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RADIO REVIEW

Reg. U.S. Pat. Off.

A Digest of the Latest Radio Hookups

Edited by S. Gernsback

Containing *Illustrated* Radio Encyclopedia

See Page 81

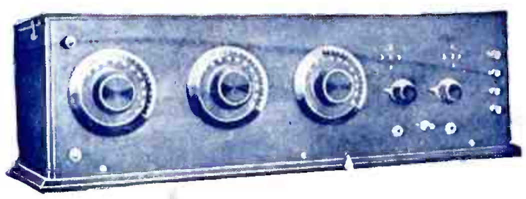
Published by the
CONSRAD CO. Inc.
NEW YORK CITY

Just Seven Simple Tools

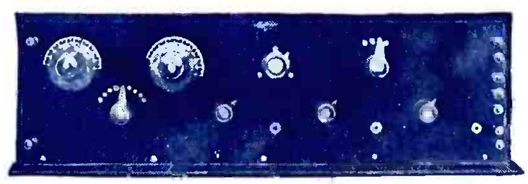
SUPER-HETERODYNE

THE TROPADYNE

THE NEUTRODYNE



5-TUBE COCKADAY



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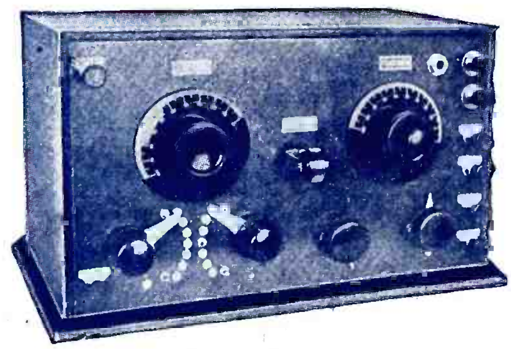

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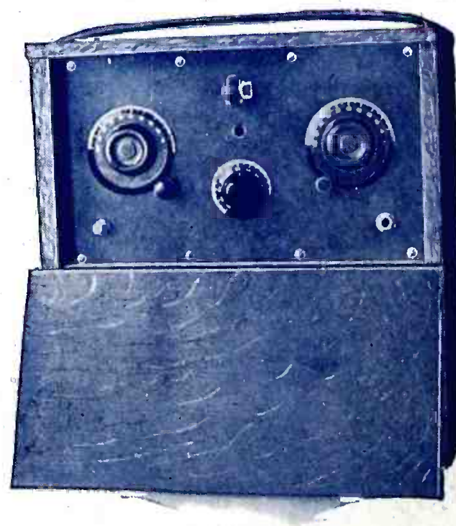

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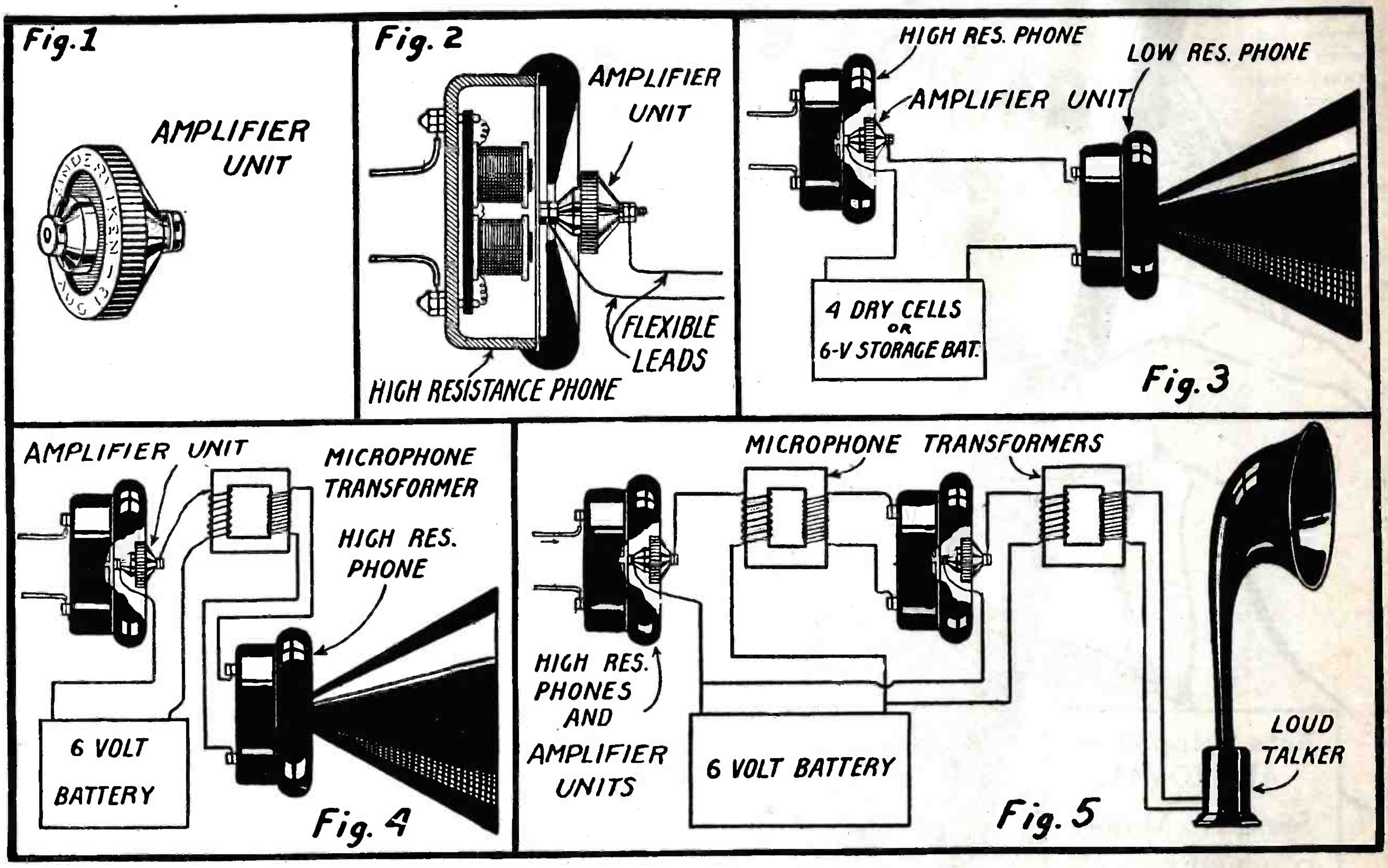

FIG. 1 shows the amplifier unit, actual size.

FIG. 2 shows how the unit is attached to a telephone receiver. The first procedure is to mount the unit on the diaphragm of a telephone receiver, which usually is a high resistance telephone, either 1,000 or 1,500 ohms.

Next we select the loud speaking telephone. If a low resistance telephone is available, it should have for maximum efficiency an impedance equal to the resistance of the amplifier unit, or about 10 ohms; it is connected up as shown in Figure 3. A 5 ohm telephone receiver is used in this circuit with a 6-volt storage battery.

Two telephones taken from a good double head-set of 2,000 to 3,000 ohms which do not rattle on strong currents, are employed in Fig. 4, one at the receiving end, the other as loud talker. In this hook-up there is one instrument which must absolutely be used with this combination, the transformer. As stated before in connection with Fig. 3, the impedance of the telephone, if used in direct connection, should equal the resistance of the unit. But as the impedance of the telephone in Fig. 4 is much higher than the resistance of the unit, it may be 200 times as great, a transformer having a step-up ratio is used to match up the resistance of the unit with the impedance of the loud speaking telephone. In other words, the primary coil of the transformer should have an impedance (which is sometimes called "A. C. resistance") equal to the resistance of the unit, or about 10 ohms, and the secondary coil should have an impedance equal to the impedance of the high resistance telephone. This transformer may be purchased in any Radio Store and is called a microphone transformer or modulation transformer, designed primarily to use in radio transmitting sets. A 6-volt battery gives the best results. The current passing through the unit will vary from .1 to .25 ampere.

FIG. 5 shows a circuit for further increasing the volume of sound. This is simply two of the circuits, such as shown in Fig. 4, linked together. This arrangement is highly sensitive and the telephones on which the units are mounted should be packed in a box of cotton, as the slightest vibration or sound in the room will be picked up and heard in the loud talker. Any sensitive radio loud talker may be used in this particular circuit.

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RADIO REVIEW

REG. U.S. PAT. OFF.

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

In This Issue

S. GERNSBACK'S RADIO ENCYCLOPEDIA

Fifth Installment

EMPHATIC proof that very many of our readers are at this moment constructing receivers is offered in the flood of letters which the postman daily unloads upon our desk, bringing a thousand and one questions from our friends in every part of the country.

¶ We have tried faithfully to answer all these letters individually, but the volume of them makes it impossible to attempt any longer to keep up with our correspondence in this way. We should need an organization ten times as large as the present staff of RADIO REVIEW, adequately to handle the continuing influx of this mail.

¶ To meet this situation more efficiently, we have adopted the plan, beginning with this issue, of devoting a number of pages each month in this, your magazine, to a department of "READERS' PROBLEMS," in which we shall publish answers to questions which interest a majority of RADIO REVIEW readers.

¶ As an instance, we have received no less than 1,500 inquiries concerning the number of turns required in the construction of a certain coil. All such questions will hereafter be answered collectively through this new department, instead of by individual correspondence—except where a coupon is used as explained on page 69, when the query will be answered directly by mail.

¶ Another innovation launched with this issue will be found in the new section under the heading, "INTERNATIONAL RADIO DIGEST." This department has been created for reviewing all well-known radio publications in this country and abroad, and will report in a concise manner all the outstanding features contained from month to month in the radio press the world over.

¶ We should like to hear from our readers as to what they think about these new undertakings, and we are always more than glad to have our friends suggest further ways of making RADIO REVIEW the kind of magazine they want it to be.

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 5

NOVEMBER, 1925

Contents *of* This Issue

RADIO REVIEW, NOVEMBER, 1925 VOLUME I, NUMBER 5

Published monthly by The Consrad Co., Inc., 233 Fulton Street, New York, N. Y., telephone number Cortland 7777; H. Gernsback, President; S. Gernsback, Vice President and Treasurer; R. W. De Mott, Secretary. Price 35c a copy; subscriptions $3.50 a year in the United States of America, Canada and all countries within the domestic postal zone; elsewhere $4.00 a year, payable in advance. Subscriptions only acceptable in U. S. currency or stamps. No foreign currency or stamps. Checks and money orders should be drawn to the order of THE CONSRAD CO., Inc.

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Entered as second class matter, March 10, 1925, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

PRINTED IN THE U. S. A.

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53 Park Place
New York City

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RADIO REVIEW

SIDNEY GERNSBACK, Editor.
W. G. MANY, Associate Editor.
Offices, 233 Fulton St. New York City.

Vol. I NOVEMBER, 1925 No. 5

A Six-Tube Self-Contained Loop Set

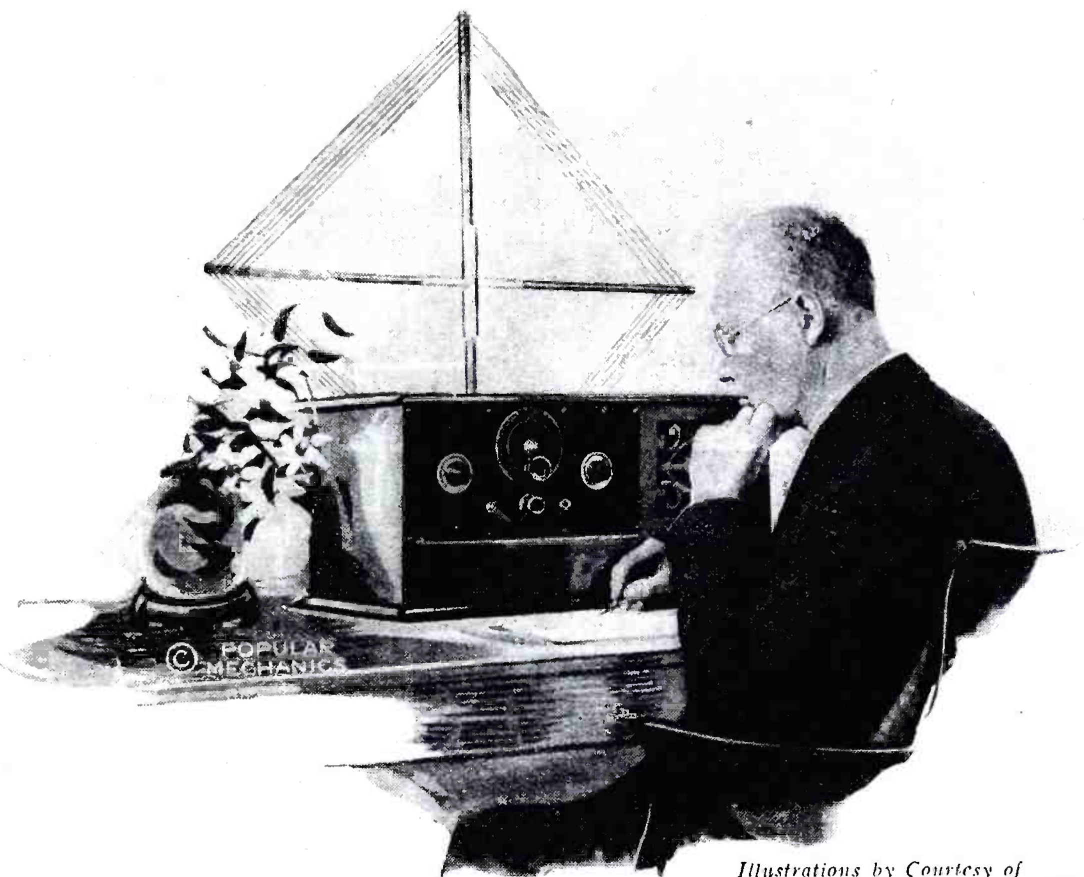
Details for Constructing an Exceptionally Efficient Single-Control Receiver

THERE is a constant demand for a six-tube, self-contained loop receiver, capable of coast-to-coast reception, that can be operated on dry batteries. The instrument described herein by *F. L. Brittin* appeared in *Popular Mechanics* magazine and was designed in Popular Mechanics radio laboratory in response to this demand. Mr. Brittin describes the set as follows.

In order that this set may rightly be called a self contained receiver, the A and B-batteries, as well as the horn, are incorporated in the cabinet with the instrument. The receiver is designed for loop operation, although it can be used with an outside aerial; best results, however, are obtained with the loop. The instrument tunes more closely on the latter, and interference from other stations and static are minimized. The use of an outside aerial tends to broaden the tuning, and bring in extraneous noises.

Good tone, long distance and selectivity are the outstanding features of this receiver. Twenty-seven stations were logged in one evening from Chicago, with good tone and very satisfactory volume on the loud speaker. These stations included Washington, Pittsburgh, Schenectady, Detroit, Cincinnati, Jefferson City, Fort Worth and Los Angeles, all on the loop. No ground is used. The self-contained feature appeals to the feminine members of the family, because there are no messy storage batteries or trailing wires to be kept in order, and its ready portability permits the operator to move the instrument quickly from one room to the other. The instrument is easy to build, and the cost is about $110, which is not high for a set of this type, including, as it does, tubes, batteries, cabinet with built-in loud speaker and loop.

When in operation, place the loop at least 6 ft. from metal objects, such as steam radiators or heating pipes, which would be likely to absorb a part of the energy that would otherwise go to the loop. In buildings where there is an appreciable amount of steel construction, this becomes a real factor with any loop receiver, and the loop will often lose its directional effect, if the set does not refuse to operate at all on distant stations.



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

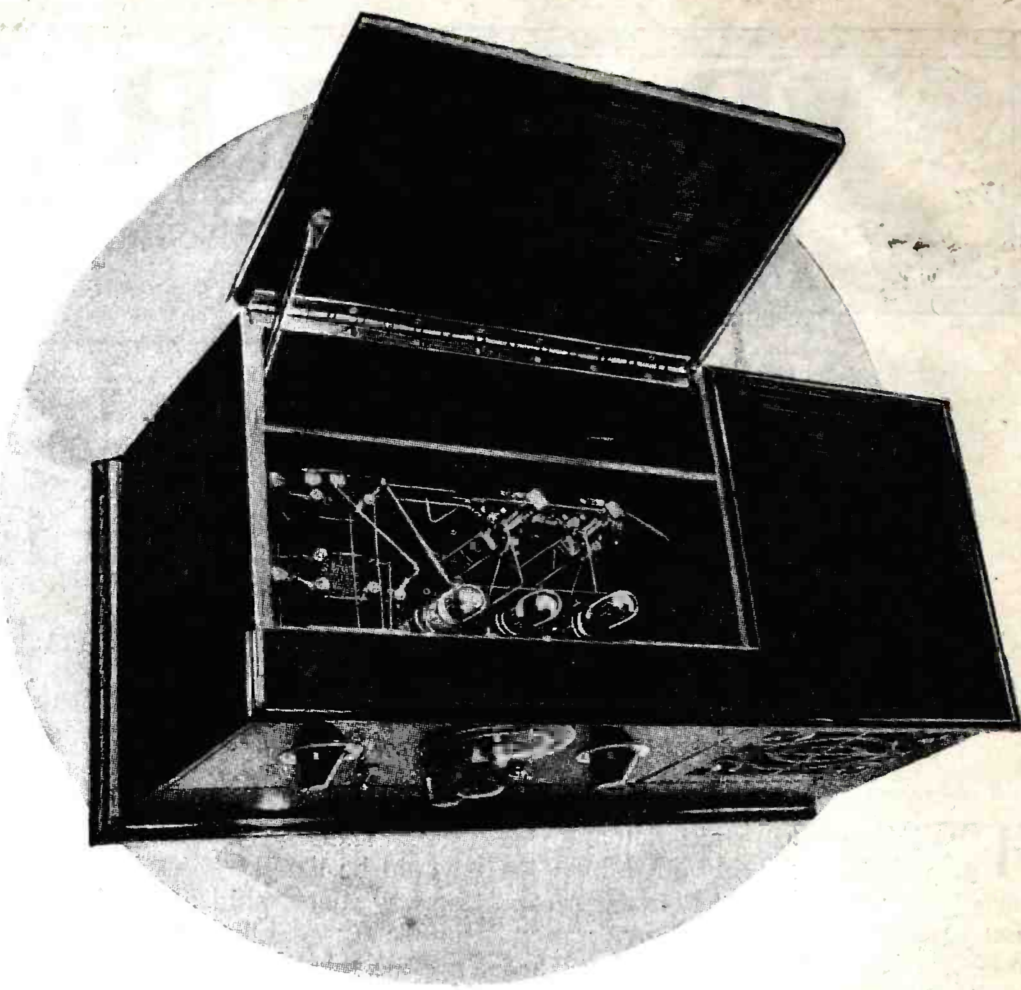
The six-tube self-contained loop set in operation.

It is best to obtain all the parts before beginning construction. The front-panel and baseboard layouts are very simple and clearly shown in the blackprint diagram. The dimensions of the panel and baseboard will vary, of course, according to the size of the cabinet used. No. 14 tinned-copper busbar is used throughout the circuit. Spaghetti tubing is not necessary unless some of the leads should run so close together that there would be possibility of their touching. Keep all plates and grid leads well separated and do not parallel them. Where it is necessary to cross these leads, do so at right angles. Use soldering lugs under all binding posts, and use solder and flux sparingly.

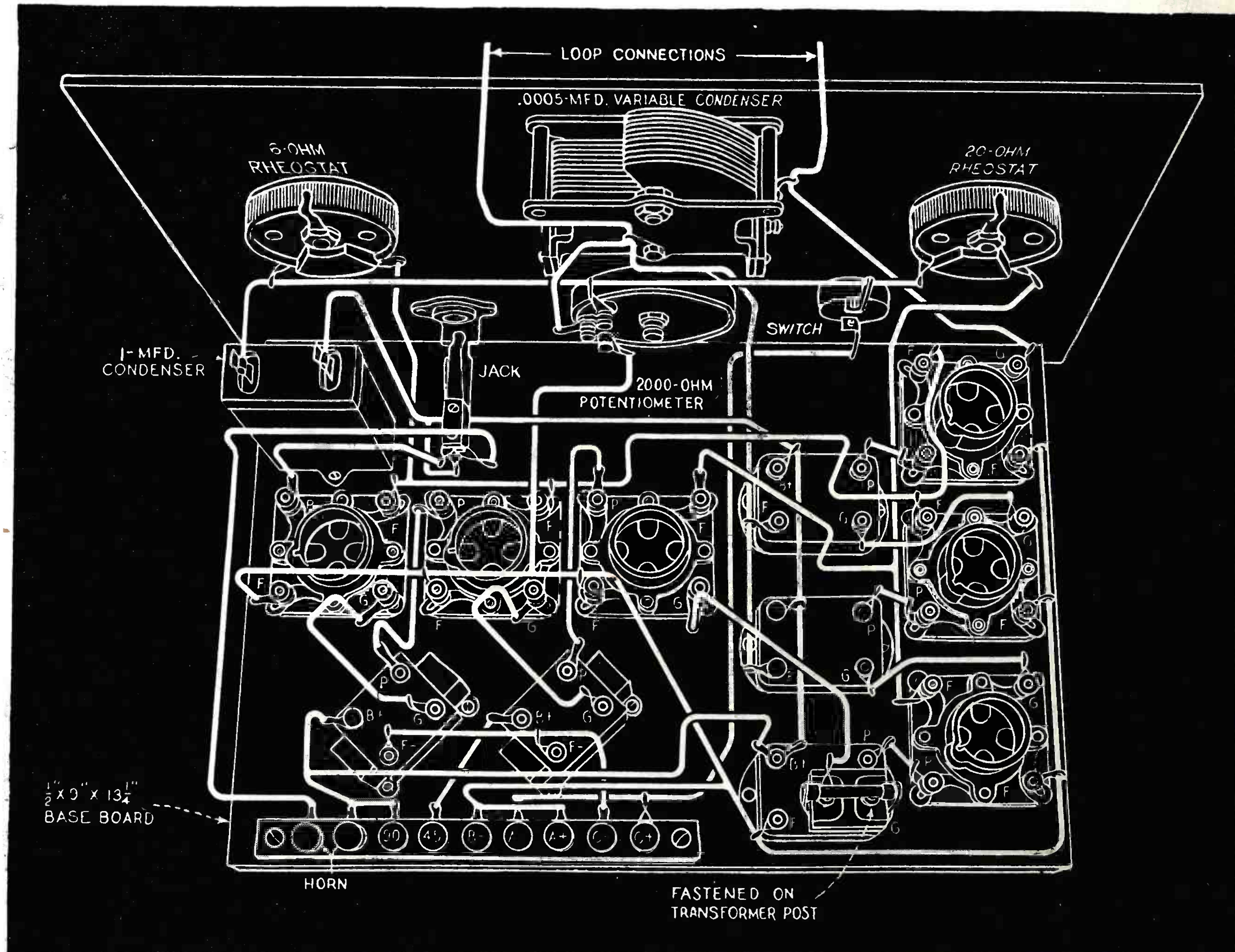
The A, B and C-battery connections are given in the caption under the diagram. The A-battery consists of six No. 6 dry cells connected in series-parallel. The A-positive and B-negative terminal posts are connected together at the terminal strip, but the A-negative terminal is not connected to them. The B-battery consists of 22½-volt units connected in series; the C-battery is a 4½-volt unit.

LIST OF PARTS

1 bakelite or formica panel, 3-16 by 7 by 14 in.
1 baseboard, ½ by 9 by 13¼ in.
1 Cardwell variable condenser, .0005 mfd.
1 vernier dial.
2 audio-frequency transformers, ratio 3½ to 1.
3 Dubilier duratran radio-frequency transformers, range 225 to 550 meters.
6 tube sockets for UV-199 or C-299 tubes (spring or sponge rubber base).
1 small toggle filament switch.
1 by-pass condenser, 1 mfd.
1 6-ohm rheostat.
1 20-ohm rheostat.
1 2,000-ohm potentiometer, G.R.L. or similar type.
1 .00025 Dubilier grid condenser with clips.
1 3-meg. grid leak.
9 binding posts.
1 terminal strip, bakelite or formica, 3-16 by ⅝ by 7½ in.
1 jack having three terminals; two springs; one break contact; frame insulated.
6 No. 6 dry cells.
4 No. 5156 Burgess B-battery units, 22½ volts.
1 No. 2370 Burgess 4½-volt C-battery.
6 UV-199 or C-299 tubes.
1 cabinet with built-in horn, and battery compartment as specified.
1 loop, standard type.



A top view of the set showing upper compartment.

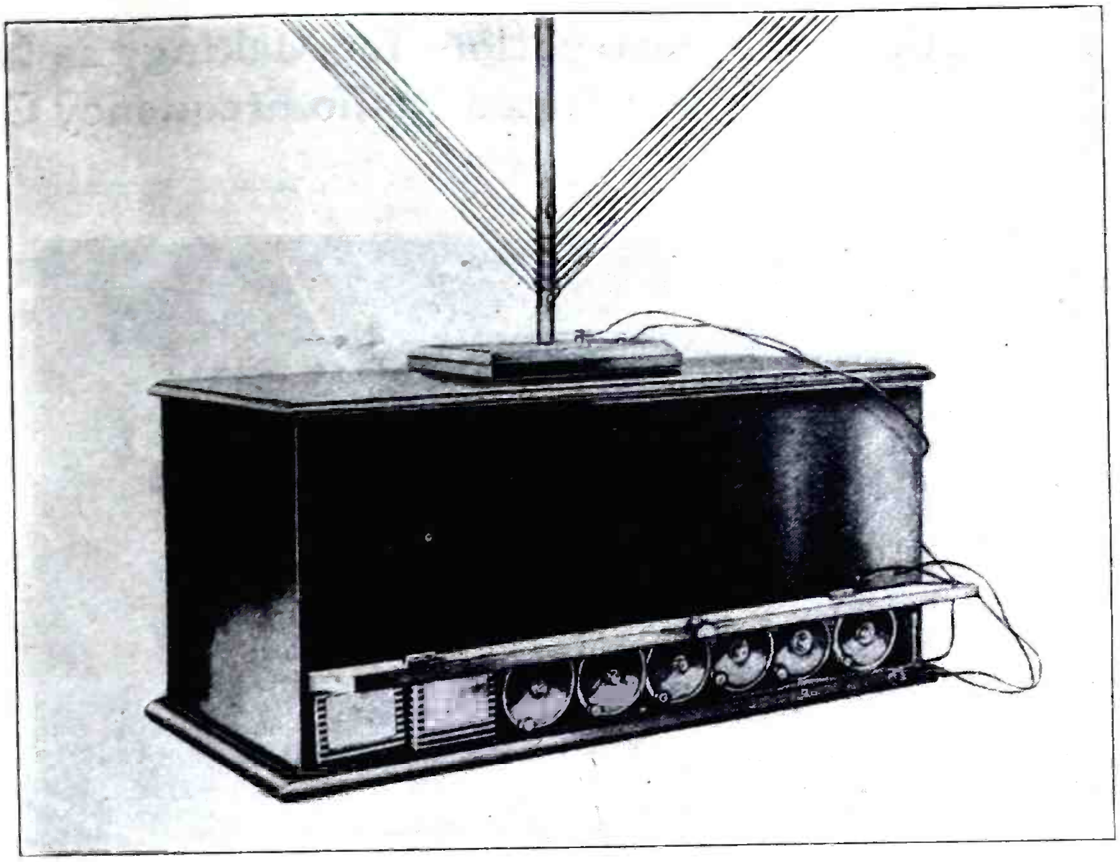


The above shows the complete assembly and wiring of the six-tube self-contained loop set. The binding posts on the insulating strip are connected as follows: Reading from the left—First two, loud speaker; third, 90 volts +"B" battery; fourth, 45 volts +"B" battery; fifth, "B" battery —; sixth, "A" battery — 4½ volts; seventh, "A" battery +; eighth, "C" battery — 4½ volts; and ninth, "C" battery +.

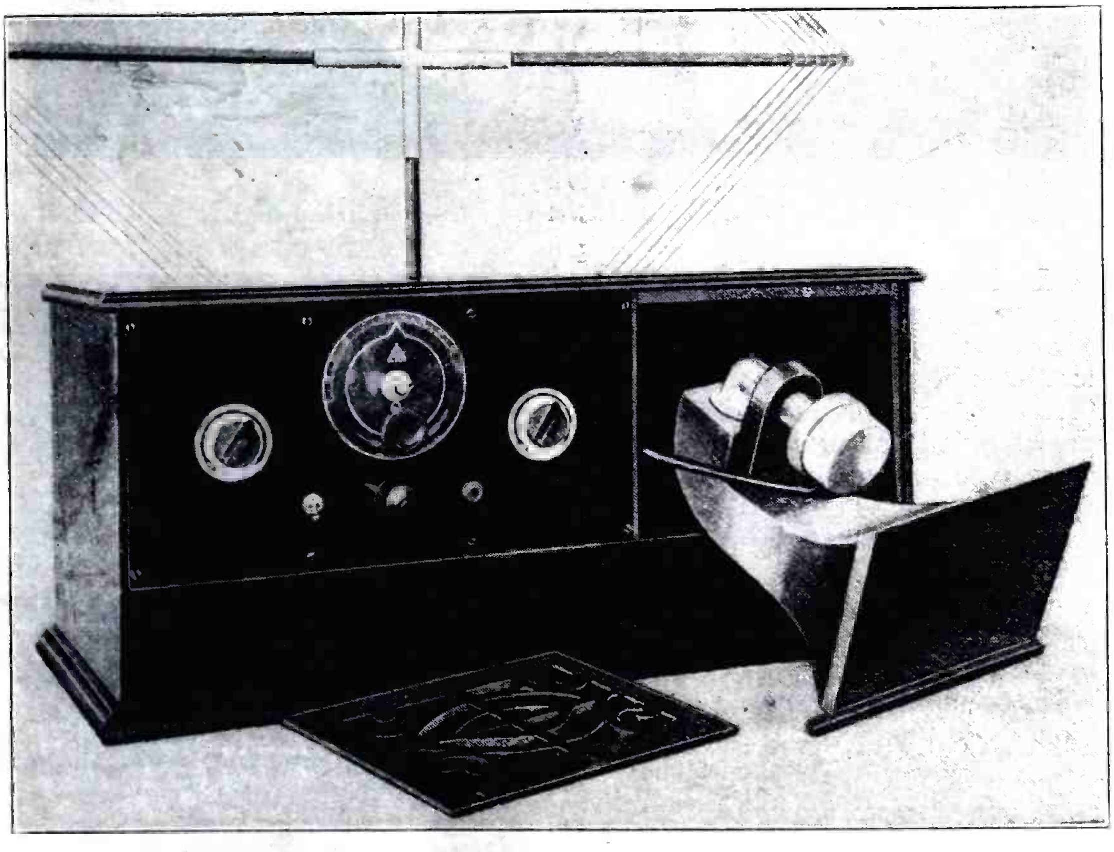
Flexible rubber-covered wire is used to connect these batteries to their respective binding posts on the terminal strip. The arrangement of the A-, B- and C-batteries in the lower compartment of the cabinet is shown in the rear view of the cabinet. Only two of the B-battery units can be seen, as they are placed one pair behind the other. The reader will note the position of the A-battery cells; the C-battery is placed behind these cells, and does not show in the illustration. The leads are taken up to the binding-post terminal strip through holes in the upper instrument compartment: the flexible leads are taken through holes drilled in the rear of the cabinet. The cabinet is well designed and very compact; it may be built by the reader if desired, but can be obtained from a radio dealer or direct from the manufacturers. The horn is built into the cabinet. This construction is clearly shown in the front view on this page, showing the horn partly pulled out; the grill shown in the illustration is screwed in front of the horn when assembled. The cabinet is 23⅜ in. long, 11¼ in. high and 10⅝ in. deep in over-all dimensions. A wood partition divides the horn compartment from the instrument.

The instrument should be tested for shorts before mounting in the cabinet, the batteries temporarily connected to the terminals, and each socket tested successively with one tube, or a test lamp of the flashlight type, before placing all the tubes in the sockets. Turn up the rheostats for this test. If all connections are correct, turn off the rheostats and place all the tubes in the sockets. The instrument can now be mounted in the cabinet and the battery terminals connected; the terminal cord from the horn is brought through the wood partition and connected to the binding posts provided on the terminal strip, marked "horn." The loop is connected, and the set is ready for operation.

Do not screw the instrument panel permanently in the cabinet until the instrument is thoroughly tested on distant stations. It may be necessary to try several different tubes in the detector socket until one is found that gives the best results in this position. Also switch the other tubes around for best position. The grid leak is another critical instrument; try several leaks of varying resistances, for instance, a 2, 3 and 4-meg., one of which will be found to give the best results. The following instructions will be found helpful in tuning the set. Turn on the filament switch, turn up the 6-ohm rheostat which will be designated as the volume control, and the 20-ohm rheostat which controls the filament voltage on the detector and third stage of radio-frequency amplification, both to a point about two-thirds over. Also turn up the potentiometer to about the same point. Now slowly rotate the vernier dial on the variable condenser until the station whistle is picked up in the horn, then back off the rheostats and the potentiometer until the station comes in clear, at maximum volume. To obtain this result, it may be necessary to change the setting of the vernier dial, and also to turn the loop a little. The detector rheostat and the volume-control rheostat, together with the vernier-condenser dial, are the "tuning" elements. It is not often that the potentiometer setting need be changed, but it will be found critical on the distant stations. The settings of the rheostats will, of course, vary a little according to the condition of the batteries. The vernier-condenser dial setting will always remain the same on the same loop, and can be permanently logged.



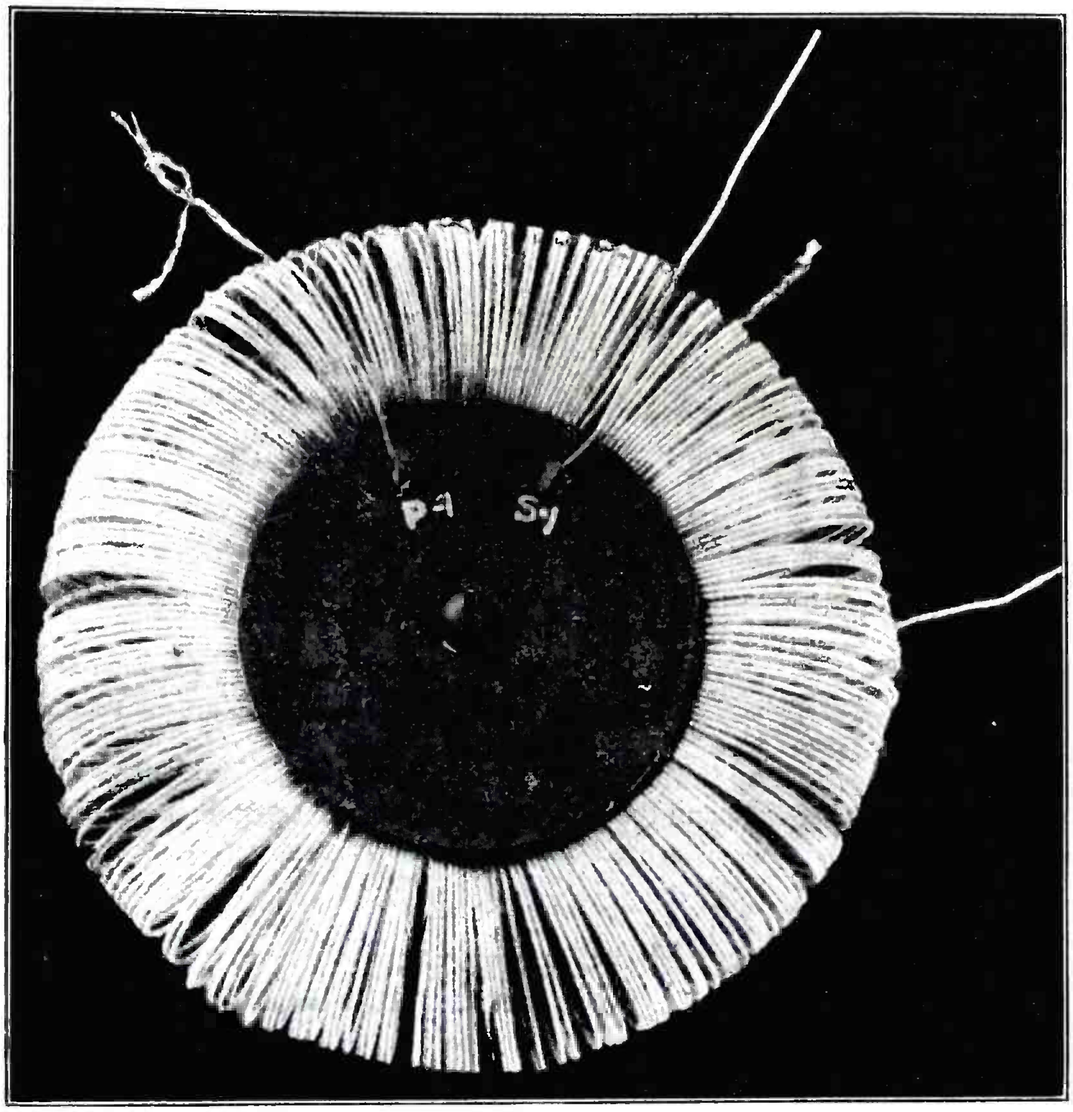
Rear view of the cabinet showing how the "A," "B" and "C" batteries are installed in a compartment. This compartment is provided with a hinged door, making the batteries easily accessible. Also note how the leads to the loop are brought out through two holes in the rear.



A front view of the set with the loud speaker unit and horn removed. The dial used on the shaft of the variable condenser is preferably of the vernier type in order to provide micrometer control.

Home-Made Toroidal Coils

Complete Instructions for Making the Latest Type of Coil for Tuned Radio Frequency Circuits



Illustrations by Courtesy of Radio World (New York)

Fig. 2. The completed toroidal radio frequency transformer.

ALONG with the many advances in the radio art and particularly in so far as tuning devices are concerned, there have been any number of new or different forms of inductance. We are not particularly concerned with the ordinary type of tuning coil, but rather with the coils used in tuned radio frequency circuits. There are some dozens of varieties now in use and still the search goes on apace. The latest and most efficient form is known as the toroidal or "doughnut" coil. The principle is by no means new, but its application is comparatively recent. Its chief value lies in the fact that it has no external field to conflict with the fields in other parts of the circuit. The data on the coil given in the following by *George B. Hostetter*, recently appeared in *Radio World*, New York, and will amply repay the constructor for what trouble its building may entail.

Procure a cardboard tube 1¼ in. diameter and about 9 or 10 in. long (Fig. 1). On this wind a layer of ordinary twine string (B) fastening the end with a tiny piece of adhesive tape (A). Over this wrap a thickness of writing paper. Get a roll of ½-in. adhesive tape and cut off a piece about 21 in. long. Split each end of this piece for a distance of 7 or 8 in. Lay the tape lengthwise on the tube, sticky side out, pushing the split ends into the ends of the tube out of the way. Now wind on 225 turns of No. 24 D.C. or S.C.C. wire (D1, D2), securing the ends by punching a hole in the tape.

Lay one of the ¼ in. pieces of tape back over the coil and the opposite ¼ in. on the other end so as to form a strip ½ in. wide over the top of the coil.

About ¼ in. from the end of this winding start the primary, winding 4 turns of the same wire (E1). Do not break the wire but run it along the tape for 2½ in., then wind four more turns (E2). Run along the tape again 2¼ in. and wind 4 more turns (E3) this makes 12 turns in all for the primary.

Each coil of four turns could be held in place temporarily by small pieces of adhesive tape.

Now take the other two pieces of ¼ in. tape and stick them tightly in place over the primary as at (F).

Pull the tape (A) loose and unwind

(*Continued on page* 15)

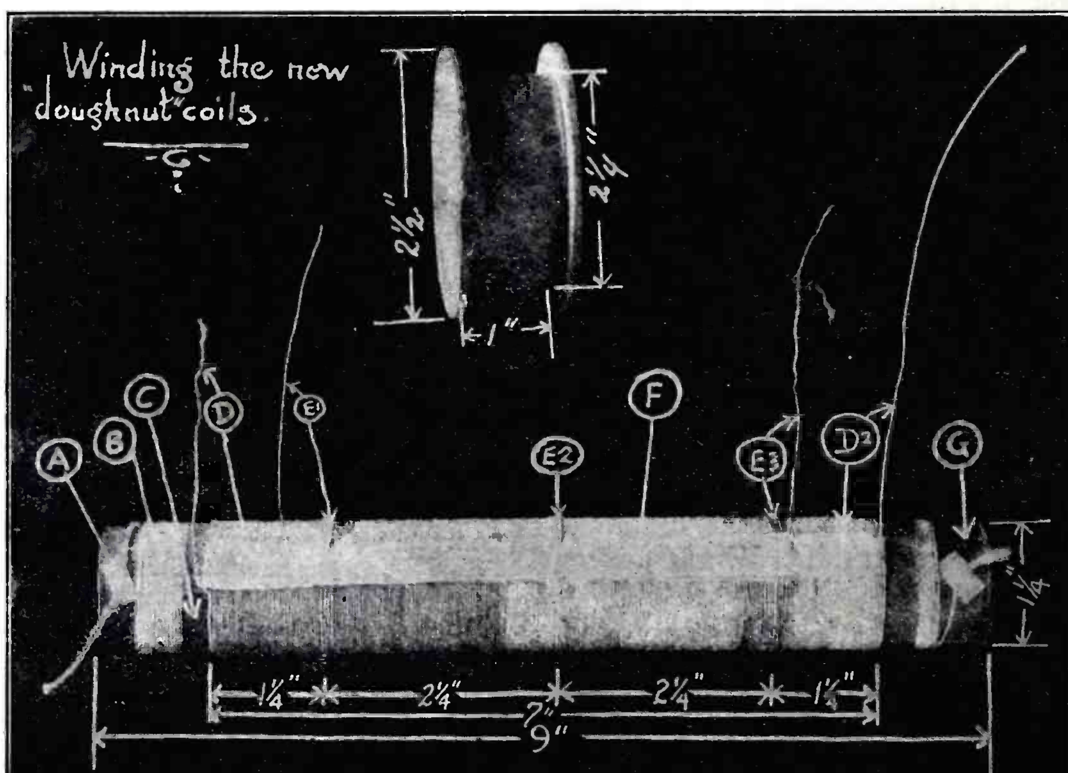


Fig. 1. Showing (on top) the spool which constitutes the mount or form on which the coil is placed after being wound, and (lower view) the original form on which the wire is placed prior to removal. The text explains the designations.

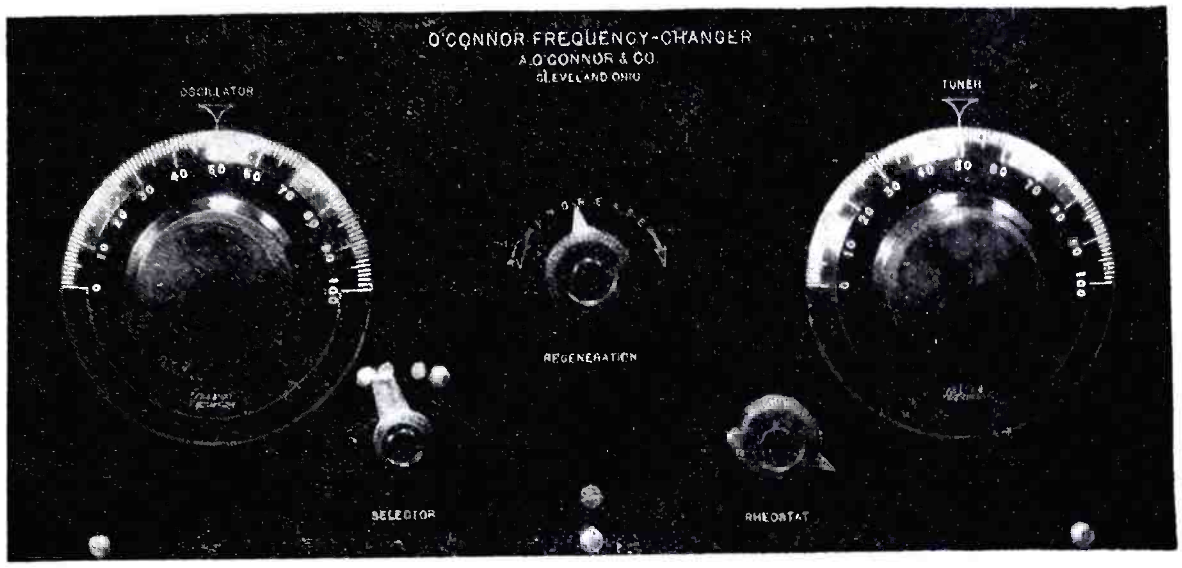
How to Make Your Receiver A Super

A Simple and Inexpensive Unit Which the Home Constructor Can Easily Build

A SUPER-HETERODYNE of two tubes is not only possible but practical; any receiver now in operation may be made into a sensitive, selective super-heterodyne. With these two thoughts in mind, the writer began experiments over a year ago that brought the results outlined in this article describing a simple one-tube unit that will make a "super" out of any good receiver, be it simple or complicated.

Briefly, this unit changes incoming signals to a given frequency, just like the best of super-heterodynes, and the receiver that the listener now possesses acts as the "intermediate frequency amplifier" that is such an important part of present super-heterodynes. This unit is not difficult to construct, requires but little room, and uses standard parts that may be readily obtained.

Such a unit will allow hundreds of thousands of listeners to have the benefits of the "super" at small cost and without discarding their present receivers.



Illustrations by Courtesy of Radio Broadcast (New York)

Fig. 3. The panel view of the frequency changer. Simplicity and symmetry are the keynotes of construction and layout. Due to the engraved indicators, the functions of the various control dials are self explanatory.

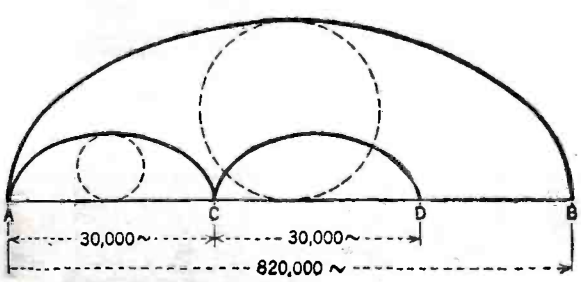


Fig. 1. The broadcasting band of frequencies is 820,000 cycles wide and is represented here by taking a point on the circumference of a wheel and marking out its path as it rolls along the frequency line. At the end of one complete revolution the point has traversed 820,000 cycles. The smaller wheel representing the oscillator dial traces a similar path but in one revolution it traverses only 30,000 cycles. There are two points 60,000 cycles apart that a given station may be heard.

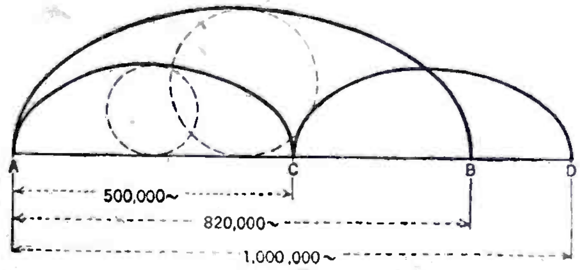


Fig. 2. By making the smaller wheel much larger, the path a given point on its circumference would trace out is longer. Before it completes two revolutions however, it is outside the broadcasting band, and for this reason there will be only one point on the oscillator dial where a given station will be heard.

Mr. A. O'Connor begins his article in *Radio Broadcast*, New York, in the above fashion. It certainly sounds interesting and we can assure you that it is. This business of making a "super" out of your old receiver is like making a Rolls Royce out of a flivver. The idea is well worth trying and the description is so clear and understandable that little difficulty should be experienced in making such a unit. The article goes on as follows:

What the "Super" Really Is

To understand just how such a simple super-heterodyne may be constructed it is necessary to delve a bit into the theory underlying this selective circuit. The "super" is really a frequency-changer.

In super-heterodyne receivers incoming frequencies are changed to some lower frequency, after which they are amplified by "intermediate-frequency" amplifiers and then detected in the usual fashion. The lower frequency varies with different super-heterodynes, but usually is about 30,000 cycles (10,000 meters). There are reasons why this frequency may not be much lower, but few why it cannot be higher, and that is what is done in this unit where an intermediate frequency of about 500,000 cycles (600 meters) is used.

These lower frequencies are generated by a phenomenon called "beats" and are the result of compounding two waves of different frequency. As a concrete example, let us suppose the intermediate amplifiers are tuned to 30,000 cycles and an incoming signal has a frequency of 750,000 cycles (400 meters). Within the receiver is a frequency generator which we may vary until the difference between its frequency and that of the incoming wave is 30,000 cycles. At this point the intermediate amplifiers work best and the signal will be passed along to the detector.

This lower frequency may be obtained, in general, at two adjustments of the oscillator dial, namely, at the 750,000 plus 30,000 or 780,000 cycles and 750,000 minus 30,000 or 720,000 cycles. These two points correspond to 417 and 385 meters.

Thirty thousand cycles is such a small percentage of the broadcasting frequencies that the two points on the oscillator dial are always close to the value of the incoming frequency, although on the longer waves the two points are farther apart on the dial than at the low wave-length end of the dial.

These two points are 60,000 cycles apart, and the action of tuning a given station at two points within the broadcasting band is something like a small wheel revolving within a large one as shown in Fig. 1. The small wheel may begin to rotate at any point, but at the end of two complete revolutions the same broadcasting station may be heard again. And since the present broadcasting band covers 820,000 cycles, it is apparent that there will always be two points on the oscillator dial for each incoming frequency—if the intermediate amplifiers are tuned to 30,000 cycles.

Suppose, however, that the intermediate amplifiers are tuned to 500,000 cycles. In this case, the same station will be found at two points 1,000,000 cycles apart, and since the broadcasting band is only 820,000 cycles wide, we may plan our coils and condensers so that the incoming frequency will be heterodyned at only one point on the oscillator dial.

All we have to do now is to design an oscillator that will beat at frequencies 500,000 cycles different from incoming frequencies. At the lower end of the broadcast wave-length band, 220 meters equals 1,363,636 cycles and at the other end of the broadcasting band, 550 meters corresponds to 545,454 cycles. To find the frequency of the oscillator to give us the required 500,000-cycle beat note, we must add to or subtract 500,000 cycles from these two extreme frequencies. Thus:

220 meters = 1,363,636 cycles plus 500,000 cycles = 1,863,636

220 meters = 1,363,636 cycles minus 500,000 cycles = 863,363

550 meters = 545,454 cycles plus 500,000 cycles = 1,045,454

550 meters = 545,454 cyles minus 500,000 cycles = 45,454

Therefore, an oscillator of the range 1,863,636 to 1,045,454 or an oscillator of the range of 863,363 to 45,454 cycles would give the required beat frequency. These two oscillators would cover wave-lengths from 161 to 287 meters or 348 to 6600 meters. Obviously the first one is the proper one to use.

In this case there will be only one point in the oscillator dial where a given station may be found as shown in Fig. 2.

There is still another advantage in heterodyning to 500,000 cycles. When heterodyning to 30,000 cycles, it is quite often the case that the lower one of the two points for station No. 1 is in exactly the same spot as the upper point of station No. 2 which is on a sharter wave-length. This causes heterodyning with the attendant howls and moans. Sometimes the upper point of station No. 1 interferes with the lower point of station No. 3 which is on a longer wave-length; again we

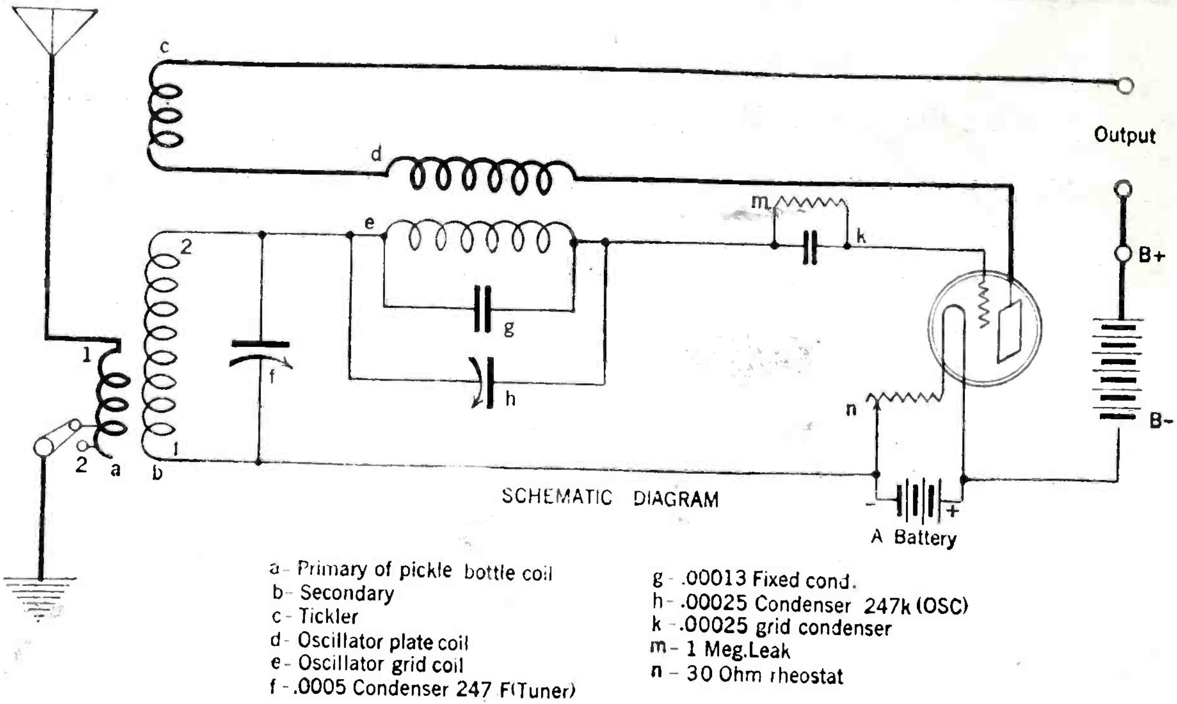


Fig. 4. The Schematic diagram of the frequency changer showing the Armstrong system of securing local oscillations in the first detector tube.

LIST OF PARTS

1 Formica panel 7x14x3/16 in.
1 Baseboard 12¾x7x½ in. Poplar.
2 National Velvet Vernier 4-in. Dials.
1 General Radio Switch Lever ⅞-in. with 2 Contact Points and 2 stops.
1 General Radio No. 301 Knob and Pointer; for use on the tickler coil.
1 General Radio No. 301 Rheostat 30-ohm.
1 General Radio No. 247 F Condenser .00025 mfd. logarithmic plates.
3 ½-in. Lengths Formica Tubing 5/16 in. o. d. 3/16 in. i. d. to space Item 7 from panel.
1 Formica Coupling Member for Item 7 (Fig. 6).
1 General Radio 247F Condenser .0005 mfd. logarithmic plates.
3 ½-in. Lengths Formica Tube 5/16 in. o. d. 3/16 in. i. d.
1 Eastern Coil Corporation Coupler, Broadcast Wavelength (15 turns on tickler, with middle tap on primary).
1 King Socket R730 for UV-201-A Tube.
1 Dubilier Grid Condenser .00025 mfd. Type 601-G.
1 Daven Grid Leak .1 megohm.
1 Binding Post Panel complete with 9 binding posts.
1 Oscillator Coupler as per Fig. 7; coupler includes two coils as per description later in this article.
Screws, wire, spaghetti, terminal lugs, etc.

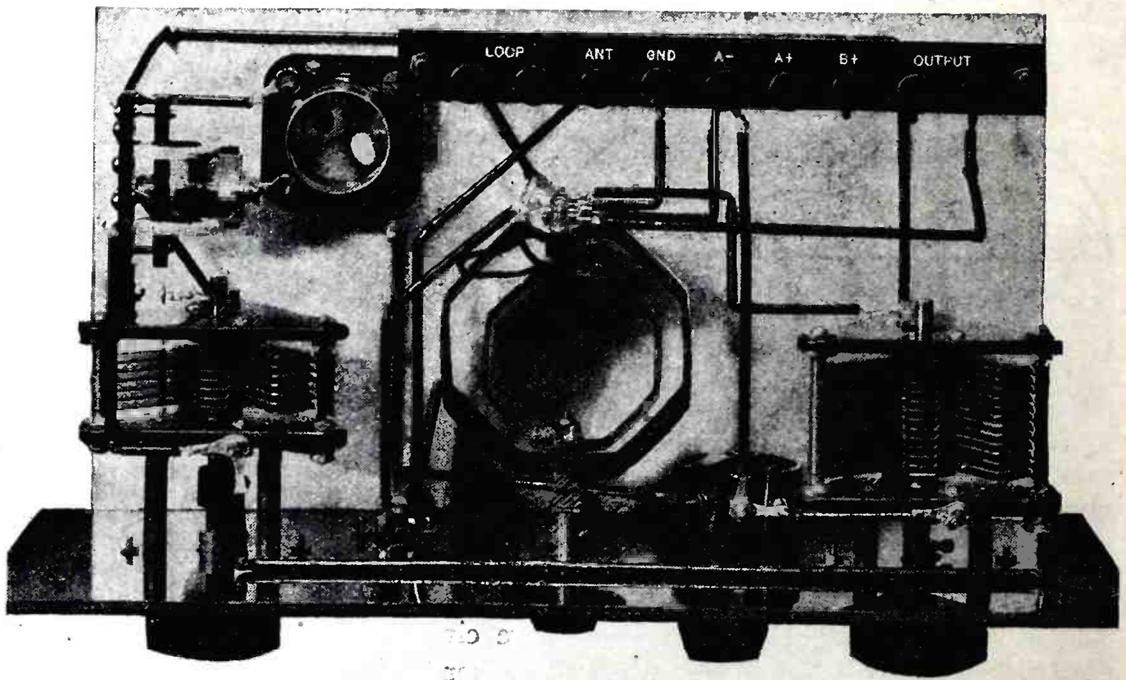


Fig. 5. Looking down on the layout one clearly sees the general disposition of parts and the wiring scheme. The frequency-changer is really a very simple unit as this photograph shows.

have heterodyning with the resultant discordance, and we find that we are unable to get station No. 1 clearly on either of its two points. Such a condition is impossible with 500,000 cycle beat frequencies, as it is impossible to get a station at more than one point on the oscillator dial.

With most "supers," the oscillator is continually making an audible heterodyne with the incoming station as the dial is turned between the two points for the incoming station. This is because of the fact that halfway between the two points it is actually on the exact frequency of the incoming station. With a 500,000-cycle beat frequency this is impossible, as the oscillator always beats 500,000 cycles away from the incoming station.

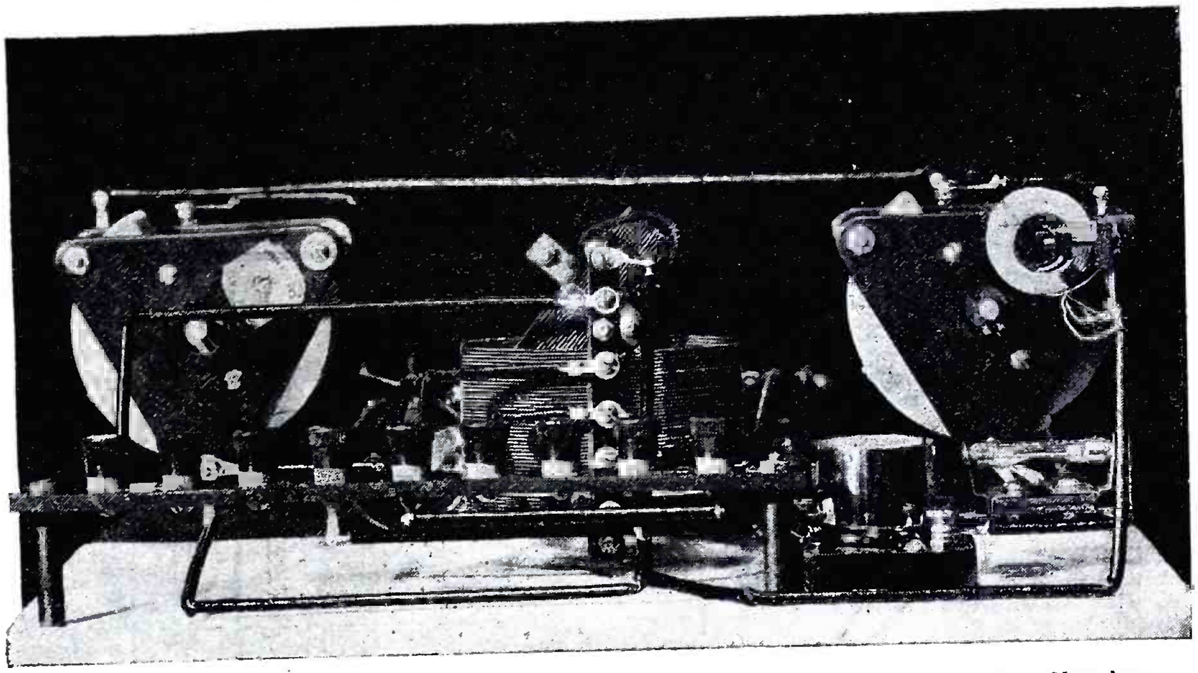


Fig. 9. This rear view shows clearly the disposition of the coils and other apparatus. Note how the oscillator coils are clamped between the two bakelite strips which are fastened to the oscillator condenser.

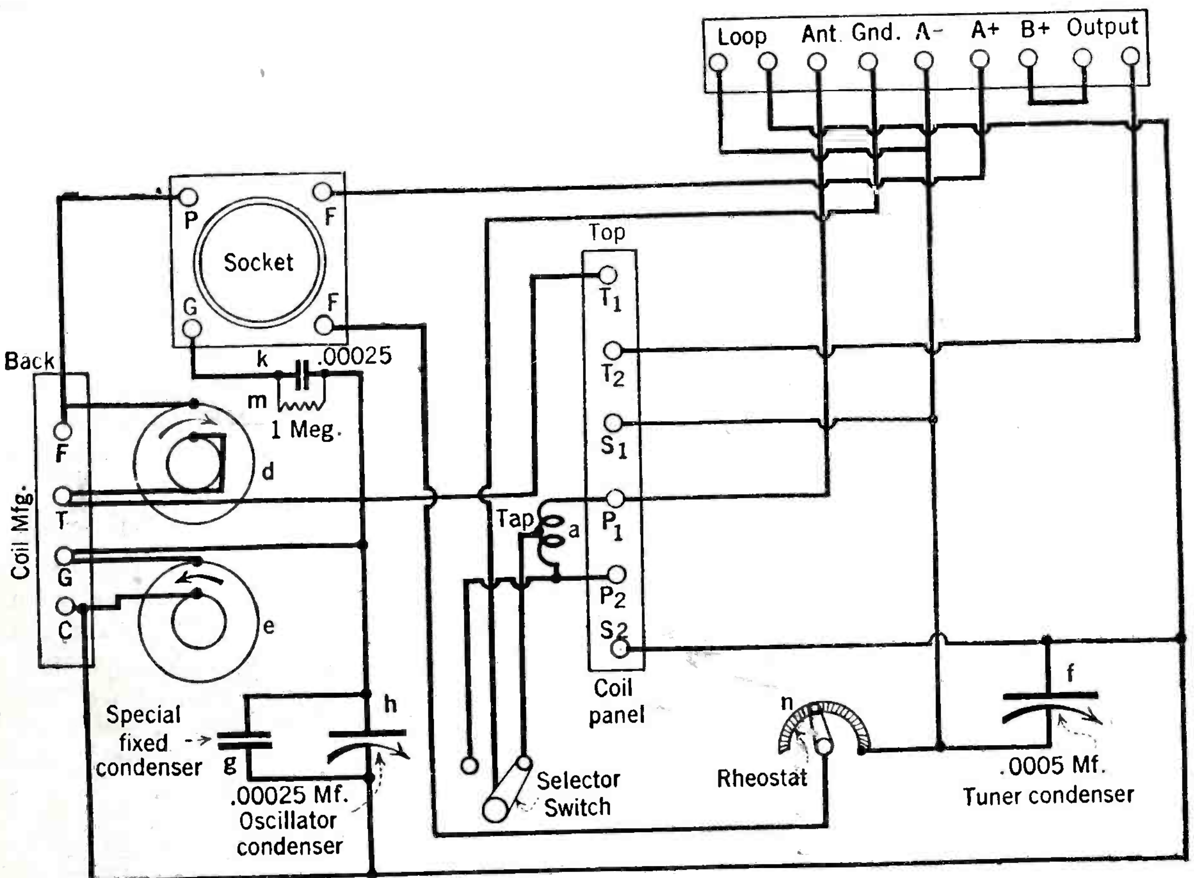


Fig. 6. The wiring diagram of the one-tube super-heterodyne showing the connections of the various units.

How Your Present Receiver Is Used

Now that we have the 500,000-cycle beat note generated in our frequency-changer, it remains to provide an intermediate amplifier tuned to this frequency, and here is where our receiver now in operation comes in. All that is necessary is to tune it to 600 meters (500,000 cycles) and to place its antenna and ground connection to the output of the frequency-changer, and we have a super-heterodyne.

Fig. 4 shows the schematic diagram of the circuit and Fig. 6 shows the connection hookup. In Fig. 6, coils A, B and C are the three windings of a three-circuit tuner, the primary (A) being untuned. Incoming stations are tuned by the condenser F across the primary coil B. Their frequencies are heterodyned to 500,000 cycles by oscillator coils D and E, the latter coil being tuned by condenser G and H. Condenser G is placed in the circuit to increase the spread of the stations on the oscillator dial. The plate circuit, before it is introduced into the next tuning circuit, is brought into inductive relation with the secondary tuning coil B, thus causing regeneration and increasing both volume and selectivity. The plate circuit now contains, among other frequencies, the desired frequency of 500,000 cycles, which is introduced into the receiving system, where it is tuned and rectified in the same way that a 600-meter station can be tuned in.

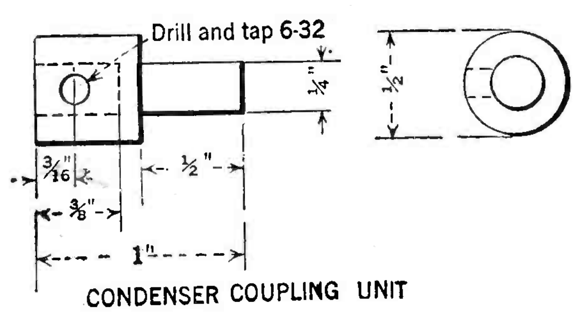


Fig. 8. To shield the condenser from body capacity effects it should be placed some distance from the panel and this coupling member enables the proper spacing to be carried out.

You will note that in this arrangement one tube receives and heterodynes at the same time. Up until a year ago this was not considered feasible, because tuning the oscillator circuit would detune the antenna circuit, due to the two frequencies being so close together. Major Armstrong showed that it is possible, if the frequencies are quite a distance apart, and exhibited an ingenious scheme for using one tube while maintaining a low frequency intermediate wave. In the frequency-changer which we are describing, the two circuits are always 500,000 cycles apart and tuning one circuit has no effect on the other. In constructing the frequency-changer, the idea of low loss has been kept constantly in mind, and, by direct comparison, low loss parts gave the best results. Distributed capacity in coils was hunted down, and condensers of the highest type were used, the oscillator condenser being insulated from the hand by means of a good dielectric. The parts used are listed below, but of course equivalent parts can be used, always providing that the constants are correct.

Fig. 7 shows the actual drilling template for the panel, but of course changes must be made if other material is used.

Fig. 8 shows a coupling member for

the .00025-mfd. variable condenser. This insulates the condenser from body capacity. Item No. 3 in the list above covers three Formica tubes which are

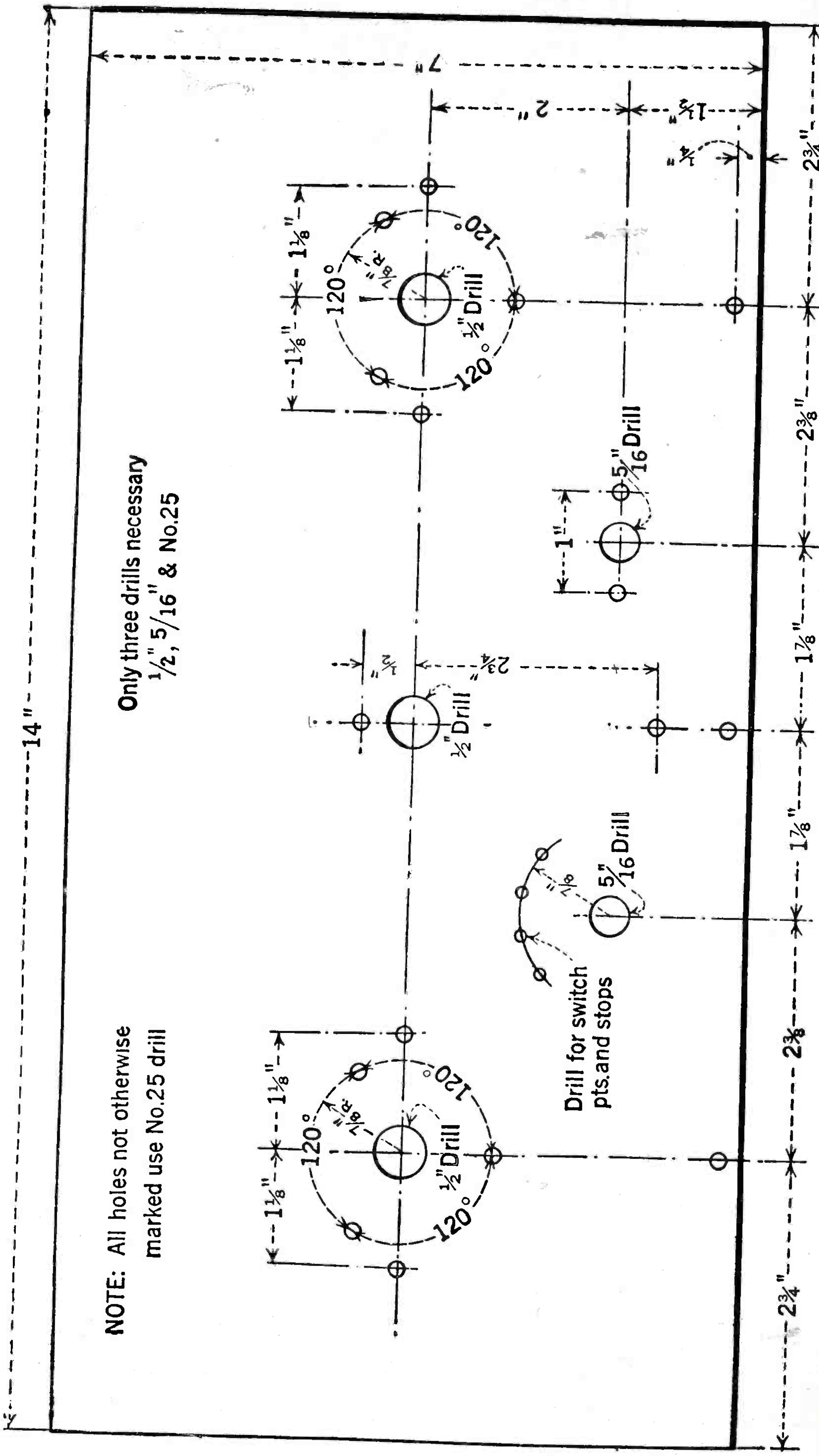


Fig. 7. This is the actual drilling template for the panel, and the dimensions given apply to the parts described in this article. Changes will have to be made if other parts are substituted.

used to set the oscillator condenser back from the panel, and to line it up with the other condenser. Item 11 covers spacers for the .0005 mfd. condenser. These are necessary because the design of the Velvet Vernier dial requires that the condenser be set back from the panel.

The Eastern Coil Corporation coupler is known as a pickle-bottle coil, and has fewer turns than normal due to the fact that it is in circuit with the plate coil of the oscillator coupler.

The Unusual Oscillator Coupler

Fig. 10 shows the details of the oscillator coupler. This coupler is not the conventional type at all. In the usual coupler, the coupling between the plate and grid coils is fixed, and the coils are so large that their external fields exert an influence on all parts within a range of several inches. An attempt was made in this frequency-changer to design an oscillator which would have no effect on other parts, and this result was finally achieved. The coils shown have an exceptionally small external field, and the grid coil is placed 1¼ in. back of the oscillator variable condenser, a position in which it has no effect on the condenser. The coils are known as "cross-wound," and have about as little distributed capacity as any coil known. The coils are wound on a ⅝-in. core, are ⅛ in. thick, and each has 49 turns of No. 24 double cotton covered wire. Experimenters who desire to wind their oscillator coils, and are unable to make cross-wound coils, can use Lorenz (basket-weave) such as made by the Perfection Coil Co. or Sickles (diamond-weave) coils, and attain the same results, although the coils should be set back some distance from the oscillator variable condenser. By a cut-and-try method, the right number of turns can be ascertained, the calibration being determined by changing the old receiving set to 600 meters (or as high as possible), and adjusting turns on the oscillator grid coil until 545 meters comes in at approximately 95 on the oscillator dial, and 220 meters at 5 on the dial. Without fixed condenser G of Fig. 4 it would be impossible to obtain this spread on the dial and the capacity of this condenser will have to be determined by trial. The value used in the frequency-changer shown in the photograph was .00013 mfd.

As mentioned above, in the usual oscillator coupler the coupling between plate and grid coil is fixed. Yet the best value of coupling varies with the frequency, and experiments have shown that most couplers have a value of coupling that is good for some frequencies and poor for others.

The best value of coupling for a given frequency is minimum coupling; in other words, the coupling should be decreased until the point is reached where the tube is just ready to stop oscillating. By finding this coupling distance for all frequencies, a point can be determined that will give the best average coupling for all frequencies. In the coupler shown in Fig. 10 this point is determined by test, and the coil locked in place.

How to Put the "Super" Together

Mount all apparatus on panel and baseboard, assemble the oscillator coupler on rear of .00025 mfd. condenser, or some distance back of the condenser if other than cross-wound coils are used. Connect the parts as per connection diagram Fig. 10, soldering wires to the terminal lugs instead of wrapping them around screws. Connections to S1 and S2 on the pickle-bottle coil should preferably be of flexible wire, as these two wires must be disconnected if a loop is to be used. A loop can be used when this unit is to be attached to a multi-tube set such as a neutrodyne, or tuned radio frequency set. If the unit is to be used with a single-circuit or three-circuit regenerative set, a loop can be used if maximum selectivity and a range of 100 to 200 miles is all that is desired.

After all internal connections are made, connect the battery terminals to the same battery terminals on your present set, making sure that positive "B" on the frequency-changer has a value of at least 45 volts. You will notice that there is no minus "B" on the frequency-changer. This is because this connection is taken care of in your present set. Connect the antenna and ground to the frequency-changer instead of to your present set. If you have a five- or six-tube radio frequency set, you may use a loop instead of the antenna and ground by disconnecting S1 and S2 of Fig. 2 from the secondary winding of the pickle-bottle coupler. Now

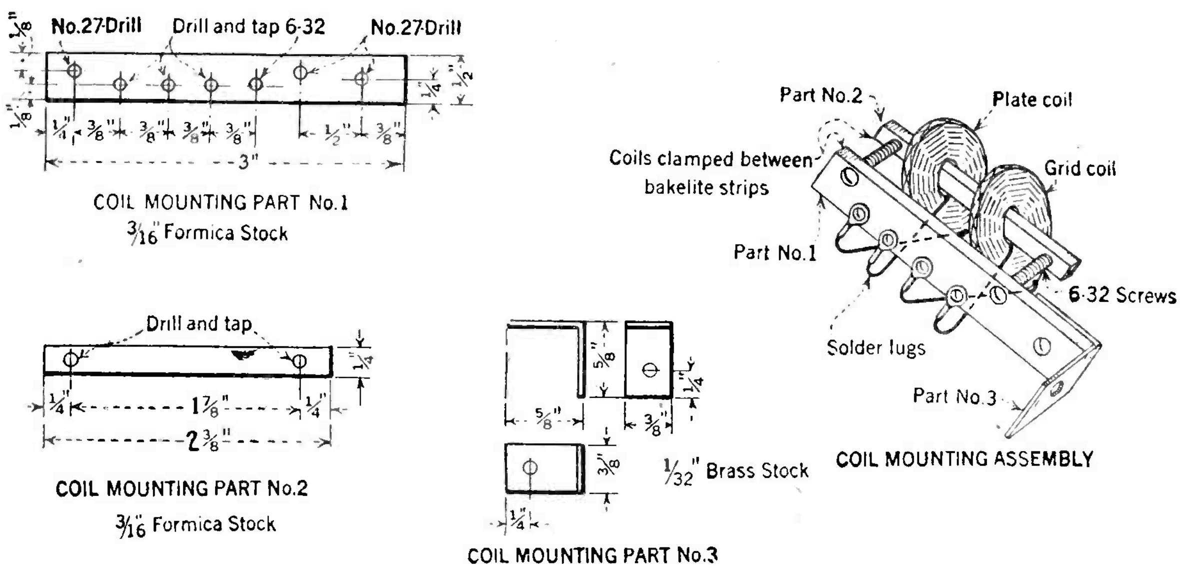


Fig. 10. The details of the oscillator coupler are shown in this figure. Small coils placed at some distance from their tuning condensers decrease the external field and the resultant coupling effects to other parts of the circuit.

tune your receiving set to 600 meters, get maximum regeneration, and leave your dials set. All tuning is now taken care of by the two dials on the frequency-changer panel and regeneration can be obtained by rotating the pickle-bottle tickler.

Care Must Be Used In Connections

Be very careful to examine *the circuit in your set* to which the output circuit of the frequency-changer is connected. This circuit *must not* be connected to the "A" battery circuit, or else there will be a short-circuit across 45 volts of the "B" battery. In some regenerative sets, and in neutrodynes, the "A" battery is grounded and this connection must be broken.

By carefully following the suggestions here given, it will be a simple matter to build such a unit and attach it to almost any of the present-day receivers. The urge for long distance can be satisfied in this manner without sacrificing any of the inherent qualities of whatever set is used and at the same time selectivity will be much improved.

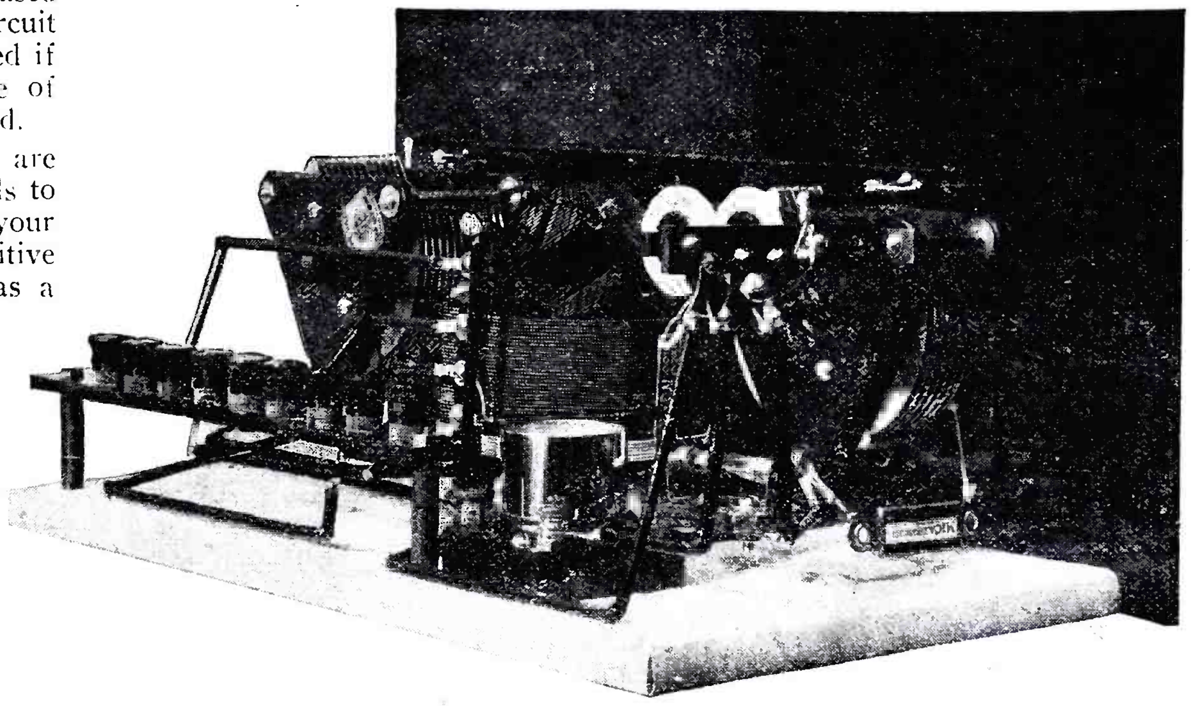


Fig. 12. A perspective of the completed frequency changer. The grid leak and condenser are supported by the tube socket and the wiring to it.

