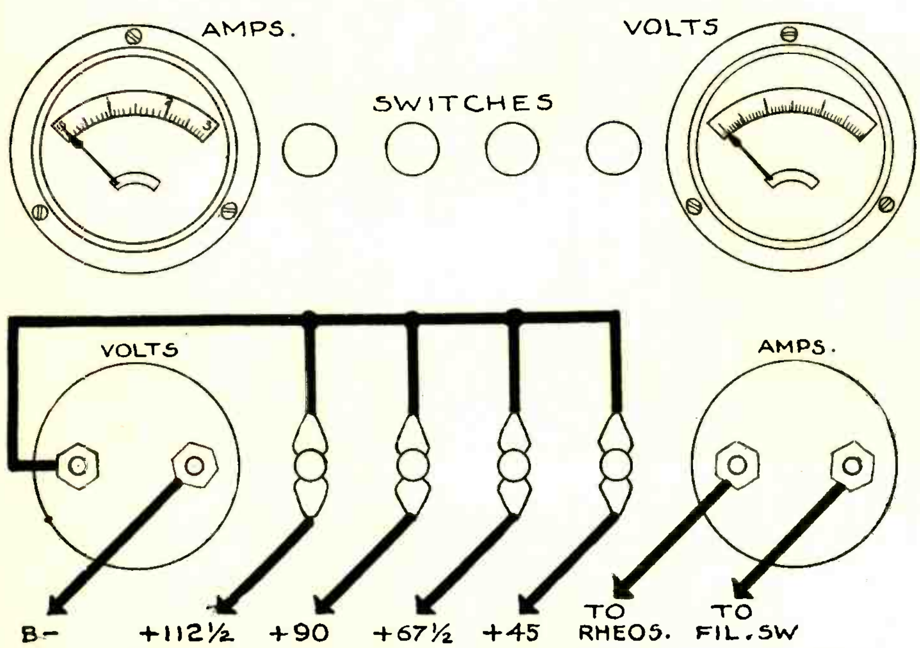


Diagram for drilling holes by which wiring is passed through shelf, all holes being keyed by letter for reference. Upper drawing is view of shelf from top. Lower drawing is reverse view from bottom.

hole F and through it to the A minus line that connects all the rheostats. Next carry a spaghettied lead from the F minus terminal lug of the third R. F. transformer, the W-2, across to the G terminal of the secondary of the first A. F. transformer. From the



Proper method of connecting panel mount meters and switches. Upper illustration is view from face of panel; lower illustration wiring arrangement from rear.

F terminal of the same secondary of this same A. F. transformer carry a spaghettied lead to the F minus of the fourth R. F. transformer, the W-3. To this same lead two other spaghettied connections are made en route—one to the B plus terminal (in Moderns also marked F) of the primary of the same A. F. transformer and the other, at a point about one and one-quarter inch from the R. F. transformer connection, directly over to the C plus binding post.

While we are about it we will carry a lead from this C plus binding post across to hole B and through to the A minus line that connects the rheostats. Then back to the first A. F. transformer again where we drop a short bare connection from the P terminal of the primary to the crystal bracket screw and nut.

Now moving to the second A. F. transformer, we first take a bare lead from the G terminal of the secondary to the grid terminal of the fifth tube. Then from the F terminal of the secondary a spaghettied lead goes to the minus 3-V. C battery binding post.

Next we go to the input push-pull transformer. Here we take bare leads from the two secondary terminals to the two grid terminals of the push-pull tube sockets, and a third lead, spaghettied, from the upper middle terminal to the minus 9 V. C battery terminal.

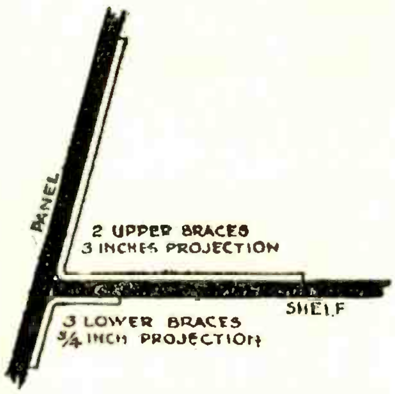
Plate and B Plus Leads

There remain now only the plate and B plus leads. First a spaghettied lead from the B plus 45 V. binding post to the B plus terminal of the first (W-T), R. F. transformer. Next, from the B plus 67½ V. battery terminal to the second and third (W-1 and W-2) R. F. transformers. From this same lead, at a point directly opposite the first stage phone jack (between the first two A. F. transformers) take a spaghettied connection across to the bottom outer (toward you) lug of the jack. From the top outer lug of this jack (nearest shelf) take a spaghettied lead to the B plus terminal of the fourth (W-3) R. F. transformer. From the inner jack lug nearest the shelf pass a spaghettied lead down and around to the P terminal of the primary of the second A. F. transformer. From the remaining inner jack lug pass a spaghettied lead to the other primary terminal of the same A. F. transformer.

Next from the plate terminal of the fifth tube socket carry a spaghettied lead to the outer lug of the second stage jack that is nearest the shelf. From the other outer lug take a spaghettied lead to the B plus 90 V. battery binding post, keeping it well away from other leads, particularly the push-pull grid leads. Then from the inner jack lug nearest the shelf take a spaghettied lead to the primary or input terminal of the input push-pull transformer that is nearest the back of the shelf. From the other input terminal a spaghettied lead goes to the remaining inner jack lug.

Now leads are brought from the

plate terminals of the two push-pull tube sockets to the nearest terminals of the output push-pull transformer.



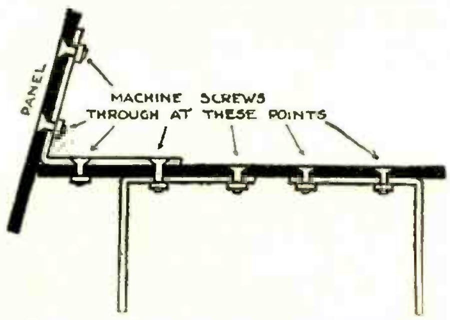
This is the exact angle at which panel should be fastened to shelf and should be used as a guide for bending brass support brackets.

The upper and centre terminal connects to the B plus 112-120 V. battery binding post by a spaghettied lead. The two output terminals then connect to the single jack, the terminal nearest the panel going to the lug nearest the shelf, the other passing above it a half-inch closer to the shelf.

There now remain only the meter connections and the bypass condensers. The special diagram shows how the connections are made to the voltmeter. From the B minus or zero terminal on the meter take a lead down through hole I in shelf and connect to A plus terminal of nearest push-pull tube socket, as this is in the common A plus-B minus line.

lower lug of the plus 45 V. switch. Next, from B plus 67½ volt lead where it connects to first-stage jack, through hole K to lower lug of 67½ V. switch. Next, from B plus 90 V. lead where it connects to second-stage jack, through hole J to lower lug of 90 V. switch. Last, from B plus 112 V. middle terminal on output push-pull transformer, through hole H to lower lug of plus 112 V. switch.

Connect B batteries to binding posts and if meters register properly when



How shelf legs and panel end brackets are fastened.

each switch is pulled out, and swing back to zero when switch is pushed back, the connections are right. Never pull two switches at the same time as this short circuits part of your B battery. And never leave any switch pulled out and meter reading, as the resistance in the meter will overheat and be ruined. The meters are only for momentary readings, not for continuous registration of high B voltages.

densers on the input and output push-pull transformers can be connected in the same way, but the capacities will have to be experimented with to assure best results. The remaining condenser can be connected on one side directly to the grid terminal of the input push-pull transformer and on the other side to the A minus lead which passes at the transformer's base.

When the set is completed the C battery 9 1-2 volt units in series, the first tapped at from 3 to 4 1-2 volts, stand on the shelf inside the cabinet, next to the C binding posts.

If the plate voltages indicated are used, clearest reception and greatest stability in operation will be had. Greater volume, however, is obtainable by putting 67 volts on the first R. F. stage instead of 45, and 90 volts in-

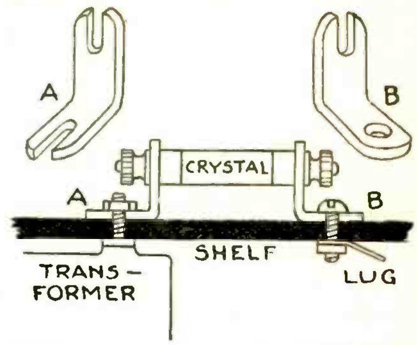
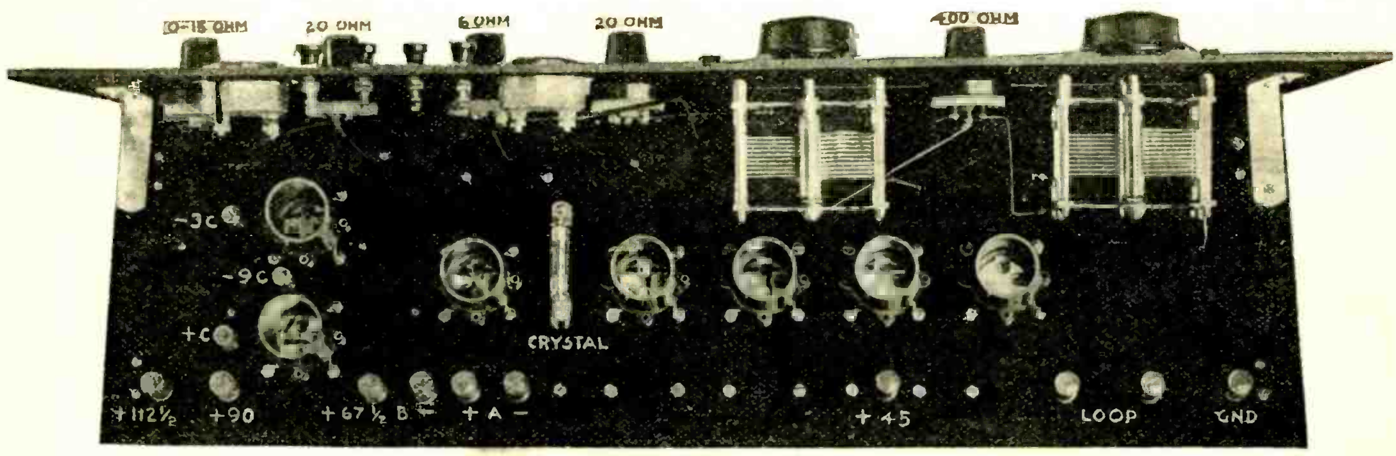


Diagram of cartridge crystal mounting and method of slotting brackets.

stead of 67 on the next three, either stepping the last stage of audio up to a higher voltage or letting it remain at 90. A little sacrifice in quality and



A top view of the panel and shelf assembly indicating the location of parts.

The little Benjamin switches come with two lugs attached. Set them so that these lugs all set vertically, being careful that the same terminal of each switch is at the top position so that all will work in identically the same manner as one connection will be common. This common connection is a lead connecting all four upper lugs and the B plus or 120 V. terminal of the meter.

Now take a spaghettied lead from the B plus 45 V. battery terminal under shelf, around back of the second and third R. F. transformers and across to hole L in shelf and to the

Bypass Condensers

The capacity of the bypass condenser shown in the schematic diagram across the A minus and B plus is one microfarad. An additional condenser of from .00025 to .0005 capacity, not shown in the diagram, possibly may be found of advantage connected across the primary of the second A. F. transformer. Both condensers on the first A. F. transformer can be of the capacity indicated and be connected directly across the primary terminals and secondary terminals. The con-

ease of control will result. A common plate voltage of 90 can be used, but operation becomes more critical. As an alternative, 67 can be used on all four R. F. stages and 90 or more on the free audio.

A C battery voltage of from 3 to 4½ should be used on the last stage of audio with at least 9 on the push-pull. The push-pull B battery voltage can be varied from 110 to 120.

The "De Luxe" model of the Resonatone receiver was designed for the radio fan who wants the best, what-

(*Continued on Page 36*)

The Harkness Counterflex Receiver

Directions for Assembling the New Three-Tube Reflex

THE Harkness Counterflex set is one of the most efficient forms of reflex receivers which has thus far been presented to the radio public. If this set is built with the best of care as to neatness of workmanship, the constructor will find that he will not be disappointed for his efforts.

The assembly of a well-designed layout as built for commercial purposes has recently been given in *Radio in the Home* Magazine by *Kenneth Harkness* as follows:

Of course, you cannot build this set with any odd parts which you have lying around the house; for instance, of all the audio transformers on the market, there are only three makes which will conveniently fit this set. If you do not own any of these transformers you will have to buy them. Similarly, you need a special triple socket subpanel to make this receiver; but this, and all other parts, can be purchased, and all you have to do is to assemble and wire them in the usual manner. You don't need any special tools—just the usual screw-driver, pliers and soldering iron.

The wiring is particularly easy, because the set was designed with this object expressly in view. It was carefully designed for quantity production in a factory, and, since the bending and soldering of wires is one of the most costly items of production, you will realize it was necessary to arrange the parts so that they could be wired together as easily as possible.

The main difference between this receiver and the average home-built set lies in the arrangement of the tube sockets and audio-frequency transformers. Amateur constructors usually mount their tube sockets and audio-frequency transformers alongside each other on a wooden baseboard, whereas, in this receiver, a hard-rubber triple-socket "subpanel" is used. The audio-frequency transformers are mounted *underneath* this subpanel and the entire unit is held to the front panel of the receiver with two small brackets. Fig. 10 shows how this simplifies the wiring of the audio-frequency transformers. It would manifestly be impossible to obtain such short, direct wiring if the tube sockets and audio transformers were mounted alongside each other on a baseboard.

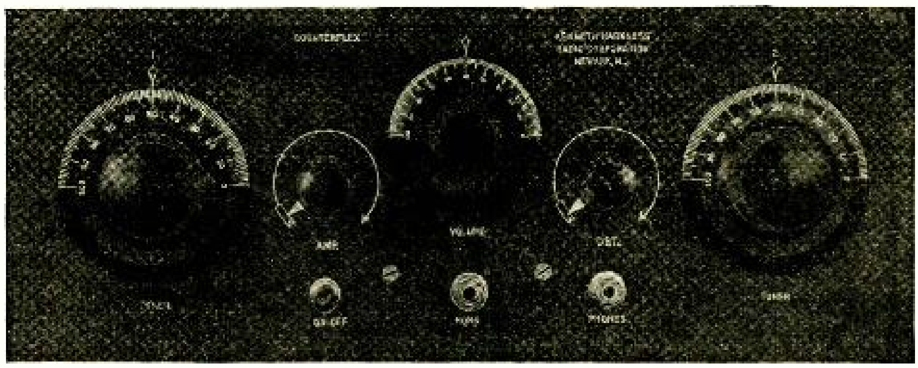
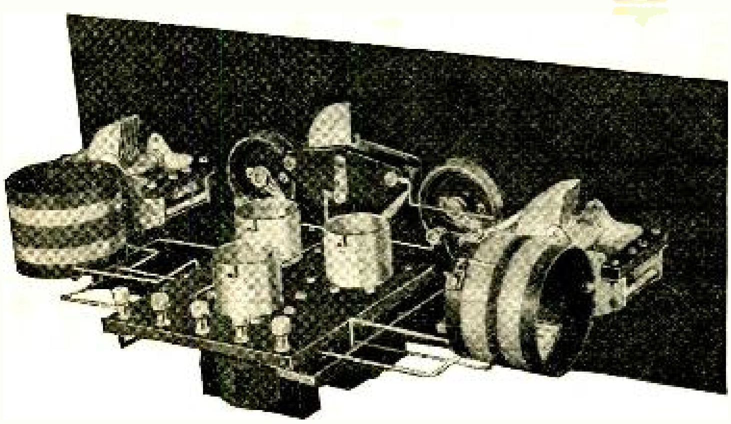


Fig. 1.—Front panel view of the Counterflex receiver showing the arrangement of tuning controls and rheostats.



Illustrations by Courtesy of Radio In The Home (Phila., Pa.)

Fig. 2.—How the parts appear from the rear of the panel all mounted and wired.

Fig. 4 shows the schematic wiring diagram. The necessary parts used in the construction of the three-tube Counterflex receiver shown in the accompanying illustrations can be purchased either in the form of a kit ready for assembly or separate parts. The list is given in the following:

1 front panel (Radion or Formica), measuring 7 in. x 18 in.
1 Harkness triple socket subpanel with mounting brackets.
1 Harkness or Shamrock counterformer, Type T1.
1 Harkness or Shamrock counterformer, Type T2.
1 Harkness or Shamrock counterdon vernier condenser.
2 Harkness, Shamrock or Kardon audio-frequency transformers.
5 binding posts.
2 20-ohm rheostats.
1 filament battery switch.
1 3-prong telephone jack.
1 4-prong filament control telephone jack.
1 grid condenser (.00025 mfd.).
1 grid leak (1 megohm).
1 fixed condenser .0001 mfd.
1 fixed condenser .00025 mfd.
2 3¾" dials.
1 3" dial.
2 lengths of "spaghetti."
6 lengths of bus-bar (or Celatsite wire).

The rheostats, jacks, fixed condensers, dials, etc., are all standard parts; any good makes can be used.

The triple-socket ubpanel is not so well known as the other parts, being a new product and designed somewhat differently from the usual triple socket. This subpanel was designed especially for the three-tube Counterflex receiver, although it can be used, of course, to build any three-tube set. Holes are already drilled in this panel for the audio-frequency transformers and battery binding posts. Mounting brackets are supplied. It is absolutely necessary to use one of the three specified makes of audio frequency transformer, as these are the only kinds which will fit underneath the subpanel. Other makes of transformers are designed only for upright mounting on a base-

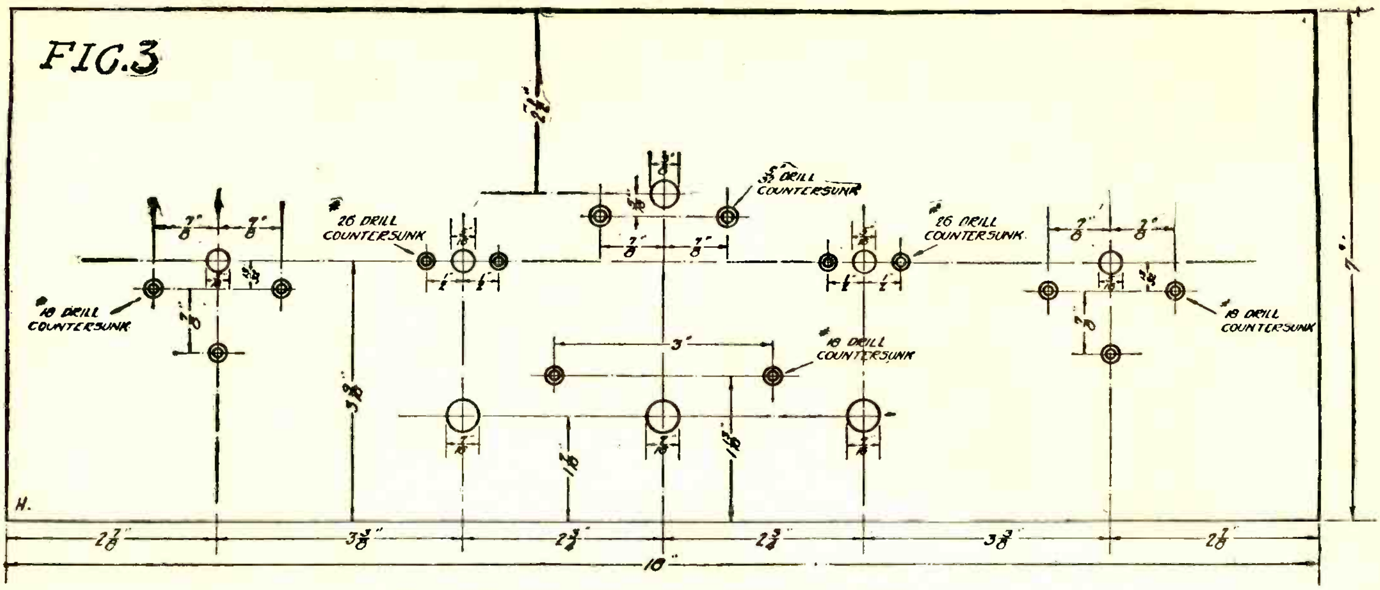


Fig. 3.—The panel layout, giving dimensions for drilling holes.

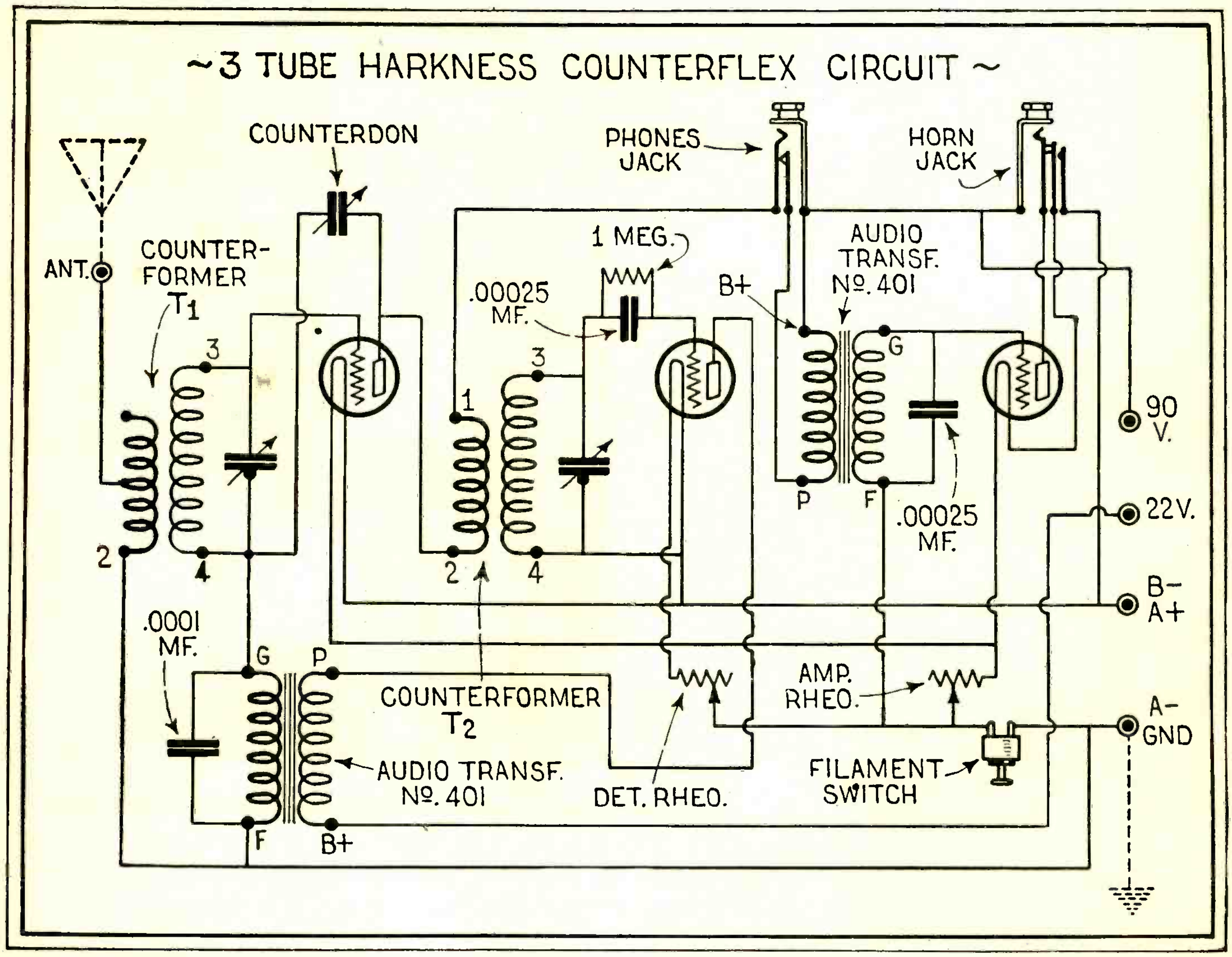


Fig. 4.—A schematic wiring diagram of the Harkness Counterflex.

board and cannot be used to build this set.

The Counterformer can either be purchased complete or the coils can be wound and mounted on .00025 mfd. variable condensers. The winding specifications of the coils are as follows:

Countercoil T1: Secondary coil has sixty-five turns of No. 28 silk-covered wire wound on a formica form 2⅝ inches in diameter. Primary coil has fifteen turns, with a tap at the tenth turn, the primary being wound on top of the secondary coil but separated from it by a piece of insulating paper or Empire cloth. Both coils are wound in the same direction.

Countercoil T2: Secondary has sixty turns of No. 28 silk-covered wire, also wound on a form 2⅝ inches in diameter. Primary coil has thirty turns. The coils are wound in the same direction and in the same manner as Type T1.

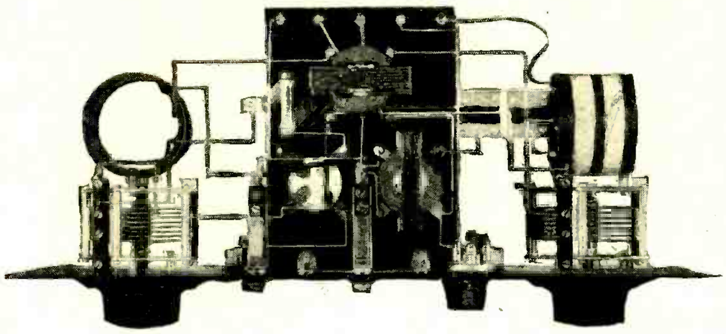


Fig. 5.—A bottom view of the Counterflex. Neatness and simplicity in design is evident.

The above constants, of course, are only correct when variable condensers with maximum capacity of .00025 mfd. are used with the coils.

The terminals of the manufactured countercoils are numbered and these numbers appear in the diagram of Fig. 4. In this diagram terminal No. 1 of T1 is the beginning of the primary coil and terminal No. 3 the beginning of the secondary. Terminal No. 1 of T2 is the beginning of the primary coil of this transformer, but terminal No. 4 is the beginning of the secondary. When wiring the receiver it is essential that the connections to these terminals be made correctly.

The Harkness Counterdon, mentioned in the above list of parts, is a three-plate variable condenser which is visible in the photographs of the complete set.

The Counterdon is just a vernier condenser given this name, as it was designed to cover the correct range of capacity needed by the counteracting condenser of the Counterflex circuit. The Counterflex circuit needs a counteracting condenser of a much higher capacity than is afforded by some vernier condensers on the market. The "neutralizing" condensers sold for the neutrodyne circuit are quite unsuitable; their capacity is much too low.

Before assembling and wiring this receiver it is necessary to drill the front panel. For this you need a small hand-drill and a few drills. Fig. 3 shows the exact positions and sizes of the various holes. You can lay out the positions of these holes directly on the panel itself or make a full-size drawing, paste it over your panel and locate the centers of the holes with a center punch.

When building a radio set, most amateur constructors assemble all the parts and then wire the completely assembled set. In these pages, however, is shown how to assemble and wire this receiver step by step, clearly illustrating each step as we go along. You can imagine, if you wish, that this receiver is being passed through a standardized factory on a moving belt and that the instructions given below are addressed to the workmen who perform each progressive step until the receiver is completed.

First Step—(*See Fig.* 6) — Mount the triple socket subpanel, the two rheostats, the battery switch and the two telephone jacks on the front panel, as in Fig. 6. This drawing shows how the parts appear when you look underneath the subpanel. The names of the various parts are also indicated in this drawing. If you have some experience in designing and wiring receivers you will realize that this arrangement of the apparatus permits unusually simple and efficient wiring.

Second Step—(*See Fig.* 7)—Bend five pieces of wire into the shapes required, as indicated in Fig. 7, remembering to make allowance for the room which the audio transformers will occupy when they are later mounted beneath the tube sockets, as in Fig. 10.

Solder these five wires to the terminals indicated in Fig. 7 so that they join the terminals together as follows:

Wire No. 1—From negative filament contact of reflex socket (1A) to negative filament contact of second audio tube socket (1B), then to one side of the amplifier rheostat (1C).

Wire No. 2—From negative filament contact of detector tube socket (2A) to one side of detector rheostat (2B).

Wire No. 3—From plate contact spring of second audio tube socket (3A) to third prong of horn jack (3B). By the third prong I mean the third prong from the top, the first prong being the one farthest from the framework of the jack.

Wire No. 4—From fourth prong of horn jack (4A) to third prong of phone jack (4B).

Wire No. 5—From 90-volt B plus binding post (5A) to Wire No. 4 (at point 5B).

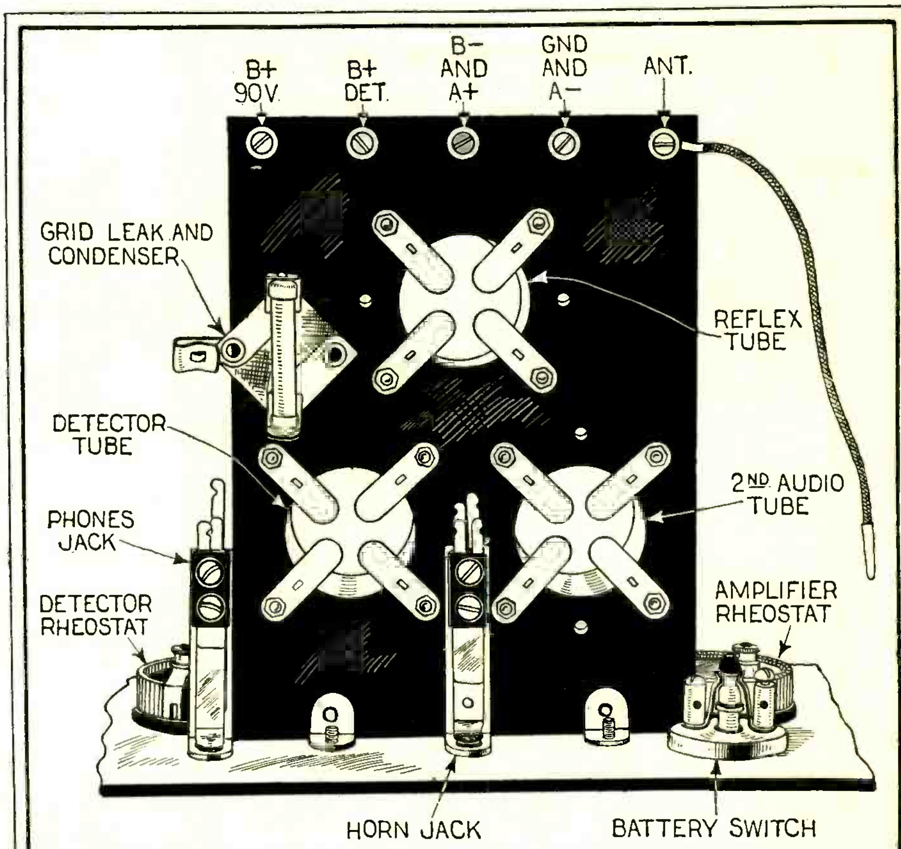


Fig. 6.—Method of mounting the subpanel, rheostats, and jacks on the front panel.

Third Step—(*See Fig.* 8) — Bend and solder five more wires as follows:

Wire No. 6—From positive filament contact of second audio tube socket (6A) to second prong of horn jack (6B).

Wire No. 7—From A plus binding post (7A) to first prong of horn jack (7B). This wire passes straight over the reflex tube socket (under the reflex audio transformer when it is mounted in position) and should be partly covered with spaghetti to prevent any possibility of the tube socket contacts shorting on it. Spaghetti, of course, is not required if you use Celatsite wire.

Wire No. 8—From positive filament contact of detector tube socket (3A) to positive filament contact of reflex tube socket (3B), then to wire No. 7 (at point 8C). Note that the portion of this wire which passes over the detector tube socket must also be covered with spaghetti, if ordinary bus-bar is used.

Wire No. 9—From grid contact of detector tube socket (9A) to one side of the grid condenser (9B). The grid condenser is not attached to the subpanel; it is merely held in place by the wires soldered to it.

Wire No. 10—From A minus binding post (10A) to one side of battery switch (10B).

Fourth Step—(*See Fig.* 9)—To finish up the wiring of the filament circuit, bend and solder this remaining connection:

Wire No. 11—From open side of detector rheostat (11A) to open side of amplifier rheostat (11B), and then to open side of battery switch (11C). When bending this wire remember to make allowance for the space which the Counterdon will occupy when it is mounted on the front panel. (See Fig. 2).

Fifth Step—(*See Fig.* 10)—Mount the two audio-frequency transformers as shown in Fig. 10. Make sure you mount them so that the markings P, B+, G and F, stamped on the metal housing of each transformer, occupy the positions indicated in the drawing. The transformers specified in the list of parts are made in two styles, one with soldering lug or binding-post terminals and the other without terminals.

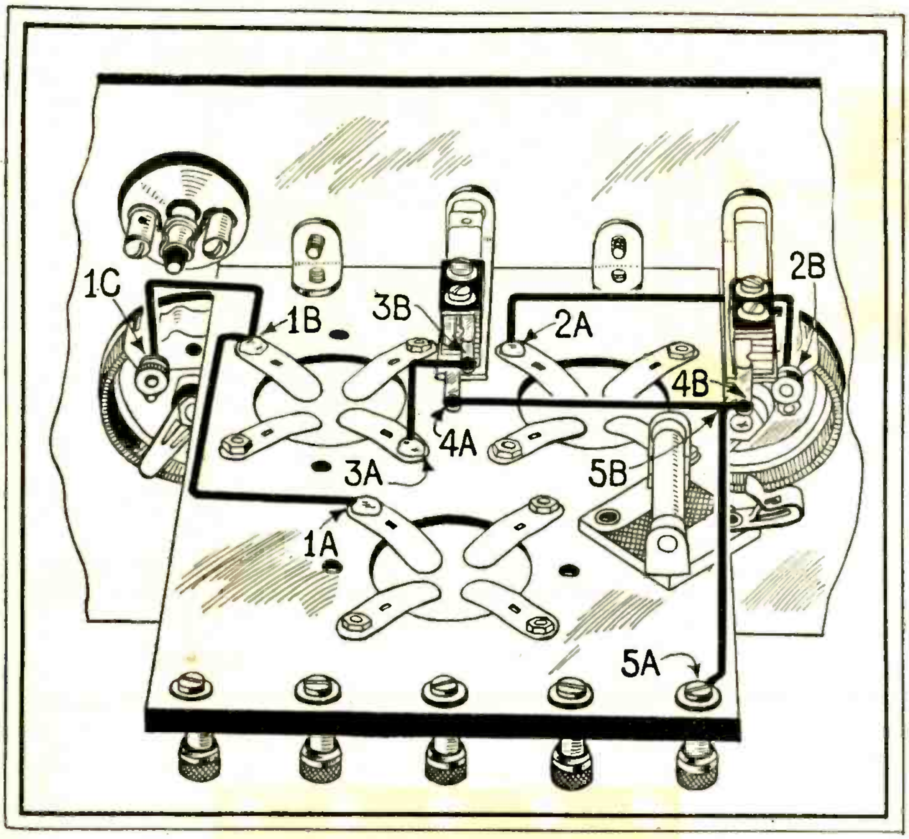


Fig. 7.—Second step is to wire the negative leads of the "A" battery.

It will be noticed that the type used in building this set has no terminals. Short direct connections are made with the flexible leads of the transformer coils, thereby simplifying the wiring.

Cover the flexible leads of the transformer coils with spaghetti of the required length and solder them as follows:

Connection No. 12—B+ lead of the reflex audio transformer to DET+ binding post (12).

Connection No. 13—Plate (P) lead of the reflex audio transformer to the plate contact of the detector-tube socket (13). Pass this lead underneath the transformer as shown in the drawing.

Connection No. 14—Filament (F) lead of the reflex audio transformer to wire No. 10 (at point 14).

Do not connect the grid (G) lead of the reflex transformer yet. Instructions for this will be given later.

Connection No. 15—Grid (G) lead of second audio transformer to grid contact of second audio tube socket (15).

Connection No. 16—Filament (F) lead of second audio transformer to wire No. 10 (at point 16).

Connection No. 17—Plate (P) lead of second audio transformer to center prong of phone jack (17).

Connection No. 18—B+ lead of second audio transformer to the fourth prong of horn jack (18).

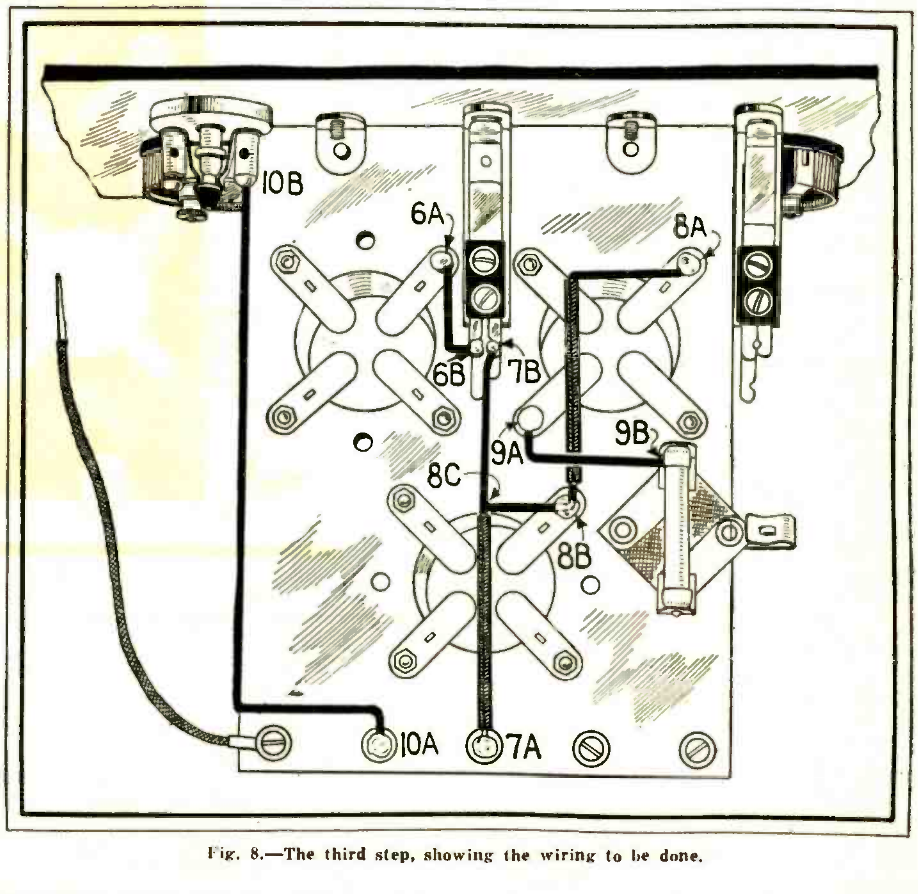


Fig. 8.—The third step, showing the wiring to be done.

Sixth Step—(*See Fig.* 11)—Mount Counterformers T1 and T2 on the front panel. In Fig. 11 Counterformer

T1 appears on the right and Counterformer T2 on the left. The terminals of the Couterformers are numbered, the numbers appearing on the labels inside the coils. Be careful when wiring to these terminals. It is extremely important that these transformers be correct y connected in the circuit.

Make the following connections:

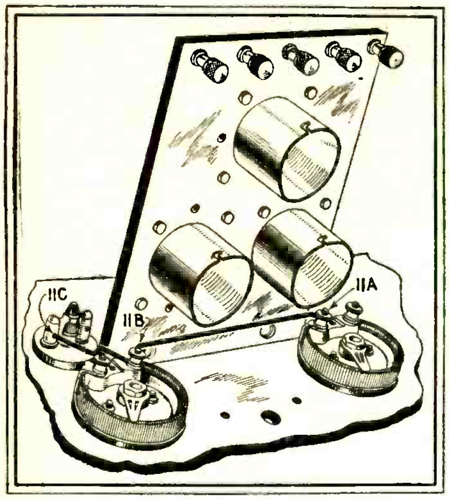


Fig. 9.—Finishing the wiring of the filament circuit.

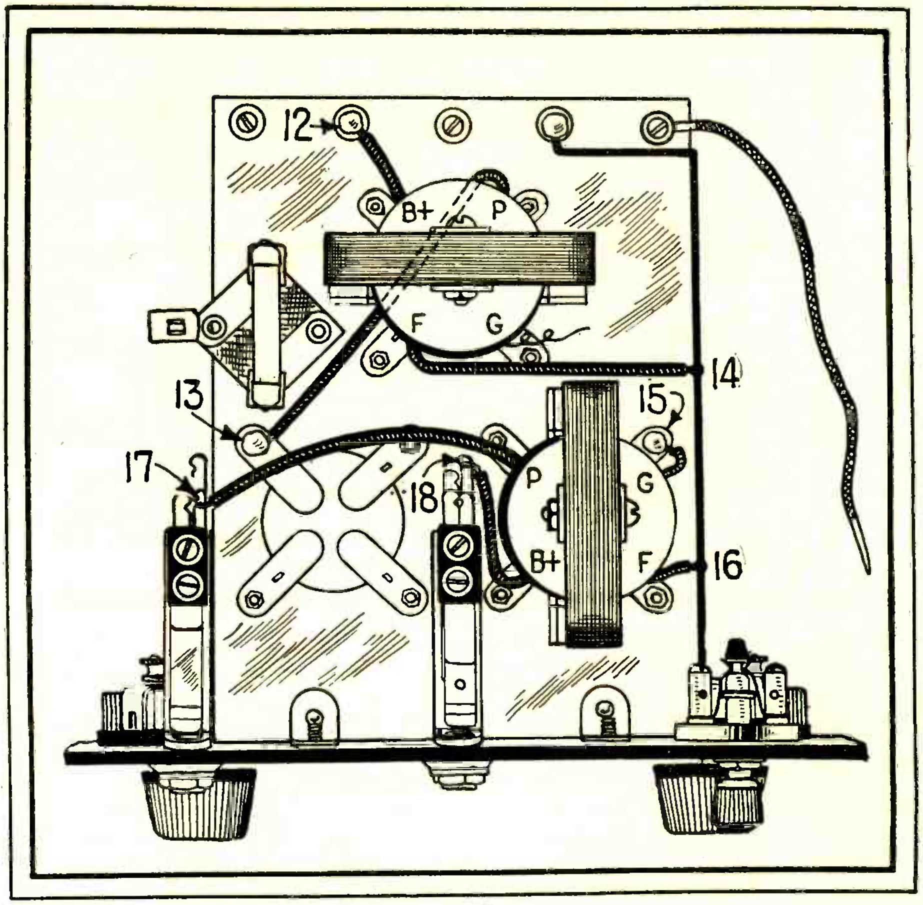


Fig. 10.—The assembly of the audio frequency transformers underneath the subpanel simplifies wiring.

Wire No. 19—From terminal No. 2 (19A) of Counterformer T1 to wire No. 10 (at point 19B).

Connection No. 20—Solder one side of the .00025 mfd. fixed condenser to wire No. 19 (at point 20).

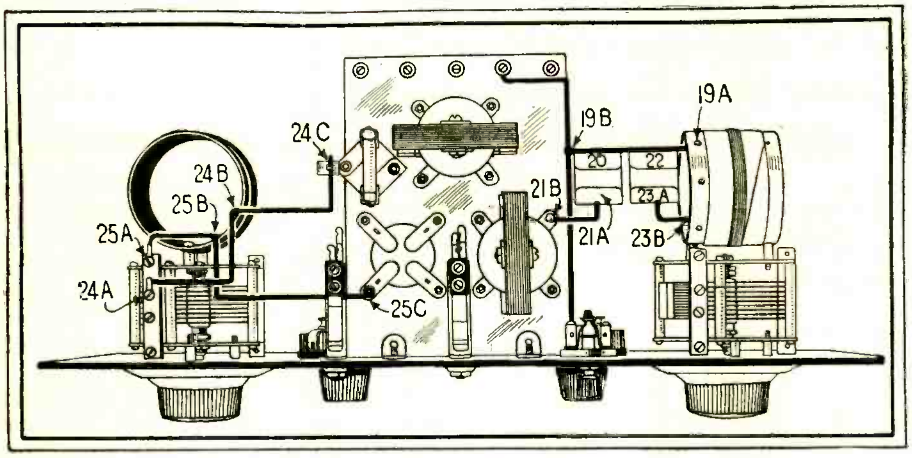


Fig. 11.—Sixth step is to mount the two Counterformers T1 and T2.

Wire No. 21—From open side of the .00025 mfd. fixed condenser (21A) to grid contact of second audio tube socket (21B).

Connection No. 22—Solder one side of the .0001 mfd. fixed condenser to wire No. 19 (at point 22).

Wire No. 23—From open side of .0001 mfd. fixed condenser (23A) to Terminal No. 4 of Counterformer T1 (23B).

Wire No. 24—From stationary plates of Counterformer T2 variable condenser (21A) to terminal No. 3 of Counterformer T2 (24B), then to open end of the grid condenser (24C).

Wire No. 25—From movable plates of Counterformer T2 variable condenser (25A) to terminal No. 4 of Counterformer T2 (25B), then to positive filament contact of detector tube socket (25C).

Seventh Step—(*See Fig.* 12)—Bend and solder the following wires:

Wire No. 26—From terminal No. 1 of Counterformer T2 (26A) to the first prong of phone jack (26B).

Wire No. 27—From terminal No. 2 of Counterformer T2 (27A) to plate contact of reflex tube socket (27B).

Wire No. 28—From terminal No. 4 of Counterformer T1 (28A) to the rotor plates of Counterformer T1 variable condenser (28B), then to the grid

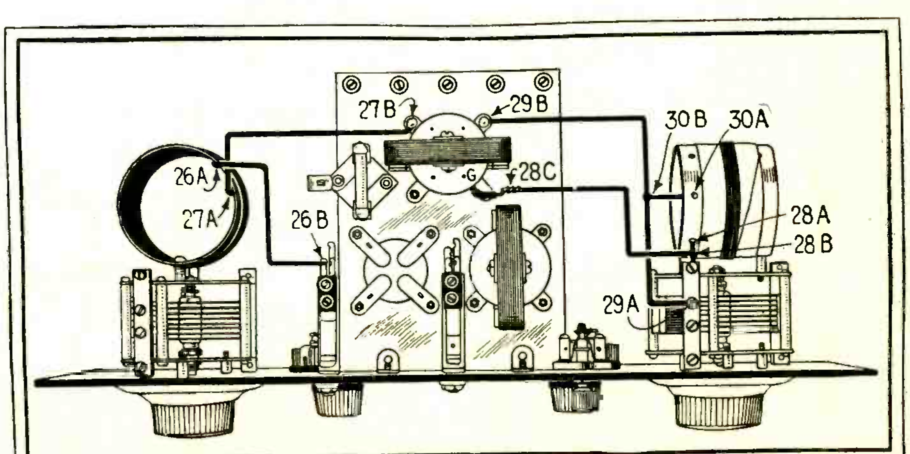


Fig. 12.—Wiring the leads from terminals of the Counterformers as the seventh step in assembling the Counterflex.

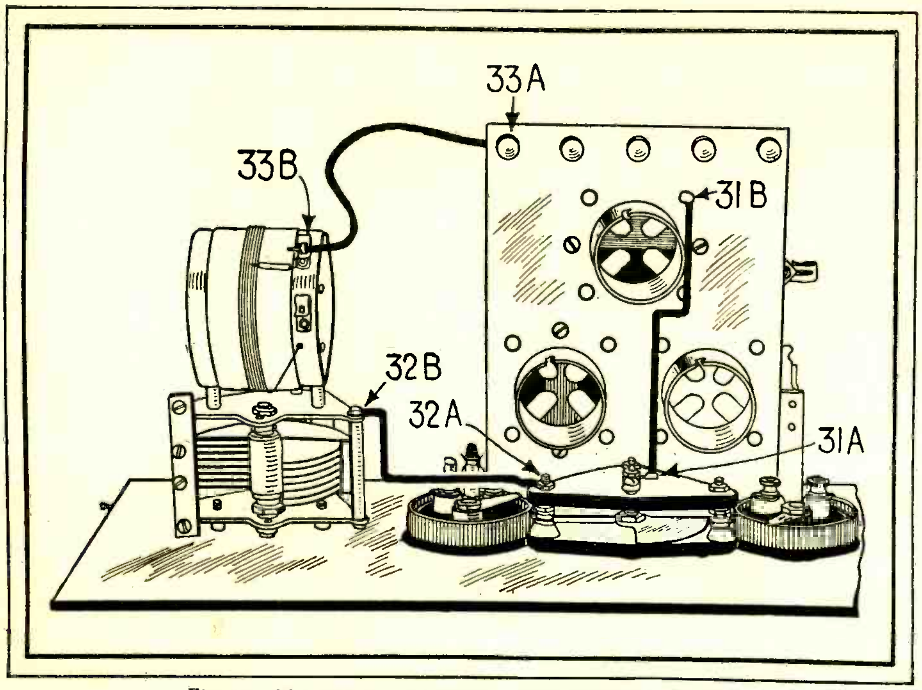


Fig. 13.—The last step of wiring which completes the set.

(G) lead of the reflex audio transformer (28C). To make this connection run the bus-bar close up to the reflex audio transformer, wrap the grid lead of the transformer around the bus-bar, and solder.

Wire No. 29—From stationary plates of Counterformer T1 variable condenser (29A) to grid contact spring of reflex tube socket (29B).

Wire No. 30—From terminal No. 3 of Counterformer T1 (30A) to wire No. 29 (at point 30B).

Eighth Step—(*See Fig.* 13)—Mount the Counterdon on the front panel. Then make the last three connections:

Wire No. 31—From the movable plate of the Counterdon (31A) to the movable plate of the reflex tube socket (31B). Note that this lead runs over the top of the subpanel, this being the most direct route.

Wire No. 32—From the stationary plates of the Counterdon (32A) to the movable plates of Counterformer T1 variable condenser (at point 32B).

Wire No. 33—From the antenna binding post (33A) to one of the clips on Counterformer T1 (33B). Make this connection with a flexible wire. Connect to the clip which gives the best results with your aerial. Mount the two large dials on the shafts of the variable condensers and the three-inch dial on the shaft of the Counterdon. Attach these dials so that they read "100" when the movable plates of the condensers are completely enclosed within the stationary plates.

And that's all—but you had better run over everything again and check up your wiring to make sure you have made no mistakes before you hook up the batteries and tune in.

Building a Wave Trap

A Device Which May Improve Selectivity of Your Present Receiver

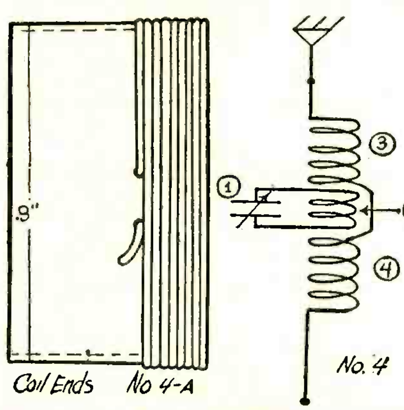
QUITE often a nearby transmitting station causes considerable annoyance to the listener-in when a more distant station is wanted. A set which is unable to tune out a station under these conditions can often be made selective by the addition of a wave trap. Constructional details of this piece of apparatus have been described by *Ernest H. Jones* in the *Toledo News-Bee*, as follows:

Parts Required for the Wave Trap

One .0005 mfd. straight-line-frequency condenser. (1 in diagram.)
One set of coils. (2, 3 and 4.)
One 4-inch dial to fit the condenser shaft.
One 7x7-inch panel.
One 7x7-inch baseboard.
Two binding posts.
Bus wire, screws, etc.

Winding the Coils

The coils for the wave trap are wound on a tube, three inches in diameter, either cardboard or composition. Wind one of the end coils first. To do this, start about ½-inch from the end of the tube and wind 20 turns of No. 22 D. C. C. wire. End the coils as shown in the sketch (No. 4a). Allow ¼-inch between the coils and wind on 15 turns for the condenser coil. Then wind the third coil exactly like the first one. Cut the tube off with a sharp knife ½-inch from the end of the third coil. Connect the inside ends of the two end coils. Be sure to wind the coils in the same direction.



Illustrations by Courtesy of Toledo News-Bee

Showing how the coils of the wave trap are wound and diagram of the aerial circuit in which it is connected.

Mounting the Condenser and Coils

Drill the mounting holes for the condenser and mount it on the panel. The holes for the binding posts can be placed opposite each other, one on each side of the condenser position and above it. Drill two holes in the bottom edge of the panel for the baseboard screws. After the baseboard has been fastened to the panel by means of the two screws, bend two small brackets out of sheet brass and mount the coils on the base by means of these.

Connect the two ends of the middle coil to the condenser; one to the rotor plates and the other to the stator plates.

The ends of the two larger coils connect to the binding posts. One wire to each one.

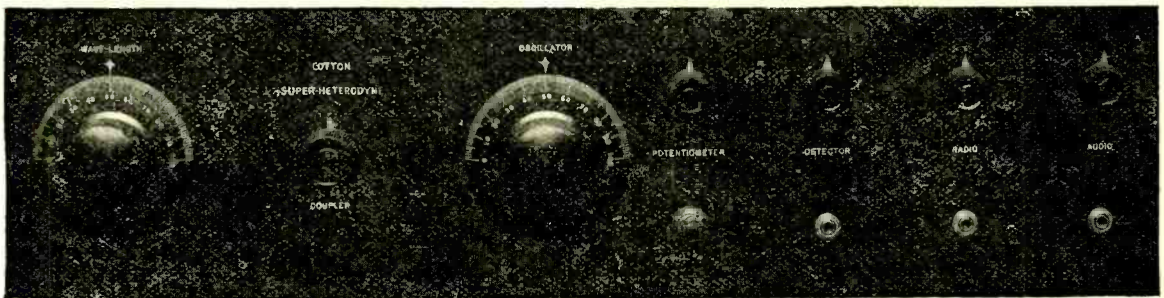
To use the wave trap, connect the aerial to one of the binding posts and from the other run a short length to the antenna binding post on the receiver. Tune in the station desired and if any interference is present from other stations broadcasting on nearby wave-lengths the wave trap can be adjusted to tune them out. To do this, move the dial on the wave trap until the interference from the other station is completely eliminated from the receiving set. When this is done the wave trap is absorbing the undesired wave. Retune the set, for the setting of the wave trap will probably throw it out of its best adjustment, and the interference will not bother the desired reception.

The Cotton Super-Heterodyne

Construction Data on a New Super which Has Proven Highly Efficient

IT is acknowledged by the majority of radio authorities that the Super-Heterodyne is the peer of all radio sets. This statement is true only insofar as practical constructional work gives the builder a set which operates as well in practice as its theoretical design intends it to.

Unfortunately many of these receivers which have been constructed in the past do not operate to full efficiency. This is due to many reasons, among which are, poor or mediocre parts, poor design or layout or poor workmanship in the constuction of the set.



Illustrations by Courtesy of Los Angeles Evening Express

A front view of the Cotton Super-Heterodyne. The tuning controls are at the left and the filament controls and jacks at the right.

The Super-Heterodyne described herewith appeared in the weekly radio supplement of the *Los Angeles Evening Express* and was quoted after an article by *R. W. Cotton*, the designer. In the article on Mr. Cotton's Super-Heterodyne many valuable pointers are given on the selection of parts as used in the original set.

While the following description covers principally the assembly and wiring of the set rather than constructional details of particular parts, the constructor who intends to build the set with purchased parts as shown in the accompanying photos will find this information of great assistance.

Parts

The parts necessary to construct this receiver are not as many or expensive as the general public has been led to believe. The author has discussed each part separately in this article, telling what to look out for in purchasing parts, and what seem to him to be the best parts for the particular purposes for which they are wanted.

By that it is not meant to imply that other parts are not as good, but it is impossible in picking out a design, to try out all of the various parts on the market, and it has been the designer's experience that of the numerous super-heterodyne sets which he has constructed, the parts listed herein are the best for the set described herein.

There is one fact to bear in mind which the author cannot over-emphasize, and that is this: Use the best parts and remember that "The best is the cheapest in the long run."

This receiver is for loop reception, as this method in general is the best because of its portability, selectivity, and less interference from static—both "man-made" and atmospheric.

The specifications of the loop which is suited to this receiver as shown in Figure 1, are as follows:

LIST OF PARTS

8—Cle-ra-tone Sockets.
1—Chelton midget condenser.
2—15 ohm rheostats.
1—5 ohm rheostat.
1—200 ohm potentiometer.
2—DX National condensers .0005 with 4-inch dial.
3—Grid leak mountings.
1—Carter "Imp" battery switch.
2—Carter Hold-Tite jacks, Double Circuit.
1—Carter Hold-Tite jack, Single Circuit.
1—Samson Super-Kit, including:—
  1—Samson oscillator coupler.
  1—HW-RI 5,000 meter filter.
  3—HW-RI 5,000 meter intermediate frequency transformers.
9—Eby binding posts.
  [3—Loop; 1 A—; 1 A+B—; 1 B+Det; 1 B+ Amp; 1C—; 1 C+.]
1—HW-A2; 6:1 Radio Samson audio transformer.
1—HW-A2; 3:1 Ratio Samson audio transformer.
5—No. 601 Micadon fixed condensers.
  Capacities: 1—.005 mfd.
  2—.0005 mfd.
  2—.001 mfd.
2—1 mfd. by-pass condensers.
3—Daven grid leaks.
  Resistance: 1—.05 meg. with mounting.
  2—5. meg. with mounting.
1—Front panel, 7"x28"x3/16".
1—Base panel, 8"x27"x3/16".
3—Brackets.
1—Small knob for coupler.
Bus bar, spaghetti, soldering lugs, solder, etc.

Length of long sides—25"; length of short sides—12½"; distance across the top of the loop—18"; total height of the loop—33".

The wire on the loop is wound on 5/16" centers and is composed of 12 turns of No. 18 Belden insulated braid with a tap taken off at the exact center of the wire. The pieces of wood which support the wire are 4 by ¼" thickness by 1½" wide and notches are cut in one side of these, which are ⅛" deep and 5/16" on centers to accommodate the wire. The loop frame should be made of any good dry 1" square wood.

It is recommended whenever possible that the constructor purchase a ready-made loop, as there are several good ones on the market to select from. Bear in mind that the loop which you purchase must have a mid-tap, and should be of the same general style as shown in Figure 1.

There is a great deal of question in the average experimenter's mind as to the relative merits of Litz wire as against that of ordinary stranded wire. If the constructor is building his own loop, the advantage of having Litz wire is probably not worth the extra amount of money which the use of Litz would involve.

There are a great many people who desire to use an antenna and ground with any receiver they may use. If it is desired to use an antenna with this set, all that is necessary is to connect the antenna wire to the ground wire by means of approximately four or five feet of stranded insulated wire. This wire may be turned once around the outside of the loop.

In selecting panels, both for the front and base of this set, the constructor is given considerable latitude in that he may use hard rubber, bakelite or many of the composition panel materials available on the market. If hard rubber is used, the panel should be ¼″ in thickness; otherwise 3/16″ will be satisfactory.

Bakelite is preferable, as this material seems to run more uniform and with perhaps a higher finish than some of the other materials.

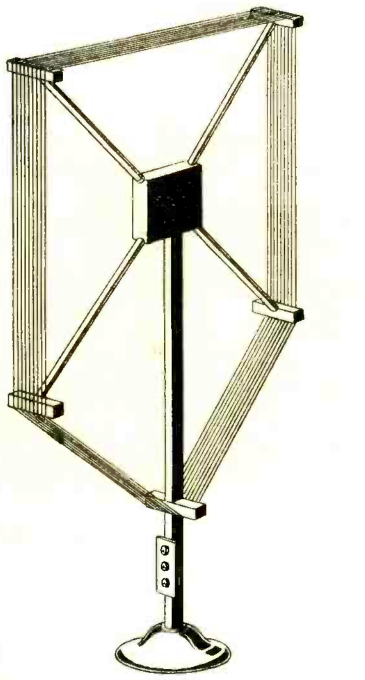
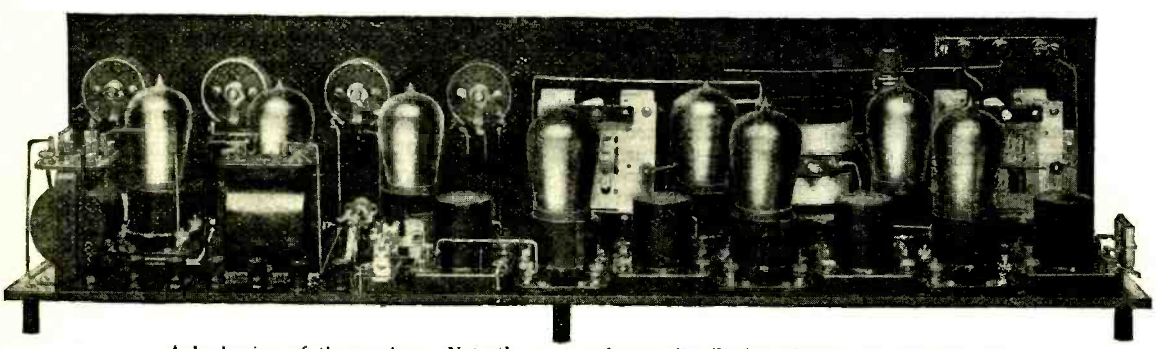


Fig. 1.—The loop aerial used with the set may be constructed as shown above.

It is recommended that the base panel be of this material or similar, rather than of wood—whereas good dry wood or wood impregnated with paraffin is an exceptionally good insulating material. In a great many cases it has been found that wood which has not been seasoned has caused a great deal of trouble when used for baseboards—particularly if bare wires are led through the board and come in contact with the wood.



A back view of the receiver. Note the neat and even distribution of parts on the subpanel.

In choosing variable condensers for this set, it is well to purchase one of the so-called "low loss" type with a grounded rotor. There are many of these on the market, which are very good.

Be sure in buying this, that the minimum capacity is low—at least not more than .00002 mfd., this reading to be taken when the rotor plates are entirely removed from those of the stator.

There are two variable condensers of .0005 mfd. maximum capacity required for this set. Also one small variable feed back condenser of approximately .000045 mfd. maximum capacity, if regeneration is used in the first detector.

Referring to the wiring diagram of this set, it will be noted that the grid condensers of the first and second detectors are in the usual position, and that the grid leaks are connected from the grids to the positive ends of the filament.

With the grid leaks connected as shown in the diagram, it makes no difference to which side of the filament the grid return is connected, since there is no direct current in the grid return, owing to the presence of the grid condenser.

In the oscillator circuit you will note also a grid leak and grid condenser. This is essential for satisfactory operation of the oscillator over the entire range. Without the grid leak and condenser, a large amount of energy is lost in the grid circuit when the oscillator is in operation, since for a part of the time during each cycle the grid is positive.

A UV201A tube will operate best as an oscillator with a grid leak of about 30,000 ohms, although this value is not critical. A grid leak of 50,000 ohms or .05 meg-ohms will work very satisfactorily.

The grid oscillator condenser only acts as a by-pass for the alternating current and need only be large enough to serve this purpose. For the oscillator in question, a value of about .005 mfd. will be good, although a .004 mfd. or a .006 mfd. will do as well.

The oscillator coupler shown in the photos of the set is manufactured by the Samson Electric Company, and is rather a departure in design from the ordinary coupler. On account of this fact the following data are set down to explain the reason for its design:

This coupler has been designed to give the necessary variation in frequency over the range of the 5,000 meter intermediate frequency transformers. This means that it will not be found that part of the time the heterodyning will be done by the harmonics and part of the time by the fundamental. For the proper operation of the 5,000 meter transformers, the oscillator must range in wavelength from about 215 meters to about 600 meters. This variation can be obtained within the scale of the ordinary .0005 mfd. condenser dial.

In order to accomplish this wide variation in wave-length, it is necessary that the winding of the plate coil on the coupler shall not be of wire of too small a cross section, for as the cross section becomes smaller, the winding is more compact with the attendant increase in self capacitance, which tends to make the lowest frequency obtainable with the coil in the oscillator circuit higher than it would be were this capacitance not present, and this apparent capacitance adds to that of the variable condenser.

Another fact which cannot be overlooked is that in order for the oscillator coil and condenser to "oscillate," the energy necessary must come from the tube, or more properly from the "B" battery through the relay action of the tube. In order for this to happen, the coupling between the oscillator coil and the grid coil must be right. In an oscillator designed for use for the Super-Heterodyne, frequency variation from one extreme to the other must be obtained by a single, uniform adjustment for convenience. This means that there can be but one coil and but one condenser.

For any given frequency, there is one best relationship for the oscillator coil, the grid coil and the condenser. In the oscillator for the Super-Heterodyne, a compromise must be made. Above all else, the compromise must not affect the stability of the oscillator. If the oscillator is made up of the ordinary tuned plate type, it will be found that if it oscillates very efficiently at the low frequencies, it will tend to become unstable at the higher frequencies if only the condenser capacity is varied.

In this particular coupler which is shown in the photos, an extra tap is taken off the oscillator coil for the plate lead, which increases the stability at the high frequency end, and allows at the same time sufficient coupling between the plate and grid coils to ensure operation with vigor over the entire scale of the condenser. In order that the frequency variation shall be proper, it is necessary to make sure that the condenser used has a low zero capacity. A good condenser of the .0005 mfd. variety will have a zero capacity of about .000015 mfd.

The Intermediate Frequency Amplifying Transformers have been said to be the heart of the Super-Heterodyne circuit, and this statement is without question true, as the difference between a good Super-Heterodyne and an average Super-Heterodyne lies in the material used in this particular part of the set.

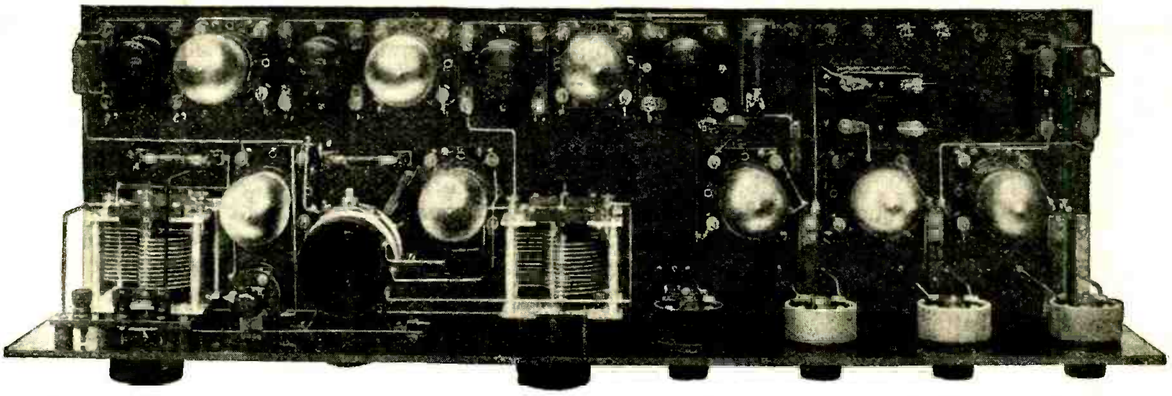
The author tried out numberless amplifying transformers for this purpose, as well as constructing several himself, ranging in wave-length from 2,000 meters to 10,000 meters, both of the iron core and air core construction.

There has been a great deal of discussion as to which of these extremes is best, and each wave-length which is mentioned in this band will find its particular supporter, but the author has found that the 5,000 meter band seems to offer the advantages of both the higher and lower without some of their disadvantages.

There has also been a large amount of discussion as to the relative advantages of iron core transformers vs. air core transformers. In the design of the transformers used in this set, it is believed that a happy medium has been struck, as the transformers are primarily of the air core type with a very small amount of iron in them.

This iron is introduced only in a quantity sufficient to broaden the peak of the transformer. Great care is taken that it does not have the disadvantage of necessitating the tuning of each stage—or of matching the transformers. These transformers are sufficiently sharp so that great amplification is obtained, and yet they are not so sharp that they will not work properly together without matching, or so that the side bands are cut.

The Input or Filter Transformer is of the air core type, and brought to a sharp peak by the use of a .001 mfd. fixed condenser across its primary winding. This Input Transformer is sufficiently sharp to eliminate interference and cause sharp tuning, but its peak is broad enough so that none of the side bands are prohibited from passing through it—thus ensuring good quality of reception. By its use the first detector tube is enabled to operate most efficiently, since the condenser acts as a by-pass for the frequency of the incoming wave.



The Cotton Super-Heterodyne as it appears looking down from the top. Note that practically all of the wiring is beneath the subpanel.

Regeneration in the First Detector

The reader will note that the diagram calls for a three-tap loop which is necessary in order to use regeneration in the first detector.

By using a three-tap loop and inserting a small feed-back condenser, it is possible to create regeneration, which adds the following properties to the operation of this set:

First, it makes the loop more directional;

Secondly, it makes the tuning sharper on the variable condenser, which tunes the loop;

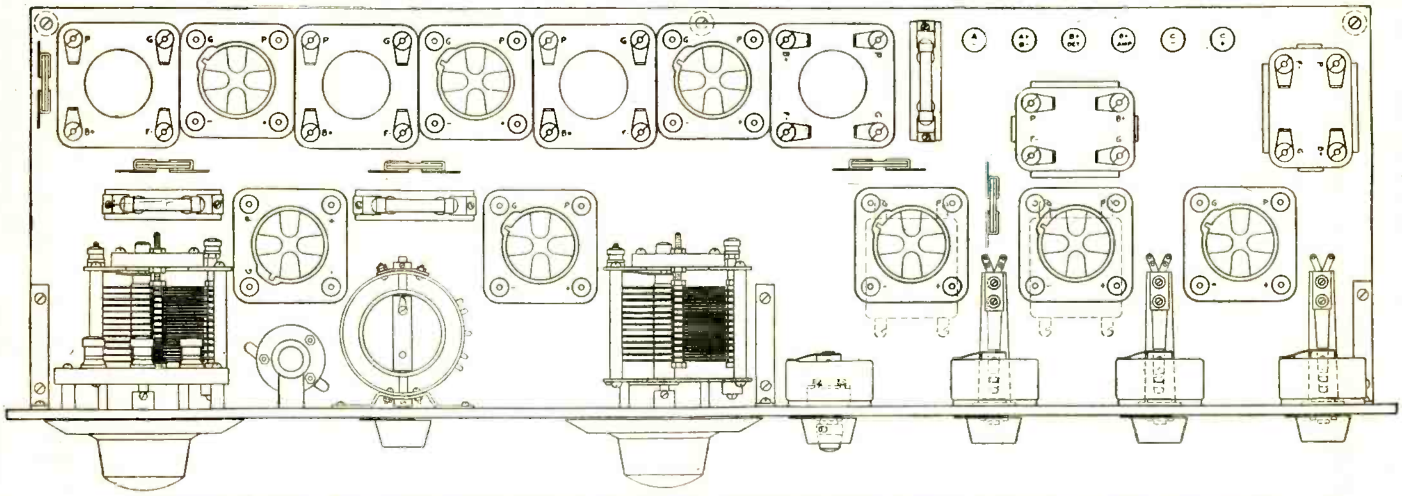
Thirdly, it increases the sensitivity of the first detector tube;

Fourthly, it makes possible neutralization in the first tube if desired.

There are three rheostats required in this particular Super-Heterodyne—one controlling the first and second detector tubes of 15 to 30 ohms resistance; the second one controlling the oscillator and the three intermediate frequency tubes of 5 to 10 ohms resistance, and one controlling the two audio tubes of 15 to 30 ohms resistance.

There are eight sockets required for this set. A high grade socket should be used—preferably of the non-metallic type, such as those made of glass, porcelain or all bakelite. In fact, any good socket may be used.

It is important particularly in the filter transformer, that fixed condensers which are of the capacity marked on them be used. These condensers should be of the mica type, with the exception of the large by-pass condensers, which may be of waxed paper and tin foil construction. All condensers must be sufficiently well constructed to withstand a high plate voltage.



The layout of the set showing all parts in their proper position. Follow this arrangement as near as possible when assembling.

On the Input Transformer it is suggested that the purchaser ask to have a .001 mfd. condenser tested on a capacity meter to ensure its being the correct capacity.

In trying out a great many audio frequency transformers in this circuit, it has been the experience of the designer that a 6 to 1 ratio transformer in the first stage and a 3 to 1 ratio transformer in the second stage seems to be the right combination.

Small tinned copper wire or insulated wire is the very best material to use in the construction of this set. Wire smaller than No. 14 is not recommended for use in the filament circuit, but smaller wire may be used elsewhere in the set.

Rosin core solder should be used, or plain solder with a mixture of rosin and alcohol as a flux. Never use paste or acid core solder, as this has a tendency to create trouble later on.

It is generally recommended that eight tubes of the C301A type or similar be used throughout. In case the experimenter wishes to use the D21 Sodion tubes as detectors in the place of the C301A type, the only necessary change to ensure best results is that the grid return be made negative instead of positive.

Any good "B" batteries may be used on this set. There are 90 volts used in all—45 on the radio frequency and detector tubes, and 90 on the audio amplifier tubes.

Although the first cost is greater, storage "B" batteries are recommended for any set of this character, as in the long run they are by far the cheaper, as the life of dry "B" batteries on a set of this character is not high, due to the current consumption—which is normally from 25 to 30 miliamps.

Any good 6-volt 100 amp. hour storage battery or larger is recommended for the filament current, using C301A or similar tubes.

Construction of the Set

It is rather needless to go into a long description as to how to construct the set. The photographs, layout, and wiring diagram are sufficient means for anyone to accomplish this work satisfactorily.

A few general ideas, however, may be helpful:

The first thing to do is to fasten the instruments to the base panel and to the front panel. Do not, however, put these panels together. Wire all that can be done on the front panel, and then wire all that can be accomplished on the base panel.

When these are finished, attach the front panel to that of the base panel by brackets and finish the wiring from panel to base. Make all the joints rigid enough so that it is possible to slide the set on your table by the joint which has just been made. This will save you the trouble of broken connections at some later date.

The assembly layout shows each part in its proper position and the set can be wired according to the schematic diagram. The best way to construct the set is to do all of the filament wiring first. Then follow with the wiring of the "B" battery connections; this in turn, may be followed with wiring of the loop tuning circuit and the oscillator circuit.

Testing and Preparing for Operation

The first thing to do is to be sure that the wiring is correct so that the tubes will not be burned out; connect your "A" battery to the "A" battery binding posts, taking one tube and inserting it in each successive socket with the filament switch on and rheostat controlling the particular tube socket which you have the tube in, about half way on. If the tube lights in each place controlled by the rheostat corresponding to the socket in which the tube is inserted, you may be reasonably certain that the filament wiring is correct.

Then connect the "A" battery to the detector "B" battery terminals, taking one tube and inserting it in each socket as before. If the tube does not light this wiring is correct. Do the same thing with the "A" battery connected to the amplifying "B" terminals.

Next connect the "B" battery to the "B" battery binding posts and insert the telephone plug in the detector jack. This should give you a click showing that the "B" battery circuit is correct. Now insert one tube in each socket successively with the filament current on, and if nothing happens, the "B" battery connections are not shorted with that of the "A" battery. Now put all tubes in their respective sockets and connect the three tap loop to the three binding posts. The center tap of the loop must by all means be connected to the center binding post.

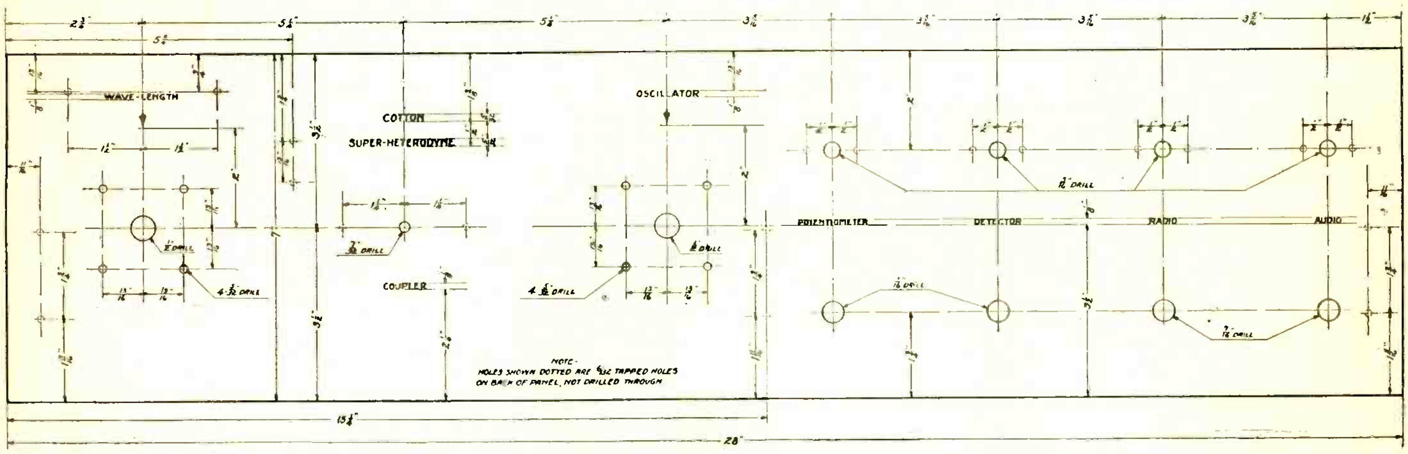
Turn on the detector tubes to approximately normal brilliancy, which will be about three-quarters of the rheostat. Follow this by turning on the intermediate frequency amplifiers and the oscillator by means of the rheostat which controls them, to their normal brilliancy. Be sure that the midget condenser is at its minimum capacity. When listening to a low wave-length station, 1,000 or more miles away, move the midget condenser up to the point where the greatest signal strength is obtained without distortion. In some cases it may be possible to throw the first detector tube into oscillation by means of this small condenser, and of course it would be set just beneath this point. Now that this condenser is set, it will not have to be varied.

On a station of at least 1,000 miles away, make the adjustment of the oscillator rotor to the minimum coupling position that it is possible to attain without decreasing signal strength. This may be accompanied by a small change in the oscillator condenser dial. Now that this adjustment is fixed, it need not be changed, except when a new oscillator tube may be inserted in the oscillator socket.

Try out the different tubes in different positions throughout the set, as some act in one capacity better than others. Now place the potentiometer about midway of its arc; by turning this to the right you should notice a decided click. This shows that the radio frequency tubes have gone into oscillation.

Leaving the radio frequency tubes in this manner, slowly rotate the oscillator dial. If whistles are heard, it shows that the oscillator is performing its function. Now turn the potentiometer to the left until there is a click, showing that the radio frequency amplifier has gone out of oscillation. Now rotate the oscillator condenser dial slowly together with that of the loop tuning dial. These will run fairly uniform, not more than ten degrees apart.

This testing should occur when local broadcast stations are known to be in



A panel drilling template may be drawn on a sheet of paper according to the dimensions given above.

operation, and as the oscillator dial is turned, the station will be heard to come in.

Now turn the loop tuning dial to the point at which the music or speech comes in the best. Also do this with the oscillator dial. Then move the potentiometer on to the right within a short way of the point where the radio frequency amplifier goes into oscillation. This potentiometer may be set at this point, and very rarely need be changed.

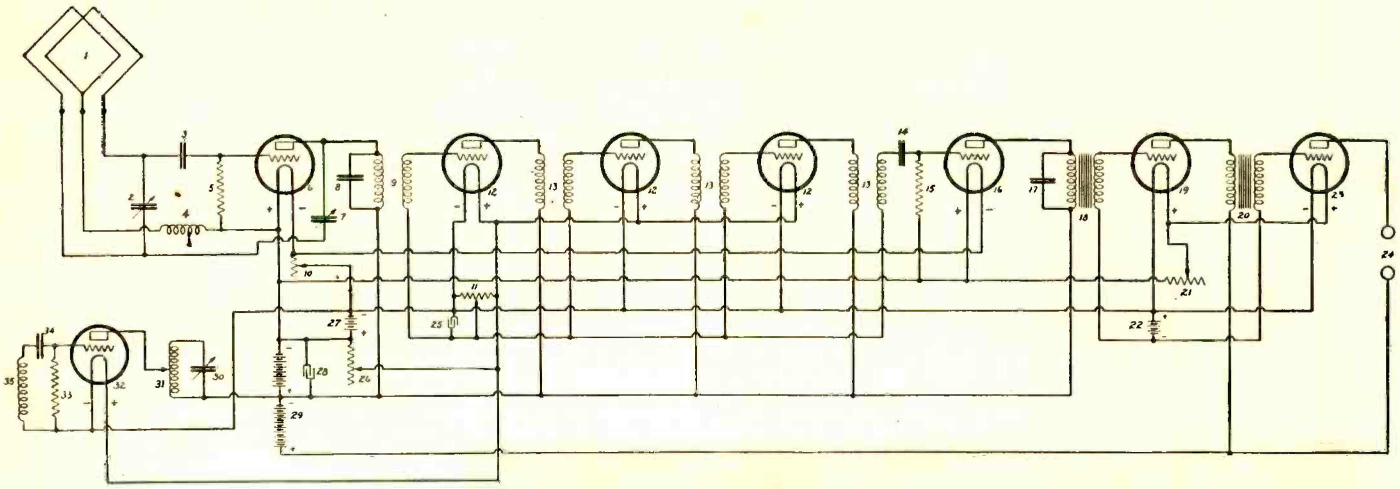
Trouble Shooting

If the set does not function as outlined, you should look for the following sources of trouble before blaming the receiver itself: "A" or "B" batteries discharged; loop phones or loud speaker out of order; broken connections leading to the set; poor tubes.

If none of these are found to be the trouble, try a pair of phones across the primary of the input transformer, turning the oscillator dial if whistles are heard. This shows that the first detector tube and oscillator are working properly. This leaves the trouble to a large extent in the intermediate frequency amplifier which should be tested again very carefully.

If the potentiometer does not control the oscillation of the intermediate frequency amplifying tubes, their circuit should be looked over, as there is probably a broken connection in the wiring.

If body capacity is apparent in the tuning of the loop condenser, this would indicate that the first detector tube is in an unstable condition. To overcome this, reduce the amount of capacity in the midget condenser and cut down the filament current in the detector tube.



The circuit diagram of the Cotton Super-Heterodyne. The set is wired to correspond following the key to the parts as given below.

1	Center tap loop.		13	Samson HW-R1 transformers	60 Kc.	25	Pot. by-pass condenser.	1 mf.
2	Loop condenser	.0005 m.f.	14	2nd Det grid condenser	.0005 m.f.	26	Radio rheostat.	5 ohms.
3	1st Det grid condenser.	.0005 m.f.	15	2nd Det. grid leak	3-5 meg.	27	"A" Battery.	
4	Oscillator pick-up coil.		16	2nd Det. tube		28	"B" Battery by-pass condenser.	1 m.f.
5	1st Det. grid leak	3-5 meg	17	Phone condenser	.001 m.f.	29	"B" Battery.	90 Volts.
6	1st Det tube		18	Samson HW-A2 transformer	6-1 ratio.	30	Oscillator condenser.	.0005 mf.
7	Feed-back condenser	.000045 mf.	19	1st audio tube		31	" plate coil	
8	Filter condenser.	.001 m.f.	20	Samson HW-A2 transformer	3-1 ratio	32	" tube.	
9	Samson HW-R1 Filter.	60 kc.	21	Audio rheostat.	15 ohms	33	" grid leak	.05 meg.
10	Detector Rheostat	15 ohms	22	"C" Battery.	4.5 volts	34	" grid condenser	.005 m.f.
11	Potentiometer.	200 ohms	23	2nd. audio tube		35	" grid coil.	
12.	Radio frequency tubes.		24	Output terminals.				

Testing Connections of Your Set

It is certainly aggravating to turn to your radio set, light up all of the tubes, turn the dials, and yet not hear a peep. It happens now and then with the best of receivers.

Touch the grid terminal of the detector tube socket with your finger. If you do not hear a sound you may be sure something is wrong. If you are experienced with your set you will know instantly without this test whether your set is "live" or not, merely by the sound of the tubes. There is a sort of hollow, slightly noisy sound from any set while the tubes are operating and no signals are tuned in.

In fully half of the cases of this kind the trouble lies in the fact that one of the tips from the headphones or the loud speaker have become disconnected and fallen from the binding post or plug.

This breaks the circuit and you will hear very little or nothing. Examine the connections of your phone or loud speaker cord carefully.

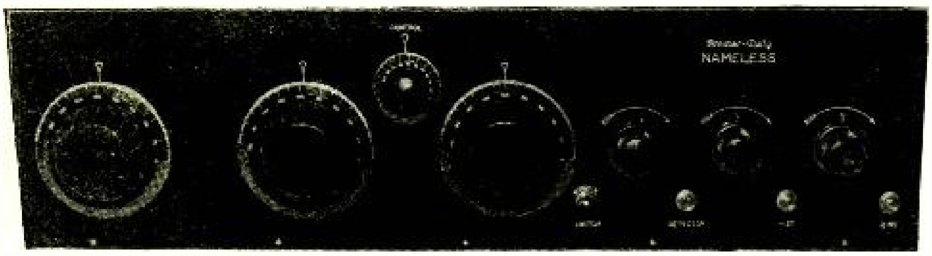
In cases where the connection is made with the receiver through a plug, make sure that one of the tips have not become loosened inside the cover of the plug and fallen out. It often happens that one of the screws or springs that grip the terminals of the tips become loosened so that a pull on the cord pulls the tip out, thereby breaking the contact.

Some types of telephones are provided with a very poor type of connection from the cord to the receiver case. Examine this point very carefully to make sure that the wire has not become broken inside of the insulation.—*Wisconsin News.*

Construction of the "Nameless" Set

A New Tuned Radio Frequency Receiver Built with Standard Parts

CHICAGO, St. Louis, Cleveland, Detroit, Cincinnati, in fact the entire Middle West, have been swept by the veritable tornado of popularity attending introduction of the "Nameless" Receiver, and now New York radio opinion is beginning to shake under the gale of approval that has greeted this circuit.



Front view of the "Nameless" set, which in many respects resembles the conventional neutrodyne, save for the small compensating condenser as seen between the second and third dial.

Stuart Rogers describes this receiver in a recent issue of the *N. Y. Telegram and Evening Mail.* He goes on to write as follows:

We wondered why the designers of this set called it the "Nameless." At first we thought that so many men had a hand in it that they couldn't agree upon any name that would give all equal credit. Then we were sure it was because, like all the rest of us, they were sick and tired of hearing about "dynes" and "flexes."

Now, though, we are sure it was because they could not think of a name good enough for it.

What else could it be but the logical two stages of tuned radio frequency, detector with feedback and two stages of audio—and, most important of all, a variable primary in the antenna tuning system. This combination has always been ideal.

What the originators of this set have done in a nutshell is this—combined two highly sensitive stages of tuned radio frequency oscillation, increased the selectivity by incorporating a semi-tuned antenna, and added a stage of transformer audio amplification for volume and toned this down with one stage of resistance coupled A. F. to insure quality.

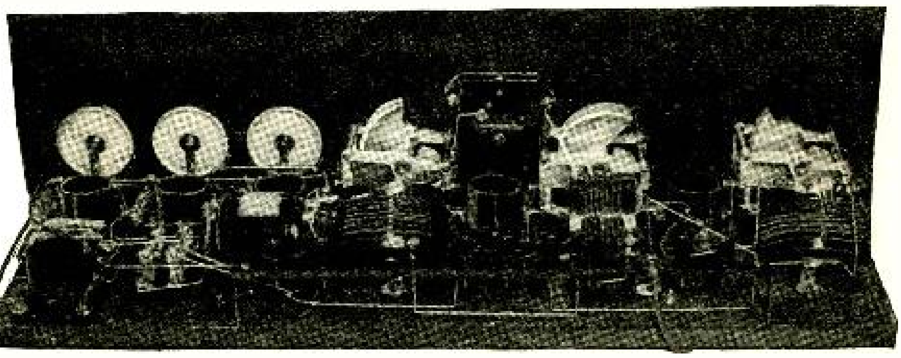
All this has been accomplished by careful design of the three coils—all of which are space wound and bank wound on lattice type bakelite forms—one of the most efficient methods of actual low-loss construction yet discovered.

It will be noticed from the drawings on the opposite page that the secondary winding of the first stage of tuned radio frequency is divided, and that the primary of the second R. F. stage is divided, an oddity with a purpose.

Careful experimentation with the number of turns on the primaries disclosed that a small number of turns on the first and a somewhat larger number on the second transformer gave just the proper ratio of increase per stage, to be handled nicely without constant, inherent squealing.

Stations Well Separated

All three of these coils are tuned with low-loss straight line wave length condensers, which make for ample separation of station signals over the entire range of the instruments, instead of crowding the low wave stations within a small band and separating the high wave stations with more leeway than is really necessary. A better set of condensers yet would be straight line frequency condensers.



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

This photo of the panel and baseboard layout serves as a splendid guide for the constructor in arranging the parts.

Here, then, we have true low-loss coils tuned by real low-loss condensers, with suppressed capacitative feedback into the first R. F. stage, the whole being controlled by a carefully balanced compensating condenser.

Everything has been carefully worked out to give maximum efficiency throughout. Consequently the builder of this circuit should adhere very carefully to the prescribed layout of apparatus.

The proper separation of the coils and short direct leads, even to the extent of using rubber insulated wire, is almost essential to complete success with this receiver. Disregard the neater appearance of a form wiring job with bus bar. It's results you are after, and this set will give them to you—if you heed these suggestions.

Improvements and Modifications

Since the original hook-up was given to the public in blue print form by the manufacturers much experimenting has been done with it by various competent technical men.

Of all the number, none has created so favorable an impression with the writer as the modification worked out by Philip Vary, a well known circuit experimenter. It is his revamped model which is described on this page.

The writer deems the hook-up which is shown in this article to be the last word—the very best modification—that is possible with it.

Practically the only change over the designers' specifications are in the audio stages. Here a Rauland Lyric transformer is recommended for the first stage, followed by one Daven resistance unit. This still makes the set a five tube affair, but the use of a Rauland Lyric, with its extreme amplification, gives plenty of volume on local stations, with wonderful quality. Now we add one stage of Daven resistance coupled amplification. One stage of resistance coupling is usually deemed worthless, but this is not true when it follows upon such a powerful first stage as is provided by a transformer of the type of the one prescribed for this circuit.

Now, then, let's get to work and build it, first, of course, supplying ourselves with these necessary parts:—

Three coils (B.-T. Nameless).
Three .00025 variable condensers.
One .00004 vernier condenser or B-T. three plate.
Five Benjamin sockets.
One Rauland Lyric A. F. transformer.
One Daven resistance mounting.
One Daven .1 resistance.
One Daven .25 resistance.
One .006 Dubilier fixed condenser.

Furthermore, it is possible for the prospective builder to get this material so cheaply and in so many different ways that the saving is hardly worth the labor involved in building.

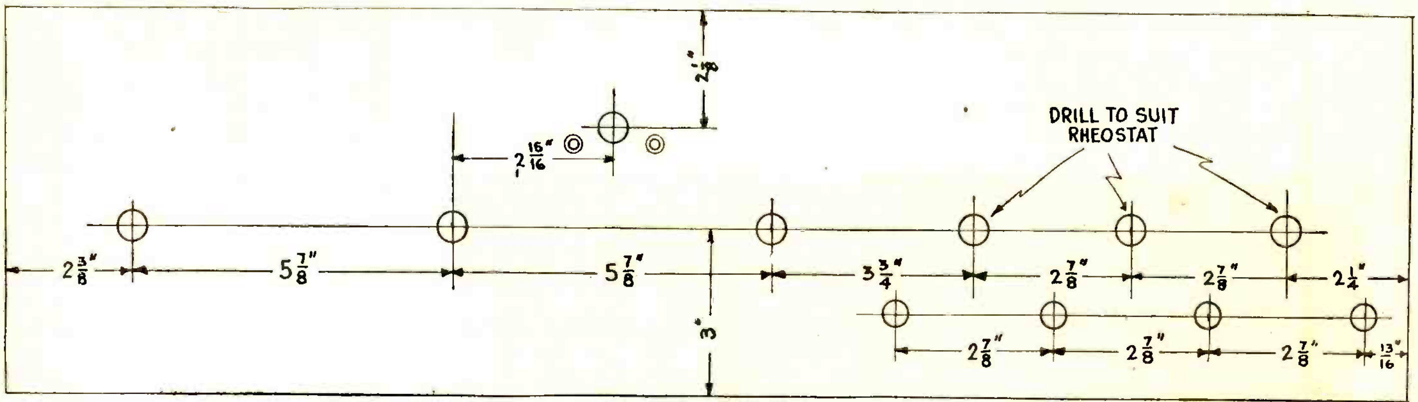
The antenna coil can be purchased separately, or the three coils can be purchased as a kit, or the complete kit, consisting of the three coils, three condensers, the vernier condenser, the two inch dial and a set of blue prints can be had, if that is desired.

Because of the completeness of the diagrams which accompany this story, before fastening the panel to the baseboard.

Leads to the jacks should be soldered next, to insure easy access to the prongs before the space in front of and alongside of these rather clumsy units becomes inaccessible with many wires.

This much out of the way, the rest is easy.

If you cannot follow the two diagrams, schematic and picture hook-up, any instructions that could be given here would be futile.



The front panel layout of the "Nameless" set giving dimensions for drilling the necessary holes.

One filament switch.
One Yaxley rheostat (30 ohms).
One Yaxley rheostat (20 ohms).
One single circuit jack.
Two double circuit jacks.
Two fixed condensers, .001 mfd.
Three 4-inch vernier dials.

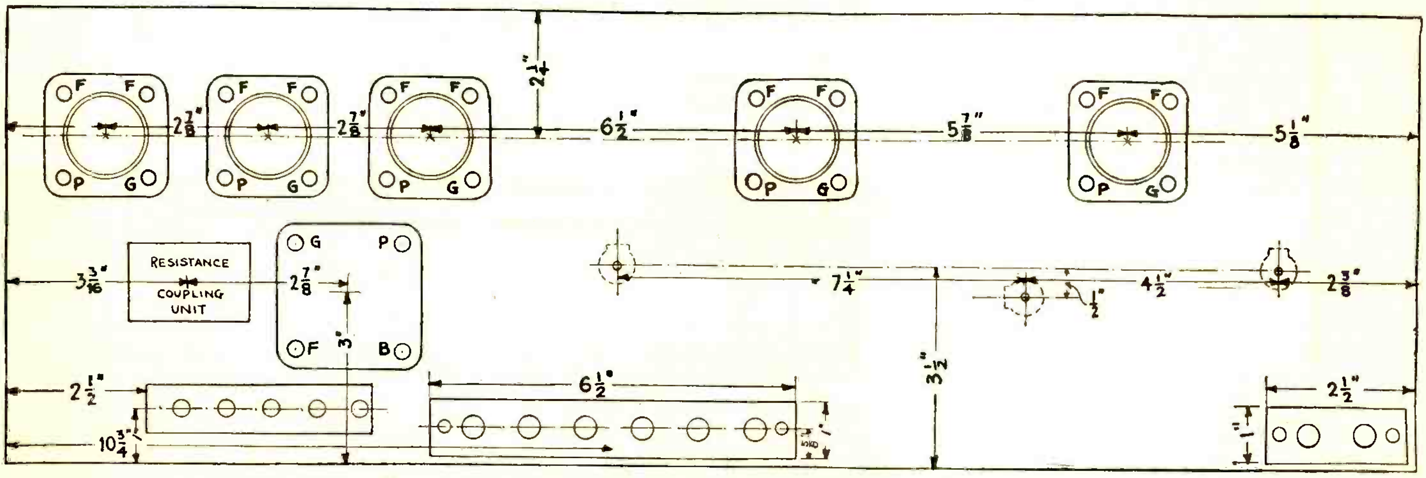
very little space will be devoted to the actual constructional data.

Since every essential measurement for the drilling of holes and the placement of the parts upon the baseboard and the panel are given, it is only with the wiring that we need be concerned.

This much done, only the battery leads remain to be hooked up before the receiver is ready for tuning.

Battery Voltages Critical

The proper "B" and "C" battery voltages are very important, so make



Baseboard layout showing the position of the parts to be mounted thereon.

One 2-inch dial.
One variable grid leak.
Five 201A tubes.
One 7-volt "C" battery (Burgess).
One binding post strip.
One panel 7x26 inches.

Coils Too Hard to Make

Specifications for winding the coils will not be given in this article, for the sole reason that the writer believes the making of space wound, bank wound coils to be beyond the ability of ninety per cent of the readers. It really is difficult.

Wire as You Mount

It is recommended that the parts to be mounted upon the baseboard be placed first. These should be wired together, in so far as possible, immediately. This includes all the filament plus leads, the filament minus leads between tubes, the grid leads between audio transformers and tubes and the lead from the detector grid post to one side of the variable grid leak and condenser.

Next mount the prescribed parts that go upon the panel, connecting up the rheostats, the coil and condenser leads, as shown, and in that order, all

sure that you have them as follows:—Connect up three heavy duty 45 volt units in series. For the detector, tap between 16½ and 67½ volts, the exact voltage to be determined by test.

A voltage between 45 and 90 will be found necessary for the R. F. tubes and the full 135 volts are required for the audio stages, although it will work on 90 volts.

Negative "C" battery biassing is all important, too. From the F post on the first audio transformer connect in the 3 volts. For the radio frequency tubes tap first at 4½ volts. However, if, by using this voltage you cannot control the oscillation of the set with corrosion on the antenna wire, aside from the joints, upon transmission and

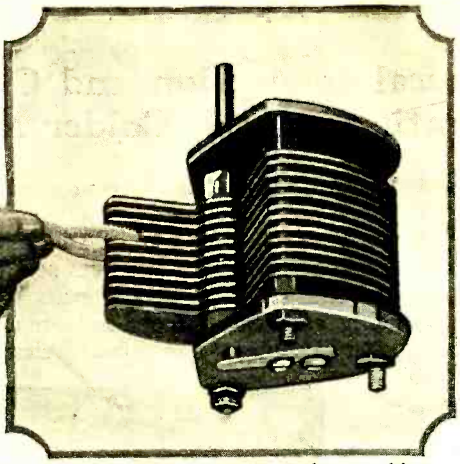


Fig. 4.—Cleaning plates of standard type of variable condenser with a pipe cleaner.

reception. It will, however, be found, in the case of broadcast reception, that even a quite badly corroded antenna wire will give excellent results, provided the connection between the antenna and lead-in is firmly soldered and electrically perfect. In transmitting sets, particularly of low power and those operating on a short wave length, corrosion of this nature has a detrimental effect, but as far as the broadcast listener is concerned, it may be completely disregarded. Therefore, after you have made sure that all the joints on your antenna are perfect, you may entirely forget about the corrosion on the rest of the wire.

Now that you have a perfectly soldered joint, it is a good idea at this time to guard against further corrosion. An excellent method of accomplishing this is illustrated in Fig. 1. Wrap several layers of friction tape over the joint, continuing the wrapping for an inch or so on either side of the twisted parts of the wires. Draw the tape tightly so that it will adhere firmly to the wire. Then paint this tape covering with shellac, being sure that all of the tape, as well as a short length of wire on either side of the covered portion, is completely covered by the liquid. The aerial can then be immediately hoisted into place, allowing the shellac to dry after the antenna is in position.

The Aerial Switch

If your lead-in is provided with an aerial switch so that the antenna may be connected to the ground when not used for reception, the switch should be looked after. It is probably located out in the open and, therefore, quite subject to corrosion. Clean the blade and jaws with fine sandpaper so that they make a good contact. Unless the wires connected to the switch are soldered in lugs which, in turn, are clamped under screws, remove the wires, polish them thoroughly with fine sandpaper and replace, tightening the machine screws as much as possible.

If a lightning arrester is used, be sure that here also the connections are clean and tight. If that type of arrester is employed which is equipped with a spring clip for fastening the connections, remove the wires, clean them and insert them in the clips after bending the latter out a little so as to restore the spring of the metal and so

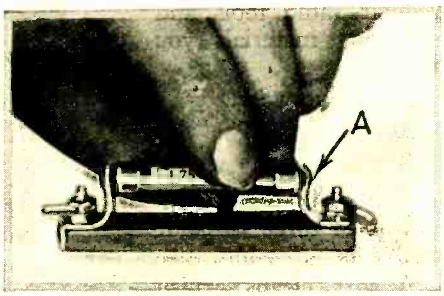


Fig. 5.—Cartridge type grid leak.

as to insure firm contact. If the wires are held to the arrester by machine screws and nuts, clean as before and tighten the nuts thoroughly.

All of these precautions are taken so as to be sure that the current set up in the antenna by the radio waves will reach the receiving set with as much strength as possible. Now that this has been accomplished, we must provide a satisfactory return connection. That is, the ground connection must be carefully and thoroughly made or otherwise all of the time spent in working on the antenna will bring small results. The average radio receiving set is grounded to a water pipe or to a length of iron pipe driven into the ground and the wire is connected thereto by means of a ground clamp. Here is another point where corrosion may take place, particularly if the connection is exposed to the outside atmosphere. If the ground clamp is badly corroded, replace it with a new one after thoroughly cleaning the pipe at the point where the connection is made. Here you can also prevent future corrosion to a very great extent by the use of tape and shellac. Cover the entire ground clamp, an inch or so of the wire connected to it and an inch of the pipe on either side of the clamp with tape, leaving no openings for the entrance of air to the clamp and pipe. Then apply a coat of shellac and allow it to dry. The effect of the tape and shellac is to prevent dampness and atmospheric moisture from reaching the metals and so corroding them at the point of contact.

Before we leave the subject of collective agencies, as antennae or aerials are sometimes termed, let us note in passing the loop antenna. An ordinary type is illustrated in Fig. 2 and the two flexible wires which connect this piece of apparatus to the receiving set are shown. As the loop is turned, these flexible wires are twisted, and through continued use will sometimes break. Often the wires under the coverings break, but the open point is not noticeable because the insulation remains intact. Such an event would be denoted by a sudden cessation of reception, or at least a greatly reduced volume. In such a case, install new flexible wires. Even though there is no trouble as yet with these flexible wires, but if the insulation is badly worn and twisted, install a new pair anyway. This will guard against future trouble.

After you have finished your complete inspection of the antenna and ground systems, you will be ready to start on the receiving set itself. The first thing to do is to disconnect all wires from the receiving set, including the antenna, ground, all batteries and phones or loud speaker. Better remove all wires from the batteries also, so that the loose ends will not short circuit. Place the batteries to one side until they are ready for their share of attention. Do the same with the loud speaker or phones and then remove the receiving set from the cabinet. You will then be ready to completely inspect the various component parts of the set under the best conditions. Here you will find that a flashlight will come in handy for getting a closer view of the various parts that may happen to

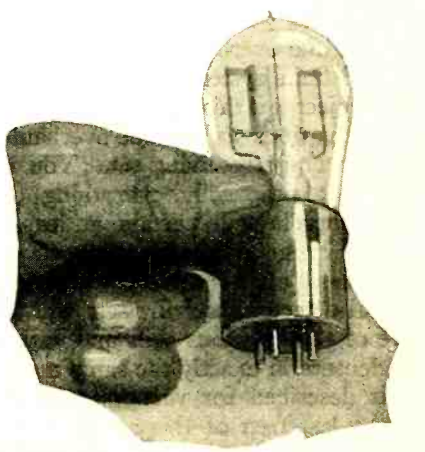


Fig. 6.—Standard tube showing contacts—a source of trouble if not cleaned occasionally.

be hidden by other instruments. A flashlight may often disclose a loose or broken connection or a defective instrument which would otherwise pass unnoticed.

We show in Fig. 3 a rear view of a typical radio receiving set with the various parts that will bear inspection and overhauling. If careful attention is paid to every point outlined below, you may replace the set in the cabinet with perfect assurance that it is ready for another season of good results.

The various points indicated in Fig. 3 are as follows: A indicates the inductance coil, which may be any one of many various types. B is a variable condenser. Practically all of them are of a type similar to this one and will be taken care of in the same manner. C indicates a combined grid condenser and variable grid leak. This instrument is completely sealed in and usually needs no attention whatsoever, unless it has been used so often that the resistance unit is worn away. In such a case, it will be necessary to replace the leak with a new one. D indicates the vacuum tube socket in this receiving set, while E is the rheostat and F an open circuit jack.

We will now deal with the care of the various instruments in detail. Consider all types of inductance coils, an example of which is indicated by A, in Fig. 3. Dust collecting on the surfaces of coils has a detrimental effect which cannot be overlooked. This may be quickly and easily removed if a soft, clean varnish brush about one inch wide is used. Simply brush the dust off the surface of the coil, carefully working into all crevices and corners. This applies to all types of coils, either of the low loss type or those wound on cylindrical tubes. In any event, remove all dust.

The condenser next comes in for its share of attention. Dust often collects between the plates of the condenser and thus forms a partial connection between the various plates with the result that the operating efficiency of the receiving set is lowered. This point would seem to be a very hard one to get at, but if you will take an ordinary pipe cleaner and bend it into a loop, as shown in Fig. 4, you will be able to run it in and out between the plates of the condenser and so remove every trace of dust and dirt therein. Treat all of the variable condensers in your receiving set in this manner, being careful to get in between each and every plate.

The variable type of grid leak was mentioned above. If, however, you use one of the tubular type, such as illustrated in Fig. 5, it is well to remove the cartridge from the clips, bend the latter together slightly and, with fine sandpaper, brighten the tips of the cartridge so that they will make good contact with the springs. Then replace the leak in the clips.

Now we will turn to the vacuum tube socket. All the remarks below will pertain to each and every socket in the receiving set, regardless of the number. Each one should receive the same careful attention. A standard socket is shown at D, in Fig. 3, and

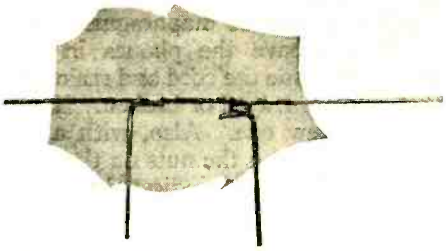


Fig. 8.—The connection at left is well soldered, while that at the right is not strong.

another one in Fig. 6. In the latter, we have removed the socket from the set so that the parts of it can be more

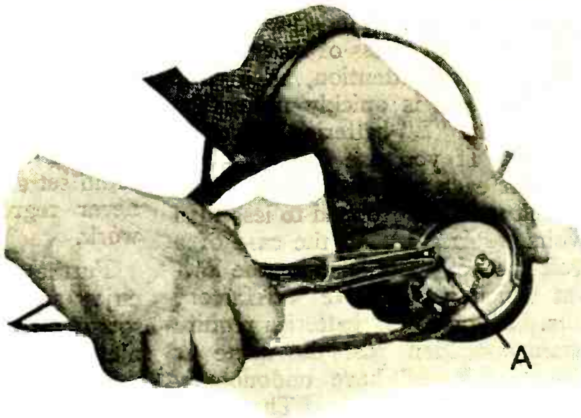


Fig. 9—Tighten nuts on back of phone so that connecting wires are securely fastened. When wires or cord become broken or noisy new ones should be connected in.

plainly seen. Note the flat springs pointed to by the pencil in the photo. Often these springs become weakened, due to continued pressure, and do not make perfect contact with the prongs of the tube. In such an event, you can reach one finger inside the tube socket and bend up the ends of the springs so that their life is restored and so that they will firmly press against the prongs on the base of the tube. These prongs are indicated by the pencil in Fig. 7. They should be noticed also and if they are at all dull or corroded scrape them lightly with fine sandpaper or a file so that they are bright. Then when you replace the tube in the socket you may be sure that perfect contact will be made between the prongs and the springs and no losses will occur at this point.

We will now consider the rheostat indicated by E, in Fig. 3. You may have noticed occasionally in the operation of your set that the filament seems to flicker occasionally and at the same time music is affected. This may frequently be due to a loose contact arm on the rheostat, which should be immediately remedied. So, in your overhauling, look at these arms and move them back and forth several times in order to see whether there is any looseness.

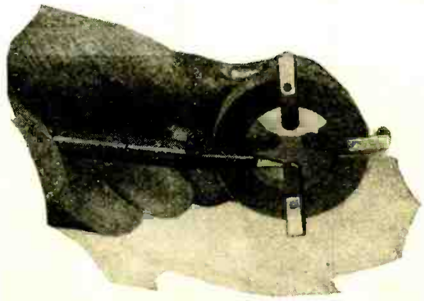


Fig. 7.—The pencil indicates a bent contact spring on the vacuum tube socket.

If the arm does not seem to be making perfect contact with the wire wound on the sector, remove the arm, bend it down slightly and replace. It should then make perfect contact. With carbon-pile rheostats you will seldom, if ever, find any trouble. Just brush off the outside of the container so that no dust collects thereon, forming a leakage path, and further attention will be unnecessary.

The jack, indicated by F, will give a little trouble if dust is allowed to accumulate in any great quantity on the short insulating strips which separate the spring or springs from the frame. The varnish brush mentioned above will remove any dust found here.

After you have completed the cleaning of all the instruments, bring a soft cloth into play to dust off the panel, the baseboard and all the crevices around them. You will not be able to get it all out with a cloth, but do the best you can. Then take the stick of sealing wax mentioned above, rub it briskly with the piece of flannel cloth until it is thoroughly electrified and run the end of the wax along the various cracks and crevices where the cloth could not reach. The wax, being electrified, will attract fine particles of lint and dust to it that cannot be removed by any other process and the result will be a very clean set. This method of removing foreign material can also be applied to other points on the receiving set where a cloth or brush cannot be used.

Next, look over the connections of the set. You may find one or more connections made as indicated in Fig. 8. Such a type is very bad and is liable to cause trouble, as it may break when least expected. In such an event get out your soldering iron and make the connection so that it appears as shown in Fig. 8. Such a connection is as nearly electrically perfect as it is possible to make one. After you have gone over the wiring, take each and every wire between your fingers and tug it slightly at any place where it is connected to other wires. You will quickly locate any loose and broken connections by this method and they may be quickly and easily repaired.

This completes all of the overhauling work necessary on the set itself. The loud speaker will seldom, if ever, need overhauling, as most of them are completely enclosed and so are not subject to the action of dust and weather conditions. If, however, you have a radio receiving set which employs headphones, these will need some attention. If you will look through the small hole in the center of the cap you will undoubtedly notice a small rusty spot inside. Removing the cap, you will find that this rusty spot is on a thin disk of soft iron. You can remove this disk, but take great care not to bend it. Remove the rust with fine sandpaper and place a drop of very thin oil on the metal and spread it out. Then wipe the disk off carefully, still taking care not to bend it, and replace in the phones in the same position as it was removed. In other words, have the same side of the diaphragm, as this disk is called, on the inside as was in that position before the cap was removed. Do the same with the disk, or diaphragm, in the other receiver. If the diaphragms are so badly rusted that the metal seems to have been weakened, address the manufacturers of your receivers for a new pair of diaphragms. Also, while you have the phones in your hands, examine the cord and make sure that it is not frayed or broken. If it is, install a new one. Also, with a pair of pliers, tighten the nuts on the backs of the receivers, as indicated by A, in Fig. 9. If the tips enter the casing of the receiver, tighten up the set-screws with a screw-driver while you have the cap and diaphragm off the receiver proper.

Fig. 10.—Using tooth brush and alcohol to clean surface of detector crystal.

Before you put your radio set into operation, and even before you connect the batteries to it, test these latter with a voltmeter. Undoubtedly the "A" battery, regardless of its type, has received careful attention, as a drop in voltage here is quickly noticeable. However, the "B" batteries are often neglected. If you use dry "B" batteries, test each unit separately. If a 22½-volt unit has dropped to less than 19 volts, replace it. In the case of a 45-volt unit, 39 volts is about the lowest at which it will give satisfactory results. Storage "B" batteries require constant attention just the same as "A" batteries and have undoubtedly been cared for regularly. Therefore, in your overhauling, just give these batteries their usual care.

To Crystal Users

Below we give a few points which will be of interest to those who use crystal receiving sets or who are employing crystal detectors in reflex receivers. It may be that recently the signals have started to get dim or the set does not seem to work as well as it formerly did. If the overhauling of the set as described above does not seem to bring back satisfactory results, remove the crystal from its clamp or cup and scrub the surface carefully with alcohol, taking care not to touch that surface with the fingers. A small brush, as indicated in Fig. 10, will greatly assist in this cleaning process. While you have the crystal out of the cup, clean the end of the contact which touches the surface of the crystal. A fine file or sandpaper will accomplish this very nicely, and will provide a clean contact for the freshly cleaned crystal.

Just because your radio receiving set happens to be functioning quite properly at the present moment, do not think that it may not need overhauling. If it has been in use for a period of six months or so, it is undoubtedly ready for a complete overhauling and the time to do so is before something goes wrong. So now set aside your day for the spring cleaning of your radio set and be assured that you will never regret the time spent in this work.

Furthermore, you will be able to enjoy summer reception with a minimum of noises in the set itself. Static alone is bad enough and you should take every precaution to prevent set noises from annoying you. Overhauling the instruments as described above will accomplish this.

Dull Finish for Radio Panels

For the home builder it is best to use a dull panel, that is, one from which the glossy finish has been removed. This prevents a smeary appearance caused by fingerprints, etc. Most manufactured sets have a dull finish if desired. All you require is a little 00 steel wool or sandpaper, machine oil, and elbow grease. If you are not prepared to do a little rubbing, don't try dulling your panel, but if you are proceed as follows:

Fasten the panel firmly to some stationary object with a clamp and rub with a handful of the steel wool or a strip of sandpaper tacked to a block of wood. Make the stroke the length of the panel and press in any little indentations that may be discovered. Do not rub up and down or in circles. This will spoil the grain and give the face of the panel a scratched appearance. When the entire surface is devoid of gloss or has acquired a gray velvety appearance, wipe off with a soft cloth to remove all particles of steel or sand.

Then with another clean cloth saturated with light machine oil rub the panel lengthwise over its entire surface. Allow the oil to stand for a few minutes, then wipe off with another clean piece of cloth. The panel is now ready for use and handling will not show marks. It is very handy to have some kind of a marker on the panel at the edge of the dials as an indicator. This can be made permanently and neatly by taking a sharp pointed object of hard metal and scratching a small mark in the panel at the point where an indicator is desired. Press hard and firmly when doing this in order to prevent the instrument from slipping.

Fill the mark with common school chalk and wipe off the surplus.—*Boston Traveler.*

The Metric 3-1 Regenerative Receiver

Oscillates Over Entire Broadcast Wave Band with Radio Frequency Amplifier

THE Metric receiver illustrated herewith is something new in the line of regenerative sets. It employs low-loss pancake coils, and regeneration is controlled by means of variable condensers, one of the simplest methods known. Details for building the Metric receiver appeared in *The N. Y. Evening World* Radio Section. *H. G. Silbersdorff,* the author described it as follows:

This set is compact, simple to operate and exceptionally easy to construct. Regeneration is obtained by the varying of a capacity connected to the plate circuit of the detector tube, something different from standard practice, in which regeneration is obtained by means of a variable inductance such as a variometer or the regulation feedback or tickler coil.

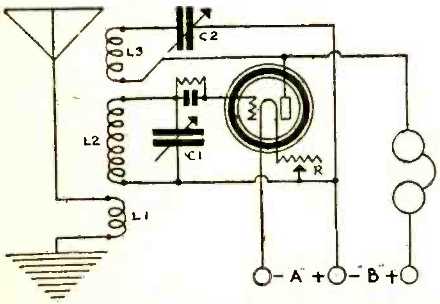
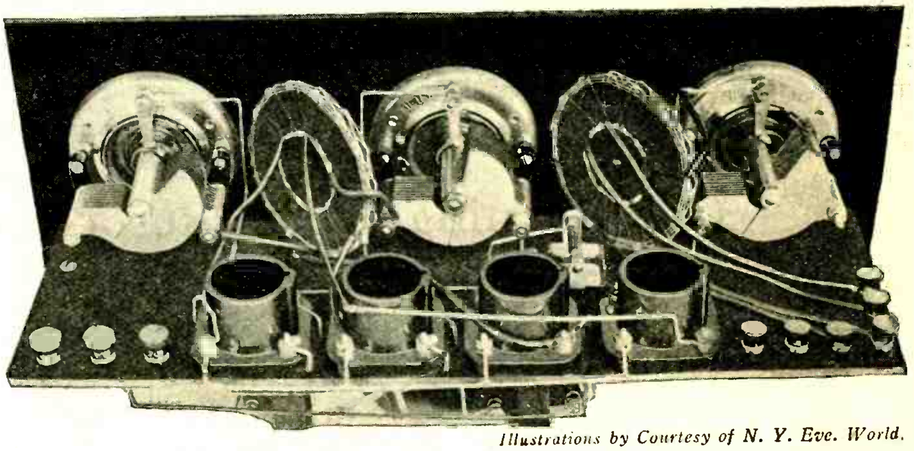


Fig. 1—Schematic wiring diagram of the Metric receiver employing only one tube.

Regenerative circuits have always been popular, probably always will be. With such circuits properly constructed and handled it is possible to cover surprising distances with but a single tube and with selectivity, which is so essential to those living in congested radio centres.

Let us assume we have a set operating on a weak signal with the detector tube on the very edge of oscillation; we are working at the full capacity of sensitiveness of the detector. We can go no further, but we hear in the faint background still other whistles very, very weak, and, try as we will, cannot tune out the whistle and bring in the voice. The thrill of hearing a real distant station is ours, but cannot be satisfied because we cannot increase the signal voltage to make an impression on the grid. We are using two stages of audio amplification and can continue no further in this direction, as the noises will be amplified to a far greater extent than will the weak signal. To further explain, I might add that the audio amplifier will amplify a loud signal better than it will a weak one. There is but one thing left to do and that is to amplify the signal before it gets to the grid of the detector; then, having a greater initial signal on which to work, it will not be lost in the maelstrom of noises taking place in the audio amplifier. To do this we must add another tube and transformer with its secondary tuning condenser as the radio frequency amplifier.