It is also possible, by proper application, to use this frequency changer in conjunction with a crystal receiver, permitting reception over long distances and with a selectivity unheard of in a single-tube receiver. Many further ways of utilizing it will suggest themselves to the experienced amateur constructor.

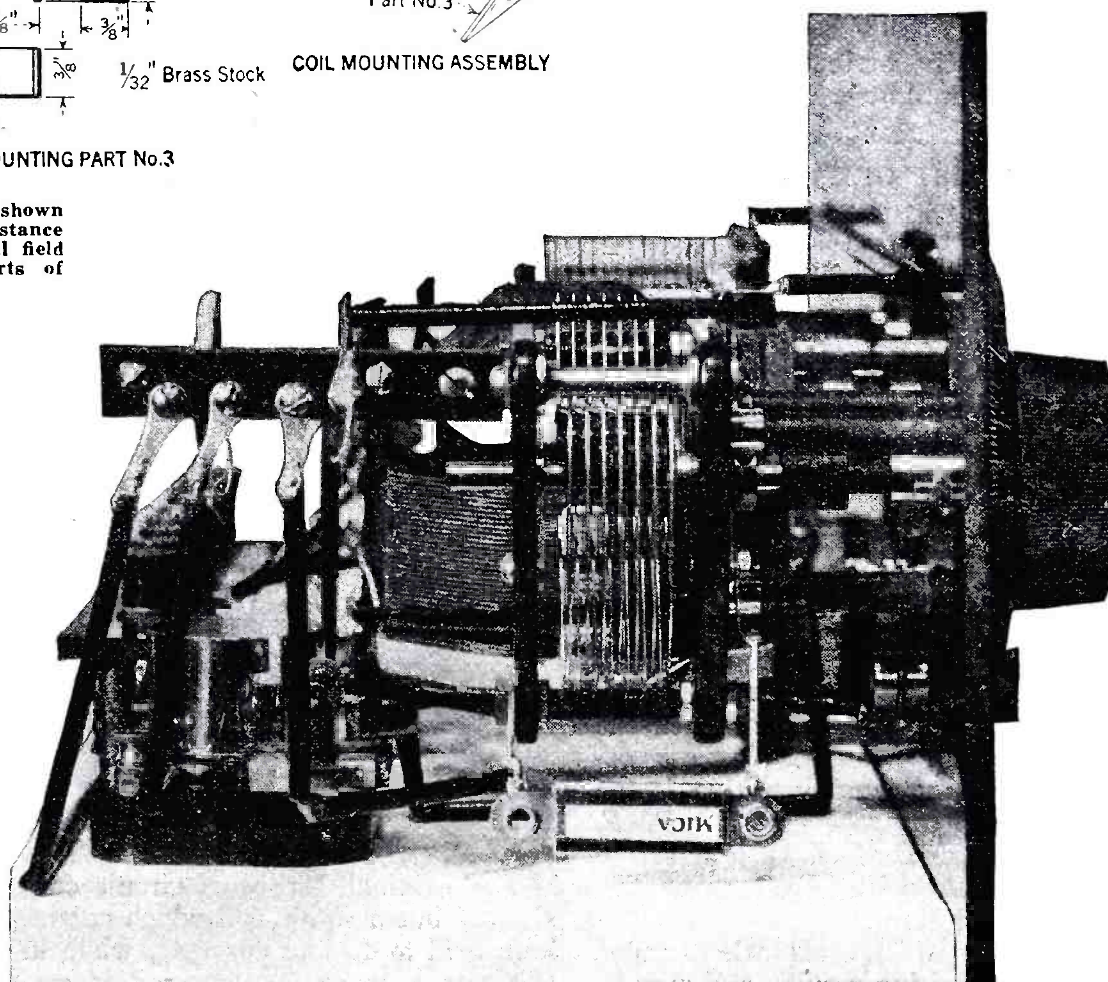


Fig. 11. End view showing the method of placing the condenser some distance behind the panel to lessen body capacity effects. The separation of the coupling coils is clearly shown here.

A Uni-Control Regenerator

Simple Constructional Directions for the Novice Desiring to Build a One-Tube Set

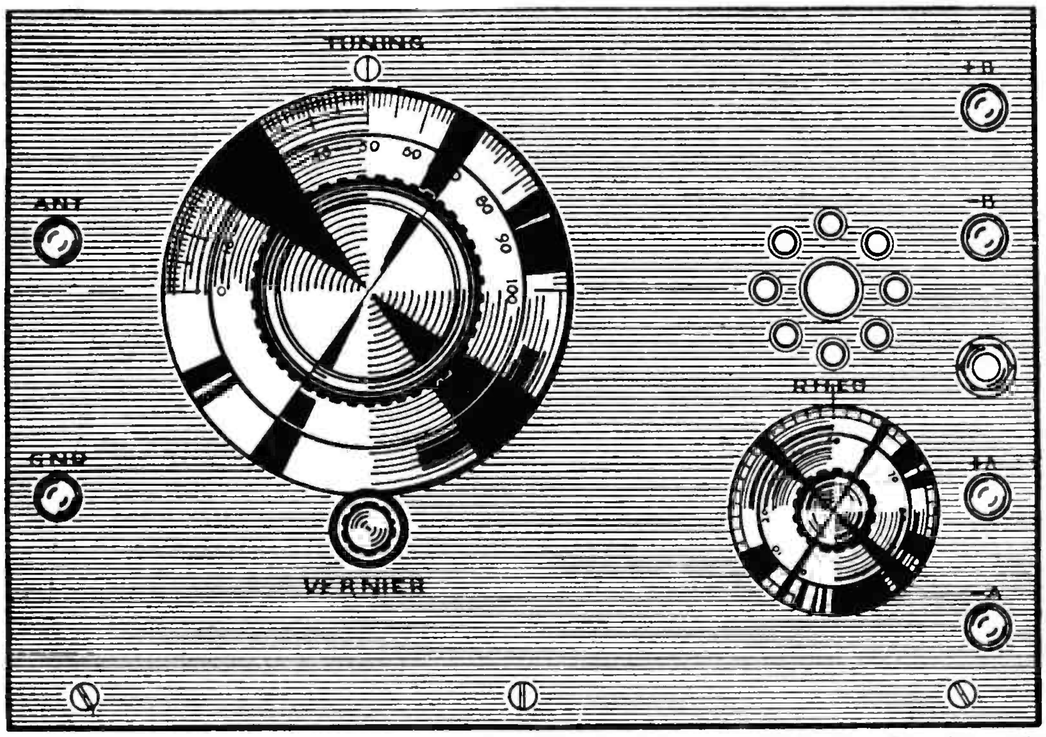
ASIDE from the question of expense, many fans prefer to commence their active radio construction by building a simple one-tube receiver. From here, the majority progress by easy stages until at last they attain the

LIST OF PARTS

1 Panel 7x10x3/16 in.
1 Baseboard 6x9x⅝ in.
1 Freshman Variable condenser .0005 mfd.
1 Socket, any good make.
2 Spiderweb coil forms 5 in. diameter.
1 Freshman Grid-leak condenser .00025 mfd.
1 Rheostat, resistance to suit tube.
1 Vernier dial.
1 Open circuit phone jack.
6 Binding posts.
1 Fixed condenser .001 or .002 mfd.
1 2-in. Rheostat dial.
½ lb. No. 24 D. C. C. magnet wire.

pinnacle of success, which may be a five tuber or possibly a Super-heterodyne. For the beginner, or even the more experienced fan, the simplest possible set for efficient operation is the one-dial control regenerator. *R. F. Robbins* has described such a set in *Radio*, San Francisco, California. The full details follow:

A receiver which costs little to make, delivers surprising results, and may be built and operated by even the most inexperienced tyro can be adapted from the DeForest ultra-audion. The cost for a one-tube set should not exceed $9.00 exclusive of the tubes, batteries, antenna and phones.



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

Fig. 1. Front panel view of the uni-control regenerative receiver.

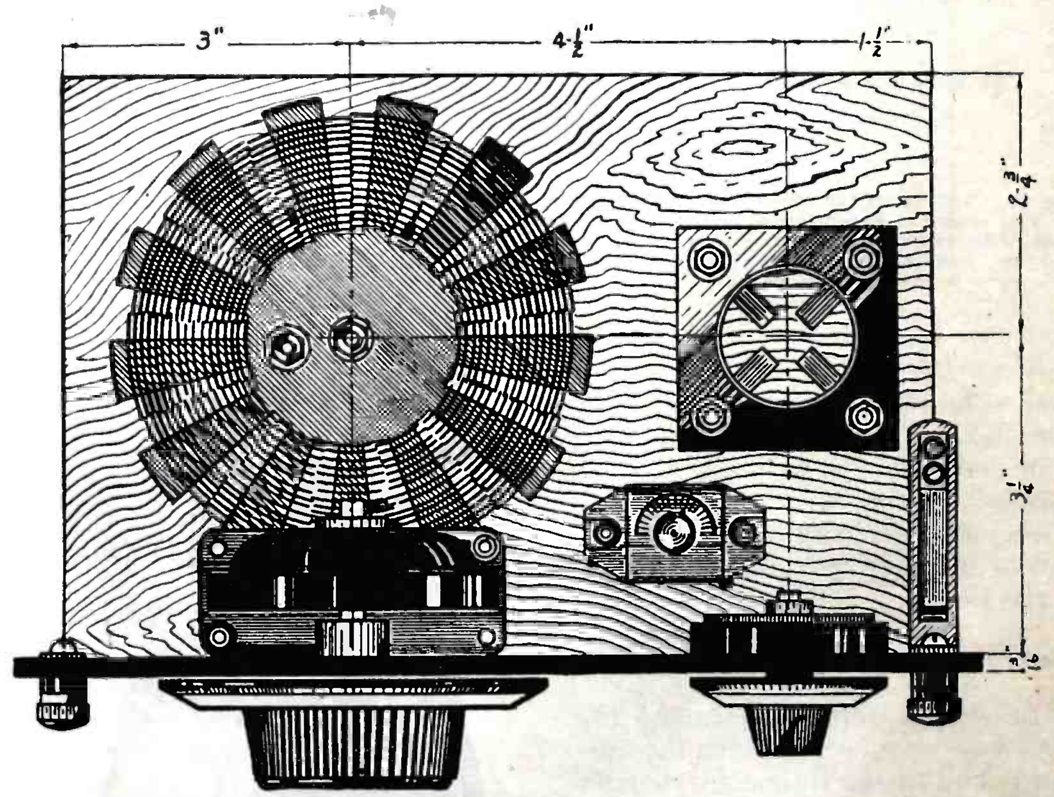


Fig. 2. Baseboard layout of the set with dimensions.

The original DeForest circuit consists of but a single coil which carries both grid and plate currents, while in this one a separate plate coil is employed for loose coupling, and as a tickler. Most of the experimenters who have tried out this set declare that it is singularly free from the radiation which generally characterizes the straight ultra-audion. The entire tuning is accomplished by but one vernier dial operating a .0005 mfd. variable condenser. The regeneration is controlled entirely by the rheostat. Unlike the Armstrong regenerative circuit the DeForest regenerative employs the *plate* coil as the primary pickup agency. In this it partakes somewhat of the nature of an untuned aperiodic primary and the regulation tickler coil. The control, however, is much more uniform over the whole tuning range and some of the distances covered by local enthusiasts who have built it are almost beyond belief. The best reception thus far reported by reliable parties at Portland, Maine, is Hastings, Neb.

The panel layout will depend upon the parts selected, most of which are accompanied by a template showing location of holes to be drilled. The general arrangement is shown in Fig. 1.

The baseboard layout is shown in Fig. 2. Only one of the spider-web coils is shown. The coils are mounted on a roundhead 8/32 machine screw 1¼ in. long which fits into a 3/16 in. hole drilled through the baseboard as shown in the rear panel view of Fig. 3. The socket is mounted with the grid and plate terminals facing the spider-web coils.

The spider-web coils consist respectively of 50 and 20 turns of No. 22 D.C.C. wire and are mounted by means of washers and nuts so as to have ½ in. separation. The 20 turn plate coil is the lower and the 50 turn grid the upper. The windings should run in the same direction.

The panel is now screwed in place and the condenser, rheostat, jack and binding posts are mounted in their proper places. This completes the assembly work and we are ready to do the wiring.

The circuit is shown in Fig. 4. Keep all wiring widely spaced and as short and direct as possible. All connections should be carefully soldered.

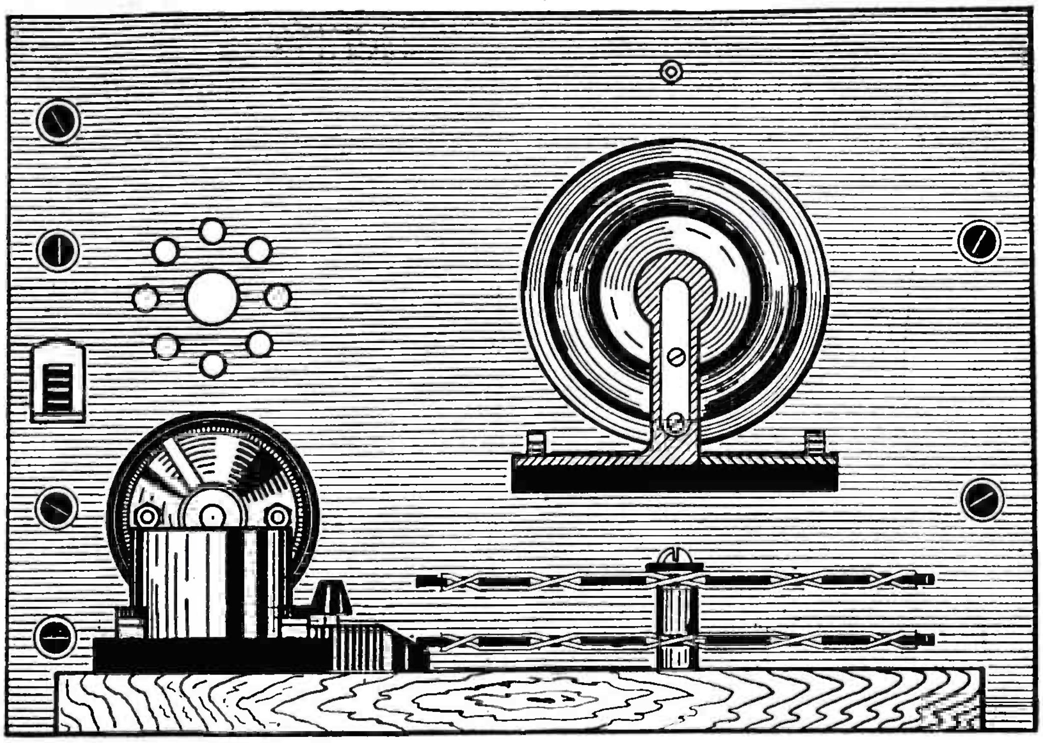


Fig. 3. Rear panel view.

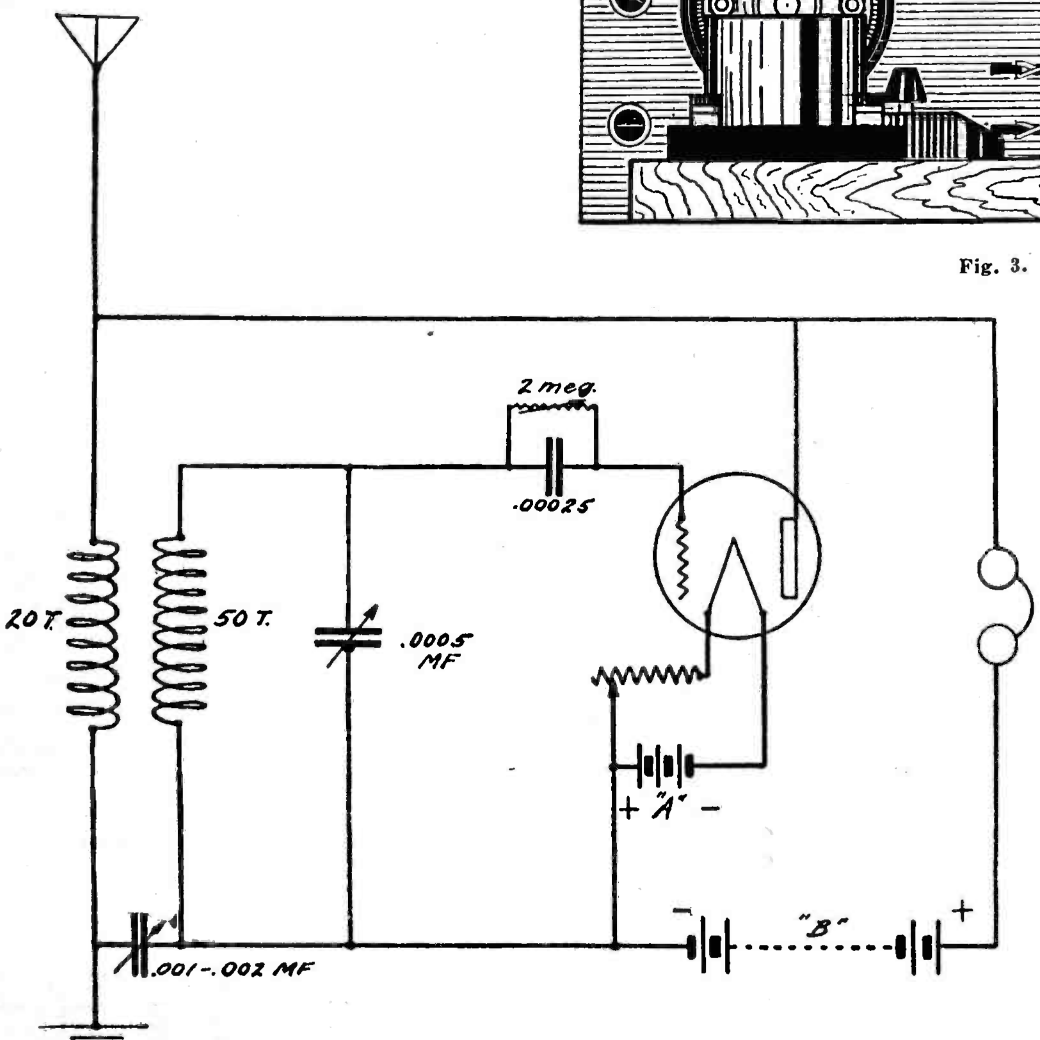


Fig. 4. Circuit diagram of the set.

The two spider-webs are connected as follows: Secondary or grid coil, center terminal to filament and condenser rotor, outer turn to fixed plates of condenser and to grid condenser. Plate coil or primary, outer terminal to antenna and plate, inner terminal to ground and r.f. bypass condenser. The hookup is not in the least complicated and no great difficulty should be experienced in getting the job done. Spaghetti covering for all the bus wire is advised for the sake of tube life-insurance. The matter of getting the right value for the r.f. condenser will be more or less a matter for experimentation. Some get good results with a .001 while others prefer a larger value. Much depends upon the tube used.

In action this set is very positive and will operate with fair uniformity over practically all of the effective tuning range of the condenser. A rheostat with means for extremely fine adjustment like the Bradleystat or Fil-ko-stat will find an appropriate application here, especially as so much of the success of the set hinges upon this feature. The tuning procedure is simple. Turn the condenser dial slowly until the signal becomes audible. If the tone is not clear reduce the rheostat until volume reaches the right value commensurate with clarity. Further improvement in quality will be obtainable by minute adjustments of the variable grid-leak. If all directions have been followed faithfully you should have a set capable of surprising power and of a very fair degree of selectivity considering the simple means employed for the tuning.

Home-Made Toroidal Coils

(*Continued from page* 8)

the string, pulling it out at the end. This will allow the coil to slip off the tube very easily. Then the layer of writing paper may be removed.

Cut a piece of lightweight cardboard 1 in. wide and bend it into a ring whose outside diameter is exactly equal to the length of the secondary coil, measured on the tape.

Cut two circles of heavy cardboard 2½ in. in diameter, glue the ring to these discs, forming a spool.

With a piece of adhesive tape fasten one end of the coil to the spool, bring the other end of the coil around until the ends meet. Fasten with another piece of tape, working between the turns of the coil, which may be straightened back into place after the ends are secured.

You will now have a coil as shown in Fig. 2.

The leads may be brought out through holes punched in the discs as shown.

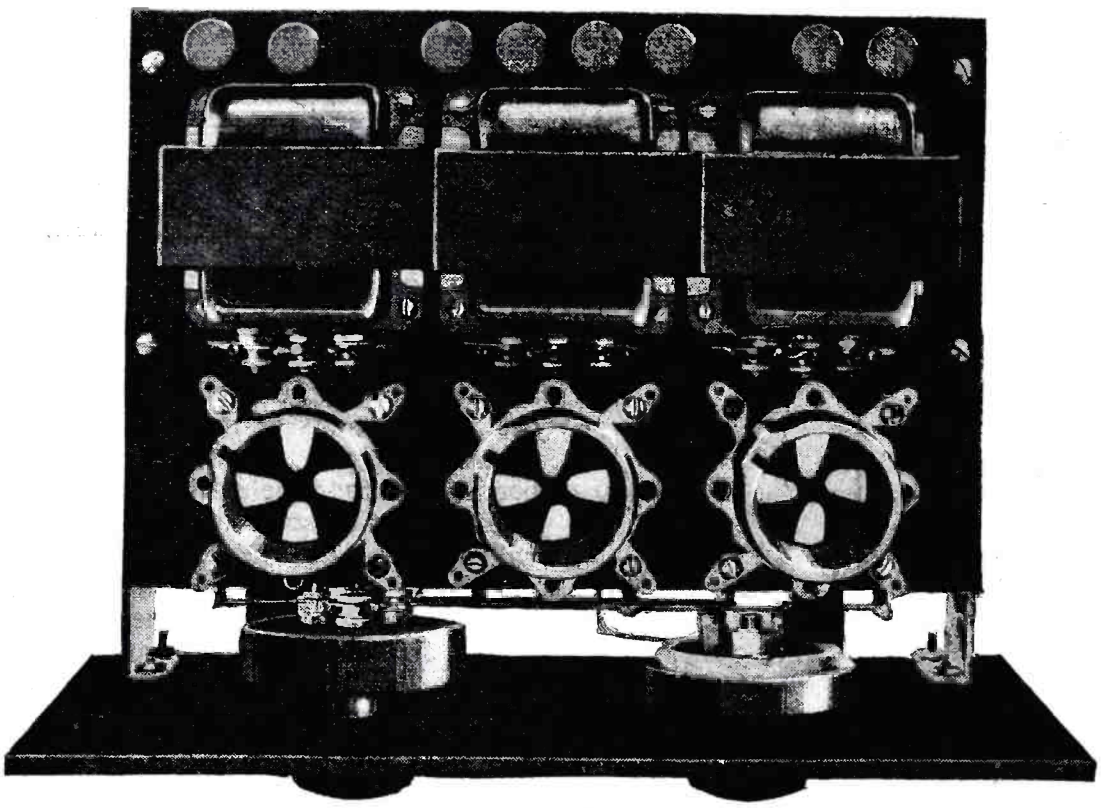
These coils may be used in any tuned radio-frequency circuit and eliminate the necessity of special placement of coils or the use of a potentiometer or other stabilizing device. The secondary is tuned with a .00035 mfd. variable condenser.

In a regenerative set the coils block radiation.

A Modern Choke Audio Amplifier

Directions for Making the New Three-Stage Choke Amplifier

WITH the development of radio receivers to a point where consistent reception over comparatively great distances is possible it is inevitable that efforts to improve the quality should ensue. Many arguments are advanced in favor of the various forms of amplifiers in use, but there is little question regarding the superiority of choke or resistance amplifiers over the conventional transformer systems, providing of course that careful attention is paid to the details. Without intending any inference as to superiority of the choke system over the resistance type of amplifier, we can recommend the amplifier described by *McMurdo Silver* in *The Chicago Evening Post*. Mr. Silver's story follows:



Illustrations by Courtesy of The Chicago Eve. Post

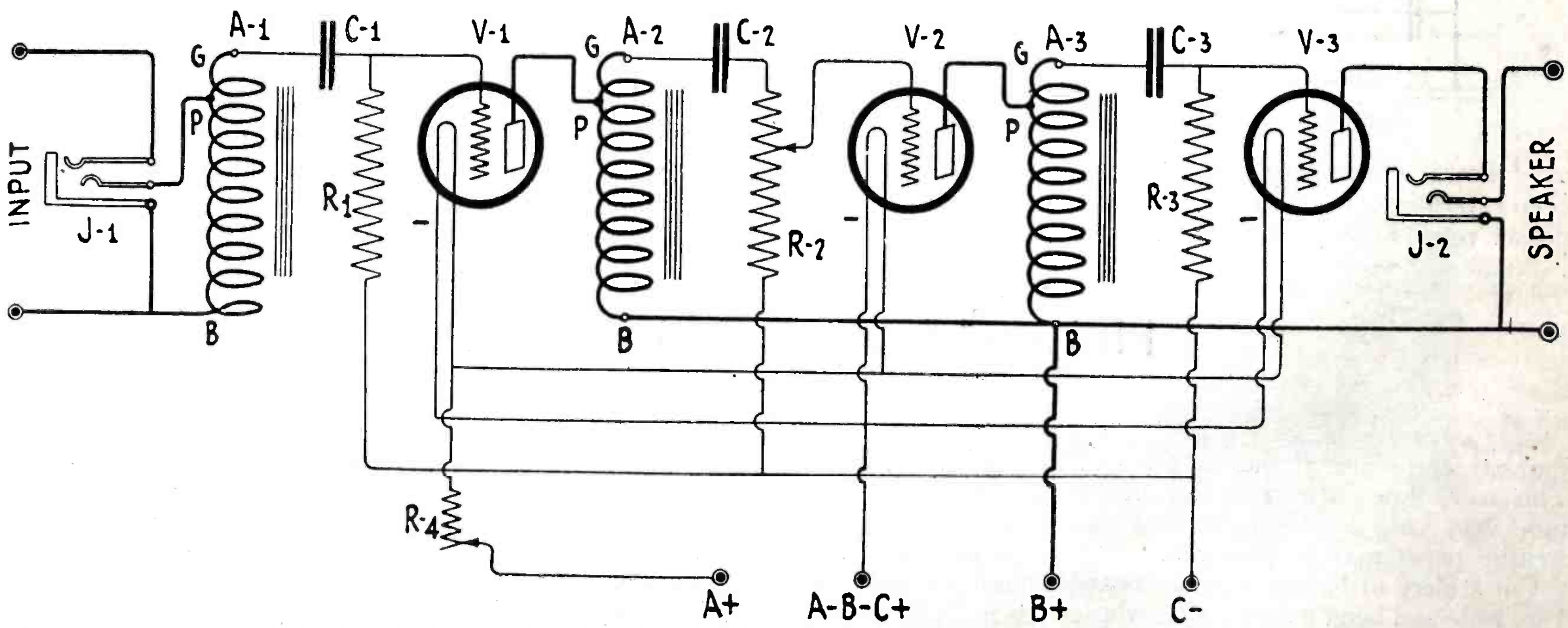
Photo showing a top view of the completed choke amplifier. Note the simplicity and compact arrangement of parts. The bakelite sub-panel is fastened to the front panel by means of Benjamin brackets.

There are but three generally recognized types of audio-frequency amplifiers suitable for radio work—transformer, choke and resistance coupled—and at the present stage of their development the type giving the greatest amplification provides the poorest quality of reproduction, and vice versa.

The first type referred to is the transformer-coupled amplifier, such as is commonly found in commercial receivers. In this amplifying system, the gain or increase in signal strength, per stage, is very great, while the quality of reproduction is not particularly good, since all transformers have a tendency to attenuate the frequencies below 200 cycles to a very pronounced degree, while all frequencies above this range receive substantially equal amplification in good transformers. All in all, the transformer amplifier will probably long retain its popularity, particularly so long as broadcast transmission is monitored at the transmitting station to compensate for the predetermined average receiving amplifier's deficiencies. More simply expressed, broadcast stations transmit stronger low notes than high ones to compensate for poor low-note and good high-note amplification in average receivers.

Resistance Coupled Amplifiers

The next extreme type is the resistance-coupled amplifier, which, properly assembled, possesses a substantially straight line frequency characteristic; that is, it gives uniform am-



Schematic wiring diagram of the amplifier. Care should be taken to make all connections as shown, especially to the choke coils.

plification to all frequencies supplied to it. This is unquestionably the ideal amplifier, where efficiency is no consideration. Its gain per stage is low; always lower than the amplification constant of the tube. The "B" battery potential for good amplification required is three to five times what should be necessary, and an excessive number of stages is required to obtain good volume, compared to a transformer system.

These two systems may well be considered the extremes of audio amplification, one sacrificing quality for volume; the other doing just the reverse. Obviously, there is a compromise which will permit good gain and good quality, yet with few of the drawbacks of either type. This compromise is found in impedance-coupled amplification. The arrangement is practically equivalent to a resistance-coupled amplifier, except that instead of using a coupling device with a high A.C. resistance by virtue of its high D.C. resistance, with consequent waste of "B" battery, a choke coil is used of low D.C. resistance, yet possessing a high A.C. resistance, due to its inductance. Here, then, we have the equal of a resistance amplifier for quality and amplification, yet using no more "B" battery than a transformer amplifier, without the waste of four-fifths of the "B" battery voltage required in the resistance amplifier. The problem now is to increase the gain per stage to compare with a transformer amplifier.

Transformer Amplifier Gain

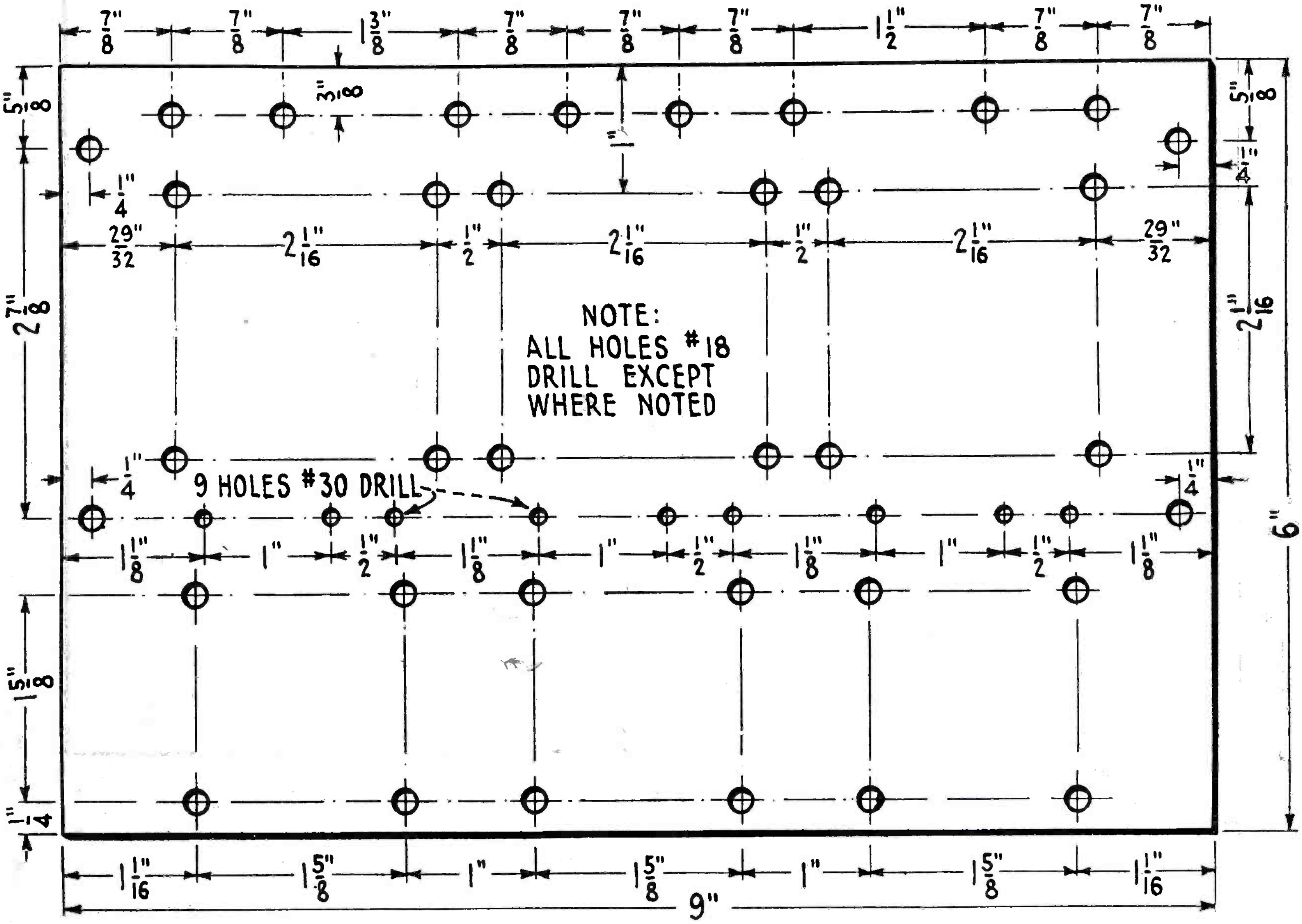
First let us consider the probable gain in a transformer amplifier. It is, under conditions of load impedance equaling tube impedance, equal to the voltage amplification constant of the tube, times the voltage step-up of the transformer, divided by two. Using a UV-201A with a three-to-one transformer, the gain is about eight times three over two, or twelve. If the transformer ratio had been six to one, the gain would be about twenty-four and the quality poor. In the choke-coupled amplifier the gain is as above, except that we may ignore the divisor "two" since the load impedance is so far in excess of the tube impedance that practically all of the available voltage is across the load.

In the chokes used, a new and yet old idea has been utilized; they are tapped and function as step-up auto-transformers with a ratio of one to one and one-half. Therefore our gain may be considered as eight times one and one-half, or twelve; as much as was obtained with a transformer amplifier, though in practice not quite as much, for various reasons. Had the step-up feature not been used, the gain would have been eight, as against a probable 6.5 to 7.5 for resistance coupling.

Moderate Step-Up Radio

Summing up, what we desire in a choke is a moderate step-up ratio, a very high inductance in order that maximum voltage will be delivered to the choke, and that the variation of reactance with frequency will be of such an order that a practically straight line frequency characteristic will result. An inductance value of 350 henries, with a step-up ratio of 1:1-15, a low D.C. resistance, low distributed capacity, and a large core to insure handling of high powers. These features are found admirably combined in a new transformer which deserves a good word, for it is the first real amplifying choke ever marketed.

A three-stage choke amplifier, with the first two stages functioning as voltage amplifiers and the last as a power amplifier, is illustrated. It will



Details for drilling the bakelite or hard rubber sub-panel on which the three choke coils, sockets and binding posts are mounted. Note how the sockets are mounted in the accompanying photo. All connections are made beneath this sub-panel.

give slightly better amplification than a two-stage transformer amplifier, as good quality as a resistance amplifier, yet with low "B" battery consumption, and may be operated with any standard receiver, or it may be built directly into a set.

Modulator Is Used

A jack is provided for input and output, with no interstage jacks to vary volume. Instead, a modulator is used, which gives a smooth, uniform control of volume from practically nothing to the full output. This is a very handy device, for it permits adjustment to any desired volume, rather than the usual coarse variations by stages.

A schematic circuit is shown which can easily be followed even by the novice, since each instrument is designated exactly as it is in its physical makeup. The two drilling layouts are respectively the front and subpanel. The complete unit is on a 7 x 10 x 1/8 or 3/16 inch panel, seven inches deep. On the front appear the volume control, rheostat and two jacks. All binding posts are in the rear. The necessary parts are listed below:

Three Thordarson A-1, A-2, A-3 choke coils.

Three C-1, C-2, C-3 fixed condensers.

One R-2, C-R-L modulator, 500,000 ohms.

One R-1, 1½-meg. grid leak.

One R-3, ¼-meg. grid leak.

One J-1 jack.

One J-2 jack

One R-4, 6½-ohm rheostat.

Two grid leak mounts.

Eight insulated top binding posts.

One 7 x 10 x 3/16 inch bakelite panel.

One 6 x 7 x 3/16 inch subpanel.

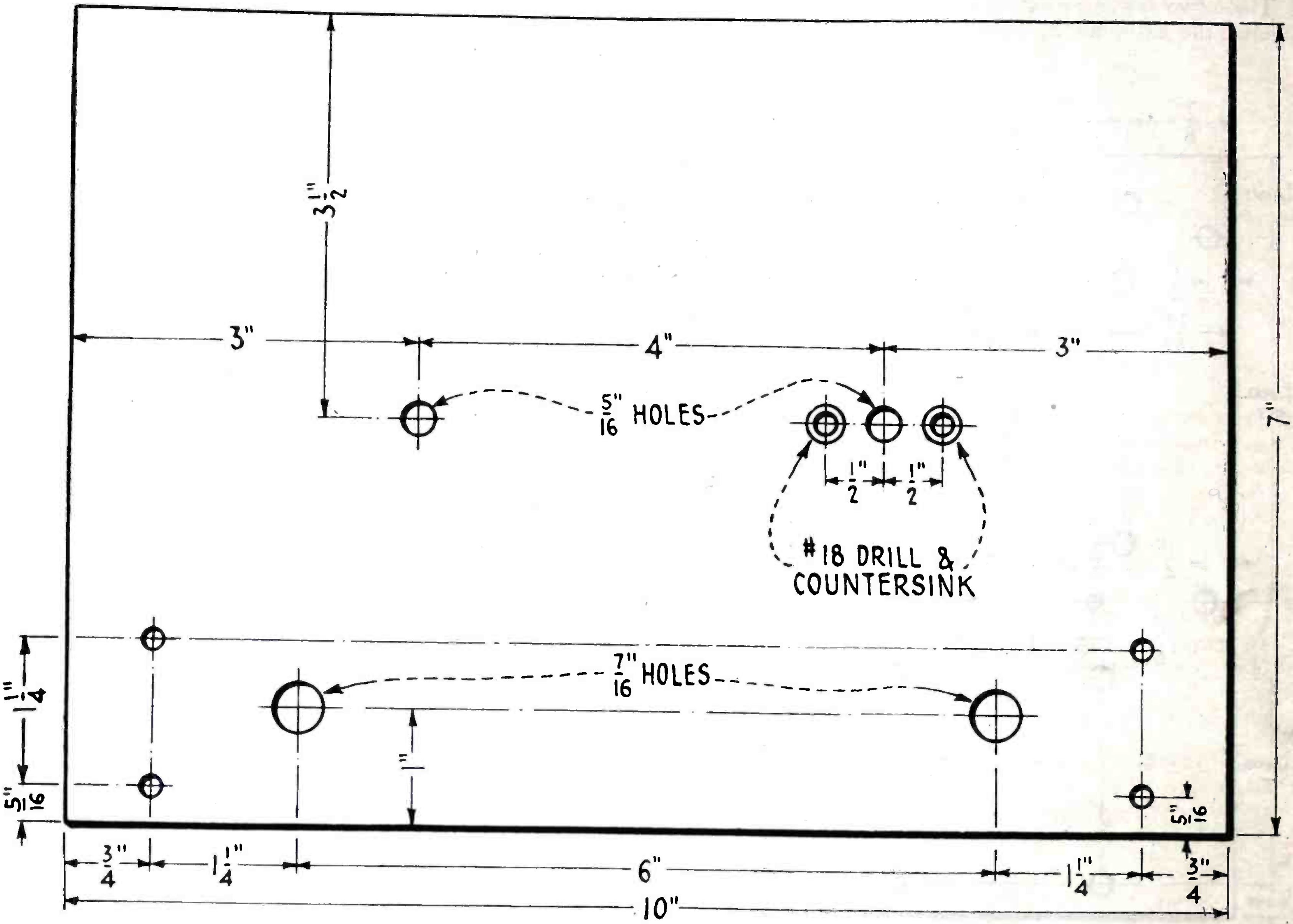
Three Benjamin sockets.

One set shelf-mounting brackets.

Lugs, busbar, No. 6-32 flat head machine screws, nuts and solder.

After all parts have been procured they should be carefully examined and all nuts, screws, etc., tightened up. Lugs may be put on binding posts where necessary. After drilling, graining and engraving the panels, the parts should be mounted, the sockets removed from their bases and fastened directly to sub-base, as shown in the photo. The sub-base assembly may be completely wired, then attached to the front panel, and the few remaining wires run in. Busbar or flexible hook-up wire may be used, with a well-tinned soldering iron, rosin-core solder and a small amount of paste.

The amplifier may be tested with any receiver, in the usual fashion, using 90 volts of "B" battery and 4½ volts of "C" battery. The "A" battery should suit the type of tube used. The only trouble likely to be encountered is blocking or choking on strong signals, which may be avoided by using lower values of grid leaks.



Front panel layout of the amplifier with dimensions of the holes to be drilled.

Keep Jack Contacts Clean

Dirty contacts of phone jacks will produce sizzling and frying noises in the headphones or loud speaker. The simplest way to clean these jack contacts is to let them close on a piece of fine sandpaper and then pull the sandpaper out. Repeat this process with the sandpaper turned over and then both contacts are surely clean. Do not use emery paper, because emery powder is conductive and may partially short-circuit the jack.—*N. Y. Herald Tribune.*

Build Your Own Radio Meter

How to Make and Operate a Practical Wave Meter

HERE is a radio instrument which will prove to be a practical utility for determining wave-lengths of the various broadcasters as well as comparing inductances, capacities, measuring resistances, checking frequencies, etc. It is almost indispensable for use in tuning your set to a distant station and measuring the wave-lengths of interfering radio telegraph stations and thus recognize them as ships, amateurs, etc. You can use it as a rejector or interference eliminator and assure yourself of undisturbed reception. *C. William Rados* recently described this instrument in *Radio Progress* magazine, Providence, R. I., as follows:

The radio meter, known as a frequency meter, a decremeter, or wave meter, is simply a coil and condenser

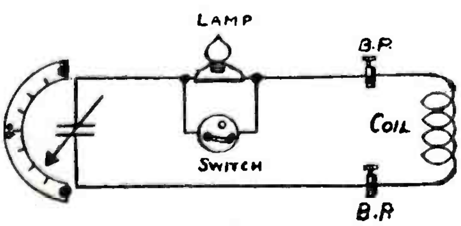


Fig. 3. Here is the simple hook-up of this meter.

adjusted so that the pointer reads wave frequencies (or vibrations per second) instead of mere numbers or degrees. Thus when your dial on the *radio* set reads 50, it means to you perhaps KGO or WBAP. The number 50 might just as well be "abc" or "$%†." It would be just as good an indicator for KGO or WBAP. On the radio meter, however, when the dial reads 50 it will mean to you 700 k. c. If you have a clean white scale on your dial, you will probably want to pencil in this wave speed and thus do away with meaningless numbers.

A Reading Means Something

So we see that the radio meter consists of a coil, a variable condenser, and a scale which will mean something after it has been calibrated. This will be mounted in a box so that it may be carried.

The two essential parts of this instrument are the variable condenser and the coil. A condenser which is mechanically very rugged *must* be used. Pick a first class unit like the General Radio, Acme, Cardwell, or Premier. If you know some army, navy, or commercial operator, ask him if he can procure for you a commercial condenser such as they use on ships and in the army. The one used in the illustration, Fig. 1, has plates 1/16 inch thick. If it is rugged it will not lose its calibration when jarred or dropped. It is not necessary to bother about "low

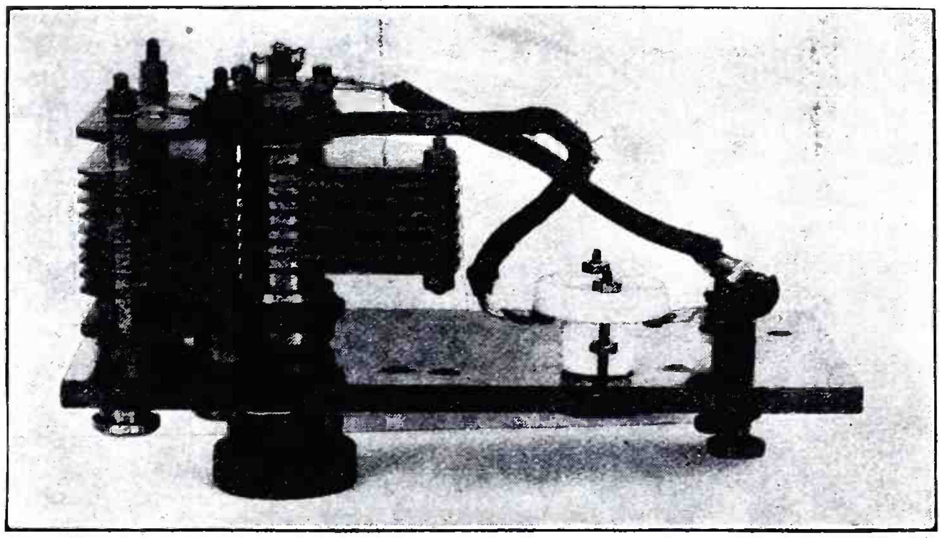


Illustration by Courtesy of Radio Progress (Providence, R. I.)

Fig. 1. A rugged condenser like this one must be used or else the readings will shift.

loss." If your condenser is strong and husky, it will suffice.

The reason for the heavy plates is not to reduce the resistance as much as it is to prevent the thin pieces of metal from becoming bent. When condenser plates are evenly spaced, they have a certain capacity, depending on the dimensions, but as soon as anyone of the plates (except end ones) gets bent the capacity always increases. You will want to be able to rely on this meter and so you must make sure that the condenser does not change its value.

It Covers the Range

The coil is wound on a form about 3½ inches in diameter. Use 25 turns of No. 20 d.c.c., and wind on as tightly as possible. Give the coil a light coat of "dope" and hang up to dry. When thoroughly dry, put on a couple of husky terminals as in the photographs. If you are going to use only one coil, you may fasten it permanently to the panel, but it is a much more flexible arrangement to mount the coils as in the photograph, Fig. 2. Then if you want to get up to 3,000 kc. (100 meters) or to 300 kc. (1,000 meters), all that is necessary is to wind a new coil and slip it on. The coil for which the details were just given will cover a range of from 1,360 to 600 kc. (220 meters to 500 meters), making it just right for broadcast reception.

With a good condenser and coil, you have the makings of a good radio meter. But you will need a box or panel of some sort to mount the instrument on. The set photographed (Fig. 2) shows about the handiest way to mount such a meter. The box used is a voltmeter case such as electricians, telephone men, and laboratories have. It measures 7½ inches square inside which is large enough to contain the panel.

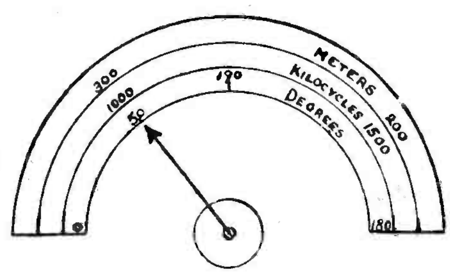


Fig. 4. The semi-circular scale reads both speed and length of waves

Mounting Parts

Mount the condenser on a small rubber or radion panel with a pair of large binding posts as shown in the photo. If you think that you may ever work around any kind of a radio transmitter, then mount on the panel a small 1-volt flash lamp and socket. The binding posts are used for connecting the coils and the lamp is an indicator which will light up when you bring it near a transmitter.

As this lamp naturally takes some energy even though it is very small in watts, it will not work with an ordinary receiver. The amount of power picked up by a receiving aerial is so very minute that even if all of it were concentrated in this lamp, it would not even glow. However, when used near a transmitting set, the power is sufficiently great to make it shine.

As it introduces resistance into the line, it is a disadvantage to leave it in circuit unless it is being used. That is why in Fig. 3 a switch is shown which short circuits the lamp when not in use.

The case is a real convenience, because many uses will develop, not the least of which will be loaning it to your neighbors. The case with its carrying handle comes in very handy. I got mine at an electricians for the low price of one dollar. This is very cheap for a new solid oak case. The cover of these cases will slip off so that the meter may be placed on top of a receiving set and used as a wave trap.

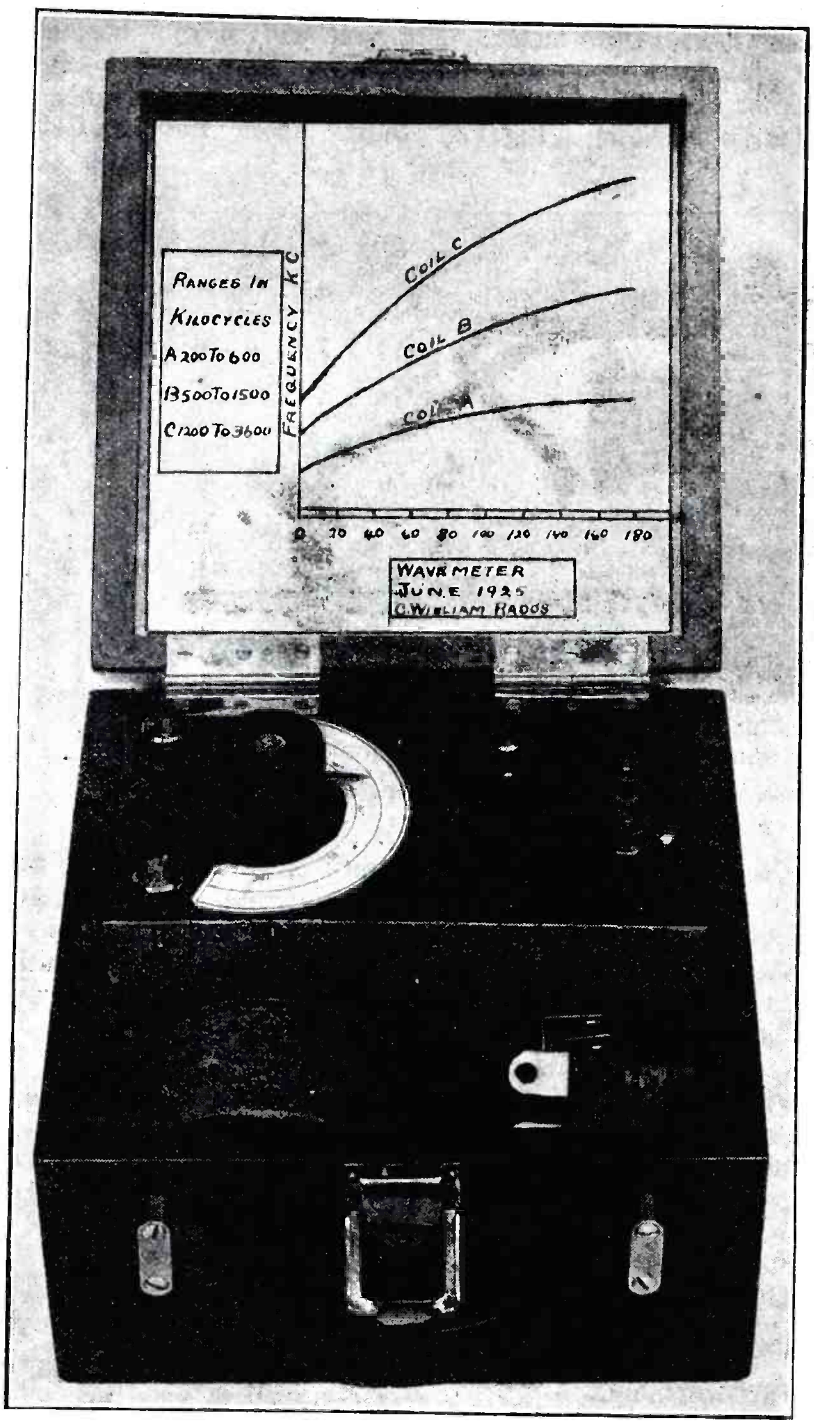


Fig. 2. Here is a view of complete meter. Extra coils are in front. The curves on cover read direct

When making the scale for this instrument, you must decide whether you are going to use meters or kilocycles or perhaps both. Of course, meters wavelength has been the standard in the past, but it looks now as if frequency were going to be used as it is much easier to understand and to work with. Both scales will be illustrated in this article so that you can take your choice.

Two Scales Used

Two separate scales are to be made. One of these, Fig. 4, is pasted to the instrument underneath the pointer; this shows clearly as the semi-circular white paper in Fig. 2. The other, Fig. 5, is pasted in the cover of the box. The lower one is marked off in degrees, kilocycles and meters. Of course the latter two are to tell what wave is being used while the degrees are needed only to compare the reading with the chart in the cover. The latter is more accurate than the semi-circular scale but not nearly as convenient.

The chart in the cover is also arranged to carry the curves of three or four different coils—as many as you use. The scale under the pointer had better be limited to the range which you use most, that of the broadcasting stations. To use the upper chart, notice what number of degrees the pointer rests on and then run up the line as shown in Fig. 5, from the number 50 until it meets the curve. From there go straight across to the left until the answer is found—1,000 kc. in this illustration.

Notice that the chart does not start with a zero wave opposite zero degrees. This is because there is a certain amount of leakage capacity in the set even when the condenser dial is turned to zero degrees. The line of the wave is not straight since an ordinary condenser plate is used. If instead you employed a condenser which had its plates shaped so as to give straight line frequency, then Fig. 5 would be straight. The same thing is true with straight line wavelength if used with a corresponding condenser.

In laying out the dial scale, Fig. 4, notice that as the kilocycles of frequency increase the wave-length in meters decreases. Thus 1,000 kc. is opposite 300 meters while 1,500 kc. is equivalent to 200 meters. To convert from one to the other, divide 300,000 by the figure for either meters or kilocycles and it will give you the answer in the other unit. A more exact figure for this constant is 299,800.

In order to make the scale read up from left to right in kilocycles, attach the knob to the condenser shaft so that when the movable and stationary plates are in mesh the pointer reads zero. In that case the meters will decrease from left to right. To make the meters read up, the pointer should read 180 degrees with the plates in mesh.

With a good condenser, which has a low ratio of minimum to maximum capacity, as the rotor is turned from way out to way in mesh, the range of frequency will be at least three to one. That is, if we start at 500 kc. it will run to 1500, while if a larger coil is used so that it starts at 200, then the upper range will be 600 kc. Remember that the frequency does not vary uniformly as the capacity is changed. It is the *square* of the capacity which counts, and so to get a three to one ratio of frequency or wave length for that matter, we must have a 9 to 1 ratio of total capacity. Since there is some leakage capacity in the wiring, it will require a condenser whose ratio between high and low is probably ten or twelve to one or more to accomplish these results.

The only hard part about this instrument will be the calibration. Your meter up to this point is as valuable as any other coil and condenser connected together, in that you do not know what the wave speed of the meter is when your pointer reads, say 50.

Calibrating consists in marking the scale so that it will read in wave speeds or lengths. With your receiving set ready, tune in some station a few hundred miles away. Use head phones and tune the wave in as sharply as possible. The station is to be preferably one of the accompanying list (Fig. 6), as all these broadcasters have been certified by the federal government.

Use a Certified Station

This list is taken from the Department of Commerce "Radio Service Bulletin." They represent measurements made by the Bureau of Standards over a period of nearly two years. You will notice that the last two columns which give the average and the greatest per cent. error in the waves sent out by the stations, is remarkably low. Of course, this table shows only what has been done in the past and the government naturally gives no guarantee that they will keep up the good work in the future.

When the station is in well, put your

radio meter on top of the receiver cabinet close to the secondary. Turn the radio meter knob until you hear a click in the phones. Mark the point on the scale. Then turn the handle to some other point until you hear another click. Mark this spot, too. The point half-way between these two marks will be the wave-length which is the same as that of the distant station. To insure accuracy when you have located two points thus, increase the distance between the radio meter and the receiver.

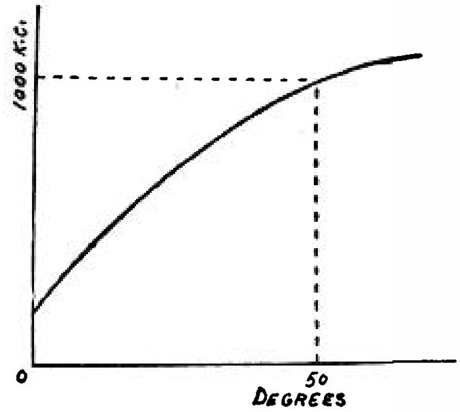


Fig. 5. How to use the curves in cover of Fig. 2.

By doing this you will be able to bring the two points together, and so get a better check on the wave-length. By marking several points thus on the scales, you will get an idea of the range your meter covers.

After you have calibrated one coil you draw the curve as shown in Fig. 5. Another coil may now be substituted as Fig. 6 illustrates. Its calibration will lie above or below the line already drawn, depending on the size and number of turns in the winding. Three or four such coils will include the entire range of frequencies usually used. Even a single coil, if it has the right number of turns (which may be found by experiment) will cover the broadcast range.

Of course, there are other ways of calibrating your radio meter. Instead of listening to a distant broadcast station you can set another wave meter into oscillation (use a buzzer) and then turn your own until it clicks.

Station.	Owner.	Location.	Assigned frequency (kilocycles).	Period covered by measurements (months).	Number of times measured.	Deviations from assigned frequencies noted in measurements. Average.	Greatest since April 20, 1925.
						Per cent.	*Per cent.*
WVA.	United States Army	Annapolis, Md	100	2	34	.02	0.4
WEAF.	American Telegraph & Telephone Co	New York, N. Y	610	5	52	0.0	0.0
WCAP.	Chesapeake & Potomac Telephone Co	Washington, D. C	640	20	94	.1	.2
WRC.	Radio Corporation of America	Washington, D. C	640	17	74	.1	.2
WSB.	Atlanta Journal	Atlanta, Ga	700	20	84	.1	.3
WGY.	General Electric Co	Schenectady, N. Y	790	23	126	.1	.1
WBZ.	Westinghouse Electric & Manufacturing Co	Springfield, Mass	900	13	39	.1	.2
KDKA.	Westinghouse Electric & Manufacturing Co	East Pittsburgh, Pa	970	20	163	.1	.1

Fig. 6. These stations are so steady that the U. S. Government recommends them as frequency standards.

Getting It From Washington

If you can read code, you will be able to calibrate it by listening to WWV, Washington, which sends out the most accurately tuned waves in the country. Such waves especially intended for tests are sent out twice a month.

The simplest use of your radio meter is for tuning your set. Suppose you are listening for Scotland which you know is transmitting on 660 kc. (452 meters.) Set your receiver oscillating and then turn your radio meter until it is on 660 kc. Leaving it there on top of your radio, turn your receiver dials until you hear the familiar clicks again. You will know that your set is at tune or adjusted for 660 kc.

Now suppose you have your set tuned to this wave speed. Of course, Scotland may be a little off, say 658 or 662 kc. Then all you have to do is move your dials just a trifle one way or another, and if you do not hear your station, you can be sure that no one else in your vicinity can pick them up at that particular time unless his set is a lot more sensitive than yours. Contrast that with the usual method of turning

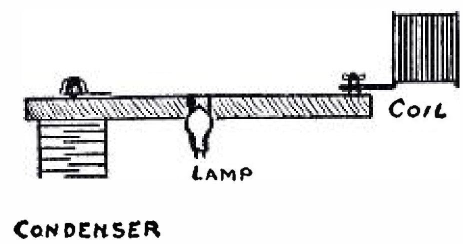


Fig. 7. The range of wave is governed by the coil. Its size may be conveniently changed.

dials, wiggling rheostats, lighting tubes, etc.

Helps You Get Call Letters

Another great use is that of identifying distant stations. You often hear some announcer's indistinct far-off mumble of words which you try in vain to pick up. If you have your radio meter handy you can check up on the wave speed used and so identify the unknown station.

Another use is the designing of the circuits for a new hook-up. Suppose you have built a new set and want to find out its wave range. Run it with the above mentioned click method, first with the dials turned to 0 and then with them turned to 100. If you want to hear KDKA or WGY on the high speed wave (short length) and your radio meter is calibrated it will be very easy for you to find them.

Faults in Your Head Phones

Many times the phone cords become broken, and on account of the outer covering this fault can scarcely be detected by appearance only. The break is usually near the tips. You may sometimes find out by shaking and bending the cords at different places. If you get no results by this procedure, substitute another cord, and take note if there is any difference; or, if you have no other cord handy, connect up the phones with any pieces of wire that may be lying around.

In some of the cheaper phones the connections from the magnets to the binding posts may not be good, so it is best to look inside to see if everything is all right. Be very careful in doing this, as the parts of a receiver are very delicate, and apt to get out of adjustment. First unscrew the cap, and then remove the diaphragm by sliding it off the edge; for if you attempt to lift it straight up it is liable to get bent. Look at the wiring, and feel if the connections to the binding posts are tight. Then replace the diaphragm accurately and screw on the cap.—*N. Y. Eve. World.*

A Second Step R. F. Amplifier for a 2-Tube Reflex

A Simple Means for Satisfying the Urge for DX by Improving Its Selectivity and Sensitivity

THE two-tube reflex is all that can be wished for in reception of local stations, but it is lacking in selectivity for distance and requires a silent night for any sort of DX demonstration. The addition of a third tube will solve this difficulty.

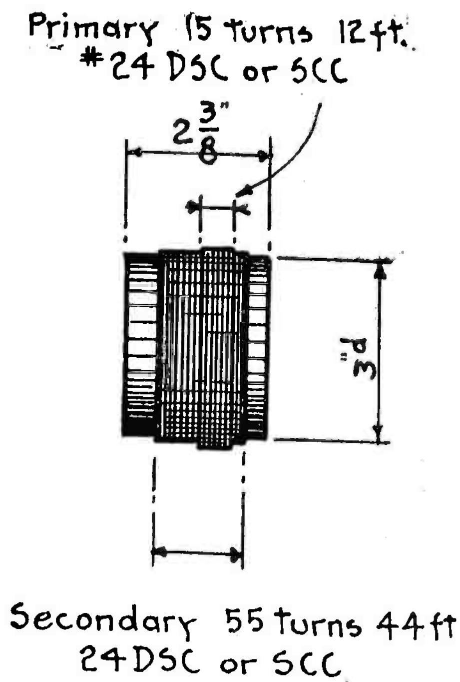
This is the introduction to an article from *Radio*, San Francisco, California, wherein *E. C. Nichols* shows the DX fan how to reach out with a two-tube reflex by the simple expedient of adding an extra stage of tuned radio frequency. The rabid fan who operates one of the many efficient two-tube reflex arrangements may think he has a remarkable outfit. Most of them boast of the results obtainable, "with only two tubes, mind you!" Well, after all, what is one tube more or less, especially if its addition will greatly improve the distance-getting ability of your receiver.

Not satisfied with merely offering data on the procedure of introducing this extra step of radio frequency, the author makes use of the latest thing in coils and gives complete information on the construction of a toroidal inductance to use with this combination. Having no external field, this coil should permit the augmenting step to function at its best without danger of introducing troublesome confliction of external fields. Mr. Nichols continues as follows:

A little experimenting with the various reflex circuits will reveal the following facts:

First: A third stage of audio will give greater volume, less quality and no increase in selectivity or sensitivity.

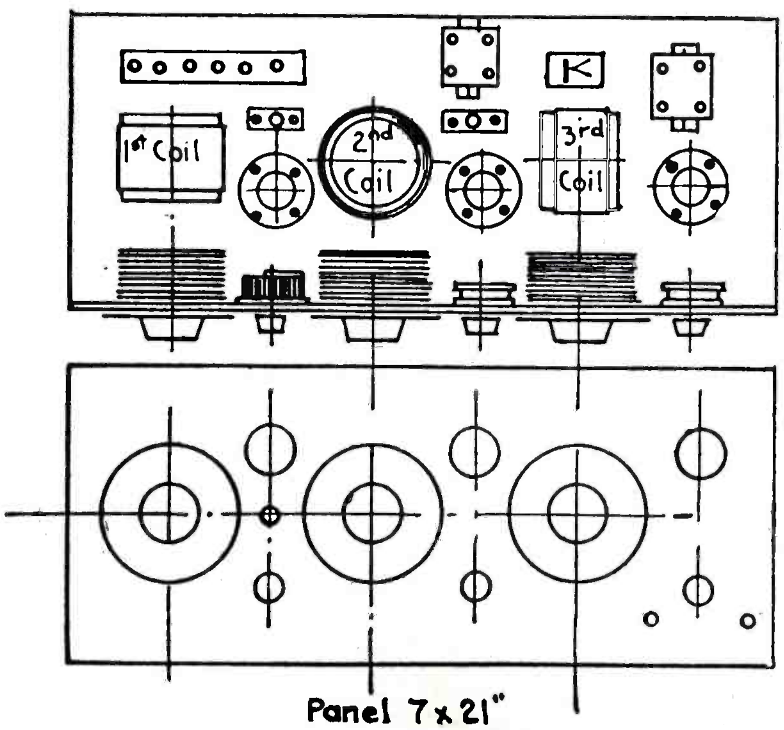
Second: The addition of a tube detector will increase the sensitivity and volume at the sacrifice of quality and stability with very little increase in selectivity.



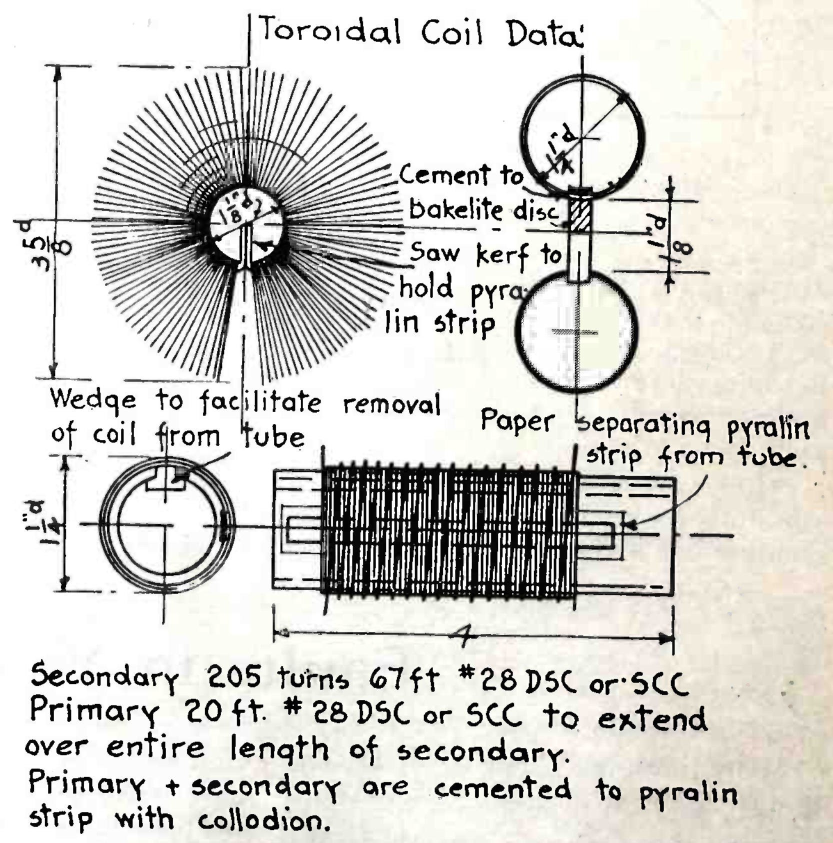
Standard coil dimensions.

Third: The addition of a second stage of radio frequency will give the desired combination of selectivity, sensitivity, quality and volume for both local and long distance stations. The addition of this third control does not add any great difficulty in tuning, as the third dial is not critical. The tendency toward self-oscillation is removed by applying the method of counterbalancing the internal capacity of the tube, invented by C. W. Rice of the Western Electric Company.

Having found the addition of a second stage of radio frequency the most desirable, the next consideration will be the selection of parts. A receiver located near broadcast stations should use the lower ratio audio transformers to insure good quality, because of the stronger initial signal received. These ratios should be 3 to 1 in both stages. A receiver located some distance from any source could use two 5 to 1 or 6 to 1 transformers. A higher ratio is not advisable. The logic of this will be apparent when we consider the relationship of strength of signal received to volume delivered by receiver.



Baseboard and panel layouts.



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

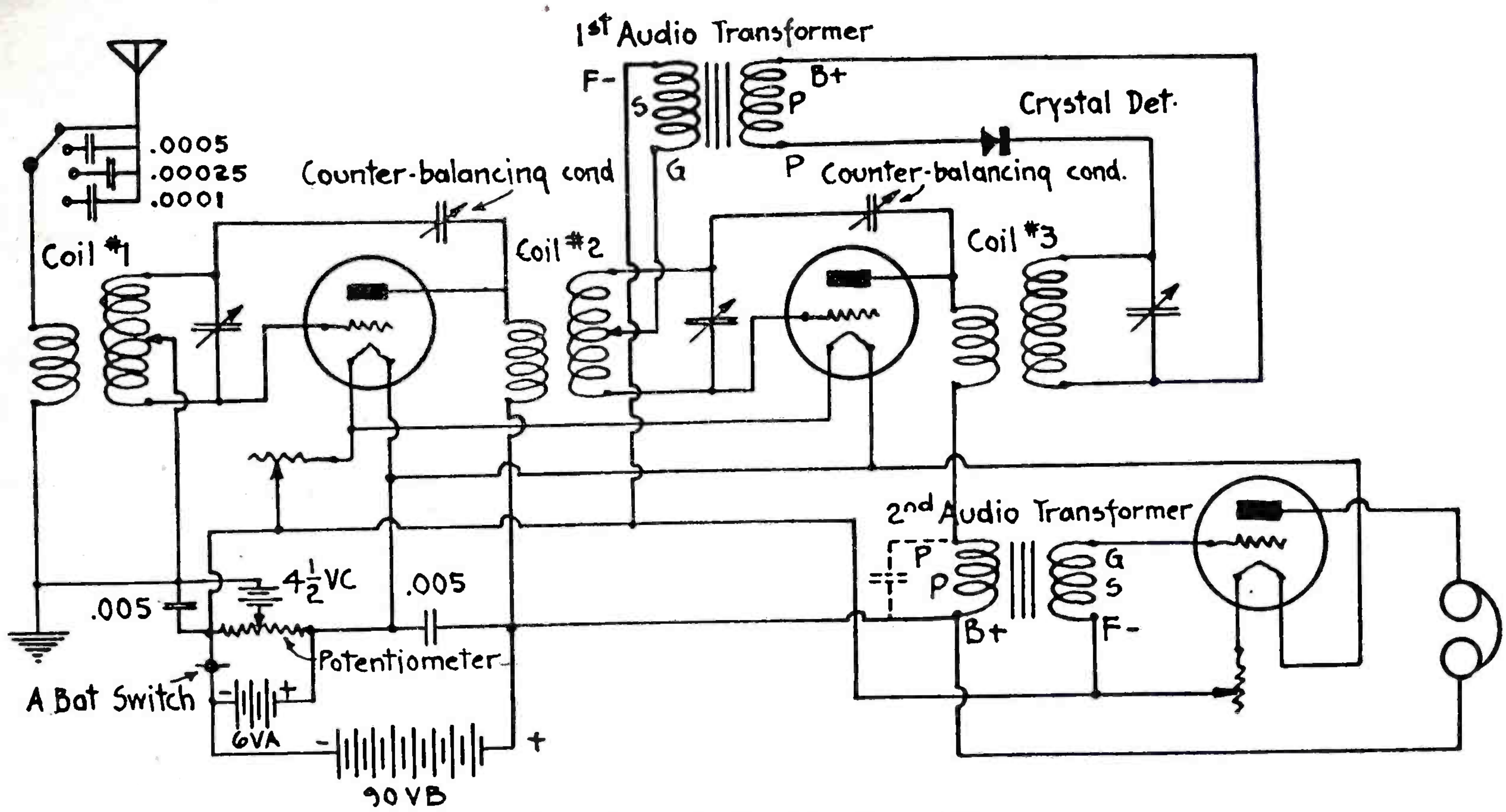
Toroidal coil dimensions.

The condensers can be the usual .0005 mfd. (23 plate) or the .000375 mfd. (17 plate). The coils can be made or purchased and modified as required. The counterbalancing condenser should not exceed .00005 mfd. with a very low minimum. A vernier condenser is not desirable. The selection of the remaining parts requires no special note.

low internal capacity, comparing favorably with the low capacity coils on the market.

The construction of the set can be carried out by the step method. All wiring should be temporary, silk or

In the next step add the second stage of audio in the usual way. Try a .005 mfd. fixed condenser on the primary of the audio transformer for increased volume. A .00025 condenser on the secondary is not necessary except in



Circuit diagram for three-tube reflex receiver.

Each of the three coils should be wound on 3-in. diameter tubing with 15 turns on the primary and 55 turns on the secondary of No. 24 silk or cotton covered wire. Two of the coils are tapped at the center of the secondary winding. The primary may be wound directly over the secondary with thin

cotton covered wire, excepting the filament circuit, which may be permanent. The final wiring can be done after the set has been tested and arranged.

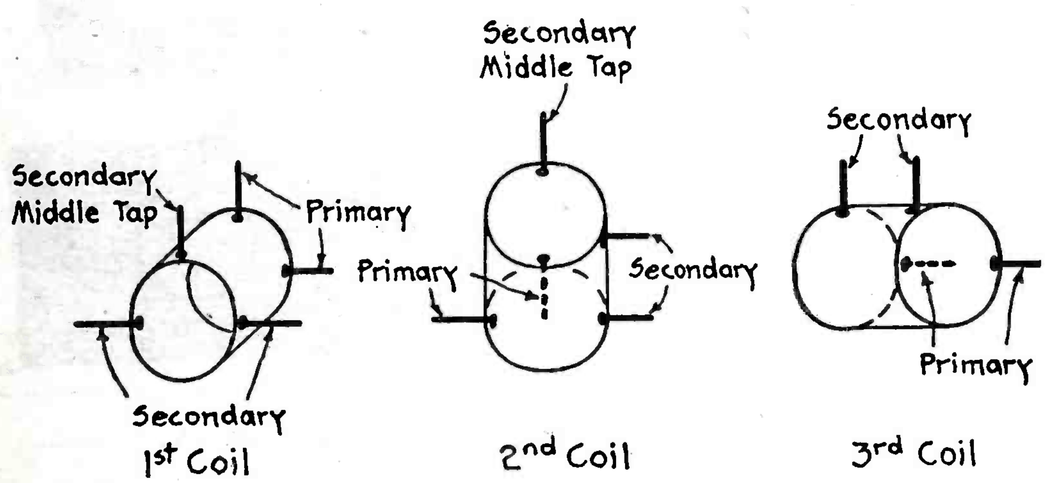
The reflexed tube will be the first to wire and test, for which test the antenna and ground are connected to the primary of coil No. 2 and the phones

the necessity of improving the quality.

The final step is the adding of the

LIST OF PARTS

1 Front panel 7x21 in.
1 Baseboard 9x21¾ in.
1 Filament snap switch.
1 400-ohm potentiometer.
3 Sockets.
2 Rheostats.
2 Audio transformers.
3 17 or 23 plate condensers.
2 Single jacks.
¼ lb. No. 24 D.S.C or S.C.C.
6 Binding posts.
1 Pc. bakelite, 1x6x¼ in.
3 Pcs. 3 in. diam. tubing 2½ in. long.
1 Crystal detector.
2 Counterbalancing condensers.
1 4½-volt "C" battery.
1 Point switch and 4 points.
Fixed condensers, dials and miscellaneous small parts as described.



Coil terminals to simplify wiring.

silk or paper between the two windings. The coils are placed in the set at right angles as shown in diagram.

As a suggestion to those experimentally inclined, the toroidal coil should pay them for their efforts since, in this coil, all inductive effect between the coils is removed, permitting greater amplification. A diagram is shown giving general dimensions for manufacture. It is interesting to note that this coil has the added advantage of

in place of the primary of the second audio transformer. In testing this step, if there is a tendency toward self-oscillation, reverse the primary connection on the last coil. There have been numerous complaints that the two-tube reflex has a tendency to oscillate. The above adjustment is a sure cure. The counterbalancing condenser may be omitted, but in this case of adding the third tube, its presence insures no self-oscillation.

first step of radio frequency. The most important adjustment here is that of the counterbalancing condenser. This adjustment, however, is simplicity itself and not as critical as the same adjustment in the neutrodyne circuits. Here the capacity of the counterbalancing condenser is increased until all tendency toward self-oscillation is removed. The counterbalancing condenser should be carefully tested for a possible short cir-

(*Continued on page* 46)

Two Sets for Great Volume

Receivers Producing Tremendous Volume with Very Little Loss of Tone Quality

PERSONAL fancies and whims, the vagaries of likes and dislikes, have their place in radio as in other phases of existence. We prefer salt on our canteloupe, but do not attempt to force our opinion on others. Similarly, we do not enjoy music or other programs that evince a desire to puncture our eardrums. Many fans, however, like more volume than is obtainable with the average receiver. For them the article by Sidney E. Finkelstein, appearing in *Radio World,* New York, will solve the problem. The reader who follows instructions and builds either of these sets can rest assured that the music thus obtained can be used for dancing, even in a hall of substantial proportions. The article follows:

Add to the usual two stages of transformer-coupled audio-frequency amplification one stage of push-pull audio (the last stage) and you will obtain volume that may be described as terrific. If you have a good strong speaker, fine! If you haven't watch out for that diaphragm! You could operate the set in a dance hall and everybody could hear the music above the shuffling of a thousand feet. Across water it is not difficult to hear such a set clearly for a couple of miles.

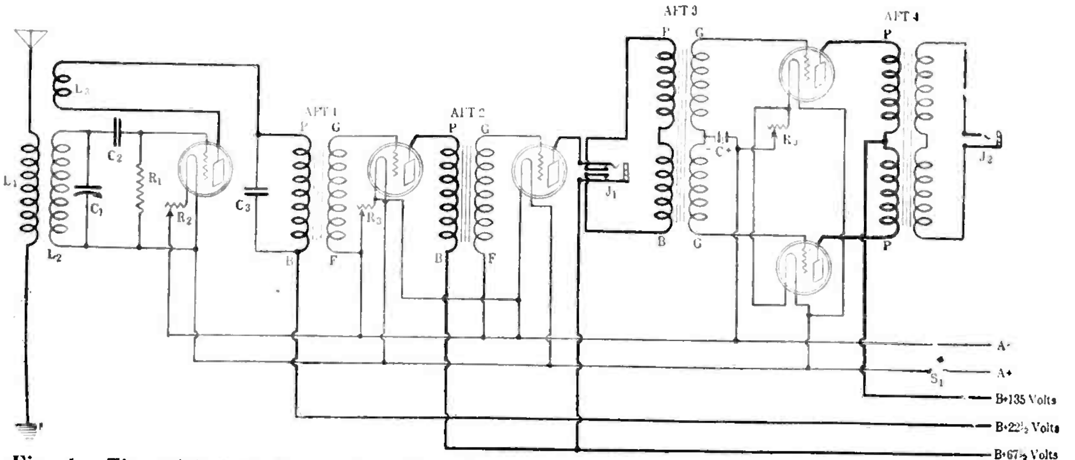


Fig. 1. The wiring of the push-pull audio set. Photos of the completed set are shown in Figs. 1A, 2, 3 and 4.

Volume, more volume! That is the cry today. Well, for those who want it, here it is, in two forms. First there is the push-pull method, as shown in Fig. 1 and photographically. This set I built myself, and I can assure you that you never heard such great volume combined with fair quality. Of course there is a slight decline in quality when you heap on such a great amount of audio, but, as I said, the volume *is* there.

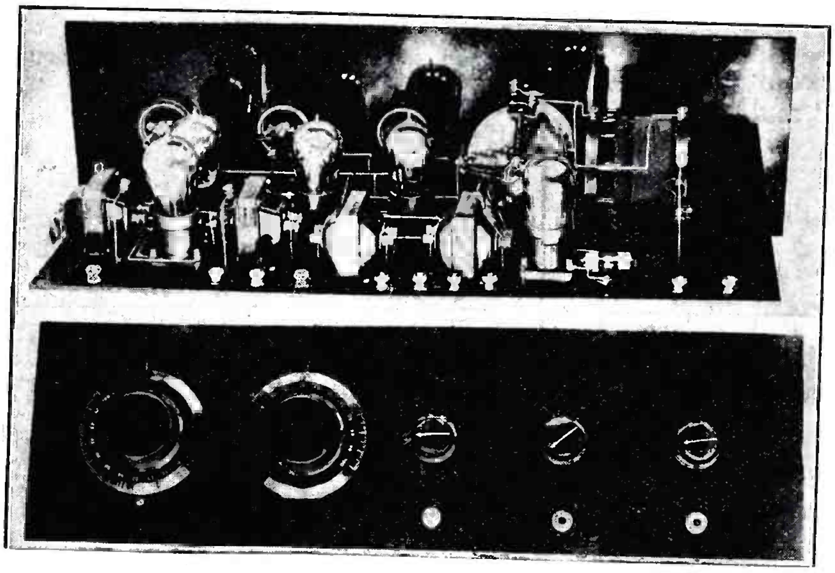
Looking at Fig. 1, the tuner is of the 3-circuit regenerative variety. L1,L2,L3 is a 3-circuit tuning coil, tuned by a .0005 mfd. variable condenser. The tickler is the only other control. As is well known, it is difficult to excel the 1-tube regenerator both for volume and distance reception.

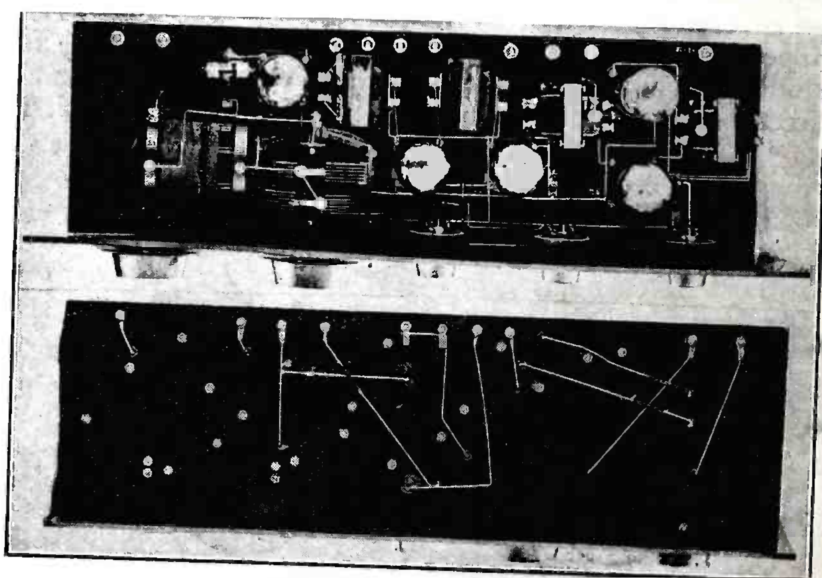
4-to-1 Ratio

There is no jack until you reach the second audio output, as we are after enormous speaker volume and will not bother with earphones. Please note that only one tube is used for the radio work of the receiver, and four tubes for the audio.

How Push Pull Works

Although there are two tubes in the last audio stage, this is only one step of amplification. Such is the push-pull system, whereby the load is distributed evenly between the two tubes. The output of the second audio stage is delivered to the primary of the input transformer of the push-pull stage. The secondary of the input transformer has three posts, two extreme ones, going to the respective grids of the push-pull tubes, the mid-tap being connected to C minus. This is the common grid return. C plus, of course, goes to A minus. As 135 volts are used on the push-pull tube plates, the grid biasing battery should have about 6 volts. The other transformer in the push-pull stage is known as the output transformer. Here the primary has three connections, the two extremes going to the respective plates and the midpoint to B plus 135 volts. The secondary has only two posts, these going to the single-circuit jack, the final output. Hence, the input transformer primary corresponds, in design of connection, to the output transformer





Illustrations by Courtesy of Radio World (New York)

Fig. 1A (upper left hand), rear view of the 3-circuit tower with two stages of transformer audio and one stage of push-pull. Fig. 2, the panel. Fig. 3 (upper right hand), top view. Fig. 4, how wires are carried under the baseboard.

secondary, and there is like similarity between the secondary of the input transformer and the primary of the output one. Note that the speaker tips do not go to plate and B+ but pick up induced current.

Coils in Set

The constants for the circuit may be: L1, 14 turns; L2, 45 turns, both on one tubing or quartzite form, about 3½ in. outside diameter, using No. 24 silk over cotton, otherwise No. 22 single cotton covered wire. The spacing between L1 and L2 is about ¼ in. and may be less. More is scarcely advisable. L3, the tickler, may be wound on a form 2¾ in. diameter, 2¼ in. high, consisting of 30 turns, 15 on each side of where the rotor shaft protrudes. The tickler will work well in any relative position, that is, whether 2 in. above the top of the secondary form, or rotating within the secondary form. Some radioists prefer that the tickler rotate within the secondary, at the end opposite to the one where the aperiodic primary is wound, and that the grid return (A plus) be connected to that end of L2 nearer the tickler. That would require the other end of L2 to go to the grid condenser, while the aerial would be joined to the terminal of L1 which adjoins the grid end of L2. The other end of L1 would go to ground. Hence ground and A plus would be the extreme end connections on the stator, while grid and aerial would be the adjoining connections.

C2 is the fixed grid condenser, .00025 mfd. R1 is a fixed grid leak in the diagram, and that is what I used, although with so much audio at the other end I have since found it preferable to use a variable grid leak. The audio hookup introduces a resistance into the radio side of the circuit beyond doubt, hence the usual grid leak value (when no extraordinary audio is used) must not be taken for granted.

C3 is a bypass condenser, .001 mfd. R2 is a 20-ohm rheostat, as the 5-volt tubes are used throughout.

In the audio circuit, R3 is 15 ohms and controls the two usual transformer stages. R4 is of the same value, as it governs the two tubes in the push-pull stage. The wiring may be traced from Fig. 1 and hints on the placement of parts and some of the battery wiring may be obtained by a glimpse at the photographs.

Transformer-Resistance Audio

Another circuit for enormous volume, with a little better quality, is the one comprising one stage of transformer coupling and three stages of resistance coupling. This will not give as great volume as the previous circuit, but it is an excellent one for the quality specialists and those who haven't speakers designed to handle special power. A good strong speaker intended only for two transformer stages will handle the transformer-resistance hookup.

The set, embodying this idea, as built by C. V. Curthoys, of Lenox, Mass., is shown in photographs, the electrical wiring being presented in Fig. 5. Mr. Curthoys, in forwarding the photographs of the panel view and the inside of his set, wrote:

"This set was recently built for a deaf man. It employs one stage of RF, with regeneration on the detector, one stage of transformer audio and three stages of resistance-coupled audio. It has a switch to cut out the regeneration, a rheostat on the RF and one on the detector, one variable grid leak and a variable resistance for the voltage drop on the first RF. It has filament-control jacks, employing Daven filament ballasts on the audio tubes. It has been heard a quarter of a mile away with 150 volts on the plate (B plus Amp. No. 2 in the diagram), using an inexpensive loud speaker."

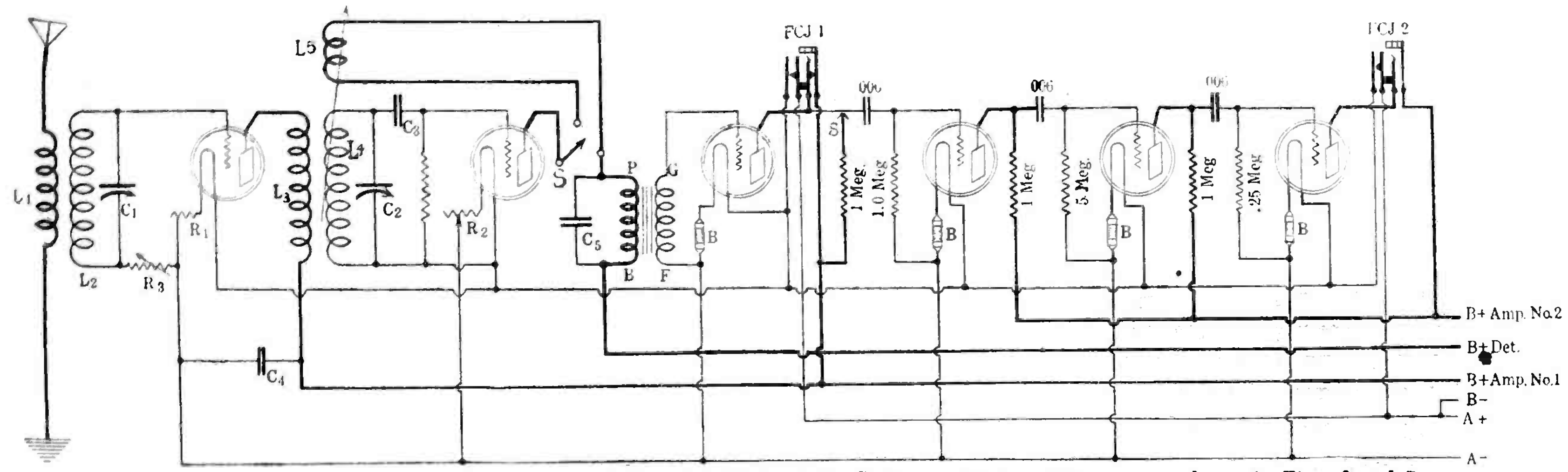


Fig. 5. The circuit diagram of the wiring of the set built by C. V. Curthoys. Photos of the set are shown in Figs. 6 and 7.

The Fundamental Circuit

The circuit, therefore, is a representation of just what Mr. Curthoys built. The fundamental radio circuit employed is that of The Diamond of the Air, with Mr. Curthoys' addition of the resistance R3, which may be a variable one going up to 100,000 ohms. This is an oscillation control. The switch to cut regeneration in or out is his own idea, too. The wiring shows

(*Continued on page 28*)

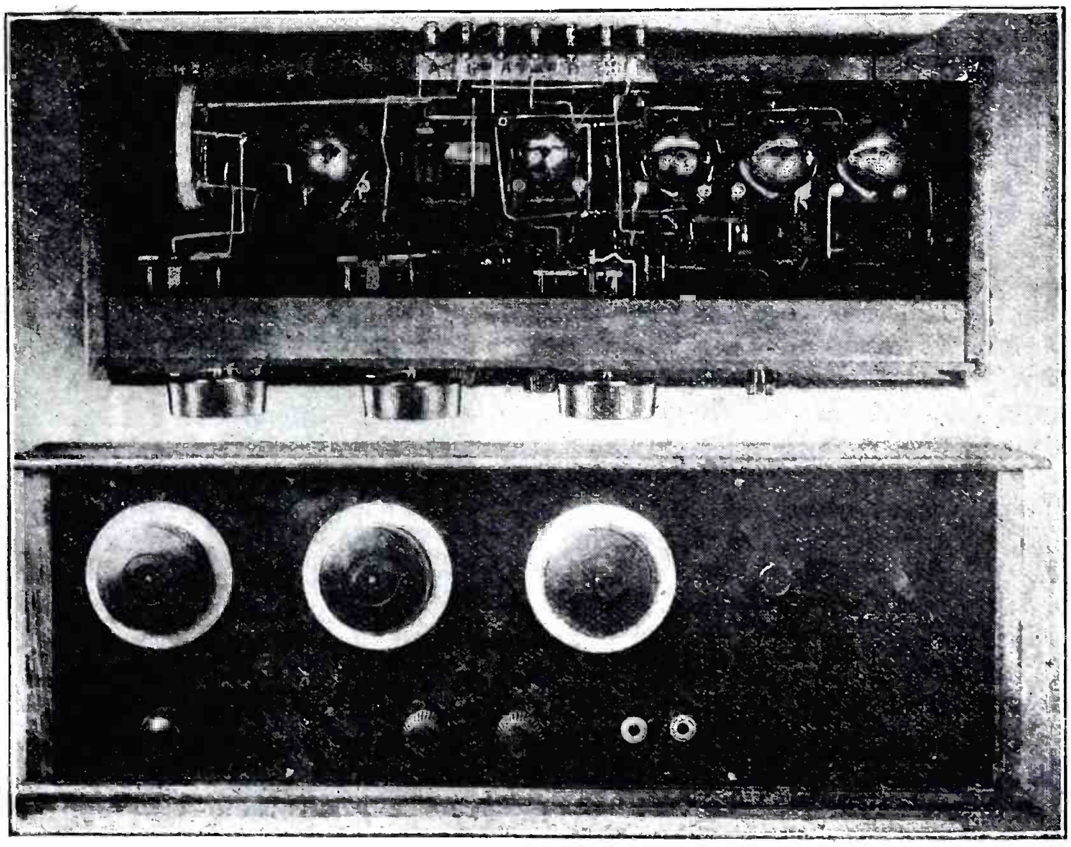


Fig. 6 (top), rear view of a set built by C. V. Curthoys, of Lenox, Mass. Fig. 7 shows the front view of panel and cabinet. It is a 6-tube set, built for a deaf man. There are one stage of tuned RF, regenerative detector, one stage of transformer audio and three stages of resistance audio.

The 9XH—9EK No. III Short Wave Set

An Autodyne Type Receiver which Covers the Wave Band of 10 to 100 Meters

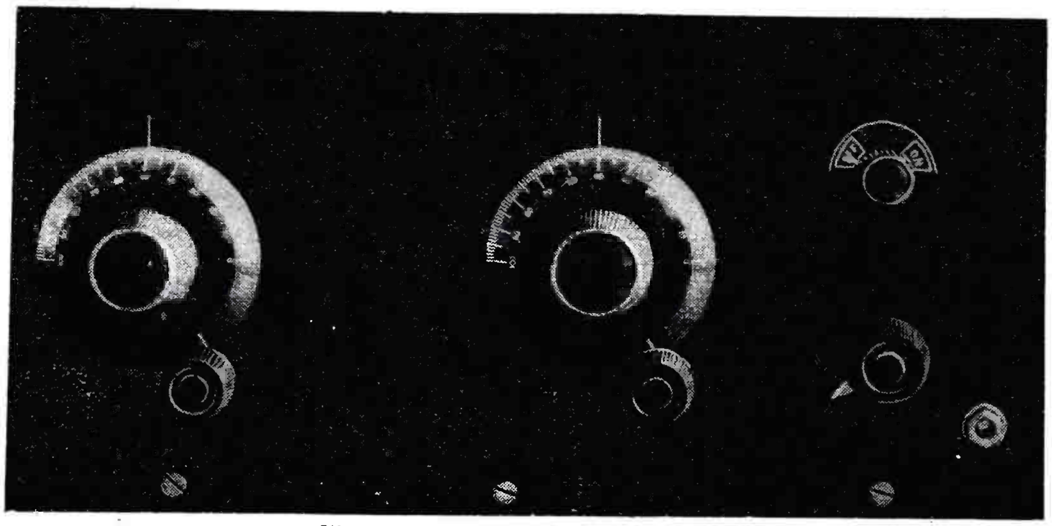
DR. J. H. DELLINGER, Chief of Radio Laboratory, Bureau of Standards, in an article surveying the current progress in Radio Engineering makes the following statement:

"The most conspicuous recent development in radio engineering is the conquest of the new domain of ultra-radio or very high frequencies (short waves)."

He also points out that a very large part of the more popular literature on radio is devoted to the subject of broadcast receiving.

From time to time some mention is made in the press of phenomenal results that are being obtained by radio experimenters at wave-lengths less than 100 meters with relatively small powers. These results sem to indicate that the shorter waves (frequencies from 3,000 to 20,000 kilo-cycles) refuse to obey the theories, in part at least, for longer wave propagation. There is therefore a field for research and experiment concerning which, at the present time, there seem to be few set rules and but little available data regarding circuit arrangements and apparatus suitable for reliable transmission and reception.

In view of these facts and of the fact that short wave activities of world wide interest are now being planned and carried on, this article is presented to our readers for the purpose of describing the construction of the 9XH—9EK No. III short wave receiver. This data as written by *W. H. Hoffman* was contained in a circular recently published by the *C. F. Burgess Laboratories*, Madison, Wisconsin, and is given complete herewith. There are discussed, also, some of the advantages and the disadvantages of different receiver arrangements when used at these high frequencies. It is hoped that the data may be helpful to others desiring to take part in short wave activities or experiments and perhaps help stimulate experimental and research work in these undeveloped high frequency regions. Mr. Hoffman writes as follows:



Illustrations by Courtesy of Burgess Battery Co. (Madison, Wis.)

Front view of the receiver showing controls.

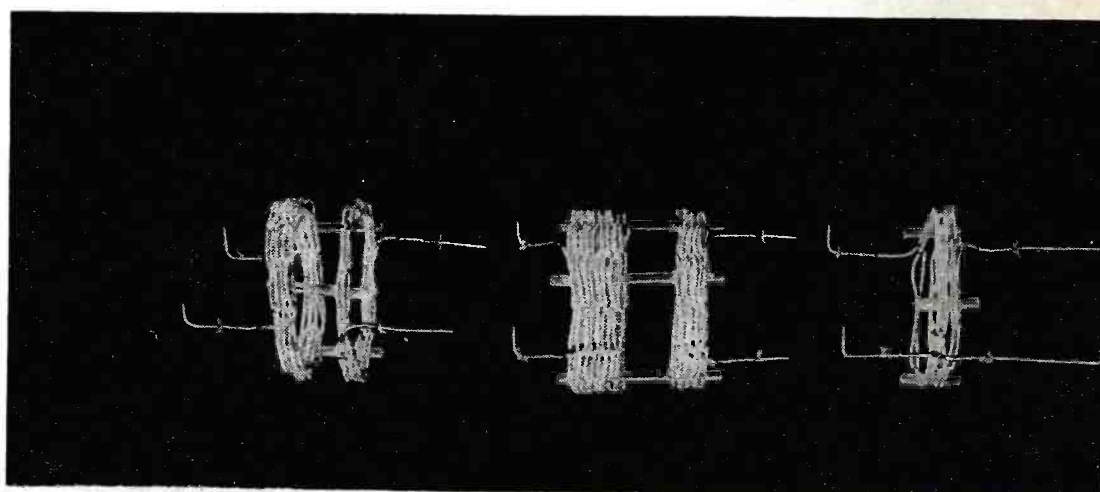
Since the general use of the three element vacuum tube in radio receivers the reception of continuous wave signals, such as are made use of in practically all radio telegraph transmitters today, is accomplished by the beat method. The principles of beat reception are described in all modern radio text books and so generally understood by the radio public that no explanation will be made here further than to state that a local source of radio frequency current is combined with the incoming signals in such a manner that when the resultant current is connected to the input of a detector tube the signals become audible in the detector output circuit.

The local source of radio frequency current may be a separate oscillator tube or may be generated by the tube which is used as a detector.

At the present time there do not seem to be any receiving methods for use at the high frequencies which are little if any better than those using the oscillating detector, provided the essential requirements of the oscillating detector, (autodyne) are carefully complied with. Many circuit arrangements may be employed which embody the autodyne principles and conform to the requirements for such a receiver and for a given wave-length probably give approximately equal response to an incoming signal. However, where it is desired to receive over one or more bands of frequencies, one receiver may have distinct advantages over another.

The 9XH—9 EK Receiver No. III

The 9XH—9 EK short wave receiver No. III is of the autodyne type and is believed to make use of the known advantages insofar as is reasonably practicable. Some of these are as follows:



Coil systems removed from receiver.

(a) Adjustable capacity coupling to the antenna.
(b) A minimum "Body Capacity" effect.
(c) Can be calibrated.
(d) Dielectric and surface leakage losses reduced to a minimum.
(e) Connecting leads are short and direct.
(f) All materials are well spaced from the fields of the coils.

(g) No choke coils are required.

(h) Oscillation control causes a minimum of wave-length change.

The accompanying photographs and circuit diagram show the arrangement of the receiving parts and the manner in which they are supported and connected.

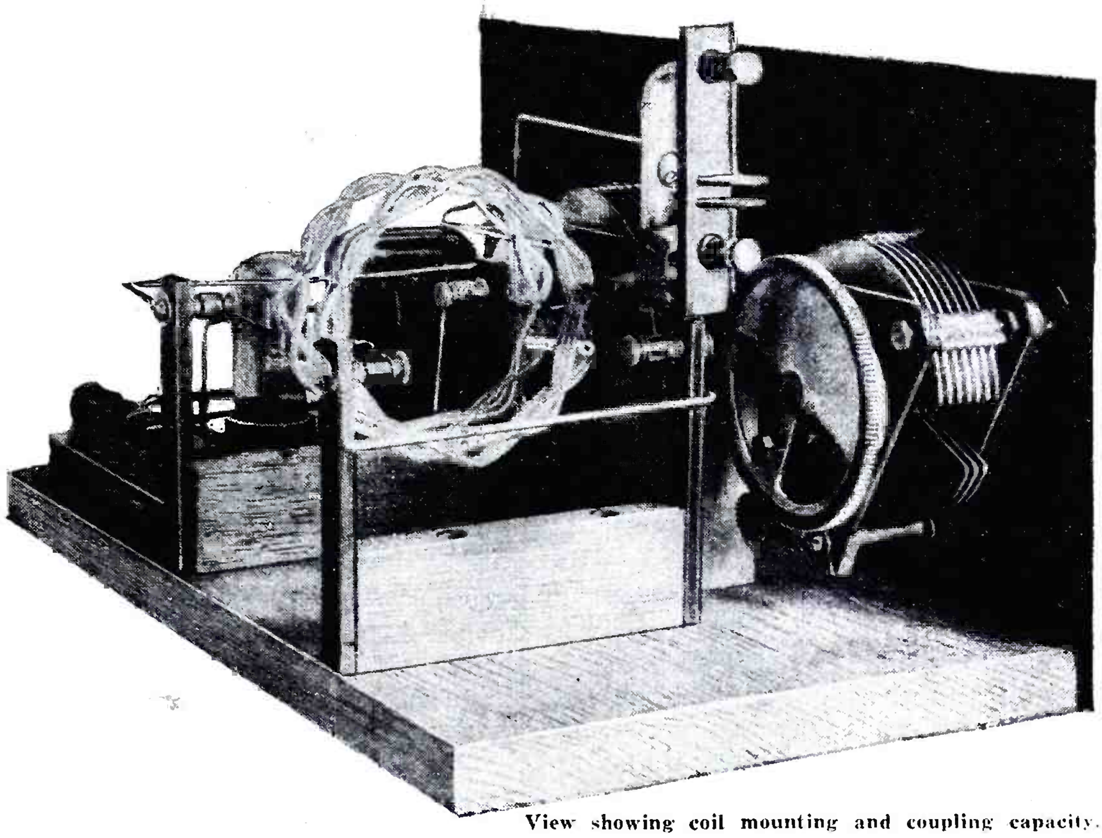
Antenna and Grid Circuit

The antenna is connected to the top side of a small adjustable condenser that consists of two 3/4" copper discs soldered on the ends of two short pieces of No. 12 bare copper wire. The wire is in turn supported by binding posts that are mounted on a narrow strip of hard rubber, the whole arrangement being supported by the connecting leads. This small capacity serves to couple the antenna to the secondary or grid coil and allows adjustment to any desired degree of coupling required between the antenna and grid circuit. In general, the larger and longer the antenna the less will be the degree of coupling required to bring a desired signal. By adjusting the plates for wide separation antenna having dimensions as great as those ordinarily used for broadcast reception may be used, or by adjusting until the separation is close, antenna not more than 15 to 25 feet may be used within the room for reception of signals from great distances.

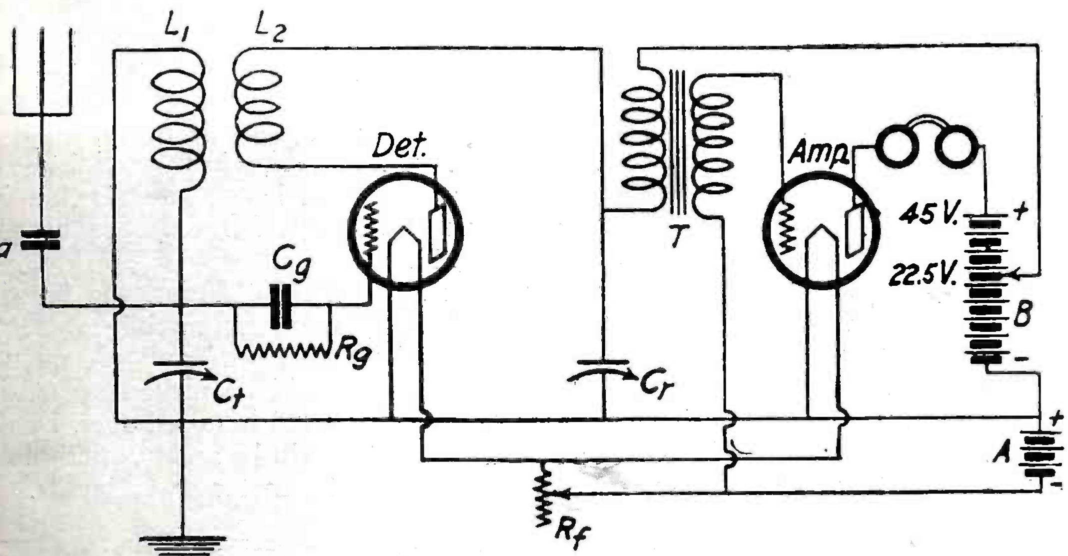
Coupled in this manner the antenna is aperiodic or untuned, thus eliminating any antenna circuit tuning adjustment, and the small coupling capacity serves practically the same purpose as the few turns in the antenna circuit of the popular three coil receiver where the antenna is untuned.

Body Capacity

The effect of the capacity of one's body near the parts of a short wave receiver becomes more marked than that at the longer wave-lengths. This is due undoubtedly, in part, to the fact the inductances and capacities making up a receiver of this sort are in themselves small in value. There are therefore points of relatively high potential in the receiver circuit that should be kept spaced away from the front panel where the hands will be used for tuning and other adjustments, for, at these short wave-lengths the presence of one's hand within a few inches of a high potential point such as the antenna condenser or the grid coil will introduce enough capacity into the circuits to completely detune them and tune out a signal.



View showing coil mounting and coupling capacity.



Schematic diagram of the 9XH-9EK short wave set No. III. See nomenclature at the right for parts.

The photographs show that all points having a relatively high potential to ground and the associated connecting leads have been kept as far behind the panel as is reasonably possible without unduly lengthening the leads.

Coil Arrangement—Calibration

Coil systems for each wavelength band are shown in the photograph. Each consists of a secondary or grid coil and a tickler coil, which are supported on glass rods at fixed distances apart and held in position by a few drops of collodion. The ends of the secondary coils turn downward while those of the tickler coils extend in a horizontal direction. When these coil systems are placed in their supporting terminals, they are situated in a definite position in respect to the other parts and cannot be reversed or inverted. Each system can therefore be calibrated and the calibration will hold upon removing and replacing the coils.

The coil supporting terminals are a common type of binding post with

NOMENCLATURE

Ca = Antenna coupling condenser. Two 3/4" metal discs, adjustable in binding posts.

Ct = Tuning Condenser. Three rotary plates, any low loss condenser.

Cr = Regeneration control condenser. 0.00025; any good make.

Cg = Grid condenser. 0.00025 MFD fixed mica.

L1 = Grid coil, diameter 3 in. No. 16 D. C. C. Copper wire, Lorenze Type. 17½ turns for 80 meter band, 7½ turns for 40 meter band, 2½ turns for 20 meter band.

L2 = Tickler coil, diameter 3 in. No. 16 D. C. C. Copper wire, Lorenze Type. 9½ turns for 80 meter band, 4½ turns for 40 meter band, 3½ turns for 20 meter band.

Rf = Filament rheostat. 30 ohms for 199 tubes, 6 ohms for 201A tubes.

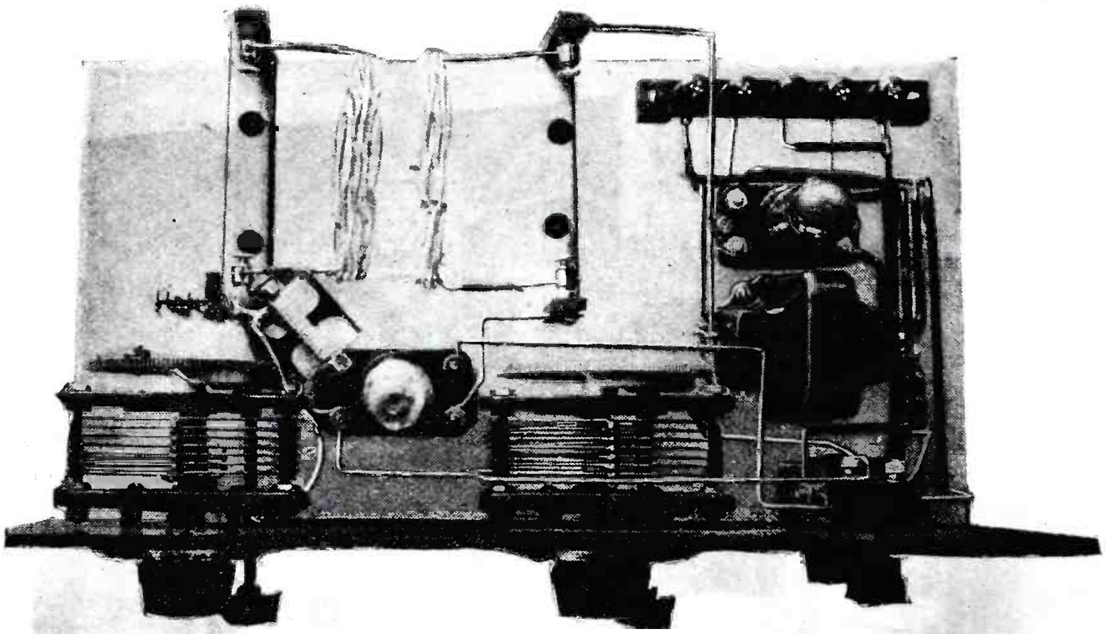
T = Audio transformer. Any good make.

Rg = Grid Leak. Fixed, 9 megohms. (Different Tubes may require from 5 to 9 megs.)

Coils for each waveband fixed in position relative to one another by 3 glass rods and few drops of collodion.

holes turned in position for properly supporting the coils.

The binding posts are mounted at the tops of four long hard rubber strips. In this manner the paths through insulating materials between any two terminals are made so long



that both capacity and resistance losses are reduced to a negligible amount. The position of the coils is such, relative to the other apparatus, that neither dielectric materials nor metal parts are situated closely in the fields of the coils, yet, all connecting leads in the radio frequency portions of the circuit are short and direct.

The "B" battery circuit is "Series" fed to the detector tube. This has the advantage of eliminating the necessity for a radio frequency choke coil and stopping condenser as used in a parallel feed system.

Oscillation Control

Oscillation control is of the capacity type as shown in the circuit diagram. Although the detector tube of an autodyne receiver must be in an oscillating condition in order to receive continuous wave signals, the strength of the oscillatory current must be within easy control if the maximum signal strength is to be received, for the signals will be greatest at the adjustment near where oscillations cease. This is just the reverse of the condition for maximum signal strength when receiving voice or music which will be at a maximum just before the circuit goes into oscillation and is usually called the point of maximum regeneration. Either point may be readily adjusted to and held by this receiver. This type of oscillation control has the advantage over the movable tickler type in that it causes very little change in tuning. Change in settings of the control capacity will cause just enough wavelength change to act as a very fine vernier for final tuning.

Operation of the Set

After lighting the tube filament and adjusting the filament rheostat for proper voltage across the tube the oscillation control condenser should be set a few degrees above the point where oscillations begin. The tuning condenser is then varied until signals are tuned in. The shorter the wavelength the sharper the signals will appear to be and the final adjustment of beat note can be most easily found by changing the setting of the oscillation control condenser a few degrees one way or the other. If the signals to be received are very weak the setting of the oscillation control condenser should be kept very near the point where oscillations cease.

Range

The ranges of the coil systems are as follows: Large coil system 55 meters to 100 meters. Medium coil system 28 meters to 50 meters. Small coil system 15 meters to 25 meters.

If it is desired to make the wave bands of the coil systems overlap, one more movable plate should be added to the tuning condenser. However, if this is done the same number of degrees of movement of the tuning condenser will cause a greater wave-length change and tuning will become very sharp, especially when using the small coil system.

It will be noted that when using the present arrangement there is a wavelength change from 15 meters to 25 meters, with the small coil system. This is equivalent to 8,000 kilocycles change made in 180 degrees movement of the dial. If the 180 degrees of the dial are divided into 100 divisions the average frequency change per division is 80 kilocycles. In order to properly tune in a signal, adjustment to from 1-3 to ½ a kilocycle should be possible, and is obtained as previously stated by the slight tuning action of the regeneration control capacity. From these facts it becomes obvious that some different arrangement must be employed for tuning a receiver for reception of signals at wave-lengths much below 20 meters. This arrangement will have to be such that the value of the constants of the circuit are changed less rapidly when tuning.

Precaution Against Irregular Action

The presence of an antenna system or a tuned circuit in close proximity to the receiver may draw out enough energy from it to make oscillation control poor or even prevent the receiver from oscillating over a band of wavelengths.

All contacts should be perfect. This applies especially to tube prongs and to the rotary plates of the variable condensers. Friction or sliding connections are apt to be noisy.

Condensers having straight line wave-length or better straight line frequency characteristics are to be preferred.

It has been noted that the ignition systems of many automobiles generate and radiate waves of radio frequency. Such waves will be picked up at distances of several hundred feet, by this receiver and will be most noticeable on the 40 and 20 meter wave bands.

Two Sets for Great Volume

(*Continued from page 25*)

two filament-control jacks, FCJ1 and FCJ2, of the same construction, i. e., 4-spring jacks, a switch being used to omit the first plate resistor (100,000-ohm fixed cartridge type) when listening on the first audio stage, which under the circumstances must have been for earphone use.

Wants Larger Coupling Condensers

As to the coupling-isolating condensers, marked .006 in the diagram, this capacity is the one most commonly used, but it is well to consider the advisability of using larger capacities. My idea of the right capacity, to reduce some of the distortion resulting from too-small capacity condensers, is .5 mfd. Even 1.0 mfd. would be better, but maybe a little too large, physically, to satisfy some fans. The 1.0 may come 3 in. long and 2 in. wide, and fans don't relish such sizes of condensers. In fact, as I intimated, .006 is a commercial compromise, and my idea of a more efficient compromise is .5 mfd.

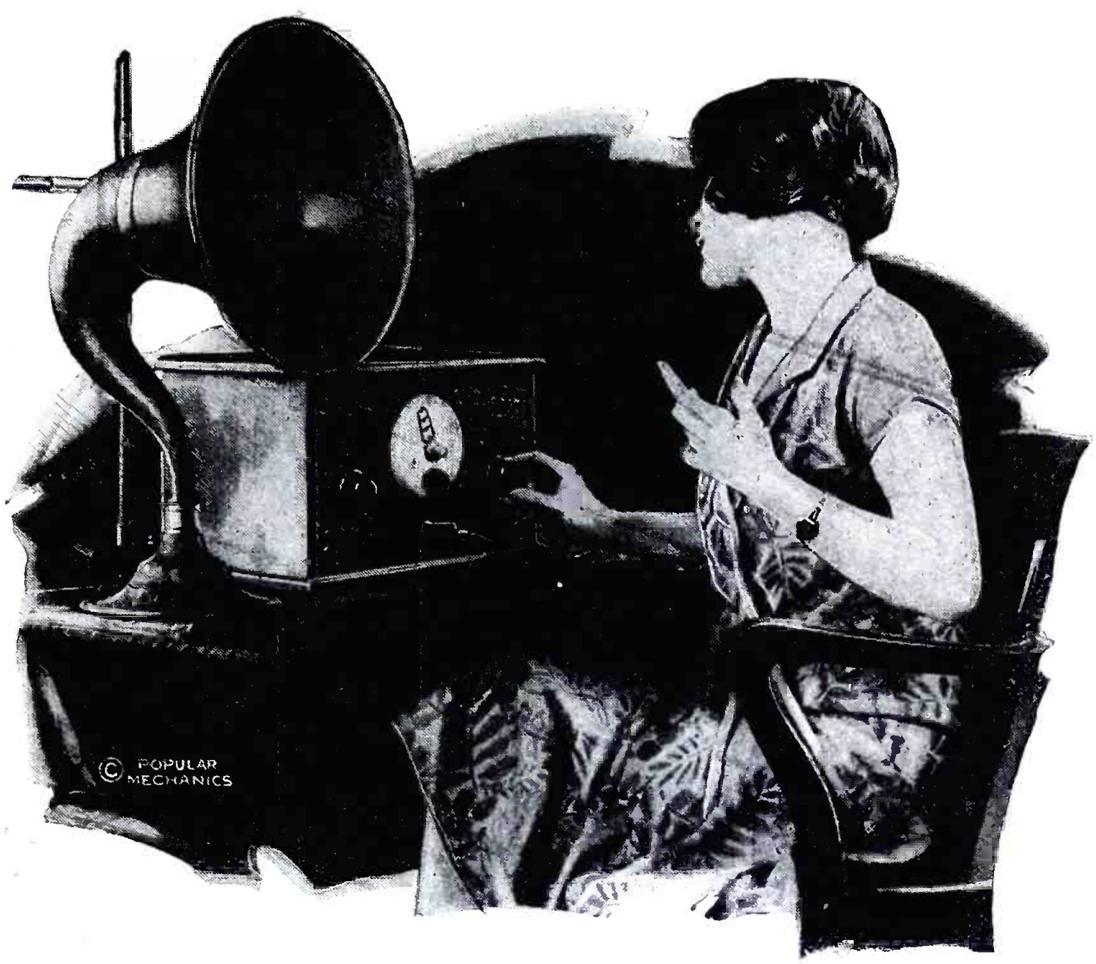
A Single-Control Four-Tube Loop Set

Compactness Plus Efficiency and Simplicity Are the Keynotes of This Receiver

THE vast majority of present-day receivers using tuned radio frequency amplification are intended for use with an outside antenna, however small. This is all very well for many fans, but there are many instances where such antenna installations are not practicable, or, in fact, often barred by rules of the property owners. Then again, a certain proportion of radio fandom will prefer a set that requires no antenna on the roof or even a short installation within the building. For them a set operating on a loop is the only solution, unless some complicated system of radio frequency amplification can do away with even the loop. This latter is no simple affair, so accepting the loop as the natural and most efficient solution, the set described by *E. R. Haan* in *Popular Mechanics* Magazine should prove of interest. Combining simplicity of control with selectivity and volume, this four-tube set offers many excellent features. The article is given in the following:

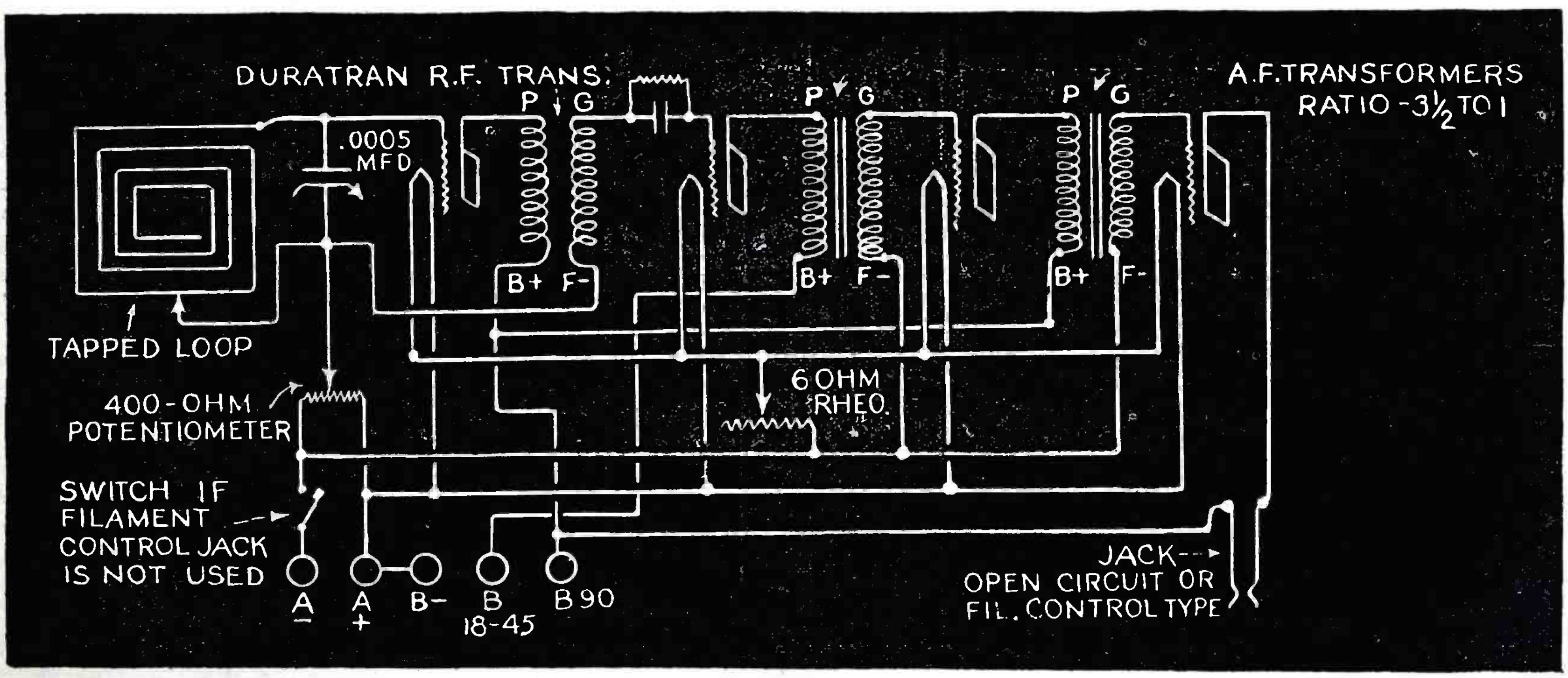
One of the most selective receivers ever built in *Popular Mechanics* radio laboratory is a simple, cheap, four-tube loop set, which has only one tuning control, making it extremely easy to operate, and the whole set is contained in a cabinet 12 in. long. Besides showing remarkable selectivity, it has also been found very sensitive and has a splendid tone quality. While half a dozen Chicago stations were broadcasting at full blast, it was really a surprise to hear outside stations come in on a loud speaker without any interference.

The circuit used here is simply the ultra-audion adapted to a loop, putting a stage of radio-frequency amplification ahead of the detector, and feeding the plate output of the first tube back into the loop in practically the same



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

Small, inexpensive receiving set, which operates on a tapped loop and gives great volume on a loud speaker. It is very selective.

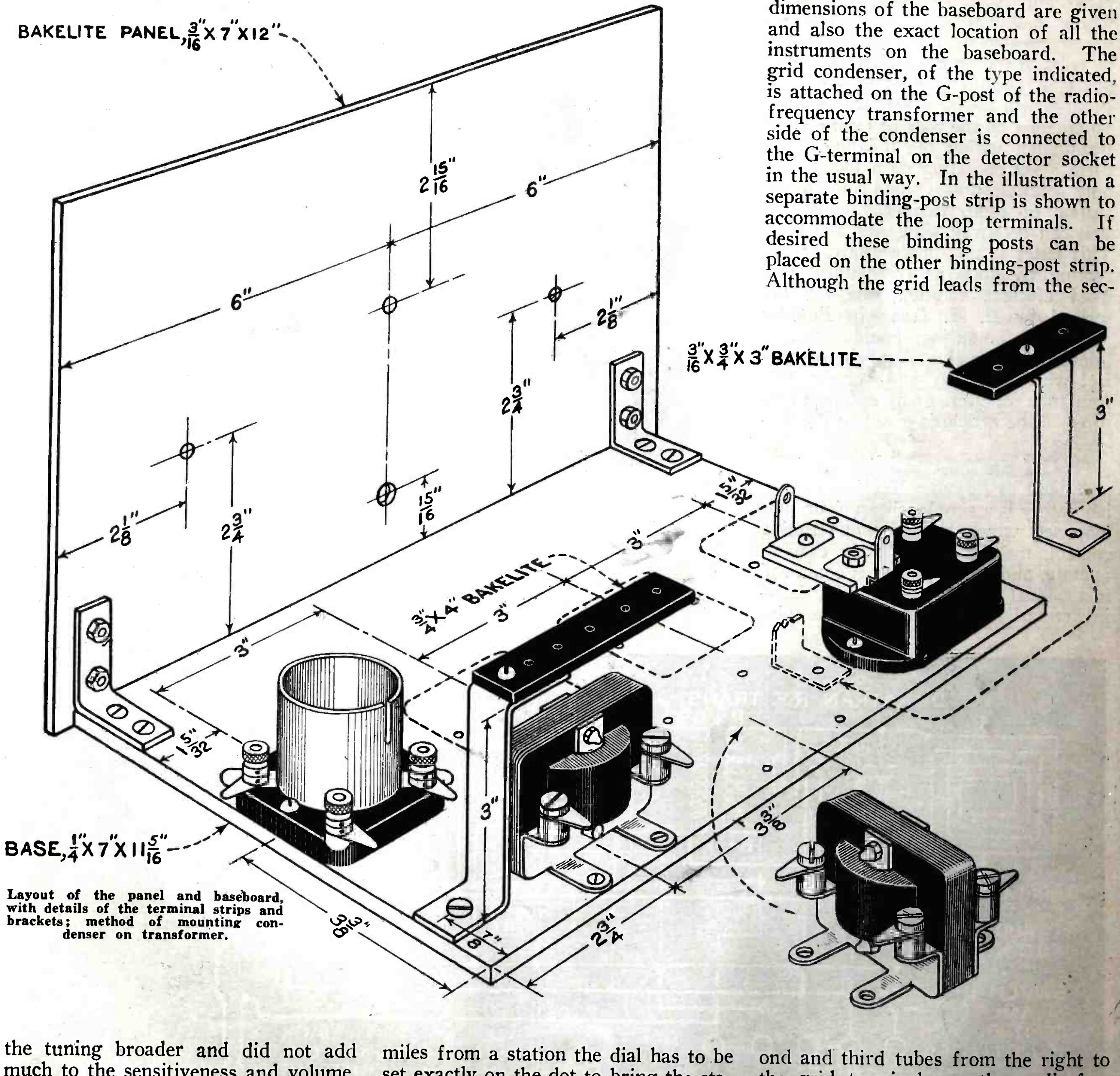


Schematic diagram of the set. Note the tapped loop employed. This loop is of the Lincoln or Nazeley type.

way as it is fed back into the outside aerial, in the usual ultra-audion hookup. Only this feed-back line is not connected to the plate terminal on either the socket or the radio-frequency transformer, which would make a short circuit if used with a loop, but the inductive method of coupling is used, the feed-back line being connected to the secondary side of the radio-frequency transformer. This gives a greater feed-back than the other method and makes the use of a loop possible. Two stages of radio-frequency amplification were also tried with the same method of regeneration, but this made the tuning broader and did not add much to the sensitiveness and volume. On four tubes the volume of locals on a loud speaker was really too great and had to be reduced for comfort.

One reason for the sharp tuning of this set is the use of a tapped loop. An outside aerial cannot be used at all and an ordinary loop is not satisfactory. When the whole inductance of the loop is used by setting it on the last tap, or when an ordinary untapped loop is used, the full 180-degree range of the tuning condenser varies between wave-lengths of 370 to 550 meters, and stations, operating on lower wave-lengths cannot be brought in at all. When the second to the last tap is used the condenser range varies between 225 and 400 meters, effectively cutting out all stations on higher wave-lengths. This method of tuning brings in the stations at points farther apart on the dial than usual, and enables one to tune much closer. When located 4 or 5 miles from a station the dial has to be set exactly on the dot to bring the station in, and any squeal can then be eliminated by means of the potentiometer. Incidentally the volume can be controlled entirely with the potentiometer, and also, of course, with the rheostat. Either a 21 or 23-plate condenser can be used, the latter being preferable. All tubes are of the 201-A type, and the maximum current passed by the set is only 1 ampere. Any good audio-frequency transformers can be used.

The panel is first laid off and drilled for the condenser and condenser dial, the rheostat, potentiometer, jack and two angle brackets. Measure the distances carefully and prick-punch the centers of the holes before drilling. The exact size of the holes varies with the make of instruments used. It is a good idea to drill small holes and enlarge them by means of a hand reamer to accommodate the instruments. A standard panel 7 by 12 in. is used. The dimensions of the baseboard are given and also the exact location of all the instruments on the baseboard. The grid condenser, of the type indicated, is attached on the G-post of the radio-frequency transformer and the other side of the condenser is connected to the G-terminal on the detector socket in the usual way. In the illustration a separate binding-post strip is shown to accommodate the loop terminals. If desired these binding posts can be placed on the other binding-post strip. Although the grid leads from the second and third tubes from the right to the grid terminals on the audio-frequency transformers are not as short as they might be, they are at right angles with the corresponding plate leads, and this will prevent howls due to induction. A filament-control jack is used; this eliminates the need for a separate switch and makes it impossi-



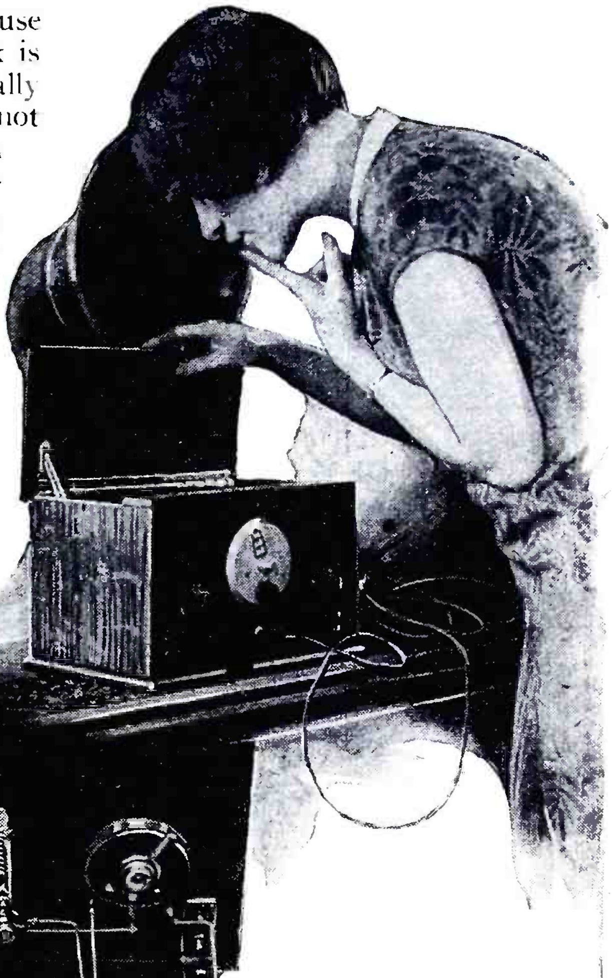
Layout of the panel and baseboard, with details of the terminal strips and brackets; method of mounting condenser on transformer.

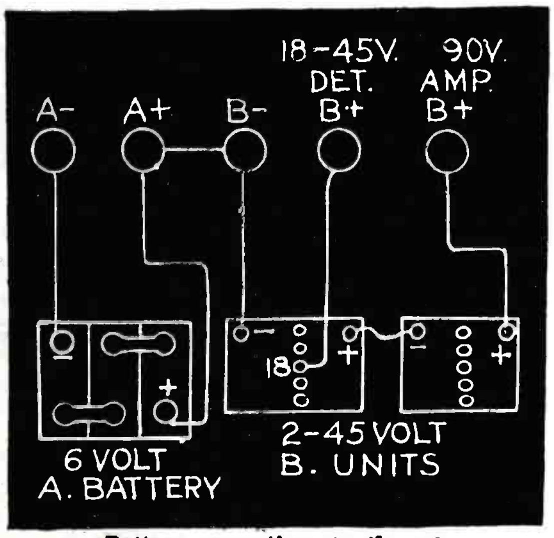
LIST OF PARTS

1 tapped loop. Lincoln type.
1 7 by 12-in. cabinet.
1 7 by 12-in. panel.
1 7 by 11½-in. baseboard.
1 low-loss, variable condenser. .0005-mfd.
1 vernier dial for condenser.
1 400-ohm potentiometer.
1 6-ohm rheostat.
1 filament-control jack. Carter No. 103.
1 .00025-mfd. grid condenser.
1 2-megohm grid leak.
4 sockets, standard type.
1 radio-frequency transformer. Duratran R.F.
2 audio-frequency transformers. 3½—1 ratio A.F.
4 201-A tubes.
7 binding posts.
2 angle brackets.
4 oval-head, nickel-plated screws. wood screws, wire, solder, etc.

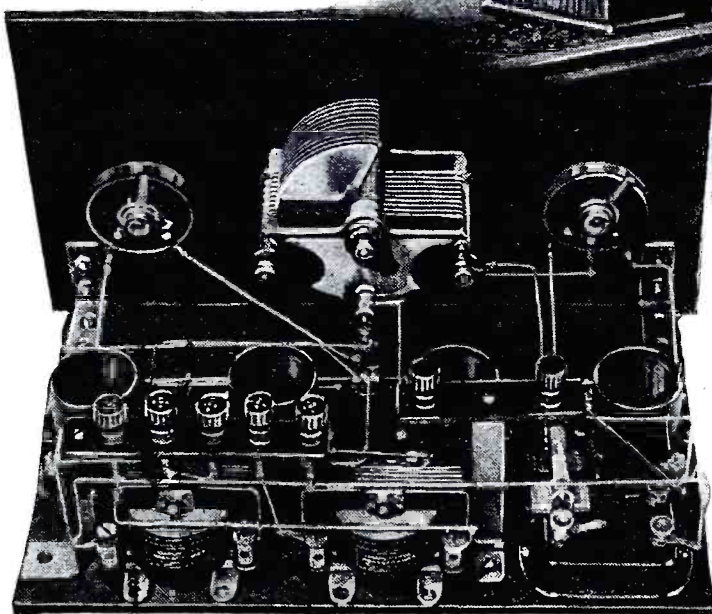
ble to leave the tubes burning, because the moment the horn or phone jack is removed, the current is automatically cut off. When wiring this set it is not necessary to use spaghetti, although if the builder has not had much experience in wiring radio sets before, it is better to be safe and use spaghetti, which will preclude the possibility of getting the wires crossed and in this way short-circuiting the tubes. All connections must be soldered securely, but too much flux should not be used, as it is apt to run down between the terminals and the nuts, and this will

(*Continued on page* 34)

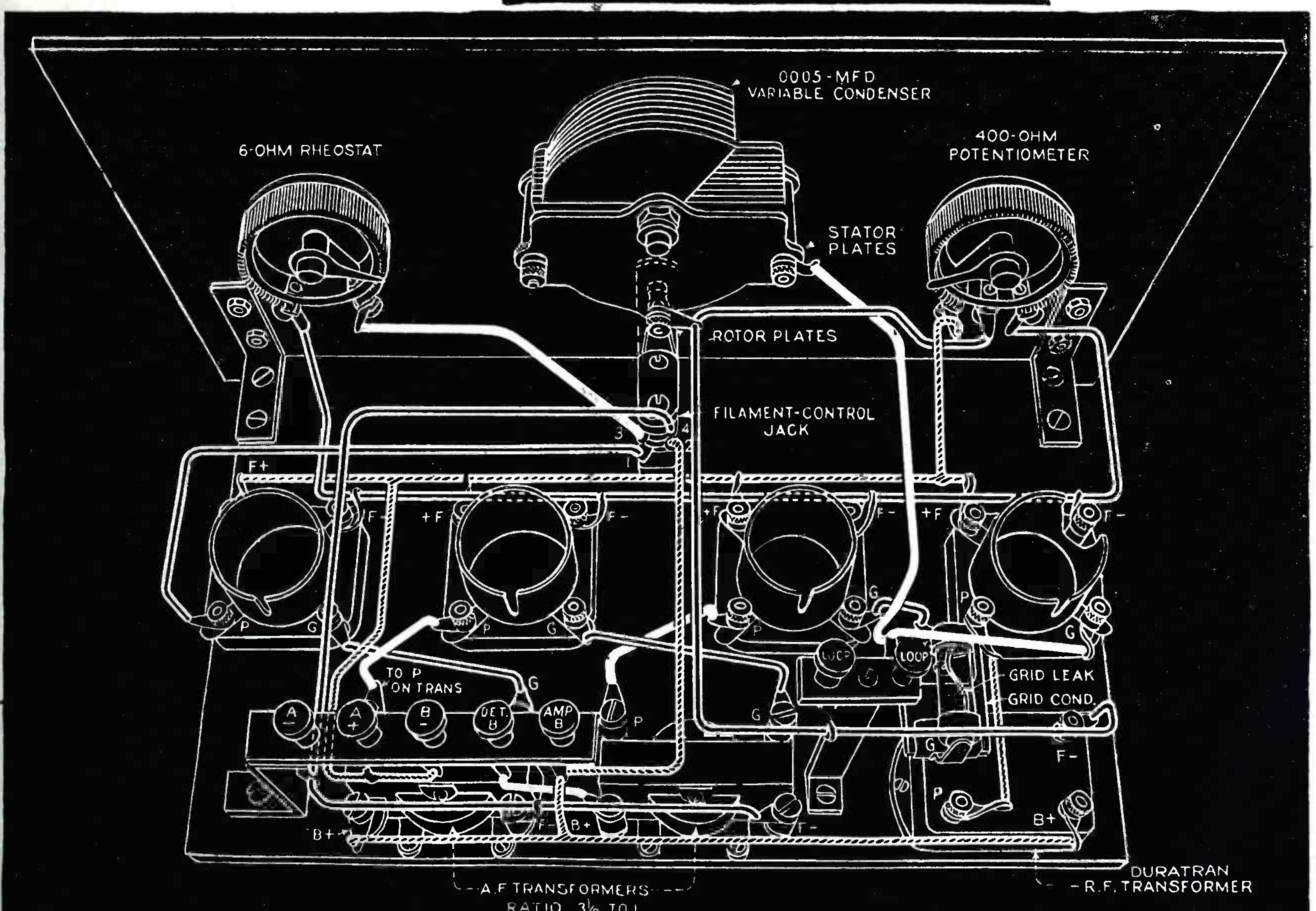




Battery connections to the set.



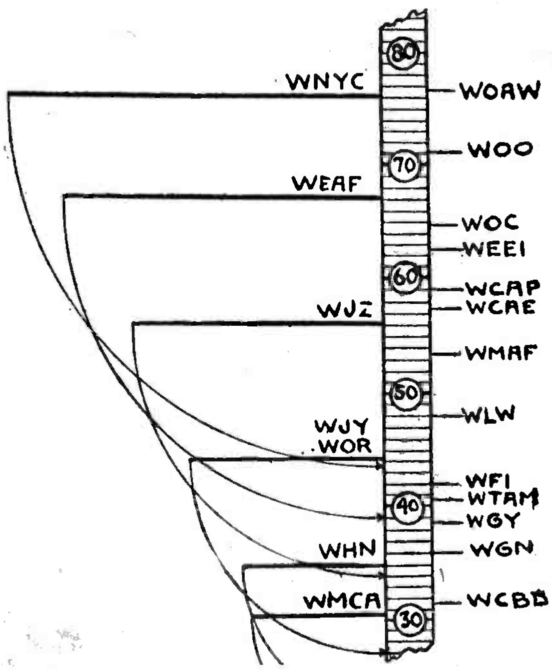
Rear view of the four-tube loop receiver, showing how the instruments are located in this compact set. Below is a more detailed layout and wiring diagram.



A Thermometer Station Log

A Novel Chart for Recording Stations by Dial Settings

THE season of good radio reception and "distance getting" is now here, and it is high time for us to prepare new log charts. The old logs that we used last season will be of little use to us now, so many of the old stations being off the air, so many new ones having taken their place, so



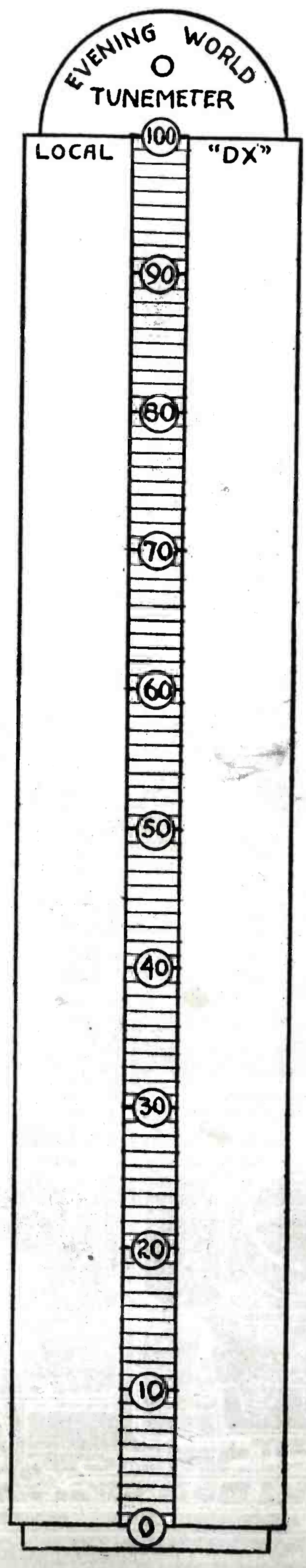
Illustrations by Courtesy of The N. Y. Evening World.

Calibration scale of oscillator dial of a super-heterodyne receiver. In making logs for super-heterodyne sets it is advisable to allow an ample margin on the left of the chart in order to record harmonics as shown in the log above.

many call letters and wave-lengths having been changed.

We are presenting herewith a form of radio log that is not only a little "different," but also simple and convenient. The directions for making this practical thermometer station log were recently given in the *N. Y. Evening World* by H. C. as follows:

At the right will be seen a log for making a record of the stations received on your radio set. This can be redrawn on a larger scale and pasted on heavy cardboard or a thin strip of wood; drill a hole in the top and hang it on the wall just as you do a thermometer. Hang it near your set where it is always in plain view and conveniently within reach for closer examination or the addition of new stations.



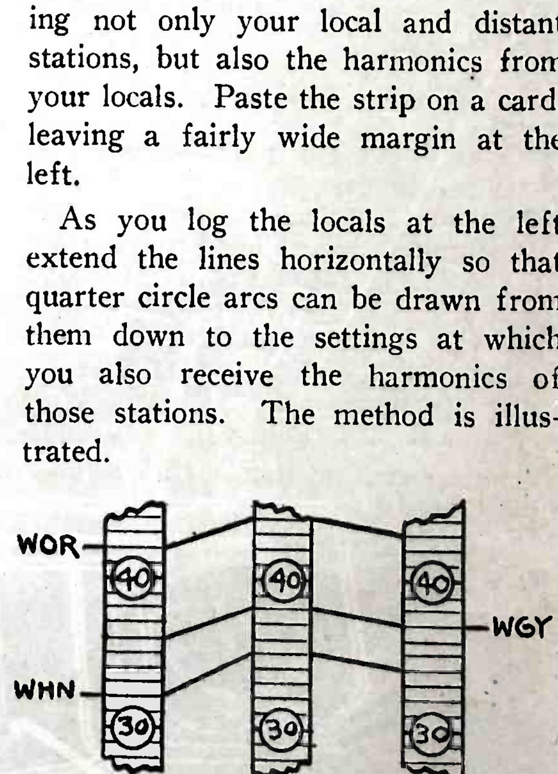
The log as illustrated can be used not only for one-dial sets, but also for others, as in most cases the main tuning, so far as station logging is concerned, is done with one dial.

The numbers correspond to the numbers on your dial. Simply enter the local stations on the left side of the numbered strip at the points where you find them on your dial, and the distant stations at the right.

If you are working a neutrodyne or tuned radio frequency set with three dials and prefer to keep settings of all three dials, simply cut out three of these numbered strips, paste them on the cardboard vertically parallel, with a little separation between, then connect the settings with lines as shown in the illustration, which shows a section of such a log.

If you are working a super-heterodyne of the usual type the numbered strip offers an ideal method of charting not only your local and distant stations, but also the harmonics from your locals. Paste the strip on a card, leaving a fairly wide margin at the left.

As you log the locals at the left extend the lines horizontally so that quarter circle arcs can be drawn from them down to the settings at which you also receive the harmonics of those stations. The method is illustrated.



How a three dial set can be logged. Three calibrated strips are numbered to correspond to the divisions of the dials. Thus, the dial settings for each station can be logged as shown.

As the harmonics check opposite the settings for your distant stations, you will never be fooled by them, and in your "DX fishing" you will know where to keep away from them.

A Paper Disc Loud Speaker

Details for Constructing an Efficient Cone Type Speaker

HERE is a real worth-while loud speaker that the home constructor can build at very little cost. It will be found free from the blasting effect which is prevalent in most all horn type speakers and we can recommend it in preference to the latter. *James Farnworth*, of Liverpool, England, recently described this paper disc speaker in *The Experimenter* magazine as follows:

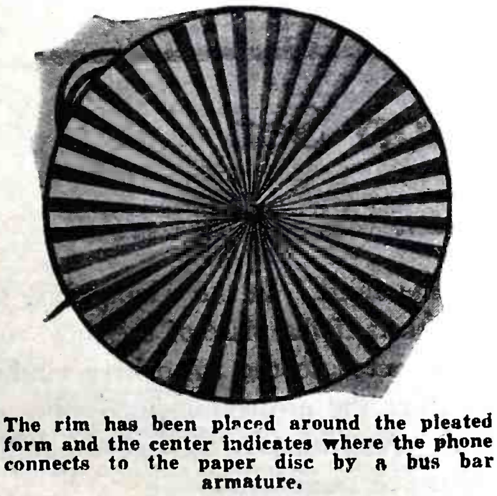
This loud speaker is the invention of a Frenchman, Dr. Luminir. It is manufactured in England on a commercial scale and is within the reach of every radio experimenter, as it costs but a few dollars to make.

The operation is simple; the essential parts consist merely of a large pleated stiff paper diaphragm actuated by an ordinary headphone or loud speaker unit. The results are quite satisfactory; it is equal to the average loud speaker in volume, and superior to all horn type loud speakers in tone quality. All the overtones and harmonics are reproduced without distortion, and the lower notes of the musical scale, where many other loud speakers fail, sound especially well. It is an ideal loud speaker and can be made very artistic in appearance, as the illustrations show.

Constructing the Speaker

The writer has experimented with various kinds of paper, including parchment, and has found parchment substitute, a heavy hand-rolled paper, the best. This can be obtained at many stationers for a few cents a sheet. If not long enough two pieces can be joined together.

Experiments with various sizes of frames from 8 inches to 18 inches in diameter showed that a 12-inch one is the best.

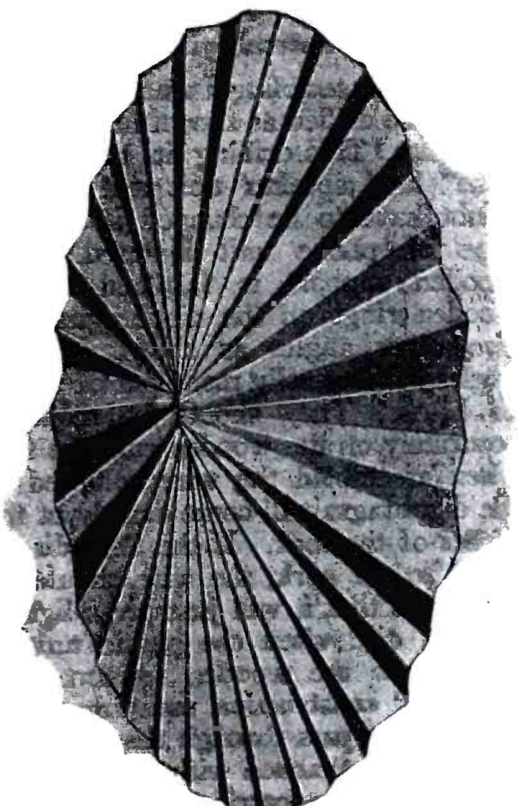


The rim has been placed around the pleated form and the center indicates where the phone connects to the paper disc by a bus bar armature.

The Pleated Paper Disc

The parchment substitute should first be treated with a transparent lacquer. This can be obtained at any paint store. It is the kind used for lacquering brass work. The lacquer should be applied to both sides of the paper and one coat will be sufficient. This helps to waterproof the paper and make it a little thicker.

Rule lines down the width of the paper one-half inch apart, as shown. One-half inch is left over for joining. Now pleat the paper in half-inch pleats on the ruled lines so that it will look something like a fan closed up; be very careful in making the pleats or when

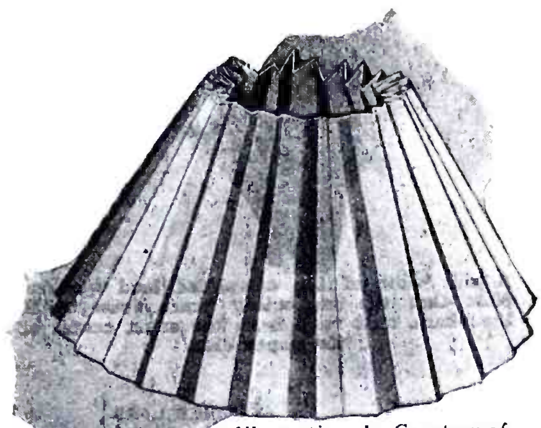


By the palm of the hand the cone-shaped form is pressed into shape and becomes a flat disc as shown above. The wooden hoops secure the outside while the center is pasted to a cork.

the circle is formed it will not form to shape. When the pleats are made, bring the ends together and lap them over one-half inch and glue with liquid glue, forming a corrugated cylinder. Place something heavy on the joint until it sets.

The next operation is to form the paper into a disc. Put one end of the cylinder on the table and hold the other end with the left hand. Spread out the bottom end on the table and with the left hand press down on the top and the paper will spread out in the form of a radially pleated disc. When released, the center will rise up and leave a hole in the middle.

Smear a fair amount of the liquid glue on the center of the pleats. Insert



Illustrations by Courtesy of The Experimenter (N. Y.)

When the paper has been folded in pleat fashion, two ends are pasted together, forming the above cone-shaped object. It might be found advisable to iron each pleat, so as to increase the strength.

the cork in the center hole and press the whole flat down on the table. The edges of the paper pleats will then bite into the cork if properly made. Lay the finished disc on a flat table with the weight on the center. The best way to do this is to place a cup over the cork

LIST OF MATERIALS

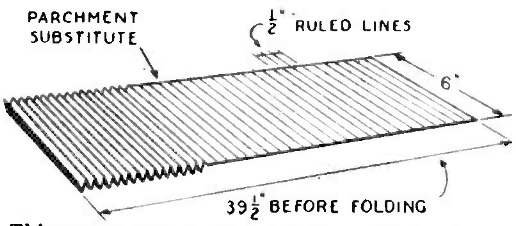
- 1 Adjustable "Rico Melotone" phone unit.
- 1 Embroidery frame, 12 inches in diameter.
- 1 Sheet of parchment substitute, 39½ inches by 6 inches.
- 1 Cork ¼-inch in diameter by ½-inch long.
- 1 Piece of copper bus bar wire, 3 inches long.
- 1 Piece of wood 12 x 1½ x ¾ inches.
- 2 Brass angles.

and place a heavy book on the cup. It should be left to stand for several hours until the glue is fairly dry.

The Frame

Procure an embroidery frame 12 inches in diameter at an embroidery store. The frame consists of two wooden rings, one fitting inside the other. Place the paper disc or fan on the smaller ring. The paper will lap over about ¼ inch all around. Care should be taken to see that it does not lap over more at one side than the other, otherwise the cork will not be in the center. Place the larger ring on the top of the disc, and press down into place. The lap-over of the edges should now be between the two rings to form something like a tambourine. Two pairs of hands are better than one when doing this, for it will be found that when you press one end the other will come up. Now glue a

A side view of the completed loud speaker. Note that the supporting brace upon which the phone unit rests is in the exact center of the paper disc.

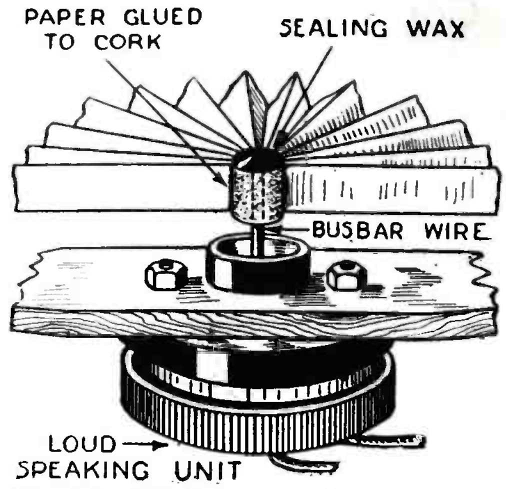


Thirty-nine inches of paper are spread out on a flat surface and ruled off by half-inch lines. Pleat the paper by following the lines.

thin fibre or ebonite disc on the inside end of the cork. The reason for doing this is that the fibre is harder than the cork and the bus bar wire soldered to the diaphragm of the phone unit that is to bear up on it will not bore into the fibre as it would into the cork. Another way is to push the bus bar wire through the cork and let it project about 1/8 inch on the other side. It is then tightly sealed to the cork with sealing wax, glue or shellac.

The Phone Unit

Any headphone can be used, preference being given to the ones in which the pole pieces can be adjusted. Loud speaker phone units or phonograph attachments are ideal. The one shown in the photographic views gave excellent results. This is the "Rico Melotone" Phone Unit. The cap should be unscrewed and the bus bar wire soldered to the center of the diaphragm as shown. Be sure it is in the exact center. This particular phone unit has a metal cap. Two holes were drilled



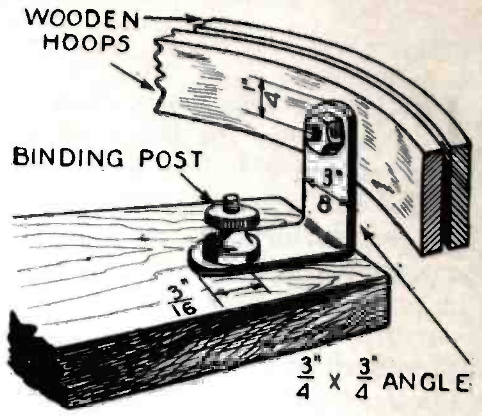
The paper cone is now pasted upon the cork center. The bus bar leading from the diaphragm of the phone to the cone must be in the exact center. Sealing wax will secure the bus bar armature.

through this cap for No. 6 screws and the screws fastened as shown. The cap was then re-screwed on the phone unit.

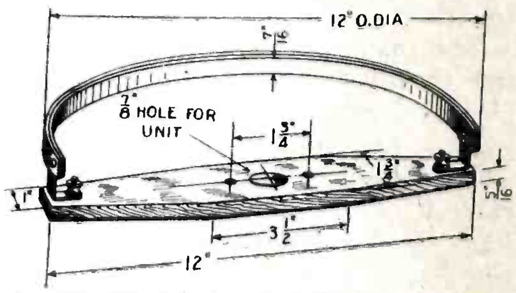
Assemblying

Before assembling a wooden support should be drilled as shown in the detail drawing. This drilling fits the "Melotone" loud speaker unit and will no doubt have to be changed if another type of phone unit is used. The wooden support is fastened to the wooden rings on the diaphragm with two brass angles as shown. These angles can be easily made out of pieces of brass. They should be mounted accurately on the wooden rings so that when assembled the wire soldered to the diaphragm will come exactly at the center of the cork. If the fibre disc is glued to the cork, the wire should be cut off so that it will just press lightly on this disc when the phone unit is screwed to the wooden support. In the other construction mentioned, the wire should pass through the cork and be securely attached with sealing wax on the front as described.

The phone unit should be connected to the radio set in the usual way. When a station is tuned in, the phone unit should be adjusted for best results. A very close adjustment to the diaphragm is possible with this speaker and the signals will be very loud and clear. They will not have the blasting effect produced by the horn type speaker. To enhance the artistic effect the speaker may be mounted on a



A detailed drawing of how the phone unit board is connected to the hoops supporting the pleated disc. The pleated paper is held by the pressure of the two hoops. It is found advisable, so as to doubly secure pleated discs, to glue the paper in the hoops before pressure is exerted by the hoops themselves.



A more detailed drawing of the hoop and baseboard system of the paper disc loud speaker. For the sake of clearness, half of the hoop has been removed.

bronze statue or any heavy weighted base. A statue may be obtained from most art or novelty stores, or attractive lamp bases may be used. The base should preferably be of heavy metal so that the speaker will not be top heavy.

Of course, the paper disc can be lacquered in any color to suit the taste. Gold or silver bronze may also be used with excellent results.

This loud speaker has many advantages over the horn type. There are no "rattling" or "sizzling" noises. In fact, the average set noises are not as powerfully reproduced, in comparison with the signal, as in the loud speaker. Even static discharges are not noticed as much when heard through this type of loud speaker.

A Single-Control Four-Tube Loop Set

(Continued from page 31)

prevent good electrical contact. Soldering lugs should be used under all nuts. Care must also be taken to bring the lead from the grid of the first tube to the stator-plate terminal on the condenser, not to the rotor-plate terminal. This eliminates a certain amount of trouble due to hand capacity, as the rotor side of a condenser is usually connected directly to the shaft, which projects through the panel, and to which the tuning dial is attached, allowing little space between the hand and the shaft. In the wiring diagram it looks as if the plate of the third tube is connected to the A-positive binding post, but the projecting lug is the one on the P-terminal of the second audio-frequency transformer.

A Universal Battery Charger

Complete Description of a Two-Ampere Alternating Current Charger

YOUR enthusiastic radio fan must be congratulated on his perseverance and nerve in the matter of constructing his own radio sets and parts without regard for the complexity of the units. It requires much careful attention to details to build a large super-heterodyne and yet there are any number of amateur fans who have built them and obtained good results. All this is by way of leading up to the conclusion that many ardent fans will build their own tube rectifier units for charging storage batteries, providing the proper information is obtainable. This information in complete form was given by *Mr. Roland F. Beers,* in *Radio Broadcast*, New York. The article follows:

Battery chargers may be classified into three general groups: electrolytic, thermionic, and vibrator types. When adapted to charging radio or automobile storage batteries, all three types possess similar operating characteristics. Their principal function is to convert the 110-volt alternating current obtained from a light socket to direct current at proper voltages to charge storage batteries.