In the Metric 3-1 regenerative receiver this can easily be done by using another coil, exactly the same as the 3-1 used as a tuning unit for the R. F. transformer and antenna coupler. These coils are wound in spider web fashion, having a 6-turn primary wound next to the core, a 55-turn secondary, as a middle winding, and around the outer edge of this a 12-turn tickler, all being wound with No. 22 D. S. C. wire and each with a different color to distinguish it from the winding next to it, the primary white, the secondary orange, and the tickler blue.



Illustrations by Courtesy of N. Y. Eve. World.

Assembly of the four-tube Metric set showing how the coils and condensers are mounted on the panel and sub-panel. Note that the audio frequency transformers are placed beneath the tube sockets.

The photograph clearly shows the location of the two coils and three .0005 mfd. variable condensers. The coils are mounted at an angle, the exact position of same not being important, so long as the mass of metal in the condenser is not in the direct field of the secondary winding; also it helps to conserve on space, making it possible for the set to be mounted on a 7x18 panel.

The circuit diagram (Fig. 2) clearly shows methods of connection of the complete receiver. A schematic diagram of connections of a simple detector unit is given in Fig. 1 so that the reader may readily trace out the connections to the 3-1 coil. From this we see coil L1 is the untuned primary and is connected between the antenna and ground. The secondary is next and is shunted by a .0005 condenser, taking care to have its stationary plates connected to the grid, the rotary plate connection being continued to the positive side of the A battery.

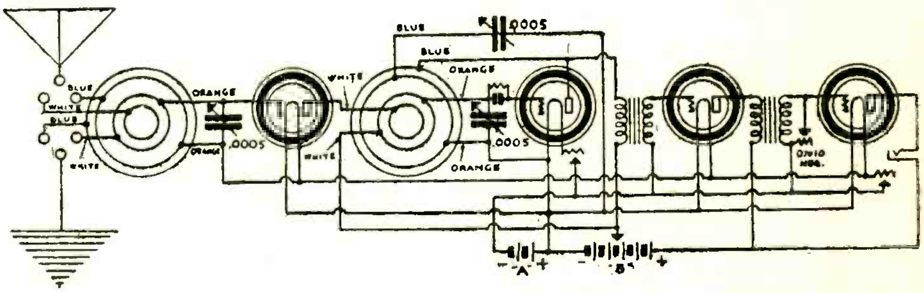


Fig. 2—Wiring diagram of the four-tube Metric receiver with the additions of one stage of radio frequency amplification and two audio frequency stages.

One side of the tickler coil is connected directly to the plate of the tube, the remaining side going to the stationary plates of condenser C2, the movable plates also being connected to the A positive. A second connection is made directly to the plate of the tube this being the phones or the primary of the first audio transformer.

When radio frequency is added the above winding L1 is disconnected from the antenna and ground and is connected in the plate circuit of the R. F. tube, this acting as an untuned primary of the R. F. transformer, the balance of connections remaining the same.

We now divert our attention to the head end, in which another Metric 3-1 coil is used for an antenna coupler. The same inside winding can be used as the primary, being connected between aerial and ground, the secondary, the orange colored winding, being shunted by the third .0005 mfd. condenser, which has its stationary plates connected to the grid and the movable ones to the negative filament.

The audio amplifier is connected in the conventional manner with a 3½ to 1 and a 5 to 1 audio transformer, a variable resistance of 0 to 10 megohms being connected across the secondary, which acts somewhat as a volume control as well as reducing noises so apt to occur when high amplification is obtained.

A number of combinations in connections can be obtained with the head end Metric coil, which with proper use can be used to advantage in obtaining selectivity and volume. For example, on this coil either the 6-turn or the 12-turn winding can be used, or we can connect the two together, resulting in an 18-turn primary. This will give very loud signals, but will be somewhat broad in tuning. Using the 12 turns gives us an increase in selectivity with little loss in volume.

Greater selectivity is obtained with the 6-turn primary, the greatest selectivity being obtained when there is no actual metallic connection between the antenna and ground. That is to say, the antenna is connected to one end of the 12-turn winding and the ground to one end of the 6 turns. This leaves one free end on each winding, and remarkable selective tuning is the result. This feature will be appreciated by those living very close to high powered broadcasting stations, making it possible for them to tune out the local and bring in other stations.

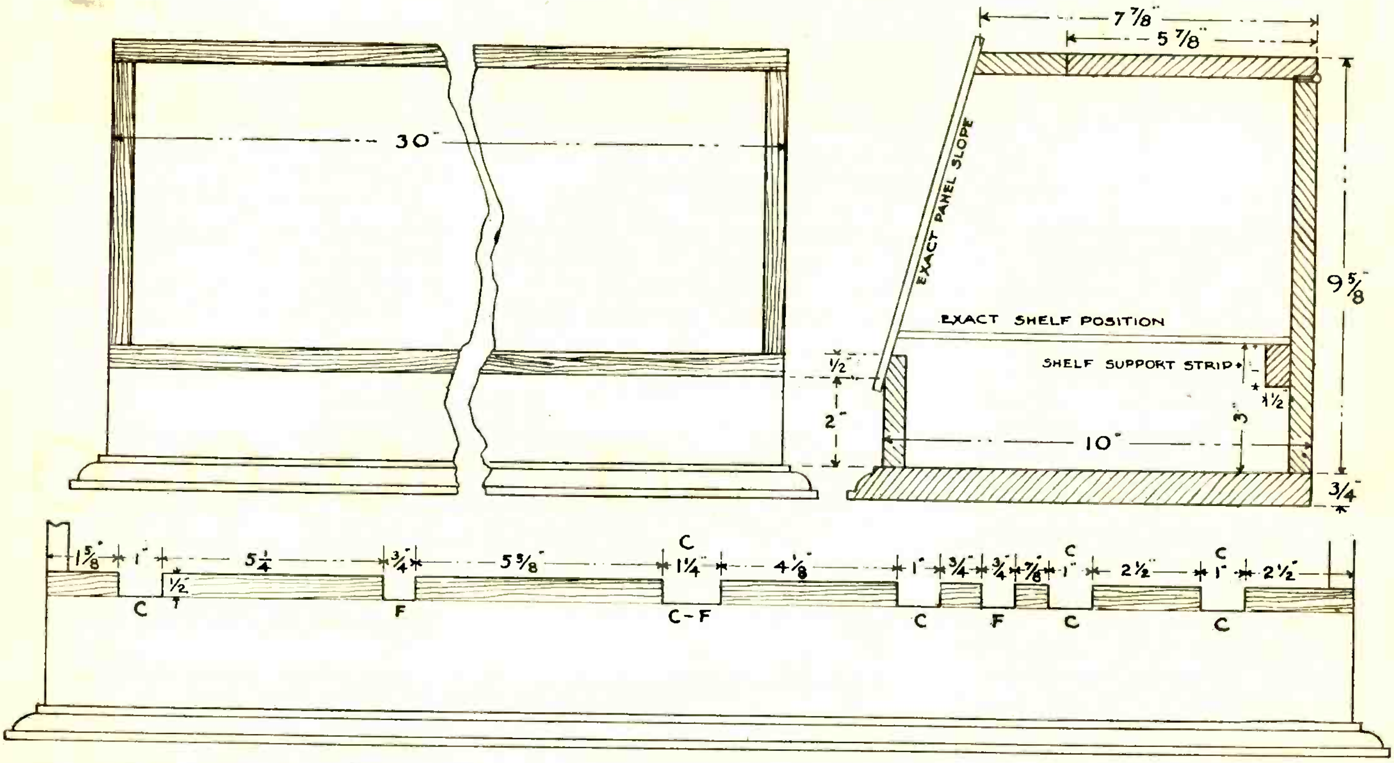
The Evening World Resonatone Receiver

(*Continued from page 16*)

ever the cost, and wants his set to "look like a million dollars."

The same circuit, however, can be built into a more modest receiver at far less cost and with half the labor of construction, and yet be able to do, when completed, everything that the more expensive model will do in the way of performance. The picture diagram of the circuit suggests a tentative layout for a conventional model.

As the great selectivity of the Resonatone is in part due to its design for loop operation, choice of a loop is important. If your location demands great selectivity, the pancake type of loop will give you the sharpest tuning. Otherwise I recommend the box type, for although you sacrifice a little of the loop's selectivity, you gain in the increased strength of signals from distant stations and get noticeably "fuller" reception from the locals



Slope panel cabinet specifications—If the above diagrams are exactly followed the set will fit into cabinet when finished. Slots in top front edge permit passage of switches and jacks at C, C, C, C, C, and shelf brackets at F, F, F (see panel template). Shelf support strip should extend across back of cabinet to keep weight of instruments from warping shelf. Panel slope and shelf position are indicated.

In either case, however, the inductance should be standard for tuning with a .0005 condenser, not only so that you can cover the entire broadcast wave band but so that your dial settings will correspond.

A 60 to 600 Meter Tuner

A Radio Set with a Wave-Length Range Below the Average Broadcast Receiver

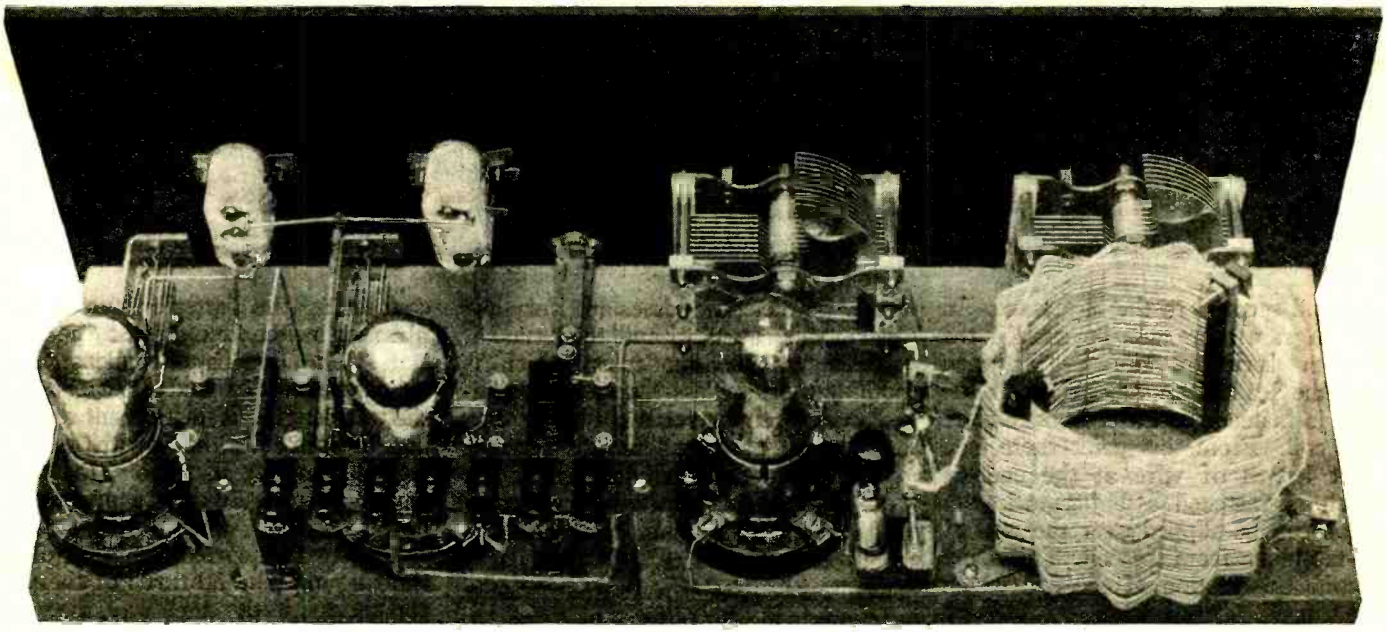
THE average broadcast listener has a receiver designed to operate on wave lengths between about 200 and 550 meters, efficiency at the upper and lower limits being problematical in many cases.

Occasionally he hears of broadcasting on wave lengths below 200 and even 100 meters, but as the tuners ordinarily described for short wave reception are operable only on short waves, he concludes, quite rightly, that between the two, the choice lies with the more popular and widely used band up to about 550 meters.

Writing in *Wireless Age, Robert Alan* describes a receiver designed to operate equally well from 60 to 600 meters, thus taking in all commercial levels of broadcasting and even permitting reception of certain dot and dash transmission at 600 meters. Following is construction data and other information.

Constructional Details

The only part of this receiver which will involve any difficulties to the home builder is the construction of the tuning coil. This consists of about 90 turns of No. 18 D. C. C. To secure best results it is best to use double cotton covered insulation. The single cotton insulation is not strong enough to withstand any rough treatment in the course of winding the coil, and the single-silk and double-silk-covered wire in this winding is not considered as good an insulation as the double-cotton-covered. Before winding the coil secure a piece of strong 7/8 inch wood 6 inches square (we used 3/8 inch Dilecto, but the wood if strong enough will serve the purpose). Lay out on this piece a circle 4½ inches in diameter and divide its circumference into thirteen sections by the use of an accurate pair of dividers. Then drill at these intersections holes big enough to take a good sized 6 inch spike. The holes should be of such size so that the spikes can be removed. Then drive into these holes the thirteen spikes.



Illustrations by Courtesy of Wireless Age (New York)

Fig. 1—Rear view showing arrangement of parts on panel and baseboard.

LIST OF PARTS

- One .000009 mfd.-.0005 mfd. General Instrument variable condenser
- One .000006 mfd.-.0003 mfd. General Iistrument variable condenser
- One 7x21 Radion panel
- One 7x1 binding post strip Radion
- Two Na-Ald De Luxe dials
- One Carter filament jack switch
- Two Pacent jacks, audio filament lighting
- Three Standard sockets
- Two Bradleystats
- Two Amertran audio frequency transformers
- One .00025 mfd. grid condenser
- One 1½ megohm gridleak
- Seven Eby binding posts
- Four strips of hard rubber 4"x½"
- Eight lengths of bus wire
- Three lengths of spaghetti
- One 6"x20½" baseboard
- One pound of No. 18 D. C. C.

The windings should then be started. The plate coil comes first and consists of 45 turns of wire. The turns are made by going outside one spike and inside the next two, then outside one and inside the next two, etc. A tap is taken at the 30th turn. When this winding is completed break the wire, leaving about 8 inches of it for connection purposes, then right at the end of this winding start the secondary or grid winding. Continuing in the same direction wind eight turns of wire, which will form the antenna circuit. At the end of the eight turns take off a tap and wind 40 more, which forms the grid coil. These 40 turns should be tapped at the 10th. When the winding is completed take several yards of 16 pound test fishline and between the spikes where the wires cross tie up the coil. At each cross section of wire the coils should be fastened with this fishline. When the coil is completely tied up remove the spikes and the coil. Now to support the coil on the baseboard take four one-half inch hard rubber strips one inch longer than the coil itself and drill one-eighth inch holes one-quarter inch from the ends of each one. One strip is then put through the loop in the winding form and the other strip placed two panel mounting rheostats. Next to the rheostats and six and one-half inches in from each end of the panel place the two variable condensers. In the center of the panel and two and one-half inches down from the top the second radio frequency transformer is mounted. Directly below this is placed the battery switch. Three inches to either side of this switch the two phone jacks are placed. See Fig. 2.

Now mount the sub-panel with the brass brackets to the base of the variable condensers. Two other brackets are fastened to the rheostats and then to the sub-panel.

Two Winsted audio frequency transformers are used and are unmounted, so that they can be easily placed beneath the sub-panel. They are separated as far apart as space permits. The two sub-panel variable resistances are placed in between the two audio sockets beneath the base. These two resistances are used to control the audio stage filament circuits.

The binding posts are placed along the rear of the sub-panel and well spaced so that there will be no danger of exterior wires touching when connecting up the receiver.

Referring to photos and drawings given herewith, the constructor has a very clear view of the interior, exterior and circuit diagram of the set. There is nothing difficult in wiring this receiver, since the last three tubes are wired in the same manner as the conventional three-circuit. The single stage of radio is wired up as usual.

For the benefit of those employing the standard three-circuit three-tube set a special tuned radio frequency unit will be described herewith.

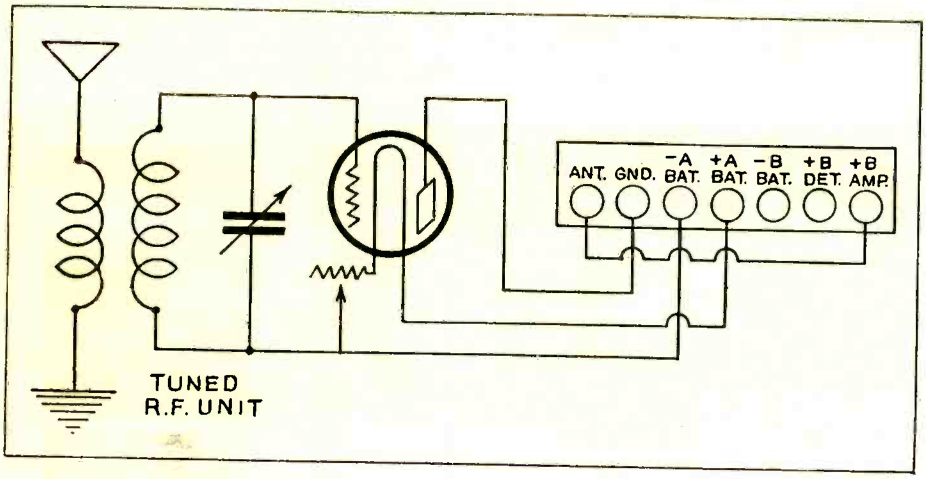


Fig. 3.—Schematic diagram of tuned radio frequency unit which can be used with almost any three-tube set to increase the range.

The following parts will be required for the actual construction of this radio frequency unit:

One Globe radio frequency transformer.

One variable condenser of .0005 microfarad (low loss).

One tube socket.

One thirty-ohm rheostat.

One binding post strip with nine binding posts.

One panel 7 x 10 x 1/4 inches.

One wooden baseboard 7 x 8 inches.

Bus bar, brackets and screws.

The panel is drilled so that the variable condenser is in the center, with the rheostat either below it or on the side. The binding post strip is placed at the rear of the baseboard.

Tuned R. F. Unit

Referring to the schematic diagram, shown in Fig. 3, we have the circuit of the tuned R. F. unit. The aerial is connected to one end of the primary coil and the ground to the other end.

One end of the secondary coil is connected to the post on the tube socket marked "G." The other end of the inductance is connected to the negative filament circuit. The variable condenser is shunted directly across the secondary winding.

The schematic diagram shows the plate of the tube socket connected to a post marked GND and the B battery plus connected to the post marked ANT. This is in reality the output of the unit and is connected to the primary coil of the three-circuit tuner of the standard set now in use.

Other connections, such as the filament circuit, will not be described in detail, since they are of the regular form.

Such a tuned radio frequency unit will be found very handy around the radio shack for testing purposes. It can be connected to any type of set by merely joining the two output posts to the primary of the other receiver. This same type of unit is used in the main set described in this article.

One of the main advantages of the four-tube receiver is its excellent selectivity. Stations can be tuned in and out within a fraction of a degree on the dials. As far as volume is concerned, nothing can be said except that the windows rattle in the writer's home when locals are in operation. Nothing need be said as to the DX getting qualities of the set, since the regular three-tube set will bring in the coast frequently, and when it is connected together with a tuned radio frequency amplifier the old DX record is sure to be increased.

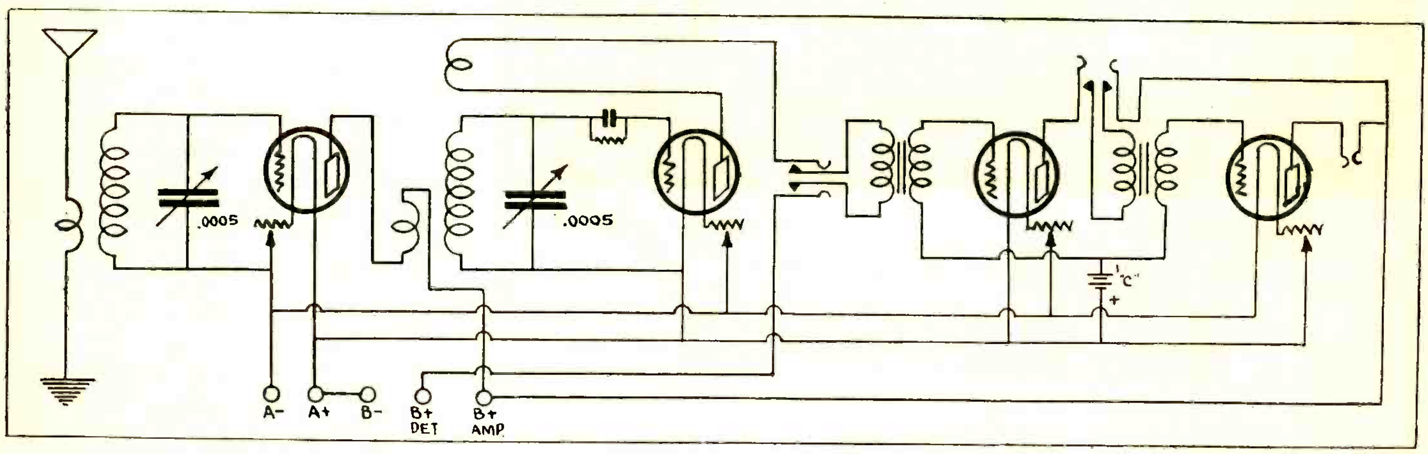
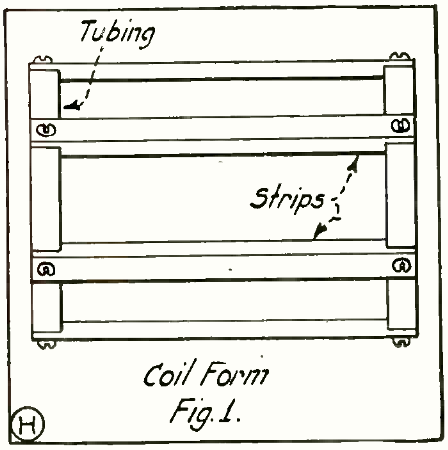


Fig. 4.—Schematic diagram of the complete set. If telephone by-pass condenser is desired it can be connected across the primary terminals of the first audio transformer.

How to Build a Simple Low Loss Receiver

A Set Designed for Efficiency and to Cover the Entire Broadcast Band

IN this day of the low loss tuner and the wide wave-length band, in which the numerous broadcast stations operate, two things are required of a receiving set. First, it must have few losses, which in turn give the set selectivity, volume, and the opportunity to bring in distant stations, and second the set, or rather the tuner, must be able to cover the entire wave-length band now in use by the broadcasting stations.



Details of construction of coil form showing mounting details for bakelite strips and end pieces.

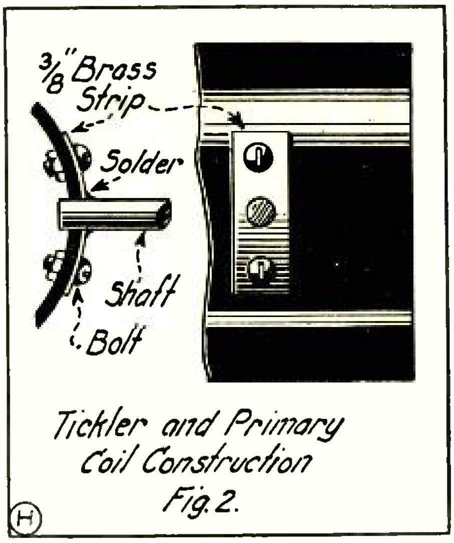
An ideal set of this type has been described by C. K. Devant in the *New York Evening Graphic Radio Section*, and is given as follows:

To design a tuner properly it is necessary that the constructor of a set understand just what controls the tuning range of a set. The wave length of a tuning circuit depends on the capacity and inductance in that circuit. If the circuit contains a fixed inductance value and a variable capacity, a greater wave-length range will be covered than were a fixed capacity and a variable inductance used—that is, in most cases.

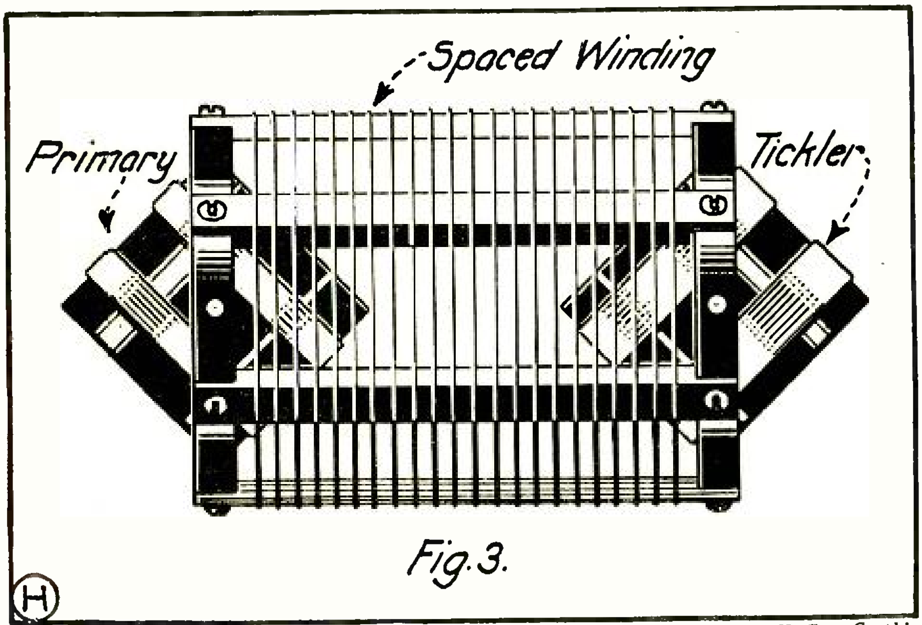
Condenser Tuning

With a fixed inductance, the inductance changes slightly with the frequency, but this change can be ignored with the ordinary tuners, and with a variable condenser connected across the inductance the highest wave length to which the circuit is to respond is easily obtained. It is the shortest wave length that offers the difficulty.

In order that a tuner have a very low as well as a high wave length for its limits, it is necessary to have two things in the circuit. One is a condenser having a very low minimum capacity and a coil with a low distributed capacity. The reason for this is that, having a fixed inductance value in the circuit, the capacity range is the controlling element of the tuner. Therefore, it is easily seen that if a condenser having a high minimum capacity were to be used with a coil having a large distributed capacity, the minimum wave length to which the circuit would respond would be much higher than were the ideal conditions fulfilled, i. e., that of a condenser having an extremely low minimum and a coil with no distributed capacity at all.



Detail of tickler form and arrangement of shaft of tickler and primary.



Illustrations by Courtesy of N. Y. Eve. Graphic

The complete tuning unit showing mounting of rotary coils.

Low Loss Tuner

The purpose of this article is to describe for the fans a tuner that is low loss in design and construction if built properly, and capable of covering the entire broadcast wave-length band.

The much misnamed two-circuit regenerative circuit has been chosen because of its simplicity in both construction and tuning. Some fans may recognize the circuit if it were called by its misnomer, the "three-circuit tuner." Just why this name should have been given to this set is a mystery to the writer.

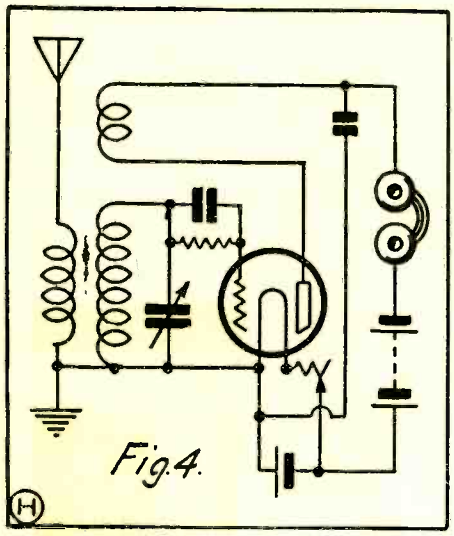
The necessary parts for the construction of a one-tube receiver of this type are:—

One 7 by 12 inch panel.
One 7 by 11 inch baseboard.
One low loss condenser, maximum capacity .0005 mfd.
One tube socket.
One tube.
One rheostat, resistance to fit tube used.
One .00025 mfd. grid condenser.
One .0005 mfd. fixed condenser.
One grid leak.
One half pound spool of No. 20 DCC wire.
One half pound spool of No. 14 DCC wire.

Six composition rods, ¼ inch diameter by 6¾ inches long.

Two composition tubes, 1 inch wide by 4½ inches in diameter; wall should be 3/16 inch thick.

One composition tube, 1 inch wide by 3 inches in diameter.



Schematic diagram of circuit used as a one tube receiver.

One composition tube, 1½ inches wide by 3 inches in diameter.

Two brass rods, ¼ inch diameter by 4 inches long.

Two brass strips, ⅝ inch wide, 1½ inches long by 1/16 inch thick.

Sixteen round head nickel plated machine screws, 6/32 by ⅜ inch long, nuts to fit also.

One single circuit jack.

Six binding posts.

One binding post strip.

Batteries, phones, aerial, and ground.

Coupler Construction

The coupler is the first item to be attended to in the construction of the set. For any one who has built couplers before the drawings will be all that is necessary to go by, but for the benefit of those who have not had any experience in building couplers full instructions will be given.

In Fig. 1 on page 41 a drawing of the partly assembled coupler is given. This is the part that is to be built first. The two 4½ inch composition tubes are prepared for assembly by marking off six equidistant points on the circumference of each. At each of these points, which should be in the exact center of the tubes, drill a hole with a No. 27 drill. Then in the exact center of the tubes drill a quarter inch hole to the shafts of the primary and tickler coil. The location of all the holes and the reason for their being is shown in the drawing.

Preparing Rods

The composition rods are next prepared. One inch from each end of each rod file the rods half way through, so that they will set evenly on the composition tubes when they are bolted down, as shown in Fig. 1. Care should be taken while doing the filing that the rods are not broken and that the two filed notches are on the same side of the same rod. They won't fit well if the notches are not filed so as to be on the same side. With the notches filed, the rods are drilled also with the No. 27 drill one-half inch from each end. When all have been drilled the form is assembled, as shown in the diagram. After assembly, test the strength of the rods. If they are weak, then it will be necessary to take down the form and insert a composition tube in the center to support the rods. This tube need not be longer than one inch. Fifty turns of No. 14 DCC wire are wound on the form, slightly spaced as shown in Fig. 3.

The primary coil is the next one to be wound. In the exact center of the one by three inch composition tube drill a quarter-inch hole. Then in one of the brass strips drill a center hole one-quarter inch in diameter, and one-quarter inch from each end of the strip drill a hole with the No. 27 drill.

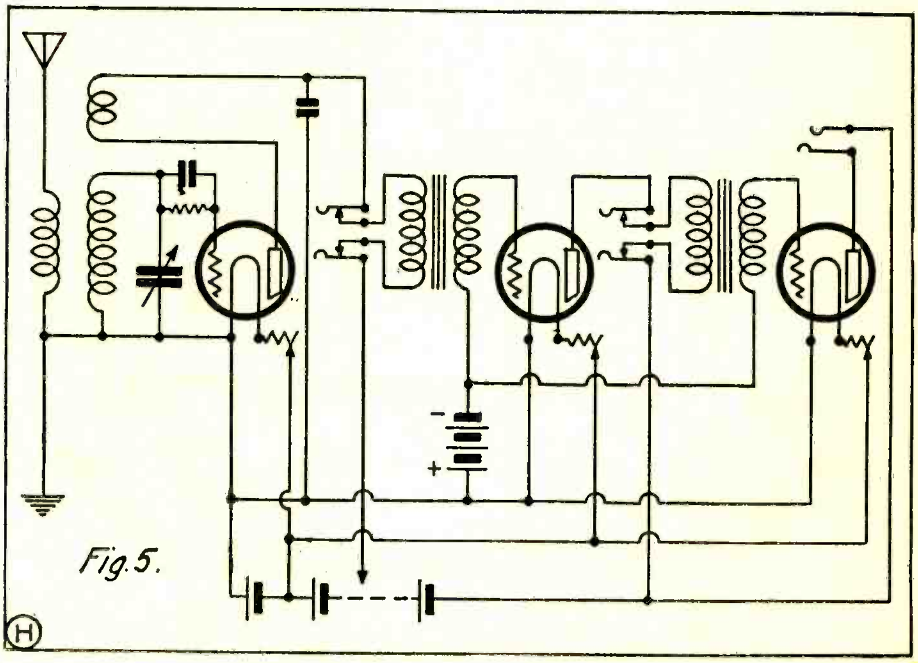
The brass strip should be mounted on the composition tube, as shown in the diagram given in Fig. 2, the center hole in the brass strip fitting over the hole drilled in the composition tube.

The tickler coil is wound on the larger three inch composition tube. A brass strip is mounted in the center of this tube in the same manner as the one on the primary coil. This coil should be wound full of wire. The required number of turns must be found after the set is in operation. Some sets will need more than others. Instructions for finding the correct number of turns will be given later.

With all the coils wound, the next step is to assemble them. This is done by placing the tickler and primary coils inside the secondary coil and forcing the brass rods through the holes in the secondary coil form to the other coils. The ends of the brass rods should not protrude inside the primary or tickler coils more than one-eighth inch. The rods are then soldered to the brass strips. The completed coil is shown in Fig. 3.

Coupler Mounting

The method of mounting the coupler to the panel will be left to the constructor, as he probably has some brass angles or strips that could be used up in this duty. The simplest method would be to slip two angles under the bolts holding the rods on either side of the shaft hole and bending the angles so that a short face would rest on the panel when the shafts were placed in the panel holes.



Schematic diagram showing wiring for complete three tube receiver.

The Primary Coil

The primary coil has fifteen turns of No. 20 DCC wire wound on the tube. Seven turns are wound on each side of the brass center strip. When drilling the binding holes for securing the start and end of the coil, place these holes opposite the brass strip; that is, on the opposite side of composition tube upon which the brass strip is mounted.

The panel layout for this set can only take one form with two variations. The form is obvious. The variations lie in the position of the secondary condenser and the coupler. Either one may come first on the panel.

The wiring diagram for the one-tube receiver is given in Fig. 4. The connections to the tickler and primary coil are made by means of flexible

(*Continued on page* 52)

Reflex Circuits for the Set Builder

Ranging from a Single Tube Reflex with One Control to a Three-Stage Set with Three Controls

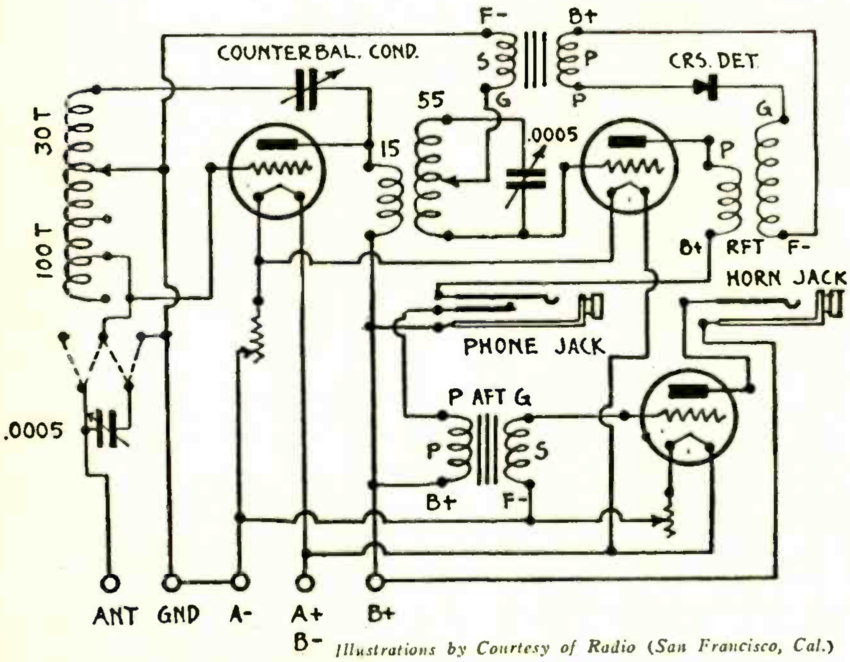
THE general trend toward simplification of controls in the commercial receivers should arouse in those who build their own, the desire to take advantage of any condition in a circuit which will permit the elimination of a control without sacrificing efficiency. This should apply particularly to one of the most popular and perhaps the most satisfactory receivers of the less pretentious type, namely, the single tube reflex. In the following article from *Radio* Magazine, *E. C. Nichols* describes three circuits based on experiments with the single tube reflex in the endeavor to simplify controls and apply the latest developments in tuned radio frequency amplification, with suggestions for the proper type of antenna coupling.

Mr. Nichols' explanation reads on as follows:

In the future, the use of the crystal detector should prevail to a much greater extent because of its many advantages. It means good quality which should be pre-eminent in any radiocast receiver. It has quiet operation due to its conductive isolation from the rest of the circuit. This latter advantage makes it preferable when *A* and *B* battery eliminators are used.

The tendency to jump to new circuits sometimes results in overlooking desirable features in a receiver about to be discarded. This happened in the case of the untuned radio frequency amplifying transformer, a satisfactory piece of apparatus when used under the proper conditions. This condition exists in the single tube reflex and the untuned R. F. transformer can be used to advantage in this circuit.

Usually those who purchase or build a receiver purely for entertainment from local sources prefer the simplest sort of station selector. When considering the single tube reflex, it will be noted that the second control is not very effective for greater selectivity because of the effect which the crystal and audio transformer have on it. This suggests the idea of discarding it altogether and substituting in its place an untuned R. F. transformer having a range from 200 to 600 meters. This substitution results in a single control receiver comparing favorably with the two control circuit in volume and selectivity. The use of the untuned R. F. transformer is not a new idea and its application at this point is extremely practical. This transformer should be carefully selected by actual test in the circuit as the different makes vary considerably. An Acme type R4 was used in these experiments. Fig. 1 shows the single control circuit with an additional step of audio amplification with interstage jacks.



Illustrations by Courtesy of Radio (San Francisco, Cal.)

Fig. 2.—A single circuit tuner with two stages of radio frequency amplification.

The two circuit tuner can be constructed in various ways but the most desirable incorporates adjustable coupling. The secondary has 55 turns of No. 24 d. c. c. wound on a 3 in. tube and is tuned by a .0005 mfd. variable condenser. The primary has 15 to 20 turns wound on a rotor and is mounted

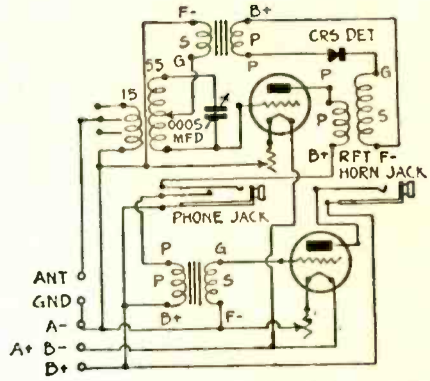


Fig. 1.—A single control Reflex with one stage of radio frequency amplification.

in the end of the secondary tube. An easy way is to wind a 15 turn primary with taps at 8 and 12 turns directly over the secondary winding with paper or cloth insulation between. The specially wound coils can be used if desired. Winding an ordinary cotton string between each turn will reduce the internal capacity of the coil and, if used, the number of turns should be increased about 25 per cent. When testing the circuit any tendency to self oscillation can be avoided by reversing the leads to the primary of the untuned R. F. transformer.

In Figs. 2 and 3 are shown circuits with an additional stage of tuned R. F. amplification which will be found to be the most satisfactory when greater selectivity combined with stronger signal strength are required, making a two control receiver with two stages of R. F. amplification. The stability of the first tube is obtained by the adaptation of the Rice method of counterbalance to prevent oscillation, permitting the tube to be worked to its maximum efficiency. A small neutralizing condenser is used for this adjustment. A small amount of regeneration is desirable in any receiving circuit providing it is controllable and care should be taken when adjusting the counterbalancing condenser to take advantage of this fact as too much capacity will impair the distance capabilities of the receiver.

In case of any circuit the type of tuning coil or antenna coupling should be determined after considering the lo-

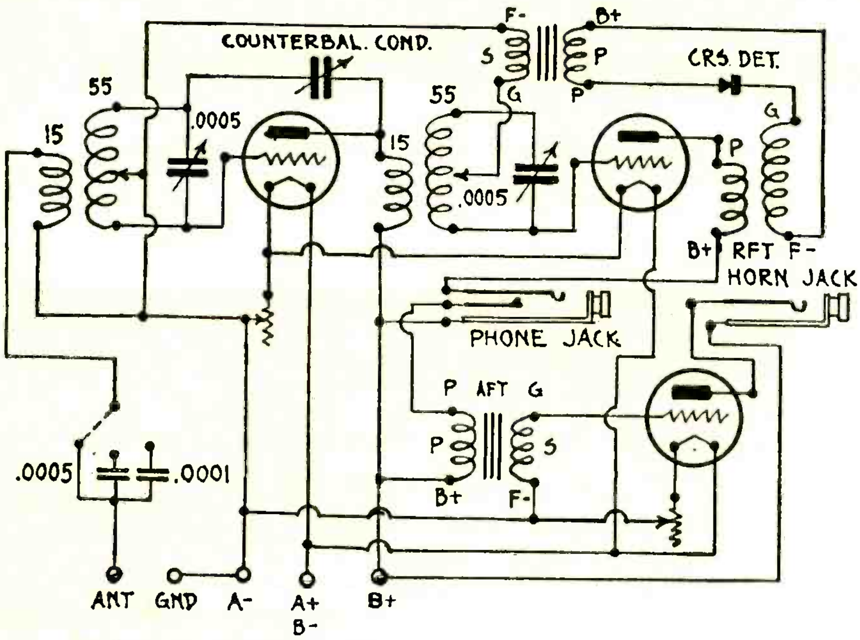


Fig. 3.—A two circuit tuner with two stages of radio frequency amplification.

cation of the receiver relative to the nearest radiocasting source and possible interference. The receiver close in demands selectivity and a two circuit tuner, while those in the remote districts require greater signal strength and should take advantage of the single circuit tuner when ever possible.

The two circuit tuner in Fig. 3 is the same as that in Fig. 2 except for the addition of a middle tap on the secondary coil which leads to the negative filament. One end of the secondary coil goes to the grid as usual, the other end goes to the counterbalancing condenser which is connected to the plate of the first tube. The use of the condenser bank in the antenna circuit will increase efficiency on the lower wavelengths and improve selectivity.

The single circuit tuner in Fig. 2 should be 100 turns on a 3 in. tube with one or two taps and a .0005 variable condenser. To aid in counterbalancing there is an additional 30 turns continuing from the ground tap and connecting to the counterbalancing condenser. A switching arrangement is shown for connecting the variable condenser in series or multiple with the tuning coil. There will always be those who are reluctant to discard the superior sensitiveness of the tube detector for the crystal and Fig. 4 shows a switch combination whereby a crystal or tube detector can be used, the change being instantaneous, affording an ideal means of comparing these two methods of rectification.

Although the use of three stages of R. F. amplification is usually associated with laboratory apparatus and considered too complex for radiocast reception, it is possible by taking advantage of certain inherent factors

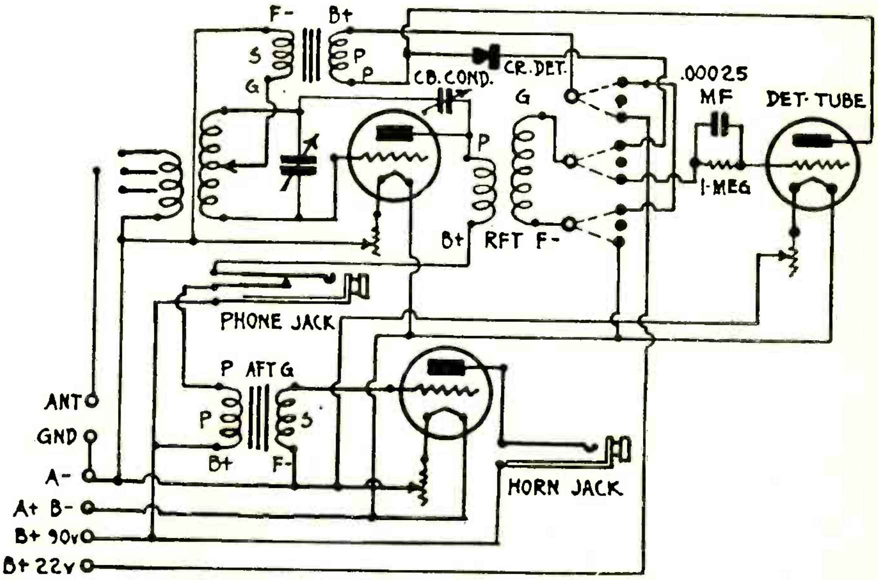


Fig. 4.—A circuit using either crystal or tube detector.

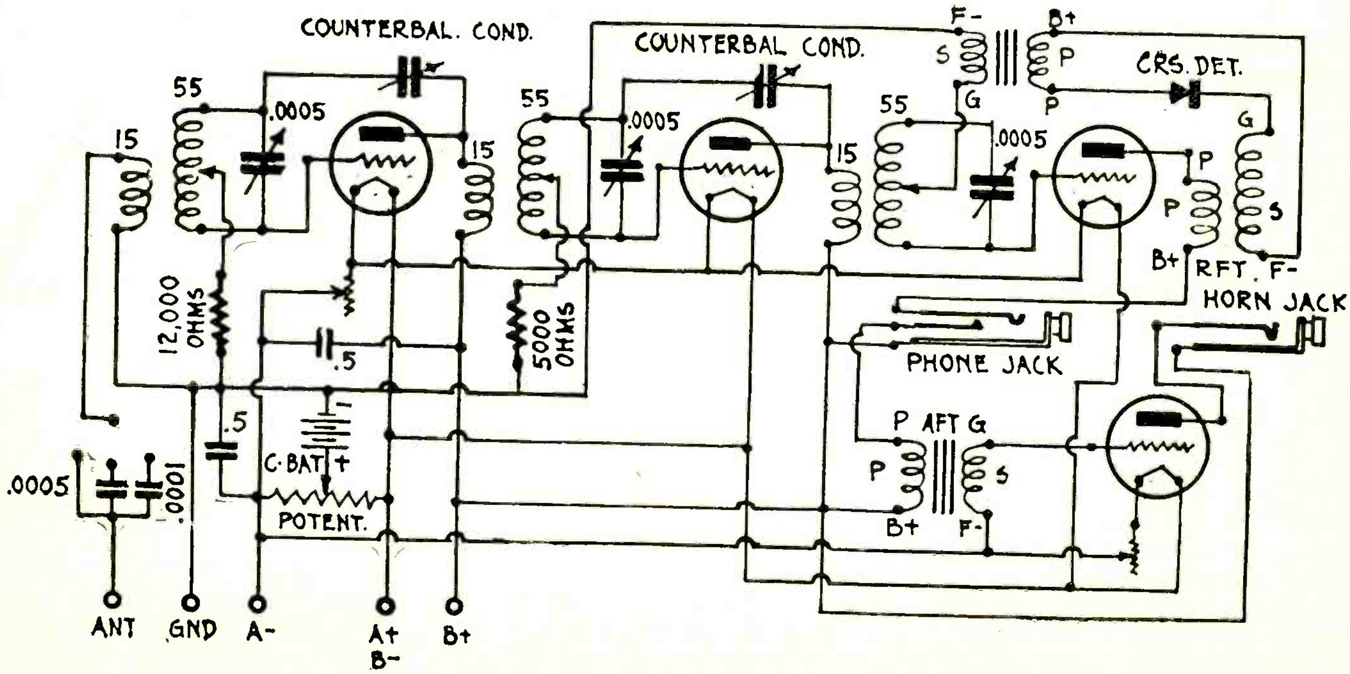


Fig. 5.—A circuit diagram for three stages of radio frequency amplification.

existing in a circuit and combining with them an efficient method of tube counterbalance to construct a thoroughly satisfactory and efficient receiver of this type for DX and local reception. Fig. 5 shows a circuit of this type using three stages of R. F. amplification with three controls combining good tone quality with sensitivity and the required selectivity.

Here again the Rice method of tube counterbalance is used on the first and second stages of R. F. The crystal detector and the untuned R. F. transformer assist in stabilizing the third R. F. tube. It has been necessary in most cases of multi-stage R. F. amplification to take advantage of every possible condition which will assist in greater stability. In the case of three stages of R. F. this meant a single circuit tuner and untuned antenna circuit with the consequent loss in selectivity.

It will be noted in Fig. 5 that a radical departure from ordinary practice has been made, resulting in perfect stability combined with a two circuit tuner and a tuned antenna. These three necessary features are obtained by the use of high resistances in the negative C battery connection of the secondaries of the two circuit tuner and the first tuned R. F. transformer. In these experiments a 12,000 ohm resistance was used on the tuner and a 5,000 ohm resistance on the first tuned R. F. transformer. Several values of resistance should be tried for best results. This application of resistance should not be confused with the various methods used to obtain stability by inserting so-called "lossers" in a circuit. The efficiency is in no way impaired as the application of the resistance is in the high resistance grid filament circuit and is a very small proportion of the total resistance of this circuit. This results in the damping out of any parasitic oscillations. Primarily the use of resistance in this way was suggested to me by Mr. Hugo Benioff of Pasadena, and in these experiments proved to be entirely satisfactory.

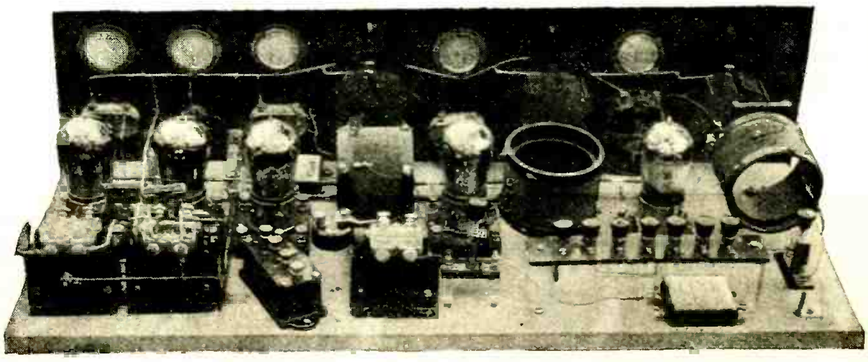


Fig. 6.—A rear view of the three control receiver.

The tuned R. F. transformers are made by winding 55 turns of No. 24 d. c. c. on a three inch tube with a central tap and a primary of 15 turns wound directly over the secondary. A .0005 mfd. variable condenser is used for tuning. The two circuit tuner is the same as used in Fig. 3. A back panel view of the three control receiver is shown in Fig. 6 and the general arrangement of parts in Fig. 7.

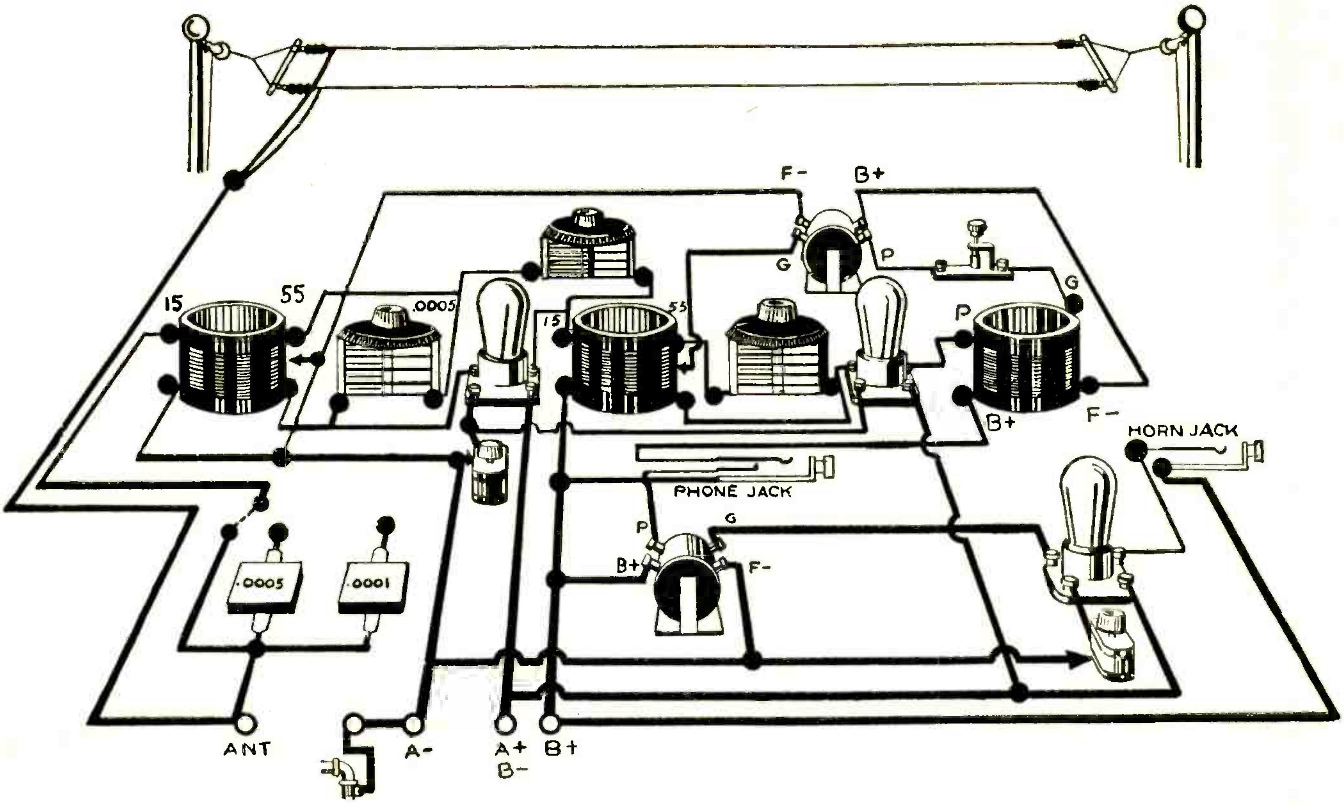


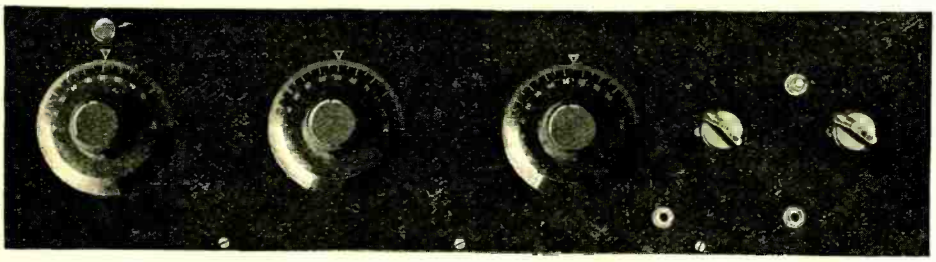
Fig. 7.—General arrangement of parts for the three control receiver.

The construction of this receiver carried out step by step affords one the interesting opportunity of learning just how much sensitivity and selectivity each step of R. F. adds in its turn. The careful testing and adjusting of each step as it is added will result in a very satisfactory receiver.

The Monophase Circuit

A Receiving Set which Incorporates a Novel Method of Controlling Oscillation in R. F. Amplifiers

IN radio reception, improvements invariably come through the attempt to force each piece of apparatus forming the whole to work at greater efficiency. The best set—that is, the one which will bring in the most DX and at the same time give the clearest and most pure reproduction of sounds—is the one in which every component is functioning at its best.



Illustrations by Courtesy of Radio News (New York)

Showing the front panel view of the new monophase receiver. Note the small adjusting knob over the first dial.

This line of investigation—constantly working toward deleting the losses from each piece of apparatus—has been responsible for all the recent advances in the field of radio frequency amplification design. From the old transformer coupled stages we have progressed to the tuned steps, and then to the neutralized type. Each of these advances in design served to eliminate some particular loss in the set. The transformers were inefficient in their transfer of energy from one stage to the next. Consequently, some designer conceived the idea of substituting the tuned method of transfer for the old transformer method.

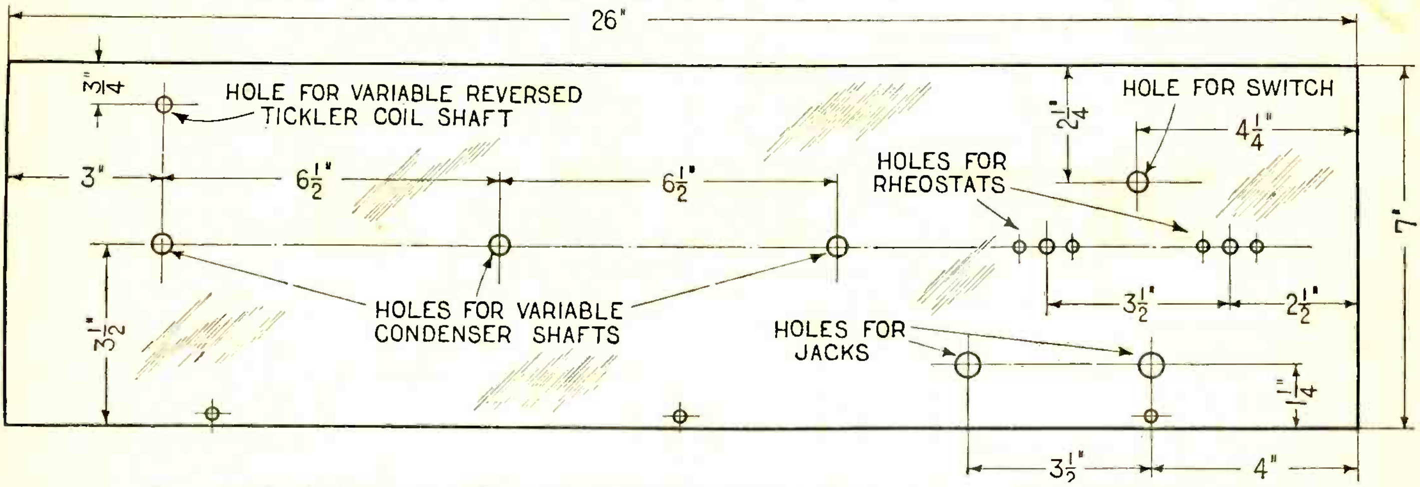
Here another difficulty arose. Something had to be done to control the oscillating characteristics of the tube, since the small inter-element capacity often forced it into oscillation on account of the proximity of wave-length values between the grid and plate circuit of the tube. A losser in the form of a potentiometer was inserted in the circuit to damp out these unwanted oscillations.

Then along came the Neutrodyne with its neutrodons which served the same purpose, i. e., to stop the deleterious effect of the capacity of the tube. This method was infinitely more effective from the standpoint of operation than the old potentiometer method of controlling the tube.

Then, independently and about the same time, the superdyne principle was brought out. This method is nothing more nor less than reversing the tickler so that its power is turned back into the grid circuit in the *reverse* direction. This serves to damp out the signals rather than build them up, as is the case in the ordinary regenerative set. But, in order to make the radio frequency tube operate at its greatest possible efficiency, its plate circuit is tuned so that some regeneration is obtained and the tickler is used to control the oscillation characteristics of the tube.

This circuit is one of the best, tube for tube, that has ever been brought out. The great difficulty with it and the reason it has never gained a wide popularity was the trouble encountered in operating it. A great deal of practice and patience is necessary, and the ordinary broadcast listener, when he has a family that wishes to enjoy the product of the radio set, is loath to install an instrument so fraught with difficulties.

Now comes an improvement on the superdyne principle which circumvents the difficulties encountered in the original and at the same time retains the greater part of its efficiency.

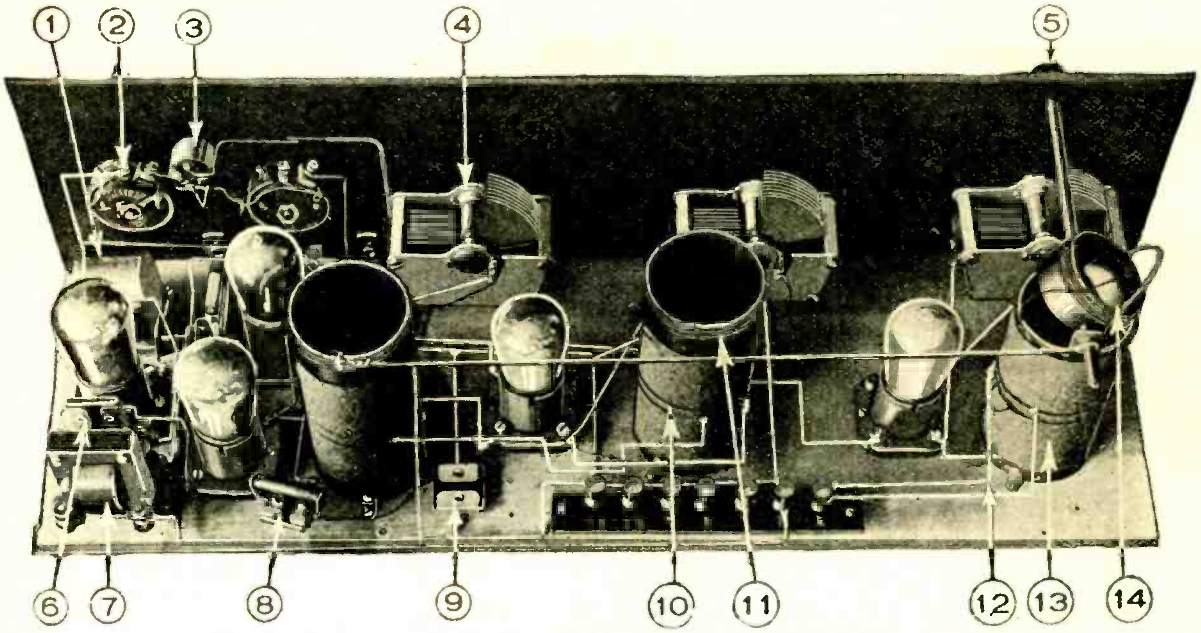


Dimensional details of the panel. This layout affords ample convenience in wiring and gives a pleasing symmetrical effect.

This is the Monophase, described in *Radio News* by *Frank H. Dalet,* who continued as follows:

First will be discussed the theory upon which the circuit operates, in the second place the construction of the set and then its operation.

It is well known that when several stages of radio frequency amplification are employed in radio receivers there is a tendency for self-oscillation to occur in the circuits. This is due to the feeding back of radio frequency energy from the plate circuit of a tube to the grid circuit of any other tube, or to its own grid circuit. The incoming signal voltages, therefore, act as a trigger, releasing a large amount of energy stored up in the "B" batteries, which tends to drown out the signals and at the same time radiate energy from the antenna connected to the receiving station. This radiated energy causes considerable annoyance



The monophase in full dress. Nos. 1 and 7 are the audio transformers; 2, filament rheostat; 3. switch; 4. variable condenser; 5. coil control; 6 and 9, by-pass condensers; 8, grid leak and condenser; 10. primary winding; 11. bucking coil; 12 and 13, secondary windings, and 14, the variable coupling bucking coil.

to neighbors, as well as preventing them from receiving the signals they desire.

Feed-Back

The feed-back of energy referred to in the paragraph above was accomplished either through the capacity ex-

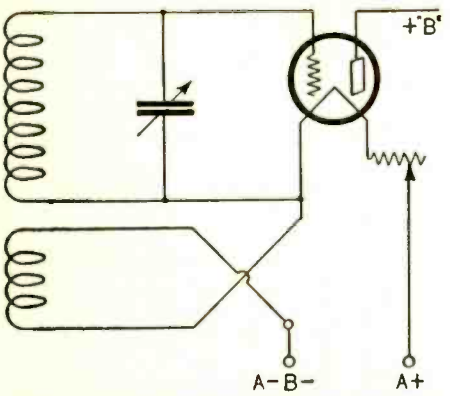


Fig. 1.—Circuit diagram which is the principle of the monophase. As can be noted, a reversed feed-back coil is incorporated in the filament circuit.

isting in the tubes or through magnetic coupling between coils in proximity to one another. There are, in general, three ways of preventing this feed-back: viz., the introduction of resistance into the oscillatory circuits, neutralization of the tube capacity or magnetic coupling, introduction into the circuits of electro-motive forces which have a polarity (or phase) opposed to that of the incoming signals.

The last method is that employed in the superdyne receiver and is also the method which has been employed in this receiver. There is a difference, however, in the way in which the circuit stability is accomplished, for in the superdyne this so-called "negative feed-back" is accomplished by coupling a coil in the plate circuit of a stage to a coil in the grid circuit, whereas, in the Monophase system the coupling is between a coil in the filament circuit and the one in the grid circuit.

The fundamental circuit diagram is shown in Fig. 1. Here the common terminal (the negative filament connection) is broken and the feed-back coil connected across the break. The polarity of the feed-back coil is to be made such that it will prevent self-oscillation; that is, when the set is put in use, the amplification should decrease as the coupling is increased. When the coupling is loosened the amplification will gradually increase up to the critical point, at which oscillations will occur.

It has been generally noticed that in regenerative receivers, more especially of the three-circuit tuner type, changes in the tickler coupling will change the setting of the tuning condenser. In this arrangement, however, the coupling between the feed-back coil and the coil in the grid circuit is made very loose, so that the reaction between the two circuits is very small. This loose coupling prevents the tuning circuit from being appreciably affected by the setting of the feed-back coil, so that the tuning of the set will always remain nearly constant.

Fig. 2 shows the complete wiring diagram of the set. Three such feed-back coils are used, one for each stage of radio frequency amplification and one for the detector circuit. One might think that by using so many adjustable parts, the operation of the set would become very complicated. Such is not the case, however, for it will be found that two of the feed-back coils can be left untouched once they are adjusted, so that the number of tuning controls in the set is reduced to the three condenser dials and one dial for adjusting the first feed-back coil or compensator.

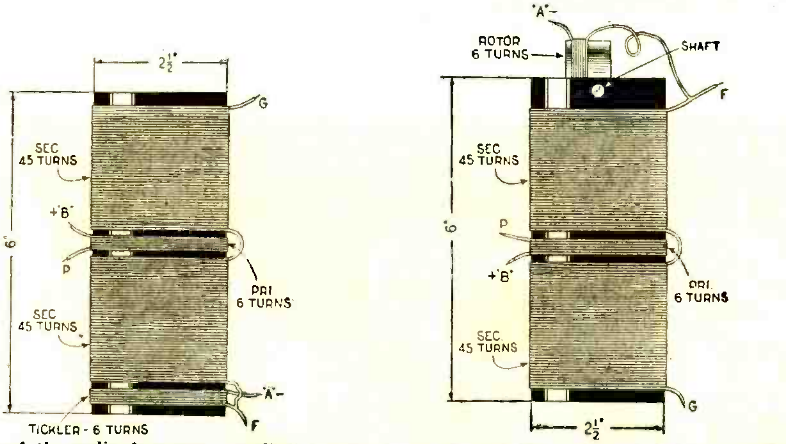
The idea is that the second stage of R. F. amplification is adjusted on the long waves, so that, as the feed increases with the short waves, there will be less tendency for oscillations. That is, the set is tuned in on the longest wave it is desired to receive, say 600 meters, and the second and third compensating coils adjusted carefully to the point at which howling just ceases. After this, they can be left alone, for on all wave-lengths shorter than this there will be less tendency for self-oscillation to occur, on account of the increased negative feed-back on the shorter wave-lengths.

Amplification

The amplification in these stages will always be high, however; in fact, it will be very close to the amplification obtainable at the critical point, for exceedingly small adjustment of the compensators is necessary to start or stop oscillations. After the second and third compensators are properly adjusted they are to be left alone and the circuits can be brought up to the critical point by manipulating the first compensator alone.

The photographs show the arrangement of the apparatus in the set. There is nothing unusual in the general layout, except that the spacing between the several coils is rather generous and the rest of the apparatus must be of good design. The audio frequency end of the circuit is the same as usual.

There is an interesting point in connection with the placing of the feed-back coils which deals with their position with respect to the secondaries of the tuning units. It will be noted in this circuit that the compensator is placed at that end of the secondary coil which is connected to the filament. There is a very good reason for this, it being that the controlling is done at the low potential end of the coil, and the adjustment of the compensators will not be so critical.



Details of the radio frequency coupling transformers. Two of the first type and one of the second are needed.

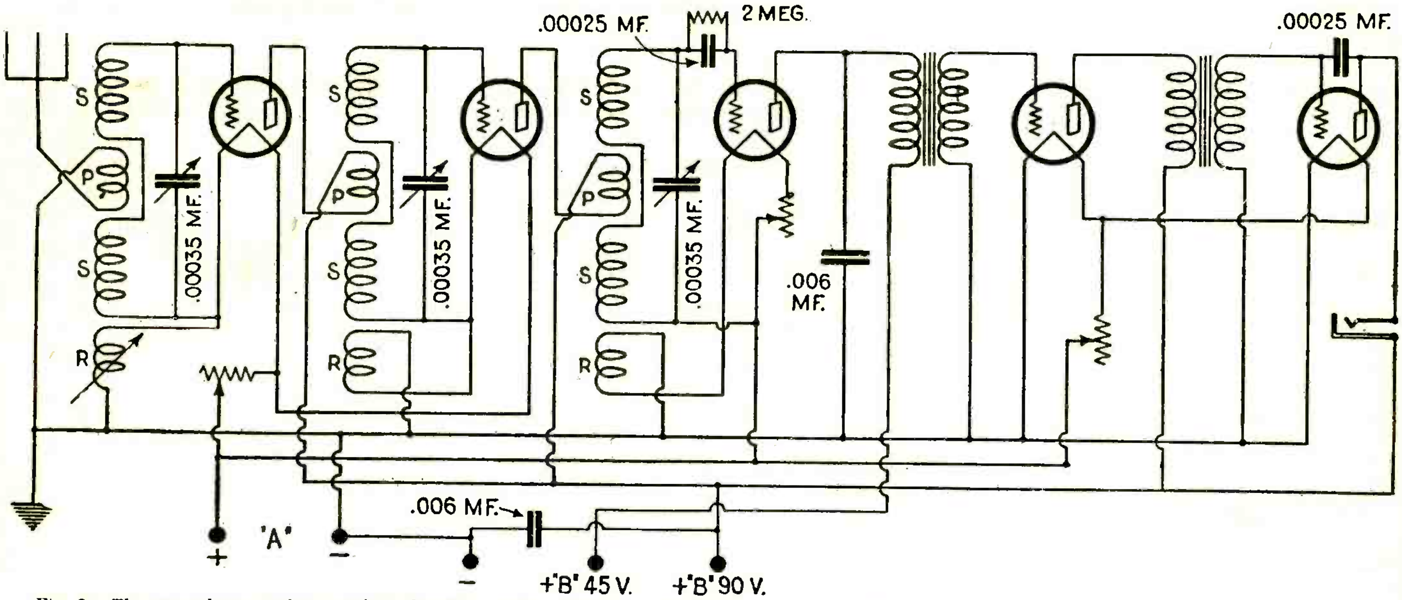


Fig. 2.—The monophase receiver employs the above wiring diagram. Tests have proved conclusively that it is very sharp in tuning, gives great amplification and is very selective.

This is contrary to the general practice of placing ticklers at the grid end of the coil, but this latter is done in cases where it is desired to increase the regeneration by tightening the coupling. Again, it must be remembered that the third winding is not similar to the reversed tickler in the superdyne, but it does create a bucking E. M. F. which acts against the oscillating circuit and produces a tendency toward damping. It will be remembered, too, that the coupling must be loosened in this circuit to increase the regeneration. It is at once evident that we are not trying to increase regeneration. The only regeneration that will exist in the receiver is that which it inherently possesses due to the natural tendencies of radio frequency amplifiers.

We are thus merely taking the radio frequency amplifier as it is and reducing the seriousness of its great important fault by making this fault controllable. The potentiometer does this, and so do many other devices that are in use, but in this case the efficiency of reception is not reduced, since we are not introducing a resistance loss in the circuits, but an electromotive force in opposition to the self-generated oscillations.

The construction of the coils to be used in this receiver is a very important one. The general construction can be readily learned by following the text of this article with one eye and the sketch shown in Fig. 3 with the other.

Constructional

The first step in assembling this receiver is to procure the best of the necessary materials. A 7x26-inch panel and a 7x24-inch baseboard are fastened together in the customary manner, after the panel is drilled with the necessary holes, as shown in the diagram.

The construction of the radio frequency transformers is not a difficult one. Three bakelite or hard rubber tubes 2½ inches in diameter and 6 inches long are required. There are wound 45 turns of No. 22 D. C. C. wire. A 6-turn winding of the same size wire composes a primary winding ⅛ of an inch from the first winding. The secondary winding is then continued for another 45 turns. The compensating coil is next placed on the tubing and consists of 6 turns of wire wound in the opposite direction to that of the other windings. Two small brackets are used to fasten the radio frequency transformers to the baseboard.

The above description pertains to two of the transformers, the third being slightly different in that the compensating coil, instead of being wound on the tube itself, is placed on a small rotor at one end of the tube. This rotor is a piece of bakelite tubing 2 inches in diameter and 1 inch long, at one end of which is placed the 6-turn winding. It is not necessary that the wire be wound in any specific direction, since the coil can be readily turned through 180 degrees and thus change its polarity.

The wiring of the receiver is not very difficult, since there are no set rules except that careful work brings good results. In case trouble is experienced from the beginning, the connections to the compensating coils should be reversed one at a time until the undesirable oscillations are eliminated. It will be found advisable to place two by-pass condensers across the "B" battery and also to use a .00025 mfd. condenser between the

(Continued on page 50)

An "A" Batteryless Audio Amplifier

Practical Directions for Heating the Tube Filaments from the 110-Volt A. C. Lighting Supply

THERE are many instances where it is desired to add a two-stage audio amplifier to a single dry cell tube receiver or even to a simple crystal set. But the most serious obstacle to the idea is the tube and battery question. What kind of tubes will give the best results and how are they to be operated?

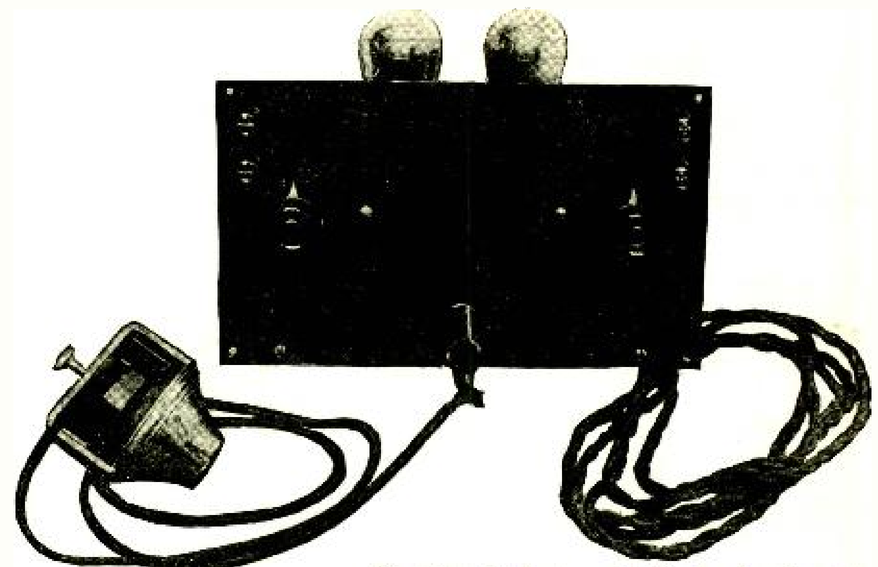
If the set to which the amplifier is to be added is of the dry cell tube type, at first thought it seems most practical to employ dry cell tubes for amplification also. The filaments of these tubes may be heated either from a multiple or series multiple connected *A* battery of standard No. 6 dry cells, or from a small storage battery of suitable voltage, if desired. An amplifier might be added to a crystal set in the same manner.

The degree and quality of amplification obtainable with dry cell tubes, however, is hardly comparable to that afforded by larger tubes of the storage battery type which require from 5 to 6 volts and from ¼ to 1 ampere. This is especially true in the case of amplifiers consisting of two or more tubes. The storage battery tube has a greater input and output capacity than the dry cell tube and is therefore capable of delivering the greater amount of energy with less distortion to the loud speaker. Thus, storage battery tubes should be used in preference to dry cell tubes whenever circumstances will permit.

The above is an introduction by *Ferd Humphreys* to his very interesting article in *Radio*, San Francisco, California, in which he describes a practical and economical method of utilizing the alternating current house lighting system to supply current for lighting the filaments of the tubes of an audio amplifier unit. Mr. Humphreys goes on to say:

The problem of operating the filaments of amplifier tubes from alternating current has a number of practical solutions. Perhaps the safest, simplest, least expensive and most satisfactory of these consists in the use of a bell ringing transformer in connection with a potentiometer and a *C* battery. In the event that the radio constructor wishes to build his own eliminator, he may purchase the necessary parts and incorporate them in the amplifier.

The writer recently constructed a two-stage audio amplifier employing C-301-A or UV-201-A tubes for use with a single dry cell tube regenerative receiver. The filaments of the amplifier were operated from alternating current by means of a bell ringing transformer in accord with the desire to eliminate the storage battery. It was not deemed worth while to go to the expense of incorporating a *B* battery eliminator in the amplifier inasmuch as the *B* battery is not particularly troublesome and will give good service when used with a two-stage amplifier.



Illustrations by Courtesy of Radio (San Francisco, Cal.)

Front panel view of the "A" Batteryless two-stage audio amplifier. The amplifier tubes are arranged to project through the top of the cabinet.

A view of the completed amplifier is shown in the accompanying photo. The following list of parts was purchased for the construction of the amplifier:

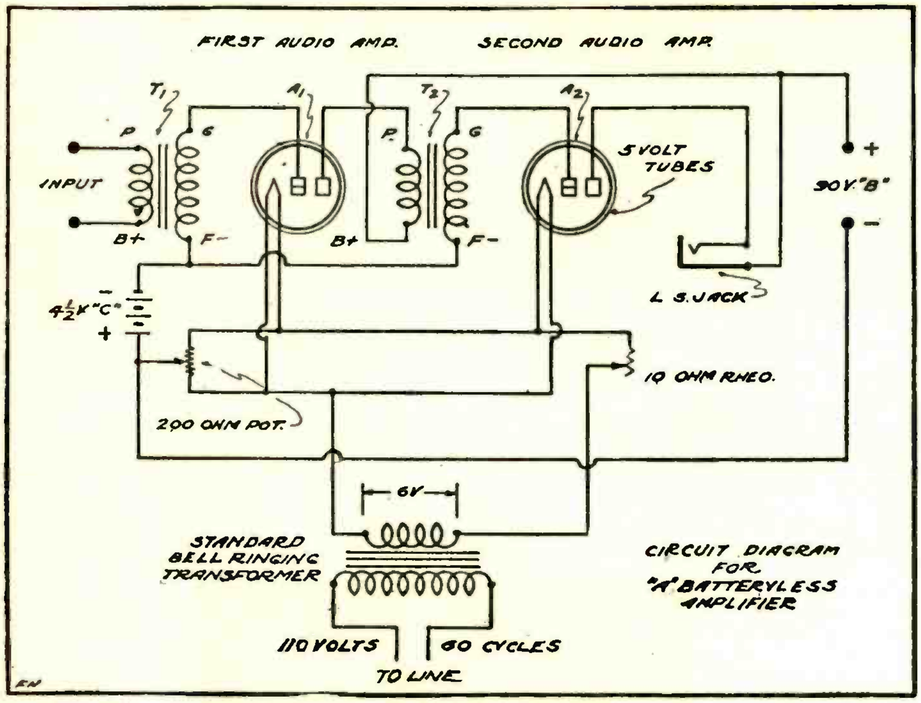
1 Panel, black, 6x10½x3/16 in.
1 Baseboard, 9x7x½ in.
1 Potentiometer, 200 ohms.
1 Rheostat, 10 ohms.
2 C-301-A amplifier tubes.
2 Tube sockets, panel mounting.
1 Phone jack, single circuit.
2 Audio transformers.
1 Bell ringing transformer.
1 *C* battery, 4½ volts.
4 Binding posts, black moulded.
10 ft. lamp cord, twisted pair.
1 Attachment plug.
1 Cabinet

Necessary screws, bus bar for connections, and soldering lugs.

The tube sockets are mounted to the center of the panel at equal distances from its ends, the height of the sockets being adjusted to permit the tubes to be inserted therein through holes made in the top of the cabinet. The potentiometer and rheostat are mounted to the ends of the panel at the center of its height. They appear at the left and right, respectively, in the photograph. The jack is located at the lower center of the panel. At the upper left and right corners of the panel, the input and *B* battery binding posts, respectively, may be seen. All of the panel mounted parts are placed to give a well-balanced appearance. Oval-headed nickel-plated wood screws are used to secure the panel to the cabinet and to the baseboard. Oval-headed machine screws of similar finish are used to fasten the sockets to the panel.

To the baseboard are mounted the audio transformers, bell ringing transformer and *C* battery. The bell transformer is secured to the left rear corner of the base and the *C* battery is mounted to the right rear corner of the same. A clamp, constructed of galvanized iron and held to the base by flat-heated wood screws, accommodates the *C* battery.

The amplifier was wired in accordance with the circuit diagram herewith. In the process of wiring, special attention was given to the arrangement of the alternating current leads to and from the bell transformer with respect to the input and output circuits of the amplifier. The leads from the secondary terminals of the transformer to the filament terminals of the tube sockets were kept well away from the audio transformer leads and the grid and plate connections to the sockets.



Circuit diagram. Note the connection of the bell ringing transformer, potentiometer and "C" battery.

A separation of at least 1 inch was maintained between parallel leads and these were kept short and avoided as much as possible. The wiring was also kept away from the bell transformer. This was done in the interest of preventing any "hum" which might result from objectionable induction between the bell transformer leads and the amplifying circuits.

In an improperly constructed amplifier of this type, a hum is possible because of the rapid reversals of alternating current flowing through the input and output circuits of the bell transformer. The pitch of the hum is double the frequency of the supply current which is generally of the order of 60 cycles per second.

The bell transformer employed has three secondary terminals. These permit of three different voltages for the operation of bells of different sizes. Two adjacent terminals are marked 6 volts, and another adjacent pair are marked 8 volts. By connecting to the two outer terminals of the transformer a potential of 14 volts may be obtained. When employing this transformer for operating the 5-volt filaments of an amplifier, the 6-volt terminals are used. One end of the lamp cord is connected and soldered to two flexible leads provided on the transformer and the other end of the cord is connected to the attachment plug. The soldered connection to the transformer is thoroughly taped to prevent short circuit.

The use of a filament control jack for turning the amplifier on and off should be avoided in this instance because of the liability of such a jack to introduce a slight hum by virtue of the intimate association of alternating current with the output circuit of the last amplifier tube. The jack springs act as the plates of a condenser in this respect and serve to couple the alternating current filament circuit to the output circuit.

If the grid return leads of this amplifier are connected directly to one or the other of the filament leads, as is the practice in amplifiers employing direct current on the filaments, the grids of the tubes will be alternately biased positive and negative owing to the flow of alternating current through the filaments. This, of course, would produce a very loud hum in the loud speaker and would render the amplifier operative only when the grids were negatively biased. The necessary negative grid bias for amplification is provided by means of the *C* battery and potentiometer.

The ends of the potentiometer resistance winding are connected to the filament supply leads and the grid return leads of both tubes are common and connected to the arm of the device through the *C* battery. The amplifier is adjusted for zero hum by rotating the arm of the potentiometer to the middle of the resistance. When the proper adjustment has once been found, the potentiometer need not be touched again.

The life of the *C* battery averages about 8 months, as it serves only to place a voltage on the grids of the tubes. The filament rheostat is adjusted to the point above which no additional increase in the brilliancy of the filaments has the effect of improving amplification. A *B* battery of 90 volts was connected to the binding posts provided.

When tested, the amplifier was used in conjunction with an improvised loud speaker consisting of a phonograph receiver attachment and a Victrola. The amplifier worked with perfect satisfaction and no difficulty was experienced in adjusting the potentiometer for smooth amplification. With the potentiometer out of adjustment, however, the effect of the hum was to modulate to such an extent that the distortion resulting was unbearable. The potentiometer is most easily adjusted for zero hum when no radiocasting is being received.

The Monophase Circuit

(*Continued from page* 48)

grid and plate terminals of the last audio frequency amplifier tube.

It was found that 20-ohm rheostats, of which three are required, gave the necessary critical adjustment and added remarkably to the sensitivity of the set.

As regards the selectivity of the set, it is safe to say that it surpasses the majority of those on the market today. In sensitivity, too, due to the exacting values of the apparatus used and the correct engineering principles involved, the receiver stands as a big step in the development of tuned radio frequency sets.

As will be noted, the coils are fully 6½inches apart, reducing to a minimum the tendency towards inter-stage coupling with resultant oscillations. Two stages of audio frequency amplification will be found to give more than sufficient volume, it being necessary to incorporate a by-pass condenser across the grid and plate terminals of the last tube.

A Home-Made Loud Speaker

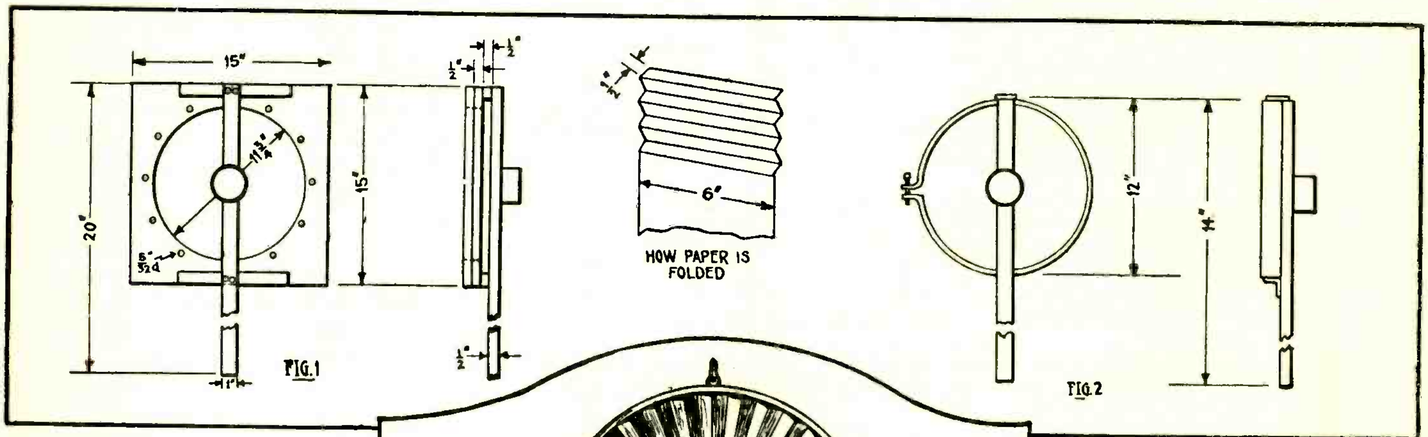
Construction of a Pleated Disc Loud Speaker, Affording Pure Tone Reproduction

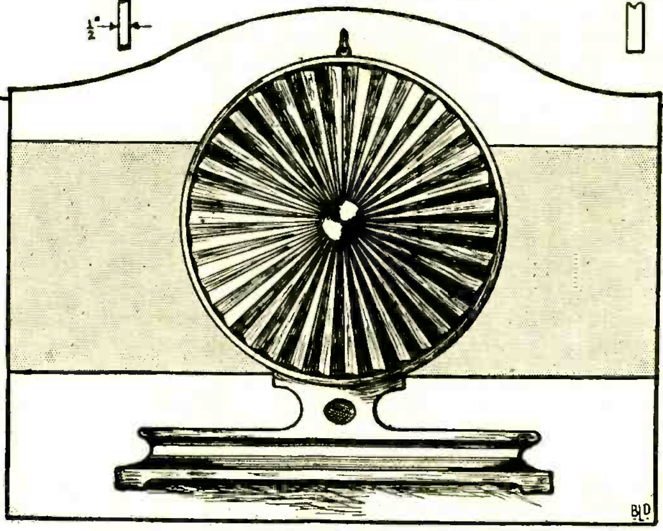
ONE of the most important and at the same time most neglected features in a radio receiver is the loud speaker. The average fan will spend hours building a new type of receiver guaranteed to be possessed of the cardinal virtues and even a few added accomplishments, and use with this "marvelous" outfit a cheap, inefficient loud speaker. On the proven theory that any radio receiver is only as good as the poorest important part used, close attention should be paid the reproducing unit.

The major difficulty with the ordinary form of loud speaker, using a horn of wood, metal or composition, is its inability to properly respond in a uniform manner to all the tone frequencies. Of the many attempts to fashion a speaker that will respond uniformly to the necessary frequencies, permitting as near reproductive purity as possible, the paper cone or pleated disc type has probably approached closest to the ideal. Such a loud speaker was described in detail in the *Buffalo Evening News* by *B. Carnie.* The article follows:

As many fans will say, such a design of loud speaker is by no means the first, but after reading this article they will admit that it is a decided improvement, and simple to make. Cost of construction is also a detail.

This article is a result of the controversy which has raged recently regarding the efficiency of the pleated type of loud speaker. Many fans who might wish to try for themselves the results of a speaker of this design have been deterred by the high cost of the unit and the trouble involved, while the performance, in their particular case, might be signally disappointing. Here this obstacle is removed, and for a portion of the cost and by faithfully following the details of construction, the fan may build a loud speaking unit which will equal, in performance and appearance, the commercial product.





Illustrations by Courtesy of Buffalo Eve. News.

Constructional details of the pleated disc loud speaker and the finished reproducer.

We have now the choice of a square instrument or a circular one, the only difference being that in the former the reproduction is deeper in tone and fuller in volume than the latter. This is due to the incorporation of a "stiffener" of three-ply wood in the square model. This advantage, if advantage it is, is offset by the fact that the circular model is purer in reproduction of music and speech. Here again it is a matter of taste, some preferring the deep tone, others extreme purity.

Making the Diaphragm

As has already been stated, paper is the material used for the diaphragm, but every kind of paper will not do. Different qualities have different effects on the results obtained from the finished instrument. Texture and weight of the paper, also the dimensions, must necessarily be taken into consideration. Different diametrical measurements of the diaphragm also mean different tone and signal strength.

The diaphragm in each type of instrument here shown is twelve and one-half inches in diameter when completed and ready to be mounted. Note that the diameter is extended one-quarter inch by the center plug. The would-be constructor must then obtain from a good stationery store the type of paper known as "parchment substitute," a heavily rolled hand-made paper. The cost is about ten or fifteen cents for a large sheet.

The strip used should be six inches wide and thirty-nine and one-half inches long, and marked off in parallel lines one-half inch apart for folding. Great care should be taken in cutting the strip to these dimensions, otherwise it will not be possible to bend it into disc shape. If the length of the sheet will not allow one strip being used, two strips may be cut and joined together.

We are now ready for "proofing." This is done, before the strip is marked off and folded, by gently brushing it over on one side with the lacquer. The paper will now be found to be damp-proof, crack-proof and tough, while the weight will not be appreciably increased. Using the pencil lines as a guide, the paper may now be folded firmly and with care. Don't be afraid of cracking it. Join the two ends of the folded strip so as to form a cylinder and stick them firmly together. Two to three hours will be sufficient to dry it, and we are now ready for the next step.

The Disc

Stand the paper cylinder on a wooden bench and convert it into a cone shape by pulling the folds together at the apex. Slowly press the paper so that the base spreads out into a fan shape.

The top edge is then drawn together in the middle on a level with the bench. Release it again, and we have a cone once more, with a fairly large center hole. The center should now have a good coat of liquid glue. Place a piece of blotting paper on the bench to absorb any surplus glue and to prevent sticking, then place a small cork 9/16 inch in length and 1/4 inch in diameter in the center hole and again press the paper down to bench level. The stiff paper will obtain a firm purchase in the cork, and we will have a firm center when all is dry. The diaphragm should be kept flat by means of a wooden ring and a heavy weight at this stage. The glue should set within forty-eight hours.

Mounting the Disc

Figs. 1 and 2 will no doubt make construction a simple matter, but we will give some additional explanation. In Fig. 1 a piece of rubber tubing is placed between the three-ply boards. This is done to insure a tight grip on the edge of the diaphragm. Some glue or amberoid should be smeared on the wood before the rubber is placed in position. The clamping screws are fitted into the front board before fixing the rubber, and the corresponding holes in the back board should be of sufficient dimension to slip easily over them without altering the position of the diaphragm, which now rests lightly on the rubber. The washers and nuts are now secured.

This is not so easy to shape as the square unit, but a little care will overcome all difficulties. The method employed must not be departed from, or trouble will be encountered when the diaphragm is to be fitted between the rings of the embroidery frame used in the construction. This frame is twelve inches in diameter.

Place the inner ring on a flat surface and gently turn the edge of the paper over all round the ring. Loosen the clamping of the outer ring and press the latter partly over the inner ring and diaphragm. Tighten up the clamping as far as possible before pressing the ring home.

If the finished instrument is to be neat the above should be attended to, as the removal of any superfluous paper usually causes creasing and ruins the appearance of the unit. Should it be impossible to obtain an outer split ring fitted with clamp, it will be necessary to cut through the wood, removing a strip one-eighth inch in size. Fit on each end a small brass strip in the form of an angle bracket with a terminal passing through a small hole in each.

The Earphone

The earphone unit should be either one of the adjustable reed variety or one with adjustable magnets fitted with a reed. The former, although a little more expensive, is better suited to our requirements.

The metal diaphragm is removed and put aside, the metal reed unscrewed and a piece of stiff wire two and one-half inches long, either screwed or soldered on to the nipple of the reed. The exact length of this wire will have to be fixed during final adjustments, the length mentioned above giving ample room for shortening if necessary. The center hole of the ebonite cap should be made a little larger and two extra holes provided, one on each side of the center hole. These holes are for the purpose of fitting the cap to the wooden cross-piece of the frame.

It is necessary that the spindle which passes through the hole in the middle of the cross-piece should rest on the exact center of the diaphragm. Therefore, particular care should be taken when centering the hole in the cross-piece. A small circular piece of celluloid, glued to the cork center of the diaphragm, insures a firm contact. Next screw the ebonite cap on to the cross-piece, replace the reed and spindle in the earpiece and screw the latter on to the cap, but not necessarily tight home.

Final Adjustments

Final adjustments, as in the case of an ordinary loud speaker, are made with the milled adjusting screw. It may be found that after a time the paper diaphragm has stretched a little. If this is so, screw the earpiece further home, thus bringing the spindle firmly on to the celluloid center piece on the cork. Everything is now permanently fixed and the purity of reproduction obtained from this instrument will fully justify the care taken in the making. Simplicity of design is the keynote in the construction, and with this type acoustical conditions need not be considered as much as in the horn type of speaker.

How to Build a Simple Low Loss Receiver

(*Continued from page* 42)

wire. The more flexible the wire the better, as then smooth control over coupling variation will be obtained.

When the set has been wired and the accessories connected, tune in the highest wave station. Then if the tickler coil is not almost all the way in—that is, parallel to the secondary—take off enough wire to make this coil almost parallel to the secondary coil.

Tuning Receiver

The tuning of the set is simple. The antenna or primary coil is set at approximately the coupling shown in the drawing given in Fig. 3. Then the secondary condenser is set at about 10 on the dial and the tickler coil turned until a click is heard in the phones, denoting the oscillation of the tube. Then the secondary condenser is turned toward full capacity until a station is picked up, keeping the tube oscillating all the time. After stations have been once received, it should not be necessary to tune them in with the tube oscillating, and the tickler coil should be turned with the secondary condenser, so that the tube is operating just below the oscillating point, which, by the way, is the most sensitive point.

As a general rule, most fans wish to have a three-tube set instead of a one-tube set, so a diagram for the three-tube receiver, employing the tuner as described herein, is given in Fig. 5.

Equipment List

The parts necessary for the additional stages of audio frequency amplification are as follows:—

Two audio frequency transformers.
Two tubes.
Two rheostats.
Two sockets.
Two double circuit jacks.
One "C" battery, 4½ volts.
One 7 by 18 inch panel, instead of the 7 by 12 as given before.

When using the three-tube receiver to receive distant stations it is always advisable to use one stage of audio frequency amplification, as then no change will be necessary when the loud speaker is plugged in the last stage. If the phones are used in the detector plate circuit and then removed, so as to permit using the loud speaker, it will be necessary to retune the station on the loud speaker, as the difference between the phones and the primary of the audio transformer is enough to either make the tube oscillate or lessen the volume of the signal.

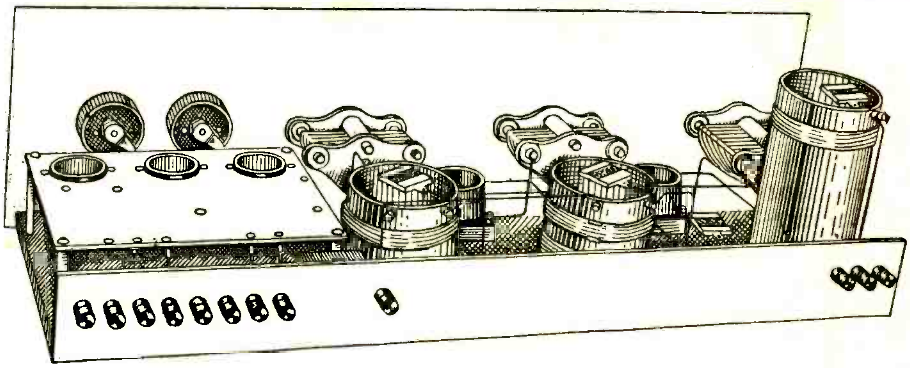
The New Splitdorf Receiver

Complete Details for Building a Permanently Neutralized Radio Frequency Set

THE Splitdorf neutralized receiver is another tuned radio frequency receiver that possesses qualities very seldom found in other receivers similar in design. The circuit of this five tube set is permanently balanced. It does not require neutralizing condensers or angle settings of the transformers to prevent oscillation. Furthermore, the set, if properly constructed, cannot be made to oscillate under any operating condition. This set was designed for the man who wants to enjoy the reception of radio broadcasting without experimenting and "tinkering" further than the actual construction of the receiver. Good results are secured with either outside or indoor antenna. In houses where it is impossible to erect an aerial, just the ground will pick up enough energy to successfully operate the set.

The Splitdorf five-tube set has been recently described in the *N. Y. Telegram and Evening Mail* Radio Section, giving full details of construction. *William A. Schudt,* the author, describes the set as follows:

Two stages of tuned radio frequency amplification, detector and two stages of audio frequency amplification make up the set. The set will operate with uniform efficiency throughout the entire broadcasting wave length band, which covers from 225 to 550 meters. Special air core radio frequency transformers together with low loss tuning variable condensers and specially fixed neutralizing condensers, make up the radio frequency side of the receiver. The two stage audio frequency amplifier, with all necessary apparatus, is mounted upon a small sub-panel, which



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

Rear view of the Splitdorf receiver as it appears when completed. Note the method of mounting the tube shelf and other parts.

is fastened to the main panel at the left hand side (facing the rear).

All instruments should be well spaced and carefully and securely mounted. Both the front and rear panels should be of good insulating material, preferably hard rubber.

It will be noted that, in addition to the complete radio frequency transformers mentioned in the list of parts, we have listed parts necessary for the construction of them. If you are planning on purchasing the coils ready made, then disregard the cardboard tubes and the magnet wire; if you decide to make the transformers yourself, then disregard the three radio frequency transformers.

Necessary Parts

For the construction of this set the following parts will be necessary:—

One low-loss 43-plate variable condenser.

Two low-loss 17-plate variable condensers.

One Splitdorf antenna inductance.

Two Splitdorf radio frequency inductances.

Two audio frequency transformers, $3\frac{1}{2}$ to 1 and 5 to 1 ratio.

Five tube sockets.

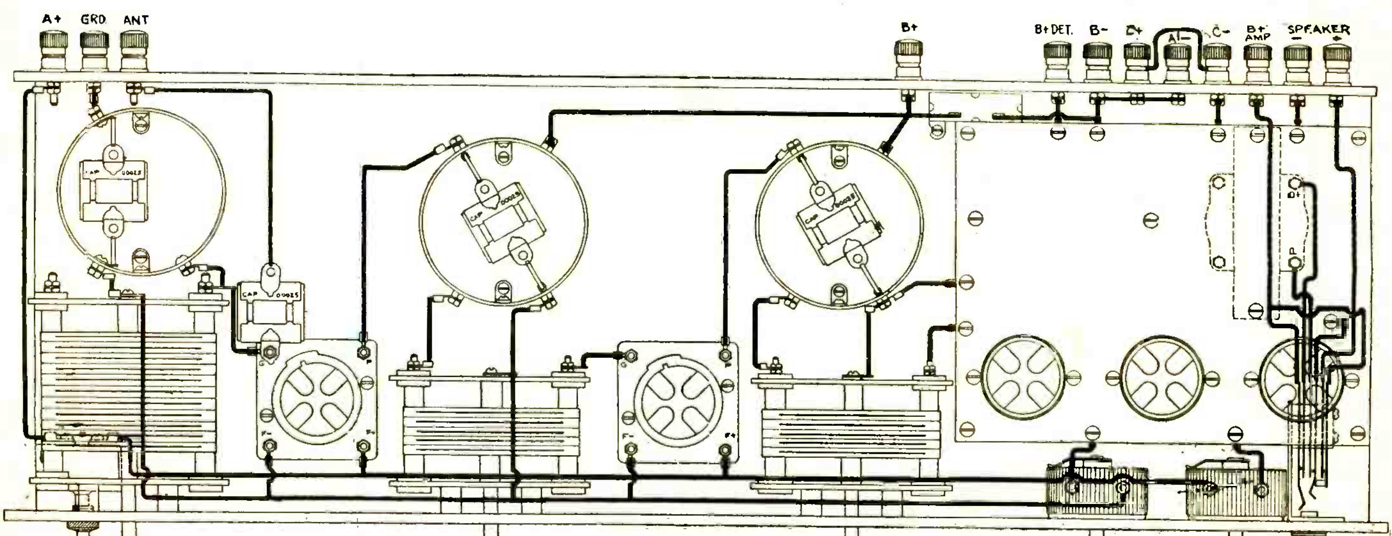
One hard rubber or bakelite panel, 7x24 inches, $\frac{1}{4}$ inch in thickness.

One wooden baseboard, $6\frac{1}{2}$x23 inches.

One hard rubber or bakelite rear panel, 3x24x$\frac{1}{4}$ inches.

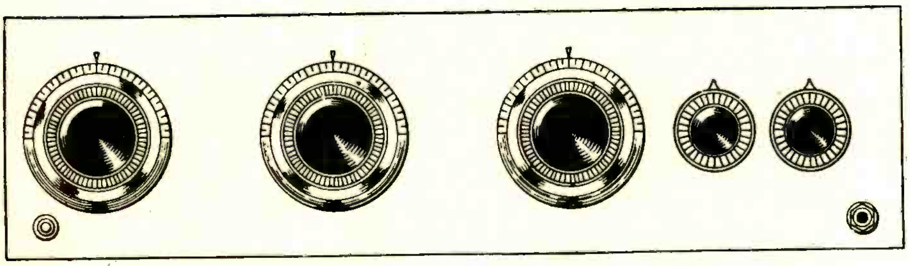
One rheostat of ten ohms.

One special type phone jack.



Complete layout of parts on the baseboard and tube shelf. Details of wiring parts are clearly indicated in order that the constructor can follow them directly from this illustration.

One battery switch.
Twelve engraved binding posts.
One small sub-panel, 7x5 inches.
Two 2¼ inch dials for rheostats.
Three 4 inch dials for variable condensers.
One fixed mica condenser of .006 microfarad.
One fixed mica condenser of 1 microfarad.



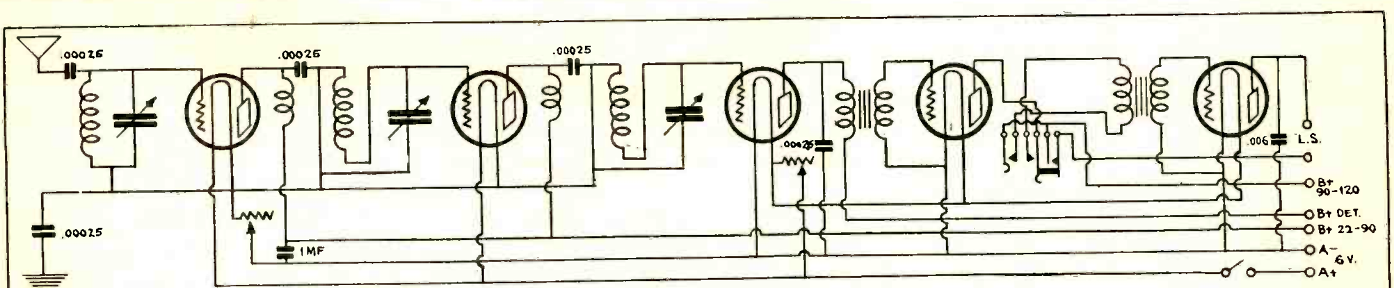
Front panel layout showing the position of tuning controls and rheostats.

Five fixed mica condensers of .00025 microfarad.
Two small brass brackets for holding rear panel in place.
Four large brass strips for holding small sub-panel in place.
Two cardboard or hard rubber cylinders 3½ inches in diameter and 4 inches in length. One 3½ inches in diameter and 6 inches in length.
Other essential screws, bus bar and wire.

Winding Coils

For the construction of the radio frequency coils a quarter of a pound of No. 22 D. C. C. magnet wire and half a pound of No. 16 D. C. C. magnet wire will be necessary.

Thirty turns of No. 22 wire are wound around the top portion of the six inch cylinder, starting the winding about an inch from the top of the tube. The wire should be drawn as tightly as possible and no varnish or other "dope" should be applied to the finished inductance.



A schematic wiring diagram of the Splitdorf 5-tube receiver.

The winding of the next two inductances is varied to some extent and extreme care must be exercised in their construction. First, the secondary coil is wound on, and following this the primary is wound directly over the top portion of the secondary. Starting about three-quarters of an inch from the top of the cylinder, sixty turns of the No. 22 wire are wound on in the same direction as the first coil. Now, the primary coil, which shall consist of seven turns of No. 16 wire, is wound over the secondary or first layer. Great care must be given this winding so that both coils stay in place without having to use any adhesive fluid. The rear view of the set does not show this winding very clearly. Two such radio frequency coils or transformers are made up.

The transformers can either be mounted directly on the rear end of the variable condensers or fastened to the wooden baseboard by means of small brass brackets.

Now that all the apparatus is on hand the actual assembling of the parts can be started, the first step being the laying out of the panel and drilling it. This is done in the regular manner by cutting out a piece of cardboard the exact size of the main panel and marking off the exact location of the various instruments with a ruler and a compass. Perhaps the most efficient method of placing the apparatus on the panel is that shown in the upper drawing on the preceding page.

When the template is finished it should be placed over the front of the panel and held in place by two clamps. Then with a centre punch and a hammer the different holes are impressed upon the surface of the panel and can be drilled immediately.

As soon as the panel is drilled the wooden baseboard can be screwed to it with three or four wood screws. Next the rear panel is drilled to accommodate twelve binding posts mounted as shown in the drawing of the interior of the set.

The large coil form with the 43-plate variable condenser is mounted on the extreme right hand side of the set (facing it from the rear). The next coil, together with the 17-plate variable condenser, is placed alongside of the first R. F. transformer. Following this comes the last R. F. transformer, which is shown mounted just left of the centre of the set.

It can be readily seen from the illustration that the detector and the two stages of audio frequency amplification are mounted in one unit. This unit can be purchased and assembled in the set.

However, the audio unit can be easily constructed at home with the aid of a few tools. Three holes large enough to accommodate the diameter of the tube sockets are drilled at the back end of the small sub-panel. Three tube sockets are placed in these holes and held to the sub-panel by machine screws attached to the base.

Now, below the sub-panel and some distance out from the tube sockets the two audio frequency transformers are placed. They are set at right angles to each other and spaced as far apart as space permits.

Machine screws are placed along the edge of the sub-panel and lugs are fastened to them. To these screws and lugs all leads from the unit are connected, so that when it is placed in the set the external connections have simply to be soldered to these lugs. To this sub-panel the four brass strips are fastened and then in turn screwed to the wooden baseboard. Of course the height of the unit is a very important factor, but will have to be determined by the constructor, since the size of the audio frequency transformers and the placement of the rheostats on the panel all have to be figured before any standard can be had. The other two tube sockets are placed in between the three variable condensers as shown in the interior view of the receiver.

With all the instruments properly placed the outfit is now ready to be wired, or "hooked up," as most of us call it. The schematic diagram, as well as the picture hook-up, is shown elsewhere in this article.

From the binding post marked for the aerial a wire is run to one side of a fixed condenser of .00025 microfarad. The other side of this fixed condenser is connected to the top of the first radio frequency inductance (shown on the extreme left of the set). The same wire is fastened to the fixed plates of the variable condenser and then to the post on the first tube socket marked for the grid, the other side of the inductance being connected to the rotary

(*Continued on page* 60)

An Attractive Three-Tube Receiver

A Three-Tube Honey-Comb Coil Receiver Affording Dependable Results for Moderate Distances

BEAUTY is said to be in the eye of the beholder, which in a radio sense is to say that what may be a very attractive receiver to one might easily be the opposite to another. The blasé American radio enthusiast when shown a receiver having honey-comb coils mounted on the outside of the panel is quite apt to turn up a more or less patrician nose, and can possibly be heard to murmur, "Obsolete!" It has also been said, however, that beauty is only skin deep, and perhaps under the surface there may be real value.

The reader may not agree with *Mr. Stanley G. Rattee* in his statement regarding the attractiveness of the three-tube honey-comb coil receiver described by him in the *Wireless Weekly*, London, England, but if he will take the trouble to delve beneath the outer skin he may be agreeably surprised. From a theoretical and practical standpoint this set embodies some very excellent features. The article, containing full constructional details, is given herewith:

One of the simplest three-tube receivers which may be operated is that incorporating a detector and two audio-frequency amplifiers, so that, with such an arrangement, the number of tuning controls is brought down to a minimum.

The construction of the receiver under description is such that either one, two or three tubes may be used, the actual circuit arrangements necessary in such circumstances being controlled by the use of jacks, the filament lighting circuit also being controlled by this means.

Power Tubes

Allowance is made for the use of power tubes in the audio-frequency stages, when desired, by the inclusion of special B terminals to take the additional voltage required; provision is also made for grid-bias when necessary.

The illustrations of the receiver show that honey-comb coils are used in the conventional two-way coil holder, allowing, therefore, a wide band of wave lengths to be covered. The tubes, it will be observed, are situated at the back of the panel, inspection windows being provided for any observations which may be deemed necessary with regard to filament brilliancy. In order that different types of tubes may be used, the receiver is also fitted with dual rheostats.

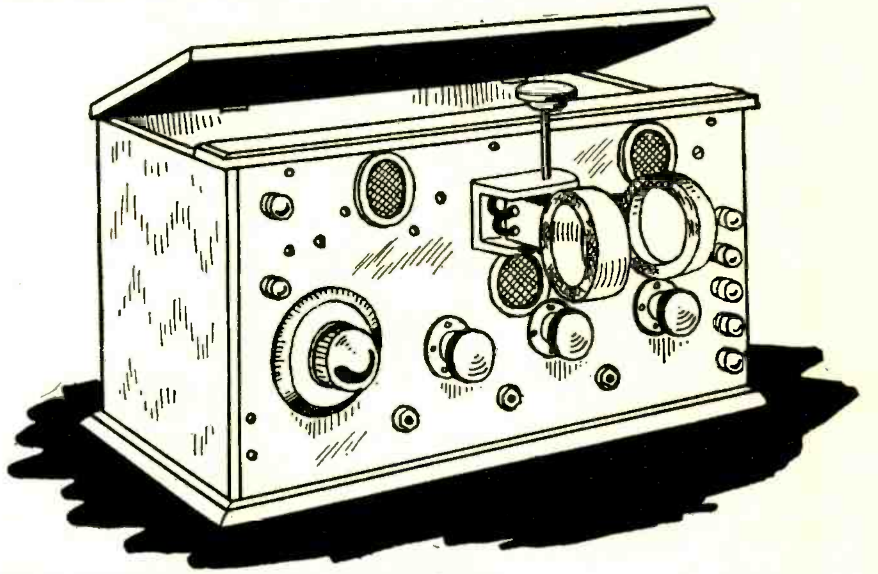
Terminals

The illustration showing the face of the panel will indicate the simple yet effective layout of the parts. The two terminals seen to the left of the panel are for the aerial and ground connections, whilst those on the right, reading from the bottom upwards are the A negative, the A positive, the B negative, the B positive for the detector tube, and, lastly, the B positive for the two audio-frequency tubes; the telephones are, of course, connected into the circuit by means of the plug which is inserted in the jack giving the required number of tubes.

The Grid Battery

It will be observed from the terminals indicated that there are no terminal connections for the grid battery. Provision is made for these by the inclusion of flexible leads fitted with plugs or Fahnestock clips contained within the box, which proceed from the secondaries of the two A. F. transformers and A negative for plugging into the usual tapped type grid battery, which is now procurable; access to this battery for the quick adjustment of grid-battery voltages is given by lifting the hinged lid of the containing box.

Referring once again to the illustration showing the face of the panel, the jacks previously mentioned will be seen along the base line of the panel, and reading from left to right, serve the following uses: By plugging in at the first jack the receiver becomes a simple single-tube regenerative arrangement, the filaments of the two low-frequency tubes not being lighted. By plugging in at the second jack the circuit is the same as before, plus one stage of audio, the filaments of both tubes being lighted automatically. By plugging in at the third jack all three tubes are in circuit, the filaments again being lit up by the insertion of the plug.



Illustrations by Courtesy of Wireless Weekly (London, England)

The compact and neat appearance of the receiver is easily conveyed by this illustration.

The Circuit

The theoretical circuit diagram, illustrated herewith, indicates the exact arrangement of the receiver and the connections which have to be made to the jack. The coil L1 constitutes the aerial tuning inductance, which is a honey-comb coil of a suitable size for the wave length required, tuned by the variable condenser C1. This coil (L1) is coupled to the tickler coil L2, which is another honey-comb coil of suitable size. C4 is the grid-condenser, whilst R4 represents the grid-leak across it; C2 is across either the phones or primary of the first transformer. The working of the jacks may be understood from this figure by a careful reading of the following explanation, together with an equally careful observation of the contacts involved, numbers being given to these for purposes of clarity.

Using the detector tube alone, we insert the plug, which has the telephones across it, in the single closed jack, with the result that contacts four and five are broken and connection is made between four and six, thereby placing the telephones in the plate circuit of the first tube in the usual manner of a single-tube circuit, the B connection being made via contact four of the same jack.

By removing the plug from the single closed jack contacts four and five are again brought together, introducing the primary of the first A. F. transformer into the plate circuit of the tube V1, the B connection still being via the contact four. Inserting the plug into the double filament jack results in a detector and amplifier circuit by virtue of the fact that the primary of the A. F. transformer is already in the plate circuit of the first tube, and by inserting the plug in the second jack the filament of the second tube is lighted through the separating of contacts two and three and the connecting of contacts one and two; similarly, the telephones are introduced into the plate circuit of the second tube by the breaking of contacts four and five and the connecting of four and six.

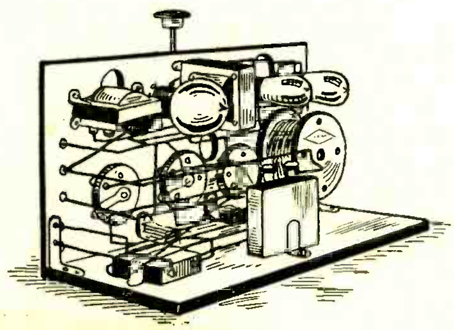
On removing the plug from the double filament jack contacts two and three again make connection, as do also contacts four and five, and by plugging in at the third or single-filament jack, contacts one and three come together to light the filament of the third tube, and similarly, light the filament of the second tube via the contacts two and three of the double-filament jack. In the same manner contacts four and six complete, through the telephones connected to the plug, the circuit to the plate of the last tube and B battery; the plate of the second tube being connected to the primary of the second A. F. transformer through contacts four and five of the double filament jack.

Parts and Materials

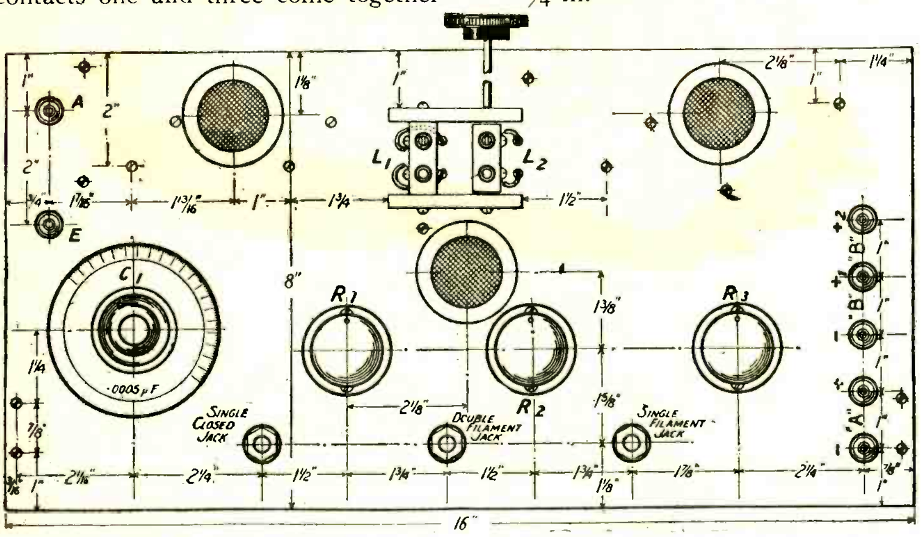
Those readers who desire to construct this receiver will find below a complete list of components embodied in the receiver illustrated.