The direct current output of battery chargers is not uniform in magnitude but is composed of a series of individual pulses, each a half cycle of rectified alternating current as shown in Fig. 1. With the advent of each half cycle of rectified wave, there occurs a change in current from the charger, increasing and decreasing rapidly as shown by the shape of the current curve at A. Here is shown the introduction of a positive half cycle or half wavelength, of duration denoted by ½T, where T represents the period of an entire cycle or wavelength. During this first half period, energy is fairly shoved into the storage battery. The total amount of charging energy per cycle is represented by the area beneath the curve A times the average voltage for the same period. During the second half period, ½T, we have a complete cutting off of the charging current, which is caused by the valve or rectifier action of the charger. If the charger is of the electrolytic or thermionic type, we may say in truth that a valve is closed to the reversed current, as shown by the flat portion of the curve at B. In the vibrator charger, a switch automatically opens the battery circuit at the end of the first half cycle in order to prevent a reversal of current through the battery. At the end of this complete wave and at the beginning of a second, we repeat the action and charging of the battery is resumed.

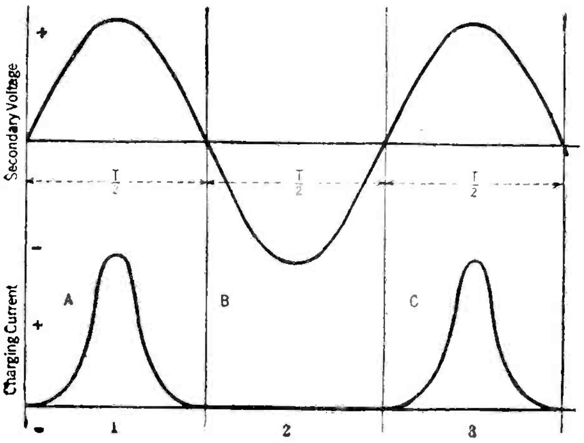
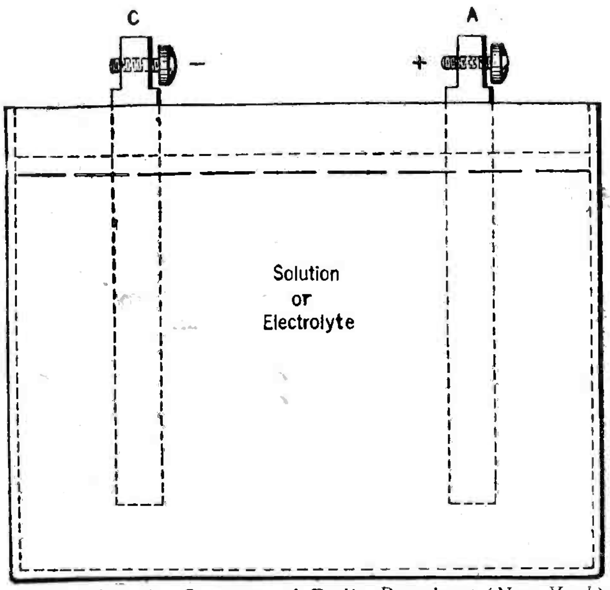


Fig. 1. A graphic representation of how a charger functions. The curve labeled "secondary voltage" shows the sine wave-form of the 60-cycle lighting circuit. That curve labeled "charging current" shows the portion of the alternating wave which is rejected in the rectifier allowing only the periodic pulsations of that portion of the curve where the current is "direct current" to enter the battery.



Illustrations by Courtesy of Radio Broadcast (New York)

Fig. 2. A chemical rectifier in its simplest form. The positive terminal is the anode and the negative electrode is the cathode. Current may be passed from the cathode to the anode but not vice versa. Therefore, when the alternating current is on the positive half of the cycle, current flows through the rectifier into the battery, but when the current is on the negative side of the cycle no current flows. This also produces a pulsating periodic flow of d.c.

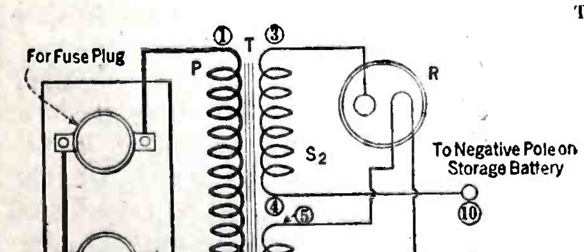


Fig. 3. The actual circuit diagram of the Beers tungar rectifier. This is different from that of the charger circuit in Fig. 10 in that a separate charging secondary is provided. Alternating current is induced into this secondary while the circuit in Fig. 10 is that of an auto-transformer employing the conductive system. There is no great difference between the two.

Never Charge Batteries Connected to a Receiver

A brief study of the character of the current supplied by battery chargers as outlined above will show why it is neither feasible nor advisable to charge storage batteries while they are connected to a radio receiver. The constantly changing battery current, when applied to the radio antenna and ground system, causes untold disturbance in the surrounding ether and may be interpreted as a form of malicious interference with radio reception. Fortunately, many charger manufacturers connect one side of the A.C. line to the output of the charger so that a house fuse is blown when the charger is operated as it is connected to a radio receiver.

Let us return to the consideration of charger design, in order to determine what are the elements with which we have to contend. The charger of lowest cost, from the point of view of home construction, could be made of the electrolytic type, provided pure metals could be procured for the rectifier electrodes. The rectifier cell illustrated in Fig. 2 consists of two electrodes, A and C, suitably suspended in a water solution in such a fashion that rectification occurs without excessive heating of the rectifier cell. The combination usually employed in home-constructed chargers is a lead (negative) and an aluminum (positive) electrode dipping into a saturated solution of common borax. Other solutions which have been used successfully for charging B batteries are sodium phosphate, ammonium phosphate, and sodium acid tartrate. One form of this charger on the market consists of an iron cup which contains the solution, into which dips the aluminum rod. Another form of electrolytic rectifier on the market consists of a tantalum electrode dipping into a solution of sulphuric acid, whose specific gravity is 1.250. The area of the tantalum electrode is 15 sq. cms. and the volume of the electrolyte must be great enough to prevent excessive temperature rise.

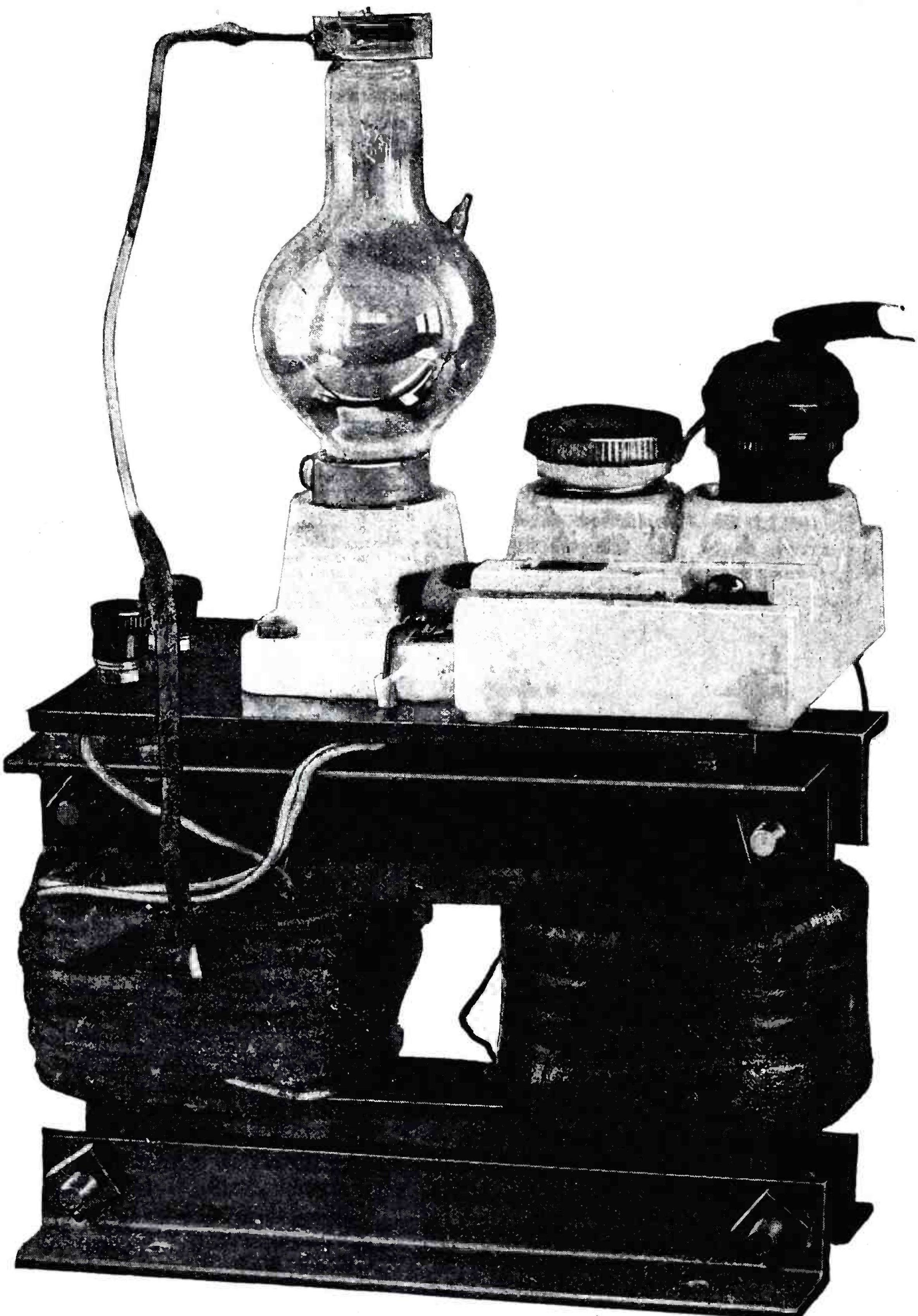


Fig. 4. How the made-up charger looks. A bakelite panel, situated above the transformer coil supports the output terminals, tungar tube, socket and input socket with fuse block.

A Two-Ampere "Universal" Charger

Figure 3 is a schematic diagram which shows the electric apparatus and connections necessary to assemble a battery charger. Details of construction are given below for a two-ampere charger which has universal frequency characteristics. That is to say, this charger, when built in accordance with the specifications, will operate satisfactorily on commercial frequencies ranging from 25 to 70 cycles, inclusive. The design disclosed below is not perhaps the most economically constructed for use on 60-cycle current, but its cost of operation is very small and should prove no objection to the experimenter who really wants to build his own charger. In addition, the improved efficiency of operation will be of considerable advantage to the battery owner from the standpoint of power consumption. The no-load power of this charger on 60-cycle supply was measured and found to be less than 10 watts. The full load power consumption was found to be 150 watts.

Fig. 3 shows a transformer with three windings, which we will designate as P, S′ and S″. P is the primary winding and is connected to the 110-volt alternating current light socket. S′ is the filament secondary and supplies the power for heating the tungar bulb filament. This winding is provided with a center tap (6-7) which will be explained in detail later. Winding S″ is the charging winding and supplies the necessary potential to operate the tungar arc. Leads are taken out from points 9 and 10 which lead, respectively, to the positive and negative terminals of the storage battery.

How a Thermionic Rectifier Operates

The operation of the tungar or other thermionic rectifier is fairly simple of explanation. It is well known that a heated filament *in vacuo* under the stress of potential will emit electrons which will flow in the direction of the applied potential. In other words, if the hot filament be made cathode and the cold plate the corresponding anode, a stream of electrons, hence electricity, will flow from cathode (—) to anode (+). However, no current will flow in the reverse direction, from plate to filament, and in this fact we obtain the valve or rectifier action of the tube. Now when we attempt to obtain heavy electronic emission *in vacuo* (i.e. of the order of 1 ampere) we are confronted with a secondary phenomenon. Very soon so many electrons fill the space between plate and filament that they neutralize the effect of the positive charge on the plate. The result is a slowing up of the electron stream, and a decrease in the current output of the rectifier. In order to offset the effect of the space charge, as it is called, the manufacturers of the tungar tube introduce into the chamber a small amount of inert gas, called argon. This gas is unable to unite chemically with the metallic elements within the tube, but is capable of ionization through the bombardment of the electron stream. The constant impact of the billions of electrons passing to the anode soon detaches from the atoms of argon gas their positive nuclei and their charges. When these positive charges are liberated, their immediate action is to neutralize the space charge of the tube, as established by the excess electrons in the space between filament and plate. Every positive charge attaches itself to a negative electron and the result is a neutral atom. The process of breaking up and reconstruction continues until the tungar tube is shut off, and the total effect of the ionization is to produce a greater current-carrying capacity.

It may be mentioned here that the

tungar and similar types of thermionic tube do not perform well on voltages above 50 on account of the irregularity in the ionization process. If it were

TRANSFORMER CORE

Symbols	Author's Design
Cross-Sectional Area = a × b	2.0 Sq. Ins.
Outside Dimensions:	
Length = a + c	5.5 Ins.
Width = a + d	4.5 Ins.
Height = b	1.4 Ins.
Width of Steel Strips = a	1.4 Ins.
Thickness " " = t	.014 Ins.
Size of Window = e × f	4.6 Sq. Ins.
Weight of Core = (2c + 2d) (a × b) × .28 Lbs.	8.0 Lbs
Mean Length of Core = 2c + 2d	14.4 Ins.

not for this fact, the tube might be used as the rectifier element in a form of B battery eliminator, as has been attempted by the author.

We will now proceed to the construction of a two-ampere charger, as illustrated in the photograph, Fig. 4. The part of the unit most difficult to construct is the transformer, but if the following instructions are carefully studied, the author believes that the experimenter will have very little trouble in obtaining successful operation from his model.

The following table gives the exact amount of materials required. Deviations from the design given below may require somewhat greater amounts of copper and steel, which will have to be estimated by the builder.

MATERIALS REQUIRED

8 lbs. silicon steel, thickness .018" to .010"	$ 1.60
1 lb. No. 20 d. c. c. wire	1.00
1¼ lb. No. 15 d. c. c. wire	1.25
½ lb. No. 14 d. c. c. wire	.50
1 porcelain Edison socket	.20
1, 2-plug porcelain fuse block	.35
2 separable plugs	.30
1 2-ampere plug fuse	.05
28 inches 1 inch x ⅛ inch angle iron	.25
4 2 x ¼ inch stove bolts and nuts	.05
2 battery clips	.40
1 Fahnestock clip	.05
6 feet twisted lamp cord	.15
4 feet rubber covered No. 14 flexible cord	.25
1 2-ampere tungar rectifier tube, list	4.00
1 bakelite panel 4 x 7 inches	.25
	$10.65

Prices given above are the highest retail prices experienced by the author. Most builders have access to materials at lower cost.

In Fig. 5 are given the complete dimensions of the transformer core. In view of the difficulty with which the average amateur obtains silicon steel sheets such as are necessary to make this transformer a few remarks may be of service in the process of construction.

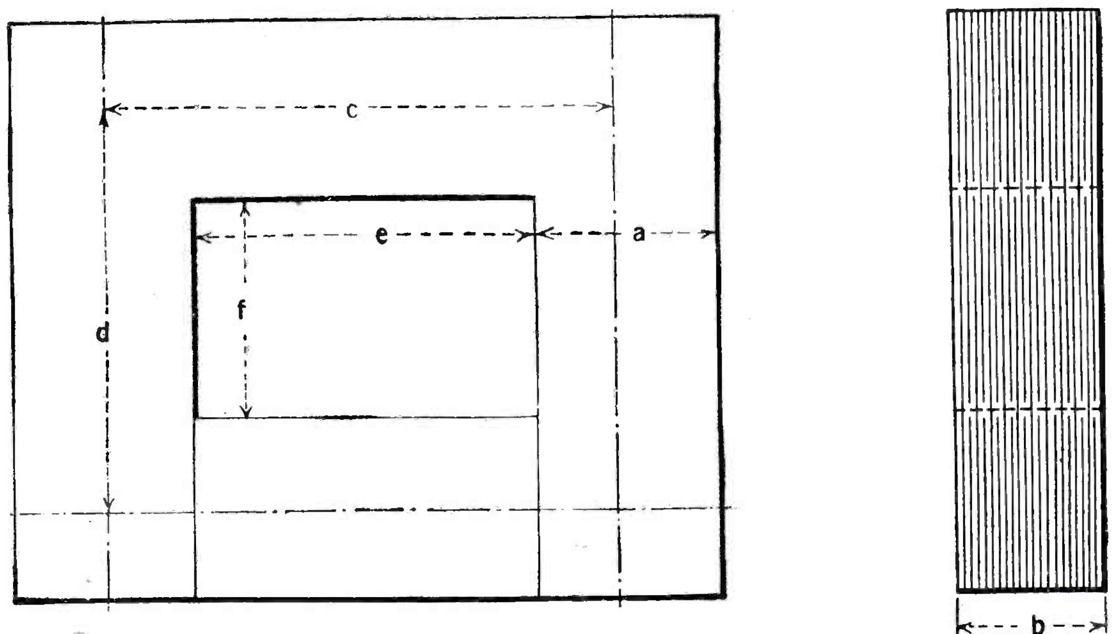
The simplest way to obtain the steel laminations for the core is to go to your local electric light company office and ask for a junked pole transformer of from 1 to 5 k. v. a. capacity. Such transformers are often thrown away and are frequently sold for $1 or less. If you are fortunate enough to obtain one of these burned out units, your problem of finding steel of the right quality is solved.

Another equally good source of silicon steel is from amateur supply houses who make a specialty of furnishing this material to transmitting amateurs. Advertisements of these firms are carried in current radio periodicals. The price is generally less than 20 cents per pound in 10-pound lots.

soft iron as is specified for the silicon sheet steel. For the lower frequency design, such as 25 cycles, use one half more cross-sectional area in the core. For example, using soft iron on 25-cycle chargers, we would build a core measuring in cross-section 1.8 inches x 1.8 inch or the equivalent, instead of the core as specified, which measures 1.4 inches x 1.4 inches. For frequencies intermediate between 25 and 60 use a direct proportion to obtain the proper amount of soft iron. However, the author strongly recommends the use of silicon sheet steel, if it can possibly be obtained.

Making the Core from Power Transformer Parts

If you have obtained a junked transformer, place it near a hot stove or furnace for half a day in order to



TRANSFORMER CORE

Symbols	Author's Design
Cross-Sectional Area = a×b	2.0 Sq. Ins.
Outside Dimensions: Length=a + c	5.5 Ins.
Width = a + d	4.5 Ins.
Height=b	1.4 Ins.
Width of Steel Strips = a	1.4 Ins.
Thickness " " = t	.014 Ins.
Size of Window = e × f	4.6 Sq.Ins.
Weight of Core=(2c + 2d)(a × b) × .28 Lbs.	8.0 Lbs.
Mean Length of Core= 2c + 2d	14.4 Ins.

Fig. 5. The details and specifications for the construction of the core are outlined here. After the core-pieces are cut, it is absolutely essential that burrs be removed from the edges and that they be entirely flat. This is necessary to obtain the required number of pieces for the specified height of the core.

Assuming that you are still unable to obtain silicon steel of approximately .014 inch thickness (limits .010 inch to .018 inch), get in touch with transformer manufacturers or steel jobbers, from trade journals which are frequently on file in public libraries. Many times the author has received extreme courtesy from such firms who are willing to accommodate their inquirers with small quantities of scrap steel.

As a last resort for core material, go to your local tinsmith and get the best grade of soft sheet iron or steel he has. For the 60-cycle design outlined below, use exactly the amount of

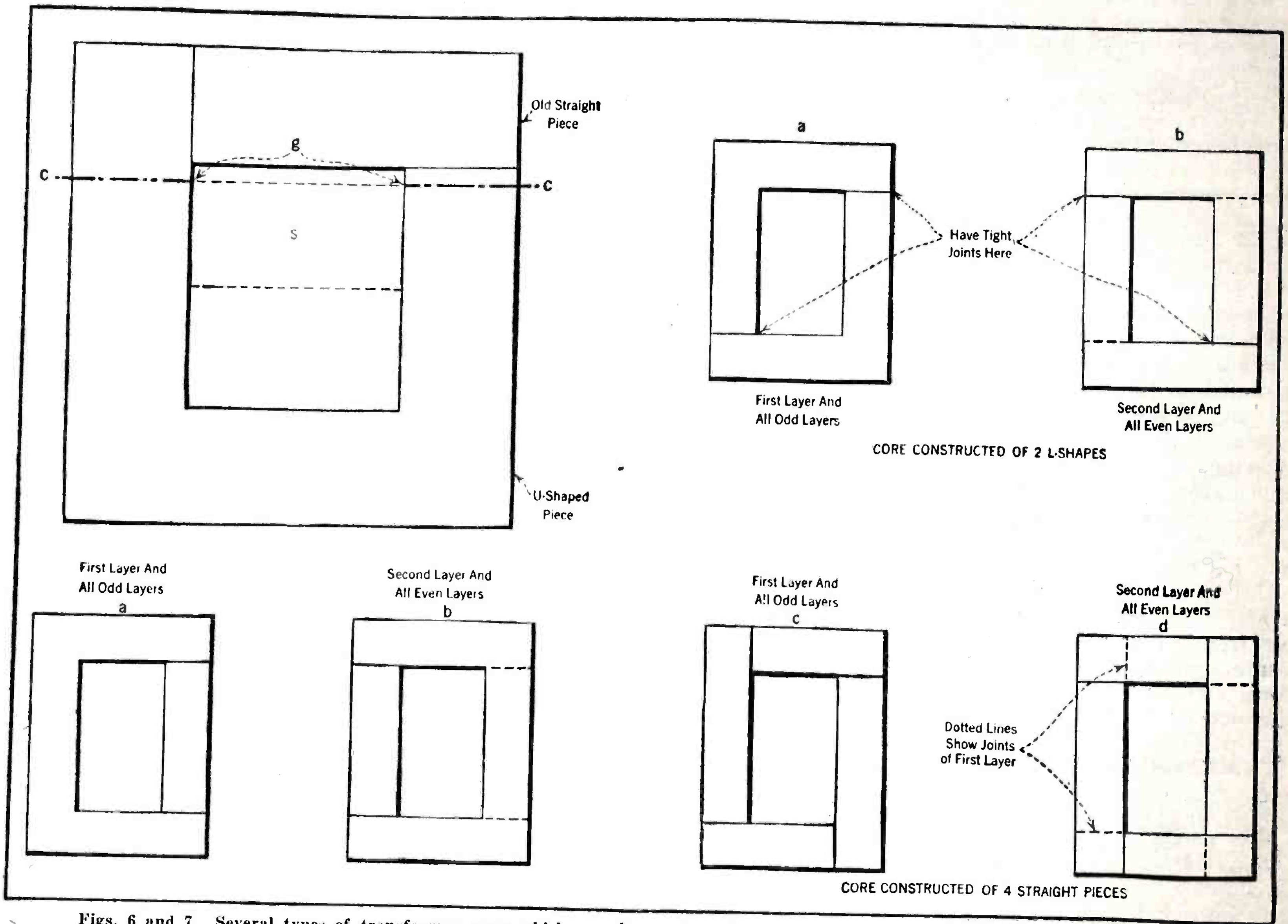
soften the filling compound. Having removed the cover, attack the bolts which hold the core to the case. Remove these, together with as much of the black filling compound as possible and dump out the transformer on a pile of old newspapers. If the core can now be taken out of doors and washed with kerosene, most of the black compound can be cleaned off. With a heavy block of wood or wooden mallet, drive out the core from the center of the windings. A convenient way to do this is to block up the windings on two 2 x 4-inch pieces while you are hammering on the core in the attempt to start it. Once loosened, the entire core can be pushed out when it will fall into bunches of steel laminations. These should be carefully separated and cleaned off with kerosene or carbon tetrachloride. Avoid bending or breaking any of the pieces, as you may need them all during the construction of the charger.

Most power transformers are made up of U-shaped pieces and straight own cutting, unless he is cautious in preventing accidents. In either event, the entire lot of steel can be cut out in this manner in less than an hour.

In case you have been unable to obtain the U-shaped pieces for the core, you may possibly get enough steel from the old transformer to make up the charger core in other ways. Fig. 7 shows the possibilities that may

First Core Assembly

Having determined the size and shape of the core within the limits specified above, the pieces are temporarily assembled to determine if enough steel has been cut out. Piles of each leg or half core are stacked up and clamped up in a vise so that the actual core height (b) can be measured.



Figs. 6 and 7. Several types of transformer cores which may be employed in this construction. The sketches are self-explanatory.

pieces, as shown in Fig. 6. If you are fortunate enough to obtain such pieces as these, your core construction will be very simple. The dotted line shown at c—c, Fig. 6, shows how the steel laminations can be cut down to make the proper sized core. End pieces (shown at s) can be cut from the waste to make a closed rectangle. When cutting the steel for the core, extreme care should be taken in obtaining a perfectly tight fit at g, Fig. 6. If the cutting is done by hand, only very large shears should be used and each strip should be accurately measured and marked out before cutting. Carelessness in assembling this part of the charger may result in its failure to operate. The best way to cut the pieces for the core, regardless of their shape, is to take the entire lot of steel and your pattern to the local tinsmith's shop, where you will find squaring shears that may be used to great advantage in obtaining square edges. Often the tinsmith will let you do your

occur with commercial transformers, and the ingenuity of the experimenter will serve him in assembling the right amount of core material. Fig. 5 shows the dimensions recommended for an efficient two-ampere charger on all frequencies. On account of the variations in the sizes of steel laminations available, it may be impossible to adhere to these dimensions exactly. For the benefit of those who do find these variations, the following limits will be helpful:

	min.	max.
1. Cross-sectional area of core—a x b .... may be, as shown, 1.4 in. x 1.4 in. or 1 in. x 2 in. or 2 in. x 1 in. etc.	2.0 sq. in.	2.0 sq. in.
2. Mean length of core —2c + 2d .... where c and d are measured along center line of core	12.0 in.	6.0 in.
3. Area of window—e x f —(c + a) (d + a)	3.8 sq. in.	4.6 sq. in.

When sufficient steel has been prepared, the outside measurements and cross-section are taken and noted for future reference.

We now proceed with the winding of the coils P, S′ and S″. The first thing to do is to cut from a block of wood a piece shaped exactly like the section of the core which is to contain the windings (see Fig. 8). Dimensions shown are for the design recommended by the author. Whatever changes are necessitated by variation in steel sizes must be calculated by the builder. The winding block should be approximately 0.10 inch larger than the maximum width and height of the core in order to facilitate application of the completed windings. Slots 0.75 inch wide and 0.10 inch deep are cut longitudinally along each face of the block, in which strips of friction tape are laid before the winding is begun. A hole is drilled through the center of the block large enough to pass a ¼-inch stove bolt for clamping the block in a chuck. Two pieces 3 inches x 3 inches are now cut from ¼-inch stock to provide heads for holding the winding in place as it is wound. Quarter-inch holes are also centered in these pieces as shown in Fig. 8. The winding form and spool heads are now assembled upon the ¼-inch bolt, and a nut clamps the entire form together as shown in Fig. 8. The protruding end of the stove bolt is clamped in the chuck of a breast drill, hand drill, or carpenter's brace preparatory to winding the coils. Four pieces of ¾-inch friction tape are cut approximately 6 inches long and laid squarely in the slots provided for them. The long ends of the tape are drawn up over the edge of the spool heads and stuck together in one spot near the center of the spool heads. A strip of heavy Manila wrapping paper is now cut four feet long and as wide as the distance between spool heads. Fig. 8 shows this strip, 1.7 inches wide. This strip of paper is tightly wrapped over the winding form after gluing the first end in place. If the builder sees fit, he may apply a thin layer of glue continuously over each layer of paper so that the paper shell when completed will serve as a firm support for the coils.

Winding the Coils

The primary winding is wound first and consists of 570 turns of No. 20 d.c.c. wire, wound in smooth layers. The first end of the primary winding is brought up the side of the spool and is later taped in place by means of one of the adjacent strips of tape. Approximately 24 turns per inch should be wound and pains should be taken to wind the wire as smoothly as possible, preventing overlapping of adjacent turns. When the winding is completed the end of the wire is left about eight inches long as a terminal to connect to the flexible extension cord or terminal block as shown in the photograph. The long ends of tape which have hitherto been fastened to the spool ends are now drawn tightly over the winding and fastened in place. The spool heads are removed and the entire winding is now taped securely with one layer of friction tape, half lapped. The coil is now ready for assembly, but before we can put the laminations in place we must prepare the second coil, which has two separate windings, S′ and S″.

Winding S″ consists of 150 turns of No. 15 d.c.c. wire wound in the same manner as P. Terminals are brought out each end of the coil, each consisting of about eight inches of the same wire used to wind the coils, No. 15 d.c.c. One layer of friction tape is wrapped securely over S″, and then winding S′ is applied, which consists of 11 turns of two parallel No. 14 d.c.c. wires with a tap at the 5½ turn. For convenience in winding this coil, the half pound of No. 14 d.c.c. which the builder has purchased is divided into two equal lengths which are wound together on one spool preparatory to winding the parallel strands. Then as the spool is unreeled during the process of winding, it will be a simple matter to maintain the two wires parallel at all times, and to avoid their twisting or crossing each other. The tap brought out at the 5½ turn should be a loop taken in the two wires at the same point, and should be in length about two inches. This tap is later cleaned thoroughly and a generous coating of solder is applied to form a lug of large current-carrying capacity. The end terminals of this winding (S′) are treated in the same manner and are left of such a length that they can be carried directly to the screws on the Edison socket without splicing. It is important that this circuit be of very low resistance (i.e., less than 1 ohm) so that it will carry the filament current of 4 amperes without heating. The finished coil, containing the windings S′ and S″, is now removed from the winding form and taped with one half-lapped layer of friction tape.

How to Assemble Core and Windings

In Fig. 4 may be seen the appearance of the finished coils as they are assembled on the core. When assembling the core, the steel strips or laminations should be inserted from first one side and then from the other so as to alternate the position of the air gap in the core at every layer. Figs. 6 and 7 show the position of the various types of laminations and the manner in which they should be arranged. Care should be taken when assembling the steel core that the insulation on the windings is not damaged to such an extent that turns of wire may become short-circuited to one another or to the core. When nearing the top of the core, place the partly assembled transformer in a vise, compressing the laminations as much as possible, and then squeeze in a few more pieces of steel. It may be necessary to hammer the last one or two pieces in place in order to

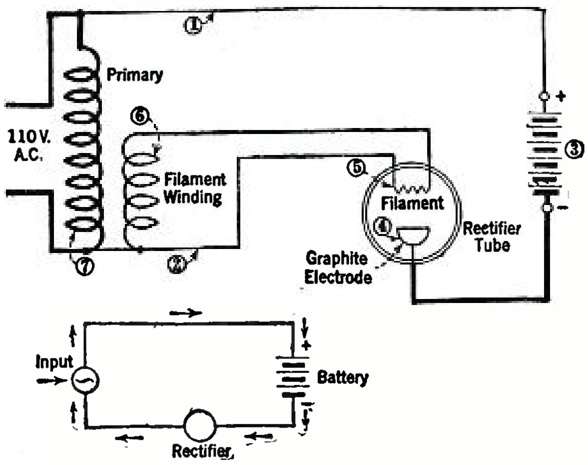
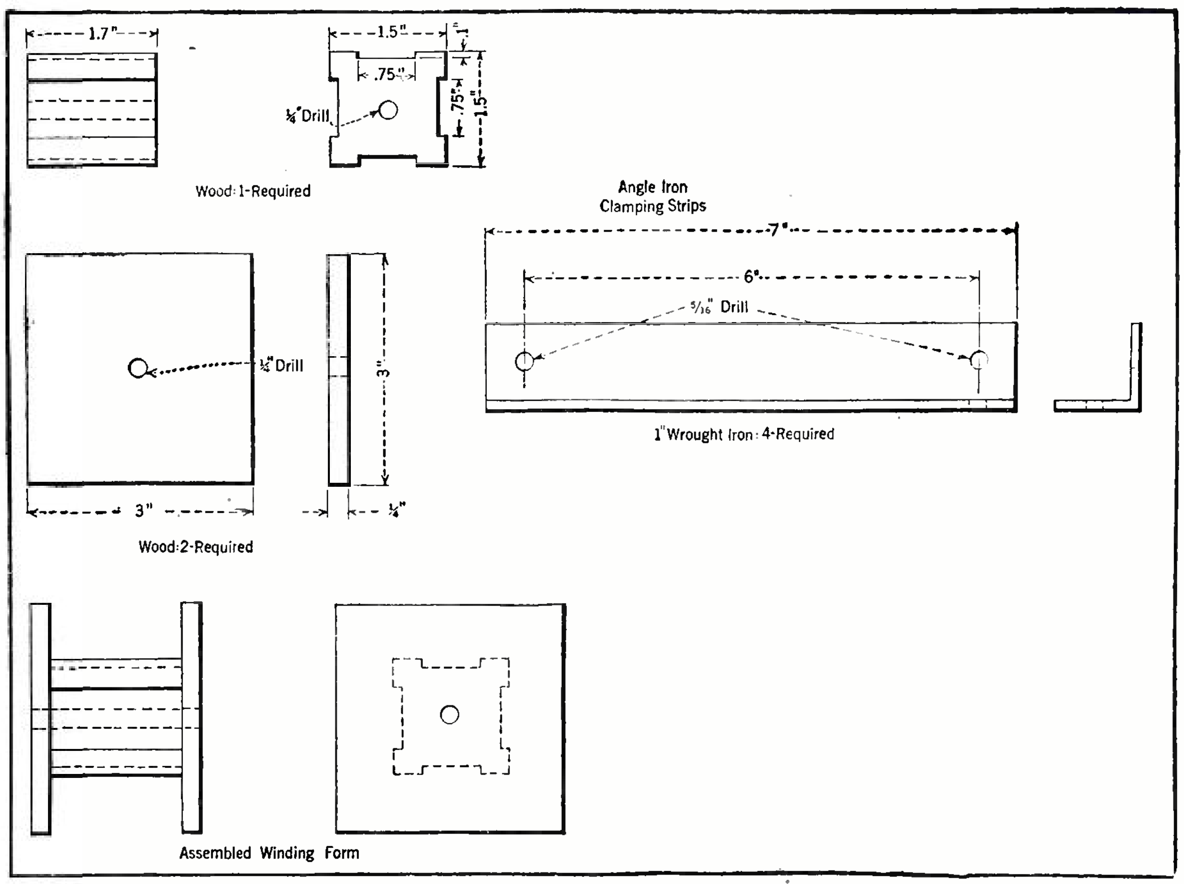


Fig. 10. How the tungar tube rectifies. The transformer primary (7) induces into the filament winding (6) a voltage for lighting the filament of the tube (5). When the battery (3) is in the circuit and current turned on, an arc is set up between the fialment and the graphite electrode (4). When the line (1) is positive, current flows through it to the battery and through the electrode (4). Then through the arc to the filament and back to the other side of the line (2) completing the circuit. However, when the line (1) is negative, current tends to flow into the bulb from the filament to the graphite electrode, but as the resistance offered to the flow of current in this direction is very high no current will flow through it to the battery. Therefore, periodic pulsations of current in the right direction of flow is passed through the battery changing the chemical composition of its negative and positive plates, thus restoring them to their original charged condition. This is a simple rectifier circuit of the standard manufactured type of tungar rectifier. Both this type and that described by Mr. Beers produce the same results.



Figs 8 and 9. Details of construction for the coil winding form and angle pieces. Note that some of the dimensions are indicated in decimals and it is suggested that constructors adhere to these specifications.

obtain the necessary cross-sectional area of the core, but the operation should be attended with great care lest the coil windings become damaged.

The completed transformer is clamped together between four pieces of one-inch angle iron or hard wood strips as shown in Fig. 9. One-quarter inch stove bolts, two inches long, are needed for the transformer design shown in Fig. 5; others may be supplied by the builder to suit his individual requirements. The completed

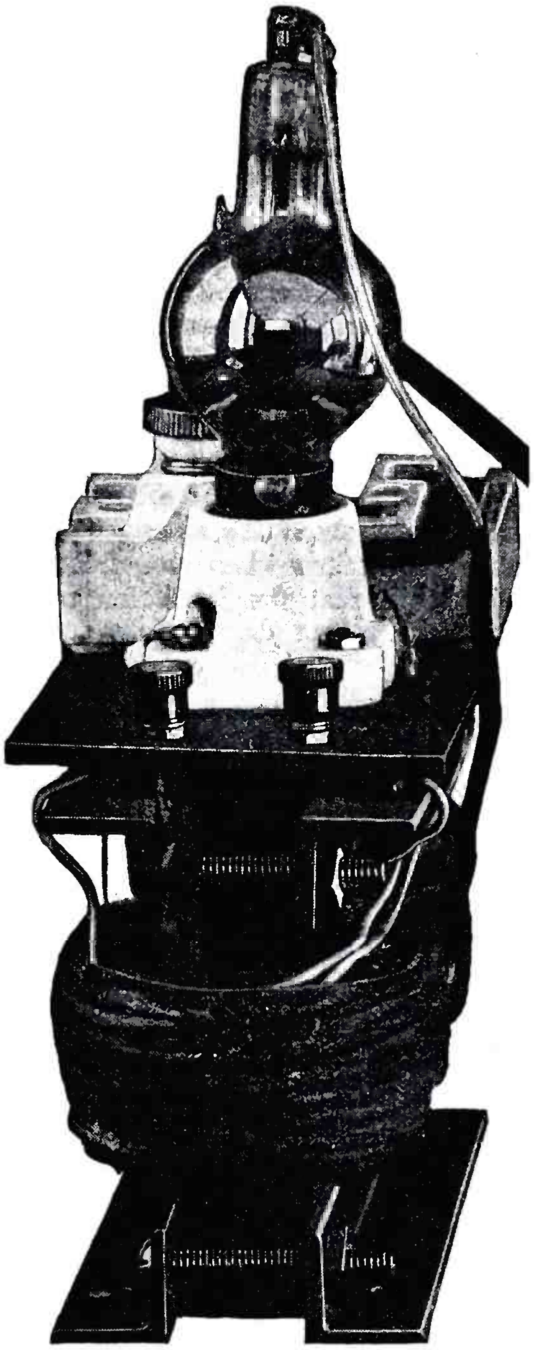


Fig. 11. Another view of the completed charger. This is an end-view picture and shows how the angle pieces are employed not only to hold the core together but as fect and supports for the bakelite shelf.

transformer should now be given a coat of black insulating paint in order to preserve the appearance and prevent rusting of the iron parts. It is advisable to paint the lead wires as well, in order to improve the effect of the insulation on them. For want of better insulating paint, the author used automobile enamel, which has withstood the heating effect of the charger remarkably well.

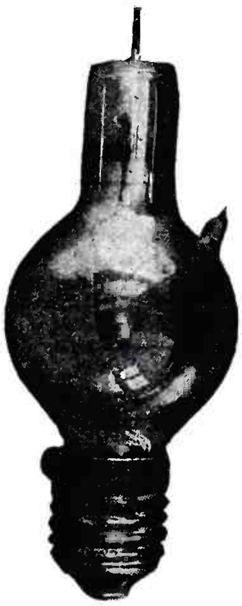


Fig. 12. A typical rectifier tube. The screw-base allows it to be inserted in a standard lamp socket from which current is obtained for the filament. Connection is made to the graphite disc by means of a Fahnestock connector which clips on to the wire post projecting from the other end of the tube.

We are now ready to assemble the charger in whatever manner seems advisable to the builder. If he desires, he may cut a baseboard of ½-inch hard wood, measuring 7 x 8 inches, and all parts may be assembled on this base in a compact manner. A more shipshape assembly, and one which leads to a more commercial appearance, is illustrated in Fig. 4, where a terminal board of ¼-inch bakelite 4 x 7 inches is mounted on the top of the transformer and contains the tungar tube socket, battery terminals and fuse block. The terminal board is set by brass bushings ¼ inch above the angle iron brackets and holes are drilled for mounting the various equipment and for passing the lead wires up to the proper terminals. This method of assembly and wiring, suggested by H. F. Mason, is very compact and neat, as may be seen from the photograph, Fig. 4.

The porcelain fuse block serves two purposes: as a fuse holder for the two-ampere fuse and as a terminal block for the 110-volt extension cord. Wiring and connections are made in accordance with Fig. 3. Leads to the storage battery clips should be of No. 14 stranded rubber covered wire, and if a twin conductor cable is used, a polarity indicator should be provided. For want of a better indication, the terminal leading to the positive battery terminal may have a knot tied in it, or it may have a red string tied to it. The 110-volt extension cord may be of ordinary lamp cord.

Final Instructions

When the charger has been assembled and connected to the battery for charging, inspection should be made to observe the initial performance. If possible, the charging rate should be measured, if only by means of a Ford dash ammeter or similar device. When charging a 6-volt storage battery, the rate should be 2 amperes; on a 12-volt battery the rate will be 1 ampere. If the charger delivers less current than the above amounts, and still gives some current greater than zero, turns should be added to winding S″ until the proper rate is attained. The percentage of turns it is necessary to add may be calculated from the percentage deviation from the normal charging rate. In case the charger fails entirely to operate, first look for loose wires or broken connections. Then try reversing the battery leads or clips and observe if charging ensues. Occasionally it will require the addition of several turns of wire to winding S″ in order to obtain satisfactory starting of the tungar arc, but this should be necessary only when the transformer has been assembled or wound carelessly. The extra turns are then necessary to offset the excess leakage flux from the transformer core.

When the charger has been adjusted so that it does charge at the proper rate, it should be left charging for at least two hours under inspection before it is pronounced satisfactory. During the inspection period, tests should be made of the core and coil temperatures. They will normally run at such a temperature that the hand can just be held upon the hot parts without burning. Occasionally a charger will be found that will blister the hand if left on more than 15 seconds, but this charger is running at a high loss. If the temperature of any of the parts become as hot as this, look for short-circuited turns, low quality steel, or careless assembly of the core. Any of these three points will in itself be sufficient to warrant rebuilding the transformer.

A Few Simple Suggestions

The fan who builds his own receiver will find considerable help in these simple kinks: 1. Powder your hands with some soft talcum powder before winding coils. Insulation won't come off and wires will be worked more easily. 2. Bend bus wire with long-nose pliers, so that a small circle of the wire can be made for terminal connections. 3. Best connections are made with such circled connections, and the nut screwed down tight. 4. Change tubes around every once in a while. They may give better results.—*Lansing State Journal.*

A New Type of All Wave Set

Construction Details of a Small Set with a Large Wave-Length Range

THE intense interest manifested in radio broadcast reception is paralleled in a smaller way by that shown by fans who have a liking for code reception. When both desires chance to be present in the mind of the radio enthusiast there comes a natural question as to the ability of the average set to reach up to the top levels of broadcasting wave-lengths and down to the comparatively low waves used by the amateurs. Few standard receivers will work over both bands.

Writing in *Radio Progress*, Providence, R. I., *Edward W. Smith* has described a novel arrangement whereby a wide range of wave-lengths may be covered with the same receiver. Mr. Smith writes as follows.

Can you read the code? If so, you are able to get a good deal of enjoyment out of your radio set that the mere broadcast listener must miss.

However, you naturally don't want a set which will pick-up only dots and dashes, but refuses to bring in the musical program. Code signals, you recall, run on 1,500,000 cycles and up (200 meters and below) and also in the band around 500 kc. (600 meters). A radio set which will pick up such a wide band of frequencies is usually quite bulky.

How to Get in Small Space

With the idea of combining in the small space that happened to be available, a set that could be used for the reception of broadcast programs and an all-wave set for bringing in the lower waves, the writer hit upon the following design for a receiver which would have these qualities. The instrument gives excellent service in the field for which it was designed and it is with the idea in mind of bringing to your attention whatever may be new or unusual in its construction that this article was written. For the convenience of those who may contemplate its construction, a list of the parts used is given at the end of the article.

The wiring diagram of the set is given in Fig. 1.

Coils L1, L2, L3 are the windings associated with the tuning of the broadcast range of the receiver and were constructed as follows: The primary coil, L1, of the broadcast receiver, consists of nine turns of about No. 23 double cotton covered Litzendraht, wound directly over the secondary, in the middle with the turns spaced about one-eighth of an inch apart. L2, L3 are respectively the secondary and tickler coils and are arranged so that the tickler rotates within the secondary. In constructing this unit, the writer took an old Shamrock vario-coupler and removed the stand and rotor from it. The winding, which had previously been on the rotor was removed, and a new winding consisting of about 20 turns of the same double silk covered Litzendraht wire as was mentioned above was wound on.

The Litzendraht wire consists of 49 strands of No. 40 enamelled wire, which are distributed into seven bundles of seven strands each.

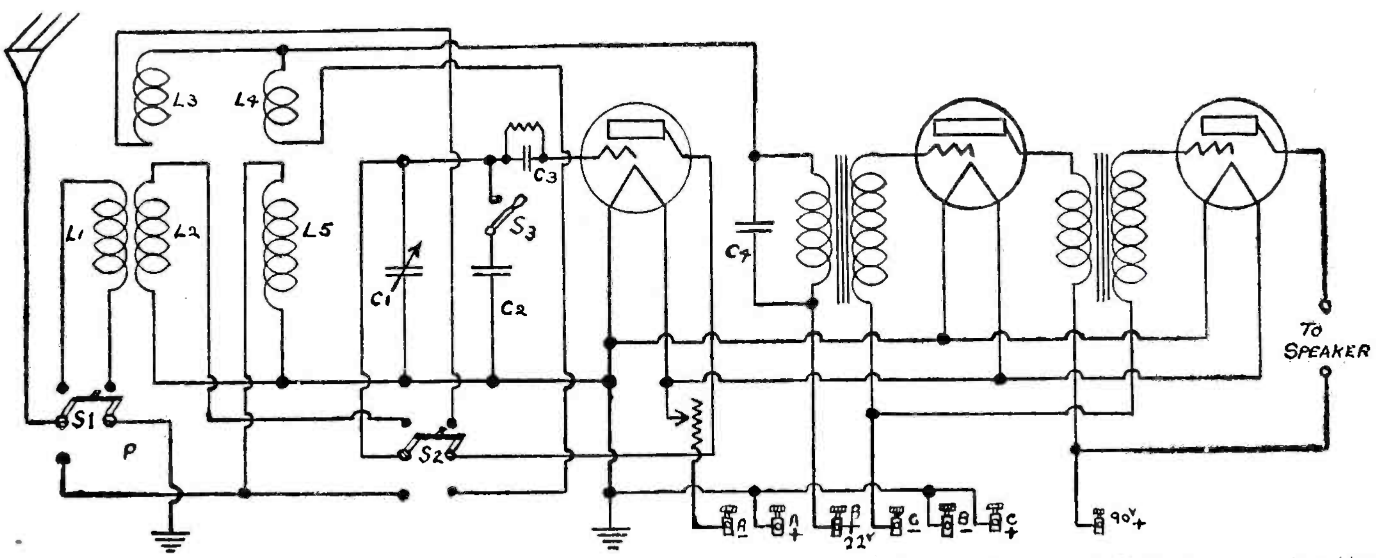
How This Wire Differs

This is the equivalent in area of copper of No. 23 wire. The Litzendraht, of course, differs from ordinary lamp cord, which contains a number of wires in this respect. The wires, which make up the strands of lamp cord, are individually not insulated, and as they all touch each other the current flows freely between them. The Litzendraht, on the other hand, is made up of strands, each of which is enameled, and thus insulated from its neighbors.

The bundles of seven wires are so arranged that each one of them occupies all positions possible in the complete cable. Such wire has very small high frequency resistance provided that care is taken in soldering it so that all the component wires are securely soldered at both ends, and that no strands are broken.

A new secondary coil form was then made of three and five-eighths inch, outside diameter bakelite tubing two and one-half inches long. On this form the secondary coil was then wound, consisting of 45 turns of the Litzendraht wire and the whole assembled as it was originally, with the tickler coil rotating within the secondary. This done, the primary coil was constructed as mentioned above, and the ends secured by threading them through two small holes at either end of the secondary coil form.

It may appear foolish at first thought that Litzendraht should be recommended for the secondary winding of



Illustrations by Courtesy of Radio Progress (Providence, R. I.)

Fig. 1. This hook-up uses a four-pole double throw switch, shown here divided into S1, S2. The entire range of broadcast and code may be heard.

a regenerative set, since the tickler coil will introduce energy into the secondary which will tend to make up for any losses that may occur, the degree depending on the tightness of coupling of the tickler. Such might be the case if it were not for the phenomenon of "threshold" voltage. The detector tube requires a certain minimum (threshold) voltage on the grid to make it work at all. Therefore, decreasing the resistance of the secondary circuit by the use of Litzendraht, and low power factor (low loss) condensers, will tend to bring in stations which would otherwise not be heard, if the signal received from them was not sufficient to bring the grid voltage to the threshold value.

With this in mind it is very important that in soldering to the various coils, especially the secondary, great care should be taken to see that each individual wire of the Litzendraht is clean and securely soldered. It is very easy to run up the resistance of such a coil by insecure soldering.

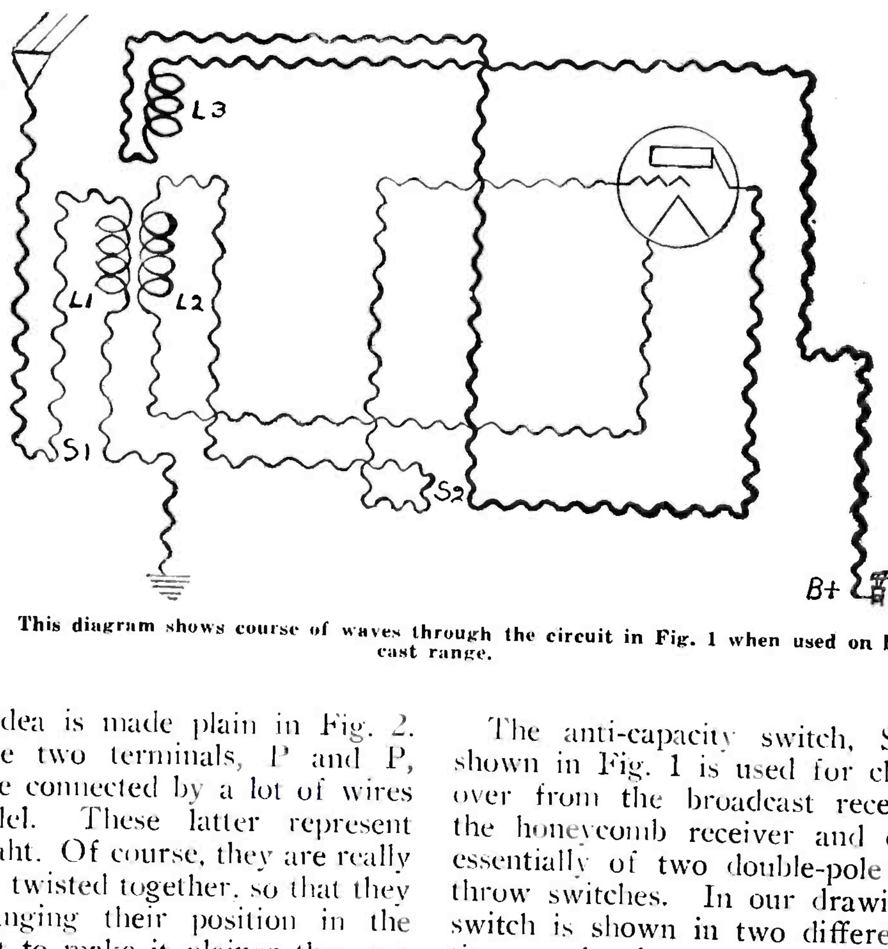


Fig. 3. This diagram shows course of waves through the circuit in Fig. 1 when used on broadcast range.

This idea is made plain in Fig. 2. Here are two terminals, P and P, which are connected by a lot of wires in parallel. These latter represent Litzendraht. Of course, they are really woven or twisted together, so that they keep changing their position in the cable, but to make it plainer they are here shown side by side. There is a break in one of the wires at X. If this were ordinary cable the current would flow around this break by leaving the end of the broken strand and flowing sidewise into the surrounding copper wires and then back again into the other broken end.

With Litzendraht this can not be done. As already explained, such wire has each individual strand insulated from its neighbors so the cross flow around the break is prevented. Of course it follows that the entire strand is dead and worthless. The break, instead of being in the middle, may be at the end where it is not well soldered.

The result in any case is a reduction of the conductivity and a proportional increase in the losses.

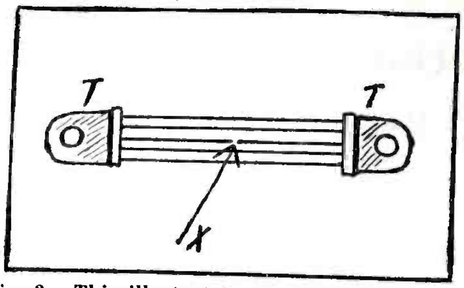


Fig. 2. This illustrates why Litzendraht must be well soldered.

Must Have Good Range

For the condenser, C1, any good low loss condenser may be used, such as the Hammerlund, Cardwell or Premier, provided that it has the right capacity. Condensers of this type usually have a low minimum capacity, eight per cent. or less of the maximum value. This wide range is distinctly worth while, as it increases the possible wave-speed range with a given coil.

The anti-capacity switch, S1, S2, shown in Fig. 1 is used for changing over from the broadcast receiver to the honeycomb receiver and consists essentially of two double-pole double throw switches. In our drawing this switch is shown in two different sections, each of two poles. This is in order to make the diagram easier to follow. Actually a single four pole unit would be preferable, although two double pole switches would work as well. The particular one used in this case was an old telephone switch. In the middle or off position all circuits are open, while throwing the switch arm down or up connects in either the honey comb or the broadcast circuit, respectively.

When to Omit One Wire

It will be noticed in the diagram that throwing the switch, S1, into the up position connects in the vario-coupler set while the down position throws in the honeycomb set. The point, P, on switch, S1, which would normally be used for the ground end of the honeycomb coil connection is left open and the filament battery positive grounded (lower center of diagram). This was done to cut out one wire and at the same time it tends to stabilize the secondary circuit of the broadcast receiver, preventing it from oscillating.

Turning next to the slow (long) wave end of the hook-up, it can be seen that this consists of a single circuit arrangement with a tickler coil to produce regeneration. The reason that a circuit which is normally rather unselective, especially on the slower waves, was chosen will be explained in detail a little further on. Suffice to say that it has given very satisfactory results. The same condenser is used to tune this circuit as is used for the short wave set but provision is made to shunt it by a .0005 microfarad Dubilier mica condenser to give greater wave frequency range.

As this set was designed with the idea in mind of having maximum flexibility and efficiency with a minimum of controls, the filaments are all operated from the same rheostat, and UV-201A sockets are used throughout. This makes it possible to use any type of tube, with the trifling change of using adapters if other than 201A tubes are used.

This condenser is controlled by switch, S3. When this is closed, it adds its capacity, C2, to that of the main control, C1. Since the latter has a maximum figure of .0005, you see it will double the total number of microfarads, bring it up to a figure of .001. By thus doubling the capacity, the effect on wave frequency is increased 40 per cent. You might naturally conclude that this change in capacity would halve the frequency (double the wave length) but the effect on wave speed varies as the *square root* of the capacity, not as the capacity itself.

A Special Leak Needed

The next point of interest and importance in the set is the variable grid leak for the detector tube. In the set described it was of the familiar type to all radio fans, the Bradleyleak. For the proper operation, or perhaps more accurately, the best operation of any detector tube, it is essential that the grid leak be of the proper value for the tube with which it is to be used. Since as we shall see later, the operation of the set I am describing depends to a very large extent upon having a variable grid leak which can be depended on, the writer recommends that a Bradleyleak or one equally good be used.

Turning to the rest of the circuit, you will see that it is of the conventional design, using a "C" battery to bias the grids of the audio amplifying tubes. Any good brand of audio transformer may be used but those having a high primary inductance are to be preferred since they tend to increase the amplification of the lower frequencies which are often woefully lacking when cheap transformers are employed.

Uses Two Control System

Operation of the set is carried on as follows: With the switch, S1, S2 in the *up* position, according to the diagram, the broadcast end of the circuit is connected in. Tuning is carried on easily and conveniently by varying the condenser, C1, in the diagram while the volume is controlled by varying the coupling of the tickler coil, L3. The two control system makes the operation of the set extremely simple over the broadcast range.

The course of the radio waves in that case is shown in Fig. 3. The oscillations run down from the aerial through switch, S1, primary L1, to ground. The secondary vibrations run from the coil through switch S2 to the grid, and also to the filament. The output from the plate is conducted by switch S2 to the tickler, L3, and from there to the "B" battery. The output from the detector is amplified through two steps of audio in the ordinary manner.

Before explaining the best method of operating the set when switched to the slow wave circuit, it might be well to go into a little detail concerning the theory of its operation in order that the operator may have a clearer idea of what he is doing. Probably all operators of broadcast sets or at least all of them who have used a single circuit radio have noticed that with the tuning condenser set at any particular value, bringing the tickler coupling up will make the set oscillate at its own natural period and that if the coupling be still further increased, a kind of audio frequency oscillation is produced in the phones which varies from a sort of grunt up to a high squeal depending on the constants of the circuit. By varying the resistance of the grid leak this audio oscillation may be varied over a range of from roughly two cycles per second to a frequency which is above the audible range.

Adjust Grid Leak

In using a grid leak which is smoothly variable, the whole range can be covered without any abrupt changes in frequency. In tuning the slow wave end then, the adjustments are first carried out in the ordinary way. As soon as the desired station is tuned in, the tickler coil is brought up until the grunt is heard. The grid leak resistance is then increased until the note changes to a very high-pitched whistle which is almost inaudible. A slight readjustment of the tuning will then bring the signal desired up to a point where at a conservative estimate it is ten times as loud as it was before. At the same time a very noticeable increase in selectivity is brought about.

In working at these slow (long) waves, switch, S1, S2, is thrown down with the results shown in Fig. 4. Here the waves start at the aerial and are carried by switch, S1, to the point Y, where they divide. The main part of the oscillation goes through coil, L5, where it is tuned by the condenser, and the voltage tap from Y passes through switch, S2, to the grid. The output from the plate is led through S2 to tickler coil, L4, and from there back to the "B" plus.

Brings in Europe Well

As the reader has probably deduced by this time, a form of super-regeneration is used to increase the sensitivity and selectivity of a circuit which is normally rather broad. That it accomplishes the desired result there is no doubt, for the writer has been able to bring in almost all the slow-wave stations in Europe, some of which operate on waves around 30 kc. (10,000 meters) where the interference is very bad. These stations came in loud and clear on one stage of audio with practically no interference whatever, lowering the pitch of the variation frequency by means of the volume of the signal, but too much of this is not to be recommended, as a point is finally reached where the strength of the squeal is greater than the signal.

This method of increasing the volume can be used at broadcast wavelengths as well as the longer waves, although the writer does not recommend it when receiving music, as the variation frequency tends to tear up the program unless a very high variation frequency is used, in which case the amplification is cut down considerably. Another serious disadvantage of this method is that it radiates waves from your aerial and so destroys the enjoyment of all your neighbors.

Try It Out Yourself

Just what variation frequency is best suited to each particular case the experimenter can easily determine for himself, as it is easily changed by varying the grid leak, no special coils and condensers being necessary.

The honeycomb coil mounting is one of the ordinary two-coil types with one fixed and one adjustable coil holder, and is mounted on the front of the panel. The coils to use depend on what wave you are after.

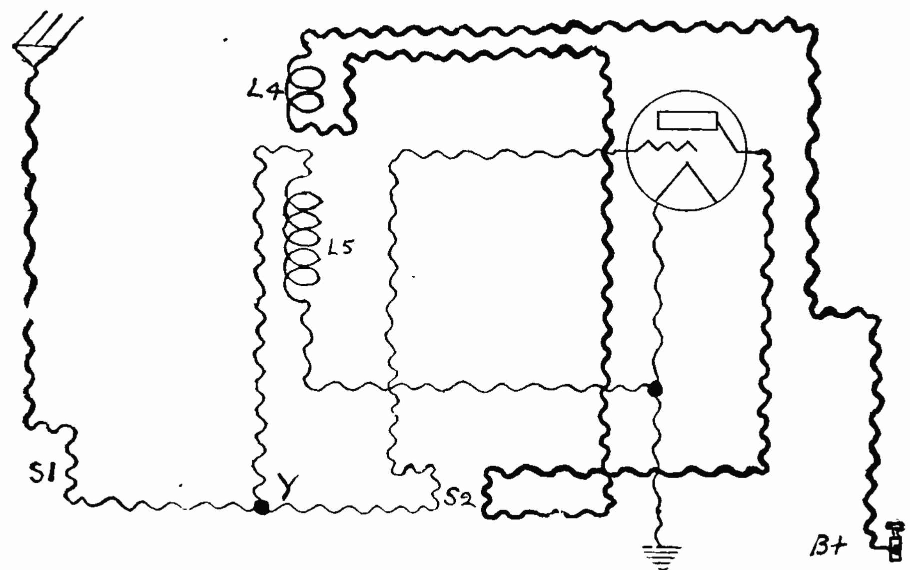


Fig. 4. By switching to wireless range, the vibrations divide at Y, and are tuned through L5.

With the belief that the average experimenter prefers to design his own panel, cabinet and so forth, the writer has purposely omitted these details, but it might possibly be of assistance to the experimenter to know that the set which has just been described is mounted on a 7-inch by 18-inch panel and sub-base 6 inches deep.

- 1 Shamrock variocoupler or equivalent. See text.
- 1 Two-coil honeycomb coil mounting.
- 1 Rheostat, 2 ohm.
- 1 Variable grid leak (Bradleyleak).
- 1 .0005 microfarad variable condenser.
- 2 .00025 microfarad mica condensers.
- 1 .00025 microfarad grid condenser.
- 1 Anti-capacity switch. See text.
- 2 Audio transformers.
- 3 UV-201A tube sockets.
- 6 lengths of bus bar wire, approximately.
- 8 Binding posts.

Notes On Antenna Installation

Some Constructional Details for an Antenna to Withstand the Cold Winter Weather

"NO MATTER how good a receiver may be, a poor antenna system will spoil the whole works. It might not seem so, but the antenna is really the heart of the receiver, even though there are many things in the receiver that often receive major honors.

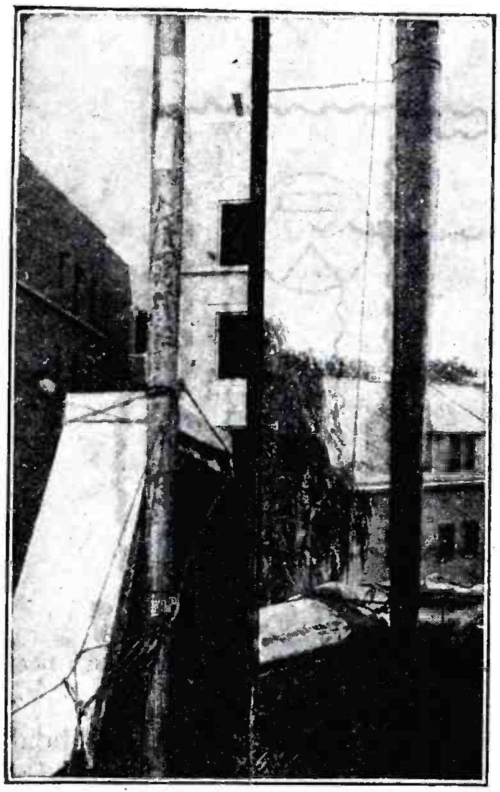


Fig. 1 (left hand photo), showing how one of the poles is held in place. This is at the slanting portion of the roof. Note the large amount of rope holding the pole. Fig. 2 (at right), showing how the pole which is at the cornice of the roof, looks. Note the guy wire coming down from the pole.

Without an antenna you are lost, even if it is a coil antenna (loop)."

This is the introduction by *Lewis Winner,* to his article in *Radio World,* New York, in which he outlines some important considerations in the construction of the antenna for broadcast reception. The opening statements are open to some question from a practical standpoint, but the author evidently works under the assumption that a little knowledge is dangerous for the average radio listener. Some sets will work fairly well with any old kind of antenna, but the intention of this article is to show certain features that will make for real efficiency—not just ordinary reception. In congested areas the installation of a good antenna is no easy matter. However, read the balance of Mr. Winner's article in the following. It may save much wasted energy and aid you to retain a certain amount of good nature when the set is finally placed in operation.

A good antenna improves the reception of signals. Now comes the question as to exactly what is the best type of antenna to install and how it should be installed. The best type of antenna, I think, is the V-shaped, because the entire length of the aerial is used and the utmost directional effects are obtained. Soldering is also made a convenience. That is, you do not have to climb up to the end of the antenna lead to solder on the lead-in. Some persons solder the connection on before the antenna is tightened. In this way, they have to judge the tightness of the antenna by their eyes, which is a very poor way to do. Notice in Fig. 3 that the lead-in is a part of the antenna proper, and also that the soldering is done after the complete antenna is tightened and put up. Another advantage of this type of antenna is that the aerial wire is never broken at any point, which does away with increased resistance due to poor contact.

The lead-in should be placed in the direction of the station that you prefer to receive most and with greatest volume.

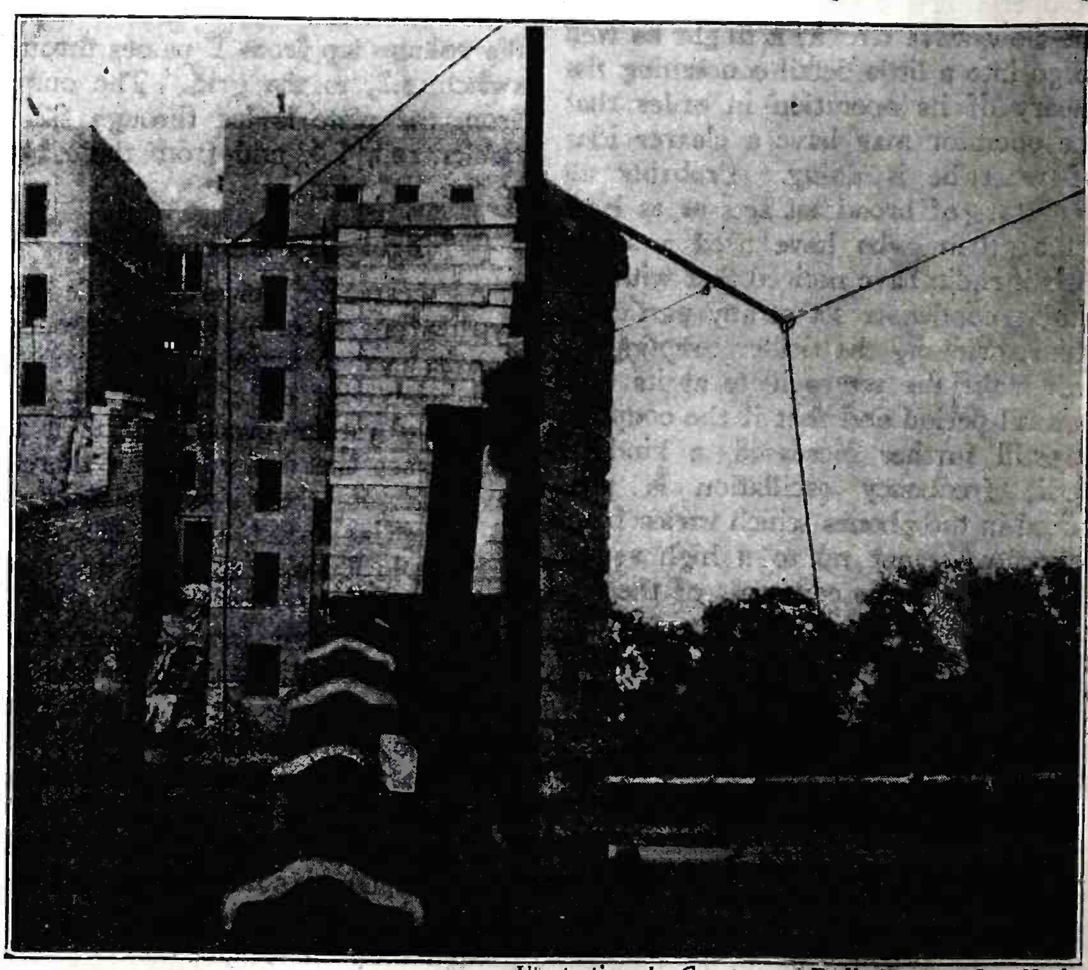
Those employing the L type of antenna always have trouble with a sagging aerial. This is due to the pull that the lead-in has on the antenna.

Poles Are Important

Another consideration of importance will be the poles that the antenna is to be attached to.

Ordinary block sticks are most commonly used. This type of pole is usually placed inside of carpets to keep the carpets from unrolling. The popularity is due to the cheapness and ease of obtaining them. These poles bend and warp easily. They are the worst type of aerial poles.

Other types used are broom sticks, which are poor, due to the thin length of wood, causing the wood to bend easily when subjected to a strong pull; iron slats, which are fine, if you have the proper means to put them up. These irons are best installed in the slots of wash poles which are on the tops of roofs of some houses. The next and most elaborate type are the steel poles. These are expensive and require a lot of space for installing.



Illustrations by Courtesy of Radio World (New York)

Fig. 3 (at left), showing how the lead-in should be placed. Note how far away from the building the wire is. Fig. 4 (at right), showing another view of the lead-in. Note the eyescrew at the end of the stick. Note how the antenna wire and the lead-in are so joined, that it is difficult to tell where the antenna begins. The other rope which is wound on the stick and described in the text has been left out of the picture, so that a clear view of the lead-in may be had by the reader.

The last, and I think the best, are the masthead poles. These were used by the navy and are now being discarded, which is to the advantage of the radio public. They are purchaseable at some stores for a very moderate price, with express charges prepaid. This is one of the season's best buys, and this is a good time to buy, as now is the season for reinstalling or repairing your antenna for the coming winter.

Look to Your Roof

The next thing to consider when installing your antenna is the roof the poles are to be placed on. If it is a tin roof you are in a bad fix, because tin is a wonderful absorber of radio energy. However this can be partly offset by putting up extremely high poles. A tarred roof is the best. Look over the layout of the roof carefully, scrutinizing every nook and corner for the purpose of finding the ideal place to put the poles. They should be put at the opposite ends of the roof. I placed one near the slanting edge of the roof,

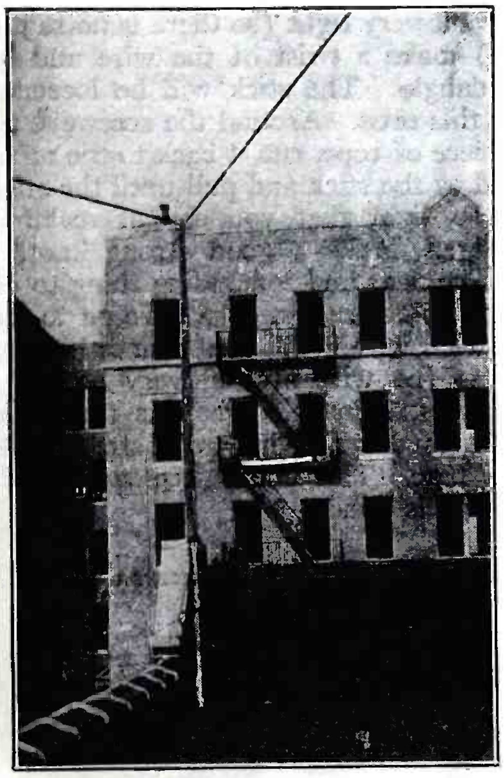


Fig. 5, showing a view of one of the poles. The guy wires are difficult to see, due to the similar background. Note the height of the pole, and how the antenna is continued right through the insulator.

and the other near a cornice. These places are both clearly shown in Figs. 1 and 2. See if there is a chimney near where the lead-in is to be made. This is for the purpose of placing a long stick so as to place the lead-in away from the wall.

Wooden Poles

When purchasing an antenna pole there are several things to be noted. First, see if you think the pole is high enough (16 feet above roof is average height).

If you have a tin roof, then the poles will have to be much taller, about 22 feet. Tin absorbes radio frequency energy and if the poles are low, which will cause the antenna wire to be low, your signals may be very weak. The weight of the poles is also important. Of course it is difficult to weigh such a large article, especially in a radio store.

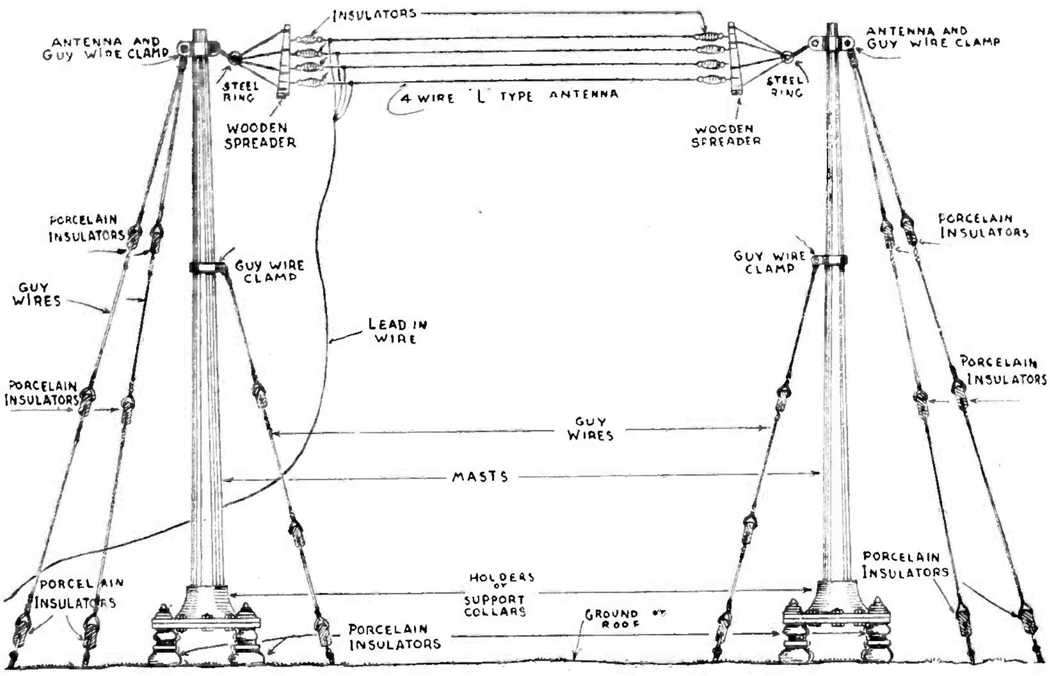
It can easily be done, though. Just grasp the pole at the center and lift it up and down. If it is fairly easy to lift it is all right in weight. If scales are available the weight of the poles may be thus determined and should not exceed 20 lbs.

Now as to the quality of the wood. Inspect it closely. Note if the wood is hard or soft. This is best done with a pen knife, by notching. The harder the wood the better. See that there are no knots. These prevent convenient drilling. See that the pole is solid. There may be cracks present, but these cracks, if only ¼ in. to ½ in. in depth do not weaken the pole.

The construction of the pole is also important. A straight pole is all right, but it gives; that is, when subjected to a strong pull, it will bend. The remedy for this is a pole which looks like that in Fig. 5. Note the peculiar build. It looks like a huge oar. In the center, it is 6 in. in diameter and decreases to 1½ in. at the beginning of pole. This is true of both sections. This bulky mid-section gives the pole wonderful resistivity to winds. There should be one notched section in each half of the pole for holding the guy wires.

The Water Test

A good way to see if the poles take to dampness is to put some water on a section of the pole. Wait about two minutes. If the water is mostly on top, the wood is all right. Some wood will hardly absorb moisture at all, but this type has been chemically treated and is expensive. The less a wooden pole absorbs moisture, the longer it will last, as poles which take in moisture rot very quickly.



Many folks think an antenna having four wires improves the reception of signals. This type of antenna causes very broad tuning, due to the large amount of capacity and effective antenna resistance. A great many of the present day transmitters desire a lot of capacity, due to the high power. In the transmitter the resistance is overcome by the high voltage output, but in the receiver there is no output, it is all coming in and nothing to counteract this resistance. With an antenna of the multi-wire type a very small inductance is required, and even then one has to decrease the fundamental wave-length of the receiver by series condensers. Louder signals will be received with this antenna, but then the signals may be heard all over the dials. The shorter the antenna, the sharper the receiver will tune in signals. This type of transmitting antenna is being done away with on board ship. Single wire antennas are rapidly taking 2 and 3 wire aerials. Note the large amount of space this type of antenna requires.

How to Put the Poles Up

Before putting up the poles all the guy wires, insulators and antenna wire, should be attached thereto. When putting these poles up have some one help you hold them in place so that they can be securely held. Take one pole. At one extreme end, 3 in. to 4 in. from the top, screw, a hook in. Make it as tight as possible. Now take the insulator, run the beginning of antenna wire through one hole and twist the wire, so that a good hold is obtained. Solder the connection of the wires. Through the other hole of insulator run some heavy hemp rope or No. 12 rubber insulated wire. About 1½ ft. will do. Twist this wire around the insulator ring tightly. Now run other end through screw eye. Run once through this eye and the other times around the pole twice. When coming around the third time twist around other twisted portion (coming from insulator). Tighten with a pair of pliers.

Run the antenna wire out. Try not to make too many kinks in the wire. Unroll the wire, turn by turn.

Unwrap the wire until you have let out enough wire for it to be pulled through the insulator of the other pole. This means that about 80 feet of wire will be left out, while 20 feet are still in the roll.

In one of the notches (each is 6 in. wide), wrap five turns of hemp rope and make a loose knot, leaving the rest of the rope dangling. Now measure off the complete length of the guy wire from the top of notch. This measurement should be made to the place where you contemplate placing the clamp. Say it is 10 ft. Then at 7 ft. cut the rope.

Insert a turn-buckle at this point. A turn-buckle is a threaded dented bolt 5 in. long, having a pair of turn-screws. They are situated at the extreme ends of the respective halves of the buckle. One turns in the opposite direction to the other. The holder of these screws is turned, and since they both turn in the opposite direction, the guy wire can be loosened and tightened. Insert the other one-quarter of the rope on the other end of the buckle. Do not make loose connection, as there will not be enough rope left out for tightening.

Clamp is Tightened

Now put a clamp in place on cornice, where you measured the length of the guy wire from the pole. Tighten the clamp. Insert the end of rope in clamp and tie securely. Make strong knots in all cases where the strain is great, as a loose knot, or one that seems tight will quickly break when subjected to any kind of a pull.

On the other notch place another rope in the same manner. Place another clamp on another cornice of the roof, this one being about 15 ft. away from the other one and in a favorable position for holding the pole safely. About five feet from the bottom of the pole drill a hole 1 in. in diameter. Run some rope through this hole and leave enough rope out for tieing purposes. See Fig. 2. Note that the pole is in the corner of the roof, place a clamp on this end. Run the rope through the clamp twice, then back again on the pole a couple of times. This will give you a secure enough hold. Now take some more rope and wrap it around the pole and the clamp so that the pole holds without any one supporting it. Put the guys up. Tighten the turnbolts. See if the pole wiggles or swings, when subjected to strain. If it does, put more rope around the end of the cornice. Do not be afraid of the fact that this will make an ugly looking affair, because you will have to depend upon strength there and not looks. You are putting up a couple of strong poles, remember that.