Transformers

In the matter of the transformers, these should not be chosen at random, but should be of types which go well together, and since most of the better makes offer no difficulty in this respect, after a little experimenting as to which should follow the other, the reader should soon be able to decide upon a pair to best suit his needs. A point worthy of mention, by the way, is that, with a given pair of transformers the changing of tubes in either A. F. stage, or both, very often gives improved results both with respect to volume and clearness of reproduction.



This sketch, showing the wiring, also indicates how the grid battery is mounted.



The layout of the panel and drilling dimensions. A and B battery terminals are mounted on the right of the panel and aerial earth at the left.

1 Bakelite panel, measuring 16 x 8 x 1/4 in.
1 cabinet.
3 bezels.
7 binding posts.
1 two-way coil holder.
1 variable square law condenser .0005 MF. (23 plate).
3 sockets for panel mounting.
3 dual filament rheostats.
1 grid condenser .0002 MF.
1 fixed condenser .001 MF.
1 grid-leak of 1½ megohms.
1 fixed condenser of 1 MF.
2 audio-frequency transformers.
1 single closed jack.
1 double-filament jack.
1 single-filament jack.
1 plug.
Quantity of square bus bar.
2 angle brackets for securing the panel to the baseboard.

The Panel

As there are now so many panels procurable which are guaranteed to be free from surface leakage it seems neither necessary to buy the inferior quality nor to instruct readers as to the treatment which should be given to such material. The drilling of the panel should be carried out in accordance with the particulars given in that figure illustrating the layout, and after all counter-sinkings have been made where necessary the components may be mounted. In connection with this part of the constructional work readers will save themselves a very considerable amount of trouble if they mount the two-way coil holder in the position indicated before mounting the first audio-frequency transformer. Again, mounting the center bezel prior to mounting the middle filament rheostat further simplifies this work; further than this, the parts may be mounted as best suits the constructor's desire or convenience.

Wiring the Components

The connections in a receiver of this type are necessarily many in view of the contacts involved in including the three jacks, and in this respect the work will be greatly simplified if the jack connections are proceeded with in the first place, freedom from entanglement with other wires being thus secured.

The various connections necessary may be followed from the practical wiring diagram, whilst for simplicity the connections to the jacks are shown separated in the circuit diagram, the numbers on the contacts corresponding in the two illustrations. In wiring-up this receiver it is recommended that all connections be soldered and all leads be kept as short as possible; further, where leads run parallel they should be well spaced, and where leads cross they should do so at right angles.

Preliminary Testing

With the wiring of the parts completed it is suggested that the rheostats be turned to the off position, the tubes inserted in their sockets, and the A battery connected, when, by inserting the plug into each of the jacks in turn, the filament lighting circuit of each tube may be tested by means of the rheostats. If all is well join the terminals B+1 and B+2 together by means of a piece of wire and connect them to the positive of the B battery, the B negative being connected to the terminal intended for it and as marked in the illustration of the panel layout. Connect the aerial and ground to their respective terminals and insert a No. 100 coil in the fixed socket of the two-way coil holder with a No. 150 coil in the moving socket, and endeavor to receive some sort of signal, noting whether the set oscillates as the moving coil is brought nearer to the fixed. In the event of no oscillation taking place the connections on the moving socket of the coil holder should be reversed and searching again tried. If no success is attained in this direction the connections should be very carefully checked with those given in the wiring diagram, still more care being taken to see that the connections themselves are good.

Mounting the Panel

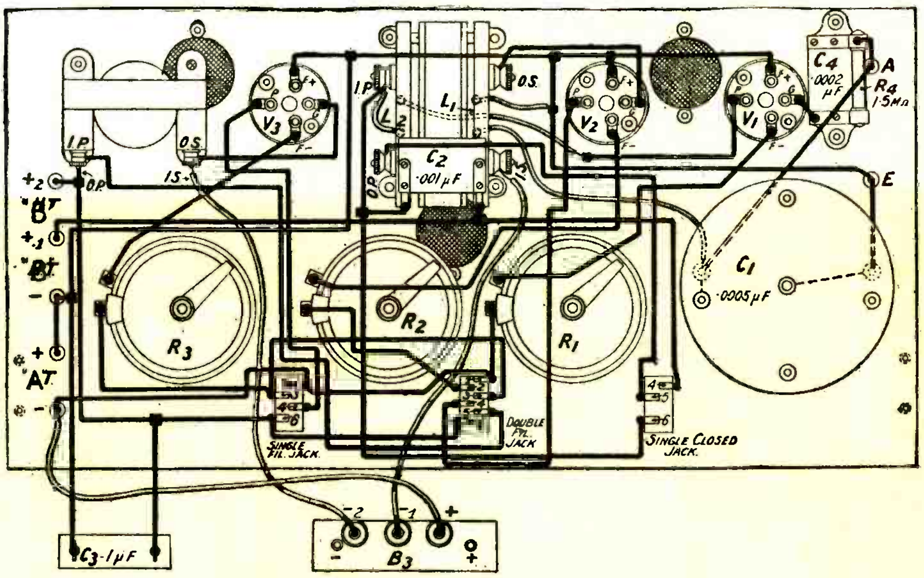
Assuming that all is well, the panel may be mounted to the baseboard by means of the angle brackets mentioned in the list of components. Upon this baseboard, as the back of panel illustrations show, are mounted the condenser which goes across the B battery, and also the grid battery. The method of securing this latter is that of employing two clips such as those used for mounting plate resistances, the battery being wedged between the clips. A simpler method than that illustrated for securing to the baseboard the condenser across the B battery, is to screw it to the baseboard by means of wood screws through the two small holes in the feet of the condenser.

Tubes

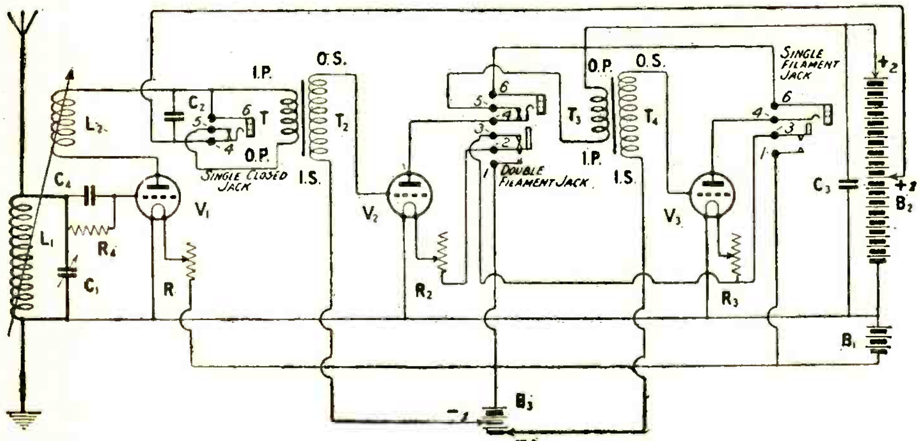
The receiver will work with practically any type of tubes. Irrespective of what tubes may be chosen, particular care should be taken to see that the proper B voltage is applied, this information being obtained from the wrapper of the tube chosen; the same remarks apply also to grid bias. The manner in which the B connections should be made is to first remove the joining wire between B+1 and B+2, and with the B negative still connected, connect B+1 by means of a flexible lead to a tap of the B battery, which will be suitable for detecting purposes, the exact value being found by experiment in conjunction with information given by the manufacturers of the tube. The terminal B+2 should be similarly connected to another tap of the B battery of a higher value also found by experiment, based upon the information supplied by the manufacturer.

Grid Battery Connections

The flexible lead which is connected to the A battery — should be fitted with a red wander-plug and connected to the positive of the grid battery, whilst the two flexible leads from the secondaries of the transformers should be fitted with leads and that lead which is connected to the first transformer plugged into, say, the 1½-volt tap of the grid battery, with the lead from the second transformer plugged into the 3-volt tap.



The wiring of the receiver may be followed from this drawing. The connections to the jacks are numbered in accordance with those given in the theoretical circuit diagram.



The theoretical circuit. The connections to the jacks should be carefully noted, the numbers corresponding with those given in the wiring diagram.

Operating the Receiver

To use the receiver for the first time it is probably better to insert the plug in the first jack, thus using the set as a single-tube arrangement without the necessity of adjusting the extra B voltages. In order to tune stations using wave lengths up to 400 meters, a No. 25 or 35 coil should be used in the fixed-coil socket with a No. 50 in the moving socket. For wave lengths above 400 meters, yet below 600 meters, a No. 50 coil should be used in the fixed-coil socket with a No. 75 in the moving. For the reception of higher wave lengths a No. 150 coil is necessary in the first socket with a No. 200 as the moving coil.

Having chosen suitable coils, they should be separated as far as they will go before pushing in the plug and lighting the tube, after which slowly turn the condenser, at the same time bringing the coils near together until the desired signals are heard, being extremely careful meanwhile that the set is not made to oscillate. Once the signals have been adjusted to their loudest by the careful and deliberate adjustment of both condenser and tickler coil, the plug may be removed from the first jack and inserted in the second, when the filament temperature of the second tube should be adjusted for the best results. With these obtained, vary the position of the B+2 lead for the loudest signals consistent with clearness, and also vary the amount of grid-bias by means of the plug from the first A. F. transformer for distortionless results. In the same way plug in the third tube, again varying the B voltage. Also vary the grid-bias by means of the plug from the second A. F. transformer or from both transformers as experiment and results indicate.

It is not suggested that this receiver is a long-range instrument, but those readers who, having constructed such a set, endeavour to tune the more distant stations, will be surprised at the sensitivity of such a simple circuit with its remarkably easy tuning facilities.

Reflexing the 3-Circuit Tuner

A Receiving Set That Can Be Logged

A SET of considerable power and range is the Reflexed 3-Circuit Tuner. It embodies a stage of tuned radio-frequency amplification ahead of a regenerative detector, two transformer-coupled audio stages being employed. The first of these two audio stages is reflexed in the radio-frequency tube.

Details for constructing the Reflexed 3-Circuit Tuner as described by *Herman Bernard* in *Radio World* Magazine is as follows:

One RF Stage Enough

One stage of radio-frequency is about all the RF that can be added to a regenerative detector. Two stages will not be successful, unless neutralized, and some losses are necessarily sustained by the neutralization process. The reason for this condition is found in the tubes themselves. One stage of tuned RF ahead of a regenerative detector is theoretically at least the equal of two stages preceding a non-regenerative detector, since regeneration is the most effective form of radio-frequency amplification known. Another RF stage in the regenerative set would set up too much free oscillation or otherwise reduce tube efficiency, while more than one regenerative stage is out of the question when one desires a set possessing some stability. The only way of gaining greater effective amplification is by the heterodyne system.

Excellent Results Possible

No reflex set is simple to build. One ever-present problem is to shorten the leads as much as possible. There is no way of avoiding the long lead from the detector output to the first audio primary. But by careful construction and wiring excellent results may be obtained.

Choice of Coils

One has a rather wide choice of coils for use in this circuit. The three variable condensers C1, C2, C3 are .0005 mfd. each, normally 23 plates.

No. 20 double silk-covered wire is used for the radio-frequency transformers, L1L2 and L3L4. On a 3½" diameter tubing 4" high wind near the top, ten turns of this wire to constitute the primary L1. Terminate. As close as possible to the primary start the secondary, L2, which will consist of 41 turns of the same kind of wire wound in the same direction. The other RFT should be made the same way, except that the secondary L4 should have 40 turns instead of 41. This is on account of the capacity of the plate of the RF tube being added to the capacity of the condenser C2, thereby requiring slightly less inductance on the secondary. The two condensers therefore may be tuned approximately in step. The impedance coil L5, tuned by variable condenser C3, is wound on a 3" diameter tubing 3" high and comprises 43 turns of No. 24 double cotton-covered wire. These directions take into account the formulas for best inductance value, the proportion of the axial length of the secondary (the number of inches from terminal to terminal) to the diameter of the tubing being scientifically observed.

Spider-web fans may use a 5½" diameter form, winding 45 feet of No. 20 SCC wire for L2 and 44 feet for L4. The primaries consist of six feet each of the same wire, wound with the secondary, about in the center thereof. The plate coil would have 43 feet of the same kind of wire.

Those who prefer basketweave coils may use a 3½" diameter, placing fifteen dowel sticks equi-distant about the circumference, and wind 46 turns of No. 18 double cotton-covered wire for the secondary L2, the primary consisting of ten turns, wound simultaneously with the secondary, in approximately the center of the winding. The secondary L4 would have one less turn. The plate coil L5 would consist of 44 turns.

If commercial type coils are desired, the Globe or Wallace RF transformer may be used for L1L2 and L3L4, these being of the Lorenz type (basketweave). The Eastern pickle-bottle and the ARC radio-frequency transformers also are good. Anyone having three RFT may use only the secondary of one of them as the plate coil L5, omitting the primary altogether.

Keeping Dials in Step

If after the set is built the dials are found not to read in step they can be made to do so approximately by removing turns, one at a time, for the coils whose condensers give the higher readings. However, be sure that the dials are correctly affixed. When the plates are totally in mesh (parallel) the reading should be 100 or 180, depend-

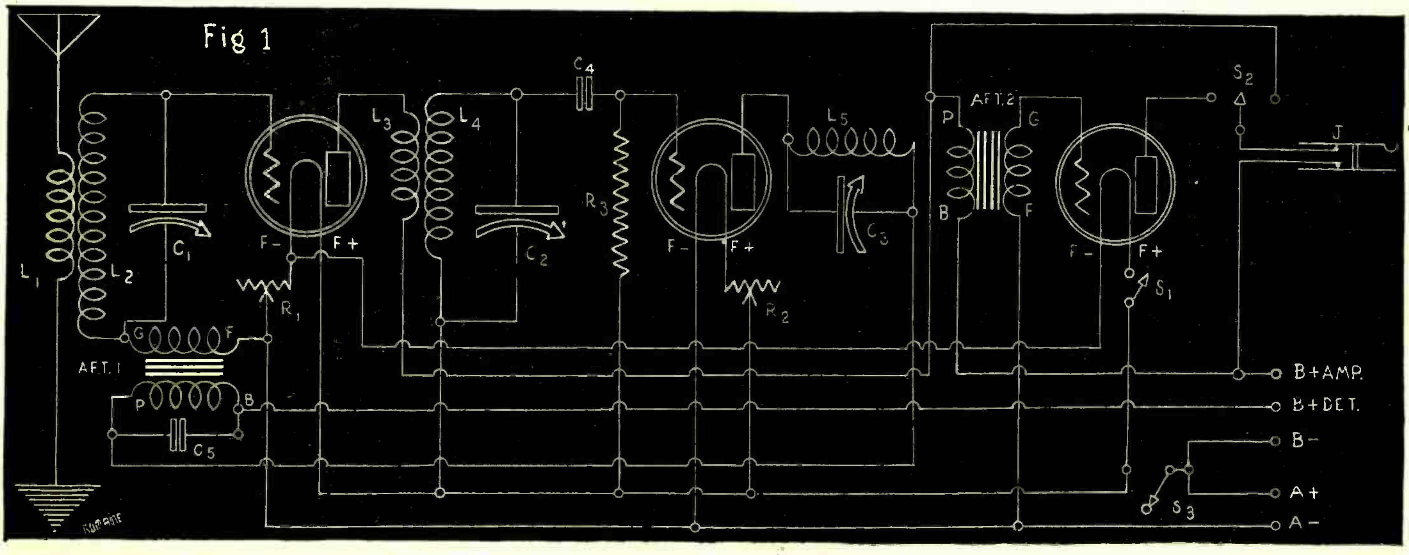


Fig. 1.—Wiring diagram of the Reflexed 3-Circuit Tuner. A single-circuit jack is used for the output of both the first and second audio stages. There are three controls, all of them .0005 mfd. variable condensers.

ing on the type of dial used. For much of the range the dials may be kept fairly close together as to readings if they are set at an identical reading for a given station on a rather high wavelength (as, for instance, 67, 67, 67 for WEAF, 492 meters).

Achieving Regeneration

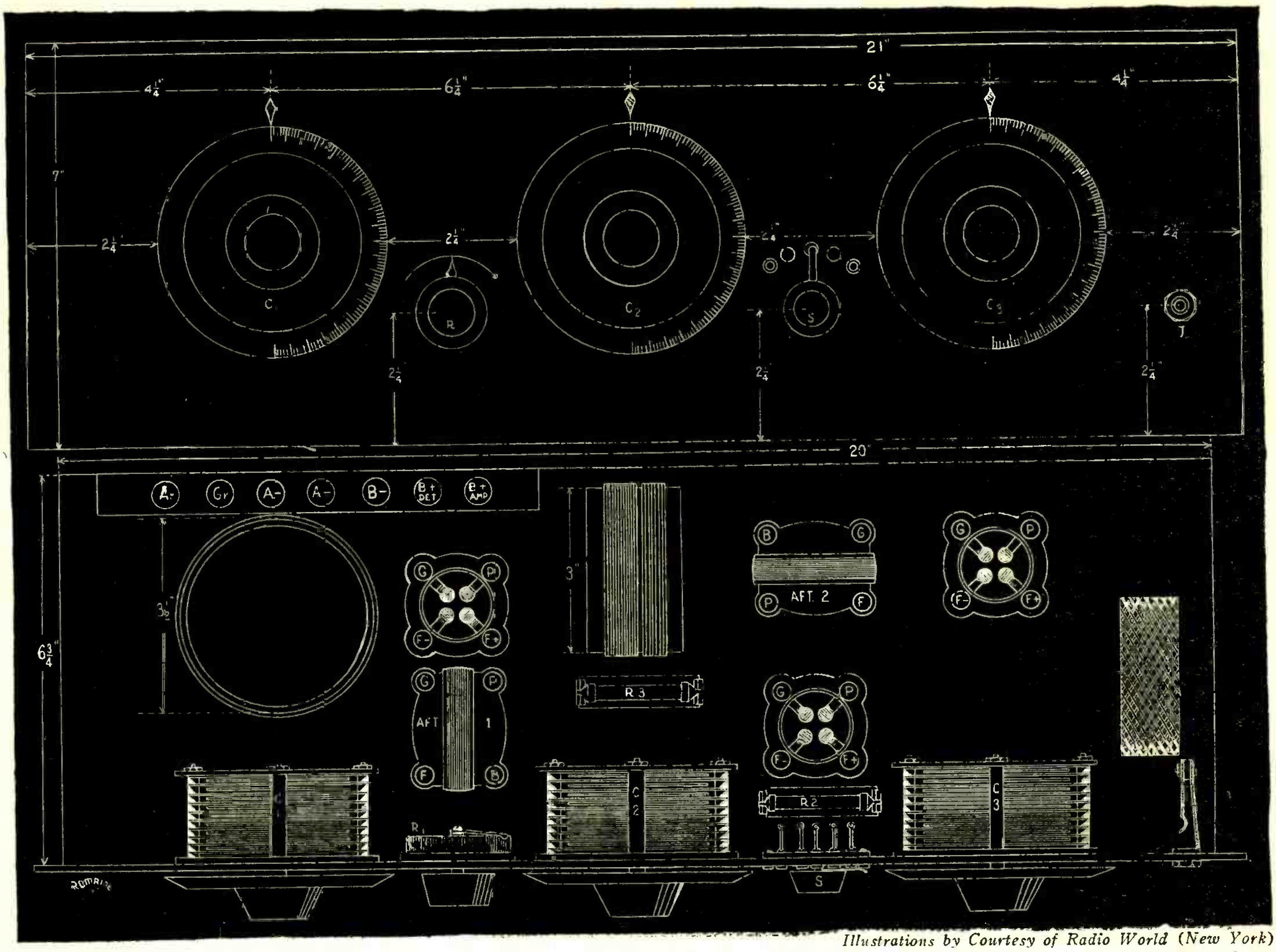
The plate coil is tuned by a variable condenser to put the plate of the detector tube in resonance with the grid of that tube, thereby occasioning regeneration through the capacity between the plate and grid elements within the tubes themselves. The leads of the plate, usually a shovel-shaped element, and of the grid, a sort of grillwork, are brought through the vacuum of the glass envelope to seals near the base. Usually some red substance distinguishes these seals. The red composition tends to keep the temperature of the seals about the same as that of the glass. Each seal is like a plate of a two-plate condenser, hence here the radio-frequency energy is passed from plate to grid. Indeed, even when there is no tuned plate there is a trivial transfer of energy in this direction, but not enough to constitute regeneration which is a controlled condition of oscillation, that makes a set unstable.

Aid of Bypass Condenser

A bypass condenser C5 will be seen across the primary of the first audio-transformer. This condenser is usually important in this particular circuit. Some tubes more readily regenerate by the tuned plate method than others. Occasionally a tuned plate set does not respond as successfully as desired, due to "lethargy" in the elements, and this condenser often cures the defects. A tube on the verge of an outlived usefulness will not do in this detector socket, although it might show up fairly well if the tickler method of regeneration were used. The tickler method consists of returning the plate current of the tube to the grid by means of a rotatable coil placed in the plate circuit and in inductive relationship to the grid coil (secondary).

LIST OF PARTS

One 7 x 21-inch panel.
One 7 x 20-inch baseboard.
One terminal strip (binding posts).
Two RF transformers, as described (L1L2, L3L4).
One plate coil, as described (L5).
Two audio-frequency transformers of different ratios are used, the higher ratio should be in the first stage (AFT1, AFT2).
Three .0005 mfd. variable condensers (C1, C2, C3).
Three sockets.
Two UV201A tubes or 301A tubes.
One Sodion tube.
One 6-ohm rheostat (R1).
One 20-ohm rheostat (R2).
One variable grid leak (R3).
One fixed condenser, .001 (C5).
One fixed condenser, .00025 mfd. (C4).
One single-circuit jack (J).
One push-pull battery switch (S1).
One tapswitch consisting of two or three switchpoints, two end stops and a switch arm (S2).
100 ft. aerial wire, 50 ft. No. 14 insulated lead-in wire, screws, hardware, solder, round tinned bus-bar for internal connections.



Illustrations by Courtesy of Radio World (New York)

Fig. 2.—The panel layout, and Fig. 3, the assembly plan of the set. Instead of the plate coils described in the article a honeycomb coil may be used. It may be a 75-turn coil from which four 14 turns have been removed.

Tubes For the Circuit

This circuit works very well with dry-cell tubes. WD11, C11, WD12 or C12 may be used throughout, or interchangeably. These tubes are splendid detectors, good radio and audio-amplifiers. The 199 and 299 tubes also may be used, but they require 4½-volt A battery, whereas the others require 1½. The 199 and 299 tubes are at least as good as the others mentioned in the radio and audio stages, but it is not so easy to get a good one for the detector circuit, due perhaps to difficulty in manufacture, as this product runs very unevenly as a detector. However, if you can buy one that is tested for its detecting power you will have a fine combination with 199 or 299 tubes throughout.

Better than the dry-cell tubes, although somewhat more expensive in the long run, are the UV201A and C301A tubes. These may be used throughout, or interchangeably. They require a 6-volt storage battery. When it comes to choosing a detector the UV200 or C300 will be found considerably more sensitive. This type of tube draws one whole ampere, while the 201A and equal draw only .25 ampere. A detector tube as good as the 200 or 300 is the D21 Sodion, which also draws only .25 ampere. Those desiring to use the Sodion should change the grid return in the detector stage (end of L4). The grid return is that connection of a coil whose other terminal goes to the grid of a tube. Fig. 1 shows the grid return of L4 going to positive A. For the Sodion tube, and even for the 200 and 300, this should be to negative A. The Sodion, like the 200 and 300, is to be used only as a detector.

A novelty in Fig. 1 is the method of plugging in the first and second audio stages. Instead of two jacks, one a double-circuit, the other a single-circuit jack, only one is employed, and it is of the single-circuit variety. At least two switch points are placed on the panel, or three may be used, if a dead one is desired in center. One switch point is connected to the P post of the second audio-transformer, the other switch point to the plate of the third and last (second audio) tube. The switch arm is joined to the spring of the jack, the right angle of the jack going to B plus amplifier voltage (usually 90). Thus earphone service, or even speaker operation on some locals, may be obtained from the first audio output, and the greater volume from the second audio output. The detector output is not tapped. As the plates of both amplifier tubes take the same B voltage, the operation of the switch enables one to tap either the first or second audio output without removing the plug from the jack. The first audio output, at a quick glance, might seem to be short-circuited, since the plate is tapped from the P post to AFT2, whose B post goes to B plus amplifier voltage, while the jack angle also goes to this B voltage. However, close inspection will show that the primary of the second audio transformer (PB of AFT2) is merely in parallel with the phones.

Coil Connections

A word about the coil connections. Take care to connect the aerial to the top terminal of L1, the bottom terminal thereof of ground. The next terminal (the beginning of the secondary L2, next to the ground connection) goes to the G post of the AFT1, the end of L2 to the grid. The rotor of the condenser C1 goes to the beginning or filament end of L2, the stator to the end or grid connection. The same directions hold true of L3L4. The plate coil may be connected either way.

One rheostat R1 controls the two amplifier tubes. It should be 6 ohms. But an Amperite, D11 type, may be used instead, thus omitting one minor control. A rheostat must be used in the detector tube. It should be in the positive leg, as shown, unless the Sodion is used.

The battery switching system enables one to turn on and off all three tubes with one operation. If it is desired to turn off the second audio tube when listening on the first stage, put a second battery switch, in the A+ lead of the third socket.

An Optional Condenser

No fixed condenser is shown across the secondary of the first audio-transformer. Probably none will be needed. But if music quality proves none too good, put a .001 mfd. fixed condenser there, connecting one side of the condenser to the G post, the other to the F post.

Take care to have all grid returns direct to battery leads or branches thereof, and not to filament posts. In other words, do not force the grid return through the resistance of a rheostat.

The Grid Leak and Condenser

The grid leak should be variable. It is connected from the grid post of the detector tube socket to the filament plus post of the most convenient socket. C4 is the grid condenser, .00025 mfd.

The New Splitdorf Receiver

(*Continued from page* 54)

plates of the variable condenser and to the rheostat connected to the negative "A" battery. The ground lead is also connected to this side of the inductance, but a fixed condenser of .00025 microfarad is also in series with it.

Now for the plate circuit. From the post marked "P" run a wire to the top of the primary winding of the second radio frequency transformer, and then in turn to one side of another .00025 condenser.

The other side of the primary winding is connected to the "B" plus binding post. Now connect the other side of the fixed condenser to one side of the secondary of the second R. F. transformer. This same side of the inductance is connected to the rotary plates of the variable condenser and also to the common "A" minus lead. The other end of the secondary goes to the stationary plates of the variable condenser and to the post marked for the grid on the second tube socket.

Exactly the same procedure is followed out for the next radio frequency transformer.

The audio stages are wired in the conventional manner except for the use of a special jack. This jack simply disconnects the positive "B" battery lead from the last stage when the phones are inserted in the first stage. The one microfarad fixed condenser is connected from the "B" battery plus of the radio frequency amplifier tubes to the "A" and "B" battery common lead. Another fixed condenser of .00025 microfarad is connected from the plate side of the first audio frequency transformer to the common "A" battery minus lead. Still another by-pass condenser is used from the plate side of the loud speaker to the common "A" battery minus lead. This one is of .006 microfarad.

About all of the more important connections have been thoroughly discussed in the above paragraphs. The rest of the receiver consists of conventional wiring and can be followed very easily from the two diagrams.

No doubt by this time the constructor has been wondering why twelve binding posts are called for. Well, the extra two are merely placed on the rear panel in case a "C" battery is ever used in the set. If one is included in the circuit, it is merely necessary to alter the wiring in the audio stages for this purpose and bring out the leads to the binding posts intended for this purpose.

The twelve binding posts should bear the following engravings: From left to right, facing the rear, first two for the loud speaker; third, "B" plus amplifier; fourth, "C" battery minus; fifth, "A" battery minus; sixth, "C" battery plus; seventh, "B" battery minus; eighth, "B" battery plus detector; ninth, "B" battery plus R. F. amplifier; tenth, antenna; eleventh, ground, and twelfth, "A" battery plus.

When the set is finished and all batteries are properly connected, the head phones or the loud speaker may be used in the initial trial. In tuning all three dials will have readings quite similar to one another.

A Baby Super Set with Filter Coils

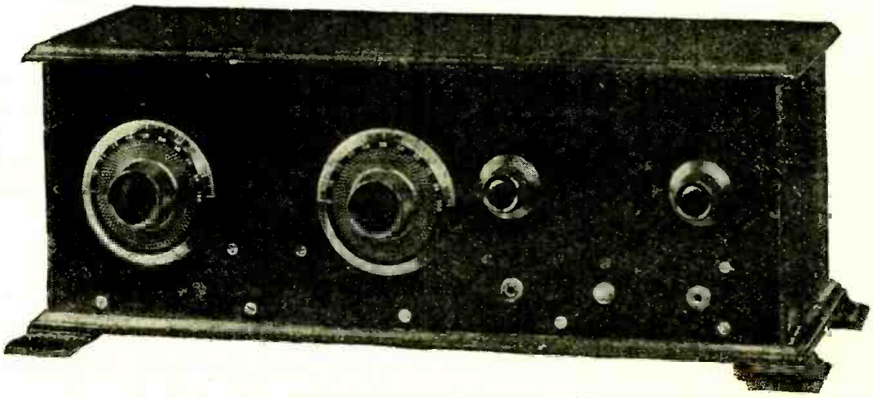
Number of Controls Reduced to a Minimum Assuring Ease of Tuning and Elimination of Local Interference

MANY are the receivers designed to effect a practical, efficient combination of radio frequency amplification and regeneration in the detector stage. Equally numerous are the arrangements to obtain tuning simplicity without loss of selectivity or sensitivity. *George C. Moody* has described a receiver in the *Radio Times* (*New York*), that not only covers these essentials, but uses only four tubes and utilizes the coils used with the Filter Tuner circuit that enjoyed brief vogue some months ago. The description of this set follows:

Superheterodyne? No — in size. Yes, in results—but minus all the undesirable features of its big brother. We will call this circuit the Baby Super Set. The tuning of this circuit is found only in smaller sets. The number of controls have been kept to a minimum, and a sharpness of tuning will be experienced that will come as a pleasant surprise to those of you who have been troubled with local interference. The ability of this circuit to log distant stations is an accomplished fact, due to the fundamental principles employed.

Tuned Radio Frequency

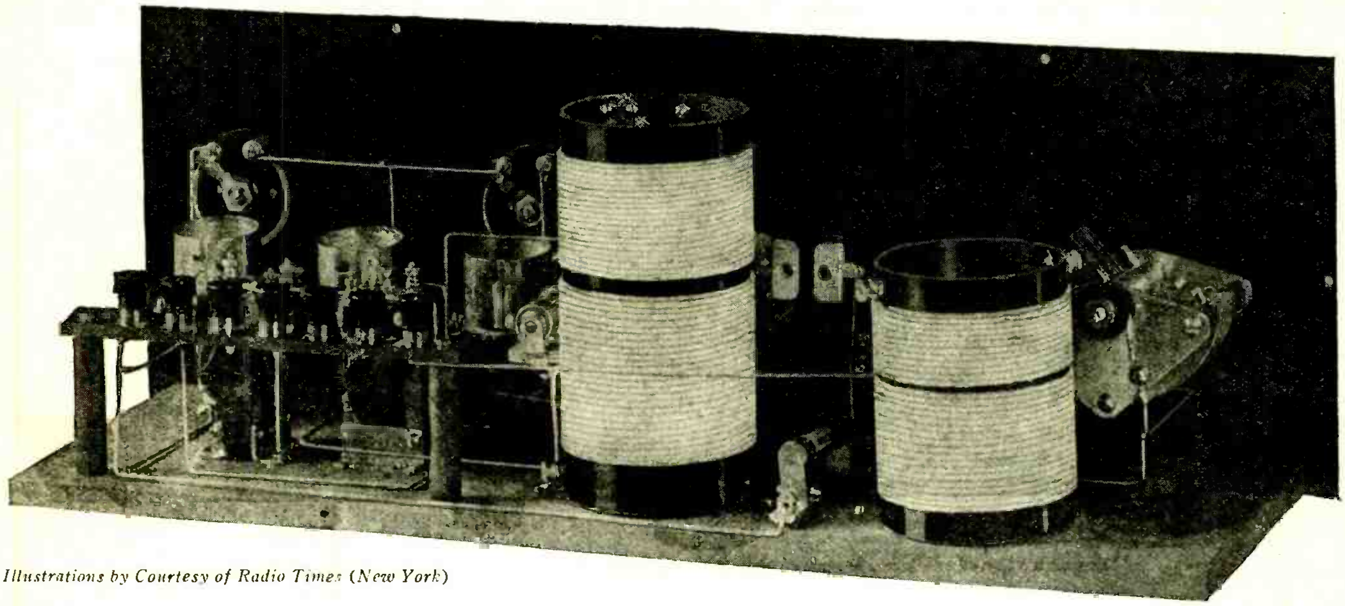
Combining radio frequency amplification with regeneration has held the attention of both the radio engineer and the dyed in the wool fan for the past two years, both realizing that could they make one stage of tuned radio amplification work in connection with a good regenerative set the results would be equal, if not superior, to sets employing five to eight tubes, using straight radio frequency amplification. In the Baby Super we have accomplished this without sacrificing the simplicity of the set. This stage of radio amplifies the weak signals of distant stations to such an extent that loud speaker reception is secured on stations that were only audible on the headphones of less sensitive sets. A potentiometer is not necessary in this circuit as we have found that the rheostat will control all the oscillations of the radio frequency amplifier. A special 48,000 ohm resistance is used in combination with a .002 fixed condenser in coupling this stage of radio amplification to the detector circuit. It might be well to add a word of caution here as to the resistance to be used in this circuit. It should be of good quality as a poor resistance will spoil the operation of the set; such a resistance may be secured from any reliable dealer.



Completed set ready for operation.

Fixed Regeneration

Since regeneration was mentioned in the first paragraph some readers have been asking themselves, will this set reradiate? It will not. One control has been eliminated by employing a fixed tickler coil. This not only does away with one troublesome control but also increases the stability of the circuit. The set will oscillate over the entire broadcast wave band and unlike some Super and Radio frequency circuits, it will give you uniform amplification at all wave lengths. Regen-



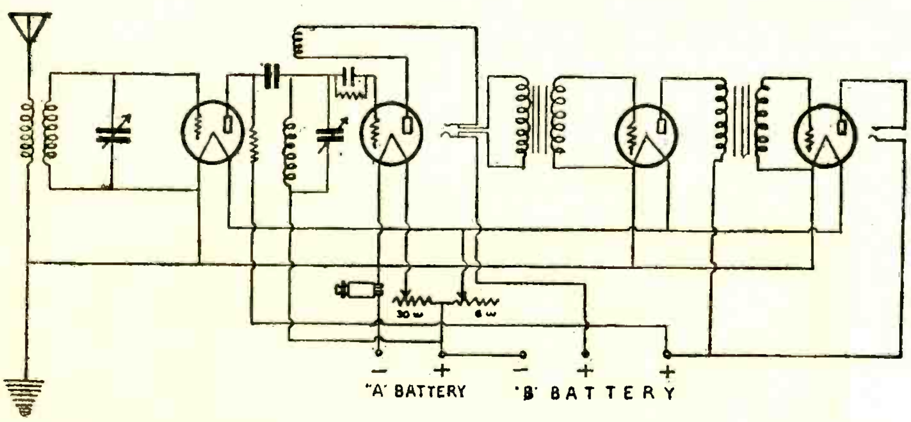
Illustrations by Courtesy of Radio Times (New York)

Rear view of completed set showing panel and baseboard layout.

eration as employed in this circuit combined with the Radio frequency amplification gives the highest possible amplification and selectivity for the number of tubes employed.

Low Cost

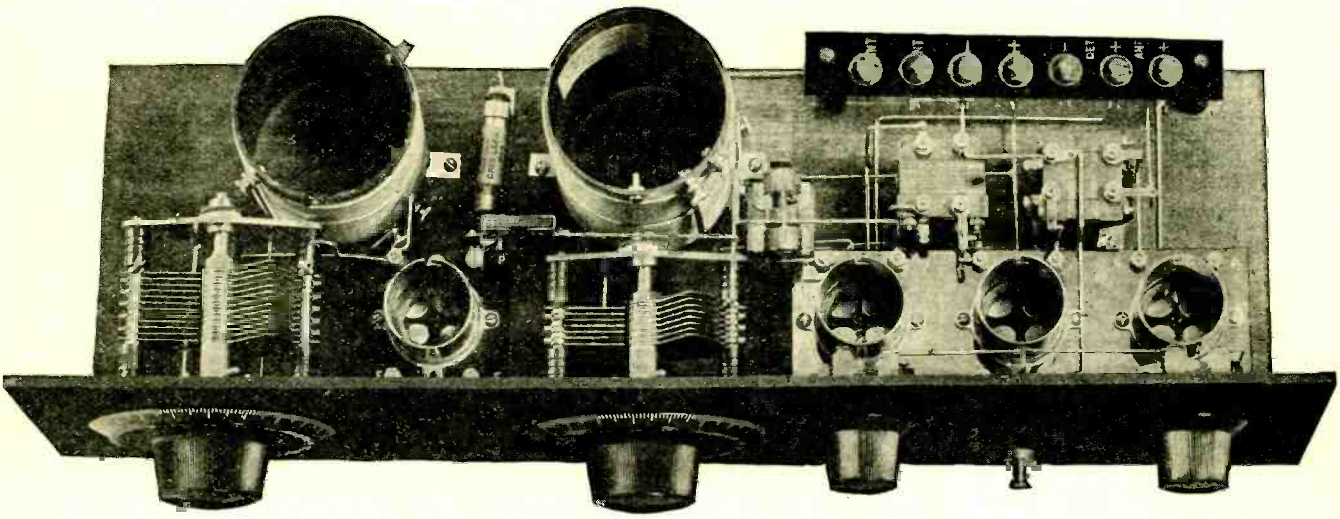
As only four tubes are employed, i. e., three amplifier and one detector, the "A" and "B" battery drain has been kept to a minimum. Three 201-A



Circuit diagram of the baby super. Carefully follow the connections when wiring the set.

tubes should be used in the amplifier and a UV 200 in the detector socket; 67½ to 90 volts B battery will be just right for the 201-A and 16 to 22½ for the UV 200. As the drain on the "A" battery is not heavy the storage battery need not be over 60 ampere hour capacity, although one slightly larger would be preferable.

The number of parts necessary to construct this receiver is also an ad-



Top plan view of receiver showing assembly of parts and spacing. Note symmetrical arrangement.

vantage to those who build their own, only two variable condensers being necessary.

Arrangements of Parts

By referring to the photographs and diagram of the circuit the simplicity of the set will remove any doubt you may have had as to your ability to properly construct this receiver. There are no complicated balancing out processes to bother with and the arrangement of parts on the panel and baseboard are such that make for simplicity of wiring, tuning, and highest general efficiency of the completed receiver. One condenser is a 13 plate low loss which tunes the one stage of radio frequency amplification. A 23 plate condenser is shunted across the secondary coil and tunes the detector circuit. The grid condenser should have a capacity of .00025 mfd., and for best results the constructor should use a variable grid leak. In selecting sockets care should be exercised to use only such sockets that have bakelite or pyrex base and good stiff contacts as a faulty socket can spoil an otherwise perfectly good set. In the model set the author used panel mount sockets of a well known manufacturer. The use of panel mount sockets not only adds to the appearance of the set but simplifies the wiring. The two-stage Audio Amplifier used in this circuit is the standard Two Step Audio Hook Up. Standard transformers may be used with good results. Preferably a 5½ to 1 for the first stage and a 3½ to 1 or 3 to 1 for the second stage. The quality of reception when using this circuit is all that could be desired, but in case the instructor wishes to experiment, there is a variable resistance manufactured that may be placed across the secondary of the second stage, which will eliminate any distortion present and also make the set more quiet in operation.

Proper Coils

The inductances used in this set are the Famous Journal Filter Tuner Coils. The design of the coils, including number of turns, size and all are just right for this hook up. A set of these two coils can be purchased at almost any local radio store. For the best results, would recommend that you use the coils wound on the tubing in preference to the spider web or so-called low loss coils.

Wiring Hints

In wiring this receiver, would suggest that the same general scheme of placement of parts as shown by the photos be followed. All the parts should be securely fastened to the baseboard before the actual wiring is commenced. The filament wires to the sockets, coils, and transformers should be wired before fastening all the solder connections. See that the wire is bright and clean before soldering and would suggest that you use rosin core solder. In case you use acid, be very careful to thoroughly clean off all surplus flux from around the joint. When soldering the connections to the jacks extra care should be used. Do not use any more acid, paste, or other soldering compound than necessary as the acid tends to run into the insulating bushings on the jacks, and causes a direct short or at least a very high leakage. As the actual current we have to deal with is very small at its best, we should do the best we can in the way of using all the care possible to make all the joints as tight and clean as possible.

Stations are easily tuned in by adjustment of the two condenser dials, but on extreme distant stations or stations of low power it will be found necessary to also adjust the detector rheostat. This rheostat plays an im-

(*Continued on page 74*)

Data on the McCaa Anti-Static Circuits

Static and Other Disturbances Cut Out of Radio Receivers by Means of These Devices

FOR some time the report that Dr. D. G. McCaa, radio engineer for the Electric Apparatus Company, Parkesburg, Pa., had invented a device which would materially reduce the intensity of static finding its way into a radio receiving set has beeen circulating. Not only would this device reduce the interference caused by static, the report went on to say, but it would reduce the interference caused by other high decrement discharges, such as interference caused by arc lighting systems, steam precipitators, X-ray machines, radio-frequency furnaces, etc.

Fred H. Canfield recently explained this device in *The New York Herald Tribune*. His article read as follows:

Parkesburg, a small manufacturing town located midway between Philadelphia and Harrisburg, has been the scene of many interesting and successful radio experiments carried on by Horace A. Beale, Jr. and his staff. The Radio Laboratory at Parkesburg was the home of one of America's first powerful radio broadcasting stations, WQAA, and still houses that powerful amateur station 3ZO, which was recently successful in carrying on two-way radio communication with Z4AG, an amateur station located in New Zealand, nearly 8,000 miles away. Another thing for which this laboratory will be remembered is the wonderful work carried on under the call 3O1, with a portable field radio station completely installed on an automobile truck. It is believed that this station was one of the first of its kind, and it accomplished a great deal by demonstrating the possibilities of a portable radio transmitter.

The Towers

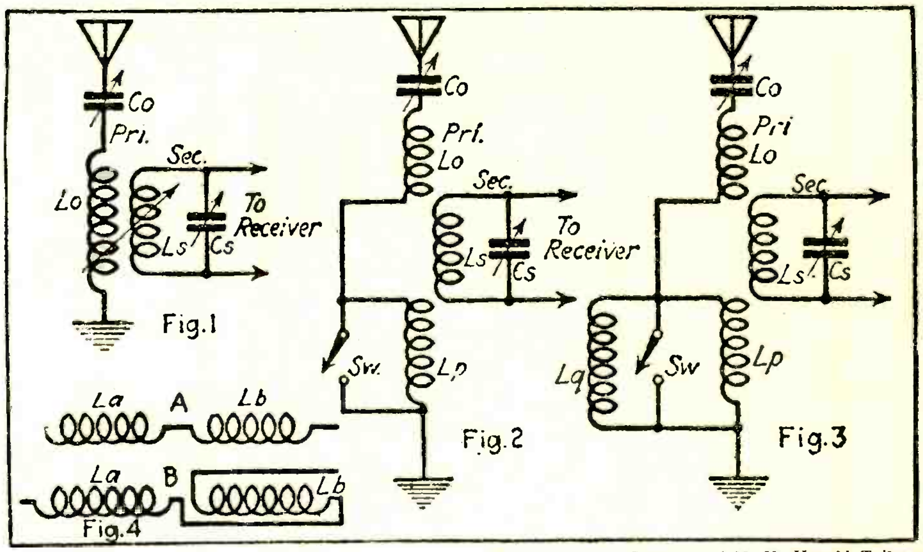
Two immense towers 185 feet in height and about 400 feet apart on the top of a hill located about 1,000 feet from the station first attract the attention. Spread between the towers is a large radio antenna, and almost directly under the antenna is the two-story structure which houses the Parkesburg Radio Laboratory. The first floor is used as a garage and generator room, and the second floor, where the radio experimentation is carried on, is divided into a number of small rooms, each of which is shielded. In one of these is placed the apparatus for experimenting with the McCaa anti-static device. In another room some one is experimenting with a 500-watt short wave telephone transmitter, while in a third room is located a complete long wave broadcasting station.

During the writer's brief stay at Parkesburg he interviewed Mr. Beale, the owner of this installation; Dr. McCaa, the inventor of the McCaa anti-static device, and Mr. Richardson, who assists Mr. Beale in his short wave experiments. From these interviews much was learned about the valuable scientific radio research work being carried on at Parkesburg.

Two Anti-Static Devices

There are two distinct types of the McCaa anti-static device. Each works on a somewhat similar principle and they may be used for similar purposes. The first and simpler of these two systems is known as the "driver" circuit and is used chiefly for the reception of radio telegraph or code signals. The second system, which is slightly more difficult to operate, may be used for either telegraph or telephone reception and is known as the "repeater" circuit. Both these systems accomplish precisely the same results for the type of reception for which they are intended, namely, they reduce the signal static ratio. Two examples of this follow:

On a given night, with an ordinary receiver, signals of a certain station are received with an intensity of five times audibility, and the static received at the same time on the same wave-length has an intensity of one hundred times audibility. Under these conditions, if a McCaa anti-static device were introduced in the circuit the intensity of the signal would remain five, but that of the static would be reduced to less than five times audibility, and possibly only a very small fraction of this figure. In the above example the intensity of static is reduced in excess of 2,000 per cent; however, this is not always the case.



Illustrations by Courtesy of N. Y. Herald Tribune.

Simple tuning devices and methods of blocking signals.

If the above conditions remained the same except that the received signal has an intensity of fifty times audibility, the introduction of the McCaa anti-static device would reduce the static at least 50 per cent and possibly a great deal more. In other words, these examples show that this anti-static device always reduces the signal-static ratio to better than one to one, but does not necessarily reduce the static the same amount with all signals.

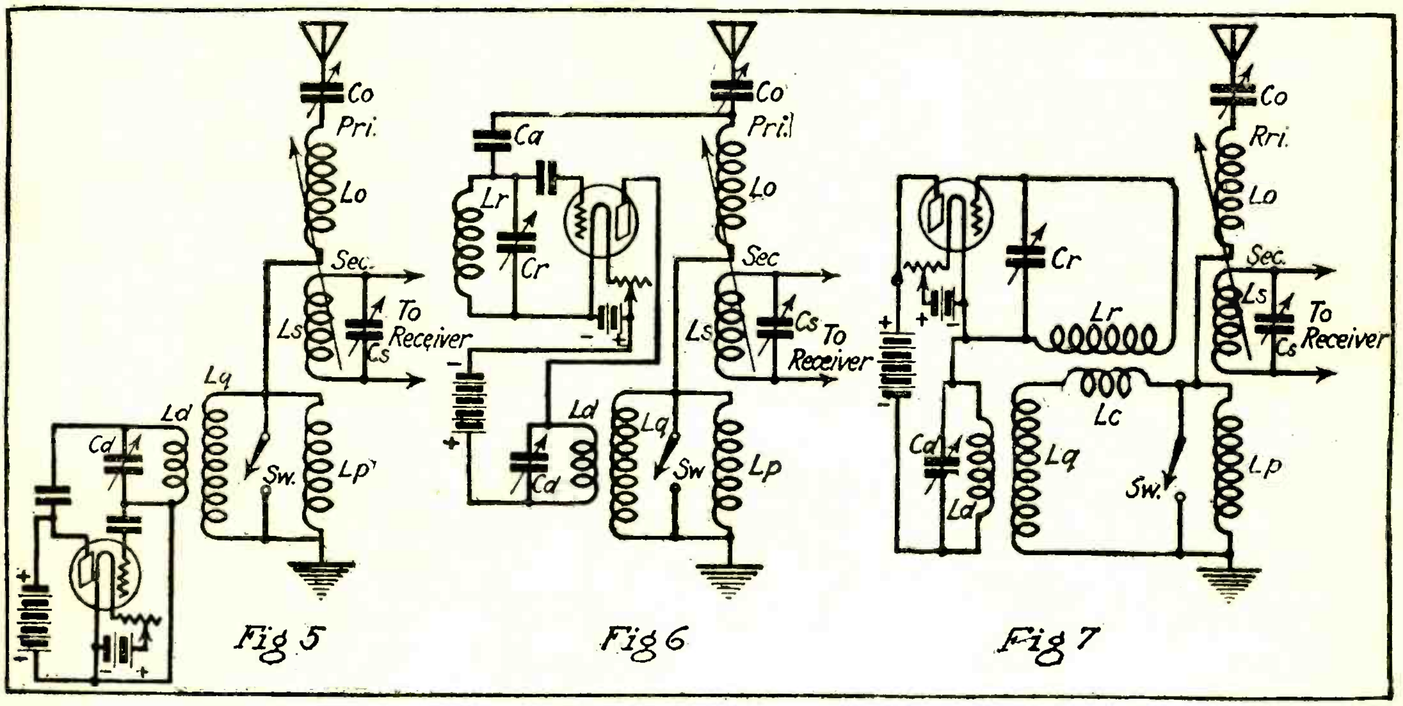
How Much Reduction

The question naturally arises: "How much better is the signal-static ratio than one to one?" This is impossible to answer because it depends upon so many conditions and varies with practically every station. At this time, however, it might be interesting to tell the results of some experiments conducted in California by Dr. McCaa, when he was trying to answer this question for himself.

In these experiments a receiver equipped with a McCaa device, which was different from the circuits herein described, was tuned to a station, and as much of the static was balanced out as possible. Resistance from an audibility meter was then introduced in the plate circuit until both signal and static were inaudible in the room in which the loud speaker was located. At this static device was inserted in the circuit it was possible to understand every word of a talk that was being given.

The writer is not trying to create the impression that these anti-static devices are static eliminators—they are not, for they only reduce the signal-static ratio. True, so far as unmodulated code signals are concerned, they reduce static to a point where it is no longer of any importance, and in broadcasting reception they often make possible the enjoyment of a program which it would otherwise be impossible to hear, but they do not eliminate static.

tion, the signals from that station, and also any static on the air, will be received with maximum intensity. Another possibility is that the primary and secondary circuits are not tuned to the same wave length. In this case neither signal nor static will be received with full strength, if at all.



Various arrangements of the static reducing device.

point the resistance of the audibility meter was slowly reduced and three observers were asked to tell when they first heard signs of static. The average opinion of these three observers was that the signal had reached an intensity of 270 times audibility before static was heard, or in simpler words, the signal was 270 times as loud as the static.

An Experiment

Another very interesting experiment was performed at Parkesburg in the writer's presence. The signals of the powerful trans-Atlantic station MUU, Aberdeen, Scotland, were tuned in and some man-made static was then created which made it impossible to hear the trans-Atlantic station. Under these conditions the use of the anti-static device made it possible to receive MUU on a loud speaker with practically no static. Proof that the reduction of static was not imaginary was furnished by causing the signals to operate a tape receiver, which in turn printed the signals perfectly without any sign of interference.

Still another evidence of the efficiency of this device was given before the writer in Lancaster, Pa., when real static was very severe, and accompanied by other noises, due to arc lights. On this occasion Station KDKA was tuned in, but it was impossible to understand anything said above the constant roar of static. After an anti-

It is also true that they perform differently on all stations, and the reasons for this will be better understood after their electrical operation has been explained.

Before going too far into the discussion of anti-static devices the difference between signals and static should be understood. Signals, including both telephone and telegraph, are always on a definite wave length, and in order to receive both the primary and secondary circuits of a receiver should be tuned to the wave length of the transmitting stations. Static, on the other hand, has no definite wave length, and will be received at any time both the primary and secondary circuits of a receiver are in resonance. An example of this may be had by referring to the diagrams herewith.

Fig. 1 shows an ordinary coupled circuit tuner with the primary winding, Lo, tuned by the variable antenna series condenser Co, and the secondary winding, Ls, tuned by the variable shunt condenser Cs. In this circuit, if both the primary and secondary circuits are tuned to the wave length of a sta-

To continue this discussion it is necessary to refer to Fig. 2. This circuit is the same as Fig. 1, except that an inductance Lp, which is equal in value and opposite in direction to that of Lo, has been inserted in the ground lead of the receiver, and the switch, Sw, has been provided to short circuit coil Lp. In this circuit, if the switch Sw is closed, the circuits Lo, Co and Ls Cs can be tuned to the wave length of a station and both the signals from that station and static will be received as in Fig. 1.

However, if after these two circuits have been tuned to the wave length of a station, the switch sw is opened both signal and static will be entirely balanced out of the circuit and nothing will be heard in the phones. This is because Lo and Lp, which are equal in value and opposite in direction, neutralize each other and make it impossible for either signal or static to enter the secondary circuit of the receiver.

The Problem

It has been shown how both signal and static may be eliminated from a radio receiver, and the problem now remains to find a method of allowing the signal to re-enter the receiver without the static; or, better stated, to find a method of allowing all of the signal to re-enter the receiver and at the same time limiting the value of the static to equal or less than that of the received signal.

A third possible circuit is shown in Fig. 3. This is identical with Fig. 2, except that the inductance Lq, which is much larger than Lp, has been connected in shunt with Lp. This inductance Lq is so much larger than Lp that Lp is hardly aware of its existence in the circuit. As it stands Lq has practically no effect upon the reception of signals. It is also interesting to note that because of the high inductance value of Lq and the comparatively low inductance value of Lp, only a small fraction of the signal energy will pass through Lq.

In Fig. 3 if the switch is closed and the primary and secondary circuits are tuned to the wave length of some station both signals and static will again be received, as in Figs. 1 and 2. Also, when the switch is opened both signals and static will be eliminated, because the circuit is the same as Fig. 2, except that a large inductance, which has no effect upon the circuit, has been connected in shunt with Lp. It is now possible to see that if in the reception of code signals the inductance of Lq were reduced just as a dot or dash was transmitted, it would have the effect of short circuiting Lp, retuning circuits Lo, Co and Ls Cs to the wave length of the signal, and allowing the signal to enter the secondary circuit of the tuner. Then if at the completion of the dash the inductance of Lq were again increased it would prevent static from being received between the dashes and dots of a message.

What It Does

If an electrical device could be developed that would vary the inductance of Lq synchronously with the dots and dashes of the received signal and at the same time not reduce the value of the inductance Lq more than necessary it would be an anti-static device which would limit the intensity of static to that of the received signal. *This is exactly what is accomplished by the McCaa anti-static device.*

Before it is possible to understand how this control of the inductance Lq is obtained it is first necessary to understand the principle upon which a variometer operates. In Fig. 4 the two diagrams represent variometers and in each case the coils are represented by La and Lb. In Fig. 4 (A) the coils of the variometer are aiding each other and in Fig. 4 (B) the coils of the variometer are bucking each other. When the variometer is adjusted as in (A) the inductance of the variometer is greatly increased, and when adjusted as in (B) the inductance of the variometer is much less than the inductance of its two coils used separately. An automatic electrically operating variometer, with Lq of Fig. 3 as one of its coils, therefore, would solve the problem of decreasing the inductance value of Lq.

A McCaa Circuit

In Fig. 5 is the wiring diagram of a McCaa anti-static device of the driver type. It will be noticed that this circuit is that of Fig. 3 with a driver coupled to coil Lq. The way in which this circuit operates is as follows:

Switch Sw is first closed and the desired signal tuned in with Co and Cs. The switch is then opened and the coupling between Ls and Lo adjusted until both signal and static is balanced out of the receiver. The vacuum tube in the driver is then placed in operation and the tuning condenser of the driver (Cd) is adjusted until the driver is oscillating near the wave length of the desired station. The weak oscillations of the station to be received are passing through coil Lq, and as oscillations of nearly the same frequency are in coil Ld, which is coupled to coil Lq, the effect of a variometer adjusted as in Fig. 4 (B) is had at regular stated intervals. This reduces the inductance of Lq and has the effect of short-circuiting coil Lp, which in turn retunes circuit Lo Co to that of the desired station and allows the signal to pass through.

It is also a fact that when coils Lq and Ld are working together the inductance of Lq is just low enough to allow all of the signal to pass, and this does not allow the intensity of the static to rise above that of the signal.

Limitations of Driver

From the description just given it can be seen that anti-static devices employing the driver circuit are operative when it is desired to receive code or telegraph signals by the audible beat methods. In this reception of radio telephony, the received signal varies in intensity with the speech or music transmitted, and if static is to be reduced the inductance of coil Lq in Fig. 5 may be varied synchronously with the receiving signal, or varied by a driver at a rate above audible beats. By utilizing the received oscillations themselves to vary the inductance of coil Lq, a synchronous field may be set up in Ld. How this may be accomplished is shown in Figs. 6 and 7.

Fig. 6 is an anti-static device employing a repeater circuit. A glance at the diagram will show that it is essentially the same as the circuit given in Fig. 3, plus a tuned plate and grid vacuum tube circuit coupled between the grid and the antenna with a condenser, and coupled between the plate and coil Lq inductively. This circuit operates as follows:

With the switch sw closed, the primary and secondary circuits, Lo Co and Ls Cs are tuned to the wave length of the desired station. The switch Sw is then opened and the coupling between Lo and Ls adjusted until both signal and static have been balanced out of the circuit. The repeater tube may now be placed in action by lighting its filament and tuning both the plate and grid circuits to the wave length of the desired signal.

What happens is this: The antenna is free to oscillate on a wave length somewhat higher than that of the de-

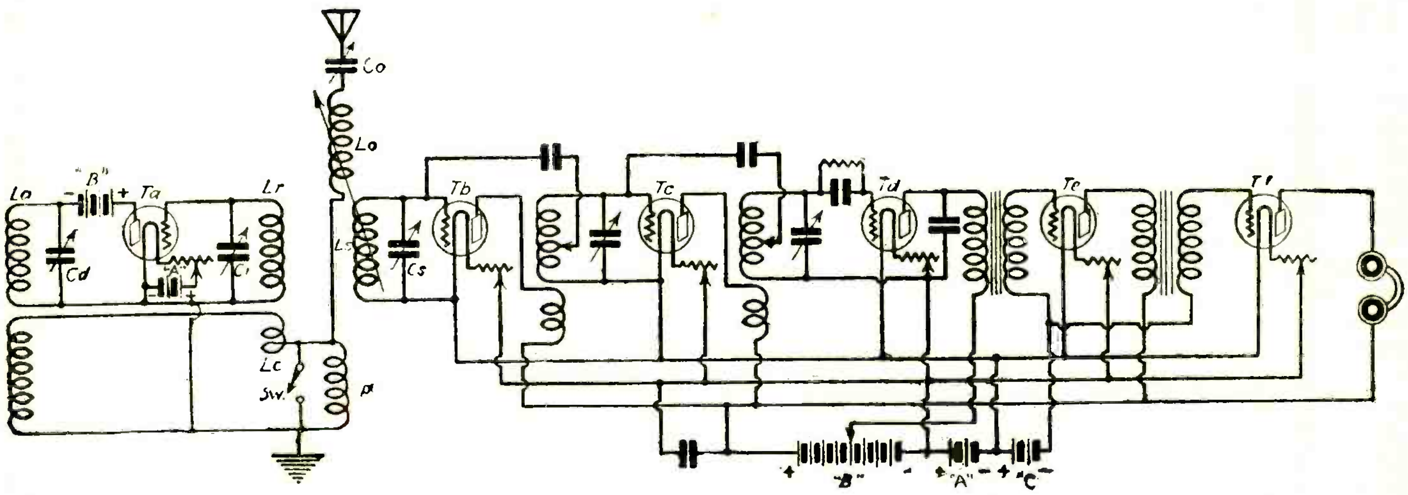


Fig. 8.—Arrangements of the static reducing device employing repeater circuits.

sired station, and as the circuit Lr, Cr, the grid circuit of the repeater tube, which is coupled to the antenna through the condenser Ca, is tuned to the wave length of the received signal, it will receive very little static, but will pick up the forced oscillations of the desired signal because it is tuned to the wave length of the signal. These oscillations will be amplified by the repeater tube and passed on to the plate circuit of that tube, Ld, Cd, where they are used to vary the inductance of coil Lq, which in turn has the effect of short-circuiting coil Lp. This allows the signal to enter the secondary circuit with very little static.

Another Repeater

Fig. 7 is another repeater circuit which performs similarly to the circuit shown in Fig. 6, but has several advantages over the latter. The chief difference between the two circuits is the way in which the antenna circuit is coupled to the grid circuit of the repeater tube. In the circuit now under discussion the small coupling coil, Lc, makes it possible to couple the two circuits inductively instead of through the capacity Ca used in Fig. 6. For reasons too lengthy to discuss here, this circuit is to be preferred over the circuit given in Fig. 6 for broadcast reception.

So far only the circuit diagrams of anti-static devices have been discussed and nothing has been said about their construction. There are, however, several other important things which must be considered and these will be taken up in the order of their importance.

Tubes to Use

1. The tubes to be used: The electrical characteristics of the vacuum tube used in the repeater circuit of these systems make it possible for them to operate as they do, and if the proper tube is not used, results will not be obtained. Because it is necessary that the weak oscillations be amplified in the repeater circuit, a vacuum tube with a high amplification constant is required. Of the available tubes, the Western Electric 216-A, the Radio Corporation UV201-A, and the Cunningham C301-A are the best; however, if a Meyers Hi-Mu tube is to be had it will give better results. Dry cell tubes, such as the UV199, WD11, and WD12, are not desirable.

2. Shielding: An anti-static device is of little value if the receiver is not shielded, for the coils and wires in the receiving set will pick up static direct without the use of an antenna. It is, therefore, necessary to shield completely the anti-static device, the receiver, the batteries, and all wires leading from the anti-static device to the receiver and from the storage and B batteries to the set. The importance of this can be better appreciated when it is known that an unprotected piece of wire, not more than six inches in length, is capable of picking up a great deal of static.

3. The ground: For these circuits to work properly a good ground connection must be had. A McCaa anti-static device will not function as it should if it is connected in the middle of the antenna.

4. Efficiency of apparatus: The amount of static eliminated by these devices is largely dependent upon the efficiency of the apparatus in the repeater circuit and in the secondary circuit of the receiver. All coils and condensers in these circuits must be of a low-loss design if results are to be had.

The Best Circuits

5. The receiving circuit: The anti-static devices which use a repeater circuit will operate when used with any non-regenerative receiver, but *will not* work well with a regenerative receiver or any other receiver in which regeneration takes place in the secondary circuit. This means that an anti-static device can be connected before any neutrodyne, super-heterodyne, crystal receiver, or radio-frequency set that is incapable of regenerating, but cannot be used with a regenerative set or radio-frequency receiver which regenerates.

6. Static coupling: The static coupling between coils Lo, Lp and Ls must be reduced to a minimum for best results. This is accomplished by the use of a good ground connection and by placing the coils at least one inch apart.

7. Batteries: The same batteries may be used for both the receiving tubes and the repeater tube. They do not, however, produce as satisfactory results as if separate batteries were used for the repeater tubes. Also the negative terminal of the repeater tube A battery should be connected with the ground.

Up to this point the writer has made no attempt to describe the construction of a receiver employing a McCaa anti-static device. The reason for this is that there is still room for much development work in the design of inductances and other parts of the circuit. From experience, however, the writer has learned that if data are withheld from an article hundreds of letters requesting more information will be received. To satisfy this demand for more data in advance the following brief description of a receiver utilizing an anti-static device is given.

Constructional Data

The wiring diagram in Fig. 8 is that of a standard five-tube neutrodyne receiver plus a McCaa anti-static device of the repeater type. In this diagram Ta is the repeater tube, Tb and Tc are the two radio-frequency amplifier tubes, Td is the detector tube and Te and Tf are the two audio-frequency amplifier tubes. The circuit from tube Tb on is unchanged and is the same as any standard neutrodyne receiver. The input circuit of tube Tb, however, and also the antenna circuit, have been altered to make possible the installation of the anti-static device.

For the neutroformer which usually couples the first tube of a neutrodyne to the antenna circuit, the coils Lo, Ls and Lp have been substituted. These coils may either be homemade coils or honeycomb coils. If honeycomb coils are selected each may have fifty turns. The coupling between Ls and Lp should be fixed so that the coils are about an inch apart and some arrangement should be made for changing the coupling between Lo and Ls. If homemade coils are used each coil should have approximately sixty turns of No. 22 d. c. c. wire on a three-inch diameter tube and they should be coupled the same as the honeycomb coils.

The coils Lr and Lc are also coupled and may be either 50 and 10 turn honeycomb coils, respectively, or 60 and 10 turn homemade coils wound on a three-inch diameter tube with No. 22 d. c. c. wire. The coupling between these coils is not variable. After the proper value of coupling has been found by experiment it may be made permanent.

Coils Ld and Lq are also shown coupled in the diagram. They may be 50 and 75 turn honeycomb coils, respectively, or 60 and 90 turn homemade coils wound on a three-inch diameter tube with No. 22 d. c. c. wire. The coupling between these coils is also fixed after the proper value has been determined by experiment.

The proper values for the various capacities used in this circuit are as follows: Co, .001 mfd. (43 plate); Cs, .000035 mfd. (17 plate); Cr., .00035 mfd. (17 plate); Cd, .00035 mfd. (17 plate).

In building this set it is advisable to place both the anti-static device and the receiver in the same cabinet. This cabinet must be shielded and the shield should be connected to the ground. It is also advisable to shield the anti-static device from the receiver proper. The batteries should also be shielded either by placing them inside the cabinet or in metal boxes which are connected to the ground. The wires from the batteries to the set may be effectively shielded by using BX cable, the outside covering of which should also be connected to the ground. For the phone wires special phone cords which are shielded with a flexible copper braid are desirable.

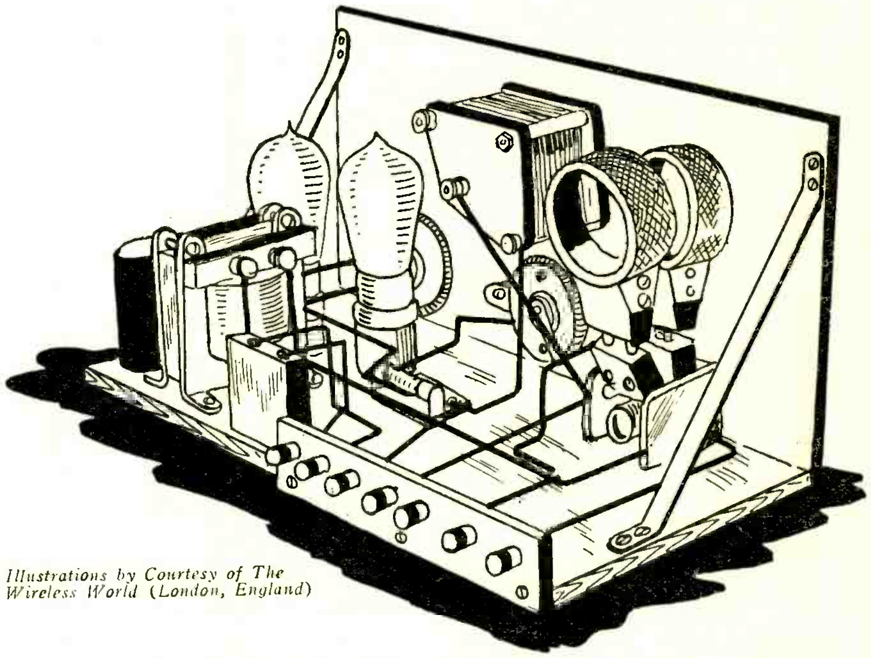
Before the set will work properly the builder will probably find that he has to do considerable experimental work with it. However, after it has been properly balanced it will perform as described and will be found very much worth while.

A Two-Tube Honey-Comb Coil Set

A Simple Receiver of British Design that Can Be Used for Amateur or Broadcast Reception

ONE hears so much nowadays about reflex and super-heterodyne that we are liable to forget the first love—the late lamented honey-comb coil type. While we in the United States have gone far into radical development in receivers, our English brothers have occupied themselves with improving the old reliable systems as well. An interesting comparison is raised by *Hugh S. Pocock* in *The Wireless World*, London, England, giving what appears to be a very efficient arrangement for two tubes and honey-comb coils. The complete article follows:

In spite of the multiplicity of designs for receivers and the almost inexhaustible variety of circuits which can be employed, there still remains a simple circuit which has not lost in popularity through the introduction of so many competitors. The combined detector and one stage audio frequency amplifier (Fig. 1) still maintains its popularity amongst amateurs throughout the world. Such a receiver is used by nearly all amateurs as a general standby set, and daily records of long distance reception are sufficient to indicate that its efficiency leaves little to be desired in the hands of a careful operator. It has, moreover, the advantage that it is comparatively simple to operate, and therefore searching for long distance stations can be done without much difficulty. When skill has been acquired on a receiver of this type it is surprising how little is missed of any signal capable of reaching the aerial. It would be out of place here to enter into the controversy which is still going on amongst amateurs as to whether a circuit of this type can rival super-heterodynes and other more elaborate receivers. No doubt the super-heterodyne can give much better results when properly designed and handled, but it is often much more a matter of skill in the operation of a receiver than the type of circuit used which accounts for the extraordinary achievements in long distance reception.



Illustrations by Courtesy of The Wireless World (London, England)

Fig. 1.—Rear view showing layout of parts on panel and baseboard.

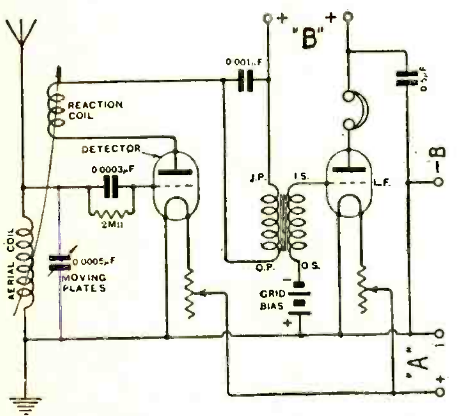


Fig. 2.—Schematic diagram of the circuit.

The purpose of describing the present receiver is to give a convenient and compact design for using honey-comb coils with a two-tube circuit so that the receiver may be a standby for the use of the general amateur, whilst it is also a convenient arrangement for use for broadcasting, and at reasonable ranges will give good loud speaker strength without resorting to pushing regeneration to the point of producing interference.

Controls of Panel

The controls for tuning as shown in the illustration of the front panel are two, one being the variable condenser across the aerial coil and the other the knob for adjusting regenerative coupling. The two filament resistances are the only other controls to manipulate. A feature of the arrangement is the employment of a type of coil-holder which is suitable for behind panel mounting, so that the plug-in coils can be accommodated behind the

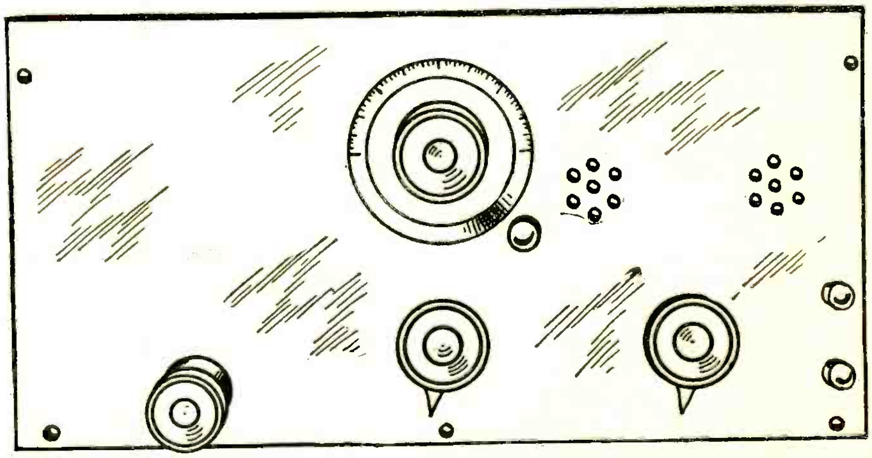


Fig. 3.—Panel layout showing arrangement of dials. Note simplicity of controls.

panel instead of being fitted, as is more usual, but rather clumsy in appearance, on the side of the box housing the set. This type of coil-holder gives a neat

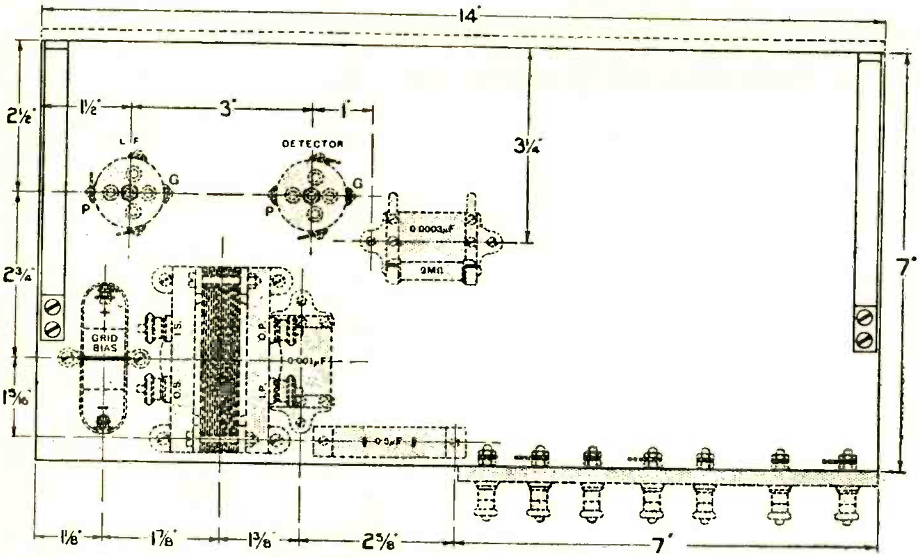


Fig. 4.—Top plan showing arrangement of parts on baseboard.

appearance to the finished receiver, whilst in addition it gives particularly easy adjustment with one control. The type of variable condenser used is one giving a vernier adjustment, but without the employment of an additional vernier condenser plate.

List of Parts Required

The list of parts required for the receiver is a small one, and the cost is also proportionately small. No expensive parts are made use of, and the wiring and general construction is of the simplest. The following parts will be required:

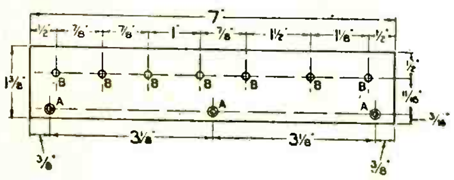


Fig. 5.—Layout for binding post mounting strip.

1 Bakelite panel, 7 x 14 ins., which is a standard size for Radion panels if the constructor desires to make use of one of these.
1 Variable condenser, 0.0005.
1 Two-coil holder for mounting behind the panel.
2 Sockets.
2 Filament rheostats.
1 A. F. transformer.
1 Grid condenser, with clips for grid leak, having values of 0.0003 MF. and 2 megohms respectively.
1 Fixed condenser of capacity 0.001 MF.
1 Fixed condenser having a capacity of 0.5 MF. for use across the terminals of the B battery.
1 Three-cell dry battery for providing negative bias to the grid of the second tube.
9 Terminals, two for mounting on the front of the panel for the telephones, and seven at the back of the panel on a strip of Bakelite, size 7 x 1⅜ ins., as shown in the illustration.
1 Wooden baseboard, size 7 x 14 ins., on which all parts, except those which are actually fitted to the front panel, are attached.

Three holes will be required for the standard rheostats. Both the variable condenser and the two-coil holder fitted to the panel may be of a type using one-hole mountings. The remaining holes to be drilled in the panel are those for the telephone terminals, for fixing the panel to the wooden baseboard (Fig. 1) by means of wood screws, and the screw holes for fixing the brass brackets, which support the panel. In addition, if desired, holes may be drilled through as shown to provide peep holes through which to see when the valves are lit if the set is housed in a box. The terminal strip (Fig. 5) is screwed to the back edge of the baseboard so that it will come flush with the outside of the box in which the receiver may be contained. Three terminals are provided for battery connections; one is the common negative, and the other two are provided in order that additional potential can be applied to the plate of the second tube. Although any type of tube would function satisfactorily in the A. F. stage, it is better if a tube of a type specially designed for amplifying stages is employed such as the UV201A or C301A.

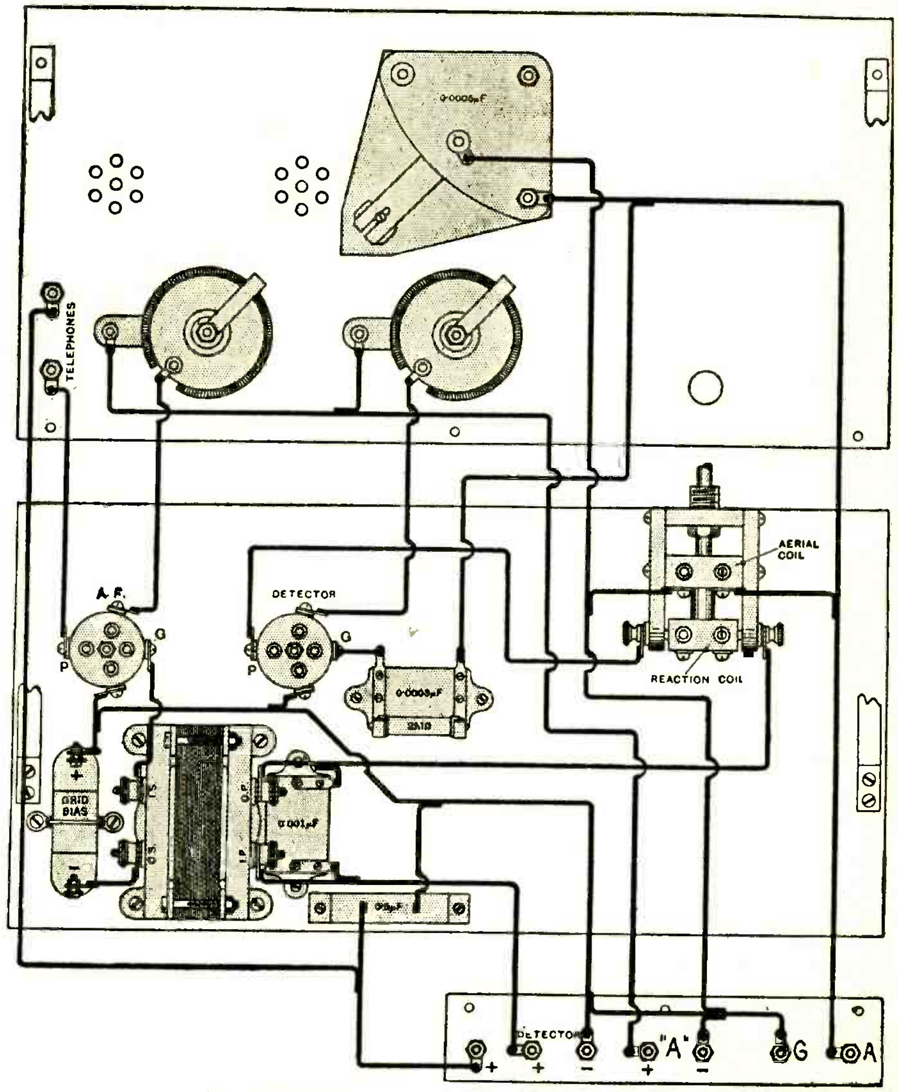


Fig. 6.—Complete perspective diagram of the receiver.

The three-cell dry battery provides a negative bias of 4½ volts, and the B may then be 100 volts. A fixed condenser of 0.001 MF. capacity is em-

(*Continued on page 77*)

Notes On Reflexing Receivers

The Observations of an Ardent Experimenter on the Subject of Reflexing

DIFFERENCE of opinion is the basis of all sports, and so it is in science — particularly radio. If there were no differences of opinion there could be little progress. It is always well to have both sides of a question. Therefore we should feel indebted to *A. L. Budlong* for his ex-

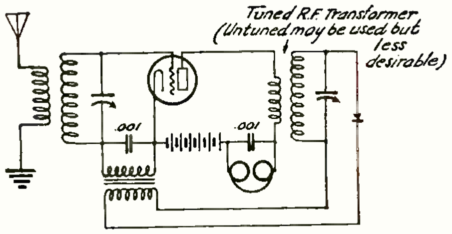


FIG. 1

cellent article on the subject of reflex receivers as given herewith from *QST* Magazine.

Writing about something you don't believe in is always poor policy, so it is with mingled feelings that the author takes up the subject of reflex receivers.

Reflexing started with the French during the war, and has since attained a high pinnacle in the ranks of broad-

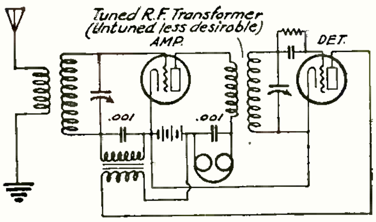


FIG. 2

cast receivers. Under certain conditions the scheme possesses considerable merit, but, like everything else, the principle has been very much overdone, and certain types of reflex receivers, in my humble opinion, do not possess the advantages claimed for them.

Since space is limited, we will list rather briefly some of the various reflex combinations commonly resorted to, and an opinion of their desirability.

The One-Tube Reflex

1. When employing a single tube as R.F. and A.F. amplifier, a crystal for detection, and a "fixed" R.F. transformer, we do not believe this receiver is particularly valuable for any use. Our experience has been that it is "the bunk" for DX, and for local work several sets of this kind gave no noticeably greater volume than a straight crystal detector and single audio stage.

2. When a tuned transformer is used, as shown in Fig. 1, the set gains much in DX ability. The results on extreme distance are not better—or even as good—as can be obtained with a straight regenerative detector. For fairly *strong* signals, however, *louder* reception is possible.

Multi-Tube Reflexes

1. First of all, we will consider the two-tube reflex using a single amplifier tube and tube detector instead of a crystal. (See Fig. 2.) Using an untuned transformer, the set performs fairly well—especially on some of the weaker signals that the crystal-detector set would not get. It is not strongly recommended with the untuned transformer, however.

2. Using a tuned R.F. transformer in this combination, the set is a mighty fine little receiver. Results can be very favorably compared to those obtained with a three-tube set employing one R.F. detector and one A.F.

3. Under this heading we will classify all reflex sets using two or more stages of radio frequency ampli-

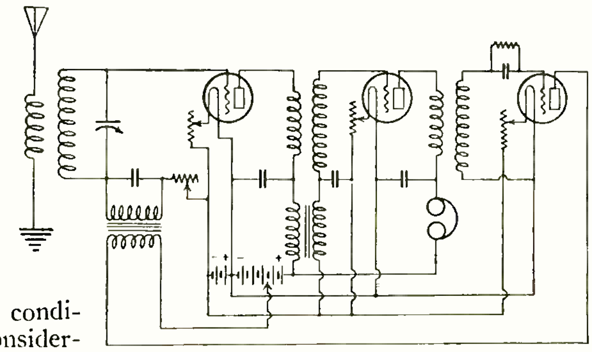


FIG. 2a THREE TUBE REFLEX

fication. They are, on the whole, very good performers, whether crystal or tube detector is used. Even with "fixed" R.F. transformers the results are worth-while, although obviously better results can be obtained with tuned air-core transformers. A typical receiver of this type is shown in Fig 2a.

Stabilizing Methods

The old reliable method of stabilization—i. e., prevention of oscillation in the R.F. stages—is by the use of a potentiometer across the "A" battery, as shown in Fig. 3. Sometimes this is used only on the first stage; at other times the grid returns of all the R.F. tubes are brought down to the potentiometer arm. The former method is better for fixed transformers; the latter for tuned transformers. The method is not recommended for two reasons. First, the positive potential necessary for stabilization plays havoc with the life of the "B" battery; second, the positive potential doesn't help the audio quality in the reflexed audio

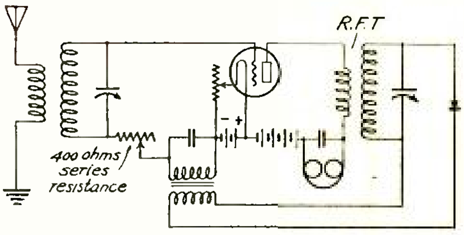


FIG. 4

stages. The series resistance shown in Fig. 4 is better. Our only objection to this is that it is critical to wavelength changes, and necessitates frequent adjustment.

Stabilization by reducing the number of turns in the primaries of the R.F. transformers is one of the easiest methods, but, in the opinion of the writer, one of the least desirable. Amplifica-

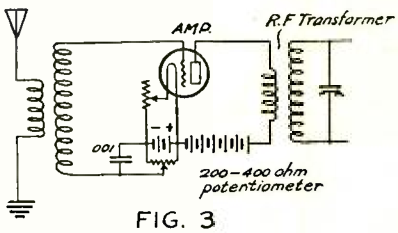


FIG. 3

Illustrations by Courtesy of QST (Hartford, Conn.)

tion falls off at the higher waves if the number of turns is kept low enough to prevent oscillation at the lower end of the scale.

Neutralization by the Hazeltine method has been tried and proves fairly successful in a single-stage reflex. Reflexing has been adapted to multi-stage neutrodynes, but we are inclined to the belief that they owe their "neutralization" more to small primaries in the R.F. transformers than to actual capacity neutralization. It is the opinion of Wheeler, and others, that reflexing a *real* neutrodyne would have bad effects on stabilization, probably resulting in an upsetting of the balance and a tendency to oscillate.

A variation of the neutrodyne reflex is the Harkness neutroflex. This is simply a reflex in which neutralization is obtained by the Rice system instead of the Hazeltine system. See Fig. 5.

Reflexing Standard Receivers

This article started with the intention of telling how to adapt reflexing to some of the more common types of receivers. All this other talk about reflex sets has been incidental. Now let's get down to business.

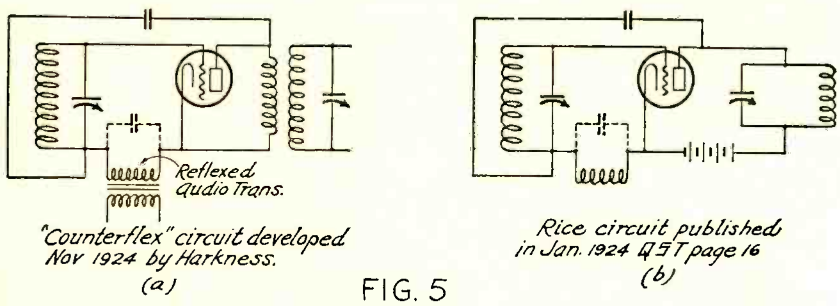


FIG. 5

The Reinartz Receiver

One of the most common types of receivers now in use is the Reinartz. This is shown in Fig. 6a. In Fig. 6b is shown how the first tube may be converted into an amplifier, a second tube added and used as a detector, and then the whole thing reflexed. Our Reinartz receiver isn't really a Reinartz any more, but it will work. For the 200-600 meter brand the R.F. transformer is made by winding 60 turns of No. 22 D.S.C. wire on a four-inch tube for the secondary, and winding 25 turns of the same size wire over the "low" end for the primary. Tuning of the secondary is effected by a .00025 mfd. variable condenser. The audio transformer may be any ratio. Use a high ratio for code work, where quality is not an essential. For phone work use a transformer of not more than 5:1 ratio.

Reverse the connections to the feed-back coil. Your feedback coil will have a stabilizing effect, and may entirely prevent oscillation if properly adjusted. If it won't effect complete neutralization, you can avoid oscillation by keeping the R.F. tuning condenser below the oscillation point.

The grid condenser in the first tube must be removed, or short-circuited, while it is desirable also to bring the grid-return of the first tube back to the "negative" of the "A" battery instead of to the "positive," it is not absolutely essential to do so.

Variometer Regenerator

We don't like this one so much, because it is hard to make it work with a tube detector. The thing has a beautiful tendency to howl. The only thing to do is to use a crystal detector. The changes are shown in Figs. 7a and 7b. As stated before, we don't think much of one-tube reflexes with crystal detectors, but that is about all you can do with the variometer receiver. Of course, you can try a tube detector if you want to, but we don't want to mislead you into thinking that all is going to be love and roses when it comes to making it work. Better stick to the crystal.

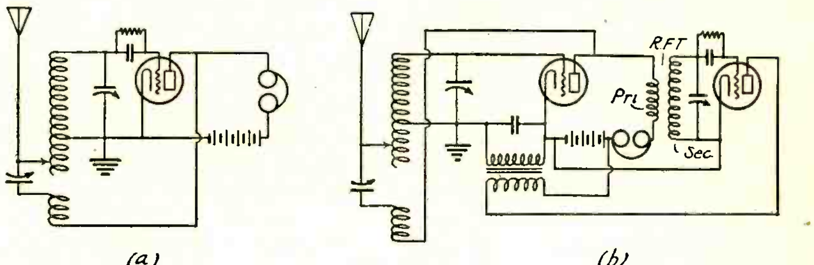


FIG. 6

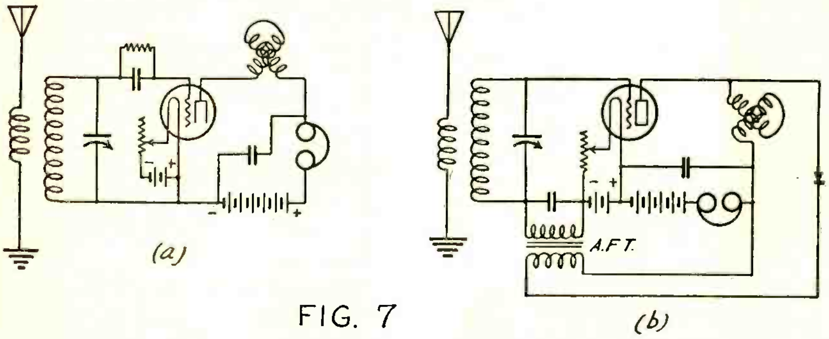


FIG. 7

A way in which a tube detector can be added fairly satisfactorily is shown in Fig. 8. The circuit has to be torn to pieces to do it, however. The variometer becomes the tuned secondary of a radio frequency transformer "T." The primary consists of 12 turns of wire in a 3½-inch circle. These turns are tied together, and then the whole winding is struck against the variometer as shown in Fig. 8b. This winding is "P" in Fig. 8a.

Tickler Regenerator

The tickler type of regenerator is not particularly difficult to adapt to reflexing. Probably the best way of doing this would be to use a tuned transformer in the plate circuit *in addition* to the tickler, as shown in Figs. 9a and 9b. "A" shows the original circuit, and "b" the reflex. The tickler is connected up as a "reverse" tickler, and is used, as in the Miner superdyne, for an oscillation control.

A Neutrodyned Reflex

We now come to the last circuit, probably one of the best—a neutrodyne reflex. Only one stage of R. F. amplification is used. In both this circuit and the tickler reflex previously mentioned the R. F. transformer is made up as follows: Primary, 25 turns of No. 22 D.S.C. wire wound over a secondary of 60 turns of the same size wire on a four-inch tube. The secondary is tuned with a .00025 mfd. variable condenser. The tap for the neutrodon connection in Fig. 10 is taken off the 30th turn of the secondary, the turns being counted from the "low," or filament, end of the coil.

With the large primary the neutrodon adjustment will be critical, but the results will be worth the trouble. Browning and Drake have shown by recent experiments that a large-primary transformer gives noticeably greater amplification than a transformer with a small primary.

How Much "B" Battery

Some day, manufacturers, and the dear radio public also, are going to wake up to the fact that high plate voltage on R.F. amplifiers is *the bunk*. High voltages give better results on the strong signals, but not on the weak ones, which are the ones you want to get. A superheterodyne recently tested out gave best results on *weak* signals when but 22½ volts were used on the plates of the R.F. tubes. Higher than 45 volts is not recommended under any circumstances.

But in a reflex set, we use the tubes both as R.F. and A.F. amplifiers, and A.F. amplifiers must have higher voltages to make noise. This, of course, means that the R.F. end of the argument is at a disadvantage, which is another reason why we are not in love with this reflex business. However, we will concede some additional volts to the reflex amplifier tubes, solely and simply for the sake of the audio end.

Go ahead and use as high as 67½ volts on the reflex amplifier tubes—darn it!

Reflexing on Short Waves

The writer does not take reflexing on short waves particularly seriously for the reason that reflexing involves R.F. amplification, and R.F. amplification on short waves is of doubtful value. Lately this particular phase of reception has received considerable impetus by the work of Magner, 6BCP, who worked two-way with Australia using the Roberts' reflex as adapted to short waves by Zeh Bouck. The Roberts' circuit is simply a neutrodyne one-stage R.F. amplifier, a regenerative detector, and a reflexed audio stage. Its principal value would seem to be that it results in a non-radiating receiver, and increased selectivity through the introduction of additional tuned circuits.

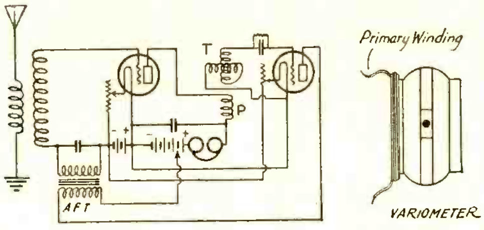


FIG. 8

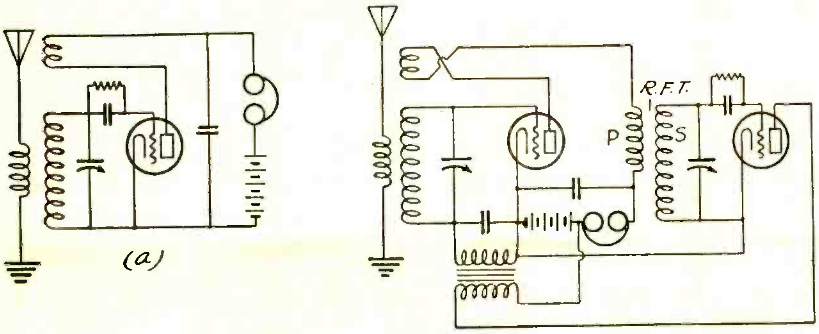


FIG. 9

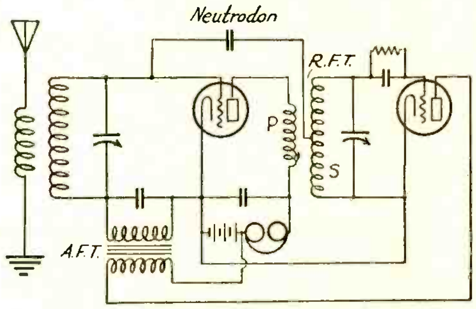


FIG. 10

Since reflexing involves complications, the advantages of the receiver could more easily be incorporated in a set employing a neutrodyne amplifier, regenerative detector, and straight audio amplifier. A set of this type has been built and operated by Don Wallace, 9ZT, and was described in the January, 1925, issue of *QST*.

While on the subject of R.F. amplification it might be mentioned that so far no short-wave receiver employing R.F. amplification (including superheterodyne) has demonstrated an ability to get greater *distance* than a s i n g l e oscillating-detector-and-one-stage-audio low loss tuner. Signals are brought in louder; we get more noise, perhaps—but the DX ability of the simple oscillating detector is yet to be improved upon.

To be sure, occasional impassioned articles are written on some new supersensitive low-wave R.F. amplifier set that has been developed, but it is significant that a few months later, in the majority of cases, the R.F. set is lying in the corner, and a low-loss regenerator is doing the work on the operating table.

Super-Heterodyne Circuits

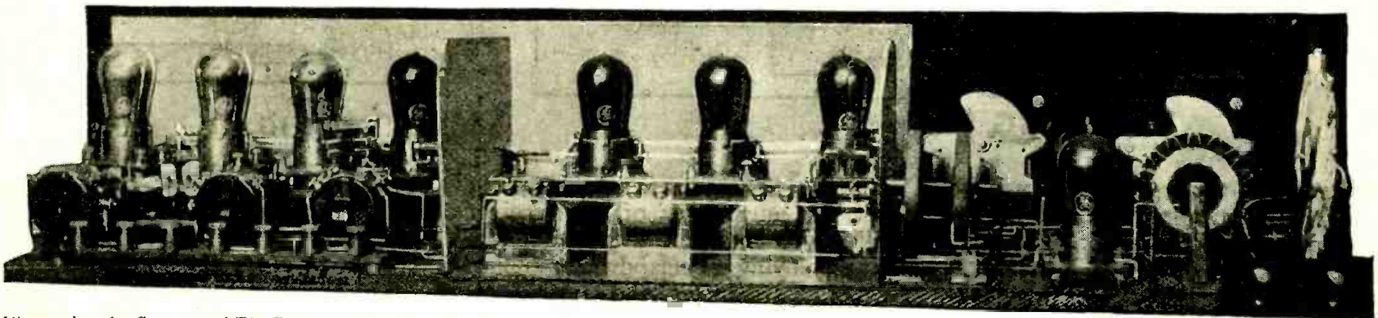
A Comparison and Brief Explanation of the Better-Known Types of Super-Heterodyne Receivers

THE experimenter who is thoroughly interested in radio should not fail to investigate the super-heterodyne method of reception. Actual tests have proved that the super-heterodyne is by far the most sensitive receiver in existence today. With a loop, aerial reception may be obtained from coast to coast of the United States. But with all this extreme sensitivity, reports indicate that only about 20 per cent of those who build this receiver attain what might be called normal reception. A little better understanding of the theory and operation of the super-heterodyne is necessary in order to produce maximum results. We are, therefore, showing five super-heterodyne circuits and will point out the main features of each so that the experimenter can try them out for himself and make his own investigations. Actual constructional data is not given. In trying out these circuits the experimenter should mount the apparatus on a board with plenty of room for connections and binding posts.

Writing in *The Experimenter, Clyde J. Fitch* presents some interesting points concerning various types of super-heterodyne receivers and gives the schematic diagrams for five of the more important arrangements. The author is peculiarly well-fitted to talk on the subject of super-heterodynes, having designed what is perhaps the simplest practical version of this receiver. It is gratifying to note that he gives his views from a purely technical and impartial standpoint, not giving way to the prevalent desire to advance one type while belittling the value of the others. After going over this brief article the reader may be better qualified to judge the merits of the particular type being used. The article continues as follows:

Standard Super-Heterodyne Circuit

Fig. 1 shows a standard super-heterodyne circuit. It is well to start with this circuit as a basis to work on and make all changes and improvements from it. In building this circuit it is well to use a loop aerial exclusively, as when properly constructed the set with a loop will give as good results as any other radio set will give with an outdoor aerial. By using a loop aerial, the comparative efficiency of the set is more easily observed.



Illustrations by Courtesy of The Experimenter (New York)

Rear view of a typical 9-tube super-heterodyne employing the standard circuit, Fig. 1, with push-pull audio amplification. Note the metal shields between the audio and intermediate amplifiers.

We will not go deeply into the theory of the super-heterodyne as this has been covered elsewhere. It suffices to say that this receiver is divided into four parts: namely, the frequency changer, the intermediate frequency amplifier, the detector, and the audio frequency amplifier. The frequency changer consists of an oscillator, tube 1, Fig. 1 and a detector, tube 2. The purpose of the oscillator is to heterodyne the radio currents received by the loop, thus setting up a beat note of a much lower frequency than either the signal frequency or the oscillator frequency. The beat note frequency is equal to the difference between the oscillator frequency and the signal frequency, indicating that the oscillator may be adjusted to a frequency above or below the signal frequency and consequently all stations will be received on two settings of the oscillator condenser dial.

The beat frequency or intermediate frequency may lie anywhere between the incoming radio frequency and the audio frequency at the output. In practice it usually is at a frequency having a wave-length between 1,000 meters and 10,000 meters (300,000 to 30,000 cycles). Excellent results are obtained at a frequency of 50,000 cycles (6,000 meters), and this frequency may be chosen as a basis to work on. The intermediate frequency amplifier consisting of tubes 3, 4 and 5 must be adjusted to amplify at this intermediate frequency of 50,000 cycles.

The intermediate frequency transformers are usually of the iron core type. In Fig. 1 we show the method used in the standard super-heterodyne. The first three transformers are designed to operate over a wide range of wave-lengths from about 2,000 to 10,000 meters. But as sharp tuning is required for this amplifier in order to obtain selectivity, some form of filter coupler is required that will by-pass currents of one frequency only. This consists of a transformer made up of two honeycomb coils, one of which is sharply tuned by a variable condenser. This coil is connected in the grid circuit of the detector, tube 6. Tubes 7 and 8 are audio frequency amplifiers and as the connections are standard, they need not be described here. Note that a variable resistance (R) is connected across the second transformer to control the volume and prevent or reduce circuit noises. A .006 mfd. condenser is absolutely necessary across the primary of the first audio transformer to by-pass the powerful intermediate frequency currents. Low ratio transformers of about 3 to 1 give best results in both audio stages.

The data for building this set is as follows: The loop aerial should be of standard design for broadcast reception. It may be tapped if desired for use for amateur or short wave reception. It is shunted by a .0005 mfd. variable condenser. The oscillator coils may be wound on a three-inch tube, spaced one-half inch from another. For broadcast reception coil L-1 should have 55 turns when shunted by a .0005

Five of the Latest Super-Heterodynes

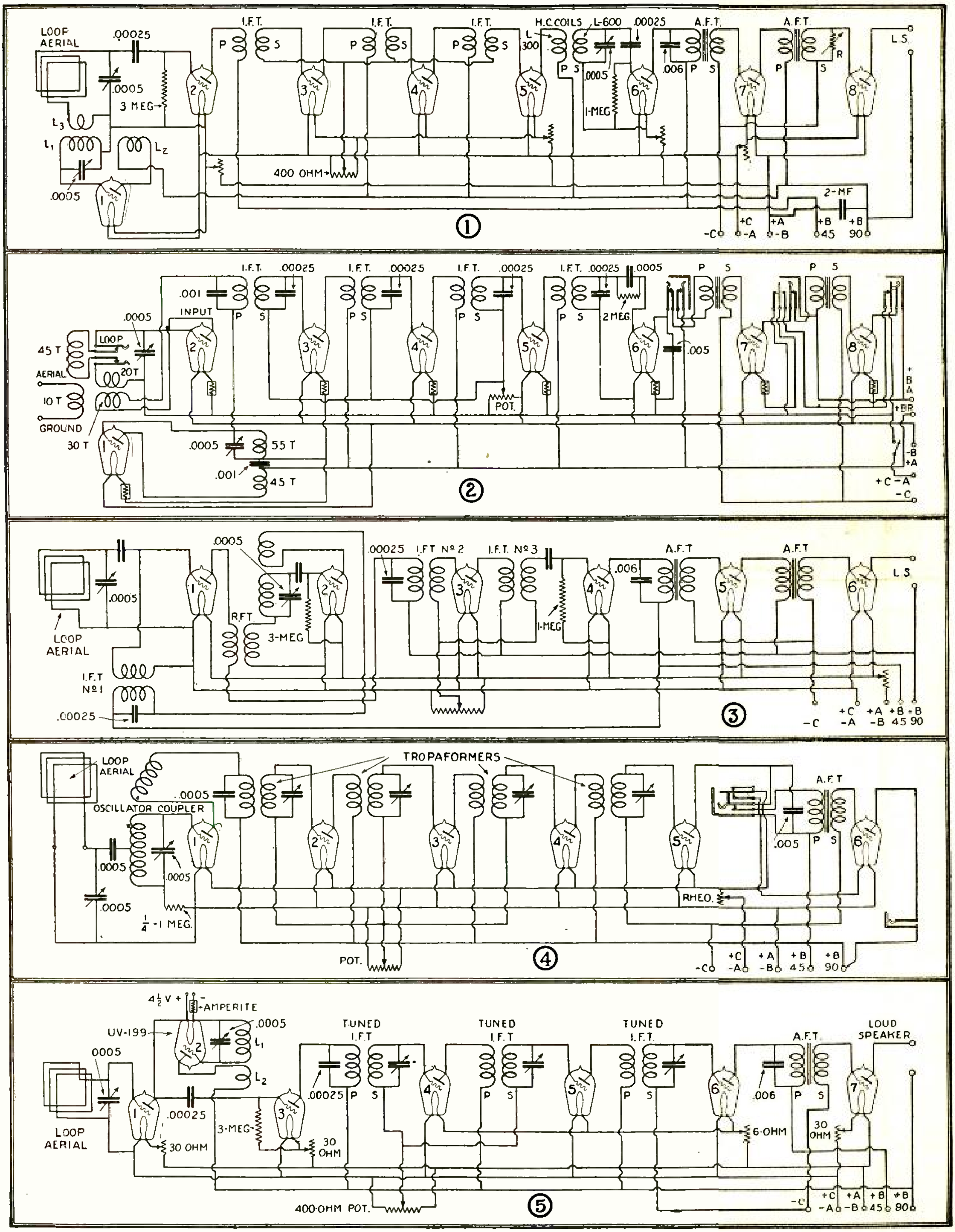


Fig. 1.—The standard 8-tube super-heterodyne using transformer coupled amplifiers. Fig. 2.—The L-2 Ultradyne using the modulation system and regeneration. Fig. 3.—The 6-tube second harmonic super-heterodyne. Fig. 4.—The 6-tube Tropadyne using tuned intermediate transformers. Fig. 5.—A special 7-tube super-heterodyne.

mfd. condenser. For amateur reception it may have 20 turns. Coil L-2 should have 30 turns for broadcast reception and for amateur reception 10 turns wound in the same direction as coil L-1. Coil L-3 is the pickup coil and consists of about 6 turns. No. 22 DCC wire may be used for all these coils.

The intermediate transformers may be obtained from any reliable radio dealer. There are many types on the market. The filter coupler as shown consists of a 300-turn honeycomb coil and a 600-turn honeycomb coil shunted by a .0005 variable condenser. The constants of the other parts are indicated in the drawing.

Model L-2 Ultradyne

As an improvement over the standard super-heterodyne we are showing in Fig. 2 the circuit diagram of the popular eight-tube Ultradyne receiver. This receiver is of simplified construction in that it employs Amperites for the filament current control instead of the usual filament rheostats. There are eight tubes. The oscillator, tube 1, may be constructed according to the instructions given in connection with Fig. 1. The circuit shows two coils of 55 turns and 45 turns, the 55 turn coil being shunted by a .0005 mfd. condenser. The other constants of the circuits are given. Note the 20-turn and 30-turn coils in the modulator, tube 2, for regeneration. Any small variocoupler may be used for this.

In trying these circuits it may be well for the experimenter to build an intermediate amplifier, detector, and audio amplifier in one unit so that the unit may be used for all experiments.

Second Harmonic Super-Heterodyne

Another improvement on the standdard super-heterodyne is depicted in Fig. 3 which shows the circuit diagram of the six-tube super-heterodyne sold by the Radio Corporation of America. Due to lack of information on this receiver we cannot give constructional data for building the set. The action may be described with reference to the diagram and will show experimenters the steps taken by radio engineers for improving the super.

Tube 1 is used as a short wave radio frequency amplifier. It is connected to the loop aerial and the tuning condenser. In the plate circuit of this tube we have a fixed radio frequency transformer designed to cover the entire broadcast range from 200 to 600 meters. This transformer no doubt is of the iron core type and has a secondary winding of only a few turns. The secondary is connected to the grid circuit of the oscillator, tube 2. The oscillator coils and condensers are proportioned so as to give a frequency of half the signal frequency, so that the second harmonic of the oscillator frequency heterodynes the signal frequency. In other words, the oscillator should be designed to cover a wavelength range of 400 to 1,200 meters. The grid condenser and leak shown in this circuit may not be used.

The plate circuit of the oscillator tube feeds into the intermediate frequency transformer No. 1 which is reflexed back into the first tube as shown. The secondary is connected in parallel with the loop. Therefore, tube 1 amplifies both signal frequency and intermediate frequency. Intermediate frequency transformer No. 2 is connected in the plate circuit of tube 1 and feeds into tube 3. The remaining part of the circuit is standard. The complete circuit gives the equivalent of one stage of short wave R.F. amplification, detector, oscillator, two stages of intermediate amplification, detector, and two stages of audio amplification.

The Tropadyne Receiver

Another simple six-tube super-heterodyne circuit is shown in Fig. 4. In this circuit the first detector and oscillator are combined in the one tube by connecting the loop circuit between the filament and nodal point or center tap of the oscillator circuit. This eliminates one tube from the standard, and by using special tuned intermediate transformers, the volume is increased to such a point that only one stage of audio amplification is required, with the result that six tubes do the work of eight.

The oscillator coupler may be any vario-coupler now on the market, and connections are made to the center turn of the secondary coil as shown. Fifty-five turns on a three-inch tube shunted by a .0005 mfd. condenser are suitable for broadcast reception. The constants of the circuit are given and need not be mentioned again. The only critical part of the whole circuit is the grid leak which preferably should be adjustable.

Special Super-Heterodyne

A new super-heterodyne circuit which has never before appeared in print is shown in Fig. 5. This circuit is given merely for experimenters to investigate as to the best of the writer's knowledge it has never been hooked up.

We are all familiar with resistance coupled amplifiers, using a vacuum tube as the coupling resistance. In this circuit we use a UV-199 tube for this purpose and light its filament by a separate small flashlight battery. This is tube 2 in the diagram. An Amperite is recommended in the filament circuit. In addition to acting as a coupling resistance in a short wave radio frequency amplifier, we connect our oscillator coil to this tube and make it act as an oscillator also. Thus in tube 1 we have a short wave amplifier using tube 2 as a coupling resistance, which also is an oscillator and heterodynes the received currents. Both oscillator frequency, signal frequency, and the difference between the two or beat frequency are impressed on the grid of the detector, tube 3, which detects the intermediate frequency. This, of course, is amplified by tubes 4 and 5, and the audio currents are detected by tube 6 and amplified by tube 7. In both this circuit and the Tropadyne circuit, Fig. 4, no grid condenser and grid leak is used for the second detector. Far better results are obtained as regards quality and volume when using a "C" battery for the second detector, instead of the grid condenser and grid leak.

A Baby Super with Filter Coils

(*Continued from page 62*)

portant part in the tuning of the set, as a slight adjustment will tune out a station completely. The radio frequency rheostat should also be carefully adjusted, but it does not require the same attention that the detector commands.

If you have purchased good parts and have wired this circuit with care you will find yourself well paid for your trouble. You should be able to receive any station within range of the set with the same quality of reception as received from the local stations.

In the following is given a list of the parts necessary for the construction of this set.

1 .00025 Variable Condenser.
1 .0005 Variable Condenser.
1 Single Panel Mount Socket.
1 Triple Panel Mount Socket.
1 48,000 Ohm Resistance.
1 .002 Fixed Condenser.
1 .00025 Fixed Grid Condenser.
1 3 Megohm Grid Leak.
1 Single Jack.
1 Double Jack.
1 6 Ohm Rheostat.
1 30 Ohm Rheostat.
1 Filament Switch.
2 Audio Transformers "Standard Make."
1 Set Binding Posts.
1 Set Journal Filter Coils.
1 18-inch Panel (either hard rubber or bakelite).
1 16-inch Baseboard.

Necessary bus wire, screws, nuts, etc.

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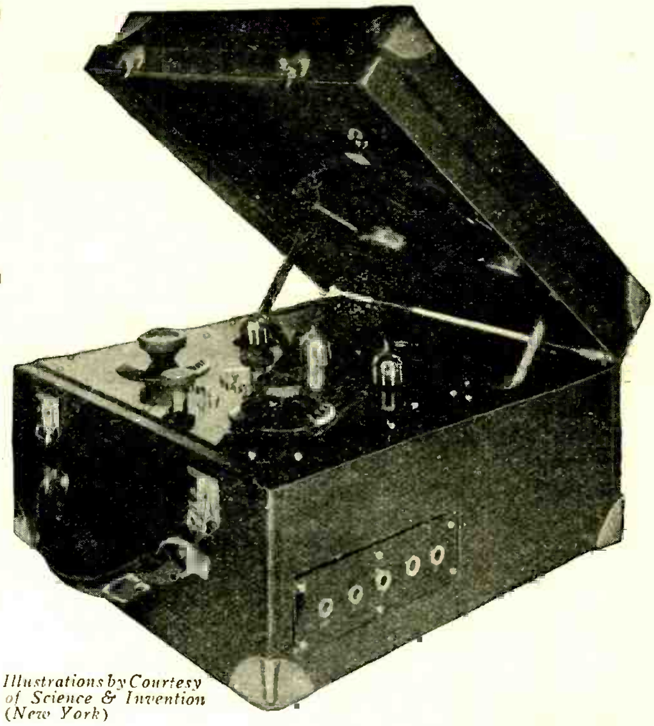
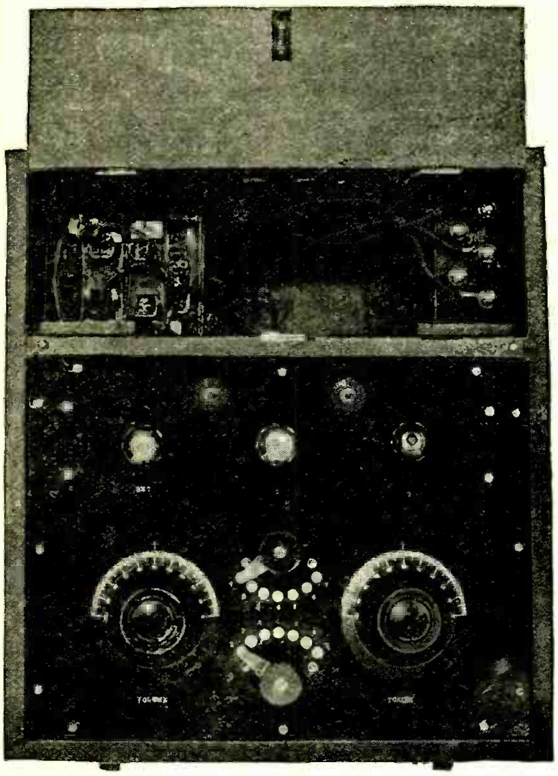
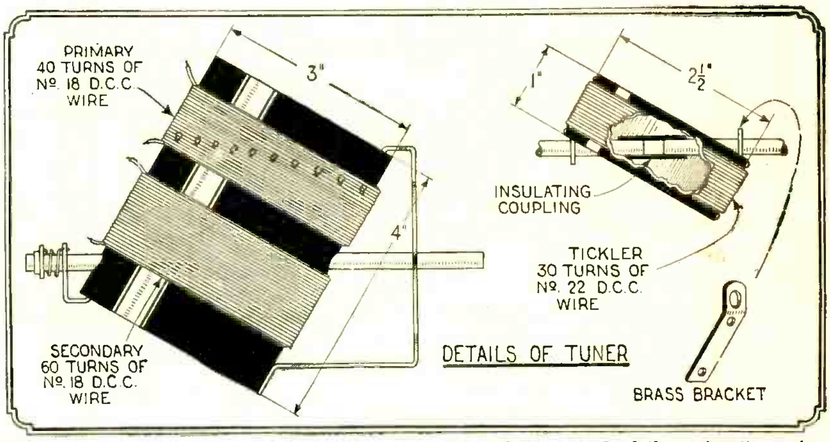


This portable set employs the standard regenerative circuit, and contains all the necessary batteries within a compact carrying case.

Illustrations by Courtesy of Science & Invention (New York)



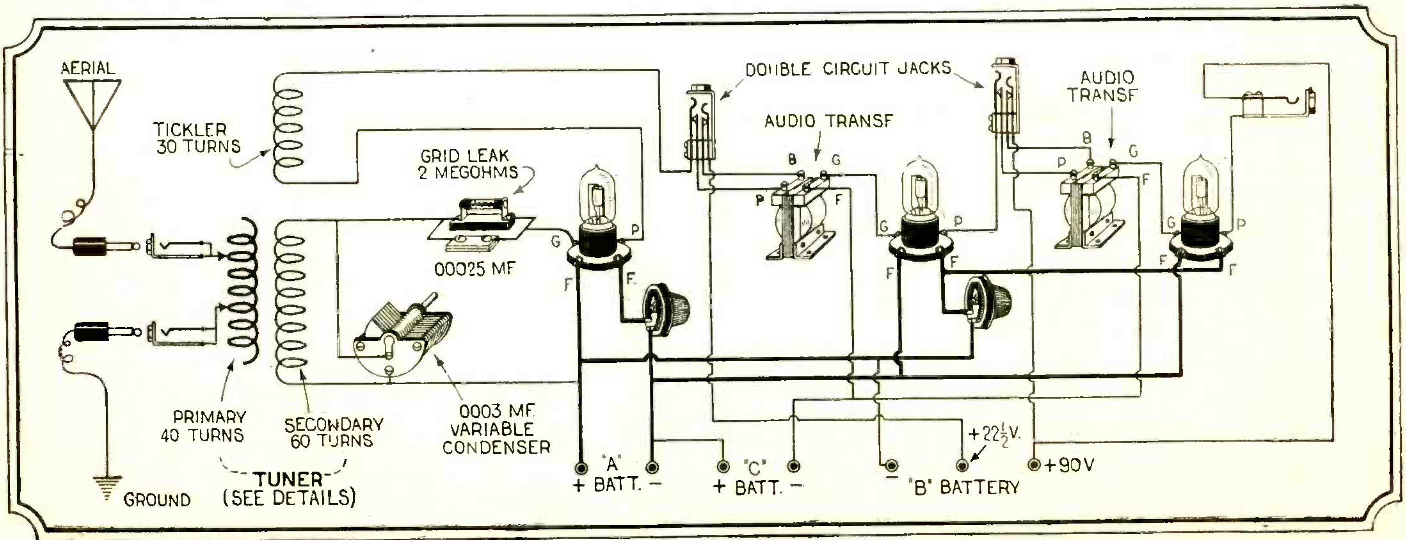
UV-199 tubes are used and operate splendidly. Note separate battery compartment.