LIST OF PARTS

- Two strong masthead poles.
- Four turnbolts.
- Four porcelain insulators.
- One roll of No. 14 hard-drawn copper wire (100 ft.).
- 100 ft. of No. 14 rubber-insulated copper wire.
- Two rolls of hemp rope.
- One broomstick.
- One-half dozen screweyes.
- One roll of tape.
- One roll of solder, paste and soldering iron.
- Four screw clamps.

Now for the other pole. According to the picture, Fig. 1, it seems as if I used up all the rope that I could find in the house, but that pole has no chance of falling down regardless of the wind. Guy this pole in the same way that you did the other. Before doing this, though, put a screweye in the pole. Then put the insulator on. Run the antenna wire that you tied to this end of the roof through the insulator and let the wire dangle, having someone hold it until you put the pole up. As soon as the pole is erected tie the wire on some cornice of the roof, watching that there are no kinks present in the wire.

After you have installed both poles test them for their resistivity. This is done by pulling on the antenna wire with a great deal of energy, at least until you have made the wire as tight as you possibly can. The poles should not shake or bend. Watch out for the guy wires or rope and see that they do not snap.

The Lead-in

Now for the lead-in. This should be 3 feet from the wall. Here is where a broomstick comes into use. Drill two holes (1 in. in diameter) at the extreme top and bottom of the stick. Run a wire through one of the holes and tie. Continue running this wire around the entire top of the chimney until you reach the pole again. Run the wire through the other hole and tie. At the end of the pole a small screweye should be screwed in. Run the antenna wire through this eye. Tape the entire circumference of the eye. Pull the antenna wire again and as soon as you have it very tight (so there is no sag at all) make a twist of the wire and let it dangle. The stick will be loosened by this time. Around the screweye tie a piece of rope, run it back to the other end of the stick and pull until the stick is so tight that you cannot make it budge. Make a good strong knot.

The next and concluding thing to do is to solder the antenna wire on to the lead-in wire. If you cannot solder, wrap the wire around very securely. Put some tin foil over this turn, and then cover with some good strong rubber tape. This is not necessary if soldering is done.

A Second Step R. F. Amplifier for a 2-Tube Reflex

(Continued from page 23)

cuit, as a short-circuited "B" battery would result. It should be stated that the counterbalancing condenser is also a help in selectivity. A test with it and without it will demonstrate this. The "C" battery connected with the potentiometer, as shown in the diagram, insures the proper grid bias on the first tube, better quality on local reception, and helps in getting distant stations.

The antenna arrangement of fixed condensers and point switch can be used or not as desired. This arrangement is a great help in selectivity, and the long antenna in combination with it has all the advantage over a short antenna. A variable 23-plate condenser can be used in place of this arrangement. The fixed condensers on the "C" battery and potentiometer, and on the "B" battery, are used as a by-pass and are for greater efficiency.

In Pasadena, probably one of the poorest locations in California for long-distance reception, this receiver has brought in stations in Chicago, Calgary, Canada; Chihuahua, Mexico, etc., with four 500-watt local stations on the air. The receiver will tune within ten meters of local stations in this long-distance work.

Powerful radio transmitting equipment is being installed in a new laboratory being built by the General Electric Co. six miles south of Schenectady. This will be devoted to a study of means for improving transmission quality and reliability and to tests on static and fading. The transmitters will have a maximum power of 100 kw. with plate supply as high as 30,000 volts D.C. The antenna structures include three towers 300 ft. high arranged in the form of a triangle. From these steel masts almost any type of antenna may be strung capable of operation between 600 and 3,000 meters. A fourth steel tower, 150 ft. high, may be connected to any of the trio of masts for work on wave-lengths from 200 to 600 meters. In addition to the steel towers there are numerous wooden masts for antenna systems for experimentation on wave-lengths from 15 to 200 meters.

Tools for the Radio Builder

A List and Description of Essential Tools for the Home Radio Constructor

WRITING in *The Experimenter*, New York, *Robert Hertzberg* explodes some popular fallacies regarding the number and complexity of the essential tools for home radio construction. The author, with somewhat more tact than the editors, has carefully refrained from dwelling on the human frailties of amateur enthusiasts in this connection. The author will probably not create any furore of appreciation among the hardware fraternity, but he certainly is due a vote of thanks from the fan who "rolls his own." If you have not already depleted your local hardware dealer's stock of tools, read the following article and save expense and trouble.

One of the qualities that makes radio experimenting such an alluring hobby is the fact that it calls for neither an extensive knowledge of mechanical processes nor for an extensive layout of mechanical tools. This feature of the pastime, probably more than any other, is what makes possible the home construction, by inexperienced persons, of so many excellent and successful receiving sets.

However, some tools are required for the work, and the man who finds himself fascinated by radio can make no wiser move than to equip himself with them at the outset. In fact, he should buy tools first and radio instruments afterward; if he favors the radio instruments first he will quickly discover, upon his first attempt to assemble the parts, that *fingernails make poor screwdrivers, scissors indifferent wire-cutters and bread-knives ineffectual hole borers*.

The actual tools required for the home radio laboratory are few and inexpensive. Those mentioned in the following list will fill every requirement that set-assembly or set-repair will present.

(1) *Hand drill with chuck to take drills up to ¼-inch; assortment of drills from 1/16-inch to ¼-inch*. Small drill stocks especially suited for radio work and costing only about $3.00 are made by all the big tool firms like Yankee, Millers-Falls, etc. The drills themselves should be of the best steel; cheap ones are useless after one excursion through a bakelite, hard rubber or celeron panel.

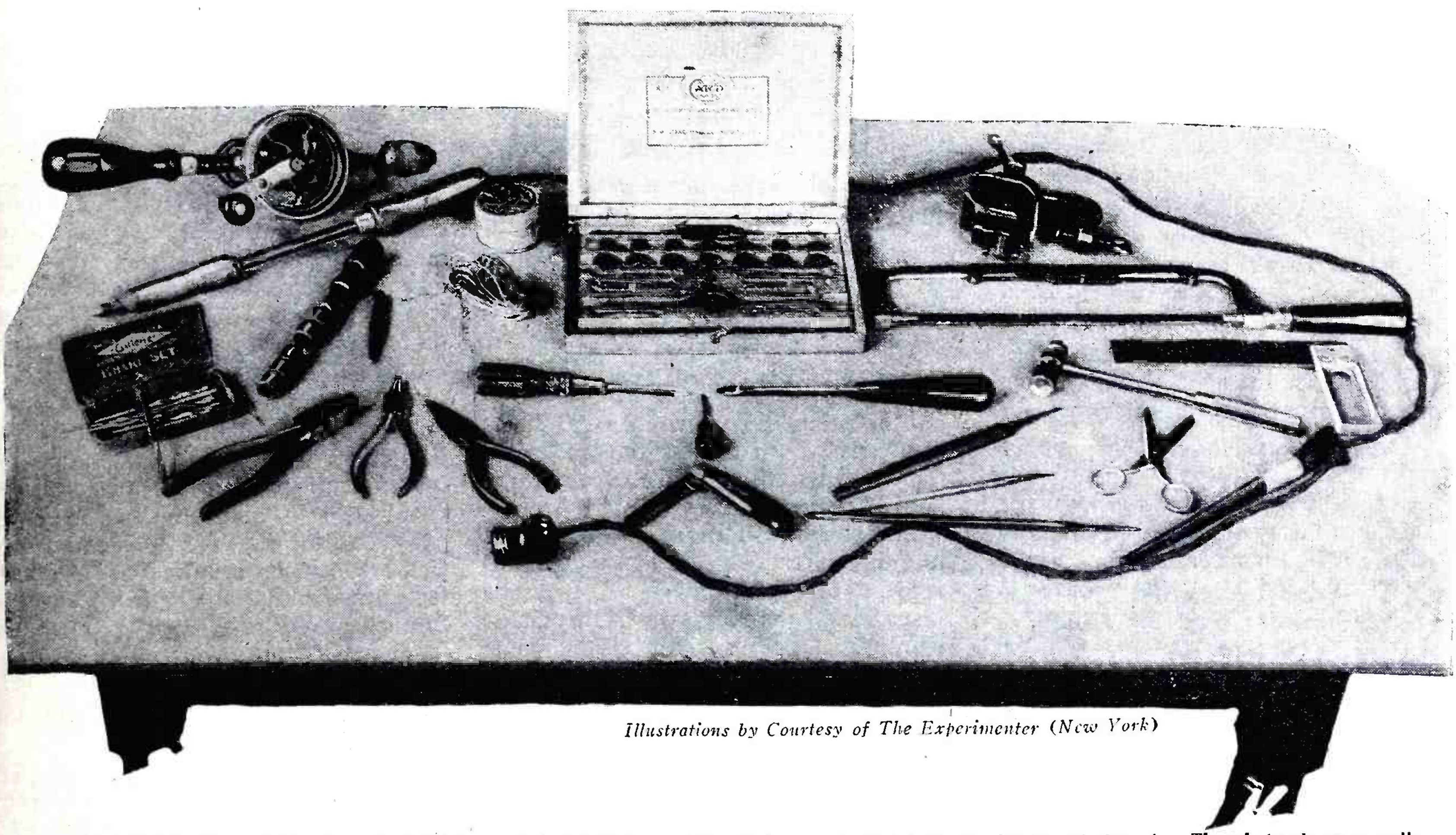
(2) *Electric soldering iron; 2-oz. can of Nokorode or other solder paste; pound roll of soft wire solder*. There are dozens of small irons designed for the fine soldering jobs encountered in radio work. A good one costs between $2.00 and $5.00.

(3) *Small detachable vise*. The jaws should be 2½ or 3 inches wide, and the clamp large enough to fit comfortably on the edge of a table or window sill. It should cost not more than $1.50.

(4) *Hacksaw*. A perfectly good one can be bought for as little as 50 cents.

(5) *Three pairs of pliers*. These are important items, as pliers are the most frequently used tools in radio construction. One pair should be of 6-inch size, side-cutting, and with square, heavy jaws; the second should be 5-inch size, side-cutting, and with jaws that taper to a point; the third should be 5-inch, non-cutting, and with tapered, round-nose jaws. The imported nickel-plated junk should be carefuly looked over; the bright finish covers weak steel. Good pliers are made in this country by Krauter, Pexto, Utica and others.

(6) *Three screwdrivers*. These are



Illustrations by Courtesy of The Experimenter (New York)

"A good worker is no better than the tools he works with." Expensive tools are not necessary, careful use of them is. The photo shows a well-selected set for the radio constructor. The set of dies and taps are not essential.

also important tools. One should have a 5-inch blade, another a 3-inch one, while the third should have a very slim blade that will fit set-screws and the like. Cheap screwdrivers are poor investments; there are screws without number in radio parts, and they can be properly tightened only with strong tools.

(7) *Small ball-pene hammer.* Nails are rarities in radio sets, but there are many holes to be center-punched. A most excellent all-metal hammer can be purchased in any of the Woolworth emporiums for the munificent sum of 10 cents.

(8) *Carpenter's square, 6-inch size.* One is indispensable for marking instrument locations. A good one is obtainable for a dime.

(9) *Three files.* One should be flat and about an inch wide at the base; the second should be three-cornered, about 3/8 inch on a side, and the third round, about 1/4 inch in diameter. All three will cost 30 cents.

(10) *Strong jack-knife.* One of the "Boy Scout" type is extremely handy.

(11) *Small pair of scissors.* Scissors are cleaner and quicker than a knife for trimming insulation and cutting tape; they cost only ten cents.

(12) *Steel center punch.* One is necessary for locating holes in panels.

(13) *Brush.* A round, long-haired one helps clean dust and shavings out of inaccessible corners and crevices.

(14) *Set of "Spintites,"* or socket wrenches, a very necessary adjunct.

That's all. The writer's own tool box contains these instruments and no others, and with them, during the past eight years, he has constructed receiving and transmitting sets embodying practically every circuit that has appeared in print.

The entire absence of wood-working tools such as rip, cross-cut and back saw, brace and bit, chisels and a plane will be noted. Although it is unquestionably a good thing to have these on hand, the little woodwork radio sets require does not warrant their outright purchase. Completely assembled cabinets and nicely squared baseboards, all cut to fit standard panels, are priced so cheap that it will avail the home mechanic nothing to attempt to duplicate them in his kitchen workshop. Besides, planing can be done properly only if the work is securely fastened in a large vise which in turn is solidly bolted to a husky timber work-bench, and such an arrangement is decidedly impracticable in the average apartment or small house.

The lack of things like taps and dies also invites inquiry. These items are not costly, but frankly they are unnecessary. Fully 99 per cent of the threaded fittings on radio parts are of 6/32 or 8/32 size, and attachments of these dimensions are available in such number and variety that the radio experimenter need never worry about fussing with his own threading. The writer has had a complete set of taps and dies up to 1/4 inch for more than five years, and the only time he ever used the devices was when he wanted to remove the rough edges from a batch of new condenser mounting screws.

The tang of the flat file makes the best reamer imaginable for working out large holes for condenser shafts after the largest drill in the hand drill set has been used. The steel at the tang is slightly annealed, and therefore will not break off if the tool is twisted too suddenly. This is also very convenient for enlarging holes that are just too small to pass instrument fastening screws, especially if the panel has already been mounted and cannot be clamped down securely for another drilling.

The soldering iron, of course, is an absolute necessity. So much has been written about the art of soldering in general that nothing need be said here about it. The writer wishes only to admonish the embryo experimenter to learn to solder well before he even looks a radio catalogue in the face.

The pliers need little explanation. The pair that will see the most service is the 5-inch tapered-nose pair, as it can be made to reach into awkward corners to hold wires being soldered, to tighten all manners of small nuts, to adjust springs, and to serve a dozen other purposes. The heavy pair is generally useful for wire cutting and for securing larger nuts. The round-nose pair is reserved entirely for making loops in bus bar, and for this function alone it justifies its cost. It should not be used for tightening things, as the thin, round jaws will spring out of shape and will frequently cause the handles to bite a piece of flesh out of the user's palm. This has happened more than once to the writer, so he knows, painfully, whereof he speaks.

The long brush is a surprisingly useful object, and is something no owner of a set should be without. It gets into all dust-collecting corners and crevices and cleans them out as thoroughly as if a vacuum cleaner had been applied to them. It is many times more convenient than a rag, for rags have an annoying habit of pushing dust and dirt into cracks and under little ledges; it can be forced into right angle bends that no finger-stiffened cloth can possibly reach.

The tools described in this article are by no means the only ones that find use in an experimental radio laboratory, but they will fully satisfy all the usual needs of the radio experimenter of limited means. If a man can afford such delectable luxuries as a power drill press and a lathe, for which most "fans" would give their right hand, he should by all means purchase them and install them in his workshop. He will find them exceedingly helpful, but not absolutely necessary.

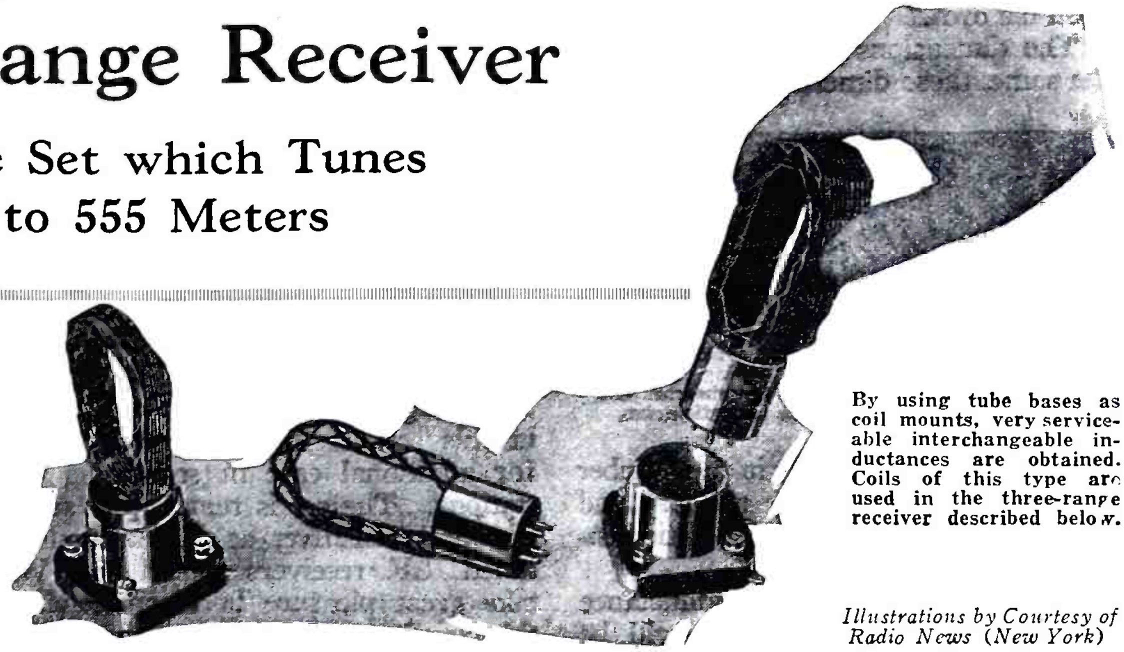
What some workers can accomplish with an ordinary knife and screwdriver, others cannot duplicate with the most expensive apparatus or machinery. The knack of using a tool in the correct manner comes not only from experience, but from learning from others. To use a hacksaw blade as a file or the sharp point of a drill as a punch is as bad a practice as drilling a hole with a chisel.

The Antenna Lead-In

The antenna lead-in should be installed as carefully as the antenna. For one, the lead-in should be well insulated and it is advisable to keep the lead-in about four to five inches from the side of the building. This will not only meet fire regulations but it will also keep the lead-in from touching the side of the building when the wire swings. Under all conditions insulate the lead-in as it comes through the window or building. Do not run the antenna lead-in with the ground wire. The ground wire should be kept as far away as possible from the lead-in. For best results it is advisable to solder all of the joints in the lead-in, if any. If it is impossible to solder the joints then wrap each joint very tightly and cover with tape or tin foil. This will prevent the joint from corroding.—*The N. Y. Evening World.*

A Three-Range Receiver

A Five-Tube Set which Tunes from 40 to 555 Meters



By using tube bases as coil mounts, very serviceable interchangeable inductances are obtained. Coils of this type are used in the three-range receiver described below.

Illustrations by Courtesy of Radio News (New York)

THE receiver shown in the accompanying photos was recently described in *Radio News* Magazine by *Sylvan Harris* and incorporates several features which are highly desirable for reception on wave-lengths between 40 and 555 meters. The set is not difficult to construct, as there are no complicated switches involved in its makeup, the variation of wave-lengths being obtained by interchangeable coils. Mr. Harris' description of this set follows:

Multi-range receivers have been designed in the past, but it seems that most all of them have required a number of switches.

The problem is rather simple when there is only one tuned circuit to consider, but when we try to make a tuned radio frequency amplifier tune over several ranges it means that a great deal of convenience and beauty of design will be lost. This is because the coils used must be either tapped or replaceable. If they are to be tapped, this means a multitude of switches, for it is obvious that all the taps cannot be brought into one switch. It they were, there would be considerable coupling between the stages which would result in decreased amplification.

If the coils are to be replaceable, as they used to be in the days when so many experimenters used the honeycomb coils, there is the same inconvenience that applies to manipulating so many switches in the case of the tapped coils. The tendency nowadays is to make the operation of the sets as simple as possible, and certainly a half-dozen switches or coils do not by any means add to the simplicity of the set.

How the problem will finally be overcome in the commercial form of set is problematical. Of course, there is the possibility of using several switches behind the panel, all operated by a long shaft, or interlocked in some way by wires or toothed racks so as they can be operated simultaneously by a single knob or lever. This method, however, is a little complicated for the average person to build, but I believe that manufacturers of sets may have to adopt it.

There are many experimenters who are laboring under the impression that the wave range can be increased merely by lowering the minimum capacities of the tuning condensers. The wave range certainly can be lowered by doing this, but it can be lowered only a very little. If you don't believe me, try this yourself. Connect two variable condensers in series, and set both of their dials at zero. Having the two minimum capacities in series will give a minimum capacity somewhere near half what it was. It will be found that if the set operates at all satisfactorily, the wave range will be lowered only by a few meters.

The set described in this article is the usual radio frequency amplifier connected to a detector and two stages of audio frequency amplification. Regeneration is controlled by a potentiometer, as shown in the wiring diagram Fig. 1.

The three wave-length ranges are obtained by means of the replaceable coils, which are shown in the accompanying photographs. These coils are of the basket type, which anyone can wind very easily. The method of winding is shown in the accompanying sketch.

When finished, the coils are mounted in an ordinary tube base, which can be heated and removed from an old burnt-out electron tube. A bit of sealing wax suffices to hold the coil in place. Coils made in this fashion may be bought at the radio stores, if the reader

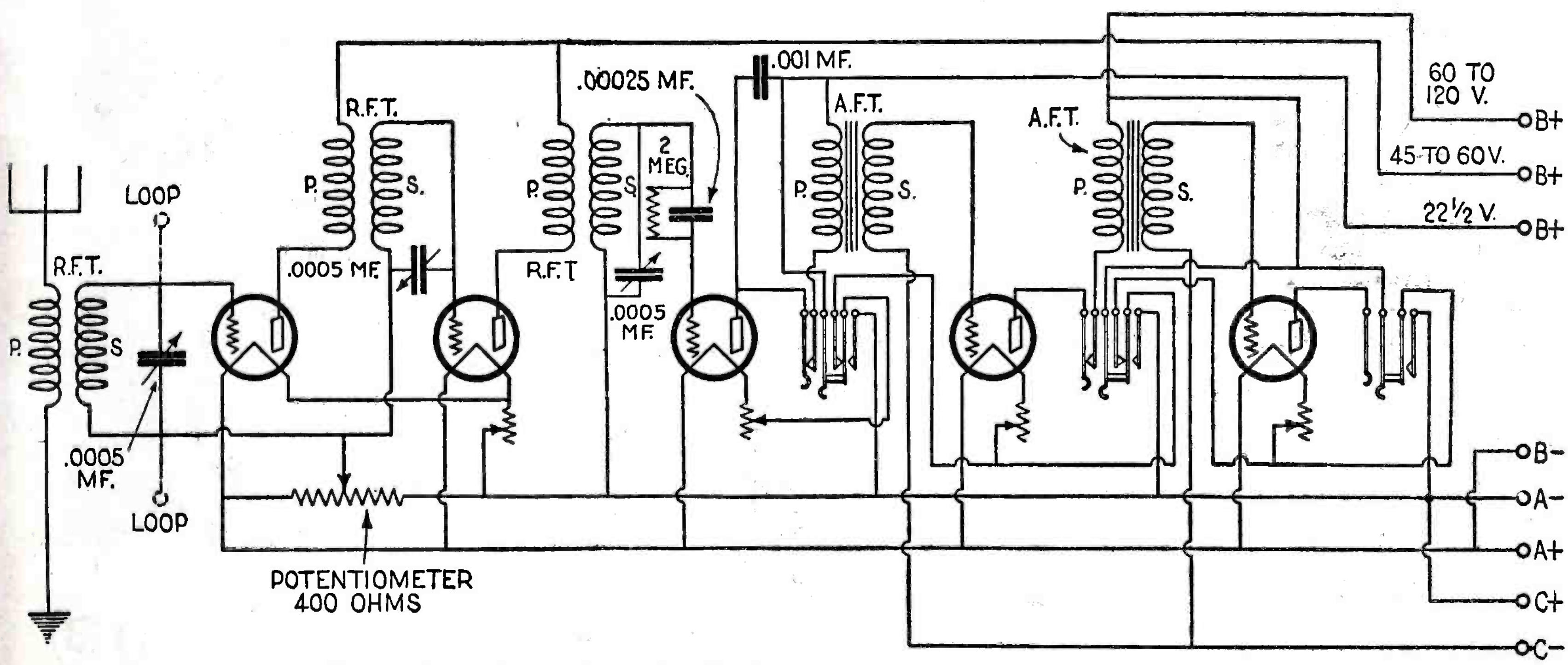
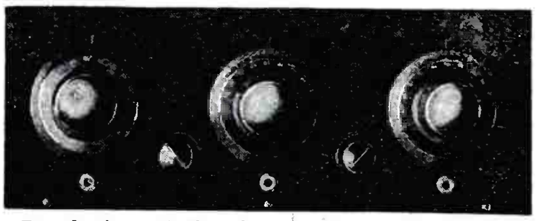


Fig. 1. Circuit diagram for receiver that has a wave-length range from 40 to 555 meters.

does not wish to take the trouble to "roll his own."

The dimensions of the coils are all the same, these dimensions being given



Panel view of the three-range receiver. The three larger dials are the tuning controls. The first knob at the left is the rheostat and the one at the right is the potentiometer.

below. They differ only in the number of turns employed. The primary and secondary coils are wound and tied together by the lacing string.

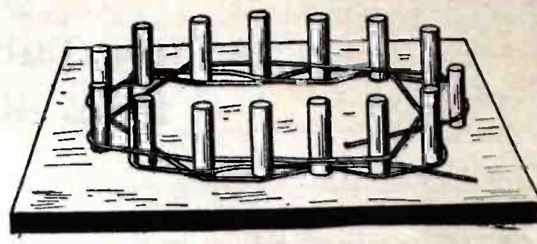
The method of winding inductance coils that is described below will be

The coils used have the following numbers of turns:

	Primary	Secondary
Coil No. 1	4	8
Coil No. 2	8	16
Coil No. 3	10	40

As a result of thus dividing the range into three parts, it will be a very easy matter to tune to the short-wave stations, where the ether congestion is very bad at the present time. Many stations will be tuned in which it was heretofore impossible to hear. It is advisable to use straight-line frequency condensers in this set, as well as in any other, for additional ease in separating the stations. The set is remarkably selective and sensitive, as all multi-stage tuned R.F. receivers should be. We take great pleasure in recommending this circuit to our readers as the second

directly behind the radio frequency amplifier, instead of on a line with it. This has the advantage of keeping the set within small space limits and, further-

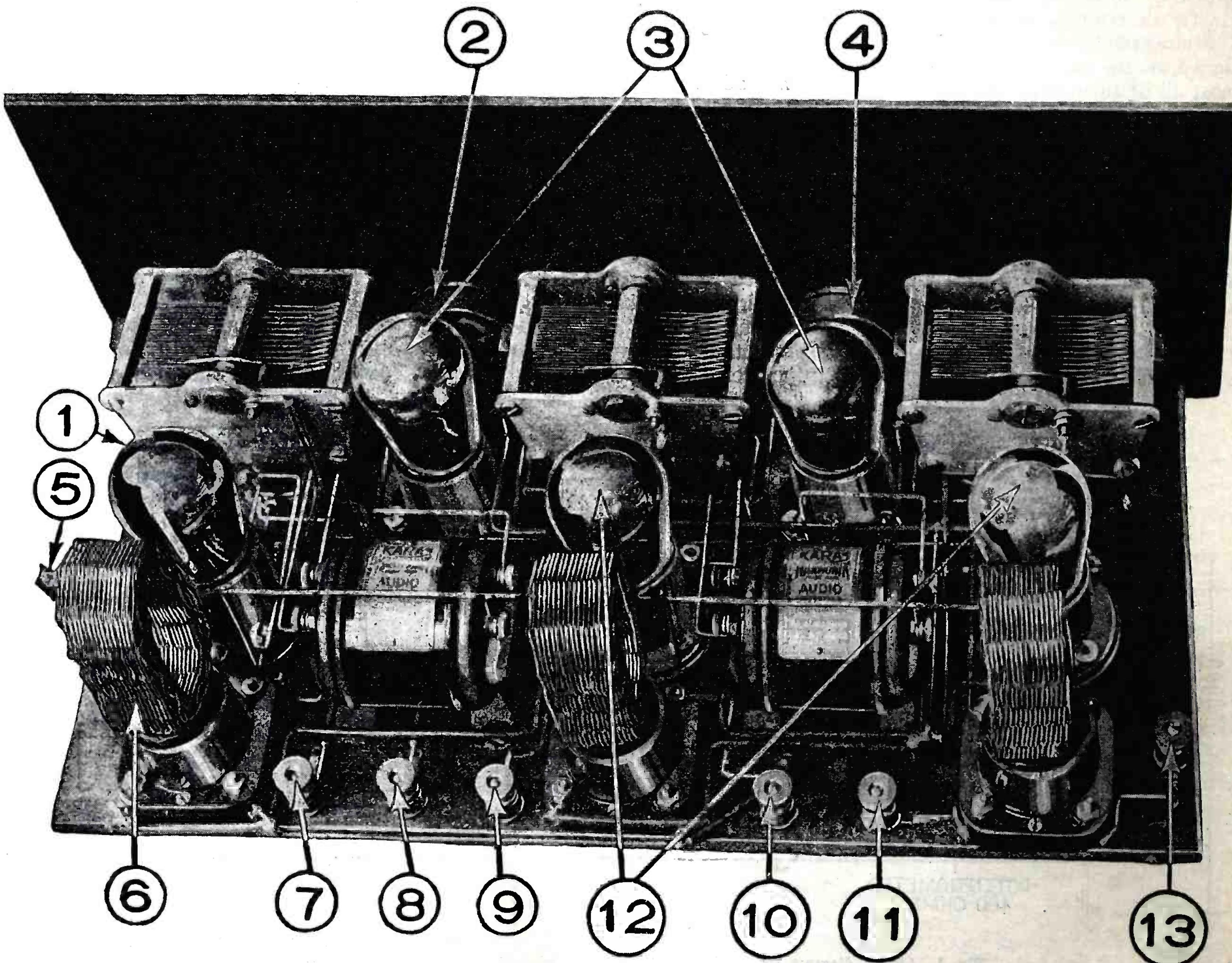


This figure illustrates the method of winding the rectangular coils which are shown in the photograph below. The pegs are not laid out in a circle as is usual, but follow a rectangular path, as suggested in the text.

more, utilizes a considerable amount of space of the baseboard which generally goes to waste.

Method of Winding Coils

The coils used in this receiver are



Rear view of the three-range receiver. 1 is the detector tube; 2, a potentiometer; 3, radio frequency amplifier tubes; 4, a rheostat; 5, the gridleak; 6, removable coil for different wave-lengths; 7, +45 volts; 8, +"A" and —"B"; 9, —"A"; 10, +90 volts; 11, antenna binding post; 12, audio frequency amplifier tubes; 13, the ground binding post.

found to be one of the easiest for the home set constructor.

The set, as described, will give a total wave range of 40 to 555 meters, and will be divided into the following ranges with a 0.0005 mfd. condenser:

Coil No. 1	40-180	meters
Coil No. 2	100-300	"
Coil No. 3	224-550	"

of the series of multi-range receivers. All those parts of the receiver which have not been described in detail in this article are the same as those in the usual tuned R.F. set, so that no one should have any difficulty in following the wiring diagram and building the set. To be a little different, the audio frequency amplifier has been mounted

more or less rectangular in shape. The reason for this is that in the set for which they were designed the apparatus was arranged as compactly as possible in order to have the leads connecting the different instruments at a minimum length; if the coils had been circular in shape they would have been too near

(*Continued on page* 53.)

An All-Wave Tuned Radio Frequency Set

How to Build a Receiver to Cover the Frequency Band from 1500 to 116 Kilocycles (200 to 2600 Meters)

OCCASIONALLY one hears of European stations being received on this side of the Atlantic, generally in winter, and usually with a special type of receiver. After some years of listening to statements of marvelous distances covered we have grown into a state of cynical disbelief. This attitude is bound to undergo a change soon, because many of the stations in England and various parts of the Continent are inaugurating high-power broadcasting which may readily be capable of reaching us under very ordinary conditions. Just now it seems that most of these stations operate on a wave-length far above our broadcast band. For example, Cheltenham, England, has opened up with about 25,000 watts (most English stations are of the 500-watt variety) and is working on a wave of 1600 meters. Naturally no standard broadcast receiver here will reach that high, but it is possible to design one to cover all waves within a wide band.

For the fans who are desirous of having a try at the "other side," *Zeh Bouck's* article which recently appeared in *Radio Broadcast*, New York, is given here. The description is very complete, and, as the author has pointed out, if it will not receive American stations in Belgium, and, conversely, European stations here, it will at least cover wavelengths that hold much of interest.

Unlike American stations, foreign broadcasters are not confined to the frequency band between 1500 and 520 kilocycles (200 to 575 meters). On the contrary, many foreign stations, particularly those of continental Europe, broadcast on frequencies below 500 kilocycles (above 600 meters), as well as upon the wavelengths with which our domestic amateurs are familiar. This elasticity of tuning somewhat complicates the situation of the foreign enthusiast, whose problems were recently brought home to the writer by the request of a Belgian friend for a receiver filling these particular requirements.

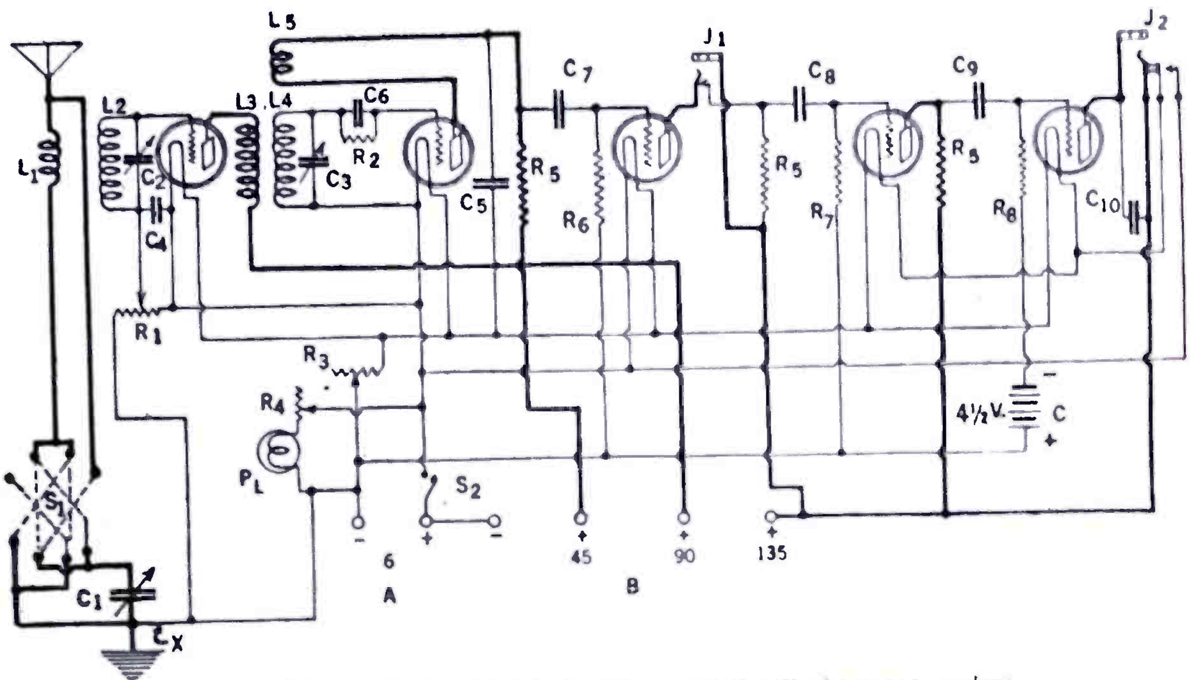
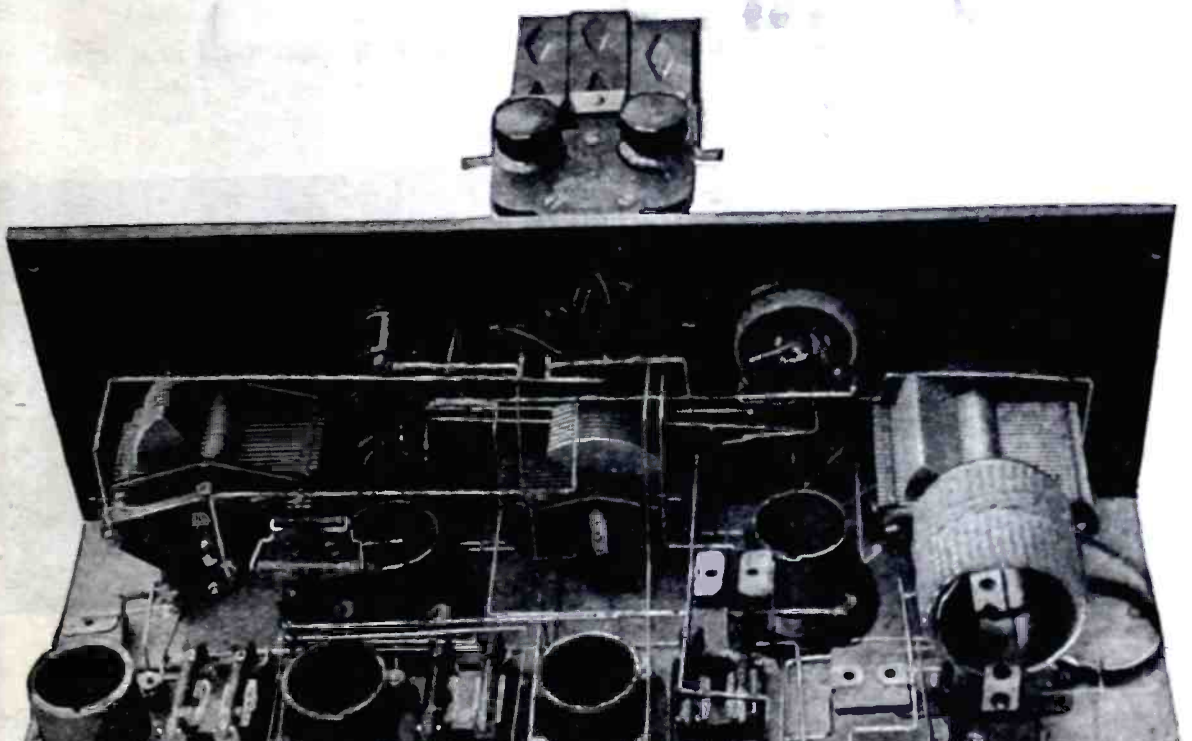


Fig. 1. The circuit diagram for the all-wave tuned radio frequency receiver.



Illustrations by Courtesy of Radio Broadcast (New York)

Fig. 2. Back panel view of the all-wave set showing construction of the resistance-coupled amplifier and the mounting of L1 and L2.

The set is to be operated at Turnhout, Belgium, some three hundred miles from SBR Brussels, the nearest broadcasting station, and about seventy-five miles from Antwerp. As the radio entertainment of my friend's family will be divided between England and the continent (and perhaps American stations), the receiver must respond with equal efficiency over a comparatively large frequency band — between 1500 and 116 kilocycles (200 to 2600 meters).

It is, of course, difficult to design an efficient receiver to cover this band employing one permanent set of inductances, i. e., using sufficiently large coils to attain the higher waves, and tapping for the lower waves. The losses and inefficiencies attending such extensive tapping would seriously impair the effectiveness of the receiver on the higher frequencies (lower waves).

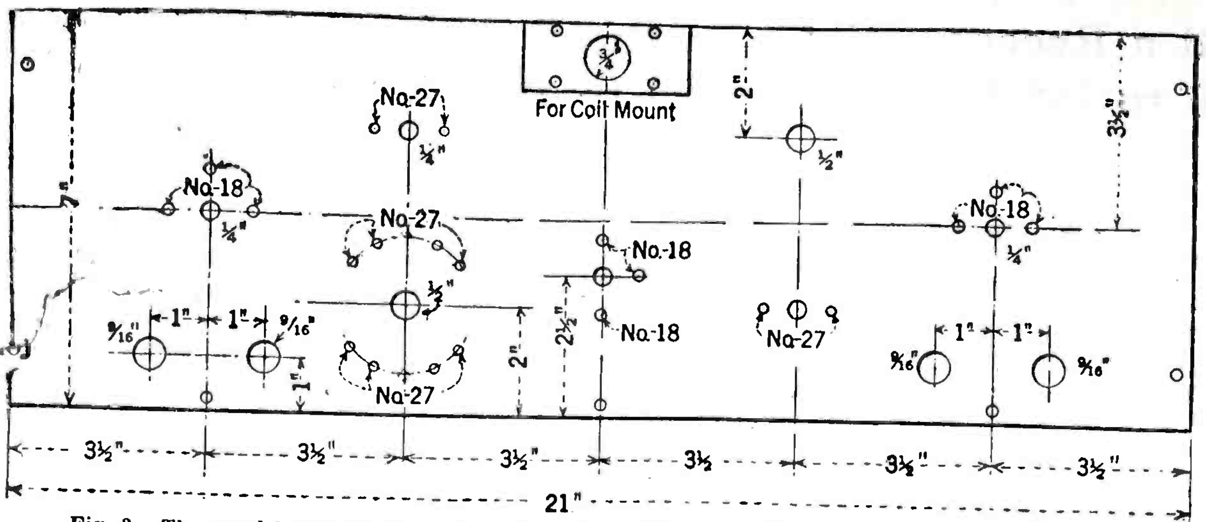


Fig. 3. The panel layout for the universal receiver. The numerals near the designated holes indicate the size drills to be used in drilling them.

Honeycomb coils suggest themselves in the usual three coil, primary, secondary, and tickler arrangement, as an obvious solution. Unfortunately, the wide separation of foreign stations implies the necessity of at least one stage of radio frequency and amplification if consistent reception of four-fifths of the stations is to be achieved. The efficiencies of the honeycomb coils in the conventional long wave circuits, however, are quite applicable to radio frequency amplification, and the ultimate receiver almost solves its own problems in the form of a "five honeycomb coil set."

With the growing stimulation of interest in international broadcasting and its reception, it is probable that many American enthusiasts will be interested in duplicating this receiver.

Honeycomb Inductances Are Used

The circuit is diagrammed in Fig. 1. The coils L are all honeycombs. L_1 is the antenna primary, and L_2 secondary inputting to the r.f. tube. L_3 functions as the primary of the radio-frequency transformer. L_4 is the r.f. secondary in the grid circuit of the detector tube, and L_5 is the tickler coil. It will be observed that the circuit is merely the conventional three-coil arrangement with the addition of a stage of tuned radio frequency amplification. In changing wave bands, the coils in each of the five mounts are replaced by different sizes. By selecting the proper values, any frequencies used to-day for transmission of radio telephony or telegraphy can be received.

Returning to the circuit, switch S_1 is the usual series-parallel switch which adds considerably to the tuning possibilities of the antenna tuning-condenser C_1. C_1 is preferably a forty-three plate variable condenser. C_2 and C_3 are secondary tuning variable condensers each having a capacity of .0005 mfd. C_4 is a .006 mfd. Micadon bypass condenser. C_3 is a .0025 mfd. bypass. C6 is the usual .00025 mfd. grid condenser. C7, C8, and C9 are the isolating-coupling condensers of the resistance-coupled amplifier, all being Micadons of .006 mfd. capacity. C10 is an output bypass condenser, capacity .006 mfd. which may or may not be necessary in individual receivers.

R_1 is a three hundred- to four hundred-ohm potentiometer which stabilizes the r.f. circuit. R_2 is the conventional 2-megohm grid leak across the grid condenser. R_3 is a General Radio ten-ohm rheostat. R_4 is a dismantled twenty-ohm rheostat placed in series with the small three-volt pilot lamp, PL. This lamp is located behind a colored glass jewel on the panel and is an effective and attractive signal that the tubes are burning. It is not, of course, essential to the operation of the receiver. R_5 throughout the resistance-coupled amplifier represents the coupling resistors of one hundred thousand ohms resistance. R6, R7, and R8 are amplifier grid leaks, having respective values of 1 megohm, ½ megohm, and ¼ megohm.

The coupling resistors, coupling condensers, and amplifying tube grid leaks are combined for efficient compactness into three Daven Resisto-Couplers. Daven resistors are used throughout the amplifier. The initials on the diagram represent the initialing on the couplers.

J_1 is a standard closed circuit jack, placed in the plate circuit of the first audio frequency tube. This is preferable to plugging-in on the detector. Jack J_2 is an open circuit jack with filament control. Switch S_2 turns on all filaments when the loud speaker plug is in the jack J_2, and the first three tubes with the plug is in jack J_1.

The 4.5-volt C battery while not altogether necessary, is desirable. Particular note should be taken of the amplifier grid leak connections.

Construction

The construction details of the all-wave receiver are clearly suggested in the panel layout, Fig. 3, and in the photographs of the completed receiver, Figs. 2, and 4.

Referring to the back of panel photograph, Fig. 2, the Cotocoil single honeycomb coil mountings are screwed to the baseboard near the right hand (rear view) end. Coils L_1 and L_2 are plugged into these receptacles. Partly hidden and to the right of the coils a resistance strip from a rheostat can be discerned, fastened to the baseboard. This is placed in series with the small three-volt pilot lamp as described in reference to the circuit diagram.

The pilot lamp itself is screwed into a small miniature socket from which the porcelain shell has been removed. It is placed beneath the antenna tuning condenser, and the glass jewel can be seen in the lower left of Fig. 4.

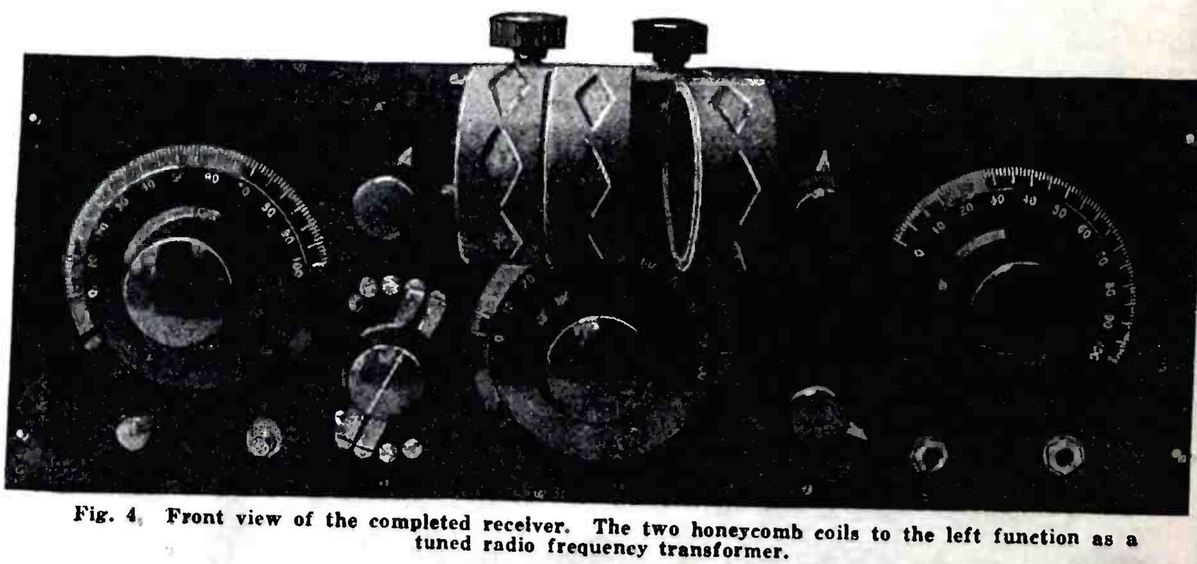


Fig. 4. Front view of the completed receiver. The two honeycomb coils to the left function as a tuned radio frequency transformer.

The large dial controls, in the panel photograph Fig. 4, are, left to right, tuning condensers, C_1, C_2, and C_3. The lower left is the series-parallel switch. The upper right hand knob is the midget vernier condenser across the tuning condenser C_3. Below the vernier is the potentiometer.

In wiring the receiver, particular care should be observed in making connections between the A battery and the various tubes, resistances, and switches, being careful to follow every sequence on the diagram.

Operation

Tuning and operation of the receiver is quite the same as that of the conventional three honeycomb coil arrangement with the slight added complication of an extra control.

The following is a table of coil sizes for the various domestic and foreign broadcasting wavelengths:

L_1	L_2	L_3	L_4	L_5
1500 TO 600 KILOCYCLES (200-500 METERS)				
35	50	35	50	75
665 TO 334 KC. (450 TO 900 METERS)				
100	100	50	100	120
483 TO 272 KC. (620 TO 1100 METERS)				
100	150	75	150	150
272 TO 115 KC. (1100 TO 2600 METERS)				
150	250	150	250	200

Unfortunately, the receiver I am describing was not in my hands sufficiently long to determine coil values for still higher waves. It is suggested that the experimenter guide himself by the sizes specified for the conventional three-coil long wave receiver.

There is also no reason why the all-wave receiver, efficiently constructed, should not be quite satisfactory on the extremely short waves—the region of megacycles. With Lorenz coils wound on a three-inch form, with fifteen spokes, the following sizes should cover from 40 to 70 meters. L_1 3 turns, L_2, 6 turns, L_3, 5 turns, L_4, 6 turns and L_5 11 turns. On these extremely high frequencies, it is recommended that capacity neutralization be substituted for bias stabilization, with the potentiometer. A three-turn neutralizing coil should be wound simultaneously with L_3, and connected as in the usual Roberts or Browning Drake arrangements. It is suggested that experimentation on wavelengths below two hundred meters be left to the more advanced and serious experimenter and amateur. The manipulation of the receiver on these frequencies requires more than ordinary skill, and even a comparatively non-radiating receiver, such as we have described is not innocuous under inexperienced operation.

LIST OF PARTS

The circuit diagram, Fig. 1, represents the following parts used in the construction of the receiver:

One three coil Branston Mounting
Two Cotocoil mounting brackets
5 Na-ald Sockets
2 .0005 mfd. variable condensers
1 .001 mfd. variable condenser
1 Midget vernier condenser (across C_3)
1 series parallel switch
1 Cutler-Hammer battery pull switch
1 General Radio ten-ohm rheostat
1 400-ohm General Radio potentiometer
1 .00025 mfd. Micadon
5 .006 mfd. Micadons
1 .0025 mfd. Micadon
4 Daven grid leak resistors, 2 meg., 1 meg., ½ meg. and ¼ meg.
3 Daven 100,000-ohm coupling resistors
1 7-inch x 21-inch bakelite panel
3 Daven Resisto-Couplers
8 Eby binding posts
1 Pacent closed circuit jack
1 Pacent open circuit, filament control jack

These parts represent an approximate cost of thirty-five dollars. To this price must be added the expense of whatever honeycomb coils are selected for reception of various frequencies.

In operating the all-wave receiver, the potentiometer should always be kept sufficiently far on the positive side to stabilize the r.f. tube.

Selectivity will be increased as coupling is loosened between L_3 and L_4, as is usual with honeycomb receivers. Loosening this coupling will also increase the effectiveness of the r.f. controls. If situated within a mile or so of a high powered station, interfering oscillations may force themselves across the radio-frequency circuits. Breaking the connection close to the ground lead at X, Fig. 1 will eliminate such by-pass interference.

High-Mu Tubes in the Last Audio Stage

It is recommended that five-volt vacuum tubes be used throughout the receiver. They will give excellent loud speaker results on distant stations with a good antenna. However, if high-mu tubes (there are several makes on the market) are available, they can be employed most effectively in the first and second stages of the resistance-coupled amplifier. A power tube (never a high-mu tube) in the output socket will increase the possible volume without distortion. If the output is taken from jack J_1, a standard tube should be used in the first resistance-coupled stage.

The tuning characteristics of the all-wave receiver are most satisfactory, providing selectivity and distance, while the resistance-coupled amplifier insures quality beyond reproach.

The following is a list of long wave broadcasting stations:

Foreign Broadcasting Stations

AUSTRALIA:
2FC, 272 kc. (1100 meters)
2FL, 389 kc. (770 meters)
3LO, 174 kc. (1720 meters)
5MA, 352 kc. (850 meters)
AUSTRIA:
RH, 500 kc. (600 meters)
BELGIUM:
BAV, 272 kc. (1100 meters)
CZECHO-SLOVAKIA:
OKP, 260 kc. (1150 meters)
Komarov 167 kc. (1800 meters)
Prague, PRG, 300 kc. (1000 meters)
DENMARK:
OXE, 130 kc. (2400 meters)
FRANCE:
FL, 115 kc. (2600 meters)
GERMANY:
LP, 440 kc. (680 meters)
HOLLAND:
PCGG, 280 kc. (1070 meters)
PA5, 286 kc. (1050 meters)
PCFF, 150 kc. (2000 meters)
HUNGARY, BUDA PESTH:
150 kc. (2000 meters)
SPAIN:
EBX, 250 kc. (1200 meters)
SWITZERLAND:
HBI, 272 kc. (1100 meters)

A Three-Range Receiver

(Continued from page 50)

the interfering magnetic fields of the transformers.

The coils are 3 inches in length and are 1½ inches wide. They are wound with No. 22 D.S.C. wire. The winding form that is used for the construction of these coils is laid out as shown in the accompanying sketch, but with dimensions that are the length and width of the coil. The pegs on which the wire for the coils is wound are spaced approximately one-half inch apart. There are fifteen of these pegs, which should be ⅛ inch in diameter and smooth enough for the wire to be easily slipped off after the coils have been wound.

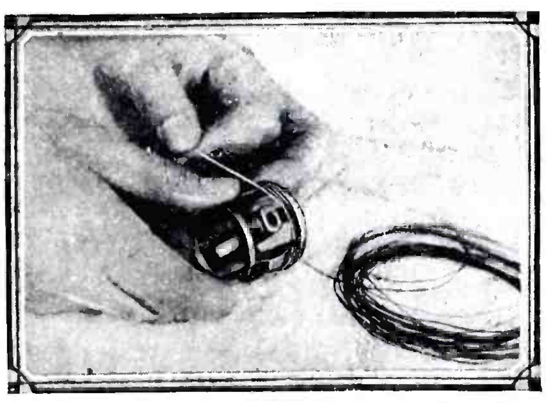
The primary and the secondary of these radio frequency transformers are wound on the same form and should have the number of turns noted in the table above. After the primary and the secondary are wound, they are then bound together with thin, strong string, so that the coil will retain in shape. The completed coil is then placed in the top of an empty tube socket and the leads soldered to the prongs of the tube socket. The coil is fastened in place with sealing wax, which may be obtained from an old discarded "B" battery.

Converting a Tuner to Short Waves

Tune In Below 150 Meters for New Thrills

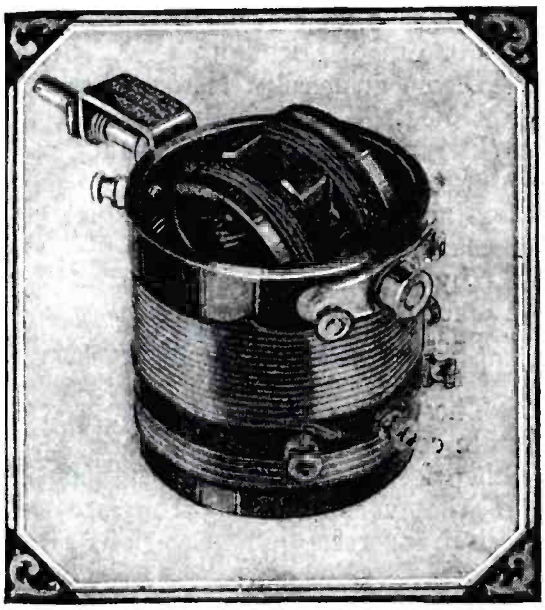
IN the following article from *Science and Invention* magazine, New York, *Herbert E. Hayden* gives some very valuable data for rewinding a tuner in order to cover the short wave bands which are now being widely adopted by broadcast stations throughout the country. Mr. Hayden writes as follows:

Since several short-wave radio broadcast stations have been put into operation, the interest in these short waves has become great. KDKA broadcasting on 62 meters seems to be getting out over the country in an exceptional manner and many other stations experimenting with waves in this neighborhood have reported similar results. Not only are there many broadcasting stations on the short waves, but there are also thousands of code stations. The amateur bands centering around 40 and 80 meters hold a world of interest to anyone who can copy code and this knowledge can be picked up very easily with a little practice. We give herewith a list of the most important stations, both phone and code, which are operating on the short waves.



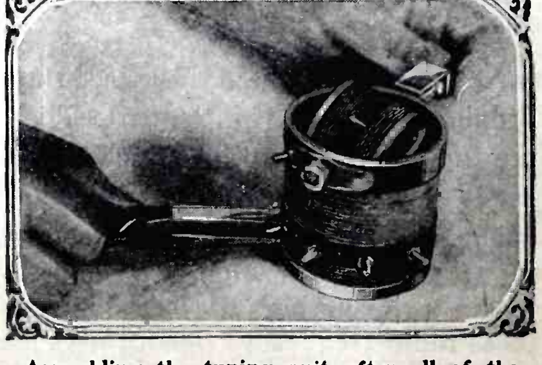
The tickler coil is rewound, using the wire that was removed from the original secondary. Twelve turns are to be used.

Wave	Call	Location
20.0	POX	Nauen, Germany
25.0	2YT	Poldhu, England
25.0	AGF	Nauen, Germany
26.0	AGA	Nauen, Germany
30.0	2XI	Schenectady
32.0	2YT	Poldhu, England
35.0	2XI	Schenectady
36.0	LPZ	Buenos Aires
38.0	2XI	Schenectady
40.0	1XAO	Belfast, Ireland
43.0	WIX	New Brunswick
47.0	POZ	Nauen, Germany
50.0	NKF	Anacostia, D. C.
56.0	KFKX	Hastings, Neb.
59.8	KDKA	Pittsburgh, Pa.
60.0	1XAO	Belfast, Ireland
60.0	2YT	Poldhu, England
62.0	KDKA	Pittsburgh, Pa.
67.0	8XS	Pittsburgh, Pa.
70.0	POX	Nauen, Germany
71.5	NKF	Anacostia, D. C.
74.0	WIR	New Brunswick
75.0	SFR	Paris, France
75.0	WQM	Rocky Point, L. I.
76.0	POX	Nauen, Germany
83.0	RDW	Moscow, Russia
84.0	NKF	Anacostia, D. C.
85.0	SFR	Paris France
85.0	8GB	Kahuku, T. H.
86.0	NQC	Belfast, Ireland
90.0	6XO	Poldhu, England
90.0	1XAO	Paris, France
92.0	2YT	San Diego, Cal.
94.0	2YT	Poldhu, England
95.0	SFR	Paris, France
96.0	8XS	Pittsburgh, Pa.
99.0	6XI	Bolinas, Cal.
100.0	POX	Nauen, Germany
100.0	2XI	Schenectady
100.0	NAM	Norfolk, Va.
103.0	WGH	Tuckerton, N. J.
107.0	2XI	Schenectady
112.0	1XAO	Belfast, Ireland
115.0	FL	Paris, France
120.0	1XAO	Belfast, Ireland
146.0	6XO	Kahuku, T. H.



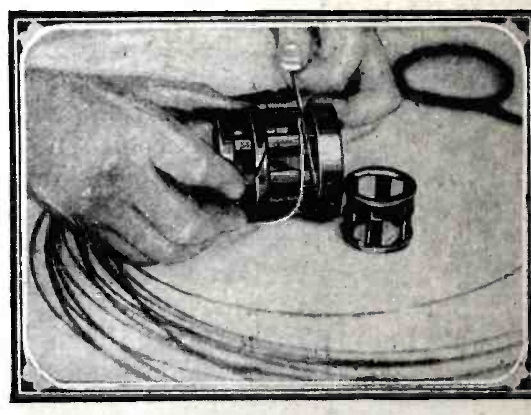
Illustrations by Courtesy of Science & Invention (New York)

A completed short-wave coil, ready to be incorporated in a receiving set.



Assembling the tuning unit after all of the sections have been rewound according to the data furnished in the text.

The average broadcast set employing a three-circuit tuner can be changed to a short-wave receiving set very easily and the photographs detail all of the necessary operations. The circuit for hooking up a three-circuit receiver for the shorter waves remains exactly the same; the only change necessary is in the winding of the coils. For instance, if the type tuner is used as shown in the photos, the first step necessary is to remove all of the metal fittings from the frame of the stator and tickler coil. Then remove all the wire from all three of the coils. Secure about 25 feet of braided copper wire, or if this is not available the same quantity of No. 16



Winding the bare copper wire and the heavy cord side by side on the secondary section of the stator form.

bare copper wire may be employed. Fasten one end of whichever wire you get to the coil form and wind the wire on the form, spacing each turn with a piece of cord about the same size as the wire. This can be done by winding the cord and the wire side by side on the form. The result will be as pictured. Wind both the primary and secondary in this way, placing four turns on the former and twelve turns on the latter.

(*Continued on page* 56.)

A Novel Three-Tube Reflex

An Excellent Circuit for Obtaining Five-Tube Distance and Volume from Three Tubes

HERE is an article by *H. E. Wright,* which recently appeared in *Radio World,* New York, giving full details for the construction of a three tube reflex receiver capable of doing five-tube duty as to volume and distance. No comment is necessary, as the proof of the efficiency is in the reception, and we have had the privilege of seeing the really remarkable results accomplished with this arrangement. Mr. Wright's article is as follows:

The usual type of 3-tube reflex circuit consists of one stage of straight radio-frequency, one stage of radio and one of audio-frequency reflexed, crystal detector, and one stage of straight audio-frequency. In some instances however, two of the tubes, and sometimes even three are reflexed, but this procedure makes the circuit very difficult to construct and, as a rule, it does not give the amplification which might be expected.

The circuit given herewith is somewhat different but it is undoubtedly a most efficient 3-tube set, both as regards volume and the ability to get DX.

The oscillatory high-frequency current from the antenna passes first through the first tube where it is amplified at radio frequency, then through the second tube, where it is further amplified at radio-frequency. After being rectified by the crystal detector, the signal, which is now of an audible frequency, passes back into the first tube where it is amplified at audio-frequency. There also seems to be a slight amount of regeneration present in this tube which accounts for the distances from which this set will receive. The second tube, being reflexed, then acts as an audio-amplifier, while the last tube is a stage of straight audio-frequency.

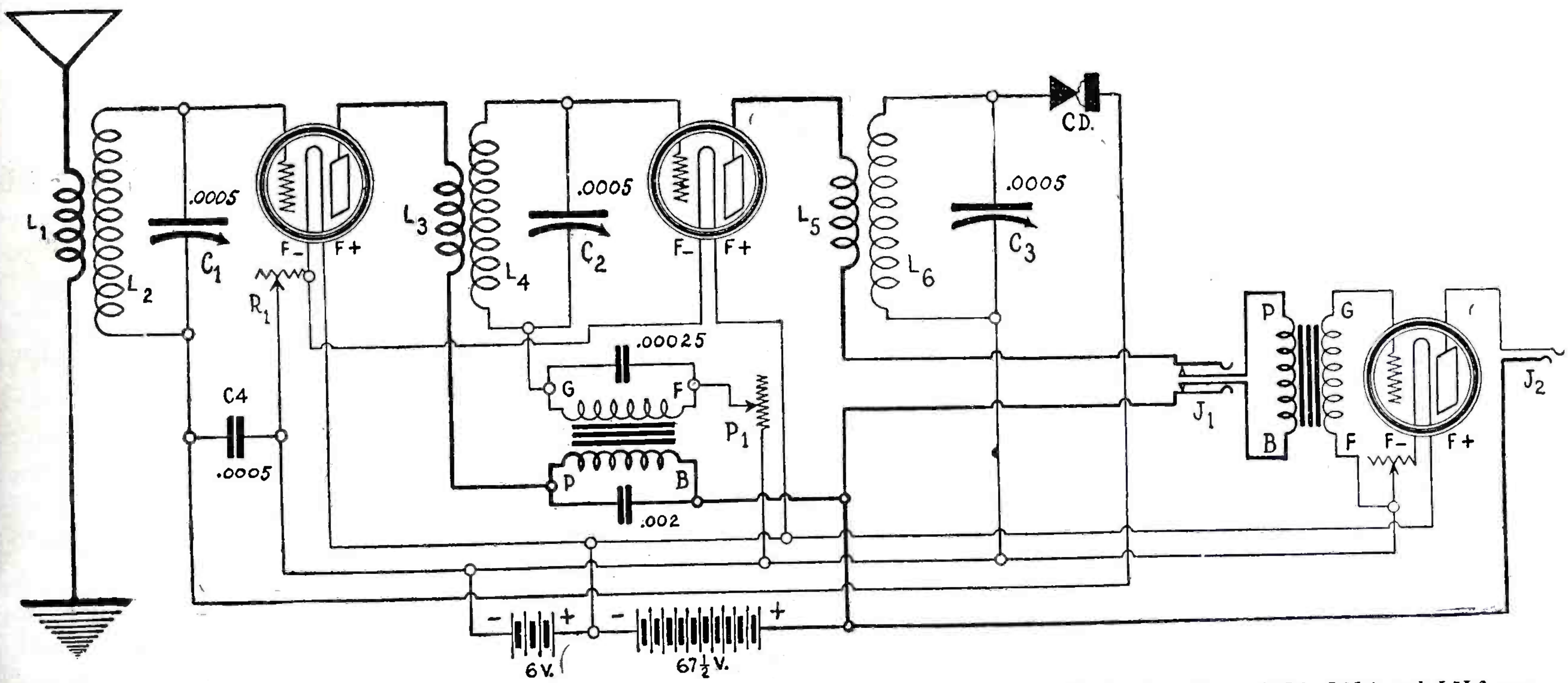
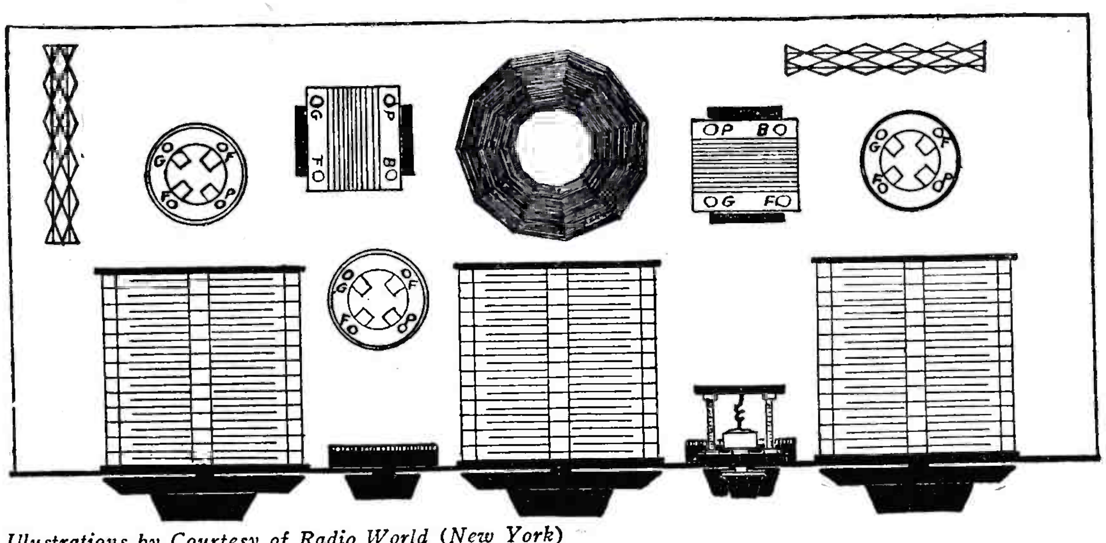


Fig. 1. Great volume and 1,200 miles on speaker were the results obtained by H. E. Wright from this 3-tube reflex. L1L2. L3L4 and L5L6 are radio-frequency transformers. The variable condensers are .0005 mfd. normally 23 plates. Two stages of RF. crystal detector and three audio stages are used. The first audio stage uses no step-up transformer, this being replaced by C4. The second tube is reflexed for the second audio stage. The third tube is a free audio stage. P1 is a potentiometer; spider-web coils are used.



Illustrations by Courtesy of Radio World (New York)

Fig. 2. The assembly plan of the novel 3-Tube Reflex Set.

More Volume From Large Tubes

As there is no step-up transformer included in the grid circuit of the first tube, the audio-frequency amplification obtained from this tube depends solely on the amplification factor of the tube used. The large tubes give proportionally greater volume than the smaller ones. However, if dry cells are to be used, very excellent results are obtained by the use of the U. V. 199 type. I used these tubes in the experimental set.

I used the De Forest crystal.

The potentiometer P1 has a resistance of 400 ohms and is used to prevent oscillation of the second tube when very strong signals are being tuned in. This method of stabilization does not distort nor does it materially reduce the volume, as would be the case if the grid potential was changed.

How to Wind the Coils

All the coils are wound on spider-web forms having an inside diameter of 2". L1L2, L3L4, L5L6 are radio-frequency transformers of two coils each, placed side by side with the windings running in the same direction. The secondaries L2, L4, L6 each have fifty turns of 24 DCC. The primaries are wound with number 24 DSC, L1 having 12 turns, L3 18 turns, and L5 32 turns. Do not use double cotton covered wire for the primaries as they would then be of a larger size, and the additional capacitative coupling between the two coils would probably be sufficient to cause oscillation of either or both of the first two tubes. No. 22 wire will do nicely.

Wiring Directions

1. Connect one F post on each of the three sockets together and continue the wire to the A plus. Connect the movable arms of both rheostats together then continue the wire to the A minus. Connect the other two F posts on the first two sockets together and continue the wire to the other terminal of the rheostat R1. Run a wire from the other terminal of R2 to the remaining F post on the third socket. The filament circuits are now complete.

2. The antenna post is connected to the beginning of the L1 winding. The end goes to the ground.

3. The beginning of L2 goes to one terminal of the condenser C1 then to one side of the fixed condenser C4, then to the cup side of the crystal detector. The other side of C4 goes to the A minus. The end of L2 goes to the other terminal of C1, then to the G post of the first socket. The beginning of L4 connects to one terminal of the second condenser C2, then to the G post of the first audio-transformer. The F post of this transformer goes to the A minus. A .00025 fixed condenser is connected across the G and A posts. The end of L4 goes to the other terminal of C2, then to the G post of the second socket. The beginning of coil L6 goes to one side of condenser C3, then to the A minus. The end of L6 goes to the other terminal of C3 and is continued to the catwhisker side of the crystal detector. The G post of the third socket goes to the G of the second audio transformer. The F post of the transformer goes to the movable arm of the potentiometer. One of the other terminals of the potentiometer goes to the A minus.

4. The P post of the first socket goes to the beginning of the coil L3. The end of the L3 goes to the P post of the first audio-transformer. The B post of this transformer goes to the B plus. Connect a .002 fixed condenser across the P and B posts. The P post of the second socket goes to the beginning of the coil L5. The end of this coil goes to the outside spring of the first jack. The inside spring adjacent to this spring goes to the P post of the second audio-transformer. The other inside spring goes to the B post of this transformer. The other outside spring of this jack is connected to one of the springs of the second jack and the wire is continued to the B plus. The other spring of the second jack goes to the P post of the third socket.

5. Connect the A plus with the B minus.

How to Tune the Set

The tuning of this set is comparatively simple, being somewhat similar to that of the Neutrodyne. The first two controls tune rather sharply, the third being slightly broader. You may be able to hear signals even though the set is incorrectly tuned, but all three circuits must be tuned to absolute resonance if maximum volume is to be obtained. It may take you a week to learn to tune the set properly. Then all you have to do is turn the dials and "listen to them roll in." The quality of reproduction is exceedingly good, due to the use of a crystal detector.

Stations within an 800 mile radius come in quite well on the loudspeaker using only the first two tubes. Station KFKX, a distance of 1,200 miles, has been brought in several times on the speaker using only the first two tubes. When you consider that only one audio transformer was being used in conjunction with tubes of the UV199 type, you will admit that this was rather remarkable. The volume obtained by the use of all three tubes was very great.

It is not recommended that the novice attempt to construct this set, although the fan who has had some slight experience in building circuits should have no trouble.

Trouble Shooting

If, after turning on the tubes, a loud hum is heard it indicates that the crystal detector is out of adjustment. If a continuous high pitched whistle is heard, try reversing the primary connections to the first audio transformer. If a loud whistle is heard when tuning in stations, either of the first two tubes may be oscillating. Turn the potentiometer arm until the entire resistance is included in the circuit. If, when the potentiometer is turned, the pitch of the whistle does not change, it is the first tube which is oscillating. This may be eliminated by removing three or four turns from L3. If the pitch does change it is the second tube which is oscillating. This may sometimes be eliminated by changing the adjustment of the crystal detector. If this is ineffective several turns must be removed from L5. Of course the set may be stabilized by connecting the free end of the potentiometer to the positive A post, thus giving a slight positive bias to the grid of the second tube, but if this is done the volume will be reduced. If the volume on out-of-town stations is poor you probably have a defective crystal.

Converting a Tuner to Short Waves

(*Continued from page* 54.)

For rewinding the tickler coil, use the wire that was removed from the secondary and wind 12 turns of it on the rotor form. Now put all the parts together again, fasten the wires to their respective binding posts and you will have a coil of the type shown in the photograph.

The writer found that a coupler built after the specifications given above would tune from 35 to 150 meters with a .0005 mf. variable condenser shunted across the secondary. Oscillation and regeneration control are very smooth. After rewiring this coupler into your set you will be able to listen in on many stations that you never heard before and the writer is sure that you will be well pleased with the results obtained.

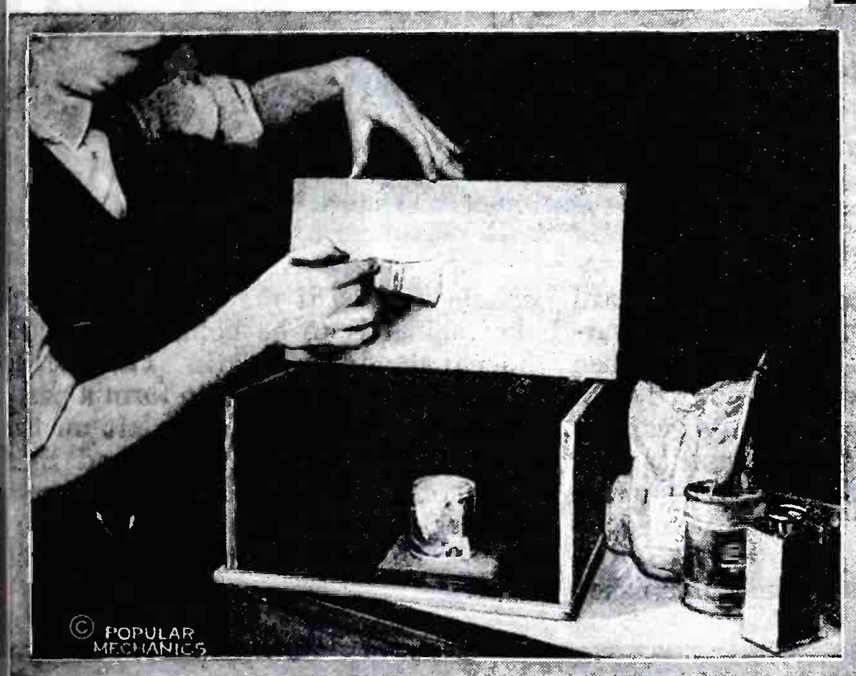
If you desire to receive from even shorter wave stations than those which this coil will reach, take a tap off the secondary. Two taps may be necessary in order to get good flexibility. However, this can be quickly determined by experimenting and no set rules need be given here.

Decorating the Radio Cabinet

How to Refinish Your Radio Cabinet in Artistic Decorative Design

READY-MADE cabinets are generally finished in dark-brown colors to harmonize with the usual type of living-room furniture. For variety's sake an ornamental design in attractive antique, in Chinese lacquer, or in "tiffany" will be found to give a pleasing effect. *C. M. Owens* describes how to do this in *Popular Mechanics* Magazine as follows:

Recently I was given the job of refinishing a cheap-looking mahogany-stained cabinet, which the owner wished to improve. I suggested an antique finish in ivory and proceeded to do the work in the following way: The entire surface was first sanded down with No. 0 sandpaper and then dusted off well. Two thin coats of white shellac were applied to prevent the mahogany stain from "bleeding" (showing through the finish paint). Sometimes two coats of shellac will not prevent this trouble, so it is advisable to apply an extra coat or two, especially over the edges and corners, where bleeding is most apt to occur; each coat must be thoroughly dry before the next is applied. When the last coat of shellac is dry, it is sanded down with No. 0 sandpaper. It should be kept in mind that the smoother the surface, the better the final finish will be; the shellac should fill every crevice and scratch, and all dirt particles that stick to the surface must be removed by sanding. Two coats of flat white paint, colored a little with raw sienna, are then applied. This paint must be thin enough to permit it to be applied evenly, but not so thin that it runs. If, after the first coat of flat white, the mahogany stain bleeds through, apply another coat of shellac to prevent the stain from bleeding through subsequent coats.



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

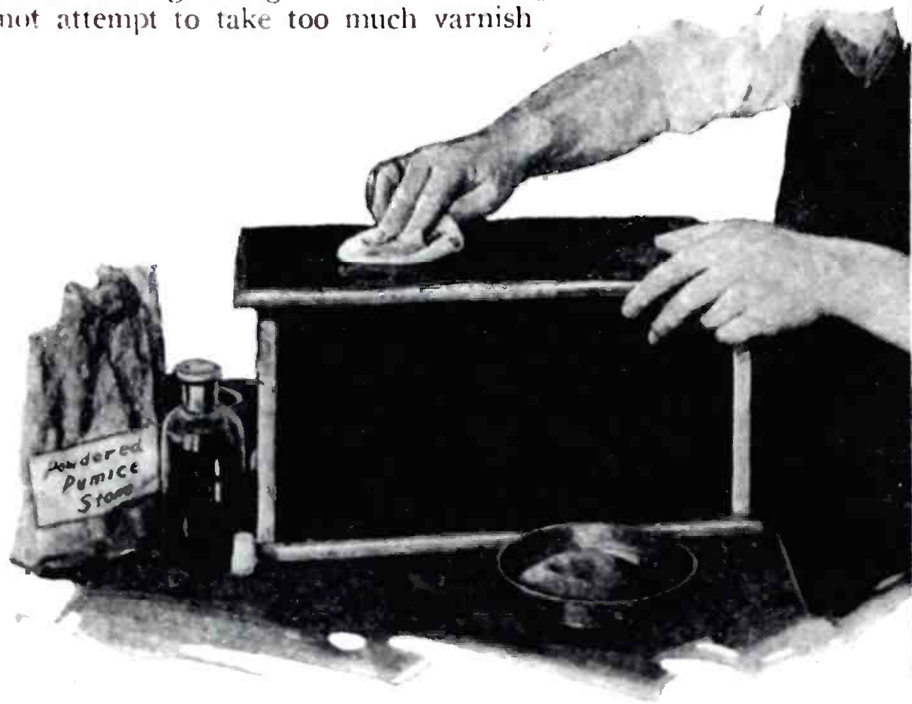
Left, applying flat white paint; above, stippling on a design through a stencil; below, pouncing with a cloth ball to give mottled effect.

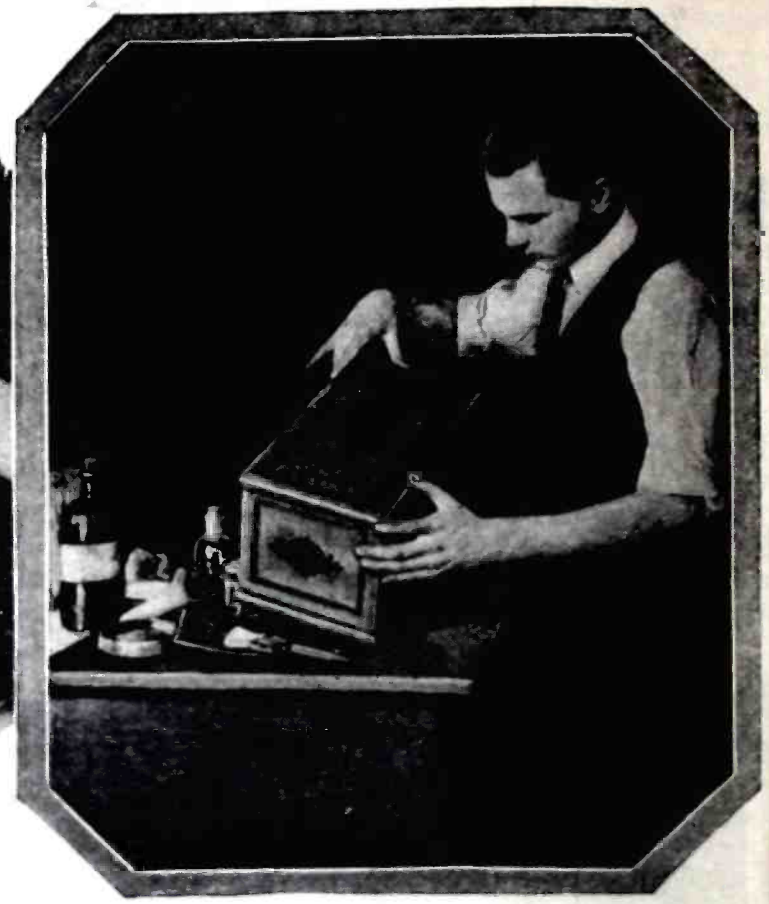
After the second coat of flat white has dried, the stencil work is done. Stencils of all kinds can be purchased at large paint stores; usually a catalogue containing the various designs will be sent free to anybody requesting one. Colors ground in oil are used for stenciling, a few drops of Japan drier being added to assure quick drying. The stenciling job in this case consisted in putting a simple black border on the top and sides of the box and a center design to match. A light pencil mark was drawn along the edge to help in laying the stencil on straight. The stencil is held securely with two fingers while the color is stippled into the perforations with a brush (an old shaving brush will serve the purpose well). The stencil paint must be heavy so that it will not flow under the stencil, causing blotches and runs. Only a little of the paint is used on the brush — just enough to cover the white paint distinctly. Care must be taken to hold the stencil firmly so that it will not slip, smearing the work. If this happens, remove the smear with a clean rag, saturated with turpentine, and then wipe dry.

The mottled or antique effect is produced by pouncing the surface with a cloth ball or dry brush after a darker color has been applied, which in this case may be burnt umber or raw sienna, thinned with turpentine. This is applied evenly all over the surface, and while still wet the cloth ball is pounced over it to give the desired effect. The color should be left heaviest around the corners and center.

Varnish is next applied, after the surface has dried thoroughly. A good grade of clear varnish should be used—not a damar varnish. The work should be done in a clean room where there is little or no chance of dust and dirt getting on the varnish while it dries. Usually amateurs experience trouble in not being able to keep the surface clean. Varnish runs and dries best when the temperature is about 80 to 85°. A good 2-in. brush is a handy size for applying varnish on a radio cabinet. Care must be taken to give a good even coat; do not attempt to take too much varnish on the brush, smearing it on one place with the idea to brush it out evenly. This can be done with paint, but varnish is very tacky, which makes it hard to spread. Only a little varnish should be taken on the brush and this applied with quick, light strokes. If any hairs come out of the brush onto the surface they should be picked out at once with a pin or sharp knife blade, or they will disfigure the whole job. After the first coat of varnish is thoroughly dry, rub it down with powdered pumice stone and rubbing oil. This can be done with a piece of felt cut from an old hat. Care must be taken not to rub too hard over the corners and edges or the varnish will be cut. The dust is then cleaned off with a rag saturated with turpentine, and a second coat of varnish applied, proceeding in the same way as before. After this is dry, the surface is cleaned off and polished with good furniture polish.

If the cabinet is entirely unfinished at the start, paste wood filler is applied to fill up the pits. This is always necessary in case of mahogany, walnut and oak. The filler can be obtained in different colors. Of course, a light color should be used if the finished color of the cabinet is to be light, and a dark filler if the finish is dark. The filler is thinned with turpentine to form a paste and is brushed on thickly, left on the surface for a few minutes and then wiped off. After 24 hours the first coat of shellac is applied. The stain must always be used before applying the filler.

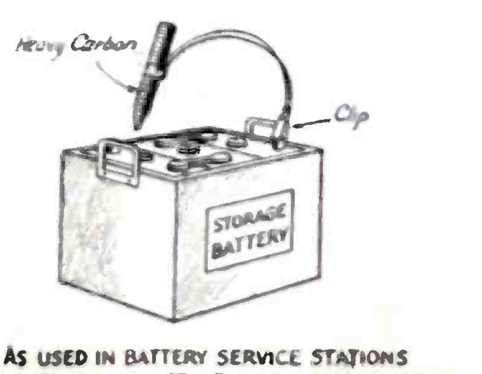




Left, rubbing down first coat of varnish with powdered pumice stone and rubbing oil; right, radio cabinet finished in antique after it was completed.

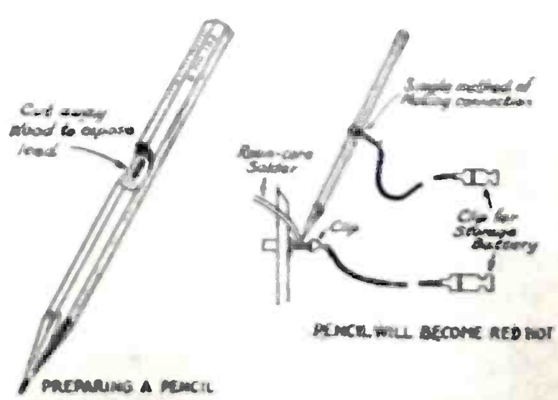
A Soldering Hint

That there are more ways than one to kill a cat, has long been an axiom; herewith we help verify the fact. An ordinary pencil, properly doctored, plus a storage battery, will do excellent soldering.



AS USED IN BATTERY SERVICE STATIONS TO BURN ON LUGS, ETC., FOR A NUMBER OF YEARS

The sketch shows the method of connection and use. The battery current is passed through the pencil lead heating it red-hot, which, in turn, heats the joint to be soldered and melts the solder. This, like the use of the soldering iron, requires a certain knack for success that is only acquired through trial; so don't be disappointed with a few failures. Self-fluxing resin core solder should be used.



PREPARING A PENCIL FOR SOLDERING

These things you should know: Make the distance the current has to travel through the pencil lead rather short so that sufficient current will pass to heat the lead; otherwise the lead's resistance will be too high. To avoid such an occurrence, make your connection close to the point—about an inch away. Use only soft lead pencils, No. 2, HB, etc., as the hard leads heat up and burst with a sharp crack. The better the grade of pencil, the better it works. In using the metal magazine pencils, be certain to use a sufficient length of pencil lead to avoid overheating. Also, generally, the metal pencil body will heat somewhat.

Don't worry about the load on your storage battery as it is not heavy. It may run as high as ten amperes but generally stays in the vicinity of two to five amperes. (*QST, Hartford, Conn.*)

INTERNATIONAL RADIO DIGEST

by A. P. Peck and Leon L. Adelman

Popular Wireless and Wireless Review

England, August 8, 1925.—Some novel and very interesting stunts for the radio fan are described in detail in the article entitled "Practical Radio Experiments." Here the reader finds out how to eliminate the lead-in, how to make a set stop working by telling it to do just that and numerous other valuable as well as amusing things.

* * *

A comparison between the effects of regeneration and the results produced by the use of radio frequency amplification will be found under the head of "H.F. Versus Reaction Amplification." The discussion is not at all technical, with the exception of one or two simple formulas and the points brought forth in favor of each method of boosting signal strength are very interesting.

* * *

"Some Crystal Fallacies" reveals many interesting facts about crystals. Experiments with them and their care are discussed, and some kinks in their use are given. Some different types of crystals are compared and the reader will find himself in possession of much information regarding crystals in general after perusing this article.

Probably all of our readers are not familiar with the fact that the English radio bugs are very much addicted to the use of crystal detectors. This is true and any Americans who think that detectors of this nature are worth working with (and they are) will find various English publications well worth reading.

* * *

Simple sets always find favor with a great majority of fans. Some very good single tube sets that will give excellent results and which open a field for experimental work are described and illustrated under the head of "Experiments With An Ultra-Audion Unidyne Circuit." All of those inclined to delight in trying out unusual circuits will be interested in the facts and illustrations contained in this article.

* * *

Some rather heavy technical dope is given in the article entitled "H. F. Intervalve Coupling." ("R.F. Amplification Coupling," in other words—*Ed.*) However, for those that are interested in the theoretical side of radio, this article is very worth while. It gives some dope that would otherwise not be found except after long search and serves as a basis for interesting experimental work.

* * *

August 15, 1925.—Some people are of the opinion that crystal detectors cannot be used with inside aerials. If, however, a sufficiently large aerial is used, it can be connected to a crystal detector receiving set with quite good results. There are four conditions that must be met in this work and they are clearly outlined in the article entitled, "Fundamentals of Crystal Reception With Indoor Aerials."

* * *

"Wireless by Light Rays" is the title of an article that discusses signalling over beams of light. Because directed radio signals can be sent and received in this way, the system is very interesting. Those who are inclined toward the study of various wireless system will find much to interest them in this short article.

* * *

A discussion of reflexing and combining tubes in Super-Heterodyne receivers so that the initial expense and upkeep cost can be reduced as low as possible is the subject of a treatise entitled, "Reducing Valves in the Supersonic Heterodyne Receiver." The reflecting of circuits in this most efficient of all sets as well as combining the oscillator and first rectifier tube is discussed. Many circuits are given that will interest every Super-Heterodyne fan as well as a good many of those who heretofore have steered clear of this multi-tube set because of its cost.

* * *

The Wireless Constructor

England, August, 1925.—As indicated by the title of this interesting publication, the articles contained in it are dedicated particularly to the person who likes to build his own radio set. Every item in the issue is of absorbing interest because of the way they are presented and because of the amount of information contained in them.

In England, in particular, double reaction, or in American terms, double regeneration, is a very popular method of obtaining increased volume and efficiency from a minimum number of tubes. A most complete article is presented on this subject entitled, "A Two Valve Double-Reaction Receiver." Translated into American, this title means, "A Two-Tube Double Regeneration Receiver." Every conceivable detail from panel layouts and lists of parts to circuits and photographs of the set is presented. In addition, there is a supplement to the issue in the form of a large blue print that shows all of the connections of the various parts after they have been assembled on the panel. The set as described in the article has been designed for using honeycomb coils or other flat inductances. However, the ingenuity of the American builder should enable him to adapt this receiver to other types of inductances. Even at that, honeycomb coils are not so bad and if you can obtain them in the correct sizes you could build a set exactly like the one under discussion. The writer of this article has undoubtedly done considerable experimental work with double regeneration receivers as is evidenced by the complete directions for operation and tuning that he gives. The article is to be highly recommended in every way and we are sure that American readers will have success with a double regeneration receiver if they will only take the time to experiment with the circuit and get everything in prime operating conditions.

* * *

If you are at all interested in crystal detector work you will like the article entitled, "A Simple Adaptable Crystal Receiver." A novel method of tuning involving copper sheets that are varied across the face of a flat inductance is interesting and could give quite good results. A double crystal detector of rather novel design is also described. Full constructional details on everything are given.

* * *

A humorous article entitled, "Tuning Made Easy" affords many laughs and is written more or less in radio terms.

* * *

We find another reflex circuit described in the article entitled, "An Interesting Valve—Crystal Receiver." Only one tube is used and a crystal detector provides rectification. As usual, in English apparatus, honeycomb coils or flat inductances are employed. The circuit is rather novel because of the regeneration or reaction feature incorporated in it and the entire article is worthy of consideration.

* * *

Troubles in low frequency or audio frequency transformers are discussed under the heading of "Finding Faults In Low Frequency Transformers." Tests for various troubles are described and if you have ever had trouble with audio frequency amplifiers, you will find much to interest you in this short article.

* * *

A single tube set incorporating a standard type of wave-trap is described in the article entitled, "The Wave-Trap Single-Valve Receiver." The circuit is not new, being that of a single circuit receiver, but the arrangement is novel, particularly the incorporation of the wave-trap directly in the set.

* * *

"Hand-Capacity in Tuning" is the title of an article that gives several methods for eliminating this undesirable symptom that often presents itself when regenerative or oscillating tuners are being used.

* * *

Many little hints that will be of interest to everyone who makes his own radio apparatus will be found in the section entitled, "Practical Work Shop Hints." Soldering, drilling panels and other items are discussed in simple yet concise language.

* * *

"Improving Your Selectivity" tells us something about non-selective tuners and gives some hints on how to increase the selectivity by means of making your aerial system correct, providing a perfect ground and incorporating loose coupled circuits or wave-traps. The whole article is interesting and makes profitable reading.

* * *

All experimenters like to look at new circuits, dope them out and find out just what goes on when they are hooked up. You will find a great field for your imagination opened in the article entitled, "Some Useful Circuits." Six arrangements of typical English form are illustrated in both schematic and pictorial form and each of them is described in detail.

* * *

England, September, 1925.—This particular issue of this well edited construction magazine also includes a large blue print of the receiver that is featured in this issue. The title of the article is "Selectivity With Ease of Control." In it, a three-tube set of good design and incorporating both radio and audio frequency amplification is described in detail. The blue print is in more or less picture form and shows every necessary connection between instruments as they have been mounted on the panel. Several pictures of the completed set serve to make this article most complete.

In the filament circuit, troubles often arise but are usually neglected to a very great extent. Some of them are outlined under the head of "Faults in the Filament Circuit" and the writer describes methods of eliminating the troubles.

* * *

A most simple honeycomb coil—crystal detector receiver is described in the article entitled "A Simple All-Enclosed Local or Daventry Receiver." A single tuning control is used in this set and although it is designed for use in England, still the average ingenious reader can work over the various details so that a set will result that can be used for covering the American broadcast bands.

* * *

Under the title of "Some Simple Experiments," the fundamental principles underlying tuning and oscillation in electrical circuits are discussed in detail and analogies are given which will aid the beginner in understanding just what takes place in certain parts of radio sets.

* * *

Choke coil coupled amplification is not given much attention on this side of the "pond," but it is certainly worthy of a whole lot more than it does get. The article entitled "A Two-Stage Choke Amplifier" gives some details that would be hard to find in American publications and the entire article is certainly worthy of close attention. You will find all of the details that you could possibly desire in this article even to the names of the manufacturers of the various special instruments used.

* * *

More theory is given in the article "The Tuning of a Circuit: What It Means and How It is Accomplished." Examples of tuning circuits are many and help to make the article more understandable.

* * *

"Low-Loss and the Reinartz Circuit" is the heading of an article that gives all the necessary constructional details for a rather unique Reinartz receiver, the coils of which are wound according to the very latest "low-loss dope." A very neat panel arrangement, only 12 inches long by 8 inches high incorporates the two necessary tuning controls and in back of it all of the apparatus is placed. Only a single tube is used in this circuit but anyone desiring to do so could easily add an audio frequency amplifier.

* * *

It is rather unusual to find a radio article of a rather technical type presented in conversational form just as though the arguments put forth were those of two radio bugs talking with each other. This, however, is found under the heading of "John Anstruther's Wireless Talks," and the article is novel as well as instructive.

Several diagrams and charts aid in explaining the action of vacuum tubes.

* * *

Another section called "Practical Work Shop Hints" is included in this issue and makes mighty interesting reading for the radio constructor.

* * *

The Wireless Magazine

England, September, 1925.—For experimental purposes it is hard to beat a unit panel set. A good many interested fans who like to try out different circuits use unit panels that enable them to change over from one system to another with the least possible trouble. A beginning for a unit panel equipped laboratory will be found described under the heading of "Building a Unit Set." In this article a crystal detector or vacuum tube unit and a complete three-circuit tuning unit are described in complete detail and panel layouts are given. If you are interested in experimental work of any kind you will find much of value in this short but well illustrated article.

* * *

The radio transmitter at Daventry, England, is operating on 1600 meters wave-length. The result is that many receiving sets cannot tune in this station. An excellent article on raising the wave-length of receivers is given under the title of "Adapting Your Set for Daventry."

* * *

"As Good a Set as Money Can Buy" is the title of an article describing in detail a four-tube set using radio and audio frequency amplification. The detector in this case is a vacuum tube. Circuits in both schematic and picture form and photographs make the construction of this set very clear. The set should be very selective in operation as it is built on a very good principle.

* * *

Those of you who like humor in connection with radio will enjoy many a good laugh over the article entitled, "The Not-tonightingale."

* * *

We all want to save money in connection with our radio sets and therefore will all be interested in the article headed, "How the Reflex Saves a Valve." A discussion of reflex circuits in general is given in this article and sectional diagrams explain the text very well.

* * *

Wiring a radio set is at best a tedious proposition and unless you follow some kind of a system, you are liable to get into a veritable maze before you are half through. If, however, you will read the article entitled, "Wiring Made Easy," you will find some hints therein that will aid you immeasurably in doing this part of radio construction correctly.

* * *

It seems that the drilling of panels is a subject upon which too much can never be said. Therefore, the article entitled, "How to Prepare Your Panels" is most interesting, because unlike other articles of a similar nature, it is illustrated in detail with photographs, and particular attention given to the cutting of comparatively large holes in bakelite. This article even goes so far as to detail the construction of a hole cutting tool.

* * *

Wireless Weekly

England, July 29, 1925.—In the construction of a wave-meter it is most important that a good condenser be used and that certain features be observed in selecting that instrument. Just how you should go about this is described in the article entitled, "Choosing a Condenser for a Wave-Meter." If you once get a good condenser and have it calibrated for certain fixed inductances, your wave-meter will always be accurate.

* * *

The grid damping of an ordinary detector tube circuit has quite a little to do with the resulting selectivity of that particular circuit. In the article entitled, "Damping Losses in Valve Rectifying Circuits," an excellent discussion of this subject is presented in as clear as possible form. Fundamental circuits are given for measuring the damping in the detector circuit and the conclusions drawn from the results obtained are outlined. Every real student of radio will be interested in the theory and practice put forth in this article.

* * *

Short-wave reception is so comparatively new that in certain quarters very little is known about it. It is, however, quite well known that ordinary broadcast receiving apparatus cannot always be pressed into service for use in short-wave work and therefore some of the parts need separate consideration. The article entitled, "Selecting Components for Short-Wave Reception," shows just how you should go about determining what apparatus can be used for short-wave work. Everything from condensers to tube sockets is discussed and you will undoubtedly learn quite a little by reading this article.

The article entitled, "Straight-Line Frequency Condensers," is a reprint from our own American Radio News and needs no lengthy comment here. Most of us know that Sylvan Harris' knowledge of straight line frequency condensers is wide and varied and therefore we can take what he says in this article as being true.

* * *

Many experimenters encounter trouble when they try to make up satisfactory radio frequency amplifiers using transformers for coupling two or more tubes together. An excellent discussion of this subject and one that will interest all of those concerned with radio frequency amplification work is given in the article entitled, "Faults in Transformer Coupled Note Amplifiers." You will undoubtedly learn many things from this article including various tests for faulty transformers.

* * *

August 5, 1925.—Sometimes we encounter trouble in making one detector tube oscillate in a circuit where another one of the same make will perform perfectly. Just why this is so is not always understood, but a perusal of the article entitled "Why One Valve Oscillates more Easily Than Another" will undoubtedly shed a considerable amount of light on this subject.

* * *

Every true experimenter likes to design his own apparatus to meet his particular wants. You will, therefore, find quite a lot of information in the article entitled, "Inductance Design and Losses." There is a great deal to be said on this subject, particularly in regard to the forms upon which coils are wound. You will find much of this detailed in this article.

* * *

Short-wave inductances are another source of trouble, particularly if they are not rigidly made. Therefore, the article entitled "A Useful Short-Wave Inductance" is to be recommended because of the information it contains regarding this most important of short-wave subjects.

* * *

August 12, 1925.—We all know or have heard at one time or another that the internal capacity of a vacuum tube affects its operation to a very great extent. A good bit of theory on this subject is incorporated in a small space under the title of "The Effect of Valve Capacities on Self-Oscillation."

* * *

The selectivity of a radio receiver depends to a very great extent upon the inductance coils used in the circuit and the method of coupling various inductances together. Some very good tips upon this particular subject are given under the title of "Some Selective Coupling Devices." More material on the subject of straight line frequency condensers will be found under the heading "Some Further Notes on Straight Line Frequency Condensers." This subject is of particular interest to all American broadcast listeners at this time and the article is well written and contains a quantity of valuable material.

* * *

Fading is something that has puzzled a good many of us for a long time. Just what it is and why it happens is still a mooted question but food for thought on this subject is given in the article entitled, "The Nature of Fading."

* * *

September 9, 1925.—With short-wave reception always in the foreground at this present time, the article entitled "A Single Valve Short-Wave Receiver" is of particular interest. Although there is nothing new in the circuit employed, still the article is written definitely yet simply and inductance details are given. Photographs show all of the layout of the apparatus and schematic and picture diagrams help the article along. It is well worth reading and should not be missed.

* * *

What the average radio fan does not know about insulators would fill practically every book and article written on that subject. Therefore the compilation of data presented under the head of "Some Properties of Insulators" should be very interesting to most of us. Just what an insulator does and what properties it should have are discussed in detail and then the good and bad points of various materials are described.

* * *

In America the average fan wants to have a radio receiving set that will tune over the entire broadcast band or, in other words, from 200 to 550 meters without changing any inductances. Such a set is described in detail in the article entitled, "Getting the Largest Tuning Range." The set as described will tune from 165 to 750 meters or, in other words, using only one variable condenser it will more than cover our broadcast band. The article is presented in such a way that it not only makes interesting reading but is instructive as well.

* * *

Again we find further information on straight line frequency condensers. No more need be said of this article than of the other. It is good and certainly well worth reading.

* * *

The Wireless World and Radio Review

England, July 29, 1925.—"Long Distance Summer Reception" is the title of the first article in this issue but, of course, the set described in it can be used all year round. It is a six-tube Super-Heterodyne type of set and from the description and illustrations given, even the veriest beginner should be able to build it. Everything is clearly described even to the making of the input transformer.

* * *

August 5, 1925.—The set described under the head of "Auto-Transformer Coupled Receiver" is one employing three tubes and a rather novel tuning arrangement. One stage of radio frequency amplification and one of audio frequency amplification is included. The auto-transformer coupling is between the R. F. and the detector tubes. Complete detailed instructions and photographs make the article most complete.

* * *

A theoretical yet informative article is the one entitled, "Distortion in Amplifiers." Reasons for this peculiarity are given and comparisons are made between various types of couplings for audio frequency amplifiers. The charts show graphically comparisons between different types of transformers and choke coil coupling devices.

* * *

August 12, 1925.—Our American readers should be much interested in the very complete article entitled, "Telephony and C. W. 100 Meter Transmitter." Not only is a completed set described and discussed in detail but formulas for calculating the exact sizes of the various instruments are also given. This set is very compact, the panel being only 10 inches wide and all of the instruments being included directly in back of it.

* * *

Tuners for short waves always receive attention from readers, particularly if they are rather novel. "A Short Wave Variometer" is the title of an article that describes an instrument which we are sure all short-wave fans will be interested in. The construction details and method of hooking up this unique tuner are given.

* * *

September 2, 1925.—Crystal oscillators have never reached more than the experimental laboratory stage but nevertheless, to the earnest student of radio in general, circuits of this nature present much interest. Here is an article that gives much information on this subject and its title is "Practical Crystal Oscillator." The author of this article has built a set of this nature and consequently, the resumé of his results is illustrated with photographs of the original unit. The article is not complete in this issue but is to be concluded in the following or September 9th number. However, much information is contained in this one article and it would be well for the reader to get both this and the next issue so that he can have all of the information at hand.

* * *

The section entitled "Novelties from Our Readers" is a sort of a radio kinks section and contains much of value.

* * *

Another single tube receiver of rather novel design but whose circuit is comparatively old is described under the head of "Single Valve Broadcast Receiver." The wave-length range is only from 300 to 550 meters but if the American BCL likes the particular type of set described, he should have no trouble in redesigning the coils so that the set will tune to the lowest American broadcast waves, namely, 200 meters.

* * *

The electrical properties of crystal rectifiers are described under the head of "Crystal Detectors." Many detailed curves serve to make this article most complete and informative. It, however, is also to be continued in the September 9th issue of this publication.

* * *

MODERN WIRELESS

England, August, 1925.—A very neatly designed and well constructed four-tube receiver is described under the title of "A Selective Loud Speaker Receiver." Illustrated with many photographs and diagrams, this article is complete in every possible detail. Even a list of parts is given, but of course English names of manufacturers are used. However, the really interesting radio constructor should have no trouble in securing duplicate parts in this country.

* * *

Whether an aerial should be long or short, high or low, is discussed under the title of "Large or Small Aerials?" Just what must be considered in the construction of an aerial is carefully discussed in detail. The article is accompanied by several photographic illustrations of various types of aerials.

* * *

Choke coil coupled amplification is always interesting to American readers because of the fact that it is not much in use in this country. Therefore, the article entitled "A Choke Coupled Two-Valve Receiver" should be read and studied carefully. You will undoubtedly learn something about this particular subject in this way. Another interesting point in this article is that the Reinartz method of obtaining regeneration is employed and this in connection with the unique amplifier gives excellent results. An efficient type of wave-trap circuit is included in this set so as to sharpen the tuning when there are powerful stations nearby.

* * *

A combination of a well known transmitting circuit and an equally popular receiving circuit is described in the article entitled "A Selective Hartley-Reinartz Circuit for Broadcast Reception." This circuit has been well known to transmitting amateurs for a long time and is widely used in receiving sets for use on short waves. For broadcast work it should be equally efficient and with inductive antenna coupling it should not radiate to any bothersome extent.

* * *

The rabid experimenter will surely like the article entitled "Some Two-Valve Circuits Worth Trying." Novel kinks of foreign origin are included in these circuits and the whole experimental article is of equal interest. Seven schematic circuits illustrate as many different types of two-tube receiving sets.

* * *

Again the subject of faithful reproduction comes up and some good pointers along this line will be found under the title of "A Chat On Good Reproduction." Improved types of audio frequency amplifiers are discussed.

* * *

"A Self-Contained Three-Valve Receiver" is the head of a descriptive article dealing with a three-tube receiver of what will appear to the American reader to be novel design. The set is so designed that with the correct size cabinet all of the batteries and accessories can be contained within it. Many photographs and diagrams aid in showing the reader just how every part is positioned.

* * *

EXPERIMENTAL WIRELESS & The WIRELESS ENGINEER

England, July, 1925.—As it happens, the first article in the magazine is a conclusion of a series entitled "Aerial Tuner Design." A careful perusal of its contents shows it to be very well written and covering the theory and practice from an engineering standpoint of view rather than from that which might be resorted to by the average amateur or layman. Graphical representations of the effects of parallel capacity in crystal and tube circuits supplement the discussion and tables which appear intricate and are apt to frighten the uninitiated besprinkle the complex equations which play an important part. The effects of aerial capacity, coil and aerial resistance and various other vital factors are dealt with in a manner which causes us to commend the article as being one of real intrinsic value. The fact that the discussion is rather lengthy, about twelve pages, shows that its authors have spent considerable time in preparing it. We like to see such good reports in our foreign contemporaries.

* * *

"The Propagation of Electric Waves Through Liquids" may seem a rather difficult subject to handle. And so it is. The author is very careful to show that a big difference exists between the conduction of an electric current through a liquid and the conduction of a similar current through a metallic wire. In part he goes on to say: "In the wire we have a number of free electrons which pass between the places occupied by the fixed atoms of the metal when a potential is applied. In a solution, such as the sulphuric acid of the secondary cell, there are no fixed atoms—which is the reason why the liquid flows—and it is also believed that there are no great number of free electrons. It does however contain a very great quantity of ions, *i. e.*, atoms or groups of atoms which have gained or lost an electron or electrons, thereby acquiring a charge of electricity."

The author then goes on to show that two kinds of ions exist in the case of the sulphuric acid—positively charged and negatively charged ions. The question then arises: "Do the ions simply swing backward and forward with the oscillating current or do they never move very far from a given position, it standing to reason that at the high frequencies it would become impossible for the ions to complete their swing across the solution in one cycle of the wave. Statements are given of the researches of scientists to the effect that the conductivity of a solution decreased with the frequency, but that later observation by an eminent French investigator, disclosed the fact that the conductivity remained the same for direct and alternating currents of all frequencies. In conclusion, it is stated that ". . . we may say that no special electrolytic effects are to be expected due to the passage of wireless waves passing through or over the surface of the sea, which will behave exactly as does a metallic conductor having practically the same conductivity as the sea water.

The article, although short, is interesting and should prove the substance of further research work especially among those interested in electrochemistry.

* * *

Much excitement and comment of a laudatory nature was manifest lately, with the first convention of amateurs from all parts of the globe. "The Paris Conference" as the heading of a report giving in full detail the events and accomplishments of the International Amateur Radio Union, is well worth the time which one would spend in reading it. On April 15th, 1925, delegates from the following countries came together to decide the organization of an international union which would bring together the amateurs of the world into a more harmonious group which could co-operate to better advantage: Argentina, Austria, Belgium, Brazil, Canada, Czecho-Slovakia, Denmark, England, France, Finland, Germany, Hungary, Italy, Japan, Luxembourg, Netherlands, Newfoundland, Poland, Spain, Sweden, Switzerland, Uruguay, United States.

Organization and co-operation are necessary to the amateur and more so at this period. This for the reason that the encroaching broadcast wave-bands are gradually narrowing down the available space in the ether for the amateur. And without a background of a strong army of amateurs who have an equal right and privilege to the use of the ether, the amateur's case would be hopelessly lost. We are glad indeed to see that the U. S. recognizes the amateur as indispensable and further glad that other nations are gradually assuming this point of view.

* * *

A relatively lengthy article on the "Rectification of Small Radio Frequency Potential Differences" is found to be full of data concerning crystal rectification. Although one may imagine that all concerning the crystal detector has been written, much has still to be learned about its true method of functioning. The theory and operation of the crystal is completely covered and the article is well written.

* * *

Although it is admitted that we are far in advance of the field in the manufacture of tubes—in advance from all viewpoints—still there are developments being made on the other side which command attention. An article dealing with the characteristics of some of the better English tubes is supplemented with charts and graphs showing all necessary information and gives the substance for comparison between American and English tubes. This will convince those who believe that foreign tubes are better than those obtainable here, that the others simply "don't shine in." True, there are some good foreign tubes, but we have the best. The characteristics prove it.

* * *

"Fading Measurements" is an extremely interesting story of experiences in trying to determine the exact nature of that phenomenon which has been puzzling scientists and radio engineers for a long time. By a systematic study of the nature of the intervening ground and topography between broadcasting and receiving stations, the weather conditions and atmospheric changes, the variations in the recorded graphs were accounted for to some extent.

* * *

A supplementary account of "Some Recent Observations on Periodic Fading and the Night Effect" further clarifies the subject and offers food for more argumentation and debate. Notes on the intensity of signals of constant amplitude from local and distant stations are in abundance and speculation is made concerning the Heaviside theory and other atmospheric effects.

* * *

Everyone is hearing about the wonderful results being accomplished on 20, 40 and 80 meters and of the pranks of the short waves on and below 40 meters. In "Long Distance Work," the author, who is a full-fledged amateur who prefixes his "sine" with a G, has reviewed in brief the results of experiments on the short waves. How some amateurs on this side are heard and come in on the other is shown in the statement that 40 meters comes in best. This is a hint to the would-be all-around-the-world ham.

* * *

August, 1925.—The subject of filters in an article by that name is nicely covered by a man who seems to have had considerable experience along that line. The general ideas, practical design, theory and operation is covered with a view in mind to help those intending to design their own. Band pass and band stop filters, high pass and low pass filters, giving resonance curves and formulas are explanatory and aid in understanding the intricate complications which one unaccustomed to such work may find himself in.

* * *

What type of rectifier are you using? This is a question which is often repeated these days in connection with the charging of storage batteries. In the first of a scheduled series of articles on the subject, the mechanical types of rectifiers are discussed. There are several varieties of this kind and among the ones generally more known are the half-wave rectifier using a vibrating single pole switch synchronously operated; the full wave rectifier using a two-way switch and mid-point tap on the transformer; the full wave rectifier without mid-tap using a double pole switch synchronously operated; different forms of the rotary synchronous type and interrupter-commutator types. Each type is given a review and the advantages and disadvantages are carefully weighed.

* * *

Under the title of "The Perfect Set," which we admit is rather stretching the point somewhat, there follows a description of a reflex receiver using two tubes and a crystal. We all know about the good qualities of the crystal reflex set—its purity of tonal reproduction, its cheapness of cost and saving of tubes, its excellent volume and other meritorious features. There are, of course, other types of receivers which give good results and this leaves the subject open to debate: Which is the best circuit and why? At best, it must be admitted that the crystal is a rather delicate and unstable detector unit, though its reproduction is clearer than the vacuum tube.

* * *

A description of G6TM which reads like a fairy-tale and which furnishes enough inspiration to any amateur to make him go up and grease his antenna, is found full of "dope" on kinks to be employed in the construction of a radio station. Due to the superior types of transmitters used here, we find that many "Yanks" are being logged quite frequently in England and elsewhere.

* * *

A clearly written description of the manner one should go about in calibrating an oscillator from a standard, or by use of its harmonics when the fundamental frequency is known, is of especial interest to the transmitting amateur who must be careful not to exceed the wave-length assigned for his use.

* * *

In "The Self-Capacity of Inductance Coils," an enlightening dissertation which is hard to digest when one has had little previous experience with single and multi-layer coils, the author, H. J. Barton Chapple, Wh.Sch., B.Sc. (Lond.), A.C.G.I., D.I.C., A.M.I.E.E., makes apparent the losses due to self-capacity and insulation leakage. The information is evidently for the perusal of those other than amateurs, as the subject is technical to an advanced degree.

* * *

As a whole, the issue appears to be altogether too technical for the average mind and evidences a serious lack of those types of manuscripts which are easy to read and which convey meaning to the uninitiated, who are in the majority, and who buy a magazine to get information from it. The material is good, but, in the vernacular, too "high-brow."

* * *

Amateur Wireless and Electrics

England, July 18th, 1925.—The first article, and which the editors acknowledge as being ridiculous from its name, "Tuning With the Rheostats," is one on which we believe very little or nothing has ever appeared in print before. In part: "To some readers the title of this article may seem startling, if not actually ridiculous, for the rheostats are meant simply to brighten or dim the filaments of valves, whilst the tuning is done as a rule with variable inductances or condensers. But, as we shall see, the filament potential has a very considerable effect upon the tuning of the receiving set, and the rheostats may be used very effectively as a means of obtaining fine adjustments."

It is true, nevertheless, that tuning can be accomplished to a limited extent with the rheostats, but it is totally inadvisable to allow any but the proper filament current to operate the tubes with. It is particularly stressed that a slight change of filament current will often aid in bringing in DX.

* * *

It seems as though the reflex circuit using regeneration by the tuned plate method is becoming very popular, for in the second story in the magazine we find a description of a single tube and crystal set for the music lover. We admit that sets of this kind are capable of good reproduction—a quality which must not be overlooked in music.

* * *

Our fears are confirmed that there exists no filament switch on the other side. For in a page of hints for the radio builder, a circuit is given in which it is specified that the potentiometer be connected in such manner that the latter will automatically be cut out of the battery circuit and thus prevent undue drain, when the filament rheostat is put in the off position.

* * *

There are other tips ranging from building a neutrodyne condenser—a gigantic undertaking—to methods of properly mounting *short wave* inductances—the latter supplemented with a photo showing an inductance of such a size which would have done Marconi justice. It looked capable of a 1,000-meter range!

* * *

"Building an Amateur Direction Finding Station," of which Part I is found to appear, brings to mind the great advantages which direction finding holds in the commercial field of wireless. The principle of direction finding, its application and means for going about the construction of a well-designed outfit are given. The simple method of triangulation, the advantage of taking the minimum instead of the maxima, and the calibration of the positions, make the article interesting. The Bellini-Tosi D.F. system is graphically illustrated.

* * *

Does a condenser condense? Under the title of "The Condenser in Theory and Practice," it is attempted to clarify a situation which is many times misleading to the majority of readers. Capacity, its governing factors and its effect on circuits is brought out in clear style, but outside of giving an analogy, it is feared that the article is worthless, since mere statements without supplementary reasons cannot be accepted as truth.

* * *

Making weather maps by careful observation of wireless data may appear to be an arduous task, but it is true that some headway and success is being gained along these lines. A record is kept of signal intensity, fading and then checked with the weather conditions, an attempt being made to find a relationship between them.

* * *

The Reinartz receiver has enjoyed considerable publicity and praise from everyone who has built it. We note with interest the fact that a complete description of such a set designed for broadcast reception and for loud speaker operation has been prominently featured.

* * *

There are several short squibs in the magazine, amongst which we find a brief on the Aurora Borealis and Wireless. "The Aurora Borealis, or 'northern lights,' is produced by streams of charged corpuscles shot out from the surface of the sun, usually from those disturbed areas known as sun spots. The corpuscles in their passage through interstellar space are deflected by the earth's magnetic field and are finally more or less massed around the northern and southern polar regions. They enter the earth's atmosphere with enormous velocity, penetrating up to a distance of forty or fifty miles above the ground. As they smash through the rarefied atmosphere they break up the air molecules and liberate free electrons. In this way they help to maintain the zone of ionized air known as the Heaviside layer, which in turn plays so large a part in guiding wireless waves over the curved surface of the earth."

This does indeed sound like a plausible explanation and may be true to a great extent. At any rate, the basic reasoning is free from any conceivable defects. We like to see notes of this kind, as they give the mind some real valuable food.

* * *

August 1st, 1925.—It certainly is good to note that the first article is one dealing with the subject of "Interference: Is the Amateur to Blame?" Since the majority of broadcast listeners are prone to blame the amateurs for the interference which he may be experiencing, and since many of these complaints are unwarranted, the situation is clarified by recounting the multiplicity of causes from which the trouble may arise. In many cases, the source of interference may readily be traced to commercial and ship stations handling traffic on wave-lengths which heterodyne the broadcast waves. Then there are so many more causes for blame: battery chargers, street cars, motors, elevators, high frequency apparatus, and X-ray and violet ray machines, etc.

* * *

How do you run your ground connection from the lightning switch, straight or indirectly? A short discourse on the subject shows the danger in running it so that it has loops and turns which add impedance to the line. This results in a condition wherein if lightning struck the wire, the chance for its doing more damage than otherwise would be greatly enhanced. The charge given to an aerial by a flash of lightning is both heavy and sudden and it always seeks to get to the earth by the most direct route. Rather than travel around a loop of wire, it will if the distance is not too great, spark across the loop even though the air resistance it encounters in doing so may amount to thousand of ohms, whilst the resistance of the loop may be only a fraction of an ohm.

* * *

As regards the superior broadcasting, the new super-power station at Daventry which was recently opened, is regarded by the British as the last word in transmitters. Our own WGY super station is only about ten times as powerful! A special crystal receiver is described and a careful scrutiny of the article fails to reveal anything of a special nature. This receiver is specified as the best crystal set with which to receive Daventry. A multilayer-spaced inductance tuned by a .0005 variable condenser, a crystal detector and a .002 fixed condenser across the phones constitute the set. It is special because of the high wave-length upon which the new 5XX works.

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Part 2 of the series entitled "Building An Amateur Direction Finding Station" is found to contain instructions for building the goniometer, the most important instrument in that type of compass station.

* * *

The Geneva Conference, one which was called to untangle the impossible situation in Europe in regards to broadcast stations, has, after a careful study decided to change the existing wave-lengths in such an extent where interference from ships, etc., will not cause concern amongst the broadcast listeners. An interesting portion of the findings is in the number of radio stations existing in foreign countries. Thus, Austria has three; Belgium, one; Holland, one; Finland, five; Sweden, twelve; Norway, one; Spain, eleven; Portugual, one; Switzerland, two; Hungary, one; Britain, twenty; France, twelve; Germany, sixteen; Italy, one; Czecho-Slovakia, two; and the same countries have about three dozen stations projected.

AUSTRALIA'S FOREMOST RADIO JOURNAL

RADIO BROADCAST

OFFICIAL ORGAN OF THE WIRELESS INSTITUTE OF AUSTRALIA (Federal Convention Victorian Division)

Australia, May, 1925.—Here we find much of interest to the transmitting ham as well as to the broadcast listener. Under the title "Experimental Radio A5BG" a rather complete description of that well-known station and two photos of the installation are shown. Some good dope on the subject of transmission is given and the circuit diagram of A5BG will be sure to interest many hams. In fact, the entire article is about as complete a treatise on the subject of one particular ham station as it has been our privilege to read in many a day.

* * *

Every beginner in radio has many questions to ask about how he or she should go about erecting an aerial and how a new set should be installed. "Making a Start" is the name of a very explanatory article that will clear up many of the points that are always bothersome. The information given should start more than one embryo radio fan on the right road. The one fault that we find with this otherwise good article is that no photos or other illustrations are given. We believe that such an addition would increase the value of the text matter 100 per cent. However, the author makes his directions quite clear, and since he seems to take everybody into consideration, we can almost forgive him for the lack of illustrations.

* * *

A little note in this issue warns of the necessity of trying your different tubes in different positions in the receiver. You should always try changing them around until they are found to give the best results.

* * *

Distortion is the one big bug-bear in the use of amplifiers that give great volume. In the article "Eliminate All Distortion," the author describes in detail the construction of a three-tube resistance coupled amplifier that can be added to any standard detector circuit or even a set employing one stage of transformer coupled amplification. All of the necessary details for the building of this unit are given as are the values of the various resistances and capacities that are necessary for the proper operation of a really good amplifier of this type. While the subject treated is not new, still the data contained in this article is so well arranged and complete that the description is worthy of attention.

* * *

A series of tests that Australian operators are undertaking to determine the influence of location is described in an article of that title. This series is one that is worthy of the attention of various earnest experimenters throughout the world as the results that can be obtained by a systematic search of the nature described should add greatly to our knowledge of the effect that location has on fading, strength of reception and other factors in which we are all interested. These particular Australian tests are being carried on by amateur transmitting stations and the results will be published in a future issue of the periodical being reviewed.

* * *

Many interesting topics from the world at large are included under the title "World-Wide Wireless." One item in particular caught and held the writer's attention as it gave credit to a "ham" for some very good work that he had done. Much of merit is frequently done by the modest persons that are working for the promotion of radio but all too little of the good work is brought to the attention of the public. We are glad to see that this publication is giving the ham his just dues.

* * *

The section entitled "DX Notes" is devoted to ham activities and much interesting gossip from the ham world is related in it. Nor is this all. There is a world of practical information sandwiched in the various paragraphs in such a way that the result is easy, entertaining reading that really teaches.

* * *

Although the title of the next article is "For the Short Waves," still it describes a tuner that might in this country be called almost universal. In fact it is that as far as the ham and the B. C. L. is concerned. Most of the data necessary for the construction of a Reinartz type of receiver that, with interchangable coils, will tune from 50 to 550 is given. There is some fault to be found with the editing of this particular issue. Lines are miserably and sometimes hopelessly transposed and in some cases important material seems to be missing. However, the really interested fan can glean enough material from the article mentioned to build this receiver without much trouble. From our experience with similar circuits, we will say that this one should be good.

* * *

Engraving of panels by the amateur is a subject upon which much could be written, but sad to relate, few people that know anything about this subject seem to think of writing about it. Here we find one exception and the result is an informative article, illustrated, upon the subject. It tells how to make the tool that is required, how to use it and how to fill in the marks and letters after they have been made. Altogether, the article is interesting and instructive.

* * *

"Faithful Reproduction" is something that interests everyone that likes to receive radiophone. It is also the title of an interesting little article that deals with the ways and means of obtaining it. If you get this issue, do not overlook this article just because it does not take up much room.

* * *

Very often we like to take our loud speaker to some other room or out on the porch where it is cool, but when we do so, assisted by an extension cord, troubles of all sorts arise, not the least of them being the proper tuning of the set. In the article "Operate Your Loud Speaker by Remote Control" many obscure points relative to that subject are cleared up.

* * *

If you would use transformer coupled audio frequency amplification at its best, you must use care in selecting the transformers, particularly as to turns ratio as related to the position that the instrument will occupy in the set. Interesting details that will aid you in this work are contained in the item entitled "The Audio Frequency Transformer."

* * *

Crystals for rectification purposes are broadly discussed under the title "Crystals." Many different kinds, their values and the ways in which they should be used are described. Although some of the foreign trade names of crystals will sound queer to the Americanized ear, the natural crystal names are all familiar and the crystal fan will, we are sure, be more than pleased with the data of this article.

* * *

POPULAR RADIO WEEKLY

Australia, July 22, 1925.—Descriptions of how to build single tube radio receiving sets are always interesting to everyone. Often we can learn many things by reading over articles of this nature and such is the case with the one entitled, "How To Make a Simple Single Valve Receiving Set." Here, a regenerative tuner of rather novel design is described, the construction illustrated and all of the necessary connections given. Regeneration in this circuit is caused by the old ultra-audion principle, but the antenna is inductively coupled to the secondary and, therefore, radiation from the secondary circuit out into the air is practically prevented. We must compliment the editors of this publication upon the way in which the illustrations for this article were handled. They are clear and simple in the extreme and no one should have any difficulty in following all the steps outlined.

The twenty-first article of a series of papers presented by a radio builder outlines the construction of a most efficient type of two-tube reflex receiver using a crystal detector for rectification, and a most selective tuner. The set described is typically English in its number of controls and in regard to the circuit used. However, it should certainly give the very best of results and anyone reading the article will have all the data that he could possibly require at his command. The various inductance coils are carefully described and thoroughly illustrated. Every detail is attended to from the list of parts used to the method of tuning the set. A very complete circuit diagram in picture form is of great assistance when used in connection with the schematic diagram that is also furnished.

* * *

"The Gramdiophone" is the title of a short descriptive article which will aid many radio constructors in adapting receiving sets to phonograph cabinets. Although no exact details or directions are given, still suggestions are put forth that will aid the radio constructor in his work. A cross sectional diagram of a phonograph converted into a combination talking machine and radio set is of great assistance and it also shows a novel way of fastening a loud speaking receiving unit to the tone arm of the phonograph so that no changes need be made when it is desired to use the talking machine for its original purpose. As a suggestive article sans details, this one is to be recommended highly.

* * *

Everyone recommends a periodical cleaning of the radio set, but no where have we ever read of a particular situation that more graphically illustrates the necessity of a really thorough cleaning rather than the usual slipshod job than the one contained in the short article entitled, "An Annoying Fault." A general cleaning had been given to the set under discussion but one day it suddenly ceased to function properly. After much investigation and a great loss of time, it was found that a *hair* had become wedged across the grid and "A" battery terminals and was causing all the trouble. When it was removed the set operated normally.

* * *

The four electrode vacuum tube is thoroughly discussed in an article of that title. Circuits, mainly of the reflex type, are illustrated and although no details for the construction of various instruments are given, still those that are used are simple and well known enough to enable anyone at all familiar with experimental radio to obtain the desired results. Four element tubes offer a great field for research and since there is so little actual data published on their operation, this article is of particular value.

July 1, 1925.—In foreign countries, compact inductance coils of the spiderweb or honeycomb type are extremely popular. This is often attributed to the fact that European broadcasters operate on such widely separated wave-lengths that interchangeable coils must be used in order to cover all of them. At any rate, flat inductances of the spiderweb type are often most handy for experimental work. In an item entitled, "A Different Spiderweb Arrangement," an excellent type of tuner using spiderweb coils is described and illustrated. The number of turns for all three of the inductances used is given, they being used in the so-called three-circuit tuner type of hookup. In this particular set a novel arrangement of the three coils is used, the tickler being fixed on the baseboard and the primary and secondary arranged so that they can be rotated closer to or further away from that coil. The one fault with this article is that the point last mentioned is not brought out clearly and it is left to the imagination of the reader to a very great extent.

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To all of us, whether we own a single vacuum tube or a dozen of them the Super-Heterodyne receiver is always interesting because of the wonderful work that can be done with it. Even though we may not be able to build one of them for ourselves, we can get a lot of enjoyment out of reading about what others have done with this set. Under the title of "A Super-Sensitive Long Range Receiver," by Paul F. Godley, of amateur fame, describes a Super-Heterodyne using resistance coupled intermediate frequency amplification. With this arrangement, almost any number of intermediate tubes can be used between the first and second detectors. Mr. Godley describes the theory underlying the Super-Heterodyne receiver in a simple manner and his article, accompanied by many good drawings is a pleasure to read. We are sure that many American radio fans will find much of interest in this article.

* * *

The item entitled, "Home-Made Basket Coils" gives us more information on flat compact inductances, particularly on how to make the forms and how to wind the wire. No further comment is necessary other than to say that the article does not give very much information other than what has been published heretofore.

* * *

Under "Hints On Radio Set Construction" a list of tools that every amateur builder should have on hand is given and other valuable information is outlined in a simple concise manner.

The steadily increasing popularity of a single wire aerial for all purposes is graphically outlined in the article entitled, "Single Wire Antenna Effective for Transmission." Those amateurs who have not yet become converted from the old multiple wire antenna system to the single wire type should read this article and find out something about what can be done with only one wire.

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WIRELESS WEEKLY

Australia, July 3, 1925.—It is often stated that a single vacuum tube receiver will not operate satisfactorily on a loop antenna. This, however, is not always true and a well designed circuit used with a loop aerial will give fairly good results for local reception. A set of this nature is completely described under the title of "A Single Valve for a Frame Aerial."

* * *

This magazine carries a regular weekly department entitled, "The Amateurs' Proficiency Certificate." In it much of value to the transmitting experimenter is given. This department in this particular issue deals with simple transmitting circuits and the theory of their operation. It is simple and plain and the informtaion given is well worth studying.

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Good home-made aerial insulators that are quite cheap and should give excellent results are described under the heading of "Low Loss Aerial Insulators." The article also deals with various tried and true methods of bringing the lead-in into the house.

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July 10, 1925.—A rather unique two-tube receiver for use with a loop aerial that employs a tap on the loop for regeneration is described under the head of "A Good Two-Valver." Everything from the layout of the instruments, as shown by photographs, to the construction of the loop is described. The tickler feed-back as provided by the loop is set, not adjusted, but even at that good results should be obtained particularly if a variable grid leak is employed.

* * *

"An All Purpose Single Valver" describes the construction of a one tube set that can be changed into several different kinds of circuits without rebuilding. This is an excellent article for the experimenter who likes to play with new circuits and should furnish food for further experimental work along the line of constructing sets of a similar nature that will be even more flexible.

* * *

"The Amateurs' Proficiency Certificate" this week describes various types of rectifiers for use in transmitters. Reading over this article we find that the data given is very good, particularly that pertaining to the construction of an electrolytic rectifier. This is a mighty good article for the transmitting ham.

* * *

July 31, 1925.—The description of the construction and operation of a nine-tube Super-Heterodyne takes up over four pages of this issue and is well worth perusing. Details are given for the construction of the various parts of the set, baseboard and panel layouts are given and a complete circuit diagram of the whole set is shown. Various hints put forth in the article help to make it more valuable and everyone interested in Super-Heterodyne construction should certainly make it a point to read this exposition on that subject.

* * *

A four-tube circuit that is sure to give good results if it is constructed as described in the article will be found under the title of "The Sure Fire Circuit for 3LO." It seems that in Australia the height of the BCL's ambition is to receive the signals from 3LO. It is claimed that this can positively be done with the receiver under discussion and because of its novel regeneration and tuned radio frequency phases we are sure that it will interest more than one American experimenter.

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RADIO IN AUSTRALIA & NEW ZEALAND

Australia, July 8th, 1925.—The first article which appears in this issue is entitled "Progress in Radio Receiving During 1924." Its author, Alfred N. Goldsmith, Chief Broadcast Engineer of the R. C. A., deals with the advance in design and efficiency of receiving sets. After dwelling at length on the development of tubes, loud-speakers, simplicity of tuning and improved appearance of sets, the author goes on to say: "Thus it will be seen that broadcast reception has kept pace with the conditions imposed by present-day broadcast transmission, and that the substantial improvements made in 1924 have gone far toward meeting the essential requirements of the user, *i. e.*, selectivity, sensitivity and quality of reproduction."

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A description of Z4AG, one of the leading amateur stations in New Zealand, shows that amateurs in such far-distant climes have been following in the footsteps of the American amateur and have been equipping themselves with the latest types of circuits, low-loss apparatus and working enough DX to cause some of their American contemporaries to sit up and take notice. Z4AG is working steadily on 20 meters, a wave-length which has shown promise of some remarkable results. The owner and chief operator holds the distinction of being the first N. Z. amateur to establish two-way communication with England in daylight.

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In the article by C. D. Maclurcan, entitled "Various Notes—and Many Things," will be found several warnings to the amateur, reminding him that there are laws governing transmission in respect to tuning, coupling, wave-lengths, interference and other factors not to be overlooked. This article brings to mind the situation on this side, as well as that in Australia. Although it must be admitted that the American is as well behaved as any other, a gentle reminder now and then would not be amiss. It is hoped that this hint will cause some of those who are in the least in doubt about any clause in the rules and regulations, to carefully review the new and revised laws. As in everything else the American amateur must lead—and deportment, among other things, counts a great deal.

* * *

The four electrode vacuum tube made famous by the introduction of the Solodyne receiver in this country by Hugo Gernsback, editor of *Radio News,* is reviewed in an article by that name. Its possibilties are outlined briefly and conjecture is made as to whether it will be found as leading to new and important later developments.

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The subject of power transformers is a bit hard of understanding for the layman, but the author of the article on this seemingly indigestible subject has taken pains to bring forth in clear and concise manner the various rules, laws and underlying principles that go into the consideration in constructing suitable transformers of high efficiency.

* * *

"The Potentiometer" is the heading of a short, well-meaning discourse having to do with the correct use of the sometimes indispensable device which controls regeneration. Thus in part: "Should I disconnect my accumulator or A battery when I have finished listening-in on a set using a potentiometer?" The answer as given is emphatically "Yes"! The article goes on to say: "A little application of Ohm's Law will show that a potentiometer of 300 ohms resistance connected a six-volt storage battery will take a current of .02 ampere or 20 milliamperes from the battery. If the potentiometer is left on continuously for twenty-four hours the current consumption will be .48 ampere-hour, in a week it will be 3.36 ampere-hours and in three weeks 10.08 ampere-hours. Taking the rating of a

40-ampere-hour capacity battery, it will be seen that in three weeks the battery will have been drained of one-fourth of its energy. From an economic viewpoint, it is therefore advisable to disconnect the battery when not in use."

Evidently it is assumed that sets employing potentiometers do not have any means of breaking the filament circuit; for if a potentiometer is connected in a radio circuit properly, when the set is turned off by means of either battery switch or rheostat, the potentiometer will also be disconnected from across the active battery.

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IRISH RADIO JOURNAL

THE OFFICIAL ORGAN OF THE RADIO ASSOCIATION OF IRELAND

Ireland, August 1, 1925.—A new high powered broadcasting station operating under the call of 5XX has opened at Daventry, England, and is now in operation on a wave-length of 1600 meters. A complete illustrated description of this station is given in this magazine.

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The bane of the radio constructor is usually the making of suitable inductance coils for his receiver, particularly if he is interested in covering a comparatively large band of wave-lengths. The article entitled, "Making and Mounting Card Inductances" tells in a simple and straightforward manner just how cheap yet reliable inductances can be made at home. Illustrations accompanying the text make everything as clear as possible. Sufficient data is given to enable the builder to make his own coils and from the experience that he gains, he can make up other coils that will cover different bands. A method of mounting these "card" or spiderweb inductances always seems rather hard to figure out and a simple one is illustrated in this article.

* * *

Everyone who is at all interested in radio should have a working knowledge of the code that is used by various radio telegraph stations. Under the title, "Learning the Code," an excellent exposition on this work is given. The writer tells just how he went through the learning of the code and how gradually his speed increased until he was able to perform satisfactorily. We like one reason that the author gives for learning the code and that is so that you can place interference at the proper doorsteps and not just blame it on the first party that you happen to think of. If you can read the code, you can be sure of who it is that breaks up your concerts.

The article entitled "On Buying Valves" gives much information on the workings of vacuum tubes or as many foreigners term them, valves. In this article various tests are mentioned and their importance described. Although the writer has evidently kept English tubes in mind throughout his discourse, still the information that is given will undoubtedly be of interest to everyone and will help them to understand the actual functioning of their tubes.

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In "The Question Box" several queries are answered and the information contained is well worth looking up. The best point discussed in this department is the elimination of interference from a local power generating station.

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September 1, 1925.—A discussion of resistance coupled amplification both of a practical and theoretical nature appears under the title of "A Two-Valve Resistance Coupled Low Frequency Magnifier." Some good dope on this method of boosting signal strength is given in quite a simple manner.

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Trouble shooting is discussed in brief in the article entitled, "What Is Wrong With Your Set." Several of the usual troublesome points in radio sets are dealt with and their elimination mentioned.

* * *

RADIO NEWS

New York, U. S. A., November, 1925.—Editorially speaking, the editor of *Radio News,* Hugo Gernsback, on the subject of "Who Pays for Radio Broadcasting?" hits the nail on the head and asks those who kick about the publicity that some individuals and firms get on the air, for the reason for their objections. After all, states Mr. Gernsback, "Without your having to pay any money for the free entertainment which you get on the air, why object to the little advertising that of necessity must go on the air to make such entertainment possible?"

And it appears to us that this is the most satisfactory and most plausible method of procedure and will result in the continued efforts of the broadcast stations in presenting good, wholesome programs and entertainment.

* * *

We are still another jump ahead. Radio and the movies are now linked—the result of a prediction made by the editor in September, 1919. Recently at one of the big studios out West, a test was made in which a film was run off and at the same time the actors rehearsed the play in synchronism and with the necessary spoken words and music which were picked up by a miscophone and transmitted to a distant city where the same film was shown at more than a dozen theatres and where the words and music to accompany were amplified to enable a large audience to hear.

In the face of these facts we are forced to sit up and take notice; dreams which may seem wild, may bear fruit.

* * *

The trials and tribulations of the Rice Expedition are related in full by one of the radio operators who accompanied the expedition to the headwaters of the Amazon. The experiences of transmitting on various wavelengths and the results obtained with them, make very interesting reading material aside from the fact that the dangers and hardships which the party had to undergo, make a thrilling story. To read how a little short-wave transmitter kept the brave party in constant touch with civilization, thousands of miles from home, shows the indispensability of radio transmission and of the radio amateur, for it was the latter who performed such valiant work in handling the many messages between the expedition and their homes.

* * *

In the article on "Hot Cathode Metal Vapor Tubes," one will find a technical discussion on gas filled radio tubes which employ a hot cathode or filament and a liquid as an anode. Electrons, ionization, helium, argon, neon, krypton, xenon, and other scientific terms abound in profusion and give impetus to the descriptive account.

* * *

Most of the amateurs are on 80 meters and are slowly but surely following the precedent set by others in the use of 40 meters as a channel for steady and reliable communications. A neatly designed transmitter for use on these wave-lengths is described in detail and a receiver for the same ranges is completely described. Of especial interest, we find that a chart giving the comparisons between different waves, showing the varying peculiarities of fading, static, range, etc. This is the type of article we like to see—something which conveys real information to the amateur and helps him by giving him the right kind of "dope" for which he many times looks for in vain.

* * *

Since the progress of radio has been so extremely fast, we are not surprised to find new and ingenious receivers on the market. New mechanical arrangements, new tuning devices, circuits, modifications and improvements and a host of other additions and embellish-

(*Continued on page* 73.)

Readers' Problems

CONDUCTED BY G. F. KOENIG

THIS Department is conducted for the benefit of our Readers. We shall be glad to answer here questions for the benefit of all, but we can publish only such matter as is of sufficient interest to all.

1. This Department cannot answer more than three questions for each correspondent. Please make these questions brief.
2. Only one side of the sheet should be written upon; all matter should be typewritten or else written in ink. No attention paid to penciled matter.
3. Sketches, diagrams, etc., must be on separate sheets.
4. Please do not ask for construction data on manufactured parts, such as transformers, kits, etc., as such data cannot in all cases be obtained from the manufacturers.
5. We are obliged to request that every inquiry which the reader wants to be answered by mail has to be accompanied by a remittance of one dollar to defray a part of the cost of the work involved.

(1) Mr. Jas. Dividson, Lexington, Ky., writes:

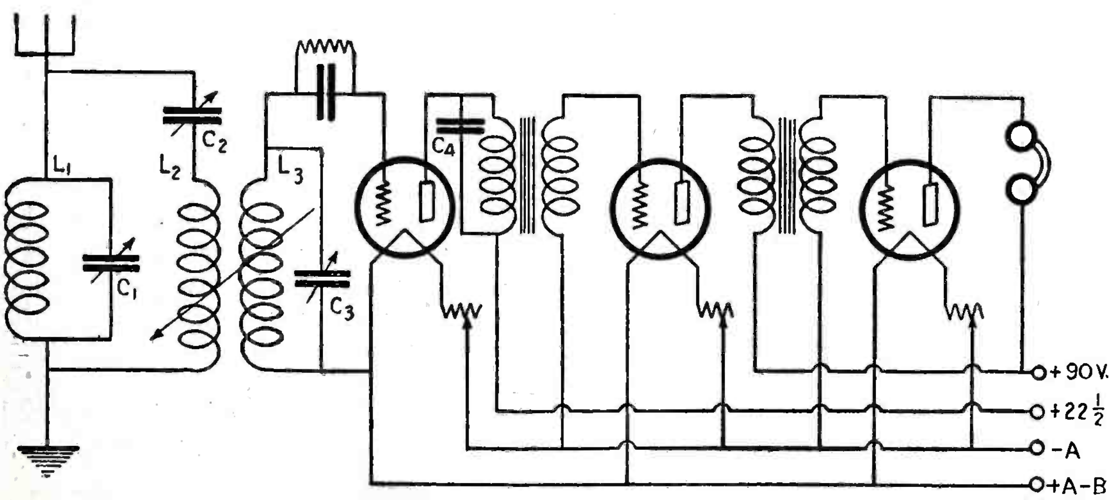
Q. 1. Please send me the address of the manufacturer of the Marle transformer used in making the B-battery Eliminator described in RADIO REVIEW for September, page 53.

A. 1. The Marle Type 200 transformer used in the construction of this B-battery Eliminator can be secured from the Marle Engineering Company, 309 Main street, Orange, N. J.

(2) Mr. Ernest Waggoner, Vacaville, Cal., writes:

Q. 1. In your September issue of RADIO REVIEW in the "Construction of a Selector Tuner," page 55, you failed to print the hook-up, Fig. 8, which shows how to wire up the parts. As this is something I have been looking for, for my single circuit receiver, I would appreciate very much to have the diagram if you have it.

A. 1. This hook-up was accidently omitted from the article, but same is given herewith.



Q. 2. A three-tube set incorporating the principle of the Selector Tuner.

The inductance L1 consists of 20 turns of No. 14 DCC wire on a 3-inch tube and is shunted by the variable condenser C-1 which has a capacity of .001 mf. The coils, L2 and L3, which are in inductive relationship to one another, may be honeycomb coils of 50 turns each. It should also be noticed that the inductance L1 should not be near the other two inductances, L2 and L3; the condensers C2 and C3 have a capacity of .0005 mf. C4 must be determined by experiment.

(3) Mr. Robt. T. Davies, 51 Mitchell street, Providence, R. I.:

A. 1. For answer to your inquiry see reply to Mr. Ernest Waggoner (2) above.

(4) Mr. A. P. Esten, 2019 N. 4th street, Philadelphia, Pa., writes:

Q. 1. In your September edition of RADIO REVIEW you have a hook-up called the "Rasla" (three-tube reflex) with instructions as to how to build this set. It impressed me very much so I bought the necessary parts and started to construct same. There are two points, however, that have me stumped. First: In the printed instructions for wiring it states: "Join the B terminal of the type T. D. tuner to the '—B' binding post." Then on the opposite page in "Fig. 2" it shows the B terminal of T. D. tuner connected to the "+B" terminal. Which is correct?

A. 1. The "B" terminal of the T. D. tuner is connected to the "+B" binding post.

(5) Mr. J. B. Bowers, 316 Main street, Zanesville, Ohio, says:

Q. 1. In regard to the "Baby Super Set" in the July number of RADIO REVIEW. Please tell me where I may purchase the "Famous Journal Filter Tuner Coils" for this hook-up, or directions for winding them.

A. 1. We are giving you the data on the coils in order that you may make your own if you so desire. If you do not care to make them they can probably be purchased from the Bruno Radio Corporation, 220 Fulton street, New York, N. Y.

Use tubing three inches in diameter, one tube six inches long, the other four inches long. On the smaller tube wind 40 turns and then another coil 25 turns, both in the same direction. The two windings should be separate and spaced about one-half inch apart on the tube. The larger tube has one winding of 40 turns and another of 60 turns, also in the same direction.

All these coils should be wound with No. 22 double cotton covered wire. The placing of the coils in relation to each other can be seen by study of the photograph on page 62 of RADIO REVIEW for July, 1925.

(6) Mr. J. W. Swain, 2803 Burton boulevard, Kansas City, Mo., asks:

Q. 1. Please advise me where I might get the "Marle transformer, Type 200" to make the "B-Battery Eliminator" as described in the September number of RADIO REVIEW.

A. 1. This transformer can be purchased from the Marle Engineering Company, 309 Main street, Orange, N. J.

(7) Mr. John Tranetzki, 1801 Second street, Wausau, Wis., writes:

Q. 1. Please give me the name and address of the company that sells the parts for the "Three-Tube Rasla" set that was described in the September issue of RADIO REVIEW.

A. 1. The "Rasla" instruments mentioned in the list of parts used in the construction of the set in question

QUESTIONS AND ANSWERS

It is impossible for the editors to answer individually the thousands of letters reaching the offices of this magazine.

If our readers desire information regarding construction data, etc., they are cordially invited to send us their inquiries and we will endeavor to publish answers to same under the department of *Readers' Problems.*

If an individual answer is wanted, please fill out the coupon below and mail it to us with a dollar bill.

Nov. 25

INFORMATION COUPON

To the Editor of *Radio Review,*
233 Fulton Street, New York, N. Y.

I am sending you herewith $1.00 for which I ask you to answer the inquiry contained in attached sheet.

Name ....

Address ....

Town.................. State........

can be obtained from the Martin Copeland Company, Providence, R. I.

(8) Mr. J. D. Nichols, 24 Anable street, Long Island City, N. Y., writes:

Q. 1. Could you inform me what size wire to use for tickler coil, also what capacity condenser and leak on short wave loop receiver of Alex. Maxwell's, published in September issue of RADIO REVIEW, page 73, as it is not given in text and would like to give the circuit a try out. Can I use pig-tail connections on connecting up coils, also what voltage is best on "B" batteries?

A. 1. Tickler coil as wound on the cover of the ice cream container consists of not more than 8 turns of No. 20 D. C. C. wire. However, the exact number of turns can best be determined by experiment. Wind your coil with 8 turns and remove the necessary number of turns after the set has been placed in operation. Grid condenser .00025 mfd, leak 2 megohms; primary condenser 11 plate, .00025 mfd capacity, secondary condenser same as primary condenser; pig-tail connections are satisfactory; "B" battery should be variable to 45 volts, proper voltage must be determined by experiment.

(9) Mr. Oliver H. P. Young, 152 Conn avenue, New London, Conn., asks:

Q. 1. Please advise if it is possible to use straight line frequency condensers successfully in the Tropadyne receiver.

A. 1. This type of condenser will prove more efficient than any other type obtainable.

(10) Mr. J. N. Squires, Westhampton Beach, Long Island, inquires:

Q. 1. Will you please tell me where I might obtain a blueprint and panel layout of the "Baby Super Set With Filter Coils" which is published in the July issue of RADIO REVIEW?

A. 1. We do not believe that there are blueprints published for this set, although we advise you to get into communication with the Liberty Radio Company, 106 Liberty street, New York, N. Y., for further information regarding same.

(11) Mr. Bert Sehm, Minneapolis, Minn.

Q. 1. I have your May issue of RADIO REVIEW in which I have been reading about the Victoreen Super-Heterodyne. Will you please tell me where the parts are obtainable?

A. 1. The parts for the Victoreen Super-Heterodyne are sold in kit form and can be purchased from The Victoreen Radio Corporation, 6513 Cedar Avenue, Cleveland, Ohio.

(12) Mr. Wilber Read, Glendale, Calif.

Q. 1. In the diagram of the 60 to 600 meter tuner on page 38 of the July RADIO REVIEW there is a choke coil in the plate circuit. I can find no reference to it in the accompanying article nor is it mentioned in the list of parts. I would be very grateful if you would send me the directions for its construction.

A. 1. The choke coil used in the 60 to 600-meter tuner described in the July issue of RADIO REVIEW may be 250 turns of No. 32 or 34 insulated wire wound on a two-inch tube. This coil uses an air core.

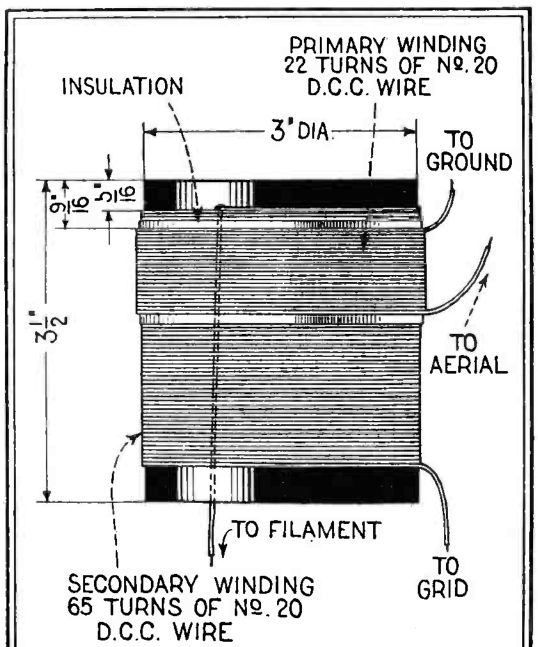
(13) Mr. J. M. Christie, 4141 W. Pine Boulevard, St. Louis, Mo.

Q. 1. Your July, 1925, issue describes the Harkness Counterflex Receiver. I have a Harkness two-tube reflex and can you advise me where I can secure details to convert my two-tube reflex into a three-tube Counterflex?

A. 1. Full details for the conversion of the two-tube Harkness Reflex into a three-tube Counterflex can be obtained by communicating with the Harkness Radio Corporation, 727 Frelinghuysen Avenue, Newark, N. J.

(14) Mr. E. M. Feeney, 173 Beach 150th street, Rockaway, N. Y., has been experimenting quite extensively with the set described on page 61 of the July issue of RADIO REVIEW, entitled "A Baby Super Set with Filter Coils," and has very kindly let us have the results of his findings as to the coils, etc.

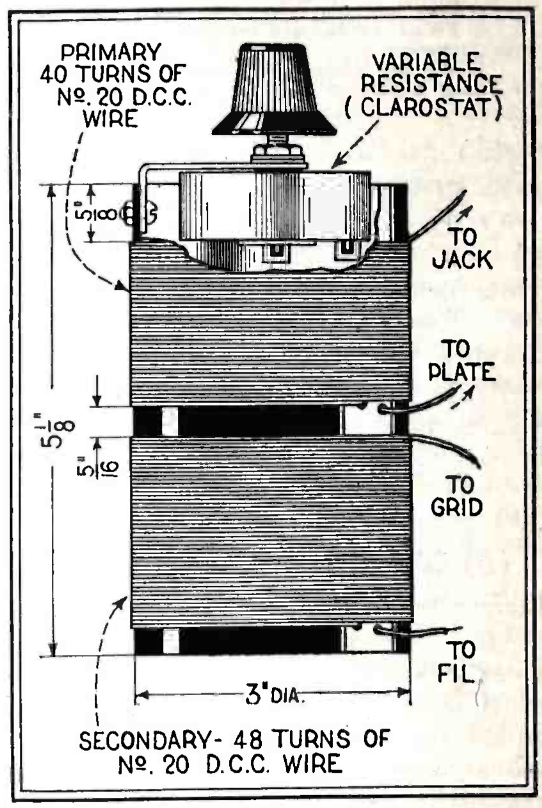
For the radio frequency tuner Mr. Feeney used a three-inch tube and first wound thereon 65 turns of No. 20 D. C. C. wire for the secondary. The filament "F" lead was run through the inside of the tube so that both the filament and grid leads were at one end of the tube.



Q. 14 (Fig. 1). Radio frequency tuner for "Baby Super Set."

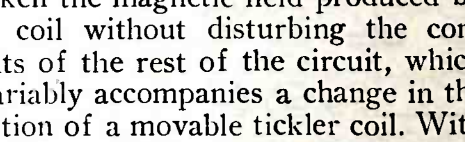
After completing the secondary winding he wound on top of the secondary winding 22 turns of No. 20 D. C. C. wire which formed the primary. This winding was so placed that it is located between the center of the coil and the filament end of the secondary winding, as shown in Figure No. 1. A .00025 mfd variable condenser was used to tune the secondary of this radio frequency transformer.

For the main tuner Mr. Feeney also used a three-inch tube and wound thereon for the tuning coil 48 turns of No. 20 D. C. C. wire and for the tickler coil 40 turns of the same kind of wire. The tuning coil he shunted with a .0005 mfd variable condenser. This unit is shown in figure No. 2, the tuner and tickler being marked "Secondary" and "Primary," respectively.



Q. 14 (Fig. 2). Tuner, tickler and variable resistance used in Mr. Feeney's experiments with the "Baby Super."

He further found that a "Clarostat," shown in Fig. 3, placed across the tickler winding and mounted inside of the tube, as shown in Fig. 2, not only makes the circuit more stable, but also increases the volume because close coupling can be maintained between the tickler and secondary on all wavelengths, and its function across the tickler or plate coil is to strengthen or weaken the magnetic field produced by this coil without disturbing the constants of the rest of the circuit, which invariably accompanies a change in the position of a movable tickler coil. With the "Clarostat" coupling between the secondary and tickler is always fixed and at maximum and therefore a



Illustrations by Courtesy of American Mechanical Laboratories, Inc., Brooklyn, N. Y.

Q. 14 (Fig. 3). Type of variable resistance which was used to aid control of regeneration.

signal of much greater volume can be obtained, together with a still more important advantage, one that appeals to everyone—a greater freedom from distortion in voice and music.

For the inductances and capacities specified Mr. Feeney found that an aerial approximately 100 feet long over all produced the best results.

As this set aroused such interest among our readers we are passing on to them the result of Mr. Feeney's experiments with this circuit, in the hope that it will be of service.

Further, we desire to call attention to a slight typographical error which appeared on page 62 of the July issue of RADIO REVIEW in the description of the set in question. The text said: "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." This is a transposition, as the 23 plate condenser is the one to be placed so as to tune the one stage of radio frequency, and the 13 plate condenser controls the wavelength of the detector circuit, as shown in the photograph on page 62 of the issue referred to.

(15) Mr. John C. Eddy, 29 St. Mary's Court, Brooklyn, N. Y.:

Q. 1. In the September issue of RADIO REVIEW is described "A Stable Seven-Tube R. F. Receiver." Could you tell me size of coils and gauge of wire used to wind? Also if it is possible to use (Fig. 6) honeycomb coils for 250 windings. If there are any blueprints of this set I would like to get them.

A. 1. In reply to your question as to whether honeycomb coils can be used in place of the 250 turn coils shown, will say that they can be very satisfactorily used, coils having 150, 200 and 250 turns covering the broadcast band nicely. Should you desire to wind choke coils instead, wind about 150 turns of No. 40 S.C.C. on a tube about 2¾ inches in diameter. Taps are taken off to a ten-point switch from the ends of the coil and from the fiftieth turn. From the fiftieth turn to the 120th taps are made at every tenth turn.

The tickler coil, aperiodic aerial coil and the wave trap coil may also be honeycomb coils in connection with a three-coil mounting. The tickler coil should have approximately 35 turns. If necessary, one turn could be taken off the tickler at a time until the set functions smoothly.

We regret that we do not publish blueprints to cover the set in question.

(16) Mr. Ernest Devens, 1 Eastman Terrace, Poughkeepsie, N. Y.:

Q. 1. In the RADIO REVIEW of September you have described a five-tube Acme set and how to build it. You give the parts required but do not give the name of the crystal. Will you please let me know the name of the crystal?

A. 1. We do not recommend the use of a fixed crystal detector, but have found from experiment that any variable crystal is very much more efficient.

(17) Mr. Jos. A. Rozell, 562A Gates avenue, Brooklyn, N. Y.:

Q. 1. In your issue of RADIO REVIEW of September you offer "A Short Wave Set of Unusual Merit," page 26. I have completed this up to the various taps and here I am stumped.

I have followed the specifications set down for size of tubing for coil and wound a solid coil of thirty-five (35) turns, tapping off at the 1st, 3rd, 5th, 6th, 9th, 12th, 18th and 20th turns. I then connected the 1st turn to the .00025 grid condenser, to grid post of detector tube socket. The 35th turn connected to rotor of .00025 variable condenser, to .00005 fixed condenser, to antenna. Then a lead from the plate of detector tube socket going to stator of same condenser. From here on I am stumped.

Kindly inform me as to the correct way of finishing taps with switch points; it will be deeply appreciated.

Am I correct in winding one coil and tapping off, or should I wind four distinct coils?

A. 1. We note you state that you have wound a solid coil of thirty-five turns, tapped off at the 1st, 3rd, 5th, 6th, 9th, 12th, 18th and 20th turns. This is entirely wrong, as four separate coils must be used, one each for the 20, 40, 80 and 200 meter bands. The second paragraph, third column, of page 27 in the September issue of RADIO REVIEW described how each of these coils is tapped in two places, i. e., so that one end of the coil will connect at "1," the first tap at "2," the second tap at "3" and the other end of the coil at "4." For the different wave bands the particular coil for that wave is plugged into the socket after the fashion of the "honeycomb" coils, which method is doubtless familiar to you. The diagram on page 27 of the September issue will show you at "1" the coil, and at "2" the base into which it is plugged, the four taps being plainly visible. These taps are made with the use of small telephone tip jacks and telephone tips, or there are on the market various makes of tips and jacks for this purpose.

(18) Mr. Richard Trimble, 104 West Second, Winslow, Ariz.:

I am going to build the radio set that you show in your September issue of the RADIO REVIEW on page 28, known as "The Super-regeno-dyne," and I don't know the size of some of the parts. I would like to know:

Q. 1. The number of "ohms" in each of the rheostats.

Q. 2. The specifications of the grid leak and the grid condenser.

Q. 3. Is it possible to use the set without a ground?

The answers to your questions follow in numerical order:

A. 1. The resistance of the various rheostats will depend, of course, upon the type of tubes you use. You have not stated whether you will use dry cell tubes, and which kind, or storage battery tubes. However, the author of the article in question used 199 tubes and for these the rheostats should be as follows: Radio frequency amplifier, 30 ohms; detector, 30 ohms; audio frequency amplifier, 20 ohms.

A. 2. The grid condenser should be approximately .00025 mfd., and the grid leak from 2 to 5 megohms.

A. 3. Probably the more satisfactory method of operation is with a good permanent ground, but a counterpoise would also work very well. This is merely a second aerial strung about fifteen feet above the ground, and as nearly under the first aerial as possible. Connect it to the ground binding post of your set.

(19) Mr. G. Miller, 269 Madison street, Passaic, N. J.:

Q. 1. I saw an article in the RADIO REVIEW for September about the construction of the home-made "B" battery eliminator. Would like to have your opinion if it will operate a set with 199 tubes with success.

A. 1. If the instructions as to the construction of this eliminator are carefully followed out there is, in our opinion, no reason why it should not operate your set using 199 tubes.

(20) Mr. G. F. Moore, Hinsdale, Ill.:

Q. 1. I attempted to build the "Baby Super Set With Filter Coils" as described in the July issue of the RADIO REVIEW, but could not get the amplifier tubes to light.