Bank winding is employed for the coils of the tuner, although any standard three-circuit coupler can be used.

WITH the approach of summer and the inevitable vacation which accompanies it, many of us would, literally, be "tickled silly" to have a real portable light-weight receiver to take along. If you begin the construction of the set now you will have no reason to fear that it will not be ready when your vacation comes around. Not only is it simple to construct but it fulfills all the requirements which make it worth the building. It is entirely self contained, simple in operation, sensitive and selective, rugged and attractive. Its extreme light weight makes it all the more appealing.

With this brief but convincing message, *Lynn Mathews*, writing in *Science & Invention*, New York, graciously steps aside in his description of a vacation receiver and allows the illustrations and perspective diagrams to present their own story.



Five jacks, one each for the aerial and ground, detector and first and second stages of amplification afford very handy connection terminals. The antenna is a coil of bell wire 125 feet long which, when not in use, is placed in the battery box. Two 20-ohm rheostats are used to control the filament circuits. Two 3-cell flashlight batteries in parallel will last indefinitely for the filament supply. The set will operate a loud speaker on locals.

A Simple One-Tube Receiver

A Circuit Developed During the World War Proves Excellent for Broadcasting

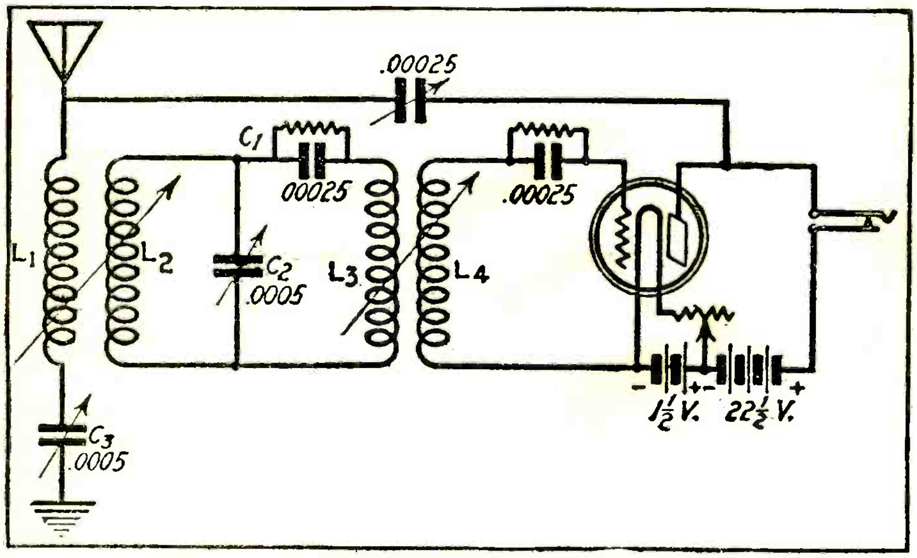
THERE has as yet survived the rush of neutrodynes and super-heterodynes the man who likes to fool around with a single tube receiver, and not quite so much attention has been paid to him lately as to the man who can afford a seven or ten tube set. People claim that the "one-tube bug" is dying, but such is not the case. A man must crawl before he can walk, and in radio he must play around with single or two tube sets before he gets enough courage to get a set of parts for a fine eight or nine tube set.

However, whether a single circuit, double circuit or triple circuit receiver is used, the complaint of the one-tube set users is that they cannot construct a receiver capable of being used with fair success and no interference.

The circuit described herewith by *Robert L. Dougherty* appeared in a recent issue of *The New York Herald-Tribune*. It is said that this circuit, while not guaranteed to receive all sorts of DX stations will at least allow the user to hear one station at a time.

The circuit, which is a compound loosely coupled circuit, was used during the war on the English ships when communication on extremely short waves was necessary. It combines several features not usually found in the ordinary circuit, namely, because of the very pertinent fact that information on it has been sadly lacking. An examination of the circuit shown herewith will show the reader that this circuit is seemingly a double-tuned loosely coupled receiver, This is true, but there are several incidental features of the set which make it of great value to those who desire a simply operated receiver with a minimum of first expense and a minimum of upkeep expense.

The apparatus necessary for the construction of this receiver is not expensive and should not stand the builder any more than $25 complete, using the very best parts obtainable. Further than that, amplification may be added to it to make possible the use of a loud speaker, if such is desired. In such a case, the regulation two-stage amplifier is simply hooked on to the outlet posts of the detector. The apparatus necessary for the construction of the set as depicted is as follows: Two loose-coupled tuners (variocouplers of the standard make, with 90 degrees rotation of the rotor, may be used, or two sets of honeycomb coils may be used), one socket; one WD11, C12, UV199 or C299; one good vernier rheostat, one grid leak and condenser, two good low loss .0005 mfd. condensers, one good .00025 mfd. vernier variable, one small switch, one .00025 mfd. fixed condenser.



Illustrations by Courtesy of N. Y. Herald-Tribune.

Fig. 1—Schematic diagram of the circuit.

As shown, the receiver consists of really three circuits—the antenna circuit, coupled to the intermediate tuning circuit, which in turn is closely coupled by means of the second coupler to the detector circuit. Regeneration is secured by placing a condenser in the plate circuit, which is coupled to the antenna of the set. This is not a very well known method of obtaining regenerative effects, but is nevertheless very trustworthy and operates with a minimum of distortion and radiation.

One thing that will be of interest to the fan who is contemplating this receiver is the fact that if the set is correctly operated and constructed it is possible to log it fairly accurately, although no log as of a neutrodyne should be expected. There is, however, a certain faithfulness of action ensuing from its correct operation that will give what might be termed a log.

In order to build this receiver purchase the materials mentioned in the bill of materials and lay them out "bread-board style" on the table. This is necessary in order to determine the correct distance that L1-L2 should be from L3-L4, as there should exist a certain amount of coupling between the two, and this distance varies with the type of coupler used. The writer used two Manhattan couplers, with spiderweb-wound 180-degree rotors, and the coupling value for this style of unit was 5 inches between centers, or a total of 2½ inches between sides.

When the correct distance for this coupling is found, it will manifest itself in the following manner: A station can be tuned in on L1-L2, and with the condenser C1 thrown out of the circuit the circuit will not respond to any station on that wave length. Then, when the switch is thrown and the condenser short-circuited the station will again be heard. If too close coupling or no coupling at all is present between the two coils it will be found that signals will be weak in the first place, and, in the second, interference will manifest itself even though the secondary of the first coil is short-circuited.

The manner of tuning this receiver, once it is completed is entirely different from that of any other receiver using magnetic coupling or capacitances to produce resonant circuits. There is a certain set way of getting results out of it, and there is practically just one way of operating the set at all. The tube is first inserted in the socket and the filament turned on. Then the antenna coupling condenser, connecting the antenna to the plate of the tube, is next turned to maximum position. The coupling of the two tuners is placed somewhere between three quarters and maximum, and the two condensers are then rotated almost in step with one another. A signal will be heard when the two circuits are in resonance with one another, and in all likelihood the tuning will be rather broad on the first of the condensers.

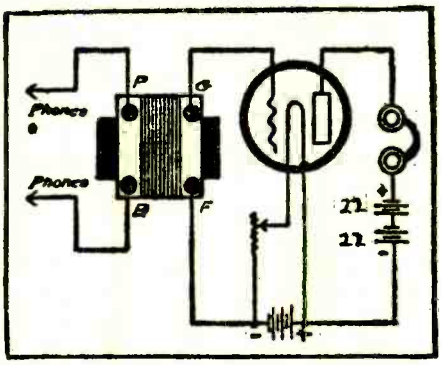


Fig. 2—A one-step amplifier for use with this circuit.

Set this condenser for maximum signal strength and loosen the coupling between the antenna and secondary of the first coil; at the same time adjust the condenser tuning this circuit until maximum strength is noted, with least interference. The regenerative condenser is next adjusted until the tube is just on the "spill" point but not in violent oscillation. The final adjustment of the entire circuit is the coupling of the detector tube circuit. This should be done very carefully, because the tuning in this circuit is extremely sharp; and, once the correct position is found for a given station, leave it alone, as otherwise the tube will again break into oscillation and start in to squeal and howl.

Just what may be expected of this circuit is a question. The identical one above was hooked up temporarily on an old panel to demonstrate the idea, and no trouble was experienced in bringing in stations in Philadelphia, Schenectady, Round Hill, Mass., or any other not too distant station. The history of the circuit is that it is the old Marconi multiple-tuned antenna circuit tuner, but, while such may be the case, the first record of its being used in actual practice was, as before stated, on board the British battleships during the early part of the World War, when lots of work was being done on short waves of 50 to 100 meters. In case the amateur who is building one of these desires it to work on that band, it is advised that a double circuit tuner, built specially for that work, be made or purchased. It is doubtful, however, if the manner of obtaining regeneration would work on that wave, so in that case a 25 or 35 turn honeycomb, shunted by the .00025 mfd. variable condenser, could be used

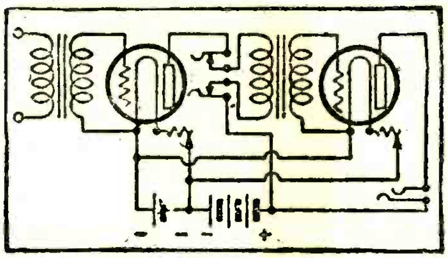


Fig. 3—A two-step amplifier for use with the circuit described.

in the place of the antenna feedback. This coil and condenser are placed in the plate lead of the tube and regeneration obtained in that fashion.

A Two-Tube Honey-Comb Coil Set

(*Continued from page* 68)

ployed across the primary of the audio frequency transformer.

After the parts have all been placed and fixed, the wiring can be proceeded with, and for this Fig. 6 should be carefully followed. The wiring should be done with bare No. 14 tinned copper, suitable lengths being stretched to straighten them before the bends are made, and the wires can then be fitted to their respective connections. It is always convenient to use terminal lugs wherever possible, and to solder the wires to these. This simplifies the soldering, and gives a much neater appearance than is obtained by soldering the wires direct to the terminals. In addition, if at any time it is desired to disassemble the receiver, this can be done without finding that terminals and other pieces of apparatus are spoiled by the adhesion of solder. It will be seen that no switch has been provided to enable the variable condenser to be placed in parallel or series with the aerial coil, and in this receiver the variable condenser is permanently in parallel. This has been done partly for the sake of simplicity and partly because, when one considers that in changing over from the parallel to series position, or *vice versa,* a gap will occur in the wave-length range if the same coils are left in, there is not much to be gained by arranging to switch from the parallel to series position unless compensating fixed condensers are to be provided. It is always possible to interchange the coils so as to cover additional wave lengths as required.

It is preferable to fit a 0.001 MF. condenser across the terminals of the telephones, but this is not absolutely necessary, and has not been shown in the set.

This receiver is primarily intended for reception on the broadcast wavelengths and upwards by the employment of different coils, but those who desire to receive on the short wavelengths can do so also by a slight addition to the arrangement shown. This will be described here in case the constructor may care to adopt the method.

A flat coil wound on a card should be obtained, having, say, 15 turns of insulated wire of a gauge not less than No. 22. One end of the coil is connected to the aerial, instead of connecting the aerial to the terminal provided on the set, and the other end of the flat coil is connected to the common ground terminal. The coil can be coupled to the tuned coil of the receiver by slipping it between the panel and the honey-comb coil of the receiver.

By varying its position the amount of coupling can also be varied, and it will be found that using short wave coils of honey-comb type, it is easy to tune down to very short wave-lengths.

Before concluding, it is desired to point out that the circuit is one which will energize the aerial and cause interference easily if the reaction coil is brought near to the aerial coil. Care should be taken to see that when receiving broadcasting, the reaction coil should be far away from the aerial coil and this precaution will also result in clearer reception of the transmissions.

No particulars are included of the construction of a cabinet to house the set. In preparing such a box the principal point which should be borne in mind is that the top should be hinged to provide access to the tubes and for the purpose of changing coils.

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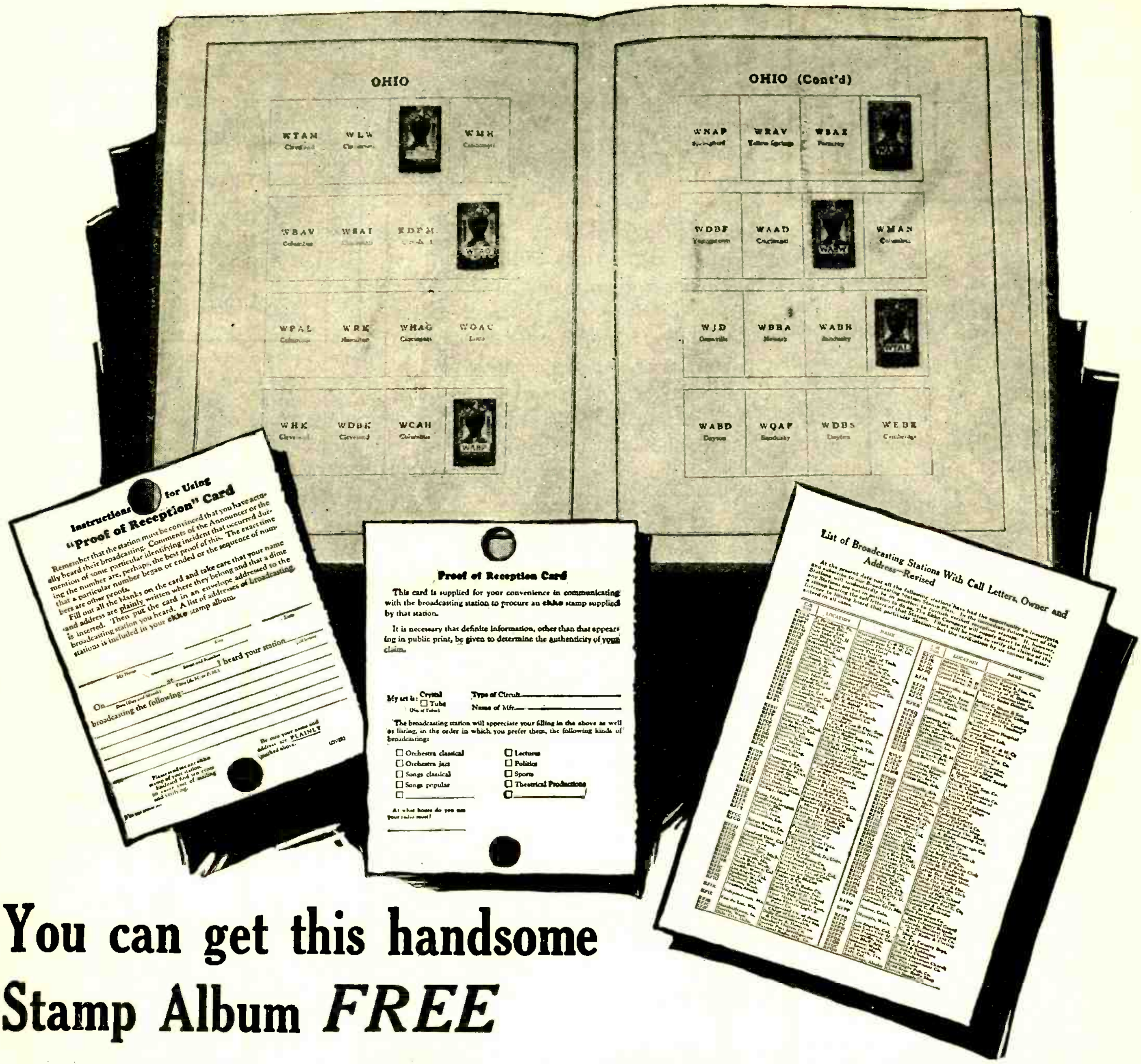

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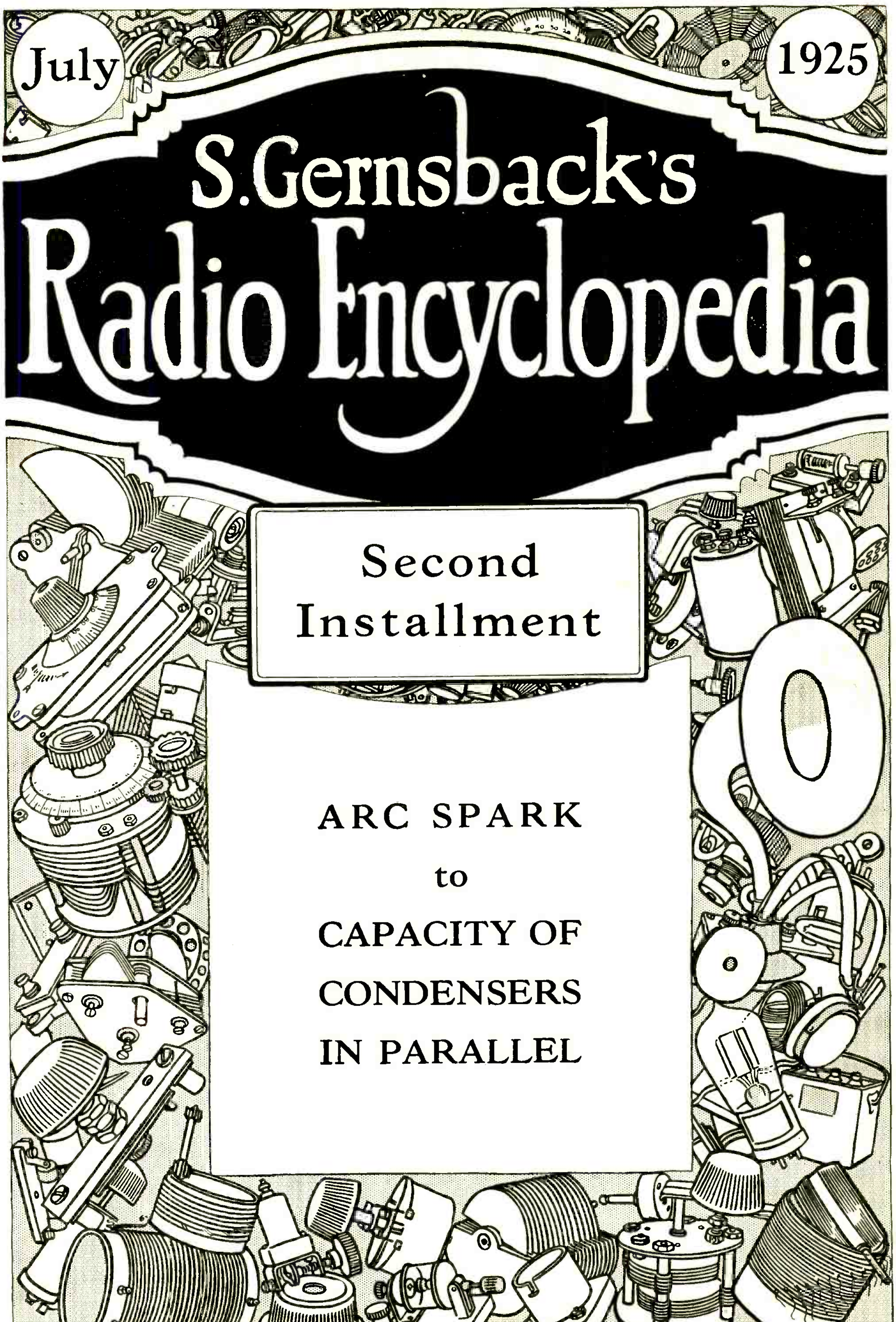


July 1925

S. Gernsback's Radio Encyclopedia

Second Installment

ARC SPARK

to

CAPACITY OF CONDENSERS IN PARALLEL

Printed in the United States of America

ARC SPARK—A spark in which there is a slight arcing due to some current from the transformer leaking across a gap which is too small. Such a spark gives very poor production of *active sparks*. Is generally due to insufficient *capacity* in the circuit and arises from *volatilization* of the metallic electrodes forming the spark gap.

ARC TRANSMITTER—See *Arc Generator*.

ARCO, Graf George Von—Born at Grassgorschutz, Schlesien, Germany, he was educated at Berlin University and the Technical High School, Charlottenburg.

Graf George Von Arco.

Assistant to Professor Slaby, 1898, he was part inventor of the Slaby-Arco system of wireless telegraphy. He was appointed manager of the Gesellschaft fur Drahtlose Telegraphie, 1903, and first carried out a practical radio telephony demonstration over a distance of twenty-one miles in 1906. At the International Radiotelegraph Congress held at London in 1912 he exhibited a *high-frequency alternator* with static frequency step-up transformers, as now used in the high-power station of Nauen, Germany. Arco has written a large number of papers on radio, including quenched spark signalling, high-frequency alternators, the Telefunken singing spark system, long distance radio transmission, as well as being the author of a considerable number of patents, including a vacuum tube receiver circuit for high-frequency amplification patented in collaboration with Meissner in 1914.

ARGON—Chemical Symbol A. Atomic weight 39.9. A gaseous element, a component of the atmosphere.

Pure Argon Gas is used commercially in certain types of transmitting tubes to prolong the life of the filament. Disintegration of a filament is often rapid under stress of the heavy currents used for transmission. This tendency to deteriorate is lessened by the use within the tube of pure Argon Gas.

ARMATURE—The part of a *dynamo* machine in which the *electromotive force* is created due to *electromagnetic induction*. The term is also used to denote the piece of soft iron placed across the poles of a *horseshoe magnet* to prevent loss of magnetism.

In electrical machines it is commonly used to refer to the moving part (revolving armature type—see *Alternator*), and may be divided into two broad classes as: revolving or stationary. With regard to the core construction they are broadly classified as (a) Ring,

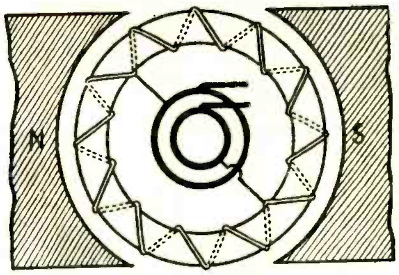


Fig. 1. Ring Type Armature.

(b) Disc and (c) Drum. Fig. 1 shows the arrangement of an armature of the Ring type; the Disc type is illustrated

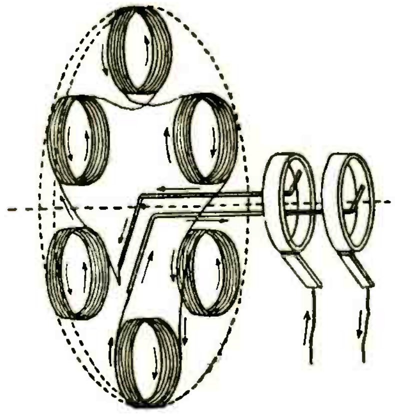


Fig. 2. Disc Type Armature.

in Fig. 2, and Fig. 3 shows the Drum type which is almost universally used; Fig. 4 shows a complete armature ready for assembly in a modern alternator.

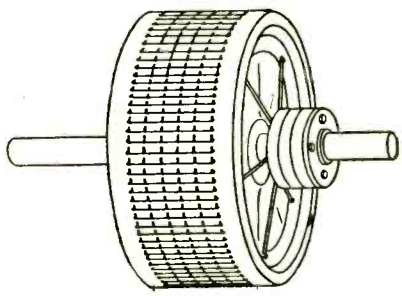


Fig. 3. Drum Type Armature.

X—The drum armature is almost exclusively used in modern generating machines. The ring type has the inherent disadvantage in that the copper inside the ring is magnetically inactive.

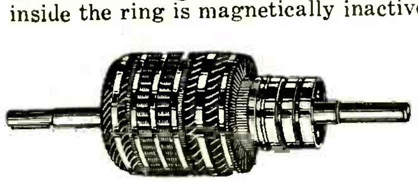


Fig. 4. A Complete Armature

The Disk type was an electrical improvement on the original Gramme Ring form, but they were impractical due to mechanical difficulties.

ARMATURE OF A DYNAMO—The part of a generator of electric current in which the E.M.F. (*Electromotive force*) to be utilized is produced by the relative motion of lines of *magnetic force* and conductors. The conductors are sometimes called "inductors" and the iron part the "Core." (See *Armature*.)

ARMOR—In electrical usage, a shield or protective covering for wire or cable. Usually a lead or aluminum wrapping in convolute form.

ARMSTRONG, Edwin H.—Born in the United States of America, December 18th, 1890. He was educated at Columbia University, where he specialized in radio engineering. He served under Professor M. Pupin at Columbia University in the Hartley Research Laboratory, and is a director of the American Institute of Radio Engineers, the medal of which he has been awarded. Armstrong began experiments with wireless at the age of fifteen, and in 1913, while he was still a student at Columbia, he discovered the now famous feed-back or *regenerative* circuit, which was the cause of litigation, spreading over a number of years in the United States of America, before his patents were upheld. In March, 1915, he described the circuits employed by him with the Pliotron or three-element vacuum tube. Armstrong was the first to reveal that, with a certain value of feed-back coupling between the plate and grid circuit, a vacuum tube would become a high-frequency generator. His patent was dated January 31st, 1913. His fame became world-wide when he announced his discovery of the *super-regenerative circuit*, one of the most widely discussed and important developments in Radio. His paper on "Some Recent Developments of Regenerative Circuits," dealing with the super-regenerative circuits, was read before the Institute of Radio Engineers in New York on June 7th, 1922.

Edwin H. Armstrong.

The originator of the *super-regenerative* circuit has a number of other important patents to his credit, some of which will undoubtedly have far-reaching effects. In conjunction with Professor Pupin he invented a method for the elimination of *jamming*, especially that due to strays.

ARMSTRONG CIRCUITS—The various circuits devised by E. H. Armstrong, an American engineer. The more important of these are the *Regenerative*, *Super Regenerative* and *Super Heterodyne.* The principle of regeneration is one that has revolutionized the art of radio reception and broadcasting. The vast majority of present day receivers use regeneration in one form or another. Basically, regeneration is the process of returning a certain portion of the unrectified or radio frequency (*q.v.*) current from the plate circuit of the detector tube to the grid circuit. This has the effect of reducing the resistance of the grid circuit and thus permitting more ready passage of the weak impulses. The result is not only to greatly increase the sensitivity of the detector to weak signals, but actually to step up or amplify the volume of the received signals. In Fig. 1, coils L1 and L2 are the aerial tuning units in conjunction with the variable condenser, C1; C2 and C3 are variable condensers of low capacity; L3 is the plate control for regenerative action; T is the telephone receiver, G, P and F are respectively the grid, plate and filament elements of the tube; R the filament rheostat, and A and B the batteries for filament and plate. In the illustration Fig. 2, C1 is the aerial tuning condenser, L1 the primary coil of a standard vario coupler; V1 the grid variometer and V2 the plate or regeneration variometer. L2 is the secondary of the vario coupler, and the balance of the elements are as in Fig. 1, GL being the customary grid leak and condenser. Regenerative receivers have come into some disfavor owing to their tendency to radiate annoying signals into the antenna, and also the howling within the set when not properly adjusted. While regeneration in some form or other is used in the majority of receivers, it is not widely used now in its original state. (See *Neutrodyne, Tuned Radio Frequency,* etc.)

There are many types of regenerative set, some extremely simple and others more complicated. The original Armstrong regenerative circuit is shown in Fig. 1. Fig. 2 shows a more modern application of the regenerative principle and at the same time a more complicated one. (See *Regeneration, Super Regeneration* and *Super Heterodyne.*)

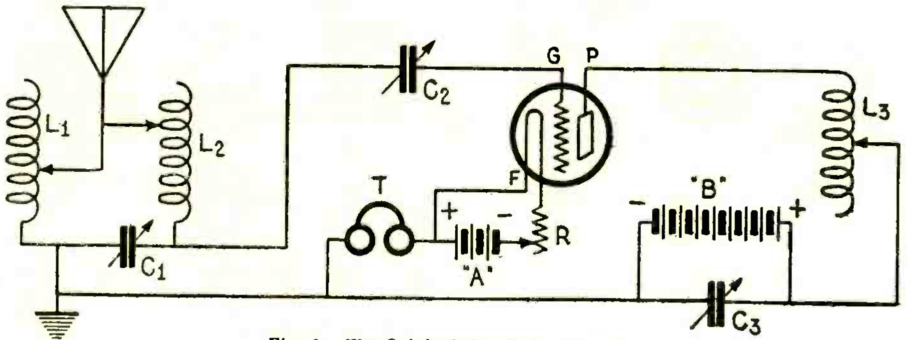


Fig. 1. The Original Armstrong Circuit.

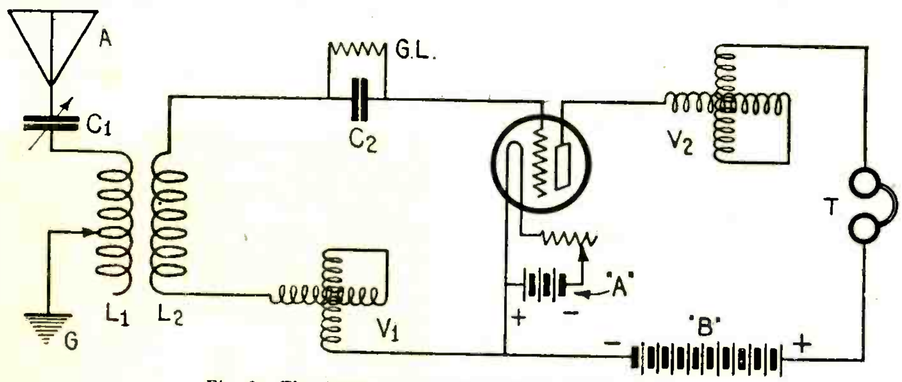


Fig. 2. The Armstrong 3-Circuit Regenerative Receiver.

ARRESTER—A device used for by-passing heavy electrical discharges in the atmosphere in the vicinity of the antenna when they strike the antenna. It ordinarily consists of a small gap between two metallic points connected in series with the antenna and ground in order to protect the apparatus and property against danger. (See *Lightning Arrester.*)

A. R. R. L.—Abbreviation for American Radio Relay League.

ARTIFICIAL ANTENNA — See *Mute Antenna.*

ARTIFICIAL MAGNET—A magnet produced by magnetizing a piece of steel that previously had no magnetic attraction. May be produced by rubbing a *natural magnet* or another artificial magnet across a piece of hard steel in the same direction a number of times. (See *Electro-magnet.*)

ASSUMED DIRECTION OF CURRENT FLOW—The direction which an electric current is assumed to take in its flow. Current is generally considered as leaving the *positive* terminal of its source, flowing through the circuits external to the source, and thence to the *negative* terminal of the source. The direction of flow within the source itself is from the negative to the positive terminal. (See *Theory of Current Flow.*)

ASTATIC COILS—Coils wound in such a manner that, when connected together, they neutralize each other's effect and produce no external *magnetic field.* They are used in the measurement of *inductance.*

ASYMMETRIC CONDUCTOR — One that permits the flow of greater current in one direction than in another. Non-symmetrical as to conductivity.

ASYMMETRICAL EFFECT—The lack of symmetry in the directional effect in a loop or frame aerial due to lack of symmetry in construction. (See *Loop Aerial.*)

ASYNCHRONOUS—A term used in referring to AC (Alternating Current) motors or generators and also to *dischargers* used in radio transmission. As applied to alternating current machines it is signified that the speed of rotation of the machine does not have any definite relation to the *frequency* of the currents produced—thus, out of *synchronism.* (See *Synchronous.*)

An asynchronous radio circuit is one which is not tuned to, or in syntony with, the frequency of the *oscillations* impressed on it. (See *Aperiodic.*)

ASYNCHRONOUS ROTARY DISCHARGE—A spark discharge produced at electrodes of a *rotary discharger* (*q. v.*) for transmitting radio signals, in which the spark rate or number of sparks per second has no relation to the *frequency* of the *alternating current.* (See *Spark Discharge.*)

ASYNCHRONOUS SPARK GAP—See *Spark Gap.*

ATMOSPHERIC ABSORPTION — The portion of the total reduction of radiated power due to atmospheric conductivity, reflection and refraction. The amount of energy loss in radio transmission due to atmospheric factors. This applies only to *electromagnetic waves* (*q.v.*) in *motion in the ether* and should not be confused with the reception losses due to atmospheric disturbances.

ATMOSPHERICS — See *X's, Strays, Static.*

ATTENUATION — of the electric or magnetic intensity or of the average energy density in electric waves refers to the reduction in strength with increase of distance traversed due to absorption or equivalent losses, as distinguished from the reduction in strength due to geometrical divergence. In free space, the geometrical divergence of waves from a small source involves a diminution of the average energy density in accordance with the inverse square law; plane waves (e. g., along wires) suffer no reduction by divergence, but undergo attenuation due to resistance and other line faults. (See *Attenuation, Geometrical Divergence*).

ATTENUATION, GEOMETRICAL DIVERGENCE—The gradual decrease in strength of electromagnetic waves (radio signals) as the distance which they have traversed increases. The effect on the waves as they travel through the air is essentially the same as in the case of light waves. Now if a beam of light is viewed one mile from its source it will have a certain intensity, but if it is viewed again from a distance of two miles the intensity will be much less. In the case of radio waves, the intensity is said to decrease as the square of the increased distance traveled; that is to say, if they have a certain power at a distance of five miles from the transmitter, the same waves at twice the distance or ten miles will be found to have a strength only one-quarter as great. Similarly, if the waves travel fifteen miles or three times the distance, the signal strength will be only one-ninth that of the same waves at a distance of five miles from the transmitter.

AUDIBILITY—The measure of strength of received radio signals as heard in a telephone receiver connected to the radio receiving apparatus. A radio telegraph signal which is at all audible can be read, i.e., the dots and dashes distinguished from one another; radio broadcast programs heard with at least some degree of clarity.

AUDIBILITY (Radio Telegraph) — A measure of the ratio of the telephone current producing a signal in a telephone receiver to that producing a barely audible signal. (A barely audible signal is one which just permits the differentiation of the dot and dash elements of the letters sent in code.) In the simple shunted telephone method of measuring signals the audibility is defined as:

$$\frac{s + t}{s}$$

where s and t are the *impedances* of shunt and telephone respectively.

AUDIBILITY FACTOR—A measure of signal strength obtained by observing the *resistance* to be placed in shunt with the telephones of a receiving station to reduce the signals to unit audibility. Approximately, the audibility factor is proportional to the power absorbed from the signal waves by the receiving apparatus. Unit audibility is the strength of signal at which dots and dashes can just be discriminated.

AUDIBILITY METER — A device for comparison of the strength of received signals, either from different stations

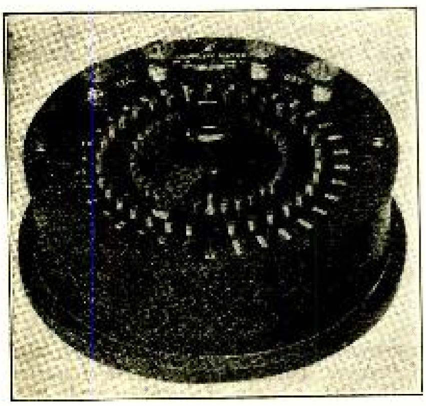


Photo by courtesy of General Radio Co.

An Audibility Meter.

or with different circuits by means of a variable *resistance* shunted (placed) across the phones. This resistance is decreased until the signals are just audible in the phones. Now, if another station is tuned in, or the circuit changed in some manner, the signals may either be entirely inaudible or they may be much louder, this giving an idea of the *comparative* strength without actual measurement. A popular type of Audibility Meter is shown in the above illustration.

For measurements with an audibility meter, the following shunt formula is used:

$$K = \frac{s + t}{s}$$

Where s is the *impedance* of the *shunt* resistance and t the impedance of the phones, then K is the audibility constant. In general practice a *series* resistance is devised to compensate for the reduction in resistance of the shunt circuit, this keeping the impedance of the plate circuit constant.

AUDIO AMPLIFIER—An *amplifier* used to increase the volume of signals of *audio frequency* (*q. v.*). Audio amplifiers are connected in the circuit of the detector in place of the phones (input) as shown in Fig. 1. This is the standard two stage audio amplifier. The separate stages each consist of a *vacuum tube, a transformer, socket* for

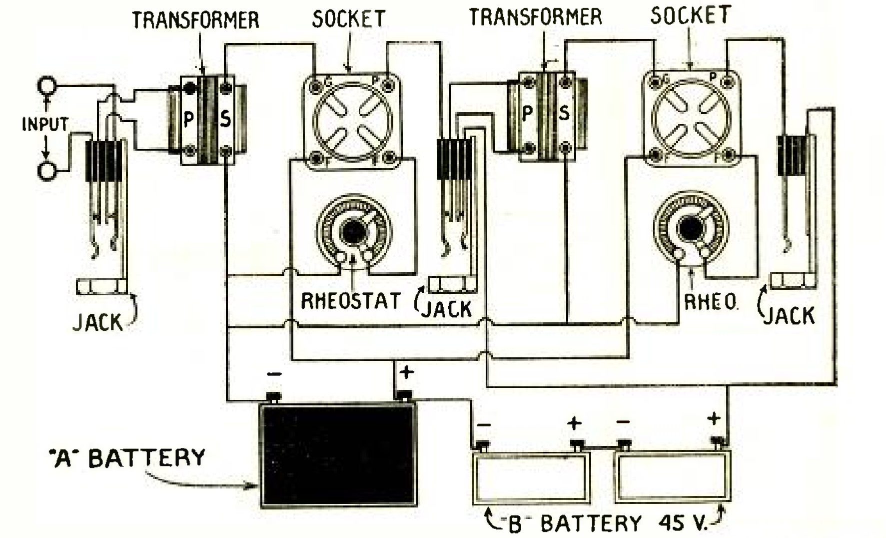


Fig. 1. A standard two stage Audio Amplifier employing phone jacks for detector, first stage, and second stage Audio Amplifiers.

the tube and a control *rheostat*. If desired one rheostat may be used for both amplifier tubes as the *filament* current (*q. v.*) can be the same if the tubes are of a similar design. This is known as "transformer coupled amplification." Another much used method is known as "resistance coupled amplification."

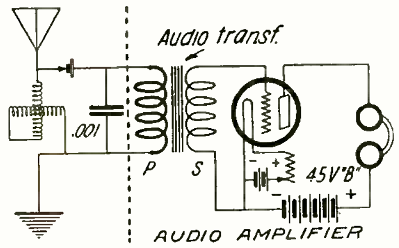


Fig. 2. A one stage Audio Amplifier connected to a crystal receiving set.

Fig. 2 shows one stage of audio frequency amplification connected to a crystal receiving set. There are numerous variations of audio amplification. (See *Push-Pull Amplification*, also *Resistance Coupled Amplifier*, and *Power Amplifier*.)

AUDIO FREQUENCY — A frequency corresponding to normally audible sound waves, i.e., between 40 and 10,000 per second. The limits of audibility are given variously from 16 to 20,000 cycles, but for ordinary usage may be taken as from 40 to 10,000 cycles per second. In audio frequency amplification as used in conjunction with the tuning and detector apparatus of the radio receiving set, the volume of the received sound is amplified or increased over that of the originally rectified sound waves. (See *Radio Frequency*; also *Amplifier*.)

AUDION—The name given by Dr. L. De Forest to a *vacuum tube detector* which possesses a glowing *cathode* and has a steady E. M. F. (*Electromotive force*) permanently applied between *anode* and hot *cathode* and two cold *anodes*. (See *Vacuum Tube*.)

AUSTIN, Louis Winslo, Ph.D.—Born in Ordwell, October 30th, 1867. Graduated at Middlebury College and studied at Clarke University and the Universities of Strasburg and Berlin. Noted for the fact that he is head of the U. S. Naval Telegraphic Laboratory, Washington, D. C., and for his work in measuring high frequency currents.

AUTO-COHERER — A coherer having automatic action to release the particles that cohere when circuit is established. Now obsolete. (See *Coherer*.)

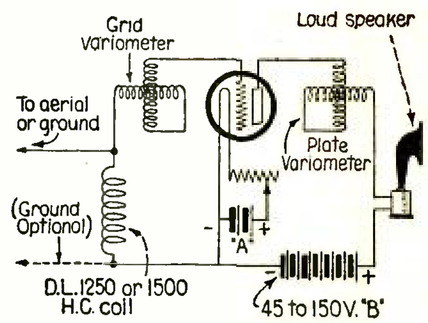
AUTODYNE RECEPTION—See *Self-Heterodyne Reception*.

AUTO INDUCTIVE COUPLING—See *Coupling*.

AUTOMATIC INTERRUPTER—A vibrating electro-mechanical device to make and break an electric circuit by using the energy passing through it. The most common example is that of a *spark coil*. An interrupter may be used for several purposes. In the case of a spark coil it is used to produce sparks for transmission of signals. In another form it may appear in a mechanical battery *charger*, in this instance being used to interrupt the *alternating current* and permit passage of the current in one direction only. A *buzzer* uses a type of interrupter—a vibrating device producing a buzzing sound having a pitch dependent on the rapidity with which the vibrations take place.

AUTOMATIC TRANSMITTER—An apparatus for operating a sending *key* mechanically. (See *Wheatstone Transmitter*.)

AUTOPLEX—A type of radio receiver employing one vacuum tube, operating



Circuit of the Autoplex radio receiver.

along the lines of the *Super-regenerative* principle and designed to operate a Loud-speaker. The circuit comprises two standard variometers, a 1500 turn duo-lateral coil, and the usual vacuum tube, socket, batteries, etc. It is extremely critical in operation, but if carefully assembled will give excellent volume under good conditions. Illustration shows the circuit diagram of the Autoplex receiver.

AUTO-RECEIVER—A device for the automatic reception and recording of radio signals. It is essential in the reception of signals transmitted by an Automatic transmitter (see *Wheatstone Transmitter*) as the speed is too high to permit reception by ear. There are three general classes of automatic receiver: a *resonance intensifier* in conjunction with an inking arrangement; a *phonographic recorder* and a recorder using *photographic means*. In the latter method, a powerful beam of light is projected on to a mirror which is arranged to respond to the signals in approximately the same manner as a mirror *galvanometer*. In the phonographic type, the signals are reproduced on a drum. (See *Resonance Intensifier, Photographic Recorder*, also *Phonographic Recorder*.)

AUTO TRANSFORMER—A device for changing voltage in a circuit carrying alternating currents. A form of *transformer* having but one winding, any part of which may be used as the *primary* and any part as the *secondary*. In Fig. 1 the two windings P and S are continuous, although different sizes of wire may be used according to the purpose for which intended. In this case the voltage taken from the secondary D E will be less than the voltage impressed at A B, because the secondary has fewer turns of wire than the primary. Now in Fig. 2, this conditions is reversed, and as the primary has only a few turns of wire and the secondary has a comparatively large number, the voltage obtained from D E will be greater than that impressed at A B. The voltage ratio is approximately proportional to

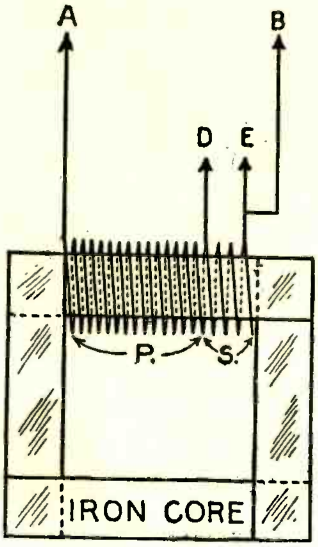


Fig. 1.

the ratio of wire turns. Thus, if the primary has 100 turns of wire and a pressure of 100 volts is placed at A B, then the voltage at D E would be within certain limits about equal to the number of turns of the secondary. In other words, if the number of turns on the secondary is one-third the number of turns on the primary, then the voltage at D E will be approximately one-third that impressed at A B. The main advantage of the autotransformer is that a saving is accomplished by having the primary and secondary windings combined. The chief disadvantage is that where extremely high voltages are used there is always danger of the two windings be-

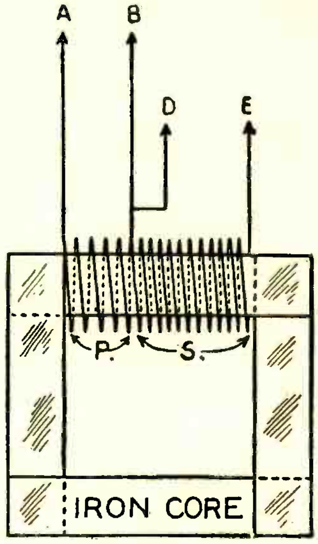


Fig. 2.

coming crossed or shorted. (See *Short*.) For this reason they are used mainly for comparatively low voltages. One of the most common forms is the step-down type, known as a "bell-ringing transformer." These are used to cut down the voltage of an electric light line to suitable value for use with small toys or bells. If the transformer is used to increase the voltage, it is known as a "step-up" transformer. (See *Transformer—Radio, Audio*.)

AUTO TRANSFORMER COUPLING—See *Coupling*.

B

B—Abbreviation for Baumé, the scale used in a *hydrometer* (*q.v.*)

B. A. AMPERE—The standard ampere fixed by the British Association for the Advancement of Science.

BACK COUPLING—See *Reactance Coils*.

BACK ELECTRO-MOTIVE FORCE—An *Electromotive force* (E.M.F.) which opposes the original electromotive force. The more common term is "*Counter E. M. F.*" In many arrangements of electrical circuits there will be an electromotive force set up in such manner as to oppose the impressed voltage or force. This will be true in the case of a *choke coil* in which any variation in the pressure or electromotive force applied to the coil will result, under proper conditions, in the production of a back or counter-electromotive force that will oppose the change in the original force.

This phenomena is frequently found in electrical circuits; at times introduced for a purpose and at others self-introduced, and therefore demanding consideration in design of apparatus. The rotation of the *armature* of a motor creates a counter E. M. F. opposed to the impressed E. M. F. and upon which the driving power of the motor depends. When an external E. M. F. is impressed on a circuit in which there exists a local E. M. F., the flow of the current through that portion of the circuit containing the local E. M. F. will result in an increase or decrease of energy depending on whether the local E. M. F. is opposed to, or in the same direction as, the external E. M. F. (See *Counter Electromotive force*.)

BACK OSCILLATION—When the *condenser* of a transmitting circuit of the spark type discharges across the *spark gap* some of the *high frequency* current may flow back through the secondary of the transformer instead of taking its normal path across the gap. This back flow is usually referred to as *Back oscillation* or kick back, and is apt to break down (see *Breaking Down of Insulation*) the insulation of the transformer if not prevented or controlled. Back oscillation is retarded ordinarily by means of coils of wire having a certain arbitrary *inductance* value. When the high frequency discharge from the condenser has any tendency to break through, the *reactance* of these coils becomes so great that they act in effect as insulators. As the capacity and inductance of these coils might create an *oscillatory circuit* of the same *natural period* as the primary oscillator, they are shunted with non-inductive carbon resistances. These coils are termed "*choke*" coils.

BAKELITE — An insulating material having widespread use in radio. It possesses great strength and has a high *dielectric* (insulating) value together with the ability to withstand high temperatures. This material is furnished in many forms and under a variety of trade names, being considered one of the best of the insulating compounds.

Chemically known as *Oxybenzylmethylenglycol anhydride*. It is produced by the union under heat and pressure of phenol and formaldehyde together with a small percentage of some alkaline agent. Is heat resisting up to about 500 degrees Fahrenheit—disintegration setting in somewhere above that point.

BALANCED CIRCUIT—An electric circuit arranged in such manner with relation to adjacent or neighboring circuits as to do away with the effect of *mutual induction* (*q.v.*).

BALANCED DETECTORS—A term applied to an arrangement of opposed rectifying *detectors* for reducing the effects of strong *strays* in receiving apparatus. The detectors must be balanced for violent *electro-motive forces*, but not balanced for the moderate E. M. F.'s due to the signals. Actually, a method of eliminating stray impulses in reception.

BALANCED METALLIC CIRCUIT—A circuit through conductors (wire or any metal) in which the total resistance is the same on each side of the circuit. (See *Circuit.*)

BALANCED ROTARY CONDENSER—A variable condenser having some arrangement for keeping the plates accurately balanced in rotation at all

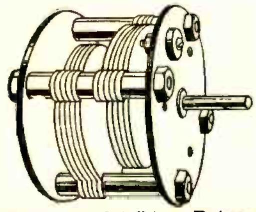


Fig. 1. A "Balanced-Plate" type Rotary Condenser.

points. Fig. 1 shows a form known as the "balanced plate" type. In this case the plates are so arranged that half the movable plates are on one side and half on the other side of the shaft.

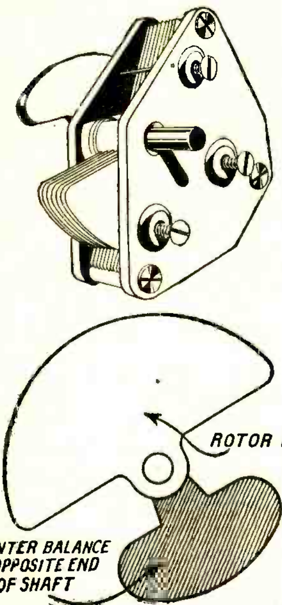


Fig. 2. A Counter-Balanced Rotary Condenser and illustration showing how the counter balance is attached to shaft.

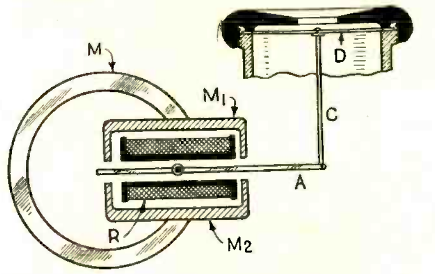
This maintains the balance of the part. Fig. 2 shows another method known as "counter-balanced." The weight of the balance is the same as that of the movable plates and its position on the other side of the shaft serves to maintain balance. The idea is to prevent the plates slipping due to lack of balance and thus keep the setting at the desired point after adjustment.

BALANCING—Any method of eliminating interference by reducing the *amplification* of the undesired signals while permitting full amplification of the desired signals. (See *Interference Eliminator.*)

BALANCING AERIAL—An aerial system designed to permit reception of signals from distant points without interference from a powerful nearby transmitter. The system involves the use of two aerials, one for balancing, the other for receiving. The receiving aerial is tuned to the wavelength of the desired signals, while the balancing aerial is tuned to the wavelength of the nearby station (the interfering signals).

In operation the receiving circuit is coupled to each aerial *electro-magnetically*, and is acted on by both series of *oscillations* (distant and nearby waves). By careful adjustment of *coupling* and phase relation of the *induced currents*, the interfering wave may be balanced out in effect and the desired oscillations received.

BALDWIN RECEIVER—Perhaps the most sensitive type of telephone receiver thus far developed. It employs what is known as a "balanced armature," the signals being produced by the vibrations of a *diaphragm* which is not acted on directly by the magnets. The illustration shows the general plan of a receiver of this type. The *armature* (A) is of soft iron and is pivoted between two U-shaped soft iron pieces (M1, M2) mounted on the ring-shaped horseshoe magnet (M) as indicated. The armature is acted on by the magnets in response to incoming signals and the movement of this element in turn acts



Principle plan of the Baldwin Receiver unit.

on the mica diaphragm (D) by means of a fine brass wire (C). The usual windings (R) are placed between the two pole pieces, the armature being mounted in a central slot. These receivers are much used both for headphones and for loud-speaker units. In the latter case the mica diaphragm is generally made heavier to handle the more powerful vibrations due to the *amplification* of the signals.

When no fluctuating impulses (signals) flow through the windings (R), there is no *magnetic stress* on the armature (A), because this member is suspended centrally between the pieces (M1) and (M2), the magnetic attraction of which are equal. Now when a fluctuating impulse flows through the windings (R) it produces a magnetic flux which combines with the flux of the permanent magnet (M) and the total flux is distributed asymmetrically or unevenly on both sides of the armature. The result is a rocking vibratory movement to this member which is in turn communicated by the juncture wire (C) to the diaphragm (D), producing the audible signals. (For a comparison of this action with the conventional telephone receiver action, see *Telephone Receiver.*)

BALKITE BATTERY CHARGER—An electrolytic battery charger which makes use of a sulphuric acid solution and tantalum as the valve metal. Used for charging *storage batteries* from *alternating current.* See illustration.

Photo by courtesy of Fansteel Products Co.

A Balkite Battery Charger.

Note: The name Balkite is derived from the name of the man who perfected the process of extraction of tantalum from its ores.

BALLAST TUBE—An automatic means of regulating the *filament current* of vacuum tubes. The device is enclosed in a glass tube and is arranged to permit passage of a certain fixed amount of current. The ballast element is a wire whose *resistance* changes with the current through it, due to the change of resistance with the temperature of the wire. When the *electromotive force* increases beyond normal, the increased current raises the temperature and hence the resistance, so that the current is held to the normal value.

B. and S.—Abbreviation for Brown and Sharpe Gauge (*q.v.*).

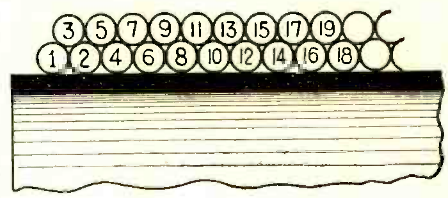
BAND OF FREQUENCIES—A continuous range of *frequencies* extending between two frequencies. (See *Band of Wavelengths;* also *Band Pass Filter.*)

BAND PASS FILTER—A *filter* arrangement designed to permit passage of all *frequencies* extending between two definite frequencies but excluding all other frequencies. (See *Band of Frequencies.*)

BAND OF WAVE-LENGTHS—A continuous range of *wave-lengths* extending between two definite wave-lengths. For example, the usual broadcast band of wave-lengths is approximately 250 meters to 550 meters.

BANKED BATTERY—A *battery* that has its *cells* connected in *parallel.*

BANK WINDING—A form of winding for coils in which the turns are staggered so that two or more layers may be used without having large distributed capacity losses. The illustration shows method of bank winding for two layers. Note that in this form the *electrostatic capacity* between any two turns is only that between adjacent



Method of bank winding wire on a coil form.

turns, representing only a small part of the total winding, whereas on the usual form of winding the adjacent turns would represent a good portion of the total *inductance* and hence the effect of distributed capacity would then be much greater. (See *Distributed Capacity.*)

BARRETER—A receiving instrument consisting essentially of a small mass of conducting material that is heated by the passage of an *oscillatory* current, and arranged so that the consequent alteration of electrical *conductivity* affects an indicating instrument, such as a telephone receiver or *galvanometer.*

BASKET COIL—Variometers—couplers, etc. (See *Basket Wound.*)

BASKET WOUND—A method of winding coils, such as variometers or variocouplers. The winding is a latticework of wires in skeleton form, the object being to save weight and eliminate large losses such as occur in the types using a great deal of solid insulating material. The illustration

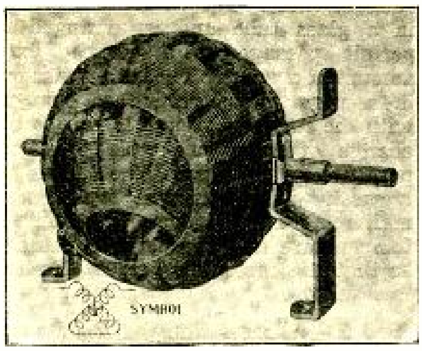


Photo by courtesy of Amer. Radio & Research Corp.

A Basket Wound Variometer.

shows a popular form of basket variometer.

BATTERY—In the electrical field, a group of *primary or storage cells, dynamos*, or *condensers* grouped together to form a single unit. The term is often used incorrectly to refer to a single cell—as "dry battery," the correct name for which is "dry cell." Thus a group of condensers joined together as one unit is termed a battery, also a number of dynamos arranged as a single unit for the production of electrical energy. (See *Dry Cell*, also *Battery of Alternators, Storage Battery, "A," "B" Battery*, etc.)

"B" BATTERY—An appliance for obtaining electricity of sufficient voltage to supply the plate of a *vacuum tube*.

There are two types of "B" batteries, viz., the *dry cell* type and the

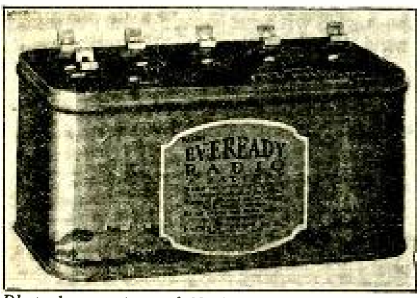


Photo by courtesy of National Carbon Co., Inc.

Fig. 1-A. A popular type of "B" Battery of 22½ volts.

storage types. In order to obtain the high voltage required for vacuum tube plates, many small cells are connected in series. The usual method is to connect them together and seal in a square

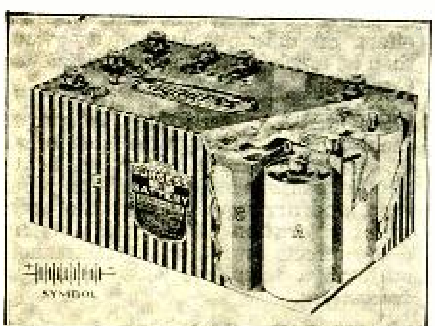


Photo by courtesy of Burgess Battery Co.

Fig. 1-B. A "B" Battery showing the contents of small cells.

package. Often taps are brought out so that various voltages may be obtained for *critical* vacuum tubes. The most popular voltages which dry cell "B" batteries give are 22½ and 45 volts. The storage "B" battery is similar to the ordinary storage battery with the exception that the cells are much smaller, but contain more cells in series. These can be charged in the same manner as the "A" or *storage battery*. In Fig. 1, we have a popular type of "B" battery. This is tapped in order that different voltages may be obtained.

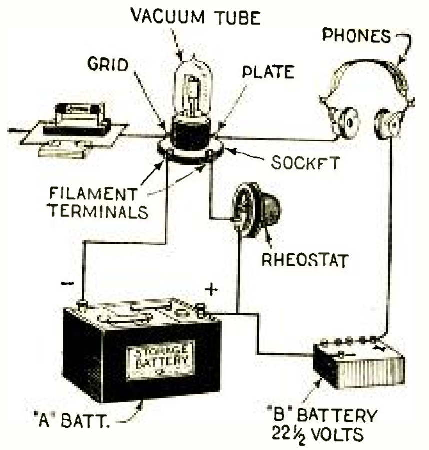


Fig. 2. Manner of connecting a "B" Battery in the circuit of a vacuum tube detector.