A. 1. If your amplifier tubes fail to light it is apparent that you have not followed the diagram correctly, as this set functions very well indeed if no connections are omitted.

We would suggest that you turn to page 62 in the July issue of RADIO REVIEW, and make a close check of your wiring against the diagram which appears on that page. As you trace each wire, check that wire off on the diagram, and in that way you will find the connection which you have omitted. Of course, it may be possible that the circuit has been correctly followed and that the trouble is due to some defective part. Possibly the filament prongs on the amplifier tube sockets are not making contact with the tubes. Bend the prongs up slightly. Your amplifier rheostat may be open circuited.

(21) Mr. H. N. Potter, South Coast Park, Eucinitas, Calif.:

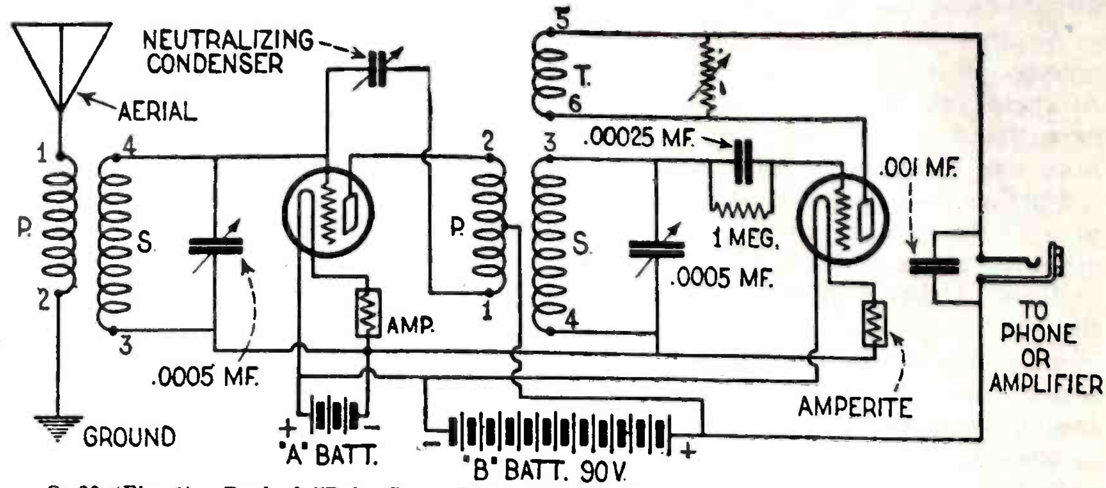
Q. 1. In the September issue of RADIO REVIEW, page 31, in list of parts for the "Power House" set "Summit" R. F. transformers are listed. Where can these be gotten?

A. 1. These transformers can be procured from the Summit Manufacturing Company, 485 Broad street, Newark, N. J.

(22) Mr. A. Holtz, of Brooklyn,

N. Y., has been doing considerable experimenting with the "Baby Super Set With Filter Coils" which was described on page 61 of the July issue of RADIO REVIEW, and inasmuch as this set produce a real 'Baby Super' I have decided to try, if possible, to improve the tuning quality of this receiver.

"After many unsuccessful attempts, I finally succeeded in building one that



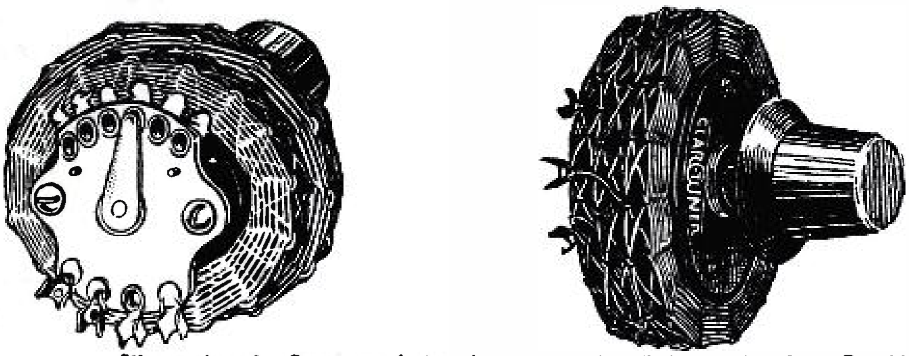
Q. 22 (Fig. 1). Revised "Baby Super Set" which permits neutralization. In this circuit using 201A tubes up to 90 volts may be used for detector "B" battery, but the correct amount must be determined by experiment.

created such a favorable impression among our readers we are quoting Mr. Holtz's letter for the information of those who have been experimenting with the "Baby Super":

"I have built the Baby Super Receiver as described in the July issue of your valued magazine, from the parts left over from my Filter Tuner Set, and have given this baby a fair test and found this receiver to be a fairly good one for general use; but in order to can be called a real 'Baby Super' insofar as tone quality, selectivity and volume are concerned. In order to obtain these results I had to depart a trifle from the original hook-up as shown on page 62 of RADIO REVIEW for July, 1925. The changes made are shown in the accompanying diagram and can be made by anyone in a half hour's time.

"You will observe from my diagram

that I have substituted the old Filter Tuner coils with more up-to-date tuning units called 'Clarotuner, Model 2-RK,' consisting of an antenna coil neighbors will enjoy their evening programs and will be safe from annoyance of radiation when I go out for DX.



Illustrations by Courtesy of American Mechanical Laboratories, Inc., Brooklyn, N. Y.

Q. 22 (Fig. 2). Antenna coil on left, and detector tuner on right, which were used in the "Neutralized Baby Super" as described by Mr. Holtz.

with a tapped primary and tapped switch mounted permanently on the coil. This arrangement simplified installation and enabled me to tune the antenna much more efficiently than with the old method, and is of great assistance when it comes to tuning in on DX stations.

"The detector tuner differs radically from the old types of tickler feed-back tuners, and instead of having the feed-back coil movable, as is the usual practice, the feed-back coil is controlled by a variable resistance. This combination is built right into the Clarotuner, which makes tuning sharper and provides a more accurate system of electrical control; the primary on this tuning coil is provided with a tap for neutralizing. I have taken advantage of this provision, and from now on my

"On the diagram, Fig. 1, you will see that the connections, both on the antenna coil and on the detector tuner (shown in Fig. 2), are numbered. These numbers correspond with the numbering on the Clarotuner as marked by the manufacturer, and are of a great help to fans for proper wiring. The selectivity of my set has been improved fully 50 per cent, and now I am able to tune in any station on high or low wave-lengths without any interference.

"I have run a test between my Baby Super and a manufactured five-tube T.R.F. receiver, and in every case the Baby Super performance was much better than the five-tube T.R.F., and when it comes down to the low wave-lengths the five-tuber was beaten all hollow."

International Radio Digest

(Continued from page 68.)

ments are pervading the market until the profusion among those about to purchase a receiver, is a state of comparative bewilderment. Several of these new and interesting receivers appear in an article which describes their relative merits. Circuits are given and the reader is allowed to judge for himself. A close study of the principles involved gives ample opportunity for learning more about the greatest art.

* * *

In order to receive the entire broadcast range, from around 200 to 600 meters, it is necessary, in order to get the various stations with the same ease and clarity, to divide the tuning arrangement into two parts. This allows the short wave stations to be tuned in over a much larger part of the dial, hence greater ease in tuning. Especially is this necessary when there are several powerful local stations operating at the same time. The use of straight line frequency condensers also improves the operation of tuning and many stations can be tuned in without the ticklish and hair-breath adjustment which so often takes the fun and pleasure out of radio.

Full details are given so that the average radio set builder or even beginner can finish a set which will give satisfactory results and which will be a real pride to him. The article is fully recommended to those looking for the very best at a reasonable cost.

* * *

The inventions of Reginald A. Fessenden, of which part 9 appears, makes interesting reading for the one engrossed learning about the origin and development of our modern radio inventions. Discussion and historical data is given concerning the Heaviside layer, the Fessenden horizontal wave system and electrolytic condenser and special string galvanometer. The chapter contains real meat for the enthusiastic experimenter.

* * *

Controlling an automobile in perfect fashion by radio may seem to the average mind as a thing rather far-fetched, yet, it was conducted in successful manner, as "The Radio Controlled Automobile," shows explicitly. Imagine a car without a driver being steered, slowed-up, stopped and started in heavy traffic, without the semblance of difficulty! Will the day come when all one will have to do is to press a button and be carried to our destination, without troubling about accidents, delays and traffic detours? A wild dream, but who can tell?

* * *

"The Life and Work of Lee De Forest" is concluded with the events leading up to the invention of the phonofilm, the device which allows the simultaneous transmission of the voice with moving pictures—talking movies as it is known. It is greatly advised that the whole life history of De Forest be read, as many interesting highlights will be found which will aid materially in bracing up one's dampened spirits, as De Forest had to undergo considerable difficulty in his struggle for success.

* * *

Imagine a single gaseous rectifier tube which gives full wave rectification! Yes, it is a possibility, as an interesting description shows it to be. The used gas is helium and since the tube represents something new, the article should be of value to all. It is claimed that it offers a perfect "B" battery supply current and is very efficient in its operation.

* * *

"Sound Photographs and Their Reproduction," written by a man who has spent considerable in experimenting with the subject and who is well versed in radio telematics, will be found of especial interest and value. A clearly defined argument is outlined and a logical discussion entered upon in which the talking moving picture is subjected to a rigorous and practical questionnaire and in which the outstanding points of advantage and disadvantage are carefully explained. The author foresees the main question of perfection in reproduction as being the sole barrier between the acceptance or rejection by the public.

* * *

Among the new and guaranteed circuits, we find the Counterphase circuit given considerable prominence. Of importance, the toroidal coils are stressed as being the very thing to use as the inductances for the radio frequency circuits. Since no or very little external fields are created by such type of inductance, it is claimed that better results in reproduction and quality are obtained.

We agree as far as the limited external field is concerned, but balk at the mention of the toroid as being an efficient inductance. The fact is, it has the highest losses of any form of inductance, but it so happens that it serves the purpose of a radio frequency tuning inductance to very good advantage.

* * *

Now that most of us have read reams concerning straight line frequency condensers, there is appearing on the market a large amount of so-called straight line frequency dials which are for the purpose of converting the ordinary straight line capacity type of condenser into the better variety which have come into popularity of late. A comprehensive article dealing with the subject describes several different types of dials and how they perform their function.

* * *

Did you know the number of types of audio frequency amplifiers there are? If so, can you name them in the order of their relative merits? Which is the most efficient? Which produces the greatest volume? The best reproduction? These are important questions, yet few can answer them correctly. To fulfill a breach left open, a complete discussion on the various types, giving their theory of operation, characteristics and other important notations, is supplemented with diagrams, photos and curves showing the exact relationship and value of each. Constructional details are also given so that the reader may build the type he prefers and get the best results from it. The article is the first of its kind we have ever seen published.

* * *

So that radiation may be prevented and interference cut down to a minimum, a symposium on the means of doing it has been written in popular style and explains how to successfully cope with the situation. The fundamental principle of a radiation eliminator has been fully described and its practical application has been demonstrated to the attainment of a successful end. Those who suffer from interference troubles are warmly recommended to review the article.

* * *

Working in the radio field, in an endeavor to aid the art by contributing helpful advice and suggestions, *The Radio News* Laboratories have not been slow in realizing the wonderful possibilities involved. Every month there appears a new series of experiments the results of which are given for the benefit of the readers. In the current issue, a method of testing condensers, which is easy to follow, is fully described and all details concerning the procedure is carefully and clearly given. For the man eager to learn the intricacies of radio and to obtain a more firm foundation in its underlying principles and application to existing problems, the series of reports and experiments as explained each month, is alone well worth the price of the magazine.

To our mind, a department such as this fulfills a long-felt want and that it does more good to the reader than to have technical discussions which many do not comprehend and which many more do not want to read.

If you are an amateur you will appreciate the title of an article which deals with the conduct and layout of an amateur station. "Why Run a Junk Shop" seems to be rather abrupt and blunt, but it is the logical way to present the question. Many of the amateurs are a bit careless in the manner in which their shack is kept and in but very few of them we will find a condition bordering upon scrupulous cleanliness and neatness. Such an ideal condition is not always possible, as the erstwhile ham is continually trying new experiments and doing a thousand and one things which add to clutter up the place and give it the air of a busy dive.

* * *

We are afraid that the author of the article does not do justice to the conscientious experimenter who has been to so large an extent an active contributor to the art of radio. It is one thing to preach idealism and another distinct thing to practice it. The American amateur in his shack or bedroom laboratory has done a great deal, and the romance which the unkempt surroundings of a million loose wires, batteries, dials and knobs and switches have held no fear for him. Given a junk shop, he can create a real laboratory, but what's the difference? Looks don't count in experimental radio. Ask the amateur. He knows.

* * *

Are you getting the most from your crystal set? If you still have such a set, and some of them are very good ones, you will find a few good pointers in an article which deals with the very subject. The crystal has several very good advantages over the tube and as a result has not been entirely discarded. Many reflex sets employ crystal detectors and excellent tonal quality is afforded. Suggestions are given to enable the beginner to choose the proper kind of crystal and how to improve the range and sharpness in tuning. The function of the wave-trap is clarified and the use of a buzzer exciter is depicted in clear language. The author who is well-known to the radio enthusiasts as a prominent writer, has invoked his clearest style and has written so that the uninitiated can readily grasp the threads and follow the simple outline. This is another point we wish to bring out. Many other magazines lose sight of the fact that there are a great number of beginners who need catering to and publish only articles of highly technical information. We are happy to see that *Radio News* is keeping the beginner in mind.

* * *

The departments are unusually interesting this month—the Radiotics, for example, being full of new jokes and funny remarks. It is evident from the new items reported as tested and being OK, that the *Radio News* laboratories are busily engaged in weighing the merits of the products of different manufacturers. The page entitled Correspondence from Readers is worth reading, since it contains letters which form a wide opinion on certain subjects.

We must admit that the "I Want To Know" department is the very best medium which we have ever come across in which questions and answers of real worth are given. The material contained in that department is easily the most up-to-date reading matter we've seen in a long while. The departmental editor is to be commended for his painstaking and thorough work.

* * *

In summing up our comments on *Radio News* for the month of November, we would like to say that the issue contains such material which is of general interest both to the layman and advanced technician. Along with this the editors have given their readers an opportunity to show their mettle and have inaugurated a novel contest. The front cover shows a radio receiver and a fan listening-in. It is obvious from casual inspection that several mistakes have been made in the drawing and the readers are asked to find as many as 34 of them. This we admit gives ample chance for those interested in radio to exercise their keen powers of perception.

* * *

Science and Invention

New York City, U. S. A., October, 1925.—Several of the large radio companies of the United States are now conducting experiments with high power or superpower broadcasting stations. Whether or not such stations will be acceptable to the radio public is a question that cannot be readily answered. However, all sides of it are considered in the article entitled "Superpower—Is It Here To Stay?" Just what the radio fan will have to do if superpower comes to stay is discussed and three types of sets that will aid considerably in tuning out interference from nearby superpower stations are illustrated.

* * *

Radio has become such an integral part of our life that it is now used in many different ways other than the broadcasting of entertainment. Many of these ways are interestingly described in the article enttiled "Radio As An Aid To Humanity."

* * *

An excellent discourse on short-wave reception is given under the head of "Converting Your Tuner To Short Waves." Here the reader is shown how an ordinary three-circuit coupler can be rewound to receive from short-wave stations. Data is given which will enable anyone to make the required changes.

* * *

Under the title "Hints for the Radio Builder" many little kinks that will be of interest to all experimenters are given.

More and more radio fans are becoming interested in radio transmission. An article that will fulfill a long felt want is that coming under the general head of "The Radio Constructor" and which describes the construction of a low powered C. W. and phone transmitter. This set operates on an ordinary amplifying tube and will give excellent results.

* * *

In the Radio Oracle Department many questions of interest to all are answered in simple detail.

* * *

The EXPERIMENTER

New York, U. S. A., November, 1925.—As a foreword, *The Experimenter* is a magazine devoted entirely to experimental electricity, chemistry and radio. Each month, the latest new experimental researches and advances are written in a clear and interesting style, by leading scientists and experimenters. The radio department is of especial importance to those following the progress of the art and almost every month, a decidedly new discovery is fully detailed. Other subjects are carefully and accurately reviewed and the reader may well rest assured that the contents of articles appearing in *The Experimenter* are vouched for as authentic.

* * *

"The Luludyne" is a highly absorbing and amusing article dealing with the perfection of a radio receiver which combines ease of tuning, or control, distance-getting ability, excellent reproduction and good volume. It is modeled after a girl in whose honor it was built and is supposed to fulfill all the good characteristics which are possessed by the charming young lady. Although the article conveys a good bit of humor, the author is to be commended upon the manner in which he handled the story and interspersed technical facts and explicit reasons where it was necessary.

Upon a careful study of the receiver we find that the author has not overstepped himself in calling it the very best to build. It consists of a low-loss regenerative detector to which audio frequency of the highest quality is added. One stage of transformer coupled and three stages of resistance coupled comprise the excellent amplifier unit which gives such exceedingly fine reproduction.

We would suggest that the one who is intending to construct a five-tube radio receiver, read the article and follow the instructions given. He will make no mistake and will always be thankful for the advice. The receiver will answer his every need and will be something of which he will be proud.

* * *

In the third of a splendid series of articles on "Sound and Audio Frequency Amplification" will be found valuable information on the resistance-coupled amplifier and its design and construction. Every specification made is followed by a plausible reason which explains just why that specific part has been specified. In other words, the author does not merely say something and let it go at that. All his statements are fully substantiated by facts and the reader does not have to stretch his imagination nor display any incredulity. The discussion is not allowed to become too technical and anyone acquainted with the simplest rudimentary knowledge can readily understand.

Thus, for instance, the statement is made that the resistance-coupled amplifier is in reality capacity-coupled. And in truth it is. The coupling capacity is a main factor which many manufacturers have more or less disregarded, with the result that the resistance-coupled amplifier has not as yet reached its highest stage of perfection. The author points out the trouble and gives the remedy in logical fashion. And to back his statements, he describes the construction of the most perfect type of amplifier using resistance coupling. Anyone who can listen to reason and loves to read logic, will greatly enjoy reading this article by Theodore H. Nakken, well-known research engineer and scientist. It is heartily recommended to all.

* * *

Pages after pages have been written on the construction and supposed use of the wave-meter. Frankly, we must admit that we have read many of these nondescript manuscripts, but although in many instances, the writer gave full constructional details, he invariably spoiled everything by failing to conclude the article with at least a brief resume of the correct use and application of the wave-meter to radio receivers and transmitters. We have finally come across such an article which we can say is complete in its scope. The author has forseen the situation, and has gone at length into the many and varied uses of the wave-meter. It does us good to see a story which conveys real information and which is valuable.

* * *

An audio frequency modulated radio frequency oscillator may sound rather complicated, but in reality such a device is as handy as a wave-meter and finds many more uses. We find the one described to be an oscillator capable of generating frequencies over two ranges, a short-wave and long-wave range. The modulator is a small buzzer and is operated on the same battery which lights the filament of the tube. A pickup coil and variometer are included in the outfit and the average experimenter will find it to be very reasonable in cost. Receivers can be tested, calibrated and compared, transmitters can be checked up and CW signals can be heterodyned, other signals measured and other uses found for such an indispensable adjunct to the radio laboratory.

* * *

A regular feature in *The Experimenter* is the double page containing the data sheets—something we have failed to notice in other contemporary magazines. The beginner will find these data sheets of inestimable value, as all the important information on the various allied subjects are condensed into concise and well written material. They are arranged to be saved in a book.

* * *

The relations between the amateur and broadcast listener are very well shown in an article by the Assistant Radio Inspector of the Ninth Governmental District. When one is apt to blame the other for creating interference, the possible causes should be gone over, with the view in mind to prevent antagonism amongst neighbors. All sources of interference troubles are carefully complied into respective lists and indexed. Tracing down trouble is made an easy task and the process of deduction and inference is admirably shown in beautiful fashion.

The story has a moral and that is never to be hasty in condemning before ascertaining. And that, we all must agree pertains not only to our radio troubles!

The article is nicely illustrated and rather than state the full details, it will suffice to say that the famous Bull Montana is depicted as "The Thinker"—with due apologies to Rodin.

* * *

In general, we would say that the November issue of *The Experimenter* shows a decided tendency towards progress. The articles are all well written and in an easy style which appeals to even the mind which cannot grasp subjects very easily. What pleases us most is that no exaggerations are made and no gross statements find their way into the magazine—a condition which prevails in many instances in some other publications, in order to incite comment from the inexperienced layman, but which usually brings down an avalanche of refutations from those who know.

"The truth and nothing but the truth" is indeed an excellent medium to abide by, but it is shameful the way some magazines lay claim to bringing forth to the unwary public, what is heralded as being the best ever. Usually, along with these claims, the magazine containing them is lauded by its publishers as the best authority on the market. And many people do believe it until they find out the truth. If ever you are in doubt concerning certain so-called inside information ask the one who knows. Ask the amateurs who you will find patronize only those magazines which convey real authentic "dope." We are happy to know that *The Experimenter* is one of these. Its articles prove it.

* * *

THE NEW YORK HERALD
New York Tribune
RADIO MAGAZINE

New York City, U. S. A., August 30, 1925.—A rather interesting radio fiction story leads this issue.

A multi-tube receiver of somewhat conventional design yet interesting for its compactness and simple circuit is described in the article entitled "Directions for Constructing and Operating a Six-Tube Super-Autodyne."

* * *

Real laboratory receiving sets that are adaptable to various circuits usually are made up in unit form. Such a combination is described under the head of "Directions for Constructing a Laboratory Type Three-Tube Receiver." The rather unique construction of the instruments is the most interesting part of this article as otherwise the circuit is quite conventional.

* * *

One thing that we all like to do is to keep our set in perfect working order at all times. How to do this is the subject of a short, snappy discussion entitled, "How to Keep Your Set in A-1 Condition On All Occasions."

* * *

The National
Radio Weekly
HERALD-EXAMINER
The Radio Magazine with the Greatest Circulation in the World

Chicago, Ill., U. S. A., August 23, 1925.—A set of simple design and good working qualities is described in the "Radio Work-Bench" section. Using three tubes, it is designed to operate on a loop aerial with fairly good results.

* * *

The Telegram-MAIL
Radio Section

New York City, U. S. A., August 29, 1925.—If we could eliminate static from our radio receiving sets we would have made another step forward in the art of radio reception. Up to the present time this is not possible but, on the other hand, static can be reduced quite a little. Several methods are discussed under the head of "The Latest Theoretical Static Reducers." A discussion of early experiments along this line is given. The construction of a static reducing unit to be used with any receiving set is given in detail.

Some interesting experimental work can be done with large loop aerials if you have the room for erecting the same. Some data on work of this nature will be found in the article entitled "A Radio Compass Loop for Your Receiver." Although concise details are not given, still sufficient material is presented to enable anyone with some knowledge of radio to go ahead with the work and find out some interesting facts for himself.

* * *

September 5, 1925.—It is often said that radio sets should be mounted on the finest of insulating panels. This is not always true as evidenced by the material presented in the article entitled "An Efficient All Wood Mounted Transmitter." It is advised that all transmitting amateurs look up this article as they will find much of general interest contained in it.

The addition of a single stage radio frequency amplifier is not always a satisfactory one and those who wish to use this system and make something really good out of it should read the article entitled "More Power to the One Step R. F. Amplifier."

* * *

Sometimes experimenters find that when they build too compact a set the results are not all that could be desired. If, however, the various points detailed in the article entitled "Save Space Without Loss of Efficiency" are followed, all that can be desired in the way of results should be obtained.

* * *

The Sun
RADIO SECTION

New York City, U. S. A., August 29, 1925.—Some very good information regarding resistance coupled audio frequency amplification appears under the title of "Ins and Outs of Resistance Coupling." This article is said to be the result of a complete laboratory analysis of the relative merits of transformer and resistance coupling. From a theoretical standpoint it should interest every radio student.

* * *

Toroidal coils and resistance coupling are items that are comparatively new to the radio broadcast fan and a combination article dealing with the two should be of great interest. This particular article describes a set that uses both thoroidal coil and resistance coupling with very good results.

* * *

September 5, 1925.—The section of a radio receiver where most of the volume originates is in the second or third stage of audio frequency amplification. Therefore, it is well to select a tube that will give the very best of results in this particular location. How to do this is told in the article entitled "A Test of Power Tubes."

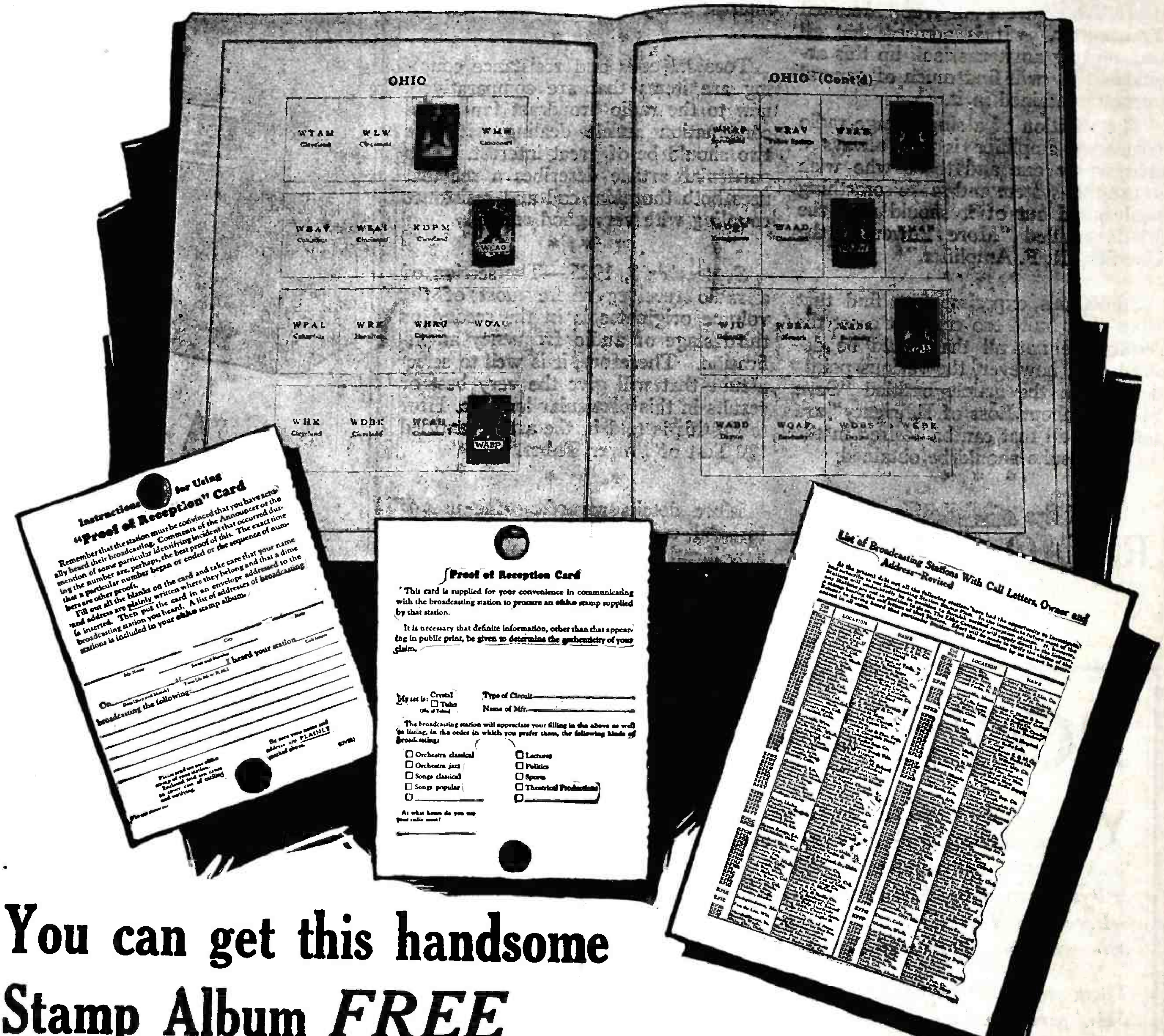
* * *

More details regarding the use of toroidal coils and resistance coupled amplification are presented in this issue.

* * *

The New Radio Stamp Fad

Here is the DX Radio Stamp Album just like the ones we owned in our youth, in which were placed the rare stamps of the countries of the world. Some were hard to get, some couldn't be purchased for love or money; but the fun of the hobby was the seeking of rare stamps and the eventual possession. So it will be with the DX Radio Stamp Album. There will probably be some stamps you will never be able to own, but there will be many you will be proud to have and be able to show to other radio enthusiasts. It's an interesting game. Below the Album is shown the "Proof of Reception Cards" of which a generous supply is furnished with each Album. A dime placed in the hole in the card and sent to the station you heard brings back a stamp for your Album.



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This beautiful EKKO Stamp Album, illustrated above, will be given away absolutely free with a subscription to any one of our four magazines: *"Radio News," "Science and Invention," "The Experimenter," "Motor Camper and Tourist."*

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The album consists of 96 pages, size 9 x 12 and is bound in extra heavy stiff cover.

With the Album is furnished a large Crams comprehensive radio map of the United States and Canada; a supply of "Proof of Reception Cards" and also some stickers. The Album contains a list of broadcast stations of the United States and Canada with wave-lengths and columns for recording dial setting, a table of stations arranged according to wave-lengths and a section for log records.

We have acquired 1,000 of these Albums especially for our subscribers. The coupon on this page filled out and mailed to us with $2.50 will entitle you to a twelve months' subscription to any one of our four magazines and one of these EKKO Stamp Albums free.

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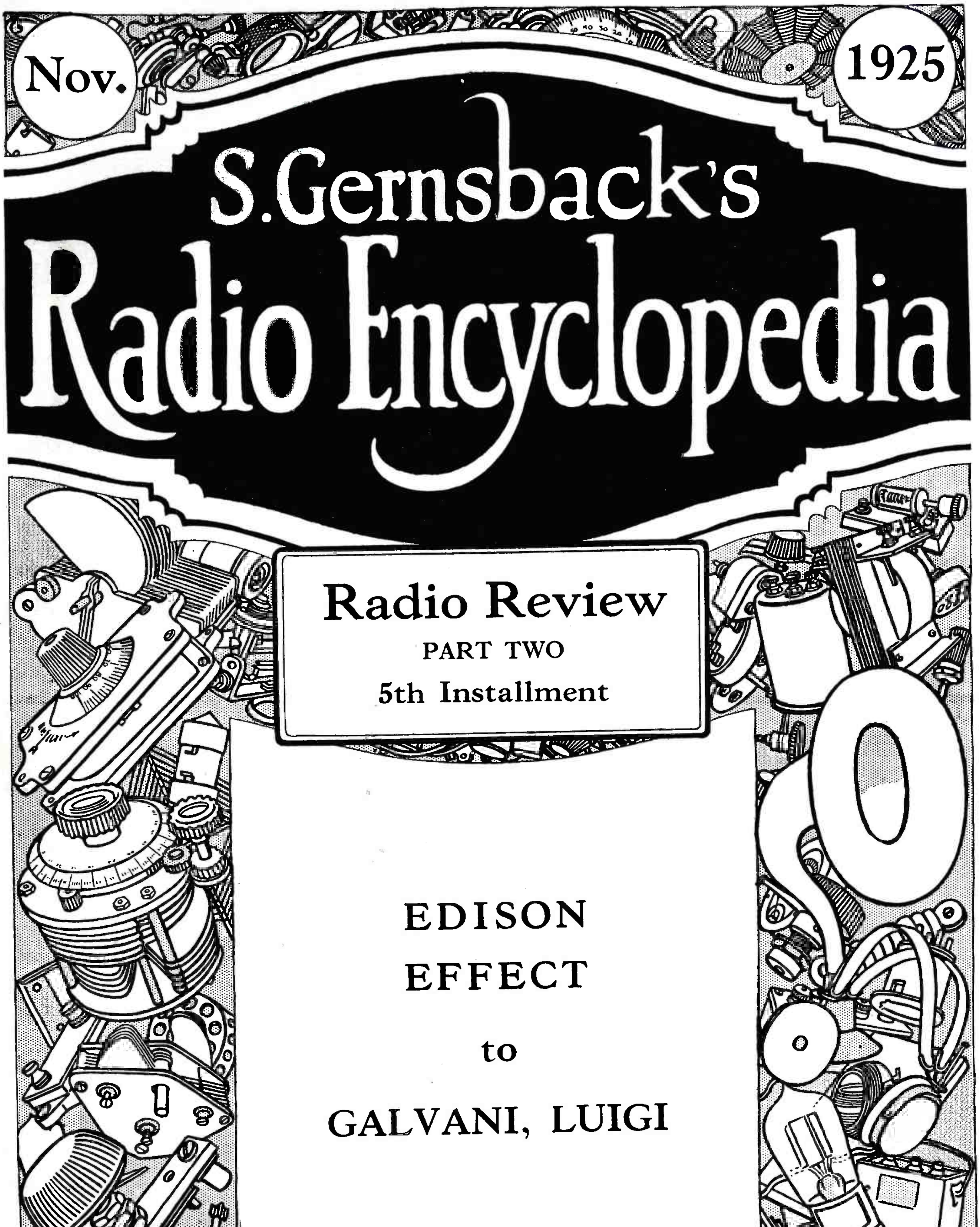


Nov. 1925

S. Gernsback's Radio Encyclopedia

Radio Review

PART TWO

5th Installment

EDISON EFFECT

to

GALVANI, LUIGI

PREVIOUS INSTALLMENTS

FIRST INSTALLMENT — Consisting of definitions from "A" BATTERY to ARC OSCILLATOR contained in May 1925 issue of Radio Review, Vol. 1, No. 1.

SECOND INSTALLMENT — Consisting of definitions from ARC SPARK to CAPACITY OF CONDENSERS IN PARALLEL contained in July 1925 issue of Radio Review, Vol. 1, No. 2.

THIRD INSTALLMENT — Consisting of definitions from CAPACITY OF CONDENSERS IN SERIES to COUPLING COEFFICIENT contained in September 1925 issue of Radio Review, Vol. 1, No. 3.

FOURTH INSTALLMENT — Consisting of definitions from COUPLING, DEGREE OF to EDISON, THOMAS A. contained in October, 1925, issue, of Radio Review, Vol. 1, No. 4.

ERRATUM

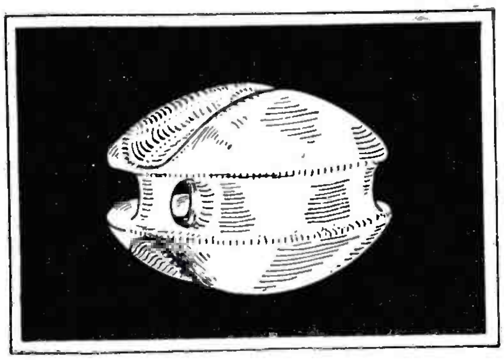
In the July issue of *Radio Review,* the definition in the Encyclopedia under the heading *The Brown & Sharpe Copper Wire Gauge* contained an error. In the third and fourth columns this should read: If the resistance per one thousand feet of a certain size wire is, say, 50 ohms, then 500 feet of the same size wire would have a proportionately less amount of resistance, or ½ of 50 ohms, that is 25 ohms.

EDISON EFFECT—The blackening of the inner surface of an electric light bulb during use. Edison noticed that after the lamp had been burned for some time a coating of black formed on the inner surface and increased in density, becoming finally almost opaque. Edison's experiments, followed by those of *Professor Fleming* (q.v.) resulted in the development of the *Fleming valve* (q.v.)., it having been determined that the black coating was due to the discharge of *electrons* from the hot *filament*. (See *Vacuum Tube, Electron Emission*, etc.)

EFFICIENCY—A very flexible term in electrical practice. Generally speaking, the ratio of useful output of any piece of apparatus to total input. Efficiency is customarily expressed in terms of percentage. Thus, broadly, a piece of apparatus may produce as useful output 80 per cent of the total input. (See *Power Factor*.)

EFFECTIVE ELECTROMOTIVE FORCE—The square root of the mean square of the full alternating current wave. Usually abbreviated R. M. S. (root—mean—square). The effective value of the E. M. F. (electromotive force) is thus taken as the square root of the mean of the squares of the *instantaneous values* over a complete period. (See *Instantaneous Values*.)

EGG INSULATOR—A name applied to a certain type of *strain insulator* due to its egg-like form. The illustration shows such an insulator. The two con-



An egg insulator.

nections to the insulators are so arranged that the wires will still be looped together in the event that the insulator breaks. (See *Insulator*, also *Insulation of Aerial*.)

ELASTICITY—A property of matter which permits it to resist any change in shape or bulk and permits it after such a change to return to its original state. This property of materials by virtue of which they are enabled to return to their original state after the force causing the distortion has been removed is a very important one in all branches of engineering. Its chief application in radio is in the matter of aerials and aerial guy wires. While the average aerial installation does not represent any serious problems in stress, the large aerial systems of commerial stations must be carefully designed in this respect. For example, a guy wire of one material may have more elasticity than one of similar size in another material. The amount which the wire will stretch under a certain load may be determined by use of a table giving the elasticity of various metals. (See *Electric Elasticity*.)

ELECTRIC ABSORPTION—An effect in *condensers*. That quality of a condenser by means of which it absorbs or "soaks up" a charge of electricity, and conversely, retains part of the charge when the condenser is momentarily discharged. This effect is more apparent in cases where a solid *dielectric* material is used. In fact, *air condensers* (q.v.) are said to have little electric absorption. The reason for this is that mica or other solid dielectrics are strained to a greater extent than air dielectric after the condenser has received a charge. (See *Soaking In*, also *Dielectric Absorption*.)

ELECTRIC DISPLACEMENT—A term proposed by Maxwell to denote a quantity expressing the state or condition of a dielectric in an electric field in accordance with the supposition that such a field is created by the transfer of positive electricity to one end of the field of force and negative electricity to the other end of the so-called *tubes of force* (q.v.). (See *Displacement Current*, also *Electrostatic Induction*, and *Flux Density, Electrostatic*.)

ELECTRIC ELASTICITY—In a dielectric material, the property which permits it to arrest passage of a *displacement current* (q.v.) due to electric stress. It is equivalent to the electric stress divided by the electric strain. (See *Dielectric*, also *Displacement Current*.)

ELECTRIC FIELD—The area surrounding an electrified body in which the electrical influence of that body can be measured or noticed. Also any area or region in which there is an electric force either steady or varying in intensity. For example, the *dielectric* or insulating surface of a *condenser* (material separating the plates) contains an electric field. Similarly, an electric field always surrounds a wire or other conductor carrying electric current. (See *Field, Magnetic; Field, Electromagnetic; Field, Electrostatic;* also *Flux*.)

ELECTRIC INDUCTION—The transfer of an electric state from a charged or electrified body to a non-electrified body without electrical contact. (See *Induction*.)

ELECTRICITY—The term given to an invisible form of energy. Electricity is not tangible to the human senses, but its effects can readily be detected. The phenomenon of electricity is regarded as due to the separation and independent movement of constituent parts of atoms—known as *electrons*. While electricity is really an intangible thing so far as the human perceptions are concerned, it is known to science not only through its effects or manifestations of energy, but has actually been reduced to quantities. The mass of electricity has been determined, as has also the *rate of flow*, etc. We have units which are used for the basis of all calculations in electricity. Thus, *voltage* is regarded as the propelling force; the quantity of electricity is given in *coulombs*, the *current* or rate of flow of electricity is given in *amperes*, etc. Each term for the various phases of electricity is based on a certain unit which represents definite values under given conditions. The universally accepted theory in chemistry is that all matter is made up of molecules, which in turn are composed of one or more atoms. These atoms now are regarded as comprising minute solar systems made up of positive and negative electrical particles. (For more complete explanation of the *electron theory* see *Electron Theory*; see also *Magnetism, Current, Voltage*.)

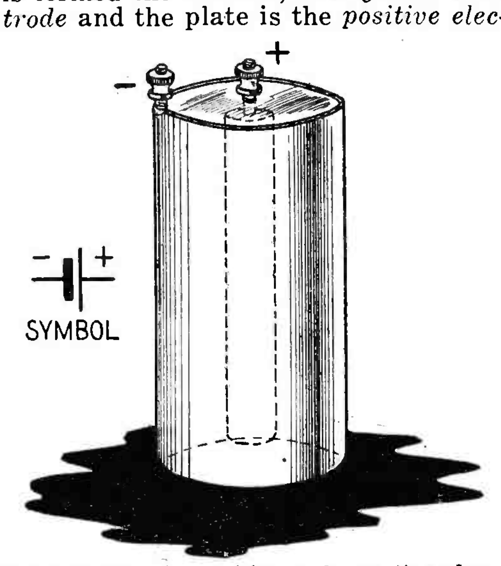
ELECTRO-CHEMICAL CONDENSER—See *Electrolytic Condenser*.

ELECTRO-CHEMICAL EQUIVALENT—The amount of a substance liberated by *electrolytic action* (electrolysis) by the passage of one *coulomb* (q.v.) of electric current. It represents the weight in grams of each element of an *electrolyte* (q.v.) which is deposited by one coulomb of electricity. It has been determined that one coulomb will liberate .00001035 grams of hydrogen, which is therefore used as the electro-chemical equivalent of hydrogen. Electro-chemical equivalents are much used in applying the law of electrolysis. This law states that the amount (weight) of an *ion* liberated at an *electrode* each second during *electrolysis* is equal to the strength of the *current* (amperes) multiplied by the electro-chemical equivalent. The corresponding equivalents of other elements compared to hydrogen may be determined by multiplying the figure .00001035 by the atomic weight of the other element in grams and dividing the result by the *valency* (q.v.) of the element in question. (See *Electrolysis*, also *Electrolyte*.)

ELECTRO-CHEMICAL SERIES—A table of metals arranged in accordance with the *potential* they produce in a particular *electrolytic* solution.

ELECTRO-CHEMISTRY—The science dealing with chemical changes due to electricity or effected by means of electricity. (See *Electrolysis*, also *Cell*, and *Storage Batteries*.)

ELECTRODE—The conductor through which electric current enters or leaves an electrical device. That is to say the pole or terminal of the current carrying conductors separated by a medium through which electric current can flow from one to the other. The most common usage of the term is in referring to the *positive* and *negative* poles (q.v.) of a *primary* or *storage cell*. In the case of a *dry cell*, the two electrodes are the carbon rod or block in the center and the zinc container in most cases. In radio it is used to designate the *filament* and *plate* elements of a vacuum tube. The filament is termed the *cathode*, or *negative electrode* and the plate is the *positive elec-*



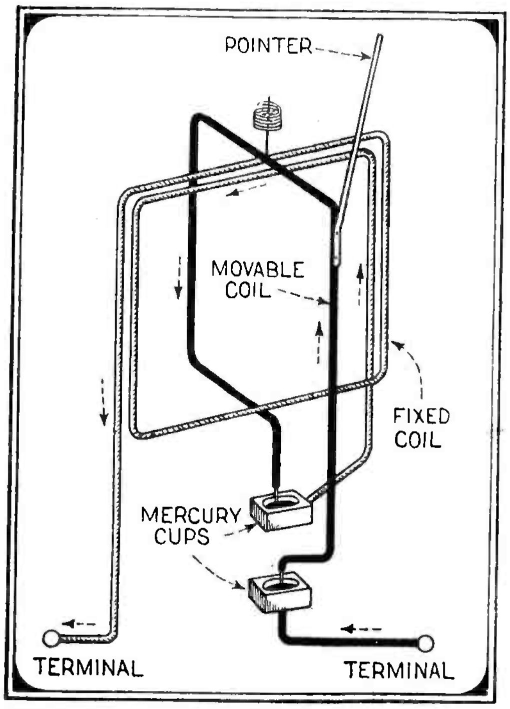
Dry cell showing positive and negative electrodes.

trode or *anode*. The illustration shows an ordinary *dry cell* or *primary cell* with the two electrodes designated as positive and negative. (See *Anode, Cathode, Battery, Electrolysis, Positive Electrode* and *Negative Electrode*.)

ELECTRODYNAMIC—Term used to denote electric currents or the forces exerted by one current upon another.

ELECTRO-DYNAMICS—A branch of the science of electricity dealing with electricity in motion; the study of the force exerted by electric currents upon each other. This branch of electricity was first accorded serious attention when the French scientist, *A. M. Ampere* (q.v.) announced the result of his investigations in collaboration with D. F. J. Arago. Ampere stated in 1820 that *parallel conductors* through which electric currents were flowing in the same direction had a tendency to be attracted to each other and to be repelled when the currents were flowing in opposite directions. The subject is discussed under its various separate headings. (See *Ampere, Electricity, Magnetism.*)

ELECTRO-DYNAMOMETER—A device for measuring the *current* and *voltage* in a circuit; that is, the actual power in a circuit. It is a form of *wattmeter* (q.v.) designed to indicate the power in *watts*. It is of particular importance in measuring the power in *alternating current* circuits. In the case of *direct current*, the watts in the circuit are the product of the volts multiplied by the amperes, the result being the actual power. In the case of alternating current, however, the product of the volts and amperes is not necessarily, in fact, seldom, the true power or watts. Here we have the problem of true watts and apparent watts, or volt-amperes. If a voltmeter and an ammeter are connected in a circuit and read separately, the readings indicate the maximum voltage and the maximum current or amperage. The product of these two values is the power in watts in a direct current circuit. If the current is an alternating one, the true watts or actual power will be the product of the *instantaneous values* (q.v.) of voltage and current. Under certain conditions in a circuit carrying alternating currents, the current may lag behind or precede the voltage. In other words, the maximum value of current is not reached at the same moment as the maximum value of the voltage. In this case the true watts can only be determined by obtaining the values of volts and amperes at the same instant, i.e., instantaneous values. The electro-dynamometer shown in the illustration gives the instantaneous values, or rather their product, and thus indicates the power or true watts. Here the heavy lines represent the current or moving coil and the light lines the stationary or voltage coil. (See *Dynamometer*, also *Wattmeter.*)



Electro-dynamometer with the current or moving coil shown by heavy lines and the stationary or voltage coil by light lines.

ELECTROLINES—A term advanced by *Professor J. A. Fleming* (q.v.) to designate the lines of electric force radiating from an electron. These lines are pictured as analogous to long straight wires extending in all directions from the center of a small sphere. (See *Electron*, also *Electromagnetic Waves.*)

ELECTROLYSIS—The decomposition of a comopund substance, generally a liquid, into its component parts by the action of an electric current passing through it. While electrolysis is an undesired effect in certain phases of electrical power work, causing composition of grounded structures, its application to radio is mainly in the case of cells for producing an *electromotive force* or to furnish current for lighting tubes. The constituent elements of a chemical compound such as used in a wet cell or any device using an electrolyte for the production of electric current, are known as *ions* (q.v.). These ions, which are separated during electrolysis, are of two kinds. The electro-positive ions are known as *cations*, and the electro-negative ions are known as *anions*. The electro-positive ions appear at the cathode or negative electrode during electrolysis and therefore are of positive origin. The electro-negative ions appear at the positive electrode and are therefore of negative origin. This is easily understood when the ions are considered as moving from the positive electrode or to the negative. Thus the ions appearing at the negative electrode must have come from the positive electrode and are therefore considered electro-positive in nature. The illustration shows the action of the ions in a typical *primary cell* (q.v.). The ions are considered as carrying the current through the electrolyte—each ion carrying a fixed charge of electricity of positive or negative nature. An ion is capable of carrying only a certain fixed charge of electricity and therefore any increase in the current will necessarily be accomplished by an increase in the number of ions. (See *Primary Cell, Electrolyte, Electrolytic Detector, Interrupter* and *Condenser.*)

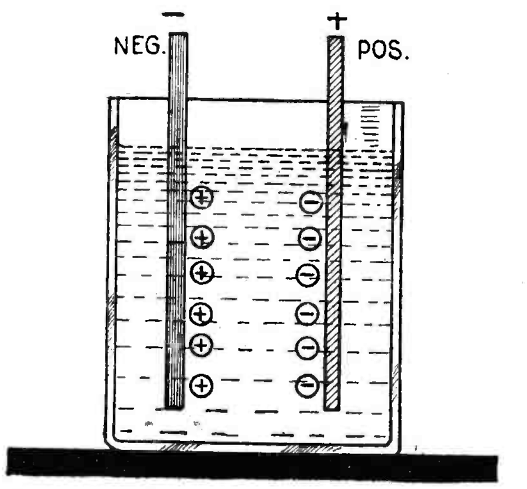


Illustration showing the action of ions in a primary cell.

ELECTROLYTE—The liquid decomposed during electrolysis, as the exciting fluid or solution in a wet cell or primary cell. The liquid used in any primary, secondary or electrolytic cell. (See *Cell*, also *Storage Battery.*)

ELECTROLYTIC ACTION—The decomposition of a chemical compound (electrolyte) into its constituent elements—ions, by the passage of an electric current through it. (See *Electrolysis, Ions*, also *Cell.*)

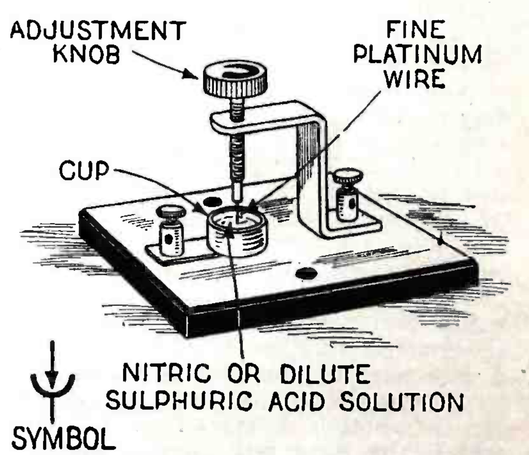
ELECTROLYTIC BATTERY CHARGER—A device for converting alternating current such as supplied for house lighting purposes, to direct current for the purpose of charging storage batteries. Essentially one or more cells containing an electrolyte and two metal electrodes, generally lead and aluminum, so arranged that current can only pass in one direction, thus making it uni-directional and suitable for charging batteries. Such chargers are arranged to rectify either one-half of the alternating current cycle, or both halves of the wave. (See *Charger, Storage Battery, Electrolytic Rectifier*, also *Electrolytic Cell.*).

ELECTROLYTIC CELL—An arrangement of two *electrodes* in an electrolyte through which electric current can be passed to produce electrolysis. The electrolyte is decomposed or separated into ions by the action of the current, and at each of the electrodes one of the substances of which the electrolyte is composed accumulates. Such a cell is often used to measure electric current, as the amount of a substance deposited on the electrode depends directly on the amount of current passed through the electrolyte. (See *Electrolysis.*)

ELECTROLYTIC CONDENSER—A form of condenser making use of two electrodes placed in an electrolyte and used for alternating current circuits of high voltage and low frequency, low voltage and high frequency or high voltage and high frequency. The action of such an arrangement as a condenser depends on the fact that upon the passage of certain forms of alternating currents through it, a gas is formed around the electrodes, causing *polarization* (q.v.) and opposing the current. This polarization creates a very good insulating medium and a condenser of such nature can be made to have very high capacity. An electrolytic condenser may be used to prevent any sudden surge of pressure due to lightning or other causes. The polarization is instantaneous when any surge of voltage takes place and thus forms an automatic safety device which operates instantly and returns to its normal characteristics as a condenser as soon as the surge has passed. (See *Capacity*, also *Condenser.*)

ELECTROLYTIC CONDUCTION—The action in an electrolyte wherein the ions that have been separated carry positive and negative electric charges in opposite directions to the electrodes. (See *Electrolysis.*)

ELECTROLYTIC DETECTOR A device which converts high frequency currents into direct current pulsations capable of operating a telephone receiver. It is an extremely sensitive detector of electromagnetic waves (radio signals). The illustration shows a simple form as originally used in place of the customary crystal detector. A fine platinum wire dips into a

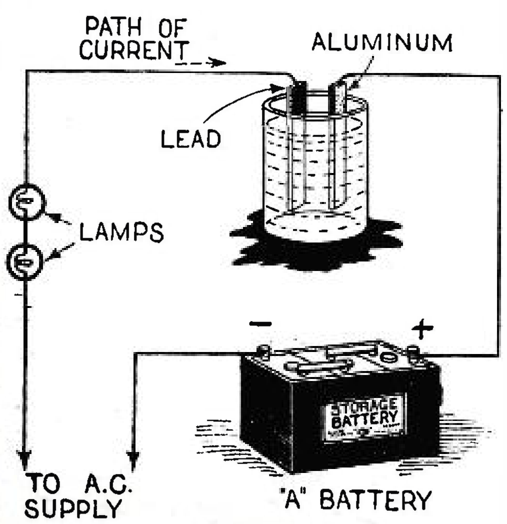


Electrolytic detector originally used in place of a crystal detector for radio reception.

cup of acid solution, generally either nitric or dilute sulphuric. The fine wire is lowered until it just touches the acid solution and must be very carefully adjusted as it has a tendency to curl up, its diameter being usually but one five thousandth of an inch or less. The high frequency currents can pass in only one direction through the detector which gives the rectifying action and makes the signals audible in the head phones. There are several theories regarding the action of an electrolytic detector, the most probable one being that the contact of the wire on the surface of the acid solution gives the effect of a very small *electrolytic condenser.* (q.v.) When the high frequency currents are passed through the detector there is a polarization action which causes high resistance to current in one direction but not in the other. (See *Detector*, also *Polarization.*)

ELECTROLYTIC INTERRUPTER—A device using electrodes immersed in an electrolyte for the purpose of interrupting or breaking up the flow of current. It is used mainly for induction coils for producing high voltages. The common form comprises a lead plate as a cathode or negative element and a platinum wire extending beyond a glass or porcelain tube in which it is tightly imbedded, both immersed in an electrolyte of dilute sulphuric acid. When current passes through, bubbles form on the platinum electrode causing temporary stoppage of the current. The bubbles are automatically dissipated and the current flows again, this operation occurring at rapid intervals and giving as many as 1000 interruptions per second. (See *Interrupter*, also *Induction Coil.*)

ELECTROLYTIC RECTIFIER—A device for changing alternating current into direct current by use of electrodes placed in an electrolytic solution. The action of such electrolytic cells or rectifiers is to permit current to pass only in one direction, thus suppressing one half of each cycle and producing a direct current. The illustration shows

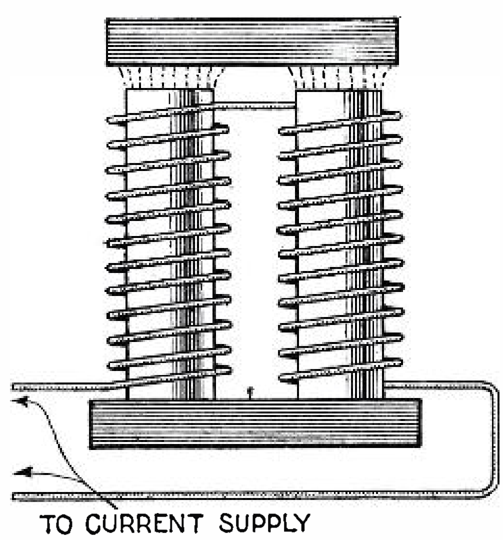


Customary method of electrolytic rectification.

one of the customary arrangements for electrolytic rectification, being an electrolytic cell with two electrodes, one being aluminum and the other a lead electrode. One or more lamps are placed in series or shunt in the circuit to permit the proper current flow. The positive pole of a storage battery is connected to the aluminum plate as shown and the lead electrode connects to the other side of the alternating current line and back to the negative side of the battery. At one instant current flows in the normal direction through the battery, but when the current reverses and flows in the opposite direction through the electrolytic cell, oxygen is given off at the aluminum electrode and forms a thin film of aluminum oxide which acts as an insulator and prevents the passage of the current in that direction. Thus with one cell one half of each alternating current cycle is stopped or cut off when the aluminum electrode is made positive and the result is an intermittent direct current suitable for charging batteries. Such rectifiers are also used for supplying current to the filaments of vacuum tubes, or voltage to the plate members of the tubes, particularly for transmitting. (See *Electrolytic Rectifier Full Wave*, also *Balkite Battery Charger.*)

ELECTROLYTIC RECTIFIER FULL WAVE—This system is much used for charging storage batteries from an alternating current house lighting supply. Four cells are used in this instance. The electrolyte may be a solution of hydrolchloric or sulphuric acid, or a saturated solution of sodium phosphate or bicarbonate of soda. Each cell has two electrodes, one iron or aluminum and the other lead. The positive pole of the storage battery is connected to the lead electrodes of two cells and the negative pole is connected to the aluminum electrodes of two cells. By this means both halves of the alternating current cycle are rectified to direct, pulsating current. This is known as *full wave rectification* (q.v.) (See *Charger, Storage Battery, Balkite Battery Charger,* also *Rectifier.*)

ELECTRO-MAGNET—A magnet using a curved or straight piece of soft iron or other magnetic material so arranged as to become magnetized by the passage of electric current through a coil of wire surrounding it. The illustration shows one of the commonest forms of electro-magnet. This type is used



One of the common forms of electro-magnets.

in a bell or buzzer to draw down the vibrator bar and break the circuit. (For explanation of action see *Buzzer.*) When the current is withdrawn from an electro-magnet, the magnetic force or attraction ceases. Electro-magnets are used for a variety of purposes in radio, such as for test buzzers, head phones, relays, etc. (See *Magnet*, also *Magnetic Lines of Force.*)

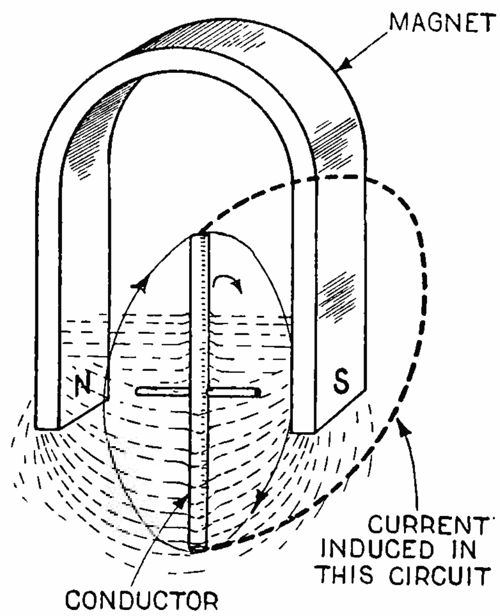
ELECTROMAGNETIC CONTROL—The control of various switches and other apparatus by means of *electromagnets*, usually through an auxiliary contact at a distant point. (See *Remote Control*, also *Electromagnet.*)

ELECTROMAGNETIC FIELD—The space understood to be filled with *electromagnetic lines of force.* (See *Flux*, also *Lines of Force.*)

ELECTROMAGNETIC FLUX—The distribution of the lines of force through an electromagnetic field. (See *Flux*, also *Lines of Force.*)

ELECTROMAGNETIC IMPULSE—An impulse or electromagnetic disturbance conveyed to the ether from a conductor carrying high frequency currents. Another term for the electromagnetic waves involved in radio. (See *Electromagnetic Waves.*)

ELECTROMAGNETIC INDUCTION — The production of electric currents through a change in a *magnetic field* (q.v.). Its production is due to a change in the number of lines of force which are linked with a conducting circuit. The simplest example of this means of producing current is shown in the illustration. Here a conductor is arranged to be moved in the immediate vicinity of a magnet, causing a change in the number of lines of force that link the conductor and creating an induced current. This current will persist only so long as the conductor con-



Simple method of producing electric currents by causing changes in the magnetic field.

tinues to be moved in the magnetic field. That is to say when there is no longer any change in the magnetic lines of force linking the conductor, there will be no current induced. The discovery of electromagnetic induction and formulation of its laws was primarily due to the scientist *Faraday* (q.v.). Faraday's law governing electromagnetic induction follows: "The induced electromotive force around any circuit is the rate of the decrease of the total flux of magnetic induction through the circuit." (See *Induction, Flux*, and *Lines of Force.*)

ELECTROMAGNETIC INSTRUMENTS —Electrical measuring instruments such as voltmeters, ammeters, etc., which depend for their action on the exertion of electromotive forces upon iron armatures. (See *Ammeter, Thermal;* also *Voltmeter.*)

ELECTROMAGNETIC MICROPHONE —A type of microphone in which the sound waves due to speech or music cause vibrations of a suspended coil in a magnetic field, inducing in the coil minute waves of electromotive force corresponding in form to the original sound waves. A form of microphone used in radiophone (broadcasting) transmission when purity of sound is an important consideration. Such a microphone requires that the induced currents be heavily amplified. (See *Microphone*, also *Speech Amplifier.*)

ELECTROMAGNETIC RADIATION—The propagation or radiation of electromagnetic waves through the ether. (See *Electromagnetic Waves*, also *Ether.*)

ELECTROMAGNETIC ATTRACTION—The attraction existing between unlike poles of electromagnets. This attraction is identical with that of two unlike poles of ordinary magnets. (See *Magnetic Attraction and Repulsion.*)

ELECTROMAGNETIC REPULSION—The tendency of two like poles of electromagnets to act against or repel each other. (See *Magnetic Attraction and Repulsion.*)

ELECTROMAGNETIC SWITCH—A switch for breaking electrical circuits by the action of an electromagnet.. (See *Electromagnet*, also *Remote Control.*)

ELECTROMAGNETIC THEORY OF LIGHT—The theory and consequent scientific proof that radio waves and light waves are practically identical in nature. Light waves travel at a tremendous speed through the ether, approximately 186,000 miles per second, which is also understood to be the velocity of electromagnetic or radio waves. (See *Electromagnetic Waves.*)

ELECTROMAGNETIC UNITS—The fundamental or absolute units employed in electricity as a basis for calculations and on which the practical units are based. The effects of electricity, and hence electricity itself, can be measured in two ways. The first is the measurement of the quantity of electricity by the force it exerts upon another stationary quantity of electricity. This is known as the *electrostatic system.* The second is by measuring the force which a given quantity of electricity exerts upon a *magnetic pole* when flowing through a nearby conductor. This is referred to as the electromagnetic system. Fundamental or absolute units are derived from the fundamental units of *length, mass* and *time.* These units are the *centimeter of length, the gramme of mass* and the *second of time.* The term centimeter-gramme-second, referring to this system, is abbreviated C.G.S. system. The practical units of electricity are known as *volts, amperes*, etc., and are based on the absolute units. (See *Electrostatic, Units, C.G.S. System*, also *Ampere, Erg, Dyne* and *Coulomb.*)

ELECTROMAGNETIC WAVES—The term applied to the energy radiated from an *antenna* in radio transmission. So called because it is understood to travel in the form of waves. One-half the energy of such a wave is electrical and the other half electromagnetic. *Electromagnetic waves* travel with the speed of light waves or approximately 186,000 miles per second. These waves are of extremely high frequency—that is, their direction changes many thousand times each second. This will be better understood by means of the illustration showing the arrangement of the electric and *magnetic fields* around a radiating antenna. Here the lines represent the electric field and the shaded portion the magnetic field. The lower loops or "feet" of these waves are assumed to pass over the surface of the earth which is a conductor. Thus when electromagnetic waves are being radiated from an antenna, circular distributions of electric charges are in the earth's surface around the antenna, these charges being alternately negative and positive, the bands of charge spreading out or radiating from the antenna in the manner shown in the illustration. These waves are subject to various influences which have a tendency to refract or reflect the waves much in the manner of light waves.

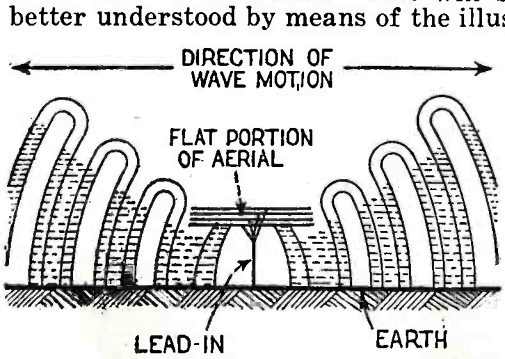


Illustration showing the arrangement of the electric and magnetic field around a radiating antenna.

As these waves move out from the antenna they gradually increase in height, although the distance between the "feet," i.e., from one wave to another, remains the same. This distance is known as the wave-length. (See *Reception of Electromagnetic Waves*, also *Wave-length, Radiation Transmission.*)

ELECTROMETER—An instrument used for measuring potential differences (voltages) and, under certain conditions, power in *watts.* The operation of the instrument depends upon the attraction or repulsion of electrostatic charges and it may be used for either direct or alternating current measurements. (See *Voltmeter, Electrostatic.*)

ELECTROMETRY—The practice or science of electrical measurement. (See *Meter, Voltmeter.*)

ELECTROMOTIVE FORCE—Symbol E or ϵ—abbreviation E.M.F. The force or electrical pressure which starts and maintains a current of electricity through a conductor. Electromotive force is commonly referred to in terms of volts and is abbreviated E.M.F. The electromotive force in electricity is analogous to the difference of level which produces pressure in pipes carrying water and forces the water to flow. Electromotive force is produced by a difference of potential, and this in turn sets up the flow of current. The illustration *Fig. 1A* shows a simple primary cell or electrolytic cell, and *Fig. 1B* is the analogous action of two tanks holding water, connected by a pipe and so arranged that the water level in one tank is higher than in the other, thus having a difference of level and creating pressure which makes the water flow. The water in tank A being at a higher level than in the other, the pressure causes the water to seek its common level and it flowed into tank B through the pipe. This flow continues as long as there is difference of level. In the case of the cell *Fig. 1A* there are two electrodes, one of which is at a higher potential than the other. That is to say, one is in a state of higher electrification than the other, causing a difference of potential and producing an electromotive force. This force is in the direction from the point of greater potential to point of lesser potential as in the case of the water, and causes a flow of current in that direction. Here the flow is from B to A in the electrolytic solution and from A to B externally through the conductor C. Thus as long as there exists a difference of potential, current will flow in an attempt to equalize the potentials. (This statement holds true only under ideal conditions. See *Polarization.*) This flow of current in the illustration *Fig. 1A* is according to *Ohm's law* (q.v.), i.e., a difference of potential of one volt will cause one ampere to flow through the external circuit when the resistance of the circuit is one ohm. (See *Ampere, Ohm, Volt, Resistance.*)

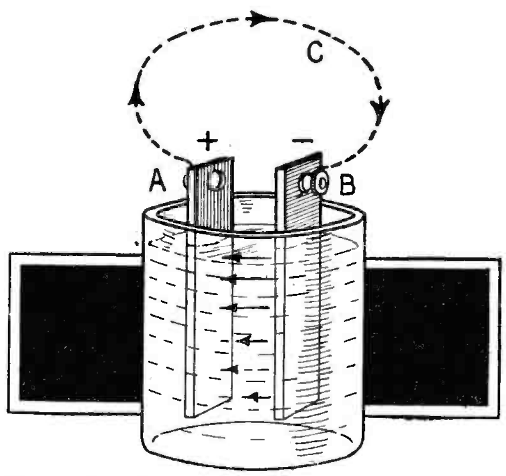


Fig. 1-A. A simple primary or electrolytic cell.

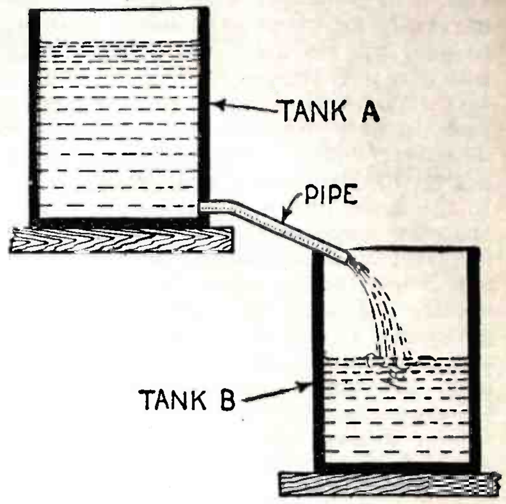


Fig. 1-B. Water in tank "A" seeks its level by discharging into tank "B" in a manner analogous to the flow of electric current where a potential difference exists.

ELECTRON—The smallest negative charge of electricity known. An English investigator, Dr. Johnstone Stoney, is credited with having named the electron, although it was so named by him in anticipation of its being isolated and measured. The actual proof of the earler assumptions was due to Sir J. J. Thomson and others, who actually measured, and in all effect weighed, the minute particles of negative electricity. (See *Electron Theory.*)

ELECTRON FLOW—The theory of movement of free electrons along a conductor through which an electric current is flowing. (See *Electron*, also *Current, Assumed Direction of Flow.*)

ELECTRON EMISSION—The emission or discharge of electrons or minute particles of negative electricity from a heated body, particularly in a vacuum. The emission of electrons in a vacuum tube is the basis of operation of all vacuum tubes as used in radio. (See *Electron Theory*, also *Vacuum Tube, Theory of Operation.*)

ELECTRON THEORY—The assumption that the atoms of all substances contain one or more particles of negative electricity, which is of course paramount to saying that all matter is electricity. These particles are known as electrons, and while the assumption is referred to as a theory, it has been rather definitely proven by numerous experiments, and electrons have actually been measured. Under the electron theory it is assumed that the charge carried by a single electron is the smallest possible charge which can exist in nature and that no charge of electricity exists or can be produced which is not an integral multiple of this charge. (Note: This is merely a mathematical way of stating that any charge of electricity is equivalent to the combined charges of a certain number of electrons.) Probably the most accurate conclusion regarding the charge carried by an electron is due to experiments carried on by Prof. A. E. Millikan of the University of California. His measurements state this charge of a single electron as being 4.77×10^{-10} electrostatic unit, which is 1.59×10^{-19} of a *coulomb* (q.v.). While the mass or weight of an electron is said to vary with its velocity, assuming

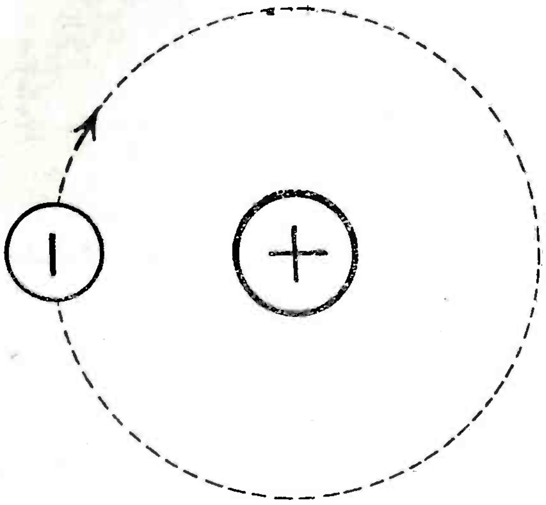


Illustration showing the electron, or negative particle, revolving around the proton or positive nucleus.

a velocity of less than one-tenth that of light, the mass will be 8.9×10^{-28} grams. This is approximately one seventeen hundredth of the weight or mass of an atom of hydrogen. For purposes of calculation the electron is assumed to be in the shape of a sphere. The radius has been estimated at approximately 10^{-13} centimeter. When it is considered that a centimeter is somewhat less than half an inch it is readily seen that an electron is an infinitesimal affair.

The figures as to velocity of electrons vary somewhat with different authorities, but it is probably about 100 kilometers (approximately 62½ miles) per second at a temperature of zero degrees centigrade, the speed increasing as the temperature rises. Electrons may be understood as comprising minute solar systems of their own. In the illustration the *electron* or negative particle is shown revolving around the *proton* (q.v.) or positive nucleus in the manner of a planet revolving around the sun. This represents a normal atom of hydrogen, the simplest of all atoms, which, as shown, is composed of a single positive nucleus and a single electron revolving around it. In the case of an atom of helium there is a doubly charged positive nucleus, or proton, and two negative electrons revolving around it. Other atoms have as many as 92 electrons.

All vacuum tubes used in radio operate on the basis of the emission of electrons from a heated filament within the tube. These electrons are being emitted from the hot filament at all times during operation of the tube. When the incoming signals are such as to charge the grid negatively they are repelled and held back to the filament, thus offering no path for the signals. When the incoming signals have reversed their polarity, as they do thousands of times each second, the grid will be positively charged and the electrons will be aided in their travel to the plate, thus forming a conductive path for the currents. This, of course, results in the elimination of one-half of each cycle of the incoming currents or oscillations. That is to say, they are rectified to direct pulsating currents. (See *Amplifier, Vacuum Tube, Theory of Operation* and *Space Charge.*)

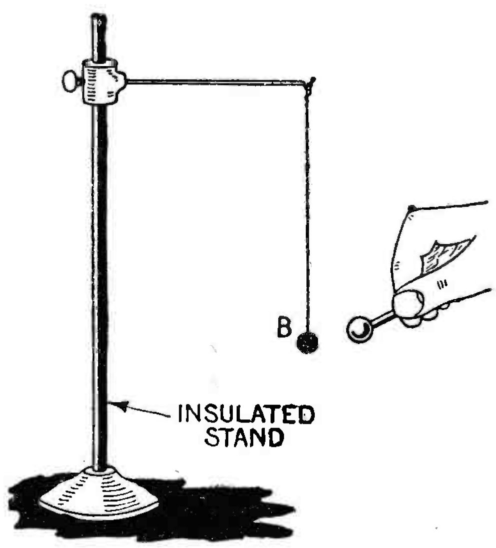
ELECTRON RELAY—A term occasionally applied to a three element tube (vacuum tube). This alternate term is obviously derived from the fact that the vacuum tube makes use of the path of electrons and in effect acts as a relay. (See *Electron.*)

ELECTRON TUBE—Any tube using a high vacuum and depending for operation on the emission of electrons from a heated *cathode*. (See *Electron*, also *Vacuum Tube.*)

ELECTRONEGATIVE—Having the property of being attracted to the positive pole of an electrolytic cell. The electronegative component. (See *Anion*, also *Cathion.*)

ELECTROPOSITIVE—Having the property of being attracted to the negative pole of an electrolytic cell during electrolysis. The electropositive component. (See *Anion*, also *Cathion.*)

ELECTROSCOPE—A device for detecting minute differences of potential (voltages). Such a machine will not measure the voltage but merely indicate its presence. The simplest form of electroscope is shown in the illustration. Here a ball B, composed of the pith of some wood, preferably elder due to its extreme lightness, is suspended by a thin silk thread from an insulated stand. The object under investigation is moved near the pith ball, which will be repelled or attracted by the object if the object is in a state of electrification; but will remain motionless if no difference of potential exists. (See *Voltmeter, Potential, Difference of.*)



Simplest form of electroscope.

ELECTROSE—An insulating composition much used in electrical power work and for radio purposes. It has very high compressive strength, is hard and tough without being brittle, and is moisture, water and oil proof. Electrose is used extensively for antenna insulation. (See *Insulator*).

ELECTROSTATIC—The term used to designate EMF's (electromotive forces) or potentials, charges, etc., and the resultant forces. That is to say, electricity at rest or stationary in a body in order to distinguish it from the forces due to *electro-dynamics* (q.v.).

ELECTROSTATIC CAPACITY—The amount of electricity which a condenser or similar body is capable of storing. If a condenser is capable of receiving and storing one *coulomb* of electricity under a potential of one *volt* it is said to have an electrostatic capacity of one *farad*, which is the unit of electrostatic capacity. The electrostatic capacity of a condenser depends on several factors, mainly the size of the plates and the nature and thickness of the dielectric material (insulating sheets). (See *Capacity*, also *Condenser.*)

ELECTROSTATIC CHARGE—The presence of electricity in the form of electrostatic lines of force in a body such as a charged conductor. (See *Charge.*)

ELECTROSTATIC COUPLING—The association or coupling of circuits one to another by means of electrostatic action, i.e., condensers. Any capacitive association of one circuit with another. (See *Coupling.*)

ELECTROSTATIC FIELD—A region wherein forces are present and exerted due to the presence of electric charges. It is the area immediately surrounding a charged body. (See *Field, Electromagnetic*, also *Field, Electrostatic*).

ELECTROSTATIC FLUX—Lines of force making up an electrostatic field. (See *Field, Flux*, also *Flux, Electrostatic*).

ELECTROSTATIC FLUX DENSITY—The density or number of electrostatic lines of force in a unit area of an electrostatic field. (See *Electrostatic Field*, also *Flux Density.*)

ELECTROSTATIC FORCE—The force due to interaction of electric charges. (See *Electrostatic Field*, also *Electrostatic Flux Density.*)

ELECTROSTATIC INDUCTION—The production of a charge in a body due to the presence of an opposite charge in a nearby conductor, or synonymous with displacement in the case of a condenser. Electrostatic influence or induction is the basis on which condensers operate. In the illustration *Fig.* 1 is a simple circuit containing a source of potential, which in this case is a battery. As the circuit is closed through the key a momentary flow of current takes place. This flow of current is accompanied by a condition of electric strain in the insulating material of the condenser. The electrically strained dielectric or insulating material exerts a back pressure against the pressure or force of the battery, and when this back pressure is equal to the original battery pressure the flow ceases. The strain in this dielectric is known as *electric displacement* and this displacement can be transmitted or passed on to neighboring parts of the medium and thence into space. Under the proper conditions this displacement and the magnetic field which accompanies it may be detached from the circuit and move independently in space. This is the fundamental process in the radia-

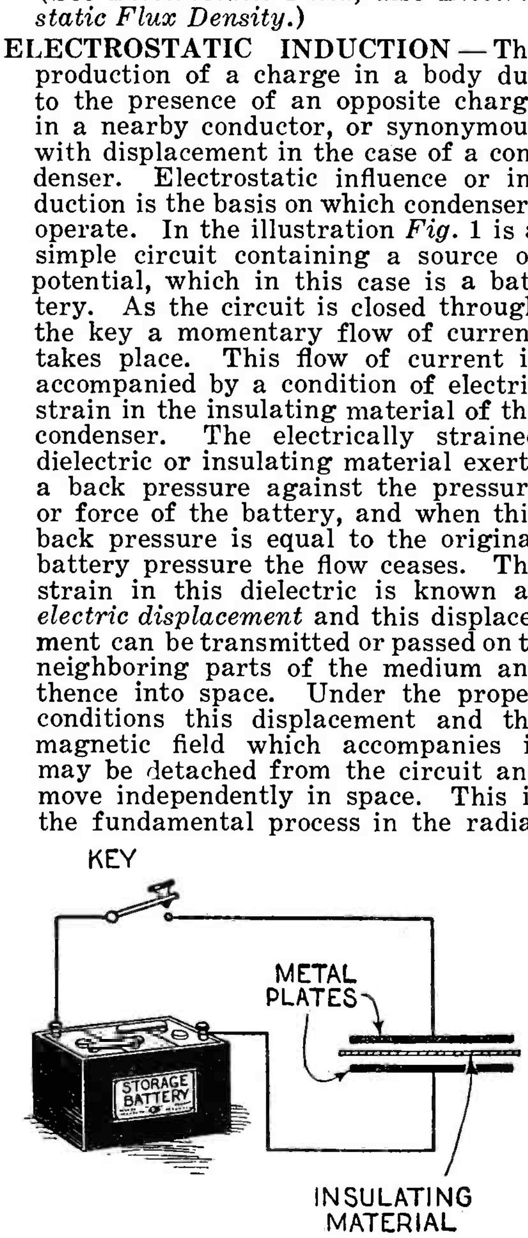


Fig. 1. A simple circuit for illustrating electrostatic induction.

tion of *electromagnetic waves* (q.v.). Now, in *Fig.* 2, A and B represent two conductors, both insulated. If conductor A has a positive charge and is brought close to conductor B, although not in actual contact with it, the result is a displacement of electric charge which results in the near side of conductor B becoming negative, while the opposite side assumes the same sign (positive) as conductor A. Actually B has received no charge, but has been placed in a state of strain due to electrostatic induction between it and the conductor A. Due to the negative charge induced on B, the positive potential difference of A has been decreased and in order to maintain the constant potential it must be given a further supply of electricity. In this manner it is actually possible to store the electricity by electrostatic induction between two conductors or plates,

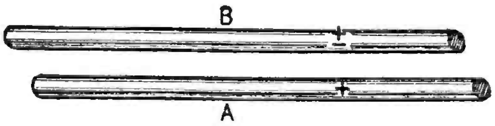


Fig. 2. Illustration of displacement of electric charge due to proximity of charged conductors.

by reason of the strain in the insulating medium—air in the case of the two conductors—which in turn passes the displacement on to conductor B. (See *Conductor*, *Capacity*, *Electrostatic*, also *Induction.*)

ELECTROSTATIC LEAKAGE—The gradual loss through leakage, of the electrostatic charge in a body, due to the fact that perfect insulation is impossible to obtain. (See *Electrostatic Induction.*)

ELECTROSTATIC LINES OF FORCE—The lines of force traversing an electrostatic field. That is to say the *electrostatic flux* (q.v.).