The manner of connecting up the "B" batteries in radio receiving is shown in Fig. 2. Here one battery of

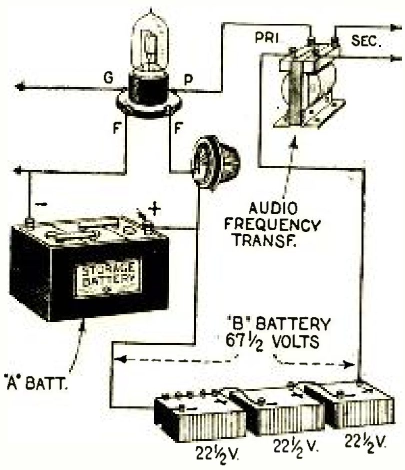


Fig. 3. "B" Battery of 67½ volts connected in an amplifier circuit.

22½ volts is used. In Fig. 3, three batteries are connected in series so that 67½ volts are obtained.

A common "B" battery may be used for the detector tube and the amplifier as shown in Fig. 4.

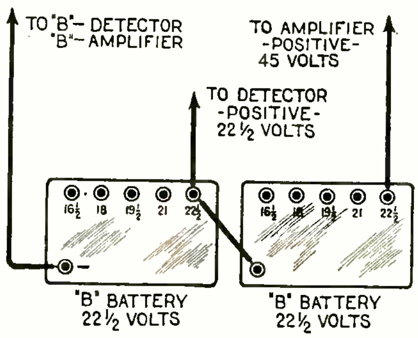


Fig. 4. How a common "B" Battery may be used both for detector and amplifier.

If separate batteries for each tube are desired, the circuit should be connected as in Fig. 5. This lengthens the life of the "B" battery as the drain on the battery is much less, i.e., only

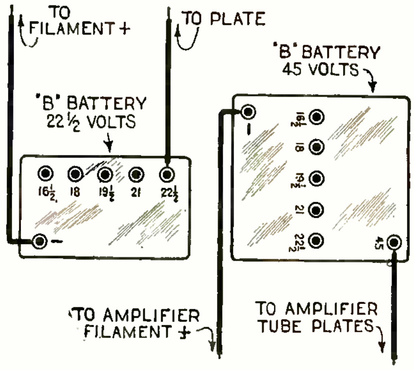


Fig. 5. Method of employing separate "B" Batteries for the detector and amplifier.

one vacuum tube is operated on each battery.

BATTERY OF ALTERNATORS—In ordinary electrical work such as house lighting, several *alternators* for the production of alternating current may be used together as one source of power. Also in high-power radio transmission, several *high-frequency alternators* may be used together to produce added power. (See *High-Frequency Alternator.*)

BATTERY TESTING INSTRUMENTS—The various devices used for determining the condition of batteries used as radio apparatus. (See *Ammeter, Voltmeter*, also *Hydrometer.*)

BEAT FREQUENCY—The *frequency* or number of vibrations per second of a series of *oscillations* representing the difference between two other series having different frequencies. It is numerically equal to the difference between the original two series of oscillations. Thus, if we have a series of oscillations having a frequency of 100,000 *cycles* per second, and combine it with another series having a frequency of 90,000 or 110,000 cycles, the *beat frequency* will be 10,000 cycles or the difference between the other two frequencies.

X. The frequency of recurrence per second of either maxima of addition or minima of opposition of two superposed periodic phenomena having the same nature but of different frequencies. The time measure of vibration of a beat or heterodyne. (See *Heterodyne*, also *Beats.*)

BEATS—When two sets of *oscillations* of different *frequencies* occur in the same system, the difference in the frequency or rapidity of vibration causes a new set of oscillations having a frequency equal to the difference between the original two sets. This may be accidental as in the case of certain types of receivers such as the *regenerative* type, in which case the beat oscillations are undesired and cause interference or disturbances in the set. Then again a beat frequency may be purposely introduced as in the case of the *Super-Heterodyne receiver*. Here we have the natural incoming oscillations from the antenna combined with a series of oscillations produced locally in the system. The result is a new set of oscillations where the incoming series and the locally produced series are not of the same frequency. (For more complete explanation see *Super-Heterodyne Receiver.*)

X. Where two *periodic phenomena* are *super-posed* or run together and the frequencies differ, the gradual change in *phase difference* produces a condition wherein the *amplitudes* are in opposition at one instant and in concurrence at a later instant with the various intermediate stages during the interval. (See *Heterodyne*, also *Beat Frequency*.)

BEG OHM—A *resistance* of one billion *ohms*. (See *Megohm.*)

BELIN, EDOUARD—French scientist, the inventor of what is considered the first practical system of radio transmission of photographs. The device

Brown photo.
Edouard Belin.

can be used for sending photos by cable or telephone lines as well as radio. (See *Transmission of Photographs by Radio.*)

BELL, Alexander Graham (1847-1922)—Scottish scientist. Born in Edinburgh, March 3rd, 1847, he was educated at the High School and University and graduated as a doctor of medicine. In

Alexander Graham Bell.

1870 he went to Canada, and in 1872 became professor of vocal physiology in the University of Boston. In 1876 he exhibited his apparatus for the transmission of sound, afterwards developed into the telephone.

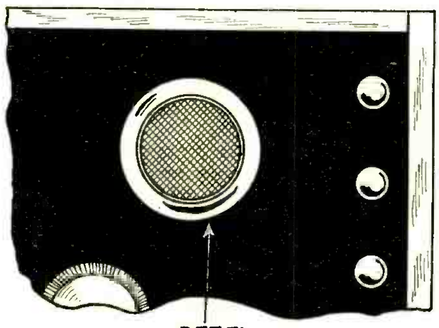
Bell was experimenting with an electric invention by means of which he hoped to make speech visible to the deaf. A delicate metal reed was caused to vibrate by spoken speech and to transmit an electric current to the opposite end of a wire, where the vibrations of the first reed were reproduced in a second reed by a magnet. He found that it was possible to transmit not merely vibrations of the original reed, but to reproduce the sound itself in the vibrations of the second reed. In 1878 he invented the photophone, to enable sound to be transmitted by variations on a beam of light, and later a phonograph. Bell was the author of many scientific papers, was awarded the Albert Medal of the Royal Society of Arts in 1902 and the Hughes Medal of the Royal Society in 1918. He died Aug. 2nd, 1922.

BELLINI, Dr. Ettore—Born in Foligno, Italy, April 13th, 1876. Educated at the University of Naples. Noted as Electrical Engineer to the Royal Italian Navy, and chief of the Naval Electrical Laboratory at Venice. Joint inventor with Captain Tosi of the "Radiogoniometer" (*q. v.*), a device for finding the direction of transmitted radio signals.

BELLINI-TOSI AERIAL — See *Goniometer.*

BELLINI-TOSI DIRECTION FINDER—See *Goniometer.*

BEZEL — In mechanics, generally a groove and flange made to receive a beveled edge. In its adaptation to radio some liberty was taken with its real meaning. Its significance in this



A Bezel on the panel of a radio receiving set.

sense is a small metal ring having a wire mesh or glass center. It is fitted into a circular hole in the panel of a radio receiver and used as a peep hole to enable the operator to know at all times the conditions of the tubes, whether or not they are properly lighted.

BILLI CONDENSER—A variable *condenser* of low *capacity*, consisting of two brass tubes, one of which is arranged to slide in and out of the other for the purpose of varying the capacity. Such condensers were much used before the days of broadcasting, in conjunction with any circuit using a crystal and battery for detector. This type of condenser has long been obsolete in the United States.

BINDING POST—A screw and nut arrangement used on electrical units and radio apparatus to make convenient connections from an external source to the desired point within the apparatus. Binding posts are provided, for instance, to make handy connections from batteries to the set and from the aerial and ground leads. The illustration shows a popular type of binding post.

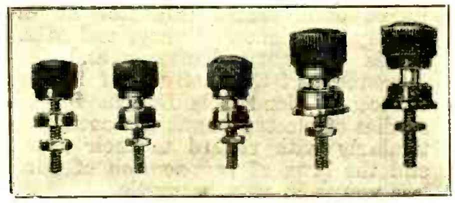


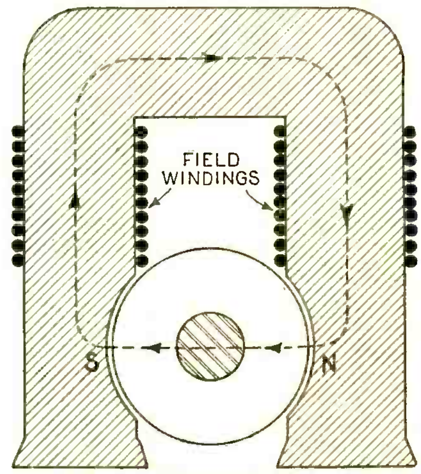
Photo by courtesy of The H. H. Eby Mfg. Co.

A group of Binding Posts as used on electrical and radio apparatus.

BI-POLAR—Having two *poles*. Usually a *dynamo* or motor whose *armature* rotates between a *field magnet* having only two poles. The most modern types are of the Multi-polar variety. (See *Bi-polar Magnetic Field.*)

BI-POLAR ARMATURE WINDING—An *armature* wound in a manner to permit its use with a dynamo having a bi-polar magnetic field.

BI-POLAR MAGNETIC FIELD — The magnetic field (*q.v.*) created between



A Bi-Polar Magnet of a dynamo.

two magnetic poles. The illustration shows a common form of bi-polar magnet for a dynamo. Bi-polar magnetic fields are now used as a rule only for direct current machines of low power, such as those under 5 *Kilowatts*. (See *Dynamo*, also *Generator*.)

BI-TELEPHONE RECEIVER—A headset with two receivers or phones as generally used in radio. In the early days of radio transmission it was the custom to use only one phone.

BLONDEL, Andree—French electrical expert. Born at Chaumont, France, in 1863, he graduated at Paris University, and studied electric waves, on which subject he early contributed a number of papers to various scientific journals. In 1893 he invented the *oscillograph*, an instrument somewhat similar to a mirror *galvanometer*, for showing curves of *oscillating* or *alternating currents*. This invention opened up a fresh field in the study of alternating currents. In the same year Blondel explained for the first time mathematically the effect of inertia in the shunting of *alternators*. He is responsible for a system of acoustically syntonic wireless telegraphy, and for directed waves produced by a double aerial. In 1902 he patented a method for producing electric oscillations for wireless telephony, and has written many papers on microphonic control for transmitters, wireless telephony, the singing arc, etc.

BLONDLOT, Professor Prosper Rene—French wireless expert. Born at Nancy, France, in 1849, studied at

Paris, and became professor at the faculty of sciences, Nancy, and afterwards Honorary Professor and Correspondent of the Institute of France. Professor Blondlot is famous for his studies of electro-magnetic waves, particularly with regard to their speed, and the laws of *propagation* of wireless waves in various media.

BLOWER MOTOR—A motordriven fan used to deliver a high pressure blast at the *spark gap* to prevent *arcing.* (See *Spark Gap,* also *Spark Discharger.*)

BLOWOUT—See *Magnetic Blowout.*

BLUE GLOW—A condition within a *vacuum tube* when the vacuum has become poor. After continued use a tube will often hold a small percentage of gas, which causes a blue glow when current is passed through it. A tube in this condition is a poor *detector* or *amplifier* and should be replaced. The condition should not be confused with the glow often caused by an excessive voltage. In this latter case decreasing the voltage to the normal value will generally permit the tube to be operated efficiently. The blue glow in this case is due to *ionization* of the residual gas by the excessively high *potential* impressed across the elements of the tube.

BOARD OF TRADE UNIT—B.O.T. 1,000 Watt Hours. One and a third Horse Power.

BODY CAPACITY—The effect of the human body when tuning a radio receiving set. The hand when placed on or near the controls very often throws the receiver out of balance with the incoming signals. In the case of very *sharp tuning* this effect is more in evidence and is likely to cause howls due to *self-oscillation.* The howling is due to the production of an audible *beat frequency* in the system, caused by the combination of the local *oscillations* with the incoming signal oscillations. The remedy may be to shield the panel with metal foil or in some cases to merely alter the direction of the leads from the *tuning condenser.* The experienced operator seldom pays much attention to the phenomena, as a little practice enables the listener-in to compensate for the effect. To make this more clear, if, when tuning the set, the withdrawal of the hand from the dial *detunes* the set or throws it out of balance, it is due to the fact that the hand has acted as a certain amount of *capacity* in the circuit, and naturally its withdrawal is equivalent to a change in the condenser setting. A simple system is to turn the control beyond the point of maximum volume, then when the hand is withdrawn the capacity will drop to its proper value. This can be mastered very readily. If the tuning condenser is connected across the secondary, i.e., one side to the grid, and the other to the grid return, the stator plates of the condenser should be connected to the grid of the tube. If metal foil or thin copper sheeting is used for shielding it should be connected to the ground post of the set.

The tendency of the human body to insert an arbitrary capacity in the circuit. The phenomena is especially noted where maximum volume is obtained only by very critical control close to the oscillating point, in which case the circuit may be thrown out of *resonance.*

BOLITHO CIRCUIT—A *super-regenerative circuit* patented in England in 1919 by Captain J. B. Bolitho. The circuit was originally intended to operate a relay device. The circuit has been adapted to use as an *amplifier* for radio reception.

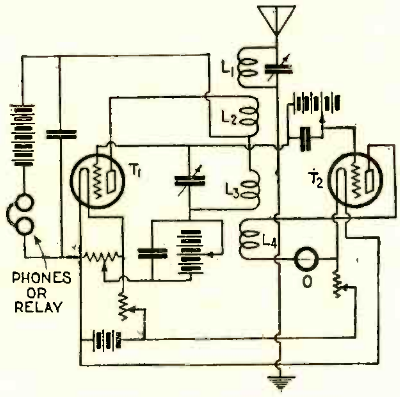


Diagram of the Bolitho Circuit.

In the illustration the phones may be replaced by a loud speaker or relay. In operation, T1 is held at a point just below that where *oscillation* sets in by means of T2 which is excited by an oscillator O in the plate circuit and coupled by means of coil L4 to the tuned grid circuit through L2 and L3, the coupling, as explained, being so arranged that the tube is always just below the oscillating point. A *reaction coil* L4 is placed in the plate circuit of T2 in such manner as to oppose the magnetic linkage between coils L2 and L3. The *frequency* of the generator O is lower than that of the received signals. As indicated, the grids of both tubes T1 and T2 are joined together and the tube T2 maintains the circuit in a receptive condition when tube T1 is tuned just below the oscillating point.

The oscillator O makes the *plate* of T2 alternately *positive* and *negative* with the following effect: When the plate of T2 is negatively charged there is no current in coil L4, this coil therefore not affecting coils L2 and L3, and permitting tube T1 to build up self oscillation. When the plate is made positive by the action of the oscillator, current flows through coil L4, and as it is coupled in opposition to coils L2 and L3 it neutralizes the coupling between L2 and L3 and prevents transfer of energy between the grid and plate circuits of the tube T1. This tends to stop the self oscillation and makes the circuit receptive to the energy (signal) produced by outside signals in the aerial coil L1. The frequency, of course, is determined by the frequency of the oscillator O. The system is especially adapted to the reception of continuous wave signals. (See *Super-regenerative circuit,* also *Feed-back* and *Regenerative circuits.*)

BOLOMETER—Type of *Wheatstone Bridge* having an easily heated *resistance,* such as a very fine wire in one arm. (See *Wheatstone Bridge.*)

BOOSTER—An expression signifying a small *dynamo* used in conjunction with main dynamo to temporarily raise, when necessary, its normal *pressure.* It is generally driven by a motor supplied with energy from the main generator and thus becomes in effect a *continuous current transformer.* Frequently used for charging *accumulators* of a generating plant. The term "Boost" is also used to denote increase or a stepping-up of any electrical quantity. (See *Amplification.*)

BORNITE—A *crystal rectifier* much used in radio reception. It is a natural sulphide of iron and copper, having a metallic blue lustre. This mineral is used in combination with zincite or copper pyrites as a crystal detector. Such combinations are generally known as "crystal to crystal" detectors to distinguish them from the ordinary variety using one mineral and a wire contact.

BORON—A non-metallic chemical element used in radio as one of the electrodes for the *T. Y. K. Arc.* Chemical symbol B, atomic weight 11.0, specific gravity 2.6.

B. O. T.—The customary abbreviation for *Board of Trade Unit.* The unit represents 1,000 *watt hours.* (See *Board of Trade Unit.*)

BOX AERIAL—A term occasionally applied to loop aerials. (See *Loop aerial,* also *Frame Aerial.*)

BRADFIELD INSULATOR—A particular form of *Lead-in Insulator,* consisting of an ebonite tube provided with zinc cone and ebonite spark discs, for breaking up continuous streams of rain running down outside which might cause the aerial to become grounded. The whole is held in position, half way through roof of operating room, by means of a stuffing box. The aerial is led in by means of a conducting rod through center of tube. (See *Petticoat insulator.*)

BRANLY COHERER—Early form of *Marconi Coherer.* (See *Coherer.*)

BRANLY, EDOUARD—French radio expert. Born at Amiens, France, Oct. 23rd, 1844. He was educated at Paris and afterwards became Fellow of the University, doctor of physical science, and doctor of medicine. Branley early made a study of electro-magnetic waves, and in 1890 and 1891 patented methods of operating a local relay circuit from a distance by means of wireless waves. In 1900 he was awarded the Grand Prix by the International Jury of Superior Precept Instruction for his exhibition of radio-conductors.

In 1890 Branly published an account of his very extensive series of observations on the electrical conductivity

Edouard Branly.

of loosely packed metal filings, and he made the extremely important observation that an electric spark at a distance had the power of suddenly changing the electric *conductivity* of loose masses of powdered *conductors.* To Branley is due the *coherer* named after him.

BRAUN, FERDINAND — Professor at the University of Strasburg, and one of the leading world authorities on Radio transmission. As early as 1899 Braun was granted a patent for *closed oscillating* systems with an *inductively coupled* antenna. The system was claimed by Braun to possess a much greater efficiency than the directly coupled systems. The Braun transmitting set, as manufactured by Siemens and Halske, consisted of a large coil worked into an *electrolytic interrupter,* a set of *Leyden jars,* enclosed *spark gap, oscillation transformer* wound with insulated wire placed in oil, and for the receiving set the standard type of *coherer relay* and Morse register. In 1899 Braun established communication between Cuxhaven and Heligoland, using aerial wires 90 feet high, and the inductive coupled aerial connection for transmitting. In 1903 Braun joined with Slaby, von Arco, and Siemens to form the Telefunken system of transmission. Professor Braun was awarded the Nobel prize with Marconi in 1900, for his work in wireless. Braun has devised a method of directional wireless which depends upon the interference of *electric waves* travelling in the same direction but different in *phase.* Three simple vertical wire aerials are set up in positions corresponding to the angular points of an equilateral triangle, and *oscillations* are created in these which differ from one another in phase. In 1897 Professon Braun published a description of his cathode ray tube, and afterwards pointed out, in 1902, how such a tube could be used to trace the forms of alternating current waves.

BRITISH STANDARD WIRE GAUGE —The standard wire gauge of Great Britain. The table shows the various diameters in thousandths of an inch (mils.).

WIRE GAUGES IN MILS.

GAUGE	New British Standard
0 000 000	500
000 000	464
00 000	432
0 000	400
000	372
00	378
0	324
1	300
2	276
3	252
4	232
5	212
6	192
7	176
8	160
9	144
10	128
11	116
12	104
13	92
14	80
15	72
16	64
17	56
18	48
19	40
20	36
21	32
22	28
23	24
24	22
25	20
26	18
27	16.4
28	14.8
29	13.6
30	12.4
31	11.6
32	10.8
33	10.0
34	9.2
35	8.4
36	7.6
37	6.8
38	6.0
39	5.2
40	4.8

BREAK or BREAKER — See *Circuit Breaker.*

BREAKDOWN POTENTIAL or BREAKDOWN VOLTAGE—The voltage necessary to *break down* or puncture a *dielectric.* The ability of any *insulating* material to resist breakdown is an important matter. An insulator or dielectric material is usually given a certain rating or point above which it is likely to fracture. Thus, a condenser may have a breakdown rating of 500 volts. That is to say that voltages up to 500 and slightly over may be handled with safety, but any large increase above that figure may result in puncture of the material by the excessive potential or voltage. The relation between dielectric strength and breakdown voltage is shown in the following formula:

$$V = cd\,\tfrac{2}{3}$$

Where d is the thickness of dielectric in millimeters
V the potential difference in volts
c-a constant representing the potential difference required to cause a dielectric breakdown of a sample of the material 1 mm. thick. (See *Dielectric Strength.*)

BREAKING DOWN OF DIELECTRIC— In a *condenser,* the gradual weakening of the *dielectric* or insulating sheets which eventually causes them to permit direct passage of the current. For example, if a force of 1000 volts is applied for a considerable period to a condenser that has been designed for a maximum of 500 volts, the insulating material between the plates would probably be punctured by the current. (See *Break-down Potential.*)

BREAKING DOWN OF INSULATION —The same effect as referred to under *Breaking Down of Dielectric.* The insulation weakens and permits the ready passage of electric currents. (See *Break-down Potential.*)

BRIDGES—See *Capacity Bridge,* also *Wheatstone Bridge.*

BRIDGING—A term occasionally used for *shunt* (q.v.) connections. Thus, a grid condenser is generally shunted or bridged by a *grid leak.*

BROADCAST—Transmission of music, news and other matters of general interest and entertainment by means of *radio telephony.* (See *Broadcasting, General Treatise on Methods.*)

BROADCASTING, GENERAL TREATISE ON METHODS—The application of radio telephony to the transmission through the ether of musical programs, speech or any form of news or entertainment, in such manner that it can be readily received by anyone possessing a radio receiver sufficiently sensitive and capable of being tuned to resonance with the particular waves being sent out. While broadcasting in its present world-wide scope is a comparatively new enterprise, it has actually been used to a more or less degree since the practical development of the wireless telephone. As near as records can be determined, the first actual broadcasting was done in 1912. It was, however, not until after the world war that it began to develop into an industry of prominence. Now it occupies a place of very definite importance in everday life; carrying news and entertainment into the remote corners of the earth, far removed from telephone or telegraph communication.

Fig. 1. A bank of 250-watt transmitting tubes in a Radio Broadcast Station. Note the small receiving tube for comparison of size.

The fundamental principles of broadcasting are essentially those of radio transmission, with the addition of means of combining the speech or music vibrations with the regular radio waves. First we have to consider the radio waves of high-frequency—alternating current that changes in direction many thousands of times each second. These high frequency waves are known as the carrier waves. The frequency of these waves varies according to the length of the waves (wavelength), in the case of American broadcasting stations, being between 250 and 550 meters in most cases, which means a frequency range of approximately 550,000 to 1,200,000 cycles.

Now by means of a microphone, a device similar in principle to the mouthpiece of an ordinary telephone, but designed to handle large currents, the air pressure waves, i.e., speech or music, are converted into variations of electric current. By use of suitable amplifying apparatus, the strength of the electric waves radiated from the antenna is varied to correspond electrically to the acoustic or sound variations due to the speech or music being impressed on the microphone. The speech or music waves are low frequency waves, generally ranging between 100 and 4000 per second. Thus, while the carrier wave oscillations are of high frequency, the variations in it are low frequency, corresponding to the ordinary speech or music vibrations.

speech amplifier system, comprising vacuum tubes and the necessary associated circuits.

These amplified currents are applied to the grid of a control tube or bank of tubes and result in large variations in the plate current of the tubes. (See *Theory of Vacuum Tube.*) The control tubes are supplied with filament current from storage batteries or special low voltage D. C. generators, and the high voltage applied to the plates of the tubes is furnished by generators. This power will vary in most cases from about 1,000 to 5,000 volts. In some broadcasting stations, the power is obtained through high voltage direct current generators, while in others, the

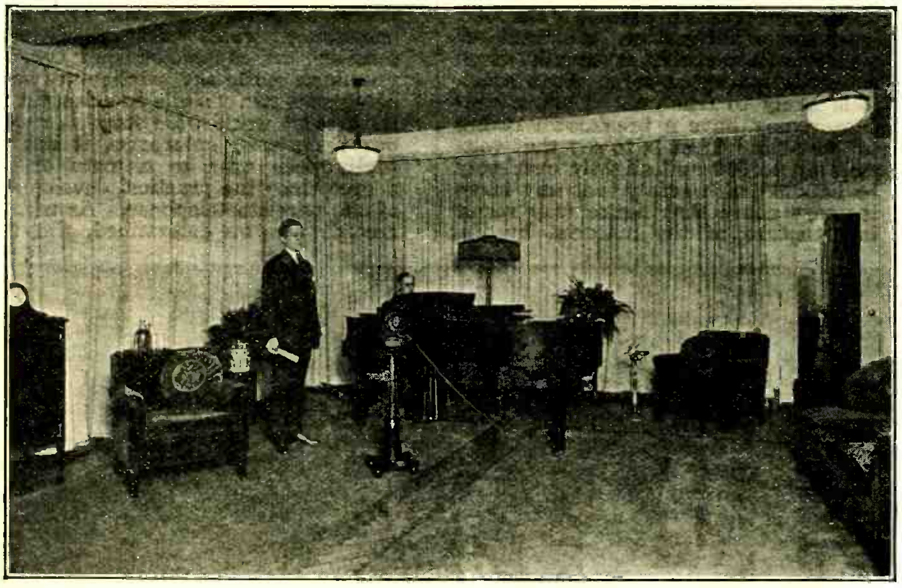


Fig. 2. Studio of a modern Radio Broadcast Station.

The process of varying the radiated wave in accordance with the sound waves is known as *modulation.* This adjustment is of the utmost importance, as defects here result in distorted or improperly modulated sound waves and the reproduction cannot be perfect. The reception of broadcast programs is essentially the same as that of ordinary radio signals, with the exception that care must be used at the receiving end to preserve the form of the original vibrations. When dot and dash signals are received, the tone is of comparatively little importance, whereas with voice or music it is essential that the tone quality be retained.

In broadcasting the high frequency oscillations are produced by means of a tube or group of tubes, practically identical with those used for reception, but designed to handle large currents and voltages. The majority of American stations use vacuum tubes of 250 watts power rating, one or more of them being used to obtain the total power required. These tubes are shown in the illustration, Fig. 1.

When a program is being broadcast, the action is somewhat as follows: The artists are disposed before the microphone with due regard to the effect of certain instruments. That is to say, one type of instrument may be placed near the microphone, while another must be placed farther away, owing to the differences in tone and volume. This is done to prevent any one tone or range of tones from predominating. These speech or music currents are converted into electrical variations by the microphone and then increased many times in power or amplitude by means of a

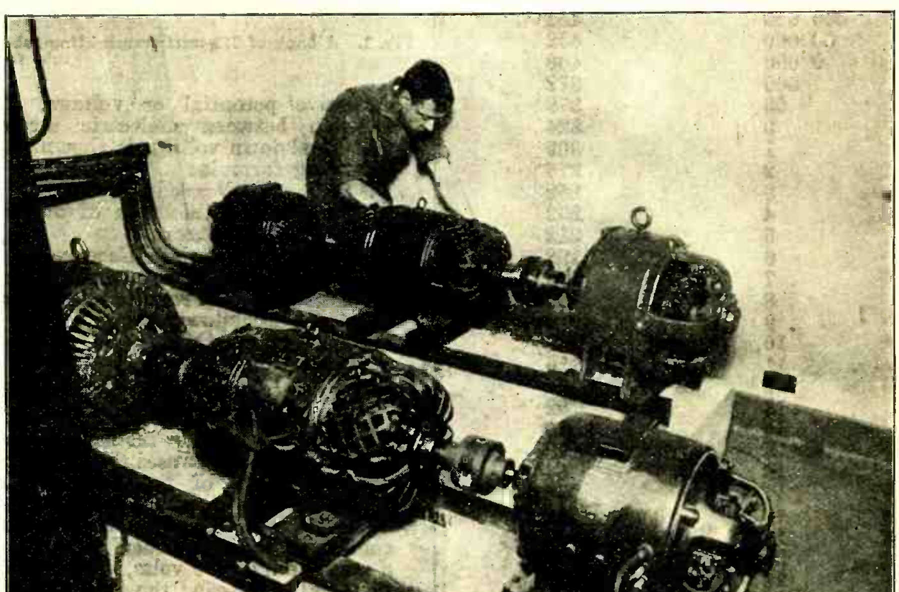
alternating current supply is stepped up or transformed through high voltage transformers and then rectified by means of special vacuum tubes.

The high frequency waves are applied to the antenna system tuned circuits and carefully modulated in accordance with the variations of the speech or music being transmitted. The action of the transmitter and the effect of the modulation must be carefully observed at all times during the transmission of programs. (See *Harmonic Suppressor,* also *Oscillograph.*) Fig. 2 shows the studio of a modern broadcasting station. It is interesting

Fig. 3. Main control panels of a Radio Broadcast Station.

to note that these studios are very carefully arranged and the walls cushioned to prevent troublesome acoustic effects. There must be no reverberation—echoes—or the transmitted program would be distorted by the additional or repeated tones. Fig. 3 shows the main control panels. Fig. 4 illustrates the power generating system of a typical broadcasting station.

The radio waves generated and radiated from the broadcasting station travel away from the antenna at tremendous speed—that of light waves, or about 186,000 miles per second. These waves radiate off into space in



Photos by courtesy of Station WRNY (New York)

Fig. 4. A section of the generator room with power plant in a Radio Broadcast Station.

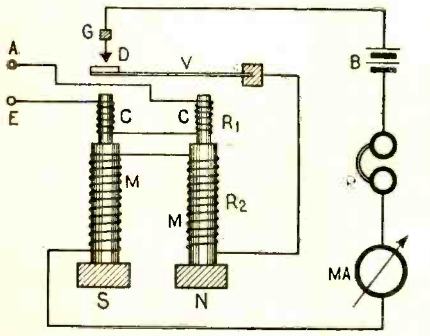
much the same manner as light waves, but a certain portion apparently follow the curvature of the earth. When these waves impinge on a receiving aerial they follow the path of least resistance, and being then in the nature of electrical impulses, they follow the aerial and lead-in wire to the receiving set, and thence to the ground. The receiver is arranged in such fashion that it corresponds electrically to the antenna circuit of the transmitting station. That is to say, the receiver is placed in resonance with the particular signals desired. The usual system of detecting, either with a simple crystal or by means of vacuum tubes, may be followed by special amplification which will make the signals audible on a loud speaker. In many cases the signals are amplified in their original form (radio frequency amplification), then rectified by the detector and further increased in volume at audio frequency. (See *Modulation, Speech Amplifier, Electromagnetic Waves, etc.*)

BROAD TUNING—A term used to designate the lack of *selectivity* in reception or in transmission, the use of several *waves* rather than a sharp, pure wave. If a receiving set is of such a nature that it is difficult or impossible to receive the desired signals without hearing any other, the set is said to be "broadly tuned." (See *Tuning*, also *Selective Tuning.*)

BROKEN CIRCUIT—See *Open Circuit.*

BROWN AMPLIFYING RELAY—An arrangement whereby the comparatively weak signals received by a *crystal detector*, usually of the *carborundum type*, may be *amplified* or increased in intensity, either to allow a recording machine to be used or merely to make the signals more readily audible in the ear phones. The device consists essentially of an arrangement for controlling and stepping up the vibrations in conjunction with a small *battery* or *dry cell.*

One example of such a relay is shown in the illustration. In this case the soft iron *cores* cc are *magnetized* by the *permanent magnets* mm, the poles of which are marked n and s. R1 is a fine wire winding such as is ordinarily used in ear phones and R2 is a larger winding placed over the main magnets mm. Directly above the



The Brown Amplifying Relay Circuit.

soft core cc with the windings R1 is placed a steel vibrating tongue V having a contact D which touches lightly contact G. Contact G is of a special alloy of osmium and iridium and the contact D is a carbon button, which in contact with G forms a *microphone.* The winding R2 is joined with the telephone P and the battery B, all in series with the microphonic contact. When current (signal current) enters the leads A—E through the windings R1 the result is a change of *flux* in the core of the magnet which vibrates the tongue V. This in turn varies the current of the battery B and causes correspondingly greater sounds in the ear phones P. Several of these relays may be connected together to permit a much greater *amplification* of the original signals.

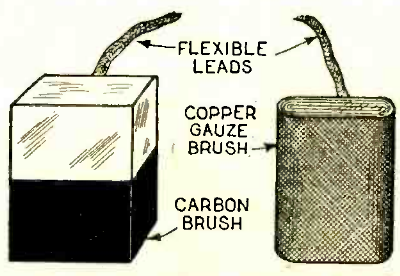
BROWN & SHARPE GAUGE—The American wire gauge adopted as standard for wires for electrical purposes. Commonly known as B. & S. The various sizes run from 40 to 0000, 40 having a diameter of .00314 inch, and 0000 being .46 inches in diameter. We refer to wire having a diameter of .00314 inch as being 40 B. & S. gauge. (*See page 26 for table.*)

BROWN, Sidney George—Born in Chicago, U. S. A., in 1873, of English parents, he was educated at Harrogate and London University. An early study was made by him of the subject of submarine telegraphy. During these investigations he invented the magnifying relay for cables. Another important invention was the cable drum relay. In the year 1898 he invented the magnetic shunt. Since that time many of his activities have been directed to the solution of problems in telephone and wireless telegraphy.

In particular the radio experimenter will know the telephone receivers bearing his name and the important developments of the *microphone relay.* In the field of land telegraphy and telephony, his activities have resulted in the invention of such items as the carbon telephone relay system, which is largely used on land trunk lines for the transmission and reception of telephony.

He is a Fellow of the Royal Society and Vice-President of the Radio Society of Great Britain. His writings on technical subjects are extensive, and numerous valuable patents have been taken out by him, including the vacuum tube *oscillation generator* in 1916 and ionic electric relays in 1918.

BRUSH—A device for collecting current from the *commutator* (*q.v.*) of a *dynamo* or supplying current to the commutator of a motor. Brushes are made in a great variety of forms, the most



Two different types of Brushes. At the left is shown a carbon brush, and at the right a copper gauze brush.

common being carbon blocks or brass or copper gauze. The illustration shows two different types.

BRUSH ANGLE—The angle formed by a brush in its contact with the *commutator.* The angle is usually 45°. If the brushes do not bed properly, sparking is apt to occur.

BRUSH DISCHARGE—A faintly luminous discharge which takes place on the surface of *conductors* charged to *high potential*, due to *ionization.* This effect can be noted at times on the *antenna* of a powerful transmitting station. (See *Corona.*)

BRUSH HOLDER—Metal clamp capable of adjustment which holds the *brush* in position on the *commutator* of a dynamo or motor. (See *Brush.*)

BRUSH LOSS—The loss in *watts* or power due to the friction of the brushes against the *commutator.* This loss is at a minimum when the brushes make perfect contact at the proper angle.

BRUSH PRESSURE—A term used to designate the pressure with which the brushes bear on the *commutator* of a dynamo machine and also referring to the voltage or *electrical pressure* delivered at the brushes.

B. S. G.—Abbreviation for British Standard Gauge of Wire, commonly known as B. S. (See *British Standard Wire Gauge.*)

B. T. U.—Abbreviation for "British Thermal Unit," being the commonly used heat unit. The amount of heat required to raise the temperature of a pound of water one degree Fahrenheit at ordinary atmospheric pressure.

BUCHER, Elmer E.—Born Akron, Ohio, Nov. 11, 1885. Educated at high school and private tutors. An American pioneer, Experimental Engineer with DeForest Wireless Telegraph Company in 1903; constructed several high power stations in Middle West and Gulf Coast and later for United Wireless, which absorbed the Deforest Company. Organized training school for United Wireless and instituted first radio schools for Y. M. C. A. in New York City. Supervised commercial operations and conducted research work for United Wireless; later instructing engineer Marconi Wireless Tel. Co. Technical Editor "Wireless Age" 1913 to 1917. Appointed Commercial Engineer for newly formed Radio Corporation of America in 1920, and since 1922 has been in charge of general sales for that corporation. Author of numerous standard works on radio, including "Practical Wireless Telegraphy," "Wireless Experimenters' Manual," "Vacuum Tubes in Wireless Communication," and many others. Holds numerous U. S. patents on radio systems and devices.

BUCKLED DIAPHRAGM—Warping of the *diaphragm* of a phone as used in radio. Excessive voltages if applied direct to the head-phones will often bend the diaphragms. Any such defect may seriously impair the operation of the part and when it is noted that a diaphragm is bent or warped through rough usage or the application of too great voltages, it is best to replace it immediately.

BUCKLING OF PLATES—During discharge of a *storage battery* the plates gradually expand, owing to the fact that lead sulphate has about twice the volume of the same quantity of lead peroxide. Should this expansion or discharge take place too quickly, the plates will bend or buckle. (See *Storage Battery.*)

BUNSEN BURNER—A form of gas burner frequently used in radio construction for heating the soldering iron where electricity is not available. By special arrangement of the parts, the gas is combined with the proper amount of air before it reaches the burning part. This is done by driving the gas through a tube with small holes drilled to allow the air to be sucked in. This method promotes complete combustion and gives a non-luminous flame that heats the soldering iron without

THE BROWN & SHARPE (B. & S.) COPPER WIRE GAUGE—Below is a comprehensive copper wire table, which is the standard one in use in the United States. The resistance and cross-sectional areas of various sizes of conductors are given, so that considerable calculating can be done with the data at hand. A mil means 1-1000 (one thousandth) of an inch. Hence a wire with a diameter of 9 thousandths of an inch could also be stated as having a diameter of 9 mils. The area of cross-section of the wire in circular mils is found by squaring the diameter in mils; thus the 9 mil conductor would have 9 times 9, or 81 circular mils area. This is the end area of the wire, of course, and is used in all electrical figuring. If the resistance per 1,000 feet of a certain size wire is, say, 50 ohms, then 50 feet of the same size wire would have a proportionately less amount of resistance, or ½ of 50 ohms equals 25 ohms. The resistance per foot is found by dividing the resistance in ohms per 1,000 feet by 1,000. This wire table is for bare copper wire. Conductors, according to the B. & S. standard gauge, halve their sectional area in circular mils (Cir. Mils) for every 3 gauge sizes smaller wire; and double their sectional area in Cir. Mils for every 3 gauge sizes increase.

Gauge Number.	Size		Weight and Length.			Resistance.			Carrying Capacity, 2,000 Amperes p. sq. in. section.
	Diameter in Mils.	Square of Diameter or circular Mils.	Grains per Foot.	Pounds per 1000 Feet.	Feet per Pound.	Ohms per 10000 Feet.	Feet per Ohm.	Ohms per Pound.	Amperes.
0000	460.000	211600.0	4477.2	639.60	1.564	.051	19929.7	.0000785	430
000	409.640	167804.9	3550.5	507.22	1.971	.063	15804.9	.000125	262
00	364.800	133079.0	2815.8	402.25	2.486	.080	12534.2	.000198	208
0	324.950	105592.5	2236.2	319.17	3.133	.101	9945.3	.000815	165
1	289.300	83694.49	1770.9	252.98	3.952	.127	7882.8	.000501	130
2	257.630	66373.22	1404.4	200.63	4.994	.160	6251.4	.000799	103
3	229.420	52633.53	1113.6	159.09	6.285	.202	4957.3	.001268	81
4	204.310	41742.57	883.2	126.17	7.925	.254	3931.6	.002016	65
5	181.940	33102.16	700.4	100.05	9.995	.321	3117.8	.003206	52
6	162.020	26250.48	555.4	79.34	12.604	.404	2472.4	.005098	41
7	144.280	20816.72	440.4	62.92	15.893	.509	1960.6	.008106	32
8	128.490	16509.68	349.3	49.90	20.040	.643	1555.0	.01289	26
9	114.430	13094.22	277.1	39.58	25.265	.811	1233.3	.02048	20
10	101.390	10381.57	219.7	31.38	31.867	1.023	977.8	.03259	16
11	90.742	8234.11	174.2	24.89	40.176	1.289	775.5	.05181	13
12	80.808	6529.93	138.2	19.74	50.659	1.626	615.02	.08237	10.2
13	71.961	5178.39	109.6	15.65	63.898	2.048	488.25	.13087	8.1
14	64.084	4106.75	86.87	12.41	80.580	2.585	386.80	.20830	6.4
15	57.068	3256.76	68.88	9.84	101.626	3.177	306.74	.33133	5.1
16	50.820	2582.67	54.67	7.81	128.041	4.582	243.25	.52638	4.0
17	45.257	2048.19	43.33	6.19	161.551	5.183	192.91	.83744	3.2
18	40.303	1624.33	34.37	4.91	203.666	6.536	152.99	1.3312	2.5
19	35.390	1252.45	26.50	3.786	264.136	8.477	117.96	2.2392	1.96
20	31.961	1021.51	21.60	3.086	324.045	10.394	96.21	3.3438	1.60
21	28.462	810.09	17.14	2.448	408.497	13.106	76.30	5.3539	1.28
22	25.347	642.47	13.59	1.942	514.933	16.525	60.51	8.5099	1.08
23	22.571	509.45	10.77	1.539	649.773	20.842	47.98	13.334	.80
24	20.100	404.01	8.55	1.221	819.001	26.284	38.05	21.524	.63
25	17.900	320.41	6.77	.967	1044.126	33.135	30.18	34.298	.50
26	15.940	254.08	5.38	.768	1302.083	41.789	23.93	54.410	.40
27	14.195	201.49	4.26	.608	1644.737	52.687	18.98	86.657	.31
28	12.641	159.79	3.39	.484	2066.116	66.445	15.05	137.283	.25
29	11.257	126.72	2.69	.384	2604.167	83.752	11.94	218.104	.20
30	10.025	100.50	2.11	.302	3311.258	105.641	9.466	349.805	.16
31	8.928	79.71	1.67	.239	4184.100	133.191	7.508	557.286	.13
32	7.950	63.20	1.33	.190	5263.158	168.011	5.952	884.267	.098
33	7.080	50.13	1.06	.151	6622.517	211.820	4.721	1402.78	.078
34	6.304	39.74	.847	.121	8264.463	267.165	3.743	2207.98	.062
35	5.614	31.52	.658	.094	10638.30	336.81	2.969	3583.12	.049
36	5.000	25.00	.525	.075	13333.33	424.65	2.355	5661.71	.039
37	4.453	19.83	.420	.060	16666.66	535.33	1.868	8922.20	.031
38	3.965	15.72	.315	.045	22222.22	675.22	1.481	15000.5	.025
39	3.531	12.47	.266	.038	26315.79	851.789	1.174	22415.5	.020
40	3.144	9.88	.210	.030	33333.33	1074.11	.931	35803.8	.015

depositing soot as in the case of an ordinary luminous flame.

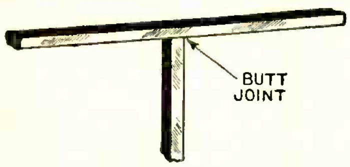
BURSTYN, Dr. W.—Born in Austria, 1877. Educated at Vienna University. Noted as: Developer of the *quenched spark system* in radio transmission, upon which he worked in conjunction with Baron Lepel in 1907 to 1912.

BUS BAR—A single bar, usually copper, which serves as a common connector for a number of pieces of apparatus. Also referred to as Omnibus Bar.

BUS BAR WIRE—Square copper wire, usually tinned, much used in making radio connections. This wire is generally furnished in lengths of two or two and a half feet and is particularly efficient for radio work, as it offers a low *resistance* connection, makes a neat appearance, and is suitable for soldering at joints.

BUSHING—Pieces of insulating material, usually fibre or rubber composition, used to *insulate* parts of radio apparatus or in mounting machine screws or shafts of *condensers* and other devices. The term is also applied to brass or other metal bearings through which the shaft of a piece of apparatus is run.

BUTT JOINT—A method joining two lengths of wire together by placing them end to end or at right angles and



Showing how a Butt Joint is made.

soldering the joint. The illustration shows a common butt joint.

BUZZER—An electric call signal device that makes a buzzing noise caused by the rapid vibrations of a contact breaker in a circuit using a small *battery* or *cell*. (See *Testing Circuit.*)

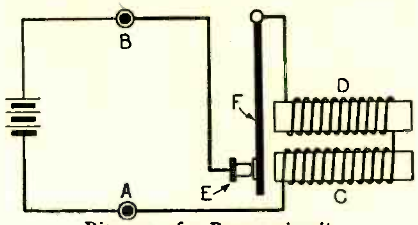
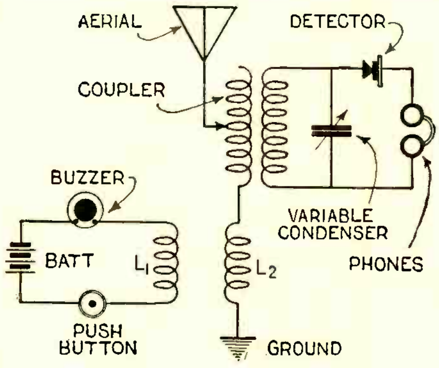


Diagram of a Buzzer circuit.

As the *current* flows from the posts A B the *electro-magnets* C and D are energized and draw down the vibrator spring F. This breaks the contact between E and F and as the current no longer flows the magnets release the spring F, which returns to its normal position and establishes the circuit once more. This making and breaking of the circuit takes place so rapidly that the vibrator makes a buzzing or humming sound, the speed with which it vibrates determining the pitch of the note. (See *Frequency*, also *vibration.*)

BUZZER EXCITER—A method of using a *buzzer* to produce local signals in a crystal receiving circuit to permit sensitive adjustment of the *detector*. The illustration shows a common method of producing signals to test the receiving set in this manner. In this case a small coil having a few turns of wire is placed in the buzzer circuit as indicated and a similar one is placed in the ground lead of the receiving set. When the button is depressed the buzzer is set in vibration and a transfer of energy takes place between L1 and L2. This causes an *oscillating* impulse (*q.v.*) to flow through the receiver circuit. The detector can then be adjusted to the most sensitive point at which it can be left until outside signals are heard. Another but less efficient method of exciting the circuit is to connect a short length of wire from the contact point of the buzzer to the ground connection of the receiving set. The former system is much more practical and furnishes better test signals.



Buzzer Exciter.

Coil L1 being placed in *inductive relation* to coil L2, which is in the antenna circuit, undergoes a change of *flux* when the buzzer is *excited.* This sets up a *difference of potential* across coil L2 which charges the antenna ground system and produces oscillation at a definite *frequency* according to the adjustment. Now if the secondary circuit is tuned to resonance with the primary circuit, the signals will be audible in the phones when the detector is properly adjusted. Also called *Buzzer Wave Generator.*

BUZZER MODULATION—See *Modulation.*

BUZZER PRACTICE SET—A combination of a *buzzer* and signalling key arranged on a baseboard used for the purpose of practicing signalling.

B. W. G.—The abbreviation for Birmingham Wire Gauge—a system of gauging wire used in England. (See *B & S Gauge*, also *British Standard Wire Gauge.*)

BY-PASS CONDENSER — See *Condenser*, also *Filter.*

C

C—The chemical symbol for carbon. When printed in *italics*, it is also the symbol for *coulomb* in electrical practice. It is the international symbol for *capacity.*

CABLE—A number of wires stranded together, used to carry electrical currents, heavily insulated and often covered by a sheath or outer coating of lead, rubber, gutta percha, or braided silk or cotton. The term is used very often in a broad sense to signify any heavy wire or strand of wires that may be insulated more thoroughly than is ordinarily the case. (See *Conductor*, *Stranded Wire*, etc.)

CADMIUM—A chemical metallic element somewhat resembling zinc. In color, white with a bluish tinge. It is useful in fusible alloys because of its property for uniting readily with other metals, having a low melting point. Its electrical conductivity is about 25% of that of silver. It is very useful in the construction of a crystal detector, the molten metal holding the crystal firmly and as it melts at a low temperature the heat will not affect the sensitivity of the crystal. Cadmium is also used in making cells, notably the *Weston Cell.* (See *Weston Cell.*)

CAGE ANTENNA—An aerial having a number of wires arranged in cylindrical form, suspended either vertically or as a horizontal top. So named because of its resemblance to a cage. (See *Aerial.*)

CALCULATION OF CAPACITY—The mathematical or comparative determination of *capacity.* There are various formulas in use for calculating capacity under various conditions, such as for capacity of various types of condensers, or the capacity of a circuit. Rough approximations of capacity of condensers might be obtained by direct comparison with a known value. Other formulas are used for the calculation of antenna capacity. For determining the capacity of flat condensers, such as fixed condensers used for transmitting or receiving circuits, the following formula is generally used:

$$C = 0.0885\,K\,\frac{S}{r}$$

In this case, C is the capacity in micro-micro farads; to obtain result in the usual units of micro-farads, divide the result by one million. S is the surface area of one plate in square centimeters; r is the thickness of the dielectric in centimeters and K a constant depending on the material between the plates of the condenser. (See *Dielectric Constants.*)

CAL-ELECTRICITY — Electricity produced in the secondary of a transformer due to changes in temperature of the core. This current is in addition to the current normally induced in the secondary. (See *Transformer*, *Core*, also *Core Losses.*)

CALIBRATION — A process whereby instruments such as *galvanometers*,

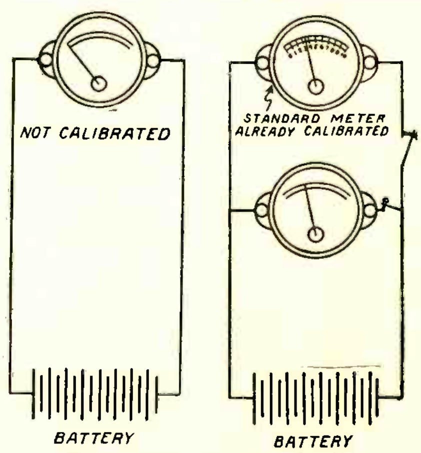


Fig. 1. Fig. 2.
Calibrating a Meter

ammeters, *wavemeters*, etc., are made to indicate certain values. Before such instruments can be made use of, it is necessary to mark the dials in such a manner that the indicator showing on the dial or scale will have a definite meaning in terms of electrical values. Thus, a voltmeter before calibration is shown in Fig. 1. When it is placed across a battery, the pointer will move to some position on the white space, but without indicating any definite value. Now by testing with another meter which is already marked or calibrated in volts, we find, for example, that when the pointer is at the middle point in its swing, it indicates 10 volts. Similarly various other positions are found to indicate more or less voltage by comparison with the standard. This is shown in Fig. 2. It will be understood that one of the small switches must be open at all times. The reading of the calibrated meter is taken with the other meter out of the circuit (switch open), then the reading is marked on the other meter at the point indicated with the calibrated meter out of the circuit. Such a method would, of course, be inefficient and it is shown only to give a rough idea of the purpose and meaning of calibration. Another example of calibration is in the case of a dial on a receiver. Fig. 3 shows the usual form of dial used in tuning a receiving set. The dial is marked off to scale, from 1 to 100, the numbers having no particular significance. Now if we find that when the tuning dial is set at 20 it is adjusted for a wavelength of 260 meters, we can put that figure in place of the 20. The same procedure can be followed throughout the entire range of the dial, and when thus marked in terms of a definite quantity—wavelength in meters in this case—the dial is said to be calibrated.

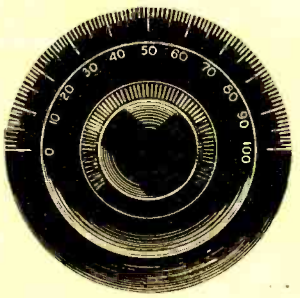


Fig. 3.

A dial as used on radio receiving sets may be Calibrated according to different wavelengths.

The actual method to be followed out in calibrating will depend on the equipment available and the accuracy desired. If a standard of comparison is available, it saves a great deal of work. Thus, a voltmeter can easily be calibrated by means of a standard meter, already calibrated, and a source of steady voltage controlled by a rheostat. An ammeter can be calibrated in the same manner by using a standard ammeter, and a wavemeter can be calibrated from another wavemeter of known values.

Calibration may be done in such a manner that the readings require mathematical solution to determine their value in terms of actual volts, amperes, meters and so on, or it may be *absolute*, in which case the readings are directly in terms of the quantity and require no solution. (See *Voltmeter Calibration, Wavemeter Calibration,* also *Rough Calibration.*)

CALIDO—An alloy containing nickel and chromium with a small percentage of iron. The melting point is very high, about 1550 degrees centigrade. Calido wire is much used as a *resistance*, particularly for heating devices. The chief characteristics are as follows: maximum working temperature 1100 degrees centigrade; microhms per cubic centimeter at 20 degrees centigrade, 100; temperature coefficient per degree centigrade, 0.00034; specific gravity, 8.2.

CALLAND CELL—A primary cell used in French telegraph work. It is a form of gravity cell having a negative electrode of copper and a positive electrode of amalgamated zinc, the electrolyte being zinc sulphate. Crystals of copper sulphate are used as a depolarizer. (See *Gravity Battery.*)

CALORIE—The unit of heat in the C. G. S. (Centimeter-Gram-Second) (q.v.) system. It is equivalent to the amount of heat necessary to raise the temperature of one gram of water from 0° to 1° centigrade. (See *Thermal,* also *C. G. S.*)

CALORIMETER—In electrical practice, an instrument used to measure the heat generated in a conductor carrying an electric current.

CAMBRIC, VARNISHED—Varnished muslin used as an insulating material. Also known as Empire Cloth. (See *Spaghetti.*)

CANAL RAYS—When an electric discharge takes place between the *anode* and a perforated *cathode* in a vacuum tube, fine pencils of light are seen to pass through the perforations in the cathode. These rays are called *canal rays*, and consist of positively charged particles. They produce phosphorescence on the wall of the tube.

Canal rays travel at a lesser velocity and in the opposite direction to the cathode rays. This fact and also the fact that the rays are deflected by powerful electric or magnetic fields in the opposite direction to cathode rays, is taken as proof that they consist of positively charged particles. (See *Cathode Rays.*)

CAPACITANCE—A term very often used as synonymous with *capacity*. Due to the fact that capacity may refer to the current carrying ability of a conductor and also to electrostatic capacity, it has been suggested that capacitance be used to refer only to *electrostatic capacity* of a body or device. Capacity would then refer to *current carrying ability*. (See *Capacity,* also *Electrostatic.*)

CAPACITATIVE REACTANCE—That part of the *reactance* of a circuit carrying alternating current which is due to the *capacity* in the circuit. (See *Reactance* also *Impedance.*)

CAPACITATIVE COUPLING—See *Coupling.*

CAPACITY—Generally speaking, the quantity of electricity in any form which a body is able to store or contain. The term is usually qualified to denote the particular case, such as *electrostatic capacity*, which is a measure of the ability of a condenser to store up energy in the form of electrostatic charges; also *current-carrying capacity* of a conductor, which is considered as the ability of a wire to carry a certain amount of electric current without overheating. The tendency in electrical literature is to use the term capacitance as applying to the electrostatic capacity of a condenser. Thus, a certain condenser may have a capacitance of 2 micro-farads. The unit of electrostatic capacity is the *farad.* This is understood as the capacity of a condenser that will store one *coulomb* of electricty under an electromotive force of one *volt.* When V is expressed in volts, C in farads, and Q in coulombs, $C = Q/V$.

CAPACITY CIRCUIT—An electrical circuit in which the *capacity* is very large compared with the *inductance*. The inductance may be considered negligible.

CAPACITY CONVERSION FACTORS—In the calculation of *capacity*, as the capacity of a condenser, there are several different units. For instance, a *farad* is a large unit of capacity and is equal to one million *microfarads*, or conversely, a microfarad is equal to one millionth of a farad. In the same way a farad is equal to one billionth of an *abfarad*. The four units used in capacity measurement are the *farad, micro-farad, micromicrofarad, statfarad* and *abfarad.* The following table gives the conversion factors for these various units:

$$1 \text{ abfarad} = \begin{cases} 10^9 \text{ farads} \\ 10^{15} \text{ mfds.} \\ 9 \times 10^{20} \text{ stfds.} \end{cases}$$

$$1 \text{ farad} = \begin{cases} 10^{-9} \text{ abfd.} \\ 10^{6} \text{ mfds.} \\ 9 \times 10^{11} \text{ stfds.} \end{cases}$$

$$1 \text{ mfd.} = \begin{cases} 10^{-15} \text{ abfd.} \\ 10^{-6} \text{ farads} \\ 9 \times 10^{5} \text{ stfds.} \end{cases}$$

$$1 \text{ stfd.} = \begin{cases} 1/9 \times 10^{-20} \text{ abfd.} \\ 1/9 \times 10^{-11} \text{ farad} \\ 1/9 \times 10^{-5} \text{ mfd.} \end{cases}$$

$$1 \text{ mmfd.} = 10^{-6} \text{ mfd.}$$

In the table above, farad is abbreviated Fd.; abfarad is shown as abfd.; microfarad is mfd., micromicrofarad is mmfd. and statfarad is stfd. In dealing with large figures containing many ciphers the amount is shown as 1,000,000 is 10^6 and $\frac{1}{1{,}000{,}000}$ is 10^{-6}, etc. (See *Capacity, Farad,* also *Unit.*)

CAPACITY EARTH or CAPACITY GROUND—A substitute for the usual ground connection where the wires or plates are buried beneath the ground or attached to a water or steam pipe. It is in effect a second aerial, and is placed either under the regular aerial or to one side. It is more used in radio transmission than in reception. (See *Counterpoise.*)

CAPACITY ELECTROSTATIC—See *Capacity* also *Electrostatic Capacity.*

CAPACITY FREQUENCY FACTOR—The relation between the apparent capacity of a condenser and the *electrostatic capacity*. (See *Capacity, Condenser* also *Electrostatic.*)

CAPACITY OF CONDENSERS IN PARALLEL—When several condensers are connected in parallel the resultant capacity is the sum of the individual capacities. It is written:

$$\text{Capacity} = C_1 + C_2 + C_3, \text{etc.}$$

It will be evident that the resultant capacity of condensers connected in parallel is just the reverse of case for resistances, where the total resistance is less than that of the smallest individual resistance in the parallel connection. (See *Resistance Measurement* also *Capacity of Condenser in Series,* also *Condensers in Series* and *Condensers in Parallel.*)

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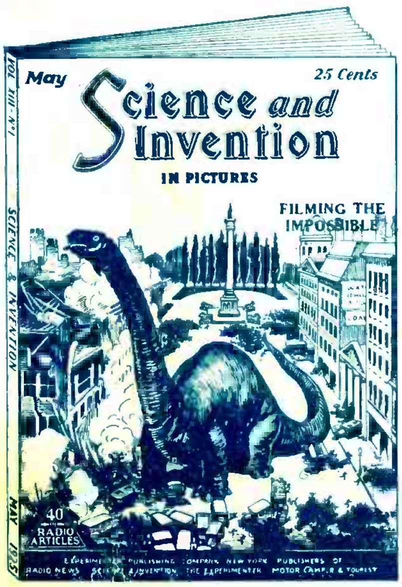

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