ELECTROSTATIC STRAIN—The strain or state of stress in which a body is placed when in an electrostatic field. In a condenser, the strain experienced by the *dielectric* (q.v.) when the condenser is in a state of charge. (See *Condenser*, also *Capacity*, *Electrostatic*).

ELECTROSTATIC SYSTEM—The electrostatic system of C.G.S. units. One of the absolute unit systems in electrical practice. (See *C.G.S.*, also *Electrostatic Units* and *Electromagnetic Units.*)

ELECTROSTATIC UNITS—A system of measurement used in electrical engineering based on the unit of electric quantity under the *C.G.S. system* (q.v.). This unit quantity of electricity is the quantity of electricity which, placed on a small sphere will repel an equal quantity of electricity of the same sign (both negative or both positive) on a similar sphere with a force of one *dyne* (q.v.) when the centers of the respective spheres are one centimeter apart. With this definition it is assumed that the spheres are in a vacuum, otherwise the distance between centers would vary according to the dielectric or insulating medium. (See *C.G.S.*, *Electromagnetic Units*, also *Conversion Factors.*)

ELECTROSTATIC VOLTMETER — A meter for measuring voltage, depending for its action on the electrostatic action between a fixed and a moving plate connected respectively to the two poles or terminals between which the source of potential is connected. (See *Electrostatic Force*, also *Voltmeter.*)

ELECTROSTATIC WATTMETER — A type of wattmeter depending on the electrostatic action between two sets of fixed and moving plates. (See *Electrostatic Force*, also *Wattmeter.*)

ELECTRO-THERMAL METER — The term sometimes applied to a *hot-wire ammeter* (q.v.) or voltmeter operating on the principle that the heat generated by the passage of an electric current through a constant resistance will be equal to the square of the current. (See *Thermal Ammeter.*)

ELEMENT—A term primarily applied in chemistry to the substances which are not subject to decomposition by electric analysis (see *Electrolysis*). These elements are hydrogen, helium, etc. The term is also used quite generally to denote components such as the electrodes in a primary cell or the plate, grid and filament members of a vacuum tube. (See *Cell*, also *Vacuum Tube.*)

EMANATE—"To flow forth or proceed, as from a source."—Webster. Thus, emanating, issuing from, as the emanation of electrons from a hot filament in a vacuum tube. The throwing off of electrons. (See *Electron Emission.*)

E.M.F. — The abbreviation for electromotive force. The practical unit of E.M.F. is the volt. (See *Electromotive Force*, also *Volt.*)

EMISSION—The act of sending forth. Used chiefly to designate the emission of electrons from the filament of a vacuum tube as used in radio. The flow of these electrons between filament and plate is controlled by the grid. (See *Electron Emission*, also *Vacuum Tube, Theory of Operation.*)

EMISSION CURRENT—In a vacuum tube for transmitting it is the product of the tube current multiplied by the plate voltage and is generally given in watts. Generally speaking, the power for which the tube is designed. (See *Transmitting Tube*, *Power Rating*, also *Vacuum Tubes.*)

EMISSIVITY OF FILAMENT — The ability of a filament to emit electrons when heated by an electric current. (See *Electron*, also *Vacuum Tube.*)

EMPIRE CLOTH OR PAPER—A closely woven cambric coated with two or more films of an oxidized oil, or a tough paper treated with some oxidized oil. Empire products serve as insulating materials for transformers, condensers and various other devices requiring thin insulating sheets. In a transformer for relatively high voltages, insulated paper is used between the layers of windings and in certain types of fixed condensers it is used as a dielectric material. The cloth has a higher breakdown strength; that is, it will stand higher voltages than paper. (See *Breakdown Potential*, also *Dielectric.*)

ENAMELED WIRE — Wire, generally copper, covered with a coating of enamel as an insulating covering and to protect it from moisture and corrosion. (See *Magnet Wire.*)

ENDODYNE—A term occasionally used to describe reception of radio signals by means of locally generated oscillations such as in the case of the *heterodyne* (q.v.), but wherein these oscillations are created by a circuit or system that is part of the receiving circuit and not a separate arrangement. (See *Self Heterodyne.*)

ENERGY—The capacity for doing work in an electrical sense. Energy is something furnished to a body by means of work done on it. Thus, if a ball is thrown, the operation of throwing is the work, and the ball itself in traveling performs work, the means of doing this work being the energy. There are two kinds of energy, *potential*, as in the case of electricity, and *kinetic*, the energy of a body due to motion. Kinetic energy belongs properly in the realms of mechanics and so will be passed over here with only this brief mention.

When we speak of a difference of potential in a primary cell, it means in effect that the body or cell has potential energy. That is to say, the energy is present although not active. If, now, a wire is connected across the two terminals of the cell, the difference of potential will cause electric current to flow from one pole to the other. Actually, in a cell of this type, we have chemical energy stored up. When a circuit is completed, the stored chemical energy is converted into electrical energy or creates the difference of potential, which in turn causes current to flow and electrical *work* is thus done. (See *Potential*, also *Voltage* and *Generator.*)

EPSTEIN HYSTERESIS TESTER — A device for measuring *hysteresis* and *Eddy current loss* in a sample of sheet iron by using an alternating current wattmeter. The device is used for determining the properties of samples of iron, particularly those to be used for transformers. (See *Eddy Currents*, also *Transformer*, *Hysteresis* and *Wattmeter.*)

EQUIVALENT RESISTANCE — The value which a resistance would be required to have in order to permit the same quantity of current to flow with the same applied electromotive force (voltage) as in the case of a piece of apparatus wherein there are other factors besides pure resistance to determine the amount of current. (See *Impedance*, also *Reactance.*)

ERG—The fundamental unit of mechanical work under the *C.G.S. system* (q.v.). This is defined as the work done by a force of one *dyne* (q.v.) when the body producing the force and the body on which the force acts are one centimeter apart. (See *Joule*, also *Practical Units.*)

E.S.U. — Abbreviation sometimes used for *electrostatic units* (q.v.). (See *Electromagnetic Units.*)

ETHER—or AETHER—The term used to denote the supposed or hypothetical medium by means of which electromagnetic and light waves are propagated. (See *Ether Waves.*)

ETHER WAVES—Term sometimes applied to electromagnetic or radio waves on account of the assumption that they travel through the supposed medium ether. The assumption of an all-pervading medium such as ether has been the basis of the major part of the extensive research work carried on with light and electromagnetic waves for many years. Various experiments have shown beyond reasonable doubt that there is some such medium, capable of conducting or rather permitting passage of light waves and radio waves. So accurate has this work been that it has been proven beyond question that light waves travel through the ether with the tremendous velocity of 186,000 miles per second (approximately). It has also been determined that radio waves travel at this same speed through the ether. It has further been proven that radio waves all travel at the same identical velocity, regardless of their length, form and other factors. (See *Electromagnetic Waves*, also *Theory of Propagation of Electromagnetic Waves.*)

EXCITER—A small direct current dynamo used for the purpose of exciting the field magnets of an alternating current generator. Such a device is generally a part of the main machine and mounted on the main shaft, but it may also be a separate unit. The purpose is to furnish current to the field magnets (electromagnets) to create a magnetic flux. (See *Alternator*, also *Generator.*)

EXPLORING COIL—A coil of insulated wire wound on a rotating form as an integral part of a direction finder or *goniometer.* (See *Direction Finder*, also *Goniometer.*)

F

F—The abbreviation for *dielectric field intensity* (see *Field*, also *Dielectric*), also used as the symbol for the unit of *magneto-motive force*, the *gilbert* (q.v.). The small or lower case f is sometimes used to denote the *farad*, the practical unit of *electrostatic capacity* (q.v.) and also as a symbol for *frequency* (q.v.).

FADING—The tendency of radio signals to decrease in volume or amplitude, or to fade. The strength of a signal is seldom the same at different hours of the day or night, generally being stronger during the dark hours of the night. This has been attributed to a variety of causes, the most plausible being that the air is more free of disturbances during the night and thus permits more ready passage of the waves through the ether. The difference between the strength of signals in the daytime and at night is sometimes very pronounced, but the phenomenon of fading is usually noticed only when distant signals are being received. It has been fairly definitely established that fading of signals is due to the reflection of the transmitted waves. (See *Wave Distortion*, also *Reflection and Refraction.*)

FALL OF POTENTIAL—See *Potential Drop.*

FAN AERIAL—An aerial, usually for transmission, constructed in the shape of a fan. (See *Aerial.*)

FAN CONNECTOR—A small triangular or fan-shaped piece of metal arranged with several holes along one edge, with set screws for fastening in each the several wires of the lead-in of a multi-wire aerial. The lower apex is fitted with some sort of connecting device to permit a single wire to be led in to the receiver. (See *Lead-In.*)

Illustration by Courtesy of Radio Specialty Co., Inc.

Fan Connector—The leads from each wire of a multi-wire aerial go to the wide portion and are held by the set screws: the lead to the set goes to the small end.

FARAD — The unit of *electrostatic capacity.* It is the practical unit of capacity and is defined as the capacity of a condenser that is capable of being charged to a potential difference of one volt by a charge of one ampere for one second; i.e., one *coulomb* (q.v.). "Farad" is a contraction of the name of the distinguished English scientist *Michael Faraday* (q.v.). Inasmuch as the farad is too large a unit for practical purposes, the *micro-farad*, or one millionth of a farad, is commonly used. (See *Electrostatic Capacity*, also *Condenser.*)

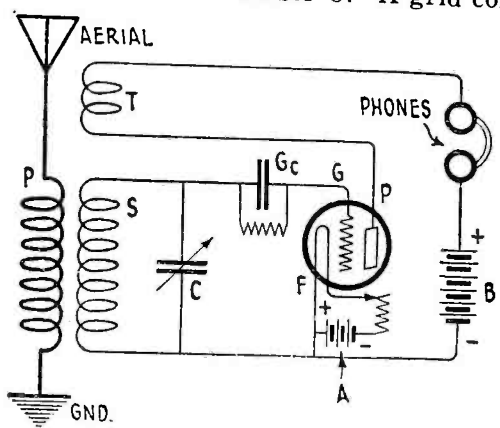
FARADAY, MICHAEL. Born 1791, died 1867. An English scientist famous for his discoveries in chemistry, electricity and magnetism. He first produced the rotation of the magnetic needle around the electric current in 1821, based upon Oersted's discovery of electromagnetism in 1820; he discovered electromagnetic induction (1831), a principle upon which is founded the development of dynamo machinery; specific inductive capacity (1838); magnetic polarization of light (1845); diamagnetism (1846). He was a brilliant experimenter, and contributed greatly to the knowledge upon which is based present-day practice of electricity.

Michael Faraday.

FEEBLY DAMPED—In spark transmission, signals that are only slightly damped. Where each succeeding oscillation in a train of oscillations is of slightly lesser *amplitude* (q.v.) than the one preceding it, the signals are said to be slightly damped to distinguish them from signals that are highly damped and thus die out quickly. (See *Damping*, also *Damped Waves.*)

FEED—In electrical parlance, to furnish with a current of electricity. (See *Feed-Back.*)

FEED-BACK—A term applied in radio to the coupling of one circuit to another, whereby a portion of the current present in one circuit is fed back or returned to the other circuit. The common use of the term is in reference to regeneration, where a certain portion of the radio frequency current present in the plate circuit of a detector is returned to the grid circuit of the tube by some form of coupling between the two circuits. It may also apply to the tendency of high-frequency currents to become transferred from one circuit to another due to undesired coupling between two or more circuits. The illustration shows a simple feed-back or regenerative circuit. The incoming signal energy is transferred from the primary of the coupler to the secondary by means of inductive coupling and tuned by the condenser C. A grid con-



Regenerative circuit in which the coil "T" returns, or "feeds back" to the grid circuit a portion of the radio frequency current in the plate circuit, resulting in increased amplification.

denser and leak GC are placed in the grid circuit in the customary manner. A feed-back or reaction coil T is placed in the plate circuit and inductively coupled to the main coil. A portion of the radio frequency current in the plate circuit or output circuit is transferred back to the grid circuit by the coupling effect between the coil T and the secondary of the coupler. This serves in effect to reduce the resistance of the grid circuit and produces more current in the output or plate circuit, thus acting as a form of amplifier. (See *Regeneration, Tickler.*)

FEED-BACK COIL—An inductance coil placed in the plate circuit of a regenerative receiver and arranged in inductive relation to the grid coil (secondary of tuner) for the purpose of effecting feed-back or regeneration. (See *Feed-Back*, also *Regeneration.*)

FEED-BACK COUPLING—Any process by which the plate circuit of a detector is coupled to the grid circuit to allow a portion of the output current to be transferred back to the grid circuit to produce regeneration. (See *Feed-Back*, also *Regeneration.*)

FEED-BACK EFFECT — The effect of feeding back of currents from one circuit to another as in the case of a *regenerative circuit* (q.v.). Generally the expression "feed-back effect" refers to an undesired feed-back. This may be the action of radio frequency components of the currents present in one part of a circuit being fed back to another part of the circuit due to the coupling effect of various coils or other devices used in the circuit. (See *Feed-Back*, also *Regeneration.*)

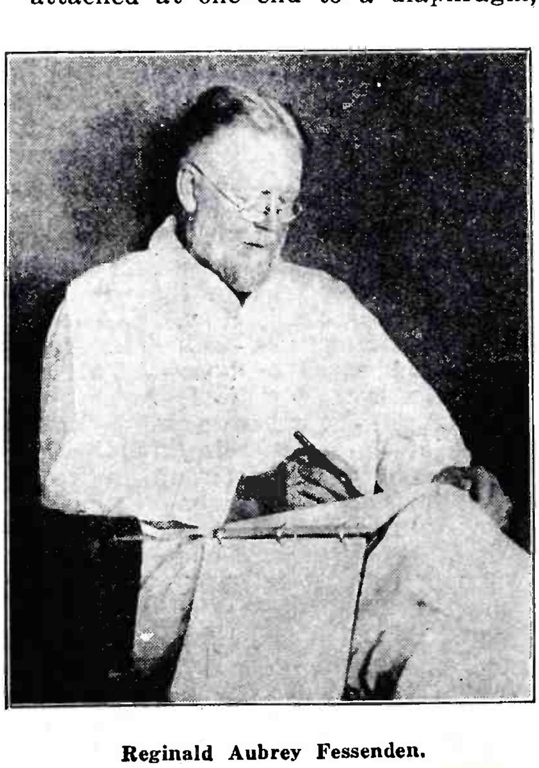
FEED-VOLTAGE MODULATION — A process of modulating or varying the amplitude of a radio frequency alternating current to correspond to any wave form of speech vibrations as in radio broadcasting. The system involves the introduction of additional power into the circuit of the radio frequency generator until the desired wave form variations are obtained. This is done particularly in the case of a vacuum tube transmitter, in which case the voltage supplied to the plate of the tube is altered (increased or decreased) to accomplish the purpose. (See *Modulation.*)

FERRO-MAGNETIC MODULATOR—A device for modulating or varying the amplitude of radio frequency current to correspond in wave form to the speech or music vibrations in broadcasting. The system makes use of what is known as the *hysteretic energy absorption* of iron, or in some cases utilizes the variation of inductance of iron-core coils. (See *Modulation,* also *Ferro-magnetic Substances.*)

FERRO-MAGNETIC SUBSTANCES — Elements or compounds such as iron, nickel, cobalt and others which are strongly attracted by magnetic fields of force. Such substances vary widely in their magnetic properties when subjected to temperature changes. Soft iron loses its magnetization almost immediately on removal of the magnetizing source, and for this reason it is used as a pole piece in an electromagnet. (See *Electromagnet,* also *Magnetism* and *Magnetic Properties.*)

FESSENDEN, REGINALD AUBREY. —Canadian-American Radio expert. Born at Milton, Canada, October 6, 1866, and educated at New York and Port Hope, Ontario. Fessenden became inspecting engineer for the Edison Company, New York, and afterwards professor of physics and electrical engineering at Western University, 1892. Professor Fessenden is the author of a well-known system of wireless, and below are briefly described some of the patents bearing his name.

In 1906 and 1907 Fessenden invented a number of microphone transmitters which carried heavy currents for long periods, and also a heavy current telephone relay which allowed the controlling of heavy currents by means of small currents originating in an ordinary microphone circuit or coming from a telephone line. One of these transmitters was called by Fessenden a trough transmitter. It consisted of a soapstone annulus to which were clamped two plates having platinum-iridium electrodes. Through a hole in the center of one plate passed a rod attached at one end to a diaphragm,



Reginald Aubrey Fessenden.

and at the other to a platinum-iridium spade. The two outside electrodes were water-jacketed. This form of transmitter required no adjusting, all that was necessary being to place about a teaspoonful of carbon granules in the center space. It was able to carry as much as 15 amperes continuously without articulation falling off, and had the advantage that it never packed. By a combination of the trough transmitter and a differential magnetic relay, Fessenden produced a transmitting relay for magnifying very feeble currents. An amplification of fifteen times is possible without any loss of distinctness. Fessenden is also responsible for a duplex system of Radio telephony, and the *heterodyne* method of reception is due to him. Fessenden has written largely on radio subjects, and is one of the leading authorities on both transmission and reception.

FIBER—or FIBRE—A term used for a variety of substances, composed of fine slender thread-like materials, particularly a composition of vulcanized or compressed paper. It is much used in radio as an insulating material for panels and connection blocks. It is not as efficient as insulating medium as bakelite or some forms of rubber composition, but is durable, cheap and comparatively easy to drill. (See *Bakelite.*)

FIELD—The space occupied by electric or magnetic lines of force. (See *Electric Field.*)

FIELD DENSITY—The strength of an electric or magnetic field. It is measured by the number of electric or magnetic lines of force contained in a given cross-sectional area. (See *Density, Flux,* also *Electric Field* and *Field, Magnetic.*)

FIELD, ELECTRIC—The space traversed or occupied by electric lines of force. (See *Electric Field.*)

FIELD, ELECTROMAGNETIC — The total area traversed by electromagnetic lines of force. The region in which electromagnetic lines of force are exerted. (See *Field,* also *Electrostatic Force.*)

FIELD, ELECTROSTATIC—The region in which electrostatic forces are present or exerted. The total area traversed by electrostatic lines of force. (See *Field,* also *Electrostatic Flux.*)

FIELD MAGNET—An *electromagnet,* usually a core of soft iron surrounded by a winding of insulated wire, employed in generating machines to produce a strong magnetic field. As the *armature* of a *generator* revolves the conducting surfaces pass through the *magnetic field* created by the *field magnets.* This field may be merely the ordinary magnetic force due to permanent magnets, but is usually due to the powerful magnetic lines of force resulting from passage of electric current through electromagnets. (See *Alternator,* also *Alternating Current, Theory of Production* and *Electromagnet.*)

FIELD, MAGNETIC—The region through which magnetic flux passes. Usually refers to the space (air) through which the magnetic flux lines pass as distinguished from the activity in the iron path tself. (See *Field,* also *Magnetic Flux.*)

FIELD REGULATOR or RHEOSTAT—Any device for varying the magnetic strength of the field magnets in a dynamo or electric motor, by which variations certain changes may be accomplished in the operation or performance of the machine. A field rheostat is often used in an electric motor to vary the strength of the field and thus either increase or decrease the speed of the machine without the necessity of changing the applied voltage. If the strength of the field (magnetic) is reduced by insertion of resistance, the armature or rotating part speeds up in an attempt to generate the same *counter-electromotive force* (q.v.), which means greater speed. On the other hand, if the resistance is

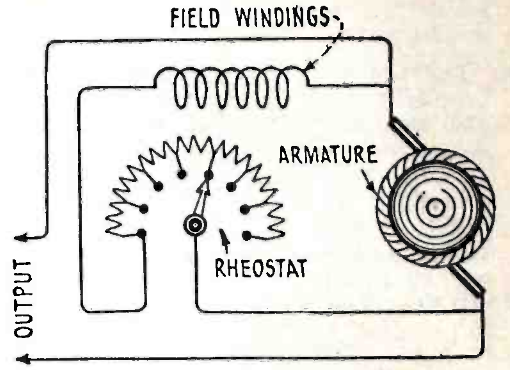
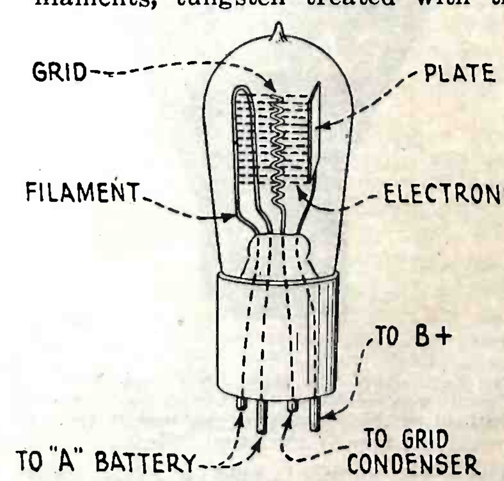


Illustration showing method of connecting a field rheostat or regulator in the circuit of a shunt wound generator.

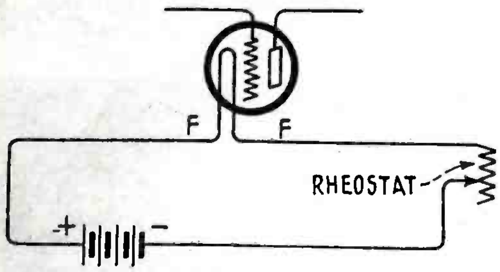
removed—that is, the strength of the field increased—the fact that the armature is running through a stronger field reduces the speed of rotation, the same counter-electromotive force being present. The use of a field regulator or rheostat in connection with a generator is for the purpose of varying the output voltage without the necessity of altering the speed of the machine. The illustration shows the connection of a field rheostat or regulator in the circuit of the *shunt wound generator* (q.v.). (See *Generator, Rheostat, Resistance.*)

FILAMENT—A fine wire, one of the elements of a vacuum tube, which is heated to throw off electrons. The term is also used to refer to the fine wire used in an incandescent lamp. The filament of a vacuum tube is generally made of tungsten and is supported by glass pillars within the tube in such manner as to be insulated from the other elements. Filaments are made to be heated with various voltages from 1.1 to 6 volts in most receiving tubes, but much higher in the case of high power transmitting tubes. The filament may consume considerable current as in the old styles of six-volt tubes which consumed one ampere. The modern tubes have thoriated filaments, tungsten treated with thorium, which permits maximum efficiency with a minimum of current consumption. When the filament is heated in the vacuum tube, by having the proper amount of voltage applied, electrons are thrown off and fill the space between filament and grid and grid and plate as shown in the illustration. (See *Electron Theory,* also *Vacuum Tube, Theory of Operation.*)



When an "A" battery is connected to the filament terminals, heating the filament, electrons are thrown off and fill the space between filament, grid and plate.

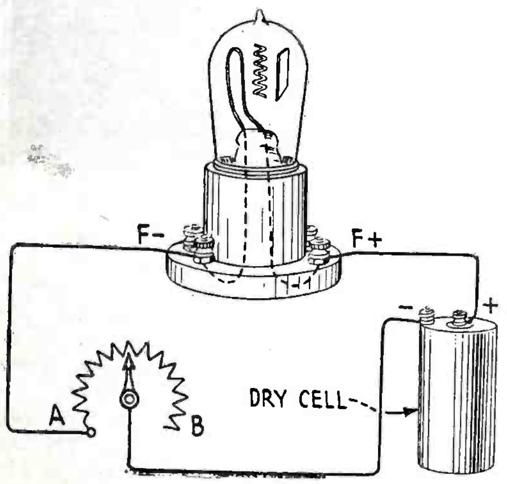
FILAMENT BATTERY—The battery or cell used in lighting the filament of a vacuum tube. These range from a *dry battery* (q.v.) having a voltage of one and a half volts, to storage batteries of six volts. Filament batteries are connected across the filament of a



Method of connecting "A" battery in series with rheostat to regulate filament of vacuum tube.

vacuum tube in the manner shown in the illustration. The rheostat is inserted to permit the supply of current to the filament to be varied and thus change the operation of the tube. (See *Filament*, also *Vacuum Tube, Theory of Operation.*)

FILAMENT CONSUMPTION — The amount of current consumed by the filament of a vacuum tube. The current requirements of vacuum tubes are



The current produced by the dry cell battery, flowing through the rheostat and filament, is consumed by the filament, at a rate depending upon the type of tube.

always stated by the manufacturer, either in amperes or fractional amperes, or in the case of extremely low consumption, in thousandths of an ampere (milliamperes). Some typical examples are the UV201A and C201A types, which require one-quarter ampere at five volts; the WD11 and 12 and C11 and 12 types, which require one-quarter ampere at approximately 1.1 volts, and the UV200 and C200 tubes, which require one ampere at six volts. Of the so-called standard types, the UV199 and C199 tubes consume the least current, requiring but sixty milliamperes or .06 ampere, with from three to four and a half volts. The statement that a certain tube consumes one-quarter ampere indicates that in operation one-quarter ampere is consumed each hour, this current being supplied by dry cells or storage batteries known as the *"A" battery* (q.v.).

It will be apparent from the above that the more current consumed by the filament the greater will be the drain on the dry cells or storage battery. For this reason, and also to lengthen the life of the filaments, it is well to operate the tubes at the lowest efficient brilliancy. The brilliancy of the filament may be controlled by adjustment of the filament rheostat. In the illustration the usual "A" battery, which in this case is a dry cell, is shown connected to the filament of a vacuum tube with a rheostat in series between one filament connection and the negative terminal of the dry cell. Now as the arm of the rheostat is moved from A toward B resistance is introduced into the circuit between the filament and dry cell. As this resistance increases the current in the circuit of the filament will decrease according to *Ohm's Law* (q.v.); i.e., Current = Voltage ÷ Resistance, the current in amperes or fractional amperes and the resistance in ohms. (See *Ampere, Current, Filament Resistance or Rheostat* and *Vacuum Tube.*)

FILAMENT CURRENT — The current used to light the filament of a vacuum tube. Different tubes require different amounts of current; that is, one tube may consume a small fraction of an ampere and another may require a full ampere. Of the tubes most commonly used, the UV199 type uses the least current, this tube requiring only .06 of an ampere each hour. The WD11 and 12 types require one-quarter ampere per hour and also the UV201A, while the now obsolete UV200 and UV201 required a full ampere. The 199 type operates with filament voltage of 3 volts, although it is often used with three dry cells in series which deliver 4½ volts; the WD11 and 12 require 1.1 volts each, which is usually furnished by a dry cell, while the UV201A type is operated with a six-volt storage battery. (See *Vacuum Tubes, Types of*, also *Vacuum Tube, Theory of Operation.*)

FILAMENT, FORMULA FOR ELECTRON FLOW—The extent of electron emission—that is, the number of electrons—emitted from a hot filament in a vacuum tube is subject to certain definite laws. In ordinary practice the actual number of electrons are not referred to, the ability of the filament to emit electrons being measured in fractional amperes of output current. Thus a tungsten filament having a diameter of .0125 centimeters operating with a power dissipation of 3.1 watts per centimeter of length has been found to emit a current of .03 amperes. This result was obtained with a filament having a clean surface and with no absorbed gas on its surface. The formula for electron flow most commonly used is as follows:

$$I_B = AT^{1/2} \epsilon^{-\frac{b}{T}}$$

I_B is the electron current in milliamperes per square centimeter of filament surface, T is the absolute temperature and A and b depend on the metal used for the filament.

FILAMENT RESISTANCE or RHEOSTAT—A device placed in the filament circuit of a vacuum tube, connected between the filament battery and either filament lead on the tube socket for the purpose of reducing or controlling the filament voltage. The illustration Fig. 1 shows one type of

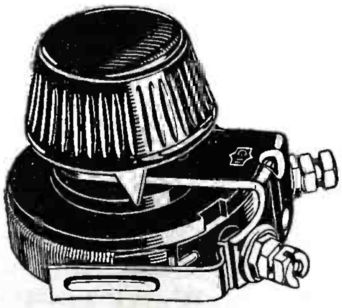


Illustration by Courtesy of The Cutler-Hammer Mfg. Co.
Fig. 1. A type of rheostat used to control the flow of current to the filament of a vacuum tube.

filament rheostat which is used to permit variation of the filament current. Fig. 2 shows the manner of connecting such resistance in the filament circuit of a vacuum tube. Fig. 3 illustrates a type of filament control known as an automatic rheostat. In this form of filament resistance a fine wire is placed in a glass tube filled with an inert gas. The wire has the property of increasing its resistance rapidly with any increase in

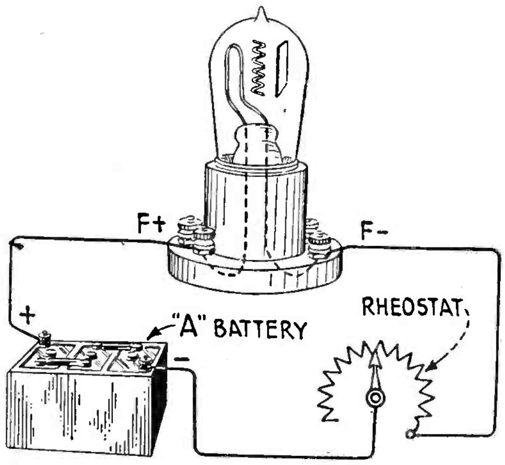


Fig. 2. Showing method of connecting a rheostat in "A" battery circuit of a vacuum tube.

the current passing through it. It is thus possible to arrange such a device to pass only a fixed amount of current for any type of vacuum tube. The device is thus not only an automatic rheostat, but also a safety valve which

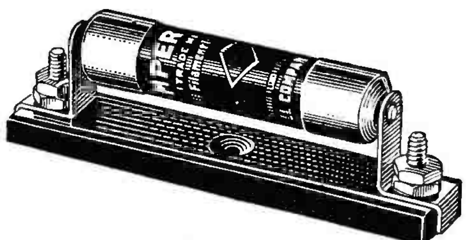


Illustration by Courtesy of the Radiall Co.
Fig. 3. A type of automatic rheostat.

prevents excessive current reaching the filament and injuring it. These controls are coming into widespread use due to these features and the fact that they reduce the number of controls necessary to operate a receiver. Fig. 4 shows a resistance which is used in series with a rheostat having small resistance in order to enable its use

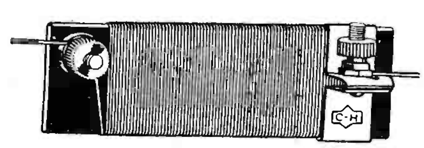
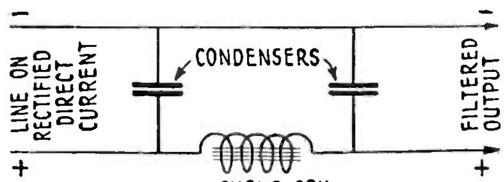


Illustration by Courtesy of The Cutler-Hammer Mfg. Co.
Fig. 4. Resistance used in series with a rheostat having a small resistance in order to enable its use with tubes requiring less current.

with tubes requiring less current to operate. (See *Filament*, also *Vacuum Tube.*)

FILAMENT, THORIATED—A filament or heating element of a vacuum tube in which a certain amount of *thorium* (q.v.) has been incorporated. The introduction of this rare metal into the filament in small quantities gives it the property of emitting electrons at a relatively low temperature. From a practical standpoint this permits a vacuum tube to be operated with a low *filament consumption* (q.v.). A common example of the use of thorium in filaments is that of the UV201A or C201A vacuum tubes, which operate with a filament voltage of 5 volts and consume but one-quarter ampere of current, giving essentially the same results as the former type UV201 and C201 tubes which consumed one ampere. The value of thorium used in this manner is readily appreciated, the current consumption being materially lessened and the life of the tube conceivably lengthened. (See *Thorium Treatment of Filaments*, also *Vacuum Tubes, Type UV201A and C201A.*)

FILTER—In radio, a device arranged to permit passage through an electrical circuit of currents of certain frequency or *frequencies* (q.v.) while excluding others of different frequencies, or any device for producing smooth direct current from a generating source such as a *direct curent dynamo*, or for smoothing out *rectified direct current.* Filters of one sort or another are much used where rectified direct curent or direct current from a generator is to be used for operation of tubes in radio trans-



Conventional method of filtering rectified direct current for use as plate supply of a vacuum tube.

mission or reception. In the case of rectified direct current, that is the current derived from any device for changing alternating to direct current, there is always present a tendency on the part of the current to surge or ripple. In other words, it is not smooth and of constant voltage, or there may be present a generator hum which will seriously interfere with proper operation of a tube. The illustration shows the conventional method of filtering rectified direct current for use as plate supply with vacuum tubes in receiving sets. This system may also be used in connection with the output of a direct current generator or dynamo. A filter circuit may be arranged to pass a band of frequencies (see *Band Pass Filter*) or it may be made to pass either high or low frequency current. (*See Filter, High Pass;* also *Filter, Low Pass.*)

FILTER, BAND PASS—See *Band Pass Filter.*

FILTER CONDENSER—The condenser, either fixed or variable, forming a part of a circuit for filtering. (See *Filter*, also *Acceptor*, *Wave Trap* and *Rejector.*)

FILTER, HIGH PASS—A filter circuit arranged to permit current above a certain frequency to pass freely while blocking out or attenuating all frequencies below it. (See *Filter*, also *Filter, Low Pass.*)

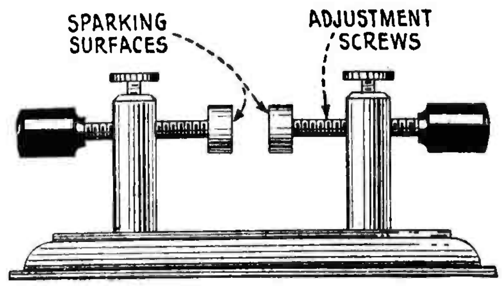
FILTER, LOW PASS—A filter circuit arranged to permit currents below a certain frequency to pass freely while blocking currents of higher frequency. (See *Band of Frequencies*, also *Filter, High Pass.*)

FIXED COILS—Inductance coils as used in radio circuits, having no mechanical means of variation, such as in a *Variocoupler or movable coil.* (q.v.) The majority of tuned radio frequency receivers employ fixed coils, shunted by variable condensers. These are known as *tuned radio frequency transformers.* (q.v.) (See *Coupler, Loose*, also *Coupler, Vario.*)

FIXED CONDENSER — A condenser having a certain definite or fixed value of capacity. Any condenser that is not variable. (See *Condenser*, also *Condenser, Variable.*)

FIXED RESISTANCE—Any resistance device having a fixed or non-variable value. (See *Rheostat*, also *Potentiometer.*)

FIXED DISCHARGER—A fixed *spark gap.* (q.v.) A spark gap used in transmission of radiotelegraphic signals in which the electrodes or sparking surfaces are not moved during operation. (See *Disc Discharger.*)



A type of fixed spark gap.

FLAME MICROPHONE—A type of microphone for radio telephone transmission, wherein the height of a coal gas flame is varied by and according to the speech fluctuations and the resulting pulsations made audible by means of a selenium cell and phones. (See *Microphone*, also *Selenium Cell.*)

FLASH SIGNALLING— See *Code*, also *Morse Light.*

FLAT-TOP AERIAL or ANTENNA—An aerial, generally composed of a number of wires placed adjacent to each other equally spaced on a spreader, or hoop, and suspended parallel with the earth. A flat-top aerial may be of the kind known as the *T type aerial* (q.v.) or in the form of an inverted L. (See *Aerial.*)

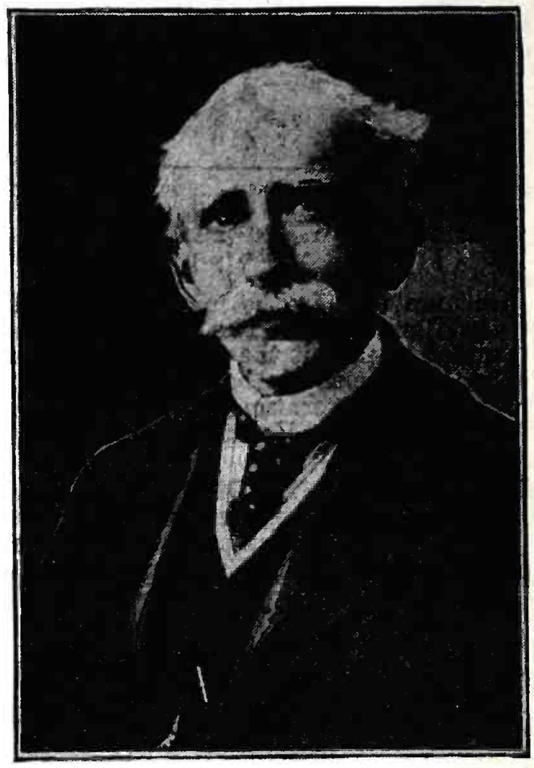
FLAT TUNING—A term sometimes applied where the *resonance curve* (q.v.) has a flat top, that is where the peak of resonance is not sharply defined. The effect is known as *broad tuning.* (q.v.) (See *Resonance*, also *Tuning.*)

FLEMING, JOHN AMBROSE. British radio expert. Born in Lancaster, November 29, 1849, he was educated at University College, London, the Royal School of Mines, and St. John's College, Cambridge.

From 1873-74 Fleming was demonstrator at the Royal College of Chemistry, and in 1877 he began work under Clerk-Maxwell at the Cavendish Laboratory, Cambridge. There he carried out a series of experimental researches on the British Association Standards of Electrical Resistance. In 1881 Dr. Fleming was appointed the first professor of mathematics and physics at University College, Nottingham, but the following year he joined the Edison Electric Light Company, and on the amalgamation of the Edison and Swan Companies, he was appointed advising electrician, a post he held for twenty years. In 1885 Fleming was appointed to the newly founded professorship of electrical engineering at University College, London, and he was entirely responsible for the design and equipment of the new electrical and engineering laboratories which were opened in 1893. In 1892 he was elected Fellow of the Royal Society.

Dr. Fleming has been very closely associated for many years with radio telegraphy and telephony, and has since 1899 acted as the scientific advisor to Marconi's Wireless Telegraph Company. He is well known as the inventor of the thermionic two electrode vacuum tube, or glow-lamp detector, which was one of the greatest steps forward in radio telephony.

Dr. Fleming has written a very large number of papers and books on wireless telegraphy and telephony, and his "Principles of Electric Wave Telegraphy" is the standard treatise on the subject. He has also published an "Elementary Manual of Radio Tele-

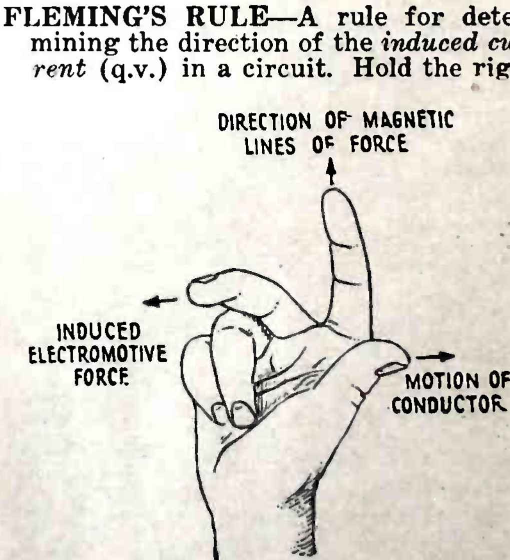


John Ambrose Fleming.

graphy and Radiotelephony"; "The Wonders of Wireless Telegraphy"; "The Thermionic Valve and Its Development"; "A Pocket Book for Wireless Telegraphists," and other books. As a lecturer at the Royal Society of Arts he has obtained a world-wide reputation for his lectures on electric oscillations and electric waves, Hertzian wave telegraphy, high-frequency measurements, etc. He has given many lectures on wireless at the Royal Institution.

Fleming was awarded the Hughes gold medal of the Royal Society in 1910 as an acknowledgement of the value of his work in electrical science and engineering, and he has twice been awarded the Institution Premium of the Institution of Electrical Engineers, the highest award for communicated papers, and he is an Albert Gold Medallist of the Royal Society of Arts awarded to him for the pioneer invention of the thermionic valve.

FLEMING'S RULE—A rule for determining the direction of the *induced current* (q.v.) in a circuit. Hold the right



Method of using the right hand in determining the direction of the induced current.

hand as shown in the illustration with the thumb, forefinger and middle finger as nearly as possible at right angles to each other. If the thumb is then pointing in the direction of motion of the conductor and the forefinger points along the direction of the magnetic lines of force, the middle finger will then point in the direction of the induced electromotive force. (See *Induced Current*, also *Electromotive Force.*)

FLEMING VALVE—The forerunner of the modern vacuum tube. It was invented in 1904 by Professor J. A. Fleming and was for a short time used as a detector in place of the customary crystal or coherer types. The value of the discovery of the Fleming valve lies chiefly in its influence on the course of radio development, as in itself it was not nearly as efficient as a good crystal detector. As a result of the discovery of the Fleming valve, however, many leading scientists bent their efforts toward the discovery of better methods of detecting radio waves, culminating in the three element vacuum tube designed by Dr. Lee De Forest.

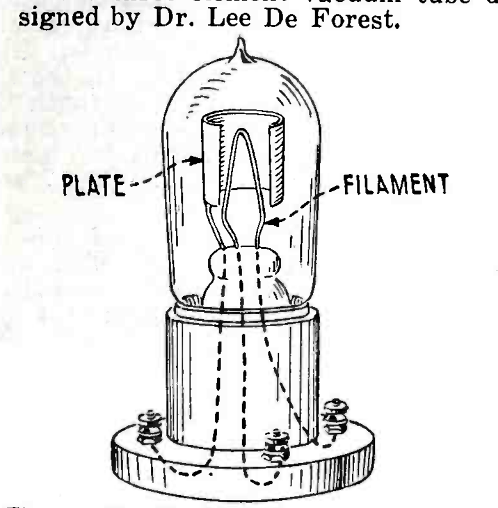


Fig. 1. The Fleming valve, which contained but two elements; i. e., filament and plate. It was the forerunner of the modern vacuum tube.

The Fleming valve consists essentially of an incandescent lamp using a filament of carbon, tungsten or tantalum which can be rendered incandescent by an electric current. The filament is sealed in a glass tube which is highly evacuated, that is from which practically all air has been excluded. Surrounding the filament, but separated from it is a metal cylinder, both ends of the filament and the plate being attached to outside connections by means of leads sealed in the tube. The illustration, Fig. 1, shows the general arrangement of such a tube. The operation of the tube is due to the emission of electrons from the heated filament. It was demonstrated by several investigators that a filament made of certain metals has the property of throwing off minute particles of negative electricity or electrons when heated to a relatively high temperature. It was also found (see *Electron*) that these electrons are thrown off in greater profusion when the filament is placed in high vacuum. It was also found that the escape of negative electrons from the filament would in time leave it positively charged, this charge having an attraction for the negative electrons and preventing their escape from the filament. Hence it was necessary to apply a charge of negative electricity to the filament. The electrons were now found to escape in great number, but had the effect of forming a *space charge* (q.v.) of negative electricity around the filament, which in time served to repel the escape of any more electrons. To counteract this tendency a strong positive charge was applied to the metal plate surrounding the filament. This made the plate positive in respect to the electrons and served to attract them away from the filament. The stream of electrons thus affords a path for current to flow from filament to plate, and the action of the tube as a detector of high frequency waves depends on this principle. If the tube is connected as indicated in the illustration, Fig. 2, it will serve to rectify the incoming signals, that is change them from high frequency alternating currents, to pulsating direct current. The action is as follows: The aerial is connected to the secondary circuit by means of a standard coupler. The coils, marked L2, are the primary and secondary of this coupler; C1 and C2 are variable condensers, F the filament of the Fleming valve, B the battery for lighting the filament of the valve and also to supply voltage to the plate, T a pair of headphones, P a 400 ohm potentiometer and R a standard filament rheostat. The incoming signals in the form of high frequency currents, change direction many times each second. Thus, at one instant the plate will have a positive charge while the next instant it will have a negative charge as a result of the changes in direction of

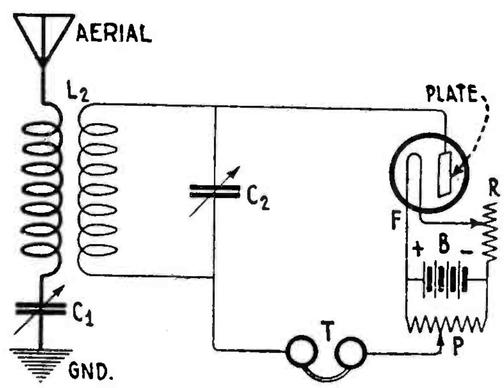
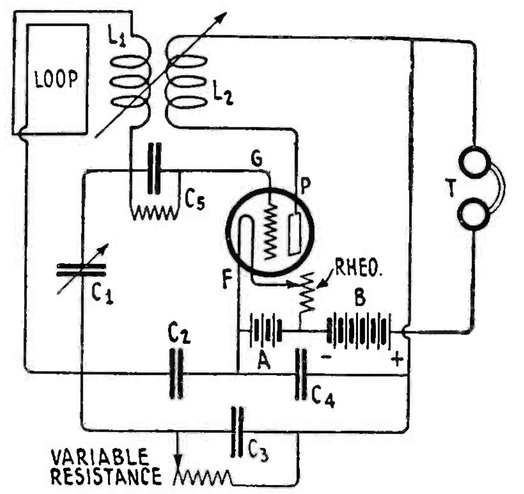


Fig. 2. Method of connecting a Fleming valve in a radio receiving circuit.

the currents impressed across the tube from the antenna circuit. While the plate is positive, electrons will be attracted away from the filament, which at that instant will be negative with respect to the plate. The current thus flows for an instant, stopping when the impressed current changes its direction and makes the plate negative. In this manner we have a flow of current from filament to plate in one direction in the form of surges appearing at every other alternation or change of current. The diaphragms of the phones will respond to these uni-directional surges and will give out sounds almost identical with the original signals transmitted. The tube thus serves as a rectifier of the incoming signals and is known as a detector of high frequency waves, or oscillations. The Fleming valve principle is used in rectifying tubes for changing alternating current to direct current for charging batteries, its use as a detector for radio reception having died out almost entirely. (See *Charger, Storage Battery, Detector, Tungar, Rectigon,* also *Vacuum Tube.*)

FLEWELLING CIRCUIT—A modification of the Armstrong Super-regenerative circuit, designed by the American experimenter, Flewelling. In this system, the tendency toward *self-oscillation* (q.v.) is retarded by the use of fixed condensers which are arranged to have a *damping* (q.v.) effect on the grid of the detector tube, automatically controlling the oscillations of the tube. The circuit controls the self-oscillation of the tube without the necessity for the separate control tube used in the Armstrong circuit. The illustration shows the original Flewelling circuit. It is essentially a standard regenerative circuit with certain necessary modifications.

The coils L1 and L2 give magnetic coupling between the plate circuit and the grid circuit. C1 is a variable condenser for tuning and condensers C2, C3 and C4 are of the fixed type and afford a path of relatively low *impedance* (q.v) for the high frequency currents. C5 is the customary grid blocking condenser across which a grid leak is shunted. The usual telephone receivers T, the plate battery B and the filament battery A are included in the circuit in the customary manner. The coils L1



The Flewelling circuit.

and L2 may be two honey-comb coils having respectively 50 and 75 turns. The tuning condenser C1 should be .0005 mfd. for the broadcast band of wave-lengths and the loop may be almost any form.

In operation three forms of current pass through the plate circuit including the coil L2, namely, the direct current from the plate battery B, the uni-directional surges of rectified current due to the action of the tube as a rectifier and the high frequency currents transferred through the medium of the magnetic coupling of the two coils L1 and L2. The battery current is present only in the plate circuit, the condensers C2, C3 and C4 blocking the direct current from the grid circuit. These condensers also block the rectified currents but afford two paths for the high frequency currents or oscillations. The condensers C2, C3 and C4 have definite values, respectively .005, .005 and .006 micro-farads, to allow a by-pass through the grid to the filament, thus causing accumulation of electrons on the grid and stopping oscillation of the tube. The charge then leaks off by means of the grid leak connected across C5, the tube then building up oscillations again and continuing the process during operation. The high resistance connected across C3 is variable and permits control of the by-pass of high frequency current of the grid. Careful adjustment is necessary to obtain maximum signal strength without distortion. (See *Armstrong Circuits, Regenerative Circuit,* also *Super-Regenerative Circuit.*)

FLEX—Term used in Great Britain and occasionally in this country to refer to a number of small wires twisted or stranded together to form a single flexible conductor. (See *Flexible Wire.*)

FLEXIBLE LEAD—Any conductor, particularly the connections from rotary parts of couplers or condensers, in which the conductor is made up of a number of fine wires in such a way that the necessary bending in operation of the unit will not snap the wire as would be the case with a solid conductor. (*See Pig-tail,* also *Flexible Wire.*)

FLEXIBLE WIRE—Any conductor composed of a number of fine wires to permit constant handling and bending without breaking. (See *Flexible Lead.*)

FLOAT, BATTERY — Term sometimes applied to the bulb or float in a hydrometer for testing the condition of storage batteries. (See *Hydrometer.*)

FLOW OF CURRENT—An expression used to denote the passage of electric current along a conductor. (See *Current, Direction of Flow (Assumed),* also *Current.*)

FLOW OF MAGNETIC FLUX—The passage of lines of magnetic force through any magnetic circuit. (See *Flux,* also *Field, Magnetic.*)

FLUCTUATING CURRENT—An electric current that does not have steady value, rising and falling in strength or pressure. A current that is not constant. (See *Constant Current,* also *Voltage, Constant.*)

FLUORESCENT SCREEN—A screen or surface coated with fluorescent matter, used to exhibit shadows cast by rays from various types of tubes. Its application in radio is chiefly in the *Cathode Ray Tube.* (q.v.)

FLUX—A very broad term in physics. The three more common examples of flux are: (a) to denote *electrostatic or magnetic flux* (q.v.); (b) a substance used in soldering for the purpose of making the solder flow readily and making it adhere to the parts being united, and (c) in metal smelting, a mineral—customarily chalk or limestone—added to the charge in the furnace to absorb mineral impurities and dispose of them in the form of slag. *Flux* is also used to refer to the amount of heat or light flowing or passing through a given distance or area in a given time. (See *Electrostatic Flux, Flux Density,* also *Flux, Magnetic.*)

FLUX DENSITY—The number of lines of force per square centimeter of sectional area of a magnetic path. The unit of magnetic flux in the C.G.S. (Centimeter Gram Second) or electromagnetic system of units is the Maxwell. It is generally referred to as a "line." As a magnetic flux is merely the effect of magneto-motive force, we can take the rule that the magnetomotive force is 1.257 x ampere turns as the rule for determining the intensity or density of magnetic flux. (See *Flux; Field, Magnetic,* also *Ampere Turns* and *Maxwells.*)

FLUX DISTRIBUTION—The distribution of lines of force in a magnetic or electrostatic field of force. (See *Field,* also *Flux.*)

FLUX, ELECTROSTATIC — Another term for electric displacement as in the case of a condenser. The density of electrostatic flux refers to the intensity of an *electrostatic field.* (q.v.) (See *Flux Density, Field, Electrostatic,* also *Electric Displacement.*)

FLUX LEAKAGE—Any loss or dissipation of magnetic or electrostatic flux. (See *Flux, Electrostatic,* also *Flux, Magnetic.*)

FLUX LINES—The lines of force in a field of force in which electrostatic or electromagnetic force is exerted. An alternate term for *lines of force.* (q.v.)

FLUX, MAGNETIC—The term broadly used to denote the grouping of magnetic lines of force in a *magnetic field.* (q.v.). The most common example of magnetic flux is in the case of an ordinary bar magnet as shown in the illustration Fig. 1.

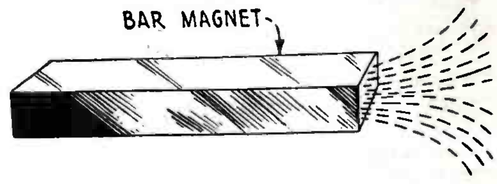


Fig. 1. Bar magnet, showing how the lines of force, or magnetic flux, create a magnetic field as indicated by dotted lines.

Here the lines of force or magnetic flux create a magnetic field indicated by the dotted lines. The number of lines of force in a field of unit area is used as a basis for determining the density of the flux. (See *Flux Density.*) This effect or magnetic flux field is also present when a current of electricity is allowed to circulate around a coil of wire, the larger the current and the greater the number of turns, the more powerful the flux created. The illustration Fig. 2 shows a coil of wire through which current is assumed to be passing, the dotted lines indicating the flux field. (See *Choke Coil, Transformer, Magnet,* also *Flux, Electrostatic* and *Magneto-motive Force.*)

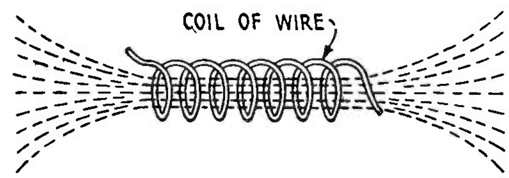


Fig. 2. Coil of wire through which current is assumed to be passing, the dotted lines indicating the flux field.

FLUX MAGNETISM — The magnetic flux, or total number of lines of force passing through a magnetic circuit. It is equal to the product of the magnetic density (see *Flux Density*) and the cross sectional area of the magnetic path. It is also referred to as magnetic flow. (See *Magnetic Flow.*)

FLUXMETER—A device for measuring flux density. The Grassot fluxmeter uses an *exploring coil* (q.v.) in conjunction with a special form of moving coil galvanometer. The coil is suspended on a silk fiber and its movements actuate a pointer across a scale. (See *Flux, Magnetic.*)

FLUX, SOLDERING — See *Soldering Flux, Flux.*

FOCUS or FOCI—The point or points at which converging lines meet. The magnetic foci are the points on the earth's surface in the vicinity of the magnetic poles, where the magnetic force of the earth is the greatest. Essentially a mathematical term.

FORCE—An influence exerted upon a body so as to produce a change or a tendency to change its state of rest or motion. This is mechanical force. In electricity we have its electrical analogy—*electromotive force.* This is the force which causes motion of electricity and sustains the electric currents against the resistance of a circuit. (See *Electromotive Force.*)

FORCE, MAGNETO-MOTIVE—The force which produces magnetic flux as in the case of a magnet moving through a magnetic circuit. The abbreviation is M. M. F. and its unit is the *gilbert.* (q.v.) (See *Magneto-motive Force.*)

FORCED OSCILLATIONS — Electrical vibrations or high frequency oscillations which are imposed upon an *oscillatory circuit* without being in tune or resonance with the natural period of vibration of the circuit. The opposite of a free oscillation in which case the circuit oscillates freely on its own account at the same frequency as the imposed or incoming oscillations or one of the *harmonics* (q.v.) of this frequency. Free and forced oscillations may be present in the same oscillatory circuit, the forced oscillations being set up during the first stages of induction of free oscillations. (See *Free Oscillations,* also *Oscillatory Circuit.*)

FORM FACTOR—The ratio of the *root-mean-square value* (q.v.) to the algebraic mean ordinate taken over one alternation (half cycle), starting with zero value of current. It is the ratio of the r.m.s. value of an alternating electromotive force, current, etc., to its true mean value. (See *Wave Analysis.*)

FORMULA—A principle or rule expressed in mathematical terms or chemical symbols. Formulae are much used in radio to state a problem as, for example, a formula for calculation of wave-length, which is written: Wave-length=$1884\sqrt{LC}$. This states the problem or rule for the determination of wave-length. Here we have certain values represented by symbols. The capacity is represented by C, the inductance by L, the wave-length in meters being the product of the square root of the product of these two multiplied by the factor 1884. (See *Measurement of Wave-length.*)

FOSTER BRIDGE—A form of *Wheatstone Bridge* (q.v) of the slide wire variety designed to permit comparison of two low value resistances that are nearly equal. It was devised by Professor Carey Foster and is used to determine the difference between two resistances as distinguished from the usual bridge for measuring the resistance of a single unit. (See *Wheatstone Bridge.*)

FOUCAULT CURRENT—Another name for *eddy currents,* the *electro-magnetic currents* due to the circulation of induced current in the mass of a conductor. Foucault first proved that these currents were productive of losses of energy as they cannot be utilized except in certain forms of meters. (See *Damping of Instruments.*) Alternating currents tend to set up eddy currents in metal masses near them. Thus in the case of a transformer, eddy currents are produced in the iron core due to the induced currents circulating through its mass. These currents are wasteful and means are therefore used for reducing them. The core of a transformer may be made of numerous flat pieces called laminations, which serve to prevent the free movement of eddy currents in the core. (See *Eddy Currents,* also *Transformer* and *Core Losses.*)

FOUR ELEMENT or FOUR ELECTRODE TUBE—A vacuum tube having four elements instead of the usual three. The standard tube has three elements, namely, grid, filament and

A four element vacuum tube.

plate. The four element tube has an additional grid element. The illustration shows one form of tube having a double grid arrangement. Such a tube can be used for high and low frequency amplification and as a detector simultaneously or it may be used in conjunction with the Solodyne system, which does not use the customary B battery to supply potential to the plate element. (For more complete explanation of the action of a four element tube in the latter manner see *Solodyne*). (See also *Vacuum Tube.*)

FOURTH CIRCUIT—A method of controlling oscillation of a regenerative detector used in the *Cockaday Circuit.* (q.v.)

FRAME AERIAL—An alternate name for *loop aerial*, a type of aerial consisting of a number of turns of wire wound on an insulated frame and used in place of the regular outdoor aerial with sensitive receiving sets. (See *Loop Aerial.*)

FREE ALTERNATING CURRENT—Term applied to alternating current assumed to be produced by the application of a single impulse of electricity to an *oscillatory circuit.* (q.v.) See *Free Oscillations.*)

FREE ELECTRONS—Name given to the outer electrons of an atom, which become detached under various chemical transformations and are assumed to participate in electrical effects or phenomena. Free electrons are so named to distinguish them from the bound electrons of the proton or positive nucleus of an atom. (See *Electron,* also *Proton.*)

FREE MAGNETISM—The portion of magnetism which does not follow the magnetic path through the metal of a magnetized body, but leaves the surface of the magnet. Sometimes referred to as *surface magnetism.* (See *Magnetism.*)

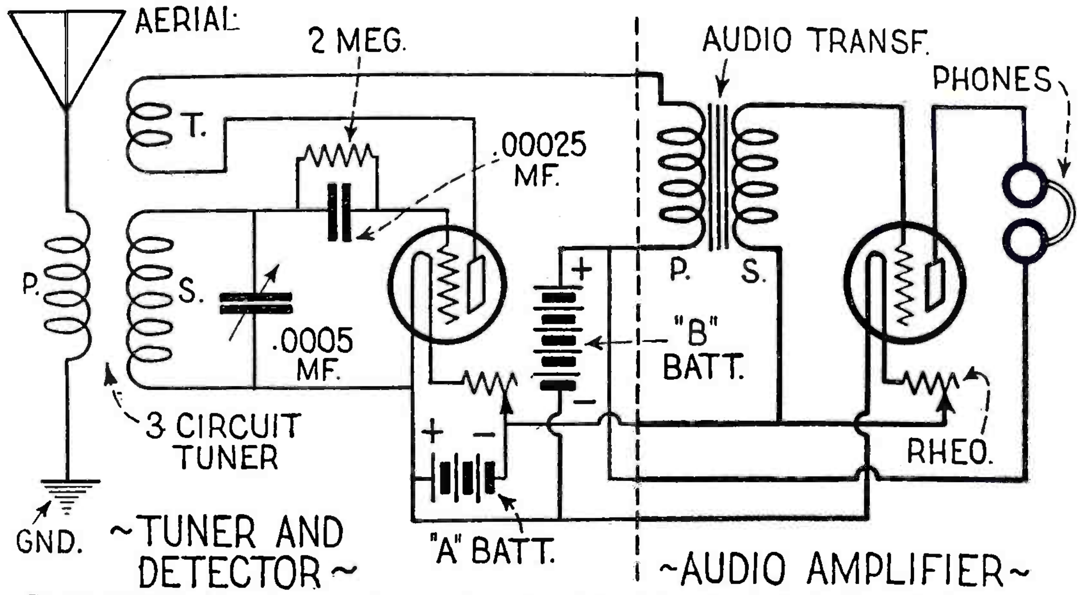
FREE OSCILLATIONS — Oscillations having the natural frequency of the circuit in which they occur. (See *Forced Oscillations.*)

FREQUENCIES—The plural of the term denoting the number of complete cycles per second in an alternating current. In referring to vibrations, particularly audible or so-called *voice frequencies*, the term is used to imply all frequencies that are normally considered audible. (See *Frequency.*)

FREQUENCY—A term adapted from academic English to use in electrical practice. Thus, the number of times a certain action is repeated per unit of time. In the case of an *alternating current* (q.v.) the current reverses its direction of flow at certain definite intervals. If the reversing process takes place 120 times per second—that is 60 reversals from negative to positive and vice versa—the frequency of the current is said to be 60 cycles. In ordinary commercial practice the majority of alternating current generators produce an alternating current or E.M.F. having a frequency from 25 cycles per second to 60 cycles per second. In radio transmission the alternating current or E.M.F. (Electro Motive Force) has an infinitely higher frequency—the reversals taking place many thousands of times each second. (See *Alternating Current, Theory of Production,* also *Alternation, Cycle* and *Periodicity.*)

FREQUENCY, AUDIO—In radio, a frequency within the limits at which audible sounds are produced. It is generally considered as a frequency less than 10,000 cycles per second, although some authorities refer to frequencies up to 16,000 or 20,000 cycles as being within the limits of audibility. For ordinary practice, the human ear is capable of hearing sounds only up to about 2,500 cycles per second. In receiving sets the audio frequency currents appear only in the circuits carrying the rectified currents, although some types of super-heterodyne receiver use an intermediate frequency as low as 30,000 cycles per second, these signals then being rectified and made audible in the telephone receivers. (See *Frequency Circuit, Audio,* also *Frequency, High.*)

FREQUENCY CIRCUIT, AUDIO—Any circuit in a radio receiver or transmitter which carries currents within the arbitrary limits of audibility. In the diagram shown herewith, the heavy lines are the connections of the audio frequency circuit. In this part of the circuit only currents of audio frequencies are present. (See *High Frequency Component of Plate.*)



In the diagram above, the heavy lines to the right of the dotted line indicate the audio-frequency circuit of a radio receiver.

FREQUENCY, ALTERNATOR OF—The frequency of an alternating current dynamo or alternator is expressed in cycles per second. With each complete revolution of the *armature* a complete *cycle* or double *alternation* of current is generated. (See *Alternator.*) It is therefore a simple matter to determine the frequency of alternating current generated when the number of revolutions per second and the number of field poles or magnets is known. The frequency will be $f=\frac{N \times S}{2}$, N being the number of field poles and S the number of revolutions per second. The divisor 2 is used to convert the result in *alternations* per second to cycles per second, one cycle representing two alternations. (See *Alternating Current, Theory of Production of,* also *Frequency.*)

FREQUENCY BAND—A term used to denote all the frequencies lying within a certain minimum and maximum limit. Thus, in broadcasting, the frequency band will be the frequencies corresponding to the wave-lengths within the broadcast band. This will be generally between 550,000 and 1,500,000 cycles, or a wave-length band of approximately 200 to 550 meters. (See *Band of Frequencies.*)

FREQUENCY CARRIER—In radio broadcast transmission, the radio frequency (high frequency) wave with which the audio frequency speech variations are superposed. (See *Broadcasting, General Treatise on Methods,* also *Carrier Wave.*)

FREQUENCY CHANGER—A device for converting currents at a certain frequency into currents of a higher or lower frequency, without change of phase or voltage. A frequency converter. Generally an *alternator* driven by a *synchronous motor.* The term is also applied erroneously to certain forms of super-heterodynes. (See *Ultradyne.*)

FREQUENCY CIRCUIT, RADIO—The circuits in a receiver in which only high or radio frequency currents are supposed to be present. (See *Feed-Back, Audio Frequency,* also illustration in connection with *Frequency Circuit, Audio.*)

FREQUENCY, FUNDAMENTAL—The frequency of the fundamental wave. (See *Fundamental Frequency.*)

FREQUENCY, GROUP—The frequency of the separate trains of waves in radio communication. (See *Group Frequency,* also *Wave Train.*)

FREQUENCY, HIGH—Frequencies over certain definite limits, generally from 10,000 to 20,000 cycles per second in radio usage. Commonly used as synonymous with radio frequency. It is the opposite of low or audio frequency. (See *Frequency,* also *Audio Frequency, Limits of Audibility.*)

FREQUENCY, LOW—Frequencies below certain limits, generally 10,000 or 20,000 cycles per second. (See *Frequency; Limits of Audibility.*)

FREQUENCY METER—A device for indicating the frequency of an alternating current in cycles per second. The most simple form uses a system of tuned, vibrating reeds. The illustration shows a frequency meter of the

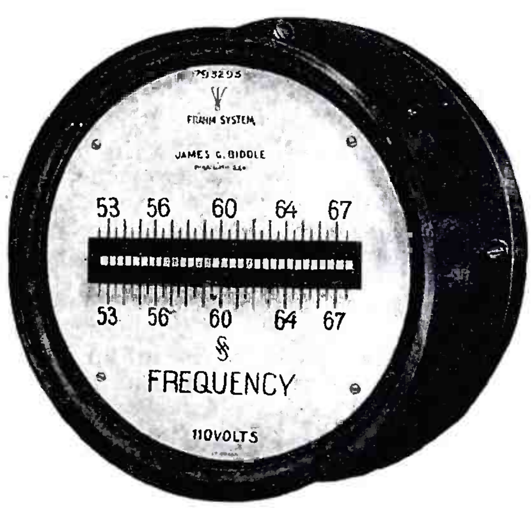


Illustration by Courtesy of Jas. G. Biddle.
A vibrating reed type of frequency meter.

reed type. These reeds may be arranged to respond to various frequencies in a similar manner to the reeds in various musical instruments. These reeds are acted upon by an alternating current magnet. When the magnet is acted upon by an alternating current sent through the windings, the reed nearest to that frequency will vibrate in sympathy with the vibration due to the alternating magnetic effect on the magnet. Such meters and also those of the *induction type* are used for comparatively low frequencies such as occur in commercial lighting systems. For measurement of the high frequencies used in radio communication somewhat different systems are used. (*See Frequency.*)

FREQUENCY, RADIO—An alternating current or electromotive force above certain definite limits, generally above 10,000 or 20,000 cycles per second. The line of demarcation between *audio frequency* and *radio frequency* is not very sharply defined, as, in radio usage frequencies that are actually inaudible to the human ear may yet be referred to as audio frequencies. The term is used to differentiate between the rectified or audio currents and the high frequency oscillations such as are impressed on the antenna in receiving or transmitting. (See *Audio Frequency*, also *Frequency, Low.*)

FREQUENCY, UNIT OF—Frequency of alternating currents is expressed in cycles per second and is generally written f. (See *Frequency*, also *Cycle.*)

FREQUENCY, VARIATION OF POWER FACTOR WITH—When a condenser is charged and *dielectric absorption* (q.v.) takes place, it is always accompanied by a loss of power which is apparent in the form of heat produced in the condenser. This loss of power varies with the frequency of the current impressed on the condenser and it is therefore said that the *power factor* (q.v.) varies with the frequency. (See *Condenser, also Dielectric Absorption.*)

FULL LOAD CURRENT—The current delivered from any electrical source, such as a dynamo or generator operating at its maximum load. The maximum current obtainable from an electric source.

FULL WAVE RECTIFICATION — In rectifying alternating current, the process of rectifying both the positive and negative alternations or half cycles. The majority of rectifiers for charging storage batteries rectify only a half wave, or half cycle, and thus do not utilize the full alternating current cycle. (See *Rectifier, Full Wave*, also *Charger, Storage Battery.*)

FULLER CELL—A type of primary cell formerly much used in telephone, telegraph or any intermittent work. (See *Cell, Open Circuit.*) A zinc electrode cast in the shape of a cone is at the end of a soft copper wire and rests at the bottom of a porous cup immersed in a dilute solution of sulphuric acid. The carbon electrode is in an outer jar in a bichromate solution. (See *Cell.*)

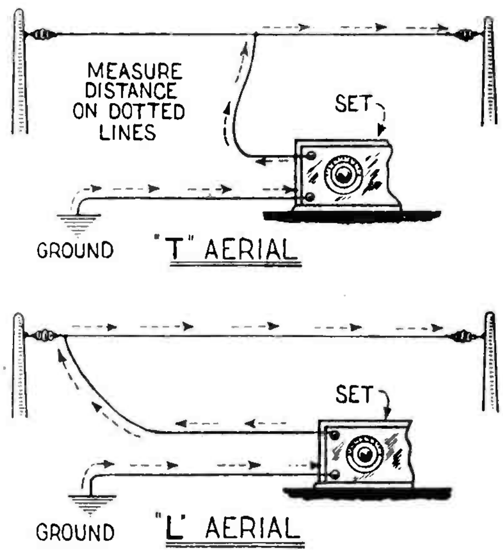
FUNDAMENTAL FREQUENCY — The frequency or number of cycles per second of the fundamental wave. (See *Frequency*, also *Fundamental Wave.*)

FUNDAMENTAL UNITS—Units based on the fundamental quantities of length, mass and time. Under the *C. G. S. system* the unit of length is the centimeter; of mass, the gram; and time, the second. The absolute system of units. (See *Centimeter-Gram-Second.*)

FUNDAMENTAL WAVE—In an alternating current, the component of the wave form that is a pure sine wave of the principal frequency. Upon this principal frequency the various higher frequencies (harmonics) may be superposed. A fundamental wave when combined with other frequencies which are a whole multiple of it produce the harmonious note. These terms are derived from acoustics in which the fundamental is the pure sound wave or pure note. (See *Sine Wave of Alternating Current or EMF.*)

FUNDAMENTAL WAVELENGTH — Term used to denote the wave-length at which the inductance and capacity of a coil or antenna would be in resonance. In referring to antennas the fundamental wave-length is the wave-length corresponding to the frequency at which free oscillations will occur. This is often referred to as the natural wave-length and the corresponding frequency is referred to as the natural frequency of the antenna.

For practical purposes the fundamental wave-length of an aerial (antenna) may be computed from the dimensions. Where no loading inductance is used, a single wire flat top antenna (T or inverted L type) will have a fundamental wave-length approximately four times the distance from the ground connection to the extreme end of flat or horizontal portion as measured in meters. Thus, if the antenna is of the L type with a top one hundred feet long and a lead-in and



Method of measuring the fundamental wave-length of "T" and inverted "L" types of aerials.

ground connection sixty feet long, the fundamental wave-length will be about $4 \times (100+60) \times 1.1$, the result being given in feet. Now as wave-length is always stated in meters it will be necessary to divide this result by 3.28 which is the rough conversion factor from feet to meters. The multiplier 1.1 adds ten per cent to the figures for necessary correction of length. If the antenna is of the T type, the length of the flat portion would be considered as half of the total horizontal length or 50 feet instead of 100 feet. The illustration shows method of measuring length. (See *Wave-length Calculation for Antennae.*)

FUSE—A device used in electrical circuits to prevent the passage of excessive currents. Generally a strip of fusible metal, commonly lead with a small percentage of tin, enclosed in a fiber or insulated and fireproof container and inserted in the circuit. When the temperature, due to excessive current, reaches a certain limit, the fuse "blows" causing a break in the circuit. It is thus possible to limit the

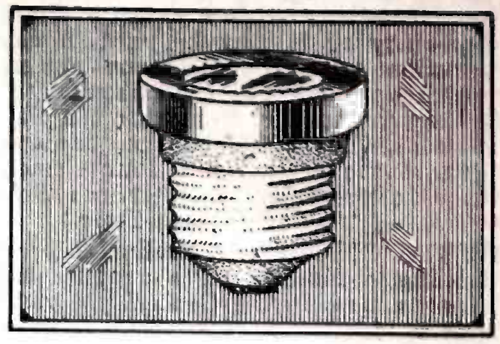


Fig. 1. A common type of fuse used in lighting, heating and power circuits.

current flowing in a circuit to a definite maximum in order to protect instruments from excessive charges. The most common use is in commercial

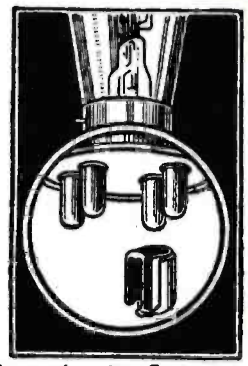


Illustration by Courtesy of Radio Equipment Co.

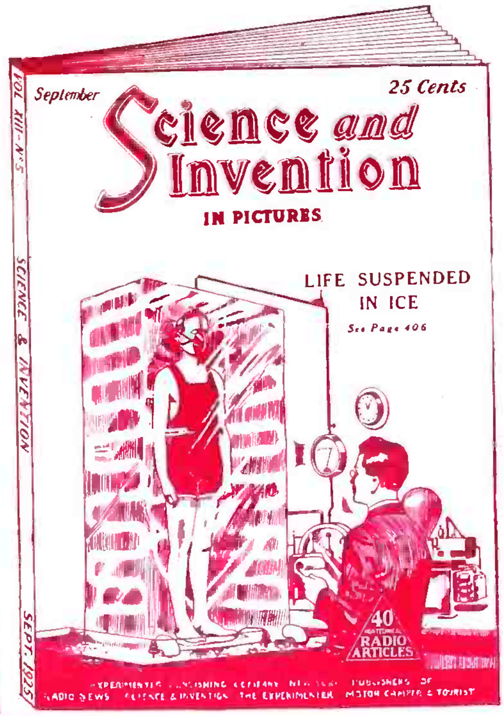
Fig. 2. A fuse used to protect the filament of a vacuum tube from damage by excessive voltage.

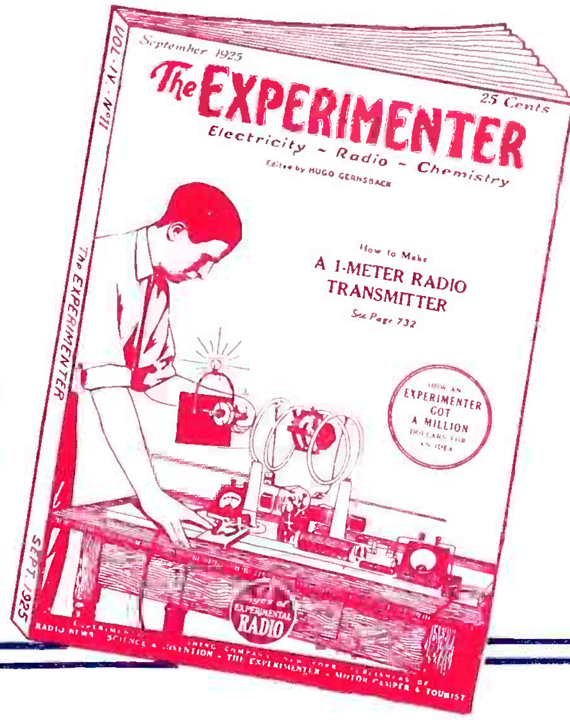
lighting and heating systems where the current on any line is generally limited to ten or twenty amperes for the protection of the lines leading in to the building. In radio, fuses are sometimes used in the filament circuit of vacuum tubes to protect the tubes in the event of a higher voltage being inadvertently applied to the terminals. The illustrations show the standard commercial form (Fig. 1) and the special type used in vacuum tube circuits (Fig. 2). (See *Circuit Breaker.*)

GALENA—A natural crystal sulphide of lead. Chemical symbol PbS. It is an ore of lead, grey in color and showing brilliant metallic lustre when fractured in cubical form. Galena crystals are used either alone or in conjunction with other minerals as *crystal rectifiers* (*detectors*) in radio reception. When used in combination it is generally in conjunction with *graphite* or *zincite*. Used alone, the contact may be a fine wire or *cat whisker*. (q.v.) (See *Crystal Detector.*)

GALVANIC BATTERY—The term, now obsolete, formerly applied to a primary battery or group of primary cells. (See *Cell.*)

GALVANI, LUIGI. Born 1737, died 1798.—An Italian physician and physiologist noted as the discoverer of galvanic or current electricity. While dissecting the legs of a frog, they came by accident into contact with dissimilar metals which caused muscular action in them. Galvani thought that he had discovered electricity in animal matter. Volta attributed the action to the metallic contact and thereupon constructed his voltaic pile, the forerunner of the primary cell.





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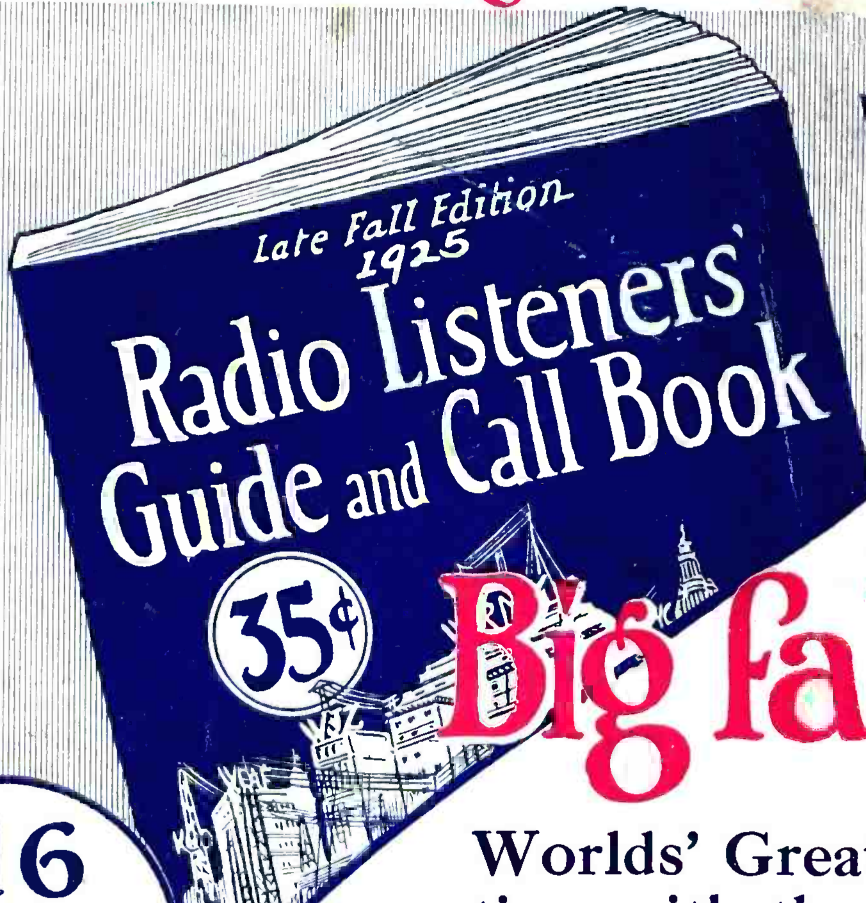

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